Middle Jurassic cyclostome bryozoans from the Polish Jura

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New collections of bryozoans from the Middle Jurassic (Late Bajocian and Bathonian) of Poland add significantly to our knowledge of the diversity and biogeography of the Cyclostomata at a time when they were the dominant bryozoan order in the fossil record. A total of 16 species and one form-genus ("Berenicea") are present. Most are encrusters, predominantly on hiatus concretions. A single erect species was found in deposits interpreted as regurgitates of a marine vertebrate. The following new species are described: Microeciella annae sp. nov., M. kuklinskii sp. nov., M. maleckii sp. nov., M. mokrskoensis sp. nov., M. magnopora sp. nov., Reptomultisparsa harae sp. nov., and Hyporosopora bugajensis sp. nov. The taxonomic importance of the morphology of both the gonozooids and pseudopores is underlined, especially for encrusting species of the "Berenicea" type that are otherwise difficult to distinguish from one another. The described bryozoan assemblage encrusting hiatus concretions from the Polish Middle Jurassic is the richest that has been documented globally from this kind of substrate.

Key words: Bryozoa, Cyclostomata, Middle Jurassic, Bajocian, Bathonian, Poland.

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Introduction

Cyclostomes are the only extant order of the bryozoan class Stenolaemata. The Jurassic period was a crucial time in cyclostome evolution, witnessing their radiation and brief domination prior to the appearance of the order Cheilostomata which prevail in Late Cretaceous–Recent bryozoan faunas. The first significant evolutionary radiation of cyclostomes occurred in the Middle Jurassic (Taylor and Larwood 1990; Jablonski et al. 1997), the order peaking at an estimated 77 species and 29 genera in the Bathonian (Taylor and Ernst 2008). Our knowledge of the Middle Jurassic radiation of cyclostomes is geographically constrained, as the data available is based essentially on studies of French, German, English and to a lesser extent Russian (Viskova 2006, 2007, 2008) and North American (Cuffey and Ehleiter 1984; Taylor and Wilson 1999) material. Maximum species richness documented for the Middle Jurassic occurs in the Bathonian Caillasse de la Basse Ecarde at St Aubin-sur-Mer, Normandy from where 33 species have been recorded within sponge reef and hardground settings (Walter 1970; Palmer and Fürsich 1981; Taylor and Ernst 2008). The rich Normandy, bryozoan fauna may serve as a reference point for evaluating other Jurassic localities.

Jurassic bryozoans have been neglected compared to older and younger representatives of the phylum (Taylor and Ernst 2008). The causes are twofold. Firstly, Jurassic bryozoans mainly consist of cyclostomes, the taxonomy of which relies on a few skeletal features only. Currently, critical characters, at least for genus-level taxonomy, are larval brooding polymorphs called gonozooids. However, gonozooids are lacking in many colonies, probably due to some unknown environmental factors (McKinney and Taylor 1997). Secondly, cyclostome distribution in the Jurassic is very patchy geographically, and most species consist of small-sized, encrusting colonies that may be easily overlooked (Taylor and Ernst 2008).

Studies of Jurassic bryozoans from Poland are very limited. Middle Jurassic bryozoans were first described by Reuss (1867) from the uppermost Bathonian–lowermost Callovian condensed deposits of the classic locality at Balin in southern Poland. This collection has been recently revised by Taylor (2009) who established the presence of 23 species. Rehbinder (1914), during stratigraphical work on the Bajocian–Bathonian deposits of the Polish Jura area, listed some cyclostomes which he assigned to such genera as Berenicea, Diastopora and Stomatopora. However, as his work is not illustrated, it is impossible to confirm his identifications. Cyclostomes referred to as Berenicea parvitubulata Gregory, 1896 and Stomatopora dichotoma (Lamouroux, 1821) were described by Pugaczewska (1970) from the Kimmeridgian of Wierzbia and Sobków, and the Tithonian of Brzostówka in central Poland. More recently, Upper Jurassic bryozoans have been investigated by Hara and Taylor (1996) from the Oxfordian of
Bałtów, and by Hara and Taylor (in press) from the Kimmeridgian of Małogoszcz and Wierzbica, central Poland. In addition, Zatoń et al. (2006) and Hara (2007) summarized the generic diversity of the Polish Bajocian–Bathonian and Callovian–Oxfordian bryozoans, respectively.

Here we describe some newly-collected Middle Jurassic cyclostome bryozoans from the Polish Jura (south-central Poland). These Bajocian–Bathonian bryozoans include several new species, adding significantly to our knowledge of bryozoan diversity during the Jurassic in the eastern part of the Mid-European epicontinental Basin. Pseudopore morphology, as visible using SEM, is shown to be valuable in discriminating between species of otherwise very similar morphology.

Institutional abbreviation.—GIUS, Department of Palaeontology, Faculty of Earth Sciences, University of Silesia, Poland; NHM, Natural History Museum, London, UK.

Other abbreviations.—AD, aperture diameter (in ceriopores); FWL, frontal wall length (of autozooids); FWW, autozooid frontal wall width; GDL, gonozooid dilated length (i.e., length of the brood chamber); GTL, gonozooid total length; GW, gonozooid width; IWT, interzooidal wall thickness; LAM, longitudinal apertural measurement (of autozooids); LPM, longitudinal peristome measurement; OL, ooeciopore length; OW, ooeciopore width; PL, pseudopore length; PW, pseudopore width; TAM, transverse apertural measurement; TPM, transverse peristome measurement.

Geological setting

The Polish Jura is a monoclinal structure oriented from south-east to north-west in southern and south-central Poland, from the Kraków area in the south to Wieluń in the north (Fig. 1). The Middle Jurassic sediments of the Polish Jura were deposited in the Polish Basin that was an eastern extension of the Mid-European epicontinental sea. The Polish Basin was bordered by the Fennoscandian Shield to the north, the Belorussian High and Ukrainian Shield to the east, the Bohemian Massif to the west and the pre-Carpathian landmass to the south (see Dadlez 1989; Ziegler 1990; Feldman-Olszewska 1997). During Bathonian times, the Polish Basin broadened incrementally, attaining its peak in the Late Bathonian when almost the entire area of the Polish Lowlands was submerged by the sea (Matyja and Wierzbowski...
1998). Sedimentation was dominated by clastic deposits (Feldman-Olszewska 1997) which, as suggested by Dadlez (1997) and Marynowski et al. (2007), were primarily derived from the Fennoscandian and Bohemian landmasses.

The Upper Bajocian and Bathonian epicratonic sediments of the Polish Jura comprise a monotonous sequence of dark-grey, unconsolidated clays and mudstones, intercalated with numerous isolated or horizon-forming carbonate (calcite and siderite) concretions. The sediments are referred to as the Ore-bearing Częstochowa Clay Formation (e.g., Dayczak-Calikowska et al. 1997; Majewski 2000; Matyja and Wierzbowski 2000; Kopik 2006; Marynowski et al. 2007), and are thought to have been deposited in a quiet marine environment, generally below storm wave-base (see Matyja et al. 2006a, b, c) on an oxygenated sea-floor (Szczepanik et al. 2007; Zatoń et al. 2009). However, occasional horizons of hiatus concretions (sensu Voigt 1968) occur in the Polish Jura (Zatoń et al. 2006), marking distinct pauses in sedimentation and/or erosion of the sea-floor. The common abrasion of the concretions, best manifested in the form of truncated Gastrochaenolites borings, attests to the episodic presence of shallower and more hydrodynamically agitated environments.

The ore-bearing clays are currently exposed in numerous clay-pits, the majority of which are still active. They are hydrodynamically agitated environments. The common abrasion of the concretions, best manifested in the form of truncated Gastrochaenolites borings, attests to the episodic presence of shallower and more hydrodynamically agitated environments.

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Material and methods

Most (>100 colonies) of the bryozoans here investigated come from hiatus concretions. However, a few branch fragments were also found in faunal aggregates interpreted as re-gurgitates (Zatoń and Salamon 2008) at Gnaszyn Dolny (Middle Bathonian, Morrisiceras morrisi Zone), and one well-preserved colony occurs on an oyster shell from Kawo- drza Górna (Lower Bathonian, Zigzagiceras zigzag Zone). It must be stressed that the bryozoans encrusting shells are uncommon and when present are generally not well-preserved in the ore-bearing clays of the Polish Jura due to their common encrustation by siderite and pyrite. Therefore, the hiatus concretions provide the best material for study.

Colonies and groups of colonies were sawn off the hiatus concretions, cleaned ultrasonically and examined in an uncoated state using a LEO 1455VP low vacuum scanning electron microscope housed at the NHM. Images were generated using backscattered electrons (BSE detector).

Measurements of bryozoan morphological characters are mostly based on Pitt and Taylor (1990).

Systematic palaeontology

Phylum Bryozoa Ehrenberg, 1831
Class Stenolaemata Borg, 1926
Order Cyclostomata Busk, 1852
Suborder Tubuliporina Milne-Edwards, 1838
Family Stomatoporidae Pergens and Meunier, 1886
Genus Stomatopora Bronn, 1825
Type species: Alecto dichotoma Lamouroux, 1821, Bathonian, Calvados, France.

Stomatopora bajocensis (d’Orbigny, 1850)

Fig. 2A.

1850 Alecto bajocensis sp. nov.; d’Orbigny 1850: 288.
1867 Stomatopora bouchardi Haimé, 1854; Reuss 1867: 2 (partim).
1963 Stomatopora bajocensis (d’Orbigny, 1850); Illies 1963: 74, pl. 7: 1–2.
1970 Stomatopora bajocensis (d’Orbigny, 1850); Walter 1970: 36, pl. 1: 7.
2009 Stomatopora bajocensis (d’Orbigny, 1850); Taylor 2009: 22.

Material.—Two fragmentary colonies GIUS 8-3509-1–2.

Measurements.—FWL, 825–1575 μm; FWW, proximal: 120–140 μm, distal: 220–300 μm; LAM, 80 μm; LPM, 120 μm; TAM, 80 μm; TPM, 110 μm; PW, 6.3 μm.

Description and remarks.—This encrusting, uniserial species has been found on only two hiatus concretions. In both cases, the ancestrula is lacking and branches bifurcate at an angle of about 110°, suggesting an early astogenetic stage. Autozooids are straggly, long and slender, proximally narrow but gradually widening towards the distal end. Peristomes and apertures are circular in outline, about 110 and 80 μm in diameter, respectively. Apertures may possess deep diaphragms. Pseudopores are widely-spaced and almost circular in outline.

Although the ancestrula is missing and the astogenetic stages of the colonies cannot therefore be determined exactly, the size of the autozooids is characteristic of Stomato-
Stomatopora recurva Waagen, 1867

Fig. 2B.

1867 Stomatopora recurva sp. nov.; Waagen 1867: 647, pl. 32: 9a, b.
1867 Stomatopora dichotoma Lamouroux, 1821; Reuss 1867: 2 (partim), pl. 1: 3.
1970 Stomatopora boucaldi Haime, 1854; Reuss 1867: 2 (partim).
1867 Stomatopora dichotomoides d’Orbigny, 1850; Reuss 1867: 3 (partim).
2009 Stomatopora recurva Waagen, 1867; Taylor 2009: 26, figs. 2C, 3E, F.

Material.—Five fragmentary colonies GIUS 8-3509-2–6.

Measurements.—FWL, 1000–1100 μm; FWW, 600–800 μm; LPM, 200–300 μm; TPM, 250–450 μm; PW, 15–17.5 μm.

Description and remarks.—Only five fragmentary colonies, with worn and partly infilled zooids, of this uniserial species were found, all encrusting hiatus concretions. The anestruela seems to be lacking. The branches, 600–800 μm wide, are straight or curved (Fig. 2B₁). The bifurcation angles as high as 125° decreasing to about 87°. Delayed separation of daughter branches may occur after bifurcation, briefly producing bilateral branches (Fig. 2B₁). The apertures of autozooids are spaced 1000–1100 μm apart, similar to the specimens of Stomatopora recurva from Balin (Taylor 2009). Peristomes are preserved to a height of about 125 μm. Pseudopores are teardrop-shaped, large, 15–17.5 μm wide, bevelled and closely spaced.

The robustness of this species distinguishes it from the other Jurassic species of Stomatopora, such as S. bajocensis (d’Orbigny, 1850), S. dichotomoides (d’Orbigny, 1850), and S. corallina (d’Orbigny, 1850) (see Taylor 2009).

Stratigraphic and geographic range.—Uppermost Bajocian of Mokrsko and Middle Bajocian of Bugaj, Polish Jura. Stomatopora recurva is also known from the Upper Aalenian–Lower Bajocian of Germany, France and England (Walter 1970), and uppermost Bajocian–lowermost Callovian of Balin, southern Poland (Taylor 2009).

Genus Proboscinospora Pitt and Taylor, 1990

Type species: Proboscina divisa Vine, 1893, Middle Jurassic, Cornbrash (probably basal Callovian), Thrapston, Northamptonshire, England.

Proboscinospora? sp.

Fig. 2C.

Material.—One poorly preserved colony GIUS 8-3509-7.

Measurements.—FWL, 500–800 μm; FWW, 200–300 μm; LAM, 120–200 μm; TAM, 83–120 μm; LPM, 183–266 μm; TPM, 133–200 μm; PL, 15–20 μm; PW, 2.5–3.8 μm.

Description.—Colonies encrusting with narrow oligoserial, ribbon-like branches. Generally up to 2–3 autozooids across the width of the branches which are slightly convex, low, and bifurcate irregularly at variable angles (Fig. 2C₁). Autozooids are elongate, have circular or longitudinally elliptical apertures, variably spaced and short preserved peristomes. Frontal walls are ornamented by very narrow, slit-like pseudopores elongated parallel to growth direction (Fig. 2C₂).

Remarks.—Colonies form agrees with the genus Proboscinopora, introduced by Pitt and Taylor (1990) for Proboscina-like colonies lacking basal gonozooids (it is possible that peristomial gonozooids were developed but were lost when the peristomes broke off). However, the fragmentary nature of the single colony described here precludes its unequivocal identification as Proboscinopora as it may alternatively be an infertile colony of Oncousoecia (see Taylor and Zatoń 2008) which has a very similar colony-from. The distinctive slit-like pseudopores while typical of many stomatoporids can also be found in species of Microeciella (family Oncousoeciidae) and Multipsarsa (family Multipsarsidae) (see below and Taylor 2009).

Stratigraphic and geographic range.—Middle Bajocian of Bugaj, Polish Jura.

Family Oncousoeciidae Canu, 1918

Genus Microeciella Taylor and Sequeiros, 1982

Type species: Microeciella beliensis Taylor and Sequeiros, 1982, Toarcian, Jurassic, Belchite, Spain.

Remarks.—Microeciella was introduced by Taylor and Sequeiros (1982) for bereniciform cyclostomes with simple ovoidal gonozooids that had previously been incorrectly assigned to Microecia (a subjective junior synonym of Plagioecia). The status of the genus was recently clarified by Taylor and Zatoń (2008) who argued that recent species placed in Eurystrotes Hayward and Ryland, 1985 actually belonged in Microeciella. Five new species of Microeciella are recognized among the material studied here. They can be distinguished using the following key:

1. autozooidal frontal wall width < 200 μm
2. autozooidal frontal wall width > 200 μm
3. ooeiciopore located distally of brood chamber M. annae ooeiciopore subterminal
4. brood chamber elongate, about 1.5 × longer than wide M. mokrskoensis brood chamber equidimensional M. maleckii
5. ooeiciopore significantly smaller than autozooidal aperture M. kuklinskii ooeiciopore about same size as an autozooidal aperture M. magnopora
Microeciella annae sp. nov.

Fig. 3.

Etymology: In honour of the late Anna Zatoń (1958–2002), the first author’s mother.

Type material: Holotype: GIUS 8−3509−8, colony encrusting an oyster shell; paratype: GIUS 8−3509−9, colony encrusting a hiatus concretion.

Type locality: Kawodrza Góra (“Gliński” clay-pit), Polish Jura, Poland.

Type horizon: Ore-bearing Częstochowa Clay Formation, Lower Bathonian (Zigzagiceras zigzag Zone), Jurassic.

Material.—Two colonies, the holotype and paratype listed above.

Measurements.—FWL, 466–800 μm; FWW, 116–150 μm; LAM, 66–83 μm; TAM, 58–75 μm; LPM, 100–116 μm; TPM, 83–108 μm; GTL, 1180 μm; GDL, 685 μm; GW, 500 μm; OL, 91 μm; OW, 100 μm; PL, 7.5–12.5 μm; PW, 5 μm.
Diagnosis.—*Microeciella* with ovoidal brood chambers and a terminal, subcircular ooeciopore located on a short, straight ooeciostome; autozooids small, frontal walls less than 150 μm wide; pseudopores longitudinally elongate, spindle-shaped.

Description.—Colony encrusting, small (holotype 8 mm in diameter), multiserial, unilamellar, discoidal, bereniciform (Fig. 3A). Growing edge low.

Autozooids small, elongate, flat proximally and slightly convex distally; zooidal boundaries grooved. Peristomes salient, tapering distally. Apertures subcircular to longitudinally elongate. Pseudopores narrow, teardrop to spindle-like in shape, pointed distally, sparse (Fig. 3D).

Gonozooids common, occurring in three generations in the holotype (Fig. 3A); however, all but two are crushed, and one of the remaining two is incompletely formed. Proximal frontal wall flat, indistinguishable from an autozooid. Brood chamber ovoidal, only slightly longer than wide, convex, lateral edges indented by apertures of neighbouring autozooids, roof densely pseudoporous. Ooeciopore terminal, located beyond distal edge of brood chamber, subcircular, smaller than autozooidal aperture; ooeciostome short, upright, tapering distally. Remarks.—This new species of *Microeciella* differs from the type species *M. beliensis* Taylor and Sequeiros, 1982, as well as from other Jurassic *Microeciella* species including *M. duofluvina* (Cuffey and Ehleiter, 1984), *M. pollostos* Taylor and Wilson, 1999, in its terminal ooeciopore and more rounded brood chamber. The terminal ooeciopore of *M. annae* sp. nov. is reminiscent of the Recent species *M. suborbicularis* (Hincks, 1880) (see Taylor and Zatoń 2008), previously placed in *Eurystrotos* (Hayward and Ryland 1985). *Microeciella* sp. from the Upper Bathonian–Lower
Callonian of Balin, southern Poland, has a similar ovoidal brood chamber but a subterminal ooeiciopore (see Taylor 2009).

One infertile colony from the Middle Bathonian of Bugaj (GIUS 8–3509-9), which possesses a similar discoidal colony-form, autozooids and pseudopores, is provisionally assigned to Microeciella annae. 

Stratigraphic and geographic range.—Lower Bathonian of Kwodzra Góra and Middle Bathonian of Bugaj, Polish Jura.

Microeciella kuklinskii sp. nov.

Fig. 4.

Etymology: In honour of Dr. Piotr Kukliński, a bryozoan ecologist from the Institute of Oceanology, Polish Academy of Sciences, Sopot.

Type material: Holotype: GIUS 8-3509-10; paratypes: GIUS 8-3509-11–12.

Type locality: Bugaj, Polish Jura, Poland.

Type horizon: Ore-bearing Częstochowa Clay Formation, Middle Bathonian (Tulites subcontractus or Morrisiceras morrisi Zone), Jurassic.

Material.—The holotype and two paratypes listed above.

Measurements.—FWL, 1000–1371 μm; FWW, 250–333 μm; LAM, 125–200 μm; TAM, 125–150 μm; LPM, 166–266 μm; TPM, 183–233 μm; GDL, 735 μm; OW, 815 μm; OL, 65 μm; OW, 65 μm; PL, 20–23 μm; PW, 15–18 μm.

Diagnosis.—Microeciella with ovoidal or heart-shaped brood chamber, strongly subterminal ooeiciopore; autozooids large, frontal walls more than 250 μm wide; pseudopores large; teardrop-shaped pseudopores; nanozooids occasionally present.

Description.—Colony encrusting, multiserial, unilamellar, bereniciform.

Autozooids large, elongate, with flat proximal and convex distal frontal wall; zooidal boundaries distinct. Preserved peristomes short, tapering distally. Apertures subcircular to longitudinally elongate. Pseudopores moderately spaced, large, teardrop-shaped, pointed distally (Fig. 4A, B).

Nanozooids occur sporadically over the colony surface only in one paratype (GIUS 8-3509-12), often in close proximity to autozooidal apertures (Fig. 4B); peristomes short, upright; apertures circular to subcircular in outline, c. 70 μm long by 63 μm wide.

Gonozooids uncommon, with flat to slightly convex frontal walls, proximally indistinguishable from autozooids. Brood chamber ovoidal or heart-shaped, only slightly wider than long, accentuated by two small lobes distally (Fig. 3B), roof densely pseudoporous, similar in convexity to autozooidal frontal walls. Ooeiciopore subterminal, located well below distal edge of brood chamber, circular in outline, much smaller than an autozooid aperture.

Remarks.—Although only one colony preserves a gonozooid, the overall morphology of this species of Microeciella is sufficiently distinct to justify the creation of a new species. Two paratype colonies (GIUS 8-3509-11–12) without gonozooids are included in this species on the basis of their similar autozooid and pseudopore characteristics. It is worth noting that nanozooids, polymorphs occurring rarely in Jurassic bryozoans, have never been detected previously in the genus Microeciella. Their scattered occurrence on the colony surface is reminiscent of the extant cyclostome Plagioecia saraiensis. Silén and Harmelin (1974) interpreted such patterns of “occasional nanozooid” development as due to irregularities of the substratum disturbing the normal growth of the colony and resulting in narrowing of the space available such that a normal autozooid could not be budded.

Stratigraphic and geographic range.—Middle Bathonian of Bugaj, Polish Jura.

Microeciella maleckii sp. nov.

Fig. 5.

Etymology: In honour of the late Professor Jerzy Malecki, author of numerous papers on Polish fossil bryozoans.


Type locality: Ogrodzieniec, Polish Jura, Poland.

Type horizon: Ore-bearing Częstochowa Clay Formation, Upper Bathonian (Procerites hodsoni Zone), Jurassic.

Material.—One colony, the holotype.

Measurements.—FWL, 563–913 μm; FWW, 100–163 μm; LAM, 75–113 μm; TAM, 50–88 μm; LPM, 113–150 μm; TPM, 75–125 μm; GDL, 838 μm; GDL, 525–725 μm; GW, 513–700 μm; OL, 38 μm; OW, 50 μm; PL, 6.3–12.5 μm; PW, 5–6.3 μm.

Diagnosis.—Microeciella with ovoidal, bulbous brood chambers indented by autozooidal peristomes and subterminal, subcircular to slightly transverse ooeiciopores; autozooids small, frontal walls less than 165 μm wide; pseudopores teardrop-shaped, pointed distally.

Description.—Colony encrusting, multiserial, unilamellar, bereniciform.

Autozooids small, elongate with slightly convex frontal walls; zooidal boundaries distinct, grooved. Peristomes tapering distally. Apertures subcircular to longitudinally elongated, some closed by terminal diaphragms. Pseudopores moderately spaced, teardrop-shaped, longer than wide, pointed distally (Fig. 5D).

Gonozooids partly or entirely crushed (Fig. 5B, C). Proximal frontal wall indistinguishable from an autozooid. Brood chamber ovoidal, only slightly longer than wide, bulbous, convex frontal wall, outline indented by apertures of neighbouring autozooids, roof densely pseudoporous. Ooeiciopore subterminal, smaller than an autozooidal aperture, subcircular or slightly transverse.

Remarks.—Cyclostomes having similar ovoidal, bulbous brood chambers with subterminal ooeiciopore have been recently described by Viskova (2008) from the Middle Oxfordian of Russia under the name Hyporosopora mittai Viskova, 2008. However, as the genus Hyporosopora is used for cyclostomes with subtriangular, boomerang-like or heart-shaped brood chambers, the species described by Viskova (2008) is better placed in Microeciella. The new species M. maleckii differs from M. mittai in having wider gonozooids, 713–700 μm compared to 370–400 μm in M. mittai. Differ-
ences between *M. maleckii* and other species of *Microeciella* described in the present study are evident from the species identification key (above).

**Stratigraphic and geographic range.**—Upper Bathonian of Ogrodzieniec, Polish Jura.

*Microeciella mokrskoensis* sp. nov.

**Etymology:** From the type locality Mokrsko.

**Holotype:** GIUS 8-3509-14.

**Type locality:** Mokrsko, Polish Jura, Poland.

**Type horizon:** Upper Bajocian (*Parkinsonia parkinsoni* Zone).

**Material.**—One colony, the holotype.

**Measurements.**—FWL, 807–923 μm; FWW, 115–161 μm; LAM, 92–115 μm; TAM, 69–92 μm; LPM, 138–161 μm; TPM, 104–161 μm; GTL, 1086 μm; GDL, 657 μm; GW, 428 μm; PL, 12.5–17 μm; PW, 5 μm.

**Diagnosis.**—*Microeciella* with longitudinally elongate gonozooids, the brood chamber about 1.5 times longer than wide; autozooids small, frontal wall width less than 165 μm; pseudopores elongate, pyriform, pointed distally.

**Description.**—Colony encrusting, multiserial, unilamellar, bereniciform, with distinct rejuvenative growth (Fig. 6A).

Autozooids small, elongate with frontal wall flat proximally but slightly convex distally; zooidal boundaries shallowly grooved or indistinct. Peristomes short, upright, tapering distally. Apertures circular to longitudinally elongated, some closed by deep terminal diaphragms. Pseudopores closely spaced, longitudinally elongated, pyriform, pointed distally (Fig. 6D).

Gonozooids represented by one aborted and one roofless example. Proximal frontal wall indistinguishable from an autozooid. Brood chamber longitudinally elongate, about 1.5 × longer than wide (Fig. 6C). Ooeciopore not observed, inferred to have been subterminal.

**Remarks.**—All of the gonozooids observed in the studied colony are either aborted or have lost the roofs of their brood chambers. Nevertheless, their overall morphology is sufficiently different from that seen in the other species of *Microeciella* described in this paper to justify the recognition of *M. mokrskoensis* as a separate species. The long gonozooid is somewhat reminiscent of *M. beliensis* Taylor and Sequeiros, 1982, from the Lower Jurassic of Spain (see Taylor and Sequeiros 1982), and *M. duofluvina* (Cuffey and Ehleiter, 1982).
1984) from the Middle Jurassic Carmel Formation of Utah (see Taylor and Wilson 1999). However, *M. mokrskoensis* differs from *M. beliensis* in having wider and much longer gonozooids, whereas the brood chamber of *M. duofluvina* is more than 2 × longer than wide compared with 1.5 × in *M. mokrskoensis*.

**Stratigraphic and geographic range.**—Upper Bajocian of Mokrsko, Polish Jura.

**Microeciella magnopora** sp. nov.

*Fig. 7.*

**Etymology:** In reference to the unusually large size of the ooeciopore.

**Type material:** Holotype: GIUS 8−3509−15; paratype: GIUS 8−3509−2.

**Type locality:** Bugaj, Polish Jura, Poland.

**Type horizon:** Middle Bathonian (*Tulites subcontractus* or *Morrisiceras morrisi* Zone), Jurassic.

**Material.**—Holotype and paratype listed above.

**Measurements.**—FWL, 850–1150 μm; FWW, 250–275 μm; LAM, 100–125 μm; TAM, 100–125 μm; LPM, 125–200 μm; TPM, 150–175 μm; GTL, 1250–1625 μm; GDL, 550–725 μm; GW, 512–625 μm; OL, 150 μm; OW, 162 μm; PL, 15–16.5 μm; PW, 1.6–3.3 μm.

**Diagnosis.**—*Microeciella* with gonozooids having equidimensional, ovoidal or heart-shaped brood chambers with a large ooeciopore about the same size as an autozooidal aperture; autozooids large, frontal walls more than 250 μm wide; pseudopores narrow, slit-like.

**Description.**—Colony encrusting, sheet-like, multiserial, benniciform. Early astogenetic stages preserved but ancestrula not visible.

Autozooids large, elongate, widening distally towards apertures, with rather flat frontal wall but with distinct boundaries. Peristomes short, upright, tapering distally. Apertures circular to subcircular, some closed by terminal diaphragms. Pseudopores closely-spaced, narrow, slit-like, longitudinally elongate (*Fig. 7A₄*).

Gonozooids uncommon. Proximal frontal wall indistinguishable from that of an autozooid. Brood chamber ovoidal or heart-shaped, V-shaped at its proximal end, slightly longer than wide, bulbous, roof densely pseudoporous (*Fig. 7Aₒ*). Ooeciopore, preserved in only one gonozooid, subterminal, circular in outline, large, similar in size to an autozooidal aperture (*Fig. 7A₃*).

**Remarks.**—Although the gonozooids in the paratype specimen are roofless, without the distinctive large ooeciopore be-
ing visible, the general shape of the brood chambers is similar to the holotype, as are the autozooids and pseudopores. Therefore, we place the two specimens in the same new species, *M. magnopora*.

No other species of *Microeciella* have such a large ooeciopore as that of *M. magnopora*, in which it is approximately the same size as the autozooidal apertures. Neglecting ooeciopore size, the closest resemblance among the Polish species of *Microeciella* described in this study is with *M. kuklinskii* which has autozooids of about the same size and a similarly-shaped brood chamber. However, the pseudopores of the two species are quite different, those of *M. kuklinskii* being broad and teardrop shaped, contrasting with the narrow, slit-like pseudopores of *M. magnopora*.

**Stratigraphic and geographic range.**—Middle Bathonian of Bugaj, Polish Jura.
Family Multisparsidae Bassler, 1935
Genus Reptomultisparsa d’Orbigny, 1853
Type species: Diastopora incrustans d’Orbigny, 1850; Bathonian, Normandy, France.

Reptomultisparsa harae sp. nov.

Fig. 8.

Etymology: In honour of Dr Urszula Hara, bryozoologist at the Polish Geological Institute, Warsaw.

Type material: Holotype: NHM D52832; paratype: GIUS 8−3509−16.

Type locality: Shipton Gorge, Dorset.

Type horizon: Inferior Oolite, Microzoa Beds (Upper Bajocian, Parkinsonia parkinsoni Zone), Jurassic.

Material.—Holotype and one paratype listed above, the latter from the Middle Bajocian of Bugaj, Polish Jura.

Measurements.—FWL, 900–1260 μm; FWW, 240–260 μm; LAM, 160–200 μm; TAM, 120–160 μm; LPM, 220–260 μm; TPM, 180–220 μm; GTL, 2100–2400 μm; GDL, 1570–1620 μm; GW, 660–760 μm; OL, 190–215 μm; OW, 165–215 μm; PL, 12.5–17.5 μm; PW, 1.25–2.5 μm.

Fig. 8. Multisparsid cyclostome bryozoan Reptomultisparsa harae sp. nov. from the Middle Jurassic Inferior Oolite of England and ore-bearing clays of the Polish Jura. A. Holotype NHM D52832, Upper Bajocian, Shipton Gorge, Dorset, UK. A1, colony with gonozooids; A2, close-up of a gonozooid; A3, autozooids, some of which have terminal diaphragms; A4, pseudopores. B. Paratype, GIUS 8−3509−16, Middle Bajocian, Bugaj, Polish Jura. B1, autozooids and worn gonozooid; B2, pseudopores. Scale bars 1 mm (A1), 200 μm (A2), 100 μm (A3, B1), 20 μm (A4, B2). BSE SEM images of uncoated specimens.
Diagnosis.—Reptomultisparsa with elongate ovoidal brood chamber, 2–3 × longer than wide, ooeciopore subcircular and about same diameter as an autozooidal aperture; autozooids large, about 250 μm wide; pseudopores slit-like.

Description.—Colony encrusting, sheet-like, multiserial, unilamellar, bereniciform. Early growth stages unknown.

Autozooids large, elongate with slightly convex frontal walls; zooidal boundaries well-marked, shallowly grooved. Preserved peristomes short, tapering distally. Apertures circular or longitudinally elliptical. Pseudopores slit-like, much longer than wide, densely spaced (Fig. 8A4, B2).

Gonozooids common, well-preserved in the holotype (Fig. 8A1, A2) and crushed or aborted in the paratype (Fig. 8B1). Proximal frontal wall long, flat. Brood chamber convex, longitudinally elongated, ovoidal in shape, 2–3 × longer than wide, edges indented by apertures of neighbouring autozooids. Roof densely pseudoporous. Ooeciopore subterminal, circular or somewhat transversely elliptical, as large as an autozooidal aperture.

Remarks.—There are no significant differences between the holotype of this new species from the British Upper Bajocian and the paratype from the Polish Middle Bathonian. The two colonies have autozooids of similar size, the shape and size of the gonozooids is identical, and both have distinctive slit-like pseudopores. The type species of Reptomultisparsa, R. incrustans, has much larger gonozooids than R. harae and forms multilamellar colonies on gastropod shells inferred to have been occupied by hermit crabs (see Taylor 1994 and references therein). Many other Jurassic species assigned to this genus (e.g., R. walfordiana [Canu and Bassler, 1922], R. cobra [Pitt and Thomas, 1969], R. incrustans [d’Orbigny, 1850], and R. microstoma [Michelin, 1845]) have flatter colony surfaces, with more convex autozooidal frontal walls and brood chambers, as well as autozooidal apertures spaced widely apart relative to their diameters. The Polish Oxfordian species R. norberti Hara and Taylor, 1996, differs from R. harae in having a gonozooid of low profile with a very wide ooeciopore.

Stratigraphic and geographic range.—Upper Bajocian of Shipton Gorge, Dorset, England, and Middle Bathonian of Bugaj, Polish Jura.

Reptomultisparsa aff. cobra (Pitt and Thomas, 1969) Fig. 9.

Material.—Three colonies on two samples: GIUS 8-3509-17–18, two of which possess gonozooids.
Measurements.—FWL, 472–980 μm; FWW, 120–180 μm; LAM, 66–100 μm; TAM, 57–85 μm; LPM, 100–133 μm; TPM, 100–116 μm; GTL, 1760 μm; GDL, 1120–1216 μm; GW, 600–733 μm; OL, 121 μm; OW, 114 μm; PL, 7.5–10 μm; PW, 6.3–7.5 μm.

Description.—Colony encrusting, multiserial, sheet-like, bere-niciform, multilamellar; surface planar. Spiral overgrowths are common (Fig. 9A). Growing edge low, only one generation of zooids visible at the budding zone (Fig. 9A). Early growth stages unknown.

Autozooids slender, variable in length but mostly long, with flat or very gently convex frontal walls, zooidal boundaries indistinct. Apertures widely spaced, circular or slightly elongated, some closed by terminal diaphragms. Peristomes short, upright. Pseudopores teardrop-shaped, densely spaced, longer than wide, usually pointed distally, located at boundaries between narrow longitudinal strips of calcification (Fig. 9D).

Gonozooids preserved in two colonies, uncommon, crushed and/or filled with pyrite. Proximal frontal wall flat, indistinguishable from an autozooid. Brood chamber evidently more convex than an autozooid, longitudinally elongated, spindle-like in shape with maximum width at mid-length (Fig. 9C). Ooeiopore subterminal, circular in outline, larger than an autozodial aperture.

Remarks.—The Polish material described here differs from the holotype of R. cobra (Pitt and Thomas, 1969), originally described from the Lower Bathonian of southern Britain (Oxfordshire), which has a more elongate, less spindle-shaped brood chamber. However, the differences are slight, the British and Polish material having autozooids and pseudopores of similar sizes and shapes. A related species from Balin with larger autozooids was recently described under the name R. aff. cobra (Pitt and Thomas, 1969) by Taylor (2009).

Stratigraphic and geographic range.—Middle Bathonian of Bugaj, Polish Jura.

Genus Idmonea Lamouroux, 1821

Type species: Idmonea triquetra Lamouroux, 1821, Bathonian, Normandy, France.

Idmonea sp.

Fig. 10.

Material.—GIUS 8-3509-19, Gnaszyn Dolny, Middle Bathonian, comprising six branch fragments, partially coated by siderite, retrieved from a sample interpreted as a regurgitate by Zatoń and Salamon (2008).

Measurements.—FWL, 400–507 μm; FWW, 147–187 μm; LAM, 80–107 μm; TAM, 67–107 μm; LPM, 120–133 μm; TPM, 93–133 μm; PW, 8 μm.

Description.—Colony erect comprising bifurcating branches about 820 μm in diameter, ovoidal in cross-section.

Autozooid frontal walls flat to slightly convex, a distinct convex boundary wall present. Apertures transversely elliptical or circular, some closed by terminal diaphragms, variable in size with those located at the midline of the branches being largest (Fig. 10A). Peristomes short, upright. Pseudopores small and dense, teardrop-shaped, about as long as wide, pointed distally (Fig. 10B).

Gonozooids not observed.

Remarks.—Historically, the tubuliporine genus Idmonea has been interpreted in different ways, either as an encruster with branches of a subtriangular shape in cross-section, or as an erect genus with branches of similar cross-sectional shape. As was noted by Pitt and Taylor (1990), the Jurassic type species, I. triquetra Lamouroux, 1821, has encrusting branches. However, from the encrusting base, erect branches may arise with ovoidal cross-sections and autozooids opening around the entire circumference (Walter 1970). These contrast with branches of erect species historically assigned to Idmonea, signifying a taxonomic difference. The erect branches described here from the Polish Jurassic do, however, possess an ovoidal cross-section, although the morphology of the encrusting base is unknown. The branches were found in the sample interpreted as regurgitate by Zatoń and Salamon (2008). Therefore,
they may have been swallowed by a durophagous marine vertebrate, either incidentally or as part of its normal diet.

Stratigraphic and geographic range.—Middle Bathonian of Gnaszyn Dolny, Polish Jura.

Family Plagioeciidae Canu, 1918
Genus Hyporosopora Canu and Bassler, 1929
Type species: Hyporosopora typica Canu and Bassler, 1929, Bathonian of Normandy, France.

Hyporosopora bugajensis sp. nov.

Fig. 11.

Etymology: From the type locality Bugaj in the Polish Jura.
Type species: Hyporosopora typica Canu and Bassler, 1929, Bathonian of Normandy, France.

Family Plagioeciidae Canu, 1918
Genus Hyporosopora Canu and Bassler, 1929
Type species: Hyporosopora typica Canu and Bassler, 1929, Bathonian of Normandy, France.

Hyporosopora bugajensis sp. nov.

Fig. 11.

Etymology: From the type locality Bugaj in the Polish Jura.
Type species: Hyporosopora typica Canu and Bassler, 1929, Bathonian of Normandy, France.

Type material: Holotype: GIUS 8-3509-20; paratype: GIUS 8-3509-21.
Type locality: Bugaj, Polish Jura.

Type horizon: Ore-bearing clays (Middle Bathonian, Tulites subcontractus or Morrisiceras morrisi Zone), Jurassic.

Material.—Holotype and paratype listed above.

Measurements.—FWL, 750–1388 μm; FWW, 183–250 μm; LAM, 100–166 μm; TAM, 100–150 μm; LPM, 166–200 μm; TPM, 116–233 μm; GTL, 1183 μm; GDL, 510 μm; GW, 920 μm; OL, 40 μm; 70 μm; PL, 2.5–5 μm; PW, 15–17.5 μm.

Description.—Colony encrusting, sheet-like, multiserial, bereiniciform, unilamellar, surface covered by transverse growth checks (Fig. 11A).

Autozooids long, with flat to slightly convex frontal walls; zooidal boundaries distinct, shallowly grooved. Preserved peristomes short, tapering distally. Apertures circular to elliptical, some closed by diaphragms, irregularly arranged often forming ill-defined transverse rows. Pseudopores transversely elongate, narrow, gull wing-shaped, spaced a moderate distance apart (Fig. 11D).

Gonozooid preserved in the holotype only. Proximal part indistinguishable from an autozooid. Brood chamber small, inflated, broad, width nearly twice length, elliptical (Fig. 11C), lateral margins slightly indented by autozooidal apertures. Roof densely pseudoporous. Ooeiciopore terminal, transversely elliptical, much smaller than an autozooidal aperture. Ooeiciostome short, upright.

Remarks.—This new species of Hyporosopora species has the longest autozooids, averaging 1113 μm, of all the bereiniciform cyclostomes described in the present paper.

Fig. 11. Plagioeciid cyclostome bryozoan Hyporosopora bugajensis sp. nov. from the Middle Jurassic ore-bearing clays of the Polish Jura, holotype, GIUS 8-3509-20. A. Colony view. B. Autozooids. C. Partly crushed gonozooid. D. Pseudopores. Scale bars: 300 μm (A), 100 μm (B, C), 20 μm (D). BSE SEM images of uncoated specimens.
gonozooid is small for Hyporosopora and more transversely elliptical than the type species H. typica or H. tenera (Reuss, 1867) in which it more clearly resembles an equilateral triangle. Transversely elongate pseudopores, as seen in the new species, are rare in cyclostomes and have not been recorded previously from any species of Hyporosopora. The gull wing-shaped pseudopores of H. bugajensis most closely resemble those seen in the unifoliate erect species Diastopora lamourouxi Milne Edwards, 1838. These pseudopores are sufficiently unusual that we have no hesitation in assigning an infertile colony to H. bugajensis as a paratype.

Stratigraphic and geographic range.—Middle Bathonian of Bugaj, Polish Jura.

Hyporosopora tenera (Reuss, 1867)

1867 Berenicea tenera sp. nov.; Reuss 1867: 8 (partim), pl. 1: 9.
2009 Hyporosopora tenera (Reuss, 1867); Taylor 2009: 37, figs. 7C, 9A–F.

Material.—GIUS 8-3509-12.

Measurements.—FWL, 300–440 μm; FWW, 112–137 μm; LAM, 75–112 μm; TAM, 75–100 μm; LPM, 100–125 μm; TPM, 100–125 μm; GDL, 500 μm; GW, 1000 μm; OL, 66 μm; OW, 91 μm; PL, 15–17.5 μm; PW, 2.5 μm.

Description.—Colony encrusting, sheet-like, multiserial, bere-niciiform, unilamellar, discoidal in shape (Fig. 12A). Autozooids small, elongate, with slightly convex frontal walls exhibiting fine growth lines; zooidal boundaries distinctly shallowly grooved. Preserved peristomes short, upright. Apertures small-sized, generally circular but sometimes longitudinally elongate, occasionally closed by terminal diaphragms. Pseudopores longitudinally elongate, narrow, slit-like, rather sparse (Fig. 12D).

Gonozooids represented by one example close to colony margin. Brood chamber inflated, much wider than longer, rounded subtriangular in shape, distal edge almost straight, roof densely pseudoporous (Fig. 12C). Proximolateral margins indented by apertures of neighbouring autozooids. Ooeiciopore terminal, wider than longer but almost circular, smaller than an autozooidal aperture.

Remarks.—The morphology of the gonozooid and the size and other characteristics of the autozooids in this specimen match those of the holotype of Hyporosopora tenera (Reuss, 1867) from the Upper Bathonian–Early Callovian of Balin, as recently redescribed by Taylor (2009). The only differ-
ence is the somewhat smaller brood chamber. However, as the colony described has only one gonozooid preserved, we cannot compare the full size-range of gonozooids between the holotype and the new specimen.

_Hyporosopora tenera_ (Reuss, 1867) differs from the most similar species _Hyporosopora typica_ by having much smaller autozooids, the width of which is well below 200 μm.

**Stratigraphic and geographic range.**—Middle Bathonian of Bugaj, Polish Jura and Upper Bathonian to Lower Callovian of Balin, southern Poland.

_Hyporosopora aff. sauvegei_ (Gregory, 1896)

Fig. 13.

**Material.**—Two colonies: GIUS 8-3509-22 and NHM BZ 5612(2).

**Measurements.**—FWL, 716–816 μm; FWW, 266–283 μm;

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Fig. 13. Plagioeciid cyclostome bryozoan _Hyporosopora aff. sauvegei_ (Gregory, 1896) from the Middle Jurassic ore-bearing clays of the Polish Jura. **A.** Middle Bathonian, Bugaj, GIUS 8-3509-22. A1, colony view; A2, autozooids; A3, boomerang-like gonozooid, ooeciopore arrowed; A4, heart-shaped gonozooid, ooeciopore arrowed; A5, pseudopores. **B.** Middle Bathonian, Bugaj, NHM BZ 5612(2), subtriangular gonozooid, ooeciopore arrowed. Scale bars: 1 mm (A1), 100 μm (A2–A5, B), 20 μm (A3). BSE SEM images of uncoated specimens.
LAM, 133–200 μm; TAM, 133–150 μm; LPM, 200–283 μm; TPM, 166–233 μm; GDL, 760–783 μm; GW, 1300–1450 μm; OL, 100–130 μm; OW, 100–116 μm; PL, 12.5–15 μm; PW, 10 μm.

Description.—Colony encrusting, sheet-like, multiserial, be- reniciform, unilamellar, surface covered by transverse growth checks (Fig. 13A1).

Autozooids large, elongate, gently convex, zooidal bound- aries distinct. Preserved peristomes short, tapering distally. Apertures circular to longitudinally elliptical, some closed by terminal diaphragms. Pseudopores densely spaced, teardrop-shaped, wide, pointed distally (Fig. 13A5).

Gonozooids present but crushed, one preserved in speci- men NHM BZ 5612(2) and two in specimen GIUS 8-3509-22. Proximal part flat. Brood chamber shape variable within same colony (GIUS 8-3509-22): much broader than long, boomerang-like (Fig. 13A3) or nearly equidimensional and heart-shaped with prominent distal lobes (Fig. 13A4). Roofs densely pseudoporous. Margins indented by neighbouring autozooidal apertures. Ooeiciopore terminal, subcircular, much smaller than autozooidal aperture. Ooeiostome short, upright.

Remarks.—The material described here resembles the holotype (NHM B194) of Hyporosopora sauvagei from the Upper Bathonian Bradford Clay of Bradford on Avon, Wiltshire, England. However, the Polish material has tear−drop−shaped pseudopores in contrast to those of the holotype which are transversely elongate and broadly U−shaped. Colonies of putative H. sauvagei from Balin also possess tear−drop−shaped pseudopores (Taylor 2009). However, in view of the importance for taxonomy of pseudopores shown by the current study, it is best to assign both the Balin and Bugaj material to H. aff. sauvagei.

Stratigraphic and geographic range.—Middle Bathonian of Bugaj, Polish Jura.

Hyporosopora sp.

Material.—One colony GIUS 8-3509-23.

Measurements.—FWL, 566–700 μm; FWW, 150–166 μm; LAM, 58–116 μm; TAM, 66–116 μm; LPM, 100–133 μm; TPM, 100–133 μm; GDL, 816 μm; GW, 500 μm; PL, 8.8–10 μm; PW, 8.8–10 μm.

Description.—Colony encrusting, sheet-like, multiserial, bereniciform, unilamellar.

Autozooids elongate, frontal walls flat to convex, zooidal boundaries indistinct in some places. Preserved peristomes short, tapering distally. Pseudopores poorly preserved due to worn frontal walls, large, as wide as long, drop-shaped, pointed distally (Fig. 14B). One broken gonozooid preserved. Brood chamber small, broader than long, bulbous, sharply delineated from proximal frontal wall, subtriangular in outline with distally extending two lateral lobes; roof densely pseudoporous (Fig. 14A). Ooeiopore not visible.

Remarks.—This species is characterized by a small brood chamber differing in shape and size from the other species of Hyporosopora described here. While it may represent a new species, more material is required to justify such distinction.

Stratigraphic and geographic range.—Upper Bathonian of Żarki, Polish Jura.

Family Incertae sedis

“Berenicea” spp.

Material.—51 colonies: GIUS 8-3509-2, GIUS 8-3509-23–73.

Remarks.—Several spot- or sheet-like tubuliporine colonies that are badly preserved (26 colonies are abraded) or devoid of gonozooids (the rest of the colonies) cannot be generically
assigned and are therefore placed in the form-genus “Berenicea” (see Taylor and Sequeiros 1982).

Stratigraphic and geographic range.—Uppermost Bajocian to Bathonian of Ogrodzieniec, Żarki, Bugaj, Mokrsko, and Krzyworzeka, Polish Jura.

Suborder Cerioporina Hagenow, 1851
Family Cavidae d’Orbigny, 1854
Genus Ceriocava d’Orbigny, 1854
Type species: Millepora corymbosa Lamouroux, 1821, Bathonian, Normandy, France.

Fig. 15. Cerioporine cyclostome bryozoan Ceriocava sp. from the Middle Bathonian of Bugaj, Polish Jura. A. NHM Bz 5612(1). A1, centre of cone-like subcolonies; A2, autozooidal apertures; A3, elongated and curved gonozooid. B. NHM BZ 5613, centre of cone-like subcolonies. C. NHM BZ 5614. C1, centre of flabellotrypiform colony; C2, pseudopores. Scale bars 300 μm (B), 200 μm (A1, A3, C1), 100 μm (A2), 20 μm (C2). BSE SEM images of uncoated specimens.
Ceriocava sp.

Fig. 15.

Measurements.—AD, 133–200 μm; IWT, 50–133 μm; GTL, 3500 μm; GW, 333 μm; PL, 15–20 μm; PW, 20–28 μm.


Description.—Colonies varying from dome- and cone-like with autozooids opening over entire upper surface (Fig. 15A, B), or flabellate (flabellotrypiform) with autozooids opening only at subvertical growing edge and frontal surface of colony comprising exterior wall, depressed centrally (Fig. 15C1).

Autozooidal apertures rounded polygonal, surrounded by thick interzooidal walls (mean thickness 64–81 μm) with ridges at zooidal boundaries giving a honeycomb-like pattern (Fig. 15A2); terminal or subterminal diaphragms visible in thin-sections. Pseudopores, best visible on frontal surfaces of flabellotrypiform colonies, densely spaced, teardrop-shaped with broad base (mean width 22 μm), pointed distally (Fig. 15C2).

Gonozooids narrow and elongate, often curved; roof pseudoporous; ooeociopore not identified (Fig. 15A3).

Remarks.—As interpreted by Walter (1970), Ceriocava corymbosa (Lamouroux, 1821) encompasses a wide range of colony morphotypes, including the ramose erect forms normally associated with the genus as well as flabellotrypiform and dome-shaped encrusters. Material of this “species” from the Upper Bathonian–Lower Callovian of Balin exhibits a further morphotype: dendroid colonies composed of stacks of cap-like overgrowths (Taylor 2009). It is beyond the scope of the current paper to resolve the difficult taxonomy of Jurassic Ceriocava which would demand both thin section and SEM study of a large amount of comparative material. However, toptotypical Ceriocava corymbosa (Lamouroux, 1821) from Normandy differs from the Polish material described here by its larger autozooidal apertures (mean diameter 268 μm), much smaller (mean width 10 μm) and denser pseudopores, and shorter but much wider gonozooids.

Stratigraphic and geographic range.—Upper Bajocian to Upper Bathonian of Mokrsko, Bugaj, Ogrodzieniec, and Krzyworzeka, Polish Jura.

Discussion

The majority of bryozoans recorded from the Jurassic globally have small, encrusting colonies and in ecological terms were “weeds” (Taylor and Ernst 2008). Most were assigned by 19th century researchers to the genera Stomatopora, Proboscina, and especially, Berenicea. Their taxonomy caused difficulties at that time and continues to do so today. Species of “Berenicea”, now treated as a form-genus (Taylor and Sequieros 1982), differ very subtly from one another. Some of the differences are manifested in zooidal size but others only become apparent when gonozooids are present or after scanning electron microscopy of the tiny pseudopores. With respect to gonozooids, these brooding polymorphs have been used for genus- and family-level taxonomy since the work of Canu and Bassler (Canu 1918; Canu and Bassler 1929). However, gonozooids are typically present in only a small minority of colonies (McKinney and Taylor 1997); those colonies lacking gonozooids can be difficult or impossible to identify and are best assigned simply to the form-genus “Berenicea”.

Much less use has been made of pseudopores in cyclostome taxonomy because these micron-scale features were too small to study prior to the advent of SEM. It is becoming clear that striking differences exist in the morphologies of pseudopores between species of cyclostomes. In some species they are more or less circular when viewed on the surfaces of frontal exterior walls (e.g., Stomatopora bajocensis, Fig. 2A2), whereas in others their shape is non-equidimensional. For example, many of the species described in this paper have teardrop-shaped pseudopores (e.g., Stomatopora recurva, Fig. 2B2; Microeciella kuklinskii, Fig. 4A4; Hyporo−sopora aff. sauvegi, Fig. 13A5), whereas others are longitudinally elongated teardrop-shaped (e.g., M. annae, Fig. 3D, M. malecki, Fig. 5D), longitudinally slit-shaped (e.g., Pro−boscinopora? sp., Fig. 2C2; Reptomultisparsa hareae, Fig. 8A4, B2), or transversely elongate and gullwing-shaped (e.g., H. bugajensis, Fig. 11D). Similar variations in pseudopore shape have been noted in previous studies of Jurassic (Taylor 2009; Hara and Taylor in press) and Recent (Taylor and Zatoń 2008) cyclostomes of the Berenicea-type. While pseudopore shape has undoubted value in distinguishing between species that may be extremely similar in other respects, its significance at higher taxonomic levels has yet to be evaluated. At least some pseudopore morphologies cut traditional taxonomy based largely on gonozooids.

The combination of gonozooid and pseudopore morphology has allowed us to distinguish a far greater number of species en−crusting mostly hiatus concretions from the Late Bajocian to Bathonian of the Polish Jura than would otherwise have been possible. At least 11 different species of the Berenicea-type have been distinguished, representing a significant increase in the previously known diversity of cyclostomes in the Middle Jurassic of Poland. The preservation of the material studied here is good, allowing pseudopore morphology to be resolved in detail. Unfortunately, this is not the case for many other Jurassic bryozoan faunas, especially those from well-cemented carbonates in which it may not be possible to achieve such taxonomic precision.

Jurassic bryozoans en−crusting hiatus concretions are known mainly from Germany and England. However, little attention has been paid to them and thus the diversity of organisms colonizing these substrates is poorly known. Hitherto, the richest bryozoan assemblage was known only from the Plen−bachian (Lower Jurassic) hiatus concretions of Osterfeld, Germany (Voigt 1968; Illies 1971, 1973), where seven species represented mainly by Stomatopora and “Berenicea” were encountered. Upper Sinemurian (Lower Jurassic) bryozoans en−crusting hiatus concretions from Dorset, England (Hesselbo
and Palmer 1992) are encrusted by “Berenicea”- and Stomatopora-like colonies, but these have not been described in detail. Beside the form-genus “Berenicea”, fifteen species are described from the hiatus concretions of the Polish Jura, making the assemblage the richest ever reported on this kind of substrate.

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