

Bryozoan fauna from the Mississippian (Visean) of Roque Redonde (Montagne Noire, southern France)

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urn:lsid:zoobank.org:pub:BA9B2FF0-9D3B-44AF-894F-419DE5AE4C13

Ernst A., Wyse Jackson P. N. & Aretz M. 2015. — Bryozoan fauna from the Mississippian (Visean) of Roque Redonde (Montagne Noire, southern France). *Geodiversitas* 37 (2): 151-213. <http://dx.doi.org/10.5252/g2015n2a2>

ABSTRACT

A bryozoan fauna from the Mississippian (Visean) of Roque Redonde (Montagne Noire, southern France), contains 38 species (12 cystoporates, 2 trepostomes, 6 cryptostomes [rhabdomesines], and 18 fenestrates). Of them 9 are new: *Fistulipora tolokonnikovae* n. sp., *Dybowskiella rotunda* n. sp., *Dybowskiella piriforme* n. sp., *Eridopora suarezi* n. sp., *Volgia deftera* n. sp., *Cystodictya gallensis* n. sp., *Megacanthopora enodata* n. sp., *Fabifenestella macrofenestrata* n. sp., and *Baculopora redondensis* n. sp. Beside them, one new genus with a new species is established: *Gorjunopora gallica* n. gen., n. sp. Furthermore, 23 species characteristic of the Mississippian of Eurasia and North America were identified. The bryozoan species show various palaeobiogeographic connections. The closest connections are to the Mississippian (Visean) of the British Isles and the Russian Platform. Moreover, some connections to the Mississippian of Germany, Ukraine, Spain, Kuznets Basin, North America and Kazakhstan can be traced. The studied bryozoan assemblage is represented mainly by delicate growth forms and suggests a calm water environment.

KEY WORDS

Mississippian,
bryozoans,
taxonomy,
southern France,
palaeobiogeography,
new combination,
new genus,
new species.

RÉSUMÉ

Une faune à bryozoaires du Mississippien (Viséen) du Roque Redonde (Montagne Noire, Sud de la France). Une faune à bryozoaires est décrite du Mississippien (Viséen) du Roque de Redonde (Montagne Noire, Sud de la France). Cette faune comprend 38 espèces (12 cystoporatés, 2 trepostomés, 6 cryptostomés [rhabdomesinés], et 18 fenestrés), dont neuf espèces sont nouvelles : *Fistulipora tolokonnikovae* n. sp., *Dybowskiella rotunda* n. sp., *Dybowskiella piriforme* n. sp., *Eridopora suarezi* n. sp., *Volgia deftera* n. sp., *Cystodictya gallensis* n. sp., *Megacanthopora enodata* n. sp., *Fabifenestella macrofenestrata* n. sp., *Baculopora redondensis* n. sp. Un nouveau genre avec une nouvelle espèce est décrit : *Gorjunopora gallica* n. gen., n. sp. En plus, 23 espèces caractéristiques du Mississippien eurasiatique et nord-américaines sont identifiées. Les corrélations paléobiogéographiques sont variables. Celles les plus proches existent avec le Mississippien (Viséen) des Îles britanniques et de la plate-forme Russe. D'autres corrélations paléobiogéographiques existent avec le Mississippien de l'Allemagne, de l'Ukraine, de l'Espagne, du Bassin Kouznetsk, de l'Amérique du Nord et du Kazakhstan. La faune étudiée est majoritairement composée des morphologies fragiles ce qui suggère un milieu de vie dans un environnement peu agité.

MOTS CLÉS

Mississippien,
bryozoaires,
taxonomie,
Sud de la France,
paléobiogéographie,
combinaison nouvelle,
genre nouveau,
espèces nouvelles.

INTRODUCTION

The Carboniferous was a time of profound changes in the geosphere and biosphere. Important palaeogeographical changes in Europe are the Hercynian orogeny and closing of remnants of the Rheic Ocean (Scotese & McKerrow 1990). Global sea level was relatively high in Mississippian times providing relatively broad shelf areas for various benthic communities. Tournaisian and early and middle Viséan faunas were broadly cosmopolitan in a circumequatorial belt and latitudinal diversity gradients were relatively minor (Ross & Ross 1985, 1990). During the later part of the Viséan and the Serpukhovian (Namurian), the Hercynian orogeny, caused by the collision of Euramerica with Gondwana, disrupted these cosmopolitan equatorial faunal patterns. This was also a time of progressively cooler temperatures throughout the world, of dramatic reduction in faunal diversity, and of high rates of extinction of both species and genera (Stanley & Powell 2003).

Bryozoans represent a phylum of sessile colonial metazoans, with a fossil record going back at least to the Early Ordovician. In the Palaeozoic, bryozoans inhabited various marine environments, being often rock-forming. Their skeletons being mainly of low magnesium calcite display a high potential for preservation, which has led to them being useful for various kinds of palaeontological research (Cuffey 1970; McKinney & Jackson 1989; Taylor & Allison 1998). Carboniferous bryozoans were abundant and diverse and are well known from various areas worldwide. Ross (1981) and Bancroft (1987) outlined importance of the Carboniferous bryozoans for palaeobiogeography and stratigraphy.

The presence of bryozoans in Carboniferous rocks of the Montagne Noire has been repeatedly mentioned (e.g., Böhm 1935; Mamet 1968; Aretz 2002a), but these organisms have never been studied in detail. The only Carboniferous bryozoan fauna in southern France to be studied in detail is found in

calcareous siltstones in the vicinity of the Ardengost Limestone (central Pyrénées) (Devolvé & McKinney 1983).

This research represents the first taxonomic description of the bryozoan fauna from the Mississippian (Viséan) of Roque Redonde (Montagne Noire, southern France), and discussion of their palaeobiogeographical, stratigraphical and ecological importance.

GEOGRAPHICAL AND STRATIGRAPHICAL SETTING

The bryozoan material is from the Roque Redonde, a hill 500 m southeast of the village of Vailhan, Département d'Hérault, about 50 km west of Montpellier (Fig. 1). Its crater-like morphology results from a disused quarry on top of the hill. The access road to this quarry is the type locality of the upper Viséan Roque Redonde Formation (Poty *et al.* 2002) (Fig. 2).

The Viséan rocks of the Montagne Noire have been described by Böhm (1935), Mamet (1968), Vachard (1977), and Engel *et al.* (1981). Aretz (2002a, b), Poty *et al.* (2002), Aretz & Herbig (2003), Vacard & Aretz (2004) and Pille (2008) provided detailed information on the stratigraphy, sedimentology, and palaeoecology of the late Viséan and Serpukhovian succession. The region is structurally complex and Carboniferous rocks are found in several nappes of Variscan age (Gèze 1949; Gèze *et al.* 1952; Engel *et al.* 1981) but only the highest Mont Peyroux Nappe contains Viséan carbonates (Fig. 1). The carbonates occur as separate blocks of various size surrounded by siliciclastic rocks. They were derived from a highly instable shelf and were transported down slope into the basin (Engel *et al.* 1981). The original stratigraphic sequence is preserved in these olistolithes and thus a stratigraphic division into Roque Redonde and Roc de Murviel formations could be established (Poty *et al.* 2002). The Roque Redonde Formation consists of pure, often massive limestones. It was dated

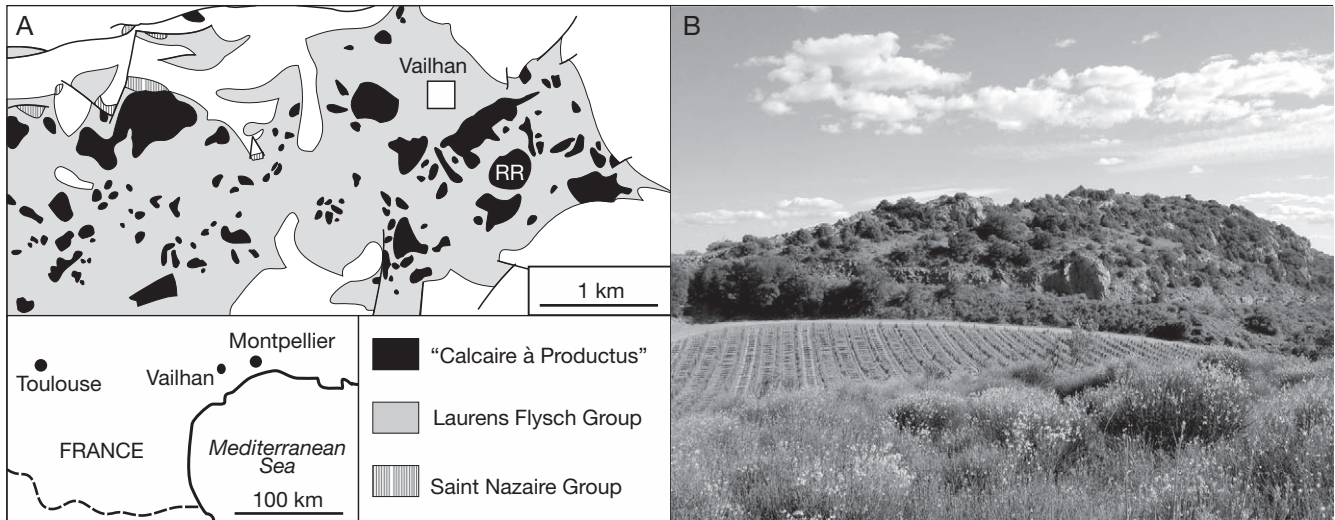


FIG. 1. — **A**, Localisation of the Roque Redonde outcrop on a geological map showing the numerous limestone olistoliths (**black**) incorporated in the siliciclastic flysch deposits of the Laurens Flysch Group (**grey**) in the vicinity of Vailhan (modified from Engel *et al.* 1981); **B**, view on the Roque de Redonde from the NW. Abbreviation: RR, Roque Redonde.

Chrono stratigraphy		Biostratigraphy				Lithostratigraphy		
		M	C	H	P	Mamet 1968	Vachard 1977	Poty <i>et al.</i> 2002 + Korn & Feist 2007
Mississippian	Serpukhovian	19-17	Cf7	MFZ 16	RC9			Roc de Murveil Formation RM RM
	Late Visean	16s	Cf6d	MFZ 15	RC8	Calcaire de Vailhan		Karst Laurens Flysch Group RR RR RR
Asbian	16i	Cf6g	MFZ 14	RC7b	Bioherms de Cabrières	Calcaire à Productus	Colonne Fm.	

FIG. 2. — Stratigraphic overview of the Late Visean and Serpukhovian limestone olistoliths of the Montagne Noire. Abbreviations: **M**, Mamet 1968; **C**, Conil *et al.* 1991; **H**, Hance & Devuyt in Poty *et al.* 2006; **P**, Poty in Poty *et al.* 2006.

as Brigantian based on corals and carbonate microorganisms (Aretz 2002a, b; Poty *et al.* 2002; Pille 2008).

The Roque Redonde comprises 110 m of the Roque Redonde Formation, which consists of pale coloured very thick bedded limestones with mostly thrombolitic to peloidal textures with few bioclasts (Aretz 2002a; Pille 2008). The horizon, which has yielded the bryozoans, is unique in the Roque Redonde Formation, because it comprises thinner bedded, very coarse, skeletal limestones containing abundant crinoids, bryozoans, brachiopods, rugose and tabulate corals. These limestones are distinctive in that they contain shaly partings, which are often related to bedding.

Microfacies analyses show small-scaled changes in composition and texture of the limestones, which result in layers of less vertical (2-6 cm thick) and horizontal extent. Some layers are graded (fining-upward). The texture of the limestone ranges from wackestone to grainstone, or floatstone and rudstone if bioclasts become larger. Cementstones are common in the upper part of the horizon. Carbonate mud and detrital mud are present throughout the horizon. Independent from the texture, all limestones are rich in bioclasts. Fragments of bryozoans and echinoderms dominate, less abundant are brachiopods, corals, gastropods, and ostracodes. Few foraminifers and calcareous algae were found in thin sections, which is

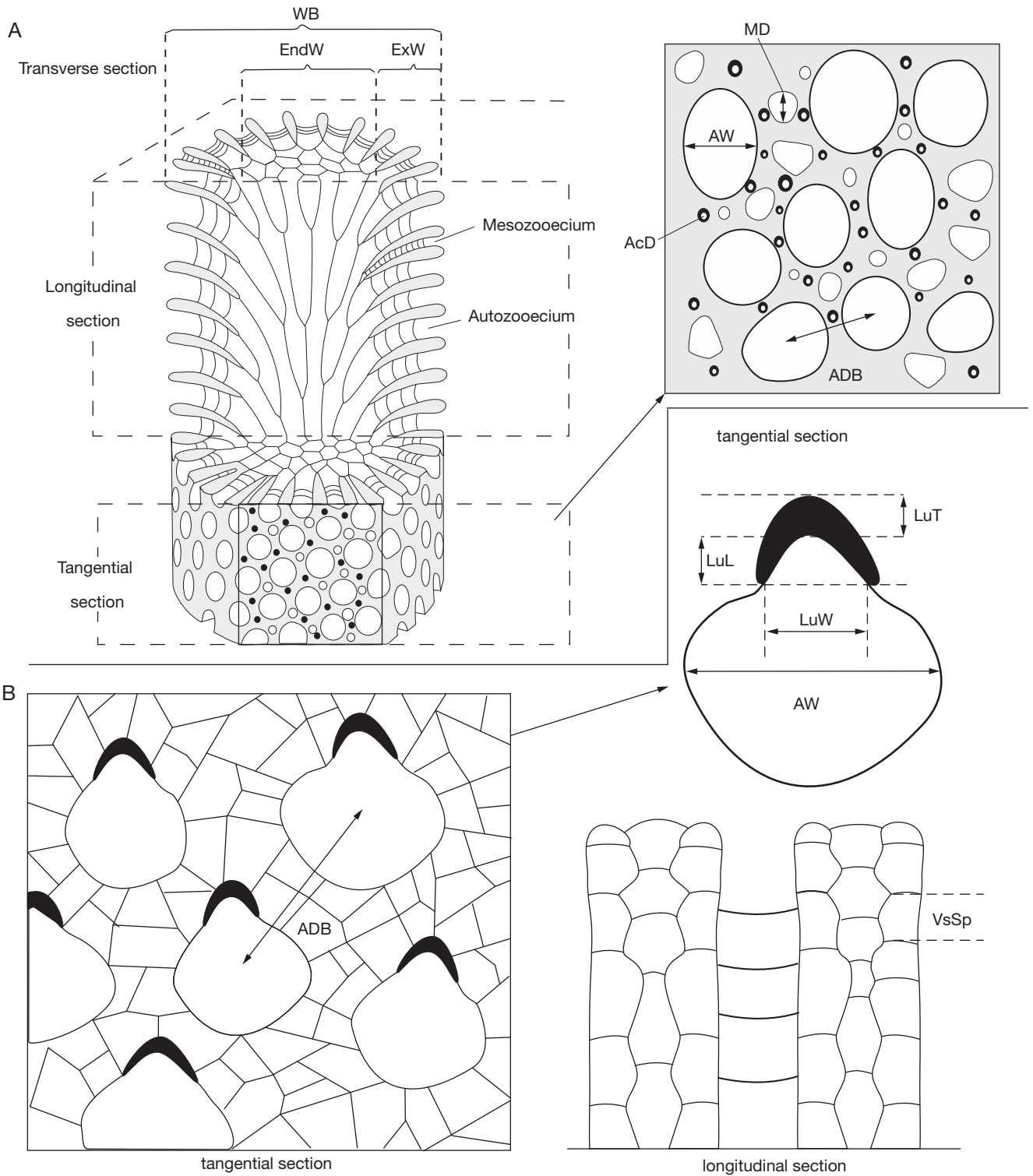


FIG. 3. — Some important measurements made on the trepostome and cystoporate bryozoans. Abbreviations: **ADB**, aperture spacing; **AW**, autozoecial aperture width; **LuL**, lunarium length; **LuW**, lunarium width; **LuT**, lunarium thickness; **VsSp**, vesicle spacing; **WB**, branch width; **EndW**, endozone width; **ExW**, exozone width; **AcD**, acanthostyle diameter; **MD**, meso-/exilazooecia diameter.

in contrast to the rest of the section where these organisms can be abundant (Pille 2008). The size of the bioclasts varies, most are fragmented skeletal elements (e.g., a handful of well-preserved rugose coral among *c.* 250 specimens). In thin sections, fenestellid bryozoans are often very small, in

contrast to field observations where larger zoaria have been documented (3×8 cm).

The abundance of mud (lime and detrital) and a rather good preservation of some delicate bryozoans found on bed surfaces indicates deposition and sedimentation under low-energy condi-

tions in calmer water. This deposition is periodically interrupted by deposition under higher energy. This could be due to storm events, which result in the importation of allochthonous material (fragmented macrofossils) from a somewhat distant source, and potential reworking of an autochthonous fauna. The latter may be indicated by incrustations of bryozoans and small tabulate corals on crinoid ossicles and few brachiopods.

MATERIAL AND METHODS

From the collected rock material 174 thin sections were prepared. Bryozoans were mainly investigated in thin sections using a binocular microscope in transmitted light. A few free samples were studied using SEM. Morphologic character terminology is partly adopted from Anstey & Perry (1970) for trepostomes and from Hageman (1991) for fenestrates and Hageman (1993) for cryptostomes (Figs 3; 4). Studied material is deposited in the Senckenberg Museum, Frankfurt (Main), Germany (prefix SMF), and the Geological Museum, Trinity College, Dublin, Ireland (prefix TCD.)

SYSTEMATIC PALAEOONTOLOGY

Superorder PALAEOSTOMATA

Ma, Buttler & Taylor, 2014

Phylum BRYOZOA Ehrenberg, 1831

Class STENOLAEMATA Borg, 1926

Order CYSTOPORATA Astrova, 1964

Suborder FISTULIPORINA Astrova, 1964

Family FISTULIPORIDAE Ulrich, 1882

Genus *Fistulipora* M'Coy, 1849

TYPE SPECIES. — *Fistulipora minor* M'Coy, 1849. Carboniferous; England.

DIAGNOSIS. — Massive, encrusting or ramose colonies. Cylindrical autozoecia with thin walls and complete diaphragms. Apertures rounded, possessing horseshoe-shaped lunaria. Autozoecia separated by the extrazoooidal vesicular skeleton.

COMPARISON. — *Fistulipora* M'Coy, 1849 differs from *Eridopora* Ulrich, 1882 in having rounded, horseshoe-shaped lunaria instead of triangular ones. Furthermore, *Eridopora* develops persistently encrusting colonies, whereas *Fistulipora* may also develop massive and branched colonies. *Fistulipora* differs from *Dybowskiella* Waagen & Wentzel, 1886 in the shape of lunaria, whose ends does not inflect autozoecial chambers.

OCCURRENCE. — Ordovician to Permian; worldwide.

Fistulipora tolokonnikovae n. sp.

(Fig. 5A-E; Appendix)

ETYMOLOGY. — The species is named in honour of Zoya Tolokonnikova, who has contributed significantly to the study of Devonian and Carboniferous bryozoans.

HOLOTYPE. — SMF 23.110.

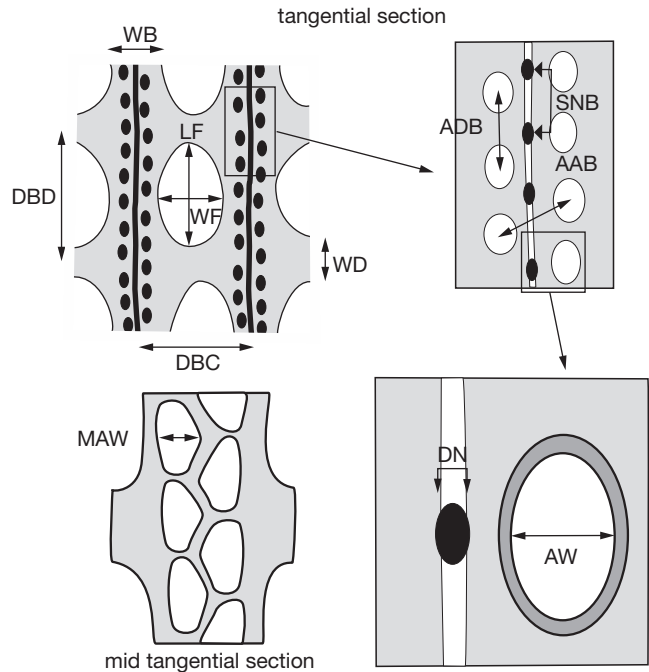


FIG. 4. — Some important measurements made on the fenestrate bryozoans. Abbreviations: **ADB**, aperture spacing along branch; **AAB**, aperture spacing diagonally; **AW**, autozoecial aperture width; **WB**, branch width; **WD**, dissepiment width; **WF**, fenestrule width; **LF**, fenestrule length; **DBC**, distance between branch centres; **DBD**, distance between dissepiment centres; **DN**, node diameter; **SNB**, node spacing; **MAW**, maximum chamber width.

PARATYPES. — SMF 23.111, TCD.60333, 60335, 60345.

TYPE LOCALITY. — Roque Redonde (Montagne Noire, southern France).

TYPE HORIZON. — Carboniferous, Mississippian (upper Visean).

DIAGNOSIS. — Thin to moderately thick encrusting colonies, partly multilayered; apertures large, with well developed lunaria; vesicles small to large, 9-17 surrounding each autozoecial aperture; maculae present, consisting of vesicular skeleton.

DESCRIPTION

Encrusting, partly multilayered colony, 2.34-2.73 mm thick. Separate sheets in multilayered colony 0.87-1.53 mm thick. Autozoecia growing from thin epitheca, bending in the early exozone to the colony surface. Basal diaphragms rare to common, straight, thin, 2-5 in each autozoecium, concentrated usually in proximal parts of autozoecia. Autozoecial apertures circular to oval. Lunaria well-developed, rounded; ends of lunaria not indenting autozoecia. Vesicles small to large, separating autozoecia in 1-2 rows, 9-17 surrounding each autozoecial aperture, with rounded to flat roofs, polygonal in tangential section. Autozoecial walls granular prismatic, 0.010-0.015 mm thick. Maculae 1.25-1.63 mm in diameter, spaced 7.6-8.4 mm from centre to centre, consisting of vesicular skeleton.

COMPARISON

Fistulipora tolokonnikovae n. sp. is similar to *Fistulipora djebaglinica* Nikiforova, 1933 from the Mississippian of

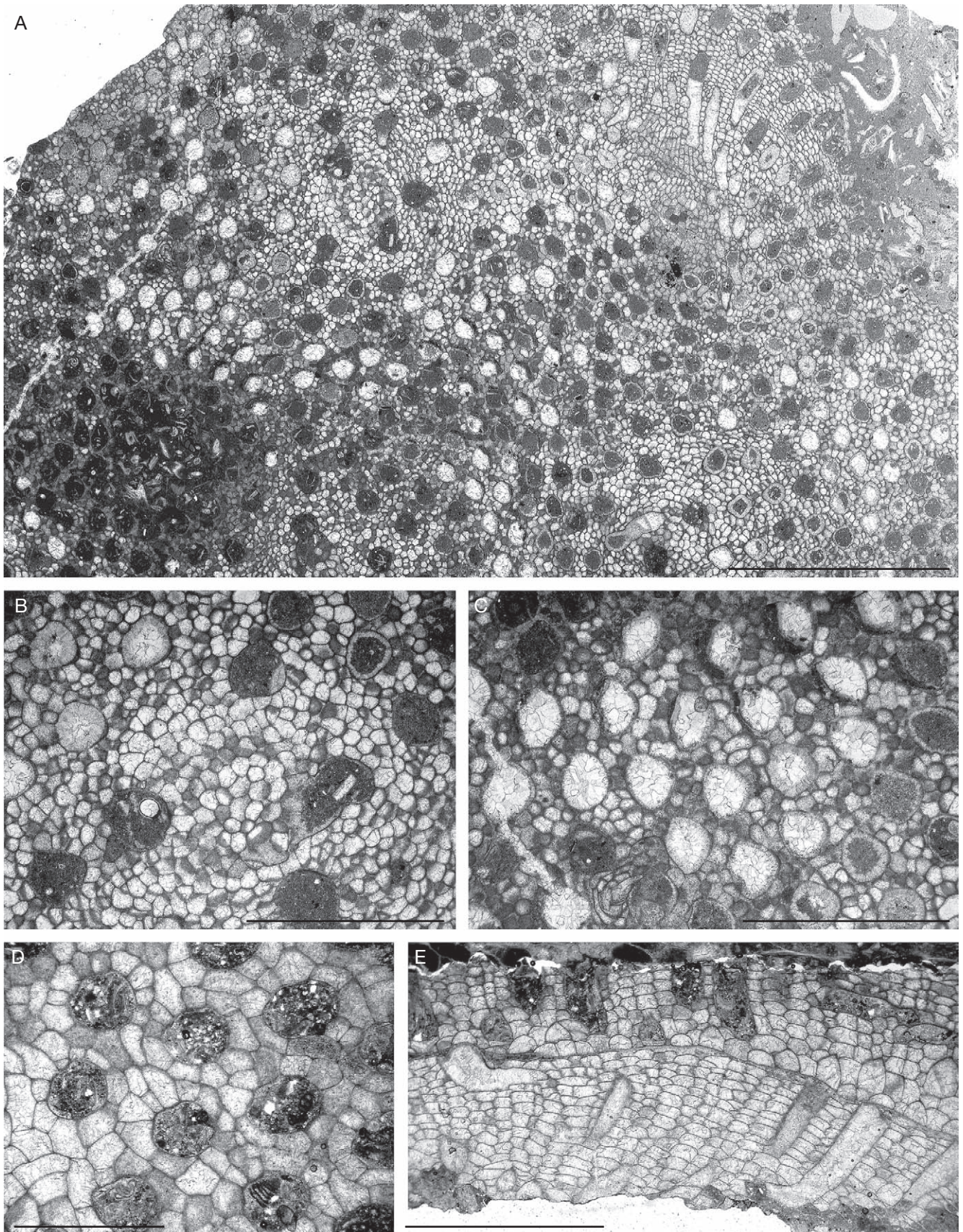


FIG. 5. — **A-E**, *Fistulipora tolokonnikovae* n. sp.; **A**, Tangential section, holotype SMF 23.110; **B-C**, tangential section showing maculae, autozooccal apertures and vesicles, holotype SMF 23.110; **D**, tangential section showing autozooccal apertures and vesicles, paratype SMF 23.111; **E**, longitudinal section, paratype SMF 23.111. Scale bars: A, 5 mm; B, C, E, 2 mm; D, 1 mm.

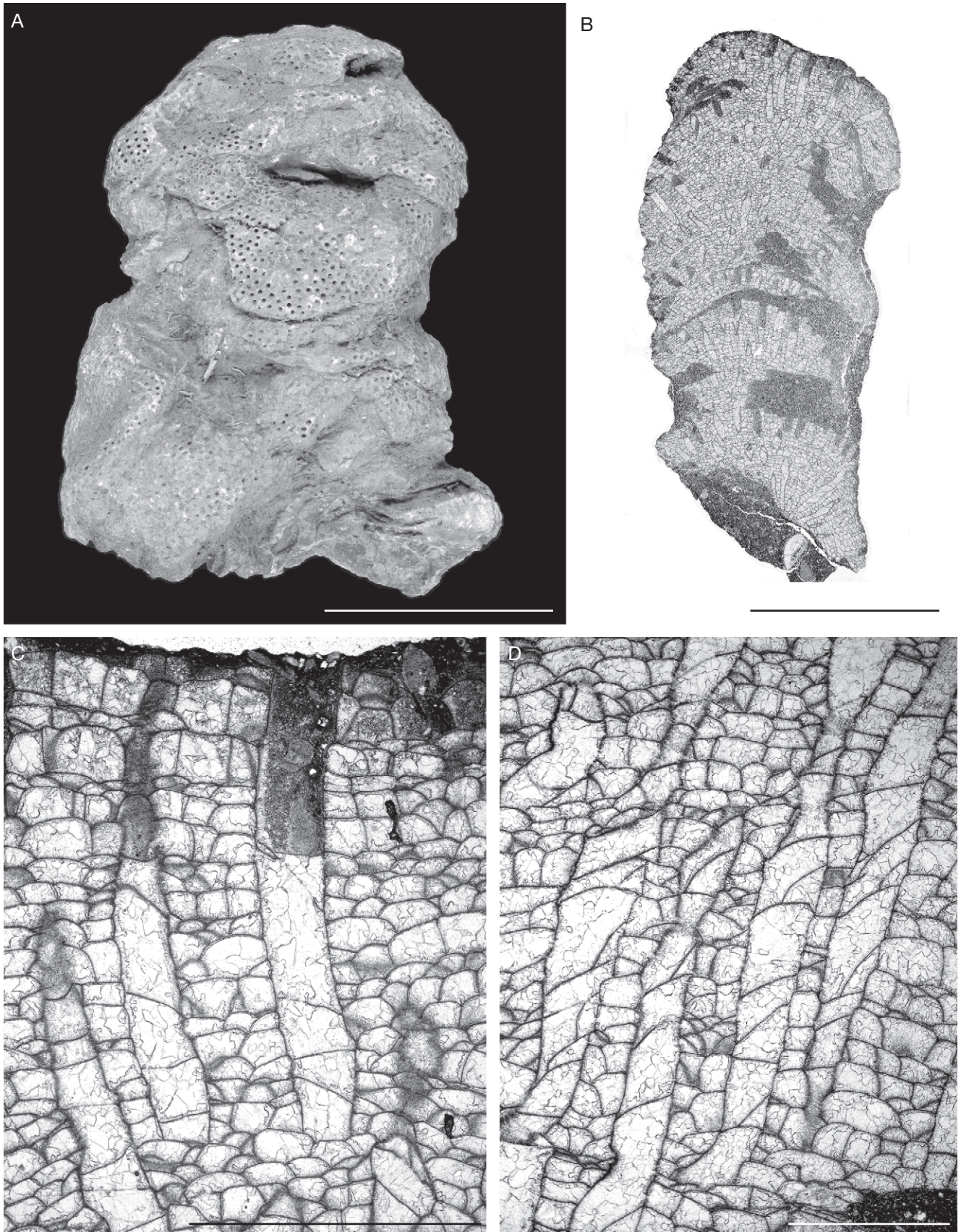


FIG. 6. — **A-D**, *Fistulipora prolifica* Ulrich, 1884; **A**, general view of a multilayered colony, SMF 23.119; **B**, longitudinal section through the multilayered colony, SMF 23.115; **C-D**, longitudinal section showing autozoecia with diaphragms and vesicular skeleton, SMF 23.115 (**C**), SMF 23.114 (**D**). Scale bars: A, 20 mm; B, 10 mm; C, D, 2 mm.

Turkestan, but differs from it in larger autozooeical apertures (aperture width 0.36-0.55 mm vs 0.25-0.28 mm in *F. djebaglinica*). *Fistulipora tolokonnikova* differs from *F. monoseriata* Schulga-Nesterenko, 1955 from the Lower Carboniferous of Russia in arrangement of vesicles in 1-2 rows between autozooeica instead of 1 row in the latter species.

Fistulipora prolifica Ulrich, 1884
(Figs 6A-D; 7A, B; Appendix)

Fistulipora prolifica Ulrich, 1884: 45, 46, pl. 3, fig. 2, 2a. — Trizna 1958: 41, 42, pl. 3, figs 5, 6.

MATERIAL. — SMF 23.112-SMF 23.118 (thin sections); SMF 23.119 (free colony).

OCCURRENCE. — Carboniferous, Mississippian (Visean); USA (Kentucky). Carboniferous, lower Visean; Kuznets Basin, Russia. Carboniferous, Mississippian (upper Visean); Roque Redonde (Montagne Noire, southern France).

DESCRIPTION

Encrusting, multilayered colony. Separate sheets in multilayered colony 1.05-4.30 mm thick. Autozooeica growing from thin epitheca, bending at their bases towards the colony surface. Basal diaphragms common to abundant, often inclined, concentrated usually in proximal parts of autozooeica. Autozooeical apertures circular to oval. Lunaria weakly developed. Vesicles moderately large, separating autozooeica usually in a single row, locally in 2 rows, 6-10 surrounding each autozooeica aperture, with rounded to flat roofs, polygonal in tangential section. Autozooeical walls granular prismatic, 0.010-0.015 mm thick. Maculae present, consisting of vesicular skeleton, 0.9-2.4 mm in diameter, slightly elevated.

COMPARISON

Fistulipora prolifica Ulrich, 1884 differs from *F. incrustans* (Phillips, 1836) from the Mississippian of British Isles in larger autozooeical apertures (average aperture width 0.39 mm vs 0.32 mm in *F. incrustans*). *Fistulipora prolifica* differs from *F. parvilabrum* Schulga-Nesterenko, 1955 in larger and widely spaced autozooeical apertures (average autozooeical width 0.39 mm vs 0.29 mm in *F. parvilabrum*; average autozooeical spacing 0.74 mm vs 0.56 mm in *F. parvilabrum*).

Fistulipora cf. tubulosa Nikiforova, 1933
(Fig. 7C-F; Appendix)

Fistulipora tubulosa Nikiforova, 1933: 6, pl. 1, figs 6, 7; 1948: 9, 10, pl. 1, figs 1, 2. — Nekhoroshev 1956: 9, 10, pl. 1, figs 1, 2. — Trizna 1958: 36, 37, pl. 1, figs 1-5.

MATERIAL. — SMF 23.120-SMF 23.130, TCD.60337.

OCCURRENCE. — Carboniferous, Mississippian (upper Visean); Roque Redonde (Montagne Noire, southern France).

DESCRIPTION

Encrusting colony, 1.5-2.3 mm thick. Autozooeica growing from thin epitheca, bending in the early exozone to the colony surface. Basal diaphragms absent or common, up to 5 in autozooeica, thin, concentrated usually in proximal parts of autozooeica. Autozooeical apertures circular to oval. Lunaria well-developed, triangular to horseshoe-shaped; ends of lunaria not indenting autozooeica. Vesicles moderately large, separating autozooeica in 1-2 rows, 7-14 surrounding each autozooeica aperture, with rounded roofs, polygonal in tangential section. Autozooeical walls granular prismatic, 0.010-0.015 mm thick. Maculae present, consisting of vesicular skeleton.

COMPARISON

The present species is similar to *Fistulipora tubulosa* Nikiforova, 1933 from the Lower Carboniferous of Kazakhstan and Russia. The only difference is that the species from Montagne Noire was not found to produce a tubular colony like in previous records. However, tubular colonies are usually produced by encrusting of ephemeral substrates, which decay after death, and so such colonies are potentially encrusting also other kinds of substrate. *Fistulipora tubulosa* Nikiforova, 1933 described by Nikiforova (1948) (this work was finished by Nekhoroshev) has unusually small and abundant vesicles, 15-17 surrounding each autozooeical aperture (vs 7-14 in present material and 9-12 in the holotype). *Fistulipora tubulosa* is similar to *F. djebaglinica* Nikiforova, 1933 from the Mississippian of Turkestan, but differs from it in larger autozooeical apertures (aperture width 0.24-0.43 mm vs 0.25-0.28 mm in *F. djebaglinica*).

Fistulipora parvilabrum Schulga-Nesterenko, 1955
(Fig. 8A-C; Appendix)

Fistulipora parvilabrum Schulga-Nesterenko, 1955: 61-64, pl. 2, figs 1, 2.

MATERIAL. — SMF 21.770-SMF 21.772, TCD.60333, 60338, 60345.

OCCURRENCE. — Carboniferous, Mississippian (Visean); Russia. Carboniferous, Mississippian (upper Visean); Roque Redonde (Montagne Noire, southern France).

DESCRIPTION

Encrusting to submassive colony, 1.56-3.35 mm thick. Autozooeica growing from thin epitheca, bending in the early exozone to the colony surface. Basal diaphragms common, 4-6 in each autozooeicum, concentrated usually in proximal parts of autozooeica. Autozooeical apertures circular to oval. Lunaria well-developed, horseshoe-shaped; ends of lunaria not indenting autozooeica. Vesicles moderately large, separating autozooeica in 1-2 rows, 7-11 surrounding each autozooeica aperture, with rounded roofs, polygonal in tangential section. Autozooeical walls granular prismatic, 0.005-0.010 mm thick.

COMPARISON

Fistulipora parvilabrum Schulga-Nesterenko, 1955 differs from *F. incrustans* (Phillips, 1836) in smaller autozooeical apertures (average aperture width 0.29 mm vs 0.32 mm in *F. incrustans*).

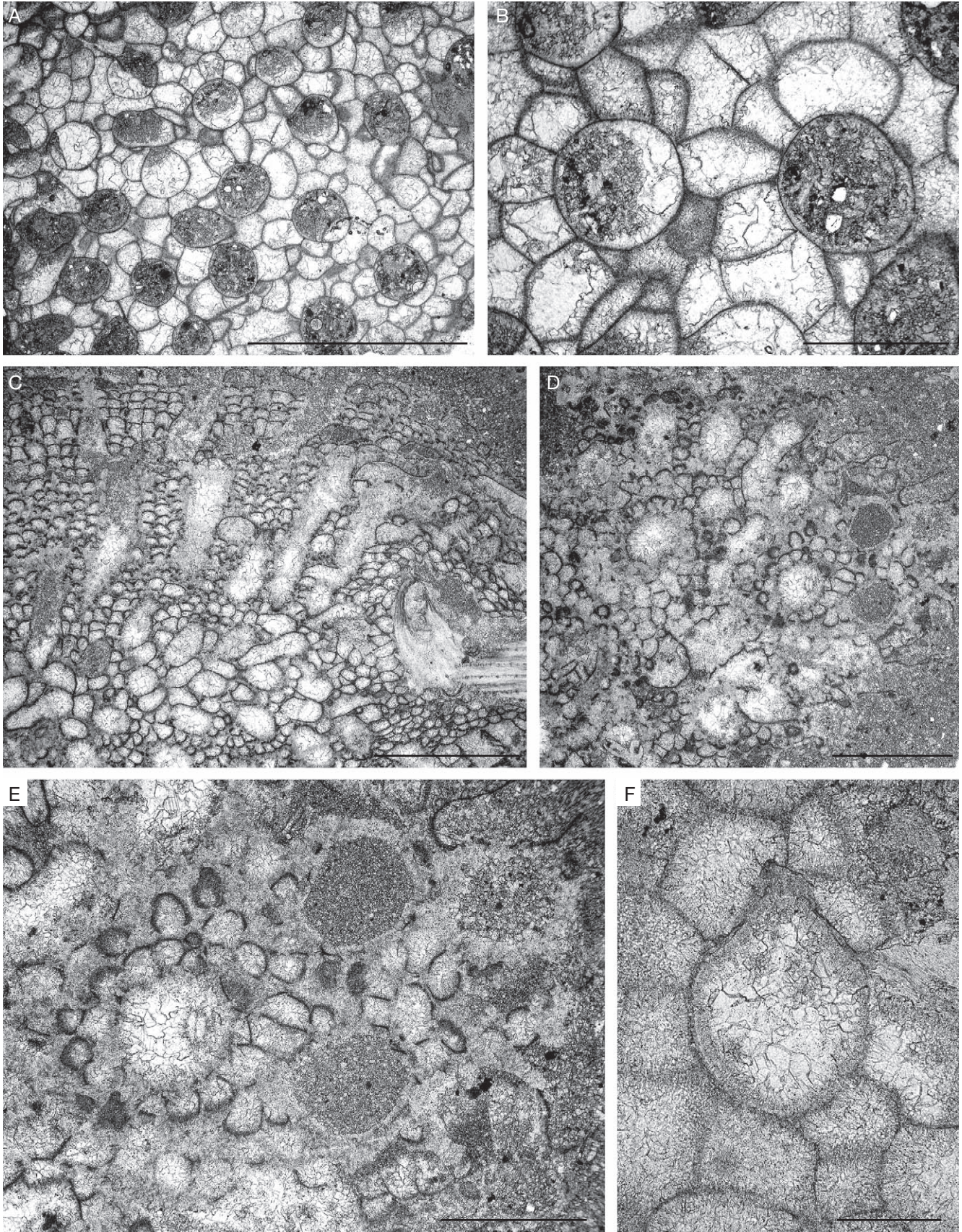


FIG. 7. — *Fistulipora prolifica* Ulrich, 1884; **A-B**, tangential section showing autozoecial apertures and vesicles, SMF 23.117; **C-F**, *Fistulipora* cf. *tubulosa* Niki-forova, 1933: **C**, longitudinal section, SMF 23.123; **D, E**, tangential section, SMF 23.124; **F**, tangential section showing autozoecial aperture with lunarium, SMF 23.124. Scale bars: A, 2 mm; B, E, 0.5 mm; C, D, 1 mm; F, 0.2 mm.

Fistulipora sana Trizna, 1958
(Fig. 8D-F; Appendix)

Fistulipora sana Trizna, 1958: 41-42, pl. 3, figs 5-6. — Lu, Xia & Li, 1978: 327, pl. 1, figs 17-18. — Gorjunova & Morozova, 1979: 31, pl. 1, Fig. 1.

MATERIAL. — SMF 21.773-SMF 21.776.

OCCURRENCE. — Carboniferous, Mississippian (upper Visean); Roque Redonde (Montagne Noire, southern France). Carboniferous, Mississippian (Visean); Russia (Siberia), Mongolia. Carboniferous, Mississippian (Visean), Coahai Formation; Weining, western Guizhou, China.

DESCRIPTION

Encrusting colony, 0.60-0.78 mm thick. Autozooezia growing from thin epitheca, bending in the early exozone to the colony surface. Basal diaphragms rare to absent, straight, thin. Autozooezial apertures circular to oval. Lunaria weakly developed, horseshoe-shaped; ends of lunaria not indenting autozooezia. Vesicles small, separating autozooezia in 1-2 rows, 8-13 surrounding each autozooezia aperture, with rounded roofs, polygonal in tangential section. Autozooezial walls granular prismatic, 0.005-0.015 mm thick.

COMPARISON

Fistulipora sana Trizna, 1958 differs from *F. parvilabrum* Schulga-Nesterenko, 1955 in smaller distances between autozooezial apertures (averagely 0.40 mm vs 0.56 mm in *F. parvilabrum*), and smaller and more abundant vesicles. *Fistulipora sana* differs from *F. taidonensis* Trizna, 1958 from the Visean of Siberia in larger autozooezial apertures (aperture width 0.19-0.32 mm vs 0.18-0.20 mm in *F. taidonensis*).

Genus *Dybowskiella* Waagen & Wentzel, 1886

TYPE SPECIES. — *Dybowskiella grandis* Waagen & Wentzel, 1886 by original designation. Permian; India.

OCCURRENCE. — Middle Devonian – Upper Permian; worldwide.

DIAGNOSIS. — Ramose, hollow ramose, massive, or encrusting colonies. Autozooezia cylindrical, subcircular in transverse section of endozone, having rounded apertures, isolated by abundant polygonal vesicles. Basal diaphragms thin, straight or curved. Lunaria horseshoe-shaped, present in endozone and exozone; ends of lunaria inflect into autozooezial chamber. Autozooezial walls with granular boundary and light-coloured granular-prismatic cortex. Vesicular skeleton in endozone and exozone. Vesicles subrectangular with flat to slightly curved roofs. Small acanthostyles or tubuli in exterior stereom present. Monticules elevated or flat, with central cluster of vesicles surrounded by larger autozooezia in radial arrangement.

COMPARISON

Dybowskiella Waagen & Wentzel, 1886 differs from *Fistulipora* M'Coy, 1849 in the shape of lunaria, which ends inflect autozooezial chambers. *Dybowskiella* differs from *Eridopora* Ulrich, 1882 in having horseshoe-shaped lunaria instead of triangular ones.

Dybowskiella rotunda n. sp.
(Figs 8G, 9A-C; Appendix)

ETYMOLOGY. — The species name refers to the rounded shape of apertures and lunaria (from Latin “*rotundus*” – rounded).

HOLOTYPE. — SMF 21.777.

PARATYPE. — SMF 21.778-SMF 21.780.

TYPE LOCALITY. — Roque Redonde (Montagne Noire, southern France).

TYPE HORIZON. — Carboniferous, Mississippian (upper Visean).

DIAGNOSIS. — Moderately thick encrusting colonies; apertures large, with well developed rounded lunaria; autozooezial diaphragms common to abundant; vesicles large, separating autozooezia in 1-2 rows, 6-10 surrounding each autozooezial aperture.

DESCRIPTION

Encrusting colony, 0.9-2.9 mm thick. Autozooezia growing from thin epitheca, bending in the early exozone to the colony surface. Basal diaphragms straight or slightly inclined, common to abundant, 2-7 in each autozooezium. Autozooezial apertures circular to oval. Lunaria well-developed, rounded, rounded; ends of lunaria indenting deeply autozooezia. Vesicles large, irregular, separating autozooezia in 1-2 rows, 6-10 surrounding each autozooezia aperture, with rounded roofs, polygonal in tangential section. Autozooezial walls granular prismatic, 0.010-0.015 mm thick.

COMPARISON

Dybowskiella rotunda n. sp. differs from *Dybowskiella piriforme* n. sp. in larger autozooezial apertures (average aperture width 0.34 mm vs 0.21 mm in *D. piriforme*) and in presence of diaphragms. *Dybowskiella rotunda* n. sp. differs from *D. regularis* Perry & Gutschick, 1959 from the Amsden Formation (Late Mississippian) of Montana, USA, in larger apertures, larger vesicles and smaller number of vesicles around autozooezial apertures (6-10 vs 11-13 in *D. regularis*).

Dybowskiella piriforme n. sp.
(Figs 9D-F; 10A-D; Appendix)

ETYMOLOGY. — The species name refers to the pear-shaped apertures of this species.

HOLOTYPE. — SMF 21.781.

PARATYPES. — SMF 21.782-SMF 21.793, TCD.60336.

TYPE LOCALITY. — Roque Redonde (Montagne Noire, southern France).

TYPE HORIZON. — Carboniferous, Mississippian (upper Visean).

DIAGNOSIS. — Colony in form of hemispheric or globular masses; apertures small, with well-developed long lunaria; lunaria with 3-5 styles; basal diaphragms absent; vesicles small to large, separating autozooezia in a single row, 5-9 surrounding each autozooezia aperture.

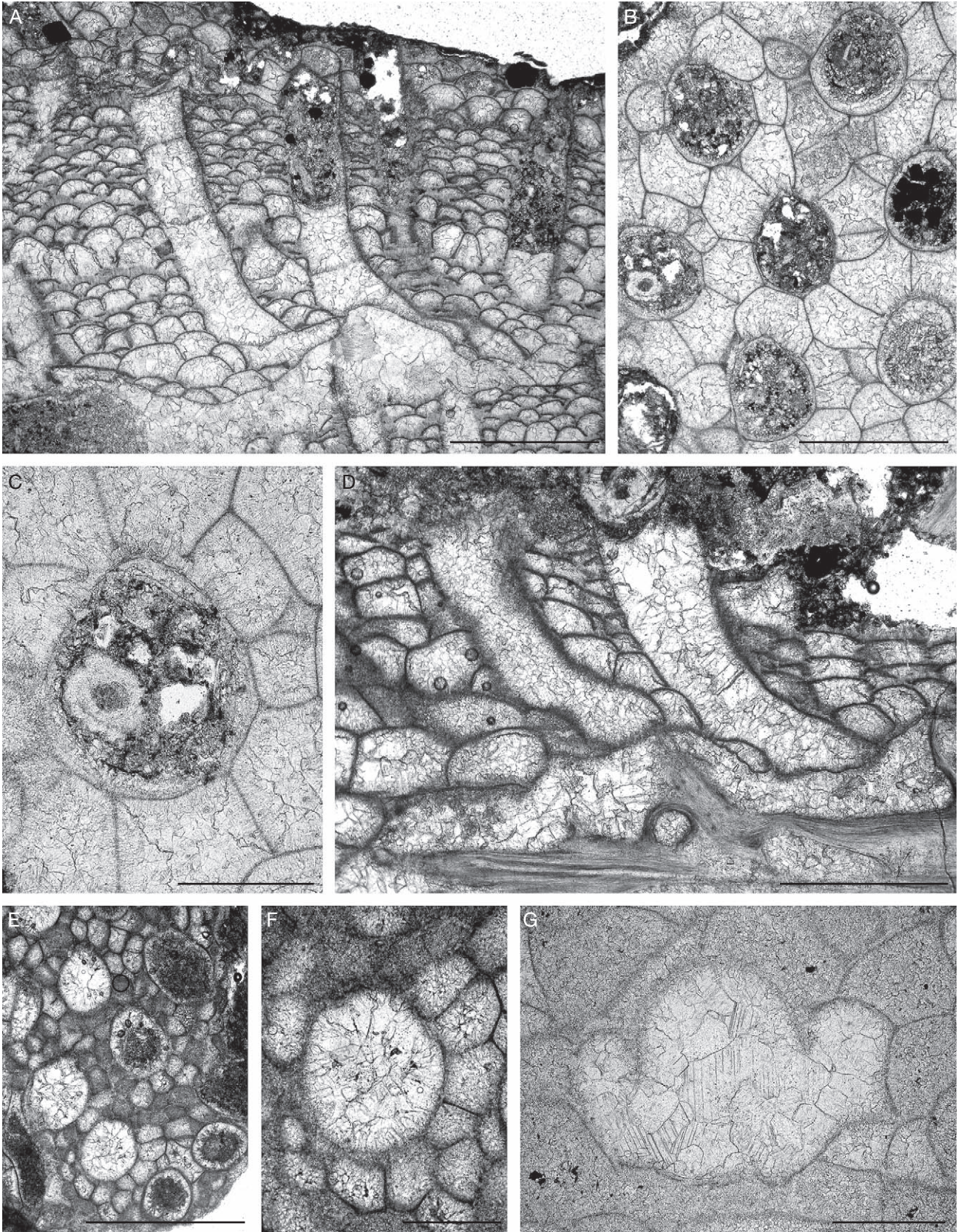


FIG. 8. — **A-C**, *Fistulipora parvilabrum* Schulga-Nesterenko, 1955; **A**, longitudinal section, SMF 21.770; **B**, tangential section, SMF 21.771; **C**, tangential section showing autozoecial aperture with lunarium, SMF 21.771. **D, F**, *Fistulipora sana* Trizna, 1958; **D**, longitudinal section, SMF 21.775; **E**, tangential section, SMF 21.774; **F**, tangential section showing autozoecial aperture with lunarium, SMF 21.774. **G**, *Dybowskiella rotunda* n. sp., holotype SMF 21.777. Scale bars: A, E, 1 mm; B, D, 0.5 mm; C, F, G, 0.2 mm.

DESCRIPTION

Encrusting colony forming usually hemispheric to globular masses, 0.9-1.5 mm thick. Autozoocelia growing from thin epitheca, often for long distances parallel to substrate, bending in the early exozone to the colony surface. Basal diaphragms absent. Autozoocelial apertures circular to oval. Lunaria large, long, thick, containing 3-5 styles; lunarial styles 0.010-0.015 mm in diameter; ends of lunaria indenting autozoocelia. Vesicles small to large, separating autozoocelia in a single row, 5-9 surrounding each autozoocelia aperture, with rounded to flat roofs, polygonal in tangential section. Autozoocelial walls granular prismatic, 0.005-0.010 mm thick.

COMPARISON

Dybowskiella piriforme n. sp. differs from *D. lebedevi* Nikiforova, 1927 from the Lower Carboniferous of Ukraine in smaller autozoocelial apertures (0.17-0.25 mm vs 0.30-0.35 mm in *D. lebedevi*). Furthermore, *Fistulipora elegans* Schulga-Nesterenko, 1955 from the Moscovian of the Russian Platform is similar to the present species. However, *F. elegans* has larger and thicker lunaria.

Genus *Eridopora* Ulrich, 1882

TYPE SPECIES. — *Eridopora macrostoma* Ulrich, 1882 by original designation. Lower Carboniferous; North America.

DIAGNOSIS. — Thin encrusting colonies. Oval apertures with strongly developed lunaria of distinct triangular shape. Cylindrical autozoocelia with thin walls and complete diaphragms. Vesicular skeleton consists of angular vesicles.

OCCURRENCE. — Devonian to Permian; worldwide.

COMPARISON

Eridopora Ulrich, 1882 differs from *Fistulipora* M'Coy, 1849 and *Dybowskiella* Waagen & Wentzel, 1886 in having large triangular lunaria instead of horseshoe-shaped ones, and predominantly encrusting colonies.

Eridopora suarezi n. sp. (Figs 10E, F; 11A; Appendix)

ETYMOLOGY. — The species is named in honour of Juan Luis Suárez Andrés in acknowledgment of his studies of Palaeozoic bryozoans of Spain.

HOLOTYPE. — SMF 21.794.

PARATYPES. — SMF 21.795-SMF 21.801, TCD.60338, 60345.

TYPE LOCALITY. — Roque Redonde (Montagne Noire, southern France).

TYPE HORIZON. — Carboniferous, Mississippian (upper Visean).

DIAGNOSIS. — Thin to moderately thick encrusting colonies; apertures moderate in size, with large triangular lunaria; vesicles large, 6-11 surrounding each autozoocelial aperture; maculae present, consisting of vesicular skeleton.

DESCRIPTION

Encrusting colony, 0.42-3.35 mm thick. Autozoocelia growing from thin epitheca, bending in the early exozone to the colony surface. Basal diaphragms rare. Autozoocelial apertures circular to oval. Lunaria well-developed, triangular; ends of lunaria not indenting autozoocelia. Vesicles small to large, separating autozoocelia in 1-2 rows, 6-11 surrounding each autozoocelia aperture, with rounded roofs, polygonal in tangential section. Autozoocelial walls granular prismatic, 0.005-0.010 mm thick. Maculae consisting of vesicular skeleton, slightly elevated, 1.0-1.2 mm in diameter, surrounded by larger autozoocelia with lunaria directed to the centre of the macula.

COMPARISON

The present material is similar to *Eridopora macrostoma* Ulrich, 1882 from the Mississippian of USA and the British Isles. However, it differs in larger vesicles and in smaller apertures (average aperture width 0.32 mm vs 0.39 mm (Bancroft 1986) to 0.41 mm (McKinney 1972) in *E. macrostoma*).

Suborder HEXAGONELLINA Morozova, 1970

Family HEXAGONELLIDAE Crockford, 1947

Genus *Volgia* Stuckenberg, 1905

Ramiporina Schulga-Nesterenko, 1933: 40.

TYPE SPECIES. — *Coscinium arborescens* Stuckenberg, 1895, by original designation. Pennsylvanian; Russia.

DIAGNOSIS. — Colony consisting of erect bifoliate lobes, with secondary branches diverging at right angles in crucifix-shaped pattern. Mesotheca with a dark and thin middle layer and two light and thick outer layers, containing median tubuli and longitudinal ridges parallel to growth direction. Autozoocelia recumbent on the mesotheca or epitheca for a long distance, then bending upwards abruptly or gently, intersecting the surface almost perpendicularly. Hemisepta absent. Thin, complete diaphragms in autozoocelia, common to abundant. Autozoocelial apertures circular to oval, with thick peristomes. Lunaria obscure. Autozoocelia separated by vesicular skeleton in endozone and by thick stereom in exozone. Microacanthostyles (tubuli) in stereom. Maculae lacking.

OCCURRENCE. — Carboniferous; Russia, Germany, France.

COMPARISON

Volgia Stuckenberg, 1905 differs from *Prismopora* Hall, 1883 in colony shape (branched with crucifix-pattern of branch diversion versus trifoliate, irregularly branching in *Prismopora*), as well as in absence of hemisepta. *Volgia* differs in colony shape from *Glyptopora* Ulrich, 1884 (radially trifurcating and fused together branches which form a honeycomb-shaped structure), and from *Evactinopora* Meek & Worthen, 1865 (multifoliate colony consisting of 4-8 vertical bifoliate branches radiating from centre).

Volgia deftera n. sp. (Figs 11B-F; 12A-F; Appendix)

Evactinopora sp. – Ernst 2005: 51, fig. 1C-E, G.

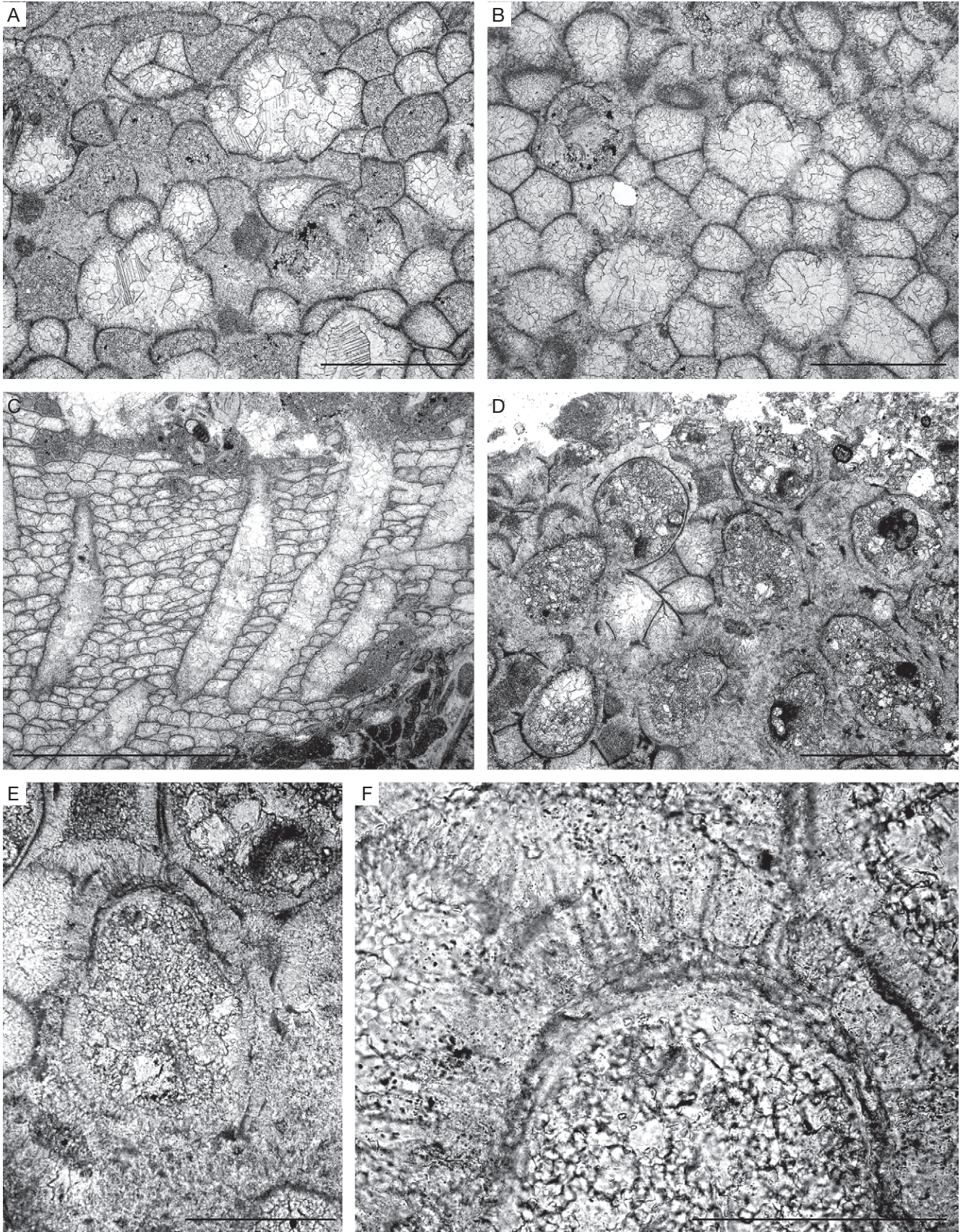


FIG. 9. — **A-C**, *Dybowskiella rotunda* n. sp.; **A**, tangential section, holotype SMF 21.777; **B**, tangential section, paratype SMF 21.780; **C**, longitudinal section, holotype SMF 21.777. **D-F**, *Dybowskiella piriforme* n. sp., holotype SMF 21.781: **D**, tangential section, **E**, **F**, tangential section showing autozoocel aperture with lunarium. Scale bars: A, B, D, 0.5 mm; C, 2 mm; E, 0.2 mm; F, 0.1 mm.

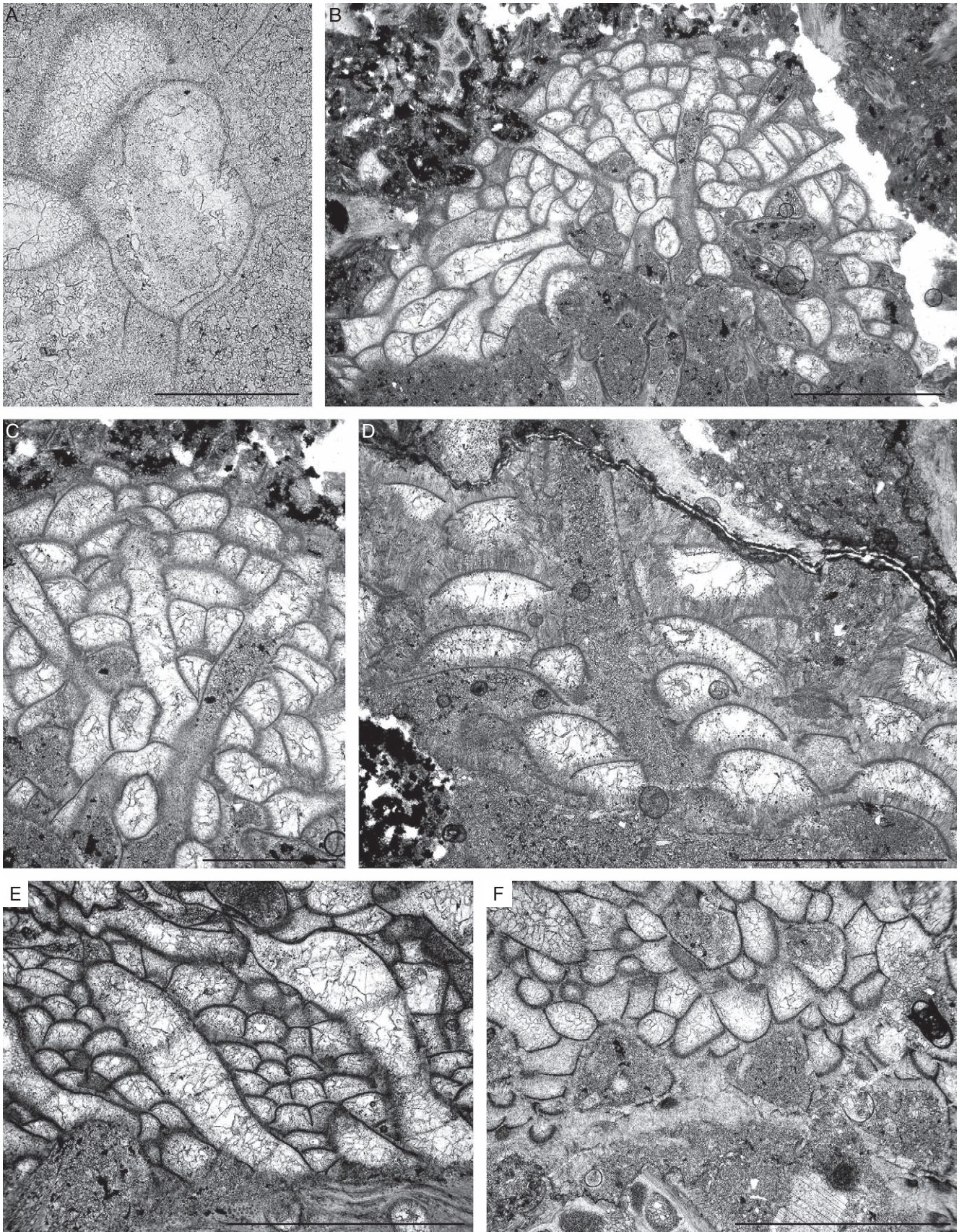


FIG. 10. — **A-D**, *Dybowskiella piriforme* n. sp.; **A**, tangential section showing autozooeceal aperture with lunarium, paratype SMF 21.787; **B-D**, longitudinal section, paratype SMF 21.786; **E, F**, *Eridopora suarezi* n. sp. **E**, longitudinal section, paratype SMF 21.799; **F**, tangential section, holotype SMF 21.794. Scale bars: A, 0.2 mm; B, E, F, 1 mm; C, D, 0.5 mm.

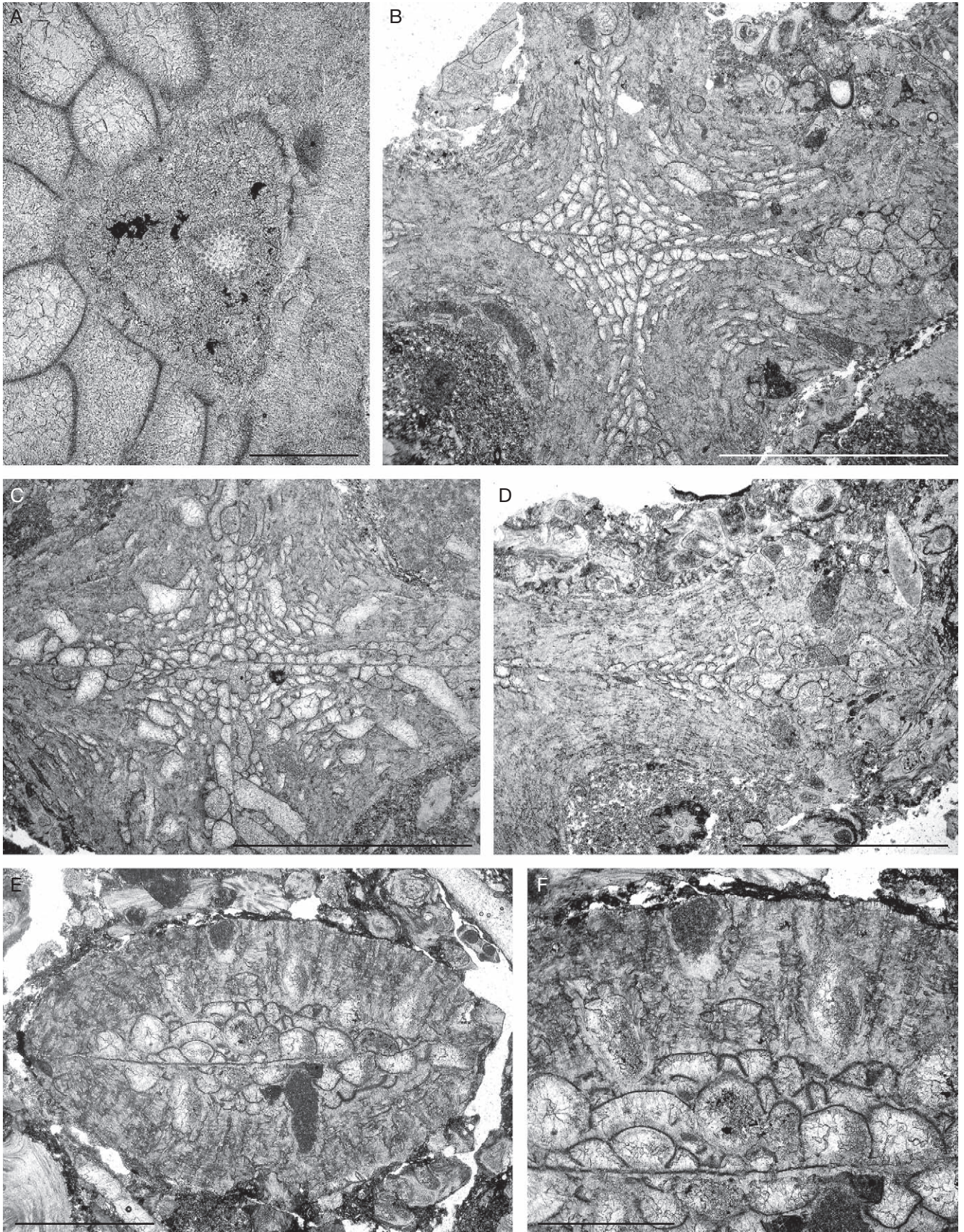


FIG. 11. — **A**, *Eridopora suarezi* n. sp., tangential section showing autozoecial aperture, holotype SMF 21.794; **B-F**, *Volgia deftera* n. sp.: **B**, transverse section of the colony, holotype SMF 21.802; **C**, transverse section of the colony, paratype SMF 21.812; **D**, longitudinal section, paratype SMF 21.811; **E**, **F**, branch transverse section, paratype SMF 21.805. Scale bars: A, 0.2 mm; B-D, 2 mm; E, 1 mm; F, 0.5 mm.

ETYMOLOGY. — The species name refers to the being the second known species of the genus (from Greek “*defteros*” – the second).

HOLOTYPE. — SMF 21.802.

PARATYPES. — SMF 21.803–SMF 21.814.

TYPE LOCALITY. — Roque Redonde (Montagne Noire, southern France).

TYPE HORIZON. — Carboniferous, Mississippian (upper Visean).

DIAGNOSIS. — Crucifix-shaped colonies with relatively thick branches; mesotheca with median tubuli and longitudinal ridges parallel to growth direction; thin complete diaphragms occasionally present; hemisepta absent; lunaria weakly developed, irregularly horseshoe-shaped; vesicles moderately large, polygonal in tangential section, with rounded roofs, arranged in 1–2 rows between autozoecia, 10–12 surrounding each autozoecial aperture; stereom thick, consisting of laminated material, completely separating autozoecia in exozone, containing abundant tubules; metazoecia (? exozonal tubes) locally abundant, flask-shaped, restricted to stereom; maculae lacking.

DESCRIPTION

Colony consisting of erect bifoliate lobes, with secondary branches diverging at right angles in crucifix-shaped pattern. Branches 3.30–3.35 mm wide and 1.44–2.10 mm thick. Mesotheca 0.010–0.015 mm thick, with a dark and thin middle layer and two light and thick outer layers, containing median tubuli and longitudinal ridges parallel to growth direction. Median tubuli 0.015–0.020 mm in diameter consisting of hyaline calcite, rounded in transverse section, developing short and densely spaced lateral projections (Fig. 12A, B). Autozoecia recumbent on the mesotheca or epitheca for a relatively long distance, then bending upwards abruptly, intersecting the surface almost perpendicularly. Thin, complete diaphragms in autozoecia occasionally present. Autozoecial apertures circular to oval. Lunaria weakly developed, irregularly horseshoe-shaped. Vesicular skeleton well developed, covered in exozone by thick stereom. Vesicles moderately large, polygonal in tangential section, with rounded roofs, arranged in 1–2 rows between autozoecia, 10–12 surrounding each autozoecial aperture. Stereom thick, consisting of laminated material, completely separating autozoecia in exozone, containing abundant tubules. Tubules 0.010–0.015 mm in diameter, with hyaline cores and narrow laminated sheaths. Indistinct maculae consisting of stereom and metazoecia (exozonal tubes) present. Metazoecia (? exozonal tubes) locally abundant, flask-shaped, restricted to stereom.

COMPARISON

The new species differs from *Volgia arborescens* (Stuckenberg, 1895) by larger autozoecial apertures (0.17–0.29 mm vs 0.14–0.15 mm in *Volgia arborescens*). Furthermore, no heterozoecia were reported in *V. arborescens*. *Evactionopora* sp. (Ernst 2005: 51) from the Mississippian (Visean) of Sauerland (Germany) is placed in the new species. It possesses five rays instead of four. However, that is a result of the bifurcation of one ray. Otherwise, it shows typical crucifix pattern (Ernst 2005, Fig. 1C). That specimen has branches of 4.2–4.6 mm width and 1.5–1.6 mm thickness.

Family CYSTODICTYONIDAE Ulrich, 1884

Genus *Cystodictya* Ulrich, 1882

TYPE SPECIES. — *Cystodictya ocellata* Ulrich, 1882 by original designation. Lower Mississippian; Kentucky, USA.

DIAGNOSIS. — Bifoliate colony, strap-like, branching in plane of mesotheca. Autozoecia with peristomes and lunaria. Ridges between autozoecial rows lacking. Mesotheca thin to moderately thick, indistinctly laminated to granular-prismatic, with low ridges, running parallel to ranges of autozoecia. Autozoecia teardrop-shaped at their basis, quadrate in cross-section; partly isolated by boxlike vesicles; recumbent portion short; blunt proximolateral hemisepta at zoecial bend, indenting zoecial cavity and producing slight hook-shaped appearance of autozoecia in deep tangential section. Diaphragms lacking. Walls laminated; boundary serrated, tubules in cortex. Lunarium in exozone, light colored, laminated, some with core and proximal rib. Compound range walls thin in endozone with dark boundary continuous into dark central layer of mesotheca; thick in exozone with many flexures and irregular tubuli. Vesicles small, boxlike, in endozone; low blisters in inner exozone; stereom in exozone; laminated with tubuli and flexures.

OCCURRENCE. — Middle Devonian – Upper Carboniferous; worldwide.

COMPARISON

Cystodictya Ulrich, 1882 differs from *Sulcoretepora* d’Orbigny, 1849 by teardrop-shaped apertures, straight mesotheca and autozoecial walls, which are distinctly tripartite in *Sulcoretepora* and more homogenous in *Cystodictya*. Furthermore, *Cystodictya* possesses hemisepta which is absent in *Sulcoretepora*. *Cystodictya* differs from *Dichotrypa* Ulrich in Miller, 1889 by absence of acanthostyles in exterior stereom.

Cystodictya gallensis n. sp. (Fig. 13A–H; Appendix)

ETYMOLOGY. — The species name is derived from the Latin *Gallia* for France.

HOLOTYPE. — SMF 21.815.

PARATYPES. — SMF 21.816–SMF 21.823, TCD.60333, 60335, 60336, 60337, 60340, 60341.

TYPE LOCALITY. — Roque Redonde (Montagne Noire, southern France).

TYPE HORIZON. — Carboniferous, Mississippian (upper Visean).

DIAGNOSIS. — Bifoliate branches with mesotheca; median tubules absent; autozoecia tubular; diaphragms lacking; blunt proximolateral hemisepta at zoecial bent present; autozoecial apertures circular to oval, arranged in 7–9 alternating rows on the colony surface; lunaria distinct, horseshoe-shaped; vesicular skeleton well developed; vesicles small to moderate in size, partly separating autozoecia in at mesotheca, and completely separated them in exozone in 1–2 rows; stereom thick, containing abundant tubules.

DESCRIPTION

Bifoliate branches, 1.64–2.42 mm wide and 1.23–1.64 mm thick. Mesotheca 0.010–0.015 mm thick; median tubules absent. Autozoecia tubular, teardrop-shaped at their bases,

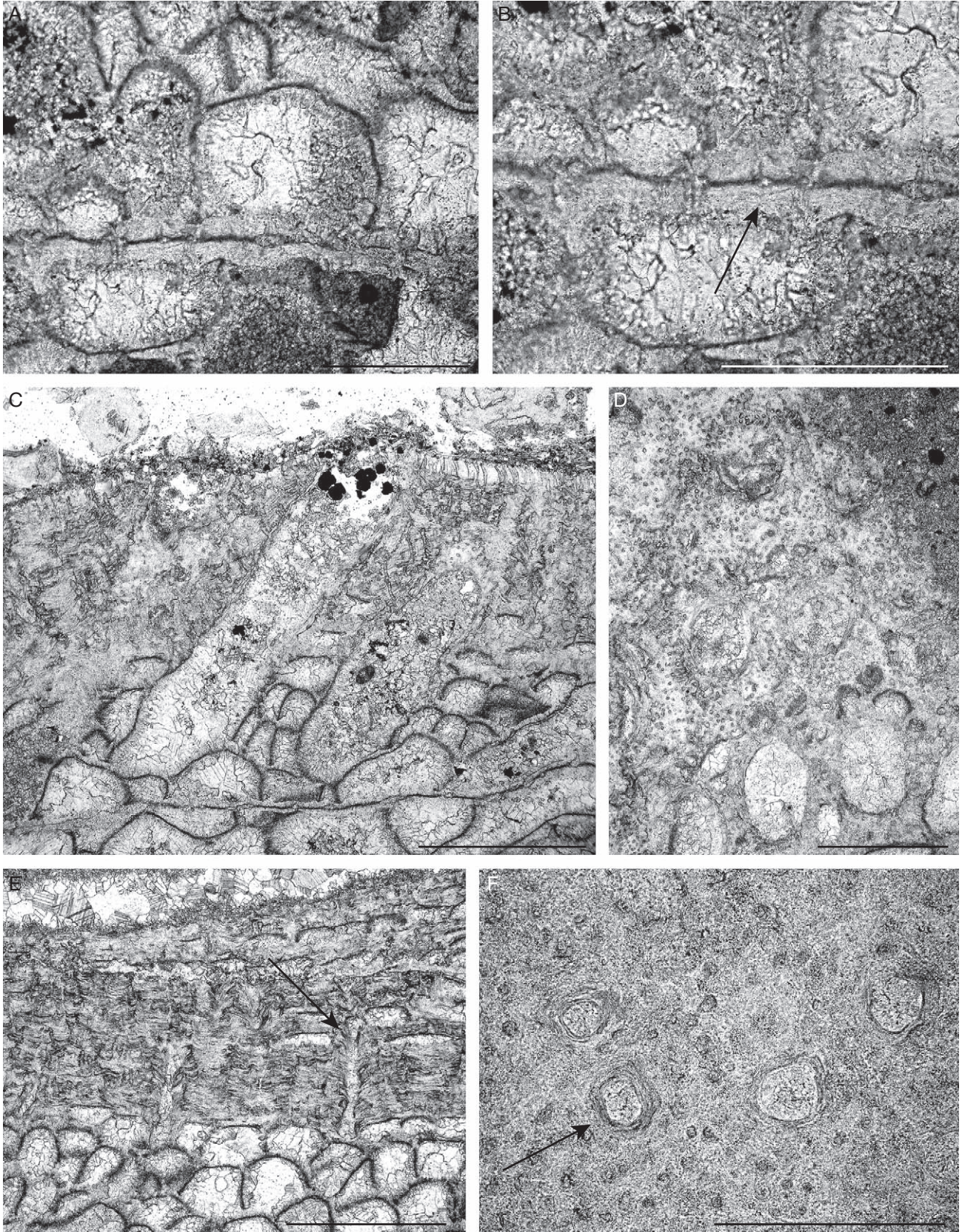


FIG. 12. — **A-F**, *Volgia deftera* n. sp.; **A, B**, branch transverse section showing mesotheca with median tubuli (arrow), paratype SMF 21.805; **C**, longitudinal section, paratype SMF 21.804; **D**, tangential section showing autozooeical apertures, metazooecia (? exozonal tubes) and tubules, paratype SMF 21.810; **E**, longitudinal section showing external skeleton with metazooecia and tubules (arrow), SMF 21.810; **F**, tangential section showing autozooeical apertures and tubules (arrow), paratype SMF 21.809. Scale bars: A, B, F, 0.2 mm; C-E 0;5 mm.

quadrate in cross-section, recumbent on the mesotheca for a relatively short distance, then bending upwards at low angles in exozone and intersecting the surface almost perpendicularly. Diaphragms lacking; blunt proximolateral hemisepta at zooecial bend present. Autozooecial apertures circular to oval, arranged in 7-9 alternating rows on the colony surface. Lunaria distinct, horseshoe-shaped. Vesicular skeleton well developed, covered in exozone by thick stereom. Vesicles small to moderate in size, polygonal in tangential section, with rounded roofs, partly separating autozooecia in at mesotheca, and completely separated them in exozone in 1-2 rows. Autozooecial walls laminated, with serrated boundaries, 0.005-0.010 mm thick in endozone. Stereom thick, consisting of laminated material, completely separating autozooecia in exozone, containing abundant tubules. Tubules 0.005-0.010 mm in diameter.

COMPARISON

Cystodictya gallensis resembles *C. dichotoma* Nikiforova, 1933 from the Mississippian of Turkestan with chambers separated up to two times their diameter by vesicular tissue. However hemisepta are not developed in *C. dichotoma* and chambers diverge at a higher angle towards the zoarial surface than observed in *C. gallensis*. Additionally it is similar to *C. astrepta* Karklins, 1986 from the Late Mississippian of Utah, USA in general form and size, but has significantly more vesicular tissue developed between autozooecial chamber. Comparison with other *Cystodictya* species shows that *C. gallensis* is distinctive.

Genus *Sulcoretepora* d'Orbigny, 1849

Arcanopora Vine, 1884: 204.

Acanthopora Vine – Morozova 1960: 86 (incorrect subsequent spelling). — Mstania Schulga-Nesterenko 1955: 175.

TYPE SPECIES. — *Flustra ? parallela* Phillips, 1836 by original designation. Lower Carboniferous of Whitewell; Yorkshire, England.

DIAGNOSIS. — Colony narrow bifoliate ribbons, dichotomously branched in plane of mesotheca; elongate, rounded autozooecia in ranges, rhombically arranged on lateral sides of branches; lunaria elevated on proximolateral sides of autozooecia; range walls elevated; monticules absent; branch margins narrow, non-celluliferous. Mesotheca with dark central layer and laminated outer layers; sharply folded in centre, undulatory near branch margins; median tubules absent. Autozooecia full width and rectangular to parallelogram shaped in deep tangential section; contiguous; alternating across mesotheca. Compound range walls with dark median zone continuous into boundary zone in mesotheca; lateral zones laminated; branched dark zones and tubuli in thickened range walls in exozone. Autozooecia subquadrate to subhemispherical in cross section at mesotheca; angular teardrop shaped in deep tangential section in mid exozone and partially isolated between range walls by small, blister-like vesicles. Lunaria laminated, indistinct. Vesicles adjacent to mesotheca only at noncelluliferous margins. Stereom laminated with tubules in endozone.

OCCURRENCE. — Devonian to Permian, Europe, North America, Asia.

COMPARISON

Sulcoretepora d'Orbigny, 1849 differs from *Cystodictya* Ulrich, 1882 by absence of hemisepta, often plicated and folded mesotheca as well as by distinctly tripartite wall microstructure.

Sulcoretepora parallela (Phillips, 1836) (Fig. 14A-E; Appendix)

For synonymy see Wyse Jackson (1996: 158).

MATERIAL. — SMF 21.824-SMF 21.837, TCD.60342.

OCCURRENCE. — Carboniferous, Mississippian (Visean); Roque Redonde (Montagne Noire, southern France), Britain, Ireland.

DESCRIPTION

Branched bifoliate colonies. Branches lens-shaped in transverse section, 0.60-1.08 mm wide and 0.54-0.75 mm thick in the thickest portion of transverse section. Autozooecia short, budding from a straight mesotheca, trapezoid to semicircular in transverse section at their bases, rectangular in deep tangential section, becoming rounded in the exozone. Mesotheca 0.005-0.010 mm thick, protruding laterally on both sides of colony. Rare planar diaphragms present in autozooecia. Autozooecial apertures circular to oval, arranged in 3-5 alternating rows on the colony surface. Lunaria obscure. Vesicles few, flat, having rounded roofs, occurring mainly at the base of exozone. Stereom weakly developed, laminated, containing small tubules. Longitudinal crests dividing apertural rows well developed.

COMPARISON

Sulcoretepora parallela (Phillips, 1836) is similar to *S. magnistriata* Schulga-Nesterenko, 1955 from the Lower Carboniferous of Russia but differs in smaller branch width and thickness, as well as in smaller autozooecial apertures (autozooecial aperture width 0.08-0.13 mm vs 0.10-0.15 mm in *S. magnistriata*).

Family GONIOCLADIIDAE Waagen & Pichl, 1885

Genus *Ramiporalia* Schulga-Nesterenko, 1933

TYPE SPECIES. — *Ramiporalia dichotoma* Schulga-Nesterenko, 1933 by original designation. Lower Permian; Northern Urals.

DIAGNOSIS. — Colonies consisting of bifoliate dichotomous branches. Autozooecia hemispherical in transverse section at mesotheca, growing in two to five rows on each side of the mesotheca. Apertures with lunaria. Thin mesotheca protruding as ridge on the circular reverse side and as sharp keel on peaked obverse side. Thin-walled autozooecia usually separated by vesicular skeleton. Vesicles small in endozone and in inner exozone.

OCCURRENCE. — Carboniferous; Europe, North America, Australia.

COMPARISON

Ramiporalia Schulga-Nesterenko, 1933 differs from *Goniocladia* Etheridge, 1876 in having freely branching colony instead of reticulate one in the latter genus. *Ramiporalia* differs from

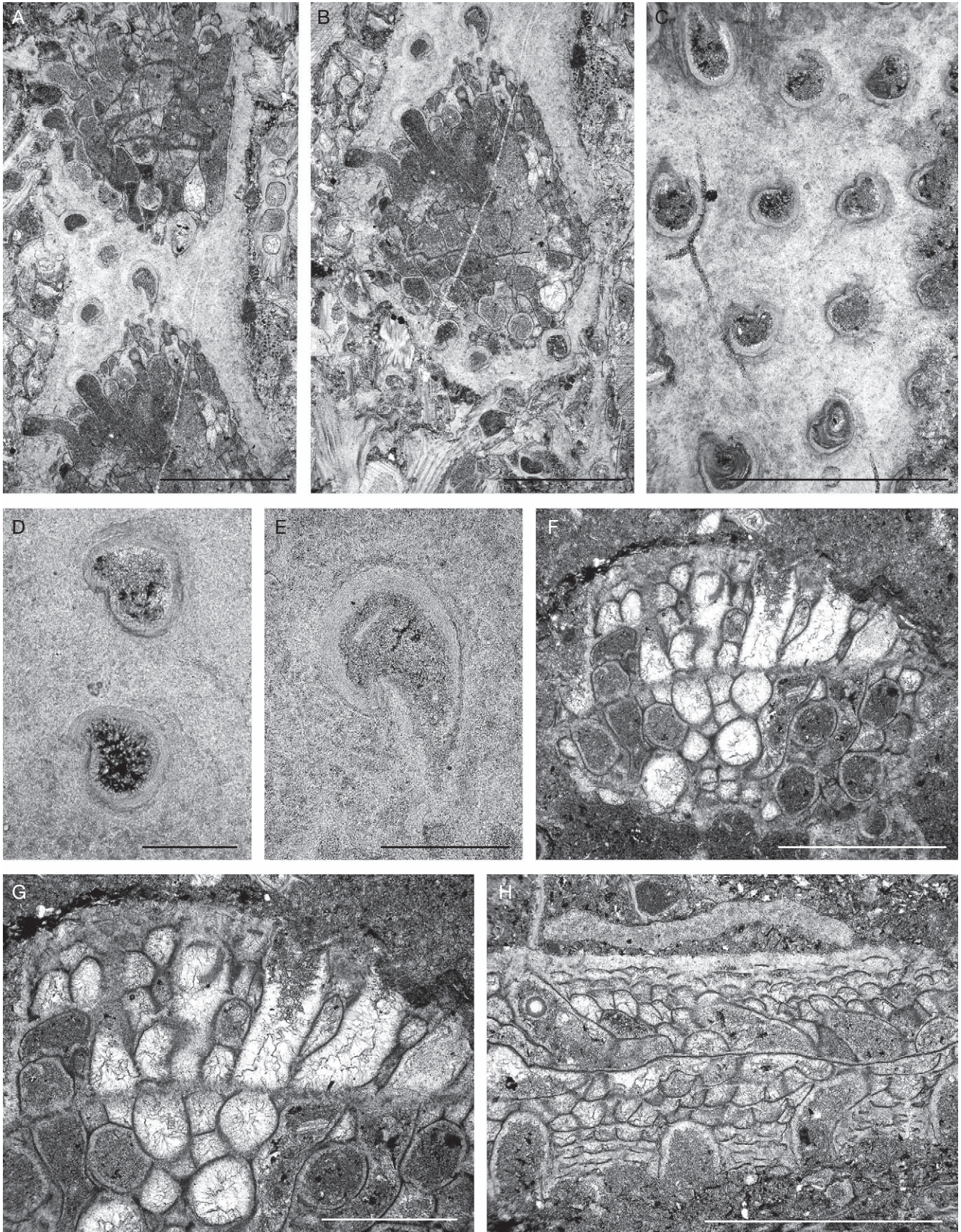


FIG. 13. — **A-H**, *Cystodictya gallensis* n. sp.; **A-B**, branch oblique section, paratype SMF 21.822; **C-D**, tangential section, holotype SMF 21.815; **E**, tangential section showing autozoecial aperture, paratype SMF 21.822; **F-G**, branch transverse section, paratype SMF 21.819; **H**, branch longitudinal section, paratype SMF 21.816. Scale bars: A-C, F, H, 1mm; D, E, 0.2 mm; G, 0.5 mm.

Ramipora Toulou, 1875 in having freely branching colony instead of pinate one with secondary and tertiary branches deriving from the main branch in the latter genus. Furthermore, mesotheca in *Ramiporalia* protrudes only on the celluliferous side as low carina, whereas mesotheca in *Ramipora* protrudes both on celluliferous and non-celluliferous sides.

Ramiporalia robusta Delvolve & McKinney, 1983
(Figs 14F-H, 15A-D, 16A-C; Appendix)

Ramiporalia robusta Delvolve & McKinney, 1983: 327, 328, pl. 2, figs 8, 9, text-fig. 3.

MATERIAL. — SMF 21.838-SMF 21.848, TCD.60336, 60337, 60338, 60341, 60343.

OCCURRENCE. — Carboniferous, Mississippian (upper Visean); Roque Redonde (Montagne Noire, southern France). Carboniferous, Mississippian (Serpukhovian); Pyrénées, France.

DESCRIPTION

Reticulate colony consisting of anastomosing bifoliate branches. Branches 1.23–3.67 mm wide and 0.49–1.64 mm thick. Autozoecia tubular, semicircular in transverse section at their bases, relatively short, budding in 5–7 rows from each side of thin mesotheca, opening on both sides of the median carina. Basal diaphragms rare. Mesotheca consisting of granular-prismatic material, 0.02–0.03 mm thick. Autozoecial apertures arranged regularly in 5–7 diagonal rows on both sides of a median carina, rounded, having 0.030–0.45 mm thick peristome. Lunaria moderately developed, directed proximally. Autozoecial walls 0.005–0.010 mm thick, granular-prismatic. Extrazoecial skeleton consisting of columnar calcite crystals oriented perpendicularly to the colony surface. Vesicular skeleton moderately developed, consisting of low small vesicles with flattened roofs, concentrated mostly in endozone.

COMPARISON

Ramiporalia robusta Delvolve & McKinney, 1983 differs from *R. symmetrica* McKinney, 1972 from the Mississippian of Alabama, USA, in thicker branches and larger distances between aperture centres (0.36–0.54 mm vs 0.25–0.50 mm in *R. symmetrica*).

Order TREPOSTOMATA Ulrich, 1882

Suborder AMPLEXOPORINA Astrova, 1965

Family STENOPORIDAE Waagen & Wentzel, 1886

Genus *Tabulipora* Young, 1883

TYPE SPECIES. — *Cellepora urii* Fleming, 1828 by monotypy. Carboniferous; Scotland.

DIAGNOSIS. — Ramose, encrusting, cylindrical or massive colonies. Autozoecia with basal diaphragms and ring septa. Autozoecial walls irregularly thickening with development of monilae. Exilazoecia rare. Acanthostyles of two sizes: small microacanthostyles and large macroacanthostyles.

OCCURRENCE. — Carboniferous-Permian; worldwide.

COMPARISON

The genus *Tabulipora* Young, 1883 differs from the genera *Stenopora* Lonsdale, 1844 and *Stenodiscus* Crockford, 1945 by the development of ring septa.

Tabulipora howsii (Nicholson, 1881)
(Fig. 16D-H; Appendix)

For synonymy see Wyse Jackson (1996: 151, 152).

MATERIAL. — SMF 21.849-SMF 21.854, TCD.60339, 60340, 60343.

OCCURRENCE. — Carboniferous, Mississippian (Visean); Britain, Ireland, Germany (Velbert Anticline, Rhenish Massif (Wyse Jackson & Weber, 2005)), Roque Redonde (Montagne Noire, southern France).

DESCRIPTION

Encrusting to submassive colony, 2.7 mm thick. Autozoecia prismatic, having polygonal shape in transverse section, containing rare diaphragms and abundant ring septa. Ring septa concentrated in exozones, occupying about a half of the autozoecial chamber space. Acanthostyles moderately large, concentrated predominantly in maculae, having narrow hyaline cores and wide laminated sheaths. Exilazoecia rare, small, polygonal in transverse section, occurring predominantly in maculae. Endozonal walls granular, 0.015–0.020 mm thick; exozonal walls monilae-shaped thickened, laminated, serrated, with distinct autozoecial boundaries, 0.05–0.07 mm thick. Maculae consisting of larger autozoecia present, 2.2–2.4 mm in diameter.

COMPARISON

Tabulipora howsii (Nicholson, 1881) differs from *T. urii* (Fleming, 1828) in larger autozoecial apertures (average aperture width 0.28 mm vs 0.19 mm in *T. urii*). *Tabulipora howsii* differs from *T. stragula* Karklins, 1986 from the Mississippian of Utah, USA in smaller autozoecial apertures (average aperture width 0.28 mm vs 0.39 mm in *T. stragula*).

Family DYSTRITELLIDAE Dunaeva & Morozova, 1967

Genus *Dyscritella* Girty, 1911

TYPE SPECIES. — *Dyscritella robusta* Girty, 1911 by original designation. Lower Carboniferous; Arkansas, USA.

OCCURRENCE. — Devonian to Triassic; worldwide.

DIAGNOSIS. — Dendroid and encrusting colony with abundant acanthostyles and exilazoecia. Autozoecia parallel to longitudinal direction of the colony in endozone; gradually bending outward in exozone. Diaphragms in autozoecia lacking or very rare; lacking in exilazoecia. Exilazoecia circular to angular in cross section and separated from the autozoecia and from each other by thick walls. Two sizes of acanthostyles may be present. Zooecial walls thin in endozone, rapidly thickening in the exozone (modified after Ernst & Gorgij, 2013).

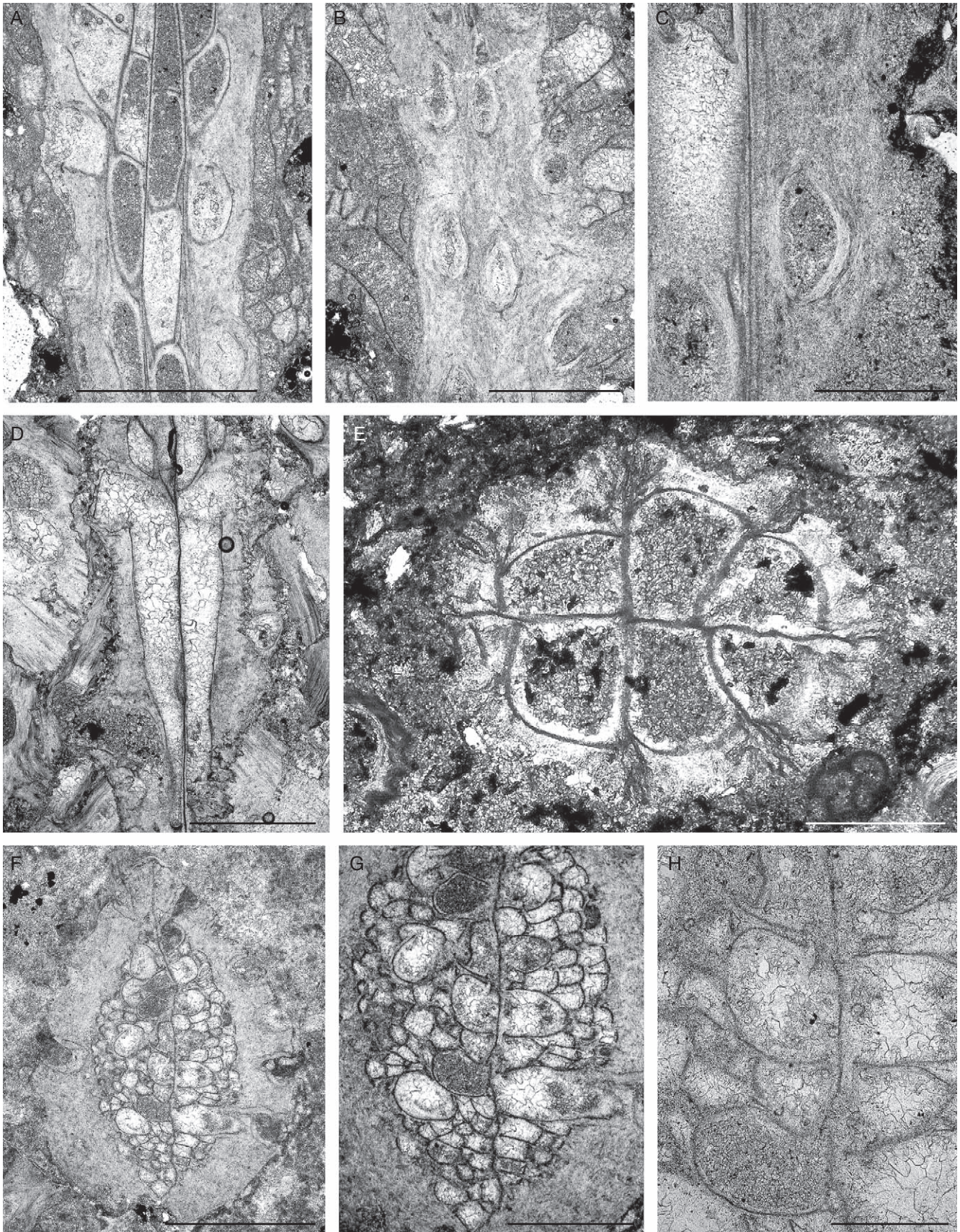


FIG. 14. — **A-E**, *Sulcoretepora parallela* (Phillips, 1836); **A**, deep tangential section, SMF 21.824. **B**, tangential section, SMF 21.824; **C**, tangential section, SMF 21.837; **D**, longitudinal section, SMF 21.827. **E**, branch transverse section, SMF 21.833; **F-H**, *Ramiporalia robusta* Delvolve & McKinney, 1983, branch transverse section, SMF 21.843. Scale bars: A, B, D, G, 0.5 mm; C, E, H, 0.2 mm; F, 1 mm.

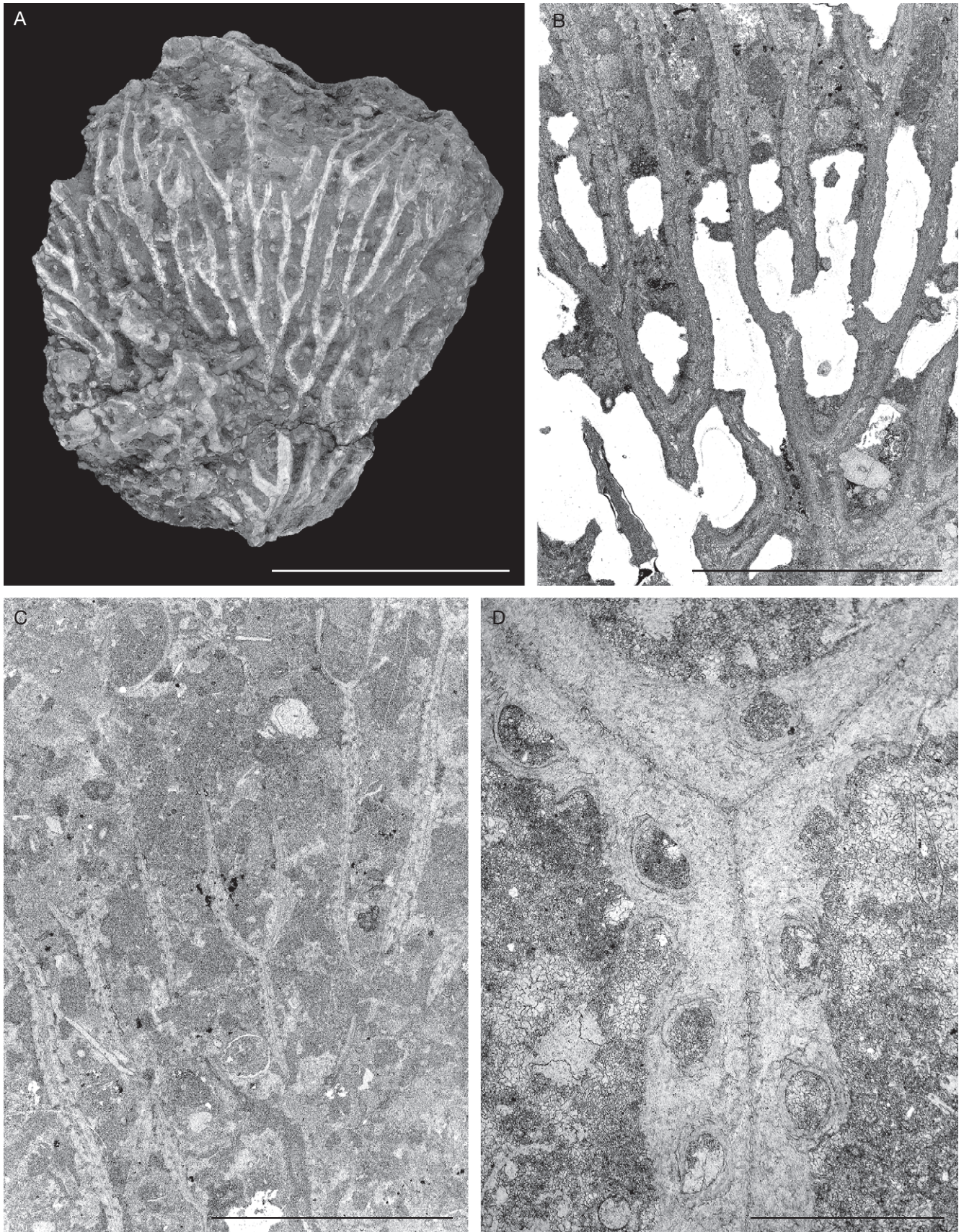


FIG. 15. — **A-D**, *Ramiporalia robusta* Delvolve & McKinney, 1983; **A**, general view of the colony; **B**, mid-tangential section of the colony, SMF 21.841; **C, D**, shallow tangential section of the colony, SMF 21.842. Scale bars: A, 30 mm; B, C, 10 mm; D, 0.5 mm.

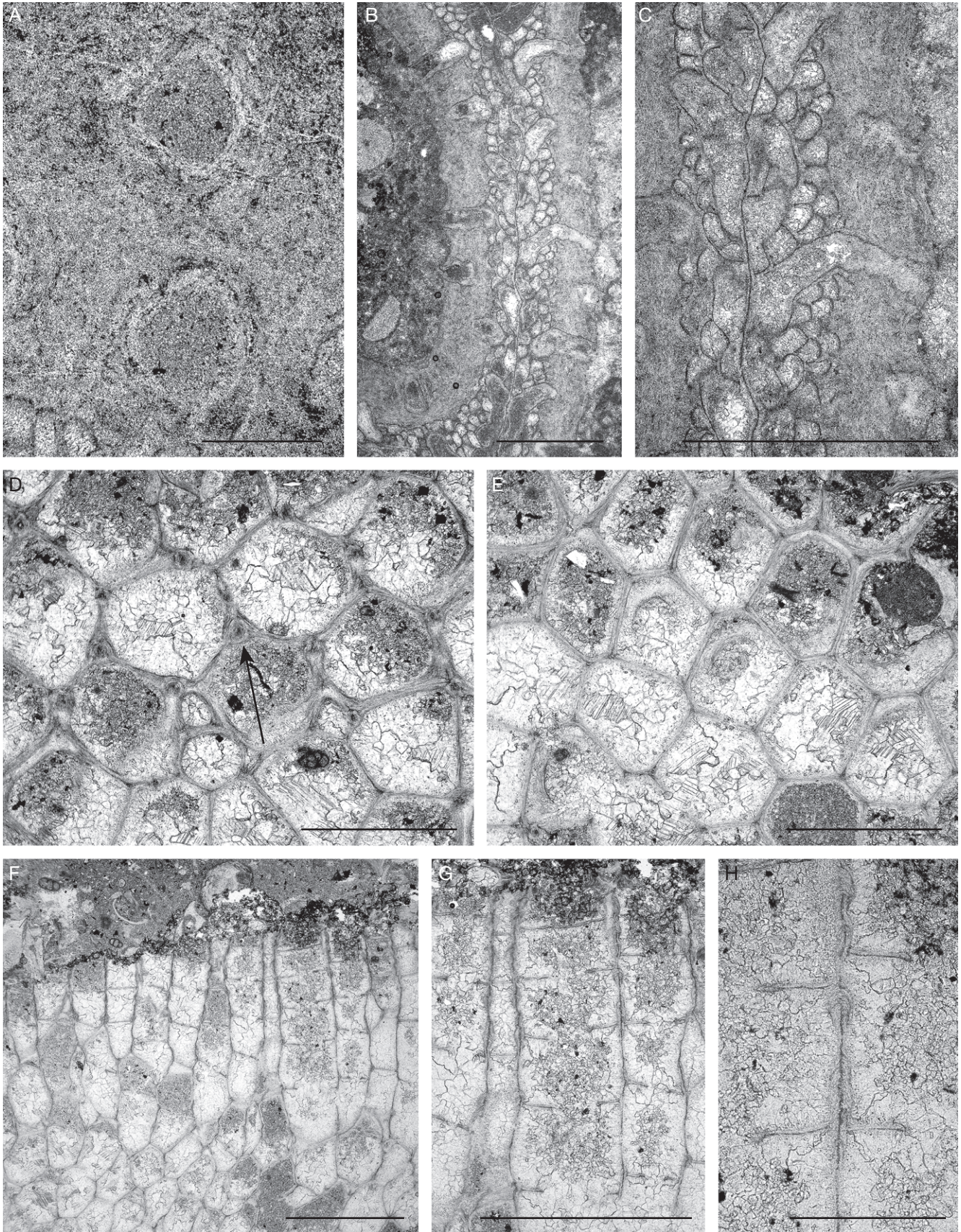


FIG. 16. — **A-C**, *Ramiporalia robusta* Delvolve & McKinney, 1983; **A**, shallow tangential section showing autozooeical aperture, SMF 21.839; **B, C**, branch mid-tangential section, SMF 21.841; **D-H**, *Tabullipora howsii* (Nicholson, 1881); **D, E**, tangential section showing autozooeical apertures and acanthostyles (**arrow**), SMF 21.852; **F, H**, longitudinal section showing ring septa, SMF 21.851. Scale bars: A, H, 0.2 mm; B, C, F, G, 1 mm; D, E, 0.5 mm.

COMPARISON

Dyscritella Girty, 1911 generally lacks diaphragms which are commonly developed in the similar genus *Dyscritellina* Morozova in Dunaeva & Morozova, 1967.

Dyscritella sp.
(Fig. 17A)

MATERIAL. — TCD.60345, SMF 21.897.

OCCURRENCE. — Carboniferous, Mississippian (upper Visean); Roque Redonde (Montagne Noire, southern France).

DESCRIPTION

Small encrusting colony on unknown cylindrical substrate, 0.30-0.34 mm thick; autozooeical chambers simple, tubular, diverging from budding base at angle of between 45-80°, sub-parallel in endozone, with abrupt turn at endozone-exozone boundary. Zooeical walls tripartite in endozone, with a thin central dark zone surrounded by thin paler laminated skeleton. Walls thick, uniform width in exozone, with acanthostyles developed from base of exozone. Diaphragms or other intrachamber structures not developed. Exilazooecia present as small elongate u-shaped tubes, one or two in exozone between autozooeical apertures.

COMPARISON

On the basis of just one specimen preserved in longitudinal section only it is not possible to determine all of its specific characteristics and so it is left in open nomenclature.

Order CRYPTOSTOMATA Vine, 1884

Suborder RHABDOMESINA Astrova & Morozova, 1956

Family ARTHROSTYLIDAE Ulrich, 1882

Genus *Nematopora* Ulrich, 1888

TYPE SPECIES. — *Trematopora minuta* Hall, 1876 by original designation. Silurian of Indiana; USA.

OCCURRENCE. — Middle Ordovician to Permian; worldwide.

DIAGNOSIS. — Delicate, erect dichotomously branching colonies, composed of straight branches, sub-circular to circular in cross-section; axial region consisting of well defined medial axis, planar medial wall developed locally in some species; autozooeical tubular, triangular in cross section in endozone, inflated on their bases, diverging from the medial axis, bending abruptly in exozone, having a length of 4-6 times their diameter; rare diaphragms can appear; autozooeical apertures oval or rounded, dorsally flared, arranged regularly in 4 to 10 longitudinal rows, commonly having peristomes; zooeical boundaries well defined, narrow; extrazooeical skeleton well developed; paurostyles common on ridges in many species; nodes rarely occur. Heterozooecia absent.

COMPARISON

Genus *Nematopora* Ulrich, 1888 differs from *Ulrichostylus* Bassler, 1952 by the shape of autozooeical which bend in exozone.

Nematopora hibernica Wyse Jackson, 1996
(Fig. 17B-D; Appendix)

Nematopora hibernica Wyse Jackson, 1996: 124, figs 3b, 6, 7.

MATERIAL. — TCD.60334, 60337, 60342, 60348, 60349.

OCCURRENCE. — Mississippian, Visean; Ireland (Wyse Jackson, 1996), Roque Redonde (Montagne Noire, southern France).

DESCRIPTION

Delicate colonies comprising dichotomising branches; cross-sectional shape circular to polygonal. Autozooeical chambers arranged in five rows on obverse surface. Interapertural walls undulatory between autozooeical in longitudinal rows, smooth with small stylets along their crests. Autozooeical apertures pyriform, twice as long as wide. Reverse surface barren, smooth with faint longitudinal rows of small stylets. Autozooeical chambers vermiform, elongate in tangential section, six times long as wide, developed from sinuous central axis; slight deviation towards outer margin at exozone; exozone wall of coarsely granular skeleton.

COMPARISON

Nematopora hibernica is one of eight species in the genus described from Carboniferous successions worldwide (Wyse Jackson, 1996, Appendix 4), and differs from them in having fewer rows of autozooeical.

Genus *Pseudonematopora* Balakin, 1974

TYPE SPECIES. — *Nematopora? turkestanica* Nikiforova, 1948 by original designation. Lower Carboniferous of the Middle Asia.

OCCURRENCE. — Upper Devonian (Famennian) to Pennsylvanian (Bashkirian); Europe, Russia, Kazakhstan, China, Mongolia.

DIAGNOSIS. — Ramose colonies with occasional dichotomising branches. Branches of constant width, circular to semicircular in transverse section. Autozooeical occurring in 6 to 16 longitudinal rows, budding in an annular manner, originating from a central axis or median wall. Autozooeical apertures circular to oval in shape, with proximal peristomes. Vesicular skeleton may be present in the exozone. Diaphragms and acanthostyles absent, terminal diaphragms common.

COMPARISON

Pseudonematopora Balakin, 1974 differs from *Nematotrypa* Bassler, 1911 by absence of hemidiaphragms in autozooeical and nodes on the colony surface.

Pseudonematopora planatus Wyse Jackson, 1996
(Fig. 18A-C)

Pseudonematopora planatus Wyse Jackson, 1996: 126-127, fig. 3c, 10-15. — Ernst 2005: 59, fig. 4c-g. — Ernst & Rodríguez 2013: 187, 8d-8f.

MATERIAL. — SMF 21.855-SMF 21.859, TCD.60332, 60333, 60339, 60340, 60342, 60344, 60345.

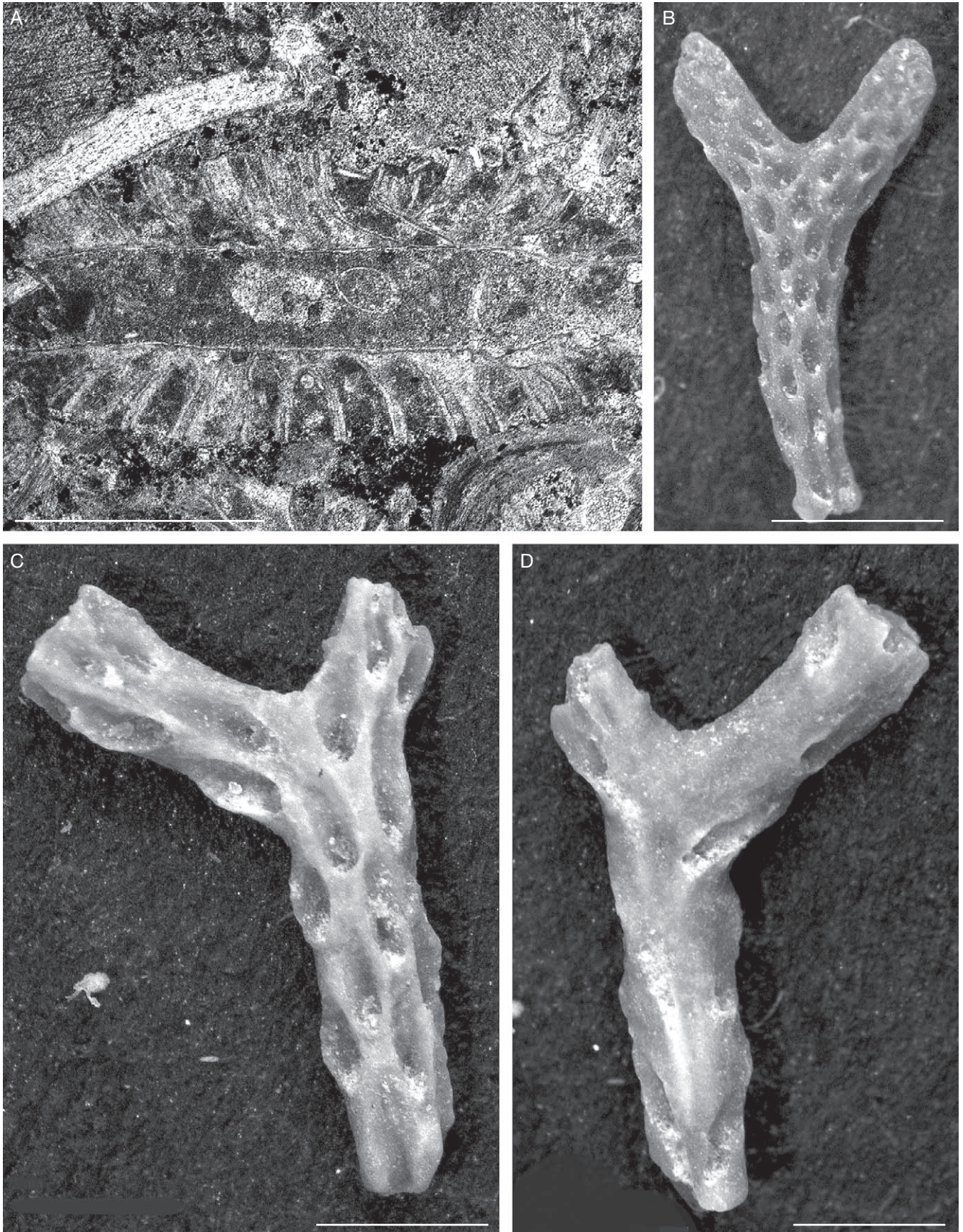


FIG. 17. — **A**, *Dyscritella* sp., longitudinal section, TCD.60345; **B-D**, *Nematopora hibernica* Wyse Jackson, 1996; **B**, obverse colony surface, TCD.60348; **C**, obverse colony surface, TCD.60349; **D**, reverse colony surface, TCD.60349. Scale bars: A, 0.5 mm; B-D, 1 mm.

OCCURRENCE. — Mississippian, Visean; Ireland (Wyse Jackson, 1996), Germany (Ernst 2005), Carboniferous, Mississippian (upper Visean); Roque Redonde (Montagne Noire, southern France), Spain (Ernst & Rodríguez 2013).

DESCRIPTION

Ramose colony, circular or slightly angular in cross-section, 0.54-0.75 mm in diameter. Short autozooezia budding in spiral order from the central axis. Hemisepta absent; terminal diaphragms common. Autozooezical apertures oval to teardrop-shaped, 0.10-0.14 mm wide, arranged in regular diagonal rows. Autozooezicia displaying two types of walls – the inner bright granular-prismatic and the outer dark laminated. The inner granular-prismatic walls building three-layered endozone walls consisting of two bright outer layers and the dark inner one. Neither heterozooezicia nor styles present.

COMPARISON

Pseudonematopora planatus Wyse Jackson, 1996 differs from *P. turkestanica* (Nikiforova, 1948) from the Mississippian (Visean) of Kazakhstan in having thinner branches and smaller apertures (branch width 0.54-0.75 mm vs 0.80-2.80 mm in *P. turkestanica*; aperture width 0.10-0.14 mm vs 0.17-0.22 mm in *P. turkestanica*) (Wyse Jackson 1996, appendix 6), as well as in absence of heterozooezicia. *Pseudonematopora planatus* differs also from *P. balakini* Gorjunova, 1988 from the Pennsylvanian (Bashkirian) of Mongolia in having thinner branches and smaller apertures (branch width 0.54-0.75 mm vs 0.88-1.10 mm in *P. balakini*; aperture width 0.10-0.14 mm vs 0.18-0.22 mm in *P. balakini*), as well as in absence of heterozooezicia.

Family NEMATOTRYPIDAE Spjeldnaes, 1984

Genus *Clausotrypa* Bassler 1929

[= *Nemacanthopora* Termier & Termier, 1971]

TYPE SPECIES. — *Clausotrypa separata* Bassler, 1929 by original designation. Lower Permian; Timor (Indonesia).

DIAGNOSIS. — Branched colonies; autozooezicia elongated-tubular with rare diaphragms; autozooezical apertures rounded or oval; tectitooeicia common, irregular, closed by laminated skeleton near colony surface; acanthostyles on the surface common; autozooezical walls laminated, having dark serrated boundaries.

OCCURRENCE. — Carboniferous – Permian; Europe, Asia.

COMPARISON

Clausotrypa Bassler, 1929 differs from *Nematotrypa* Bassler, 1911 in absence of hemiphragms and budding pattern of autozooezicia, which bud from a distinct median axis in *Nematotrypa*. *Nemacanthopora* Termier & Termier, 1971 was separated from *Clausotrypa* because of its shape of autozooezicia (shorter vs longer autozooezicia in *Clausotrypa*). However, this character is quite subjective and inconsistent within species placed to both genera, and, apparently depends on the branch diameter.

Therefore, *Nemacanthopora* is assigned as junior synonym of *Clausotrypa*.

Clausotrypa ramosa (Owen, 1973)

(Fig. 18D-I; Appendix)

Sulcoretepora? *ramosa* Owen, 1973: 304, pl. 9A-C.

Clausotrypa ramosa – Wyse Jackson 1996: 137, figs 37-41. — Ernst 2005: 59, fig. 4I, J.

MATERIAL. — SMF 21.860-SMF 21.871, TCD.60339, 60343, 60344.

OCCURRENCE. — Carboniferous, Mississippian (Visean); Ireland, Roque Redonde (Montagne Noire, southern France).

DESCRIPTION

Cylindrical branches, 1.01-1.64 mm in diameter, with 0.44-0.80 mm wide endozone and 0.30-0.60 mm wide exozones. Autozooezicia long, cylindrical, budding parallel to the branch axis for a long distance, gently curved toward to the colony surface. Autozooezical apertures oval. Thin, planar diaphragms rare in autozooezicia. Tectitooeicia abundant, separating autozooezicia in 1-3 rows, restricted to exozone, covered by thick calcitic skeleton on the colony surface. Acanthostyles large, having distinct hyaline cores, 4-9 surrounding each aperture and arranged irregularly in spaces between autozooezicia. Autozooezical walls laminated, having dark serrated boundaries, 0.020-0.025 mm thick.

COMPARISON

Clausotrypa ramosa (Owen, 1973) is similar to *C. monticola* (Eichwald, 1860) but differs from it in smaller distances between aperture centres (averagely 0.76 mm vs 0.81 mm in *C. monticola*).

Family RHABDOMESIDAE Vine, 1884

Genus *Rhabdomeson* Young & Young, 1874

Coeloconus Ulrich, 1889: 298.

TYPE SPECIES. — *Rhabdomeson progradile* Wyse Jackson & Bancroft, 1995 by subsequent designation of Wyse Jackson & Bancroft (1995) (ICZN Opinion 1854; ICZN 1996). Lower Carboniferous, Mississippian (Visean-Serpukhovian); Britain and Ireland.

DIAGNOSIS. — Rhabdomesid with delicate dendroid colony with irregularly dichotomizing branches. Autozooezicia regularly budding around central axial cylinder in an annual or spiral manner. Hemisepta common. Autozooezical apertures elliptical, pyriform or rhombic, closely spaced, arranged in quincunx on colony surface; of constant or variable dimensions around branch. Stylets abundant and structurally diverse (after Wyse Jackson and Bancroft, 1995).

OCCURRENCE. — Middle Devonian to Upper Permian; worldwide.

COMPARISON

Rhabdomeson Young & Young, 1874 differs from other rhabdomesines in the presence of a central axial cylinder, from

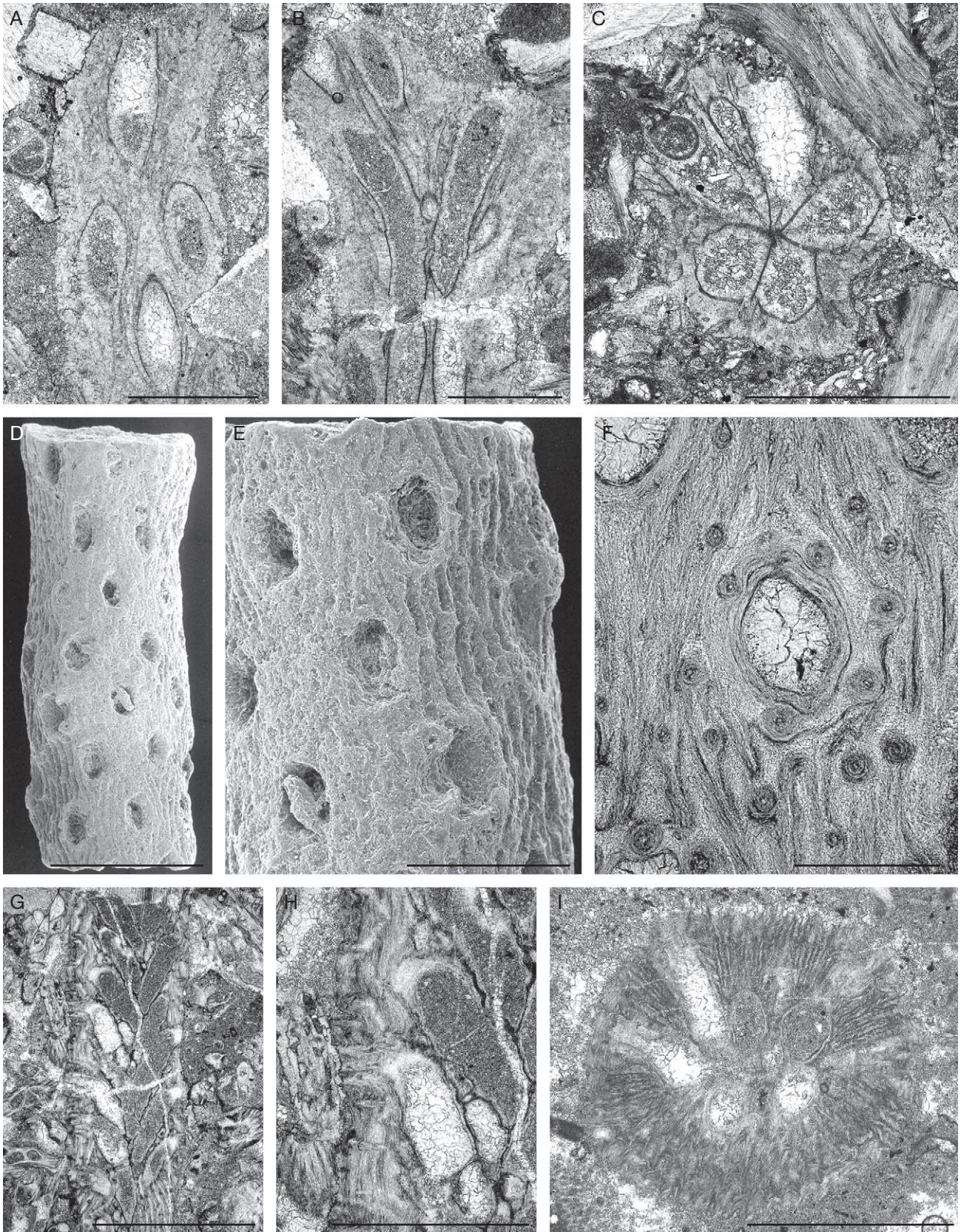


FIG. 18. — **A-C**, *Pseudonematopora planatus* Wyse Jackson, 1996; **A**, tangential section, SMF 21.857; **B**, longitudinal section, SMF 21.857; **C**, Transverse section, SMF 21.856; **D-I**, *Clausotrypa ramosa* (Owen, 1973); **D**, **E**, branch surface, SMF 21.871; **F**, tangential section, SMF 21.869; **G-H**, longitudinal section, SMF 21.869; **I**, transverse section, SMF 21.862. Scale bars : A-C, E, F, 0.5 mm; D, H, I, 1 mm; G, 2 mm.

Silenella Gorjunova, 1992 in absence of aktinotostyles, from *Pseudorhabdomeson* Gorjunova, 2002 in having a rounded axial tube instead of a polygonal one and in the presence of differentiated styles instead of aktinotostyles.

Rhabdomeson progracile Wyse Jackson & Bancroft, 1995 (Fig. 19A-F; Appendix)

For synonymy see Wyse Jackson & Bancroft (1995: 30, 31).

MATERIAL. — SMF 21.872-SMF 21.883.

OCCURRENCE. — Carboniferous, Mississippian (Visean-Serpukhovian); Britain, Ireland. Carboniferous, Mississippian (upper Visean); Roque Redonde (Montagne Noire, southern France).

DESCRIPTION

Branched colonies with narrow axial cylinder. Branches 0.60-1.63 mm in diameter. Axial cylinder circular to polygonal, 0.1-0.2 mm in diameter. Autozoecia budding in a spiral pattern diverging at angles of 27-40° from the axial cylinder, arranged 10-14 in the first row around the axial cylinder, hexagonal to rhomboid in transverse in the endozone. Autozoecial apertures oval, arranged in regular diagonal rows. Macroacanthostyles large, long, 4 arranged around each aperture building a regular hexagonal pattern. Microacanthostyles small, 1-2 arranged between macroacanthostyles. Paurostyles scattered on the colony surface. Superior hemisepta small, blunt, positioned at distal end of the autozoecia, visible only in occasional sections; inferior hemisepta absent. Diaphragms absent.

COMPARISON

Rhabdomeson progracile Wyse Jackson & Bancroft, 1995 is similar to *R. regularis* Nekhoroshev, 1932, and *R. spinosum* Morozova, 1955, in terms of size, and in the positioning of a solitary prominent acanthostyle situated proximally of autozoecial apertures. *R. progracile* differs from *R. regularis* in having larger hemisepta and wider autozoecial apertures, and from *R. spinosum* in acanthostyles that are smaller and a wider exozone (Wyse Jackson & Bancroft 1995: 34).

Family RHOMBOPORIDAE Simpson, 1895

Genus *Saffordotaxis* Bassler, 1952

TYPE SPECIES. — *Rhombopora incrassata* Ulrich, 1890 by original designation. Lower Mississippian; USA (Kentucky).

DIAGNOSIS. — Branched colonies with distinct linear axis. Endozones and exozones distinctly separated. Autozoecia with oval apertures and regularly thickened walls in the exozone, diverging at angles of 20-30° from the axis, bending sharply in exozones and intersecting the colony surface at angles of 80-90°; polygonal in endozone becoming hexagonal and rounded at colony surface. Longitudinal arrangement of autozoecia regular. Diaphragms complete, rare. Hemisepta absent. Metazoecia and acanthostyles absent. Aktinotostyles common to abundant, arranged in single or multiple rows, arising in the exozone.

OCCURRENCE. — Middle Devonian to Lower Permian; worldwide.

COMPARISON

Saffordotaxis Bassler, 1952 differs from *Primorella* Romantchuk & Kiseleva, 1968 in shape of autozoecia with sharp bend in the exozone.

Saffordotaxis incrassata (Ulrich, 1888) (Figs 19G-I; 20A-D; Appendix)

Rhombopora incrassata Ulrich, 1888: 89, pl. 14, fig. 16; 1890: 652, pl. 70, fig. 12. — Nekhoroshev 1953: 148, pl. 17, fig. 5. — Trizna 1958: 199, pl. 54, figs 4-65.

Saffordotaxis incrassata – Blake 1983: 558, fig. 289, 1a-e.

Saffordotaxis incrassatus – Gorjunova 1985: 117, pl. 7, fig. 2.

MATERIAL. — SMF 21.884-SMF 21.890, TCD.60340.

OCCURRENCE. — Carboniferous, Mississippian (upper Visean); Roque Redonde (Montagne Noire, southern France).

DESCRIPTION

Branched colonies, 0.81-1.35 mm in diameter, with 0.29-0.55 mm wide endozones and 0.26-0.40 mm wide exozones. Autozoecia tubular, growing in spiral pattern from the distinct median axis at angles of 25-29° in endozones, abruptly bending in exozones and intersecting colony surface at angles of 52-64°; having a triangular to rhombic, tear-drop shape in transverse section of endozone. Autozoecial apertures oval, arranged in regular diagonal rows on branches. Basal diaphragms rare, thin, planar. Aktinotostyles abundant, arranged in a single row between autozoecia. Autozoecial walls finely laminated, with dark dividing layer, 0.01-0.02 mm thick in endozone; laminated, without distinct boundaries in exozones. Exozonal walls containing abundant mural spines.

COMPARISON

Saffordotaxis incrassata (Ulrich, 1888) is similar to *S. retrusus* Gorjunova, 1985 from the Visean of Kazakhstan, but differs in having thicker colonies (branch diameter 0.81-1.35 mm vs 0.65-0.90 mm in *S. retrusus*), and smaller autozoecial apertures (aperture width 0.06-0.10 mm vs 0.15-0.19 mm in *S. retrusus*).

Genus *Megacanthopora* Moore, 1929

Neorhombopora Shishova, 1964: 55.

TYPE SPECIES. — *Megacanthopora fallacis* Moore, 1929 by monotypy. Graham Formation (Pennsylvanian); Texas, USA.

DIAGNOSIS. — Branched colonies with wide exozone (one-third to two-third of the branch radius). Autozoecia with oval apertures and irregularly thickened walls in the exozone, diverging at angles of 45° from the axis, intersecting the colony surface at angles of 80-90°. Longitudinal arrangement of autozoecia irregular. Diaphragms complete, rare, occurring only in the exozone. Metazoecia rare to common. Acanthostyles uncommon. Aktinotostyles abundant, generally closely spaced, arising in the exozone. Autozoecial walls laminated, containing mural spines.

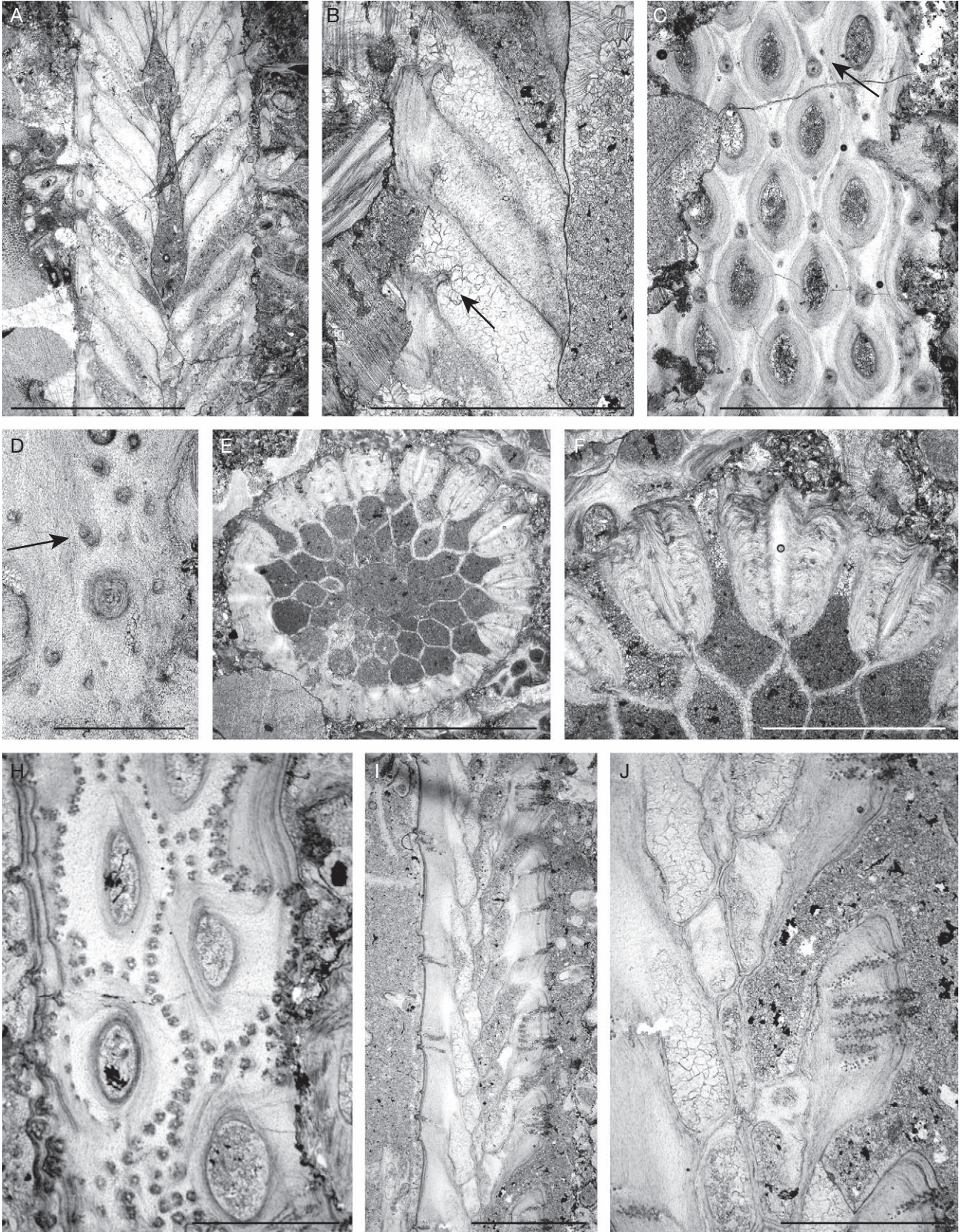


FIG. 19. — **A-F**, *Rhabdomeson progradile* Wyse Jackson & Bancroft, 1995; **A**, longitudinal section showing axial cylinder, SMF 21.882; **B**, longitudinal section showing autozooeal chambers with hemisepta (**arrow**), SMF 21.882; **C**, tangential section showing autozooeal apertures, acanthostyles and paurostyles (**arrow**), SMF 21.872; **D**, tangential section showing acanthostyles and paurostyles (**arrow**), SMF 21.872; **E, F**, branch transverse section, SMF 21.875; **G-I**, *Saffordotaxis incrassata* (Ulrich, 1888), SMF 21.889; **G**, tangential section showing autozooeal apertures and aktinostyles; **H, I**, branch longitudinal section. Scale bars: A, 2 mm; B, C, E, H, 1 mm; D, 0.2 mm; F, G, I, 0.5 mm.

OCCURRENCE. — Lower Carboniferous – Upper Permian; worldwide.

COMPARISON

Megacanthopora Moore, 1929 differs from *Rhombopora* Meek, 1872 in having abundant metazooecia.

REMARKS

Astrova (1978), Dunaeva (1973), and Gorjunova (1985, 1996) assigned this genus to the Stenoporidae (Trepotomida). Blake (1983: 579-580) placed it in the Rhomboporidae (Rhabdomesina, Cryptostomata), and put the genus *Neorhombopora* Shishova, 1964 to the genus *Megacanthopora* Moore, 1929, because the type species *Rhombopora crassa* Ulrich, 1884 possesses acanthostyles.

Megacanthopora enodata n. sp.
(Figs 20E-I; 21A; Appendix)

ETYMOLOGY. — The species name refers to being it distinct among other *Megacanthopora* species (from Latin “enodatus”, distinct).

HOLOTYPE. — SMF 21.891.

PARATYPES. — SMF 21.892-SMF 21.896.

TYPE LOCALITY. — Roque Redonde (Montagne Noire, southern France).

TYPE HORIZON. — Carboniferous, Mississippian (upper Viséan).

DIAGNOSIS. — Branched colonies of intermediate diameter; exozones wide; large acanthostyles and abundant aktinostyles; metazooecia common; rare basal diaphragms; autozoecial walls laminated with numerous mural spines.

DESCRIPTION

Branched colonies, 1.50-1.90 mm in diameter, with 0.66-0.82 mm wide endozones and 0.42-0.54 mm wide exozones. Autozoecia tubular, growing for short distance parallel to branch axis, abruptly bending in exozones and intersecting colony surface at nearly right angle; having polygonal shape in transverse section of endozone. Autozoecial apertures oval to slightly polygonal, arranged irregularly on branches. Basal diaphragms rare, thin, planar. Aktinostyles abundant, arranged irregularly between autozoecia. Acanthostyles large, with narrow hyaline cores and wide laminated sheaths, arranged irregularly on the colony surface. Metazooecia small and short, arranged irregularly on the colony surface. Autozoecial walls finely laminated, with dark dividing layer, 0.01-0.02 mm thick in endozone; laminated, without distinct boundaries, protruded by abundant mural spines, 0.18-0.19 mm thick in exozones. Mural spines irregularly arranged in exozonal wall, opening into autozoecial cavities and on colony surface, 0.005-0.010 mm in diameter.

COMPARISON

Megacanthopora enodata n. sp. differs from *M. fallacis* Moore, 1929 in thinner branches (branch diameter 1.50-1.90 mm vs 2.0-3.5 mm in *M. fallacis*) and in smaller distances be-

tween aperture centres (0.30-0.44 mm vs 0.33-0.60 mm in *M. fallacis*). *Megacanthopora enodata* differs from *M. gracilis* Dunaeva, 1973 from the Lower Carboniferous (Namurian) of Ukraine in larger apertures (aperture width 0.13-0.19 mm vs 0.10-0.18 mm in *M. gracilis*).

Order FENESTRATA

Suborder FENESTELLINA Astrova & Morozova, 1956
Family FENESTELLIDAE King, 1849

Genus *Rectifenestella* Morozova, 1974

TYPE SPECIES. — *Fenestella medvedkensis* Schulga-Nesterenko, 1951 by original designation. Upper Carboniferous (Kasimovian); Russia.

DIAGNOSIS. — Reticulate colonies consisting of fine to intermediately robust branches and straight dissepiments. Autozoecia triangular to pentagonal in mid tangential section. Superior hemisepta present; inferior hemisepta absent. Low keel carrying one row of intermediate nodes (modified after Morozova, 2001, p.45).

OCCURRENCE. — Devonian to Permian; worldwide.

COMPARISON

Rectifenestella Morozova, 1974 differs from *Laxifenestella* Morozova, 1974 in having pentagonal shape of autozoecia in mid tangential section and absence of inferior hemisepta, from *Minilya* Crockford, 1944 in having a single row of nodes on the keel instead of two alternating rows in *Minilya*.

Rectifenestella sp.
(Figs 21B-D; Appendix)

MATERIAL. — SMF 21.898.

OCCURRENCE. — Carboniferous, Mississippian (upper Viséan); Roque Redonde (Montagne Noire, southern France).

EXTERIOR DESCRIPTION

Reticulate colony formed by straight branches joined by relatively narrow dissepiments. Fenestrules rectangular, elongated. Autozoecia arranged in two rows on branches. Autozoecial apertures circular, with low peristome with 8 apertural nodes (stellate structure); 2 to 3 apertures spaced per fenestrule length. Keel narrow, low, containing small densely spaced circular nodes.

INTERIOR DESCRIPTION

Autozoecia short, pentagonal in mid tangential section; with short to moderately long vestibule. Axial wall between autozoecial rows strongly zigzag; aperture positioned at distal end of chamber. Superior hemisepta indistinct; inferior hemisepta absent. External laminated skeleton well-developed on both obverse and reverse sides. Heterozoecia not observed.

COMPARISON

Rectifenestella sp. is similar to *R. frutex* (M'Coy, 1844) from the Mississippian of Ireland, but differs from it in wider branches

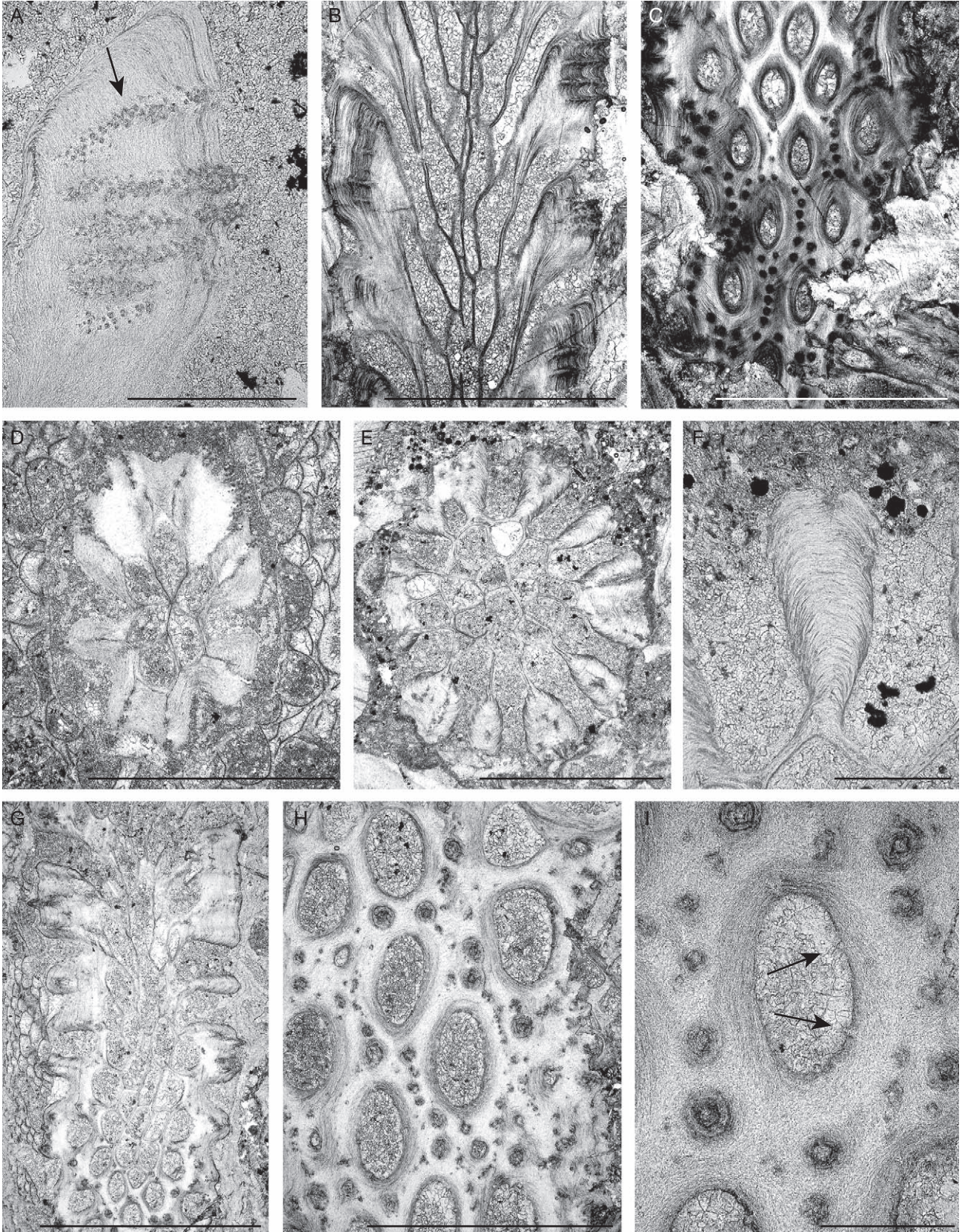


FIG. 20. — **A-D**, *Saffordotaxis incrassata* (Ulrich, 1888); **A**, longitudinal section showing aktinostyles in the autozoecial wall (arrow), SMF 21.889; **B**, longitudinal section, SMF 21.890; **C**, tangential section, SMF 21.890; **D**, branch transverse section, SMF 21.886; **E-I**, *Megacanthopora enodata* n. sp.; **E**, branch transverse section, paratype SMF 21.893; **F**, branch transverse section, paratype SMF 21.895; **G**, longitudinal section, paratype SMF 21.894. **H**, tangential section, holotype SMF 21.891; **I**, tangential section showing autozoecial apertures, acanthostyles, aktinostyles and mural styles (arrows), paratype SMF 21.896. Scale bars: A, E, I, 0.2 mm; B-E, H, 1 mm; G, 2 mm.

(0.29–0.35 mm vs 0.14–0.20 mm in *R. frutex*) and longer fenestrules (0.44–0.58 mm vs 0.33–0.39 mm in *R. frutex*).

Similarly *Rectifenestella* sp. differs from *R. constans* (Foerste, 1887) described from the Mississippian of the Russian Platform by Schulga-Nesterenko (1951) in wider branches (0.29–0.35 mm vs 0.20 mm in *R. limbata*) and larger fenestrules (fenestrule length 0.44–0.58 mm vs 0.38–0.43 mm in *R. limbata*; fenestrule width 0.22–0.29 mm vs 0.17–0.20 mm in *R. limbata*). Tavener-Smith (1973, p. 411) considered *R. frutex* and *R. limbata* to be synonymous. It is also very close, but not identical, to *R. asiatica* (Nikiforova in Schulga-Nesterenko 1951). It differs mainly in the more closely spaced keel nodes (distance between node centres 0.11–0.18 vs 0.30 mm in *R. asiatica*).

Genus *Spinofenestella* Termier & Termier, 1971

Alternifenestella Termier & Termier, 1971: 42.

TYPE SPECIES. — *Fenestella spinosa* Condra, 1902 by original designation. Lower Permian (Wolfcampian); North America.

DIAGNOSIS. — Reticulate colonies with relatively wide and thick branches and relatively thin dissepiments. Autozoecia arranged in two rows on the branches. Autozoecia triangular in mid tangential section, triangular to pentagonal proximal to bifurcations. Narrow keel with single row of nodes developed.

OCCURRENCE. — Lower Devonian – Upper Permian.

COMPARISON

Spinofenestella Termier & Termier, 1971 differs from the genus *Rectifenestella* Morozova, 1974 by the triangular shape of the autozoecia in mid tangential section.

Spinofenestella major (Nikiforova, 1933) comb. nov. (Fig. 21E–I; Appendix)

Fenestella major Nikiforova, 1933: 16. — Schulga-Nesterenko 1951: 93, 94, pl. 17, fig. 3, pl. 18, fig. 2.

Fenestella donaica – Nikiforova 1927: 250, pl. 12, figs 8, 9.

Fenestella donaica var. *major* Nikiforova, 1933: 16, pl. 16, figs 4, 5. — Nekhoroshev 1948: 28, pl. 2, fig. 3, pl. 10, fig. 5.

Alternifenestella major – Gorjunova 2013: 576, 577, pl. 5, fig. 2.

MATERIAL. — SMF 21.899.

OCCURRENCE. — Carboniferous, Mississippian (upper Visean); Roque Redonde (Montagne Noire, southern France). Carboniferous, Mississippian; Ukraine, Donetz Basin. Carboniferous, Mississippian (Serpukhovian); Russian Platform. Middle Carboniferous; Kazakhstan.

EXTERIOR DESCRIPTION

Reticulate colony formed by straight branches joined by narrow dissepiments. Fenestrules oval to rectangular, about twice as long as wide. Autozoecia arranged in two rows on branches. Autozoecial apertures circular, with low smooth

peristome; 3 to 5 apertures spaced per fenestrule length. Median keel low, narrow, containing small elliptical nodes. Nodes 0.03–0.05 mm in diameter, spaced 0.14–0.18 mm from centre to centre.

INTERIOR DESCRIPTION

Autozoecia short, triangular to trapezoid in mid tangential section; with short to moderately long vestibule in longitudinal section. Axial wall between autozoecial rows strongly zigzag; aperture positioned at distal end of chamber. Superior hemisepta present, long, curved proximally; inferior hemisepta absent. External laminated skeleton well-developed on both obverse and reverse sides. Heterozoecia not observed.

COMPARISON

Spinofenestella major (Nikiforova, 1933) comb. nov. differs from *Spinofenestella donaica* (Lebedev, 1924) in longer fenestrules (0.77–1.02 mm vs 0.55–0.65 mm in *S. donaica*). *Spinofenestella major* comb. nov. differs from *S. donaiciformis* (Schulga-Nesterenko, 1951) in smaller and more closely spaced nodes on the median keel (distance between node centres 0.14–0.18 mm vs 0.30–0.42 mm in *S. donaiciformis*).

Spinofenestella cf. *simplaris* (Trizna, 1961) (Figs 22H; 23A–C; Appendix)

Fenestella simplaris Trizna, 1961: 75, 76, pl. 8, figs 3, 4, text-fig. 27.

MATERIAL. — SMF 21.906–SMF 21.910.

OCCURRENCE. — Carboniferous, Mississippian (upper Visean); Roque Redonde (Montagne Noire, southern France).

EXTERIOR DESCRIPTION

Reticulate colony formed by straight branches joined by wide dissepiments. Fenestrules oval to rectangular, long, narrow. Autozoecia arranged in two rows on branches. Autozoecial apertures circular, with low smooth peristome; 3 to 4 apertures spaced per fenestrule length. Large elliptical nodes on the low keel, widely and irregularly spaced.

INTERIOR DESCRIPTION

Autozoecia short, triangular to trapezoid in mid tangential section; with short to moderately long vestibule in longitudinal section. Axial wall between autozoecial rows strongly zigzag; aperture positioned at distal end of chamber. Superior hemisepta weakly developed; inferior hemisepta absent. External laminated skeleton well-developed on both obverse and reverse sides. Heterozoecia not observed.

COMPARISON

The present material is similar to *Spinofenestella simplaris* (Trizna, 1961) from the Mississippian of Urals. However, the present material has significantly longer fenestrules (0.83–1.02 mm vs 0.55–0.75 mm in *S. simplaris*). The present material differs from *Spinofenestella plebeia* (M'Coy, 1844) from the Lower Carboniferous of Ireland, in wider branches (average branch

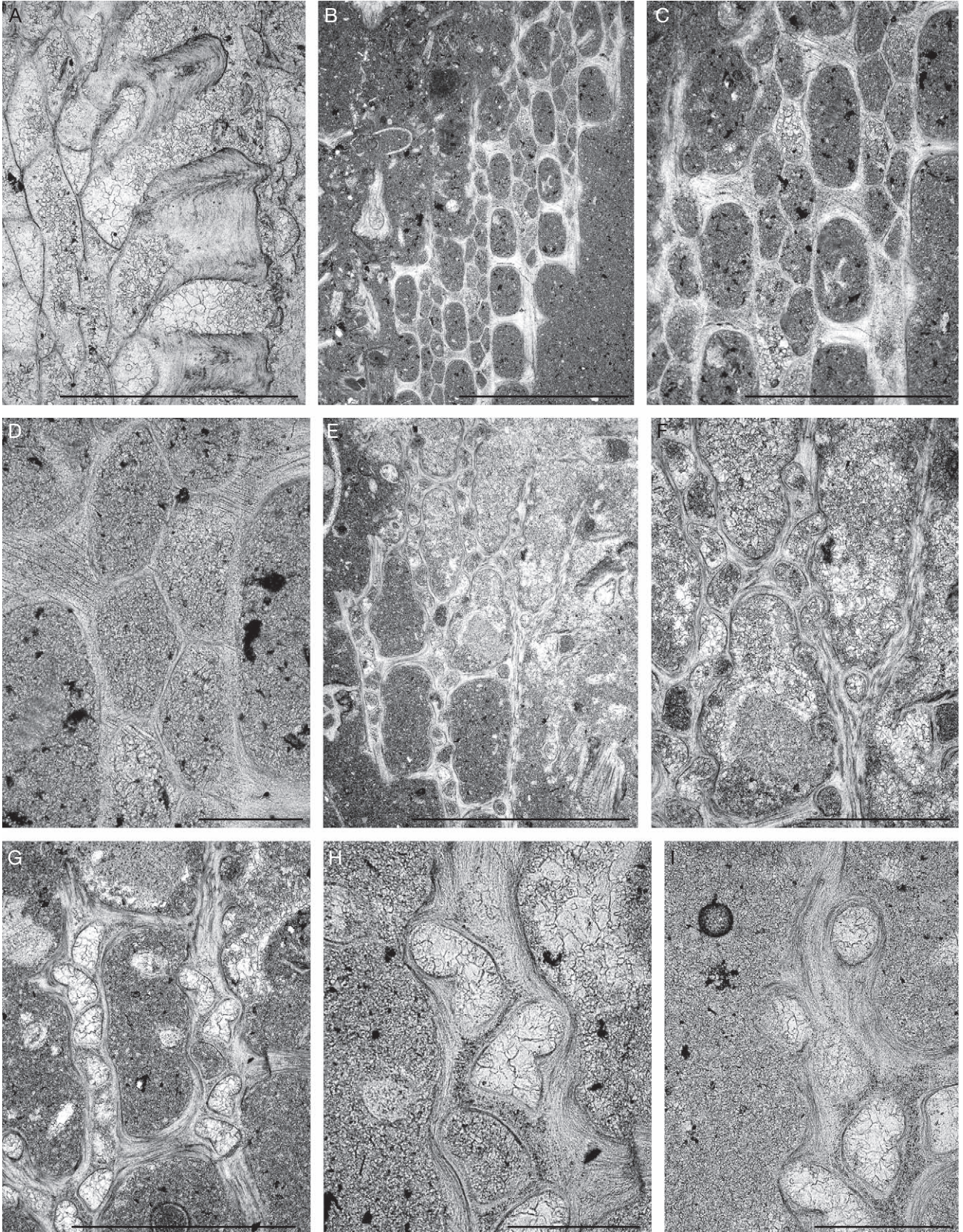


FIG. 21. — **A**, *Megacanthopora enodata* n. sp., longitudinal section showing autozoecial walls with aktinostyles and mural spines, paratype SMF 21.895. **B-D**, *Rectifenestella* sp., SMF 21.898, tangential section; **E-I**, *Spinofenestella major* (Nikiforova, 1933) comb. nov., SMF 21.899; **E-G**, tangential section of the colony; **H**, mid-tangential section of the branch showing autozoecial chambers with hemisepta; **I**, tangential section of the branch showing autozoecial apertures. Scale bars: A, C, G, I, 1 mm; B, E, 2 mm; D, H, I, 0.2 mm; F, 0.5 mm.

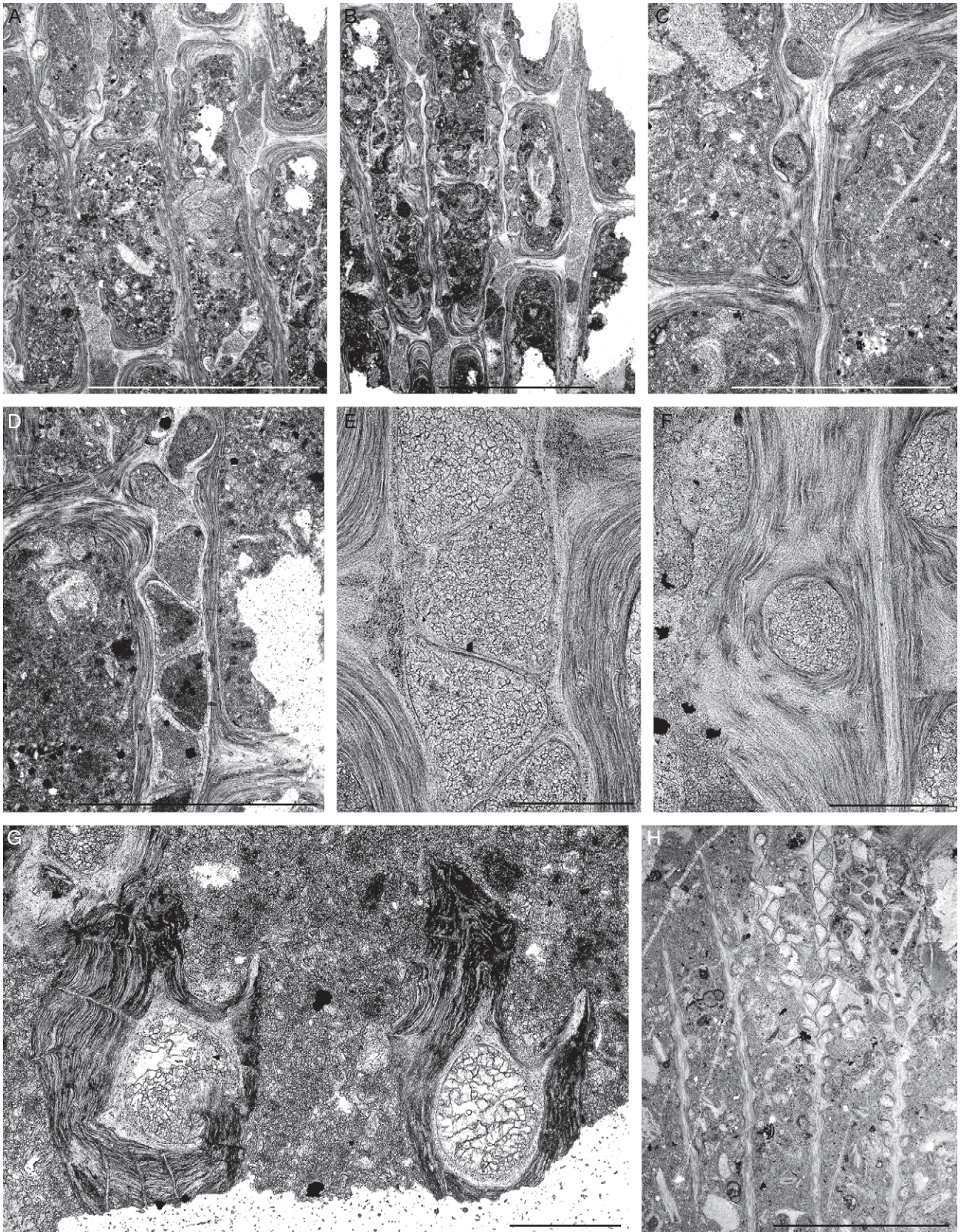


FIG. 22. — **A-G**, *Spinofenestella* sp. 1; **A, B**, tangential section, SMF 21.901; **C**, tangential section showing apertures and keel, SMF 21.900; **D**, mid-tangential section showing autozooeal chambers, SMF 21.900; **E**, mid-tangential section showing autozooeal chambers, SMF 21.901; **F**, tangential section showing autozooeal apertures, SMF 21.901; **G**, branch transverse section, SMF 21.901. **H**, *Spinofenestella* cf. *simplaris* (Trizna, 1961), tangential section, SMF 21.908. Scale bars: A, B, 1 mm; C, D, 2 mm; E, F, G, 0.2 mm; H, 2 mm.

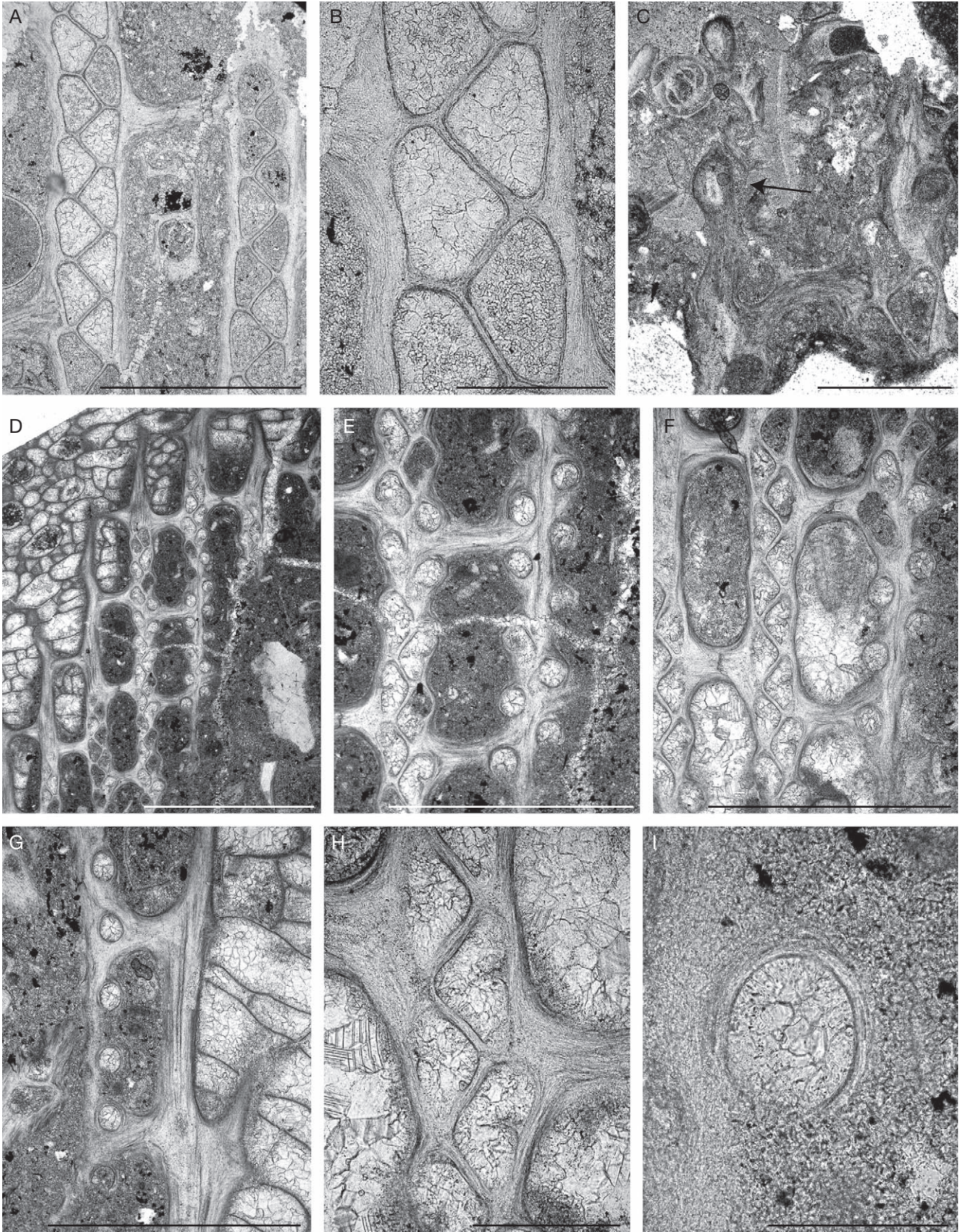


FIG. 23. — **A-C**, *Spinofoenestella* cf. *simplaris* (Trizna, 1961); **A-B**, mid-tangential section, SMF 21.908; **C**, tangential section showing nodes on keel (arrow), SMF 21.906; **D-I**, *Spinofoenestella* sp. 2, SMF 21.911; **D-G**, tangential section; **H**, mid-tangential section showing autozoecial chambers; **I**, autozoecial aperture. Scale bars: **A, E-G**, 1 mm; **B, H**, 0.2 mm; **C**, 0.5 mm; **D**, 2 mm; **I**, 0.1 mm.

width 0.38 mm vs 0.29 mm in *S. plebeia*), and wider dissepiments (average dissepiment width 0.23 mm vs 0.17 mm in *S. plebeia*). It differs from *S. triangularis* (Nekhoroshev, 1953) from the Mississippian of Kazakhstan in wider branches (branch width 0.35–0.42 mm vs 0.15–0.20 mm in *S. triangularis*).

Spinofenestella sp. 1
(Fig. 22A–G; Appendix)

MATERIAL. — SMF 21.900–SMF 21.905.

OCCURRENCE. — Carboniferous, Mississippian (upper Visean); Roque Redonde (Montagne Noire, southern France).

EXTERIOR DESCRIPTION.

Reticulate colony formed by straight branches joined by wide dissepiments. Fenestrules oval to rectangular, long, narrow. Autozoocelia arranged in two rows on branches. Autozoocelial apertures circular, with low smooth peristome; 3 to 6 apertures spaced per fenestrule length. Median keel low, narrow, containing small elliptical nodes. Nodes 0.03–0.04 mm in diameter, spaced 0.38 mm from centre to centre.

INTERIOR DESCRIPTION

Autozoocelia short, triangular to trapezoid in mid tangential section; with short to moderately long vestibule in longitudinal section. Axial wall between autozoocelial rows strongly zigzag; aperture positioned at distal end of chamber. Superior hemisepta weakly developed; inferior hemisepta absent. External laminated skeleton well-developed on both obverse and reverse sides, traversed by small microstyles. Microstyles 0.010–0.015 mm in diameter. Heterozoocelia not observed.

COMPARISON

Spinofenestella sp. 1 most closely resembles *S. ungaryensis* (Popeko, 1967) from the Lower to Middle Carboniferous of Asiatic Russia. The branch width and fenestrule width are similar, but the fenestrules are shorter in *S. ungaryensis* 1.20–1.80 mm vs 1.33–2.38 mm in the Montagne Noire material.

Spinofenestella sp. 2
(Fig. 23D–I; Appendix)

MATERIAL. — SMF 21.911.

OCCURRENCE. — Carboniferous, Mississippian (upper Visean); Roque Redonde (Montagne Noire, southern France).

EXTERIOR DESCRIPTION

Reticulate colony formed by straight branches joined by relatively wide dissepiments. Fenestrules rectangular, elongated. Autozoocelia arranged in two rows on branches. Autozoocelial apertures circular, with low smooth peristome; 3 to 4 apertures spaced per fenestrule length. Keel wide, low, containing small widely spaced elliptical nodes.

INTERIOR DESCRIPTION

Autozoocelia relatively long, triangular in mid tangential section; with short to moderately long vestibule in longitudinal section. Axial wall between autozoocelial rows strongly undulating; aperture positioned at distal end of chamber. Superior hemisepta long, proximally curved; inferior hemisepta absent. External laminated skeleton well-developed on both obverse and reverse sides. Heterozoocelia not observed.

COMPARISON

Spinofenestella sp. 2 is similar to *S. tenuiseptata* (Schulga-Nesterenko, 1941) from the Carboniferous of northeast Russia (as described by Morozova, 1981, p. 70) in branch width (0.26–0.30 mm vs 0.26–0.28 mm) and fenestrule dimensions (length 0.72–0.75 mm vs 0.55–0.80 mm; width 0.19–0.28 mm vs 0.27–0.45 mm). However, *S. tenuiseptata* lacks the distinctive superior proximally curved hemisepta developed in the French specimen.

Genus *Laxifenestella* Morozova, 1974

TYPE SPECIES. — *Fenestella sarytsbevae* Schulga-Nesterenko, 1951 by original designation. Mississippian (Serpukhovian); Russia.

DIAGNOSIS. — Reticulate colonies of different shape, with relatively wide and thick branches and moderately wide dissepiments. Autozoocelia arranged in two rows on the branches, rectangular to pentagonal in mid tangential section. Axial wall between autozoocelial rows weakly undulating. Both superior and inferior hemisepta present. Narrow keel with single row of nodes developed (modified after Morozova [2001: 44]).

OCCURRENCE. — Lower Devonian – Upper Permian; worldwide.

COMPARISON

Laxifenestella Morozova, 1974 differs from *Fenestella* Lonsdale, 1839 in rectangular to pentagonal shape of autozoocelia in mid tangential section and presence of well-developed hemisepta.

Laxifenestella kondrovensis
(Schulga-Nesterenko, 1955) comb. nov.
(Figs 24A–F; Appendix)

Fenestella kondrovensis Schulga-Nesterenko, 1955: 117–120, pl. 18, fig. 3. — Xia & Liu 1986: 149, 150, pl. 1, figs 3, 4.

MATERIAL. — SMF 21.912–SMF 21.914.

OCCURRENCE. — Carboniferous, Mississippian (upper Visean); Roque Redonde (Montagne Noire, southern France). Carboniferous, Mississippian (Serpukhovian); Russia.

EXTERIOR DESCRIPTION

Reticulate colony formed by straight branches joined by wide dissepiments. Fenestrules oval to rectangular, about twice as long as wide. Autozoocelia arranged in two rows on branches. Autozoocelial apertures circular, with low smooth peristome; 2 to 4 apertures spaced per fenestrule length. Keel wide, low, containing a single row of small, closely spaced nodes.

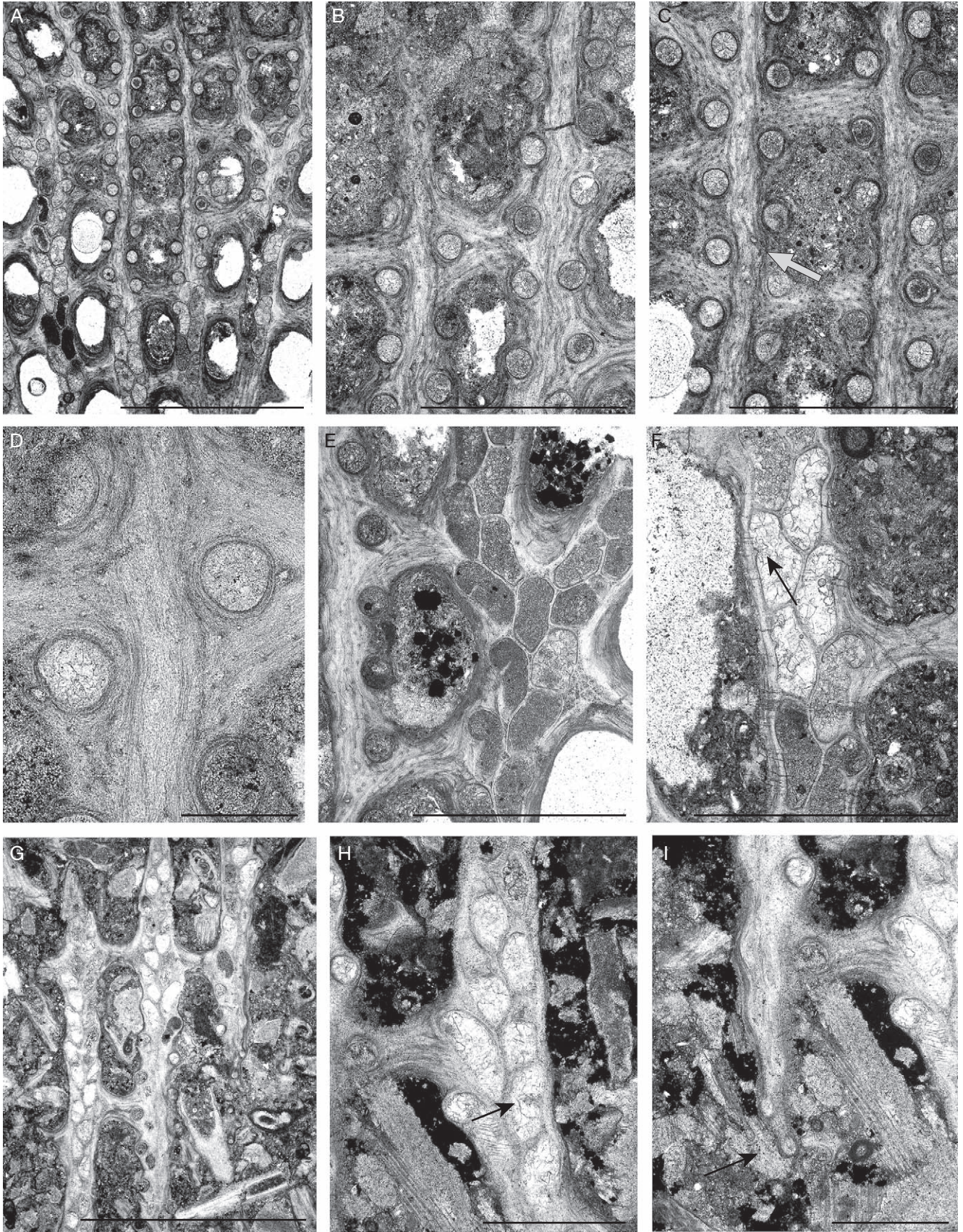


FIG. 24. — **A-F**, *Laxifenestella kondrovensis* (Schulga-Nesterenko, 1955); **A-D**, tangential section showing autozooeal apertures and low median keel with nodes (arrows), SMF 21.912; **E**, mid-tangential section showing autozooeal chambers with hemisepta, SMF 21.912; **F**, mid-tangential section showing autozooeal chambers with hemisepta, SMF 21.914. **G-I**, *Fabifenestella macrofenestrata* n. sp., holotype SMF 21.915; **G-H**, mid-tangential section showing autozooeal chambers with hemisepta (arrow); **I**, tangential section showing keel nodes (arrow). Scale bars: A, G, 2 mm; B, C, E, F, 1 mm; D, 0.2 mm; H, I, 0.5 mm.

INTERIOR DESCRIPTION

Autozooezia relatively long, roughly pentagonal to rectangular in mid tangential section; with short to moderately long vestibule in longitudinal section. Axial wall between autozooezial rows weakly zigzag. Both superior and inferior hemisepta present, positioned in the distal half of autozooezial chamber. External laminated skeleton well-developed on both obverse and reverse sides. Heterozooezia not observed.

COMPARISON

Laxifenestella kondrovensis (Schulga-Nesterenko, 1955) differs from *L. maculasimilis* Snyder, 1991 from the Mississippian (Visean) of USA in wider branches (average branch width 0.42 mm vs 0.30 mm in *L. maculasimilis*), larger distances between branch centres (0.78 mm vs 0.52 mm at average in *L. maculasimilis*), and widely spaced autozooezial apertures (average distance between aperture centres 0.34 mm vs 0.26 mm in *L. maculasimilis*). *Laxifenestella kondrovensis* differs from *L. serratula* (Ulrich, 1890) in having 2-3 apertures per fenestrula, in wider branches (average branch width 0.42 mm vs 0.27 mm in *L. serratula*), larger distances between branch centres (0.78 mm vs 0.44 mm at average in *L. serratula*), and widely spaced autozooezial apertures (average distance between aperture centres 0.34 mm vs 0.24 mm in *L. serratula*).

Genus *Fabifenestella* Morozova, 1974

TYPE SPECIES. — *Fenestella praevirgosa* Schulga-Nesterenko, 1951 by original designation. Upper Carboniferous (Gzhelian); Russia.

DIAGNOSIS. — Reticulate colonies of different shape, with moderately wide and thick branches and moderately wide dissepiments. Autozooezia arranged in two rows on the branches, rectangular to pentagonal in deep tangential section and fabiform in shallow to mid tangential section. Axial wall between autozooezial rows weakly undulating. Both superior and inferior hemisepta present. Low and wide keel with alternating nodes developed (modified after Morozova [2001: 53]).

OCCURRENCE. — Lower Carboniferous – Upper Permian; worldwide.

COMPARISON

Fabifenestella Morozova, 1974 differs from *Exfenestella* Morozova, 1974 in presence of low and wide keel with alternating nodes. *Fabifenestella* differs from *Minilya* Crockford, 1944 in having rectangular to fabiform autozooezial shape in mid tangential section instead of triangular one.

Fabifenestella macrofenestrata n. sp. (Figs 24G-I; 25A-E; Appendix)

ETYMOLOGY. — The species name refers to the distinctive large size of fenestrules of the new species.

HOLOTYPE. — SMF 21.915.

TYPE LOCALITY. — Roque Redonde (Montagne Noire, southern France).

TYPE HORIZON. — Carboniferous, Mississippian (upper Visean).

DIAGNOSIS. — Branches straight; dissepiments relatively wide; fenestrules about twice as long as wide; autozooezial apertures with 8 nodes; 4-6 apertures per fenestrula length; median keel wide, low, with densely spaced alternating nodes; nodes varying in size; autozooezia fabiform with distinct inferior and superior hemisepta; axial wall weakly or strongly undulating; heterozooezia present in form of elliptical chambers on obverse branch surface.

EXTERIOR DESCRIPTION

Reticulate colony formed by straight branches joined by relatively wide dissepiments. Fenestrules oval to rectangular, about twice as long as wide. Autozooezia arranged in two rows on branches. Autozooezial apertures circular, with low peristome, containing 8 nodes; 4 to 6 apertures spaced per fenestrula length. Keel wide, low, containing densely spaced alternating nodes. Nodes varying in size, elliptically shaped.

INTERIOR DESCRIPTION

Autozooezia relatively long, roughly pentagonal to rectangular in deep tangential section, becoming fabiform in mid tangential section; with short to moderately long vestibule in longitudinal section. Axial wall between autozooezial rows weakly to strongly undulating; aperture positioned at distal end of chamber. Both superior and inferior hemisepta present, positioned in the distal half of autozooezial chamber. External laminated skeleton well-developed on both obverse and reverse sides. Heterozooezia in form of elliptical chambers (apparent brooding structures), positioned on obverse branch side, having own 0.010-0.015 thick laminated walls, 0.11-0.16 mm wide and 0.18-0.25 mm long.

COMPARISON

Although *Fabifenestella macrofenestrata* n. sp. is erected on the basis of a single specimen, a rigorous comparison of other *Fabifenestella* species shows it to be unique in relation to the large size of the fenestrules and meshwork. Although a single specimen cannot show potential variation in meshwork parameters these are generally constant within a species. *Fabifenestella macrofenestrata* n. sp. is similar to *F. fabalis* (Shishova, 1960) from the Pennsylvanian of Transbaikalia and Mongolia, but differs from it in presence of 4-6 apertures per fenestrula length instead of 2-3 in *F. fabalis*. *Fabifenestella macrofenestrata* n. sp. differs from *F. praevirgosa* (Schulga-Nesterenko, 1951) from Pennsylvanian (Gzhelian) of Russia in longer fenestrules (1.14-1.50 mm vs 0.75-0.90 mm in *F. praevirgosa*). *Fabifenestella macrofenestrata* sp. nov. differs from *Fabifenestella binodosa* (Shcherbatykh, 1970) in wider branches (0.35-0.43 mm vs 0.27 mm in *F. binodosa*), and in longer fenestrules (1.14-1.50 mm vs 0.78-0.80 mm in *F. binodosa*). *Fabifenestella edzhekalensis* Morozova, 1981 from the Mississippian (Visean-Serpukhovian) of Russia has similar heterozooezia (oval chambers 0.24 mm long and 0.16 mm wide). However, this species has considerable smaller fenestrules than the new one.

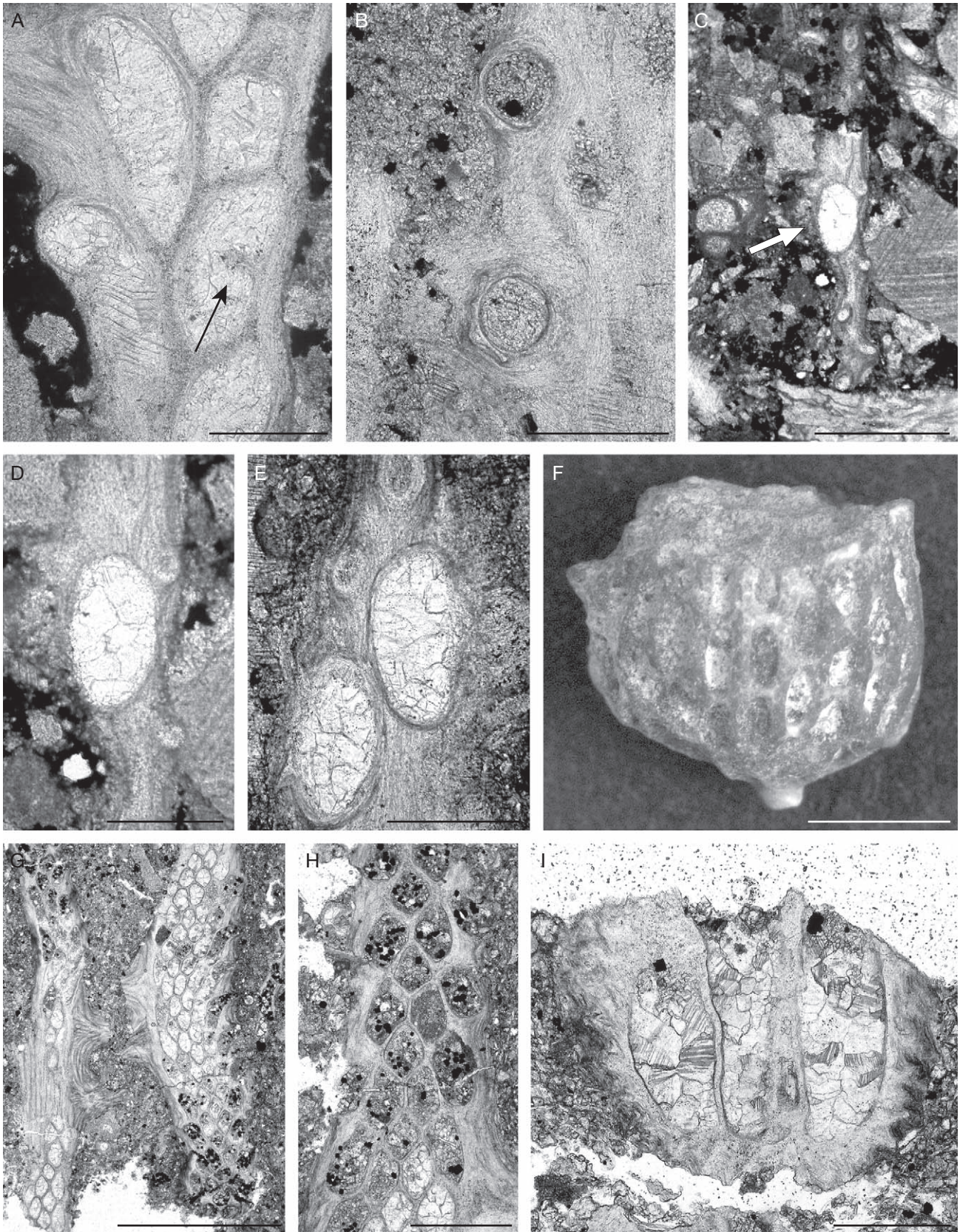


FIG. 25. — **A-E**, *Fabifenestella macrofenestrata* n. sp., holotype SMF 21.915; **A**, mid-tangential section showing autozooeical chambers with hemisepta (arrow); **B**, tangential section showing autozooeical apertures and apertural nodes; **C-E**, tangential section showing apparent brooding structures (**C**, arrow). **F**, *Ptilofenestella carrickensis* Tavener-Smith, 1965, TCD.60346; **G-I**, *Polypora dendroides* M'Coy, 1844; **G, H**, mid-tangential section showing autozooeical chambers, SMF 21.920; **I**, branch transverse section, SMF 21.918. Scale bars: A, B, D, E, H, 0.2 mm; C, G, 0.5 mm; F, G, 2 mm.

Genus *Ptilofenestella* Tavener-Smith, 1965

TYPE SPECIES. — *Ptilofenestella carrickensis* Tavener-Smith, 1965, by original designation. Mississippian (Visean); Ireland.

DIAGNOSIS. — Colony small, basket-shaped, with obverse surface on exterior surface. Branches narrow straight to moderately sinuous; dissepiments regularly spaced; fenestrules subrectangular. Two rows of autozoocia per branch; low median keel on obverse side of branch with nodes aligned in single row. Very long spine extends proximally from colony origin; autozoocial chambers small, triangular in deep tangential sections, bean-shaped in shallow endozone; reverse surface of branches smoother (modified from McKinney, pers. comm. April 2011).

OCCURRENCE. — Mississippian; Ireland, France.

COMPARISON

Ptilofenestella Tavener-Smith, 1965 is similar to *Spinofenestella* Termier & Termier, 1971 in the shape of autozoocia and in presence of median keel with nodes, but differs from it by the basket-shaped colony with long central proximal spine.

Ptilofenestella carrickensis Tavener-Smith, 1965. (Fig. 25F)

Ptilofenestella carrickensis Tavener-Smith, 1965: 491, pl. 66, figs 1-14, text-figs 5-6. — Wyse Jackson *et al.* 2009: 76-77, fig. 1.

MATERIAL. — TCD.60346, 60347.

OCCURRENCE. — Carboniferous, Mississippian (Visean); Counties Fermanagh and Leitrim, Ireland, Roque Redonde (Montagne Noire, southern France). Mississippian (Brigantian); Loughshinney, Co. Dublin, Ireland (Wyse Jackson *et al.* 2009).

DESCRIPTION

Colonies form basket-shaped expansions 4.5 mm high by 5 mm wide, composed of 17 to 20 slightly sinuous branches, joined by short dissepiments. Fenestrules rounded rectangular, about twice as long as wide. Keel low, with a single row of small nodes. Autozoocia arranged in two rows on outer-side of branches, autozoocial apertures circular, 4 to 5 per fenestrule length; autozoocial chambers pentagonal in mid-depth tangential-section. Spine 0.3 mm in diameter developed from proximal portion of colony, broken so full length unknown.

COMPARISON

The specimens from Roque Redonde fall within the range and morphology exhibited in *P. carrickensis* from the type locality.

Family POLYPORIDAE Vine, 1884

Genus *Polypora* M'Coy, 1844

TYPE SPECIES. — *Polypora dendroides* M'Coy, 1844, by subsequent designation of Vine (1884: 194). Lower Carboniferous; Ireland.

DIAGNOSIS. — Reticulate colonies of different shape built by straight or slightly undulating, bifurcating branches, joined at regular intervals by

straight dissepiments without autozoocia. Autozoocia arranged in four alternating rows on branches, 5-6 rows before and 2-3 after bifurcation. Autozoocial chambers tubular, short, having weakly developed inferior hemisepta and short vestibule, regularly hexagonal in mid tangential section. Autozoocial apertures rounded. Keels between longitudinal rows of autozoocia weakly developed or absent. Microacanthostyles and nodes usually present on obverse surface (after Morozova 2001).

OCCURRENCE. — Lower Devonian to Upper Permian; worldwide.

COMPARISON

Polypora M'Coy, 1844 is similar to *Paucipora* Termier & Termier, 1971. The latter has well developed hemisepta and shorter autozoocia. *Polypora* differs from *Polyporella* Simpson, 1895 in presence of four rows of autozoocia on branches instead of three in the latter genus.

Polypora dendroides M'Coy, 1844 (Figs 25G-I; 26A; Appendix)

Polypora dendroides M'Coy, 1844: 206, pl. 29, fig. 9 (lower figure). — M'Coy in Sedgwick & M'Coy 1855: 115. — Hoernes 1886: 229, fig. 231. — Stuckenberg 1888: 35, pl. 4, figs 1-3; 1895: 159, pl. 22, fig. 14. — Nicholson & Lydekker 1889: fig. 471a-a'. — Nikiforova 1938: 145, pl. 33, figs 7-9. — Bassler 1953: G125, fig. 86, 7a, b. — Miller 1963: 167, pl. 23, figs 1-3. — Tavener-Smith 1973: 478, pl. 23, figs 1-7. — Bancroft 1987: 196. — Morozova & Lisitsyn 1996: 533, pl. 5, figs 2a-c. — Morozova 2001: 80, pl. 39, figs 1a, b. — Wyse Jackson *et al.* 2006: 762-765, pl. 7, figs 1-11, text-fig. 1p-r.

Polypora dendroides M'Coy in Griffith, 1842: 10, *nomen nudem*.

Polypora dendroidea M'Coy – Morozova 1981: 5.

MATERIAL. — SMF 21.916-SMF 21.920.

OCCURRENCE. — Carboniferous, Mississippian (Tournaisian-Visean); Roque Redonde (Montagne Noire, southern France); Counties Wexford and Fermanagh, Ireland, ?Russia.

EXTERIOR DESCRIPTION

Reticulate colonies composed of moderately wide branches jointed by moderately wide dissepiments. Autozoocia arranged in 3-5 alternating rows on branches. Autozoocial apertures rounded to oval, 7-10 spaced per length of fenestrule. Fenestrules oval, narrow.

INTERIOR DESCRIPTION

Autozoocial chambers moderately long, generally rhombic to roughly hexagonal in the mid tangential section. Hemisepta absent. External laminated skeleton well-developed, traversed by abundant small microacanthostyles. Heterozoocia not observed.

COMPARISON

Polypora dendroides M'Coy, 1844 differs from *P. gracilis* Prout, 1860 from the Mississippian of Illinois, USA, in wider branches (average branch width 0.75 mm vs 0.58 mm in *P. gracilis*). *Polypora dendroides* differs from *P. bukhtarmensis* Nekhoroshev, 1956 from the Mississippian (Tournaisian-Visean) of Altai, in wider branches (branch width 0.56-1.00 mm vs 0.60-0.75 mm in *P. bukhtarmensis*), as well as in spacing of 7-10 apertures per fenestrule length instead of 4-6 in *P. bukhtarmensis*.

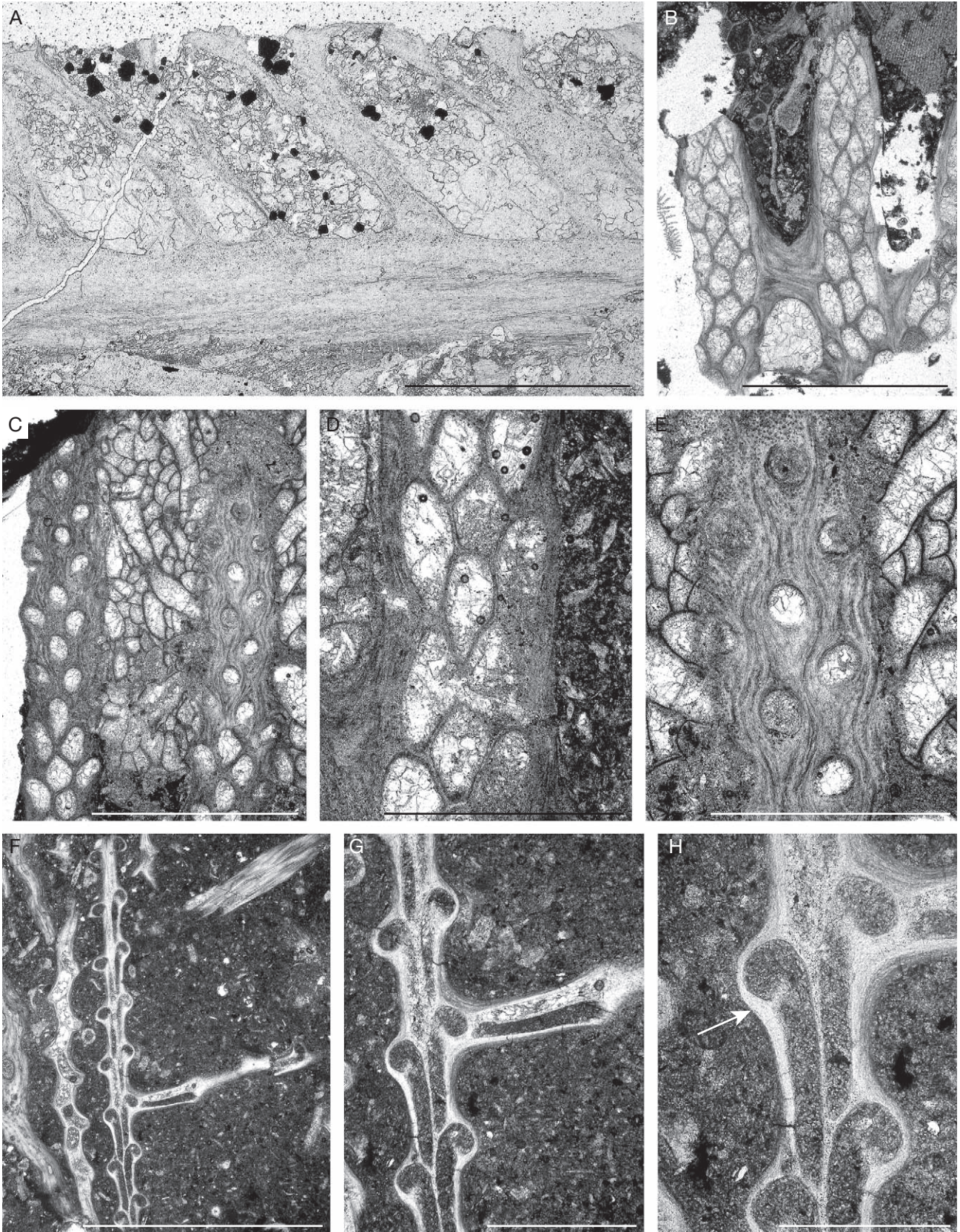


FIG. 26. — **A**, *Polypora dendroides* M'Coy, 1844, longitudinal section, SMF 21.919. **B-E**, *Polypora marginata* M'Coy, 1844, SMF 21.921; **B-D**, mid-tangential section showing autozoecial chambers and apertures; **E**, tangential section showing autozoecial apertures, undulatory striations and branch surface; **F-H**, *Diploporaria tenella* Wyse Jackson, 1988, mid-tangential section showing autozoecial chambers with hemisepta (arrow) and apertures, SMF 21.923. Scale bars: A, G, 0.5 mm; B, C, F, 2 mm; D, E, 1 mm; H, 0.2 mm.

Polypora marginata M'Coy, 1844
(Fig. 26B-E; Appendix)

Polypora marginata M'Coy, 1844: 206, pl. 29, fig. 5. — Miller 1963: 168, pl. 24, fig. 3 (*non* Geinitz, 1866: 69, pl. 5, figs 11a, b, 12a, b).

Polypora marginata M'Coy in Griffith, 1842: 10 (*nomen nudem*).

MATERIAL. — SMF 21.921-SMF 21.922.

OCCURRENCE. — Carboniferous, Mississippian (Visean); Roque Redonde (Montagne Noire, southern France); Co. Tyrone, Ireland.

EXTERIOR DESCRIPTION

Reticulate colonies composed of moderately wide branches jointed by wide dissepiments. Autozooezia arranged in 3-4 alternating rows on branches. Autozooezial apertures rounded to oval. Low undulating longitudinal ridges/striations between autozooezia developed. Fenestrules subrectangular, long and narrow.

INTERIOR DESCRIPTION

Autozooezial chambers moderately long, generally rhombic to roughly hexagonal in the mid tangential section. Hemisepta absent. External laminated skeleton well-developed, traversed by abundant small microacanthostyles. Heterozooezia not observed.

COMPARISON

Polypora marginata M'Coy, 1844 is easily distinguished from other *Polypora* species of the same age on the basis of possessing elongate rounded fenestrules with short dissepiments, and wavy longitudinal striations on the obverse surface.

Family ACANTHOCLADIIDAE Ulrich, 1890

Genus *Diploporaria* Nickles & Bassler, 1900

TYPE SPECIES. — *Glaucanome (Diplopora) marginalis* Young & Young, 1875 by original designation. Lower Carboniferous (Visean); British Isles.

DIAGNOSIS. — Colony consisting of thin main branches and rare lateral branches of identical morphology. Both main and lateral branches bearing two rows of autozooezia.

OCCURRENCE. — Lower Carboniferous – Lower Permian; Europe, USA, Asia.

COMPARISON

Diploporaria Nickles & Bassler, 1900 differs from *Penniretepora* d'Orbigny, 1849 in rare lateral branches, whereas *Penniretepora* possesses a pinnate colony with regularly arranged lateral branches either side of the main branch.

Diploporaria tenella Wyse Jackson, 1988
(Figs 26F-H, 27A; Appendix)

Diploporaria tenella Wyse Jackson, 1988: 201, fig. 1b, 2b, 4d-f, 7a, b; 1996: 141, 142, fig. 42a, 45. — Wyse Jackson & Weber 2005: 377, fig. 1a.

MATERIAL. — SMF 21.923-SMF 21.925, TCD.60336, 60337, 60340, 60342.

OCCURRENCE. — Carboniferous, Mississippian (Visean); Ireland, Germany (Velbert Anticline, Rhenish Massif), Roque Redonde (Montagne Noire, southern France).

DESCRIPTION

Colony consisting of straight branches bifurcating nearly at right angle. Branches 0.29-0.32 mm wide. Autozooezia arranged in 2 alternating rows on branches. Autozooezial apertures rounded to oval, with smooth peristome, 0.085-0.095 mm in diameter, spaced 0.32-0.43 mm (0.38 mm at average) from centre to centre. Single sharp node on the peristome, directed proximally. Autozooezial chambers long, subrectangular in the mid tangential section. Superior hemisepta long, curved distally; inferior hemisepta absent. External laminated skeleton thin. Branch reverse side smooth. Heterozooezia not observed.

COMPARISON

Diploporaria tenella Wyse Jackson, 1988 possesses distinctive elongate quadrate-shaped autozooezial chambers in mid-tangential section which separates it from other *Diploporaria* species. Externally *D. tenella* resembles *D. bifurcata* (Ulrich, 1890) with a sinuous branch margin, although apertures are more widely spaced in the latter. *D. tenella* differs from the type species *D. marginalis* which has trapezoidal-shaped chambers, and a well-developed peristome that projects beyond branch margins producing a strongly serrated outline.

Genus *Baculopora* Wyse Jackson, 1988

TYPE SPECIES. — *Vincularia megastoma* M'Coy, 1844 by original designation. Mississippian; Ireland.

DIAGNOSIS. — Acanthoclatiid forming delicate irregularly branching colonies; branches divide, or develop as lateral branches; branches straight or gently flexulous and taper distally, with four to seven rows of autozooezia on main and lateral branches; reverse surface longitudinally striated with microstyllets; autozooezial bases pentagonal to hexagonal (diamond-shaped) (modified after Wyse Jackson, 1988, p. 198, Wyse Jackson, 1996, p. 140).

OCCURRENCE. — Two definite species are known: *Baculopora megastoma* (M'Coy, 1844) from the Mississippian of Ireland, Germany, Russia, and *B. redondensis* n. sp. from the Mississippian of France (present paper). *Baculopora* sp. was mentioned from the Mississippian of Mongolia (Morozova et al. 2003: 131).

COMPARISON

Baculopora Wyse Jackson, 1988 resembles *Ichthyorachis* M'Coy, 1844 in possessing four to six rows of autozooezia on branches, but lacks regularly offset or opposite secondary lateral branches.

REMARKS

The species *Pseudohornera ossipovae* Schulga-Nesterenko, 1955 from the upper Visean (Mississippian) of Russia coincides in its morphology and dimensions with *Baculopora megastoma* (M'Coy, 1844). Therefore, *Pseudohornera ossipovae* is synonymised with the latter species.

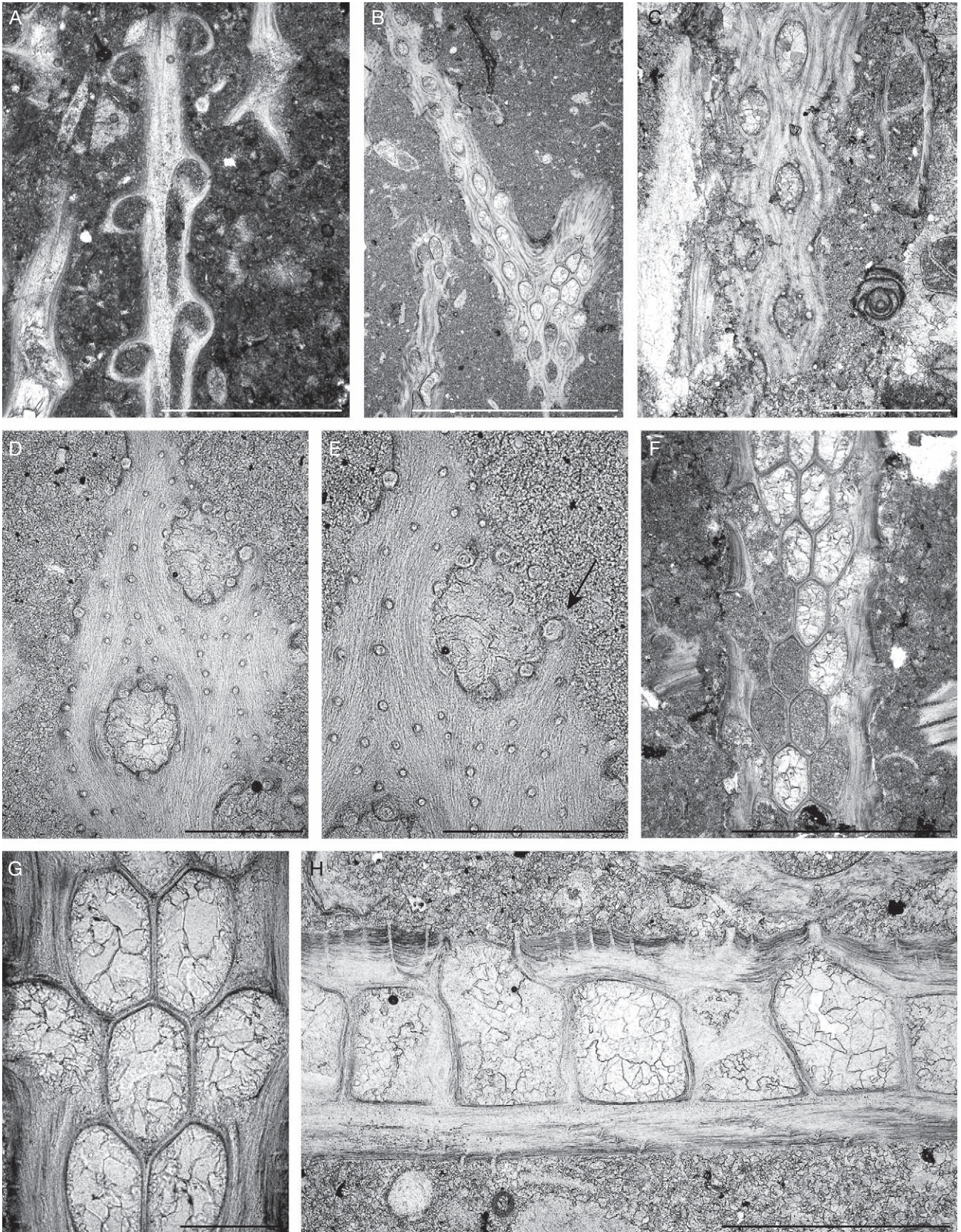


FIG. 27. — **A**, *Diploporaria tenella* Wyse Jackson, 1988, tangential section showing autozooeal apertures, SMF 21.923; **B-H**, *Baculopora redondensis* n. sp.; **B**, tangential section of a dichotomizing branch, paratype SMF 21.944; **C**, tangential section showing autozooeal apertures, holotype SMF 21.947; **D, E**, tangential section showing autozooeal apertures with nodes (arrow), paratype SMF 21.944; **F, G**, mid-tangential section showing autozooeal chambers, paratype SMF 21.930; **H**, branch longitudinal section, paratype SMF 21.939. Scale bars: A, C, H, 0.5 mm; B, 2 mm; D, E, G, 0.2 mm; F, 1 mm.

Baculopora redondensis n. sp.
(Figs 27B-H; 28A, B; Appendix)

ETYMOLOGY. — The species name refers to the type locality Roque Redonde.

HOLOTYPE. — SMF 21.947.

PARATYPES. — SMF 21.926-SMF 21.946, SMF 21.948-SMF 21.955, TCD.60333, 60335, 60350-60353.

TYPE LOCALITY. — Roque Redonde (Montagne Noire, southern France).

TYPE HORIZON. — Carboniferous, Mississippian (upper Viséan).

DIAGNOSIS. — Straight dichotomous branches; autozoecia in 2 to 6 rows; autozoecial apertures with 4-11 variably sized nodes; reverse surface smooth with 10 to 15 longitudinal rows of microstylets.

DESCRIPTION

Colonies of straight dichotomous branches, with undulating lateral margins; lateral branches not observed; branches oval to flattened in transverse section, 0.63-0.98 mm wide, 0.5-0.6 mm thick. Autozoecia arranged in 2 to 6 rows; apertures circular to longitudinally oval, surrounded by 4-11 variably sized nodes; apertural nodes 0.015-0.035 mm in diameter; spaced 3 to 4 diameters apart; interapertural walls carry three wavy rows of microstylets; autozoecial chambers polygonal in mid-tangential section, generally hexagonal (diamond-shaped), relatively short and high; lined with thin laminar skeleton; terminal diaphragms occurring; reverse surface smooth with 10 to 15 longitudinal rows of microstylets; microstylets 0.005-0.010 mm in diameter.

COMPARISON

Baculopora redondensis n. sp. differs from *B. megastoma* (M'Coy, 1844) in wider branches (0.63-0.98 mm vs 0.33-0.74 mm in *B. megastoma*). Furthermore, *Baculopora redondensis* differs in wider spacing of autozoecial apertures (distances between aperture centres along branch 0.42-0.73 mm vs 0.33-0.53 mm in *B. megastoma*).

Genus *Filites* Počta in Barrande, 1894

TYPE SPECIES. — *Filites bohemicus* Počta in Barrande, 1894 by original designation. Lower Devonian; Czech Republic.

DIAGNOSIS. — Colonies consisting of straight main branches with frequent lateral branches; two rows of autozoecia both on main and lateral branches; autozoecia triangular to trapezoid in mid tangential section; hemisepta absent; superstructure absent; keel low without nodes.

OCCURRENCE. — Lower Devonian-Upper Permian; worldwide.

COMPARISON

Filites has the same colony shape as *Penniretepora* d'Orbigny, 1849, but differs from the latter in the shape of autozoecia in mid tangential section (triangular to trapezoid vs rectangular to pentagonal) and in the absence of keel nodes.

Filites cf. *laxa* (Young & Young, 1876) comb. nov.
(Figs 28C-F; Appendix)

Glauconome laxa Young & Young, 1876: 331, pl. 4, figs 33-34.

Glauconome elegantula Etheridge, 1877: 35, pl. 2a, figs 3-6.

Penniretepora elegantula Etheridge, 1877. — Olaloye 1974: 500, pl. 21, figs 1-4.

Penniretepora laxa — Graham 1975: 8, pl. 2, figs 9-10, pl. 6, figs 1-2.

MATERIAL. — SMF 21.956-SMF 21.960.

OCCURRENCE. — Carboniferous, Mississippian (upper Viséan); Roque Redonde (Montagne Noire, southern France).

DESCRIPTION

Pinnate colonies consisting of straight main branches with frequent lateral branches. Main branches 0.41-0.66 mm wide; lateral branches 0.26-0.38 mm wide, diverging at angles 58-79° from main branches, spaced 0.66-1.20 mm from centre to centre. Autozoecia having circular to oval apertures, arranged in two rows both on main and lateral branches; two-three apertures between two neighbouring lateral branches. Peristomes distinct, containing 18-24 nodes. Peristomal nodes 0.010-0.015 mm in diameter. Nodes on branches absent.

INTERNAL DESCRIPTION

Autozoecial chambers triangular to trapezoid in mid tangential section both on main and secondary branches, relatively short, inflated, with moderately long vestibules. Hemisepta absent. Axial wall strongly zigzag from base to crest, not projecting as frontal keel. Extrazoecial skeleton moderately developed, traversed by abundant microstylets; microstylets diverging from inner hyaline skeleton, regularly spaced across entire colony surface, 0.010-0.015 mm in diameter. Reverse side without any ornamentation.

COMPARISON

The material from France compares well with *Penniretepora laxa* (Young & Young, 1876) from the Carboniferous of Scotland in respect of gross external morphology, branch sizes and lateral branch spacing. The main branches of the Scottish specimens are slightly flexuous. The specific attribution of the French material is not definitive as the internal features of the type specimens of *P. laxa* remain unknown

Genus *Penniretepora* d'Orbigny, 1849

Acanthopora Young & Young, 1875: 327.

Pinnatopora Vine, 1883: 191.

TYPE SPECIES. — *Retepora pluma* Phillips, 1836. Mississippian; Yorkshire, England.

DIAGNOSIS. — Fine main branch and short, regularly arranged secondary branches without dissepiments. Two rows of autozoecia on the main branch and on the secondary branches.

OCCURRENCE. — Devonian to Permian; worldwide.

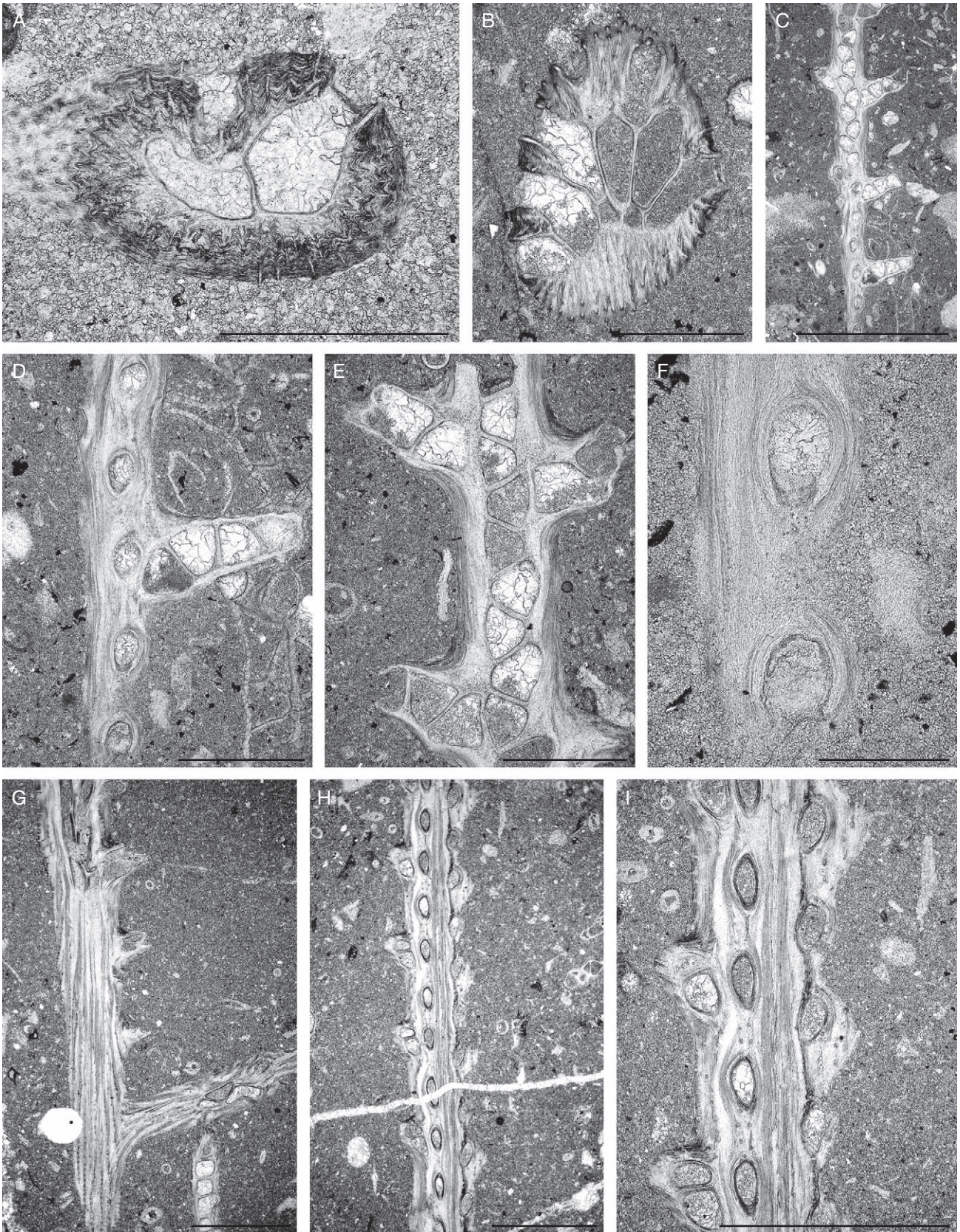


FIG. 28. — **A, B**, *Baculopora redondensis* n. sp.; **A**, branch transverse section, paratype SMF 21.939; **B**, branch oblique section showing autozooeical chambers, paratype SMF 21.941; **C-F**, *Filites cf. laxa* (Young & Young, 1876), tangential to mid-tangential section showing autozooeical chambers and apertures, SMF 21.956; **G, H**, *Penniretepora volgensis* Shishova, 1959, SMF 21.964; **G**, tangential section showing the reverse branch side; **H, I**, tangential section showing autozooeical apertures and median keel. Scale bars: A, B, D-F, 0.5 mm; C, 2 mm; G-I, 1mm.

Penniretepora volgensis Shishova, 1959
(Figs 28G, H; 29A-D; Appendix)

Penniretepora volgensis Shishova, 1959: 17, fig. 1.

MATERIAL. — SMF 21.961-SMF 21.964.

OCCURRENCE. — Carboniferous, Mississippian (Visean); Russia. Carboniferous, Mississippian (upper Visean); Roque Redonde (Montagne Noire, southern France).

DESCRIPTION

Pinnate colonies consisting of straight main branches with frequent lateral branches. Main branches 0.38-0.70 mm wide, lateral branches 0.18-0.38 mm wide, diverging at angles 60-84° from main branches, spaced 0.72-1.05 mm from centre to centre. Autozoecia having circular to oval apertures, arranged in two rows both on main and lateral branches; two to three apertures between two neighbouring lateral branches. Median keels low, containing rare elliptical nodes.

INTERNAL DESCRIPTION

Autozoecial chambers rectangular to pentagonal in mid tangential section both on main and secondary branches, relatively long, inflated, with moderately long vestibules. Superior hemisepta short; inferior hemisepta absent. Axial wall straight to weakly undulating from base to crest, projecting as narrow and low frontal keel. Extrazoecial skeleton moderately developed, traversed by abundant microstyles; microstyles diverging from inner hyaline skeleton, regularly spaced across entire colony surface, 0.010-0.018 mm in diameter. Reverse side containing longitudinal rows of microstylets.

COMPARISON

Penniretepora volgensis Shishova, 1959 differs from *P. timofeevae* Balakin, 1975 from the lower Visean of Turkmenistan in larger distances between lateral branches (0.72-1.05 mm vs 0.50-0.75 mm in *P. timofeevae*).

Penniretepora cf. *pluma* (Phillips, 1836)
(Figs 29E-I; 30A; Appendix)

MATERIAL. — SMF 21.965-SMF 21.966.

OCCURRENCE. — Carboniferous, Mississippian, Visean; Britain, Ireland, Roque Redonde (Montagne Noire, southern France).

DESCRIPTION

Pinnate colonies consisting of straight main branches with frequent lateral branches. Main branches 1.00-1.05 mm wide, lateral branches 0.52-0.60 mm wide, diverging at angles 57-80° from main branches, spaced 0.72-1.05 mm from centre to centre. Autozoecia having circular to oval apertures, arranged in two rows both on main and lateral branches; apertures surrounded by 14-16 apertural nodes, producing faintly denticulated margin two-three apertures between two neighbouring lateral branches. Median keel low, containing rare elliptical nodes and longitudinal rows of microstylets.

INTERNAL DESCRIPTION

Autozoecial chambers rectangular to pentagonal in mid tangential section both on main and secondary branches, relatively long, inflated, with moderately long vestibules. Superior hemisepta short; inferior hemisepta absent. Axial wall straight to weakly undulating from base to crest, projecting as narrow and low frontal keel. Extrazoecial skeleton moderately developed, traversed by abundant microstyles; microstyles diverging from inner hyaline skeleton, regularly spaced across entire colony surface, 0.010-0.018 mm in diameter. Reverse side containing longitudinal rows of fine tubules.

COMPARISON

This species is characterised by circular to oval apertures, surrounded by small apertural nodes, and which are proximally extended into a small slit or fossula. As such it broadly resembles *P. pluma*, but differs from it in the rectangular to pentagonal shape of autozoecial chambers and the closer spacing of apertures.

Genus *Gorjunopora* n. gen.

TYPE SPECIES. — *Gorjunopora gallica* n. sp. Carboniferous, Mississippian, upper Visean; Roque Redonde (Montagne Noire, southern France).

ETYMOLOGY. — The genus is named in honour of the Russian bryozoologist Raisa Gorjunova whose extensive research has increased our knowledge of Palaeozoic bryozoans.

DIAGNOSIS. — Colonies consisting of straight main branches with frequent lateral branches; two rows of autozoecia both on main and lateral branches; autozoecia triangular to trapezoid in mid tangential section; long superior hemisepta present; internal curved hemisepta in middle part of chambers present; superstructure absent; keel low with one row of weakly alternating nodes.

OCCURRENCE. — *Gorjunopora gallica* n. gen., n. sp. from the Carboniferous, Mississippian (Visean) of France (present paper), and *G. triangulata* (Schulga-Nesterenko, 1955) from the Visean of the Russian Platform.

COMPARISON

Gorjunopora n. gen. differs from *Filites* Počta in Barrande, 1894 in presence of long superior and internal hemisepta as well as in alternating nodes on low keel. *Gorjunopora* n. gen. differs from *Penniretepora* d'Orbigny, 1849 in the shape of autozoecial chambers (triangular to trapezoid vs rectangular to pentagonal in *Penniretepora*), presence of long superior and internal hemisepta as well as in alternating nodes on low keel

Gorjunopora gallica n. gen., n. sp.
(Fig. 30B-I; Appendix)

ETYMOLOGY. — The species name refers to the discovery of this species in France.

HOLOTYPE. — SMF 21.967.

PARATYPES. — SMF 21.968-SMF 21.972.

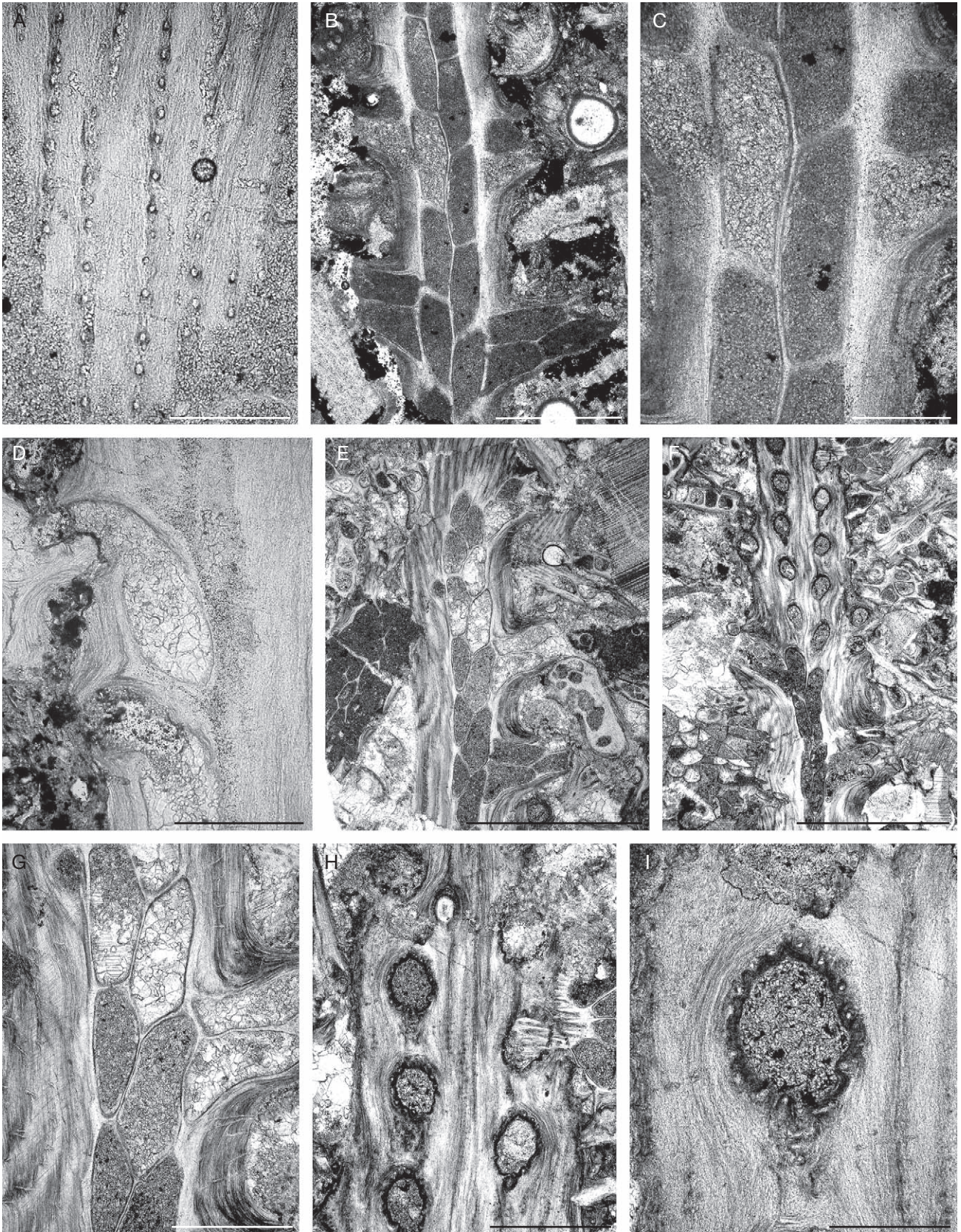


FIG. 29. — **A-D**, *Penniretepora volgensis* Shishova, 1959; **A**, tangential section showing the reverse branch side, SMF 21.964; **B, C**, mid-tangential section showing autozoecial chambers, SMF 21.962; **D**, branch oblique section showing autozoecial chambers, SMF 21.961; **E-I**, *Penniretepora cf. pluma* (Phillips, 1836); **E**, mid-tangential section showing autozoecial chambers, SMF 21.965; **F**, tangential section showing autozoecial apertures, SMF 21.966; **G**, mid-tangential section showing autozoecial chambers, SMF 21.965; **H, I**, tangential section showing autozoecial apertures with nodes and median keel, SMF 21.966. Scale bars: A, C, D, I, 0.2 mm; B, G, H, 0.5 mm; E, 2 mm; F, 1 mm.

TYPE LOCALITY. — Roque Redonde (Montagne Noire, southern France).

TYPE HORIZON. — Carboniferous, Mississippian (upper Viséan).

DIAGNOSIS. — As for genus.

DESCRIPTION

Pinnate colonies consisting of straight main branches with frequent lateral branches. Main branches 0.22-0.36 mm wide, lateral branches 0.14-0.22 mm wide, diverging at angles 57-81° from main branches, spaced 0.69-1.05 mm from centre to centre. Autozoecia having circular to oval apertures, arranged in two rows both on main and lateral branches; one aperture between two neighbouring lateral branches. Median keels low, containing alternating elliptical nodes.

INTERNAL DESCRIPTION

Autozoecial chambers triangular to trapezoid in mid tangential section both on main and secondary branches, relatively long, inflated, with moderately long vestibules. Superior hemisepta long, proximally curved; internal curved hemisepta in middle part of chambers present. Axial wall strongly zigzag from base to crest, projecting as narrow and low frontal keel. One row of weakly alternating and closely spaced nodes on keel present. Extrazooecial skeleton moderately developed, traversed by abundant microstyles; microstyles diverging from inner hyaline skeleton, regularly spaced across entire colony surface, 0.010-0.015 mm in diameter. Reverse side showing fine longitudinal striation.

COMPARISON

Gorjunopora gallica n. gen., n. sp. is similar to *G. triangulata* (Schulga-Nesterenko, 1955) from the Viséan of the Russian Platform. *Gorjunopora gallica* differs in having larger distances between aperture centres (averagely 0.38 mm vs 0.28 mm in *G. triangulata*) and spacing of one aperture between neighbouring lateral branches instead of two apertures in *G. triangulata*.

Incertae Sedis

“*Thamniscus*” *colei* Wyse Jackson, 1988
(Fig. 31A-D; Appendix)

Thamniscus colei Wyse Jackson, 1988: 205, figs 1c, 2c, 4g-j, 7c-f; 1996: 143, fig. 48. — Wyse Jackson & Bancroft 1994: 215-7, fig. 1a-f. — Wyse Jackson & Weber 2005: 377, fig. 1k.

MATERIAL. — SMF 21.973, TCD.60356.

OCCURRENCE. — Carboniferous, Mississippian (Viséan); Ireland, Germany (Velbert Anticline, Rhenish Massif), Roque Redonde (Montagne Noire, southern France).

DESCRIPTION

Freely branching, dichotomous colonies. Branches 0.54-0.74 mm wide. Autozoecia arranged in 2-3 rows on branches, pentagonal to hexagonal in mid tangential section. Autozoecial apertures circular, with smooth peristomes. Single node on proximal part of peristomes present, mm in diameter. Fine striation between apertures developed.

COMPARISON

The genus *Thamniscus* King, 1849 is apparently monotypical, with the type species *Thamniscus perplexus* Ernst in Lisitsyn & Ernst, 2004 which is only known from the Upper Permian Zechstein of Europe (Lisitsyn & Ernst 2004; Wyse Jackson et al. 2006). Many species were placed in the genus on the basis of the freely branching colony form, having various internal morphology. “*Thamniscus*” *colei* Wyse Jackson, 1988 differs from the type species in having pentagonal to hexagonal shape of autozoecial chambers in mid tangential section instead of rhombic one in *T. perplexus*, and in the absence of cyclozoecia. “*Thamniscus*” *colei* should be classified in a separate genus. However, the material from Roque Redonde is represented by only one fragment which is not sufficient to erect a new genus here.

Fenestrata sp.

(Figs 31E-I; Appendix)

MATERIAL. — Single specimen SMF 21.974.

OCCURRENCE. — Carboniferous, Mississippian (upper Viséan); Roque Redonde (Montagne Noire, southern France).

DESCRIPTION

Colony shape unknown, apparently pinnate to loosely branching with occasional transverse connections. Branch width 1.02-1.20 mm. Autozoecia arranged in two rows on branches, triangular to trapezoid in mid tangential section. Autozoecial aperture circular, surrounded by a rim of 10-14 nodes. Apertural nodes 0.010-0.025 mm in diameter. Median keel low, undulating, containing large elliptic and widely spaced nodes. External skeleton 0.29-0.43 mm thick, laminated, traversed by abundant microstylets. Internal skeleton granular, 0.055-0.065 mm thick.

COMPARISON

Comparison of this species is difficult because of restricted material. It shows similarities to *Narynella* Morozova, 2001 in the shape of autozoecia and presence of keel with large and widely spaced nodes. However, *Narynella* has typical reticulate colony shape and weakly developed external laminated skeleton.

DISCUSSION

The bryozoan fauna from the Mississippian Roque Redonde of Montagne Noire, southern France, contains 38 species. They include one new genus with one species *Gorjunopora gallica* n. gen., n. sp. and nine new species: *Fistulipora tolokonnikova* n. sp., *Dybowskiella rotunda* n. sp., *Dybowskiella piriforme* n. sp., *Eridopora suarezi* n. sp., *Volgia deftera* n. sp., *Cystodictya gallensis* n. sp., *Megacanthopora enodata* n. sp., *Fabifenestella macrofenestrata* n. sp., and *Baculopora redondensis* n. sp. Thus, about one quarter of the described bryozoans are endemic to the Roque Redonde.

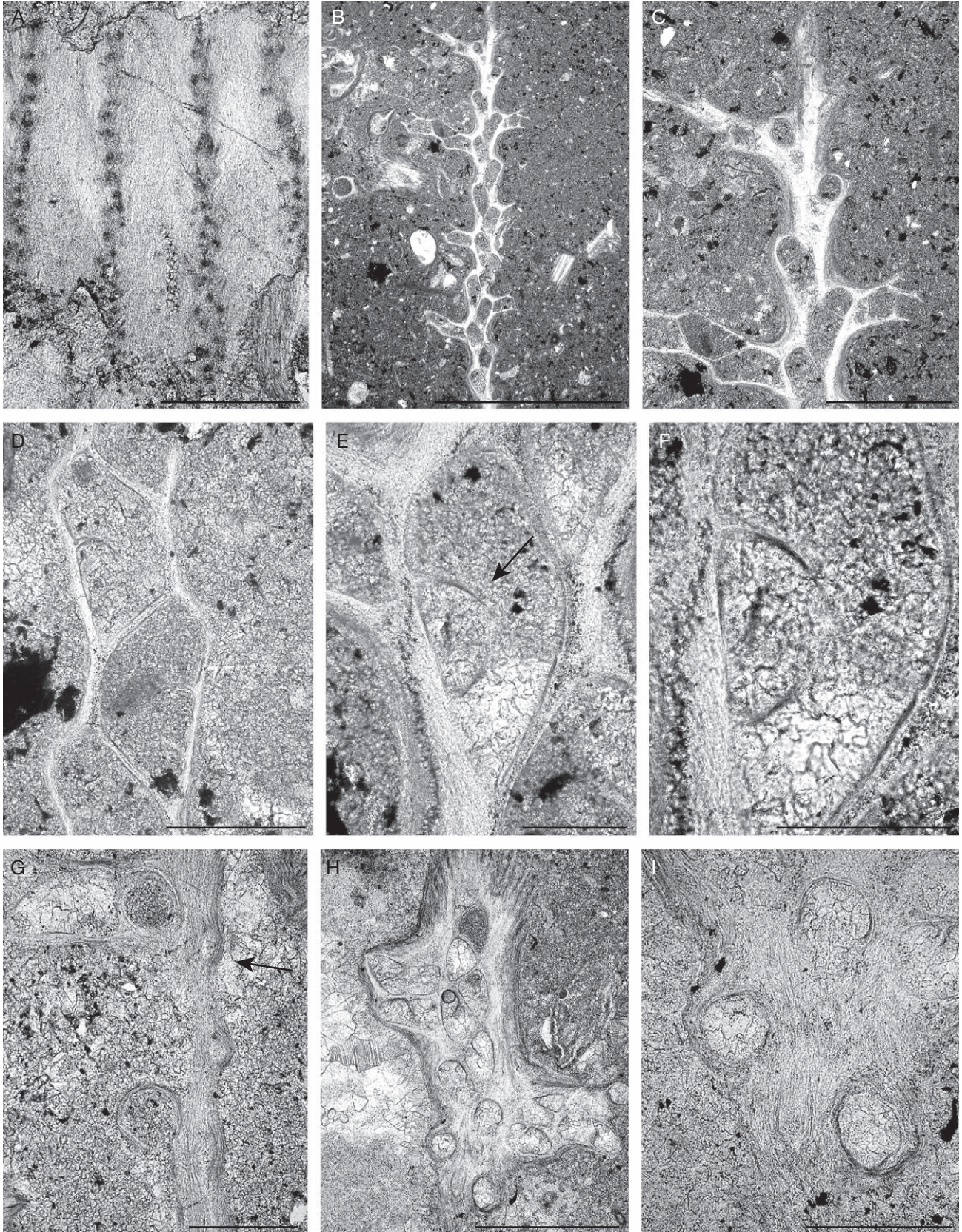


FIG. 30. — **A**, *Penniretepora* cf. *pluma* (Phillips, 1836), tangential section showing the reverse branch side, SMF 21.966; **B-I**, *Gorjunopora gallica* n. gen., n. sp.; **B, C**, tangential section, holotype SMF 21.967; **D-F**, mid-tangential section showing autozooeical chambers with hemisepta (**arrow**), holotype SMF 21.967; **G**, tangential section showing nodes (**arrow**), paratype SMF 21.970; **H, I**, tangential section showing autozooeica chambers and apertures, paratype SMF 21.972. Scale bars: A, D, G, I, 0.2 mm; B, 2 mm; C, H, 0.5 mm; E, F, 0.1 mm.

This ratio is comparable to larger faunas described elsewhere (Tavener-Smith 1973; Wyse Jackson 1988, 1996) and very reasonable in respect due to the limited modern descriptions of bryozoans from the southern Variscan realm. Furthermore, twenty-three species identified in this fauna show various palaeobiogeographical connections (see below). Additionally, five species are described in open nomenclature: *Dyscritella* sp., *Rectifenestella* sp., *Spinofenestella* spp. (1-2), and *Fenestrata* sp.

Ramiporalia robusta Delvolvé & McKinney, 1983 is the only species in common of the two bryozoan associations described from the Mississippian of southern France, and so far an endemic species for southern France. Their different ages, Visean versus Serpukhovian, could influence the composition. However, the Visean assemblage at Roque Redonde contains taxa, which are known elsewhere from the Serpukhovian, and thus the age differences should not be the only reason for compositional changes. The influence of facies seems to be a more reasonable argument, because the Pyrénées assemblage is from fine-grained dark calcareous detrital rocks, whereas the Roque Redonde assemblage is found in carbonate facies.

The studied bryozoan fauna shows palaeobiogeographic relations to the Mississippian of the British Isles (*Tabulipora howsii* (Nicholson, 1881), *Nematopora hibernica* Wyse Jackson, 1996, *Pseudonematopora planatus* Wyse Jackson, 1996, *Clausotrypa ramosa* (Owen, 1973), *Rhabdomeson progracile* Wyse Jackson & Bancroft, 1995, *Ptilofenestella carrickensis* Tavener-Smith, 1965, *Polypora dendroides* M'Coy, 1844, *Polypora marginata* M'Coy, 1844, *Diploporaria tenella* Wyse Jackson, 1988, *Filites* cf. *laxa* (Young and Young, 1876), *Penniretepora* cf. *pluma* (Phillips, 1836), "*Thamniscus*" *colei* Wyse Jackson, 1988). The species *Filites* cf. *laxa* (Young and Young, 1876) and *Penniretepora* cf. *pluma* (Phillips, 1836) are morphologically close to the original species described from the Mississippian of the British Isles. Furthermore, several species stress the connection to the Mississippian of the Russian Platform: *Fistulipora parvilabrum* Schulga-Nesterenko, 1955, *Spinofestella major* (Nikiforova, 1933) comb. nov., *Laxifenestella kondrovensis* (Schulga-Nesterenko, 1955), and *Penniretepora volgensis* Shishova, 1959). The record of *Laxifenestella kondrovensis* (Schulga-Nesterenko, 1955) from the Upper Carboniferous (Gzhelian) of China is doubtful, however. *Spinofenestella* cf. *simplaris* (Trizna, 1961) is similar to the original species from the Mississippian of Urals. The genus *Volgia* Stuckenberg, 1905 is known originally from the Carboniferous of Russia. The new species *V. deftera* n. sp. has been previously recorded from the Visean of Germany (Ernst 2005) from the same locality where *Clausotrypa ramosa* (Owen, 1973) has been recorded.

Diploporaria tenella Wyse Jackson, 1988, "*Thamniscus*" *colei* Wyse Jackson, 1988 and *Tabulipora howsii* (Nicholson, 1881) have been found in the Mississippian (Visean) of the Velbert Anticline, Rhenish Massif, Germany (Wyse Jackson & Weber 2005). *Pseudonematopora planatus* Wyse Jackson, 1996 is a characteristic species for the Mississip-

pian of Europe. It has been found in Ireland, Germany, Spain, and France.

Fistulipora prolifica Ulrich, 1884 and *Saffordotaxis incrassata* (Ulrich, 1888) were originally described from the Mississippian of USA. *Saffordotaxis incrassata* has been found also in the Mississippian of Kazakhstan (Nekhoroshev 1953), Kuznets Basin (Trizna 1958), and Mongolia (Gorjunova 1985). *Fistulipora prolifica* was recorded from the Mississippian of Kuznets Basin (Trizna 1958). One more species, *Fistulipora sana* Trizna, 1958, confirms connection to the Mississippian of the Kuznets Basin.

Palaeobiogeographic connections to Kazakhstan can be supposed by the species *Fistulipora* cf. *tubulosa* Nikiforova, 1933 which is close to the original species from the Mississippian (Visean) of Kazakhstan. *Spinofestella major* (Nikiforova, 1933) comb. nov. was originally described from the Mississippian of Ukraine (Donbass), and was additionally recorded from the Middle Carboniferous of Central Kazakhstan (Nekhoroshev 1948) and from the Mississippian (Serpukhovian) of the Russian Platform (Schulga-Nesterenko 1951).

Quantitative analyses (Fig. 32) have been performed to test the outlined palaeobiogeographical connections of the species found at Roque Redonde. The dataset used for these analyses only contains the absence and presence of the species found at Roque Redonde. This restriction is chosen to partly counter-balance the limited number of modern descriptions of Carboniferous bryozoans and their inter- and intraspecific variabilities. In consequence, the composition of the dataset does not allow detailed analyses of the relationships between all palaeobiogeographical units, and it imposes that the Montagne Noire fauna is an out-group in the hierarchical clusters (Fig. 32). Although restricted, these analyses help to identify the occurrences/abundances of species known in the Montagne Noire in clusters or single palaeobiogeographical units, and finally to test the robustness of palaeobiogeographical closeness and palaeogeography for the Montagne Noire fauna.

The hierarchical clusters and the non-metric multivariate ordination analysis (NMDS) indicate as general trend that relative geographical proximity of the defined palaeobiogeographical units to the Montagne Noire is an important factor. Those regions situated palaeogeographically closest to the Montagne Noire, the number of species known in the Montagne Noire species is high, and thus they are the closest in the analyses (Fig. 32). The high number of Montagne Noire species in the Rhenohercynian faunas (British Isles and Germany) advocate for faunal exchange between the northern and southern Variscan realms. However, the relatively low total number of bryozoan species in the Montagne Noire compared to contemporaneous strata in the Rhenohercynian realm indicates a much more effective palaeobiogeographical barrier than expressed in the analysis due to the omission of the taxa not present in the Montagne Noire (Fig. 32). Facies restrictions may be an additional factor. The connections to the Russian platform are different depending on the chosen analy-

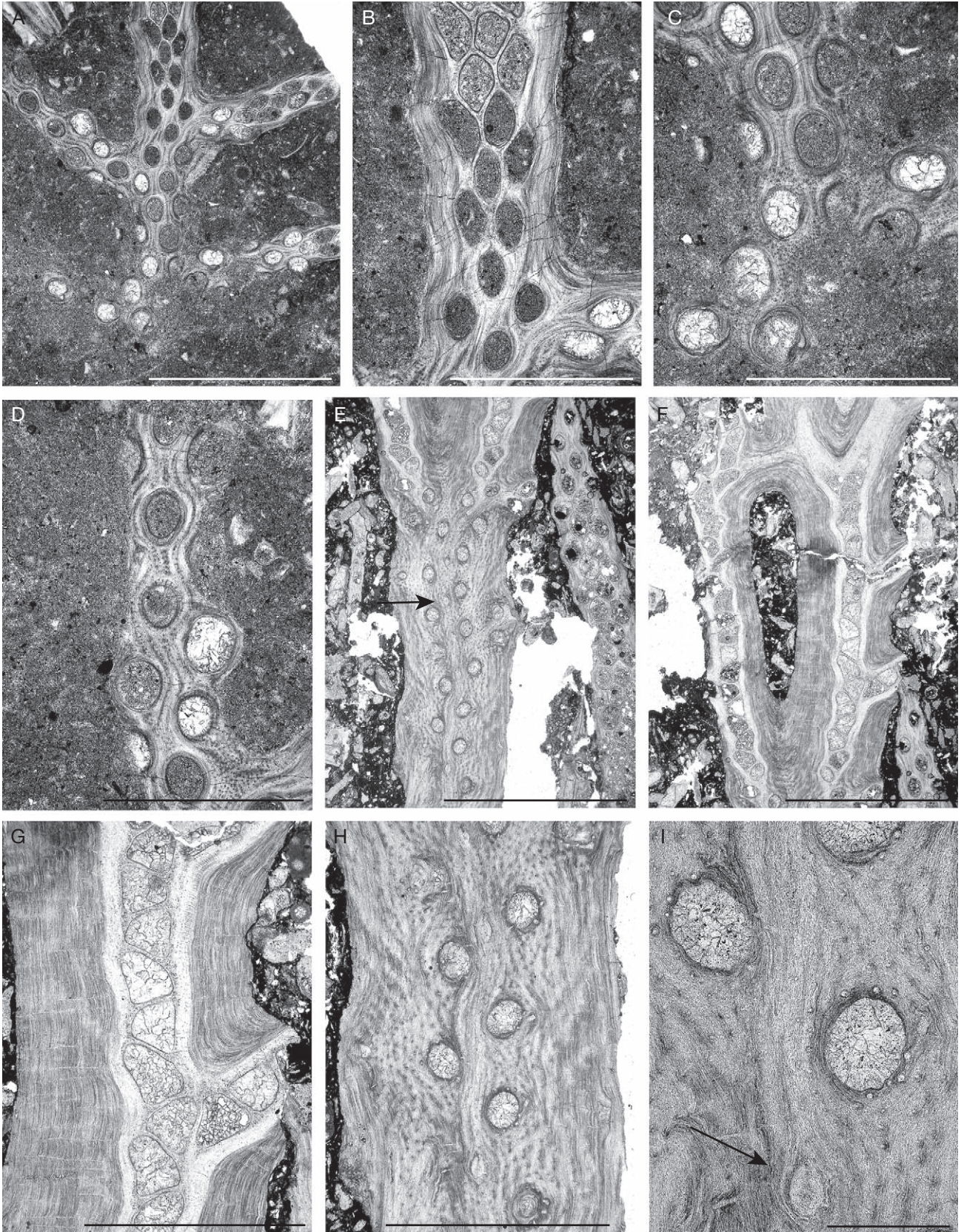


FIG. 31. — **A-D**, *Thamniscus colei* Wyse Jackson, 1988, tangential section showing autozooeal apertures and branch surface, SMF 21.973; **E-I**, *Fenestrata* sp., SMF 21.974; **E, H, I**, tangential section showing autozooeal apertures and nodes (arrows); **F, G**, mid-tangential section showing autozooeal chambers and external laminated skeleton. Scale bars: A, E, F, 2 mm; B-D, G, H, 1mm; I, 0.2 mm.

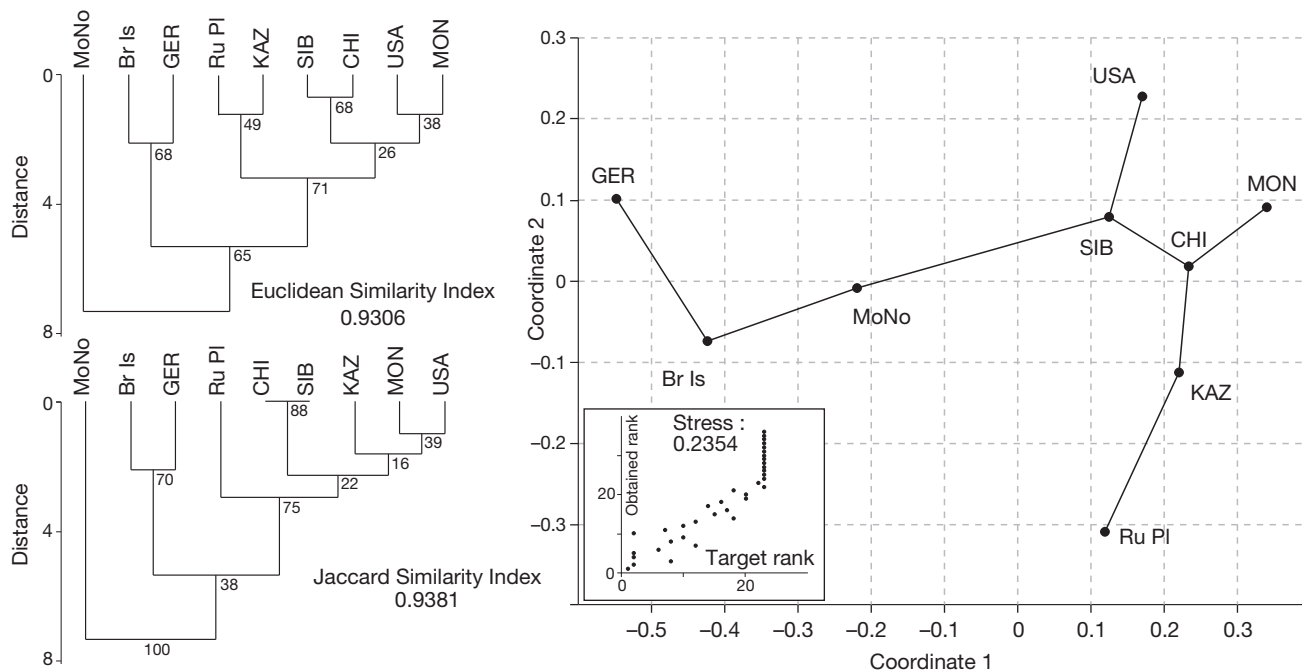


FIG. 32. — Palaeobiogeographical affinities of the Roque Redonde bryozoan assemblage. Left side: Dendrograms for the totality of species found at Roque Redonde using two different similarity indices, Jaccard and Euclidean. Cluster method: Ward; Percentages of node robustness: bootstrap probability. Cluster analysis agglomerative coefficients for each analysis is indicated in the bottom right corner. Right side: Plots for NMDS analyses with Dice similarity index for all taxa. Minimum span tree is given for the nine palaeobiogeographical units. Insert shows the Shepard plot and stress of the analysis. Palaeobiogeographical units: **MoNo**, Montagne Noire based on the Roque Redonde assemblage; **Br Is**, British Isles; **GER**, Rhenisch Massif, Germany; **Ru PI**, Russian Platform *sensu lato*; **SIB**, Siberia; **KAZ**, Kazakhstan and neighbouring countries; **MON**, Mongolia and northernmost China; **CHI**, South China; **USA**, North America, mainly Midwest Continent. All analyses performed with PAST (Hammer *et al.* 2001).

ses. They are closer in the hierarchical clusters than in the NMDS where the minimum span tree privileges the closeness to palaeogeographical more distanced areas in the eastern Palaeotethys. Again, this might be an artefact from the composition of our dataset, but there was at least some faunal exchange between the Montagne Noire and the Russian Platform. A direct connection between North America and the Montagne Noire is not expressed in the analyses. The bryozoans from North America cluster with the faunas from East Asia, possibly indicating faunal exchange between both sides of the Panthalassa Ocean. Similarities of the Montagne Noire fauna to those regions result from cosmopolitan taxa.

The described fauna is clearly dominated by fenestrates (18 species, or 47.37%), followed by cystoporates (12 species, or 31.58%), and rhabdomesine cryptostomes (6 species, or 15.78%). Trepostomes are represented only by two species (5.27%). This composition broadly reflects the general composition of Carboniferous bryozoan faunas (Ross 1981; Bancroft 1987), when taxonomic diversity is largely driven by the evolution within fenestrates. For example, the bryozoan fauna from the Visean of County Fermanagh, Ireland shows the following composition (Wyse Jackson 1996: 164): 49 fenestrates (71%), 9 cryptostomes (13%), 7 trepostomes (10.2%), and 4 cystoporates (5.8%). So far, trepostomes seem to be under-represented at Roque Redonde.

In general, the studied fauna contains mainly small delicate species and implies calm, low energy environment.

Fenestrates are represented by large to moderately sized reticulated colonies (*Polypora*, *Spinofenestella*, *Rectifenestella*, and *Fabifenestella*), as well as by delicate pinnate and freely branching ones (*Penniretepora*, *Filites*, *Gorjunovia*, *Baculopora* and “*Thamniscus*”). Cystoporates include mainly small globular or incrusting colonies (*Fistulipora* (except *Fistulipora prolifica* which can produce quite large multi-layered colonies), *Dybowskiella*, *Eridopora*), and bifoliate, lenticular branched (*Cystodyctia*, *Sulcoretepora*, *Volgia*, and *Ramiporalia*). Rhabdomesine cryptostomes are all branched ramose, mainly of small diameter (0.36–2.42 mm). *Tabulipora howsii* (Nicholson, 1881) can produce massive colonies up to 2.7 mm thick, whereas *Dyscritella* sp. developed small encrusting colonies (less than 0.5 mm in thickness).

Acknowledgements

Wolfgang Reimers, Kiel, is acknowledged for his assistance in preparation of thin sections. Andrej Ernst thanks the Deutsche Forschungsgemeinschaft (DFG) for financial support (project ER 278/6.1). George Sevastopulo (Trinity College, Dublin) is thanked for providing some specimens. This study is a contribution to the IGCP 596 “Mid-Palaeozoic climate and biodiversity”. We thank the reviewers Hans Arne Nakrem, Oslo and Catherine Reid, Christchurch for their incisive comments that improved this paper.

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Submitted on 14 May 2014;
accepted on 3rd December 2014;
published on 26 June 2015.

APPENDIX

Descriptive statistics. Abbreviations: **N**, number of measurements; **X**, mean; **SD**, sample standard deviation; **CV**, coefficient of variation; **MIN**, minimum value; **MAX**, maximum value.

Fistulipora tolokonnikovae n. sp.

	N	X	SD	CV	MIN	MAX
Autozooeical aperture width, mm	40	0.45	0.060	13.16	0.36	0.55
Autozooeical aperture spacing, mm	40	0.72	0.091	12.72	0.60	0.90
Vesicle diameter, mm	40	0.15	0.039	25.42	0.08	0.29
Vesicles per aperture	40	13	2.098	16.26	9	17
Vesicle spacing, mm	40	0.10	0.024	24.59	0.05	0.17
Lunarium length, mm	10	0.06	0.019	33.90	0.04	0.10
Lunarium width, mm	10	0.22	0.033	15.18	0.18	0.29
Lunarium thickness, mm	10	0.03	0.013	38.55	0.02	0.06

Fistulipora prolifica Ulrich, 1884

	N	X	SD	CV	MIN	MAX
Autozooeical aperture width, mm	25	0.39	0.047	12.24	0.30	0.49
Autozooeical aperture spacing, mm	25	0.74	0.104	14.16	0.54	0.96
Vesicle diameter, mm	25	0.21	0.055	26.68	0.11	0.30
Vesicles per aperture	25	7	1.108	15.13	6	10
Vesicle spacing, mm	25	0.18	0.059	32.90	0.05	0.29

Fistulipora cf. tubulosa Nikiforova, 1933

	N	X	SD	CV	MIN	MAX
Autozooeical aperture width, mm	115	0.33	0.043	13.15	0.24	0.43
Autozooeical aperture spacing, mm	115	0.60	0.092	15.35	0.42	0.84
Vesicle diameter, mm	115	0.14	0.036	26.14	0.07	0.24
Vesicles per aperture	61	10.3	1.944	18.88	7.0	14.0
Vesicle spacing, mm	50	0.09	0.026	28.24	0.05	0.16
Lunarium length, mm	18	0.09	0.028	29.71	0.06	0.16
Lunarium width, mm	18	0.20	0.035	17.91	0.13	0.24

Fistulipora parvilabrum Schulga-Nesterenko, 1955

	N	X	SD	CV	MIN	MAX
Autozooeical aperture width, mm	20	0.29	0.027	9.23	0.25	0.34
Autozooeical aperture spacing, mm	20	0.56	0.094	16.77	0.40	0.78
Vesicle diameter, mm	20	0.16	0.040	25.12	0.08	0.22
Vesicles per aperture	15	9	1.348	15.24	6	11
Vesicle spacing, mm	20	0.13	0.044	33.03	0.07	0.22
Lunarium length, mm	7	0.09	0.036	39.11	0.05	0.15
Lunarium width, mm	7	0.19	0.033	17.52	0.14	0.23

Fistulipora sana Trizna, 1958

	N	X	SD	CV	MIN	MAX
Autozooeical aperture width, mm	30	0.26	0.039	14.90	0.19	0.32
Autozooeical aperture spacing, mm	30	0.40	0.055	13.77	0.31	0.52
Vesicle diameter, mm	30	0.10	0.016	16.50	0.07	0.14
Vesicles per aperture	11	10.5	1.508	14.42	8.0	13.0
Vesicle spacing, mm	30	0.09	0.021	23.70	0.06	0.14

Dybowskiella rotunda n. sp.

	N	X	SD	CV	MIN	MAX
Autozooeical aperture width, mm	50	0.34	0.072	21.01	0.24	0.50
Autozooeical aperture spacing, mm	50	0.59	0.081	13.85	0.42	0.81
Vesicle diameter, mm	50	0.15	0.037	25.06	0.07	0.22
Vesicles per aperture	30	9.3	1.264	13.59	6.0	12.0
Vesicle spacing, mm	30	0.13	0.038	29.72	0.06	0.20
Lunarium length, mm	30	0.10	0.030	28.95	0.06	0.18
Lunarium width, mm	30	0.21	0.037	17.41	0.14	0.29

APPENDIX. — Continuation.

Dybowskiella piriforme n. sp.

	N	X	SD	CV	MIN	MAX
Autozooeceal aperture width, mm	20	0.21	0.029	13.57	0.17	0.25
Autozooeceal aperture spacing, mm	20	0.38	0.061	16.04	0.26	0.48
Vesicle diameter, mm	20	0.16	0.061	37.24	0.08	0.29
Vesicles per aperture	7	7	1.345	19.62	5	9
Vesicle spacing, mm	20	0.15	0.034	23.35	0.10	0.23
Lunarium length, mm	17	0.12	0.025	21.26	0.09	0.16
Lunarium width, mm	17	0.14	0.015	10.66	0.12	0.17
Lunarium thickness, mm	12	0.039	0.008	20.25	0.025	0.055

Eridopora suarezi n. sp.

	N	X	SD	CV	MIN	MAX
Autozooeceal aperture width, mm	30	0.32	0.039	12.35	0.26	0.40
Autozooeceal aperture spacing, mm	30	0.56	0.071	12.73	0.42	0.66
Vesicle diameter, mm	30	0.16	0.044	28.15	0.08	0.25
Vesicles per aperture	30	8.7	1.264	14.52	6.0	11.0
Vesicle spacing, mm	30	0.11	0.024	22.13	0.06	0.16

Volgia deftera n. sp.

	N	X	SD	CV	MIN	MAX
Branch width, mm	3	3.33	0.029	0.87	3.30	3.35
Branch thickness, mm	3	1.80	0.335	18.58	1.44	2.10
Endozone width, mm	3	0.94	0.250	26.53	0.70	1.20
Autozooeceal aperture width, mm	17	0.20	0.029	14.39	0.17	0.29
Autozooeceal aperture spacing, mm	5	0.65	0.106	16.28	0.50	0.78
Autozooeceal aperture spacing diagonally, mm	5	0.38	0.025	6.59	0.36	0.42
Exozonal tube diameter, mm	20	0.03	0.010	29.19	0.02	0.06

Cystodictya gallensis n. sp.

	N	X	SD	CV	MIN	MAX
Branch width, mm	6	2.06	0.351	17.06	1.64	2.42
Branch thickness, mm	2	1.44	0.290	20.20	1.23	1.64
Autozooeceal aperture width, mm	30	0.18	0.023	12.29	0.16	0.23
Autozooeceal aperture spacing, mm	15	0.61	0.082	13.36	0.48	0.81
Autozooeceal aperture spacing diagonally, mm	17	0.37	0.043	11.53	0.29	0.48
Vesicle diameter, mm	20	0.08	0.016	21.12	0.05	0.10

Sulcoretepora parallela (Phillips, 1836)

	N	X	SD	CV	MIN	MAX
Branch width, mm	14	0.86	0.140	16.28	0.60	1.08
Branch thickness, mm	9	0.64	0.069	10.79	0.54	0.75
Autozooeceal aperture width, mm	17	0.10	0.018	17.45	0.08	0.13
Autozooeceal aperture spacing, mm	19	0.67	0.054	8.08	0.56	0.78
Autozooeceal aperture spacing diagonally, mm	11	0.36	0.065	18.28	0.25	0.44
Maximal chamber width, mm	7	0.15	0.015	9.80	0.14	0.18

Ramiporalia robusta Delvolve & McKinney, 1983

	N	X	SD	CV	MIN	MAX
Branch width, mm	10	2.36	0.598	25.33	1.23	3.67
Branch thickness, mm	10	1.00	0.414	41.34	0.49	1.64
Distance between branch centres, mm	10	3.13	0.614	19.64	2.50	4.70
Autozooeceal aperture width, mm	20	0.16	0.015	9.26	0.14	0.18
Autozooeceal aperture spacing, mm	20	0.43	0.055	12.80	0.36	0.54
Vesicle diameter, mm	20	0.07	0.012	17.66	0.05	0.10
Vesicle spacing, mm	20	0.11	0.023	20.99	0.07	0.14

APPENDIX. — Continuation.

Tabulipora howsii (Nicholson, 1881)

	N	X	SD	CV	MIN	MAX
Autozooeical aperture width, mm	20	0.28	0.021	7.51	0.24	0.31
Autozooeical aperture spacing, mm	20	0.32	0.025	7.74	0.29	0.36
Autozooeical aperture width, mm (maculae)	15	0.41	0.030	7.23	0.36	0.47
Autozooeical aperture spacing, mm (maculae)	15	0.48	0.046	9.58	0.42	0.58
Acanthostyle diameter, mm	20	0.06	0.009	15.98	0.04	0.08
Exilazooecia width, mm	10	0.09	0.018	19.00	0.07	0.12
Hemiphragm spacing, mm	20	0.32	0.058	18.40	0.23	0.44

Nematopora hibernica Wyse Jackson, 1996

	N	X	SD	CV	MIN	MAX
Branch diameter, mm	17	0.61	0.149	24.36	0.36	0.81
Autozooeical aperture width, mm	13	0.15	0.074	48.18	0.085	0.28
Autozooeical aperture spacing, mm	14	0.61	0.264	42.9	0.29	0.99
Autozooeical aperture spacing diagonally, mm	17	0.32	0.138	42.39	0.16	0.59

Clausotrypa ramosa (Owen, 1973)

	N	X	SD	CV	MIN	MAX
Branch diameter, mm	6	1.27	0.253	19.87	1.01	1.64
Exozone width, mm	4	0.40	0.134	33.36	0.30	0.60
Endozone width, mm	4	0.60	0.167	28.04	0.44	0.80
Autozooeical aperture width, mm	20	0.13	0.016	12.88	0.10	0.16
Autozooeical aperture spacing, mm	10	0.75	0.054	7.14	0.67	0.82
Autozooeical aperture spacing diagonally, mm	10	0.38	0.052	13.45	0.31	0.46
Acanthostyle diameter, mm	20	0.034	0.007	19.69	0.025	0.050
Tectitooecia width, mm	5	0.030	0.006	20.41	0.020	0.035

Rhabdomeson progracile Wyse Jackson & Bancroft, 1995

	N	X	SD	CV	MIN	MAX
Branch diameter, mm	15	1.99	0.303	15.21	1.47	2.42
Exozone width, mm	15	0.46	0.103	22.24	0.30	0.62
Endozone width, mm	15	1.06	0.273	25.79	0.68	1.74
Axial tube diameter, mm	15	0.41	0.084	20.75	0.17	0.58
Autozooeical aperture width, mm	20	0.10	0.013	12.83	0.08	0.13
Autozooeical aperture spacing, mm	20	0.55	0.034	6.09	0.46	0.58
Autozooeical aperture spacing diagonally, mm	20	0.32	0.028	8.87	0.28	0.36
Acanthostyle diameter, mm	20	0.070	0.008	10.87	0.060	0.085

Saffordotaxis incrassata (Ulrich, 1888)

	N	X	SD	CV	MIN	MAX
Branch diameter, mm	3	1.10	0.272	24.76	0.81	1.35
Exozone width, mm	3	0.33	0.070	21.50	0.26	0.40
Endozone width, mm	3	0.44	0.136	30.71	0.29	0.55
Autozooeical aperture width, mm	13	0.08	0.015	19.54	0.06	0.10
Autozooeical aperture spacing, mm	14	0.65	0.072	11.08	0.50	0.72
Autozooeical aperture spacing diagonally, mm	16	0.34	0.046	13.54	0.28	0.44
Aktinostyle diameter, mm	20	0.03	0.006	16.22	0.02	0.05

Megacanthopora enodata n. sp.

	N	X	SD	CV	MIN	MAX
Autozooeical aperture width, mm	25	0.16	0.019	11.77	0.13	0.19
Autozooeical aperture spacing, mm	20	0.37	0.034	9.00	0.30	0.44
Metazooecia width, mm	10	0.05	0.016	32.66	0.03	0.08
Acanthostyle diameter, mm	25	0.07	0.016	22.09	0.05	0.10
Aktinostyle diameter, mm	25	0.032	0.005	15.58	0.025	0.040

APPENDIX. — Continuation.

Rectifenestella sp.

	N	X	SD	CV	MIN	MAX
Branch width, mm	7	0.31	0.020	6.27	0.29	0.35
Dissepiment width, mm	11	0.12	0.013	10.92	0.10	0.14
Fenestrule width, mm	11	0.24	0.026	10.87	0.22	0.29
Fenestrule length, mm	14	0.52	0.035	6.82	0.44	0.58
Distance between branch centres, mm	8	0.49	0.028	5.61	0.44	0.53
Distance between dissepiment centres, mm	14	0.62	0.042	6.79	0.54	0.69
Aperture width, mm	5	0.10	0.007	6.59	0.09	0.11
Aperture spacing along branch, mm	7	0.29	0.019	6.40	0.26	0.32
Aperture spacing diagonally, mm	6	0.24	0.012	4.84	0.23	0.26
Maximal chamber width, mm	15	0.13	0.007	5.50	0.12	0.14
Node width, mm	8	0.027	0.005	19.73	0.020	0.035
Distance between node centres, mm	8	0.14	0.024	17.07	0.11	0.18
Apertures per fenestrule length	8	2.3	0.463	20.57	2.0	3.0

Spinofenestella major (Nikiforova, 1933), comb. nov.

	N	X	SD	CV	MIN	MAX
Branch width, mm	10	0.22	0.020	8.96	0.20	0.26
Dissepiment width, mm	10	0.10	0.009	9.21	0.09	0.12
Fenestrule width, mm	10	0.35	0.063	18.04	0.29	0.47
Fenestrule length, mm	10	0.86	0.080	9.37	0.77	1.02
Distance between branch centres, mm	10	0.58	0.071	12.31	0.47	0.70
Distance between dissepiment centres, mm	10	0.95	0.070	7.43	0.87	1.10
Aperture width, mm	10	0.078	0.003	3.40	0.075	0.080
Aperture spacing along branch, mm	15	0.32	0.020	6.15	0.29	0.36
Aperture spacing diagonally, mm	15	0.22	0.009	4.32	0.20	0.23
Maximal chamber width, mm	10	0.12	0.007	6.15	0.10	0.12

Spinofenestella cf. *simplaris* (Trizna, 1961)

	N	X	SD	CV	MIN	MAX
Branch width, mm	10	0.38	0.024	6.28	0.35	0.42
Dissepiment width, mm	10	0.23	0.053	23.13	0.17	0.37
Fenestrule width, mm	10	0.38	0.038	9.86	0.31	0.42
Fenestrule length, mm	10	0.93	0.060	6.45	0.83	1.02
Distance between branch centres, mm	10	0.72	0.087	12.12	0.58	0.82
Distance between dissepiment centres, mm	10	1.17	0.091	7.85	1.03	1.33
Aperture width, mm	10	0.11	0.007	5.97	0.10	0.12
Aperture spacing along branch, mm	10	0.35	0.012	3.56	0.33	0.37
Aperture spacing diagonally, mm	10	0.27	0.025	9.28	0.24	0.31
Maximal chamber width, mm	10	0.18	0.010	5.49	0.16	0.19
Node width, mm	20	0.09	0.018	21.54	0.06	0.13
Distance between node centres, mm	20	0.39	0.099	25.63	0.19	0.55
Apertures per fenestrule length	15	3.3	0.488	14.64	3.0	4.0

Spinofenestella sp. 1

	N	X	SD	CV	MIN	MAX
Branch width, mm	12	0.40	0.020	4.96	0.37	0.44
Dissepiment width, mm	15	0.26	0.063	24.43	0.18	0.37
Fenestrule width, mm	15	0.50	0.100	19.87	0.34	0.66
Fenestrule length, mm	14	1.72	0.291	16.87	1.33	2.38
Distance between branch centres, mm	15	0.93	0.111	11.98	0.78	1.20
Distance between dissepiment centres, mm	13	2.02	0.250	12.34	1.72	2.63
Aperture width, mm	16	0.12	0.011	9.66	0.10	0.13
Aperture spacing along branch, mm	16	0.43	0.032	7.59	0.37	0.47
Aperture spacing diagonally, mm	16	0.32	0.024	7.49	0.28	0.36
Maximal chamber width, mm	15	0.20	0.032	16.25	0.10	0.24
Apertures per fenestrule length	10	4.3	0.949	22.06	3.0	6.0

APPENDIX. — Continuation.

Spinofenestella sp. 2

	N	X	SD	CV	MIN	MAX
Branch width, mm	10	0.29	0.014	4.98	0.26	0.30
Dissepiment width, mm	10	0.14	0.016	11.31	0.12	0.16
Fenestrule width, mm	10	0.23	0.030	12.77	0.19	0.28
Fenestrule length, mm	10	0.73	0.011	1.44	0.72	0.75
Distance between branch centres, mm	10	0.52	0.049	9.59	0.45	0.61
Distance between dissepiment centres, mm	10	0.87	0.025	2.90	0.84	0.92
Aperture width, mm	20	0.09	0.005	5.64	0.08	0.10
Aperture spacing along branch, mm	20	0.25	0.015	6.05	0.22	0.28
Aperture spacing diagonally, mm	20	0.21	0.014	6.83	0.19	0.25
Maximal chamber width, mm	20	0.10	0.008	7.85	0.09	0.12
Apertures per fenestrule length	8	3.3	0.463	14.24	3.0	4.0

Laxifenestella kondrovensis (Schulga-Nesterenko, 1955) comb. nov.

	N	X	SD	CV	MIN	MAX
Branch width, mm	35	0.42	0.050	11.79	0.33	0.55
Dissepiment width, mm	35	0.27	0.078	28.78	0.14	0.40
Fenestrule width, mm	35	0.35	0.076	21.53	0.23	0.54
Fenestrule length, mm	35	0.81	0.214	26.35	0.55	1.25
Distance between branch centres, mm	35	0.76	0.100	13.09	0.60	1.00
Distance between dissepiment centres, mm	35	1.10	0.157	14.32	0.86	1.63
Aperture width, mm	40	0.11	0.011	9.55	0.10	0.15
Aperture spacing along branch, mm	40	0.34	0.037	11.02	0.29	0.42
Aperture spacing diagonally, mm	40	0.32	0.027	8.40	0.25	0.38
Maximal chamber width, mm	40	0.16	0.012	7.79	0.14	0.19
Node width, mm	20	0.03	0.005	20.40	0.02	0.04
Distance between node centres, mm	19	0.19	0.050	25.77	0.15	0.35
Apertures per fenestrule length	45	3.1	0.505	16.10	2.0	4.0

Fabifenestella macrofenestrata n. sp.

	N	X	SD	CV	MIN	MAX
Branch width, mm	10	0.39	0.030	7.76	0.35	0.43
Dissepiment width, mm	10	0.21	0.027	12.72	0.17	0.25
Fenestrule width, mm	10	0.44	0.052	11.78	0.37	0.54
Fenestrule length, mm	10	1.27	0.095	7.49	1.14	1.50
Distance between branch centres, mm	10	0.77	0.057	7.41	0.66	0.84
Distance between dissepiment centres, mm	10	1.52	0.159	10.44	1.35	1.87
Aperture width, mm	15	0.09	0.006	5.97	0.08	0.10
Aperture spacing along branch, mm	15	0.33	0.017	5.13	0.31	0.36
Aperture spacing diagonally, mm	15	0.36	0.024	6.63	0.34	0.41
Maximal chamber width, mm	10	0.12	0.011	9.31	0.11	0.14
Node width, mm	20	0.06	0.013	21.39	0.05	0.08
Distance between node centres, mm	20	0.18	0.026	14.66	0.14	0.24
Apertures per fenestrule length	20	4.7	0.657	13.98	4.0	6.0
Heterozooecia width, mm	10	0.13	0.016	13.07	0.11	0.16
Heterozooecia length, mm	10	0.23	0.025	11.27	0.18	0.25

Ptilofenestella carrickensis Tavener-Smith, 1965

	N	X	SD	CV	MIN	MAX
Branch width, mm	5	0.24	0.03	12.2	0.22	0.29
Dissepiment width, mm	6	0.16	0.014	8.3	0.15	0.19
Fenestrule width, mm	7	0.31	0.05	16.3	0.24	0.37
Fenestrule length, mm	7	0.70	0.105	15.0	0.48	0.82
Distance between branch centres, mm	5	0.54	0.044	8.3	0.49	0.59
Distance between dissepiment centres, mm	4	0.90	0.053	5.9	0.83	0.96
Aperture width, mm	3	0.07	0.015	21.5	0.06	0.08
Aperture spacing along branch, mm	3	0.15	0.015	10.2	0.13	0.16
Maximal chamber width, mm	3	0.09	0.006	6.4	0.08	0.09

APPENDIX. — Continuation.

Polypora dendroides M'Coy, 1844

	N	X	SD	CV	MIN	MAX
Branch width, mm	9	0.75	0.193	25.65	0.56	1.00
Dissepiment width, mm	3	0.30	0.104	35.08	0.18	0.38
Fenestrule width, mm	3	0.93	0.237	25.41	0.67	1.13
Distance between branch centres, mm	3	1.36	0.300	22.10	1.05	1.65
Aperture width, mm	13	0.11	0.008	6.86	0.10	0.12
Aperture spacing along branch, mm	14	0.38	0.035	9.16	0.35	0.48
Aperture spacing diagonally, mm	10	0.27	0.012	4.52	0.25	0.29
Maximal chamber width, mm	15	0.15	0.012	8.05	0.14	0.17

Polypora marginata M'Coy, 1844

	N	X	SD	CV	MIN	MAX
Branch width, mm	8	0.79	0.136	17.25	0.63	1.02
Dissepiment width, mm	3	0.43	0.099	23.12	0.36	0.54
Fenestrule width, mm	3	0.57	0.066	11.50	0.50	0.63
Fenestrule length, mm	2	4.15	0.212	5.11	4.00	4.30
Distance between branch centres, mm	3	1.52	0.150	9.88	1.35	1.64
Distance between dissepiment centres, mm	2	4.6	0.424	9.22	4.3	4.9
Aperture width, mm	20	0.13	0.007	4.94	0.12	0.14
Aperture spacing along branch, mm	20	0.54	0.037	6.94	0.46	0.63
Aperture spacing diagonally, mm	20	0.35	0.038	10.94	0.28	0.42
Maximal chamber width, mm	20	0.22	0.021	9.65	0.18	0.25

Diploporaria tenella Wyse Jackson, 1988

	N	X	SD	CV	MIN	MAX
Branch width, mm	4	0.30	0.013	4.16	0.29	0.32
Aperture width, mm	4	0.090	0.004	4.54	0.085	0.095
Aperture spacing along branch, mm	13	0.38	0.041	10.75	0.32	0.43

Baculopora redondensis n. sp.

	N	X	SD	CV	MIN	MAX
Branch width, mm	30	0.78	0.110	14.03	0.63	0.98
Aperture width, mm	55	0.10	0.011	10.98	0.07	0.13
Aperture spacing along branch, mm	50	0.53	0.061	11.49	0.42	0.73
Aperture spacing across branch, mm	50	0.29	0.026	9.05	0.24	0.361
Maximal chamber width, mm	30	0.16	0.016	9.91	0.13	0.19
Apertural node diameter, mm	10	7.4	2.459	33.22	4.0	11.0

Filites cf. *laxa* (Young & Young, 1876) comb. nov.

	N	X	SD	CV	MIN	MAX
Main branch width, mm	10	0.50	0.080	15.91	0.41	0.66
Lateral branch width, mm	10	0.32	0.039	12.30	0.26	0.38
Lateral branch spacing, mm	24	0.96	0.166	17.19	0.66	1.20
Lateral branch diverging angle	10	68.7	7.119	10.36	58.0	79.0
Aperture width, mm	14	0.10	0.005	5.42	0.09	0.11
Aperture spacing along branch, mm	10	0.38	0.031	8.13	0.36	0.46
Aperture spacing across branch, mm	5	0.28	0.027	9.51	0.25	0.32
Maximal chamber width, mm	20	0.18	0.015	8.34	0.14	0.20

Penniretepora volgensis Shishova, 1959

	N	X	SD	CV	MIN	MAX
Main branch width, mm	9	0.49	0.096	19.52	0.38	0.70
Lateral branch width, mm	17	0.28	0.066	23.69	0.18	0.45
Lateral branch spacing, mm	22	0.83	0.089	10.70	0.72	1.05
Lateral branch diverging angle	10	71.6	6.818	9.52	60.0	84.0
Aperture width, mm	40	0.09	0.009	10.06	0.07	0.10
Aperture spacing along branch, mm	37	0.38	0.067	17.67	0.28	0.50
Aperture spacing across branch, mm	35	0.32	0.028	8.75	0.25	0.38
Maximal chamber width, mm	13	0.118	0.007	6.12	0.100	0.125

APPENDIX. — Continuation.

Penniretepora cf. pluma (Phillips, 1836)

	N	X	SD	CV	MIN	MAX
Lateral branch spacing, mm	4	1.26	0.156	12.43	1.10	1.47
Lateral branch diverging angle	2	71.0	5.657	7.97	67.0	75.0
Aperture width, mm	9	0.15	0.016	10.58	0.12	0.16
Aperture spacing along branch, mm	10	0.49	0.033	6.63	0.46	0.54
Aperture spacing across branch, mm	10	0.52	0.048	9.27	0.44	0.60
Maximal chamber width, mm	3	0.22	0.006	2.59	0.22	0.23

Gorjunopora gallica n. gen., n. sp.

	N	X	SD	CV	MIN	MAX
Main branch width, mm	9	0.28	0.045	16.27	0.22	0.36
Lateral branch width, mm	17	0.17	0.022	13.21	0.14	0.22
Lateral branch spacing, mm	22	0.82	0.102	12.44	0.69	1.05
Lateral branch diverging angle	11	66.8	7.167	10.73	57.0	81.0
Aperture width, mm	14	0.085	0.007	8.81	0.075	0.100
Aperture spacing along branch, mm	10	0.38	0.030	7.79	0.34	0.42
Aperture spacing across branch, mm	6	0.29	0.016	5.70	0.28	0.32
Maximal chamber width, mm	16	0.12	0.010	8.45	0.10	0.13
Node diameter, mm	16	0.04	0.007	16.21	0.03	0.05
Node spacing, mm	13	0.21	0.043	20.63	0.17	0.30

“*Thamniscus*” *colei* Wyse Jackson, 1988

	N	X	SD	CV	MIN	MAX
Branch width, mm	3	0.61	0.113	18.47	0.54	0.74
Aperture width, mm	10	0.15	0.019	12.83	0.13	0.18
Aperture spacing along branch, mm	8	0.55	0.085	15.47	0.43	0.64
Aperture spacing across branch, mm	14	0.32	0.031	9.73	0.27	0.38
Maximal chamber width, mm	7	0.15	0.011	7.35	0.14	0.17

Fenestrata sp.

	N	X	SD	CV	MIN	MAX
Aperture width, mm	16	0.12	0.005	4.21	0.11	0.13
Aperture spacing along branch, mm	10	0.43	0.037	8.61	0.40	0.52
Aperture spacing diagonally, mm	12	0.39	0.043	11.09	0.34	0.48
Maximal chamber width, mm	15	0.18	0.010	5.36	0.16	0.20
Node width, mm	6	0.05	0.008	14.44	0.04	0.06
Distance between node centres, mm	6	0.46	0.060	13.09	0.40	0.53
Apertural nodes diameter, mm	20	0.012	0.004	30.99	0.010	0.025