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

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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 espèces 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 le 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 Visean 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 Visean 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 (Visean) 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 Monpellier (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 Visean Roque Redonde Formation (Poty *et al*. 2002) (Fig. 2).

The Visean 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 Visean 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 Visean 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

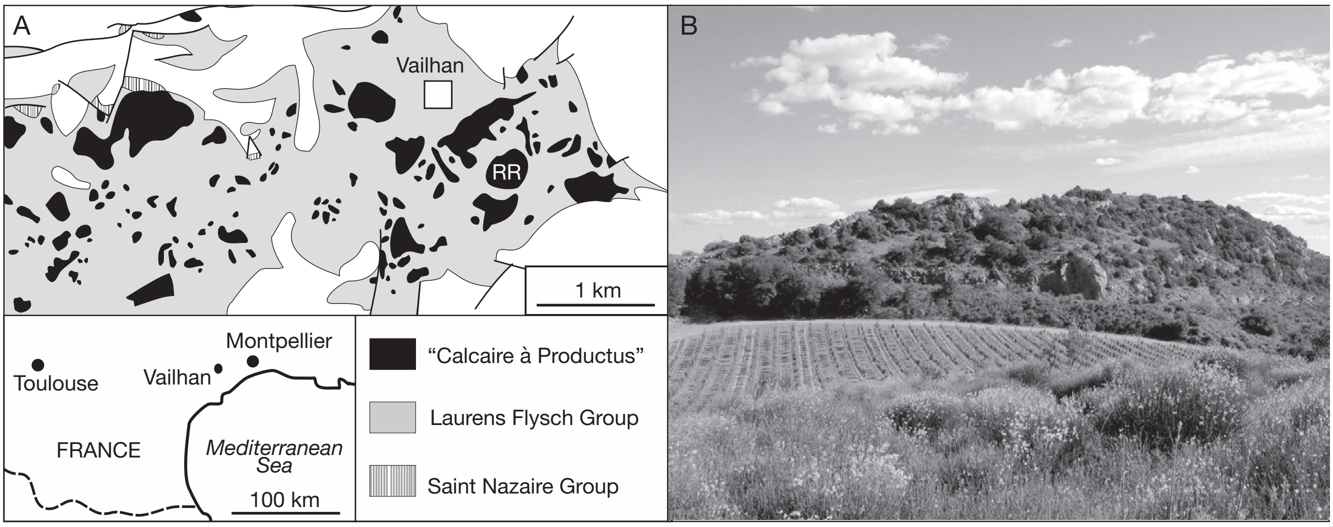

Fig. 1. — **A**, Localisation of the Roque Redonde outcrop on a geological map showing the numerous limestone olistoliths (**black**) incorporated in the siliciclastic flysch deposits of the Laurens Flysch Group (**grey**) in the vicinity of Vailhan (modified from Engel *et al.* 1981); **B**, view on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

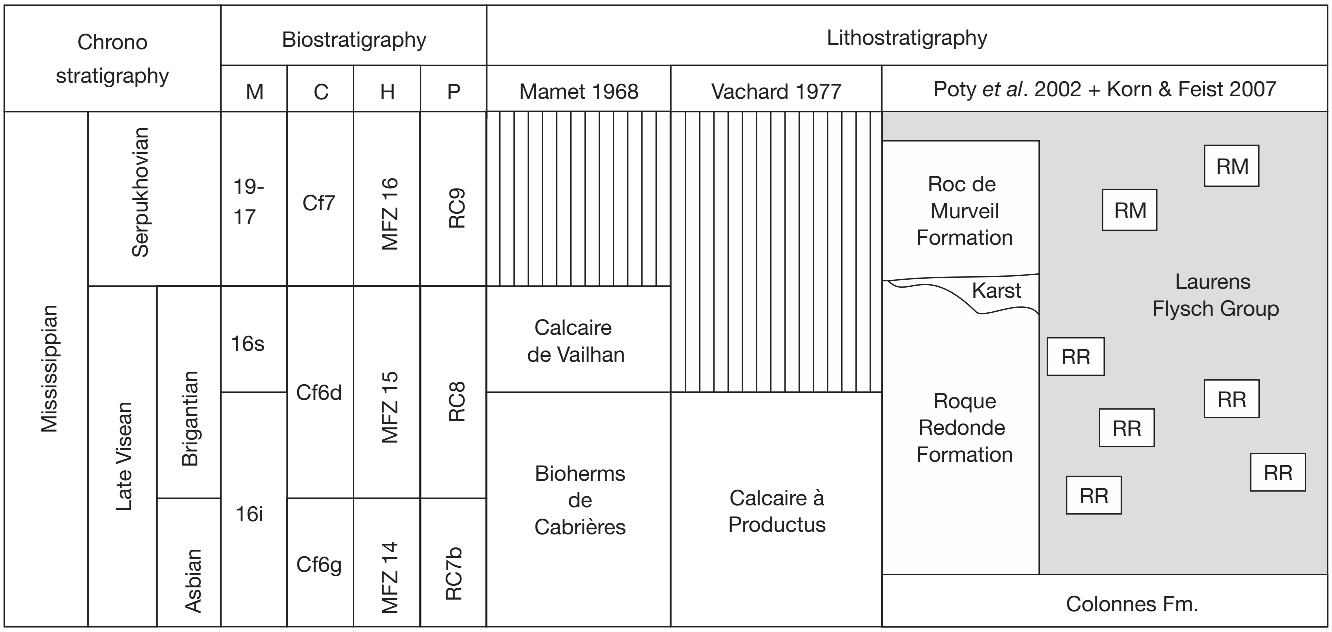

Fig. 2. — Stratigraphic overview of the Late Visean and Serpukhovian limestone olistoliths of the Montagne Noire. Abbreviations: **M**, Mamet 1968; **C**, Conil *et al.* 1991; **H**, Hance & Devuyst *in* Poty *et al.* 2006; **P**, Poty *in* Poty *et al.* 2006.

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

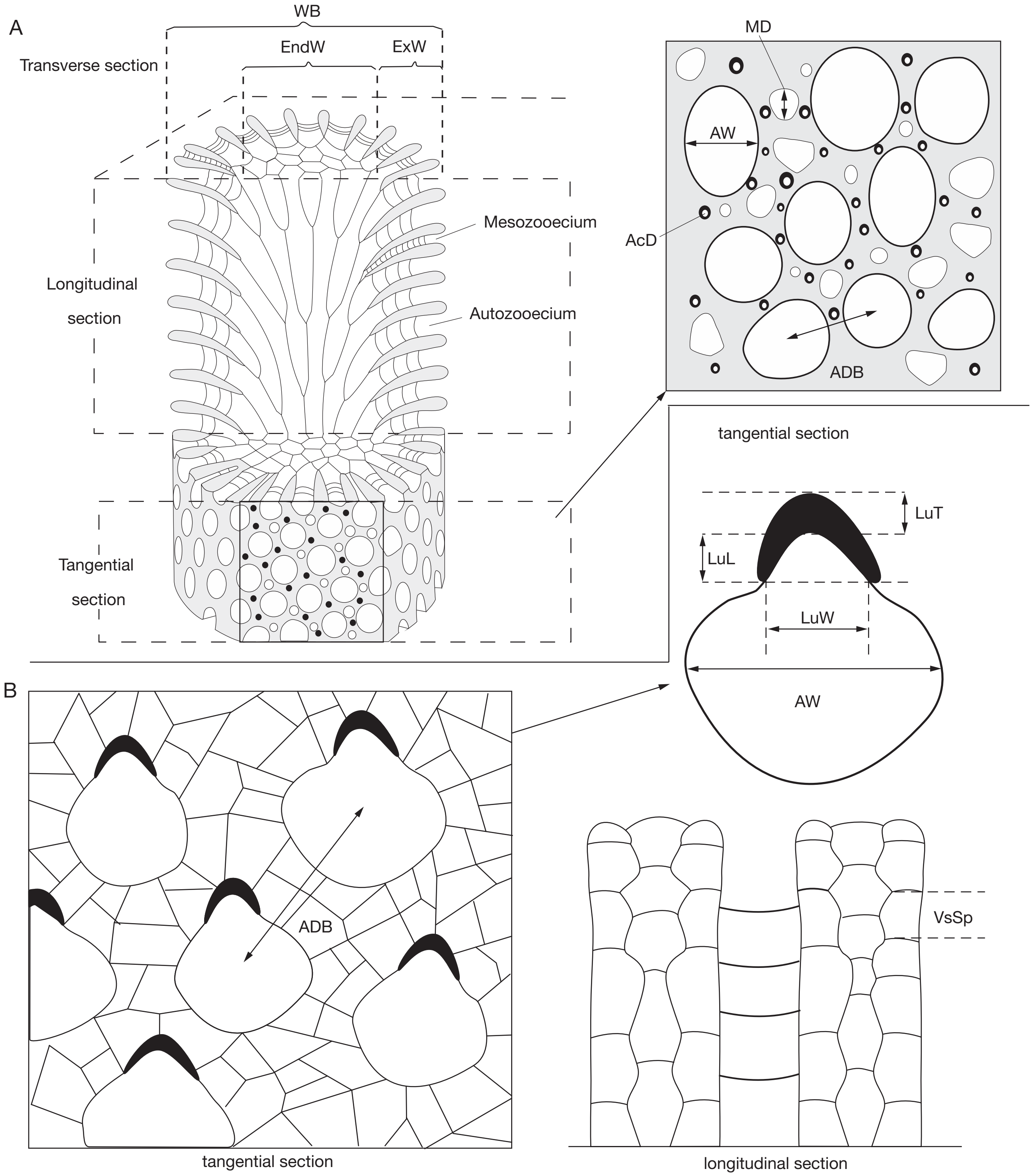

Fig. 3. — Some important measurements made on the trepostome and cystoporate bryozoans. Abbreviations: **ADB**, aperture spacing; **AW**, autozooecial aperture width; **LuL**, lunarium length; **LuW**, lunarium width; **LuT**, lunarium thickness; **VsSp**, vesicle spacing); **WB**, branch width; **EndW**, 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 conditions 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 allochtonuous 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 section 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 Senkenberg Museum, Frankfurt (Main), Germany (prefix SMF), and the Geological Museum, Trinity College, Dublin, Ireland (prefix TCD.)

SYSTEMATIC PALAEONTOLOGY

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 autozooecia with thin walls and complete diaphragms. Apertures rounded, possessing horseshoe-shaped lunaria. Autozooecia separated by the extrazooidal 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 autozooecial 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.

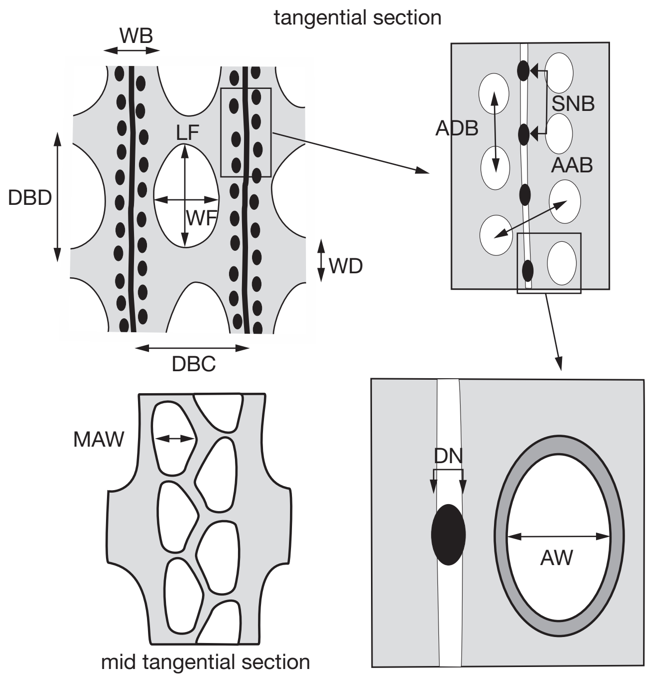

Fig. 4. — Some important measurements made on the fenestrate bryozoans. Abbreviations: **ADB**, aperture spacing along branch; **AAB**, aperture spacing diagonally; **AW**, autozooecial aperture width; **WB**, branch width; **WD**, dissepiment width; **WF**, fenestrule width; **LF**, fenestrule length; **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 autozooecial 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. Autozooecia growing from thin epitheca, bending in the early exozone to the colony surface. Basal diaphragms rare to common, straight, thin, 2-5 in each autozooecium, concentrated usually in proximal parts of autozooecia. Autozooecial apertures circular to oval. Lunaria well-developed, rounded; ends of lunaria not indenting autozooecia. Vesicles small to large, separating autozooecia in 1-2 rows, 9-17 surrounding each autozooecial aperture, with rounded to flat roofs, polygonal in tangential section. Autozooecial 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

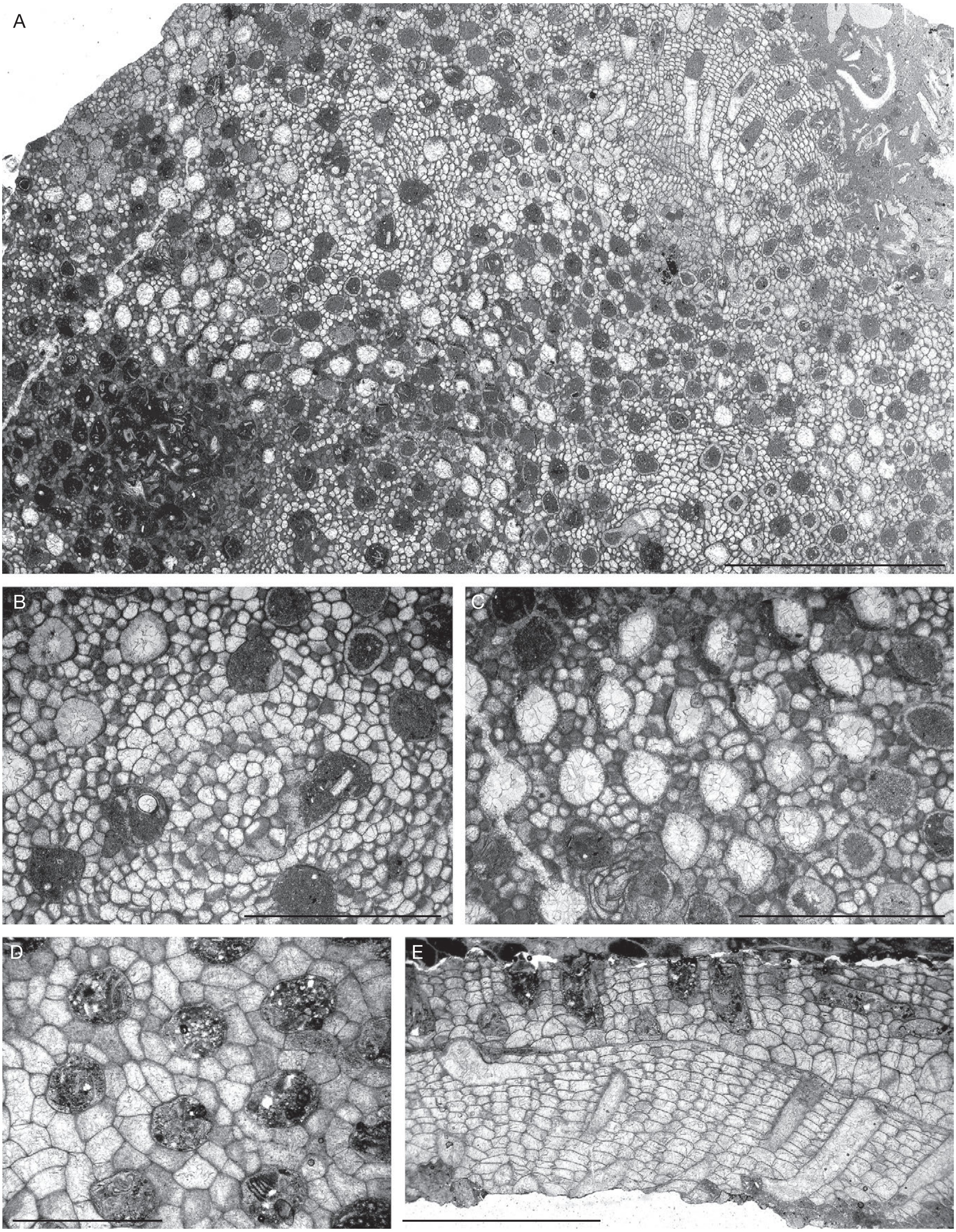

Fig. 5. — **A**-**E**, *Fistulipora tolokonnikovae* n. sp.; **A**, Tangential section, holotype SMF 23.110; **B**-**C**, tangential section showing maculae, autozooecial apertures and vesicles, holotype SMF 23.110; **D**, tangential section showing autozooecial apertures and vesicles, paratype SMF 23.111;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

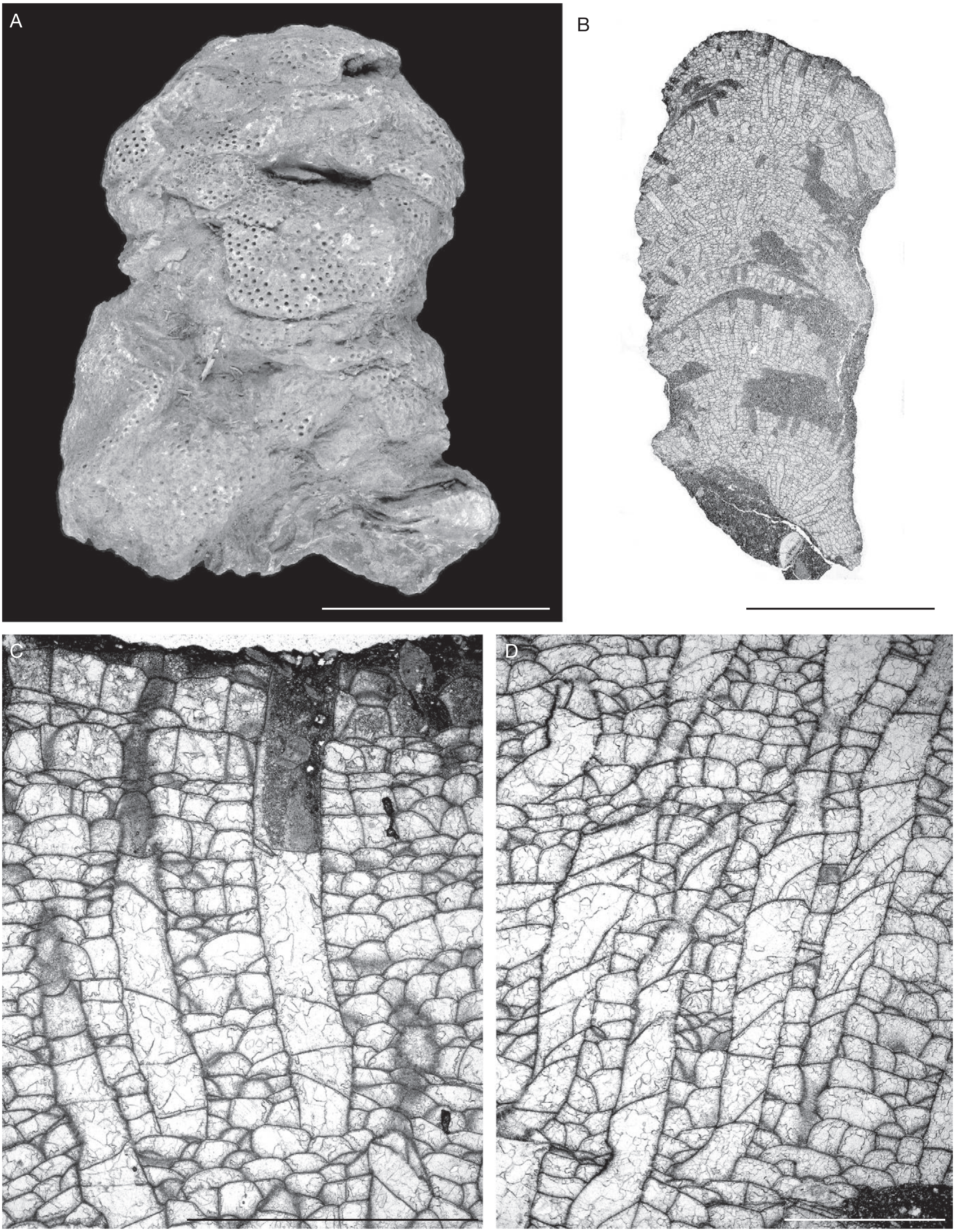

FIG. 6. — **A**-**D**, *Fistulipora prolifica* Ulrich, 1884; **A**, general view of a multilayered colony, SMF 23.119; **B**, longitudinal section though the multilayered colony, SMF 23.115; **C-D**, longitudinal section showing autozooecia with diaphragms and vesicular skeleton, SMF 23.115 (**C**),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

Turkestan, but differs from it in larger autozooecial apertures (aperture width 0.36-0.55 mm vs 0.25-0.28 mm in *F. djebaglinica*). *Fistulipora tolokonnikovae* differs from *F. monoseriata* Schulga-Nesterenko, 1955 from the Lower Carboniferous of Russia in arrangement of vesicles in 1-2 rows between autozooecia 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. Autozooecia 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 autozooecia. Autozooecial apertures circular to oval. Lunaria weakly developed. Vesicles moderately large, separating autozooecia usually in a single row, locally in 2 rows, 6-10 surrounding each autozooecia aperture, with rounded to flat roofs, polygonal in tangential section. Autozooecial 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 autozooecial 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 autozooecial apertures (average autozooecial width 0.39 mm vs 0.29 mm in *F. parvilabrum*; average autozooecial 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. Autozooecia growing from thin epitheca, bending in the early exozone to the colony surface. Basal diaphragms absent or common, up to 5 in autozooecia, thin, concentrated usually in proximal parts of autozooecia. Autozooecial apertures circular to oval. Lunaria well-developed, triangular to horseshoe-shaped; ends of lunaria not indenting autozooecia. Vesicles moderately large, separating autozooecia in 1-2 rows, 7-14 surrounding each autozooecia aperture, with rounded roofs, polygonal in tangential section. Autozooecial 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 autozooecial 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 autozooecial 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. Autozooecia growing from thin epitheca, bending in the early exozone to the colony surface. Basal diaphragms common, 4-6 in each autozooecium, concentrated usually in proximal parts of autozooecia. Autozooecial apertures circular to oval. Lunaria well-developed, horseshoe-shaped; ends of lunaria not indenting autozooecia. Vesicles moderately large, separating autozooecia in 1-2 rows, 7-11 surrounding each autozooecia aperture, with rounded roofs, polygonal in tangential section. Autozooecial walls granular prismatic, 0.005-0.010 mm thick.

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

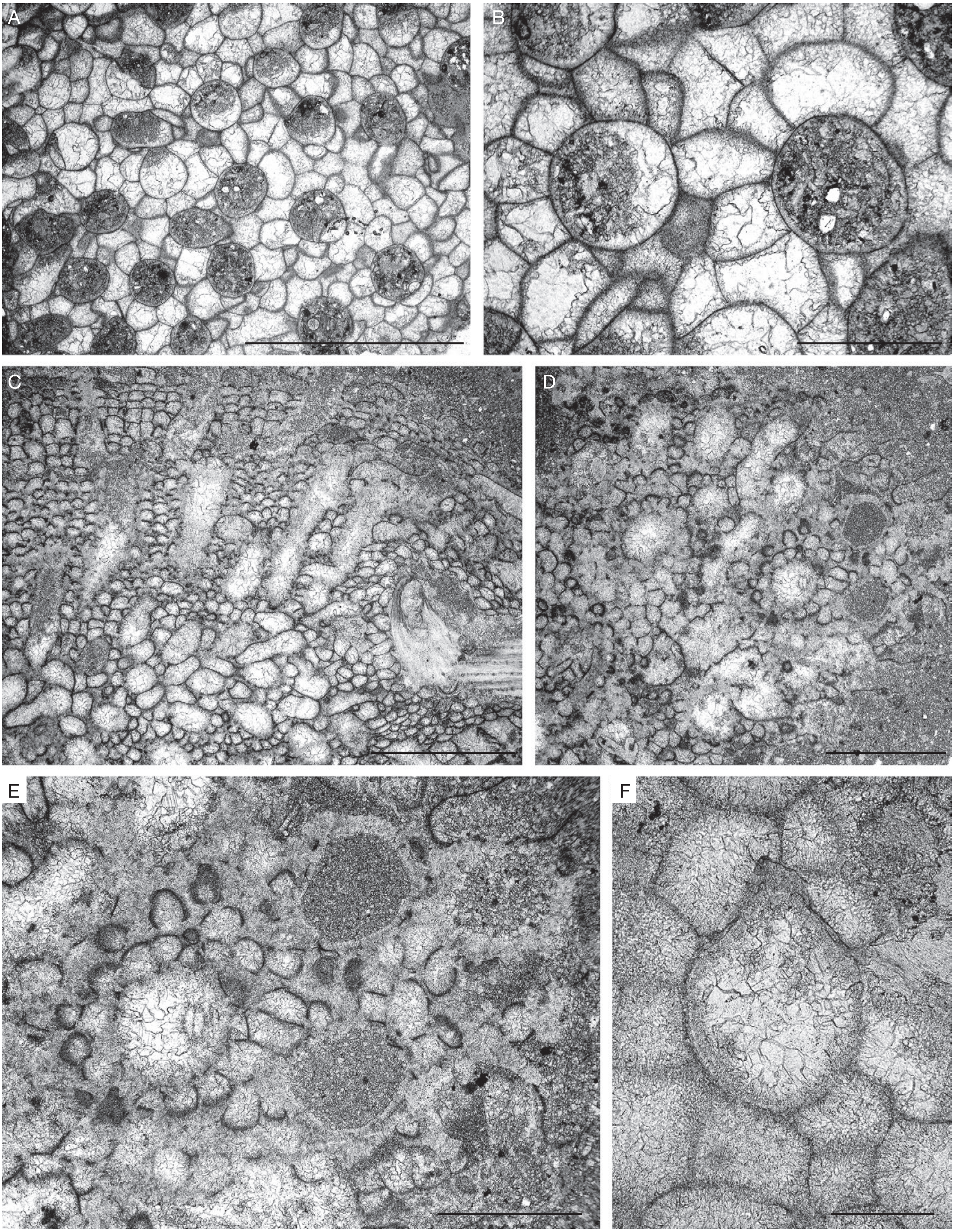

Fig. 7. — *Fistulipora prolifica* Ulrich, 1884; **A**-**B**, tangential section showing autozooecial apertures and vesicles, SMF 23.117; **C**-**F**, *Fistulipora* cf. *tubulosa* Nikiforova, 1933: **C**, longitudinal section, SMF 23.123; **D**, **E**, tangential section, SMF 23.124; **F**, tangential section showing autozooecial 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. Autozooecia growing from thin epitheca, bending in the early exozone to the colony surface. Basal diaphragms rare to absent, straight, thin. Autozooecial apertures circular to oval. Lunaria weakly developed, horseshoe-shaped; ends of lunaria not indenting autozooecia. Vesicles small, separating autozooecia in 1-2 rows, 8-13 surrounding each autozooecia aperture, with rounded roofs, polygonal in tangential section. Autozooecial 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 autozooecial 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 autozooecial 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. Autozooecia 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 autozooecial chamber. Autozooecial 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 autozooecia in radial arrangement.

Comparison
Dybowskiella Waagen & Wentzel, 1886 differs from *Fistulipora* M'Coy, 1849 in the shape of lunaria, which ends inflect autozooecial 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; autozooecial diaphragms common to abundant; vesicles large, separating autozooecia in 1-2 rows, 6-10 surrounding each autozooecial aperture.

Description
Encrusting colony, 0.9-2.9 mm thick. Autozooecia 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 autozooecium. Autozooecial apertures circular to oval. Lunaria well-developed, rounded, rounded; ends of lunaria indenting deeply autozooecia. Vesicles large, irregular, separating autozooecia in 1-2 rows, 6-10 surrounding each autozooecia aperture, with rounded roofs, polygonal in tangential section. Autozooecial walls granular prismatic, 0.010-0.015 mm thick.

Comparison
Dybowskiella rotunda n. sp. differs from *Dybowskiella piriforme* n. sp. in larger autozooecial 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 autozooecial 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 autozooecia in a single row, 5-9 surrounding each autozooecia aperture.

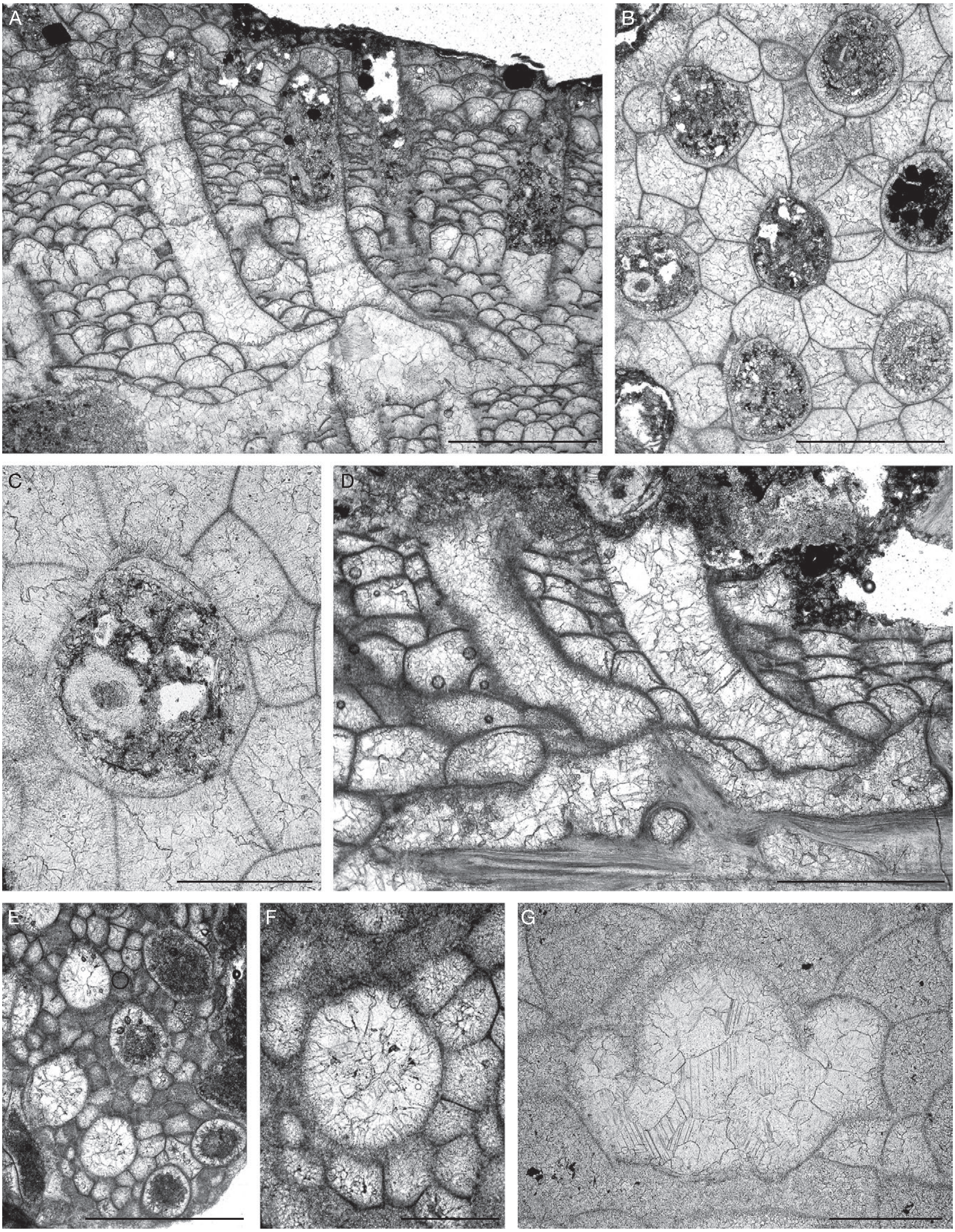

Fig. 8. — **A**-**C**, *Fistulipora parvilabrum* Schulga-Nesterenko, 1955; **A**, longitudinal section, SMF 21.770; **B**, tangential section, SMF 21.771; **C**, tangential section showing autozooecial aperture with lunarium, SMF 21.771. **D**, **F**, *Fistulipora sana* Trizna, 1958; **D**, longitudinal section, SMF 21.775; **E**, tangential section, SMF 21.774; **F**, tangential section showing autozooecial 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. Autozooecia growing from thin epitheca, often for long distances parallel to substrate, bending in the early exozone to the colony surface. Basal diaphragms absent. Autozooecial 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 autozooecia. Vesicles small to large, separating autozooecia in a single row, 5-9 surrounding each autozooecia aperture, with rounded to flat roofs, polygonal in tangential section. Autozooecial 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 autozooecial 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 und 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 autozooecia 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 autozooecial aperture; maculae present, consisting of vesicular skeleton.

Description

Encrusting colony, 0.42-3.35 mm thick. Autozooecia growing from thin epitheca, bending in the early exozone to the colony surface. Basal diaphragms rare. Autozooecial apertures circular to oval. Lunaria well-developed, triangular; ends of lunaria not indenting autozooecia. Vesicles small to large, separating autozooecia in 1-2 rows, 6-11 surrounding each autozooecia aperture, with rounded roofs, polygonal in tangential section. Autozooecial 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 autozooecia 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. Autozooecia 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 autozooecia, common to abundant. Autozooecial apertures circular to oval, with thick peristomes. Lunaria obscure. Autozooecia 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.

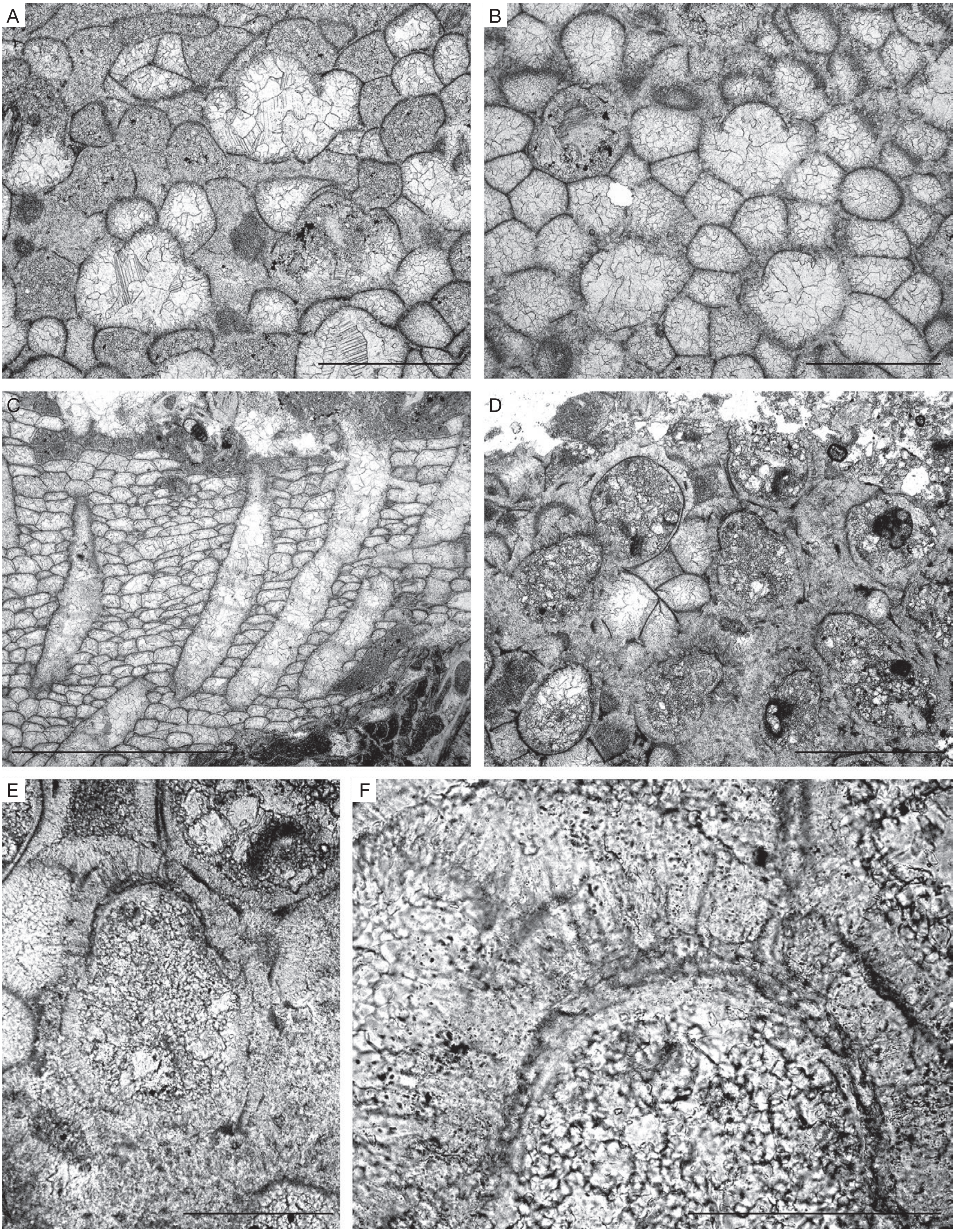

Fig. 9. — **A**-**C**, *Dybowskiella rotunda* n. sp.; **A**, tangential section, holotype SMF 21.777; **B**, tangential section, paratype SMF 21.780; **C**, longitudinal section, holotype SMF 21.777. **D**-**F**, *Dybowskiella piriforme* n. sp., holotype SMF 21.781: **D**, tangential section, **E**,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

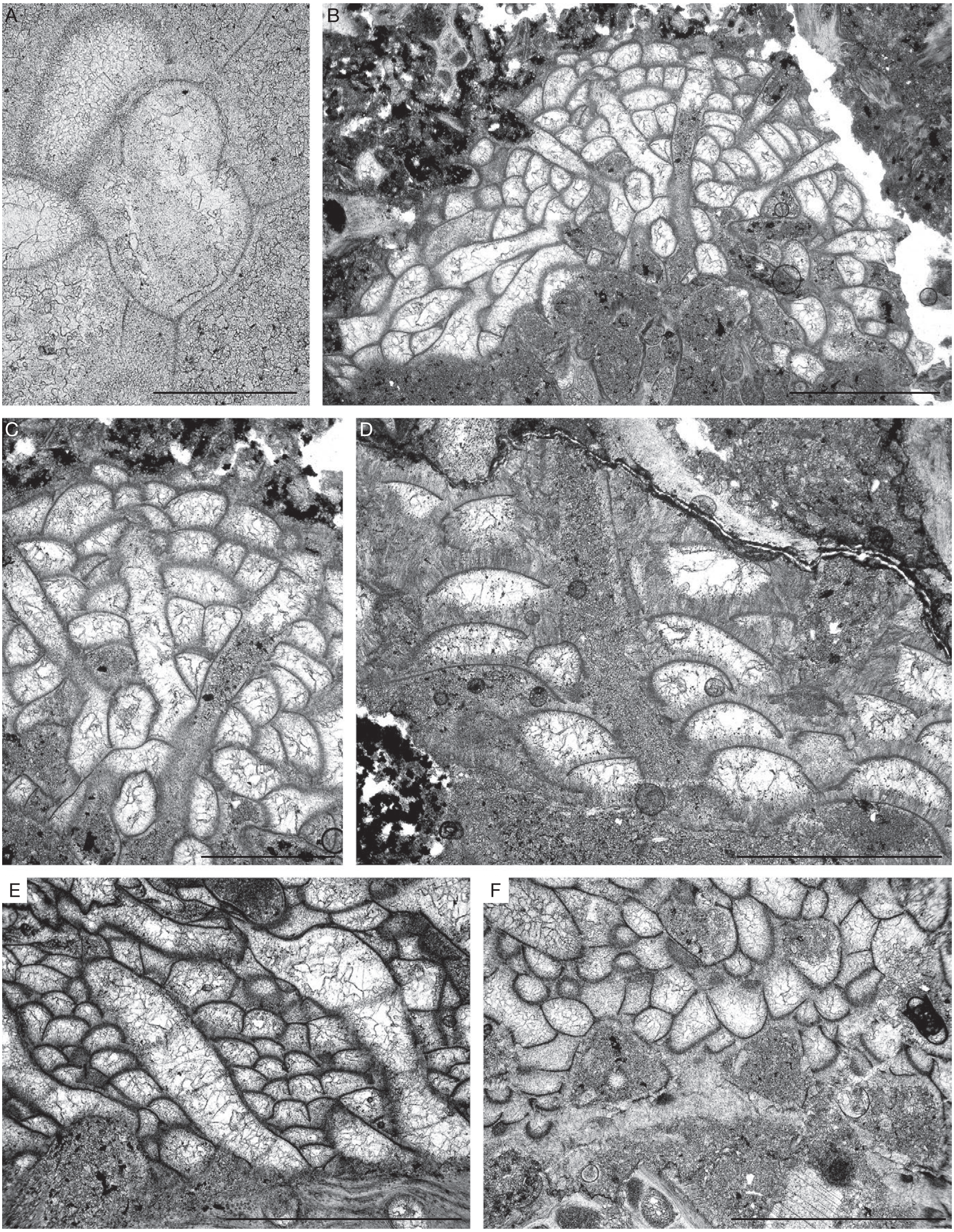

Fig. 10. — **A**-**D**, *Dybowskiella piriforme* n. sp.; **A**, tangential section showing autozooecial aperture with lunarium, paratype SMF 21.787; **B**-**D**, longitudinal section, paratype SMF 21.786; **E**, **F**, *Eridopora suarezi* n. sp. **E**, longitudinal section, paratype SMF 21.799; **F**,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

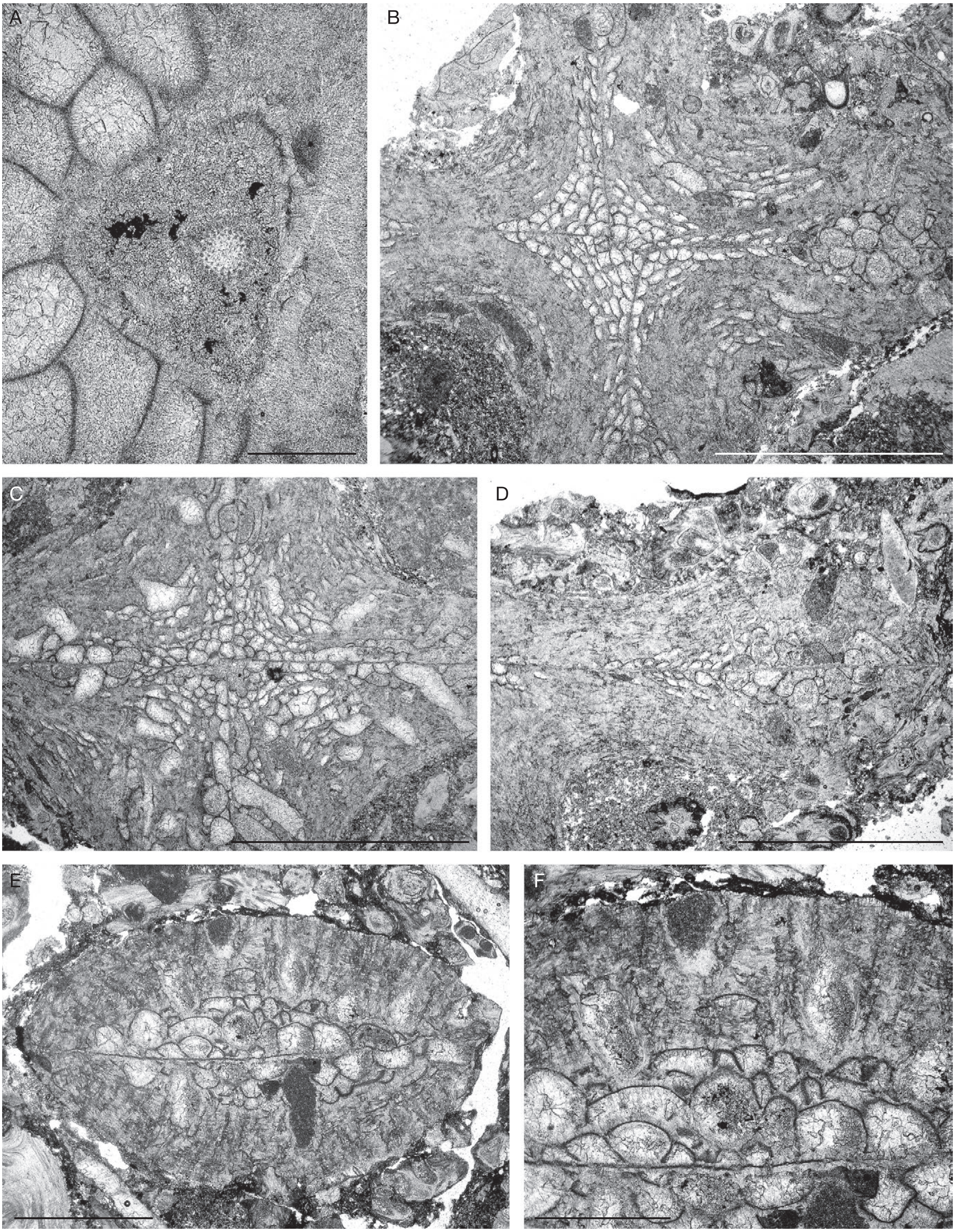

FIG. 11. — **A**, *Eridopora suarezi* n. sp., tangential section showing autozooecial aperture, holotype SMF 21.794: **B-F.** *Volgia deftera* n. sp.; **B**, transverse section of the colony, holotype SMF 21.802; **C**, transverse section of the colony, paratype SMF 21.812; **D**, longitudinal section, 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 autozooecia, 10-12 surrounding each autozooecial aperture; stereom thick, consisting of laminated material, completely separating autozooecia in exozone, containing abundant tubules; metazooecia (? 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). Autozooecia recumbent on the mesotheca or epitheca for a relatively long distance, then bending upwards abruptly, intersecting the surface almost perpendicularly. Thin, complete diaphragms in autozooecia occasionally present. Autozooecial 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 autozooecia, 10-12 surrounding each autozooecial aperture. Stereom thick, consisting of laminated material, completely separating autozooecia 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 metazooecia (exozonal tubes) present. Metazooecia (? exozonal tubes) locally abundant, flask-shaped, restricted to stereom.

Comparison

The new species differs from *Volgia arborescens* (Stuckenberg, 1895) by larger autozooecial apertures (0.17-0.29 mm vs 0.14-0.15 mm in *Volgia arborescens*). Furthermore, no heterozooecia 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. Autozooecia with peristomes and lunaria. Ridges between autozooecial rows lacking. Mesotheca thin to moderately thick, indistinctly laminated to granular-prismatic, with low ridges, running parallel to ranges of autozooecia. Autozooecia teardrop-shaped at their basis, quadrate in cross-section; partly isolated by boxlike vesicles; recumbent portion short; blunt proximolateral hemisepta at zooecial bend, indenting zooecial cavity and producing slight hook-shaped appearance of autozooecia 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 autozooecial 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. — Bioliate branches with mesotheca; median tubules absent; autozooecia tubular; diaphragms lacking; blunt proximolateral hemisepta at zooecial bent present; autozooecial 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 autozooecia 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. Autozooecia tubular, teardrop-shaped at their bases,

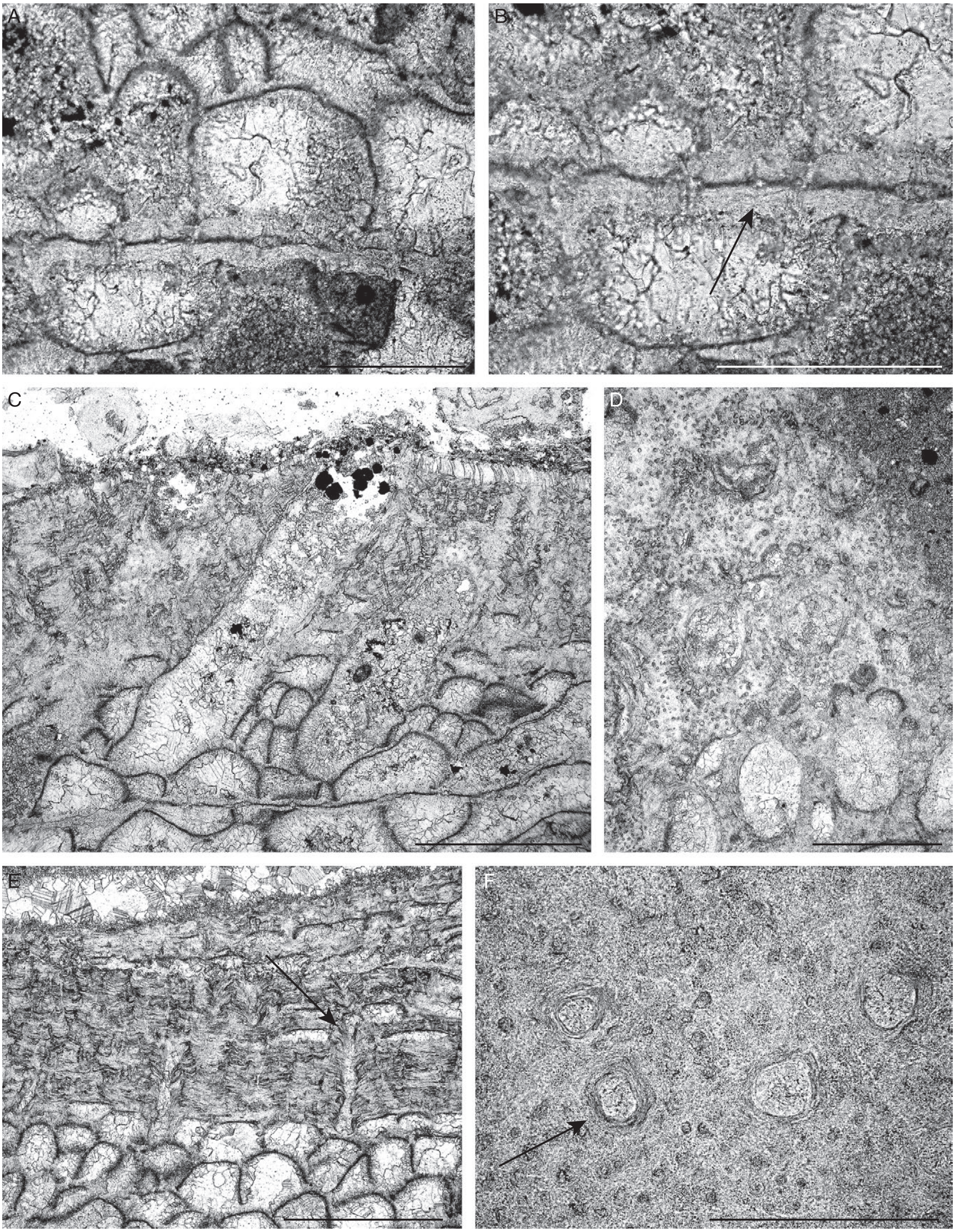

FIG. 12. — **A**-**F**, *Volgia deftera* n. sp.; **A**, **B**, branch transverse section showing mesotheca with median tubuli (arrow), paratype SMF 21.805; **C**, longitudinal section, paratype SMF 21.804; **D**, tangential section showing autozooecial apertures, metazooecia (? exozonal tubes) and tubules,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

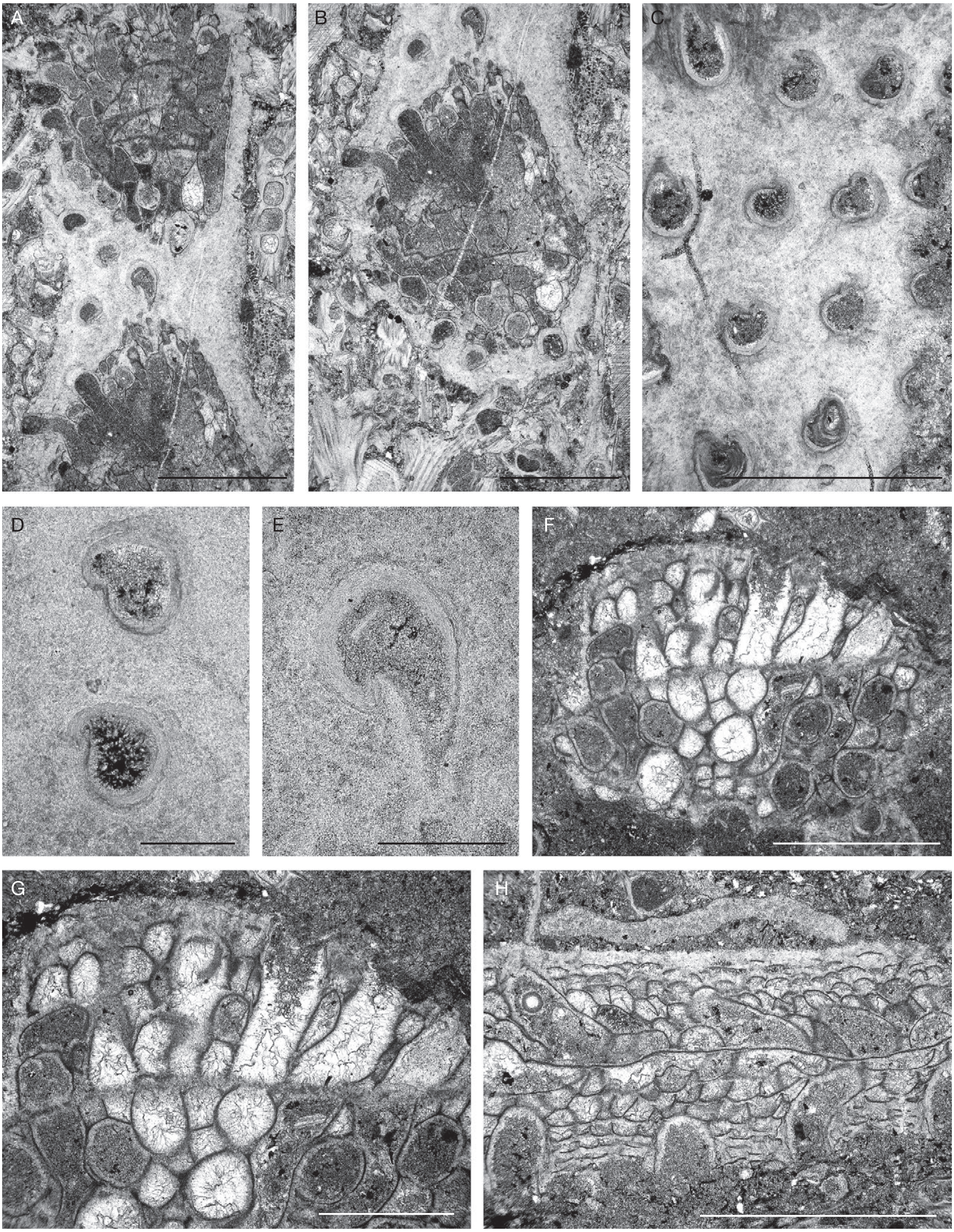

Fig. 13. — **A-H**, *Cystodictya gallensis* n. sp.; **A-B**, branch oblique section, paratype SMF 21.822; **C-D**, tangential section, holotype SMF 21.815; **E**, tangential section showing autozooecial aperture, paratype SMF 21.822; **F-G**, branch transverse section, paratype SMF 21.819; **H**, branch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

Ramipora Toula, 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 cairna, whereas mesotheca in *Ramopora* 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. Autozooecia 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. Autozooecial 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. Autozooecial walls 0.005-0.010 mm thick, granular-prismatic. Extrazooecial 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. Autozooecia with basal diaphragms and ring septa. Autozooecial walls irregularly thickening with development of monilae. Exilazooecia 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. Autozooecia 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 autozooecial chamber space. Acanthostyles moderately large, concentrated predominantly in maculae, having narrow hyaline cores and wide laminated sheaths. Exilazooecia 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 autozooecial boundaries, 0.05-0.07 mm thick. Maculae consisting of larger autozooecia present, 2.2-2.4 mm in diameter.

COMPARISON

Tabulipora howsii (Nicholson, 1881) differs from *T. urii* (Fleming, 1828) in larger autozooecial 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 autozooecial 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 exilazooecia. Autozooecia parallel to longitudinal direction of the colony in endozone; gradually bending outward in exozone. Diaphragms in autozooecia lacking or very rare; lacking in exilazooecia. Exilazooecia circular to angular in cross section and separated from the autozooecia 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).

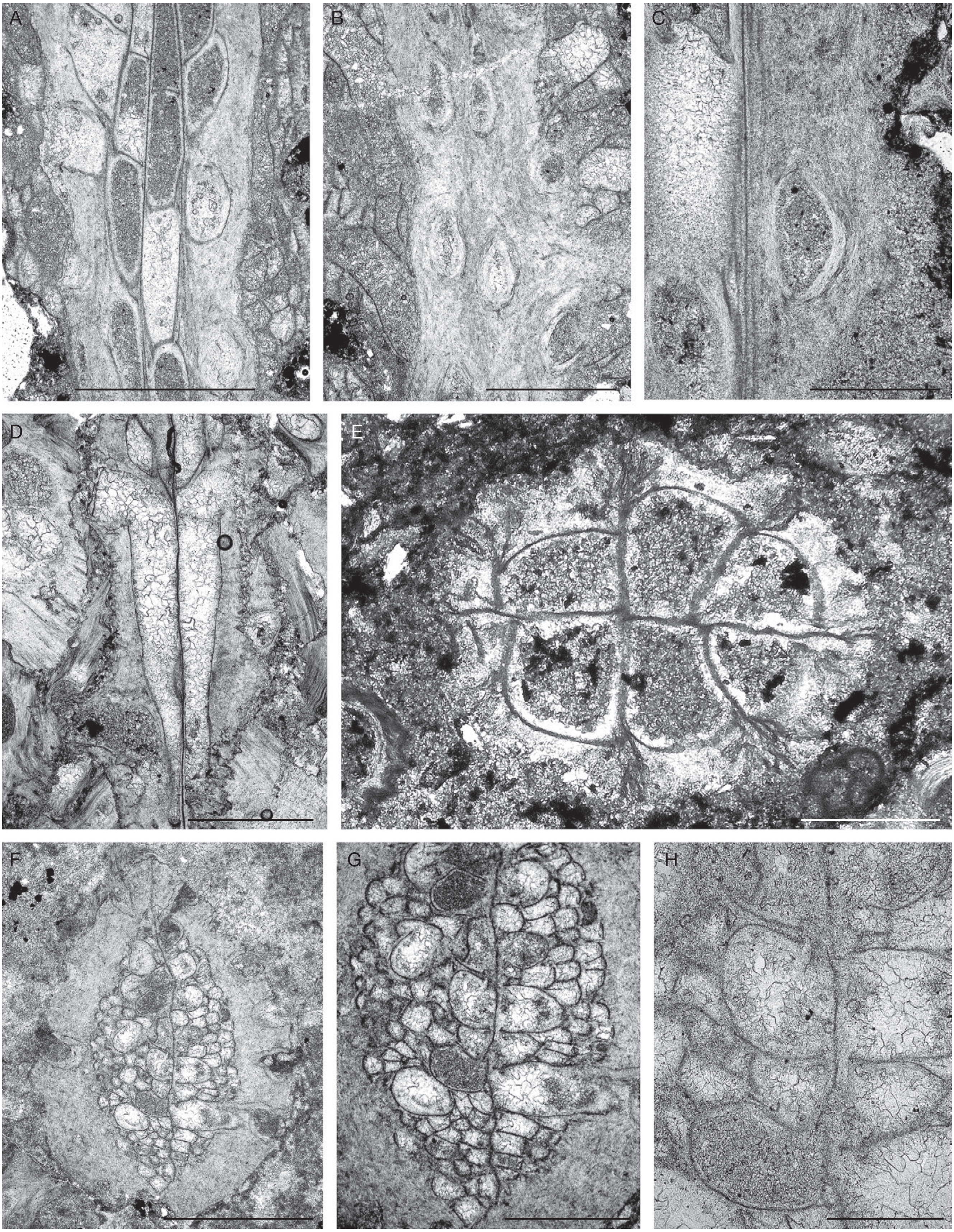

FIG. 14. — **A**-**E**, *Sulcoretepora parallela* (Phillips, 1836); **A**, deep tangential section, SMF 21.824. **B**, tangential section, SMF 21.824; **C**, tangential section, SMF 21.837; **D**, longitudinal section, SMF 21.827. **E**, branch transverse section, SMF 21.833; **F**-**H**, *Ramiporalia 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.

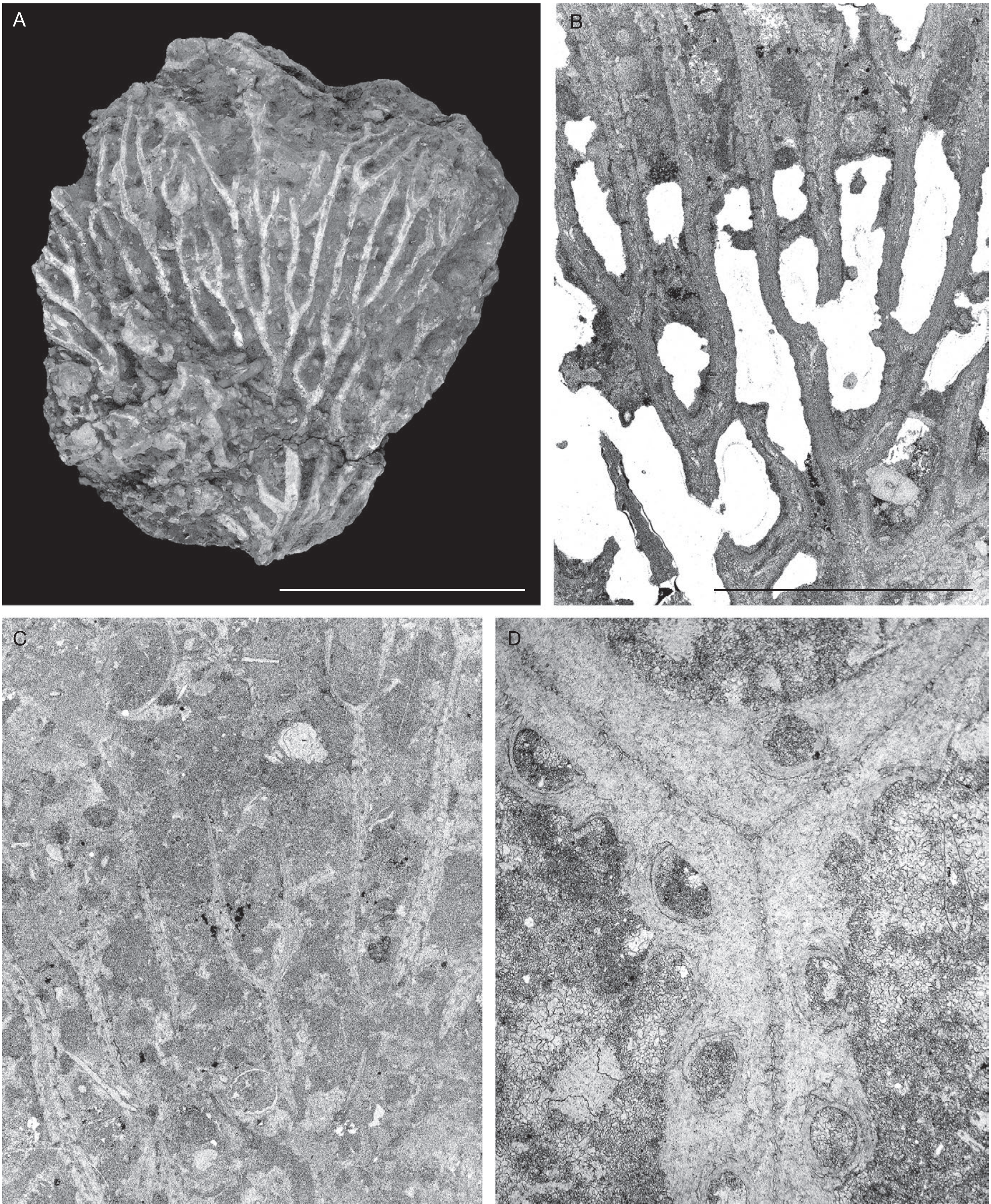

Fig. 15. — **A**-**D**, *Ramiporalia robusta* Delvolve & McKinney, 1983; **A**, general view of the colony; **B**, mid-tangential section of the colony, SMF 21.841; **C**, **D**, shallow tangential section of the colony, SMF 21.842. Scale bars: A, 30 mm; B, C, 10 mm; D, 0.5 mm.

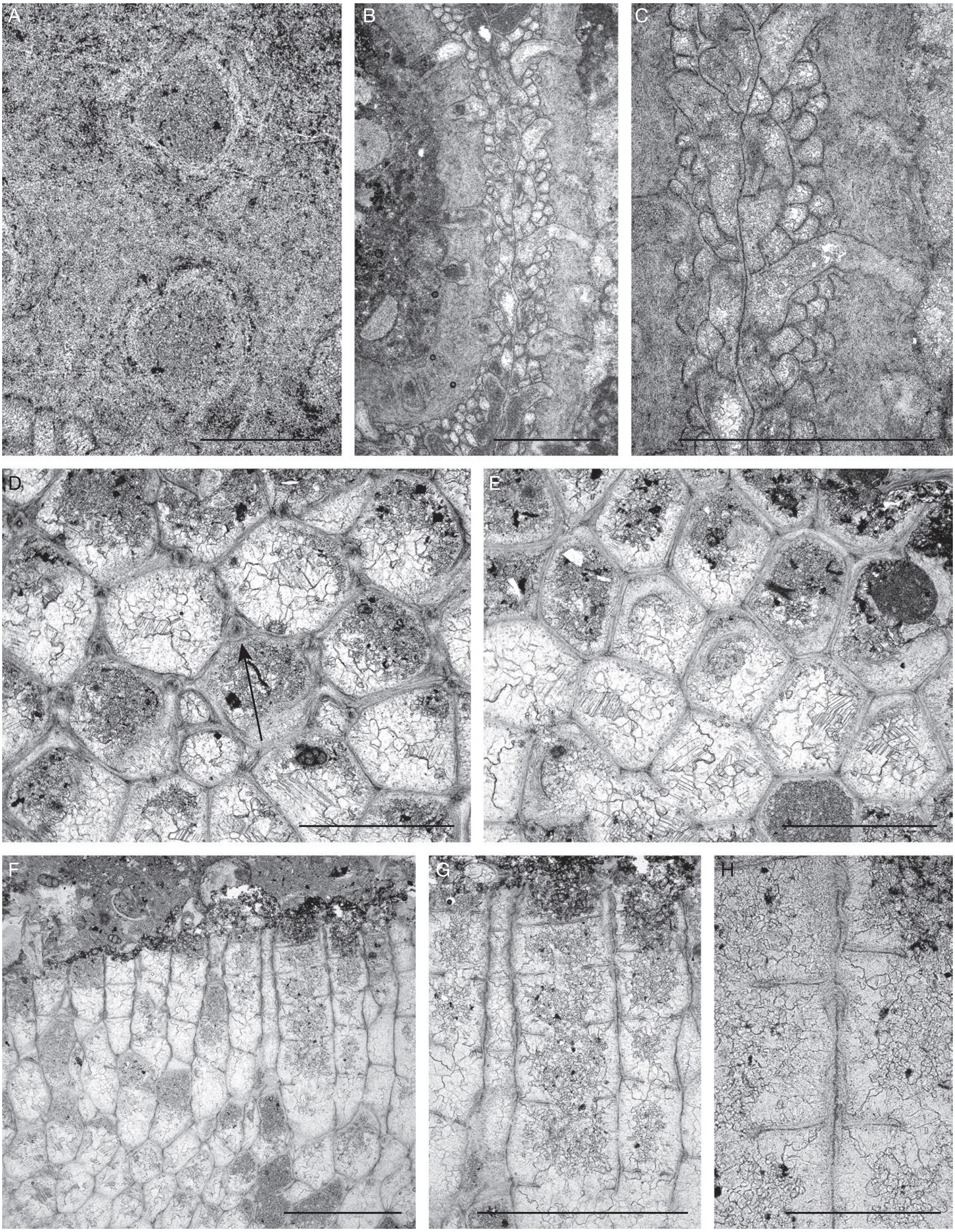

Fig. 16. — **A**-**C**, *Ramiporalia robusta* Delvolve & McKinney, 1983; **A**, shallow tangential section showing autozooecial aperture, SMF 21.839; **B**, **C**, branch mid-tangential section, SMF 21.841; **D**-**H**, *Tabulipora howsii* (Nicholson, 1881); **D**, **E**, tangential section showing autozooecial 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; autozooecial chambers simple, tubular, diverging from budding base at angle of between 45-80°, subparallel in endozone, with abrupt turn at endozone-exozone boundary. Zooecial 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 autozooecial 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; autozooecia 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; autozooecial apertures oval or rounded, dorsally flared, arranged regularly in 4 to 10 longitudinal rows, commonly having peristomes; zooecial boundaries well defined, narrow; extrazooecial 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 autozooecia 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. Autozooecia arranged in five rows on obverse surface. Interapertural walls undulatory between autozooecia in longitudinal rows, smooth with small stylets along their crests. Autozooecial apertures pyriform, twice as long as wide. Reverse surface barren, smooth with faint longitudinal rows of small stylets. Autozooecial 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 autozooecia.

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. Autozooecia occurring in 6 to 16 longitudinal rows, budding in an annular manner, originating from a central axis or median wall. Autozooecial 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 autozooecia 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.

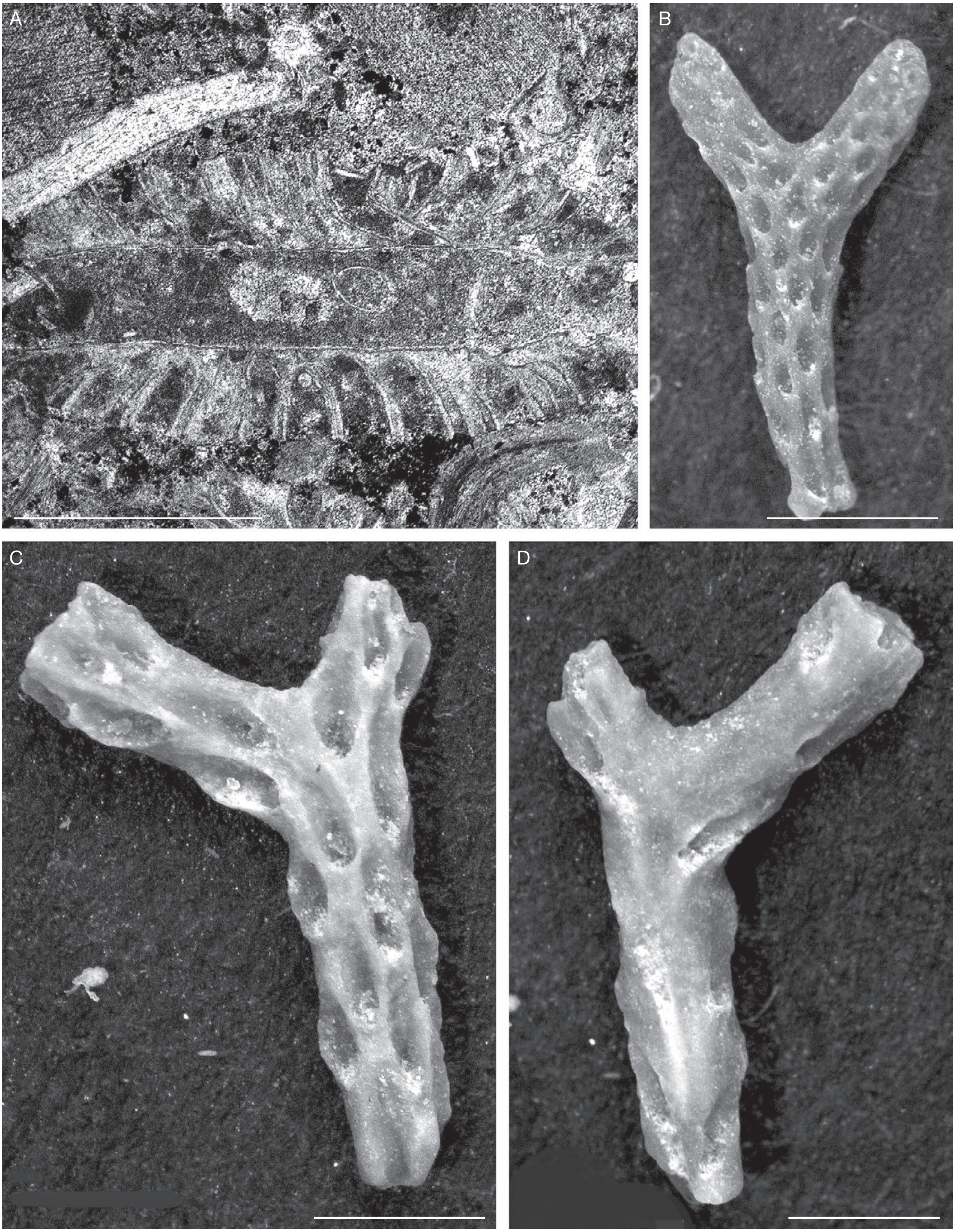

FIG. 17. — **A**, *Dyscritella* sp., longitudinal section, TCD.60345; **B**-**D**, *Nematopora hibernica* Wyse Jackson, 1996; **B**, obverse colony surface, TCD.60348; **C**, obverse colony surface, TCD.60349; **D**, reverse colony surface, TCD.60349. Scale bars: A, 0.5 mm; B-D, 1 mm.

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 autozooecia budding in spiral order from the central axis. Hemisepta absent; terminal diaphragms common. Autozooecial apertures oval to teardrop-shaped, 0.10-0.14 mm wide, arranged in regular diagonal rows. Autozooecia 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 heterozooecia 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 heterozooecia. *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 heterozooecia.

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; autozooecia elongated-tubular with rare diaphragms; autozooecial apertures rounded or oval; tectitozooecia common, irregular, closed by laminated skeleton near colony surface; acanthostyles on the surface common; autozooecial 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 autozooecia, which bud from a distinct median axis in *Nematotrypa*. *Nemacanthopora* Termier & Termier, 1971 was separated from *Clausotrypa* because of its shape of autozooecia (shorter vs longer autozooecia 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. Autozooecia long, cylindrical, budding parallel to the branch axis for a long distance, gently curved toward to the colony surface. Autozooecial apertures oval. Thin, planar diaphragms rare in autozooecia. Tectitozooecia abundant, separating autozooecia 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 autozooecia. Autozooecial walls laminated, having dark serrated boundaries, 0.020-0.025 mm thick.

Comparison
Clausotrypa ramosa (Owen, 1973) is similar to *C. monticula* (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 progracile* 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. Autozooecia regularly budding around central axial cylinder in an annual or spiral manner. Hemisepta common. Autozooecial 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

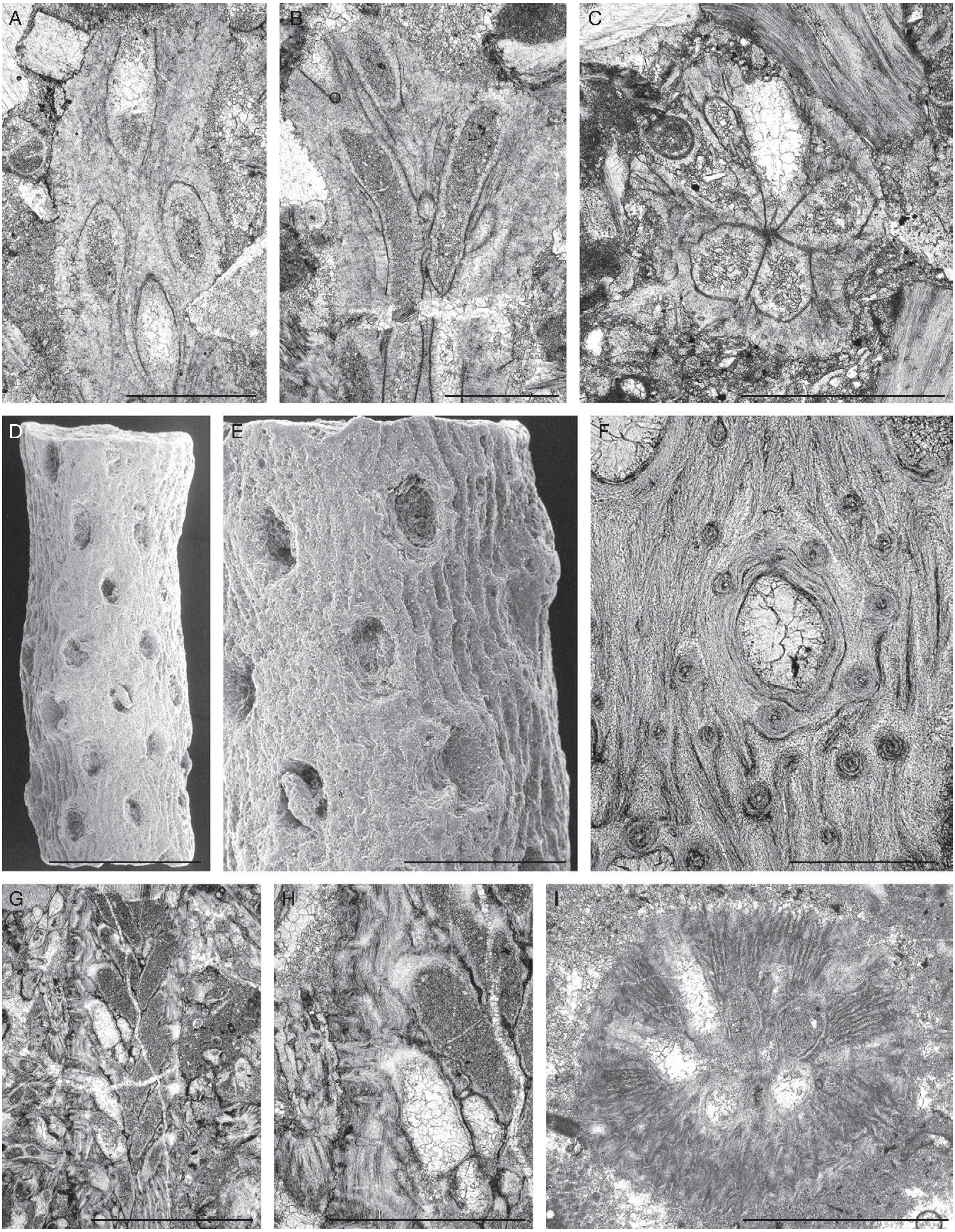

Fig. 18. — **A**-**C**, *Pseudonematopora planatus* Wyse Jackson, 1996; **A**, tangential section, SMF 21.857; **B**, longitudinal section, SMF 21.857; **C**, Transverse section, SMF 21.856; **D**-**I**, *Clausotrypa ramosa* (Owen, 1973); **D**, **E**, branch surface, SMF 21.871; **F**, tangential section, 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. Autozooecia 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. Autozooecial 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 autozooecia, 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 autozooecial apertures. *R. progracile* differs from *R. regularis* in having larger hemisepta and wider autozooecial 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. Autozooecia 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 autozooecia regular. Diaphragms complete, rare. Hemisepta absent. Metazooecia 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 autozooecia 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. Autozooecia 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. Autozooecial apertures oval, arranged in regular diagonal rows on branches. Basal diaphragms rare, thin, planar. Aktinotostyles abundant, arranged in a single row between autozooecia. Autozooecial 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 autozooecial 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). Autozooecia 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 autozooecia irregular. Diaphragms complete, rare, occurring only in the exozone. Metazooecia rare to common. Acanthostyles uncommon. Aktinotostyles abundant, generally closely spaced, arising in the exozone. Autozooecial walls laminated, containing mural spines.

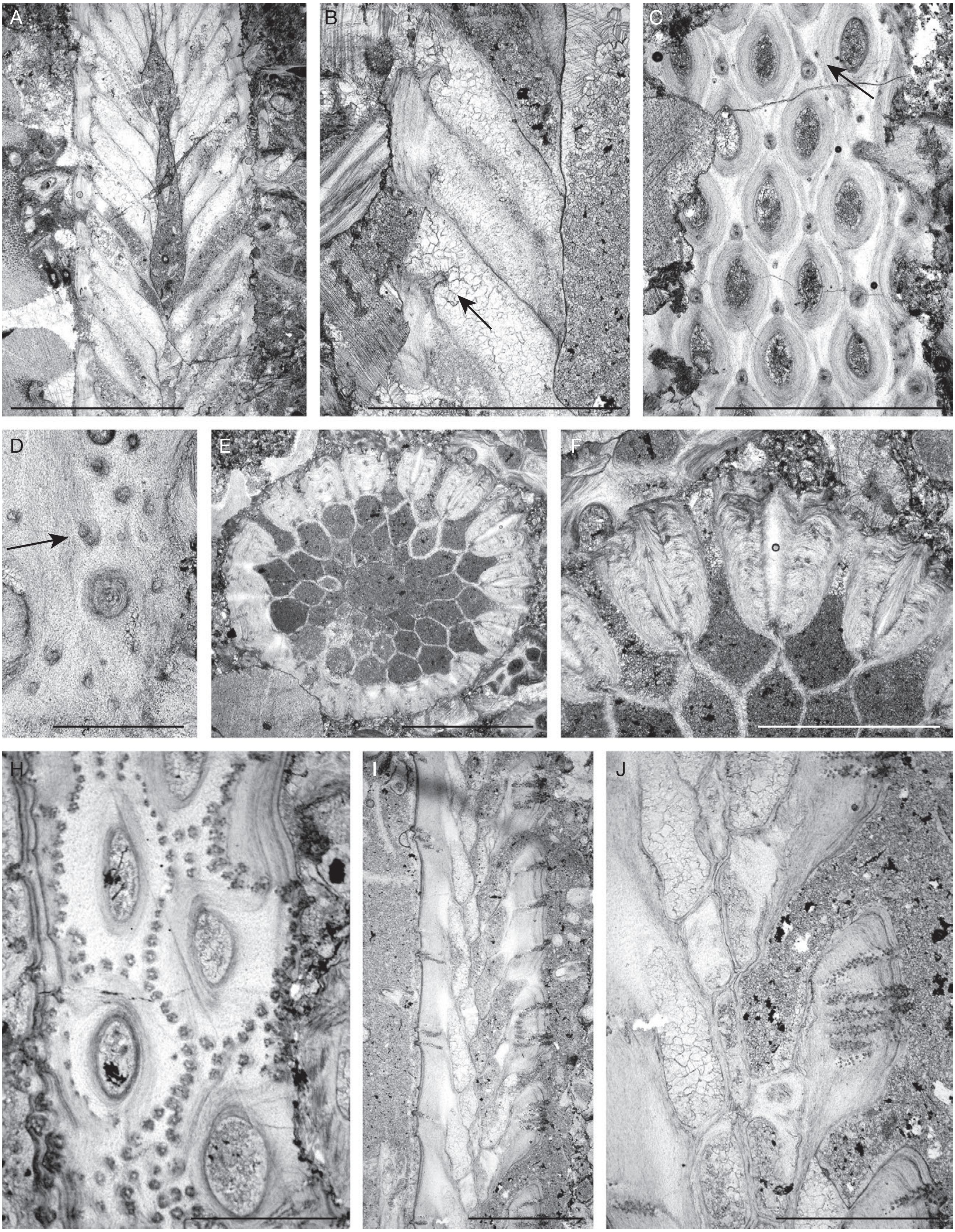

Fig. 19. — **A**-**F**, *Rhabdomeson progracile* Wyse Jackson & Bancroft, 1995; **A**, longitudinal section showing axial cylinder, SMF 21.882; **B**, longitudinal section showing autozooecial chambers with hemisepta (**arrow**), SMF 21.882; **C**, tangential section showing autozooecial apertures, acanthostyles 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 autozooecial apertures and aktinotostyles; **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 (Trepostomida). 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 Visean).

Diagnosis. — Branched colonies of intermediate diameter; exozones wide; large acanthostyles and abundant aktinotostyles; metazooecia common; rare basal diaphragms; autozooecial 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. Autozooecia 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. Autozooecial apertures oval to slightly polygonal, arranged irregularly on branches. Basal diaphragms rare, thin, planar. Aktinotostyles abundant, arranged irregularly between autozooecia. 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. Autozooecial 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 autozooecial 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 between 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. Autozooecia 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 autozooecia 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 Visean); Roque Redonde (Montagne Noire, southern France).

Exterior description
Reticulate colony formed by straight branches joined by relatively narrow dissepiments. Fenestrules rectangular, elongated. Autozooecia arranged in two rows on branches. Autozooecial 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
Autozooecia short, pentagonal in mid tangential section; with short to moderately long vestibule. Axial wall between autozooecial 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. Heterozooecia 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

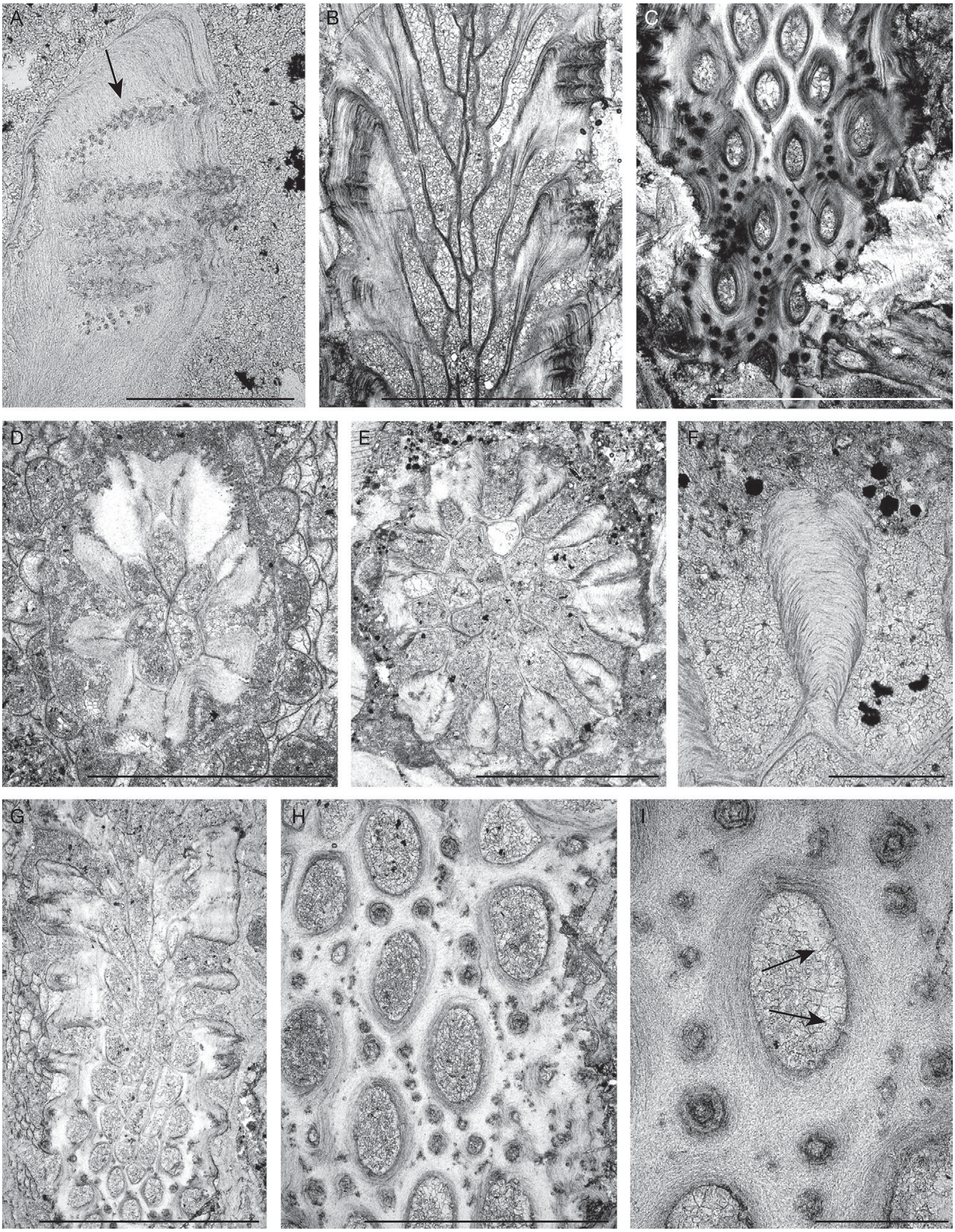

Fig. 20. — **A**-**D**, *Saffordotaxis incrassata* (Ulrich, 1888); **A**, longitudinal section showing aktinotostyles in the autozooecial wall (arrow), SMF 21.889; **B**, longitudinal section, SMF 21.890; **C**, tangential section, SMF 21.890; **D**, branch transverse section, SMF 21.886; **E**-**I**, *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 autozooecial apertures, acanthostyles, aktinotostyles 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. Autozooecia arranged in two rows on the branches. Autozooecia 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 autozooecia 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. Autozooecia arranged in two rows on branches. Autozooecial 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

Autozooecia short, triangular to trapezoid in mid tangential section; with short to moderately long vestibule in longitudinal section. Axial wall between autozooecial 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. Heterozooecia 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. Autozooecia arranged in two rows on branches. Autozooecial 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

Autozooecia short, triangular to trapezoid in mid tangential section; with short to moderately long vestibule in longitudinal section. Axial wall between autozooecial 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. Heterozooecia 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

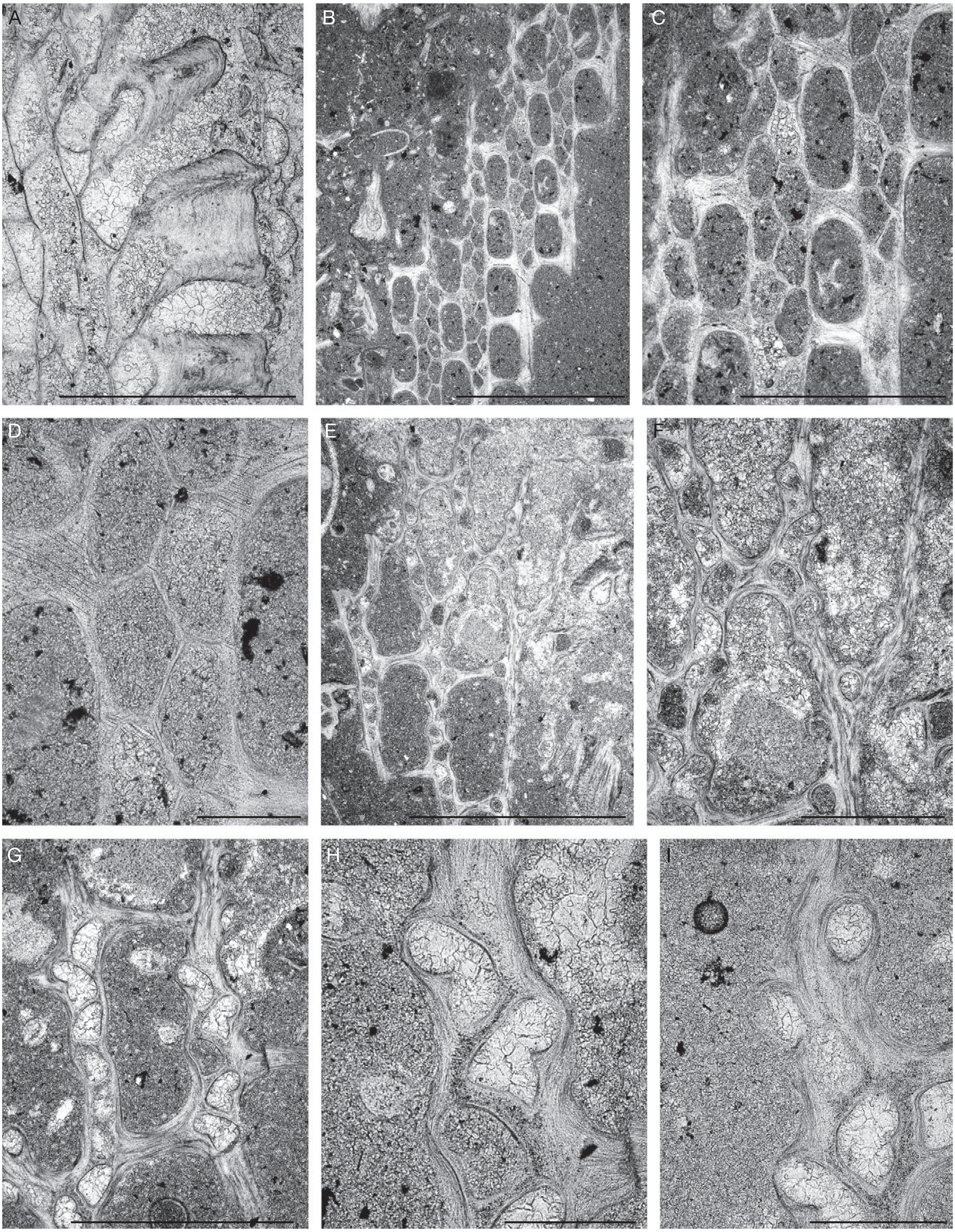

FIG. 21. — **A**, *Megacanthopora enodata* n. sp., longitudinal section showing autozooecial walls with aktinotostyles and mural spines, paratype SMF 21.895. **B**-**D**, *Rectifenestella* sp., SMF 21.898, tangential section; **E-I**, *Spinofenestella major* (Nikiforova, 1933) comb. nov., SMF 21.899;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

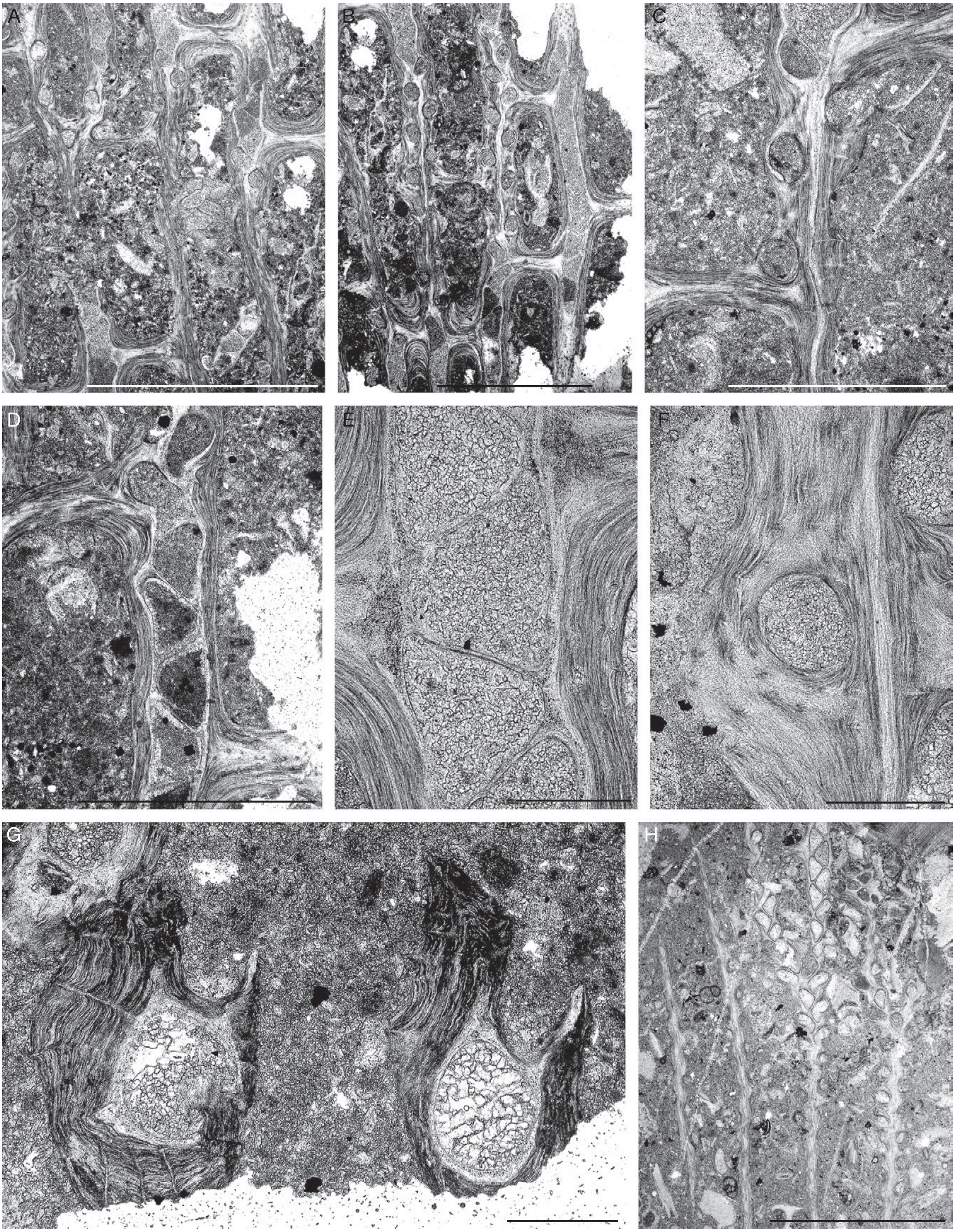

Fig. 22. — **A**-**G**, *Spinofenestella* sp. 1; **A**, **B**, tangential section, SMF 21.901; **C**, tangential section showing apertures and keel, SMF 21.900; **D**, mid-tangential section showing autozooecial chambers, SMF 21.900; **E**, mid-tangential section showing autozooecial chambers, SMF 21.901; **F**, tangential section showing autozooecial 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.

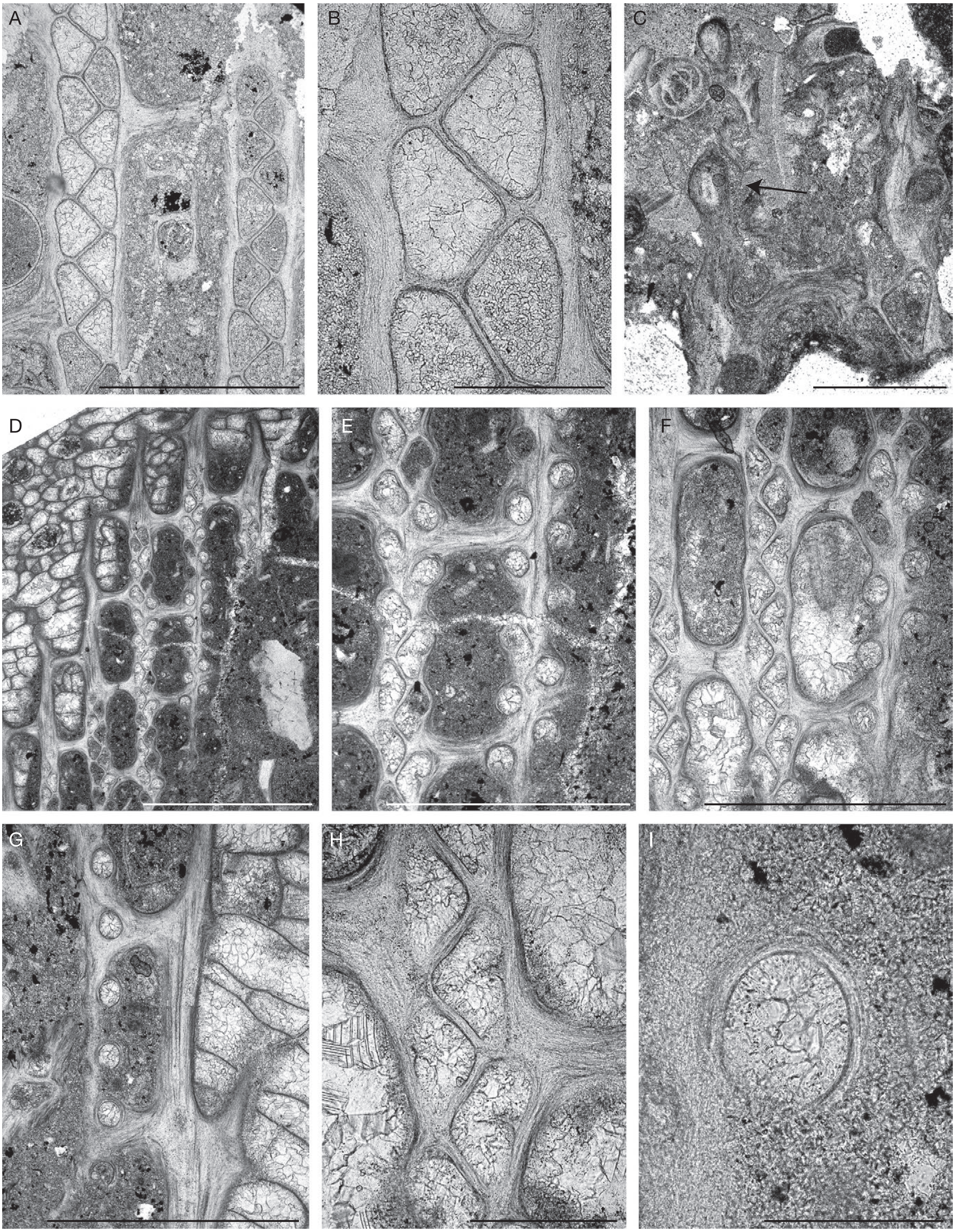

FIG. 23. — **A-C**, *Spinofenestella* cf. *simplaris* (Trizna, 1961); A-B, mid-tangential section, SMF 21.908; C, tangential section showing nodes on keel (arrow), SMF 21.906; **D-I**, *Spinofenestella* sp. 2, SMF 21.911; **D-G**, tangential section; **H**, mid-tangential section showing autozooecial chambers; **I**, autozooecial aperture. Scalr 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. Autozooecia arranged in two rows on branches. Autozooecial 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
Autozooecia short, triangular to trapezoid in mid tangential section; with short to moderately long vestibule in longitudinal section. Axial wall between autozooecial 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. Heterozooecia not observed.

Comparison
Spinofenestella sp. 1 most closely resembles *S. ungadyjensis* (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. ungadyjensis* 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. Autozooecia arranged in two rows on branches. Autozooecial 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
Autozooecia relatively long, triangular in mid tangential section; with short to moderately long vestibule in longitudinal section. Axial wall between autozooecial 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. Heterozooecia 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 sarytshevae* 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. Autozooecia arranged in two rows on the branches, rectangular to pentagonal in mid tangential section. Axial wall between autozooecial 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 autozooecia 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. Autozooecia arranged in two rows on branches. Autozooecial 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.

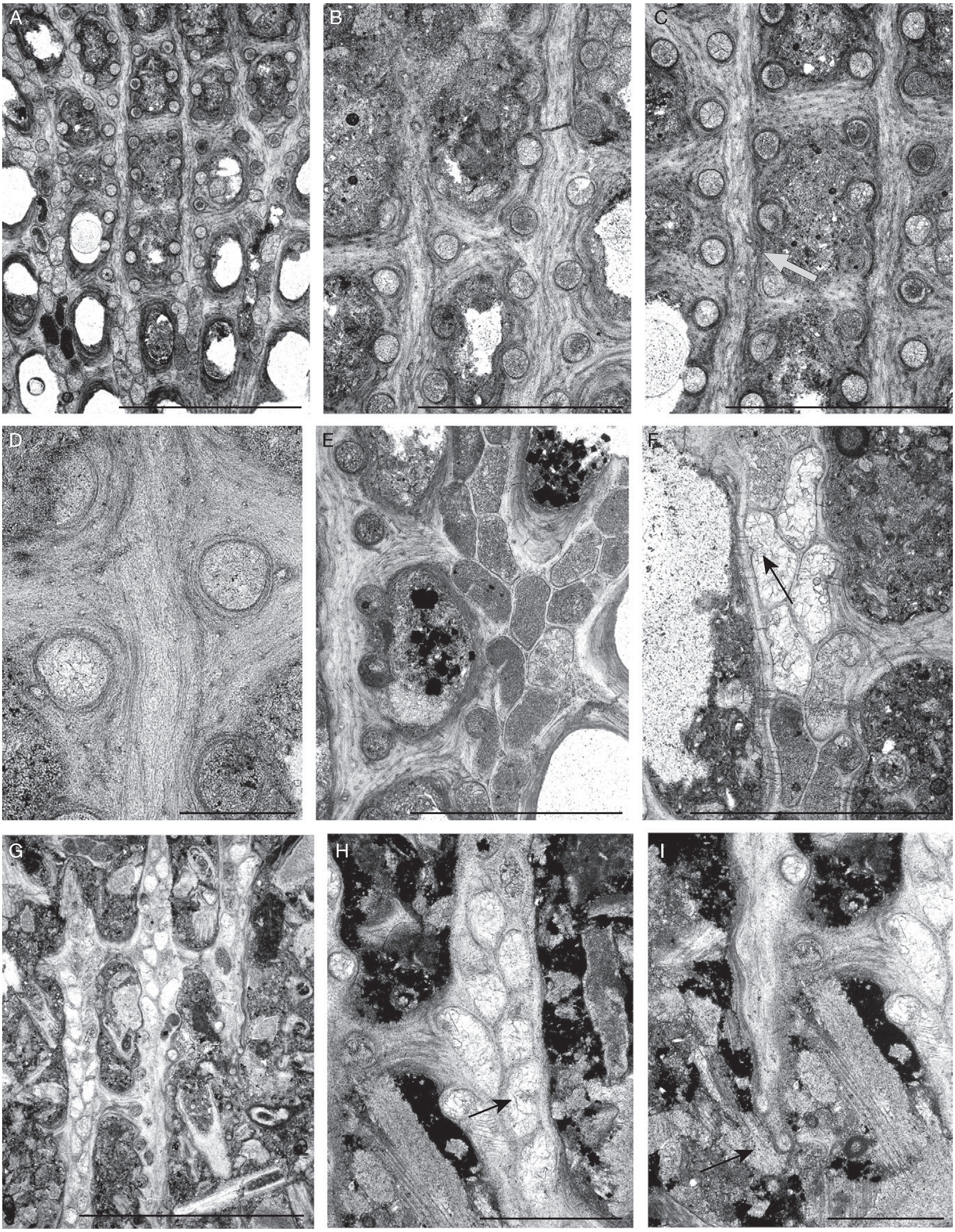

Fig. 24. — **A**-**F**, *Laxifenestella kondrovensis* (Schulga-Nesterenko, 1955); **A**-**D**, tangential section showing autozooecial apertures and low median keel with nodes (**arrows**), SMF 21.912; **E**, mid-tangential section showing autozooecial chambers with hemisepta, SMF 21.912; **F**, mid-tangential section showing autozooecial chambers with hemisepta, SMF 21.914. **G**-**I**, *Fabifenestella macrofenestrata* n. sp., holotype SMF 21.915; **G**-**H**, mid-tangential section showing autozooecial 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
Autozooecia relatively long, roughly pentagonal to rectangular in mid tangential section; with short to moderately long vestibule in longitudinal section. Axial wall between autozooecial rows weakly zigzag. Both superior and inferior hemisepta present, positioned in the distal half of autozooecial chamber. External laminated skeleton well-developed on both obverse and reverse sides. Heterozooecia 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 autozooecial 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 fenestrule, 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 autozooecial 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. Autozooecia 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 autozooecial 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 autozooecial 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; autozooecial apertures with 8 nodes; 4-6 apertures per fenestrule length; median keel wide, low, with densely spaced alternating nodes; nodes varying in size; autozooecia fabiform with distinct inferior and superior hemisepta; axial wall weakly or strongly undulating; heterozooecia 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. Autozooecia arranged in two rows on branches. Autozooecial apertures circular, with low peristome, containing 8 nodes; 4 to 6 apertures spaced per fenestrule length. Keel wide, low, containing densely spaced alternating nodes. Nodes varying in size, elliptically shaped.

Interior description
Autozooecia 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 autozooecial rows weakly to strongly undulating; aperture positioned at distal end of chamber. Both superior and inferior hemisepta present, positioned in the distal half of autozooecial chamber. External laminated skeleton well-developed on both obverse and reverse sides. Heterozooecia 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 fenestrule 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 heterozooecia (oval chambers 0.24 mm long and 0.16 mm wide). However, this species has considerable smaller fenestrules than the new one.

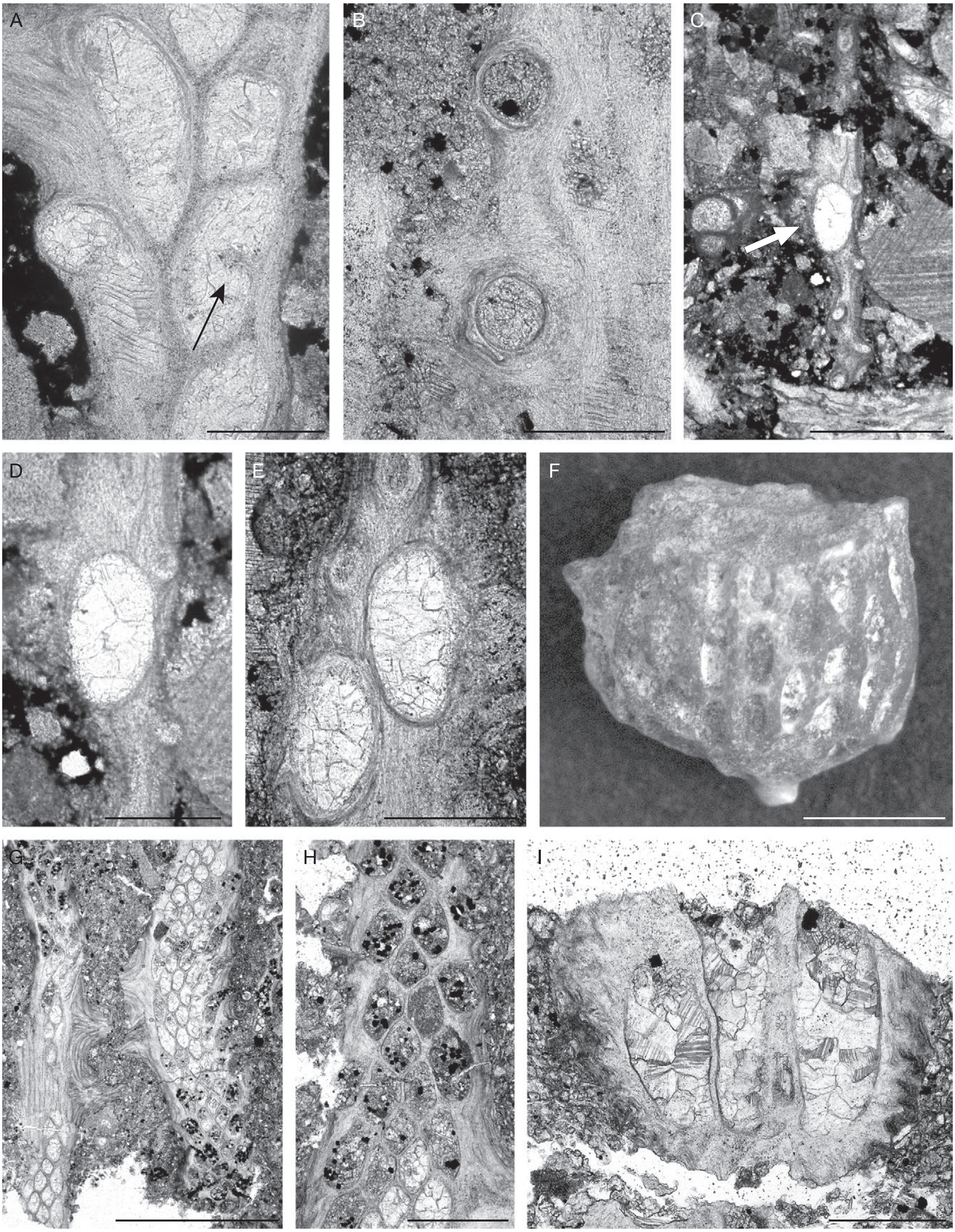

Fig. 25. — **A**-**E**, *Fabifenestella macrofenestrata* n. sp., holotype SMF 21.915; **A**, mid-tangential section showing autozooecial chambers with hemisepta (arrow); **B**, tangential section showing autozooecial apertures and apertural nodes; **C**-**E**, tangential section showing apparent brooding structures (C, arrow). **F**, *Ptilofenestella carrickensis* Tavener-Smith, 1965, TCD.60346; **G**-**I**, *Polypora dendroides* M'Coy, 1844; **G**, **H**, mid-tangential section showing autozooecial 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 autozooecia per branch; low median keel on obverse side of branch with nodes aligned in single row. Very long spine extends proximally from colony origin; autozooecial 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 autozooecia 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. Autozooecia arranged in two rows on outer-side of branches, autozooecial apertures circular, 4 to 5 per fenestrule length; autozooecial 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 autozooecia. Autozooecia arranged in four alternating rows on branches, 5-6 rows before and 2-3 after bifurcation. Autozooecial chambers tubular, short, having weakly developed inferior hemisepta and short vestibule, regularly hexagonal in mid tangential section. Autozooecial apertures rounded. Keels between longitudinal rows of autozooecia 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 autozooecia. *Polypora* differs from *Polyporella* Simpson, 1895 in presence of four rows of autozooecia 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. Autozooecia arranged in 3-5 alternating rows on branches. Autozooecial apertures rounded to oval, 7-10 spaced per length of fenestrule. Fenestrules oval, narrow.

Interior description

Autozooecial 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. Heterozooecia 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*.

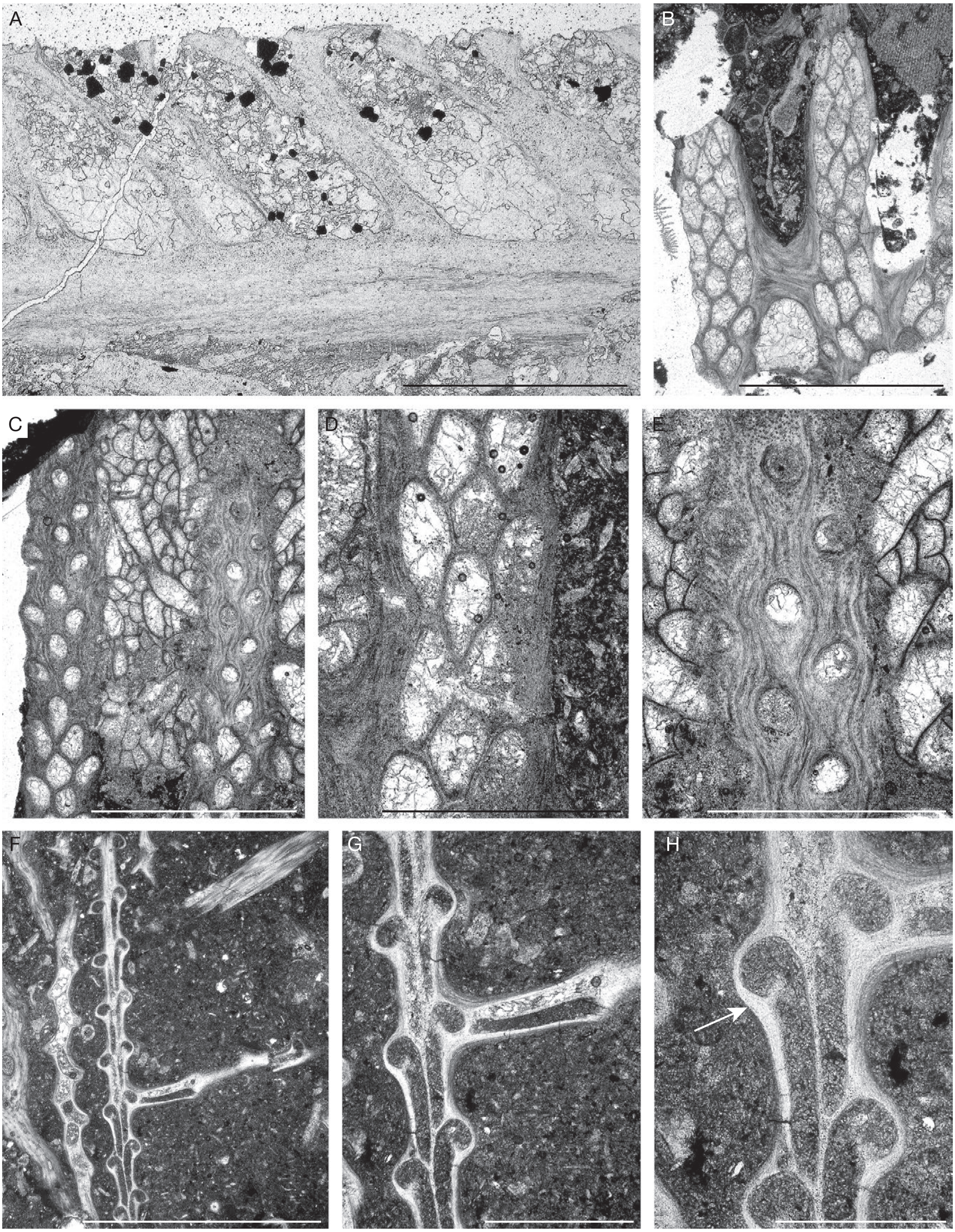

FIG. 26. — **A**, *Polypora dendroides* M'Coy, 1844, longitudinal section, SMF 21.919. **B-E**, *Polypora marginata* M'Coy, 1844, SMF 21.921; **B**-**D**, mid-tangential section showing autozooecial chambers and apertures; **E**, tangential section showing autozooecial apertures, undulatory striations and branch surface; **F**-**H**, *Diploporaria tenella* Wyse Jackson, 1988, mid-tangential section showing autozooecial 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. Autozooecia arranged in 3-4 alternating rows on branches. Autozooecial apertures rounded to oval. Low undulating longitudinal ridges/striations between autozooecia developed. Fenestrules subrectangular, long and narrow.

INTERIOR DESCRIPTION

Autozooecial 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. Heterozooecia 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. — *Glauconome* (*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 autozooecia.

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. Autozooecia arranged in 2 alternating rows on branches. Autozooecial apertures rounded to oval, with smooth peristome, 0.085-0.095mm 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. Autozooecial chambers long, subrectangular in the mid tangential section. Superior hemisepta long, curved distally; inferior hemisepta absent. External laminated skeleton thin. Branch reverse side smooth. Heterozooecia not observed.

COMPARISON

Diploporaria tenella Wyse Jackson, 1988 possesses distinctive elongate quadrate-shaped autozooecial 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. — Acanthocladiid 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 autozooecia on main and lateral branches; reverse surface longitudinally striated with microstylets; autozooecial 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 autozooecia 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.

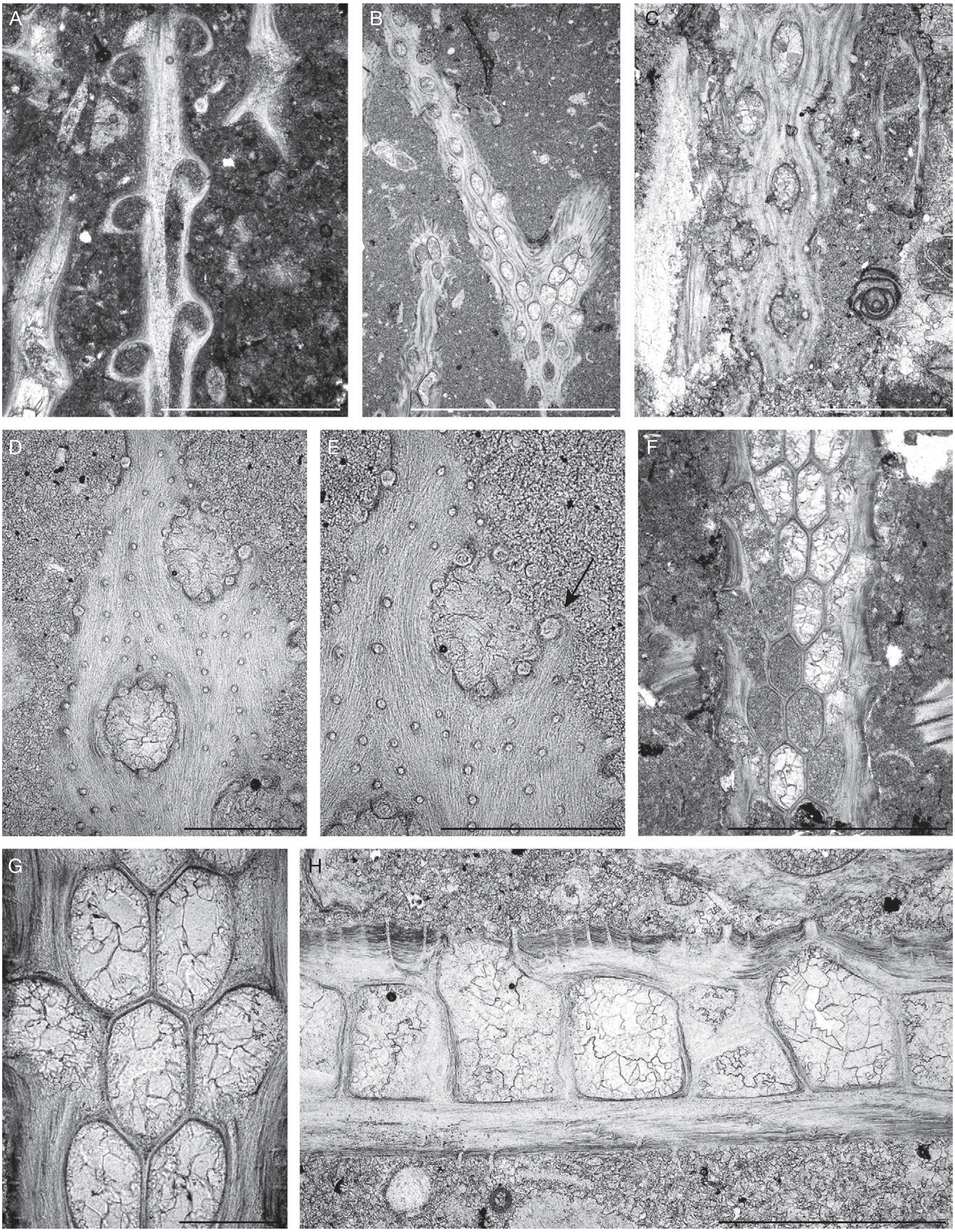

Fig. 27. — **A**, *Diploporaria tenella* Wyse Jackson, 1988, tangential section showing autozooecial apertures, SMF 21.923; **B**-**H**. *Baculopora redondensis* n. sp.; **B**, tangential section of a dichotoming branch, paratype SMF 21.944; **C**, tangential section showing autozooecial apertures, holotype SMF 21.947; **D**, **E**, tangential section showing autozooecial apertures with nodes (arrow), paratype SMF 21.944; **F**, **G**, mid-tangential section showing autozooecial 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 Visean).

Diagnosis. — Straight dichotomous branches; autozooecia in 2 to 6 rows; autozooecial 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. Autozooecia 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 microstyles; autozooecial 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 autozooecial 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 autozooecia both on main and lateral branches; autozooecia 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 autozooecia 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 Visean); 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. Autozooecia 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
Autozooecial 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. 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 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 autozooecia on the main branch and on the secondary branches.

Occurrence. — Devonian to Permian; worldwide.

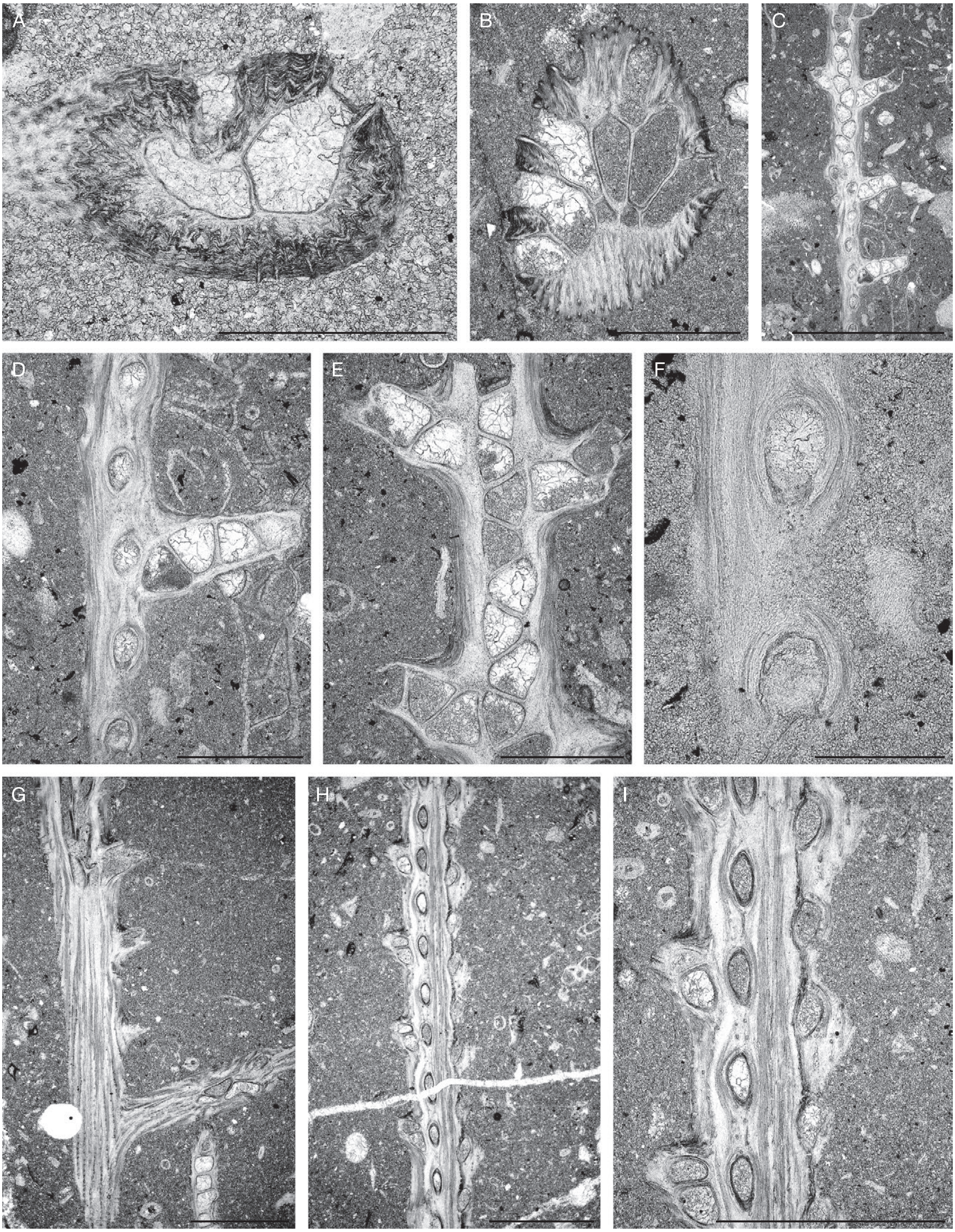

Fig. 28. — **A**, **B**, *Baculopora redondensis* n. sp.; **A**, branch transverse section, paratype SMF 21.939; **B**, branch oblique section showing autozooecial chambers, paratype SMF 21.941; **C**-**F**, *Filites* cf. *laxa* (Young & Young, 1876), tangential to mid-tangential section showing autozooecial 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 autozooecial 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. Autozooecia 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
Autozooecial 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. Extrazooecial 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. Autozooecia 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 microstyles.

INTERNAL DESCRIPTION
Autozooecial 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. Extrazooecial 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 autozooecial 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 autozooecia both on main and lateral branches; autozooecia 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 autozooecial 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.

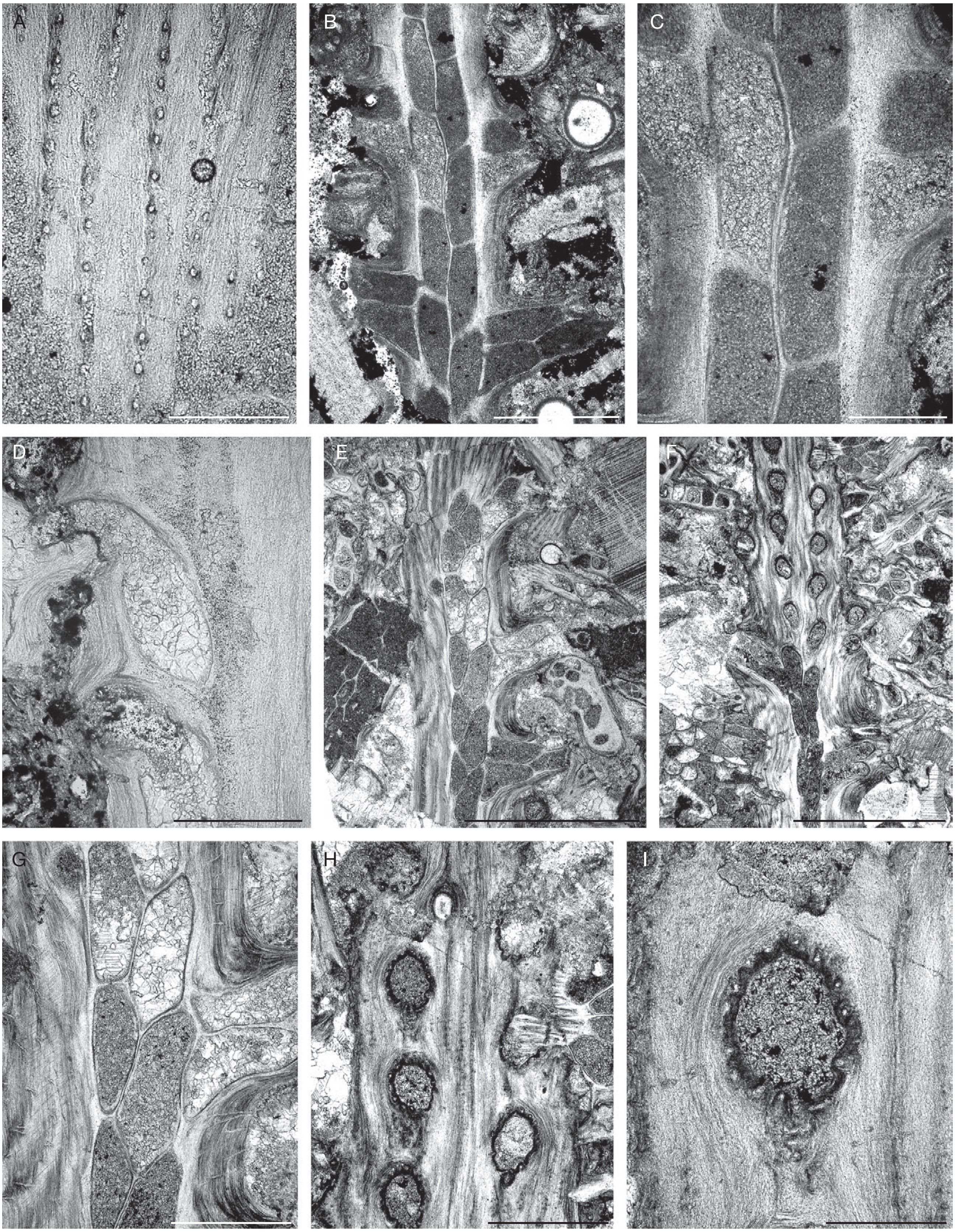

Fig. 29. — **A**-**D**, *Penniretepora volgensis* Shishova, 1959; **A**, tangential section showing the reverse branch side, SMF 21.964; **B**, **C**, mid-tangential section showing autozooecial chambers, SMF 21.962; **D**, branch oblique section showing autozooecial chambers, SMF 21.961; **E**-**I**, *Penniretepora* cf. *pluma* (Phillips, 1836); **E**, mid-tangential section showing autozooecial chambers, SMF 21.965; **F**, tangential section showing autozooecial apertures, SMF 21.966; **G**, mid-tangential section showing autozooecial chambers, SMF 21.965; **H**, **I**, tangential section showing autozooecial 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 Visean).

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. Autozooecia 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

Autozooecial 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 Visean 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 (Visean); Ireland, Germany (Velbert Anticline, Rhenish Massif), Roque Redonde (Montagne Noire, southern France).

Description

Freely branching, dichotomous colonies. Branches 0.54-0.74 mm wide. Autozooecia arranged in 2-3 rows on branches, pentagonal to hexagonal in mid tangential section. Autozooecial 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 autozooecial chambers in mid tangential section instead of rhombic one in *T. perplexus*, and in the absence of cyclozooecia. "*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 Visean); 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. Autozooecia arranged in two rows on branches, triangular to trapezoid in mid tangential section. Autozooecial 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 autozooecia 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 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. Thus, about one quarter of the described bryozoans are endemic to the Roque Redonde.

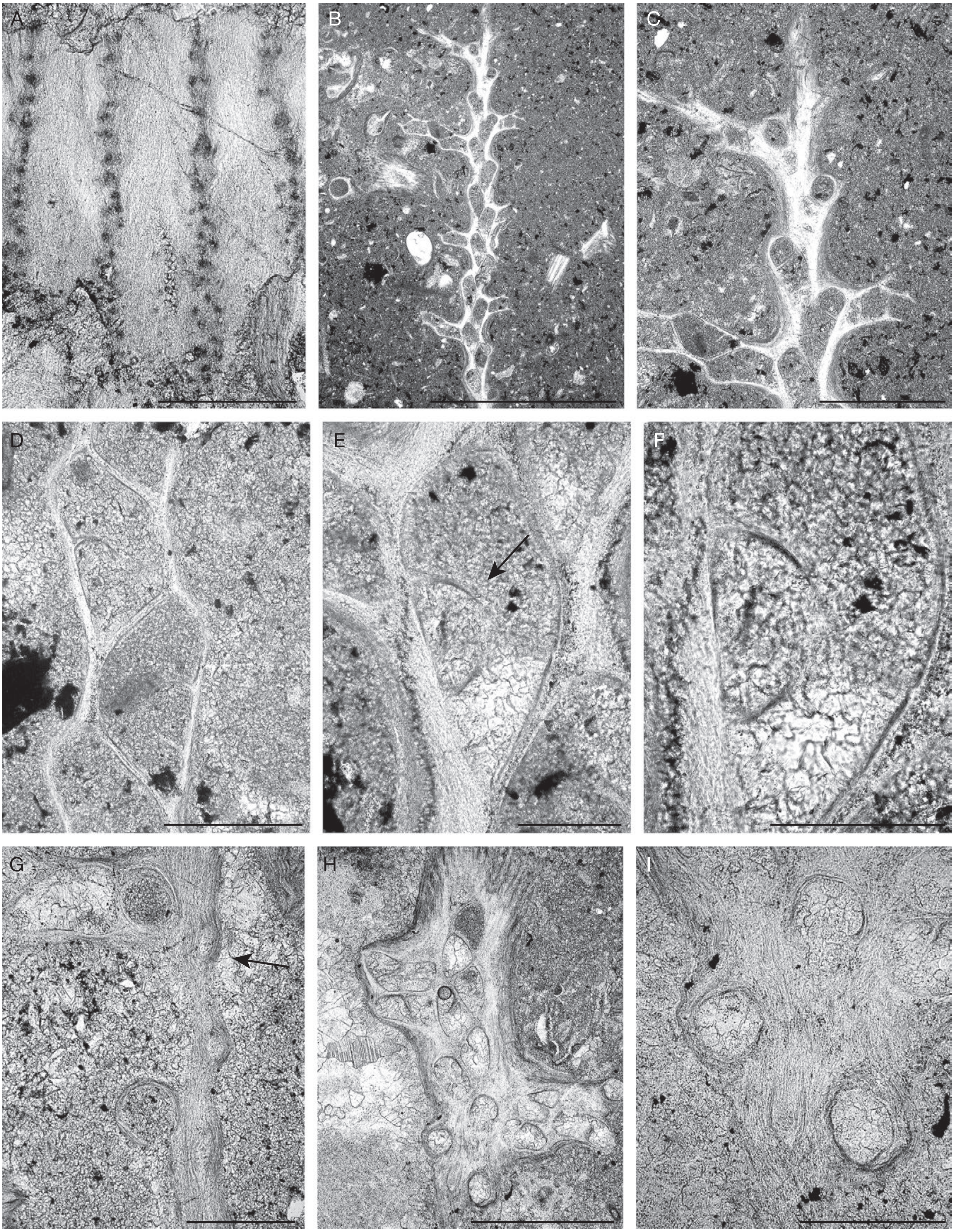

Fig. 30. — **A**, *Penniretepora* cf. *pluma* (Phillips, 1836), tangential section showing the reverse branch side, SMF 21.966; **B**-**I**. *Gorjunopora gallica* n. gen., n. sp.; **B**, **C**, tangential section, holotype SMF 21.967; **D**-**F**, mid-tangential section showing autozooecial chambers with hemisepta (**arrow**), holotype SMF 21.967; **G**, tangential section showing nodes (**arrow**), paratype SMF 21.970; **H**, **I**, tangential section showing autozooecia 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 Mississippian 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 palaeogeographical 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-

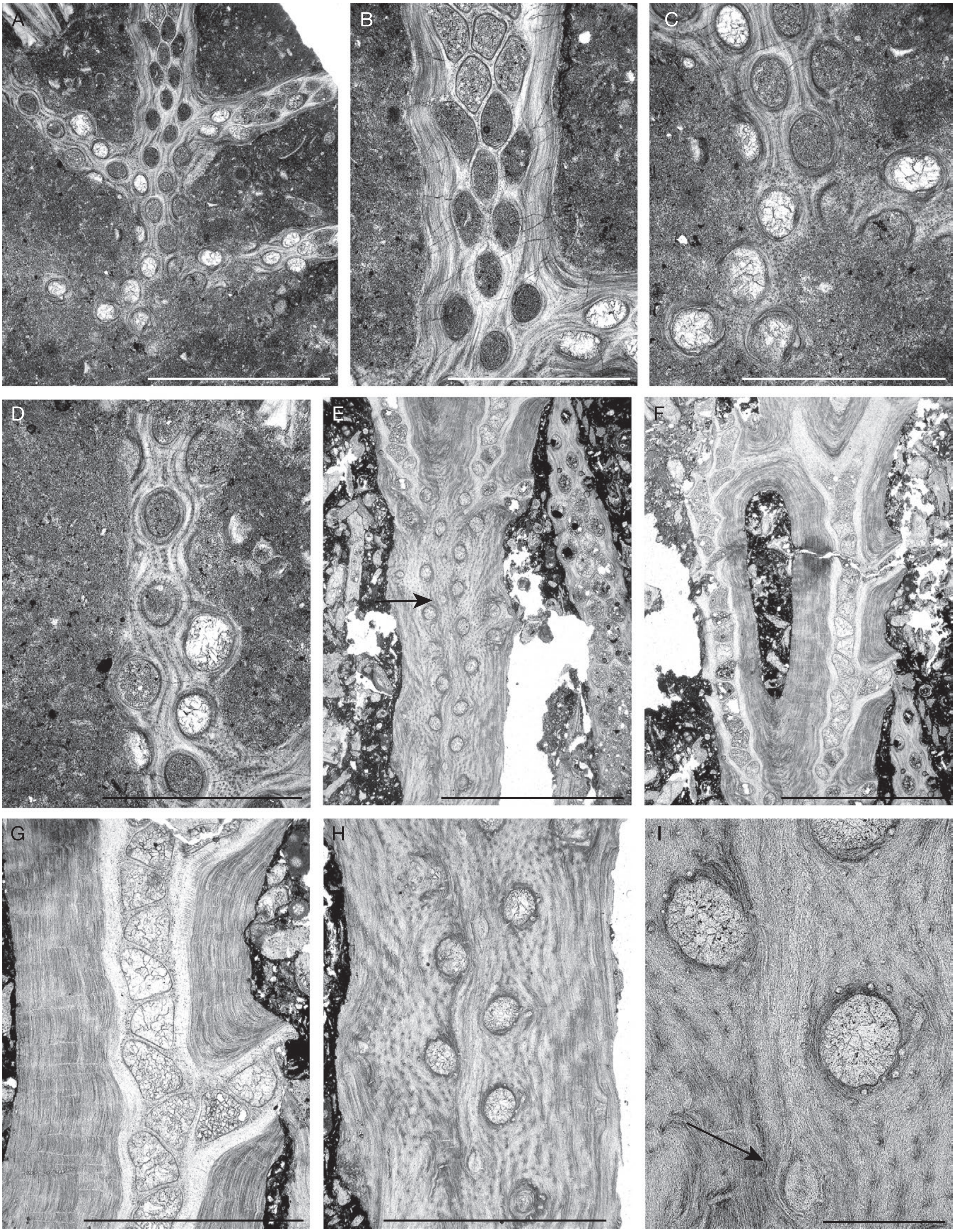

Fig. 31. — **A**-**D**, "*Thamniscus*" *colei* Wyse Jackson, 1988, tangential section showing autozooecial apertures and branch surface, SMF 21.973; **E**-**I**, Fenestrata sp., SMF 21.974; **E**, **H**, **I**, tangential section showing autozooecial apertures and nodes (arrows); **F**, **G**, mid-tangential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

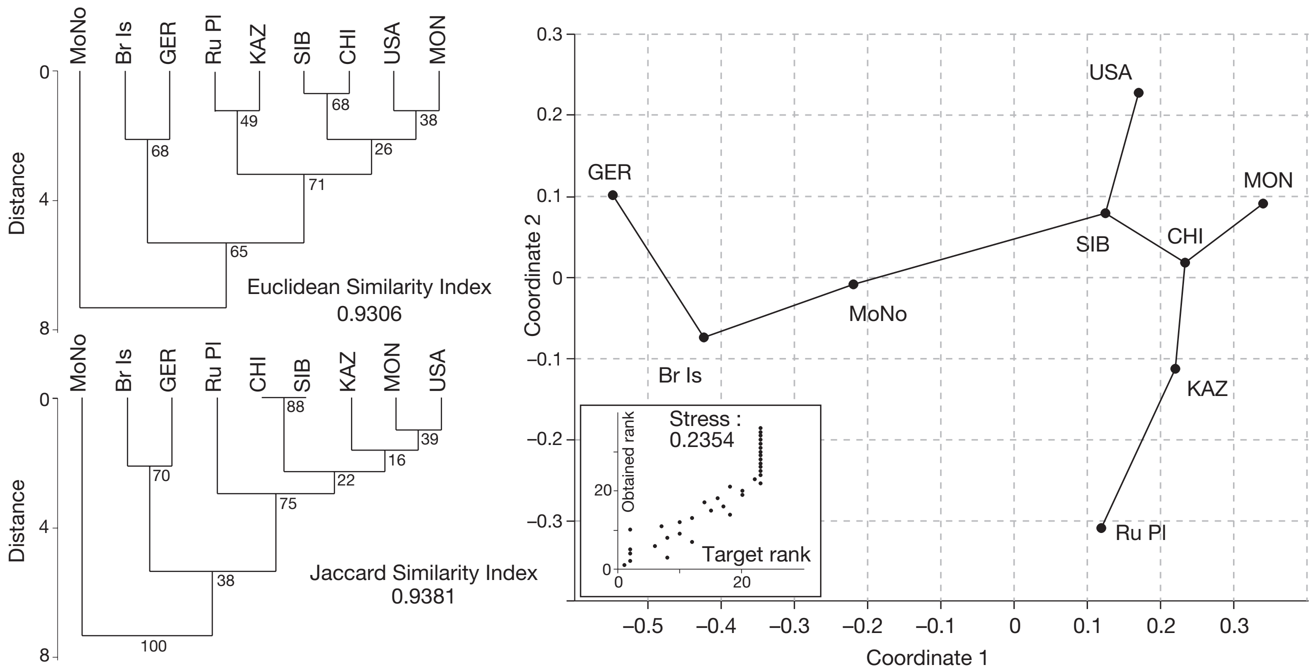

FIG. 32. — Palaeobiogeographical affinities of the Roque Redonde bryozoan assemblage. Left side: Dendrograms for the totality of species found at Roque Redonde using two different similarity indices, Jaccard and Euclidean. Cluster method: Ward; Percentages of node robustness: bootstrap probability. Cluster 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 palaeogeographical 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 Pl**, 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 Montange 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 multilayered 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 submassive colonies up to 2.7 mm thick, whereas *Dyscritella* sp. developed small encrusting colonies (less than 0.5 mm in thickness).

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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
Autozooecial aperture width, mm	40	0.45	0.060	13.16	0.36	0.55
Autozooecial 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
Autozooecial aperture width, mm	25	0.39	0.047	12.24	0.30	0.49
Autozooecial 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
Autozooecial aperture width, mm	115	0.33	0.043	13.15	0.24	0.43
Autozooecial 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
Autozooecial aperture width, mm	20	0.29	0.027	9.23	0.25	0.34
Autozooecial 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
Autozooecial aperture width, mm	30	0.26	0.039	14.90	0.19	0.32
Autozooecial 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
Autozooecial aperture width, mm	50	0.34	0.072	21.01	0.24	0.50
Autozooecial 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
Autozooecial aperture width, mm	20	0.21	0.029	13.57	0.17	0.25
Autozooecial 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
Autozooecial aperture width, mm	30	0.32	0.039	12.35	0.26	0.40
Autozooecial 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
Autozooecial aperture width, mm	17	0.20	0.029	14.39	0.17	0.29
Autozooecial aperture spacing, mm	5	0.65	0.106	16.28	0.50	0.78
Autozooecial 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
Autozooecial aperture width, mm	30	0.18	0.023	12.29	0.16	0.23
Autozooecial aperture spacing, mm	15	0.61	0.082	13.36	0.48	0.81
Autozooecial 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
Autozooecial aperture width, mm	17	0.10	0.018	17.45	0.08	0.13
Autozooecial aperture spacing, mm	19	0.67	0.054	8.08	0.56	0.78
Autozooecial 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
Autozooecial aperture width, mm	20	0.16	0.015	9.26	0.14	0.18
Autozooecial 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
Autozooecial aperture width, mm	20	0.28	0.021	7.51	0.24	0.31
Autozooecial aperture spacing, mm	20	0.32	0.025	7.74	0.29	0.36
Autozooecial aperture width, mm (maculae)	15	0.41	0.030	7.23	0.36	0.47
Autozooecial 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
Autozooecial aperture width, mm	13	0.15	0.074	48.18	0.085	0.28
Autozooecial aperture spacing, mm	14	0.61	0.264	42.9	0.29	0.99
Autozooecial 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
Autozooecial aperture width, mm	20	0.13	0.016	12.88	0.10	0.16
Autozooecial aperture spacing, mm	10	0.75	0.054	7.14	0.67	0.82
Autozooecial 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
Tectitozooecia 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
Autozooecial aperture width, mm	20	0.10	0.013	12.83	0.08	0.13
Autozooecial aperture spacing, mm	20	0.55	0.034	6.09	0.46	0.58
Autozooecial 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
Autozooecial aperture width, mm	13	0.08	0.015	19.54	0.06	0.10
Autozooecial aperture spacing, mm	14	0.65	0.072	11.08	0.50	0.72
Autozooecial aperture spacing diagonally, mm	16	0.34	0.046	13.54	0.28	0.44
Aktinotostyle diameter, mm	20	0.03	0.006	16.22	0.02	0.05

Megacanthopora enodata n. sp.

	N	X	SD	CV	MIN	MAX
Autozooecial aperture width, mm	25	0.16	0.019	11.77	0.13	0.19
Autozooecial 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
Aktinotostyle 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