GEOLOGICAL SURVEY OF CANADA
G. M. DAWSON, C.M.G., LL.D., F.R.S., DIRECTOR

CONTRIBUTIONS

TO

CANADIAN PALÆONTOLOGY

VOLUME IV

PART I

A REVISION OF THE GENERA AND SPECIES OF CANADIAN PALÆOZOIC CORALS

The Madreporaria Perforata and the Alcyonaria

BY

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OTTAWA
PRINTED BY S. E. DAWSON, PRINTER TO THE QUEEN'S MOST EXCELLENT MAJESTY
1899

No. 672

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Corals, as is well known, form a large proportion of the fossils found in the Palæozoic rocks of Canada. Unfortunately, however, the classification and nomenclature of these corals have long been in a state of some confusion. With a view to remedying this, Mr. Lambe has, at Mr. Whiteaves's suggestion, undertaken a revision of the genera and species.

The present report on the Madreporaria Perforata and the Alcyonaria, with five plates, forms the first part of the fourth volume of "Contributions to Canadian Palæontology". A second part, now in course of preparation and to be illustrated by thirteen plates, is intended to conclude the revision of this class so far as present material permits.

GEORGE M. DAWSON.

GEOLOGICAL SURVEY DEPARTMENT.
OTTAWA, October, 1899.

GEOLOGICAL SURVEY OF CANADA.

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PART I.

A REVISION OF THE GENERA AND SPECIES OF CANADIAN PALÆOZOIC CORALS.

The Madreporaria Perforata, and the Alcyonaria,

BY

LAWRENCE M. LAMBE.

The following pages consist of a revision of the genera and species of Canadian Palæozoic corals, with as complete a description as possible of their structural characteristics. The classification of the corals in the first volume of Nicholson and Lydekker's Manual of Palæontology has been for the most part adhered to and, in most cases, original descriptions of the genera and species, as the writer understands them, have been prepared. As far as the material available will permit, the various genera of the *Madreporaria Perforata* are taken up in order and later those of the *Alcyonaria*. At a future time it is hoped to complete a revision of the *Actinozoa* by a similar treatment of the remaining sections of the *Zoantharia*. It is attempted to show that some forms hitherto considered of little value as regards the determination of the age of the deposits in which they occur, on account of their wide range in geological time, are capable of indicating definite horizons through the possession of distinctive structural peculiarities. The advances made in palæontology of recent years and the new light thrown on some doubtful points of structural detail, through the medium of additional and sometimes better preserved material, have either necessitated the removal of some species to different genera or have strengthened others in the positions already assigned to them.

All the fossils mentioned in the following pages with few exceptions are in the collection of the Geological Survey Department at Ottawa and are the result of many years collecting in all parts of the Dominion by officers of the Survey.

The writer takes this opportunity of expressing his thanks to Mr. Whiteaves for critical suggestions made during the progress of this report, and to Professor H. Alleyne Nicholson for the loan of a number of types of Canadian species of fossil corals described in the two "Reports upon the Palæontology of Ontario" and in his "Palæozoic Tabulate Corals."

ACTINOZOA.

ZOANTHARIA.

1. Madreporaria Perforata.

FAVOSITIDÆ.

Genus Favosites, Lamarck, 1816.

(Hist. des An. sans. Vert., vol. II., p. 204.)

Calamopora, Goldfuss. 1826. Petrefacta Germaniæ, vol. I., p. 77.
Emmonsia, Milne-Edwards and Haime. 1851. Polyp. Foss. des Terr. Palæoz., p. 246.
Astrocerium, Hall. 1851. Palæon. New York, vol. II., p. 120.

Corallum of variable shape, massive or branching, composed of contiguous, prismatic, polygonal corallites, that are placed in communication with each other by circular mural pores; walls thin and bearing on their inner surface spiniform septa or squamulæ; tabulæ numerous, complete, horizontal; basal attachment small; lower surface covered by an epitheca.

In this genus the corallum may be discoidal, hemispherical, spherical, lobate, digitate or clavate, with numerous modifications, and also ramose. The corallites are in close contact with each other, without a complete amalgamation of the walls, and are either polygonal, subpolygonal or circular; they emerge at right angles to the surface and in the ramose forms diverge outward from an imaginary central axis; they are either equal or subequal, or are distinctly of two sizes, in which latter case the larger ones are subangular or circular, and the smaller ones polygonal. Septa are represented by tubercles or spines, arranged in vertical rows or irregularly distributed, or by horizontal, tongue-shaped processes (squamulæ) also occurring in rows. The mural pores are placed in the sides of the corallites, or close to or in the angles; in the former case they occur in one, two or three definite vertical rows or are disposed without order. Longitudinal striations sometimes occur on the inner surface of the walls, one to each space between the rows of pores. Although the walls of the corallites are typically thin, a decided thickening is at times observable. Opercula are present, in some species, closing

the calyces. The tabulæ are frequently crenulated, or have more or less well defined depressions at the margin.

As has been already pointed out by Rominger,* all Cambro-Silurian or Silurian species of this genus have spiniform septa whilst those of the Devonian have squamulæ.

Favosites Gothlandica, Lamarck.

Plate I., fig. 1.

Favosites Gothlandica, Lamarck. 1816. Hist. des An. sans Vert., vol. II., p. 206.
" " Goldfuss. 1829. Petrefacta Germaniæ, pl. XXVI., figs. 3a, 3e.
Favosites favosa, Goldfuss. 1829. Ibid, pl. XXVI, figs. 2a—c.
Favosites Gothlandica, Lonsdale. 1839. Murch. Sil. Sys., p. 682, pl. 15 bis, figs. 3, 3a and 4.
" " Milne-Edwards and Haime. 1851. Polyp. Foss. des Terr. Palæoz., p. 232; and 1855, Brit. Foss. Corals, p. 256, pl. LX., figs. 1, 1a.
" " McCoy. 1855. Brit. Palæoz. Foss., p. 20.
" " Billings. 1863. Geology of Canada, p. 305, fig. 302; and 1866, Cat. Sil. Foss. of Anticosti, p. 32.
" " Nicholson. 1875. Palæon. of Ont., p. 51.
Favosites favosa, Nicholson. 1875. Ibid, p. 52.
Favosites Gothlandica, Nicholson. 1875. Palæon. of Ohio, vol. II., p. 224.
Favosites favosa, Nicholson. 1875. Ibid, p. 229.
Favosites favosus, Rominger. 1876. Geol. Sur. Mich., Foss. Corals, p. 20, pl. IV., figs. 1—4 and pl. V., fig. 2.

Corallum growing in subhemispherical, discoid or irregularly shaped massive expansions generally with a more or less convex upper surface; basal portion covered by a concentrically wrinkled and finely striated epitheca. Corallites prismatic, generally rather equal in the same specimen, varying in different individuals from about 2 or even less to 5 mm. wide. Pores circular, surrounded by a slightly raised rim, in one, two or three rows in the sides of the corallites; averaging from about ·25 to ·33 mm. in diameter. Tabulæ complete, flat, at times concave or convex, and varying considerably, even in the same specimen, in their distances apart from each other; they frequently exhibit concentric lines of growth. Marginal depressions or crenulations are often developed in the tabulæ and in some specimens are very noticeable, extending for some distance toward the centre of the tabulæ; in the same specimen these crenulations may be well marked in some of the tabulæ and altogether wanting or but slightly formed in others. Short, close set, sharply pointed septal spines project inward, with frequently a slight upward inclination, from the walls of the corallites; sometimes they are arranged apparently without order, at other times in more or less definite longitudinal rows.

* Geological Survey of Michigan, Fossil Corals, p. 19. 1876.

F. Gothlandica occurs at numerous localities in the Niagara, Guelph and Lower Helderberg formations, in divisions 2, 3 and 4 of the Anticosti group and in rocks of supposed Hudson River age at Stony Mountain, Manitoba. The specimens in the collection are from the following localities—in the Niagara from Thorold, Ont., E. Billings; Rockwood, Ont., R. Bell, 1861; Owen Sound, Ont., J. Townsend, 1874; Grand Manitoulin and Cockburn Islands, Lake Huron, R. Bell, 1866; Drummond Island, Lake Huron; at the north end of Lake Temiscaming, Que., R. Bell, 1877 and A. E. Barlow, 1883, 1884: in the Guelph from Galt, Ont., R. Bell, 1861: in the Lower Helderberg from l'Anse au Gascon, Baie des Chaleurs, R. Bell, 1862; l'Anse à la Vieille and l'Anse à la Barbe, Baie des Chaleurs: in divisions 2, 3 and 4 of the Anticosti group from various localities, J. Richardson, 1856 and Professor John Macoun, 1883. The specimens from Stony Mountain were collected by T. C. Weston in 1884. Two small specimens were also collected on the east side of Mansfield Island, Hudson Bay by R. Bell in 1884 from rocks that have been doubtfully referred to the Niagara. A number of specimens were obtained by A. P. Low at Limestone Rapids on the Fawn branch of the Severn River in 1886 in rocks which are supposed to be "not older than the Galena and may be as new as the Niagara."*

In 1894 specimens were obtained at Fort Churchill, Hudson Bay, by J. B. Tyrrell, in rocks that have been referred to as of Cambro-Silurian age.

In addition to the above localities *F. Gothlandica* was collected in rocks of Silurian age at Davis Point, Lake Manitoba, by J. B. Tyrrell, 1888, and at the west side of Cedar Lake, at Cross Lake Rapids and at Grand Rapids, Saskatchewan River near its mouth by J. B. Tyrrell, 1890; also at a slightly lower geological horizon, a few miles south of Long Point (station 1030), Lake Winnipeg by D. B. Dowling, 1891.

Favosites aspera, d'Orbigny.

Plate I., fig. 2.

Favosites alveolaris, Lonsdale. 1839. Murch. Sil. Sys., p. 681, pl. 15 bis, figs. 1, 1*a*., 1*b* and 2, 2*a*.

Favosites aspera, d'Orbigny. 1850. Prodr. de Paléont., vol. I., p. 49.

" " Milne-Edwards and Haime. 1851. Polyp. Foss. des Terr. Palæoz., p. 234.

" " Milne-Edwards and Haime. 1855. Brit. Foss. Corals, p. 257, pl. LX., figs. 3, 3*a*.

" " McCoy. 1855. Brit. Palæoz. Foss., p. 20.

* Geological Survey of Canada, Annual Report, 1886, new series, p. 18 of Mr. Low's report.

Favosites prolificus, Billings. 1865. Canadian Naturalist, 2nd series, vol. II., p. 429; and 1866, Cat. Sil. Foss. of Anticosti, p. 6.
Favosites (?) *capax*, Billings. 1866. Cat. Sil. Foss. of Anticosti, p. 6.
Favosites Niagarensis, Rominger (non Hall). 1876. Geol. Sur. Mich., Foss. Corals. p. 22, pl. V., fig. 1.
Favosites aspera, Lebedeff. 1892. Obersilurische fauna des Timan, p. 8. pl. I., figs. 1, *a*, *b*, *c*.
Favosites prolificus, Whiteaves. 1895. Palæoz. Foss., vol. III., pt. II., p. 113.

Corallum massive, attaining to a considerable size, subhemispherical or broadly expanding and agreeing in general external form with *Favosites Gothlandica*, Lamarck; upper surface generally convex, under surface as a rule rather flat, protected by an epitheca. Corallites prismatic, with an average width of nearly 2 mm., generally rather equal in the same specimen. Tabulæ complete, horizontal, often concavely or convexly bent, rather close together, generally from ·5 to 1 mm. apart but frequently more distant and showing a considerable variation even in the same specimen. Small marginal pits or depressions in the tabulæ are sometimes developed in this species, but as a rule they are small and inconspicuous. Pores of moderate size, placed in or close to the angles of the corallites, in some specimens very numerous and about ·75 mm. apart, sometimes encircled by a raised border. Occasionally pores are seen in the sides of the corallites, but this seems to be exceptional. Septal spines sharply pointed, as a rule short but capable, as is evinced by some specimens, of a much greater degree of development and becoming moderately long. In this species the septal spines are not so numerous as in the preceding and occur more generally in longitudinal rows.

The corallites of some specimens are very much below the average width of nearly 2 mm. being less than 1 mm., whilst in other specimens they are very unequal and vary in diameter from about ·5 to 2 mm.

This species occurs in the Hudson River formation in Anticosti and at Stony Mountain, Manitoba, as well as at Stonewall, Manitoba, near the latter place; it is also found in the four divisions of the Anticosti group.

Specimens of a *Favosites* have also been collected at East Selkirk and Lower Fort Garry, Manitoba, that are doubtfully referred to this species; they do not show the pores although otherwise the structure is well preserved. The rocks at these localities have been assigned by Mr. Whiteaves to the Galena-Trenton so that if through the medium of other specimens from these places the pores are found to be situated at the angles of the corallites, the downward extension of the range of *Favosites aspera* will be considerable.

The largest specimen in the museum is from Stony Mountain and was collected by R. W. Ells in 1875; it is 10 inches broad, 2½ inches in

maximum thickness or height and is a portion only of the entire corallum.

Specimens of *Favosites aspera* were collected in the Silurian (Niagara) near the mouth of the Saskatchewan River at Roche Rouge by J. B. Tyrrell in 1890, and a little lower down the river at Grand Rapids by D. B. Dowling in 1891; also in the Cambro-Silurian at a locality (station 1030) a few miles south of Long Point, Lake Winnipeg, by D. B. Dowling in 1891.

Favosites Hisingeri, Milne-Edwards and Haime.

Favosites Hisingeri, Milne-Edwards and Haime. 1851. Polyp. Foss. des Terr. Palæoz., p. 240, pl. XVII., figs. 2, 2*a*, 2*b*.
Astroccrium venustum, Hall. 1852. Palæon. New York, vol. II., p. 120, pl. 34, figs. 1*a*—*j*.
Astrocerium parasiticum, Hall. 1852. Ibid, p. 122, pl. 34, figs. 2*a*—*i*.
Astrocerium pyriforme, Hall. 1852. Ibid, p. 123, pl. 34 A, figs. 1*a*—*e*.
Favosites Hisingeri, Milne-Edwards and Haime, 1855. Brit. Foss. Corals, p. 259, pl. 61, figs. 1, 1*a*, 1*b*.
Calamopora venusta, Rominger. 1862. Am. Jour. Sci. and Arts, 2nd series, vol. XXXIV., p. 394.
Favosites venusta, Nicholson. 1875. Palæon. of Ont., pp. 52 and 65.
Favosites venustus, Rominger. 1876. Geol. Sur. Mich., Foss. Corals, p. 22, pl. V, fig. 3.
Favosites Hisingeri, Whiteaves. 1895. Palæoz. Foss., vol. III., pt. II., p. 51.
Astrocerium venustum, Whitfield. 1882. Geol. of Wisconsin, vol. IV., p. 270, pl. XIII., figs. 8, 9, 10.

Corallum forming massive expansions of irregular shape, attaining a considerable size but seldom more than 2 or 3 inches in thickness; lower surface protected by an epitheca. Corallites prismatic, small, varying in diameter from ·5 to 1·5 mm. across in the same specimen. Septal spines numerous, sharply pointed, long, reaching to or almost to the centre of the corallites, generally curved slightly upward and arranged in longitudinal rows. Pores of moderate size, occurring in one or two rows in the sides of the corallites. Tabulæ flat, horizontal, about from two to four in a space of 1 mm.

This species differs from *F. Gothlandica* in the smallness of its corallites and the much greater length of the septal spines; from *F. aspera*, in which the septal spines are frequently of considerable length, it is easily recognized by the pores being placed in the sides instead of at or near the angles of the corallites and by the smaller size of the corallites in average specimens.

Favosites hispida, Rominger,* is a form which differs from *F. Hisingeri*, as generally understood, only in a slight increase in the diameter of the

* Geological Survey of Michigan, Fossil Corals, p. 22, pl. V., fig. 4. 1876.

corallites which, in the former species, are described as being a little over 1·5 mm. wide. The difference in the size of the corallites in the two species is so slight that the writer is inclined to regard *F. hispida* as not specifically distinct from *F. Hisingeri*, but rather as a form of the latter in which the corallites are a trifle larger than the average.

Occurs in the Niagara and Guelph formations in Ontario; on Cockburn and Drummond Islands, Lake Huron and at Thorold (Niagara); at Elora and near Durham, lot 16, concession 1, Bentinck township, county of Grey (Guelph).

Favosites Niagarensis, Hall.

(Non F. Niagarensis, Rominger.)

Favosites Niagarensis, Hall. 1852. Palæon., New York, vol. II., p. 125, pl. 34A bis, figs. 4*a*—*i*.

A number of specimens of a favosite coral, in the collection of this survey, from rocks of presumably Lower Helderberg age are here referred to this species; they have been collected, by officers of the survey at various dates since 1858, between Cap des Rosiers and Cape Gaspé, at Cap Bon Ami, Gaspé, on the Matapedia and Restigouche rivers, at one mile east of the Little Cascapedia River and at Cap Bon Ami, N.B., near Dalhousie. These specimens are either spherical or clavate, with gradations between these forms, and seem generally to have had a small basal attachment. The corallites are rather unequal in size and vary in diameter from ·5 mm. to slightly over 2 mm. The tabulæ are well preserved, regular and complete, from about five to ten occurring in a space of 5 mm. The sides of the corallites are beset with small spiniform septa and are pierced by one or two rows of pores. In one specimen from Cap Bon Ami, Gaspé, the coral, beginning with a basal diameter of 2 cent., increases in thickness slowly for some distance upward, then expanding more rapidly, reaches a diameter of nearly 6 cent. near the top and is rather regularly rounded above; the total height of the specimen is 22 cent.

The Canadian coral agrees with the one described by Hall, in having corallites that are smaller than those of *F. Gothlandica*, in the position of the pores in the sides of the corallites and in the small basal point of attachment of the corallum. Its general contour is often spherical but frequently becomes higher than broad and sometimes clavate. In the description of *F. Niagarensis* the corallum is stated to be spherical or irregular in form.

In describing *Favosites Helderbergiæ**, Hall states that it "differs from *Favosites Niagarensis*, which it resembles in the size of its cells, in

* Palæon. New York, vol. VI., p. 8, 1887.

having more numerous diaphragms and in the mural pores being on the lateral faces instead of at the angles of the cells." This last distinction disappears when we consider that *F. Niagarensis* is described as having pores "distinctly visible in the sides of the cells," and the figures of this species* would lead to the belief that the distances apart of the tabulæ are very variable. The only difference then between *F. Helderbergiæ* and *F. Niagarensis* appears to be in the shape of the corallum which in the former species is "large, lenticular, depressed convex or hemispherical," and in the latter spherical or clavate, a difference which though slight, may be considered sufficient, if it be constant, for the separation of the two species.

Favosites Gaspensis. (Sp. nov.)

Corallum subdendroid or irregularly lobate with polygonal calyces opening on the entire surface; branches or lobes compressed laterally and varying in their lesser diameter from over 20 to less than 8 mm. The corallites radiate from an imaginary central axis and emerge at right angles to the surface; they are thin walled, polygonal in section and rather unequal in size but average nearly 3 mm. in width with a few that are somewhat larger. Walls of the corallites pierced by one or two rows of circular pores and carrying on their inner surfaces numerous short septal spines. Tabulæ complete, horizontal, about ·5 mm. apart.

This species is of interest on account of the shape of the corallum and of the large size of the corallites; it bears some resemblance, particularly in the size of the corallites, to the branching coral *Favosites cervicornis*† (Can. Jour., new series, vol. IV., p. 110, fig. 9) from the Corniferous of Ontario, but differs therefrom in several particulars especially, as all Silurian corals of this genus do from those of the Devonian system, in having septal spines instead of squamulæ.

One specimen from l'Anse au Gascon, Baie des Chaleurs, Que.; collected by R. Bell in 1862. Lower Helderberg formation.

Favosites basaltica, Goldfuss. (Sp.)

Plate I., figs 3, 3*a*.

Calamopora basaltica (pars), Goldfuss. 1829. Petrefacta Germaniæ, vol. I., p. 78, pl. XXVI., fig. 4*a* (cæt. exclusis).
Favosites Gothlandica, Billings. 1859. Canadian Journal, new series, vol. IV., p. 104, figs. 2, 3, 4.
Favosites basaltica, Billings. 1859. Ibid, p. 106, fig. 8.

* Op. cit., pl. 34 A bis, figs. 4*b*, 4*e*, 4*f*.
† Vide, p. 12.

Calamopora epidermata, Rominger. 1862. Am. Jour. Sci. and Arts, 2nd Series, vol. XXXIV., p. 396.

Favosites Gothlandica, Nicholson. 1874. Palæon. of Ont., p. 45, (with reference only to the coral from the Corniferous limestone and Hamilton formation).

Favosites Forbesi, Nicholson. 1874. Palæon. of Ont., p. 48, pl. VII, fig. 8 and pl. VIII., fig. 4.

Favosites Forbesi, var. *tuberosa*, Nicholson. 1879. Palæoz. Tab. Corals, p. 62, pl. III., figs. 2, 2*a*—*e*.

Favosites epidermatus, Rominger. 1876. Geol. Sur. Mich., Foss. Corals, p. 28, pl. VIII., figs. 1, 2, 3.

Favosites tuberosus, Rominger. 1876. Ibid, p. 30, pl. IX., figs. 1, 2.

Favosites tuberosa, Hall. 1876. Illus. Dev. Foss., pl. VIII., figs. 1—7, pl. VI., fig. 6 and pl. XI., fig. 1; ibid, var. pl. I., fig. 1, pl. IV., fig. 1, and pl. VII., fig. 1.

Favosites epidermata, Hall. 1876. Illus. Dev. Foss., pl. VI., figs. 1—5 and pl. XII., figs. 6, 9—13; ibid, var. *corticosa*, pl. X., figs. 1—6 and pl. XI., figs. 11, 12.

Favosites tuberosa, Whiteaves. 1889. Contr. to Can. Palæon., vol. I., pt. II., p. 121.

Corallum forming irregularly shaped, more or less spreading masses, often with flat or sublobate minor expansions proceeding from the upper surface, or the general form may be hemispherical, subspherical, pyriform, lobate, clavate or even subramose; basal attachment small. Under surfaces and often the sides protected by a strong wrinkled epitheca; the wrinkles are generally rather irregularly disposed and overlap or run into each other, but in some specimens they are more nearly parallel and give to the epitheca a ribbed appearance. The basal portion of the corallum is frequently strongly plicated. The ends of the corallites, when directed upward or outward, except at the top of the corallum, are generally closed by opercula which show a certain amount of concentric structure. The corallites are generally prismatic and rather equal in size when the surface of the corallum is moderately flat but round and unequal in size in specimens or parts of specimens where the surface is rounded; varying in diameter in the same colony or in different individuals from 2 mm., or even less, to 4 or 5 mm. Tabulæ horizontal, complete, sometimes apparently formed by the union of several squamulæ which are present in large numbers. Pores piercing the sides of the corallites in from one to three longitudinal rows, in some specimens large and placed close together, in others smaller and farther apart, generally surrounded by a raised rim which is frequently not preserved on much weathered surfaces. Inner surface of the corallites marked, with varying distinctness, by longitudinal impressed lines, one to each space, between the rows of pores.

This coral is subject to much variation in outward form, in the size and number of the mural pores and in the size and shape of the corallites themselves, whilst its appearance is much affected by the state of preservation of the epitheca and of the tabulæ and squamulæ, especially the

last, which are frequently not preserved, leaving the walls of the corallites on the inside quite smooth.

The squamulæ occur one above another in longitudinal rows corresponding in a general way with the rows of pores, those of one row frequently interlocking with those of another. When the mural pores are numerous the squamulæ are generally placed one above each pore, but, when fewer in number and farther apart, two or three squamulæ are found occupying the space between any two pores of a longitudinal row. From this it would appear that the squamulæ may be equally numerous when the pores are distant from each other or when they are placed close together. Most frequently the squamulæ have their bases only preserved but under favourable circumstances they are seen to reach the centre of the corallite in the form of thin tongue-shaped processes that are longer than broad and at times inclined slightly upward.

In different coralla the pores vary in diameter from about ·33 to ·50 mm., and in their distance from each other; in some specimens, especially in those in which the pores are large, they are about ·50 mm. from each other, whilst in others they are as much as 2 mm, apart vertically. In most cases the absence of the raised border of the pores is probably due to weathering, as examples occur in which the rim is present in certain portions of the corallum and absent in more exposed parts; in the case of the latter the pores appear larger than they really are.

As in some other species of the genus, small marginal depressions in the tabulæ are not unfrequently developed.

Broadly expanded examples sometimes measure nearly 9 inches across with a height of 3 or 4 inches; clavate specimens occur that are 10 or more inches high and a few inches thick; some of the pyriform specimens are 6 or 7 inches high and 5 or 6 inches in breadth.

The large collection of specimens of this species in the museum of the Geological Survey has enabled the writer to study the many transitional stages between examples with large close set pores, which are undoubtedly the *F. tuberosa* of Rominger, and others that agree in every particular with *F. epidermata*, Rominger.

Abundant in the Corniferous formation of Ontario.

Favosites hemispherica, Milne-Edwards and Haime. (Sp.)

Favosites alveolaris, Hall. 1843. Geol. of New York, p. 157, No. 13, figs. 1, 1*a*.
Emmonsia hemispherica, Milne-Edwards and Haime. 1851. Polyp. Foss. des Terr. Palæoz., p. 247.
" " Milne-Edwards and Haime. 1853. Brit. Foss. Corals, p. 218, pl. XLVIII., figs. 4, 4*a*.
Calamopora hemispherica Rominger. 1862. Am. Jour. Sci. and Arts, 2nd Series, vol. XXXIV., p. 394.
Favosites hemispherica Billings. 1859. Canadian Journal, new series, vol. IV., p. 105, figs. 5, 6, 7.
" " Nicholson. 1874. Palæon. of Ont., p. 49, pl. VIII., fig. 3.
Favosites (Emmonsia) hemispherica, Nicholson. 1879. Palæoz. Tab. Corals, p. 67, fig. 15, pl. III., figs., 3, 3*a*, 3*b*.
Favosites Emmonsii, Rominger. 1876. Geol. Sur. Mich., Foss. Corals, p. 26, pl. VII., figs. 1, 2.
" " Hall. 1876. Illus. Dev. Foss., pl. IX., figs. 1—6; pl. XI, fig. 5; pl. XII., figs. 1—5.
Favosites hemisphærica, Whiteaves. 1889. Contr. to Can. Palæon., vol. I., pt. II, p. 121.

Corallum forming large masses, sometimes nearly 1 foot across and over 4 inches in thickness or height. Corallites prismatic, rather unequal in size, varying from 1 to 2·5 mm. in diameter in the same specimen. Pores with raised margins, in one, two or three rows in the sides of the walls of the corallities, placed close together; about ·2 mm. in diameter and ·50 mm. apart. Tabulæ apparently absent. Squamulæ very numerous, one above each pore, reaching to and often past the centre of the corallites, frequently inosculating, thin at the edge with strong bases, about ·50 mm. apart vertically and often inclined slightly upward or downward; those of one row generally alternating and interlocking with those of another.

Complete tabulæ seem to be wanting, but as in *Favosites basaltica* the union of several squamulæ, on about the same level, may result in the production of an undulating and rather imperfect partition across the corallite.

This species differs from *F. basaltica*, Goldfuss, in the apparent absence of true tabulæ and in the somewhat more numerous squamulæ, although if a comparison be made with some specimens of *F. basaltica* in which the pores and squamulæ are abundant, the difference is seen to be so slight as to make it doubtful whether *F. hemispherica* is really distinct from *F. basaltica;* perhaps it would be better to regard it rather as a variety of *basaltica* than as a distinct species. In 1859, in the Canadian Journal, vol. IV., p. 108, Mr. Billings expressed a doubt as to whether the two species are really separable.

Occurs in the Corniferous limestone of Ontario.

Favosites Canadensis, Billings. (Sp.)

Fistulipora Canadensis, Billings. 1858. Rep. of Progress for 1857, Geol. Survey of Canada, p. 165 ; and 1858, Canadian Naturalist, vol. III., p. 420 ; also 1859, Canadian Journal, new series, vol. IV., p. 98, fig. 1.
Calamopora Canadensis, Rominger. 1862. Am. Jour. Sci. and Arts, 2nd series, vol. XXXIV., p. 397.
Fistulipora Canadensis, Nicholson. 1874. Palæon. of Ont., p. 63.
Favosites Canadensis, Rominger. 1876. Geol. Sur. Mich., Foss. Corals, p. 29, pl. VIII., fig. IV and pl. XV., fig. 3.
" " Whiteaves. 1889. Contra. to Can. Palæon., vol. I., pt. II., p. 121.

Corallum forming large spreading masses with an undulating or irregularly nodular upper surface and a concentrically striated epitheca covering the basal portion ; frequently 3 or 4 inches in thickness and 1 foot in diameter. In the most typical specimens there is a differentiation of the corallites into comparatively large rounded or almost circular tubes, at an average distance of about 4 mm. apart, and smaller prismatic tubes in the intervals. In portions however of the same specimens the difference in the shape and size of the two forms of corallites may be less apparent or may disappear altogether, whilst in some individuals prismatic corallites, having an average diameter of about 1 mm., alone occur ; the circular corallites are from 1 to nearly 2 mm. in diameter. Pores small, about ·17 mm. in diameter, close together, about ·33 mm. apart vertically, in one, two or three rows in the sides of the corallites. Tabulæ horizontal, entire. Squamulæ abundant, of the usual tongue-like shape, passing to the centre and frequently combining to form pseudo-tabulæ.

Found in the Corniferous limestone of Ontario. According to Rominger this coral has at times a "digitato-ramose or reticulated growth with orifices on all sides of the stems."

Favosites cervicornis, Milne-Edwards and Haime.

Favosites cervicornis, Milne-Edwards and Haime. 1851. Polyp. Foss. des Terr. Palæoz., p. 243.
" " Milne-Edwards and Haime. 1855. Brit. Foss. Corals, p. 216, pl. XLVIII., fig. 2.
" " Billings. 1859. Canadian Journal, new series, vol. IV., p. 110, fig. 9.
" " Nicholson. 1874. Palæon. of Ont., p. 52.
? Favosites arbuscula, Hall. 1876. Illus. Dev. Foss., pl. XXXVI., figs. 1—9.
Pachypora cervicornis, Whiteaves (pars). 1891. Contr. to Can. Palæon., vol. I., pt. III., p. 206.

Corallum with rather short, stout, bifurcating, cylindrical branches growing upward from a stout base or rising independently from a common, almost lamellar base ; the branches are often somewhat compressed laterally in their upper portions, sometimes rather globose or thickened, and are

evenly rounded above. A thin epitheca covers the lower part of the corallum and extends for some distance up the branches. Within, the corallites diverge obliquely outward and upward from an imaginary axial line and terminate at right angles or rather obliquely to the surface ; they are moderately thin walled throughout their length and polygonal in section, but in some cases, the walls become quite stout. Calyces unequal in size, generally with smaller ones dispersed between the larger ones ; varying in diameter in the same specimen from 2 mm., or even slightly more, to 1 mm. Pores not very numerous, of moderate size, in one or sometimes two rows in the sides of the corallites. Tabulæ horizontal, complete. Inner surfaces of the walls bearing numerous, horizontal, lamellar squamulæ that project only a short distance into the corallites. In the basal part of the corallum the outlines of the calyces are clearly defined in the epitheca which is also roughened by irregular, raised, horizontal ridges.

Two specimens from Ontario show the low bushy shape of the corallum well ; one is slightly over 7 cent. high, nearly 13 cent. broad with nine main subdivisions which during life were apparently about to bifurcate ; the other is nearly 11 cent. high, 16 cent. broad with about the same number of stems or main branches, each of which subdivides two or three times.

Found in the Corniferous formation of Ontario, and of the Moose River district. The specimens in the collection of the survey from Ontario are from the township of Walpole, Haldimand county and from the township of Wainfleet in the county of Welland. One specimen was collected in 1888 by R. G. McConnell at the "Ramparts" McKenzie River (Devonian).

Favosites clausa, Rominger.

Favosites clausus, Rominger. 1876. Geol. Sur. of Mich., Foss. Corals, p. 36, pl. XIV.
Favosites clausa, Nicholson. 1879. Palæoz. Tab. Corals, p. 75, pl. IV., figs. 1—1*c*.
" " Whiteaves. 1889. Contr. to Can. Palæon., vol. I., pt. II., p. 121.

This species is described by Rominger as consisting of "Clustered, rapidly branching and anastomosing flexuous stems, varying from one-half to one centimeter in thickness. Tubes unequal, the larger ones circular, measuring in different specimens from one-half to one and a half millimeter in diameter ; the smaller tubes filling the interstices between the larger ones are subangular. Orifices at the ends of the branches all open ; on the sides of the stems most of them are found closed by opercula. Opercula flat or convex, some of them decorated with twelve marginal carinæ radiating toward the centre. Diaphragms partly simple and regular, but largely intermingled with irregular partial septa, formed

by the development of lateral squamæ analogous to the vertical rows of leaflets in other species of Favosites. Pores numerous."

This species differs from *F. nitella*, Winchell only in its mode of growth; in *F. clausa* the corallum is dendroid, in *F. nitella* it is generally discoidal, but sometimes digitato-ramose. In the original description* of the latter species it is said to occur in "small masses varying from globoid to elongate or scarcely branching."

Whether *F. clausa* is really distinct from *F. nitella* is a question which can only be solved by the study of a large series of specimens showing the variation in form of the corallum in both species; such a series is not at present available to the writer.

The specimens in the collection of the survey are from the Hamilton formation of Ontario, at Thedford and vicinity, in the township of Bosanquet, and from the Aux Sable River; and from the Corniferous at Cayuga, Ont.

Favosites radiciformis, Rominger.

Favosites radiciformis, Rominger. 1876. Geol. Sur. Mich., Fossil Corals, p. 33, pl. XII., figs. 1, 2.

"Cylindrical and apparently procumbent creeping stems of variable thickness, from the diameter of a finger to that of a man's wrist, and often several feet in length, with anastomosing or straddling branches. Tubes of two sizes—the larger ones circular, from one to one and a half millimeter wide, the smaller ones angular, filling the interstitial spaces between the larger tubes. Walls stout. Diaphragms rarely regular, straight, usually complicated with the rows of lateral squamæ." "Pores large and moderately numerous. The terminal parts of the stems are always formed of comparatively thin-walled, regularly formed tube orifices. On the lateral faces of the stems, the orifices are often considerably narrowed and disfigured by incrassation of the tube walls, while the lateral pore channels retain their usual diameter, and become transformed into long vermicular ducts of nearly equal size with the principal tube channels. Such specimens are very unlike, in external appearance, those with normally formed tube orifices."

With this species are identified a few fragmentary specimens from the Corniferous limestone near Woodstock, Ont., collected by Alexander Murray in 1860, and two fragments from rocks of the same age at Long Portage, Missinaibi River to Moose Factory, R. Bell, 1877. In one of the specimens from Woodstock the openings of the corallites are very

*Winchell. 1886. Rep. Lower Penins. of Michigan, p. 89.

much reduced in size by the excessive thickening of the walls. The specimens apparently belong to the older parts of the corallum and none of them show the terminal ends of the stems. This species appears to be closely allied to *Cladopora*, and might with propriety be placed in that genus.

Favosites turbinata, Billings.

? Calamopora basaltica (pars), Goldfuss. 1829. Petrefacta Germaniæ, vol. I., p. 78, pl XXVI., figs. 4*c*, 4*d*, (cæt. exclusis).

? Calamopora hemispherica, Troost. 1840. Fifth Geol. Rep., Tennessee, p. 72. Description inadequate; no figure.

? Favosites hemispherica, Yandell and Shumard. 1847. Contr. to Geol. of Kentucky, p. 7.

Favosites turbinata, Billings. 1859. Canadian Journal, new series, vol. IV., p. 109; and 1860, ibid, vol V., p. 258, figs. 7, 7*a*.

Calamopora turbinata, Rominger. 1862. Am. Jour. Sci. and Arts, 2nd series, vol. XXXIV., p. 399.

Favosites turbinata, Nicholson. 1874. Palæon. of Ont., p. 49, pl. VIII., figs. 1, 2.

Favosites hemisphericus, Rominger. 1876. Geol. Sur. Mich., Foss. Corals, p. 24, pl. VI., figs. 1, 2, 3, 4 and pl. X., fig. 2.

Favosites hemispherica, Hall. 1876. Illus. Dev. Foss., pl. II., figs. 1—5; ibid, var. a (subturbinate forms), pl. II A, figs. 1—7; ibid, var. pl. II B, fig. 8 and pl. III. fig. 1; ibid, var. *turbinata* pl. II B., figs. 1—7, pl. II C, fig. 5 and pl. IV., fig. 2; ibid, var. *recta*, pl. II C, figs. 1—4; ibid, var. *distorta*, pl. V., figs. 1—5.

Favosites turbinata, Whiteaves. 1889. Contr. to Can. Palæon., vol. I., pl. II, p. 121.

Corallum normally turbinate with the apex of the cone as the initial point, but varying very considerably in shape; up to about 15 cent. in diameter. The corallum is almost invariably strongly curved for a short distance from the pointed base and expands more or less rapidly, at times so rapidly as to make the breadth much greater than the height. Or, the growth of the corallum may continue in an upward direction, without much increase in breadth, producing a club-shaped form which may be straight, curved or abruptly bent or twisted. The corallites curve outward from an imaginary central axis and emerge at or nearly at right angles to the surface; they are distinctly prismatic, of rather uniform size, from about 1 to over 2 mm. in diameter and are faintly striated transversely on the outside. In some specimens scattered tubes of a size noticeably larger than the average sized ones may be observed. The outer ends of the corallites over the whole of the surface of the corallum, except at or near the top, are closed by concentrically striated opercula which frequently exhibit about twelve crenulations or depressions at the edge. The opercular coverings appear to thicken and amalgamate with age and to then have the appearance of a rather thin, smooth epitheca in which the prismatic ends of the corallites can still be traced. The pores are more frequently arranged in a single than a double row in the sides of the corallites but their size and distance apart seem

to be subject to considerable variation. The tabulæ are complete and are on an average, about 1·5 mm. apart, and in some specimens "squamulæ" are seen to be present though never apparently in large numbers.

Abundant in the Corniferous and Hamilton formations of Ontario; found also in the Oriskany sandstone. The largest specimen in the museum is from the Corniferous; it was about 1 foot long when perfect and is over 5 inches in diameter at its broadest part. *Calamopora basaltica* of Goldfuss from the Eifel (pl. XXVI, figs. 4c, 4d, op. cit.) bears a strong resemblance in the size and curve of its corallites and the arrangement and size of the pores to *F. turbinata*, Billings. The specimen figured by Goldfuss is a fragment only, so that it is impossible to tell what the shape of the corallum was when entire, although the marked curve of the corallites might suggest a form similar to the typical one of *F. turbinata.*

In the enlarged drawing the pores are in a single row on two sides of the corallites and there is a partly double row on a third side, also in figure 4c the pores are shown in single and double rows. The tabulæ are apparently complete.

If, at any future time, it is found that *F. turbinata* is the same specifically as the coral represented by Goldfuss in these two figures, the name *turbinata* would still remain in use as the other form of *Calamopora basaltica*, Goldfuss from Lake Erie (fig. 4a), which is in the writer's opinion conspecific with *F. epidermata*, Rominger and was evidently considered the type of the species by its author, as it is mentioned and figured first, should be known as *F. basaltica*, Goldfuss.

It is possible that the *Calamopora hemispherica* of Troost is conspecific with *F. turbinata* but the description is so indefinite as to render it a matter of conjecture whether the two belong to the same species or not. As the "Fifth Geological Report to the Twenty-third General Assembly of Tennessee" may be difficult of access to many it is thought advisable to give Troost's description in extenso; it is as follows:—"Calamopora hemispherica, nobis. The fossil to which I have applied the name of *hemispherica* occurs, so far as I have been able to observe, only in hemispherical masses. It is formed of tubes of such size that nine of them, placed the one next to the other, will occupy half an inch; they radiate from the centre towards the circumference. In the interior of the mass they are internally and externally prismatic, but the upper surface is so much incrusted, that their oral apertures have no regular shape. Some of these tubes (on water worn masses) project here and there, and are then internally as well as externally cylindrical, and not connected together; they may be mistaken for *Syringopora.* The transverse septa are flat, and the connecting pores placed in the middle of the sides."

Yandell and Shumard in the "Contributions to the Geology of Kentucky" refer to Troost's fossil in the following words :—"*Favosites hemispherica.*—This fossil the most characteristic of the shell-beds, to which it is limited, is abundant on the Falls, and is found in masses of a hemispherical figure, which vary from one to ten inches in diameter. It is most commonly calcareous, though sometimes it is siliceous ;" no further information regarding the structure is given.

Rominger states in his "Fossil Corals of Michigan" that "all the original specimens of Fav. hemisph. kept in Mr. Yandell's collections are identical with *Favosites turbinatus* of Billings." As to most palæontologists, however, definite descriptions with figures are often the only means available for the study of already described species, and as Billings has evidently given the first description with figures that places beyond doubt the identity of the fossil referred to, it appears best, to the writer at least, in the interests of science, that the name *turbinata* should be retained for this particular species.

Favosites nitella, Winchell.

Favosites nitella, Winchell. 1866. Rep. Lower Pen. of Michigan, p. 89.
" *nitella*, Rominger. 1876. Geol. Sur. Mich., Foss. Corals, p. 32, pl. XI., fig. 4.
Favosites placenta, Rominger. 1876. Ibid., p. 32, pl. XI., figs. 1, 2, 3.
" " Hall. 1876. Illus. Dev. Foss., pl. XXXIV., figs. 10, 11 and pl. XXXV., figs. 1—12.
" " Whiteaves. 1889. Contr. to Can. Palæon., vol. I., pt. II., p. 121.

Corallum small, discoid or at times digitate with a tendency to become nodose or to branch. When discoid the coral expands laterally from a basal initial point of attachment, and rarely exceed 5 inches in diameter and between $1\frac{1}{2}$ inch and 2 inches in height; the edges are thin, the upper surface flat or undulating, at times nodose, the lower surface generally uneven, covered by a concentrically wrinkled and finely striated epitheca. In gaps in the epitheca of the under surface, at the edges and sometimes on portions of the upper surface the ends of the corallites are closed by opercula. In the digitate forms the corallites incline outward from an imaginary axis and have their outer ends closed by opercula except at the top, or if the coralla or portions of them were prostrate or inclined as they appear to have been at times, opercula are seen on the lower surfaces only.

Corallites unequal in size, prismatic, with rather thick walls and rounded angles, varying in diameter from ·50 to 1 mm. in the same corallum. In some specimens or at times in parts only, almost circular corallites about 1 mm. or slightly less in diameter are developed and are seen at varying intervals apart on the surface, the spaces between being

occupied by corallites of smaller size but of the usual shape. Pores rather large, about ·33 mm. in diameter, from 1 to 1·5 mm. apart vertically and in a single row in the sides of the corallites. Tabulæ horizontal, complete; squamulæ present in small numbers and of the usual shape.

This species approaches most nearly to *Favosites Canadensis*, Billings, of the Corniferous limestone, from which it may be easily recognised principally by the small size and characteristic shape of the corallum, by the smallness of the corallites and by its having rather large pores in single rows as well as by the comparative fewness of the squamulæ.

Abundant in the Hamilton formation of Ontario.

Favosites Alpenensis, Winchell.

Favosites Alpenensis, Winchell. 1866. Rep. Lower Pen. of Michigan, p. 88.
Favosites Hamiltonensis, Rominger. 1876. Geol. Sur. Mich., Foss. Corals, p. 27, pl. VII., figs. 3 and 4.
Favosites Hamiltoniæ, Hall. 1876. Illus. Dev. Foss., pl. XXXIV., figs. 1—9.
Favosites Gothlandica, Whiteaves (cfr. F. Billingsii, Rominger, and F. Hamiltoniæ, Hall). Contr. to Can. Palæon. vol. I., pt. IV., p. 272.

Corallum massive, irregular in shape, attaining sometimes a diameter of about 1 foot with a height or thickness of 4 or 5 inches. Corallites prismatic, unequal in the same specimen, varying from 1 to 2·5 mm. in width. Pores of moderate size, about ·25 mm. in diameter, occurring generally in one row, though sometimes in two rows in the sides of the corallites. A slightly raised margin is seen round many of the pores but this is evidently not a constant character as very frequently the edges of the pores are quite plain or even slightly depressed when weathering would not account for the change. Tabulæ complete, horizontal, at times slightly concave or convex; frequently exhibiting marginal depressions. Squamulæ few in number, rather small, narrow and rather short, extending only a short distance into the corallites. Inner surface of corallites faintly striated longitudinally.

This species is distinguishable from other Devonian *Favosites* principally by the size of the corallites whose sides have most frequently only one row of pores and by the fewness and small size of the squamulæ as well as the large number of well developed tabulæ.

Found in the "Middle Devonian*" of Lakes Winnipegosis and Manitoba.

Western shore of Dawson Bay, Lake Winnipegosis, J. W. Spencer, 1874, one specimen (loose) and at Whiteaves Point, Professor J. Macoun,

1875, one specimen (a portion of a large mass 1 foot in diameter); at a number of localities at the southern end of Dawson Bay, and also at St. 125 on the east side of Lake Winnipegosis, J. B. Tyrrell, 1889; and at Monroe Point, Lake Manitoba, J. B. Tyrrell and J. F. Whiteaves, 1888. These specimens are preserved in the dolomitic limestone of this region.

Mr. E. Billings and Professor Nicholson have expressed the opinion that *Favosites Gothlandica* is common to the Silurian and Devonian formations of Canada. It was on the strength of these determinations that Mr. Whiteaves identified the Manitoba specimens of *F. Alpenensis* with *F. Gothlandica*. Dr. Rominger however, has shown that the Silurian species may be distinguished by their spiniform septa and the Devonian forms by their squamulæ.

Favosites Billingsii, Rominger.

Favosites Billingsii, Rominger. 1876. Geol. Sur. Mich., Foss. Corals, p. 28.
Favosites Gothlandica, Nicholson. 1879. (not *F. Gothlandica*, Lamarck. 1816.) Palæoz. Tab. Corals, p. 46, but quoted on p. 56, from Arkona, Ont., as var. *Billingsii*, Rominger.
Favosites Gothlandica, var. *Billingsii*, Whiteaves. 1889. Contr. to Can. Palæon., vol. I., pt. II., p. 121.

Corallum growing in broadly expanding discs, of varying convexity above, with a small central base of attachment; under surface rather flat with irregular concentric ridges and covered by an epitheca marked by minute concentric lines. Corallites prismatic, unequal, with an average width of about 2·5 mm.; in some specimens a few dispersed corallites occur that are noticeably larger than the others and attain a maximum diameter of about 4 mm. Pores generally in one sometimes in two rows in the sides of the corallites; about ·33 mm. in diameter and surrounded by a raised margin. Tabulæ complete, horizontal, numerous, in distance apart varying from less than 1 mm. to 2 or 3 mm. and frequently exhibiting a varying number of marginal depressions. Squamulæ present in small numbers only. Where the exterior of a corallite is exposed in a fractured surface it is seen to be delicately striated in a transverse direction.

The largest specimen seen by the author is 10 inches in diameter and 3 inches high but Dr. Rominger in his original description of the species records a diameter of 3 feet.

Abundant in the Hamilton formation of Ontario.

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* Contr. to Can. Palæon., vol. I., pt. IV., p. 258.

Favosites digitata, Rominger.

Favosites digitatus, Rominger. 1876. Geol. Sur. Mich., Foss. Corals, p. 38, pl. XV., fig. 4.
Pachypera cervicornis, Whiteaves (pars). 1891. Contr. to Can. Palæon., vol. I., pt. III., p. 206.
" " Whiteaves. 1892. Cont. to Can. Palæon., vol. I., pt. IV., p. 273.

Corallum consisting of cylindrical or slightly flattened, irregularly branching stems varying in diameter from about 7 to 20 mm., or even more, and apparently seldom attaining to any great size. The terminal ends of the branches are sometimes slightly attenuated, at other times they are thickened and end abruptly. Corallites prismatic, not very thin walled. Calyces rather at right angles to the surface, somewhat unequal in size measuring from slightly over 2·5 to 1 mm. in diameter in the same individual; they radiate outward toward the surface in the manner usual in branching forms of this genus. Tabulæ horizontal, complete, apparently not numerous. Squamulæ well developed and abundant on the inner surfaces of the corallites. Pores of moderate size, in some specimens rather distant and irregularly disposed, in others inclined to form single rows.

Favosites digitata occurs in the Hamilton formation of Ontario, in the middle Devonian of Lakes Winnipegosis and Manitoba and the Devonian of the Mackenzie River basin; its nearest ally seems to be *F. cervicornis*, Milne-Edwards and Haime, of the Corniferous formation in Canada, from which it is distinguished by its much less robust and more straggling form of growth, by having fewer pores that apparently do not occur in regular rows, and by further slight differences in structure that are noticeable when specimens of the two species are compared side by side.

Devonian.—Thedford, Ont.; Lake Manitoba, Pentamerus Point, Big Sandy Point and east side of Narrows, J. B. Tyrrell, 1888; Lake Winnipegosis, Dawson Bay, J. B. Tyrrell, 1889; Hay River, forty miles above its mouth, R. G. McConnell, 1887 (one specimen), the "Ramparts" Mackenzie River, R. G. McConnell, 1888 (three fragments), Vermilion Falls, Peace River, R. G. McConnell, 1889 (one specimen).

Genus Alveolites, Lamarck, 1801.

(Syst. des An. sans Vert., p. 375.)

Corallum in the form of hemispherical or discoidal masses or irregularly shaped expansions of varying thickness, composed of more or less flattened, intimately united, thin walled corallites opening most frequently obliquely to the surface and connected by mural pores placed generally in the

lateral angles; tabulæ complete, transverse or somewhat oblique; septa occurring as spines or longitudinal ridges, seldom in the form of squamulæ; attached centrally below and with a basal epitheca.

In the genus *Alveolites* there is no expansion of the corallites at the calyces nor is there any thickening of the walls near the surface. The calyces are typically subtriangular and oblique to the surface, although in some species this obliquity is less apparent, as is also the compression of the corallites. The pores and tabulæ, septal spines or squamulæ are as a general rule not so numerous as in *Favosites* whilst the development of longitudinal ridges forms one of the features which distinguish this genus from *Favosites* and suggests its near relationship to *Cladopora*.

Alveolites Labechei, Milne-Edwards and Haime.

Alveolites Labechei, Milne-Edwards and Haime. 1851. Polpy. Foss. des Terr. Palæoz., p. 257.
" " Milne-Edwards and Haime. 1855. Brit. Foss. Corals, p. 262, pl. LXI., figs. 6, 6*a*, 6*b*.
" " Billings. 1866. Cat. Sil. Foss. of Anticosti, p. 33.

In division 3 of the Anticosti group at South Point, Anticosti, and in division 4 at South-west Point and at the Jumpers, Anticosti, is found in abundance an *Alveolite* which was identified by the late Mr. Billings with this species. An *Alveolite* similar in structure to the Anticosti one is found at Fossil Hill, Manitoulin Island, Lake Huron and at Skunk Island off the south-western end of Manitoulin Island, also a little further west at Point Detour and at Owen Sound, Ont. A small specimen which probably also belongs to this species was found at l'Anse au Gascon, Baie des Chaleurs, in rocks that have been assigned to the Lower Helderberg formation. The specimens from Skunk Island, Manitoulin Island, Point Detour and Owen Sound are from the Niagara formation, and those from Anticosti from the probable equivalent of that formation on the island.

A specimen that is thought to belong to this species was collected on the north-east side of Lake Winnipegosis (Station 227, No. 198) by J. B. Tyrrell, in 1889 (Silurian).

The corallum of the Canadian representatives of this species takes the form of a low spreading mass, attached centrally at the base, with a somewhat convex upper surface, and a flat concentrically wrinkled lower surface with a thin epithecal covering; a specimen from South-west Point, Anticosti, has a breadth of about 8 inches with a thickness of nearly 2 inches at the centre. Other specimens, some of them from Manitoulin Island and vicinity, depart from this form of growth and have a less symmetrical shape; they are frequently much thicker without a cor-

responding increase in breadth. The corallites are compressed and diverge from one or more basal points outward with calyces oblique to the upper surface; they are thin walled throughout their length and vary in breadth from ·5 to 1 mm., with a height of about ·25 mm. Pores of moderate size placed at the angular edges of the corallites. Tabulæ numerous, directly transverse, about ·5 mm. apart. In some of the Lake Huron specimens a longitudinal ridge is present on the lower side of the calyces, and two or three rows of septal spines can be seen projecting from the inner surface of the upper wall of the corallites.

Of this species Milne-Edwards and Haime remark that it very closely resembles *A. suborbicularis*, Lamarck, of the Devonian formation, a species that has not as yet been recognized in Canada.

Alveolites Niagarensis,* Rominger.

Alveolites Niagarensis, Rominger. 1876. Geol. Sur. Mich., Foss. Corals, p. 39, pl. XVI., figs. 1 and 2, but not *A. Niagarensis*, Nicholson, 1875.

"Convex hemispherical masses of concentrically laminated structure, covered by an epithecal crust on the lower concave side, or undose, discoid expansions composed of superimposed layers of prostrate tubes, diverging with a slight spiral twist from a central vertex, several of which are sometimes observed on an expansion. The compressed tubes are always more convex on the upper sides, with a corresponding concavity of the lower sides, which rest on the convexities of the subjacent tubes. The compression is sometimes only moderate, and the outside of the oblique orifices is formed by a projecting arched lip; in other specimens the compression is stronger, the orifices become narrow, lanceolate, or fissure-like, with an appressed subplane lip on the outer side. The orifices of the majority of specimens are surrounded by a cycle of denticules, corresponding to longitudinal rows of spinules along the inner surface of the tube walls. The rows are rarely fully twelve in number, and some of them are always more strongly developed than others. In some specimens no denticulation of the orifices can be observed, and the tube channels are found to be almost smooth; this is not the case in all cases owing to the want of development of the crests or spinules; these seem often to have been obliterated by imperfect preservation in the process of petrification."

* In 1889 Mr. S. A. Miller in his "North American Geology and Palæontology" proposed the name *A. undosus* for this species. As Nicholson had already, in 1875, in the "Palæontology of Ontario" described a dendroid coral from the Niagara limestone at Rockwood, Ont., under the name *Alveolites Niagarensis*, and as this coral is not an *Alveolites* but most probably a *Cladopora*, the specific name of Rominger's coral is here retained.

"Diaphragms somewhat distant and oblique. Pores large, marginal, causing a pouch-like dilation of the tube wall at the spot where situated. Diameter of tubes in the wider transverse direction varies in different specimens, from a half to one millimeter, which difference in size greatly alters their aspect. The degree of compression of the tubes, their more erect or more prostrate position in various specimens also cause numerous variations in their appearance, but no tangible line between one and another of the forms exists." "It occurs in great abundance in the Niagara group of Drummond Island, at Point Detour, and in other localities." (Rominger.)

With this species are identified specimens collected by R. Bell, at the north end of Lake Temiscaming, Que., in 1887, by J. B. Tyrrell, in 1890, at Grand Rapids, Roche Rouge, Cross Lake Rapids and Chemahawin, all on the Saskatchewan River, in the district of Saskatchewan, by D. B. Dowling, at Grand Rapids, in 1881, and by A. E. Barlow, on the Isle of Mann (Burnt Island) Lake Temiscaming, Que., in 1893. At these localities the rocks are of Niagara age. The large prominent pores mentioned by Rominger are well shown, especially in the specimens from Cross Lake Rapids, where the rock is a light yellow dolomitic limestone, and the coral is preserved so that the corallites are free of matrix and show the tabulæ and septal spines; in the examples from Lake Temiscaming the structure is best seen in sections. Another specimen was collected at Limestone Rapids, on the Fawn branch of the Severn River, by A. P. Low, in 1886.*

The corallites in these particular specimens are irregularly polygonal, scarcely any compression is noticeable and they emerge rather at right angles than obliquely to the surface. A near approach to *Favosites* is thus seen to occur in a species which shows a considerable variation in structural details on which depend its generic affinities.

Alveolites Goldfussi, Billings.

Alveolites Goldfussi, Billings. 1860. Canadian Journal, new series, vol. V., p. 255, fig. 5.
" " Nicholson. 1874. Palæon. of Ont., p. 56.
" " Rominger. 1876. Geol. Sur., Mich., p. 42, pl. XVII., fig. 2.
" " Hall. 1876. Illus. Dev. Foss., pl. XIV., figs. 5—9.
" " Whiteaves. 1889. Contr. to Can. Palæon., vol. I., pt. II., p. 121.

Corallum forming discoidal masses with an undose upper surface; attached by the centre of the basal surface, which is approximately horizontal, uneven and covered by a thin, minutely and concentrically striated epitheca; sometimes measuring as much as 9 inches across, with

See foot-note p. 4.

a thickness of 2 or 3 inches. The corallites, as seen in vertical sections radiate upward and outward from the basal nucleus with a spiral twist and emerge obliquely to the surface; they are thin walled throughout their length, subpolygonal in transverse section, about 1·5 mm. wide and ·9 mm. high, generally with a broadly arched convex upper wall, one or two somewhat concave lower walls and two short, straight, side walls, with modifications of these. The obliquity of the corallites to the surface and their compression are subject to much variation, those that are most oblibue showing the greatest amount of compression. The corallites undergo no change at the surface, they end abruptly without expanding and without any thickening of their walls, the calyces being subpolygonal and of the same shape and size as the corallites in the interior of the corallum. Mural pores of moderate size, occurring in the sides of the walls of the corallites, not numerous. Tabulæ complete, placed at irregular intervals. The inside surfaces of the walls of the corallites, as shown by natural exposure through weathering and by means of sections, are studded with numerous small squamulæ arranged in longitudinal rows, those of one row alternating with those of the next, in the manner so usual in certain species of Devonian *Favosites*. On the basal surface of the corallum the thinness of the epitheca permits of the shape of the corallites, which here radiate outward almost horizontally from the centre, being clearly seen.

Of not infrequent occurrence in the Hamilton formation of Ontario, and also found in the Corniferous limestone, as is evinced by a specimen in the collection from Cayuga, Ont., collected by J. DeCew.

Alveolites squamosa, Billings.

Alveolites squamosus, Billings. 1860. Canadian Journal, new series, vol. V., p. 257.
" " Rominger. 1876. Geol. Sur. Mich., p. 41, pl. XVI., figs. 3 and 4.

Corallum in the form of irregularly shaped expansions, attached by the centre of the base, sometimes 5 or 6 inches in diameter and about 1 inch thick. Often a much greater thickness is attained by the growth of additional layers of coral, one above the other. Upper surface irregular, generally more or less convex, lower surface flat, protected by a thin, somewhat concentrically wrinkled epitheca, in which the lateral outlines of the corallites radiating outward can be seen. Corallites thin walled, compressed, very oblique to the surface, from ·5 to 1 mm. broad and about ·25 mm. high; in transverse section they are broadly arched above, and concave on either side of the centre below. The interior of the corallites is studded with numerous sharply pointed

septal spines, and near the calyces a longitudinal ridge is present on the lower wall, whilst in some specimens indications of two longitudinal ridges can be seen occupying the inner surface of the upper wall. Pores numerous and placed at the angular sides of the corallites. Tabulæ complete.

Found in the Corniferous limestone of Ontario.

Alveolites vallorum, Meek.

? Alveolites suborbicularis, Lamarck. 1816. Hist. des An. sans. vert., vol. II., p. 186.
? Calamopora spongites, var. *tuberosa*, Goldfuss. 1829. Petrefacta Germaniæ, p. 80, pl. XXVIII, figs. 1*a*—*e* (cæt. exclusis).
Alveolites vallorum, Meek. 1868. Trans. Chicago Acad. of Sciences. vol. I., p. 86, pl. XI., figs. 9, 9*a*.
? Alveolites suborbicularis, Nicholson. 1879. Palæoz. Tab. Corals, p. 126, pl. VI., figs. 2, 2*a*—*b*.
Alveolites vallorum, Whiteaves. 1891. Contr. to Can. Palæon., vol. I., pt. III., p. 207; and 1892, ibid, vol. I., pt. IV., p. 274.

Corallum forming irregular expansions of considerable thickness with a small basal attachment, upper surface generally uneven of variable shape, under surface provided with an epithecal covering, somewhat flat, at times showing rough concentric wrinkles marking successive stages of growth, reaching a breadth of 5 or 6 inches with a thickness of about $1\frac{1}{2}$ inch. Corallites moderately thin walled throughout their length, flattened, wider than high, with a broadly arched upper wall and generally doubly concave on the lower side, reaching the surface at a somewhat oblique, but rather variable angle; average size ·75 mm. wide and ·5 mm. high. Pores of fair size, about ·2 mm. in diameter and ·5 mm. apart, occurring in single rows near the two angular sides of the corallites. Tabulæ numerous, complete, from about eight to fourteen in a space of 5 mm. Numerous small spiniform septa project from the inner surfaces of the walls of the corallites; these are only seen in very well preserved specimens, either in polished sections or when the corallites are free from matrix. A strong longitudinal ridge is present on the lower surface of the calyces and extends apparently for a short distance only into the interior of the corallites. At times the corallites appear to radiate from a number of centres, with a consequent result that the corallites in these specimens are rather unequal in size, and their obliquity to the surface is variable.

This species was described by Meek from specimens collected by Robert Kennicott at the "Ramparts" on the Mackenzie River, forty miles above old Fort Good Hope. Through the kindness of the authorities of the Smithsonian Institution, Washington, the writer has been

enabled to examine Meek's type specimens and to compare them with specimens in the Survey collection, from the Hay, Mackenzie, Peace and Moose rivers, and Lake Winnipegosis, that had been referred by Mr. Whiteaves to Meek's species.

Alveolites vallorum bears a striking resemblance to *A. suborbicularis*, Lamarck, as figured by Goldfuss in the Petrefacta Germaniæ, pl. XXVIII., figs. 1*a*—*e*. The resemblance in structural details between the two species is also seen in a description given by Nicholson of some specimens of *A. suborbicularis* collected by him in the Eifel; this authority is inclined to separate a form with numerous spiniform septa and a pedunculate base from one with an incrusting habit in which septa were not seen. From Goldfuss's figures it would appear that the corallum is very variable in shape and would include both forms. As regards the septa, they can be recognized only under favourable circumstances in well preserved specimens. The retention of Meek's species for the reception of the Canadian specimens is, however, thought advisable until it can be ascertained by direct comparison what the true relationship of *A. vallorum* to *A. suborbicularis* really is.

This species is represented in the collection by specimens from Devonian rocks at the following localities: junction of the Red and Peace rivers, A. R. C. Selwyn and J. Macoun, 1875; between the Long Portage of the Missinaibi branch of the Moose River and Moose Factory, R. Bell, 1877; Hay River, forty miles above its mouth, R. G. McConnell, 1887 and 1888; Mackenzie River at the "Ramparts" and at "Rock by the river's side," R. G. McConnell, 1888; Peace River at Vermilion Falls, R. G. McConnell, 1889; Lake Winnipegosis, J. B. Tyrrell, 1889, on the Red Deer River, at several localities in Dawson Bay, on Manitou Island, on a small island off Weston Point, and on Snake Island.

Genus Cœnites, Eichwald. 1829.

(Zool. Spec. t. I., p. 179.)

Limaria, Steininger. 1831. Mem. Soc. Géol. de France,, t. I., p. 339.

Corallum dendroid or forming thin expansions with a basal epitheca, composed of flattened or subpolygonal corallites that reach the surface by an abrupt bend and terminate in narrow slit-like calyces almost at right angles to the surface; walls of the corallites thin except at the surface where they are suddenly thickened; mural pores irregularly dispersed; tabulæ complete, transverse, rather distant; three longitudinal ridges are sometimes present in the outer ends of the corallites.

Cœnites appears to be most nearly related to *Cladopora*, from which it is distinguished by the shape of the calyces and by the sudden, not gradual, thickening of the walls of the corallites at the surface. The corallites are at first prostrate, when the corallum has the form of a thin expansion, but when it is dendroid they are almost upright in the centre of the branch or stem. The calyces are transversely elongated and may be straight or curved.

Cœnites juniperina, Eichwald.

Cœnites juniperinus, Eichwald. 1829. Zoolog. speciale, t. I., p. 197.
Limaria clathrata, Lonsdale. 1839. Murch. Sil. Sys., p. 692, pl. 16 bis, figs. 7, 7 *a*, 7 *b*.
Cœnites juniperinus, Milne-Edwards and Haime. 1851. Polyp. Foss. des Terr. Palæoz., p. 301.
Limaria ramulosa, Hall. 1852. Palæon. New York, vol. II., p. 142, pl. XXXIX., figs. 4*a*—*d*.
Cœnites juniperinus, Milne-Edwards and Haime. 1855. Brit. Foss. Corals, p. 276, pl. LXV., figs. 4, 4*a*.
Alveolites repens, Billings. 1863. Rep. of Progress, Geol. Survey of Canada, p. 323.
Alveolites Niagarensis, Nicholson and Hinde. 1874. Canadian Journal, new series, vol. XIV., p. 152 and 1875, Palæon. of Ont., p. 56, fig. 27.
Limaria ramulosa, Rominger. 1876. Geol. Sur. Mich., Foss. Corals, p. 43.
Cœnites juniperinus, Nicholson. 1879. Palæoz. Tab. Corals, p. 134, pl. VI., figs. 5, 5 *b*.

"Corallum dendroid, of cylindrical dichotomously-dividing branches, the diameter of which is generally about two lines. Corallites nearly vertical in the centre of the branches, with thin walls, and about one-sixth of a line in diameter; gradually diverging in their upward course till they reach a point from one-quarter to half a line from the surface, when they suddenly bend outwards, their walls being now greatly thickened, and the visceral chamber reduced to a mere slit. Calices fissure-like and elongated in the direction of the transverse diameter of the branches, their long diameter about one-third of a line; the lower margin adorned with two prominent teeth, while the upper margin carries a single tooth corresponding in position to the notch between the lower teeth. Tabulæ not very numerous, but well developed and complete. Mural pores moderately numerous, circular, not excessively large, irregularly distributed." (Nicholson.)

A number of fragments, from 1 to 2 inches long, of a dendroid coral with cylindrical branches, about 4 mm. thick, from the Niagara formation at Thorold, Ont., are referred to this species. In longitudinal sections the structure is seen to be similar to that described by Nicholson; the thickening of the walls of the corallites when they bend abruptly outward near the surface, and the mural pores and tabulæ are clearly seen. Transverse sections show that a prominent longitudinal ridge occupies the

inner sides of the corallites near the surface, and in one corallite this ridge is opposite to two ridges in the outer wall.

Niagara formation.—Thorold, Ont., collected by E. Billings.

Cœnites lunata, Nicholson and Hinde.

Cœnites lunata, Nicholson and Hinde. 1873. Canadian Journal, new series, vol. XIV., p. 151, figs. 2*a*, *b*, *c*.
" " Nicholson. 1875. Palæon. of Ont., p. 55, figs. 25*a*, *b*, *c*.

"Corallum forming a thin crust, apparently about two-thirds of a line in thickness. Calyces strongly curved, crescentic or lunate, their form being due to the projection into their cavity of a single strong rounded tooth developed from the concave lip. Calyces about one-fourth of a line in their long diameter, and one-eighth of a line across; eight in the space of two lines. Corallites perpendicular to the surface, appearing as if embedded in a dense cœnenchyma, though this is most probably due simply to the great thickening of their walls." (Nicholson and Hinde.)

Niagara formation.—Owen Sound, Ont., J. Townsend, 1874; north end of Lake Temiscaming, Que., R. Bell, 1887; and the "Jumpers" Anticosti.

Cœnites Selwynii, Nicholson. (Sp.)

(Plate I., figs. 4, 4*a*.)

Alveolites Selwynii, Nicholson. 1874. Geological Magazine, new series, vol. I., p. 15, fig. 3; 1874, Palæon. of Ont., p. 56, fig. 15, plate VII,, fig. 4.

Corallum in the form of a thinly incrusting expansion about 2 mm. thick with a thin basal epitheca. Corallites flattened throughout their length, prostrate and by a sudden upward bend debouching at right angles, or with only a slight obliquity to the surface; average breadth slightly over 1 mm., average height ·25 mm. Walls of the corallites thin, except at the surface, where they are greatly thickened, causing the calyces to have the form of narrow slits. Calyces more or less curved, sometimes straight, about 2 mm. long and ·25 mm. wide with thick rounded margins and a broad not very distinct lip on the concave side of the opening; a depressed line surrounding the calyces defines the outer limits of the corallites. Tabulæ complete, distant. Mural pores of medium size, placed about 1 mm. apart in the narrow edges, but also occurring irregularly in the broad sides of the corallites. The epitheca is finely striated in a direction at right angles to the length of the corallites. The calyces are sometimes quite straight, but it is usual to find them either evenly curved backward or else bending backward at either end; they are about 1 mm. in advance of each other and overlap laterally.

Cœnites Selwynii bears a close resemblance to the Silurian *C. linearis*, Milne-Edwards and Haime*, but its calyces are about twice as broad and are more generally curved than straight.

Rare in the Corniferous limestone of Ontario; the specimen described by Nicholson, the only one that he had seen, was collected at Port Colborne; the single specimen representing the species in the collection of the Geological Survey was obtained by Mr. S. W. Howard, at Hagersville, Ont., and presented to the museum in 1890.

Genus Cladopora, Hall. 1852.

(Palæon. New York, vol. II., p. 137.)

Corallum ramose, sometimes reticulated, flabellate or palmate, or forming laminar expansions, composed of closely united, subpolygonal corallites with expanded calyces that are oblique to the surface and margined below by a lip; walls of the corallites at first thin but becoming gradually thicker as the surface is approached; pores not numerous, dispersed; tabulæ complete, transverse; three denticulated ridges developed near the calyces; squamulæ sometimes present; opercula closing the calyces present in some species; epitheca rarely developed.

This genus is distinguished from *Favosites* and *Alveolites* principally by the gradual thickening of the walls of the corallites near the surface, and by the expansion of the calyces, which are bordered below by a more or less prominent lip. The corallites are at first subpolygonal and sometimes slightly compressed, later becoming more nearly circular as the walls thicken; in the ramose or fan-shaped forms they diverge from an inner axial line or plane and end in circular, oval, reniform, sometimes almost lunate calyces more or less oblique to the surface. The longitudinal ridges apparently do not extend far into the corallites and end where the calycular expansion takes place. The walls of the corallites are distinct and do not completely coalesce.

Cladopora multipora, Hall.

Cladopora multipora, Hall. 1852. Palæon. New York, vol. II., p. 145, pl. XXXIX. figs. 1 *a—g*.
Favosites? multipora, Nicholson. 1875. Palæon. of Ontario, p. 53.

"Frond ramose or reticulate; branches short, terete, in the reticulations cylindrical; cells numerous, closely arranged, penetrating to the axis in a slightly oblique direction; openings upon the surface subangular or circular, sometimes apparently tranverse; reticulations irregu-

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Brit. Fossil Corals, pl. LXV. fig. 3.

lar, and the dichotomous branches often extending beyond and terminating in terete forms. Cells 48 or 60 in the space of an inch longitudinally." (Hall).

This species is represented in the survey collection by specimens from Lake Temiscaming, Que., collected by Sir William Logan, in 1845, and Dr. Robert Bell, in 1887.

From an examination of the Canadian specimens it is seen that the corallum is formed of a number of upright stems, with an average diameter of 3·5 mm., growing closely together in an irregular manner and frequently branching and anastomosing so as to form an obscurely reticulated mass. The corallites are almost vertical, or only slightly inclined outward in the central part of the stems or branches, but near their distal ends they bend rather abruptly outward so that the calyces are almost at right angles to the surface. The walls of the corallites become stouter as they approach the surface, where the maximum thickness is attained. The calyces are rather irregularly disposed, not arranged in definite rows, somewhat angular, wider than high, their distance apart vertically being about equal to their width; from ·3 to ·5 mm. wide and about half as high. Tabulæ and septa have not been recognized, but comparatively large mural pores are seen to be present.

Milne-Edwards and Haime, in their British Fossil Corals, p. 263, make *Cladopora multipora*, Hall synonymous with their species *Alveolites? seriatoporoides*. This opinion, the writer is not fully prepared to follow, and prefers, for the present at least, to refer the Canadian specimens to Hall's species.

Locality.—Lake Temiscaming, Que.; Niagara formation.

Cladopora crassa, Rominger. (Sp.)

Limaria crassa, Rominger. 1876. Geol. Sur. Mich., Foss. Corals, p. 44, pl. XVIII., fig. 1.

Coral thinly incrusting, from 2 to 4 mm. thick, but at times apparently thicker, due to the growth of one layer over the other, composed of thin walled and sometimes slightly compressed, prostrate corallites that bend upward to the surface with thickened walls and end in moderately oblique, transversely subelliptical calyces with a not very prominent lip on the upper edge. Calyces about ·75 mm. in width and slightly less from back to front, and separated from each other by an average distance, due to the thickened walls at the surface, of ·5 mm. Sometimes by the growth of a layer on the basal surface of another, a comparatively thick expansion is formed having calyces opening on either

sides. Mural pores of average size, irregularly dispersed. Tabulæ complete, apparently numerous. Rominger mentions the presence in his specimens*, in the interior of the corallites, of three "crests" such as are found in *Cladopora cryptodens*, Billings, one on the inner side of the wall near the mouth, the other two opposite on the outer wall. The epitheca covering the lower surface and mentioned by Rominger in his description of the species is not preserved in the Canadian specimens.

This species is very like the Devonian form *Cladopora turgida*, Rominger in general appearance and structure, and apparently differs only from it in its less robust growth and in its usually incrusting habit.

Niagara formation.—North end of Lake Temiscaming, Que., R. Bell, 1887; Isle of Mann (Burnt Island) Lake Temiscaming, A. E. Barlow, 1893.

Cladopora cryptodens, Billings. (Sp.)

(Plate I., figs. 5, 5*a*.)

Alveolites cryptodens, Billings. 1859. Canadian Journal, new series, vol. IV., p. 115, fig. 16.
Favosites polymorpha (*pars*), Billings. 1859. Ibid, p. 111, fig. 11.
Striatopora formosa, Billings. 1860. Canadian Journal, new series, vol. V., p. 254.
Cladopora magna, Hall and Whitfield. 1873. Twenty-third Report, N.Y. State Museum of Nat. Hist., p. 230, pl. 10. figs. 3 and 4.
Cladopora cryptodens, Rominger. 1876. Geol. Sur. Mich., Foss. Corals, p. 49, pl. XX., figs. 1 and 2.
Pachypora or *Alveolites* (cfr. *A. cryptodens*, Bill.), Whiteaves. 1892. Contr. to Can. Palæon., vol. I., pt. IV., p. 273.

Corallum ramose, rather straggling in its growth, consisting of slender stems, circular in transverse section, sometimes as much as 15 mm. in diameter, that branch or bifurcate at rather distant intervals. Corallites radiating upward and outward, and issuing obliquely to the surface in slightly expanded somewhat circular calyces margined below by a sharp prominent well defined lip. Walls of the corallites moderately thin at first, but becoming thicker as the surface is approached, where the maximum thickness is attained. Corallites circular or rounded polygonal in section, gradually increasing in size until an average diameter of 1·5 mm. is attained at the surface. Tabulæ, as seen in longitudinal section, complete, about ·5 mm. apart. Squamulæ small, occurring on the sides of the walls of the corallites. Pores rather irregular in distribution, of moderate size. Three longitudinal ridges are present in the interior of the corallites; beginning near the mouth they appear to extend a short distance inward and are apparently denticulated at the edge; one of these

* From the Niagara limestone of Point Detour, Drummond Island, Lake Huron, &c.

ridges occupies the side nearest the axis of the stem or branch and is opposed by the remaining two on the side toward the exterior.

A certain amount of variation is noticeable in different specimens, and in parts of the same specimen, in the obliquity of the calyces to the surface; in the lower parts of the corallum especially, the corallites are apt to emerge more nearly at right angles to the surface. That this species is at times reticulated, is borne out by a specimen presumably belonging to this species, in which frequent coalescence of the branches is observable. In some specimens many of the calyces are closed by opercula.

In only a few of the specimens are the longitudinal ridges apparent, the corallites being as a rule either filled with matrix or quite empty with smooth sides. The tabulæ and squamulæ are seen in longitudinal sections, whilst the pores are preserved in most of the specimens. The wearing or weathering of the surface, with the destruction of the lips of the calyces, brings to light the subcircular or polygonal outlines of the individual corallites, a feature not seen when the surface is entire.

In a specimen of *C. cryptodens*, in which the tooth-like ridges are preserved near the mouths of the corallites, striations are seen on the walls of the calyces, as in *Striatopora formosa*. These two species are strikingly similar in outward form and the discovery in the former of a character which was relied on for their specific as well as generic separation, can scarcely leave any doubt as to their being conspecific. The calicular striations are not seen except in weathered specimens and may represent septal ridges or grooves only partially developed, or possibly are the result of the unequal weathering of the wall substance of the corallites. The specimen of *C. cryptodens* referred to was obtained in the Corniferous limestone at Rama's Farm, Port Colborne, Ont., by E. Billings in 1857.

This species occurs in the Corniferous limestone of Ontario and in the Devonian formation on the Red Deer River, Lake Winnipegosis; it has also been collected from Devonian rocks at the Long Portage, Missinaibi River, and on the Albany River.

Cladopora labiosa, Billings. (Sp.)

Alveolites labiosa, Billings. 1859. Canadian Journal, new series, vol. IV., p. 104, figs. 14 and 15.
Cladopora prolifica, Hall and Whitfield. 1873. Twenty-third Report N.Y. State Museum of Nat. Hist., p. 230, pl. 10, fig. 2.
Alveolites labiosa, Nicholson. 1874. Palæon. of Ont., p. 53, fig. 12.
Alveolites Billingsi, Nicholson. 1874. Ibid, p. 55, fig. 14*c*.
Cladopora labiosa, Rominger. 1876. Geol. Sur. Mich., Foss. Corals, p. 51, pl. XXI., fig. 2.

Corallum ramose, reticulate or subpalmate; branches or subdivisions circular or oval in transverse section, varying in thickness from 3 to about 8 mm.; calyces oblique to the surface, slightly expanded, with the outer edge produced into a strong projecting lip, subcircular sometimes slightly broader than high, from about ·3 to ·5 mm. across; when the surface is abraded the openings appear triangular and higher than broad owing to the loss of the lip. The calyces are sometimes about their own diameter apart, often closer. Corallites rounded polygonal or subcircular, their walls thickening gradually toward their distal ends. Mural pores small, few in number, irregularly placed. What appear to be tabulæ have been observed in some specimens. Rominger mentions (op. cit.) having seen longitudinal ridges in the interior of the corallites of this species, as in *Cladopora cryptodens*, Billings, but they have not been detected in the specimens that have come under the writer's notice.

This species differs from *Cladopora cryptodens*, Billings, to which it is most nearly allied, principally in the more slender form of the corallum and in its more delicate structure.

Occurs in the Corniferous limestone of Ontario; a loose specimen was collected by R. Bell, in 1886, on the Albany River which flows in the latter part of its course through a large Devonian area.

Cladopora Fischeri, Billings. (Sp.)

Alveolites Fischeri, Billings. 1860. Canadian Journal, new series, vol. V., p. 256, fig. 6.
" " Nicholson. 1874. Palæon. of Ont., p. 57.
Cladopora Fischeri, Rominger. 1876. Geol. Sur. Mich., Foss. Corals, p. 47, pl. XIX., figs. 1 and 4.
Pachypora Fischeri, Nicholson and Etheridge, jun. 1877. Jour. Linn. Soc., vol. XIII., p. 362, pl. XX., figs. 18—20.
" " Nicholson. 1879. Palæoz. Tab. Corals, p. 91, fig. 16.
" " Whiteaves. 1889. Contr. to Can. Palæon., vol. I., pt. II., p. 121.

Corallum in the form of irregularly palmate or flabellate, thin expansions, arising from a short, stout, stalk-like base and attaining to a considerable size; sometimes as much as 4 inches high, seldom more than 6 mm. thick and at times expanding above to a breadth of about 3 inches. Corallites irregularly polygonal, having an average diameter of about ·5 mm. but varying considerably in size, with moderately thin walls that exhibit a gradual thickening toward the calyces. The corallites bend outward and upward, as in other species of this genus having a palmate or flabellate corallum, from a central axial plane and issue obliquely to the surface on both sides of the expansion. Calyces, with an average breadth of about ·75 mm., circular, transversely oval, semicircular or reniform, with the lower edge produced so as to form a sharp-edged lip;

distance apart variable, depending on the amount of thickening of the walls of the corallites at the surface, but generally less than their width. In parts of the corallum, possibly where the regularity of growth has been disturbed, the calyces are nearly or quite at right angles to the surface and irregular in shape, with rounded outlines and without a lip. Often on one side of the expansion, as in *Cladopora turgida*, Rominger, the outlines of the calyces are less sharply defined and more depressed than on the other, the difference in the two sides resulting possibly from the corallum not growing quite erect, the side on which the more sharply defined calyces are being probably uppermost. The calyces are frequently closed by opercula. Mural pores of moderate size, about 1 mm. apart vertically, and not occurring in regular rows. Tabulæ complete, few in number.

This species is apparently nearly related to *Cladopora turgida*, Rominger, from which it can be readily distinguished by the comparative thinness of its corallum and more delicate form of growth generally, and by the smaller size of its calyces, which have thinner walls and are consequently much closer together.

Abundant in the Hamilton formation of Ontario, and found occasionally in the Corniferous limestone of the same province.

Cladopora frondosa, Nicholson. (Sp.)

Alveolites frondosa, Nicholson. 1874. Geological Magazine, new series, vol. I., p. 15, pl. II., fig. 2; 1874, Palæon. of Ont., p. 57, fig. 16.
Cladopora Canadensis, Rominger. 1876. Geol. Sur. Mich., Foss. Corals, p. 48, pl. XIX., fig. 3.
Pachypora frondosa, Nicholson and Etheridge, jun., 1877. Jour. Linn. Soc., vol. XIII., p. 362.
" " Nicholson. 1879. Palæoz. Tab. Corals, p. 94, fig. 17.
" " Whiteaves. 1889. Contr. to Can. Palæon., vol. I., pt. II., p. 121.

Corallum irregularly palmate with a stout massive base, spreading above into a thin lobate expansion; three or four or probably more inches in height, somewhat less in breadth, from 1 to about 5 mm. thick in the upper portion, and sometimes attaining a diameter of as much as 23 mm. near the base. Corallites subpolygonal or circular, ·3 mm. in average diameter, beginning with moderately thin walls that become gradually thickened as they proceed outward from the central axial plane to the surface on both sides, where their greatest thickness, which is often considerable, especially in the basal portion of the corallum, is reached. Calyces small, lunate or crescentic, about ·6 or ·7 mm. in breadth, provided below with a sharp lip that is more or less prominent and often depressed below the general level; generally about their own breadth apart, or even

less, but often more widely separated, especially near the base. Lips of the calyces more or less indented at the centre. As in *C. Fischeri*, Billings, and *C. turgida*, Rominger, the outlines of the calyces are more rounded off or less sharply defined on one side of the corallum than on the other, and on this side also faint polygons, surrounding the calyces, are sometimes seen marking the limits of contiguous corallites at the surface.

Abundant in the Hamilton formation of Ontario. Mural pores rather small, few in number. Tabulæ not observed, but they are mentioned by Nicholson as being present in specimens examined by him.

This species is distinguished from *C. Fischeri* mainly by the smaller size of the corallites and the decidedly crescentic shape of the calyces; it appears to form a link connecting this genus with *Cœnites*, Eichwald, in which the walls of the corallites are very much thickened at the surface, and the calyces have the form of curved or linear fissures.

Cladopora turgida, Rominger.

Cladopora turgida, Rominger. 1876. Geol. Surv. Mich., Foss. Corals, p. 48, pl. XIX., fig. 2.

Corallum in the form of flabellate expansions with rounded edges, attaining a height of over 5 inches with a thickness of about 10 mm., and of varying breadth. Corallites diverging upward and outward from an imaginary inner axial plane, which is often nearer one side of the expansion than the other, and issuing obliquely to the surface on both sides and on the edges of the corallum; calyces generally slightly over 1 mm. in maximum width, circular or transversely oval, with a slightly thickened lip forming the lower boundary, and generally less than their width apart. The corallites, owing to the excentricity of the axial plane from which they ascend, are often longer on one side of the expansion than on the other, the longer corallites having more prominent and less oblique calyces than the shorter ones. Corallites almost circular and greatly thickened as the surface is approached. Mural pores, distant, rather small. What appear to be tabulæ are seen in a few specimens at distant intervals. The calyces, especially in the lower portions of the corallum, are frequently closed by opercula.

Occurs in the Corniferous limestone of Ontario. A fragment of a specimen of this species was collected by R. Kennicott at the "Ramparts," Mackenzie River, and is the property of the United States National Museum at Washington.

Cladopora lichenoides, Rominger.

Cladopora lichenoides, Rominger. 1876. Geol. Surv. Mich., Foss. Corals, p. 46, pl. XVII., figs. 1 and 4.

Corallum spreading horizontally in rather thin laminar expansions, from 2 or 3 mm. to over 10 mm. in thickness, with an epitheca on the lower side; frequently the expansions occur one above the other in an approximately parallel sequence, one tier connected with the one immediately below it at one or more points, but otherwise distinct and separated by varying distances. Corallites averaging 1 mm. in diameter, at first prostrate and as a rule slightly flattened, then bending upward and becoming more nearly circular in transverse section, and finally emerging at a slightly oblique angle to the surface. Walls of the corallites thin below, but gradually thickened as the surface is approached, in some specimens considerably more than in others. Calyces rather variable in shape, irregularly subpolygonal or oval, 1 mm. in average width, three or four occurring in a space of 5 mm.; they are without a definite lip except when their obliquity to the surface becomes pronounced. Tabulæ complete, distant. Squamulæ, as shown in one specimen, occurring on the inside of the walls of the corallites. Mural pores of moderate size, not abundant.

This species in having corallites that are more or less flattened when prostrate near the base of the expansion shows a certain likeness to *Alveolites*, which, however, disappears when the walls of the corallites become thick; it is readily distinguished from other species of *Cladopora* by its general form of growth.

Found in the Corniferous limestone of Ontario.

Cladopora Rœmeri, Billings. (Sp.)

Alveolites Rœmeri, Billings. 1860. Canadian Journal, new series, vol. V., p. 255.
" " Nicholson. 1874. Palæon. of Ont., p. 54.
Cladopora Rœmeri, Rominger. 1876. Geol. Sur. Mich., Foss. Corals, p. 50, pl. XX., fig. 3.
Alveolites Rœmeri, Whiteaves. 1889. Contr. to Can. Palæon., vol. I., pt. II., p. 121.
" " (pars) Whiteaves. 1891. Contr. to Can. Palæon., vol. I., pt. III., p. 207 (specimen collected by R. G. McConnell).

This species was defined by Mr. Billings in the following short description—"Stems from two to three lines in diameter, usually cylindrical, but sometimes sub-palmate, branching. Cells transversely oval, about half a line wide and one-fourth of a line in length; in general distant from each other from half a line to two-thirds of a line in the longitudinal direction of the stem, and half that distance in the transverse direction."

The branches or stems are generally found in a fragmentary condition, in pieces an inch or two in length. An examination of the type and other specimens in the collection of the Geological Survey tends to show that the only difference between this species and *C. Fischeri*, Billings, is found in the shape of the corallum, which in the former is ramose with cylindrical or subpalmate branches, and in the latter irregularly palmate or flabellate.

What has already been said about the general structure of *C. Fischeri*, as regards the form and size of the corallites and calyces, the disposition of the mural pores and other details, applies equally to *C. Rœmeri*, the only differences being those incidental to the change in the form of the corallum. Although in the latter species the cylindrical stems become at times subpalmate, no specimens of either species have apparently been seen that would justify the opinion that the two forms passed the one into the other; in the meantime therefore the writer is inclined to regard *C. Rœmeri* as worthy of specific distinction.

Found in the Hamilton formation of Ontario, and recognized by Mr. Whiteaves in a specimen collected by R. G. McConnell, in 1875, from the upper Devonian of the Peace River, in the district of Athabasca.

Genus Michelinia, De Koninck. 1842.

(An. foss. des terr. Carb. de la Belgique, p. 29.)

Corallum in lenticular, hemispherical or subcylindrical masses, attached by the centre of the base and provided with an epitheca; corallites thin walled, in contact or contiguous only at intervals, polygonal when touching, circular when apart, unequal in size, often large, their inner surfaces longitudinally striated by numerous impressed lines with septal spines on the interspaces; mural pores irregularly distributed or in vertical rows, also, when the corallites are in contact only at intervals, in single or double horizontal rows; tabulæ convex or flat, with small secondary tabulæ or cysts.

Michelinia convexa, d'Orbigny.

Michelinia convexa, d'Orbigny. 1850. Prodr. de Paléont., t. I. p. 107.
" " Milne-Edwards and Haime. 1851. Polyp. Foss. des Terr. Palæoz., p. 251, pl. 16, fig. 1.
" " Billings. 1859. Canadian Journal, new series, vol. IV., p. 112, fig. 13.
" " Nicholson, 1874. Palæon. of Ontario, p. 63.
" " Rominger. 1876. Geol. Sur. Mich., Foss. Corals, p. 72, pl. XXVI., figs. 1 and 2.

Corallum when young of a disk-like form with a convex upper surface and almost flat below, becoming later of a more hemispherical shape and passing with age into a roughly upright cylindrical mass without much lateral expansion; attaining a height of 10 or 11 inches with a breadth of 4 or 5. The point of attachment of the corallum is at the centre of the base which is covered by a strong, concentrically wrinkled epitheca. Corallites large, polygonal, thin walled, attaining a diameter of 9 or 10 mm., with small ones interspaced among the large ones; in some specimens the average size of the mature corallites is much less. Tabulæ strongly convex, numerous, with many secondary tabulæ or cysts resting on the complete tabulæ, principally nearer the walls of the corallites than at the centre, the whole forming a vesiculose mass filling the interior of the corallites. The presence of the secondary tabulæ on the primary ones gives to the latter a peculiar blistered appearance when seen from above. In corallites of average size about forty parallel, longitudinal striæ occur on the inner surface of the walls, which are further decorated on the spaces between the striæ by numerous short blunt septal spines. Pores of rather unequal size, edged with a raised rim, generally irregularly distributed though sometimes becoming more numerous and forming regular vertical rows between the longitudinal striæ.

Occurs in the Corniferous limestone of Ontario at Port Colborne, Cayuga and near Woodstock.

Michelinia Clappii, Milne-Edwards and Haime. (Sp.)

Chonostegites Clappi, Milne-Edwards and Haime. 1851. Polyp. Foss. des Terr. Palæoz., p. 299, pl. XIV., figs. 4, 4*a*.
Michelinia intermittens, Billings. 1859. Canadian Journal, new series, vol. IV., p. 113.
Haimeophyllum ordinatum, Billings. 1859. Canadian Journal, new series, vol. IV., p. 139, fig. 29.
Michelinia Clappii, Rominger. 1876. Geol. Sur. Mich., Foss. Corals, p. 75, pl. XXVIII., figs. 3 and 4.

Corallum forming large, somewhat hemispherical or lenticular masses, broadly convex above and rather flat or convex below, with subparallel corallites diverging outward and upward from a central basal point; reaching a breadth of over 1 foot and sometimes about 8 inches high. The corallites are thin walled, constricted at varying intervals, polygonal when in contact, circular and separated by a space from each other where constricted. In some specimens the corallites are large, nearly 8 mm. in average diameter, and slightly but sharply contracted at intervals of from 1 to 4 mm., the average width of the corallites where constricted being a little over 5 mm.; as seen from above the corallites appear circular. In other specimens the corallites are smaller, averaging

about 5 mm. in diameter when in contact, and the constrictions are much more pronounced and very variable in their distance apart, causing the corallites to appear as slender cylindrical tubes from 2 to 5 mm. in diameter, with abrupt thin horizontal expansions at intervals of from 1 to over 10 mm. apart; the spaces separating the cylindrical portions of the corallites are here seen to be frequently much wider than the diameter of the corallites themselves. Between these extremes intermediate gradations occur in the same or in different specimens. The expansions in some specimens occur somewhat in the same plane, forming a floor in which the polygonal outlines of the corallites are seen in juxtaposition. The interior of the corallites is obscurely marked by from about thirty to fifty longitudinal striæ. Pores unequal in size, sometimes over ·5 mm. in diameter, generally in one or two horizontal rows, where the corallites are in contact. Septal spines represented by close set, longitudinal, often interrupted rows of stout sharply pointed tubercles, generally more clearly defined on the contracted parts of the corallites than elsewhere. Tabulæ numerous, and of the same nature as those of *M. convexa*. The exterior surface of the corallites is marked by fine encircling rings of growth and by longitudinal lines corresponding to the inner striations. In a part of one specimen in particular the corallites, which are elsewhere normal in structure, approach closely in structure those of *M. convexa* in that they are constricted only at rather lengthy intervals, leaving the corallites polygonal and in contact for some distance.

Occurs in the Corniferous limestone of Ontario, near Woodstock, and in the townships of Walpole and Cayuga.

Michelinia favositoidea, Billings. *em.* (*favosoidea*).

Michelinia favosoidea, Billings. 1859. Canadian Journal, new series, vol. IV., p. 114.
Michelinia favositoidea, Rominger. 1876. Geol. Sur. Mich., Foss. Corals, p. 73, p. XXVII., fig. 4.

"Corallum forming large hemispheric or flattened masses; cells unequal in size, adult diameter about two lines and a half; diaphragms flat, horizontal, with small vesicular swellings, usually around the margins of the upper surface; septal striæ very obscure, six to eight on each plane side of the cells; pores very small, irregularly distributed, sometimes in rows of five or six across the cell, about one-sixth of a line distant from each other in some places, and sometimes absent in spaces of half a line in width." (Billings). In the type specimen small, stout, short septal spines occur in abundance on the inner surfaces of the walls of the corallites.

Found in the Corniferous limestone at Port Colborne, Ont.

Genus Striatopora, Hall. 1852.

(Palæon. New York, vol. II., p. 156.)

Corallum dichotomously branching, made up of subpolygonal corallites that terminate at the surface in expanded, shallow, radially striated and slightly oblique, unequal calyces that join each other in sharply defined polygonal outlines; walls of the corallites at first thin but gradually thickening toward the surface; pores irregularly distributed; tabulæ complete, distant.

Striatopora flexuosa, Hall.

Striatopora flexuosa, Hall. 1852. Palæon. New York, vol. II., p. 156, pl. XL. B, figs. 1*a*—*e*.
" " Nicholson. 1875. Palæon. of Ont., p. 55, fig. 26*a*.

"Coral composed of bifurcating or irregularly ramose stems; branches terete; cells large, angular below, and opening in a circular striated aperture; striæ extending beyond the cell, particularly in an upward direction; cells arranged in an irregularly alternating series; calicles labellate or extended on the lower side, and uniting above in angular ridges separating the cells; apertures very unequal in size.

"This species is readily distinguished by the form and arrangement of its cells, which are of much larger proportionate size than any of the ramose corals of the group. The apertures are round, but open into an angular depression, which is limited on the lower side by the calicle, but extends upwards to unequal distances depending upon the arrangement of the cells. The striæ which are visible in the circular cell extend beyond into its angular space, and are very distinct in well preserved specimens." (Hall.)

The specimens on which Professor Hall's description was based were collected in the shale of the Niagara formation at Lockport, N.Y.

In the museum of the Geological Survey is a specimen of this species, apparently identified by the late Mr. Billings, from the Niagara formation, Sydenham Road, county of Grey, Ont.; collected by R. Bell, in 1861.

The principal point of difference between *S. flexuosa* and *S. Linneana*, Billings, is that the calyces of the former are larger and not so crowded together as those of the latter.

Striatopora Linneana, Billings.

Striatopora Linneana, Billings. 1860. Canadian Journal, new series, vol. V., p. 253, fig. 1.
" " Nicholson. 1874. Palæon. of Ont., p. 59.
Striatopora Linnæana, Rominger. 1876. Geol. Sur., Mich., Foss. Corals, p. 59, pl. XXIII., figs. 5, 6.
Striatopora Linneana, Nicholson. 1879. Palæoz. Tab. Corals, p. 100, pl. V., figs. 2—2*d*.
Striatopora Linnæana, Whiteaves. 1889. Contr. to Can. Palæon., vol. I., pt. II., p. 121.

Corallum dendroid, composed of stems, from 5 to over 10 mm. thick, that branch generally dichotomously, at varying intervals. Corallites subpolygonal, at first thin walled and nearly vertical in the centre of the stems, then, curving gracefully outward with gradually thickening walls, they emerge at the surface, inclined slightly upward, and expand into wide, shallow calyces which join each other in sharp, thin edged, polygonal outlines. About twelve, sharply defined, longitudinal grooves pass outward from the interior of the corallites over the faces of the calyces, at the bottom of which they are most clearly marked. Calyces unequal in size, with numerous small ones intercalated between the larger ones; width varying in the large ones from about 1·5 to slightly over 2 mm. Mural pores of moderate size, irregularly distributed, not very numerous, occurring in the faces of the expanded calyces as well as in the inner parts of the corallites. Tabulæ complete, transverse, distant.

Devonian.—Hamilton formation; township of Bosanquet, county of Lambton, Ont., at Thedford (Widder) and Bartlett's Mills.

Genus Trachypora, Milne-Edwards and Haime. 1851.

(Polyp. Foss. des Terr. Palæoz., p. 305.)

Corallum ramose, consisting of cylindrical stems composed of short corallites diverging from an imaginary central axis in an alternating manner and opening on the surface in generally four rows of oval, very slightly oblique, distant calyces; walls of corallites thickening rapidly; mural pores small; tabulæ directly transverse, few in number; septa apparently obsolete; edges of calyces obscurely striated in a radial direction; surface between the calyces delicately sculptured by irregular, longitudinal, impressed lines.

Trachypora elegantula, Billings.

Trachypora elegantula, Billings. 1860. Canadian Journal, new series, vol. V., p. 254, figs. 2, 3, 4.
Dendropora elegantula, Rominger. 1876. Geol. Sur. Mich., Foss. Corals, p.63, pl. XXIII., fig. 2.
Trachypora elegantula, Hall. 1876. Illus. Dev. Foss., pl. XXXIII., figs. 1—8.
" " Nicholson. 1879. Palæoz. Tab. Corals, p. 108, pl. V., figs. 4—4c.
" " Whiteaves. 1889. Contr. to Can. Palæon., vol. I., pt. II., p. 121.

Corallum upright, ramose, with branches proceeding from the stems at somewhat obtuse angles, and also branching dichotomously; stems 5 mm. in thickness and under, circular in section, sometimes flattened on four sides so as to be almost square in section. Oval calyces, with slightly raised margins, open on the surface in four or five longitudinal rows; sometimes one or two calyces occur separately between the rows. The raised margin of the calyces is frequently not continued across their

upper ends, or is not as well defined there as at the sides and below. The calyces average 1·5 mm. in height or length and 1 mm. in width, those of a row being at a distance from each other about equal to their length, and the rows themselves are at varying distances apart proportionate to the thickness of the stems or branches. The size of the calyces is about the same in large as in small stems. The surface between the calyces is delicately sculptured longitudinally by interrupted, generally wavy striæ.

In longitudinal sections, short, slightly curved corallites are seen to pass upward and outward from an imaginary axial line to the surface, the calyces pointing slightly upward. The corallites on opposite sides of the axial line are at the same height and alternate with those of the other rows; this alternation is seen in longitudinal sections and is continued in the arrangement of the calyces at the surface. In the centre of the stems the corallites are small, about ·5 mm. or less in width, subpolygonal, with thin walls, which rapidly grow thicker toward the surface. After the walls become thick all trace of the boundaries of contiguous corallites, as far as can be learned by transverse and longitudinal sections, is lost; and no indications of them are seen on the surface. Mural pores, small, few in number, confined apparently to those parts of the corallites where the walls are not excessively thickened. Tabulæ few in number, complete, directly transverse. It is noticed that when the stems are flattened on four sides the rows of calyces occur on the angles. No septa or striæ are seen, in longitudinal or transverse sections, in the interior of the corallites, but near the edges of the calyces obscure striations are observed passing out over the raised margins in a radial direction.

Devonian.—Hamilton formation; not uncommon at Thedford, Ont.

Genus Calapœcia, Billings. 1865.

(Canadian Naturalist, new series, vol. II., p. 425.)

Corallum massive, composed of rather equal, polygonal, subpolygonal or circular corallites either in contact and polygonal or distant and circular; walls of corallites of moderate thickness, amalgamated when in juxtaposition; pores so numerous as to reduce the walls to a mere lattice-work, forming regular longitudinal and horizontal rows; spiniferous septal ridges about twenty in number, between the longitudinal rows of pores and passing out over the slightly exsert edges of the calyces; tabulæ complete, horizontal, often with secondary tabulæ; spaces between corallites crossed by irregular horizontal diaphragms.

Calapœcia Canadensis, Billings.

Plate I., figs. 6, 6*a* and 7.

Calapœcia Canadensis, Billings. 1865. Canadian Naturalist, new series, vol. II., p. 426.
Calapœcia Huronensis, Billings. 1865. Ibid, p. 426.
Calapœcia Anticostiensis, Billings. 1865. Ibid, p. 426; and 1866, Cat. Sil. Foss. of Anticosti, p. 32, figs. 15*a*, 15*b*.
Columnopora cribriformis, Nicholson. 1874. Geological Magazine, new series, vol. I., p. 253, figs. 1*a*—*c*.
" " Nicholson. 1875. Palæon. of Ont., p. 25; and 1875, Geol. Survey of Ohio, vol. II., pt. II., p. 187, pl. XXII., figs. 8, 8*a*, 8*b*.
Houghtonia Huronica, Rominger. 1876. Geol. Sur. Mich., Foss. Corals, p. 17, pl. III., figs. 3 and 4.
Columnopora cribriformis, Nicholson. 1879. Palæoz. Tab. Corals, p. 164, pl. VII., figs. 2, 2*a*—*d*.
" " Whiteaves, 1880. Rep. of Progress for 1878-79, Geol. Survey of Canada, p. 48 C.
" " Whiteaves, 1881. Rep. of Progress for 1879-80, Geol. Survey of Canada, p. 57 C.

Corallum forming hemispherical, subspherical or somewhat turbinate, at times irregularly rounded, masses of polygonal, subpolygonal or circular corallites diverging from a basal beginning or point of attachment; reaching a height of nearly 6 inches with a breadth of about 4 inches. Corallites usually nearly equal in size in the same specimen and varying in diameter in different specimens from 2 to 4 mm.; either in contact and polygonal, or circular and separated from each other by a space of varying width. In the same specimen circular and polygonal corallites with intermediate gradations, sometimes occur, or they may be all circular or all polygonal, the circular corallites being at times nearly their own diameter apart but more frequently about half that distance and often almost in contact. Walls of the corallites of moderate thickness, about ·25 mm. through, apparently completely amalgamated when the walls are in contact, perforated by large pores placed close together and forming regular horizontal and longitudinal rows. Pores circular, oval or quadrangular and so numerous as to reduce the walls to a mere reticulation of upright bars and horizontal rings the former of which are generally somewhat the stronger of the two and appear in the inside of the corallites as longitudinal ridges. Spiniform septa stout at the base, sharply pointed, about ·3 mm. long and inclined slightly upward, occurring in from about eighteen to twenty-two longitudinal rows, a spine springing from each intersection of the mural ridges with the transverse rings. Tabulæ complete, horizontal, sometimes slightly concave or convex, often somewhat irregular from the introduction of secondary tabulæ; from four to six in a space of 2 mm. When the corallites are not in contact the interven-

ing spaces are crossed by horizontal diaphragms somewhat stouter than, but at about the same distance apart as, the tabulæ and showing the same irregularities of growth. The longitudinal ridges appear on the outer surface of the walls, in the spaces between the corallites, as costæ; they pass over the edges of the calyces and connect with corresponding ridges in contiguous corallites. The costal ridges at the surface, when the corallites are separate, extend radially but a very short distance, about ·5 mm. beyond the confines of the calyces, leaving the surface of the corallum between the corallites smooth; this intercalicular surface is at times marked by obscure, contiguous, polygonal outlines surrounding individual corallites, but no trace of this demarcation is seen in transverse or longitudinal sections. The edges of the calyces are but slightly elevated above the intercalicular surface and in worn specimens appear as smooth raised rings. No definite traces of a basal epitheca have been detected.

Calapœcia Canadensis occurs in the Birdseye and Black River, and Hudson River formations. In the former it is found in the Ottawa district and in the latter on the islands at the north end of Lake Huron, on Snake Island, Lake St. John, Que., and on the Island of Anticosti; it is also found in the Galena-Trenton limestone of the Lake Winnipeg district and of the region to the north. Specimens have been collected at the following localities and have been available for study and comparison. In the Birdseye and Black River, near Ottawa, Ont., E. Billings, at Hull (Ottawa), Que., J. Stewart, 1886; Paquette's Rapids, Ottawa River, T. C. Weston, 1872 and 1881, hill south of Clear Lake (loose), county of Renfrew, township of Sebastopol, R. W. Ells and L. M. Lambe, 1896, near Point Blue, Lake St. John, Que., A. R. C. Selwyn and J. Richardson, 1870. In the Hudson River, north side of Drummond Island, Lake Huron, A. Murray, 1847, Cape Smith and Rabbit Island, Lake Huron, R. Bell, 1859, Wreck Point, Anticosti, J. Richardson, 1856, west side of Gamache (or Ellis) Bay, Anticosti, T. C. Weston, 1865, Snake Island, Lake St. John, J. Richardson, 1857. In the Galena-Trenton, Lower Fort Garry, R. Bell, 1880, T. C. Weston and A. McCharles, 1884, East Selkirk, Manitoba, T. C. Weston, and A. McCharles, 1884; Big Grindstone Point and Deer Island, Lake Winnipeg, J. B. Tyrrell, 1889, first limestone exposure south of Long Point, Lake Winnipeg, D. B. Dowling, 1891, junction of the Churchill Rivers (drift), R. Bell, 1879, Markham Lake, Telzoa River, lat. 62° 44′, long. 103°, J. B. Tyrrell, 1893, Herb (Wekusko) Lake, District of Saskatchewan, J. B. Tyrrell, 1896, also Fort Churchill, Hudson Bay (Cambro-Silurian), J. B. Tyrrell, 1894.

The large number of specimens of this genus obtained of late years, and now in the collection of the survey, have convinced the writer that *C. Canadensis* and *C. Huronensis* cannot be retained as distinct species

and also that between *C. Canadensis* and *C. Anticostiensis* intermediate forms exist connecting these two species. In the specimens from East Selkirk, Manitoba, particularly, a gradual transition can be traced from those specimens, structurally identical with either *C. Canadensis* or *C. Huronensis*, in which the corallites are in contact and polygonal, to those, indistinguishable from *C. Anticostiensis*, in which the corallites are even perhaps slightly farther apart than in the type specimen of that species. On the evidence of these specimens the writer has been forced to regard *C. Canadensis*, *C. Huronensis* and *C. Anticostiensis* as belonging to the same species, no constant structural or other difference having been found that would justify their being kept separate.

Genus Syringolites, Hinde. 1879.

(Geological Magazine, decade II., vol. VI., p. 244.)

Corallum broadly expanding, composed of upright, contiguous polygonal corallites, with walls perforated by two or three longitudinal rows of pores; tabulæ funnel-shaped, invaginated and open below so as to form a continuous tube occupying the centre of each corallite; septa represented by numerous tubercles or short spines irregularly disposed on the inner surface of the walls of the corallites; calyces equal, polygonal, of moderate depth.

Syringolites Huronensis, Hinde.

Syringolites Huronensis, Hinde. 1879. Geological Magazine, decade II., vol. VI., p. 246, figs. A, B, C, D.
" " Nicholson. 1879. Palæoz., Tab. Corals, p. 179, fig. 27.

Corallum growing in broad, thick expansions, and according to the author of the species, with a basal epitheca; the only specimen in the collection has a maximum breadth of over 4 inches with a thickness of about 1 inch, it is slightly convex above and flat below. Corallites upright, polygonal, generally with five, six or seven sides, in close contact, thin walled, with an average diameter of 2·5 mm. and placed in communication with each other by mural pores. Tabulæ funnel-shaped, sloping backward toward the centre, where they become tubular, and remaining open below, each tabula connects with the preceding one so as to form a continuous tube, nearly 1 mm. wide, occupying the centre of the corallite; from eight to ten tabulæ occur in a space of 5 mm. Pores rather small, in two or three rows in the sides of the corallites. Septa small, spiniform, present in large numbers, apparently without definite order, on the inner surface of the walls of the corallites; spines similar to these in size and shape and equally abundant occur on the upper surface of the tabulæ and extend into the tube. Calyces rather

equal in size, regularly polygonal, moderately deep, separated from each other by thin, sometimes slightly wavy edges.

Occurs in the Niagara formation near Manitouaning, Grand Manitoulin Island, Lake Huron; the single specimen in the museum of the survey was collected by G. Jennings Hinde.

Dr. Clemens Schlüter* regards *Syringolites* as congeneric with *Rœmeria*†, Milne-Edwards and Haime, a genus founded for the reception of the species *Calamopora infundibulifera*‡, Goldfuss, from the Devonian of the Eifel. It may be stated, however, that Dr. G. Jennings Hinde¶ had the opportunity of making a close study of the specimens upon which Goldfuss and Milne-Edwards and Haime based their descriptions before making the Canadian coral the type of a new genus.

Genus Romingeria, Nicholson. 1879.

(Palæoz. Tab. Corals, p. 114.)

Quenstedtia, Rominger. 1876. Geol. Sur. Mich., Foss. Corals, p. 70 (Non *Quenstedtia*), Morris and Lycett, 1854.

"Corallum lax, spreading, attached basally, and free throughout the greater part of its extent. Corallites cylindrical, annulated, multiplying by lateral gemmation, and typically producing new tubes in umbellate whorls or verticils, which are placed at short intervals. Where their walls are in contact, their visceral chambers are placed in communication by means of mural pores. Tabulæ complete, remote, apparently not distinctly infundibuliform. Septa represented by vertical rows of spinules." (Nicholson.)

Romingeria umbellifera, Billings, (Sp.)

Aulopora umbellifera, Billings. 1859. Canadian Journal, new series, vol. IV., p. 119.
" " Nicholson. 1874. Palæ. of Ontario, p. 43, pl. VI., fig. 4.
Quenstedtia umbellifera, Rominger. 1876. Geol. Sur. Mich., Foss. Corals, p. 70, pl. XXXIII., fig. 3.
§ *Aulopora umbellifera*, Whiteaves. 1877. Rep. of Progress, Geol. Survey of Canada, 1875-76, p. 317.
Romingeria umbellifera, Nicholson. 1879. Palæoz Tab. Corals, p. 116, fig. 19.

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* Anthozoen des rheinischen Mittel-Devon, von Dr. Clemens Schlüter, p. 99, 1889.

† Monographie des Polypiers Fossiles des Terrains Palæozoïques par MM. Milne-Edwards et Jules Haime, p. 253. 1851.

‡ Petrefacta Germaniæ, von August Goldfuss, pt. I., p. 78, pl. XXVII., figs. 1*a*, 1*b*. 1826-33.

¶ Op. cit., p. 245.

§ The fact that the name *Quenstedtia* was preoccupied was pointed out, in 1877, by Mr. Whiteaves (op. cit.), who purposely retained the generic name used by Billings for this species in order to allow Dr. Rominger to substitute another one.

In the original description of this species Billings remarks: "The parent stems are about one line in diameter, and remain single and straight for the distance of one quarter, or half an inch, when they give off branches in all directions, sometimes ten or twelve at once. These are at first oblique or somewhat parallel with the main tube, and are connected laterally; they then radiate like the spokes of a wheel, at right angles to the parent corallites, each soon giving birth to a similar circlet of new tubes."

Dr. Rominger points out that the parent stem after having given forth a circle of branchlets grows on in a straight line and again produces a similar circle at a higher level; he also mentions that within the group of young corallites the main stem is generally inflated.

In one of the type specimens in this museum a few small circular openings between contiguous branchlets, and between them and the parent stem are plainly seen; these appear to be structural, and are evidently the same as the pores mentioned by Rominger in his description of the species. The tabulæ are irregular in disposition, from 1 to several lines apart; they appear to be generally convex or obliquely transverse. The exterior of the tubes is annulated by striæ of equal strength, about eight occurring in a space of 1 line. No septal spines have been observed.

This species was first consigned provisionally to the genus *Aulopora*, by Billings, who stated, however, that it possibly should constitute a new genus. Later this idea was carried out by Rominger, who proposed *Quenstedtia* as the name of a genus for the reception of this species as the type. Unfortunately this name was preoccupied, and Nicholson substituted the name *Romingeria* in its stead, in honour as he says "of one who has so largely contributed to the elucidation of the fossil corals of North America."

Devonian.—Corniferous limestone of Ontario; also from rock of the same age at Long Portage, Missinaibi River.

Genus FLETCHERIA, Milne-Edwards and Haime. 1851.

(Polyp. Foss. des Terr. Palæoz. p. 300.)

"Corallum composed of cylindrical tubes which multiply by calycinal gemmation, and which are not united laterally, either by connecting tubes as in *Syringopora*, nor by mural expansions as in *Thecostegites*; walls strong and furnished with a complete epitheca; calyces circular or subcircular, with thin edges; septa rudimentary; tabulæ complete, horizontal, well developed." (Milne-Edwards and Haime.)

Fletcheria incerta, Billings. (Sp.)

Plate I, figs. 8, 8*a* and 9.

Columnaria incerta, Billings. 1859. Canadian Naturalist, vol. IV., p. 428, figs. 1 and 2.

Corallum in the form of irregularly shaped, somewhat hemispherical masses composed of long, cylindrical corallites that proceed upward and outward, subparallel to each other, from a basal centre. Corallites from ·75 to 1·5 mm. in diameter, up to a distance of slightly over 1 mm. apart; although usually circular in transverse section they may become subcircular when in partial contact or polygonal when crowded together, the walls of individual corallites always remaining distinct from those of contiguous ones. Tabulæ numerous, flat or slightly convex or concave, from ·5 to 4 or 5 mm. apart. Septa, apparently spiniform, very minute. The corallites have a complete epitheca faintly marked transversely by lines of growth.

Locality and formation.—Mingan Islands, Island of Montreal and near the city of Ottawa. Chazy limestone.

Collectors.—Sir W. E. Logan, J. Richardson and E. Billings. One specimen from St. Charles Island, Mingan Islands, collected by J. Richardson, in 1860, is fully 4 inches in height.

In transverse sections of the tubes the writer has seen what appear to be very small spiniform septa. He has had difficulty in satisfying himself as to whether the increase in growth of the corallum is due to lateral or calicinal gemmation, but the combination of characters is thought to be more in accord with those of *Fletcheria* than with those of any other genus.

Dr. Nicholson* is of the opinion that *Vermipora*, Hall (stated by Rominger to have mural pores) is most nearly allied to, if not an actual synonym of *Fletcheria*.

Genus Nyctopora, Nicholson. 1879.

(Palæoz. Tab. Corals, p. 182.)

"Corallum composite, massive, of polygonal corallites, which radiate from the base of the spheroidal corallum, to open on its upper surface, and are in complete contact throughout their entire length. Walls of the corallites thin, and so completely amalgamated that no trace whatever of the original lines of division between the tubes can be detected. Mural pores numerous, small, in more than one series, occupying the sulci between the septa. Septa in the form of marginal vertical ridges, which extend

* Palæozoic Tabulate Corals, p. 70.

along the whole length of the tubes, from ten to fifteen in number in each corallite, not divisible into an alternating series of longer and shorter lamellæ. Tabulæ numerous, complete, horizontal." (Nicholson.)

The specimens from the typical locality referred to below and about whose specific identity with Nicholson's coral there can scarcely be any doubt, disagree with the generic characters as quoted above in the size, arrangement and number of the septa. In these specimens the septa are distinctly of two sizes, and are sixteen in number, eight very short septa alternating with eight longer ones. It is probable that in the type specimens the septa were not so clearly defined as in those examined by the writer.

Nyctopora Billingsii, Nicholson.

Plate II., figs. 1, 1*a*.

Columnaria Goldfussi, Nicholson. 1875. Palæon. of Ontario, p. 9. But not *C. Goldfussi*, Billings. 1857.

Nyctopora Billingsii, Nicholson. 1879. Palæoz. Tab. Corals, p. 184, pl. IX., figs. 3, 3*a*—*c*.

Two specimens from Peterborough, Ont., are identified with this species; one is depressed hemispherical and measures $2\frac{1}{2}$ inches across and 1 inch high, the other is somewhat pyriform in shape and is $2\frac{1}{2}$ inches high and $1\frac{3}{4}$ inch broad. Their structure is as follows:—Corallites polygonal, from 1 to 1·25 mm. in diameter, in close contact and without apparently a thorough coalescence of the walls, which are generally of moderate thickness. Septa short, lamellar, sixteen in number, eight primary ones alternating with eight secondary ones; the primary septa, as seen in transverse sections, project about ·25 mm. beyond the walls of the corallites toward the centre, and are twice the size of the secondary septa. Tabulæ flat, from two to seven or eight in a space of 2 mm.

Trenton formation.—Collected by Mr. Roger, Peterborough, Ont. The writer has not been able to detect the presence of mural pores in the above two specimens from the typical locality.

SYRINGOPORIDÆ.

Genus Syringopora, Goldfuss, 1826.

(Petrefacta Germaniæ, t. I., p. 75.)

Harmodites, Fisher. 1828. Notice sur les Tubipores fossiles, p. 19.

Corallum fasciculate, more or less compact, or lax and spreading, composed of long, cylindrical, generally upright, subparallel, straight or

flexuous corallites that increase by lateral budding and are placed in communication with each other by hollow, cylindrical, horizontal tubes; septa represented by longitudinal rows of small sharply pointed spines; tabulæ irregularly funnel-shaped, invaginated, generally incomplete, often in the form of cystose plates inclined upward from near the centre of the corallites to the sides, typically leaving a central space; corallites at the base prostrate and either contiguous and forming a leaf-like expansion, or openly reticulated; epitheca with annular growth lines.

The distance apart of the corallites and their thickness vary considerably in different species. The hollow connecting processes are obsolete and replaced by a single circular opening when the corallites by flexure or geniculation are brought into contact with each other. The tabulæ are typically somewhat funnel-shaped and form a more or less continuous tube-like space in the centre of the corallites, or they may consist of a variable number of plates resting on each other and curving obliquely upward toward the wall, but so arranged as to leave a central space; the number of cystose plates necessary to complete the circumference of a corallite is very variable. On account of their smallness the spiniform septa are seldom preserved.

Syringopora verticillata, Goldfuss.

Syringopora verticillata, Goldfuss. 1826. Petrefacta Germaniæ, vol. I., p. 76, pl. XXV., figs. 6*a*, 6*b*.
" " Billings. 1858. Rep. of Progress for 1857, Geol. Survey of Canada, p. 170.
" " Rominger. 1876. Geol. Sur. Mich., Foss. Corals, p. 79, pl. XXX., figs. 1 and 2.

Billings describes this species as "forming large masses, corallites nearly straight, about two lines in diameter, and from two to three lines distant; connecting tubes three or four lines distant, verticillating, or three or four radiating from the tube at the same level in different directions, like the spokes of a wheel." The specimen from which this description was taken was collected at the head of Lake Temiscaming, Que. (Niagara) by Sir Wm. E. Logan in 1845. The original specimens referred to by Goldfuss are from Drummond Island (Niagara), Lake Huron.

In 1887 additional material was obtained by Dr. R. Bell at the north end of Lake Temiscaming, Que., and in 1893 and 1894 Mr. A. E. Barlow collected specimens on the Isle of Mann (Burnt Island) at the north end of the lake. In these specimens it is seen that the corallites in some individuals are so close together as to be nearly in contact, in which case the connecting bars are almost obsolete; in others the corallites

are not so crowded, or are comparatively distant from each other, as in Goldfuss's figure.

A favourite place for the commencement of the growth of the corallum, as is evinced by the Lake Temiscaming examples, was the rounded upper surface of hemispherically shaped masses of *Favosites*.

Formation.—Niagara.

Syringopora bifurcata, Lonsdale.

Syringopora bifurcata, Lonsdale. 1839. Murch. Sil. Sys., p. 685, pl. 15 bis. figs. 11, 11*a*, 11*b*.

Growing in masses composed of upright, slightly geniculated corallites averaging 1½ line in diameter and at times nearly as much as 3 lines apart. The geniculations of the corallites are on an average about 5 lines apart, and on account of these changes in the direction of their growth, the corallites are frequently brought almost into contact with each other. Connecting bars or tubes, stout, short, occurring at the geniculations or where the corallites are close together, or if the corallites are comparatively strait and parallel to each other, about 3 or 4 lines apart. The outer surface of the corallites is roughened by moderately strong but irregular annulations. In other respects this species presents nothing unusual in its structure.

Niagara formation.—Cape Wingfield, Lake Huron. A. Murray. 1861; Isle of Mann (Burnt Island), Lake Temiscaming, Que. A. E. Barlow. 1893.

Lower Helderberg group.—L'Anse à la Vieille, Que. R. Bell. 1862 (identified by E. Billings); "The Forks" Scaumenac River, Que., and 1 mile east of the Little Cascapedia River, Que., R. W. Ells. 1883.

Syringopora Dalmanii, Billings.

Plate II., fig. 2.

Syringopora Dalmanii, Bill. 1858. Rep. of Progress, for 1857, Geol. Survey of Canada, p. 169.

"Forming large masses; corallites long, sub-parallel, slightly radiating, occasionally a little flexuous, annulated, one line or rather more in diameter, distant usually half a line, occasionally in contact or where flexures occur, more than one line apart; connecting processes very short, about two lines distant." (Billings.)

This species differs from *Syringopora bifurcata*, Lonsdale, principally in having a more compact and less robust form of growth; the corallites are straighter, closer together and of smaller diameter.

Niagara formation.—Head of Lake Temiscaming, Que. Sir Wm. E. Logan; north end of Lake Temiscaming Que. Dr. R. Bell. 1887.

Syringopora retiformis, Billings.

Plate II., fig. 3.

Syringopora retiformis, Billings. 1858. Rep. of Progress for 1857, Geol. Survey of Canada, p. 170.
" " Nicholson. 1874. Palæon. of Ont. p. 58.
Syringopora tenella, Rominger. 1876. Geol. Sur. Mich., Foss. Corals, p. 80. pl. 30, fig. 4.

"Forming large masses; corallites much geniculated, frequently anastomosing or connecting by stout processes; diameter of corallites about two-thirds of a line, distant from each other from half-a-line to a line and a half; distance of connecting processess one line to three lines, usually about two lines."

In this species, as in some others of the genus, the corallites show a certain variation in the regularity of their growth, especially in the basal portion of a corallum; instead of the corallites being in a general way parallel to each other they are sometimes lax in their mode of growth, a result probably due to disturbing influences during the life of the coral. This laxity of growth is apparent in a specimen from Owen Sound, Ont., which bears a striking resemblence to *S. tenella*, Rominger, as figured on plate XXX. of the Fossil Corals of Michigan. One of the principal characteristics of *S. tenella*, from the Niagara of Point Detour, Michigan and Drummond Island, Lake Huron, is the coming together of the corallites without the intervention of connecting tubes, a feature particularly noticeable in the above mentioned example of *S. retiformis* from Owen Sound. In other examples of *S. retiformis*, in which there is a more general parallelism of the corallites, it is difficult frequently to determine whether there are short connecting tubes present, or whether the corallites are in juxtaposition, at the geniculations. The corallites in *S. retiformis* are described as being "much geniculated, frequently anastomosing or connecting by stout processes." Judging from Dr. Rominger's description and figure the writer is led to believe that *S. tenella*, Rominger, is the same as *S. retiformis*, Billings. It may be well to state that the Niagara rocks extend in an apparently unbroken line from Point Detour and Drummond Island eastward to Owen Sound.

Niagara group.—Isthmus Bay, Lake Huron. A Murray; lot 13, concession 7, Derby township, county of Gray, R. Bell; Owen Sound, Ont., J. Townsend, 1882.

SYRINGOPORA INFUNDIBULA, Whitfield.

Syringopora infundibula, Whitfield. 1877. Ann. Rept. Geol. Surv., Wis., p. 79.
Cystostylus infundibulus, Whitfield. 1882. Geol. of Wisconsin, p. 274, pl. XIV., fig. 7.
Cystostylus infundibulus, Whiteaves. 1884. Palæoz. Foss. vol. III., pt. I., p. 2 and 1895, pt. II., p. 49.

Cystostylus infundibulus is described (op. cit.) as having "transverse diaphragms represented only by deeply funnel-formed, imperfect plates or cysts, appearing on the broken surface as a series of deep inverted cones or funnels, placed one within the other so closely as to produce by their united tubes an almost or quite continuous columella along the centre of the corallite; the cystose plates are never continuous around the whole circumference, but are so closely arranged that from two to four may be counted in a length equal to the diameter of the tube."

The tabulæ in the corallites of *Syringopora* are generally stated to be funnel-shaped. Nicholson, in the Palæozoic Tabulate Corals, p. 208, qualifies this by describing them as "well developed, usually more or less regularly funnel-shaped, and often giving rise to a more or less continuous tube occupying the axis of the visceral chamber." On p. 211 of the same work excellent figures are given, of the corallites of *S. reticulata*, Goldfuss (the type of the genus) as seen in longitudinal and horizontal sections showing the inner structure. The tabulæ are here shown to be imperfectly funnel-shaped, as a rule not continuous round the inner circumference of the corallites and to have their regularity broken at times by the introduction of cysts or blisters such as are found in *Cystiphyllum*. The inner structure of the corallites, as shown in these figures, is a fair example of what is to be found in most of the Palæozoic species of *Syringopora* in Canada.

Judging from the figure appended to the description of *Cystostylus infundibulus*, Whitfield, there is nothing in the structure of this coral, in the writer's opinion, to necessitate its removal from the genus *Syringopora* as generally understood. It is possible that *Cystostylus infundibulus* may be found to be not distinct from *S. verticillata*, Goldfuss.

The coral described by Prof. R. P. Whitfield occurs in the upper part of the Niagara group of Wisconsin, in the vicinity of Wauwatosa and Milwaukee. It is stated to have been found only in the solid limestone, the inner structure being revealed on fractured surfaces but the exterior surface of the corallites has not been seen.

In specimens of this species from the Guelph formation at Durham, Ont., the coral is preserved in a manner similar to that of the Wisconsin specimens. The general disposition of the corallites with their connecting tubes is well shown, as is also the inner structure.

Guelph formation.—Durham, Ont. J. Townsend, 1883.

Mr. Whiteaves has recorded the occurrence of this species at New Hope (now called Hespeler), E. Billings, 1857 : Elora, David Boyle : as well as at Durham, J. Townsend, 1883.

Syringopora compacta, Billings.

Syringopora compacta, Billings. 1858. Rep. of Progress for 1857, Geol. Survey of Canada, p. 169.

"Forming large hemispherical masses of straight parallel or slightly diverging corallites, which are so closely aggregated as to compose a nearly sclid mass ; about six corallites in two lines.

"This species differs from all others of this genus hitherto described in the closeness of the corallites. These are so small, straight and closely united that large masses broken in the longitudinal direction of the tubes have the aspect of some species of *Monticulipora*." (Billings.)

In *Syringopora compacta* the corallites are seldom more than ·33 mm. apart and often at frequent intervals they are contiguous. The connecting tubes are necessarily very short, and, when the corallites touch each other, they are replaced by circular openings like the pores of *Favosites*. The average diameter of the corallites is about ·66 mm. The corallites seen in longitudinal section present the usual deeply depressed or irregularly funnel-shaped diaphragms distinctive of the genus.

Lower Helderberg formation.—L'Anse à la Vieille, Que. Sir Wm. E. Logan. 1843.

Syringopora Maclurei, Billings.

Syringopora tubiporoides, Billings. 1858. Rep. of Progress for 1857, Geol. Survey of Canada, p. 171.
" " Billings. 1859. Canadian Journal, new series, vol. IV., p. 115, fig. 17.
Aulopora cornuta, Billings. 1859. Ibid. vol. IV., p. 118, fig. 20.
Syringopora Maclurei. Billings. 1860. Ibid. vol. V., p. 258.
" " Billings. 1863. Geology of Canada, p. 366, fig. 366.
" " Nicholson. 1874. Palæon. of Ont., p. 41.
" " Nicholson. 1875. Geol. Surv. of Ohio, vol. II., p. 241.
" " Rominger. 1876. Geol. Sur. Mich., Foss. Corals, p. 82, pl. XXXI., figs. 1, 2 and 3.

"This species is found in large masses of long slightly flexuous corallites. These have a diameter of about one line and a half, and owing to their flexuosity, are at times in contact, and often two, three or four lines apart. In large colonies which have grown luxuriantly without the interference of disturbing causes, the corallites are more regular than in the smaller or

stunted groups, in which the corallites are much bent and confused. The connecting processes are very short and distinct, and appear to be sometimes mere inosculations of the stems. The corallites after growing separately for a short distance, approach each other and seem to grow together or adhere to each other for the space of a line and a half or more, they then diverge and again unite. These points of contact occur at distances varying from three lines to six, nine, or even twelve lines. Externally they exhibit numerous other indistinct annulations, and also faint indications of longitudinal striæ." (Billings.)

In 1860 Mr. Billings, who had previously identified this species with *S. tubiporoides*, Yandell and Shumard, found that it was really quite distinct and proposed the specific name *Maclurei* for the Canadian coral. He also qualified the original description by stating that the average diameter of the corallites is more nearly one line than one line and a half (vide Can. Jour., vol. V).

The exterior of the corallites of this species presents a rather smooth surface, the annulations or lines of growth being faint and indistinct, but indications of longitudinal striæ have not been observed by the writer. The diameter of the corallites varies in different specimens from $1\frac{1}{2}$ to 1 line, and there is a certain amount of variation in individual specimens; the average thickness appears to be slightly over 1 line or about 2·5 mm. In specimens with very flexuous corallites the growth seems to be more robust than when the corallites are comparatively straighter and closer together. Connecting tubes proper, though seldom seen, are short and stout, most frequently the corallites touch each other and are brought into communication with each other without the intervention of tubes.

The writer has examined the type specimens of *Aulopora cornuta*, Billings, in the museum with a view to the elucidation of, if possible, some of its characters. The fossils are fragments only and have been damaged by the action of acid so that many details of structure are lost. On a close examination, however, the broken ends of some of the tubes show what appear to be the remains of "infundibuliform tabulæ," seen in cross section, with evidences of a central tube. Also, a longitudinal section obtained by rubbing down one of the branches, revealed the usual syringopora-like structure, from which the writer is led to believe that this fossil should properly be referred to the genus *Syringopora*. Further, a comparison of the types of *Aulopora cornuta* with examples of *Syringopora Maclurei*, Billings, suggests the probability that the former species was founded on portions of the basal growth of the latter species.

Dr. Rominger (op. cit, p. 71) regards *A. cornuta* as a synonym of *Romingeria umbellifera*, but seems to be guided entirely by external char-

acters. In the writer's opinion he does not prove conclusively that the fossils described by Billings are referable to *R. umbellifera*, in fact the inner structure of the types of *A. cornuta* leads to quite a contrary conclusion.

Devonian.—Abundant in the Corniferous limestone of Ontario. Also Long Portage, Missinaibi River to Moose Factory (Corniferous), R. Bell, 1877.*

Syringopora perelegans, Billings.

Plate II., fig. 4.

Syringopora elegans, Billings. 1858. Rep. of Progress for 1857, Geol. Survey of Canada, p. 172.
Syringopora perelegans, Billings. 1857. Canadian Journal, new series, vol. IV., p. 117, fig. 19.
" " Billings. 1863. Geology of Canada, p. 366, fig. 368.
" " Nicholson. 1874. Palæon. of Ont., p. 41.
" " Rominger. 1876. Geol. Sur. of Mich., Foss. Corals, p. 81, pl. XXXI., part of fig. 2 and fig. 4.†

"Corallites one line in diameter, sometimes a little more or less, distant a little less than one line, connecting tubes half a line in diameter, and distant from one line to one line and a half, usually projecting at right angles, but sometimes a little oblique. Epitheca with numerous annulations, generally indistinct, but under certain circumstances of growth sharply defined and deep, so much so as to give to the corallites the appearance of the jointed stalk of a crinoid. The young individuals are produced by lateral budding, and in one specimen examined the whole colony appears to be based upon a broad lamellar foot secretion like that which forms the base of a Favosite.

"The distance of the corallites is usually about a line, but like all the other species, this one varies a good deal in this respect. When some cause has intervened to prevent their regular growth they are much flexed, and consequently at times more distant than when they have been undisturbed. The connecting tubes on the same side of the corallite are three or four lines distant, but generally on the other sides one or two others in the same space occur, making the average distance one line or one line and a half." (Billings.)

* Geol. Survey of Canada, Rep. of Progress for 1877-78, p. 5c, Provisional list of fossils collected between the Long Portage of the Missinaibi branch of the Moose River and Moose Factory, by Mr. Whiteaves, in Dr. Bell's Report on the east coast of Hudson's Bay.

†Fig. 3, pl. XXXI., evidently represents a specimen of *S. Maclurei*, Bill.

The corallites of this species are as a rule moderately straight and seldom approach each other close enough to be in contact, they are connected together by straight tubes of about half the thickness of the corallites themselves, and are frequently deeply constricted at intervals of about 1·2 mm., sometimes more and often less. In some specimens the corallites are often two lines apart.

From different specimens in the survey collection it is seen that the base of the corallum may consist of an open reticulation of prostrate corallites, or that the corallites, diverging from one or more centres and closely packed together in one plane, may form a single undulating leaf-like horizontal basal expansion, with at times secondary ones parallel to and at no great distance above the main one. Dr. Rominger figures* a portion of the latter form of basal expansiou of this species; the sudden up-bending of the corallites is well shown.

The name of this species was changed by Mr. Billings from *S. elegans* to *S. perelegans*, the former name being preoccupied, as stated in a footnote on page 117 of volume IV, of the Canadian Journal.

This species differs from *S. Maclurei* in having corallites that are slenderer, much more strongly annulated, straighter and therefore more nearly parallel to each other, and in having the connecting tubes more highly developed. Dr. Nicholson considers it to be nearly related† to *S. reticulata*, Goldfuss, from the Carboniferous rocks of Europe.

Devonian.—Abundant in the Corniferous limestone of Ontario. Long Portage, Missinaibi River to Moose River (Corniferous), R. Bell, 1877.

Syringopora Hisingeri, Billings.

Syringopora Hisingeri, Billings. 1858. Rep. of Progress for 1857, Geol. Survey of Canada, p. 172.
" " Billings. 1859. Canadian Journal, new series, vol. IV., p. 116, fig. 18.
Aulopora filiformis, Billings. 1859. Canadian Journal, new series, vol. IV., p. 119, (not of Nicholson.)
Syringopora Hisingeri, Billings. 1863. Geology of Canada, p. 366, fig. 367.
" " Nicholson. 1874. Palæon. of Ont., p. 40.
" " Rominger. 1876. Geol. Sur. Mich., Foss. Corals, p. 84, pl. XXXII.
Aulopora filiformis, Whiteaves. 1891. Contr. to Can. Palæon, vol. 1, pt. III., p. 211, pl. XXIX., fig. 1.

"This species forms large masses of very long, nearly parallel or slightly varying, slender corallites, which are closely aggregated and

*Op. cit vide supra, fig. 2.
† Palæontology of Ontario, p. 41. 1874.

present a rugged or knobby appearance from the great number of the connecting tubes. The diameter of the corallites is one-third of a line, or a little more. The tubes of connection are distant from two-thirds of a line to one line and a half. The distance between the corallites is for the greater part less than their diameter. The young corallites branch from the sides of the adult individuals, and immediately become parallel with the parent, and connected with it again by the usual tubes of connection." (Billings.)

S. Hisingeri seems to have had, as a rule, a comparatively small base of attachment and to have had an upright growth with the height much greater than the breadth. As in *S. perelegans*, the corallum began its growth as an aggregation of flattened, prostrate corallites, forming a lamellar or an open reticulated base, from which at regular intervals the corallites ascend by a sudden upturn. The corallites in some specimens reach a thickness of half a line.

Mr. Billings was of the opinion that this species is closely allied to Edwards and Haime's *S. Verneuili* and *S. Cleviana*, both from the Onondaga and Corniferous limestones of Ohio. Unfortunately the Ohio specimens were not figured, and in the case of the last named species the description is very meagre and altogether inadequate. As regards *S. Verneuili* it differs, judging from the very short description, from *S. Hisingeri* in having its corallites much farther apart. In the numerous specimens belonging to the collection of this survey, the corallites are seen to be almost always separated by a space equal to or less than their diameter, whereas in *S. Verneuili*, the corallites are said to be distant two or three times their diameter.

Devonian.—Found in the Corniferous limestone of Ontario; Long Portage, Missinaibi River to Moose Factory (Corniferous), R. Bell, 1877.*

An examination of the type of *Aulopora filiformis*, Billings, has led to the conclusion that it belongs to the genus *Syringopora* and is most likely the basal reticulation of *Syringopora Hisingeri*, Billings. The specimen described by Billings is adherent to and covers a dorsal valve of *Streptorhynchus Pandora*, Bill. with an open reticulation of prostrate tubes which are attached to the shell by the entire lower surface. Toward the centre and on one side of the reticulation the tubes rise to a greater height than elsewhere and are connected together by transverse processes. The broken ends of some of the tubes show in transverse section what appears to be a syringopora-like structure, viz.: the remains of a central tube and of, though less clearly, invaginated tabulæ. On account of the slenderness of the tubes and the damage already done to the specimen by having been

* See foot-note on page 56.

immersed in acid, it was found impracticable to obtain a longitudinal section of them. The presence alone of transverse bars connecting adjacent corallites would probably justify, without further corroboration, the conclusion that in *Aulopora filiformis* we have a true *Syringopora*.

A comparison of the basal reticulation of one of the types of *Syringopora Hisingeri*, Billings, with the type of *A. filiformis*, shows the resemblance between the two to be so strong as to scarcely leave any doubt as to their being specifically identical.

That *A. filiformis*, Billings, is in all probability a *Syringopora* was first suggested by Mr. Whiteaves in 1891 (op. cit. p. 211). At this time, in describing *Hederella Canadensis*, Nicholson, he had occasion to refer to *A. filiformis*, Billings, and in connection with the latter species remarks that it appears to him "to be the immature state of a species of *Syringopora*."

The type specimen of *A. filiformis* bears the label Rama's Farm, Port Colborne, Ont., Corniferous limestone; E. Billings.

Syringopora nobilis, Billings.

Syringopora nobilis,	Billings.	1858. Rep. of Progress for 1857, Geol. Survey of Canada, p. 171.
"	"	Billings. 1859. Canadian Journal, new series, vol. IV., p. 118.
"	"	Nicholson. 1874. Palæon. of Ont., p. 40.
"	"	Rominger. 1876. Geol. Sur. Mich., Foss. Corals, p. 84, pl. XXXII.
"	"	Whiteaves. 1889. Contr. to Can. Pal., vol. I., pt. II., p. 120.

The original description of this species is as follows—"Corallites three lines in diameter, distant two to four lines. The connecting processes in this species have not been observed, but the size of the corallites is quite sufficient to separate it from any known species." In 1859, Mr. Billings (Can. Jour., vol. IV.) further says "This species is distinguished from all others of the genus by the great size of the corallites, which sometimes attain the diameter of five lines. In the young state the form is that of an *Aulopora*, but the adult specimens have branches three or more inches in length, with an internal arrangement of infundibuliform diaphragms, which are so blended together as to produce a structure somewhat similar to the vesicular tissue of the genus *Cystiphyllum*. The external wall is thick and rather strongly annulated."

Nicholson in the Palæontology of Ontario refers to this species in the following words—"Corallum lax, spreading, increasing by the production of lateral buds. Corallites very large, varying with age from one and a half to five lines in diameter, apparently not connected by transverse processes. Septa obsolete; tabulæ infundibuliform. Epitheca

thick, with encircling striæ and stronger annulations." He also considers it doubtful "if the species can with propriety be retained under *Syringopora*" principally on account of the apparent absence of transverse connecting tubes.

In the individuals upon which the original description was based connecting tubes were not seen, but Dr. Rominger (op. cit) figures a specimen in which a horizontal process connecting two corallites is clearly shown, proving beyond doubt that this coral has been properly referred to the genus *Syringopora* and that connecting tubes, though not generally seen, are still sometimes present.

From the specimens in the collection of this survey it is seen that on the inner surface of the corallites there are about twenty longitudinal rows of short septal spines. In each row the spines are about 0·5 mm. apart. The inner arrangement of upwardly and outwardly curved plates, which in the original description of the species are referred to as "infundibuliform tabulæ," is identical with that which is found in other species of the genus, and the more or less central space frequently left by the inclined imperfect tabulæ, and sometimes referred to as a "central tube" is also seen.

Devonian.—Corniferous limestone of Ontario; also in the Hamilton formation of Ontario.

Syringopora intermedia, Nicholson.

Syringopora intermedia, Nicholson. 1874. Palæon. of Ont., p. 126.
" " Whiteaves. 1889. Contr. to Can. Palæon., vol. 1, pt. II., p. 120.

"Corallum lax, spreading, increasing by the production of lateral buds. Corallites cylindrical, often more or less crooked, having a diameter of from one line to a line and a half, or rarely two lines, the lateral buds being produced at angles of from 90° to 40°, and at intervals of from two to four lines. No connecting horizontal processes between the corallites, but sometimes abortive spines or nodes. Epitheca with fine encircling striæ, and irregular growth-swellings and geniculations. Internal structure, of infundibuliform tabulæ." (Nicholson.)

The largest specimen seen by the writer was collected by Johnson Pettit, in the township of Bosanquet, Ont., in 1868; it is 4 inches long, $2\frac{1}{2}$ inches broad, with a maximum height of $2\frac{1}{2}$ inches and is evidently only a portion of the corallum. The corallites have an average diameter of $1\frac{1}{3}$ line and are about from 1 line to $1\frac{1}{2}$ line from each other, although they are frequently closer together and often coalesce. The corallum grows upward in an irregular manner from a spreading, prostrate net-

work of rapidly budding corallites; the irregularity of growth is caused by the constant twisting of the corallites, and the giving off of many young corallites at different angles. One specimen in the collection shows a basal reticulation, about three by two inches across, adherent to the upper surface of a *Favosite*.

Devonian.—Hamilton formation; township of Bosanquet, county of Lambton, Ont., Johnson Pettit, 1868, and Thedford, Ont., Rev. Hector Currie, 1882.

Syringopora reticulata, Goldfuss.

Syringopora reticulata, Goldfuss. 1826. Petrefacta Germaniæ, vol. I., p. 76, pl. XXV., fig. 8.
" " Nicholson. 1879. Palæoz. Tab. Corals, p. 215, fig. 30 and pl. X., fig. 5.
Syringopora (?) species, Whiteaves. 1877. Rep. of Progress for 1875-76, Geol. Survey of Canada, p. 98.

A specimen of *Syringopora*, referable to this species, was collected by Dr. A. R. C. Selwyn, at Fossil Point, on the Peace River, B.C. The corallites are slightly flexuous, about $\frac{5}{6}$ of a line (1·7 mm.) in average diameter, and distant from $\frac{1}{2}$ line to 1 line from each other; they are connected together by numerous moderately slender transverse tubes from 1 to 2 or 3 lines apart. In longitudinal and transverse sections the usual invaginated plate structure is seen.

The specimen of *S. reticulata* figured by Goldfuss is from Olne, in the province of Limbourg (lower Carboniferous) and Nicholson regards this species as one of the most characteristic fossils of the Carboniferous limestone of England. The rocks occurring at Fossil Point have been referred by Mr. Whiteaves (op. cit.) to the Devonian or Carboniferous formations.*

Devono—Carboniferous.—Fossil Point, Peace River, B.C. A. R. C. Selwyn. 1875.

Syringopora ramulosa, Goldfuss.

Syringopora ramulosa, Goldfuss. 1826. Petrefacta Germaniæ, vol. I., p. 76, pl. XXV., fig. 7.
" " McCoy. 1855. Brit. Palæoz. Foss., p. 83.
" " Edwards and Haime. 1851. Polyp. Foss. des. Terr. Palæoz, p. 289.

In the collection of this survey, is a specimen of *Syringopora* which appears to agree better with this species than with any other. Its corallites average in diameter about $1\frac{1}{2}$ line; they are slightly flexuous, often

*See reference to the "Banff limestones," on the next page.

almost touch each other, but are seldom distant more than 1 line. Transverse connecting tubes occur at rather long intervals. The inner structure is well preserved and consists of more than usually large inclined plates (funnel shaped tabulæ).

The Canadian fossil differs from the type of *S. ramulosa* principally in the corallites being somewhat straighter, and in there being apparently fewer connecting tubes. The principal point of agreement is the size of the corallites. The characters of the species as set forth by McCoy (op. cit.) sustain the writer in the opinion that the coral under consideration is in all probability more properly referable to this species than to any other of the genus.

S. ramulosa occurs in the Lower Carboniferous or mountain limestone of England (the "Eubergangskalke" of Goldfuss).

The specimen here referred to was collected in 1879, from the "Lower Banff limestone" by Prof. John Macoun, in the Bow River Pass, Alberta, about fifteen miles west of Morley, at the "Gap."

The "Lower Banff limestone" is a term applied by Mr. McConnell to the lowest division of a series of limestones and shales of Carboniferous age, found in the valley of the Bow River. It immediately overlies limestones that in his opinion represent the Devonian in that locality. Mr. McConnell also believes that the limestones of Fossil Point, Peace River, from which the specimen of *S. reticulata* previously mentioned, was obtained, are the same as those found at the base of the Banff limestones in the Bow River Pass.

Genus Cannapora, Hall.

The generic characters of this genus are given by Rominger (Fossil Corals of Michigan) in the following words,—"Colonies of closely approximated, erect tubules, with stout walls, sprouting from an incrusting basal expansion formed of prostrate tubules growing and multiplying in the same manner as an *Aulopora*. The erect ends of the tubules are annulated by wrinkles of growth and by sharp-edged, periodical offsets marking an interruption and renewed growth from the inner circumference of the old orifices. The sides of the tubes are partly connected by horizontal expansions of the walls, partly in direct contiguity, in which latter case the otherwise circular tubes are pressed into a polygonal shape, and connect in the contiguous parts by lateral pores. The orifices are slightly dilated at the margins, radiated by twelve spinulose projections, rows of which extend through the whole length of the tubes. Diaphragms are not often developed,* direct transverse, and not funnel-shaped as in *Syringopora*."

* The diaphragms are, judging from specimens from Ontario, horizontal, numerous and placed rather close together, but are frequently not preserved.

Cannapora junciformis, Hall.

Cannapora junciformis, Hall. 1852. Palæon. New York, vol. 11, p. 43, pl. XVIII., figs. 1*a—f*.
Cannapora annulata, Nicholson and Hinde. 1874. Canadian Journal, new series, vol. XIV., p. 154.
" " Nicholson. 1875. Palæon. of Ont., p. 58.
Syringopora junciformis, Rominger. 1876. Geol. Sur. Mich., Foss. Corals, p. 85, pl. XXXIII., fig. 4.
Syringopora fibrata, Rominger. 1876. Ibid, p. 81, pl. XXX., fig. 3.

The original description and figures of this species and the general characters assigned to the genus, of which this species is the type, are necessarily imperfect on account of the poor state of preservation of the specimens primarily at Professor Hall's disposal.

The Niagara rocks of Ontario have yielded specimens in which the general form of growth is seen to better advantage and the inner structure is more clearly defined. A certain amount of variation, often accentuated by the state of preservation of the fossils, is noticeable in the size of the corallites and in the surface markings.

In this species the corallites are very close together, parallel, nearly straight, and annulated by more or less well defined sharp-edged ridges which are prolonged at intervals and serve as a means of connection between contiguous corallites. The base evidently adhered to foreign objects and is made up of an aggregation of close-set, prostrate corallites, diverging from one or more centres and forming a crust from which the corallites at regular intervals grew erect. This basal lamellar expansion is formed on the same principal as that of some species of *Syringopora*. Corallites from about 0·75 to 2 mm. in diameter in different specimens. Tabulæ rather regular in disposition, horizontal, close set. Septa spiniform, occurring in about twelve longitudinal rows.

The corallites in the specimens available for study in this museum show a decided variation in the amount of development of the annulations as well as in the size of the corallites themselves. One example from the vicinity of Owen Sound, Ont., bears a strong resemblance to the specimen figured by Hall (op. cit. pl. XVIII., fig. 1*b*) in having comparatively smooth tubes, another from the same locality, with strongly annulated corallites, agrees more with the form described by Nicholson and Hinde under the specific name *annulata* but which is, in the writer's judgment, not separable from Hall's species, or at the most could only be regarded as a variety.

Springopora fibrata, Rominger (op. cit.) from the Niagara of Drummond Island, Lake Huron, seems to belong to this species, and is represented, in the museum collection, by some specimens from this

locality as well as from the vicinity of Owen Sound, Ont. These specimens are silicified, and in many cases deceptive in appearance on account of the apparent smaller diameter and greater distance apart of the corallites. The apparent smallness of the corallites is due to the fact that in some cases the silicious casts only of the tubes remain, which are connected together by horizontal processes. These connections are evidently the casts of the "lateral pores" by which, according to Rominger, the contiguous corallites of *Cannapora* are placed in communication with one another. In a specimen from Owen Sound, a weathered surface presents the appearance of *Syringopora fibrata*, but on the other side of the same specimen, where the corallites have been less exposed, the true characters of the coral are apparent. On the weathered side comparatively distant casts of corallites, about ·5 mm. in diameter, are seen, whilst on the other side the corallites themselves are shown, about 1 mm. in average diameter, very close together and indistinguishable from specimens of *Cannapora junciformis* from the same locality, in which the more or less annulated tubes, horizontal tabulæ and spiniform septa are better preserved.

Niagara formation.—Lot 13, concession 2, township of Derby, county of Grey, Ont., R. Bell; and at Owen Sound, Ont., J. Townsend. 1874.

2. Alcyonaria.

HALYSITIDÆ.

Genus Halysites, Fischer. 1813.

(Zoognosia, 3rd ed., t. 1, p. 387.)

Catenipora, Lamarck. 1816. Hist. des An. sans Vert., t. ii., p. 206.

Corallum reticulate and fasciculate, made up of long, upright, cylindrical corallites that are either joined to each other by their edges in a chain like series so as to form vertical, anastomosing laminæ inclosing interspaces of variable size, or the laminæ are approximated so that their corallites are contiguous or nearly so, while the interspaces are reduced to a minimum; between each pair of corallites in any particular lamina a tubule is generally present, parallel to and of the same length as the corallites; tabulæ numerous, complete, horizontal, occurring both in the corallites and the tubules; septal spines in twelve longitudinal rows in the corallites; a horizontally striated epitheca covers the free sides of the corallites.

Of the genus *Halysites* two species are known to occur in Canada, viz., *H. catenularia*, L. and *H. compacta*, Rominger.

Taking into consideration the first named species, it is seen that specimens of this coral differ materially, not only in the size and shape of the corallites and the meshes or spaces which they inclose, but if the inner structure is studied by means of longitudinal and transverse sections, it will be apparent that differences exist here also.

The size and form of the corallites and meshes have been used as a basis for the separation of the "chain-coral" into species and varieties, and Professor H. Alleyne-Nicholson has proposed an arrangement dependent on the internal structure, still there remains some doubt as to whether a number of well defined species exist or whether there is only a single species with perhaps some varieties.

If an arrangement according to the outside form be attempted, or if the inner structure be relied on only as a basis for classification, it will be found almost impossible to arrive at satisfactory conclusions.

The variations in the general manner of growth of the corallum (caused by the size and shape of the corallites and inclosed spaces) and the marked differences to be found in the inside structure, appear to be sufficiently constant at different geological horizons to allow of varieties with certain characteristics being considered distinctive of the horizons in which they are found.

The examination of a large number of Canadian specimens shows that not only do they vary in the size and shape of their corallites and of the inclosed spaces, but they also differ in their internal structure to a very considerable extent, with variations between the extreme forms. As regards the mere outward shape so great a diversity exists that it is almost possible to trace a gradual transition of such forms with small corallites and meshes as *H. catenularia* var. *micropora*, Whitfield, to those with large corallites and meshes similar to *Catenipora labyrinthica* of Goldfuss. In the same individual the size and shape of the meshes may change to a marked degree: as for example, in a specimen from the Niagara limestone of Ontario, the manner of growth is found to be similar in one portion of the corallum to that of *H. escharoides*, Lam., as figured by Goldfuss, with small but rather regularly shaped meshes and in another part to that of *H. agglomerata*, Hall, with rows of corallites running in parallel lines. The corallum seems to have adopted the latter mode of growth when its lateral expansion was interfered with or restricted.

The corallites show a marked difference in their size and shape as seen in horizontal section. In a specimen from the Lower Helderberg rocks near the mouth of the Little Cascapedia River, Que., the corallites measure as much as 4 mm., by 2·5 mm., but in another specimen from the north-east side of the Columbia River near

Donald, B.C. (Silurian) they do not exceed ·7 mm. by ·45 mm. in size; between these extreme forms may be found specimens with corallites of various sizes. Corallites that are markedly quadrangular in transverse section are met with, as well as those, in diffferent specimens, that are almost quadrangular, oval, both broadly and narrowly oval and circular, whilst both circular and oval corallites frequently occur in the same specimen. *H. gracilis*, Hall, was separated as a distinct species principally on account of its corallites being "quadrangular" as seen in horizontal section; as will be seen further on, there are other reasons for still considering it as distinct from the typical form of *H. catenularia*, at least as a variety indicative of distinct geological horizons.

If after finding so many transitions in outward appearance between extreme forms of this coral as to render a specific classification upon this basis alone extremely difficult, if not impossible, one passes on to an examination of its internal structure, difficulties arising from transitional changes are again met with. Nicholson has adopted a classification of the different forms based on a microscopical study of the internal construction, and has separated them into two groups; in one he places those forms in which the corallites are found apparently contiguous, in the other those having a tabulate space of variable width separating the corallites. In his "Manual of Palæontology," 3rd ed. vol. I., p. 339, Dr. Nicholson observes "The species of *Halysites* may be divided into two groups, according as the corallum is composed throughout of corallites of one size or consists of two sets of corallites of different sizes. The common *H. escharoides* of the Silurian rocks is an example of the forms in which the corallites are similar. On the other hand, in the familiar *H. catenularia* of the same formation, the corallum consists of large corallites separated by the intervention of small closely tabulate tubes." An examination of the structure of Canadian specimens reveals the fact that in different specimens the small closely tabulate tubes or tubules described by Nicholson are not constant in their proportionate size to the corallites and differ in size from those which are wider than the corallites themselves to those which have a scarcely appreciable width, making a gradual transition to the forms in which the tubules appear to be obsolete. In a specimen from l'Anse au Gascon, Baie des Chaleurs (Lower Helderberg) the tubules sometimes exceed the corallites in width and are furnished with very close set tabulæ which have an almost vesicular appearance on account of the introduction of secondary tabulæ; the tabulæ are depressed in the centre and are bent downward at their edges. In the Niagara formation in Ontario examples occur in which the tubules are slightly less than one half the width of the corallites, but the majority of the specimens from this formation in Ontario, at Lake

Temiscaming, at Cross Lake Rapids on the Saskatchewan River and at Cedar Lake, and from rocks of nearly if not the same age in Anticosti, the tubules are from $\frac{1}{7}$ to $\frac{1}{3}$ the width of the corallites.

Particular stress has been laid on the presence or absence of septal spines by Dr. Nicholson. In his "Palæozoic Tabulate corals," p. 229, it is stated that "the form known as *H. escharoides*, Lam., is distinguished from the typical *H. catenularia*, Linn., not only by the superficial characters just mentioned,* but also by the constant possession of spiniform septa, and the apparantly constant absence of small tubes between the large ones." This is not borne out, however, by Canadian specimens. An example from the Niagara limestone of Ontario has tubules between the corallites admirably shown as well as rows of septal spines; other examples with tubules and septal spines have been collected at Lake Temiscaming (Niagara), at Cross Lake Rapids on the Saskatchewan River and at Cedar Lake (Niagara) and from the Lower Helderberg rocks of l'Anse-au-Gascon, l'Anse à la Barbe, &c., Baie des Chaleurs. When the tubules are present and the septal spines are not seen, it is possible that the latter, on account of their small size, have not been preserved or are not sufficiently distinct to be recognized.

The gradation of one form of *H. catenularia* into another would lead to the belief that it consists of one typical form with several stratigraphical varities; the typical form not being the oldest.

It is found however that the *Halysites* of different geological horizons have distinctive characteristics which are apparently constant. This is important as affording a guide to the determination of the relative ages of the earlier Palæozoic rocks in this country, and as placing a value on the occurrence of *Halysites* in these rocks far greater than it has hitherto had.

Taking *H. catenularia*, *L.*, as the type of the species and regarding the coral as found in rocks of Niagara age, and distinctive of that formation in Canada, as its equivalent in this country, it is the opinion of the writer that the divergent forms, whilst sufficiently distinct for varietal differentiation, would scarcely admit of specific separation: they are here regarded as varieties yet distinctive of definite horizons.

A table,† for comparative use, has been prepared from data obtained from Canadian specimens, the property of the Geological Survey, giving measurements of the corallites and tubules, the shape and distance apart of the tubulæ, and stating whether septal spines have been observed or not, with the name of the collector, date of collection and formation

* The size of the tubes (corallites) and the dimensions of the meshes of the corallum.
† Page 74.

from which the specimens were obtained. From this table it can be seen that *H. catenularia* and its varieties range from the Black River limestone at the base of the Trenton formation up to the rocks of the Lower Helderberg group; and that the Black River limestone in eastern Canada, the Galena-Trenton of theLake Winnipeg region, &c., in the west, the Hudson River, Niagara, Guelph and Lower Helderberg formations have their distinctive varieties.

Mr. Whiteaves has drawn my attention to the fact that the chain coral was collected (probably for the first time in North America) at Drummond Island, Lake Huron, by Dr. J. J. Bigsby, in 1819 or 1820 (see p. 204 of the first volume of the second series of the Transactions of the Geological Society of London, published in 1824). Also that the next mention of *Halysites* as occurring in Canada, if not in America, was made by William Henry Fitton, M.D., F.R.S., G.S., &c., on p. 559 of appendix No. 4 to the "Narrative of the Arctic Land Expedition to the mouth of the Great Fish River, and along the shores of the Arctic Ocean, in the years 1833, 34 and 35, by Capt. Back, R.N., London, 1836." In reference to the limestone fossils brought by Capt. Back, from Lake Winnipeg, Dr. Fitton says..... "There is also one specimen which, though not in good preservation, is doubtless a *Catenipora* or chain-coral,....." The exact locality is not given, but the fossil is in all probability the same as one of the forms from Lake Winnipeg or vicinity mentioned in the table accompanying this paper.

Halysites catenularia, L.

Plate III., figs. 1, 1*a*, 1*b*, 2, 2*a* and 3, 3*a*.

The typical form as identified by United States and Canadian palæontologists under this name, or that of *Catenipora escharoides*, Lam., and *C. agglomerata*, Hall.

The most typical form of the chain coral, in the writer's judgment, occurs in the Niagara formation of Ontario, at and near Owen Sound, on Cockburn Island, and at Lake Temiscaming; near the mouth of the Saskatchewan River; and in rocks of nearly if not the same age in Anticosti and near Donald, B.C.

The specimens show a considerable variation in the size of the meshes, within certain limits, as can be seen from the table of measurements; tubules are present between the corallites, averaging about ·5 mm. in width, and having close set, almost at times vesicular, strongly arched tabulæ; septal spines are well preserved in some specimens, in others they are only indicated and at times not preserved.

Specimens have been collected from the Guelph formation which are possibly referable to the typical form; they are preserved in the char-

acteristic yellow dolomite, and do not show any very minute details of structure ; there are indications of spiniform septa, but tubules so far have not been recognized with any degree of certainty, although there are evidences of what might be tubules with rather arched tabulæ. Mr. Whiteaves records the occurrence of *H. catenularia* in the Guelph formation of Ontario (vide Pal. Foss. vol. III., pt. II., p. 47), at Guelph, collected by E. Billings, 1857 ; at Elora, R. Bell, 1861 ; at Hespeler, T.C. Weston, 1867 ; and at Durham, J. Townsend, 1878—82.

Halysites catenularia, var. Quebecensis. (Var. nov.)

Plate IV., figs. 1, 1*a*, 1*b*.

In the Geology of Canada, 1863, p. 165, Billings mentions the occurrence of *H. catenularia* at Lake St. John, Que. Speaking of the lower Silurian strata exposed between the mouth of the Metabechouan River and Blue Point, he says, "the lower rocks of the series are limestones, and their fossils indicate that they belong to the Birdseye and Black River and Trenton formations."..... The chief part of the limestones are of a yellowish-grey, and at the Ouiatchouan in a three foot bed of this description at the base of the series..... there was met with *Halysites catenulatus*, in no other place found so low on the American continent." The specimens from this locality bear a strong resemblance in outward form to *H. escharoides*, Lam., as figured by Goldfuss in the Petrefacta Germaniæ, vol. 1, figs. 4*a*, 4*b*. 4*c*. In most of the specimens the inner structure is difficult to make out, but in one specimen in particular remarkably narrow tubules are observed. The corallites are oval and the tabulæ rather flat and not very close together. This variety can be recognized by its general form of growth with small meshes and rather small corallites, and by the presence of very narrow tubules with rather distant, flat tabulæ. Some of the most perfect specimens are hemispherical in shape and attain a breadth of 6 to 8 inches.

Halysites catenularia, var. gracilis, Hall.

Plate III., figs. 5, 5*a*, 5*b*, 6 and 7.

Catenipora gracilis, Hall. 1851. Geol. Lake Superior Land Dist., vol. 2, p. 212, pl. XXIX., fig. 1*a*, 1*b*.

This form is distinctive of the Galena-Trenton, as it occurs at Lake Winnipeg and further north, and of the Hudson River formation in Anticosti and the province of Ontario. Hall described this form in 1851 as a distinct species under the name *H. gracilis*. The rocks of Hudson River age at Green Bay, Wisconsin, from which the specimen described

by Hall (op. cit.) was obtained are seen further to the east in the Manitoulin Islands. The original description is as follows—"Coral massive, or hemispheric; cells quadrangular or sub-oval; walls thin; interspaces rarely thicker than the walls; arranged in a single series, in wide irregular reticulations. This species differs from the *C. escharoides* in the almost quadrangular form of the cells and the extremely thin walls, the reticulations are wider and the whole aspect less solid than in that species. From *C. agglomerata*, it differs essentially in the form and arrangement of the cells."....."Eastern shore of Green Bay, Wisconsin." What is particularly noticeable in this variety is the marked angularity of the corallites, their sides being flattened, and the apparent absence of tubules between them. The longitudinal rows of septal spines are beautifully preserved in some specimens, especially in a few from East Selkirk, Manitoba. The variability of the size of the meshes is again seen in this variety, showing that something apart from the mere shape of the corallum is necessary for differential use.

Halysites catenularia, var. micropora, Whitfield.

Plate III., fig. 4.

Halysites catenulatus, var. *microporus*, Whitfield. 1882. Geol. of Wisconsin, vol. IV., p. 272, pl. XIII., fig. 6.

In the Niagara formation of Ontario specimens are met with that have very small corallites. These are similar to the specimen, already mentioned, from near Donald, B.C. (Silurian) and one from the Jumpers, Anticosti (Silurian). In most of the specimens seen the meshes are rather small, but in some they are comparatively large and irregular. In none, however, was the inside structure seen by means of sections, so that the writer is unable to state whether tubules are present or not, nor could this be decided from the fossils when examined at the surface.

This form appears to be similar to *H. catenularia*, var. *micropora*, Whitfield, from the Niagara group of Wisconsin; its corallites are of about the same size, nearly twenty occurring in the space of 1 inch.

Pending further knowledge of the details of its structure, this small form is, for the present, referred to the Wisconsin variety.

Halysites catenularia, var. simplex. (Var. nov.)

Plate IV., figs. 3, 3*a*.

The principal characteristics of this variety are, the large size of its corallites, its long narrow meshes and the absence of tubules. A single

specimen was obtained from rocks of Lower Helderberg age, near the mouth of the Little Cascapedia River, Que.; it is preserved in limestone and there is no evidence of tubules being present; what appear to be septal spines are indistinctly seen.

Halysites catenularia, var. amplitubulata. (Var. nov.)

Plate IV., figs. 4, 4*a*.

This might rightly be considered the most striking of the varieties of this species; in it the tubules are found to be as large as and even larger than the corallites themselves. It occurs in the Lower Helderberg rocks of l'Anse à la Barbe and l'Anse au Gascon, Que. Only portions of different coralla were collected, so that it is difficult to make out exactly its general form of growth, although it appears to be rather spreading. The details of structure are stated in the accompanying table and the figures will give an idea of the great development of the tubules. Septa have not been seen. The tabulæ of the tubules are noticeably coalescent; they are close set, concave at the centre and abruptly bent down at the edges. The corallites are almost circular and their tabulæ are comparatively regular and distant.

Halysites catenularia, var. nitida. (Var. nov.)

Plate IV., figs. 2*a*, 2*b*.

A number of specimens, sometimes in masses 6 inches and more across, from the Lower Helderberg rocks found at l'Anse à la Barbe and vicinity, Baie des Chaleurs and Neigette Falls, near Rimouski, Que., represent this variety in the collection. The meshes made by the corallites are small; the corallites themselves are small, oval in section and separated by moderately narrow tubules; in longitudinal sections the compactness and regularity of the tabulation of both the corallites and tubules is noticeable. Septal spines are present.

Halysites compacta, Rominger.

Plate IV., figs. 5, 5*a*, 6, 7 and 8, 8*a*.

Halysites compactus, Rominger. 1876. Geol. Sur. Mich., Foss. Corals, p. 78, plate XXIX., fig. 3.
" " Whiteaves. 1884. Palæoz. Foss., vol. III., pt. I., p. 2.
Halysites agglomeratus var. *compactus*, Whiteaves. 1895. Ibid, vol. III., pt. II., p. 48.

This species is thus defined in Dr. Rominger's work on corals: "Tubes * oval, in chain-like, lateral conjunction, but these laminæ are so closely approximated, that no retiform loops are formed by them; they come in contiguity with each other from all sides, and leave only small, angular, lacunose interstices in the corners of their intersection, which are not larger than the tube orifices themselves. By this close approximation of the tubes on all sides many of them become pressed into a polygonal form and resemble a *Favosites*, from which they differ, however, in the absence of lateral pores. The diaphragms of the tubes are closely approximated, flat, concave or convex in the same specimens. Their diameter is about one and a half millimeter. Found in the Niagara group along the outcrops of the Upper Peninsula, at the shore of Lake Michigan. In a stratum of an outcrop at the mouth of Manistique River this species is quite common."

Halysites compacta occurs in Canada, as far as is now known, in the Niagara formation at Lake Temiscaming, Ont., in the Guelph formation at Galt, Elora and Hespeler, Cnt., and near Donald, B.C., in rocks of Silurian age. The Guelph specimens in the collection of the survey were seen by Dr. Rominger, who testified to the correctness of Mr. Whiteaves's identification (vide op. cit. p. 2). Dr. Robert Bell in 1887 obtained three specimens from Lake Temiscaming, one of which (Plate IV., fig. 5) is identical with the type as figured by Rominger, and agrees at all points with the specific description. Another (Plate IV., fig. 6) shows a slight variation in that the corallites are not always in contact, there being interspaces which are at times slightly larger than the corallites. The third is similar to a number of specimens collected in 1893 and 1894 by Mr. A. E. Barlow, of this Survey, also at Lake Temiscaming, at a locality about two miles distant from where Dr. Bell collected his, which although belonging most probably to Dr. Rominger's species, still depart from this typical form in so decided a manner as to be worthy of notice. A single specimen was also collected in 1885, by Prof. A. P. Coleman, on the N. E. side of the Columbia River, near Donald, B.C., from rocks of Silurian age, and another was obtained by J. B. Tyrrell, in 1890, in rocks of the same age at the foot of Grand Rapids, near the mouth of the Saskatchewan River.

If we imagine a specimen of *H. catenularia*, L., with the corallites brought so close together as to be in actual contact, and to have the meshes so far reduced in size as only to be represented by small, generally triangular, spaces at intervals round the corallites, then we have a typical specimen of *H. compacta*, Rominger.

* The word "tube" used by Dr. Rominger, has reference to the corallites, and not to the tubules between the corallites.

In Dr. Bell's Lake Temiscaming specimen (Plate IV., fig. 5) the corallites have an average diameter of 1·5 mm., and are hexagonal or pentagonal in section; the interspaces are roughly triangular, about ·5 mm. across and occur at the sides of the hexagonal corallites one to each side. The septa are only obscurely indicated. The tubules found in *H. catenularia* between the corallites are present here also; they are about $\frac{1}{3}$rd the width of the corallites in diameter, and are seen in longitudinal sections to have tabulæ; they are difficult to recognize in transverse sections. Flat or concave and occasionally convex close-set tabulæ, about fourteen in a space of 5 mm., are present in the corallites and the tubules have evenly rounded convex or arched tabulæ, about fifteen to twenty in a space of 5 mm. (Plate IV., fig. 5*a*).

The second specimen from Lake Temiscaming, (Plate IV., fig. 6) collected by Dr. Bell, might almost be regarded as a connecting link between specimens of *H. catenularia*, L., in which the meshes are very small, and the typical form of *H. compacta*. In this specimen the spaces between the corallites are generally about the same size or slightly smaller, but occasionally larger than the corallites, and are rather quadrangular in shape; in other respects this fossil is identical with the above mentioned specimen. In parts, however, of the same specimen the corallites are seen to be in contact and to have the subtriangular interspaces as in Rominger's type. The average diameter of the corallites is 1·5 mm.

The specimens brought by Mr. Barlow from Lake Temiscaming differ in the following respects from the first mentioned form, viz., the corallites are smaller, circular instead of being hexagonal in shape, and the interspaces instead of being triangular are roughly oval or circular and reduced in size: generally six are seen surrounding a single corallite. Longitudinal sections reveal the presence of tubules, from $\frac{1}{3}$ to $\frac{1}{2}$ the width of the corallites, with close set, narrowly arched tabulæ, about twenty of which are found in a space of 5 mm. The tabulæ of the corallites are flat or concave and there are from fourteen to eighteen in 5 mm. In some of the specimens the spiniform septa, twelve in number, are beautifully preserved (Plate IV., figs. 8, 8*a*). The corallites in this form are further apart on account of their walls being proportionately thicker and it is difficult to discern the difference between the tubules proper and what now represent the interspaces greatly reduced in size. In fact, Mr. Barlow's specimens might readily at first sight be mistaken for a form of *Heliolites* with very few "small corallites" between the larger ones.

Prof. Coleman's fossil (Plate IV., fig. 7) agrees in the arrangement of the corallites and interspaces with Rominger's figure and Dr. Bell's first

Species and variety.		Locality.	Formation.	Shape and average size of corallites	Average width of tubules.
H. catenularia, var. Quebecensis.	1	Lake St. John, Q Blue Point and vicinity.	Black River limestone.	Oval. ..... Length..1·25 mm. Breadth .1·00 "	0·2
	2	East Selkirk and various localities, Lake Winnipeg.	Galena—Trenton.	Oval to somewhat quadrangular. Length..1·85 mm. Breadth .1·25 "	Not seen....
H. catenularia, var. gracilis, Hall.	3	Jack Head Island, Lake Winnipeg.	Galena—Trenton.	Quadrangular..... Length..2·25 mm. Breadth .2·00 "	Not seen....
	4	Nelson River, 2nd and 3rd Limestone Rapids.	Galena—Trenton.	Quadrangular..... Length .1·75 mm. Breadth .1·25 "	Not seen....
	5	North of Grand Rapids, Saskatchewan R. (Station No. 102.)	Galena—Trenton.	Oval to somewhat quadrangular. Length..1·50 mm. Breadth .1·00 "	Not recognizable.
	6	Churchill Harbour, Hudson Bay.	Galena—Trenton?	Quadrangular. .... Length..1·10 mm. Breadth .0·95 "	Not seen....
	7	West End Camp, Anticosti, Que.	Hudson River.	Somewhat quadrangular. Length..1·50 mm. Breadth .1·00 "	Not seen....
	8	Gamache Bay, Anticosti.	Anticosti Gr. Division 1. (Silurian.)	Rather broadly oval. Length..1·50 mm. Breadth .1·00 "	Not satisfactory seen.
		Wall's Cove, Anticosti.	Anticosti Gr. Division 2. (Silurian.)		
	9	Jumpers, Anticosti	Anticosti Gr. Division 4 (Silurian.)	Oval. .... Length..2·00 mm. Breadth .1·50 "	0·5
	10	Lake Temiscaming	Niagara	Broadly oval to circular. Length..1·75 mm. Breadth .1·50 "	0·5
	11	Lake Temiscaming	Niagara.....	Oval. ..... Length..2·50 mm. Breadth .2·00 "	0·5
	12	Lake Temiscaming	Niagara.....	Narrowly oval..... Length..1·00 mm. Breadth .0·50 "	Not seen....
	13	Lake Temiscaming	Niagara.....	Same as No.	10, except th
H. catenularia, L.	14	Owen Sound and Huronia Point, Cockburn Island.	Niagara.....	Oval and rather narrowly oval. Length..2·75 mm. Breadth .2·00 "	0·75 In some specimens 0·5

Average size of meshes.	Whether with septal spines or not.	Tabulæ of corallites.	Tabulæ of tubules.	Collector. Date.
Rather small, about 4 mm. wide.	None seen....	Straight or slightly concave, about 10 in 5 mm.	Straight, about 10 in 5 mm.	J. Richardson, '57. W. McOnat & Jno. Leitch, 1871.
Large and irregular, often narrow and long, when somewhat circular 9 mm. wide.	In East Selkirk specimens beautifully preserved, in Lake Winnipeg specimens sometimes preserved.	Generally flat, sometimes slightly concave or convex, 6 to 9 in 5 mm.	——	T. C. Weston, 1884. J. B. Tyrrell, 1889. D. B. Dowling, 1890, 1891. L. M. Lambe, 1890. Dowling & Lambe, 1890.
Very irregular in size. 8 mm. across when moderately circular.	Not seen.....	Flat, 8 in 5 mm. on an average.	——	D. B. Dowling and L. M. Lambe, 1890.
6 mm. across.....	Present	Slightly concave or flat, 8 to 10 in 5 mm.	——	R. Bell, 1879.
About 6 mm. across on an average.	Beautifully preserved.	Flat, slightly concave or convex, 8 in 5 mm.	——	J. B. Tyrrell, 1890.
Very small, from 1 to 2 mm. wide.	Not seen.....	Straight, 10 in 5 mm.	——	J. B. Tyrrell, 1894.
7 mm. across.....	Indicated	Flat or slightly concave, 8 in 5 mm. on an average.	——	J. Richardson, '56.
About 6 mm. wide.	Indicated	Flat, often slightly concave. Frequently with secondary tabulæ, 14 in 5 mm.	——	J. Richardson, '56.
6 mm. in width....	Not seen.....	Straight or slightly concave, about 8 to 12 in 5 mm.	Straight or convex, 16 to 20 in 5 mm.	J. Richardson, '56.
Varying from abo't 4 by 4 mm. and even smaller to 55 by 7 mm.	Indicated	Generally straight, often concave, sometimes convex, about 10 in 5 mm.	Very strongly convex, 18 or 20 in 5 mm.	R. Bell, 1887. A. E. Barlow, 1893, 1894.
Large and spreading.	Not seen.....	Same as in	No. 8.	A. E. Barlow, 1893, 1894.
Very variable in size. From 3 by 3 mm. to 15 by 4 mm.	Not seen.....	Generally flat, about 16 in 5 mm.	——	A. E. Barlow, 1893, 1894.
at the tubules are	apparently wa	nting.		R. Bell, 1887. A. E. Barlow, 1893, 1894.
91 mm. across.....	Not seen.....	Flat, about 6 in 5 mm.	Flat, about 12 in 5 mm.	R. Bell, 1866. J. Townsend, 1882.

Species and variety.		Locality.	Formation.	Shape and average size of corallites.	Average width of tubules.
H. catenularia, var. micropora, Whitfield.	15	Derby township, nr. Owen Sound, Ont.	Niagara.....	Circular or oval. .... L. 1·50 to 2·00 mm. Breadth 1·50 "	Silicified specimens, structure obscure, tubules not seen.
	16	Derby township, nr. Owen Sound, Ont.	Niagara.....	Broadly oval to circular. Diameter 1·25 mm.	0·75
	17	Cross Lake Rapids, Saskatchewan R. and Cedar Lake.	Niagara.....	Oval to circular. ... From 3 by 2 mm. to 1·5 by 1 mm.	0·40
	18	NE side Columbia River, B.C. near Donald.	Upper Silurian	Broadly oval..... Length..2·50 mm. Breadth 2·00 "	Not seen....
	19	NE side Columbia River, B.C. near Donald.	Upper Silurian	Oval..... Length .0·70 mm. Breadth 0·45 "	Not seen....
	20	Hespeler, Ont.....	Guelph.....	Oval..... From 1·50 by 1·00 to 3·50 by 2·50 mm. in different specimens.	Not recognizable.
H. catenularia, var., simplex.	21	One mile east of Little Cascapedia River, Que.	Lower Helderberg.	Oval..... Length..4·00 mm. Breadth..2·5 "	Not present.
H. catenularia, var., amplitubulata.	22	L'Anse à la Barbe, l'anse au Gascon, Que.	Lower Helderberg.	Broadly oval..... L. 2·5 to 2·00 mm. Breadth..1·75 "	2·0 to 2·25
H. catenularia, var., nitida.	23	L'Anse à la Barbe, l'Anse auGascon, l'Anse aux Bouleaux & l'Anse à la Vieille, Que.	Lower Helderberg.	Oval..... Length..1·45 mm. Breadth..1·00 "	0·50
	24	Neigette Falls, Q..	Lower Helderberg?	Same as No.	23.

Average size of meshes.	Whether with septal spines or not.	Tabulæ of corallites.	Tabulæ of tubules.	Collector. Date.
In different specimens from 3 mm. to 7 mm. across with some long irregular meshes.	Not seen.....	Flat, 8 to 12 in 5 mm.	———	J. Townsend, 1883.
Generally long and narrow, width from 2 to 3 mm.	Septal spines well preserved.	Concave, about 8 in 5 mm.	Convex, vesicular in places, about 20 in 5 mm.	R. Bell, 1859. J. Townsend, 1883.
Broad and spreading.	Indicated	Generally flat, often slightly concave or convex, about 8 in 5 mm.	Very convex and close set, 24 in 5 mm.	J. B. Tyrrell, 1890.
About 8 mm. across	Not seen.....	Generally flat, about 8 in 5 mm.	———	Prof. A. P. Coleman, 1885.
Rather irregular. About 5 mm. across.	Internal	structure not preserved.		Prof. A. P. Coleman, 1885.
In parallel rows about 6 mm. apart in other specimens large and spreading, some of the expansions as broad as 11 cent.	Indications of septa.	In small form 8 in 5 mm. slightly concave, in large form 4 or 5 in 5 mm. concave.	———	T. C. Weston, 1867.
Meshes very long and narrow ; corallites in parallel lines.	Not seen.....	Flat or slightly concave, 6 in 5 mm.	———	R. W. Ells, 1883.
.....	Not seen.....	Flat also slightly convex or concave, 6 in 5 mm.	Slightly concave, abruptly bent down at the edges, 20 in 5 mm.	R. Bell, 1862.
Long and narrow ; corallites often in paralled rows. Meshes from 5 to 3 mm. across.	Present	Flat or slightly convex, 10 to 20 in 5 mm.	Straight or slightly convex, vesicular at times, 20 in 5 mm.	Logan, 1843. R. Bell, 1862. J. Richardson. T. C. Weston, 1880.

mentioned Lake Temiscaming specimen. The corallites are hexagonal, about 2 mm. in diameter, and the interspaces triangular. In this specimen the coral is well shown on a weathered surface, but below the surface the structure is not sufficiently preserved to reveal anything in longitudinal or transverse sections.

The Guelph representatives of this species have corallites about or slightly over 2·5 mm. in diameter, and the interspaces are generally rather irregular in shape and as a rule narrower than the corallites, although their length is sometimes as much as the breadth of two corallites, thus showing a tendency to form true meshes and to depart from the typical growth of *H. compacta* in which no meshes are formed and the corallites touch each other on every side. The corallites are circular in section and have rather thick walls. The specimens available for study are preserved in a light yellow dolomite which does not admit of much detail of structure being made out: the presence of septal spines is indicated but no tubules between the corallites have been detected. The tabulæ of the corallites are flat or concave and occasionally convex; from five to seven occur in a space of 5 mm. It will be thus seen that *H. compacta* as found in the Guelph formation of Ontario is much coarser or more robust than those forms found in the Niagara formation at Lake Temiscaming, Ont.

Mr. Whiteaves records the collection of this species at Galt, Ont., by the Rev. A. Bell, 1846–50; at Elora, Ont., by Dr. R. Bell, 1861 and D. Boyle, 1883; and at Hespeler, O., by T. C. Weston, 1867. There is in the survey collection a specimen from Durham, Ont., collected by J. Townsend in 1883.

HELIOPORIDÆ.

Genus Heliolites, Dana, 1846.

(Wilkes's Expl. Exped. Zooph., p. 541.)

Corallum discoidal, hemispherical or pyriform, sometimes in explanate masses, at times ramose, composed of parallel, more or less distant, cylindrical corallites that emerge at right angles to the surface in generally slightly exsert calyces; spaces between the corallites filled with numerous, intimately united, polygonal tubules parallel to the corallites and of the same length; walls of the tubules thin, regular; septa twelve in number, of equal size, sometimes reaching the centre of the visceral chamber, not present in the tubules; tabulæ numerous, horizontal, regular, occurring both in the corallites and tubules; epitheca covering the base.

Heliolites interstincta, L. (Sp.)

Plate II., figs. 6, 6*a*.

Madrepora interstincta, Linné. 1767. Syst. Nat., éd. 12, p. 1276.
Heliolites interstincta, Milne-Edwards and Haime. 1851. Polyp. Foss. des Terr. Palæoz., p. 214.
" " Milne-Edwards and Haime. 1855. Brit. Foss. Corals, p. 249, pl. LVII., figs. 5, 5*a*–*d*.
" " Nicholson. 1875. Palæon. of Ont., p. 51.
Heliolites interstinctus, Rominger. 1876. Geol. Sur. Mich., Foss. Corals, p. 11., pl. I., fig. 1.
Heliolites interstincta, Nicholson. 1880. Sil. Foss. of Girvan, pp. 57 and 254, pl. XVI., figs. 1—4.

Corallum generally irregularly hemispherical or discoidal with a more or less convex upper surface, attached by the centre of the basal surface, which usually exhibits concentric foldings or ridges of growth and is protected by an epithecal covering; attaining a diameter of nearly 7 inches with a height of about 3 inches. In its initial stages the corallum is of a pyriform or subspherical shape. Corallites proceeding radially from the basal beginning and issuing at right angles to the surface; they are from 1 to 3 mm. apart, circular, averaging 1·5 mm. in diameter and showing little variation in size in the same specimen. The spaces between the corallites are occupied by numerous polygonal tubules, parallel to the corallites, from ·25 to ·33 mm. in diameter in different specimens, there being from three to twelve tubules in a straight line between adjacent corallites. The horizontal tabulæ of the corallites are rather regular in disposition, from three to four occurring in a space of 1 mm. The tubules have tabulæ similar to those of the coral-

lites and at very regular intervals apart but closer together, about six occurring in a space of 1 mm. In transverse sections the corallites exhibit twelve, delicate, sharply pointed septa of equal size, but whether they are in the form of longitudinal ridges, septal spines or spinulose carinæ has not been determined from the specimens available for study. The tubules are devoid of septa. The edges of the calyces are but slightly elevated above the general surface of the corallum.

Occurs in the Niagara formation and Lower Helderberg group; specimens from the Lower Helderberg in the collection are from l'Anse à la Vieille, Baie des Chaleurs; from west of l'Anse à la Barbe, Baie des Chaleurs, W. E. Logan, 1843, (identified by E. Billings); from Pointe au Bouleaux, Baie des Chaleurs, W. E. Logan, 1843, and l'Anse au Gascon, Baie des Chaleurs, R. Bell, 1862; from the Niagara there is one specimen from Assiginack township, Grand Manitoulin Island, Manitouaning Bay at "Fossil Hill," J. Townsend, 1883.

Heliolites subtubulata, McCoy. (Sp.)

Plate II., figs. 7, 7*a*.

Palæopora interstincta, var. *subtubulata*, McCoy, 1851. Brit. Palæoz. Fossils, p. 16, pl. I. C, figs. 2, 2*a*, 2*b*.

Heliolites Murchisoni, Milne-Edwards and Haime, 1851. Polyp. Foss. des Terr. Palæoz., p. 215.

" " Milne-Edwards and Haime, 1855. Brit. Foss. Corals, p. 250, pl. LVII., figs. 6*a*, 6—*c*.

Heliolites microporus, Eichwald. 1860. Lethea Rossica, p. 454, pl. XXV., figs. 7a, 7b, 7c.

Heliolites subtubulatus, Rominger. 1876. Geol. Sur. Mich., Foss. Corals, p. 12, pl. I, fig. 4.

Corallum in the form of explanate masses of irregular shape and varying thickness, sometimes becoming somewhat hemispherical or pear-shaped; at times reaching a considerable size, 5 or 6 inches broad and from 1 or 2 to 4 inches thick or high. Lower surface apparently covered by a thin epitheca. Corallites parallel to each other and at right angles to the surface, circular, averaging ·75 mm. in diameter, and varying in different specimens from slightly under ·75 mm. to 1 mm.; they are distant from each other from 1, or even less, to 2 mm. The interstitial tubules are polygonal, from three to eight in a straight line between neighbouring corallites. Twelve septa of equal size nearly reach the centre of the corallites. Horizontal tabulæ occur in the corallites and tubules at rather regular intervals, those of the former being farther apart than those of the latter; in the corallites there are three or four in a space of 1 mm. and in the tubules five or six in the same distance. The calyces

are slightly exsert, their edges appearing at the surface as well marked rings a little above the level of the intervening tubular areas. This species is distinguished from others of the genus by its small and rather distant corallites.

H. subtubulata occurs in the Niagara formation and the Lower Helderberg group; in the Niagara at the north end of Lake Temiscaming, Que., collected by R. Bell, 1887, and at "The Jumpers," division IV., Anticosti Group, Anticosti, J. Richardson, 1856; in the Lower Helderberg at l'Anse à la Barbe, Baie des Chaleurs, W. E. Logan, 1843; west of l'Anse à la Barbe, J. Richardson; at l'Anse à la Vieille, Baie des Chaleurs, ? J. Richardson, and at the same locality, R. Bell, 1862. A poorly preserved specimen from the Niagara of Owen Sound, Ont., collected by J. Townsend in 1874, appears to belong to this species. Rominger records the occurrence of this species in the Niagara of Point Detour and Drummond Island, Lake Huron.

Heliolites inordinata, Lonsdale. (Sp.)

Porites inordinata, Lonsdale. 1839. In Murchison, Silur. Syst., p. 687, pl. 16 bis, figs. 12, 12 *a—c*.

Heliolites inordinata, Milne-Edwards and Haime. 1851. Polyp. Foss. des Terr. Palæoz, p. 217.

" " Milne-Edwards and Haime. 1855. Brit. Foss. Corals, p. 253, pl. LVII., figs. 7, 7*a*.

Corallum ramose or lobate, with branches or lobes circular or oval in section, from 3 or 4 mm. to nearly 2 cent in diameter, proceeding from a massive base. The generality of specimens usually consists of fragments of branches from the upper part of the corallum, but one specimen in the collection shows that the basal part may be massive, with branches or lobate processes of considerable thickness springing therefrom. Corallites circular, about 1·5 mm. in diameter, seldom more than 1 mm. apart, often much closer, with twelve septa reaching to the centre. Interstitial tubules polygonal, three or four in a space of 1 mm. In the branches the corallites and tubules diverge from an imaginary central axis, terminating either at right angles or slightly inclined to the surface, in which latter case the calyces are rather oval than circular, the lengthening taking place in the longitudinal direction of the branch. Tabulæ horizontal, in the tubules four or five occur in a space of 1 mm., but in the corallites they are not quite so close set.

H. inordinata is distinguished from other species of the genus principally by its ramose form.

Lower Helderberg group.—West of l'Anse à la Barbe, Baie des Chaleurs, W. E. Logan, 1843, (identified by E. Billings), l'Anse à la Vieille, Baie des Chaleurs, R. Bell, 1862, and two specimens from l'Anse à la Vieille probably collected by J. Richardson.

Genus Plasmopora, Milne-Edwards and Haime, 1849.

(Compt. Rend., t. XXIX, p. 262.)

Propora, Milne-Edwards and Haime. 1849. Compt. Rend., t. XXIX., p. 262.

Corallum hemispherical or irregularly massive, with a convex upper surface; corallites long, cylindrical, at right angles to the surface, distant, their interspaces filled with numerous parallel, polygonal tubules defined by distinct walls; tabulæ of the corallites regular, horizontal, numerous, those of the tubules convex, interfering with the regularity of the walls; septa twelve in number, well developed, sometimes almost obsolete, confined to the corallites.

The chief point of difference between *Heliolites* and this genus is, that whereas, in the former the tubules have regular, well-defined, vertical walls and horizontal tabulæ, similar to those of the corallites but more numerous, in the latter the tubules are filled with convex plates that disturb the orderly arrangement of the walls, causing them to be irregularly zigzag instead of straight in their upward growth.

Plasmopora follis, Milne-Edwards and Haime.

Plate II, figs. 8, 8a.

Plasmopora follis, Milne-Edwards and Haime. 1851. Polyp. Foss. des Terr. Palæoz., p. 223, pl. 16, figs. 3, 3a.
" " Rominger. 1876. Geol. Sur. Mich., Foss. Corals, p. 13, pl. III, fig. 2.

This species is found in the form of large masses, sometimes 6 inches in breadth, of somewhat irregular shape, generally convex above and presumably covered below by an epitheca. Corallites from 1·25 to 1·5 mm. in diameter, circular, distant from ·3 to 1 mm. Tubules polygonal, from one to three in the shortest line between neighbouring corallites. Tabulæ are present in the corallites; they are horizontal, from three to five occurring in a space of 1 mm. In longitudinal sections convex tabulæ are seen in the tubules, giving the cœnenchymal structure a vesicular appearance; and whereas in transverse sections the polygonal outlines of the tubules are clearly defined, in longitudinal sections the tubular walls appear as zigzag vertical lines, rendered obscure by their amalgamation with the

downward bent edges of the tabulæ. Septa apparently represented only by a slight thickening of the walls of the corallites.

Lower Helderberg group.—L'Anse à la Vieille, Baie des Chaleurs, west of fault, ? J. Richardson, and one mile east of mouth of Little Cascapedia River, Baie des Chaleurs, R. W. Ells, 1883.

Plasmopora petaliformis, Lonsdale. (Sp.)

Plate II., figs. 9, 9*a*.

Porites petalliformis, Lonsdale. 1839. In Murchison, Silur. Syst., p. 687, pl. 16, figs. 4, 4*a*.
Plasmopora petaliformis, Milne-Edwards and Haime. 1851. Polyp. Foss. des Terr. Palæoz., p. 221.
" " Milne-Edwards and Haime. 1855. Brit. Foss. Corals, p. 253, pl. LIX., figs. 1, 1*a*—*c*.
Heliolites sparsus, Billings. 1865. Canadian Naturalist, new series, vol. II., p. 428.
" " Billings. 1866. Cat. Sil. Foss. of Anticosti, p. 31.

Corallites 2 mm. in diameter or slightly under, circular, with twelve equal lamellar septa, almost extending to the centre; distant from each other from about 1 to 4 mm. Between the corallites are numerous irregularly polygonal tubules, rather unequal in size, from four to eight occurring in a line between adjacent corallites. The tabulæ of the corallites are horizontal and placed close together, from three to five in a space of 1 mm. The tubules are occupied by more or less convex or concave tabulæ which interfere with the regularity of the walls of the tubules; the latter appear in longitudinal sections as parallel, somewhat irregular lines running in a vertical direction to the surface. The Canadian specimens examined have the structure well preserved, but they do not show the external form; according to Lonsdale and Milne-Edwards and Haime the corallum is hemispherical.

This species differs from *Plasmopora follis*, Milne-Edwards and Haime in having larger and more distant corallites, with a larger number of cœnenchymal tubules in the interstitial spaces.

Niagara formation and Lower Helderberg group.—Anticosti group, division IV., Anticosti, two miles west of Chicotte River, J. Richardson, 1856; l'Anse à la Vieille, Baie des Chaleurs, ? J. Richardson.

Genus Lyellia, Milne-Edwards and Haime. 1851.

(Polyp. Foss. des Terr. Palæoz., p. 226.)

Corallum massive, of various shapes, globular, pyriform or hemispherical, sometimes tuberose or discoidal, also in the form of flabellate or lobate expansions with calyces on both sides; corallites cylindrical, varying in

their distance from each other, sometimes touching; interstitial structure vesicular, made up of convex plates, of rather unequal size, resting on each other; septa represented by twelve, spinose, longitudinal raised ridges or carinæ that appear at the slightly exsert edges of the calyces as rounded tubercules; intercalicular surface often granular or tuberculous; tabulæ of the corallites numerous, horizontal; basal epitheca present.

The genus *Lyellia* differs principally from both *Heliolites* and *Plasmopora* by having vesicular structure between the corallites instead of more or less well defined tubules.

Lyellia affinis, Billings.

Plate V., figs. 1, 1*a*.

Heliolites affinis,* Billings. 1865. Canadian Naturalist, new series, vol. II., p. 427.
" " Billings. 1866. Cat. Sil. Foss. of Anticosti, pp. 5 and 30, fig. 12.
Lyellia papillata, Rominger. 1876. Geol. Sur. Mich., Foss. Corals, p. 15, pl. II., fig. 3.

The corallum of this species, as shown by the numerous specimens in the collection of the Geological Survey, and as stated by Billings in his original description, is hemispherical, globular, pyriform, clavato-turbinate or tuberose; in its earlier stages it is discoidal with a slightly convex upper surface and flat or concave below. The smallest specimen in the collection is about 16 mm. in diameter and 4 mm. thick; it is composed of about fifty-eight corallites, and has the base protected by a concentrically wrinkled epitheca. From larger specimens the corallum is seen to attain a breadth of a little over 4 inches when hemispherical, and a height of 3 to 5 inches when pyriform. Corallites circular, from 1 to 2 mm. in diameter with an average width of about 1·5 mm., touching each other, or at slight distances up to one-half their width apart; sometimes when crowded they become subpolygonal. Interstitial spaces filled with vesicular tissue formed of small, more or less, convex plates. Tabulæ of the corallites, horizontal or slightly convex or concave, from two to four in a space of 1 mm. Septa twelve in number, when well preserved, seen to reach about one-quarter of the way to the centre of the corallites. The edges of the calyces, when the surface is not worn, bear twelve rounded tubercles slightly raised above the intercalicular areas.

Occurs in the Hudson River and Niagara formations, in the four divisions of the Anticosti group, and in the Lower Helderberg group. In the

*In the "Fossil Corals of Michigan," 1876, p. 16, Dr. Rominger pointed out that *Heliolites affinis*, Billings, *Heliolites speciosa* Billings, and *Heliolites exigua*, Billings, all belong to the genus *Lyellia*.

Hudson River of the Island of Anticosti, and the divisions of the Anticosti group, at numerous localities, T. C. Weston, 1855 and 1865, J. Richardson, 1856, and J. Macoun, 1883; in the Niagara, at Thorold, Ont., E. Billings, 1857, on the Isle of Mann (Burnt Island), Lake Temiscaming, Que., A. E. Barlow, 1893, at Cross Lake Rapids, Roche Rouge, and Grand Rapids, Saskatchewan River, Sas., J. B. Tyrrell, 1890, (by whom it was identified with *L. papillata*) and at Grand Rapids, D. B. Dowling, 1891; in the Lower Helderberg, at "The Forks" of the Scaumenac River, Que., R. W. Ells, 1883.

Lyellia Americana, Milne-Edwards and Haime.

Plate V., figs. 2, 2*a*.

Lyellia Americana, Milne-Edwards and Haime. 1851. Polyp. Foss. des Terr. Palæoz, p. 226, pl. 14, figs. 3, 3*a*.
Heliolites speciosus, Billings. 1865. Canadian Naturalist, new series, vol. II., p. 426.
Heliolites speciosus,* Billings. 1866. Cat. Sil. Foss. of Anticosti, p. 30, fig. 13.
Lyellia Americana, Rominger. 1876. Geol. Sur. Mich., Foss. Corals, p. 14, pl. II., figs. 1 and 2.

Corallum hemispherical, turbinate or subpyriform, sometimes measuring 5 or 6 inches across. Corallites circular, at right angles to the surface, where they are slightly exsert, varying in diameter in the same and in different specimens from 2 to 3 mm.; they are separated from one another by spaces varying from 1 to about 5 mm. in width, but when crowded together in any part of the corallum they become almost contiguous. Septa twelve in number, in the form of carinæ bearing stout spines extending half way or in some specimens almost to the centre of the corallites; in many specimens the carinæ alone remain projecting slightly inward from the walls of the corallites. Interstitial spaces filled with vesicular structure made up of convex plates resting on each other and inclosing somewhat lenticular shaped cavities varying in width from 1 to 5 or 6 mm. Tabulæ of the corallites horizontal, often rather irregular, two or three in a space of 1 mm. The edges of the calyces are slightly exsert, crenulated and decorated by a circle of twelve rounded tubercles; similar well marked tubercles occur on the surface between the calyces. It is only in well preserved specimens and ones in which the surface is not abraded that the tubercles are seen.

Occurs in the Niagara formation and in division I of the Anticosti group; in the Niagara, half a mile north-west of Portage Bay, Lake Manitou, Grand Manitoulin Island, Lake Huron, R. Bell, 1865, at Owen Sound, Ont., J. Townsend, 1882, on the Isle of Mann (Burnt Island), Lake Temiscaming, Que., A. E. Barlow, 1893; in division I of the Anti-

* See foot-note page 84.

costi group, Anticosti, at White and Junction cliffs, T. C. Weston, 1865. A specimen labelled R. H, 1867, from the Guelph formation at Hespeler, Ont., is here doubtfully referred to this species; the specimen is a mould of the upper convex surface of a small corallum and shows the size and distance apart of the calyces.

One specimen from Lake Temiscaming, depressed turbinate in shape, is $6\frac{1}{2}$ inches broad and 4 inches high.

Lyellia exigua, Billings. (Sp.)

Plate V., figs. 3, 3*a*.

Heliolites exiguus†, Billings. 1865. Canadian Naturalist, new series, vol. II., p. 428.
" " Billings. 1866. Cat. Sil. Foss. of Anticosti, p. 31, fig. 14.

Corallum subhemispherical, with a moderately convex upper surface and concave below; a concentrically wrinkled epitheca covers the basal surface. The type specimen, the only one representing the species in the collection, is 45 mm. long, 30 mm. broad and 13 mm. high. Corallites circular, ·75 mm. wide, separated from each other by distances generally equal to or less than their width, but varying from 1 to 5 mm. wide. Tabulæ of the corallites horizontal, from two to five occurring in a distance of 1 mm. The inner surface of the walls of the corallites is marked by twelve faint septal ridges, but whether these bore spines or not has not been determined. Spaces between the corallites filled with vesicles of rather unequal size, varying from about ·16 to over ·5 mm. in width. The surface of the corallum between the calyces has a granular appearance caused by the exposure of the vesicles through weathering. The edges of the calyces appear as rings slightly raised above the general level of the surface.

Gamache Bay, Anticosti, in division I. of the Anticosti group, T. C. Weston.

Lyellia decipiens, Rominger.

Lyellia decipiens, Rominger. 1876. Geol. Sur. Mich., Foss. Corals. p. 15, pl. III., fig. 1.

A single specimen from the Niagara formation of Grand Manitoulin Island, Lake Huron, collected by J. Townsend in 1883, is identified with this species; it is in the form of a small, somewhat discoidal mass, 3 inches across and a little over 1 inch high, rather flat above and convex below, where it apparently had an epithecal covering. The calyces are margined by a ring distinctly higher than the surface between the coral-

† See foot-note p. 84.

lites, but in other respects it agrees with the description of Rominger's species, which is characterized as follows :—" Flat, undose expansions of laminated structure. Tubes one millimeter wide, orifices not projecting, crenulated by twelve marginal crests. Diaphragms slightly convex. Interstitial spaces usually larger than one tube diameter, their surface delicately reticulated by circumscribed cell spaces, as in *Heliolites*, but in vertical sections exhibiting a distinctly interlacing vesiculose structure, and not a tubular cœnenchym. Found in the Niagara group of Point Detour and Drummond Island (Lake Huron)."

This species differs from *Lyella exigua*, Billings, only in having larger corallites with larger intercalicular areas.

Lyellia superba, Billings. (Sp.)

Plate V., figs. 4, 5 and 5*a*.

Trematopora superba, Billings. 1866. Cat. Sil. Foss. of Anticosti, p. 93.

Corallum forming flabellate or flattened narrow expansions with lobes or branches lying in the same plane, and with calyces on both sides as well as on the rounded edges. The corallum attains a breadth in the flabellate forms of 8 or 9 cent with a thickness of from 5 to 10 mm. Corallites circular, from ·45 to about ·6 mm. in diameter and at a distance from each other generally greater than their width, but varying from ·5 to 1·5 mm. The corallites proceed outward from the central axial part and emerge at right angles to the surface, the circular margins of the calyces being slightly exsert. The spaces between the corallites are filled with vesicles of rather unequal size, varying from ·25 to ·75 mm. wide, those in the inner part being somewhat larger than those near the surface, making the structure near the surface more compact. Tabulæ are present in the corallites ; they are horizontal, regularly disposed, about four occurring in a distance of 1 mm. Septa of the usual number, twelve, but little developed. The type specimen is 13 cent. high, broken at both ends, elliptical in transverse section, about 2 cent. broad throughout its length and about 8 mm. thick, with lobate outgrowths proceeding at an obtuse angle from the main part of the corallum.

A very strong resemblance exists between *Heliolites Grayi*, Milne-Edwards and Haime, judging from their description and figures, and *Lyellia superba*, Billings. The former species was described as follows* " Corallum composite, dendroidal, forming lamellar sublobated expansions, both surfaces of which bear calices. These are placed at various distances

* Monograph of the British Fossil Corals, Milne-Edwards and Haime, 1850–1854, p. 252, pl. LVIII., figs. 1, 1*a*.

from each other (one, two, or three times their diameter), and are limited by a small, well-marked, circular ridge, formed by the exsert edge of 12 subequal thick septa. The canaliculæ of the cœnenchyma are somewhat irregular, and their parieties are rather thick. Diameter of the calices about one third of a line." The authors of this species referred it to the genus *Heliolites*, but the irregularity of the "canaliculæ of the cœnenchym" suggests the possibility of the spaces between the corallites being filled with vesicles rather than with tubules having tabulæ. If after further research this surmise prove correct, *Heliolites Grayi* would of necessity be removed to the genus *Lyellia* and the two species perhaps united under the older name, as the similarity between the two forms would then be such as to make this step expedient.

Occurs in the Niagara group of Ontario. The type specimen was collected at Cabot's Head, Georgian Bay, by Alexander Murray; other specimens are from lot 13, concession 7, Derby township, near Owen Sound, Ont., R. Bell, and from Owen Sound, J. Townsend, 1874.

Genus Lyopora, Nich. and Eth., jun., 1878.

Monogr. Sil. Foss. of Girvan, p. 25.

"Corallum composite, massive, composed of tubular, sub-cylindrical or hexagonal corallites, which are more or less completely fused with one another. Walls of the corallites extraordinarily thick and dense, destitute of mural pores. Columella absent. Septa rudimentary, few in number, having the form of irregular ridges on the interior of the wall. Tabulæ complete. No cœnenchyma." (Nich. and Eth., jun.)

Lyopora Goldfussi, Billings. (Sp.)

Plate V., figs. 6, 6*a* and 7.

Columnaria Goldfussi, Billings. 1858. Rep. of Progress for 1857, Geol. Survey o Canada, p. 166; and Canadian Naturalist, vol. III, p. 420.

Corallum hemispherical, subspherical or forming irregularly shaped rounded masses, sometimes as large as 2 or 3 inches high and 4 or 5 inches broad, composed of polygonal, subpolygonal or circular, moderately thick walled corallites that diverge upward and outward from the base and are in close or partial contact with each other. When the corallites are circular and only partially in contact, small interspaces of irregular shape and size are left between them; these are reduced to a minimum in size and number, or are absent when the corallites are polygonal and touch each other on all sides. The divisional lines between the walls of contiguous corallites

are frequently very obscure and difficult to see, although apparently a complete amalgamation does not take place. Corallites from about 1 to 2 mm. in diameter in different specimens, but often exhibiting a considerable variation in size in the same individual. Tabulæ complete, flat or slightly concave, from four to six occurring in a space of 2 mm.; they are also apparently present in the interspaces, but a little closer together than those of the corallites. Septa twelve in number in mature corallites, in the form of longitudinal blunt ridges, equally developed and extending but a very short distance, about 2 mm. beyond the walls toward the centre of the corallites. The calyces are shallow, with the septa moderately distinct; the intercalicular spaces are also visible at the surface.

Hudson River formation.—At Snake Island and (loose) at Traverse Point, Lake St. John, Que., J. Richardson, 1857, at Wreck Point, Anticosti, Que., J. Richardson, 1856, and at Cape Smith, Lake Huron, R. Bell, 1859.

The smallest specimens from Lake St. John are not more than 1 inch or $1\frac{1}{2}$ inch broad and 1 inch high, other specimens are intermediate in size between these and a large one that is 5 inches broad and nearly 3 inches high.

This species originally referred to *Columnaria*, has been assigned to the above genus, although it differs in having the walls of the corallites of only a moderate thickness, instead of being *extraordinarily* thick. In the Silurian Fossils of Girvan, pl. I., in the figures illustrating *L. favosa*, McCoy, sp. the great thickness of the walls is not so very apparent, especially in fig. 1*a*. In *L. Goldfussi* the septa are equal, always twelve in number, and the tubular spaces between the corallites form a marked feature of some of the specimens, viz., those in which the corallites are circular. These interspaces appear to have tabulæ, a feature which, if taken with the cylindrical form of the corallites and the number of the septa, suggests an approach to the genus *Heliolites*. The retention of this species in the genus *Lyopora* would necessitate a slight amendment of the original generic description.

Genus Protarea, Milne-Edwards and Haime, 1851.

(Polyp. Foss. des Terr. Palæoz., p. 146.)

Corallum incrusting; corallites upright, opening at the surface in adjacent, shallow, rounded calyces; walls of the corallites not clearly defined; septa about twelve in number, stout, combining to form a thick pseudocolumella; interseptal spaces crossed by horizontal dissepiments; tubules occuping the spaces between the corallites, thick-walled, narrow, with numerous, complete, horizontal tabulæ and without septa; calyces tuberculous at the centre and at the edge.

Protarea vetusta, Hall. (Sp.)

Plate V., figs. 8, 8*a*.

Porites? vetusta, Hall. 1847. Palæon. of New York, vol. I., p. 71, pl. XXV., figs. 5*a*, 5*b*.
Protarea vetusta, Milne-Edwards and Haime. 1851. Polyp. Foss. des Terr. Palæoz., p. 208, pl. 14, figs. 6, 6*a*.
Heliolites tenuis, Billings. 1865. Canadian Naturalist, new series, vol. II., p. 428.
" " Billings. 1866. Cat. Sil. Foss. of Anticosti, p. 32.
Protarea vetusta, Nicholson. 1875. Palæon. of Ont., p. 9 and Geol. Surv. of Ohio, vol. II., p. 221.

Corallum thinly incrusting, with a thickness of from 1 to 3 mm., covering an area 2 or 3 inches across; by the growth of one layer upon another a thickness of about 10 mm. may be attained. Calyces shallow, circular or subpolygonal, from 1 to 1·5 mm. in diameter, nearly touching or from ·5 to 1·5 mm. apart, with twelve stout septa whose inner ends combine to form a pseudocolumella having the appearance at the bottom of the calyces of a number of tubercles. Between the calyces at the surface are numerous subpolygonal openings, from one to five or six in a straight line between adjacent calyces; these become contracted a little below the surface and are continued vertically downward as parallel narrow tubes with thick walls. The structure, as seen in longitudinal sections immediately below the calyces, is obscure and not definitely defined from the surrounding tubules, but the spaces between the septa are apparently crossed by independent transverse dissepiments which are not of the nature of true tabulæ. The tubules are crossed by horizontal tabulæ at rather close intervals. The rounded, exsert ends of the septa at the edges of the calyces, together with the tubercles at the bottom of the calyces and the presence often of tubercles in the intercalicular areas, give the surface of the corallum a granular appearance.

Occurs in the Trenton formation at and in the vicinity of Ottawa, Ont., in division I of the Anticosti group, Anticosti, and in the Hudson River formation in Manitoba. The specimens in the possession of the Geological Survey were collected at Ottawa by Dr. Van Cortlandt, at Ottawa, by H. M. Ami, 1882, and on the Castor River near Castleman, county of Russell, Ont., 1884, near Douglas, county of Renfrew, Ont., 1896, by R. W. Ells and L. M. Lambe, those from Anticosti at Junction Cliff by T. C. Weston, 1865. Nicholson mentions its occurrence (op. cit.) in the Trenton limestone at Peterborough, Ont. The specimens described by Hall are from the lower part of the Trenton formation at Watertown, Jefferson county, New York. It has been recognized from the lower beds of the Hudson River formation at Stony Mountain, Manitoba, by Mr. Whiteaves, but is not known to occur elsewhere at this horizon in Canada, although it appears to be a not uncommon fossil in the Cincinnati group

of Ohio. Mr. Whiteaves has also recognized it from the Galena-Trenton of Lake Winnipeg.

Protarea vetusta, var. magna, Whiteaves.

Protarea vetusta, var. *magna*, Whiteaves. 1897. Contr. to Can. Palæon, vol. III., pt. 3, p. 155, pl 18, figs. 2, 3, 3*a*.

From the Galena-Trenton of Lower Fort Garry, Manitoba, R. Bell, 1880, and T. C. Weston, 1884.

Genus Stylaræa, Von Seebach, 1866.

(Zeitschr. d. deutsch. Geol. Ges., Bd. XVIII., p. 304.)

"Corallum composite, the sclerenchyma traversed by numerous fine inosculating canals. Corallites short, opening on the surface by rounded or polygonal calices, of moderate depth. Septa in the form of a variable number of short blunt ridges extending into the interior of the visceral chamber, the axis of which is occupied by a well developed circular or oval columella, which the septa do not nearly reach. Strong and complete tabulæ present or absent. Corallum encrusting, or (?) attached only at a single point." (Nicholson.)

Stylaræa parva, Billings. (Sp.)

Plate 5, figs. 9, 9*a* and 9*b*.

Columnaria parva, Billings. 1859. Canadian Naturalist, vol. IV., p. 428.
? Stylarœa occidentalis, Nich. and Eth., jun. 1878. Sil. Foss. of Girvan, p. 62, pl. IV., figs. 2, 2*a*, 2*b*.

Corallum thinly incrusting, from 1 to 5 or 6 mm. thick, forming flat expansions, with well marked, sunken, shallow calyces, on the upper surface; the single specimen* in the collection is convex above, measures about 6·5 cent. across and has a maximum thickness of 16 mm., attained by the succession of five layers of growth the one over the other. Corallites polygonal or subcircular, with thick walls and an average width of ·75 mm., either in contact or up to a distance of half their width apart. The centre of the corallites is occupied by a cylindrical, rod-like, columella which appears at the bottom of the calyces as a prominent rounded

* Although there is only one specimen now representing this species in the collection, Mr. Billings evidently had several specimens, as he states that the "species occurs in large, globular, irregular, pyriform or wide depressed convex masses," and further adds that "some of the flattened masses appear to have been more than one foot wide, and often they have a thin stratified structure or are composed of successive layers, the divisional planes between which divide the corallites at right angles."

tubercle. Tabulæ numerous, horizontal, at regular intervals apart of ·5 mm. Septa, sixteen in number, alternately long and short, the longer passing half way to the centre and apparently not reaching the columella, the smaller septa seen only in transverse sections and not recognizable in the calyces. When the walls of the corallites are not in actual contact the interstitial spaces are apparently filled with cœnenchymal tissue, the exact structure of which has not been clearly ascertained although in transverse sections it appears to be obscurely reticulated by faint linear markings.

Chazy limestone.—Mingan Islands, Que., W. E. Logan and J. Richardson, 1856.

The similarity between the fossil from the Mingan Islands, described by Billings, and *Stylarœa occidentalis*, Nich. and Eth. jun., from the lower Silurian rocks of the Girvan district in Ayrshire, Scotland, is obvious to any one comparing the above description with the published one of the latter species; that they are specifically identical is probable, but not having seen actual specimens of the Girvan fossil the writer is unwilling to assert positively that they belong to the same species.

Dr. Nicholson refers (op. cit. p. 95) the Craighead limestone near Girvan and its associated shales from which *S. occidentalis* was obtained, to a "tolerably low position in the Lower Silurian series, corresponding perhaps with the upper part of the Trenton limestone or the base of the Cincinnati and Hudson River formations of North America," and mentions being struck with "the strongly *American facies* of the Craighead corals and in particular their resemblance to those of the Trenton and Cincinnati groups."

TETRADIIDÆ.

Genus TETRADIUM, Dana. 1846.

(Wilkes's Exped. Zoophytes, p. 701.)

Corallum massive, composed of long, upright intimately united, thin walled corallites that have a quadrangular or petaloid transverse section; septa springing from the centre of the walls, lamellar, stout at the base, thin towards the edge, typically four in number, reaching about half way to the centre of the visceral chamber; secondary septa frequently present near the angles, raising the total possible number to twelve; tabulæ numerous, complete, horizontal; increase by fission of the corallites.

TETRADIUM FIBRATUM, Safford.

Plate II., fig. 5.

Tetradium fibratum, Safford. 1856. Am. Jour. Sci. and Arts, vol. XXII., p. 237.
Tetradium minus, Safford. 1856. Ibid, vol. XXII., p. 238.
Tetradium apertum, Safford. 1856. Ibid, vol. XXII., p. 238.
Tetradium fibratum, Billings. 1863. Geology of Canada, pp. 136, 137, 139, fig. 71*a*, and pp. 141, 149, 163, 177, 178, 185, 186, 194, 195, 218 and 938.
" " Nicholson. 1875. Palæon. of Ont. p. 10.
Tetradium minus Nicholson. 1875. Palæon. of Ont. p. 28.
Tetradium Huronense, Foord, in parte. 1883. Contr. to Can. Cambro-sil. micro-pal. p. 25, pl. VII., figs. 1*b*, 1*c*, 1*d*, 1*e*, (not 1*a*).

Tetradium fibratum, Safford, the type of the genus, is described as having a corallum which is "massive, hemispherical, or flattened hemispherical, composed of diverging tubes. Cell tubes four-sided with thin and slightly rugose walls; the four lamellæ distinct, nearly reaching the centre of the tubes; breadth of full-grown tubes usually about, or but little more than half a line, varying occasionally from $\frac{1}{3}$rd to $\frac{3}{4}$ths of a line. Transverse septa usually absent. A few have been seen in one specimen, which were about twice the breadth of a tube apart." From the upper half of the Lower Silurian rock of Middle Tennessee (Hudson River).

Tetradium minus was characterized by Safford as having smaller corallites than *T. fibratum*, viz., from $\frac{1}{4}$th to $\frac{1}{3}$rd of a line in breadth. No other distinguishing characters were given. This fossil was collected in the rocks of the upper division of the Lower Silurian series of Middle Tennessee (Hudson River).

Nicholson, in his Palæontology of Ontario, p. 28, expresses a doubt as to whether specimens of *T. minus** from the Hudson River of the River Credit, Ont., and at Manitouaning, Grand Manitoulin Island, are really distinct from *T. fibratum*, as described by Safford.

In Canada *Tetradium* is found at many localities in rocks of the Birdseye and Black River formation. The corallites in these specimens are of rather unequal size, varying in specimens from different localities from $\frac{1}{4}$th to $\frac{3}{4}$ths of a line in width, and in individual specimens from $\frac{1}{3}$rd to $\frac{3}{4}$ths, from $\frac{1}{4}$th to about $\frac{1}{2}$, and from $\frac{1}{4}$th to $\frac{1}{3}$rd of a line in breadth; a specimen from Gloucester Co., near Ottawa, has corallites with an average width of $\frac{1}{2}$ a line. The septa in some specimens reach nearly to the centre of the corallites, in others they are not so highly developed. The tabulæ are seldom seen in longitudinal sections.

*Nicholson in his Palæozoic tabulate corals, p. 232, and in his manual of Palæontology, vol. 1, p. 341, apparently regards *T. minus* as the type of the species. As *T. fibratum* was described by Safford before his other species of *Tetradium*, it may be presumed that the founder of the species looked upon *T. fibratum* as the type.

Specimens of *Tetradium* have been collected from the Hudson River formation at Cape Smyth, Lake Huron, and at Streetsville, Ont., that have corallites varying in width from $\frac{1}{3}$rd to $\frac{1}{2}$ of a line. The tabulæ in these specimens are as a rule preserved; they are flat and from four to ten occur in a space of 1 line. The septa show the same variation in development as is found in those of the Birdseye and Black River specimens, and the corallites also vary in size to some extent in individual specimens.

A specimen of *Tetradium* collected by Prof. J. H. Panton from rocks of Galena-Trenton age at East Selkirk,* Manitoba, has corallites of rather unequal size, varying in width from not quite $\frac{1}{4}$th to $\frac{1}{2}$ of a line. The tabulæ are delicate, flat and placed about $\frac{1}{4}$th of a line apart. The septa extend only a very short distance from the walls of the corallites toward the centre.

If in *T. fibratum* the corallites vary in width from $\frac{1}{3}$th to $\frac{3}{4}$ths of a line, and in *T. minus* from $\frac{1}{4}$th to $\frac{1}{3}$rd of a line, and that this constitutes the sole difference between the two species, then it would be difficult to tell to which of these species many Canadian specimens from the above mentioned horizons belong, as the majority of those examined have corallites that range in width from $\frac{1}{4}$th to $\frac{1}{2}$ of a line.

The writer has not observed any differences in structure in Canadian specimens of this coral that are, in his opinion, sufficient to warrant a specific or even a varietal subdivision; they are therefore here referred to under the name *T. fibratum*.

In his "Contributions to the Micro-palæontology of the Cambro-Silurian rocks of Canada" Mr. A. H. Foord has described under the name *T. Huronense* two distinct forms, one the *Stenopora Huronensis* of Billings, since found to be a *Labechia*, the other *T. fibratum*, Safford. The specimens referred to and figured by Foord are in the museum of the Geological Survey, and are from the Hudson River formation at Cape Smyth, Lake Huron. The specimen represented in plate VII., fig. 1, of Mr. Foord's paper, is a mass of *T. fibratum* coated* to a thickness of from about 11 to 2 lines by *Labechia Huronensis*, Bill. Figure 1*a* is a representation of a portion of a mass of *Labechia Huronensis* and figs. 1*b*, 1*c*, 1*d*, 1*e* illustrate the structure of *T. fibratum* (poorly preserved) as seen in horizontal and longitudinal sections, taken from the specimen shown in fig. 1.

* This specimen was received as a donation from the Peter Redpath Museum through Sir J. William Dawson, and had previously been recognized as *Tetradium fibratum* by Prof. Panton and Mr. Whiteaves.

A number of specimens from the Birdseye and Black River formation at Pakenham, Ont., and in the township of McNab, Ont., show the corallites, on a weathered surface, strewn about separately or in fascicles. Mr. Billings referred these to *T. fibratum* and they are labelled as such in the museum. The fossil in this state of preservation is very probably what Safford named *T. apertum*; the separation of the corallites of *T. fibratum*, perhaps after the death of the colony, from each other, or the division of the corallum into small bundles or fascicles of corallites might give a result such as is found in these specimens.

In the Geology of Canada, 1863, mention is made of *Tetradium fibratum* as occurring in the Birdseye and Black River formation in the vicinity of Montreal, Que.; at Pointe Claire and Joliette, Que.; at Les Ecorchés, near Murray Bay, Que.; at Vanluvin's Mills in Storrington township, county of Frontenac, Ont., and in Loughborough township of the same county; in Marmora township, county of Hastings, Ont., and on La Cloche, Thessalon and Campement d'Ours Islands, Lake Huron. In the same report its occurrence in the Hudson River formation at Cape Smyth, Lake Huron is referred to.

The size of the corallites of specimens from the following localities are:

Formation.	Locality.	Size of Corallites.
Birdseye & Black River.	Plantagenet township, Prescott county. J. Richardson, 1850.	Over $\frac{1}{2}$ to $\frac{1}{4}$ of a line; irregular in size.
	McNab township, Renfrew county. J. Richardson, 1853.	$\frac{3}{4}$ to $\frac{1}{3}$ of a line; irregular in size.
	Pakenham township, Lanark county. J. Richardson, 1853.	Over $\frac{1}{2}$ to $\frac{1}{4}$ of a line; irregular in size.
	Gravel Point, St. Joseph's Island, Lake Huron. T. C. Weston, 1882.	$\frac{1}{2}$ to $\frac{1}{4}$ of a line; irregular in size.
	West Shore Great Manitou Island, Lake Nipissing. A. E. Barlow, 1894.	$\frac{1}{2}$ to $\frac{1}{4}$ of a line; irregular in size.
	Gloucester township, Carleton county. W. R. Billings, 1895.	Average $\frac{1}{2}$ of a line; rather regular in size.
	Pauquette's Rapids, Ottawa River.....	Over $\frac{1}{2}$ to over $\frac{1}{4}$ of a line; irregular in size.
	Ottawa, O. T. C. Weston, 1886.....	$\frac{1}{8}$ to $\frac{1}{4}$ of a line; irregular in size.
	Pointe Claire, Que. N. J. Giroux, 1895	$\frac{1}{2}$ to $\frac{1}{4}$ of a line; irregular in size.
Galena-Trenton....	East Selkirk, Man. J. H. Panton.....	Not quite $\frac{1}{2}$ to $\frac{1}{4}$ of a line; irregular in size.
Hudson River....	Cape Smyth, Lake Huron. R. Bell, 1859.	$\frac{1}{2}$ to $\frac{1}{3}$ of a line; irregular in size.
	Cape Smyth, Lake Huron. R. Bell, 1859. (Coated with Labechia.)	Average about $\frac{1}{8}$ of a line.
	Credit River, Streetsville, O. J. B. Tyrrell, 1888.	Average not quite $\frac{1}{2}$ of a line.

* Ann. and Mag. Nat. Hist. 5th Series, vol. XVIII., p. 18. 1886.

In the above mentioned specimen from Pointe Claire, the corallites show the usual four septa extending toward the centre, but at times also secondary ones proceeding from the main wall one to each space between the primary septa and the angles of the tube wall. A corallite in which these secondary septa are developed suggests a stage of growth preparatory to its division into four smaller ones, and strengthens the idea that the manner of increase of the corallum was by fission of the old tubes. When by the union of the primary septa young corallites were formed, the secondary septa became in turn primary ones in the new corallites, in which septa were probably also developed on the newly completed septal-walls. At a certain stage of growth it is thus seen that a corallite may have as many as twelve septa, four of them being primary and eight secondary.

April, 1897.

PLATE I.

Favosites Gothlandica, Lamarck (page 3).

Figure 1. Side view of a corallite from a specimen from l'Anse à la Vieille, Baie des Chaleurs, showing the mural pores, tabulæ and septal spines; for greater clearness the tabulæ are omitted from the central part and the septal spines from the upper part of the figure. Five times the natural size.

Favosites aspera, d'Orbigny (page 4).

Figure 2. Side view of a corallite from a specimen from Stonewall, Manitoba; as in figure 1 the septal spines and tabulæ are not shown together. Magnified five times.

Favosites basaltica, Goldfuss (page 8).

Figure 3. Representation of the arrangement of the tabulæ and squamulæ in the interior of a corallite of a specimen from the Corniferous limestone of Ontario; the tabulæ alone are shown in the upper part of the figure. Enlarged five times.

Figure 3*a*. A few corallites from the same specimen as seen from above, showing complete tabulæ in some of the corallites. Enlarged five times.

Cœnites Selwynii, Nicholson (page 28).

Figure 4. Portion of the upper surface of a specimen from Hagarsville, Ontario. Five times the natural size.

Figure 4*a*. Vertical section of the same specimen. Enlarged five times.

Cladopora cryptodens, Billings (page 31).

Figure 5. Side view of a few calyces of a specimen from the Corniferous limestone of Ontario. Enlarged five times.

Figure 5*a*. Corallites from the same specimen, as seen in transverse section immediately below the calyces and showing the three septal ridges. Five times the natural size.

Calapœcia Canadensis, Billings (page 43).

Figure 6. Longitudinal section of portion of a specimen from Lower Fort Garry, Manitoba; three corallites are here represented with a space crossed by diaphragms separating two of them. Enlarged two and one half times.

Figure 6*a*. Transverse section from the same specimen, similarly enlarged.

Figure 7. A rather diagrammatic representation of the interior of a corallite of a specimen from Lower Fort Garry, Manitoba; the tabulæ are purposely left out. Five times the natural size.

Fletcheria incerta, Billings (page 48).

Figure 8. Transverse section of portion of a specimen with cylindrical corallites from St. Charles Island, Mingan Islands, Gulf of St. Lawrence. Enlarged five times.

Figure 8*a*. Longitudinal section of a few corallites from the above specimen, similarly enlarged.

Figure 9. Transverse section of a portion of a specimen, with polygonal corallites, from the same locality. Five times the natural size.

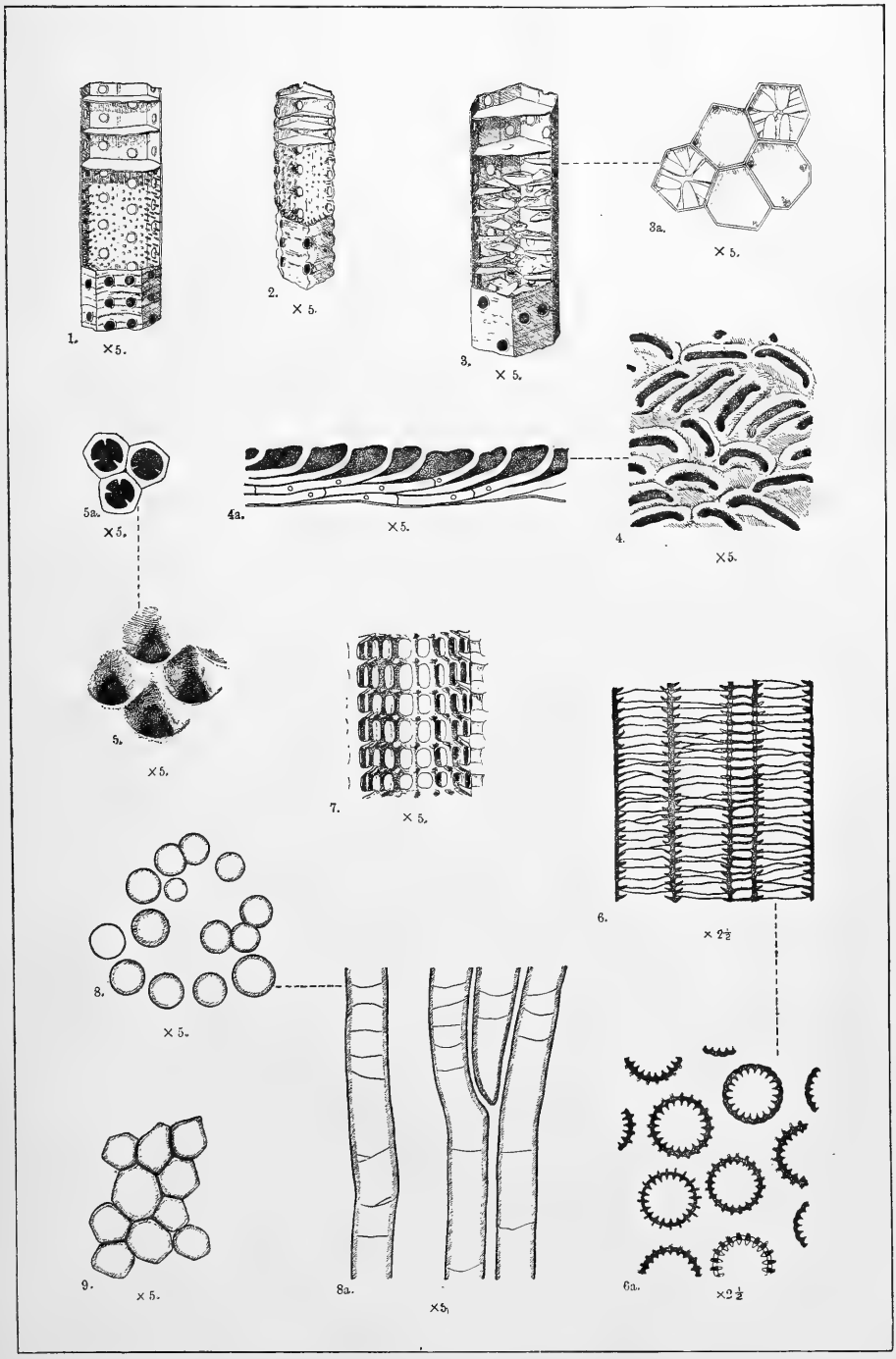

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PLATE II.

Nyctopora Billingsii, Nicholson (page 49).

Figure 1. Transverse section, enlarged five times, of corallites of a specimen from Peterborough, Ontario.

Figure 1*a*. Longitudinal section of corallites of the same. Magnified five times.

Syringopora Dalmanii, Billings (page 51).

Figure 2 Side view of part of a corallum from Lake Temiscaming, Que. Natural size.

Syringopora retiformis, Billings (page 52).

Figure 3. Side view of part of a specimen from the township of Derby, county Grey, Ontario, Natural size.

Syringopora perelegans, Billings (page 56).

Figure 4. View of the under side of a part of the leaf-like basal expansion of a specimen from the Corniferous limestone of Ontario. Natural size.

Tetradium fibratum, Safford (page 93).

Figure 5. Transverse section of a few corallites that show secondary septa ; from Pointe Claire, Island of Montreal. Magnified thirteen times.

Heliolites interstincta, L. (page 79).

Figure 6. Transverse section of corallites in a specimen from west of l'Anse à la Barbe, Baie des Chaleurs. Five times the natural size.

Figure 6*a*. Longitudinal section of the same, similarly magnified.

Heliolites subtubulata, McCoy (page 80).

Figure 7. Transverse section from a specimen from l'Anse à la Vieille, Baie des Chaleurs. Enlarged five times.

Figure 7*a*. Longitudinal section of the same. Enlarged five times.

Plasmopora follis, Milne-Edwards and Haime (page 82).

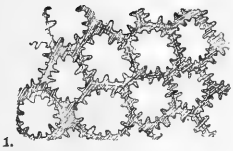
Figure 8. Transverse section of a few corallites of a specimen from one mile east of the mouth of the Little Cascapedia River, Baie des Chaleurs. Magnified five times.

Figure 8*a*. Longitudinal section of the same also magnified five times.

Plasmopora petaliformis, Lonsdale (page 83).

Figure 9. Transverse section of corallites of a specimen from two miles west of Chicotte River, Anticosti. Five times enlarged.

Figure 9*a*. Longitudinal section of the same. Five times the natural size.



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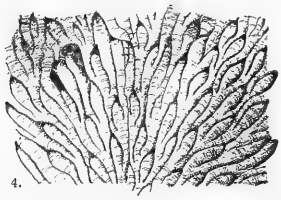

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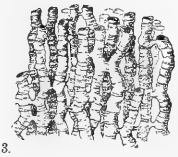

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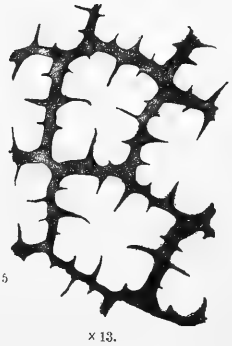

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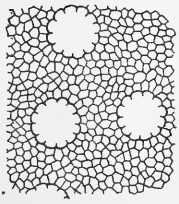

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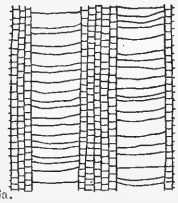

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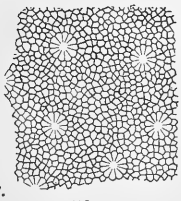

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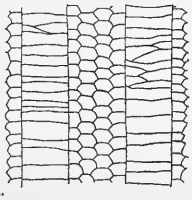
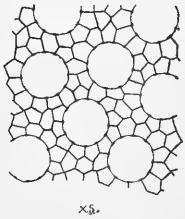
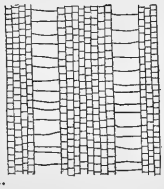


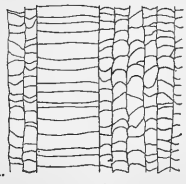
8a. ×5.



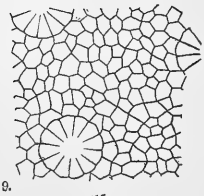
8. ×5.



7a. ×5.



9a. ×5.



9. ×5.

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PLATE III.

Halysites catenularia, L. (page 68).

Figure 1. Portion of an average specimen from Lake Temiscaming, Que., with corallites of average size. Natural size.

Figure 1*a*. Transverse section of two corallites of the same, showing the position of the tubules. Enlarged five times.

Figure 1*b*. Corallites and tubules of the same, as seen in longitudinal section. The tabulæ of the tubules are strongly arched whilst those of the corallites are generally flat or slightly concave. Enlarged five times.

Figure 2. Portion of a specimen from the Niagara of Ontario with corallites that are almost circular. Natural size.

Figure 2*a*. Transverse section of two corallites of the same showing the septal spines and the tubules. A longitudinal section of these corallites is similar to what is shown in fig. 1*b*. Enlarged five times.

Figure 3. A natural longitudinal section of a specimen from the Guelph formation of Ontario. Natural size.

Figure 3*a*. Transverse section of the corallites of the same. Natural size.

Halysites catenularia, var. micropora, Whitfield (page 70).

Figure 4. Portion of a specimen from the Niagara of western Ontario showing a marked irregularity in the shape of the meshes. Natural size.

Halysites catenularia, var. gracilis, Hall (page 69).

Figure 5. The general form and arrangement of the corallites as seen in a specimen from East Selkirk, Man. Natural size.

Figure 5*a*. Corallites of the same, as seen in transverse section. Enlarged five times.

Figure 5*b*. Corallites of the same, viewed in longitudinal section. The septal spines on the sides of the corallites appear as dots. Five times the natural size.

Figure 6. Portion of a specimen from Jack Head Island, Lake Winnipeg, in which the corallites are large and more than usually angular. Natural size.

Figure 7. Part of a specimen from Churchill Harbour, Hudson Bay, with very small corallites. Natural size.

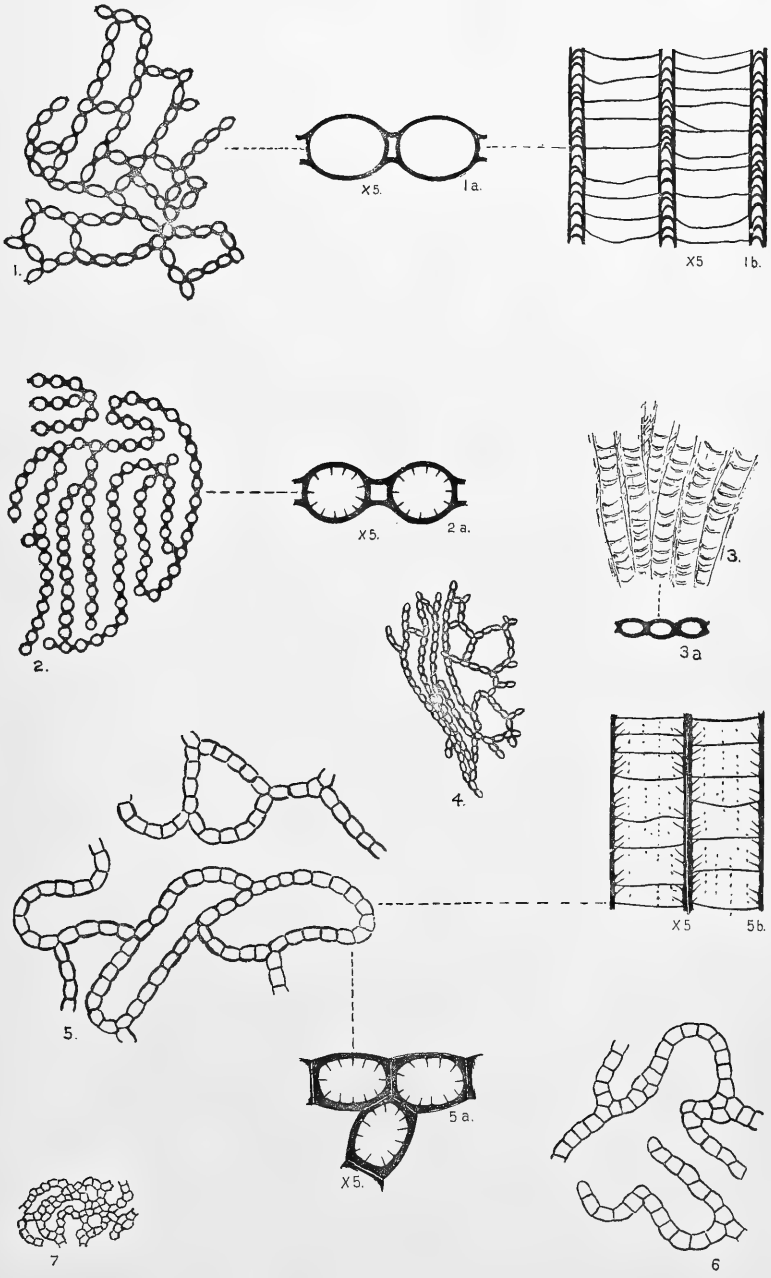

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PLATE IV.

Halysites catenularia, var. Quebecensis (page 69).

Figure 1. A few meshes, showing the general arrangement of the corallites, of a large specimen from Lake St. John, Que., two miles south of Blue Point. Natural size.

Figure 1*a*. Transverse section of two corallites of the same. Five times the natural size.

Figure 1*b*. Longitudinal section of the same, showing the tabulæ in the corallites and tubules. Enlarged five times.

Halysites catenularia, var. nitida (page 71).

Figure 2. The shape of the meshes in a portion of a specimen from L'Anse à la Barbe, Baie des Chaleurs, Que. Natural size.

Figure 2*a*. Transverse section of corallites and tubules of the same, showing their relative size Enlarged five times.

Figure 2*b*. Longitudinal section of the same showing the tabulæ and septal spines. Enlarged five times.

Halysites catenularia, var. simplex (page 70).

Figure 3. Transverse section of two corallites of a specimen from near the mouth of the Little Cascapedia River, Que. Five times the natural size.

Figure 3*a*. Longitudinal section of the same. Enlarged five times.

Halysites catenularia, var. amplitubulata (page 71).

Figure 4. Transverse section of two corallites and a tubule of a specimen from L'Anse au Gascon, Baie des Chaleurs, Que., showing the great development of the latter. Enlarged five times.

Figure 4*a*. Longitudinal section of the same showing the tabulæ of the corallties and tubule. Enlarged five times.

Halysites compacta, Rominger (page 71).

Figure 5. General arrangement of the corallites as seen in a specimen from the north end of Lake Temiscaming, Que., showing the triangular interspaces. Twice the natural size.

Figure 5*a*. Longitudinal section of two corallites and a tubule of the same; the section does not lie exactly in the plane of the tubule, and shows an interspace on either side. Enlarged five times.

Figure 6. Portion of a specimen, from the same locality as the above, with nearly circular corallites and comparatively large interspaces. Twice the natural size.

Figure 7. View of the weathered surface of a specimen from the north-east side of the Columbia River, B.C. Natural size.

Figure 8. Arrangement of the corallites, tubules and interspaces in a specimen from the Isle of Mann (Burnt Island), Lake Temiscaming, Que. Twice the natural size.

Figure 8*a*. The same enlarged; five times the natural size.

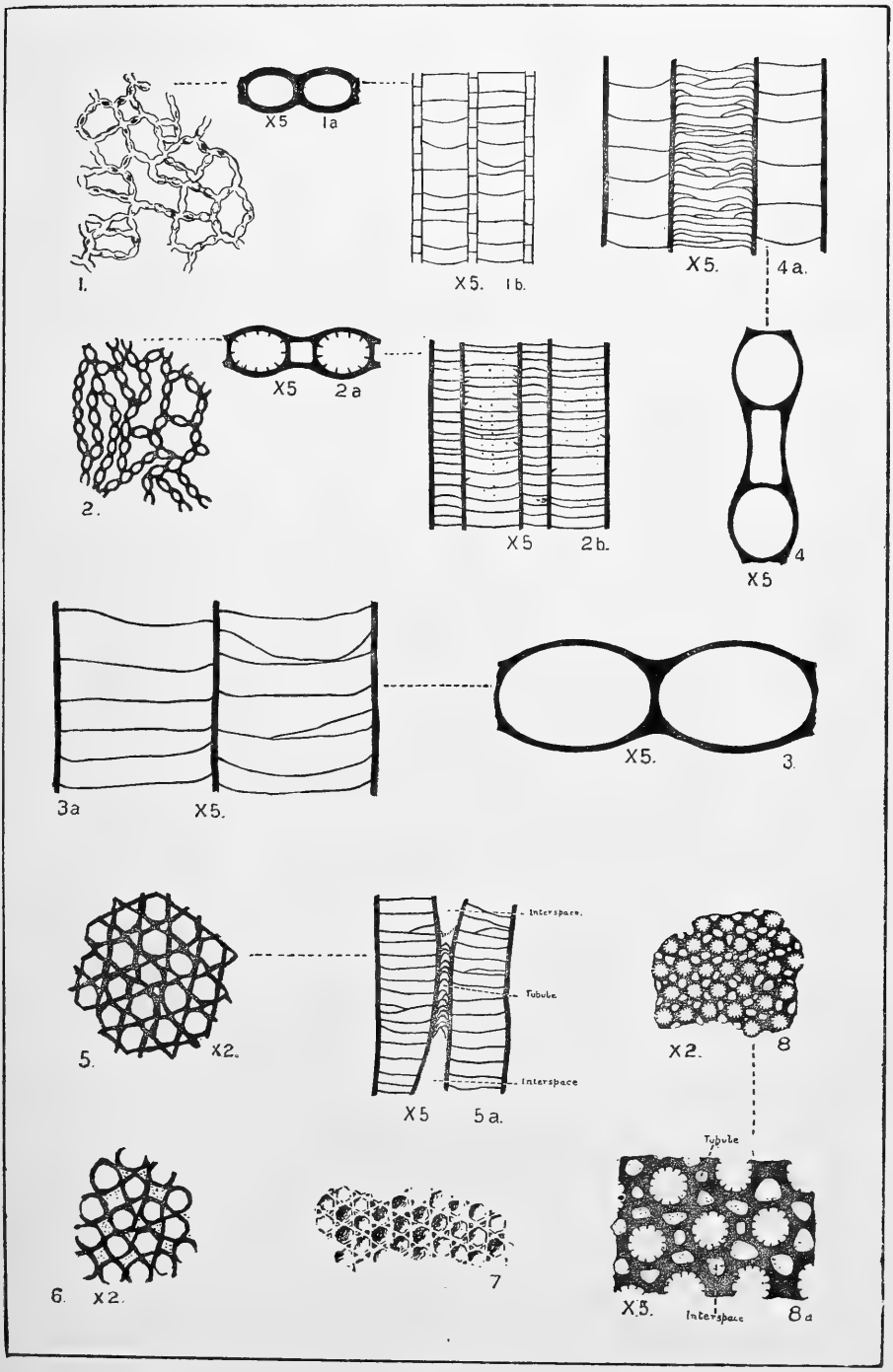

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PLATE V.

Lyellia affinis, Billings (page 84).

Figure 1. Transverse section of part of a specimen from three miles west of Jupiter River, Anticosti. Magnified five times.

Figure 1*a*. Longitudinal section of the same. Enlarged five times.

Lyellia Americana, Milne-Edwards and Haime (page 85).

Figure 2. Corallites, as seen in transverse section, in a specimen from Grand Manitoulin Island, Lake Huron. Five times the natural size.

Figure 2*a*. Longitudinal section of the same. Five times the natural size.

Lyellia exigua, Billings (page 86).

Figure 3. Horizontal section showing the disposition of the corallites in a specimen from Gamache Bay, Anticosti. Enlarged five times.

Figure 3*a*. Longitudinal section from the same specimen, also enlarged five times.

Lyellia superba, Billings (page 87).

Figure 4. Type specimen from Cabot's Head, Georgian Bay. One half the natural size.

Figure 5. Transverse section from a specimen from Owen Sound, Ontario. Five times the natural size.

Figure 5*a*. Longitudinal section of the same. Enlarged five times.

Lyopora Goldfussi, Billings (page 88).

Figure 6. Transverse section from a specimen from Snake Island, Lake St. John, Que., showing polygonal corallites. Five times the natural size.

Figure 6*a*. Longitudinal section of the same, also magnified five times.

Figure 7. Transverse section from a specimen from the some locality, showing circular corallites. Enlarged five times.

Protarea vetusta, Hall (page 90).

Figure 8. Transverse section, a little below the surface, in a specimen from Ottawa, Ontario. Enlarged five times.

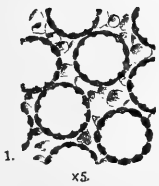
Figure 8*a*. Longitudinal section of the same showing a calyx with the pseudocolumella occupying the centre of the corallite. Enlarged five times.

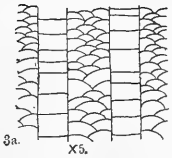
Stylaræa parva, Billings (page 91).

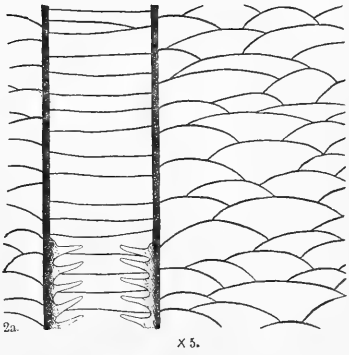
Figure 9. Part of the upper surface of a specimen from the Mingan Islands, Gulf of St. Lawrence. Enlarged five times.

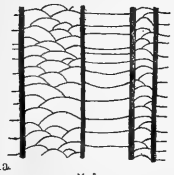
Figure 9*a*. Transverse section from the same specimen. Magnified five times.

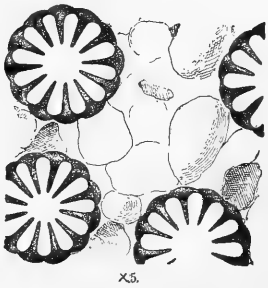
Figure 9*b*. Longitudinal section from the same, likewise enlarged five times.

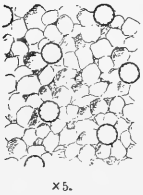


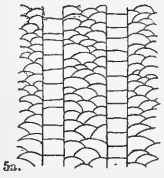


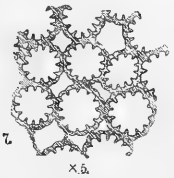


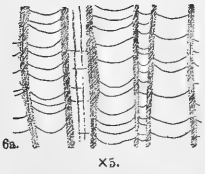


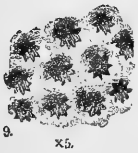


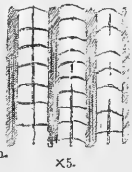


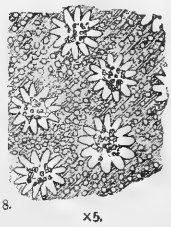












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GEOLOGICAL SURVEY OF CANADA
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CONTRIBUTIONS

TO

CANADIAN PALÆONTOLOGY

VOLUME IV.

PART II

A REVISION OF THE GENERA AND SPECIES OF CANADIAN PALÆOZOIC CORALS

The Madreporaria Aporosa and the Madreporaria Rugosa

BY

LAWRENCE M. LAMBE, F.G.S.

Assistant Palæontologist.

OTTAWA
PRINTED BY S. E. DAWSON, PRINTER TO THE QUEEN'S MOST EXCELLENT MAJESTY
1900

No. 712

The following report on the Madreporaria Aporosa and the Madreporaria Rugosa forms a second part to the previously published report on the Madreporaria Perforata and the Alcyonaria, the two forming parts I and II of the fourth volume of "Contributions to Canadian Palæontology." Thirteen plates illustrating the text accompany the present publication.

GEORGE M. DAWSON.

Geological Survey Department,
Ottawa, December, 1900.

ERRATUM.

Page 196 line 13 from top, *for* venusta *read* Whiteavesiana.

GEOLOGICAL SURVEY OF CANADA.

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BY

LAWRENCE M. LAMBE.

ACTINOZOA.

ZOANTHARIA (continued.)

3. Madreporaria Aporosa.

COLUMNARIADÆ.

Genus COLUMNARIA, Goldfuss. 1826.

Columnaria (pars), Goldfuss. 1826. Petrefacta Germaniæ, vol. I, p. 72.
Favistella, Hall. 1847. Palæon. New York, vol. I., p. 275.
Palæophyllum, Billings. 1858. Rep. of Progress for 1857, Geol. Survey of Canada, p. 168.
Cyathophylloides (pars), Dybowski. 1873. Monograph I., pp. 78 and 123.
Favistella, Nicholson. 1875. Palæon. of Ont., p. 21.

Corallum composite or fasciculate, massive, attached by the base, composed of polygonal, subpolygonal or cylindrical corallites whose walls are imperforate and when contiguous are not completely amalgamated. Septa lamellar, generally well developed and alternately long and short, the primaries nearly or quite reaching the centre of the visceral chamber; in one species they are short and of nearly equal size. Tabulæ typically horizontal and complete, but sometimes their continuity in the same plane is broken by the septa. When the corallites are separate and cylindrical

an epitheca is present marked by annular growth lines and longitudinal ribbing. Increase by lateral calicinal gemmation.

Type species.—*C. alveolata*, Goldfuss.

Range.—Cambro-Silurian, Devonian.

Columnaria alveolata, Goldfuss.

(Non Columnaria alveolata, Hall, Billings, Rominger.)

Plate VI., figs. 1, 1*a*.

Columnaria alveolata, Goldfuss. 1826. Petrefacta Germaniæ, vol. I., p. 72, pl. XXIV., figs. 7a, b, c.
Columnaria multiradiata, Castelneau. 1843. Essai sur le Syst. Silur. de l'Amér. septentr., p. 44, pl. 19, fig. 1.
Favistella stellata, Hall. 1847. Palæon. New York, vol. I, p. 275, pl. 75, figs. 1a, b. c.
Columnaria alveolata (pars), Milne-Edwards and Haime. 1851. Polyp. Foss des Terr. Palæoz., p. 309.
Columnaria Blainvilli, Billings. 1858. Rep. of Progress for 1857, Geol. Survey of Canada, p. 166.
Favistella stellata, Billings. 1863. Geology of Canada, p. 206, figs. 202a, b.
" " Nicholson. 1875, Palæon. of Ont., p. 22; and Geol. Surv. of Ohio, vol. II., p. 185.
Columnaria stellata, Rominger. 1876. Geol. Sur. Mich., Foss. Corals, p. 90, pl. XXXIV., fig. 3 and pl. XXVIII., fig. 1.
Columnaria alveolata, Nicholson. 1879. Palæoz. Tab. Corals, p. 195, pl. X., figs. 1, 1a.
" " Whiteaves. 1897. Palæoz. Foss. vol. III., pt. III., p. 151.

Corallum massive, roughly hemispherical to almost circular when young, and becoming more irregular in shape with age; basal attachment small. Corallites polygonal, unequal in size, varying when fully developed from about a little over 2 to 6 or 7 mm., closely connected with one another throughout their length and diverging slightly from a central basal point. Septa, numbering from about twenty to over thirty, alternately large and small, the latter extending a very short distance beyond the walls of the corallites, the former almost or quite reaching the centre. Tabulæ complete, horizontal, generally bent downward at their edges, about from two to four in a space of 2 mm. Calyces polygonal, rather shallow, exhibiting the septa. The division lines between contiguous corallites are generally distinctly seen in transverse sections.

This species occurs abundantly in the Hudson River formation, and Dr. Whiteaves has recognized it in the Trenton limestone of the Lake Winnipeg district. It is represented in the museum of the Geological Survey by specimens from Anticosti, from various localities in Ontario, and from Lake Winnipeg and the Red River valley. Its corallites vary somewhat in size in the same and different specimens; in some they are

of considerable size interspersed with much smaller ones, in others they are uniformly rather large, or they may be small with little disparity in size.

The coral from Snake Island, Lake St. John, Que., (Hudson River formation), described by Billings under the name *C. Blainvilli*, is here referred to this species, from which it was separated specifically on account of the supposed smaller size of its corallites. It does not differ, however, in this respect from specimens of *C. alveolata*, Goldfuss, in which the corallites are rather below the average in size. In the Lake St. John specimen the corallites have an average diameter of 3 mm., but are sometimes nearly 4·5 mm. in diameter, the septa are alternately large and small and number about twenty-four. The tabulæ as well as the septa are identical in shape and disposition with those of *C. alveolata*.

As has already been stated, the tabulæ are generally deflected at the margin, but in some specimens they are less depressed where they touch the septa than they are between them, causing the tabulæ to have a crinkled or plicated appearance near their edges, a not uncommon development in some species of *Favosites*.

Rominger mentions (op. cit. p. 90) the occurrence of this species in rocks of Niagara age at Point Detour, Lake Huron.

Hudson River formation.—North Point, Drummond Island, Lake Huron, J. Richardson, 1847; Cape Symth, Lake Huron, R. Bell, 1859; Credit River at Streetsville, Ont., J. B. Tyrrell, 1888; Snake Island, Lake St. John, J. Richardson, 1857; English Head, Anticosti, J. Richardson, 1856.

Trenton formation.—East Selkirk and Lower Fort Garry, Manitoba, R. Bell, 1880, A. McCharles, 1884, L. M. Lambe, 1890; Jack Head Island, Lake Winnipeg, D. B. Dowling and L. M. Lambe, 1890; Markham Lake, Telzoa River, District of Mackenzie, (lat. 62° 44′, long. 103°), J. B. Tyrrell, 1893.

In 1896, Dr. R. W. Ells and the writer found, at Stewart's quarry (near Sand Point), lot 18, concession 11, township of McNab, Renfrew county, Ont., in the Black River limestone, specimens of *C. alveolata*, Goldfuss, and *C. Halli*, Nicholson, in situ, within a few feet of each other. The writer is not aware that *C. alveolata*, Goldfuss, has previously been recorded in Canada or the United States from as low a horizon as the Black River limestone. A transverse section of the corallites of the specimen from Stewart's quarry is shown on plate VI.

Columnaria Halli, Nicholson.

(Non Columnaria alveolata, Goldfuss.)

Plate VI., figs. 2, 2a.

Columnaria alveolata, Hall. 1847. Palæon. New York, vol. I., p. 47, pl. 12, figs. 1, 1a--c.
" " Billings. 1863. Geology of Canada, p. 139, fig. 70.
" " Nicholson. 1875. Palæon. of Ont., p. 8.
" " Rominger. 1876. Geol. Sur. Mich., Foss. Corals, p. 89, pl. XXXIV., figs. 1, 2 and 4.
Columnaria (?) Halli, Nicholson. 1879. Palæoz. Tab. Corals, p. 200, pl. X., figs. 3, 3a.

Corallum attaining to a considerable size and formed of polygonal corallites in close contiguity throughout their length. The corallites vary in width from 4 to nearly 11 mm., and are much more irregular in size than in *C. alveolata*, Goldfuss. The septa, in the form of lamellar keels and numbering in all from about twenty-five to forty, are of nearly equal size and project only a short distance into the visceral chamber; their free edges are denticulated and in well preserved specimens their differentiation into two alternating sizes is distinctly seen. The tabulæ are horizontal, entire, often slightly concave or convex, but not turned down at the edges, nor crenulated as is frequently the case in *C. alveolata*. In some specimens the division line between the corallites can be seen clearly in transverse section or when weathering has taken place. The initial corallites seem to be larger as a rule than those of the corallum when it has attained a larger growth.

This species is typical of the Birdseye and Black River formation in the provinces of Quebec and Ontario. In the Geology of Canada, 1863, it is recorded as occurring in the province of Quebec at Montreal and Pointe Claire, at St. Lin and Joliette, north of Montreal, also on the Riviere au Lard, Cap de la Magdelaine township, county of Champlain.

In the museum of the Survey it is represented by specimens from Paquette's Rapids, Ottawa River; from Cornwall township, county of Stormont, Ont.; from Pakenham, McNab and Stafford townships west of Ottawa; from Rockland quarry in the vicinity of Ottawa; from St. Vincent de Paul, Isle Jesus, Que.; from Rivière au Lard, county of Champlain; also from Gravel Point, St. Joseph Island, Lake Huron and from the west shore of Great Manitou Island, Lake Nipissing, Ont.

The specimen of *C. Halli*, from which the figures on plate VI. are taken, is from the Black River limestone at Stewart's quarry, near Sand Point, on the Ottawa River, a few miles west of Arnprior.

Columnaria rugosa, Billings. (Sp.)

Plate VI., figs. 3, 3*a*, 3*b*.

? Lithostrotion Stokesi, Milne-Edwards and Haime. 1851. Polyp. Foss. des Terr. Palæoz., p. 440, pl. 20, fig. 2.
Palæophyllum rugosum, Billings. 1858. Rep. of Progress for 1857, Geol. Survey of Canada, p. 168.
Columnaria erratica, Billings. 1858. Ibid, p. 166.
Diphyphyllum Stokesi, Whiteaves. 1897. Palæoz. Foss. vol. III., pt. III., p. 152, pl. XVII., figs. 5, 5*a*, 5*b*.
Columnaria rugosa, Lambe. 1899. Ottawa Naturalist, vol. XII., p. 217.

"The generic characters ascribed to the genus *Palæophyllum* were—'Corallum fasciculate or aggregate; corallites surrounded by a thick wall; radiating septa extending the whole length; transverse diaphragms either none or rudimentary; increase by lateral budding.'

"The type specimen, by far the most perfect specimen in the collection, has been closely examined, and, by means of a longitudinal section of one of the corallites, close set complete horizontal tabulæ are found to be present. The supposed absence or rudimentary condition of tabulæ being the only character distinguishing *Palæophyllum* from *Columnaria*, the knowledge that tabulæ exist removes the barrier to the union of these two genera.

"*Columnaria rugosa* may be defined as follows:— corallum consisting of an aggregation of circular or rounded polygonal corallites, from about 3 to 9 mm. in diameter, which are in contact with one another or free for greater or less distances. Septa, numbering about forty in well developed corallites, alternately long and short, the long ones reaching to or almost to the centre, the short ones almost rudimentary. Tabulæ complete, horizontal, slightly irregular, at times slightly concave or convex and often turned downward at their edges, about four in a space of 2 mm. Increase by lateral calicular gemmation. Exterior of corallites marked by annular lines of growth and faint longitudinal lines corresponding with the septa within.

"The corallites in this species vary considerably in size in some specimens, in others they are more uniform, and when in contact whether circular or polygonal, they still remain distinct one from another, generally with interspaces between them.

"*Columnaria erratica*, Billings, was described as 'forming large masses of corallites, either in contact or separate. The separate cells are round, those in contact more or less polygonal, the radiating septa rudimentary, forming about four sulci in the breadth of one line upon the interior;

diameter of corallites from two to five lines, in general about three and a half lines. The transverse diaphragms are not visible in the specimens examined. The walls of the separate corallites are thick and concentrically wrinkled.' This species is now represented in the museum collection by a single specimen, labelled in the handwriting of Mr. Billings, which consists of a portion of a corallum with corallites that are circular when free or almost polygonal when crowded together; it unfortunately does not show the septa, but tabulæ are clearly distinguishable. Judging from the manner of growth of *C. erratica*, the presence of tabulæ and the stated presence of septa, the writer is inclined to believe that the description of *C. erratica* was based on imperfectly preserved specimens of *C. rugosa*, and that the two species are identical, especially in view of the fact that out of a number of examples of the latter species only one shows the septa at all, but fortunately in this case very well." (Lambe, 1899.)

Trenton formation.—Lake St. John, Little Discharge, Blue Point, Que., J. Richardson, 1857; near Blue Point, A. R. C. Selwyn and J. Richardson, 1870; 2 miles south of Blue Point, W. McOuat, 1871; all the specimens are silicified, and the structure is best seen where weathering has taken place. Also at Lower Fort Garry, about 19 miles below Winnipeg, on the Red River, Manitoba, four specimens, one collected by Donald Gunn in 1858, the other three by T. C. Weston in 1884.

The specimens from Lower Fort Garry have their structure well preserved and are, in the writer's opinion, clearly referable to Billings's species.

Columnaria calicina, Nicholson.

Plate VI., fig. 4.

Favistella calicina, Nicholson. 1874. Rep. Brit. Ass., Trans. of sections, p. 89; and 1875, Palæon. of Ont., p. 24, figs. 9 *a*, *b*.
Columnaria Hertzeri, Rominger. 1876. Geol. Sur. Mich., Foss. Corals, p. 90.
Columnaria calicina, Nicholson. 1879. Palæoz. Tab. Corals, p. 197, pl. X., figs. 2, 2*a*.

This species was described by Nicholson from specimens obtained from the Hudson River formation at the Credit River, Ont.; it is represented in this museum by specimens from the typical locality, as well as by others from the same geological horizon at Cape Smyth, Lake Huron, and from the Hudson River of Anticosti.

Specific characters.—Corallum, attaining at times a diameter of over 15 cent., composed of corallites that may be either free and circular in section or aggregated and polygonal or subpolygonal in section. The corallites may be to a great extent free from the beginning of the growth of the corallum, or they may only attain a circular form at a later stage

of growth, or they may form reticulated loops, not unlike a large *Halysites*, or loose fascicles, with free corallites irregularly interspersed. The corallites are from about 3 to 6 mm. in diameter, and the line of division between them, when closely crowded together, is quite distinct. The septa vary in number from about twenty-eight to thirty-eight, of which one half pass to the centre or nearly so, the remainder are very short and might easily escape notice. The tabulæ are horizontal, entire and deflected at the periphery. The outer surface of the corallites is strongly marked by encircling lines of growth and longitudinal ridges. New corallites seem to be reproduced by lateral calicinal budding.

This species approaches very closely to *Columnaria rugosa*, Billings, from the Trenton of Lake St. John, Que., indeed it is questionable whether it would not be best to consider it as a variety of the latter species. Its corallites have not such a free growth as those of the Trenton form, and are, when crowded together, more decidedly angular and in closer contact. In *C. rugosa* the corallites are more generally circular in section, even when aggregated, and the appearance of the corallum suggests a somewhat stronger growth.

Hudson River formation.—Cape Smyth, Lake Huron; Credit River at Streetsville, Ont., J. B. Tyrrell, 1888. The largest specimen from the last named locality is over 10 cent. high and nearly 15 cent. across; the initial basal point is present and the divergence of the corallites, the gradual growth of the corallum and the admixture of circular and polygonal tubes are well shown. A slightly worn and evidently loose specimen labelled "East of White Cliff, Gamache Bay, Anticosti, J. Richardson, 1856," is probably from the Hudson River formation of this island.

Columnaria disjuncta, Whiteaves.

Columnaria (Cyathophylloides) disjuncta, Whiteaves. 1892. Contr. to Can. Palæon., vol. I, pt. IV., p. 269, pl. XXXIV., figs. 3, 3a, 3b.

"Corallum composite, consisting apparently of a colony of cylindrical, straight or flexuous, ascending or erect corallites, which are separate but sometimes partially in contact, or more or less closely aggregated; diameter of the corallites averaging about five millimetres, their mural investment single and external. Surface markings of the corallites unknown, though in transverse sections there are indications of longitudinal ribs, corresponding to the septa within. Calyces deep, with erect sides: primary septa thirteen, simple, neither crenulated nor denticulated, very thin, laminar and extending to the centre at and below the bottom of the cup: secondary septa similar in number and structure to the primaries, but reaching only half way to the centre. The only internal structures

besides the septa, are rather distant, thin and laminar horizontal diaphragms, which partake partly of the nature of tabulæ and partly of dissepiments. These diaphragms either form almost continuous floors across the corallites (at intervals of from one to two millimetres apart) and thus resemble tabulæ, except that their continuity appears to be interrupted by the septa, or they are disconnected and not on the same plane and thus partake more of the nature of dissepiments, though they are never curved." (Whiteaves.)

Of this species Dr. Whiteaves says: "It is clearly congeneric, and may even prove to be conspecific, with the *Cyathophylloides Rhenanum* of Frech, from the Devonian rocks of the Eifel, which Dr. Frech informs the present writer (Dr. Whiteaves) is also a *Columnaria*."

This coral, as its name implies, has corallites which are normally separate and cylindrical, but when at times they are crowded together they become polygonal, as is shown by some of the specimens in the collection.

C. disjuncta may be regarded as an extreme form of the genus; *C. alveolata* and *C. Halli* are species in which the corallites are contiguous, *C. rugosa* and *C. calicina* species in which the corallites are as often free as in contact and *C. disjuncta*, a species in which the corallites are generally free.

Devonian (*American Stringocephalus zone**). Pentamerus Point, Lake Manitoba, J. B. Tyrrell and J. F. Whiteaves, 1888. South-west shore of Dawson Bay, Lake Winnipegosis, at the mouth of Steep Rock River, J. B. Tyrrell, 1889.

4. Madreporaria Rugosa.

CYATHAXONIDAE.

Genus Petraia, Münster, 1839.

Petraia, Münster. 1839. Beitr. zur. Petrefaktenkunde, vol. I., p. 42.

Corallum simple, conical, small. Epitheca complete. Calyx deep at times reaching almost to base of corallum. Septa of two orders, primaries and secondaries, little developed. Sometimes a cardinal and two alar septa are conspicuous. The tetrameral arrangement of the septa well indicated by the septal furrows on the surface. Septal fossette sometimes present. No tabulæ dissepiments nor columella.

Type species.—*P. decussata*, Münster.

Range.—In Canada, Cambro-Silurian, Silurian.

*The term "American Stringocephalus zone" is used at Dr. Whiteaves's suggestion, until we know whether it is synchronous with the European "Stringocephalus zone" or not.

PETRAIA PROFUNDA, Conrad. (Sp.)

Plate VI., figs. 5, 5a, 5b.

Cyathophyllum profundum, Conrad. 1843. Proc. Acad. Nat. Sci. Philadelphia, p. 335.
Streptelasma profunda, Hall. 1847. Palæon. New York, vol. I., p. 49, pl. 12, figs. 4, 4a—e.

Corallum simple, turbinate, very slightly curved, sharply pointed below, higher than broad and apparently seldom more than about 3 cms. in length. Outer surface marked by transverse growth annulations of unequal strength at irregular distances apart, and by narrow, distinct, longitudinal septal furrows. Calyx wide and very deep reaching almost to the base of the corallum. Septa, of two orders, primary and secondary, alternating, denticulated at their edges, carinated on their sides and numbering in all in well developed individuals as many as ninety. The primaries extend to the bottom of the cup as thin lamellæ standing out about 2 mm. from the side walls, the secondaries reach only about half way to the bottom and are little more than uniserial rows of denticles. Both kinds of septa become low and obtusely rounded near the mouth of the calyx. Three principal septa are developed, a cardinal septum and two lateral or alar septa; the bilateral symmetry of the septa and their pinnate arrangement on the convexly curved or dorsal side of the corallum is distinctly noticeable.

A particularly well preserved specimen in the collection is 30 mm. high and 26mm. broad at the top.

Locality.—La Petite Chaudiere, Ottawa, Ont., collected by E. Billings, also Paquette's Rapids, Ottawa River, collected by T. C. Weston in 1872. Birdseye and Black River formation.

PETRAIA APERTA, Billings.

Petraia aperta, Billings. 1862. Palæoz. Foss., vol. I., p. 102, figs. 89*a* and *b*.

Original description.—"Corallum simple, turbinate, short, widely expanding; cup deep, broadly concave in the bottom, with a distinct septal fossette on one side. Radiating septa from one hundred to one hundred and fifty. Surface with a few annulations of growth, and finely marked with the longitudinal septal striæ, of which there are from five to seven in the width of one line. The specimens are from four to six lines in height, and from eight to twelve lines in width at the margin. Depth of the cup about half the height. The point of attachment is very nearly central."

Locality.—Paquette's Rapids, Ottawa River, Birdseye and Black River formation; collector E. Billings. Specimens were also obtained at this locality by T. C. Weston in 1872.

Petraia pygmæa, Billings.

Plate VI., figs. 6, 6*a*, 6*b*.

Petraia pygmea, Billings. 1862. Palæoz. Foss., vol. I, p. 103, fig. 91.
" " Billings. 1866. Cat. Sil. Foss. of Anticosti, p. 33.
Petraia pygmæa, Nicholson. 1875. Palæon. of Ont., p. 59.

Corallum simple, very small, elongato-conical, gently curved, sometimes slightly constricted above or at mid-length, from 3 to 10 mm. long, averaging about 6 mm. in length, and with a breadth at the top generally from about one-third to one-half the length. Outer surface showing faint transverse rings of growth and longitudinal septal markings. Calyx deep, rather pointed below, often reaching more than half way toward the base of the corallum. Septa of two sizes, the primaries in the form of stout, sharp-edged ridges, apparently denticulated, the secondaries, very small but distinct, alternating with the primaries; in number about twenty-eight.

Localities.—Collected by J. Richardson in 1856 on the Island of Anticosti, at Cape Sand Top Bay, division II. Anticosti group; at Heath Point Lighthouse and at East Point, Ottawa Brook, division III. Anticosti group; and at Chaloupe River, division IV. Anticosti group. This coral is found at these localities in large numbers on weathered surfaces of limestone. Nicholson records its occurrence in the Niagara formation at Thorold, Ont.

PALÆOCYCLIDÆ.

Genus Microcyclus, Meek and Worthen. 1868.

Microcyclus, Meek and Worthen. 1868. Geol. Surv., Illinois, vol. III., p. 420.

"Corallum free, or with a minute central point of attachment, discoidal, without columella; calice very shallow, or nearly obsolete, and provided with a single small fossette; septa short, nearly regularly radiating, or with a few of those nearest the fossette converging a little towards its sides; epitheca well developed." (Meek and Worthen.)

Type species.—*M. discus*, Meek and Worthen.

Range. Devonian. (Hamilton formation.)

MICROCYCLUS DISCUS, Meek and Worthen.

Microcyclus discus, Meek and Worthen. 1868. Geol. Surv., Illinois, vol III., p. 420, pl. XI., figs. 7, *a*, *b*.
" " Nicholson. 1874. Palæon. of Ont., p, 39. figs. 9*a*, 9*b*.

Corallum simple, small, discoidal with a thin periphery, varying in diameter from 4 to over 15 mm., and generally not more than 9 mm. in maximum thickness, somewhat convex above, flat or convex below, adherent by part of the lower surface to foreign objects such as very small shells, fragments of crinoidal columns, etc. Epitheca complete, covering the basal surface, concentrically marked by irregular accretion ridges and by very fine close-set lines of growth with sometimes slight indications of radial septal furrows. Septa numbering from about thirty-six to forty-eight, thick, in the form of convergent, somewhat angular ridges on the upper surface, of two sizes, alternating, the primaries passing a little more than half way toward the centre, the secondaries only about one-third the length of the primaries. Middle of upper surface smooth, generally slightly concave. Fossette, comparatively deep, conspicuous, narrow, extending from near the centre toward the margin, where it is occupied by one septum. A constriction of the calicular surface seems to be not uncommon and results in a slight thickening of the corallum. Not infrequently a coalescence of two or three primary septa or of the secondary septa with the primaries takes place, giving the septa the appearance of bifurcating or trifurcating. In a vertical section through the corallum no tabulæ nor dissepiments are apparent.

Meek and Worthen in their description of the species mention a breadth attained by one of their specimens of 0·77 inch with a height of 0·15 inch.

Localities.—Not uncommon in the Hamilton formation of Ontario; collected by the Reverend H. Currie in 1882 at Widder, Ont. and by Dr. Whiteaves on the Sable River, Ont. in 1891.

ZAPHRENTIDÆ.

Genus STREPTELASMA, Hall, 1847.

Streptoplasma, Hall, 1847. Palæon. New York, vol I., p. 17. (Changed in explanation of figures to *Streptelasma*.)

Corallum simple, conical. Epitheca complete. Calyx generally of moderate depth. Septa numerous, well developed, their outer ends combining to form a thickening of the thin wall proper; of two sizes alternating, the larger twisted at the centre, the secondaries usually embedded in the thickened wall or projecting only slightly from it. No true tabulæ

their place taken by dissepiments of unequal size, curving convexly upward and inward toward the centre where they form in combination with the inner twisted ends of the primary septa an axial, more or less cellulose columella that projects as a boss from the bottom of the cup. Septal fossette usually present. The arrangement of the septa tetrameral.

Type species.—*S. expansa*, Hall.

Range.—Cambro-Silurian, Silurian, Devonian.

Streptelasma corniculum, Hall.

Plate VI., figs. 7, 7*a*, 7*b*.

Streptelasma (*Streptoplasma*) *corniculum*, Hall. 1847. Palæon. New York, vol. I. p. 69, pl. 25, figs. 1a--d.
Petraia Ottawaensis, Billings. 1865. Canadian Naturalist, new series, vol. II, p. 429.
Streptelasma corniculum, Rominger. 1876. Geol. Sur. Mich., Foss. Corals, p. 141 (pars), pl. LI, upper row, specimens from the Trenton formation only.

Corallum simple, elongato-conical, curved, gradually increasing in size from a pointed base until a maximum breadth of about 3 cent. is reached in a length of between 6 or 7 cent., average size somewhat smaller. Outer surface marked transversely by accretion ridges of rather variable size and disposition. Epitheca complete with distinct longitudinal septal furrows. Calyx moderately deep, with steep sides and a convex floor; its depth measured from the centre of its floor is equal to rather less than one-third of the height of the corallum. Septa well developed, of two orders, primaries and secondaries, alternating, numbering in all in mature individuals from about ninety to one hundred and twenty, the primaries reaching the centre with their inner ends twisted, the secondaries extending but a short distance inward from the wall. The free edges of the septa in the calyx are denticulated. Dissepiments at times having the appearance, in longitudinal sections of the corallum, of true tabulæ, irregular, subordinate to the septa between which they curve upward convexly toward the centre of the visceral chamber, where they lose their individuality and form with the twisted inner ends of the primary septa an axial area of cellulose structure.

Localities.—Collected by Sir William E. Logan, in 1845, at Paquette's Rapids, Ottawa River, by James Richardson at the same place, and by R. D. Ells and L. M. Lambe, from the vicinity of Douglas, Eganville and Cobden, in 1896; Birdseye and Black River formation. Collected by E. Billings, also by H. M. Ami in 1883, from the Trenton formation at Ottawa, Ont. This species is mentioned (Rep. Palæont. Prov. Ontario, 1875) by Nicholson, as occurring in the Trenton limestone at Peter-

Streptelasma robustum, Whiteaves.

Plate VII., fig. 1.

Streptelasma corniculum (?) Hall. Large and robust variety. Whiteaves. 1881. Rep. of Progress for 1879-80, Geol. Survey of Canada, p. 57c.

Streptelasma robustum, Whiteaves. 1896. Canad. Rec. Sci., vol. VI., p. 391.

" " Whiteaves. 1897. Palæoz. Foss., vol. III., pt. III., p. 153, pl. XVIII., figs. 1, 1a.

"Corallum simple, elongate conical, usually rather strongly curved, though some specimens are not so much curved as others, very large for the genus, attaining to a length of seven inches as measured along the curve of the convex side, to a height of nearly five inches, and to a breadth or width of nearly two inches and a quarter at the summit. In some adult or nearly adult specimens the sides are so much compressed (perhaps abnormally so) that the convexly arched region is obtusely angulated in the centre, longitudinally; in some young specimens this region is distinctly flattened, but others are circular in outline in transverse section, or as seen from above. Septa alternately long and short, varying in number in large specimens from one hundred and sixty to one hundred and seventy in all, the longer ones extending to the centre at the bottom of the calyx. Surface marked with transverse wrinkles and numerous fine striæ of growth in well-preserved specimens, but often so much worn, apparently prior to fossilization, as to be almost smooth.

"Longitudinal sections through the centre of large specimens show that the calyx is not very deep, and that its cavity occupies, but a small proportion of the entire length. Below the calyx the corallum is filled with strongly developed and apparently thickened septa, with well-marked dissepiments between them, and these septa, with their dissepiments, unite in the centre in such a way as to form a large irregularly reticulated pseudo-columella, which projects slightly above the centre of the base of the calyx, as a boss of irregular shape, but with a narrowly rounded summit.

"This fine coral is especially abundant, and attains to a large size in the Red River valley, at Lower Fort Garry and East Selkirk, Manitoba, where it was collected by Dr. R. Bell, in 1880, by T. C. Weston and A. McCharles in 1884, by L. M. Lambe in 1890, and by D. B. Dowling in 1891.

"On the western side of Lake Winnipeg a few comparatively small and very imperfect specimens, which may be referable to this species, were collected at Deer Island by T. C. Weston in 1884, at Little Black Island by J. B. Tyrrell in 1889, at Jack Head and Snake islands by D. B. Dow-

ling and L. M. Lambe in 1890, at Dog Head, Dancing Point, Little Tamarack and Selkirk islands, and on the main shore opposite the north end of Selkirk Island and north of the Saskatchewan by D. B. Dowling in 1891. Most of the specimens from these localities appear to widen out much more rapidly, at a short distance from the pointed base, than any of the eastern examples of *S. corniculum* do, but a single specimen from Little Black Island approaches very near to that species.

"A small specimen, which is probably also referable to *S. robustum*, was collected at the junction of the Little and Great Churchill rivers by Dr. R. Bell in 1889.

"When fully grown this species can be readily distinguished from *S. corniculum* by its very much larger size and more robust habit of growth." (Whiteaves.)

Formation.—Galena-Trenton.

Streptelasma rusticum, Billings. (Sp.)

Plate VII., figs. 2, 2*a* and 3.

Streptelasma corniculum, Milne-Edwards and Haime. 1851. Polyp. Foss. des Terr. Palæoz., p. 398, pl. 7, figs. 4, 4*a*, 4*b*.
Petraia rustica, Billings. 1858. Rep. of Progress for 1857, Geol. Survey of Canada, p. 168.
Zaphrentis Canadensis, Billings. 1862. Palæoz. Foss. vol. I., p. 105, figs. 93 *a*—*c*.
Petraia Canadensis, Billings. 1863. Geology of Canada, p. 208, fig. 205.
Streptelasma corniculum, Nicholson. 1875. Palæon. of Ont., p. 26; and Geol. Surv. of Ohio, vol. II., p. 218.
" " Rominger. 1876. Geol. Sur. Mich., Foss. Corals, p. 141 (pars), pl. LI., upper row, specimens from the Hudson River formation only.

Original description.—"Straight or slightly curved, covered with a strong epitheca, which is more or less annulated with broad shallow undulations; radiating septa about one hundred or usually a little more; much confused in the centre, where they form a vesicular mass; every alternate septum much smaller than the others, only half the whole number reaching the centre. Length from two inches and a half to three inches and a half. Diameter of cup one inch to one inch and a half; depth of cup half an inch or somewhat more.

This species appears to be the same as that described by Edwards and Haime under the name of *Streptelasma corniculum*. The true *S. corniculum* of Mr. Hall is a very different species, being always shorter nd much curved.

"*Formation and Locality.*—Hudson River group; Snake Island, Lake St. John, Que.; collected by J. Richardson in 1857." (Billings.)

The types of *Zaphrentis Canadensis* are from the Hudson River formation of Drummond Island, Lake Huron, and were collected by A. Murray in 1847. A number of specimens, in the museum of the Survey, and labelled *Petraia rustica*, were collected at Cape Smyth, Lake Huron (Hudson River formation) by R. Bell in 1859. Since then a few specimens were obtained by Commander J. G. Boulton, R.N., at Cape Smyth in 1884.

A comparison of the types of *P. rustica* from Lake St. John with the types of *Z. Canadensis* from Drummond Island and the specimens from Cape Smyth, forces the writer to the opinion that all are the same specifically, and are properly referable to the genus *Streptelasma*.

The following description of the species has been drawn from all the available material:—

Corallum simple, elongate conical, sometimes straight but more often moderately curved near the bottom, expanding slowly from a pointed base, and usually becoming somewhat cylindrical above the midheight; length in mature individuals measured along the convex curve from 70 to 90 mm., with a diameter at the top averaging a little over 30 mm. Outer surface rather smooth, transversely ribbed with obscure growth accretions interspersed with finer growth markings. Epitheca complete, with longitudinal septal furrows only faintly indicated. Calyx moderately deep, with steep sides and a convex floor; its depth at the side varying in different specimens from about 18 to 25 mm. Septa numbering from about one hundred to one hundred and fifty, the primaries and secondaries alternating, the former passing to the centre, where they are often considerably twisted, the latter very feebly developed; the primaries are very short near the calicular rim, gradually lengthening until they project about 4 mm. from the wall a short distance above the bottom of the cup in the floor of which they reach the centre. Free edges of the septa in the cup denticulated. Dissepiments arched inward to the centre, occupying the interseptal loculi, forming with the twisted inner ends of the primary septa the confused central structure characteristic of *Streptelasma*. The dissepiments show a considerable variation in the amount of their development and regularity, they generally rise upward toward the centre forming at the bottom of the calyx a rough convex floor, but less frequently they are more nearly horizontal and less irregular, at which time they may have a Zaphrentine appearance that points to the near relationship existing between the genera *Streptelasma* and *Zaphrentis*.

As regards the illustrations of *Z. Canadensis* on p. 105 of volume I., Palæozoic Fossils, it may be said that in figure *a* the distinctness of the septal furrows is exaggerated and suggests a rough surface not seen in the

specimens examined, and in figure *b*, a longitudinal section of the type specimen, continuous tabulæ are represented as stretching across the visceral chamber with no indications of septa; the specimen itself shows dissepiments that arch upward and inward on either side, but that are unusually flat at the centre, and primary septa that cut into the dissepiments and disturb their regularity at the centre.

Streptelasma angulatum, Billings. (Sp.)

Petraia angulata, Billings. 1862. Palæoz. Foss., vol. I., p. 103, figs. 90 *a* and *b*.
" " Billings. 1866. Cat. Sil. Foss. of Anticosti, p. 7.

Original description.—"Of this species we have only three small specimens. They are irregularly conical, moderately curved, expanding from an acute point to a width of seven lines at a height of about eight lines, acutely angulated on the side opposite the concave curve. Surface with a few obscure annulations of growth, and besides engirdled with numerous smaller obscure lines, from four to six in one line. The cup appears to be about four lines deep in a specimen eight lines in length. There appear to be three or four septal striæ on the outside in the width of one line. The specimens being imbedded in stone, the number of the septa cannot be ascertained.

"The distinctive character of this species consists in its acutely angular shape."

Localities.—Island of Anticosti, Que. at Charleton Point and at the west end of the island, collected by J. Richardson, 1856; Hudson River formation.

Transverse and longitudinal sections of the type specimens of *S. angulatum* show that the cup is equal in depth to one-half the height of the corallum, the septa number about seventy-five and are alternately long and short, the former reach the entire whilst the latter are quite diminutive. Further details of structure are not clearly shown; the specimens are small and probably immature.

The angularity of the convex curve of the corallum is a noticeable feature of some of the specimens of *S. robustum*, Whiteaves, from the Galena-Trenton formation of the Red River valley, Manitoba, and it is not in the western species considered to be a character sufficiently reliable for specific differentiation.

Possibly the species *S. angulatum* is founded on young, angulated specimens of *S. selectum*, Billings.

STREPTELASMA SELECTUM, Billings. (Sp.)

Plate VI., figs. 8, 8*a*.

Petraia selecta, Billings. 1865. Canadian Naturalist, new series, vol. II., p. 429.
Petraia pulchella, Billings. 1865. Ibid., p. 429.
Petraia selecta, Billings. 1866. Cat. Sil. Foss. of Anticosti, pp. 7 and 33.
Petraia pulchella, Billings. 1866. Ibid., p. 33.

Corallum simple, conical, acutely pointed at the base and generally considerably curved below, reaching a length of about 37 mm., measured on the convex curve, and a diameter above of 25 mm. Outer surface frequently showing rings of growth and when not worn longitudinally marked by fine, distinct septal furrows. Calyx steep-sided, having a more or less prominent, conical projection rising centrally from its base, with a depth equal to about one-half the height of the corallum, but sometimes shallower. Septa in the largest specimen numbering about eighty, in smaller specimens between fifty and sixty; primaries reaching the centre where they are slightly twisted and form with the dissepiments the vesicular mass that projects from the bottom of the cup, secondaries short and inconspicuous. As in the majority of the species of this genus, the primaries frequently unite in sets of twos and threes near the centre of the visceral chamber. In the cup the primaries decrease in size and near the top are scarcely distinguishable from the secondaries; both orders of septa are apparently denticulated on their thin, free edges and carinated on their sides. Dissepiments curving upward and inward toward the centre between the septa and forming with the inner ends of the primary septa the confused cellulose structure characteristic of the genus.

Localities.—West End Lighthouse, Anticosti, Que., Hudson River formation; also at 1 mile east of Junction Cliff and at White Cliff, Gamache Bay, Anticosti, division I., of the Anticosti group; J. Richardson, 1856, and T. C. Weston, 1865.

STREPTELASMA CALICULUS, Hall.

Plate VII., figs. 4, 4*a*, 4*b*, 4*c*.

Streptelasma calicula, Hall. 1852. Palæon. New York, vol. II., p. 3, pl. 32, figs. 1 *a–k*.

A number of well preserved specimens from Grimsby and Thorold, Ont., and Lake Temiscaming are here referred to Hall's species, but with a certain amount of uncertainty on account of the paucity of structural details given in the original description of *S. caliculus*.

These specimens may be described as follows.—Corallum simple, small, conical, slightly curved below and sharply pointed, attaining a length of

nearly 4 cent. with a diameter above of about 2·2 cent. and an average length rather over 2 cent. Outer surface conspicuously marked by longitudinal septal furrows that indicate the pinnate mode of addition of new septa and the positions of the cardinal and alar septa, transverse growth markings faint. Calyx with thin erect sides, its depth often nearly equal to about one-half the height of the corallum. Septa about fifty in number in moderately large specimens, of two sizes, alternating, the primaries passing to or nearly to the centre, the secondaries small and projecting only slightly inward beyond the mural investment. The inner ends of the primary septa often coalesce in sets of twos or threes near the centre of the visceral chamber. In longitudinal sections, thin, delicate dissepiments, partaking somewhat of the nature of tabulæ, are seen to arch upward and inward in the interseptal loculi to the centre, forming with the inner ends of the primary septa an axial cellulose structure that has a convex surface at the bottom of the cup. In the calyx the primary septa standing out prominently from the wall are seen to be carinated on their sides and to have denticulated free edges, the secondaries being reduced almost to uniserial rows of denticles; in longitudinal sections of the corallum the inner edges of the primaries have the appearance of being strongly serrated.

Localities.—Grimsby, Ont., T. C. Weston, 1887; Thorold, Ont., Rev. J. M. Goodwillie; Isle of Mann (Burnt Island), Lake Temiscaming, Que., A. E. Barlow, 1893. Niagara formation.

Streptelasma latusculum, Billings. (Sp.)

Plate VI., figs. 9, 9*a*.

Petraia latuscula, Billings, 1862. Palæoz., Foss., vol. I., p. 104, figs. 92*a* and *b*.
" " Billings, 1866. Cat. Sil. Foss. of Anticosti, p. 33.
Streptelasma corniculum, Whiteaves. 1880. Rep. of Progress for 1878--79, Geol. Survey of Canada, p. 49c.
Streptelasma rusticum, Whiteaves, 1895. Palæoz. Foss., vol. III., pt. II., p. 113.

Corallum simple, conical, short, at first gaining in breadth rapidly, then becoming more cylindrical above, slightly curved, pointed below, annulated by growth accretions and longitudinally striated by moderately distinct septal furrows; length of largest type specimen (fig. 92, original description), measured along an imaginary axial line, 27 mm., maximum breadth 22 mm., immature corallites generally broader than high. Calyx with steep sides, its depth equal to about two-fifths of the height of the corallum, in immature individuals rather deeper proportionately, its floor convexly elevated and showing the primary septa as thin keels passing to the centre. In the calyx the primary septa ascend as sharp-edged ridges,

gradually decreasing in size upward, their free edges bearing denticulations that extend over their sides as obscure carinæ; the secondary septa are similarly formed but are conspicuously smaller, and at times are scarcely more than uniserial rows of tubercles. Septa in average sized individuals from about sixty to eighty in number, the primaries beneath the floor of the cup passing to the centre, their inner ends being slightly twisted and frequently united in twos and threes before reaching the centre, the secondaries very small. Dissepiments comparatively large, directed convexly upward and inward toward the centre in the interseptal spaces and forming with the septal ends the central structure whose upper surface constitutes the convex floor of the cup.

With this species is identified the small *Streptelasma* from the upper and lower beds of the Hudson River formation at Stony Mountain, Man., collected by R. W. Ells in 1875, and by T. C. Weston in 1884.

Localities.—Anticosti, Que., at 3 miles west of Jupiter River, at East Point and at the "Jumpers," in divisions II., III., and IV. of the Anticosti group; collected by James Richardson in 1856.

Streptelasma latusculum, var. trilobatum, Whiteaves.

Streptelasma rusticum, var. *trilobatum*, Whiteaves. 1895. Palæoz. Foss., vol. III., pt. II., p. 113.

This variety is represented by some well preserved specimens collected by Mr. T. C. Weston, at Stony Mountain, Manitoba, in 1884.

The normal form from this locality is thought to more nearly resemble *Streptelasma latusculum* than *S. rusticum*, and has been referred to the former species (see p. 114), in consequence of which the trilobed variety has been classed under the above name.

Formation.—Hudson River.

Streptelasma prolificum, Billings. (Sp.)

Plate VIII., figs. 1, 1a.

Zaphrentis prolifica, Billings. 1858. Rep. of Progress for 1857, Geol. Survey of Canada p. 176.

" " Billings. 1859. Canadian Journal, new series, vol. IV., p. 121, figs. 22, 23.

? Zaphrentis corticata, Billings. 1874. Palæoz. Foss. vol. II., pt. I., p. 9, pl. I., figs. 4, 4a, 4b.

Zaphrentis prolifica, Nicholson. 1874. Palæon. of Ont., p. 23, pl. III., figs. 2, 2a; and 1875,. Geol. Surv. of Ohio, vol. II., p. 237.

Zaprhentis genitiva, Billings. 1874. Canadian Naturalist, new series, vol. VII., p. 235.
Heterophrentis prolifica, Billings. 1874. Ibid., p. 236.
Zaphrentis prolifica, Rominger. 1876. Geol. Surv. Mich., Foss. Corals, p. 146, pl. LIII, upper row.

Corallum simple, conical, slightly curved, pointed and sometimes rather attenuated at the base, often annulated by well marked rounded growth ridges. Epitheca complete, showing fine transverse growth lines and longitudinal septal furrows. Corallum attaining a length of as much as 165 mm., measured on the convex curve, with a breadth at the cup rim of about 60 mm., but with an average size in small specimens of between 50 and 70 mm. in length by from 25 to 35 mm., in diameter above, with all gradations between these extreme sizes. Calyx with steep walls, its depth often nearly equal to about one-half the height of the corallum: in large specimens not quite so deep. Septa well developed, of two sizes alternating, some of the primaries generally extending to the centre where they are twisted, the secondaries equal in length to about one-sixth the diameter of the corallum; in large specimens numbering in all up to about one hundred and thirty or even more, in small specimens from ninety to one hundred. Dissepiments occupying the interseptal loculi, large, arching from the walls upward and inward toward the centre where they are more or less horizontal and often contorted and twisted. The inner ends of the primary septa appear in the broadly convex cup bottom as sharp-edged converging keels that either combine at the centre to form a more or less exsert laterally compressed boss or become twisted together without the formation of a decided central prominence or as is not infrequently the case the centre may be smooth and comparatively free of septa. The primary septa often coalesce in twos and threes near their inner ends. A deep lateral septal fossette is present in the bottom of the calyx and extends toward the centre in line with the longer axis of the central projection; its position is independent of the curvature of the corallum. In the calyx the septa gradually change into low, rounded ridges as the rim is approached.

Localities and formations.—Abundant in the Corniferous limestone of Ontario; collected by E. Billings in 1857 at Rama's Farm, Port Colborne, and by E. and J. DeCew in the township of Cayuga in the same year: there are also specimens in the collection from the Corniferous of the townships of Oneida and Walpole. Not uncommon in the Hamilton formation of Ontario. Also from rocks of Devonian age at Long Portage, Missinaibi River to Moose Factory, R. Bell, 1877, as well as some loose specimens collected by Mr. George Barnston on the Moose River.

The specimen described as *Zaphrentis corticata*, is from Split Rock, Percé, Que., collected by T. Curry: Lower Devonian (Billings).

The writer is inclined to believe that the species *Heterophrentis spatiosa*,* Billings, is founded on short and unusually widely expanding specimens of *S. prolificum*. The two type specimens are from Rama's Farm, Port Colborne, Ont. Mr. Billings was doubtful as to the validity of the species and concluded the original description with the remark that it is "closely related to *Z. prolifica*, and may perhaps be united with it when its characters become more fully known."

Streptelasma rectum, Hall.

Plate VII., fig. 5.

Strombodes ? rectus, Hall. 1843. Geol. of New York, p. 210, fig. 5.
Cyathophyllum rectum, Milne-Edwards and Haime. 1851. Polyp. Foss., des Terr. Palæoz. p. 372.
Streptelasma recta, Hall. 1876. Illus. Dev. Foss., pl. XIX., figs. 1—13.
Streptelasma rectum, Whiteaves. 1891. Contr. to Canad. Palæon., vol. I., pt. III., p. 199, pl. XXVII., figs. 1, 1*a*, and 2.

The specimens that have been identified as representing this species in Canada were collected on the Mackenzie River, 10 miles below Bear River, by R. G. McConnell, in 1888.

The Canadian specimens may be described as follows. — Corallum simple, conical, straight or only slightly curved, pointed at the base, reaching a length of 38 mm. with a maximum breadth of 15 mm. Outer surface rather smooth with indistinct transverse accretion ridges and minor lines of growth, and pinnately arranged longitudinal septal furrows; epitheca complete. Calyx exceeding in depth one-half the height of the corallum, its enclosing wall thin and steep, the floor consisting of an exsert mass formed of dissepiments and primary septal ends. Septa stout, alternately long and short, the primaries generally uniting in twos or threes near the centre, secondaries almost obsolete; numbering altogether in different sized specimens from about seventy to one hundred and ten. In the calyx the primaries extend over the floor to the centre, but on the sides they are much reduced in size and project only about 1·5 mm. inward from the wall; free edges of the septa strongly toothed, the denticulations being represented on the sides of the septa as slight linear thickenings of the septa directed outward toward the wall. Dissepiments irregular, small, occupying the narrow interseptal loculi, inclined obliquely and convexly inward toward tho centre.

Formation.—Devonian (Cuboides zone).

* Described as *Zaphrentis spatiosa* in 1858 in the Report of Progress for 1857, and later in 1874 in the Canadian Naturalist, new series, vol. VII, p. 235 under the name *Heterophrentis spatiosa*.

Genus ZAPHRENTIS, Rafinesque and Clifford. 1820.

Zaphrentis, Rafinesque and Clifford. 1820. Ann. des Sci. Phys. de Bruxelles, vol. 5, p. 234.
Caninia, Michelin. 1841. Atti della riunione degli Scienziati italiani in Torino.
? Polydilasma, Hall. 1852. Palæon. New York, vol. II., p. 112.

Corallum simple, varying in shape from conical to conico-cylindrical. Epitheca complete. Tabulæ extending across the visceral chamber. No interseptal dissepiments as in *Cyathophyllum*. Septa of two orders, alternating, the primaries sometimes reaching the centre and slightly twisted, their vertical continuity generally interrupted more or less by the tabulæ on whose upper surface they pass toward the centre as sharp keels or carinations, secondaries feebly developed. Septal fossette usually conspicuous. No columella.

Type species.—*Z.* (*Caninia*) *patula*, Mich.

Range.—Upper Cambro-Silurian, Silurian, Devonian, Carboniferous.

ZAPHRENTIS AFFINIS, Billings.

Plate VII., figs. 6, 6*a*, 6*b*.

Zaphrentis affinis, Billings. 1865. Canadian Naturalist, new series, vol. II., p. 430.
Zaphrentis bellistriata, Billings. 1865. Ibid., p. 430.
Zaphrentis affinis, Billings. 1866. Cat. Sil. Foss. of Anticosti, pp. 7 and 34.
Zaphrentis bellistriata, Billings. 1866. Ibid., pp. 8 and 34.

Corallum simple, conico-cylindrical, large, attaining a length of about 19 cent. with a diameter at the upper end of slightly over 6 cent., somewhat curved near the base, moderately straight above, generally broadest at the calyx, sometimes of maximum breadth at midlength and slightly diminishing in size from there up, annulated irregularly by accretion ridges varying in prominence and distinctness. Epitheca complete, with fine transverse, crowded growth lines and marked longitudinally by distinct low rounded ridges corresponding with the interseptal spaces within. Tabulæ complete, flat or slightly concave near the centre, turned down at the edges, from 1 to 2 mm. apart or even closer, frequently inosculating. Septa of two orders, primaries and secondaries, alternately long and short, the primaries extending to or almost to the centre of the visceral chamber for the inner part of their length at least as carinations on the tabulæ, secondaries about one-quarter the length of the primaries; in a specimen 45 mm. in diameter they number about one hundred. Calyx nearly as deep as broad with vertical sides and a broad somewhat convex floor or bottom radially striated by the septa.

Localities.—At Wreck Point and White Cliff, Anticosti, Hudson River formation, and at Gamache Bay, in division I. of the Anticosti group; collected by T. C. Weston in 1865.

The specimens grouped under the name *Zaphrentis bellistriata* present no characters that would cause the writer to think otherwise than that they are rather small and in some cases very young specimens of *Z. affinis*; the largest specimen, 4 inches in length, (labelled Wreck Point, Anticosti, and mentioned in the original description) is crushed laterally, the tabulæ are broken and the calyx is distorted. The type specimens of *Z. bellistriata* were collected at Wreck Point, Anticosti, in the Hudson River formation, and in division I. of the Anticosti group, also at 1 mile east of Otter River, Anticosti, as well as at other localities in division II. of the Anticosti group; J. Richardson and T. C. Weston, collectors.

Zaphrentis patens, Billings.

Plate VIII., figs. 2, 2*a*.

Zaphrentis patens, Billings. 1865. Canadian Naturalist, new series, vol. II., p. 430.
" " Billings. 1866. Cat. Sil. Foss. of Anticosti, p. 33.

Corallum simple, with a shallow widely expanding calyx whose margins slope gently upward or become horizontal near the periphery and are marked by converging septa that do not meet, but leave a broad smooth surface at the centre. Septa of two sizes, primaries and secondaries alternating, and numbering in all about seventy-two, of which the former, as seen in a natural transverse section about 10 mm. beneath the bottom of the cup, pass a little more than half way to the centre as carinations on the tabulæ, whilst the secondaries are little more than thin ridges on the inside of the wall. On the margins of the calyx the primaries appear as sharp-edged raised plications, with the secondaries between them as uniserial rows of denticles. Tabulæ, as seen in a radial vertical section, complete, regular, 1 or less than 1 mm. apart, extending from one side of the corallum to the other, concave, flat at the centre, suddenly bent down at the edge; the flat, central, smooth part not encroached on by the septa is about one-third of their breadth. Fossette deep, narrow, placed at one side of the calyx and occupied by a primary septum.

The measurements of the type specimen as already given in the original description are as follows:—"The specimen is broken off at nine lines below the margin of the cup. Diameter of the lower extremity, twenty-one lines, and of the cup at the margin, thirty-three lines. It thus expands, in this part, one inch in a length of nine lines. It may have been more cylindrical below. In the cup there are thirty-six large septa

nearly three lines apart at the margin. Between these are thirty-six smaller ones, which are scarcely half a line in height, and have their edges serrated with small denticulations about three in one line. There is a deep septal fossette on one side. Surface and lower parts unknown." (Billings.)

Locality.—Cormorant Point, Anticosti, division III of the Anticosti group (Silurian), collected by J. Richardson, 1856.

Zaphrentis Stokesi, Milne-Edwards and Haime.

Plate IX., figs. 1, 1*a* and 2.

Zaphrentis Stokesi, Milne-Edwards and Haime. 1851. Polyp. Foss. des Terr. Palæoz., p. 330, pl. 3, fig. 9.
? Caninia bilateralis, Hall. 1852. Palæon. New York, vol. II., p. 41, pl. 17, fig. 3, and p. 113, pl. 32, fig. 3.
? Polydilasma turbinatum, Hall. 1852. Ibid, p. 112, pl. 32, fig. 2.
Zaphrentis Stokesi, Billings. 1866. Cat. Sil. Foss. of Anticosti, p. 34.
" " Nicholson. 1875. Palæon. of Ont., pp. 43 and 58.
Zaphrentis Stokesii, Rominger. 1876. Geol. Sur. Mich., Foss. Corals, p. 144, pl. LI., three figures in lower row.

Original description.—"Polypier allongé, sans bourrelets d'accroissement, courbé, légèrement comprimé dans le sens opposé à la courbure. Calice subelliptique, mediocrement profond. Fossette septale située du côté de la grande courbure. Soixante-quatre cloisons principales, subégales, assez minces, très-légèrement épaissies à la muraille où l'on distingue quelquefois les deux feuillets qui les forment, alternant avec un égal nombre de cloisons rudimentaires et se continuant suivant une direction un peu flexueuse jusqu'au centre du plancher supérieur, lequel est un peu relevé. Hauteur du polypier, 8 centimètres; largeur du calice 4, sa profondeur près de 2.

"Silurien. Drummond Island (Lac Huron)."

Rominger gives a fuller description from specimens from the Niagara of Point Detour, Drummond Island and mentions the occurrence of the species at Masonville, Iowa in the same formation.

Three simple corals from the upper beds of the Anticosti group in Anticosti were referred to this species by Mr. Billings as early as 1866.

In 1893 Mr. A. E. Barlow of the Geological Survey obtained, from the exposure of Niagara rocks at the north end of Lake Temiscaming, a good series of a simple coral that is thought to belong to this species.

The Lake Temiscaming specimens may be characterized as follows.—Corallum simple, elongate, conical, slightly curved, sometimes annulated by low growth ridges, ranging in length as measured on the convex curve in mature individuals from about 60 to 100 mm. with a diameter at the

cup rim of from 25 to 50 mm. Epitheca complete, with longitudinal septal furrows moderately distinct. Septa numbering from about sixty-four to one hundred and thirty-six, alternately long and short, the primaries reaching the centre and generally curved, the secondaries 2 or 3 mm. in length sometimes apparently almost obsolete. Calyx averaging about 15 mm. in depth, with steep sides and a very slightly convex floor above which the primary septa converge as sharp keels to the centre; the free edges of the septa on the sides of the calyx are denticulated. Tabulæ numerous, close-set, stretching across the visceral chamber, turned down at the edge and flat at the centre. A septal fossette is present on the convex curve. Laterally the septa are continuous vertically but toward and at the centre they often become mere carinations on the upper surfaces of the tabulæ.

This species in some respects resembles *Streptelasma rusticum* of the Hudson River formation and more particularly the extreme forms of that species that have been described under the name of *Zaphrentis Canadensis*. Its Streptelasmoid affinities are indicated by a thickening of the outer ends of the septa and by the strong development of the primary septa which, however, often have their vertical continuity broken near the centre by the tabulæ. On the other hand, there seems to be, with few exceptions, an absence of the axial cellulose structure characteristic of *Streptelasma*, true tabulæ extending across the entire visceral chamber. On the whole *Z. Stokesi* may be regarded as a species intermediate between the two genera *Streptelasma* and *Zaphrentis*, combining as it does structural peculiarities suggestive of both genera.

Dr. Rominger has expressed the opinion that a strict distinction of the above genera is not possible and has placed *Streptelasma* with *Zaphrentis* as a sub-generic form.

Localities.—Cormorant Point, Anticosti, Que., division III. of the Anticosti group, J. Richardson, 1856, South-west Point and the "Jumpers", Anticosti, division IV., J. Richardson 1856 and one mile south of Junction Cliff, Anticosti, division I., T. C. Weston, 1865. Cabot's Head, Georgian Bay, Lake Huron, R. Bell, 1859, north end of Lake Temiscaming, Que., R. Bell, 1887, also Isle of Mann (Burnt Island), Lake Temiscaming, A. E. Barlow, 1893; Niagara formation.

Zaphrentis Shumardi, Milne-Edwards and Haime. (Sp.)

Plate VIII., figs. 3, 3*a* and 4.

Cyathophyllum Shumardi, De Verneuil, MSS.
" " Milne-Edwards and Haime. 1851. Polyp. Foss. des Terr. Palæoz., p. 370, pl. 7, fig. 3.

Zaphrentis, sp. undetermined, Billings. 1863. Geology of Canada, p. 391.
Zaphrentis cinctosa, Billings. 1866. Cat. Sil. Foss. of Anticosti, p. 92.
Zaphrentis rugatula, Billings. 1874. Palæoz. Foss., vol. II., pt. I., p. 8, pl. 1, figs. 3, 3*a*.
Amplexus Shumardi, Rominger. 1876. Geol. Sur. Mich., Foss. Corals, p. 152, pl. LIV., upper row.

Represented in the collection of the Geological Survey by two specimens (the types of *Z. cinctosa*) from the Clinton and Niagara formations, one from Cockburn Island, Lake Huron, the other from near Owen Sound. The general shape, manner of growth and structure of the corallum leaves little doubt, at least in the mind of the writer, as to their being referable to Milne-Edwards and Haime's species described from specimens from the upper Silurian of Perry County, Tennessee. Rominger's specimens are from the Niagara group of Drummond Island and Point Detour, Lake Huron, and from Masonville, Iowa.

The Canadian specimens may be described as follows:—Corallum simple, cylindrical, curved, and annulated at somewhat regular intervals by distinct, prominent, angular ridges or frill-like expansions, from ·5 to over 1 cent. apart, that represent periodic arrests of growth and the position of former calyces; reaching a length of over 8 cent. measured along the convex curve and from 2 to 2·5 cent. in diameter at the summits of the annular ridges. Epitheca striated transversely by fine lines of growth crossing the well-marked longitudinal septal furrows at right angles, so as to cause a cancellation of the surface. Calyx deep, with very steep, thin enclosing side walls. Septa, in the neighbourhood of sixty, alternately long and short, the former passing to or almost to the centre, the latter poorly developed and very short; in the calyx they ascend the sides as low denticulated ridges, becoming gradually less prominent and more rounded as the rim is approached. Tabulæ extending from wall to wall, flexuous, irregular and turned down at the edge.

Localities.—East side of Cockburn Island, 2 miles north of McLeod's Harbour, R. Bell, 1859; and in the township of Derby, lot 13, concession 2, near Owen Sound, R. Bell, 1866: in the Clinton and Niagara formations.

It is probable that the fossil occurring in the Guelph formation at Hespeler and Guelph, Ontario, and referred by Nicholson (Palæon. of Ontario, 1875, p. 67) to *Amplexus Yandelli*, really belongs to this species.

A comparison of the types of *Zaphrentis rugatula*, Billings, with the specimens from the above mentioned localities, Cockburn Island and Owen Sound, reveals a similarity of form and structure that carries with it a conviction that they are not separable specifically. The specimens of *Z. rugatula* were collected at Cape Gaspé, Que., by Sir W. E. Logan in Gaspé limestone No. 1, of whose age Mr. Billings in discussing the

relative geological positions of the eight divisions of the limestones (op. cit. p. 2) says, "The two lower divisions (1 and 2) are most probably Silurian; about the age of the Helderberg of the New York geologists." In 1858 nearly fifty specimens were obtained by J. Richardson at Cap Bon Ami near Dalhousie, N.B., in rocks of the same age; these show the decided cancellation of the surface and the periodic annular swellings, as well as in many instances the basal extremity which is quite pointed and sometimes has a scar of attachment preserved.

Zaphrentis incondita, Billings.

Zaphrentis incondita, Billings. 1874, Palæoz. Foss. vol. II, pt. I, p. 7, pl. I, figs. 1, 1a, 1b, 2, 2a, 2b.

"Corallum simple, turbinate and strongly curved at the base, becoming cylindrical above; nine or more inches in length and over two inches in diameter. From the acute base upwards it expands to a thickness of about fifteen lines in a length of two inches, and to twenty-four lines, in four inches; above which the body of the coral becomes more nearly cylindrical, or only very gradually increasing in diameter. Surface with numerous engirdling ridges of various size, the larger are from half a line to five lines in width, and are often angular on their crests. Upon these larger ridges and in the grooves between them are numerous smaller ridges, or transverse striæ, generally two or three in a width of one line. The longitudinal, or septal striæ, are in general only obscurely seen, being obliterated by the transverse grooves; there are five or six of them in the width of three lines.

"In the interior of the coral, the radiating septa reach the centre in the basal portion. But, above a diameter of one inch, there is a large space in the centre occupied by the transverse diaphragms alone, the septa not extending more than half an inch inward. There are two sets of them, the smaller projecting inward rarely to the depth of one line. There is one of the smaller between each two of the longer.

"The transverse diaphragms are well developed. They are much undulated in the central portion and strongly curved downwards near the exterior. There appear to be ten or twelve of them in the length of one inch; but owing to their undulations, there are sometimes places in which they are separated to the distance of two or three lines, while elsewhere they may be nearly in contact. The septal fossette has not been observed.

"*Varieties.*—Occurring along with the above is a somewhat more slender form with, in a general way, the same external characters, but with the transverse diaphragms more regular and the septa extending in-

ward nearly to the centre. One specimen has a diameter of eighteen lines and another sixteen lines.

"A third specimen is only twelve lines in diameter, with the same characters as the last two.

"The materials are not sufficient to enable us to decide positively whether they all belong to the same species or not. Should there be more than one species, the specific name above given ought to be retained for the larger form first above described." (Billings.)

Locality.—Indian Cove, Gaspé, Que., in the Gaspé limestone No. 8, stated by E. Billings to be nearly of the age of the Oriskany sandstone; collected by R. Bell in 1862.

The typical form of this species appears to be more slender than *Z. gigantea*, of a higher geological horizon, and differs from it principally in having shorter and rather fewer primary septa and more irregularly disposed tabulæ, as well as in having a more pronounced curve at the base. In the type specimen of *Z. incondita* there are one hundred and twenty-five septa, alternately long and short, seen in a transverse section four and a half inches above the basal end, as measured along the convex curve; in this section four or five of the septa are observed to extend inward almost to the centre of the corallum.

Zaphrentis cingulosa, Billings.

Plate VIII., figs. 5, 5*a*, 5*b*.

Zaphrentis sp. undetermined, Billings. 1863. Geology of Canada, p. 439.
Zaphrentis cingulosa, Billings. 1874. Palæoz. Foss., vol. II., pt. I, p. 10, pl. I., fig. 5.

Corallum simple, cylindrical, slender, curved below to a radius of between 7 and 8 cent., straight above, regularly annulated by strong distant ridge-like expansions. The only specimen representing the species is imperfect at both ends and is distorted by lateral compression; its length along the convex curve is over 17 cent., its breadth below about 3 cent., with little or no increase in size above, and the average distance apart of the ribs is about 17 mm. Epitheca cancellated by longitudinal septal furrows and almost as distinct transverse growth lines. The corallum consists of a succession of invaginated, inverted, truncated cones, the result of periodic expansions, representing arrests of growth and former calyces, from within each of which the renewed growth of the corallum in turn began. Septa well developed, forming by the union of their outer ends a strong wall from which the primaries and secondaries extend inward in alternating order a distance of 5 or 6 mm. and 2 or 3 mm. respectively, numbering in all about sixty-four. Tabulæ, very much

fractured by the pressure to which the corallum has been subjected, apparently well developed, flat and extending from wall to wall.

Locality.—Mount Joli, near Percé. Que., one specimen collected by Sir Wm. Logan; Gaspé limestone No. 8 which according to E. Billings is about the age of the Oriskany sandstone.

Zaphrentis gigantea, Lesueur. (Sp.)

Plate IX., figs. 3, 3*a*.

Caryophyllia gigantea, Lesueur. 1820. Mém. du Mus., t. VI., p. 296.
Zaphrentis gigantea, Milne-Edwards and Haime. 1851. Polyp. Foss. des Terr. Palæoz., p. 340, pl. 4., figs. 1, 1*a*—*c*.
" " Billings. 1859. Canadian Journal, new series, vol. IV., p. 121.
" " Nicholson. 1874. Palæon. of Ont., p. 22, pl. III., figs. 1, 1*a*.
Zaphrentis Eriphyle, Billings. 1874. Canadian Naturalist, new series, vol. VII., p. 233.
Zaphrentis Hecuba, Billings. 1874. Ibid., p. 234.
Zaphrentis gigantea, Rominger. 1876. Geol. Sur. Mich., Foss. Corals, p. 145, pl. LII.
" " Lambe. 1899. Ottawa Naturalist, vol. XII., p. 252.

"'Polypier cylindro-conique, très-long, à bourrelets d'accroissement larges et peu saillants; fossette septale proportionnellement un peu petite, située très-près de la muraille; au moins 70 cloisons égales, minces, arrivant sur la partie supérieure des planchers jusqu'à une petite distance du centre, où elles sont légèrement flexueuses; un égal nombre de cloisons rudimentaires; planchers très-grands, envahissant les loges intercloisonnaires, où l'on ne voit pas de traverses vésiculeuses indépendantes, et lisses en dessous dans une grande étendue. La longueur est fréquemment de 40 à 50 centimètres ou même plus, le diamètre du calice de 7 ou 8' (Milne-Edwards and Haime).

"The description given by Rominger of this species is a thorough and accurate one, and makes allowance for the variations that exist in this in common with many other species; it appears in the following words:—'Conico-cylindrical, horn-shaped polyparia, attaining in some specimens a size of two and a half feet in length, by a diameter of three inches. Some enlarge their diameter rapidly to a certain thickness, and then grow on in a uniformly cylindrical shape; others are in the young state, slender, flexuose, and irregularly constricted stems, and grow gradually to larger diameters. The surface of the polyparia is covered by an epitheca with shallow annular wrinkles of growth, and longitudinally ribbed by septal striæ, which, however, are not in all specimens equally distinct. Calyces spacious, with erect walls, and acute, wedge-like margins; bottom broad, marginally depressed and flat in the centre. In one place of the circumference the diaphragms are more deeply depressed by a septal fovea. Radial lamellæ stout, linear, alternately long and short, but appearing

nearly equal on the margins of the calyces, where the sharp crested leaves of the inside expand into low rounded rugæ. The extension of the radial crests toward the centre is subject to variations; in some the central part of the diaphragms remains smooth, and the crests are confined to their peripheral circumference; in others the crests reach as low carinæ to the centre and become irregularly entangled in their convergence, but these central portions of the crests are merely superficial, and do not intersect the diaphragms to form continuous vertical leaves. The number of lamellæ in calyces of about two and a half inches diameter is 150 to 160, half of which are of the smaller size. Found in the upper Helderberg limestones of Michigan, Canada, Ohio, and in the Western States.'" (Lambe, 1899.)

Localities and formation.—At Rama's farm, Cayuga, and at other localities in Ontario; Corniferous limestone.

Zaphrentis mirabilis, Billings. (Sp.)

Plate X., figs. 1, 1*a*, 1*b*.

Amplexus mirabilis, Billings. 1874. Canadian Naturalist, new series, vol. VII., p. 232.
Zaphrentis invenusta, Billings. 1874. Ibid., p. 233.
Zaphrentis Egeria, Billings, pars. 1874. Ibid., p. 234 (the third specimen mentioned in the description).
Zaphrentis subrecta, Billings. 1874. Ibid., p. 235.
Zaphrentis Leda, Billings. MS.
Zaphrentis mirabilis, Lambe. 1899. Ottawa Naturalist, vol. XII., p. 255.

"Original description.—'Corallum sometimes abruptly curved in different directions, expanding to a width of from fifteen to twenty lines in a length of four or five inches from the base; above which it becomes more nearly cylindrical. Surface with fine engirdling striæ, in general four or five in the width of two lines, but in some places, the same number occur in the width of one line. There are also numerous angular rings of growth, distant from two to fifteen lines from each other, with subconcave spaces between. Septal costæ rounded, distinctly defined by sharp striæ between them, seven or eight in the width of three lines near the base, and four or five in the same near the calice. There are about forty large septa at the calice, where the diameter is about eighteen lines, with the same number of small ones between them. The larger have a depth of three or four lines and the smaller one line. All of the septa are more or less curved, sometimes very tortuous. The tabulæ have not been observed.

"'The above description was drawn up from a specimen, eleven inches in length, measured along all the curves. It is fifteen lines in diameter at five inches from the base, and about eighteen lines at the cup. The

septal costæ are very distinctly defined at the base but become more flattened and obscure upwards. In external characters it resembles *A. exilis*, but the much greater development of the septa distinguishes it therefrom.' (Billings.)

"This species is regarded by the present writer as belonging to the genus *Zaphrentis* on account of its well developed septa; it appears to differ from *Z. gigantea*, Lesueur, principally in being more slender, in having fewer septa and in being typically more strongly annulated. In the type specimen a longitudinal section through the cup shows complete, slightly concave tabulæ stretching across the visceral chamber from wall to wall and abruptly turned down at their edges.

"The types of *Z. invenusta*, *Z. Egeria* and *Z. subrecta* are believed to be identical with *Z. mirabilis*, and to the same species are assigned a number of other specimens in the collection that possess the slender form and the comparatively few septa that are characteristic of the species.

"Using the type specimen as a basis *Z. mirabilis* may be described as follows:—

"Corallum simple, long, cylindrical, slender, pointed at the base, generally curved or variously twisted, ending above in a moderately deep cut with thin vertical side walls and a flat or slightly undulating bottom; reaching a length of a foot or more and apparently not exceeding between four and five cent. in diameter. Septa of two sizes, alternating, the primaries somewhat flexuous, reaching generally rather more than half way to the centre, the secondaries somewhat variable in their length, being in different specimens from less than one-third to about three-fourths as long as the primaries; numbering in all from about sixty to one hundred. On the surface of the corallum the position of the outer ends of the septa is indicated by distinct, shallow, longitudinal furrows. Tabulæ complete, numerous, flat or undulating, turned down at the edges. A small septal fovea is generally discernible near the lateral margin on one side of the convex curve." (Lambe, 1899.)

Localities and formation.—Corniferous limestone of Ontario. The type specimen is from lot 14, concession 1, Oneida township, county of Haldimand, collected by E. DeCew in 1857; another and larger specimen is from lot 31, concession 4, Cayuga township, county of Haldimand and was also collected by E. DeCew.

Zaphrentis Minas, Dawson.

Plate VII., figs. 7, 7a, 7b.

Zaphrentis Minas, pars. Dawson. 1868. Acadian Geology, second edition, p. 286, small specimens, fig. 48a.
Zaphrentis Minas, Lambe. 1899. Ottawa Naturalist, vol. XII., p. 254.

"Corallum simple, turbinate, small, slightly curved, about twice as long as broad, pointed below and obscurely marked transversely by low accretion ridges. Epitheca complete, with distinct longitudinal septal furrows and fine, close-set, transverse growth lines showing on the surface. Calyx deep, with thin vertical walls and a moderately flat bottom, the depth equal to more than one-half the width. Tabulæ rather irregular, crossing from side to side, with minor incomplete tabulæ at times resting on the principal ones. Septa, from about sixty-five to seventy-five in number, alternately long and short, the long ones passing to the centre, the remainder only about 1 mm. in length; on the walls of the calyx the primaries are reduced to thin, sharp-edged ridges, and the secondaries become almost obsolete. Fossette of moderate depth, extending outward to the wall on the flat or concave side of the coral.

"The figure accompanying the original description does not give a correct idea of the depth and form of the calyx; the specimen from which the drawing was evidently made is 40 mm. in length along the convex curve, about 23 mm. in maximum breadth near the top, and the calyx, as seen in a longitudinal section of the corallum, is about 12 mm. deep.

"*Locality.*—West River, Pictou, N.S., collected by Professor How; Lower Carboniferous formation. Two small specimens and the basal extremity of a third, the property of the Peter Redpath Museum, McGill University, Montreal.

"This species is very closely related to, if not identical with *Zaphrentis Enniskilleni*, Milne-Edwards and Haime (Brit. Foss. Corals, p. 170, pl. XXXIV., fig. 1,) of the Carboniferous limestone of the north-west of Ireland." (Lambe, 1899.)

The writer is desirous of here placing on record his indebtedness to the late Sir J. William Dawson for the loan of the types of *Z. Minas*, *Cyathophyllum Dawsoni* and *Clisiophyllum Billingsi*, with permission to make sections of them.

Genus Amplexus, Sowerby. 1814.

Amplexus, Sowerby. 1814. Mineral Conchology, vol. I., p. 165.

Corallum simple, elongate, subconical. Epitheca complete. Tabulæ highly developed. Septa very short, although still differentiated into

primaries and secondaries. No dissepiments. Septal fosette present. Differs from *Zaphrentis* only in the feeble development of the septa.

Type species.—*A. coralloides*, Sowerby.

Range.—Silurian, Devonian, Carboniferous.

Amplexus cingulatus, Billings.

Plate X., figs. 2 and 3, 3a.

Amplexus cingulatus, Billings. 1862. Palæoz. Foss. vol. 1, p. 106.

"Corallites very elongate, cylindrical, varying from 3 to 8 lines in diameter, annulated at various distances by prominent usually sharp-edged rings of growth, with concave spaces between. Radiating septa from fifty to eighty, according to the size of the corallite, extending inwards about one-sixth of the diameter. The inner area occupies fully five-sixths of the whole diameter; the transverse septa or tabulæ thin, slightly undulating, from $\frac{1}{4}$ to $\frac{3}{4}$ of a line apart. Surface with about two longitudinal septal striæ in one line, the ridges between which are often divided by a smaller stria.

"The annulations are distant from each other from 2 to 14 lines, the most common distance being about half an inch. They are usually sharp-edged, but often in the younger corallites they are either obtusely rounded or represented by mere enlargements of the diameter of various forms and distances.

"This species appears to be gregarious, as great numbers are found on the same slabs of limestone, lying across each other in all directions and broken into fragments from 1 to 4 inches in length." (Billings.)

Localities.—L'Anse à la Barbe, Baie des Chaleurs, Que., Silurian*; collected by Sir William Logan, 1843, and also at l'Anse au Gascon, by R. Bell, in 1862.

*In the "Geology of Canada, 1863," it is said (p. 933) of the limestones, exposed on the coast of the Baie des Chaleurs in the vicinity of Anse à la Vieille, Anse au Gascon and Anse à la Barbe, that they "contain a fauna, which is, upon the whole, distinct from that of the Niagara and Guelph formations on the one hand, and from that of the Lower Helderberg on the other; while at the same time it is more closely allied to the fauna of the Ludlow group of England than any other yet discovered in the Silurian rocks of America. It (the Upper Silurian of the Baie des Chaleurs) seems to occupy a position between the Niagara and the Lower Helderberg, but to be more intimately connected with the former than with the latter." In a table of probable equivalents among the Palæozoic rocks of Great Britain and North America included in the above work the "limestones of Gaspé and the Baie des Chaleurs" are placed in the same column with the "Lower Helderberg group" of New York and the "Ludlow Group" of Great Britain. In the "Palæozoic Fossils," vol. III., pt. I., Dr. Whiteaves states that in his opinion the limestones of Anse à la Barbe and Anse à la Vieille seem to be most nearly equivalent to the Guelph formation of Ontario, Ohio and Wisconsin. In part I., of volume IV, of the "Contributions to Canadian Palæontology" the term Lower Helderberg has been used in connection with the Baie des Chaleurs limestones at Anse à la Barbe, &c., in a sense as comprehensive as that evidently implied by the term in the "Geology of Canada."

The manner of gemmation is shown in one specimen in which a small bud, about two lines in diameter and of the same length, is produced in one of the calicular expansions at a distance of over 2 inches below the broken upper end of the parent.

On the same tablet with the type specimen is a small fragment, slit longitudinally, in which the tabulæ are deeply concave at the centre and turned down at the edges and the primary septa, as seen in a transverse section, extend about half way to the centre, partly as carinæ on the tabulæ, and number about forty-seven, making the total number of septa ninety-four.

Amplexus Yandelli, Milne-Edwards and Haime.

Plate IX., figs. 4, 4*a*, 4*b*.

Amplexus Yandelli, Milne-Edwards and Haime. 1851. Polyp. Foss. des Terr. Palæoz., p. 344, pl. 3, figs. 2, 2*a*.
" " Billings. 1859. Canadian Journal, new series, vol. IV., p. 123.
" " Nicholson. 1874. Palæon. of Ont., p. 31.
" " Rominger. 1876. Geol. Sur. Mich., Foss. Corals, p. 154, pl. LIV., lower row.

Original description.—"Polypier très-long, cylindroïde, irrégulièrement contourné, montrant des bourrelets d'accroissement et des rétrécissements bien marqués. Calice médiocrement profond; le plancher supérieur lisse dans une grande étendue. Fossette septale profonde, arrondie, très-rap prochée de la circonférence. Soixante-seize cloisons, alternativement plus grandes et plus petites, minces, droites, très-étroites. Longeur 7 centimètres, diamètre du calice 1·5.

"Devonien. *Amérique du Nord:* chutes de l'Ohio" (Milne-Edwards and Haime).

The coral that has been identified with this species occurs in the Corniferous formation near Woodstock, Ont. There are three small specimens in the collection, the largest of which is 6 cent. long with a diameter near the upper end of 13 mm.; their form and structure is as follows:—Corallum simple, nearly cylindrical, increasing very slowly in diameter, irregularly curved or flexuous, annulated by ridges of growth, or frill-like expansions, that are at unequal distances apart and of varying prominence. Wall thin, covered by an epitheca that is conspicuously marked longitudinally by septal furrows of the same size and transversely by minor growth lines of unequal strength. Tabulæ stretching from side to side, flat, turned down at the edges, 1 or 2 mm. apart. Septa from about fifty to sixty in number, of two sizes alternating, the primaries 2 mm. long and denticulated on their inner edges, the secondaries represented only by uniserial rows of small, rather sharply pointed tubercles.

Locality and formation.—Near Woodstock, Ont., collected by A. Murray in 1857; Corniferous limestone.

In the original description of *A. Yandelli*, from the Falls of the Ohio, no mention is made of a particularly slight development of the secondary septa such as is seen in the Woodstock specimens, in fact in the figures these septa are shown as being comparatively long; also in the references made to the species by Billings, Nicholson and Rominger very little is said about the septa and nothing from which it might be inferred that the secondaries consisted of tubercles only.

Amplexus exilis, Billings.

Plate IX., figs. 5, 5a, 5b.

Amplexus exilis, Billings. 1874. Canadian Naturalist, new series, vol. VII., p. 232.

Original description.—"Corallum more or less curved, expanding to a diameter of 14 lines at $3\frac{1}{2}$ inches from the base. Surface with very distinctly defined costal striæ, of which there are 5 in the width of 3 lines, where the diameter is about one inch, and 6 or 7 in the same space at the base. There are about 64 septa where the diameter is 14 lines. The larger of these are scarcely a line in depth; the smaller about half that size. The tabulæ are very thin, flat or slightly undulating, distant from each other from 1 to 6 lines.

"Owing to the fragile character of the shell, good specimens of this species are rare. The best in our collection consists of the lower 6 inches partly imbedded in the rock. By the application of acid, the whole of the interior has been completely freed from the limestone which filled it, so that it shows the tabulæ and septa perfectly. It is curved somewhat irregularly to a radius of between 4 and 5 inches. There are numerous small rings of growth, in general not very prominent, but with some that are angular and strongly elevated. These are, sometimes, so deep that they give to the costal striæ, a nodose appearance.

"The extremely rudimentary state of the septa, distinguishes this species from all the described American forms known to me." (Billings.)

Locality and formation.—Corniferous limestone of Ontario.

Genus Pycnostylus, Whiteaves.

Pycnostylus, Whiteaves. 1884. Palæoz. Foss., vol. III., pt. I., p. 2.

Generic characters.—"Internal structure very similar to that of *Amplexus*, the radiating septa being rudimentary and extending but a short

distance from the inner surface of the outer wall, but the tabulæ, though well developed and complete, are entirely horizontal and neither bend upwards at the periphery nor embrace each other with their reflexed margins. Corallum compound, consisting apparently of an aggregation of numerous, slender, cylindrical or sub-cylindrical polyp stems, which divide by calicular gemmation at distant intervals into sets of three, four or more, ascending, sub-parallel, contiguous, flexuous branches. Structure of the calices previous to gemmation, and characters of the basal portion of the corallum unknown." (Whiteaves.)

Type species.—*P. Guelphensis*, Whiteaves.

Dr. Whiteaves (Palæoz. Foss., vol. III., pt. II., p. 49, 1895), further remarks: "The genus *Pycnostylus*, of which *Orthopœdium*, Schluter, 1889, is probably a synonym, differs from *Amplexus* only in the circumstance that it grows in colonies of compound and apparently fasciculated corallites."

Pycnostylus Guelphensis, Whiteaves.

Plate X., figs. 4, 4*a*.

? Amplexus laxatus, Billings, 1863, Geology of Canada, pp. 340 and 342, with no description nor figures.
Amplexus (?) sp. Nicholson, 1875. Palæon of Ont., p. 66,
Pycnostylus Guelphensis, Whiteaves, 1884 Palæoz. Foss., vol. III., pt. I., p. 3, pl. I., figs. 1, 1*a*, 1*b*.
" " Whiteaves, 1895. Ibid, pt. II., p. 49.

Original description.—"Corallites long and slender, averaging from 3 to 7 mm. in diameter, and dividing uniformly at the same point into either three or four branches. Epitheca marked by transverse constrictions and re-elevations at irregular distances, but not longitudinally ribbed. Primary septa alternating with smaller secondary ones."

Localities and formation.—New Hope (name changed to Hespeler in 1858), Ont., E. Billings, 1857; Guelph, Ont., R. Bell, 1861; Hespeler, Ont., T. C. Weston, 1867; Elora, Ont., Mr. D. Boyle, 1880; Durham, Ont., Mr. J. Townsend. Guelph limestone.

It may also be remarked that — the septa average thirty-two in number, the primaries being about ·75 mm. in length when well preserved, the secondaries slightly smaller. The tabulæ are complete, flat, often slightly convex or concave, rather far apart, from five to nine occurring in a distance of 1 cent. The corallites often touch each other and sometimes continue in contact for some distance, and are seldom more than their own diameters apart. In longitudinal sections the new corallites, in sets of four or occasionally three, are seen to spring simultaneously from the inner surface of the wall of the parent

corallite and to fill the entire visceral chamber where, by their pressure on each other, they are at first angular but diverging slightly they rise as complete cylindrical corallites each in turn to subdivide again. The largest specimen in the collection, representing a corallum of greater size, is rougly 17 cent. high and 16 cent. broad.

Pycnostylus elegans, Whiteaves.

Pycnostylus elegans, Whiteaves, 1884. Palaeoz, Foss., vol. III., pt. I., p. 4, pl. I., figs. 2, 2*a*.
" " Whiteaves, 1895. Ibid, pt. II., p. 49.

Original description.—" Corallites attaining to a diameter of from 13 to 17 mm.: increasing by calicular gemmation in such a manner as to divide into six or seven branches on the same plane: external surface regularly and longitudinally ribbed, the ribs alternating with the septa within: all the septa of uniform length and size.

" The only specimen of this coral in which calicular gemmation is plainly visible is presented by figure 2 on plate 1 (op. cit.). Part of this specimen is covered with rock, but on the exposed surface five buds are visible, one of which is an inch and a quarter long, while the other four are broken off at their bases. Judging by the diameter of the buds in proportion to that of the calyx from which they spring, it is probable that the entire cycle would consist of either seven or eight.

" It is possible that the specimens for which the above name is provisionally suggested may prove to be portions of the basal extremity of *P. Guelphensis* denuded of their epitheca, but at present no intermediate examples between the two forms have been collected."

Localities and formation.—Hespeler, Ont., T. C. Weston, 1867; Durham, Ont., Mr. J. Townsend. Guelph limestone.

The number of septa in mature corallites of this larger form varies from about forty-five to fifty-five and there are four or five tabulæ in a space of 1 cent.

CYATHOPHYLLIDÆ.

Genus Cyathophyllum, Goldfuss. 1826.

Cyathoplyllum, Goldfuss. 1826. Petrefacta Germaniæ, vol. I., p. 54.
Heliophyllum, Hall. 1848. U. S. Explor. Exped., Zooph., Dana.

Corallum simple, aggregate or astræiform. Increase by calicular gemmation. Epitheca complete. Septa regularly radial, lamellar, well developed, generally in two alternating sizes, primaries and secondaries, the former sometimes reaching the centre of the visceral chamber where

they may be slightly twisted. Septal carinæ often present. Tabulæ poorly developed, confined to a narrow central area, generally somewhat irregular. Dissepiments numerous, forming a broad vesicular zone surrounding the tabulæ. Fossette sometimes present.

Type species.—*C. dianthus*, Goldfuss.

Range.—Silurian, Devonian and Carboniferous.

Cyathophyllum Anticostiense, Billings.

Plate X., figs. 5, 6, 6*a*, 7 and 8.

Cyathophyllum Anticostiense, Billings. 1862. Palæoz. Foss., vol. I., p. 109.
Cyathophyllum solitarium, Billings. 1866. Cat. Sil. Foss. of Anticosti, p. 93.
Cyathophyllum Anticostiense, Lambe. 1899. Ottawa Naturalist, vol. XII., p. 237.

"Corallum simple, of moderate size, cylindro-turbinate, straight or very slightly curved, broadest near the upper end, attaining a length of about 18 cent. with a maximum diameter of over 6·5 cent. Epitheca very thin, preserved only in small patches, showing indications of the structure beneath. Calyx rather shallow, its sides expanding outward in a gentle convex curve. Internally there is a narrow tabulate zone, about one-fifth or one-fourth the diameter of the corallite, with a broad combined vesicular and septate zone surrounding it. Tabulæ thin, numerous, inosculating, in some coralla bent down at the margin, eight or ten occurring in a space of 5 mm. Septa straight, numbering from about one hundred to one hundred and twenty, of two definite lengths alternating with each other, one half reaching the centre of the visceral chamber, the remainder stopping short of the tabulæ, becoming weak and subordinate to the dissepiments near the periphery. Dissepiments strongly developed, small, numerous, curving upward and outward between the septa, appearing in radial sections of the corallites as slightly convex plates enclosing narrow and comparatively long spaces. In tangential sections near the surface the dissepiments are seen to be angular midway between the septa, both halves of a dissepiment curving downward toward each other convexly. The dissepiments on either side of a septum generally correspond, so that at the surface with the scant development of the septa in that part, they appear as close-set horizontal wavy lines simulating the structure of *Chonophyllum* more particularly that of *C. magnificum*, Billings." (Lambe, 1899.)

Localities.—South-west Point, Anticosti, division IV. of the Anticosti group, four specimens collected by J. Richardson in 1856. Also from half a mile north-west of Portage Bay, Lake Manitou, Grand Manitoulin Island, Lake Huron, R. Bell and H. G. Vennor, 1865 (type of *C. solitarium*); Clinton and Niagara formations.

Cyathophyllum Euryone, Billings.

Plate XI., figs. 1, 1a, 1b.

Cyathophyllum Euryone, Billings. 1862. Palæoz. Foss., vol. I., p. 110.
" " Billings. 1866. Cat. Sil. Foss. of Anticosti, p. 34.

"Turbinate, curved at the base, expanding to a diameter of one inch at the height of from one to one and a half inches, then becoming cylindrical; radiating septa about one hundred; cup with a flat or gently convex bottom, which is in width about half the whole diameter; inner area full half the whole width, with flat or convex tabulæ; outer area with the cells ascending in lines which meet the exterior at an angle of about 45°; the vesicles acutely oval, from one to one and a half lines in length, with a thickness of one-third or one-half a line. Surface, in a worn specimen, strongly sulcated by the septal striæ, of which there are four or five in one line." (Billings.)

Locality.—"The Jumpers," Anticosti, in division IV., of the Anticosti group; collected by J. Richardson, 1856.

Cyathophyllum articulatum, Wahlenberg.

Plate X., figs, 9, 9a, 9b.

Madreporites articulatus Wahlenberg. 1821. Nov. Act. Soc. Upsal., vol. VIII, p. 87.
Cyathophyllum articulatum, Milne-Edwards and Haime. 1851. Polyp. Foss. des Terr Palæoz., p. 377; and 1855, Brit. Foss. Corals, p. 282, pl. LXVII., figs. 1, 1a.
" " Lambe. 1899. Ottawa Naturalist, vol. XII., p. 219.

"To this species are assigned a number of specimens from the Niagara rocks of Lake Temiscaming; their general form, manner of growth and structure may be described as follows: Corallum composite, fasciculate, with upright, slightly flexuous, subparallel corallites, increasing by lateral or by marginal calicular gemmation from an initial basal parent, and forming clusters reaching a height of over 20 cent. and of variable breadth. Corallites subcylindrical, strongly expanded and constricted at unequal intervals with generally free thin margins to the expansions, coming together and adhering to each other where enlarged, of unequal size, the young corallites often proceeding upward with little increase in diameter, at other times rapidly gaining breadth; varying in diameter from about 5 to 20 mm., the largest being sometimes slightly over 20 mm. in diameter. Outer surface covered by an epitheca with numerous slight rings of growth and with strongly marked septal furrows. Septa, tabulæ and dissepiments well developed. Septa numbering from sixty to over seventy in the large corallites, of two alternating

sizes, the primaries passing quite to or nearly to the centre of the visceral chamber, in the latter case leaving the tabulæ smooth at the centre, the secondaries small, reaching generally less than half way to the centre. Tabulæ forming a definite central zone equal in breadth to about half the diameter of the corallite, flat or slightly concave, often deflected at the margin. Dissepiments, as a whole, rather small but unequal in size, occupying the interseptal spaces between the tabulæ and the outside wall, encroaching at times on the tabulæ. Calyces moderately deep, with steeply ascending sides and most often with expanded thin margins.

"In the description given by Milne-Edwards and Haime of this species (Brit.Foss.Corals) the septa are stated to be 'about sixty in number, thin, equally developed.' This is evidently a misprint as far as the equality of the septa is concerned, as in fig. 1a supplementing the description, the septa are shown as of two orders, numbering in all about sixty, half of which almost reach the centre of the visceral chamber, whilst the remainder are only about half that size." (Lambe, 1899.)

Localities.—"The Forks," Scaumenac River, Que., R. D. Ells, 1883, and Isle of Man (Burnt Island), Lake Temiscaming, Que., A. E. Barlow, 1893 : Niagara formation. In 1880, Col. C. C. Grant collected at Hamilton, Ont., in rocks belonging to the Clinton formation a coral that is thought to belong to this species.

Cyathophyllum Wahlenbergi, Billings.

Plate XI., figs. 2, 2*a*, 2*b*.

Cyathophyllum Wahlenbergii, Billings. 1862. Palæoz. Foss., vol. I., p. 108.
Cyathophyllum Wahlenbergi, Billings. 1866. Cat. Sil. Foss. of Anticosti, p. 34.

Corallum composed of an aggregation of long, cylindrical, upright, slightly flexuous corallites that increase by lateral calicinal gemmation and are so close together as to touch each other or to be separated by spaces generally less than their own diameter; found in colonies measuring 30 cent. or more across. As many as three or four buds at a time sometimes produced by the parent cells. Surface of corallites roughened by frequent and sudden annular constrictions and enlargements at irregular intervals. Epitheca marked transversely by faint lines of growth and longitudinally by depressed lines indicating the position of the septa within.

Inner structure consisting of well defined septa, of vesicles partly filling the interseptal spaces, and of tabulæ forming a central area. Septa numbering about forty-two, of two sizes alternating with each other, the larger passing almost or quite to the centre of the corallites, the remainder

reaching only half way. Vesicles in a varying number of rows, generally from about three to five, small and inclined obliquely upward and outward. Tabulæ placed close together, three or four to 1 mm., flat at the centre but deflected at the circumference, occupying about half the diameter of the corallite; generally the disposition of the tabulæ is irregular owing to the presence of numerous small cysts or minor vesicular secondary tabulæ.

According to Billings this coral resembles *C. articulatum*, Wahlenberg, but is a smaller species, and is larger and more strongly annulated than *C. flexuosum*, Lonsdale.

Locality.—East Point, Anticosti, in division III, of the Anticosti group; collected by J. Richardson, 1856.

Cyathophyllum interruptum, Billings.

Plate XI., figs. 3, 3*a*, 3*b*.

Cyathophyllum interruptum, Billings. 1862. Palæoz. Foss., vol. I., p. 109.

Corallum apparently simple, strongly curved, with periodic enlargements of growth representing successive calyces, giving the coral the appearance of a number of inverted cones set one within the other; enlargements about 18 mm. apart on the concave side or inner curve. The type specimen, the only one known, is over 11 cent. in length and has a maximum breadth near the upper end of about 4·5 cent. Calyx small, but moderately deep, with steep sides and flat at the bottom where it is about 9 mm. wide; depth somewhat over 10 mm. Septa numerous, between one hundred and twenty and one hundred and thirty, alternately long and short, the longer passing to the centre, the shorter reaching about half way; in the peripheral area the septa are all thin but toward the centre the larger ones are apparently thickened. Vesicular zone broad, restricting the tabulæ to a narrow central area 8 or 9 mm. broad. The vesicles or dissepiments filling the interseptal spaces, are small and diminish slightly in size outward. Tabulæ flat, their regularity of disposition somewhat interfered with by the septa and vesicles. Epitheca thin, showing faint longitudinal septal striations and in places marked by short transverse wrinkles that are apparently the result of a slight protrusion of the epitheca by the outer edges of the dissepiments beneath.

Locality.—L'Anse à la Barbe, Baie des Chaleurs; Silurian*; collector Sir William Logan, 1843.

* See foot-note on p. 129 as to age of rocks.

Cyathophyllum Pennanti Billings,

Plate XI., figs. 4, 4*a*, 4*b*.

Cyathophyllum Pennanti, Billings, 1862. Palæoz, Foss., vol. I., p. 107.

Colonies of cylindrical, flexuous, slightly divergent, upright corallites that increase rapidly by lateral calicular gemmation, forming masses from 30 to 60 cent. in diameter. Three or four buds spring from a parent corallite at a time. Corallites crowded closely together and frequently in contact, annulated by numerous rounded swellings, with shallow constrictions between; small nodular outgrowths are developed when the corallites approach each other sufficiently and serve to strengthen the general growth of the colony. Epitheca marked by numerous faint, transverse lines of growth, and striated longitudinally by narrow septal grooves. The corallites, in some specimens bud at intervals of from 3 to 6 cent. after having attained a diameter of from 10 to 15 mm., but in others, evidently on account of overcrowding, they bud with much less frequency.

Septa numbering sixty, alternately large and small, one-half passing to the centre, remainder reaching not quite half way. Tabulæ well developed, close set, about eight in a space of 2 mm. flat in the centre and shallowly grooved round the periphery, occupying about half the entire diameter. Vesicles small, inclined obliquely outward and upward and filling the interseptal loculi in from about three to six rows.

This coral is closely allied to *C. articulatum*, Wahlenberg, from which it differs in being less strongly annulated and in the possession of the strengthening nodular outgrowths as well as in a few minor details of structure; the strengthening connexions between the corallites give to the corallum an appearance somewhat similar to that of some species of *Diphyphyllum*.

Locality.—L'Anse au Gasçon, Baie des Chaleurs; Silurian*; collector Sir William Logan, 1843.

Cyathophyllum Zenkeri, Billings.

Plate XII., fig. 1.

Cyathophyllum Zenkeri, Billings, 1860. Canadian Journal, new series, vol. V., p. 262, fig. 11.
" " Nicholson, 1875. Palæon. of Ont., p. 76.

Corallum simple, short, cone-shaped, strongly curved especially at the pointed base, reaching a height of 9 cent. as measured on the convex or

* See foot-note on page 129.

outer curve and a diameter at the top of 4 cent. Epitheca smooth, showing faint annular transverse lines of growth and longitudinal depressed septal lines. Calyx wide with almost vertical sides, flat at the bottom with septa passing to the centre; in the type specimen it is 28 mm. across at the top and 18 mm. deep. Tabulate area large, occupying nearly three-fifths of the entire diameter. Tabulæ flat, moderately regular, from ·5 to 2 mm. apart, bent down at their edges, where a number of cystose plates are introduced. Vesicular area narrow, made up of rather unequal arched dissepiments, that curve upward and outward from the edges of the tabulæ; the vesicles decrease slightly in size from within outward. In the walls of the cup the septa are of equal length, but beneath in the tabulate area many of them pass to the centre, whilst the remainder apparently do not encroach on the tabulæ; septa numbering in all from about one hundred and forty to one hundred and fifty. A septal fossette is present at the edge of the bottom of the calyx on the side next to the concave curve of the coral. The tetrameral arrangement of the septa is well shewn in the type specimen.

Locality and formation.—Rama's farm, near Port Colborne, Ontario, Corniferous limestone; collector E. Billings, 1857.

Cyathophyllum Spenceri, Lambe.

Plate XII, figs. 2, 2*a*, 2*b*.

Acervularia profunda, Billings. 1876. Rep. of Progress for 1874-75, Geol. Survey of Canada, p. 68.
Cyathophyllum profundum, Whiteaves. 1892. Contr. to Can. Palæon., vol. I, pt. IV p. 267.
" " var. Whiteaves. 1892. Ibid, p. 268, pl. XXXIV, figs. 4, 4*a*.
Cyathophyllum Spenceri, Lambe. 1899. Ottawa Naturalist, vol. XII, p. 238.

"Corallum composite, formed by closely connected, crowded, polygonal, generally hexagonal corallites that diverge from a small base and form thick somewhat explanate masses; largest specimen seen about 15 cent. broad and 6 cent. thick or high. Frequently spaces are left between the corallites at or near the edge of the corallum due to the less crowded growth of the corallites and their assumption of a more nearly cylindrical form. A line of contact between contiguous corallites is recognizable, showing that each corallite is contained inside its own walls, also some specimens have been preserved in such a manner as to admit of the corallites being separated from each other along this line of contact. Surface of corallites irregularly ribbed transversely, with fine growth lines between, and longitudinally striated by shallow septal grooves. Corallites varying in size in the same individual and in different specimens, from about 8 to 12 mm., in the majority of specimens, and from 10 to 17 mm. in the

largest specimen. Calyces polygonal in outline, their confluent margins prominently angular, depth about one-half the width, sides steep, bottom narrowly concave, septate to the centre. Septa of two lengths, from about forty-eight to fifty-six in number, in different specimens, of which the longer meet at the centre of the visceral chamber and the remainder reach more than half way and often nearly to the centre, their sides not ornamented with arched carinæ. Tabulæ flat, close set, four or five in a length of 1 mm., moderately regular, their continuity in a horizontal plane often interrupted by the passage of the septa through them, narrow, forming a small but well-defined central area from about $\frac{1}{5}$ to $\frac{1}{3}$ the diameter of the corallite in width. Vesicular zone surrounding the tabulate area, broad, made up of small vesicles of rather equal size, in eight or nine obliquely ascending rows, filling the interseptal loculi. Increase apparently by interstitial gemmation.

"This species differs from *C. quadrigeminum*, Goldfuss, principally in having a much narrower tabulate area and a resultant broader vesicular zone, in having the two orders of septa more nearly of a size and in the absence of septal carinæ." (Lambe, 1899.)

Localities.—Dawson Bay, Lake Winnipegosis, J. W. Spencer, 1874; Lake Manitoba, on the east side of the Narrows, J. B. Tyrrell, 1888; and Lake Winnipegosis at Snake Island and in Dawson Bay, also at Lower Salt Spring, Red Deer River, J. B. Tyrrell and D. B. Dowling, 1889; Devonian (American Stringocephalus zone) and possibly Upper Devonian.

Cyathophyllum vermiculare, Goldfuss, var. præcursor, Frech.

Astrocyathus vermicularis, Ludvig. 1866. Korallen aus palæolithischen Formation (Palæontographica, vol. XIV), t. 58.

Cyathophyllum vermiculare, Goldf. mut. n. prœcursor. Frech. 1886. Die Cyathophylliden und Zaphrentiden des deutschen Mitteldevon, (Palæontol. Abhandl., Dames und Kayser, vol. III), p. 63, pl. II, (XIV) figs. 4, 6—10.

" " Goldfuss, var. præcursor, Whiteaves. 1892. Contr. to Can. Palæon., vol. I, pt. IV, p. 263, pl. XXXV, figs. 1, 1*a*, 1*b*.

A few specimens of a simple coral from a number of localities on Lake Winnipegosis and its vicinity have been referred by Dr. Whiteaves to the above species, on the authority of Dr. Frech.

In these Lake Winnipegosis specimens the corallum varies from a short, straight and rather stout form to one that is more cylindrical, proportionately longer and somewhat flexuous; length in different specimens from 3 to nearly 5 cent. and breadth from 2·5 to 3·5 cent. The surface exhibits numerous, slight, annular ridges and constrictions, whilst the epitheca is smooth but marked by minor transverse lines of growth and

faint longitudinal septal furrows. The calyx has sloping sides and is moderately deep, its width is equal to about two-thirds the diameter of the coral above and its depth about three-fifths its width. The septa vary in number from about sixty-five to eighty, and are alternately long and short, one half passing to the centre where they are often twisted, the remainder reaching not quite half way. In the calyx the septa have their free edges denticulated and at the bottom their twisted ends form a slightly raised boss in some specimens. The tabulæ are very feebly developed, they average about 5 mm. in width, are flat, and seem to be much interfered with by the longer septa. The central confused area of tabulæ and twisted septa gives way laterally to a broad vesicular zone, made up of oblique dissepiments, that become more regular in disposition and smaller in size as the outside of the coral is approached. A septal fossette is indicated in two of the specimens.

Localities.—A number of places on the Red Deer River, Dawson Bay and Lake Winnipegosis, District of Saskatchewan and Province of Manitoba; Devonian; collectors, D. B. Dowling, 1888, J. B. Tyrrell and D. B. Dowling 1889.

Cyathophyllum Richardsoni, Meek. (Sp.)

Aulophyllum? Richardsoni, Meek. 1868. Trans. Chicago Acad. of Sciences, vol. I, p. 81, pl. XI, figs. 3, 3*a*.

Cyathophyllum Richardsoni, Whiteaves. 1891. Contr. to Can. Palæon., vol. I, pt. III, p. 200, pl. XXVII, figs. 3 and 4.

Corallum simple, curved below, becoming cylindrical above and sometimes slightly flexuous, marked generally by strong accretion ridges, especially near the base, on the side of the convex curve; from 4 to 8 cent. in length and averaging about 2 cent. in maximum diameter. Epitheca, when well preserved, seen to be marked transversely by fine wavy lines of growth, about ten in the space of 1 mm., and longitudinally by well-defined septal striæ. Calyx of moderate size and varying somewhat in depth, sometimes as deep as wide, but generally much more shallow, and showing a considerable variation in the form of the bottom. Septa about seventy-two in number, generally thickened for a short distance inward from their outer ends, thirty-six of them extending to the centre of the visceral chamber, the others half way, more often much less than half way, to the centre. Denticulations present on the free edges of the septa in the cup and continued over their sides obliquely downward and outward as carinæ. Tabulæ small, irregular, vesicular, having more the form of large flat dissepiments than true tabulæ. Vesicles occupying the interseptal loculi between the ill-defined central area and the outer wall, small, formed by curved dissepiments ascending in rows obliquely outward.

Mackenzie River, at the "Ramparts;" Upper Devonian; collector, R. G. McConnell, 1888. Red Deer River, Lake Winnipegosis, J. B. Tyrrell, 1889; Devonian (Cuboides zone); one specimen.

This species resembles *C. vermiculare*, var. *præcursor*, Frech, from the Upper Devonian rocks of Lake Winnipegosis and vicinity, but has a more slender corallum; the inner structure in the two species is somewhat similar, but in the Mackenzie River form the septa are stouter in the peripheral area and the difference in length of the longer and shorter septa, as seen in transverse section, is more marked.

Cyathophyllum ellipticum, Hall and Whitefield. (Sp.)

Chonophyllum (Ptychophyllum) ellipticum, Hall and Whitfield. 1873. Twenty-third Report, N. Y. State Museum of Nat. Hist., p. 233, p. 233, pl. IX., fig. 13.

Campophyllum Soetenicum, Schluter. 1889. Anthozoen des rheinischen Mittel-Devon., p. 39, taf. III., figs. 1--6.

Campophyllum ellipticum, Whiteaves. 1891. Contr. to Can. Palæon., vol. I., pt. III., p. 202, pl. XXVII, figs. 5 and 6, and appendix, p. 422.

Corallum simple, conico-cylindrical, curved at the base and in older specimens curved again above, but in the opposite direction. Surface marked by strong encircling swellings of growth at irregular intervals, and showing distinct longitudinal linear depressions, representing the septa within. Epitheca smooth, with fine wavy transverse lines. A diameter of 3 cent. is reached in a length of nearly 6 cent.; the largest specimen in the collection, one that has unfortunately been broken across, not far below the bottom of the cup, has a maximum diameter of 5·5 cent. Calyx large, with steeply ascending sides that expand rapidly near the margin; bottom of cup wide, flat, carinated almost to the centre by septa; depth somewhat less than the width of the cup at the bottom. Septa numbering from about seventy to one hundred, of two orders, the primaries meeting the tabulæ and continued thereon to the centre of the visceral chamber as carinæ, the secondaries short, extending only about ·5 cent. inward from the outer wall. Tabulæ well developed, generally broader than the half diameter of the coral, flat, bent down at the edges. Vesicles in the interseptal spaces coarse, of unequal size, forming a peripheral dissepimental area of variable width.

Localities.—Hay River, forty miles above its mouth, Mackenzie District, R. G. McConnell, 1887; and Athabasca River, thirty miles below Red River, R. G. McConnell, 1890. Devonian (Cuboides zone.)

As Professor Calvin thinks that the Hay River fossil figured on plate XXVII, fig. 5, of the first volume of the "Contributions to Canadian Palæontology," is not specifically identical with *Chonophyllum ellipticum*,

Hall and Whitfield, Dr. Whiteaves has proposed the name of *Cyathophyllum McConnelli* for the former. But the specimens from the Hay and Athabasca rivers seem to the writer to agree remarkably well with Hall and Whitfield's description of *C. ellipticum* and with the internal structure of a specimen of *C. ellipticum* sent by Dr. Griffith, from Rockford, Iowa, the typical locality; for this reason Dr. Whiteaves's original identification is retained.

A variety of this species, from the Upper Devonian rocks of Lake Winnipegosis, has been recognized by Dr. Whiteaves, who makes the following descriptive remarks thereon:* "It differs from the types from the Devonian rocks of the Athabasca River only in having its central area occupied by flexuous, irregularly disposed, but for the most part continuous tabulæ, rather than by large interseptal dissepiments, and in its narrower vesiculose peripheral zone, the inner margin of which is more clearly defined."

One specimen from the south-western shore of Cameron Bay, Lake Winnipegosis, J. B. Tyrrell, 1889.

Cyathophyllum Athabascense, Whiteaves.

Cyathophyllum Athabascense, Whiteaves, 1891. Contr. to Can. Palæon.., vol. I., pt. III., p. 202, pl. XXXII., figs. 1, 1*a*, 1*b*.

"Corallum simple, elongate-turbinate and slightly curved; epitheca well developed, marked with rounded and not very prominent longitudinal ribs, which are much broader than the grooves between them, and by transverse striæ or wrinkles and an occasional constriction caused by an arrest of growth. Calyx circular, rather deep, with steep sides; septa about thirty-four in number, simple, not bearing arched carinæ on their sides and apparently not denticulated at their summits. Interior structure, as seen in longitudinal sections, consisting of an outer or peripheral zone of oblique ascending rows of rather large vesicles, and of a broad central area in which the interstices between the septa are crossed by large curved dissepiments, whose size, shape and disposition are very irregular. Transverse sections made a little below the base of the calyx show that the thirty-four septa extend almost to the centre, and that they are all equal in length." (Whiteaves.)

Locality—Athabasca River, three miles below the Calumet River; Devonian (Cuboides zone); collector R. G. McConnell, 1890.

*Contr. to Can. Palæon., 1892, vol. I., pt. IV., p. 269, pl. XXXIV., figs. 8, 8a.

Cyathophyllum Waskasense, Whiteaves.

Cyathophyllum Waskasense, Whiteaves, 1892. Contr, to Can. Palæon., vol. I., pt. IV., p. 264, pl. XXXIV., figs 5, 5*a*, 6 and 7.
Cyathophyllum dianthus, pars. Whiteaves, 1892. Ibid, vol. I., pt. IV., p. 264 (specimen from Red Deer River).

"Corallum simple, or proliferous and consisting of a single corallite from which as many as from four to six lateral and divergent buds proceed, or increasing by calycinal gemmation, the simple forms and those from which lateral buds are produced being conical, rather slender and more or less curved or bent. Epitheca faintly ribbed longitudinally, transversely striated and marked also with a few irregularly disposed constrictions and re-elevations, the results of periodic arrests of growth; calyx rather deep, flat at the bottom and with nearly vertical sides; primary septa twenty-four, extending about half-way to the centre and slightly irregular; secondary septa equal in number to the primaries, but not reaching more than half as far inward.

"Internal structure, as seen in longitudinal sections, consisting of a very narrow outer zone of vesicular tissue and of a broad inner tabulate area. The vesicles are small and rather regularly disposed, while the tabulæ, which are for the most part complete and regular in their disposition, are very close-set, flat in the centre, but bent downward at their outer margins." (Whiteaves.)

In this species the septa are denticulated on their free edges and carinated on their side faces.

Localities.—Red Deer River and Dawson Bay, Lake Winnipegosis; Devonian: collector J. B. Tyrrell, 1889.

Cyathophyllum petraioides, Whiteaves.

Cyathophyllum petraioides, Whiteaves, 1892. Contr. to Can. Palæon., vol. I., pt. IV., p. 265, pl. XXXIV., figs. 1, 1*a* and 2.

"Corallum simple, straight or slightly curved, in well preserved specimens attached to some foreign body by a small and partially clasping basal expansion, conical and broadly spreading, the entire height being not much greater than the width at the summit. Outer surface marked with faint longitudinal costæ, also by fine transverse striæ and a few rather course wrinkles at irregular intervals. Calyx circular, oblique in some specimens but not in others, subconical but irregular in shape, usually very deep and in most cases excavated to within an extremely short distance of the base; septa about forty-five* in number and apparently equal

* The septa may be said to vary in number from about forty to sixty according to the size of the corallum.

in size, consisting of mere ridges, which are acute and moderately prominent in the upper portion of the sides of the cup, but which are much more strongly developed at and towards its base. Internal structure, as shown in longitudinal sections, consisting of vesicular tissue between the septa; tabulæ almost but not entirely absent, a single transverse diaphragm at the bottom of the cup being observable in two out of the ten specimens collected."

Dimensions of an average sized specimen: "greatest height, 39 mm., maximum width, 29 mm. In another specimen the greatest height is about 40 mm. and the width at the summit, 32 mm." (Whiteaves).

Localities.—Onion Point, Lake Manitoba, J. F. Whiteaves and J. B. Tyrrell, 1888; small island at extreme south end of Lake Winnipegosis and at the Lower and Upper Salt Springs, Red Deer River, J. B. Tyrrell, 1889. Devonian.

Cyathophyllum cæspitosum, Goldfuss.

Plate XII., figs. 3, 3*a*, 3*b*.

Cyathophyllum cæspitosum, Goldfuss, 1826. Petrefacta Germaniae, vol. I., p. 60, pl. XIX., figs 2*a-d*.
" " Milne-Edwards and Haime, 1851. Polyp. Foss. des Terr. Palæoz., p 384.
" " Milne-Edwards and Haime, 1853. Brit. Foss. Corals, p. 229, pl. LI, figs 2, 2*a*, 2*b*.
" " Whiteaves, 1891. Contr. to Can. Palæon., vol. I., pt. III., p. 200, (Peace River specimen), also pt. IV., p. 264.

This species is represented by a small mass of corallites increasing by lateral calicinal gemmation, collected by Prof. John Macoun, in 1875, on the Peace River near the mouth of Red River; Devonian (Cuboides zone). The specimen in question may be described as follows: corallum bushy, made up of a loose aggregation of corallites, averaging, when full grown, about 9 mm. in diameter, that diverge radially from a basal central point and form a mass 6 or 7 cent. high and about 12 cent. in diameter. Small corallites spring from the sides of the calyces of the mature ones. Corallites cylindrical, slightly but definitely constricted at irregular intervals. Epitheca rather smooth, with feeble transverse lines of growth and faint longitudinal septal striæ. Calyces moderately deep, with steep sides, showing primary and secondary septa, the former of which pass nearly to the centre of the bottom of the cup. Septa, numbering in all from about forty-four to forty-eight, alternately long and short, the primaries, as seen in transverse sections, almost reaching the centre of the visceral chamber, whilst the secondaries are scarcely discernible beyond what appears to be a thickening of the wall, formed by the union

of the outer ends of the septa with the secondaries; their free edges in the calyces are denticulated and their sides carinated. Tabulæ distinct, flat, often slightly irregular in disposition, not quite one-half the diameter of the corallites. Vesicles, between the tabulæ and the wall, comparatively large, unequal in size, often intruding on the tabulæ.

Cyathophyllum ceratites, Goldfuss.

Cyathophyllum Ceratites, Goldfuss, 1826. Petrefacta Germaniæ, vol. 1. p. 57, pl. XVII., figs, 2*a*—*h*.
Cyathophyllum ceratites, McCoy. 1855. Brit. Palæoz. Fossils, p. 70.
" " Freck. 1886. Die Cyathophylliden und Zaphrentiden des deutschen Mitteldevon (Palæontol. Abhandl., Dames und Kayser, vol. III.) p. 64.
Cyathophyllum cæspitosum, Whiteaves. 1891. Contr. to Can. Palæon., vol. I., pt. III., p. 200, pl. XXVII, figs. 7 and 8. (single corallites from Hay River.)
Cyathophyllum dianthus, Whiteaves. (teste Frech.) 1892. Contr. to Can. Palæon., vol. I., pt. IV., p. 264; (not the specimen from Lower Salt Spring, Red Deer River.)

To this species are referred seven simple coralites collected by Mr. R. G. McConnell in 1887 from the Devonian rocks of Hay River, Mackenzie District, forty miles above its mouth. The following description has reference to these specimens, four of which have been slit to show longitudinal or transverse sections :—corallum simple, conical when young, later becoming cylindrical above, generally curved, sharply pointed below, marked by annular, more or less decided, ridges and constrictions. Epitheca smooth, with faint transverse lines of growth, but with scarcely any indication of septal grooves. The largest of the conical specimens has a diameter of about 2 cent. and a length of 4 cent. measured along the convex curve, the more cylindrical ones have a maximum diameter of less than 2 cent. with a length varying between 6 and 8 cent. Calyx sometimes as deep as wide, more often shallower, narrowing slightly toward the bottom where it is flat or evenly concave. Septa from about fifty to seventy in number, alternately long and short, the long ones almost reaching the centre, thick near their outer ends, the short ones, stout, seldom more than 2 mm. in length; their outer ends, when the epitheca is wanting, appearing at the surface as strong costal ribs. Septa delicately denticulated at their free edges and carinated on the sides, prominent and sometimes appearing to pass over the somewhat rounded margin of the calyx. Tabulæ numerous, close set, equal in breadth to about half the diameter of the corallite, generally concave. Vesicles of the peripheral area, enclosing the tabulæ, rather large, unequal in size; numerous, much maller vesicles occur between the costal ends of the septa.

Cyathophyllum Dawsoni, Lambe.

Plate XII., figs. 4, 4*a*, 4*b*.

Zaphrentis Minas, pars. Dawson. 1868. Acadian Geology, second edition, p. 286 (longest specimen).
Cyathophyllum Dawsoni, Lambe. 1899. Ottawa Naturalist, vol. XII,, p. 239.

"Corallum simple, elongate, slightly curved, in the type specimen broadest at the midlength, contracted near the top, annulated somewhat irregularly by well marked ridges and constrictions, and by minor ridges of growth, the whole outer surface, when sufficiently well preserved, showing fine, close set, transverse raised lines about twelve in the space of 1 mm., as well as longitudinal septal striations. Type specimen 6 cent. long, as measured on the convex curve, imperfect below where the basal part, possibly about 3 or 4 cent. in length, has been broken off. Calyx shallowly concave, smooth at the bottom, with the septa prominent on the margin and sides. Tabulæ broad, flat, usually bent down at the edge, close set, forming a definite central area a little over 1 cent. in breadth. Septa rather crooked, of two lengths, the longer reaching the tabulæ and often encroaching on them, the shorter not quite half the length of the larger ones, irregular, rather poorly defined, numbering in all about sixty. Vesicular zone, outside the tabulæ, averaging about 5 mm. in breadth, made up of unequal, arched dissepiments directed upward and outward between the septa." (Lambe, 1899.)

Locality.—Kennetcook, Nova Scotia, collected by Professor How; Lower Carboniferous; one specimen belonging to the collection of the Peter Redpath Museum, McGill University, Montreal.

Cyathophyllum Thoroldense. (Sp. nov.)

Plate XI., figs. 5, 5*a*, 5*b*.

Corallum simple, small, cylindro-conical, curved often, more particularly, at the base, sometimes curved in more than one direction or twisted, generally sharply pointed below; varying in length from about 30 to 75 mm. measured along the convex curve and in breadth at the top from about 12 to 20 mm. Outer surface strongly annulated at times by growth swellings. Epitheca complete, with delicate transverse lines and fine but distinct longitudinal septal furrows. Septa of two orders, alternating, the first almost reaching the centre of the visceral chamber, the second very short extending but slightly inward from the wall, in the larger specimens numbering altogether from about sixty to eighty. The septa bear carinæ on their side faces, about four occurring in a space of

4 mm. Tabulæ flat, narrow, rather distant from each other in vertical disposition, often encroached on by the septa and the dissepiments that arch obliquely upward and outward between the septa. Dissepiments large and unequal near the tabulate area, becoming much smaller and more regular near the periphery. The primary septa in the cup are prominent, alternating with the feebly developed secondaries: below a narrow central space is left forming the bottom of the cup.

Localities.—Thorold, Ont., a few specimens collected by E. Billings in 1857, also by Sir W. E. Logan; St. Catharines, Ont., collected by A. Murray. Niagara formation.

Cyathophyllum Pasithea, Billings.

Plate XII., figs. 5, 5*a*, 5*b*.

Cyathophyllum Pasithea, Billings. 1862. Palæoz. Foss., vol. I., p. 112.

Corallum simple, conico-cylindrical, straight with periodic constrictions that give it the appearance of being made up of a succession of short, broad, truncated, invaginated cones with prominent angular upper margins, contracted and rounded at the top, the whole surface regularly marked by longitudinal septal grooves. Calyx, in the single specimen representing the species, small, only 6 mm. in diameter, and about 4 mm. deep, smooth and concave at the bottom, with steep sides on which the septa appear. Tabulæ varying from deeply concave to flat, with secondary convex tabulæ or blisters, the whole forming a somewhat visicular central area about 7 mm. broad. Septa about eighty-four in number, of equal size, confined to the extratabulate zone, with close-set, strong, straight carinæ on their sides, three or four in the space of 1 mm., directed obliquely downward and outward. Dissepiments arching upward and outward in the interseptal loculi, at right angles to the direction of the carinæ, small, of rather equal size and often in as many as nine or ten rows.

The single specimen, the type of the species, is 21 mm. in maximum breadth, 42 mm. long and is damaged at the basal end.

Locality.—L'Anse à la Vieille, Baie des Chaleurs, Que., collected by Sir W. E. Logan, 1843; Silurian. *

Cyathophyllum Halli, Milne-Edwards and Haime. (Sp.)

Strombodes helianthoides? Hall. 1843. Geol. of New York, pt. IV., p. 209, fig. 3.
Heliophyllum Halli, Milne-Edwards and Haime. 1851. Polyp. Foss. des Terr. Palæoz., p. 408, pl. 7., figs. 6, 6a, 6b; and 1853, Brit. Foss. Corals, p. 235, pl. LI., fig. 3.

*See foot-note p. 129.

Heliophyllum Ericense, Billings. 1859. Canadian Journal, new series, vol. IV., p. 124.
Heliophyllum Cayugaense, Billings. 1859. Ibid, p. 124.
Heliophyllum Canadense, Billings. 1859. Ibid, p. 125.
Heliophyllum Halli, Billings. 1859. Ibid, p. 126.
Heliophyllum Colbornense, Nicholson. 1873. Canadian Naturalist, new series, vol. VII., p. 143; and 1874, Palæon. of Ont., p. 25, pl. V., fig. 4.
Heliophyllum proliferum, Nicholson. 1874. Geological Magazine, new series, vol. I., p. 59; and 1874. Palæon. of Ont., p. 27.
Cyathophyllum Halli, Rominger. 1876. Geol. Sur. Mich., Foss. Corals, p. 98, pl. XXXV., four specimens in upper row.
Heliophyllum Halli, Hall. 1876. Illus. Dev. Foss., pl. XXIII, figs. 1–5, 12 and pl. XXV., figs. 1–7.
Heliophyllum proliferum, Hall. 1876. Ibid, pl. XXVI., figs. 1, 2, 5.

Corallum simple or by prolific budding becoming aggregate, broadly or narrowly turbinate, conico-cylindrical or cylindrical, with many variations of these forms, straight, curved, twisted, or geniculated, frequently contracted above, generally exhibiting numerous annular constrictions and swellings, base small, pointed, the epitheca marked by numerous parallel rings of growth and striated longitudinally by distinct linear septal furrows or depressions; attaining a diameter of over 10 cent., and a length of about 30 cent. Increase by lateral calicinal gemmation, sometimes as many as eight or nine buds springing simultaneously in a circle from the sides of the calyx, Calyx with numerous modifications in shape, in the short coralla, generally rather shallow with broadly expanding, more or less reflexed margins, more inclined to become deep with steep sides in the elongate forms, the sides radially ribbed by the free denticulated edges of the septa that converge toward the bottom of the cup, where the longer ones either meet with straight or twisted ends, at times uniting to form a low boss, or falling short of the centre leave exposed a smooth surface formed by the upper tabulum. A narrow septal fossette is present in the cup. Septa of two orders, primaries and secondaries, the former passing to or almost to the centre, the latter reaching a little past half way, strongly carinated on their side faces, the carinæ curving upward and inward from the wall, each corresponding pair forming, by their union on the free edges of the septa in the cup, a prominent tooth-like projection or short transverse rib: near the margin of the cup the difference in size between the primaries and the secondaries is generally not recognizable. The distance apart of the carinæ from each other is subject to considerable variation in different specimens and to a small extent in the same individuals, from four to twelve occurring in the space of 5 mm. The septa number from about sixty-eight to one hundred in specimens having a diameter of from 4 to 6 cent., in thicker specimens sometimes as many as one hundred and fifty can be counted. Tabulæ small, flat in the centre, bent down at the edge, rendered vesiculose by the introduction of cystose plates and generally somewhat disturbed in

their regularity by the inner ends of the sepia, confined to a central zone varying in breadth from about one-fourth to one-third of the entire diameter of the corallum. Vesicles filling the septal interspaces outside the tabulate zone, small, strongly curved with their convex sides upward, resting on each other and against the sides of the septa, their general direction being upward and outward at right angles to that of the arched carinæ of which they are independent in their disposition.

Locality.—Abundant in the Corniferous and Hamilton formations of Ontario.

Cyathophyllum tenuiseptatum, Billings. (Sp.)

Heliophyllum tenuiseptatum, Billings, 1859. Canadian Journal, new series, vol. IV., p. 126.
Cyathophyllum juvene, Rominger, 1876. Geol. Sur. Mich., Foss. Corals, p. 100, pl. XXXV., three specimens in upper row.
Heliophyllum elegantulum, Nicholson, 1876. Proc. Royal Soc. Edinburgh, p. 150; and 1889, Manual of Palæon., p. 289, figs. 168A and B.

Dr. Rominger succinctly describes this species in his remarks on *Cyathophyllum juvene* as follows—"A very constant form found in association with the preceding species (*Heliophyllum Halli*), resembling it in all particulars, but in all proportions smaller. The arched carinæ are closely approximated, twenty-four on the space of a centimeter. Number of lamellæ from sixty to seventy in the circumference of calyces two and one quarter centimeters wide, which is about the largest size observed."

Locality.—Found in the Hamilton formation in Ontario.

Dr. Rominger records its occurrence also in the Upper Helderberg strata of New York, Ohio and Kentucky.

Cyathophyllum exiguum, Billings. (Sp.)

Heliophyllum exiguum, Billings, 1860, Canadian Journal, new series, vol. V., p. 261, figs, 9 and 10.
Petraia Logani, Nicholson, 1874. Palæon. of Ont., p. 30, pl. III., figs 3, 3*a–f*.
Petraia (?) Logani, Nicholson, 1875. Canadian Naturalist, new series, vol. VII., p. 143.
Zaphrentis exigua, Rominger, 1876. Geol. Sur. Mich., Foss. Corals, p. 149, pl. LIII.
Heliophyllum exiguum, Hall, 1876. Illus. Dev. Foss., pl. XXXII, figs. 1–4.

Corallum simple, small, conical, slighly curved, pointed below, flattened on the side of the convex curve, near the base; varying in size from about 20 mm. long, measured on the convex curve, by about 15 mm. across the top of the cup, to as large as 30 mm. by 26 mm. Epitheca complete. Outer surface showing coarse transverse ridges of growth with minor growth lines between, and longitudinal septal furrows with the cardinal and alar septa generally clearly indicated. Calyx moderately deep, rather oblique, often

oval in outline on account of the flattening of the corallum on the convex side. Septa well developed, primaries and secondaries alternating, the former generally reaching the centre, with their inner ends slightly twisted, the latter about half the length of the primaries, carinated, conspicuous in the calyx and prominent on its rim; in well developed individuals numbering in all from about sixty to seventy-five. Tabulæ apparently absent or very slightly developed. Dissepiments small, occupying the spaces between the septa near their outer ends. Septal fossette narrow, extending from the centre of the bottom of the calyx outward to and enclosing the cardinal septum.

Localities and formation.—Rama's Farm, Port Colborne, Ont., E. Billings, 1857, and Hagersville, Ont., J. F. Whiteaves, 1890; Corniferous limestone. Not uncommon.

Cyathophyllum parvulum, Whiteaves. (Sp.)

Heliophyllum parvulum, Whiteaves. 1891. Contr. to Can. Palæon., vol. I., pt. III., p. 203, pl. XXVII, figs. 9, 9*a*, 10.

"Corallum small, simple, either nearly straight, subconical and not much longer than broad, or somewhat bent, irregularly distorted in growth and proportionately rather narrower but apparently never either slender or narrowly elongated. Calyx circular in outline, moderately deep: septa thirty-six of each kind, their edges, as seen in the cup, presenting a toothed appearance, which is due to the passing over them of arched carinæ: primary septa reaching nearly to the centre at the bottom of the cup: secondary septa very short and feebly developed: septal fossette lateral, shallow. Epitheca thin, transversely striated and wrinkled, with an occasional rather deep constriction, and marked also with longitudinal, rib-like markings which correspond to the septa within. Internal structure, as seen in a longitudinal section through the centre of each specimen, consisting of a narrow central tabulate area, surrounded by a broad, external zone of vesicular tissue. The tabulate area occupies about one fifth of the entire diameter, and the tabulæ are straight, regular and closely arranged. In the outer vesicular zone the vesicles are slightly smaller and more regularly disposed towards the outside than near the centre, their general direction being in rows which curve obliquely upward and outward. The general direction of the arched carinæ which cross the sides of the septa throughout their entire length, on the other hand, is uniformly upward and inward." (Whiteaves).

Locality.—Hay River, Great Slave Lake, District of Mackenzie, forty miles above its mouth, R. G. McConnell, 1887; Devonian (Cuboides zone).

Cyathophyllum coalitum, Rominger.

Cyathophyllum coalitum, Rominger. 1876. Geol. Sur. Mich., Foss. Corals, p. 107, pl. XXXVIII, figs. 4.
Cyathophyllum confluens, Hall. 1876. Illus. Dev. Foss., pl. XXVI, figs. 3, 4 and pl. XXVII.

"Astræiform masses of very large, polygonal polyp cells measuring about four centimeters in diameter, each one surrounded by its own complete wall. Surface of calyces expanded, discoid, with an abrupt but shallow central pit, the reversed bottom of which conically projects, covered by the central ends of the radial crests. Lamellæ linear, subequal, from sixty to seventy in the circumference of a calyx, crenulated by transverse trabeculæ (bars), which are the ends of lateral, arched carinæ decorating the side faces; about fourteen carinæ on the length of one centimeter. Interstitial spaces filled with vesicles arranged in arched rows running diagonally across the carinations. Central area traversed by transverse, larger plates, which are much intersected by the vertical lamellæ. The structure of this coral is identical with *Cyathophyllum Hallii*. from which it differs principally in its cespitose, compound growth. Found frequently in silicified condition in the drift, connected with fossils of the corniferous limestone". (Rominger).

Locality and formation.—Ontario; Corniferous limestone.

Cyathophyllum Anna, Whitfield. (Sp.)

Cyathophyllum (Acervularia) Davidsoni, Whiteaves. 1879. Rep. of Progress for 1877-78 Geol. Survey of Canada, p. 5 c.
Stylastrea Anna, Whitfield. 1882. Ann. New York Acad. Sci., p. 199; and 1890, ibid, p. 520, pl. VI., figs. 1-5.
Cyathophyllum Anna, Whiteaves. 1892. Contr. to Can. Palæon., vol. I., pt. IV., p. 266.

In the original description of this species the corallum is described as being "compound and growing in irregular or more or less hemispherical masses of several inches in diameter, which are formed of a large number of closely aggregated polygonal cell tubes of rather small size." The measurements of the Canadian specimens and their details of structure are as follows:—corallites from about 5 to 10 mm. in diameter, generally hexagonal in transverse section, rather unequal in size, Calyces averaging about 5 mm. in depth, with steep sides, flat and smooth at the bottom. Tabulæ smooth, presenting a somewhat vesiculous or blistered appearance, forming a conspicuous and sharply defined axial area slightly less than one-half the width of the corallite. Septa nearly of the same size, though generally there is a sufficient difference in their length to allow of the two orders being distinguished, from about twenty-eight to thirty-six in

number, strictly confined to the extratabulate area, sharply carinated on the sides and denticulated at the edge. Distepiments small, strongly arched, occurring in five or six regularly ascending rows between the septa at right angles to the downward curve of the septal carinæ. Increase by interstitial gemmation.

This species differs from both *C. quadrigeminum* and *C. Spenceri* in many essential points, but more particularly in having a well marked tabulate area into which the septa do not extend.

Localities.—Woodstock, Ont., A. Murray, 1866, Corniferous formation. Long Portage of the Missinaibi River, R. Bell, 1877, Lake Manitoba, on the east side of the Narrows, J. B. Tyrrell, 1888, and Dawson Bay, Lake Winnipegosis, J. B. Tyrrell, 1889; Devonian (American Stringocephalus zone).

The specimens from these localities are beautifully preserved and show almost every detail of structure.

Cyathophyllum quadrigeminum, Goldfuss.

Plate XII., figs. 6 and 7, 7*a*, 7*b*.

Cyathophyllum quadrigeminum, Goldfuss, 1826. Petrefacta Germaniæ, vol. I., p. 59, pl XVIII., figs. 6*b*, 6*c* and pl. XIX., figs. 1*a*, 1*b*.
" " Milne-Edwards and Haime. 1851. Polyp. Foss. des Terr. Palæoz., p. 383.
Cyathophyllum arcticum, Meek, 1868. Trans. Chicago Acad. of Sciences, vol. I., p. 79, pl. XI., figs. 8, 8*a*, 8*b*.
Cyathophyllum quadrigeminum, Frech, 1886. Die Cyathophylliden und Zaphrentiden des deutschen Mitteldevon, (Palæontol, Abhandl., Dames und Kayser, vol. III.) p. 72, pl. III. (XV.) figs. 1, 1*a*.
Cyathophyllum arcticum, Whiteaves, 1891. Contr. to Can. Palæon., vol. I., pt. III., p.199.

Represented in the collection by two well preserved specimens that show the general form of the corallum; collected by R. G. McConnell in 1888 at the "Ramparts" on the Mackenzie River; Devonian (Cuboides zone).

These two specimens may be described as follows:—corallum made up of intimately connected, polygonal, generally hexagonal tubes that diverge from a single basal corallite, the increase being apparently only by interstitial gemmation, and form small masses, convex above and obtusely pointed below; larger specimen 8 cent. in breadth and 5 cent. in height. Calyces on the upper convex surface. Lower surface covered by a protecting epitheca striated by roughly concentric lines of growth. Corallites unequal in size, varying in diameter from about 9 to 16 mm. in the larger specimen and from 5 or 6 to 10 mm. in the other. In trans-

verse sections the line of division between the walls of adjacent corallites is well shown. Calyces moderately deep, their depth being about equal to or somewhat more than half their diameter, flat at the botttom, their sides steep with well defined septa of two sizes, the larger of which reach the middle of the bottom; marginal junction of contiguous calyces sharply angular. Septa from thirty to fifty in number, alternately long and short, the longer extending to the centre, the others less than half that length, carinated on their sides. Tabulæ about one-half the width of the diameter of the corallite, flat or concave, irregular, inclined to become vesiculous, bounded exteriorly by a narrow zone of rather small, outwardly ascending, curved dissepiments between the septa.

In describing *C. arcticum*, from the Mackenzie River basin, Meek notices the resemblance of his specimens to *C. quadrigeminum*, Goldfuss. In the figures of *C. quadrigeminum* in the Petrefacta Germaniæ two sizes of septa are clearly shown as well as both interstitial and calycinal gemmation.

Genus Crepidophyllum, Nicholson and Thompson. 1876.

Crepidophyllum, Nicholson and Thompson. 1876. Proc. Royal Soc. Edinburgh, vol. IX., p. 149.

Corallum aggregate, formed of cylindrical corallites that grow upward close together or touching each other, or else connected by periodic expansions constituting a series of horizontal floors. Increase by marginal calicinal gemmation. Epitheca complete. Septa well developed, strongly carinated, the inner ends of the primaries combining to form a narrow axial tube which is sometimes open longitudinally on the side of the septal fossette. Tabulæ confined to the central tubular area. Vesicular zone broad, surrounding the tabulate area.

Type species.—*C.* (*Diphyphyllum*) *Archiaci*, Billings.

Range.—Devonian.

Crepidophyllum Archiaci, Billings. (Sp.)

Plate XIII., figs. 1, 1a.

Diphyphyllum Archiaci, Billings. 1860. Canadian Journal, new series, vol. V., p. 260, fig. 8.

Heliophyllum sub-cæspitosum, Nicholson. 1874. Geological Magazine, new series, vol. I., p. 58, pl. IV., fig. 9; and Palæon. of Ont., p. 27, fig. 5.

Diphyphyllum Archiaci, Nicholson. 1875. Palæon. of Ont., p. 74, fig. 41.

" " Rominger. 1876. Geol. Sur. Mich., Foss. Corals, p. 125, pl. XLVII., upper row and right half of lower row.

Corallum aggregate, made up of cylindrical stems that proceed upward from an initial, basal corallite and by lateral calicular gemmation form large explanate masses somewhat flat above and irregularly convex below; the largest specimen seen measuring 23 cent. across and nearly 10 cent. high at the centre. Corallites touching each other or separated by spaces generally less than their half diameters, usually somewhat flexuous, with not very pronounced annular constrictions and growth-swellings at unequal intervals, furnished with a complete epitheca exhibiting fine transverse lines and longitudinal septal furrows; varying in diameter from 5 to 20 mm., with an average diameter of about 15 mm. The young corallites rapidly reach a mature size; they appear to proceed from expansions or outgrowths of the side of the parent stem that represent lateral extensions of former calyces. Septa about fifty-two in number in average sized corallites, of two sizes, alternating with each other, the larger of which by the union of their inner edges forming a wall that encloses a narrow axial tabulate area as in *Crepidophyllum colligatum*, whilst the shorter are only two-thirds as long. Their sides bear arched carinæ that curve upward and inward from the outer wall and appear on the free edges of the septa in the calyx as small transverse teeth. Tabulate area, cylindrical, varying in diameter from a little less than 2 to 4 mm, with frequently a gap in the inner wall indicating the position of the septal fosette. Tabulæ flat, horizontal, about six occurring in a space of 5 mm. Interseptal spaces, as far inward as the inner edges of the secondary septa, filled with outwardly ascending rows of small vesicles. Calyces shallow, flat at the centre where the upper end of the inner wall is visible, their sides at first rapidly ascending, then spreading horizontally at the margin.

Locality and formations.—Abundant in the Hamilton formation of Ontario, less common in the Corniferous limestone of the same province.

Crepidophyllum colligatum, Billings. (Sp.)

Plate XIII., figs. 2, 2*a*, 2*b*.

Heliophyllum colligatum,' Billings. 1859. Canadian Journal, new series, vol. IV, p. 126.
" " Nicholson. 1874. Palæon. of Ont., p. 28, pl. V., figs. 3, 3*a*.
Diphyphyllum colligatum, Rominger. 1876. Geol. Sur. Mich., Foss. Corals, p. 126, pl. XXXVIII., fig. 3.

Corallum compound, made up of straight, subparallel, cylindrical corallites that radiate from a single initial corallite and by rapid gemmation form large explanate masses that attain a breadth of over 30 cent. and a height or thickness of about 23 cent. the upper surface being slightly convex and the basal surface rather flat. Corallites periodically and ab-

ruptly expanded at corresponding levels, the expansions, generally concavely curved below and flat above, meeting in polygonal outlines and forming a succession of continuous level floors one above the other, representing a repetition of calicular extensions, between which the cylindrical unexpanded parts are separated from each other by spaces generally less in width than, although sometimes equal to or exceeding, the half diameters of the cylindrical parts. The distance apart of the horizontal floors is moderately constant in the same individual, but variable in different specimens; in one specimen as many as sixteen occur in a space of 5 cent., in another only three or four are observed in the same distance, the average number being eight or ten in 5 cent. Average breadth of cylindrical parts of corallites about 9 mm., that of the expansions about 12 mm., the difference, however, between the unexpanded and the expanded parts is often much greater in some specimens, the latter reaching a breadth at times of over 2·5 cent. with a breadth in the former of about 10 mm. The whole of the exposed surface of the corallites is covered by a strong epitheca marked by fine annular sculpture lines, about 12 in a space of 2 mm., as well as by occasional slight but distinct growth swellings or constrictions and longitudinal, narrow septal furrows. The thin edges of the expansions of adjacent corallites not entirely coalescent but separated from each other by a thin wall which is evidently the upward extension of the epitheca. Calyces circular, rather shallow with horizontally expanded margins slightly raised above the surrounding floor, flat at the bottom where the inner wall with its enclosed upper tabulum appears. Septa from about fifty to sixty in number, of two alternating sizes, the longer not passing to the centre of the visceral chamber but by the union of their inner edges forming a wall that encloses the central tubular area, 3 or 4 mm. in width, holding horizontal tabulæ of which there are nine or ten in a space of 5 mm.; the shorter septa fall short of the inner wall. The septa extend outward through the expansions but are not confluent with those of contiguous corallites; throughout they are decorated on their side faces by close-set, obliquely and inwardly ascending carinæ, from about six to ten in the space of 2 mm., that appear on their free edges in the cup as minute transverse bars or denticulations. Small dissepiments curving convexly upward and outward occupy the interseptal spaces between the inner ends of the secondary septa and the outer wall. Pore-like openings, similar to those observed in the different species of *Phillipsastræa*, are here also found in the dissepiments. Increase by lateral calicular gemmation, the buds appearing as if springing from the floor between the corallites.

Locality and formation.—Abundant in the Corniferous limestone of Ontario.

Genus DIPHYPHYLLUM, Lonsdale. 1845.

Diphyphyllum, Lonsdale. 1845. Murchison's Geology of Russia in Europe, vol. I., p. 622.
Eridophyllum, Milne-Edwards and Haime. 1850. Brit. Foss. Corals, p. lxxi.
Diplophyllum, Hall, 1852. Palæon. New York, vol. II., p. 115.

Corallum aggregate, composed of upright, subparallel, cylindrical corallites with intervals between them, usually equal to or less than their diameters and generally united by lateral, thorn-like, mural outgrowths. Increase by lateral budding. Epitheca complete. Septa lamellar, straight, their sides generally carinated, of two orders alternating, the primaries seldom reaching the centre. Dissepiments small, regular, arching convexly upward and outward against the wall in the interseptal loculi, usually in a single but sometimes in a double series. Tabulæ numerous, broad, stretching across the visceral chamber inside the dissepimental zone, generally slightly deflected at the edge. No columella. No inner wall.

Type species.—*D. concinnum*, Lonsdale.

Range.—Silurian, Devonian and Carboniferous.

This genus differs from that of *Cyathophyllum* principally in its manner of gemmation, in having lateral strengthening processes, in the greater development of the tabulæ, and in having the dissepiments in one or two series only. From *Crepidophyllum* it is distinguished primarily by the absence of an inner wall and in having proportionately larger tabulæ and a smaller dissepimental area.

The thorn-like spurs thrown out horizontally so as to reach or clasp adjacent corallites do not connect the visceral chamber of one corallite with that of another, as in the genus *Syringopora*, but serve as external supports to the corallites to strengthen the growth of the corallum.

In transverse sections of the corallites the cut edges of the regular and equal sized dissepiments, when occurring in a single series, have the appearance of a second wall placed a short distance within the wall proper. A second mural investment, however, such as is found in *Crepidophyllum*, does not in reality exist.

DIPHYPHYLLUM RUGOSUM, Milne-Edwards and Haime. (Sp.)

Eridophyllum? rugosum, Milne-Edwards and Haime. 1851. Polyp. Foss. des Terr. Palæoz., p. 425, pl. 10, figs. 4, 4a, 4b.
Diphyphyllum rugosum, Rominger. 1876. Geol. Sur. Mich., Foss. Corals, p. 121, pl. XLV., fig. 2.

Two specimens from the Niagara formation of Ontario are doubtfully referred to this species. Their corallites are larger (averaging about 8

mm. in thickness) than those figured by Milne-Edwards and Haime, with which they agree, however, in their manner of increase, viz. gemmation from the sides or from the connecting processes. According to Dr. Rominger the increase is by prolific calycinal budding, a feature not shown by the Ontario specimens, which, nevertheless, correspond in other particulars with Rominger's description and figure of specimens from the Niagara group of Indiana and Kentucky.

Localities.—One specimen from Cabot's Head, Georgian Bay, collected by A. Murray: another from the county of Grey, township of St. Vincent, lot 28, concession 9, collected by A. S. Cochrane in 1885. Niagara group.

Diphyphyllum cæspitosum, Hall. (Sp.)

Plate XIII., figs. 3, 3a, 3b.

Diplophyllum cæspitosum, Hall. 1852. Palæon. New York, vol. II., p. 116, pl. 32, figs. 1a—r.
Cyathophyllum pelagicum, Billings. 1862. Palæoz. Foss., vol. I., p. 108.
" " Billings. 1866. Cat. Sil. Foss. of Anticosti, p. 34.
Diphyphyllum cæspitosum, Nicholson. 1875. Palæon. of Ont., p. 59.
" " Lambe. 1899. Ottawa Naturalist, vol. XII., p. 240.

"Corallum aggregate, composed of upright, slender, flexuous, cylindrical corallites, increasing by lateral gemmation and forming large colonies. Corallites varying in diameter from about 5 to 8 mm., frequently touching each other, covered by an epitheca marked annularly by fine growth lines and longitudinally by faint septal striæ. Septa of two sizes alternating with each other, the primaries almost reaching the centre, the secondaries about half the length of the primaries, averaging in number, according to the size of the corallite, from about forty to fifty in all. Dissepiments arching upward, between the septa, against the outside wall, generally in a single series, their cut edges, as seen in transverse section, assuming the appearance of an inner wall situate less than 1 mm. from the wall proper. Tabulæ large, numerous, stretching across the visceral chamber so as to reach the dissepimental zone on either side, flat or slightly concave at the centre, deflected downward near the periphery, about ten occurring in a space of 5 mm.

"*Locality.*—Becscie River Bay, Anticosti, division II., Anticosti group, collected by J. Richardson in 1856; according to Billings the colonies measure from 6 to 15 inches in diameter.

"Professor Nicholson mentions this species as occurring abundantly and in large masses in the Niagara limestone of Thorold, Ont. (op. cit. p. 59)." (Lambe, 1899.)

Diphyphyllum multicaule, Hall. (Sp.)

Plate XIII., figs. 4, 4a, 4b, 4c.

Syringopora ? multicaulis, Hall. 1852. Palæon. New York, vol. II, p. 119, pl. 33, figs. 3a-g.
Eridophyllum Vennori, Billings, 1865. Canadian Naturalist, new series, vol. II., p. 431.
Diphyphyllum multicaule, Rominger. 1876. Geol. Sur. Mich., Foss. Corals, p. 121, pl. 45., figs. 3 and 4.
" " Lambe. 1899. Ottawa Naturalist, vol. XII., p. 241.

"Corallum composed of upright, subparallel, cylindrical corallites, from about 2·5 to 5 mm., in thickness, that increase by lateral budding and form colonies sometimes over 12 cent. high and exceeding 10 cent. across. Corallites slender, flexuous, separated from each other by spaces equal to or less than their own diameters, connected at irregular and frequent intervals by horizontal acanthiform outgrowths or lateral spurs that are to all appearances not solid but show traces of vesicular structure within. Septa numbering from about thirty-two to thirty-eight in average sized corallites, alternately long and short, the longer passing to the centre, the shorter reaching about half way. Curved dissepiments in the outer part of the interseptal spaces in a single or sometimes apparently in a double series. Tabulæ close-set, about twenty in a space of 5 mm., deflected downward at their margins, difficult to make out in the silicified specimens examined. Epitheca well developed, showing faint annular markings and longitudinal septal lines.

"The corallites of this species are more slender than those of the preceding, and the septa are less numerous". (Lambe, 1899.)

Localities.—Grand Manitoulin Island, Lake Huron, Alexander Murray, 1847; half a mile north-west of Portage Bay, Lake Manitou, Grand Manitoulin Island, R. Bell and H. G. Vennor, 1865 (type of *Eridophyllum Vennori*, Clinton formation); Fossil Hill, Grand Manitoulin Island, J. Townsend, 1883; one and a half mile south-east of South Bay, Grand Manitoulin Island, R. Bell, 1891. Niagara group.

Diphyphyllum Verneuilanum, Milne-Edwards and Haime. (Sp.)

Plate XIII., figs. 5, 5*a*, 5*b*.

Eridophyllum Verneuilanum, Milne-Edwards and Haime. 1851. Polyp. Foss. des. Terr. Palæoz., p. 424, pl. 8., figs. 6, 6*a*.
" " Billings. 1859. Canadian Journal, new series, vol. IV., p. 131, fig. 26.
" " Nicholson. 1874. Palæon. of Ont., p. 35, figs. 7*a*, *b*, *c*.
" " Nicholson. 1875. Geol. Surv. of Ohio, part II., p. 239.

Corallum composed of an aggregation of large, upright, flexuous, often much geniculated corallites, that increase by lateral gemmation and are

connected and held together by numerous strong, robust, lateral out growths. Corallites seldom much more than their thickness apart, varying in diameter from about 7 to 14 mm., often exhibiting strongly marked annular swellings and constrictions at irregular intervals, frequently coming in contact and growing together without the intervention of connecting processes. Outer surface consisting of an epithecal covering with, as in other species of the genus, faint transverse growth lines and regular longitudinal linear depressions indicating the position of the septa. Septa strongly carinated, numbering from about forty-five to sixty, of two alternating lengths, the primaries reaching little more than half-way to the centre, the secondaries about two-thirds the length of the primaries. Tabulæ broad, flat, directly transverse, about six to ten in a space of 5 mm. Vesicles in two or three, generally two rows in the interseptal spaces between the tabulæ and the wall. According to Billings the coralla reach a width of from 2 to 3 feet.

D. Verneuilanum has larger and more robust corallites than the other species of *Diphyphyllum* referred to here as occurring in the Silurian and Devonian rocks of Canada.

Locality and formation.—Common in the Corniferous limestone of Ontario.

Diphyphyllum strictum, Milne-Edwards and Haime. (Sp.)

Eridophyllum strictum, Milne-Edwards and Haime. 1851. Polyp. Foss. des Terr. Palæoz., p. 424, pl.. 8, fig. 7.
" " Billings. 1859. Canadian Journal, new series, vol. IV., p. 133.
" " Nicholson. 1875. Geol. Surv. of Ohio, pt. II., p. 238 and Palæon. of Ont., p. 74.

A specimen from the Corniferous formation collected by A. Murray and referred by Mr. Billings in 1859 to this species may be described as follows :—Corallites subparallel, slightly flexuous, separated from each other by spaces on an average rather less than half their diameters in width, from about 4 to 12 mm. thick, with numerous alternating sharp annular swellings and constrictions, and developing rather feeble connecting processes. Increase by lateral gemmation, the young corallites springing from the upper surface of the connecting processes and growing upward parallel to the parent corallites, frequently for some distance with little increase in size. Septa, with arched carinæ on their sides, about fifty in number in adult corallites, of almost equal length, reaching half way to the centre where they abut against the tabulæ. Dissepiments small, regular, entirely filling the interseptal spaces. Tabulæ flat or concave, often turned up at their margins, from four to ten occurring in a space of 5 mm. Epitheca showing fine transverse growth lines and longitudinal septal markings. Both in transverse and longitudinal sections

of the corallites, the sharp division between the septal area and the enclosed tabulate area is noticeable, especially in transverse sections, where the cut edges of the innermost dissepiments often assume the appearance of an inner wall, which, however, is apparently not present.

The single specimen in the collection has corallites in which the vesicular area is rather larger than is usual in *Diphyphyllum*, a development suggestive of an approach to *Cyathophyllum*, to which genus, however this coral cannot properly be referred, on account of its mode of growth and increase; it shows affinities to both the genera *Diphyphyllum* and *Crepidophyllum*, but is precluded from the latter by the apparent absence of an inner wall. Additional material would doubtless throw light on the inner structure of this coral and determine its generic and specific affinities with more certainty.

Locality and formation.—The fragment from near Woodstock, Ontario, referred to by E. Billings; Corniferous limestone.

Diphyphyllum Simcoense, Billings. (Sp.)

Plate XIII., figs. 6, 6*a*, 6*b*.

Eridophyllum Simcoense, Billings. 1859. Canadian Journal, new series, vol. IV., p. 132, fig. 27.
Diphyphyllum stramineum, Billings. 1859. Ibid, p. 135.
" " Nicholson. 1874. Palæon. of Ont., p. 33, pl. V., fig. 6.
Eridophyllum Simcoense, Nicholson. 1874. Ibid, p. 34, pl. VI., fig. 5.
Diphyphyllum Simcoense, Rominger. 1876. Geol. Sur. Mich., Foss. Corals, p. 122, pl. XLVI., figs. 3 and 4.
Amplexus or *Diphyphyllum*, Whiteaves. 1892. Contr. to Can. Palæon., vol. I., pt. IV., p. 270, pl. XXXV., figs. 2, 2*a*.
Diphyphyllum Simcoense, Lambe. 1899. Ottawa Naturalist, vol. XII., p. 242.

"Corallum bushy, composed of flexuous, cylindrical corallites radiating upward from a small basal beginning and rapidly increasing by lateral budding so as to form colonies at times 25 cent. high and equally broad. Corallites varying in diameter from 3 to 6 or 7 mm. frequently roughened by annular swellings of growth and constrictions, covered by an epitheca showing minor growth markings and longitudinal septal furrows. There is a marked variation in different colonies in the number of horizontal spurs connecting the corallites: in some specimens they are numerous, from about 2 to 4 mm. apart vertically, springing outward from all sides of the corallites, in others they occur at less frequent intervals, whilst in some they appear to be almost absent. Septa short, bearing arched carinæ on their sides, divisable into two sizes, primaries and secondaries, numbering in all from about thirty to forty, the primaries seldom reaching half-way to the centre of the visceral chamber, the secondaries very short,

projecting but little inside of the single row of curved dissepiments in the interseptal spaces. In transverse sections of the corallites the dissepiments have the appearance of an inner wall about ·5 mm. distant from the wall proper, as in the Silurian species *D. cæspitosum*, Hall. Tabulæ well developed, flat, horizontal, bent slightly down at their edges; from ten to fifteen in a space of 5 mm.

"This species is somewhat similar, in its internal structure, to *D. cæspitosum*, Hall, from which it differs principally in having shorter and less numerous septa.

"The coral from the Devonian (American Stringocephalus zone) of Dawson Bay and vicinity, Lake Winnipegosis, described by Dr. Whiteaves (op. cit. pp. 270 and 271), and referred to by him as bearing 'a remarkably close resemblance in size, shape and internal structure' to 'the *Diphyphyllum straminium* of Billings,' is here referred to *D. Simcoense*, with which the writer considers *D. stramineum* to be conspecific, a view already expressed by Dr. Rominger in his excellent work on fossil corals." (Lambe, 1899.)

Locality and formation.—Abundant in the Corniferous limestone of Ontario.

Diphyphyllum arundinaceum, Billings.

Plate XIV., figs. 1, 1*a*, 1*b*.

Diphyphyllum arundinaceum, Billings. 1859. Canadian Journal, new series, vol. IV., p. 134.
" " Nicholson. 1874. Palæon. of Ont., p. 32, pl. VI., fig. 1.
Diphyphyllum—(?) compare *D. arundinaceum* and *D. stramineum*, Billings. Whiteaves. 1877. Rep. of Progress for 1875-76, Geol. Survey of Canada, p. 102.

Found in large colonies of long, flexuous, cylindrical corallites, that vary in diameter from 6 to 10 mm. and are separated from each other by spaces equal to or less than their diameters. Of the mode of increase and of the size attained by the coralla, Mr. Billings, in his original description of the species, says:—"The young corallites sometimes spring from the side of the parent, with a slender base, and curving upwards immediately, become parallel with those of the whole group. In large colonies frequent instances may be seen where, instead of this lateral budding, a bifurcation takes place, both branches being of the same size. In large groups, owing to the numerous additions of young, the corallites diverge slightly, as if radiating from a point. The colonies are from six inches to several feet in diameter, and large blocks of stone are of frequent occurrence, which are penetrated at right angles to the stratification by the closely crowded stems." Corallites free from sudden constrictions, provided with a well-

developed epitheca, with slight annular growth lines and strongly marked septal furrows. Lateral connecting spurs short, distant, developed only when the corallites by their flexions are brought almost into contact with each other. Septa well developed, numbering from about forty to sixty, carinated on their sides, alternately long and short, the longer not quite reaching the centre of the visceral chamber, the shorter about half the length of the primaries. Vesicles small, formed by regular curved dissepiments in two rows, occupying the interseptal spaces near the wall. Tabulæ broad, flat or concave at the centre, deflected downward near the margin, from about five to eight in a space of 5 mm.

Localities and formation.—Corniferous limestone of Ontario; also a loose specimen from Peace River, B.C., between Fossil Point and the Cañon of the Mountain of Rocks, collected by Professor John Macoun in 1875 (Devonian).

Genus ACERVULARIA, Schweigger. 1820.

Acervularia, Schweigger. 1820. Handb. der Naturg., p. 418.

"Corallum, composite, fasciculate or more often massive; increasing by calicular gemmation. Corallites with two distinct walls as in *Aulophyllum*. Septa well developed between the two walls but much less so in the central area. No columella. Tabulæ little developed." (Milne-Edwards and Haime: Polypiers Fossiles).

Type species. A. Rœmeri, Milne-Edwards and Haime.

Range.—Silurian and Devonian.

This genus differs from *Phillipsastræa* and *Pachyphyllum* principally in having the limits of individual corallites defined by distinct walls, whilst the inner mural investment distinguishes it from the composite forms of *Cyathophyllum*.

ACERVULARIA GRACILIS, Billings. (Sp.)

Plate XIV., figs. 2, 2a.

Strombodes gracilis, Billings. 1865. Palæoz. Foss. vol. I., p. 113, fig. 94.
Acervularia gracilis, Lambe. 1899. Ottawa Naturalist, vol. XII., p. 211.

"Original description.—'Corallum in large masses, consisting of cells from 2 to 3 lines in diameter, most of them pentagonal. Cup about 1 line in depth, with an irregularly rounded central style $\frac{1}{2}$ line in height, and one-third or one-half the whole width of the corallite. There appear to be 30 or 40 septal striæ on the inner side of the cup.'

"The figure on p. 113 of the above quoted work represents about one-fourth of the surface of the only specimen of this species in the collection. The specimen is silicified and not preserved as well as might be desired, but by a careful examination of natural longitudinal and transverse sections, the structure can be made out with sufficient clearness to give the following data :—Corallum astræiform, made up of polygonal corallites, from 3 to 7 mm. in diameter, with deep calyces that join each other in sharp-edged outlines and that have steep sloping sides and a rounded boss, roughly 2 mm. in breadth at the bottom. Each corallite is contained within its own walls from which spring lamellar vertical septa, whose free edges are moderately conspicuous in the calyces. Septa, numbering from about thirty to forty, alternately long and short, the former continued to the centre, where they are twisted, the latter about one-half, or slightly more than one-half, the length of the former. Dissepiments convex, arching evenly upward and outward, and filling the interseptal loculi in a circumferential area whose breadth is equal to the length of the secondary septa, or about one-fourth the diameter of the corallite. Within the outer area is a zone of dissepiments or vesicles that rise upward toward the centre and, in combination with the proximal ends of the primary septa, form a subvesicular mass that appears at the bottom of the calyx as a rounded projection.

" The presence of continuous vertical septa, such as the above, in corallites that are enclosed by definite walls, makes clear the necessity of removing the species represented by this specimen from the genus *Arachnophyllum* (*Strombodes*) ; although some details of structure are obscured by crystallization, yet sufficient characters are preserved to suggest affinities to *Acervularia* to which genus this species is for the present assigned." (Lambe, 1899.)

Locality.—Manitouaning, Grand Manitoulin Island, Lake Huron, collected by A. Murray, 1847. Niagara group.

Acervularia Davidsoni, Milne-Edwards and Haime.

Plate XIV., fig. 3.

Acervularia Davidsoni, Milne-Edwards and Haime. 1851. Polyp. Foss. des Terr. Palæoz., p. 418, pl. IX., figs. 4, 4*a*, 4*b*.

Acervularia Davidsoni?, Hall. 1858. Rep. Geol. Surv. of Iowa, vol. I., pt. II., p. 476, pl. I., figs 8*a*. 8*b*.

Acervularia Davidsoni, Nicholson. 1875. Geol. Surv. of Ohio, vol. II., pt. II., p. 240.

Original description.—"Polypier astréiforme, à surface subplane, sommets des polypiérites en polygones un peu inégaux et un peu irréguliers, dont les côtes sont un peu en zigzag. Murailles intérieures peu distinctes au

dehors, et indiquées par un bourrelet circulaire peu prononcé qui circonscrit un calice un peu profond et dont le diamètre fait à peu près la moitié de la grande diagonale des polygones. Une quarantaine de rayons cloisonnaires, minces, droits, qui commencent à la muraille épithécale, et dont la moitié seulement traverse la muraille intérieure et atteint jusque près du centre en présentant un petit lobe paliforme. Dans une coupe horizontale ou dans un état de fossilisation que nous avons représenté dans la fig. 4*b*, la muraille intérieure est bien prononcée. Les traverses sont serrées dans l'aire comprise entre les deux murailles. Grande diagonale des polygones, 10 à 12 millimètres ; diamètre des calices, 4 ou 5.

"Devonien. *France* : Ferques. *Etats-Unis :* Jeffersonville, Ohio Falls." (Milne-Edwards and Haime.)

A specimen of an astræiform coral, bearing the name of this species, in the collection of the Geological Survey, was collected by A. Murray in 1866, in the Corniferous formation near Woodstock, Onario.

In the form and structure of the corallites this specimen agrees with the above description : the septa number from forty-four to forty-eight, are thin throughout their length, carinated on their sides and alternately long and short, the longer reaching the centre, with their ends twisted together, the shorter a little more than half the length of the long ones. A pseudo inner-wall, seen in horizontal sections, and a well marked feature in the calyces, is formed by the sudden stoppage of the interseptal dissepiments near the proximal ends of the shorter septa. The small circular openings in the dissepiments between the septa noticed in specimens of *Phillipsastræa Billingsi*, Calvin, and *P. Verneuili*, Milne-Edwards and Haime, are also seen in this specimen ; they tend to strengthen the belief in the close relationship of the genera *Phillipsastræa* and *Acervularia*.

Genus PHILLIPSASTRÆA, d'Orbigny. 1849.

Phillipsastræa, d'Orbigny. 1849. Note sur des Polypiers fossiles, p. 2.

Corallum composite, with an epitheca covering the basal surface. Increase by marginal calycinal gemmation. Corallites confluent, not bounded by a definite wall. Calyces horizontally expanded at the margin, with a central pit surrounded by an exsert rim. Tabulæ often forming a narrow axial area. Septa confluent with those of neighbouring corallites, sometimes carinated, of two sizes, the primaries reaching the centre of the visceral chamber. Dissepiments filling the interseptal spaces. A pseudo-inner wall is suggested by the sudden stoppage of the secondary septa,

and sometimes by a thickening of the innermost dissepiments and the septa in a cycle surrounding the tabulæ.

Type species.—*P. Hennahi*, d'Orbigny.

Range.—Devonian and Carboniferous.

PHILLIPSASTRÆA VERNEUILI, Milne-Edwards and Haime.

Plate XIV., fig. 4.

Phillipsastrea Verneuili, Milne-Edwards and Haime. 1851. Polyp. Foss. des Terr. Palæoz., p. 447, pl. 10, fig. 5.
" " Billings. 1859. Canadian Journal, new series, vol. IV., p. 127, fig. 24.
Phillipsastrea affinis, Billings. 1874. Plæoz. Foss., vol. II., pt. I., p. 11.
Phillipsastræa Verneuili, Nicholson. 1875. Palæon. of Ont., p. 78.
" " Rominger. 1876. Geol. Sur. Mich., Foss. Corals, p. 127, pl. XXXVII., fig. 2.
" " Whiteaves. 1879. Rep. of Progress for 1877-78, Geol. Survey of Canada, p. 5c.
" " Lambe. 1899. Ottawa Naturalist, vol. XII., p. 250.

"Corallum forming large discoidal masses over 30 cent. broad and 8 cent. thick or high, upper surface flat, lower surface irregular, strongly marked by concentric foldings or wrinkles of growth and covered by an epitheca. Septa numbering from about thirty to forty-six. Corallites varying in diameter from 10 to 16 mm. Central pit of the calices from 3 to 5 mm. in diameter. In no particular does this species differ from *P. Billingsi*, except in the smaller size of its corallites and in a diminution in the number of the septa. In transverse sections and in weathered specimens it is observed that a single row of pore-openings occurs between each pair of septa, the pores piercing the dissepiments where they rest on each other, the distance apart of the pores in a single row thus depending on the size of the dissepiments. This pore structure, which appears not to have been noticed previously in species of this genus, and which is well shown in some specimens of *P. Billingsi*, in the collection, is apparently somewhat analagous to that which is seen in some species of the genus *Arachnophyllum*.

"*Localities.*—Corniferous formation of Ontario; Indian Cove, Gaspé, in the Gaspé limestone, No. 8* (Oriskany formation), collected by R. Bell in 1862; also three loose specimens from the Devonian area south of Hudson Bay, collected by R. Bell in 1877, at Long Portage, Missinaibi River to Moose Factory. Of the Long Portage specimens one has corallites of average size, but the other two have corallites and calicinal pits that are considerably larger than those of specimens usually assigned to

* See reference on p. 124 to the age of the Gaspé limestone, No. 8.

this species and approach in size those of the smaller forms of *P. Billingsi*. Measurements taken from the two last mentioned specimens give the following results:—Diameter of calyces from 17 to 20 mm., diameter of central pits 6 to 7 mm. In all three specimens the septa number from about forty to forty-four, and the pore-openings can be detected in natural transverse sections.

"Dr. Whiteaves records* the occurrence of this species in the Hamilton formation on the authority of Mr. Schuchert, who collected a good specimen of it at Bartlett's Mills in 1895." (Lambe, 1899.)

Phillipsastræa Verrilli, Meek. (Sp.)

Plate XIV., figs. 5, 5*a*, 5*b* and 6.

Smithia Verrilli, Meek. 1868. Trans. Chicago Acad. of Sciences, vol. I., p. 83, pl. XI., figs. 7, 7*a*, 7*b*.
Phillipsastræa Hennahi, Whiteaves. 1891. Contr. to Can. Palæon., vol. I., pt. III., p. 204.

Corallum compound, forming irregular, depressed subhemispherical masses, commonly convex above and obtusely pointed below, but somewhat varied in shape and subspherical when young; composed of confluent corallites, from 5 to 10 mm. in diameter, that terminate above in calyces that have a central pit surrounded by a raised circular rim, averaging about 3 mm. in width and 1 or 2 mm. high, outside of which is a flat sunken margin striated by radiating septal ridges of equal size. Increase by marginal calicinal gemmation. Covered below by a concentrically wrinkled epitheca. Surface of attachment small. Septa generally confluent with those of neighbouring corallites, carinated on their sides, thickened near the centre of the corallite so as to form a pseudowall that appears at the surface as the raised rim surrounding the central pit, numbering from twenty to nearly forty, of two alternating sizes, the secondaries scarcely projecting past the inner wall beyond which the primaries are attenuated and continued to the centre, where they are generally twisted. Tabulæ usually well developed, flat, filling the area inside the inner wall and cut into by the primary septa, twelve or fourteen occurring in a space of 5 mm. Dissepiments rather small, convex, occupying the interseptal spaces in the marginal area and arching slightly upward toward the tabulæ. The raised mural rings of the surface show in well preserved specimens a considerable variation in their amount of protrusion, but in worn specimens the general appearance of the surface resembles that of the type specimen as figured (op. cit.) The septal ridges, although of equal size in the marginal area, become slightly

* Geol. Surv. Canada, Contr. Canad. Palæont., vol. I., pt. V., p. 365.

differentiated in passing over the mural rings and conspicuously so in descending into the pit, at the bottom of which the primaries only pass to the centre. Circular pore-openings in the dissepiments at their junction with each other, such as are found in other species of the genus, have been recognized in specimens of this species also.

Localities and formations.—Corniferous limestone of Ontario. Also at the following localities in Athabasca and Mackenzie districts from the Devonian (Cuboides zone)—Peace River, near Vermilion Falls, Professor J. Macoun, 1875; Peace River, seven miles below the mouth of Red River, Mr. W. Ogilvie, 1875; Hay River, forty miles above its mouth, R. G. McConnell, 1887; Peace River, Vermilion Falls, R. G. McConnell, 1889. The largest specimen, one from the Vermilion Falls, measures 17 cent. across and is between 8 and 9 cent. high at the centre. Meek's type specimen is from the Anderson River, Mackenzie District, lat. 67° N., long. 126° W. (Devonian). Also one specimen from the Devonian of Moose River, Ont., R. Bell, 1895.

This species seems to pass by insensible gradations into more robust forms that are with difficulty distinguishable from *P. Verneuili*, Milne-Edwards and Haime, described originally from the Devonian of Wisconsin. It also shows a close affinity to *P. Woodmani*, White, from the Devonian of Iowa, which is distinguished from it, however, principally by having much more exsert circular rims surrounding the pits, by an elevation of the tabulæ, near the centre, over which the primary septa do not pass, and by an absence of carinæ on the septa.

Phillipsastræa Verrilli, var. exiguum. (Var. nov.)

Plate XIV., fig. 7.

Phillipsastræa Verrillii, Whiteaves. 1891. Contr. to Can. Palæon., vol. I., pt. III., p. 205.

What is considered a variety of the preceding species is represented by a few specimens from the Devonian (Cuboides zone) of Hay River and Vermilion Falls. The coralla reach a fair size and have corallites from about 5 to 7 mm. in breadth, but the central pits average only about 1·5 mm. in diameter, and the septa vary in number from sixteen to twenty. The largest specimen, which is slightly convex above and obtusely pointed below, measures over 11 cent. in breadth and is 5 cent. high.

Localities.—Hay River, forty miles above its mouth, Mackenzie District, R. G. McConnell, 1887, and Vermilion Falls, Peace River, Athabasca District, R. G. McConnell, 1889.

PHILLIPSASTRÆA BILLINGSI, Calvin.

Phillipsastræa gigas, Billings. 1859. Canadian Journal, new series, vol. IV., p. 128; incorrectly identified with *Arachnophyllum (Astrea ?)* gigas, Owen.

" " Nicholson. 1875. Palæon. of Ont., p. 77.

Phillipsastrea gigas (?), Rominger. 1876. Geol. Sur. Mich., Foss. Corals, p. 128, pl. XXXVII., fig. 4.

Phillipsastrea billingsi, Calvin. 1893. American Geologist, vol. XII., p. 111, pl. VI., figs. 1 and 2.

Phillipsastræa Billingsi, Lambe. 1899. Ottawa Naturalist, vol. XII., p. 249.

"Corallum composite, large, discoidal, more or less convex above, rather flat below, formed of slightly divergent, confluent, polygonal corallites, from about 2 to over 4 cent. in diameter, that increase by marginal calicinal gemmation from a central basal beginning ; attaining a breadth of over 40 cent. and a height of nearly 12 cent. Basal surface covered by a concentrically wrinkled epitheca. Corallites not bounded by a wall, their septa meeting and becoming confluent with those of neighbouring corallites ; opening on the upper surface in calyces having a broadly convex, exsert, reflexed circular rim surrounding a deep, steep-sided pit measuring from about 8 to 10 mm. in diameter, and 4 or 5 mm. deep. Septa well developed, numbering from about forty to sixty, of two alternating sizes, the larger reaching the centre and becoming somewhat twisted, or falling short of it, the smaller not extending beyond the sides of the central pit ; they are decorated on their sides by arched carinæ curving upward and inward and appearing on their free edges in the central pit and reflexed calicinal margins as small transverse denticulations. Tabulæ, forming a narrow axial area, at times well developed, flat at the centre, turned down at the edge, the primary septa passing over them to the centre as carinæ, at other times, interfered with by the septal ends which cut into them and destroy their horizontal continuity, giving them more the character of dissepiments than of tabulæ. Dissepiments filling the interseptal spaces and curving upward and outward in regular order, those in the peripheral region being generally larger than those nearer the centre; they are pierced at their junction with each other by oval or circular pore-openings forming a uniserial row midway between the septa." (Lambe, 1899.)

Locality and formation.—Corniferous limestone of Ontario.

Genus PACHYPHYLLUM, Milne-Edwards and Haime. 1850.

Pachyphyllum, Milne-Edwards and Haime. 1850. Brit. Foss. Corals, p. lxviii.

"Corallum astræiform ; septa numerous, well developed, reaching the centre and passing over the wall. Calyces marked by strongly developed exothecal tissue. Devonian" (Zittel : Traité de Paléontologie).

Type species.—*P. Bouchardi*, Milne-Edwards and Haime.

Range.—Devonian.

The chief point of difference between this genus and *Phillipsastræa* is that in the latter the distal ends of the septa of individual corallites connect with those of adjacent corallites, whilst in the former the union of the corallites is effected wholly or for the most part by peripheral vesicular tissue without the aid of the septa.

Pachyphyllum is regarded by some well known authorities as a good genus but it is also ranked as a subgenus of *Phillipsastræa*, and again the separation of the two genera has been looked upon with entire disfavour as being artificial and inappropriate.

Pachyphyllum Devoniense, Milne-Edwards and Haime.

Plate XIV, figs. 8, 8*a*.

Pachyphyllum Devoniense, Milne-Edwards and Haime. 1851. Polyp. Foss. des Terr. Palæoz., p. 397.
" " Milne-Edwards and Haime. 1853. Brit. Foss. Corals, p. 234. pl. LII., figs. 5, 5a.
Phillipsastrea (*Pachyphyllum*) *Devoniensis*, Frech. 1885. Korallen-fauna des Oberdevons in Deutschland, p. 67, taf. VI., figs. 2, 2a.
Pachyphyllum Devoniense, Whiteaves. 1891. Contr. to Can. Palæon., vol. I., pt. III., p. 205.

The single specimen referred to this species was collected by Professor Macoun in 1875, on the Peace River, between the mouth of Red River and Vermilion Falls.

The specimen in question is slightly worn and the finer surface markings consequently lost, but transverse and longitudinal sections have been made that show the structural details of the interior excellently; it may be described as follows:—Corallum compound, irregular in shape, somewhat subhemispherical, roughly convex above and flat below, 10 cent. in greatest breadth and about 6 cent. high, made up of confluent corallites that diverge from a central basal point of attachment. Corallites from about 8 to 12 mm. broad, with no demarcation of their outer boundaries, their centres at the surface projecting 4 or 5 mm. above the surrounding margins and forming strongly exsert rings enclosing sunken pits averaging 7 mm. in diameter. In transverse and longitudinal sections the corallites are seen to be made up of an axial area of irregular tabulæ surrounded by a cycle of septa that is in turn enclosed within a peripheral zone of vesicular tissue confluent with the like tissue of adjacent corallites. Septa thick, with smooth sides, numbering from about thirty-six to forty-two, of two orders, primaries and secondaries, the for-

mer converging to the centre where they generally meet and are frequently twisted, the secondaries about one-quarter the length of the primaries; both sizes of septa start inward at an equal distance from the centre, the primaries becoming suddenly thin and continuing so for the inner half of their length. Outer zones of neighbouring corallites by their union forming a continuous vesicular tissue surrounding and separating the septal cycles. The convex plates forming the vesicles incline slightly upward toward the septa, continue for some distance inward and downward as dissepiments in the interseptal loculi and becoming larger and flatter at the centre of the visceral chamber form an axial area of irregular tabulæ.

Locality.—Peace River, Athabasca District, Prof. J. Macoun, 1875; Devonian (Cuboides zone).

Genus Blothrophyllum, Billings.

Blothrophyllum, Billings. 1859. Canadian Journal, new series, vol. IV., p. 129.

Generic characters—"Corallum, simple, turbinate or cylindrical. Internal structure, consisting of a central area occupied by flat, transverse diaphragms, an intermediate area with strong radiating septa, and an outer area in which there is a set of imperfect diaphragms projecting upwards, and bearing on their upper surfaces rudimentary radiating septa. A thin complete epitheca and a septal fossette. Generic name from Greek $\beta\lambda\omega\theta\rho\acute{o}\varsigma$." (Billings).

Type species.—*B. decorticatum*, Billings.

Range.—Devonian.

Blothrophyllum decorticatum, Billings.

Plate XV., figs. 1, 1*a*.

Blothrophyllum decorticatum, Billings. 1859. Canadian Journal, new series, vol. IV., p. 130, fig. 25.
" " Nicholson. 1874. Palæon. of Ont., p. 119, pl. IV., fig. 3.
" " Rominger. 1876. Geol. Sur. Mich., Foss. Corals, p. 112, pl. XLI.

Corallum simple, conico-cylindrical, long and flexuous, pointed and conical at the base, cylindrical above, strongly annulated at short and rather regular intervals by growth markings representing the rims of former calyces, reaching a thickness of over 7 cent., one specimen having a diameter of between 4 and 5 cent. and a length of over 40 cent. although imperfect at both ends. Calyx of moderate depth, with broad

margins, from the circumference of which the thin-edged septa converge leaving a broad, flat, smooth surface, the central part of the uppermost tabulum, exposed at the bottom, although occasionally the septa are continued as carinations to the centre. A deep septal fossette occurs in the side of the bottom of the cup. Internal structure consisting of a combined tabulate and septate area. in breath equal to about one-half the diameter of the corallum, with a peripheral vesicular zone surrounding it. Septa, numbering from about one hundred to over one hundred and seventy in individuals of different degrees of slenderness, of two orders, alternately long and short, continuous vertically within the psendowall formed by the innermost plates of the vesicular area, the primaries cutting through the down-turned edges of the tabulæ for some distance, but leaving the broad, flat or concave central portion untouched; in the vesicular area their vertical continuity is broken and they pass outward as sharp carinations on the calicular margins, their differentiation in size being still well marked. Tabulæ broad, flat, undulating or slightly concave at the centre, bending downward when they meet the septa and passing between them to the inner limit of the vesicular zone. The blister-like plates of the outer area, large, directed upward and outward, supporting the periodic calicular margins formed in the growth of the corallum. Epitheca thin, complete, with longitudinal striations corresponding to the number and position of the septa, and with fine transverse growth lines; in most specimens its decortication, to a greater or less extent, exposes the large vesicles within, or as is frequently the case, the removal of the outer area by weathering lays bare the surface of the more compact core-like septo-tabulate inner zone. As in *Acrophyllum Oneidaense*, small spinous processes occur on the surface near the basal extremity.

Localities and formation.—Corniferous limestone of Ontario; loose specimens have also been collected by Mr. George Barnston on the Albany River near Old Fort Henley and on the Moose River (Devonian).

Genus LONSDALEIA, McCoy, 1849.

Lonsdaleia, McCoy. 1849. Ann. and Mag. Nat. Hist., second series, vol. III., p. 10.

"Corallum fasciculate or astræiform. Besides the external wall, there is a second, accessory, internal one. Columella thick, formed of rolled lamellæ. Peripheral part of the corallites, included between the two walls, filled with vesicular endotheca; septa well developed, reaching to the vicinity of the columella but not extending to the outer wall. Carboniferous." (Zittel: Traité de Paléontologie.)

Type species.—*L. duplicatus*, Martin, sp.

Range.—Carboniferous.

Lonsdaleia Pictöense, Billings. (Sp.)

Plate XIV., figs. 9, 9*a*.

Lithostrotion Pictoense, Billings. 1868. Dawson's Acadian Geology, second edition, p. 285, fig. 83.
Lonsdaleia Pictoense, Lambe. 1899. Ottawa Naturalist, vol. XII., p. 248.

"Corallum compound, fasciculate, composed of long, upright, flexuous, cylindrical corallites that increase freely by lateral calicinal gemmation and are separated from each other by spaces of variable width, though frequently in contact. Corallites attaining a breadth of about 10 mm., the young ones beginning with a diameter of between 2 and 3 mm. Epitheca complete. Internal structure consisting of a circumferential vesicular zone, in breadth equal to about one-fifth the diameter of the corallite, defined within by a stout inner wall that encloses a tabulate area, at the centre of which is a comparatively large columella about 1 mm. in thickness. From the inner wall converge short, strong, well defined septa that are occasionally extended outward into the vesicular zone and more rarely reach the outer wall. The septa, about twenty in number, extend only about half-way across the space between the inner wall and the columella; alternating with them are observed occasionally rudimentary septa which are also indicated in the outer wall in those exceptional instances when the primary septa traverse the peripheral vesicular area. Tabulæ moderately regular, about twelve in a space of 5 mm., inclined slightly upward at their junction with the inner wall and rising suddenly and inosculating with each other near the centre so as to form the columella. Vesicles of the outer area long and narrow, formed by curved plates rather unequal in size, that are directed obliquely upward and outward, and fill the space between the two walls.

"Represented in the collection by a small fragment, roughly 4 cent. broad and over 2 cent. high, embedded in compact limestone that hides the exact characters of the surface of the corallites.

"*Locality*—East River, Pictou, Nova Scotia, collected by Sir J. William Dawson; Lower Carboniferous." (Lambe, 1899.)

Genus Clisiophyllum, Dana. 1846.

Clisiophyllum, Dana. 1846. Am. Jour., Sci., and Arts, 2nd series, vol. I., p. 187.

"Corallum simple, turbinate or subcylindrical. Septa numerous, well developed. In the centre of the calyx is a conical or tent-shaped projection over which pass the prolongations of the first order of septa in straight or spiral lines. Within are three concentric zones: the central

zone formed of a system of vertical or twisted lamellæ and of vesicular tabulæ; the median zone formed of large vesicles made up of horizontal plates; the peripheral zone filled with a very fine vesicular tissue. Silurian to Carboniferous." (Zittel: Traité de Paléontologie.)

Clisiophyllum Billingsi, Dawson. (Sp.)

Plate XIV., figs. 10, 10*a*.

Cyathophyllum Billingsi, Dawson. 1868. Acadian Geology, second addition, p. 287, fig. 84*b*.
Clisiophyllum Billingsi, Lambe. 1899. Ottawa Naturalist, vol. XII., p. 247.

"Corallum simple, turbinate, evenly curved, annulated by distinct ridges of growth, terminating above in a shallow calyx; nearly 5 cent. long as measured on the convex curve, 18 mm. broad near the top. Epitheca complete, thin, with very fine, close-set, transverse growth lines and longitudinal septa striæ. Internally a narrow peripheral, vesicular area, in breadth equal to about one-fifth the maximum diameter of the corallum and made up of small convex plates arching upward and outward, surrounds a broad inner zone of vesicles that are directed upward and inward and fill the interseptal spaces, the centre being occupied by a columella that appears at the bottom of the calyx as a thin, laterally compressed projection. Septa about seventy-two in number, of two sizes alternating with each other, the primaries well developed, a few of them passing to the centre, the remainder almost reaching the centre, the secondaries very short. In the calyx the secondaries appear only at the periphery but the primaries are conspicuous as sharp-edged lamellæ converging toward the centre. On the surface where the epitheca has been removed by weathering the outer edges of the two orders of septa are exposed as longitudinal ribs of equal strength with the horizontal edges of the vesicular plates filling the spaces between them.

"*Locality.*—Lower Stewiacke, county of Colchester, Nova Scotia, collected by Mr. C. F. Hartt; Lower Carboniferous. One specimen, the property of the Peter Redpath Museum, McGill University, Montreal." (Lambe, 1899.

Genus Acrophyllum, Thomson and Nicholson.

Acrophyllum, Thomson and Nicholson. 1876. Ann. and Mag. Nat. Hist., fourth series, vol. XVII., p. 455.

Generic characters.—"Corallum simple, turbinate, or cylindro-conical. Epitheca thin, with numerous encircling striæ and annulations of growth. Central area occupied by strong tabulæ, which are not vesicular, and are

very strongly elevated centrally, and at the same time more or less twisted with a spiral bending, so as to give rise to a central funnel-shaped and obliquely contorted eminence. This eminence is formed solely by the elevation of the successive tabulæ ; and no vertical plates take part in its formation as is the case in *Clisiophyllum* The septa are well developed, lamellar, usually prolonged over the upper surfaces of the tabulæ in the form of striæ which extend nearly to the centre. External area traversed by the septa, which are united by comparatively remote angular dissepiments. No columella. A well-marked septal fossette." (Thomson and Nicholson.)

Type species.—*A. (Clisiophyllum) Oneidäense*, Billings.

Range.—Devonian.

Acrophyllum Oneidäense, Billings. (Sp.)

Plate XVI., figs 1 and 2.

Clisiophyllum Oneidaense, Billings. 1859. Canadian Journal, new series, vol. IV., p. 128.
" " Nicholson. 1874. Palæon. of Ont., p. 20, pl. IV, figs. 4 and 5.
Acrophyllum Oneidaense, Thomson and Nicholson. 1876. Ann. and Mag, Nat. Hist. fourth series, vol. XVII., p. 455.
Clisiophyllum Oneidaense, Rominger. 1876. Geol. Sur. Mich., Foss. Corals, p. 109, pl. XL, upper row.

Corallum simple, conico-cylindrical, pointed below and generally curved for a short distance above the base, at first turbinate then becoming cylindrical and often somewhat flexuous or bent, attaining a length of over 36 cent. and a thickness of about 6 cent. ; one specimen measures 6 cent. in diameter not more than 8 cent. above the base. Annulated by numerous strong and decided wrinkles of growth and provided with an epitheca marked by minor transverse lines of growth and longitudinal septal furrows corresponding to the primary and secondary septa beneath. The surface for a distance of 5 or 6 cent. from the base is often decorated by numerous transverse rows of spinous outgrowths up to 2 or 3 mm. in length. Calyx deep, with a sharp rim and steep sides, in which the free edges of the septa appear as thin lamellæ surrounding a prominent, conical, twisted boss that rises abruptly from the bottom ; from about one-third to nearly one-half the diameter of the coral in depth. A narrow fossette is present in the bottom of the cup. Septa numbering from about one hundred in slender specimens, to over one hundred and ninety in large individuals, of two orders, primaries and secondaries, alternating, the latter so small as to be almost obsolete, the former strong, cutting the edges of the tabulæ, a variable number passing over the tabulæ as carinæ, some reaching, others falling short of the apex of the central boss and all partaking of the twist of that prominence. Tabulæ well developed, form-

ing an inner zone, in breadth about five-sevenths of the entire diameter, turned down at the edges and raised centrally, in the form of a large cone that appears as the striking projection in the bottom of the cup. This conical boss is from 1 to over 1·5 cent. in height, and is twisted in a direction contrary to that of the hands of a watch when viewed from above; the carinal septa that reach the apex stand out as sharp ridges, giving the cone a rugose appearance. Surrounding the broad tabulate zone is a narrow vesicular area made up of rather large, convex dissepiments filling the intersepted spaces and curving upward and outward.

Mr. James Thomson and Professor Nicholson included in the genus *Acrophyllum*, the two species *A. Oneidaense*, Billings, and *A. pluriradiale*, Nicholson, although the latter species is stated in the original description (Palæont. of Ontario, 1874, p. 21) to differ from the former, principally in the absence of an external vesicular area, a structural difference that would scarcely allow of their being classed in the same genus. The collection of corals from the Corniferous formation of Ontario in the possession of the Geological Survey at the present time comprises no specimens that agree with the description of *A. pluriradiale*, Nicholson.

Localities and formation.—Abundant in the Corniferous limestone of Ontario. It has been collected also (loose) in the Devonian area south of James Bay by George Barnston on the Moose River, and on the Albany River near Old Fort Henley; by R. Bell at the Grand Rapids of the Mattagami River, and on the Moose River, in 1895; at Long Portage, Missinaibi River to Moose Factory, by R. Bell, in 1877.

Genus Lithostrotion, Fleming. 1828.

Lithostrotion, Fleming. 1828. British Animals, p. 508.

"Corallum fasciculate or astræiform, composed of cylindrical, slender corallites, with an epitheca. Columella styliform, compressed laterally; septa well developed, sometimes reaching the columella. Central part of the corallite crossed by irregular tabulæ, peripheral part occupied by a vesicular endotheca. Carboniferous." (Zittel: Traité de Paléontologie.)

Type species.—*L. basaltiforme*, Fleming.

Lithostrotion Macouni, Lambe.

Plate XIV., figs. 11, 11*a*, 11*b*.

Favosites—(?), Whiteaves. 1877. Rep. of Progress for 1875-76. Geol. Survey of Canada, p. 98.

Lithostrotion Macounii, Lambe. 1899. Ottawa Naturalist, vol. XII., p. 220.

"Corallum astræiform, composed of long, upright, slightly flexuous, closely packed, distinct, prismatic corallites that have five, six or seven

sides and average about 3 mm. in breadth, forming masses evidently of considerable size; represented by two fragments, the largest of which is 8 cent. high and 6 cent. broad. The corallites are somewhat irregularly marked by decided transverse, often slightly oblique, growth ridges, and are covered by an epitheca regularly striated longitudinally by septal furrows. Calyces not observed. Septa from eighteen to twenty-two in number, alternately long and short, the former passing to the centre and producing a slender columella, the latter extending only a short distance inward from the wall. Frequently a primary septum instead of passing to the centre joins the one next to it at a short distance from that point. A narrow peripheral area formed of small upwardly and outwardly arching plates in one or two cycles surrounds a broad tabulate inner zone. Tabulæ flat or slightly raised at the centre, where they are crossed by the columella, about fifteen occurring in a space of 5 mm.

"This species resembles *Lithostrotion* (*Stylaxis*) *irregularis*, McCoy,* from the Carboniferous limestone of Derbyshire, but the corallites are smaller, the septa are less numerous and there are fewer rows of vesicles." (Lambe, 1899.)

Locality.—Fossil Point, Peace River, British Columbia, two fragments probably belonging to one specimen, collected by Professor J. Macoun in 1875; Lower Carboniferous.

CHONOPHYLLIDÆ.

Genus OMPHYMA, Rafinesque and Clifford. 1820.

Omphyma, Rafinesque and Clifford. 1820. Ann. des Sci. Phys. de Bruxelles. vol. 5. p. 234.

? Ptychophyllum, Milne-Edwards and Haime. 1850. Brit. Foss. Corals, p. lxix.

"Single conical polyp cells of cyathophylloid structure, composed of invaginated calycinal cups, the bottoms of which have the form of spacious diaphragms, either smooth or crested by the radial lamellæ uniting in the centre. The ascending side walls of the cups are encircled by linear, crest-like plications, which connect into uninterrupted vertical laminæ, within this intermediate area. At the peripheral cup margins the plications become tent-shaped, embracing one another in their superposition, but not always combining with their edges into uninterrupted vertical leaves. The interlamellar interstices are traversed by transverse plates, and divided into cellulose spaces, but the dissepiments are not independent vesiculose leaflets; they make part of the tent-shaped folds of the invaginated series of cell cups, and represent the rounded, outwardly directed flexion of the plicated cup walls, while the inwardly turned folds are

* Brit. Palæoz. Fossils, 1855, p. 101, pl. 3A, fig. 5.

sharply crested. Root like, cylindrical excrescences from the side walls of the polyparia, by which they are attached to other bodies, are a peculiarity of the different species of *Omphyma*, which, however, are not exclusively so to them, but are also noticed in other forms of the cyathophylloid family. As another distinctive character of *Omphyma*, the development of four septal foveæ is mentioned by Milne-Edwards, but they are generally not all equally distinct, while very frequently only one of them is obvious, the others being almost obsolete. The genus *Ptychophyllum*, described by Milne-Edwards as being organized like *Chonophyllum*, differing from it in the twisted converging ends of the radial lamellæ, forming a central false columella, is likewise in close structural relationship with Omphyma, and in the special case of *Ptychophyllum Stokesii*, I found its affinity with *Omphyma verrucosa* so great that I altered the name of the first from *Ptychophyllum* to *Omphyma*." (Rominger).

Type species.—*O.* (*Madrepora*) *turbinata*, Fougt.

Range.—Silurian.

The genus *Ptychophyllum* was founded in 1850, by Milne-Edwards and Haime, with *P. Stokesi*, from the Niagara of Drummond Island, Lake Huron, as the type species (not *P. patellatum*, Schloth., sp. as stated by Zittel, in his Traité de Paléontologie, vol. 1, p. 232, French translation).

If, as Dr. Rominger asserts, *P. Stokesi* is really an *Omphyma* (and he has described it as such) then *Ptychophyllum* must be regarded as synonymous with *Omphyma*.

Dr. Rominger in describing *O. verrucosa* and *O. Stokesi*, from Drummond Island, the typical locality of both species, remarks that "it is sometimes difficult to draw a line of distinction between specimens of these two species."

The genus *Streptelasma*, Hall, 1847, is classed by Dr. Lindström in his "Index* to the generic names of palæozoic Corals" as a synonym of *Ptychophyllum*, Milne-Edwards and Haime, 1850, although why, if they are synonymous genera, *Ptychophyllum* created three years later than *Streptelasma*, should be retained in preference to Hall's genus is not clear to the writer. However, the Zaphrentoid genus *Streptelasma* has no affinity whatever with the Cyathophylloid genus *Ptychophyllum*.

Omphyma verrucosa, Rafinesque and Clifford.

Omphyma verrucosa, Rafinesque and Clifford. 1820. Ann. des Sci. Phys. de Bruxelles, vol. 5., p. 125.

? Coral, Stokes. 1824. Trans. Geol. Soc., second series, vol. I., pl. XXIX., fig. 1 (on the right).

* Bihang till k. sv. vet.-akad. handl., band 8, No. 9.

Omphyma verrucosa, Milne-Edwards and Haime. 1851. Polyp. Foss. des Terr. Palæoz., p. 403.
Zaphrentis Bigsbyi, Billings. 1866. Cat. Sil. Foss. of Anticosti, p. 92.
Omphyma verrucosa, Rominger. 1876. Geol. Sur. Mich., Foss. Corals, p. 117, pl. XLIV., lower row.

The description given by Milne-Edwards and Haime is as follows: "Cette espèce est allongée, cylindro-turbinée, souvent courbée; les bourrelets d'accroissement sont très-prononcés; ses prolongements radiciformes espacés, mais quelquefois situés très-près du calice. Sa hauteur est d'environ 6 ou 7 centimètres; le diamètre du calice est de 3 ou 4.

"Silurien. *Amérique du Nord:* Ile de Drummond sur le lac Huron.

"Coll. Stokes."

With this species are identified two exfoliated specimens from the Niagara of Grand Manitoulin Island, Lake Huron, collected by Mr. J. Townsend in 1883. The specimen described by Mr. Billings under the name *Zaphrentis Bigsbyi* is from rocks of the same age on the east side of Cockburn Island, two miles north of McLeod's Harbour, collected by R. Bell in 1866.

Rominger's specific description is as follows:—

"Conical polyparia, attaining in larger specimens the length of one decimeter by a calyx diameter of from seven to eight centimeters. Surface of the silicified specimens generally exfoliated; if perfect, it is covered by an epithecal wall with annular wrinkles of growth, and longitudinally striate by septal furrows. From the sides of the conical walls numerous cylindrical, root-like prolongations grow out, serving for attachment of the coral to other bodies: these appendices were not distributed equally over the surface, but seemed to form only on those sides where a chance for attachment was offered by close proximity of an object. Calyces spacious, with steeply ascending sides and a gently expanded margin; bottom broad, convex, with depressed circumference, flat or somewhat concave in the centre, which may be almost smooth, or the lamellæ may extend over it as carinations, becoming twisted in the centre. On the ascending sides of the calyx the lamellæ have the form of acute linear laminæ alternating in size, a smaller and a larger one near the bottom of the calyx always united into pairs. In the marginal portions of the calyces, the two plates forming the linear crests diverge at the base, and open into a tent-shape. The four septal foveæ are scarcely ever distinct — two of them, or it may be only one, being plainly developed.

"The centre of the polyparia is, in vertical sections, seen regularly intersected by large transverse plates, and the continuity of the vertical crests is interrupted. Number of lamellæ in calyces of six or seven centimeters diameter from one hundred to one hundred and ten. Associated

with the elongated type form already described are shorter conical specimens, with broad, expanded calyx margins, and generally with a very prominent bottom, covered by twisted radial crests, seeming to be a mere variety of the former kind.

"Occurs in the Niagara group of Drummond's Island."

Omphyma Eriphyle, Billings. (Sp.)

Plate XV. figs. 2, 2*a*, 2*b*.

? Omphyma subturbinata, Milne-Edwards and Haime. 1855. Brit. Foss. Corals, p. 288, pl. LXVIII. figs. 1, 1*a-c*.
Cyathophyllum Eriphyle, Billings. 1862. Palæoz. Foss. vol. I, p. 111.
Omphyma Eriphyle, Lambe. 1899. Ottawa Naturalist, vol. XII, p. 243.

"Corallum simple, large, cylindro-turbinate. Outer surface marked transversely with shallow constrictions alternating with low growth-swellings, 5 or 6 mm. broad, representing successive calicular margins. Epitheca thin, with numerous transverse growth lines and longitudinal depressed linear markings 2 or 3 mm. apart. Internal structure, as viewed in longitudinal and transverse sections, composed of a central tabulate area, about one-third the diameter of the corallite, surrounded by a broad vesicular zone. Tabulæ flat, close set, moderately regular, sometimes anastomosing, about twelve in a space of 1 cent. Vesicles unequal in size, from 1 or 2 mm. to over 1 cent. in length, made up of arched plates curving upward and outward. The tabulæ are at intervals continued obliquely outward over the vesicles so as to form in reality a succession of invaginated cups flat at the bottom with dilated convex sides. Septa discontinuous vertically, formed by the infolding of the sides of the cups, broad and angular at the periphery, becoming lamellar within, not encroaching on the tabulate area, numbering about eighty, and apparently of equal length. Calyx moderately deep. Length from 10 to 25 cent., diameter from 5 to 6·5 cent." (Lambe, 1899.)

Locality.—L'Anse à la Vieille, Baie des Chaleurs, collected by Sir W. E. Logan in 1843; Silurian.

Genus Arachnophyllum, Dana. 1846.

Arachnophyllum, Dana. 1846. Am. Jour. Sci. and Arts, 2nd series, vol I., p. 186.
Astræophyllum, Nicholson and Hinde. 1874. Canadian Journal, new series, vol. XIV. p. 152.
? Vesicularia, Rominger. 1876. Geol. Sur. Mich., Foss. Corals, p. 134.

Corallum composite, with a basal epithecal covering. Corallites upright, confluent, each consisting of a series of invaginated calyces whose

expanded margins uniting with those of adjacent corallites form a succession of continuous floors, supported by coarse vesicular structure. Calyces shallow, impressed centrally with a small pit that is at times surrounded by an elevated rim; their marginal boundaries more or less distinct and polygonal in outline, sometimes scarcely defined. Septa lamellar and continuous vertically in the neighbourhood of the central pit, outwardly developing into superficial radial foldings of the calycinal margins. Tabulæ generally inconspicuous, forming a narrow axial area at the centre of the visceral chamber. Dissepiments occupying the interseptal loculi in a zone surrounding the tabulæ; in the peripheral area they develop into blister-like plates that form the supporting vesicular tissue continuous from one corallite into the next. Septa radii at times poriferous.

Type species.—*A.* (*Acervularia*) *Baltica*, Lonsdale.

Range.—Silurian.

Arachnophyllum pentagonum, Goldfuss. (Sp.)

Plate XV., figs. 3, 3*a*.

Strombodes pentagonus, Goldfuss. 1826. Petrefacta Germaniæ, vol. I., p. 62, pl. XXI., figs. 2*a*, *b*.
" " Milne-Edwards and Haime. 1851. Polyp. Foss. des Terr. Palæoz., p. 430.
" " Rominger. 1876. Geol. Sur. Mich., Foss. Corals, p. 130, pl. XLVIII., figs. 1 and 2.
" " Whitfield. 1882. Geol. of Wisconsin, vol. IV., p. 275, pl. XV., fig. 5.

Corallum compound, explanate, discoidal, slightly convex above, with a flat or undulating lower surface roughened by irregular coarse wrinkles of growth, and with a small central base of attachment; attaining a diameter of over 13 cent. and a thichness of 3 or 4 cent. Epitheca covering the basal surface, marked by fine concentric growth lines. Polyparia upright, very slightly di ergent, confluent, opening above in shallow calyces, impressed at the centre with a small pit, and meeting in obtusely elevated polygonal outlines. Calyces from about 1 to over 2 cent. in width, radially marked by fine, obtusely angular septal ridges that connect with those of adjacent calyces. Central pit from about 2·5 to 6 mm. wide, or averaging about one-fourth the diameter of the calyces. Septa numbering from thirty to forty at the margin of the central pit, within which they are lamellar and continuous vertically; of these half reach the centre of the visceral chamber, whilst the remainder stop short of the centre, frequently all or some of the septa coalesce in sets of twos near the bottom of the pit, each pair continuing to the centre as a single septum.

On emerging from the central pit the septa become augmented in number, many of them bifurcating or trifurcating, and continue outward as superficial radial foldings of the calycinal margins. A double row of minute pore-openings occurs in each septal ridge, one row on either side of the central line, the openings in either row generally alternating with those of the other. In vertical sections each corallite is seen to be composed of a series of invaginated calyces whose margins, uniting with those of adjacent calyces at the same level, form a succession of superposed continuous floors. In the interseptal spaces in the vicinity of the central pit occur small arched dissepiments rising obliquely outward; these continued outward, in the area to which the septa do not extend as vertical lamellæ, become larger and more unequal in size, forming vesicular tissue, on which the successive calycinal floors rest. Small inconspicuous, horizontal tabulæ occupy the centre of the visceral chamber. Increase by intercalicular gemmation.

Locality.—Grand Manitoulin Island, Lake Huron, collected by R. Bell and H. G. Vennor, in 1865, and by J. Townsend, in 1882 and 1883; Niagara formation.

This species cannot be distinguished from *A. striatum*, d'Orbigny, according to Rominger, who (on page 131, op. cit.) says "it is impossible to draw a dividing line between them; all gradations of sizes, from the large to the small forms, can be found associated in the same localities, and in structure not the least difference exists between them."

Arachnophyllum mamillare, Dale Owen. (Sp.)

Plate XV., fig. 4.

Astrea mamillaris, Dale Owen. 1844. Rep. Geol. Explor. Iowa, Wisconsin and Illinois, p. 70, pl. XIV., fig. 3.
Strombodes mamillatus, Rominger. 1876. Geol. Sur. Mich., Foss. Corals, p. 132, pl. XLVIII., fig. 4.

To this species is assigned a specimen collected at Grand Manitoulin Island, Lake Huron, by J. Townsend, in 1883; it agrees in the size and shape of its calyces with the figure of the type specimen (op. cit., pl. xiv. fig. 3) and with Rominger's description and figure of specimens from the Niagara rocks of Point Detour, Lake Huron.

The Grand Manitoulin Island specimen may be described as follows:—

Corallum discoidal, somewhat convex above, flat below, measuring 15 cent. across and 4 cent. high at the centre. Basal surface wrinkled, covered by an epitheca showing concentric growth lines, and with a small central point of attachment. Corallites slightly divergent, opening on

the surface in radially septate calyces with narrow, sunken confluent margins and broad cone-shaped central prominences enclosing deeply excavated pits that are from 1 to nearly 2 cent. apart and vary in width from 5 to 7 mm. The septa average thirty-six in number, are alternately long and short in the pits, half passing to the centre, the others terminating in the vertical pit sides; the differentiation in the size of the septa is apparent at times on the outer descending slopes of the central projections but is lost on the sunken marginal floors where the septal ridges attain a maximum breadth of nearly 1 mm. The presence of septal pore-openings has not been detected. Other structural details as described in former species.

From *A. diffluens* this species differs principally in its much more robust growth, in the greater size of the calycinal pits, and in the proportionately larger mammiform cones.

Formation.—Niagara.

Arachnophyllum diffluens, Milne-Edwards and Haime. (Sp.)

Plate XIV., fig. 12.

Strombodes diffluens, Milne-Edwards and Haime. 1851. Polyp. Foss. des Terr. Palæoz., p. 431.
" " Milne-Edwards and Haime. 1855. Brit. Foss. Corals, p. 294, pl. LXXI., figs. 2, 2a.
" " Billings. 1866. Cat. Sil. Foss. of Anticosti, p. 34.
Strombodes pigmæus, Rominger. 1876. Geol. Sur. Mich., Foss. Corals. p. 131, pl. XLVIII., fig. 3.
Arachnophyllum diffluens, Lambe. 1899. Ottawa Naturalist, vol. XII., p. 244.

"Corallum forming laminar or discoidal expansions, composed of confluent corallites whose calyces open on the surface with scarcely any line of demarcation between them; reaching a breadth of 9 cent. and a thickness of between 2 and 3 cent. Calyces, varying in width from 8 to 12 mm., flat or shallowly concave in the marginal area, with a circular, elevated rim surrounding a central pit 3 or 4 mm. in diameter from which radiate the septa as narrow convex ribs having a maximum breadth of about ·5 mm. The elevated rims surrounding the pits stand, in some specimens, much more prominently above the surrounding, sunken, calycinal extensions than in others, whilst at times they develop into salient, conical projections with the pit forming an excavation at the top. Lateral junction of contiguous calyces sometimes very slightly raised, more often seen as a plane surface in which no dividing line is apparent. Septa averaging thirty in number as in other species of the genus, lamellar and continuous vertically in the vicinity of the central pit, converted on the flat calicinal margin into surface ribs that join those of neighbouring calyces; of two

orders, alternating with each other within the pit, the primaries reaching the centre or leaving a narrow, circular, smooth spot at the centre, the secondaries not continued beyond the sides of the pit. As in *A. pentagonum*, Goldfuss, a coalescence of the inner septal ends in sets of twos, and their continuance as single septa is often observed. Double rows of pore-openings are present in the septal ridges. The dissepimental and vesicular structure is similar to that of *A. pentagonum*, only proportionately smaller. Small flat tabulæ occur in the centre of the visceral chamber." (Lambe, 1899.)

Localities.—Five miles west of Chicotte River, Anticosti, J. Richardson, 1856, division IV., Anticosti group. Owen Sound, Ont., J. Townsend, 1874 to 1883; north end of Lake Temiscaming, Que., R. Bell, 1887: Niagara formation.

Arachnophyllum eximium, Billings. (Sp.)

Plate XVI., figs. 3, 3*a* and 4.

Strombodes eximius, Billings. 1866. Cat. Sil. Foss. of Anticosti, p. 93.
Arachnophyllum eximium, Lambe. 1899. Ottawa Naturalist, vol. XII., p. 245.

"*Original description.*—'Corallum composite, apparently forming large depressed hemispherical colonies. Corallites from 9 to 15 lines across, the calice slightly concave in the outer half of the width, the central depression 3 or 4 lines wide. There are about fifty septo-costal radii in a corallite 14 lines across. This species differs from *Strombodes pentagonus* and *Strombodes striatus* (both of which occur in the same beds) in having much coarser radii.'

"Additional specimens were collected by J. Townsend on Grand Manitoulin Island in 1883; one specimen in particular shows the structure admirably.

"Further details as to the growth of the corallum are here appended:—Corallum composite, explanate, discoidal, sometimes over 13 cent. broad and 3 cent. thick, upper surface flat or slightly convex. Corallites upright, confluent, varying in breadth from 2 to 3 cent., with shallowly concave calyces whose boundaries are poorly defined and only slightly elevated. Calyces with a well marked, rather deep and comparatively broad central pit, averaging nearly 1 cent. in width, having steep, at times almost vertical sides and a flat bottom. Tabulæ, forming a well defined axial area, flat or slightly convex, turned down at their edges, as broad as the pit is wide, about sixteen in a space of 5 mm. Septa numbering from forty to about fifty-two, lamellar and uninterrupted in a narrow area surrounding the tabulæ, of two orders, the primaries reaching the centre

of the tabulæ as carinæ, the secondaries not infringing on the tabulæ; beyond the confines of the central pit their vertical continuity is interrupted and they radiate outward as gradually broadening, flatly convex ribs, reaching a maximum breadth of 2 mm. at the edge of the calycinal extension where they meet the septal ribs of adjacent calyces. Pore-openings in the septal ribs have not been recognized in specimens belonging to this species. The vesicular structure supporting the calycinal floors, developed at intervals in the upward growth of the colony, is composed of blister-like plates that are proportionately rather smaller and less convex than in other species of the genus, also the radially folded calycinal floors appear to be developed with greater frequency and are consequently closer together than in *A. pentagonum*, Goldfuss, from which this species differs in many essential points. Between the lamellar septa arched dissepiments curve downward to meet the tabulæ." (Lambe, 1899.)

Locality.—West Point, Grand Manitoulin Island, Lake Huron, R. Bell, 1866, and Grand Manitoulin Island, J. Townsend, 1883; Niagara formation.

Genus CHONOPHYLLUM, Milne-Edwards and Haime. 1850.

Chonophyllum, Milne-Edwards and Haime. 1850. Brit. Foss. Corals, p. lxix.

Corallum simple, short and broadly expanded or by the superaddition of successive calycinal expansions becoming conico-cylindrical. Calyx steep-sided with expanded horizontal or reflexed margins. Central area irregularly tabulate with a convex calicular surface. Peripheral area broad, vesicular. Septa sometimes reaching the centre, thin and continuous vertically in a cycle surrounding the tabulæ where they are of two sizes, but in the peripheral expansion developing into superficial and equal, rounded ribs that unite laterally so as to form a laminar surface-covering to the supporting vesicles.

Type species.—*C.* (*Cyathophyllum plicatum*) *perfoliatum*, Goldfuss. Upper Silurian (Niagara) of the Island of Gotland, Sweden.

Range.—Silurian, Devonian.

CHONOPHYLLUM CANADENSE, Billings. (Sp.)

Plate XVII, figs, 1, 1a, 1b, 1c, 2, 3, 3a, 3b and 4.

Ptychophyllum Canadense, Billings. 1862. Palaeoz. Foss., vol I., p. 107.
" " Billings. 1866. Cat. Sil. Foss. of Anticosti, p. 34.
Chonophyllum Canadense, Lambe. 1899. Ottawa Naturalist, vol. XII., p. 222.

"Corallum large, circular, much broader than high, expanding laterally from a small, obtusely pointed base into a broad, thin, frill-like, horizontal

extension, above whose upper surface rises abruptly a central calicular area about one-fourth the breadth of the corallum; attaining a breadth of over 19 cent. and a thickness at the centre of about 4 cent. Height of the central part enclosing the calyx, above the level of the surrounding surface, in large individuals, from about 1·5 to 2 cents. Calyx * about twice as wide as high, with a diameter of about one-tenth the breadth of the corallum, flat at the bottom and with very steep sides. Septa, in the visceral chamber, lamellar, of two orders, primaries and secondaries, alternating, the former meeting at the centre with a slight amount of twisting, the latter not quite half the length of the former; ascending the sides of the calyx as sharp-edged lamellæ they pass down and over the extracalicular surface as gradually broadening, flatly convex, radiating ridges having a maximum breadth near the periphery of 7 mm.; they number in different individuals from about seventy-four to eighty-four. Well developed flat or concave tabulæ, turned down at their edges and as broad as one-half the width of the calyx, are seen in a radial section, beneath the bottom of the cup. The whole of the upper surface is marked by fine, raised, interrupted and concentric, ripple-like growth lines, generally less than 1 mm. apart, those of one septal ridge sometimes continuous with, at other times alternating with those of adjacent ridges; the basal surface presents a similar appearence except that here the septal radii are concave instead of being convex. The structure of the walls of the calyx and of the extended frill-like margin appears to be very dense. In radial sections the gradual growth of the corallum outward is indicated by parallel lines approximately at right angles to, and joining the ripple-like markings on, the upper and lower surfaces. In vertical tangential sections the septa are seen to be made up of superimposed convex layers resembling the septal structure of *C. Magnificum*, Billings, but denser.

"*Locality.*—South-west Point, Anticosti, division IV. of the Anticosti group, collected by J. Richardson, 1856." (Lambe, 1899.)

Chonophyllum Belli, Billings.

Plate XVI., figs. 5 and 6.

Chonophyllum Belli, Billings. 1865. Canadian Naturalist, new series, vol. II., p. 431.

Corallum at first short and broader than high, with a deep calyx having broadly expanded generally reflexed margins, with age increasing in height and assuming a subcylindrical form by the superaddition of successive invaginated calycinal expansions; type specimen 7 cent. in height, slightly over 3 cent. in average breadth, pointed at the base.

* Originally described as the basal centre "excavated into a cup-like cavity."

Calyx with rapidly expanding horizontal or reflexed margins surrounding a steep-sided central pit at the bottom of which is a rounded boss showing the convergence of the inner ends of the septa; depth nearly one half its width. Septa as seen in the calyx, radiating outward with little or no incipient twisting, sharp-edged at first and when ascending the steep sides of the central pit but developing on the expanded margin into low convex ridges about 1 mm. broad at the periphery where they are of nearly equal size although elsewhere they show a differentiation into alternating primaries and secondaries most noticeable on the side of the pit. The rapidly increasing area of the calyx outside the pit necessitates the addition of new septal ribs which are supplied by intercalation or by the bifurcation or trifurcation of the old ones.

An inner axial area, showing in the bottom of the calyx of the tppe specimen as a rounded projection, is formed by the presence of narrow tabulæ, turned down at the edges, over which the septa pass, either meeting at a point or not continued quite so far, so as to leave a small, smooth, central space, 3 or 4 mm. in diameter. Outside the tabulate area is a broad zone of arched plates, of unequal but rather large size, that fill the spaces between and support the periodic calycinal expansions. Strengthening acanthiform growths developed from the under, concave surface of the arched plates are noticed in many places. Septa, in the type specimen, numbering about ninety, thin, apparently carinated on their side faces, of two alternating sizes, the larger passing almost to the centre, the shorter not encroaching on the tabulæ, their vertical continuity interfered with by the vesicles as the periphery is approached; represented on the calycinal margins by the low septal ridges.

Locality.—Grand Manitoulin Island, Lake Huron, collected in 1865 by R. Bell and H. S. Vennor; Clinton formation.

Chonophyllum nymphale, Billings. (Sp.)

Plate XVIII., figs. 1, 1*a*.

Cyathophyllum nymphale, Billings. 1862. Palæoz. Foss., vol. I., p. 111.
Chonophyllum nymphale, Lambe. 1899. Ottawa Naturalist, vol. XII., p. 251.

"Corallum simple, short, broadly expanded, concave on the lower surface, convex above; dimensions of the type and only specimen known, height at centre 4 cent., breadth about 9 cent. Basal surface apparently provided with an epitheca. Calyx shallow, convex at the centre, with broadly expanding reflexed margins exhibiting about eighty low, rounded septal ribs that increase in breadth outwardly. In a radial section a central area, about 1 cent., in breadth, is disclosed; it

is made up of small slightly convex plates arching upward and inward so as to form an axial vesiculo-tabulate mass whose surface appears in the calyx as a rounded protuberance. Surrounding the central area is a broad vesicular zone in which can be detected the gradual growth upward of the corallum by the superposition of vesicular layers, 2 or 3 mm. in thickness, each layer terminating above in a thin covering of flexuous, continuous laminæ representing the position of the surface of previous calyces. The convex plates composing the vesicular layers are small, generallay 1 mm. or less in length. The septa, starting at the confines of the central vesicular area, radiate outward as their vertical laminæ and disappear in the pripheral region; they are represented on the calicular surface by the gradually broadening superficial convex ribs, that are connected with each other laterally. In tangential sections at the margin of the calicular expansions the cut edges of the septal ribs, here about 3 mm. in breadth, appear as horizontal continuous parallel wavy lines. What appear to be septal carinæ or possibly structures analogous to the supporting processes of the septal laminæ as developed in some species of the genus are seen in the radial section of the corallum." (Lambe, 1899.)

Locality.—Anse à la Vieille, Baie des Chaleurs, one specimen collected by Sir W. E. Logan in 1843; Silurian.

Chonophyllum magnificum. Billings.

Chonophyllum magnificum, Billings. 1860. Canadian Journal, new series, vol. V., p. 264, pl. I.
" " Rominger. 1876. Geol. Sur. Mich., Foss. Corals, p. 115, pl. XLIII., upper row.
" " Sherzer. 1892. A revision and monograph of the genus *Chonophyllum*; Bull. Geol. Soc. Amer., vol. 3, p. 267, pl. 8, figs. 2, 3, 4 and 5,

Corallum short and broadly expanding, or cylindro-turbinate, with gradations between these extreme forms, obtusely pointed and slightly curved at the base, terminating above in a widely spreading calyx whose centre is deeply excavated so as to form a pit, from about one third to nearly one-half the entire diameter in width, from which the septa radiate outward to the periphery; the type specimen is between 16 to 17 cent. broad, about 8 cent. high, and has one hundred and thirty-two septa in the marginal area, other specimens in the collection are of smaller size, a specimen of the cylindro-turbinate form has a maximum height of 16 cent. with a breadth of about 10·5 cent. Septa lamellar on the sides of the pit, bifurcating when about half way up and gradually changing on the expanded margin into low, convex ridges, from about 3 to 5 mm. broad, in the type specimen, near the periphery where they are seen in

vertical tangential sections to be made up of a series of thin, separate, superimposed convex layers, of which from about eighteen to between thirty and forty occur in a space of 5 mm. and between which are numerous small granules or short supporting pillars. The broad septal layers as they converge become gradually more compressed laterally until they form, by the bending down of their sides on each other, comparatively thin, double, lamellar plates. The septa that pass down into the pit from above do not apparently extend inward to the centre, but stop at the bottom of the steep sides where they meet and alternate with an equal number of septa that reach the centre and are there slightly twisted; how far the latter septa extend outward has not been ascertained, but they do not appear on the sides of the central pit. Small, convex, dissepiments arching upward and outward occur in the very narrow interseptal spaces; toward the centre of the visceral chamber they become larger and more irregular in disposition. Of the septal layers W. H. Sherzer in his monograph of the genus *Chonophyllum* where an accurate and detailed description is given of the complicated structure of *C. magnificum*, says: "Along the medial plane of each septum these layers are approximately horizontal for a short distance, curve gradually downward toward the sides, and finally are sharply deflected, fusing with one another along their edges to form the side faces of the septum. Occasionally a layer, or a series of layers, unites directly with those just beneath before reaching the side, and thus takes no part, for some distance at least, in the actual formation of the septal faces. When the septum has become too narrow, an upper layer may send down its edges upon each side completely enwrapping as many as twelve or fifteen older ones, thus suggesting their method of growth. In general, these layers are not continuous from one septum to its neighbour, but each septum is made up of an independent series. Occasionally they pass completely across for a short distance, arching upward in the interseptal cavity and assisting in the formation of the vesicles." "In radial sections through the septa the cut edges of these layers appear as delicate parallel lines, sloping gently from the edge of the calyx downward toward the centre. Intersected at right angles by the supporting growths they present, in typical forms, a *Stromatopora*-like appearance." Epitheca complete, thin, with concentric growth markings, and with narrow slightly raised lines directed toward the base, indicating the position of the interseptal spaces, between which the surface is gently concave.

Localities and formation.—Corniferous limestone of Ontario; Rominger mentions its occurrence at Mackinac Island, in the drift of the lower peninsula of Michigan, at the Falls of the Ohio, at Charleston Landing, Indiana and in other exposures of the Upper Helderberg (Corniferous) group.

Although this species is retained in the genus to which it was originally assigned by Mr. Billings, the writer is strongly of the opinion that it should form the type of a separate genus as its structure is quite dissimilar in its main features to that of the Silurian corals grouped round the type *C. perfoliatum*, Goldfuss, sp.

CYSTIPHYLLIDÆ.

Genus CYSTIPHYLLUM, Lonsdale. 1839.

(Ety. κύστις, cavity, φυλλον, leaf.)

Cystiphyllum, Lonsdale. 1839. Murch. Sil. Syst., pt. II., p. 691.
Conophyllum, Hall. 1852. Palæon. New York, vol. II., p. 114.

Corallum simple or aggregate. Corallites varying from conical to cylindrical; when aggregate, increasing by lateral calicinal budding. Epitheca complete. No true tabulæ nor septa. Inner structure vesicular, composed of convex plates curving upward and outward, the central ones more nearly horizontal and generally larger than the others. Septa represented by radial rows of denticulations, or by spinulose or rounded ridges, on the upper surface of the blister-like plates. In one species (*C. sulcatum*) a distinct fossette, with at times two obscure lateral ones, is present in the calyx, as well as faint septal furrows on the surface showing a pinnate arrangement. Calyx of varying depth, its concave surface formed of the uppermost blister-like plates that in the case of *C. sulcatum* combine to form a continuous laminar floor marked by superficial radiating rounded ridges.

Type species.—*C. Siluriense*, Lonsdale.

Range.—Silurian, Devonian.

CYSTIPHYLLUM NIAGARENSE, Hall. (Sp.)

Plate XVI., fig. 7.

Conophyllum Niagarense, Hall. 1852. Palæon. New York, vol. II., p. 114, pl. 32, figs. 4a—n.
Cystiphyllum Huronense, Billings. 1866. Cat. Sil. Foss. of Anticosti, p. 92.
Cystiphyllum Niagarense, Rominger. 1876. Geol. Sur. Mich., Foss. Corals, p. 137, pl. XLIX., fig. 3.
" " Sherzer. 1892. A revision and monograph of the genus *Chonophyllum*; Bull. Geol. Soc. Amer., vol. 3, p. 266.
" " Lambe. 1899. Ottawa Naturalist, vol. XII,, p. 224.

"The type specimen of *C. Huronense* is from the Niagara rocks of Cockburn Island, Lake Huron, and was collected by Dr. R. Bell, in 1865. Rominger has pointed out that *Conophyllum Niagarense*, Hall is in

reality a *Cystiphyllum* and mentions its occurrence in the Niagara group of Drummond Island, Lake Huron and at Point Detour, as well as in the Niagara of Kentucky, Iowa and Indiana. The specimen from Cockburn Island is preserved in such a way as to show the longitudinal ribbing of the surface, the form, size and direction of the cystose plates within and the radial rows of denticulations on the calicular margins as a root-like extension near the basal extremity; details of structure such as these, taken with the general form and manner of growth of the corallum, induce the writer to believe that *C. Huronense* should properly be referred to Hall's species from the Niagara of the State of New York.

"Rominger's description of this species is comprehensive and accurately describes the Canadian specimen: it appears in the following words— 'Conical polyp cells attached to other bodies at the base, and by additional root-like prolongations from the sides. Stems elongated, subcylindrical, or shorter turbinate, annulated by superficial constrictions with tortuous flexions, or by periodical total interruptions in the growth of a calyx, and the formation of a new cell from within. The calyces are moderately deep, uniformly spreading from an obtusely angustated bottom; margins erect: their surface is blistered, and is radially striate by spinulose crests, developed in some specimens with more distinctness than in others. The surface of the polyp stems in well preserved condition is longitudinally ribbed by septal striæ, but it often happens that the outer walls are destroyed, and that the stems are of rough exfoliated aspect, exhibiting the concave side of the blisters composing the cell cups, and the free edges of the single invaginated cups composing the stems.'" (Lambe, 1899.)

Cystiphyllum maritimum, Billings.

Plate XVIII., figs. 2, 2a.

Cystiphyllum maritimum, Billings. 1863. Palæoz. Foss., vol. I., p 112.

Corallum simple, turbinate, slightly curved, 7 cent. high and about 6 cent. broad at the top, annulated somewhat irregularly by a number of constrictions and ridges of growth. Epitheca complete, showing close-set, fine, transverse lines and also well marked longitudinal ribbing which is accentuated in the underlying structure when the epithecal covering is decorticated. Calyx shallow, about 13 mm. deep, with sides sloping evenly to the centre, radiated by narrow, apparently denticulated or spinulose, septal ribs of which there are seven or eight in a space of 5 mm. The inner structure, revealed by a transverse and a longitudinal section, is dense and composed of very small convex plates whose general direction is obliquely upward and outward from the centre, those at the

centre being comparatively horizontal and frequently larger in size. In a longitudinal section the calycinal spinules are represented by faint, short, linear markings at right angles to the direction of the vesicles. In a transverse section the septal ribs appear as concentric cycles of inwardly directed short prolongations from the cut edges of the vesicles, the whole having the appearance of indistinct interrupted septa converging from the periphery toward the centre.

Locality.—Anse à la Vieille, Baie des Chaleurs : collected by Sir W. E. Logan, in 1843. Silurian. One specimen, apparently distorted by lateral pressure.

Cystiphyllum vesiculosum, Goldfuss. (Sp.)

Cyathophyllum vesiculosum, Goldfuss. 1826. Petrefacta Germaniæ, vol. I., p. 58, pl. XVII., figs. 5a–e, and pl. XVIII, figs. 1a–d.
Cystiphyllum cylindricum, Hall. 1843. Geol. of New York, pt. IV., p. 209, figs. 1, 2. Non Lonsdale.
Cystiphyllum vesiculosum, Milne-Edwards and Haime. 1851. Polyp. Foss. des Terr. Palæoz., p. 462 ; and 1853, Brit. Foss. Corals, p. 243, pl. LVI., figs. 1, 1a, 1b.
Cystiphyllum Americanum, Milne-Edwards and Haime. 1851. Polyp. Foss. des Terr. Palæoz., p. 464, pl. 13, figs. 4, 4a.
Cystiphyllum Senecaense, Billings. 1859. Canadian Journal, new series, vol. IV, p. 137.
Cystiphyllum grande?, Billings. 1859. Ibid, p. 139.
Cystiphyllum Americanum, Billings. 1859. Ibid, p. 139.
" " Nicholson. 1874. Palæon. of Ont., p. 36, pl. VI., fig. 8 ; and *C. vesiculosum*, Nicholson, 1874, ibid, p. 37, fig. 8.
Cystiphyllum superbum, Nicholson. 1875. Palæon. of Ont., p. 73, pl. I., fig. 1.
Cystiphyllum Americanum, Rominger. 1876. Geol. Sur. Mich., Foss. Corals, p. 137, pl. L., upper row and right-hand half of lower row.
" " Hall. 1876. Illus. Dev. Foss., pl. XXVIII., figs. 1-7.
Cystiphyllum vesiculosum, Lambe. 1899. Ottawa Naturalist, vol. XII., p. 257.

"Corallum simple, varying from turbinate to conico-cylindrical, pointed at the base, straight or curved, flexuous or geniculated, sometimes long and slender, at other times comparatively short and thick. Annulated by growth expansions and constrictions, in some specimens much more pronounced than in others, frequently contracted at the calicular end. Epitheca complete, thin, showing minor rings of growth, the whole marked by fine transverse lines of which, in well preserved specimens, as many as twenty-four can be counted in a space of 2 mm.; faint longitudinal indications of linear septal markings are also not infrequently developed. Calyx of variable depth, in short, turbinate coralla comparatively shallow, often with broad margins, in more cylindrical forms generally somewhat deeper in proportion to the diameter and with steeper sides. Surface of calyx blistered and often marked radially by interrupted, more or less distinct, superficial septal ridges. Inner structure entirely vesiculose, composed of convex blister-like plates resting on each other and directed

obliquely outward and upward to the periphery; at the centre of the visceral chamber the vesicles are more nearly horizontal and as a rule larger than the others.

"This species is very variable in shape and size, sometimes in the stout, short forms reaching a diameter of over 10 cent. with a length of about 27 cent., in the slender forms an equal length may be attained with a thickness of only 3 or 4 cent. In his description of *C. Senecäense*, Billings mentions a variation in length from three inches to two feet, with a diameter of three-quarters of an inch to an inch and a half. The same authority in referring to the size of *C. grande*, says, 'There are fragments of this species in the collection of the Geological Survey of Canada, five inches in diameter; and one specimen, still lying in the rock, is known which is three feet long.'

"Examples of twin corallites with a common epitheca are not infre quent.

"*Locality.*—Abundant in the Corniferous and Hamilton formations of Ontario." (Lambe, 1899.)

CYSTIPHYLLUM AGGREGATUM, Billings.

Plate XVIII., fig. 3.

Cystiphyllum aggregatum, Billings. 1859. Canadian Journal, new series, vol. IV., p. 137, fig. 28.

? Cystiphyllum fruticosum, Nicholson. 1875. Geological Magazine, new series, vol. II., p. 32, pl. I., figs. 3, 3a; and 1875, Palæon. of Ont., p. 73, pl. I., figs. 3, 3a.

Cystiphyllum aggregatum, Rominger. 1876. Geol. Sur. Mich., Foss. Corals, p. 138.

Cystiphyllum cæspitosum, Schlüter. 1882. Sitzungsberichte der niederrhein. Gesellschaft für Natur u. Heilkunde in Bonn; and 1889, Anthozoen des rheinischen Mittel-Devon, band VIII., heft 4, p. 86, pl. VIII., figs. 1—3.

Cystiphyllum aggregatum, Lambe. 1899. Ottawa Naturalist, vol. XII., p. 225.

"*Original description.*—'The only specimen of this very distinct species that has come under my observation is in the cabinet of the Canadian Institute. It consists of a mass of cylindrical corallites closely aggregated and in places united by projecting folds of the outer wall, as in the genus *Eridophyllum*. The individuals are completely enveloped in a thin epitheca which is obliquely wrinkled and filled with small sublenticular cells, one or two lines in width. Diameter of longest corallite in the group, one inch, and of the smallest, five-eighths of an inch."

"Since the above was written a number of very fine specimens of this species, some of them of large size, have been added to the collection of the Geological Survey, therefore it is thought desirable to amplify the

original description by the following, the result of an examination of the additional material :—Corallum aggregate, forming large masses sometimes a foot and a half across and over a foot high, composed of upwardly directed, flexuous, subcylindrical corallites that increase rapidly by lateral calicinal gemmation from a single parent corallite. As a result of their mode of growth from a small basal beginning, the corallites are somewhat divergent, those near the confines of the corallum sometimes growing almost horizontally. Corallites strongly and irregularly annulated, growing close together, frequently touching each other, their coherence being often strengthened at the points of contact by an increased development of the ridges of growth, or from want of space they may be closely pressed against one another for some distance. Mature corallites varying in diameter from 1 or 2 to over 3 cent., the young ones beginning with an average breadth of about 5 mm. and growing upward beside the old stems with a very slow increase in size. Epitheca thin, complete, showing minor, transverse growth markings. Inner structure vesicular, similar to that of *C. vesiculosum* from which this species apparently differs only in its aggregate form." (Lambe, 1899.)

Localities and formation.—Abundant in the Corniferous limestone of Ontario; Rominger mentions its occurrence in large clusters in the Hamilton group of Thunder Bay.

Cystiphyllum sulcatum, Billings.

Cystiphyllum sulcatum, Billings. 1858. Rep. of Progress for 1857, Geol. Survey of Canada, p. 178,
" " Billings. 1859. Canadian Journal, new series, vol. IV., p. 136.
" " Nicholson. 1874. Palæon. of Ont., p. 38, pl. VI, fig. 7.
" " Rominger. 1876. Geol. Sur., Mich., Foss. Corals, p. 138, pl. L, lower row, left-hand figures.
" " Hall. 1876. Illus. Dev. Foss., pl. XXXII, figs. 16-20.

"Corallum simple, short, turbinate, much curved, expanding at the rate of between forty and forty-five degrees from the minute sharp curved point upwards; cup oblique, the lower margin being on the side of the lesser curvature, moderately deep, and nearly regularly concave, the bottom covered with obscure coarse rounded radiating ridges; a shallow rounded groove or fossette extending from the centre to the higher margin, and in some specimens two others much less distinct, radiating to the sides at right angles to the main groove. Exterior encircled by obscure undulations, and longitudinally striated by the rudimentary radiating septa. The vesicular structure consists of irregular sub-lenticular cells, from half a line to two lines in width; length of the convex side, from one inch and a half to three inches, the usual length appears to be

about two inches or a little more; width of cup from one inch to one inch and a half; depth about half an inch." (Billings).

The largest specimen in the collection measures four inches along the convex curve and two inches across the cup from the higher to the lower side, other specimens are of all sizes from three-quarters of an inch in length up. The epitheca is complete and generally well preserved. The continuous laminar floor of the calyx in some specimens shows no trace of the vesicular structure below, in others it is more or less blistered; its development at intervals as the corallum grew larger can be seen in a number of specimens.

Locality and formation.—Abundant in the Corniferous limestone of Ontario.

Genus ACTINOCYSTIS, Lindström, 1882.

Actinocystis, Lindström. 1882. Öfvers. Vet. Ak. Fhandl., XXXIX., No. 3, p. 21.

Corallum simple, differing from *Cystiphyllum* only in the possession of septa that are feebly developed more particularly in the base or toward the centre.

Type species.—*A.* (*Cystiphyllum*) *Grayi*, Milne-Edwards and Haime.

Range.—Silurian, Devonian.

ACTINOCYSTIS VARIABILIS, Whiteaves.

Cysteophyllum Americanum, var. arcticum, Meek. 1868. Trans Chicago Acad. of Sciences, p. 80, pl. XI., figs. 6, 6a, 6b.
Heliophyllum (like *H. Halli*), Billings. 1876. Rep. of Progress for 1874-75, Geol. Survey of Canada, p. 68.
Cystiphyllum Americanum, var. *arcticum*, Whiteaves. 1891. Contr. to Can. Palæon., vol. I., pt. III., p. 206.
Actinocystis variabilis, Whiteaves. 1892. Ibid, pt. IV., p. 271, pl. XXXV., figs. 3, 3a.

Original description.—"Corallum simple strongly curved, varying in shape from broadly turbinate and widely expanding, with the breadth at the summit exceeding the height, to cylindro-conical and somewhat contracted at the summit; outer surface apparently almost smooth and marked only with a few transverse wrinkles; calyx rather deep, conical, narrow at the base; septa about eighty-five in number, extending from the exterior to within a short distance from the centre, but feebly developed, thin, and rarely, if ever, quite straight, their regularity being frequently disturbed by anchylosis with the walls of the interseptal vesicles. Internal structure, apart from the septa, essentially the same as that of *Cystiphyllum* and consisting exclusively of coarse vesicular tissue. The vesicles are very large in the central area and diminish gradually in size

toward the periphery. As viewed in longitudinal sections, they appear as lenticular cells which radiate obliquely upward and outward from the centre of the coral."

Localities.—Lake Winnipegosis, at various localities; collected by J. W. Spencer, 1874: J. B. Tyrrell and D. B. Dowling, 1889; Devonian (American Stringocephalus zone). Collected also by R. G. McConnell in 1888 from the Devonian rocks of the Mackenzie River, at the "Ramparts", and by A. P. Low, on the Moose River, Ont., 1896 (Devonian).

Genus Cayugæa. (Gen. nov.)

Corallum simple, conico-cylindrical. Epitheca complete. A broad, vesicular, peripheral area surrounds a central, axial, tabulate area, the two areas being separated from each other by an inner wall. No septa.

Type species.—*C. venusta*, mihi.

Range.—Devonian (Corniferous formation.)

Cayugæa Whiteavesiana. (Sp. nov.)

Plate XVIII., figs. 4, 4*a*, 4*b*.

Corallum simple, large, conico-cylindrical. Outer surface strongly ringed by rather regular and sudden constrictions of growth, from about 7 to 14 mm. apart. Epitheca, complete with transverse fine growth lines and obscure broken, longitudinal, depressed, linear markings. The only specimen known is about 18 cent. long and represents the upper part of the corallum which, judging from the slow rate of increase in thickness, may have attained a total length of 60 cent. (or roughly 2 feet); diameter of specimen above about 7 cent., below about 6 cent. Longitudinal and transverse sections reveal a central tubular area about 25 mm. in width, filled with numerous tabulæ, and separated from a surrounding peripheral vesicular area by a well defined inner wall. Tabulæ flat or slightly concave, generally turned up near the edge, moderately regular in their disposition. Vesicular area made up of outwardly ascending cystose plates, very unequal in size, resting on each other and enclosing spaces from 2 or 3 mm. to about 2 cent. in length. Septa absent and only indicated in a feeble way by the longitudinal epithecal markings. The specimen is crushed above, so as to obscure the form of the calyx, and the basal part is broken off.

Locality and formation.—Cayuga, Ont., collected by J. DeCew; Corniferous limestone.

This coral has structural characters of so peculiar a nature as to preclude its being referred to any described genus known to the writer. The combination of well developed tabulæ enclosed within a distinct wall surrounded by vesicular tissue, is certainly most curious as well as interesting, more particularly when the absence of septa is considered. The name of the new genus founded for the reception of this Corniferous coral, is suggested by the locality from which the specimen was obtained.

The absence of septa and the strong development of vesicular tissue suggest affinities to *Cystiphyllum*, and for the present at least *Cayugœa* is placed with the *Cystiphyllidæ*.

INDEX TO GENERIC AND SPECIFIC NAMES.

PLATE VI*.

Columnaria alveolata, Goldfuss (page 98).

Figure 1. Transverse section of corallites of a specimen from Stewart's quarry (near Sand Point), lot 18, concession 11, township of McNab, Renfrew county, Ont. ; enlarged two and a half times.

Figure 1*a*. Longitudinal section from the same specimen; enlarged two and a half times.

Columnaria Halli, Nicholson (page 100).

Figure 2. Transverse section of a specimen, from Stewart's quarry, found associated with *C. alveolata* ; enlarged two and a half times.

Figure 2*a*. Longitudinal section from the same specimen ; similarly enlarged.

Columnaria rugosa, Billings (page 101).

Figure 3. Side view of part of the type specimen from "Little Discharge," Lake St John, Que.

Figure 3*a*. Longitudinal section of one of the corallites.

Figure 3*b*. Transverse section of the same.

Columnaria calicina, Nicholson (page 102).

Figure 4. Transverse section of a specimen from Streetsville, Ont. ; enlarged two and a half times.

Petraia profunda, Conrad (page 105).

Figure 5. Side view of a specimen from La Petite Chaudière, Ottawa, Ont.

Figure 5*a*. Longitudinal section of the same specimen.

Figure 5*b*. The calyx of the same, as seen from above.

Petraia pygmæa, Billings (page 106).

Figure 6. Side view of a specimen from Heath Point lighthouse, Anticosti.

Figure 6*a*. Longitudinal section of the same specimen.

Figure 6*b*. Transverse section of the same, above the bottom of the calyx.

Streptelasma corniculum, Hall (page 108).

Figure 7. Side view of a specimen collected by Mr. E. Billings, at Ottawa, Ont.

Figure 7*a*. Longitudinal section of the same specimen.

Figure 7*b*. Transverse section of another specimen from the same locality.

Streptelasma selectum, Billings (page 113).

Figure 8. Side view of a specimen (one of the types of *S. pulchella*) from Gamache Bay Anticosti.

Figure 8*a*. Longitudinal section of the same.

Streptelasma latusculum, Billings (page 114).

Figure 9. Side view of type specimen from the "Jumpers," Anticosti. The drawings reproduced with the original description were made from this specimen.

Figure 9*a*. Longitudinal section of the same.

* All the figures are of natural size, unless otherwise stated.

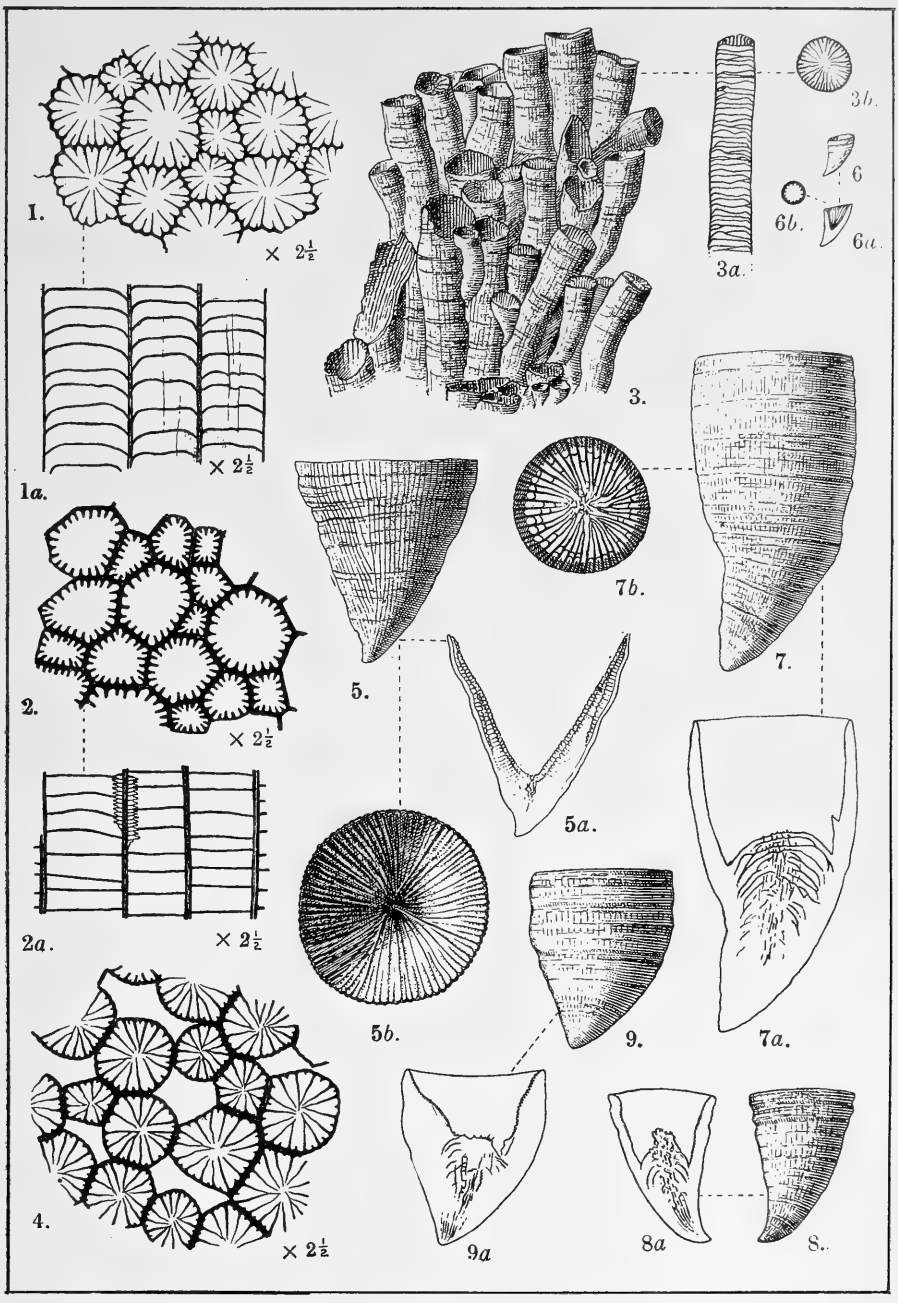

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PLATE VII.

STREPTELASMA ROBUSTUM, Whiteaves (page 109).

Figure 1 Transverse section of a specimen, from East Selkirk, Man., collected by the writer in 1890.

STREPTELASMA RUSTICUM, Billings (page 110).

Figure 2. Side view of a specimen from Lake St. John, Que.
Figure 2*a*. Longitudinal section of the same specimen.
Figure 3. Transverse section of a stouter specimen from the same locality.

STREPTELASMA CALICULUS, Hall (page 113).

Figure 4. Side view of a specimen from Grimsby, Ont., showing the position of one of the alar septa.
Figure 4*a*. Longitudinal section of the same.
Figure 4*b*. Transverse section of the same.
Figure 4*c*. Another view of the same specimen to show the surface markings indicating the position of the cardinal septum.

STREPTELASMA RECTUM, Hall (page 117).

Figure 5. Transverse section of a specimen from the Mackenzie River.

ZAPHRENTIS AFFINIS, Billings (page 118).

Figure 6. Side view of one of the type specimens, from Wreck Point, Anticosti.
Figure 6*a*. Longitudinal section of the same.
Figure 6*b*. Transverse section of the same.

ZAPHRENTIS MINAS, Dawson (page 128).

Figure 7. Side view of one of the types from West River, Pictou, N.S.
Figure 7*a*. Longitudinal section of the same.
Figure 7*b*. Transverse section of the same.

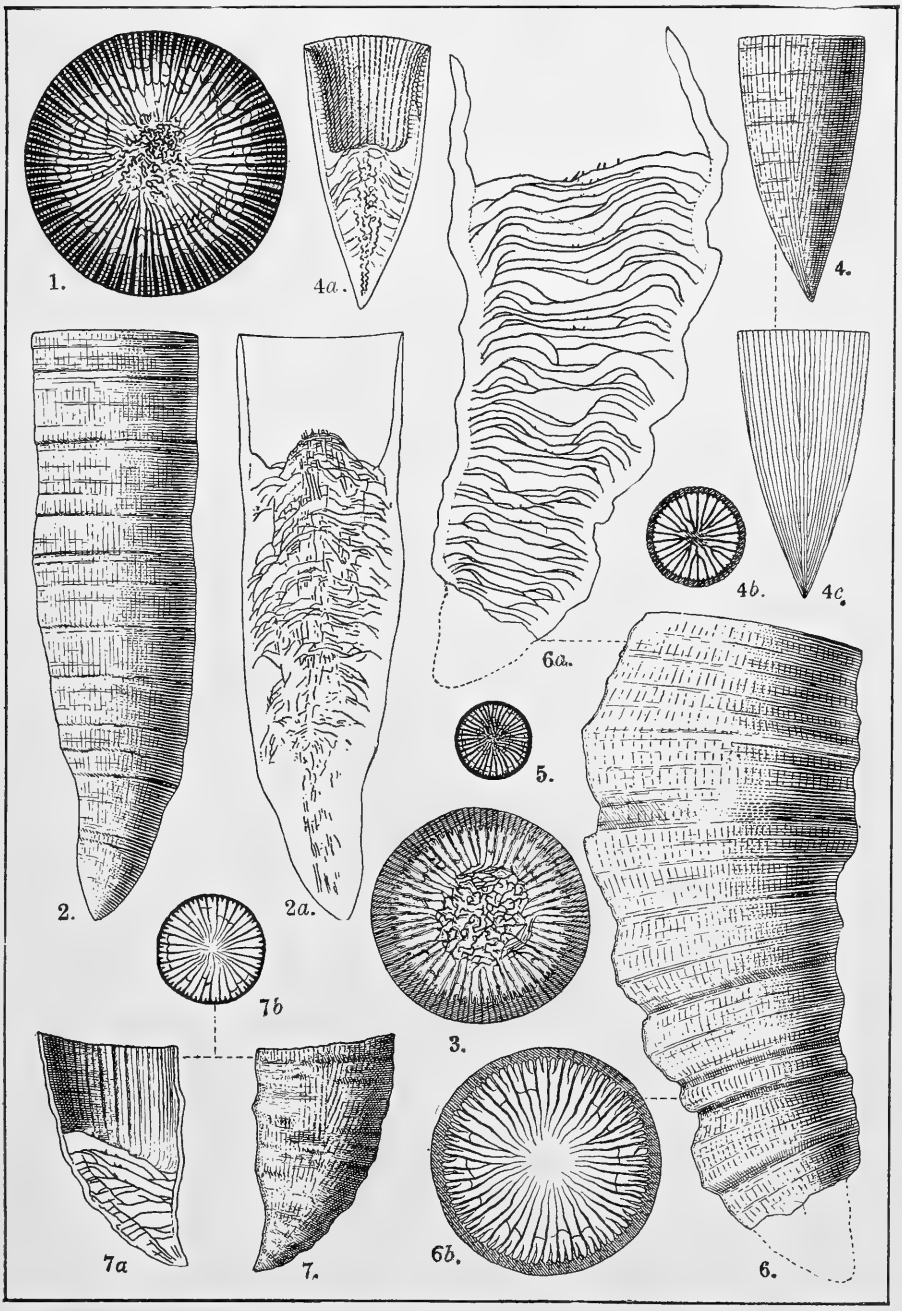

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PLATE VIII.

Streptelasma prolifica, Billings (page 115).

Figure 1. Longitudinal section of a specimen from the Corniferous limestone of Ontario.
Figure 1*a*. Transverse section of the same, beneath the bottom of the calyx.

Zaphrentis patens, Billings (page 119).

Figure 2. The type specimen, as seen from above.
Figure 2*a*. Longitudinal section of the same with a restored dotted outline of the base: *s*, septum; *f*, fossette.

Zaphrentis Shumardi, Milne-Edwards and Haime (page 121).

Figure 3. Side view of a specimen from near Owen Sound, Ont. (one of the types of *Z. cinctosa*).
Figure 3*a*. Transverse section of the same.
Figure 4. Longitudinal section of a specimen from Cap Bon Ami, N.B.

Zaphrentis cingulosa, Billings (page 124).

Figure 5. Side view of the type specimen; reduced one-half.
Figure 5*a*. Longitudinal section of the same.
Figure 5*b*. Transverse section of the same.

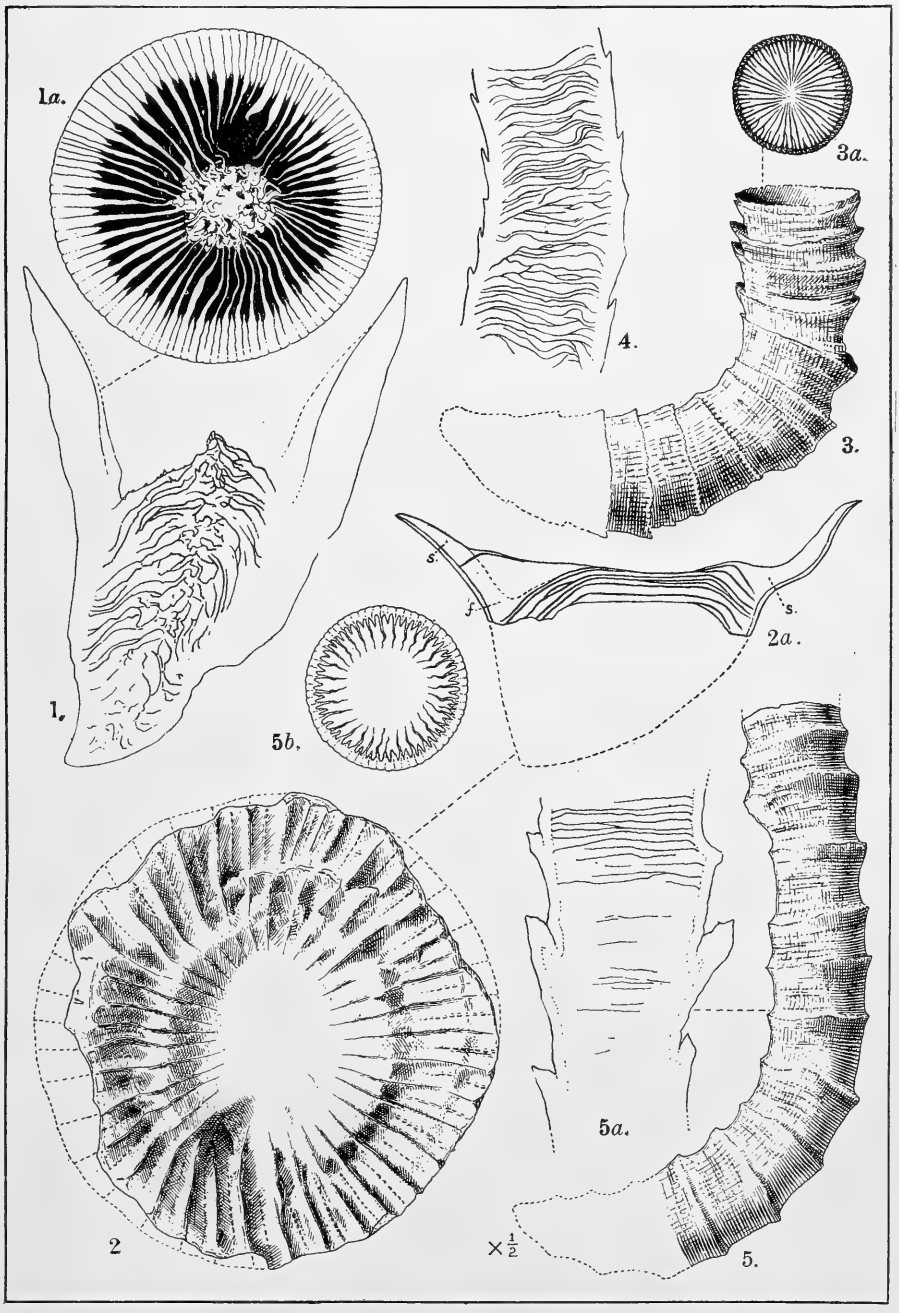

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PLATE IX.

Zaphrentis Stokesi, Milne-Edwards and Haime (page 120).

Figure 1. Side view of a specimen from Lake Temiscaming, Que.
Figure 1*a*. Longitudinal section of the same.
Figure 2. Transverse section of a smaller specimen from the same locality.

Zaphrentis gigantea, Lesueur (page 125).

Figure 3. Longitudinal section of a specimen from near Woodstock, Ont.
Figure 3*a*. Transverse section of the same.

Amplexus Yandelli, Milne-Edwards and Haime (page 130).

Figure 4. Side view of a specimen from near Woodstock, Ont.
Figure 4*a*. Longitudinal section of the same.
Figure 4*b*. Transverse section of the same.

Amplexus exilis, Billings (page 131).

Figure 5. Side view of the type specimen; one-half the natural size.
Figure 5*a*. Natural longitudinal section of the same; one-half the natural size.
Figure 5*b*. Transverse section of the same; one-half the natural size.

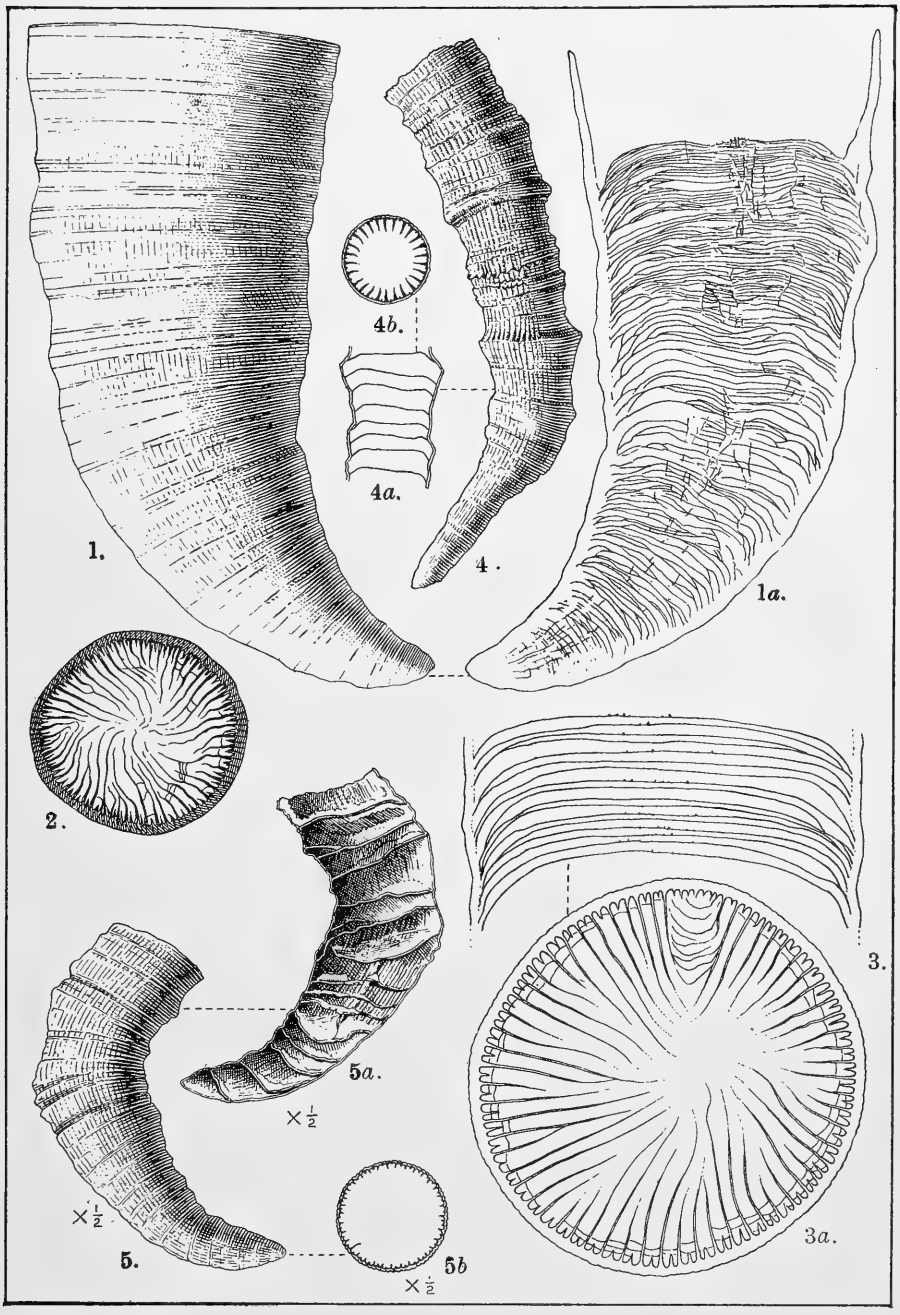

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PLATE X.

Zaphrentis mirabilis, Billings (page 126).

Figure 1. Side view of the type specimen; one-third the natural size.
Figure 1*a*. Longitudinal section of the same showing the depth of the calyx.
Figure 1*b*. Transverse section of the same.

Amplexus cingulatus, Billings (page 129).

Figure 2. Side view of one of the corallites of a small colony from Anse à la Barbe, Que.
Figure 3. Longitudinal section of a corallite from the same specimen.
Figure 3*a*. Transverse section of the same corallite.

Pycnostylus Guelphensis, Whiteaves (page 132).

Figure 4. Longitudinal section of a corallite to show the manner of budding; twice the natural size.
Figure 4*a*. Transverse section of the same to show the triangular shape of the new corallites and the disposition of their septa; twice the natural size.

Cyathophyllum Anticostiense, Billings (page 134).

Figure 5. Side view of a specimen from the Island of Anticosti; one-half the natural size.
Figure 6. Longitudinal section of the upper part of another specimen from the same locality, showing the calyx.
Figure 6*a*. Transverse section of the same.
Figure 7. Tangential section, near the surface, showing the dissepiments and the poorly developed distal ends of the septa; from a specimen from South-west Point, Anticosti. Twice the natural size.
Figure 8. Surface of a decorticated specimen (the type of *C. solitarium*) from Portage Bay, Lake Manitou, Grand Manitoulin Island, Lake Huron. Twice the natural size.

Cyathophyllum articulatum, Wahlenberg (page 135).

Figure 9. A few corallites of a specimen from Lake Temiscaming, Que.
Figure 9*a*. Longitudinal section of a corallite.
Figure 9*b*. Transverse section of the same.

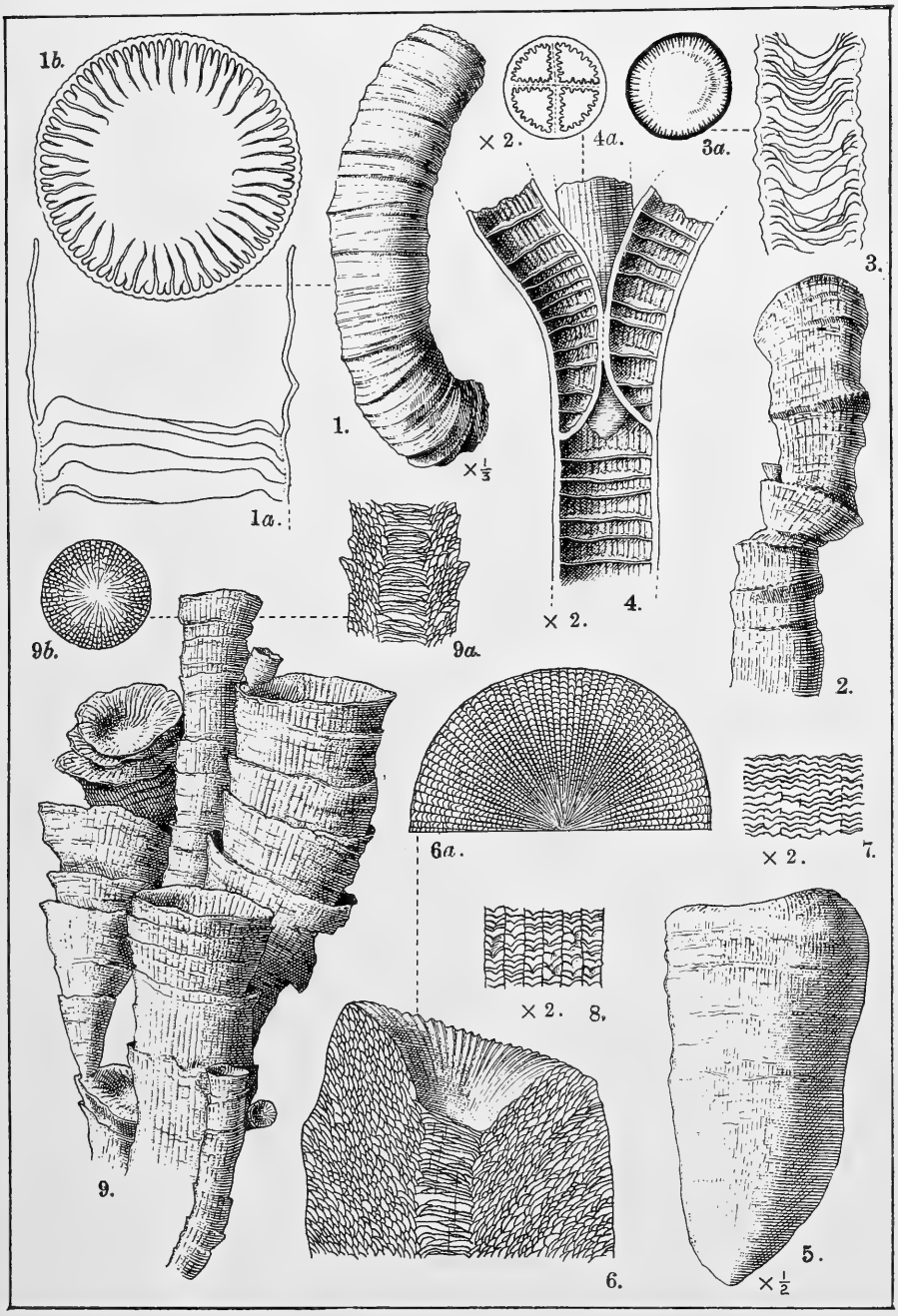

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PLATE XI.

Cyathophyllum Euryone, Billings (page 135).

Figure 1. Side view of the type specimen from the "Jumpers," Anticosti, Que.
Figure 1*a*. Longitudinal section of the same.
Figure 1*b*. Transverse section of the same.

Cyathophyllum Wahlenbergii, Billings (page 136).

Figure 2. A few of the corallites of the type specimen from East Point, Anticosti, Que.
Figure 2*a*. Longitudinal section of one of the corallites; twice the natural size.
Figure 2*b*. Transverse section of the same; twice the natural size.

Cyathophyllum interruptum, Billings (page 137).

Figure 3. Side view of the type specimen from Anse à la Barbe, Baie des Chaleurs, Que., one-half the natural size.
Figure 3*a*. Longitudinal section of the upper part of the same, showing the calyx.
Figure 3*b*. Transverse section of the same.

Cyathophyllum Pennanti, Billings (page 138).

Figure 4. Some of the corallites of the type specimen from Anse au Gascon, Baie des Chaleurs, Que.
Figure 4*a*. Longitudinal section of one of the corallites; twice the natural size.
Figure 4*b*. Transverse section of the same; twice the natural size.

Cyathophyllum Thoroldense (page 147).

Figure 5. Side view of the type specimen from Thorold, Ont.
Figure 5*a*. Longitudinal section of the same.
Figure 5*b*. Transverse section of the same.

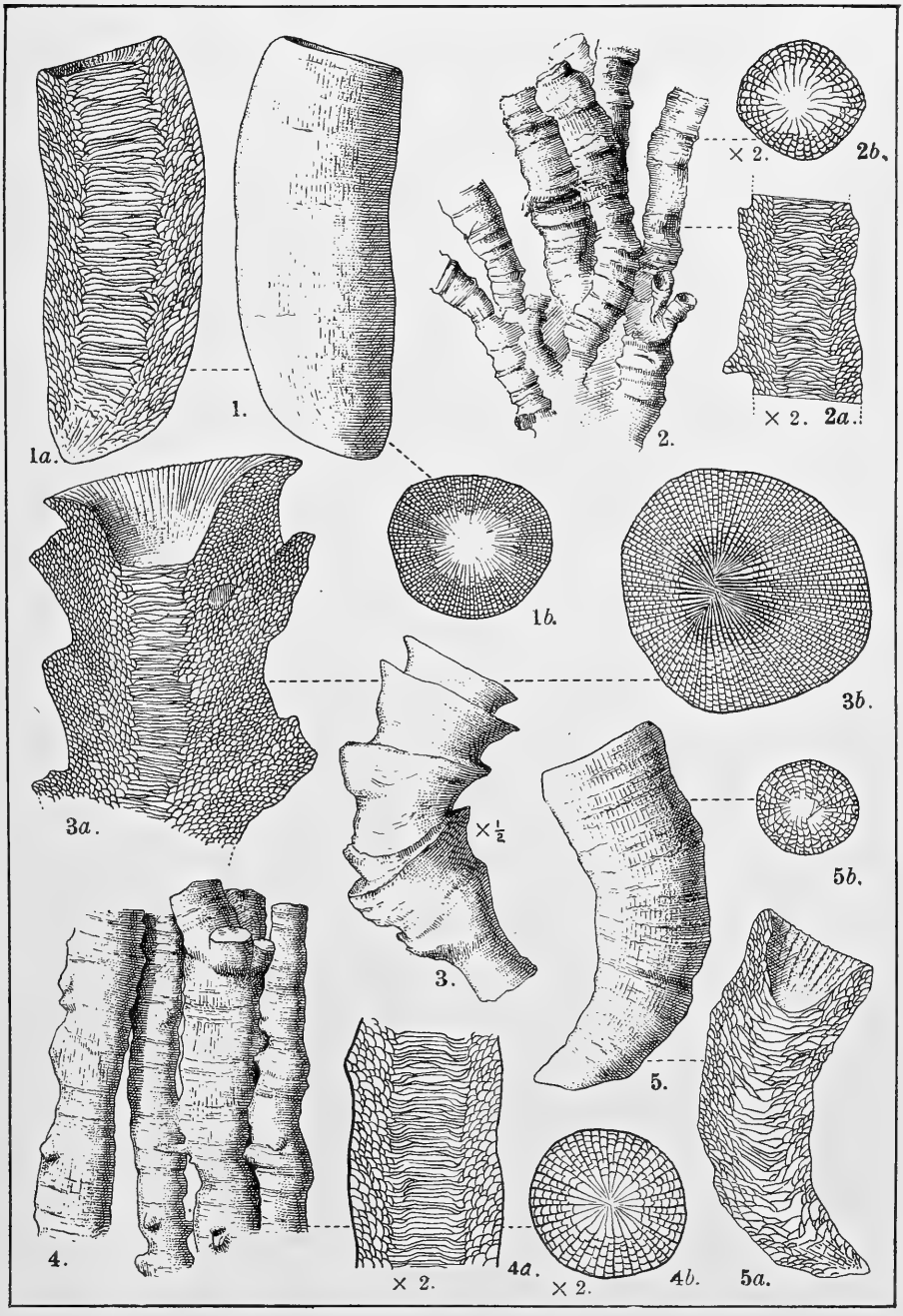

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PLATE XII.

Cyathophyllum Zenkeri, Billings (page 138).

Figure 1. Longitudinal section of the type specimen, from near Port Colborne, Ont., showing the form of the calyx.

Cyathophyllum Spenceri, Lambe (page 139).

Figure 2. A few of the corallites of the type specimen from Dawson Bay, Lake Winnipegosis.
Figure 2*a*. Longitudinal section of one of the corallites; twice the natural size.
Figure 2*b*. Transverse section of the same; twice the natural size.

Cyathophyllum cæspitosum, Goldfuss (page 145).

Figure 3. A few of the corallites of the specimen from the Peace River, near the mouth of Red River.
Figure 3*a*. Longitudinal section of one of the corallites, showing the calyx; twice the natural size.
Figure 3*b*. Transverse section of the same; twice the natural size.

Cyathophyllum Dawsoni, Lambe (page 147).

Figure 4. Side view of the type specimen from Kennetcook, Nova Scotia.
Figure 4*a*. Longitudinal section of the same.
Figure 4*b*. Transverse section of the same.

Cyathophyllum Pasithea, Billings (page 148).

Figure 5. Side view of the type specimen from Anse à la Vieille, Baie des Chaleurs, Que.
Figure 5*a*. Longitudinal section of the same.
Figure 5*b*. Transverse section of the same.

Cyathophyllum quadrigeminum, Goldfuss (page 153).

Figure 6. Calyces of a small specimen from the "Ramparts," Mackenzie River.
Figure 7. Transverse section of a few corallites of a larger specimen from the same locality.
Figure 7*a*. Transverse section of one of the corallites; twice the natural size.
Figure 7*b*. Longitudinal section of the same, showing the calyx; twice the natural size.

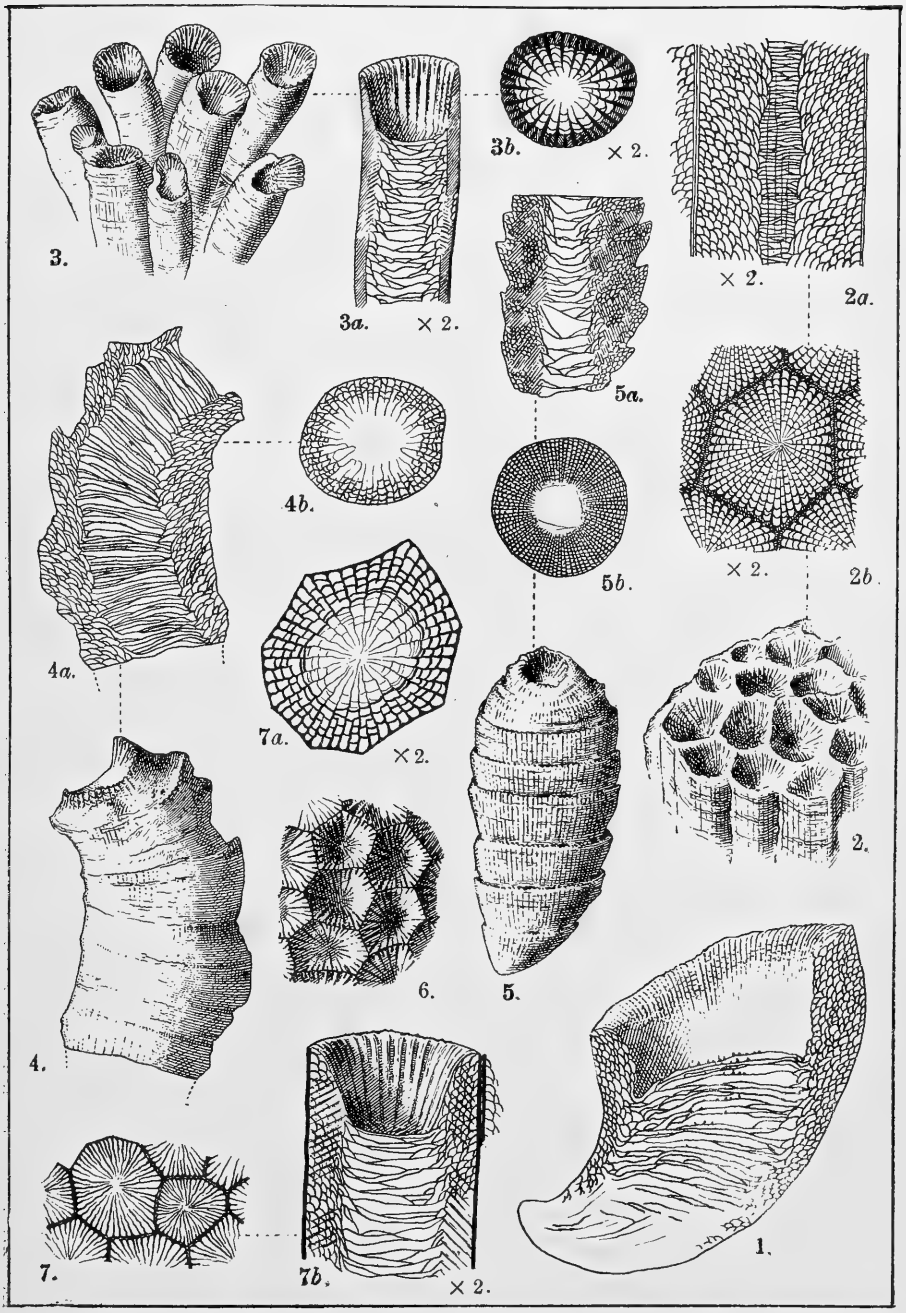

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PLATE XIII.

Crepidophyllum Archiaci, Billings (page 154).

Figure 1. Longitudinal section of one of the corallites of a specimen from Thedford, Ont.; twice the natural size.

Figure 1*a*. Transverse section of the same; twice the natural size.

Crepidophyllum colligatum, Billings (page 155).

Figure 2. A few calyces of a specimen from the township of Walpole, Haldimand county, Ont.

Figure 2*a*. Longitudinal section of one of the corallites; twice the natural size.

Figure 2*b*. Transverse section of the same; twice the natural size. The upper half of the section passes through one of the expansions of the corallite; the lower half is through the cylindrical part.

Diphyphyllum cæspitosum, Hall (page 158).

Figure 3. Relative position of the corallites to each other as seen in transverse section; from the type specimen of *C. pelagicum* from Becscie River Bay, Anticosti, Que.

Figure 3*a*. A corallite of the same specimen, shown partly in longitudinal section; twice the natural size.

Figure 3*b*. Transverse section of the corallite; twice the natural size.

Diphyphyllum multicaule, Hall (page 159).

Figure 4. Side view of part of a specimen from Grand Manitoulin Island, Lake Huron.

Figure 4*a*. Corallites, as seen from above, in the same specimen.

Figure 4*b*. Longitudinal section of one of the corallites; twice the natural size.

Figure 4*c*. Transverse section of the same; similarly enlarged.

Diphyphyllum Verneuilanum, Milne-Edwards and Haime (page 159).

Figure 5. Side view of corallites of a specimen from the township of Walpole, Haldimand county, Ont.

Figure 5*a*. Longitudinal section of a corallite showing the extension of the vesicular structure into the connecting outgrowth; twice the natural size.

Figure 5*b*. Transverse section of the same showing septa as well as vesicles in the outgrowth; twice the natural size.

Diphyphyllum Simcoense, Billings (page 161).

Figure 6. A few of the corallites of the type specimen from near Woodstock, Ont.

Figure 6*a*. Longitudinal section of one of the corallites; twice the natural size.

Figure 6*b*. Transverse section of the same; enlarged twice.

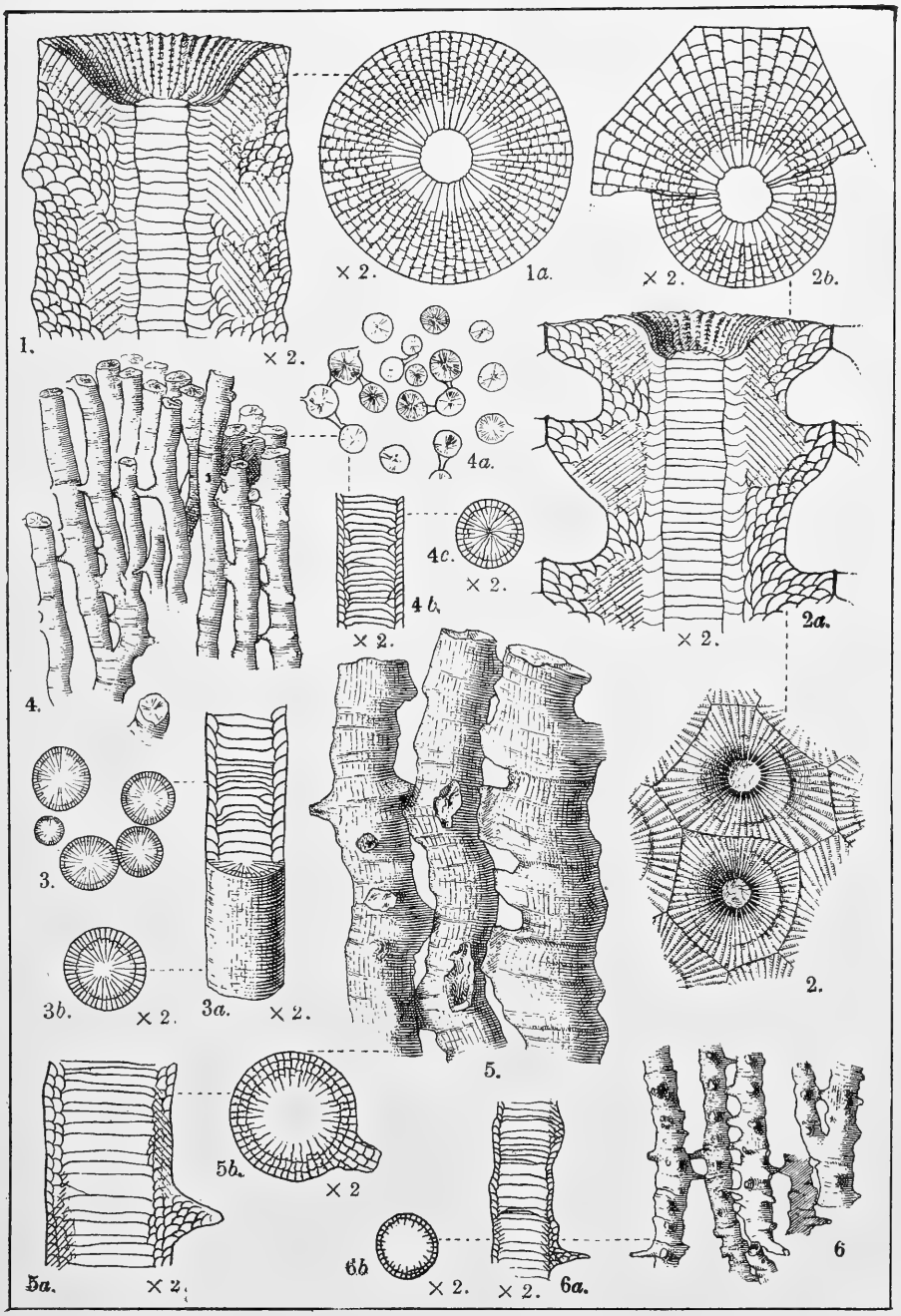

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PLATE XIV.

Diphyphyllum arundinaceum, Billings (page 162).

Figure 1. Side view of corallites of a specimen from the Corniferous formation of Ontario.
Figure 1*a*. Longitudinal section of one of the corallites ; twice the natural size.
Figure 1*b*. Transverse section of the same ; twice the natural size.

Acervularia gracilis, Billings (page 163).

Figure 2. Transverse section of some of the corallites of the type specimen from Manitouaning, Grand Manitoulin Island, Lake Huron ; twice the natural size.
Figure 2*a*. Longitudinal section of two of the corallites, showing the calyces ; twice the natural size.

Acervularia Davidsoni, Milne-Edwards and Haime (page 164).

Figure 3. Transverse section of corallites of a specimen from near Woodstock, Ont.

Phillipsastræa Verneuili, Milne-Edwards and Haime (page 166).

Figure 4. A few of the calyces of a specimen from lot 2, concession 4, Rainham township, county of Haldimand, Ont.

Phillipsastræa Verrilli, Meek (page 167).

Figure 5. Part of the calicular surface of a specimen from Vermilion Falls, Peace River, District of Athabasca.
Figure 5*a*. Transverse section of corallites from the same specimen ; one and a half times the natural size.
Figure 5*b*. Longitudinal section of corallites from the same specimen ; similarly enlarged.
Figure 6. Part of the upper surface of a specimen, with somewhat smaller corallites, from Hay River, forty miles above its mouth, District of Athabasca.

Phillipsastræa Verrilli, var. eximium (page 168).

Figure 7. A few of the calyces of a specimen from the same locality on the Hay River.

Pachyphyllum Devoniense, Milne-Edwards and Haime (page 170).

Figure 8. Transverse section of corallites of a specimen from Peace River, between the mouth of Red River and Vermilion Falls, District of Athabasca ; enlarged one and a half times.
Figure 8*a*. A longitudinal section of corallites from the same specimen ; similarly enlarged.

Lonsdaleia Pictöense, Billings (page 173).

Figure 9. Longitudinal section of one of the corallites of the type specimen from East River, Pictou, N.S. ; twice the natural size.
Figure 9*a*. Transverse section of another of the corallites of the same specimen ; twice the natural size.

Clisiophyllum Billingsi, Dawson (page 174).

Figure 10. Side view of the type specimen from Lower Stewiacke, county of Colchester, N. S.
Figure 10*a*. Longitudinal section of the same, showing the calyx.

Lithostrotion Macouni, Lambe (page 176).

Figure 11. A few of the corallites of the type specimen from Fossil Point, Peace River, B.C..
Figure 11*a*. Longitudinal section of two of the corallites ; magnified four times.
Figure 11*b*. Transverse section of a few of the corallites ; twice the natural size.

Arachnophyllum diffluens, Milne-Edwards and Haime (page 183).

Figure 12. Part of the calicular surface of a specimen from Owen Sound, Ont.

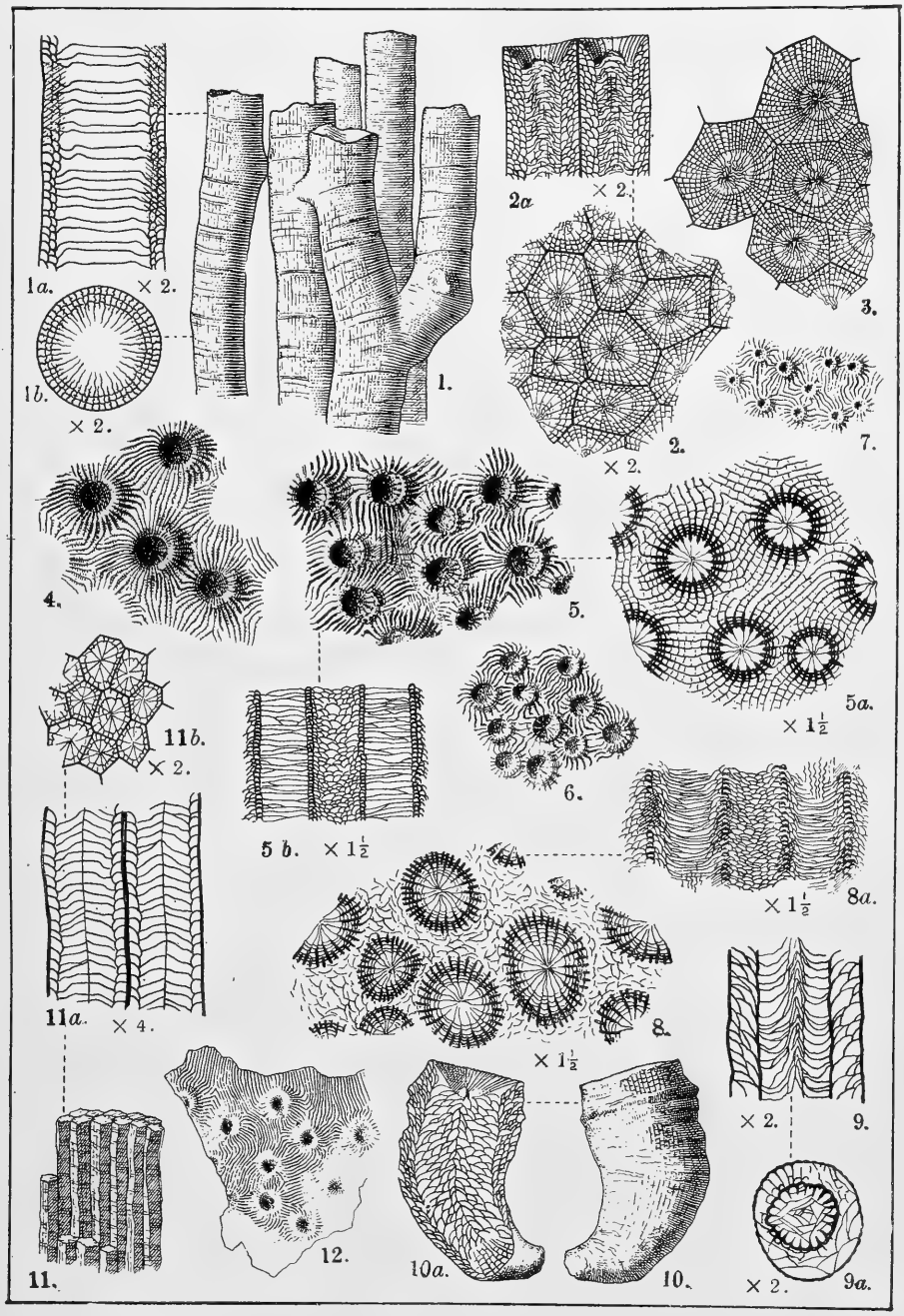

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PLATE XV.

Blothrophyllum decorticatum, Billings (page 171).

Figure 1. Longitudinal section of a type specimen from the county of Haldimand, Ont.

Figure 1*a*. Transverse section of the same.

Omphyma Eriphyle, Billings (page 180).

Figure 2. Type specimen from Anse à la Barbe, Baie des Chaleurs, Que.; reduced one-half.

Figure 2*a*. Longitudinal section of the same.

Figure 2*b*. Transverse section of the same.

Arachnophyllum pentagonum, Goldfuss (page 181).

Figure 3. Part of the calicular surface of a specimen from Grand Manitoulin Island, Lake Huron.

Figure 3*a*. Septal ridges showing the double rows of pore-openings; magnified four times.

Arachnophyllum mamillare, Dale Owen (page 182).

Figure 4. Part of the upper surface of a specimen from Grand Manitoulin Island, Lake Huron.

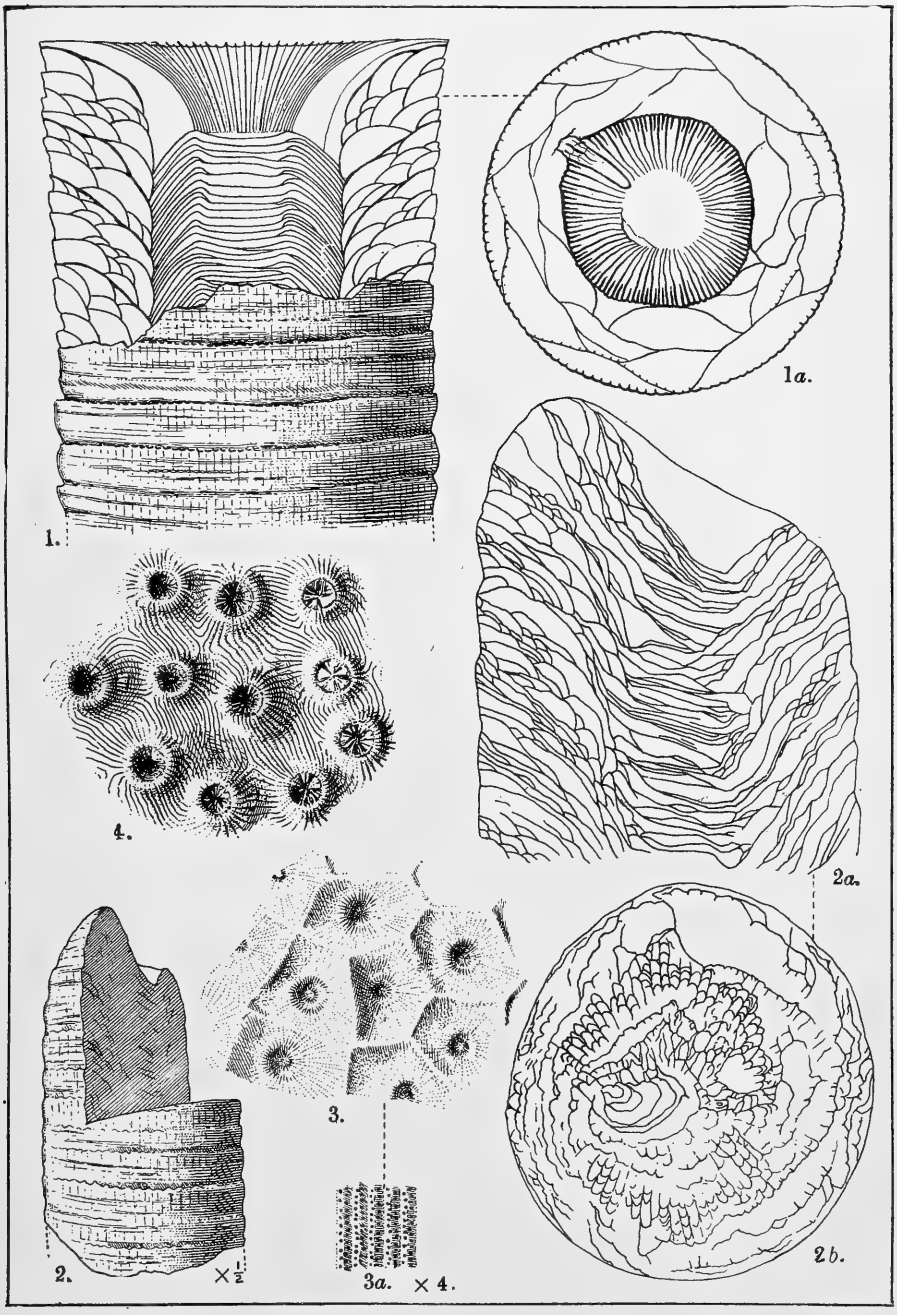

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PLATE XVI.

Acrophyllum Oneidaense, Billings (page 175).

Figure 1. Side view of a specimen from the Corniferous formation of Ontario, showing the calyx in perspective and part of the tabulate and vesicular areas in longitudinal section.

Figure 2. Transverse section of another specimen.

Arachnophyllum eximium, Billings (page 184).

Figure 3. Part of the calicular surface of the type specimen from West Point, Grand Manitoulin Island, Lake Huron.

Figure 3*a*. Longitudinal section of one of the corallites of the same; twice the natural size.

Figure 4. Transverse section of a corallite of another specimen from Grand Manitoulin Island; enlarged two diameters.

Chonophyllum Belli, Billings (page 186).

Figure 5. Side view of the type specimen from the east side of the village in the bight of West Bay, Grand Manitoulin Island, Lake Huron.

Figure 6. The calyx of another specimen, as seen from above; from half a mile northwest of Portage Bay, Lake Manitou, Grand Manitoulin Island, Lake Huron.

Cystiphyllum Niagarense, Billings (page 190).

Figure 7. Side view of a specimen from Cockburn Island, Lake Huron (type of *C. Huronense*).

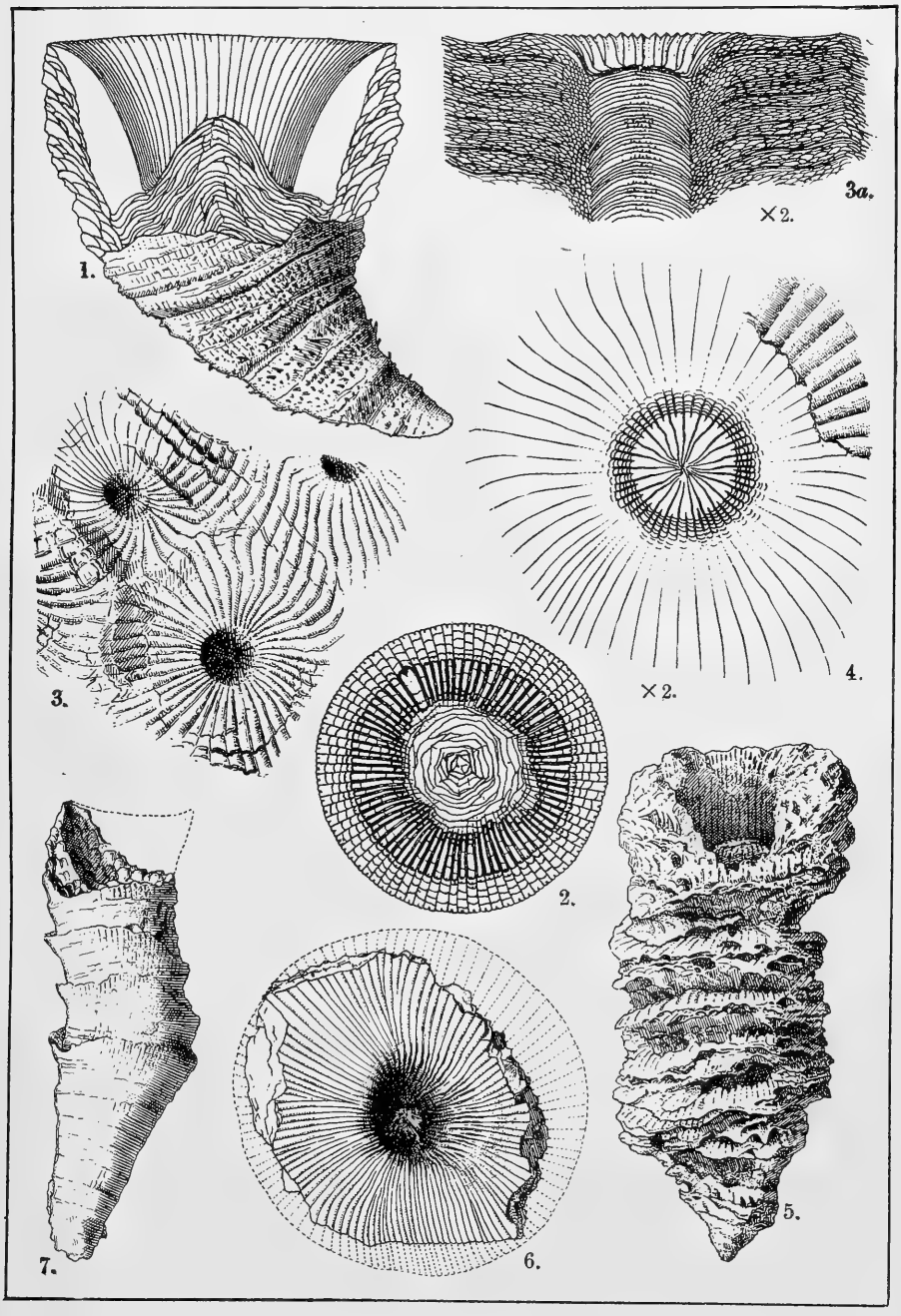

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PLATE XVII.

Chonophyllum Canadense, Billings (page 185).

Figure 1. Type specimen, as seen from above, showing the calyx and the horizontal frill-like extension surrounding it; from South-west Point, Anticosti. One half the natural size.

Figure 1*a*. Side view of the same; one half the natural size.

Figure 1*b*. The raised concentric markings of the upper surface.

Figure 1*c*. Diagrammatic section of the type specimen; one half the natural size.

Figure 2. Longitudinal section through the calyx of a young individual from South-west Point, Anticosti.

Figure 3. Longitudinal section through the calyx of a larger specimen from the same place

Figure 3*a*. Part of the same section, enlarged twice, to show the structure.

Figure 3*b*. Transverse section of the specimen, represented in figure 3, through the visceral chamber a little above the base.

Figure 4. Vertical tangential section, showing the superimposed layers of two septal ridges, about midway between the raised calicular area and the edge of the lateral extension; from another specimen from South-west Point, Anticosti. Twice the natural size.

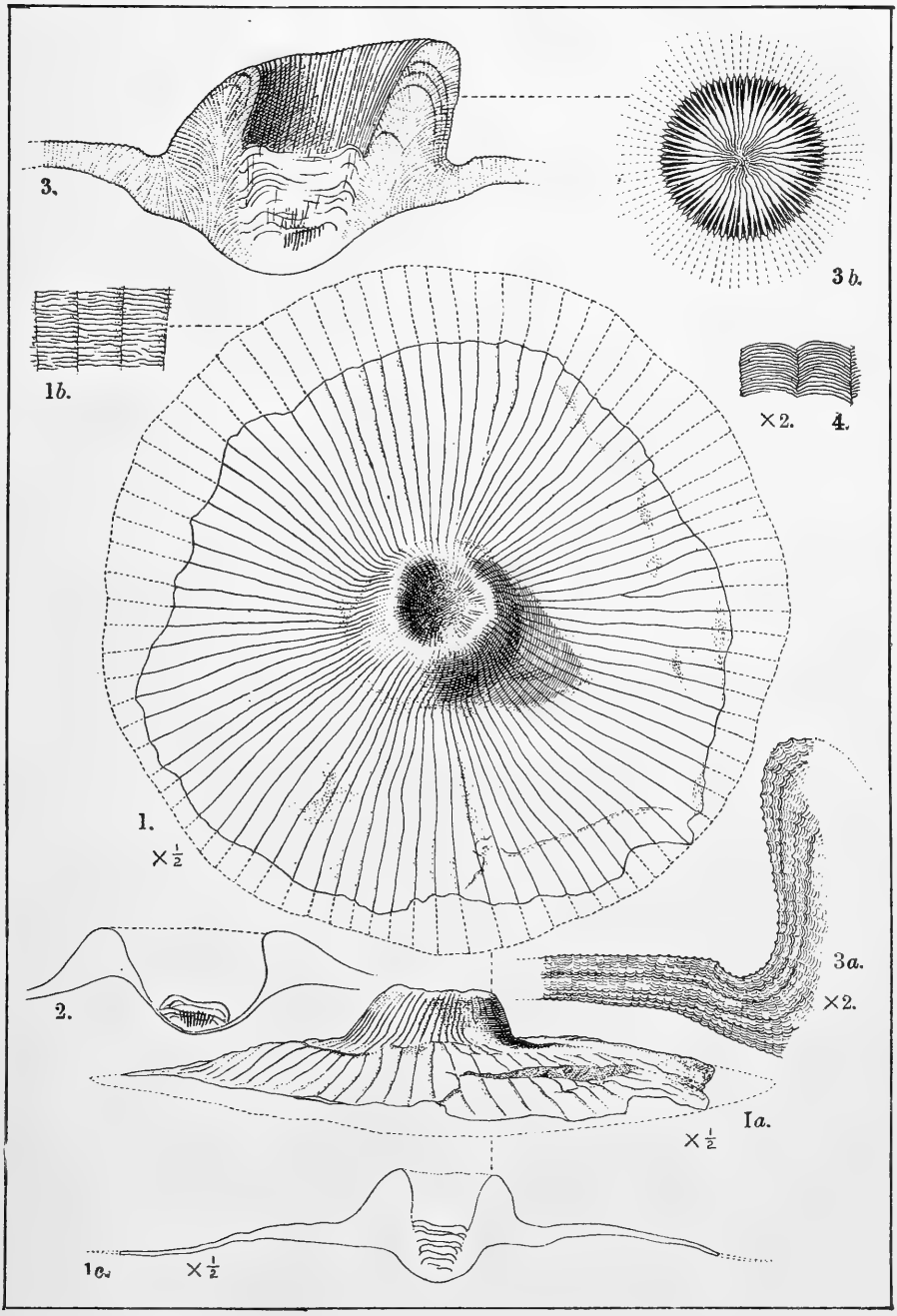

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PLATE XVIII.

CHONOPHYLLUM NYMPHALE, Billings (page 187).

Figure 1. Side view of the type specimen from Anse à la Vieille, Baie des Chaleurs, Que.; three-fourths the natural size.

Figure 1*a*. Longitudinal section of the same. On account of their smallness the vesicles are shown only in places.

CYSTIPHYLLUM MARITIMUM, Billings (page 191).

Figure 2. Side view of the type specimen from Anse à la Vieille, Baie des Chaleurs, Que.

Figure 2*a*. Longitudinal section of the same. As in figure 1*a* the vesicular structure is here also only partially represented.

CYSTIPHYLLUM AGGREGATUM, Billings (page 193).

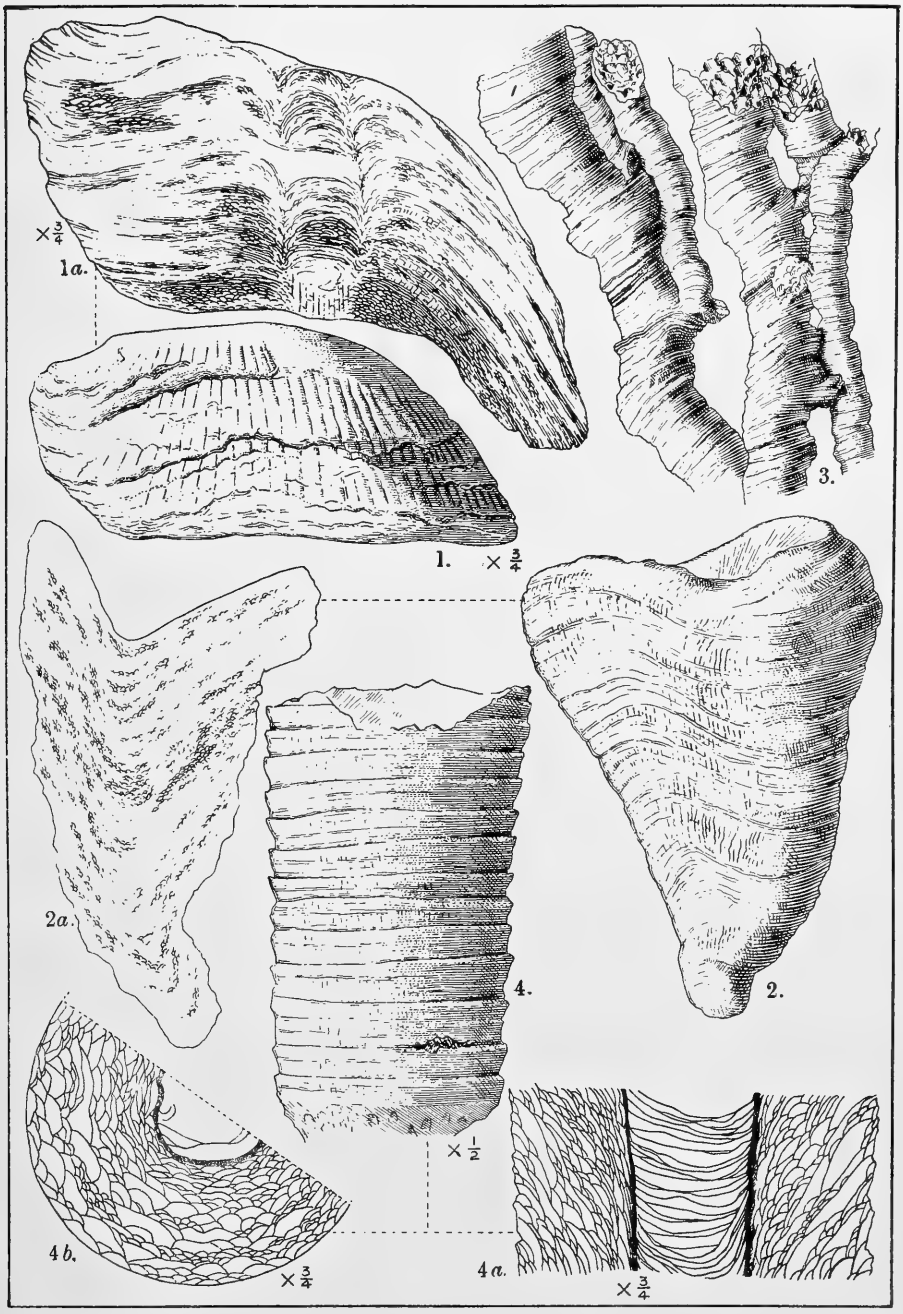
Figure 3. Side view of a few corallites of a specimen from lot 6, concession 13, township of Walpole, Haldimand county, Ont.

CAYUGÆA WHITEAVESIANA (page 196).

Figure 4. The type specimen from the north half of concession 1, lot 53, Cayuga township, county of Haldimand, Ont.; one-half the natural size.

Figure 4*a*. Longitudinal section of the same; three-fourths the natural size.

Figure 4*b*. Transverse section of the same; similarly reduced.



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