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New Devonian and Carboniferous Bryozoans of the Holy Cross Mountains (Central Poland)

I. P. Morozova[a], O. B. Weis[a], and G. Racki[b]

[a]*Paleontological Institute, Russian Academy of Sciences, Profsoyuznaya ul. 123, Moscow, 117997 Russia*
[b]*Silesian University, Sosnowiec, Poland*
e-mail: oweiss@mail.ru, racki@us.edu.pl

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Abstract—New bryozoans from the Middle–Upper Devonian (Eifelian–Frasnian) and the Lower Carboniferous (Tournaisian) of the Holy Cross Mountains in central Poland are described: *Bigeyella sparsa* gen. et sp. nov., *B. separata* gen. et sp. nov., *Eridopora singula* sp. nov., *Leptotrypa pulchra* sp. nov., *Kysylschinipora klarae* sp. nov., *Coelotubulipora rara* sp. nov., *Alternifenestella genuina* sp. nov., *Exfenestella polonica* sp. nov., and *Rectifenestella localis* sp. nov. Some paleogeographic and stratigraphic aspects of the Paleozoic deposits of this region are discussed and main bryozoan localities are described.

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Key words: Bryozoa, Eifelian, Givetian, Frasnian, Tournaisian, paleogeographic, Poland.

INTRODUCTION

In the Devonian–Carboniferous carbonate deposits of the Holy Cross Mountains in central Poland (Fig. 1), bryozoans are a minor component in many fossil benthic reef-rock associations, which are usually dominated by brachiopods. From the second half of the 19th century on (Gürich, 1896; Sobolev, 1909), bryozoans characterize the Middle–Upper Devonian only in the northern part of central Poland, where the Devonian is represented predominantly by deposits of clayey shales (Kiepura 1965, 1973; Morozova et al., 2002). Notwithstanding the fact that Middle–Upper Devonian deposits (Givetian–Famennian) of the southern part of the region (Kielce Region) were recently studied in detail paleobiologically (Racki, 1993), the bryozoans remain as yet poorly studied.

The Devonian deposits of the Holy Cross Mountains, which are well exposed and rich in fossils, belong to a long belt stretching from the southwestern margin of the East European Platform to the Variscan (Hercynian) zone of folding. The deposits of the ancient shelf are up to 600 km wide and stretch from western Europe to Ukraine along the continental margin of "Old Red Sandstone" (Laurasia). The two facies that dominate in the Holy Cross Mountains region, shallow-water (in the Kielce Region) and deep-water (Łysogóry), gradually change into each other (Racki, 1993), thus allowing comparisons of facies changes in the fauna (Figs. 1a–1c, 2). An almost symmetrical change in facies occurs in the forereef portions of the Frasnian Dyminy Reef, which was fringed with more deep-water zones on the shelf that were characterized by a lack of oxygen (intrashelf deep-water basins): Chęciny-Zbrza (southern) and Łysogóry–Kostomłoty (northern) (Racki, 1993; Szulczewski, 1995).

The changes in the Middle–Upper Devonian epicontinental facies of the carbonate shelf show that the vast platform inhabited by stromatoporoids and corals experienced a long-term (although discontinuous) submergence, which came to a close in the Viséan Age (Racki, 1993; Szulczewski, 1995). The depositional events fit perfectly with the Euramerican curve of sea-level change (Johnson et al., 1985). In particular, the submergence at the end of the Late Givetian (at the beginning of transgressive cycle IIb) of the shallow-water area with *Stringocephalus*, which involved the entire shelf in southern Poland (Racki, 1993; Sobstel, 2003), was a key depositional event. As a consequence this biogeographic unit acquired deep-sea benthos with a rich bryozoan fauna, contrasting with the benthic fauna of more northerly regions of the Holy Cross Mountains (Morozova et al., 2002).

Although the shallow-water and reef-forming Givetian associations (sections studied in the Kielce Region) served as the main source material for the systematic study of bryozoans, the fauna of deeper waters from two stratigraphic levels that are well-studied paleontologically, the Eifelian (older) and Tournaisian (younger) (Fig. 2), was also described.

Bryozoan Localities

The richest bryozoan localities are the Laskowa and Górno localities from the Kostomłoty zone (Racki, 1993). Some bryozoans from these localities were described earlier (Morozova et al., 2002). New addi-

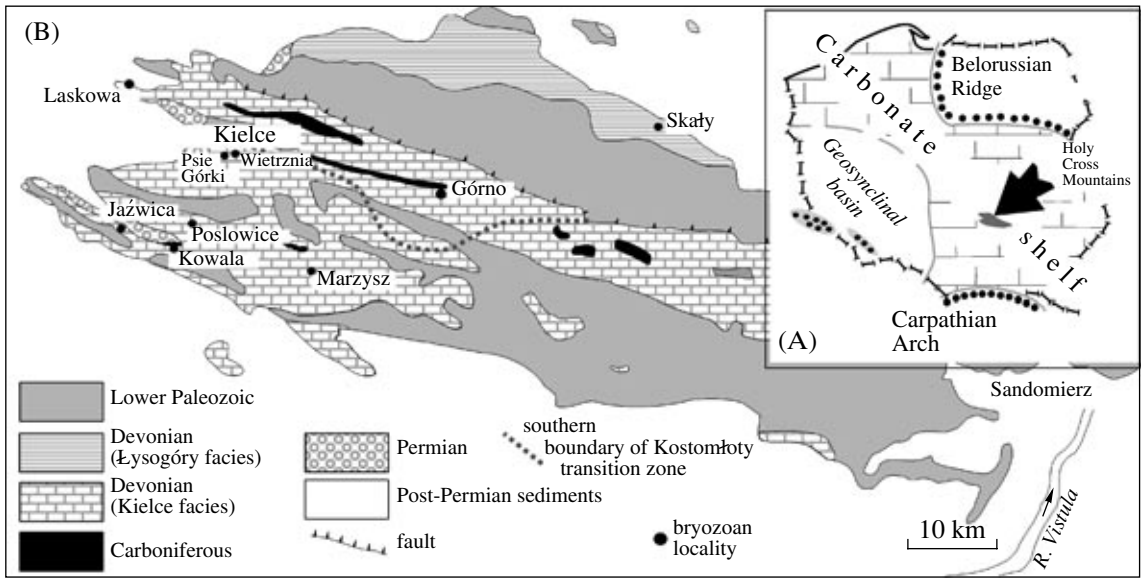


Fig. 1. Map of bryozoan localities (according to Racki, 1993, text-fig. 2). Designations: (A) Poland, (B) Holy Cross Mountains.

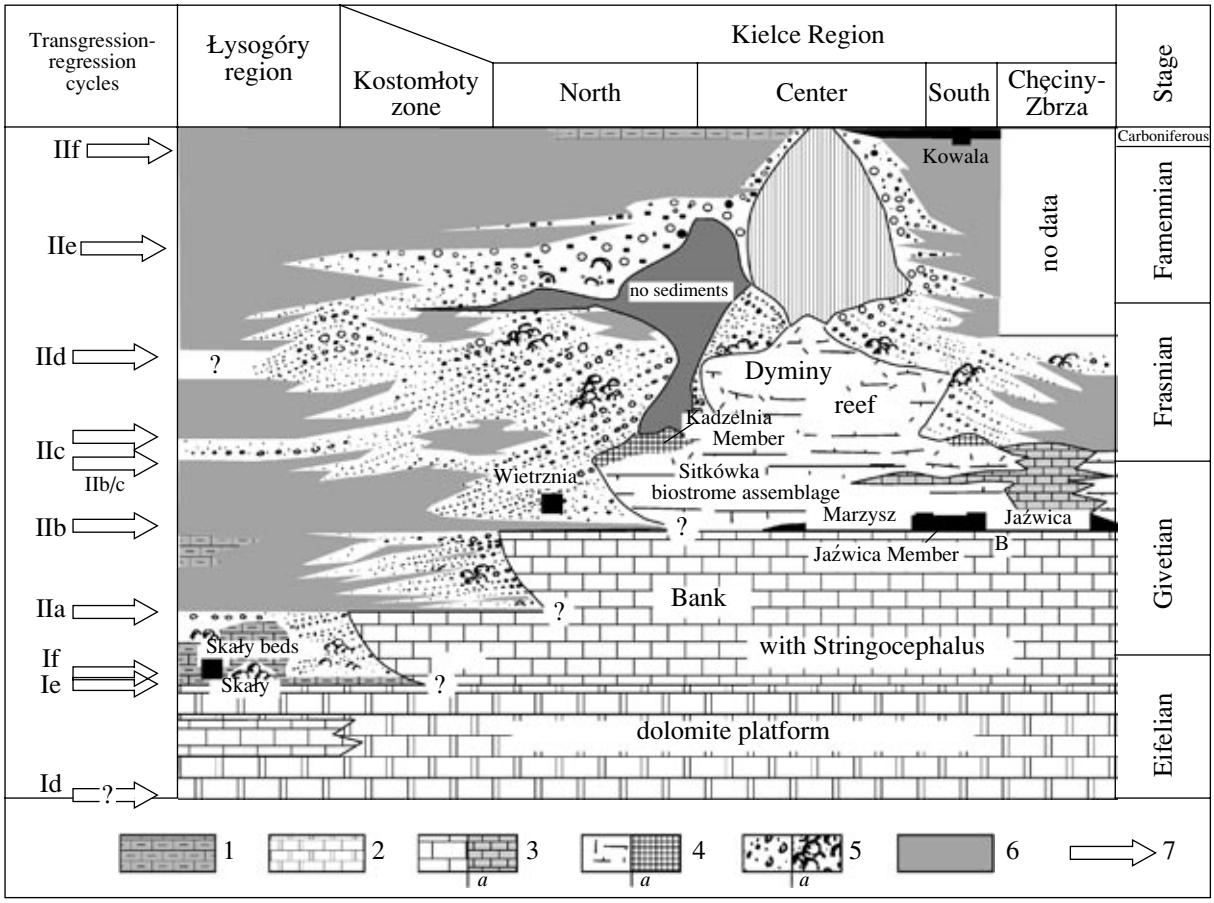


Fig. 2. Facies profile of the Middle–Late Devonian deposits of the Holy Cross Mountains showing the bryozoan localities; (Id–IIf) transgression-regression cycles (according to Johnson et al., 1985, with modifications). Designations: (1) limestone-marl facies of the open shelf; (2) dolomites; (3) facies of limestones and bioherms, (*a*) intruded the shelf sediments; (4) reef facies, (*a*) muddy forereef facies; (5) slope facies, (*a*) organic, algal structures; (6) marl-clay facies of the inner parts of the basin; and (7) transgression.

tional material comes from the following sections (in the stratigraphic sequence; Figs. 1b, 2):

Skały. Bryozoans were found in two samples from the upper Member XIV (shales with brachiopods) in the basal part of the Skały section (Pajchlowa, 1957). A member of clayey shales that contained diverse perfectly preserved fossil material, including bryozoans (Kiepura, 1965, 1973), was uncovered in an operating quarry in Skały in 1989. Shales with brachiopods correlate with the uppermost Eifelian conodont *kockelianus* Zone in the facies of the Łysogóry basin (Malec and Turnau, 1997). The bryozoans *Exfenestella polonica* sp. nov. and *Rectifenestella localis* sp. nov. are described from this locality.

Jaźwica (= Łgawa Hill). In the type area, this is a member of micritic limestone (Kowala Association) (Narkiewicz et al., 1990; Racki, 1993) that was discovered in an operating quarry (Wójcik, 1997; Morozova et al., 2002, pl. 1). These deposits are an important element of an open-sea benthic assemblage that contain bryozoans, which are dominated by rhabdomesids, numerous brachiopods, and "spirorbisids" (Racki, 1993, p. 116). The lithology of the deposits shows that in the Givetian Age there were short-term muddy-bottom biotopes alternating with shoals inhabited by stromatoporoids and corals, which formed bioherms in the Kielce Region. Judging by the characteristic conodont fauna of *Icriodus subterminus* (Racki, 1993), the uppermost Givetian level of marly limestones (Member B) may correlate with the base of the *falsiovalis* Zone. The bryozoans *Leptotrypa pulchra* sp. nov., *Coelotubulipora rara* sp. nov., and *Alternifenestella genuina* sp. nov. are described from this place.

Marzysz. The Jaźwica Member can be traced westward based on a characteristic ecological assemblage with a well-preserved biota (Racki, 1993), which contains, among other animals, a rich echinoderm fauna (Boczarowski, 2001). Bryozoans are a minor component of all Late Givetian faunas in this locality.

Wietrznia. On the northern margin of the Kielce carbonate platform, more abundant remains of bryozoans in diverse facies of the reef slope are only contained in the abandoned Wietrznia-I quarry at Kielce, at the lower levels (Wietrznia beds, Member A_2 in Makowski) (Makowski in Racki et al., 1993). The thin interbeds of marls in the thick-bedded limestones of the terminal Givetian (Racki and Bultynck, 1993) that formed in deeper waters (Kostomłoty facies) are enriched in bryozoans. They include three bryozoan species that were described earlier (Morozova et al., 2002) from the Givetian and Frasnian beds of Górno. In addition, the following new bryozoans are designated from these beds: *Kysylschinipora klarae* sp. nov., *Bigeyella separata* gen. et sp. nov., and *B. sparsa* gen. et sp. nov. One species, *Fistulipora* cf. *parvimenta* Bigey, was identified earlier from a thin-layered section of the Middle Frasnian stromatolite structures located near Psie Górki) Hill (Member C in Gawlik, according to Racki et al., 1993).

Kowala. Two bryozoan taxon were identified from the Devonian–Carboniferous transitional beds uncovered in the Kowala-I quarry north of the operating quarry in 1992 (Malec, 1995). The bryozoans from this locality were found in association with diverse microfauna in sample R I/225 from the uppermost level of marl-carbonate Radlin beds, which correlate with the Tournaisian *Weyerognathus triangulus* Zone (Przezdzienk, 1994; Dzik, 1997). A new species, *Eridopora singula* sp. nov., is described in this paper from this locality.

MATERIAL

The material studied was collected by one of the authors (G. Racki) during fieldwork beginning in 1979 in cooperation with his Silesian University colleagues and students.

G. Racki wrote the Introduction and Bryozoan Localities sections; I.P. Morozova and O.B. Weiss studied the collection of bryozoans and wrote the Systematic Paleontology section. The material studied is housed in the Paleontological Institute of the Russian Academy of Sciences, coll. no. 4873.

SYSTEMATIC PALEONTOLOGY

Class Stenolaemata

Order Cystoporida

Suborder Fistuliporina

Family Fistuliporidae Ulrich, 1882

Genus *Eridopora* Ulrich, 1882

***Eridopora singula* Morozova et Weis, sp. nov.**

Plate 11, fig. 1

Etymology. From the Latin *singulus* (single).

Holotype. PIN, no. 4873/100; central Poland, Kowala Gorge; the Lower Carboniferous, Tournaisian, Radlin Beds (Member D).

Description. The colony is encrusting, unilaminate, 0.70–1.30 mm thick. The endozone is narrow, 0.03–0.06 mm wide. The autozooecia in the endozone form an angle of 30°–40°; their walls are 0.10–0.15 mm thick. In the exozone, which occupies most of the colony, the autozooecia are aligned perpendicular to the substrate. The walls of autozooecia are 0.04 mm thick. The apertures of autozooecia are either circular (0.25 mm in diameter) or slightly elongated (0.28–0.32 mm long and 0.22–0.25 mm wide). The peristome is smooth, 0.03 mm thick. The lunaria are rounded-elongated, narrow, 0.12–0.14 mm long, and 0.07–0.08 mm wide. The wall of lunarium is 0.03–0.04 mm thick. The distance between the tips of lunarium entering the aperture is 0.04–0.05 mm. The autozooecia may occasionally contain diaphragms located near the col-

ony surface. A 2-mm-long stretch contains 4–4.5 apertures of autozooecia in all directions. The cystozooecia are circular or polygonal in section, 0.02–0.08 mm in diameter, and are located around the autozooecia in one to three rows. Some regions of the colony contain monticles formed by accumulations of cystozooecia. The monticles are 0.85–0.90 mm long and 0.40–0.50 mm wide. The apertures of autozooecia that surround the monticles are presented to the latter by the proximal tips of lunaria.

The layer of calcareous material at the colony surface is lost.

Comparison. The new species differs from the most closely related species *E. macrostoma* Ulrich, which was originally described from the deposits of the Keokuk Formation in the Lower Carboniferous of North America (Ulrich, 1882) and subsequently from the Viséan of the Donets Basin (Nikiforova, 1933), Kazakhstan (Nekhoroshev, 1953), and the Kuznetsk Basin (Trizna, 1958), in the unusual shape of the narrow, rounded-elongated lunaria and in the cystozooecia that vary sharply in diameter from 0.02 to 0.08 mm.

Material. Holotype.

Order Trepostomida

Suborder Halloporina

Family Atactotoechidae Dunkan, 1939

Genus *Leptotrypa* Ulrich, 1883

***Leptotrypa pulchra* Morozova et Weis, sp. nov.**

Plate 11, figs. 2 and 3

Etymology. From the Latin *pulcher* (beautiful).

Holotype. PIN, no. 4873/102; central Poland, Jaźwica quarry; Middle Devonian, upper Givetian Stage, Jaźwica Formation of the Kowala Association (Member B).

Description. The colonies are overgrown by slender branches of algae from 0.09 to 1.5 mm in diameter. The layer of the colony is 0.06–0.10 mm thick. The endozone is slightly separated, the walls of autozooecia are 0.010–0.015 mm thick in the endozone and gradually increase in thickness toward the surface of the colony in the exozone. At the base of the exozone the walls are 0.02 mm thick; at the periphery of the colony, 0.03 mm. The apertures of the autozooecia are packed closely together, rhombic, and are arranged in regular diagonally intersecting rows. The apertures are 0.16–0.19 mm long and 0.13–0.14 mm wide. A 2-mm-long stretch of the colony contains 7.5–8 apertures both longitudinally and diagonally. Very occasionally autozooecia may contain single thin diaphragms. At the corners of the junctures of the walls of autozooecia each autozooecium is surrounded by three or four acanthozooecia 0.02–0.03 mm in diameter. The exilazooecia are uncommon, circular in section, 0.02–0.04 or, more rarely, 0.09 mm in diameter.

Comparison. This species differs from the closely related species *L. rhombocella* Morozova, 1960 from the Vassinskie beds of the Frasnian Stage of the Upper Devonian of the Kuznetsk Basin (Morozova, 1960, p. 54–55, pl. II, fig. 2b, text-fig. 5) in the colonies being less thick (0.06–0.09 mm instead of 0.11–0.20 mm in *L. rhombocella*) and in the more elongated apertures of autozooecia (0.16–0.19 mm long and 0.13–0.14 mm wide), whereas in *L. rhombocella* the length and width of apertures are equal (0.20 mm). The species compared are undoubtedly closely related.

Material. In addition to the holotype, 12 incomplete colonies from the type locality (paratype nos. 4873/104–4873/115).

Suborder Amplexoporina

Family Ulrichotrypellidae Romantchuk, 1968

Genus *Kysylschinipora* Volkova, 1974

***Kysylschinipora klarae* Morozova et Weis, sp. nov.**

Plate 11, fig. 4

Etymology. In honor of the author of the genus Klara Naumovna Volkova.

Holotype. PIN, no. 4873/116; central Poland, Górno-Józefka Hill; Middle Devonian, Upper Givetian Stage, Laskowa Góra Beds (Member A).

Description. The colonies are encrusting, they encrusted upright growing objects, apparently algae. The encrusting layer is 0.68–0.72 mm wide. The endozone is narrow, 0.18–0.20 mm wide, the walls of autozooecia are here 0.02 mm thick. The exozone is

Explanation of Plate 11

The magnification is ×40 for all figures.

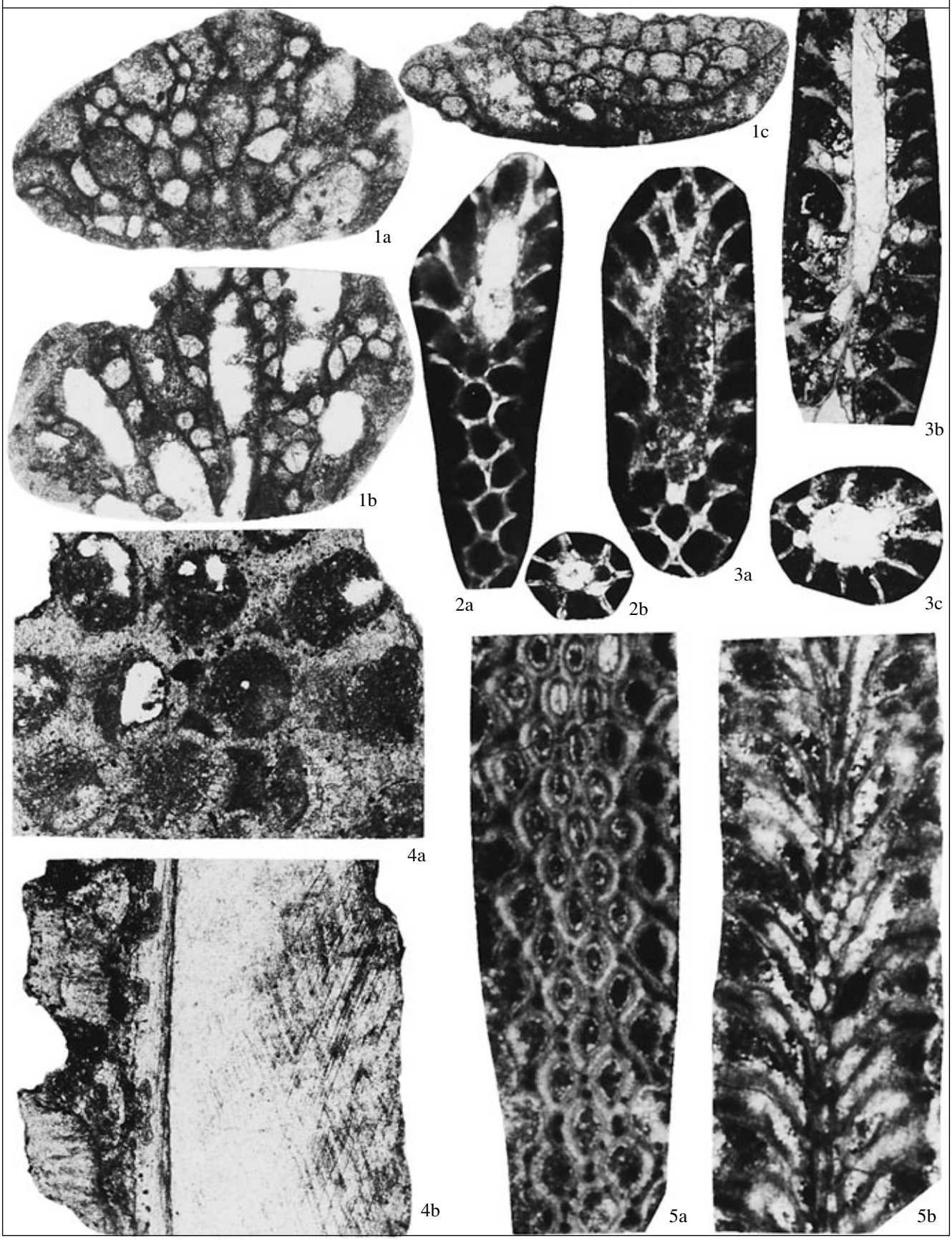
Fig. 1. *Eridopora singula* Morozova et Weis, sp. nov.; holotype PIN, no. 4873/100: (1a) tangential section; (1b) longitudinal section; (1c) cross section; central Poland, Kowala Gorge; Lower Carboniferous, Tournaisian, Radlin beds (Member D).

Figs. 2 and 3. *Leptotrypa pulchra* Morozova et Weis, sp. nov.; (2) holotype PIN, no. 4873/102: (2a) shallow and deep tangential shallow sections; (2b) cross section; (3) specimen PIN, no. 4873/104: (3a) tangential section; (3b) longitudinal section; (3c) cross section; central Poland, Jaźwica quarry; the Middle Devonian, upper Givetian Stage, Jaźwica Formation of the Kowala Association (Member B).

Fig. 4. *Kysylschinipora klarae* Morozova et Weis, sp. nov.; holotype PIN, no. 4873/116: (4a) tangential section; (4b) longitudinal section showing the capillaries in the walls of the exozone; central Poland, Górno-Józefka Hill; Middle Devonian, upper Givetian Stage, Laskowa Góra beds (Member A).

Fig. 5. *Bigeyella sparsa* Morozova et Weis, gen. et sp. nov.; holotype PIN, no. 4873/119: (5a) tangential section; (5b) longitudinal section; central Poland, Górno-Józefka Hill; Upper Devonian, Frasnian Stage, middle Wietrznia Series (Member C).

Plate 11



well-defined because of the greatly thickened walls of autozooecia, which are 0.35–0.54 mm thick. The autozooecia in the endozone are almost parallel to the substrate and 0.05–0.07 mm wide. At the base of the exozone the autozooecia are pointed to the colony surface, are 0.18–0.20 mm wide, and gradually widen in the exozone up to 0.28–0.36 mm. In the exozone, the walls of autozooecia vary in thickness from 0.18 to 0.36 mm. The autozooecia contain single (if any) diaphragms. The apertures of the autozooecia are circular or irregularly circular and are randomly arranged. The apertures are 0.25–0.36 mm in diameter. The walls separating the apertures of neighboring autozooecia are 0.09–0.30 mm thick; a 2-mm-long stretch of the colony contains three or four apertures depending on the region. There are maculae that consist of autozooecia in which apertures 0.20–0.25 mm in diameter are closed on the colony surface by a thin layer of calcareous material. The maculae are usually 0.25 mm long and 0.20 mm wide. The exilazooecia are widely spaced, circular or angular in section, 0.12–0.15 mm in diameter, confined to the exozone. The walls of the autozooecia in the exozone are pierced by large uniform pores (capillaries) that are packed closely together, arranged in parallel rows, and subangular in section. The pores are 0.09–0.10 mm in diameter.

Comparison. The new species differs from the type species of the genus *Kysylschinipora nekhoroshevi* Volkova from the Givetian Stage of southeastern Altai (Volkova, 1974, p. 40, pl. XIII, fig. 2) in the larger sizes of the apertures of autozooecia (0.25–0.36 mm instead of 0.15–0.16 mm), in the smaller number of apertures within a 2-mm-long stretch (3–4 instead of 7–8 in *K. nekhoroshevi*), and in the thickness of the walls of autozooecia varying from 0.13 to 0.36 mm, whereas in *K. nekhoroshevi* the walls of autozooecia are slightly and uniformly thickened in the exozone up to 0.07–0.08 mm. It differs from *K. formosa* Kopaevich from the Givetian beds of southwestern Mongolia (Kopaevich, 1984, p. 109, pl. XLI, fig. 1) in the circular shape of the apertures of autozooecia, which are polygonal in *K. formosa*, and in the greatly thickened walls of autozooecia in the exozone. In addition, in the new species a 2-mm-long stretch contains three or four apertures of autozooecia instead of six to eight in *K. formosa*. The new species differs in the almost total absence of diaphragms in autozooecia, which are especially numerous in *K. formosa.*

Material. Holotype and paratype no. 4873/117 from the type locality.

Order Rhabdomesida

Family Rhabdomesidae Vine, 1883

Genus *Coelotubulipora* Yang, Hu et Xia, 1988

***Coelotubulipora rara* Morozova et Weis, sp. nov.**

Plate 12, figs. 4 and 5

Etymology. From the Latin *rarus* (rare).

Holotype. PIN, no. 4873/125; central Poland, Jaźwica quarry; Middle Devonian, Upper Givetian Stage (Member B).

Description. The colonies are thinly branched and have a centrally located axial cavity of circular cross section, which represents a primary zooecium 0.20–0.25 mm in diameter. The colonies are 0.65–0.70 mm in diameter. The autozooecia that budded from the primary zooecium are shaped like long tubes that at the initial stages of the development were narrowed and aligned almost parallel to the primary zooecium. At the subsequent stages of the development the autozooecia gradually widened and deflected to the colony surface at an angle of 45° and gradually, without a single turn went into the exozone. The walls of the primary zooecium are 0.015 mm thick; in the endozone the walls of autozooecia are 0.01–0.02 mm thick; in the exozone the walls greatly and unevenly thicken from 0.08 to 0.20 mm. The autozooecia contain only occasional diaphragms; hemisepta are absent, perhaps they are hidden from view by the secondary thickenings of

Explanation of Plate 12

The magnification is ×40 for all figures, except for Fig. 2, ×30.

Figs. 1 and 2. *Bigeyella sparsa* Morozova et Weis, gen. et sp. nov.; (1) holotype PIN, no. 4873/119: cross section; (2) specimen PIN, no. 4873/118: tangential section; central Poland, Górno-Józefka Hill; Upper Devonian, Frasnian Stage, middle Wietrznia Series (Member C).

Fig. 3. *Bigeyella separata* Morozova et Weis, gen. et sp. nov.; holotype PIN, no. 4873/120: (3a) tangential section; (3b) longitudinal section; (3c) cross section; central Poland, Górno-Józefka Hill; Middle Devonian, upper Givetian Stage, Laskowa Góra beds (Member A).

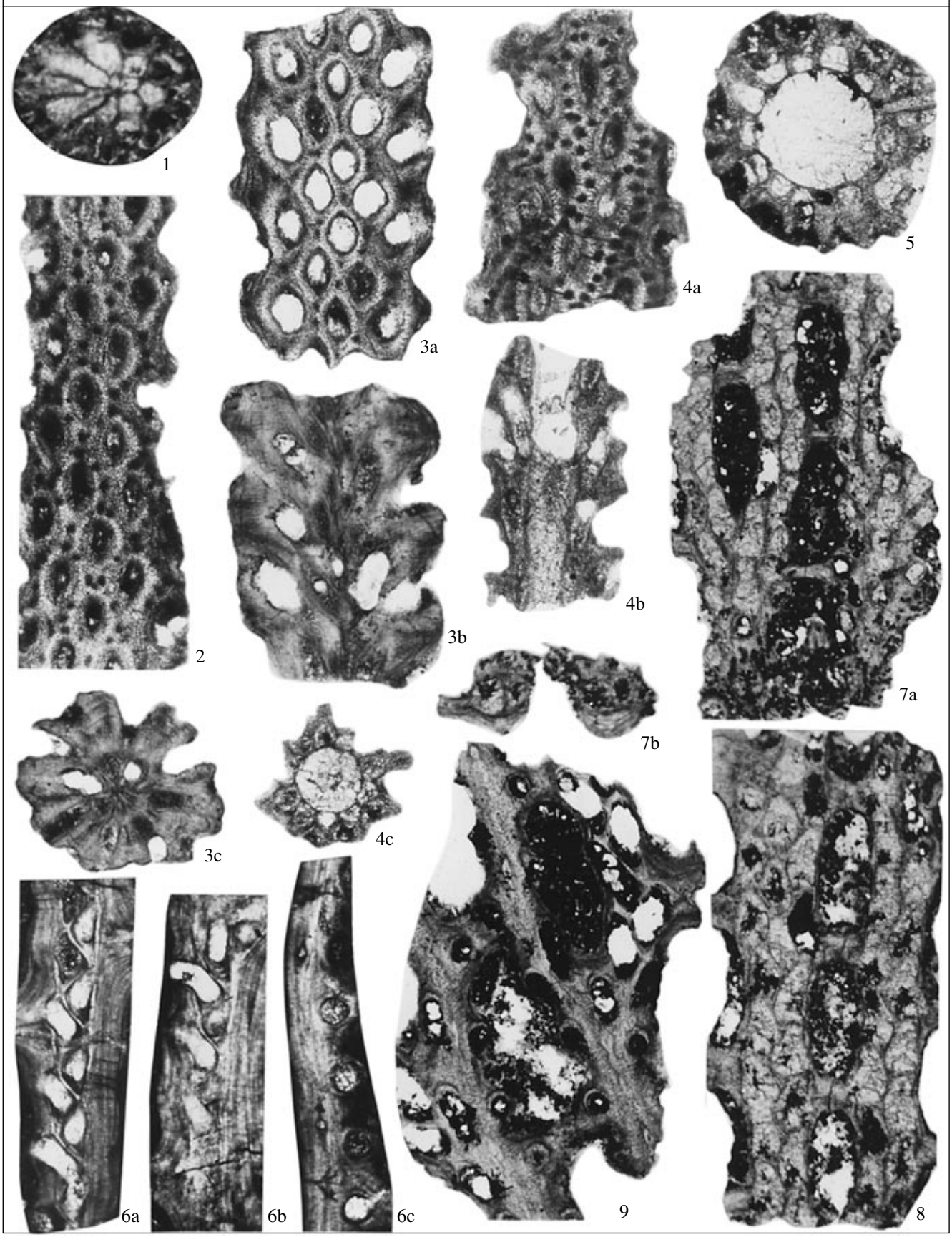
Figs. 4 and 5. *Coelotubulipora rara* Morozova et Weis, sp. nov.; (4) holotype PIN, no. 4873/125: (4a) tangential section; (4b) longitudinal section; (4c) longitudinal section; (5) specimen PIN, no. 4873/126: cross section; central Poland, Jaźwica quarry; Middle Devonian, upper Givetian Stage (Member B).

Fig. 6. *Alternifenestella genuina* Morozova et Weis, sp. nov.; holotype PIN, no. 4873/127: (6a) deep tangential section; longitudinal section; shallow tangential section; central Poland, Kielce Region, Wietrznia quarry; Middle Devonian, upper Givetian Stage (lower Member B).

Figs. 7 and 8. *Exfenestella polonica* Morozova et Weis, sp. nov.; (7) holotype PIN, no. 4873/128: (7a) tangential section; (7b) cross section; (8) specimen PIN, no. 4873/129: tangential section; central Poland, Skały quarry; Middle Devonian, Eifelian Stage, Skały Formation (Member XIV).

Fig. 9. *Rectifenestella localis* Morozova et Weis, sp. nov.; holotype PIN, no. 4873/130: tangential section; central Poland, Skały quarry; Middle Devonian, Eifelian Stage, Skały Formation (Member XIV).

Plate 12



the thick walls of the exozone. The apertures of autozooecia are oval-shaped, are arranged in longitudinal and diagonally intersecting rows, which are not always regular. The apertures are 0.08–0.12 mm long and 0.05–0.06 mm wide. The longitudinal and diagonal distances between the neighboring apertures are 0.24–0.30 and 0.20–0.25 mm, respectively. Two-mm-long longitudinal and diagonal stretches of the colony contain six or eight to nine apertures, respectively. The walls separating the neighboring apertures of autozooecia are 0.10–0.20 mm thick. Near the colony surface the walls of the exozone have numerous nodes, which usually are arranged in a row that forms a single continuous ring around the apertures of autozooecia. Each aperture is surrounded by 9 to 11 nodes. Within those regions of the colony where the walls are greatly thickened, the nodes are arranged in three or four rows. The nodes are 0.03–0.04 mm in diameter. The walls of the exozone contain very small, abundant capillaries 5–6 μm in diameter. The metazooecia are very uncommon, circular in section, 0.06–0.07 mm in diameter, and confined to the exozone.

Comparison. The new species differs from the most closely related species *P. interminuta* Yang, Hu et Xia (Yang et al., 1988, p. 162, pl. XXVI, figs. 1–3, text-fig. 18) from the Tournaisian Stage of the Lower Carboniferous of Hunan province in China in the thickness of the walls of the exozone (0.08–0.20 mm instead of 0.02 mm), shape of the apertures of autozooecia (oval instead of rounded and polygonal), and the abundance of nodes and capillaries: the number of nodes around the apertures in *P. rara* sp. nov. is 9–11, whereas in *P. interminuta* they does not exceed 4–5. In addition, the new species differs from *P. interminuta* in the absence of hemisepta.

Remarks. The authors of the genus *Coelotubulipora* placed it into the family Stenoporidae of the order Trepostomida. However, we believe that this genus should be placed into the family Rhabdomesidae of the order Rhabdomesida because the structure of the primary zooecium in this genus resembles that of the primary zooecium in the genus *Rhabdomeson*. In addition, these genera are characterized by a similar budding pattern of autozooecia, which results in the autozooecia surrounding the primary zooecium in a continuous ring and assuming triangular or polygonal outlines in the cross section of the colony.

Material. Holotype and paratype no. 4873/126 from the type locality.

Genus *Bigeyella* Morozova et Weis, gen. nov.

Etymology. In honor of Françoise Bigey, who made an outstanding contribution to the study of the Devonian bryozoans of France.

Type species. *Bigeyella sparsa*, sp. nov.

Diagnosis. Colonies thinly branched. Autozooecia tubular, arranged in spiral, with their bases forming longitudinal central axis. Autozooecia contain hemisepta and diaphragms in varying numbers. Apertures of autozooecia oval, more rarely circular, arranged in regular diagonally intersecting rows. Colony surface contains numerous nodes surrounding apertures of autozooecia and numerous small capillaries.

Species composition. In addition to the type species, the new genus includes species described earlier by different authors under the generic name *Rhombopora: B. granulosa* (Nekhoroshev, 1977) from the Emsian deposits of the Lower Devonian of Kazakhstan (Nekhoroshev, 1977, p. 135, pl. XXXI, fig. 1); *B. yukonensis* (Astrova, 1972) from the Eifelian Stage of Western Canada (Astrova, 1972, p. 84, pl. IV, figs. 5–7); and *B. hemiseptata* (Morozova, 1960) from the Frasnian Stage of the Kuznetsk Basin (Morozova, 1960, p. 142, pl. XXXIII, fig. 2) and northern France (Bigey, 1988, p. 314, pl. 39, figs. 6–9). To the genus *Bigeyella* are also assigned the bryozoans described from the Devonian of central Poland under the generic name *Primorella*: *B. nitida* (Morozova et Weis, 2002) from the Upper Givetian Stage (Morozova et al., 2002, p. 314, pl. 6, figs. D–G) and *B. indigena* (Morozova et Weis, 2002) from the Frasnian Stage of the same region (Morozova et al., 2002, p. 314, pl. 6, figs. H–J), as well as the new species *B. separata* (the Givetian Stage of central Poland), which is described below.

Comparison. The new genus differs from the genus *Rhombopora* and from the other genera of the order in the absence of acanthozooecia and in the presence of numerous nodes and capillaries that are well developed on the surface of the walls of the exozone.

Bigeyella separata Morozova et Weis, sp. nov.

Plate 12, fig. 3

Etymology. From the Latin *separatus* (separate).

Holotype. PIN, no. 4873/120; central Poland, Górno-Józefka Hill; Middle Devonian, Upper Givetian Stage, Laskowa Góra Beds (Member A).

Description. The colonies are shaped like slender branches 0.85–0.90 mm in diameter. The endozone is 0.40–0.42 mm wide; the exozone is 0.23–0.25 mm thick. The autozooecia are mainly narrow, 0.03 mm wide, directed at an angle of 60° to the colony surface, and gradually widening in the exozone up to 0.07–0.08 mm. The walls of autozooecia in the endozone are 0.07–0.08 mm thick; in the exozone the walls greatly and unevenly thicken from 0.10 to 0.18 mm. The autozooecia within the exozone contain very infrequent diaphragms. The apertures of autozooecia are oval and are arranged in diagonally intersecting rows. The apertures are 0.16–0.18 mm long and 0.07–0.08 mm wide. The longitudinal and diagonal distances between the centers of neighboring apertures are 0.35–0.40 and 0.25–0.27 mm, respectively. Two-mm-long longitudinal and diagonal stretches of the colony contain five and eight

apertures, respectively. On the surface of the colony the walls separating the apertures of autozooecia have two nodes 0.02–0.03 mm in diameter that are arranged one above the other. Thus, each aperture is usually surrounded by six nodes. In the deep sections nodes diminish in size. Surrounded by capillaries, the bases of nodes resemble stellatopores. The capillaries are numerous, very small, 7–8 μm in diameter, especially abundant on the colony surface.

Comparison. The new species differs from the most closely related species *B. nitida* (Morozova et Weis, 2002) from the Givetian of central Poland and *B. indigena* (Morozova et Weis, 2002) from the Frasnian Stage of the same region (Morozova et al., 2002, p. 314, text-figs. 6E–6J) in the unusually thick walls of autozooecia (0.07–0.08 mm in the endozone and 0.10–0.18 mm in the exozone instead of 0.015 mm at most in the endozone and 0.10–0.13 mm in the exozone), in the very infrequent diaphragms in the autozooecia instead of three to five diaphragms in the above species, and in the dimensions of the apertures of autozooecia (0.16–0.18 mm long and 0.07–0.08 mm wide instead of 0.17–0.20 mm long and 0.10 mm wide in *B. nitida* and 0.13–0.14 mm long and 0.10 mm wide in *B. indigena*).

Material. Holotype and paratype nos. 4873/123 and 4873/124 from the type locality.

***Bigeyella sparsa* Morozova et Weis, sp. nov.**

Plate 11, fig. 5; Plate 12, figs. 1 and 2

Etymology. From the Latin *sparsus* (particolored, adorned).

Holotype. PIN, no. 4873/119; central Poland, Górno-Józefka Hill; Upper Devonian, Frasnian Stage, Middle Wietrznia Series (Member C).

Description. The colonies are thinly branched, 1.0–1.10 mm in diameter, the endozone is 0.50–0.58 mm wide, the exozone is 0.18–0.20 mm thick. The autozooecia are tubular and are directed from the base of the endozone to the surface at an angle of 45° and at the boundary between the endo- and exozones gradually turn at an angle of 80°–90°. The walls of autozooecia in the endozone are 0.02 mm thick; in the exozone the walls thicken up to 0.08–0.09 or, more rarely, 0.12 mm. The autozooecia contain infrequent diaphragms and very uncommon hemisepta, located at the boundary between the endo- and exozone. The apertures of autozooecia are oval and are arranged in longitudinal and diagonally intersecting rows. The apertures are 0.11–0.12 mm long and 0.07–0.08 mm wide. The longitudinal and diagonal distances between the centers of neighboring apertures are 0.40–0.45 and 0.25–0.30 mm, respectively. Two-mm-long longitudinal and diagonal stretches of the colony contain seven and ten apertures, respectively. On the colony surface (in the walls separating the apertures of autozooecia), there are spiny nodes 0.02–0.03 mm in diameter that are arranged one above the other within each interspace between the neighboring apertures. In some regions of the colony the number of nodes in the walls of the exozone increases; thus, they surround each aperture of autozooecia by a continuous row of eight or nine nodes. The capillaries are very small (7–8 μm in diameter) and closely spaced.

Comparison. The new species differs from the most closely related species *B. indigena* Morozova et Weis, 2002 (Morozova et al., 2002, p. 314, text-figs. 6H–6J), which was described from the coeval deposits of central Poland, in the considerably thinner branches of colonies (1.0–1.10 mm instead of 1.70–2.0 mm in *B. indigena*), smaller dimensions of the apertures of autozooecia (0.11–0.12 mm × 0.07–0.08 mm instead of 0.12–0.14 mm × 0.10–0.11 mm in *B. indigena*), and the presence of very uncommon diaphragms.

Material. Holotype and paratype no. 4873/118 from the type locality.

Class Eurystomata

Superorder Fenestellidea

Order Fenestellida

Family Fenestellidae King, 1849

Genus *Exfenestella* Morozova, 1974

***Exfenestella polonica* Morozova et Weis, sp. nov.**

Plate 12, figs. 7 and 8

Etymology. From Poland.

Holotype. PIN, no. 4873/128. central Poland, Skały quarry; Middle Devonian, Eifelian Stage, Skały Association (Member XIV).

Description. Micrometric formula: 18-20/10-12//12-14. The colony has straight or slightly bent bifurcating branches and large lateral processes. The branches are unevenly thickened. A 10-mm width of the colony contains 18–20 branches. The common width of the branch is 0.40–0.45 mm (the maximum width of the branch is 0.50–0.60 mm; the thinner portions of the branch are 0.40 mm wide at most). The third autozooid is wedged into the branch before the bifurcation and increases the width of the branch up to 0.60 mm. Immediately after the bifurcation the branches are 0.25 mm wide. The dissepiments are straight, short, 0.17–0.18 mm wide. The fenestrules are oval-shaped, 0.60 mm long, and 0.30 mm wide. A 10-mm-long stretch along the colony contains 10–12 fenestrules. The chambers of autozooecia are bean-shaped and are arranged in an alternating fashion. In the deep tangential section the chamber of autozooecium is 0.27 mm long and 0.1 mm wide. The distance between the centers of the neighboring chambers in the row is 0.26–0.27 mm. One fenestrule corresponds to 2–2.5 autozooecia. The apertures of autozooecia are circular, with a wide peristome, directed usually toward the fenestrule. The diameter of the aperture with and without the peristome is 0.05 and 0.10 mm, respectively. Hemisepta are absent. A 5-mm-long stretch along the branch contains 12–14 apertures. The carina

is low, with high nodes oval in section, the nodes are 0.07 mm long and 0.05 mm wide. The distance between the centers of the neighboring nodes is 0.35 mm. A 1-mm-long stretch along the colony contains 3.5–4 nodes. The capillaries are small, closely spaced, 0.02 μm in diameter; there are also larger and more widely spaced capillaries 0.07 μm in diameter.

Comparison. In the main measurements of the meshwork, the new species differs from *E. tastauensis* (Troizkaya, 1968) from the Givetian Stage of Kazakhstan (Troizkaya, 1968, p. 123, pl. XIX, fig. 2) in the shorter and wider fenestrules (the length of fenestrule is 0.60 mm instead of 0.84–0.46 mm and the width is 0.30 mm instead of 0.21–0.27 mm), in the presence of nodes on the carina, and in the wedging of the third autozooid before the bifurcation of the branch. It differs from the second species *E. tobolica* (Nekhoroshev, 1977) from the Famennian–Tournaisian deposits of Kazakhstan (Nekhoroshev, 1977, p. 96, pl. XVI, fig. 1) in the smaller dimensions of fenestrules (the length is 0.60 mm instead of 1.00–1.60 mm and the width is 0.30 mm instead of 0.46–0.64 mm) and in the presence of nodes.

Material. Holotype and paratype no. 4873/129 from the type locality.

Genus *Rectifenestella* Morozova, 1974

Rectifenestella localis Morozova et Weis, sp. nov.

Plate 12, fig. 9

Etymology. From the Latin *localis* (local).

Holotype. PIN, no. 4873/130; central Poland, Skały quarry; Middle Devonian, Eifelian Stage, Skały Formation (Member XIV).

Description. Micrometric formula: 15-16/9//15. The colony has large fenestrules and straight bifurcating branches that are circular in section and connected by straight dissepiments. A 10-mm width of the colony contains 15–16 branches. The branch is 0.20–0.25 mm wide, before the bifurcation (with an autozooid wedged into the branch) the branch widens up to 0.40–0.45 mm, after the bifurcation the branch is 0.10–0.15 mm wide. The dissepiments are straight, 0.17–0.20 mm wide. The fenestrule is oval, 0.90–1.0 mm long, and 0.40–0.50 mm wide. A 10-mm-long stretch along the colony contains nine fenestrules. The autozooecia are slightly alternate, pentagonal in section, with the superior hemiseptum. The chamber of an autozooecium is 0.40 mm long and 0.12 mm wide. The distance between the centers of the neighboring chambers in the row is 0.30–0.35 mm. One fenestrule corresponds to three autozooecia. The apertures of the autozooecia are circular and enter the fenestrule, their peristome is smooth, occasionally there is a node in the lower part of the peristome. The aperture is 0.07–0.08 mm in diameter, the peristome is 0.02 mm wide. A 5-mm-long stretch along the branch contains 15 apertures. The carina is low, with large nodes ovally elongate in section and arranged in a row, the nodes are 0.06 mm long and 0.03 mm wide. A 1-mm-long stretch along the colony contains 1.5–2 nodes. The capillaries are small, closely spaced, 0.02 μm in diameter.

Comparison. This species differs from the most closely related species *R. tokrauensis* (Troizkaya, 1968) from the Givetian beds of Kazakhstan (Troizkaya, 1968, p. 124, pl. XX1, fig. 2) in the far larger fenestrules (0.90–1.0 mm long and 0.40–0.50 mm wide instead of 0.58–0.65 mm long and 0.25–0.27 mm wide in *R. tokrauensis*). In addition, the new species has nodes that are large and elongated (0.06 mm long and 0.03 mm wide), whereas *R. tokrauensis* has nodes that are circular and smaller in diameter (0.10 mm). In the structure of the meshwork and measurements of many elements of the colony, the new species resembles *R. altshedatensis* (Morozova, 1960) from the Givetian deposits of the Kuznetsk Basin (Morozova, 1960, p. 122 pl. XXIX, fig. 3, text-fig. 23), but it differs in the larger fenestrules (0.90–1.0 mm long and 0.40–0.50 mm wide instead of 0.70–0.90 mm long and 0.30–0.35 mm wide in *R. altshedatensis*) and in the presence of far larger nodes on the carina, which measure 0.06 × 0.03 mm, whereas in *R. altshedatensis* the nodes measure 0.03 × 0.02 mm.

Material. Holotype and paratype no. 7348/133 from the type locality.

Genus *Alternifenestella* Termier et Termier, 1971

Alternifenestella genuina Morozova et Weis, sp. nov.

Plate 12, fig. 6

Etymology. From the Latin *genuinus* (genuine).

Holotype. PIN, no. 4873/127; central Poland, Kielce Region, Wietrznia quarry; Middle Devonian, Upper Givetian Stage (lower Member B).

Description (Fig. 3). Micrometric formula: 11-12/4-5//19-20. The colony is fan-shaped and has large fenestrules, straight branches, and slender dissepiments. A 10-mm width of the colony contains 11 or 12 branches; the branch is 0.35–0.37 mm wide; before the bifurcation, 0.45–0.50 mm; immediately after the bifurcation, 0.22–0.24 mm. Before the bifurcation there is no additional autozooecia. The dissepiments are straight, 0.14–0.15 mm wide. The fenestrules are rectangular, with greatly elongated lateral walls. The fenestrule is 1.90–2.50 mm long and 0.20–0.35 mm wide. A 10-mm stretch along the colony contains 4–4.5 fenestrules. The chambers of autozooecia are arranged on the branches in an alternating fashion and are shaped like short tubes with a short vestibule and short poorly developed inferior hemiseptum. In the deep tangential section the autozooecia are trapezoidal and triangular in shape. In the shallow sections autozooecia are almost oval in outline. The apertures of autozooecia are circular, entering the fenestrules, with a thin smooth peristome. Some regions of the colony contain apertures closed by opercula with a small opening at the center.

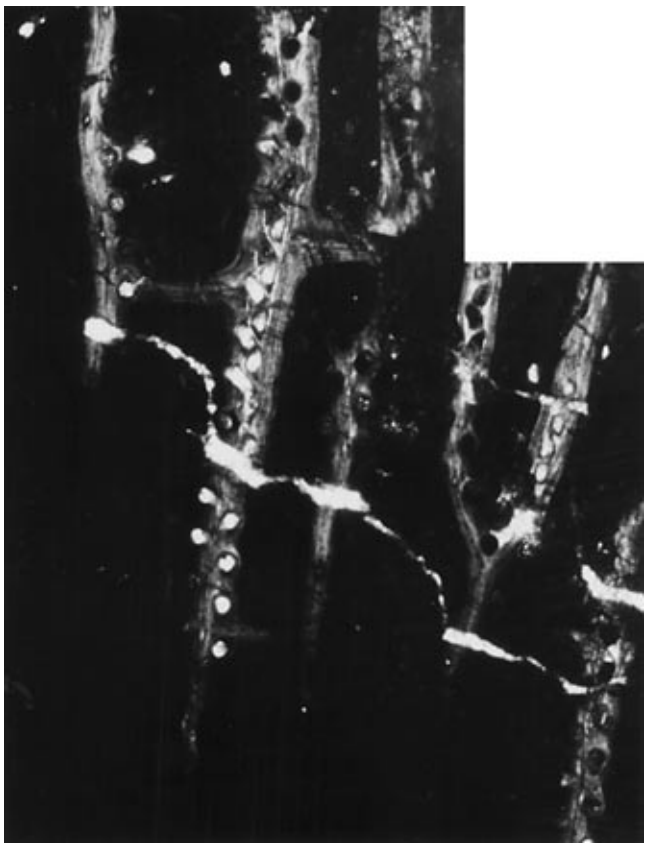


Fig. 3. *Alternifenestella genuina* Morozova et Weis, sp. nov.; holotype PIN, no. 4873/127. General appearance of the colonies in tangential section, ×20; central Poland, Kielce Region, Wietrznia quarry; Middle Devonian, Upper Givetian Stage (lower Member B).

The aperture is 0.07–0.08 mm in diameter; the peristome is 0.016 mm thick. The distance between the centers of the neighboring apertures in the row is 0.27–0.30 mm. A 5-mm-long stretch along the branch contains 19–20 apertures. The carina is low, 0.12 mm wide, with small nodes circular in section. The nodes are 0.04 mm in diameter. The distance between the centers of the neighboring nodes in the row is 0.21–0.23 mm. A 1-mm-long stretch contains four or five nodes. The capillaries are very small, closely spaced, 8 μm in diameter. There are also larger and more widely spaced capillaries 10–12 μm in diameter.

C o m p a r i s o n. The new species differs from the closely related species *A. afonitschevi* (Nekhoroshev, 1977), which was described under the generic name *Fenestella* from the Givetian deposits of the Middle Devonian of the northeastern Balkhash area (Nekhoroshev, 1977, p. 98, pl. XIV, fig. 6), in the considerably longer fenestrules (1.90–2.50 mm instead of 0.90–1.25 mm in *A. afonitschevi*) and in the smaller measurements of the chambers of autozooecia and their apertures (a 5-mm length along the branch contains 19–20 apertures instead of 14–15 in *A. afonitschevi*). The new species also differs in the smaller and more closely spaced nodes (a 1-mm length contains 4–4.5 nodes instead of 2 in the Kazakhstan species).

M a t e r i a l. Holotype.

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