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PEARSONITES, A NEW PALEOGENE PLANKTONIC FORAMINIFERAL GENUS FOR THE BROEDERMANNI LINEAGE

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ABSTRACT

The new genus *Pearsonites* with *P. broedermanni* as type species is herein formalized to accommodate the early to middle Eocene globorotaliform taxa of the *broedermanni* lineage with a wall texture bearing muricae. Our analysis of specimens from the Pacific Ocean reveals a substantial similarity in wall structure with the genus *Acarinina*. In particular, the development and organization of the muricae, the hourglass shape of the pores, and the morphological features suggest that *Pearsonites* nov. gen. evolved from *Acarinina* in the late Paleocene. Herein we group three species previously considered morphologically and evolutionarily related to the Paleocene genus *Igorina* Davidzon, 1976, within *Pearsonites* nov. gen.: *P. broedermanni* (Cushman & Bermudez, 1949), *P. lodoensis* (Mallory, 1959), and *P. anapetes* (Blow, 1979). Species assigned to *Pearsonites* nov. gen. are relatively common in the stratigraphic interval from the late Paleocene (Zone P5) to the middle Eocene (Zone E9).

INTRODUCTION

For more than a century after the mid-1800s, the taxonomy of planktonic foraminifera was based on typological species concepts. The advent of the scanning electron microscope (SEM) in the mid-1900s, besides facilitating more accurate morphological descriptions and illustrations of taxa, allowed detailed examinations of the wall structure, first performed on extant planktonic species (e.g., Lipps, 1966; Blow, 1979; Spiegler & Bijvank, 1986; Hemleben et al., 1989). These analyses led to the discovery of different wall structures such as the spinose wall, characterized by long, thin, needle-like spines planted in the wall, and the nonspinose wall. Within the spinose group, the wall surface can be smooth, as typified by *Globigerina*, or honeycomb cancellate, formed by more-or-less regular polygonal ridges with needle-like spines planted at the polygonal junctures, as typified by *Globigerinoides* (Hemleben et al., 1989). The nonspinose group includes smooth, normally perforate walls (e.g., *Globorotalia*), a cancellate-type of wall structure with subparallel longer ridges connected by shorter ridges that originate from coalescing pustules (typified by *Neoglobobulimina*; Figs. 1.1a–d), and smooth microporulate (pore size <1 µm) walls with sparse small pustules (Hemleben et al., 1989; Olsson et al., 1999). Consequently, wall-structure type became the primary criterion for classifying Neogene–Recent planktonic foraminifera, and it has been further linked to specific habit and food requirements (Hemleben et al., 1989). In the early 1990s, investigations of wall structures were extended to the Paleocene planktonic

foraminifera. Hemleben et al. (1991) reported the presence of needle-like spines associated with a cancellate wall structure in two species from the earliest Paleocene, and several others in younger Paleocene–Eocene levels, indicating that the widespread adaptation of spinose forms for food-gathering evolved at the beginning of the Paleocene after the mass extinction at the Cretaceous/Paleogene boundary. These authors indicated that the early Paleocene assemblages also include taxa characterized by nonspinose neoglobobuliminid-type cancellate and smooth-walled wall textures. Their work was continued by Olsson et al. (1992), who provided numerous observations and illustrations of other species within the spinose-cancellate group. In addition, Olsson et al. (1992) erected the genus *Praemurica* (Figs. 1.2a–d) to accommodate Paleocene species with a nonspinose neoglobobuliminid-type cancellate wall structure (i.e., praemuricate wall type) to avoid confusion with the modern genus *Neoglobobulimina*.

In the mid-Paleocene a new distinct nonspinose-type wall structure evolved within two globorotaliform groups, the surfaces of which were originally described as spinose by many authors (e.g., Bolli, 1957; Blow, 1979). The first or muricate group, includes the genera *Acarinina* Subbotina, 1953 (Figs. 1.3a–d), *Morozovella* McGowran in Luterbacher, 1964 (Fig. 1.4a–d), and *Morozovelloides* Pearson & Berggren, 2006, which are important components of mid-Paleocene to middle Eocene assemblages. The distinctive feature of the muricate wall texture is the presence of coarse conical pointed pustules (muricae of Blow, 1979, or pseudospinae of Benjamini & Reiss, 1979). The muricae usually concentrate around the umbilical area, but may cover the whole test (as in *Acarinina*) or concentrate along the peripheral margin, forming a keel called a muricocarina (as in *Morozovella* and *Morozovelloides*; Blow, 1979; Olsson et al., 1999; Hemleben & Olsson, 2006). Unlike the thin acicular spines on spinose walls, muricae grow on smooth surfaces and are layered structures as part of the wall.

The second group has a biconvex test, small umbilicus, subangular to keeled periphery, and a smooth to weakly and finely pustulose surface (e.g., the Paleocene taxa *Globorotalia pusilla pusilla* Bolli, 1957, *G. pusilla laevigata* Bolli, 1957, and *G. tadjikistanensis* Bykova, 1953). These species were informally named “biconvex morozovellids” by some authors (Blow, 1979; Boersma & Premoli Silva, 1983; Toumarkine & Luterbacher, 1985; Premoli Silva & Boersma, 1988), but were included in the resurrected genus *Igorina* Davidzon, 1976, by Loeblich & Tappan (1987). In agreement with the latter authors, Berggren & Norris (1997) retained *Igorina* as valid, and later Olsson et al. (1999) reported that the wall structure of this genus (Figs. 1.5a–d) was nonspinose-cancellate and therefore praemuricate, as in *Praemurica*. However, *Igorina* differed in that “as pustule growth becomes more and more prominent the test wall

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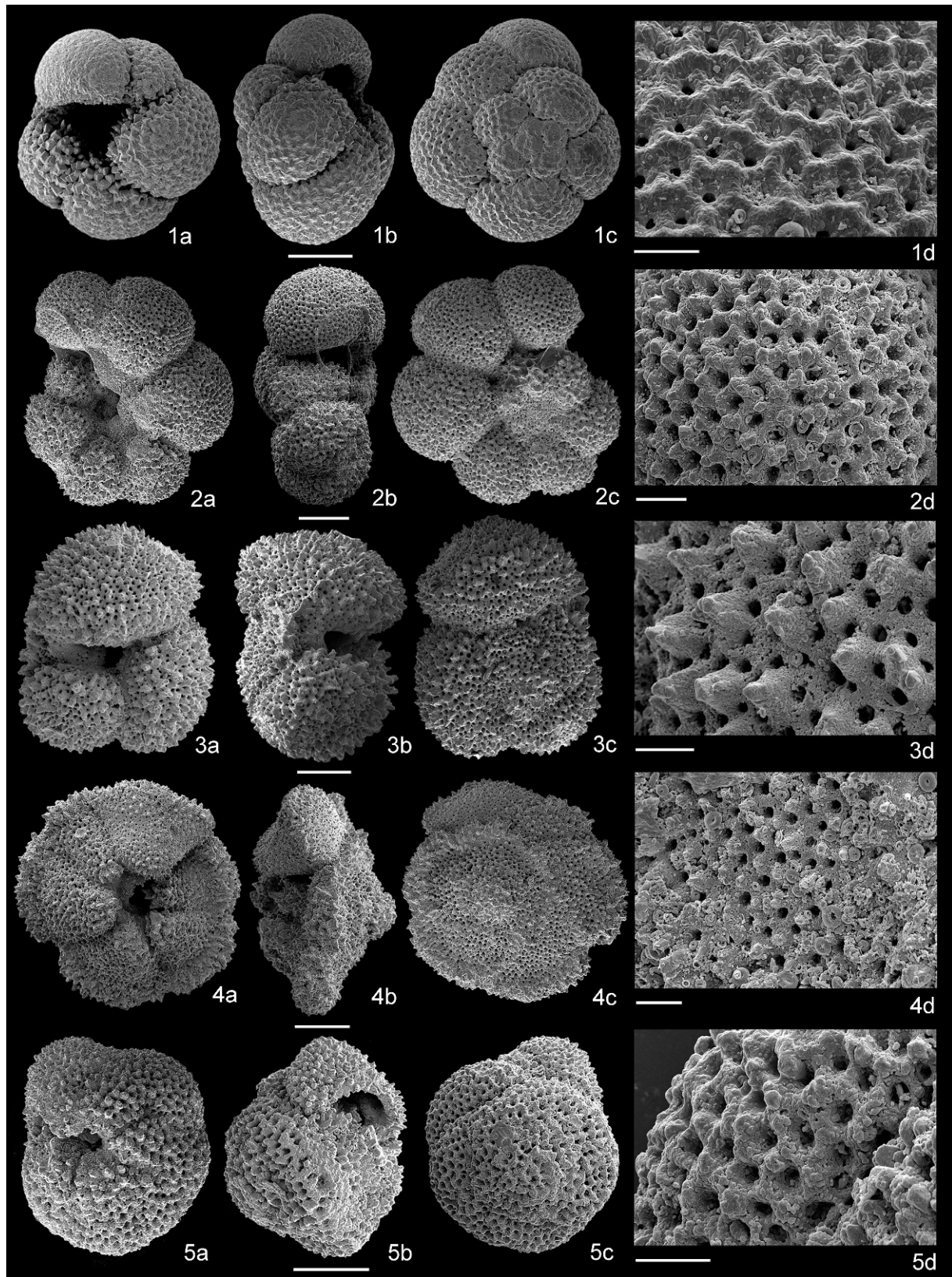


FIGURE 1. **1** *Neogloboquadrina dutertrei*, sample 198-1210A-1H-CC. **2** *Praemurica inconstans*, sample 198-1209B-25H-2, 71–72 cm. **3** *Acarinina pseudotopilensis*, sample 143-865B-11H-4, 48–50 cm. **4** *Morozovella acutispira*, sample 198-23H-7, 11–12 cm. **5** *Igorina tadjikistanensis*, sample 143-865B-14H-4, 47–49 cm. The nonspinose *N. dutertrei*-type wall texture is characterized by pustules and well-defined ridges that grow on the surface of test (1d), and it is very similar to Paleocene *Praemurica* (2d) and *Igorina* (5d), even though ridges in the latter are poorly defined. In *Acarinina* (3d) and *Morozovella* (4d), heavy pustules (muricae) grow on the wall surfaces. The inner whorl of *I. tadjikistanensis* is obscured by dense pustules forming a crust (5c). Scale bar = 100 μ m in 1a–c, 2a–c, 3a–c, 4a–c, 5a–c; scale bar = 50 μ m in 1d, and = 20 μ m in 2d, 3d, 4d, 5d.

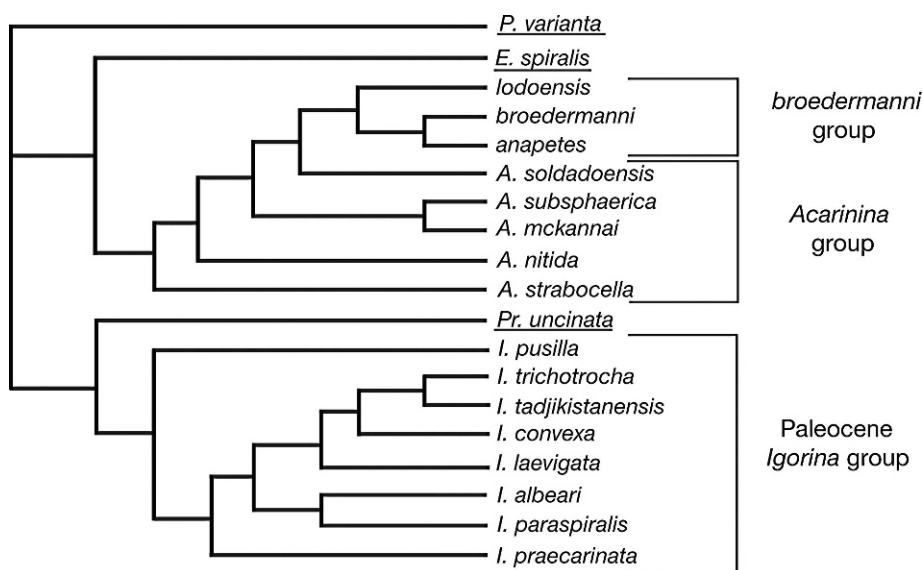


FIGURE 2. Phylogenetic relationships between the Paleocene *Igorina* and *Acarinina* groups. The phylogenetic tree shows that the *broedermanni* group is closely related to *Acarinina* (modified after Soldan et al., 2011). *Pr.* = *Praemurica*; *E.* = *Eoglobigerina*; *P.* = *Parasubbotina*; *I.* = *Igorina*; *A.* = *Acarinina*.

becomes thicker and encrusted” (Olsson et al., 1999, p. 12) especially over the inner whorls, a feature also developed in modern neogloboquadrinids.

Pearson (1993) and Berggren et al. (2006a) also included in the genus *Igorina* the *broedermanni* plexus, which is characterized by small size and biconvex–planoconvex tests with an overall rounded periphery; this morphology first appeared in the late Paleocene, becoming very abundant in early middle Eocene subtropical assemblages. Soldan et al. (2011) revised the taxonomy and the phylogenetic relationships of *Igorina* by using a parsimony analysis based on morphological parameters. Their results show that 1) the *broedermanni* group is closely related to muricate taxa and probably evolved from the genus *Acarinina* (Fig. 2), and 2) the wall texture of the *broedermanni* group is different from Paleocene *Igorina*. Specifically, the *broedermanni* group has a test surface fully covered by muricae and the wall is devoid of any traces of crust, which is typically present in *Igorina*. From these observations, it is clear that the genus

Igorina, as now interpreted, is polyphyletic as it comprises true Paleocene *Igorina* and the phylogenetically unrelated *broedermanni* group with its nonspinose, thinly muricate wall structure. Consequently, *Pearsonites* nov. gen. is herein erected to accommodate taxa traditionally assigned to the *broedermanni* group, which is biostratigraphically important in early–middle Eocene assemblages.

MATERIALS AND METHODS

The specimens analyzed in this study came from three Ocean Drilling Program (ODP) holes drilled in the Pacific Ocean: Leg 143, Hole 865B (Allison Guyot), and Leg 198, Holes 1209B and 1210A (Shatsky Rise; Fig. 3), which contain calcareous oozes composed of planktonic foraminifera and calcareous nannofossils. The preservation of planktonic foraminifera is sufficient for species identification, although tests are often recrystallized. Sample sediments were disaggregated in water, wet-sieved, and

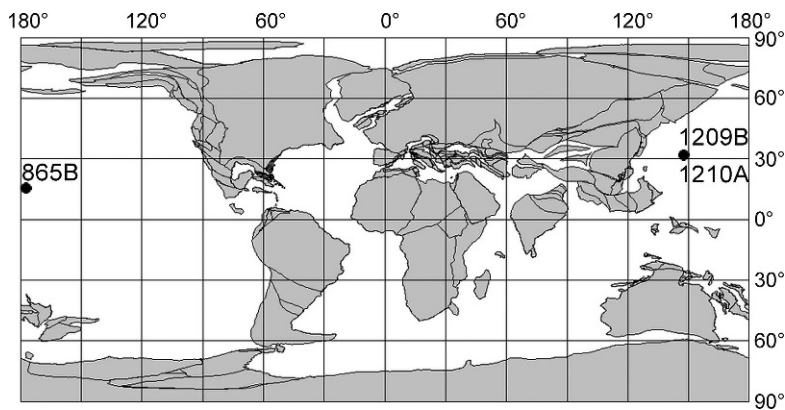


FIGURE 3. Paleogeographic reconstruction for the early Eocene (50 Ma) according to Schettino & Scotese (2005; <http://www.serg.unicam.it/Reconstructions.htm>), showing the locations of the Ocean Drilling Program sites that yielded the specimens of the *broedermanni* group analyzed in this study.

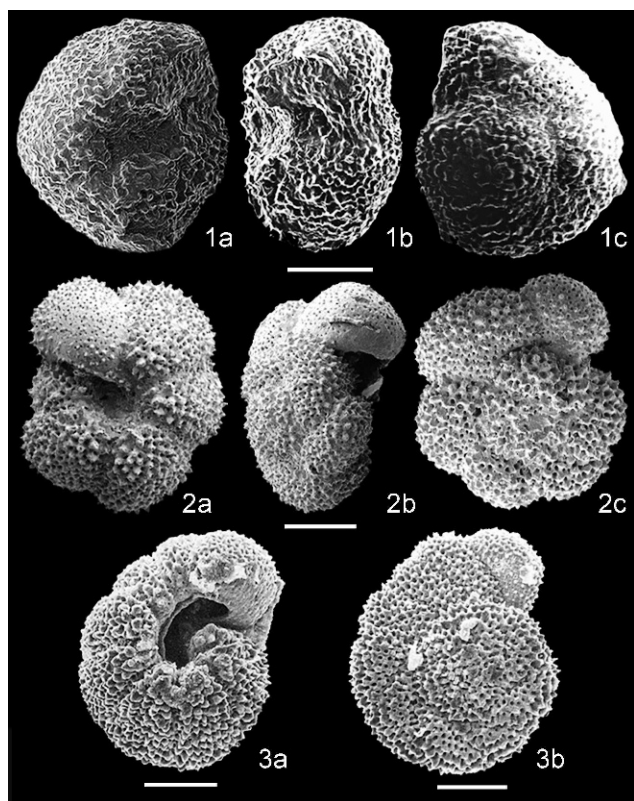


FIGURE 4. 1 *Globorotalia* (*Truncorotalia*) *broedermanni* Cushman & Bermudez, 1949, holotype, middle Eocene, Capdevila Formation, Havana Province, Cuba. 2 *Globorotalia broedermanni lodoensis* Mallory, 1959, holotype, lower Eocene, lower part of Lodo Formation, Kern County, California. 3 *Globorotalia* (*Acarinina*) *broedermanni anapetes* Blow, 1979, holotype (3a) and paratype (3b), Zone E9, Sample RS.24, Kilwa area, Tanzania. Scale bars = 100 μ m, images reproduced from Berggren et al. (2006a).

dried according to the methods described in Petrizzo et al. (2005) and Soldan et al. (2011). The wall structure of the best-preserved specimens was examined by SEM. In addition, several specimens of *Igorina*, *Acarinina*, and the *broedermanni* group were dissected using a surgical knife to study in detail the internal structure of the wall and shape of the wall pores. Figured specimens are deposited in the Micropaleontological Collection, Università degli Studi di Milano, Dipartimento di Scienze della Terra “A. Desio,” Italy.

THE BROEDERMANNI GROUP

The *broedermanni* group includes three species originally described as *Globorotalia* (*Truncorotalia*) *broedermanni* Cushman & Bermudez, 1949, *G. broedermanni lodoensis* Mallory, 1959, and *G. (Acarinina) broedermanni anapetes* Blow, 1979 (Fig. 4). These species commonly occur in early–middle Eocene subtropical assemblages (Berggren et al., 2006a). Blow (1979, p. 934) stated that the species *lodoensis*, the ancestor of the *broedermanni* lineage, evolved from *G. convexa* Subbotina, 1953, and he included the three species of the group in the subgenus *Acarinina*, as did Toumarkine & Luterbacher (1985). Conversely, Premoli Silva & Boersma (1988, p. 348) considered all the species mentioned by Blow (1979) close to *Morozovella* on the basis

of the wall structure and the general shape, but retained the generic name *Morozovella* in quotation marks. They suggested a possible relationship between the species *lodoensis* and *convexa* that, however, were included in two different groups, the “small morozovellids” and “biconvex morozovellids,” respectively, while they treated the species *broedermanni* and associated morphotypes as a separate group. Instead, Pearson (1993) considered the *broedermanni* plexus related to *Acarinina pusilla* and *A. convexa* and designated *lodoensis* as its ancestor, a taxon that appears close to the Paleocene/Eocene boundary. Subsequently, the *broedermanni* plexus was included in the genus *Igorina* by Berggren & Norris (1997, p. 62) and Berggren et al. (2006a); these authors derived the species *Igorina lodoensis* from *I. tadjikistanensis* (Bykova, 1953), a senior synonym of *I. convexa* (see also Olsson et al., 1999; Aze et al., 2011). However, Hemleben & Olsson (2006) observed that the wall texture of Eocene “*Igorina*” resembles that of the acarininids.

As mentioned above, Soldan et al. (2011), based on the results of a parsimony analysis on Paleocene–Eocene taxa, suggested a close relationship between the *broedermanni* group and *Acarinina* species. This relationship is herein further discussed and reinforced by presenting a detailed study of the wall texture within representatives of the *broedermanni* group. Contrary to Paleocene *Igorina* with a wall surface that appears to be encrusted with short pustules (Fig. 5.1d), representatives of the *broedermanni* group never have an encrusted wall, and thin muricae are developed almost uniformly on the test surface (Soldan et al., 2011; Figs. 5.2d, e). Furthermore, the *broedermanni* wall resembles the muricate wall of *Acarinina*. In fact, in the *broedermanni* group, small muricae grow between the pores and become thicker around the umbilical area (Figs. 5.2, 5.3), the same arrangement seen in species of *Acarinina* (Fig. 5.4) but not in *Igorina*, where the pustules maintain a constant size on the surface of the shell (Soldan et al., 2011; Fig. 5.1).

The pores on the surface of the species *anapetes* (Figs. 5.3d, e) are scattered and dense, and among them grow muricae that usually are more developed on the first chambers of the test. On *broedermanni* tests (Figs. 5.2d, e), the pores, although not surrounded by calcitic ridges as in *Igorina* (Figs. 5.1e, d), remain relatively separate. In *Acarinina* (Figs. 5.4d, e), the pustules grow between the pores and form muricae with their increased size. The surface muricae in *lodoensis* (Figs. 6.1d, e) are very similar to those in *Acarinina*, resembling, in particular, those found in *A. mckannai* (White, 1928) (Figs. 6.2d, e) and *A. wilcoxensis* (Cushman & Ponton, 1932) (Figs. 6.3d, e). They (Figs. 7.1a–d) are also well-developed on the entire surface of the shell, while in specimens of *broedermanni* (Figs. 7.2a–d) and *anapetes* (Figs. 7.3a–d) the muricae are concentrated around the umbilical area and are less coarse on the spiral side.

To verify the taxonomic affinities between the *broedermanni* group and *Acarinina*, we closely examined the pore shape. Usually two wall layers can be observed in test cross sections. Those perpendicular to the wall surface reveal distinctive hourglass-shaped pores (Fig. 8) that are wide toward the external surface of the test, narrow at the level

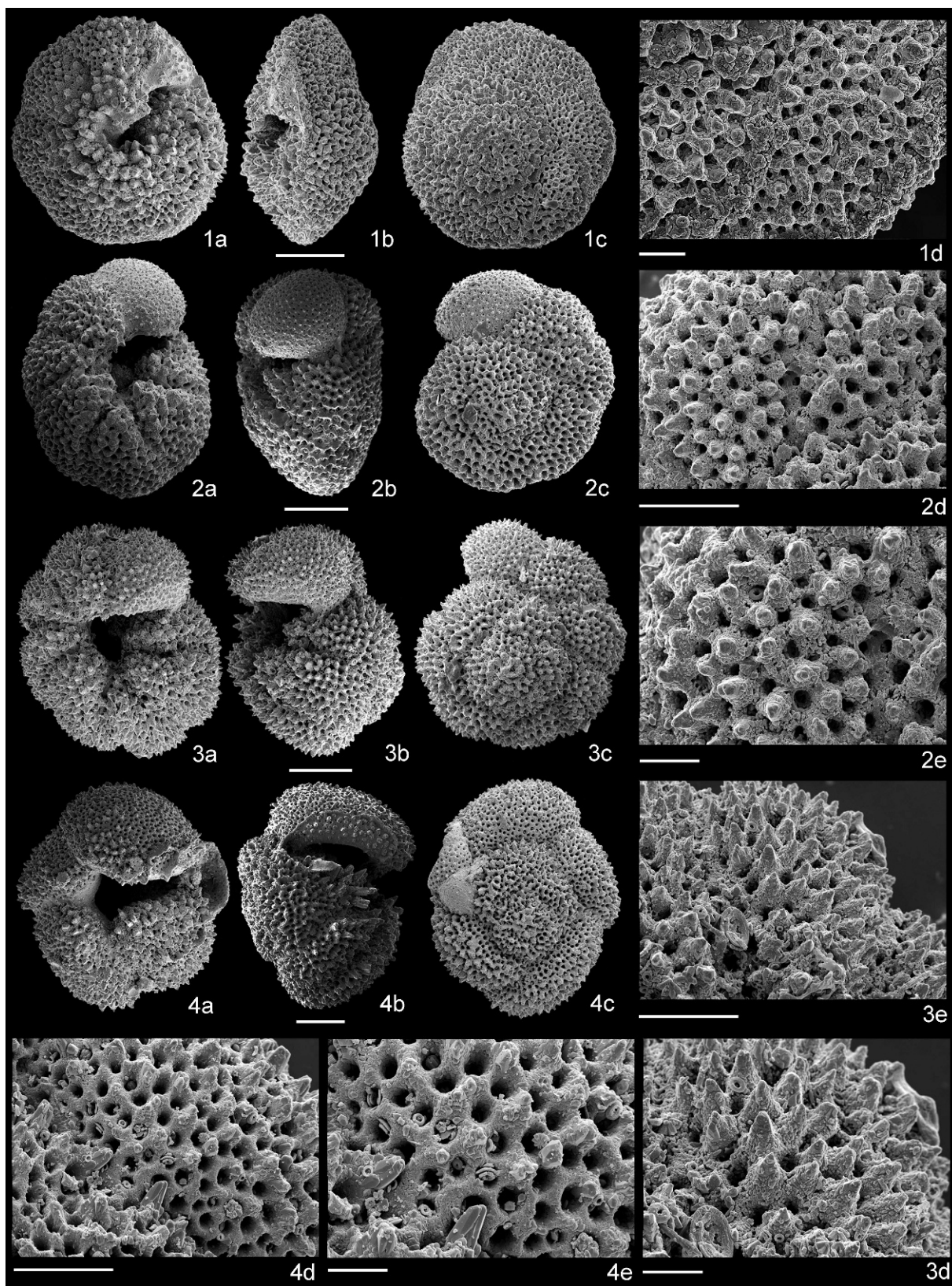


FIGURE 5. **1** *Igorina laevigata*, sample 198-23H-7, 10–11 cm. **2** *Pearsonites broedermanni*, sample 143-865B-8H-2, 130–132 cm. **3** *Pearsonites anapetes*, sample 143-865B-8H-2, 130–132 cm. **4** *Acarinina angulosa* sample 143-865B-12H-6, 95–97 cm. The pustules between pores in the wall texture of *Igorina* (1d) are short and less developed compared to the heavy pustules in *Pearsonites* specimens (2d, e, 3d, e). The pustules in the wall texture of *P. broedermanni* (2d, e) and *P. anapetes* (3d, e) are similar to the muricae of *Acarinina* (4d, e). Scale bar = 100 μ m in 1a–c, 2a–c, 3a–c, 4a–c; scale bar = 50 μ m in 2d, 3d, 4d, and = 20 μ m in 1d, 2e, 3e, 4e.

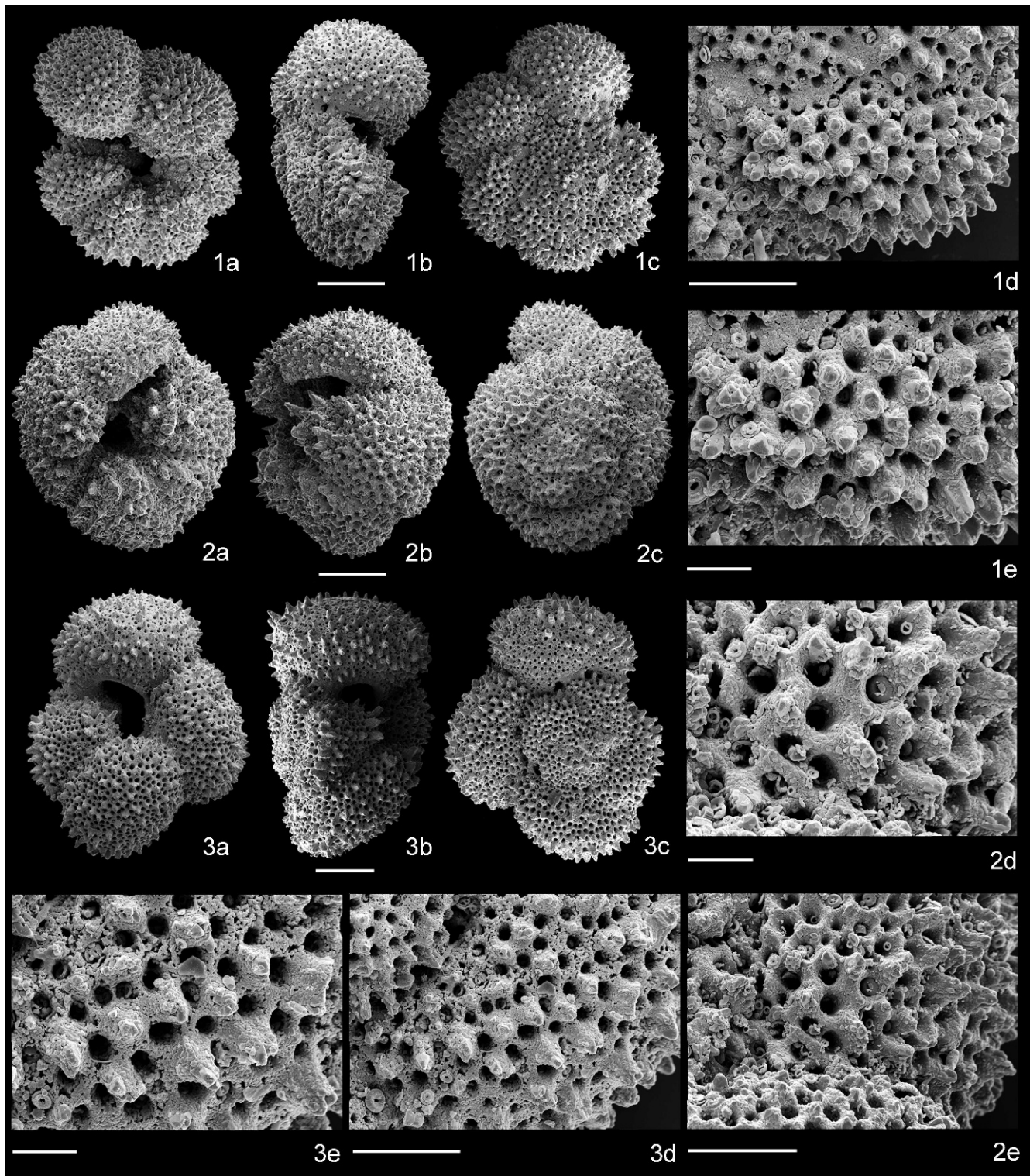


FIGURE 6. **1** *Pearsonites lodoensis*, sample 143-865B-11H-4, 48–50 cm. **2** *Acarinina mckannai*, sample 198-1209B-23H-1, 143–144 cm. **3** *Acarinina wilcoxensis*, sample 143-865B-11H-4, 48–50 cm. The pustules on the wall surface of *P. lodoensis* (1d, e) are very similar to the muricae of *A. mckannai* (2d, e) and *A. wilcoxensis* (3d, e). Scale bar = 100 μ m in 1a–c, 2a–c, 3a–c; scale bar = 50 μ m in 1d, 2e, 3d, and =20 μ m in 1e, 2d, 3e.

of the primary organic membrane (POM), then slightly enlarged again through the inner lamella of calcite toward the inner surface. This pore shape is consistently present in both *Acarinina* and *Igorina*. However, in *Acarinina* the

hourglass part within the outer layer is longer than that observed in Paleocene species of *Igorina*. In *anapetes* (Figs. 8d, e) the pores throughout the outer layer are more elongated relative to those of Paleocene *Igorina* (Figs. 8g–i),

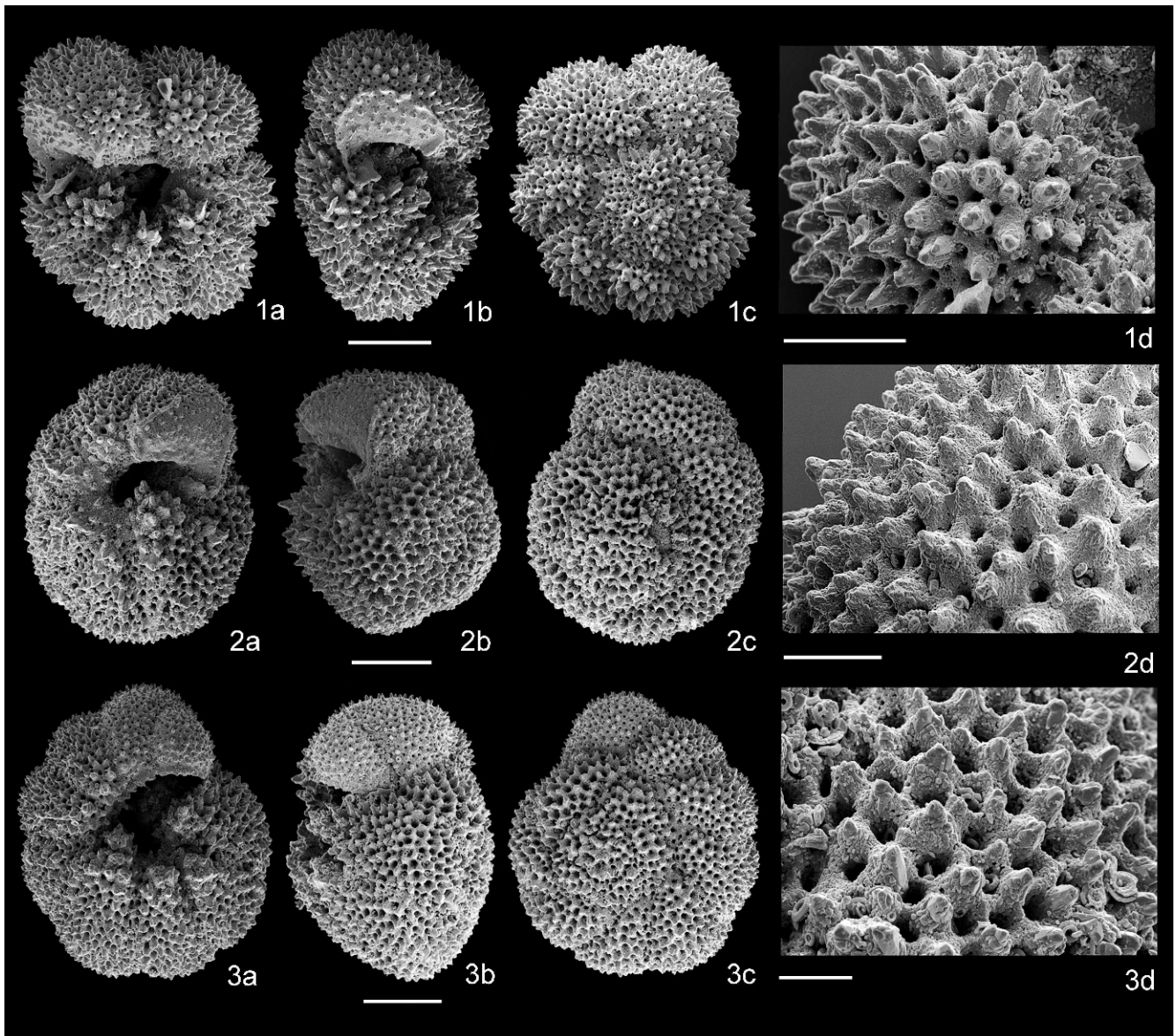


FIGURE 7. **1** *Pearsonites lodoensis*, sample 143-865B-11H-4, 48–50 cm. **2** *Pearsonites broedermanni*, sample 143-865B-8H-2, 130–132 cm. **3** *Pearsonites anapetes*, sample 143-865B-8H-2, 130–132 cm. The muricae tend to be in *P. broedermanni* (2d) and *P. anapetes* (3d) than in *P. lodoensis* (1d). Scale bar = 100 µm in 1a–c, 2a–c, 3a–c; scale bar = 50 µm in 1d, 2d, and = 20 µm in 3d.

and are more similar to the pores of *Acarinina* (Figs. 8a–c). Moreover, in Paleocene igorinids (Figs. 8g–i), the pores become narrower in the calcite layer below the gap left by the deterioration of the organic layer. In *Acarinina* (Figs. 8a–c) and in the *broedermanni* group (Figs. 8d–f), the pores become narrower in the outer calcite layer at the level of the POM gap. It is not clear whether these differences are due to the specific ontogeny of the examined specimens or are characteristic features of each genus. However, based on these observations, we believe that the species belonging to the *broedermanni* group, characterized by a nonspiny wall structure and thin muricae, should be separated from the genus *Igorina* and included in a new genus.

Our observations are supported by the cladistic analysis of Soldan et al. (2011) that demonstrated that the lineage of the *broedermanni* group is closely related to the *Acarinina*

mckannai-soldadoensis group (Fig. 2). Further evidence of such a relationship is provided by *Acarinina esnehensis* (Nakkady, 1950) (Fig. 9), a taxon included in the *soldadoensis* lineage by Berggren et al. (2006b). This species is characterized by a lower, medium-long trochospire; more open (less compact) spire; an open, deep umbilicus; radial sutures on the umbilical side and slightly curved ones on spiral side; and 5–6 globular/subglobular chambers on the spiral side that tend to become trapezoidal and more elongate than in *A. soldadoensis*. Moreover, the muricae in *A. esnehensis* are robust on the umbilical side and on the inner spire, but weakly developed on the last chambers of the spiral side. These features are clearly present in *lodoensis*, the oldest member of the *broedermanni* lineage, and suggest that *A. esnehensis* is the likely ancestor of that lineage. In support of this interpretation, transitional

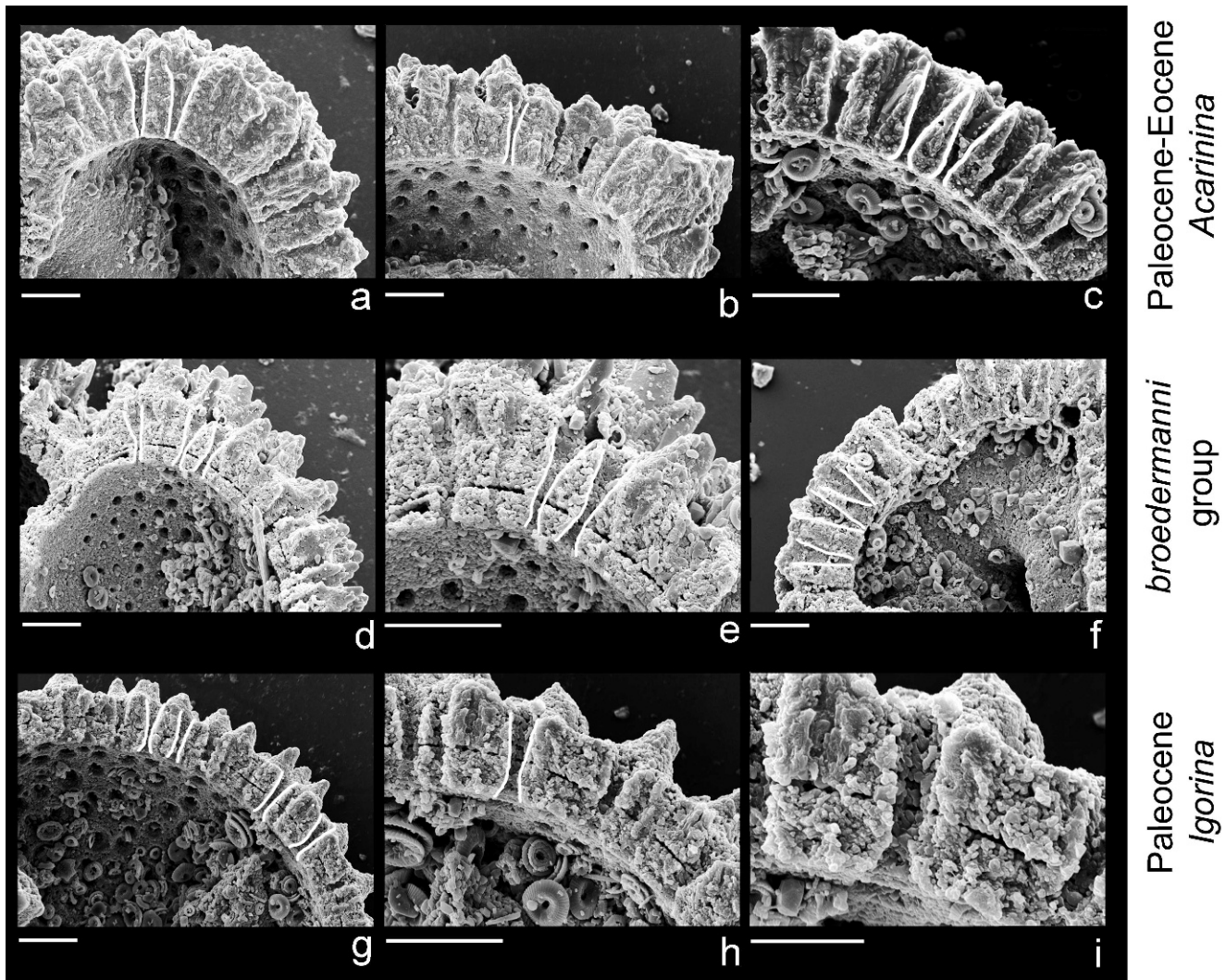


FIGURE 8. Pores in cross section; pore edges have been retouched to show their shape. The pores in *Acarinina mckannai* (a, b) and in *A. esnehenensis* (c) become narrow in the outer calcite layer and are similar to those in *Pearsonites anapetes* (d, e) and *P. lodoensis* (f) of the *P. broedermanni* group. In *Igorina tadjikistanensis* (g–i), the pores become narrow in the inner calcite layer. The gap of the primary organic membrane between the outer and inner calcite layers is visible in d, e, g–i. The inner calcite layer is not preserved in a, b, f. Scale bar = 20 μ m in a–h, and = 10 μ m in i.

specimens from *esnehenensis* to *lodoensis* have been observed in lower Eocene assemblages of the Pacific region. Tests of the latter morphotypes have flattened spires and increased number of chambers, and gradually evolved to assume a globorotaliform morphology, which is a distinctive feature of the new genus *Pearsonites*. In addition, the sutures on the spiral side became more sharply recurved in *P. broedermanni* and *P. anapetes*. The latter species became extinct in the middle Eocene (Zone E9/E10 boundary), and no descendants of this genus are currently known.

SYSTEMATIC TAXONOMY

Order FORAMINIFERIDA Eichwald, 1830
Superfamily GLOBIGERINACEAE Carpenter,
Parker & Jones, 1862

Family TRUNCOROTALOIDIDAE Loeblich &
Tappan, 1961

Genus *Pearsonites* Soldan, Petrizzo & Premoli Silva, nov. gen.

Type species. *Globorotalia* (*Truncorotalia*) *broedermanni*
Cushman & Bermudez, 1949

Figs. 4.1–4.3, 5.2, 5.3, 6.1, 7.1–7.3

Etymology. Named in honor of Professor Paul N. Pearson for his outstanding contributions to the study of Paleogene foraminifera.

Wall texture. Nonspinose with thin muricae.

Description. Test low trochospiral, weakly biconvex to planoconvex, with 6–10 chambers in the last whorl. Spiral side with subglobular to subquadrate chambers that increase very gradually in size; sutures slightly depressed to flush and slightly recurved to oblique. Umbilical side with triangular chambers; sutures nearly straight, depressed. Umbilicus generally widely bordered by coalescing circumumbilical muricae. Aperture a low arch extending toward the peripheral margin that is subrounded to subangular.

Species included. Three species (*P. lodoensis*, *P. broedermanni*, and *P. anapetes*) are now assigned to *Pearsonites*, based on both wall texture and morphological similarities.

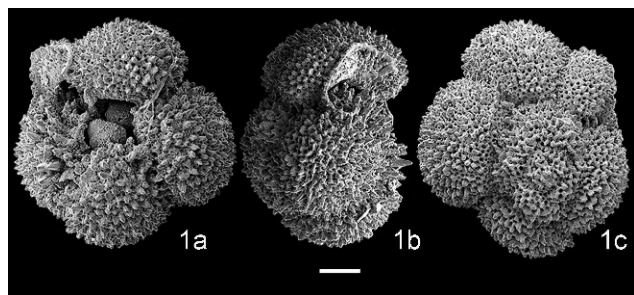


FIGURE 9. 1 *Acarinina esnehensis*, sample 143-865B-11H-4, 48–50 cm. Scale bar = 100 μ m.

Pearsonites lodoensis (Mallory, 1959), first described from the lowermost Eocene of the Lodo Formation (California), is characterized by having a rather large umbilicus, 6–7 chambers in the final whorl, a lobulate equatorial outline, and round-subangular peripheral margin. On the spiral side, it displays slightly depressed sutures that are very slightly recurved on the last chambers.

Pearsonites broedermanni (Cushman & Bermudez, 1949), described from lower Eocene strata of the Capdevila Formation (Cuba), has a weakly biconvex test that tends toward being planoconvex, a narrow umbilicus, a rounded periphery, and 6–7 chambers in the last whorl. The sutures on the spiral side are weakly depressed, and obliquely curved in the last whorl.

Pearsonites anapetes, described by Blow (1979) from the early middle Eocene (Zone P11= E9) at Kilwa (Tanzania), is characterized by a planoconvex test with 8–9 (rarely 10) almost equidimensional chambers, nearly straight oblique sutures that are barely depressed in the last chambers, and a relatively broad umbilicus.

Recently, Rögl & Egger (2012) redescribed *Globorotalia salisburgensis* Gohrbandt, 1967, originally described from Eocene deposits of the Helvetic nappe system (north Salzburg, Austria). These authors provided SEM images of a *G. salisburgensis* paratype and a drawing of the holotype that they included in *Igorina*. Upon close examination these new figures show an asymmetrically

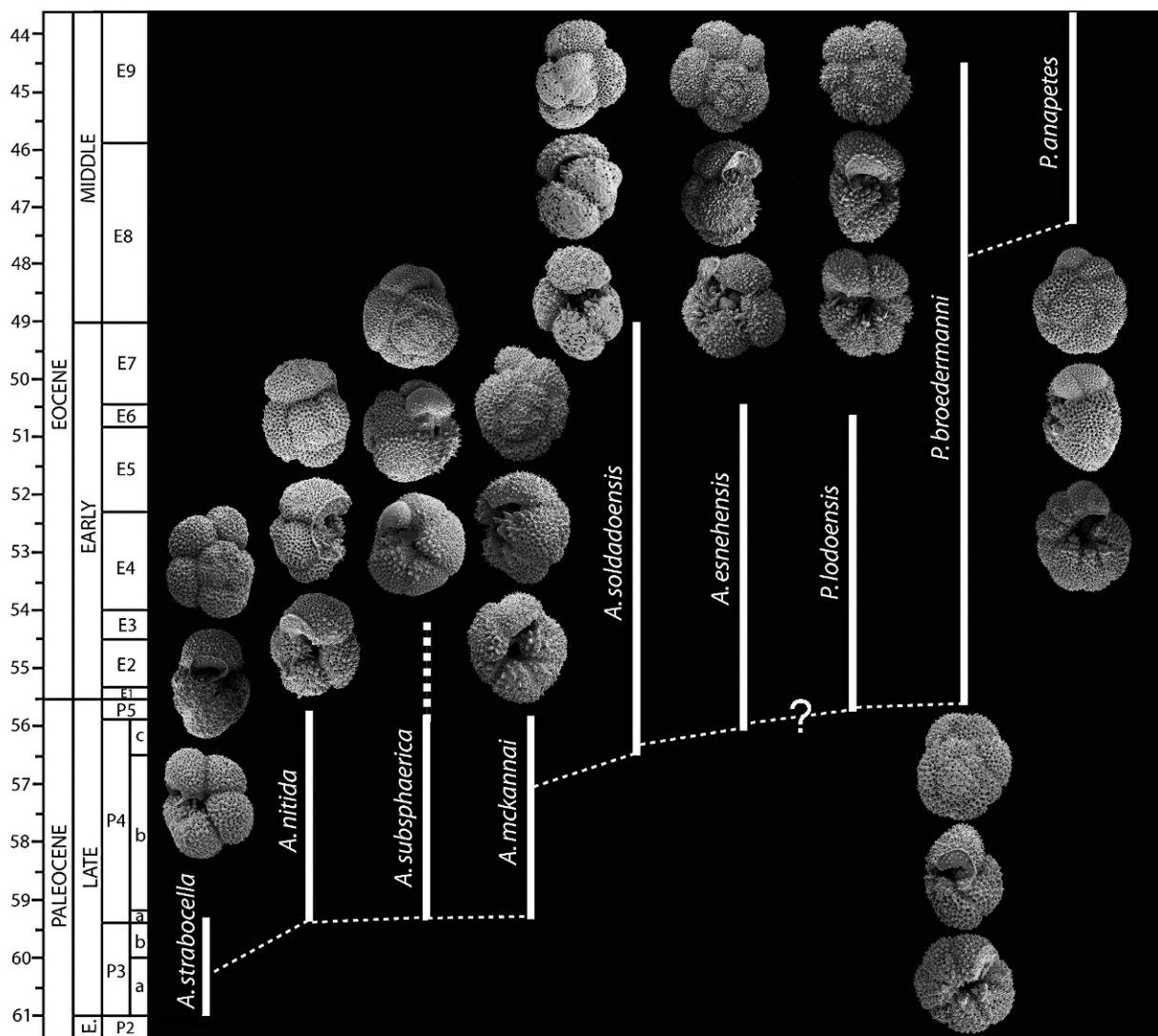


FIGURE 10. Phylogenetic reconstruction of the *P. broedermanni* lineage. The species stratigraphic distribution is after Petrizzo et al. (2005) and Soldan et al. (2011). Biostratigraphic scheme according to Berggren & Pearson (2005). *A.* = *Acarinina*; *P.* = *Pearsonites*.

biconvex test with a strongly convex umbilical side, angular peripheral margin, equatorial outline that is slightly lobate, strongly curved sutures on the spiral side, and apparently praemuricate and encrusted wall texture. However, the overall wall texture and morphology are very similar to the Paleocene genus *Igorina*. In view of its uncertain taxonomic affinities, we prefer not to include *G. salisburgensis* in the *P. broedermanni* group.

In agreement with Berggren et al. (2006a), *Globorotalia mattseensis* and *G. wartsteinensis* erected by Gohrbandt (1967) and *Acarinina planodorsalis* Fleisher, 1974, are morphotypes that fall within the variability of *P. broedermanni*.

Phylogenetic relationships. *Pearsonites* nov. gen. likely evolved from the *Acarinina mckannai-soldadoensis* plexus in the late Paleocene (Zone P5; Soldan et al., 2011; Fig. 10). We have observed that *P. broedermanni* evolved from *P. lodoensis* in the middle part of Zone P5 (late Paleocene) by increasing the number of chambers (6–7) in the final whorl, culminating in the evolution of *P. anapetes* (8–10 chambers; Fig. 10).

In the evolution of the *P. broedermanni* group, the sutures initially change from slightly curved in *P. lodoensis* to curved in *P. broedermanni*. *Pearsonites anapetes*, however, displays radial and oblique sutures. In addition, the chambers in *P. lodoensis* are almost equidimensional, while in *P. broedermanni* the chambers become tangentially elongate (subrectangular) and in *P. anapetes* the chambers are radially elongated (subtrapezoidal to subquadrate). In agreement with Blow (1979, p. 914) and Berggren et al. (2006a), we consider *P. anapetes* as the end-member of the *Pearsonites broedermanni* lineage.

Distinguishing features. *Pearsonites* nov. gen. is distinguished from *Acarinina* in having a biconvex to planoconvex test, a globorotaliform coiling mode, a narrower umbilicus, subglobular to subquadrate chambers on the spiral side and triangular chambers on the umbilical side, and less coarse, more uniformly sized muricae. It differs from *Igorina* in having a lower trochospire tending to planoconvex, a rounded peripheral margin, a larger umbilicus, and a typically muricate wall texture without a crust on the spiral side.

Geographic distribution. Widely distributed in tropical-subtropical areas of the world (Indo-Pacific realms, Atlantic Ocean, and Caribbean Sea). It has been also reported from the Tethys, Caucasus Mountains, east Africa, and California.

Stratigraphic range. Zone P5–top of Zone E9.

CONCLUSIONS

The *broedermanni* group, previously placed in the genus *Igorina* (Berggren & Norris, 1997; Olsson et al., 1999; Berggren et al., 2006a), is here included in *Pearsonites* nov. gen. This taxon displays a biconvex globorotaliform test morphology and is characterized by having subglobular to subquadrate chambers on the spiral side and triangular chambers on the umbilical side. It possesses a nonspinose wall texture with muricae on the test surface. The oldest species, *P. lodoensis*, shows a rather coarse muricate test similar to *Acarinina*, while in its descendants, *P. broedermanni* and *P. anapetes*, the muricae are finer on the spiral

side and heavier ones are developed only around the umbilicus.

Detailed analyses of the wall texture suggest that *Pearsonites* is phylogenetically related to *Acarinina* as the calcite wall structures are more similar to muricae than to the short pustules of the Paleocene igorinids (i.e., *I. pusilla*, *I. albeari*). In *Pearsonites*, the shell is not encrusted (as in *Igorina*) because the pustules remain isolated and increase in size to become muricae. Moreover, analysis of the pore structures in cross section seems to confirm the similarities and affinities between the wall texture of *Pearsonites* and *Acarinina*. In both genera, the hourglass-shaped pores become narrow in the outer calcite layer, whereas in *Igorina* species the pores are tight in the inner calcite layer. *Pearsonites* nov. gen. evolved in the late Paleocene–early Eocene from the rounded acarininids (*A. soldadoensis*), as demonstrated by cladistics analysis.

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