

# Restudy of the type specimens of *Phanerostomum asperum* Ehrenberg 1854 (Late Cretaceous, Foraminifera)

Marius D. Georgescu

Department of Geosciences, University of Calgary, 2500 Northwest Drive, Calgary, Alberta T2N 1N4, Canada  
email: dgeorge@ucalgary.ca

**ABSTRACT:** Revision of the type material of *Phanerostomum asperum* Ehrenberg, 1854 from the Upper Cretaceous of Rügen Island (northern Germany) shows that it is a planispiral species assignable to the genus *Globigerinelloides* Cushman and ten Dam, 1948; its stratigraphical range is Santonian–Maastrichtian.

**Keywords:** planktic foraminifera, Late Cretaceous, taxonomy, *Globigerinelloides asperum*.

## INTRODUCTION

*Phanerostomum asperum* Ehrenberg 1854 was illustrated but not described from the Upper Cretaceous (Lower Maastrichtian) white chalk of Rügen Island (northern Germany), Santonian – (?) lower Campanian of the Upper Missouri Basin (USA) and upper Campanian–Maastrichtian of the Mississippi Basin (USA). The original material is deposited at the Museum of Natural History, Berlin. The Ehrenberg Collection is of paramount importance for the study of late Cretaceous planktic foraminifera, for the many species and genera described by this author in a series of pioneering works in the middle XIX<sup>th</sup> century (Ehrenberg 1839, 1843, 1844, 1854, 1856). Foraminifera described and illustrated by C.G. Ehrenberg were thoroughly reviewed only once in the XIX<sup>th</sup> century by Parker and Jones (1872a, b, c, d, e). In discussion of *P. asperum* these authors noted that the specimen from Rügen is trochospiral.

Cushman (1927a) described the Ehrenberg Collection in detail and noted its excellent state: "... for the most part still in excellent condition, the balsam slightly yellowed with age, as is to be expected, but very clear indeed and showing no signs of deterioration, and the specimens in no wise impaired for study" (Cushman, 1927a, p. 487). He also noted that: "... specimens may be studied both in transmitted light, the method by which Ehrenberg largely worked, and by reflected light, by which it is possible to get a good idea of the surface." (*ibid.*, p. 488).

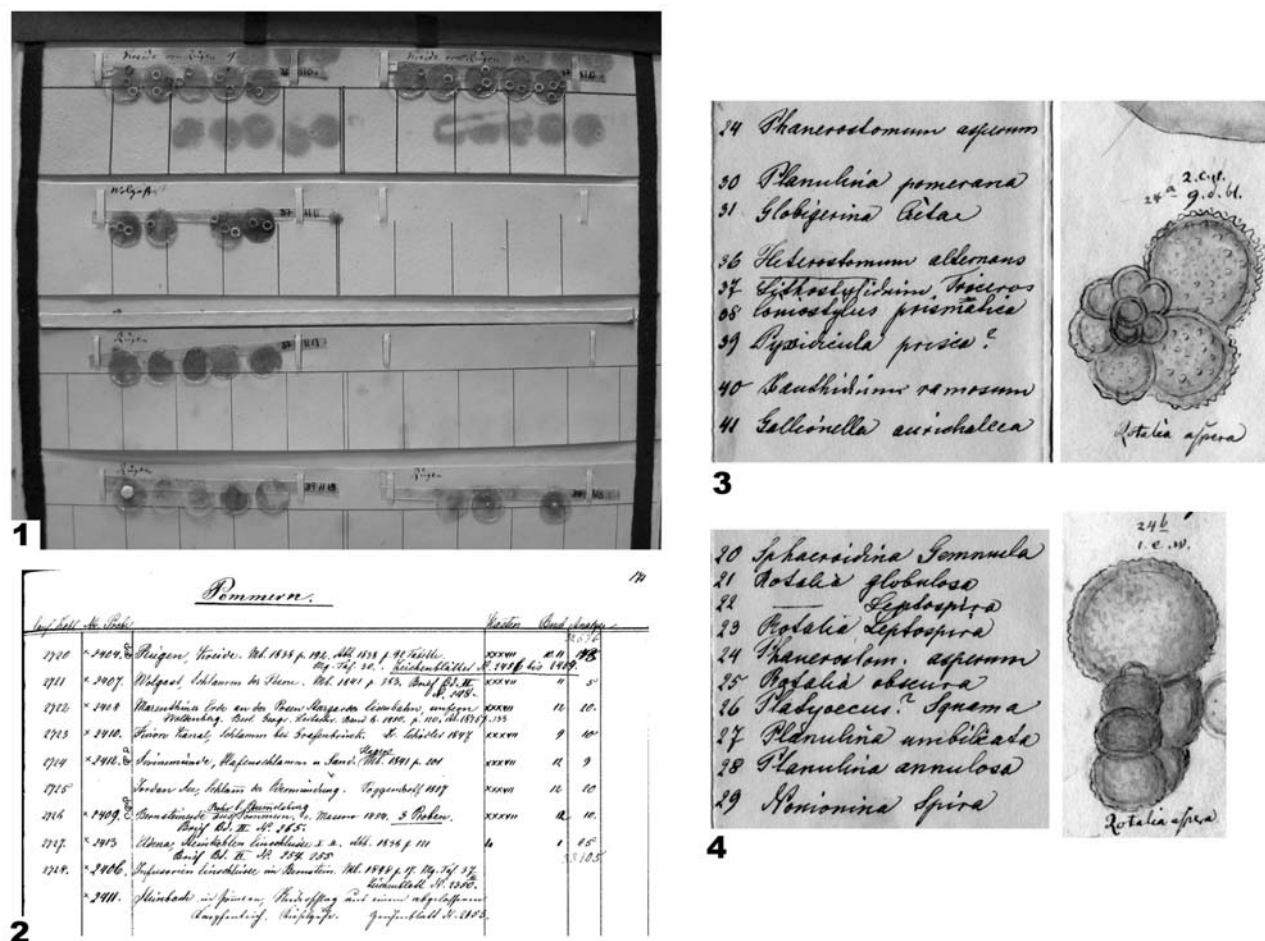
The type material of *Rotalia aspera* (Ehrenberg 1854) re-examination was recommended by Brönnimann (1952, p. 48), who considered that the original description and figures are inadequate. However, the discussion was made under *Globigerinella escheri escheri* (Kaufmann in Heer, 1865), a planispiral species. Apparently Brönnimann (1952) was not aware that Ehrenberg (1854) mentioned two distinct taxa: *R. aspera* and *P. asperum*, which are trochospiral and planispirally coiled respectively and, moreover, Ehrenberg (1854) did not provide a description for any of his new species.

Pessagno (1967, p. 275) designated the Ehrenberg's specimen from the Rügen Island as lectotype of *Globigerinelloides asperum* and this taxonomical act was followed in all the subse-

quent studies; it is obvious in Pessagno's remarks that the lectotype designation was based on the literature study and did not follow a direct examination of the original material. The specimens studied by Ehrenberg are caught in a mass of cooked and therefore brittle Canada balsam, between two mica slides, and a specimen reorientation to illustrate both lateral and edge views would have been virtually impossible. Therefore the lectotype designated by Pessagno is in fact two distinct specimens (Masters 1977, 1980). The lectotype was therefore considered the first illustrated specimen in the plates (Ehrenberg 1854, pl. 30, fig. 26a).

Barr (1968a) mentioned an examination of the material in the Ehrenberg Collection, with special focus on the species *Rotalia aspera* and *P. asperum*. He noted that the "... examination of these specimens in detail was difficult as they are embedded in balsam which has turned a dark amber color; they could readily be observed, however, using transmitted light as was done by Ehrenberg" (Barr, 1962a, p. 313). This is the first mention of the deteriorating state of the Canada balsam in which the foraminiferal tests in the Ehrenberg Collection are preserved.

The validity of *G. asperum* was contested by Masters (1977, p. 401) who, following Parker and Jones (1872c) and Sliter (1968), considered that Ehrenberg (1854)'s illustrations cannot warrant an unequivocal assessment of test coiling. Instead he opted for the next available name: *G. abberanta* (Netskaya 1948). In a subsequent note, Masters (1980) gave a detailed account of five of Ehrenberg's Cretaceous planktic foraminiferal species, *G. asperum* among them. Masters (1980) also examined material from the original bulk samples and illustrated the first Scanning Electron Microscope (SEM) images of specimens from the Ehrenberg Collection, noting the occurrence of gerontic specimens with biaperturate final chamber in *G. asperum*. Despite the relevant material obtained from the bulk sample from Rügen Island, Masters (1980, p. 96) expressed doubts on the planispiral coil of the lectotype selected by Pessagno (1967) and suggested that the other specimen (Ehrenberg 1854, pl. 30, fig. 26b) is clearly planispiral and should be designated as lectotype.



TEXT-FIGURE 1

Ehrenberg collection materials. 1: Case 37, Book 11 – the lectotype is located in Slide 9d (upper left corner). 2: detail of the Clara Ehrenberg Sample Catalogue with the samples 2404a and b from the Rügen Island. 3: extracts of the Drawing 2458 (fig. 24a) showing the lectotype. 4: extracts of the Drawing 2457 (fig. 24b). Note the discrepancy between the captions and identifications under the figure in both drawings.

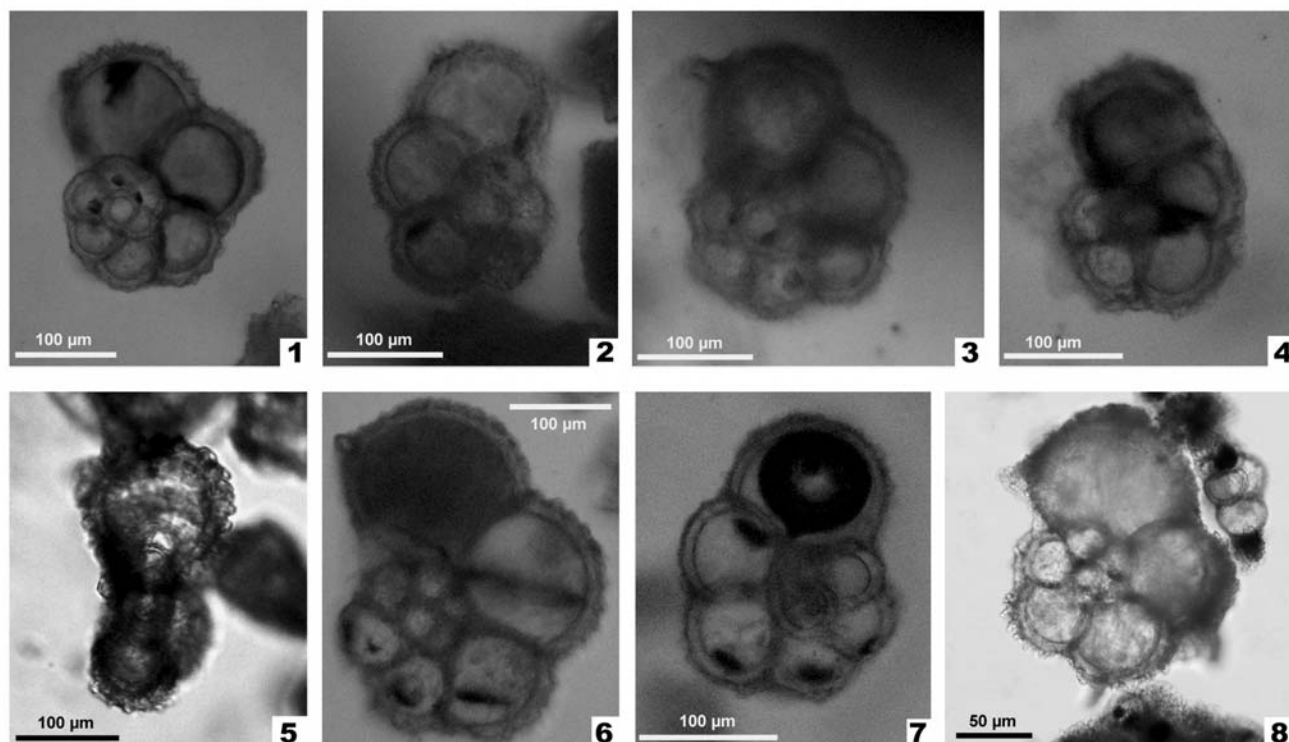
These data show that there are still significant controversies regarding the test morphology of *G. asperum*. A new re-examination of the original material of this species was undertaken as part of a thorough restudy of the Ehrenberg Collection planktic foraminifera in order to clarify its morphology and stratigraphical range.

## MATERIAL PROVENANCE

The first objective was to restudy the C.G. Ehrenberg material from Rügen Island (northern Germany) in the Museum of Natural History (Berlin), from which the lectotype selected by Pessagno (1967) was designated. The mica slides, which contain these specimens, are deposited in Case 37, Book 11 (Text-figure 1: 1). The lectotype is in Mica disk 37–11–9d (Text-figure 1: 1, 3) and is in a relatively good state of preservation; the darker areas on the specimen resulting from the Canada balsam alteration did not affect the proloculus and all the chamber outlines are sharply defined (Text-figure 2: 1). The original drawings were found in the Ehrenberg Drawing Collection as follows: a black and white version (Drawing 1754), and a sepia drawing, most likely a draft of the corresponding plate in *Mikrogeologie* (Drawing 2458) (fig. 24a). The speci-

men in edge view (Ehrenberg, 1854, pl. 30, fig. 26b), which was selected by Masters as lectotype, is in the Mica disk 37–11–1e. There are two drawings in which this specimen occurs, namely a black and white version (Drawing 1754), and a sepia version (Drawing 2457) (fig. 24b). The specimens are labelled as *R. aspera* in the drawings (Text-figure 1: 3–4). Drawing 2957, which, according to Masters (1980, p. 96) includes both original *G. asperum* illustrations, contains drawings of sponge spicules.

The bulk sample from which C.G. Ehrenberg collected the original specimens of *G. asperum* was found in the collection and it has the number 2404a; sample 2404b also exists. The two samples match the record in the Clara Ehrenberg Sample Catalogue (unpublished, p. 171, available at <http://download.naturkundemuseum-berlin.de/Ehrenberg>), which lists all the samples from which C.G. Ehrenberg collected the material studied during his career (Text-figure 1: 2). Approximately 1.5 cm<sup>3</sup> of soft, white chalk was disintegrated in water and then sieved using the classical procedure in sample washing. It yielded an assemblage of benthic and planktic foraminifera (Pl. 1, Figs 1–29), which indicates an early Maastrichtian age: *Nodogerrina pseudoscripta* (Cushman 1937), *Lenticulina rotulata* Lamarck 1804, *Guttulina*



TEXT-FIGURE 2

Specimens of *G. asperum* from the Ehrenberg Collection (1–4: Case 37, Book 11–Rügen Island and 5–6: Case 23, Book 4–Upper Missouri) and Bailey Collection (7) from Upper Missouri. 1: lectotype (Mica disk 37–11–9d). 2–4: paralectotypes (Mica disks 37–11–9a, 9e and 9d respectively). 5: paralectotype (Mica disk 37–11–1e). 6–7: paralectotypes from Mica disk 23–4–1a. 8: hypotype from Slide 1108.

*trigonula* (Reuss 1845), “*Heterohelix*” *striata* (Ehrenberg 1839), *Planoheterohelix* sp., *Globotruncanella minuta* Caron and González Donoso in Robaszynski and others 1984, *Rugoglobigerina rugosa* (Plummer 1927), *Bolivinoidea decoratus decoratus* (Jones in Wright 1886), *B. pettersoni* Brotzen 1945, *Gyroidinoides turgida* (von Hagenow 1842), *Gavelinella complanata* (Reuss 1851) and *Cibicidoides bembix* (Marsson 1878); this age based on the benthic and planktic foraminiferal content matches those for the Rügen chalk by means of calcareous nannoplankton (Sissingh 1977), brachiopods (Surlyk 1970), belemnites (Schulz 1979), ostracods (Herrig 1966) and benthic foraminifera (Frenzel 2000).

Ehrenberg Collection Case 23, Book 4 contains the material from the Upper Cretaceous (upper Santonian–lower Campanian) sediments of the Upper Missouri region (USA). The specimen illustrated by Ehrenberg (1854, pl. 32, group I, fig. 24) is trochospiral, most likely belonging to genus *Archaeoglobigerina* Pessagno 1967. Although rare, specimens of *G. asperum* were found in all the Mica disks (Text-figure 2: 5–6). Two detached specimens are herein reported from the Sample 1595b, which contains a late Santonian–early Campanian planktic foraminiferal assemblage consisting of the following species: “*Heterohelix*” *americana* (Ehrenberg 1843), “*H.*” *reussi* (Cushman 1938), *Spiroplecta americana* Ehrenberg 1844, *Laeviheterohelix pulchra* (Brotzen 1936), *Globigerinelloides prairiehillensis* Pessagno 1967, *Costellagerina pilula* (Belford 1960) and *Fingeria kingi* (Trujillo 1960). This assemblage presents similarities to that reported from the Smoky Hill

Shale of the Niobrara Formation of Kansas (Frerichs and Dring 1981). Lithologically sample 1595b consists of green–olive shaly chalk, which corresponds to the main lithology of this lithostratigraphic unit (Hattin 1965; Frerichs and Dring 1981). Therefore, it appears reasonable to assume that the original sample in the Ehrenberg Collection was collected from the Smoky Hill Member of the Niobrara Formation, although the precise section location is unknown (Nicollet 1841, 1843; Bailey 1841, 1844, 1845; Parker and Jones 1872c; Loeblich and Tappan 1962).

The material from Missouri and Mississippi studied by C.G. Ehrenberg was sent to him by J.W. Bailey, pioneer of American micropaleontology, known mostly for his studies on siliceous microfossils, such as diatoms and radiolarians. Four slides with foraminifera from the Smoky Hill Member of the Niobrara Formation, which were not studied in detail after J.W. Bailey, which are deposited in the Farlow Herbarium (Harvard University) yielded well-preserved specimens of *G. asperum* (Text-figure 2: 7). The slides are labelled 1108 to 1111 and have the foraminiferal specimens mounted in Canada balsam, similar to those in the Ehrenberg Collection. Although there are traces of alteration around the slide margins, the Canada balsam is in a good preservation state and test ornamentation features can be easily observed, even after more than 170 years since slide preparation. Apparently these slides were prepared from the same samples Bailey had sent to Ehrenberg and the most complete label on slide 1109 confirms this: “Yellow Calcareous Marl, Cretaceous, Upper Missouri, Mr. Nicollet”.



*Globigerinelloides asperum* is a frequent species in Santonian–Maastrichtian tropical and temperate water sediments worldwide and has been studied by the author from a variety of locations during the last twenty years. They include the Late Cretaceous white chalk of Northern Ireland and England (McGugan Collection, University of Calgary) and southeast Romania, Deep Sea Drilling Project Hole 111A Orphan Knoll (North Atlantic Ocean), DSDP Sites 305 and 463 (Shatsky Rise and Mid-Pacific Mountains respectively, equatorial central Pacific Ocean), Ocean Drilling Program Holes 1050C and 1052E (Blake Plateau, Western north Atlantic Ocean), etc.. Although often affected by diagenesis and low-magnitude recrystallization, the material is still well-preserved and allows high resolution morphological observations on test ultrastructure, ornamentation and porosity. Specimens from the wells drilled under the auspices of the DSDP/ ODP/Integrated Ocean Drilling Program (IODP) are labelled following the standard procedure: leg number–site (hole) number–core number–section number, sample number in centimetres. The specimens illustrated in this study are deposited in the Museum of Natural Sciences, Berlin (ECO 049).

## TAXONOMY

Higher classification units are after Loeblich and Tappan (1987).

Order Foraminiferida Eichwald 1830

Suborder Globigerinina Delage and Hérourard 1896

Superfamily Planomalinae Bolli and others 1957

Family Globigerinelloidea Longoria 1974

Subfamily Globigerinelloidinae Longoria 1974

Genus *Globigerinelloides* Cushman and ten Dam 1948

Type species. *Globigerinelloides algeriana* Cushman and ten Dam 1948.

***Globigerinelloides asperum* (Ehrenberg 1854) emended Georgescu**  
Plate 2, figures 1–13, plate 3, figures 1–15, text-fig. 2: 1–7

*Phanerostomum asperum* EHRENBURG 1854, pl. 30, figs 26a, 26b, non pl. 32, group I, fig. 24, non pl. 32, group II, fig. 42. –CUSHMAN 1927b, pl. 34, fig. 24.

*Globigerina cretacea* d'Orbigny. PARKER and JONES 1872c, p. 189. *Rotalia aspera* Ehrenberg. BEISSEL, 1891, pl. 14, figs 1–6.

*Globigerina aspera* Ehrenberg, non EGGER 1902, p. 170, pl. 21, figs 18–20. –FRANKE 1928, p. 192, pl. 18, fig. 10.

*Globigerina aequilateralis* Brady. ? CHAPMAN 1892, pl. 15, fig. 14. –EGGER 1902, pl. 21, fig. 9. –HERON–ALLEN and EARLAND 1910, p. 424, pl. 8, figs 11–12.

*Globigerinella aspera* Ehrenberg, non CARMAN 1929, p. 315, pl. 34, fig. 6. –CUSHMAN 1931, p. 44, pl. 6, fig. 5. –non JENNINGS 1936, p. 194, pl. 4, fig. 11. –BROTZEN 1936, p. 170, pl. 13, fig. 2, text–fig. 62. –non LOETTERLE, 1937, p. 45, pl. 7, fig. 4. –MARIE 1941, p. 235, pl. 36, fig. 336. –BROTZEN 1942, fig. 8C. –SCHIJFSMA 1946, p. 94, pl. 6, fig. 8. –BANDY 1951, p. 508, pl. 75, fig. 3. –VISSER 1951, p. 285, pl. 8, fig. 15. –non HAMILTON 1953, p. 226, pl. 30, fig. 5. –SUBBOTINA 1953, p. 120, pl. 13, fig. 5. –HAGN 1953, p. 92, pl. 8, fig. 7. –BOLIN 1956, p. 294, pl. 39, figs 10–11. –BUKOWY and GEROCH 1957, p. 317, pl. 28, figs 1–2. –non SMITTER 1957, p. 199, fig. 20. –BELFORD 1960, p. 91, pl. 25, figs 4–6. –GRAHAM 1962, pl. 19, fig. 3A. –HERM 1962, p. 49, pl. 3, fig. 6. –GRAHAM and CHURCH 1963, p. 64, pl. 7, fig. 17. –non NORTH and CALDWELL 1964, p. 25, pl. 4, fig. 8. –CATI 1964, p. 251, pl. 41, fig. 3.

*Globigerinella abberanta* NETSKAYA 1948, p. 220, pl. 2, fig. 3.

*Biglobigerinella algeriana* TEN DAM and SIGAL 1949 p. 234, figs 1–3.

*Globigerina biforaminata* HOFKER 1956a, p. 76, pl. 9, fig. 68; –HOFKER 1960c, fig. 19. –HOFKER 1966, p. 78, pl. 14, fig. 82, pl. 17, figs 64, 76.

*Globigerinella biforaminata* (Hofker). HOFKER 1956b, fig. 20. –HOFKER 1956c, p. 53, figs 2, 5. –BUKOWY and GEROCH 1957, p. 317, pl. 28, fig. 3.

*Globigerina aspera* f. *plana* ? HOFKER 1957, p. 414, fig. 475, lower specimen.

*Globigerina aspera* (Ehrenberg). HOFKER 1958, p. 472, pl. 5, fig. 27. –ANSARY and FAKHR 1958, p. 132, pl. 2, fig. 12. –HOFKER 1960a, pl. 2, figs 20–27.

*Biglobigerinella biforaminata* (Hofker). HOFKER 1960a, pl. 2, figs 28–29. –HOFKER 1960b, fig. 1: 12. –OLSSON 1960, p. 44, pl. 8, figs 7–8. –MELLO 1969, p. 95, pl. 2, figs 3–5. –MORRIS, p. 280, pl. 6, fig. 13.

*Planomalina aspera* (Ehrenberg). BARR 1961, p. 561, pl. 69, fig. 4. –MARTIN 1964, p. 84, pl. 10, fig. 7.

*Planomalina rowei* BARR 1961, p. 564, pl. 69, fig. 2.

*Globigerina* (*Globigerinella*) *aspera* (Ehrenberg). HOFKER 1961, fig. 54.

*Biglobigerinella multispina* Lalicker. JORDAN 1962, p. 6, pl. 1, fig. 8.

*Planomalina* (*Globigerinelloides*) *messinae* (Brönnimann). BERGGREN 1962, p. 44, pl. 8, figs 6, 8, fig. 6: 1–6, fig. 7: 1–8.

*Globigerinella voluta* (White). HERM 1962, p. 51, pl. 3, fig. 7.

*Globigerinella voluta pinguis* HERM 1962, p. 52, pl. 1, fig. 1.

*Planomalina* (*Globigerinelloides*) *aspera aspera* (Ehrenberg). non VAN HINTE 1963, p. 97, pl. 12, figs 2–3, text–fig. 15. –VAN HINTE 1965, p. 85, pl. 1, fig. 2.

*Planomalina* (*Globigerinelloides*) *messinae messinae* (Brönnimann). VAN HINTE 1963, p. 100, pl. 12, fig. 6.

*Globigerinelloides aspera* (Ehrenberg). BARR and CORDEY 1964, p. 309. –BARR 1966, p. 503, pl. 78, fig. 4. –BARR 1968a, p. 313, pl. 37, figs 3, 6. –BARR 1968b, pl. 2, fig. 2. –NEAGU 1970, p. 63, pl. 25, figs 22–23. –HANZLIKOVÁ 1972, p. 98, pl. 25, fig. 1. –BARR 1972, p. 11, pl. 1, fig. 3. –VILLAIN 1977, p. 72, pl. 13, figs 4–5.

*Globigerina* (*Biglobigerinella*) *biforaminata* Hofker. PERLMUTTER and TODD 1965, p. 18, pl. 5, figs 2–3. –TODD 1970, p. 152, pl. 5, fig. 10.

*Globigerinelloides asper* (Ehrenberg). TAKAYANAGI 1965, p. 201, pl. 20, fig. 9. –PORTHAULT in DONZE and others 1970, p. 63, pl. 9, figs 8–9. –MASTERS 1980, p. 96, pl. 1, figs 1–5, fig. 1.

*Globigerina asperiformis* HOFKER 1966, p. 157, pl. 25, fig. 170.

*Globigerinelloides asperus* (Ehrenberg). PESSAGNO 1967, p. 274, pl. 60, figs 4–5. –EL–NAGGAR 1971, pl. 3, figs i–j. –FRERICHS and others 1975, p. 302, pl. 2, figs 1–3. –FRERICHS and DRING 1981, p. 68, pl. 2, figs 1–2. –non KRASHENINNIKOV and BASOV 1983, p. 803, pl. 2, figs 1–3. –FRERICHS and DEISS 1987, fig. 5:2. –GAWOR–BIEDOWA 1982, p. 77, pl. 12, figs 7–8.

*Globigerinelloides messinae* (Brönnimann). SLITER 1968, p. 99, pl. 15, figs 3, 5. –HANZLIKOVÁ 1969, p. 45, pl. 12, figs 1–3.

*Globigerinelloides multispina* (Lalicker). DOUGLAS 1969, p. 161, pl. 9, fig. 6. –SMITH and PESSAGNO 1973, p. 13, figs 1–2. –QUILTY 1992, p. 380, pl. 1, figs 17–18.

*Globigerinelloides volutus* (White). FRERICHS and others 1975, p. 305, pl. 2, figs 4–6. –PERYT 1980, p. 50, pl. 7, figs 1–2. –PETERS 1983, p. 46, pl. 2, figs 7, 13. –STRONG 1994, p. 4, pl. 1, figs 1–2. –CAMPBELL and others 2004, fig. 11: CC–DD.

*Globigerinelloides abberanta* (Netskaya). MASTERS 1977, p. 401, pl. 8, figs 3, 5. –ABDEL–KIREEM and ABDOU 1979, p. 184, pl. 1, figs 1–3.

*Globigerinelloides algeriana* (ten Dam and Sigal). ABDEL–KIREEM and ABDOU 1979, p. 184, pl. 1, fig. 4.

*Globigerinelloides irregularis* ABDEL–KIREEM and ABDOU 1979, p. 184, pl. 1, fig. 5.

*Globigerinelloides prairiehillensis* Pessagno. ABDEL–KIREEM 1980, p. 185, pl. 1, figs 1–3. –PERYT 1980, p. 50, pl. 8, figs 1–4.

*Globigerinelloides* aff. *multispina* (Lalicker). BERGSTRESSER and FRERICHS 1982, p. 358, pl. 1, figs 11–12.

*Globigerinelloides asperus asperus* (Ehrenberg). non BELFORD 1983, p. 48, pl. A1, figs 1–4.

*Globigerinelloides rowei* (Barr). NEAGU 1987, p. 291, pl. 12, figs 13–19.

**Emended diagnosis.** Test planispiral with 5 ½–6 globular chambers in the final whorl, ornamented with dome-like pustules, which are equally developed over the test surface; test wall is simple and perforate (pore diameter 0.3–1.0 µm).

**Description.** Test is involute planispiral with lobate outline, and consists of eight to eleven globular to subglobular chambers arranged in  $1\frac{1}{4}$  to  $1\frac{1}{2}$  whorls; there are  $5\frac{1}{2}$ –6 chambers in the final whorl with rapid or, more rarely, moderate size increase. Sutures are depressed, straight and radial. Test is biumbilicate; umbilical regions are small, with a diameter of approximately 20–25% of the maximum test diameter. The test is symmetrical in edge view, with low to moderate chamber thickness increase; periphery is broadly rounded and without peripheral structures. Aperture is in equatorial position, a low to medium high arch at the base of the last formed chamber and bordered by a thin lip; gerontic specimens occasionally present biaperturate final chamber. No relict apertures occur in the umbilical regions. Chambers are ornamented with dense dome-like pustules (4.8–6.7  $\mu\text{m}$ ), which are equally developed over the test surface. Test wall is calcitic, hyaline, simple and perforate; pores are circular, with a diameter of 0.3–1.0  $\mu\text{m}$ .

**Stratigraphical range.** Santonian–Maastrichtian; maximum observed frequency is in the Santonian–lower Campanian and lower–middle Maastrichtian sediments.

**Geographical distribution.** Cosmopolitan.

**Remarks.** The emendation is proposed to accommodate the new data on test ornamentation, ultrastructure and porosity. *Globigerinelloides asperum* frequently occurs in association with *G. prairiehillensis* Pessagno, 1967; it differs from it by having the test consisting of fewer whorls ( $1\frac{1}{4}$  to  $1\frac{1}{2}$  rather than 2 to  $2\frac{1}{2}$ ), fewer chambers in the final whorl ( $5\frac{1}{2}$  to 6 rather than 6 to 7) and higher rate of chamber size increase. It differs from *G. alvarezi* (Eternod Olvera, 1959) and *G. ehrenbergi* (Barr, 1961) by having fewer chambers in the final whorl, which increase in size at a higher rate. It differs from *G. subcarinata* (Brönnimann, 1952) mainly by lacking the subacute periphery and imperforate peripheral band on the earlier chambers of the final whorl, and from *G. burlingtonensis* Petters, 1977 mostly by having a narrower umbilical region and lacking the slight radial elongation of the last-formed one or two chambers. *Globigerinelloides messinae* (Brönnimann, 1952) has a lower rate of chamber thickness increase, which results in a compressed appearance of the test in edge view; this feature is not present in *G. asperum* and for this reason the two species are considered distinct. The main aperture in *G. asperum* is in peripheral position, but an adult specimen with asymmetrical aperture, in which one branch extends in the umbilical area, is herein reported (Pl. 2, Figs 10–13). A gerontic stage with biaperturate chamber or doubled chambers with respect to the test symmetry plan was documented by Masters (1980, pl. 1, fig. 4); apparently such specimens are extremely rare and none of them are recorded in this study.

## CONCLUSIONS

Restudy of the type material of *Phanerostomum asperum* (Ehrenberg, 1854), together with additional collection material from the J.W. Bailey Collection and new specimens from DSDP/ODP/IODP holes helped in clarifying the morphology and stratigraphical distribution of this species. A detail investigation of the literature further contributed to the species revision.

The lectotype selected by Pessagno (1967) and illustrated by Ehrenberg (1854, pl. 30, fig. 26a) is planispirally coiled. Therefore this species is assignable to the genus *Globigerinelloides*

Cushman and ten Dam, 1948. Six species and subspecies are considered synonyms of *G. asperum*: *Globigerinella abberanta* Netskaya 1948, *Globigerina biforaminata* Hofker 1956a, *Planomalina rowei* Barr 1961, *Globigerinella voluta pinguis* Herm 1962, *G. asperiformis* Hofker 1966 and *Globigerinelloides irregularis* Abdel-Kireem and Abdou 1979. The ancestry of *G. asperum* is unknown and can only be solved in the context of a complete revision of the genus *Globigerinelloides*. The similarities in the test ornamentation, ultrastructure and porosity indicate that *G. asperum* may phylogenetically relate to *G. prairiehillensis* or *G. burlingtonensis*.

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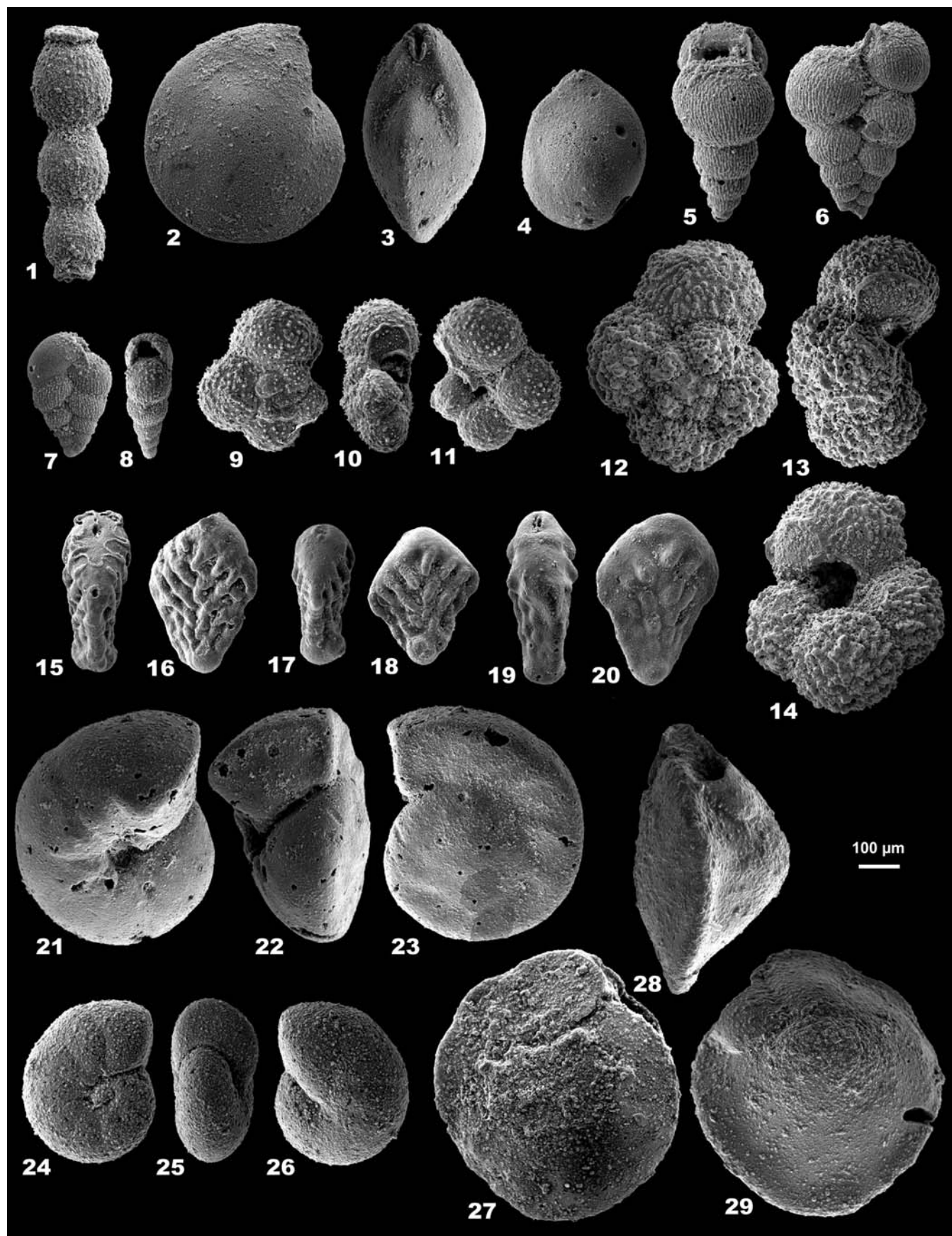
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## PLATE 1

Benthic and planktic foraminiferal assemblage from C.G. Ehrenberg Sample 2404a from the Rügen Island.

- |   |  |
|---|--|
| 1 <i>Nodogerina postscripta</i> (ECO 049–14).           | 15–18 <i>Bolivinoides decoratus decoratus</i> (ECO 049–20 and ECO 049–19). |
| 2–3 <i>Lenticulina rotulata</i> (ECO 049–15).           | 19–20 <i>Bolivinoides pettersoni</i> (ECO 049–18).                         |
| 4 <i>Guttulina trigonula</i> (ECO 049–10).              | 21–23 <i>Gyroidinoides turgida</i> (ECO 049–09).                           |
| 5–6 “ <i>Heterohelix</i> ” <i>striata</i> (ECO 049–08). | 24–26 <i>Gavelinella complanata</i> (ECO 049–21).                          |
| 7–8 <i>Planoheterohelix</i> sp. (ECO 049–03).           | 27–29 <i>Cibicidoides bembix</i> (ECO 049–17).                             |
| 9–11 <i>Globotruncanella minuta</i> (ECO 049–13).       |  |
| 12–14 <i>Rugoglobigerina rugosa</i> (ECO 049–16).       |  |





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## PLATE 2

Four paralectotypes of *G. asperum* collected from Sample 2404a, and deposited in the Ehrenberg Collection.  
Specimens deposited at the Museum of Natural Sciences (Berlin).

1–3 (ECO 049–05).

7–9 (ECO 049–04).

4–6 (ECO 049–01).

10–13 (ECO 049–02).





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### PLATE 3

Five hypotypes of *G. asperum* from the upper Santonian–lower Campanian sediments of the Blake Plateau (western North Atlantic Ocean); Sample 171B–1050C–20–1, 42–45 cm. Specimens deposited at the Museum of Natural Sciences (Berlin).

1–3 (ECO 049–56).

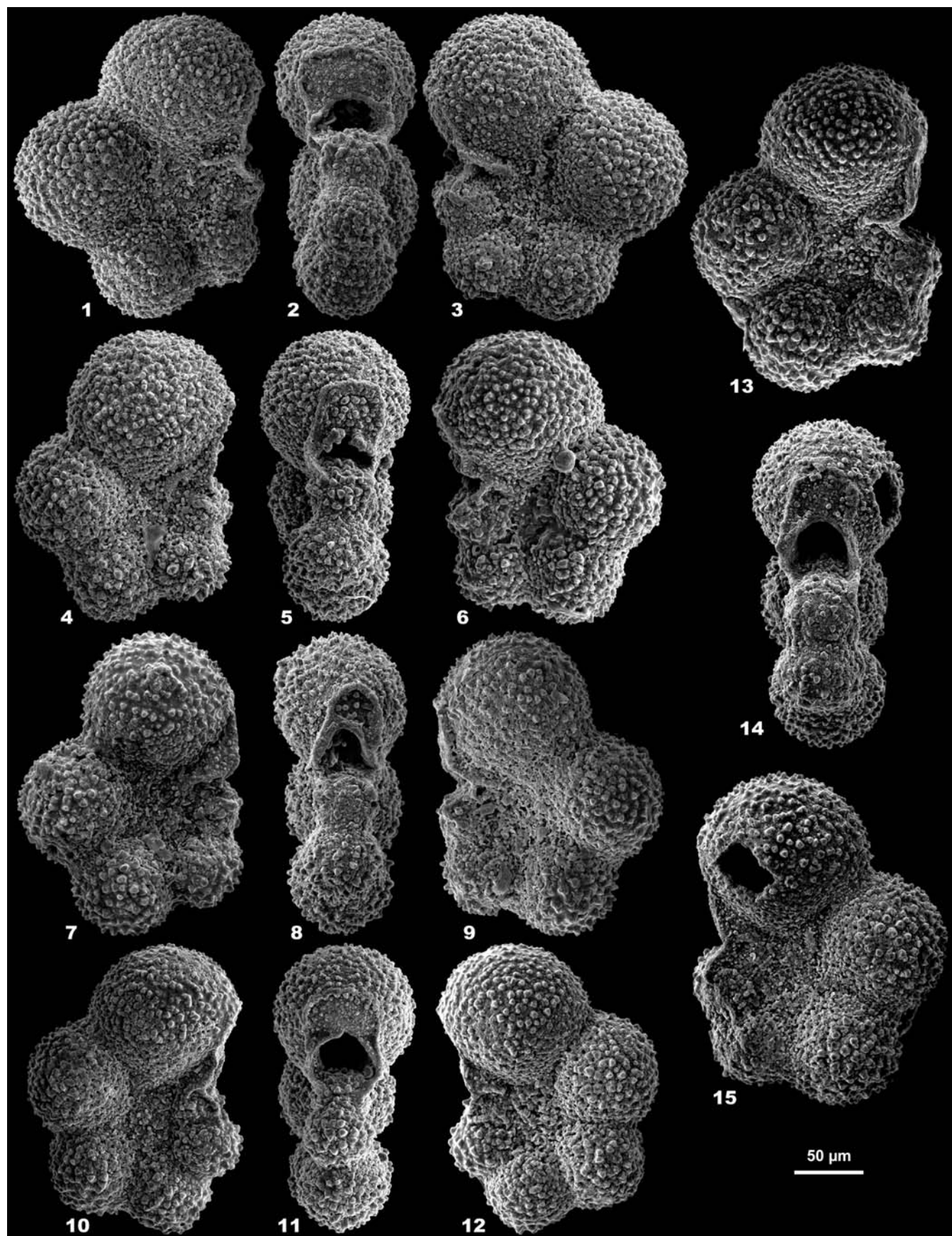
4–6 (ECO 049–57).

7–9 (ECO 049–58).

10–12 (ECO 049–59).

13–15 (ECO 049–60).







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