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15. BENTHIC FORAMINIFERAL BIOSTRATIGRAPHY OF SITE 861, CHILE TRIPLE JUNCTION, SOUTHEASTERN PACIFIC[1]

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ABSTRACT

Description of the assemblage composition and stratigraphic ranges of benthic foraminifers and identification of 78 benthic foraminiferal species from Pliocene to recent sections recovered from ODP Site 861 holes found that the foraminiferal assemblages are characteristic of bathyal depths and agree with recent faunas from water depths between 1300 and 2500 m in the Peru-Chile Trench. Some species reported to live in shallower depths than Site 861 at 1651 m are probably displaced. Redeposited foraminifers occur commonly in samples from diamictites and differ from autochthonous assemblages by their yellow color and poor preservation. Higher abundances of *Melonis pompilioides* in the "broken formation" below 400 mbsf indicate a former deposition in greater water depths than Site 861 and support the interpretation of this formation as accreted hemipelagic sediments of the oceanic plate. A benthic foraminiferal assemblage zonation proposed for the succession comprises the *Uvigerina senticosa* Assemblage Zone from sea floor to 158.86 mbsf (0–1.33 Ma), the *Stilostomella* cf. *consobrina* Assemblage Zone from 158.86 to 448.50 mbsf (1.33–3.1 Ma), and the *Uvigerina mantaensis* Assemblage Zone below 448.50 mbsf (3.1 to >3.4 Ma). The top of the *S.* cf. *consobrina* Assemblage Zone corresponds to the *Stilostomella* Extinction as described from the low- to mid-latitude eastern Atlantic and the Manihiki Plateau in the southwestern tropical Pacific.

INTRODUCTION

Benthic foraminifers are widely used for biostratigraphically subdividing Mesozoic and lower Cenozoic sediments. Many species appeared first in the early Eocene, after the late Paleocene extinction (e.g., van Morkhoven et al., 1986). For the late Cenozoic, however, biostratigraphical correlations using deep-sea benthic foraminifers can be difficult because most of the foraminifers display extended stratigraphic ranges (e.g., Boltovskoy and Guissani, 1990). As a result, benthic foraminifers have been scarcely used for stratigraphic purposes in the late Cenozoic. A subdivision of Neogene and Quaternary sequences by using benthic foraminifers was attempted by Lutze (1979; Fig. 7) at Deep Sea Drilling Project (DSDP) Site 397 (Northwest African continental margin) who subdivided the Pliocene to Pleistocene succession into five faunal units. The aim of the present paper is to describe the stratigraphic ranges and assemblage composition of benthic foraminifers from Ocean Drilling Program (ODP) Site 861 and to assess datum levels that are useful for a biostratigraphical subdivision. We attempt to describe a benthic foraminiferal assemblage zonation and correlate this with the standard nannofossil and plankton foraminifer zones.

The *Stilostomella* Extinction

Several Pliocene genera and species as *Nodogenerina* sp., sp., *Stilostomella* sp., sp., *Plectofrondicularia advena,* and *Pleurostomella brevis,* die out in the mid Pleistocene. A short interval with the last occurrence (LO) of these taxa is recognized in sediment cores from the low- to mid-latitude eastern Atlantic and in the tropical to northern Pacific (e.g., Beiersdorf et al., unpubl. data; Caralp, 1984; Keller, 1980; Lutze, 1979; Resig, 1976; Thomas, 1985; 1987). The LO of species from this assemblage is defined as the *Stilostomella* Extinction by Weinholz and Lutze (1989). This level has been dated by correlation with the magnetostratigraphy and high-resolution oxygen-isotope records and the ages vary between 0.64 and 1.3 Ma. Most of the LO's roughly correlate, however, with the boundary of Brunhes/Matuyama magnetochrons at 0.78 Ma. Generally, the *Stilostomella* Extinction happened much earlier in greater water depths, far from the shore, and in areas away from high productivity. The cause behind this extinction is not yet fully understood. The earlier disappearance in greater water depths indicates a successive displacement and restriction of areas with favorable ecological conditions for species from this assemblage (Weinholz and Lutze, 1989). From biostratigraphical studies on Cretaceous benthic foraminifers is known, that the extinction of benthic species happened not isochronously but is apparently time-transgressive. The extinction pattern gives also evidence for a successive restriction of living space for the species regarded (Schönfeld, 1990). Despite diachronism, the extinction of a benthic species is considered as single event. In this paper, we attempt to assess the assemblage composition and extinction pattern of *Stilostomella* and affiliate taxa in the mid-latitude southeastern Pacific. The age of the *Stilostomella* Extinction is constrained by correlation with the standard nannofossil zonation.

Geological Setting

Site 861 is the most shoreward site of ODP Leg 141 and is located in a water depth of 1652 m, midway on the continental slope off Chile at 45°51′S (Fig. 1). The site is well below 800 m water depth where significant faunal changes occur in the Peru-Chile Trench (Ingle et al., 1980). The drilling at Site 861 penetrated forearc basin strata down to 351.9 m below seafloor (mbsf) (Unit I and Subunits IIA, IIB; Behrmann, Lewis, Musgrave, et al., 1992). They are underlain by deformed hemipelagic sediments of the "broken formation," which may represent the top of the accretionary wedge (Unit III). This formation was encountered down to 496.3 mbsf. Calcareous nannofossils and planktonic foraminifers indicate, that the oldest sediments recovered in forearc basin deposits and accreted hemipelagic sediments are of late Pliocene. The sediments recovered at Site 861 comprise mostly silty clays to clayey silts. Many diamictites, which are interpreted as debris flows, a few turbiditic sand layers, and some volcanic ash beds are intercalated in the interval between 43.8 to 351.9 mbsf (Subunits IIA and IIB).

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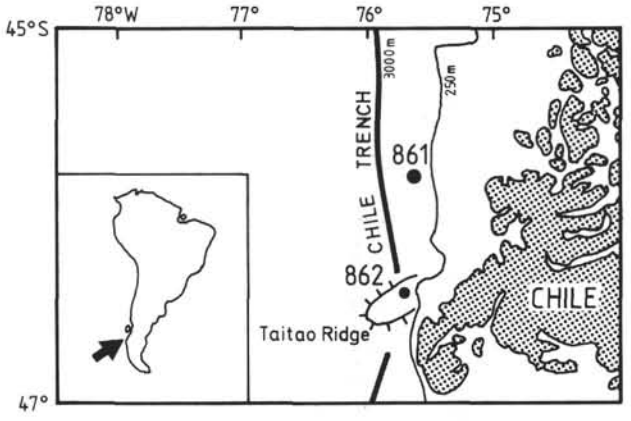

Figure 1. Location map of Site 861.

MATERIAL AND METHODS

For the study of benthic foraminifers, we used the same samples from Holes 861C and 861D, taken aboard ship, as for planktonic foraminifer studies. The samples, approximately 20 cm^3, were processed according to the degree of induration. Soft silts and clays were washed over a 63 µm mesh. Stiff silty clays were dried and then soaked in diluted H_2O_2 solution until they were sufficiently disintegrated. Indurated mudstones were dried in vacuo and soaked in paraffin. The samples were then put into highly concentrated soda lye and gently heated at 60°–80°C until they were completely disintegrated. The disintegrated samples were washed over a 63 µm mesh and dried, and the fossils were separated under a binocular microscope. The entire grain-size fraction >180 µm was picked out for benthic foraminifers. For the 63- to 180-µm fraction, a half-one to eight-one split was made and picked out as well. The foraminifers were collected in single-cell slides and their relative abundances were estimated. In the range charts, the abundances are categorized as follows: R = rare, less than 3%; F = few, 3% to 15%; and C = common, 15% to 30%. The state of preservation is described as G = good, M = moderate, and P = poor.

RESULTS

Benthic Foraminiferal Assemblages

Benthic foraminifers are abundant or common and moderately to well-preserved in the Hole 861C sequences down to Sample 141-861C-20X-CC (170.20 mbsf). The abundance varies from 30 to 3000 specimens per 20 cm^3 sample in this part of the succession. They become rare below 170.20 mbsf, where abundances of only 12 to 240 tests per 20 cm^3 sample are recorded (Table 6 of Spiegler and Müller, this volume). The preservation is moderate or poor. Seventy-eight benthic foraminiferal species were identified. Their names and taxonomic references are given in the Appendix. The assemblages are dominated by *Uvigerina peregrina, Uvigerina bifurcata, Bulimina striata mexicana, Oridorsalis umbonatus,* and *Hoeglundina elegans.* Common faunal elements are *Melonis barleeanum, Cibicidoides wuellerstorfi, Cibicidoides mckannai, Cassidulina crassa, Pullenia bulloides,* and *Globobulimina affinis. Cassidulina laevigata, Bulimina alazanensis, Uvigerina senticosa, Nonionella auris, Epistominella pacifica, Nodogenerina adolphina,* and *Stilostomella* cf. *consobrina* are sporadically frequent.

Paleobathymetry

Benthic foraminifers are usually good indicators of environmental conditions, bathymetry, transport, and sedimentation processes. The complicated oceanographic setting (Ingle et al., 1980) and scarcity of data about recent depth distributions of benthic foraminifers in the area allows, however, only a cautious paleobathymetrical interpretation of foraminiferal assemblages.

The fauna at Site 861 is bathyal and resembles associations described by Bandy and Rodolfo (1964) from a water depth between 1863 and 2486 m. Site 861 is also within the depth range of most of the common species as reported by Ingle et al. (1980). *Oridorsalis tener* [=*umbonatus*], *Cibicidoides bradyi, Gyroidina zelandica, Globobulimina affinis,* and *Melonis affinis* [=*barleeanum* in our opinion] show abundance maxima at depths of 1326, 1800, and 1864 m, close to the depth of Site 861 (1652 m). *Melonis pompilioides* and *Uvigerina senticosa* were found by Bandy and Rodolfo (1964) and Ingle et al. (1980), however, only at water depths far below that of Site 861 (2489 and 3550 m, respectively). The abundance of *M. pompilioides* increases at Site 861 below 400 mbsf. This part of the succession belongs to the "broken formation" of deformed hemipelagic sediments (Behrmann, Lewis, Musgrave, et al., 1992). Hemipelagic muds with intercalated distal turbidites are deposited on the oceanic plate seaward of the Chile Trench axis in water depths of 2500 to 3200 m off southern Chile (Thornburg et al., 1990). Higher abundance of *M. pompiliodes* below 400 mbsf indicate deposition in greater water depth than Site 861 is located today. This supports the interpretation of the "broken formation" as accreted hemipelagic sediments which have been detached from the subducted oceanic plate.

Some faunal elements (e.g., *Bucella peruviana, Bolivina spissa,* and *Ehrenbergina glabra*) are reported from shallower water depths than at Site 861. They occur in the low- to mid-latitude eastern Pacific from 44 to 240 m, 183 to 1170 m, and 73 to 640 m, respectively (Boltovskoy and Theyer, 1970; Resig, 1981; Uchio, 1960; Wiesner, 1931). These species are therefore regarded as displaced forms that indicate near-bottom downslope transport.

Paleoceanography

Site 861 is located at 1652 m water depth at the lower depth level of Antarctic Intermediate Water (AAIW). AAIW is formed by subsurface mixing at and north of the Antarctic Polar Front (AAPF) and spreads northward to 15°S (Pickard and Emery, 1990). Off the coast of southern Chile, AAIW is characterized by an oxygen minimum zone and high nutrient contents between 900 and 1700 m (Ingle et al., 1980). A correlation of benthic foraminiferal assemblages with AAIW properties is not possible to date because of the lack of data on the distribution of living benthic foraminifers at intermediate depths north of the AAPF (Herb, 1971; Mackensen et al., 1993).

A peculiarity at Site 861 is the presence of *Uvigerina hollicki,* which has been described previously only from the Atlantic. Off the coast of Northwest Africa, *U. hollicki* occurs in organic-rich sediments underlying an area of high primary productivity at water depths between 1500 and 3000 m (Lutze, 1986; Lutze and Coulbourn, 1984). As such, ecological conditions favorable for this species may include high flux-rates of particulate organic matter. At Site 861, *U. hollicki* is recorded in samples from Core 141-861C-1H (0.45 to 3.00 mbsf), Holocene and Termination Ib in age. Below 3.0 mbsf *U. hollicki* is found only in a few samples. The next occurrence in Sample 141-861C-3H-5, 60–65 cm, (19.10 mbsf) coincides with Oxygen Isotope Event 5.5 (i.e., the last Interglacial; Schönfeld et al., this volume). The presence of *U. hollicki* in Holocene samples from Site 861 reveals that flux rates of particulate organic matter were higher then as compared with glacial conditions, a contention which is supported by increased Holocene C_{org} contents (Behrmann, Lewis, Musgrave, et al., 1992). This organic matter may either come from local upwelling and accumulate in a density interface at the base of AAIW, or it derives from the AAPF and is carried to this area by AAIW. As low oxygen contents indicative of the decay of organics prevail over the whole depth range of the AAIW, it is more likely that the organic material comes from the AAPF. The distribution of *U. hollicki* would then indicate a lower glacial productivity at the AAPF (Shimmield et al., 1994) or a different flow path of the AAIW in the southern Pacific.

Redeposited Faunas

The foraminiferal assemblages in the Site 861 sequence show two distinct modes of preservation in many samples from below 42 mbsf. Some calcareous specimens are translucent to white in color and moderate to well preserved, as are those from samples above 42 mbsf. The preservation of the others is moderate to poor, and their color is light yellow to orange. No forms with transitional colors are observed. Though the assemblage composition of the "white fauna" is similar to that of samples where only one mode of preservation is recognized, the "yellow fauna" shows a high portion of large miliolids (e.g., *Miliolinella subrotunda* and *Quinqueloculina seminula*).

In Sample 141-861C-6H-CC (50.50 mbsf), one yellow specimen of *Nodogenerina adolphina* was found. This level is dated to 0.29 Ma by using the age model derived from the oxygen-isotope stratigraphy (Table 1 of Schönfeld et al., this volume). *N. adolphina* occurs first in the white fauna at Sample 141-861-28X-4, 52–57 cm (233.12 mbsf), which is more than 1.6 Ma (Spiegler and Müller, this volume). A LO at 0.29 Ma is much younger than all known LOD's of the genus *Nodogenerina* (Weinholz and Lutze, 1989). As such, the yellow specimens are regarded as redeposited. A detailed comparison of the sample depths and core descriptions reveals that most of the samples containing yellow foraminifers were taken from diamictites, which are interpreted as debris flows (Behrmann, Lewis, Musgrave, et al., 1992). As debris flows may incorporate surficial sediments on their way downslope (e.g., Wright and Anderson, 1982) we concluded that the white fauna may represent the assemblage of near-surface sediments. It may not be displaced over a greater depth interval, as their composition differs not significantly from the regular fauna. As such, the white fauna of samples containing redeposited specimens is included in the range charts (Tables 1 and 2 [back-pocket foldout, this volume]). For the assessment of foraminiferal zones and the description of faunal trends, however, these samples were discarded.

Foraminiferal Stratigraphy and Faunal Trends

No profound changes in the benthic foraminiferal assemblage are recognized over the succession. However, some species show distinct stratigraphic ranges and marked changes in abundance. In the following we refer to those samples from Hole 861C, where no redeposited forms were recorded.

From the uppermost sample down to Sample 141-861C-2H-CC (12.50 mbsf) *Cibicidoides mackannai* is frequent, and *Uvigerina auberiana* and *Uvigerina hollicki* occur in moderate abundances. Warm-water-indicative planktonic foraminifers were found in this interval. Below Sample 141-861C-2H-CC, *Uvigerina senticosa* and *Epistominella pacifica* occur commonly. At Sample 141-861C-5H-6, 130–132 cm (39.10 mbsf; the base of nannofossil Zone NN21), *Uvigerina senticosa* becomes more frequent and the abundance of *Cibicidoides wuellerstorfi* decreases downhole. *Cassidulina parkerae* is found only in samples below 39.10 mbsf.

The uppermost part of the succession at Site 862 (Taitao Ridge, 1275 m water depth), 70 km south, is also characterized by warm-water-indicative planktonic foraminifers and the occurrence of *Uvigerina auberiana* and *Uvigerina hollicki.* Elevated epibenthic foraminifers, such as *Rupertina stabilis, Cibicides refulgens,* and *Cibicides lobatulus,* are frequent here. They were not found, however, at corresponding levels at Site 861.

The greatest change in assemblage composition at Site 861 occurs between Samples 141-861C-18X-CC (158.30 mbsf) and 141-861C-19X-CC (168.20 mbsf), approximately 10 m above the base of nannofossil Zone NN19, which marks the Pliocene/Pleistocene boundary. *Trifarina angulosa, Uvigerina senticosa* and *Epistominella pacifica* have their first occurrence (FO) at Sample 141-861C-19X-1, 59–64 cm (158.89 mbsf). *Stilostomella* cf. *consobrina* shows its LO in this sample. It becomes more frequent downhole from Sample 141-861C-28X-4, 52–57 cm, where *Nodogenerina adolphina* has its highest occurrence. *N. adolphina* occurs in samples with redeposited foraminifers higher in the hole (Sample 141-861C-27X-5, 64–69 cm; 225.65 mbsf). Below Sample 141-861C-29X-1, 129–131 cm (238.99 mbsf), *Dentalina* sp. sp. and *Mucronina* sp. become frequent. In Hole 861D, *Uvigerina mantaensis* occurs below Sample 141-861C-11R-CC (448.50 mbsf) but was also recorded with redeposited foraminifers in Sample 141-861C-6R-3, 127–130 cm (393.17 mbsf), a few meters above the base of the *G. inflata* Planktonic Foraminiferal Zone.

Benthic Foraminiferal Assemblage Zonation

The new benthic foraminiferal assemblage zonation for the succession at ODP Site 861 comprises three zones (Fig. 2). Because the magnetostratigraphy was not yet established (Behrmann, Lewis, Musgrave, et al., 1992) and the oxygen isotope stratigraphy is applicable only in the upper part of the succession down to 73.25 mbsf (Schönfeld et al., this volume), the ages of zonal boundaries were estimated by linear interpolation between nannofossil zonal boundaries by using the age model of Spiegler and Müller (this volume).

Uvigerina senticosa *Assemblage Zone*

Range: seafloor to 158.89 mbsf, (0 to 1.33 Ma); upper boundary: not defined; lower boundary: LO *Stilostomella* cf. *consobrina.*

Uvigerina senticosa occurs above 158.89 mbsf with low to moderate relative abundances in most of the samples. It is frequent in the interval between Samples 141-861C-5H-6, 130–132 cm (39.10 mbsf), and 141-861C-4H-4, 109–114 cm (27.59 mbsf). The species does not occur, however, above Sample 141-861C-2H-CC (12.50 mbsf). The FO of *Uvigerina senticosa* at Site 861 may not represent its first appearance (FA). Off the coast of Peru, this species was found in upper Pliocene sediments (Resig, 1990, Tables 7 and 8). Boersma (1984) supposed that *Uvigerina senticosa* evolved apparently from *Uvigerina mantaensis* in the Pliocene. The ranges of both species, however, do not overlap at Site 861, which would allow a study of the phylogenetic relationships between them.

Stilostomella *cf.* consobrina *Assemblage Zone*

Range: 158.86 to 448.50 mbsf (1.33 to about 3.1 Ma); upper boundary: LO of *Stilostomella* cf. *consobrina*; lower boundary: LO of *Uvigerina mantaensis.*

Stilostomella cf. *consobrina* occurs with low relative abundances below 158.89 mbsf in most of the samples. It is not recorded, however, in the interval between Samples 141-861C-19X-CC (168.20 mbsf) and 141-861C-25X-CC (218.60 mbsf). The species is common in Sample 141-861C-28X-4, 52–57 cm (233.12 mbsf), where *Nodogenerina adolphina* has its LO. *S.* cf. *consobrina* and *N. adolphina* had not been reported from the Pacific to date. In Italy, *S.* cf. *consobrina* ranges from the middle Miocene to mid-Quaternary and *N. adolphina* is recorded from the Oligocene to mid-Pliocene (Dondi and Barbieri, 1982). The LO's of *Stilostomella* cf. *consobrina* and *Nodogenerina adolphina* correspond to the *Stilostomella* Extinction in the nannofossil Zone NN19, at about the Brunhes/Matuyama boundary as described from the Eastern Atlantic (Weinholz and Lutze, 1989) and the Manihiki Plateau in the southwestern tropical Pacific (Beiersdorf et al., in press). The age of the LO of *Stilostomella* cf. *consobrina,* as interpolated between the upper boundaries of nannofossil Zones NN18 and NN19, is distinctively older than those given by Weinholz and Lutze (1989) and Beiersdorf et al. (in press), ranging between 0.73 and 0.996 Ma. The anomalously old date at Site 861 might be artificial and result from an unconformity. The nannofossil distribution reveals that the lowermost part of the Pleistocene might be missing (Behrmann, Lewis, Musgrave, et al., 1992).

Uvigerina mantaensis *Assemblage Zone*

Range: 448.50 to 496.30 mbsf (approximately 3.1 Ma to at least 3.4 Ma); upper boundary: LO of *Uvigerina mantaensis*; lower boundary: not defined.

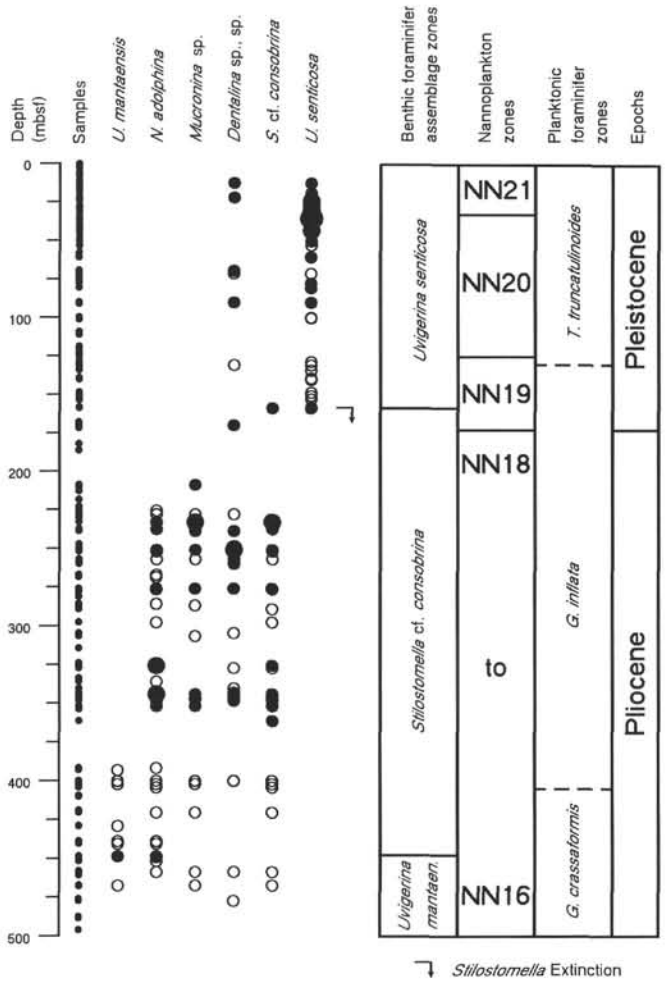

Figure 2. Stratigraphic ranges of index species, benthic foraminiferal zonation, and nannoplankton and plankton foraminifer zones (after Spiegler and Müller, this volume) of the combined succession at Site 861. Abundances: Small dots = rare, larger dots = few to common; circles indicate occurrence in samples in which reworked foraminifers were recorded.

Uvigerina mantaensis occurs with low relative abundances below Sample 141-861D-6R-3, 127–130 cm, (393.17 mbsf) in most of the samples. Only Sample 141-861D-11R-CC (448.50 mbsf) yields no redeposited foraminifers, so this level is taken as a reliable LO and thus marks the zonal boundary (Fig. 2). *U. mantaensis* was initially described from the upper Miocene of Ecuador (Cushman and Edwards, 1938) and was recorded at ODP sites off the coast of Peru, from the lower to upper Miocene (Resig, 1990). The last appearance of this species is constrained by Boersma (1984) to nannofossil Zone NN16. The LOD of *Uvigerina mantaensis* in Hole 861D is within nannofossil Zone NN16 (Spiegler and Müller, this volume).

SUMMARY

This paper describes assemblage composition and stratigraphic ranges of benthic foraminifers from ODP Site 861 (Chile Triple Junction, southeastern Pacific). Seventy-eight benthic foraminiferal species were identified. Redeposited foraminifers occur commonly in samples from diamictites. These foraminifers are discerned from autochthonous assemblages by their yellow color and poor preservation.

The assemblages are dominated by *Uvigerina peregrina, Uvigerina bifurcata, Bulimina striata mexicana, Oridorsalis umbonatus* and *Hoeglundina elegans.* The fauna is bathyal and resembles recent assemblages in the Peru-Chile Trench from water depths between 1300 and 2500 m. Some faunal elements (e.g., *Bucella peruviana, Bolivina spissa,* and *Ehrenbergina glabra*) live at lesser water depths than at Site 861 and are probably displaced by near-bottom downslope transport. *Melonis pompilioides* and *Uvigerina senticosa* live, however, in depths below that of Site 861 (1651 m). Higher abundances of *M. pompilioides* below 400 mbsf indicate a former deposition in greater water depth than Site 861 is located today. This supports the interpretation of the "broken formation" encountered below 351.9 mbsf as accreted hemipelagic sediments from the oceanic plate. *Uvigerina hollicki,* a species indicating high flux-rates of particulate organic matter, was found in samples dated to Holocene and the last Interglacial. As Site 861 is presently at the lower depth level of AAIW, which comes from the AAPF, the absence of *U. hollicki* during the last Glacial would indicate lower glacial productivity at AAPF or a different flow path of AAIW.

A new benthic assemblage zonation proposed for the succession at Site 861 comprises the *Uvigerina senticosa* Assemblage Zone from sea floor to 158.89 mbsf (0 to 1.33 Ma) followed by the *Stilostomella* cf. *consobrina* Assemblage Zone from 158.89 to 448.50 mbsf (1.33 to 3.1 Ma), and the *Uvigerina mantaensis* Assemblage Zone below (3.1 to at least 3.4 Ma). The upper part of the *Stilostomella* cf. *consobrina* Assemblage Zone is characterized by the LO of the index species *Nodogenerina adolphina* and *Mucronina* sp. In the upper part of this zone, *Dentalina* sp., sp. show higher abundances than above and below. This extinction pattern corresponds to the *Stilostomella* Extinction as described from the Eastern Atlantic and the Manihiki Plateau in the southwestern tropical Pacific.

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APPENDIX

Taxonomic Note

Stilostomella cf. *consobrina* (d'Orbigny, 1846)
(Plate 2, Figs. 2, 3)

Dentalina consobrina d'Orbigny, 1846, p. 46, pl. 2, figs. 1–3.
Stilostomella consobrina (d'Orbigny) Barker, 1960 (in part), p. 130, pl. 62, fig. 24.
Siphonodosaria consobrina (d'Orbigny) var. emaciata (Reuss) Dondi and Barbieri, 1982, pl. 35, fig. 8.
Stilostomella consobrina (d'Orbigny). Papp and Schmid, 1985, p. 29, pl. 11, figs. 1–5.

Description. The test is uniserial, arcuate and has six to twelve chambers. The proloculus is slightly greater in diameter than the second chamber and bears a short spine on the apex. The early chambers are low and have the same height and diameter. The height of chambers increases gradually throughout. The sutures are indistinct and not depressed in the early portion of the test. In the later portion, the chambers are slightly inflated and the diameter at the sutures remains constant leading to progressively depressed sutures. The aperture is round, smooth and bears a low denticle. The foramen is broad oval, kidney-shaped, and bears a small collar. The wall is smooth and shows no ornamentation.

Size. 500–800 µm long, 80–120 µm diameter.

Remarks. Shape and test morphology of our specimens from ODP Site 861 are very similar to those from d'Orbigny's type locality Baden (Vienna Basin). Specimens from the Vienna Basin are, however, more robust and double sized than those from the Chile Triple Junction. As anything but the size differs significantly, we refer our specimens preliminarily to *Stilostomella consobrina.* The figures of d'Orbigny (1846) led to some confusion because they exaggerate the incision of sutures in the early portion of the tests which is not displayed by specimens from the type locality. Thomas (1987, pl. 14, figs. 6–7) refered forms with depressed sutures to *S. consobrina,* which are, in our opinion, more similar to *Nodogenerina sagriensis* (Bagg, 1912).

Occurrences. *Stilostomella* cf. *consobrina* occurs in upper Pliocene to lower Pleistocene sediments from ODP Site 861, it is recorded in Italy from the middle Miocene to mid-Quaternary, and was dredged off central Chile by the H.M.S. *Challenger* at station no. 300 from 2515 m waterdepth.

Faunal Reference List

Type references are given for each species recognized. If the original description and figures were not accessible, the reader is referred to those used for species determination. Species that also are recorded in the redeposited "yellow fauna" are marked with "*".

Anomalina globulosa Chapman and Parr, 1937, p. 117, pl. 9, fig. 27.
Bolivina spissa Cushman, 1926 - *Brizalina spissa* (Cushman) Whittaker, 1988, p. 102, pl. 11, figs. 17–20.
*Bucella peruviana** = *Rotalina peruviana* d'Orbigny, 1839b, p. 41, pl. 1, figs. 12–14.
*Bulimina alazanensis** Cushman, 1927, p. 161, pl. 25, fig. 4.
*Bulimina denudata** Cushman and Parker, 1938, p. 57, pl. 10, fig. 1.
*Bulimina striata** mexicana = Bulimina inflata Seguenza var. mexicana Cushman, 1922, p. 95, pl. 21, fig. 2.
*Bulimina striata striata** d'Orbigny, 1826, p. 269.
*Buliminella tenuata** Cushman, 1927, p. 149, pl. 2, fig. 9.
*Cassidulina crassa** d'Orbigny, 1839b, p. 56, pl. 7, figs. 18–20.
*Cassidulina laevigata** d'Orbigny, 1826, p. 282, pl. 15, figs. 4,5.
*Cassidulinoides parkerianus** = Cassidulina parkeriana Brady, 1881, p. 59.
Cassidulinoides tenuis Phleger and Parker, 1951, p. 27, pl. 14, figs. 11–13.
Chilostomella ovoidea Reuss, 1850, p. 380, pl. 48, fig. 12.
*Cibicides lobatulus** = *Nautilus lobatulus* Walker and Jakob, 1798, p. 642, pl. 14, fig. 36.
Cibicides refulgens Montfort - Barker, 1960, p. 190, pl. 92, figs. 7–9.
*Cibicidoides bradyi** = *Truncatulina bradyi* Trauth, 1918, p. 235.
*Cibicidoides mckannai** = *Cibicides mckannai* Galloway and Wissler, 1927, p. 65, pl. 10, fig. 5.
*Cibicidoides corpulentus** = *Cibicides robustus* Phleger and Parker, 1952, p. 31, pl. 17, figs. 1–4.
*Cibicidoides hitchcockae** = *Rosalina hitchcockae* Galloway and Wissler, 1927, p. 62, pl. 10, fig. 2.
*Cibicidoides wuellerstorfi** = *Anomalina wuellerstorfi* Schwager, 1866, p. 258, pl. 7, figs. 105, 107.
Clavulina sp. "A" Boltovskoy and Theyer, 1970, p. 320, pl. 1, fig. 29.
Dentalina communis = *Nodosaria (Dentaline) communis* d'Orbigny, 1826, p. 254.
*Dentalina filiformis** = *Nodosaria (Nodosaire) filiformis* d'Orbigny, 1826, p. 253.
Discanomalina coronata = *Anomalina coronata* n. - Parker and Jones, 1857, pl. 10, figs. 15, 16.
*Ehrenbergina glabra** = *Ehrenbergina hystrix* var. *glabra* Heron-Allen and Earland, 1910 - Wiesner, 1931, p. 132, pl. 22, fig. 262.
Epistominella pacifica = *Pulvinulinella pacifica* Cushman, 1927, p. 165, pl. 5, figs. 14, 15.
Glandulina laevigata = *Nodosaria (Glandulina) laevigata* n. - d'Orbigny, 1826, p. 252, pl. 10, figs. 1–3.
*Globobulimina affinis** = *Bulimina affinis* d'Orbigny, 1839a, p. 105, pl. 2, figs. 25, 26.
*Globobolimina spinifera** = *Bulimina spinifera* Cushman, 1927, p. 151, pl. 2, fig. 15.
*Globobulimina turgida** = *Bulimina turgida* Bailey, 1851, p. 12, figs. 28–31.
*Globocassidulina subglobosa** = *Cassidulina subglobosa* Brady, 1881, p. 30.
*Gyroidina neosoldanii** Brotzen, 1936, p. 158.
*Gyroidina orbicularis** d'Orbigny, 1826, p. 278, 1, Mod. 13.
*Gyroidina zelandica** Finlay, 1939, p. 323, pl. 28, figs. 138–140.
*Hoeglundina elegans** = *Rotalia (Turbinulina) elegans* d'Orbigny, 1826, p. 276.
*Hormosina globulifera** Brady, 1879 - Barker, 1960, p. 80, pl. 39, figs. 1–6.
Karreriella bradyi = *Gaudryina bradyi* Cushman, 1911, p. 67, fig. 107.
Lagena gracillima Seguenza, 1862.
*Lagena striata** = *Oolina striata* d'Orbigny, 1839b, p. 21, pl. 5, fig. 12.
Martinottiella communis = *Clavulina communis* d'Orbigny, 1826, p. 268, Mod. 4.
*Melonis barleeanum** = *Nonionina barleeana* Williamson, 1858, p. 32, pl. 3, figs. 68, 69.
*Melonis pompilioides** = *Nautilus pompilioides* Fichtel and Moll, 1798, p. 31, pl. 2, figs. a–c.
*Miliolinella oblonga** (Montagu, 1803) - Barker, 1960, p. 10, pl. 5, fig. 4.
*Miliolinella subrotunda** (Montagu, 1803) - Thies, 1991, p. 23, pl. 14, fig. 3.
*Nodogenerina adolphina** = *Dentalina adolphina* d'Orbigny, 1846, p. 50, pl. 2, figs. 18–20.
*Nonionella auris** = *Valvulina auris* d'Orbigny, 1839b, p. 47, pl. 2, figs. 15–17.
Nonionella sp. Parker, 1954, pl. 6, figs. 8, 9.
*Oridorsalis umbonatus** = *Rotalina umbonata* Reuss, 1851, p. 75, pl. 5, fig. 35.
*Stilostomella** cf. *consobrina* = *Dentalina consobrina* d'Orbigny, 1846, p. 46, pl. 2, figs. 1–3.
Parafissurina ovata = *Ellipsolagena ovata* Wiesner, 1931, p. 126, pl. 20, fig. 244.
*Pullenia bulloides** = *Nonionina bulloides* d'Orbigny, 1826, p. 293.
*Pullenia quinqueloba** = *Nonionina quinqueloba* Reuss, 1851, p. 71, pl. 5, fig. 31.
*Pyrgo lucernula** = *Biloculina lucernula* Schwager, 1866, p. 202, pl. 4, figs. 14, 17.
*Pyrgo murrhina** = *Biloculina murrhyna* Schwager, 1866, p. 203, pl. 4, fig. 15.
*Pyrgo oblonga** = *Biloculina oblonga* d'Orbigny, 1839b, p. 163, pl. 8, figs. 21–23.
*Pyrgo serrata** = *Biloculina serrata* Bailey, 1861, p. 350, pl. 8, fig. E.
*Quinqueloculina seminula** = *Quinqueloculina seminulum* (Linnaeus) Barker, 1960, p. 10, pl. 5, fig. 6.
Rupertina stabilis Wallich - Barker, 1960, p. 202, pl. 98, figs. 1–12.

Saccamina sphaerica Sars, 1868, p. 248.
Stainforthia complanata = *Virgulina schreibersiana* Czjzek var. *complanata* Egger, 1893, p. 292, pl. 8, figs. 91–92.
*Trifarina angulosa** = *Uvigerina angulosa* Williamson, 1858, p. 67, pl. 5, fig. 140.
*Triloculina tricarinata** d'Orbigny, 1826, p. 299, pl. 7, Mod. 94.
*Uvigerina auberiana** d'Orbigny, 1839b, p. 106, pl. 2, figs. 23, 24.
*Uvigerina bifurcata** d'Orbigny, 1839b, p. 53, pl. 7, fig. 17.
*Uvigerina hollicki** Thalmann, 1950 - Phleger et al., 1953, p. 38, pl. 8, figs. 1–3.
Uvigerina mantaensis Cushman and Edwards, 1938, p. 84, pl. 14, fig. 8.
*Uvigerina peregrina** Cushman, 1923, p. 166, pl. 42, figs. 7–10.
Uvigerina senticosa Cushman, 1927, p. 195, pl. 3, fig. 14.
Valvulineria laevigata Phleger and Parker, 1951, p. 25, pl. 13, figs. 11, 12.

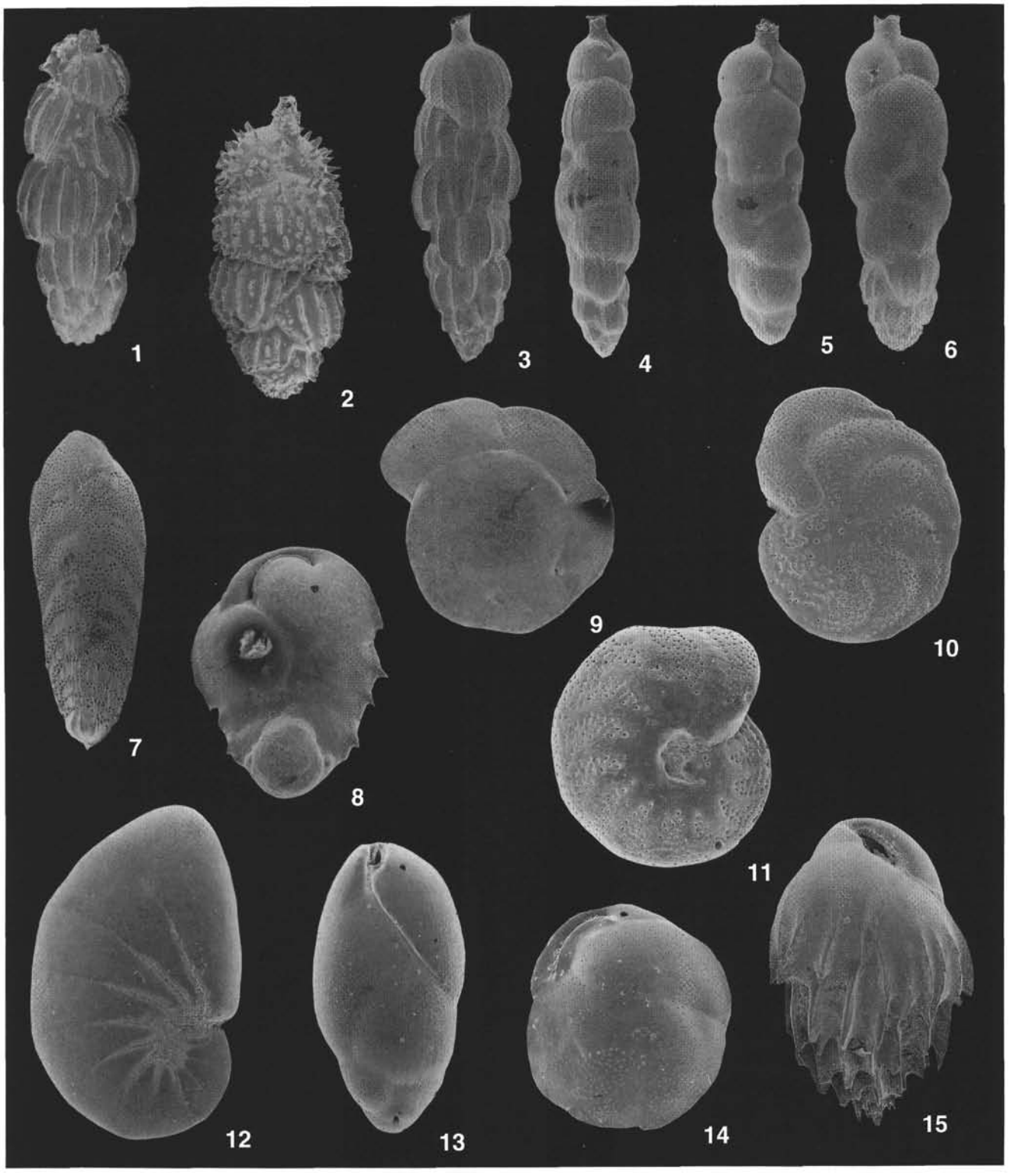

Plate 1. **1.** *Uvigerina peregrina* Cushman, ×70, Sample 141-861C-2H-3, 9–14 cm. **2.** *Uvigerina hollicki* Thalmann, ×70, Sample 141-861C-1H-1, 45–49 cm. **3, 4.** *Uvigerina bifurcata* d'Orbigny, (3) ×60, Sample 141-861C-16X-3, 84–86 cm, (4) ×50, Sample 141-861C-3H-CC. **5, 6.** *Uvigerina senticosa* Cushman, (5) ×70, Sample 141-861C-3H-CC, (6) ×60, Sample 141-861C-16X-3, 84–86 cm. **7.** *Bolivina spissa* Cushman, ×80, Sample 141-861C-15X-2, 6–10 cm. **8.** *Ehrenbergina glabra* Heron-Allen and Earland, ×60, Sample 141-861C-1H-1, 45–49 cm. **9.** *Oridorsalis umbonatus* (Reuss), ×80, Sample 141-861C-2H-3, 131–136 cm. **10.** *Cibicidoides wuellerstorfi* (Schwager), ×40, Sample 141-861C-16X-3, 84–86 cm. **11.** *Melonis barleeanum* (Williamson), ×92, Sample 141-861C-3H-2, 70–75 cm. **12.** *Nonionella auris* (d'Orbigny), ×100, Sample 141-861C-3H-CC. **13.** *Globobulimina affinis* (d'Orbigny), ×70, Sample 141-861C-2H-3, 131–136 cm. **14.** *Cassidulina laevigata* d'Orbigny, ×165, Sample 141-861C-3H-CC. **15.** *Bulimina striata mexicana* Cushman, ×60, Sample 141-861C-1H-CC.

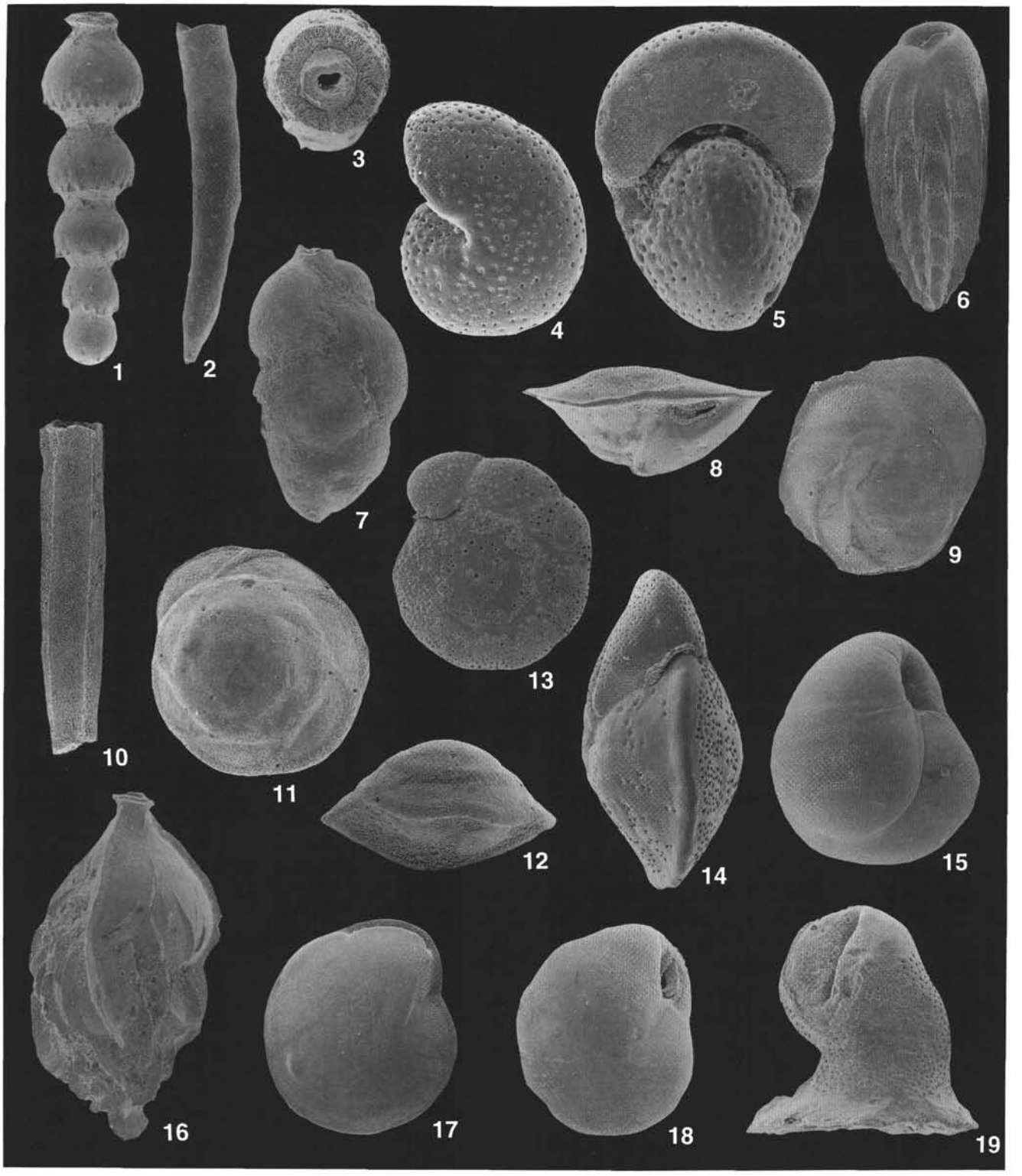

Plate 2. **1.** *Nodogenerina adolphina* (d'Orbigny), ×120, Sample 141-861C-31X-CC. **2, 3.** *Stilostomella* cf. *consobrina* (d'Orbigny), (2) ×90 (broken specimen), Sample 141-861C-31X-2, 12–14 cm, (3) apertural view, ×200, (broken specimen), Sample 141-861C-31X-CC. **4, 5.** *Melonis pompilioides* (von Fichtel and von Moll), ×180, Sample 141-861D-9R-1, 120–122 cm, (4) side view, (5) apertural view. **6.** *Bulimina alazanensis* Cushman, ×150, Sample 141-861C-12X-1, 103–105 cm. **7.** *Uvigerina mantaensis* Cushman and Edwards, ×125, Sample 141-861D-6R-CC. **8, 9.** *Epistominella pacifica* (Cushman), ×133, Sample 141-861C-4H-CC, (8) side view, (9) spiral side. **10.** *Mucronina* sp., ×80, Sample 141-861C-28X-4, 52–57 cm. **11, 12.** *Bucella peruviana* (d'Orbigny), ×125, Sample 141-861C-13X-1, 66–77 cm, (11) spiral side, (12) side view. **13, 14.** *Cibicidoides mckannai* (Galloway and Wissler), Sample 141-861C-1H-2, 87–92 cm, (13) spiral side, ×60, (14) side view, ×80. **15.** *Globocassidulina subglobosa* (Brady), ×140, Sample 141-861C-20X-CC. **16.** *Trifarina angulosa* (Williamson), ×150, Sample 141-861C-4H-CC. **17.** *Hoeglundina elegans* (d'Orbigny), ×50, Sample 141-861C-20X-CC. **18.** *Cassidulina crassa* d'Orbigny, ×70, Sample 141-861C-12X-1, 103–105 cm. **19.** *Rupertina stabilis* Wallich, ×60, Sample 141-862A-1H-1, 14–16 cm.