Rivista Italiana di Paleontologia e Stratigrafia	volume 116	no. 3	10 pls.	pp. 283-308	November 2010

TREPOSTOME BRYOZOANS FROM THE LOWER - MIDDLE DEVONIAN OF NW SPAIN

ANDREJ ERNST

Received: May 27, 2010; accepted: September 11th, 2010

Key words: Bryozoa, taxonomy, Devonian, Spain, palaeobiogeography.

Abstract. The present paper presents descriptions of 11 trepostome bryozoan species from the material deposited at the Geological Centrum Göttingen, Germany, and Nationaal Natuurhistorisch Museum (Naturalis), Leiden, Netherlands. The studied material comes from the Lower to Middle Devonian (Emsian-Eifelian) deposits of different localities in Cantabrian Mountains, NW Spain. Three species are new: *Leptotrypella maculata* n. sp., *Anomalotoechus tabulatus* n. sp. and *Eifelipora tenuis* n. sp. The genus *Mongoloclema* is reported for the first time from the Devonian of Europe. The described fauna displays palaeobiogeographic relations to the Lower Devonian (Pragian) of Bohemia and to the Middle Devonian of Kazakhstan and Michigan (USA).

Riassunto. Vengono descritte 11 specie di briozoi trepostomi su materiale depositato nel Geological Centrum Göttingen, Germania, e nel Nationaal Natuurhistorisch Museum (Naturalis), Leiden, Olanda. Il materiale studiato proviene dal Devoniano Inferiore e Medio (Emsiano-Eifeliano) di diverse località dei monti Cantabrici nel NO della Spagna. Tre sono le specie nuove: *Leptotrypella maculata* n. sp., *Anomalotoechus tabulatus* n. sp. e *Eifelipora tenuis* n. sp. Il genere *Mongoloclema* viene identificato per la prima volta nel Devoniano dell'Europa. La fauna descritta ha rapporti paleobiogeografici con il Devoniano Inferiore (Pragiano) della Bohemia e con il Devoniano Medio del Kazakhstan e del Michigan (USA).

Introduction

Bryozoa are abundant and diverse in the Devonian worldwide (Cuffey & McKinney 1979). This period was a time of important changes in the structure and global composition of bryozoan faunas (Bigey 1985; Horowitz et al. 1996). However, despite their abundance and importance, Devonian bryozoan faunas in Europe have been scarcely investigated. Whereas the bryozoans from the Lower Devonian of Bohemia and France are relatively well studied (Bigey 1972, 1980, 1981, 1986; McKinney & Kříž 1986; Ernst 2008b, 2009; Ernst & May 2009), the Lower Devonian bryozoans of Spain remain poorly known. A few recent publications have focused on the Devonian bryozoans of Spain (Suarez Andrés 1998, 1999a-c; Suárez Andrés & González 2000a, b). These papers contain descriptions of several species from the Moniello Formation (late Emsian - early Eifelian) of Cantabrian Zone (NW Spain), mainly fenestrate taxa were described.

The present paper provides taxonomic descriptions of trepostome bryozoans from the Lower to Middle Devonian (Emsian-Eifelian) of the Cantabrian Mountains, NW Spain (Fig. 1). This study is a part of a project supported by the Deutsche Forschungsgemeinschaft, titled "Evolution, palaeoecology and palaeobiogeography of the Devonian Bryozoa of Europe and adjacent areas" (ER 278/4-1 u. 2) which was conducted during 2006-2009. The aim of the project was to carry out a comprehensive study of regional bryozoan faunas and their evaluation in regarding evolution, palaeoecology and palaeobiogeography.

Geological setting

In the Cantabrian Mountains of northern Spain, a well-developed succession of Palaeozoic rocks is exposed. This succession consists of an alternation of siliciclastic shelf sediments and carbonate platform rocks. The entire succession experienced only moderate deformation during the Variscan orogeny (e.g., Comte 1959;

Institut für Geowissenschaften der Christian-Albrechts-Universität zu Kiel, Ludewig-Meyn-Str. 10, D-24118 Kiel, Germany.
E-mail: ae@gpi.uni-kiel.de.

Fig. 1 - Position of study area in Cantabrian Mountains, NW Spain (rectangle).

Truyols et al. 1990). Carbonate platform deposits are prominent throughout the Devonian and Carboniferous. During the Devonian, a carbonate ramp (Abelgas Formation; Keller 1988, 1997) and two carbonate shelves became established in the Cantabrian Mountains, the Santa Lucía Formation and the Portilla Formation (Comte 1959), respectively. These carbonate platform deposits are highly fossiliferous and many different groups have been described from these rocks so far.

Most of the studied material for the present paper is labelled as "La Vid Formation (Emsian), Cantabrian Mountains, NW Spain". These samples were collected before the modern understanding of the Devonian stratigraphy of NW Spain. The "La Vid Formation" as understood by collectors represents apparently the upper part of the La Vid Group corresponding to the Esla Formation (Keller 1988, 1997; Fig. 2). Another part of the material is clearly labelled as collected from the Santa Lucía Formation which overlies the Esla Formation (see chapter Material and methods).

The Esla Formation is represented by deposition of pelagic subtidal shales that gradually change into variegated marlstones, limestones and shales of Villayandre Member (serotinus conodont zone) in the uppermost part of the formation (Keller 1988, 1997; Keller & Grötsch 1990; Hoffman & Keller 2006). The base of the Esla Formation is dated as *gronbergi* conodont zone (Keller 1997). The Esla Formation reflects a successive shallowing of the depositional environment caused by eustatic sea-level changes. Above this succession, the carbonate platform of the Santa Lucía Formation was established.

The Emsian-Eifelian Santa Lucía Formation was deposited across a vast carbonate shelf (De Coo 1974; Méndez Bediá 1976; Buggisch et al. 1982; Hofmann & Keller 2006) from the *serotinus* through the *partitus* conodont zones (Buggisch et al. 1982; García López & Sanz López 2002). Three major facies belts were present on this shelf. In the north, restricted lagoonal deposits with peritidal facies are found that include abundant terrigenous siliciclastic mud. To the south and west, this lagoon was separated from open-marine influence by a reef belt in which major individual buildups are aligned parallel to depositional strike. On the seaward side of this reef belt, open-marine limestones are found, either as autochtonous deposits or as debris derived from the reefs.

Materials and methods

Material for this study comes from collections of the Nationaal Natuurhistorisch Museum (Naturalis) in Leiden, Netherlands, and the Geological Centrum Göttingen. For the study, 130 randomly as well as precisely oriented thin sections were made from the extensive rock material. Two sets of thin sections were used. The first set was prepared from the rock material housed at the Geological Centrum Göttingen, Germany. These thin sections have collection numbers GZG.IN.0.010.512 and GZG.IN.0.010.529. Separate thin sections of the same sample are numbered by adding a subnumber suffix.

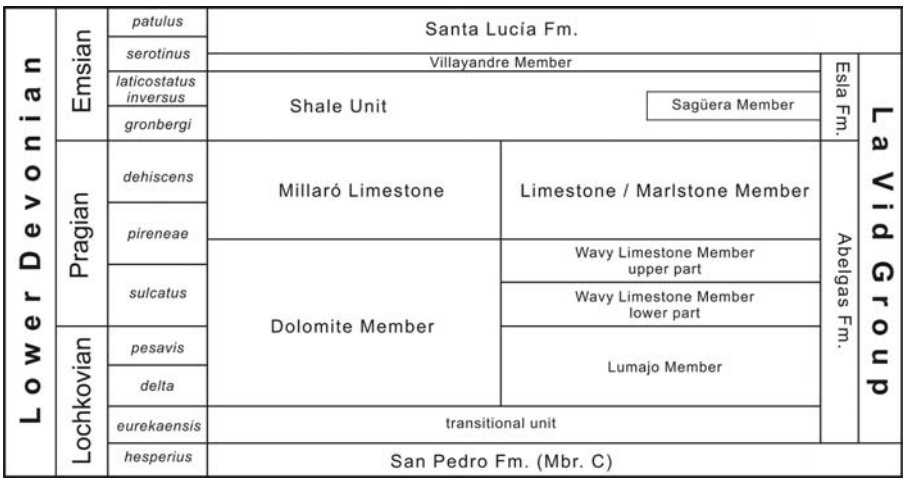


Fig. 2 - Stratigraphy of the Lower Devonian of the Asturo-Leonese Basin (after Keller 1997).

Sample GZG.IN.0.010.512 refers to "La Vid Formation, profile SE Villayandre, units 9-11, Lower Devonian (Emsian)" (= lower part of the Esla Formation, Lower Devonian, Emsian), profile southeast the village of Villayandre, Cantabrian Mountains, NW Spain. From this sample 37 thin sections were prepared.

Sample GZG.IN.0.010.529 comes from the Marl Unit (? = Villayandre Member, serotinus conodont zone) of Esla Formation, Lower Devonian (Emsian), profile near the village of Villayandre, Cantabrian Mountains, NW Spain. From this sample 7 thin sections were prepared.

Another set of material includes rock samples housed at the Nationaal Natuurhistorisch Museum (Naturalis) in Leiden, Netherlands, registered under numbers RGM 211 536 - RGM 211549. Unfortunately, not all samples possess necessary information on locality and stratigraphy. From this material 86 thin sections were prepared.

Sample RGM 211 536 refers to "La Vid Formation (Lower Devonian, Emsian) in the vicinity of Portilla de Luna (42°56′N 5°49′ W)" (? = Esla Formation, Lower Devonian, Emsian).

Samples RGM 211 537-541 and RGM 211 544 come from the Santa Lucía Formation (Lower Devonian, Emsian-Eifelian) of Caldas de Luna (42°56′N 5°52′ W).

Sample RGM 211 542 refers to "La Vid Formation near Collada del Campo de la Puerta (42°55′N 5°02′W)" (? = Esla Formation, Lower Devonian, Emsian).

Samples RGM 211 543 and RGM 211 547 refer to "Middle part of the La Vid Formation (Lower Devonian, Emsian) near Puerto de la Cubilla (42°59′N 5°54′W)" (? = Esla Formation, Lower Devonian, Emsian).

Sample RGM 211 545 has no exact information, refers to "La Vid Formation of NW Spain" (? = Esla Formation, Lower Devonian, Emsian).

Sample RGM 211 546 refers to "La Vid Formation, section near the village of Villayandre (42°54′N 5°09′W), Cantabrian Mountains, NW Spain" (? = Esla Formation, Lower Devonian, Emsian).

Samples RGM 211 548-549 refer to the "La Vid Formation" (? = Esla Formation, Lower Devonian, Emsian), localities unknown, Cantabrian Mountains, NW Spain.

Bryozoans were investigated in thin sections using binocular microscope in transmitted light. Morphologic character terminology is partly adopted from Anstey & Perry (1970). The following morphologic characters were measured and used for statistics in the studied material:

Branch width, colony thickness, exo- (endo-) zone width, autozooecial aperture width, aperture spacing, acanthostyle diameter, meso- (exila-) zooecia diameter, autozooecial (mesozooecial) diaphragm spacing, number of meso- (exila-) zooecia and acanthostyles surrounding each autozooecial aperture, wall thickness in exozone, and macular diameter (spacing).

The spacing of structures is measured as a distance between their centres. Statistics were summarized using arithmetic mean, sample standard deviation, coefficient of variation, and minimum and maximum values (see Appendix).

Systematic palaeontology

Phylum **Bryozoa** Ehrenberg, 1831

Class **Stenolaemata** Borg, 1926

Order **Trepostomata** Ulrich, 1882

Suborder **Halloporina** Astrova, 1965

Family Heterotrypidae Ulrich, 1890

Genus *Leioclema* Ulrich, 1882

[= *Lioclema* Ulrich, 1882]

Type species: *Callopora punctata* Hall, 1858. Lower Carboniferous; Iowa (USA)

Diagnosis: Encrusting, branched, less commonly massive colonies. Autozooecia with polygonal to rounded-polygonal, sometimes petaloid apertures. Autozooecial diaphragms rare. Mesozooecia abundant, with abundant diaphragms, often beaded. Acanthostyles abundant, commonly large. Autozooecial walls thin in endozone; laminated, regularly thickened in exozones (modified after Astrova 1978).

Comparison. *Leioclema* Ulrich, 1882 differs from *Heterotrypa* Nicholson, 1879 in having rare autozooecial diaphragms and abundant acanthostyles and mesozooecia, from *Stigmatella* Ulrich & Bassler, 1904 in having abundant mesozooecia.

Occurrence. Lower Silurian to Upper Carboniferous; worldwide.

Leioclema elegans Ernst, 2008

Pl. 1, figs 1-5; Appendix

1981 *Eridotrypa* cf. *eximia* Yaroshinskaya, 1970 - Bigey, p. 114-116, pl. 11, figs 5-10.

2008b *Leioclema elegans* Ernst, 2008, p. 331-332, pl. 1, figs 1-7.

Material: RGM 211 539-1-(1-3), RGM 211 539-8, RGM 211 546, GZG.IN.0.010.512a, b-(1-2), d-(1-3), e-2,f-2, f-4, g-(3, 4, 8, 10), GZG.IN.0.010.529c, e.

Occurrence. Koněprusy Limestone, Lower Devonian (Pragian); Zlatý Kůň, Czech Republic. Lower Devonian (Upper Emsian); Ménez-Bélair Syncline, Armorican Massif, France. Marl Unit of Esla Formation, Lower Devonian (Emsian); section near the village of Villayandre, Cantabrian Mountains, NW Spain. Lower part of Esla Formation, Lower Devonian (Emsian); section southeast of the village of Villayandre, Cantabrian Mountains, NW Spain. Santa Lucía Formation, Lower-Middle Devonian (Emsian-Eifelian); Caldas de Luna, Cantabrian Mountains, NW Spain.

Description. Ramose branching and encrusting colonies. Branched colonies 1.5-3.0 mm in diameter, with distinctly separated endozones and exozones. Endozones 1.00-1.04 mm wide, exozones 0.3-1.0 mm wide, encrusting sheets 0.60-1.95 mm in thickness. Secondary overgrowths occurring. In encrusting colonies, autozooecia budding from a thin epitheca, on short distances parallel to the substrate, then bending sharply and intersecting the colony surface at right angle. In branched colonies, autozooecia growing parallel to branch axis for short distance in endozones, bending in exozone and intersecting the colony surface at angles of 90°. Autozooecial apertures rounded-polygonal to petaloid due to indenting acanthostyles. Autozooecial basal diaphragms rare to absent, thin, straight or slightly

deflected proximally. Mesozooecia abundant, 4-10 surrounding each aperture, polygonal in cross section, often beaded, containing abundant and thick diaphragms, sometimes as large as autozooecia, usually sealed by skeleton at the colony surface. Acanthostyles moderately large, abundant, 2-6 surrounding each aperture, originating in the distal part of exozone, often indenting autozooecia, having distinct calcite cores and dark laminated sheaths. Walls granular, 0.010-0.012 mm thick in endozones; distinctly laminated, merged, 0.03-0.05 mm thick in the exozone. Indistinct maculae consisting of slightly larger zooecia and more abundant mesozooecia.

Comparison. *Leioclema elegans* Ernst, 2008 (Ernst 2008b) differs from *L. ahuettensis* Ernst, 2008a from the Middle Devonian of Rhenish Massif in shorter distances between centres of autozooecial apertures (average distance 0.25 mm vs. 0.36 mm in *L. ahuettensis*).

Suborder **Amplexoporina** Astrova, 1965

Family Atactotoechidae Duncan, 1939

Genus *Leptotrypella* Vinassa de Regny, 1921

Type species: *Chaetetes barrandei* Nicholson, 1874. Middle Devonian; Ontario (Canada)

Diagnosis: Branched colonies. Autozooecia with polygonal to rounded-polygonal apertures. Autozooecial diaphragms lacking in endozones; rare to common in exozones. Exilazooecia rare. Acanthostyles long, common to abundant. Autozooecial walls granular, thin in endozones; laminated, mainly merged but sometimes serrated, irregularly thickened in exozones (modified after Astrova 1978).

Comparison. *Leptotrypella* Vinassa de Regny, 1921 differs from *Leptotrypa* Ulrich, 1883 in having branched colony, and from *Anomalotoechus* Duncan, 1939 in having branched colonies and absence of diaphragms in endozones.

Occurrence. Middle Silurian to Lower Carboniferous; worldwide.

Leptotrypella parva Duncan, 1939

Pl 1, figs 5-6, Pl. 2, figs 1-3; Appendix

1939 *Leptotrypella parva* Duncan, p. 229-230, pl. 9, figs 4-5.

Material: RGM 211 536-3-(1-2), RGM 211 539-1-(1-2).

Occurrence. Traverse group, Gravel Point Stage (Middle Devonian, Givetian); Michigan, USA. ? Esla Formation, Lower Devonian (Emsian); Portilla de Luna, Cantabrian Mountains, NW Spain. Santa Lucía Formation, Lower-Middle Devonian (Emsian-Eifelian); Caldas de Luna, Cantabrian Mountains, NW Spain.

Description. Branched and encrusting colonies. Branches 3.4-3.8 mm in diameter. Exozones 0.75-0.84 mm wide, endozones 1.90-2.12 mm wide. Encrusting sheets 1.11-1.35 mm thick. Autozooecia long in endozones, bending at low angles in exozones. Autozooecial apertures oval. Autozooecial diaphragms abundant in exozone, thin, straight or slightly deflected proximally. Exilazooecia locally common, 0-5 surrounding each autozooecial aperture, short, restricted to exozones, rounded to polygonal in cross section. Acanthostyles moderately large, common, locally absent, usually 2 surrounding each autozooecial aperture, originating in basal exozone, having distinct cores and laminated sheaths, protruding above colony surface. Autozooecial walls granular, 0.010-0.015 mm thick in endozones; laminated, merged, without distinct zooecial boundaries, 0.03-0.07 mm thick in exozones. Secondary cingulum often developed, relatively thin, with lamination parallel autozooecial wall surface. Mural spines common to abundant in exozone, 0.020-0.035 mm in diameter, curved proximally. Maculae consisting larger zooecia, 1.2-1.5 mm in diameter, spaced 1.8-2.0 mm from centre to centre.

Comparison. *Leptotrypella parva* Duncan, 1939 differs from *L. undans* Duncan, 1939 in fewer and smaller acanthostyles. Furthermore, Duncan (1939) identified *Leptotrypella undans* by axial ratio (ratio of endozone width to branch diameter) as 0.8:1. This ratio was given as 0.45:1 for *L. parva*, whereas the present material has axial ratio 0.55:1. No mural spines were reported from both species of Duncan (1939). *Leptotrypella parva* differs also from *L. vulgata* Astrova, 1964 from the Lower Devonian (Lochkovian) of Ukraine in having fewer acanthostyles per autozooecial aperture (0-2 vs. 4-6 in *L. vulgata*).

Leptotrypella provecta Boardman, 1960

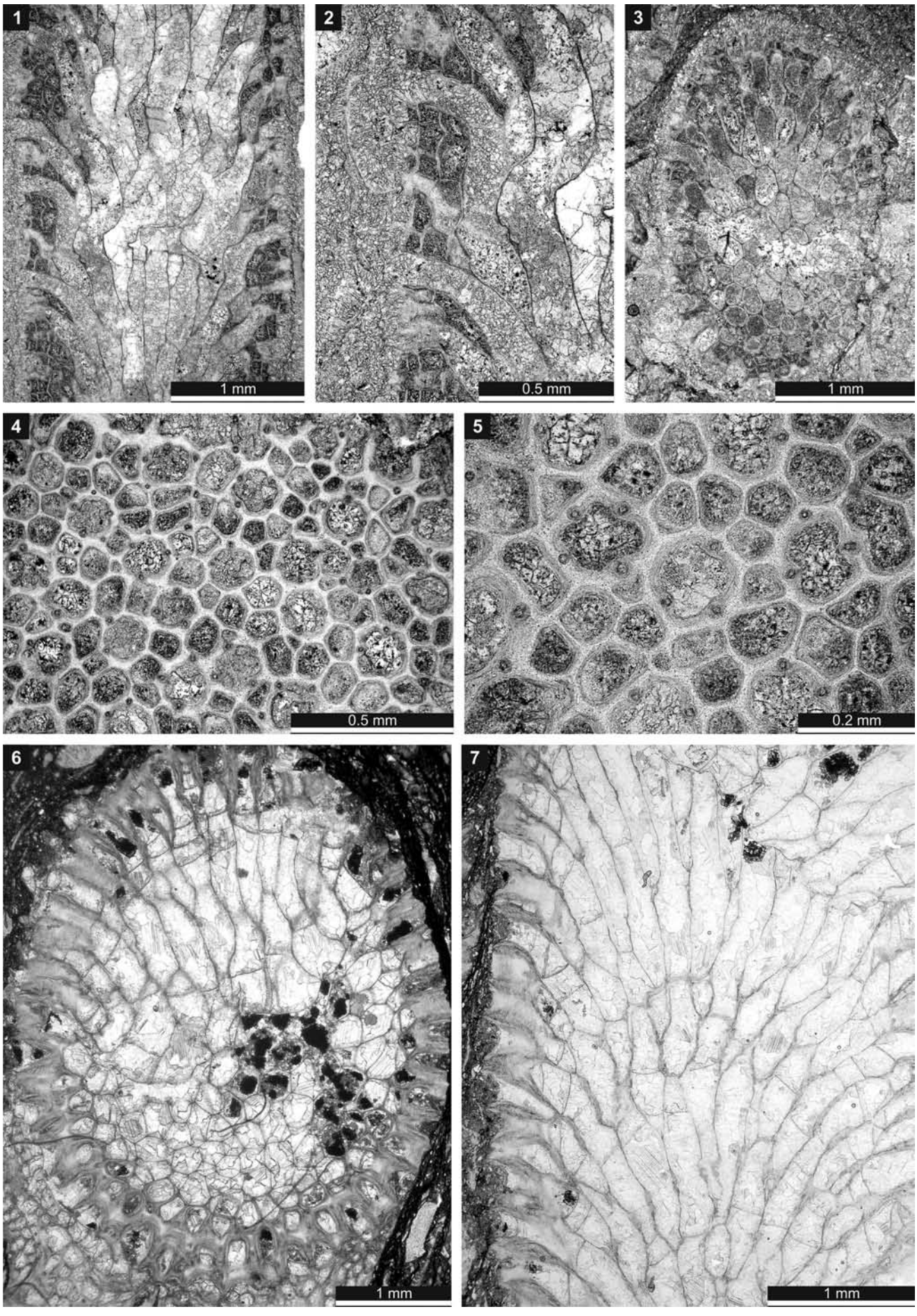
Pl. 2, figs 4-6, Pl. 3, figs 1-4; Appendix

1960 *Leptotrypella* (*Leptotrypella*) *mesostena provecta* Boardman, p. 56, pl. 6, figs 7-8.

PLATE 1

Figs 1-5 - *Leioclema elegans* Ernst, 2008. Lower part of Esla Formation, Lower Devonian (Emsian); Villayandre, Cantabrian Mountains, NW Spain.
1-2: longitudinal sections. GZG.IN.0.010.512b-2; 3: branch oblique section. GZG.IN.0.010.512f-4; 4-5: tangential sections. GZG.IN.0.010.512b-2.

Figs 6-7 - *Leptotrypella parva* Duncan, 1939. ? Esla Formation, Lower Devonian (Emsian); Portilla de Luna, Cantabrian Mountains, NW Spain.
6: branch oblique section. RGM 211 536-3-2; 7: longitudinal section. RGM 211 536-3-1.


1
1 mm
2
0.5 mm
3
1 mm
4
0.5 mm
5
0.2 mm
6
1 mm
7
1 mm

Material: RGM 211 536-1-3, RGM 211 536-1-9, RGM 211 536-8-1, RGM 211 536-2-4, RGM 211 536-2-5, RGM 211 536-2-13, RGM 211 543-4.

Occurrence. Hamilton Group, Ledyard member of Ludlowville shale (Middle Devonian, Givetian) of New York, USA. ? Esla Formation, Lower Devonian (Emsian); Portilla de Luna and Puerto de la Cubilla, Cantabrian Mountains, Spain.

Description. Branched and encrusting colonies. Secondary overgrowth occurring. Branches 3.4-4.5 mm in diameter. Exozones 0.7-0.9 mm wide, endozones 2.0-2.7 mm wide. Encrusting sheets 0.55-1.08 mm thick. Autozooecia long in endozones, bending at low angles in exozones. Autozooecial apertures oval. Autozooecial diaphragms abundant in exozone, thin, straight or slightly deflected proximally. Exilazooecia common, 1-5 surrounding each autozooecial aperture, locally absent, short, restricted to exozones, rounded to polygonal in cross section. Acanthostyles large, abundant, 2-4 surrounding each autozooecial aperture, originating in basal exozone, having distinct cores and laminated sheaths, protruding above colony surface. Autozooecial walls granular, 0.005-0.010 mm thick in endozones; laminated, merged, without distinct zooecial boundaries, 0.075-0.138 mm thick in exozones. Secondary cingulum often well developed, with lamination parallel autozooecial wall surface. Mural spines common to abundant in exozone, 0.020-0.025 mm in diameter, curved proximally. Maculae elevated, consisting larger, usually thick walled zooecia, 1.35-2.10 mm in diameter, spaced 2.2-2.6 mm from centre to centre.

Comparison. *Leptotrypella provecta* Boardman, 1960 is similar to *L. multitecta* Boardman, 1960 in having abundant mural styles and moderately large and abundant acanthostyles. However, it differs in having thicker autozooecial walls and smaller autozooecial apertures (autozooecia width 0.07-0.10 mm vs. 0.20-0.28 mm in *L. multitecta*).

Leptotrypella maculata n. sp.

Pl. 3, figs 5-8, Pl. 4, figs 1-6; Appendix

Etymology: The specific name '*maculata*' refers to the presence of well-defined maculae of the new species (from Latin "*maculatus*" - spotted).

Holotype: RGM 211 540-2.

Paratypes: RGM 211 540-1, RGM 211 538-1-(1-2).

Type locality: Caldas de Luna, Cantabrian Mountains, NW Spain.

Type stratum: Santa Lucía Formation, Lower-Middle Devonian (Emsian-Eifelian).

Diagnosis: Branched and encrusting colonies; autozooecial diaphragms abundant to absent, straight or inclined; exilazooecia rare, small; acanthostyles common, locally absent, moderately large; megastyles present; mural spines absent; cyst-like spherical structures in autozooecial walls present; maculae well-defined, regularly spaced, consisting of larger zooecia with thickened walls and megastyles.

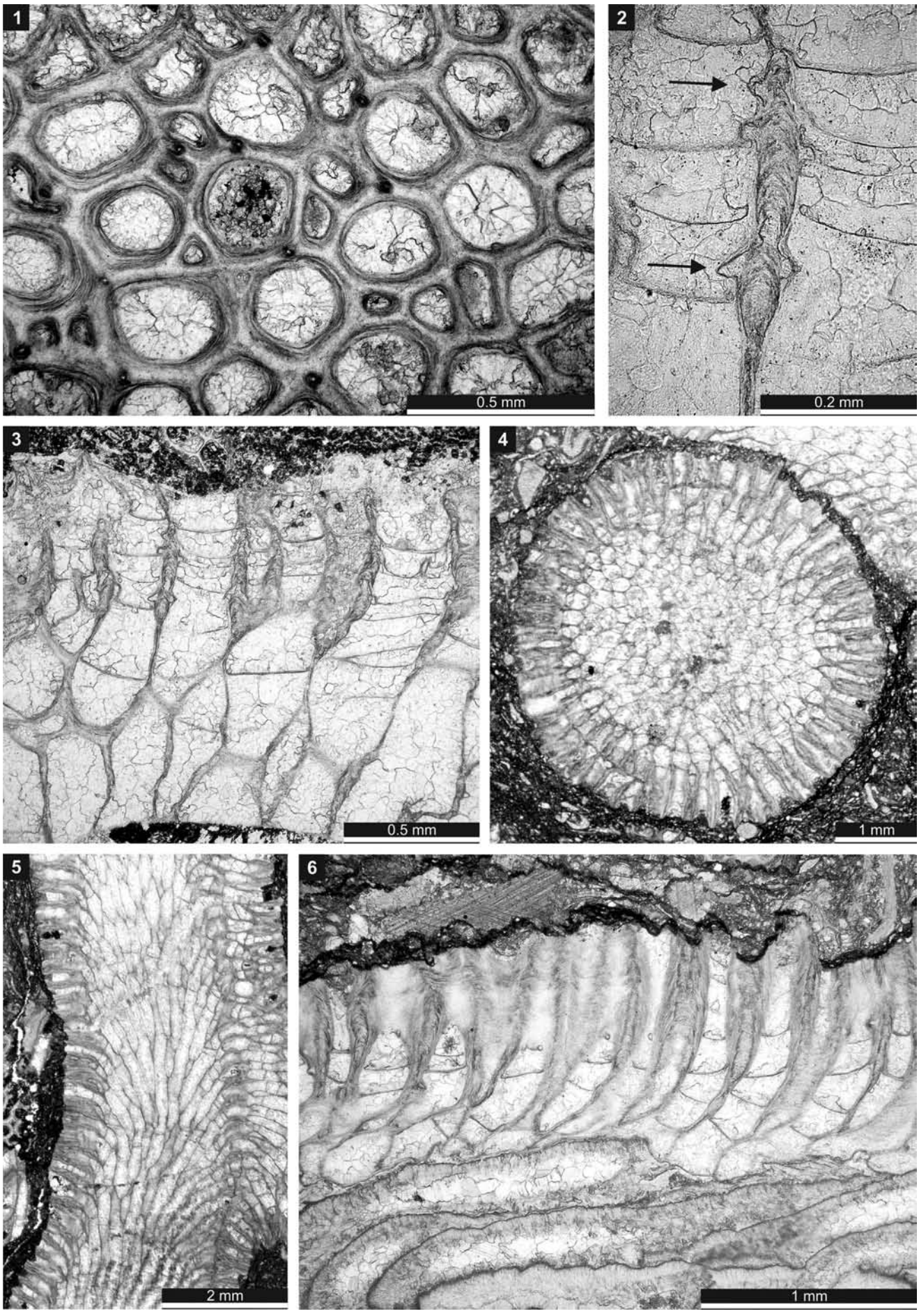
Description. Branched and encrusting colonies. Branches 7-12 mm in diameter. Exozones 1.0-3.5 mm wide, endozones 5-6 mm wide. Encrusting sheets 3.1-3.6 mm thick. Autozooecia long in endozones, bending at low angles in exozones. Autozooecial apertures polygonal. Autozooecial diaphragms rare in endozone; common to absent in exozone, abundant in the transition between endo- and exozone, thin, straight or inclined. Exilazooecia rare, short, restricted to exozones, rounded to polygonal in cross section. Acanthostyles moderately large, common, locally absent, 1-6 surrounding each autozooecial aperture, originating in basal exozone, having distinct cores and laminated sheaths, protruding above colony surface. Massive megastyles present, having wide hyaline cores and relatively narrow laminated sheaths, originating repeatedly through the colony, concentrated usually in maculae. Autozooecial walls granular, 0.005-0.015 mm thick in endozones; laminated, merged, without distinct zooecial boundaries, 0.025-0.070 mm thick in exozones, often thickened in macular zooecia. Secondary cingulum not developed. Mural spines absent. Cyst-like spherical structures in autozooecial walls common, 0.08-0.10 mm in diameter. Maculae consisting of larger zooecia and megastyles, 1.1-1.9 mm in diameter, spaced 2.1-3.5 mm from centre to centre.

Comparison. *Leptotrypella maculata* n. sp is similar to *L. aequabilis* Duncan, 1939 from the Traverse Group of Michigan, USA, in presence of thick acanthostyles in maculae. The new species has smaller apertures than those in *L. aequabilis* (average autozooecia width 0.16 mm vs. 0.20 mm in *L. aequabilis*). Duncan (1939: 224) mentioned no mural spines in walls of *L. aequabilis*. However, the longitudinal section of *L. aequabilis* (Duncan 1939, pl. 9, fig. 7) exhibits several apparent mural spines, which are absent in *L. maculata*.

PLATE 2

Figs 1-3 - *Leptotrypella parva* Duncan, 1939. Santa Lucía Formation, Lower-Middle Devonian (Emsian-Eifelian); Caldas de Luna, Cantabrian Mountains, NW Spain.
1: tangential section. RGM 211 539-1-1; 2-3: longitudinal sections showing autozooecial walls and mural spines (arrows on Fig. 3). RGM 211 539-1-2.

Figs 4-6 - *Leptotrypella provecta* Boardman, 1960. ? Esla Formation, Lower Devonian (Emsian); Portilla de Luna, Cantabrian Mountains, NW Spain.
4: branch transverse section. RGM 211 536-1-3; 5: branch longitudinal section. RGM 211 536-8-1; 6: longitudinal section of an encrusting colony. RGM 211 536-2-13.


1
0.5 mm
2
0.2 mm
3
0.5 mm
4
1 mm
5
2 mm
6
1 mm

Genus *Atactotoechus* Duncan, 1939

Type species: *Atactotoechus typicus* Duncan, 1939, by original designation. Traverse Group (Middle Devonian); Michigan (USA).

Diagnosis: Encrusting, massive and branched colonies. Autozooecia with polygonal to rounded-polygonal apertures. Diaphragms abundant, straight or inclined. Cystiphragms singly or several in cluster. Exilazooecia rare. Acanthostyles absent or present in small numbers in maculae. Autozooecial walls thin in endozone; serrated, irregularly thickened, finely laminated in exozone (modified after Astrova 1978).

Comparison. *Atactotoechus* Duncan, 1939 differs from *Orbignyella* Ulrich & Bassler, 1904 in having thickened autozooecial walls and absence of acanthostyles.

Occurrence. Lower Silurian to Upper Devonian; worldwide.

Atactotoechus cartus Boardman, 1960

Pl. 5, figs 1-4; Appendix

1960 *Atactotoechus cartus* Boardman, p. 73, pl. 18, figs. 1-6.

1960 *Atactotoechus cartus cartus* Boardman, p. 73-74, pl. 18, figs. 4-6.

1960 *Atactotoechus cartus pilatus* Boardman, p. 74, pl. 18, figs. 1-3.

Material: Two colonies GZG.IN.0.010.512f-3, g-14.

Occurrence: Hamilton Group, Wanakah member of the Ludlowville shale (Middle Devonian, Givetian) of New York, USA. Lower part of Esla Formation, Lower Devonian (Emsian); section southeast of the village of Villayandre, Cantabrian Mountains, NW Spain.

Diagnosis: Branched colonies; exozones distinctly separated from endozones; diaphragms abundant in exozones; cystiphragms few; exilazooecia absent; acanthostyles rare, small.

Description. Ramose branched colonies. Branches 1.7-2.3 mm in diameter. Exozones 0.36-0.63 mm wide, endozones 0.98-1.04 mm wide. Exozones distinctly separated from endozones. Autozooecia long in endozones, bending sharply in exozones. Autozooecial apertures polygonal with rounded corners. Autozooecial diaphragms abundant in exozones, straight or inclined; absent to rare in endozones. Cystiphragms common. Exilazooecia absent. Acanthostyles locally present, usually absent, small, having distinct narrow cores and laminated sheaths. Autozooecial walls granular, 0.010-0.015 mm thick in endozones; serrated in the longitudinal view and merged in the tangential section, 0.020-0.040 mm thick in exozones. Maculae consisting of larger autozooecia, not well observed in present material.

Comparison. *Atactotoechus cartus* Boardman, 1960 differs from *A. acritus* Boardman, 1960 in having smaller colonies, less abundant acanthostyles and smaller autozooecia (aperture width 0.12-0.24 mm vs. 0.20-0.29 mm in *A. acritus*).

Genus *Anomalotoechus* Duncan, 1939

[= *Stereotoechus* Duncan, 1939]

Type species: *Anomalotoechus typicus* Duncan, 1939, by original designation. Traverse Group (Middle Devonian); Michigan (USA)

Diagnosis: Encrusting, massive, less commonly branched colonies. Autozooecia with polygonal to rounded-polygonal apertures. Diaphragms abundant in exozones, straight or inclined. Exilazooecia rare, short. Acanthostyles abundant. Autozooecial walls thin in endozone; finely laminated, strongly and irregularly thickened in exozone (modified after Astrova, 1978).

Comparison. *Anomalotoechus* Duncan, 1939 differs from *Leptotrypa* Ulrich, 1883 in having massive and branched colonies, thickened walls and abundant diaphragms, from *Atactotoechus* Duncan, 1939 in having abundant acanthostyles.

PLATE 3

Figs 1-4 - *Leptotrypella provecta* Boardman, 1960. ? Esla Formation, Lower Devonian (Emsian); Portilla de Luna, Cantabrian Mountains, NW Spain.
1: tangential section. RGM 211 536-8-1; 2: tangential section of a macula. RGM 211 536-2-13; 3: tangential section showing autozooecia, exilazooecia, acanthostyles and mural styles (arrows). RGM 211 536-2-5; 4: branch longitudinal section showing basal diaphragms and a mural spine inside of autozooecial chamber (arrow). RGM 211 536-8-1.

Figs 5-8 - *Leptotrypella maculata* n. sp. Santa Lucía Formation, Lower-Middle Devonian (Emsian-Eifelian); Caldas de Luna, Cantabrian Mountains, NW Spain.
5: holotype. Branch transverse section showing autozooecial walls and acanthostyles. RGM 211 540-2; 6: paratype. Branch longitudinal section showing autozooecial walls and basal diaphragms. RGM 211 540-1; 7: paratype. Branch tangential-transversal section. RGM 211 538-1-1; 8: holotype. Branch transverse section. RGM 211 540-2.

PLATE 4

Figs 1-6 - *Leptotrypella maculata* n. sp. Santa Lucía Formation, Lower-Middle Devonian (Emsian-Eifelian); Caldas de Luna, Cantabrian Mountains, NW Spain.
1: holotype. Tangential section of non-macular area. RGM 211 540-2; 2: holotype. Tangential section of macular area. RGM 211 540-2; 3: holotype. Tangential section of macular area showing megastyles in thickened autozooecial walls (arrows). RGM 211 540-2; 4-5: paratype. Longitudinal section showing basal diaphragms and megastyles in autozooecial walls. RGM 211 538-4-3; 6: holotype. branch transverse section showing autozooecial wall with a cyst-like spherical structure. RGM 211 540-2.

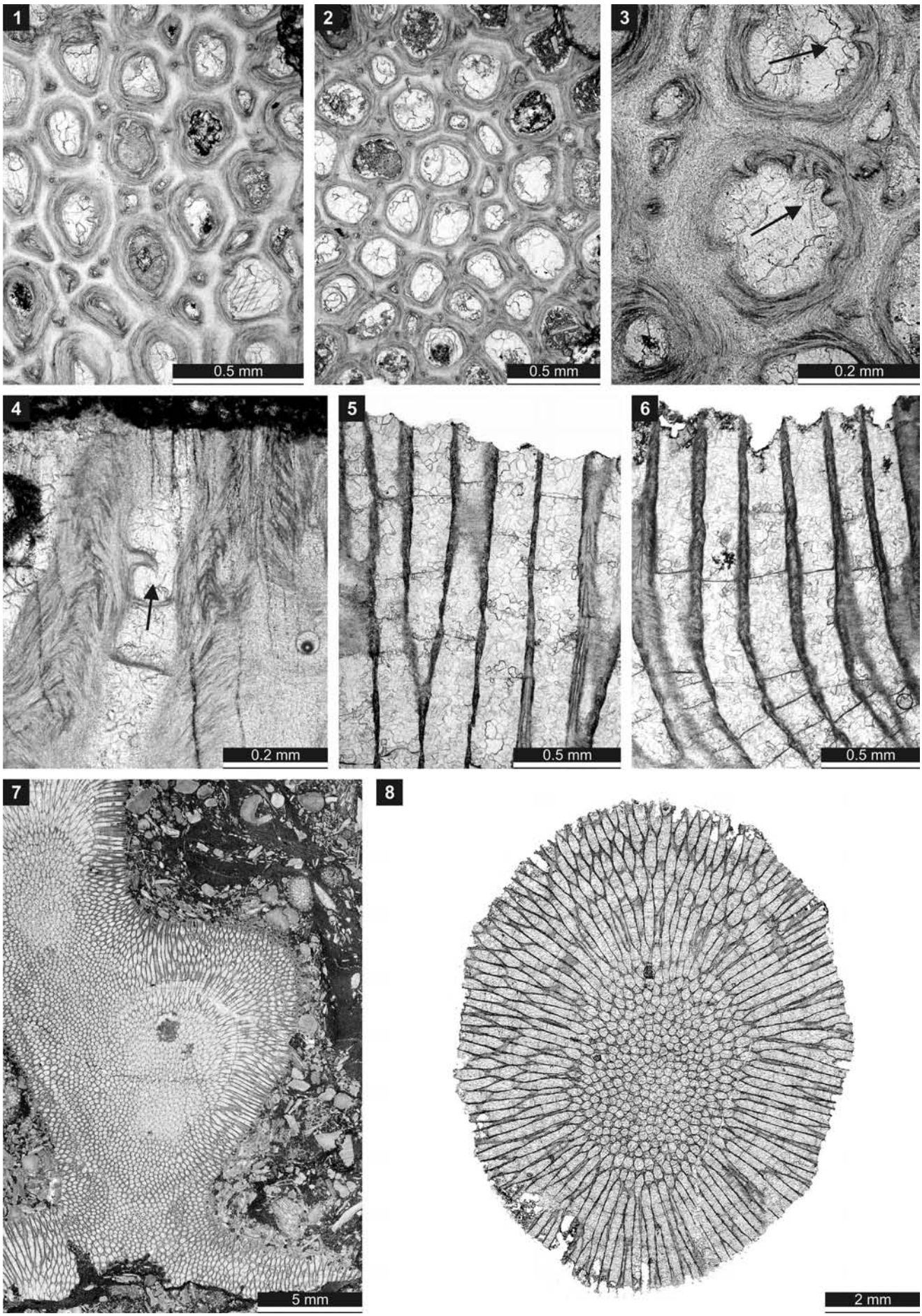


PLATE 3

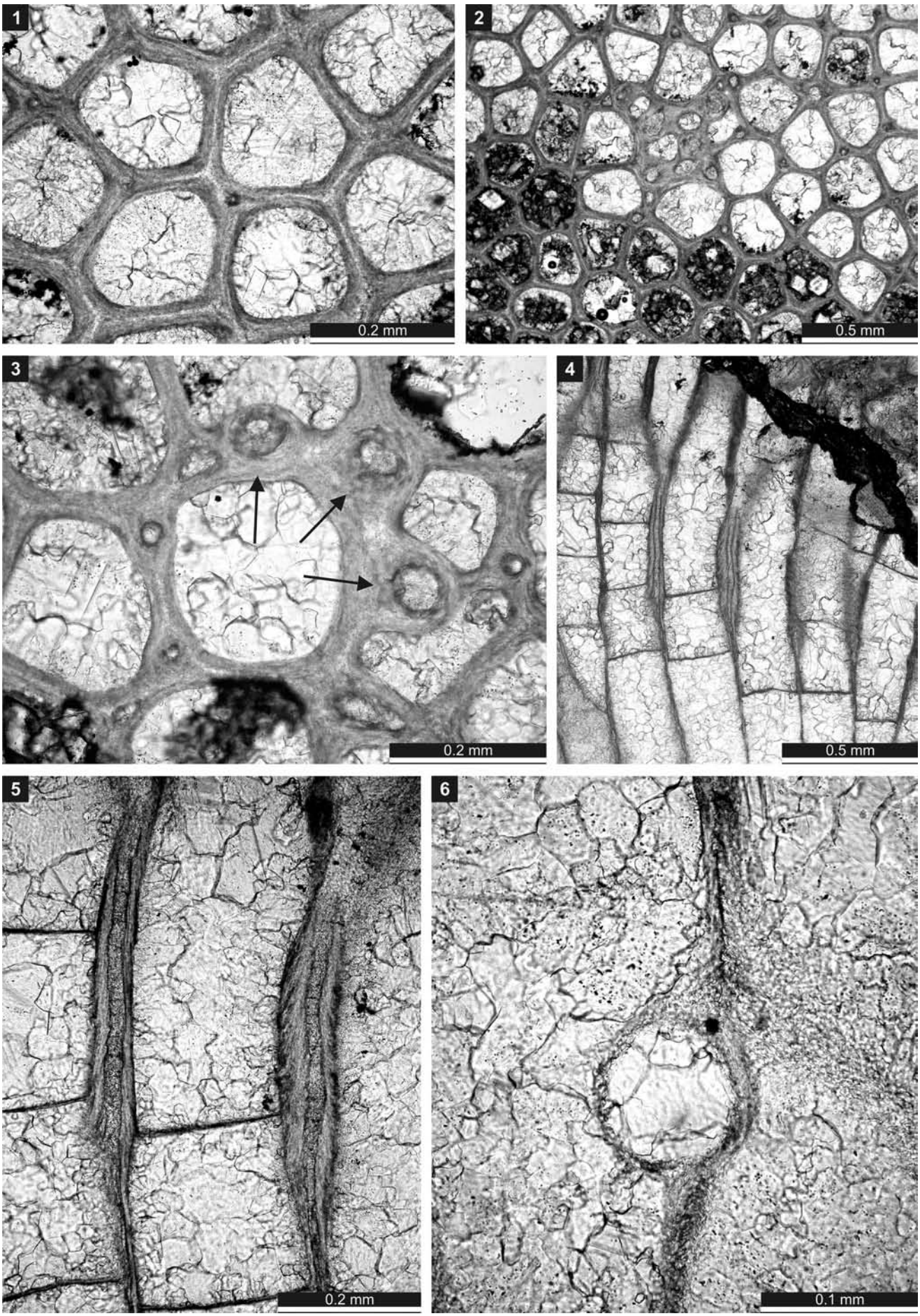


PLATE 4

Anomalotoechus alpenensis (Duncan, 1939)

Pl. 5, figs 5-8, Pl. 6, figs 1-5; Appendix

1939 *Stigmatella alpenensis* Duncan, p. 233-234, pl. 4, figs. 4-6.

Material: RGM 211 536-1-9, RGM 211 538-4-3, RGM 211 540-2-(1-3), RGM 211 547.

Occurrence. Traverse group, Genshaw Formation (Middle Devonian, Givetian); Michigan, USA. ? Esla Formation, Lower Devonian (Emsian); Puerto de la Cubilla, Portilla de Luna, Cantabrian Mountains, NW Spain. Santa Lucía Formation, Lower-Middle Devonian (Emsian-Eifelian); Caldas de Luna, Cantabrian Mountains, NW Spain.

Description. Massive colonies up to 35 mm in thickness. Secondary overgrowths common, separate sheets 1.9-8.0 mm thick. Exozones 1.05-1.44 mm wide. Autozooecia long, prismatic, having polygonal cross sections. Autozooecial apertures rounded-polygonal. Autozooecial diaphragms widely spaced in endozones, common to abundant in exozones, usually straight or slightly curved distally, locally absent. Exilazooecia rare, short, with rounded apertures. Acanthostyles moderately large, having narrow hyaline cores and indistinct laminated sheaths, 1-3 surrounding each autozooecial aperture, locally absent. Autozooecial walls granular, locally strongly crenulated, 0.005-0.010 mm thick in endozones; merged, showing reversal V-shaped lamination without distinct zooecial boundaries, irregularly thickened, with serial thickenings throughout the colony, 0.025-0.063 mm thick in exozones. Maculae large, elevated, consisting of large autozooecia, 1.95-2.75 mm in diameter, spaced 2.65-3.70 mm from centre to centre.

Comparison. *Anomalotoechus alpenensis* (Duncan, 1939) differs from *A. traversensis* (Duncan, 1939) in having fewer autozooecial diaphragms. *Anomalotoechus alpenensis* is also similar to *A. corrugatus* (Nekhoroshev, 1948) from the Middle Devonian (Givetian) of Altay, but differs from it in having smaller apertures (autozooecial aperture width 0.13-0.25 mm vs. 0.25-0.36 mm in *A. corrugatus*).

Anomalotoechus tabulatus n. sp.

Pl. 6, fig. 6, Pl. 7, figs 1-3; Appendix

Etymology: The specific name '*tabulatus*' refers to the presence of abundant diaphragms and cystiphragms in autozooecia (from Latin "*tabulatus*" - floor).

Holotype: RGM 211 536-1-11.

Paratypes: RGM 211 536-1-6, RGM 211 536-2-9, RGM 211 539-1-(1-2).

Type locality: Portilla de Luna, Cantabrian Mountains, NW Spain.

Type stratum. ? Esla Formation, Lower Devonian (Emsian).

Another occurrence: Santa Lucía Formation, Lower-Middle Devonian (Emsian-Eifelian).

Diagnosis: Encrusting (subramose) colonies; exozones indistinctly separated from endozones; diaphragms and cystiphragms abundant in exozones; exilazooecia rare; acanthostyles common, moderately large.

Description. Encrusting (subramose) colonies, separate sheets 0.30-0.75 mm in thickness. Exozones indistinctly separated from endozones. Autozooecia long, bending gently in endozones, having polygonal cross sections. Autozooecial apertures rounded-polygonal. Autozooecial diaphragms restricted to exozones, locally common, 2-5 occurring in each autozooecium; locally absent. Cystiphragms present in exozone, occupying about half space of the autozooecial chamber. Exilazooecia rare, short, with rounded apertures. Acanthostyles moderately large, 3-6 surrounding each autozooecial aperture, having distinct cores and laminated sheaths. Autozooecial walls granular, 0.005-0.010 mm thick in endozones; irregularly thickened, merged, showing reversal U-shaped lamination without distinct zooecial boundaries, 0.04-0.07 mm thick in exozones. Maculae not observed.

Comparison. *Anomalotoechus tabulatus* n. sp. differs from *A. typicus* Duncan, 1939 in more abundant and well-defined cystiphragms.

Family Eridotrypellidae Morozova, 1960

Genus *Eridotrypella* Duncan, 1939

Type species: *Batostomella obliqua* Ulrich, 1890. Middle Devonian; Michigan (USA)

Diagnosis: Branched colonies. Autozooecial apertures irregularly polygonal. Autozooecial walls laminated, without distinct zooecial boundaries, irregularly thickened, containing spherulites. Diaphragms complete, varying in number. Exilazooecia rare. Acanthostyles varying in size and number.

Comparison. *Eridotrypella* Duncan, 1939 differs from *Eostenopora* Duncan, 1939 in colony form (ramose branched vs. encrusting or massive colonies).

Stratigraphic and geographic range. Silurian-?Carboniferous; worldwide.

Eridotrypella valida Duncan, 1939

Pl. 7, figs 4-6, Pl. 8, figs 1-2; Appendix

1939 *Eridotrypella valida* Duncan, p. 219-220, pl. 7, figs 12-14.

Material: Two thin sections of a single colony RGM 211 538-1-(4-5).

Occurrence. Traverse group, Bell shale, Ferron Point Formation (Middle Devonian, Givetian); Michigan, USA. Santa Lucía Formation, Lower-Middle Devonian (Emsian-Eifelian); Caldas de Luna, Cantabrian Mountains, NW Spain.

Description. Ramose branched colony, 3.7 mm in diameter. Exozone 0.48-0.63 mm wide, endozones 2.74-2.44 mm wide. Exozones distinctly separated from endozones. Autozooecia long in endozones, bending sharply in exozones. Autozooecial apertures polygonal with rounded corners. Autozooecial diaphragms absent to rare in endozones; usually thick, abundant in transition between endozone and exozone, straight or inclined. Exilazooecia rare, short, polygonal in cross section. Acanthostyles rare, moderately large, having distinct narrow cores and laminated sheaths. Autozooecial walls granular, locally weakly crenulated, 0.005-0.010 mm thick in endozones; serrated in the longitudinal view and merged in the tangential section, 0.055-0.110 mm thick in exozones. Maculae not observed.

Comparison. *Eridotrypella valida* Duncan, 1939 differs from *E. spinifera* Duncan, 1939 in fewer acanthostyles and thicker autozooecial walls.

Genus *Eifelipora* Ernst, 2008

Type species: *Eifelipora ramosa* Ernst, 2008 (Ernst, 2008a), by original designation. Middle Devonian (Givetian); eastern Rhenish Massif, Germany.

Diagnosis: Branched colonies; secondary overgrows common; proximal hemiphragms common; autozooecial walls containing spherules in exozones; exilazooecia rare to common; acanthostyles locally abundant.

Comparison. *Eifelipora* Ernst, 2008 is similar to *Eridotrypella* Duncan, 1939, but differs in the presence of hemiphragms. The new genus differs also from *Eridocampylus* Duncan, 1939 in shape and arrangement of hemiphragms. *Eridocampylus* has curved and serrated hemiphragms which are arranged on all autozooecial chamber walls. *Eifelipora* differs from *Stenophragmidium* Bassler, 1952 in wall structure without monilae shaped thickenings and containing spherules.

Occurrence. Middle Devonian (Eifelian-Givetian) of Rhenish Massif, Germany. Lower Devonian (Emsian) of Spain.

Eifelipora tenuis n. sp.

Pl. 8, figs 3-7; Appendix

Etymology: The specific name '*tenuis*' refers to the thin colonies of the new species (derived from Latin '*tenuis*' = thin).

Holotype: GZG.IN.0.010.512f-1.

Paratypes: GZG.IN.0.010.512 (a, b-1, b-3, c-5, c-8, e-1, e-3, e-4, d-4, f-5, g-3, g-12, g-15).

Type locality: Section southeast of the village of Villayandre, Cantabrian Mountains, NW Spain.

Type stratum: Lower part of Esla Formation, Lower Devonian (Emsian).

Diagnosis: Branched colonies; proximal hemiphragms common; autozooecial walls containing spherules in exozones; exilazooecia rare to common; acanthostyles abundant.

Description: Ramose colonies with relatively narrow, distinctly separated exozones; secondary overgrowths occurring. Branches 0.81-1.29 mm in diameter, endozones 0.42-0.54 mm wide, exozones 0.13-0.20 mm wide. Autozooecia tubular-prismatic, growing parallel to branch axes in endozone, bending abruptly in exozone and intersecting colony surface at angles of 78-80°. Autozooecial apertures rounded-polygonal. Basal diaphragms common to absent, restricted to exozone, straight or slightly curved distally, thin. Hemiphragms abundant in exozones, positioned on proximal wall, moderately thin, short to moderately long, straight to weakly curved proximally. Autozooecial walls granular, 0.005-0.010 mm thick in endozone; laminated, containing spherules, 0.030-0.055 mm thick in exozones. Exilazooecia abundant, 2-7 surrounding each autozooecial aperture, small, originating in basal exozone. Acanthostyles abundant, 2-7 surrounding each autozooecial aperture, having distinct cores and laminated sheaths, originating in basal exozone. Maculae absent.

Comparison. *Eifelipora tenuis* n. sp. differs from *E. ramosa* Ernst, 2008 (Ernst, 2008a) from the Middle Devonian of Rhenish Massif in thinner branches (average branch diameter 1.01 mm vs. 1.67 mm in E. *ramosa*) and more abundant acanthostyles and exilazooecia.

Family Anisotrypidae Dunaeva & Morozova, 1967

Genus *Boardmanella* Gorjunova & Weis, 2003

Type species: *B. richardi* Gorjunova & Weiss, 2003, by original designation. Middle Devonian (Givetian); Mongolia.

Diagnosis (emended): Branched colonies with distinct exozones; autozooecia prismatic, growing parallel to the branch axis in

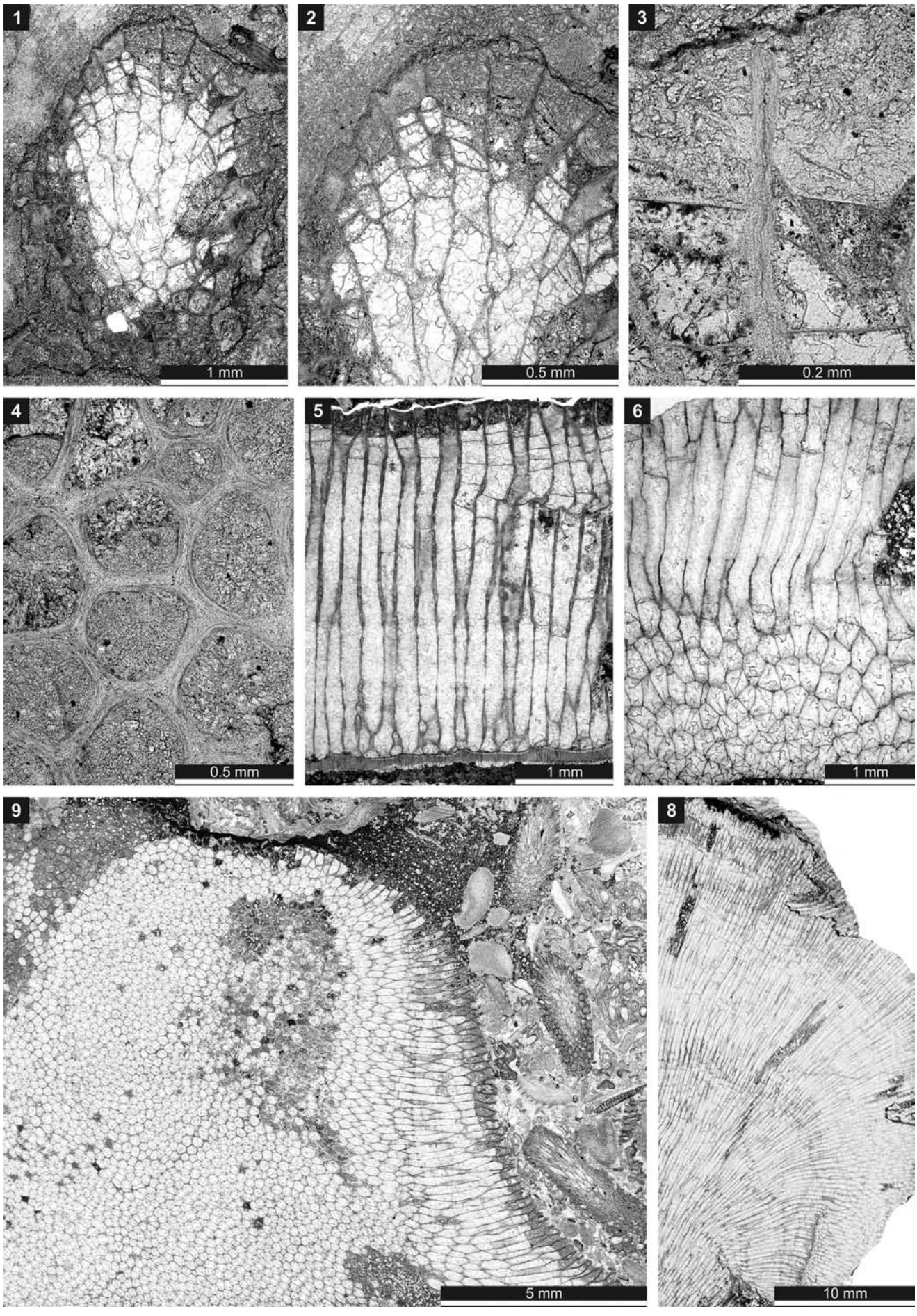
---

PLATE 5

Figs 1-4 - *Atactotoechus cartus* Boardman, 1960. Lower part of Esla Formation, Lower Devonian (Emsian); Villayandre, Cantabrian Mountains, NW Spain.
1-3: branch oblique section showing basal diaphragms and cystiphragms. GZG.IN.0.010.512f-3; 4: tangential section. GZG.IN.0.010.512g-14.

Figs 5-7 - *Anomalotoechus alpenensis* (Duncan, 1939). Santa Lucía Formation (Lower Devonian, Emsian-Eifelian); Caldas de Luna, Cantabrian Mountains, NW Spain.
5: longitudinal section of encrusting colony. RGM 211 538-4-2; 6: transverse section of encrusting colony. RGM 211 541-2-3; 7: transverse section of massive colony. RGM 211 539-1-9.

Fig. 8 - *Anomalotoechus alpenensis* (Duncan, 1939). ? Esla Formation, Lower Devonian (Emsian); Puerto de la Cubilla, Cantabrian Mountains, NW Spain. Longitudinal section of massive colony. RGM 211 547.


1
1 mm
2
0.5 mm
3
0.2 mm
4
0.5 mm
5
1 mm
6
1 mm
9
5 mm
8
10 mm

endozones, then bending in exozones at moderate angles, polygonal in transverse section; autozooecial apertures rounded to oval or rounded-polygonal; basal diaphragms usually absent, locally present, thin, straight; exilazooecia rare to abundant, short, varying in size; paurostyles (Gorjunova & Weis, 2003) always covered by skeletal material; varying in size and number; autozooecial walls regularly thickened in exozones, straight, merged without distinct zooecial boundaries and showing reverse U-shaped lamination.

Comparison. *Boardmanella* Gorjunova & Weis, 2003 is superficially similar to *Dyscritella* Girty, 1911 in having rare to absent diaphragms and regularly thickened autozooecial walls. However, the styles in *Boardmanella* are different to those in *Dyscritella*. Gorjunova & Weis (2003) correctly noted the similarity of these styles to paurostyles of Blake (1983). However, the styles in *Boardmanella* do not correspond completely to the terminus "paurostyle" *sensu stricto*. Species placed by Gorjunova & Weis (2003) to the genus *Boardmanella* have a typical combination of morphological characters (wall structure, rare or lacking diaphragms), and they also have styles varying in size and number, but always covered by skeletal material. Blake (1983: 538-539) regarded paurostyles as the simplest kind of styles consisting of small rods, usually 0.02-0.04 mm in diameter, and with narrow laminated sheaths. The main difference between acanthostyles and paurostyles is that acanthostyles usually protrude upon the colony surface and have wide, well-developed laminated sheaths. For aims of the present paper, the terminus "paurostyles" is used in the description, although the need for the new name is obvious.

Occurrence. Following species of *Boardmanella* are known from the Devonian worldwide: *B. richardi* Gorjunova & Weiss, 2003 from the Middle Devonian (Givetian) of Mongolia, *B. interporosa* (Ulrich & Bassler, 1904) from the Lower Devonian of USA), *B. antiqua* (Nekhoroshev, 1977) from the Lower Devonian (Pragian-Emsian) of Kazakhstan, *B. bohemica* (Ernst, 2008) (Ernst 2008b) from the Lower Devonian (Pragian) of Bohemia and Lower-Middle Devonian (Emsian-Eifelian) of Spain, *B. inermis* (Kopajevich, 1984) from the Middle Devonian (Eifel) of Mongolia, *B. devonica* (Volkova, 1974) from the Middle Devonian (Givetian) of Altai, *B. uniserialis* (Kopajevich, 1984) from the Middle Devonian (Eifelian-Givetian) of Mongolia, *B. elliptica* (Kopajevich, 1984) from the Middle-Upper Devonian (Givetian-Frasnian) of Mongolia, *B. indistincta* (Nekhoroshev, 1977) from the Upper Devonian (Famennian) of Kazakhstan.

Boardmanella bohemica (Ernst, 2008)

Pl. 9, figs 1-8; Appendix

2008b *Dyscritella bohemica* Ernst, p. 341-342, pl. 5, figs 5-9.

Material. RGM 211 536-2-(1, 3, 7, 8, 10, 11, 12), RGM 211 538-1-(3, 4, 5), RGM 211 538-2-(1, 3, 4, 6), RGM 211 538-4-3, RGM 211 541-1-(1-4), RGM 211 541-3-(2-6), RGM 211 541-4-1.

Occurrence. Zlatý Kůň, Czech Republic; Koněprusy Limestone, Pragian (Lower Devonian). ? Esla Formation, Lower Devonian (Emsian); Portilla de Luna, Cantabrian Mountains, NW Spain. Santa Lucía Formation, Lower-Middle Devonian (Emsian-Eifelian); Caldas de Luna, Cantabrian Mountains, NW Spain.

Description. Branched colonies with distinct exozone. Secondary overgrowth occurring. Branches 1.9-4.1 mm in diameter. Endozones 1.1-1.3 mm wide, exozones 0.4-1.4 mm wide. Autozooecia long in endozone, bending at low angles in exozone. Autozooecial apertures rounded-polygonal. Autozooecial diaphragms rare to absent. Exilazooecia rare, short, rounded to oval in cross section. Paurostyles of two distinct sizes. 3-6 large paurostyles surrounding each autozooecial aperture; having indistinct cores and laminated sheaths. Commonly 1-2 small paurostyles spaced in a single row between large paurostyles. Autozooecial walls granular, 0.005-0.015 mm thick in endozones; thick, merged, laminated without distinct zooecial boundaries, 0.05-0.10 mm thick in exozones. Indistinct maculae consisting of larger autozooecia.

Comparison. *Boardmanella bohemica* (Ernst, 2008) (Ernst 2008b) differs from *B. elliptica* (Kopajevich, 1984) from the Middle-Upper Devonian (Givetian-Frasnian) of Mongolia in presence of paurostyles of two different sizes.

Genus *Mongoloclema* Shishova, 1970

Type species: *Mongoloclema ignotum* Shishova, 1970. Middle-Late Devonian; Mongolia

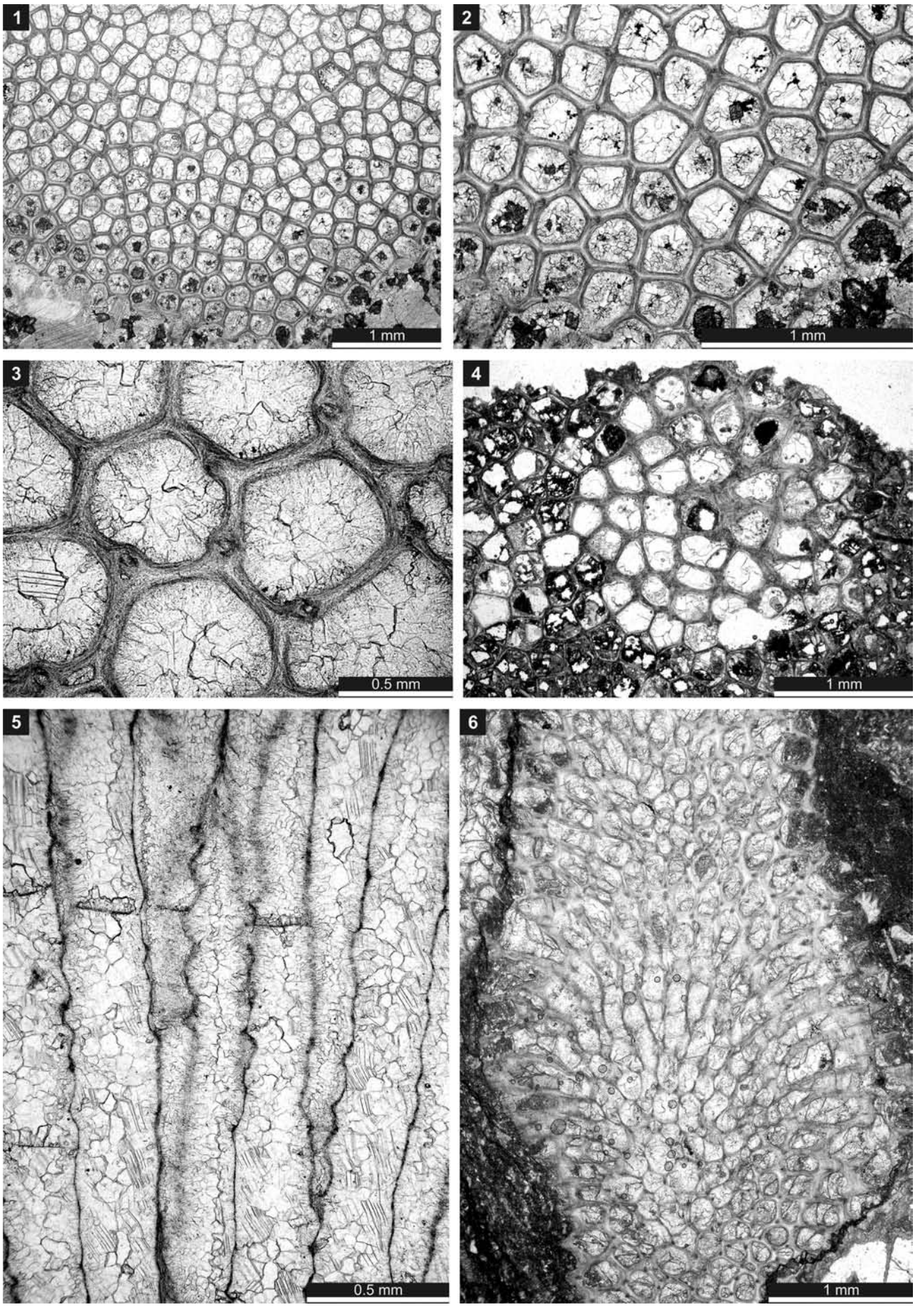
1970 *Mongoloclema* Shishova, p. 29.
1976 *Mongoloclema* Shishova, 1970 - Troitzkaya, p. 148.
1984 *Mongoloclema* Shishova, 1970 - Kopajevich, p. 128-129.
2003 *Mongoloclema* Shishova, 1970 - Morozova, Gorjunova & Ariunchimeg, p. 93.

PLATE 6

Figs 1-4 - *Anomalotoechus alpenensis* (Duncan, 1939). Santa Lucía Formation Lower-Middle Devonian (Emsian-Eifelian); Caldas de Luna, Cantabrian Mountains, NW Spain. 1-3: tangential sections. RGM 211 541-4-3; 4: tangential section of a macula. RGM 211 547.

Fig. 5 - *Anomalotoechus alpenensis* (Duncan, 1939). ? Esla Formation, Lower Devonian (Emsian); Puerto de la Cubilla, Cantabrian Mountains, NW Spain. Longitudinal section showing crenulated walls of endozone. RGM 211 547.

Fig. 6 - *Anomalotoechus tabulatus* n. sp. Santa Lucía Formation, Lower-Middle Devonian (Emsian-Eifelian); Caldas de Luna, Cantabrian Mountains, NW Spain. Holotype. Branch oblique section. RGM 211 536-1-11.


1
1 mm
2
1 mm
3
0.5 mm
4
1 mm
5
0.5 mm
6
1 mm

Diagnosis: Ramose colonies with distinct exozones; autozooecia long, growing parallel to branch axis then bending at moderately high angles to the colony surface; basal diaphragms common to abundant, thin, straight, inclined or cystiphragmoid; exilazooecia abundant, often separating autozooecia, sometimes containing thin diaphragms; styles absent; autozooecial walls finely laminated, without visible boundaries, irregularly thickened in exozone; fine tubules present in outermost parts of exozonal walls.

Comparison. Systematic position of *Mongoloclema* is uncertain. Shishova (1970) placed this genus in the rhabdomesine family Hyphasmoporidae Vine, 1886. However, *Mongoloclema* lacks typical regular budding pattern of autozooecia, which is usually observed in rhabdomesine cryptostomes. Furthermore, inclined and cystiphragmoid diaphragms are not characteristic for cryptostome bryozoans. Gorjunova (1992: 37) and Morozova et al. (2003: 93) placed *Mongoloclema* in the trepostome family Anisotrypidae Dunaeva & Morozova, 1967, apparently because of the absence of styles and presence of tubules (capillaries of authors). However, typical representatives of Anisotrypidae have autozooecial walls with distinct boundaries (serrated), whereas *Mongoloclema* possesses merged autozooecial walls.

Occurrence. Two species of *Mongoloclema* are known: *Mongoloclema ignotum* Shishova, 1970 from the Early-Middle Devonian (Emsian-Eifelian) of Mongolia, and *M. sincera* Troitzkaya, 1976, from the Middle Devonian (Givetian) of Kazakhstan (Dzungarian Alatau).

Mongoloclema sincera Troitzkaya, 1976

Pl. 10, figs 1-6; Appendix

1976 *Mongoloclema sincera* Troitzkaya, p. 148-149, fig. 1.

Material: Single specimen RGM 211 544-8.

Occurrence. Middle Devonian (Givetian); Dzungarian Alatau, Kazakhstan. Santa Lucía Formation, Lower-Middle Devonian (Emsian-Eifelian); Caldas de Luna, Cantabrian Mountains, NW Spain.

Description. Colony shape apparently ramose, ca 10 mm wide. Exozone narrow, distinctly separated, 0.48-0.90 mm wide. Secondary overgrowths not observed. Autozooecia tubular, bending in exozone at angles of 57-70° and intersecting colony surface at angles of 90°. Autozooecial apertures circular to oval and slightly polygonal. Basal diaphragms abundant in exozone, thin, straight or inclined; absent in endozone. Autozooecial walls granular, 0.010-0.015 mm thick in endozone; finely laminated, without visible boundaries, 0.020-0.055 mm thick in exozones. Exilazooecia abundant, 8-14 surrounding each autozooecial aperture, small, originating in basal exozone, occasionally containing diaphragms. Acanthostyles absent. Indistinct

PLATE 7

Figs 1-3 - *Anomalotoechus tabulatus* n. sp. Santa Lucía Formation, Lower-Middle Devonian (Emsian-Eifelian); Caldas de Luna, Cantabrian Mountains, NW Spain.
1: paratype. Longitudinal section showing basal diaphragms and cystiphragms. RGM 211 539-1-2; 2: paratype. Longitudinal section showing cystiphragms. RGM 211 539-1-2; 3: holotype. Tangential section. RGM 211 536-1-11.

Figs 4-6 - *Eridotrypella valida* Duncan, 1939. Santa Lucía Formation, Lower-Middle Devonian (Emsian-Eifelian); Caldas de Luna, Cantabrian Mountains, NW Spain.
4: tangential section. RGM 211 538-1-4; 5: branch oblique section. RGM 211 538- 1-5; 6: branch longitudinal section showing autozooecial walls and basal diaphragms. RGM 211 538-1-4.

PLATE 8

Figs 1-2 - *Eridotrypella valida* Duncan, 1939. Santa Lucía Formation, Lower-Middle Devonian (Emsian-Eifelian); Caldas de Luna, Cantabrian Mountains, NW Spain.
1: tangential section. RGM 211 538-1-4; 2: branch longitudinal section showing autozooecial wall with secondary cortex. RGM 211 538-1-4.

Figs 3-7 - *Eifelipora tenuis* n. sp. Lower part of Esla Formation, Lower Devonian (Emsian); Villayandre, Cantabrian Mountains, NW Spain.
3: holotype. Branch longitudinal section. GZG.IN. 0.010.512f-1; 4-5: paratype. Tangential sections. GZG. IN.0.010.512c-5; 6: holotype. Branch longitudinal section showing hemiphragms. GZG.IN.0.010.512f-1; 7: paratype. Branch transverse section. GZG.IN.0.010. 512f-5.

PLATE 9

Figs 1-8 - *Boardmanella bohemica* (Ernst, 2008). Santa Lucía Formation (Lower Devonian, Emsian-Eifelian); Caldas de Luna, Cantabrian Mountains, NW Spain.
1-2: branch longitudinal section. RGM 211 536-2-7; 3-4: tangential section. RGM 211 536-2-11; 5: branch transverse section. RGM 211 541-1-4; 6-7: branch transverse sections showing basal diaphragms, styles and autozooecial wall structure. RGM 211 541-1-4; 8: Branch longitudinal section. RGM 211 536-2-7.

PLATE 10

Figs 1-6 - *Mongoloclema sincera* Troitzkaya, 1976. Santa Lucía Formation, Lower-Middle Devonian (Emsian-Eifelian); Caldas de Luna, Cantabrian Mountains, NW Spain.
1-3: tangential sections. RGM 211 544-8; 4-6: branch longitudinal sections. RGM 211 544-8.

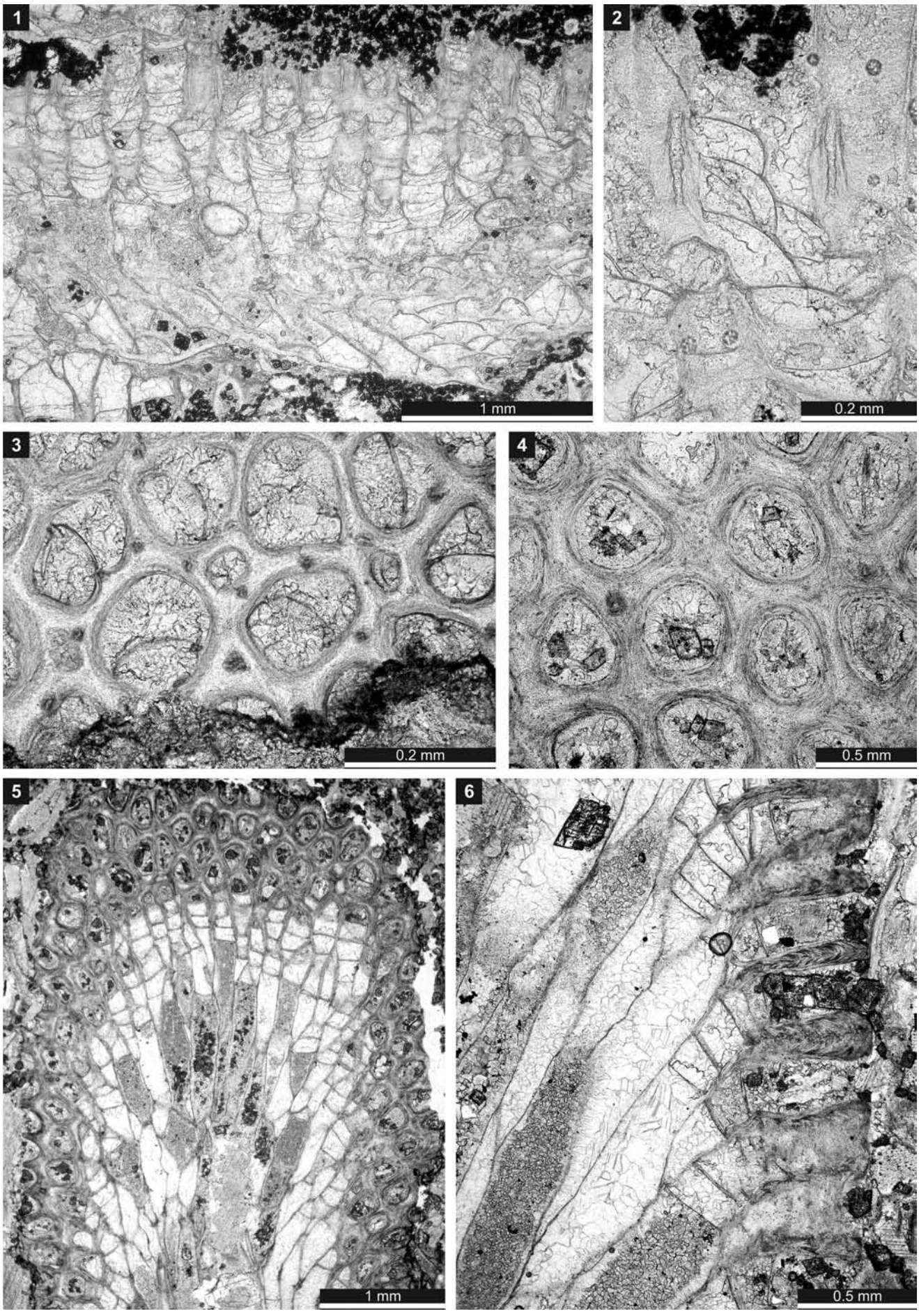


PLATE 7

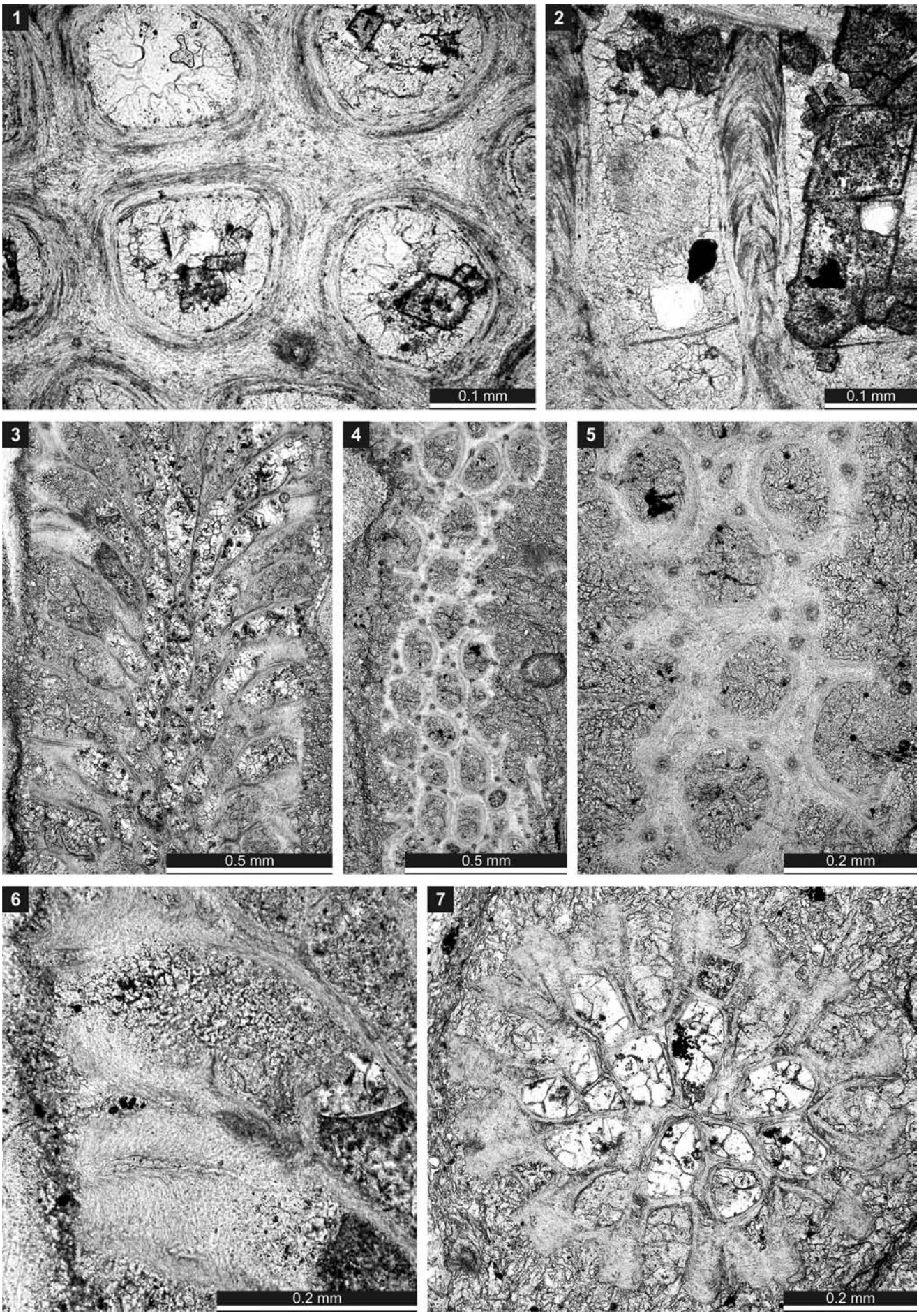


PLATE 8

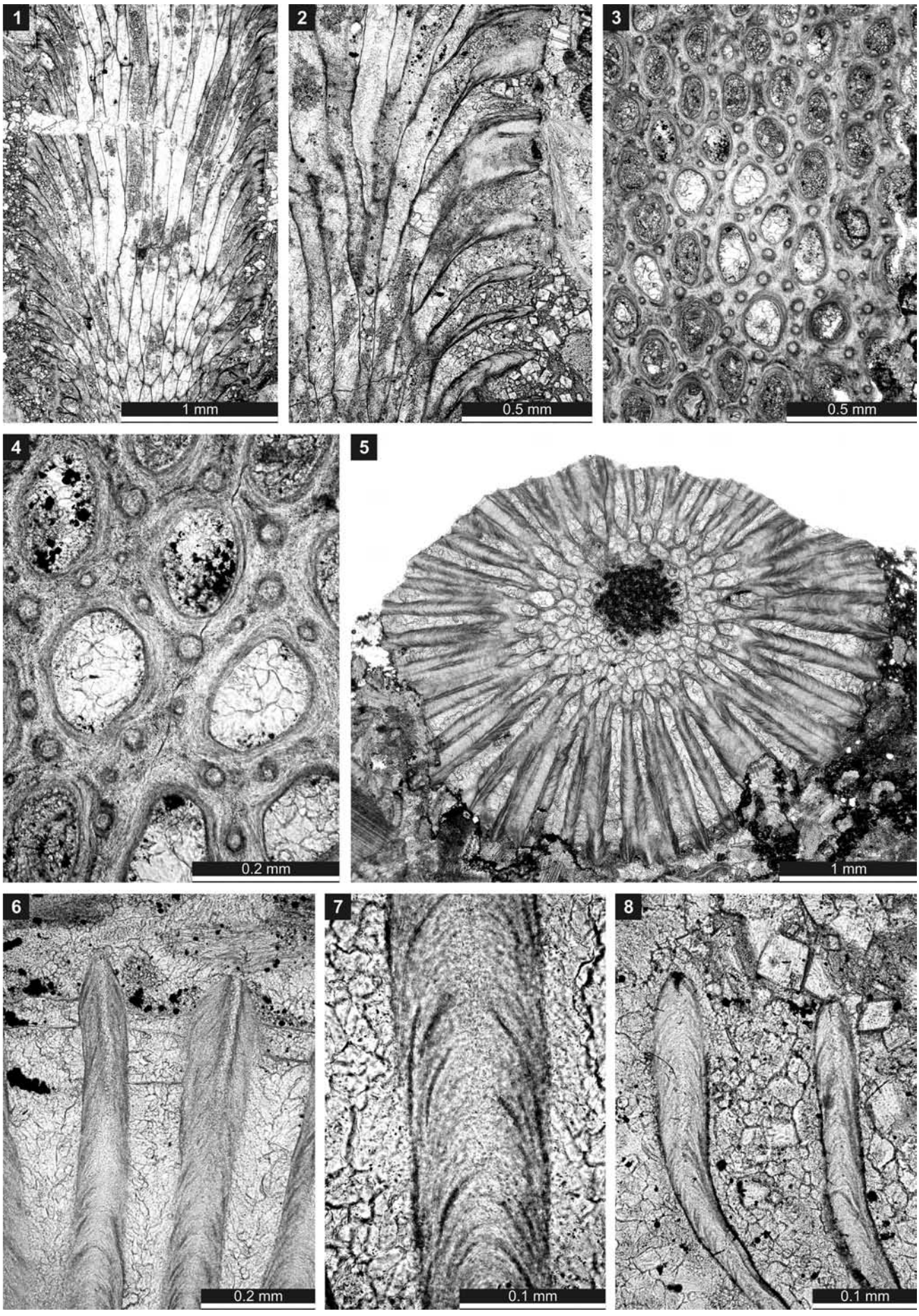


PLATE 9

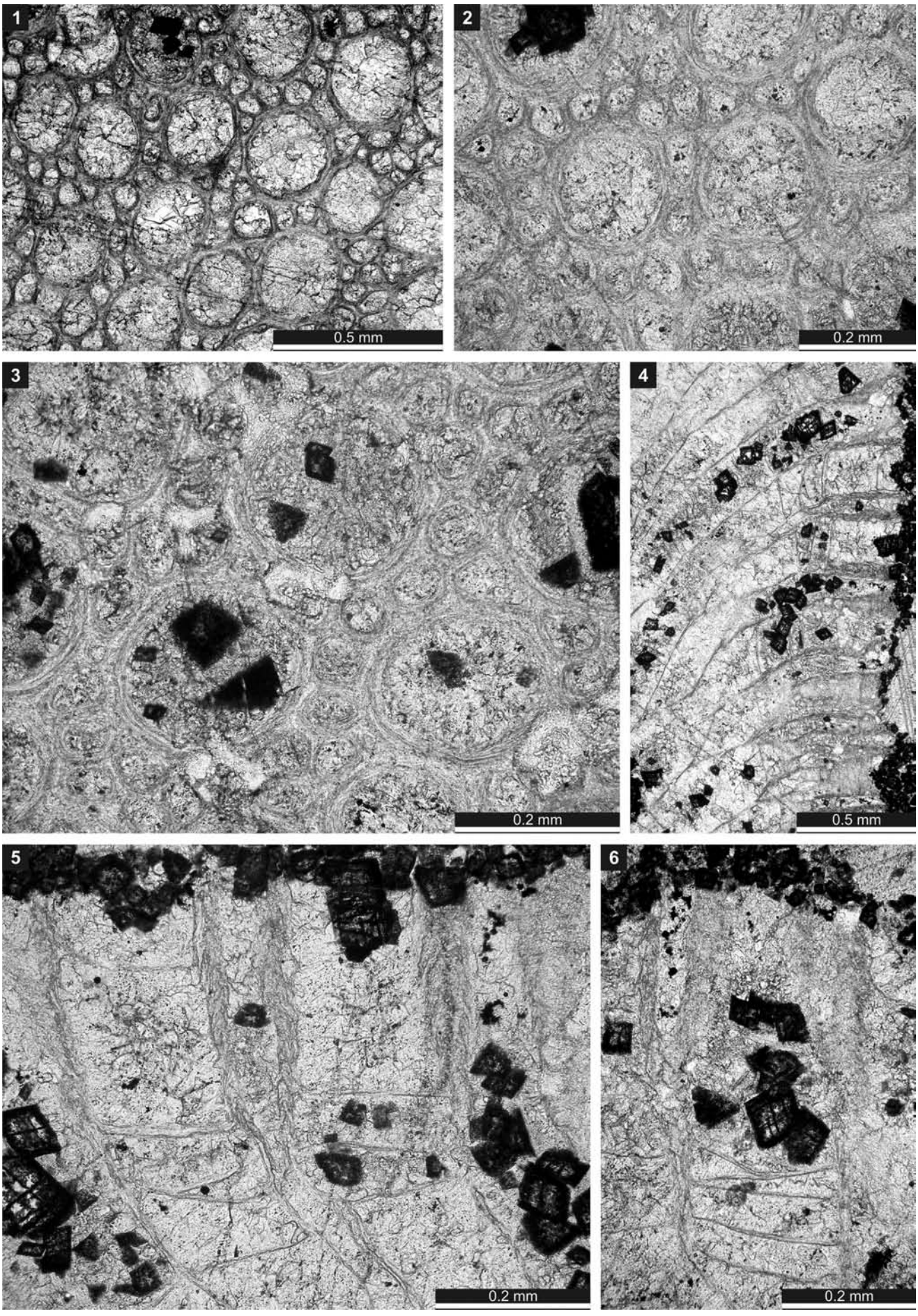


PLATE 10

maculae consisting of larger zooecia and abundant exilazooecia, 0.9-1.2 mm in diameter, spaced 2.5-3.1 mm from centre to centre.

Comparison. *Mongoloclema sincera* Troitzkaya, 1976 differs from *M. ignotum* Shishova, 1970 in having larger colonies (branch width up to 10 mm vs. 1-4 mm in *M. ignotum*), and less abundant exilazooecia. Troitzkaya (1976) and Kopajevitch (1984) distinguished *Mongoloclema sincera* from *M. ignotum* by smaller autozooecial apertures. However, these authors used only the range of measurements, what makes the comparison difficult:

Autozooecia width (shorter diameter):

M. sincera Troitzkaya, 1976	0.12-0.18 mm
Present material	0.14-0.20 mm
M. ignotum Shishova, 1970	0.10-0.15 mm
M. ignotum Shishova, 1970 (in Kopajevich, 1984)	0.12-0.22 mm

Measurements on illustrations from available publications of *M. ignotum* Shishova, 1970 (Shishova 1970; Kopajevich 1984; Morozova et al. 2003) produced the range of autozooecial widths (for intermacular zooecia) by 0.13-0.30 mm, whereas the illustration of the type specimen (Shishova 1970, fig. 12, 2a) showed the range by 0.20-0.30 mm (intermacular zooecia). Even if the true range of aperture widths of *M. ignotum* is not consequently calculated yet, it is obvious that *M. ignotum* has larger autozooecial apertures than *M. sincera*.

Conclusions

The described bryozoan fauna shows palaeobiogeographic relations to the Lower Devonian (Pragian) of Bohemia (*Boardmanella bohemica* (Ernst, 2008), *Leioclema elegans* Ernst, 2008),

Lower Devonian (Upper Emsian) of the Armorican Massif, France (*Leoclema elegans* Ernst, 2008), Middle Devonian (Givetian) of Kazakhstan (*Mongoloclema sincera* Troitzkaya, 1976), and Middle Devonian (Givetian) of USA (*Leptotrypella parva* Duncan, 1939, *L. provecta* Boardman, 1960, *Atactotoechus cartus* Boardman, 1960, *Anomalotoechus alpenensis* (Duncan, 1939), *Eridotrypella valida* Duncan, 1939). On the genus level, the genus *Mongoloclema* shows restricted distribution. It was previously reported from the Middle - Late Devonian of Kazakhstan and Mongolia. *Boardmanella* is known from the Lower Devonian of USA, Kazakhstan and Europe, Middle Devonian of Mongolia and Altay and from the Late Devonian of Kazakhstan and Mongolia. *Leptotrypella*, *Atactotoechus, Anomalotoechus,* and *Eridotrypella* are widely distributed genera.

Acknowledgements. Cor Winkler Prins, Leiden, and Mike Reich and Joachim Reitner, Göttingen, are thanked for help with providing of studied material. Raisa Gorjunova, Moscow, is thanked for her helpful comments on bryozoan taxonomy. The present study forms part of project ER 278/4-1 and 2 supported by the Deutsche Forschungsgemeinschaft (DFG), and is a contribution to IGCP 499 "Devonian land-sea interaction: evolution of ecosystems and climate". Françoise Bigey, Paris, and Juan Luis Suáres Andrés, Zurita de Pielagos, are thanked for their helpful and constructive reviews of the manuscript.

REFERENCES

Anstey R. L. & Perry T.G. (1970) - Biometric procedures in taxonomic studies of Paleozoic bryozoans. *J. Paleontol.*, 44(2): 383-398.

Astrova G.G. (1964) - Bryozoa of the Borschov and Chortkov horizons of Podolia. *Trudy Paleontologicheskogo Instituta Akademii Nauk SSSR*, 98: 1-53 [in Russian].

Astrova G.G. (1965) - Morphology, history of development and systematics of the Ordovician and Silurian Bryozoa. *Trudy Paleontologicheskogo Instituta Akademii Nauk SSSR*, 106: 1-432 [in Russian].

Astrova G.G. (1978) - The history of development, systematics, and phylogeny of the Bryozoa: Order Trepostomata. *Trudy Paleontologicheskogo Instituta Akademii Nauk SSSR*, 169: 1-240 [in Russian].

Bassler R.S. (1952) - Taxonomic notes on genera of fossil and Recent Bryozoa. *J. Washington Ac. Sci.*, 42: 381-385.

Bigey F.P. (1972) - Présence de *Ptilopora* aff. *bohemica* (bryozoaire cryptostome) dans le Dévonien du Sud-Est du Massif Armoricain. *Bull. Soc. Sci. Anjou*, 8: 15-22.

Bigey F.P. (1980) - Les bryozoaires. In: Plusquellec Y. (Ed.) - Les schistes et calcaires de l'Armorique (Dévonien inférieur, Massif Armoricain. Sedimentologie, Paléontologie, Stratigraphie. *Mém. Soc. géol. minéral. Bretagne*, 23: 181-193.

Bigey F.P. (1981) - Les bryozoaires. In: Morzadec P. (Ed.) - La tranchée de la Lézais, Emsien Superieur du Massif Armoricain. Sédimentologie, Paléontologie, Stratigraphie. *Mém. Soc. géol. minéral. Bretagne*, 24: 109-134.

Bigey F.P. (1985) - Biogeography of Devonian Bryozoa. In: Nielsen C. & Larwood G. P. (Eds) - Bryozoa: Ordovician to Recent: 9-23.

Bigey F. P. (1986) - Bryozoaires. In: Racheboeuf P.R. (Ed.) - Le Groupe de Liévin. Pridoli - Lochkovien de l'Artois (N. France). Biostratigraphie du Paléozoïque, 3: 63-84.

Blake D.B. (1983) - Systematic Descriptions for the Suborder Rhabdomesina. In: R.S. Boardman & al. (Eds) - Treatise on Invertebrate Paleontology. Part G (revised), 1. Geological Society of America and University of Kansas: 550-592, Boulder & Lawrence.

Boardman R. S. (1960) - Trepostomatous Bryozoa of the Hamilton Group of New York State. *U.S. Geol. Surv., prof. pap.*, 340: 1-87.

Borg F. (1926) - Studies on Recent cyclostomatous Bryozoa. *Zoologiska Bidrag fran Uppsala*, 10: 181-507.

Buggisch W., Meiburg P. & Schumann D. (1982) - Facies, Paleogeography and Intra-Devonian gaps of the Asturo-Leonese Basin (Cantabrian Mountains, Spain). *Neues Jahr. Geol. Paläontol., Abh.*, 163: 212-230.

Comte P. (1959) - Recherches sur les terrains anciens de la Cordillère cantabrique. *Mem. Inst. Geol. Minero España*, 60: 1-440.

Cuffey R.J. & Mckinney F.K. (1979) - Devonian Bryozoa. *Spec. Pap. Palaeontol.*, 23: 307-311.

De Coo J.C.M. (1974) - Lithostratigraphy of the Devonian Santa Lucía in León, Spain. Unpublished PhD thesis, University of Leiden.

Dunaeva N.N. & Morozova I.P. (1967) - Evolution and systematic position of certain Late Palaeozoic Trepostomata. *Paleontol. Zh.*, 4: 86-94 [in Russian].

Duncan H. (1939) - Trepostomatous Bryozoa from the Traverse Group of Michigan. *Contrib. Mus. Paleontol., Univ. Michigan,* 5(10): 171-270.

Ehrenberg C.G. (1831) - Symbolae Physicae, seu Icones et descriptiones Corporum Naturalium novorum aut minus cognitorum, quae ex itineribus per Libyam, Aegiptum, Nubiam, Dongalaam, Syriam, Arabiam et Habessiniam, studia annis 1820-25, redirent. Pars Zoologica, 4, Animalia Evertebrata exclusis Insectis: 1-10 pls., Berolini.

Ernst A. (2008a) - Non-fenestrate bryozoans from the Middle Devonian of the Eifel (western Rhenish Massif, Germany). *Neues Jahr. Geol. Paläontol., Abh.*, 250(3): 313-379.

Ernst A. (2008b) - Trepostome and cryptostome bryozoans from the Koněprusy Limestone (Lower Devonian, Pragian) of Zlatý Kůň (Czech Republic). *Riv. It. Paleontol. Strat.,* 114(3): 329-348.

Ernst A. (2009) - *Petaloporella* (Cryptostomata, Bryozoa) from the Lower Devonian of central Bohemia. *Bull. Geosci.*, 84(4): 769-772.

Ernst A. & May A. (2009) - Bryozoan fauna from the Koněprusy Limestone (Pragian, Lower Devonian) of Zlatý Kůň near Koněprusy (Czech Republic). *J. Paleontol.*, 83(5): 767-782.

García-López S. & Sanz-López J. (2002) - Devonian to Lower Carboniferous conodont biostratigraphy of the Bernesga Valley section (Cantabrian Zone, North Spain). In: García-López S. & Bastida F. (Eds) - Palaeozoic Conodonts from Northern Spain. *Inst. Geol. Min. España, Serie Cuad. Mus. Geomin.*, 1: 163-205.

Girty G.H. (1911) - New Genera and Species of the Carboniferous Fossils from the Fayetteville Shale of Arkansas. *Ann. New York Acad. Sci.*, 20: 189-238.

Gorjunova R.V. (1992) - Morphology and systematics of the Paleozoic bryozoans. *Trudy Paleontologischeskogo Instituta Akademiya Nauk SSSR*, 251: 1-168 [in Russian].

Gorjunova R.V. & Weis O.B. (2003) - New Devonian bryozoans from Mongolia *Paleontol. Zh.*, 2003(3): 49-52 [in Russian].

Hall J. (1858) - Palaeontology of Iowa. In: Hall J. & Whitney J.D. (Eds) - Report of the Geological Survey of the State of Iowa: embracing the results of investigations made during portions of the years 1855, -56 & -57: 473-724. Ch. van Benthuysen & Sons, Albany.

Hofmann M.H. & Keller M. (2006) - Sequence stratigraphy and carbonate platform organization of the Devonian Santa Lucía Formation, Cantabrian Mountains, NW Spain. *Facies*, 52(1): 149-167.

Horowitz A.S., Pachut J.F. & Anstey R.L. (1996) - Devonian bryozoan diversity, extinctions and originations. *J. Paleontol.*, 70: 373-380.

Keller M. (1988) - Die La Vid Gruppe - Fazies, Paläogeographie und synsedimentäre Tektonik im Unterdevon des Kantabrischen Gebirges (NW-Spanien). *Erlanger Geol. Abh.*, 115: 77-154.

Keller M. (1997) - Evolution and sequence stratigraphy of an Early Devonian carbonate ramp, Cantabrian Mountains, northern Spain. *J. Sed. Res.*, 67(4): 638-652.

Keller M. & Grötsch J. (1990) - Depositional history and conodont biostratigraphy of the Lower Devonian La Vid Group in the Luna area (Cantabrian Mountains, NW Spain). *Neues Jahrb. Geol.* Paläontol., Mon., 3: 141-164.

Kopajevich G.V. (1984) - Atlas of Bryozoan from Ordovician, Silurian and Devonian of Mongolia. *Sovmestnaya Sovetsko-Mongolskaya Paleontologischeskaya Ekspeditsiya, Trudy*, 22: 1-164 [in Russian].

McKinney F.K. & Kříž J. (1986) - Lower Devonian Fenestrata (Bryozoa) of the Prague Basin, Barrandian Area, Bohemia, Czechoslovakia. *Fieldiana*, *Geology new series*, 15: 1-90.

Méndez-Bedia I. (1976) - Biofacies y Litofacies de la Formacíon Moniello-Santa Lucía (Devónico de la Cordillera Cantábrica, NW de España). *Trab. Geol.*, 9: 1-93.

Morozova I.P. (1960) - Devonian Bryozoa of the Minusinsk and Kuznetsk depressions. *Trudy Paleontologicheskogo Instituta Akademii Nauk SSSR,* 86: 1-207 [in Russian].

Morozova I.P., Gorjunova R.V. & Ariunchimeg Y. (2003) - Paleontology of Mongolia: Bryozoans. 168 pp. Nauka, Moscow [in Russian].

Nekhoroshev V.P. (1948) - Devonian Bryozoa of the Altai. *Paleontology of the USSR* 3(2): 1-172. [in Russian].

Nekhoroshev V.P. (1977) - Devonian bryozoans from Kazakhstan. *Trudy VSEGEI*, 186: 1-192. [in Russian].

Nicholson H.A. (1874) - Descriptions of New Fossils from the Devonian Formation of Canada West. *Geol. Mag.,* December 2, 1(2): 51-96.

Nicholson H.A. (1879) - On the structure and affinities of the "Tabulate Corals" of the Paleozoic period, with critical descriptions of illustrative species, 342 pp. William Blackwood and Sons, Edinburgh.

Shishova N.A. (1970) - Some new Silurian and Devonian Bryozoa from Mongolia. In: Astrova G.G. & Chudinova I.I. (Eds) - New species of Paleozoic Bryozoa and corals: 28-31. Nauka, Moscow [in Russian].

Suárez Andrés J.L. (1998) - Briozoos fenestrados de la Formacion Moniello (Devonico) en el area de Arnao (Asturias, España); I, Fenestellidae. *Rev. Esp. Paleontol.*, 13(2): 187-196.

Suaréz Andrés J.L. (1999a) - Briozoos fenestrados de la Formación Moniello (Devónico) en Arnao (Asturias, España). II: Septoporidae, Polyporidae y Acanthocladiidae. *Rev. Esp. Paleontol., Nº Extraord., Homanje al Prof. J. Truyols*:, 185-193.

Suaréz Andrés J.L. (1999b) - Nuevos datos sobre los briozoos devónicos de la Zona Cantábrica. *Temas Geológico-Mineros ITGE*, 6: 643-646.

Suaréz Andrés J.L. (1999c) - Parasitismo en briozoos del Devónico de la Zona Cantábrica. Temas Geológico-Mineros ITGE, 6: 647-650.

Suárez Andrés J.L. & González C. (2000a) - Consideraciones paleobiogeográficas sobre los briozoos del Devónico de la Zona Cantábrica (Asturias, NW de España). In: Díez J. B. & Balbino A. C. (Eds) - Actas I Congresso Ibérico de Paleontologia - XVI Jornadas Sociedad Española de Paleontologia-VIII International Meeting of IGCP 421: 291-292. Universidade de Évora.

Suárez Andrés J.L. & González C. (2000b) - *Fenestrapora* Hall, 1885 (Bryozoa) del Devónico de la Zona Cantábrica. In: Díez J.B. & Balbino A.C. (Eds) - Actas I Congresso Ibérico de Paleontologia - XVI Jornadas Sociedad Española de Paleontologia-VIII International Meeting of IGCP 421: 293-294. Universidade de Évora.

Troitzkaya T.D. (1976) - The first bryozoan of the genus *Mongoloclema* from the Devonian of the USSR. *Paleontol. Zh.*, 1976(3): 148-149 [in Russian].

Truyols J., Arbizu M.A., García-Alcade J.L., García-López S., Méndez Bedia I., Soto F. & Truyols Massoni M. (1990) - The Asturian-Leonese Domain (Cantabrian Zone). In: Dallmeyer R.D. & Martínez-García E. (Eds) - Pre-Mesozoic geology of Iberia: 10-19, Springer, Berlin.

Ulrich E.O. (1882) - American Palaeozoic Bryozoa. *J. Cincinnati Soc. Nat. Hist.*, 5: 125-175, 232-257.

Ulrich E.O. (1883) - American Palaeozoic Bryozoa. *J. Cincinnati Soc. Nat. Hist.*, 6: 82-92; 148-168; 245-279.

Ulrich E.O. (1890) - Paleozoic Bryozoa. *Geol. Surv. Illinois,* 8**,** *Part 2 Palaeontol. Illinois, Section 6*: 283-688.

Ulrich E.O. & Bassler R.S. (1904) - A revision of the Palaeozoic Bryozoa. Part II: On genera and species of Trepostomata. *Smithsonian miscell. Coll.,* 47: 11-55.

Vinassa de Regny P. (1921) - Sulla classificazione dei trepostomidi. *Soc. It. Sci. Nat. Atti*, 59: 212-231.

Vine G.R. (1886) - Notes on the Yoredale Polyzoa of north Lancashire. *Proc. Yorkshire Geol. Soc.*, 9: 70-98.

Volkova K.N. (1974) - Devonian Bryozoa from the southeast Altai. *Trudy instituta geologii i geofiziki, sibirskoe otdelenie,* 199: 1-182 [in Russian].

Yaroshinskaya A.M. (1970) - Some new Early Devonian Bryozoa from Gornyi Altai. In: Astrova G.G. & Chudinova I.I. (Eds) - New species of Paleozoic Bryozoa and corals: 32-37, Nauka, Moscow [in Russian].

Appendix

Descriptive statistics

Abbreviations: N = number of measurements, X = mean, SD = sample standard deviation, CV = coefficient of variation, MIN = minimal value, MAX = maximal value.

Leioclema elegans Ernst, 2008

	N	X	SD	CV	MIN	MAX
Branch Width, mm	19	2.3	0.481	21.05	1.5	3.0
Exozone Width, mm	19	0.6	0.196	34.54	0.3	1.0
Autozooecial Aperture Width, mm	60	0.12	0.016	12.81	0.08	0.16
Aperture Spacing, mm	60	0.25	0.040	15.75	0.18	0.38
Mesozooecia Width, mm	60	0.068	0.021	31.58	0.025	0.125
Mesozooecia per Aperture	60	7.6	1.198	15.84	4.0	10.0
Acanthostyle Diameter, mm	60	0.029	0.005	17.60	0.020	0.045
Acanthostyles per Aperture	60	4.1	0.821	20.18	2.0	6.0
Mesozooecial Diaphragm Spacing	60	0.07	0.030	42.02	0.03	0.16
Exozonal Wall Thickness, mm	20	0.04	0.007	19.42	0.03	0.05

Leptotrypella parva Duncan, 1939

	N	X	SD	CV	MIN	MAX
Autozooecial Aperture Width, mm	20	0.16	0.031	18.96	0.12	0.24
Aperture Spacing, mm	20	0.24	0.035	14.75	0.18	0.30
Autozooecial Aperture Width, mm (macular)	10	0.23	0.030	12.80	0.19	0.30
Aperture Spacing, mm (macular)	8	0.34	0.054	15.70	0.30	0.46
Exilazooecia Width, mm	20	0.062	0.022	35.63	0.025	0.100
Acanthostyle Diameter, mm	20	0.042	0.007	17.92	0.030	0.060
Exozonal Wall Thickness, mm	19	0.05	0.011	21.60	0.03	0.07
Mural Spine Diameter, mm	10	0.027	0.005	19.91	0.020	0.035

Leptotrypella provecta Boardman, 1960

	N	X	SD	CV	MIN	MAX
Autozooecial Aperture Width, mm	30	0.10	0.021	20.17	0.07	0.16
Aperture Spacing, mm	30	0.25	0.036	14.35	0.18	0.32
Autozooecial Aperture Width, mm (macular)	30	0.21	0.033	15.92	0.15	0.28
Aperture Spacing, mm (macular)	24	0.36	0.048	13.36	0.30	0.45
Exilazooecia Width, mm	30	0.048	0.019	39.83	0.023	0.095
Acanthostyle Diameter, mm	30	0.043	0.009	20.47	0.030	0.063
Exilazooecia per Aperture	30	2.4	1.189	50.22	1.0	5.0
Acanthostyles per Aperture	30	3.0	0.830	27.68	2.0	4.0
Exozonal Wall Thickness, mm	20	0.101	0.021	20.58	0.075	0.138
Mural Spine Diameter, mm	10	0.024	0.002	8.75	0.020	0.025

Leptotrypella maculata n. sp.

	N	X	SD	CV	MIN	MAX
Autozooecial Aperture Width, mm	95	0.16	0.021	12.85	0.10	0.20
Aperture Spacing, mm	95	0.19	0.020	10.61	0.15	0.24
Autozooecial Aperture Width, mm (maculae)	75	0.22	0.030	14.10	0.17	0.31
Aperture Spacing, mm (maculae)	75	0.28	0.048	17.23	0.20	0.41
Acanthostyle Diameter, mm	95	0.03	0.007	20.56	0.03	0.05
Acanthostyles per Aperture	85	3.4	1.223	36.36	1.0	6.0
Megastyle diameter, mm	50	0.070	0.017	24.35	0.045	0.120
Exilazooecia Width, mm	10	0.067	0.025	36.76	0.04	0.120
Autozooecial Diaphragm Spacing, mm	25	0.102	0.026	25.20	0.05	0.15
Exozonal Wall Thickness, mm	65	0.046	0.011	22.75	0.025	0.070
Cyst Diameter, mm	10	0.09	0.008	9.12	0.08	0.10

Atactotoechus cartus Boardman, 1960

	N	X	SD	CV	MIN	MAX
Autozooecial Aperture Width, mm	20	0.17	0.030	18.27	0.12	0.24
Aperture Spacing, mm	20	0.20	0.023	11.43	0.17	0.24
Exozonal Wall Thickness, mm	15	0.03	0.005	17.02	0.02	0.04

Anomalotoechus alpenensis (Duncan, 1939)

	N	X	SD	CV	MIN	MAX
Autozooecial Aperture Width, mm	40	0.20	0.030	14.95	0.13	0.25
Aperture Spacing, mm	40	0.21	0.032	14.91	0.17	0.27
Autozooecial Aperture Width, mm (maculae)	30	0.28	0.031	11.07	0.23	0.36
Aperture Spacing, mm (maculae)	30	0.35	0.050	14.34	0.25	0.45
Exilazooecia Width, mm	10	0.042	0.015	35.50	0.025	0.068
Acanthostyle Diameter, mm	20	0.03	0.010	33.48	0.02	0.05
Exozonal Wall Thickness, mm	20	0.038	0.011	28.96	0.025	0.063
Maculae Diameter, mm	6	2.41	0.302	12.54	1.95	2.75
Maculae Spacing, mm	6	3.27	0.393	12.02	2.65	3.70

Anomalotoechus tabulatus n. sp.

	N	X	SD	CV	MIN	MAX
Autozooecial Aperture Width, mm	30	0.16	0.028	17.83	0.11	0.20
Aperture Spacing, mm	30	0.24	0.036	14.70	0.16	0.30
Acanthostyle Diameter, mm	30	0.033	0.005	15.43	0.025	0.045
Acanthostyles per Aperture	20	4.7	0.988	21.25	3.0	6.0
Exilazooecia Width, mm	15	0.052	0.016	31.18	0.035	0.080
Exozonal Wall Thickness, mm	10	0.05	0.010	20.29	0.04	0.07

Eridodrypella valida Duncan, 1939

	N	X	SD	CV	MIN	MAX
Autozooecial Aperture Width, mm	30	0.13	0.022	16.55	0.10	0.19
Aperture Spacing, mm	30	0.22	0.039	17.52	0.18	0.30
Acanthostyle Diameter, mm	6	0.06	0.009	16.27	0.05	0.075
Exilazooecia Width, mm	6	0.057	0.015	26.57	0.040	0.075
Exozonal Wall Thickness, mm	10	0.08	0.011	13.40	0.07	0.10
Autozooecial Diaphragm Spacing, mm	20	0.086	0.019	21.95	0.055	0.110

Eifelipora tenuis n. sp.

	N	X	SD	CV	MIN	MAX
Branch Width, mm	7	1.01	0.170	16.93	0.81	1.29
Endozone Width, mm	7	0.47	0.043	9.02	0.42	0.54
Autozooecial Aperture Width, mm	40	0.09	0.018	19.99	0.06	0.13
Aperture Spacing, mm	40	0.17	0.034	19.96	0.11	0.23
Exilazooecia Width, mm	40	0.032	0.012	36.81	0.015	0.060
Acanthostyle Diameter, mm	40	0.029	0.004	14.40	0.020	0.035
Exilazooecia per Aperture	20	3.3	1.333	41.01	2.0	7.0
Acanthostyles per Aperture	20	4.2	1.322	31.47	2.0	7.0
Exozonal Wall Thickness, mm	20	0.043	0.007	16.62	0.030	0.055

Boardmanella bohemica (Ernst, 2008b)

	N	X	SD	CV	MIN	MAX
Branch Width, mm	15	3.0	0.873	29.02	1.9	4.1
Exozone Width, mm	15	0.9	0.306	35.34	0.4	1.4
Autozooecial Aperture Width, mm	35	0.10	0.020	19.74	0.07	0.17
Aperture Spacing, mm	40	0.17	0.024	13.69	0.14	0.22
Macroacanthostyle Diameter, mm	40	0.04	0.009	20.74	0.03	0.07
Microacanthostyle Diameter, mm	20	0.017	0.002	12.61	0.013	0.020
Acanthostyles per Aperture	40	5.7	0.905	15.82	4.0	8.0
Exozonal Wall Thickness, mm	35	0.07	0.015	20.50	0.05	0.10

Mongoloclema sincera Troitzkaya, 1976

	N	X	SD	CV	MIN	MAX
Autozooecial Aperture Width, mm	20	0.17	0.014	8.21	0.14	0.20
Aperture Spacing, mm	20	0.27	0.040	15.06	0.20	0.34
Autozooecial Aperture Width, mm (maculae)	10	0.23	0.010	4.30	0.22	0.25
Exilazooecia Width, mm	20	0.05	0.015	29.60	0.03	0.08
Exilazooecia per Aperture	20	11.3	1.803	16.02	8.0	14.0
Exozonal Wall Thickness, mm	10	0.032	0.010	30.90	0.020	0.055