

## XI. PLANKTONIC FORAMINIFERAL STRATIGRAPHY AND A LATE PLIOCENE—EARLY PLEISTOCENE HIATUS OBSERVED IN CORE P164 FROM THE MANIHIKI PLATEAU

Hiroshi Ujiie\* and Shoji Mishima\*

### Introduction

Among 21 piston cores obtained during GH80-1 cruise by the Geological Survey of Japan, five cores taken from on the Manihiki Plateau, central Equatorial Pacific, were only available for planktonic foraminiferal study: all the others came from the basins below the calcium carbonate compensation depth. According to our preliminary examination on several samples per a core, core P162 (St. 1609; see Fig. XI-1) is composed of only late Quaternary portion, P163 (St. 1612) of too much minute foraminifers for the exact identification, P168 (St. 1624) of probably late Oligocene overlain by late Quaternary portions with very broad hiatus, and P169 (St. 1626) of a kind of turbidite. Therefore, all these cores were inadequate in purpose to obtain the biostratigraphic details. On the other hand, however, core P164 (St. 1615) gave us not only new informations about the stratigraphic ranges of some important planktonic foraminiferal taxa but also about an interesting stratigraphic hiatus. The hiatus can also be traced in core lithology and in paleomagnetic stratigraphy.

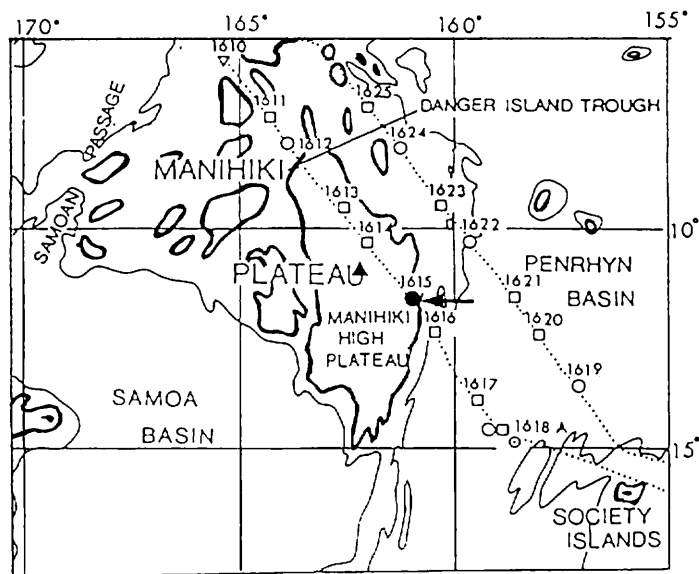


Fig. XI-1 Location map (a black triangle shows the location of DSDP Site 317).

\*Department of Marine Sciences, University of the Ryukyus, Okinawa 903-01.

## Materials and results

Being bordered by the Samoa Basin and Samoan Passage in its western margin, the Manihiki Plateau consists of three blocks of topographic high; namely, Northern, Western and High Plateaus from north to south. The last one is broadest and highest. The basalt basement older than the middle Cretaceous, Aptian, was recovered about 900 m below the sea bottom at the Deep Sea Drilling Project Site 317 located in the central area of the "High Plateau" (water depth: ca. 2600 m; Lat. 11°00'S; Long. 162°16'W) (SCHLANGER, JACKSON, *et al.*, 1976). The similar basaltic lava flow seems to compose the basement of the whole Manihiki Plateau after WINTERER *et al.*'s (1974) interpretation of seismic profiles. Above the Aptian limestone calcareous sediments predominate at Site 317, particularly, during the Cenozoic Era. Calcareous ooze to chalk has continuously been deposited under the direct influence of the South Equatorial

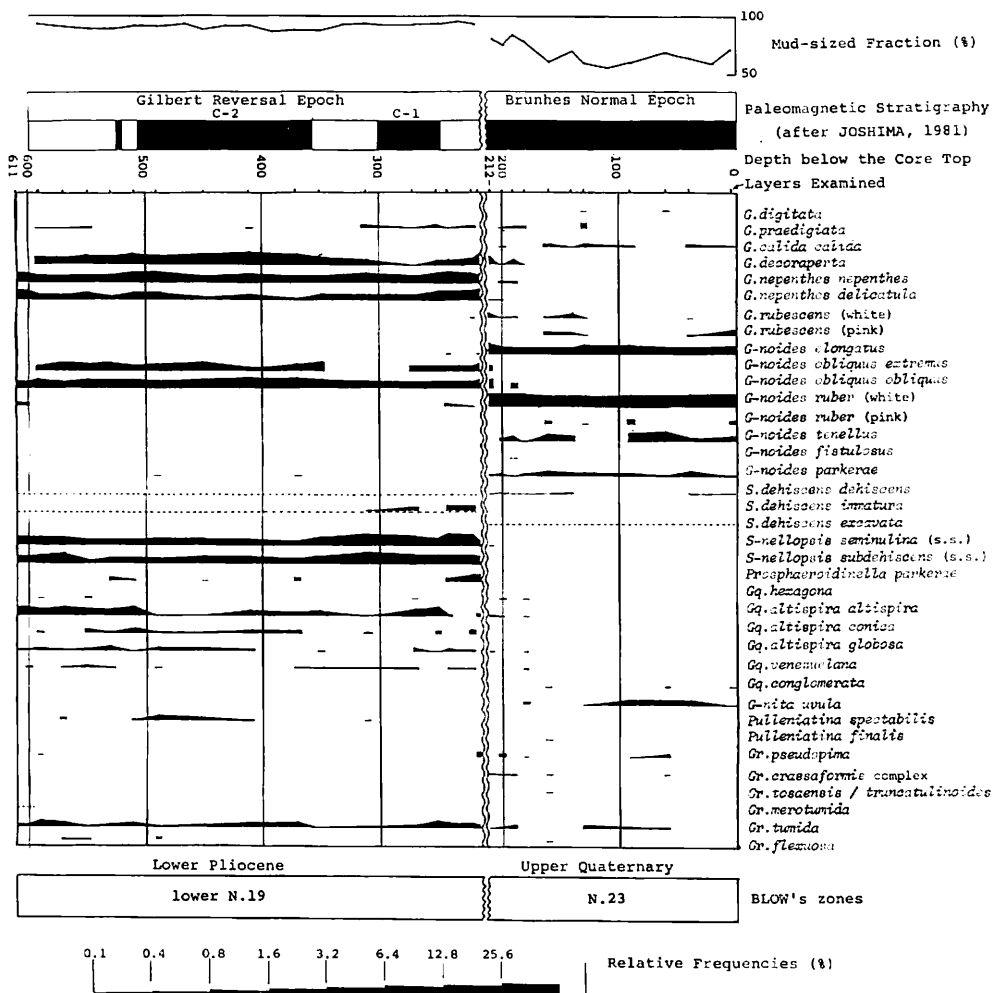


Fig. XI-2 Range chart of the selected 37 taxa of planktonic Foraminifera in the core P164, whose stratigraphic synthesis is also briefly shown.

Current. Any break has been observed from the Lower Eocene through Recent in neither nannofossil (MARTINI, 1976) nor planktonic foraminiferal biostratigraphy (KANEPS, 1976).

Core P164 treated here was taken at St. 1615 (Lat. 11°37'S; Long. 161°06'W; water depth: 3153 m) which is situated about 100 km east-southeast of DSDP Site 317 and near the eastern edge of the High Plateau. The upper 212 cm of the total length of 611 cm consists of very pale brown through pale brown to light grey (downward) nannofossil foraminiferal ooze, whereas the lower two-thirds of more whitish foraminiferal nannofossil ooze: this lithological change is rather distinct and reflect an abrupt change of relative frequency (weight percents) of the mud-sized sediment particules as shown in Fig. XI-2.

One centimeter thick sample was cut out at a stratigraphic interval of ca. 10 cm except for near the above-mentioned lithological boundary and near the core bottom, where more detailed sampling was carried out. Every sample was dried up, weighed, macerated by pouring three or less percent solution of hydrogen peroxide in ultrasonic separator for a minute, washed through a 200 mesh screen, and again dried up. The residue on the screen was weighed (thus the weight percents of mud-sized fraction can be calculated) and sieved through a 100 mesh screen in dry condition. 200-odd specimens of planktonic foraminifer per a sample were picked out for the identification from the coarser residues under a binocular microscope.

7,437 specimens in total were classified into 99 taxa as shown in an occurrence chart (Table XI-1). A biostratigraphic summary is indicated as an occurrence range chart of 37 taxa significant for dating in Fig. XI-2, where the respective frequencies are also expressed by such an exponential scale as tried before (UJHÉ and MIURA, 1971) on a Philippine Sea core analysis. Ranges of three taxa shown by dashed lines in the figure were resulted from through search of the specimens all over the treated residues; the three are seldom but stratigraphically critical. Representative species are illustrated in Figs. XI-3~6.

#### **Biostratigraphic summary and paleomagnetic stratigraphy**

If BLOW's (1969) scheme of planktonic foraminiferal zonation would be applied here, we could conclude that core P164 represents the zone N.23 (Upper Quaternary) in its upper one thirds (above 212 cm) and the lower N.19 (Lower Pliocene) in the lower two-thirds, between which a hiatus during about three million years could consequently be expected.

The assignment as N.23 is based upon the occurrences of *Sphaeroidinella dehiscens excavata* BANNER and BLOW, subordinately of pinkish *Globigerina rubescens* HOFKER, pinkish *Globigerinoides ruber* (BRADY), scarce *Globigerina (Beella) digitata* BRADY (*s.s.*), and sporadical *Pulleniatina obliquiloculata finalis* BANNER and BLOW. In addition, N.23 was originally defined by the occurrence of *Globigerina calida* PARKER (*s.s.*), which also occurs throughout the upper one thirds of the core P164. BRÖNNIMANN and RESIG (1971), nevertheless, changed its limit of range down to around the lowest N.22.

The portion lower than 212 cm level of the core contains no *Globorotalia (Turborotalia) pseudopima* BLOW but *Sphaeroidinella dehiscens* (PARKER and JONES) and its subspecies *immatura* (CUSHMAN). The upper limit of N.19 was primarily defined by the first ap-

pearance of the former taxon, while the lower one by those of the latter two. According to the original definition by BLOW (1969), *Globigerina conglomerata* SCHWAGER [= *Globoquadrina conglomerata* (SCHWAGER) in this paper], *Globigerina pseudofoliata* (PARKER) [= *Globoquadrina pseudofoliata* PARKER], and *Pulleniatina obliquiloculata* (PARKER and JONES) (*s.s.*) appeared first in the middle of N.19, whereas *Globigerina venezuelana* HEDBERG [= *Globoquadrina venezuelana* (HEDBERG)] alternatively disappeared. Concerning the N.19 portion of core P164, the last event can positively be utilized and the former three events were negatively observed. Consequently the portion may represent the lower part of N.19. This conclusion would be supported by a, though seldom, yielding of *Globorotalia* (*s.s.*) *merotumida* BANNER and BLOW near the core bottom; this species seems to have disappeared around the lower boundary of N.19.

It is interesting that some postponed occurrences of *Globigerina decoraperta* TAKAYANAGI and SAITO, *Globigerina nepenthes* TODD (*s.l.*), *Globigerinoides obliquus* BOLLI (*s.l.*), *Globoquadrina altispira* (CUSHMAN and JARVIS) (*s.s.*), *Globoquadrina altispira globosa* BOLLI, and *Globoquadrina venezuelana* (HEDBERG) were observed in the N.23, just above but beyond the hiatus. All of them should have been extinct before the Quaternary (*i.e.*, N.22) and, at the same time, provided with so stout shells that they would have been derived by reworking from beneath the hiatus. In other words, the hiatus may have been caused, at least partly, by some scouring agencies.

On the other hand, however, a postponed occurrence of delicate specimens of *Globigerinoides fistulosus* (SCHUBERT), which is thought as to have disappeared within the upper N.21 (BLOW, 1969; PARKER, 1967; and others), may suggest that the range should be extended up to the lower N.23. Some emendations of ranges may also be expected about *Globoquadrina altispira conica* BRÖNNIMANN and RESIG and *Neoacarinina blowi* THOMPSON. Both the two taxa were recovered in the N.19 of core P164, although the original descriptions said that the former ranges from the middle N.14 to lower N.16 (BRÖNNIMANN and RESIG, 1971) and the latter is restricted within the Upper Pleistocene (THOMPSON, 1973).

The paleomagnetic measurements concurrently made on the same core (JOSHIMA, this cruise report) revealed the presences of a normal epoch for the upper one thirds (above 212 cm level) and of a reversal epoch for the lower two-thirds. So far as the current correlation between planktonic foraminiferal and paleomagnetic stratigraphies (BERGGREN and VAN COUVERING, 1974) is concerned, the normal epoch corresponds to the Brunhes and the reversal one to the Gilbert, particularly its lower half. Two normal events within the Gilbert Epoch can not be correlated to Cochiti and Nunivak but to C<sub>1</sub> and C<sub>2</sub>, respectively. Thus the sedimentation rate during the N.19 period of the core can be calibrated as almost uniform.

#### **On the observed hiatus**

As shown in the foregoing lines, a remarkable hiatus was coincidentally recognized upon three different aspects of core P164 such as planktonic foraminiferal biostratigraphy, paleomagnetic stratigraphy, and lithology. In general, deep-sea hiatuses may have been ascribed to chemical dissolution by quick rising of the CCD and/or to scouring erosion by oceanic bottom current or meso-scaled eddy. The CCD change may be caused by such an ocean-wide or global event as paleoclimatic change or extraterrestrial accident,





while scouring by bottom current may give rather local effect. It is interesting to know how plays the meso-scaled eddy noticed by the POLYGON- and MODE-projects any role to cause the deep-sea hiatus, but this inquiry is still premature to be talked about.

For the case of core P164, a CCD rising may have been ineffective since the late Pliocene to early Pleistocene gap has not been recognized in the adjacent area (e.g., BRÖNNIMANN and RESIG, 1971; PARKER, 1967), even at DSDP Site 317 very closely located on the Manihiki Plateau (SCHLANGER, JACKSON, *et al.*, 1976). A main route of the northward Western Boundary Undercurrent from the circum-Antarctic region is passing through the Samoa Basin and the Samoan Passage (STOW and LOVELL, 1960), which bound the western margin of the Manihiki Plateau. In fact a sediment core taken from the bottom of the Passage shows a remarkable hiatus ranging from the Eocene to Lower Pliocene (HOLLISTER *et al.*, 1974). An eastern branch of the Undercurrent might have eroded out the site of core P164 located near the eastern edge of the Plateau during the period from the Late Pliocene to early Pleistocene. Another possibility of scouring might be due to the Pacific Bottom Water Current strengthened during the period: the current was observed on the top of the Manihiki Plateau by the GH80-1 cruise (see MATSUBAYASHI and MIZUNO, this cruise report).

Lithology above the hiatus consists of foraminiferal ooze more susceptible of dissolution than nannofossil ooze which contrastingly composes the sediment below the hiatus. According to VAN ANDEL *et al.* (1975), the CCD lowered about 400 m for the duration of hiatus so that the contrast in lithology may have been resulted in.

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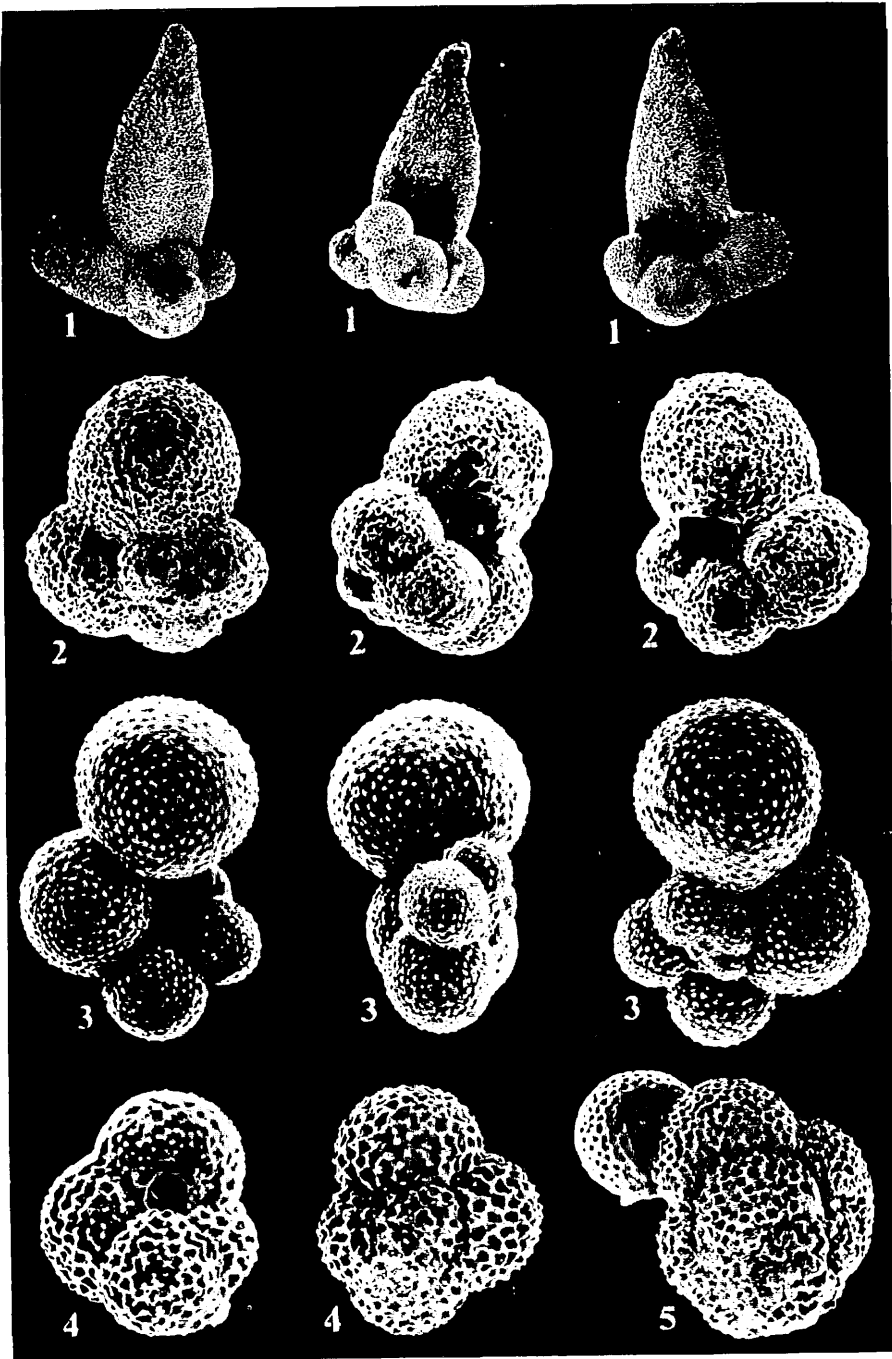


Fig. XI-3 SEM illustrations of selected foraminiferal species

1. *Globigerina digitata* BRADY (s.s.). Left: spiral, middle: apertural, right: umbilical views.  $\times 54$ , from 60 cm below the core top.
2. *Globigerina digitata praedigitata* PARKER. Left: spiral, middle: apertural, right: umbilical views.  $\times 135$ , from 130 cm.
3. *Globigerina calida calida* PARKER. Left: umbilical, middle: apertural, right: spiral views.  $\times 63$ , from 160 cm.
4. *Globigerina rubescens* HOFKER (pinkish form). Left: umbilical, right: spiral views.  $\times 180$ , from 90 cm.
5. *Globigerina nepenthes delicatula* BRÖNNIMANN & RESIG (spiral view).  $\times 126$ , from 270 cm.

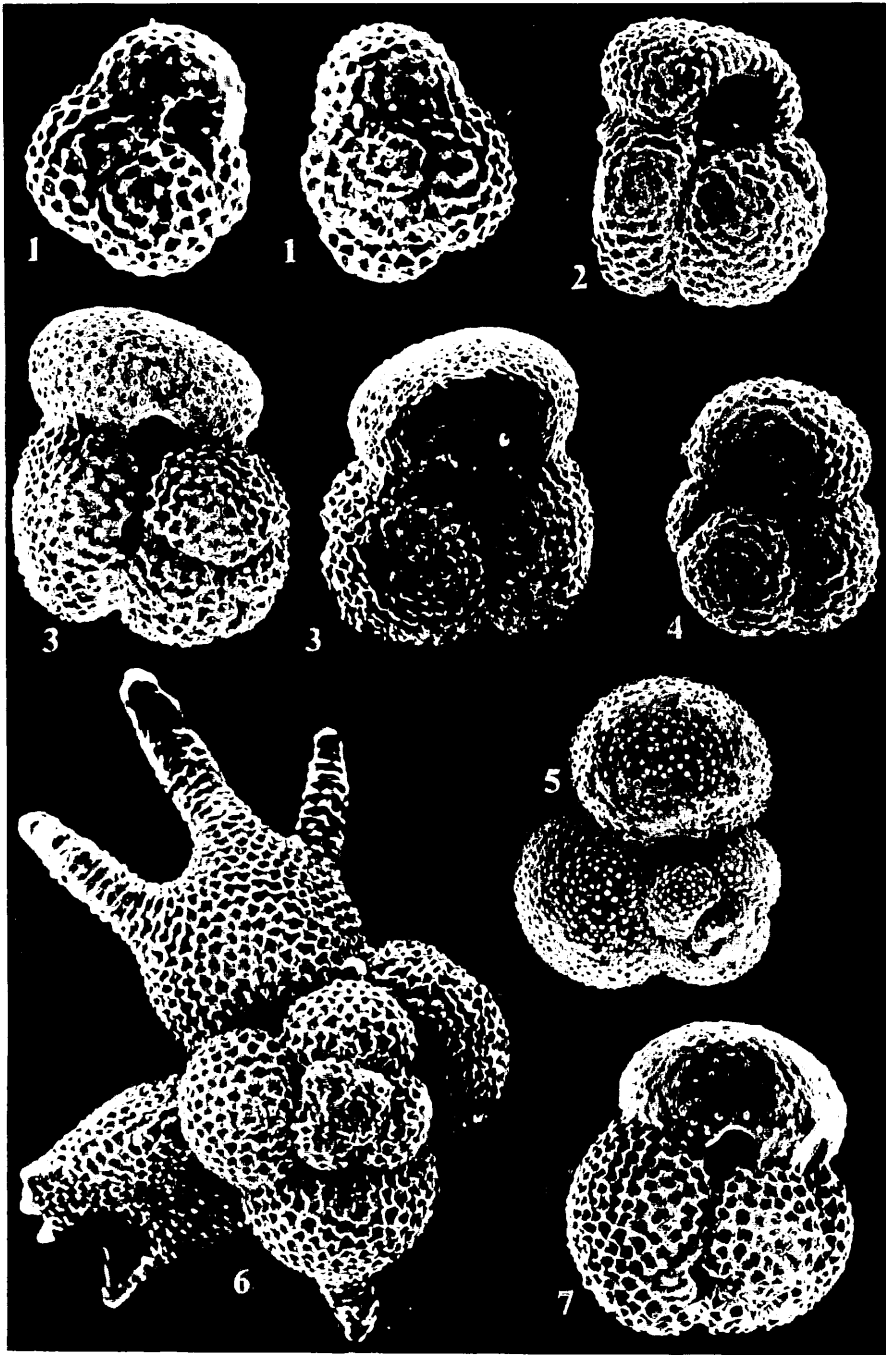


Fig. XI-4 SEM illustrations of selected foraminiferal species (continued)

1. *Globigerinoides tenellus* PARKER. Left: umbilical, right: spiral views.  $\times 180$ , from 90 cm below the core top. 2. *Globigerinoides obliquus extremus* BOLLI & BERMÚDEZ (umbilical view).  $\times 144$ , from 250 cm. 3. *Globigerinoides elongatus* (D'ORBIGNY). Left: spiral, right: umbilical views.  $\times 144$ , from 90 cm. 4. *Globigerinoides obliquus* BOLLI (s.s.) (umbilical view).  $\times 144$ , from 250 cm. 5. *Globigerinoides parkerae* BERMÚDEZ (spiral view).  $\times 144$ , from 60 cm. 6. *Globigerinoides fistulosus* (SCHUBERT) (spiral view).  $\times 90$ , from 210 cm. 7. *Globigerinoides ruber* (BRADY) (pinkish form; spiral view).  $\times 144$ , from 90 cm.

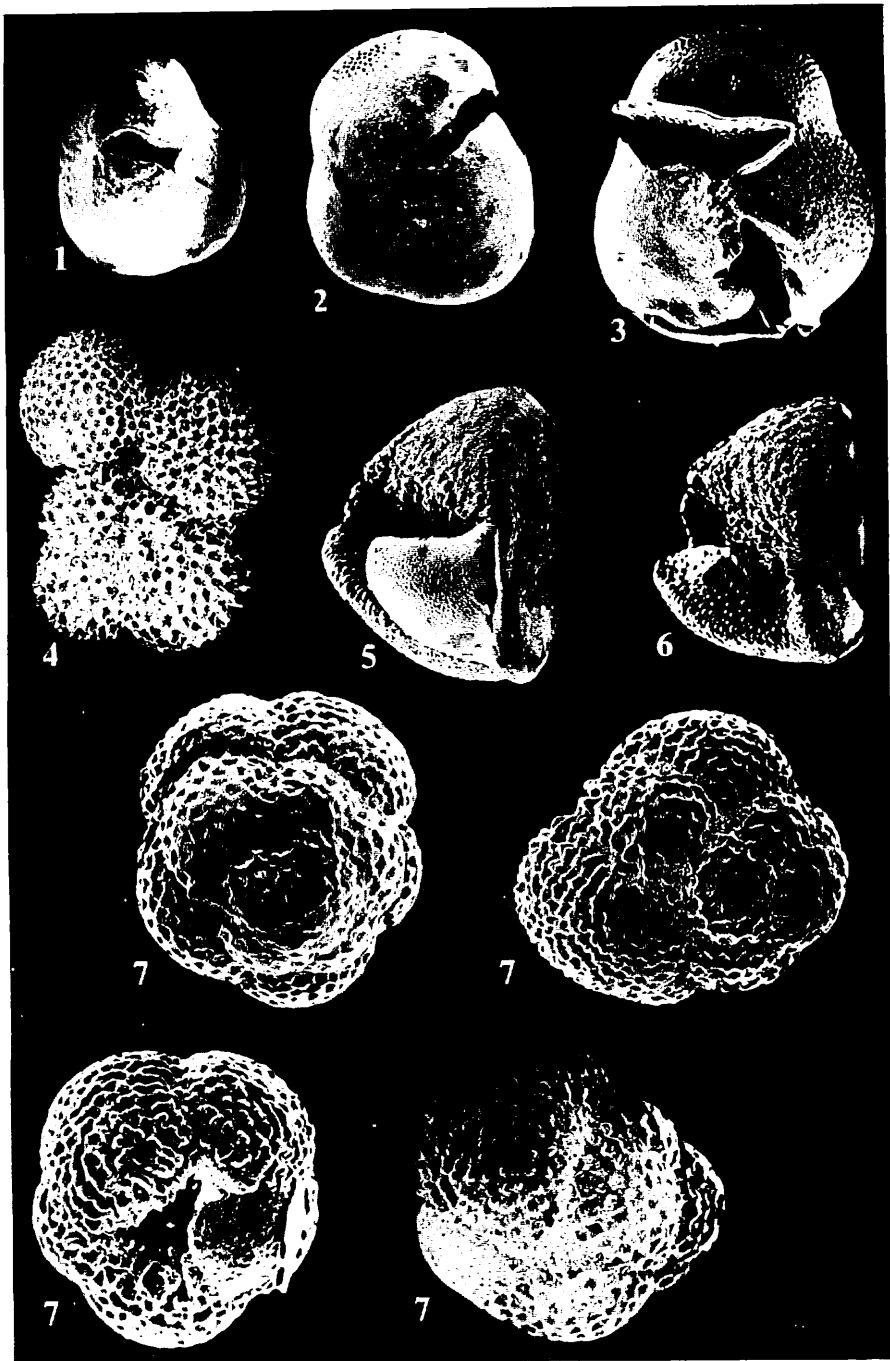


Fig. XI-5 SEM illustrations of selected foraminiferal species (continued)

1. *Sphaeroidinella dehiscens immatura* (CUSHMAN) (spiral view).  $\times 43$ , from 220 cm below the core top. 2. *Sphaeroidinella dehiscens* (PARKER & JONES) (s.s.) (spiral view).  $\times 43$ , from 600 cm. 3. *Sphaeroidinella dehiscens excavata* BANNER & BLOW (spiral view).  $\times 43$ , from 210 cm. 4. *Prosphaeroidinella parkerae* UJIIÉ (spiral view).  $\times 72$ , from 220 cm. 5. *Globorotalia* (*Turborotalia*) *tosaensis* TAKAYANAGI & SAITO—*Globorotalia* (s.s.) *truncatulinoides* (D'ORBIGNY) intermediate form (apertural view).  $\times 63$ , from 160 cm. 6. *Globorotalia* (s.s.) *truncatulinoides* (D'ORBIGNY) (approximately apertural view).  $\times 63$ , from 130 cm. 7. *Globoquadrina altispira conica* BRÖNNIMANN & RESIG. Upper-left: spiral, -right: side (opposite to the aperture), lower-left: umbilical, -right: approximately apertural views.  $\times 108$ , from 220 cm.

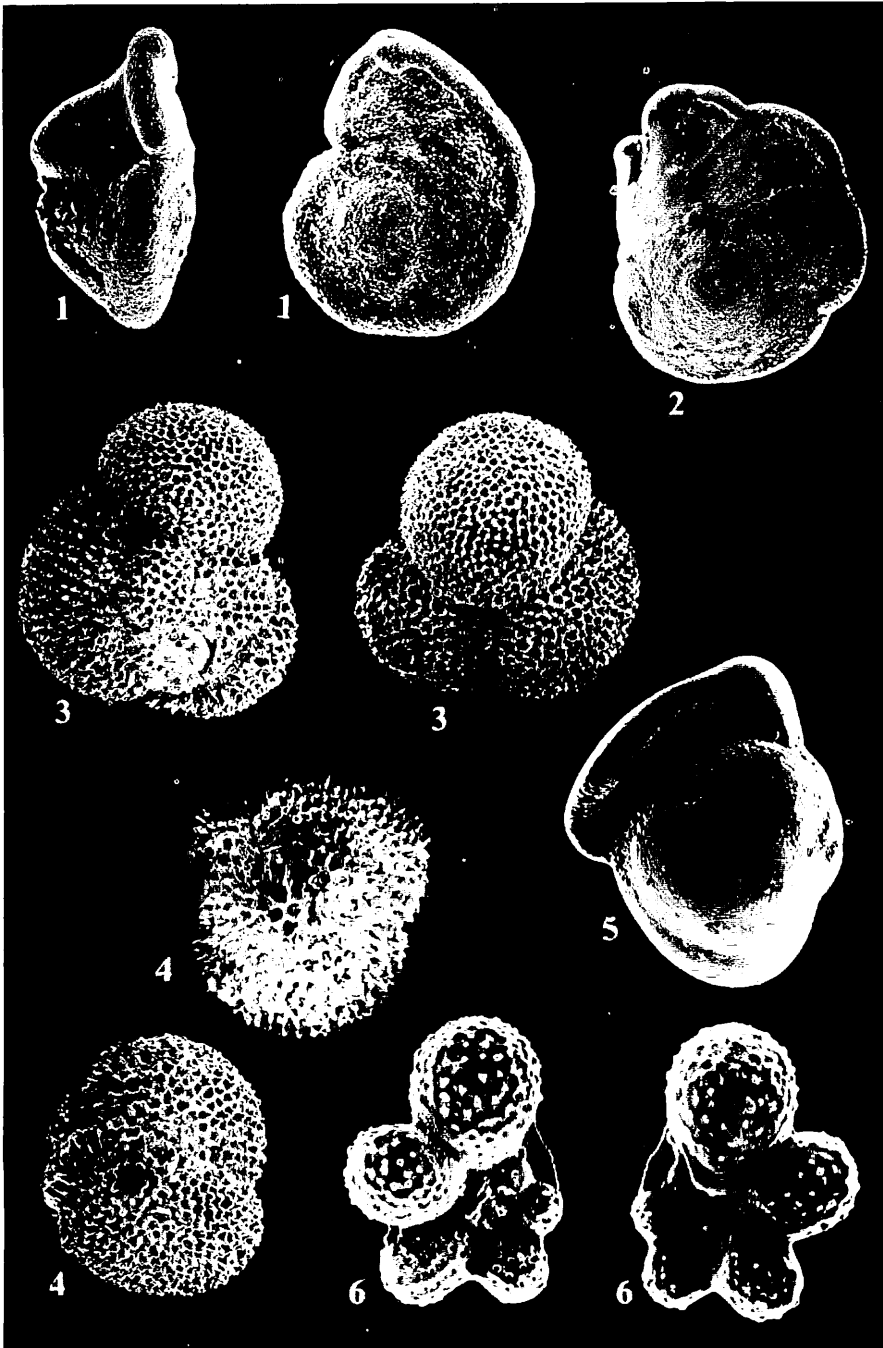


Fig. XI-6 SEM illustrations of selected foraminiferal species (continued)

1. *Globorotalia (s.s.) merotumida* BANNER & BLOW. Left: apertural, right: spiral views.  $\times 90$ , from 600 cm below the core top. 2. *Globorotalia (s.s.) tumida flexuosa* (KOCH) (spiral view).  $\times 45$ , from 490 cm. 3. "*Neoacarinia*" *blowi* THOMPSON (adult form?). Left: spiral, right: umbilical views.  $\times 72$ , from 450 cm. 4. Ditto (young form with typical wall structure). Upper: spiral, lower: umbilical views.  $\times 72$ , from 450 cm. 5. *Pulleniatina spectabilis* PARKER (apertural view).  $\times 90$ , from 450 cm. 6. *Hastigerina (Bolliella) cf. adamsi* BANNER & BLOW (young form). Left: spiral, right: umbilical views.  $\times 180$ , from 90 cm.