A segmented Paleocene cheilostomatous bryozoan and its possible relationships with pseudarcellids

JANINA SZCZECHURA

Szczechura, J. 1994. A segmented cheilostomatous bryozoan and its possible relationships with pseudarcellids. *Acta Palaeontologica Polonica* **39**, 2, 223–231.

Paired, cup-like calcitic structures from the Paleocene of Pomerania, Poland, are interpreted as complete zoaria or zoarial segments of an unknown group of cheilostomatous Bryozoa. Each of the cups in the twinned unit resembles the alleged Eocene tintinnid *Pseudarcella*. These fossil organisms may thus represent a connecting link between the more complex segmented bryozoan of bicorniferids and the extremely simplified pseudarcellids. *Geminella polonica* gen. et sp. n. is proposed.

Key words: Bryozoa, Cheilostomata, Anasca, incertae sedis, microproblematica, biology, Cenozoic.

Janina Szczechura, Instytut Paleobiologii PAN, Al. Żwirki i Wigury 93, 02-089 Warszawa, Poland.

Introduction

A previously undescribed colony type or segment of a colonial organism occurs in the Paleocene of Poland. It consists of only two chambers with close similarities in mineralogy and microstructure of the test to pseudarcellids (*sensu* Bignot 1989; however except *Bignotella* Willems 1975). Pseudarcellids are known so far from the Late Paleocene to the Oligocene of Europe (including Poland), SW Asia and North America. The similar shapes, sizes, development of the frontal sides and likely sessile way of life suggest a relationship between the new fossil and pseudarcellids. The new fossil may thus help in identification of the zoological affinities of pseudarcellids.

This paper presents evidence that both the new fossil, for which new generic name *Geminella* is here introduced, and pseudarcellids are actually cheilostomatous bryozoans.

Material

The studied specimens occur in Paleocene sediments of the northern Polish Lowlands. They are quite common in detrital limestones from the Pamiętowo borehole (at depth between 207–215 m) in West Pomerania. These limestones resemble lithologically the typical 'tuffeau' of Belgium and The Netherlands. They are of Montian age (Pożaryska 1965) and contain benthic foraminifera characteristic of a warm, shallow sea (Pożaryska & Szczechura 1968, 1970; Szczechura & Pożaryska 1971). Besides the foraminifera the studied samples contain exceptionally numerous fragments of various bryozoan colonies, ostracodes, and other skeletal debris.

Morphology of *Geminella*

Chamber structure. — The studied specimens resemble a pear turned upside-down and consist of two laterally tightly-adjoining cup-like, very finely porous structures of similar general shapes and sizes, with circular openings at the top of each (Fig. 1A–H). The openings are, in most cases, surrounded by a more or less convex circumapertural shield and a distinct ring-like structure. Some specimens (Fig. 3C–D) have a lateral, pocket-like inflation provided with a more or less distinct, terminal opening. A thin section examined in polarized light (Fig. 1H) suggests independent mineralization of the walls of each cup, which are built of cryptocrystalline calcite. The more proximal of the two cup-like structures, distinctly elongated in its basal part, is supported by a canal (Fig. 1G), while the more distal cup-like structure adjoins the proximal one along its enlarged, upper part. The surface of the cups is rough and finely furrowed. Hollows in the test wall are small, rare and irregularly distributed, and seem to have been caused by predators. The specimens are empty inside, generally recrystallized, and thus the connection between subunits is not visible.

Variability. — The size of specimens (as well as the cup-like subunits) and their general appearance, resulting from the shapes and arrangement of the cup-like subunits, shows much variability. Externally the contact between the subunits is sometimes indistinct. Also the morphology of the frontal sides of the particular cup-like subunits varies — they range from broadly open to partly covered by a shield. The lateral pocket-like inflation seems to be developed occassionally. Most of the specimens are distinctly laterally compressed. Their longitudinal axes are straight or bent.

Bryozoan affinities of *Geminella*

The microfossils described do not closely resemble any previously found. However, the specimens exhibit some features typical of bryozoans in size, general morphology and test wall structure. The most specific similarities

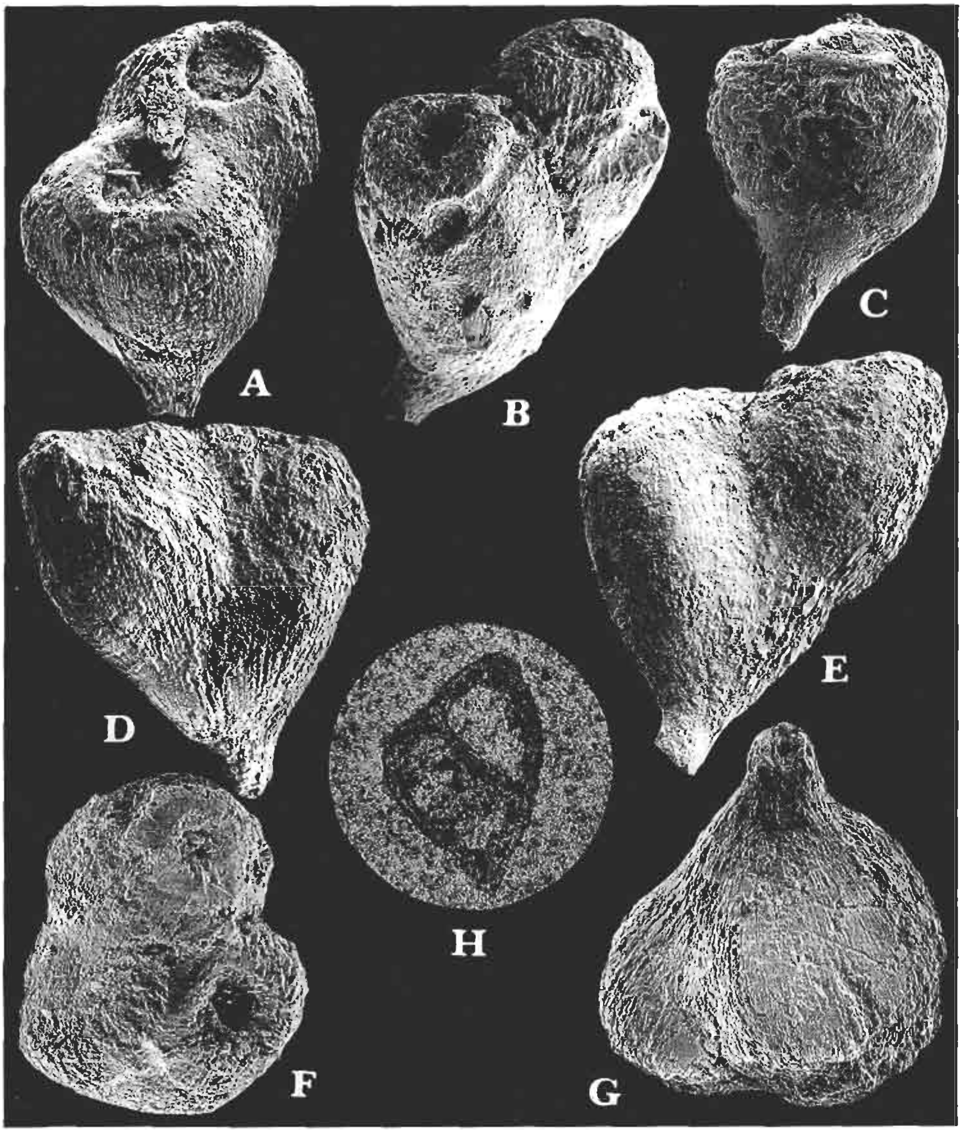


Fig. 1. A–H. *Geminella polonica* gen. et sp. n. from the Paleocene (Montian) of the Pamiętowo borehole (NW Poland), depth 208,5 m. ❑A–B, F. Specimens ZPAL. V. XXII/1–3 in somewhat oblique top views showing broadly open (A) or nearly closed (F) apertures, × 200, × 160, × 140, respectively. ❑C–E. Specimens ZPAL V. XXII/4–6 in side view, × 200, × 210, × 210, respectively (E – holotype, height – 0,29 mm, maximum width – 0,20 mm). ❑G. Specimen ZPAL V. XXII/7 in oblique side view (upside down) showing canal in the basal part of the first (proximal) zooecium, × 190. ❑H. Specimen ZPAL V.XXII/14 in longitudinal thin section showing separate (independent?) mineralization of the test parts, × 100.

to anascan cheilostomes are provided by the morphology of the apertural area. This applies especially to the distinct ring surrounding the aperture. This feature is shared by the new form with bicorniferids and some undoubted Anasca, for instance the Cretaceous encrusting species *Hoeverella krauseae* (see Taylor & Voigt 1992) and the erect Paleocene species *Calvina calloensis* (see Szczechura 1990). It may thus suggests that *Geminella* may be another member of the *Bicornifera/Bifissurinella* group, possibly a primitive representative. In comparison with established bicorniferids, *Geminella* appears to have less integrated colonies, consisting of erect subcylindrical zooecia. It remains unknown whether particular units were attached directly to the substrate by a kind of rhizoid or were parts of erect branched colonies. Distinctly compressed lateral sides of specimens suggest that they were tightly-arranged, perhaps forming a mat-like cover just above the substrate. Another possibility is that the lateral hollows (holes, cavities) are not drillings made by predators but are canals of lateral stolons and that the colony was catenicelliform (Lagaaij & Gautier 1965) in shape. There are some broad similarities between *Geminella* and the catenicellid cheilostomes (P.D. Taylor, personal communication).

Pseudarcellid affinities of *Geminella*

The cup-like subunits of *Geminella* in their general appearance, size and the cryptocrystalline calcitic test wall structure resemble the tests referred to pseudarcellids (Figs 2A–E, 3A–B, F–K). The pseudarcellids have been assigned previously to the foraminifera, tintinnids or microproblematica (cf. Tappan & Loeblich 1968; Szczechura 1979; Bugrova 1986, Bignot 1989). Recently, Bignot (1989) considered them to be of unknown origin, while Tappan (1993) assigned *Pseudarcella* (as well as almost all genera referred by Bignot to pseudarcellids) to the Tintinnidae. Also Bielokrys (1993), who distinguished 7 species (including 6 new ones) (Fig. 3A–B, F–K) of pseudarcellids in the Eocene of Ukraine, referred them to the Tintinnida. I earlier pointed out that 'the pseudarcellids have many features in common with the bicorniferids and could be related to them' (Szczechura 1992: p. 406).

The most important similarity of *Geminella* to pseudarcellids is the development of the circumapertural shield, and particularly the variable degree of their calcification. This phenomenon was earlier observed in pseudarcellids (Szczechura 1969, 1979; see also Figs 2E, 3A, F–G, I–K) and was used as an argument for exclusion of the pseudarcellids from the foraminifera as well as tintinnids. Similarly variable is the cryptocyst in undoubted bryozoans (reminiscent of *Marssonopora*, or *Rhammatopora*) (Fig. 2F–H) associated with *Geminella* from the Paleocene of Poland.

In specimens from the Eocene of Ukraine studied by Bielokrys (1993) the periapertural shield, if present, is weakly perforated (Fig. 3I–J) and bordered by a distinct ring; the latter similar to that in bicorniferids (although better developed) and the cryptocyst in anascan cheilostomes. In pseudarcellids with laterally situated, pedicle-like test elongations, the basal sides are folded and/or furrowed, replicating the substrate morpho-

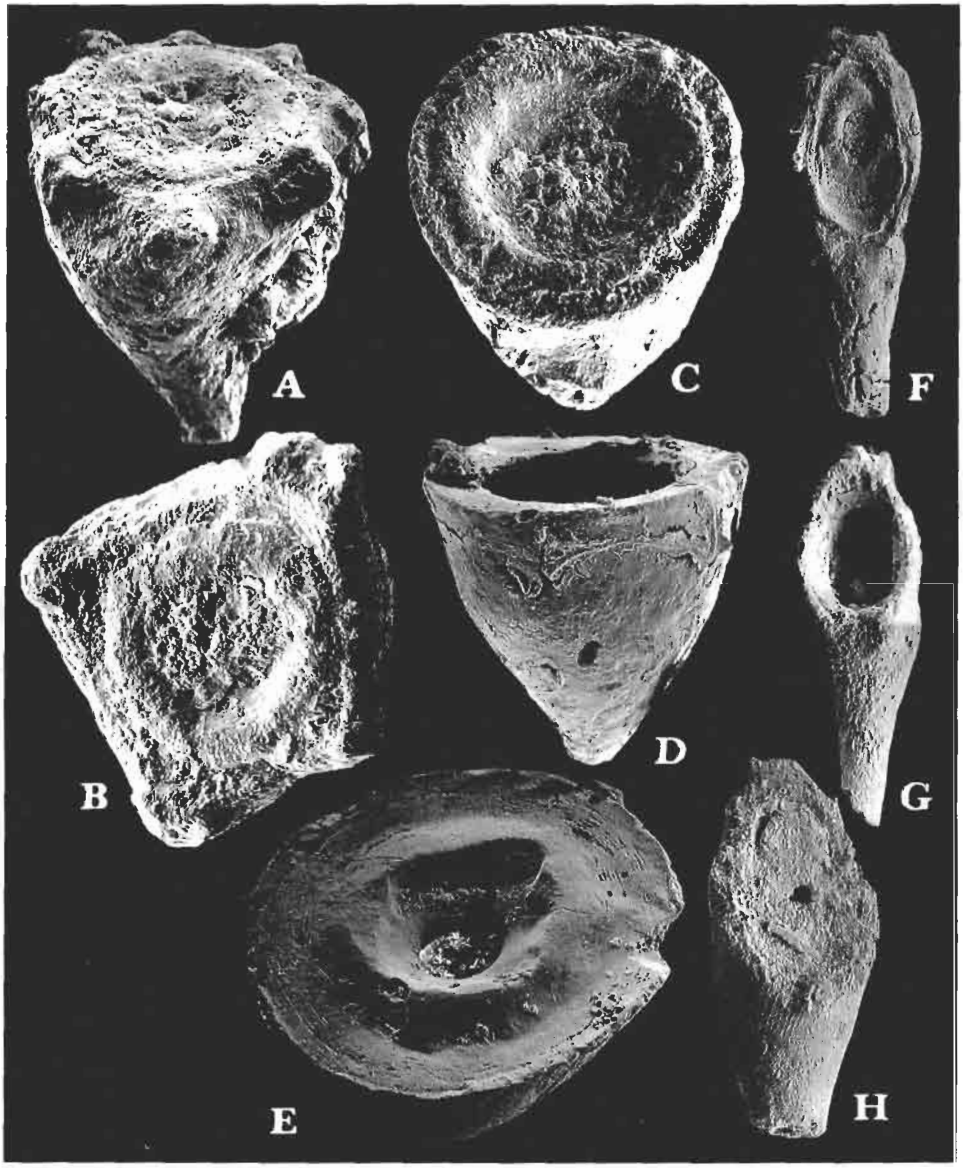


Fig. 2. ❑A–B. *Claretinella helenae* Keij 1974, Early Eocene (Ypresian) of Spain. A. Specimen ZPAL V.XXII/8 in oblique top view, × 120. B. Specimen ZPAL V. XXII/9 in side view, × 200. ❑C. *Yvonniellina* sp., Early Eocene (Ypresian) of Spain, Specimen ZPAL V.XXII/10 in oblique top view showing almost covered aperture, × 200. ❑D–E. *Yvonniellina glabra* (Szczechura 1969), Late Eocene (Bartonian) of SE Poland (Siemień exposure). D. Specimen ZPAL V.II/4 in side view showing broadly open aperture, × 170. E. Specimen ZPAL V.II/5 in top view showing almost covered aperture, × 170. ❑F–H. Uniserial anascan cheilostome from the Paleocene (Montian) of the Pamiętowo borehole (NW Poland), depth 208,5 m. F, H. Specimens ZPAL. V. XXII/11, 12 in frontal views showing calcified circumoral area, × 110, × 130, respectively. G. Specimen ZPAL V. XXII/13 in frontal view showing broadly open aperture, × 100.

logy (Bignot 1989: Pl. 2: 1–17). Thus to some degree the shape and details of morphology of pseudarcellid tests depended on the way they contacted the substrate and other tests within the colony. In the Bielokrys' specimens, more or less distinct incisions are sometimes developed at the periphery of the frontal sides (Fig. 3A, F–G, J–K), which seems to be a result of contact with the substrate. Specimens within the same sample may vary in shape and morphological details; this variability has led several authors to distinguish different genera and species. There is an apparent correlation between the shape of the aperture and the shape of the test (Fig. 3A, F–G, K), as in the articulated bryozoan *Voorthuyseniella* (cf. Szczechura 1969, 1992). Some elongated specimens from Ukraine have elliptical apertures (Fig. 3K) and their closure plates tend to be missing because they are less resistant and thus easily destroyed (Fig. 3G). Some pseudarcellids have their frontal sides armoured with strong bifid spines. All these features indicate that the pseudarcellids were sessile organisms, presumably cheilostome bryozoans. In comparison with *Geminella* and bicorniferids, they seem to represent less integrated and more specialized structural units of the colony. They differ from co-occurring zooecia of *Voorthuyseniella* in that they represent individual zooecia of a colony originally connected with other zooecia only basally, while *Voorthuyseniella* zooecia were weakly joined to neighbouring lateral zooecia as well.

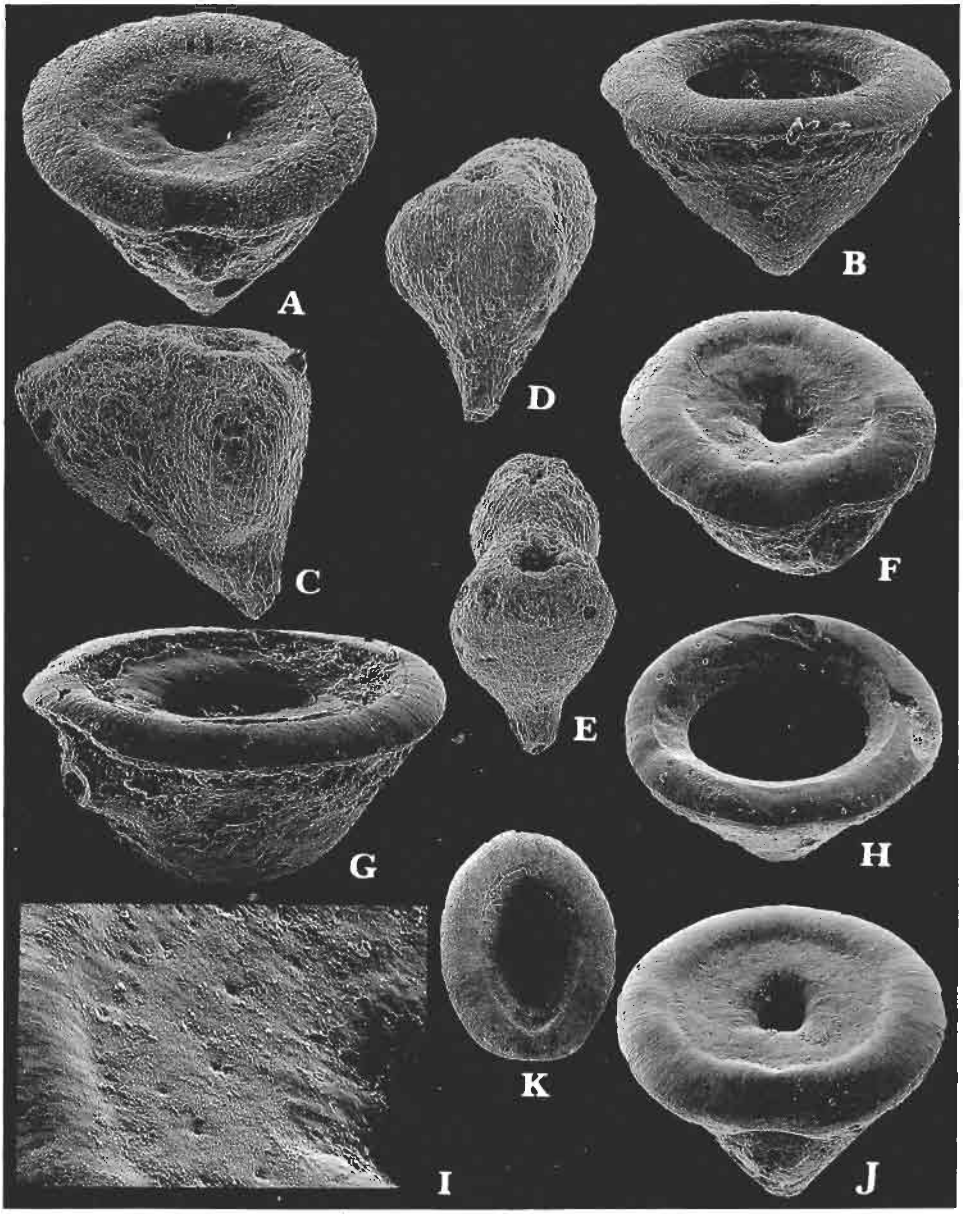
Systematics

Order Cheilostomata Busk 1852
Suborder Anasca Levinsen 1909
Family uncertain
Genus *Geminella* gen. n.
Type species: *Geminella polonica* sp. n.
Diagnosis. — As for the type species.

Geminella polonica gen. et sp. n.

Fig. 1A–H.
Holotype: ZPAL V.XXII/6, Fig. 1E.
Type horizon and locality: Puławy Formation, depth 208.5 m B 1 Foraminifer Benthic Zone, Montian, Early Paleocene; Pamiętowo borehole near Chojnice, NW Poland.
Derivation of the name: polonica — coming from Poland.
Material. — 68 specimens.
Diagnosis. — Zoarial segment consisting of two goblet-like, erect zooecia of which the second one is budded laterodistally from the first. Laterodistal pocket-like kenozooecia may occur. Aperture located at the centre of the

Fig. 3. ❑A, F, I–J. *Pseudarcella 'conoides'* Bielokrys 1993, Late Eocene of Ukraine. A, F, J. Specimens ZPAL V. XXII/58,57,56 in somewhat oblique top view showing peripheral incision of their frontal sides, × 130, × 100, × 85, respectively. I. Specimen ZPAL V. XXII/57 showing



details of the weakly perforated periapertural shield, × 420. ❑B. *Pseudarcella 'spumea'* Bielokrys 1993, Late Eocene of Ukraine. Specimen ZPAL V. XXII/64 in somewhat oblique side view, × 100. ❑C–E. *Geminella polonica* gen. et sp. n. from the Paleocene (Montian) of the Pamiętowo borehole (NW Poland), depth 208,5 m. C–D. Specimens ZPAL. V. XXII/34, 42 in side view showing lateral pocket-like inflation and rather irregularly distributed hollows, × 130, × 150 respectively. E. Specimen ZPAL V. XXII/46 in somewhat oblique side view showing lateral pocket-like inflation with opening in its upper part, × 150. ❑G, K. *Pseudarcella 'sulcifera'* Bielokrys 1993, Late Eocene of Ukraine. G. Specimen ZPAL V. XII/59 in somewhat oblique side view showing corroded periapertural shield, × 130. K. Specimen ZPAL V. XXII/60 in top view showing unevenly wide aperture, × 60. ❑H. *Pseudarcella 'laxa'* Bielokrys 1993, Late Eocene of Ukraine. Specimen ZPAL V. XXII/65 in somewhat oblique top view, × 90.

wider end of the zooecium, small, circular, bordered by a shield and ring-shaped elevation.

Occurrence. — Only the type locality.

Acknowledgements

The author is most grateful to Dr. Paul D. Taylor (The Natural History Museum, London) for his review with very useful comments on the text and for improving its language. Important opinions on the systematic position of the discussed forms were also expressed by Dr. Gérard Bignot and Dr. Armelle Poignant (Université P. et M. Curie, Paris), Dr. Dennis P. Gordon (National Institute of Water & Atmospheric Research Ltd., Wellington), Dr. Adrian J. Keij (Rijswijk), Dr. Frank K. McKinney (Appalachian State University, Boone, North Carolina, USA), as well as Professor Ehrhard Voigt (Universität Hamburg). Dr. Leonid S. Bielokrys (Kriworożskij gornorudnyj institut, Kriwoj Rog) was kind enough to send comparative material of *Pseudarcella*. SEM photographs were taken at the Electron Microscopy Laboratory of the Nencki Institute of Experimental Biology of the Polish Academy of Sciences in Warsaw by Mr Wojciech Skarżyński, and in the Institute of Paleobiology of the Polish Academy of Sciences in Warsaw by Dr. Janusz Błaszyk.

References

Bielokrys, L.S. (Белокрыс, Л.С) 1993. *Pseudaracella* (Tintinnida, Infusoria) из Эоцена Украины. *Палеонтологический Журнал* **2**, 18–29.

Bignot, G. 1989. Les Pseudarcellidés, groupe original de microfossiles incertae sedis du Paléogène. Remarques sur sa classification et description de trois especes nouvelles. *Revue de Micropaléontologie* **31**, 211–224.

Bugrova, E.M. (Бугрова, Э.М.) 1986. Палеогеновые инфузоры (состав, разпространение, фациальная приуроченность). *Палеонтологический Журнал* **1**, 16–26.

Calvez, Y.Le. 1959. Etude de quelque Foraminifères nouveaux du Cuisien franco-belge. *Revue de Micropaléontologie* **2**, 88–94.

Keij, A.J. 1969. Problematic calcareous microfossils from the Eocene of Belgium. *Proceedings of the Koninklijke Nederlandse Akademie van Wetenschappen* **B 72**, 4–13.

Keij, A.J. 1971. *Tytthocorys mexicana* n. sp. (Tintinnida) from the Middle Eocene of Mexico. *Proceedings of the Koninklijke Nederlandse van Wetenschappen* **B 74**, 4–13.

Lagaaij, R. & Gautier, Y.V. 1965. Bryozoan assemblages from marine sediments of the Rhone delta, France. *Micropaleontology* **11**, 39–58.

Lindenberg, H.G. 1965. Problematica aus dem inneralpinen Tertiär; *Pseudarcella* Spandel, emend. und *Bicornifera* n. g. *Neues Jahrbuch für Geologie und Paläontologie Monatshefte* **1965**, 18–29.

Loeblich, A. & Tappan, H. 1964. Subfamily Nodosariinae Ehrenberg, 1838. In: R.C. Moore (ed.) *Treatise on Invertebrate Paleontology, (C) Protista 2 (2)*, 512–525. Geological Society of America, Lawrence, Kansas.

Poignant, A. 1990. Nouveaux microproblematica: *Yvonniellina parva* n. sp., *Voorthuyseniella bearnensis* n. sp. et *Pseudarcella* sp. dans l'Eocène et l'Oligocene d'Aquitaine (Sud-Ouest de la France. *Revue de Micropaléontologie* **33**, 115–122.

Pożaryska, K. 1965. Foraminifera and biostratigraphy of the Danian and Montian in Poland. *Palaeontologia Polonica* **14**, 1–156.

Pożaryska, K. & Szczechura, J. 1968. Foraminifera from the Paleocene of Poland, their ecological and biostratigraphical meaning. *Palaeontologia Polonica* **20**, 1–150.

Pożaryska, K. & Szczechura, J. 1970. On some warm-water foraminifera from the Polish Montian. *Acta Paleontologica Polonica* **15**, 95–115.

Szczechura, J. 1969. Problematic microfossils from the upper Eocene of Poland. *Revista Espanola de Micropaleontologia* **1**, 81–94.

Szczechura, J. 1979. A new problematic microfossil from the Eocene of Western Europe. *Acta Palaeontologica Polonica* **24**, 265–274.

Szczechura, J. 1985. *Bifissurinella* (Bryozoa) from the Middle Miocene of the Central Paratethys. *Acta Palaeontologica Polonica* **30**, 201–208.

Szczechura, J. 1990. Marginal bryozoan *Calvina* from the Paleocene of Poland. *Acta Palaeontologica Polonica* **35**, 41–48.

Szczechura, J. 1992. Bicorniferidae: cheilostomatous Bryozoa with articulated colony branches. *Acta Palaeontologica Polonica* **36**, 399–411.

Szczechura, J. & Pożaryska, K. 1971. The Montian warm-water foraminifers in the Meridional Province of Europe. *Acta Palaeontologica Polonica* **16**, 345–388.

Tappan, H. 1993. Tintinnids. In: J.H. Lipps (ed.) *Procaryotes and Protists*. 285–303. Blackwell Scientific Publications, Boston.

Tappan, H. & Loeblich, A. Jr. 1968. Lorica composition of modern and fossil Tintinnida (Ciliate Protozoa) systematics, geological distribution, and some new Tertiary taxa. *Journal of Paleontology* **42**, 1378–1394.

Taylor, P.D. & Voigt, E. 1992. *Hoeverella krauseae* gen. et sp. nov., an unusual uniserial cheilostome bryozoan from the Campanian of Hannover. *Paläontologische Zeitschrift* **6**, 115–122.

Willems, W. 1972. Problematic microfossils from the Ypres Formation of Belgium. *Bulletin de la Société Belge de Géologie, de Paléontologie et d'Hydrologie* **81**, 53–73.

Willems, W. 1975. Microfossiles problématiques de l'Eocène moyen et superieur du sondage de Kallo (Belgique). *Revue de Micropaléontologie* **17**, 192–208.

Streszczenie

Z osadów paleocenu (montu) z Polski północnej, opisano *Geminella polonica* gen. et sp. n., stanowiącą nieznany dotąd typ kolonii, bądź segment kolonii mszywiołów Cheilostomata Anasca, o nieustalonej przynależności do rodziny. Segmenty *G. polonica* mają postać (kształt) odwróconej do góry gruszki i składają się z dwóch zooeciów, z których każde posiada terminalne ujście, natomiast tylko proksymalne zooecium jest wydłuożne u podstawy i zaopatrzone w kanalik. Wydaje się, że niektóre zooecia mają boczne, kieszeniowate, otwarte na zewnątrz wypukłości. Trudno ustalić, czy *G. polonica* tworzyła kolonie płożące czy drzewkowate.

Pojedyncze zooecia pod wieloma względami, zwłaszcza kształtem ogólnym i wykształceniem części oralnej, przypominają wapienne mikroskamieniałości zaliczane do pseudarcellidów, znane od paleocenu do oligocenu, z Europy, zachodniej Azji i Ameryki Płn., które traktowano dotąd jako otwornice, mikroproblematyki, bądź tintinnidy. Opisane dotąd liczne rodzaje i gatunki tej grupy mikroskamieniałości, wydzielone w oparciu o pokrój ogólny skorupki, wykształcenie części oralnej i położenie (jeśli istnieje) „nóżki" są nieuzasadnione; ta przypuszczalna zmienność pseudarcellidów zdaje się wynikać z kształtu (zapewne płożących) kolonii i/albo położenia poszczególnych osobników w obrębie kolonii. Wymienione cechy pseudarcellidów, a także zmienność dotycząca stopnia zwapnienia (perforowanej!) płytki oralnej sugerują, że należą one do mszywiołów, stanowiąc skrajne ogniwo w linii ewolucyjnej obejmującej bicorniferidy i *Geminella*.