

## Middle Ordovician bryozoa from the Podlasie-Brest Depression (Belarussian part): suborders Ceramoporina, Esthonioporina, Amplexoporina, Halloporina

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Bryozoa (23 species) from many boreholes in the Belarussian part of the Podlasie-Brest Depression and some adjacent areas of the East European Platform are described. Only bryozoa from the orders Cystoporida (suborder Ceramoporina) and Trepostomida (suborders Esthonioporina, Amplexoporina and Halloporina) are represented. Four species and one family are described as new. The genera *Anolotichiina* Pushkin, 1992 and *Minutolunaria* Pushkin, 1992 are redescribed. The species described occur in the Llanvirn (Azeri-Kukruse Regional stages) and Caradoc (Idavere-Oandu Regional stages). The results support the hypothesis that the study area represented an independent biogeographical region of the Baltic province, corresponding to the Brest-Volyn confacies during the Llanvirn and Caradoc.

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### INTRODUCTION

The Ordovician deposits of the Belarussian part of the Podlasie-Brest Depression are penetrated by many boreholes (Ropot and Pushkin, 1987; Pushkin, 2001; Fig. 1). These are relatively shallow-water deposits: massive limestones with thin intercalated marl layers. The rocks contain (especially in the upper part of the succession) numerous skeletal remains of invertebrates: crinoids, brachiopods, bryozoans, trilobites and others. Bryozoa have been studied extensively (Pushkin, 1973, 1975, 1976, 1977a, b, 1981, 1987a, b, c; Pushkin and Modli ski, 2002). The most widespread species of bryozoa are described in this paper. As many of the species described have been discovered in other parts of the East European Platform, information is given about these areas in the “Occurrence” section. In addition, some species from these locations are illustrated in Figures 2–9. Only bryozoa from the orders Cystoporida (suborder Ceramoporina) and Trepostomida (suborders Esthonioporina, Amplexoporina and Halloporina) are described in this paper. One family (Acanthoceramoporellidae) and four species (*Acanthoceramoporella brestica* sp. nov., *Minutolunaria illustris* sp. nov., *Atactopora gregariaformis* sp. nov. and *Hallopora mckinneyi*

sp. nov.) are regarded as new. The genera *Anolotichiina* Pushkin, 1992 and *Minutolunaria* Pushkin, 1992 are redescribed. As a whole, bryozoa from the Podlasie-Brest Depression are similar to those of the northern (the Baltic-Ladoga Glint) and southern (northwestern Belarus, Lithuania, Latvia) parts of the Baltic basin (Fig. 1), but differ in the presence of relatively numerous endemic (“Podlasie-Brest”) elements. Thus, of 23 species of bryozoa described, 6 species are established only in the Podlasie-Brest Depression: *Acanthoceramoporella brestica* sp. nov., *Anolotichiina tabulatiformis* (Pushkin), *Minutolunaria illustris* sp. nov. (also discovered in Podolia), *Amplexopora angustiformis* sp. nov., *Atactopora gregariaformis* sp. nov. and *Hallopora mckinneyi* sp. nov. The species listed are not described from other parts of the Baltic basin.

### GEOLOGICAL SETTING

The Ordovician deposits in the Podlasie-Brest Depression of Belarus are represented by relatively thin (to 40 m) mostly carbonate rocks (limestones and marls). At the base of the section there is a layer (up to 1.5 m thick) of green glauconitic sandstone (Billigen Regional Stage). The Ordovician is known only from boreholes (Fig. 1), the majority completely cored. The thickness

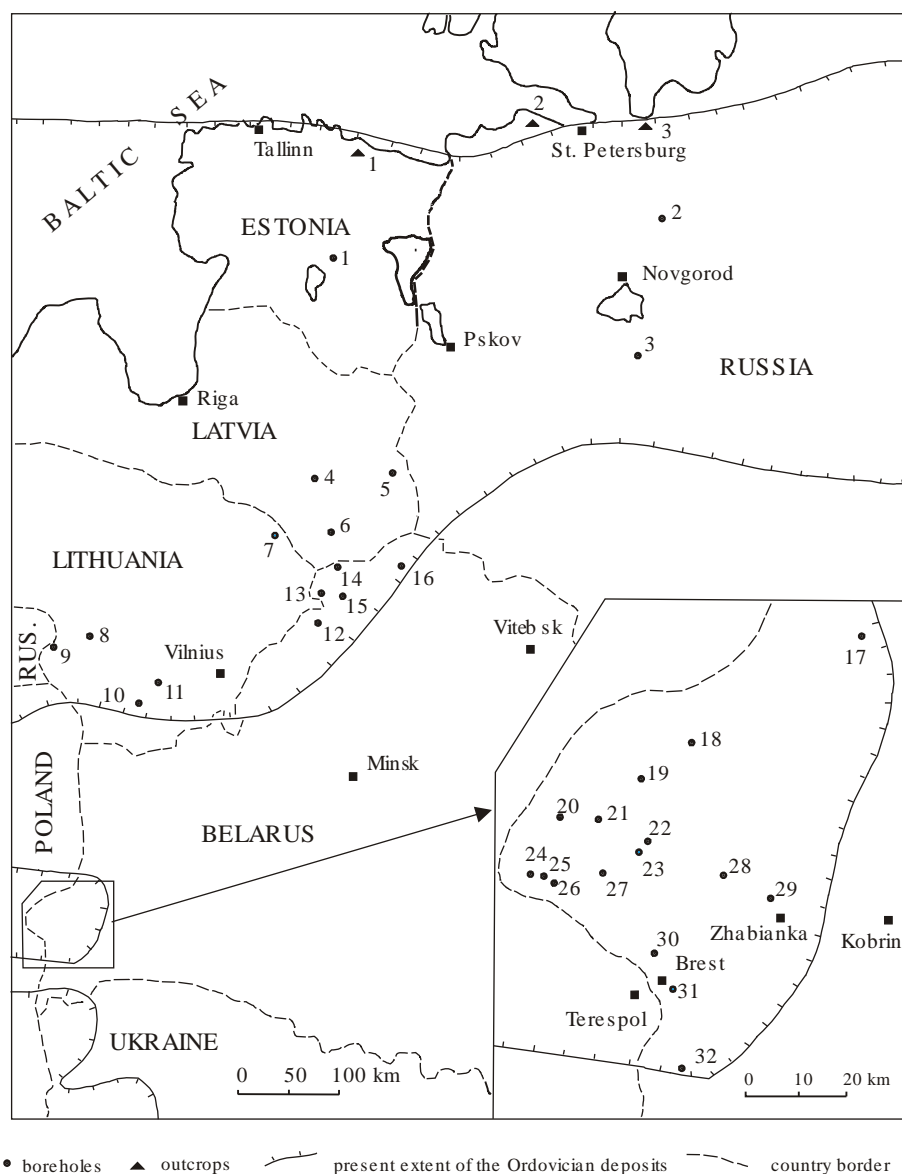


Fig. 1. Sketch of the location of the area investigated

Boreholes: 1 — Laeva 6, 2 — Chudovo 41, 3 — Serebryaniki 1, 4 — Atashiene 9, 5 — Ludza 15, 6 — Vishki 25, 7 — Butkunaji 241, 8 — Vilkavishkis 129, 9 — Kibartaji 14, 10 — Ilgaji 54, 11 — Tauchenis 49, 12 — Otskovichi 5, 13 — Vidzy 1, 14 — Vangishki 205, 15 — Richany 209, 16 — Verkhnedvinsk 1, 17 — Malye Krasniki 1, 18 — Deshevichi 27, 19 — Lesovchitsy 25, 20 — Vysokoe 1, 21 — Borstchovo 10, 22 — Rataychitsy 12, 23 — Morozovichi 16, 24 — Novoselki 29, 25 — Pribugskaya 17, 31, 26 — Orlya 28, 27 — Kustinskaya 1-op, 28 — Turna 5, 29 — Zhabinka 3, 30 — Brest 9, 31 — Skveriki 1, 32 — Stradech 17; outcrops: 1 — Aluvere quarry, 2 — Lopukhinka village, 3 — Popovka River

of the succession gradually decreases from 40 m in the west to nothing in the east. This trend is paralleled by a decrease in clay content (reduced number of marl layers). The Ordovician deposits of the Podlasie-Brest Depression of Belarus represent the Arenig, Llanvirn and Caradoc Series, i.e. Billingen (= Latorp) to Oandu (base) regional stages (Table 1). Underlying (Pakerort Regional Stage) and overlying (Rakvere-Porkuni regional stages) deposits are absent. Deposits of Oandu Regional Stage has been found only in some western boreholes near the Polish boundary. In the east of the area the upper part of the section has been gradually removed by erosion. Figure 1 shows the distribution of boreholes and outcrops of the East European Platform in which the bryozoans described were found.

The bryozoa in the Belarussian part of the Podlasie-Brest Depression occur from the base of the Dolbnev Formation (Azeri-Lasnamyagi regional stages) represented by homogeneous massive limestones overlying red limestones of Zhabinka Formation (Table 1). The abundance of bryozoa colonies (and other invertebrates) gradually increases up the section.

In the Dolbnev Formation (middle Llanvirn) bryozoa are represented by hemispherical and nodular colonies of trepostomids including (from more to less abundant): *Mesotrypa*, *Esthoniopora*, *Orbipora*, *Dianulites*, *Diazipora*. Up the section (Lesovchitsy, Vidomlya and Lystchitsy formations) (upper Llanvirn, lower and middle Caradoc) the quantity

Table 1

Stratigraphical distribution of described species of bryozoa in the Ordovician of the Podlasie-Brest Depression

Series	ARENIG				LLANVIRN			CARADOC			
Regional Stage	Billingen B <sub>I</sub>	Volkhov B <sub>II</sub>	Kunda B <sub>III</sub>	Azeri C <sub>Ia</sub>	Lasnamyagi C <sub>Ib</sub>	Uhaku C <sub>Ic</sub>	Kukruse C <sub>II</sub>	Idavere C <sub>III</sub>	Jykhvi D <sub>I</sub>	Kejla D <sub>II</sub>	Oandu D <sub>III</sub>
Formation	Leetse	Pribug	Zhabinka	Dolbnev		Lesovchitsy		Vidomlya		Lystchitsy	
<i>Ceramopora explicata</i> Pushkin, 1976											
<i>Favositella ? exserta</i> Bassler, 1911											
<i>Acanthoceramoporella brestica</i> sp. nov.											
<i>Anolotichiina tabulatiformis</i> (Pushkin, 1976)											
<i>Minutolunaria illustris</i> sp. nov.											
<i>Esthoniopora communis</i> Bassler, 1911											
<i>Dianulites petropolitanus</i> (Pander, 1830)											
<i>Dianulites janischewskyi</i> Modzalevskaya, 1953											
<i>Orbipora distincta</i> (Eichwald, 1829)											
<i>Amplexopora angustiformis</i> Pushkin, 1976											
<i>Monotrypa undulata</i> (Nicholson, 1875)											
<i>Atactopora gregariaformis</i> sp. nov.											
<i>Diplotrypa petropolitana</i> (Nicholson, 1879)											
<i>Diplotrypa moniliformis</i> Bassler, 1911											
<i>Diplotrypa hennigi</i> Bassler, 1911											
<i>Diplotrypa scalaris</i> L. Nekhorosheva, 1970											
<i>Hallopora tolli</i> Bassler, 1911											
<i>Hallopora mckinneyi</i> sp. nov.											
<i>Diazipora milleporacea</i> (Bassler, 1911)											
<i>Mesotrypa bystrowi</i> Modzalevskaya, 1953											
<i>Mesotrypa excentrica</i> Modzalevskaya, 1953											
<i>Mesotrypa mesoporica</i> (Pushkin, 1976)											
<i>Mesotrypa gutta</i> Pushkin, 1987											

and diversity of bryozoa gradually increases. Together with hemispherical and nodular forms there are abundant ramose and bifoliate colonies, associated with numerous crinoids, brachiopods and trilobites, occurring in detrital limestones and marls.

## SYSTEMATIC PALAEOONTOLOGY

Order **Cystoporida** Astrova, 1964  
 Suborder **Ceramoporina** Bassler, 1913  
 Family **Ceramoporidae** Ulrich, 1882  
 Genus *Ceramopora* Hall, 1852  
*Ceramopora explicata* Pushkin, 1976  
 (Fig. 2a–d)

1976 *Ceramopora explicata* Pushkin, p. 5, pl. I, fig. 1.  
 1990 *Ceramopora explicata* Pushkin, p. 7, pl. I, figs. 2, 3; pl. II, fig. 1.

**Holotype:** No. 12/11-185, Belarussian Geological Prospecting Research Institute (BelNIGRI), Llanvirn, Uhaku Regional Stage, Dolbnev Formation, Belarus, Brest region, Lesovchitsy 25 borehole, depth 817 m.

**Revised diagnosis:** *Ceramopora* with massive (hemispherical, nodular) and lamellar colonies; the base of hemispherical colonies concentrically wrinkled. Zooecial openings oval and irregular-circular, 0.33–0.50 mm in diameter. 3–4 zooecial openings per 2 mm. Lunaria well developed, horseshoe-shaped, separated from wall pores. Walls of zooecia porous, 0.02–0.06 mm thick. Diaphragms thin, straight, irregularly developed. Exilazooecia numerous (frequently isolated from zooecial openings), very large, with a diameter of 0.21–0.85 mm; diaphragms as in zooecia.

**Remarks.** — *Ceramopora explicata* Pushkin, 1976 differs from all described species of the genus *Ceramopora* in having very large exilazooecia.

**Occurrence.** — Llanvirn-Caradoc, Azeri-Idavere regional stages. Belarus, Podlasie-Brest Depression, Dolbnev-Vidomya formations; boreholes: Lesovchitsy 25, depth 817 m (2 specimens); Kustinskaya 1-op, depth 914.3 m (1); Novoselki 29, depth 916 m (1). Lithuania, Ilgaji 54 borehole, depth 415.2 m (1). Latvia, Vishki 25 borehole, depth 573.8 m (1). Russia: Leningrad region, village Lopukhinka (2); Novgorod region, Serebryaniki borehole, depth 1107.3 m (1).

Genus *Favositella* Etheridge and Foord, 1884  
*Favositella ? exserta* Bassler, 1911  
 (Fig. 2e–g)

1911 *Favositella exserta* Bassler, p. 102, text-fig. 36.

**Holotype:** No. 57177, United States National Museum, Llanvirn, Kukruse Regional Stage, near Jewe, Estonia.

**Revised diagnosis:** Colonies lamellar or irregular-massive. Zooecial openings are large, commonly 0.42–0.60 mm, rounded-polygonal or irregular, 3–4.5 per 2 mm. Maculae not observed. Walls of zooecia thin, frequently wavy, with small irregularly developed pores. Lunaria small, triangular, thick, developed in narrow part of openings. Length of lunaria 0.10–0.17 mm, width 0.07–0.13 mm, thickness 0.04–0.08 mm. Diaphragms in zooecial chambers usually absent but sometimes numerous (borehole Serebryaniki). Exilazooecia relatively numerous, diameter 0.14–0.52 mm. Walls of exilazooecia usually strongly curved.

**Remarks.** — Utgaard (1969) did not consider *F. exserta* to belong to genus *Favositella* because it does not have flexures on the proximal side of the lunaria. For this reason this species is only provisionally regarded as belonging to the genus *Favositella*.

**Occurrence.** — Llanvirn-Caradoc, Uhaku-Idavere regional stages. Belarus, Podlasie-Brest Depression, Lesovchitsy-Vidomya formations; boreholes: Kustinskaya 1-op, depth 917.5 m (2 specimens); Vysokoe 1, depth 842.5 m (1); Pribugskaya 17, depth 824 m (2). Latvia, Vishki 25 borehole, depth 566.6 m (1). Russia, Leningrad region, Chudovo 41 borehole, depth 273–285 m (4); Novgorod region, Serebryaniki borehole, depth 1057–1111 m (6).

## Family **Acanthoceramoporellidae** fam. nov.

**Diagnosis:** Colonies lamellar or ramose. Zooecial openings with well-developed lunaria. Lunaria and zooecial and exilazooecial walls are penetrated by small styleform structures (? minutopores Astrova, 1965 or ? styles). Walls of zooecia in exozone thickened, having lamellar microstructure, usually porous. Diaphragms from zooecial chambers rare or absent. Exilazooecia usually numerous, developed in exozone only.

**Remarks.** — Acanthoceramoporellidae can be distinguished from Anolotichiidae Utgaard, 1968 by lamellar microstructure of porous walls, development of styleform structures (? minutopores or ? styles) in zooecial walls and absence of cystiform exilazooecia.

**Genera assigned.** — *Acanthoceramoporella* Utgaard, 1968; *Anolotichiina* Pushkin, 1992; *Minutolunaria* Pushkin, 1992.

Genus *Acanthoceramoporella* Utgaard, 1968  
*Acanthoceramoporella brestica* sp. nov.  
 (Fig. 2h–j)

**Etymology:** The name from city Brest, Belarus.

**Holotype:** No. 12/59-63, BelNIGRI, Middle Ordovician, Kejla Regional Stage, Lystchitsy Formation, Belarus, Brest region, Pribugskaya 17 borehole, depth 805.3 m.

**Diagnosis:** *Acanthoceramoporella* with thin lamellar colonies; zooecial openings right-triangular in outline; lunaria horseshoe-shaped, peripheral ends of lunaria jut out in zooecial chambers; styleform structures penetrated thin walls and wide cavities around each zooecial opening; 2–3 styleform structures.

**Description.** — Colonies lamellar, thin, thickness 0.7–2.0 mm. Zooecial openings triangular, diameter 0.27–0.37 mm, 4.5–5.5 per 2 mm. Walls of both zooecia and exilazooecia thickened from colony bases, thickness 0.03–0.05 mm. Lunaria distinct, horseshoe- or helmet-shaped, peripheral ends jut out deeply in zooecial chambers. Lunarial microstructure lamellate. Length of lunaria 0.13–0.20 mm, width 0.20–0.28 mm, thickness 0.02–0.04 mm. Walls non-porous. Diaphragms in zooecial chambers absent. Exilazooecial openings relatively numerous but not isolated zooecial openings. Tangential sections of exilazooecia rounded or oval. Diaphragms absent. Stylesform structures penetrate

walls of zooecia and exilazooecia, have thin walls and wide cavities. Diameter 0.03–0.05 mm, around each zooecial opening 2–3 styleforms.

**R e m a r k s .** — *Acanthoceramoporella brestica* sp. nov. differs from *A. valliensis* Karklins, 1984 from the Shermanian Stage of the USA (Kentucky) in having distinct lunaria and triangular zooecial openings.

**O c c u r r e n c e .** — Llanvirn-Caradoc, Uhaku-Kejla regional stages. Belarus, Podlasie-Brest Depression, Lesovchitsy-Lystchitsy formations, Pribugskaya 17 borehole, depth 805.3 m (2 specimens); Vitebsk region, Vangishki 205 borehole, depth 460 m (1). Lithuania, Vilkavishkis 129 borehole, depth 949 m (1).

#### Genus *Anolotichiina* Pushkin, 1992

**T y p e s p e c i e s :** *Coenites laciniatus* Eichwald, 1860, from the Middle Ordovician (Kukruse-Kejla regional stages) of the East European Platform.

**R e v i s e d d i a g n o s i s :** Acanthoceramoporellidae with lamellar or ramose colonies. Zooecial openings with well developed lunaria, penetrated by small styleform structures (? minutopores or ? styles). Frequently in central part of lunaria one extended styleform structure is developed. Styleform structures developed also in walls of zooecia. Exozone walls thickened, having lamellar microstructure. Pores absent or rare. Diaphragms absent from zooecial chambers. Exilazooecia numerous, small with rounded transverse shape.

**R e m a r k s .** — *Anolotichiina* can be distinguished from *Acanthoceramoporella* in having ramose colonies, development of styleform structures in lunaria and usually non-porous walls of zooecia.

**S p e c i e s a s s i g n e d .** — *Coenites laciniatus* Eichwald, 1860; *Coeloclema crassimurale* Bassler, 1911; *Ceramoporella tabulatifformis* Pushkin, 1976; *Anolotichiina* sp. nov. 1; 2; 3 (non described).

#### *Anolotichiina tabulatifformis* (Pushkin, 1976) (Figs. 2k–o and 3f, g)

1976 *Ceramoporella tabulatifformis* Pushkin, p. 10, pl. II, fig. 4; pl. III, fig. 4; text-fig. 4.

**H o l o t y p e :** No. 12/13-86, BelNIGRI, Caradoc, Jykhvi or Kejla regional stages, Vidomlya Formation, Belarus, Brest region, Novoselki 29 borehole, depth 896.1 m.

**D i a g n o s i s :** *Anolotichiina* with ramose colonies; zooecial openings oval or oval-triangular; lunaria triangular with central lengthening styleform structure. Styleform structures small, thorn-like; developed in zooecial and exilazooecial walls. Exilazooecia numerous, small, with rounded and oval openings.

**D e s c r i p t i o n .** — Colonies ramose, diameter 1.5–5.0 mm. Exozone from narrow to relatively wide, about 20–35% of colony's diameter. Zooecial openings oval or oval-triangular (Figs. 2o and 3g). Length of openings 0.27–0.46 mm, width 0.17–0.25 mm; 3–4 per 2 mm. Lunaria always well developed, triangular, with central lengthening styleform structure. Styleform structures relatively numerous in zooecial walls, especially in maculae (Fig. 3g). There are nu-

merous small thorn-like styleform structures, penetrating zooecial and exilazooecial walls. Lunaria are represented by dense light carbonate substance. Length of lunaria 0.10–0.22 mm, width 0.16–0.30 mm, thickness 0.03–0.06 mm. Locally lunaria are separated from wall pores with a diameter of 0.03–0.04 mm. Walls in endozone thin and curved, in exozone thickened to 0.03–0.10 mm. Diaphragms rare, straight, developed only in endozone. Exilazooecia numerous, small, especially widely spread in maculae. Rounded and oval openings of exilazooecia have a diameter of 0.02–0.18 mm, commonly 0.04–0.10 mm. Diaphragms absent from exilazooecia.

**R e m a r k s .** — *Anolotichiina tabulatifformis* (Pushkin, 1976) differs from *A. laciniatus* (Eichwald, 1860) in having ramose colonies and only one central styleform structure in lunaria (in lunaria of *A. laciniatus* 3–5 styleform structures are developed (Pushkin and Gataulina, 1992)).

**O c c u r r e n c e .** — Caradoc, Idavere-Oandu regional stages, Belarus, Podlasie-Brest Depression, Vidomlya-Lystchitsy formations, Novoselki 29 borehole, depth 896.1 m (5 specimens); Vitebsk region, Vangishki 205 borehole, depth 433.1 m (2); Lithuania: Butkunai 241 borehole, depth 654.5–676.0 m (4); Vilkavishkis 129 borehole, depth 944.8–949.0 m (4). Latvia, Vishki 25 borehole, depth 557.4–561.2 m (2). Estonia, Aluvere quarry; Laeva 6 borehole, depth 233.0–249.2 m (6). Russia, Leningrad region, Chudovo 41 borehole, depth 273.0 m (4).

#### Genus *Minutolunaria* Pushkin, 1992

**T y p e s p e c i e s :** *Anolotichia rhombica* Bassler, 1911, Middle Ordovician, Caradoc, Rakvere Regional Stage, Estonia, Rakvere.

**R e v i s e d d i a g n o s i s :** Colonies lamellar, irregularly curved. Zooecial openings with large lunaria, penetrated by numerous styleform structures. Locally styleform structures also penetrate zooecial and exilazooecial walls. Walls with numerous large pores and lamellar microstructure. Diaphragms rare or absent from zooecial chambers. Exilazooecia varying in abundance, frequently numerous.

**R e m a r k s .** — *Minutolunaria* can be distinguished from *Anolotichiina* in having only lamellar colonies, porous walls and more numerous and irregularly spaced styleform structures in lunaria.

**S p e c i e s a s s i g n e d .** — *Anolotichia rhombica* Bassler, 1911; *A. brevipora* Bassler, 1911; *A. revalensis* Bassler, 1911; *Minutolunaria illustris* sp. nov.

#### *Minutolunaria illustris* sp. nov. (Fig. 3a–e)

**H o l o t y p e :** No. 12/13-71, BelNIGRI, Caradoc, Kejla-Oandu Regional Stage, Lystchitsy Formation, Belarus, Brest region, Novoselki 29 borehole, depth 892.5 m.

**D i a g n o s i s :** *Minutolunaria* with disc-shaped or lamellar colonies; zooecial openings oval or irregularly-oval; lunaria large, horseshoe-shaped, composed of half the zooecial circumference; styleform structures in lunaria large, numerous, (6–9 in each lunaria); walls porous; exilazooecia relatively numerous; diaphragms absent or very rare from zooecia and exilazooecial chambers.

**Description.** — Colonies disk-shaped or lamellar with basal epitheca. Zooecial openings oval or irregularly-oval, large; length 0.44–0.58 mm, width 0.20–0.41 mm; 3.0–4.5 openings per 2 mm. Maculae absent. Lunaria large, horse-shoe-shaped, composed of half of zooecial circumference. Length of lunaria 0.2–0.4 mm, width 0.3–0.5 mm, thickness 0.04–0.09 mm. Lunaria are penetrated by numerous styleform structures (Fig. 3c, d) with diameters of 0.04–0.08 mm, each lunaria contains 6–9 styleform structures. Styleform structures have indistinct boundaries and wide central cavities. Indistinct small styleform structures (0.025–0.040 mm) are locally developed in zooecial and exilazooecial walls. Walls thickened to 0.03–0.08 mm, penetrated by numerous pores of diameter 0.02–0.05 mm. Exilazooecia relatively numerous, with rounded outlines, diameter 0.08–0.34 mm. Diaphragms absent.

**Remarks.** — *Minutulunaria illustris* (Pushkin, 1976) differs from *M. rhombica* (Bassler, 1911) in having numerous exilazooecia and more numerous styleform structures in the lunaria.

**Occurrence.** — Caradoc, Kejla-Oandu regional stages, Belarus, Podlasie-Brest Depression, Lystchitsy Formation, Novoselki 29 borehole, depth 892.5 m (1 specimen). Ukraine, Dnestr River, village Naddnestrnyanka, outcrop 279 (3). Latvia, Atashiene 9 borehole, depth 740.3 m (1). Estonia, Laeva 6 borehole, depth 142.0–154.5 m (3).

Order **Trepostomida** Ulrich, 1882  
Suborder **Esthonioporina** Astrova, 1978  
Family **Esthonioporidae** Vinassa, 1920  
Genus *Esthoniopora* Bassler, 1911  
*Esthoniopora communis* Bassler, 1911  
(Fig. 3h–j)

1911 *Esthoniopora communis* Bassler, p. 260, text-figs. 151–155.  
1978 *Esthoniopora communis* Astrova, pl. I, fig. 1.

**Lectotype** (proposed herein): Specimen illustrated by Bassler, 1911, text-fig. 152, Caradoc, Jykhvi Regional Stage, Estonia, Jewe.

**Description and remarks.** — Bassler, 1911, p. 260–263.

**Occurrence.** — Llanvirn-Caradoc, Azeri-Kejla Regional stages. In the Podlasie-Brest Depression *E. communis* is found in the following boreholes (Dolbnev-Vidomya formations): Novoselki 29, depth 900.7–922.1 m (19 specimens); Pribugskaya 13, depth 830.2–832.3 m (8); Pribugskaya 17, depth 808.9–831.2 m (6); Vysokoe 1, depth 830–843 m (8); Kustinskaya 1-op, depth 909.9–915.2 m (7); Ratajchitsy 12, depth 952.5–968 m (3); Lesovchitsy 25, depth 808–813 m (2); Borstchovo 10, depth 944 m (1); Brest 9, depth 743 m (1); Orlya 28, depth 1093.0–1100.5 m (3).

This species is widespread in the Ordovician of the East European Platform.

Family **Dianulitidae** Vinassa de Regny, 1920  
Genus *Dianulites* Eichwald, 1829  
*Dianulites petropolitanus* (Pander, 1830)  
(Fig. 4a–c)

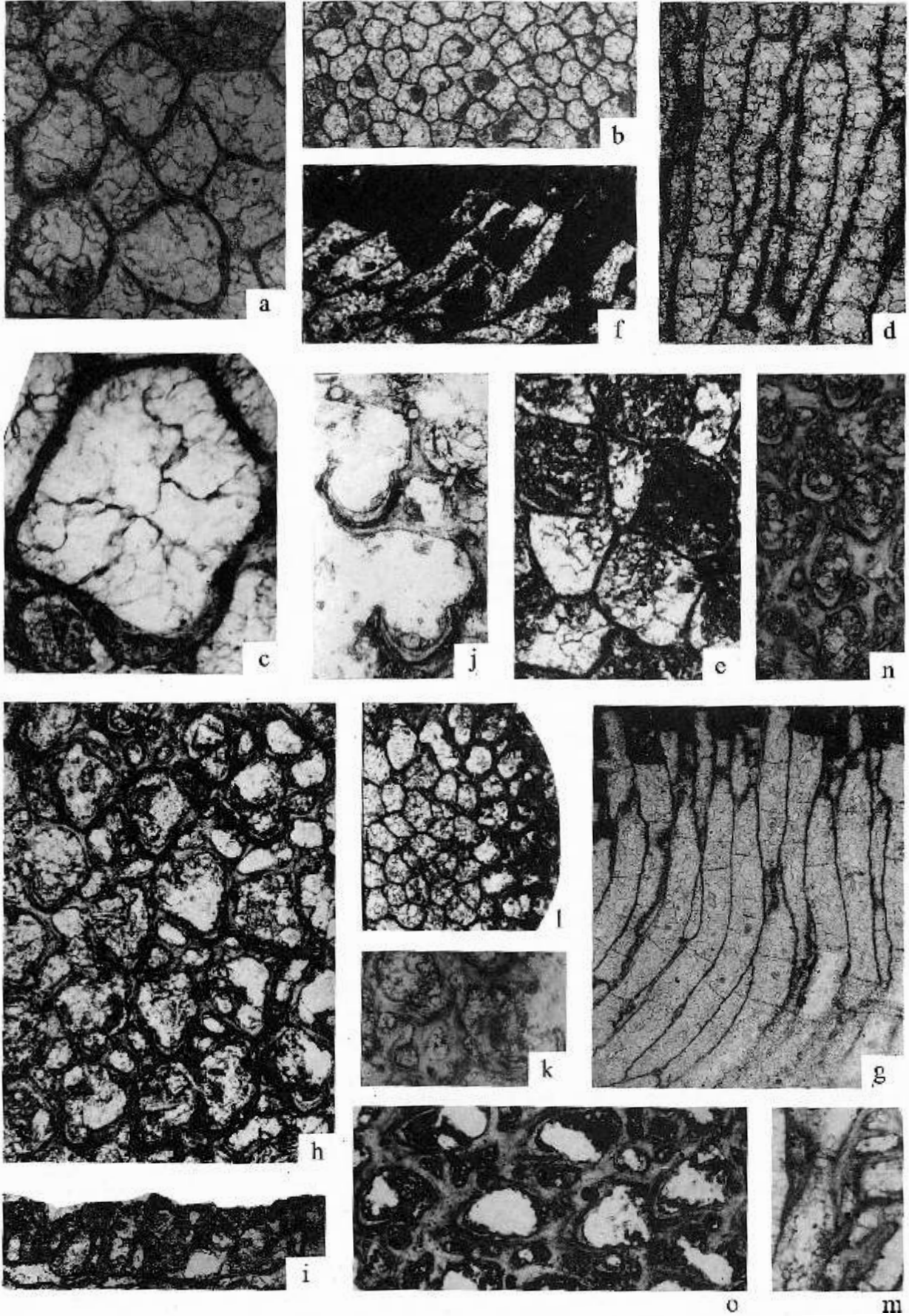
1830 *Favosites petropolitanus* Pander, p. 105, pl. I, figs. 7–11.  
1877 *Dianulites petropolitanus* Dybowski, p. 24, pl. I, figs. 4, 5.  
1911 *Dianulites petropolitanus* Bassler, p. 232–237 (pars), pl. 2, figs. 4, 5 (non fig. 6); pl. 10, fig. 7 (non figs. 8–11); text-figs. 129 (?), 132 (non figs. 130, 131).  
2001 *Dianulites petropolitanus* Pushkin and Popov, pl. 5, fig. 9; pl. 6, figs. 1–4; pl. 7, fig. 7.  
2001 *Dianulites petropolitanus* Jackcon *et al.*

**Lectotype:** Specimen illustrated by Dybowski, 1877, p. 24, pl. I, figs. 4, 5, Middle Ordovician, Estonia.

**Revised diagnosis:** Dianulites with hemispherical colonies, concentrically wrinkled and rarely nodular. Diameter of colonies 20–200 mm, height 10–50 mm. Zooecial openings regular-polygonal, usually 5–6 sides. Maculae well developed. Diameter of zooecial openings in intermacular spaces 0.58–0.70 mm, in maculae 0.72–1.05 mm. Intermacular spaces 5–6 per 2 mm, in maculae 3–4 zooecial openings. Walls indistinctly-granular, thickness 0.02–0.04 mm. Diaphragms in zooecial chambers are distributed relatively regularly, commonly 0.5–0.7 mm apart. Exilazooecia (? or juvenile zooecia) very rare, having 4-sided outlines and of small diameter (0.15–0.30 mm).

**Occurrence.** — Llanvirn-Caradoc, Kunda-Jykhvi regional stages of the East European Platform (for details see Pushkin and Popov, 2001). In the Podlasie-Brest Depression the species described here are found in the following boreholes

Fig. 2. **a–d** — *Ceramopora explicata* Pushkin, 1976; BelNIGRI, holotype 12/11-185, Llanvirn, Uhaku Regional Stage, Dolbnev Formation, Belarus, Brest region, Lesovchitsy 25 borehole, depth 817 m; tangential sections: **a** — showing general arrangement of zooecial with lunaria, and exilazooecial openings, x 40; **b** — x 10; **c** — zooecial opening showing zooecial outline and structure of lunaria, x 80; **d** — longitudinal section showing zooecial and exilazooecial chambers, porous walls, rather frequent diaphragms; x 20. **e–g** — *Favositella ? exserta* Bassler, 1911: **e, f** — BelNIGRI, 12/1-132, Llanvirn, Uhaku Regional Stage, Dolbnev Formation, Belarus, Brest region, Kustinskaya 1-op borehole, depth 917.5 m; **e** — tangential section showing general arrangement of zooecial (with poorly expressed lunaria) and exilazooecial openings, x 40; **f** — longitudinal section showing zooecial and exilazooecial chambers with rare diaphragms, x 10; **g** — BelNIGRI, 12/59-17, Llanvirn, Kukruse Regional Stage, Lesovchitsy Formation, Belarus, Brest region, Pribugskaya 17 borehole, depth 824 m, longitudinal section showing zooecial and exilazooecial chambers and curved walls, x 10. **h–j** — *Acanthoceramoporella brestica* sp. nov.: **h, i** — BelNIGRI, holotype 12/59-63, Caradoc, Kejla Regional Stage, Lystchitsy Formation, Belarus, Brest region, Pribugskaya 17 borehole, depth 805.3 m; **h** — tangential sections showing general arrangement of zooecial and exilazooecial openings, x 40; **i** — longitudinal section showing arrangement of zooecial and exilazooecial chambers, x 20; **j** — BelNIGRI, 12/41-2, Llanvirn, Uhaku Regional Stage, Krashtaji Formation, Belarus, Vitebsk region, Vangishki 205 borehole, depth 460 m, tangential section showing outline of two zooecial openings, and styleform structures; x 64. **k–o** — *Anolotichiina tabulatiformis* (Pushkin, 1976), BelNIGRI: **k–m** — BelNIGRI, holotype 12/13-86, Caradoc, Jykhvi Regional Stage, Vidomya Formation, Belarus, Brest region, Novoselki 29 borehole, depth 896.1 m: **k** — tangential section showing general arrangement of zooecial and exilazooecial openings, x 40; **l** — transverse section showing general structure of a ramose colony, x 20; **m** — longitudinal section showing arrangement of zooecial chambers in endozone, and zooecial chambers in exozone, x 40; **n** — BelNIGRI, 12/12-102, Caradoc, Idavere Regional Stage, Estonia, Aluvere quarry, tangential section showing general arrangement of zooecial (with lunaria), exilazooecial openings, and small styleform structures, x 40; **o** — BelNIGRI, 12/74-46, Caradoc, Kejla Regional Stage, Lithuania, Vilkaishkis 129 borehole, depth 944.8 m, tangential section showing general arrangement of zooecial (with lunaria) and exilazooecial openings, x 40



(Lesovchitsy Formation): Kustinskaya 1-op, depth 917.5 m (1 specimen); Vitebsk region of Belarus: boreholes Vidzy, depth 357.3–361.0 m (2); Vangishki 205, depth 449.1 m (2); Richany 209, depth 309.8 m (2); Otskovichi 5, depth 276.2 m (2).

*Dianulites janischewskyi* Modzalevskaya, 1953  
(Fig. 3k–m)

1829 *Dianulites detritus* Eichwald, p. 181.  
1856 *Dianulites detritus* Eichwald, p. 94.  
1860 *Dianulites detritus* Eichwald, p. 488, pl. XXVIII, fig. 8.  
1861 *Dianulites detritus* Eichwald, p. 115, pl. VII, fig. 8.  
1953 *Dianulites janischewskyi* Modzalevskaya, p. 138, pl. VII, figs. 5, 6; text-fig. 18.

**H o l o t y p e** : No. 15. Department of Paleontology, Geological Faculty of the University of St. Petersburg, *Echinospaerites* limestone (= Tallinn Superstage — C<sub>1</sub>), Volkhovstroj Formation, Russia, Leningrad region, Volkhov River.

**R e v i s e d d i a g n o s i s** : *Dianulites* with hemispherical, nodular or cone-shaped colonies. Base of hemispherical colonies concentrically wrinkled. Diameter of hemispherical colonies 10–80 mm, height 5–60 mm; maximum diameter of cone-shaped colonies 20–23 mm, length 30 mm. Lateral surfaces of cone-shaped colonies covered by longitudinal epitheca. Zooecial openings regular-polygonal, 0.25–0.40 mm in diameter in intermacular spaces, 0.40–0.60 mm near maculae. Maculae having diameter 1.2–1.4 mm composed of exilazooecia (or ? juvenile zooecia), which developed mainly in maculae, rarely in intermacular spaces. Walls of zooecia and exilazooecia indistinctly granular, slightly curved, thickness 0.025–0.04 mm. Diaphragms in zooecial and ? exilazooecial chambers spread relatively uniformly, distance between diaphragms usually 0.5–0.9 mm.

**R e m a r k s** . — *Dianulites janischewskyi* Modzalevskaya, 1953 differs from *D. fastigiatum* Eichwald, 1829, which also forms cone-shaped colonies, in having more frequent diaphragms in zooecial and exilazooecial chambers.

**O c c u r r e n c e** . — Arenig-Caradoc, Kunda-Kukruse regional stages of the East European Platform; Lower-Middle Ordovician of Arctic. In Belarus this species is found in the Podlasie-Brest Depression (Dolbnev-Lystchitsy formations) in the following boreholes: Morozovichi 16, depth 903 m (1 specimen); Deshevichi 27, depth 639.7 m (1); Zhabinka 3, depth 583 m (1); Pribugskaya 17, depth 808.2–811.5 m (3); Vitebsk region, Otskovichi 5 borehole, depth 276.2 m (1); Vangishki 205, depth 457.7 m (2); Verkhnedvinsk 1, depth 335.5–337.8 m (2). Lithuania, Butkunaji 241 borehole, depth 710.8 m (6); Tauchenis 49, depth 436.4 m (1); Ilgaji 54, depth 414 m (1).

Latvia, Vishki 25 borehole, depth 573.8–588.5 m (2); Ludza 15, depth 626.2–649.5 m (3) and others.

Family **Orbiporidae** Astrova, 1978  
Genus *Orbipora* (Eichwald, 1856)  
*Orbipora distincta* (Eichwald, 1829)  
(Fig. 4d, e)

1829 *Orbitulites distinctus* Eichwald, p. 180.  
1856 *Orbipora distincta* Eichwald, p. 93.  
1860 *Orbipora distincta* Eichwald, p. 484, pl. XXVIII, figs. 6, 7.  
1861 *Orbipora distincta* Eichwald, p. 114, pl. VII, fig. 7.  
1877 *Orbipora distincta* Dybowski, p. 60, pl. 2, fig. 10.  
1911 *Orbipora distincta* Bassler, p. 253, pl. 3, fig. 10; text-figs. 144–147.  
1978 *Orbipora distincta* Astrova, pl. II, fig. 1.

**L e c t o t y p e** : No. 57328, United States National Museum, Caradoc, Jykhvi Regional Stage, Estonia, Jykhvi (Baron Toll's estate) (see Bassler, 1911, text-fig. 146).

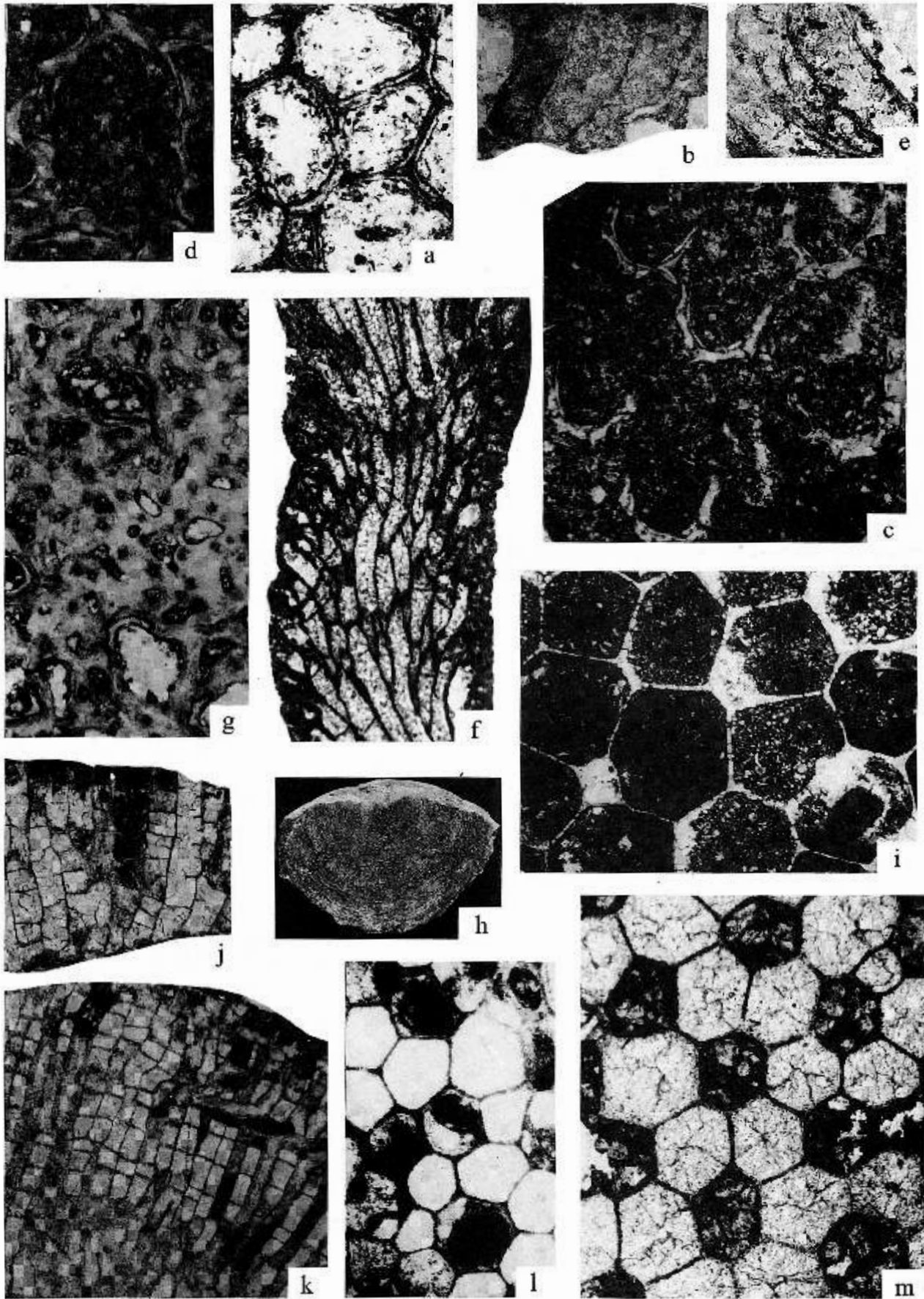
**D e s c r i p t i o n** . — *Orbipora* with flattened, discoidal colonies: diameter 10–45 mm, height 1–10 mm. The colony height to diameter ratio is usually 1:5–1:1. Base of colony has a wrinkled epitheca. The colony surfaces smooth, without elevated maculae. Zooecial openings polygonal (5–7, usually 6-corner), very large, diameter 0.70–1.00 mm. Approximately 2.5–3 openings per 2 mm. Walls uniform, indistinctly granular, thickness 0.3–0.7 mm. Diaphragms absent. Styles very numerous, 8–16 per 2 mm. Diameter of styles 0.05–1.00 mm. Styles have thin indistinctly granular walls and wide cavities.

**R e m a r k s** . — *Orbipora distincta* (Eichwald, 1829) differs from *O. solida* Bassler, 1911 from the Lower Ordovician, Kunda Regional Stage of the Baltic-Ladoga Glint, in having considerably more abundant styles and larger zooecia.

**O c c u r r e n c e** . — Llanvirn-Caradoc, Azeri-Jykhvi regional stages of the East European Platform. Widely ranging species. In the Podlasie-Brest Depression this species was found in the following boreholes (Dolbnev-Lystchitsy formations): Kustinskaya 1-op, depth 909–917.5 m (7 specimens); Pribugskaya 17, depth 808.3–820.7 m (4); Vysokoe 1, depth 831.6–843.0 m (3); Novoselki 29, depth 893.5–922.1 m (8); Lesovchitsy 25, depth 805.5–821.0 m (6); Orlya 28, depth 1099.8–1101.0 m (2); Ratajchitsy 12, depth 956–957 m (2); Deshevichi 27, depth 635.1–637.1 m (2).

Fig. 3. **a–e** — *Minutolunaria illustris* sp. nov.: **a, b** — BelNIGRI, holotype 12/13-71, Caradoc, Kejla-Oandu Regional Stage, Lystchitsy Formation, Belarus, Brest region, Novoselki 29 borehole, depth 892.5 m; **a** — tangential section showing general arrangement of zooecial and exilazooecial openings, x 40; **b** — longitudinal section showing zooecial chambers, x 20; **c–e** — BelNIGRI, 12/40-34, Caradoc, Oandu Regional Stage, Goraev Formation, Ukraine, Podolia, Naddnestrjanka village, outcrop 279; **c** — tangential section showing large lunaria with styleform structures, x 40; **d** — tangential section showing the zooecial openings with lunaria which pierce styleform structures, x 64; **e** — longitudinal section showing zooecial and exilazooecial chambers; x 20. **f, g** — *Anolotichiina tabulatiformis* (Pushkin, 1976): **f** — BelNIGRI, holotype 12/13-86, Caradoc, Jykhvi Regional Stage, Vidomlya Formation, Belarus, Brest region, Novoselki 29 borehole, depth 896.1 m, longitudinal section, x 15; **g** — BelNIGRI, 12/74-46, Caradoc, Kejla Regional Stage, Lithuania, Vilkaishkis 129 borehole, depth 944.8 m, tangential section showing maculae, protruding exilazooecia and styleform structures, well developed lunaria with central styleform structures, x 40. **h–j** — *Esthoniopora communis* Bassler, 1911: **h** — BelNIGRI, 12/38-551, Caradoc, Idavere Regional Stage, Belarus, Vitebsk region, Vishki 25 borehole, depth 565.1 m, base of colony with concentrically banded epitheca, natural size; **i** — BelNIGRI, 12/38-12, Caradoc, Idavere Regional Stage, Richany Formation, Lithuania, Vishki 25 borehole, depth 579.5 m, tangential section, x 40; **j** — BelNIGRI, 12/1-117, Llanvirn, Kukruse Regional Stage, Lesovchitsy Formation, Belarus, Brest region, Kustinskaya 1-op borehole, depth 909 m, longitudinal section, x 10. **k–m** — *Dianulites janischewski* Modzalevskaya, 1953: **k, l** — BelNIGRI, 12/6-15, Llanvirn, Uhaku Regional Stage, Dolbnev Formation, Belarus, Brest region, Morozovichi 16 borehole, depth 903 m; **k** — longitudinal section showing zooecial and ? exilazooecial chambers with numerous regularly shaped diaphragms, x 10; **l** — tangential section, x 40; **m** — BelNIGRI, 12/57-2, Caradoc, Idavere Regional Stage, Lithuania, Butkunai 241 borehole, depth 710.8 m, tangential section showing general arrangement of zooecial and ? exilazooecial openings, x 40





Suborder **Amplexoporina** Astrova, 1965  
 Family **Amplexoporidae** Miller, 1889  
 Genus *Amplexopora* Ulrich, 1882  
*Amplexopora angustiformis* Pushkin, 1976  
 (Fig. 4f, g)

1976 *Amplexopora angustiformis* Pushkin, p.20, pl. XIV, fig. 3; pl. XV, fig. 1.

**H o l o t y p e**: No. 12/8-65, BelNIGRI, Llanvirn, Uhaku or Kukruse regional stages, Lesovchitsy Formation, Belarus, Brest region, Vysokoe 1 borehole, depth 842.5–843.0 m.

**R e v i s e d d i a g n o s i s**: *Amplexopora* with ramose colonies: diameter 1.5–5.0 mm, length 5–12 mm. Width of endo- and exozone approximately equal. Zooecial openings rounded or oval: maximum diameter in intermacular spaces 0.11–0.16 mm; in indistinct maculae 0.16–0.20 mm. Approximately 9 openings per 2 mm. Walls in endozone thin, straight, in exozone thickened to 0.05–0.09 mm, with well developed dark central zone. Diaphragms thin, distance between diaphragms in exozone 0.02–0.15 mm; locally rare cystiphagms are developed. Styles have relatively wide central chamber and indistinct outlines. Diameter of styles 0.025–0.040 mm, near each zooecial opening 4–6 styles.

**R e m a r k s**. — *Amplexopora angustiformis* Pushkin, 1976 differs from *A. angusta* Astrova, 1965 from the Middle Ordovician of Vajgach Island, in having a wide exozone and larger styles with indistinct outlines.

**O c c u r r e n c e**. — Llanvirn, Uhaku or Kukruse regional stages, Lesovchitsy Formation of the Podlasie-Brest Depression, boreholes: Vysokoe 1, depth 842.5–843.0 m (3 specimens); Kustinskaya 1-op, depth 909.9 m (1).

Genus *Monotrypa* Nicholson, 1879  
*Monotrypa undulata* (Nicholson, 1875)  
 (Fig. 4h, i)

1875 *Chaetetes undulatus* Nicholson, p. 176.

1879 *Monticulipora (Monotrypa) undulata* Nicholson, p. 321, 322, pl. XIV, figs. 3, 4.

1881 *Monticulipora (Monotrypa) undulata* Nicholson, p.170, text-figs. 32, 33.

1883 *Monotrypa undulata* Foord, p. 14.

1970 *Monotrypa undulatus* Ross, p. 375, pl. 70, figs. 6, 7; pl. 71, figs. 1–6.

**L e c t o t y p e** (proposed herein): Specimen illustrated by Nicholson, 1879, p. 321, 322, pl. XIV, figs. 3, 4, Middle Ordovician, Trenton, Hudson River Group, Canada, Toronto.

**D e s c r i p t i o n**. — *Monotrypa* with irregular-massive colonies with numerous growth layers. Base of colony cellular. Maximum size of colonies 25×25×20 mm. Zooecial

openings polygonal or irregularly-polygonal (usually 6–9-corners), diameter 0.37–0.64 mm. Approximately 4–5 openings per 2 mm. Walls dense, straight or slightly wavy, homogenous, thickness commonly 0.010–0.015 mm, but locally increased to 0.020–0.025 mm. Diaphragms very thin, regularly spread, distance between diaphragms 0.23–1.4 mm, commonly 0.35–0.70 mm. Exilazooecia 4–5-corner quite numerous: 1–2 exilazooecia per 1 zooecia. Diameter of exilazooecia 0.10–0.51 mm. Longitudinal sections of exilazooecia are identical to zooecial sections.

**R e m a r k s**. — *Monotrypa undulata* (Nicholson, 1875) differs from *M. jewensis* Bassler, 1911 from Caradoc, Jykhvi-Rakvere regional stages of the East European Platform in having considerable more abundant diaphragms in the zooecial chambers.

**O c c u r r e n c e**. — Trenton of Canada, USA; Llanvirn-Caradoc, Kukruse-Kejla regional stages of the East European Platform; Belarus, Podlasie-Brest Depression, boreholes: Novoselki 29, depth 912.6 m (1 specimen — Lesovchitsy Formation); Pribugskaya 17, depth 809.9 m (1 — Lystchitsy Formation). Lithuania, Vilkavishkis 129 borehole, depth 948–951 m (2). Latvia, Vishki 25 borehole, depth 570.0–573.8 m (2). Russia, Serebryaniki borehole, depth 1014.3 m (1).

Family **Atactotoechidae** Duncan, 1939  
 Genus *Atactopora* Ulrich, 1879  
*Atactopora gregariaformis* sp. nov.  
 (Fig. 5a–c)

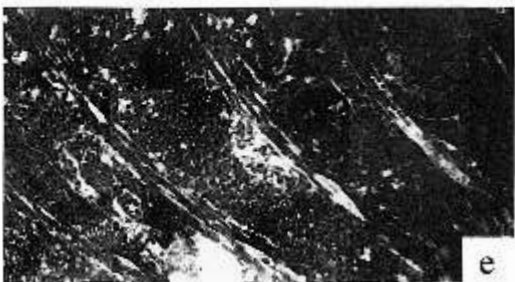
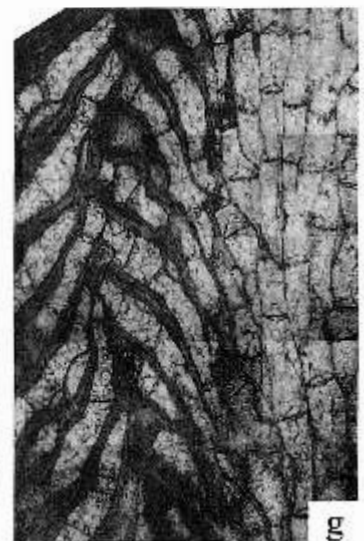
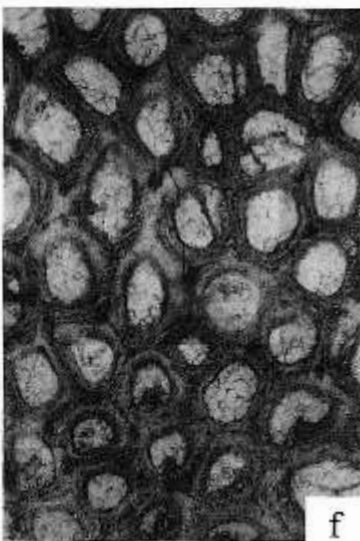
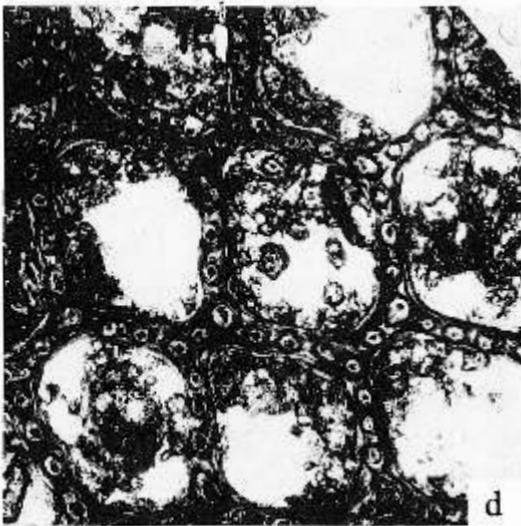
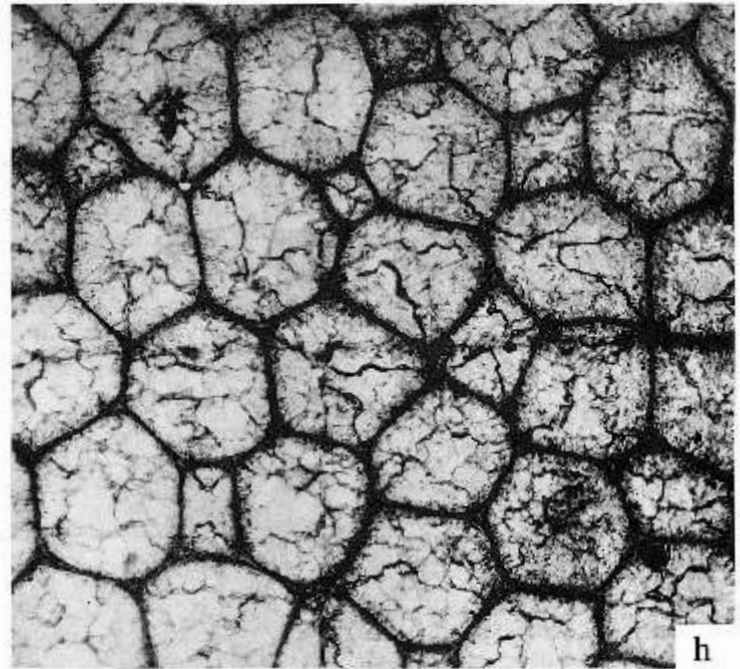
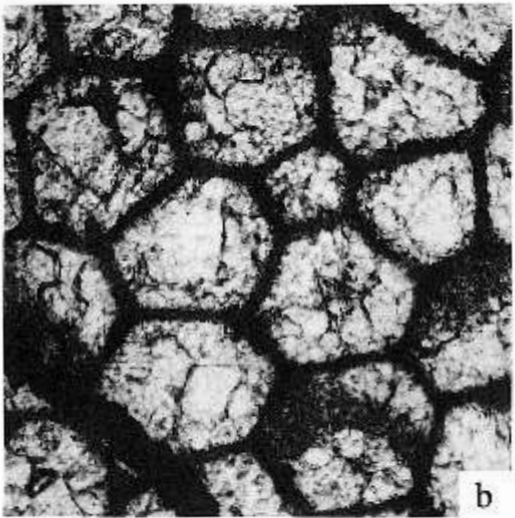
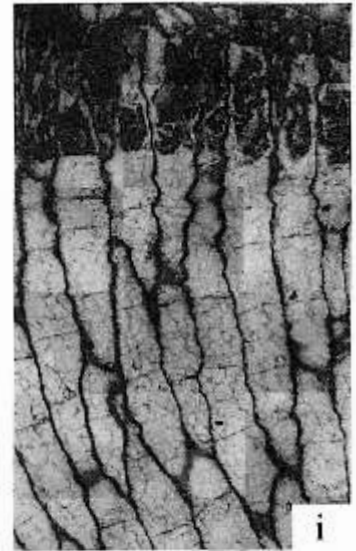
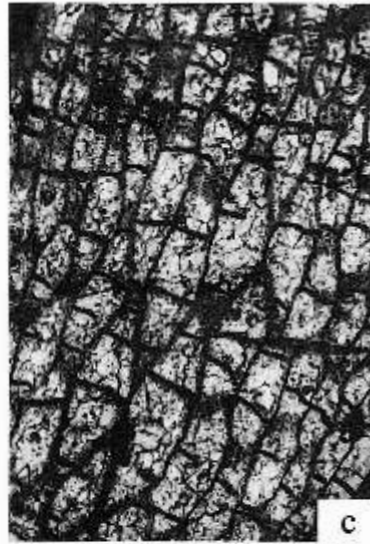
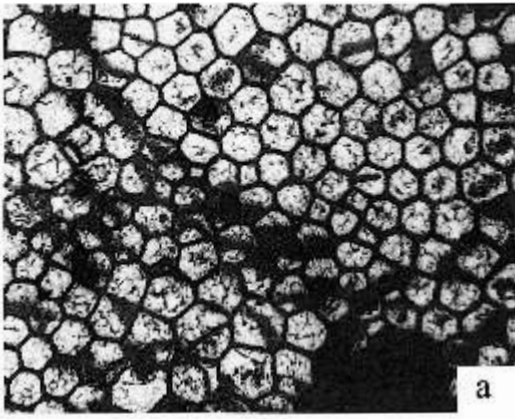
**E t y m o l o g y**: from *Atactopora gregaria* (Ulrich, 1882).

**H o l o t y p e**: No. 12/13-140, Belarussian Geological Prospecting Research Institute (BelNIGRI), Caradoc, Jykhvi Regional Stage, Vidomlya Formation, Belarus, Brest region, Novoselki 29 borehole, depth 903.8 m.

**D i a g n o s i s**: *Atactopora* with thin lamellar colonies; zooecial openings rounded or rounded-polygonal; zooecial walls composed of dark carbonate material; diaphragms numerous; exilazooecia very rare; styles numerous of different sizes.

**D e s c r i p t i o n**. — Thin laminar *Atactopora*, encrusting ramose and massive bryozoa colonies and *Echinospaerites*. Colonies usually pluristratose, thickness of layers 0.1–0.8 mm. Zooecial openings rounded or rounded-polygonal, diameter 0.15–0.29 mm. 7.5–8.5 openings per 2 mm. Walls homogenous, dense, composed of dark carbonate material, thickness 0.02–0.03 mm. Diaphragms numer-

Fig. 4. a–c — *Dianulites petropolitanus* (Pander, 1830), BelNIGRI, 12/1-129, Llanvirn, Uhaku Regional Stage, Lesovchitsy Formation, Belarus, Brest region, Kustinskaya 1-op borehole, depth 917.5 m: a — tangential section showing general arrangement of zooecial openings (alternation of maculae and intermacular spaces), x 10; b — tangential section showing general arrangement of zooecial openings in intermacular space, x 40; c — longitudinal section showing zooecial chambers with numerous diaphragms, x 10. d, e — *Orbipora distincta* (Eichwald, 1829), BelNIGRI, 12/1-131, Llanvirn, Uhaku Regional Stage, Lesovchitsy Formation, Belarus, Brest region, Kustinskaya 1-op borehole, depth 917 m: d — tangential section showing general arrangement of zooecial openings and numerous styles, x 40; e — longitudinal section showing zooecial chambers without diaphragms, x 30. f, g — *Amplexopora angustiformis* Pushkin, 1976, BelNIGRI, holotype 12/8-65, Uhaku Regional Stage, Lesovchitsy Formation, Belarus, Brest region, Vysokoe 1 borehole, depth 842.5–843.0 m: f — tangential section showing general arrangement of zooecial openings, structure of walls, and styles, x 40; g — longitudinal section showing the zooecial chambers with diaphragms and cystiphagms; x 20. h, i — *Monotrypa undulata* (Nicholson, 1875), BelNIGRI, 12/13-204, Llanvirn, Kukruse Regional Stage, Lesovchitsy Formation, Belarus, Brest region, Novoselki 29 borehole, depth 912.6 m: h — tangential section showing the general arrangement of zooecial openings, x 40; i — longitudinal section, showing zooecial chambers with numerous diaphragms and wavy zooecial walls, x 10



ous, straight, distance between diaphragms 0.04–0.25 mm. In each zoecial chamber 2–8 diaphragms. Exilazooecia very rare, diameter 0.04–0.15 mm. Styles numerous, diameter 0.02–0.08 mm, 3–5 styles near each zoecial opening.

**R e m a r k s .** — *Atactopora gregariaformis* sp. nov. differs from *A. gregaria* (Ulrich, 1882, 1893) from the Upper Ordovician (Formation Lorrein) USA (Indiana) in having relatively numerous diaphragms in zoecial chambers and larger zoecial openings.

**O c c u r r e n c e .** — Caradoc, Idavere-Kejla regional stages. Podlasie-Brest Depression (Vidomlya Formation), Novoselki 29 borehole, depth 903.8 m (4 specimens). Latvia, boreholes: Vishki 25, depth 552.3 m (1); Ludza 15, depth 603.9 m (1).

Suborder **Halloporina** Astrova, 1965  
 Family **Halloporidae** Bassler, 1911  
 Genus *Diplotrypa* Nicholson, 1879  
*Diplotrypa petropolitana* (Nicholson, 1879)  
 (Fig. 5d–i)

?1861 *Chaetetes petropolitana* Roemer, p. 28, pl. IV, fig. 8.  
 1877 *Callopora nummiformis* (Hall) Dybowski, p. 14, pl. 5, fig. 1.  
 1879 *Monticulipora (Diplotrypa) petropolitana* Nicholson, p. 313, pl. XIII, fig. 3.  
 1881 *Monticulipora (Diplotrypa) petropolitana* Nicholson, p. 156, text-fig. 30.  
 1911 *Diplotrypa petropolitana* Bassler, p. 313, text-figs. 192–195.  
 1911 *Hallopora? dybowskii* (pars) Bassler, p. 335, text-fig. 212 (non text-fig. 211).  
 1921 *Diplotrypa petropolitana* Bekker, p. 44, pl. X, figs. 1–11.  
 1965 *Diplotrypa petropolitana* Astrova, p. 183, pl. XXVII, fig. 2.  
 1970 *Diplotrypa petropolitana* Nekhorosheva, p. 74, text-fig. 2.  
 1978 *Diplotrypa petropolitana* Astrova, pl. VIII, fig. 2.

**L e c t o t y p e** (proposed herein): Specimen illustrated by Nicholson, 1879, p. 313, pl. XIII, fig. 3, Caradoc, *Chasmops* limestone, Sweden, Ostrogothia (Bassler, 1911, text-fig. 192).

**D e s c r i p t i o n .** — *Diplotrypa* with massive (usually hemispherical) colonies. The bases of colonies are covered by a strongly concentrically wrinkled epitheca. The average specimens are 2–3 cm in diameter and 1–1.5 cm in height. Maximum diameter of colonies 10 cm. Colonies surface smooth. Zoecial openings polygonal (usually 6–9-corner): average diameter in intermacular spaces 0.40–0.55 mm, in maculae

0.55–0.70 mm. In intermacular spaces approximately 3–3.5 openings per 2 mm. Walls of zooecia in all parts of colonies thin, straight, of thickness 0.010–0.015 mm. Diaphragms thin, usually straight, but locally curved; cystiphragm-like and inclined diaphragms are observed. The distance between diaphragms 0.1–1.0 mm, commonly 0.2–0.5 mm. Mesozooecia quite numerous (2–4 mesozooecia per 1 zooecia), but never completely isolated from zoecial openings. The size of polygonal (4–6-corner) mesozooecial openings is 0.05–0.40 mm. Diaphragms in mesozooecial chambers frequent, straight, separated by 0.01–0.12 mm.

**R e m a r k s .** — *Diplotrypa petropolitana* (Nicholson, 1879) differs from *D. densitabulata* Modzalevskaya, 1953 (= *D. petropolitana* (Nicholson, 1879) — Astrova, 1965, pl. XXVII, fig. 2) from the Upper Ordovician Nabala-Vormsi regional stages of the East European Platform in having more rare and uniformly spreaded straight diaphragms in the zoecial chambers.

**O c c u r r e n c e .** — Wide spread species in the Middle Ordovician (Llanvirn-Caradoc, Uhaku-Rakvere regional stages) of the East European Platform. In the Podlasie-Brest Depression (Lesovchitsy-Vidomlya formations) found in the following boreholes: Novoselki 29, depth 893.5–920.0 m (6 specimens); Kustinskaya 1-op, depth 913.2–917.5 m (4); Vysokoe 1, depth 826.6–842.0 m (4); Borstchovo 10, depth 942.6–946.2 m (2); Ratajchitsy 12, depth 956–966 m (3); Lesovchitsy 25, depth 810–821 m (3); Deshevichi 27, depth 630.8–640.1 m (4); Orlya 28, depth 1099.0–1097.8 m (7); Pribugskaya 31, depth 866.9 m (1).

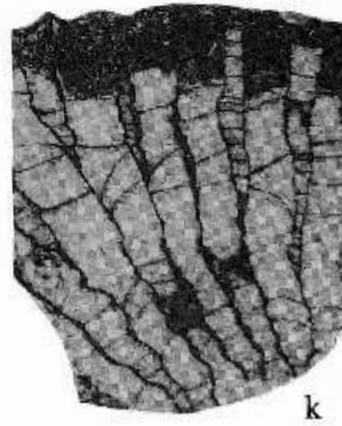
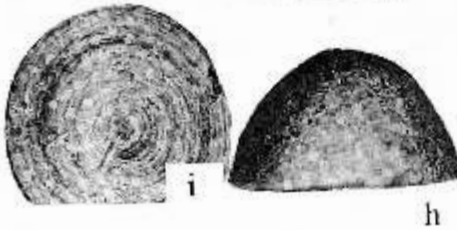
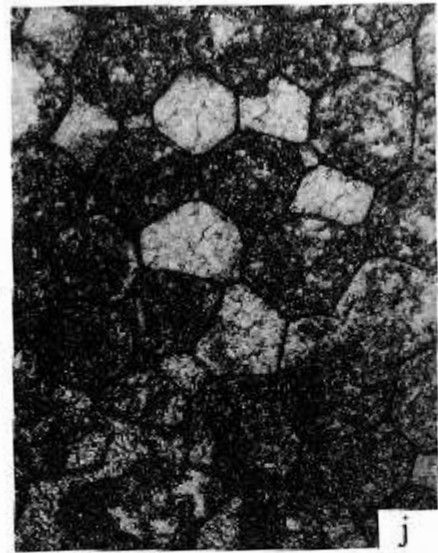
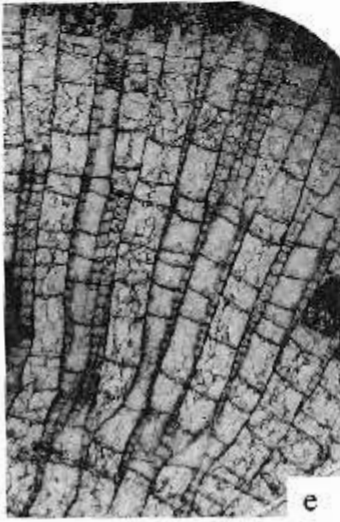
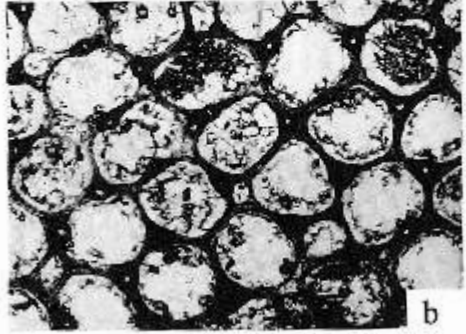
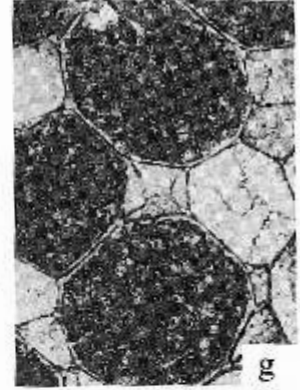
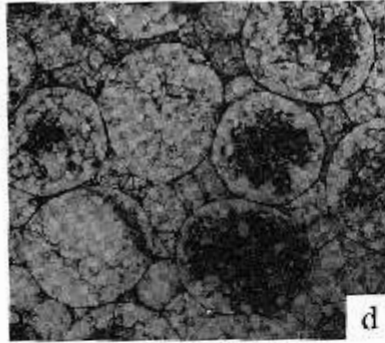
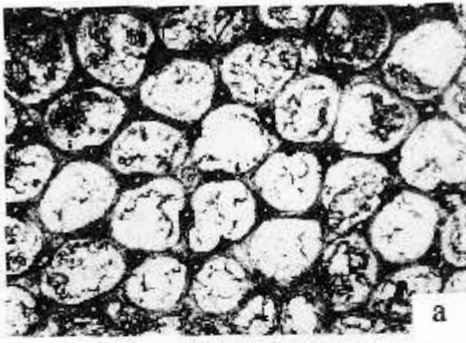
*Diplotrypa moniliformis* Bassler, 1911  
 (Fig. 5j, k)

1911 *Diplotrypa moniliformis* Bassler, p. 321, text-fig. 199.  
 1921 *Diplotrypa moniliformis* Bekker, p. 43, pl. IX, figs. 7–9.

**H o l o t y p e**: No. 57413, United States National Museum, Caradoc, Jykhvi Regional Stage, Estonia, Kukruse (Baron Toll's estate).

**D e s c r i p t i o n .** — *Diplotrypa* with hemispherical or nodular colonies of relatively small (0.5–1.5 cm) size. Bases of hemispherical colonies with concentrically wrinkled epitheca. Zoecial openings polygonal (usually irregularly-polygonal),

Fig. 5. **a–c** — *Atactopora gregariaformis* sp. nov., BelNIGRI, holotype 12/13-140, Caradoc, Jykhvi Regional Stage, Vidomlya Formation, Belarus, Brest region, Novoselki 29 borehole, depth 903.8 m: **a, b** — tangential sections showing general arrangement of zoecial openings and styles, x 40; **c** — longitudinal section showing general structure of zoecial chambers, x 20. **d–i** — *Diplotrypa petropolitana* (Nicholson, 1879): **d–f** — BelNIGRI, 12/13-186, Llanvirn, Kukruse Regional Stage, Lesovchitsy Formation; Belarus, Brest region, Novoselki 29 borehole, depth 914.5 m; **d** — tangential section showing general arrangement of zoecial and mesozooecial openings, x 38; **e** — longitudinal section showing general structure of zoecial and mesozooecial chambers, x 20; **f** — the same longitudinal section, x 38; **g** — BelNIGRI, 12/29-47, Caradoc, Idavere Regional Stage, Richany Formation, Lithuania, Ilgaji 49 borehole, depth 405.6 m, tangential section across maculae showing large sizes of zoecial and mesozooecial openings, x 40; **h, i** — BelNIGRI, 12/41-20, Caradoc, Idavere Regional Stage, Richany Formation, Belarus, Vitebsk region, Vangishki 205 borehole, depth 447.5 m; **h** — lateral view of the colony, x 2; **i** — base of colonies, x 2. **j, k** — *Diplotrypa moniliformis* Bassler, 1911, BelNIGRI, 12/29-46, Caradoc, Idavere Regional Stage, Richany Formation, Lithuania, Ilgaji 49 borehole, depth 407.2 m: **j** — tangential section showing general arrangement of zoecial and mesozooecial openings, x 40; **k** — longitudinal section showing general structure of zoecial and mesozooecial chambers, curved diaphragms in zoecial chambers, wavy structure of walls, x 20. **l, m** — *Diplotrypa hennigi* Bassler, 1911, BelNIGRI, 12/4-27, Llanvirn, Uhaku Regional Stage, Dolbnev Formation, Belarus, Brest region, Zhabinka 3 borehole, depth 742 m: **l** — tangential section showing general arrangement of zoecial and small mesozooecial openings, x 40; **m** — longitudinal section showing general structure of zoecial chambers, lacking (or rare) diaphragms and small mesozooecial chambers, x 40



6–9-corner. Maculae absent or indistinct. Diameter of openings 0.32–0.47 mm, 3–4 openings per 2 mm. Walls of zooecia thin, usually strongly and irregularly curved, thickness 0.01–0.02 mm. Diaphragms thin, straight, relatively uniformly spread, distance between diaphragms 0.2–0.8 mm. Mesozooecia abundant, but not isolated from zooecial openings. Diameter of mesozooecia 0.10–0.32 mm, diaphragms as in zooecial chambers.

**Remarks.** — *Diplotrypa moniliformis* Bassler, 1911 differs from other species of *Diplotrypa* by strongly and irregularly curved zooecial and exilazooecial walls of endo- and exozone of colonies.

**Occurrence.** — Llanvirn-Caradoc, Uhaku-Kejla regional stages of the East European Platform. In the Podlasie-Brest Depression this species has found in the following boreholes (Lesovchitsy Formation): Novoselki 29, depth 920 m (2 specimens); Vysokoe 1, depth 831.6 m (1); Turna 5, depth 743.5 m (1); Zhabinka 3, depth 743.5 m (1). Species relatively widespread on the East European Platform.

*Diplotrypa hennigi* Bassler, 1911  
(Fig. 5l, m)

1911 *Diplotrypa hennigi* Bassler, p. 322, text-fig. 200.  
1965 *Diplotrypa hennigi* Astrova, p. 187, pl. XXX, fig. 1, text-fig. 34.

**Holotype:** No. 57414, Unites States National Museum, Llanvirn, Kukruse Regional Stage, Estonia, near Tallinn (Baron Toll's estate).

**Description.** — *Diplotrypa* with nodular colonies. Diameter of colonies 5–15 mm. Zooecial openings polygonal (usually irregularly-polygonal), 5–7-corner. Maculae absent or indistinct. Diameter of openings 0.24–0.38 mm, 5.5–6.5 openings per 2 mm. Walls of zooecia thin, straight or curved, locally gradually curved. Diaphragms absent or very rare. Mesozooecia relatively numerous (but in some parts of colonies completely absent): on the average 1–2 mesozooecia per 1 zooecia. Diameter of mesozooecia 0.10–0.21 mm, distance between diaphragms 0.10–0.17 mm.

**Occurrence.** — Llanvirn-Caradoc, Uhaku-Kejla regional stages of the East European Platform. In the Podlasie-Brest Depression (Lesovchitsy-Lystchitsy formations) found in the following boreholes: Kustinskaya 1-op, depth 909

m (2 specimens); Vysokoe 1, depth 820 m (1); Turna 5, depth 742 m (1).

*Diplotrypa scalaris* L. Nekhorosheva, 1970  
(Fig. 6a–d)

1970 *Diplotrypa scalaris* L. Nekhorosheva, p. 77, pl. IV, figs. 3, 4; pl. V, fig. 2; text-fig. 3.

**Holotype:** No. 10161, Central Geological Museum (CGM) in honour of F. N. Chernyshev (St. Petersburg), Caradoc, Yugor Regional Stage, Beds with *Christiania subquadrata*, North Ural (Paj-Khoj).

**Revised diagnosis:** *Diplotrypa* with nodular and hemispherical colonies. Bases of hemispherical colonies with concentrically wrinkled epitheca. Zooecial openings rounded or rounded-polygonal, diameter 0.27–0.44 mm. About 5–6 openings per 2 mm. Walls straight or slightly curved. Diaphragms relatively numerous, straight or curved, distance between diaphragms 0.07–0.85 mm, usually 0.2–0.4 mm. Mesozooecia relatively numerous, locally form one row between zooecial openings; diameter of irregularly-polygonal mesozooecial openings 0.07–0.34 mm. Diaphragms frequent, straight, slightly curved of the mesozooecial walls, distance between diaphragms 0.06–0.16 mm. Colony bases almost completely composed of mesozooecia or mesozooecia-shaped structures with frequent and thickened diaphragms (Fig. 6c).

**Remarks.** — *Diplotrypa scalaris* L. Nekhorosheva, 1970 differs from *D. petropolitana* (Nicholson, 1879) in having numerous, frequently curved diaphragms in zooecial chambers.

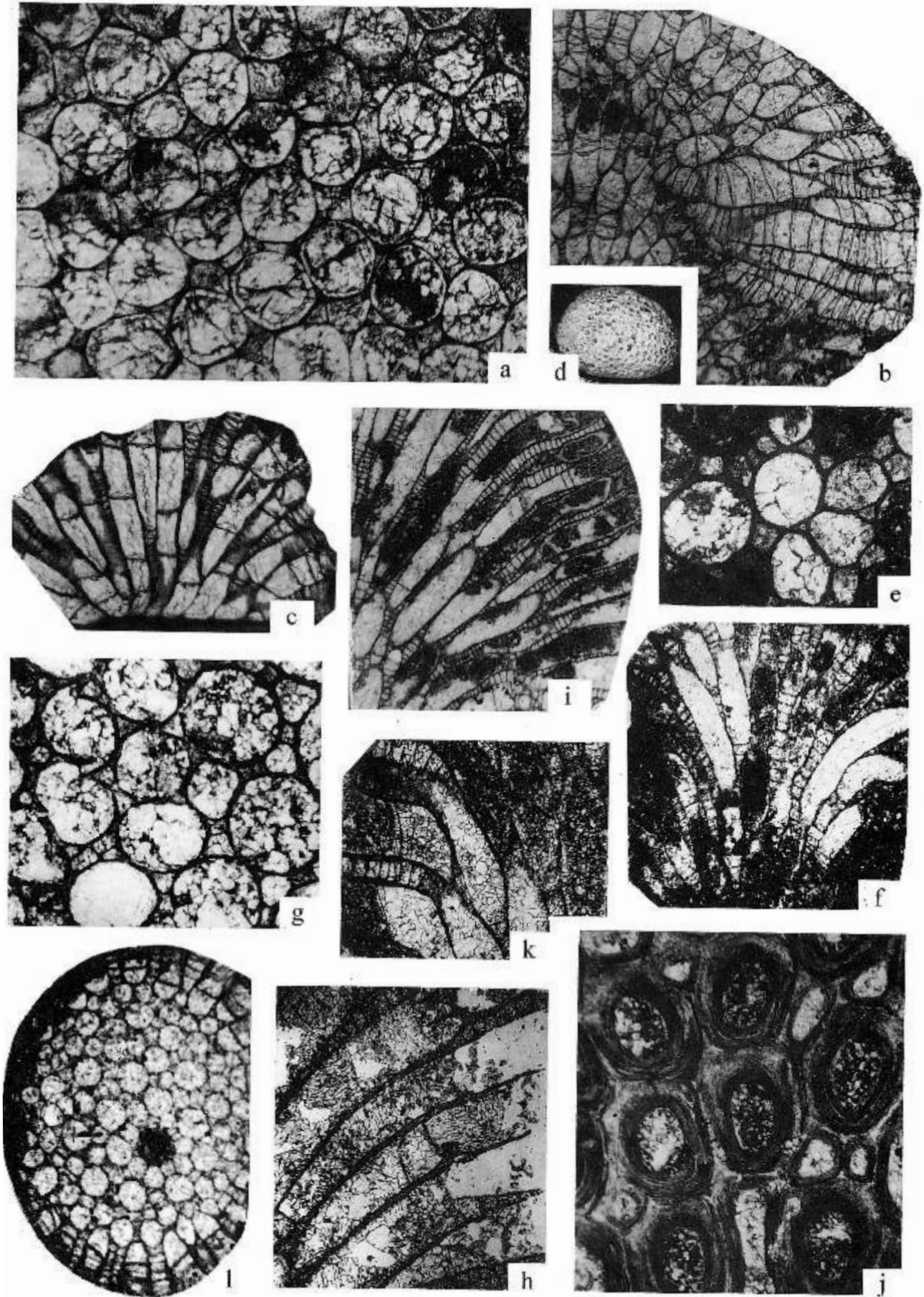
**Occurrence.** — Llanvirn-Caradoc, Yugor Regional Stage of Vajgach Island; Idavere Regional Stage (Vidomlya Formation) of the Podlasie-Brest Depression; Novoselki 29 borehole, depth 904.0–906.8 m (2 specimens); Belarus, Vitebsk region, Vangishki 205 borehole, depth 436.7–439.8 m (2 specimens, Richany Formation).

*Hallopora* Bassler, 1911  
*Hallopora tolli* Bassler, 1911  
(Fig. 6e–i)

1911 *Hallopora tolli* Bassler, p. 333, text-fig. 1.  
1941 *Hallopora tolli* Fritz, p. 564, text-fig. 1.  
1967 *Hallopora* cf. *tollii* Bork and Perry, p. 1382, pl. 176, figs. 2–6.

**Lectotype:** specimen illustrated by Bassler, 1911, p. 333, text-fig. 1, Caradoc, Jykhvi Regional Stage, Estonia, Jewe.

Fig. 6. **a–d** — *Diplotrypa scalaris* L. Nekhorosheva, 1970: **a, b** — BelNIGRI, 12/13-244, Caradoc, Idavere Regional Stage, Vidomlya Formation, Belarus, Brest region, Novoselki 29 borehole, depth 904 m; **a** — tangential section, x 40; **b** — longitudinal section, x 20; **c** — BelNIGRI, 12/13-229, Belarus, Brest region, Novoselki 29 borehole, depth 906.8 m, longitudinal section showing general structure of zooecial chambers with numerous, frequent inclined diaphragms and mesozooecial chambers with frequent diaphragms, x 20; **d** — BelNIGRI, 12/41-31a, Caradoc, Idavere Regional Stage, Richany Formation, Belarus, Vitebsk region, Vangishki 205 borehole, depth 439.8 m, lateral view of small nodular colony, x 2. **e–i** — *Hallopora tolli* Bassler, 1911: **e, f** — BelNIGRI, 12/11-166, Llanvirn, Uhaku Regional Stage, Lesovchitsy Formation, Belarus, Brest region, Lesovchitsy 25 borehole, depth 808 m; **e** — tangential section showing general arrangement of zooecial and mesozooecial openings, x 40; **f** — longitudinal section showing general arrangement of zooecial and mesozooecial chambers, x 20; **g, h** — BelNIGRI, 12/38-150, Caradoc, Jykhvi Regional Stage, Vangishki Formation, Latvia, Vishki 25 borehole, depth 560.1 m; **g** — tangential section showing general arrangement of zooecial and mesozooecial openings, x 40; **h** — longitudinal section, x 40; **i** — BelNIGRI, 12/50-21, Caradoc, Idavere Regional Stage, Latvia, Ludza 15 borehole, depth 628.1 m, longitudinal section showing general structure of zooecial chambers, lacking diaphragms, and mesozooecial chambers with frequent diaphragms, x 15. **j–l** — *Hallopora mckinneyi* sp. nov.: **j, k** — BelNIGRI, 12/13-287a, Caradoc, Kejla-Oandu regional stages, Vidomlya Formation, Belarus, Brest region, Novoselki 29 borehole, depth 892.5 m; **j** — tangential section showing general arrangement of zooecial and mesozooecial openings, x 48; **k** — longitudinal section showing general structure of zooecial and mesozooecial chambers, x 40; **l** — BelNIGRI, 12/13-263, Caradoc, Jykhvi Regional Stage, Vidomlya Formation, Novoselki 29 borehole, depth 899.3 m, transverse section of ramose colonies, x 20



**Description.** — *Hallopora* with cylindrical (sausage-shaped) or ramose, rarely branched colonies. Presence of exozone is unclear. Colony surfaces smooth. Diameter of colonies 4–8 mm, length 5–20 mm. Maculae not observed. Zooecial openings polygonal or rounded-polygonal, diameter 0.35–0.51 mm; 3.5–4.5 openings per 2 mm. Walls of zooecia thin, straight, thickness 0.01–0.02 mm. Diaphragms usually absent or very rare. Mesozooecia relatively abundant, but not isolated from zooecial openings. Diameter of mesozooecia 0.12–0.33 mm, diaphragms straight, distance between diaphragms 0.08–0.16 mm.

**Remarks.** — This species differs from other species of *Hallopora* in having cylindrical (sausage-shaped) colonies and an indistinctly developed exozone.

**Occurrence.** — The species is relatively widespread in the Middle Ordovician of the East European Platform. In Estonia — Uhaku-Kejla regional stages. Lithuania, Butkunai 241 borehole, depth 677.0 m (1 specimen). Latvia, Vishki 25 borehole, depth 560.1 m (1); Ludza 15 borehole, depth 628.1 m (1). Russia, Serebryaniki borehole, depth 999.8–1043.7 m (3); in the Podlasie-Brest Depression (Lesovchitsy Formation): Lesovchitsy 25 borehole, depth 804.8–810.7 m (3); Middle Ordovician, Black River Formation of Canada (Gaspé); Gattenberg Formation of USA (Illinois State).

*Hallopora mckinneyi* sp. nov.  
(Figs. 6j–l and 7a–e)

1987a *Hallopora onealli* (James); Pushkin, p. 150, pl. VI, figs. 4, 5.

1987a *Hallopora ovata* (Mc Kinney); Pushkin, p. 151, pl. VII, figs. 1, 2.

**Ety m o l o g y:** in honour of Dr. Frank Mc Kinney.

**H o l o t y p e:** No. 12/8-48, BelNIGRI, Caradoc, Kejla-Oandu regional stages, Lystchitsy Formation, Belarus, Brest region, Vysokoe 1 borehole, depth 820 m.

**D i a g n o s i s:** *Hallopora* with ramose colonies; transition from endo- to exozone of colonies relatively sharp; width of exozone represents 20–30% of branch width; zooecial openings rounded or oval; zooecial walls in endozone thin, slightly curved, in exozone thickened; diaphragms in endo- and exozone developed irregularly; mesozooecia quite abundant and large with frequent straight diaphragms.

**Description.** — Colonies ramose, length of fragments 10–20 mm, diameter 2–5 mm. Exozone of colonies quite wide, comprising 20–30% of the width of a branch. Zooecia in endozone oriented vertically, then sharply bent and opens at the surface at an angle of 80–90°. Zooecial openings rounded or oval; diameter between maculae 0.19–0.34 mm (usually 0.24–0.30 mm), at maculae 0.30–0.47 mm. Five to seven openings per 2 mm along longitudinal axes, in perpendicular direc-

tion 6–7 openings. Zooecial walls in endozone thin, slightly curved. In exozone thickness of zooecial walls increases to 0.10–0.17 mm and walls display well-expressed slanting-lamellar microstructure with well-developed dark central zone. Diaphragms in endozone usually absent (but locally quite abundant), in exozone always 1–5 (usually 3–4) straight or curved diaphragms. Mesozooecia quite numerous, two or three around each zooecia, developed with base of endozone. Diameter of mesozooecia varies from 0.05 to 0.34 mm, usually 0.07–0.15 mm. About colony surfaces mesozooecial chambers overgrown by a carbonate substance. Diaphragms in mesozooecial chambers straight, frequent, distance between them 0.03–0.11 mm.

**Remarks.** — These specimens have been earlier erroneously described (Pushkin, 1987a) as *H. onealli* (James, 1875) and *H. ovata* (Mc Kinney, 1971) (see synonymy). An examination of these specimens with the addition of a new extensive material (especially from the Kibartaji 14 borehole) has shown that this species belongs to the new species (*H. mckinneyi*) widespread in the Middle Ordovician (Idavere-Oandu regional stages) of the East European Platform. *H. mckinneyi*, sp. nov. differs from *H. onealli* (James, 1875) from the Upper Ordovician (Cincinnatian) of the North American Platform (Nicholson, 1881; Bassler, 1906; Cumings, 1908; non Ross, 1969) in having a wider exozone of colonies, larger mesozooecia and more rare diaphragms in zooecial chambers in exozone; from *H. ovata* (Mc Kinney, 1971) from Chicamauga Group (Trenton) of Alabama State USA it differs in displaying larger zooecia and sharply bent zooecial chambers in the transition from endo- to exozone.

**Occurrence.** — Caradoc, Idavere-Oandu regional stages. Belarus, Podlasie-Brest Depression (Vidomlya-Lystchitsy formations), boreholes: Vysokoe 1, depth 820 m (1 specimen); Novoselki 29, depth 892.5–901.5 m (17); Vitebsk region, Vidzy, depth 331.2 m (1). Latvia, Vishki 25 borehole, depth 552.3–570.0 m (7). Lithuania, Kibartaji 14 borehole, depth 1213.2–1230.5 m (more than 70).

Genus *Diazipora* Vinassa, 1920  
*Diazipora milleporacea* (Bassler, 1911)  
(Fig. 7f–j)

1911 *Mesotrypa milleporacea* Bassler, p. 201, text-fig. 109.

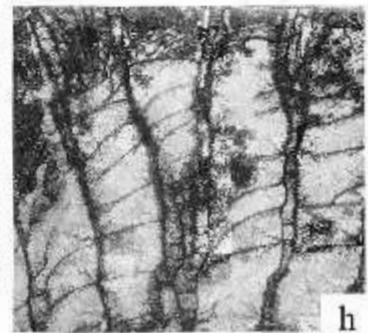
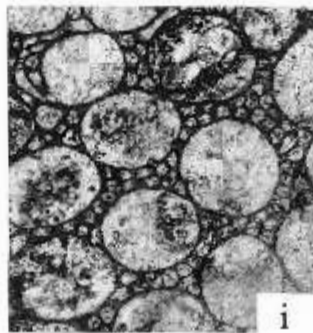
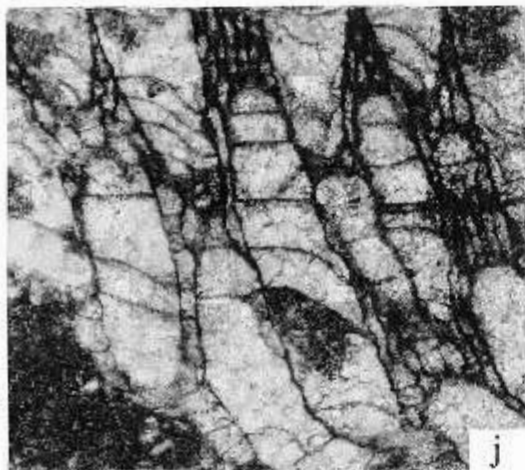
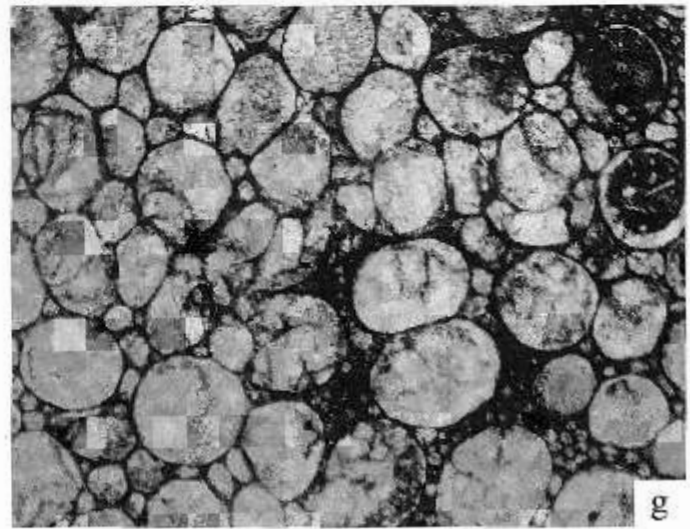
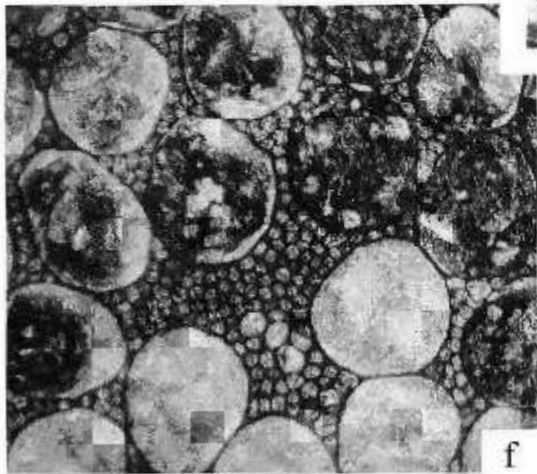
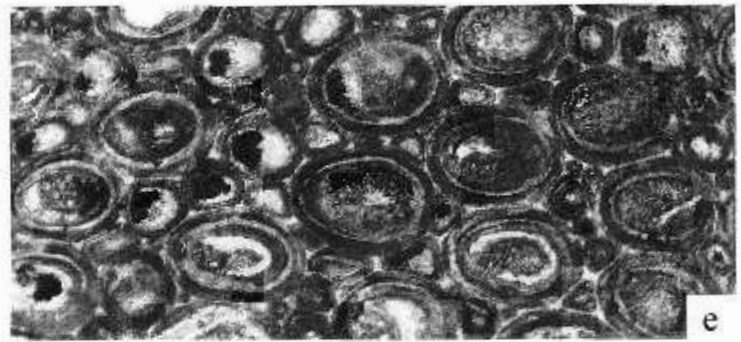
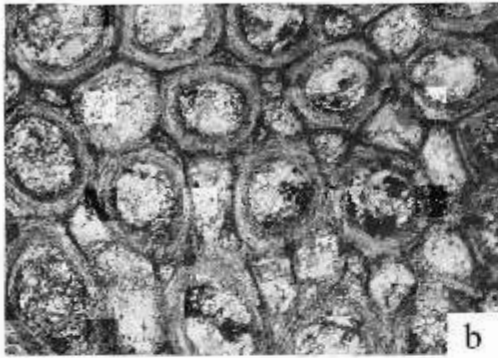
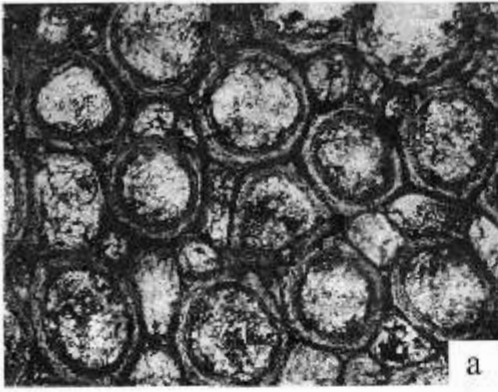
1911 *Mesotrypa milleporacea parva* Bassler, p. 203, text-fig. 110.

1970 *Diazipora milleporacea* Nekhorosheva, p. 78, pl. III, fig. 1, text-fig. 5.

**H o l o t y p e:** No. 57284, United States National Museum, Caradoc, *Chasmops* limestones, Sweden, Island of Oeland, south of Bodahamm.

Fig. 7. **a–e** — *Hallopora mckinneyi* sp. nov.: **a–d** — BelNIGRI, holotype 12/8-48, Caradoc, Kejla-Oandu regional stages, Lystchitsy Formation, Belarus, Brest region, Vysokoe 1 borehole, depth 820 m: **a, b** — tangential sections showing general arrangement of zooecial and mesozooecial openings and structure of wall, x 40; **c, d** — longitudinal sections showing general structure of zooecial and mesozooecial chambers and disposition of diaphragms, x 20; **e** — BelNIGRI, 12/51-82, Caradoc, Oandu Regional Stage, Lithuania, Kibartaji 14 borehole, depth 1213.2 m. **f–j** — *Diazipora milleporacea* (Bassler, 1911): **f–h** — BelNIGRI, 12/59-15, Llanvirn, Kukruse Regional Stage, Lesovchitsy Formation, Belarus, Brest region, Pribugskaya 17 borehole, depth 824 m: **f** — tangential section showing arrangement of zooecial and mesozooecial outlines at maculae area, x 40; **g** — the same section showing arrangement of zooecial and mesozooecial openings at intermaculae area; **h** — longitudinal section showing of the distribution of diaphragms in the zooecial chambers, x 40; **i, j** — BelNIGRI, 12/1-67, age the same, Vysokoe 1 borehole, depth 843 m; **i** — tangential section, x 40; **j** — longitudinal section, x 40





**Description.** — Colonies irregularly-massive, frequently nodular, locally hollow or lamellar. Size 5 mm to 3 cm. Zooeccial openings rounded (locally irregularly-rounded), diameter 0.25–0.41 mm, around maculae 0.41–0.65 mm. Maculae rare, composed of accumulations of neozooecia, surrounded by large zooecia, size of maculae 0.7–1.5 mm. Approximately 5–6 zoeeccial openings per 2 mm in intermacular spaces. Walls of zooecia thin, homogenous, thickness 0.010–0.015 mm. Diaphragms in zoeeccial chambers are usually numerous, commonly curved (Fig. 7h, j) (especially frequent on new colony surface), average distance between diaphragms 0.02–0.40 mm. In some colonies (or their parts) diaphragms may be completely (or almost completely) absent, but usually are numerous. Neozooecia very numerous, usually compose small accumulations in the corners between zooecia, but as a rule are not isolated from zoeeccial openings. In maculae neozooecia form larger accumulations (Fig. 7f). Diameter of neozooecia 0.03–0.27 mm, commonly 0.05–0.10 mm. Diaphragms in neozooecia usually absent, but locally very thin horizontal diaphragms, moniliformly curved of neozooecial walls, are developed (Fig. 7h, j). Distance between diaphragms 0.03–0.10 mm. Locally in the corners of the intersections of the zooecia and mesozooecia walls rare, very small (0.01–0.02 mm) polymorphic style-like structures are developed, but in most specimens these are absent.

**Occurrence.** — Widespread species in Llanvirn-Caradoc, Uhaku-Kejla regional stages of the East European Platform. Middle Ordovician, Yugor Regional Stage of North Ural (Paj-Khoj). In the Podlasie-Brest Depression founded in the following (Dolbnev-Vidomya formations) boreholes: Kustinskaya 1-op, depth 907.5–914.3 m (6 specimens); Vysokoe 1, depth 843.5 m (1); Novoselki 29, depth 896.1–921.0 m (11); Pribugskaya 17, depth 812.4–829.0 m (4).

Family **Mesotrypidae** Astrova, 1965  
Genus *Mesotrypa* Ulrich, 1893  
*Mesotrypa bystrowi* Modzalevskaya, 1953  
(Fig. 8a–h)

1829 *Orbitulites hemisphaericus* Eichwald, p. 179.

1856 *Chaetetes (Orbitulites) hemisphaericus* Eichwald, p. 91.

1860 *Chaetetes hemisphaericus* (pars) Eichwald, p. 476.

1861 *Chaetetes hemisphaericus* Eichwald, p. 112.

1953 *Mesotrypa bystrowi* Modzalevskaya, p. 114, pl. II, figs. 1, 2; text-fig. 5.

1953 *Mesotrypa bystrowi* var. *tuberculata* Modzalevskaya, p. 116, pl. II, figs. 3, 4; text-fig. 6.

1953 *Mesotrypa piriformis* Modzalevskaya, p. 118, pl. II, figs. 5, 6; text-fig. 7.

1961 *Mesotrypa excentrica* (pars) Myannil, p. 129, pl. I, fig. 7, 8; pl. VII, fig. 3; pl. VIII, figs. 1, 7.

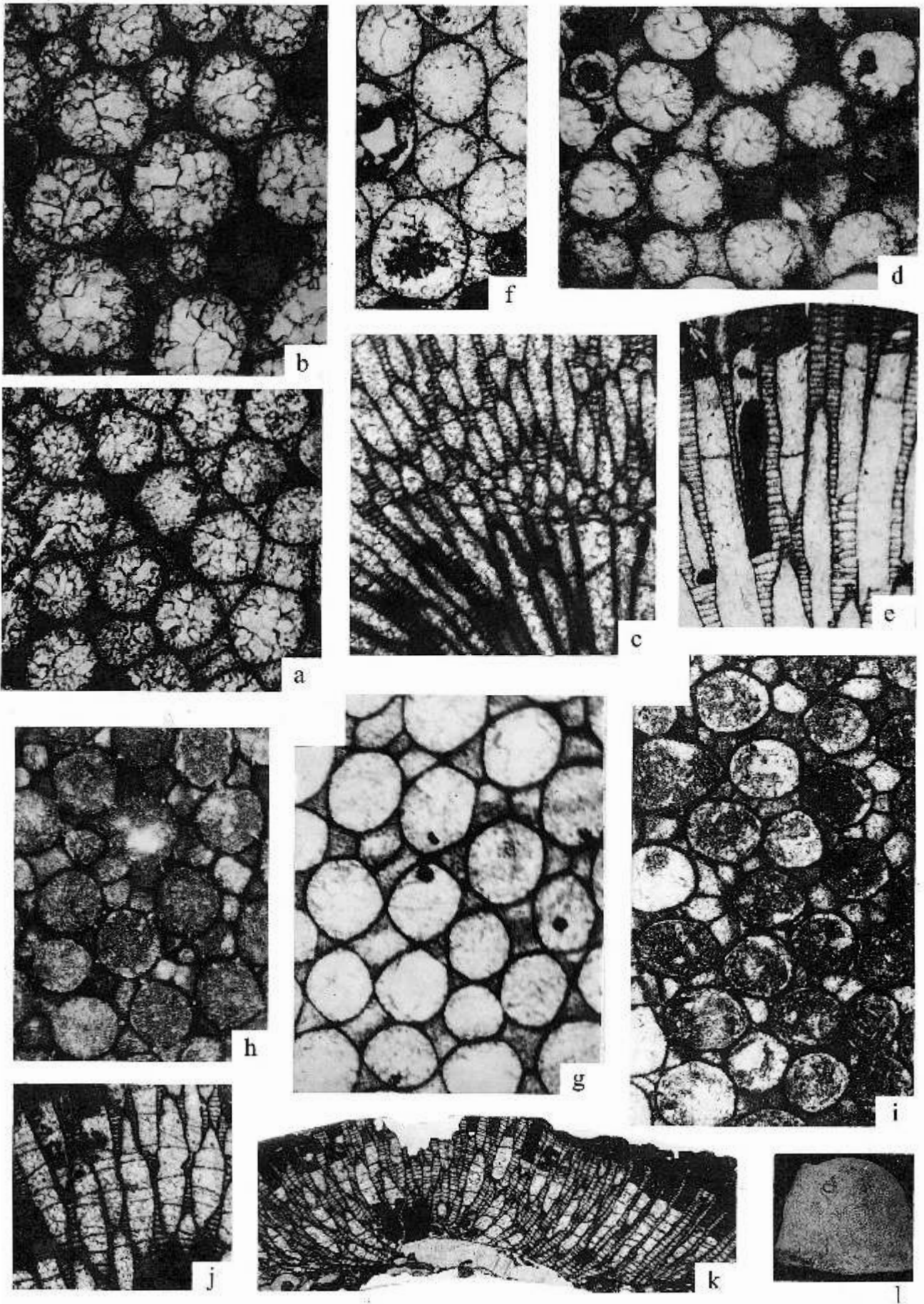
**Holotype:** No 392, Department of Paleontology, Geological Faculty of the University of St. Petersburg, Caradoc, Jykhvi Regional Stage, Estonia, Aluvere quarry.

**Diagnosis:** *Mesotrypa* with massive, generally hemispherical colonies; base of colonies cellular; zoeeccial openings commonly rounded, always in contact with each other; diaphragms in zoeeccial chambers developed very irregularly, straight or curved; mesozooecia with triangular-quadrangular openings, quite numerous, but not isolated zoeeccial openings; styles small, short, developed only near colony surface.

**Description.** — Colonies massive, generally hemispherical, rarely irregularly massive or nodular. Average diameter of hemispherical colonies 10–20 mm, height 5–10 mm. Maximum size of colonies 4–5 cm. Cellular bases of colonies form mesozooecia (or ? mesozooecia-like structures), flat, frequently with concentric wrinkles. Colony surface smooth or with elevated maculae. Zoeeccial openings rounded or slightly rounded-polygonal, always in contact with each other; diameter of openings between maculae 0.25–0.40 mm, on average 0.30–0.32 mm. Zoeeccial diameter in maculae 0.4–0.5 mm, on average 0.45 mm. In intermacular spaces 5–6 openings per 2 mm, in maculae about 4. Zoeeccial walls thin as endo- and exozone. Diaphragms in some zoeeccial chambers (or their parts) almost completely absent, in others are numerous. Usually diaphragms straight or slightly curved (rare cystiphragm-like), mean distance between them 0.3–0.8 mm. Locally at peripheral parts of colonies diaphragms strongly curved and very frequent; in this case distance between diaphragms is 0.1–0.4 mm. Mesozooecia quite numerous (but never isolated from zoeeccial openings), with triangular-quadrangular openings, diameter 0.07–0.23 mm. Diaphragms in mesozooecial chambers common, straight, separated by 0.10–0.15 mm. Styles small, short, with thin walls, developed only at colony surfaces; diameter styles about 0.02–0.03 mm.

**Remarks.** — Modzalevskaya (1953) described from the Llanvirn-Caradoc regional stages (C<sub>1</sub>–D<sub>II</sub>) 7 species and subspecies of *Mesotrypa* from the Baltic-Ladoga Glint (Leningrad region of Russia and Estonia). All species described have massive (generally hemispherical) colonies and are numerous in these rocks. Myannil (1959a, b; 1961) proposed that *M. excentrica*, *M. bystrowi*, *M. bystrowi*

Fig. 8. a–h — *Mesotrypa bystrowi* Modzalevskaya, 1953: a–c — BelNIGRI, 12/5-50, Llanvirn, Uhaku Regional Stage, Lesovchitsy Formation, Belarus, Brest region, Zhabinka 3 borehole, depth 583 m; a, b — tangential sections showing general arrangement of zoeeccial and mesozooecial openings, x 40; a — intermacular arrangement; b — maculae; c — longitudinal section showing general arrangement of zoeeccial and mesozooecial chambers, x 10; d, e — BelNIGRI, 12/11-219, Llanvirn, Uhaku Regional Stage, Lesovchitsy Formation, Belarus, Brest region, Lesovchitsy 25 borehole, depth 815 m; d — tangential section showing general arrangement of zoeeccial and mesozooecial openings, x 40; e — longitudinal section, x 20; f — BelNIGRI, 12/59-36, Caradoc, Jykhvi Regional Stage, Vidomya Formation, Belarus, Brest region, Pribugskaya 17 borehole, depth 814 m, tangential section, x 40; g — BelNIGRI, 12/1-130, Llanvirn, Uhaku Regional Stage, Lesovchitsy Formation, Belarus, Brest region, Kustinskaya 1-op borehole, depth 907.5 m, tangential section showing general arrangement of zoeeccial and mesozooecial openings, x 40; h — BelNIGRI, 12/59-43, Caradoc, Kejla Regional Stage, Lystchitsy Formation, Belarus, Brest region, Pribugskaya 17 borehole, depth 809.9 m, tangential section showing general arrangement of zoeeccial and mesozooecial openings, x 40; i–l — *Mesotrypa excentrica* Modzalevskaya, 1953: i, j — BelNIGRI, 12/1-91, Llanvirn, Uhaku Regional Stage, Lesovchitsy Formation, Belarus, Brest region, Kustinskaya 1-op borehole, depth 911.2 m; i — tangential section showing general arrangement of zoeeccial and mesozooecial openings, x 40; j — longitudinal section showing general arrangement of zoeeccial and mesozooecial openings, x 20; k — BelNIGRI, 12/1-93, location and age the same, longitudinal section, x 6.2; l — BelNIGRI, 12/1-157, Middle Ordovician, Russia, Leningrad region, Popovo (collection of E. Eichwald, No. 1/157), colonies, lateral view, natural size



*tuberculata* and *M. piriformis* (Myannil, 1959b, p. 264–271) can all be considered as *Mesotrypa excentrica* Modzalevskaya, 1953 (according to the rule of “page priority”). This name (*Mesotrypa excentrica* Modzalevskaya, 1953) has been used in numerous publications (Myannil, 1959 a, b, 1961; Pushkin, 1973, 1975, 1976, 1977, 1978, 1981, 1986, 1987a, b, c, 2001 and others). Our examination of a large collection of tangential and longitudinal sections of *Mesotrypa* from Regional stages C<sub>I</sub>–D<sub>II</sub> of the East European Platform has shown that two different, but related species (*M. bystrowi* Modzalevskaya, 1953 and *M. excentrica* Modzalevskaya, 1953) are present in these deposits, but *M. bystrowi* (non *M. excentrica*) predominates. Present observations thus agree with Modzalevskaya’s data (Modzalevskaya, 1953, p.112–115). Presumably *M. bystrowi* was considerably more widespread in the Regional Stages C<sub>I</sub>–D<sub>II</sub> in the East European Platform than *M. excentrica* (by an order of magnitude). *Mesotrypa bystrowi* Modzalevskaya, 1953 differs from *M. excentrica* Modzalevskaya, 1953 in having mainly rounded zooecial openings in contact with each other (*M. excentrica* has mainly polygonal zooecial openings, which are frequently separated from each other by mesozooecia). In addition, *M. bystrowi* is characterised by originally triangular or quadrangular mesozooecial openings while *M. excentrica* has polygonal (four- or five sided) mesozooecial openings. Our examination of Early Paleozoic bryozoa from Eichwald’s collection (i.e. Pushkin and Gataulina, 1992) has shown that *Orbitulites hemisphaericus* Eichwald, 1829 from Pulkovo (see synonymy) is the species *Mesotrypa bystrowi* Modzalevskaya, 1953. The restudy also assigned the species *Mesotrypa pyriformis* (Eichwald, 1829) (Modzalevskaya erroneously named this species as *Mesotrypa piriformis* (Eichwald, 1853)) to *M. excentrica* (see below).

**O c c u r r e n c e .** — Llanvirn-Caradoc, Azeri-Kejla regional stages (C<sub>Ia</sub>–D<sub>II</sub>) of the East European Platform. Exceptionally widespread species (Modzalevskaya, 1953; Pushkin, 1973, 1975, 1978, 1981, 1986, 2001). In the Podlasie-Brest Depression found (Dolbnev-Lystchitsy formations) in the following boreholes: Kustinskaya 1-op, depth 907.5–915.2 m (96 specimens); Turna 5, depth 743.5–747.0 m (5), Zhabinka 3, depth 583 m (2); Ratajchitsy 12, depth 956–968 m (2); Vysokoe 1, depth 820.0–836.9 m (5); Morozovichi 16, depth 890.5 m (1); Borstchovo 10, depth

953.2 m (1); Lesovchitsy 25, depth 801.2–815.0 m (17); Deshevichi 27, depth 635.1–642.2 m (16); Orlya 28, depth 1100.5 m (1).

*Mesotrypa excentrica* Modzalevskaya, 1953  
(Figs. 8i–l and 9a–c)

- 1829 *Chaetetes pyriformis* Eichwald, p. 181, pl. 2, fig. 2 (non fig. 1).  
1860 *Chaetetes pyriformis* Eichwald, p. 478.  
1861 *Chaetetes pyriformis* Eichwald, p. 112.  
1877 *Callopora piriformis* Dybowski, s. 117, pl. IV, figs. 6, 6b.  
1911 *Callopora piriformis* Bassler, 1911, p. 343, pl. V, figs. 6, 6b.  
1953 *Mesotrypa excentrica* Modzalevskaya, p. 112, pl. IV, figs. 1, 2; text-fig. 4.  
1953 *Mesotrypa pyriformis* Modzalevskaya, p. 118, pl. II, figs. 5, 6; text-fig. 7.

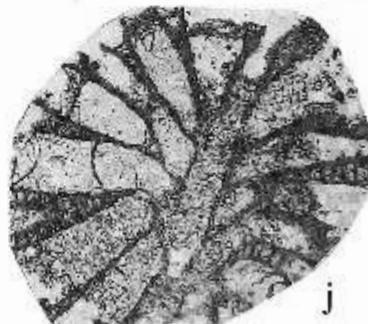
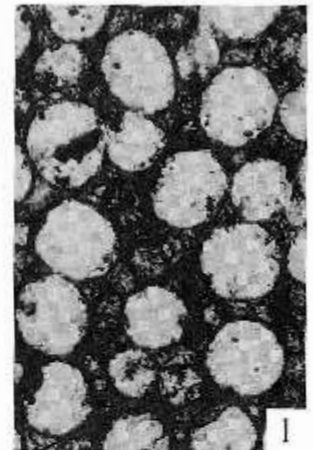
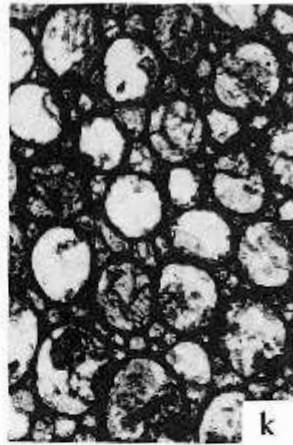
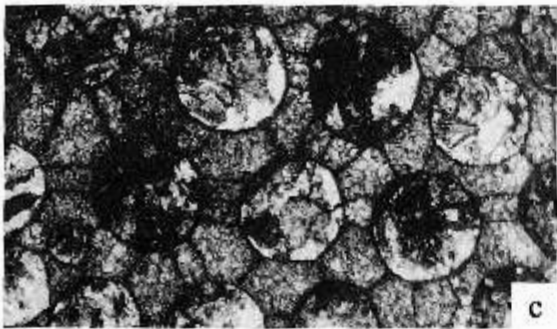
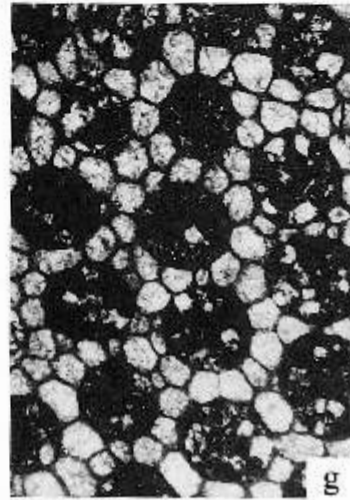
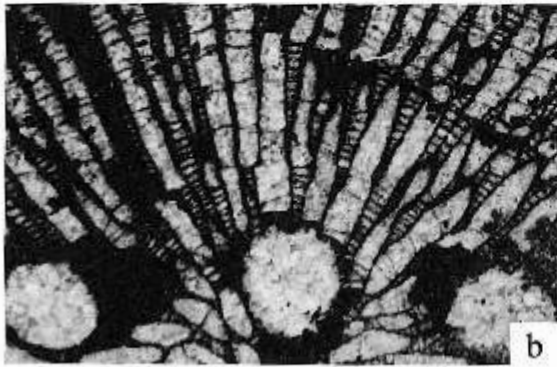
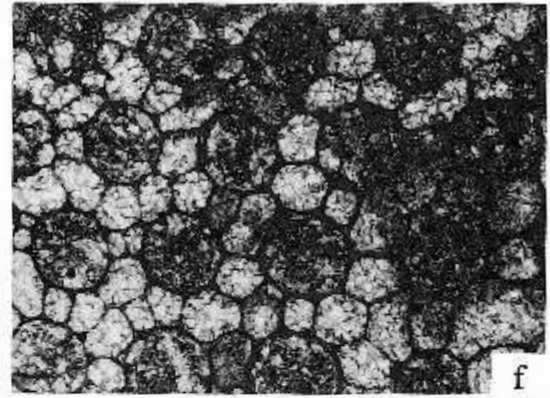
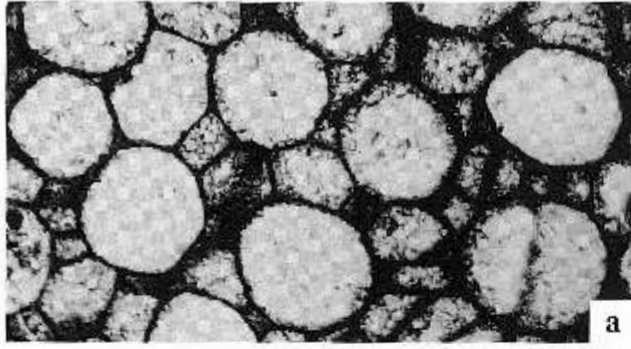
**H o l o t y p e :** No. 731, Department of Paleontology, Geological Faculty of the University of St. Petersburg, Estonia, Aluvere quarry, Caradoc, Idavere Regional Stage.

**D i a g n o s i s :** *Mesotrypa* with hemispherical or nodular colonies; zooecial openings polygonal or rounded-polygonal, frequently separated by a row of mesozooecia; diaphragms in zooecial chambers irregularly developed; mesozooecia numerous, with polygonal (4–5-cornered) openings; styles small, short, developed only at colony surfaces.

**D e s c r i p t i o n .** — Colonies massive, hemispherical or depressed (pastiliform), locally nodular (Dybowski, 1877, pl. IV, fig. 6; Bassler, 1911, pl. V, fig. 6). Surface of colonies smooth. Zooecial openings polygonal or rounded-polygonal, frequently separated by a row of mesozooecia. Zooecial diameter 0.30–0.45 mm; maculae not observed. Approximately 5 zooecial openings per 2 mm. Zooecial walls thin, straight or slightly curved in endo- and exozone. Diaphragms irregularly developed: in some zooecial chambers (or their parts) almost completely absent, in others numerous. Diaphragms usually horizontal or oblique (but not cystiphragm-like), mean distance between them 0.2–0.6 mm. Mesozooecia abundant with polygonal openings, commonly quadrangular-pentagonal in outline, diameter 0.08–0.17 mm. Diaphragms straight, abundant, distance between them 0.10–0.17 mm. Styles small, short, developed only at colony surfaces. Diameter of styles 0.015–0.025 mm.

**R e m a r k s .** — A comparison with *M. bystrowi* Modzalevskaya, 1953, is given in the description of that species. Our restudy of Early Palaeozoic bryozoa from Eichwald’s collection has shown that species *Chaetetes pyriformis* Eichwald, 1829

Fig. 9. a–c — *Mesotrypa excentrica* Modzalevskaya, 1953: a — BelNIGRI, 12/13-62a, Caradoc, Kejla Regional Stage, Vidomlya Formation, Belarus, Brest region, Novoselki 29 borehole, depth 903.2 m, tangential section showing polygonal zooecial and mesozooecial openings, x 40; b — BelNIGRI, 12/13-129, Llanvirn, Uhaku Regional Stage, Lesovchitsy Formation, Novoselki 29 borehole, depth 920.5 m, longitudinal section showing general arrangement of zooecial and mesozooecial chambers and the cavities (3) of a commensal worm, x 10; c — BelNIGRI, 12/10-10, Llanvirn, Uhaku Regional Stage, Lesovchitsy Formation, Belarus, Brest region, Deshevichi 27 borehole, depth 635.5 m, tangential section showing general arrangement of zooecial and mesozooecial (polygonal) openings, x 40. d–g — *Mesotrypa mesoporica* (Pushkin, 1976): d, e — BelNIGRI, 12/13-227, Caradoc, Idavere Regional Stage, Vidomlya Formation, Belarus, Brest region, Novoselki 29 borehole, depth 906.4 m; d — tangential section showing general arrangement of zooecial and mesozooecial openings, x 40; e — longitudinal section, x 15; f — BelNIGRI, 12/59-8, Llanvirn, Kukruse Regional Stage, Lesovchitsy Formation, Belarus, Brest region, Pribugskaya 17 borehole, depth 825 m, tangential section showing general arrangement of zooecial and mesozooecial openings, x 40; g — BelNIGRI, 12/8-55, Llanvirn, Azeri-Lasnamyagi regional stages, Dolbnev Formation, Belarus, Brest region, Vysokoe 1 borehole, depth 843 m, the same, x 40. h–l — *Mesotrypa gutta* Pushkin, 1987: h–j — BelNIGRI, 12/13-273, Caradoc, Kejla Regional Stage, Lystchitsy Formation, Belarus, Brest region, Novoselki 29 borehole, depth 893.5 m; h, i — tangential sections, x 64; j — longitudinal section, x 40; k — BelNIGRI, 12/13-258, Caradoc, Jykhvi Regional Stage, Vidomlya Formation, Belarus, Brest region, Novoselki 29 borehole, depth 901 m, tangential section showing general arrangement of zooecial and mesozooecial openings, x 40; l — BelNIGRI, 12/13-62; Caradoc, Jykhvi Regional Stage, Vidomlya Formation, Belarus, Brest region, Novoselki 29 borehole, depth 903.2 m, tangential section showing general arrangement of zooecial and mesozooecial openings, x 40



(specimens 1/157; 1/163 from Eichwald's collection) from Pulkovo belongs to the species *Mesotrypa excentrica* Modzalevskaya, 1953. Later this form (*pyriformis* non *piriformis*) was redescribed by Eichwald (1860, 1861), Dybowski (1877), Bassler (1911) and Modzalevskaya (1953) (see synonymy).

**O c c u r r e n c e .** — Llanvirn-Caradoc, Azeri-Kejla regional stages (C<sub>1a</sub>-D<sub>II</sub>) of the East European Platform. Widely ranging species. In the Podlasie-Brest Depression found in the Dolbnev-Lystchitsy formations in the following boreholes: Ratajchitsy 12, depth 958 m (1 specimen); Turna 5, depth 740–746 m (2); Deshevichi 27, depth 635.5 m (1); Pribugskaya 13, depth 730.2–732.6 m (3); Orlya 28, depth 1091.5–1101.0 m (6); Kustinskaya 1op., depth 911.2 m (3); Novoselki 29, depth 903.2 m (1). In addition this species was found in the Vitebsk region of Belarus, Lithuania, Latvia and Russia in boreholes and outcrops: Vidzy, depth 326.0–340.7 m (4); Vangishki 205, depth 434.3–449.1 m (3); Ilgaji 54, depth 414.0 m (6); Tauchenis 49, depth 434.9–440.0 m (3); Vilkavishkis 129, depth 949–960.7 m (15); Vishki 25, depth 546.5–579.5 m (8); Ludza 15, depth 600–611.5 m (4); Serebryaniki, depth 1091–1096 m (25); Popovo (1).

*Mesotrypa mesoporica* (Pushkin, 1976)  
(Fig. 9d–g)

1976 *Diplotrypa mesoporica* Pushkin, p. 28, pl. X, fig. 3.

**H o l o t y p e :** No. 12/8-55, BelNIGRI, Belarus, Brest region, Vysokoe I borehole, depth 843 m, Llanvirn, Azeri-Lasnamyagi regional stages, Dolbnev Formation.

**D i a g n o s i s :** *Mesotrypa* with lamellar or hemispherical colonies; zoecial openings rounded-polygonal, usually isolated from each other by mesozooecia; maculae absent from larger zooecia; diaphragms in zoecial chambers irregularly developed; mesozooecia very numerous, form 1–2 rows between zooecia; styles very small, indistinct, numerous: 6–12 styles about each zoecial opening.

**D e s c r i p t i o n .** — Colonies lamellar or hemispherical, rarely nodular. Bases of colonies with basal epitheca. Diameter of large hemispherical colonies 18–22 mm, height to 6–14 mm. Thickness of lamellar colonies 0.6–5.0 mm. Surface of colonies smooth. Zoecial openings rounded-polygonal usually isolated from each other by mesozooecia. Diameter of openings 0.21–0.38 mm. Maculae comprising of larger zooecia absent, but small accumulations of mesozooecia are occasionally observed. These accumulations (size 0.4–0.6 mm) are surrounded by smaller (!) than usual zoecial openings (diameter 0.14–0.20 mm). Usually 4.5–5.5 zoecial openings per 2 mm. Zoecial walls straight, locally slightly waved or curved, thickness in all parts of colonies 0.015–0.025 mm. Diaphragms irregularly developed: in some zoecial chambers almost completely absent, in others, the distance between diaphragms is 0.08–0.80 mm. Mesozooecia very numerous, always completely (or almost completely) separated from zoecial openings. Diaphragms in mesozooecial chambers numerous, horizontal, distance between them 0.03–0.14 mm. Styles very small (0.005–0.015 mm), numerous, indistinct, placed at intersec-

tions of the zoecial and mesozooecial walls. 6–12 styles around each zoecial opening.

**R e m a r k s .** — *Mesotrypa mesoporica* (Pushkin, 1976) differs from all known species of *Mesotrypa* by the very numerous mesozooecia, formed between zooecia 1–2 rows and very small, numerous, indistinct styles.

**O c c u r r e n c e .** — Llanvirn-Caradoc, Lasnamyagi-Idavere regional stages of Belarus (Podlasie-Brest Depression, Dolbnev-Vidomlya formations) and Lithuania. Boreholes: Kustinskaya 1-op, depth 909.9–913.2 m (5 specimens); Brest 9, depth 745 m (1); Vysokoe 1, depth 831–843 m (2); Borstchovo 10, depth 942.5–945.0 m (2); Lesovchitsy 25, depth 813 m (1); Novoselki 29, depth 904–913 m (8); Pribugskaya 17, depth 819.4–825.0 m (3); Ilgaji 54, depth 412.5 m (1); Kibartaji 14, depth 1236 m (1).

*Mesotrypa gutta* Pushkin, 1987  
(Fig. 8h–l)

1987a *Mesotrypa gutta* Pushkin, p. 155, pl. IX, fig. 4; pl. X, fig. 1.

**H o l o t y p e :** No. 12/13-273, BelNIGRI, Belarus, Brest region, Novoselki 29 borehole, depth 893.5 m, Caradoc, Kejla Regional Stage, Lystchitsy Formation.

**D i a g n o s i s :** *Mesotrypa* with small, nodular, sometimes hollow colonies; zoecial openings rounded or oval, contacting with each other; diaphragms in zoecial chambers usually absent; mesozooecia quite numerous, small, polygonal in outline; styles very small, indistinct, 1–5 styles around each zoecial opening.

**D e s c r i p t i o n .** — Colonies small, nodular, diameter 1–5 mm, locally hollow. Zoecial openings rounded or oval, zoecial walls always in contact with each other, diameter 0.17–0.34 mm. Maculae not observed. Approximately 8 zoecial openings per 2 mm. Zoecial walls straight, thin (thickness 0.010–0.015 mm). Diaphragms in zoecial chambers usually absent or single, straight or curved. Mesozooecia quite numerous but zoecial openings not isolated. Usually 2–4 mesozooecia per each zooecia. Diameter of polygonal mesozooecial openings 0.03–0.13 mm. Diaphragms in mesozooecial chambers straight, distance between them 0.03–0.1 mm. Walls of mesozooecia straight (not moniliform). Styles very small (0.01 mm), indistinct, developed only around colonial surface. 1–5 styles around each zoecial opening.

**R e m a r k s .** — *Mesotrypa gutta* Pushkin, 1987 differs from *M. strumaeformis* Pushkin, 1987 from the Oandu and Rakvere regional stages of the Baltic Province in having smaller zoecial openings (per 2 mm 8 against 5–6 openings in *M. strumaeformis*) and in the absence of moniliform walls of mesozooecia.

**O c c u r r e n c e .** — Caradoc, Idavere-Kejla regional stages of Belarus (Podlasie-Brest Depression, Lystchitsy-Vidomlya formations) and Latvia. Boreholes: Novoselki 29, depth 893.5–903.2 m (7 specimens); Pribugskaya 13, depth 844.7–847.5 m (3); Vangishki 205, depth 430.3–439.8 m (3); Ludza 15, depth 597.5 m (2).

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The results of these bryozoa investigations in the Belarus part of the Podlasie-Brest Depression support the hypothesis that during the Llanvirn and Caradoc this area represented an independent biogeographical region of the western part of the Baltic Provinces (= the Baltic Basin). The deposits of this biogeographical region are considered as an independent Brest-Volyn confacies (Pushkin, 1998, p. 50). In the west (Poland) this confacies grades into the Central-Baltic and Skanian confacies (Modli ski, 1973; Jaanusson, 1976; Modli ski and Szyma ski, 2001), which is considered as deeper-water. In the Brest-Volyn confacies a shallow-water benthos (bryozoans, brachiopods, crinoids, mollusks, sometimes trilobites) is predominant, while in the Central-Baltic confacies trilobites and graptolites are much more important. The taxonomic composition of bryozoa from Brest-Volyn confacies differs from the "classic" Baltic one by the presence of relatively numerous endemic "Podlasie-Brest" elements (see "Introduction" in this paper).

## CONCLUSIONS

1. This is the first monographic study of the Ordovician bryozoa of the orders Cystoporida and Trepostomida from the Belarussian part of the Podlasie-Brest Depression.

2. 23 bryozoa species (4 new species, one new family) are described from the Belarussian part of the Podlasie-Brest Depression.

3. On the whole the taxonomic composition of the bryozoa studied is similar to that of the Baltic-Ladoga Glint and other parts of the Baltic Provinces, but it is characterised by several peculiar endemic "Podlasie-Brest" elements.

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