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I.—On some new or imperfectly-known species of Stromatoporoids.—Part III

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“..... per litora spargite muscum,
 Naiades, et circum vitreos considite fontes:
 Pollice virgineo teneros hic carpite flores:
 Floribus et pictura. divæ, replete canistrum.
 At vos, o Nymphæ Craterides, ite sub undas;
 Ite, recurvato variata corallia trunco
 Vellite muscosis e rupibus, et mihi conchas
 Ferte, Dece pelagi, et pingui conchylia succo.”
N. Parthenii Giannettasii Eol. 1.

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I.—*On some new or imperfectly-known Species of Stromatoporoids.* By H. ALLEYNE NICHOLSON, M.D., D.Sc.,
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 Aberdeen.—Part III.

[Plates I.—III.]

Clathrodictyon vesiculosum, Nich. & Mur.
 (Pl. I. figs. 1–3.)

Clathrodictyon vesiculosum, Nicholson and Murie, Journ. Linn. Soc.,
 Zool. vol. xiv. p. 220, pl. ii. figs. 11–13 (1878).

Clathrodictyon vesiculosum, Nicholson and R. Etheridge, Jun., Mon.
 Sil. Foss. Girvan, p. 238, pl. xix. fig. 2 (1880).

? *Stromatopora striatella*, McCoy, British Palæozoic Fossils, p. 12
 (1851).

Cœnosteum forming laminar expansions, often of large size, having the lower surface covered by a concentrically-striated and wrinkled epitheca. Full-sized individuals may be from 6 to 9 inches in diameter and an inch or more in thickness. The upper surface is irregularly undulating, without “mamelons,” and exfoliating concentrically round the elevated points. Well-developed astrorhizæ are present; but the central canals

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of these do not open on the surface by prominent apertures. As regards minute structure, the cœnosteum is made up of closely-set horizontal laminæ, which are only slightly or not at all undulated, but which are minutely crumpled, so as to give rise to more or less imperfect radial pillars. The radial pillars are invariably confined to their respective interlaminar spaces, and are therefore not "continuous." The interlaminar spaces are broken up into minute, often imperfect, lenticular cells, which are essentially formed by curved inflections of the concentric laminæ.

In general, from eight to ten interlaminar spaces or from nine to eleven laminæ occupy the space of 1 millim.* The cells formed by the radial pillars or by the bendings of the laminæ are very variable in size, but are mostly from $\frac{1}{8}$ to $\frac{1}{16}$ millim. in length.

Obs. *C. vesiculosum* is the type species of the genus *Clathrodictyon* †, Nich. & Mur. As in all the species of the genus, therefore, the radial elements of the skeleton are incompletely developed, and never extend from one interlaminar space into another. While the radial pillars are thus imperfect, the concentric laminæ of the cœnosteum are minutely undulated, and the interlaminar spaces thus become broken up and subdivided into vesicles, the size and shape of which are exceedingly variable. Hence vertical sections of *C. vesiculosum* (Pl. I. figs. 1 and 3) show a minutely vesicular structure, the cœnosteum appearing to be made up of minute lenticular cells, arranged in horizontal or slightly curved

* It should be understood that all such measurements as the above are approximate and not absolute. They are true of one particular specimen; but even within the limits of a single slide the number of interlaminar spaces and laminæ in a given space is not absolutely constant. Still more is there a want of complete uniformity when we examine slides taken from different examples of the same species. Nevertheless, in spite of a considerable range of individual variability, each species exhibits a sufficient constancy in the *average* distance at which its component laminæ are placed apart to render this character available in specific determination.

† The genus *Clathrodictyon* is distinguished from *Actinostroma* (*Stromatopora*, auctt.) by the fact that the radial pillars are restricted to their respective interlaminar spaces, instead of being "continuous." They also do not give out whorls of radiating "arms," and hence we do not see in tangential sections the "hexactinellid" structure so characteristic of species of *Actinostroma*, though an approach to this is seen in some species of the genus (e. g. in *C. regulare*, Ros., sp.). The surface in the species of *Clathrodictyon* is usually smooth or gently undulated and mostly without definite prominences or "mamelons;" these structures are, however, not universally absent, as I formerly supposed (*Mon. Brit. Strom.* p. 77), but are present, occasionally or constantly, in two species of the genus.

rows. On the other hand, tangential sections (Pl. I. fig. 2) show the cut ends of the isolated and imperfect radial pillars along with the irregularly divided edges of the concentric laminæ. Tangential sections also show no traces of radiating "arms" springing from the radial pillars. Small astrorhizæ are seen in tangential sections, and these usually have a wall-less central canal; but the openings of the latter on the surface are not prominently elevated.

*C. vesiculosum**, Nich. & Mur., belongs to a series of forms the specific determination of which is exceptionally difficult. The forms in question, viz. *C. vesiculosum*, Nich. & Mur., *C. variolare*, Rosen, *C. Linnarssoni*, Nich., and *C. crassum*, Nich., are all easily recognized as distinct when typical examples are selected for examination. It is therefore expedient to distinguish them by separate specific names. At the same time there are close relationships between all these forms, and examples are not uncommon which show intermediate characters, and which therefore it is difficult to refer definitely to any one of the four. In a less striking form a passage may also be traced between this group of types and *C. fastigiatum*, Nich.

From the forms above mentioned *C. vesiculosum* is best distinguished by the extreme closeness with which the concentric laminæ are set and the resulting minuteness of the cells which compose the cœnosteum. Not only are the laminæ exceedingly close, but the interlaminar spaces are nearly equal in width, and the cellular tissue of the skeleton is thus approximately uniform. On the other hand, in typical examples of *C. variolare*, Ros., the interlaminar spaces are unequal in size—wide spaces alternating tolerably regularly with spaces which are much narrower than the average and which are usually arranged in groups (Pl. I. fig. 5). In *C. Linnarssoni*, Nich., again, the concentric laminæ are much less crumpled, and the cells of the interlaminar spaces are

* From a recent paper by Dr. Rominger (Proc. Acad. Nat. Sci. Phil. 1886) I gather that this observer had given the name of *Stromatopora minuta* to the present species many years ago (1871) in a memoir in which a number of Stromatoporoids were described and named. As the memoir in question, however, was never published (and is still unpublished), this name has, of course, no validity. The same observation applies to a number of additional names given by Dr. Rominger in the same memoir to various Stromatoporoids, which have been subsequently described and named by other authorities. As the non-publication of the memoir in which these names were originally given deprives the same of all force as against names published prior to 1886, it is not altogether easy to see the object gained by the reproduction of these MS. titles at the present day.

therefore much more nearly quadrangular than is the case in *C. vesiculosum*. The form which I have named *C. crassum* is sufficiently distinguished by the comparatively small number of laminae in a given space and by the great thickness of the skeleton-fibre. Lastly, *C. fastigiatum* is sufficiently separated from the present species by the much greater width of the interlaminar spaces and the chevron-like folding of the concentric laminae.

Formation and Locality. So far as known, the species is wholly Silurian (Upper Silurian). The type-specimen is from the Clinton formation of Yellow Springs, Ohio. It occurs also in the Niagara Limestone at Thorold, Ontario, and probably at many other localities in this formation. In the Wenlock Limestone of Britain it occurs at Much Wenlock, Dudley, Ironbridge, Dormington, &c. I have also collected specimens apparently belonging to this form from the Silurian ("Zone of *Pentamerus esthonus*") of Kattentack, Esthonia, and from the "Raiküll Beds" of Raiküll. In Scotland it has been collected by Mrs. Robert Gray in the Silurian rocks of Woodland Point, near Girvan.

Clathrodictyon variolare, Rosen, sp.
(Pl. I. figs. 4-6.)

Stromatopora variolaris, von Rosen, Ueber die Natur der Stromatoporen, p. 61, pl. ii. figs. 2-5 (1867).

Cœnosteum laminar, hemispherical, or massive, with a concentrically-wrinkled basal epitheca, and often attaining a large size. The surface may be smooth or may exhibit numerous "mamelons," which are sometimes small and pointed or, more commonly, low and rounded (Pl. I. fig. 4). Astrorhizæ are present, but are of small size, and do not appear to correspond in any special way with the surface-eminences or "mamelons," when these latter structures are present.

The internal structure is very similar to that of *C. vesiculosum*, the skeleton being composed of close-set concentric laminae, which are horizontal or only slightly undulated, and are minutely crumpled, so as to give rise, along with the incomplete radial pillars, to a fine vesicular tissue. From eight to ten laminae occupy a space of 1 millim.; but the interlaminar spaces are of unequal sizes, rows of large vesicles alternating with rows of small ones (Pl. I. fig. 5). In general, rows of large vesicles are separated by two or three rows of much smaller cells; but there may be only a single row of the latter or they may even be wanting in places. Tangen-

tial sections (Pl. I. fig. 6) exhibit the cut ends of the irregular radial pillars and the divided edges of the laminae, but show no characteristic feature.

Obs. As before remarked, this species is closely allied to *C. vesiculosum*, Nich. & Mur., and forms intermediate between the two are not uncommon. The character which most decisively distinguishes *C. variolare* from the latter is the alternation of rows of large cells with wider or narrower zones of exceedingly minute vesicles. In other respects the two forms stand very close to one another.

Formation and Locality. So far as known, this species is wholly Silurian (Upper Silurian). It occurs abundantly in the Silurian Limestones of Esthonia, and I have collected many examples from Kattentack and between Saage and Ridaka. The species also occurs in the Wenlock Limestone of Britain (Ironbridge and Dormington); but some of the British specimens which I should be disposed to place here differ in certain respects from the Esthonian type. Von Rosen's type-specimen (which I have examined) is from Errinal, in Esthonia.

Clathrodictyon Linnarssoni, Nich. (Pl. I. figs. 7 and 8.)

Cœnosteum laminar, often of considerable size, with a finely wrinkled basal epitheca, the upper surface being smooth and seemingly without "mamelons." Average thickness in the centre of the cœnosteum about 1 inch (in the specimens examined). Small astrorhizæ are present, with wall-less vertical canals; but these do not open above by projecting apertures.

In internal structure the cœnosteum is composed of close-set horizontal laminae, about six to eight of these occupying the space of 1 millim. The laminae may undulate gently, but are not minutely crumpled. The interlaminar spaces are crossed by numerous, small, straight radial pillars, which often do not reach the whole way from one lamina to another, and never extend out of their own interlaminar space. The interlaminar spaces are thus broken up into numerous more or less complete cells, which are oblong or square rather than lenticular in form. Tangential sections show the cut ends of the radial pillars and the astrorhizal canals, but offer nothing specially characteristic. Vertical sections (Pl. I. fig. 7) show further the wall-less axial canals of the astrorhizæ, sending off horizontal radiating branches into successive interlaminar spaces.

Obs. This species is closely allied to *C. vesiculosum*, Nich. & Mur., and *C. variolare*, Ros. It differs from both in the want of crumpling of the concentric laminæ and in the resulting fact that the interlaminar vesicles are quadrangular rather than lenticular. It differs further from *C. vesiculosum* in the greater remoteness of the laminæ, and from *C. variolare* in the approximately uniform width of the interlaminar spaces. Dr. George J. Hinde has been good enough to submit to me a number of examples of this form from Gotland, where it seems to be common; but I have not found it elsewhere.

Formation and Locality. Wenlock Limestone, Wisby, Gotland (coll. Dr. George J. Hinde).

Clathrodictyon striatellum, D'Orb., sp.
(Pl. I. figs. 9 and 10.)

Stromatopora concentrica, Lonsdale, Silurian System, p. 680, pl. xv. fig. 31 (1839).

Stromatopora striatella, d'Orbigny, Prodrome de Paléontologie, t. i. p. 51 (1850).

Stromatopora mammillata, Fr. Schmidt, Sil. Form. von Ebstland, p. 232 (1858).

Stromatopora mammillata, von Rosen, Ueber die Natur der Stromatoporen, p. 71, pl. viii. figs. 1-5 (1867).

Stromatopora mammillata, Ferd. Roemer, Lethæa Palæozoica, part i. p. 531, fig. 125 (1883).

Cænosteum mostly laminar or hemispherical, with a concentrically-wrinkled basal epitheca. Surface more or less undulated, but without definite eminences or "mamelons," the concentric laminæ usually exfoliating concentrically round elevated points. In well-preserved examples the surface shows innumerable small rounded tubercles, representing the crumpling of the concentric laminæ, and between these are minute pores. Astrorhizæ are apparently wanting.

As regards internal structure, vertical sections (Pl. I. fig. 9) show that the concentric laminæ are comparatively remote, about four interlaminar spaces, and therefore five laminæ, occupying the space of 1 millim.; but the interlaminar spaces are wider over the convexities of the undulated laminæ. The laminæ are thrown into successive undulations, which are more pronounced in some specimens than in others, but are always gentle and regularly curved. The laminæ are also regularly crumpled, in the same manner as in *C. vesiculosum*, but less completely, so that there is no appearance in vertical sections of rows of lenticular vesicles, such as are so characteristic of the latter species. Each infolding of the lamina is,

however, prolonged *downwards* * into the interlaminae space below in the form of a more or less complete radial pillar. Some of the radial pillars are quite short; others project about halfway into the interlaminae space; others cross the space and connect themselves with the lamina below; finally a few spring from the *upper* sides of the laminae. A further very characteristic point about the radial pillars is that they are very commonly double at their bases, where they spring from their producing lamina. Tangential sections (Pl. I. fig. 10) of this species are much more characteristic than is usual in the genus *Clathrodictyon*. Where such a section traverses an interlaminae space the cut ends of the radial pillars are seen in the form of dark granular masses of considerable size and usually of a more or less elongated or oval shape. When the section more or less closely coincides with a concentric lamina, the cut ends of the radial pillars are more closely set and larger in size, and often form a sort of mosaic pavement, or at other times a loose reticulation. Tangential sections are also unlike similar sections of most species of this genus in the apparent absence of astrorhizal canals.

Obs. I shall have the opportunity of dealing more fully elsewhere with the peculiarities of the minute structure of *C. striatellum*, and need not discuss them further here. In its general features the species is one which can hardly be confounded with any other member of the genus. It is most nearly related to *C. regulare*, Rosen, but is readily distinguished by its wider interlaminae spaces and by the quite peculiar form of its radial pillars. I need only add that my identification of this form as being the one which d'Orbigny had in view in establishing his species is based upon an examination of Lonsdale's original specimen, which served as the type of the species to the French palaeontologist. My identification of *Stromatopora mammillata*, Fr. Schmidt, with d'Orbigny's species is based upon specimens of the former kindly given to me by Magister Schmidt himself; and there can be no doubt as to the complete identity of the two types, such slight differences as are apparent being the result of the fact that the Estonian specimens are silicified.

Formation and Locality. Ordovician and Silurian. So far, the species has not been recognized in the Ordovician rocks

* In the illustrations which I gave of vertical sections of this species in the introduction to the 'Monograph of British Stromatoporoids' (pl. i. fig. 1 and pl. v. fig. 3) the figures were inadvertently reversed in position, so that the radial pillars are represented as growing from the *upper* sides of the laminae instead of from the lower, as is really the case.

except in Esthonia (in the "Borkholm'sche Schichten"). In the Silurian rocks it is a common species in the Wenlock Limestone of Britain (Dudley, Ironbridge, Dormington, &c.). I have also specimens from the Wenlock Limestone of Wisby, Gotland.

Clathrodictyon crassum, Nich. (Pl. II. figs. 1 and 2.)

Cœnosteum laminar, thin (about a centimetre or thereabouts in thickness), and of small size. The underside is covered with a concentrically-striated epitheca. The upper surface is studded with vermiculate tubercles and exhibits well-marked branching astrorhizal canals. "Mamelons" are not present.

As regards internal structure, the cœnosteum is seen in vertical sections (Pl. II. fig. 1) to be composed of nearly horizontal concentric laminae, of which five or six occupy the space of 1 millim. The laminae are minutely inflected and become blended with the thick radial pillars, by which the interlaminar spaces are divided into irregularly-sized oval or rounded cells. In tangential sections (Pl. II. fig. 2) the cut ends of the thickened radial pillars are seen to form a sort of loose reticulation, in which the ends of the smaller pillars usually appear as dark dots. Such sections also show numerous, large-sized, branching astrorhizal canals. The skeleton-fibre is of unusual thickness, and the width of the interlaminar spaces is therefore proportionately reduced as compared with the width of the concentric laminae.

Obs. Without entering here into minute details, it may be stated that *C. crassum* is most nearly related to *C. variolare*, Rosen; and forms intermediate between the two are not unknown. Typical examples of the present species can, however, be at once distinguished by the coarse tuberculation of the surface and the comparatively large development of the astrorhizæ, by the excessive thickness of the skeleton-fibre, by the complete reticulation of the laminae and radial pillars, and by the characteristic aspect of tangential sections.

Formation and Locality. Rare in the Wenlock Limestone of Britain (Dudley, Ironbridge, and Dormington).

Clathrodictyon fastigiatum, Nich.
(Pl. II. figs. 3 and 4.)

Clathrodictyon fastigiatum, Nicholson, Mon. Brit. Stromatoporoids, p. 43, fig. 3 (figure only).

Cœnosteum laminar and cake-like, of variable size, but of

small thickness, full-sized individuals having a diameter of 6 inches or more, with a thickness in the centre of an inch or less. The under surface is covered with a concentrically-wrinkled epitheca. The upper surface exhibits vermiculate and inosculating ridges, formed by rows of elongated tubercles, but is otherwise flat or slightly undulated, showing no "mamelons." *Astrorhizæ* are very imperfectly developed and can sometimes hardly be said to exist.

In internal structure the skeleton is composed of bent and crumpled concentric laminae, of which about five or six occupy the space of 1 millim. As shown by vertical sections (Pl. II. fig. 3), the laminae are bent in two ways. In the first place they are bent into numerous chevron-like foldings, no traces of which, however, can be seen on the surface of the cœnosteum. In the second place each lamina is minutely crumpled or inflected in such a way that the interlaminar spaces are constricted into rows of very imperfect and more or less open vesicles. The radial pillars are developed from the points of inflection of the laminae, but are mostly imperfect and thin. Hence, in vertical sections, the bent and crumpled laminae are far more conspicuous than the radial pillars. Tangential sections (Pl. II. fig. 4) exhibit the irregular and vermiculate edges of the transversely-divided and folded laminae, the cut ends of the radial pillars appearing in these as dark rounded dots. *Astrorhizæ* may sometimes be recognized in tangential sections, but are always inconspicuous.

Obs. This beautiful species has certain relationships with *C. variolare*, Rosen, and specimens occasionally occur which present a mixture of the characters of the two forms. In typical examples, however, *C. fastigiatum* can hardly be confounded with any other species of *Clathrodictyon*. It is distinguished from its nearest allies (viz. *C. variolare* and *C. visiculosum*) by the greater remoteness of the concentric laminae and by the peculiar and constant chevron-like and angular folds into which the laminae are thrown. The appearances presented by tangential sections are also exceedingly characteristic, and quite unlike those seen in any other species of *Clathrodictyon* with which I am acquainted.

Formation and Locality. Abundant in the Wenlock Limestone of Britain (Dudley, Ironbridge, Much Wenlock, Dormington). I have also collected examples of the species in the Silurian limestones ("Zone of *Pentamerus esthonus*") of Kattentack, Esthonia.

Clathrodictyon regulare, Rosen, sp.
(Pl. II. figs. 5 and 6.)

Stromatopora regularis, von Rosen, Ueber die Natur der Stromatoporen, p. 74, pl. ix. figs. 1-4 (1867).

Cœnosteum of small size ; sometimes laminar and discoidal, with a wrinkled basal epitheca ; sometimes incrusting foreign bodies. The largest specimen examined is less than 2 inches in diameter, with a maximum thickness of half an inch. The surface is smooth or slightly undulated without "mamelons," and often showing the edges of the exfoliated laminæ. Astro-rhizæ are apparently absent. In well-preserved examples the surface is studded with small rounded tubercles, representing the free ends of the radial pillars, which often send out radiating horizontal prolongations, inclosing minute interstitial pores.

As regards internal structure, the skeleton is made up of horizontal or slightly flexuous concentric laminæ, of which about six occupy the space of 1 millim. The laminæ are thick, often with a median dark line, and slightly crumpled (Pl. II. fig. 5). At each point of inflection the lamina sends down from its under surface a stout radial pillar, which may only project a short way into the interlaminar space, but which, more commonly, becomes connected with the lamina next below. The interlaminar spaces thus become broken up into rows of regular oblong cells, which are about $\frac{1}{3}$ millim. in length, but vary much in this respect. Tangential sections exhibit large, rounded, dark dots, representing the cut ends of the radial pillars (Pl. II. fig. 6). These are often connected together by distinct radiating "arms," thus showing an imperfect form of the "hexactinellid" structure so characteristic of the species of the genus *Actinostroma*. Astro-rhizal canals do not appear to be developed.

Obs. This species is readily recognized by its slightly inflected, thick laminæ, its stout radial pillars, the oblong form of the regularly disposed interlaminar cells as seen in vertical sections, and the presence of radiating "arms" connecting the radial pillars. In its general characters, both external and internal, it most closely resembles *C. striatellum*, d'Orb. ; but it is an altogether smaller form, its skeleton is much finer, and the form of the radial pillars and interlaminar cells is quite different.

Formation and Locality. Wenlock Limestone, Dudley (rare). It occurs also in the Wenlock Limestone of Wisby, Gotland. Von Rosen's original specimen (which I have examined) is from the Silurian ("Zone of *Pentamerus esthonus*") of Kleine-Ruhde, Esthonia.

Clathrodictyon cellulolum, Nich. & Mur.

(Pl. II. figs. 7 and 8.)

Clathrodictyon cellulolum, Nicholson & Murie, Journ. Linn. Soc., Zool. vol. xiv. p. 221, pl. ii. figs. 9 & 10 (1878).

Cœnosteum massive, or in the form of thick laminæ. Under surface not observed. Upper surface covered with pointed tubercles, representing the upper ends of the radial pillars, often connected with one another to form sinuous irregular ridges.

In internal structure the skeleton is composed of remote, horizontal or slightly flexuous concentric laminæ. On an average two interlaminar spaces, and therefore three laminæ, occupy the space of 1 millim. The laminæ are minutely crumpled or inflected, so as to give rise to oval interlaminar cells which vary in length from about half a millim. up to 2 millim. or more. The radial pillars look as if formed by the inflections of the laminæ; but the interlaminar cells are often crossed by delicate partitions ("interlaminar septa"), which are independent of the proper radial pillars (Pl. II. fig. 7). The skeleton-fibre is thick and has the aspect, in vertical sections, of being penetrated by fine vertical tubuli. Tangential sections (Pl. II. fig. 8) exhibit the remote, oval or round, cut ends of the radial pillars, mostly connected by sinuous lines representing the divided edges of the concentric laminæ. Astrorhizæ are apparently not developed.

Obs. This species is at once distinguished from all the other forms of *Clathrodictyon* by the coarseness of the skeletal framework. The entire skeleton, in fact, appears in vertical sections to be made up of rows of large oval vesicles. Tangential sections are also highly characteristic.

Formation and Locality. Not uncommon in the Corniferous Limestone (Devonian) of Port Colborne and other localities in Western Canada.

Clathrodictyon ostiolatum, Nich.

(Pl. III. figs. 1-3.)

Stromatopora ostiolata, Nicholson, Ann. & Mag. Nat. Hist. ser. 4, vol. xii. p. 90, pl. iv. figs. 1, 1a (1873); Rep. on the Palæontology of Ontario, p. 63 (1875).

Cœnosteum massive, composed of concentrically laminated parallel cylinders, which are more or less enveloped by laminæ concentric with the entire colony, and which terminate superficially in blunt nipple-shaped prominences. Under surface unknown. Surfaces of the laminæ smooth or with exceed-

ingly fine granulations, without tubercles or "mamelons." Astrorhizæ well developed, each system having a vertical, wall-less, axial canal, which opens on the surface of the laminae by a slightly projecting round aperture (Pl. III. fig. 3).

As regards internal structure, the skeleton is composed of exceedingly delicate concentric laminae, about five of which occupy the space of 1 millim. (Pl. III. fig. 1). The laminae are curved, in conformity with the curvatures of the fossil, but are not at all, or but slightly, inflected or crumpled. Each lamina gives off downwards numerous close-set and delicate radial pillars, which may or may not reach the lamina below. The interlaminar cells are thus more or less quadrangular in shape, though often incomplete. Tangential sections (Pl. III. fig. 2) exhibit minute rounded or oval dots, often almost linear, representing the cut ends of the radial pillars. When the section coincides with the plane of one of the concentric laminae these dots are replaced by a delicate reticulation.

Obs. Owing to dolomitisation, it is very difficult to prepare satisfactory sections of this species, the minute structure being considerably obscured by mineralisation. The species is, however, clearly referable to *Clathrodictyon*, and it is separated from the other species of the genus by the extreme delicacy of the laminae and radial pillars, the form of the interlaminar cells, and the fact that the astrorhizæ open superficially by marked and projecting apertures.

Formation and Locality. The only specimen known is from the Silurian (Guelph formation) of Guelph, Ontario.

Clathrodictyon laxum, Nich. (Pl. III. figs. 4 and 5.)

Cœnosteum laminar or incrusting, a basal epitheca being present in the former case. Upper surface smooth or slightly undulated, without "mamelons," and apparently covered with small tubercles. Astrorhizæ apparently wanting.

As regards internal structure, the skeleton is composed of horizontal or slightly flexuous concentric laminae, of which about four are placed in the space of 1 millim. (There are usually three interlaminar spaces in 1 millim.) The laminae (Pl. III. fig. 4) are comparatively thin, and are not crumpled or inflected. The interlaminar spaces are crossed by numerous delicate vertical radial pillars, most of which reach from one lamina to the next. Tangential sections (Pl. III. fig. 5) exhibit the oval or rounded cut ends of the radial pillars along with the sinuous edges of the transversely divided laminae.

Astrorhizæ may be present, but were not seen in the specimens examined.

Obs. This species is distinguished by its straight uninflected laminæ and straight radial pillars. The interlaminar spaces are therefore not subdivided into rows of vesicles, as is usual in the species of *Clathrodictyon*. The comparative remoteness of the laminæ is also a good distinguishing character, the interlaminar spaces being wider than in any other type of the genus known to me, with the exception of *C. cellulolum*. Judging from the figures and description given by Dr. Frech of a Devonian Stromatoporoid which he has named *Stromatopora philoclymenia* ("Die Korallenfauna des Oberdevons in Deutschland," Zeitschr. d. Deutschen geol. Gesell. Jahrg. 1885, p. 118), I should be inclined to believe that this would prove to be a species of *Clathrodictyon*, and that it would probably be nearly allied to the present species. *S. philoclymenia*, Frech, is, however, described as having laminæ decidedly further apart than is the case in *C. laxum*, the interlaminar spaces being stated to have a width of $\frac{1}{2}$ to $\frac{2}{3}$ millim. Moreover, the tangential section of the former is very unlike that of the present type.

Specimens of *C. laxum* sometimes occur with "Caunopora-tubes" traversing the cœnosteum, and in one such specimen, submitted to me by Dr. George J. Hinde, these tubes exhibit well-marked septal spines.

Formation and Locality. Corniferous Limestone, Port Colborne, Ontario. Also in the same formation, at Kelley's Island, Ohio.

Clathrodictyon retiforme, Nich. & Mur., sp.
(Pl. III. figs. 6-8.)

Stylodictyon retiforme, Nicholson & Murie, Journ. Linn. Soc., Zool. vol. xiv. p. 222, pl. iii. figs. 1-3.

Cœnosteum massive (?); the under surface unknown; the upper surface (Pl. III. fig. 8) covered with conspicuous, pointed, conical "mamelons," which are from 1 to 2 millim. in height, and about 3 or 4 millim. apart. The surface also is thickly studded with small round tubercles, representing the upper ends of the radial pillars.

As regards internal structure, the cœnosteum is essentially composed of sharply undulated concentric laminæ; but the continuity of the undulations of these is interfered with by the large development of the astrorhizal systems. Each of these systems consists of a vertical wall-less canal, which is surrounded by loose reticulate tissue, this being, in turn, enveloped in a series of from two to five concentrically disposed laminæ.

These concentrically laminated cylinders surrounding the axial astrorhizal canals are disposed in numbers throughout the general undulated laminæ of the skeleton. It is the upper ends of these cylinders which form the "mamelons" on the surface; and one of the axial canals terminates at the summit of each of the latter. On the other hand, the lateral or radiating canals of the astrorhizal systems are very incompletely developed.

Vertical sections (Pl. III. fig. 7) show the flexured laminæ, of which from three to five occupy the space of 1 millim. The laminæ give off stout radial pillars, which mostly extend from one lamina to the next. In many cases a larger or smaller number of the radial pillars are placed one above the other in successive interlaminar spaces. This is especially the case in the laminæ which envelop the axial astrorhizal canals, and it gives to the radial pillars, where it occurs, the appearance of being "continuous." The phenomena presented by vertical sections differ, further, according as the section traverses the astrorhizal cylinders through the centre or through the circumference.

Tangential sections (Pl. III. fig. 6) show differences in structure according as they traverse the astrorhizal cylinders or the general interstitial laminated tissue. Where such a section cuts a cylinder, we see the central astrorhizal canal with its enveloping concentric laminæ. In the tracts between the cylinders we see the cut ends of the radial pillars as oval or circular dots. The character of these shows that the species is referable to *Clathrodictyon* and not to *Actinostroma*, no radiating "arms" connecting the radial pillars being recognizable.

Obs. In the general construction of its cœnosteum, the flexured concentric laminæ, the astrorhizal cylinders, and the surface-prominences, this species has the closest possible resemblance to *Actinostroma verrucosum*, Goldf., sp. The fact, however, that the radial pillars are not "continuous" and the absence of radiating "arms" to the pillars prove that the species cannot be referred to the genus *Actinostroma* at all. It was originally referred by Dr. Murie and myself to the genus *Stylodictyon*; but this reference can undoubtedly not be sustained; and the essential characters of its structure clearly point to its being placed properly in the genus *Clathrodictyon*. From all the other known species of this genus it is sufficiently separated by the peculiar construction of its skeleton, quite apart from all minute structural characters.

Formation and Locality. Rare in the Hamilton formation (Devonian), Arkona, Ontario.

Stromatoporella (?) *tuberculata*, Nich.
(Pl. III. figs. 9-11.)

Stromatopora tuberculata, Nicholson, Ann. & Mag. Nat. Hist. ser. 4, vol. xii. p. 92, pl. iv. figs. 2, 2 a (1873); *ibid.* vol. xiii. p. 8, fig. 1 (1874); Report on the Palæont. of Ontario, p. 14 (1874).

Coenosteum of large size, laminar, the underside covered with a wrinkled epitheca. Upper surface often irregularly undulated, without "mamelons," but covered with prominent, close-set, blunt tubercles, the summits of which appear sometimes, perhaps from breakage or weathering, to be perforated (Pl. III. fig. 9). As regards internal structure, the skeleton is composed of nearly horizontal or gently flexuous concentric laminæ, of which from three to four occupy the space of 1 millim. The laminæ are not crumpled, but exhibit slight upward and downward foldings, being bent upwards at the points where radial pillars are developed (Pl. III. fig. 11). The radial pillars are placed at distances of from $\frac{2}{3}$ to 1 millim. apart, and are extremely stout; they are apparently hollow, sometimes with a central axis, and they seem as if formed by successive cone-shaped upward prolongations of the concentric laminæ. Vertical sections show the interlaminar spaces to be traversed, in addition to the proper radial pillars, by numerous curved or straight calcareous partitions, which are very delicate, and may be spoken of as "interlaminar septa."

Tangential sections (Pl. III. fig. 10) exhibit the very large oval or ring-like cut ends of the radial pillars, which are connected with one another by numerous delicate curved lines, these representing the cut edges of the "interlaminar septa."

The skeleton-fibre itself is penetrated by innumerable minute tubuli or is finely porous. Astrorrhizæ, if present at all, seem to be only incompletely developed.

Obs. This very remarkable species was originally referred by me to the genus *Stromatopora*, Goldf., which was at that time believed to comprise the forms which I now include in the genus *Actinostroma*. In its general structure it certainly most nearly resembles *Actinostroma*, and it has even points of likeness to *Labechia*. It clearly cannot be referred, however, to either of these genera, and it may be an open question whether it should not be regarded as the type of a new genus. In the meanwhile I have referred it to the genus *Stromatoporella*, Nich., with which it agrees in the porous or tubulated condition of the skeleton-fibre. It also resembles certain of the species of *Stromatoporella* (e. g. *S. arachnoidea*, Nich.) in the great development of "interlaminar septa." In any case, I know of no other type of the *Stromatoporoids* with

which it could be confounded when its minute structure is examined.

Formation and Locality. Common in the Corniferous Limestone (Devonian) of Port Colborne, Ontario.

EXPLANATION OF THE PLATES.

[As the figures of minute structure are based upon photographs, the scale of magnification is not absolutely constant, but varies between ten and twelve times. As a rule, the enlargement may be taken as being about ten times the natural size. Where a different magnifying-power has been used, or where the figures are of the natural size, this is specially stated.]

PLATE I.

Fig. 1. Vertical section of the type-specimen of *Clathrodictyon vesiculosum*, Nich. & Mur. Clinton formation, Yellowsprings, Ohio.

Fig. 2. Tangential section of the same.

Fig. 3. Vertical section of an example of *C. vesiculosum*, from the Wenlock Limestone of Much Wenlock.

Fig. 4. Surface of a broken fragment of *Clathrodictyon variolare*, Rosen, sp., of the natural size. Silurian, Esthonia.

Fig. 5. Vertical section of *C. variolare*, Rosen, from the Silurian rocks of Kattentack, Esthonia.

Fig. 6. Tangential section of the preceding specimen.

Fig. 7. Vertical section of *Clathrodictyon Linnarssoni*, Nich., from the Wenlock Limestone of Wisby, Gotland. A vertical astrorhizal canal is cut through by the section.

Fig. 8. Tangential section of the preceding specimen.

Fig. 9. Vertical section of *Clathrodictyon striatellum*, d'Orb., from the Wenlock Limestone of Dudley.

Fig. 10. Tangential section of the preceding.

PLATE II.

Fig. 1. Vertical section of *Clathrodictyon crassum*, Nich., from the Wenlock Limestone of Ironbridge.

Fig. 2. Tangential section of the same.

Fig. 3. Vertical section of *Clathrodictyon fastigiatum*, Nich., from the Wenlock Limestone of Ironbridge.

Fig. 4. Tangential section of the same.

Fig. 5. Vertical section of *Clathrodictyon regulare*, Rosen, sp., from the Wenlock Limestone of Dudley.

Fig. 6. Tangential section of the same.

Fig. 7. Vertical section of *Clathrodictyon cellulosum*, Nich. & Mur., from the Corniferous Limestone of Ontario.

Fig. 8. Tangential section of the same.

PLATE III.

Fig. 1. *Clathrodictyon ostiolatum*, Nich., vertical section, from the Silurian (Guelph formation) of Guelph, Ontario.

Fig. 2. Tangential section of the same.

Fig. 3. Surface of a fragment of the same, of the natural size, showing the prominent apertures of the axial astrorhizal canals.

- Fig. 4.* Tangential section of *Clathrodictyon laxum*, Nich., from the Corniferous Limestone, Ontario.
Fig. 5. Vertical section of the same.
Fig. 6. Tangential section of *Clathrodictyon retiforme*, Nich. & Mur. sp., from the Hamilton formation of Canada.
Fig. 7. Vertical section of the same. The right-hand half of the portion figured cuts through one of the astrorhizal cylinders near its centre; the left-hand portion traverses an adjoining cylinder near its periphery.
Fig. 8. Portion of the surface of the same, of the natural size.
Fig. 9. Part of the surface of *Stromatoporella? tuberculata*, Nich., enlarged about twice. Corniferous Limestone, Ontario.
Fig. 10. Tangential section of the same.
Fig. 11. Vertical section of the same.

II.—Notes on a *Species of Entalophora from the Neocomian Clay of Lincolnshire*. By G. R. VINE.

IN his paper on the Closure of the Cyclostomatous Bryozoa*, Mr. A. W. Waters refers to several peculiarities of the cell-coverings of Palæozoic species. In speaking of what he called *Entalophora rugosa*, d'Orb., from Naples, Mr. Waters says: "The most usual position for the calcareous plate which closes the tube would seem to be about the point where the zoæcial tube rises free from the zoarium" (p. 401). Remarking on the closure of the aperture in Carboniferous *Polypore* and *Fenestellæ*, the author refers to and quotes a previous observation, made as far back as 1878, wherein he says: "In the Cyclostomata the cells are often after a time closed by a diaphragm, in most cases some little distance down the tube"†. In all these observations I have been able to confirm Mr. Waters's statements; but there is a very great difference between the closure of Palæozoic and recent Cyclostomata.

It is not, however, for the purpose of controverting, or even of further commenting on Mr. Waters's views that I send you the present notes, but to furnish new material for the student of our fossil Polyzoa.

Through the kindness of Mr. H. Wallis Kew, of Louth, I have been able to examine in detail specimens of *Entalophora* from the Neocomian Clay at Donington-on-Bain near Louth, in Lincolnshire. Before receiving the present examples I was altogether unacquainted with species of Polyzoa from this locality, and I have searched in vain for previous records of species found in the Lincolnshire horizon. I have compared

* Journ. Linn. Soc. Zool. vol. xvii. 1884, p. 400.

† Manch. Geol. Soc. Tr. 1878, p. 2 of paper.