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Authors: Kawagata, Shungo, and Kamihashi, Tomoyuki

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Middle Pleistocene to Holocene upper bathyal benthic foraminifera from IODP Hole U1352B in Canterbury Basin, New Zealand

SHUNGO KAWAGATA[1] AND TOMOYUKI KAMIHASHI[2*]

[1]*College of Education and Human Sciences, Yokohama National University, 79-2 Tokiwadai, Hodogaya-ku, Yokohama, Kanagawa 240-8501, Japan (e-mail: kawagata-shungo-cz@ynu.ac.jp)*
[2]*Graduate School of Education, Yokohama National University, 79-2 Tokiwadai, Hodogaya-ku, Yokohama, Kanagawa 240-8501, Japan*
[*]*Present address: Sanda Elementary School, 515 Sanda, Atsugi, Kanagawa 243-0211, Japan*

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Abstract. IODP Expedition 317 recovered a 550 m-thick sedimentary sequence spanning MIS 63–MIS 1 (last 1.76 Ma), except for early MIS 5–MIS 3, from the upper bathyal zone (344 m water depth) of Canterbury Basin, east of New Zealand (Hole U1352B). Thus, this hole was chosen as the sole, well dated core to investigate time-series changes in the benthic foraminiferal fauna and paleoceanography on the upper slope off Canterbury during the Pleistocene. This paper describes and illustrates the taxonomic character of the benthic foraminifera for the upper 252 m of the hole, spanning the last *ca*. 880 ka. A total of 179 species, including unidentified species, were found and comprise 4 agglutinated species (all in Suborder Textulariina), 11 porcelaneous species (all in Suborder Miliolina), and 164 hyaline species (3 Spirillinina, 76 Lagenina, 3 Robertinina and 82 Rotaliina). Many of these species are Recent shallow- and deep-water benthic foraminifera that have been recognised previously around New Zealand or species found in the Cenozoic onland strata in the Canterbury region. However, many species with a lower frequency of occurrence have not hitherto been found in New Zealand waters, but had been reported in the Pacific or the South Atlantic oceans. Three new species (*Palliolatella grenfelli* sp. nov., *Palliolatella haywardi* sp. nov. and *Rotaliella sabaae* sp. nov.) are described here.

Key words: benthic foraminifera, Canterbury Basin, Holocene, New Zealand, Pleistocene, upper bathyal depth

Introduction

Benthic foraminifera have been studied a number of times from seafloor sediment cores recovered from east of New Zealand (Hayward, 2001, 2002; Hayward *et al*., 2004a, 2004b, 2005). Most of these investigations were done to reconstruct the paleoceanography in the deep sea by analyses of pelagic cores at Deep Sea Drilling Project (DSDP) Site 594 and Ocean Drilling Program (ODP) sites 1120–1125. ODP Site 1119 from the upper bathyal zone (395 m depth) was the only site to investigate the time-series changes in the benthic foraminiferal fauna and paleoceanography on the upper slope off Canterbury, southeastern New Zealand (Carter and Gamon, 2004).

In 2009, Integrated Ocean Drilling Program (IODP) Expedition 317 drilled at three sites on the continental shelf (U1351, U1553, U1354: 84–122 m water depth) and one site on the upper slope (U1352: 344 m water depth) of the Canterbury Basin east of New Zealand with particular focus on the sequence stratigraphy of the Miocene to Recent, when sea level changes were dominated by glacioeustasy (Expedition 317 Scientists, 2011) (Figure 1). Hole U1352B was drilled (44°56.26'S, 172°01.36'E) near Site 1119 and reached a total depth of 1927 m spanning late Eocene to Holocene. Sediment recovery was nearly 100% only at penetration depths shallower than 550 m below the seafloor (CSF-A). This well recovered section consists predominantly of mud-rich sediments with calcareous sandy mud, interbedded sand and mud, massive sand, mottled sandy mud, homogeneous mud, shelly mud, and marl and yielded microfossils (Expedition 317 Scientists, 2010). Hoyanagi *et al*. (2014) dated the upper 550 m CSF-A of the core by stable oxygen isotope stratigraphy using measurements on the benthic foraminifer *Nonionellina flemingi*, with the help of calcareous nannofossil datums. These revealed that the

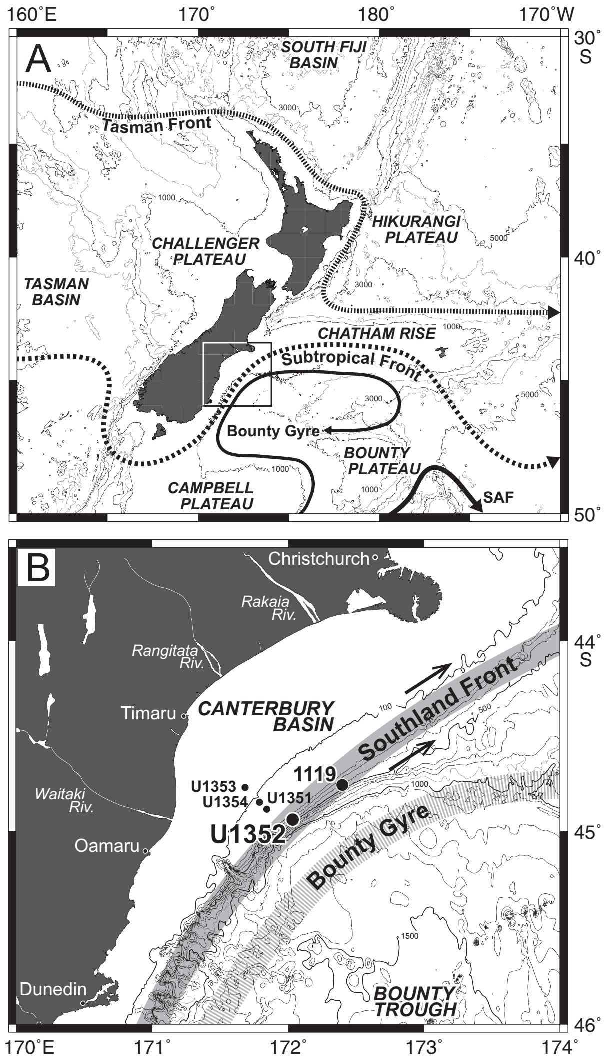

Figure 1. Location map of study area and core sites. Bathymetric contours are in meters. **A,** bathymetry and location of the modern oceanic fronts around New Zealand (modified after Carter *et al*., 1998; Neil *et al*., 2004). The Bounty Gyre is a local gyre that is branched from the Subantarctic Front. SAF: Subantarctic Front. **B,** surface currents and location of the cores drilled on the Canterbury Basin by IODP Exp.317 (U13521, U1352, U1353 and U1354) and ODP Leg. 90 (ODP 1119).

dated section is a complete succession of sediments with most of the marine isotope stages (MIS) in the LR04 stack (Lisiecki and Raymo, 2005) since MIS 63 (= 1.76 Ma) recognised, except for early MIS 5 to MIS 3 (interval between 63.3 m and 10.7 m CSF-A) where benthic foraminifera were absent or poorly preserved. Thus, Hole U1352B became the sole drilled hole used to investigate time-series changes in the benthic foraminiferal fauna and paleoceanography on the upper slope off Canterbury during the Pleistocene. To infer the paleoceanography through analyses of benthic foraminifera, firstly requires careful identification of the species, which enables appropriate comparison with similar studies around the world oceans.

The aim of this paper is to describe all the species of benthic foraminifera that occur in the upper 252 m CSF-A (Middle Pleistocene to Holocene, last *ca*. 880 kyr) of Hole U1352B from the Canterbury Basin. The paleoceanographic study of Hole U1352B on the basis of benthic foraminifera will appear elsewhere.

Geologic and oceanographic settings

The Canterbury Basin is located in the foothills east of the Southern Alps and extends down-dip beneath the Canterbury Plains of the South Island in New Zealand. It is also present over a large area offshore including a wide shelf, with its edge located *ca.* 95 km off the coastline at a depth of 140 m, and thus covers *ca.* 13000 km^2. The basin was formed as an intraplate rift with subsidence and accompanying marine transgression. Vast quantities of terrigenous sediments have been delivered from the eroding Southern Alps to the basin and comprise a thick sediment sequence (Griffiths and Glasby, 1985). Sedimentation rate has been estimated to have been 0.19 mm per year for the upper shelf slope at a depth of 395 m (Shipboard Science Party, 1999). In the glacial periods of the middle and late Quaternary, a wide area of the shelf was exposed stretching from the present coastline to a maximum 70 km off shore during lowstands of sea level (Griffiths and Glasby, 1985).

In the surface ocean of the Canterbury Basin there are two different water masses, which are bordered by the Subtropical Front (STF; known as the Subtropical Convergence, STC) considered to be the northern extent of the Southern Ocean (Figure 1). Northwest of the STF, the Subtropical Surface Water (STSW) covers the shelf and upper slope. It is characterised by warm, highly saline (>34.5) and nutrient-depleted subtropical surface water that is sourced from the Tasman Sea and flows northward. Southeast of the STF, there is the Subantarctic Surface Water (SAW) that is cool, lower in salinity (<34.1) and nutrient-rich and flows northward. The location of the STC is defined as the position of the surface isotherm at 15°C in summer and at 10°C in winter (Heath, 1985) and is set at around southern New Zealand along the continental margin in waters 250–400 m deep off the southeastern South Island (Sutton, 2003). The STC is referred to as the Southland Front (SF) along the southeast coast of the South Island and extends in a southwest to northeast direction. Along the SF, the Southland Current flows northward on both sides of the front.

Materials and methods

Samples and treatments

Samples utilised in this study were obtained from the upper 255.90 m of Hole U1352B drilled on the upper slope of the Canterbury Basin during the IODP Expedition 317 in 2009 (Figure 1). Unconsolidated mud-rich sediments were sampled at every *ca.* 0.75 m by using 20 cc plastic tubes during the expedition. The samples were freeze-dried and weighed, soaked in water, washed gently with running water over a 63-µm sieve, dried, and reweighed. An age model for this core was proposed for the upper 550 m CSF-A based on the $\delta^{18}O$ stratigraphy with the help of calcareous nannofossil bioevents, and most marine isotope stages (MIS) were identified since MIS 63 (= 1.76 Ma) (Hoyanagi *et al.*, 2014). For the upper 255.90 m CSF-A (corresponding to the last *ca.* 880 ka, since MIS 22) of the hole, 48 out of the 153 samples that were used for the stable isotope measurements were selected for the study of changes in benthic foraminifera on the upper slope. Benthic foraminifera (>63 µm) were picked from sample aliquots containing more than 200 specimens (sometimes less) and identified.

Scanning electron microphotographs were taken for all species using a JEOL JSM-5600LV scanning electron microscope (SEM), and composite multifocus optical microphotographs of selected species were taken for comparison. These illustrated specimens and types of new species are lodged in the collections of the National Museum of Nature and Science, Tsukuba, Ibaraki Prefecture, Japan, with collection ID prefixed by MPC-.

Analytical methods

Semiquantitative analysis

Semiquantitative estimates were made of species relative abundance of benthic foraminifera (very abundant: >16%, abundant: 8%–16%, common: 4%–8%, rare: 1%–4%, very rare: <1%) for each sample.

Results and summary

Benthic foraminifera occurred throughout the upper 255.90 m CSF-A of the hole (since MIS 22 at an age of *ca*. 880 ka) except for the barren interval between 63.3 and 10.7 m CSF-A, corresponding to the period of early MIS 5 to MIS 3.

Composition of benthic foraminiferal faunas

Sixteen species are recognised as abundantly occurring species with a relative abundance of >8% in any one of the examined samples. A diagram of relative abundance changes of these 16 species is shown in Figure 2. Several of these taxa occur throughout the studied section, e.g. *Cassidulina carinata*, *Cassidulina reniforme*, *Globocassidulina subglobosa* and *Angulogerina angulosa*. *C. carinata* is the most abundant species throughout the studied section with a relative abundance ranging between 2.2% and 56.7%, averaging 22.9%, and is likely more abundant in the interglacials than glacial periods. *A. angulosa* occurs almost throughout the studied section, but is more abundant in MIS 22–MIS 13 with a maximum abundance of 17.4%, averaging 5.5%. *C. reniforme* increases after MIS 12, with a maximum abundance of 25.6%, averaging 6.0%. *G. subglobosa* occurs throughout with a relative abundance between 0.9% and 31.3%, averaging 7.6%. *Pseudoparrella vitrea* is common to abundant before MIS 12 with a maximum abundance of 24.8%. On the other hand, *Abditodentrix pseudothalmanni* does not occur throughout the section, but is exclusively recognised at around the MIS 19/20 transition and between the end of MIS 13 and MIS 10 with a maximum abundance of 43.5%. Forty-six species are represented by a single specimen throughout the examined section. Several genera show higher taxonomic diversity, i.e., genera belonging to the Family Lagenidae.

Brief notes on benthic foraminifera

A total 179 species including an unidentified species were found in the examined samples and comprise 4 agglutinated species (all in Suborder Textulariina), 11 porcelaneous species (all in Suborder Miliolina), and 164 hyaline species (3 Spirillinina, 76 Lagenina, 3 Robertinina and 82 Rotaliina). Many of these species are Recent shallow- and deep-water benthic foraminifera that have been recognised previously around New Zealand (e.g. Chapman, 1906, 1909; Vella, 1957; Hedley *et al*., 1965, 1967; Hayward *et al*., 1999, 2010), and show some similarity to the Cenozoic fossil benthic foraminifera found within the onland strata in the Canterbury region (e.g. Hornibrook, 1961). However, many species with a lower frequency of occurrence have not hitherto been recorded in New Zealand waters, but had been described in the Pacific or the south Atlantic Oceans (e.g. McCulloch, 1977, 1981; Boltovskoy *et al*., 1980).

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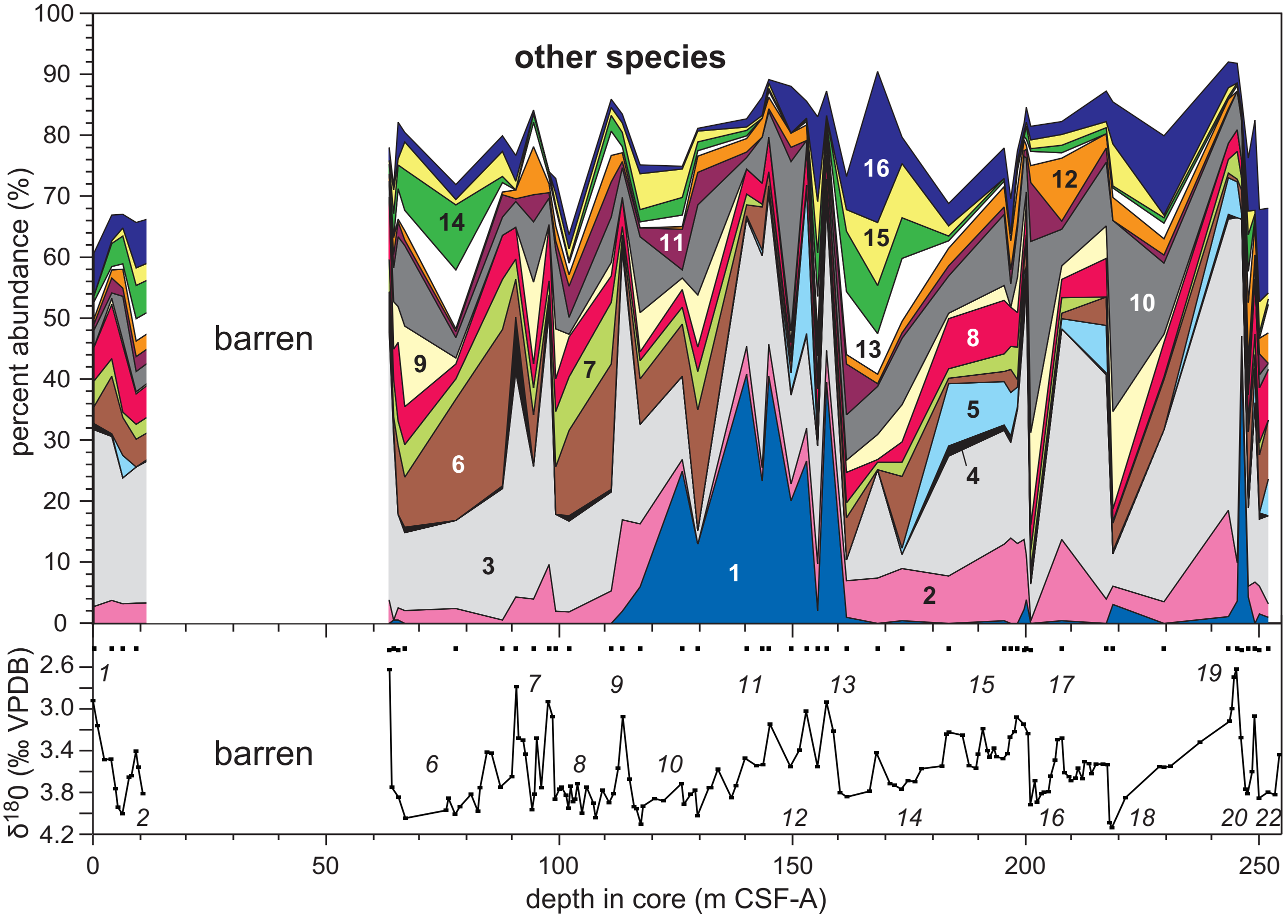

Figure 2. Down-core changes in stable oxygen isotopes of benthic foraminifera and distribution of percent abundance of 16 abundantly occurring species (>8 % in any one of the samples) in the upper *ca*. 252 m of Hole U1352B. Marine Isotope Stages (MIS) from MIS 22 to MIS 1 and stratigraphic location of benthic foraminiferal samples (small dots) are shown. Numerals in the benthic foraminiferal composition diagram represent the following species. 1, *Abditodentrix pseudothalmanni*; 2, *Angulogerina angulosa*; 3, *Cassidulina carinata*; 4, *Discorbinella vitrevoluta*; 5, *Pileolina patelliformis*; 6, *Cassidulina reniforme*; 7, *Cibicides dispars*; 8, *Gavelinopsis praegeri*; 9, *Globocassidulina crassa*; 10, *Globocassidulina subglobosa*; 11, *Pacinonion minutus*; 12, *Elphidium clavatum*; 13, *Nonionella auris*; 14, *Nonionellina flemingi*; 15, *Notorotalia inornata*; 16, *Pseudoparrella vitrea*.

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Systematic paleontology

In the following section, 179 species are described and illustrated with their ecological distribution mainly around New Zealand (Hayward *et al.*, 1999, 2010). Basically, the classification at the suprageneric levels follows Loeblich and Tappan (1987) and Hayward *et al*. (2012). Benthic depth zones that explain bathymetric distributions of benthic foraminifera in this study are shown in Table 1.

Order Foraminiferida Eichwald, 1830
Suborder Textulariina Delage and Hérouard, 1896
Superfamily Spiroplectamminoidea Cushman, 1927c
Family Spiroplectamminidea Cushman, 1927c
Subfamily Spiroplectammininae Cushman, 1927c
Genus ***Spiroplectamminina*** Cushman, 1927c
Spiroplectamminina proxispira (Vella, 1957)

Figure 3.1

Textularia proxispira Vella, 1957, p. 15, pl. 3, figs. 48, 52; Dawson,

Table 1. Terminology for benthic depth zones that explain bathymetric distributions of benthic foraminifera in this study (Hayward *et al*., 2010).

water depth (m)	Benthic depth zone	
0–50	inner	
50–100	middle	Shelf
100–200	outer	
200–600	upper	
600–1000	mid	Bathyal
1000–2000	lower	
2000–3000	upper	
3000–4000	mid	Abyssal
4000–5000	lower	
5000–	Hadal	

1992, p. 107.

Spiroplectamminina proxispira (Vella). Hayward *et al*., 1999, p. 88, pl. 2, figs. 9–11; Hayward *et al*., 2010, p. 141, pl. 4, figs. 38–40.

Textularia ensis Vella, 1957, p. 16, pl. 3, figs. 46, 47; Dawson, 1992, p. 106.

Type locality.—Cook Strait, New Zealand; Recent.

Occurrence.—Sporadic. Very rare in the core.

Remarks.—This species resembles *Textularia lateralis* Lalicker, 1935 in its squashed subtriangular test shape in side view and rhomboidal shape in cross section but differs from the latter in its flush and indistinct sutures in comparison with distinct ones.

Distribution.—This species is common at deep inner- and mid-shelf depths around New Zealand (Hayward *et al*., 1999).

Superfamily Textularioidea Ehrenberg, 1838
Family Textulariidae Ehrenberg, 1838
Subfamily Textulariinae Ehrenberg, 1838
Genus ***Siphotextularia*** Finlay, 1939a
Siphotextularia mestayerae Vella, 1957

Figure 3.2

Siphotextularia mestayerae Vella, 1957, p. 17, pl. 4, figs. 55–57; Dawson, 1992, p. 108; Hayward *et al*., 1999, p. 90, pl. 2, figs. 19–21.

Type locality.—Auckland Island, south New Zealand; Recent.

Occurrence.—Sporadic. Very rare in the hole.

Remarks.—This species is rhomboidal in cross section similarly to the New Zealand endemic species *Siphotextularia blacki* (Vella, 1957), but is distinguished from the latter species by a smaller test with concave test faces.

Distribution.—This species occurs at deep inner- and mid-shelf depths around New Zealand (Hayward *et al*., 1999).

Genus ***Textularia*** Defrance, 1824
Textularia paupercula Earland, 1934

Figure 3.3

Textularia paupercula Earland, 1934, p. 114, pl. 5, figs. 27–29.

Type locality.—Bellingshausen Sea, off Antarctica; Recent.

Occurrence.—Sporadic. Very rare in the hole.

Remarks.—Although the last chamber of the specimen examined is broken off, this species may consist of six pairs of biserial chambers, as described for the type.

Distribution.—Earland (1934) originally reported this minute *Textularia* species from the intermediate depths of the Bellingshausen Sea, Antarctica (534–2611 m water depths).

Textularia pseudogramen Chapman and Parr, 1937

Figure 3.4

Textularia gramen d'Orbigny. Brady, 1884, p. 365, pl. 43, figs. 9, 10 (*non Textularia gramen* d'Orbigny, 1846).

Textularia pseudogramen Chapman and Parr, 1937, p. 153; Barker, 1960, p. 88, pl. 43, figs. 9, 10; Jones, 1994, pl. 43, figs. 9, 10; Yassini and Jones, 1995, p. 76, figs. 118, 119, 123; Hayward *et al*., 1999, p. 91, pl. 2, figs. 27–29; Hayward *et al*., 2010, p. 148, pl. 6, figs. 30–32; Debenay, 2013, p. 98, pl. 2 (unnumbered).

Type locality.—Off Tasmania, Southwest Pacific Ocean; Recent.

Occurrence.—Sporadic. Very rare in the hole.

Distribution.—This species occurs at deep inner- to upper-bathyal depths (30–400 m) around New Zealand (Hayward *et al*., 1999); it occurs in the environments between lagoons and upper bathyal shelves in the Southwest Pacific Ocean (Debenay, 2013).

Suborder Spirillinina Hohenegger and Piller, 1975
Family Spirillinidae Reuss and Fritsch, 1861
Genus ***Mychostomina*** Berthelin, 1881
Mychostomina revertens (Rhumbler, 1906)

Figures 3.5, 3.6

Spirillina vivipara var. *revertens* Rhumbler, 1906, p. 32, pl. 2, figs. 8–10; Cushman, 1915, p. 4, pl. 1, figs. 3–6; Barker, 1960, p. 176, pl. 85, fig. 5.

Mychostomina revertens (Rhumbler). Smith and Isham, 1974, p. 66, pl. 1, figs. 1–3, 7–9: Boltovskoy *et al*., 1980, p. 39, pl. 21, figs. 17–20; Jones, 1994, p. 92, pl. 85, fig. 5; Hayward *et al*., 1999, p.

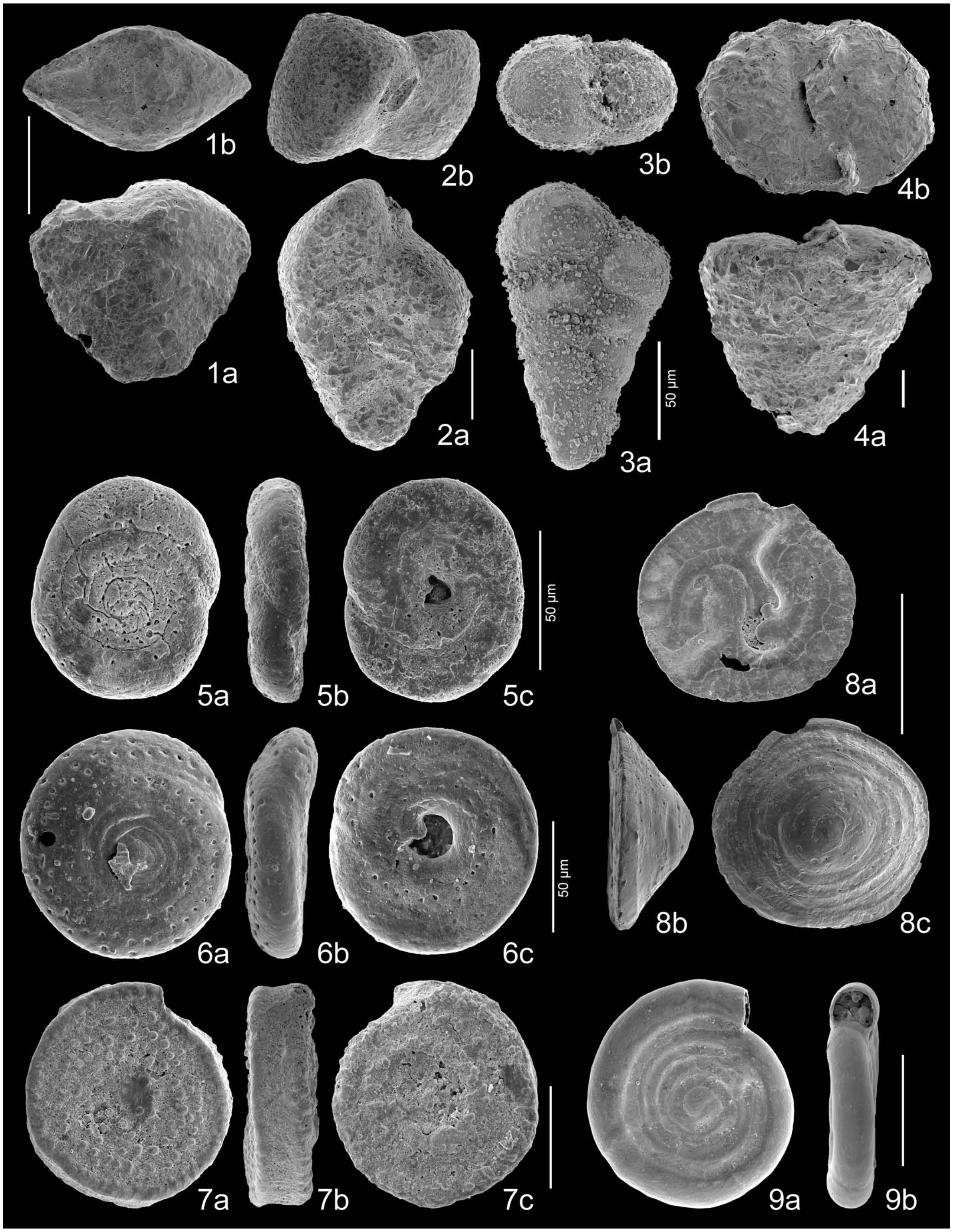

Figure 3. Photographs of benthic foraminifera from the Hole U1352B (1). Scale bars: 100 µm unless otherwise specified. **1,** *Spiroplectamminina proxispira* (Vella), MPC-28896, Sample U1352B-13H-4-W, 19-21 cm; **2,** *Siphotextularia mestayerae* Vella, MPC-28897, Sample U1352B-1H-1-W, 19–21 cm; **3,** *Textularia paupercula* Earland, MPC-28898, Sample U1352B-19H-2-W, 94–96 cm; **4,** *Textularia pseudogramen* Chapman and Parr, MPC-28899, Sample U1352B-7H-6-W, 94–96 cm; **5, 6,** *Mychostomina revertens* (Rhumbler); 5, MPC-28900, Sample U1352B-21H-3-W, 94–96 cm; 6, MPC-28901, Sample U1352B-21H-3-W, 94–96 cm; **7,** *Spirillina denticulogranulata* Chapman, MPC-28902, Sample U1352B-1H-1-W, 19–21 cm; **8,** *Patellina corrugata* Williamson, MPC-28903, Sample U1352B-28H-1-W, 19–21 cm; **9,** *Cornuspira involvens* (Reuss), MPC-28904, Sample U1352B-1H-5-W, 19–21 cm.

49, pl. 3, figs. 3, 4.
Spirillina vivipara Ehrenberg. Brady, 1884, pl. 85, fig. 5 (in part, not figs. 1–4).

Type locality.—Not designated; Recent.
Occurrence.—Sporadic. Very rare in the hole.
Distribution.—This species is recorded from North Island, the northern part of South Island and Kermadec Island in New Zealand, especially in the area east of North Island. It occurs in moderately sheltered to exposed inner-shelf environments (Hayward *et al*., 1999).

Genus ***Spirillina*** Ehrenberg, 1843
Spirillina denticulogranulata Chapman, 1907

Figure 3.7

Spirillina denticulo-granulata Chapman, 1907, p. 133, pl. 10, fig. 6a–c; Chapman, 1909, p. 354, pl. 17, fig. 3.
Spirillina denticulogranulata Chapman. Hayward *et al*., 1999, p. 92, pl. 3, figs. 5, 6.

Type locality.—Torquay, Victoria, Australia, Southwest Pacific Ocean; Recent.
Occurrence.—Sporadic. Very rare in the hole.
Distribution.—This species occurs in exposed and sheltered inner- and mid-shelf environments around New Zealand (Hayward *et al*., 1999).

Family Patellinidae Rhumbler, 1906
Subfamily Patellininae Rhumbler, 1906
Genus ***Patellina*** Williamson, 1858
Patellina corrugata Williamson, 1858

Figure 3.8

Patellina corrugata Williamson, 1858, p. 46, pl. 3, figs. 86–89; Boltovskoy *et al*., 1980, p. 42, pl. 24, figs. 17–20; Yassini and Jones, 1995, p. 163, figs. 734–745; Hayward *et al*., 1999, p. 93, pl. 3, figs. 11–13; Debenay, 2013, p. 206, pl. 14 (unnumbered); Holbourn *et al*., 2013, p. 395, figs. 1–3.

Type locality.—Waters around Great Britain; Recent.
Occurrence.—Sporadic. Very rare to rare in the hole.
Distribution.—This species occurs in exposed and fully marine inner- and mid-shelf environments around New Zealand (Hayward *et al*., 1999).

Suborder Miliolina Delage and Hérouard, 1896
Superfamily Cornuspiroidea Schultze, 1854
Family Cornuspiridae Schultze, 1854
Subfamily Cornuspirinae Schultze, 1854
Genus ***Cornuspira*** Schultze, 1854
Cornuspira involvens (Reuss, 1850)

Figure 3.9

Operculina involvens Reuss, 1850, p. 370, pl. 46, figs. 20a, b.
Cornuspira involvens (Reuss). Reuss, 1863, p. 39, pl. 1, fig. 2; Cushman, 1917, p. 25, pl. 1, fig. 2, pl. 2, fig. 2; Asano, 1956, p. 80, pl. 7, fig. 1; Hayward *et al*., 1999, p. 94, pl. 3, fig. 16; Akimoto *et al*., 2002, p. 6, pl. 6, fig. 1; Debenay, 2013, p. 105, pl. 4 (unnumbered).
Cyclogyra involvens (Reuss). Boltovskoy *et al*., 1980, p. 26, pl. 10, figs. 11, 12.

Type locality.—Tegel, Germany; "Tertiary".
Occurrence.—Sporadic. Very rare in the hole.
Distribution.—This cosmopolitan species is commonly distributed in exposed and fully marine inner-shelf environments around New Zealand (Hayward *et al*., 1999).

Superfamily Milioloidea Ehrenberg, 1839
Family Spiroloculinidae Wiesner, 1920
Genus ***Nummulopyrgo*** Hofker, 1983
Nummulopyrgo globulus (Hofker, 1976)

Figure 4.1

Biloculina globulus Bornemann. Schlumberger, 1891, p. 575, pl. 12, figs. 97–100, text-figs. 42–44 (*non Biloculina globulus* Bornemann, 1855).
Pseudopyrgo globulus (Bornemann). Hofker, 1976, p. 112, fig. 106.
Nummulopyrgo globulus (Hofker). Loeblich and Tappan, 1987, p. 330, pl. 339, figs. 7–14; Loeblich and Tappan, 1994, p. 42, pl. 101, figs. 4–12; Hayward *et al*., 2010, p. 158, pl. 9, figs. 30–32; Debenay, 2013, p. 113, pl. 5 (unnumbered).
Pyrgoella distincta McCulloch, 1977, p. 653, pl. 242, figs. 12–24.
Pseudopyrgo toddae (Andersen). Zheng, 1988, p. 272, pl. 14, figs. 3–7 (*non Biloculinella toddae* Andersen, 1961).
Nummulopyrgo sp. 1., Debenay, 2013, p. 113, pl. 5 (unnumbered).

Type locality.—Falkland Islands and adjacent seas, Subantarctic region; Recent.
Occurrence.—Sporadic. Very rare in the core, but rare in the topmost sample.
Remarks.—Hofker (1976) proposed *Pseudopyrgo* for Schlumberger's (1891) *Biloculina globulus* without noticing that *Pseudopyrgo* was preoccupied by Rasheed (1971) for *Biloculina milletti* Cushman, 1917, and thus he reproposed the genus *Nummulopyrgo* in 1983. Loeblich and Tappan (1987) designated Schlumberger's (1891) *Biloculina globulus* as the lectotype of *Nummulopyrgo globulus* (Hofker).
Distribution.—This species was reported from mid-shelf to upper bathyal depths (80–500 m) east of the North and northern South Island of New Zealand (Hayward *et al*., 2010). This species was also reported from mid-shelf to upper bathyal depths (*ca*. 80–292 m) in the Timor Sea, to the north of Australia (Loeblich and Tappan, 1994) and from mid-bathyal depth (600 m) off New Caledonia (Debenay, 2013).

Family Hauerinidae Schwager, 1876

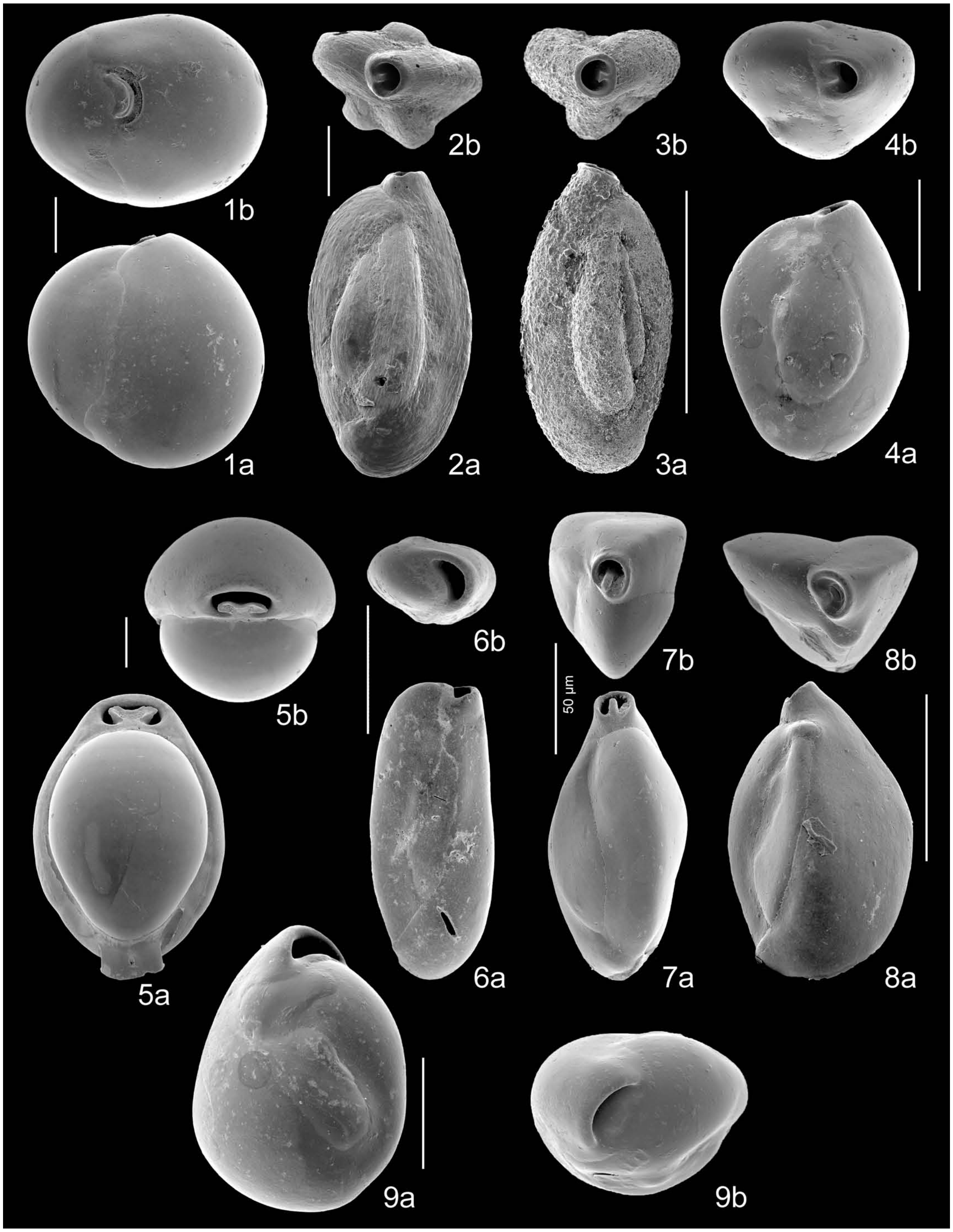

Figure 4. Photographs of benthic foraminifera from the Hole U1352B (2). Scale bars: 100 μm unless otherwise specified. **1,** *Nummulopyrgo globulus* (Hofker), MPC-28905, Sample U1352B-7H-6-W, 94–96 cm; **2,** *Quinqueloculina delicatula* Vella, MPC-28906, Sample U1352B-7H-6-W, 19–21 cm; **3,** *Quinqueloculina frigida* Parker, MPC-28907, Sample U1352B-8H-1-W, 19–21 cm; **4,** *Quinqueloculina suborbicularis* d'Orbigny, MPC-28908, Sample U1352B-18H-1-W, 94–96 cm; **5,** *Pyrgo clypeata* (d'Orbigny), MPC-28909, Sample U1352B-11H-6-W, 94–96 cm; **6,** *Triloculina* cf. *detlingae* McCulloch, MPC-28910, Sample U1352B-17H-2-W, 94–96 cm; **7,** *Triloculina trigonula* (Lamarck), MPC-28911, Sample U1352B-23H-2-W, 94–96 cm; **8,** *Triloculina* sp. 1, MPC-28912, Sample U1352B-9H-3-W, 19–21 cm; **9,** *Triloculinella pseudooblonga* (Zheng), MPC-28913, Sample U1352B-1H-3-W, 94–96 cm.

Subfamily Hauerininae Schwager, 1876
Genus ***Quinqueloculina*** d'Orbigny, 1826
Quinqueloculina delicatula Vella, 1957

Figure 4.2

Quinqueloculina delicatula Vella, 1957, p. 27, pl. 4, figs. 77–79; Hayward *et al*., 1999, p. 102, pl. 4, figs. 23, 24.

Type locality.—Off Kapiti Island in Cook Strait, New Zealand, Southwest Pacific Ocean; Recent.

Occurrence.—Sporadic. Very rare in the hole.

Remarks.—*Quinqueloculina delicatula* is distinguished by its pentagram-like, subquadrate test periphery in cross section.

Distribution.—This New Zealand endemic species is common at exposed inner-shelf to mid-shelf depths and in sheltered, deep (20–50 m) inlets around New Zealand (Hayward *et al*., 1999). Vella (1957) reported the holotype and three paratypes from outer-shelf depths of *ca*. 150 m off Kapiti Island in Cook Strait.

Quinqueloculina frigida Parker, 1952

Figure 4.3

Quinqueloculina frigida Parker, 1952, p. 406, pl. 3, fig. 20a, b; Boltovskoy *et al*., 1980, p. 45, pl. 27, figs. 8–12.

Quinqueloculina agglutinans d'Orbigny. Hedley *et al*., 1965, p. 12, pl. 2, fig. 7a, b; Hayward *et al*., 1999, p. 100, pl. 4, figs. 11, 12 (*non Quinqueloculina agglutinans* d'Orbigny, 1839a).

Quinqueloculina granulosa Natland. Uchio, 1960, pl. 2, figs. 27, 28 (*non Quinqueloculina granulosa* Natland, 1938).

Type locality.—Northwest Atlantic Ocean off Portsmouth, New Hampshire; Recent.

Occurrence.—Sporadic. Very rare to rare in the hole.

Remarks.—The specimen examined here is an elongate oval, non-sigmoid, finely arenaceous species with a circular aperture and small bifid aperture, which can be identified as *Quinqueloculina frigida* Parker, 1952. *Quinqueloculina agglutinans* d'Orbigny, 1839a found previously in New Zealand (Hedley *et al.*, 1965; Hayward *et al.*, 1999) is characterised by an oval, non-sigmoid test and considered to be the same species. *Q. agglutinans* was originally described from Recent materials from Cuba, and was lectotypified by Le Calvez (1977) for the specimen showing a very coarsely arenaceous, sigmoid, quinqueloculine test and a large oval aperture with a distinct bifid tooth and apertural rim. Our species also resembles Uchio's (1960) illustrated *Quinqueloculina granulosa* Natland, 1938 (*op. cit.,* pl. 2, figs. 27, 28) that shows a rounded chamber periphery in apertural view rather than the angular one in the type figure of *Q. granulosa*.

Distribution.—This species is distributed in fully marine, exposed to moderately sheltered, inner- and occasionally mid-shelf environments around New Zealand (Hayward *et al*., 1999; Hedley *et al.*, 1965).

Quinqueloculina suborbicularis d'Orbigny in Fornasini, 1905

Figure 4.4

Quinqueloculina suborbicularis d'Orbigny, 1826, p. 302 (*nomen nudum*); Fornasini, 1905, p. 67, pl. 4, figs. 3, 3a, b; Hayward *et al*., 1999, p. 103, pl. 5, figs. 6–8.

Quinqueloculina (*Quinqueloculina*) *suborbicularis* d'Orbigny. Vella, 1957, p. 23, pl. 6, figs. 102–104.

Type locality.—Mediterranean Sea; Recent.

Occurrence.—Sporadic. Very rare to rare in the hole.

Remarks.—Fornasini (1905) showed the figure of this species for the first time based on d'Orbigny's (1826) unpublished original illustrations of foraminifera and remained under the authorship of d'Orbigny (1826) but it was recommended that the date of publication be the date when the figure appeared in Fornasini's (1905) work (Cifelli, 1990).

Distribution.—This species is commonly distributed in exposed and inner-shelf depths around New Zealand (Hayward *et al*., 1999; Vella, 1957).

Subfamily Miliolinellinae Vella, 1957
Genus ***Pyrgo*** Defrance, 1824
Pyrgo clypeata (d'Orbigny, 1846)

Figure 4.5

Biloculina clypeata d'Orbigny, 1846, p. 263, pl. 15, figs. 19–21.

Pyrgo clypeata (d'Orbigny). Papp and Schmid, 1985, p. 89, pl. 82, figs. 4–6; Hayward *et al*., 2010, p.150, pl. 7, figs. 7–10.

Biloculina fischeri Schlumberger, 1891, p. 563, pl. 11, figs. 77, 78.

Pyrgo guerrreri (Silvestri). Hayward *et al.*, 1999, p. 99, pl. 4, figs. 7, 8.

Pyrgo aff. *ezo* Asano. Vella, 1957, p. 29, pl. 7, figs. 138, 139.

Type locality.—Baden, Germany; Miocene.

Occurrence.—Sporadic. Very rare to rare in the hole.

Remarks.—The specimen treated in this study is well comparable with the lectotype of *Pyrgo clypeata* (= *Biloculina clypeata* d'Orbigny, 1846), which shows an ovate test shape and an oval apertural opening with a large T-shaped tooth (Papp and Schmid, 1985). Hayward *et al.* (2010) illustrated this species showing a variable-length slit-like aperture with a wide flap-like tooth inside the aperture from New Zealand waters, which is seemingly longer than our specimens. However, they recognised a wide variety of test shapes and apertures based on a large population for the species. Therefore we retain this species name for our species in this study. *Pyrgo clypeata* is distinguished from *Pyrgo inornata* (= *Biloculina inornata* d'Orbigny, 1846) by its oval aperture filled with a strong bifid tooth, rather than the more circular apertural opening with a slender tooth of the latter.

Distribution.—This species is distributed in exposed to slightly sheltered, inner-shelf to mid-bathyal environments (20–1000 m) around New Zealand (Hayward *et al*., 2010).

Genus ***Triloculina*** d'Orbigny, 1826
Triloculina cf. ***detlingae*** McCulloch, 1977

Figure 4.6

Cf. *Triloculina* (?) *detlingae* McCulloch, 1977, p. 553, pl. 220, figs. 2–4.

Type locality.—Off Guadalupe Island, Mexico, Northeast Pacific Ocean; Recent.

Occurrence.—Sporadic. Very rare to rare in the hole.

Remarks.—Although the specimen examined is considered to be broken at its apertural area because of preservation, its overall test shape is comparable to McCulloch's (1977) *Triloculina* (?) *detlingae.* This species is distinguished from *Sinuloculina consobrina* (= *Triloculina consobrina* d'Orbigny, 1846), whose test has a more sloping shoulder than this species.

Distribution.—McCulloch (1977) reported this species from *ca*. 6 to 130 m depth in the Northeast Pacific Ocean.

Triloculina trigonula (Lamarck, 1804)

Figure 4.7

Miliolites trigonula Lamarck, 1804, p. 351.

Triloculina trigonula (Lamarck). d'Orbigny, 1826, p. 299, pl. 16, figs. 5–9; Hada, 1931, p. 85, text-figs. 38a, b; Todd and Brönnimann, 1957, p. 27, pl. 3, fig. 19a, b (in part, not fig. 18a, b); Barker, 1960, p. 6, pl. 3, figs. 15, 16; Matoba, 1970, p. 62, pl. 3, figs. 3a–c; Whittaker and Hodgkinson, 1979, pl. 3, fig. 8; Jones, 1994, p. 20, pl. 3, figs. 15, 16 (in part, not fig. 14); Yassini and Jones, 1995, p. 92, fig. 202; Hayward *et al.*, 1999, p. 106, pl. 5, figs. 31, 32; Kawagata, 2001, p. 73, fig. 5-3a, b; Debenay, 2013, p. 138, pl. 6 (unnumbered); Holbourn *et al*., 2013, p. 567, figs. 1, 2.

Miliolina trigonula Lamarck. Williamson, 1858, p. 84, pl. 7, figs. 180–182; Brady, 1884, p. 164, pl. 3, figs. 15, 16.

Triloculina affinis d'Orbigny. Yassini and Jones, 1995, p. 92, figs. 200, 201 (*non Triloculina affinis* d'Orbigny, 1826).

Type locality.—Grignon, France; age not given.

Occurrence.—Sporadic. Very rare in the hole.

Distribution.—*Triloculina trigonula* occurs in sheltered and exposed inner-shelf environments and extending out to outer-shelf depths around the North, Stewart and Chatham islands, New Zealand (Hayward *et al*., 1999).

Triloculina sp. 1

Figure 4.8

Occurrence.—Sporadic. Very rare in the hole, but rare in the topmost sample.

Remarks.—This unidentified specimen is characterised by having a trioculine test with a small rounded, toothed aperture at the terminus of a protruded neck and a subacute chamber margin.

Genus ***Triloculinella*** Riccio, 1950
Triloculinella pseudooblonga (Zheng, 1980)

Figure 4.9

Miliolinella pseudooblonga Zheng, 1980, p. 158, 177, pl. 2, fig. 5.

Triloculinella pseudooblonga (Zheng). Loeblich and Tappan, 1994, p. 57, pl. 88, figs. 7–18, pl. 97, figs. 10–12, pl. 98, figs. 1–3, 7–9.

Type locality.—Zhongsha Islands, South China Sea; Recent.

Occurrence.—Common only during MIS 13.

Remarks.—The specimen illustrated here does not possess a distinct apertural tooth, but may have had an apertural flap that has been broken off. This species differs from *Triloculinella chiastocytis* Loeblich and Tappan, 1994 in having less obliquely arranged chambers and a narrower apertural opening without a wide apertural flap.

Distribution.—This species occurs from inner-shelf to upper bathyal depths (*ca*. 20–290 m) in the Timor Sea, to the north of Australia (Loeblich and Tappan, 1994).

Subfamily Tubinellinae Rhumbler, 1906
Genus ***Tubinella*** Rhumbler, 1906
Tubinella funalis (Brady, 1884)

Figure 5.1

Articulina funalis Brady, 1884, p. 185, pl. 13, figs. 6–11.

Tubinella funalis (Brady). Rhumbler, 1906, p. 26, pl. 2, fig. 3; Barker, 1960, p. 26, pl. 13, figs. 6–11; Bermúdez and Seiglie, 1963, p. 187, pl. 14, fig. 6; Boltovskoy *et al*., 1980, p. 53, pl. 34, figs. 9–11; Loeblich and Tappan, 1994, p. 60, pl. 103, figs. 13, 14; Debenay, 2013, p. 139 (unnumbered).

Tubinella cf. *funalis* (Brady). McCulloch, 1977, p. 573, pl. 243, figs, 1, 2.

Type locality.—Prince Edward Islands, South Pacific Ocean; Recent.

Occurrence.—Sporadic. Very rare in the hole.

Distribution.—This species was reported from shallow water between 90 and 135 m in the South Pacific Ocean (Brady, 1884), from the middle-shelf at *ca*. 90 m depth in the northeastern Timor Sea (Loeblich and Tappan, 1994), and from New Caledonia at depths down to 25 m, in the Southwest Pacific Ocean (Debenay, 2013) and from New Zealand in waters shallower than 100 m (Hayward *et al*., 1999, Appendix VI).

Suborder Lagenina Delage and Hérouard, 1896
Superfamily Nodosarioidea Ehrenberg, 1838
Family Chrysalogoniidae Mikhalevich, 1993
Genus ***Lotostomoides*** Hayward and Kawagata in Hayward *et al*., 2012
Lotostomoides schwageri Hayward in Hayward *et al*., 2012

Figure 5.2

Lotostomoides schwageri Hayward in Hayward *et al*., 2012, p. 127, pl. 6, figs. 39–42.
Chrysalogonium intertenuatum Schwager. Mohan *et al*., 2011, pl. 3, fig. 6 (*non Chrysalogonium intertenuatum* Schwager, 1866).

Type locality.—ODP Site 1125, east of New Zealand, Southwest Pacific Ocean; late Pliocene.

Occurrence.—Sporadic. Very rare to common in the core, but never appears after MIS 15.

Remarks.—Hayward *et al*. (2012) examined the taxonomy of the uniserial species of deep-sea foraminifera and separated this species from *Lotostomoides calomorphum* (= *Nodosaria* (*Nodosaria*) *calomorpha* Reuss, 1866) by its remotely separated and equal-sized ovoid chambers throughout ontogeny rather than a large spherical proloculus followed by close-set subspherical chambers as in the latter species.

Distribution.—This species has hitherto been recorded from lower bathyal depths (1365 m) of the late Pliocene to early Pleistocene section at ODP Site 1125, east of South Island, New Zealand, in the Southwest Pacific Ocean (Hayward *et al*., 2012).

Family Nodosariidae Ehrenberg, 1838
Subfamily Nodosariinae Ehrenberg, 1838
Genus ***Botuloides*** Zheng, 1979
Botuloides pauciloculus Zheng, 1979

Figure 5.3

Botuloides pauciloculus Zheng, 1979, p. 141, pl. 9, figs. 15, 16; Hayward *et al*., 2010, p. 169, pl. 12, figs. 27, 28; Debenay, 2013, p. 163, pl. 11 (unnumbered).
Nodosaria calomorpha Reuss. Brady, 1884, p. 497, pl. 61, figs. 23–26, 27?; Cushman, 1913, p. 48, pl. 25, fig. 6a–c; Barker, 1960, p. 128, pl. 61, figs. 23–26, 27? (*non Nodosaria calomorpha* Reuss, 1866).
Glandulonodosaria calomorpha (Reuss). Jones, 1994, p. 72, pl. 61, figs. 23–26, 27?, supplementary pl. 1, figs. 10, 11; Ujiié, 1995, p. 58, pl. 3, fig. 6a, b (*non Nodosaria calomorpha* Reuss, 1866).
Orthomorphina filiformis (d'Orbigny)?. Boltovskoy *et al*., 1980, p. 42, pl. 24, figs. 14–16 (*non Nodosaria* (*Nodosaire*) *filiformis* d'Orbigny, 1826).

Type locality.—Lagoon at Nichujiao, Xisha Islands (Paracel Islands), South China Sea; Recent.

Occurrence.—Very rare and found only in MIS 6.

Remarks.—Since Brady (1884) referred to this species as *Nodosaria calomorpha* Reuss, 1866, this species had long been misidentified as the same species as *Lotostomoides calomorphum* (= *Nodosaria calomorpha* Reuss, 1866) attributed to various genera. However, this species differs from *L. calomorphum* in having a much smaller test often with two to three chambers and a simple rounded terminal aperture, rather than the four- to five-chambered large test with a reticulate terminal aperture of the latter. Boltovskoy *et al.* (1980) illustrated this species under the name of *Orthomorphina filiformis*? (=*Nodosaria* (*Nodosaire*) *filiformis* d'Orbigny, 1826), but it differs from d'Orbigny's species by showing a rectilinear uniserial test with a protruded radial aperture.

Distribution.—This species is distributed at bathyal depths (300–1500 m) off the east coast of northern New Zealand (Hayward *et al*., 2010) and is also found in embayed environments (30 m depth) around New Caledonia, in the Southwest Pacific Ocean (Debenay, 2013).

Genus ***Laevidentalina*** Loeblich and Tappan, 1986
Laevidentalina inornata (d'Orbigny, 1846)

Figure 5.4

Dentalina inornata d'Orbigny, 1846, p. 44, pl. 1, figs. 50, 51; Papp and Schmid, 1985, p. 28, pl. 9, figs. 5–9.
Laevidentalina inornata (d'Orbigny). Hayward *et al*., 2010, p. 171, pl. 12, figs. 48–52.
Laevidentalina subemaciata (Parr). Hayward *et al*., 1999, p. 110, pl. 6, figs. 22, 23.

Type locality.—Baden, Germany; Miocene.

Occurrence.—Very rare and found only at around the MIS 5/6 boundary.

Remarks.—Although the last chamber is broken off, the general morphology of our specimen with a slightly curved uniserial chamber arrangement and a basal spine at the initial end is identical to *Laevidentalina inornata.*

Distribution.—This species occurs most commonly at bathyal depths (80–600 m) off the coast of New Zealand (Hayward *et al*., 2010).

Laevidentalina sidebottomi (Cushman, 1933)

Figure 5.5

Nodosaria radicula (Linné), dentaline form. Sidebottom, 1918, p. 132, pl. 4, figs. 1–5 (*non Nautilus radicula* Linné, 1758).
Dentalina sidebottomi Cushman, 1933, p. 12, pl. 3, fig. 4.
Laevidentalina sidebottomi (Cushman). Loeblich and Tappan, 1994, p. 65, pl. 113, figs. 13–19; Hayward *et al*., 2010, p. 171, pl. 12, figs. 53–56.

Type locality.—South Pacific Ocean; Recent.

Occurrence.—Very rare and found only in MIS 15.

Remarks.—This species is distinguished by its rela-

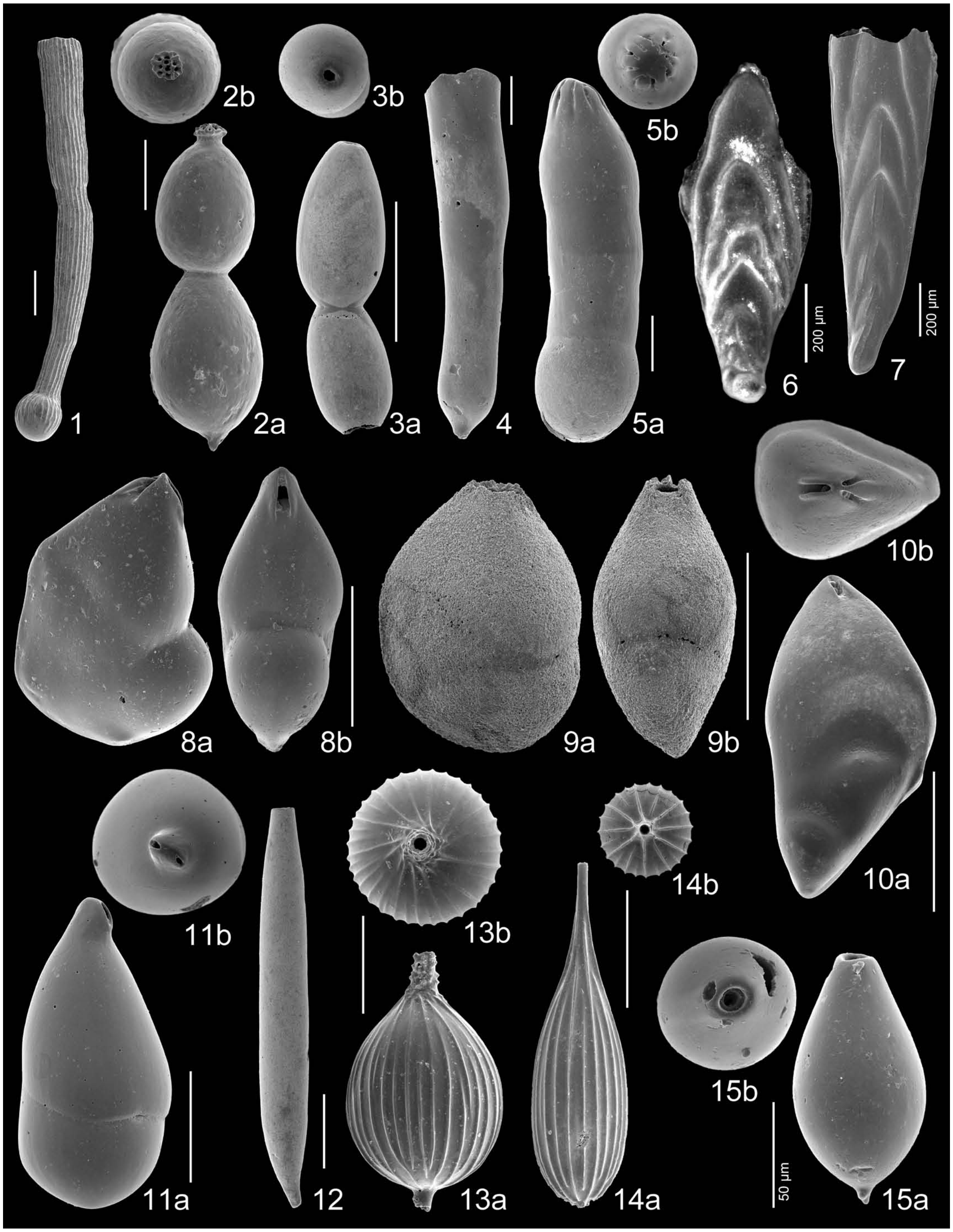

Figure 5. Photographs of benthic foraminifera from the Hole U1352B (3). Scale bars: 100 µm unless otherwise specified. **1,** *Tubinella funalis* (Brady), MPC-28914, Sample U1352B-1H-5-W, 19–21 cm; **2,** *Lotostomoides schwageri* Hayward, MPC-28915, Sample U1352B-23H-2-W, 94–96 cm; **3,** *Botuloides pauciloculus* Zheng, MPC-28916, Sample U1352B-8H-2-W, 20–22 cm; **4,** *Laevidentalina inornata* (d'Orbigny), MPC-28917, Sample U1352B-7H-6-W, 19–21 cm; **5,** *Laevidentalina sidebottomi* (Cushman), MPC-28918, Sample U1352B-22H-5-W, 19–21 cm; **6,** *Mucronina resigae* Hayward, MPC-28919, Sample U1352B-13H-4-W, 19–21 cm; **7,** *Mucronina spatulata* (Costa), MPC-28920, Sample U1352B-28H-2-W, 19–21 cm; **8,** *Lenticulina angulata* (Reuss), MPC-28921, Sample U1352B-26H-2-W, 94–96 cm; **9,** *Neolenticulina peregrina* (Schwager), MPC-28922, Sample U1352B-19H-2-W, 94–96 cm; **10,** *Saracenaria* sp. 1, MPC-28923, Sample

tively short, broad test consisting of a large proloculus followed by several quadrate and parallel-sided chambers throughout rather than globular to subglobular chambers increasing in size as more chambers are added.

Distribution.—This species occurs most commonly at outer-shelf to upper bathyal depths (100–400 m) off the coast of New Zealand (Hayward *et al*., 2010) and at middle-shelf to upper bathyal depths in the Timor Sea (Loeblich and Tappan, 1994).

Family Plectofrondiculariidae Montanaro-Gallitelli, 1957

Genus ***Mucronina*** Ehrenberg, 1839

Mucronina resigae Hayward in Hayward *et al*., 2012

Figure 5.6

Mucronina resigae Hayward in Hayward *et al*., 2012, p. 150, text-fig. 63, pl. 12, figs. 6–12.
Parafrondicularia advena (Cushman). Barker, 1960, p. 138 pl. 66, figs. 8–10 (in part, not figs. 11, 12).
Plectofrondicularia advena (Cushman). Kellar, 1980, pl. 1, fig. 13; Jones, 1994, p. 78, pl. 66, figs. 8–10 (in part, not figs. 11, 12).
Mucronina aff. *advena* (Cushman). Hayward *et al*., 2010, p. 172, pl. 12, figs. 59–61.
Frondicularia inaequalis Costa. Brady, 1884, p. 521, pl. 66, figs. 8–10 (in part, not figs. 11, 12) (*non Frondicularia inaequalis* Costa, 1855).
Proxifrons inaequalis (Costa). Hayward, 2002, p. 300, pl. 1, figs. 5–7 (in part, not figs. 4, 8, 9) (*non Frondicularia inaequalis* Costa, 1855).
Proxifrons javana (Boomgaart). Loeblich and Tappan, 1994, p. 67, pl. 118, figs. 8–10.

Type locality.—ODP Site 1119, Canterbury Basin, New Zealand, Southwest Pacific Ocean; Middle Pleistocene.

Occurrence.—Sporadic. Very rare in the core, not younger than MIS 6.

Remarks.—This species is known as the only survivor of the genus *Mucronina* from the last global extinction of deep-sea foraminifera during the mid-Pleistocene and has survived through the Pleistocene to the present day with rare occurrences (Hayward *et al*., 2012).

Distribution.—This cosmopolitan species occurs most commonly at upper bathyal to uppermost abyssal depths (400–2200 m) of the late Early Pleistocene to Recent (Hayward *et al*., 2012).

Mucronina spatulata (Costa, 1855)

Figure 5.7

Frondicularia spatulata Costa, 1855, p. 372, pl. 2, fig. 19.
Mucronina spatulata (Costa). Hayward *et al*., 2012, p. 151, text-fig. 63, pl. 12, figs. 15–22.
Frondicularia lapugyensis Neugeboren, 1856, p. 93, pl. 5, figs. 1–2.
Frondicularia hornesi Neugeboren, 1856, p. 93, pl. 5, fig. 3.
Frondicularia semicosta Karrer, 1877, p. 380, pl. 16b, fig. 26.
Frondicularia interrupta Karrer, 1877, p. 380, pl. 16b, fig. 27 (*non Frondicularia interrupta* Costa, 1855 (preoccupied)).
Proxifrons interrupta (Karrer). Popescu and Crehan, 2004, pl. 1, fig. 23, pl. 2, fig. 1.
Frondicularia raricosta Karrer, 1877, p. 381, pl. 16b, fig. 28.
Plectofrondicularia cookei Cushman, 1933, p. 11, pl. 1, fig. 26.
Frondicularia nangoensis Asano, 1936b, p. 329, pl. 37, fig. 3.
Plectofrondicularia awamoana Finlay, 1939c, p. 319, pl. 27, fig. 110; Hornibrook, 1961, pl. 12, fig. 243; Hornibrook *et al*., 1989, fig. 21:11.
Plectofrondicularia gracilis Smith, 1956, p. 93, pl. 12, figs. 2–5 (*non Plectofrondicularia gracilis* Rey, 1955 (*fide* Ellis and Messina, 1940 *et seq*.), (preoccupied)).
Plectofrondicularia toyokoroensis Yoshida, 1958, p. 269, pl. 3, fig. 3.
Parafrondicularia wairarapa Vella, 1963, p. 5, pl. 1, figs. 4–6; Hayward, 2002, pl. 2, fig. 3.
Parafrondicularia aff. *wairarapa* Vella. Gibson, 1967, pl. 6, fig. 95.
Plectofrondicularia messinae Souaya, 1965, p. 322 (replacement name for *F. interrupta* Karrer, 1877).
Plectofrondicularia smithi Kaiho, 1984, p. 119 (replacement name for *P. gracilis* Smith, 1956 (preoccupied)).
Plectofrondicularia delicatula Kaiho, 1984, p. 119, pl. 8, fig. 2.
Proxifrons badenensis (Karrer). Kawagata *et al*., 2006, pl. 1, fig. 5; O'Neill *et al*., 2007, pl. 1, fig. 12 (*non Frondicularia badenensis* Karrer, 1862).

Type locality.—Sicily; Pliocene.

Occurrence.—Very rare and found only around the MIS 20/21 boundary.

Remarks.—This species is distinguished from *Mucronina miocenica* (= *Plectofrondicularia miocenica* Cushman, 1926) by its slenderer test covered with costae of various length and strength (frequently disrupted) extending from a third to the full length of the test rather than the flared test with costae extending a third to halfway towards the distal end of the latter (Hayward *et al*., 2012).

Distribution.—This cosmopolitan species occurs most commonly in upper bathyal to uppermost abyssal depths (400–2200 m) in late Eocene to Middle Pleistocene strata (Hayward *et al*., 2012).

Family Vaginulinidae Reuss, 1860

Subfamily Lenticulininae Chapman *et al*., 1934

U1352B-9H-3-W, 19–21 cm; **11,** *Marginulina glabra* d'Orbigny, MPC-28924, Sample U1352B-1H-1-W, 19–21 cm; **12,** *Hyalinonetrion elongata* (Ehrenberg), MPC-28925, Sample U1352B-8H-2-W, 20–22 cm; **13,** *Lagena annellatrachia* Loeblich and Tappan, MPC-28926, Sample U1352B-1H-1-W, 19–21 cm; **14,** *Lagena meridionalis* (Wiesner), MPC-28927, Sample U1352B-1H-3-W, 94–96 cm; **15,** *Lagena* cf. *ollula* Buchner, MPC-28928, Sample U1352B-16H-6-W, 93–95 cm.

Genus ***Lenticulina*** Lamarck, 1804
Lenticulina angulata (Reuss, 1851b)

Figure 5.8

Robulina angulata Reuss, 1851b, p. 154, pl. 8, fig. 6a, b.
Cristellaria angulata (Reuss). Heron-Allen and Earland, 1932, p. 392, pl. 12, figs. 22, 23.
Lenticulina angulata (Reuss). Igarashi *et al*., 2001, pl. 6, fig. 13a, b.

Type locality.—Germany; "Tertiary".
Occurrence.—Very rare to rare in the hole.
Distribution.—This species was reported from shallow waters in the Falkland Islands (137 m water depth; Heron-Allen and Earland, 1932) and the Weddell Sea, Antarctica (Igarashi *et al*., 2001).

Genus ***Neolenticulina*** McCulloch, 1977
Neolenticulina peregrina (Schwager, 1866)

Figure 5.9

Cristellaria peregrina Schwager, 1866, p. 245, pl. 7, fig. 89.
Lenticulina peregrina (Schwager). Barker, 1960, p. 144, pl. 68, figs. 11–16; Srinivasan and Sharma, 1980, p. 34, pl. 6, fig. 26; van Morkhoven *et al*., 1986, p. 92, pl. 27, figs. 1, 2.
Neolenticulina peregrina (Schwager). Loeblich and Tappan, 1987, p. 406, pl. 447, figs. 9–12, 16; Loeblich and Tappan, 1994, p. 69, pl. 124, figs. 1–11; Holbourn *et al*., 2013, p. 368, figs. 1, 2.
? *Cristellaria variabilis* Reuss, 1850, p. 369, pl. 46, figs. 15, 16.
Cristellaria variabilis Reuss. Brady, 1884, p. 541, pl. 68, figs. 11–16.
Neolenticulina variabilis (Reuss). Jones, 1994, p. 80, pl. 68, figs. 11, 16 (in part, not figs. 12–15).

Type locality.—Car Nicobar, Andaman Sea, Indian Ocean; early to middle Pliocene.
Occurrence.—Very rare and found only in MIS 13.
Remarks.—The specimen examined here is characterised by having a lenticular planispiral test comprised of three chambers in the last coil and a weakly keeled periphery except for the last chamber. Although the neotype of *Neolenticulina peregrina* (= *Cristellaria peregrina* Schwager, 1866) designated by Srinivasan and Sharma (1980) is surrounded peripherally by a distinct sharp keel, less keeled specimens have also been recognised as morphological variations of the same species (e.g. Brady, 1884; van Morkhoven *et al*., 1986). Many researchers considered this species to be conspecific with *Cristellaria variabilis* Reuss, 1850, but retained them as separate species because of taxonomic uncertainty concerning Reuss's (1850) species. (e.g. Brady, 1884; van Morkhoven *et al*., 1986; Holbourn *et al*., 2013). Therefore we apply the species name of *Neolenticulina peregrina* to our specimen.
Distribution.—This species occurs from middle-shelf to lower bathyal depths (50–1500 m), mostly at outer-shelf to mid-bathyal depths (100–800 m) around New Zealand (Hayward *et al*., 2010).

Genus ***Saracenaria*** Defrance, 1824
Saracenaria sp. 1

Figure 5.10

Occurrence.—Very rare and found only in MIS 6.
Remarks.—This unidentified species is characterised by its flaring test towards the distal end, with a rectilinear chamber arrangement becoming uncoiled and triangular in cross section. Its aperture is a long slit with two short slits laid out in a Y-shape at the terminal of the test.

Subfamily Marginulininae Wedekind, 1937
Genus ***Marginulina*** d'Orbigny, 1826
Marginulina glabra d'Orbigny, 1826

Figure 5.11

Marginulina glabra d'Orbigny, 1826, p. 259, no. 55; Parker *et al*., 1865, p. 27, pl. 1, fig. 36.

Type locality.—Siena, Italy; age not given.
Occurrence.—Very rare and found only in topmost (Holocene) sample.
Remarks.—D'Orbigny (1826) proposed *Marginulina glabra* without description and illustrations, but the species was documented by the number of its plaster model. Later, Parker *et al*. (1865) illustrated this species based on d'Orbigny's plaster model of *M. glabra* and it remained under the authorship of d'Orbigny (1826). The specimen examined here has a test composed of only two chambers and two short slit apertures at the protruded distal end of the test. The test shape of our specimen is similar to that of the earlier part of *Marginulina glabra* d'Orbigny, 1826 and is regarded here as a juvenile form.

Family Lagenidae Reuss, 1862
Genus ***Hyalinonetrion*** Patterson and Richardson, 1988
Hyalinonetrion elongata (Ehrenberg, 1845)

Figure 5.12

Miliola elongata Ehrenberg, 1845, p. 371.
Lagena elongata (Ehrenberg). Brady, 1884, p. 457, pl. 56, fig. 29; Barker, 1960, p. 116, pl. 56, fig. 29 (not figs. 27, 28).
Procerolagena elongata (Ehrenberg). Albani and Yassini, 1989, p. 383, fig. 3H; Jones, 1994, p. 62, pl. 56, fig. 29 (in part, not figs. 19–22, 24–28); Yassini and Jones, 1995, p. 109, figs. 271–273.
Hyalinonetrion elongata (Ehrenberg). Debenay, 2013, p. 151, pl. 10 (unnumbered).

Type locality.—Kurdistan, Iran; age not given.
Occurrence.—Very rare and found only in MIS 6.
Remarks.—This species is distinguished from other *Hyalinonetrion* species by its elongate cylindrical test with parallel sides in the mid-portion of the test that is

tapered towards both ends rather than a fusiform test.

Distribution.—This cosmopolitan species has been reported from open estuaries, sheltered marine embayments, and the middle- and outer-shelf in the southwestern Pacific southeast of Australia (Yassini and Jones, 1995) and from a coastal bay at a depth of 10 m (Debenay, 2013).

Genus ***Lagena*** Walker and Jacob in Kanmacher, 1798
Lagena annellatrachia Loeblich and Tappan, 1994

Figure 5.13

Lagena annellatrachia Loeblich and Tappan, 1994, p. 77, pl. 142, figs. 1–8, 11, 12.
Lagena sulcata var. *spicata* Cushman and McCulloch, 1950, p. 360, pl. 48, figs. 4–6 (in part).
Lagena striata strumosa Reuss. Yassini and Jones, 1995, p. 107, figs. 321, 322, 326, 327, 330, 331 (*non Lagena strumosa* Reuss, 1863).

Type locality.—Timor Sea, to the north of Australia; Recent.

Occurrence.—Very rare and found only in topmost (Holocene) sample.

Remarks.—Loeblich and Tappan (1994) stated that the test surface around its basal spine varies from smooth to hispid to distinctly spinose. The specimen examined in this study shows striations around the apical spine rather than a smooth to hispid surface.

Distribution.—From various shallow marine conditions, such as open estuaries, middle- and outer-shelf depths in the Timor Sea (Loeblich and Tappan, 1994) and southeastern Australia (Yassini and Jones, 1995).

Lagena meridionalis (Wiesner, 1931)

Figure 5.14

Lagena gracilis Williamson. Brady, 1884, p. 464, pl. 58, fig. 19 (in part, not figs. 2, 3, 7–10, 22–24) (*non Lagena gracilis* Williamson, 1848).
Lagena gracilis var. *meridionalis* Wiesner, 1931, p. 117, pl. 18, fig. 211.
Lagena meridionalis (Wiesner). Loeblich and Tappan, 1953, p. 62, pl. 12, fig. 1; Barker, 1960, p. 119, pl. 58, fig. 19; Jones, 1994, p. 66, pl. 58, fig. 19.
Procerolagena meridionalis (Wiesner). Loeblich and Tappan, 1994, p. 79, pl. 143, figs. 7–11; Hayward *et al*., 2010, p. 169, pl. 12, figs. 21–24.

Type locality.—Antarctic Sea; Recent.

Occurrence.—Very rare and found only in the Holocene sample.

Remarks.—This species has been described under the genus *Procerolagena* Puri, 1953, which had been distinguished from *Lagena* by having an elongate, fusiform unilocular test with both ends drawn out rather than a globular to ovate flask-shaped test. However, such differences in chamber shape are regarded here as species level characters, thus *Procerolagena* is synonymous with *Lagena* in this study.

Distribution.—This species shows a cosmopolitan distribution and was originally reported from the upper bathyal zone (385 m depth).

Lagena cf. ***ollula*** Buchner, 1940

Figure 5.15

Cf. *Lagena ollula* Buchner, 1940, p. 424, pl. 3, figs. 51–53.

Type locality.—Germany; Neogene.

Occurrence.—Very rare and found only in MIS 12.

Remarks.—The specimen treated here is characterised by an inornate pyriform test with a short basal spine. Terminal end of the neck is broken off, and thus its terminal aperture with a phialine lip is not seen. Buchner (1940) proposed *Lagena ollula* with wide variations for the test shape, for example, length of neck and test width. Overall the test shape of our specimen is compared to Buchner's (1940) illustrations, though the necked apertural feature is still unclear.

Lagena spicata Cushman and McCulloch, 1950

Figure 6.1

Lagena sulcata var. *apiculata* Cushman, 1913, p. 23, pl. 9, figs. 3, 4? (secondary junior homonym of *Lagena apiculata* (Reuss) = *Oolina apiculata* Reuss, 1851c (*fide* Ellis and Messina, 1940 *et seq.*)).
Lagena sulcata var. *spicata* Cushman and McCulloch, 1950, p. 360, pl. 48, figs. 3, 7 (in part).
Lagena spicata Cushman and McCulloch. Hayward *et al*., 1999, p. 115, pl. 7, figs. 4, 5.
Lagena striata paucistriata Yassini and Jones, 1995, p. 106, figs. 323–325.

Type locality.—Equatorial South Pacific Ocean; Recent.

Occurrence.—Sporadic. Very rare to rare in the hole (during MIS 13 and MIS 7).

Remarks.—The specimen treated here is characterised by a pyriform unilocular test with approximately 20 longitudinal costae, which are sometimes bifurcated at the lower part of the test and five of which extend onto the neck, and by a short, blunt apical spine. The terminal end of the neck is broken off, therefore its terminal aperture with phialine lip is not seen.

Distribution.—This cosmopolitan species is widespread in sheltered to exposed, inner- and outer-shelf environments under fully marine conditions in New Zealand (Hayward *et al*., 1999).

Lagena sp. 1

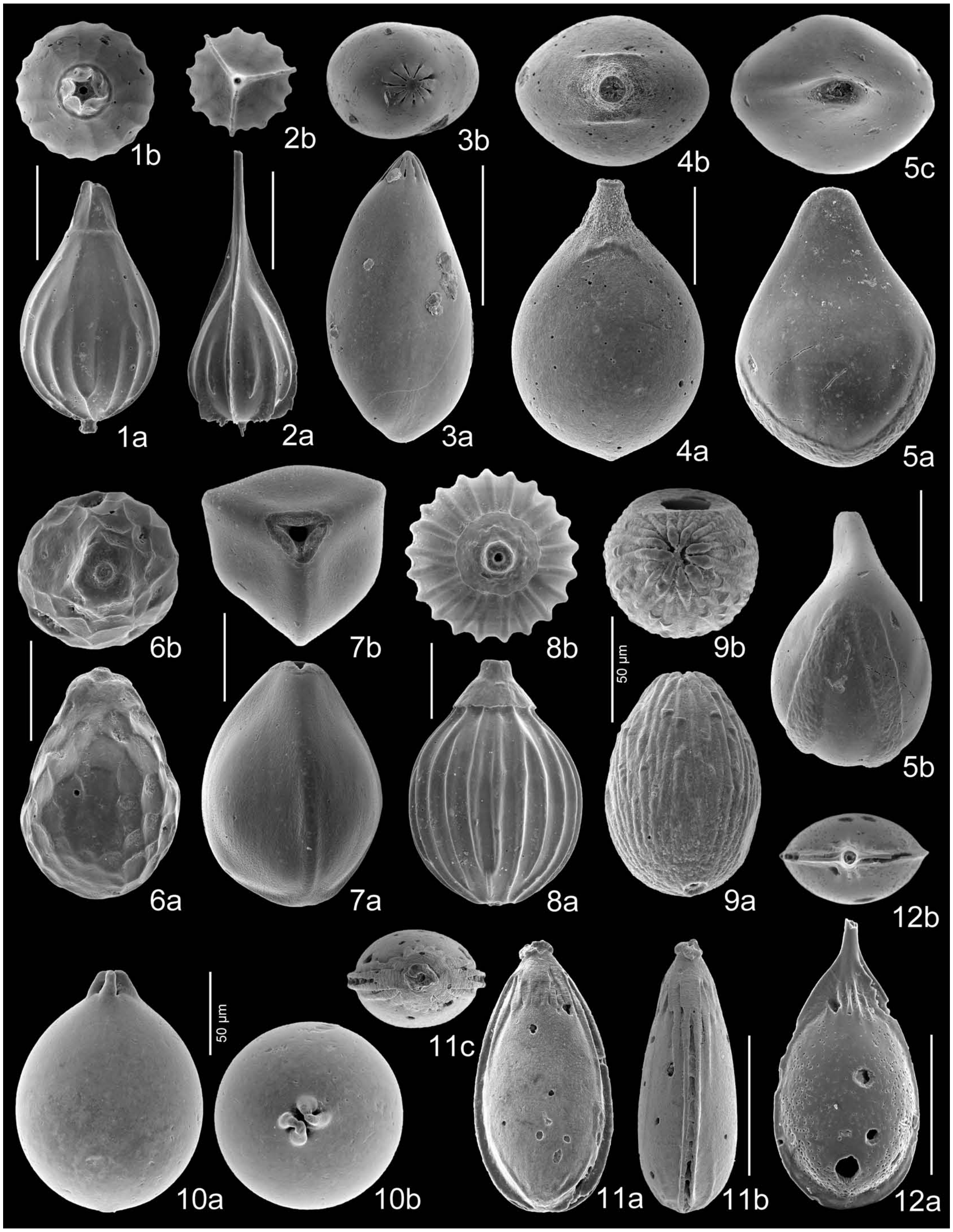

Figure 6. Photographs of benthic foraminifera from the Hole U1352B (4). Scale bars: 100 μm unless otherwise specified. **1,** *Lagena spicata* Cushman and McCulloch, MPC-28929, Sample U1352B-11H-3-W, 94–96 cm; **2,** *Lagena* sp. 1, MPC-28930, Sample U1352B-11H-6-W, 94–96 cm; **3,** *Pyrulina fusiformis* (Roemer), MPC-28931, Sample U1352B-11H-4-W, 94–96 cm; **4,** *Buchnerina* sp. 1, MPC-28932, Sample U1352B-23H-2-W, 19–21 cm; **5,** *Exsculptina eccentrica* (Sidebottom), MPC-28933, Sample U1352B-17H-4-W, 90–92 cm; **6,** *Favulina hexagona* (Williamson), MPC-28934, Sample U1352B-19H-6-W, 19–21 cm; **7,** *Galwayella globosa* (Seguenza), MPC-28935, Sample U1352B-11H-1-W, 51–53 cm; **8,** *Homalohedra bassensis* (Collins), MPC-28936, Sample U1352B-12H-6-W, 93–95 cm; **9,** *Oolina neolineata* McCulloch, MPC-28937, Sample U1352B-18H-5-W, 94–96 cm; **10,** *Oolina* sp. 1, MPC-28938, Sample U1352B-7H-6-W, 19–21 cm; **11,** *Vasicostella* cf. *enderbiensis* (Chapman), MPC-28939, Sample U1352B-8H-1-W, 19–21 cm; **12,** *Vasicostella rara* (McCulloch), MPC-28940, Sample U1352B-22H-6-W, 19–21 cm.

Figure 6.2

Occurrence.—Sporadic. Very rare to rare in the hole.

Remarks.—The specimen examined is characterised by a flask-shaped unilocular test with three primary and approximately 12 secondary longitudinal costae. The primary costae are distinct and deep, and keel-like blades extend from the chamber body to the lower part of the long neck. *Lagena alticostatiformis* McCulloch, 1977 is the most similar species but has four primary costae rather than three for our species.

Family Polymorphinidae d'Orbigny, 1839a
Subfamily Polymorphininae d'Orbigny, 1839a
Genus ***Pyrulina*** d'Orbigny, 1839a
Pyrulina fusiformis (Roemer, 1838)

Figure 6.3

Polymorphina (*Globulinen*) *fusiformis* Roemer, 1838, p. 386, pl. 3, fig. 37.
Pyrulina fusiformis (Roemer). Cushman and Ozawa, 1930, p. 54, pl. 13, figs. 3, 4, 6. (? figs. 5, 7, 8); Ujiié, 1990, p. 21, pl. 6, fig. 12a, b; Hayward *et al*., 2010, p. 173, pl. 13, figs. 5–8.

Type locality.—Germany; Neogene.

Occurrence.—Very rare and found at around the MIS 7/8 boundary.

Distribution.—This species is found at upper- to mid-abyssal depths between 2500 and 3000 m around New Zealand (Hayward *et al*., 2010).

Family Ellipsolagenidae Silvestri, 1923
Subfamily Oolininae Loeblich and Tappan, 1961
Genus ***Buchnerina*** Jones, 1984
Buchnerina sp.1

Figure 6.4

Occurrence.—Very rare and found at around the MIS 15/16 boundary.

Remarks.—The specimen examined has an inflated skittle-shaped, unilocular, unkeeled test with an oval outline in cross section rather than the much compressed, weakly unimarginated test with squared outline in cross section of *Lagenosolenia manispecularis* McCulloch, 1977.

Genus ***Exsculptina*** Patterson and Richardson, 1988
Exsculptina eccentrica (Sidebottom, 1912)

Figure 6.5

Lagena stelligera var. *eccentrica* Sidebottom, 1912, p. 392, pl. 16, figs. 5, 6; Sidebottom, 1915, p. 175, pl. 15, fig. 30.
Exsculptina eccentrica (Sidebottom). Hayward *et al*., 2010, p. 160, pl. 10, figs. 14, 15.
Lagena danica var. *pendulum* Heron-Allen and Earland, 1922, p. 166, pl. 6, figs. 13, 14.
Fissurina echigoensis (Asano and Inomata). Hermelin, 1989, p. 47, pl. 6, figs. 13, 14 (*non Entosolenia echigoensis* Asano and Inomata in Asano, 1952).

Type locality.—Southwest Pacific Ocean; Recent.

Occurrence.—Sporadic. Very rare in the hole.

Remarks.—*Exsculptina eccentrica* differs from *Fissurina echigoensis* (= *Entosolenia echigoensis* Asano and Inomata in Asano, 1952) in having a long tapered neck joined to the relatively inflated body of the test.

Distribution.—This species is found at middle and lower bathyal depths off eastern New Zealand (Hayward *et al*., 2010), on the Campbell Plateau (*ca*. 250–520 m depth: Heron-Allen and Earland, 1922), and at middle and lower abyssal depths in the tropical and subtropical Southwest Pacific Ocean (*ca*. 900–4500 m depth; Sidebottom, 1912). A fossil specimen was also found in the Pliocene section of a sediment core from an upper abyssal depth of 2207 m on the Ontong-Java Plateau (Hermelin, 1989).

Genus ***Favulina*** Patterson and Richardson, 1988
Favulina hexagona (Williamson, 1848)

Figure 6.6

Entosolenia squamosa var. *hexagona* Williamson, 1848, p. 20, pl. 2, fig. 23.
Lagena hexagona forma *typica*, Buchner, 1940, p. 433, pl. 5, fig. 74.
Oolina hexagona (Williamson). Yassini and Jones, 1995, p. 113, figs. 345, 346, 349; Hayward *et al*., 1999, p. 122, pl. 8, fig. 2; Holbourn *et al*., 2013, p. 383, fig. 1.
Favulina hexagona (Williamson). Hayward *et al*., 2010, p. 160, pl. 10, figs. 20, 21.

Type locality.—Waters around Great Britain; Recent.

Occurrence.—Sporadic. Very rare in the hole.

Remarks.—The test of our specimen is ornamented by relatively coarse hexagonal reticulations as seen in *Favulina hexagona*, rather than the finer hexagonal reticulations of *Favulina hexagoniformis* McCulloch, 1977.

Distribution.—This cosmopolitan species is widespread in sheltered to exposed, inner- and middle-shelf environments (0–200 m) under fully marine conditions around New Zealand (Hayward *et al*., 1999, 2010).

Genus ***Galwayella*** Patterson and Pettis, 1986
Galwayella globosa (Seguenza, 1862a)

Figure 6.7

Trigonulina globosa Seguenza, 1862a, p. 75, pl. 2, figs. 60–62.

Type locality.—Sicily; Miocene.

Occurrence.—Very rare and found only in MIS 7.

Remarks.—The specimen illustrated here is characterised by having a spherical chamber with a bluntly salient simple longitudinal keel at each of the three test angles and unnecked triangular terminal aperture and is identical to *Galwayella globosa*. The species differs from *Galwayella trigonomarginata* (= *Lagena sulcata trigonomarginata* Parker and Jones, 1865) in its simple keels, rather than three salient keels emphasised by marginal beading of the latter species. It is also distinguished from *Galwayella trigonoelliptica* (= *Lagena sulcata trigonoelliptica* Balkwill and Millett, 1884) by its globular rather than elliptical test shape.

Distribution.—Recent distribution of this species is unclear.

Genus ***Homalohedra*** Patterson and Richardson, 1988
Homalohedra bassensis (Collins, 1974)

Figure 6.8

Lagena bassensis Collins, 1974, p. 22, pl. 1, fig. 10.
Lagena acuticosta Reuss. Brady, 1884, p. 464, pl. 57, fig. 31 (in part, not pl. 57, fig. 32; pl. 58, figs. 20, 21) (*non Lagena acuticosta* Reuss, 1862).
Lagena sp. nov. (1). Barker, 1960, p. 118, pl. 57, fig. 31.
Oolina sp. nov. (1). Jones, 1994, p. 65, pl. 57, fig. 31.

Type locality.—Port Phillip Bay, Victoria, east Australia; Holocene.

Occurrence.—Very rare and found only in MIS 9.

Remarks.—*Homalohedra bassensis* has one flange-shaped caplike neck rather than two flanges as on the neck of *Homalohedra inusitata* (= *Lagena inusitata* Andersen, 1961). The species is distinguished from other similar species, such as *Homalohedra liratiformis* (= *Lagena liratiformis* McCulloch, 1977) and *Homalohedra apliopleura* Loeblich and Tappan, 1953, by the apparent separation between the flange on the neck and the distinct longitudinal costae. Hayward *et al*. (2010) reported the most similar species of *Homalohedra liratiformis* (= *Lagena liratiformis* McCulloch, 1977) from New Zealand waters.

Distribution.—This species is common in the Bass Strait and the outermost part of Port Phillip Bay in southeastern Australia (Collins, 1974).

Genus ***Oolina*** d'Orbigny, 1839b
Oolina neolineata McCulloch, 1981

Figure 6.9

Oolina (?) *neolineata* McCulloch, 1981, p. 101, pl. 35, fig. 16a, b.
Oolina lineata (Williamson). Albani and Yassini, 1989, p. 387, fig. 4c, d (*non Entosolenia lineata* Williamson, 1848).

Type locality.—Caribbean Sea off Panama; Recent.

Occurrence.—Very rare in the hole.

Remarks.—*Oolina neolineata* has a unilocular test with more striations and a more complex radiate aperture than *Oolina lineata* (= *Entosolenia lineata* Williamson, 1848).

Distribution.—McCulloch (1981) reported this species from Caledonia Harbour, Panama, at *ca*. 55 m depth in the Caribbean Sea. Albani and Yassini (1989) found this species in Lake Illawarra, a shallow sand barrier lagoon in southeastern Australia.

Oolina sp. 1

Figure 6.10

Oolina sp. 1. Jones, 1984, p. 103, pl. 1, fig. 27.

Occurrence.—Very rare and found only around the MIS 5/6 boundary.

Remarks.—The specimen examined here differs from *Oolina globosa* (= *Vermiculum globosum* Montagu, 1803) in having a pair of U-bolt shaped projections over the aperture.

Distribution.—This unidentified species has hitherto been reported in a deep-sea core taken at a depth of 2177 m in the northern North Atlantic Ocean (Jones, 1984).

Genus ***Vasicostella*** Patterson and Richardson, 1987
Vasicostella cf. ***enderbiensis*** (Chapman, 1909)

Figure 6.11

Cf. *Lagena enderbiensis* Chapman, 1909, p. 339, pl. 16, figs. 1a, b.

Type locality.—Off the Auckland Islands, New Zealand, Southwest Pacific Ocean; Recent.

Occurrence.—Very rare and found only in MIS 6.

Remarks.—The specimen examined resembles Chapman's (1909) *Lagena enderbiensis* except that our species has a more inflated elliptical cross section. The overall morphology of this species, characterised by a necked flask-shaped test with a rounded to oval terminal aperture indicates that it belongs to the genus *Vasicostella*.

Distribution.—This species occurs at an outer-shelf depth (*ca*. 150 m) in the subantarctic islands of New Zealand (Chapman, 1909).

Vasicostella rara (McCulloch, 1977)

Figure 6.12

Lagenosolenia rara McCulloch, 1977, p. 71, pl. 52, fig. 2.
Vasicostella rara (McCulloch). Hayward *et al*., 2010, p. 165, pl. 11, figs. 24, 25.

Type locality.—Lobos de Afuera, Peru, Southeast Pacific Ocean; Recent.

Occurrence.—Very rare and found only in MIS 15.

Distribution.—This species is recorded from inner-shelf depths at Lobos de Afuera Island off Peru (*ca*. 27 m) and off Panama (*ca*. 43 m) in the eastern Equatorial Pacific Ocean; and from the upper bathyal zone (*ca*. 450 m depth) at Guadalupe Island, Baja California, Mexico (McCulloch, 1977).

Subfamily Ellipsolageninae Silvestri, 1923

Genus ***Fissurina*** Reuss, 1850

Fissurina aequilabialis (Buchner, 1940)

Figures 7.1, 7.2

Lagena aequilabialis Buchner, 1940, p. 513, pl. 21, figs. 440, 441 (figs. 442?, 443?, 444?).

Type locality.—Germany; Neogene.

Occurrence.—Sporadic. Very rare to rare in the hole.

Remarks.—The specimen examined here compares well with those of Buchner's (1940) illustrations (figs. 440, 441) that show a semi-acute but non-keeled peripheral margin rather than other illustrations (figs. 442–444) that show a keeled periphery. Although the presence/absence of the keel is a distinct character to separate species for *Fissurina*, Buchner (1940) did not designate the holotype for this species. We prefer to describe herein Buchner's non-keeled form as *F. aequilabialis* but leave the keeled forms pending for now because of insufficient information.

Fissurina angulata (Uchio, 1951)

Figure 7.3

Entosolenia marginata var. *angulata* Uchio, 1951, p. 38, pl. 3, fig. 14.

Type locality.—Boso Peninsula, Japan; Pliocene.

Occurrence.—Sporadic. Very rare in the hole.

Remarks.—This species is distinguished from *Lagena cincta* Buchner, 1940 (= secondary junior homonym of *Fissurina cincta* Seguenza, 1862a) by its apparently thickened peripheral keel around the whole test.

Fissurina aureoligera (Buchner, 1940)

Figure 7.4

Lagena aureoligera Buchner, 1940, p. 457, pl. 9, figs. 144, 145.

Fissurina aureoligera (Buchner). Hayward and Buzas, 1979, p. 56, pl. 16, figs. 202, 203.

Fissurina wiesneri Barker. Ujiié, 1990, p. 26, pl. 9, figs. 3, 4; Yassini and Jones, 1995, p. 127, figs. 631, 632 (*non Fissurina wiesneri* Barker, 1960).

Fissurina marginata Montagu. Igarashi *et al*., 2001, p. 156, pl. 8, fig. 1a, b (*non Vermiculum marginata* Montagu, 1803).

Type locality.—Germany; Neogene.

Occurrence.—Sporadic. Very rare in the hole.

Remarks.—This species differs from *Fissurina wiesneri* Barker, 1960 (= new name for *Lagena marginata* Brady, 1884 (not *Serpula* (*Lagena*) *marginata* Walker and Boys, 1784) in having a terminal slit-like aperture with a distinct apertural lip rather than the subterminal slit that is seen in *Parafissurina* Parr, 1947 or *Pseudosolenia* Jones, 1984.

Distribution.—Yassini and Jones (1995) record this from outer-shelf to slope depths off the southeastern coast of Australia.

Fissurina biumbonata McCulloch, 1977

Figure 7.5

Fissurina biumbonata McCulloch, 1977, p. 93, pl. 68, fig. 7a, b.

Type locality.—Off Raza Island, Mexico, Northeast Pacific Ocean; Recent.

Occurrence.—Sporadic. Very rare in the hole.

Remarks.—This species is distinguished from *Fissurina mazzarensis* (=*Lagena mazzarensis* Buchner, 1940) in having a long slit aperture and a narrower keel surrounding the lower half of the test rather than the short slit-like aperture and single thin keel only at the basal end of the test of the latter species.

Distribution.—This species occurs between inner-shelf and mid–upper bathyal depths (*ca*. 30–360 m) in the Northeast Pacific Ocean (McCulloch, 1977).

Fissurina calostoma (Fornasini, 1901)

Figure 7.6

Lagena laevigata var. *calostoma* Fornasini, 1901, p. 48, text-fig. 2a, b.

Fissurina algiersensis McCulloch, 1981, p. 102, pl. 34, fig. 1a, b.

Type locality.—Italy; Neogene.

Occurrence.—Sporadic. Very rare in the hole.

Remarks.—The specimen examined here is characterised by an inornate pyriform test that is almost circular in cross section and by a produced aperture, rather than the elongate melon-seed-shaped test that is oval in cross section for *Fissurina cucurbitasema* Loeblich and Tappan, 1953.

Distribution.—McCulloch (1981) reported *Fissurina algiersensis*, synonymised with *Fissurina calostoma* in this study, from shallow waters off Algiers, Mediterranean Sea (*ca*. 11 m depth).

Fissurina circularis Todd in Cushman *et al*., 1954

Figure 7.7

Fissurina circularis Todd in Cushman *et al*., 1954, p. 351, pl. 87, fig. 27; Loeblich and Tappan, 1994, p. 88, pl. 154, figs. 13–18.

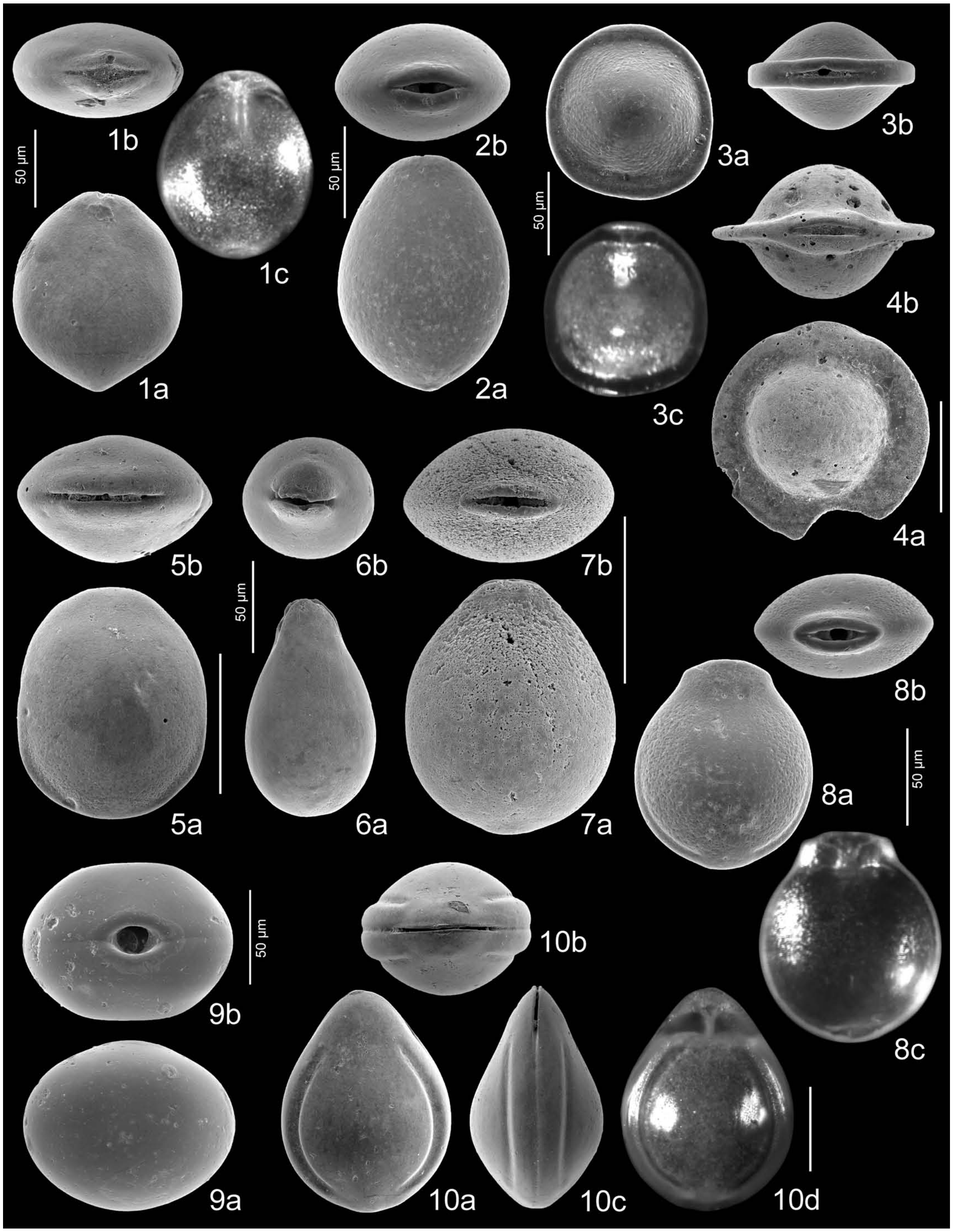

Figure 7. Photographs of benthic foraminifera from the Hole U1352B (5). Scale bars: 100 μm unless otherwise specified. **1, 2,** *Fissurina aequilabialis* (Buchner); 1, MPC-28941, Sample U1352B-1H-5-W, 19–21 cm; 2, MPC-28942, Sample U1352B-10H-6-W, 19–21 cm; **3,** *Fissurina angulata* (Uchio), MPC-28943, Sample U1352B-1H-5-W, 19–21 cm; **4,** *Fissurina aureoligera* (Buchner), MPC-28944, Sample U1352B-13H-4-W, 19–21 cm; **5,** *Fissurina biumbonata* McCulloch, MPC-28945, Sample U1352B-8H-1-W, 19–21 cm; **6,** *Fissurina calostoma* (Fornasini), MPC-28946, Sample U1352B-10H-6-W, 19–21 cm; **7,** *Fissurina circularis* Todd, MPC-28947, Sample U1352B-19H-2-W, 94–96 cm; **8,** *Fissurina circumcincta* (Buchner), MPC-28948, Sample U1352B-7H-6-W, 19–21 cm; **9,** *Fissurina compressa* (Hada), MPC-28949, Sample U1352B-22H-5-W, 19–21 cm; **10,** *Fissurina densifasciata* McCulloch, MPC-28950, Sample U1352B-8H-2-W, 20–22 cm.

Type locality.—Eniwetok lagoon, tropical northwestern Pacific, Recent.

Occurrence.—Sporadic. Very rare to rare in the hole.

Distribution.—This species occurs in middle-shelf depths (53–63 m) in the Timor Sea (Loeblich and Tappan, 1994).

Fissurina circumcincta (Buchner, 1940)

Figure 7.8

Lagena furcillifera forma *circumcincta* Buchner, 1940, p. 489, pl. 17, fig. 322.

Type locality.—Germany; Neogene.

Occurrence.—Sporadic. Very rare to rare in the hole.

Remarks.—The most distinct feature of this species is its truncated and produced apertural lip. It differs from *Fissurina cucullifera* (= *Lagena cucullifera* Buchner, 1940) and *Fissurina rimata* McCulloch, 1977 in having a thin narrow keel around the lower half of the test.

Fissurina compressa (Hada, 1936)

Figure 7.9

Lagena compressa Hada, 1936, p. 242, text-fig. 1a, b.

Type locality.—Northwestern Pacific Ocean; Recent.

Occurrence.—Sporadic. Very rare in the hole and never occurs after MIS 14.

Remarks.—This species has an oval-shaped aperture rather than typical slit-like aperture for the genus and is distinguished from *Fissurina stewartii* (= *Lagena stewartii* Wright, 1911), which has a circular test and is oval in section by having a lower elliptical test and flat side faces.

Distribution.—This species is distributed at the inner-shelf depths (15 and 42 m), Hokkaido, northern Japan (Hada, 1936).

Fissurina densifasciata McCulloch, 1977

Figure 7.10

Fissurina densifasciata McCulloch, 1977, p. 101, pl. 61, fig. 8a, b.
Fissurina fasciata (Egger). Boltovskoy and Guissani de Kahn, 1983, p. 301, pl. 2, figs. 6, 7 (*non Oolina fasciata* Egger, 1857).
Cf. *Fissurina quadricostulata*. Boltovskoy *et al*., 1980, p. 32, pl. 16, figs. 5–7 (*non Lagena quadricostulata* Reuss, 1870).

Type locality.—Off Korea, Japan Sea; Recent.

Occurrence.—Sporadic. Very rare to rare in the hole.

Remarks.—This species is distinguished from *Fissurina crassiannulata* Collins, 1974 by having a larger spherical chamber with thick peripheral band. It resembles Boltovskoy *et al*.'s (1980) *Fissurina quadricostulata* (*non Lagena quadricostulata* Reuss, 1870) but differs in showing shorter test with a larger spherical chamber. Although sphericity of the chamber is often one of key feature for separating species, we suspect Boltovskoy *et al*.'s (1980) species is the same taxon. However, we prefer to retain them as different taxa because of little information.

Distribution.—This species originally reported from middle-shelf depths (*ca*. 70 m) by McCulloch (1977), also occurs in the early Pliocene strata at the lower bathyal depth (1519 m) in the South Atlantic Ocean (Boltovskoy and Guissani de Kahn, 1983).

Fissurina aff. ***densifasciata*** McCulloch, 1977

Figure 8.1

Aff. *Fissurina densifasciata* McCulloch, 1977, p. 101, pl. 61, fig. 8a, b.
Fissurina quadricostulata (Reuss). Boltovskoy *et al*., 1980, p. 32, pl. 16, figs. 5–7 (*non Lagena quadricostulata* Reuss, 1870).

Occurrence.—Sporadic. Very rare in the hole.

Remarks.—The specimen differs from the typical *Fissurina densifasciata* McCulloch, 1977 in having a smaller, elongate oval test shape rather than a large, rounded test in the latter species. It is compared to Boltovskoy *et al*.'s (1980) *Fissurina quadricostulata* (Reuss), which has a slightly more compressed test with nearly parallel chamber sides than New Zealand species.

Distribution.—Boltovskoy *et al.* (1980) reported *Fissurina quadricostulata* (regarded here as conspecific with our species) from the shelf environments of the Southwest Atlantic Ocean.

Fissurina depressiformis McCulloch, 1977

Figure 8.2

Fissurina depressiformis McCulloch, 1977, p. 101, pl. 65, fig. 2a, b.
Fissurina subquadrata Parr. Yassini and Jones, 1995, p. 127, figs. 394, 398 (in part, not figs. 421–424) (*non Fissurina subquadrata* Parr, 1945).

Type locality.—Yokosuka Harbour, Japan, Northwest Pacific Ocean; Recent.

Occurrence.—Very rare and found only in MIS 8.

Remarks.—This species is characterised by having an elongate subrectangular, compressed test without any ornament on the test surface.

Distribution.—This species occurs in a harbour, Japan (McCulloch, 1977); and in open estuary, sheltered oceanic embayments, and inner- to middle-shelf depths off the east coast of Australia, Southwest Pacific Ocean (Yassini and Jones, 1995).

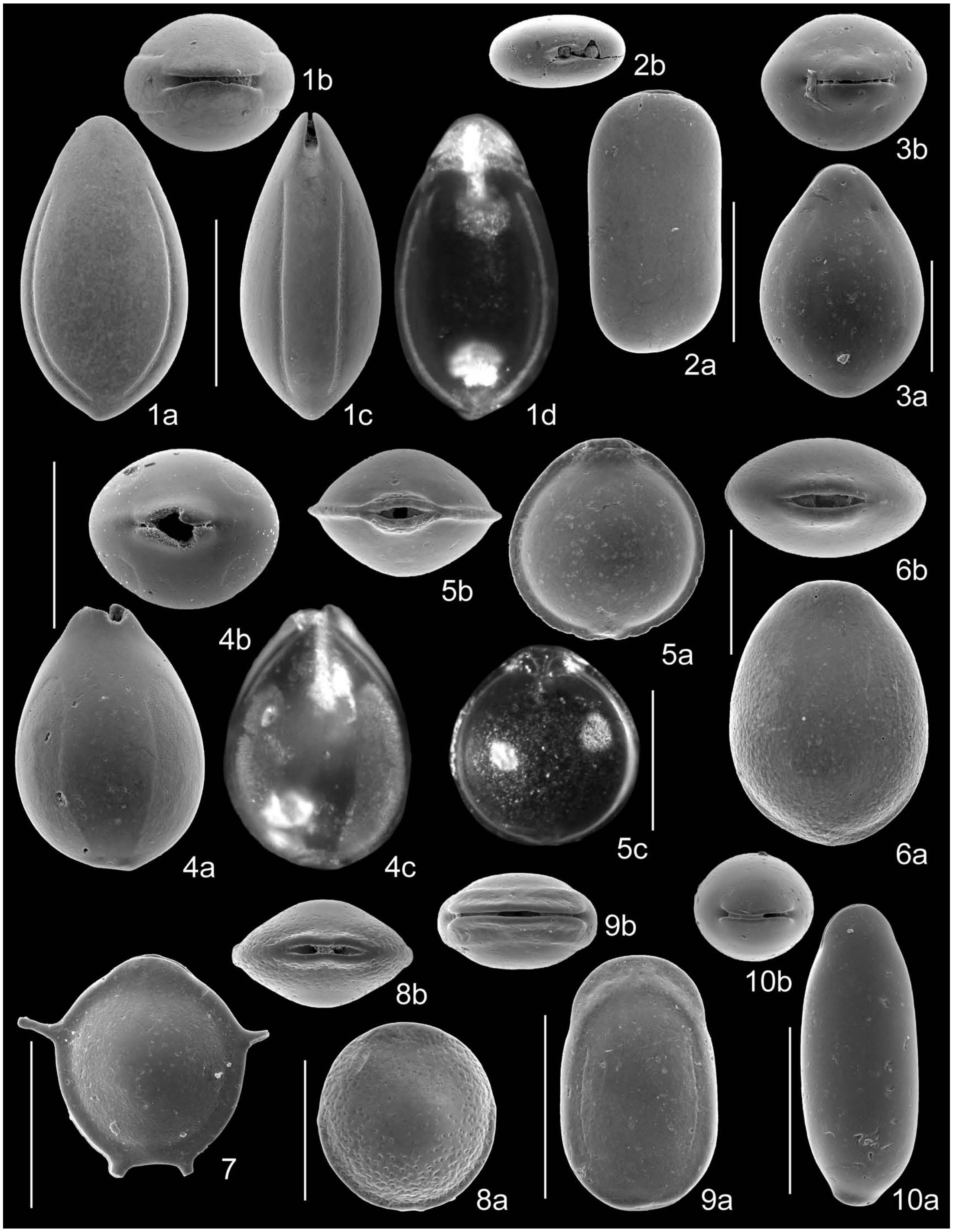

Figure 8. Photographs of benthic foraminifera from the Hole U1352B (6). Scale bars: 100 µm unless otherwise specified. **1,** *Fissurina* aff. *densifasciata* McCulloch, MPC-28951, Sample U1352B-1H-3-W, 94–96 cm; **2,** *Fissurina depressiformis* McCulloch, MPC-28952, Sample U1352B-11H-6-W, 94–96 cm; **3,** *Fissurina lucida* (Williamson), MPC-28953, Sample U1352B-28H-2-W, 19–21 cm; **4,** *Fissurina lucidiformata* McCulloch, MPC-28954, Sample U1352B-1H-3-W, 94–96 cm; **5,** *Fissurina marginata* (Montagu), MPC-28955, Sample U1352B-10H-6-W, 19–21 cm; **6,** *Fissurina mazzarensis* (Buchner), MPC-28956, Sample U1352B-1H-3-W, 94–96 cm; **7,** *Fissurina* cf. *paulispinata* McCulloch, MPC-28957, Sample U1352B-28H-4-W, 17–19 cm; **8,** *Fissurina rotalicurvata* McCulloch, MPC-28958, Sample U1352B-1H-1-W, 19–21 cm; **9,** *Fissurina subquadrata* Parr, MPC-28959, Sample U1352B-26H-2-W, 94–96 cm; **10,** *Fissurina* sp. 1, MPC-28960, Sample U1352B-26H-2-W, 94–96 cm.

Fissurina lucida (Williamson, 1848)

Figure 8.3

Entosolenia marginata var. *lucida* Williamson, 1848, p. 17, pl. 2, fig. 17.
Fissurina lucida (Williamson). Loeblich and Tappan, 1994, p. 90, pl. 156, figs. 1–3; Hayward *et al*., 1999, p. 119, pl. 7, figs. 20, 21; Debenay, 2013, p. 147, pl. 9 (unnumbered).

Type locality.—Waters around Great Britain; Recent.
Occurrence.—Very rare and found only in MIS 21.
Remarks.—This species is characterised by a horseshoe shaped, narrow opaque band around the periphery on both sides of the compressed, pyriform test.
Distribution.—This species was originally reported from shallow waters in embayments in a number of collecting places around Great Britain (and also from the Levant), and is also reported from sheltered to exposed, fully marine, inner- and middle-shelf environments in New Zealand (Hayward *et al*., 1999).

Fissurina lucidiformata McCulloch, 1977

Figure 8.4

Fissurina lucidiformata McCulloch, 1977, p. 115, pl. 58, fig. 8a, b.

Type locality.—Off the coast of California, Northeast Pacific Ocean; Recent.
Occurrence.—Sporadic. Very rare to rare in the hole.
Remarks.—This species shows a distinct pair of curved opaque bands on both sides of the test, rather than horseshoe shaped ones of the *Fissurina lucida* (Williamson, 1848).
Distribution.—This species was recorded from inner- and middle-shelf depths (*ca*. 2–80 m) off the Pacific coast of California (McCulloch, 1977).

Fissurina marginata (Montagu, 1803)

Figure 8.5

Vermiculum marginatum Montagu, 1803, p. 524.
Entosolenia marginata (Montagu). Williamson, 1858, p. 9, pl. 1, fig. 21 (not figs. 19, 20, 22–28).
Fissurina marginata (Montagu). Loeblich and Tappan, 1953, p. 77, pl. 14, figs. 6–9; Ujiié, 1995, p. 59, pl. 3, fig. 8a, b; Hayward *et al*., 1999, p. 119, pl. 7, figs. 22, 23; Kawagata, 2001, p. 81, fig. 7-3a, b; Akimoto *et al*., 2002, p. 13, pl. 31, fig. 3a, b.

Type locality.—Williamson (1858, *loc. cit.*) reported this species from a number of places around Great Britain (and also from the Levant); Recent.
Occurrence.—Sporadic. Very rare to rare in the hole.
Distribution.—This cosmopolitan species occurs at various water depths but is reported from the sheltered to exposed, fully marine, inner- and m-shelf depths in New Zealand (Hayward *et al*., 1999).

Fissurina mazzarensis (Buchner, 1940)

Figure 8.6

Lagena mazzarensis Buchner, 1940, 462, pl. 10, figs. 165, 166.

Type locality.—Off Mazzara, Sicily, Mediterranean Sea; Recent.
Occurrence.—Sporadic. Very rare in the hole.
Remarks.—This species is characterised by a compressed oval test with a single weak keel only at the basal end of the test.
Distribution.—This species occurs rarely on the inner-shelf at 60 m depth (Buchner, 1940).

Fissurina cf. ***paulispinata*** McCulloch, 1977

Figure 8.7

Cf. *Fissurina paulispinata* McCulloch, 1977, p. 121, pl. 65, fig. 18a, b.

Type species.—Fraile Bay, Northeast Pacific Ocean; Recent.
Occurrence.—Very rare and found only at around MIS 21/22 boundary.
Remarks.—The specimens studied here is characterised by a test with four spines similar to *Fissurina paulispinata* McCulloch, 1977. However, it differs from the latter species in its circular test in outline rather than a test truncated at the apertural end in the latter.
Distribution.—The most similar species, *Fissurina paulispinata* McCulloch, 1977, was reported from innermost shelf depths in Fraile Bay, Gulf of California, Mexico (McCulloch, 1977).

Fissurina rotalicurvata McCulloch, 1977

Figure 8.8

Fissurina rotalicurvata McCulloch, 1977, p. 127, pl. 65, fig. 17a, b.

Type locality.—Off the Galapagos Islands, eastern Equatorial Pacific Ocean; Recent.
Occurrence.—Sporadic. Very rare to rare and found after MIS 7.
Remarks.—This species is distinguished from *Fissurina marginata* (= *Vermiculum marginatum* Montagu, 1803) by having a circular test with minute pores on the test surface and a single keel surrounding the lower half of the test.
Distribution.—This species occurs at middle-shelf depths (*ca*. 640 m) off the Galapagos Islands, eastern Equatorial Pacific Ocean (McCulloch, 1977).

Fissurina subquadrata Parr, 1945

Figure 8.9

Fissurina subquadrata Parr, 1945, p. 203, pl. 9, fig. 5a, b; Albani and Yassini, 1989, p. 399, fig. 6K, L; Yassini and Jones, 1995, p. 127, figs. 421–424 (in part, not figs. 394, 398); Kawagata, 2001, fig. 7-5a, b; Debenay, 2013, p. 148, pl. 9 (unnumbered).
Fissurina quadrata (Williamson). Loeblich and Tappan, 1994, p. 90, pl. 155, figs. 1–6 (*non Entosolenia marginata* var. *quadrata* Williamson, 1858).
Lagena quadrata Williamson. Millett, 1901, p. 496, pl. 8, fig. 18a, b (*non Entosolenia marginata* var. *quadrata* Williamson, 1858).

Type locality.—Victoria, southeastern Australia; Recent.
Occurrence.—Sporadic. Very rare in the hole.
Distribution.—This species occurs on a sandy beach in southeastern Australia (Parr, 1945) and a lagoon (35 m depth) in New Caledonia (Debenay, 2013).

Fissurina sp. 1

Figure 8.10

Fissurina cucurbitasema Loeblich and Tappan, 1953, p. 76, pl. 14, fig. 10a, b (in part, not fig. 11a, b = holotype); Ujiié *et al.*, 1983, p. 66, pl. 2, figs. 20, 21 (*non* holotype of *Fissurina cucurbitasema* Loeblich and Tappan, 1953).
Fissurina sp. A. Kawagata, 2001, p. 83, fig. 7-6a, b.

Occurrence.—Rare in the hole and found only around the MIS 18/19 boundary.
Remarks.—This unidentified species is characterised by its non-keeled test and rounded aspect in section and is comparable to the paratype of *Fissurina cucurbitasema* Loeblich and Tappan, 1953, but not the figured holotype that shows a flattened test with a thin marginal keel. Kawagata (2001) suggested that the paratype of *F. cucurbitasema* should be separated from the true *F. cucurbitasema*, but this remains an open question. The specimen examined resembles *Fissurina truncata* (= *Lagena truncata* Brady, 1884) but differs in not having the two short basal spines seen in the latter species.

Fissurina sp. 2

Figure 9.1

Fissurina sp. B. Kawagata, 2001, p. 83, fig. 7-7a, b.

Occurrence.—Sporadic. Very rare in the hole.
Remarks.—The test of this species is oval in outline, compressed, with a smooth surface and mucronated with twin basal spines. This species resembles an elongate oval form of *Fissurina habenifera* Buchner, 1940, which has an illustrated wide variety of test shapes.

Fissurina sp. 3

Figure 9.2

Occurrence.—Sporadic. Very rare to rare in the hole.
Remarks.—The test of this unidentified species is subcircular in outline, lenticular in section, smooth-surfaced, and with a blunt single keel around the upper half of the test and distinct twin keels bordered by narrow opaque bands around the lower half of the test.

Fissurina sp. 4

Figure 9.3

Occurrence.—Very rare and found only in MIS 2.
Remarks.—This species has a similar test morphology to *Fissurina* sp. 3 (in this study) but is distinguished from the latter by its distinctly raised thick apertural lip rather than a slightly lipped slit aperture.

Fissurina sp. 5

Figure 9.4

? *Fissurina conspissata* McCulloch. Akimoto *et al.*, 2002, p. 13, pl. 31, fig. 1a, b (*non Fissurina conspissata* McCulloch, 1977).

Occurrence.—Very rare and found only in MIS 14.
Remarks.—This unidentified species is very similar to Akimoto *et al.*'s (2002) *Fissurina conspissata* McCulloch, 1977 (*op. cit.* pl. 31, figs. 1a, b) but shows a subquadrate test shape rather than one semicircular in outline. McCulloch's (1977) *F. conspissata* shows a pyriform test shape in outline and a slight produced apertural end, and is distinguishable from our species and Akimoto *et al.*'s (2002) species.

Fissurina sp. 6

Figure 9.5

Occurrence.—Sporadic. Very rare to rare in the hole.
Remarks.—This unidentified species is relatively large for the genus. It is characterised by its semicircular test encircled by a distinct thick keel, a downward opening horseshoe-shaped opaque band on both side of its test, and a long slit aperture with a thick protruded lip which merges into a peripheral keel.

Fissurina sp. 7

Figure 9.6

Occurrence.—Sporadic. Very rare in the hole.
Remarks.—The prominent feature of this species is a test with a single keel extending into a protruded apertural lip and with many costae, which merge into hexagonal reticulations on the protruded lip. *Fissurina bella* (=

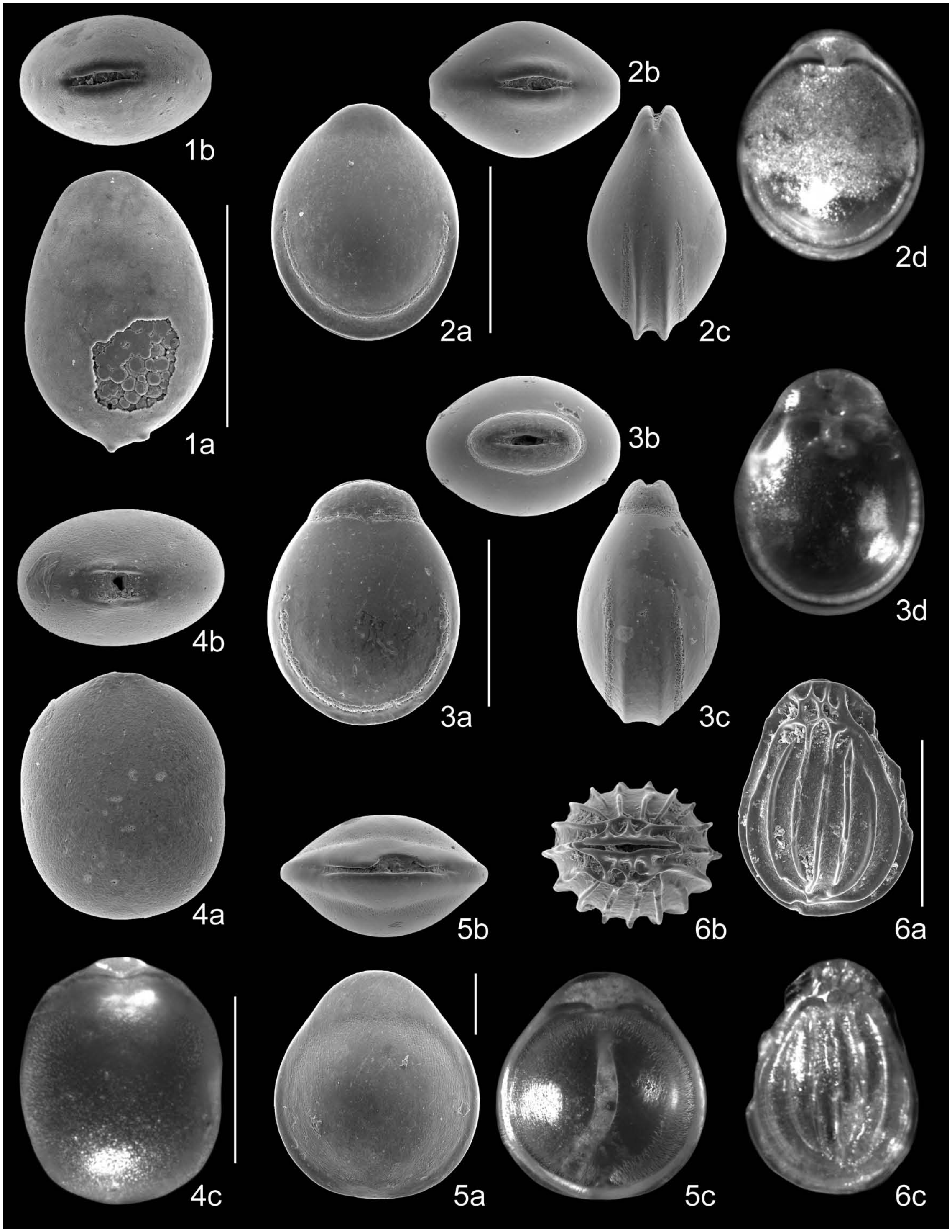

Figure 9. Photographs of benthic foraminifera from the Hole U1352B (7). Scale bars: 100 μm unless otherwise specified. **1,** *Fissurina* sp. 2, MPC-28961, Sample U1352B-1H-5-W, 19–21 cm; **2,** *Fissurina* sp. 3, MPC-28962, Sample U1352B-1H-5-W, 19–21 cm; **3,** *Fissurina* sp. 4, MPC-28963, Sample U1352B-2H-1-W, 94–96 cm; **4,** *Fissurina* sp. 5, MPC-28964, Sample U1352B-19H-6-W, 19–21 cm; **5,** *Fissurina* sp. 6, MPC-28965, Sample U1352B-2H-1-W, 94–96 cm; **6,** *Fissurina* sp. 7, MPC-28966, Sample U1352B-1H-1-W, 19–21 cm.

Lagena bella Matthes, 1939) resembles this species but differs in lacking hexagonal reticulations on the protruded lip.

Genus ***Lagenosolenia*** McCulloch, 1977
Lagenosolenia cf. ***conspissata*** McCulloch, 1977

Figure 10.1

Cf. *Lagenosolenia bradyiformis conspissata* McCulloch, 1977, p. 54, pl. 68, fig. 5a, b.

Type locality.—Off the Galapagos Islands, eastern Equatorial Pacific Ocean; Recent.

Occurrence.—Very rare and found only in MIS 11.

Remarks.—The species treated here shows a nearly flat parallel-sided test created by the combination of a small spherical chamber and a surrounding wide and thick keel, rather than the biconvex test formed by a large spherical chamber and narrow but thick keel of *Lagenosolenia conspissata* McCulloch, 1977. We suspect McCulloch's (1977) species is the same taxon, but we still need to do more work on it.

Distribution.—*Lagenosolenia conspissata* occurs at upper bathyal depths (*ca*. 300 m) in the eastern Equatorial Pacific Ocean (McCulloch, 1977).

Lagenosolenia curvituba (Parr, 1950)

Figure 10.2

Fissurina curvituba Parr, 1950, p. 311, pl. 9, fig. 2.

Type locality.—Off Tasmania, Southwest Pacific Ocean; Recent.

Occurrence.—Sporadic. Very rare in the hole.

Remarks.—This species is characterised by having an elliptical test with a wide, very short apertural neck and a phialine (everted) lip curving downward at the corners, typical of *Lagenosolenia.* The short recurved entosolenian tube of this species was not observable in our specimen because of its opaque test surface.

Distribution.—This species occurs at outer-shelf depths (128 m) off northeastern Tasmania (Parr, 1950).

Lagenosolenia nuda (Chapman, 1909)

Figure 10.3

Lagena lagenoides var. *nuda* Chapman, 1909, p. 338, pl. 15, fig. 9.

Type locality.—Off the Auckland Islands, New Zealand, Southwest Pacific Ocean; Recent.

Occurrence.—Sporadic. Very rare in the hole.

Distribution.—This species occurs on the outer-shelf (*ca*. 150 m depth) in the vicinity of the subantarctic islands of New Zealand (Chapman, 1909).

Lagenosolenia prolata McCulloch, 1977

Figure 10.4

Lagenosolenia prolata McCulloch, 1977, p. 69, pl. 60, figs. 9, 16.

Type locality.—Off the Galapagos Islands, eastern Equatorial Pacific Ocean; Recent.

Occurrence.—Sporadic. Very rare in the hole.

Remarks.—This species has a wide single keel around the test rather than the narrower one of *Lagenosolenia pressa* McCulloch, 1977 and *Lagenosolenia simpla* (= *Lagena simpla* Matthes, 1939).

Distribution.—This species occurs at inner-shelf and mid-bathyal depths (*ca*. 30–720 m) off California and off the Galapagos Islands, eastern Pacific Ocean (McCulloch, 1977).

Lagenosolenia restricta (McCulloch, 1977)

Figure 10.5

Fissurina restricta McCulloch, 1977, p. 126, pl. 65, fig. 31a, b.

Type locality.—Off California, eastern Pacific Ocean; Recent.

Occurrence.—Very rare and found only in MIS 11.

Distribution.—The species is found at middle-shelf depths (*ca*. 110 m) off California, eastern Pacific Ocean (McCulloch, 1977).

Lagenosolenia vannicapitata McCulloch, 1977

Figure 10.6

Lagenosolenia vannicapitata McCulloch, 1977, p. 75, pl. 65, fig. 8a–c.

Type locality.—Off the Galapagos Islands, eastern Equatorial Pacific Ocean; Recent.

Occurrence.—Sporadic. Very rare since MIS 7.

Remarks.—This species is distinguished from *Lagenosolenia curvituba* (= *Fissurina curvituba* Parr, 1950) by having an oviform test tapering towards the apertural end, slightly elevated apertural neck, and narrow single keel with bifurcated auricle on each side of the lower part of its keel.

Distribution.—This species occurs at inner- and outer-shelf depths (*ca*. 30–125 m) in the eastern Equatorial Pacific Ocean (McCulloch, 1977).

Genus ***Palliolatella*** Patterson and Richardson, 1987
Palliolatella antiqua (Yassini and Jones, 1995)

Figure 11.1

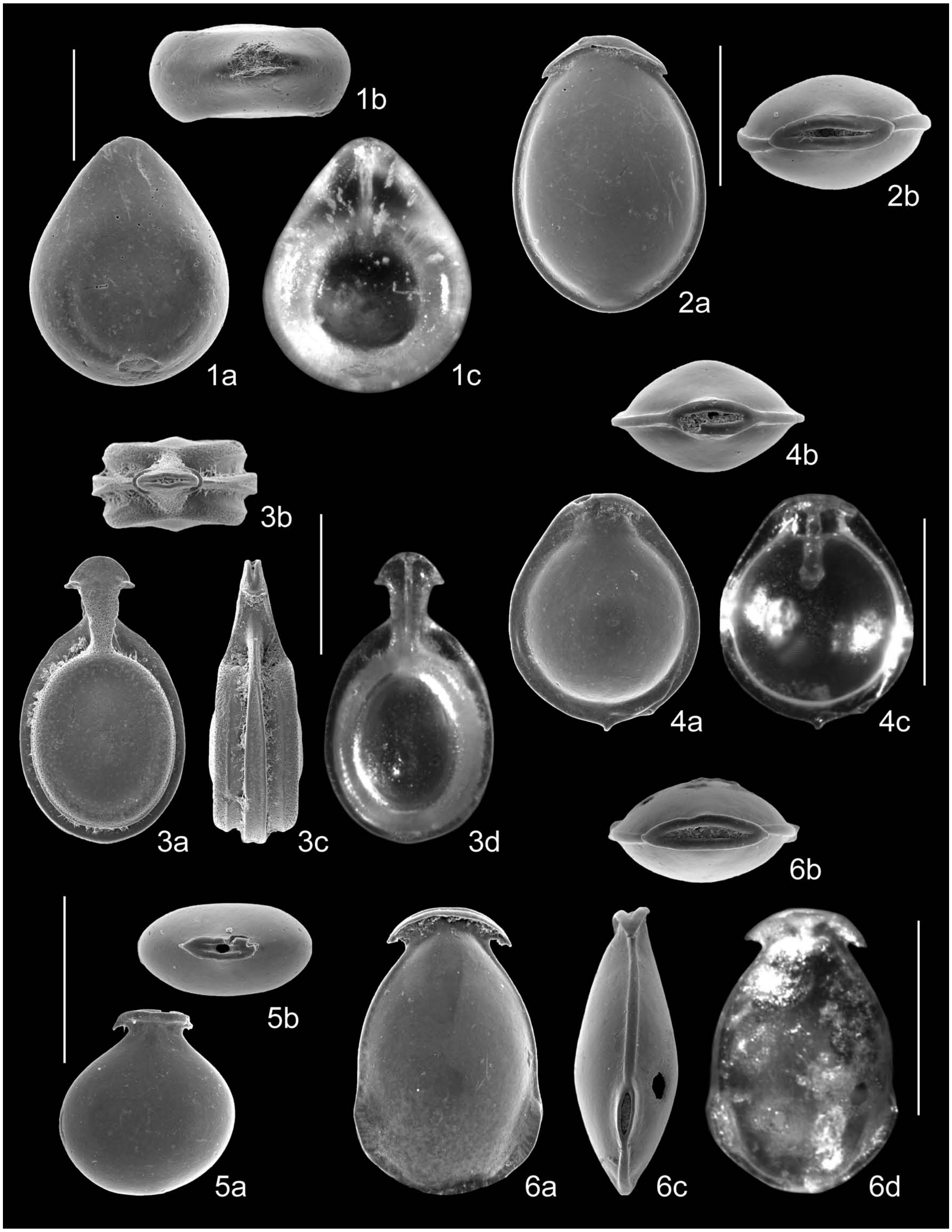

Figure 10. Photographs of benthic foraminifera from the Hole U1352B (8). Scale bars: 100 µm unless otherwise specified. **1,** *Lagenosolenia* cf. *conspissata* McCulloch, MPC-28967, Sample U1352B-16H-2-W, 94–96 cm; **2,** *Lagenosolenia curvituba* (Parr), MPC-28968, Sample U1352B-8H-1-W, 19–21 cm; **3,** *Lagenosolenia nuda* (Chapman), MPC-28969, Sample U1352B-16H-6-W, 93–95 cm; **4**, *Lagenosolenia prolata* McCulloch, MPC-28970, Sample U1352B-1H-1-W, 19–21 cm; **5,** *Lagenosolenia restricta* (McCulloch), MPC-28971, Sample U1352B-11H-6-W, 94–96 cm; **6,** *Lagenosolenia vannicapitata* McCulloch, MPC-28972, Sample U1352B-2H-1-W, 94–96 cm.

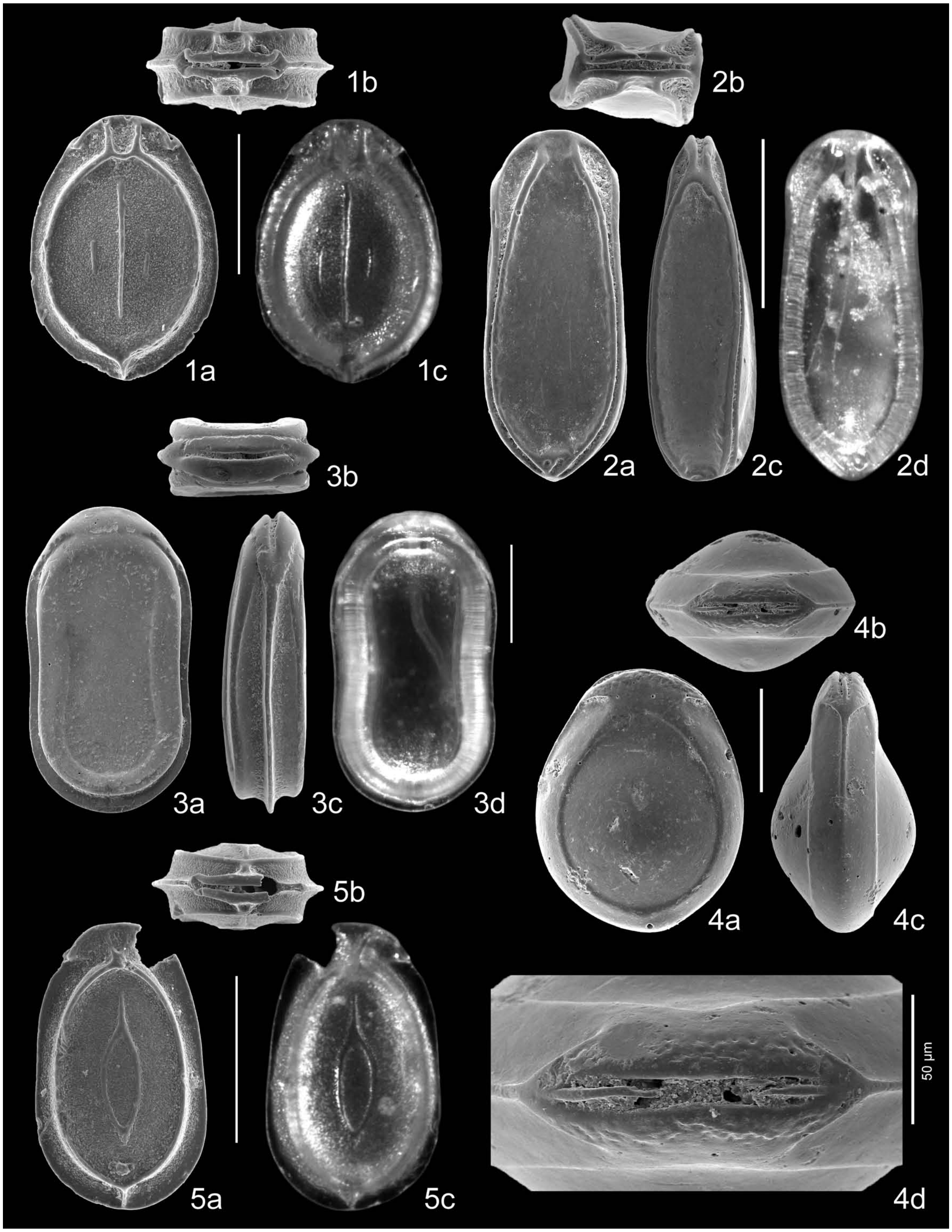

Figure 11. Photographs of benthic foraminifera from the Hole U1352B (9). Scale bars: 100 µm unless otherwise specified. **1,** *Palliolatella antiqua* (Yassini and Jones), MPC-28973, Sample U1352B-7H-6-W, 19–21 cm; **2,** *Palliolatella grenfelli* Kawagata, sp. nov., Holotype, MPC-28974, Sample U1352B-1H-5-W, 19–21 cm; **3,** *Palliolatella haywardi* Kawagata, sp. nov., Holotype, MPC-28975, Sample U1352B-16H-3-W, 94–96 cm; **4,** *Palliolatella*? aff. *quadricinctaovalis* (Matthes), MPC-28976, Sample U1352B-22H-7-W, 19–21 cm; **5,** *Palliolatella* sp. 1, MPC-28977, Sample U1352B-22H-7-W, 19–21 cm.

Fissurina antiqua Yassini and Jones, 1995, p. 121, fig. 499.
Fissurina cf. *antiqua* Yassini and Jones. Debenay, 2013, p. 145, pl. 9 (unnumbered).
Vasicostella aff. *singulata* Patterson and Richardson. Igarashi *et al*., 2001, p. 160, pl. 8, fig. 4a, b (*non Vasicostella singulata* Patterson and Richardson, 1987).

Type locality.—South of Sydney, southeastern Australia; Recent.

Occurrence.—Sporadic. Very rare to rare in the hole.

Remarks.—*Fissurina unicostata* (= *Fissurina orbignyana* var. *unicostata* Sidebottom, 1912) differs from our species in the single raised bar between the apertural lip and raised chamber periphery and longitudinal costae in the mid-central part of the chamber. No raised bars nor longitudinal costae in the mid-central part of the chamber are recognised in *Fissurina clathratiformis* McCulloch, 1977, whereas double bars but no longitudinal costae in the mid-central part of the chamber are found in *Fissurina rosalindae* McCulloch, 1977. We consider that this species belongs to the genus *Palliolatella* because of its multiple peripheral keels with a slit aperture on the terminal end of the neck and a slightly everted lip, but not hooded.

Distribution.—This species occurs at outer-shelf and continental slope depths off the southeastern coast of Australia (Yassini and Jones, 1995), and also occurs on the outer reef (100 m depth) of New Caledonia (Debenay, 2013).

Palliolatella grenfelli Kawagata, sp. nov.

Figure 11.2

Diagnosis.—A calcareous, slender unilocular form with nearly parallel sides and rounded at both ends of the test; lateral sides are edged by paired carinae.

Description.—Test unilocular, elongate, compressed, nearly parallel-sided, quadrangular in section, apertural end rounded, apical end mucronate; wall calcareous, transparent, smooth surfaced; chambers on both sides flat, lateral sides of the test edged by paired carinae, the external carinae of each face fuse together at the margins of the apertural slit, the internal carinae of each face are not fused, but connected to the apertural lip; aperture terminal, a long slit-like opening with a distinct lip, internal entosolenian tube straight, descending down two-thirds the length of the chamber lumen from the aperture, attached to one side of the internal wall.

Etymology.—Named for Hugh R. Grenfell, who is a specialist on Neogene foraminifera in New Zealand.

Type locality.—U1352B-1H-5-W, 19–21 cm, Canterbury Basin, New Zealand, Southwest Pacific Ocean; Middle Pleistocene.

Type specimen.—Holotype (MPC-28974, Fig. 11.2a–d), length 210 µm, maximum breadth 86 µm, maximum thickness 57 µm. Sample U1352B-1H-5-W, 19–21 cm.

Occurrence.—Sporadic. Very rare in the hole.

Remarks.—An elongate, almost rectangular parallel-sided test with lateral sides edged by paired carinae is also seen in *Lagenosolenia quadrangularis* (= *Lagena quadrangularis* Brady, 1884), but the latter species has a long-necked, rounded aperture rather than the elevated, lipped slit aperture of the new species.

Palliolatella haywardi Kawagata, sp. nov.

Figure 11.3

Diagnosis.—An elongate unilocular form with nearly parallel sides and both ends of the test rounded; with a central keel and lateral sides edged by a single carina.

Description.—Test unilocular, elongate, twice as long as wide, compressed, nearly parallel-sided, slightly narrower at the mid-portion, quadrangular in section, apical and basal ends rounded; wall calcareous, transparent, smooth-surfaced; chamber sides flat, periphery with a central keel, lateral sides of the test edged by a single carina; aperture terminal, a long slit-like opening, with a distinct thick lip the sides of which connect to a central keel; internal entosolenian tube straight, descending down two-thirds of the chamber lumen length from the aperture, attached to one side of the internal wall.

Etymology.—Named for Bruce W. Hayward who has long been working energetically on the shallow to deep-sea benthic foraminifera in New Zealand.

Type locality.—U1352B-16H-3-W, 94–96 cm, Canterbury Basin, New Zealand, Southwest Pacific Ocean; Middle Pleistocene.

Type specimen.—Holotype (MPC-28975, Fig. 11.3a–d), length 320 µm, maximum breadth 170 µm, maximum thickness 82 µm. Sample U1352B-16H-3-W, 94–96 cm.

Occurrence.—Sporadic. Very rare in the hole.

Remarks.—This new species seems to be most similar to *Palliolatella peponisema* Clark, 1995 from Holocene deep-sea sediments of the Southwest Pacific Ocean, but differs in its rectangular parallel-sided test slightly narrower at the mid-portion with a thick, everted lipped slit aperture rather than an elongate subfusiform rectangular parallel-sided test and long tapered necked aperture.

Palliolatella? aff. ***quadricinctaovalis*** (Matthes, 1939)

Figure 11.4

Aff. *Lagena quadricincta-ovalis* Matthes, 1939, p. 69, pl. 4, fig. 48.
Palliolatella sp. 2, Debenay, 2013, p. 157, pl. 9 (unnumbered).

Type locality.—Germany; Oligocene.

Occurrence.—Very rare in the hole.

Remarks.—The specimen treated here is characterised by its subacute and heavily unimarginate peripheral keel with a single weak central keel on the upper part of the test margin, rather than distinct double central keels as in *Palliolatella quadricinctaovalis* (=*Lagena quadricincta-ovalis* Matthes, 1939). The aperture is a narrow slit-like opening with a thick lip, which merges into its single central keel on both sides with inner projections from both sides rather than the simple slit-like opening (fissurine aperture) of *Palliolatella*. Therefore, its genus affiliation is still not clear.

Distribution.—This species occurs at a lower bathyal depth (600 m) north of New Caledonia, tropical southwestern Pacific Ocean (Debenay, 2013).

Palliolatella sp. 1

Figure 11.5

Fissurina sp. 1. Debenay, 2013, p. 149 (unnumbered).

Occurrence.—Very rare in the hole.

Remarks.—This unidentified species differs from *Palliolatella antiqua* (= *Fissurina antiqua* Yassini and Jones, 1995) by having distinctly raised subcircular rims on both sides of the mid-central part of the chamber, instead of the longitudinal costae of the latter species. Circular rims are reported in *Fissurina biconica* Silvestri, 1902 (*fide* Ellis and Messina, 1940 *et seq.*) from Recent material in Italy, but that species has a more circular test than our specimen. Circular rims are also reported in *Entosolenia circulocosta* var. *carinata* Uchio, 1951 (preoccupied by *Lagena* (*Entosolenia*) *marginata* var. *carinata* Wiesner, 1931; junior secondary homonym of *Fissurina carinata* Reuss, 1863) from the Pliocene in Japan, but raised bars connecting the apertural lip to the raised chamber periphery are not recognised in Uchio's species. We regard this species as belonging to the genus *Palliolatella* because of its multiple peripheral-keeled test with a slit aperture at the terminal end of the neck and slightly everted lip, but not hooded.

Distribution.—Debenay (2013) reported this species from a coastal bay at 10 m water depth in New Caledonia, Southwest Pacific Ocean.

Subfamily Parafissurininae Jones, 1984
Genus ***Irenita*** Jones, 1984
Irenita cornigera (Buchner, 1940)

Figure 12.1

Lagena cornigera Buchner, 1940, p. 514, pl. 22, figs. 445–450.
Irenita cornigera (Buchner). Jones, 1984, p. 117; Loeblich and Tappan, 1987, p. 429, pl. 466, figs. 3, 4.

Type locality.—Island of Ischia, Italy, Tyrrhenian Sea; Neogene and Recent.

Occurrence.—Sporadic. Very rare in the hole.

Remarks.—Buchner (1940) proposed this species with illustrations which show the morphological variation of the keel encircling the test, which are combination of a narrower single keel and a bifurcated auricle at various parts of the keel.

Distribution.—Buchner (1940) reported this species from middle-shelf depths (70 m) off Ischia in the Tyrrhenian Sea.

Genus ***Parafissurina*** Parr, 1947
Parafissurina abnormis Parr, 1950

Figure 12.2

Parafissurina abnormis Parr, 1950, p. 314, pl. 9, fig. 11a–c.

Type locality.—Antarctic Ocean; Recent.

Occurrence.—Sporadic. Very rare to rare in the hole.

Remarks.—The species examined shows a more compressed test than the type figure of this species.

Distribution.—This species occurs at upper bathyal depths in the Indian Ocean off Antarctica (Parr, 1950).

Parafissurina admiralis McCulloch, 1977

Figure 12.3

Parafissurina admiralis McCulloch, 1977, p. 137, pl. 69, fig. 3a, b; Debenay, 2013, p. 158, pl. 9 (unnumbered).

Type locality.—Off the Galapagos Islands, eastern Equatorial Pacific Ocean; Recent.

Occurrence.—Sporadic. Very rare in the hole.

Distribution.—This species is reported from mid-bathyal depths (*ca*. 750 m) off the Galapagos Islands, eastern Equatorial Pacific Ocean.

Parafissurina curta Parr, 1950

Figure 12.4

Parafissurina curta Parr, 1950, p. 318, pl. 10, figs. 6, 7; Ujiié, 1990, p. 27, pl. 10, figs. 2, 3.
Parafissurina sp. 2. Hermelin, 1989, p. 58, p. 10, fig. 14.
Parafissurina sp. 1. Igarashi *et al*., 2001, pl. 9, fig. 10a, b.

Type locality.—Antarctic Ocean; Recent.

Occurrence.—Sporadic. Very rare in the hole.

Distribution.—This species occurs at upper bathyal depths in the Indian Ocean off Antarctica (Parr, 1950); 683 m water depth in Lützow-Holm Bay, East Antarctica (Igarashi *et al*., 2001).

Parafissurina curvans (Buchner, 1940)

Figures 12.5, 12.6

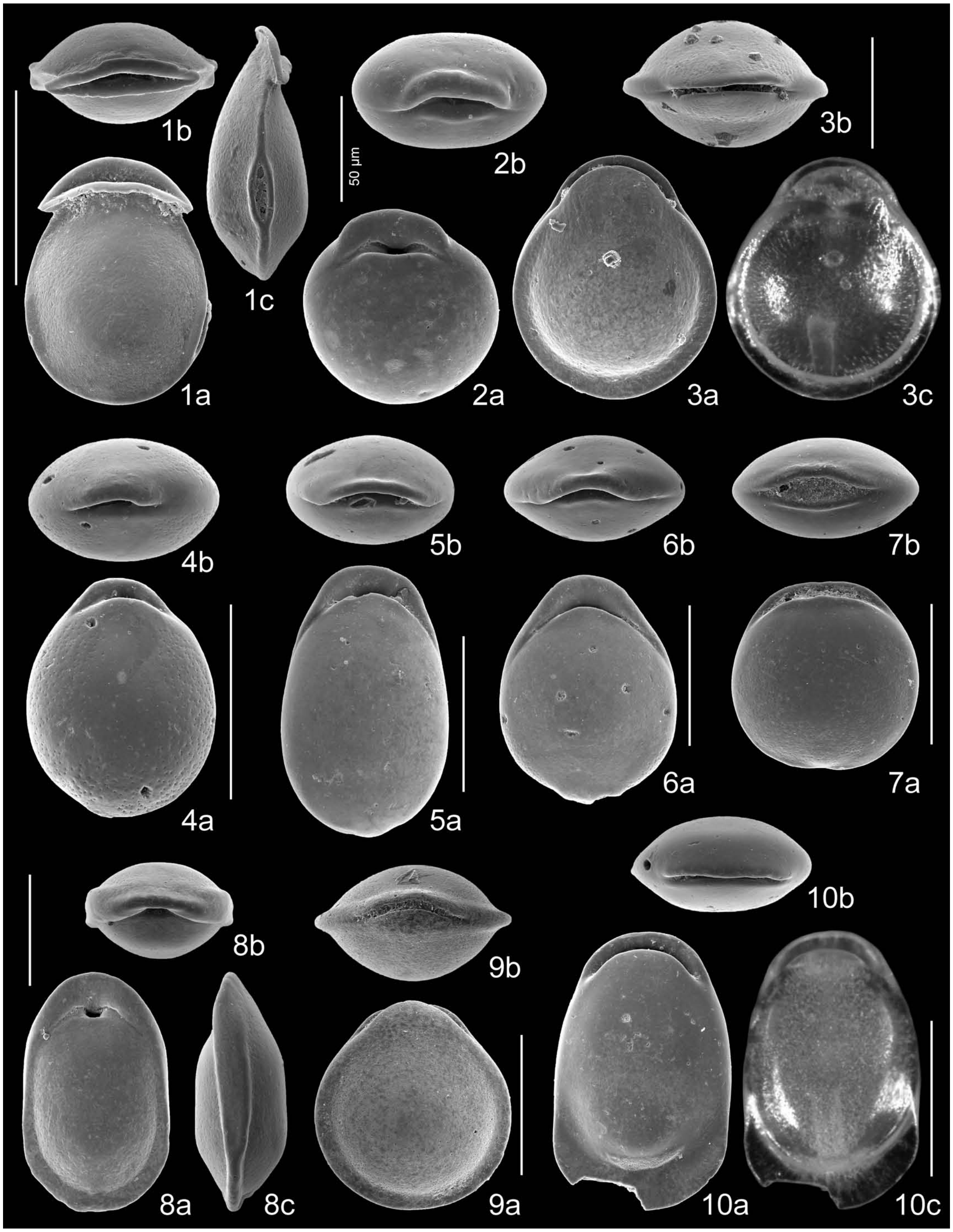

Figure 12. Photographs of benthic foraminifera from the Hole U1352B (10). Scale bars: 100 µm unless otherwise specified. **1,** *Irenita cornigera* (Buchner), MPC-28978, Sample U1352B-14H-3-W, 94–96 cm; **2,** *Parafissurina abnormis* Parr, MPC-28979, Sample U1352B-12H-6-W, 19–21 cm; **3,** *Parafissurina admiralis* McCulloch, MPC-28980, Sample U1352B-11H-4-W, 94–96 cm; **4,** *Parafissurina curta* Parr, MPC-28981, Sample U1352B-12H-6-W, 19–21 cm; **5, 6,** *Parafissurina curvans* (Buchner); 5, MPC-28982, Sample U1352B-13H-1-W, 93–95 cm; 6, MPC-28983, Sample U1352B-13H-1-W, 93–95 cm; **7,** *Parafissurina dohrnii* (Buchner), MPC-28984, Sample U1352B-1H-1-W, 19–21 cm; **8,** *Parafissurina electa* McCulloch, MPC-28985, Sample U1352B-1H-3-W, 94–96 cm; **9,** *Parafissurina lata* (Wiesner), MPC-28986, Sample U1352B-1H-1-W, 19–21 cm; **10,** *Parafissurina magnilabiata* Parr, MPC-28987, Sample U1352B-12H-6-W, 19–21 cm.

Lagena curvans Buchner, 1940, p. 540, pl. 29, figs. 621–623.
Parafissurina sp. 2. Igarashi *et al*., 2001, pl. 9, fig. 14a, b.

Type locality.—Island of Ischia, Italy; Neogene.
Occurrence.—Sporadic. Very rare in the hole.
Distribution.—This species occurs at 683 m water depth in Lützow-Holm Bay, East Antarctica (Igarashi *et al*., 2001).

Parafissurina dohrnii (Buchner, 1940)

Figure 12.7

Lagena dohrnii Buchner, 1940, p. 532, pl. 26, figs. 556–558.
Parafissurina dohrnii (Buchner). Kawagata, 2001, p. 84, fig. 7-14a, b.

Type locality.—Island of Ischia, Italy and Mediterranean Sea; Neogene and Recent.
Occurrence.—Sporadic. Very rare in the hole.
Remarks.—This species is distinguished from *Parafissurina cor* (= *Ellipsolagena cor* Wiesner, 1931) by its non-keeled peripheral margin rather than thin and narrow keel encircling the test.
Distribution.—This species occurs at inner-shelf and upper-bathyal depths (10–540 m) off Sicily, Mediterranean Sea (Buchner, 1940).

Parafissurina electa McCulloch, 1977

Figure 12.8

Parafissurina electa McCulloch, 1977, p. 145, pl. 71, fig. 12a, b; Debenay, 2013, p. 158, pl. 9 (unnumbered).

Type locality.—Off the Galapagos Islands, eastern Equatorial Pacific Ocean; Recent.
Occurrence.—Sporadic. Very rare in the hole.
Remarks.—*Parafissurina electa* has been reported as a species having a thick, marginated periphery, but not a carinated one (McCulloch, 1977; Debenay, 2013). However, we regard here that such a thick marginated periphery is synonymous with a thick peripheral keel for the species, and thus our specimen having a thick keel represents the same species as McCulloch's *P. electa*.
Distribution.—This species occurs at middle-shelf depth (*ca*. 90 m) in the Galapagos region, eastern Equatorial Pacific Ocean (McCulloch, 1977).

Parafissurina lata (Wiesner, 1931)

Figure 12.9

Ellipsolagena lata Wiesner, 1931, p. 126, pl. 26, figs. k, l.
Parafissurina lata (Wiesner). Parr, 1950, p. 315, pl. 9, fig. 17; Ujiié, 1990, p. 27, pl. 10, figs. 5–7; Ujiié, 1995, p. 59, pl. 3, fig. 10; Kawagata, 2001, p. 84, fig. 7-15.

Type locality.—Antarctic Sea; Recent.
Occurrence.—Sporadic. Very rare in the hole.
Distribution.—This species has a cosmopolitan distribution and was originally reported from the upper bathyal zone (385 m depth).

Parafissurina magnilabiata Parr, 1950

Figures 12.10, 13.1

Parafissurina magnilabiata Parr, 1950, p. 316, pl. 9, fig. 18.

Type locality.—Off Macquarie Island, Subantarctic; Recent.
Occurrence.—Sporadic. Very rare in the hole.
Remarks.—This species is characterised by a distinct thin but broad keel like a caudal fin at the base of the test (fig. 12.10a–c). One specimen possessing a weak keel unlike the typical form (fig. 13.1a, b) is considered to be a juvenile.
Distribution.—This species is reported from middle-shelf depths (69 m) off Macquarie Island (Parr, 1950).

Parafissurina multicosta (Karrer, 1877)

Figure 13.2

Fissurina multicosta Karrer, 1877, p. 379, pl. 16b, fig. 20.
Lagena multicosta (Karrer). Millett, 1901, pl. 8, fig. 17a–c.

Type locality.—Germany; Miocene.
Occurrence.—Very rare found only in MIS 15.
Distribution.—Millett (1901) reported this species from depths of *ca*. 270 m in the Malay Archipelago and *ca*. 4200 m in the South Atlantic Ocean.

Parafissurina cf. ***toweriana*** McCulloch, 1977

Figure 13.3

Cf. *Parafissurina renilla toweriana* McCulloch, 1977, p. 155, pl. 68, figs. 27, 28.

Type locality.—Off the Galapagos Islands, eastern Equatorial Pacific Ocean; Recent.
Occurrence.—Very rare; found only in MIS 8.
Remarks.—Our specimen compares well with *Parafissurina renilla toweriana* McCulloch, 1977, but differs in its distinct keel that is thicker at the apertural end rather than a thinner marginal keel. Although McCulloch (1977) mentioned that keel width is variable on her specimens, keel thickness is also possibly variable for the species. It resembles *Parafissurina hongkongensis* McCulloch, 1977 in the nature of the keel, but is distinguished from the latter by its overall test shape. It also differs from the non-keeled species *Parafissurina cor*

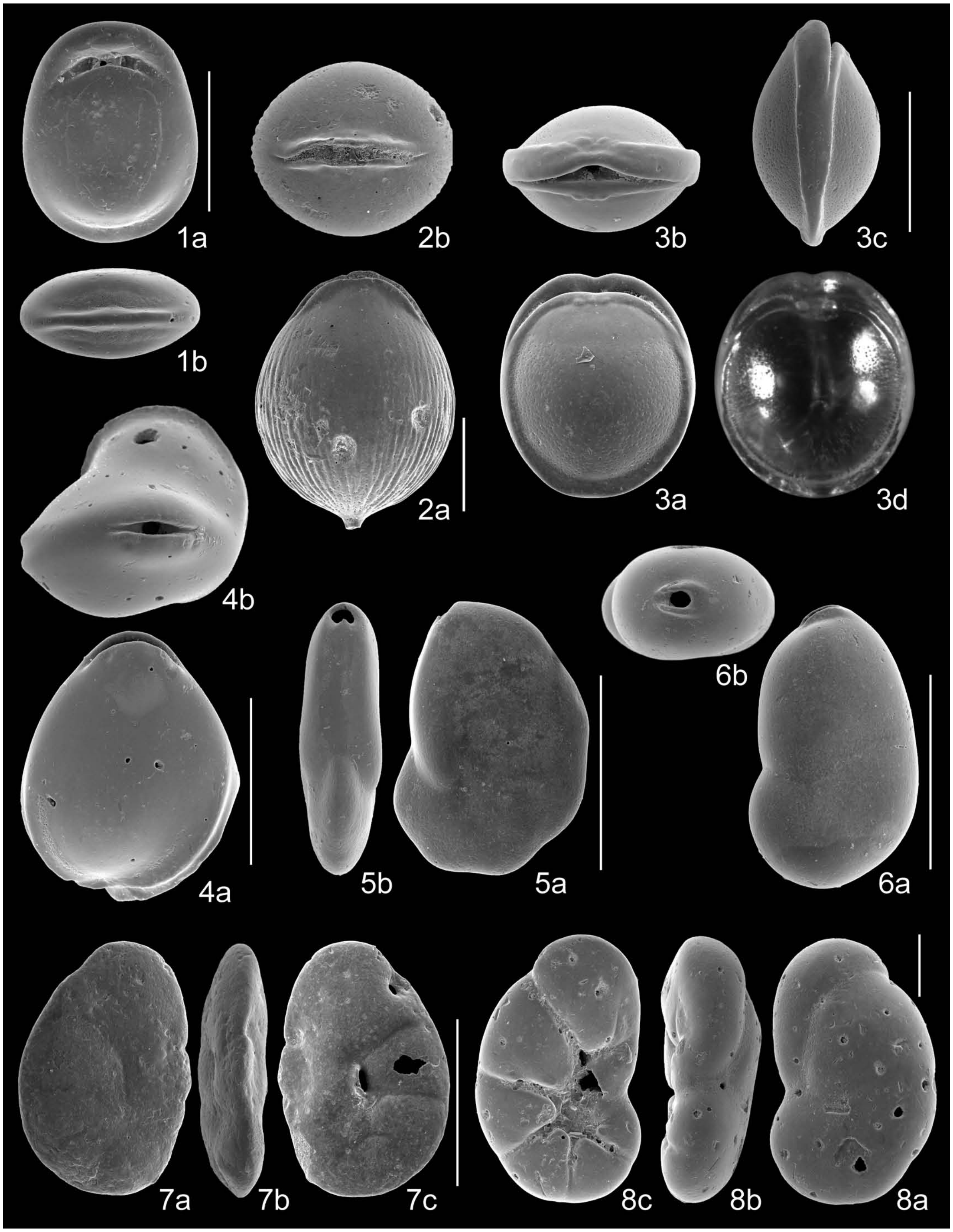

Figure 13. Photographs of benthic foraminifera from the Hole U1352B (11). Scale bars: 100 µm unless otherwise specified. **1,** *Parafissurina magnilabiata* Parr, MPC-28988, juvenile, Sample U1352B-26H-2-W, 94–96 cm; **2,** *Parafissurina multicosta* (Karrer), MPC-28989, Sample U1352B-22H-7-W, 19–21 cm; **3,** *Parafissurina* cf. *toweriana* McCulloch, MPC-28990, Sample U1352B-11H-6-W, 94–96 cm; **4,** *Parafissurina* sp. 1, MPC-28991, Sample U1352B-9H-3-W, 19–21 cm; **5,** *Briceia complectilis* McCulloch, MPC-28992, Sample U1352B-14H-3-W, 94–96 cm; **6,** *Briceia* sp. 1, MPC-28993, Sample U1352B-22H-6-W, 19–21 cm; **7,** *Cerobertina* cf. *afueriana* McCulloch, MPC-28994, Sample U1352B-10H-6-W, 19–21 cm; **8,** *Cerobertina* cf. *bartrumi* Finlay, MPC-28995, Sample U1352B-28H-4-W, 17–19 cm.

(Wiesner, 1931) and the less perforated species *Parafissurina renilla* McCulloch, 1977.

Distribution.—This species occurs at upper bathyal depths (320 m–360 m) off Guadalupe Island, Gulf of California, and off the Galapagos Islands, eastern Pacific Ocean (McCulloch, 1977).

Parafissurina sp. 1

Figure 13.4

Occurrence.—Very rare in the core.

Remarks.—The specimen examined here is probably an abnormal form of a *Parafissurina* species that is characterised by twin keels on the lower half of the test bordered by narrow opaque bands at both sides of the test.

Family Glandulinidae Reuss, 1860
Subfamily Entolingulininae Saidova, 1981
Genus ***Briceia*** McCulloch, 1977
Briceia complectilis McCulloch, 1977

Figure 13.5

Briceia complectilis McCulloch, 1977, p. 5, pl. 93, figs. 18, 19.

Type locality.—Off Panay Island, Philippines, tropical western Pacific Ocean; Recent.

Occurrence.—Very rare and found only in MIS 10.

Remarks.—The species examined here shows a small compressed, oval test that is composed of five elongate chambers in a loose planispiral coil and a simple slit-like aperture surrounded by a raised apertural margin. An internal entosolenian tube is not visible in our specimen.

Distribution.—This species occurs at inner-shelf depths (*ca*. 30 m) off Panay Island, Philippines, tropical western Pacific Ocean (McCulloch, 1977).

Briceia sp. 1

Figure 13.6

Entomorphinoides parviformis McCulloch, 1977, p. 212, pl. 92, figs. 6, 7 (in part, not figs. 4 = holotype, 5, 45).

Occurrence.—Very rare and found only in MIS 15.

Remarks.—McCulloch (1977) proposed the new species *Entomorphinoides parviformis* for a species having a symmetrical biserial sigmoid organization of its test and illustrated biserial forms (*op. cit*., pl. 92, figs. 4 (holotype), 5 and 45). She also illustrated very loosely planispirally coiled forms (*op. cit*., pl. 92, figs. 6, 7), which have a rather similar chamber arrangement to the genus *Briceia* McCulloch, 1977 and which are identical to the specimens examined in this study. We consider that the loosely planispirally coiled form can be distinguished from *E. parviformis*. An internal entosolenian tube is not visible in our specimen.

Distribution.—McCulloch (1977) reported that this species occurs mostly at inner- to outer-shelf depths in the Pacific Ocean, and also reported it from the Gulf of California (100 m water depth?), and off Peru in the eastern equatorial Pacific Ocean (30 m water depth).

Suborder Robertinina Loeblich and Tappan, 1984
Superfamily Ceratobuliminoidea Cushman, 1927c
Family Epistominidae Wedekind, 1937
Subfamily Epistomininae Wedekind, 1937
Genus ***Hoeglundina*** Brotzen, 1948
Hoeglundina elegans (d'Orbigny, 1826)

Rotalia (*Turbinulina*) *elegans* d'Orbigny, 1826, p. 276.
Epistomina elegans (d'Orbigny). Cushman, 1927a, p. 182, pl. 31, figs. 1–6; Chapman *et al*., 1934, p. 567, pl. 9, fig. 22a–c.
Höeglundina elegans (d'Orbigny). Phleger and Parker, 1951, p. 22, pl. 12, fig. 1a, b.
Hoeglundina elegans (d'Orbigny). LeRoy, 1964, p. F38, p. 6, figs. 27, 28; Boltovskoy *et al*., 1980, p. 35, pl. 18, figs. 14–17; Hayward *et al*., 1999, p. 123, pl. 8, figs. 5–7; Kawagata, 1999, p. 16, fig. 4-1a–c; Hayward *et al*., 2010, p. 183, pl. 16, figs. 16–21; Debenay, 2013, p. 199, pl. 17 (unnumbered); Holbourn *et al*., 2013, p. 298, figs. 1–3.

Type locality.—Not designated; age not given.

Occurrence.—Very rare and found only in the topmost (Holocene) sample in the hole.

Remarks.—Only one poorly preserved specimen was found in the course of our study. *Rotalia* (*Turbinulina*) *elegans* was proposed by d'Orbigny (1826) and validated with his reference to Soldani's (1798) figure (ITCZ 12.1, 12.2.1, 12.2.7).

Distribution.—This species occurs commonly at middle-shelf to bathyal depths with a few sporadic occurrences at deep inner-shelf depths around New Zealand (Hayward *et al*., 1999).

Superfamily Robertinoidea Reuss, 1850
Family Robertinidae Reuss, 1850
Genus ***Cerobertina*** Finlay, 1939b
Cerobertina cf. ***afueriana*** McCulloch, 1977

Figure 13.7

Cf. *Cerobertina* (?) *afueriana* McCulloch, 1977, p. 376, pl. 130, fig. 11a–c.

Type locality.—Off the Afuera Islands, Peru, Southeast Pacific Ocean; Recent.

Occurrence.—Sporadic. Very rare in the hole.

Remarks.—The specimen examined possesses a supplementary chamberlet around the umbilicus and resembles *Cerobertina* (?) *afueriana* McCulloch, 1977 except for its more flattened test.

Distribution.—McCulloch's (1977) species is the most similar one to the figured specimen from New Zealand. It was reported from the inner-shelf (*ca*. 28 m depth) off the Afuera Islands, Peru, Southeast Pacific Ocean.

Cerobertina cf. ***bartrumi*** Finlay, 1939b

Figure 13.8

Cf. *Cerobertina bartrumi* Finlay, 1939b, p. 118, pl. 11, figs. 2, 3.

Type locality.—Pakaurangi, Kaipara Harbour, New Zealand; early Miocene.

Occurrence.—Sporadic. Very rare to rare in the hole.

Remarks.—The specimen examined is similar to *Cerobertina bartrumi* Finlay, 1939b but differs in the lack of supplementary chamber-like insets on the shorter margin around the umbilicus, due to its being broken.

Suborder Rotaliina Delage and Hérouard, 1896
Superfamily Bolivinoidea Glaessner, 1937
Family Bolivinidae Glaessner, 1937
Genus ***Bolivina*** d'Orbigny, 1839b
Bolivina alata (Seguenza, 1862b)

Figure 14.1

Vulvulina alata Seguenza, 1862b, p. 115, pl. 2, fig. 5.
Bolivina beyrichi var. *alata* Seguenza. Brady, 1884, p. 422, pl. 53, figs. 2–4.
Brizalina alata (Seguenza). Jones, 1994, p. 58, pl. 53, figs. 2–4.
Bolivina alata (Seguenza). Cushman, 1937, p. 106, pl. 13, figs. 3–11; Barker, 1960, p. 108, pl. 53, figs. 2–4; Hayward *et al*., 2010, p. 184, pl. 16, figs. 25, 26; Holbourn *et al.*, 2013, p. 77, figs. 1–5.

Type locality.—Sicily; Pleistocene.

Occurrence.—Very rare and found only in MIS 6.

Distribution.—This cosmopolitan species occurs from outer-shelf to lower bathyal depths (100–1200 m) around New Zealand (Hayward *et al*., 2010).

Bolivina cf. ***difformis*** (Williamson, 1858)

Figure 14.2

Cf. *Textularia variabilis* var. *difformis* Williamson, 1858, p. 77, pl. 6, figs. 166, 167.
Bolivina pygmaea (Brady). Hayward *et al*., 2010, p. 186, pl. 16, figs. 39, 40 (*non Bulimina* (*Bolivina*) *pygmaea* Brady, 1881).

Type locality.—Waters around Great Britain; Recent.

Occurrence.—Very rare; found only in MIS 2.

Remarks.—Illustrated specimens (e.g. Williamson, 1858) seem to have a more compressed test with a smoother test wall than our specimens' reticulated test. Hayward *et al*. (2010) reported *Bolivina pygmaea* (Brady) which is regarded as the same species in this study.

Distribution.—Hayward *et al*. (2010) reported this species from outer-shelf to upper abyssal depths (150–2200 m) around New Zealand.

Bolivina earlandi Parr, 1950

Figure 14.3

Bolivina earlandi Parr, 1950, p. 339, pl. 12, fig. 16a, b; Hayward *et al*., 2010, p. 185, pl. 16, figs. 31–33.

Type locality.—Off Antarctica; Recent.

Occurrence.—Sporadic. Very rare to common in the hole.

Distribution.—This species occurs from upper to lower bathyal depths (219–1718 m), mostly at upper bathyal depths in the Southern Ocean (Parr, 1950); inner-shelf to lower bathyal depths (0–2000 m) off southeast New Zealand (Hayward *et al*., 2010).

Bolivina neocompacta McCulloch, 1981

Figure 14.4

Bolivina neocompacta McCulloch, 1981, p. 126, pl. 45, figs. 3, 7; Hayward *et al*., 1999, p. 126, pl. 8, figs. 12, 13.

Type locality.—Off Cape Town, South Africa; Recent.

Occurrence.—Sporadic. Very rare in the hole.

Distribution.—This species occurs in sheltered to moderately sheltered, marine and slightly brackish, inner-shelf environments, and in the outer parts of harbours around New Zealand (Hayward *et al*., 1999).

Bolivina peirsonae Uchio, 1960

Figure 14.5

Bolivina peirsonae Uchio, 1960, p. 63, pl. 7, figs. 3, 4.
Bolivina gramen (d'Orbigny). Heron-Allen and Earland, 1913 (*non Vulvulina gramen* d'Orbigny, 1839b), p. 69, pl. 5, figs. 4, 5.
? *Bolivina gramen* (d'Orbigny). Höglund, 1947, p. 274, pl. 32, figs. 25–30, text-figs. 283–285.
Bolivina pygmaea Brady. Cushman and McCulloch, 1942, p. 204, pl. 25, figs. 9–12 (in part, not fig. 8) (*non Bulimina* (*Bolivina*) *pygmaea* Brady, 1881).

Type locality.—Off San Diego, California; Recent.

Occurrence.—Sporadic. Very rare to rare in the hole.

Remarks.—This species differs from *Bolivina gramen* (=*Vulvulina gramen* d'Orbigny, 1839b) and *Bolivina pygmaea* Brady, 1881 in having a more inflated and elongate test.

Distribution.—This species was originally reported from the lowermost mid-bathyal zone (*ca*. 1000 m depth) in the eastern Pacific Ocean (Uchio, 1960).

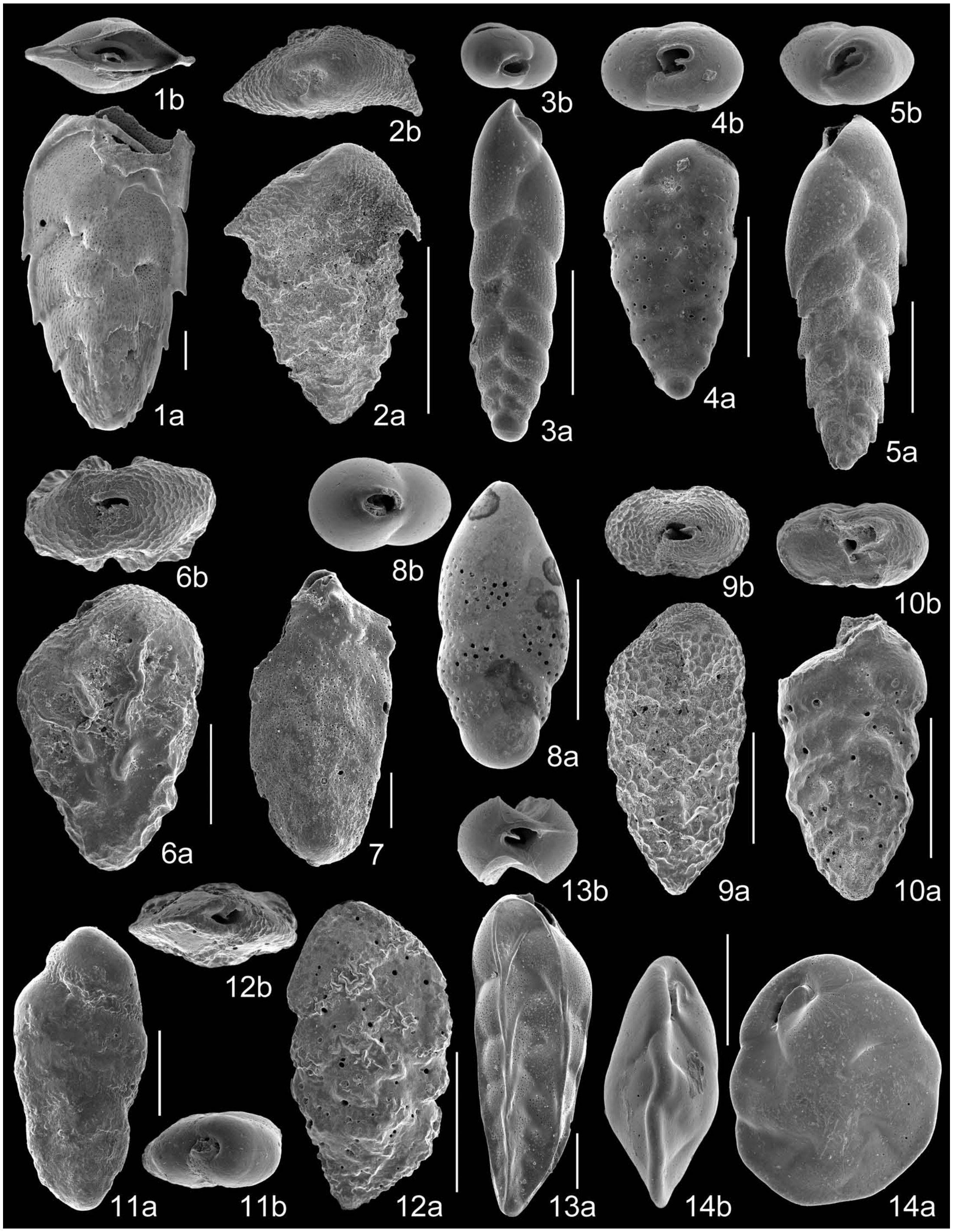

Figure 14. Photographs of benthic foraminifera from the Hole U1352B (12). Scale bars: 100 μm unless otherwise specified. **1,** *Bolivina alata* (Seguenza), MPC-28996, Sample U1352B-8H-2-W, 20–22 cm; **2,** *Bolivina* cf. *difformis* (Williamson), MPC-28997, Sample U1352B-2H-1-W, 94–96 cm; **3,** *Bolivina earlandi* Parr, MPC-28998, Sample U1352B-1H-3-W, 94–96 cm; **4,** *Bolivina neocompacta* McCulloch, MPC-28999, Sample U1352B-11H-4-W, 94–96 cm; **5,** *Bolivina peirsonae* Uchio, MPC-29000, Sample U1352B-9H-3-W, 19–21 cm; **6,** *Bolivina pseudoplicata* Heron-Allen and Earland, MPC-29001, Sample U1352B-7H-6-W, 94–96 cm; **7,** *Bolivina robusta* Brady, MPC-29002, Sample U1352B-7H-6-W, 19–21 cm; **8,** *Bolivina seminuda* Cushman, MPC-29003, Sample U1352B-19H-6-W, 19–21 cm; **9,** *Bolivina variabilis* (Williamson), MPC-29004, Sample U1352B-1H-1-W, 19–21 cm; **10,** *Bolivina* sp. 1, MPC-29005, Sample U1352B-11H-1-W, 51–53 cm; **11,** *Bolivina* sp. 2, MPC-29006, Sample U1352B-19H-2-W, 94–96 cm; **12,** *Abditodentrix pseudothalmanni* (Boltovskoy and Guissani de Khan),

Bolivina pseudoplicata Heron-Allen and Earland, 1930

Figure 14.6

Bolivina pseudo-plicata Heron-Allen and Earland, 1930, p. 81, pl. 3, figs. 36–40; Cushman, 1937, p. 166, pl. 19, figs. 12–20.
Bolivina pseudoplicata Heron-Allen and Earland. Hayward *et al*., 1999, p. 126, pl. 8, figs. 14, 15.

Type locality.—Locality not given; Recent.
Occurrence.—Sporadic. Very rare after MIS 6.
Distribution.—This species is widespread in sheltered to exposed, fully marine, inner-shelf to mid-bathyal environments, and is commonly abundant in sheltered bays, inlets and the outer parts of harbours and at bathyal depths around New Zealand (Hayward *et al*., 1999).

Bolivina robusta Brady, 1881

Figure 14.7

Bolivina robusta Brady, 1881, p. 57; Brady, 1884, p. 421, pl. 53, figs. 7–9; Cushman, 1937, p. 131, pl. 17, figs. 1–3 (in part, not fig. 4); Cushman *et al*., 1954, p. 353, pl. 87, fig. 40; Barker, 1960, p. 108, pl. 53, figs. 7–9; Hedley *et al*., 1965, p. 21, pl. 6, fig. 22a, b; Akimoto, 1990, p. 192, pl. 16, fig. 1, pl. 22, fig. 13a, b; Jones, 1994, p. 58, pl. 53, figs. 7–9; Loeblich and Tappan, 1994, p. 111, pl. 215, figs. 17, 18; Yassini and Jones, 1995, p. 130, figs. 545, 546; Kawagata, 1999, p. 17, fig. 4-3a, b; Hayward *et al*., 2010, p. 186, pl. 16, figs. 41, 42; Debenay, 2013, p. 171, pl. 12 (unnumbered).

Type locality.—Not given; Recent.
Occurrence.—Very rare and found only in MIS 2.
Remarks.—Qvale and Nigam (1985) reported *Bolivina skagerrakensis* Qvale and Nigam, 1985 from Recent sediments in a the Skagerrak (northeastern North Sea) and Norway as the most related species to *Bolivina robusta*, which is distinguished from the latter species by having a slightly keeled test.
Distribution.—This cosmopolitan species is widespread off both coasts of New Zealand and occurs between middle-shelf and upper abyssal depths (50–3000 m) around New Zealand (Hayward *et al*., 2010).

Bolivina seminuda Cushman, 1911

Figure 14.8

Bolivina seminuda Cushman, 1911, p. 34, text-fig. 55; Cushman, 1937, p. 142, pl. 18, figs. 13–15; Cushman and McCulloch, 1942, p. 210, pl. 25, fig. 14; Natland, 1950, p. 21, pl. 5, fig. 19a, b; Matoba and Yamaguchi, 1982, p. 1036, pl. 1, figs. 10a–14b; Kurihara and Kennett, 1986, pl. 2, figs. 9, 10; Hermelin, 1989, p. 60, pl. 10, figs. 17, 18; Kawagata, 1999, p. 17, fig. 4-4a, b; Hayward, *et al*., 2010, p. 186, pl. 17, figs. 1–3.
Bolivina subspinescens Cushman. Yassini and Jones, 1995, p. 131, figs. 618, 619 *(non Bolivina subspinescens* Cushman, 1922).

Type locality.—Bering Sea; Recent.
Occurrence.—Sporadic. Very rare in the hole.
Distribution.—This species is most common in bathyal depths around the world ocean; middle-shelf to lower bathyal depths (50–5000 m) around New Zealand (Hayward, *et al*., 2010).

Bolivina variabilis (Williamson, 1858)

Figure 14.9

Textularia variabilis Williamson, 1858, p. 76, pl. 6, figs. 162, 163.
Bolivina variabilis (Williamson). Loeblich and Tappan, 1994, p. 111, pl. 216, figs. 7–15. Ujiié, 1995, p. 60, pl. 4, fig. 5; Hayward *et al*., 2010, p. 187, pl. 17, figs. 6–10; Debenay, 2013, p. 172, pl. 12 (unnumbered).
Bolivina subexcavata Cushman and Wickenden, 1929, p. 9, pl. 4, fig. 4a, b; Hayward *et al*., 1999, p. 127, pl. 8, fig. 22.

Type locality.—Waters around Great Britain; Recent.
Occurrence.—Very rare to rare almost throughout the hole, but common in the Holocene sample.
Distribution.—This cosmopolitan species is widespread and common in sheltered to exposed environments and at fully marine inner-shelf to uppermost abyssal depths (0–2500 m) around New Zealand (Hayward *et al*., 2010).

Bolivina sp. 1

Figure 14.10

Occurrence.—Very rare and found only in MIS 7.
Remarks.—This unidentified species resembles *Bolivina cincta* Heron-Allen and Earland, 1932 in the nature of its limbate sutures, which are slightly raised in the earlier portion, becoming slightly depressed in the later portion of the test. However, it differs from the latter species in its roughly perforated earlier portion rather than the numerous fine perforations of the latter.

Bolivina sp. 2

Figure 14.11

Occurrence.—Very rare to rare in the hole.
Remarks.—This unidentified species is characterised

MPC-29007, Sample U1352B-17H-4-W, 90–92 cm; **13,** *Bolivinita pliozea* Finlay, MPC-29008, Sample U1352B-17H-4-W, 90–92 cm; **14,** *Cassidulina carinata* Silvestri, MPC-29009, Sample U1352B-7H-6-W, 19–21 cm.

by a compressed biserial test with slightly rough test surface and nearly flush intercameral oblique sutures except for a slightly incised last suture.

Superfamily Bolivinitoidea Cushman, 1927c
Family Bolivinitidae Cushman, 1927c
Genus ***Abditodentrix*** Patterson, 1985
Abditodentrix pseudothalmanni (Boltovskoy and Guissani de Khan, 1981)

Figure 14.12

Bolivina pseudothalmanni Boltovskoy and Guissani de Khan, 1981, p. 44, pl. 1, figs. 1–5.
Abditodentrix pseudothalmanni (Boltovskoy and Guissani de Khan). Loeblich and Tappan, 1987, p. 503, pl. 554, figs. 1–5; Ujiié, 1990, p. 29, pl. 12, fig. 2a, b; Loeblich and Tappan, 1994, p. 113, pl. 218, figs. 1, 2; Ujiié, 1995, p. 60, pl. 4, fig. 7a, b; Kawagata, 1999, p. 17, fig. 4-6a, b; Hayward *et al*., 2010, p. 188, pl. 17, figs. 11, 12; Debenay, 2013, p. 170, pl. 12 (unnumbered).
Abditodentrix pseudothalmanni (Boltovskoy and Guissani de Khan) var. Ujiié, 1995, pl. 4, figs. 8–9.

Type locality.—DSDP Site 173, Northeast Pacific Ocean; middle Miocene.

Occurrence.—Very abundant during MIS 20 and MIS 12–MIS 10, but scarce after MIS 8.

Remarks.—The specimen figured here has an irregular and acute test periphery, rather than a test periphery fringed by a raised keel and a quadrangular cross section typical of *Abditodentrix pseudothalmanni.* Ujiié (1995) reported such atypical forms as a variety from the northwestern margin of the subtropical Pacific Ocean.

Distribution.—This species occurs in the upper bathyal to upper abyssal zones (400–3000 m) around New Zealand, mostly off the east coast of the South Island (Hayward *et al*., 2010). A similar pulse of this species was found during MIS 15–12 in ODP 1119 (Hayward *et al*., 2005).

Genus ***Bolivinita*** Cushman, 1927
Bolivinita pliozea Finlay, 1939c

Figure 14.13

Bolivinita pliozea Finlay, 1939c, p. 319; Hayward, 2002, pl. 1, figs. 10, 11; Hayward *et al*., 2012, p. 235, pl. 39, figs. 15, 16.

Type locality.—Wanganui, New Zealand; Late Pliocene.

Occurrence.—Sporadic. Very rare to rare in the hole, but does not occur after MIS12.

Distribution.—This extinct species is endemic to the Southwest Pacific region and is considered to occur at upper bathyal depths (400–600 m) (Hayward *et al*., 2012). Wilson *et al.* (2005) stated that biostratigraphic datums in ODP 1119, near IODP Site U1352B, included the last occurrence of the benthic foraminifera *Bolivinita pliozea* at 133 mcd (recorded highest occurrence in MIS 13 in Wanganui Basin, onshore New Zealand, GHS personal observation), which corresponds to our observation.

Family Cassidulinidae d'Orbigny, 1839a
Subfamily Cassidulininae d'Orbigny, 1839a
Genus ***Cassidulina*** d'Orbigny, 1826
Cassidulina carinata Silvestri, 1896

Figures 14.14, 15.1

Cassidulina laevigata var. *carinata* Silvestri, 1896, p. 104, pl. 2, fig. 10.
Cassidulina carinata Silvestri. Phleger *et al*., 1953, p. 44, pl. 9, figs. 32, 37; Eade, 1967, p. 429, fig. 2 (5–9); Nomura, 1983a, pl. 3, fig. 5; pl. 4, fig. 5; pl. 23, figs. 6–9; Nomura, 1983b, p. 5, pl. 4, figs. 9–11; Mead, 1985, p. 232, pl. 3, fig. 2a, b (in part, not figs. 1a, b, 3a, b); Hasegawa *et al*., 1990, pl. 4, figs. 1, 2; Loeblich and Tappan, 1994, p. 114, pl. 220, figs. 7–12; Kawagata, 1999, p. 18, fig. 4-7a, b; Hayward *et al*., 1999, p. 127, pl. 8, figs. 23, 24; Hayward *et al*., 2010, p. 192, pl. 17, figs. 39–41.
Cassidulina laevigata Silvestri. Wells and Wells, 1994, pl. 5, figs. 5, 6 (*non Cassidulina laevigata* d'Orbigny, 1826).

Type locality.—Italy; Pliocene.

Occurrence.—Abundant to very abundant almost throughout the hole. Strongly keeled specimens (e.g. Figure 14.14a, b) occur after around the MIS 7/8 boundary with a maximum abundance of *ca.* 24% of the total fauna at around the MIS 5/6 boundary, and less keeled specimens with subacute periphery of the test (e.g. Figure 15.1a, b) occur throughout the hole.

Remarks.—Strongly keeled specimens are common at outer-shelf to upper bathyal depths (120–500 m), while weakly keeled specimens occur above and below these depths off Great Barrier Island, northeastern North Island, New Zealand (Eade, 1967).

Distribution.—This species is widespread at a wide range of depths (0–5000 m) around New Zealand, and common in exposed to moderately sheltered inner- and middle-shelf to bathyal depths (Hayward *et al*., 1999).

Cassidulina reniforme Nørvang, 1945

Figure 15.2

Cassidulina crassa var. *reniforme* Nørvang, 1945, p. 41, text-fig. 6, e–h.
Cassidulina reniforme Nørvang. Nomura, 1999, p. 43, figs. 18.18a–c, 18.19a–c, 30.3; Hayward *et al*., 2010, p. 193, pl. 18, figs. 1–3.
Cassidulina islandica forma *minuta* Nørvang, 1945, p. 43, text-fig. 8, a–c.
Cassidulina islandica var. *minuta* Nørvang. Cushman, 1948, p. 75, p. 8, fig. 11a–c.
Cassidulina islandica var. *norvangi* Thalmann in Phleger, 1952, p. 83, footnote 1.
Cassidulina norvangi Thalmann. Nomura, 1983b, p. 53, pl. 4, figs.

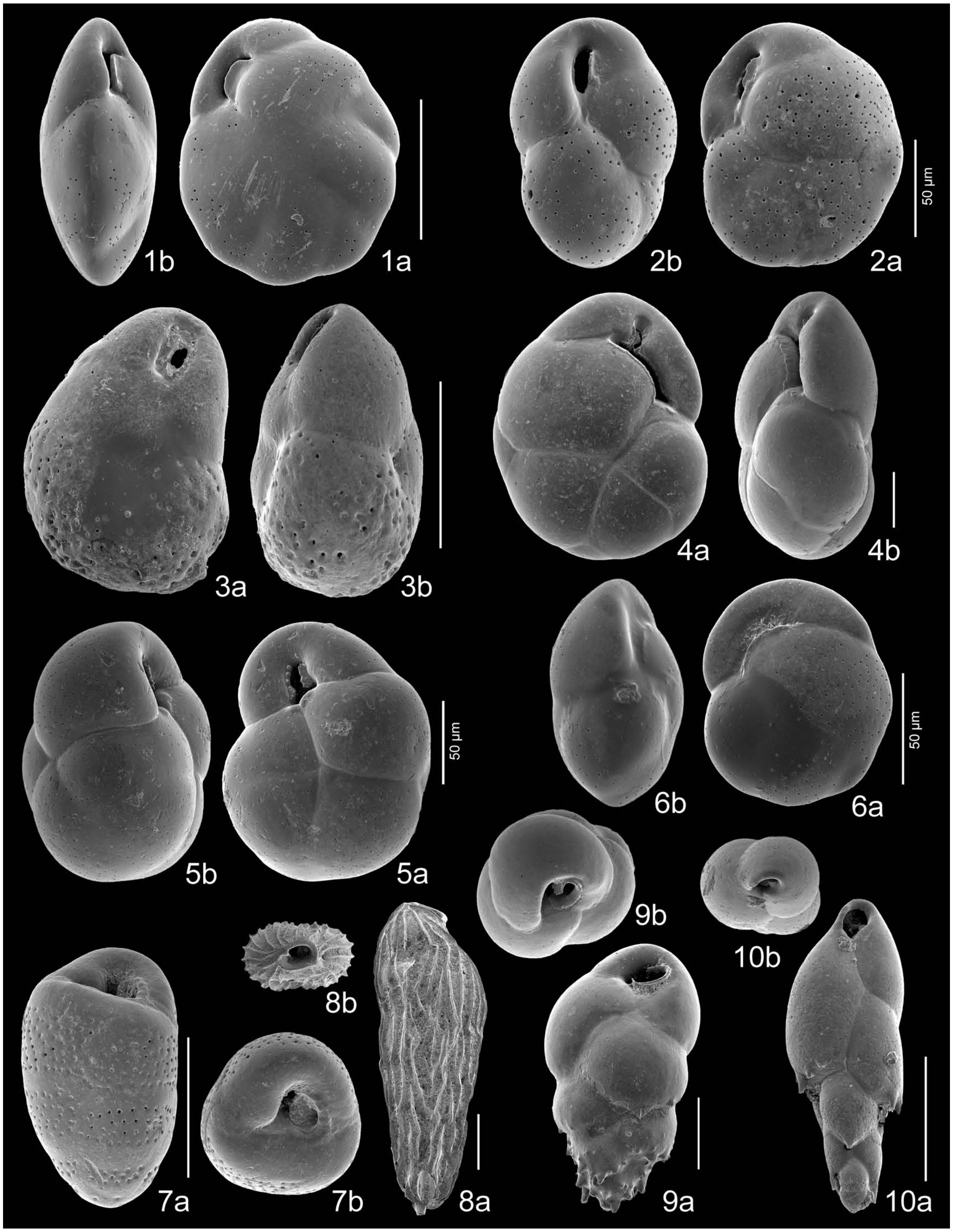

Figure 15. Photographs of benthic foraminifera from the Hole U1352B (13). Scale bars: 100 µm unless otherwise specified. **1,** *Cassidulina carinata* Silvestri, MPC-29010, Sample U1352B-7H-6-W, 19–21 cm; **2,** *Cassidulina reniforme* Nørvang, MPC-29011, Sample U1352B-12H-6-W, 19–21 cm; **3,** *Evolvocassidulina belfordi* Nomura, MPC-29012, Sample U1352B-17H-4-W, 90–92 cm; **4,** *Globocassidulina crassa* (d'Orbigny), MPC-29013, Sample U1352B-25H-1-W, 94–96 cm; **5,** *Globocassidulina subglobosa* (Brady), MPC-29014, Sample U1352B-25H-1-W, 94–96 cm; **6,** *Paracassidulina stabilis* Nomura, MPC-29015, Sample U1352B-1H-5-W, 19–21 cm; **7,** *Virgulopsis turris* (Heron-Allen and Earland), MPC-29016, Sample U1352B-23H-7-W, 19–21 cm; **8,** *Saidovina karreriana* (Brady), MPC-29017, Sample U1352B-1H-3-W, 94–96 cm; **9,** *Bulimina aculeata* d'Orbigny, MPC-29018, Sample U1352B-13H-4-W, 19–21 cm; **10,** *Bulimina spinosa* (Heron-Allen and Earland), MPC-29019, Sample U1352B-11H-4-W, 94–96 cm.

12a–c, 13, pl. 23, figs. 10–12, pl. 24, figs. 1–3; Oki, 1989, p. 143, pl. 19, fig. 1a–f; Ujiié, 1990, p. 38, pl. 18, figs. 4a–5b.
Cassidulina minuta Cushman. Boltovskoy *et al*., 1980, p. 22, pl. 7, figs. 7–10.
Cassidulina bradshawi Uchio, 1960, p. 68, pl. 9, figs. 11, 12.

Type locality.—Off Iceland, North Atlantic Ocean; Recent.

Occurrence.—Occurs almost throughout the hole and very abundant in the glacial periods of MIS 10, MIS 8 and MIS 6.

Remarks.—Nørvang (1945) proposed *Cassidulina islandica* var. *minuta* and *Cassidulina crassa* var. *reniforme* from Recent sediments in the Arctic Sea. Later, Thalmann in Phleger (1952) proposed a new variety name of *Cassidulina islandica* var. *norvangi* for Nørvang's (1945) *C. islandica* var. *minuta* (= junior primary homonym of *Cassidulina minuta* Cushman, 1933). *C. norvangi* is considered to be the same species as *C. reniforme* by several previous researchers (e.g. Nomura, 1999), and we followed their taxonomic opinions.

Distribution.—This species occurs between middle-shelf and mid-abyssal depths (50–4000 m), and is most common at outer-shelf to uppermost bathyal depths (100–2500 m) around New Zealand (Hayward *et al*., 2010).

Genus ***Evolvocassidulina*** Eade, 1967
Evolvocassidulina belfordi Nomura, 1983a

Figure 15.3

Evolvocassidulina belfordi Nomura, 1983a, p. 79, figs. 49, 50, pl. 2, fig. 6a–c, pl. 20, figs. 8–10, 12; Hayward *et al*., 2010, p. 196, pl. 19, figs. 7–9.

Type locality.—Okinawa, Japan; Pliocene.

Occurrence.—Sporadic. Very rare in the hole.

Distribution.—This species is restricted in its geographical distribution to off the North and northern South Islands in New Zealand, and occurs between middle-shelf and mid-abyssal depths (80–4000 m) (Hayward *et al*., 2010).

Genus *Globocassidulina* Voloshinova, 1960
Globocassidulina crassa (d'Orbigny, 1839b)

Figure 15.4

Cassidulina crassa d'Orbigny, 1839b, p. 56, pl. 7, figs. 18–20; d'Orbigny, 1846, p. 213, pl. 21, figs. 42, 43; Brady, 1884, p. 429, pl. 54, fig. 4a–c (not fig. 5a–c); Barker, 1960, p. 110, pl. 54, fig. 4a–c (not fig. 5a–c); Jones, 1994, p. 60, pl. 54, fig. 4a–c.
Globocassidulina crassa (d'Orbigny). Eade, 1967, p. 435, fig. 4.4; Nomura, 1983b, p. 37, text-figs. 31, 32, pl. 3, figs. 9a–c, 10a–c; Hayward *et al*., 2010, p. 197, pl. 19, figs. 19–21.
Cassidulina rossensis (Kennett). Boltovskoy *et al*., 1980, p. 23, pl. 7, figs. 15–17 (*non Globocassidulina crassa rossensis* Kennett, 1967).

Type locality.—Off the Falkland Islands, Southwest Atlantic Ocean; Recent.

Occurrence.—Occurs intermittently. Very abundant during the glacial period of MIS 18.

Remarks.—The specimens examined in this study are characterised by moderately large, compressed tests consisting of four chambers with a tripartite apertural slit and are distinguished from *Globocassidulina crassa rossensis* Kennett, 1967 by their larger tests.

Distribution.—Around New Zealand, this cosmopolitan species is restricted to bathyal and abyssal depths off the southern South Island (Hayward *et al*., 2010).

Globocassidulina subglobosa (Brady, 1881)

Figure 15.5

Cassidulina subglobosa Brady, 1881, p. 60; Brady, 1884, p. 430, pl. 54, fig. 17a–c; Phleger and Parker, 1951 (part), p. 27, pl. 14, figs. 11, 12; Parker, 1954, p. 536, pl. 11, figs. 4–9; Barker, 1960, p. 112, pl. 54, fig. 17a–c; Anderson, 1975, p. 84, pl. 11, fig. 1a, b.
Globocassidulina subglobosa (Brady). Belford, 1966, p. 149, pl. 25, figs. 11–16; text-fig. 17, 1–6; text-fig. 18, 1–4; Nomura, 1983a, pl. 13, figs. 5, 6; Nomura, 1983b, p. 20, pl. 2, figs. 8a–c, 9; Murray, 1984, p. 528, pl. 2, figs. 3, 4; Mead, 1985, p. 232, pl. 3, fig. 8; Ujiié, 1990, p. 39, pl. 21, figs. 4–7b; Jones, 1994, p. 60, pl. 54, fig. 17a–c; Ujiié and Hatta, 1994, p. 13, pl. 2, fig. 5a, b; Wells and Wells, 1994, pl. 5, fig. 7; Xu and Ujiié, 1994, p. 518, fig. 8.6; Ujiié, 1995, p. 62, pl. 5, fig. 7; Kawagata, 1999, p. 20, fig. 5-2a, b; Hayward *et al*., 2010, p. 198, pl. 20, figs. 4–6; Holbourn *et al*., 2013, p. 265, figs. 1, 2.

Type locality.—Off Brazil, tropical western Atlantic Ocean; Recent.

Occurrence.—Occurs throughout the hole. Very abundant during glacial periods (MIS 18, 16 and 12).

Distribution.—This cosmopolitan deep-sea species is widespread around New Zealand and occurs at outer-shelf to lower abyssal depths (90–5000 m) but is also abundant in shallower depths in the Bounty Trough, east of the South Island of New Zealand at around 45°S latitude (Hayward *et al*., 2010).

Genus ***Paracassidulina*** Nomura, 1983a
Paracassidulina stabilis Nomura, 1999

Figure 15.6

Paracassidulina stabilis Nomura, 1999, p. 45, figs. 29.13a–c, 30.4.
Cassidulina minuta Cushman. Boltovskoy, 1978, p. 155, pl. 2, fig. 29 (*non Cassidulina minuta* Cushman, 1933).
Paracassidulina minuta (Cushman). Nomura, 1983b, p. 66, pl. 5, fig. 16; Oki, 1989, p. 114, pl. 19, fig. 4a–c; Hasegawa *et al*., 1990, pl. 4, fig. 9; Loeblich and Tappan, 1994, p. 116, pl. 223, figs. 7, 8; Kawagata, 1999, p. 22, fig. 5-5a, b (*non Cassidulina minuta* Cushman, 1933).
Globocassidulina minuta (Cushman). Hayward *et al*., 2010, p. 198, pl.

19, figs. 22–24 (*non Cassidulina minuta* Cushman, 1933).

Type locality.—Off Paumotu Islands, tropical central Pacific Ocean; Recent.

Occurrence.—Sporadic. Very rare to rare in the hole.

Remarks.—This species is characterised by its small test with an interiomarginal slit at the base of the aperture and has been described under the name of *Paracassidulina minuta* (regarded as the same as *Cassidulina minuta* Cushman, 1933) since Nomura's (1983b) work. However, Nomura (1999) reexamined the holotype of *Cassidulina minuta* and found its aperture to be a tripartite slit as in *Globocassidulina* rather than a simple interiomarginal slit at the base of the apertural face as in *Paracassidulina*. Therefore he redefined Nomura's (1983b) *Paracassidulina minuta* and proposed the new species name of *Paracassidulina stabilis* to distinguish it from Cushman's (1933) *Globocassidulina minuta* (= *Cassidulina minuta* Cushman, 1933).

Distribution.—This species occurs from middle-shelf to mid-abyssal depths (50–4000 m) around New Zealand, and is most common in bathyal depths (200–2000 m) east of the South Island of New Zealand (Hayward *et al*., 2010).

Family Stainforthiidae Reiss, 1963

Genus ***Virgulopsis*** Finlay, 1939c

Virgulopsis turris (Heron-Allen and Earland, 1922)

Figure 15.7

Verneuilina turris Heron-Allen and Earland, 1922, p. 124, pl. 4, figs. 8–12.

Virgulopsis turris (Heron-Allen and Earland). Hedley *et al*., 1967, p. 32, pl. 9, fig. 5A, B; Hayward *et al*., 1999, 129, pl. 8, fig. 33.

Type locality.—Not designated; Recent.

Occurrence.—Sporadic. Very rare to rare in the hole.

Distribution.—This species occurs in moderately sheltered to exposed and inner-shelf environments under fully marine conditions around both islands of New Zealand (Hayward *et al*., 2010).

Superfamily Buliminoidea Jones in Griffith and Henfrey, 1875

Family Siphogenerinoididae Saidova, 1981

Subfamily Siphogenerinoidinae Saidova, 1981

Genus ***Saidovina*** Haman, 1984

Saidovina karreriana (Brady, 1881)

Figure 15.8

Bolivina karreriana Brady, 1881, p. 58; Brady, 1884, p. 424, pl. 53, figs. 19–21.

Loxostomum karreriana (Brady). Cushman, 1937, p. 184, pl. 21, figs. 17a, b; Barker, 1960, p. 110, pl. 53, figs. 19–21; Hornibrook, 1968, p. 77, fig. 14.

Saidovina karreriana (Brady). Loeblich and Tappan, 1987, p. 517; Jones 1994, p. 59, pl. 53, figs. 19–21; Yassini and Jones, 1995, p. 146, figs. 649–652; Hayward *et al*., 1999, p. 130, pl. 9, fig. 3; Hayward *et al*., 2010, p. 201, pl. 20, figs. 26–28.

Type locality.—South of Japan, Northwest Pacific Ocean; Recent.

Occurrence.—Very rare and found around the MIS 1/2 boundary.

Distribution.—This species is restricted to the western Pacific region and occurs in moderately sheltered environments to exposed inner- and middle-shelf depths under fully marine conditions, mostly common in quieter waters inside or at the entrance to deep inlets (20–40 m) around New Zealand (Hayward *et al*., 2010).

Family Buliminidae Jones in Griffith and Henfrey, 1875

Genus ***Bulimina*** d'Orbigny, 1826

Bulimina aculeata d'Orbigny, 1826

Figure 15.9

Bulimina aculeata d'Orbigny, 1826, p. 269; Brady, 1884, p. 406, pl. 51, figs. 7–9; Barker, 1960, p. 104, pl. 51, figs. 7–9; Jones, 1994, p. 56, pl. 51, figs. 7–9; Yassini and Jones, 1995, p. 147, figs. 565–567; Kawagata, 1999, p. 22, fig. 5-6a, b; Holbourn *et al*., 2013, p. 89, figs. 1–3.

Type locality.—Adriatic Sea, near Rimini, Italy; Recent.

Occurrence.—Rare in the examined samples.

Remarks.—*Bulimina aculeata* was named by d'Orbigny (1826) without figures and descriptions, but was validated by d'Orbigny's reference to figures in Soldani (1798) (ICZN Art. 12.1, 12.2.1, 12.2.7).

Distribution.—This cosmopolitan species occurs mostly between upper bathyal and upper abyssal depths (400–3000 m), but is uncommon in inner to middle-shelf, normal marine environments around New Zealand (Hayward *et al*., 1999, 2010).

Bulimina spinosa (Heron-Allen and Earland, 1932)

Figure 15.10

Virgulina schreibersiana var. *spinosa* Heron-Allen and Earland, 1932, p. 352, pl. 9, figs. 3, 4.

Virgulina (?) *spinosa* Heron-Allen and Earland. Cushman, 1937, p. 30, pl. 5, figs. 2, 3.

Bulimina spinosa (Heron-Allen and Earland). Matoba and Yamaguchi, 1982, p. 1041, pl. 2, fig. 4; Oki, 1989, p. 115, pl. 11, fig. 4a–c.

Bulimina arabiensis Bharti and Singh, 2013, p. 256, figs. 3.1–3.13.

Type locality.—Off the Falkland islands, subantarctic region; Recent.

Occurrence.—Very rare and found only around the MIS 7/8 boundary.

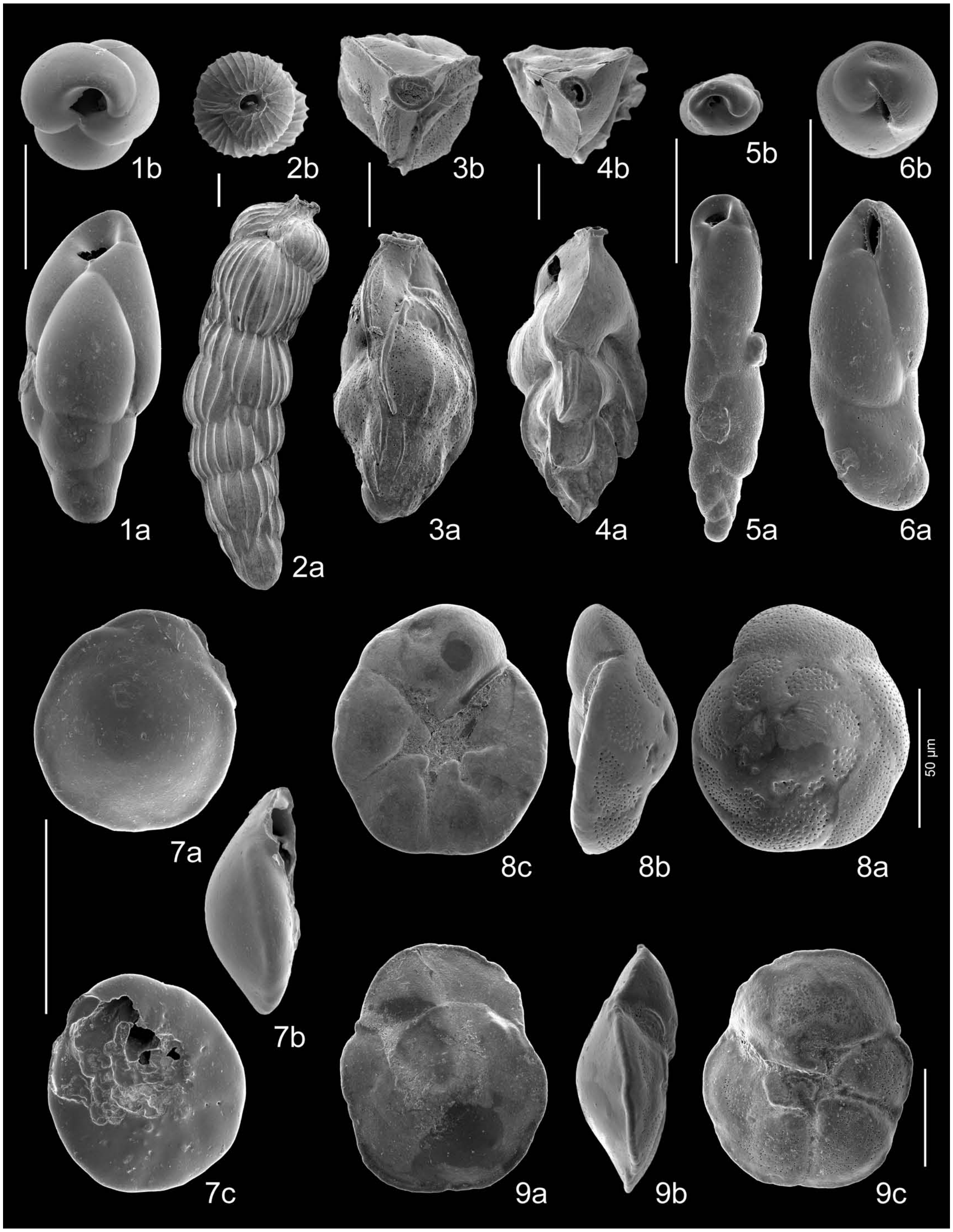

Figure 16. Photographs of benthic foraminifera from the Hole U1352B (14). Scale bars: 100 µm unless otherwise specified. **1,** *Eubuliminella exilis* (Brady), MPC-29020, Sample U1352B-9H-3-W, 19–21 cm; **2,** *Euuvigerina juncea* (Cushman and Todd), MPC-29021, Sample U1352B-8H-2-W, 20–22 cm; **3, 4,** *Angulogerina angulosa* (Williamson); 3, MPC-29022, Sample U1352B-7H-6-W, 19–21 cm; 4, MPC-29023, Sample U1352B-11H-3-W, 94–96 cm; **5,** *Fursenkoina* sp. 1, MPC-29024, Sample U1352B-1H-3-W, 94–96 cm; **6,** *Rutherfordoides rotundatus* (Parr), MPC-29025, Sample U1352B-15H-6-W, 94–96 cm; **7,** *Discorbis* aff. *malovensis* Heron-Allen and Earland, MPC-29026, Sample U1352B-14H-6-W, 19–21 cm; **8,** *Gavelinopsis hamata* Vella, MPC-29027, Sample U1352B-2H-1-W, 94–96 cm; **9,** *Gavelinopsis lobatula* (Parr), MPC-29028, Sample U1352B-2H-1-W, 94–96 cm.

Distribution.—This species occurs at mid-bathyal depths (612 m and 675 m) in the subantarctic region of the southwest Atlantic Ocean (Heron-Allen and Earland, 1932), and in the Late Pleistocene to Holocene deep-sea core retrieved at a lower bathyal depth (1230 m) in the northwestern Indian Ocean (Bharti and Singh, 2013). In the northern hemisphere, it occurs at inner-shelf to uppermost bathyal depths (30–212 m) off the northwest and southeast coast of the mainland of Japan (Matoba and Yamaguchi, 1982), and at depths of 75–225 m in Kagoshima Bay, southwestern Japan (Oki, 1989).

Genus ***Eubuliminella*** Revets, 1993
Eubuliminella exilis (Brady, 1884)

Figure 16.1

Bulimina elegans var. *exilis* Brady, 1884, p. 399, pl. 50, figs. 5, 6.
Bulimina exilis Brady. Barker, 1960, pl. 50, figs. 5, 6.
Eubuliminella exilis (Brady). Revets, 1993, p. 141, pl. 1, figs. 1–7; Jones, 1994, p. 54, pl. 50, figs. 5, 6; Holbourn *et al.*, 2013, p. 245, fig. 1.
Buliminella subfusiformis var. *tenuata* Cushman, 1927b, p. 149, pl. 2, fig. 9.
Bulimina exilis var. *tenuata* Cushman and Parker, 1947, p. 124, pl. 28, fig. 29.
Bulimina exilis var. *tenuata* (Cushman). Cushman and McCulloch, 1948, p. 248, pl. 31, fig. 2.
Buliminella cf. *tenuata* Cushman. Belford, 1966, p. 16, pl. 6, figs. 22–24, text-figs. 6.9–10.

Type locality.—Northwest of Ireland, Northeast Atlantic Ocean; Recent.

Occurrence.—Sporadic. Very rare to rare in the hole.

Remarks.—The specimen examined possesses a large globular proloculus showing a bluntly rounded initial end without an initial spine and is comparable to *Buliminella subfusiformis* var. *tenuata* Cushman, 1927b. The latter species has been separated from typical *Bulimina exilis* (=*Bulimina elegans* var. *exilis* Brady, 1884) because of its elongate tapered test with a minute proloculus and presence of a pointed initial spine (e.g. Belford, 1966). Revets (1993) examined types of these two species and concluded that Cushman's (1927b) *tenuata* is indistinguishable from the megalospheric form of Brady's (1884) *exilis*, and thus he regarded the former as a junior synonym of the latter.

Distribution.—This species occurs at mid-bathyal to upper abyssal depths (*ca*. 630–1400 m) in the Pacific Ocean (Brady, 1884); and inner-shelf to middle-bathyal depths (*ca.* 18–890 m) in the eastern Pacific Ocean (Cushman and McCulloch, 1948).

Family Uvigerinidae Haeckel, 1894
Subfamily Uvigerininae Haeckel, 1894
Genus ***Euuvigerina*** Thalmann, 1952
Euuvigerina juncea (Cushman and Todd, 1941)

Figure 16.2

Uvigerina juncea Cushman and Todd, 1941, p. 78, pl. 20, figs. 4–11.
Euuvigerina juncea (Cushman and Todd). Jung, 1988, p. 156, pl. 27, figs, 3, 5, 6, pl. 30, figs. 1, 4–7, pl. 33, figs. 3, 11, pl. 40, figs. 1–5.
Uvigerina tenuistriata Reuss. Brady, 1884, p. 574, pl. 74, figs. 4–7 (*non Uvigerina tenuistriata* Reuss, 1870).
Uvigerina peregrina var. *bradyana* Cushman, 1923, p. 168, pl. 42, fig. 12 (*non Uvigerina bradyana* Fornasini, 1900).
Uvigerina hollicki Thalmann, 1950, p. 45 (new replacement name for *Uvigerina peregrina* var. *bradyana* Cushman, 1923 (preoccupied)); Jones, 1994, p. 85, pl. 74, figs. 4–7.
Uvigerina cushmani Todd in Cushman and McCulloch, 1948, p. 257, pl. 33, fig. 1a–g; Barker, 1960, p. 154, pl. 74, figs. 4–7.

Type locality.—Timms Point, California, USA; Pliocene.

Occurrence.—Sporadic. Very rare to rare in the hole.

Remarks.—This species shows a triserial chamber arrangement throughout although the chambers become loosely coiled in the later part, but never become uniserial, the chamber arrangement seen in *Rectuvigerina* Mathews, 1945.

Distribution.—This species occurs in various depths ranging from *ca*. 20 to 400 m in the Pacific Ocean (Cushman and McCulloch, 1948).

Subfamily Angulogerininae Galloway, 1933
Genus ***Angulogerina*** Cushman, 1927c
Angulogerina angulosa (Williamson, 1858)

Figures 16.3, 16.4

Uvigerina angulosa Williamson, p. 67, pl. 5, fig. 140; Brady, 1884, p. 574, pl. 74, figs. 15, 16 (in part, not figs. 17, 18).
Angulogerina angulosa (Williamson). Cushman, 1927c, p. 69; Barker, 1960, pl. 74, figs. 15, 16; Loeblich and Tappan, 1994, p. 128, pl. 250, figs. 13–20; Ujiié, 1995, p. 63, pl. 6, fig. 9a, b.
Trifarina angulosa (Williamson). Loeblich and Tappan, 1964, p. C571, figs. 450-1a–3; Xu and Ujiié, 1994, p. 516, fig. 6.12; Jones, 1994, p. 86, pl. 74, figs. 15, 16; Holbourn *et al.*, 2013, p. 559, figs. 1–4.
Trifarina angulosa sensu lato (Williamson). Hayward *et al*., 1999, p. 134, pl. 9, figs. 23, 24; Hayward *et al*., 2010, p. 204, pl. 21, figs. 12–15.
Angulogerina carinata Cushman, 1927b, p. 159, pl. 4, fig. 3; Cushman, 1932, p. 44, pl. 6, figs. 7, 8.
Angulogerina carinata var. *bradyana* Cushman, 1932, p. 45, pl. 6, figs. 9, 10.

Type locality.—Waters around Great Britain; Recent.

Occurrence.—Occurs throughout the hole but abundant during interglacial periods (MIS 19, 15, and 9).

Remarks.—Our examined specimens show a tricarinated test with feeble discontinuous fine striations (Figure 17.3a, b) or staggered costae (Figure 17.4a, b) on the test surface and seem to make up a distinct morphological group. The lectotype (ZF3576, ex 96.8.13.32) of

Angulogerina angulosa (= *Uvigerina angulosa* Williamson, 1858), designated by Loeblich and Tappan (1964), was examined by SK at the British Museum (Natural History) and was covered by numerous discontinuous fine longitudinal costae except only the last chamber, which has a smooth surface. *Angulogerina carinata*, whether with a non-costate or sparsely costate test surface, has been regarded as a junior synonym of *A. angulosa* by researchers because of the considerable variability in the strength of costae (e.g. Hayward *et al.*, 1999, 2010).

Distribution.—This species occurs from the deep inner-shelf down to lower bathyal depths (25–2000 m) around New Zealand (Hayward *et al*., 1999, 2010).

Superfamily Fursenkoinoidea Loeblich and Tappan, 1961
Family Fursenkoinidae Loeblich and Tappan, 1961
Genus ***Fursenkoina*** Loeblich and Tappan, 1961
Fursenkoina sp. 1

Figure 16.5

Occurrence.—Sporadic. Very rare in the hole.

Remarks.—The specimen examined is characterised by its elongate test with twisted biserial chamber arrangement.

Genus ***Rutherfordoides*** McCulloch, 1981
Rutherfordoides rotundatus (Parr, 1950)

Figure 16.6

Virgulina rotundata Parr, 1950, p. 337, pl. 12, fig. 14.
Fursenkoina rotundata (Parr). Jones, 1994, p. 57, pl. 52, figs. 10, 11.
Rutherfordoides rotundata (Parr). Hayward *et al*., 2010, p. 200, pl. 20, figs. 20–23.

Type locality.—Off Tasmania, Tasman Sea, Southwest Pacific; Recent.

Occurrence.—Sporadic. Very rare to rare in the hole.

Distribution.—This species occurs at outer-shelf to upper abyssal depths (150–3000 m), mostly deeper than 400 m around New Zealand (Hayward *et al*., 2010).

Superfamily Discorboidea Ehrenberg, 1838
Family Discorbidae Ehrenberg, 1838
Genus ***Discorbis*** Lamarck, 1804
Discorbis aff. ***malovensis*** Heron-Allen and Earland, 1932

Figure 16.7

Aff. *Discorbis malovensis* Heron-Allen and Earland, 1932, p. 415, pl. 14, figs. 22–24; Boltovskoy *et al*., 1980, p. 27, pl. 11, figs. 13–15.

Type locality.—Off the Falkland Islands, Southwest Atlantic Ocean; Recent.

Occurrence.—Sporadic. Very rare to common in the hole.

Remarks.—The specimens examined resemble *Discorbis malovensis* Heron-Allen and Earland, 1932 in the convexity of their tests and very smooth test surface and flush sutures on the spiral side but they differ from the latter species by having little pustules on the umbilical side of the test, rather than the moderately pustular condition in *D. malovensis*. Boltovskoy *et al*. (1980) figured SEM images of a possible topotype of *D. malovensis* that shows numerous granules in the central part of the umbilical region and a flap extending from the umbilical margin of the last chamber over the umbilicus.

Distribution.—Heron-Allen and Earland (1932) reported *Discorbis malovensis* at inner- to middle-shelf depths (23–82 m) off the Falkland Islands.

Family Rosalinidae Reiss, 1963
Genus ***Gavelinopsis*** Hofker, 1951
Gavelinopsis hamata Vella, 1957

Figure 16.8

Gavelinopsis hamatus Vella, 1957, p. 35, pl. 9, figs. 177–180; Hayward *et al*., 1999, p. 140, pl. 10, figs. 12–14.

Type locality.—Cook Strait, New Zealand; Recent.

Occurrence.—Very rare and found only in MIS 2.

Remarks.—This species is distinguished from other *Gavelinopsis* species by its limbate, nearly flush sutures and numerous fine perforations on the spiral side of the test.

Distribution.—This species is endemic to New Zealand and is widespread in exposed to moderately sheltered and fully marine, inner- and middle-shelf environments (Hayward *et al*., 1999).

Gavelinopsis lobatula (Parr, 1950)

Figure 16.9

Discorbis lobatulus Parr, 1950, p. 354, pl. 13, figs. 23–25.
Gavelinopsis lobatulus (Parr). Barker, 1960, p. 182, pl. 88, fig. 1; Hermelin, 1989, p. 68, pl. 12, figs. 11–13.
Gavelinopsis lobatula (Parr). Jones, 1994, p. 94, pl. 88, fig. 1.
Discorbina isabelleana d'Orbigny. Brady, 1884, p. 646, pl. 88, fig. 1 (*non Rosalina isabelleana* d'Orbigny, 1839b).
Gavelinopsis praegeri (Heron-Allen and Earland). Todd, 1965, p. 18, pl. 8, fig. 1a–c; Kawagata, 1999, p. 26, fig. 6-5a–c (*non Discorbina praegeri* Heron-Allen and Earland, 1913).
"*Rotalia*" *transluscens* Phleger and Parker, 1951, p. 24, pl. 12, figs. 11a–12b; Phleger *et al*., 1953, p. 42, pl. 9, figs. 22, 23.

Type locality.—Off Tasmania, Tasman Sea, Southwest Pacific Ocean; Recent.

Occurrence.—Occurs almost throughout the core.

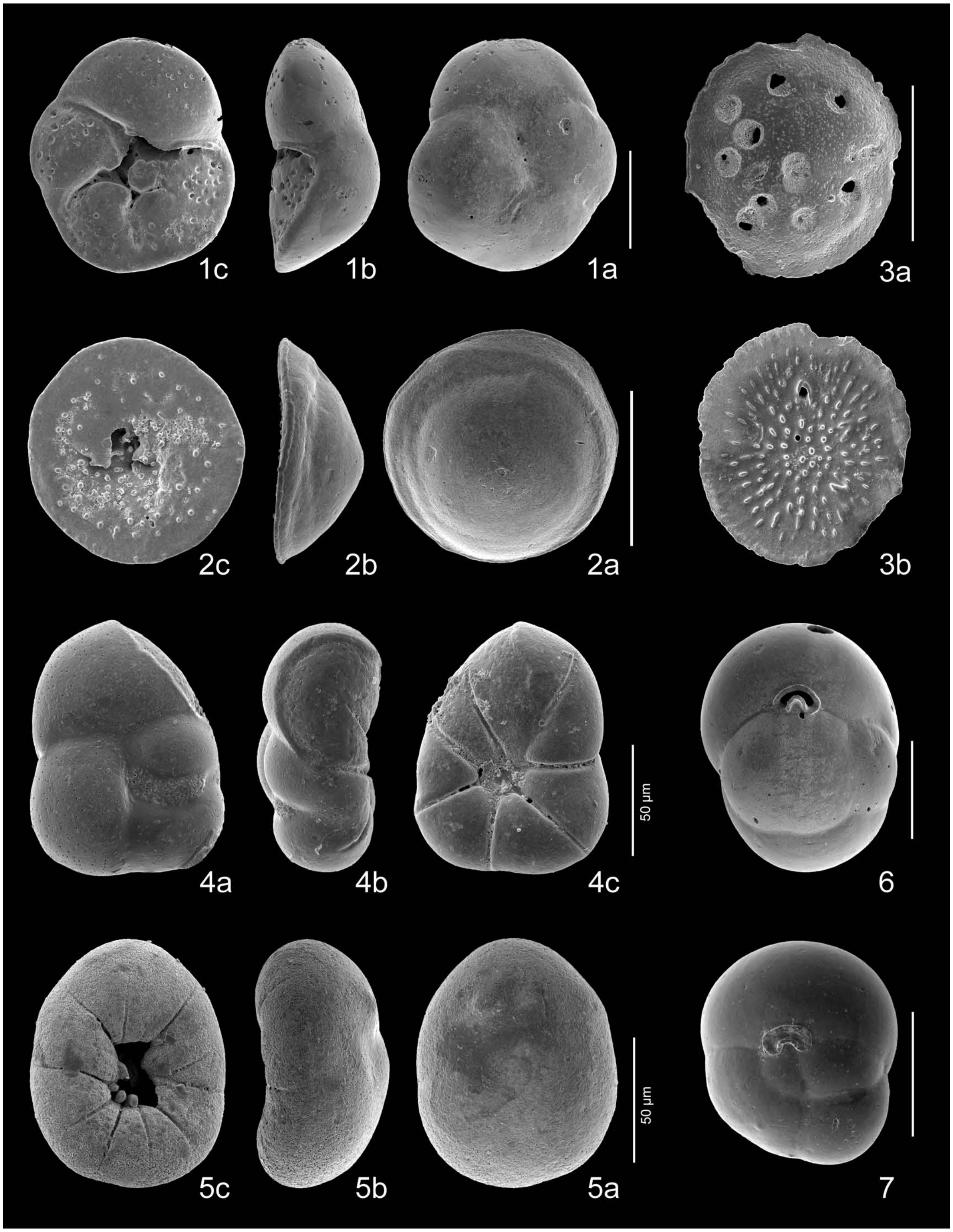

Figure 17. Photographs of benthic foraminifera from the Hole U1352B (15). Scale bars: 100 µm unless otherwise specified. **1,** *Gavelinopsis praegeri* (Heron-Allen and Earland), MPC-29029, Sample U1352B-10H-6-W, 19–21 cm; **2,** *Neoconorbina augur* (Hornibrook), MPC-29030, Sample U1352B-23H-7-W, 19–21 cm; **3,** *Rosalina vitrizea* Hornibrook, MPC-29031, Sample U1352B-18H-1-W, 94–96 cm; **4,** *Rotaliella chasteri* (Heron-Allen and Earland), MPC-29032, Sample U1352B-15H-6-W, 94–96 cm; **5,** *Rotaliella sabaae* Kawagata, sp. nov., Holotype, MPC-29033, Sample U1352B-8H-1-W, 19–21 cm; **6,** *Eusphaeroidina inflata* Ujiié, MPC-29034, Sample U1352B-18H-5-W, 94–96 cm; **7,** *Sphaeroidina bulloides* d'Orbigny, MPC-29035, Sample U1352B-11H-6-W, 94–96 cm.

Very rare to common in the hole.

Remarks.—*Gavelinopsis lobatula* has been regarded as conspecific with *Gavelinopsis praegeri* (= *Discorbina praegeri* Heron-Allen and Earland, 1913) by researchers (see synonym list in Kawagata, 1999). However, *G. lobatula* has a biconvex test with a distinctly keeled peripheral margin and nonpunctate test surface on the spiral side rather than the conical test with a usually thickened, noncarinate but subacute imperforate peripheral margin of *G. praegeri* (see Remarks on *G. praegeri*).

Distribution.—This species is widespread in the shallower waters of the tropical Pacific Ocean (Parr, 1950).

Gavelinopsis praegeri (Heron-Allen and Earland, 1913)

Figure 17.1

Discorbina praegeri Heron-Allen and Earland, 1913, p. 122, pl. 10, figs. 8–10.

Gavelinopsis praegeri (Heron-Allen and Earland). Hofker, 1951, p. 486, figs. 332–334; Hansen and Revets, 1992, p. 177, pl. 6, figs. 1–3, 7, 8; Hayward *et al*., 1999, p. 140, pl. 10, figs. 15–17; Hayward *et al*., 2010, p. 230, pl. 31, figs. 14–21.

Type locality.—Off Clare Island, Ireland; Recent

Occurrence.—Occurs almost throughout the hole. Very rare to abundant in the hole.

Remarks.—Hansen and Revets (1992) designated the lectotype of this species and figured it with SEM microphotographs. These revealed that this species is characterised by a low trochospiral test having a convex spiral side and nearly flat umbilical side, noncarinate but subacute imperforate peripheral margin bordered by minute perforations around the periphery on the umbilical side, and a large plug in the umbilicus.

Distribution.—This species is widespread at most water depths of the southwest Pacific Ocean (Hayward *et al*., 2010).

Genus ***Neoconorbina*** Hofker, 1951

Neoconorbina augur (Hornibrook, 1961)

Figure 17.2

Rosalina augur Hornibrook, 1961, p. 102, pl. 13, figs. 263, 265, 268.

Type locality.—North Canterbury, New Zealand; early Miocene.

Occurrence.—Sporadic. Very rare to rare in the hole.

Remarks.—The specimen treated here is comparable to the Miocene species *Rosalina augur* Hornibrook, 1961 in having a planoconical test with three chambers in the last whorl and minute pustules on the ventral side, except for a row of coarse pores along the spiral sutures.

Distribution.—This species has hitherto been reported only in the onland Miocene strata in the eastern part of South Island, New Zealand, which includes Canterbury (Hornibrook, 1961).

Genus ***Rosalina*** d'Orbigny, 1826

Rosalina vitrizea Hornibrook, 1961

Figure 17.3

Rosalina vitrizea Hornibrook, 1961, p. 101, pl. 13, figs. 264, 266, 269; Hayward *et al*., 1999, p. 143, pl. 11, figs. 9–11.

Type locality.—South bank of Wanganui River, New Zealand; Pleistocene.

Occurrence.—Sporadic. Very rare to rare in the hole.

Remarks.—The specimen examined is characterised by a planoconvex test (rounded and domed spiral side and flat umbilical side) with numerous minute papillae formed in a radial shape on the umbilical side rather than the combination of scattered minute papillae and larger papillae along the umbilical sutures seen in the type. Judging from its test size, we regard our species as a juvenile form of *Rosalina vitrizea*.

Family Rotaliellidae Loeblich and Tappan, 1964

Genus ***Rotaliella*** Grell, 1954

Rotaliella chasteri (Heron-Allen and Earland, 1913)

Figure 17.4

Discorbina chasteri Heron-Allen and Earland, 1913, p. 128, pl. 13, figs. 1–3 (new replacement name for *Discorbina minutissima* Chaster, 1892 (*fide* Ellis and Messina, 1940 *et seq.*)).

Discorbis chasteri (Heron-Allen and Earland). Cushman, 1931, p. 20, pl. 4, figs. 1–4.

Glabratella chasteri (Heron-Allen and Earland). Boltovskoy *et al*., 1980, p. 33, pl. 17, figs. 1–4.

Heronallenita ? *nana* Seiglie and Bermúdez, 1965, p. 61, pl. 10, figs. 5, 6.

Type locality.—Off Clare Island, Ireland; Recent.

Occurrence.—Very rare in the hole.

Remarks.—*Discorbina minutissima* Chaster, 1892 is a junior primary homonym of *Discorbina minutissima* Seguenza, 1880, and consequently Heron-Allen and Earland (1913) proposed *Discorbina chasteri* as a new replacement name for Chaster's (1892) species.

Distribution.—This species occurs at inner-shelf depths (0–20 m) in the embayment of Clare Island (Heron-Allen and Earland, 1913), and also occurs at shelf depths in the Southwest Atlantic Ocean (Boltovskoy *et al*., 1980).

Rotaliella sabaae Kawagata, sp. nov.

Figure 17.5

Diagnosis.—A minute species of *Rotaliella* consisting of an inornate, low trochospiral test with several radial grooves around the denticulate umbilicus.

Description.—Test very small, low trochospiral, slightly convex spiral side, concave umbilical side, circular in outline; chambers inflated, three in the last whorl; periphery broadly rounded; Sutures thin and flush on the spiral side, thin and depressed; wall calcareous, very thin, smooth, very finely perforate; Aperture umbilical in position with several denticulae around the umbilicus; Surface of umbilical side commonly with numerous thin radial grooves extending from the umbilicus to the peripheral margin.

Etymology.—Named for Ashwaq T. Sabaa who is an expert foraminiferal taxonomist in New Zealand.

Type locality.—U1352B-8H-1-W, 19–21 cm, Canterbury Basin, New Zealand, Southwest Pacific Ocean; Middle Pleistocene.

Type specimen.—Holotype (MPC-29033, Fig. 17.5a–c), maximum diameter 100 μm, maximum thickness 50 μm. Sample U1352B-8H-1-W, 19–21cm.

Occurrence.—Sporadic. Very rare in the hole.

Remarks.—This minute species resembles *Rotaliella heterocaryotica* Grell, 1954 (*fide* Ellis and Messina, 1940 *et seq.*) but differs in having a smooth test surface and flush sutures on the dorsal side and a nonlobulate test margin.

Family Sphaeroidinidae Cushman, 1927c

Genus ***Eusphaeroidina*** Ujiié, 1990

Eusphaeroidina inflata Ujiié, 1990

Figure 17.6

Eusphaeroidina inflata Ujiié, 1990, p. 29, pl. 11, figs. 6–12; Loeblich and Tappan, 1994, p. 141, pl. 289, figs. 4–13; Ujiié, 1995, p. 66, pl. 9, fig. 1; Kawagata, 1999, p. 27, fig. 6-7; Debenay, 2013, p. 238, pl. 21 (unnumbered).

Sphaeroidina bulloides d'Orbigny. Parker, 1964 (*non Sphaeroidina bulloides* d'Orbigny, 1826), p. 627, pl. 98, fig. 18; Corliss, 1979, p. 7, pl. 2, figs. 1, 2.

Type locality.—Off the Miyako Islands, Okinawa, northwestern Pacific Ocean; Quaternary.

Occurrence.—Sporadic. Very rare in the hole.

Remarks.—This species is distinguished from *Sphaeroidina bulloides* d'Orbigny, 1826 by its much more spherical chambers increasing rapidly in size and variable coiling axis in relation to the position of the aperture.

Distribution.—This species occurs on the middle-shelf (70 m) off New Caledonia, tropical Southwest Pacific Ocean (Debenay, 2013) and also occurs at middle-shelf and upper bathyal depths (*ca.* 71–314 m) in the Timor Sea (Loeblich and Tappan, 1994).

Genus ***Sphaeroidina*** d'Orbigny, 1826

Sphaeroidina bulloides d'Orbigny, 1826

Figure 17.7

Sphaeroidina bulloides d'Orbigny, 1826, p. 267, no. 65; Parker *et al*., 1865, pl. 2, fig. 58; Cushman and Todd, 1949, p. 13, pl. 3, figs. 8–11b; Ujiié, 1990, p. 28, pl. 11, figs. 3–5; Hayward *et al*., 1999, p. 144, pl. 11, figs. 15, 16; Hayward *et al*., 2010, p. 231, pl. 32, figs. 12, 13; Debenay, 2013, p. 249, pl. 21 (unnumbered); Holbourn *et al.*, 2013, p. 520, figs. 1–3.

Type locality.—Not designated; age not given.

Occurrence.—Sporadic. Very rare to rare in the hole.

Distribution.—This cosmopolitan species is widespread in middle-shelf to lower abyssal depths (50–5000 m), and is found frequently at outer-shelf to lower bathyal depths (100–1000 m) around New Zealand (Hayward *et al*., 2010).

Superfamily Glabratelloidea Loeblich and Tappan, 1964

Family Glabratellidae Loeblich and Tappan, 1964

Genus ***Pileolina*** Bermúdez, 1952

Pileolina patelliformis (Brady, 1884)

Figure 18.1

Discorbina patelliformis Brady, 1884, p. 647, pl. 88, fig. 3a–c (in part, not pl. 61, fig. 1).

Pileolina (?) *patelliformis* (Brady). Barker, 1960, p. 182, pl. 88, fig. 3a–c.

Glabratella patelliformis (Brady). Jones, 1994, p. 94, pl. 88, fig. 3a–c.

Pileolina patelliformis (Brady). Hayward *et al*., 1999, p. 147, pl. 12, figs. 10–12; Debenay, 2013, p. 208, pl. 14 (unnumbered).

Discorbinoides patelliformis (Brady). Akimoto *et al*., 2002, p. 19, pl. 50, fig. 3a–c.

Type locality.—Not designated; Recent.

Occurrence.—Very rare to very abundant in the hole, but sparsely occurs after MIS 11.

Remarks.—Most of the general morphology of the specimen examined here is identical to *Pileolina patelliformis*, including distinct tubercles in the central part of the flat umbilical side, but umbilical radial grooves are invisible.

Distribution.—This cosmopolitan species occurs at moderately sheltered inner-shelf depths under fully marine conditions around New Zealand (Hayward *et al*., 1999).

Pileolina radiata Vella, 1957

Figure 18.2

Pileolina radiata Vella, 1957, p. 36, pl. 8, figs. 170, 171; Hayward *et al*., 1999, p. 148, pl. 12, figs. 13–15.

Type locality.—Cook Strait, New Zealand, Southwest

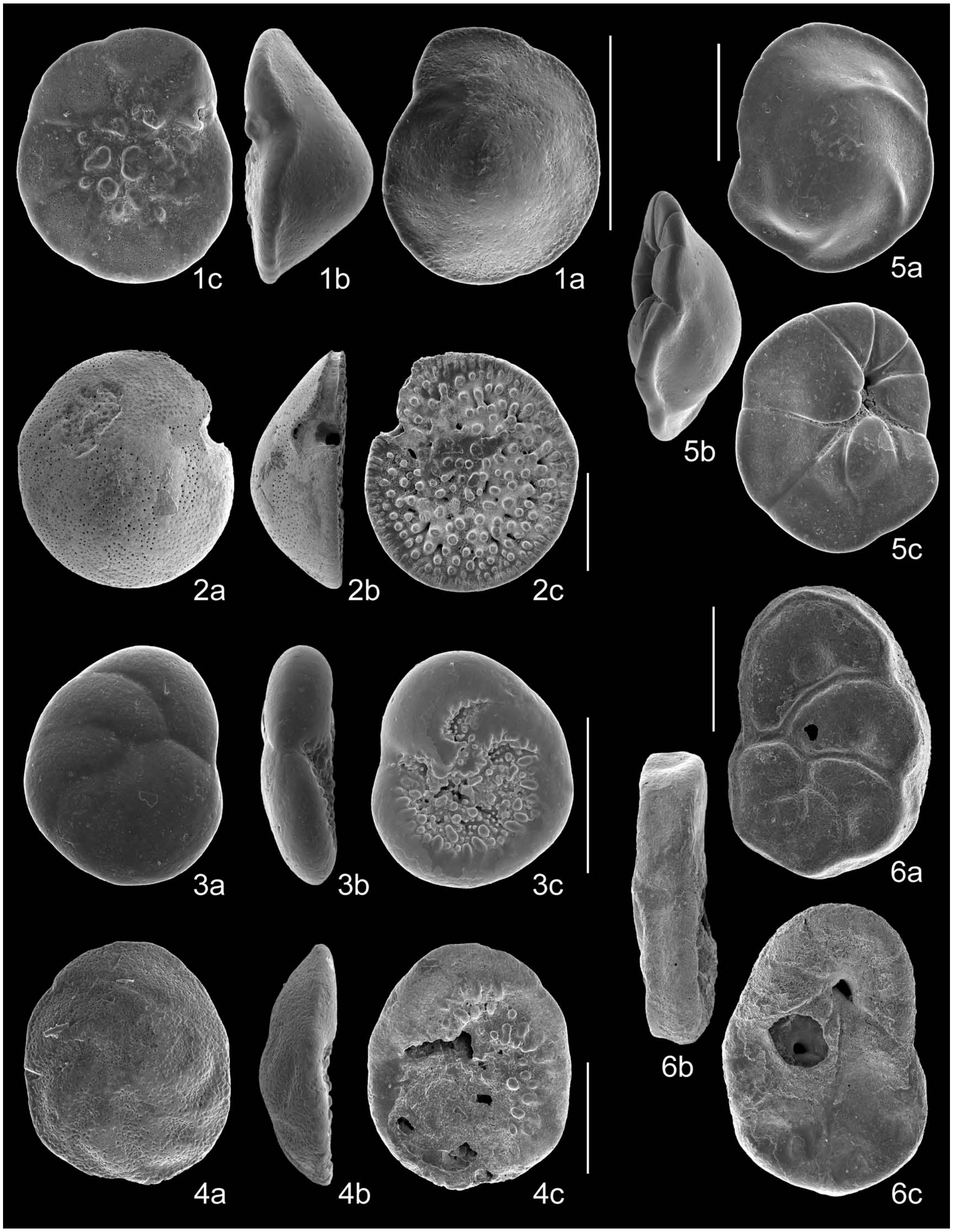

Figure 18. Photographs of benthic foraminifera from the Hole U1352B (16). Scale bars: 100 µm unless otherwise specified. **1,** *Pileolina patelliformis* (Brady), MPC-29036, Sample U1352B-1H-5-W, 19–21 cm; **2,** *Pileolina radiata* Vella, MPC-29037, Sample U1352B-1H-3-W, 94–96 cm; **3,** *Planoglabratella nimai* Yassini and Jones, MPC-29038, Sample U1352B-14H-3-W, 94–96 cm; **4,** *Planoglabratella opercularis* (d'Orbigny), MPC-29039, Sample U1352B-28H-3-W, 19–21 cm; **5,** *Heronallenia arubarensis* (McCulloch), MPC-29040, Sample U1352B-12H-6-W, 19–21 cm; **6,** *Heronallenia lingulata* (Burrows and Holland), MPC-29041, Sample U1352B-10H-6-W, 19–21 cm.

Pacific Ocean; Recent.

Occurrence.—Very rare and found only in MIS 2.

Remarks.—This species is distinguished from others by its flat umbilical test surface that is heavily covered with numerous pustules in combination with numerous fine radiating grooves at the periphery of the test.

Distribution.—This is an endemic species in New Zealand waters and commonly occurs in exposed or sheltered inner-shelf environments (0–40 m) under fully marine conditions (Hayward *et al*., 1999).

Genus ***Planoglabratella*** Seiglie and Bermúdez, 1965
Planoglabratella nimai Yassini and Jones, 1995

Figure 18.3

Planoglabratella nimai Yassini and Jones, 1995, p. 162, figs. 751, 752.

Type locality.—Windang Island, eastern Australia, Southwest Pacific Ocean; Recent.

Occurrence.—Sporadic. Very rare to rare in the hole.

Remarks.—The specimen examined shows a compressed planoconvex test with 7–8 chambers in the last coil, which are bordered by distinctly incised spiral sutures curving back to the periphery. The test surface is smooth on the spiral dorsal side and covered by numerous tubercles in the umbilical area and parts of the umbilical sutures, but lacks radial grooves extending towards its periphery from tubercles. Our specimen compares well with *Planoglabratella nimai*, but differs in having a rounded non-carinate periphery rather than a carinate one. We regard our species as a juvenile of *P. nimai*. This species differs from *Pileolina zealandica* Vella, 1957 that shows a domed planoconvex test with flush, very oblique spiral sutures and numerous tubercles and radial grooves on the umbilical side of the test.

Distribution.—Yassini and Jones (1995) reported *P. nimai* from the intertidal zone (2 m depth) in southeastern Australia.

Planoglabratella opercularis (d'Orbigny, 1826)

Figure 18.4

Rosalina opercularis d'Orbigny, 1826, p. 217, no. 7; d'Orbigny, 1839a, p. 93, pl. 3, figs. 24, 25, pl. 4, fig. 1.
Discorbina opercularis (d'Orbigny). Brady, 1884, p. 650, pl. 89, figs. 8, 9.
Discorbis opercularis (d'Orbigny). Asano, 1951b, p. 2, text-figs. 11–13.
Pileolina ? *opercularis* (d'Orbigny)?. Barker, 1960, p. 184, pl. 89, figs. 8, 9.
Glabratella opercularis (d'Orbigny). Matoba, 1970, p. 54, pl. 5, fig. 4a–c.
Planoglabratella opercularis (d'Orbigny). Jones, 1994, p. 95, pl. 89, figs. 8, 9; Hayward *et al*., 1999, p. 148, pl. 13, figs. 1–3; Debenay, 2013, p. 208, pl. 16 (unnumbered).

Type locality.—Not designated; Recent.

Occurrence.—Sparse. Very rare to rare in the hole.

Remarks.—The specimen examined shows distinct small papillae covering the centre of the umbilical region but because of preservation lacks numerous fine granules forming radial striations towards its periphery on the umbilical side of the test.

Distribution.—This species occurs in exposed to moderately sheltered, fully marine, inner-shelf environments around New Zealand (Hayward *et al*., 1999).

Family Heronalleniidae Loeblich and Tappan, 1986
Genus ***Heronallenia*** Chapman and Parr, 1931
Heronallenia arubaensis (McCulloch, 1981)

Figure 18.5

Neoheronallenia arubaensis McCulloch, 1981, p. 155, pl. 50, figs. 19–22.

Type locality.—Off Aruba, Caribbean Sea; Recent.

Occurrence.—Sporadic. Very rare in the hole.

Distribution.—This species occurs on the outer-shelf (*ca*. 140 m depth) off Aruba, Caribbean Sea (McCulloch, 1981).

Heronallenia lingulata (Burrows and Holland in Jones, 1895)

Figure 18.6

Discorbina lingulata Burrows and Holland in Jones, 1895, pl. 7, figs. 33a–c.
Heronallenia lingulata (Burrows and Holland). Hayward *et al*., 1999, pl. 13, figs. 4–6.

Type locality.—England; early Pliocene.

Occurrence.—Sporadic. Very rare to rare in the hole.

Remarks.—Sidebottom (1918) reported a similar form under the name of *Discorbina lingulata* var. *unguiculata* from mid-bathyal depths off Sydney, eastern Australia. However, it has more elevated costate sutures and a peripheral keel, instead of less raised ones as in *Heronallenia lingulata.*

Distribution.—This species occurs off the Snares Islands and Auckland Islands, south of South Island, New Zealand (Hayward *et al*., 1999).

Heronallenia pulvinulinoides (Cushman, 1915)

Figure 19.1

Discorbis pulvinulinoides Cushman, 1915, p. 23, pl. 6, fig. 3.
Heronallenia pulvinulinoides (Cushman). Dawson, 1992, p. 190; Hayward *et al*., 1999, pl. 13, figs. 7–9.

Type locality.—Off Japan, northwestern Pacific Ocean;

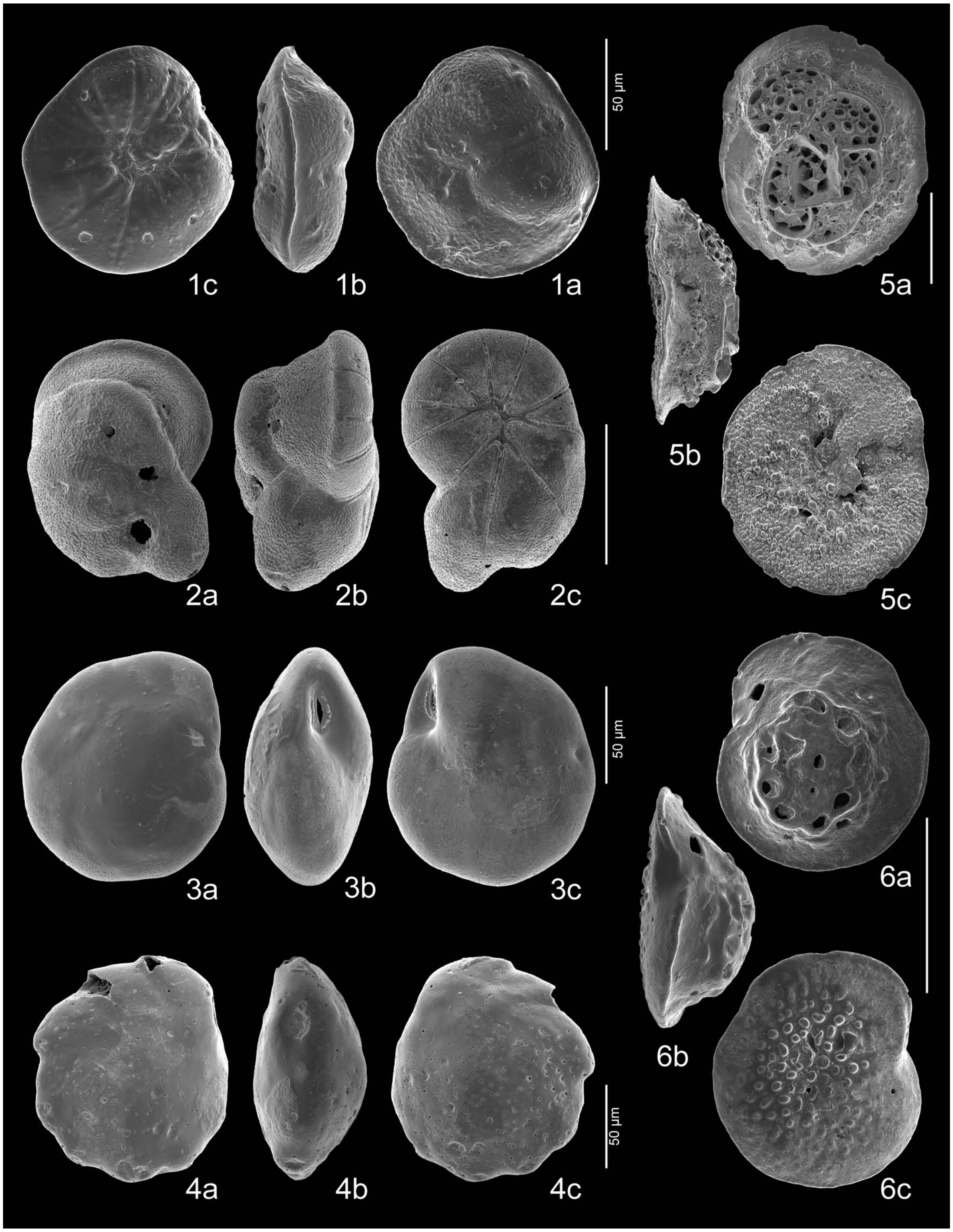

Figure 19. Photographs of benthic foraminifera from the Hole U1352B (17). Scale bars: 100 µm unless otherwise specified. **1,** *Heronallenia pulvinulinoides* (Cushman), MPC-29042, Sample U1352B-1H-5-W, 19–21 cm; **2,** *Fredsmithia laevigata* (Seiglie), MPC-29043, Sample U1352B-11H-3-W, 94–96 cm; **3,** *Pseudoparrella vitrea* (Parker), MPC-29044, Sample U1352B-2H-1-W, 94–96 cm; **4,** *Prionotolegna* sp. 1, MPC-29045, Sample U1352B-7H-6-W, 19–21 cm; **5, 6,** *Colonimilesia coronata* (Heron-Allen and Earland); 5, MPC-29046, Sample U1352B-21H-3-W, 94–96 cm; 6, juvenile, MPC-29047, Sample U1352B-7H-6-W, 19–21 cm.

Recent.

Occurrence.—Sparse. Very rare in the hole.

Distribution.—This species occurs in exposed or moderately sheltered inner- and middle-shelf environments under fully marine conditions (Hayward *et al*., 1999).

Family Buliminoididae Seiglie, 1970
Genus ***Fredsmithia*** McCulloch, 1977
Fredsmithia laevigata (Seiglie, 1964)

Figure 19.2

Buliminoides laevigata Seiglie, 1964, p. 507, pl. 4, figs. 7–9.
Fredsmithoides catalinaensis McCulloch, 1977, p. 384, pl. 103, fig. 24.

Type locality.—Off Los Testigos Islands, Venezuela, Caribbean Sea; Recent.

Occurrence.—Very rare and found only in MIS 7.

Remarks.—The genus *Fredsmithoides* McCulloch, 1977 is now considered to be a junior synonym of *Fredsmithia* McCulloch, 1977 (Loeblich and Tappan, 1987). The species examined compares well with *Fredsmithia catalinaensis* (= *Fredsmithoides catalinaensis* McCulloch, 1977) which is regarded here as a junior synonym of *Fredsmithia laevigata* (= *Buliminoides laevigata* Seiglie, 1964). The test surface of this species looks to be very smooth and without ornamentation under the optical microscope as formerly described by Seiglie (1964) and McCulloch (1977) but the SEM examination of our specimen reveals that it has a minutely crimped test surface except on the apertural face.

Distribution.—This species occurs in the shallow marine depth of 26 m off Venezuela, Caribbean Sea (Seiglie, 1964); and outer-shelf to upper bathyal depths (*ca.* 190–300 m) off California, Northeast Pacific Ocean (McCulloch, 1977).

Superfamily Discorbinelloidea Sigal, 1952
Family Pseudoparrellidae Voloshinova in Voloshinova and Dain, 1952
Subfamily Pseudoparrellinae Voloshinova in Voloshinova and Dain, 1952
Genus ***Pseudoparrella*** Cushman and ten Dam, 1948
Pseudoparrella vitrea (Parker in Phleger *et al*., 1953)

Figure 19.3

Epistominella vitrea Parker in Phleger *et al*., 1953, p. 9, pl. 4, figs. 34–36, 40, 41.
Eilohedra vitrea (Parker). Hayward *et al*., 1999, p. 150, pl. 13, figs. 14–16; Hayward *et al*., 2010, p. 228, pl. 31, figs. 1–5.

Type locality.—Gulf of Mexico; Recent.

Occurrence.—Very rare to very abundant in the hole and occurs significantly during early MIS 13.

Remarks.—Morphology of this species reveals that it belongs to the genus *Pseudoparrella*, which has a non-carinate biconvex trochospiral test with a narrow straight subequatorial slit aperture on the ventral side extending up the apertural face, parallel to the periphery of the test, and a distinct serrate apertural lip. These characters are distinguished from a keeled nearly planoconvex (flat spiral side) test with an unlipped narrow straight subequatorial slit aperture on the ventral side extending up the apertural face, parallel to the periphery of test as seen in *Epistominella* Husezima and Maruhasi, 1944, and an interiomarginal slit aperture extending vertically up the face of the last chamber near the periphery with a weak lip as seen in *Eilohedra* Lipps, 1965.

Distribution.—This species occurs in exposed and moderately sheltered environments at inner-shelf and bathyal depths (Hayward *et al*., 1999).

Subfamily Stetsoniinae Saidova, 1981
Genus ***Prionotolegna*** Loeblich and Tappan, 1994
Prionotolegna sp. 1

Figure 19.4

Prionotolegna sp. 1, Debenay, 2013, p. 231, pl. 20 (unnumbered).

Occurrence.—Rare and occurs only around the MIS 5/6 boundary.

Remarks.—This species is characterised by having a biconvex planispiral test with an inornate surface and a small rounded areal aperture, and differs from the type species *Prionotolegna paeminosa* Loeblich and Tappan, 1994, which has a roughly nodose test surface and a slit-like areal aperture.

Distribution.—This species occurs at a lower bathyal depth (600 m) on the northern shelf of New Caledonia, tropical southwestern Pacific Ocean (Debenay, 2013).

Family Discorbinellidae Sigal, 1952
Subfamily Discorbinellinae Sigal, 1952
Genus ***Colonimilesia*** McCulloch, 1977
Colonimilesia coronata (Heron-Allen and Earland, 1932)

Figures 19.5, 19.6

Discorbis coronata Heron-Allen and Earland, 1932, p. 416, pl. 14, figs. 25–30.
Parvicarinina coronata (Heron-Allen and Earland). Hornibrook, 1961, p. 118, pl. 15, figs. 310, 311, 318.
Colonimilesia coronata (Heron-Allen and Earland). Hayward *et al*., 1999, p. 151, pl. 13, figs. 23–25; Debenay, 2013, p. 192, pl. 17 (unnumbered).
Colonimilesia obscura McCulloch, 1977, p. 308, pl. 128, figs. 9–11; Loeblich and Tappan, 1994, p. 138, pl. 282, figs. 1–6, 13–15; Yassini and Jones, 1995, p. 167, figs. 860–862, 867.

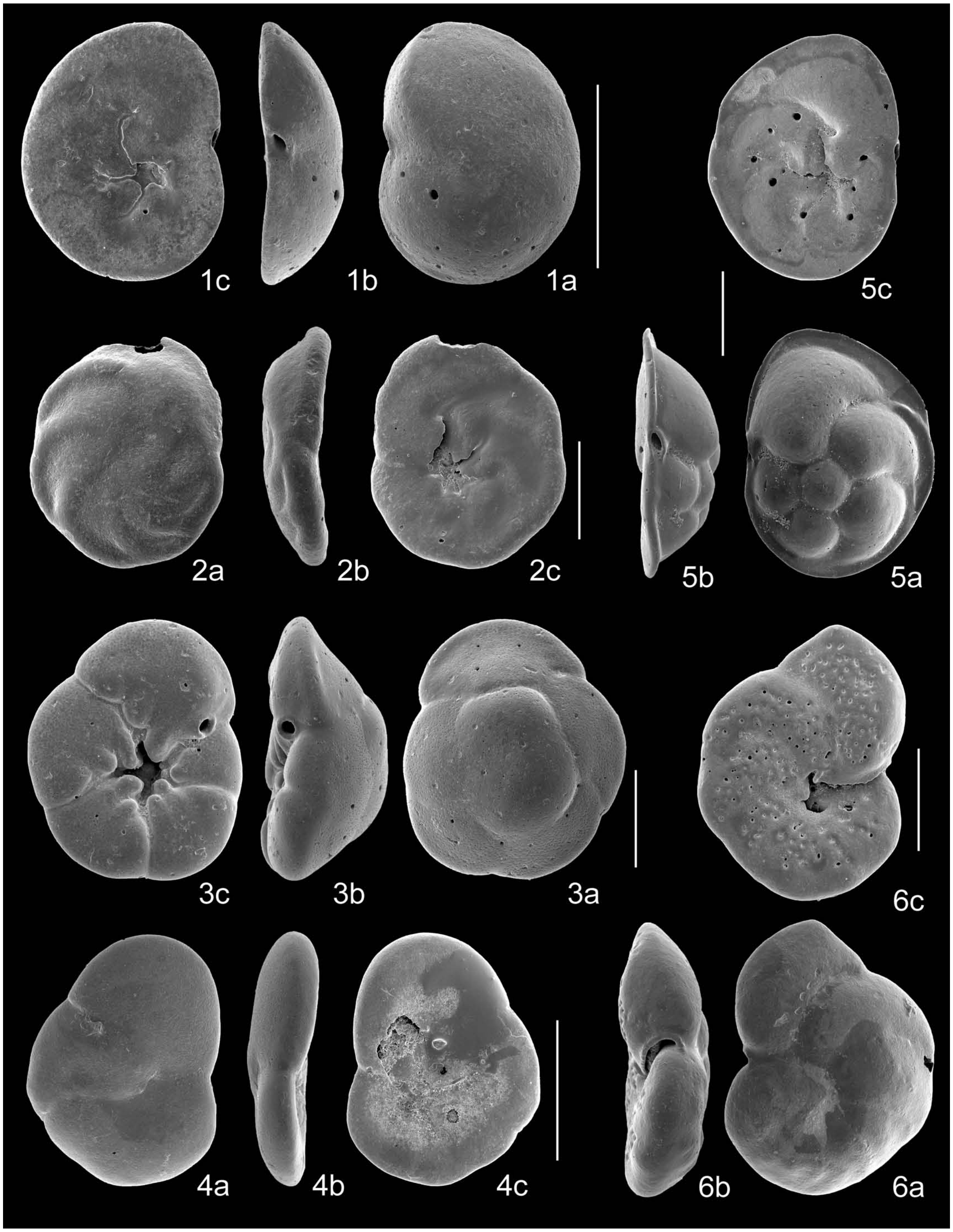

Figure 20. Photographs of benthic foraminifera from the Hole U1352B (18). Scale bars: 100 μm unless otherwise specified. **1,** *Discorbinella bertheloti* (d'Orbigny), MPC-29048, Sample U1352B-25H-1-W, 94–96 cm; **2,** *Discorbinella subcomplanata* (Parr), MPC-29049, Sample U1352B-16H-2-W, 94–96 cm; **3,** *Discorbinella vitrevoluta* (Hornibrook), MPC-29050, Sample U1352B-22H-5-W, 19–21 cm; **4,** *Discorbinella* sp. 1, MPC-29051, Sample U1352B-1H-5-W, 19–21 cm; **5,** *Laticarinina altocamerata* (Heron-Allen and Earland), MPC-29052, Sample U1352B-23H-2-W, 19–21 cm; **6,** *Planulina subinflata* Bandy, MPC-29053, Sample U1352B-14H-3-W, 94–96 cm.

Type locality.—Off the Falkland Islands and adjacent seas, subantarctic region; Recent.

Occurrence.—Sporadic. Very rare to rare in the hole.

Remarks.—This species has a conical, partially involute spiral side with tips of broken (?) chamber ends and a porous wall visible inside. Such a test morphology is more developed in adult species (Figure 19.5a–c), but not in the juvenile specimen (Figure 19.6a–c).

Distribution.—This species occurs in fully marine inner-shelf depths in New Zealand (Hayward *et al*., 2010); a coastal bay at 10 m depth off New Caledonia (Debenay, 2013); at outer-shelf to upper bathyal depths (118–304 m) off the Falkland Islands and adjacent seas, subantarctic region (Heron-Allen and Earland, 1932); inner-shelf (13–36 m) off Pilas and Bubnan islands in the Philippines (McCulloch, 1977); middle-shelf off the east coast of Australia (Yassini and Jones, 1995).

Genus ***Discorbinella*** Cushman and Martin, 1935

Discorbinella bertheloti (d'Orbigny, 1839c)

Figure 20.1

Rosalina bertheloti d'Orbigny, 1839c, p. 135, pl. 1, figs. 28–30.

Discorbinella bertheloti (d'Orbigny). Hayward *et al*., 1999, p. 152, pl. 14, figs. 1–3; Hayward *et al*., 2010, p. 211, pl. 24, figs. 4–6; Debenay, 2013, p. 194, pl. 16 (unnumbered).

Type locality.—Canary Islands, Northeast Atlantic Ocean; Recent.

Occurrence.—Occurs almost throughout the hole. Very rare to common in the hole.

Distribution.—This cosmopolitan species occurs in fully marine, deep inner-shelf to bathyal depths (30–2000 m) but occurs abundantly at middle-shelf to upper bathyal depths (50–600 m) around New Zealand (Hayward *et al*., 2010).

Discorbinella subcomplanata (Parr, 1950)

Figure 20.2

Discorbis subcomplanatus Parr, 1950, p. 355, pl. 14, figs. 1, 2.

Discorbinella subcomplanata (Parr). Hayward *et al*., 1999, p. 153, pl. 14, figs. 10–12; Hayward *et al*., 2010, p. 212, pl. 24, figs. 10–12.

Type locality.—Antarctic Ocean; Recent.

Occurrence.—Sporadic. Very rare to common in the hole.

Remarks.—This species is distinguished from *Discorbinella complanata* (= *Discorbina bertheloti* var. *complanata* Sidebottom, 1918) by its less compressed plano-convex test, a truncated and rounded periphery, and raised limbate spiral sutures, rather than a compressed plano-convex test with a carinate periphery.

Distribution.—This species occurs in inner- to middle-shelf under fully marine conditions around New Zealand (Hayward *et al*., 1999).

Discorbinella vitrevoluta (Hornibrook, 1961)

Figure 20.3

Rosalina vitrevoluta Hornibrook, 1961, p. 102, pl. 13, figs. 275–277.

Discorbinella vitrevoluta (Hornibrook). Hayward *et al*., 1999, p. 153, pl. 14, figs. 16–18.

Type locality.—Near Oamaru, Canterbury, New Zealand; early Miocene.

Occurrence.—Sporadic. Very rare to Abundant in the hole.

Remarks.—General test morphology of our species is identical to *Discorbinella vitrevoluta*, and our species shows distinct small projections extending into the umbilical depression from each chamber, rather than filled with small papillae in the central portion of the umbilicus as described by Hornibrook (1961) or weakly developed umbilical projections for a possible juvenile specimen (Bruce W. Hayward, personal communication).

Distribution.—This species occurs in sheltered fully marine, shallow water bay and exposed, inner-shelf coastal waters around New Zealand (Hayward *et al*., 1999).

Discorbinella sp. 1

Figure 20.4

Occurrence.—Sporadic. Very rare to rare in the hole.

Remarks.—The species examined here is characterised by its compressed plano-convex non-carinate test, with chambers involutedly coiled on the umbilical side and partially involute on the spiral side.

Genus ***Laticarinina*** Galloway and Wissler, 1927

Laticarinina altocamerata (Heron-Allen and Earland, 1922)

Figure 20.5

Truncatulina tenuimargo var. *altocamerata* Heron-Allen and Earland, 1922, p. 209, pl. 7, figs. 24–27.

Parvicarinina altocamerata (Heron-Allen and Earland). Hornibrook, 1961, p. 118, pl. 14, figs. 296, 199, 301, 302, 305.

Laticarinina altocamerata (Heron-Allen and Earland). Hayward and Buzas, 1979, p. 62, pl. 19, figs. 242, 243; Hayward *et al*., 2010, p. 212, pl. 24, figs. 16–18.

Type locality.—Off North Island, New Zealand, Southwest pacific Ocean; Recent.

Occurrence.—Scarce. Very rare in the hole.

Distribution.—This species is restricted to outer-shelf to bathyal depths (130–2000 m), mostly shallower than 1500 m around New Zealand (Hayward *et al*., 2010;

Heron-Allen and Earland, 1922).

Family Planulinidae Bermúdez, 1952
Genus ***Planulina*** d'Orbigny, 1826
Planulina subinflata Bandy, 1949

Figure 20.6

Planulina subinflata Bandy, 1949, p. 113, pl. 18, fig. 1a–c.
Planulina aff. *subinflata* Bandy. Ujiié, 1990, p. 35, pl. 15, figs. 4–6; Kawagata, 1999, p. 32, fig. 8-3a–c.

Type locality.—Alabama, USA; middle Oligocene.
Occurrence.—Rarely occurs only in MIS 10.
Distribution.—Kawagata (1999) reported this species from late Quaternary deep-sea core sediments collected from lower bathyal depths (*ca*. 1158–1338 m) on the Lord Howe Rise in the Tasman Sea, Southwest Pacific Ocean.

Family Cibicididae Cushman, 1927c
Subfamily Cibicidinae Cushman, 1927c
Genus ***Cibicides*** de Montfort, 1808
Cibicides dispars (d'Orbigny, 1839b)

Figure 21.1

Truncatulina dispars d'Orbigny, 1839b, p. 38, pl. 5, figs. 25–27.
Cibicides dispars (d'Orbigny). Hayward *et al*., 1999, p. 154, pl. 14, figs. 22–24.
Cibicides dispars s.l. (d'Orbigny). Hayward *et al*., 2010, p. 208, pl. 22, figs. 4–9.

Type locality.—Off Falkland Islands, Southwest Atlantic Ocean; Recent.
Occurrence.—Occurs almost throughout the hole. Very rare to abundant in the hole.
Remarks.—The species examined is less perforate, on involute side in particular, than species from the shallow-water in New Zealand as seen in Hayward *et al*. (1999).
Distribution.—This species occurs in moderately sheltered to exposed, inner- and middle-shelf environments under fully marine conditions around New Zealand (Hayward *et al*., 1999).

Cibicides lobatulus (Walker and Jacob in Kanmacher, 1798)

Figure 21.2

Nautilus lobatulus Walker and Jacob in Kanmacher, 1798, p. 642, pl. 14, fig. 36.
Truncatulina lobatula (Walker and Jacob). Brady, 1884, p. 660, pl. 92, fig. 10, pl. 93, fig. 1 (? figs, 4, 5).
Cibicides lobatulus (Walker and Jacob). Barker, 1960, p. 190, fig. 10, pl. 93, fig. 1 (? figs. 4, 5); Boltovskoy *et al*., 1980, p. 24, pl. 9, figs. 1–4; Hayward *et al*., 2010, p. 209, pl. 22, figs. 10–12; Holbourn *et al*., 2013, p. 153, figs. 1–3.
Lobatula lobatulus (Walker and Jacob). Akimoto *et al*., 2002, p. 20, pl. 54, fig. 4a–c; Debenay, 2013, p. 2001, pl. 16 (unnumbered).

Type locality.—Kent, England, Northeast Atlantic Ocean; Recent.
Occurrence.—Sporadic. Very rare to rare in the hole.
Distribution.—This cosmopolitan species occurs at inner-shelf depths around New Zealand (Hayward *et al*., 2010).

Cibicides marlboroughensis Vella, 1957

Figure 21.3

Cibicides marlboroughensis Vella, 1957, p. 40, pl. 9, figs. 189–191; Hayward *et al*., 1999, p. 155, pl. 14, figs. 25–27.

Type locality.—Off New Zealand, Southwest Pacific Ocean; Recent.
Occurrence.—Sparse. Very rare in the hole.
Remarks.—*Cibicides marlboroughensis* is a medium- to large-sized species for the genus. Chambers partly overlap the preceding whorl on the spiral side and form a slightly inflated spiral side, but the test is not a biconvex one like in *Cibicidoides* Thalmann, 1939. This species was synonymised with *Cibicides dispars* (= *Truncatulina dispars* d'Orbigny, 1839b) by Hayward *et al*. (2010) but differs in having a carinate periphery and limbate sutures on the dorsal and ventral sides, becoming less limbate towards the last chamber.
Distribution.—This species is possibly endemic in New Zealand shallow waters, occurring at middle-shelf to upper bathyal depths, but is mostly common at inner-shelf depths in sheltered bays (Hayward *et al*., 1999).

Cibicides variabilis (d'Orbigny, 1826)

Figure 21.4

Truncatulina variabilis d'Orbigny, 1826, p. 279.
Cibicidiella variabilis (d'Orbigny). Cushman, 1927c, p. 93, pl. 20, fig. 5; Cushman, 1931, p. 127, pl. 24, fig. 3; Loeblich and Tappan, 1964, p. C690, fig. 554-7a–c; Le Calvez, 1974, p. 96, pl. 25, figs. 1–4.
Cibicides variabilis (d'Orbigny). Boltovskoy *et al*., 1980, p. 25, pl. 9, figs. 12–17; Hayward *et al*., 2010, p. 210, pl. 23, figs. 14–16.

Type locality.—Adriatic Sea; Recent.
Occurrence.—Sporadic. Very rare to rare in the hole.
Remarks.—*Truncatulina variabilis* was originally proposed by d'Orbigny (1826) without figures and descriptions, but was validated by d'Orbigny's reference to figures in Soldani (1798) (ICZN Art. 12.1, 12.2.1, 12.2.7).
Distribution.—This species is widespread in New Zealand, but occurs more abundantly off the east coast of the South Island at middle-shelf to lower bathyal depths

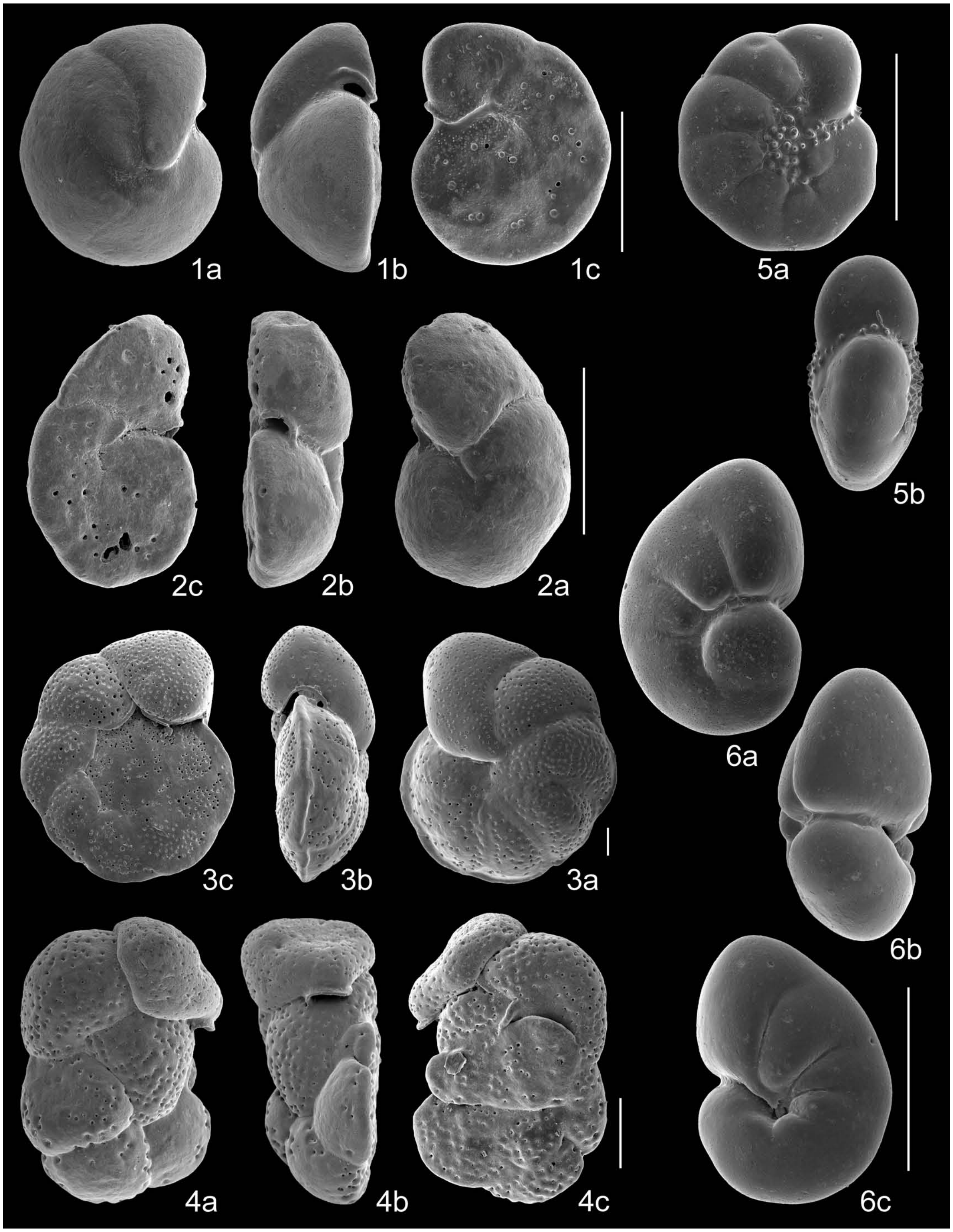

Figure 21. Photographs of benthic foraminifera from the Hole U1352B (19). Scale bars: 100 μm unless otherwise specified. **1,** *Cibicides dispars* (d'Orbigny), MPC-29054, Sample U1352B-12H-6-W, 19–21 cm; **2,** *Cibicides lobatulus* (Walker and Jacob), MPC-29055, Sample U1352B-8H-1-W, 19–21 cm; **3,** *Cibicides marlboroughensis* Vella, MPC-29056, Sample U1352B-13H-4-W, 19–21 cm; **4,** *Cibicides variabilis* (d'Orbigny), MPC-29057, Sample U1352B-17H-4-W, 90–92 cm; **5,** *Haynesina depressula* (Walker and Jacob), MPC-29058, Sample U1352B-13H-4-W, 19–21 cm; **6,** *Nonionella auris* (d'Orbigny), MPC-29059, Sample U1352B-9H-3-W, 19–21 cm.

(50–2000 m) (Hayward *et al*., 2010).

Family Nonionidae Schultze, 1854
Subfamily Nonioninae Schultze, 1854
Genus ***Haynesina*** Banner and Culver, 1978

Haynesina depressula (Walker and Jacob in Kanmacher, 1798)

Figure 21.5

Nautilus depressulus Walker and Jacob in Kanmacher, 1798, p. 641, pl. 14, fig. 33.
Haynesina depressula (Walker and Jacob). Hayward *et al*., 1999, p. 158, pl. 15, figs. 10, 11.
Elphidinonion simplex aoteanum Vella, 1957, p. 38, pl. 9, figs. 185, 186.

Type locality.—Reculver, Kent, England; Recent.
Occurrence.—Sporadic. Very rare to rare in the hole.
Remarks.—This species has a minute test showing a planispiral and slightly evolute chamber arrangement, slightly depressed sutures, and scattered fine tubercles in the umbilical region and inner margins of the chambers, but no retral processes. Taking its small test size into account, we regards our specimen as a juvenile of *Haynesina depressula* that is characterised by deeply incised sutures and a large umbilicus filled with dense tubercules.
Distribution.—This species is very rare in the brackish part of an estuary. It occurs abundantly in the sheltered, very slightly brackish seaward part of enclosed harbours and inlets in low tidal or subtidal environments (*ca*. 0–20 m) around New Zealand.

Genus ***Nonionella*** Cushman, 1926

Nonionella auris (d'Orbigny, 1839b)

Figure 21.6

Valvulina auris d'Orbigny, 1839b, p. 47, pl. 2, figs. 15–17.
Nonionella auris (d'Orbigny). Cushman, 1933, p. 45, pl. 10, fig. 10a–c, pl. 11, fig. 1a–c (in part, not pl. 10, fig. 11a–c).
Nonionoides auris (d'Orbigny). Loeblich and Tappan, 1994, p. 158, pl. 345, figs. 5–16.

Type locality.—Not designated?; Recent.
Occurrence.—Occurs almost throughout the hole. Very rare to abundant in the hole.
Remarks.—This species is characterised by the last chamber extending over the umbilicus on the umbilical side. Our figured specimen shows a very small test with a tiny umbilical extension of the chambers and a large proloculus visible on the spiral side, which is often seen in the young specimens (e.g. Hayward *et al*., 2010).
Distribution.—This species occurs at upper bathyal to lower abyssal depths (200–5000 m) around New Zealand (Hayward *et al*., 2010).

Nonionella magnalingua Finlay, 1940

Figure 22.1

Nonionella magnalingua Finlay, 1940, p. 456, pl. 65, figs. 144, 146; Hornibrook, 1961, p. 94, pl. 12, figs. 226, 232, 233; Dawson, 1992, p. 199; Hayward *et al*., 1999, p. 158, pl. 15, figs. 12, 13.

Type locality.—Not designated, New Zealand; middle Miocene.
Occurrence.—Sporadic. Very rare to rare in the hole.
Remarks.—The most distinguishable features of this species is the last chamber that forms a large inflated lobe-like extension over the umbilicus.
Distribution.—This species is an endemic to New Zealand and is common at deep inner-shelf to mid-bathyal depths under marine conditions (Hayward *et al*., 2010).

Genus ***Nonionellina*** Voloshinova, 1958

Nonionellina flemingi (Vella, 1957)

Figure 22.2

Nonion flemingi Vella, 1957, p. 37, pl. 9, figs. 183, 184.
Nonionellina flemingi (Vella). Hayward *et al*., 1999, p. 159, pl. 15, figs. 14–15; Hayward *et al*., 2010, p. 224, pl. 29, figs. 9, 10.

Type locality.—Off the Auckland Islands, New Zealand, Southwest Pacific Ocean; Recent.
Occurrence.—Occurs almost throughout the examined section. Abundant during MIS 13 and 6.
Remarks.—This species is distinguished from other allied species by its planispiral test with a narrow furcated lobe-like extension from the last chamber covering over the umbilicus on each side of the test.
Distribution.—This species is an endemic to New Zealand and occurs at middle-shelf to bathyal depths, and is also abundant at inner-shelf depths (20–50 m) in inlets or sounds (Hayward *et al*., 1999).

Genus ***Nonionoides*** Saidova, 1975

Nonionoides grateloupi (d'Orbigny, 1839a)

Figure 22.3

Nonionina grateloupi d'Orbigny, 1826, p. 294 (*nomen nudum*); d'Orbigny, 1839a, p. 46, pl. 6, figs. 6–7.
Nonionoides grateloupi (d'Orbigny). Hayward *et al*., 2010, p. 225, pl. 29, figs. 11–14.

Type locality.—Off Cuba, Caribbean Sea; Recent.
Occurrence.—Sporadic. Very rare to rare in the hole.
Distribution.—This cosmopolitan species occurs at outer-shelf to bathyal depths (100–2000 m), and is mostly common at lower bathyal depths (1000–2000 m) around New Zealand (Hayward *et al*., 2010).

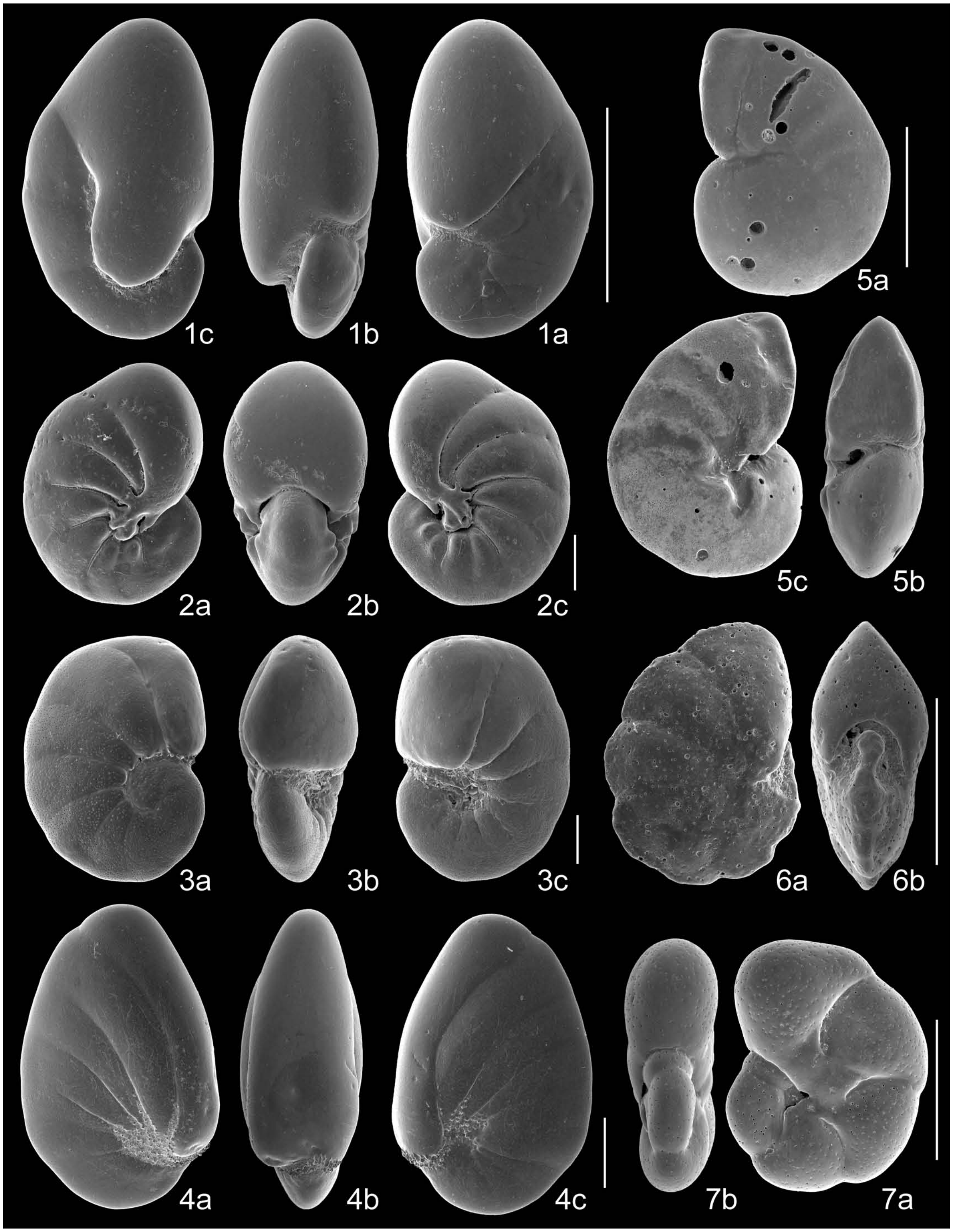

Figure 22. Photographs of benthic foraminifera from the Hole U1352B (20). Scale bars: 100 μm unless otherwise specified. **1,** *Nonionella magnalingua* Finlay, MPC-29060, Sample U1352B-1H-5-W, 19–21 cm; **2,** *Nonionellina flemingi* (Vella), MPC-29061, Sample U1352B-1H-3-W, 94–96 cm; **3,** *Nonionoides grateloupii* (d'Orbigny), MPC-29062, Sample U1352B-14H-3-W, 94–96 cm; **4,** *Nonionoides turgida* (Williamson), MPC-29063, Sample U1352B-1H-5-W, 19–21 cm; **5,** *Pseudononion chiliensis* (Cushman and Kellett), MPC-29064, Sample U1352B-11H-3-W, 94–96 cm; **6,** *Subanomalina pauperata* (Balkwill and Wright), MPC-29065, Sample U1352B-13H-4-W, 19–21 cm; **7,** *Laminononion tumidum* (Cushman and Edwards), MPC-29066, Sample U1352B-11H-6-W, 94–96 cm.

Nonionoides turgida (Williamson, 1858)

Figure 22.4

Rotalina turgida Williamson, 1858, p. 50, pl. 4, fig. 95–97.
Nonionoides turgida (Williamson). Haynes, 1973, p. 213, pl. 22, fig. 12, text-fig. 45, no. 4; Dawson, 1992, p. 199; Hayward *et al*., 1999, p. 159, pl. 15, figs. 16, 17; Debenay, 2013, p. 228, pl. 19 (unnumbered); Holbourn *et al*., 2013, p. 372, figs. 1, 2.

Type locality.—Waters around Great Britain; Recent.

Occurrence.—Very rare and found in MIS 2 and at around the MIS 1/2 boundary.

Remarks.—This species differs from other related species in having the last chamber almost the full length of the test.

Distribution.—This species occurs at inner-shelf to bathyal depths under fully marine conditions around New Zealand (Hayward *et al*., 1999).

Genus ***Pseudononion*** Asano, 1936a

Pseudononion chiliensis (Cushman and Kellett, 1929)

Figure 22.5

Nonionella chiliensis Cushman and Kellett, 1929, p. 6, pl. 2, fig. 4a–c; Boltovskoy *et al*., 1980, p. 40, pl. 22, figs. 13–16.
Nonionella chiliensis (?) Cushman and Kellett. Heron-Allen and Earland, 1932, p. 438, pl. 16, figs. 11–13.

Type locality.—Off Corral, Chile, Southeast Pacific Ocean; Recent.

Occurrence.—Very rare and found at only in MIS 7.

Remarks.—General test morphology of this species corresponds to the genus *Pseudononion* Asano, 1936a.

Distribution.—This species has been reported from shallow waters off the Chilean coast, and at a depth of 191 m between the Falkland Islands and the Straits of Magellan in the Southwest Atlantic Ocean (Heron-Allen and Earland, 1932).

Genus ***Subanomalina*** McCulloch, 1977

Subanomalina pauperata (Balkwill and Wright, 1885)

Figure 22.6

Nonionina pauperata Balkwill and Wright, 1885, p. 353, pl. 13, figs. 25, 26 (*fide* Ellis and Messina, 1940 *et seq*.).
Florilus pauperatus (Balkwill and Wright). Boltovskoy *et al*., 1980, p. 33, pl. 16, figs. 15–18.
Florilus? *pauperatus* (Balkwill and Wright). Oki, 1989, p. 147, pl. 20, fig. 3a–d.
Nonion pauperata (Balkwill and Wright). Akimoto *et al*., 2002, p. 24, pl. 59, fig. 4a–c.
Nonion pauperatum (Balkwill and Wright). Debenay, 2013, p. 227, pl. 19 (unnumbered).
Nonion cassidulinoides Hornibrook, 1961, p. 92, pl. 11, figs. 214, 215; Li *et al*., 1996, pl. 1, figs. 9, 10.
Subanomalina guadalupensis McCulloch, 1977, p. 444, pl. 180, figs. 18, 19.
Nonionellina sp., Akimoto, 1990, pl. 18, fig. 11a, b.
Linaresia sp., Loeblich and Tappan, 1994, p. 165, pl. 343, figs. 10–12.
Carinomelonis helenae Ujiié, 1995, p. 70, pl. 12, figs. 3–5.

Type locality.—Off Lambay Island, Ireland, northern North Atlantic Ocean; Recent.

Occurrence.—Sporadic. Very rare to rare in the hole.

Remarks.—The specimen examined here is characterised by a lenticular, planispiral and involute test with carinate periphery, minute perforations around the periphery. A number of researchers have regarded this species as belonging to various genera, but *Subanomalina* differs from *Nonion* de Montfort, 1808 by the presence of an umbo on both sides of the test, rather than umbilici, and from *Linaresia* González-Donoso, 1968 by having a planispiral test, rather than a slight trochospiral test. *Florilus* de Montfort, 1808 was suppressed and is an unavailable genus name for foraminifera (Loeblich and Tappan, 1987).

Distribution.—This species occurs at middle-shelf depth (*ca*. 90 m) in the North Atlantic Ocean (Balkwill and Wright, 1885), outer-shelf depth (*ca.* 180 m) off California in the Northeast Pacific Ocean (McCulloch, 1977), off Japan in the northwestern Pacific Ocean (Akimoto, 1990), and on the middle-shelf (*ca*. 62 m depth) in the Timor Sea off northern Australia (Loeblich and Tappan, 1994).

Subfamily Astrononioninae Saidova, 1981

Genus ***Laminononion*** Hornibrook, 1964

Laminononion tumidum (Cushman and Edwards, 1937)

Figure 22.7

Astrononion tumidum Cushman and Edwards, 1937, p. 33, pl. 3, fig. 17; Cushman, 1939, p. 37, pl. 10, fig. 11.
Astrononion (*Laminononion*) *tumidum* (Cushman and Edwards). Hornibrook, 1964, p. 335, pl. 1, figs. 10–13.
Laminononion tumidum (Cushman and Edwards). Loeblich and Tappan, 1987, p. 620, pl. 694, figs. 16–19; Loeblich and Tappan, 1994, p. 159, pl. 346, figs. 8, 9 (? figs. 5, 6).
Laminononion tumidulum [*sic*] (Cushman and Edwards). Kawagata, 1999, p. 33, fig. 9-2a–c; Kawagata, 2001, p. 103, fig. 13-5a, b.

Type locality.—Off Ascension Island, central tropical South Atlantic Ocean; Recent.

Occurrence.—Sporadic. Very rare to common in the hole.

Remarks.—This species is the type species of the genus and is characterised by a compressed planispiral and involute test with a subtriangular plate extending from each chamber and fusing together, covering the umbilical area.

Distribution.—Kawagata (1999) reported this species from late Quaternary core sediments collected from

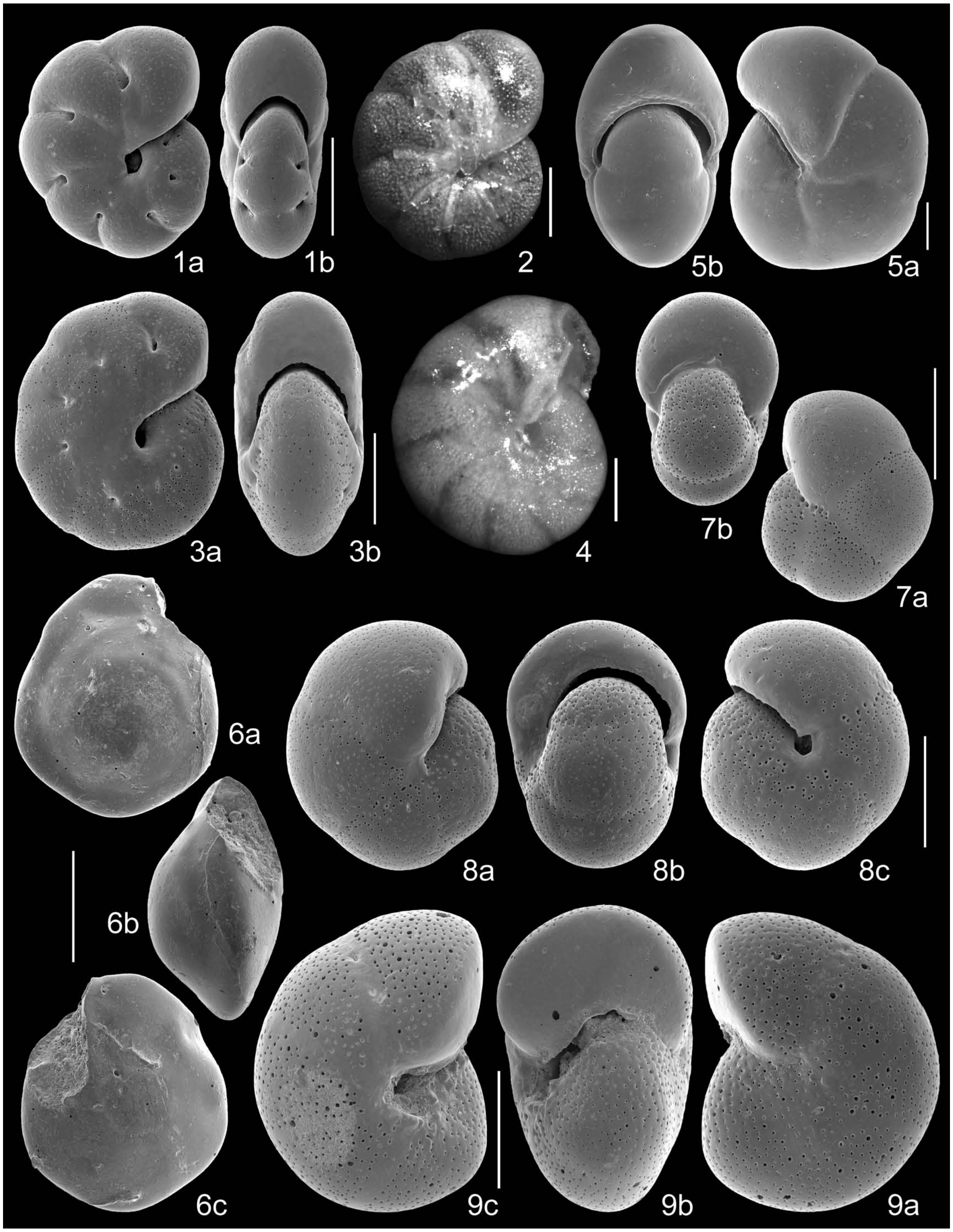

Figure 23. Photographs of benthic foraminifera from the Hole U1352B (21). Scale bars: 100 μm unless otherwise specified. **1, 2,** *Pacinonion minutus* Ujiié; 1, MPC-29067, Sample U1352B-14H-6-W, 19–21 cm; 2, MPC-29068, Sample U1352B-1H-1-W, 19–21 cm; **3, 4,** *Pacinonion novozealandicum* (Cushman and Edwards); 3, MPC-29069, Sample U1352B-18H-5-W, 94–96 cm; 4, MPC-29070, Sample U1352B-14H-3-W, 94–96 cm; **5,** *Pullenia quinqueloba* (Reuss), MPC-29071, Sample U1352B-29H-1-W, 94–96 cm; **6,** *Oridorsalis umbonatus* (Reuss), MPC-29072, Sample U1352B-13H-1-W, 93–95 cm; **7–9,** *Anomalinoides sphericus* (Finlay), 7, juvenile, MPC-29073, Sample U1352B-13H-4-W, 19–21 cm, 8, MPC-29074, Sample U1352B-12H-6-W, 19–21 cm, 9, MPC-29075, Sample U1352B-7H-6-W, 94–96 cm.

lower bathyal depths (1158–1338 m) on the Lord Howe Rise in the Tasman Sea, Southwest Pacific Ocean.

Genus *Pacinonion* Vella, 1962
Pacinonion minutus Ujiié, 1995

Figures 23.1, 23.2

Pacinonion minutus Ujiié, 1995, p. 69, pl. 11, fig. 5a, b; Kawagata, 1999, p. 34, fig. 9-3.

Type locality.—Off the Ryukyu Islands, Northwest Pacific Ocean; Recent.

Occurrence.—Occurs almost throughout the hole. Very rare to abundant in the hole.

Remarks.—Specimens of this minute-sized species from the deep sea in the Tasman Sea (Kawagata, 1999) show a very finely perforated test surface rather than a coarsely perforated one seen in specimens from the Ryukyu Islands region (Ujiié, 1995). Such variations in mode of perforation are regarded here as intraspecific differences for this species.

Distribution.—This species occurs at mid-bathyal to mid-abyssal depths around the Ryukyu Island Arc region in the northwestern Pacific Ocean (Ujiié, 1995). Kawagata (1999) also reported this species from late Quaternary core sediments collected from lower bathyal depths (1158–1338 m) on the Lord Howe Rise in the Tasman Sea, Southwest Pacific Ocean.

Pacinonion novozealandicum (Cushman and Edwards, 1937)

Figures 23.3, 23.4

Astrononion novozealandicum Cushman and Edwards, 1937, p. 35, pl. 3, fig. 18a–c; Cushman, 1939, p. 37, pl. 10, fig. 12; Hedley *et al*., 1965, p. 24, pl. 7, fig. 28A, B; Hermelin, 1989, p. 77, pl. 14, figs. 10, 11; Xu and Ujiié, 1994, p. 518, fig. 9.3a, b; Hayward *et al*., 1999, p. 157, pl. 15, figs. 8, 9; Hayward *et al*., 2010, p. 222, pl. 28, figs. 13–16; Debenay, 2013, p. 218, pl. 19 (unnumbered).

Astrononion (*Astrononion*) *novozealandicum* Cushman and Edwards. Hornibrook, 1964, p. 335, pl. 1, fig. 20.

Astrononion novo-zealandicum Cushman and Edwards. Hedley *et al*., 1965, p. 24, pl. 7, fig. 28a, b.

Astrononion novozealandica Cushman and Edwards. Ujiié, 1990, p. 42, text-fig. 3a, b.

Pacinonion novozealandicum (Cushman and Edwards). Vella, 1962, p. 290, pl. 1, figs. 10, 11; Loeblich and Tappan, 1994, p. 69, pl. 694, figs. 11–15; Ujiié, 1995, p. 69, pl. 12, fig. 1a, b; Kawagata, 1999, p. 34, fig. 9-4a, b.

Type locality.—Off New Zealand, Southwest Pacific Ocean; Recent.

Occurrence.—Sporadic. Very rare to rare in the hole.

Remarks.—This species shows the narrow sutural tubes that are characteristic of *Pacinonion* rather than the rhomboidal to triangular sutural plates of *Astrononion* Cushman and Edwards (1937).

Distribution.—This species occurs at sheltered inner- and middle-shelf environments, and is more abundant at outer-shelf to lower bathyal depths around New Zealand (Hayward *et al*., 2010); it also occurs on the southern middle-shelf off New Caledonia, Southwest Pacific Ocean.

Subfamily Pulleniinae Schwager, 1877
Genus *Pullenia* Parker and Jones in Carpenter *et al*., 1862
Pullenia quinqueloba (Reuss, 1851a)

Figure 23.5

Nonionina quinqueloba Reuss, 1851a, p. 71, pl. 5, fig. 31a, b.

Pullenia quinqueloba (Reuss). Chapman *et al*., 1934, p. 568, pl. 10, fig. 29a, b; Ujiié, 1990, p. 43, pl. 24, figs. 1–5; Yassini and Jones, 1995, p. 182, figs. 941–943, 1002–1003; Akimoto *et al*., 2002, p. 24, pl. 62, fig. 1a–c; Hayward *et al*., 2010, p. 226, pl. 29, figs. 18–20; Debenay, 2013, p. 231, pl. 19 (unnumbered).

Type locality.—Germany; Eocene.

Occurrence.—Common only in MIS 22.

Distribution.—This species occurs from middle-shelf to lower abyssal depths (50–5000 m) around New Zealand (Hayward *et al*., 2010); it also occurs at middle- to outer-shelf depths off east Australia (Yassini and Jones, 1995).

Superfamily Chilostomelloidea Brady, 1881
Family Oridorsalidae Loeblich and Tappan, 1984
Genus *Oridorsalis* Andersen, 1961
Oridorsalis umbonatus (Reuss, 1851a)

Figure 23.6

Rotalina umbonata Reuss, 1851a, p. 75, pl. 5, fig. 35.

Oridorsalis umbonatus (Reuss). Jones, 1994, p. 99, pl. 95, fig. 11.

Truncatulina tenera Brady, 1884, p. 665, pl. 95, fig. 11.

Eponides (?) *tenera* (Brady). Barker, 1960, p. 196, pl. 95, fig. 11.

Eponides? *tenera* (Brady). Kawagata, 1999, p. 26, fig. 6-4a–c.

Type locality.—Not designated; Eocene.

Occurrence.—Very rare and occurs only in MIS 9.

Remarks.—We could not see the sinuate umbilical sutures and supplementary spiral sutural apertures in our specimens as seen in *Truncatulina tenera* Brady, 1884 from the *Challenger* stations. However, Jones (1994) stated that the development of these characters is variable in Brady's (1884) unfigured specimens and thus synonymised *Truncatulina tenera* Brady, 1884 with *Oridorsalis umbonatus* (= *Rotalina umbonata* Reuss, 1851a).

Distribution.—This species commonly occurs from outer-shelf to lower abyssal depths (100–5000 m) around New Zealand (Hayward *et al*., 2010).

Family Heterolepidae González-Donoso, 1969

Genus **Anomalinoides** Brotzen, 1942
Anomalinoides sphericus (Finlay, 1940)

Figures 23.7, 23.8, 23.9

Anomalina spherica Finlay, 1940, p. 460, pl. 6, figs. 166–171.
Anomalinoides sphericus (Finlay). Hayward *et al*., 1999, pl. 15, figs. 27–29; Hayward *et al*., 2010, p. 221, pl. 28, figs. 10–12.

Type locality.—Off the Hen and Chickens Islands, New Zealand, Southwest Pacific Ocean; Recent.

Occurrence.—Rarely occurs after MIS 10.

Remarks.—Judging from the size of the test, the specimens examined here are all juvenile to young forms of this species. The young form is characterised by a low trochospiral test, preceding whorl less embraced by later chambers, dense finely punctuate test surface except on thick flush intercameral umbilical sutures, and an interiomarginal slit aperture (Figure 23.9a–c). On the other hand, the young form is characterised by having a low trochospiral to almost planispiral test with an interiomarginal but equatorially opening aperture extending from the umbilicus to the coiling axis on the opposite side (Figure 23.8a–c).

Distribution.—This species occurs at deep-inner-shelf to upper bathyal depths (30–600 m), and is most common at shelf environments off the east coast of the North Island, New Zealand (Hayward *et al*., 2010).

Family Gavelinellidae Hofker, 1956
Subfamily Gyroidinoidinae Saidova, 1981
Genus **Gyroidinoides** Brotzen, 1942
Gyroidinoides zelandica (Finlay, 1939c)

Figure 24.1

Gyroidina zelandica Finlay, 1939c, p. 323, pl. 28, figs. 138–140; Hayward and Buzas, 1979, p. 60, pl. 18, figs. 221–223.
Gyroidinoides zelandica (Finlay). Hornibrook, 1961, p. 113, pl. 16, figs. 339, 344.
Gyroidina cushmani Boomgaart, 1949, p. 124, pl. 14, fig. 1.
Gyroidinoides cushmani (Boomgaart). Akimoto *et al*., 2002, p. 25, pl. 62, fig. 4a–c.
Gyroidinoides cushmani (Boomgaart) var.. Akimoto *et al*., 2002, p. 25, pl. 62, fig. 5a–c.
Hansenisca soldanii (d'Orbigny). Loeblich and Tappan, 1994, p. 164, pl. 362, figs. 8–10; Kawagata, 2001, p. 103, fig. 13-7a–c; Debenay, 2013, p. 197, pl. 17 (unnumbered) (*non Gyroidina soldanii* d'Orbigny, 1826).

Type locality.—Island Creek, New Zealand; Miocene.

Occurrence.—Very rare and found only in MIS 10.

Remarks.—Finlay (1939c) proposed *Gyroidina zelandica* and described it as having plate-like rims projecting back from the base of the chambers in the umbilical area. Later, Boomgaart (1949) proposed *Gyroidina cushmani* and mentioned that it is characterised by knob-like thickenings of the test at chamber terminals around the umbilical openings without mentioning the existence of the plate-like rims. Thus these two species have long been treated as different taxa. Akimoto *et al*. (2002) showed the simultaneous existence of both plate-like flaps extending from the interiomarginal-extraumbilical apertural lip and base of chamber over the open umbilicus and the knob-like thickenings of the test at chamber terminals around the umbilicus in their SEM micrograph (*op cit.*, pl. 62, fig. 4). Therefore we regard these two species as conspecific and *G. cushmani* as the objective junior synonym of *G. zelandica*. *Gyroidinoides zelandica* differs from *G. allani* (= *Gyroidina allani* Finlay, 1939c) in having a smaller test with greater convexity on the umbilical side and comprising fewer chambers in the last whorl (8–9 chambers), rather than a larger compressed test with approximately 11 chambers in the last coil. Although some researchers reported this species under the name of *Hansenisca soldanii* (Loeblich and Tappan, 1994; Kawagata, 2001; Debenay, 2013), *H. soldanii* (= *Gyroidina soldanii* d'Orbigny, 1826), type species of the genus *Hansenisca* Loeblich and Tappan, 1987, has more chambers in the last coil (11 chambers) and an interiomarginal short lipped slit-like aperture extending neither into the umbilicus nor to the peripheral margin on the spiral side (Loeblich and Tappan, 1987).

Distribution.—Akimoto *et al.* (2002) reported *Gyroidinoides cushmani* (Boomgaart) and its varietal forms from Holocene core sediments collected at inner-shelf environments in Shimabara Bay (shallower than 50 m in water depth), off the west coast of Kyushu, Japan. Hornibrook (1961) stated that the stratigraphic range of this species is from Oligocene to Pleistocene in New Zealand.

Gyroidinoides sp. 1

Figures 24.2, 24.3

Gyroidinoides orbicularis (d'Orbigny). Ujiié, 1990, p. 46, pl. 26, figs. 3-7c (*non Gyroidina orbicularis* d'Orbigny, 1826).

Occurrence.—Sporadic. Very rare to rare in the hole.

Remarks.—This species shows a closed umbilicus and an interiomarginal-extraumbilical low-arched aperture rather than the interiomarginal aperture characteristic of *Gyroidina* d'Orbigny, 1826, the definition of which was emended by Hansen (1967) based on observations of his designated lectotype of *Gyroidina orbicularis* d'Orbigny, 1826; thus, we place our species under the genus *Gyroidinoides*. Sutures on both the spiral and umbilical sides of our species are flush intercameral, radial rather oblique or strongly curved back.

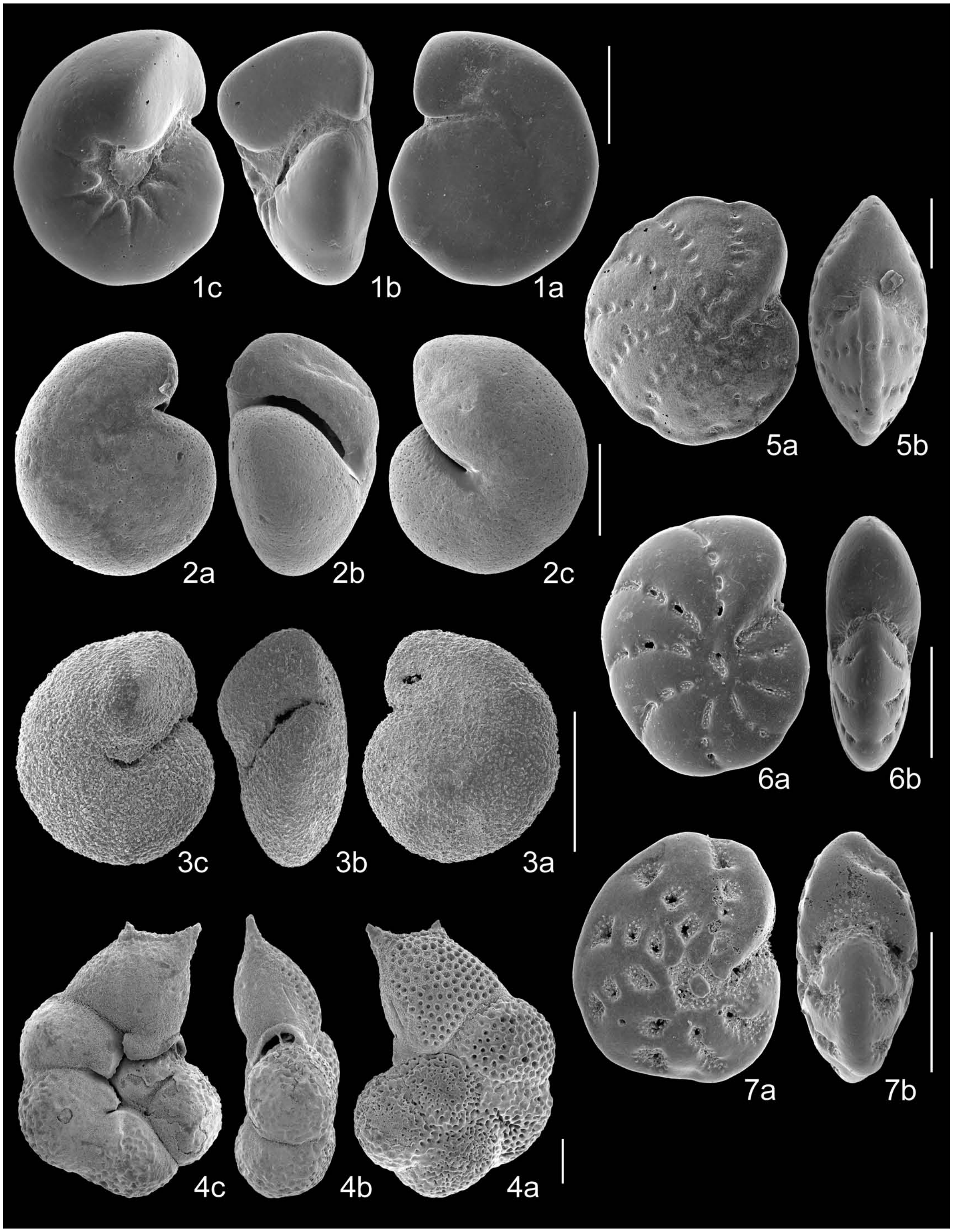

Figure 24. Photographs of benthic foraminifera from the Hole U1352B (22). Scale bars: 100 µm unless otherwise specified. **1,** *Gyroidinoides zelandica* (Finlay), MPC-29076, Sample U1352B-13H-4-W, 19–21 cm; **2, 3,** *Gyroidinoides* sp. 1; 2, MPC-29077, Sample U1352B-1H-1-W, 19–21 cm; 3, MPC-29078, Sample U1352B-18H-5-W, 94–96 cm; **4,** *Discanomalina semipunctata* (Bailey), MPC-29079, Sample U1352B-11H-6-W, 94–96 cm; **5,** *Elphidium charlottense* (Vella), MPC-29080, Sample U1352B-1H-5-W, 19–21 cm; **6,** *Elphidium clavatum* Cushman, MPC-29081, Sample U1352B-22H-6-W, 19–21 cm; **7,** *Elphidium oirgi* Hayward, MPC-29082, Sample U1352B-14H-3-W, 94–96 cm.

Subfamily Gavelinellinae Hofker, 1956
Genus ***Discanomalina*** Asano, 1951a
Discanomalina semipunctata (Bailey, 1851)

Figure 24.4

Rotalina semipunctata Bailey, 1851, p. 11, figs. 17–19.
Anomalina semipunctata (Bailey). Barker, 1960, p. 200, pl. 97, figs. 3–6.
Discanomalina semipunctata (Bailey). Loeblich and Tappan, 1987, pl. 718, figs. 1–9; Loeblich and Tappan, 1994, p. 163, pl. 361, figs. 4–6; Jones, 1994, p. 100, pl. 97, figs. 3–6; Hayward *et al*., 2010, p. 217, pl. 26, figs. 9–12.
Anomalina polymorpha Costa, 1856, p. 252, pl. 21, figs. 7–9 (*fide* Ellis and Messina, 1940 *et seq.*); Brady, 1884, p. 676, pl. 97, figs. 3–6.
Discanomalina japonica Asano, 1951a, p. 13, figs. 3–5.

Type locality.—Off New Jersey, USA, Northwest Atlantic Ocean; Recent.

Occurrence.—Very rare and found only in MIS 8.

Distribution.—This cosmopolitan species occurs at outer-shelf to uppermost bathyal depths (100–400 m) around New Zealand (Hayward *et al*., 2010).

Superfamily Rotalioidea Ehrenberg, 1839
Family Elphidiidae Galloway, 1933
Subfamily Elphidiinae Galloway, 1933
Genus ***Elphidium*** de Montfort, 1808
Elphidium charlottense (Vella, 1957)

Figure 24.5

Elphidiononion charlottensis Vella, 1957, p. 38, pl. 9, figs. 187, 188.
Elphidium charlottense (Vella). Hayward *et al*., 1997, p. 72, pl. 6, figs. 13–16, pl. 7, figs. 1, 2; Hayward *et al*., 1999, p. 165, pl. 17, figs. 6–8.

Type locality.—Queen Charlotte Sound, Marlborough, New Zealand, Southwest Pacific Ocean; Recent.

Occurrence.—Sporadic. Very rare to common in the hole.

Distribution.—This species occurs in sheltered, fully marine, shallow water (0–20 m depth), intertidal and subtidal sand beaches in particular (Hayward *et al*., 1999).

Elphidium clavatum Cushman, 1930

Figure 24.6

Elphidium incertum var. *clavata* Cushman, 1930, p. 20, pl. 7, fig. 10a, b.
Elphidium clavatum Cushman. Loeblich and Tappan, 1953, p. 98, pl. 19, figs. 8–10.
Elphidium excavatum f. *clavatum* Cushman. Hayward and Hollis, 1994, p. 215, pl. 5, figs. 6–8; Hayward *et al*., 1999, p. 169, pl. 17, figs. 11, 12.
Elphidium excavatum clavatum Cushman. Hayward *et al*., 1997, p. 76, pl. 8, figs. 14–17, pl. 9, figs. 1–8.

Type locality.—Frenchmans Bay, Maine, USA, Northwest Atlantic Ocean; Recent.

Occurrence.—Occurs almost throughout the hole. Abundant during MIS 19/20, 17 and 7 in particular.

Distribution.—This species is restricted to brackish or slightly brackish environments, and is mostly common in the middle parts of estuaries and enclosed tidal inlets around New Zealand (Hayward *et al*., 1999).

Elphidium oirgi Hayward in Hayward *et al*., 1997

Figure 24.7

Elphidium excavatum oirgi Hayward in Hayward *et al*., 1997, p. 78, pl. 10, figs. 1–8.
Elphidium excavatum f. *oirgi* Hayward. Hayward *et al*., 1999, p. 166, pl. 17, figs. 17–20.

Type locality.—Off the Cavalli Islands, New Zealand, Southwest Pacific Ocean; Recent.

Occurrence.—Scarce. Very rare in the hole.

Distribution.—This species is common in shallow marine inner-shelf depths (0–20 m), and is mostly abundant in sheltered bays (Hayward *et al*., 1999).

Subfamily Notorotaliinae Hornibrook, 1961
Genus ***Notorotalia*** Finlay, 1939a
Notorotalia depressa Vella, 1957

Figure 25.1

Notorotalia depressa Vella, 1957, p. 47, pl. 1, figs. 13, 19, 20; Hayward *et al*., 1999, p. 169, pl. 16, figs. 16–18; Hayward *et al*., 2010, p. 214, pl. 25, figs. 4–6.

Type locality.—Cook Strait, New Zealand, Southwest Pacific Ocean; Recent.

Occurrence.—Scarce. Very rare in the hole.

Remarks.—This species is distinguished from others by its compressed, low trochospiral parallel-sided test.

Distribution.—This species is endemic to New Zealand and is widespread in exposed and sheltered inner-shelf environments (*ca*. 20–70 m depth) under fully marine conditions in Cook Strait (Hayward *et al*., 1999).

Notorotalia inornata Vella, 1957

Figure 25.2

Notorotalia inornata Vella, 1957, p. 54, pl. 2, fig. 29, pl. 3, figs. 36–38; Hayward *et al*., 1999, p. 171, pl. 16, figs. 22–24.

Type locality.—Cook Strait, New Zealand, Southwest Pacific Ocean; Recent.

Occurrence.—Sporadic. Very rare to abundant in the hole, abundant during MIS 14 and 13.

Remarks.—The species is characterised by the truncated sutural ribs on the spiral side of the test, which do not connect between sutures, and by a row of pores along

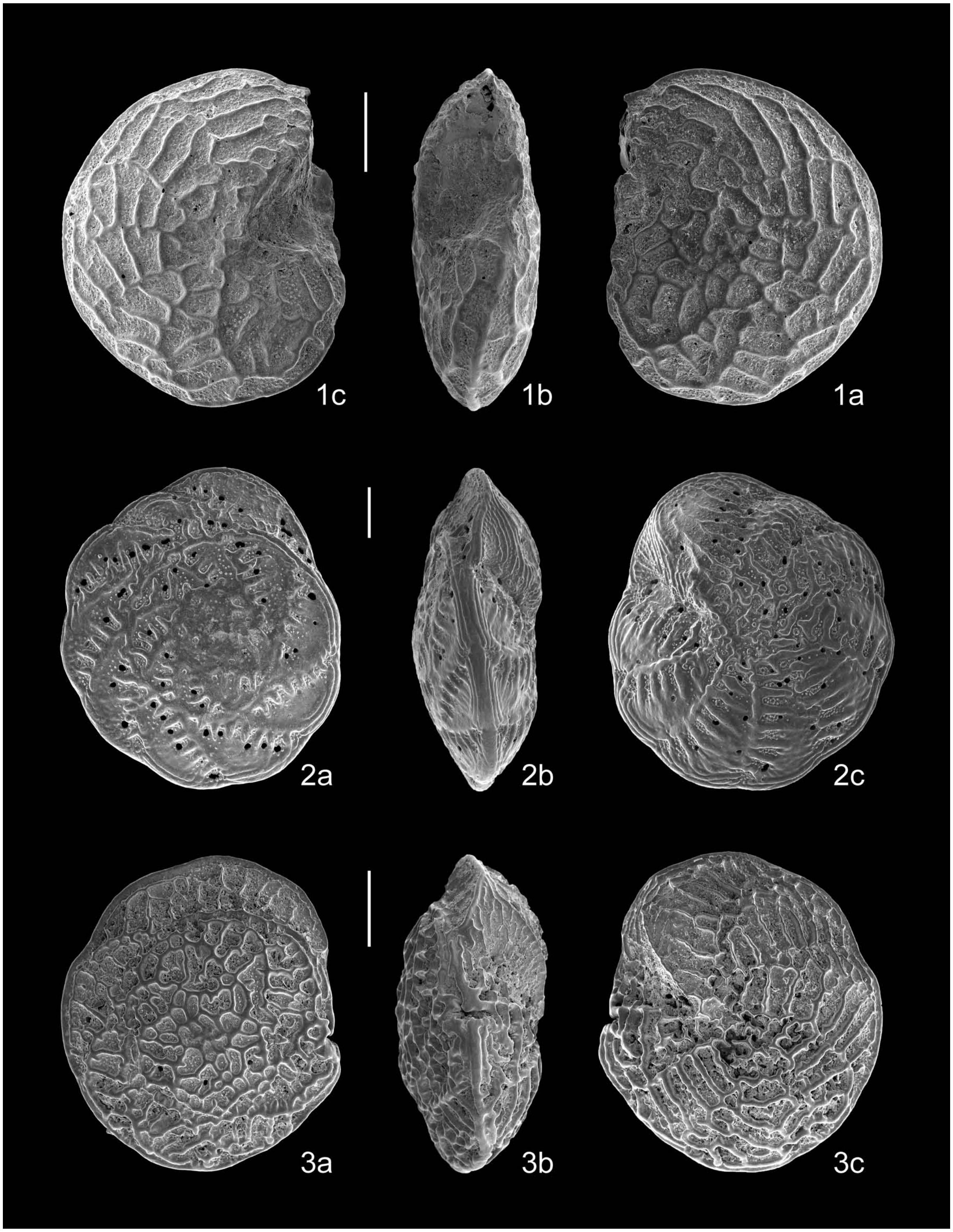

Figure 25. Photographs of benthic foraminifera from the Hole U1352B (23). Scale bars: 100 µm unless otherwise specified. **1,** *Notorotalia depressa* Vella, MPC-29083, Sample U1352B-7H-6-W, 94–96 cm; **2,** *Notorotalia inornata* Vella, MPC-29084, Sample U1352B-25H-1-W, 94–96 cm; **3,** *Notorotalia profunda* Vella, MPC-29085, Sample U1352B-1H-1-W, 19–21 cm.

the spiral suture.

Distribution.—This species occurs in exposed and moderately sheltered environments and at inner-shelf to upper bathyal depths under fully marine conditions (Vella, 1957; Hayward *et al*., 1999).

Notorotalia profunda Vella, 1957

Figure 25.3

Notorotalia profunda Vella, 1957, p. 48, pl. 1, figs. 6–8; Hayward *et al*., 1999, p. 169, pl. 16, figs. 28–30; Hayward *et al*., 2010, p. 215, pl. 25, figs. 7–9.

Notorotalia clathrata (Brady). Boltovskoy *et al*., 1980, p. 40, pl. 23, figs. 1–3 (*non Rotalia clathrata* Brady, 1884).

Type locality.—Lord Howe Rise, Tasman Sea, Southwest Pacific; Recent.

Occurrence.—Sporadic. Very rare in the core.

Remarks.—This is a small and deep-water species for the genus. Sutural ribs are distinct and a labyrinth of fine reticulations on spiral side connects with raised sutures on the umbilical side.

Distribution.—This species is endemic to New Zealand and occurs between middle-shelf to lower bathyal depths (65–1300 m), being mostly abundant at outer shelf to upper bathyal depths (90–400 m) off the east coast of South Island (Hayward *et al*., 2010).

References

Akimoto, K., 1990: Distribution of Recent benthic foraminiferal faunas in the Pacific off Southwest Japan and around Hachijojima Island. *Science Reports of the Tohoku University, Sendai, 2nd Series (Geology)*, vol. 60, p. 139–223.

Akimoto, K., Matsui, C., Shimokawa, A. and Furukawa, K., 2002: Atlas of Holocene benthic foraminifers of Shimabara Bay, Kyushu, Southwest Japan. *Kagoshima University Museum Monographs*, no. 2, p. 1–112.

Albani, A. D. and Yassini, I., 1989: Taxonomy and distribution of shallow-water lagenid foraminifera from the south-eastern coast of Australia. *Australian Journal of Marine and Freshwater Research*, vol. 40, p. 369–401.

Andersen, H. V., 1961: Genesis and paleontology of the Mississippi River delta. *Louisiana Department of Conservation*, *Geological Bulletin*, vol. 35, p. 1–208.

Anderson, J. B., 1975: Ecology and distribution of foraminifera in the Weddell Sea of Antarctica. *Micropaleontology*, vol. 21, p. 69–96.

Asano, K., 1936a: *Pseudononion*, a new genus of foraminifera found in Muraoka-mura, Kamakura-gori, Kanagawa Prefecture. *Journal of Geological Society of Japan*, vol. 43, p. 347–348.

Asano, K., 1936b: New foraminifera from the Kakegawa district, Totomi, Japan. (Studies on the fossil foraminifera from the Neogene of Japan. Part 4.). *Japanese Journal of Geology and Geography*, vol. 13, p. 325–331.

Asano, K., 1951a: *Illustrated Catalogue of Japanese Tertiary Smaller Foraminifera*, *Part 13*, *Anomalinidae*, p. 12–19. Hosokawa Printing Company, Tokyo.

Asano, K., 1951b: *Illustrated Catalogue of Japanese Tertiary Smaller Foraminifera*, *Part 14*, *Rotaliidae*, p. 1–21. Hosokawa Printing Company, Tokyo.

Asano, K., 1952: *Illustrated Catalogue of Japanese Tertiary Smaller Foraminifera, Supplement No. 1*, p. 1–17. Hosokawa Printing Company, Tokyo.

Asano, K., 1956: The foraminifera from the adjacent seas of Japan collected by the S. S. Soyo-Maru, 1922–1930. Pt. 2 Miliolidae. *Science Reports of the Tohoku University, Sendai*, *2nd Series (Geology)*, vol. 27, p. 57–83.

Bailey, J. W., 1851: Microscopical examination of soundings made by the United States Coast Survey, off the Atlantic coast of the United States. *Smithsonian Contributions to Knowledge*, vol. 2, p. 1–15.

Balkwill, F. P. and Millett, F. W., 1884: The foraminifera of Galway. *Journal of Microscopy and Natural Science*, vol. 3, p. 19–28 and p. 78–90.

Balkwill, F. P. and Wright, J., 1885: Report on some Recent foraminifera found off the coast of Dublin and in the Irish Sea. *Transactions of the Royal Irish Academy*, vol. 28, p. 317–368. (*fide* Ellis and Messina, 1940 *et seq*.)

Bandy, O. L., 1949: Eocene and Oligocene foraminifera from Little Stave Creek, Clare Country, Alabama. *Bulletins of American Paleontology*, vol. 32, no. 131, p. 5–206.

Banner, F. T. and Culver, S. J., 1978: Quaternary *Haynesina* n. gen. and Paleogene *Protelphidium* Haynes; their morphology, affinities and distribution. *Journal of Foraminiferal Research*, vol. 8, p. 177–207.

Barker, R. W., 1960: Taxonomic notes on the species figured by H. B. Brady in his Report on the Foraminifera Dredged by H. M. S. *Challenger* during the Years 1973–1876. *Society of Economic Paleontologists and Mineralogists*, *Special Publication*, 9, p. 1–238.

Belford, D. J., 1966: Miocene and Pliocene smaller foraminifera from Papua and New Guinea. *Australia Bureau of Mineral Resources Geology and Geophysics*, *Bulletin*, no. 79, p. 1–306.

Bermúdez, P. J., 1952: Estudio sistemático de los foraminiferos rotaliformes. *Boletín de Geología, Ministerio de Minas e Hidrocarburos (Caracas, Venezuela)*, vol. 2, p. 1–230.

Bermúdez, P. J. and Seiglie, G. A., 1963: Estudio sistemático de los foraminiferos del Golfo de Cariaco. *Boletin del Instituto Oceanográfico de la Universidad de Oriente*, vol. 2, p. 1–252.

Berthelin, G., 1881: Coup d'oeil sur la faune rhizopodique du Calcaire Grossier inférieur de la Marne. *Compte Rendu de la Association Française pour l'Avancement des Sciences*, 9th session, p. 553–559 (*fide* Ellis and Messina, 1940 *et seq.*).

Bharti, S. K. and Singh, A. D., 2013: *Bulimina arabiensis*, a new species of benthic foraminifera from the Arabian Sea. *Journal of Foraminiferal Research*, vol. 43, p. 255–261.

Boltovskoy, E., 1978: Late Cenozoic benthonic foraminifera of the Ninetyeast Ridge (Indian Ocean). *Marine Geology*, vol. 26, p. 139–175.

Boltovskoy, E. and Guissani de Kahn, G., 1981: Cinco nuevos taxones en Orden Foraminiferida. *Comunicaciones del Museo Argentino de Ciencias Naturales "Bernardino Rivadavia" e Instituto Nacional de Investigación de las Ciencias Naturales*, *Hydrobiología*, vol. 2, p. 43–51.

Boltovskoy, E. and Guissani de Kahn, G., 1983: Evaluation of benthic monothalamous foraminifers as guide fossils in Cenozoic deep-sea deposits of the South Atlantic. *Micropaleontology*, vol. 29, p. 298–308.

Boltovskoy, E., Guissani, G., Watanabe, S. and Wright, R., 1980: *Atlas of Benthic Shelf Foramnifera of the Southwest Atlantic*, 147 p. Dr W. Junk, The Hague.

Boomgaart, L., 1949: *Smaller Foraminifera from Bodjonegoro (Java)*, 175 p. Smit and Dontje, Sappemeer.
Bornemann, J. G., 1855: Die mikroskopische Fauna des Septarienthones von Hermsdorf bei Berlin. *Zeitschrift der Deutschen Geologischen Gesellschaft*, vol. 7, p. 307–371.
Brady, H. B., 1881: Notes on some of the reticularian Rhizopoda of the "Challenger" Expedition. Part III. 1. Classification. 2. Further notes on new species. 3. Note on *Biloculina* mud. *Quarterly Journal of Microscopical Science*, *New Series*, vol. 21, p. 31–71.
Brady, H. B., 1884: Report on the foraminifera dredged by H. M. S. Challenger during the years 1873–1876. *In*, Murray, J. *ed*., *Reports of the Scientific Results of the Voyage of H. M. S. Challenger. Zoology*, vol. 9, p. 1–814.
Brotzen, F., 1942: Die Foraminiferengattung *Gavelinella* nov. gen. und die Systematik der Rotaliiformes. *Årsbok Sveriges Geologiska Undersökning*, vol. 36, p. 1–60.
Brotzen, F., 1948: The Swedish Paleocene and its foraminiferal fauna. *Årsbok Sveriges Geologiska Undersökning*, vol. 42, p. 1–140.
Buchner, P., 1940: Die Lagenen des Golfes von Neapel und der marinen Ablagerungen auf Ischia. *Nova Acta Leopoldina, Neue Folge*, vol. 9, p. 363–560.
Carpenter, W. B., Parker, W. K. and Jones, T. R., 1862: *Introduction to the Study of Foraminifera*, 319 p. Ray Society, London.
Carter, L., Garlick, R. D., Sutton, P., Chiswell, S., Oien, N. A. and Stanton, B. R., 1998: Ocean Circulation in New Zealand. 1: 7 000 000. *National Institute of Water and Atmospheric Research*, *Chart*, *Miscellaneous Series No. 76*.
Carter, R. M. and Gammon, P., 2004: New Zealand maritime glaciation: Millennial-scale southern climate change since 3.9 Ma. *Science*, vol. 304, p. 1659–1662, DOI: 10.1126/science.1093726.
Chapman, F., 1906: On some foraminifera and Ostracoda obtained off Great Barrier Island, New Zealand. *Transactions of the New Zealand Institute*, vol. 38, p. 77–112.
Chapman, F., 1907: Recent foraminifera of Victoria: Some littoral gatherings. *Journal of the Quekett Microscopical Club*, vol. 10, p. 117–147.
Chapman, F., 1909: Report on the Foraminifera from the Subantarctic Islands of New Zealand. *In*, Chilton, C. *ed*., *The Subantarctic Islands of New Zealand, Vol. 1*, p. 317–371. Philosophical Institute of Canterbury, Government Printer, Wellington.
Chapman, F. and Parr, W. J., 1931: Note on new and aberrant types of foraminifera. *Proceedings of the Royal Society of Victoria*, *New Series*, vol. 43, p. 236–240.
Chapman, F. and Parr, W. J., 1937: Foraminifera. *Australasian Antarctic Expedition, 1911-14*, *under the leadership of Sir Douglas Mawson*, *Scientific Reports*, *Series C*, *Zoology and Botany*, vol. 1, part 2, p. 1–190.
Chapman, F., Parr, W. J. and Collins, A. C., 1934: Tertiary foraminifera of Victoria, Australia.–The Balcombian deposits of Port Phillip. Part III. *Journal of the Linnean Society of London*, *Zoology*, vol. 38, p. 553–577.
Chaster, G. W., 1892: Report upon the foraminifera of the Southport Society of Natural Science district. *First Report Southport Society of Natural Science*, p. 54–72. (*fide* Ellis and Messina, 1940 *et seq.*)
Cifelli, R., 1990: A history of the classification of foraminifera (1826–1933) Part I. Foraminiferal classification from d'Orbigny to Galloway. *Cushman Foundation for Foraminiferal Research Special Publication*, no. 27, p. 1–88.
Clark, F. E., 1995: New species of unilocular calcareous foraminifera from the Holocene of the southwest Pacific Ocean. *Journal of Micropalontology*, vol. 14, p. 1–5.
Collins, A. C., 1974: Port Phillip Survey 1957–63 Foraminiferida. *Memoirs of the National Museum of Victoria, Melbourne*, vol. 35, p. 1–61.
Corliss, B. H., 1979: Taxonomy of Recent deep-sea benthonic foraminifera from the southeast Indian Ocean. *Micropaleontology*, vol. 25, p. 1–19.
Costa, O. G., 1855: Foraminiferi fossili delle marine Terziarie di Messina. *Memorie della Reale Accademia delle Scienze (Napoli)*, vol. 2, p. 128–147 and p. 367–373.
Costa, O. G., 1856: Paleontologia del regno di Napoli, Parte II. *Atti della Accademia Pontaniana*, vol. 7, p. 113–378. (*fide* Ellis and Messina, 1940 *et seq.*)
Cushman, J. A., 1911: A monograph of the foraminifera of the North Pacific Ocean. Part 2. Textulariidae. *Bulletin of the United States National Museum*, vol. 71, p. 1–108.
Cushman, J. A., 1913: A monograph of the foraminifera of the North Pacific Ocean. Part 3. Lagenidae. *Bulletin of the United States National Museum*, vol. 71, p. 1–125.
Cushman, J. A., 1915: A monograph of the foraminifera of the North Pacific Ocean. Part 5. Rotaliidae. *Bulletin of the United States National Museum*, vol. 71, p. 1–81.
Cushman, J. A., 1917: A monograph of the foraminifera of the North Pacific Ocean. Part 6. Miliolidae. *Bulletin of the United States National Museum*, vol. 71, p. 1–108.
Cushman, J. A., 1922: The foraminifera of the Atlantic Ocean. Part 3. Textulariidae. *Bulletin of the United States National Museum*, vol. 104, no. 3, p. 1–143.
Cushman, J. A., 1923: The foraminifera of the Atlantic Ocean. Part 4. Lagenidae. *Bulletin of the United States National Museum*, vol. 104, no. 4, p. 1–228.
Cushman, J. A., 1926: Foraminifera of the typical Monterey of California. *Contributions from the Cushman Laboratory for Foraminiferal Research*, vol. 2, p. 53–69.
Cushman, J. A., 1927a: *Epistomina elegans* (d'Orbigny) and *E. partschiana* (d'Orbigny). *Contributions from the Cushman Laboratory for Foraminiferal Research*, vol. 3, p. 180–187.
Cushman, J. A., 1927b: Recent foraminifera from off the West coast of America. *Bulletin of the Scripps Institution of Oceanography*, *Technical Series 1*, no. 10, p. 119–188.
Cushman, J. A., 1927c: An outline of a re-classification of the Foraminifera. *Contributions from the Cushman Laboratory for Foraminiferal Research*, vol. 3, p. 1–105.
Cushman, J. A., 1930: The foraminifera of the Atlantic Ocean, Part 7. Nonionidae, Camerinidae, Peneroplidae and Alveolinellidae. *United States National Museum Bulletin*, vol. 104, p. 1–79.
Cushman, J. A., 1931: The foraminifera of the Atlantic Ocean, Part 8. Rotaliidae, Amphisteginidae, Calcarinidae, Cymbaloporettidae, Globorotaliidae, Anomalinidae, and Homotremidae. *United States National Museum Bulletin*, vol. 104, p. 1–179.
Cushman, J. A., 1932: Some Recent Angulogerinas from the eastern Pacific. *Contributions from the Cushman Laboratory for Foraminiferal Research*, vol. 8, p. 44–48.
Cushman, J. A., 1933: The foraminifera of the tropical Pacific collections of the "*Albatross*", 1899–1900. *United States National Museum Bulletin*, vol. 161, p. 1–79.
Cushman, J. A., 1937: A monograph of the subfamily Virgulininae of the foraminiferal family Buliminidae. *Cushman Laboratory for Foraminiferal Research*, *Special Publications*, no. 9, p. 1–228.
Cushman, J. A., 1939: A monograph of the foraminiferal family Nonionidae. *Professional Papers of the U. S. Geological Survey*, vol. 191, p. 1–100.
Cushman, J. A., 1948: Arctic foraminifera. *Cushman Laboratory for Foraminiferal Research*, *Special Publications*, no. 23, p. 1–79.
Cushman, J. A. and Dam, A. ten, 1948: *Pseudoparrella*, a new generic

name, and a new species of *Parrella. Contributions from the Cushman Laboratory for Foraminiferal Research*, vol. 24, p. 49–50.

Cushman, J. A. and Edwards, P. G., 1937: *Astrononion* a new genus of the foraminifera, and its species. *Contributions from the Cushman Laboratory for Foraminiferal Research*, no. 13, p. 29–36.

Cushman, J. A. and Kellett, B., 1929: Recent foraminifera from the west coast of South America. *Proceedings of the United States National Museum*, vol. 77, art. 25, p. 1–16.

Cushman, J. A. and Martin, L. T., 1935: A new genus of foraminifera, *Discorbinella*, from Monterey Bay, California. *Contributions from the Cushman Laboratory for Foraminiferal Research*, no. 11, p. 89–90.

Cushman, J. A. and McCulloch, I., 1942: Some Virgulininae in the collections of the Allan Hancock Foundation. *Allan Hancock Pacific Expeditions*, vol. 6, p. 179–230.

Cushman, J. A. and McCulloch, I., 1948: The species of *Bulimina* and related genera in the collections of the Allan Hancock Foundation. *Allan Hancock Pacific Expeditions*, vol. 6, p. 231–294.

Cushman, J. A. and McCulloch, I., 1950: Reports on the collections obtained by Allan Hancock Expeditions of *Velero III* off the coast of Mexico, Central America, South America and Galapagos Islands in 1932–1941, and *Velero IV* in 1949. Some Lagenidae in the collections of the Allan Hancock Foundation. *Allan Hancock Pacific Expeditions*, vol. 6, p. 295–364.

Cushman, J. A. and Ozawa, Y., 1930: A monograph of the foraminiferal family Polymorphinidae, Recent and fossil. *Proceedings of the United States National Museum*, vol. 77, p. 1–195.

Cushman, J. A. and Parker, F. L., 1947: *Bulimina* and related foraminiferal genera. *U. S. Geological Survey Professional Paper*, 210-D, p. 55–176.

Cushman, J. A. and Todd, R., 1941: Note on the species of *Uvigerina* and *Angulogerina* described from the Pliocene and Pleistocene. *Contributions from the Cushman Laboratory for Foraminiferal Research*, vol. 17, p. 70–78.

Cushman, J. A. and Todd, R., 1949: The genus *Sphaeroidina* and its species. *Contributions from the Cushman Laboratory for Foraminiferal Research*, vol. 25, p. 11–21.

Cushman, J. A., Todd R. and Post, R. J., 1954: Recent foraminifera of the Marshall Islands, Bikini and nearby atolls, part 2, oceanography (biologic). *U. S. Geological Survey Professional Paper*, 260-H, p. 319–384.

Cushman, J. A. and Wickenden, R. T. D., 1929: Recent foraminifera from off Juan Fernandez. *Proceedings of the United States National Museum*, vol. 75, p. 1–16.

Dawson, E. W., 1992: The marine fauna of New Zealand: Index of the fauna: Protozoa. *New Zealand Oceanographic Institute Memoir*, vol. 99, p. 1–369.

Debenay, J.-P., 2013: *A guide to 1,000 Foraminifera from Southwestern Pacific: New Caledonia*, 384 p. Publications Scientifiques du Muséum, Muséum National d'Histoire Naturelle, Paris.

Defrance, J. L. M., 1824: *Dictionnaire des Sciences Naturelles*, *Tome 32*, *mollus-morf*, 567 p. F. G. Levrault, Strasbourg.

Delage, Y. and Hérouard, E., 1896: La Cellule et les Protozoaires. *Traité de Zoologie Concrète*, vol. 1. p. 1–584.

Eade, J. V., 1967: New Zealand Recent foraminifera of the families Islandiellidae and Cassidulinidae. *New Zealand Journal of Marine and Freshwater Research*, vol. 1, p. 421–454.

Earland, A., 1934: Foraminifera. Part III. The Falklands sector of the Antarctic (excluding South Georgia). *Discovery Reports*, vol. 10, p. 1–208.

Egger, J. G., 1857: Die Foraminiferen der Miocän-Schichten bei Ortenburg in Nieder-Bayern. *Neues Jahrbuch für Mineralogie Geognosie Geologie und Petrefaktenkunde*, 1857, p. 266–384.

Ehrenberg, C. G., 1838: Über die blossen Auge unisichtbare Kalkthierchen und Kieselthierchen als Hauptbestandtheile der Kreidegebirge. *Bericht über die zur Bekanntmachung geeigneten Verhandlungen der Koniglichen Preussischen Akademie der Wissenschaften zu Berlin*, 1838, p. 192–200.

Ehrenberg, C. G., 1839: Über die Bildung der Kreidefelsen und des Kreidemergels durch unsichtbare Organismen. *Abhandlungen der Königlichen Akademie der Wissenschaften zu Berlin*, 1838, p. 59–147.

Ehrenberg, C. G., 1843: Verbreitung und Einfluss des mikroskopischen Lebens in Süd- und Nord-Amerika. *Abhandlungen der Königlichen Akademie der Wissenschaften zu Berlin*, 1841, Theil 1, p. 291–446.

Ehrenberg, C. G., 1845: Über das kleinste organische Leben an mehreren bisher nicht untersuchten Erdpunkten. Mikroskopische Lebensformen von Portugal und Spanien, Süd-Afrika, Hinter-Indien, Japan und Kurdistan. *Bericht über die zur Bekanntmachung geeigneten Verhandlungen der Koniglichen Preussischen Akademie der Wissenschaften zu Berlin*, 1845, p. 357–381.

Eichwald, C. E. von, 1830: *Zoologia specialis*, *vol. 2*, 323 p. Vilnae, D. E. Eichwaldus.

Ellis, B. F. and Messina, A., 1940: *Catalogue of Foraminifera*. American Museum of Natural History, New York, 1940 and supplements.

Expedition 317 Scientists, 2010: Canterbury Basin sea level: Global and local controls on continental margin stratigraphy. *In*, Expedition 317 Scientists, *IODP Preliminary Reports*, vol. 317, p. 1–133, doi:10.2204/iodp.pr.317.2010.

Expedition 317 Scientists, 2011: Site U1352. *In*, Fulthorpe, C. S., Hoyanagi, K., Blum, P. and the Expedition 317 Scientists, *Proceedings of IODP*, vol. 317, p. 1–171. Integrated Ocean Drilling Program Management International, Inc., Tokyo. doi:10.2204/iodp.proc.317. 104.2011.

Finlay, H. J., 1939a: New Zealand Foraminifera: Key species in stratigraphy–No. 1. *Transactions of the Royal Society of New Zealand*, vol. 68, p. 504–533.

Finlay, H. J., 1939b: New Zealand Foraminifera: Key species in stratigraphy–No. 2. *Transactions of the Royal Society of New Zealand*, vol. 69, p. 89–127.

Finlay, H. J., 1939c: New Zealand Foraminifera: Key species in stratigraphy–No. 3. *Transactions of the Royal Society of New Zealand*, vol. 69, p. 309–329.

Finlay, H. J., 1940: New Zealand Foraminifera: Key species in stratigraphy–No. 4. *Transactions of the Royal Society of New Zealand*, vol. 69, p. 448–472.

Fornasini, C., 1900: Intorno ad alcuni esemplari di foraminiferi adriatici. *Memorie della R. Accademia delle Scienze dell'Istituto di Bologna*, *serie 5*, tomo 8, p. 357–402.

Fornasini, C., 1901: Intorno a la nomenclatura di alcuni Nodosaridi neogenici italiani. *Memorie della R. Accademia delle Scienze dell'Istituto di Bologna*, *serie 5*, tomo 9, p. 45–76.

Fornasini, C., 1905: Illustrazione di specie Orbignyane di Miliolidi istituite nel 1826. *Memorie della R. Accademia delle Scienze dell'Istituto di Bologna*, *serie 6*, vol. 2, p. 59–76 (1–17).

Galloway, J. J., 1933: *A Manual of Foraminifera*, 498 p. Principia Press, Bloomington.

Galloway, J. J. and Wissler, S. G., 1927: Correction of names of foraminifera. *Journal of Paleontology*, vol. 1, p. 193.

Gibson, G. W., 1967: Foraminifera and stratigraphy of the Tongaporutuan Stage in the Taranaki coastal and six other sections. Part I.–Systematics and distribution. *Transactions of the Royal Society of New Zealand, Geology*, vol. 5, p. 1–70.

Glaessner, M. F., 1937: Die Entfaltung der Foraminiferenfamilie

Buliminidae. *Problemy Paleontologii*, *Paleontologicheskaya Laboratoriya Moslovskogo Gosudarstvennogo Universiteta*, vols. 2 and 3, p. 411–422.

González-Donoso, J. M., 1968: Algunos géneros y especies nuevas de Foraminíferos de la Depresión de Granada. *Acta Geologica Hispanica*, vol. 3, p. 73–77.

González-Donoso, J. M., 1969: Données nouvelles sur la texture et la structure du test de quelques foraminifès du Bassin de Grenade (Espagne). *Revue de Micropaléontologie*, vol. 12, p. 3–8.

Grell, K. G., 1954: Der Generationswechsel der polythalamen Foraminifere *Rotaliella heterocaryotica*. *Archiv für Protistenkunde*, vol. 100, p. 268–286. (*fide* Ellis and Messina, 1940 *et seq*.)

Griffith, J. W. and Henfrey, A., 1875: *The micrographic dictionary; a guide to the examination and investigation of the structure and nature of microscopic objects*, 696 p. van Voorst, London.

Griffiths, G. A. and Glasby, G. B., 1985: Input of river-derived sediment to the New Zealand continental shelf: I. Mass. *Estuarine Coastal and Shelf Science*, vol. 21, p. 773–787.

Hada, Y., 1931: Report of the biological survey of Mutsu Bay. 19. Notes on the Recent foraminifera from Mutsu Bay. *Science Reports of the Tohoku University*, *4th Series (Biology)*, vol. 6, p. 45–148.

Hada, Y., 1936: Some new monothalamous foraminifera from northern Japanese waters. *Transactions of the Sapporo Natural History Society*, vol. 14, p. 242–245.

Haeckel, E., 1894: *Systematische phylogenie der Protisten und Pflanzen*, 400 p. Georg Reimer, Berlin.

Haman, D., 1984: *Saidovina*, new name for *Loxostomina* Saidova, 1975 (*non* Sellier de Civrieux, 1968 [*sic*, 1969] and the status of *Loxostomella* Saidova, 1975 (Foraminiferida). *Proceedings of the Biological Society of Washington*, vol. 97, p. 419.

Hansen, H. J., 1967: Description of seven type specimens of foraminifera designated by d'Orbigny, 1826. *Biologiske Meddeleser udgivet af Det Kongelige Danske Videnskabernes Selskab*, vol. 23, p. 1–12.

Hansen, H. J. and Revets, S., 1992: A revision and reclassification of the Discorbidae, Rosalinidae, and Rotaliidae. *Journal of Foraminiferal Research*, vol. 22, p. 166–180.

Hasegawa, S., Sprovieri, R. and Poluzzi, A., 1990: Quantitative analysis of benthic foraminiferal assemblages from Plio-Pleistocene sequences in the Tyrrhenian Sea, ODP Leg 107. *In*, Kastens, K. A., Mascle, J. *et al.*, *Proceedings of the Ocean Drilling Program*, *Scientific Results*, vol. 107, p. 461–473. U. S. Government Printing Office, Washington, DC.

Haynes, J. R., 1973: Cardigan Bay recent foraminifera (cruises of the R. V. *Antur*, 1962–1964). *Bulletin of the British Museum (Natural History)*. *Zoology*, *Supplement*, no. 4, p. 1–245.

Hayward, B. W., 2001: Global deep-sea extinctions during the Pleistocene ice-ages. *Geology*, vol. 29, p. 599–602.

Hayward, B. W., 2002: Late Pliocene to middle Pleistocene extinction of deep-sea benthic foraminifera ("*Stilostomella* Extinction") in the Southwest Pacific. *Journal of Foraminiferal Research*, vol. 32, no. 3, p. 274–307.

Hayward, B. W. and Buzas, M. A., 1979: Taxonomy and paleoecology of Early Miocene benthic foraminifera of northern New Zealand and the north Tasman Sea. *Smithsonian Contributions to Paleobiology*, no. 36, p. 1–154.

Hayward, B. W., Grenfell, H. R., Carter, R. and Hayward, J. J., 2004a: Benthic foraminiferal proxy evidence for the Neogene palaeoceanographic history of the Southwest Pacific, east of New Zealand. *Marine Geology*, vol. 205, p. 147–184.

Hayward, B. W., Grenfell, H. R., Reid, C. M. and Hayward, K. A., 1999: Recent New Zealand shallow-water benthic foraminifera: Taxonomy, ecological distribution, biogeography, and use in paleoenvironmental assessment. *Institute of Geological and Nuclear Sciences Monograph*, no. 21, p. 1–264.

Hayward, B. W., Grenfell, H. R., Sabaa, A. T., Neil, H. L. and Buzas, M. A., 2010: Recent New Zealand deep-water benthic foraminifera: Taxonomy, ecologic distribution, biogeography, and use in paleoenvironmental assessment. *Institute of Geological and Nuclear Sciences Monograph*, no. 26, p. 1–363.

Hayward, B. W., Grenfell, H. R., Sabaa, A. T. and Sikes, E., 2005: Deep-sea benthic foraminiferal record of the mid-Pleistocene transition in the SW Pacific. *In*, Head, M. J. and Gibbard, P. L. *eds.*, Early–Middle Pleistocene Transitions: The Land–Ocean Evidence. *Geological Society (London)*, *Special Publications*, no. 247, p. 85–115.

Hayward, B. W. and Hollis, C. J., 1994: Brackish foraminifra in New Zealand: a taxonomic and ecologic review. *Micropaleontology*, vol. 40, p. 185–222.

Hayward, B. W., Hollis, C. J. and Grenfell, H. R., 1997: Recent Elphidiidae (Foraminiferida) of the South-west Pacific and fossil Elphidiidae of New Zealand. *Institute of Geological and Nuclear Sciences Monograph*, no. 16, p. 1–166.

Hayward, B. W., Kawagata, S., Sabaa, A. T., Grenfell, H. R., Van Kerckhoven, L., Johnson, K. and Thomas, E., 2012: The last global extinction (mid-Pleistocene) of deep-sea benthic Foraminifera (Chrysalogoniidae, Ellipsoidinidae, Glandulonodosariidae, Plectofrondiculariidae, Pleurostomellidae, Stilostomellidae), their Late Cretaceous-Cenozoic history and taxonomy. *Cushman Foundation for Foraminiferal Research Special Publication*, no. 43, p. 1–408.

Hayward, B. W., Sabaa, A. T. and Grenfell, H. R., 2004b: Benthic foraminifera and the late Quaternary (last 150 ka) paleoceanographic and sedimentary history of the Bounty Trough, east of New Zealand. *Palaeogeography*, *Palaeoclimatology*, *Palaeoecology*, vol. 211, p. 59–93.

Heath, R. A., 1985: A review of the physical oceanography of the seas around New Zealand -1982. *New Zealand Journal of Marine and Freshwater Research*, vol. 19, p. 79–124.

Hedley, R. H., Hurdle, C. M. and Burdett, I. D. J., 1965: A foraminiferal fauna from the western continental shelf, North Island, New Zealand. *New Zealand Department of Science and Industrial Research Bulletin*, no. 163, p. 1–48.

Hedley, R. H., Hurdle, C. M. and Burdett, I. D. J., 1967: The marine fauna of New Zealand: Intertidal foraminifera of the *Corallina officinalis* Zone. *New Zealand Department of Science and Industrial Research Bulletin*, no. 180, p. 1–86.

Hermelin, J. O. R., 1989: Pliocene benthic foraminifera from the Ontong-Java Plateau (western Equatorial Pacific Ocean): Faunal response to changing paleoenvironment. *Cushman Foundation for Foraminiferal Research Special Publication*, no. 26, p. 1–143.

Heron-Allen, A. E. and Earland, A., 1913: Clare Island Survey: Part 64. Foraminifera. *Proceedings of the Royal Irish Academy*, vol. 31, p. 1–188.

Heron-Allen, A. E. and Earland, A., 1922: Protozoa, Part 2. Foraminifera. *Natural History Reports of the British Antarctic ("Terra-Nova") Expedition*, *1910*, vol. 6, p. 25–268.

Heron-Allen, A. E. and Earland, A., 1930: The foraminifera of the Plymouth district. Part I. *Journal of the Royal Microscopical Society*, *series 3*, vol. 50, p. 46–84.

Heron-Allen, A. E. and Earland, A., 1932: Foraminifera Part 1. The ice-free area of the Falkland Islands and adjacent seas. *Discovery Reports*, vol. 4, p. 291–460.

Hofker, J., 1951: The foraminifera of the Siboga expedition. Part III. *Siboga-Expeditie*, Monographie Iva, p. 1–513. E. J. Brill, Leiden.

Hofker, J., 1956: Tertiary foraminifera of coastal Ecuador: Part II, Additional notes on the Eocene species. *Jornal of Paleontology*, vol. 30, p. 891–958.

Hofker, J., 1976: Further studies on Caribbean foraminifera. *Studies on the fauna of Curaçao and other Caribbean islands*, vol. 49, p. 1–256.

Hofker, J., 1983: Zoological exploration of the continental shelf of Surinam: The foraminifera of the shelf of Surinam and the Guyanas. *Zoologische Verhandelingen, Rijksmuseum van Natuurlijke Historie te Leiden*, vol. 201, p. 1–75.

Höglund, H., 1947: Foraminifera in the Gullmar Fjord and the Skagerak. *Zoologiska Bidrag fran Uppsala*, vol. 26, p. 1–328.

Hohenegger, J. and Piller, W., 1975: Wandstrukturen und Grossgliederung der Foraminiferen. Sitzungsberichten der Österreichisch Akademie der Wissenschften, Mathematisch-naturwissenschaftliche Klasse, Abteilung, vol. 184, p. 67–96.

Holbourn, A., Henderson, A. S. and MacLeod, N., 2013: *Atlas of Benthic Foraminifera*, 642 p. Wiley-Blackwell Publishing Ltd., Chichester and Hoboken.

Hornibrook, N. de B., 1961: Tertiary foraminifera from Oamaru district (N. Z.). Part 1–systematics and distribution. *New Zealand Geological Survey Paleontological Bulletin*, vol. 34, p. 1–194.

Hornibrook, N. de B., 1964: The foraminiferal genus *Astrononion* Cushman and Edwards. *Micropaleontology*, vol. 10, p. 33–338.

Hornibrook, N. de B., 1968: Handbook of New Zealand microfossils. *New Zealand Department of Scientific and Industrial Research, Information Series*, no. 62, p. 1–136.

Hornibrook, N. de B., Brazier, R. C. and Strong, C. P., 1989: Manual of New Zealand Permian to Pleistocene foraminifeal biostratigraphy. *New Zealand Geological Survey Paleontological Bulletin*, vol. 56, p. 1–175.

Hoyanagi, K., Kawagata, S., Koto, S., Kamihashi, T. and Ikehara, M., 2014: Data report: Pleistocene benthic foraminiferal oxygen and stable carbon isotopes and their application for age models, Hole U1352, offshore New Zealand. *In*, Fulthorpe, C. S., Hoyanagi, K., Blum, P. and the Expedition 317 Scientists, *Proceedings of the Integrated Ocean Drilling Program*, vol. 317, p. 1–12. Integrated Ocean Drilling Program Management International, Inc., Tokyo. doi:10.2204/iodp.proc.317.208.2014.

Husezima, M. and Maruhasi, R., 1944: A new genus and thirteen new species of foraminifera from the core-sample of Kasiwazaki oilfield, Niigata-Ken. *Journal of the Sigenkagaku Kenkyusyo*, vol. 1, p. 391–400.

Igarashi, A., Numanami, H., Tsuchiya, Y. and Fukuchi, M., 2001: Bathymetric distribution of fossil foraminifera within marine sediment cores from the eastern part of Lützow-Holm Bay, East Antarctica, and its paleoceanaographic implications. *Marine Micropaleontology*, vol. 42, p. 125–162.

Jones, R. W., 1984: A revised classification of the unilocular Nodosariida and Buliminida (Foraminifera). *Revista Española de Micropaleontología*, vol. 16, p. 90–160.

Jones, R. W., 1994: *The Challenger Foraminifera*, 150 p. Oxford University Press, Oxford.

Jones, T. R., 1895: *A Monograph of the Foraminifera of the Crag*, *Part II*, p. 73–210. Palaeontographical Society, London.

Jung, K. K., 1988: Morphology and taxonomy of Late Cenozoic uvigerine foraminifera from Japan. *Science Reports of the Tohoku University*, *Sendai*, *2nd Series (Geology)*, vol. 59, p. 99–175.

Kaiho, K., 1984: Paleogene foraminifera from Hokkaido, Japan. Part 2, Correlation of the Paleogene system in Hokkaido and systematic paleontology. *Science Reports of the Tohoku University*, *Sendai*, *2nd Series (Geology)*, vol. 54, p. 95–139.

Kanmacher, F., 1798: *Essays on the Microscope; the Second Edition, with Considerable Additions and Improvements*, 724 p. Dillon and Keating, London.

Karrer, F. W., 1862: Über das Auftreten der Foraminiferen in dem marinen Tegel des Wiener Beckens. *Sitzungsberichte der Kaiserlichen Akademie der Wissenschaften (Wien)*, *Mathematisch-Naturwissenschaftliche Classe*, vol. 44, p. 427–462.

Karrer, F. W., 1877: Geologie der Kaiser Franz Josefs Hochquellen-Wasserleitung, Eine Studie in den Tertiär-Bildungen am Westrande des alpinen Theiles der Niederung von Wien. *K. K. Abhandlungen der Geologischen Reischsanstalt*, vol. 9, p. 1–420.

Kawagata, S., 1999: Late Quaternary bathyal benthic foraminifera from three Tasman Sea cores, southwest Pacific Ocean. *Science Reports of the Institute of Geoscience*, *University of Tsukuba, section B*, vol. 20, p. 1–46.

Kawagata, S., 2001: Late Neogene benthic foraminifera from Kume-jima Island, central Ryukyu Island, southwestern Japan. *Science Reports of the Institute of Geoscience*, *University of Tsukuba, section B*, vol. 22, p. 63–123.

Kawagata, S., Hayward, B. W. and Gupta, A. K., 2006: Benthic foraminiferal extinctions linked to late Pliocene–Pleistocene deep-sea circulation changes in the northern Indian Ocean (ODP Sites 722 and 758). *Marine Micropaleontology*, vol. 58, p. 219–242.

Keller, G., 1980: Benthic foraminifers and paleobathymetry of the Japan Trench area, Leg 57, Deep Sea Drilling Project. *In*, Huene, R. von *et al*., *Initial Reports of the Deep Sea Drilling Project*, vols. 56 and 57, p. 835–865. U. S. Government Printing Office, Washington, DC.

Kennett, J. P., 1967: New foraminifera from the Ross Sea, Antarctica. *Contributions from the Cushman Foundation for Foraminiferal Research*, vol. 18, p. 133–135.

Kurihara, K. and Kennett, J. P., 1986: Neogene benthic foraminifers: distribution in depth traverse, southwest Pacific. *In*, Kennett, J. P., Borch, C. C. von der, *et al*., *Initial Reports of the Deep Sea Drilling Project*, vol. 90, p. 1037–1077. U. S. Government Printing Office, Washington, DC.

Lalicker, C. G., 1935: Two new foraminifera of the genus *Textularia*. *Smithsonian Misceraneous Collections*, vol. 91, p. 1–2.

Lamarck, J. B., 1804: Suite des mémoires sur les fossiles des environs de Paris. *Annales du Muséum National d'Histoire Naturelle*, vol. 5, p. 349–357.

Le Calvez, Y., 1974: Révision des foraminifères de la collection d'Orbigny I–Foraminifères des Îles Canaries. *Cahiers de Micropaléontologie*, vol. 2, p. 1–107.

Le Calvez, Y., 1977: Révision des foraminifère de la collection d'Orbigny II – Foraminifères de l'îile de Cuba–Tome 1. *Cahiers de Micropaléontologie*, vol. 1, p. 1–128.

LeRoy, L. W., 1964: Smaller foraminifera from the late Tertiary of southern Okinawa. *U. S. Geological Survey Professional Paper*, 454-F, p. 1–58.

Li, Q., Quilty, P. G., Moss, G. and McGowran, B., 1996: Southern Australian endemic and semi-endemic foraminifera: a preliminary report. *Journal of Micropalaeontology*, vol. 15, p. 169–185.

Linné, C. von, 1758: *Systema Naturae*, *10th edition*, vol. 1, 824 p. L. Salvii, Holmiae [Stockholm].

Lipps, J. H., 1965: Revision of the foraminiferal family Pseudoparrellidae Voloshinova. *Tulane Studies in Geology*, vol. 3, p. 117–147.

Lisiecki, L. E. and Raymo, M. E., 2005: A Pliocene–Pleistocene stack of 57 globally distributed benthic $\delta^{18}O$ records. *Paleoceanography*, vol. 20, PA1003. doi:10.1029/2004PA001071.

Loeblich, A. R., Jr. and Tappan, H., 1953: Studies of Arctic foraminifera. *Smithsonian Miscellaneous Collections*, vol. 121, p. 1–150.

Loeblich, A. R., Jr. and Tappan, H., 1961: Suprageneric classification of the Rhizopodea. *Journal of Paleontology*, vol. 35, p. 245–330.

Loeblich, A. R., Jr. and Tappan, H., 1964: *Part C, Protista 2*, vols. 1 and 2, 900 p. *In*, Moore, R. C. *ed.*, *Treatise on Invertebrate Paleontology*, Geological Society of America, New York and University of Kansas Press, Lawrence.

Loeblich, A. R. Jr. and Tappan, H., 1984: Suprageneric classification of the Foraminiferida (Protozoa). *Micropaleontology*, vol. 30, p. 1–70.

Loeblich, A. R., Jr. and Tappan, H., 1986: Some new and revised genera and families of hyaline calcareous Foraminiferida (Protozoa). *Transactionas of the American Microscopical Society*, vol. 105, p. 239–265.

Loeblich, A. R., Jr. and Tappan, H., 1987: *Foraminiferal Genera and their Classification*, vols. 1 and 2, 1182 p. Van Nostrand Reinhold Company, New York.

Loeblich, A. R., Jr. and Tappan, H., 1994: Foraminifera of the Sahul Shelf and Timor Sea. *Cushman Foundation for Foraminiferal Research Special Publication*, no. 31, p. 1–661.

Mathews, R. D., 1945: *Rectuvigerina*, a new genus of foraminifera from a restudy of *Siphogenerina*. *Journal of Paleontology*, vol. 19, p. 588–606.

Matoba, Y., 1970: Distribution of Recent shallow water foraminifera of Matsushima Bay, Miyagi Prefecture, northeast Japan. *Science Reports of the Tohoku University*, *Sendai*, *2nd Series (Geology)*, vol. 42, p. 1–85.

Matoba, Y. and Yamaguchi, A., 1982: Late Pliocene to Holocene benthic foraminifers of the Guaymas Basin, Gulf of California: Sites 477 through 481. *In*, Curray, J. R., Moore, D. G. *et al*., *Initial Reports of the Deep Sea Drilling Project*, vol. 64, p. 1027–1056. U. S. Government Printing Office, Washington, DC.

Matthes, H. W., 1939: Die Lagenen des deutschen Tertiärs. *Palaeontolographica*, vol. 90, p. 49–108.

McCulloch, I., 1977: *Qualitative Observations on Recent Foraminiferal Tests with Emphasis on the Eastern Pacific: Parts I-III*, 1079 p. University of Southern California, Los Angeles.

McCulloch, I., 1981: *Qualitative Observations on Recent Foraminiferal Tests*, *Part IV, with Emphasis on the Allan Hancock Atlantic Expedition Collections*, 363 p. University of Southern California, Los Angeles.

Mead, G. A., 1985: Recent benthic foraminifera in the Polar Front region of the southwest Atlantic. *Micropaleontology*, vol. 31, p. 221–248.

Mikhalevich, V. I., 1993: New higher taxa of the subclass Nodosariata (Foraminifera). *Zoolsystematica Rossica*, vol. 2, p. 5–8.

Millett, F. W., 1901: Report on the Recent foraminifera of the Malay Archipelago collected by Mr. Durrand, F. R. M. S. – Part IX. *Journal of the Royal Microscopical Society*, 1901, p. 484–497.

Mohan, K., Gupta, A. K. and Bhaumik, A. K., 2011: Distribution of deep-sea benthic foraminifera in the Neogene of Blake Ridge, NW Atlantic Ocean. *Journal of Micropaleontology*, vol. 30, p. 33–74.

Montagu, G., 1803: *Testacea Britannica or Natural History of British Shells, Marine*, *Land*, *and Fresh-Water*, *Including the Most Minute*, 606 p. J. S. Hollis, Romsey.

Montanaro-Gallitelli, E., 1957: A revision of the foraminiferal family Heterohelicidae. *Bulletin of the United States National Museum*, vol. 215, p. 133–154.

Montfort, P. Denys de, 1808: *Conchyiologie Systématique, et Classification Méthodique des Coquilles*, 409 p. F. Schoell, Paris.

Morkhoven, F. P. C. M. van, Berggren, W. A. and Edwards, A. S., 1986: Cenozoic cosmopolitan deep-water benthic foraminifera. *Bulletin des Centres de Recherches Exploration-Production Elf-Aquitaine*, no. 11, p. 1–423.

Murray, J. W., 1984: Paleogene and Neogene benthic foraminifers from Rockall Plateau. *In*, Roberts, D. G., Schnitker, D. *et al*., *Initial Reports of the Deep Sea Drilling Project*, vol. 81, p. 503–534. U. S. Government Printing Office, Washington, DC.

Natland, M. L., 1938: New species of foraminifera from off the west coast of North America and from the later Tertiary of the Los Angeles Basin. *University of California*, *Scripps Institution of Oceanography Bulletin*, *Technical Series*, vol. 4, p. 137–163.

Natland, M. L., 1950: 1940 E. W. Scripps cruise to the Gulf of California, Part IV. Report on the Pleistocene and Pliocene foraminifera. *Memoirs of the Geological Society of America*, vol. 43, p. 1–55.

Neil, H., Carter, L. and Morris, M., 2004: Thermal isolation of Campbell Plateau, New Zealand, by the Antarctic Circumpolar Current over the past 130 kyr. *Paleoceanography*, vol. 19, PA4008.

Neugeboren, J. L., 1856: Die Foraminiferen aus der Ordnung der Stichostegier von Ober-Lapugy in Siebenbürgen. *Denkschriften der Kaiserlichen Akademie der Wissenschaften (Wien), Mathematisch-Naturwissenschaftliche Classe*, vol. 12, p. 65–108.

Nomura, R., 1983a: Cassidulinidae (Foraminiferida) from the uppermost Cenozoic of Japan (Part 1). *Science Reports of the Tohoku University*, *Sendai*, *2nd Series (Geology)*, vol. 53, p. 1–101.

Nomura, R., 1983b: Cassidulinidae (Foraminiferida) from the uppermost Cenozoic of Japan (Part 2). *Science Reports of the Tohoku University*, *Sendai*, *2nd Series (Geology)*, vol. 54, p. 1–93.

Nomura, R., 1999: Miocene Cassidulinid foraminifera from Japan. *Paleontological Society of Japan*, *Special Papers*, no. 38, p. 1–69.

Nørvang, A., 1945: *Foraminifera*. *In,* Fridriksson, A. and Tuxen, S. L. *eds*., *The Zoology of Iceland*, vol. 2, part 2, 79 p. Ejnar Munksgaard, Copenhagen and Reykjavík.

Oki, K., 1989: Ecological analysis of benthic foraminifera in Kagoshima Bay, South Kyushu, Japan. *South Pacific Study*, vol. 10, p. 1–191.

O'Neill, T. A., Hayward, B. W., Kawagata, S., Sabaa, A. T. and Grenfell, H. R., 2007: Pleistocene extinctions of deep-sea benthic foraminifera: the South Atlantic record. *Palaeontology*, vol. 50, p. 1073–1102.

Orbigny, A. d', 1826: Tableau méthodique de la classe des Cephalopodes. *Annales des Sciences Naturelles*, vol. 7, p. 245–314.

Orbigny, A. d', 1839a: Foraminifères, *In*, Sagra, Ramon de la, *Histoire Physique*, *Politique et Naturelle de l'île de Cuba*, 224 p. Arthus Bertrand, Paris.

Orbigny, A. d', 1839b: *Voyage dans l'Amérique Méridionale–Foraminifères*, vol. 5, part 5, 86 p. P. Bertrand, Paris and Strasbourg.

Orbigny, A. d', 1839c: Foraminifères. *In*, Barker-Webb, P. and Berthelot, S. *eds*., *Histoire Naturelle des Îles Canaries. Tome deuxième*, *deuxième partie, contenant la Zoologie*, p. 119–146. Bethune, Paris.

Orbigny, A. d', 1846: *Foraminifères fossiles du Bassin Tertiaire de Vienne (Autriche)*, 312 p. Gide et Cie, Paris.

Papp, A. von and Schmid, M. E., 1985: Die fossilen Foraminiferen des Tertiärenbeckens von Wien. Revision der Monographie von Alcide d'Orbigny (1846). *Abhandlungen der Geologischen Bundesanstalt*, vol. 37, p. 1–311.

Parker, F. L., 1952: Foraminifera species off Portsmouth, New Hampshire. *Bulletin of the Museum of Comparative Zoology at Harvard College*, vol. 106, p. 391–423.

Parker, F. L., 1954: Distribution of the foraminifera in the northeastern Gulf of Mexico. *Bulletin of the Museum of Comparative Zoology at Harvard College*, vol. 111, p. 453–588.

Parker, F. L., 1964: Foraminifera from the experimental Mohole Drilling near Guadelupe Island, Mexico. *Journal of Paleontology*, vol. 38, p. 617–636.

Parker, W. K. and Jones, T. R., 1865: On some foraminifera from the

Atlantic and Arctic Oceans, including Davis Straits and Baffin's Bay. *Philosophical Transactions of the Royal Society of London*, vol. 155, p. 325–441.

Parker, W. K., Jones, T. R. and Brady, H. B., 1865: On the nomenclature of the Foraminifera, Part 12: the species enumerated by d'Orbigny in the "Annales des Science Naturelles", vol. 7, 1826. *Annals and Magazine of Natural History, series 3*, vol. 16, p. 15–41.

Parr, W. J., 1945: Recent foraminifera from Barwon Heads, Victoria. *Proceedings of the Royal Society of Victoria*, *New Series*, vol. 56, p. 189–218.

Parr, W. J., 1947: The lagenid foraminifera and their relationships. *Proceedings of the Royal Society of Victoria*, *New Series*, vol. 58, p. 116–130.

Parr, W. J., 1950: Foraminifera. *Reports B. A. N. Z. Antarctic Research Expedition 1929–1931*, *Series B (Zoology, Botany)*, vol. 5, no. 6, p. 232–392.

Patterson, R. T., 1985: *Abditodentrix*, a new foraminiferal genus in family Bolivinitidae. *Journal of Foraminiferal Research*, vol. 15, p. 138–140.

Patterson, R. T. and Pettis, R. H., 1986: *Gallowayella*, a new foraminiferal genus and new names for two foraminiferal homonyms. *Journal of Foraminiferal Research*, vol. 16, p. 74–75.

Patterson, R. T. and Richardson, R. H., 1987: A taxonomic revision of the unilocular foraminifera. *Journal of Foraminiferal Research*, vol. 17, p. 212–226.

Patterson, R. T. and Richardson, R. H., 1988: Eight new genera of unilocular foraminifera. *Transactions of the American Microscopical Society*, vol. 107, p. 240–258.

Phleger, F. B., 1952: Foraminifera distribution in some sediment samples from the Canadian and Greenland Arctic. *Contributions from the Cushman Foundation for Foraminiferal Research*, vol. 3, p. 80–89.

Phleger, F. B. and Parker, F. L., 1951: Ecology of foraminifera, northwest Gulf of Mexico. Pt. II. Foraminifera species. *Memoirs of the Geological Society of America*, vol. 46, p. 1–64.

Phleger, F. B., Parker, F. L. and Peirson, J. F., 1953: North Atlantic foraminifera. *Report of the Swedish Deep-sea Expedition*, *Vol. 7*, *Sediment Cores from the North Atlantic Ocean*, no. 1, p. 1–122.

Popescu, G. and Crehan, I. M., 2004: Contributions to the knowledge of Miocene foraminifera from Romania: Superfamily Nodosariacea (Fam. Nodosariidae and Vaginulinidae). *Acta Paleontologica Romaniae*, vol. 4, p. 385–402.

Puri, H. S., 1953: Contribution to the Miocene of the Florida panhandle. *Geological Bulletin*, *Florida State Geological Survey*, no. 36, p. 1–345.

Qvale, G. and Nigam, R., 1985: *Bolivina skagerrakensis*, a new name for *Bolivina* cf. *B. robusta*, with notes on its ecology and distribution. *Journal of Foraminiferal Research*, vol. 15, p. 6–12.

Rasheed, D. A., 1971: Some foraminifera belonging to Miliolidae and Ophthalmidiidae from the Coral Sea, south of Papua (New Guinea); Part II. *Journal of the Madras University*, vols. 37 and 38, p. 19–68.

Reiss, Z., 1963: Reclassification of perforate foraminifera. *Bulletin of the Geological Survey of Israel*, vol. 35, p. 1–111.

Reuss, A. E., 1850: Neues Foraminiferen aus den Schichten des Österreichischen Tertiärbeckens. *Denkschriften der Akademie des Wissenschaften (Wien) I*, p. 365–390.

Reuss, A. E., 1851a: Ueber die fossilen Foraminiferen und Entomostraceen der Septarienthone der Umgegend von Berlin. *Zeitschrift der Deutschen Geologischen Gesellschaft (Berlin)*, vol. 3, p. 49–92.

Reuss, A. E., 1851b: Ein Beitrag zur Paläontologie der Tertiär-Schichten Oberschlesiens. *Zeitschrift der Deutschen Geologischen Gesellschaft (Berlin)*, vol. 3, p. 149–184.

Reuss, A. E., 1851c: Die Foraminiferen und Entomostraceen des Kreidemergels von Lemberg. *Naturwissenschaftliche Abhandlungen*, *Wien*, *Österreich 1851*, vol. 4. (*fide* Ellis and Messina, 1940 *et seq.*)

Reuss, A. E., 1860: Die Foraminiferen der Westphälischen Kreideformation. *Sitzungsberichte der Kaiserlichen Akademie der Wissenschaften*, *Wien*, *Mathematisch-Naturwissenschaftliche Classe*, vol. 40, p. 147–238.

Reuss, A. E., 1862: Paläontologische Beiträge. I. Über eine neue Oligocäne Scalpellum-Art. *Sitzungsberichte der Kaiserlichen Akademie der Wissenschaften in Wien*, *Mathematisch-Naturwissenschaftliche Classe*, vol. 44, p. 301–342.

Reuss, A. E., 1863: Beiträge zur Kenntniss der tertiären Foraminiferen-Fauna (zweite Folge). *Sitzungsberichte der Kaiserlichen Akademie der Wissenschaften in Wien. Mathematisch-Naturwissenschaftliche Classe*, vol. 48, p. 36–71.

Reuss, A. E., 1866: Die Foraminiferen, Anthozoen und Bryozoen des deutschen Septarienthones. Ein Beitrag zur Fauna der mitteloligocänen Tertiärschichten. *Denkschriften der Kaiserlichen Akademie der Wissenschaften (Wien)*, *Mathematisch-Naturwissenschaftliche Classe*, vol. 25, p. 117–214.

Reuss, A. E., 1870: Die Foraminiferen des Septarienthones von Pietzpuhl. *Sitzungsberichte der Kaiserlichen Akademie der Wissenschaften in Wien. Mathematisch-Naturwissenschaftliche Classe*, vol. 62, p. 455–493.

Reuss, A. E. and Fritsch, A., 1861: *Verzeichniss von 100 Gypsmodellen von Foraminiferen*, *welche unter der Leitung des Prof. Dr. A. Reuss und Dr. Anton Fritsch gearbeitet wurden*, 4 p. Karl Seyfried, Prague.

Revets, S. A., 1993: The revision of the genus *Buliminellita* Cushman and Stainforth, 1947, and *Eubuliminella* gen. nov. *Journal of Foraminiferal Research*, vol. 23, p. 141–151.

Rey, M., 1955: Description de quelques espèces nouvelles de foraminifères dans le Nummulitique nord-marocain. *Bulletin de la Société Géologique de France*, series 6, vol. 4, p. 209–211. (*fide* Ellis and Messina, 1940 *et seq.*)

Rhumbler, L., 1906: Foraminiferen von Laysan und den Chatham-Inseln. (Ergebnisse einer Reise nach dem Pacific, Schauinsland 1896–1897). *Zoologische Jahrbücher*, *Abteilung für Systematik*, vol. 24, p. 21–80.

Riccio, J. F., 1950: *Triloculinella*, a new genus of foraminifera. *Contributions from the Cushman Foundation for Foraminiferal Research*, vol. 1, p. 90.

Roemer, 1838: Cephalopoden des Nord-Deutschen tertiären Meersandes. *Neues Jahrbuch für Mineralogie Geognosie Geologie und Petrefaktenkunde*, 1838, p. 381–394.

Saidova, Kh. M., 1975: *Benthonic foraminifera of the Pacific Ocean*, 3 vols., 875 p. Institut Okeanologii im. P. P. Shirshova Akademii Nauk SSSR, Moscow. (*in Russian; original title translated*)

Saidova, Kh. M., 1981: *On a up-to-date system of supraspecific taxonomy of Cenozoic benthonic foraminifera*, 73 p. Institut Okeanologii P. P. Shirshova, Akademiya Nauk SSSR, Moscow. (*in Russian; original title translated*)

Schlumberger, C., 1891: Révision des Biloculines des Grands Fonds. *Mémoires de la Société Zoologique de France*, vol. 4, p. 542–579.

Schultze, F. E., 1854: *Über den Organismus der Polythalamien (Foraminiferen) nebst Bemerkungen über die Rhizopoden im allgemeinen*, 68 p. Wilhelm Engelmann, Leipzig.

Schwager, C., 1866: Fossile Foraminiferen von Kar Nikobar. *Reise der oesterreichischen Fregatte Novara um die Erde in den Jahren 1857*, *1858*, *1859: Geologischer Theil*, *vol. 2*, *no. 2*, *Geologische*

Beobachtungen, *no. 2*, *Paläontologische Mittheilungen*, p. 187–268. C. Schwager, Vienna.

Schwager, C., 1876: Saggio di una classificazione dei foraminiferi avuto riguardo alle loro famiglie naturali. *Bolletino R. Comitato Geologico d'Italia*, vol. 7, p. 475–485.

Schwager, C., 1877: Quadro del proposto sistema di classificazione dei foraminiferi con guscio. *Bolletino R. Comitato Geologico d'Italia*, vol. 8, p. 18–27.

Seguenza, G., 1862a: *Dei terreni Tertiarii del distretto di Messina; Parte II– Descrizione dei foraminiferi monotalamici delle marné Mioceniche del distretto di Messina*, 84 p. T. Capra, Messina.

Seguenza, G., 1862b: Prime recerche intorno ai rizopodi fossili delle argille Pleistoceniche dei dintorni di Catania. *Atti della Accademia Gioenia di Scienze Naturali di Catania*, *Serie 2*, vol. 18, p. 84–128.

Seguenza, G., 1880: Le formazione terziarie nella provincia di Reggio (Calabria). *Atti della Reale Accademia dei Lincei (Roma)*, *Classe di Scienze Fisiche*, *Matematiche e Naturali*, *Serie 3*, vol. 6, p. 1–446.

Seiglie, G. A., 1964: New and rare foraminifers from Los Testigos Reefs, Venezuela. *Caribbean Journal of Science*, vol. 4, p. 497–512.

Seiglie, G. A., 1970: Additional observations on the foraminiferal genus *Buliminoides* Cushman. *Contributions from the Cushman Foundation for Foraminiferal Research*, vol. 21, p. 112–115.

Seiglie, G. A. and Bermúdez, P. J., 1965: Monografía de la familia de foraminíferos Glabratellidae. *Geos*, no. 12, p. 15–65.

Shipboard Science Party, 1999: Chapter 1. Leg 181 Summary: Southwest Pacific paleoceanography. *In*, Carter, R. M., McCave, I. N., Richter, C. and Carter, L. *et al.*, *Proceedings of the Ocean Drilling Program, Initial Reports*, vol. 181. p. 1–80. U. S. Government Printing Office, Washington, DC.

Sidebottom, H., 1912: Lagenae of the South-west Pacific Ocean. From soundings taken by H. M. S. *Waterwitch*, 1895. *Journal of the Quekett Microscopical Club*, *2nd Series*, vol. 11, p. 375–434.

Sidebottom, H., 1915: Lagenae of the South-west Pacific Ocean (supplementary paper). *Journal of the Quekett Microscopical Club*, *2nd Series*, vol. 12, p. 161–210.

Sidebottom, H., 1918: Report on the Recent foraminifera dredged off the east coast of Australia, H. M. S. "*Dart*", Station 19 (May 14, 1895), lat. 29°22'S., long. 153°51'E., 465 fathoms. Pteropod ooze. *Journal of the Royal Microscopical Society*, 1918, p. 249–264.

Sigal, J., 1952: Aperçu stratigraphique sur la micropaléontologie du Crétacé. *XIX Congrés Géologique International*, *Monographies Régionales*, *série I*, *Algérie*, vol. 26, p. 1–47. (*fide* Loeblich and Tappan, 1987)

Silvestri, A., 1896: Foraminiferi pliocenici della Provincia di Siena. Parte I. *Memorie della Pontificia Accademia dei Nuovi Lincei (Roma)*, vol. 12, p. 1–204.

Silvestri, A., 1902: Lageninae del mar Tirreno. *Memorie della Pontificia Accademia dei Nuovi Lincei (Roma)*, vol. 19, p. 133–172. (*fide* Ellis and Messina, 1940 *et seq.*)

Silvestri, A., 1923: Lo stipites della Elissoforme e le sue affinita. *Memorie della Pontificia Accademia della Scienze*, *Nuovi Lincei*, *serie 2*, vol. 6, p. 231–270.

Smith, H. P., 1956: Foraminifera from Wagonwheel Formation, Davis Den district, California. *University of California Publications in the Geological Sciences*, vol. 32, p. 65–126.

Smith, R. K. and Isham, L. B., 1974: Reinstatement of *Mychostomina* Berthelin, 1881, and emendation of Spirillinacea, all Reuss, 1862. *Journal of Foraminiferal Research*, vol. 4, p. 66–68.

Soldani, A., 1798: *Testaceographiae ac zoophytographiae parvae et microscopicae*, 148 p. Tomus Primus. Senis, Rossi. (*fide* Ellis and Messina, 1940 *et seq.*)

Souaya, F. J., 1965: Miocene foraminifera of the Gulf of Suez region, U. A. R.; Part 1 – Systematics (Astrorhizoidea-Buliminoidea). *Micropaleontology*, vol. 11, p. 301–334.

Srinivasan, M. S. and Sharma, V., 1980: *Schwager's Car Nicobar foraminifera in the reports of the Novara Expedition—A Revision*, 83 p. Today & Tomorrow's Printers and Publishers, New Delhi.

Sutton, P. J. H., 2003: The Southland Current: a subantarctic current. *National Institute of Water and Atmospheric Research*, vol. 37, p. 645–652.

Thalmann, H. E., 1939: Bibliography and index to new genera, species and varieties of foraminifera for the year 1936. *Journal of Paleontology*, vol. 13, p. 425–465.

Thalmann, H. E., 1950: New name and homonyms in foraminifera. *Contributions from the Cushman Foundation for Foraminiferal Research*, vol. 1, p. 45.

Thalmann, H. E., 1952: Bibliography and index to new genera, species and varieties of foraminifera for the year 1951. *Journal of Paleontology*, vol. 26, p. 953–992.

Todd, R., 1965: The foraminifera of the Tropical Pacific collections of the "*Albatross*," 1899–1900. Pt. 4. Rotaliniform families and planktonic families. *Bulletin of the United States National Museum*, vol. 161, p. 1–139.

Todd, R. and Brönnimann, P., 1957: Recent foraminifera and Thecamoebina from the eastern Gulf of Paria. *Cushman Foundation for Foraminiferal Research Special Publication*, no. 3, p. 1–43.

Uchio, T., 1951: New species and genus of the foraminifera of the Cenozoic formations in the middle part of the Boso Peninsula, Chiba-ken, Japan. *Transactions and Proceedings of the Palaeontological Society of Japan*, *new series*, no. 2, p. 33–42.

Uchio, T., 1960: Ecology of living benthonic foraminifera from the San Diego, California area. *Cushman Foundation for Foraminiferal Research Special Publication*, no. 5, p. 1–72.

Ujiié, H., 1990: Bathyal benthic foraminifera in a piston core from east of the Miyako Islands, Ryukyu Island Arc. *Bulletin of the College of Science*, *University of the Ryukyus*, no. 49, p. 1–60.

Ujiié, H., 1995: Benthic foraminifera common in the bathyal surface sediments of the Ryukyu Island Arc region, Northwest Pacific. *Bulletin of the College of Science*, *University of the Ryukyus*, no. 60, p. 51–111.

Ujiié, H. and Hatta, A., 1994: Additional descriptions of benthic foraminifera from coral seas between Ishigaki and Iriomote Islands, southern Ryukyu Island Arc. *Bulletin of the College of Science*, *University of the Ryukyus*, no. 57, p. 11–25.

Ujiié, H., Ichikura, M. and Kurihara, K., 1983: Quaternary benthonic foraminiferal changes observed in the Sea of Japan piston cores. *Bulletin of the National Science Museum*, *Series C*, *Geology and Paleontology*, vol. 9, p. 41–78.

Vella, P., 1957: Studies in New Zealand foraminifera; Part I- Foraminifera from Cook Strait. Part II- Upper Miocene to Recent species of the genus *Notorotalia*. *New Zealand Geological Survey Paleontological Bulletin*, vol. 28, p. 1–64.

Vella, P., 1962: Late Tertiary nonionid foraminifera from Wairarapa, New Zealand. *Transactions of the Royal Society of New Zealand*, *Geology*, vol. 1, p. 285–296.

Vella, P., 1963: Some foraminifera from the upper Miocene and Pliocene of Wairarapa, New Zealand. *Transactions of the Royal Society of New Zealand, Geology*, vol. 2, p. 1–14.

Voloshinova, N. A., 1958: On new systematics of the Nonionidae. *Trudy Vsesoyuznogo Neftyanogo Nauchno-issledovatel'skogo Geologo-razvedochnogo Instituta (VNIGRI)*, vol. 115, p. 117–191. (*in Russian; original title translated*)

Voloshinova, N. A., 1960: *Progress in micropaleontology in the work of studying the inner structure of Foraminifera*. *In*, Trudy pervego Seminara po Mikrofaune, p. 48–87. Vsesoyuznyy Neftyanoy Nauchno-issledovatel'skii Geologo-razvedochnyy Institut (VNIGRI), Leningrad. (*in Russian; original title translated*)

Voloshinova, N. A., and Dain, L. G., 1952: Fossil foraminifera of the USSR, Nonionidae, Cassidulinidae and Chilostomellidae. *Trudy Vsesoyuznogo Neftyanogo Nauchnoissledovatel'skogo Geologorazvedochnogo Instituta (VNIGRI)*, vol. 63, p. 1–151. (*in Russian; original title translated*) (*fide* Loeblich and Tappan, 1987)

Walker, G. and Boys, W., 1784: *Testacea Minuta Rariora*, *Nuperrime Detecta in Arena Littoris Sandvicensis (A Collection of the Minute and Rare Shells*, *Lately Discovered in the Sand of the Sea Shore near Sandwich)*, 25 p. J. March, London.

Wedekind, R., 1937: *Einführung in die Grundlagen der historischen Geologie. 2. Mikrobiostratigraphie. Die Korallen- und Foraminiferenzeit*, 136 p. Enke, Stuttgart.

Wells, P. and Wells, G., 1994; Large-scale reorganization of ocean currents offshore Western Australia during the Late Quaternary. *Marine Micropaleontology*, vol. 24, p. 157–186.

Whittaker, J. E. and Hodgkinson, R. L., 1979: Foraminifera of the Togopi Formation, eastern Sabah, Malaysia. *Bulletin of the British Museum*, *Natural History (Geology Series)*, vol. 31, p. 1–120.

Wiesner, H., 1920: Zur Systematik der Miliolideen. *Zoologisches Anzeiger*, vol. 51, p. 13–20.

Wiesner, H., 1931: Die Foraminiferen der Deutschen Südpolar-Expedition 1901–1903. *Deutche Südpolar-Expedition*, vol. 20, Zoologie, 12, p. 53–165.

Williamson, W. C., 1848: On the Recent British species of the genus *Lagena*. *Annals and Magazine of Natural History, Second series*, vol. 1, p. 1–20.

Williamson, W. C., 1858: *On the Recent Foraminifera of Great Britain*, 107 p. Ray Society, London.

Wilson, K., Hayward, B. W., Sabaa, A. T., Scott, G. H. and Kennett, J. P., 2005: A one –million-year history of a north-south segment of the Subtropical Front, east of New Zealand. *Paleoceanography*, vol. 20, PA2004, doi:10.1029/2004PA001080.

Wright, J., 1911: Foraminifera from the estuarine clays of Magheramorne, Co. Antrim and Limavady Station, Co. Derry. *Annual Report and Proceedings of the Belfast Naturalists' Field Club*, *Series 2*, vol. 6 (1910-11), Appendix, p. 9–19.

Xu, X. and Ujiié, H., 1994: Bathyal benthic foraminiferal changes during the past 210,000 years: Evidence from piston cores taken from seas south of Ishigaki Island, southern Ryukyu Island Arc. *Transactions and Proceedings of the Paleontological Society of Japan*, New Series, no. 175, p. 497–520.

Yassini, I. and Jones, B. G., 1995: *Recent Foraminifera and Ostracoda from Estuarine and Shelf Environments on the Southwestern Coast of Australia*, 484 p. University of Wollongong Press, Wollongong.

Yoshida, S., 1958: Miocene foraminifera from the Okawa, Oikamanai and Tobei Formations of the Toyokoro Hill, Tokachi Province, Hokkaido. *Journal of Hokkaido Gakugei University*, vol. 9, p. 265–277.

Zheng, S.-Y., 1979: The Recent foraminifera of the Xisha Islands, Guangdong Province, China. II. *Studia Marina Sinica*, vol. 15, p. 101–232. (*in Chinese with English summary and descriptions of new species*)

Zheng, S.-Y., 1980: The Recent foraminifera of the Zhongsha Islands, Guangdong Province, China. I. *Studia Marina Sinica*, vol. 16, p. 143–182. (*in Chinese with English summary and descriptions of new species*)

Zheng, S.-Y., 1988: *The Agglutinated and Porcelaneous Foraminifera of the East China Sea*, 337 p. Science Press, Beijing. (*in Chinese with English summary and descriptions of new species*)

Appendix. Census data of benthic foraminifera from Hole U1352B in the Canterbury Basin.

Sample 317-U1352B-	1H-1-W, 19–21 cm	1H-3-W, 94–96 cm	1H-5-W, 19–21 cm	2H-1-W, 94–96 cm	7H-6-W, 19–21 cm	7H-6-W, 94–96 cm	8H-1-W, 19–21 cm	8H-2-W, 20–22 cm	9H-3-W, 19–21 cm	10H-4-W, 19–21 cm	10H-6-W, 19–21 cm
Core depth (m CSF-A)	0.20	3.95	6.20	9.15	63.40	64.15	65.40	66.91	77.90	87.66	90.66
Abditodentrix pseudothalmanni						1	1				
Angulogerina angulosa	6	8	7	8	7		4	5	5	1	9
Anomalinoides sphericus	1	3	1	8	1	4	2	4	1		3
Bolivina alata								1			
Bolivina cf. *difformis*				1							
Bolivina earlandi	1	7	7	4			1		9	2	1
Bolivina neocompacta											1
Bolivina peirsonae		1							4		
Bolivina pseudoplicata	1					1					
Bolivina robusta					1						
Bolivina seminuda											
Bolivina variabilis	14	5	2	8	1		4	1	3	1	
Bolivina sp. 1											
Bolivina sp. 2	1			1	1		2	2			1
Bolivinita pliozea											
Botuloides pauciloculus								1			
Briceia complectilis											
Briceia sp. 1											
Buchnerina sp.1											
Bulimina aculeata	1		3								
Bulimina spinosa											
Cassidulina carinata	62	57	46	54	82	54	31	31	30	42	78
Cassidulina reniforme	6	20	14	11	1	3	23	20	41	50	13
Cerobertina cf. *afueriana*											1
Cerobertina cf. *bartrumi*											
Cibicides dispars	9	6	2	6	10	11	8	13	7	16	7
Cibicides lobatulus		2					1			1	
Cibicides marlboroughensis											
Cibicides variabilis	2			2		4	1	2	1	2	7
Colonimilesia coronata					1						
Cornuspira involvens			2			1		1		1	
Discanomalina semipunctata											
Discorbinella bertheloti	8	7		6		2		5	2	2	1
Discorbinella subcomplanata	2									2	2
Discorbinella vitrevoluta	2	1			10	3		2		1	19
Discorbinella sp. 1			4	1	4						
Discorbis aff. *malovensis*											1
Elphidium charlottense		5	8	15					1	2	
Elphidium clavatum	2	3	7	6	2	5	1	4	1	1	3
Elphidium oirgi										1	
Eubuliminella exilis		1							4		
Eusphaeroidina inflata					1						
Euuvigerina juncea								3			
Evolvocassidulina belfordi											
Exsculptina eccentrica											
Favulina hexagona											
Fissurina aequilabialis			4				2				2
Fissurina angulata			1								
Fissurina aureoligera											2
Fissurina biumbonata							1				
Fissurina calostoma											1
Fissurina circularis				2					1	2	
Fissurina circumcincta					1						
Fissurina compressa											
Fissurina densifasciata								4	3		
Fissurina aff. *densifasciata*		1	2						1		
Fissurina depressiformis											
Fissurina lucida											
Fissurina lucidiformata		1								3	
Fissurina marginata		1									1

Appendix. *Continued 1.*

11H-1-W, 51–53 cm	11H-3-W, 94–96 cm	11H-4-W, 94–96 cm	11H-6-W, 94–96 cm	12H-6-W, 19–21 cm	13H-1-W, 93–95 cm	13H-4-W, 19–21 cm	14H-3-W, 94–96 cm	14H-6-W, 19–21 cm	15H-6-W, 94–96 cm	16H-2-W, 94–96 cm	16H-3-W, 94–96 cm	16H-6-W, 93–95 cm	17H-2-W, 94–96 cm	17H-4-W, 90–92 cm
94.22	97.65	99.13	102.13	110.86	113.64	117.38	126.15	129.90	139.95	143.65	145.12	149.61	153.15	155.40
					4	12	53	29	90	53	86	44	95	5
8	20	4	4	12	31	21	4		10	5	11	6	19	18
	7		1	1		9		2		1			2	
3		12	7		1	2	7	15	2	1	1	1	2	5
		1												
		2												
2	3	1	6		2	2	1			1	2		1	3
1														
6		2	1		2	1								
														7
							1							
				2		1								
		1												
44	86	33	32	37	91	33	29	5	46	79	52	32	54	46
17		16	30	47	2	15	18	44	4	16	5	4	2	4
								1			1			
9	5	19	19	23	3	6	6	14	4	1		3		6
													1	
	1					1				1	1			
	2	3		1	1	5	1	1			1	1	1	4
			3											
			2										1	
			1											
	10	8	10	7	3	4			6	8	5	4	11	7
	2				4			2	2	4	1	1	5	
	6		2	1	3						3	1	1	
			2				3							
1		1						1				2		
						1		1	3					2
16	3	5	4	10	3		1	6	5	7	4	5	9	2
							1							
						1						1		1
														1
														1
			1											
1														
						1								
					1									
		1												
						1						1	1	
							3						1	
			1											1
			1											
										1		3		

Appendix. *Continued 2.*

Sample 317-U1352B-	1H-1-W, 19–21 cm	1H-3-W, 94–96 cm	1H-5-W, 19–21 cm	2H-1-W, 94–96 cm	7H-6-W, 19–21 cm	7H-6-W, 94–96 cm	8H-1-W, 19–21 cm	8H-2-W, 20–22 cm	9H-3-W, 19–21 cm	10H-4-W, 19–21 cm	10H-6-W, 19–21 cm
Core depth (m CSF-A)	0.20	3.95	6.20	9.15	63.40	64.15	65.40	66.91	77.90	87.66	90.66
Fissurina mazzarensis		1									
Fissurina cf. *paulispinata*											
Fissurina rotalicurvata	4									1	
Fissurina subquadrata											
Fissurina sp. 1											
Fissurina sp. 2			1								
Fissurina sp. 3			1					1	7		1
Fissurina sp. 4				1							
Fissurina sp. 5											
Fissurina sp. 6				3							
Fissurina sp. 7	1										
Fredsmithia laevigata											
Fursenkoina sp. 1		2							1	1	
Galwayella globosa											
Gavelinopsis hamata				1							
Gavelinopsis lobatula	7	3	7	9	8	4	1	2	2	3	9
Gavelinopsis praegeri	12	19	24	12	19	9	26	15	5	14	11
Globocassidulina crassa		2	2	1		14	12	32	2		
Globocassidulina subglobosa	6	2	16	8	4	10	23	32	7	6	9
Gyroidinoides zelandica											
Gyroidinoides sp. 1	3	1				2			1		
Haynesina depressula						1					
Heronallenia arubarensis											
Heronallenia lingulata		1								1	1
Heronallenia pulvinulinoides			1								
Hoeglundina elegans	1										
Homalohedra bassensis											
Hyalinonetrion elongata								1			
Irenita cornigera										1	
Laevidentalina inornata					1						
Laevidentalina sidebottomi											
Lagena annellatrachia	1										
Lagena meridionalis		1									
Lagena cf. *ollula*											
Lagena spicata											
Lagena sp. 1											
Lagenosolenia cf. *conspissata*											
Lagenosolenia curvituba							1				
Lagenosolenia nuda											
Lagenosolenia prolata	1										1
Lagenosolenia restricta											
Lagenosolenia vannicapitata				1							1
Laminononion tumidum	2	2	3	8	1		2			3	
Laticarinina altocamerata											
Lenticulina angulata											
Lotostomoides schwageri											
Marginulina glabra	1										
Mucronina resigae											
Mucronina spatulata											
Mychostomina revertens	2									1	
Neoconorbina augur	2	1	1			2	1	1		1	
Neolenticulina peregrina											
Nonionella auris	6	1	2	9			10	8	20	3	
Nonionella magnalingua	2		2			3			1		
Nonionellina flemingi	2	8	10	13	3	7	8	16	22	2	
Nonionoides grateloupi											
Nonionoides turgida		1	1								
Notorotalia depressa						1					
Notorotalia inornata		1	3	7	1	7	2	11	2	8	3
Notorotalia profunda	1			2		1					

Appendix. *Continued 3.*

11H-1-W, 51–53 cm	11H-3-W, 94–96 cm	11H-4-W, 94–96 cm	11H-6-W, 94–96 cm	12H-6-W, 19–21 cm	13H-1-W, 93–95 cm	13H-4-W, 19–21 cm	14H-3-W, 94–96 cm	14H-6-W, 19–21 cm	15H-6-W, 94–96 cm	16H-2-W, 94–96 cm	16H-3-W, 94–96 cm	16H-6-W, 93–95 cm	17H-2-W, 94–96 cm	17H-4-W, 90–92 cm
94.22	97.65	99.13	102.13	110.86	113.64	117.38	126.15	129.90	139.95	143.65	145.12	149.61	153.15	155.40
			1											
					1									
													1	
	1													
1														
1														
2	3	1			6	5	1	2	3			2		
8	19	11	14	10	10	3	6	9	9	8	12	4	22	12
27		17	1	5		13	4	19				4		4
20	9	27	6	17	10	25	3	33	4	17	9	61	4	9
						1								
		4	2	3		3	6		3	3		2		3
					2	2	2		1	1				
				1										
	1	1								2			2	
								1						
				1										
							1							
												2		
	1													
			1			1	1							
										1				
												1		
			1											
2	3	3	11			1	4		5	1				
	1													
								2						
	1					1								1
													2	
3	6	3	1	4	1				1	3	1	3	1	
8	2	6	4	9	2	2	4	2	1		2		2	15
1		3	2		1							1		
3	2	1	1	6	5	4	6	3	2		1		1	17
							3							
		4	4	3	3	12	10	4	1	1	2		1	20

Appendix. *Continued 4.*

Sample 317-U1352B-	1H-1-W, 19–21 cm	1H-3-W, 94–96 cm	1H-5-W, 19–21 cm	2H-1-W, 94–96 cm	7H-6-W, 19–21 cm	7H-6-W, 94–96 cm	8H-1-W, 19–21 cm	8H-2-W, 20–22 cm	9H-3-W, 19–21 cm	10H-4-W, 19–21 cm	10H-6-W, 19–21 cm
Core depth (m CSF-A)	0.20	3.95	6.20	9.15	63.40	64.15	65.40	66.91	77.90	87.66	90.66
Nummulopyrgo globulus	3		1			2					1
Oolina neolineata											
Oolina sp. 1					1						
Oridorsalis umbonatus											
Pacinonion minutus	2	5	3	6	1	4	5	2	2	7	1
Pacinonion novozealandicum	3	3	2		1	1		1		1	
Palliolatella antiqua					2						1
Palliolatella grenfelli sp. nov.			1								
Palliolatella haywardi sp. nov.					1						
Palliolatella? aff. *quadricinctaovalis*											
Palliolatella sp. 1						1					
Paracassidulina stabilis			1	1			1		3		
Parafissurina abnormis											
Parafissurina admiralis		1									1
Parafissurina curta											
Parafissurina curvans						1					
Parafissurina dohrnii	2										1
Parafissurina electa		1									
Parafissurina lata	1					1					
Parafissurina magnilabiata											
Parafissurina multicosta											
Parafissurina cf. *towaeriana*											
Parafissurina sp. 1									1		
Patellina corrugata	2		2	1	1			1	1	1	1
Pileolina patelliformis			8		1						
Pileolina radiata		1									
Planoglabratella nimai		2		1	3						
Planoglabratella opercularis					2						
Planulina subinflata											
Prionotolegna sp. 1					3						
Pseudononion chiliensis											
Pseudoparrella vitrea	15	9	5	18	4	1	12	4	5	5	9
Pullenia quinqueloba											
Pyrgo clypeata						1					
Pyrulina fusiformis											
Quinqueloculina delicatula			1		1						
Quinqueloculina frigida		8	2	4			8	5	1	2	
Quinqueloculina suborbicularis	2	3	5		2	5	3	2	3	1	2
Rosalina vitrizea								1			
Rotaliella chasteri											
Rotaliella sabaae sp. nov.							1			1	
Rutherfordoides rotundatus											
Saidovina karreriana		1									
Saracenaria sp. 1									1		
Siphotextularia mestayerae	1					1			0		
Sphaeroidina bulloides		1	1	1		2	1	1	4	2	
Spirillina denticulogranulata	1										
Spiroplectamminina proxispira											1
Subanomalina pauperata					2						1
Textularia paupercula											
Textularia pseudogramen						2					
Triloculina cf. *detlingae*											
Triloculina trigonula											
Triloculina sp. 1	6								1		
Trilocullinella pseudooblonga	4	2	4	1		6	2	7	1		3
Tubinella funalis			1								
Vasicostella cf. *enderbiensis*							1				
Vasicostella rara											
Virgulopsis turris			1	1	1	2					
total specimens	214	212	222	242	186	180	202	242	207	195	211

Appendix. *Continued 5.*

11H-1-W, 51–53 cm	11H-3-W, 94–96 cm	11H-4-W, 94–96 cm	11H-6-W, 94–96 cm	12H-6-W, 19–21 cm	13H-1-W, 93–95 cm	13H-4-W, 19–21 cm	14H-3-W, 94–96 cm	14H-6-W, 19–21 cm	15H-6-W, 94–96 cm	16H-2-W, 94–96 cm	16H-3-W, 94–96 cm	16H-6-W, 93–95 cm	17H-2-W, 94–96 cm	17H-4-W, 90–92 cm
94.22	97.65	99.13	102.13	110.86	113.64	117.38	126.15	129.90	139.95	143.65	145.12	149.61	153.15	155.40
					1	1								
9	2	3	11	13	2	3	14	12	2		1	5		6
1			4	1	2		3		3		1			1
	1									1				
											1			
				1				3						
		1							1		2	1		
				1									2	
					2				1			2		
1		2			1									
				1								1		
			1											
		1	3	1				2	2	1	1		4	2
									1	2		7	85	
2			1				4	2						
2														
							3							
	1													
1		5	5	3	3	3	1	1	3	7	1	17	10	33
			1						1		1			
		2												
		1					2							
	6		1				1	2						
			3						1					
									1					
					1				1					
							3		1					
1		2	3	4		4	2	3						1
	1					1								
						1								
			3										2	
				1										
			1					1						
	2		2					1		1			8	
1	1			2	2					1	3			
202	208	207	215	228	206	202	212	223	220	227	212	219	356	237

Appendix. *Continued 6.*

Sample 317-U1352B-	18H-1-W, 94–96 cm	18H-5-W, 94–96 cm	19H-2-W, 94–96 cm	19H-6-W, 19–21 cm	21H-3-W, 94–96 cm	22H-5-W, 19–21 cm	22H-6-W, 19–21 cm	22H-7-W, 19–21 cm	23H-1-W, 94–96 cm	23H-2-W, 19–21 cm	23H-2-W, 94–96 cm
Core depth (m CSF-A)	157.15	161.55	168.15	173.37	183.65	195.40	196.90	198.40	199.65	200.40	201.15
Abditodentrix pseudothalmanni	121	2		1		1			5	11	
Angulogerina angulosa	16	12	18	18	19	30	41	32	25	21	1
Anomalinoides sphericus	1				1					2	
Bolivina alata											
Bolivina cf. *difformis*											
Bolivina earlandi		8	2	5	1	6	7				7
Bolivina neocompacta											
Bolivina peirsonae		2	3				1				
Bolivina pseudoplicata											
Bolivina robusta											
Bolivina seminuda				1						1	
Bolivina variabilis		4	2	8	2	5	7	3	2	2	7
Bolivina sp. 1											
Bolivina sp. 2		2	3			3					
Bolivinita pliozea	1			2	1					2	
Botuloides pauciloculus											
Briceia complectilis											
Briceia sp. 1							1				
Buchnerina sp.1										1	
Bulimina aculeata										1	1
Bulimina spinosa											
Cassidulina carinata	73	7	43	5	48	45	46	54	78	128	13
Cassidulina reniforme	3	14		25	2	4	11	3	4	10	4
Cerobertina cf. *afueriana*											
Cerobertina cf. *bartrumi*	1						2				
Cibicides dispars	1	5	3	5	4	7	11	13	3	5	7
Cibicides lobatulus		1			2					1	
Cibicides marlboroughensis	1										
Cibicides variabilis			1	2	2	2	5			1	
Colonimilesia coronata					1						
Cornuspira involvens	1				1						
Discanomalina semipunctata											
Discorbinella bertheloti	5	3		6	16	11	15	10	4	6	2
Discorbinella subcomplanata				2	1	1	6	7	14		3
Discorbinella vitrevoluta	4				4	2	3	1	11	8	
Discorbinella sp. 1											
Discorbis aff. *malovensis*					1	4	16	3	3		2
Elphidium charlottense					4						
Elphidium clavatum	5	3	4	4	7	8	14	14	4	2	6
Elphidium oirgi											
Eubuliminella exilis											
Eusphaeroidina inflata		1									
Euuvigerina juncea			1		2			4			
Evolvocassidulina belfordi											
Exsculptina eccentrica									1		
Favulina hexagona				1							
Fissurina aequilabialis		1			1						
Fissurina angulata							2				
Fissurina aureoligera											
Fissurina biumbonata											
Fissurina calostoma											
Fissurina circularis	2		3					1			
Fissurina circumcincta											
Fissurina compressa						1		1			
Fissurina densifasciata		1				1				1	
Fissurina aff. *densifasciata*					1						
Fissurina depressiformis											
Fissurina lucida											
Fissurina lucidiformata	1										
Fissurina marginata				1							

Appendix. *Continued 7.*

23H-7-W, 19–21 cm	24H-7-W, 18–20 cm	25H-1-W, 94–96 cm	26H-2-W, 94–96 cm	27H-5-W, 94–96 cm	27H-7-W, 19–21 cm	28H-1-W, 19–21 cm	28H-2-W, 19–21 cm	28H-3-W, 19–21 cm	28H-4-W, 17–19 cm	29H-1-W, 94–96 cm
207.90	217.39	218.65	229.57	243.65	245.40	246.40	247.83	249.33	250.31	252.15
1		8		3	8	143	10		3	2
31	12	8	8	46	14	12	4	12	9	5
						2				
1	1	10	14				14		14	13
		1					4		1	
5		2	1	1	1	8	1	2	3	
2		2	2			1	4	2		1
		3		1					1	
80	110	14	65	126	125	63	30	52	22	31
2	14	12	19	2	1	13	25	4	19	21
				1		1			2	2
6		1	1	6	10	6	4	6	4	
	7			1						
2	2	4			1		1			
11		4	3	2	5	2	3	9	9	13
3	2			3		2		3		2
	1			2					2	
	2	3				1		2		3
	8		1	2						
24	7	10	6	4		1	22	9	5	11
		1	1							
						1				
					1					
	1		1					1		
								1	2	
		1					1			
	1				1		1			
	1		1				2			1
							2			
	1						1		2	

Appendix. *Continued 8.*

Sample 317-U1352B-	18H-1-W, 94–96 cm	18H-5-W, 94–96 cm	19H-2-W, 94–96 cm	19H-6-W, 19–21 cm	21H-3-W, 94–96 cm	22H-5-W, 19–21 cm	22H-6-W, 19–21 cm	22H-7-W, 19–21 cm	23H-1-W, 94–96 cm	23H-2-W, 19–21 cm	23H-2-W, 94–96 cm
Core depth (m CSF-A)	157.15	161.55	168.15	173.37	183.65	195.40	196.90	198.40	199.65	200.40	201.15
Fissurina mazzarensis									1		
Fissurina cf. *paulispinata*											
Fissurina rotalicurvata											
Fissurina subquadrata											
Fissurina sp. 1											
Fissurina sp. 2											
Fissurina sp. 3		2		3					2		4
Fissurina sp. 4											
Fissurina sp. 5				1							
Fissurina sp. 6										1	
Fissurina sp. 7						2					
Fredsmithia laevigata											
Fursenkoina sp. 1											
Galwayella globosa											
Gavelinopsis hamata											
Gavelinopsis lobatula					1		1	2	4	4	
Gavelinopsis praegeri	11	10	1	7	20	21	19	14	7	16	9
Globocassidulina crassa	1	4	10	13	2	6		14	9	4	33
Globocassidulina subglobosa	7	15	19	23	15	28	11	20	19	16	68
Gyroidinoides zelandica											
Gyroidinoides sp. 1	2	3	1	3		1				2	2
Haynesina depressula					1						
Heronallenia arubarensis											
Heronallenia lingulata					1	1	1	1		1	
Heronallenia pulvinulinoides						1					
Hoeglundina elegans											
Homalohedra bassensis											
Hyalinonetrion elongata											
Irenita cornigera											
Laevidentalina inornata											
Laevidentalina sidebottomi						1					
Lagena annellatrachia											
Lagena meridionalis											
Lagena cf. *ollula*											
Lagena spicata		3									
Lagena sp. 1											
Lagenosolenia cf. *conspissata*											
Lagenosolenia curvituba			1								
Lagenosolenia nuda										1	
Lagenosolenia prolata											
Lagenosolenia restricta											
Lagenosolenia vannicapitata											
Laminononion tumidum		4			1	2	2				
Laticarinina altocamerata										1	
Lenticulina angulata	2						1				2
Lotostomoides schwageri											7
Marginulina glabra											
Mucronina resigae									1		
Mucronina spatulata											
Mychostomina revertens	1				2						
Neoconorbina augur	4	1			6		6		1	2	
Neolenticulina peregrina			1								
Nonionella auris	2	21	16	22	3	2	3	7	1	3	5
Nonionella magnalingua		4		1	1						
Nonionellina flemingi	2	20	19	14	2	1		3		6	1
Nonionoides grateloupi								2			
Nonionoides turgida											
Notorotalia depressa			2								
Notorotalia inornata		7	25	19	4			1	2	2	3
Notorotalia profunda									2		

Appendix. *Continued 9.*

23H-7-W, 19–21 cm	24H-7-W, 18–20 cm	25H-1-W, 94–96 cm	26H-2-W, 94–96 cm	27H-5-W, 94–96 cm	27H-7-W, 19–21 cm	28H-1-W, 19–21 cm	28H-2-W, 19–21 cm	28H-3-W, 19–21 cm	28H-4-W, 17–19 cm	29H-1-W, 94–96 cm
207.90	217.39	218.65	229.57	243.65	245.40	246.40	247.83	249.33	250.31	252.15
						1				
									1	
			1							
			3							
								1		
3				1	3	3		3	3	
7	19	5	13	7	8	10	10	16	18	18
5	16	42	3				6			
14	31	82	27	14	14	21	6	5	4	2
			7		1	2	3		4	
									2	
	1									
	2			1		1	1	1		3
									1	
										1
							1			
				1						
			1				1		2	
							2			2
										1
							1			
						2			1	
2		1	1	3	1		2	1	6	2
2		4	6		2		12	2		10
	2									
3	3	1	2	1	1	2	14	1	2	2
			2							
4	3	18	1	4		1	9	1	10	2

Appendix. *Continued 10.*

Sample 317-U1352B-	18H-1-W, 94–96 cm	18H-5-W, 94–96 cm	19H-2-W, 94–96 cm	19H-6-W, 19–21 cm	21H-3-W, 94–96 cm	22H-5-W, 19–21 cm	22H-6-W, 19–21 cm	22H-7-W, 19–21 cm	23H-1-W, 94–96 cm	23H-2-W, 19–21 cm	23H-2-W, 94–96 cm
Core depth (m CSF-A)	157.15	161.55	168.15	173.37	183.65	195.40	196.90	198.40	199.65	200.40	201.15
Nummulopyrgo globulus					1						
Oolina neolineata		1									
Oolina sp. 1											
Oridorsalis umbonatus											
Pacinonion minutus	4	17	1	2	4	3	7	2	2	4	21
Pacinonion novozealandicum		2	1				1	3		1	
Palliolatella antiqua	1					1		1		1	
Palliolatella grenfelli sp. nov.					1						
Palliolatella haywardi sp. nov.									1		
Palliolatella? aff. *quadricinctaovalis*								2			
Palliolatella sp. 1								1			
Paracassidulina stabilis		2									
Parafissurina abnormis								1			
Parafissurina admiralis									1		
Parafissurina curta											
Parafissurina curvans	1										
Parafissurina dohrnii	1				1						
Parafissurina electa					2						
Parafissurina lata											
Parafissurina magnilabiata							1				
Parafissurina multicosta								1			
Parafissurina cf. *towaeriana*											
Parafissurina sp. 1											
Patellina corrugata		1		1	2	1	3	2		1	2
Pileolina patelliformis	5			2	25	17	21	8	6		1
Pileolina radiata											
Planoglabratella nimai	3				1	1	1	2		2	
Planoglabratella opercularis									1		
Planulina subinflata											
Prionotolegna sp. 1											
Pseudononion chiliensis											
Pseudoparrella vitrea	12	11	60	9	9	12	17	4	3	7	5
Pullenia quinqueloba											
Pyrgo clypeata								1			
Pyrulina fusiformis											
Quinqueloculina delicatula											
Quinqueloculina frigida					3	3				2	
Quinqueloculina suborbicularis	3				1		2		1	3	
Rosalina vitrizea	1	1					1				
Rotaliella chasteri											
Rotaliella sabaae sp. nov.											
Rutherfordoides rotundatus											
Saidovina karreriana											
Saracenaria sp. 1											
Siphotextularia mestayerae											
Sphaeroidina bulloides	2	6	1	6	1		1	3		1	
Spirillina denticulogranulata											
Spiroplectamminina proxispira											
Subanomalina pauperata	3	1									
Textularia paupercula			1								
Textularia pseudogramen								1			
Triloculina cf. *detlingae*	1						1				
Triloculina trigonula							1				1
Triloculina sp. 1											
Trilocullinella pseudooblonga	1				11	3	3	3		2	
Tubinella funalis											
Vasicostella cf. *enderbiensis*											
Vasicostella rara							1				
Virgulopsis turris					2	2				1	
total specimens	306	202	242	212	244	240	293	245	218	287	217

Appendix. *Continued 11.*

23H-7-W, 19–21 cm	24H-7-W, 18–20 cm	25H-1-W, 94–96 cm	26H-2-W, 94–96 cm	27H-5-W, 94–96 cm	27H-7-W, 19–21 cm	28H-1-W, 19–21 cm	28H-2-W, 19–21 cm	28H-3-W, 19–21 cm	28H-4-W, 17–19 cm	29H-1-W, 94–96 cm
207.90	217.39	218.65	229.57	243.65	245.40	246.40	247.83	249.33	250.31	252.15
								1		
3	7		3	1		2	1	2	7	
3	1	1		1				1		
1		1								
							1			
	1					1				
						1				
2			1							
	3					1	1	1	1	2
4	23	1		16	13	3	4	10		13
	1					1	2		1	
								1		
5	15	18	30	11	7	6	20	26	30	30
									1	9
										1
					1					
1						1	2			
			1						2	
	1									
										2
						1				
		3	4	1			2		2	8
1					1	5			2	
			1				2			
3		1		1	2	8		1		3
1				1					1	
232	299	262	230	264	221	329	232	177	199	216