

AN EMENDATION OF THE GENERA *BEELLA* BANNER AND BLOW, 1960, AND *TURBOROTALITA* BLOW AND BANNER, 1962, WITH NOTES ON *ORCADIA* BOLTOVSKOY AND WATANABE, 1982

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ABSTRACT

Beella Banner and Blow is emended to include the species *Beella megastoma* (Earland), 1934, in which chamber elongation is slight, varying between radial and tangential elongation, to absent. *Turborotalita* Blow and Banner is emended on the observation that the type species, *T. humilis* (Brady), 1884, is spinose. Under a discussion of *Turborotalita*, remarks are given on the ontogeny and taxonomic status of *T. cristata* (Heron-Allen and Earland), 1929. The taxonomy and morphology of *Orcadia riedeli* (Rögl and Bolli), 1973, is also discussed, with notes on its present day distribution.

INTRODUCTION

Previously, the radial elongation of adult chambers has been considered to be the main characteristic of the genus *Beella* Banner and Blow. Radial chamber elongation is considered by this author to be a specific character, diagnostic of the type species *Beella digitata* (Brady), 1879. *Beella* is emended to include the species *B. megastoma* (Earland), in which the adult chambers vary in shape from flattened (tangentially elongate) to only slightly radially elongate. All other diagnostic features of *Beella* are common to both *B. megastoma* and *B. digitata*.

The type species of *Turborotalita* Blow and Banner, *Turborotalita humilis* (Brady), has generally been considered to be nonspinose, and for this reason has also been referred to *Globigerinita* Brönnimann, 1951. The species *T. humilis* cannot be included in the genus *Globigerinita* because of fundamental differences in gross morphology. *Turborotalita* is emended to include the spinose species *T. humilis*, *T. quinqueloba* (Nataland), 1938, and *T. cristata* (Heron-Allen and Earland). For comparison, various ontogenetic stages of these species are figured in this paper.

A small planktonic foraminiferid, originally described as *Hastigerinella riedeli* Rögl and Bolli, 1973, was designated the type species for the new genus *Orcadia* by Boltovskoy and Watanabe (1982). This species has been assigned to the genera *Hastigerinopsis* by Poore (1979), and *Berggrenia* by Saito and others (1981). Closer examination proves that this species cannot be assigned to either of these genera, thus supporting the establishment of the genus *Orcadia*.

The figured specimens of *T. humilis* (Pl. 3, Figs. 6–7), *T. quinqueloba* and *O. riedeli* were collected from

the plankton (depth 5 m) from approximately 55°N latitude, 12°W longitude, in the Rockall Channel, northeastern Atlantic Ocean. The figured specimens of *B. megastoma*, *B. digitata* and *T. humilis* (Pl. 3, Fig. 12), were collected from the top centimeter of sediment from samples taken between 50°N and 55°N latitude in the southern part of the Rockall Trough. Samples were collected using the Barnett and Watson Multiple Corer (Scottish Marine Biological Association, 1975).

All figured tests of *T. cristata* (except Pl. 2, Fig. 13) were taken from the type slide ZF3276 (Heron-Allen and Earland Collection). These specimens are now stored in the following slides at the British Museum (Natural History): Pl. 2, Figs. 9 and 11, Pl. 3, Figs. 1 and 2 (in slide ZF4270); Pl. 2, Fig. 10, Pl. 3, Fig. 3 (in slide ZF4271); Pl. 2, Fig. 12 (in slide ZF4272), and Pl. 2, Fig. 13 (from the H. E. Buckley Collection, Mineralogy Department, British Museum; in slide ZF4273).

SYSTEMATIC DESCRIPTIONS

Family GLOBIGERINIDAE

Carpenter, Parker and Jones, 1862
Genus *Beella* Banner and Blow, 1960,
emended Holmes

Types species. *Beella digitata* (Brady), 1879.

Emended diagnosis. Test trochospiral to streptospiral; chambers globular, varying in shape from flattened to subspherical to digitate; spinose; aperture umbilical, commonly extraumbilical-umbilical or spiro-umbilical.

Remarks. Since the original diagnosis of *Beella* Banner and Blow (1960a) this genus has since been emended by Blow in 1965 and 1979. The emendation of this genus for the third time is a reflection of the wide range in test morphologies. Originally, *Beella* with its chambers becoming radially elongate and digitate, was considered to be a member of the Globorotaliidae on the apparent extraumbilical-umbilical position of the aperture of the lectotype of *B. digitata* (Banner and Blow, 1960a). Loeblich and Tappan (1964) considered the apertural position to be umbilical and placed *Beella* within the Globigerininae. In the most recent emendation prior to this paper, *Beella* was diagnosed as having an essentially umbilical aperture with later chambers becoming radially elongate and digitate (Blow, 1979).

Beella is hereby emended to include those tests, belonging to the species *B. megastoma*, in which the chambers of the adult test vary in shape from flattened (tangentially elongate), through spherical to radially elongate, but never become digitate.

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Beella megastoma (Earland), 1934
Pl. 1, Figs. 1–5, 8

Globigerina megastoma EARLAND, 1934, p. 177, pl. 8, figs. 9–12.

BANNER and BLOW, 1960b, p. 14, pl. 1, fig. 3.

Globigerina praedigitata PARKER, 1967, p. 151, pl. 19, figs. 5–8.

Hastigerinella digitata praedigitata (Parker). BRÖNNIMANN and REISIG, 1971, p. 1,318, pl. 50, fig. 9.

Globigerina (*Beella*) *digitata praedigitata* Parker. BLOW, 1979, p. 125.

Diagnosis. Test medium to large; thin walled; trochospiral becoming streptospiral; periphery lobulate; chambers inflated; shape variable, initially subspherical, later ovate, flattened or slightly radially elongate; aperture large, symmetrical to asymmetrical, interiomarginal, umbilical, often extraumbilical-umbilical or spiroumbilical, usually slightly recessed, bordered by thin lip.

Remarks. An examination of the type material of *Globigerina digitata* Brady, 1879, found that all of the adult tests possess one or more digitate chambers. *Beella megastoma* has an extremely variable morphology (Fig. 1), more so than *Beella digitata*. An examination of more than 150 tests, including specimens belonging to the type collection of *Globigerina megastoma* Earland, found no significant chamber elongation in any of the tests examined.

The tests of *B. megastoma* figured in Plate 1 (Figs. 1, 2, 5), were chosen for their resemblance to the lectotype and syntypes of *Globigerina megastoma* (Banner and Blow, 1960b; Earland, 1934). These specimens show little or no chamber elongation, which may have led to the restricted use of *G. megastoma*.

Radial chamber elongation is not a significant feature in the identification of *B. megastoma*. In many tests the final chamber is either flattened (tangentially elongate), with width greater than length (Fig. 1, Nos. 4, 9; Pl. 1, Figs. 1, 5), or subspherical (Fig. 1, Nos. 2, 7; Pl. 1, Figs. 2, 4). In those tests where radial chamber elongation occurs (Fig. 1, Nos. 3, 5, 8; Pl. 1, Fig. 3), the chambers never become digitate or pointed, as in *Beella digitata* (Pl. 1, Figs. 6–7), and the width is never less than half the length. In many of the larger tests of *B. megastoma*, which are commonly streptospirally coiled, the final chambers that are flattened become increasingly frequent giving the test a globular appearance. Table 1 lists the percentages of various test morphologies of *Beella megastoma* for each of three mesh-size fractions, calculated from a total count of 49 specimens.

Beella megastoma also differs from *B. digitata* in apertural ultrastructural detail. In *B. megastoma* the aperture is slightly recessed below the chamber surface (Pl. 1, Fig. 8) and the apertural lip is very thin. In *B.*

digitata the aperture protrudes slightly from the chamber surface, is more symmetrical and rectangular, and has a thicker lip (Pl. 1, Figs. 9–10).

The ultrastructure of the test wall of *B. digitata* is densely perforate containing clusters of pores separated by sharp ridges. In *B. megastoma* the surface is much smoother with an area above the aperture where the pore density is greatly reduced (Pl. 1, Fig. 8).

Both *B. megastoma* and *B. digitata* have essentially umbilical apertures, the position ranging from umbilical to extraumbilical-umbilical to spiroumbilical. The mode of coiling is either trochospiral or streptospiral. Both species show a tendency for chamber elongation. In *B. digitata* the elongation is more advanced and occurs only in a radial direction. Both species are also characterized by a thin, delicate test wall and the tendency to resorb internal septal walls.

Family GLOBOROTALIIDAE Cushman, 1927

Genus *Turborotalita* Blow and Banner, 1962,
emended Holmes

Type species. *Turborotalita humilis* (Brady), 1884.

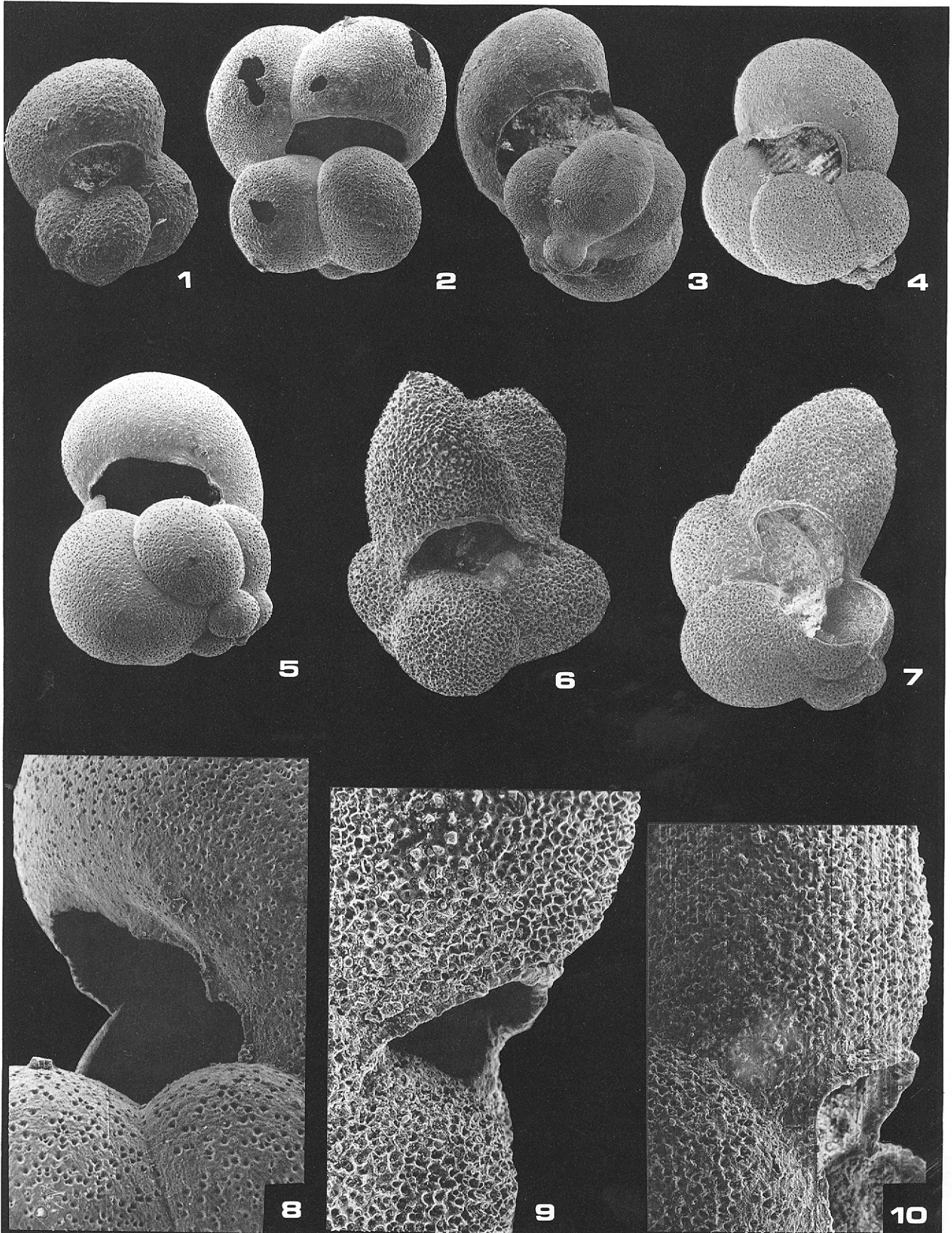
Emended diagnosis. Test low trochospiral; spinose; primary aperture interiomarginal, extraumbilical-umbilical; adults ampullate with infralaminar apertures; chambers subspherical to ovate.

Remarks. *Turborotalita* Blow and Banner, emended here to include spinosity as a diagnostic character of this genus, presents a similar taxonomic problem as some "spinose" Paleogene globorotaliid forms which are retained with the Globorotaliidae on gross morphological criteria. *Turborotalita* differs from *Turborotalia* in being spinose and by possessing an ampulla (bulla of Blow and Banner, 1962).

Turborotalita humilis, the type species of *Turborotalita* has five to seven chambers in the final whorl arranged in a low trochospire. The chambers are subspherical to ovate in shape and are spinose (Pl. 3, Fig. 6). Two juvenile specimens of *T. humilis* are figured in Plate 3 (Figs. 6–7). An adult test of *T. humilis* with a modified final chamber, the ampulla, extending over the umbilicus and along the radial sutures with several infralaminar apertures, is figured in Plate 3 (Fig. 8). *T. quinqueloba* differs in being slightly larger with fewer chambers in the final whorl. The ampulla of *T. quinqueloba* is less developed with fewer infralaminar apertures. The growth series of *T. quinqueloba* is illustrated in Plate 3 (Figs. 9–11). *Globigerina atlantisae* Cifelli and Smith, 1970, and *Globigerina egelida* Cifelli and Smith, 1970, are here considered synonymous with *T. quinqueloba* (tests figured Pl. 3, Figs. 9 and 10 respectively).

PLATE 1

1–5, 8 *Beella megastoma* (Earland). 1–5. All apertural views; 1, $\times 103$; 2, $\times 100$; 3, $\times 78$; 4, $\times 115$; 5, $\times 78$. 8. Apertural detail of Fig. 5, $\times 255$. 6, 7, 9, 10 *Beella digitata* (Brady). 6, 7. Both apertural views; $\times 115$ and 118, respectively. 9. Apertural detail of Fig. 6; $\times 280$. 10. Apertural detail of Fig. 7; $\times 280$.



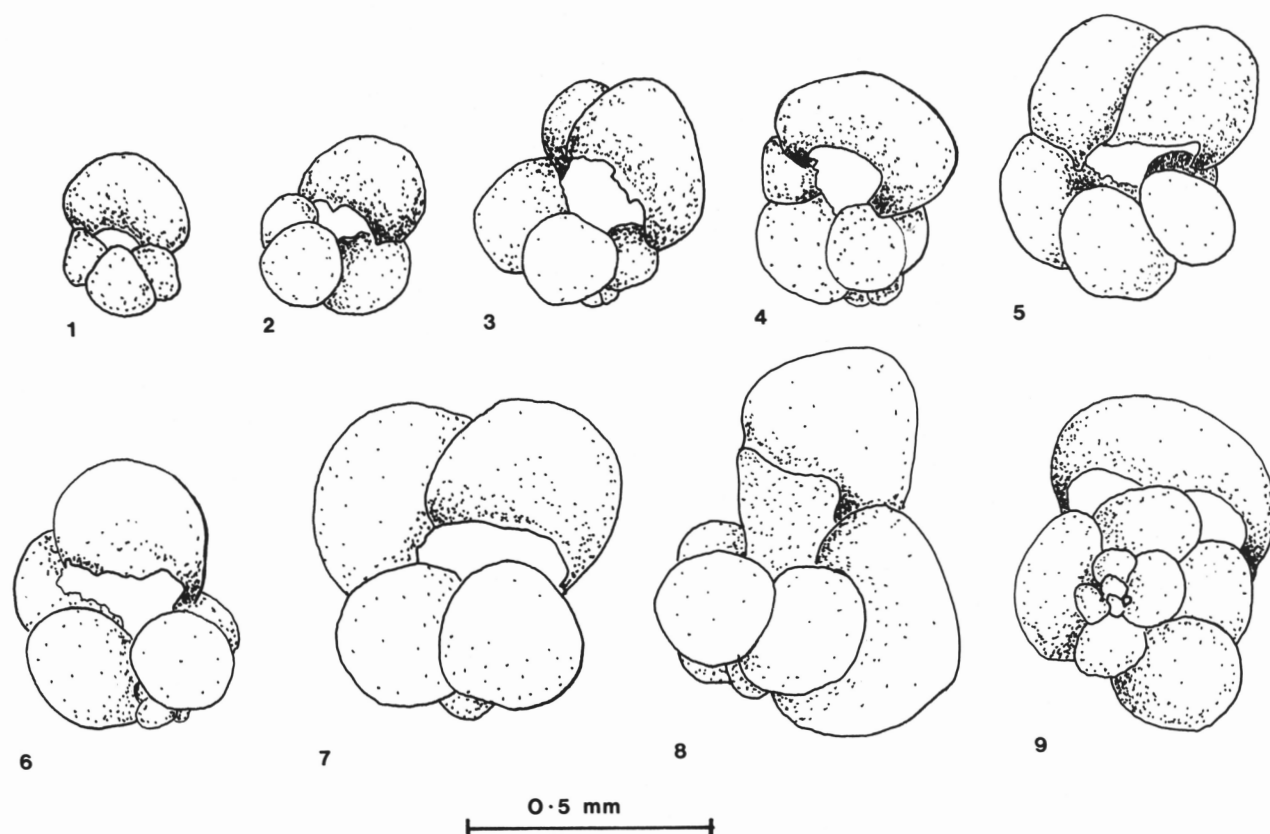


FIGURE 1. Variations in chamber shape and apertural position in *Beella megastoma*.

The similarities of *T. humilis* to *T. quinqueloba* are often discussed in the literature; both species are small, trochospiral, ampullate and have an extraumbilical-apertural. *T. quinqueloba* has long been known to be spinose and has often been placed within the genus *Globigerina*. The characters of the species *T.*

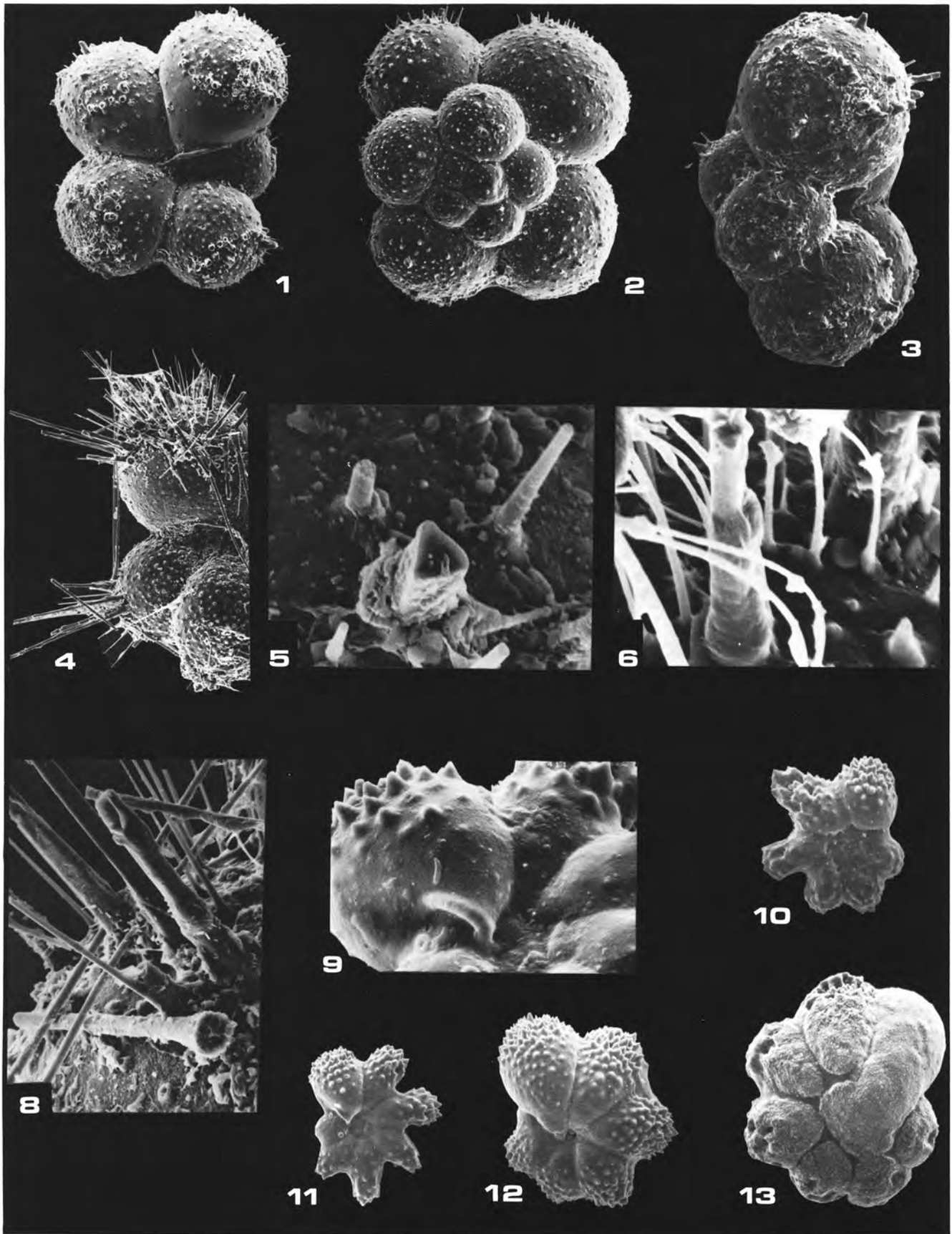
quinqueloba which place it within the genus *Turborotalita* are its ampulla and apertural position (Jenkins, 1977; Poore, 1979; Blow, 1979). *T. humilis* has usually been placed within genera considered nonspinose, such as *Globigerinita* (and previously *Turborotalita*), since it has never convincingly been shown to

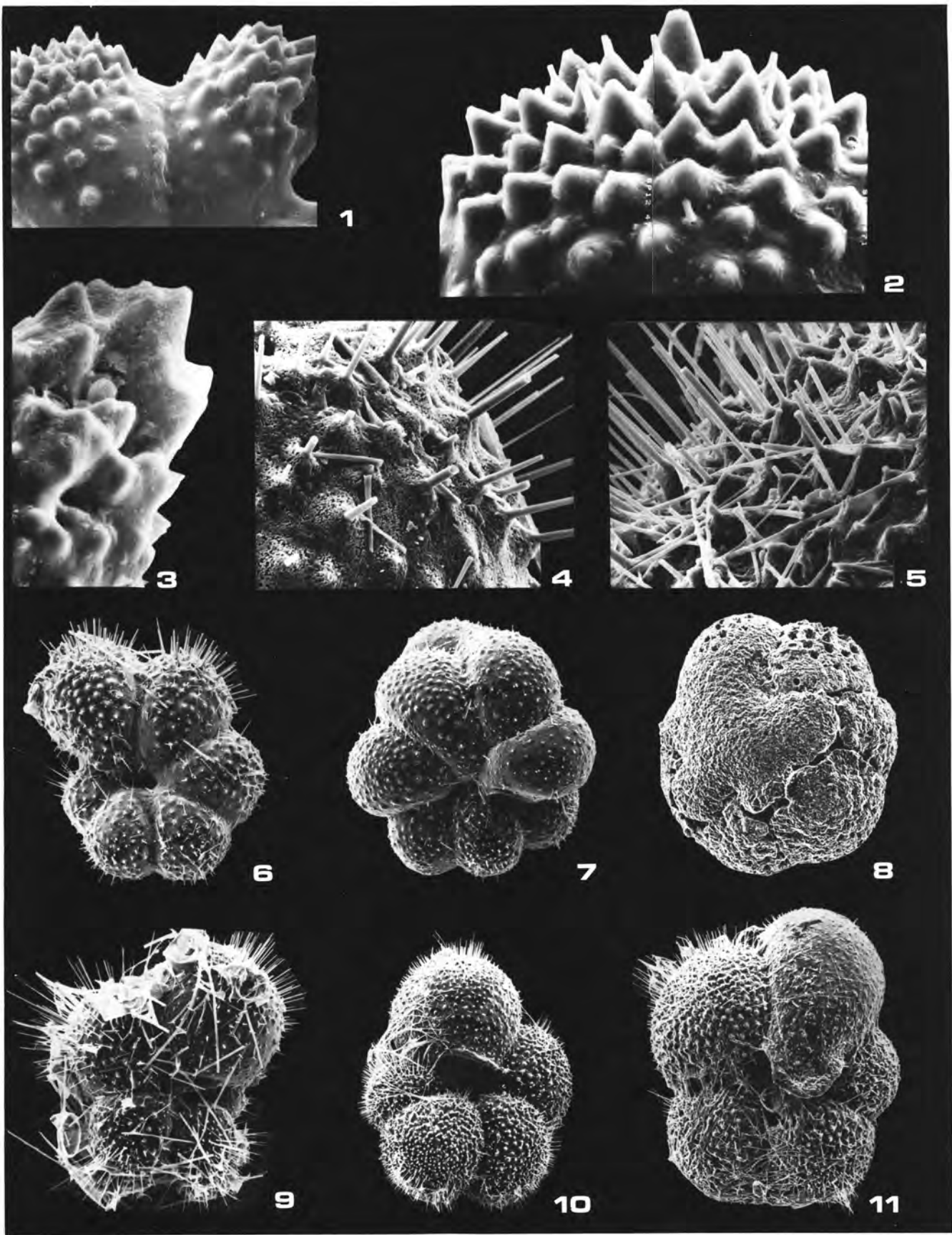
TABLE 1. The percentages of various test morphologies of *Beella megastoma* for each of three mesh-size fractions, calculated from a total count of 49 specimens.

Test size	Test feature								
	% Dextral coiling	Final chamber shape			Coiling mode		Apertural position		
		Round	Elongate	Flattened	Trocho-spiral	Strepto-spiral	Umbilical	Extra-umbilical-Umbilical	Spiro-umbilical
Average	36	55	32	13	74	26	45	36	19
500 μ	30	60	20	20	70	30	10	60	30
250-499 μ	41	52	34	14	69	31	59	21	20
150-249 μ	38	62	38	—	100	—	50	50	—

PLATE 2

1-8 *Orcadia riedeli* (Rögl and Bolli). 1. Ventral view; $\times 340$. 2. Dorsal view; $\times 340$. 3. Side view; $\times 498$. 4. View showing distal location of spines on first and last chamber of final whorl; $\times 300$. 5. Detail of triangular section of a larger spine from Fig. 1; $\times 3,500$. 6. Detail of Fig. 2 showing spine growth regeneration; $\times 3,400$. 8. Detail of Fig. 4 showing spine growth regeneration; $\times 1,600$. 9-13 *Turborotalita cristata* (Heron-Allen and Earland). 9. Detail of aperture from Fig. 11; $\times 750$. 10. Dorsal view, note distal castellate structures on earlier chambers; $\times 250$. 11, 12, 13. Growth series from juvenile to ampullate adult; all $\times 250$.





be spinose. *Globigerinita* differs from *Turborotalita* by being nonspinose, having an umbilical aperture and possessing a bulla.

A bulla is defined as a regular chamberlike structure not added in the normal progression of the spire, covering the primary umbilical cavity. An ampulla, the characteristic feature of the genus *Turborotalita*, is spinose and added in the progression of the spire in the same way as all unmodified chambers (Blow, 1979; pl. 3, fig. 11).

***Turborotalita cristata* (Heron-Allen and Earland), 1929**

Pl. 2, Figs. 9–13; Pl. 3, Figs. 1–3

Globigerina cristata HERON-ALLEN and EARLAND, 1929, p. 331, pl. 4, figs. 33–39. BANNER and BLOW, 1960b, p. 10, pl. 7, fig. 5.

Globigerina humilis (Brady). BÉ, VILKS and LOTT, 1971, p. 38, pl. 1, fig. 8.

Turborotalita cristata (Heron-Allen and Earland). POORE, 1979, p. 473, pl. 2, figs. 10–12.

Turborotalita humilis (Brady). SAITO, THOMPSON and BREGER, 1981, p. 84, pl. 25, fig. 3 only.

Diagnosis. Test very small (maximum diameter approximately 0.17 mm), very low trochospiral, with small umbilicus and seven to eight ovate chambers in the final whorl; sutures straight and radial; early chambers castellate; equatorial periphery subcircular; axial profile parallel-sided; primary aperture interiomarginal, extraumbilical-umbilical, and directed away from umbilicus; final chamber ampullate in adult tests.

Remarks. *Turborotalita cristata* is a very small and rare species. Its ontogenetic variation is largely unknown and is discussed below with an examination of *Globigerina cristata* from the type material of the Heron-Allen and Earland Collection (deposited at the British Museum, Natural History, in slides ZF3275, ZF3276, and ZF3277).

Banner and Blow (1960b), in their taxonomic remarks on *G. cristata*, suggest the possibility that two distinct species may have been figured by Heron-Allen and Earland (1929, pl. 4, figs. 33–39), with figures 33–36 being a species distinct from *G. cristata*. This author considers these specimens to be juvenile tests of *T. cristata*. In the growth series of this species (Pl. 2, Figs. 11–13) Fig. 10 was chosen for its similarity to the specimen in plate 4 (fig. 36) of Heron-Allen and Earland (1929).

The most striking features of *T. cristata*, seen particularly in pre-ampullate tests, are the massive “spinose” accretions covering the distal parts of chambers which resemble the distal spines of *B. riedeli*. These

accretions give the impression of being radially elongate chambers, but when viewed in transmitted light or when wet, they are seen to be separate structures that have developed radially outwards on the distal areas of chambers. The rounded peripheral outline of the chambers can be seen at the base of these structures. The hispidity on the surface of *T. cristata* is caused by very large spine bases, relative to its test size. In juvenile tests, these spines tend to fuse together, accumulating to form distal castellated structures (Pl. 2, Figs. 9, 10; Pl. 3, Fig. 3). As successive chambers are added to the test of *T. cristata*, the spine bases become less accreted and increasingly detached from one another. On the final chambers formed individual spine bases become isolated and the ovate shape of the chambers can be seen (Pl. 2, Fig. 11; Pl. 3, Figs. 1, 2). It is possible that the spine bases form on top of previously existing bases (Pl. 3, Fig. 3), as new chambers are added. This would result in the greatest radial extension by accretion of spine bases on earlier chambers, with the final chamber periphery being rounded (Pl. 2, Fig. 11). In adult tests, the castellate chambers become obscured by the formation of the calcite crust (Pl. 2, Fig. 13).

True spines can only be seen between the large spine bases on the figured specimens of *T. cristata*. This most probably occurs because abrasion has only left spines intact below the level of the spine base tips.

The spines of *T. cristata*, like those of *T. humilis* and *T. quinqueloba* are round in section and show little variation in width (Pl. 3, Fig. 2). The spine bases of *T. cristata* are large, in comparison with the width of its spines, and cone-shaped. They compare well with the spine bases of *T. humilis* and *T. quinqueloba* (Pl. 3, Figs. 4, 5). The spine bases of these three species of *Turborotalita* are simple, smooth and conical, without any terracing. In contrast, the spine bases of species belonging to the Globigerinidae are often irregularly shaped and terraced (Cifelli, 1982). *T. cristata* differs from other members of the genus *Turborotalita* by having spine bases that attain much larger relative proportions, displaying a tendency to join together forming castellated structures over the distal parts of earlier chambers. The spine bases of *O. riedeli* (Pl. 2, Figs. 5–8), and those of other members of the Hastigerinidae, are very different from the spine bases of species in the genus *Turborotalita*. The spine bases are smaller relative to the width of the spines and are more parallel-sided. In *O. riedeli*, the spine bases tend to break off the test surface along with the spine itself (Pl. 2, Figs. 4, 8).

Turborotalita cristata closely resembles *T. humilis*

PLATE 3

1–3 *Turborotalita cristata* (Heron-Allen and Earland). 1. Detail of last two chambers of specimen figured Pl. 2, Fig. 11; $\times 840$. 2. Detail of final chamber of specimen figured in Pl. 2, Fig. 12; $\times 1,550$. 3. Detail of distal castellated structure in penultimate chamber of specimen figured in Pl. 2, Fig. 10; $\times 1,200$. 4, 6–8 *Turborotalita humilis* (Brady). 4. Detail of spines from penultimate chamber of Fig. 6; $\times 1,850$. 6. Ventral view juvenile spinose test; $\times 369$. 7. Ventral view of aberrant juvenile; $\times 382$. 8. Ventral view of adult specimen; $\times 253$. 5, 9–11 *Turborotalita quinqueloba* (Natland). 5. Detail of spines from penultimate chamber of Fig. 11; $\times 2,300$. 9. Ventral view of juvenile; $\times 375$. 10. Ventral view of pre-ampullate test; $\times 250$. 11. Ventral view of adult; $\times 250$.

in gross morphology, but differs by being smaller; usually having one more chamber in the final whorl; having a lower trochospire, so that the inner whorl can be depressed below the outer whorl; and having a less developed ampulla, that extends over only the umbilicus and rarely along the radial sutures (Pl. 2, Fig. 13). *T. cristata* also differs from *T. humilis* by having castellate chambers.

Family HASTIGERINIDAE

Bolli, Loeblich and Tappan 1957,
emended Saito and Thompson 1976

Genus *Orcadia* Boltovskoy and Watanabe, 1982

Type species. Hastigerinella riedeli Rögl and Bolli, 1973.

Remarks. The diagnostic features of *Orcadia* are the low trochospiral and thin test; the interiomarginal extraumbilical-umbilical aperture with a rounded lip; and spines which are triangular in section and located in the distal areas of chambers.

In describing the species, Rögl and Bolli (1973) placed *O. riedeli* in the genus *Hastigerinella* Cushman, 1927, while Poore (1979) placed it in *Hastigerinopsis* Saito and others, 1976 (considered here as a junior synonym of *Hastigerinella*). *Orcadia* differs from *Hastigerinella* in not attaining planispiral or streptospiral growth, not possessing an equatorial or spiroumbilical aperture, and by not having triradiate spines. Both *Orcadia* and *Hastigerinella* (and the Hastigerinidae) have thin test walls with spines attached only to the distal ends of chambers.

Orcadia is small, but is not considered to represent the trochospiral (turborotaliid) initial stages of planispiral or streptospiral genera of the Hastigerinidae. *O. riedeli*, with its longest dimension approximately 0.15 mm, consists of two to three whorls, a characteristic number for adult trochospiral tests. In some instances it possesses a final kummerform chamber (Pl. 2, Fig. 2, and in Poore 1979; pl. 19, figs. 1–3), considered here as a late stage or adult development. Boltovskoy and Watanabe (1982) suggested that the final chambers in some specimens of *O. riedeli* show a tendency to take up a more umbilical position than earlier chambers. This author does not consider this evidence of streptospiral growth, but rather a characteristic feature of kummerform growth seen in many unrelated genera.

Orcadia differs from *Globigerinella* Cushman, 1927, in having a turborotaliid test and distally placed spines (Pl. 2, Figs. 1–4). It differs from *Turborotalita* by the absence of an ampulla and in the distal location and shape of its spines. Characters the two genera share include a turborotaliid test and an interiomarginal, extraumbilical-umbilical aperture.

Saito and others (1981) placed *O. riedeli* in the genus *Berggrenia* Parker, 1976. *Berggrenia* differs from *Orcadia* in being non-spinose, planispiral with a circular outline, having a peripheral aperture.

Well-developed spines of *Orcadia* are acutely triangular in section throughout the length of the spine (Pl. 2, Figs. 5–8). No change to triradiate spine growth

has been observed. Younger, thinner spines of *Orcadia* are rounded in section and are found growing concomitantly alongside older, broader spines. Spines ranging in shape from round and thin, to subtriangular, to acutely triangular and broader in section, are found together on the same chamber (Pl. 2, Fig. 5). The spines of *Orcadia* differ from those of *Globigerinella*, the latter being proximally round to subtriangular and distally triradiate in section, and from those of *Hastigerina* which are triradiate throughout.

Boltovskoy and Watanabe (1982) consider the smaller spines with circular cross sections to be different from the larger broader spines with triangular cross sections, the former being distributed regularly over the test, while the latter are located on distal chamber areas. Evidence obtained from the figured specimens of *O. riedeli* in this study shows that all spines are located only on the distal areas of the chambers. A mixture of small and large spines are shown in Plate 2 (Figs. 5, 6) and a smooth, nonspinose umbilical area in Plate 2 (Figs. 1, 4). In Figure 4 the absence of spines from the umbilical region of the test cannot be accounted for by spine breakage, considering the presence of such long and well-preserved spines attached to the distal chamber areas.

Boltovskoy and Watanabe (1982) add a fourth morphology, the triangular spines of *O. riedeli*, to the three spine types described by Saito and others (1976).

Examples of spine regeneration in *Orcadia* range from a thin regenerated spine with a rounded section (Pl. 2, Fig. 8), to one that is relatively broader with a triangular outline.

There is an interesting development of apparent incipient triradiate growth on the broken surface of the spine that has regenerated growth in Plate 2 (Fig. 6). On the lower right-hand side of this broken surface one short vertical blade can be clearly seen and possibly one other can be seen appearing from behind the regenerated spine. The regenerated spine itself is positioned asymmetrically on the broken spine surface in the same position where the third blade of a triradiate arrangement would be found. The position of spine regeneration in *Orcadia* is different from that seen in *Hastigerina pelagica* where regeneration takes place in the center of the triradiate spine (Bé and others, 1977; pl. 6, fig. 8).

Orcadia riedeli (Rögl and Bolli), 1973

Pl. 2, Figs. 1–8

Hastigerinella riedeli RÖGL and BOLLI, 1973, p. 567, pl. 4, figs. 1–5.

Hastigerinopsis riedeli (Rögl and Bolli). POORE, 1979, p. 472, pl. 19, figs. 1–4.

Berggrenia riedeli (Rögl and Bolli). SAITO, THOMPSON and BREGER, 1981, p. 52 pl. 12, figs. 2a–c, 3.

Orcadia riedeli (Rögl and Bolli). BOLTOVSKOY and WATANABE, 1982, p. 5, pl. 1, figs. 1–20.

Diagnosis. Test very small; trochospiral, with chambers arranged in two to three whorls with four and a half chambers in the final whorl; periphery lobulate; chambers increase slowly in size as added, spherical

to sub-spherical in shape separated by deep and straight radial sutures; aperture interiomarginal, extraumbilical-umbilical, a low arch with a pronounced and rounded lip; spines triangular in section and located on distal areas of chambers; test surface in umbilical region smooth.

Distribution. The known range of *O. riedeli* is from the Late Pleistocene to Recent. The species was originally described from Quaternary deposits in the Cariaco Basin, and later by Poore (1979) from Quaternary sediments from North Atlantic. Both Boltovskoy and Watanabe (1982) and this study record *O. riedeli* from the surface plankton. Boltovskoy and Watanabe noted the rarity of this species in their samples, occurring at an abundance of less than 0.3% in only seven out of 676 samples from Antarctic waters in the South Atlantic. They consider *O. riedeli* a typical cold water species, its occurrence in the Pleistocene deposits of the Cariaco Basin reflecting a more widespread distribution of colder water at that time. The specimens of *O. riedeli* figured in Plate 2 were collected at a depth of 5 m in the water column, over the Rockall Trough in the northeastern Atlantic. The sample was collected in May, 1980 from a position of approximately 55°N latitude, 12°W longitude, at an abundance of less than or equal to 0.1%. These waters contain a typical cold-transitional planktonic foraminiferal assemblage.

Orcadia riedeli cannot be accurately placed within the higher planktonic foraminiferal classification because its ancestry is not known. Although it possesses a turborotaliid adult morphology, it is thought to be most closely related to the Hastigerinidae because of the distal location of spines on the chamber surfaces. In *O. riedeli*, however, the spine shape differs in not being triradiate and barbed. Both *Hastigerina* and *Hastigerinella* pass through a trochospiral stage with a presumably extraumbilical-umbilical aperture, before becoming planispiral or streptospiral. *Orcadia* may represent an intermediate development between the broad *Turborotalia* stock and the genera *Hastigerina*/*Hastigerinella*, in which trochospiral growth continues through ontogeny.

Globigerina clarkei Rögl and Bolli, 1973, is another small, relatively unknown species of uncertain generic position. It was provisionally placed within the genus *Globigerina* by Rögl and Bolli (1973), in *Turborotalia* by Fleisher (1974) and in *Berggrenia* by Saito and others (1981). *G. clarkei* has an extraumbilical-umbilical aperture, is nonampullate and trochospiral and therefore does not belong within any of the above genera. It is apparently nonspinose and would therefore most probably belong within the genus *Turborotalia*. *G. clarkei* does, however, show some distal hispidity (Saito and others, 1981; pl. 26, figs. 3b, c) and so there is a possibility that this species may belong within the genus *Orcadia*.

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