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PART II

X. MICROPALEONTOLOGY OF PISTON CORES, WAKE TO TAHITI

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Introduction

During GH80–1 cruise, a series of piston coring (P158–P179) was carried out between the west of Wake and the east of Tahiti islands in the Mid-Pacific region. A total of 179 samples from piston and pilot cores obtained from 22 stations were examined for radiolarian and foraminiferal studies. The purposes of the studies are as follows:

1) To analyse the distribution of planktonic foraminifers in surface sediment samples in this region with special reference to their state of preservation.

2) To perform biostratigraphic zoning of the cores based on radiolarians and planktonic foraminifers and to make age assignment for them.

3) To describe the vertical distribution of benthic foraminiferal faunas in the cores.

Location of stations may be seen in Fig. X-1. Of each piston core water depth, core length, position of samples in core sections, and absence (−) or presence (+) of the respective microfossil groups are shown in Table X-1. The cores are in principle cut into sections of one meter long, and the positions of samples in each section are indicated by depth in cm from the top. In the table the occurrence of benthic foraminifera is marked by symbols "A" or "C": the former indicates that the assemblage is exclusively composed of agglutinated and opaline tests, and the latter does the assemblage made of both calcareous and agglutinated tests.

Method of study

Long cores in inner tube were cut into one-meter-long sections, and further longitudinally split into halves on board. Samples for microfossil analysis of 2 to 4 cm in thickness were taken from the halves.

The samples were prepared for study mostly by washing with a water spray on a sieve having 250 mesh screen. In the case of fairly indurate sediment samples, however, they were treated with a naphtha solution for disintegration (TAKAYANAGI, 1978) before wet-sieving. Dried sample was divided into two parts, one for foraminiferal analysis and the other for radiolarian study.

Foraminiferal sample was then sieved through a 200 mesh screen, and divided by a sample splitter into aliquot part, from which an adequate number of specimens were picked up for benthic faunal analysis (see later section). At the same time, the ratio of

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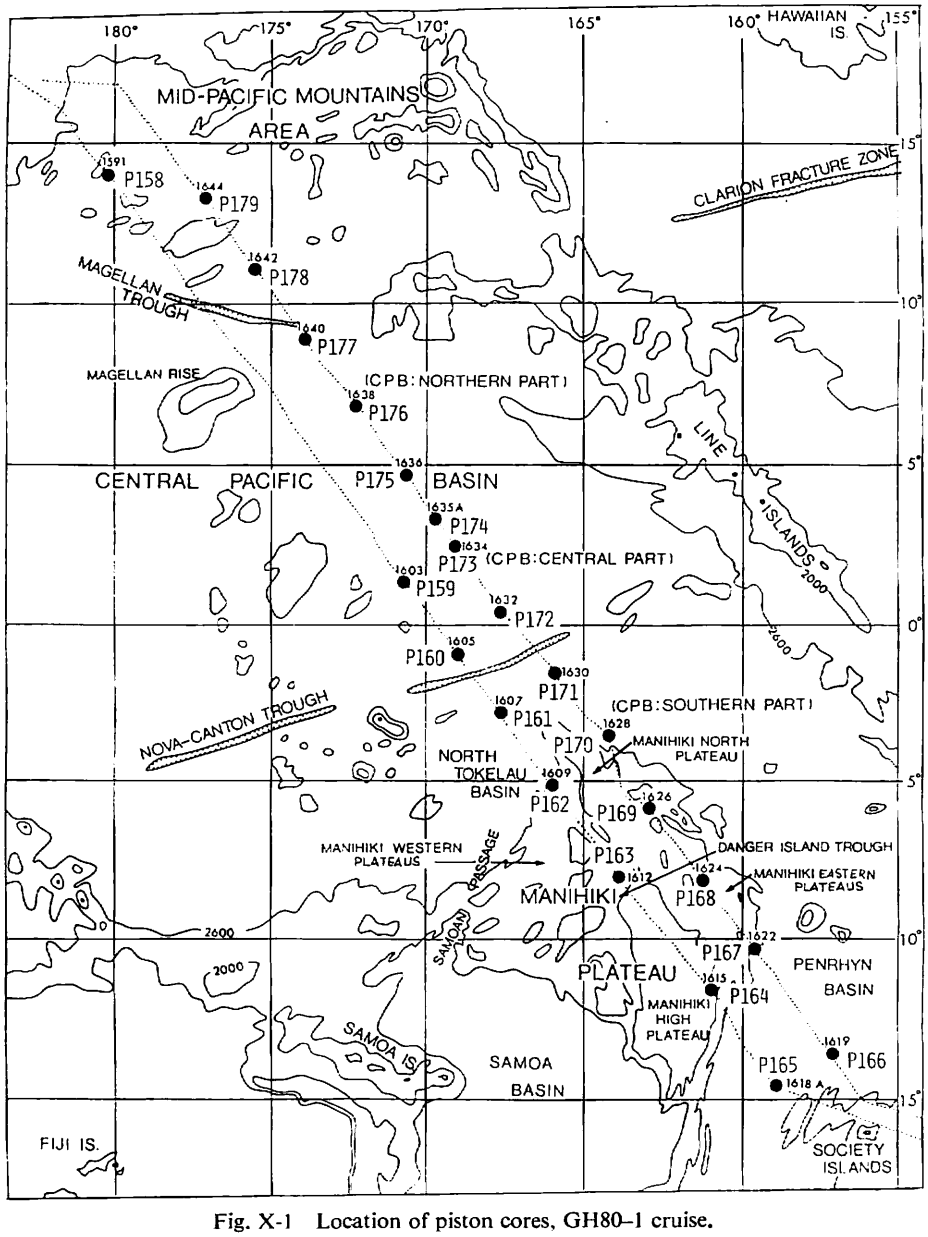

Fig. X-1 Location of piston cores, GH80–1 cruise.

planktonic forms to the total individuals (P/T) was counted. For planktonic faunal analysis, however, all specimens were picked up from the remaining coarse fraction of the whole part of the sample sieved through a 115 mesh screen. In case that the number of specimens was insufficient for analysis, additional foraminifers were picked up from the radiolarian sample before cleaning.

Radiolarian sample was processed by boiling in hydrogen peroxide and hydrochloritic

Table X-1 List of sediment samples from piston cores, GH80–1 cruise, for micropaleontological study.

Piston core (Station)	Position {Latitude {Longitude	Depth (m) Core length (cm) (Sections)	Sample		Microfossils: Radiolaria	Microfossils: Foraminifera: Planktonic	Microfossils: Foraminifera: Benthic
P158	14°03′N	5,560		1*	–	–	–
(1591)	179°45′E	201	I	10	–	–	–
		(I, II)		2*	–	–	–
				3*	–	–	–
P159	1°17′N	5,500	pilot	0– 6	+	–	–
(1603)	170°42′W	709	II	57–61	+	–	–
		(II-VIII)	III	49–53	+	–	–
			IV	50–54	+	–	–
			V	50–54	+	–	–
			VI	50–54	+	–	–
			VII	50–54	+	–	A
			VIII	50–54	+	–	–
			CC		+	–	–
P160	0°58′S	5,460	pilot	0– 2	–	–	–
(1605)	169°02′W	824	pilot	33–35	+	–	–
		(I-VIII)	I	34–37	+	+	C
			I	95–99	+	–	–
			II	50	+	–	–
			III	50	+	–	–
			IV	50	+	–	–
			V	50	+	–	–
			VI	50	+	–	–
			VII	50	–	–	–
			VIII	50	+	–	–
P161	3°02′S	5,690	pilot top		+	–	–
(1607)	167°29′W	783	I	46–50	+	–	–
		(I-VIII)	II	50–54	–	–	–
			III	50–54	+	–	A
			IV	50–54	+	+	A
			V	55–59	+	+	A
			VI	50–54	–	–	–
			VII	50–54	–	–	–
			VIII	50–54	–	–	–
			VIII	93–97	–	–	–
P162	5°12′S	4,400	V	0– 4	+	+	C
(1609)	165°51′W	421	VI	36–40	+	+	C
		(V-VIII)	VII	50–54	–	+	C
			VIII	50–54	+	–	C
			VIII	90–94	–	+	C
			CC		–	+	C
P163	8°20′S	4,810	pilot top		+	+	C
(1621)	163°48′W	787	I	54–58	+	–	–
		(I-VIII)	II	18–20	–	–	–
			II	50–54	–	+	C
			IV	50–54	–	+	C

Table X-1 (Continued)

Piston core (Station)	Position (Latitude / Longitude)	Depth (m) Core length (cm) (Sections)	Sample	Microfossils		
				Radiolaria	Foraminifera	
					Planktonic	Benthic
			VI 50–54	–	+	C
			VIII 50–54	–	+	C
			CC	–	+	C
P164	11°36′S	3,160	III 10–14	–	+	C
(1615)	161°05′W	611	IV 28–30	–	+	C
		(III-VIII)	V 7– 9	–	+	C
			V 50–52	–	+	C
			VI 50–52	–	+	C
			VII 50–52	–	+	C
			VIII 50–52	–	+	C
			CC	–	+	C
P165	14°29′S	5,500	pilot top	–	–	–
(1618A)	158°53′W	729	pilot bottom	–	–	–
		(II-XII)	II 2– 4	–	+	–
			III 50–54	–	–	–
			IV 50–54	–	–	–
			VII 68–70	–	–	–
			IX 50–54	–	–	–
			X 50–54	–	–	–
			XI 50–54	–	–	–
			XII 50–54	–	–	–
			CC	–	–	–
P166	13°34′S	5,100	pilot top	–	–	–
(1619)	157°05′W		pilot bottom	–	–	–
		(VII)?	VII 13–15	–	–	–
			VII 21–23	–	–	–
			CC	–	–	–
P167	10°16′S	5,230	pilot top	–	–	–
(1622)	159°35′W	628	II 0	–	–	–
		(II-VIII)	III 20	–	–	–
			IV 50	–	–	–
			V 50	–	–	–
			VI 50	–	–	–
			VII 50	–	–	–
			VIII 50	–	–	–
			CC	–	–	–
P168	8°08′S	3,900	III top	–	+	C
(1624)	161°12′W	570	IV top	–	+	C
		(III-VIII)	IV 30–32	–	+	C
			IV 40–42	–	+	C
			IV 90–92	–	+	C
			V 60–62	–	+	C
			VI 50–52	+	+	C
			VII 50–52	+	+	C
			VIII 50–52	+	–	C

Table X-1 (Continued)

Piston core (Station)	Position {Latitude {Longitude	Depth (m) Core length (cm) (Sections)	Sample		Microfossils		
					Radiolaria	Foraminifera	
						Planktonic	Benthic
P169	5°47′S	4,710	pilot	top	+	+	C
(1626)	162°56′W	567	IV	14–16	+	+	C
		(III-VIII)	IV	41–43	+	+	C
			IV	90–92	–	+	C
			V	28–30	+	+	A
			V	63–67	+	+	C
			V	68–70	+	+	C
			VI	16–18	–	+	C
			VI	48–50	–	+	C
			VI	93–95	–	+	C
			VII	23–25	+	+	C
			VII	38–40	–	+	C
			VII	60–62	+	+	C
			VIII	50–52	+	–	A
			CC		+	–	–
P170	3°31′S	4,980	pilot	top	+	+	C
(1628)	164°10′W	383	V	8–10	+	+	C
		(V-VIII)	V	18–20	+	+	C
			V	58–60	+	+	A
			VI	25–27	+	–	–
			VII	50–52	+	–	–
			VIII	50–52	–	–	–
P171	1°31′S	5,500	pilot	top	+	+	C
(1630)	165°52′W	785	II	50	+	–	–
		(I-VIII)	IV	50	+	–	–
			VI	50	+	–	–
			VIII	50	+	–	–
			CC		+	–	–
P172	0°26′N	5,250	I	10–12	+	–	–
(1632)	167°34′W	762	I	38–40	+	+	C
		(I-VIII)	II	28–30	+	+	C
			III	50–52	+	–	–
			III	94–96	+	–	–
			IV	50–52	+	–	–
			V	50–52	+	–	–
			VI	50–52	+	–	–
			VII	50–52	+	–	A
			VIII	50–52	+	–	–
			CC		+	–	–
P173	2°32′N	5,080	Pilot	top	+	+	C
(1634)	169°06′W	799	I	top	+	+	C
		(I-VIII)	II	50–52	+	–	–
			III	50–52	+	+	A
			IV	50–52	+	–	–
			V	50–52	+	–	–
			VI	50–52	+	–	–
			VII	50–52	+	–	–

Table X-1 (Continued)

Piston core (Station)	Position {Latitude Longitude	Depth (m) Core length (cm) (Sections)	Sample		Microfossils		
					Radiolaria	Foraminifera	
						Planktonic	Benthic
			VIII	50–52	+	–	C
			CC		+	–	–
P174	3°16′N	5,350	pilot	top	+	–	–
(1635A)	169°41′W	789	IV	50–52	+	–	–
		(I-VIII)	VII	50–52	+	–	–
			CC		+	–	A
P175	4°43′N	5,740	pilot	top	+	–	–
(1636)	170°42′W	786	I	top	+	–	–
		(I-VIII)	III	50–52	+	–	–
			V	50–52	+	–	–
			VII	50–52	+	–	–
			CC		+	–	–
P176	6°49′N	5,800	pilot	top	+	–	–
(1638)	172°15′W	784	I	top	+	–	–
		(I-VIII)	I	50–52	+	–	–
			II	50–52	+	–	–
			III	50–52	+	–	A
			IV	50–52	+	–	–
			V	50–52	+	–	–
			VI	50–52	+	–	–
			VII	50–52	+	–	–
			VIII	50–52	+	–	–
			CC		+	–	–
P177	8°58′N	5,810	pilot	top	+	–	–
(1640)	173°53′W	787	IV	80	–	–	–
		(I-VIII)	CC		–	–	–
P178	11°06′N	5,430	I	top	+	–	–
(1642)	175°29′W	782	I	40	+	–	–
		(I-VIII)	II	50	–	–	–
			III	50	–	–	–
			IV	50	–	–	–
			V	50	--	–	–
			VI	50	–	–	–
			VII	50	–	–	–
			VIII	50	–	–	–
			CC		–	–	–
P179	13°17′N	5,030	pilot	top	+	+	A
(1644)	177°08′W	337	V	10	–	–	–
		(V-VIII)	VI	40	–	–	–
			VII	50	–	–	–
			VIII	50	–	–	–
			CC		–	–	–

+: present, –: absent
A: assemblage composed of agglutinated and opaline tests
C: assemblage composed of calcareous and agglutinated test of benthic foraminifera

acid for cleaning and specimens were mounted on a slide with Entellan new (TAKAYANAGI, 1978).

Preservation and abundance of planktonic foraminifera in surface sediments

In order to trace the relationship among water depth, state of preservation of planktonic foraminiferal tests, and the ratio of planktonic individuals to the total population (P/T) in surface sediments at the respective stations, they are plotted in Fig. X-2.

Based on the relative abundances of susceptive species to solution and broken specimens, the state of preservation of planktonic foraminifera in each sample is classified into the following categories: G (good), M (moderate), and P (poor). In general, there is no sample marked with G among the cores studied. Samples from depths shallower than 4710 m (St. 1626, P169) are moderately preserved (M), but those deeper than 4810 m (St. 1612, P163) are poor in preservation (P). Below the depths deeper than 5080 m (St. 1634, P173) no remains of foraminifera are found except for St. 1630 (P171, 5500 m), in which a few specimens of benthic and planktonic forms occurred. In the present study it is indeterminable whether this exception is brought about by contamination or other causses.

The P/T ratio is rather consistent among the samples from the stations shallower than 4710 m (P169), being 96 to 99% or more. It decreases rather rapidly from 4810 m (P163) towards the deeps, and drops to 68% at a depth of 5080 m (P173). Such changes in the ratio with depth are nearly accordant to those in the state of preservation.

With relation to the lysocline and the calcite compensation depth (CCD) the result of the studied region is in harmony with the previous records. In the equatorial Pacific, there are some records: Over the wide area along the equator, lysocline depth (L) is 3800 m, while CCD is about 5000 m (PARKER and BERGER, 1971); near Ontong Java L and CCD are 3500 m and 5250 m, respectively (VALENCIA, 1973); in the Samoan Passage L is 4000 to 4300 m and CCD is 5000 to 5200 m (HOLLISTER *et al.*, 1974). Among the

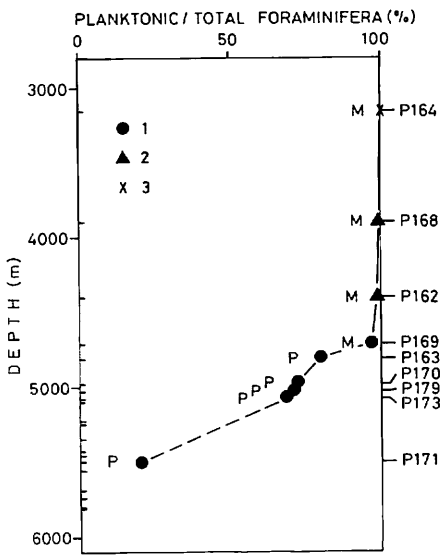

Fig. X-2 Relationship among water depth, state of preservation of planktonic foraminiferal test and ratio of planktonic foraminifera to the total population (P/T) in surface sediments. 1: pilot core top, 2: piston core top (Holocene), 3: piston core top (Pleistocene in age judged from microbiostratigraphic result); P: poorly preserved, M: moderately preserved.

samples studied, the one from the shallowest station (P164, 3160 m) is excluded from the present consideration on lysocline, because its benthic foraminifers are estimated to be early Pleistocene or older in age (see later section). The sample from the next shallowest station (P168, 3900 m) is already below the lysocline depth so far as judged from the state of preservation of calcite tests. On the other hand, the level of CCD may be clearly located between 5080 m (P173) and 5100 m (P166).

Plankton biostratigraphy

Radiolarians and planktonic foraminifers are listed in Tables X-2(a-c) and X-3. In the following lines, remarks on stratigraphic distribution of both fossil groups, their mode of occurrence and other features in each core are given for biostratigraphic and chronostratigraphic correlations among the cores. Positions of sections and samples in the piston cores are shown in Fig. X-3. All samples examined are classified into four categories based on significant fossil contents for biostratigraphy.

Radiolarian biostratigraphy

In Table X-2(a-c) listed are only species referred by RIEDEL and SANFILIPPO (1978) and TAKAYANAGI *et al.* (1979) and some additional taxa which are closely related with the former species group in evolutionary lineages. Radiolarian zones adopted herein are mostly the ones designated by RIEDEL and SANFILIPPO (1978) except for the following: the *Buccinosphaera invaginata* Zone, *Collosphaera tuberosa* Zone, *Axoprunum angelinum* Zone, and *Amphirhopalum ypsilon* Zone (=*A. praeypsilon* Zone of this report) of NIGRINI (1971), and the *Pterocanium prismatium* Zone of RIEDEL and SANFILIPPO (1970). Chronostratigraphic assignment of these biozones is principally after RIEDEL and SANFILIPPO (1978), but for convenience the top of the *Pterocanium prismatium* Zone will be treated to represent the Pliocene-Pleistocene boundary.

It is remarkable that reworked fossils are very common in most of samples. Except for

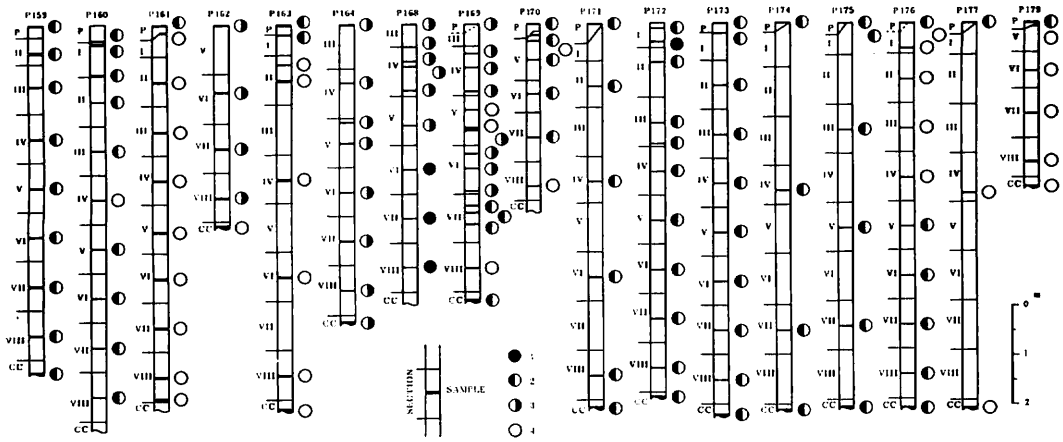

Fig. X-3 Positions of sections and samples in the piston cores. All samples are classified into four categories based on their fossil contents used for biostratigraphic assignment: 1, both planktonic foraminifera and Radiolaria; 2, Radiolaria; 3, planktonic foraminifera; 4, none.

Table X-2a Distribution of radiolarians in the cores (P159, P160, P161 and P169), GH80–1 cruise.

Species \ Sample	P159									P160										P161	P169									
	pilot 0–6	II, 57–61	III, 49–53	IV, 50–54	V, 50–54	VI, 50–54	VII, 50–54	VIII, 50–54	CC	pilot 0–2	pilot 33–35	I, 34–37	I, 95–99	II, 50	III, 50	IV, 50	V, 50	VI, 50	VII, 50	VIII, 50	pilot top	pilot top	IV, 14–16	IV, 68–70	V, 28–30	V, 63–67	VI, 48–50	VII, 23–25	VII, 60–62	VIII, 50–52	CC
Preservation:	G	G	G	G	G	G	G	G	G	G	G	G	G	G	G	G	G	G	G	G	G	M	M	M	M	M	G	M	M	M	G
Buccinosphaera invaginata Haeckel	+										–	+	+								+										
Collosphaera tuberosa Haeckel	+									+	–	+	+	–							–										
Solenosphaera omnitubus Riedel and Sanfilippo								+	+			+									+					+				+
Axoprunum angelinum (Campbell and Clark)	+	–	+	+	–	+	+	+	+			–			+	+	–	+	–	+	–		+		+			+	+		
Ommatartus tetrathalamus (Haeckel)	+	–	+	+	–	+	+	–	–	+	+	–	+	+	+	+	–	+	–	+	–	+	+	–	+	+	+	+	+	+	+
O. penultimus (Riedel)						+	+	–	–			–					–	+							+		+	+	+	+	
Amphirhopalum ypsilon Haeckel	+									+	+		–	+	–																
A. praeypsilon Sakai	+	+	+	+										+	–	+	–	+	–	+	+			–	+		+		+		
Spongaster tetras Ehrenberg	+	+	+	+	+					–	+	+	+	+	+	+	+	+	+	+	+	–	+	+	+		+	+		+	+
S. pentas Riedel and Sanfilippo					+	+		+	+									+												+	+
Pterocanium prismatium Riedel	–	+	–	+	+	+	+	+	+										+	–	+				–	+	+	+	+	+	+
P. praetextum (Ehrenberg)	–	+	–	–	+			–		+	–	+	–	–	+	+	+	–	+	–	+	–	+	+	–		+	+	+	+	+
Lychnodictyum audax Riedel		+	–	–	+	+	–	–	+					+							+										+
Cyclampterium neatum Sanfilippo and Riedel				–	+		–	+	+		–																				+
Lithopera bacca Ehrenberg	+	+	+	–	+	+	+	–	+				+	–	+	+	+	–		+	+				+	+	+	+	+		+
Stichocorys peregrina (Riedel)	–	+	+	–	+	+	+	–	+			–			+	+	+	+	+	+	+	+	+		+	–	+	+	+	+	+
Anthocyrtidium angulare Nigrini																	+	+													
A. ophirense (Ehrenberg)	+	+	+	+	–	+	+	–	+	+	+	–	+	–	+	–	+	+	–	+	+		+	–	+	+	–	+	–	+	+
Pterocorys hertwigii (Haeckel)	+									+	+	–	+	+	+	–	+	+	–		+	+									
P. sp.	+	–	+	+	–	+	+	–	–							–	–	+	–	+	–						+			+	+
Lamprocyrtis haysi Kling	+									+	+	–	+	+	+						–	+									
L. neoheteroporos Kling																	–	+	–	+					+				+		
L. heteroporos (Hays)		–																+		+											
L. hannai (Campbell and Clark)	+	–	+	+	+	–	+	+	–	–	+	+	–	+	–	+	+	+	–	+	+	–		+	–	+	+	+	+	+	+
Theocorythium trachelium (Ehrenberg)	+									–	+	+	–	+	+	+	+				+	–		–			+	+	+		
T. vetulum Nigrini																															+
Artostrobium doliolum Riedel and Sanfilippo					+	+	+	+	+																						+
Siphocampe corbula (Harting)									+											–											

very few samples, diagnostic species to Eocene to Miocene age are usually contained in the assemblages of younger age, and, in an extreme case, such reworked species occupy more than 90% of the total specific composition.

P159

No trace of reworking is observed. *Solenosphaera omnitubus* is present in the core catcher and the superjacent sample (VIII, 50–54 cm). Between the samples V, 50–54 cm and IV, 50–54 cm an evolutionary change from *Spongaster pentas* to *Spongaster tetras* and the last occurrence of *Artostrobium doliolum* are found. Further, the last occurrence of *Lychnodictyum audax* is in the sample II, 57–61 cm. Accordingly, these parts are assigned to the *Spongaster pentas* Zone. On the contrary, the uppermost part (Pilot, 0–6 cm) contains a mixed assemblage with that of the upper part of the *S. pentas* Zone (without *L. audax*) and that of the *Buccinosphaera invaginata* Zone. By lack of characteristic species of the four zones in-between, a hiatus is suggested between the samples II, 57–61 cm and the pilot, 0–6 cm.

P160

Radiolarians are generally well preserved and abundant throughout the core.

Table X-2b Distribution of radiolarians in the cores (P170, P171, P172, P175 and P177), GH80–1 cruise.

Species \ Sample	P170						P171							P172											P175						P177
	pilot top	V, 8–10	V, 18–20	V, 58–60	VI, 25–27	VII, 50–52	pilot top	II, 50–52	IV, 50–52	VI, 50–52	VIII, 50–52	CC		I, 10–12	I, 38–40	II, 28–30	III, 50–52	III, 94–96	IV, 50	IV, 50–52	V, 50–52	VI, 50–52	VII, 50–52	VIII, 50–52	CC	pilot top	top	III, 50–52	V, 50–52	VII, 50–52	CC	pilot top
Preservation	G	G	G	G	M	P	G	G	G	G	G	G	G	G	G	G	G	G	G	G	G	G	G	G	G	G	G	G	G	G	G
Buccinosphaera invaginata Haeckel			+	–			+																		+						
Collosphaera tuberosa Haeckel	–	+	+	–			+								+										–	–					+
Solenosphaera omnitubus Riedel and Sanfilippo			+																		.										
Axoprunum angelinum (Campbell and Clark)		+			+			–	–	–	+	+	–	+	+	–	–	+	–	–	+	+	–	+			–	+	+	–	
Ommatartus tetrathalamus (Haeckel)	+	–	+	+	–		–	+	–	+	+	+		+	+	–	–	+	–	–	+	+	–	+	+	+	+	–	+	+	–
O. penultimus (Riedel)		–	+	+	–				+										+											+	
Amphirhopalum ypsilon Haeckel	+	–	+	+	–		–																		+	+					
A. praeypsilon Sakai		–	+	+	–		–	+	+	–	+	+		+	+		+	+	+	–	+	+	–	–		+	–	+	+	–	–
Spongaster tetras Ehrenberg	+	–	–	+	–	+	–	+	+	–	+	+		–	–	–	+	+	+	–	+	+	+	–	+	+	–	–	+	+	–
S. pentas Riedel and Sanfilippo																				+	+										
Pterocanium prismatium Riedel		+		+				+	+	–	+	+									–	+	–	+				+	+		
P. praetextum (Ehrenberg)	+	+	–	+	+		+	+	+	+	+	+		+	–		+	–	+	+	–	+	+	–	+	+	–	–	+		–
Lychnodictyum audax Riedel											+																				
Cyclampterium neatum Sanfilippo and Riedel																															
Lithopera bacca Ehrenberg		+	+	–	+	–	+	–	+	+	–	+							+		+		+	+		+	+		+	+	+
Stichocorys peregrina (Riedel)		+	+	–	+	–	+		+	+		+					+	+						+	–	+		+	+	+	
Anthocyrtidium angulare Nigrini											+								–	+								+			
A. ophirense (Ehrenberg)	+	–	+	–	+		–	+	–	+		–		+	+	–	–	+	–	–	+	–	+	+	–	–	+	+	–	–	–
Pterocorys hertwigii (Haeckel)	+	–	+	+	+		–	+		+	+	+		+			–	+	+	–	+				–	–			+		+
P. sp.									–	+	+	–						+	+	–	+	+	–	+					+	–	
Lamprocyrtis haysi Kling	+	–	+	+	–		–								+			+							+	–	+				–
L. neoheteroporos Kling									+		+								+	–		+						–	+	+	
L. heteroporos (Hays)												+								–	+			–				+	+		
L. hannai (Campbell and Clark)	+	+	–	+	+		–	+	+	+	+	+		–	+	–	+	+	+	–	+	+	–	–	–	+	+	+	+		–
Theocorythium trachelium (Ehrenberg)	–	+	–	+	+		+	–									+	+	+	–						+			+		–
T. vetulum Nigrini											+	+									+			–							
Artostrobium dolioluni Riedel and Sanfilippo																															
Siphocampe corbula (Harting)		+																							+						+

Reworked fossils are few, but they consist the Eocene species as *Podocyrtis papalis* and *Theocampe mongolfieri* and the Miocene ones as *Calocycletta virginis* and *Dorcadospyris dentata*.

In the lowermost sample (VIII, 50 cm), *Pterocorys* sp. aff. *P. hertwigii* (of SANFILIPPO and RIEDEL, 1974) and *Pterocanium prismatium* are abundant, but such forms as *P. hertwigii* s.s., *Theocorythium trachelium* and *Anthocyrtidium angulare* are absent. In addition, *Stichocorys peregrina* recovered in the sample may be a reworked fossil, because specimens are distinctly fragmental and strongly corroded also. In the succeeding samples there found are horizons of the first appearance (FA) and the last appearance (LA) of some species: they are *P. prismatium* (LA) in VII, 50 cm, *A. angulare* (LA) in V, 50 cm, *Collosphaera tuberosa* (FA) in II, 50 cm, and *Buccinosphaera invaginata* (FA) in I, 95–99 cm. Therefore the samples are assigned to the radiolarian zones as follows:

Top–I, 95–99 cm	*Buccinosphaera invaginata* Zone
II, 50 cm	*Collosphaera tuberosa* Zone
III, 50 cm–IV, 50 cm	*Amphirhopalum praeypsilon* Zone
V, 50 cm–VI, 50 cm	*Anthocyrtidium angulare* Zone

VII, 50 cm–VIII, 50 cm *Pterocanium prismatium* Zone

P161

Radiolarian recovery is good only in the top of the pilot core. Reworked fossils in the sample, though rare, are the Eocene *Theocampe mongolfieri*, the Eocene-Oligocene *Tristylospyris triceros* and *Dorcadospyris ateuchus*, the Miocene *Cannartus tubarius*, *Ommatartus hughesi*, and *Stichocorys delmontensis*, and some Pliocene species. These species are found in association with a diagnostic assemblage to the *Buccinosphaera invaginata* Zone. The remaining sample are so poor in radiolarian contents that no information was gained for biostratigraphic assignment.

P162

Meager radiolarian assemblages were recovered from the core. Samples, as a whole, contain mixed assemblages of various ages since Eocene. However, since *Ommatartus tetrathalamus* and *Spongaster tetras* are respectively present in the samples VI, 36–40 cm and VIII, 50–54 cm, it is suggested that the sediments are of post-Pliocene age.

Species found in the sample VI, 36–40 cm are: *Ommatartus tetrathalamus*, *Cannartus laticonus*, *C. mammifer*, *C. violina*, *C. tubarius*, *Carpocanopsis bramlettei*, *C. cingulata*, *Carpocanistrum*(?) *azyx*, *Lychnocanoma elongata*, *Thysocyrtis bromia*, *Phormocyrtis striata equisita*, *Lithopera bacca*, *L. renzae*, *Cyrtocapsella cornuta*, *Stychocorys peregrina*, *S. delmontensis*, *S. wolffii*, *Eucyrtidium diaphanes*, *Calocycletta costata*, *C. robusta* group, *Podocyrtis chalata*, *P. sinuosa*, *Theocyrtis annosa*, *T. tuberosa*, *Theocampe mongolfieri*, *Dorcadospyris alata*, *D. dentata*, *D. ateuchus*, and *Tristylospyris triceros*.

Species encountered in the sample VII, 50–54 cm are: *Axoprunum angelinum*, *Ommatartus penultimus*, *O. antepenultimus*, *O. hughesi*, *Spongaster tetras*, *Carpocanopsis bramlettei*, *Lychnocanoma elongata*, *Thyrsocyrtis hirsuta tensa*, *Lithopera bacca*, *L. neotera*, *Cyrtocapsella cornuta*, *Stichocorys delmontensis*, *S. peregrina*, *S. wolffii*, *Calocycletta costata*, *C. virginis*, *Podocyrtis sinuosa*, *Theocampe mongolfieri*, *Dorcadospyris alata*, *D. dentata*, *D. ateuchus*, and *Tristylospyris triceros*.

P163

Two samples examined in this core contain a small number of individuals which are moderately preserved. Among them nearly 10% of the total population are represented by such fossils as *Calocycletta virginis*, *Stichocorys delmontensis*, *Thyrsocyrtis hirsuta*, etc. which were apparently derived from Eocene and Miocene sediments.

From the top of the pilot core, recorded are *Collosphaera tuberosa*, *Ommatartus tetrathalamus*, *Amphirhopalum ypsilon*, and *Spongaster tetras*. Although *Buccinosphaera invaginata* is not found in the sample, it is highly possible that the species happened to be missed because of its rarity. *B. invaginata* usually accounts for only about 1% of the total population in sample from the region studied. This part of the core is assigned to the *Collosphaera tuberosa* Zone or the *Buccinosphaera invaginata* Zone.

The sample I, 54–58 cm contains *Ommatartus tetrathalamus*, *Amphirhopalum praeypsilon*, *Spongaster tetras*, *Anthocyrtidium angulare*, *Lamprocyrtis hannai*, and *Theocorythium trachelium*, and belongs to the *Anthocyrtidium angulare* Zone.

P168

Abundant, moderately preserved radiolarians are present in three samples from this core. Assemblages from these samples are characterized by the abundant occurrence of *Lychnocanoma elongata*, *Theocyrtis annosa* and *Dorcadospyris ateuchus*, but lack such

species as *Calocycletta serrata, Cyrtocapsella cornuta, C. tetrapera,* etc. Such association may indicate that the studied interval is referable to the *Lychnocanoma elongata* Zone (latest Oligocene to earliest Miocene).

Many species are found to be derived from early to middle Eocene sediments, though they constitute less than 1% of the total population. They are *Dictyophimus craticula, Lithochytris archaea, Rhopalocanium ornatum, Thyrsocyrtis hirsuta hirsuta, T. hirsuta robusta, T. hirsuta tensa, T. rhizodon, T. triacantha, Theocotyle cryptocephala cryptocephala, T. cryptocephala nigriniae, T. ficus, Lamptonium fabaeforme constrictum, Theocorys anapographa, Calocycloma castum, Calocyclas hispida, Phormocyrtis striata striata, Podocyrtis papalis, P. sinuosa,* and *Theocampe mongolfieri.*

P169

Radiolarians are generally not common but moderately to well preserved in the core. In the lowest sample (CC) found are abundant *Pterocanium prismatium* and *Stichocorys peregrina* together with *Lychnodictyum audax, Pterocorys* sp. aff. *P. hertwigii* (of SANFILIPPO and RIEDEL, 1974), *Theocorythium vetulum* and *Artostrobium doliolum*, but *P. hertwigii* and *Theocorythium trachelium* are absent. Moreover, *Spongaster tetras* and *S. pentas* concur herein, and the former dominates over the latter. Therefore this sample is in the middle part of the *Spongaster pentas* Zone.

The first appearance of *Theocorythium trachelium* is recognized in the sample VII, 60–62 cm. *Pterocanium prismatium* is present in the sample VII, 23–25 cm and overlying ones. It is, however, considered to be a reworked species by reason that specimens are rare and poorly preserved. Although no further data are available from these assemblages, the interval above the sample VII, 23–25 cm is estimated to be higher than the *Pterocanium prismatium* Zone.

P170

Rich, well preserved (good to moderate) radiolarians are present in clay occupying the upper portion of this core (pilot top to sample VI, 25–27 cm), and in the lower portion they are rare and poorly preserved, especially in zeolite-rich clay (VIII, 50–52 cm).

Amphirhopalum ypsilon, Pterocorys hertwigii, Lamprocyrtis haysi and *Theocorythium trachelium* and present in the upper portion. Noticeable occurrences of species are: *Collosphaera tuberosa* (FA) and *Buccinosphaera invaginata* (FA) in the sample V, 58–60 cm, and *Axoprunum angelinum* (LA) in the sample VI, 25–27 cm. Based upon these stratigraphic distributions, the interval from the top to the sample V, 58–60 cm is assigned to the *Buccinosphaera invaginata* Zone, and the sample VI, 25–27 cm to the *Amphirhopalum praeypsilon* Zone. The sample VII, 50–52 cm may belong to the *Spongaster pentas* Zone or higher, because it does not contain *Spongaster pentas* but *S. tetras* and does poorly preserved specimens of *Stichocorys peregrina.*

P171

Among the samples examined from this core, many reworked, Eocene to Miocene forms are present in the samples of sections II and IV, but are less than 1% of the total population in the rest of samples.

The core catcher sample is rich in *Pterocanium prismatium.* Though *Stichocorys peregrina* occurs in the same sample, it is rare (less than a few percent) and mostly in a fragmental manner. *Anthocyrtidium angulare, Theocorythium vetulum, Pterocorys hertwigii,* and abundant *Pterocanium prismatium* are found in the sample VIII, 50 cm.

On the contrary, *T. vetulum* is absent, and *P. prismatium* is rare and poorly preserved in the sample VI, 50 cm. Thus it may be reasonably assumed that the last occurrence of *P. prismatium* is lower than the section VI and probably in the section VIII. The last occurrence of *Axoprunum angelinum* is in the sample II, 50 cm. *Buccinosphaera invaginata, Collosphaera tuberosa, Amphirhopalum ypsilon,* and *Lamprocyrtis haysi* are limited in the pilot-top sample. Based on these radiolarian distribution, it is concluded that the pilot-top sample is referable to the *Buccinosphaera invaginata* Zone, the interval from the samples II, 50 cm through VI, 50 cm to the *Amphirhopalum praeypsilon* Zone, and the samples VIII, 50 cm and CC to the *Pterocanium prismatium* Zone, respectively.

P172

Radiolarians are abundant and well-preserved in the present core, except for the sample II, 28–30 cm which consists of rare and moderately preserved ones. In most of the samples derived fossils are less than 1% of the total population, but they attains nearly 25% in the case of the sample II, 28–30 cm.

In the catcher sample *Pterocanium prismatium* are abundant but *Stichocorys peregrina* is very rare (less than 1%) and poorly preserved. Throughout the core it is noted on the radiolarian occurrence as: *Pterocanium prismatium* (LA) in the sample VI, 50–52 cm, *Anthocyrtidium angulare* (LA) in the sample IV, 50–52 cm, *Collosphaera tuberosa* in the sample I, 38–40 cm, and *Axoprunum angelinum* in the sample I, 10–12 cm. Accordingly, biostratigraphic assignment of the core is done as follows: the samples I, 10–12 cm to 38–40 cm to the *Collosphaera tuberosa* Zone, the samples II, 28–30 cm through III, 94–96 cm to the *Amphirhopalum praeypsilon* Zone, the samples IV, 50–52 cm to V, 50–52 cm to the *Anthocyrtidium angulare* Zone, and the samples VI, 50–52 cm through the core catcher to the *Pterocanium prismatium* Zone.

P173

Radiolarians are mostly abundant and well preserved in the core except the samples III, 50–52 cm and IV, 50–52 cm which contain few specimens. Frequencies of reworked forms vary from horizon to horizon; they amount to nearly 10% of the total population in the pilot-core top to the sample II, 50–52 cm, 90% in III, 50–52 cm, 75% in IV, 50–52 cm, less than 1% in V, 50–52 cm, 25% in VI, 50–52 cm, but become negligible (less than 1%) in VII, 50–52 cm and subsequent lower samples.

Biostratigraphic succession of the present core in term of the radiolarian zones is as follows:

Pilot top	*Collosphaera tuberosa* Zone
I, top–II, 50–52 cm	*Amphirhopalum praeypsilon* Zone
III, 50–52 cm	*Anthocyrtidium angulare* Zone
IV, 50–52 cm	*Pterocanium prismatium* Zone
V, 50–52 cm	*Stichocorys wolffii* Zone
VI, 50–52 cm	*Stichocorys delmontensis* Zone
VII, 50–52 cm–CC	*Theocyrtis tuberosa* Zone

Distinct hiatuses are recognized between the sections IV and V, and VI and VII, respectively. The former hiatus encompasses seven zones from the *Calocycletta costata* Zone to the *Spongaster pentas* Zone, while the latter does the *Dorcadospyris ateuchus* Zone, the *Lychnocanoma elongata* Zone and the *Cyrtocapsella tetrapera* Zone.

In the present investigation the pilot-top sample is assigned to the *C. tuberosa* Zone

because of the absence of *Buccinosphaera invaginata*. However, it cannot exclude the possibility that top part of the core is referable to the *Buccinosphaera invaginata* Zone. It is generally hard to conclude lack of *B. invaginata* among assemblage, for the species is primarily few in number and occurs sporadically in many cases.

P174

Radiolarians are well preserved, abundant individuals are found except for the pilot-top sample. Those in the top of the core belong in the *Collosphaera tuberosa* Zone, but reserves a possibility in the *Buccinosphaera invaginata* Zone by the same reason already mentioned. The interval between the sample IV, 50–52 cm and the core catcher belongs in the *Dorcadospyris alata* Zone. Further study is needed on the unsampled interval between the two zones to determine whether there exists a hiatus between them or a continuous sequence by slow deposition. However, conditions appear favorable for the existence of a hiatus at present. The reasons are: (1) there are no indications in sedimentary sequence of the core showing a change in rate of deposition; (2) the pilot-top sample contains many reworked, Miocene forms belonging in the *Dorcadospyris alata* Zone and/or a little younger horizon, and these forms exceed 90% of the total population, while no derived fossils are present in the lower samples.

P175

Radiolarians are rich and well preserved in the present core. The samples examined more or less contain the following Eocene to Miocene forms, but these reworked species are less than 1% of the total population in the upper portion (the pilot-top to the section III) and increase very gradually downwards in the lower portion. They are: *Lithocyclia angusta, L. crux, Lychnocanoma elongata, Eucyrtidium fistuligerum, Thysocyrtis triacantha, Cyrtocapsella cornuta, Stichocorys delmontensis, S. peregrina, S. wolffii, Calocycletta costata, C. virginis, Podocyrtis ampla ampla, P. goetheana, P. sinuosa, Theocyrtis annosa, T. tuberosa,* and *Theocampe mongolfieri.*

The samples are assigned to the radiolarian zones as follows:

Pilot top	*Buccinosphaera invaginata* Zone
I, top	*Collosphaera tuberosa* Zone
III, 50–52 cm	*Amphirhopalum praeypsilon* Zone
V, 50–52 cm	*Anthocyrtidium angulare* Zone
VII, 50–52 cm–CC	*Pterocanium prismatium* Zone

P176

Reworked, Eocene to Miocene radiolarians are abundant in the interval between the samples I, top and IV, 50–52 cm, consisting of more than 99.9% of the total population. On the other hand, they are very rare in the lower samples below the sample V, 50–52 cm and occupy less than 1%.

The pilot-top sample is referred to the *Collosphaera tuberosa* Zone, but it leaves the possibility that it belongs in the *Buccinosphaera invaginata* Zone, as mentioned in the earlier lines. The interval of the "reworked assemblage zone" is indeterminable. The sample IV, 50–52 cm is questionably assigned to the *Ommatartus antepenultimus* Zone; the samples V, 50–52 cm to VI, 50–52 cm to the *Ommatartus antepenultimus* Zone; and the samples VII, 50–52 cm to CC to the *Cannartus petterssoni* Zone.

P177

Among the samples examined from the core, only the pilot top contains radiolarians

of the *Collosphaera tuberosa* Zone (or of the *Buccinosphaera invaginata* Zone). The reworked forms amounting to 10% of the total population are all of Eocene ones as: *Lythocyclia aristotelis, Thyrsocyrtis hirsuta tensa, T. triacantha, Lamptonium fabaeforme fabaeforme, Podocyrtis ampla ampla, P. chalara, P. mitra, P. trachodes,* and *Theocampe mongolfieri.*

P178

Throughout the core the uppermost section contains radiolarians, though very rare and poorly preserved. Species recovered from the sample I, top are Eocene ones such as *Eusyringium fistuligerum, Thyrsocyrtis hirsuta tensa, T. triacantha,* and *Theocampe mongolfieri.* As for the sample I, 40 cm, no diagnostic species are found for age assignment. All the radiolarians are apparently derived fossils.

P179

Very rare, moderately preserved radiolarians are present only in the top part of the core. In the pilot-top sample there are *Collosphaera tuberosa, Ommatartus tetrathalamus, Spongaster tetras, Theocorythium trachelium* and *Theocampe amphora* group, and the assemblage belongs in the *Collosphaera tuberosa* Zone (or the overlying *Buccinosphaera invaginata* Zone). A reworked, Cretaceous? *Dictyomitra* sp. is recorded in the same sample.

Planktonic foraminiferal biostratigraphy

All planktonic foraminifera encountered in the cores are listed and their state of preservation is marked on Table X-3. Biostratigraphic zonal scheme adopted is after BLOW (1969). Stratigraphic distributions of Pliocene-Pleistocene species are examined with reference to the previous works on the Pacific region (HAYS *et al.*, 1969; SAITO *et al.*, 1975; TAKAYANAGI *et al.*, 1979).

P160

Dissolution is remarkably distinct in the core. Only *Globorotalia tumida* is present in the sample I, 34–37 cm.

P162

Foraminifers are moderately to poorly preserved in the samples examined. The assemblages of the samples VIII, 90–94 cm through V, 0–4 cm belong in Zone N.22, characterized by the concurrence of *Globorotalia truncatulinoides, G. tosaensis* and *Globoquadrina pseudofoliata.* A few, reworked Pliocene forms as *Globoquadrina* and *Sphaeroidinellopsis* are present in some samples.

P163

Foraminifers are very rare and poorly preserved in the core. Besides *Globigerinita glutinata,* found are *Globorotalia margaritae* (IV, 50–54 cm), and *Globorotalia tumida* and *Sphaeroidinella dehiscens* (pilot top). It is only apparent that the core is Pliocene or younger in age.

P164

Preservation of foraminifers is moderate to poor in the samples examined. By the presence of *Sphaeroidinella dehiscens* and *Globorotalia tumida* in the lowest sample (CC), it is shown that the core belongs in Zone N.19 or overlying zones. *Globigerina nepenthes, Globoquadrina altispira,* and *Sphaeroidinellopsis seminulina* are continuously found in the samples from the core catcher through V, 50–52 cm, but they are absent in the

overlying sample V, 7–9 cm and subsequent ones. Instead, the lowest occurrence of *Globorotalia truncatulinoides* is recognized together with *Globigerinoides fistulosus* in the sample V, 7–9 cm. Accordingly the base of Zone N.22 may correspond to this horizon. Among the three forms whose last occurrences are noted in the sample V, 50–52 cm, *Globigerina nepenthes* become extinct first as early as the time of Zone N.19. It is thus suggested that a hiatus encompassing the upper part of Zone N.19 and Zone N.21 is present within the section V. The catcher sample contains a few reworked, Eocene (to Oligocene) and Miocene forms as *Globigerina tripartita, Globigerinatella insueta* and *Globorotalia fohsi robusta.*

P165

Due to heavy dissolution only the sample II, 2–4 cm is fossiliferous. The assemblage consisting of *Globigerina rubescens, Globigerinita glutinata, Globigerinoides ruber, G. tenellus* and *Turborotalita humilis* is of the uppermost part of Zone N.21 or overlying zones.

P168

Foraminifers are rare and poorly preserved in the lower portion of the core, but rich and moderately preserved in the upper portion. Among the forms from the lower portion the following are marked by their occurrence: *Globoquadrina praedehiscens* in the sample VII, 50–52 cm and V, 60–62 cm; *Globorotalia kugleri* in VI, 50–52 cm and V, 60–62 cm; and *Catapsydrax dissimilis* and *C. unicavus* in V, 60–62 cm and IV, 90–92 cm. Based on these faunal succession, the middle part represented by the sections V and VI is assigned to the Zone P.22 to Zone N.4. The lower portion as a whole may be limited within the interval from the upper part of Zone P.21 to Zone N. 6. On the other hand, *Globorotalia truncatulinoides* is first recorded in the sample IV, 40–42 cm. Further the upper portion contains *Globoquadrina conglomerata* and dominantly dextrally coiled *Pulleniatina obliquiloculata.* Such assemblages are known from the upper Pleistocene sediments (probably Zone N.23) of the equatorial Pacific region (TAKAYANAGI *et al.*, 1979). Therefore, there is a large hiatus lying in the interval between 90–92 cm and 40–42 cm of the section IV.

P169

The present core has many reworked fossils of Late Cretaceous to Neogene age: They are mainly such thick-walled forms, as *Globotruncana arca, G. fornicata, Acarinina spinulosa, Globorotalia cerroazulensis, G. fohsi fohsi*, etc. Taking such condition into consideration, zonal assignment of the samples is carried out on the basis of the first occurrence of diagnostic species. Occurrences of *Sphaeroidinella dehiscens* in the sample VII, 60–62 cm, and *Globorotalia truncatulinoides* in the sample VI, 93–95 cm may indicate that the section VII is not lower than N.19 and that the base of the section VI is near or above the base of Zone N.22. In addition, it is likely that the sample IV, 14–16 cm with *Globoquadrina conglomerata* is late Pleistocene in age.

P170

Rare and poorly preserved planktonic foraminifers are found in the upper three samples of the core. They are mostly solution-resistant species as *Globorotalia tumida, Pulleniatina obliquiloculata, Sphaeroidinella dehiscens*, etc., ranging from Pliocene to Pleistocene in age.

P172

Rare, poorly preserved foraminifers are present in the upper samples II, 28–30 cm and I, 38–40 cm. By the presence of *Globorotalia truncatulinoides* in the former sample, it is indicated that these upper portion is Pleistocene in age.

P176

Very rare, poorly preserved foraminifers similar to those recorded from the cores P170 and P173 are found in the uppermost two samples (pilot top and I, top).

Distribution of benthic foraminifera

Following the procedure as already described before ("Method of Study"); it was originally planned to pick up 200-odd individuals of benthic foraminifers (besides two species of *Streptochilus*) from aliquot parts of the processed sample. However, due to the limitations of sample volume available for micropaleontological analysis, nearly half of the samples examined contained less than 100 individuals *in toto*.

Of 63 samples from 15 cores examined, 262 taxa were distinguished (Table X-4). Among these taxa are two species belonging to the genus *Streptochilus*, *S. globiger* (SCHWAGER) and *S. tokelauae* (Boersma). Although this genus was assumed as a planktonic foraminifer by BRÖNNIMANN and RESIG (1971), its habit is still unclear for insufficiency of subsequent information. Despite its very minute and feeble tests, apparently highly susceptible to dissolution, it was found that the relative abundance tends to increase as the state of preservation of other planktonic forms becomes progressively poor. Such observations in the present study suggest that *Streptochilus* has solution-resistant tests which are much closer to of benthic forms than planktonic ones. Accordingly *Streptochilus* is tentatively included in the benthic foraminifers for analyses.

Analysis of benthic foraminifera

By reference to the results of planktonic biostratigraphy, benthic foraminifers recovered are from Oligocene to Recent sediments except for the middle to late Miocene part.

Generally, *Oridorsalis umbonatus, Pseudoparrella exigua, Globocassidulina subglobosa,* and *Osangularia umbonifera* are relatively common constituents in the assemblage throughout the cores. On the one hand there are many common forms between the Oligocene (to early Miocene) and Pleistocene assemblages, on the other hand there are many taxa confined to either Oligocene (to early Miocene) or Pliocene and younger sediments.

At bathyal depths the percentage of benthic foraminifers to the total population is usually very small, and evolution of many of those bathyal habitants is very slow (BOLTOVSKOY, 1980). In addition, due to lack of a continuous faunal sequence in Oligocene to Holocene sediments of the studied cores, precise stratigraphic ranges of the constituent taxa are difficult to be ascertained. Under these circumstances, main efforts are directed to bring light on benthic faunal characters in terms of planktonic biostratigraphy.

Based on distribution of 70 taxa commonly occurred, cluster analysis was made for determining sample groups (Q-mode) employing samples which yielded more than 100 individuals. For a similarity index HORN's index of overlap (HORN, 1966) is adopted. Computation was carried out with NEAC ACOS System 700 computer in the Tohoku University Computer Center using a program written by S. HASEGAWA. Clustering was

done by using the weight pair group method with simple arithmetic averages.

The result of the Q-mode analysis is shown in a dendrogram (Fig. X-4). The samples were classified into five groups, A-E, at a level of 0.45 similarity index.

Taking a wide view of these groups distributed in the cores, they occupy three stratigraphic intervals. Group D is confined in the upper to uppermost parts of the cores, which are late Pleistocene to Holocene in age. On the contrary, group E is found in the

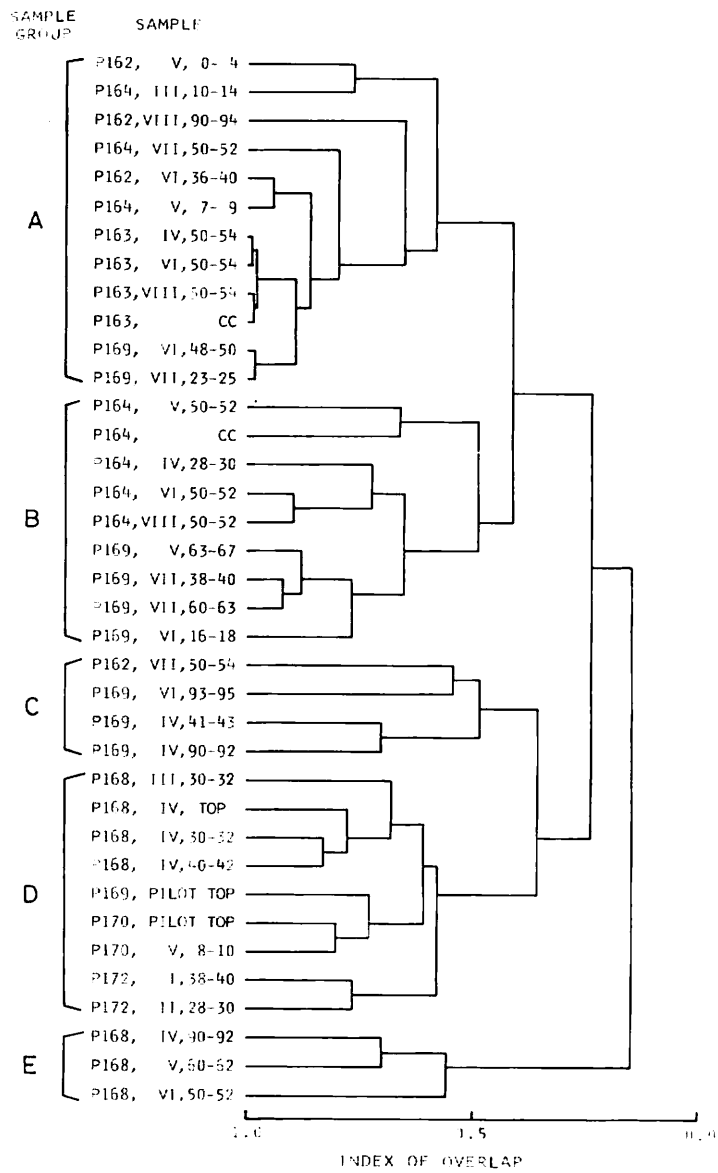

Fig. X-4 Dendrogram for Q-mode cluster analysis of benthic foraminiferal fauna from cores in the equatorial Pacific (only samples yielding more than 100 specimens are included).

lower portion of the cores of late Oligocene to early Miocene age. Groups A, B, and C appear within the Pliocene to early Pleistocene interval between those of the foregoing two groups (The middle to late Miocene benthic foraminifers are not characterized due to their absence in the sediments of the corresponding ages in the cores studied.)

Among the three groups, A, B, and C, no consistent relationship is recognized in their stratigraphic occurrence. For instance, in core P163 assemblages of the Pliocene to early Pleistocene sequence are represented by group A thoroughly; in core P162 chiefly group A with some intercalations of group C; in core P164 an alternation of groups A and B; in core P169 an alternation of groups A, B, and C. A comparison of specific composition of the assemblages among the three groups reveals that group A is dominated by *Streptochilus tokelauae* and group B by *S. globiger* but that the group C lacks in both species (Fig. X-5). These species are of minute tests (less than 200 μm). In the assemblages dominated by them, the remaining species (both benthic and planktonic) are usually represented by predominant juvenile individuals. Consequently, segregation of group C from the other two appears ascribable to such factor as mechanical sorting by bottom current. As to the difference between groups A and B, however, no ecological informations are available at present.

The groups from the respective three stratigraphic intervals are principally named after a combination of two species of common and consistent occurrence as follows:

Group D	*Eilohedra levicula-Alabamina bradyi* Assemblage
Groups A, B, and C combined	*Eavocassidulina favus-Globocassidulina crassa* Assemblage
Group E	*Globocassidulina caudriae-Stilostomella stachei* Assemblage

The stratigraphic distribution of these assemblages in the cores are shown in Fig. X-6. Brief descriptions of the assemblages are given in the following lines.

1) *Globocassidulina caudriae-Stilostomella stachei* Assemblage

In this assemblage *Stilostomella stachei, S.* sp. B, *Buliminella carteri, Pseudoparrella exigua,* and *Globocassidulina subglobosa* are relatively common. In addition, the forms limited in their occurrences within the assemblage are: *Globocassidulina caudriae, Bolivina plicatella, Amphicoryna hirsuta, Bulimina jarvisi, Cibicidoides* cf. *sinistralis, Uvigerina striatella,* and *Siphonodosaria abyssorum.*

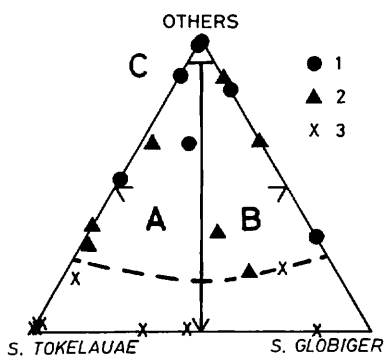

Fig. X-5 Triangular diagram of ratio of *Streptochilus globiger* (SCHWAGER), *Streptochilus tokelauae* (BOERSMA) and the other benthic species for sample groups A, B, and C. 1: sample in which medium-sized specimens (300–500 μm) predominate, 2: intermediate one between the sample groups 1 and 3, 3: sample in which smaller-sized specimens (200–300 μm) predominate. Broken line shows boundary between the sample group 3 and the other ones on figure.

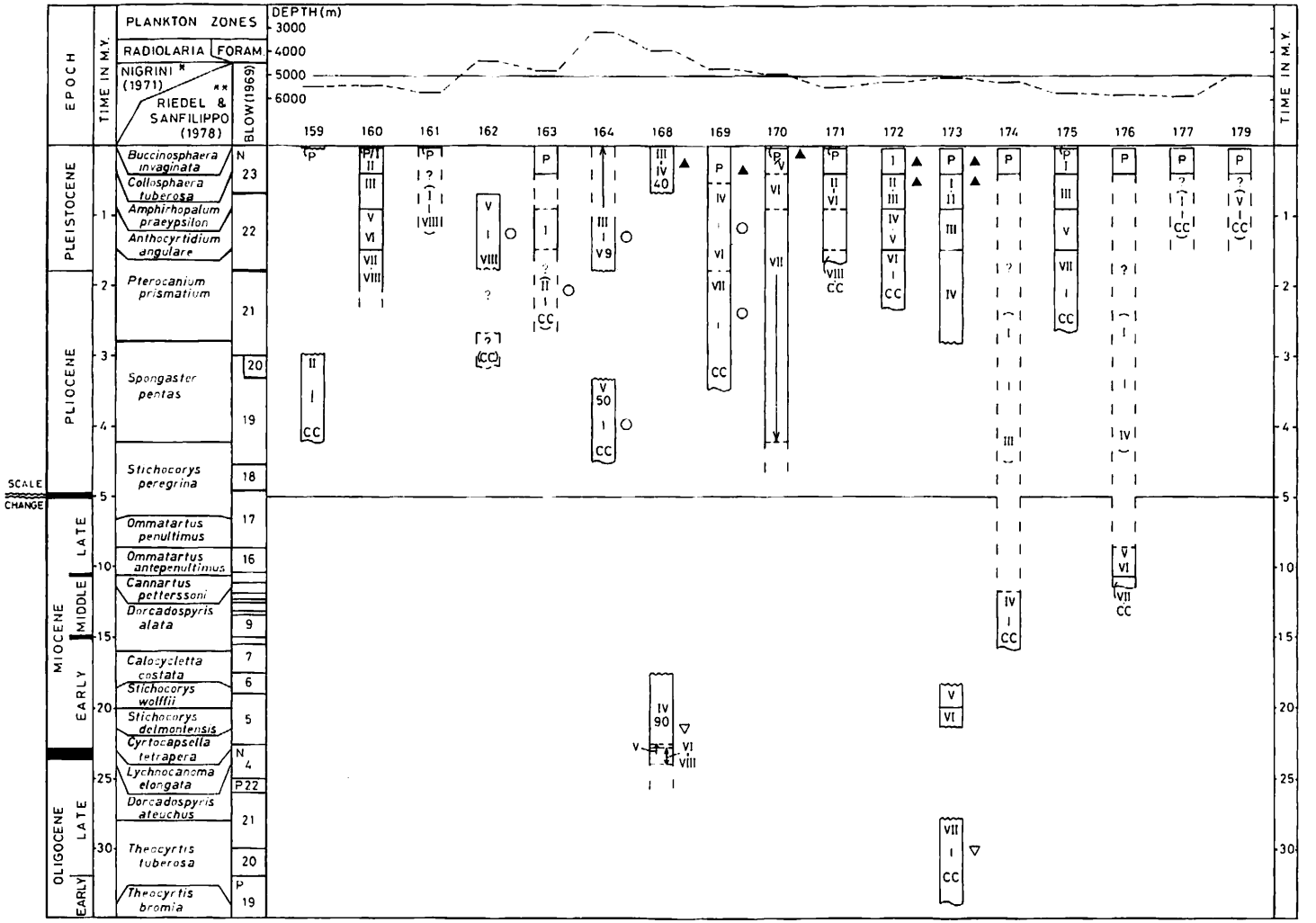

Fig. X-6 Biostratigraphy of piston cores and distribution of benthic foraminiferal assemblages. Water depth of each coring site is shown in upper part of figure. Correlation between geologic time scale and microfossil zones is based on BERGGREN and VAN COUVERING (1974) and HARDENBOL and BERGGREN (1978). * Quaternary, ** Tertiary, Benthic foraminiferal assemblages, ▲ *Eilohedra levicula-Alabamina bradyi*, ○ *Favocassidulina favus-Globocassidulina crassa*, ▽ *Globocassidulina caudriae-Stilostomella stachei*

2) *Favocassidulina favus-Globocassidulina crassa* Assemblage

Favocassidulina favus, *Globocassidulina crassa*, *Bulimina translucens*, and *Globocassidulina subglobosa* are common in the present assemblage. Species confined to the assemblage are *Frondicularia bradii* and *Nodosaria colomorpha*, although they are few in number. Most of the species appeared commonly in the assemblage are also the constituents of the under- and overlying assemblages. *Streptochilus globiger* and/or *S. tokelauae* dominate this assemblage in many cases, but fluctuate remarkably their abundance among cores and horizons.

3) *Eilohedra levicula-Alabamina bradyi* Assemblage

In this youngest assemblage occurred from the upper to uppermost parts of the sediment cores examined, dominant forms are *Globocassidulina subglobosa, Pseudoparrella exigua, Pullenia subsphaerica, P.* cf. *subsphaerica* and *Alabamina bradyi.* In association with these forms, *Pullenia bulloides, P.* sp. A, *Melonis pompilioides, M. affinis,* and *M. guadaloupae* are rather commonly found.

Summary and conclusion

1. Radiolarians and foraminifers (both planktonic and benthic) were analysed on a total of 179 sediment samples from the piston cores obtained at 22 stations in the Central Pacific.

2. Based on the state of preservation of planktonic foraminifera and their proportion to the total population, it is inferred that lysocline depth is shallower than 3900 m while CCD is around 5100 m.

3. Either radiolarians or planktonic foraminifera are useful for biostratigraphic and chronostratigraphic correlation among the cores from 17 stations. The sediments recovered from the cores range from Oligocene to Holocene in age, but are mostly of Pliocene and the younger age. Many stratigraphic hiatuses were recognized at various horizons in various cores.

4. Of these cores, only the ones from four shallower stations (less than 4710 m deep) contain commonly planktonic foraminifera almost throughout. Such mode of occurrence is in well accordance with the state of preservation of calcareous fossils in sediments as shown in Figs. X-2, -3, and -6).

5. As the result of cluster analysis, benthic foraminifers are classified into three groups of different age. They are: the *Globocassidulina caudriae-Stilostomella stachei* Assemblage of late Oligocene to early Miocene age; the *Favocassidulina favus-Globocassidulina crassa* Assemblage of Pliocene to early Pleistocene age, and the *Eilohedra levicula-Alabamina bradyi* Assemblage of late Pleistocene to Holocene age.

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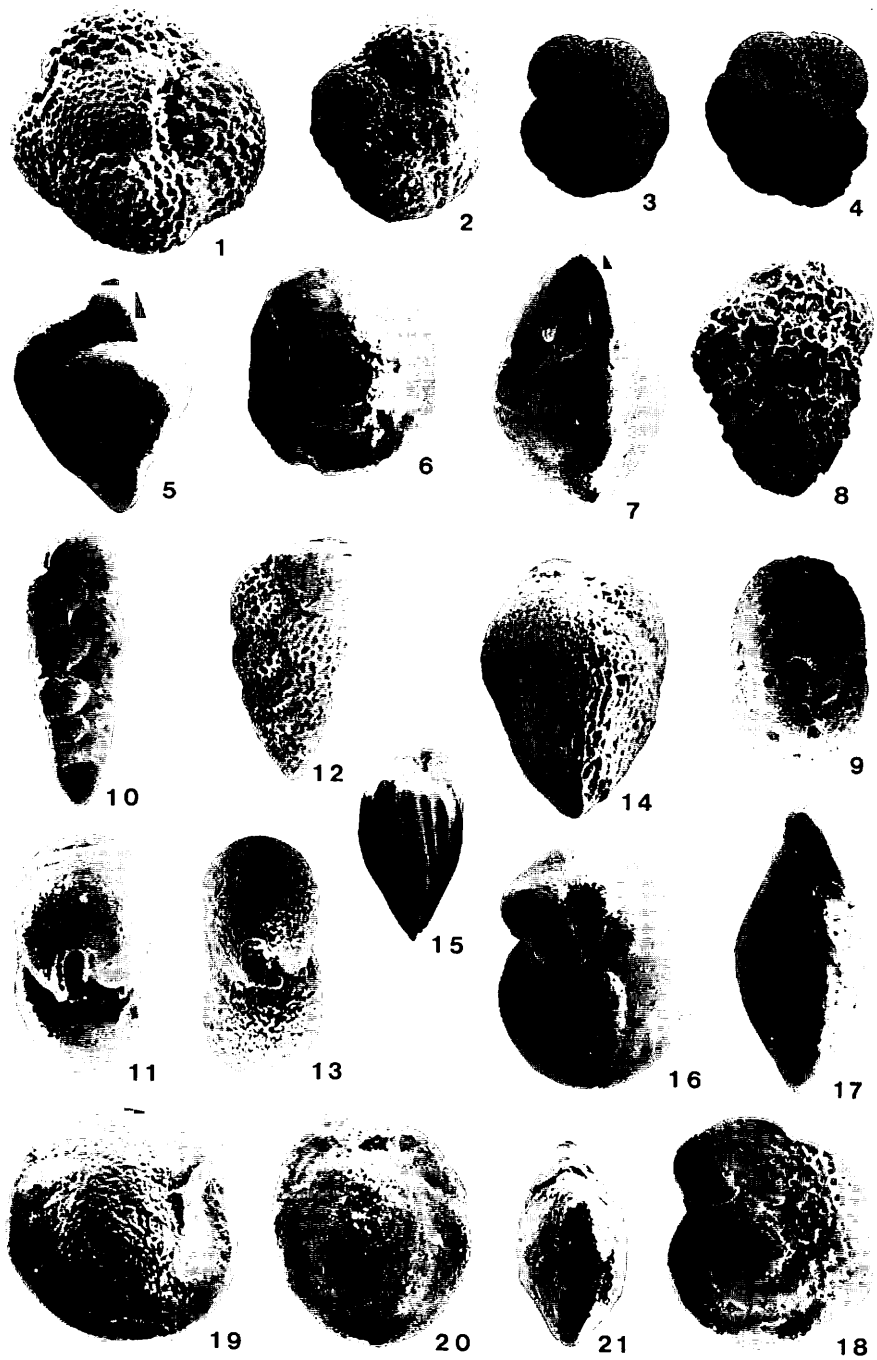

Fig. X-7 Foraminifers from the Central Pacific-1. **1.** *Catapsydrax dissimilis* (CUSHMAN and BERMÚDEZ), P168, V, 60–62 cm; ×277 **2.** *Catapsydrax unicavus* BOLLI, LOEBLICH, and TAPPAN, P168, V. 60–62 cm; ×281 **3, 4.** *Globorotalia kugleri* BOLLI, P168, V, 60–62 cm; ×277 **5.** *Pulleniatina spectabilis* PARKER, P162, VIII, 90–94 cm; ×132 **6, 7.** *Alabamina bradyi* (EARLAND), P169, pilot top; 6. ×225, 7. ×300 **8, 9.** *Bolivina plicatella* CUSHMAN, P168, V, 60–62 cm; ×426 **10, 11.** *Streptochilus tokelauae* (BOERSMA), P164, V, 7–9 cm; 10. ×300, 11. ×600 **12, 13.** *Streptochilus globiger* (SCHWAGER), P164, V, 50–52 cm; 12. ×450, 13. ×600 **14.** *Bulimina jarvisi* CUSHMAN and PARKER, P168, V, 60–62 cm; ×206 **15.** *Bulimina rostrata* BRADY, P169, VI, 93–95 cm; ×133 **16–18.** *Cibicidoides bradii* (TOLMACHOFF), P164, IV, 28–30 cm; ×150 **19–21.** *Cibicidoides* cf. *sinistralis* (CORYELL and RIVERO), P168, V, 60–62 cm; ×198.

Fig. X-8 Foraminifers from the Central Pacific-2. **1, 2.** *Ehrenbergina histrix* BRADY, P169, IV, 41–43 cm; ×137 **3, 4.** *Eilohedra levicula* (RESIG), P172, I, 38–40 cm; ×450 **5–7.** "*Eponides*" *tumidulus* (BRADY), P168, III, top; ×426 **8, 9.** *Favocassidulina favus* (BRADY), P162, VII, 50–54 cm; 8. ×99, 9. ×139 **10, 11.** *Globocassidulina caudriae* (CUSHMAN and STAINFORTH), P168, V, 60–62 cm; ×426 **12, 13.** *Globocassidulina crassa* (D'ORBIGNY), P162, V, 0–4 cm; ×300 **14, 15.** *Globocassidulina elegans* (SIDEBOTTOM), P169, IV, 90–92 cm; ×209 **16–18.** *Globocassidulina subglobosa* (BRADY), P169, VI, 93–95 cm; 16, 17. ×225, 18. ×300 **19–21.** *Globocassidulina* sp. A, P169, IV, 90–92 cm; 19, 20. ×135, 21. ×202.

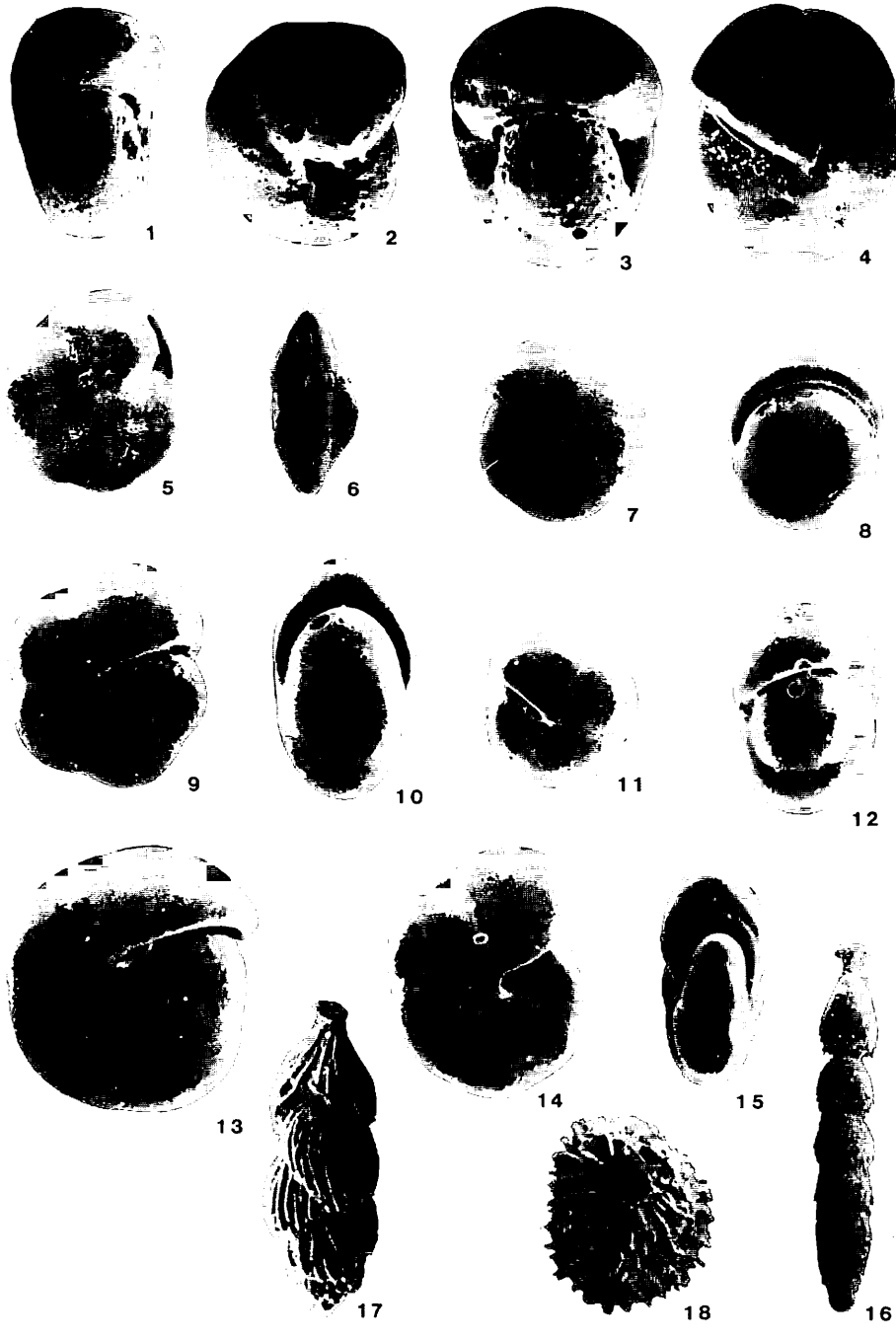

Fig. X-9 Foraminifers from the equatorial Pacific-3. **1.** *Melonis guadalupae* PARKER, P172, I, 38–40 cm; ×130 **2, 3.** *Melonis pomilioides* (FICHTEL and MOLL), P164, IV, 28–30 cm; 2. ×133, 3. ×212 **4.** *Oridosalis umbonatus* (REUSS), P164, cc; ×209 **5, 6.** *Pseudoparrella exigua* (BRADY), P168, IV, 40–42; ×150 **7, 8.** *Pullenia bulloides* (D'ORBIGNY), P172, I, 38–40 cm; ×150 **9, 10.** *Pullenia simplex* RHUMBLER, P172, I, 38–40 cm; ×281 **11, 12.** *Pullenia subsphaerica* PARR, P164, IV, 28–30 cm; 11. ×200, 12. ×300 **13.** *Pullenia* cf. *subsphaerica* PARR, P172, I, 38–40 cm; ×283 **14, 15.** *Pullenia* sp. A, P172, I, 38–40 cm; ×281 **16.** *Stilostomella stachei* SRINIVASAN, P168, VI, 50–52 cm; ×207 **17, 18.** *Uvigerina striatula* CUSHMAN, P168, V, 60–62 cm; 17. ×281, 18. ×426.

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