Stromatoporoids from the Silurian of the Oslo Region, Norway

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Silurian stromatoporoids from the Oslo Region, southern Norway, have been investigated. Fifteen species belonging to seven genera are described. Among them, one new genus, *Oslodictyon*, and three new species are proposed: viz. *Oslodictyon henningsmoeni*, *Plectostroma norvegicum*, and *Stromatopora ringerikensis*. The stromatoporoid assemblages are characterized by the Clathrodictyids such as *Clathlodictyon* and *Ecclimadictyon*. They are related to those from the Silurian of the Baltic regions such as Gotland and Estonia.

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The purpose of the present paper is to describe the Silurian stromatoporoids from the Oslo Region, southern Norway. No detailed systematic investigation on stromatoporoids from this region has hitherto been carried out; nevertheless common occurrence of stromatoporoids has been noted by many authors. Previous work on the Silurian stromatoporoids in this region has been done only by Broadhurst (1966). He investigated growth forms of stromatoporoids in relation to sedimentation and water currents, although he did not treat them taxonomically.

The present author collected stromatoporoids in the Oslo Region in the spring of 1969. The material stored in Paleontologisk Museum in Oslo was also investigated. Comparative studies of stromatoporoids described from England (Nicholson 1886–1892), Estonia (Rosen 1867, Nestor 1962, 1964, 1966), Scania (Mori 1969), and Gotland (Mori 1968, 1970) were carried out.

Fifteen species belonging to seven genera are described in this paper. Among them, one new genus, *Oslodictyon*, and three new species are proposed: viz. *Oslodictyon henningsmoeni*, *Plectostroma norvegicum*, and *Stromatopora ringerikensis*.

The Oslo Region is paleogeographically demonstrated by foreland sediments of the Caledonian geosyncline. It is important to compare the stromatoporoid assemblages between this region and the other Baltic areas such as Gotland and Estonia, where epicontinental sediments are distributed, especially from a biostratigraphical and paleoecological point of view. The present study has revealed that the Silurian stromatoporoids of the Oslo Region are related to those of Gotland and Estonia.

Material

The Silurian stromatoporoids dealt with in this paper include not only the author's collection but also the collections of Paleontologisk Museum, Oslo. The latter is mainly from the Llandoverian collected by Kiær between 1894–1913 and Kjerulf during 1861–1863. The total number of specimens is 85, among which 34 belong to Paleontologisk Museum. Sixty specimens are from Llandoverian (stages 6c–7c), twelve from Wenlockian (stages 8c–8d), and thirteen from Ludlovian? (Stage 9c). (Concerning the Norwegian stages, see Table 1.)

The number of specimens of each described species is as follows.

Family Labechiidae	
Pseudostylodictyon sp.	1
Family Clathrodictyidae	
Clathrodictyon crickmayi Parks	1
Clathrodictyon linnarssoni Nicholson	1
Clathrodictyon regulare (Rosen)	2
Clathrodictyon simplex (Nestor)	6
Clathrodictyon sulevi Nestor	1
Clathrodictyon variolare (Rosen)	16
Oslodictyon henningsmoeni, n. gen. and n. sp.	2
Ecclimadictyon fastigiatum (Nicholson)	6
Ecclimadictyon microvesiculosum (Riabinin)	1
Ecclimadictyon robustum Nestor	2
Family Actinostromatidae	
Plectostroma norvegicum, n. sp.	3

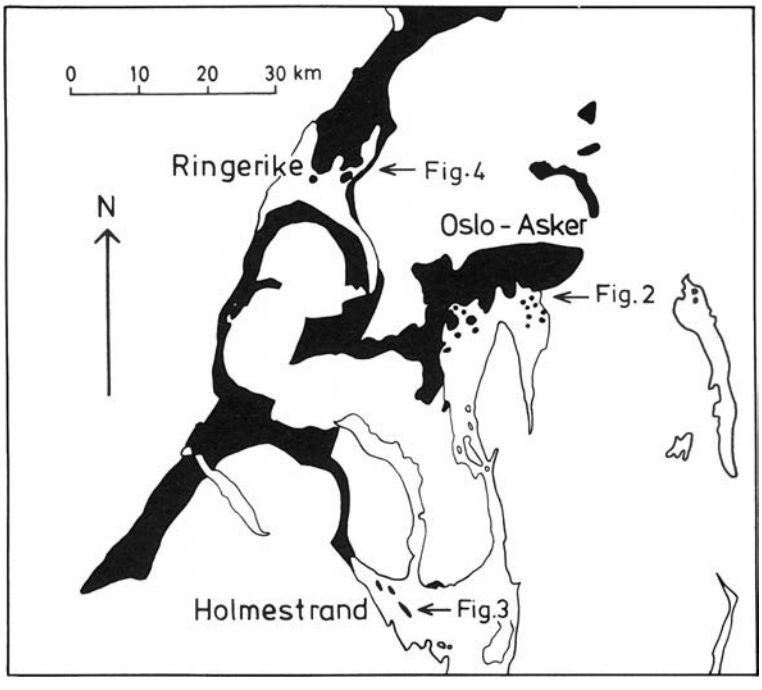


Fig. 1. The distribution of the Cambro-Silurian deposits in the central part of the Oslo Region and the fossil localities shown in Figs. 2–4.

Family Stromatoporidae	
Stromatopora discoidea (Lonsdale)	1
Stromatopora ringerikensis, n. sp.	2
Stromatopora sp.	6
Undescribed poorly preserved specimens	34
Total number of specimens	85

All the specimens described in this paper are stored in Paleontologisk Museum, Oslo.

Fossil localities

The localities where the stromatoporoid material was collected are shown in Figs. 1–4 and a list of these localities is given. The species found at each locality are mentioned. The species without locality numbers are Paleontologisk Museum collections. Unfortunately exact points of the fossil localities of the museum collections are unknown in many cases, because the material often is labelled only 'Ringerike', 'Sandvika', etc., although the stratigraphical positions are clearly noted.

Oslo–Asker district

Loc. no. 1. Road side cliff, 250 m SE of the rail road at Ringeriksveien, Sandvika, Bærum (stage 6c). *Clathrodictyon regulare.*

Loc. no. 2. Rail road cutting at Vakås, Asker, about 800 m NE of the railway station of Asker (stage 6c). *Clathrodictyon variolare, Ecclimadictyon fastigiatum.*

Loc. no. 3. Sea side exposure along the southern coast of Malmøya, S of the Oslo city (stage 7a). *Clathrodictyon linnarssoni, Clathrodictyon simplex, Clathrodictyon variolare, Ecclimadictyon fastigiatum.*

Loc. no. 4. Exposure along the road from Haslum to Sandvika at Gjettum, 1.8 km NNE of the railway station of Sandvika, Bærum (stage 7a). *Clathrodictyon simplex.*

Loc. no. 5. Exposure along the road at Dugnadveien, Gjettum, Bærum, 600 m W of the locality no. 4 (stage 8c). All the specimens are poorly preserved.

Museum collections. *Clathrodictyon regulare* (Sandvika, stage 7). *Clathrodictyon sulevi* (Sandvika, stage 7). *Clathrodictyon variolare* (Spirodden, stage 6c; Sandvika, stage 7; Malmøya, stage 7a). *Ecclimadictyon microvesiculosum* (Sandvika, stage 7).

Holmestrand district

Loc. no. 6. Sea side exposure, about 500 m N of the southernmost end of Langøya, E of Hol-

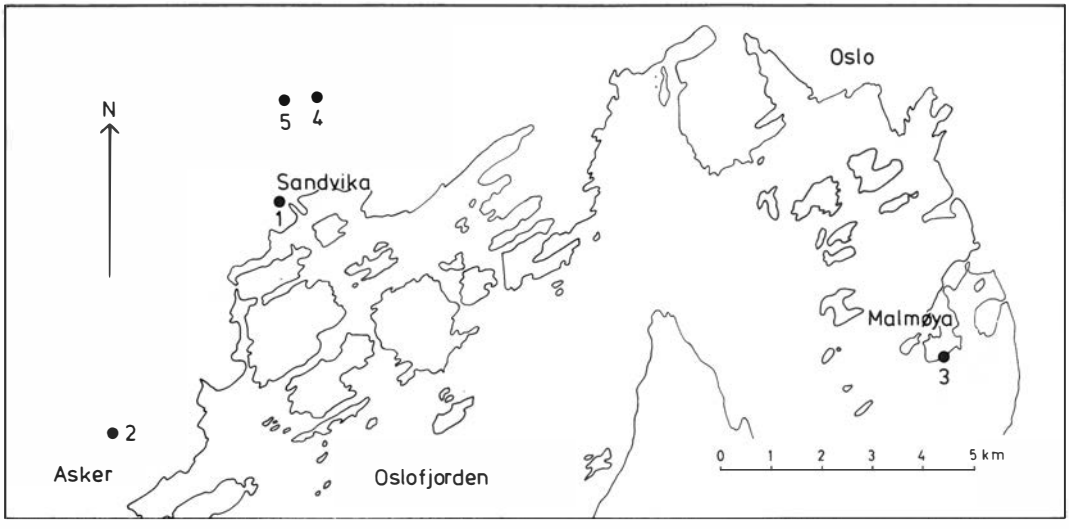


Fig. 2. Collecting localities in the Oslo-Asker district.

mestrand (stage 9c). *Ecclimadictyon robustum, Stromatopora* sp.

Museum collections. *Clathrodictyon variolare* (Bjerkøya, stage 7b).

Ringerike district

Loc. no. 7. Exposure along the lake coast, 150 m NE of the southernmost end of Limåstangen, Ringerike (stage 7a). *Ecclimadictyon fastigiatum.*

Loc. no. 8. Lake side exposure, 200 m NE of the loc. no. 7 at Rytteraker, Ringerike (stage 7b). *Oslodictyon henningsmoeni, Ecclimadictyon fastigiatum.*

Loc. no. 9. Exposure beside the main road from Sundvollen to Norderhov, about 200 m N of the cross-road, north of Vik, Ringerike (stage 7b). All the specimens are poorly preserved.

Loc. no. 10. Exposure along the road from Vik to Kroksund, 900 m NNW of the northwestern margin of the bridge at Kroksund, Ringerike (stage 8c). *Plectostroma norvegicum.*

Loc. no. 11. Lake side exposure at the northeastern end of Storøya, Ringerike (stage 8c). All the specimens are poorly preserved.

Museum collections. *Pseudostylodictyon* sp. (Limåstangen, stage 7a). *Clathrodictyon crickmayi* (Bragsøya, stage 8d). *Clathrodictyon simplex* (Gjeitøya, stage 7b; Purkøya and Storøya, stage 7c). *Oslodictyon henningsmoeni* (Vesleøya, stage 7b). *Ecclimadictyon fastigiatum* (Ringerike, stage 7). *Stromatopora ringerikensis* (Vesleøya, stage 7c).

Distribution of the stromatoporoids

Among 15 species described here, 10 species are from the Llandoverian (stages 6c,7a, 7b and 7c), 3 species from the Wenlockian (stages 8c and 8d), and 2 species from the Ludlovian? (stage 9c). Stratigraphic distribution of the species is shown in Table 1.

Llandoverian stromatoporoids are characterized by Clathrodictyids such as *Clathrodictyon* and *Ecclimadictyon*. Seven out of ten

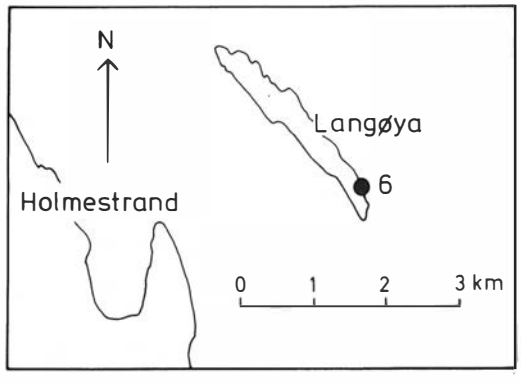


Fig. 3. Collecting locality in the Holmestrand district.

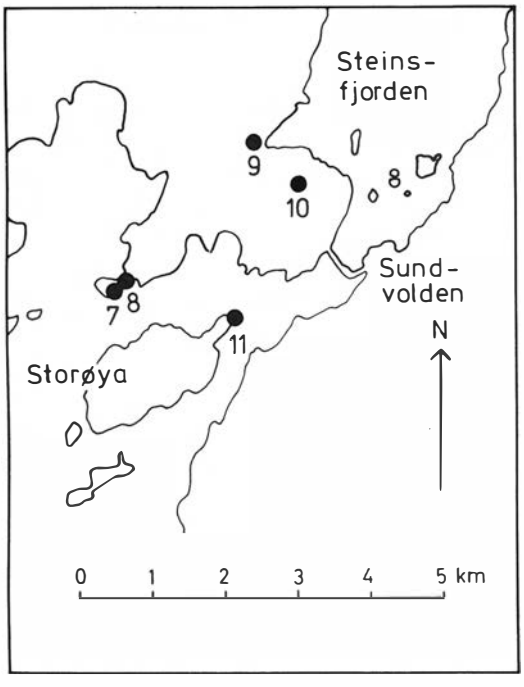


Fig. 4. Collecting localities in the Ringerike district.

species are represented by these two genera. The oldest record of the occurrence of the Llandoverian stromatoporoids in the Oslo Region is in stage 6c. Three species appear in this stage, viz. *Clathrodictyon regulare, C. variolare,* and *Ecclimadictyon fastigiatum.* Through stage 7, Clathrodictyids dominate, especially in the *Pentamerus* limestones. *Clathrodictyon variolare* is the most common Llandoverian stromatoporoid. However, this species occurs only in the Oslo-Asker and Holmestrand districts, while it is unknown in the Ringerike district. Among the Llandoverian stromatoporoids, only one species, *Pseudostylodictyon* sp., belongs to the family Labechiidae. It should be pointed out that the Labechiids are quite insignificant in the Silurian of the Oslo Region. In the family Stromatoporidae, only one species, *Stromatopora ringerikensis,* has been found in the Llandoverian. It is also insignificant in number of species and individuals compared with those of the Clathrodictyids. But it is worthy of note that the occurrence of *S. ringerikensis* is one of the earliest among the species of the genus *Stromatopora.*

Wenlockian stromatoporoids are represented by three species: *Clathrodictyon crickmayi, Plectostroma norvegicum,* and *Stromatopora discoidea.* The Wenlockian materials studied are limited; nevertheless the field occurrence of the Wenlockian stromatoporoids exceeds quantitatively those of Llandoverian ones. Therefore it is probable that the number of species and genera will increase with further studies. Present knowledge indicates that there is a difference between the Llandoverian and the Wenlockian assemblages, because no species found in the Llandoverian occur in the Wenlockian. In the Actinostromatid group, only one species, *Plectostroma norvegicum,* is known in the Silurian of the Oslo Region.

Stromatoporoids possibly of the Ludlovian are known from the Holmestrand district. Two species, *Ecclimadictyon robustum* and *Stromatopora* sp., are described. Species in the Llandoverian and the Wenlockian are unknown in the Ludlovian of the Oslo Region.

Paleoecology of the stromatoporoids

Llandoverian stromatoporoids generally occur in well bedded argillaceous limestones. Their distribution is in most cases sporadic. Each coenosteum is isolated from each other, even in

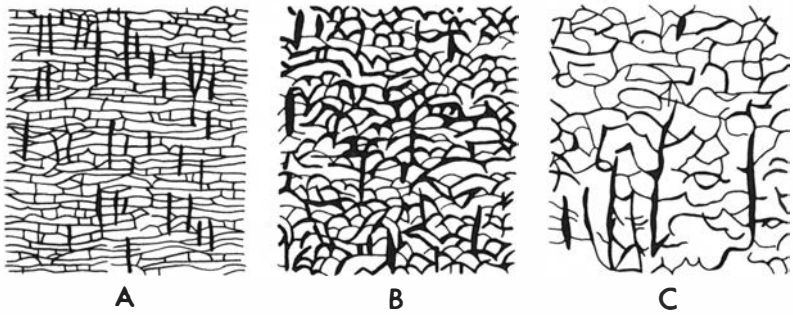


Fig. 5. Schematic representation (× 10) of vertical sections of; A: *Oslodictyon henningsmoeni,* n. gen. & n. sp., B: *Yabeodictyon balticum* Mori, and C: *Actinodictyon canadense* Parks.

places where the stromatoporoids are rather common. Many specimens are found in growth positions. Even when overturned, almost complete shapes of coenostea indicate that they may not have been transported any long distance. Small coenostea are common. Their sizes are mostly less than 10 cm in height and less than 30 cm in maximum diameter. It is exceptional to find coenostea with the diameter exceeding 30 cm. The coenostea are commonly laminar, conical, or dome-shaped. Several stromatoporoids show approximate bilateral symmetry. As noted by Broadhurst (1966), the coenostea frequently have marginal tongues or inclusions of sediments. Broadhurst pointed out that 'where the marginal tongues or inclusions of sediments are concentrated on one side of a stromatoporoid, it is suggested that this was the lee side of the growing coenosteum during unidirectional current action'. It is justifiable to consider that the shapes of stromatoporoids are greatly influenced by water current and rate of sedimentation. However, generalizations to estimate certain paleocurrent unidirection could not be made in the present investigation, because there are many varieties of inclusions of sediments within coenostea. Sizes, shapes, and mode of occurrences of the Llandoverian stromatoporoids are very similar to those in the lower part of the Visby Beds of Gotland, which are composed of frequent alternations of marls and marly limestones. It may be concluded that these stromatoporoids grew in rather deep and calm water conditions. Even if current action existed, it would not have been so strong as to abrade and destroy entire coenostea of stromatoporoids.

In the Wenlockian of the Oslo Region (Lower Spiriferid Series), stromatoporoids occur more commonly than in the Llandoverian. As mentioned by Kiær (1908) and Henningsmoen (1960), massive reef-like limestones yielding many stromatoporoids are well developed in the Ringerike district. Besides small conical or dome-shaped coenostea, large massive coenostea are also found in the Wenlockian. The largest coenosteum observed in this study is 48 cm in height and 165 cm in maximum diameter. It was found at Storøya, Ringerike (Loc. no. 11). More than half of the collected specimens at Ringerike are recrystallized. It seems that coenostea in the Wenlockian reef-like limestones are more poorly preserved than in the Llandoverian, although it is not conclusive, because the Wenlockian material investigated here is limited. The presence of large coenostea mentioned above indicates that at Wenlockian time paleoenvironments were more favourable for growth of stromatoporoids than at Llandoverian time. However, the thickness and extension of massive unstratified limestones are more restricted and the importance of stromatoporoids as reef-builders is much less than in the Baltic region, such as in the Högklint Beds of Gotland.

Possible Ludlovian stromatoporoids found at Langøya, east of Holmestrand, are all fragmented, showing signs of rolling. The largest coenosteum is 22 cm high and 33 cm in maximum diameter. At locality no. 6, well bedded argillaceous limestones are intercalated with small reef-like masses. Abundant shelly faunas occur, among which tabulate corals dominate. Stromatoporoids are quantitatively subordinate to tabulate corals such as favositids. Occurrence of fragmented stromatoporoids indicates that they grew under strong current action.

Biostratigraphic correlation

The present investigation indicates that the stromatoporoid assemblages are related to those of Estonia (Nestor 1962, 1964, 1966) and Gotland (Mori 1968, 1970). Nine out of fifteen species described in this paper are known from Estonia and Gotland.

Five species are common in the Llandoverian of both the Oslo Region and Estonia, viz. *Clathrodictyon regulare, C. sulevi, C. variolare, Ecclimadictyon fastigiatum* and *E. microvesiculosum*. Among them, *C. regulare* and *C. variolare* are restricted to the Llandoverian of the two regions. Three species have a wide stratigraphic range, being known also from the Wenlockian or Ludlovian of Gotland. *Clathrodictyon simplex* found at stage 7a–7c in the Oslo Region has been described from the lower Wenlockian of Estonia and Gotland. *Clathrodictyon linnarssoni* found at stage 7a is known in the lower Wenlockian of Gotland. As mentioned above, the stratigraphic ranges of the five species are from Llandoverian to Wenlockian, except *C. sulevi*, which is found also in the Ludlovian of Gotland. Predominance of the Clathrodictyids is a common feature of the Llandoverian both in the Oslo Region and Estonia. However, the Llandoverian assemblage of the Oslo Region is different from that of Estonia in number of species and individuals of the Labechiids; in the

Table 1. Stratigraphical distribution of stromatoporoids from the Silurian of the Oslo Region, Norway Estonia and Gotland, Sweden.

Species \ Locality and Horizon	Oslo Region																			Estonia			Gotland		
	6			Undivided 7	7			8				9								Llandoverian	Wenlockian	Ludlovian	Low. Wenlock.	Up. Wenlock.	Ludlovian
	a	b	c		a	b	c	a	b	c	d	a	b	c	d	e	f	g						
Clathrodictyon regulare (Rosen)	.	.	+	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.		+	.	.	.	.	.
Clathrodictyon variolare (Rosen)	.	.	+		+	+	.	.	.	.	.	.	.	.	.	.	.	.		+	.	.	.	.	.
Ecclimadictyon fastigiatum (Nicholson)	.	.	+		+	+	.	.	.	.	.	.	.	.	.	.	.	.		+	.	.	.	+	.
Clathrodictyon sulevi Nestor	.	.	.	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.		+	.	.	.	+	+
Ecclimadictyon microvesiculosum (Riabinin)	.	.	.	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.		+	.	.	.	+	.
Pseudostylodictyon sp.	.	.	.		+	.	.	.	.	.	.	.	.	.	.	.	.	.		.	.	.	.	.	.
Clathrodictyon linnarssoni Nicholson	.	.	.		+	.	.	.	.	.	.	.	.	.	.	.	.	.		.	.	.	+	.	.
Clathrodictyon simplex (Nestor)	.	.	.		+	+	+	.	.	.	.	.	.	.	.	.	.	.		.	+	.	+	.	.
Oslodictyon henningsmoeni, n. gen. & n. sp.	.	.	.		.	+	.	.	.	.	.	.	.	.	.	.	.	.		.	.	.	.	.	.
Stromatopora ringerikensis, n. sp.	.	.	.		.	.	+	.	.	.	.	.	.	.	.	.	.	.		.	.	.	.	.	.
Plectostroma norvegicum, n. sp.	.	.	.		.	.	.	.	.	+	.	.	.	.	.	.	.	.		.	.	.	.	.	.
Clathrodictyon crickmayi Parks	.	.	.		.	.	.	.	.	.	+	.	.	.	.	.	.	.		.	.	.	.	.	.
Stromatopora discoidea (Lonsdale)	.	.	.		.	.	.	.	.	.	+	.	.	.	.	.	.	.		.	.	.	.	+	.
Ecclimadictyon robustum Nestor	.	.	.		.	.	.	.	.	.	.	.	.	+	.	.	.	.		.	+	+	.	+	+
Stromatopora sp.	.	.	.		.	.	.	.	.	.	.	.	.	+	.	.	.	.		.	.	.	.	.	.

Oslo Region, only *Pseudostylodictyon* sp. is recorded, while in Estonia fourteen species among the genera *Pachystylostroma, Forolinia,* and *Rosenella* have been reported (Nestor 1964).

Among the three species found in the Wenlockian of the Oslo Region, *Stromatopora discoidea* is characteristic. This species is previously known only in the Wenlockian of Gotland, Estonia, and England. *Clathrodictyon crickmayi* found in stage 8c is unknown in the Baltic region, but described in the Wenlockian of Quebec, Canada (Parks 1933, Stearn & Hubert 1966).

Ecclimadictyon robustum in the Ludlovian? of the Oslo Region has been known in the Wenlockian and the Ludlovian of Gotland and Estonia.

In conclusion, Silurian stromatoporoids in the Oslo Region are rather difficult to use for such detailed biostratigraphic correlation from stage to stage as can be done with graptolites, but it is interesting to note that about two thirds of the species in the Oslo Region are distributed also in the Silurian of the Baltic epicontinental deposits.

Systematic descriptions

The taxonomic position of the stromatoporoids is controversial. Stromatoporoids have generally been considered to be closely related to Hydrozoa (phylum Coelenterata). However, Hartman & Goreau (1970) proposed a new class Sclerospongiae based on Recent material, and considered that the Recent sclerosponges are 'living fossils' of extinct stromatoporoids. Stearn (1972, 1975) compared Recent sclerosponges and stromatoporoids, and proposed a new subphylum Stromatoporata in the phylum Porifera. The present author (Mori 1976) claims that there is evidence of stromatoporoid affinity to coelenterates. In the present paper, Order Stromatoporoidea is adopted, as many authors have done up to date, although at present it is uncertain whether it can be included with confidence in the class Hydrozoa.

Order Stromatoporoidea Nicholson & Murie, 1878

FAMILY LABECHIIDAE NICHOLSON, 1879

Genus *Pseudostylodictyon* Ozaki, 1938

Pseudostylodictyon sp.

Fig. 6, A, B.

Horizon. – Pentamerus Series (stage 7a).

Locality. – Limåstangen, Ringerike.

Material. – One specimen (PMO 45154).

Description. – The coenosteum is fragmental. Its original shape and size are unknown. The surface is not preserved. The laminae are composed of a dark and thin upper layer, 0.01–0.03 mm thick and a fibrous lower layer, 0.09–0.17 mm thick. They are gently undulated and overlapping with broad cyst plates in places. The number of the laminae and cyst plates are 1–4 in 1 mm (commonly 2 or 3). Pillars are entirely absent. Denticles occur exceptionally only on a lamina in the uppermost part of the coenosteum. They are up to 0.17 mm high measured in vertical section. The mamelons are recognized in vertical section. They are 1.6 mm high on average and the distance from summit to summit is about 5 mm. In tangential section, the cut ends of the laminae and the cyst plates are undulated. No denticles were recognized in a single tangential section. Astrorhizae are absent. The original microstructure is obscure.

Remarks and comparison. – The present specimen is here referred to *Pseudostylodictyon* by having gently undulated laminae with overlapping cyst plates. The presence of denticles, though occurring very rarely, indicates that this species may be an intermediate between *Pseudostylodictyon* and *Rosenella*.

Geological age. – Llandoverian.

Geographical distribution. – Ringerike, Norway.

FAMILY CLATHRODICTYIDAE KÜHN, 1939

Genus *Clathrodictyon* Nicholson & Murie, 1878

Clathrodictyon crickmayi Parks

Fig. 6, C, D.

□ 1933 *Clathrodictyon crickmayi*, sp. nov.; Park, 9, pl. 2, figs. 5, 6. □ 1966 *Clathrodictyon crickmayi* Parks; Stearn & Hubert, 35, figs. 3, 4, 7.

Horizon. – Lower Spirifer Series (stage 8d).

Locality. – Bragsøya, Ringerike.

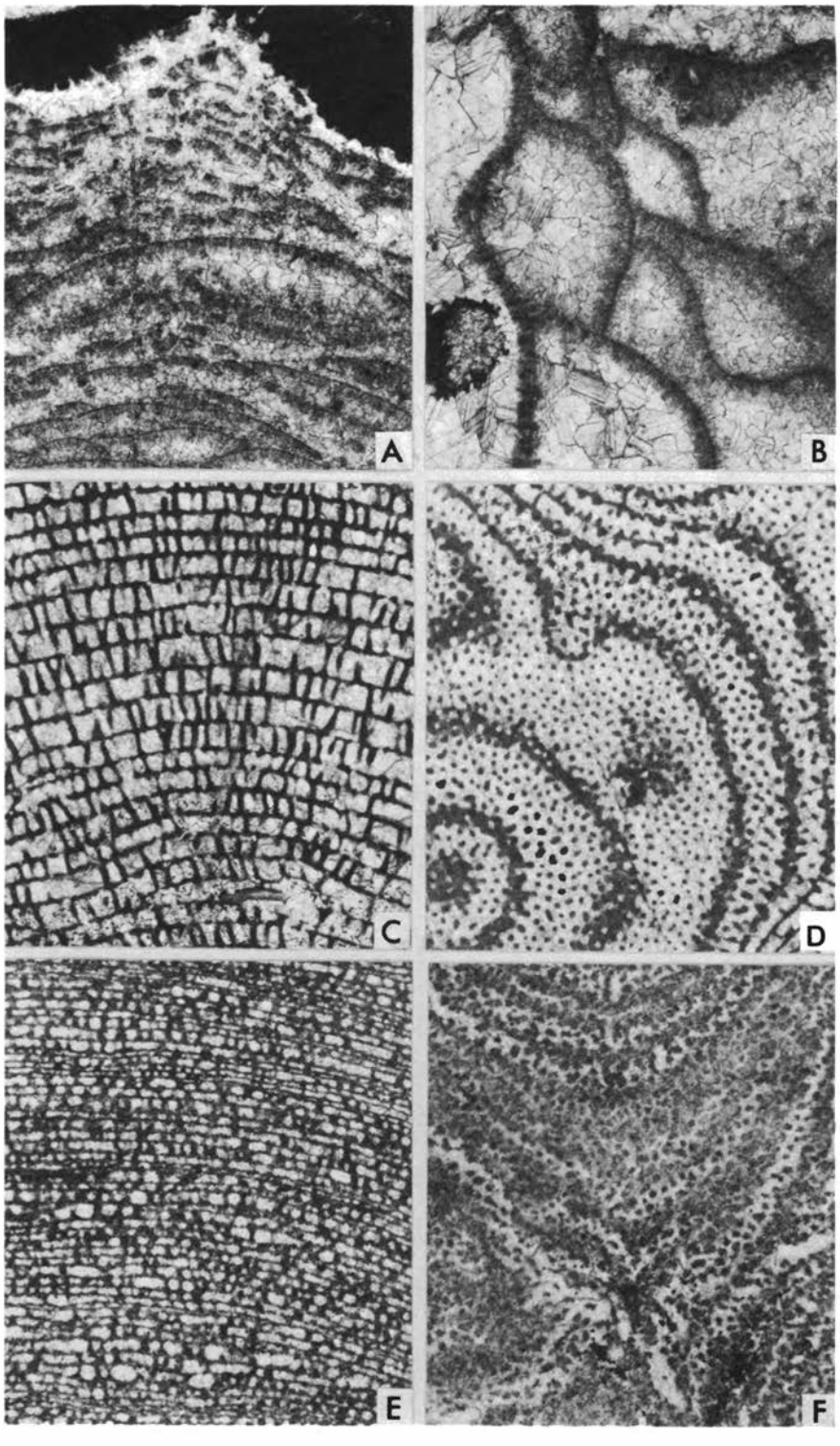
Material. – One specimen (PMO 47644).

Description. – The coenosteum is irregularly conical, 3.0 cm in height and 6.0 cm in diameter. The laminae are persistent or partly crumpled. They are regularly spaced, numbering 2–4 in 1 mm. The thickness of the laminae is variable, but generally 0.04–0.08 mm. The pillars are confined to an interlaminar space, not penetrating through the laminae. Some of the pillars are branched at top, leaving small vesicles. The pillars are counted up to 7 in 1 mm measured in vertical section. In tangential section the pillars are circular or oval. The diameter of the pillars varies from 0.03 to 0.13 mm. There are rarely very thin dissepiments, less than 0.02 mm in thickness. Astrorhizae cannot be recognized either in thin sections or on the surface. The microstructure is compact.

Remarks and comparison. – Although the present specimen has dominantly straighter laminae compared with the holotype revised by Stearn & Hubert (1966: 35), the difference is here considered to be a variation within a species, *Clathrodictyon jewetti* Girty (Girty 1895: 298, pl. 6, figs. 5, 6) from the Silurian of north America is distinguished from *C. crickmayi* by more densely distributed pillars. *Clathrodictyon gotlandense* Mori (Mori 1968: 52, pl. 3, figs. 5, 6) from Gotland differs from the present species by having astrorhizae composed of simple vertical canals.

Geological age. – Wenlockian.

Geographical distribution. – Quebec, Canada and Ringerike, Norway.


A
B
C
D
E
F

Clathrodictyon linnarssoni Nicholson

Fig. 6, E, F.

□ 1887 *Clathrodictyon linnarssoni,* Nich; Nicholson, 5, pl. 1, figs. 7, 8. □ 1951 *Clathrodictyon microtuberculatum,* n. sp. (part.); Riabinin, 32, pl. 29, figs. 2, 3; pl. 31, figs. 1, 2. □ 1967 *Clathrodictyon linnarssoni* Nicholson; Petryk, 15, pl. 1, figs. 7, 8. □ 1968 *Clathrodictyon linnarssoni* Nicholson; Mori, 55, pl. 5, figs. 3, 4; pl. 6, figs. 1, 2.

Horizon. – *Pentamerus* Series (stage 7a).

Locality. – Malmøya, Oslo (Loc. no. 3).

Material. – One specimen (PMO 97308).

Description. – The coenosteum is massive. The specimen is 2.5 cm in height and 15.0 cm in diameter. The surface is not well preserved. The laminae are thin, mostly persistent, but in places crumpled. The thickness of the laminae is 0.02–0.07 mm. The number of the laminae varies from 6 to 10, but mostly 7–9 in 1 mm. The height of the interlaminar spaces varies from 0.03 to 0.20 mm. The pillars are circular to irregular in shape in tangential section. The diameter of the pillars is 0.04 to 0.10 mm. There are up to 6 pillars in 1 mm measured in vertical section. Astrorhizae are developed. In vertical section the isolated astrorhizal canals are oval to elongate, being distinguished from the other galleries by their greater diameters. The microstructure is compact.

Remarks and comparison. – The present specimen is very similar to the holotype (thin section no. P5489, stored in the British Museum) originally described by Nicholson. This species is characterized by persistent thin laminae. The diameter of the pillars generally exceed the thickness of the laminae. The specimen described has more densely spaced laminae on an average than the Gotland material (Nicholson 1887, Mori 1968), but the variation is small. The present species differs from *Clathrodictyon variolare* (Rosen) described in this paper by straighter laminae. As discussed in the previous paper (Mori 1968, 55) the present species is well included in the genus *Clathrodicyton,* not in *Atelodictyon* as considered by Lecompte (1951–52).

Geological age. – Llandoverian to Wenlockian.

Geographical distribution. – Baffin Island, Canada, Gotland, Sweden, Estonia and Oslo, Norway.

Clathrodictyon regulare (Rosen)

Fig. 7, A, B, C, D.

□ 1867 *Stromatopora regularis* n.; Rosen, 74, pl. 19, figs. 1–4. □ non 1887 *Clathrodictyon regulare,* Rosen, sp.; Nicholson, 10, pl. 2, figs. 5, 6.
□ non 1889 *Clathrodictyon regulare,* Rosen, sp.; Nicholson, 155, pl. 18, figs. 8–11a.□ non 1915 *Clathrodictyon regulare* Rosen emend. Nich.; Boehnke, 168, fig. 12.□ non 1929 *Clathrodictyon regulare* Rosen; Yavorsky, 83, pl. 6, figs. 7, 8.□ non 1933 *Clathrodictyon regulare* von Rosen; Parks, 8, pl. 1, figs. 7, 8. □ non 1937 *Clathrodictyon regulare* (von Rosen); Ripper, 2, pl. 1, figs. 1, 2. □ non 1939 *Clathrodictyon regulare* (Rosen); Sugiyama, 438.□ non 1940 *Clathrodictyon regulare* (Rosen); Sugiyama, 106, pl. 14, figs. 1–3; pl. 15, fig. 6. □ non 1951 *Clathrodictyon regulare* (Rosen); Riabinin, 10, pl. 3, figs. 1, 2. □ non 1956 *Clathrodictyon regulare* (Rosen); Flügel, 152, pl. 3, fig. 5. □ 1962 *Clathrodictyon regulare* (Rosen); Nestor, 13, 22, pl. 4, figs. 1–4. □ 1964 *Clathrodictyon regulare* (Rosen); Nestor, 57, 106, pl. 20, figs. 1, 2; pl. 22, fig. 5.

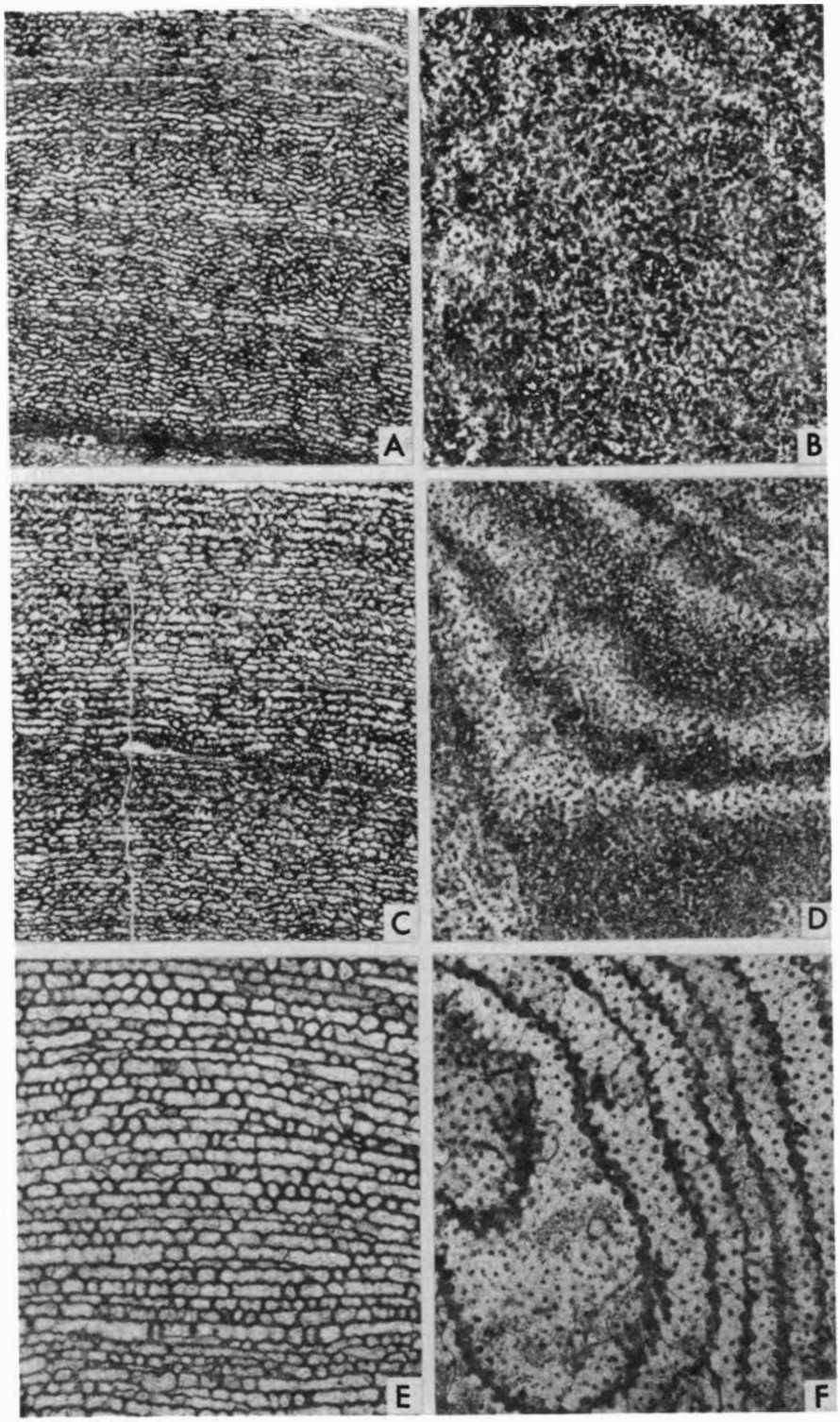
Horizon. – Stricklandia Series (stage 6c) and Pentamerus Series (stage 7 undivided).

Locality. – Ringerikesveien, Sandvika (Loc. no. 1) and Sandvika (details unknown).

Material. – Two specimens (PMO 53371 and PMO 97309).

Description. – The coenostea are fragmental and small. The larger specimen is 5.0 cm in height and 11.0 cm in diameter, while the smaller one is 2.0 cm in height and 5.0 cm in diameter. The surface is not preserved. The laminae are minutely crumpled, in places more or less persistent. Each of the laminae is composed of a single layer. The thickness of the laminae is 0.02–0.05 mm. They are regularly spaced, numbering 7–11, mostly 8–10 in 1 mm. The galleries are usually wider than the thickness of the laminae. The pillars are short, not continuing from one interlaminar space to another. Most of the pillars are composed of the downturned ends of the laminae. The number of the pillars is up to 8 in 1 mm, measured horizontally in vertical section. In tangential section the cut ends of the pillars are circular to oval, but irregular in places. The dia-

Fig. 6. All ×10. □ A, B. *Pseudostylodictyon* sp. PMO 45154. Limåstangen, Ringerike; Pentamerus Series (stage 7a). A – Vertical section, B. – Tangential section. □ C, D. *Clathrodictyon crickmayi* Parks. PMO 47644. Bragsøya, Ringerike; Lower Spirifer Series (stage 8d). C – Vertical section, D – Tangential section. □ E, F. *Clathrodictyon linnarssoni* Nicholson. PMO 97308. Malmøya, Oslo (Loc. no. 3); Pentamerus Series (stage 7a). E – Vertical section, F – Tangential section.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meter of the pillars is variable, but mostly 0.02–0.09 mm. Astrorhizae were not recognized in thin sections. The microstructure is compact.

Remarks and comparison. – Nestor (1962:13) revised the holotype and noted that *'Clathrodictyon regulare'* described by Nicholson and others is misidentified. The characteristics of the present species are the regularly and rather densely spaced laminae and absence of the astrorhizae. The specimens from the Oslo Region are very similar to the holotype revised by Nestor. *Clathrodictyon regulare* of Nicholson (1887, 1889), Boehnke (1915), and Parks (1933) has more widely spaced laminae and is referred to *C. simplex* (Nestor). *C. regulare* of Ripper (1937) has thicker (0.1 mm) and more widely spaced laminae (3–5 in 1 mm) than the holotype. It was referred to *Anostylostroma* sp. nov. A by Philip (1962).

C. regulare of Sugiyama (1939, 1940) has also thicker and more persistent laminae than the holotype. *C. regulare* of Flügel (1958a) was referred to *Anostylostroma* by Flügel (1958b). The species described by Riabinin (1951) was referred to *Rosenella dentata* by Nestor (1964).

Geological age. – Llandoverian.

Geographical distribution. – Estonia and Sandvika, Norway.

Clathrodictyon simplex (Nestor)

Fig. 7, E, F.

□ 1887 *Clathrodictyon regulare*, Rosen, sp.; Nicholson, 10, pl. 2, figs. 5, 6. □ 1889 *Clathrodictyon regulare*, Rosen, sp.; Nicholson, 155, pl. 18, figs. 8–11a. □ 1915 *Clathrodictyon regulare* Rosen emend. Nich.; Boehnke, 168, fig. 12. □ 1933 *Clathrodictyon regulare* von Rosen; Parks, 8, pl. 1, figs. 7, 8. □ 1966 *Simplexodictyon simplex*, n. sp.; Nestor, 25, 81, pl. 8, figs. 1–6. □ 1968 *Clathrodictyon simplex* (Nestor); Mori, 57, pl. 3, figs. 1, 2; pl. 4, figs. 1–6; pl. 19, fig. 1.

Horizon. – Pentamerus Series (stages 7a–c).

Locality. – Malmøya, Oslo (Loc. no. 3), Gjettum, Sandvika (Loc. no. 4) and Purkøya, Storøya and Gjeitøya, all at Ringerike.

Material. – Six specimens (PMO 21680, PMO 45489, PMO 45605, PMO 47018, PMO 97310 and PMO 97311).

Description. – The coenostea are small. The largest specimen is 4.5 cm in height and 9.5 cm in maximum diameter. The smallest one is 1.2 cm in height and 6.0 cm in maximum diameter. In a single specimen the weathered surface shows edges of exfoliated laminae and pillars, but in other specimens the surface is not preserved. The number of the laminae is 4–7, mostly 5 or 6 in 1 mm. The thickness of the laminae varies from 0.02 to 0.07 mm. In tangential section the laminae have many isolated holes which show the depressions where the laminae are downfolded. The pillars are short, numbering up to 5 in 1 mm, measured in vertical section. They are circular in tangential section, 0.04–0.10 mm in diameter. Astrorhizae are absent. The microstructure is compact.

Remarks and comparison. – In all aspects the specimens examined are very similar to the holotype from the Wenlockian of Estonia and to the specimens from the Wenlockian of Gotland. This is the first observation of this species in the Llandoverian.

Geological age. – Llandoverian and Wenlockian.

Geographical distribution. – Quebec, Canada, Dudley, England, Silurian boulders from Holland, Estonia, Gotland, Sweden and Oslo Region, Norway.

Clathrodictyon sulevi Nestor

Fig. 8, A, B.

□ 1964 *Clathrodictyon sulevi* sp. nov.; Nestor, 47, 105, pl. 15, figs. 1, 2; pl. 17, figs. 5, 6. □ 1970 *Clathrodictyon sulevi* Nestor; Mori, 93, pl. 4, figs. 3–6.

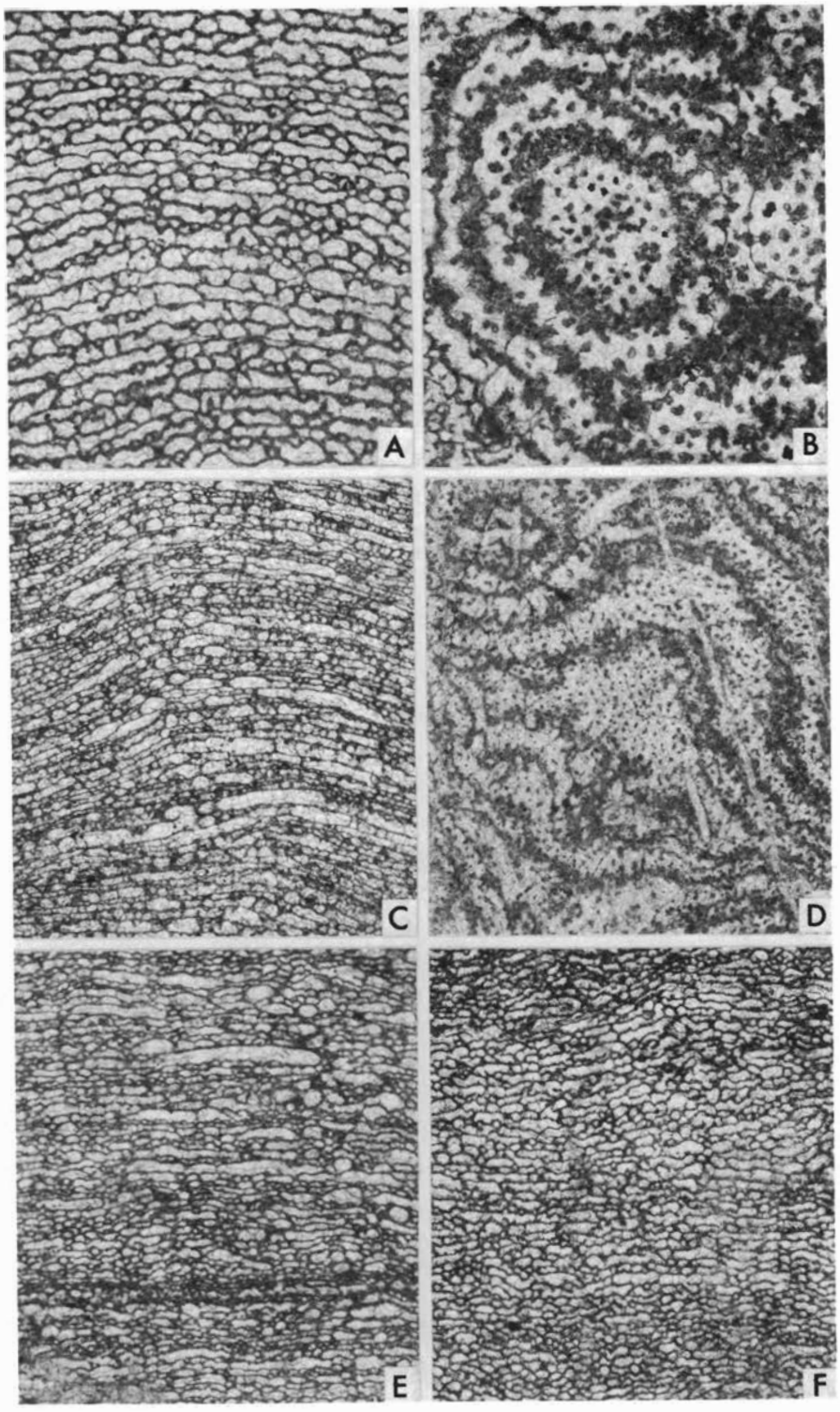
Horizon. – Pentamerus Series (stage 7 undivided).

Locality. – Engervannet, Sandvika.

Material. – One specimen (PMO 53372).

Description. – The coenosteum is small, irregularly conical. It is 3.0 cm in height and 9.0 cm in diameter. Exfoliated laminae are well recognized on the surface. The laminae are crumpled to

Fig. 7. All × 10. □ A, B. *Clathrodictyon regulare* (Rosen). PMO 53371. Ringeriksveien, Sandvika (Loc. no. 1); Stricklandia Series (stage 6c). A – Vertical section, B – Tangential section. □ C, D. *Clathrodictyon regulare* (Rosen). PMO 97309. Sandvika Pentamerus Series (stage 7 undivided). C – Vertical section, D – Tangential section. □ E, F. *Clathrodictyon simplex* (Nestor). PMO 45489. Gjettum, Sandvika (Loc. 4); Pentamerus Series (stage 7a). E – Vertical section, F – Tangential section.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persistent. They are regularly spaced, numbering 4–6 in 1 mm. The thickness of the laminae varies from 0.02 to 0.08 mm. The pillars are confined to one interlaminar space. Some of them are formed by downturned ends of the laminae. Y-shaped, branching pillars are occasionally present. At the top of these pillars, small cavities occur as seen in vertical section. There are up to 4 pillars in 1 mm measured in vertical section. In tangential section the pillars are circular, clearly distinguished from the cut ends of the laminae. They vary from 0.05 to 0.20 mm in diameter. The astrorhizae are not recognized in thin sections. The microstructure is compact.

Remarks and comparison. – In general skeletal structures the present specimen is similar to the holotype (Co 3054) described by Nestor (1964). Astrorhizae were not observed either in the holotype or in the present material, although Nestor mentioned the presence of small astrorhizae in this species.

Geological age. – Llandoverian to Wenlockian.

Geographical distribution. – Estonia, Gotland, Sweden and Ringerike, Norway.

Clathrodictyon variolare (Rosen)

Fig. 8, C, D, E, F.

□ 1867 *Stromatopora variolaris* n.; Rosen, 61, pl. 2, figs. 2–5. □ 1886b *Clathrodictyon variolare*, Rosen, sp.; Nicholson, pl. 5, figs. 5, 6. □ 1887 *Clathrodictyon variolare*, Rosen, sp.; Nicholson, 4, pl. 1, figs. 4–6. □ 1889 *Clathrodictyon variolare*, Rosen, sp.; Nicholson, 150, pl. 18, figs. 1–5; pl. 17, fig. 14. □ 1908 *Clathrodictyon variolare* von Rosen sp.; Parks, 19, pl. 7, fig. 2; pl. 8, figs. 1, 9. □? 1915 *Clathrodictyon variolare* Rosen emend. Nich.; Boehnke, 167, figs. 10, 11. □? 1928 *Clathrodictyon variolare* Rosen; Riabinin, 1042, 1049, pl. 73, figs. 5–7, 10. □ 1929 *Clathrodictyon variolare* Rosen; Yavorsky, 89, 105, pl. 8, figs. 8–10; pl. 9, figs. 1, 2. □? 1931 *Clathrodictyon variolare* Rosen; Riabinin, 216, pl. 1, figs. 6, 7. □? 1933 *Clathrodictyon variolare* von Rosen; Parks, 8, pl. 2, fig. 1. □ non 1934 *Clathrodictyon variolare* Rosen; Le Maitre, 188, pl. 13, figs. 1, 2. □ 1940 *Clathrodictyon variolare* (von Rosen) Nicholson; Chi, 294, pl. 1, figs. 3a, b. □ 1941 *Clathrodictyon variolare* (v. Rosen); Poulsen, 26, pl. 5, fig. 5. □? 1951 *Clathrodictyon variolare* (Rosen); Riabinin, 19, pl. 12, figs. 3–6; pl. 13, figs. 1–4. □ 1951 *Clathrodictyon boreale* n. sp.; Riabinin, 27, pl. 22, figs. 5–8; pl. 23, fig. 1. □ 1953 *Clathrodictyon variolare* (Rosen); Riabinin, 28, pl. 7, fig. 8. □ 1955a *Clathrodictyon variolare* Rosen; Yavorsky, 41, pl. 14, figs. 4–7. □ 1955b *Clathrodictyon variolare* (Rosen); Yavorsky, 36, pl. 53, figs. 1–3. □ non 1956 *Clathrodictyon variolare* (Rosen); Flügel, 49, pl. 1, fig. 7. □ non 1958 *Clathrodictyon variolare* (Rosen); Flügel, 154, pl. 3, figs. 1, 2. □ 1961 *Clathrodictyon variolare* Rosen; Yavorsky, 20, pl. 7, figs. 4, 5. □ 1962 *Clathrodictyon variolare* (Rosen); Nestor, 9, 22, pl. 3, figs. 1–4. □ 1962 *Clathrodictyon boreale* Riabinin; Nestor, 11, 22, pl. 7, figs. 1, 2. □ 1962 *Clathrodictyon variolare* (Rosen); Yavorsky, pl. 2, figs. 7, 8. □ 1964 *Clathrodictyon boreale* Riabinin; Nestor, 45, 104, pl. 14, figs. 3–6. □ 1964 *Clathrodictyon variolare* (Rosen); Nestor, 58, 106, pl. 20, figs. 3–6; pl. 21, figs. 7, 8.

Horizon. – Stricklandia Series (stage 6c) and Pentamerus Series (stages 7a, 7b and undivided 7).

Locality. – Malmøya, Oslo (Loc. no. 3), Vakås, Asker (Loc. no. 4), Spirodden, Asker, Engervannet, Sandvika, and Bjerkøya, Holmestrand.

Material. – Sixteen specimens (PMO 30948, PMO 43168, PMO 43172, PMO 42838, PMO 52642, PMO 53377, PMO 53381, PMO 54873, PMO 97312–97319).

Description. – The coenostea are conical or bell-shaped. Some of them are fragmental. The largest specimen is 8.0 cm in height and 14.0 cm in diameter. The smallest one is 1.5 cm in height and 5.5 cm in diameter. The astrorhizae are recognizable on the surfaces in well preserved specimens, but mamelons are present only in one specimen, in which the distances from center to center of the mamelons vary from 5 to 9 mm. The laminae are minutely crumpled, but in places persistent or strongly folded, showing variations even within a specimen. The laminae are thin, 0.02–0.04 mm, numbering 7–11 in 1 mm. They are more widely spaced where the cut ends of the astrorhizal canals are present, while they are more closely and regularly spaced where the astrorhizal canals are not present. The pillars are short and many of them are formed by downturned ends of the laminae. They are irregularly distributed, numbering up to 8 in 1 mm measured in vertical section. The cut ends of the pillars are circular to irregular in tangential section. The diameter of the circular pillars is 0.02–0.03 mm. The astrorhizae are well developed as seen in thin sections. In vertical section the astrorhizal canals are clearly distinguished from the other

Fig. 8. All × 10. □ A, B. *Clathrodictyon sulevi* Nestor. PMO 53372. Engervannet, Sandvika (stage 7). A – Vertical section, B – Tangential section. □ C, D. *Clathrodictyon variolare* (Rosen). PMO 30948. Malmøya, Oslo (Loc. no. 3); Stricklandia Series (stage 6). C – Vertical section showing astrorhizal columns, D – Tangential section. □ E, F. *Clathrodictyon variolare* (Rosen). E – Vertical section showing no astrorhizal columns. PMO 97314, Spirodden, Asker. F – Vertical section. PMO 43168. Malmøya, Oslo (stage 7).

normal galleries, since their diameter is considerably greater than that of the latter. In one specimen (PMO 30948) astrorhizal columns are present and the laminae are undulating towards the column (Fig. 8, C). But in the others the astrorhizal columns are absent. The diameter of each astrorhiza is approximately 4–6 mm. The microstructure is compact.

Remarks and comparison. – Nestor (1962) revised the type specimen of *Clathrodictyon variolare* originally described by Rosen (1876). He noted that *C. variolare* described by Nicholson and successive investigators is not identical with the holotype, and referred it to *C. boreale* Riabinin. Nestor (1962, 1964) mentioned that *C. variolare* can be distinguished from *C. boreale* by astrorhizal columns and equal heights of interlaminar spaces. Through the present investigation and examination of the type specimens of Rosen (1876) and comparative materials studied by Nicholson (1886a, b, 1889) and Nestor (1964) the writer came to the following conclusions:

As far as only the type specimens of Rosen (Co3006, Co3016 and Co3017) are concerned, Nestor's statement is accepted. However, the material from the Oslo Region indicates variations in presence or absence of astrorhizal columns and spacing of laminae and pillars. The astrorhizal columns can be observed only in one specimen with mamelons on the surface, while in the others no mamelons are recognized and the astrorhizae do not form columns as observed in vertical sections (Fig. 8, E, F), even though internal skeletal structures are quite similar to each other. In the present author's opinion, Nicholson correctly pointed out in the explanation of *C. variolare* (1889, pl. 17, fig. 14) that 'the laminae in this specimen exhibit rounded "mamelons", but these are by no means invariably present in this species', although Parks (1908: 20) stated that 'in all examples that I have examined the presence of mamelons is a characteristic feature . . . it must be remembered that Nicholson states these eminences to be sometimes wanting, but as far as my observations go this exception does not hold for American specimens.' Presence or absence of mamelons or astrorhizal columns has been generally considered to be a character of specific distinction. But at least in the case of *C. variolare* the presence of mamelons and astrorhizal columns is not a common specific character. Nestor (1964) referred *C. variolare* described by Nicholson (1889: pl. 18, figs. 2, 3) to *C. boreale* Riabinin. The examination of the specimens and thin sections of the Nicholson collection in the British Museum shows that the vertical section (P5958, 228) and the tangential section (P5958, 228a) represented in pl. 18, figs. 2, 3 by Nicholson are very similar to those of Rosen's type specimen of *C. variolare* (Nestor 1962: pl. 3, figs. 1, 2). On the other hand, the height of interlaminar spaces is of variable character. The interlaminar spaces are of equal height where cut ends of the astrorhizal canals do not appear, while the spaces are much more high and irregular than normal galleries where the astrorhizal canals are placed. Two vertical thin sections (230a and 230b) in Nicholson's specimen (P5960) from Estonia indicate that the skeletal structures vary from the *'variolare'* type to the *'boreale'* type in the sense of Nestor. It is here concluded that *C. boreale* cannot be distinguished from *C. variolare* by the character claimed by Nestor. Nestor (1964) referred several species described by Riabinin (1951) to *C. boreale*. The present species is very similar to *C. vesiculosum* Nicholson & Murie, but the cut ends of the astrorhizal canals are more eminent than in the latter as seen in vertical section.

Geological age. – Silurian, very common in Llandoverian.

Geographical distribution. – Hupeh, China, Manitoulin Island, Coast of Lake Michigan, Lake Temiskaming, Drummond Island, Anticosti, Cape Smyth, Quebec, all in Canada, Cape Madison, Greenland, Estonia, Podolia, Lithuania, River Podkamennaya Tunguska, River Listvennaya, River Moiero, River Pechora, RSSR, Dormington, England and Oslo Region, Norway.

Oslodictyon, n. gen.

Derivation of name. – *Oslodictyon,* derived from the occurrence of the type species in the Oslo Region, Norway.

Type species. – *Oslodictyon henningsmoeni,* n. sp.

Species included. – *Oslodictyon henningsmoeni,* n. sp. *O. burmantovskiense* (Yavorsky) (Yavorsky 1955a: 47, pl. 17, figs. 3, 4), *O. klintense* (Mori) (Mori 1968: 69, pl. 5, figs. 5, 6), *O. suevicum* (Nicholson) (Nicholson 1886a: 234, pl.

7, figs. 5, 6; Nestor 1964: 81, 110, pl. 30, figs. 3–6)

Diagnosis. – Coenosteum conical or massive. Skeleton composed of thin laminae and vertical pillars. Laminae straight or crumpled. Pillars of two types; one type confined in one interlaminar space and some of the pillars of this type formed by downturned flexions of laminae, and another type composed of long continuous pillars. Cut ends of the pillars of both types circular, oval or irregular, clearly distinguished from laminae in tangential section. Astrorhizae may be present. Microstructure compact.

Remarks and comparison. – The present genus is characterized by the skeleton composed of thin laminae and short pillars which are clearly allied to those of *Clathrodictyon* and long continuous pillars. It can be distinguished from *Clathrodictyon* by having continuous pillars. But close resemblance with *Clathrodictyon* indicates that *Oslodictyon* can be placed in the family Clathrodictyidae. *Oslodictyon* also resembles *Yabeodictyon* by having continuous pillars, but the latter has more zig-zag-shaped, strongly crumpled laminae showing shevron-like folds. *Oslodictyon* is furthermore similar to *Actinodictyon,* but the horizontal elements of the former consist of genuine laminae, not of cyst plates (or dissepiments) or cyst plate-like laminae. As discussed in previous papers (Mori 1968, 1970), there are two opinions in interpretation of the horizontal skeletal elements of *Actinodictyon;* one of them holds that the horizontal elements are laminae, while in the other they are interpreted as cyst plates or cyst plate-like laminae. It is here considered that whatever the horizontal elements are called, they show cyst plate-like forms that can be clearly distinguished from genuine laminae of *Clathrodictyon* type. *Actinodictyon suevicum* (Nicholson), described by Nicholson (1886) and Nestor (1964), is here included in *Oslodictyon,* because the horizontal elements are composed of real laminae. *Neoclathrodictyon* proposed by Lesovaja (1971) is considered to be synonymous with *Yabeodictyon.* Schematic representations of vertical sections of *Oslodictyon* and related genera are shown in Fig. 5. The presence of vertical continuous pillars penetrating laminae in *Oslodictyon* shows some resemblance with genera of Actinostromatidae such as *Actinostroma* and *Plectostroma,* but the horizontal elements of the present genus is entirely different from those of the latter. *Clathrodictyon burmantovskiense* Yavorsky is here included in *Oslodictyon,* because it has long pillars besides the characteristic structures of *Clathrodictyon. Clathrostroma klintense* Mori is also referred to the present genus. The genus *Clathrostroma* originally proposed by Yavorsky is now confused. As illustrated by Flügel & Flügel-Kahler (1968: 538, 667), Yavorsky (1960) proposed *Clathrostroma lekense* as the type species of the genus which was first described in 1961; nevertheless in his paper (1960) Yavorsky had already described *C. stolbergenense,* and this should thus be the type. Judging from the pictures (Yavorsky 1960; pl. 13, figs. 1–4) *C. stolbergense* is similar to *Anostylostroma.* As far as the generic description by Yavorsky (1960) is concerned, the content is similar to the diagnosis of *Oslodictyon,* but the pictures of *C. stolbergenense* do not show close resemblance with *Clathrodictyon.* In addition, lack of uniformity in the generic description, especially concerning presence or absence of 'arms' in Yavorsky's papers (1960, 1961, 1967), makes it also difficult to accept *Clathrostroma* as a valid genus.

Oslodictyon henningsmoeni, n. sp.

Fig. 9, A, B, C, D.

Derivation of name. – *henningsmoeni,* named in honour of Professor Gunnar Henningsmoen, Paleontologisk Museum, Oslo.

Holotype. – Specimen no. PMO 45420, thin section nos. PMO 45420-a and -b.

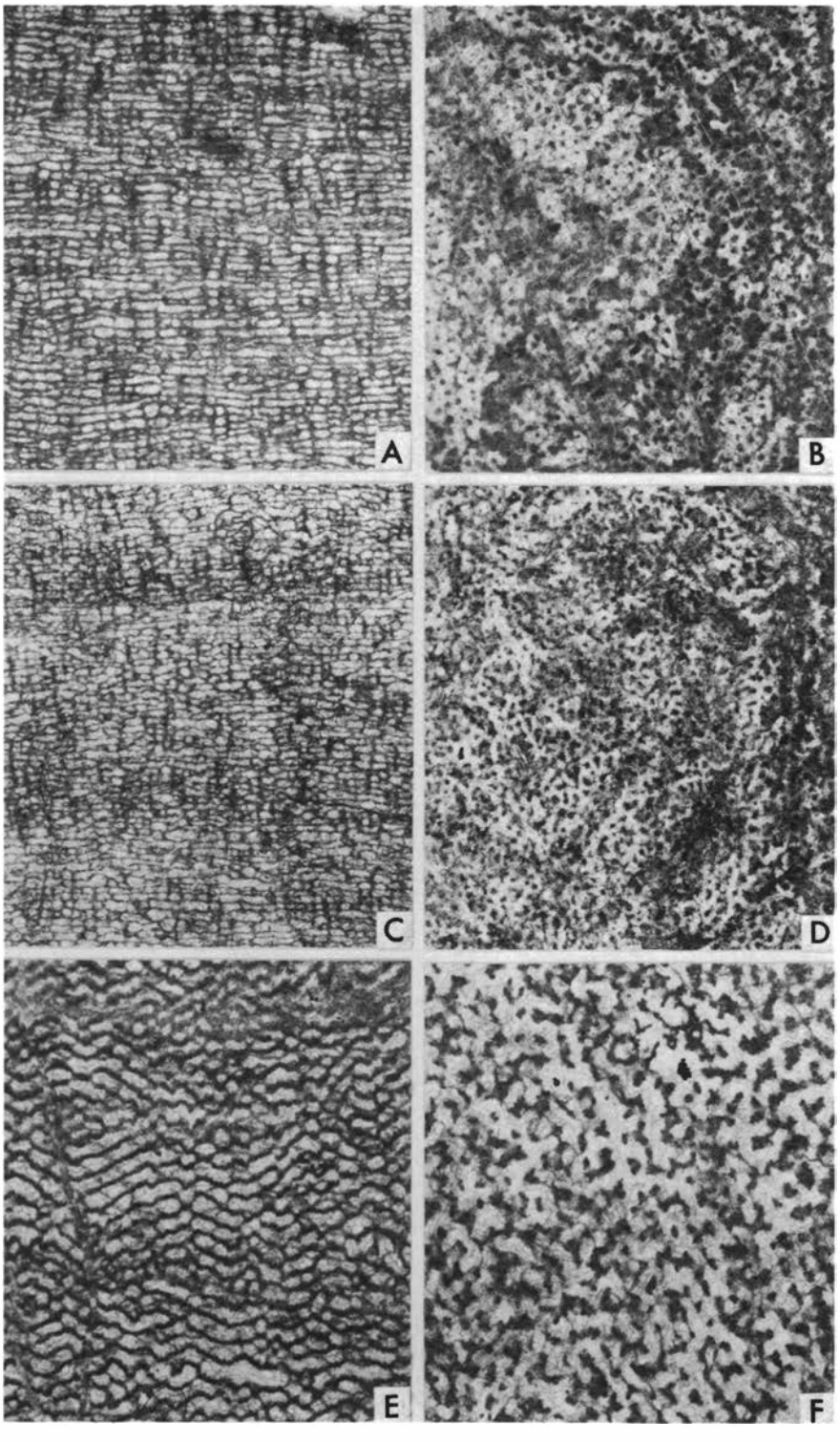
Horizon. – Pentamerus Series (stage 7b).

Type locality. – Vesleøya, Ringerike. Exact point of the locality at Vesleøya is unknown. The specimen was collected by Kiær, 1896.

Other locality. – Rytteraker, Ringerike (Loc. no. 8).

Material. – Two specimens (PMO 45420 and PMO 97320).

Description. – The holotype specimen is fragmental, 3.0 cm in height and 6.5 cm in diameter. The paratype specimen is conical, 3.0 cm in height and 9.2 cm in diameter. The surface of the paratype coenosteum is smooth. No astrorhizae are observed on the surface. The laminae are persistent or slightly crumpled. They are regularly spaced, numbering 8–11, but mostly 9 or 10 in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1 mm. The thickness of the laminae is 0.02–0.05 mm. Two types of pillars can be distinguished in vertical section. One type is very short and confined to one interlaminar space. Some of the pillars are formed by downturned flexions of the laminae. The distribution of the pillars of this type is irregular. Another type of pillars is continuous, penetrating the laminae. There are up to 6 pillars in 1 mm measured in vertical section. In tangential section both types of pillars have equal sizes in diameter. They are circular, oval or slightly elongate, being clearly distinguished from the laminae. The diameter of the pillars is 0.04–0.14 mm. Astrorhizae are not recognized in thin sections. The microstructure is obscure.

Remarks and comparison. – The present species is similar to *Oslodictyon suevicum* (Nicholson) (Nicholson 1886a, Nestor 1964), but it can be distinguished by more densely spaced laminae.

Geological age. – Llandoverian.

Geographical distribution. – Ringerike, Norway.

Genus *Ecclimadictyon* Nestor, 1964

Ecclimadictyon fastigiatum (Nicholson)

Fig. 9, E, F.

□ 1886b *Clathrodictyon fastigiatum*, n. sp.; Nicholson, 43, fig. 3; 78, fig. 12. □ 1887 *Clathrodictyon fastigiatum*, Nich.; Nicholson, 8, pl. 2, figs. 3, 4. □ 1889 *Clathrodictyon fastigiatum*, Nich,; Nicholson, 152, pl. 19, figs. 1–5. □ 1907 *Clathrodictyon fastigiatum*, Nich.; Parks, 18, pl. 1, fig. 6. □ 1908 *Clathrodictyon fastigiatum*, Nicholson; Parks, 24, pl. 7, fig. 8. □ non 1915 *Clathrodictyon fastigiatum* Nich.; Boehnke, 169, figs. 13, 14. □ non 1929 *Clathrodictyon fastigiatum* Nicholson; Yavorsky, 84, pl. 7, figs. 1–3. □ non 1937 *Clathrodictyon fastigiatum* Nicholson; Riabinin, 9, pl. 1, figs. 1, 2. □ ? 1939 *Clathrodictyon fastigiatum* Nich.; Riabinin, 6, pl. 1, figs. 6–9. □ 1941 *Clathrodictyon fastigiatum* Nicholson; Poulsen, 26, pl. 6, fig. 3. □ non 1951 *Clathrodictyon fastigiatum* Nicholson; Riabinin, 20, pl. 14, figs. 1–6. □ non 1955 *Clathrodictyon fastigiatum* Nicholson; Yavorsky, 44, pl. 15, figs. 7, 8. □ 1956 *Clathrodictyon fastigiatum* Nicholson; Stearn, 50, pl. 2, fig. 5. □ non 1961 *Clathrodictyon fastigiatum* Nicholson; Yavorsky, 28, pl. 14, figs. 4–6. □ non 1962 *Clathrodictyon fastigiatum* Nicholson; Yang & Dong, 15, pl. 8, figs. 1, 2. □ 1964 *Ecclimadictyon pandum* sp. nov.; Nestor, 69, 108, pl. 23, fig. 6; pl. 28, fig. 6. □ 1964 *Ecclimadictyon fastigiatum* (Nicholson); Nestor, 70, 108, pl 26, figs. 3–5; pl. 28, figs. 7, 8. □ 1966 *Ecclimadictyon fastigiatum* (Nicholson); Stearn & Hubert, 37, figs. 8, 16. □ 1967 *Ecclimadictyon fastigiatum* (Nicholson); Petryk, 16, pl. 2, figs. 1, 2. □ 1968 *Ecclimadictyon fastigiatum* (Nicholson); Mori, 62, pl. 8, figs. 1, 2.

Horizon. – Stricklandia Series (stage 6c) and Pentamerus Series (stages 7a, 7b and undivided 7).

Locality. – Vakås, Asker (Loc. no. 2), Malmøya, Oslo (Loc. no. 3), Limåstangen, Ringerike (Loc. no. 7) and Rytteraker, Ringerike (Loc. no. 8).

Material. – Six specimens (PMO 45027, PMO 97321–97325).

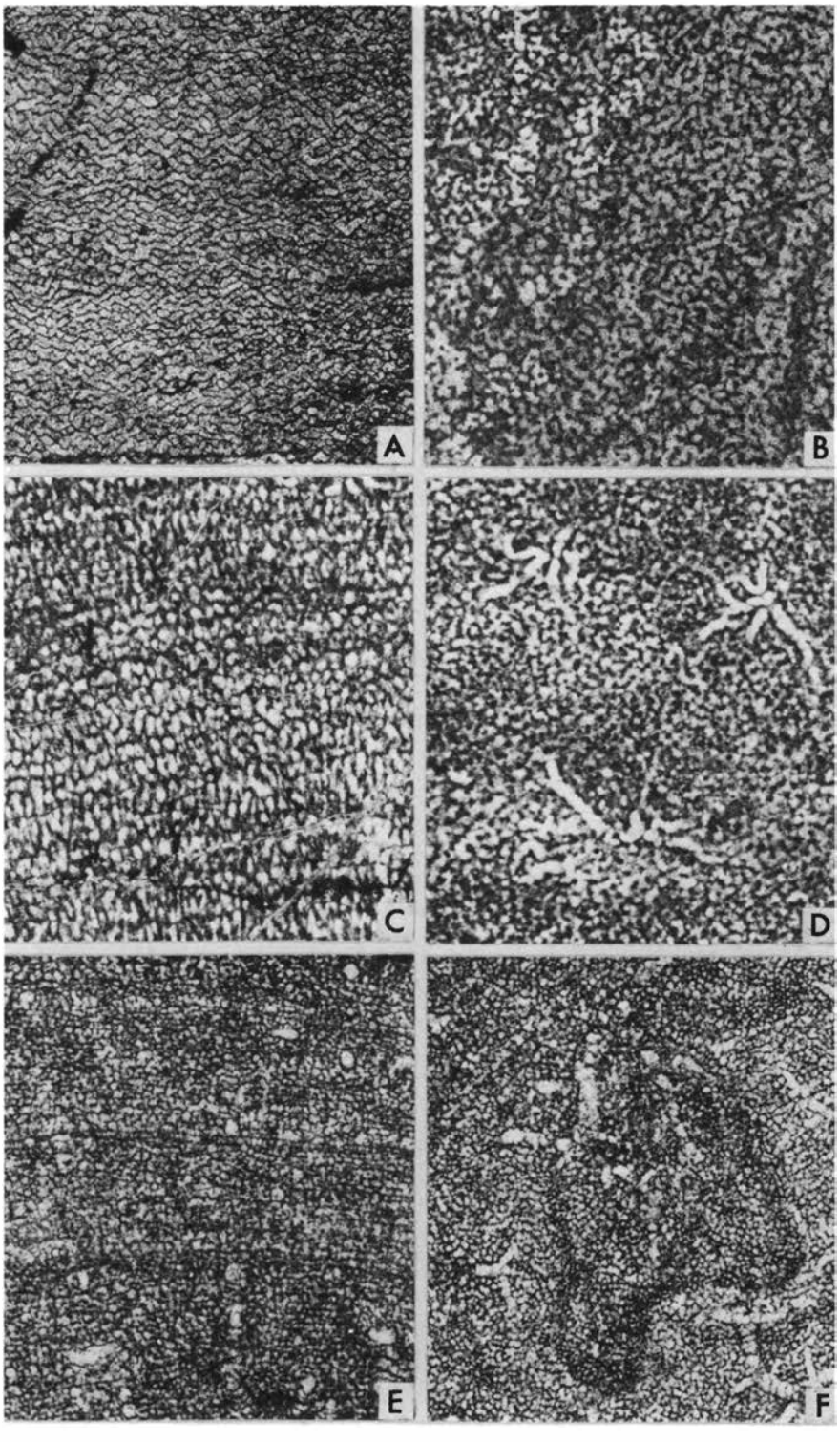
Description. – The coenostea are conical or fragmental. The largest specimen is 16.0 cm in height and 20.0 cm in diameter. The skeleton is composed of strongly crumpled, chevron-like folded laminae. The laminae are generally 0.05–0.07 mm thick, numbering 3–5, rarely 6 in 1 mm measured in vertical section. Downfolded extensions of the laminae serve as short pillars, but zigzag shaped folded laminae overlap with each other forming vesicles of various shapes and sizes. In tangential section the cut flexions of the skeleton are circular to irregularly vermiculated. The cut ends of the pillars are difficult to distinguish from those of the laminae. Astrorhizae are not recognized in thin sections. The microstructure is compact.

Remarks and comparison. – In the previous paper (Mori 1968: 63) the present species was distinguished from *Ecclimadictyon pandum* Nestor by more densely spaced laminae. However, the material from the Oslo Region indicates that the number of the laminae varies from 3 to 6 in 1 mm. Referring to Petryk (1967) it is here considered that *E. pandum* is a synonym of *E. fastigiatum*.

Geological age. – Llandoverian and Wenlockian.

Geographical distribution. – Ontario, Manitoba, Quebec and Baffin Island, Canada, Ironbridge, Much Wenlock, Dudley, and Dormington, England, Cape Madison, North Greenland, Estonia, Gotland, Sweden and Oslo Region, Norway.

Fig. 9. All × 10. □ A, B. *Oslodictyon henningmoeni*, n. gen. and n. sp. Holotype. PMO 45420. Vesleøya, Ringerike; Pentamerus Series (stage 7b) A – Vertical section, B – Tangential section. □ C, D. *Oslodictyon henningsmoeni*, n. gen. and n. sp. Paratype. PMO 97320. Rytteraker, Ringerike (Loc. no. 8); Pentamerus Series (stage 7b). C – Vertical section, D – Tangential section. □ E, F. *Ecclimadictyon fastigiatum* (Nicholson). PMO 97322, Asker (stage 6c). E – Vertical section, F – Tangential section.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Ecclimadictyon microvesiculosum (Riabinin)

Fig. 10, A, B.

□ 1951 *Clathrodictyon vesiculosum* Nich. & Mur.; Riabinin, 14, pl. 5, figs. 1, 2; pl. 6, figs. 3, 4. □ 1951 *Clathrodictyon microvesiculosum* n. sp.; Riabinin, 15, pl. 5, figs. 4, 5; pl. 6, figs. 5, 6. □ 1951 *Clathrodictyon macrovesiculosum* n. sp. (part.); Riabinin, 15, pl. 5, fig. 3; pl. 9, figs. 1, 2; non pl. 6, figs. 7, 8. □ 1964 *Ecclimadictyon microvesiculosum* (Riabinin); Nestor, 65, 107, pl. 25, figs. 1–4; pl. 28, figs. 1, 2. □ 1967 *Ecclimadictyon microvesiculosum* (Riabinin); Petryk, 19, pl. 2, figs. 3, 4. □ 1968 *Ecclimadictyon microvesiculosum* (Riabinin); Mori, 65, pl. 8, figs. 5, 6; pl. 9, figs. 5, 6; pl. 10, fig. 3.

Horizon. – Pentamerus Series (undivided stage 7).

Locality. – Sandvika. Exact point at Sandvika is unknown. It was collected by Kjerulf 1863.

Material. – One specimen (PMO 53378).

Description. – The coenosteum is fragmental, 4.5 cm in height and 14.5 cm in diameter. The surface is not preserved. The skeleton is composed of zigzag shaped, finely crumpled laminae. The laminae are 0.02–0.04 mm thick, numbering 6–9, mostly 7–8 in 1 mm measured in vertical section. The downturned extensions of the laminae form short pillars. The shape of galleries is variable, being circular to laterally elongated. No dissepiments are present. In tangential section the cut ends of the laminae and the pillars are round to irregular. Astrorhizae are developed. They are not recognized in complete form in thin sections, but only as elongated larger galleries in tangential section. The microstructure is obscure.

Remarks and comparison. – The present specimen has commonly more elongated galleries than is true for the specimens from Estonia described by Riabinin (1951) and Nestor (1964), but this difference is considered to be a variation within the species. The material belongs to the collection of Paleontologisk Museum labelled only 'etage 7, Sandvika'.

Geological age. – Llandoverian and Wenlockian.

Geographical distribution. – Baffin Island, Canada, Estonia, Gotland, Sweden and Oslo, Norway.

Ecclimadictyon robustum Nestor

Fig. 10, C, D.

□ 1966 *Ecclimadictyon robustum* sp. nov.; Nestor, 17, 80, pl. 6, figs. 3–5; pl. 7, fig. 1. □ 1966 *Ecclimadictyon astrolaxum* sp. nov; Nestor, 18, 80, pl. 5, figs. 5, 6; pl. 6, figs. 1, 2. □ 1968 *Ecclimadictyon astrolaxum* Nestor; Mori, 61, pl. 7, figs. 1, 2; pl. 9, figs. 3, 4. □ 1970 *Ecclimadictyon robustum* Nestor; Mori, 98, pl. 5, figs. 5, 6.

Horizon. – Upper Spirifer Series (stage 9c).

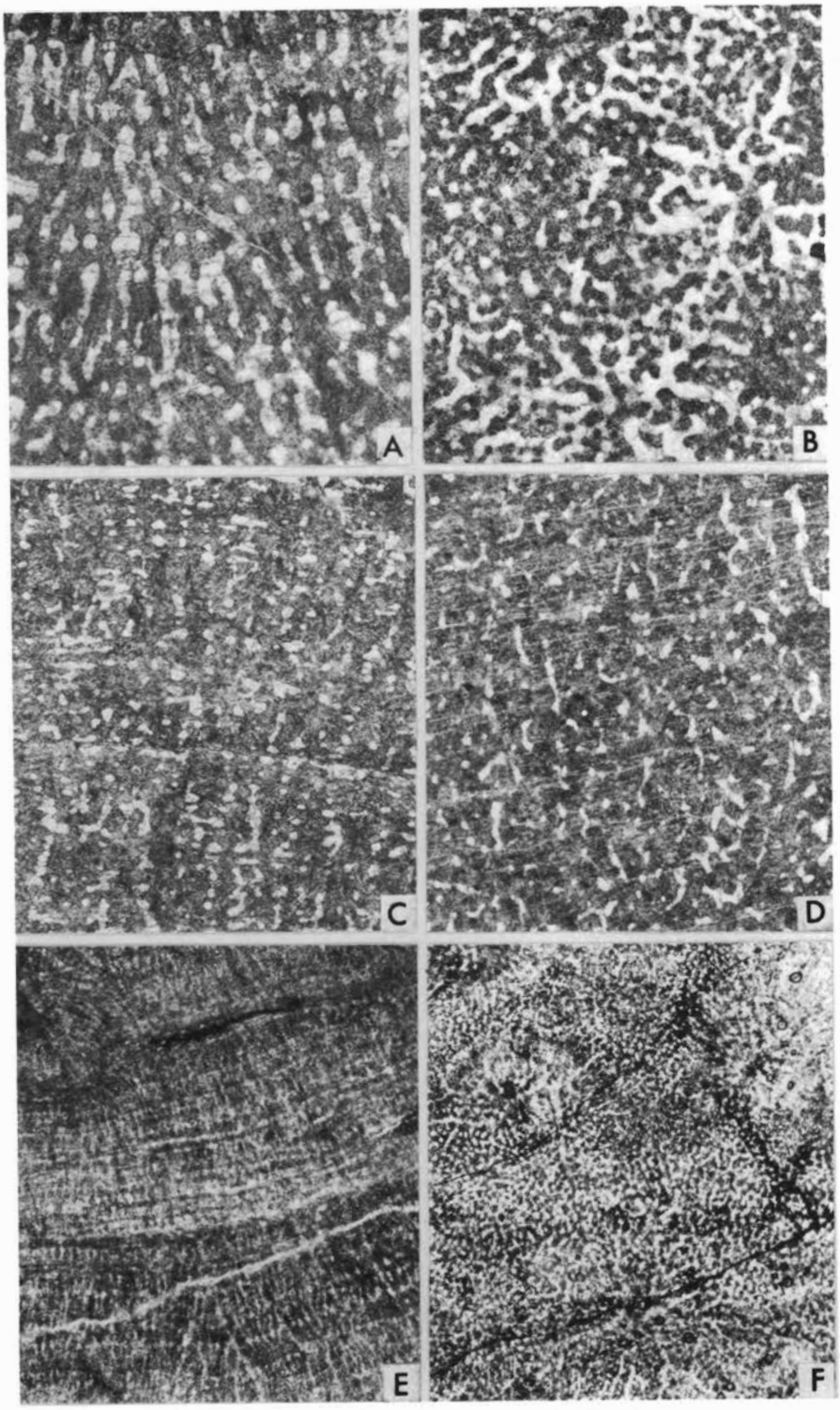
Locality. – Langøya, E of Holmestrand (Loc. no. 6).

Material. – Two specimens (PMO 97326 and PMO 97327).

Description. – The coenosteum is massive. One specimen is 12.0 cm in height and 25.0 cm in diameter and the other is 10.0 cm in height and 28.0 in diameter. The skeleton is mostly composed of strongly crumpled laminae and short pillars. The laminae are zigzag shaped, but they are rarely laterally crumpled or persistent. There are 4–6 laminae in 1 mm. The thickness of the laminae is 0.02–0.06 mm. The pillars are confined in one interlaminar space, formed by downturned flexions of the laminae. There are up to 8 pillars in 1 mm measured in vertical section. In tangential section the pillars appear as circular dots which are 0.02–0.05 mm in diameter. Very thin dissepiments 0.01 mm thick are occasionally present. Astrorhizae are well developed, forming vertical systems. They are 3–4 cm in diameter, with center-center distances of 3–5 cm. Each astrorhiza is composed of 5 or 6 mains canals and some smaller canals bifurcate from the main canals. The maximum diameter of the main canals is 0.20 mm in tangential section. In vertical section the astrorhizal canals are easily distinguished from the other galleries by their larger diameter. The microstructure is compact. A commensal rugose coral was found in the skeleton of one of the specimens investigated.

Remarks and comparison. – The present species is characterized by highly irregular zigzag shaped laminae and well developed astrorhizae. As previously mentioned (Mori 1970: 98), *Ecclimadictyon robustum* and *E. astrolaxum* are considered to be synonymous.

Fig. 10. All × 10. □ A, B. *Ecclimadictyon microvesiculosum* (Riabinin). PMO 53378. Sandvika (stage 7). A – Vertical section, B – Tangential section. □ C, D. *Ecclimadictyon robustum* Nestor. PMO 97327. Langøya, E of Holmestrand (stage 9c). C – Vertical section, D – Tangential section. □ E, F. *Plectostroma norvegicum*, n. sp. Holotype. PMO 97328. NNW of Kroksund, Ringerike (stage 8c). E – Vertical section, F – Tangential section.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Geological age. – Wenlockian and Ludlovian.

Geographical distribution. – Estonia, Gotland, Sweden and Holmestrand, Norway.

FAMILY ACTINOSTROMATIDAE NICHOLSON, 1886

Genus *Plectostroma* Nestor, 1964

Plectostroma norvegicum, n. sp.

Fig. 10, E, F.

Derivation of name. – *norvegicum* refers to the occurrence of this species in Norway.

Holotype. – Specimen no. PMO 97328, thin section nos. PMO 97328-a and -b.

Horizon. – Lower Spirifer Series (stage 8c).

Type locality. – NNW of Kroksund, Ringerike (Loc. no. 10).

Material. – Three specimens (PMO 97328, PMO 97329 and PMO 97330).

Description. – The coenostea are fragmental and small. The holotype is 4.0 cm in height and 7.2 cm in diameter. The horizontal elements are composed of rod-like radial processes. They are developed at different levels, but in places developed at same levels. In vertical section some of the cut ends of the radial processes are observed as small circular dots. They are very thin, 0.01–0.03 mm, numbering 9–11 radial processes in 1 mm. The pillars are mostly short and discontinuous. There are up to 11 pillars in 1 mm. In tangential section the cut ends of the pillars appear as small dots which are 0.02–0.03 mm in diameter. The rod-like radial processes form hexactinellid networks in tangential section. Astrorhizae are well developed. The astrorhizal canals are clearly distinguished from other galleries by larger cavities. The largest canals attain 0.32 mm in diameter. The exact sizes of the astrorhizae are unknown. The microstructure is compact.

Remarks and comparison. – The present species is characterized by short and discontinuous pillars, by which it is distinguished from other species of *Plectostroma*.

Geological age. – Wenlockian.

Geographical distribution. – Ringerike, Norway.

FAMILY STROMATOPORIDAE WINCHELL, 1867

Genus *Stromatopora* Goldfuss, 1826

Stromatopora discoidea (Lonsdale)

Fig. 11, A, B.

□ 1839 *Porites discoides*, sp. n. Lonsd.; Lonsdale, 688, pl. 16, fig. 1. □ non 1870 *Coenostroma discoideum* Lonsdale; Lindström, 6, figs. 6–13. □ 1886b *Stromatopora discoidea* Lonsd. sp.; Nicholson, pl. 3, fig. 3; pl. 7, figs. 1, 2. □ 1891 *Stromatopora discoidea* Lonsd. sp.; Nicholson, 188, pl. 24, figs. 2–8. □ 1929 *Stromatopora discoidea* Lonsdale; Yavorsky, 96, 107, pl. 10, figs. 8, 9. □ ? 1936 *Stromatopora* cf. *discoidea* Lonsd.; Riabinin, 31, pl. 1, figs. 4, 5. □ non 1947 *Stromatopora discoidea* Lonsd.; Yavorsky, 10, pl. 4, figs. 9, 10. □ ? 1951 *Stromatopora* cf. *discoidea* Lonsd.; Riabinin, 40, pl. 34, figs. 5, 6. □ non 1961 *Stromatopora discoidea* Lonsdale; Yavorsky, 40, pl. 24, figs. 1, 2. □ ? 1963 *Stromatopora* cf. *discoidea* Lonsdale; Yavorsky, 56, pl. 17, figs. 1–4. □ 1968 *Stromatopora discoidea* (Lonsdale); Mori, 82, pl. 19, figs. 5, 6.

Horizon. – Lower Spirifer Series (stage 8d).

Locality. – Bragsøya, Ringerike. Exact point at Bragsøya is unknown. It was collected by Kiær 1913.

Material. – One specimen (PMO 47631).

Description. – The coenosteum is conical, 7.0 cm in height and 12.0 cm in diameter. The skeleton is amalgamated, but vertical elements are more prominent than horizontal ones as seen in vertical section. Their thickness is 0.12–0.32 mm measured in vertical section, numbering 2–4 in 1 mm. Many of the galleries are vertically elongated. In tangential section they are circular, oval or irregularly vermiculated. The circular galleries are commonly 0.07–0.20 mm in diameter. In the galleries very thin dissepiments are developed. They are mostly straight, but some are waved, 0.02 mm or less in thickness. Astrorhizae are well developed. They are recognized as continuous elongate canals bifurcating from the center in tangential section. Their exact sizes are difficult to measure in thin section. The microstructure is cellular.

Fig. 11. All ×10. □ A, B. *Stromatopora discoidea* (Lonsdale). PMO 47631. Bragsøya, Ringerike (stage 8d). A – Vertical section, B – Tangential section. □ C, D. *Stromatopora ringerikensis*, n. sp. Holotype. PMO 45401. Vesleøya near Storøya, Ringerike (stage 7c). C – Vertical section, D – Tangential section. □ E, F. *Stromatopora* sp. PMO 97332. Langøya, E of Holmestrand (stage 9c). E – Vertical section, F – Tangential section.

Remarks and comparison. – The present specimen is closely linked to those of Gotland (Mori 1968) and England (Nicholson 1886b, 1891) in the general skeletal structures. As noted in a previous paper (Mori 1968: 82), the specimens described by Lindström (1870) should probably be excluded from *discoidea,* because through the writer's investigation the present species was found only in the Slite Beds, and none from the Östergarn, Visby, and Klinteberg areas of Gotland where Lindström's material came from. *S.* cf. *discoidea* by Yavorsky (1963) and Riabinin (1936, 1951) is difficult to compare with the present material owing to poor state of preservation.

Geological age. – Wenlockian.

Geographical distribution. – Estonia, Gotland, Sweden, Ironbridge, Much Wenlock and Dudley, England, and Ringerike, Norway.

Stromatopora ringerikensis, n. sp.

Fig. 11, C, D.

Derivation of name. – *ringerikensis* refers to the occurrence of this species at Ringerike.

Holotype. – Specimen no. PMO 45401, thin section nos. PMO 45401-a and -b.

Horizon. – Pentamerus Series (stage 7c).

Type locality. – Vesleøya, near Storøya, Ringerike. Exact point at Vesleøya is unknown. It was collected by Kiær 1896.

Material. – Two specimens (PMO 45400 and PMO 45401).

Description. – The coenosteum of the holotype is fragmental, 2.0 cm in height and 7.5 cm in diameter; the paratype is laminar, 0.5 cm in height and 6.0 cm in diameter. The skeleton is entirely amalgamated so that vertical and horizontal elements are not clearly distinguished from each other. The skeletal part occupies about 80–85 % of vertical and tangential sections. In vertical section the galleries are mostly circular to vertically elongate, forming pseudozooidal tubes. They are not conspicuous, less than 2.0 mm in vertical length. In places the galleries are arranged horizontally. The maximum width of the galleries is 0.2 mm in vertical section. Very thin dissepiments less than 0.02 mm in thickness are developed in the galleries. They are irregular in distribution. In tangential section the galleries are circular to irregularly vermiculated. Astrorhizae are developed, 6 to 10 mm from center to center, but in sections they are not observed in complete form. The microstructure is multilayered (Type B) (see Mori 1970: 70, fig. 10-f).

Remarks and comparison. – The present species is characterized by the skeletal part occupying more than 80 % of total sections and the multilayered microstructure. *S. ringerikensis* is considered to be one of the earliest species hitherto known among the genus *Stromatopora.*

Geological age. – Llandoverian.

Geographical distribution. – Ringerike, Norway.

Stromatopora sp.

Fig. 11, E, F.

Horizon. – Upper Spirifer Series (stage 9c).

Locality. – Langøya, E of Holmestrand (Loc. no. 6).

Material. – Six specimens (PMO 97331–97336).

Description. – The coenostea are fragmental. None of the specimens are in situ. The largest specimen is 12.0 cm in height and 25.0 cm in diameter. The skeleton is amalgamated. Small vertical discontinuous galleries predominate, but in places small galleries are horizontally arranged or the skeleton is densely spaced without distinct galleries. In tangential section the circular galleries are dominant. They are 0.04–0.10 mm in diameter. These galleries are occasionally fused to each other to form elongate or irregular shapes. Astrorhizae are present, but their sizes and shapes are unknown. The microstructure is melanospheric.

Remarks and comparison. – The specimens described resemble in part *Stromatopora antiqua* (Nicholson & Murie), but the irregularity of the skeletal structures of this species distinguishes it from *antiqua* and other species of *Stromatopora* from the Silurian. As the structures are variable even in a single specimen, they are not given a formal specific name in this paper, but referred to as *Stromatopora* sp.

Geological age. – Possibly Ludlovian.

Geographical distribution. – Holmestrand, Norway.

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July 1976

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