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DISTRIBUTION OF FORAMINIFERA IN CORES FROM JUAN DE FUCA RIDGE, NORTH EAST PACIFIC

by

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ABSTRACT

Benthic and planktic Foraminifera from the Juan de Fuca Ridge, North East Pacific, were identified and counted in 55 samples from 6 cores. There is a rich foraminiferan diversity of 193 taxa, one third of which are new or undescribed species. Planktic specimens are most abundant with sinistrally coiled Globoquadrina pachyderma the most common species. The majority of the 184 benthic species come from the superfamilies Buliminacea, Orbitoidacea and Cassidulinacea. The most abundant benthic species are displaced downslope and outnumber the indigenous lower bathyal fauna.

An algal 'cyst' identified as Pachysphaera sp. may prove to be a biostratigraphic marker near the Pleistocene-Holocene boundary. It occurs from the surface to between 40 and 60 cm. below a decrease in the planktic foraminiferan-radiolarian ratio, which indicates the glacial-postglacial climatic shift. This change of ratio was the only means of correlating between cores as neither the benthic nor planktic foraminiferan assemblages were useful for establishing time zones in the late Pleistocene-Holocene interval cored.

Much of the sediment represented in the cores is hemipelagic and originated from upper to lower bathyal

depths as indicated by the entrained benthic foraminifera. In the Pleistocene section of one core, detrital quartz grains and mica flakes in addition to shelf foraminifera indicate turbidite movement west and southward from the shelf.

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INTRODUCTION

Transform faults and magnetic anomalies associated with the Juan de Fuca Ridge of the North East Pacific were used by Wilson (1965) and Vine and Wilson (1965) respectively, to demonstrate sea floor spreading. This stimulated interest in the geology and geophysics of plate interactions in the area and subsequently numerous studies have contributed knowledge on the bathymetry, magnetics, seismicity, heat flow, tectonics, geology and plate interactions near the Juan de Fuca Ridge (eg. Tiffin and Seeman, 1975; Srivastava et al., 1971, Davis, Lister, and Lewis, 1976; Davis and Lister, 1977a; McManus et al., 1972, Davis and Lister, 1977b; Barr and Chase, 1974; Riddihough, 1977).

Through the above research high heat flow values were discovered in the vicinity of the Juan de Fuca Ridge and were thought to be possible sites of hydrothermal circulation and metal enrichment. To assess the possible mineralization of sediments the Geological Survey of Canada conducted a regional study in 1977 and the Department of Geological Sciences, University of British Columbia conducted studies on the sediments and geochemistry of selected areas of the Juan de Fuca and Explorer Ridges during three cruises, 1977 to 1979 [Tiffin et al., 1978; Bornhold, Tiffin and Currie, 1980; Grill et al., 1980; Cook,(in prep.);

Béland, (in prep.); Price, (1981); Hansen, (in prep)].

In addition to the geochemical and sedimentological studies conducted on the cores collected during these cruises the objectives of this study were to:

(a) identify the planktonic and benthic foraminiferan assemblages near the Juan de Fuca Ridge.

(b) evaluate the usefulness of these assemblages for dating and correlation between cores.

(c) assess peculiarities of the assemblages for recognition of turbidite sequences and the possible influence of hydrothermal processes and/or geochemical anomalies.

(d) assess the usefulness of the assemblages for paleoenvironmental interpretations with respect to the calcium carbonate compensation depth (CCD), source and rates of sedimentation and changes of oceanographic physical parameters.

Reports on foraminifera from the Pacific began a century ago with H.B. Brady's (1884) work on foraminifera, from the Challenger Expedition, which included specimens from the central and western north Pacific. This work was later taxonomically updated by Barker (1960). From 1910 to 1917 Cushman published a series of monographs on foraminifera from the north Pacific. More specific regional studies were made during the 1930's to 1950's when Natland, Crouch and

Bandy published foraminiferan depth and temperature ranges from the California coast, as summarized in Natland (1957). Studies north of California were started in the 1960's when Enbysk (1960) established the distribution of foraminifera on the shelf and slope as well as from 47 deep sea samples in the north east Pacific from Oregon to Alaska. A taxonomic study was published by Smith (1973) of foraminifera from latitudes 25° to 55° N in a more central area of the north Pacific up to the Aleutians. Bergen and O'Neil (1979) determined the distribution of foraminifera in the Gulf of Alaska. Studies which have dealt more specifically with shallower water foraminifera of the North East Pacific are by Gallagher (1979), McCulloch (1977), Todd and Low (1967), and Uchio (1960).

Although both Brady's (1884) and Cushman's (1910-1917) works have remained as basic references for taxonomic study of deep sea foraminifera in the north Pacific there have been few studies to establish the diversity, distribution or ecology of benthic foraminifera in the area. The physical environment which has determined these characteristics of the bathyal foraminifera is not well known. The north Pacific bathyal depths have generally been described as cold and dark with physical parameters such as temperature, salinity, dissolved O_2, CO_2 and nutrients

relatively stable through both distance and time (Schnitkner, 1980).

There are few references to physical oceanographic parameters in the deep northeast Pacific. Pickard (1980) presented a general survey of Pacific deep water temperature and salinity below 2000 m. along a profile at 175° W longitude. The temperature and salinity ranges were 1.1° to 2.2° C and 34.65‰ to 34.75‰ respectively. Studies from the Juan de Fuca Ridge area along Line P at 48° to 50° N. latitude and 125° to 145° W longitude at a depth of 1500 m. gave the same temperature and salinity values as above (Thomson, 1973).

No deep water is formed in the Pacific. The Antarctic is the water mass source for the Pacific Deep Water and is reflected by the uniformity of bottom conditions (Pickard, 1980; Schnitker, 1980). The Pacific deep and bottom water masses originating off Antarctica come from the south between New Zealand and Antarctica flow north and eastward across the equator bifurcating near the Hawaiian Islands (Pickard, 1980; Gordon, 1975). Although the deep flow pattern of the north Pacific has been discussed for a number of years (Reed, 1969; Edmond et al, 1971; Gordon, 1975) the resultant pattern is still unresolved (Warren, 1975).

Unlike the knowledge of deep circulation, that of the surface water patterns is well established. Waters of the north Pacific are carried eastward by the Kuroshio Current, and become part of the North Pacific Current which divides near the North American continent into the northerly Alaskan Gyre and the southerly California current. The position of the divergence varies between 50° N in the summer and 45° N in the winter (Pickard, 1980). The study area is situated within the range of the divergence shift and is therefore influenced by both northerly and southerly water masses.

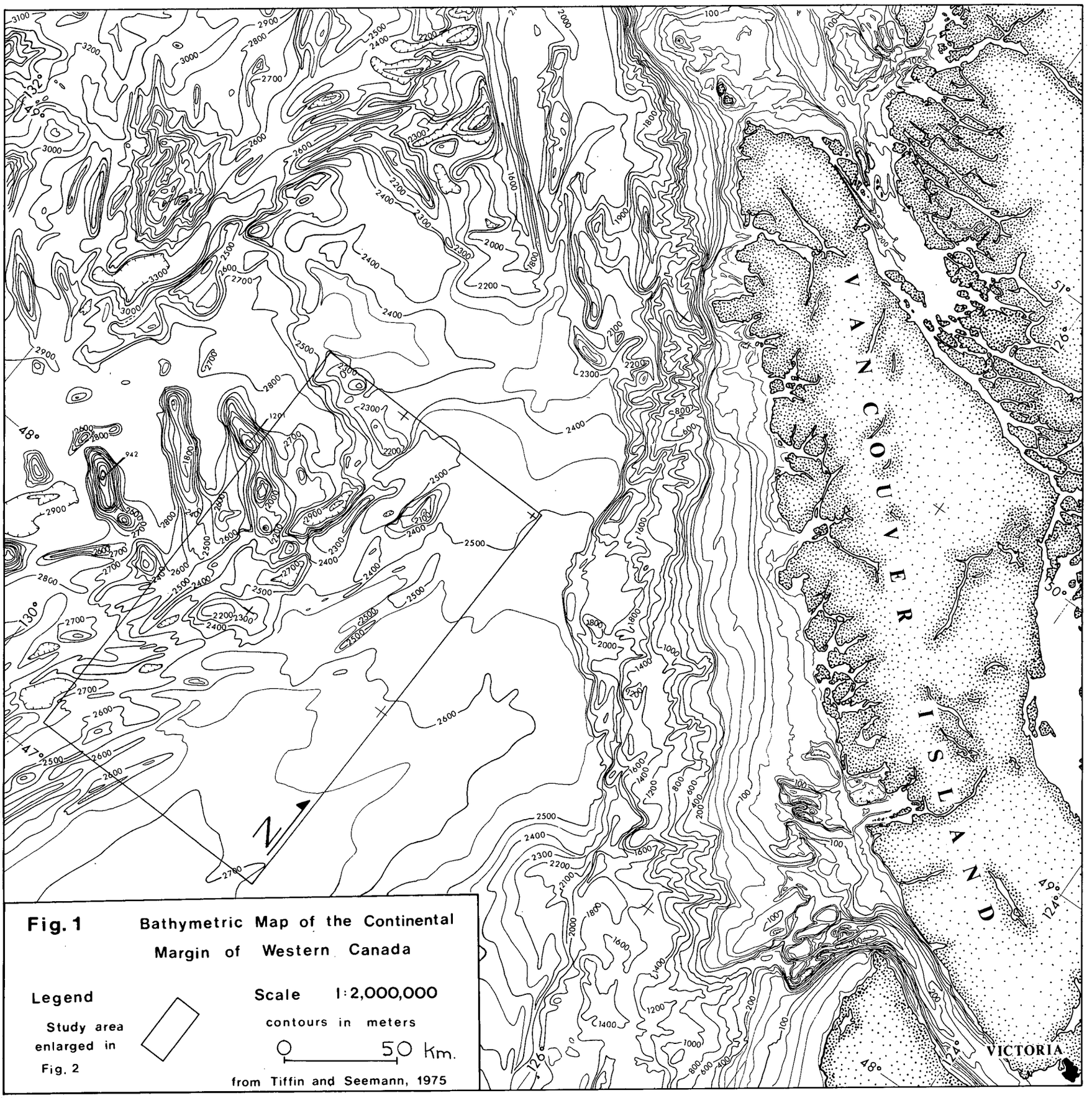

Fig. 1 Bathymetric Map of the Continental Margin of Western Canada

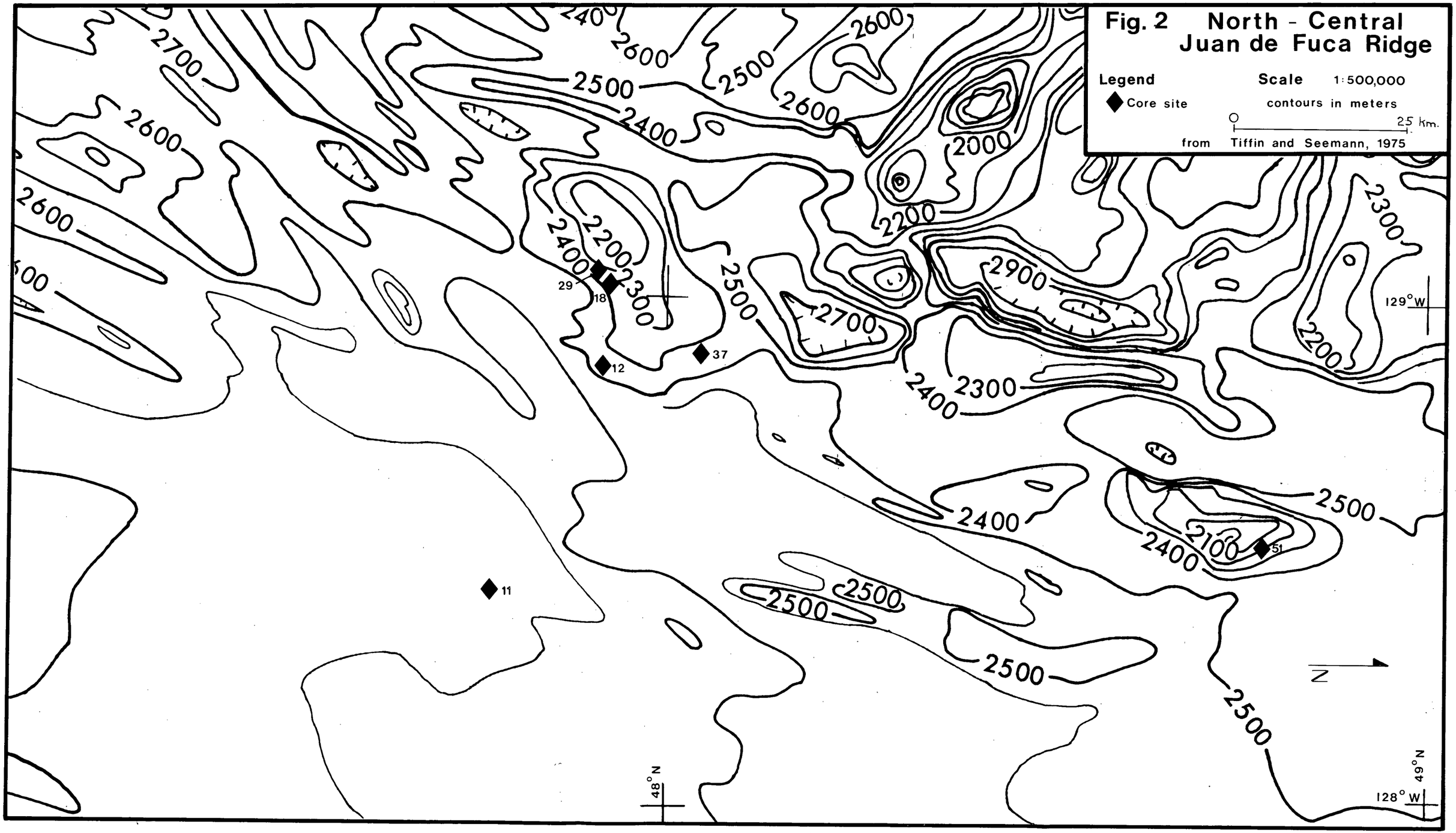

Fig. 2 North - Central Juan de Fuca Ridge

METHODS

Area and Core Locations

Loran-C navigation was used to follow predetermined track lines within the study region (Figs. 1,2). A 3.5 kHz high resolution subbottom profiling system gave shallow seismic profiles from which favourable core sites could be chosen on the basis of structures and sediment thickness.

The six cores of this study (Table 1) were taken betweeen 47° 50' N and 48° 30' N latitude and 128° 35' W and 129° 05' W longitude (Fig. 2) in depths ranging between 2150 and 2650 m. which, depending on the depth classification used (App. D), places them in a lower bathyal or upper abyssal environment. Among the numerous cores taken, six were selected for the following reasons:

Cores 51,18,29 - foraminiferan abundance and position near the ridge.

Core 37 - foraminiferan presence and position part way between Core 51 and the other more southerly ones.

Cores 11,12 - position east of the ridge in relatively thick sediment cover.

Collection and Storage

All six of the cores were collected by a 2½"

diameter gravity corer used aboard CFAV Endeavour: Cores 37 and 51 in 1977, the remainder in 1978. Core 37 was made available for sampling by the Geological Survey of Canada, the others were collected by the Dept. of Geological Sciences, University of British Columbia.

At sea, on board the Endeavour, the Univ. Brit. Col. cores were first measured, then described with respect to colour and sediment type and were subsequently subsampled at the surface for geochemical and paleontological analysis. Afterwards, the cores were sealed and stored upright in a cold locker. After the cruise the cores were split, photographed and subsampled at the University.

A standard sample size of 10 cm^3. and sampling interval of 10 cm. were attempted; however, because of the differing histories of the cores this was not always possible (Table 2). Archival halves of the cores were stored at the Department of Geological Sciences, University of British Columbia, except for Core 37 which is stored at the Pacific Geoscience Centre, Patricia Bay, B.C.

Laboratory Procedures

Sample size for this study was limited because

TABLE 1

CORE LOCATIONS

CORE NUMBER	LATITUDE	LONGITUDE	DEPTH	GENERALIZED BATHYMETRY
UBC-77-51	48° 30.0'N.	128° 52.0'W	2180 m.	Top of West Ridge, Juan de Fuca Ridge
GSC-77-37	48° 03.15'	128° 53.56'	2540	Just east and bathymetrically lower than Juan de Fuca Ridge
PGC-78-6-11	47° 50.48'	128° 37.83'	2633	Thirty km. east of Juan de Fuca Ridge in area of relatively thick sediment cover
PGC-78-6-12	47° 54.94'	128° 51.79'	2602	Five km. east of Juan de Fuca Ridge in area of thick sediment cover
PGC-78-6-18	47° 55.04'	129° 02.33'	2460	Sediment trap just west of Juan de Fuca Ridge
PGC-78-6-29	47° 54.85'	129° 03.06'	2336	Sediment trap on Juan de Fuca Ridge

TABLE 2

CORE HISTORIES

CORE NUMBER	LENGTH	HISTORY
UBC-77-51	124 cm.	Collected in June, 1977. First sampling (Fall, 1977) of 100 $cm.^3$ over top 7 cm. Second sampling (Spring, 1979) 10 $cm.^3$ over 2 cm. intervals approximately every 15 cm. Sampled in 1979: 0-12 cm. and 79-87 cm. for ^{14}C dating. (Samples and dates [App. E] from R. Cook, Dept. Geological Sciences, Univ. Brit. Col.).
GSC-77-37	192 cm.	Collected in August, 1977. Sampling (Spring, 1979) of 10 $cm.^3$ over 2 cm. intervals every 10 cm.
PGC-78-6-11	99 cm.	Collected June, 1978. Sampling (Fall, 1978) of between 10 to 28 $cm.^3$ over 2 cm. intervals every 10 cm. Samples were originally for electrical conductivity studies and were dried for 24 to 48 hours at 105° C. then later used for foraminiferal analysis.
PGC-78-6-12	123 cm.	Collected June, 1978. Sampling (June, 1978) of 36 to 50 $cm.^3$ over 2 cm. intervals every 20 cm.
PGC-78-6-18	44 cm.	Collected June, 1978. Sampling (June,1978) five smears (approx. 10 $cm.^3$) across approximately 9 cm. intervals throughout the core length.
PGC-78-6-29	51 cm.	Collected June, 1978. Sampling (June, 1978) of 10 $cm.^3$ over 2 cm. intervals every 10 cm. from 0 to

samples from the same levels were also required by co-workers for geochemical and sedimentological analysis. No attempt was made to determine wet weight because water loss is known to differ between the cores due to their differing histories (Table 2). The weight of the dried residue after wet sieving the subsample through 18 and 200 mesh standard sieves was not recorded. This was due again to differing histories and the small dried size, where several large specimens or rock chips would bias results. Instead of using weight values for comparison, the samples were standardized by using a 10 cm^3. volume.

Staining

In Cores 11, 12, 18, and 29 a sample from the top 2 cm. was preserved immediately after collection in 4% buffered formalin. Staining techniques were later used to determine the number of living specimens. The stains Rose Bengal and Sudan Black B (heated saturated solution) were used according to methods suggested by Walker et al (1974). The results were not satisfactory because both stains gave ambiguous amounts of heavy external stain. Rose Bengal, particularly, has been known to produce ambiguous results (Green, 1960; Walker et al.,1974; Ingle et al., 1980). Because of these problems no attempt has been made to indicate the presence of living specimens.

Species Identification

Taxa were identified to genus or species using the standard references for this area of the Pacific cited earlier together with the ongoing Ellis and Messina Catalogue of Foraminifera (1964-). Species type material were not available for study. Therefore identifications were based on comparisons with figures and descriptions from the above mentioned literature.

Those taxa which are undescribed (plus a few taxa based only on fragments) are designated "sp." (eg. Karreriella sp.) in Tables 3 to 7 and the Appendices.

Counting and Relative Abundance

The estimate of abundance in each sample was based on the following procedures. The whole sample or the whole of a convenient split portion was spread, as evenly as possible, over a grided picking tray. The entire tray was scanned to:

A. (i) make a mental estimate of relative abundances.

(ii) take note of pyrite and glauconite occurrence.

(iii) note the condition of the tests.

B. Four or five squares were randomly selected and a count made of the number of organisms as well as biotic

and nonbiotic particles larger than 75μ (200 mesh screen size).

The number of biotic and nonbiotic particles counted in the squares ranged from 28 up to 1,245, the average being 750. From these counts the following data were obtained: % biotic material; % nonbiotic material; % total foram. (% whole specimens [planktonic & benthic] plus % fragmented); % planktonic foram. (from % whole foram.); % benthic foram. (from % whole foram.); % radiolaria; % diatoms; % sponge spicules; % ostracods; % dinoflagellate cysts? (Table 3).

Counts of planktonic specimens were also made at this time (second last line of Table 7). From these counts the dominant planktonic species and the relative percentages were determined (Table 7). Counts were not made of Core 18 or for the 93-96 cm. interval of Core 51; however an estimate of abundance was made according to the gradational scale in the legend of Tables 3 to 7. At least the first ten Globoquadrina pachyderma were examined, in several randomly picked squares, to give a right to left coiling ratio (Table 3).

For the benthic species another counting procedure was used to determine relative percent frequencies (Tables 3 to 7). These counts were from randomly picked rows comprising 1/6 to 1/5 of the sample previously surveyed as above (line F, Tables 3 to 7). Rough estimates of the benthic population were

then obtained by multiplying the total counted by the appropriate factor. In those samples where there were very few faunal remains the whole sample was picked and counted.

Scanning Electron Photography

The scanning electron photographs in Plates 1 to 5 were taken on the SEMCO Nanlab 7 instrument at the Department of Geological Sciences, Univ. Brit. Col.

Standard stubs were left to dry overnight with a single coating of a solution containing 1 part rubber cement to 4 parts trichlorethylene. The specimens chosen from various samples among the core subsamples were mounted using a fine brush and distilled water. An iterative process of gold coat-scan-coat-scan was used. The exact thickness of coating could not be determined because the new Edmond's Sputter Coater had not yet been calibrated.

TABLE 3

Distribution of Foraminiferan species from the Juan de Fuca Ridge, N.E. Pacific.

Benthic species occurrences plotted as percentages of total benthic fauna.

Legend

- ⊠ Present less than 1%
- Rare 1-9%
- Common 10-34%
- Abundant 35-69%
- Very abundant 70-100%
- $^{11}/_{200}$ = 11,200

CORE INTERVAL	UBC-77-51										GSC-77-37																						PGC-78-6-11										PGC-78-6-12										PGC-78-6-18										PGC-78-6-29					
	0-7 cm.	0-1 cm.	14-16 cm.	34-36 cm.	49-51 cm.	64-66 cm.	79-81 cm.	93-96 cm.	120-123 cm.		0-2 cm.	10-12 cm.	20-22 cm.	30-32 cm.	40-42 cm.	50-52 cm.	60-62 cm.	70-72 cm.	80-82 cm.	90-92 cm.	100-102 cm.	110-112 cm.	120-122 cm.	130-132 cm.	140-142 cm.	150-152 cm.	160-162 cm.	170-172 cm.	180-182 cm.	190-192 cm.		0-2 cm.	10-12 cm.	20-22 cm.	30-32 cm.	40-42 cm.	50-52 cm.	60-62 cm.	70-72 cm.	80-82 cm.	90-92 cm.		0-2 cm.	20-22 cm.	40-42 cm.	60-62 cm.	80-82 cm.	100-102 cm.		0-8 cm.	8-14 cm.	14-25 cm.	25-34 cm.	34-42 cm.		0-2 cm.	10-12 cm.	20-22 cm.	30-32 cm.	40-42 cm.
A Estimated vol. of whole sample (cm.^{3})	100	10	10	10	10	10	10	10	10		15	13	12	10	10	10	12	15	14	11	13	13	14	11	16	12	12	13	14	14		10	10	12	16	16	14	18	19	28	15		50	50	44	48	44	36		10	10	10	10	10		10	10	10	10	10
B Estimated total no. benthics in sample	$^{36}/_{800}$	3280	5220	5980	5160	2800	2650	2805	80		52	80	40	50	60	70	145	212	100	570	670	280	160	100	15	10	16	7	8	2		30	40	225	75	2	40	2	5	21	10		180	125	90	-	200	200		240	800	1200	1700	1600		1030	1500	840	1550	1520
C Estimated no. benthics in unit vol. (10 cm.^{3})	3680	3280	5220	5980	5160	2800	2650	2805	80		35	62	33	50	60	70	121	140	71	518	515	215	114	91	9	8	13	5	6	1		30	40	188	47	1	29	1	2	8	7		36	25	20	-	455	56		240	800	1200	1700	1600		1030	1500	840	1550	1520
D Total population (plank. + ben.) in 10 cm.^{3}	$^{79}/_{120}$	$^{57}/_{400}$	$^{54}/_{810}$	$^{69}/_{770}$	$^{37}/_{840}$	$^{18}/_{200}$	$^{16}/_{780}$	8400	2570		700	3220	41	170	75	90	220	1680	1490	3255	2270	9250	1710	5460	180	24	650	100	120	1		60	300	630	800	1	2320	4	10	40	20		55	425	100	-	2280	160		1440	1600	2800	4350	6400		7725	$^{39}/_{000}$	9240	$^{14}/_{725}$	$^{16}/_{720}$
E Number of benthic species	129	46	46	44	54	48	43	28	33		15	17	7	18	24	15	27	44	28	36	32	25	17	24	7	3	9	3	3	2		10	19	40	32	2	11	1	3	10	7		32	36	9	-	59	16		35	37	25	42	47		51	51	46	55	70
F Number of benthic specimens counted	190	137	145	166	143	117	221	139	288		52	80	40	50	60	70	145	212	100	244	315	134	72	100	15	10	16	7	8	2		30	40	225	75	2	40	2	5	21	10		41	63	45	-	86	100		64	66	99	139	90		201	374	266	589	834
G % Biotic material	92	90	82	77	70	72	60	12	83		88	92	50	95	95	95	90	93	50	67	84	100	83	97	100	5	100	100	100	5		100	67	90	99	X	100	X	X	35	X		95	99	99	X	25	80		85	90	84	84	88		85	95	95	96	95
H % Nonbiotic material (100)	8	10	18	23	30	28	40	88	17		12	8	50	5	5	5	10	7	50	33	16	X	17	3	X	95	-	X	-	95		-	33	10	1	100	X	X	X	65	X		5	1	1	-	75	20		15	16	16	16	12		15	5	5	4	5
I % Fragments of Foraminifera	49	53	39	42	25	25	20	6	50		15	42	-	-	-	-	-	27	5	23	40	57	53	35	80	2	50	80	80	4		1	4	15	9	-	20	-	-	-	-		-	-	-	-	-	-		77	83	75	71	73		66	68	84	76	62
J % Foraminifera (whole not fragments)	43	37	42	35	44	45	38	3	31		21	50	5	10	5	5	45	60	42	44	44	43	30	61	20	3	50	20	20	1		2	30	50	85	X	80	X	X	X	X		3	85	75	X	20	70		6	4	7	8	12		15	26	11	19	33
K % Planktonic Foraminifera	41	35	38	32	38	39	32	2	24		20	50	1	7	1	1	2	55	4	37	34	42	28	60	19	3	50	20	20	1		1	26	35	78	X	79	X	X	X	X		1	80	60	X	16	45		5	2	4	5	9		13	25	10	17	30
L % Benthic Foraminifera	2	2	4	3	6	6	6	1	7		1	X	4	3	4	4	25	5	2	7	10	X	2	1	1	X	X	X	X	X		1	4	15	5	X	1	X	X	X	X		2	5	15	-	4	25		1	2	3	3	3		2	1	1	2	3
M % Radiolaria	X	X	X	X	1	2	2	3	2		52	X	45	85	90	90	45	6	3	X	X	X	X	X	-	X	-	-	-	-		98	33	25	2	X	-	-	X	35	X		72	15	25	X	5	10		2	2	2	4	2		3	X	X	X	X
N % Diatoms	X																							X								X										18			X															
O % Sponge spicule fragments	X				X	X	X				X			X		X	X	X			X	X		X										X								2	X			X	X		X	X	X	1	1		X	X		X	X
P % Dinoflagellate cysts?											X			X			X			X	X															X		X	X			X	X			X															
Q % Ostracods	X		X				X								X			X		X																																									
R Glauconite	X	X	X	X	X	X	X	X	X																								X																												
S Pyrite																			X	X	X			X																																						
T Right/Left coiling Globoquadrina pachyderma	$^{1}/_{13}$	$^{0}/_{10}$	$^{0}/_{10}$	$^{1}/_{10}$	$^{0}/_{10}$	$^{0}/_{10}$	$^{0}/_{10}$	$^{0}/_{10}$	$^{5}/_{20}$		$^{1}/_{9}$	$^{0}/_{10}$	-	-	-	-	-	$^{5}/_{15}$	$^{0}/_{10}$	$^{1}/_{10}$	$^{3}/_{12}$	$^{0}/_{10}$	$^{0}/_{10}$	$^{1}/_{10}$	-	-	-	-	-	-		-	-	-	-	-	-	-	-	-	-		$^{5}/_{3}$	$^{5}/_{10}$	$^{5}/_{12}$	-	$^{7}/_{9}$	$^{11}/_{13}$		$^{0}/_{17}$	$^{0}/_{10}$	$^{0}/_{10}$	$^{0}/_{10}$	$^{0}/_{10}$		$^{1}/_{10}$	$^{1}/_{10}$	$^{3}/_{10}$	$^{1}/_{10}$	$^{1}/_{13}$
1 Rhabdammina? sp.	X																																																													
2 Rhizammina sp.														X																																															
3 Bathysiphon rufus	X	X											X																													X														X				
4 Bathysiphon sp.																																										X																			
5 Saccammina sphaerica																																X																														
6 Ammodiscus planorbis	X																																																							X				
7 Ammodiscus sp.													X																																											X				
8 Reophax guttifer		X																																																										
9 Reophax longicollis																																																								X				
10 Reophax nodulosus																																																		X	X								
11 Reophax? sp.														X																																														
12 Spirolocammina? tenuis																																																									X			
13 Haplophragmoides sphaeriloculus	X																																																											
14 Thalmannammina sp.	X																																																											
15 Cyclammina cancellata	X																																																							X				
16 Bigenerina sp.	X	X																																																										X
17 Trochammina sp.					X																																																								
18 Ammosphaeroidina sphaeroidiniformis	X																																																											
19 Dorothia bradyi	X			X																																			X																					
20 Eggerella parkerae	X	X	X	X	X	X	X		X						X	X	X	X																X	X	X														X			X	X		X	X	X		
21 Karreriella sp.	X			X			X		X									X																X	X									X			X									X	X	X	
22 Martinottiella sp.	X																																																							X				
F Number of benthic specimens counted	190	137	145	166	143	117	221	139	288		52	80	40	50	60	70	145	212	100	244	315	134	72	100	15	10	16	7	8	2		30	40	225	75	2	40	2	5	21	10		41	63	45	-	86	100		64	66	99	139	90		201	374	266	589	834

TABLE 4

Distribution of Foraminiferan species from the Juan de Fuca Ridge, N.E. Pacific.

Benthic species occurrences plotted as percentages of total benthic fauna.

Legend

- ⊠ Present less than 1%
- Rare 1-9%
- Common 10-34%
- Abundant 35-69%
- Very abundant 70-100%

CORE INTERVAL	UBC-77-51	0-7 cm.	0-1 cm.	14-16 cm.	34-36 cm.	49-51 cm.	64-66 cm.	79-81 cm.	93-96 cm.	120-123 cm.	GSC-77-37	0-2 cm.	10-12 cm.	20-22 cm.	30-32 cm.	40-42 cm.	50-52 cm.	60-62 cm.	70-72 cm.	80-82 cm.	90-92 cm.	100-102 cm.	110-112 cm.	120-122 cm.	130-132 cm.	140-142 cm.	150-152 cm.	160-162 cm.	170-172 cm.	180-182 cm.	190-192 cm.	PGC-78-6-11	0-2 cm.	10-12 cm.	20-22 cm.	30-32 cm.	40-42 cm.	50-52 cm.	60-62 cm.	70-72 cm.	80-82 cm.	90-92 cm.	PGC-78-6-12	0-2 cm.	20-22 cm.	40-42 cm.	60-62 cm.	80-82 cm.	100-102 cm.	PGC-78-6-18	0-8 cm.	8-14 cm.	14-25 cm.	25-34 cm.	34-42 cm.	PGC-78-6-29	0-2 cm.	10-12 cm.	20-22 cm.	30-32 cm.	40-42 cm.
23 Cyclogyra sp.																																																																
24 Quinqueloculina sp.A		X					X					13	X		X	X	X		X	5	X	X		X	X								X	4	X	X							X			X																	
25 Quinqueloculina sp.B															X	X																		X	4	X										X																	
26 Quinqueloculina sp.C														X	X			X														X			X									X																			
27 Quinqueloculina sp.D					X															X												X																															
28 Pyrgo cf. P. murrhina		X				X	X			X						X		X	X															X	X								X			X	X											X			X
29 Pyrgo sp.																	X																																													
30 Pyrgoella sp.A												X	X	X	X	X			X			X											X	X	X									X																			
31 Pyrgoella sp.B																						X										X																															
32 Triloculina frigida		X	X	X	X	X	X												X		X	X												X							X																	X	X		X	X
33 Miliolinella? sp.																																		X																													
34 Scutuloris sp.																X																			X																											
35 Ammomassilina? sp.		X	X					X	X	X		X			X																													X								X					X	X	X	X	X
36 Nodosaria? sp.A		X																																													X			X								X	X	X		X
37 Nodosaria? SP.B																																																															X
38 Astacolus cf. A. hyalacrulus		X																																																													X
39 Astacolus sp.		X																	X														X																													
40 Dentalina cf. D. calomorpha		X								X																																										X									
41 Dentalina pauperata																																																														
42 Dentalina? sp.A		X					X																																					X																		
43 Dentalina sp.B						X	X																																					X													X	X	X	X	X
44 Dentalina sp.C			X				X																																																							X
45 Lagena cf. L. auriglobosa		X																																																												X
46 Lagena catenula																																																														
47 Lagena distoma		X						X					X																																					X												
48 Lagena elongata		X	X												X				X																													X													
49 Lagena foveolata paradoxa		X	X	X		X		X											X	X	X																							X	X			X													X	X
50 Lagena gibbera		X								X																																																			
51 Lagena gracilis		X			X		X	X																																																					
52 Lagena gracillima		X																																														X													X
53 Lagena hispidula		X	X				X						X							X	X														X													X										X				
54 Lagena laevis		X	X	X			X	X		X											X														X									X	X			X														
55 Lagena laevis var.		X																																		X																						X		X		
56 Lagena meridionalis		X				X																															X																									
57 Lagena mollis		X																						X																																					X	X	
58 Lagena nebulosa		X											X											X																									X													X	X
59 Lagena stelligera		X																																																												X
60 Lagena substriata		X			X	X		X																X																																		X				
61 Lagena sulcata apiculata		X																																																									X	X	X	X
62 Lagena sp. A		X																																																												
63 Lagena sp. B		X	X	X	X	X																																																								
64 Lagena sp. C		X	X	X	X	X	X																																																						
65 Lenticulina convergens		X		X		X	X																																																						
66 Lenticulina sp.		X																																																											
F Number of benthic specimens counted		190	137	145	166	143	117	221	139	288		52	80	40	50	60	70	145	212	100	244	315	134	72	100	15	10	16	7	8	2		30	40	225	75	2	40	2	5	21	10		41	63	45	–	86	100		64	66	99	139	90		201	374	266	589	834

TABLE 5

Distribution of Foraminiferan species from the Juan de Fuca Ridge, N.E. Pacific.

Benthic species occurrences plotted as percentages of total benthic fauna.

Legend

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- Common 10-34%
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CORE INTERVAL	UBC-77-51	0-7 cm.	0-1 cm.	14-16 cm.	34-36 cm.	49-51 cm.	64-66 cm.	79-81 cm.	93-96 cm.	120-123 cm.	GSC-77-37	0-2 cm.	10-12 cm.	20-22 cm.	30-32 cm.	40-42 cm.	50-52 cm.	60-62 cm.	70-72 cm.	80-82 cm.	90-92 cm.	100-102 cm.	110-112 cm.	120-122 cm.	130-132 cm.	140-142 cm.	150-152 cm.	160-162 cm.	170-172 cm.	180-182 cm.	190-192 cm.	PGC-78-6-11	0-2 cm.	10-12 cm.	20-22 cm.	30-32 cm.	40-42 cm.	50-52 cm.	60-62 cm.	70-72 cm.	80-82 cm.	90-92 cm.	PGC-78-6-12	0-2 cm.	20-22 cm.	40-42 cm.	60-62 cm.	80-82 cm.	100-102 cm.	PGC-78-6-18	0-8 cm.	8-14 cm.	14-25 cm.	25-34 cm.	34-42 cm.	PGC-78-6-29	0-2 cm.	10-12 cm.	20-22 cm.	30-32 cm.	40-42 cm.
67 Polymorphina sp.						X	X																																																							
68 Laryngosigma cf. L. hyalascidia																																																X											X	X
69 Oolina borealis		X																																																X	X		X	X			X	X	X	X
70 Oolina cf. O. botelliformis		X																																																										
71 Oolina desmophora		X						X																																																		X	X
72 Oolina globosa		X	X	X	X	X		X											X	X					X											X							X					X			X	X	X	X	X			X	X	X	X
73 Oolina globosa setosa																				X															X	X	X		X			X		X	X			X									X					
74 Oolina hexagona		X		X			X	X																																													X	X				X	X	
75 Oolina lineata?		X						X																																												X	X						
76 Oolina melo		X		X	X		X	X																																												X			X				
77 Oolina cf. O. scalariformis-sulcata		X																																																		X						X	
78 Oolina seminuda																			X																										X															
79 Oolina striato-punctata tricosta		X																																																										
80 Oolina sp. A		X	X	X			X																																														X				X	X	X
81 Oolina sp. B		X																																																										X
82 Oolina sp. C		X																																																										
83 Oolina sp. D		X																																																							X	X			X
84 Oolina sp. E																																																										X	X		X
85 Oolina sp. F							X																																																					X
86 Oolina sp. G		X																																																								X		
87 Oolina sp. H		X	X		X												X																																								X	X	X	
88 Oolina sp. I		X					X	X		X																																									X	X	X		X		X	X	X	X
89 Oolina sp. J		X																																																										
90 Fissurina cf. F. alveata		X																					X																															X						
91 Fissurina alveolata		X																																																			X			X	X		
92 Fissurina apiculata punctulata																																																								X				X
93 Fissurina cf. F. kerguelenensis		X																							X										X																									X
94 Fissurina cf. F. lucida		X		X		X																																																						X
95 Fissurina? marginata		X	X	X	X	X	X	X	X						X			X	X		X		X		X											X												X	X		X	X	X	X	X		X	X	X	X	X
96 Fissurina orbignyana		X																																																								X		X
97 Fissurina radiata		X		X	X	X	X													X																																					X	X		X
98 Fissurina seguenziana		X		X		X	X	X																																											X	X			X		X		X
99 Fissurina cf. F. spinulata		X			X	X																																			X						X											X		X
100 Fissurina sp. A		X					X									X						X																						X			X														X
101 Fissurina sp. B		X	X		X																																																		X		X			X
102 Fissurina sp. C		X																																																										X
103 Fissurina sp. D		X	X			X																																																				X	
104 Fissurina sp. E		X																																																							X		X	X
105 Fissurina sp. F		X							X																																									X											
106 Fissurina sp. G		X																																																										
107 Fissurina sp. H		X	X			X																																																						
108 Fissurina sp. I		X				X		X																																																				X
109 Fissurina sp. J		X	X																X																															X		X			X	X		X	X		
110 Fissurina sp. L		X		X	X	X																																																						
111 Fissurina sp. N		X	X	X	X	X																																													X		X	X			X		X	X
F Number of benthic specimens counted		190	137	145	166	143	117	221	139	288		52	80	40	50	60	70	145	212	100	244	315	134	72	100	15	10	16	7	8	2		30	40	225	75	2	40	2	5	21	10		41	63	45	-	86	100		64	66	99	139	90		201	374	266	589	834

TABLE 6

Distribution of Foraminiferan species from the Juan de Fuca Ridge, N.E. Pacific.

Benthic species occurrences plotted as percentages of total benthic fauna.

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CORE INTERVAL	UBC-77-51	0-7 cm.	0-1 cm.	14-16 cm.	34-36 cm.	49-51 cm.	64-66 cm.	79-81 cm.	93-96 cm.	120-123 cm.	GSC-77-37	0-2 cm.	10-12 cm.	20-22 cm.	30-32 cm.	40-42 cm.	50-52 cm.	60-62 cm.	70-72 cm.	80-82 cm.	90-92 cm.	100-102 cm.	110-112 cm.	120-122 cm.	130-132 cm.	140-142 cm.	150-152 cm.	160-162 cm.	170-172 cm.	180-182 cm.	190-192 cm.	PGC-78-6-11	0-2 cm.	10-12 cm.	20-22 cm.	30-32 cm.	40-42 cm.	50-52 cm.	60-62 cm.	70-72 cm.	80-82 cm.	90-92 cm.	PGC-78-6-12	0-2 cm.	20-22 cm.	40-42 cm.	60-62 cm.	80-82 cm.	100-102 cm.	PGC-78-6-18	0-8 cm.	8-14 cm.	14-25 cm.	25-34 cm.	34-42 cm.	PGC-78-6-29	0-2 cm.	10-12 cm.	20-22 cm.	30-32 cm.	40-42 cm.
112 Fissurina sp. O		X																																																												
113 Fissurina sp. P		X	X		X	X																	X																														X								
114 Fissurina sp. Q		X		X		X	X	X	X								X				X															X							X						X				X		X		X		X	X
115 Fissurina sp. R						X						X																																															X		
116 Fissurina sp. S								X																																																					X
117 Fissurina sp. T																																																				X									
118 Fissurina sp. U																																																				X			X					X	X
119 Fissurina sp. V		X																																																											
120 Fissurina sp. X		X																																																										
121 Parafissurina kerguelenensis		X						X																																			X					X										X	X		
122 Parafissurina biconicoformis		X							X																																																			
123 Parafissurina fusuliformis							X																																																		X		X		
124 Parafissurina lateralis		X																																																										
125 Parafissurina cf. P. neocurta																						X											X		X								X	X								X								X	X	
126 Parafissurina sp. A		X																		X																																								X	
127 Parafissurina sp. B		X																																																										
128 Parafissurina sp. C		X																																																										
129 Parafissurina sp. F																																																				X									
130 Buliminella elegantissima																																																													
131 Sphaeroidina bulloides		X	X	X	X		X		X	X							X	X		X	X																						X		X		X					X				X	X	X	X	
132 Brizalina pacifica		X	X	X	X	X	X		X	X		X	X						X	X	X	X	X	X	X			X	X						X					X				X			X											5	X	X
133 Brizalina peirsonae																						X																										X													
134 Brizalina subdepressa		X																			X			X																														X						X
135 Brizalina sp.		X	X	X	X	3	4	X				X							X																																X	X	X	X	X			X	X	X
136 Cassidulinoides tenuis				X					X																		X																																		
137 Bulimina barbata		X							X	X								X	X																	X									X		X	X											
138 Bulimina mexicana				X	X	X	X											X	X	X	X	X	X											X	X			X														X		X	X			X	X
139 Bulimina rostrata		X															X		X	9	X	X												X	9		X	X					X		10	25	X	X			X					X		X		
140 Globobulimina hoeglundi?		X	X	X				X		X									X			X	X		X	X	X							X							X		X				X	X				X				X	X	X	X	
141 Globobulimina pacifica		X			X	X	X	X	X	X				X	X		X				3	X	X		X	X								X	X	X							X	X			X													X
142 Stainforthia complanata		3	4	5	4	X	X	3	X	X			X				X	X	X			X	X		X									X													X				X		X	X		X	X	X	3	X
143 Stainforthia cf. S. rotunda																						X		X																																						
144 Stainforthia seminuda		X							X	X											X	3	X	32	X																X	X						X	4												
145 Uvigerina auberiana		X																	X		X																							X																		
146 Uvigerina juncea		X	X			X			X	X			X		X		X		X	3		X	X	X											X	X		X					X	X			X			X				X			X				
147 Uvigerina peregrina disrupta																			X	X	X	X													X						X					X		X												
148 Uvigerina senticosa		5	4	5	11	4	14	8	17	13		46	33	X	X	X	X	X	5	11	5	12	16	11	X	X		X		X		X	X	20	X	X	X		X		X		15	14	28		7	20		17	X	5	7	6		X	X	X	4	7
149 Uvigerina sp. A									X				X									X		X																																						
150 Uvigerina sp. B		X													X							X		X											X																						X				
151 Trifarina fluens																																																X													
152 Bucella frigida																																			X																											
153 Epistominella exigua		X		X		X															X	X													X												X			X							X	X	X	
154 Valvulineria? arctica		X		X	X	X				X		X							X	8	11	X		X															X								X									X	X	X	X	X
F Number of benthic specimens counted		190	137	145	166	143	117	221	139	288		52	80	40	50	60	70	145	212	100	244	315	134	72	100	15	10	16	7	8	2		30	40	225	75	2	40	2	5	21	10		41	63	45	-	86	100		64	66	99	139	90		201	374	266	589	834

TABLE 7

Distribution of Foraminiferan species from the Juan de Fuca Ridge, N.E. Pacific.

Benthic species occurrences plotted as percentages of total benthic fauna.

Legend

- Present less than 1%
- Rare 1-9%
- Common 10-34%
- Abundant 35-69%
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- * Planktonics as % of total planktonics

CORE INTERVAL	UBC-77-51 0-7 cm.	0-1 cm.	14-16 cm.	34-36 cm.	49-51 cm.	64-66 cm.	79-81 cm.	93-96 cm.	120-123 cm.	GSC-77-37 0-2 cm.	10-12 cm.	20-22 cm.	30-32 cm.	40-42 cm.	50-52 cm.	60-62 cm.	70-72 cm.	80-82 cm.	90-92 cm.	100-102 cm.	110-112 cm.	120-122 cm.	130-132 cm.	140-142 cm.	150-152 cm.	160-162 cm.	170-172 cm.	180-182 cm.	190-192 cm.	PGC-78-6-11	PGC-78-6-12 0-2 cm.	10-12 cm.	20-22 cm.	30-32 cm.	40-42 cm.	50-52 cm.	60-62 cm.	70-72 cm.	80-82 cm.	90-92 cm.	PGC-78-6-12 0-2 cm.	20-22 cm.	40-42 cm.	60-62 cm.	80-82 cm.	100-102 cm.	PGC-78-6-18 0-8 cm.	8-14 cm.	14-25 cm.	25-34 cm.	34-42 cm.	PGC-78-6-29 0-2 cm.	10-12 cm.	20-22 cm.	30-32 cm.	40-42 cm.
155 Valvulineria cf. V. glabra	X																	X	X	X	X		X										X											X			X						X	X		X	
156 Valvulineria sp. A	X		X	X	X			X									X		X				X																																	
157 Valvulineria sp. B						X								X								X																																			
158 Valvulineria sp. C											6										6	X	X		X	X	X																														
159 Heronallenia? sp.																																														X		X	X	X				X		
* 160 Globorotalia scitula	X		X	X	X	X	X			X	X		X			X	X	X	X	X	X	X	X	X		X	X				X	X	X	X		X			X		X	X	X		12	X		X	X		X		X	X	X	X
* 161 Globigerina bulloides	20	25	15	11	16	20	15		40	35	45		X	X	X	X	25	30	26	36	35	35	37	X	X	X	X			X	X	X	X	X	X		X		X	X	3		12	7		X			X		33	30	30	22	20
* 162 Globigerina quinqueloba	X			X	X	3		X		X			X			X	9	12	18	13	X	X	9	X			X	X	X			X	X	X		X	X	X			7	X		X	9											X
* 163 Globoquadrina dutertrei																															X																									
* 164 Globoquadrina hexagona																							X									X				X																				
* 165 Globoquadrina pachyderma	90	75	85	88	83	72	84	90	59	64	54	X	X	X	X	X	55	47	41	38	35	35	37	X	X	X	X	X		X	X	X	X	X		X		X		X	70	90	X	66	32		90	90	90	90	90		67	70	90	77	79
* 166 Orbulina universa	X		X		X	X							X	X	X	X	X	X	X	X			X								X	X	X								X				X												
* 167 Globigerinita glutinata				X	X	X				X	X	X	X		X	X	X	X		X		X	X								X	X	X				X		X		X	X		X	X										X	
* 168 Globigerinita? uvula						4											11	10	15	10	X	X	9	X			X		X			X	X					X						X	← 9											
169 Eponides tumidulus horvathi	X	X	8	6	X	X			X	X						X	X	6	3	4	X		X	X		X							X	X							8	X			X			X	X		X	X		6	8	5	9	9
170 Eponides sp.	X		X		X	X	X		X	X									X	X																													X		X						
171 Eilohedra levicula	27	26	32	30	55	30	51	11	34		25		X		X	X	15	7	39	60	60	24	X	X								X	9	X			X		X		40	X			44	60		28	52	40	39	38		35	29	22	27	25
172 Planulina wuellerstorfi	X	X	X	X	X	X	X	X	X	X	X		X	X	X	X	3	8	X	X	X		X				X			X	X	X	4	X		X		X		X																	
173 Cibicides sp.	X				X		X		X						X	X	X																X	X											X					X	X				X		X
174 Cassidulina cushmani	3	3	X	5	7	12	8	4	5	X	X					X	3	5	4	3	X	X	X		X							X	X							X	X		7	X		X	X	X	X	X		X	4	X	3	7
175 Ehrenbergina trigona	X	X	X	X		X	X																																			X		X		X		X	X	7	X		X	X	X	X	7
176 Globocassidulina sp.	19	26	17	8	8	X	8	X	34	X					X	X	X		7	3	X		X	X		X		X	X			X	X						X	12	X		8	X		9	9	9	12	9		11	11	14	14	12
177 Chilostomella oolina	X				X			X	X								X				X	X	X									X	X	X							X			X			X							X		X	X
178 Astrononion? cf. A. bikiniensis																X																						X						X												
179 Florilus sp. A	X																						X		X	X																														
180 Florilus sp. B	X					X									X								X																X																		
181 Pullenia bulloides	X	3	X	3	X	X	X	6	X	X	X		X	X		X	X	X	X	X	X											X	X							X	X	X	X	X		X	X	X	X	X		X	X	X	X	X
182 Pullenia subcarinata								6					X	X	X	X															X					X		X						X						X			X	X			X
183 Pullenia sp.	X			X	X	X	X	X			X			X	X	X					X											X						X			X			X													
184 Gyroidina io	4	9	4	5			3	X		8	10		X	X	X		3		3		4		X	X							X	X		X					X		X	11	11		X	X		9		4	5			5	4	7	3	6
185 Gyroidina neosoldanii	X	X	X	X	X	X			X	8			X	X	X	X		X		X														3	X		X					X	X			X			X	X	X	X	X						4
186 Gyroidina sp.		X	X	X	X	X								X			3		X		X		X									X	X								X	X			X	X											
187 Oridorsalis umbonatus	3	X		3		4	X	X									X	X	X	X	X	X	X									X	3	X		X					X			X	X		X	8	5		7			4		4	5
188 Cibicidoides kullenbergi	X	X	X	X	X	X	X	X	X			X		X	X	X	X	X	X					X									X	X		X					X	10	8		X			X	X	X	X	X		X	X	X	X	X
189 Melonis pompilioides	3	5		4	3	4	8	21	6								X	X													X		X	X							X	6						X	X	X	X	X		X	X	X	X	X
190 Melonis zaandamae	X	X	X	X	X	X	X	X	X			X	X				X																X	X							X	X						X		4	X	X				8		X
191 Melonis sp.	5	4	4	X	X	X	X	4	X																																		X					X	X	X	X			X	5	3	4
192 Hoeglundina bradyi										X						X	X	X	X	2	X											X	X	X		X			X				X		X	5											
193 Robertina charlottensis																																											X													
* Number of planktonic specimens counted	260	304	262	395	270	136	212	-	113	36	95	-	-	-	-	-	210	70	123	75	147	91	185	-	-	-	-	-	-		-	-	-	-	-	-	-	-	-	-	-	326	38	-	24	61		-	-	-	-	-		153	203	125	106	263
Number of benthic specimens counted	190	137	145	166	143	117	221	139	288	52	80	40	50	60	70	145	212	100	244	315	134	72	100	15	10	16	7	8	2		30	40	225	75	2	40	2	5	21	10		41	63	45	-	86	100		64	66	99	139	90		201	374	266	589	834

RESULTS AND DISCUSSION

Biostratigraphy

Systematics

A detailed systematic analysis was not the purpose of this study. However, differentiation of the taxa was necessary and the taxonomic confusion which exists in dealing with benthic foraminifera adds a considerable amount of time to the identification process making comparison with published results very difficult because of the abundance of synonymies (Boltovsky, 1980).

A rich foraminiferan diversity of 193 taxa was differentiated (Tables 3 to 7). Short synonymies and synoptic descriptions were tabulated in Appendix A, to provide a basic reference to taxa of this study and a referal, where possible, to published figures of synonymous species.

Of the 193 species listed one third could not be identified from published figures and descriptions (a few genera were also queried). Furthermore, variations within a species have been interpreted differently by authors. Such interpretations in this study are included in the remarks after the description (Appendix A).

The following are generalizations based on the taxonomic analysis (Tables 3 to 7):

1 Species from the suborder grouping Rotaliina

far outnumber all other forms.

2 The Textulariina and Miliolina are generally represented by only a few species within each sample.

3 The rotaliid superfamily Nodosariacea is represented by 94 species (3/4 from the subfamily Oolininae), half the total number of species identified in the study. However, species in this superfamily are typically represented by only a few individuals so that members comprise only 1 to 5% of the total benthic population.

4 The few species but abundant individuals from other superfamilies (Buliminacea, Orbitoidacea and Cassidulinacea) regularly comprise up to 30% of the total population, occasionally as high as 60%.

The first three generalized findings listed above were also noted in a study of benthic deep sea foraminifera in the southeast Indian Ocean (Corliss, 1979). The greater abundance from the suborder Rotaliina may be the result of moderate $CaCO_3$ availability (Greiner,1974; Corliss, 1979). Contradictory environmental conditions are indicated by the frequency distribution. The few but abundant species are typical of a stressed or unstable

environment whereas the diversity of taxa is indicative of stable conditions (Schnitker, 1980). Is the diversity reflecting long term overall stability and the abundance of a few, the short term microfluctations of a physical parameter such as $CaCo_3$?

Species Occurrence and Abundance

The planktonic group occurs with greatest numbers and masks the benthic fauna. There are nine planktonic species, two of which are the most abundant (Plate 1):

Globoquadrina pachyderma

Globigerina bulloides

Globigerina quinqueloba and *Globigerinita uvula* are common in a few samples. *Globoquadrina pachyderma* is overwhelmingly the most abundant throughout the cores.

The most common benthic species are, in decreasing abundance (Plate 2):

Orbitoidacea

Eilohedra levicula

Buliminacea

Uvigerina senticosa

Cassidulinacea

Globocassidulina sp.A

Gyroidina io

Eilohedra levicula is the most abundant in 60 % of the samples, Uvigerina senticosa in 30 %. Either Uvigerina senticosa or Globocassidulina sp. A occurs as the second most abundant species in 30 % of the samples. Gyroidina io, in about 15 % of the samples, is the third most common. Although the values of the percentage abundance for each of these four species varies between samples their ranking does not. For cores 51, 18, and 29 there is no significant change in the abundance of any of the four species either down the core length or between cores.

An anomalous trend does occur however in the three deepest cores (11,12 and 37) where the top 20, 40 and 60 cms., respectively, are radiolarian rich. When there is a high percentage of radiolaria the most common species is usually Uvigerina senticosa (occasionally Melonis pompilioides, or Eilohedra levicula).

Other common but less abundant species are (in order of decreasing dominance, Plates 2 to 5): Eponides tumidulus horvathi, Cassidulina cushmani, Oridorsalis umbonatus, Melonis pompilioides, Melonis sp., Stainforthia complanata, Bulimina rostrata, Planulina wuellerstorfi, Pullenia bulloides, Quinqueloculina sp.A, Ehrenbergina trigona, Hoeglundina bradyi, Cibicidoides kullenbergi, Melonis zaandamae, Sphaeroidina bulloides, Karreriella sp.

Uvigerina senticosa is the only dominant benthic species indigenous to lower bathyal depths. The other dominant species are known to occur at shallower depths (Enbysk, 1960; Bergen and O'Neil, 1979). Their abundance is considered the result of downslope transport and concentration masking the in place fauna.

Age of the Cores

Core 51, because its richness in foraminifera, was the only core of this study from which ^{14}C dates were obtained (App. E):

Core 51	Interval	0-12 cm.	19,000 BP ± 840/930 yrs.
		79-87 cm.	23,660 BP ± 1350/1620 yrs.

From the dating, plus foraminiferan richness and lack of change of the planktonic foraminiferan radiolarian ratio a late Pleistocene age is inferred throughout the length of this core. Cores 18 and 29 are also inferred to be of late Pleistocene age based on their foraminiferan richness and the lack of change in the ratio of planktonic foraminifera to radiolaria. This change of ratio is used in Cores 11,12, and 37 to indicate that the sedimentation at the top of the cores occurred during the climatic transition from glacial to nonglacial conditions. The top 20 cm. of Core 11, 40 cm. of Core 12 and 60 cm. of Core 37 are radiolarian

rich. In each of these cores planktonic foraminifera become dominant within the next 10 cm. interval down core. It is this shift in faunal dominance which marks the climatic change.

Supporting evidence of the faunal change in this study came from geochemical studies conducted on the same cores by M. Price, (1981). Price's general findings, based on geochemical analysis of 17 cores in the study area, showed that approximately the upper 40 cm. of many cores are rich in Si. A short interval below this is still high in Si with a low Ca content, then below that the situation reverses and Ca is enriched, with Si in low concentrations. This shift reflects the change in ratio of foraminifera to radiolaria.

The same change in ratio, although it seems unlikely, could be produced by a foraminiferan lysocline within which there is dissolution of the foraminifera and relative enrichment of the radiolaria. This is discussed in more detail in the section regarding abundance.

A form identified as a 'cyst' of Pachysphaera sp. (App. C) was found in only the three deepest cores (11,12,37). The 'cysts' are few in number and occur sporadically. Their presence, however, may be significant in that they are found only from the

surface to between 40 and 60 cm. below the change of the planktonic foraminiferan-radiolarian ratio.

This ratio was used by Duncan et al (1970) to date the Holocene-Late Pleistocene boundary in the N.E.Pacific at 12,500 BP. However, Barnard and McManus (1973) found it could not be used in this way because the ratio was time transgressive up the continental slope. They indicated that the shift in the ratio was more likely a reflection of the time-transgressive climatic conditions near the glacial-post glacial boundary and therefore could not be used as an isochronous biostratigraphic indicator over a wide area of the N.E.Pacific.

With regard to time stratigraphic considerations the change in ratio of planktonic foraminifera to radiolaria was used in this study to denote the climatic shift from glacial to post glacial conditions. The bathyal foraminiferan assemblages showed no significant trends among the cores and are not considered useful time stratigraphic indicators. Over 400 taxa identified in a study of samples from the middle bathyal in nine DSDP holes from the South Atlantic, South Pacific and Indian Oceans were found to be poor stratigraphic guides because the Quaternary bathyal fauna was essentially the same as that of the Oligocene (Boltovsky, 1980).

The Pachysphaera sp.'cyst' may potentially be of biostratigraphic importance in the late Pleistocene. However, further study of its identity, distribution and stratigraphic position is needed.

PALEOENVIRONMENT

Distribution and Abundance

A rigorous statistical analysis of quantitative distribution data (Tables 3 to 7) was not attempted because the original data are not considered sufficiently precise. However some qualitative trends are apparent. For instance, the average and range of abundance in Core 51 is substantially different from the remaining cores (Table 8). If such differences are significant they could be related to one or more natural or artifical conditions including those listed, then discussed below:

1 the carbonate compensation depth (CCD) and foraminiferan lysocline (depth range above the CCD where there is partial dissolution of foraminiferan tests).

2 biological interactions with such factors as temperature, salinity, oxygen, nutrient content and currents.

3 the effects of the mechanical processing of samples.

TABLE 8

POPULATION TRENDS

CORE NUMBER	NO. 10 $cm.^3$ SAMPLES	TOTAL POPL.	AVERAGE	POPL. RANGE
UBC-77-51	9	337,330	37,480	840-79,120
GSC-77-37	20	30,706	1,535	1-9,250
PGC-78-6-11	10	4,185	420	1-2,320
PGC-78-6-12	6	3,020	505	55-2,280
PGC-78-6-18	5	16,590	3,320	1,440-6,400
PGC-78-6-29	5	87,410	17,480	7,725-39,000

4 a chance relation

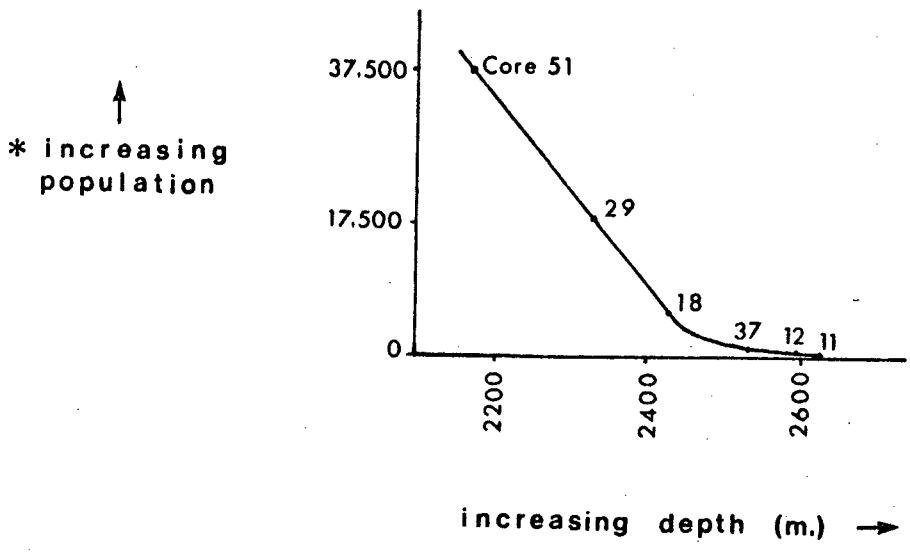
5 geographical setting influencing type and amount of sedimentation

6 diagenetic differentiation

1 The CCD and Foraminiferan Lysocline

A relationship with a lysocline and or CCD suggests an inverse relationship between abundance and depth. Cores below the CCD and within a lysocline would be expected to have lower abundances due to dissolution of foraminiferan tests. The deeper cores of this study do show a drop in abundance (Fig.3).

Fig. 3 Population: Abundance with respect to depth



* the average of total population for each core

The deepest cores are above the CCD but do approach it according to several studies on the

region. Berger and Winterer (1974) show a CCD of 3000 m. at 50° N. 130° W. and Takahashi (1975) showed the same CCD farther to the west (180° W. longitude). There was no information available for the lysocline at the sample sites. However, some of the cores might be expected to fall within a distinct lysocline. In the Central North Pacific, Peterson (1966) and Berger (1967) noted some dissolution from 200 to 3500 m. Therefore, differences in population due to lysocline effects cannot be completely discounted. However, dissolution was not indicated for the following reasons:

1(a) In visual scans of the samples very few pitted or etched specimens were found. The percentage of fragmented foraminifera, Table 3 (line I), shows fewer fragments at depth. However, these predominately planktonic fragments have the textural appearance of being mechanically broken rather than dissolved.

1(b) The benthic to planktonic ratio is consistently low throughout all the cores. Benthic species represent only 1 to 10 % of the foraminiferal population in 90% of the samples.

Parker and Berger (1971) suggested that the benthic to planktonic foraminiferan ratio is lowest in samples with no $CaCO_3$ dissolution and highest where dissolution has taken place and more resistant species

remain. Calcareous benthic tests were shown to have more resistance than planktonics (Parker and Berger, op. cit.).

In this study comparisons between core samples and among cores give no trends in the benthic to planktonic ratio, to support the hypothesis that differences in abundance are due to differential solution. However, there are no detailed data on relative ages among the cores positively excluding an undisclosed trend.

1(c) Three very small, delicate planktonic forms (averaging 180μ) are found most frequently and in highest proportions in the three deepest cores of this study (11,12,37). These species are: Globigerina quinqueloba, Globigerinita glutinata, and Globigerinita uvula.

Hecht et al (1975) found that dissolution of planktonic foraminifera in the size fraction smaller than 250μ occurs significantly faster than in larger fractions.

Small delicate planktonics in the surface sediments of the deeper cores indicates dissolution has not likely taken place.

1(d) Globorotalia scitula is found in all the cores of this study and 80 % of the samples, furthermore, its relative abundance does not change throughout the

cores. Orbulina universa is most prevalent in the three deepest cores.

Ruddiman and Heezen (1967) and Parker and Berger (1971) noted a number of planktonic species exhibited differential solution at depth. In their low to high latitude study of the South Pacific, Parker and Berger (1971) found Globigerinita glutinata to be relatively abundant except in samples from high latitudes that were subject to solution. Bé (1977) listed Globigerinata glutinata as low in resistance to solution. Globigerinita uvula was abundant in the fine fraction of Antarctic samples and other high latitude undissolved samples (Parker and Berger, 1971). Ruddiman and Heezen (1967) and Berger (1970) considered Orbulina universa very fragile and subject to solution. However, Orbulina universa has displayed inconclusive dissolution trends in both laboratory experiments and observed natural assemblages. Globorotalia scitula was found to be a solution prone species decreasing in relative abundance in more dissolved samples and greater water depths (Bé et al., 1975).

The presence of the above four species in surface samples of cores of this study is an indication that dissolution has probably not taken place.

Turning to the discussion of other factors that may be significant in producing the differing abundance and distribution trends:

2 Biological and Physical Oceanographical Interaction

The deep Pacific water is considered one of the most uniform of all oceanic water masses (Pickard, 1980; Schnitker, 1980) and because the cores were taken within 4 to 20 km. of one another, (except Core 51 which is from approximately 70 km. north of the others), faunal differences between cores due to change of physical oceanographic parameters is not considered likely unless local geothermal activity has enriched Core 51. There were no indications this was the case.

3 Mechanical Processing

The treatment was the same for all samples, except those of Core 11, and the larger populations of some cores would not be preferentially influenced by the washing and sieving. The latter may have been harsh augmenting fragmentation and decreasing the count of whole individuals. The only difference in handling of samples was that those of Core 11 were oven dried. Core 11 had the lowest total population. Different processing of duplicate samples would be necessary to resolve the question of possible deleterious effects on the faunal population of Core 11 due to oven drying.

4 Chance Relation

The great difference in the average and range of abundance of populations in Core 51 suggests that chance is improbable; however, this possiblity cannot be discounted.

5 Geographic Setting Influencing Type and Amount of Sedimentation

The geographic setting of the cores, 250 kms. offshore, and their position with respect to the Juan de Fuca Ridge (Table 1) has influenced the type and amount of sedimentation.

Sand size, nonbiotic residue in proportions 50% is found almost exclusively in those cores interpreted as late Pleistocene and in core sections below the foraminiferan-radiolarian ratio change. The nonbiotic residue is chiefly detrital quartz grains and mica flakes. The 80-82 cm. interval of Core 12 (late Pleistocene section of core) has a 75% nonbiotic residue and the following shelf foraminifera: Buliminella elegantissima, Trifarina fluens, Laryngosigma cf. L. hyalascidia and Robertina charlottensis. Although the position of this core is not associated with a distinct deep sea channel, turbidite material originating from the shelf is indicated by the biotic and nonbiotic content. No other turbidite sequences with a shelf origin were identified. This may be the result of rigid sampling every 10 cms. and missing other thin turbidite sequences.

During the Pleistocene turbidites were larger and more competent than in the Holocene and sediment was deposited more extensively across the sea floor (Griggs and Kulm, 1970). Some turbidite activity originating from the shelf can be expected in the Pleistocene sediment. No turbidites of shelf origin were found in the Holocene interval. Turbidites are presently confined to channels and it is only here that foraminifera from shelf through abyssal depths have been found in turbidite sequences whereas the interbedded hemipelagic clays have only deep fauna (Griggs and Fowler, 1971; Griggs and Kulm, 1970).

Except for shelf fauna in one turbidite sequence the remainder of the benthic foraminifera are upper to lower bathyal thereby indicating a hemipelagic sediment source. There is little continentally derived material, and much of the nonbiotic residue is basalt chips, glass shards or fecal pellet fragments. The presence of the mineral component suggests eastward downslope movement from the Juan de Fuca Ridge. The one turbidite sequence with entrained shelf fauna and other intervals with a small terrigenous component of detritral quartz grains and mica flakes have probably been carried west and southward from the shelf.

Pleistocene and Holocene intervals in the cores have differing rates of sedimentation. The two ^{14}C dates in Core 51 define a 4,660 year span when 77 cm.

of sediment was deposited. Assuming a constant supply during that time the Pleistocene sedimentation rate would be 16.5 cm./1000 yrs. The foraminiferan-radiolarian ratio change occurs at an average depth of 40 cm. Assuming a set date of 12,500 yrs. and again a steady sediment supply the Holocene rate is 3.2 cm./1000yrs.

6 Diagenetic Differentiation

In Core 37 there is a marked absence of biota after 140 cm. Below this interval there are no agglutinated, miliolid or nodosarid forms and reduced numbers of other $CaCO_3$ species. Another anomalous feature of this core is a 60 cm. interval of pyrite occurrence just above the faunal decrease. Interpretation is speculative, on the basis of the evidence from one core. A biogenic origin from reduction of organic matter, a diagenetic leaching process or a type of hydrothermal circulation may be producing these phenomena. Deeper and more extensive coring and geochemical studies might clarify these findings.

In every sample of Core 51 a mineral aggregate termed glauconie occurs in conjunction with foraminiferan richness. The glauconie is believed to consist of variable amounts of illite, montmorillonite and chlorite (Bjerkli and Ostmo-Saeter, 1973). This core is at the top of the West Juan de Fuca Ridge and is likely subject to slumping removing more recent sediment and/or to winnowing producing a lag deposit. Glauconite is believed to be an alteration product of the aggregate

glauconie. Glauconite is known to occur where there is a slow rate of sedimentation and forms from the alteration of organic matter such as fecal pellets or from the minerals illite and biotite (Reading, 1978). Core 51, may well be a lag deposit situated in a region of low sedimentation.

Bathymetric Indicators

All six cores are from approximately the same depth with the exception of Core 51 from about 500 m. shallower. With the six cores from one depth range, distinction between foraminifera living at a given depth and those displaced downslope is necessarily based on the literature.

Bergen and O'Neil (1979) determined bathymetric ranges of foraminifera in Alaskan waters. They noted shallowest occurrences of a species and set bathymetric zone boundaries where changes of population assemblages occurred. Shallowest occurrences provided a means to distinguish the true upper bathymetric limit of a population from its displacement downslope after death.

Enbysk (1960) listed species characteristic of neritic through abyssal depths for four areas north of 40° latitude in the eastern Pacific: Oregon, Washington, Vancouver Island and Alaska. She stated that the species were chosen for their abundance or persistence within a bathymetric range. Her study did not indicate shallowest occurrences.

Natland's (1957) biofacies VI (1300 to 2500 meters) off California was characterized by: Uvigerina senticosa, Bulimina rostrata, Nonion pompilioides, Pullenia bulloides. He did not indicate how the biofacies range was determined (ie. by shallowest occurrence).

Two species considered lower bathyal indicators in the previous three studies and common in this study are Uvigerina senticosa and Melonis pompilioides. Other species common in the present study and listed in one or more of the others as being depth indicators or having a first occurrence in this depth range, are (Plate 3):

Melonis zaandamae
Pullenia bulloides
Bulimina rostrata
Oridorsalis umbonatus
Sphaeroidina bulloides

These species are common throughout the length of all cores.

From published lists of characteristic bathyal species only Uvigerina senticosa is one of the four most abundant species of this study. Of the other

three abundant species, Eilohedra levicula is reported by Bergen and O'Neil (1979) from the neritic (92 m.) to the lower bathyal (2623 m.),being most common in the middle bathyal but there representing only 4 to 11 % of the total population. Uchio (1960) reported on neritic to middle bathyal (1300 m.) environments off San Diego, there he found living populations of E. levicula throughout that range, with the largest percentages in the middle bathyal (up to 16 % of the total population). Ingle et al. (1980) in a study off Peru-Chile found E. levicula from the shelf edge at 142 m. to 3550 m. They list this species among the dominant assemblage of the upper middle bathyal (500-1500 m.) but also with high occurrences in the lower bathyal.

Gyroidina io, off San Diego (Uchio, 1960), has a sporadic distribution from about 500 m. through the middle bathyal, with a living population recorded only from at least 1200 m., the lower limit of his sampling. Bergen and O'Neil (1979), found G. io, from the Gulf of Alaska, in only the middle to lower bathyal (595-2623 m.).

Globocassidulina sp. A is considered synonymous with Cassidulina subglobosa Brady of Smith (1973). She found small rare forms of this species, and one that stained with rose bengal, south of the Aleutian Islands at 4,430 m. Bergen and O'Neil (1979) report this small species from 475 to 2280 m. in the Gulf of Alaska.

Thus, of the four most abundant species only *Uvigerina senticosa* could be considered in place. From the listing of common but less abundant species in this study the following are indicators of lower bathyal ie. greater than 1500 m. depths [from the findings of Bergen and O'Neil (1979), Enbysk (1960), Natland (1957), Ingle et al (1980)] (Plate 3):

*? *Oridorsalis umbonatus*

Melonis pompilioides

Bulimina rostrata

Ehrenbergina trigona

Sphaeroidina bulloides

[*? one report in the upper bathyal (275 m.) in Ingle et al (1980) , this record was in the southern Pacific in contrast to the other three northern Pacific studies.]

According to the literature (Bergen and O'Neil, 1979; Ingle et al., 1980) the following have a first occurrence in the bathymetric levels listed and indicated possible downslope movement (Plates 3 and 4):

from the middle bathyal (500-1500 m.)

Planulina wuellerstorfi

Melonis zaandamae

from the upper bathyal (200- 500 m.)

Stainforthia complanata

from the neritic (less than 200 m.)

Cassidulina cushmani

[1] Pullenia bulloides

Hoeglundina bradyi

[2] Cibicidoides kullenbergi

[1] generally considered an indicator of lower bathyal depths, however, Enbysk (1960) reported the species from 138 m. on the Alaskan shelf.
[2] considered middle bathyal (Ingle et al (1980), however, Enbysk (1960) records living specimens at 78 m. on the Alaskan shelf.

Although the presence of these common species plus some of the four dominant forms indicates that it is possible for downslope transport from any or all of the upper depth ranges, displacement is considered unlikely from at least the neritic for the following two reasons:

(a) It cannot be discounted that living forms of these species can be found at bathyal depths. Moreover, none of these species is a member of the dominant assemblage groups of the inner through outer neritic zones (down to 200 m.). These depths are generally characterized by the genera Elphidium, Cibicides, Cassidulina [C. californica, C. subglobosa, (large robust form)] and Uvigerina [U.juncea] (Natland, 1957; Enbysk, 1960; Uchio, 1960; Bergen and O'Neil, 1979). The first two genera are not even found in this study, nor are either of the cassidulinids. However, a few specimens of Uvigerina juncea are present.

(b) Although Eilohedra levicula is a common constituent of upper bathyal faunas, 230-560 m. (Bergen and O'Neil, 1979; Ingle et al., 1980; Enbysk, 1960), it is in the middle bathyal depths of 500 to 1500 m. that it and Stainforthia complanta and Cassidulina cushmani become significant (Enbysk,1960; Bergen and O'Neil, 1979; Ingle et al., 1980). Three other species common to this study have a shallowest occurrence in the middle bathyal: Gyroidina io, Planulina wuellerstorfi, and Melonis zaandame.

From the evidence in the cores, downslope transport has occurred from upper and middle, to lower bathyal depths (a, above). The abundance in the cores of middle bathyal fauna (b, above) suggests the main component came from this depth although this cannot be proved conclusively.

Planktonic Fauna and Associated Environmental Factors

Globoquadrina pachyderma, the most abundant planktonic species throughout all cores is sinistrally coiled in the majority of samples (Table 3, line 17). However, in Core 12 there were high numbers of dextrally coiled specimens throughout. According to

Bé (1977) sinistrally coiled Globoquadrina pachyderma is an indicator of polar waters while dextral coiling occurs in transition and subpolar areas. However, the cores underlie an area considered to be subpolar to transition (ie. Bradshaw, 1959; Thomson, 1973). The reason for the discrepency in water mass association is not clear. There is no significant difference between Core 12 and the others in geographicl position or time frame. Therefore there is no indication the biota of Core 12 come from a different temperature regime. The reasons for the differences of coiling are unclear in this case.

Of the planktonic species differentiated in this study all are found in waters cooler than 18°C except Globoquadrina hexagona (Bradshaw, 1959; Bé, 1977). Within the temperature range 0° to 18°C the waters of the N. Pacific are grouped into three regions (Arctic 0°-5°C, Subarctic 5°-10°C, Transition 10°-18°C) with each of these regions having a characteristic planktonic faunal assemblage (Bé, 1977). In this study the greatest number of species were of the subarctic assemblage but the arctic and transition zones were also present (Table 9). No surface paleoenvironmental change was indicated by the planktonic foraminiferan assemblage which showed no variation within or among

Table 9

Species of this Study Related to Planktonic Foraminiferan Zones of the Northern Pacific, (adapted from Bé,1977).

0° Arctic	5°C Subarctic	10°C Transition	18°C
Globigerina pachyderma	*Globigerina bulloides*	*Orbulina universa*	
	Globigerina quinqueloba		
	Globorotalia scitula		
	Globigerinita uvula		
	Globigerinita glutinata		

cores. However, as was noted earlier the ratio of planktonic foraminifera to radiolaria is suggested as an indicator of the climatic shift from the late Pleistocene to the Holocene.

Benthic Fauna and Associated Environmental Factors

A range from neritic to lower bathyal depths are the original environments of the 184 benthic species identified. The indigenous lower bathyal fauna were outnumbered by predominantly mid and upper bathyal species displaced downslope. The bathyal fauna which show no trends throughout or among the cores indicate that no discernible change in the environment of the sea-bottom has occurred in the study area during the late Pleistocene to Holocene interval represented by the sediments cored. Furthermore, the morphology of bathyal foraminiferan tests has not evolved since the Oligocene (Boltovsky, 1980).

This unchanging aspect of the fauna is considered a reflection of stable deep sea conditions during that time. The bathyal assemblage is paradoxical in its frequency distribution and the great number of species indicates a very stable environment; but on the other hand dominance of a few species may be considered a response to unstable or stressed conditions (Schnitker, 1980). It is assumed that the

bathyal fauna are sensitive to change, ie. would have undergone evolutionary change and/or extinction had deep sea conditions altered significantly. The evolution of bathyal species has been very slow (Boltovsky, 1980).

The writer knows of no studies on living bathyal species to determine the biological influence of physical factors. The following speculative hypothesis is suggested: The Oligocene evolution of bathyal benthic species may be related to a world wide change in oceanic circulation. Since the Oligocene, widely distributed bathyal faunas (Boltovsky, 1980; Douglas, 1973) had in common the Antarctic bottom water which has flowed northward into the three major ocean basins (Pickard, 1980; Kennett, 1977) at least since the development of the Circum-Antarctic Current in the late Oligocene (Kennett, 1977; Kennett et al., 1975; Jenkins, 1974; Kennett et al., 1972). The slowly changing nature of the bathyal fauna which evolved in the Oligocene may be a reflection of the continuance of a stable deep sea circulation, from the Antarctic region, since that time. As suggested by Schnitker (1980) it may well be stratified water-masses which have influenced depth distribution of benthic foraminifera.

CONCLUSIONS

With respect to the objectives outlined in the introduction the following conclusions were reached:

(a) Within the rich diversity of 193 foraminiferan species there are one third that are new or undescribed. The majority of the 184 benthic species are from the suborder Rotaliina with a few species but abundant individuals from the superfamilies Buliminacea, Orbitoidacea and Cassidulinacea. The Nodosariacea comprise half the total number of benthic species but only 5% of the number of specimens. There are a few species from each of the Textulariina and Miliolina. The planktonic foraminifera are numerically the most abundant and from the nine planktonic species present the two most common are: Globoquadrina pachyderma and Globigerina bulloides. Four benthic species are consistently common throughout all cores and, in order of decreasing abundance, are: Eilohedra levicula, Uvigerina senticosa, Globocassidulina sp. and Gyroidina io.

Among the abundant benthic species of this study the following can be considered in place and characteristic of a lower bathyal environment: Uvigerina senticosa, Melonis pompilioides, Melonis zaandamae, Pullenia bulloides, Bulimina rostrata, Oridorsalis umbonatus and Sphaeroidina bulloides.

A major component of the faunal assemblage is interpreted as reflecting downslope movement from upper and middle bathyal depths. These mask the recognition of indigenous fauna. Specimens displaced from neritic or shelf environments are rare.

(b) Neither the benthic nor planktonic assemblage is of value for establishing time zones or correlating between cores. However, a change in the planktonic foraminiferan-radiolarian ratio can be used to delimit the climatic change from glacial to post glacial times and allows correlation between three cores. This ratio changes at an average depth of 40 cm. An algal form identified as a 'cyst' of Pachysphaera sp. (App. C) occurs from the surface to between 40 and 60 cm. below the foraminiferan radiolarian ratio change. Dependent on more precise identification and knowledge of its distribution this 'cyst' could prove to be a biostratigraphic marker close to the Pleistocene-Holocene boundary.

(c) Turbidite activity was more pronounced in the Pleistocene and is interpreted to be associated with the almost exclusive occurrence of high percentages of sand size nonbiotic residue (>50%) in subsamples from thePleistocene section of the cores. One turbidite sequence originating from the shelf was identified by

the presence of four neritic specimens and a nonbiotic residue of 75%.

Pyrite, in Core 37, in an interval just above a striking drop of foraminiferan abundance may be biogenic in origin or associated with a leaching process or possibly with hydrothermal circulation. However, further study is needed to resolve the nature of the occurrence. The Pleistocene sediment at the top of Core 51 is interpreted as the residue remaining after the slumping of recent sediment, or a lag produced by winnowing. The presence of glauconie throughout the core is suggestive of a hiatus in sedimentation and possibly the alteration of organic matter such as fecal pellets.

(d) The CCD or an associated lysocline are not interpreted as influencing abundance because there are very few pitted or etched specimens, the benthic to planktonic ratio was consistently low, and small delicate planktonics believed to dissolve readily are found throughout the cores.

The approximate thickness of sedimentation between 19,000 and 23,000 BP is 77 cm. and from the present to 12,500 BP is 40 cm. If sedimentation rates were constant this would be equivalent to 16.5 cm./1000 yrs. in the late Pleistocene and 3.2 cm./1000 yrs in the Holocene.

The sediment in the cores is almost entirely hemipelagic having originated from upper to lower bathyal depths as indicated by the entrained fauna. An associated nonbiotic residue of glass shards and basalt chips is suggestive of downslope transport eastward and southward from the Juan de Fuca Ridge. Detrital quartz grains and mica flakes plus shelf foraminiferan species, in the one turbidite sequence sampled, were probably carried west and southward from the shelf.

Sinistrally coiled Globoquadrina pachyderma are abundant throughout the cores and indicate a cold water mass influence. The change to a greater relative abundance of radiolaria in the postglacial may infer an alteration in climatic and circulation patterns at the close of the Pleistocene. The glacial-postglacial transition could not be discerned by differences in the foraminiferan assemblages.

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PLATE 1

PLANKTONIC FORAMINIFERA

Figures

1,2 *Globoquadrina pachyderma* 200X (p.118)

UBC-77-51 (0-7 cm.)
umbilical and edge views
diameter 180μ (thickness 75μ)

3 *Globigerinita uvula* 350X (p.119)

GSC-77-37 (90-92 cm.)
oblique apertural view
diam. 90μ

4,5 *Globigerina bulloides* 110X (p.117)

UBC-77-51 (0-7 cm.)
spiral and umbilical views
length 455μ (th. 310μ)

6 *Orbulina universa* 95X (p.118)

GSC-77-37 (100-102 cm.)
diam. 430μ

7,8,9 *Globorotalia scitula* 130X (p.116)

UBC-77-51 (64-66 cm.)
spiral, oblique umbilical
and edge views
diam. 365μ th. 195μ

10,11 *Globigerina quinqueloba* 230X (p.117)

GSC-77-37 (90-92 cm.)
apertural and spiral views
l. 195μ (th. 95μ)

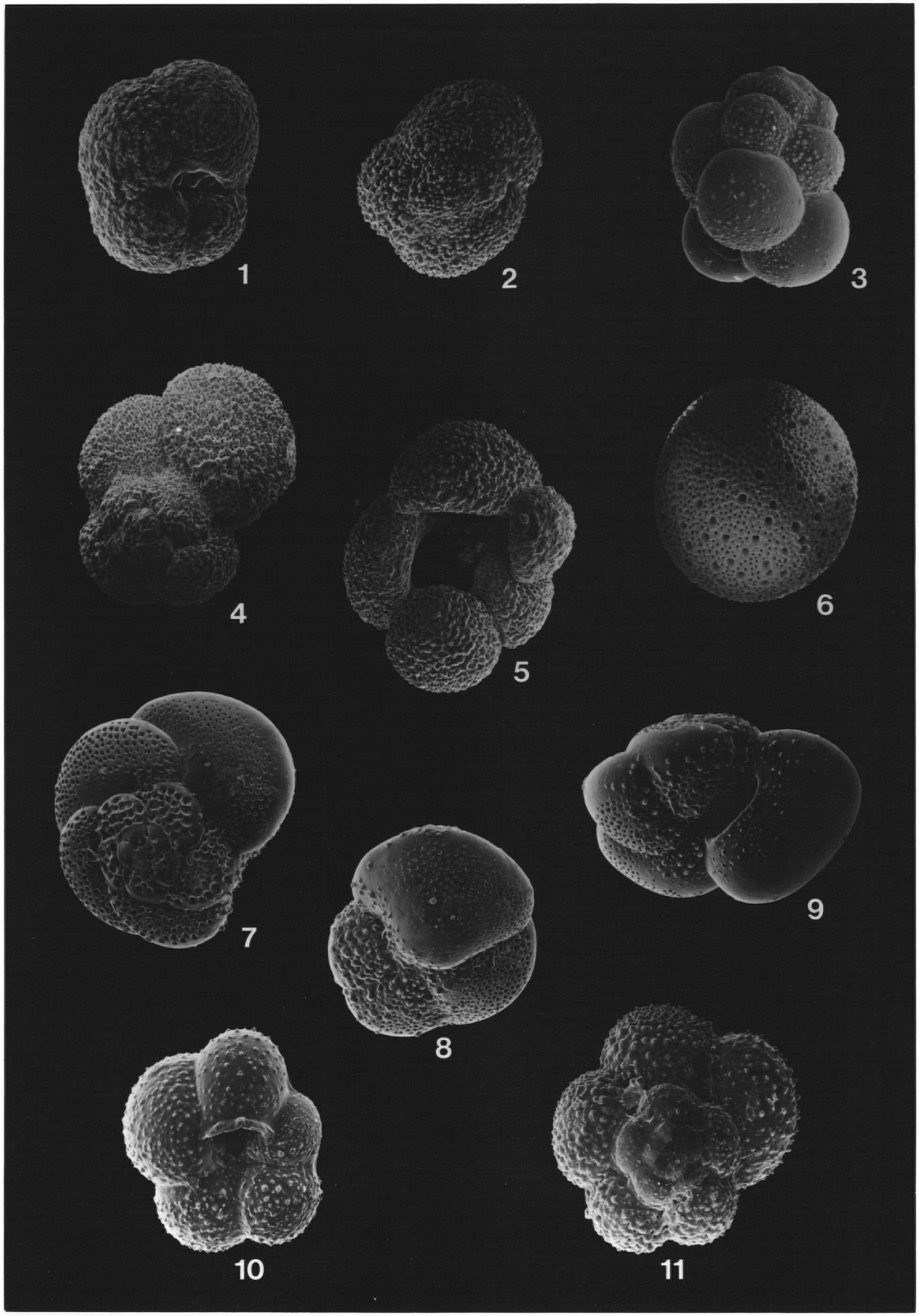
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PLATE 2

MOST ABUNDANT BENTHIC FORAMINIFERA

Figures

1,2,3 *Eilohedra levicula* 215X (p.120)

UBC-77-51 (79-81 cm.)
spiral, edge and umbilical views
diam. 210μ th. 90μ

4-9 *Uvigerina senticosa* (p.112)

UBC-77-51 (0-7 cm.)
fig.4 juvenile (smooth/papilliate) 140X
l. 220μ th. 15μ
fig.5 immature (papilliate) 100X
l. 430μ th. 260μ

GSC-77-37 (100-102 cm.)
fig.6 adult (smooth/papilliate) 55X
l. 805μ th. 365μ
fig.7 adult (smooth) 60X
l. 755μ th. 405μ
fig.8 adult (smooth/papilliate) 55X
l. 910μ th. 390μ
fig.9 adult (papilliate/spinose) 60X
l. 715μ th. 269μ

10-12 *Gyroidina io* 150X (p.125)

UBC-77-51 (0-7 cm.)
edge, umbilical and spiral views
diam. 275μ th. 180μ

13-15 *Globocassidulina sp.* 275X (p.123)

UBC-77-51 (0-7 cm.)
fig.13 umbilical view
PGC-78-6-29 (40-42 cm.)
fig.14,15 spiral and side views
l. 155μ diam. 130μ

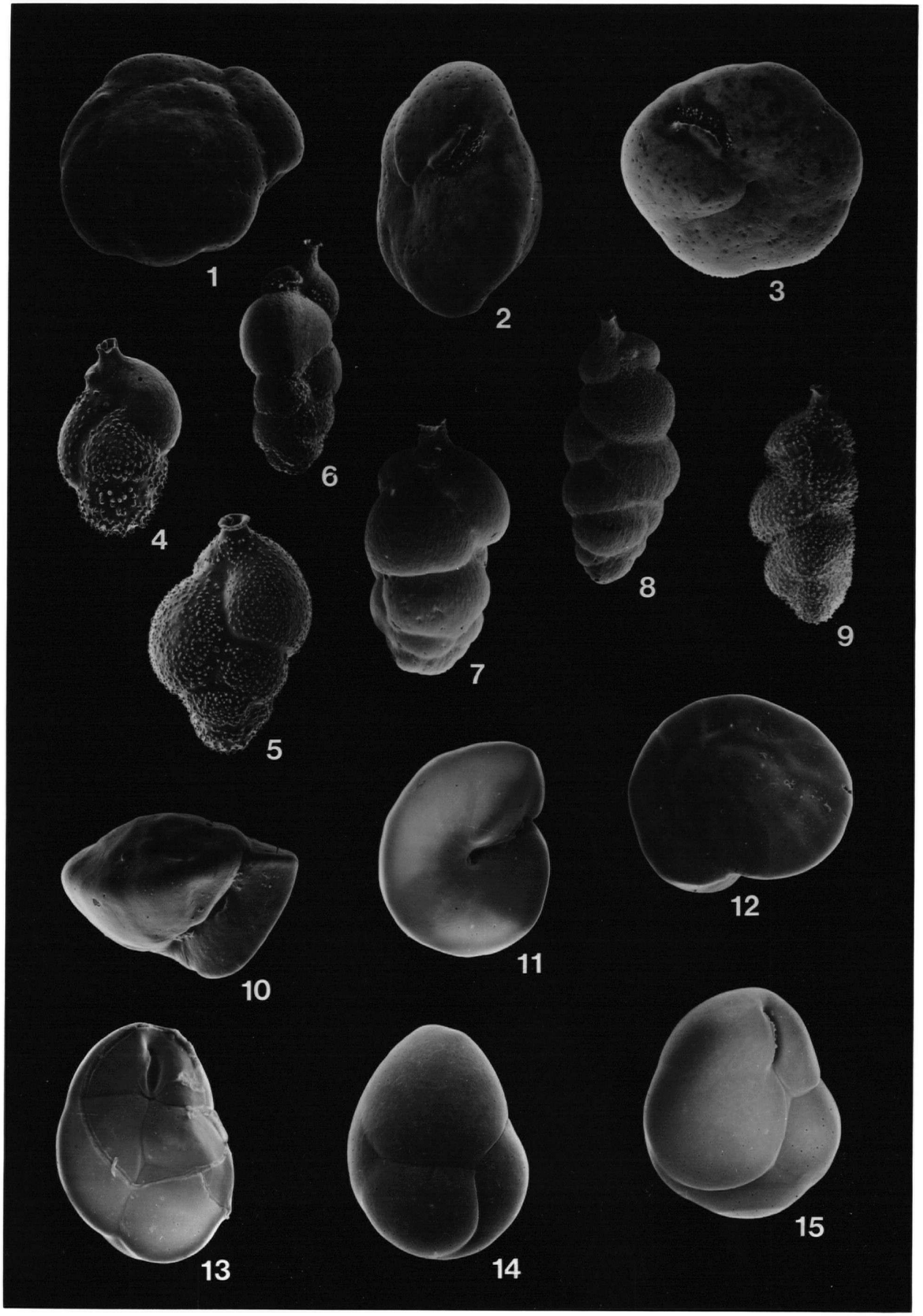
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PLATE 3
BENTHIC LOWER BATHYAL FORAMINIFERA

Figures

1,2, *Sphaeroidina bulloides* 130X (p.106)

UBC-77-51 (0-7 cm.)
spiral and umbilical views
l. 300μ diam. 235μ

3,4 *Pullenia bulloides* 150X (p.124)

PGC-78-6-29 (40-42 cm.)
edge and umbilical views
diam. 260μ

5,6 *Ehrenbergina trigona* 80X (p.122)

PGC-78-6-18 (25-34 cm.)
apertural and edge views
l. 495μ width 430μ th. 260μ

7-9 *Oridorsalis umbonatus* 7(40X) 8,9(130X)

(p.126)
PGC-78-6-29 (40-42 cm.)
spiral, edge and umbilical views
fig.7 diam. 1350μ (th. 840μ)
fig.8,9 diam. 325μ (th. 180μ)

10,13 *Melonis pompilioides* 95X (p.127)

UBC-77-51 (93-96 cm.)
spiral and edge views
l. 375μ th. 265μ

11,12 *Bulimina rostrata* 145X (p.109)

PGC-78-6-12 (40-42 cm.)
edge and apertural views
l. 300μ th. 195μ

14,15 *Melonis zaandamae* 120X (p.128)

(Middle to lower bathyal)
PGC-78-6-29 (40-42 cm.)
edge and spiral views
l. 350μ th. 155μ

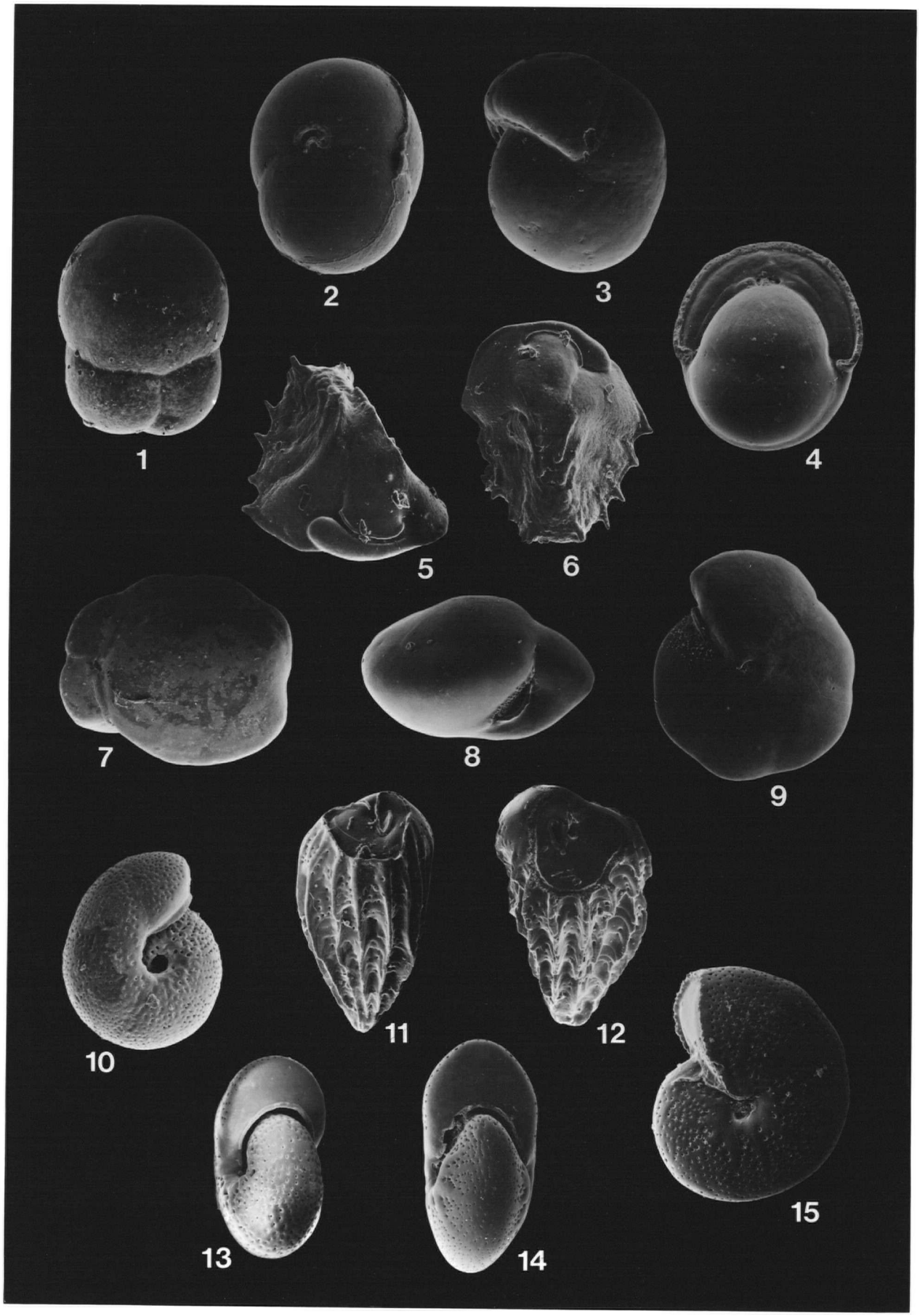
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PLATE 4
BENTHIC NERITIC, UPPER & MIDDLE BATHYAL FORAMINIFERA

Figures

1,2, *Planulina wuellerstorfi* 60X (p.121)

PGC-78-6-29 (30-32 cm.)
spiral and umbilical views
l. 665μ (th. 310μ)

3-5 *Hoeglundina bradyi* 50X (p.129)

GSC-77-37 (100-102 cm.)
spiral, edge and umbilical views
diam. 715μ th. 365μ

6,7 *Brizalina pacifica* 6(140X) 7(125X)

(p.107)
UBC-77-51 (0-7 cm.)
side and edge views
l. 310μ breadth 90μ th. 65μ

8 *Stainforthia complanata* 115X (p.110)

UBC-77-51 (0-7 cm.)
edge view
l. 365μ diam. 115μ

9,10 *Cassidulina cushmani* 110X (p.122)

UBC-77-51 (0-7 cm.)
spiral and umbilical views
diam. 350μ (th. 170μ)

11,12 *Cibicidoides kullenbergi* 80X (p.127)

PGC-78-6-29 (40-42 cm.)
spiral and oblique umbilical views
diam. 535μ th. 260μ

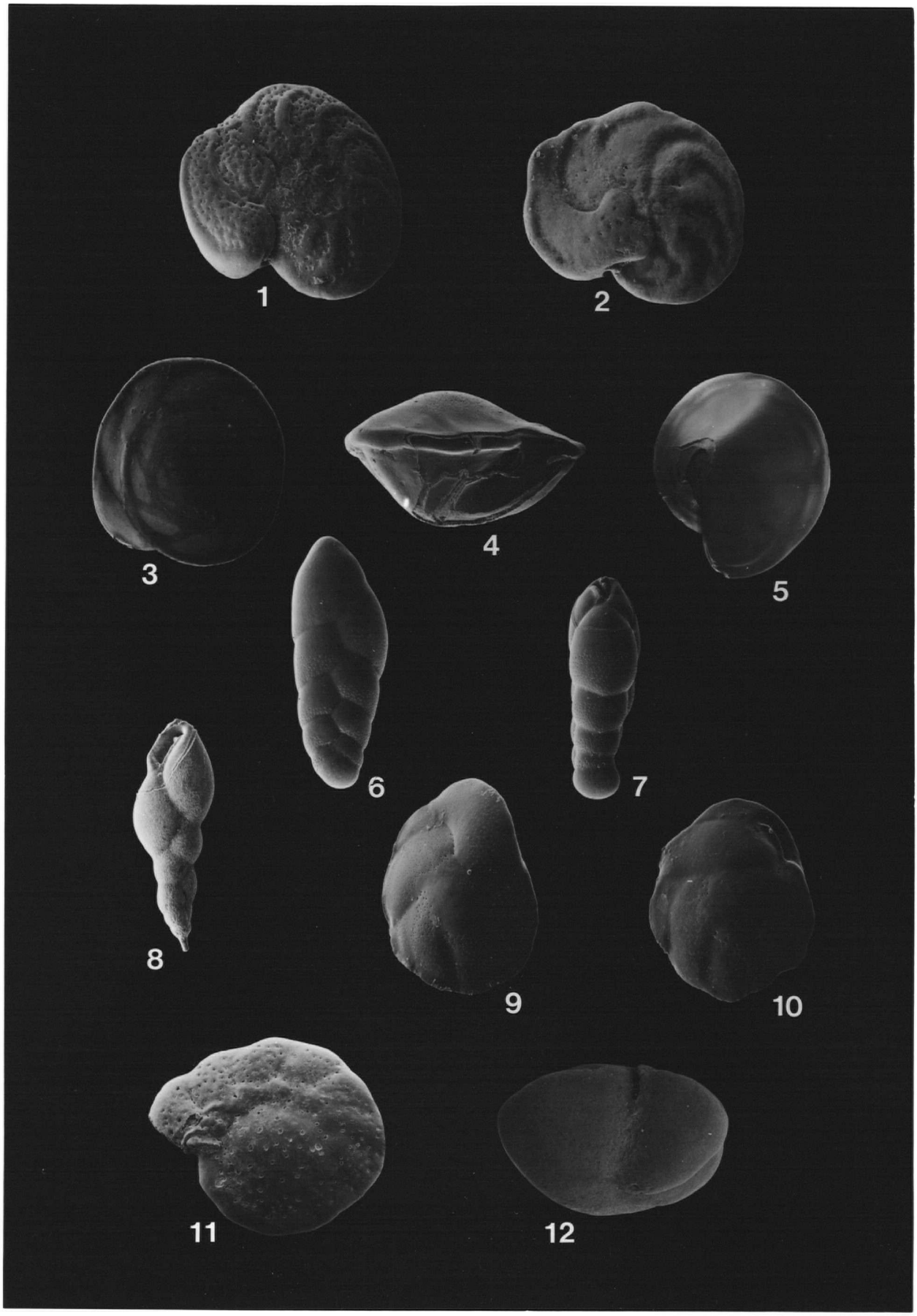
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PLATE 5
UNDESCRIBED AND MINUTE FORAMINIFERA

Figures

1,2,3 *Eponides tumidulus horvathi* 325X (p.120)

UBC-77-51 (34-36 cm.)
spiral, umbilical and edge views
diam. 120μ th.50μ

4,5 *Valvulineria? arctica* 325X (p.114)

UBC-77-51 (0-7 cm.)
umbilical and spiral views
l. 145μ (th.80μ)

6 *Quinqueloculina* sp. A 200X (p.78)

PGC-78-6-11 (10-12 cm.)
side view
l. 195μ th. 105μ

7 *Karreriella* sp. 110X (p.77)

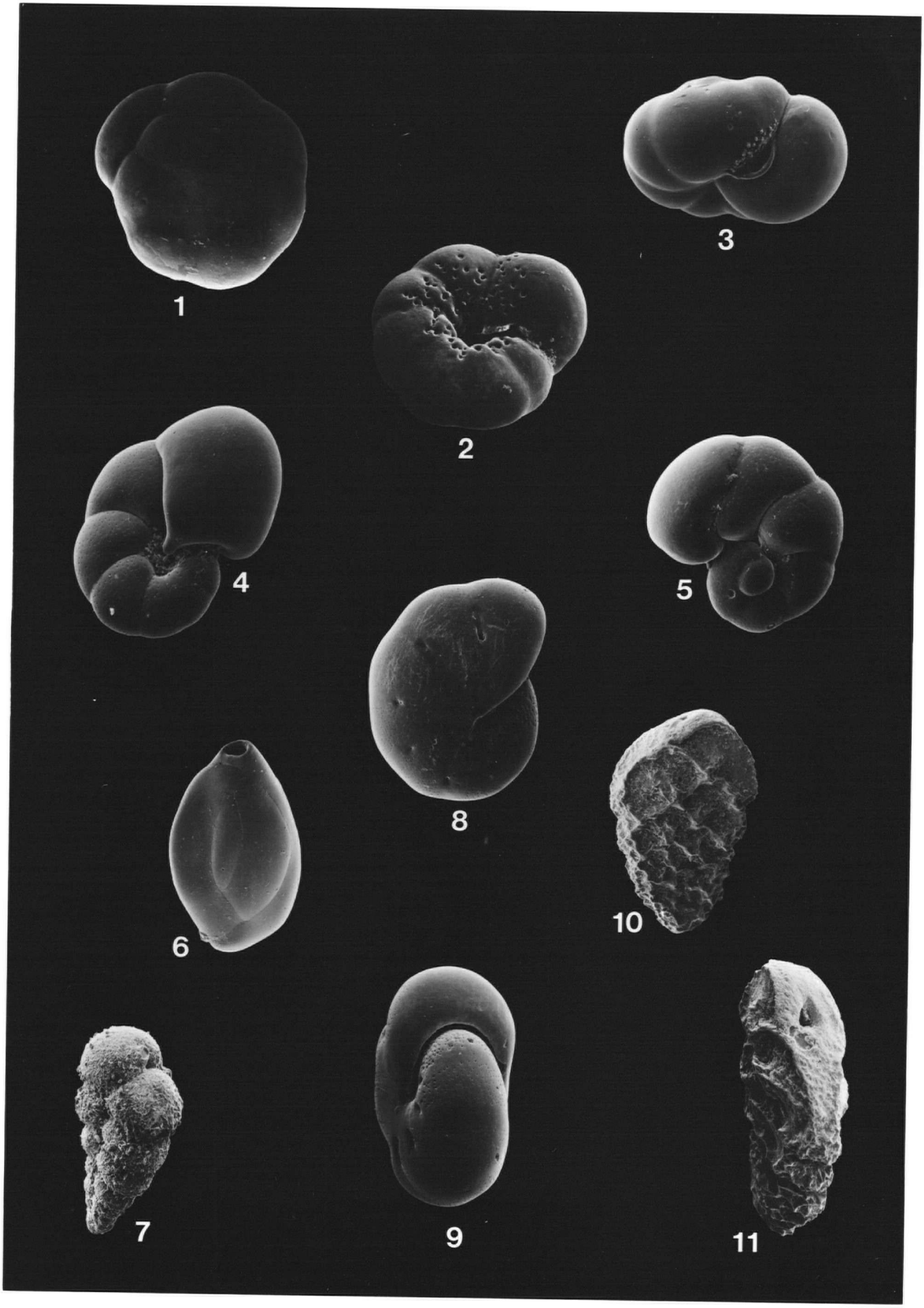
GSC-77-37 (80-82 cm.)
oblique side view
l. 350μ th. 195μ

8,9 *Melonis* sp. 140X (p.128)

PGC-78-6-29 (30-32 cm.)
spiral and edge views
l. 285μ th. 175μ

10,11 *Brizalina* sp. 10(155X) 11(190X)

(p.108)
UBC-77-51 (0-7 cm.)
side and edge views
l. 260μ th. 65μ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Appendix A

SYSTEMATIC DESCRIPTIONS

The following descriptions follow the taxonomic ordering of Loeblich and Tappan (1964).

Phylum: Sarcodina Schmarda,1871

Class: Rhizopodea von Siebold,1845

Subclass: Granuloreticulosia de Saedeleer,1934

Order: Foraminiferida Eichwald,1830

Suborder: Textulariina Delage and Hérouard,1896

Superfamily: Ammodiscacea Reuss,1862

Family: Astrorhizidae Brady,1881

Subfamily: Astrorhizinae Brady,1881

Genus: Rhabdammina M.Sars in Carpenter,1869

1 Rhabdammina ? sp.

Remarks: A few coarsely agglutinated cylindrical fragments are tentatively assigned to Rhabdammina.

Subfamily: Rhizammininae Rhumbler,1895

Genus: Rhizammina Brady,1879

2 Rhizammina sp.

Remarks: This form is represented by only a few fragmentary specimens found in one core. Test, a thin elongate, branching tube; wall coarsely agglutinated of predominately quartz grains.

Genus: Bathysiphon M.Sars,1872

3 Bathysiphon rufus de Folin

Bathysiphon rufus de Folin,1886 Act. Soc. Linn. Bordeaux, v.40 p.283, pl.6 fig.8a-c; Loeblich and Tappan, 1953, Smith. Misc. Coll. v.121, n.7, p.16, pl.1 fig.1.

Synoptic description: Test elongate, slightly tapering, irregular constrictions; wall thick, smooth and polished, finely agglutinated, yellow brown colour; aperture open end of tube.
Remarks: Identification based on fragmented specimens, most several millimeters in length.

4 Bathysiphon sp.

Synoptic description: Test large, arcuate or sinuous tube, uniform diameter; wall very coarsely agglutinated with quartz grains and numerous protruding sponge spicules.

Remarks: Specific identification not possible because of fragmented nature of the specimens.

Family: Saccamminidae Brady,1884

Subfamily: Saccammininae Brady,1884

Genus: Saccammina M.Sars,1869

5 Saccammina sphaerica M.Sars

Saccammina sphaerica M.Sars,1869, Forhandl. Vidensk. Selsk. Christiana, Aar. 1868, p.248; Cushman,J.A. 1910, US. Nat. Mus. Bull. 71 pt.1, p.38, fig.33,35,36; Barker,R.W. 1960, Soc. Econ. Paleo. Min., Spec. Publ.9, p.36, pl.18, fig.11,12,13,15; Vilks,G. 1969, Micropaleo. V.15, p.43, pl.1 fig.6.

Synoptic description: Test free, spherical; wall agglutinated, coarse quartz grains and mica flakes, colour grey; aperture rounded at end of short neck.

Family: Ammodiscidae Reuss,1862

Subfamily: Ammodiscinae Reuss,1862

Genus: Ammodiscus Reuss,1862

6 Ammodiscus planorbis Höglund

Ammodiscus planorbis Höglund,1947, Foraminifera in the Gullmar Fjord and the Skagerak. Uppsala, Univ. Zool. Bidrag, Bd.26, p.125, pl.28, fig.13,14, pl.8, fig.4a,b, p.110 tf.91.

Synoptic description: Test small, moderately thick, biconcave and regularly planispiral, about 10 whorls; slightly involute, one whorl covering 1/3 to 1/2 of previous coil; sutures distinct, slightly depressed; aperture open end of tube; wall smooth, polished, very finely agglutinated; colour uniform light orange with transparent proloculus; numerous, sporadic radial striations.

Remarks: A. planorbis differs from A. hoeglundi (Uchio) with the latter having one half the thickness of A. planorbis Hoglund.

7 Ammodiscus sp.

Remarks: Curved fragments belonging to a large Ammodiscus were found in several samples. The size and general character suggests affinity with Ammosdiscus pacifica Cushman and Valentine.

Superfamily: Lituolacea de Blainville,1825

Family: Hormosinidae Haeckel,1894

Subfamily: Hormosininae Haeckel,1894

Genus: Reophax Montford,1808

8 Reophax guttifer Brady

Reophax guttifer Brady,1881, Quart.J. Micr. Sci. V.21, p.49; Cushman, J.S., 1910, U.S. Nat. Mus. Bull. 71 pt.1 p.88, fig. 123.

Synoptic description: Test, free, single subspherical chamber with an elongate cylindrical neck on both ends; wall agglutinated quartz grains, rough, colour yellow orange.

Remarks: The fragments comprising Reophax? sp. may be broken fragments of the necks which connect chambers of R. guttifer.

9 Reophax longicollis (Wiesner)

Proteonina longicollis Wiesner,1929, Deut. Sud. Polar. Exped. V.20, p.82, pl.6, fig.55; Uchio T., 1960, Cush. Fd. Foram. Res., Spec. Publ. N.5, p.50, pl.1, fig.1,2.

Synoptic description: Test free, spherical chamber with elongate slender neck; wall agglutinated, very large mica flakes and finer quartz grains; aperture rounded, at end of slender neck.

Remarks: Uchio's specimens are figured with a less pronounced neck. The specimen of this study having incorporated large and numerous mica flakes shows affinities to Proteonina micacea Cushman.

10 Reophax nodulosus Brady

Reophax nodulosus Brady,1879, Quart. J. Micr. Sci. V.19, p.52, pl.4, fig.7,8; Cushman J.A., 1910, U.S. Nat. Mus. Bull. 71 pt.1, p.87, fig. 122.

Synoptic description: Test an elongate series of chambers each broadest proximally, tapering slightly distally; wall agglutinated, quartz grains, smooth; aperture (broken away) assumed open end of tube.

Remarks: This specimen corresponds to the long chambered, smooth walled forms mentioned by Cushman.

11 Reophax ? sp.

Remarks: Five coarsely agglutinated fragments of a short neck between enlarged segments were found in one sample, and are believed to be from one or two specimens; they may possibly represent neck fragments between chambers of Reophax guttifer Brady.

Subfamily: Lituolacea de Blainville,1825

Family: Rzehakinidae Cushman,1933

Genus: Spirolocammina Earland,1934

12 Spirolocammina? tenuis Earland

Spirolocammina tenuis Earland,1934, Discovery Repts.,V.10, p.109, pl.4, fig. 13-16.

?Sigmoilina (Quinqueloculina) tenuis (Czjzek), Enbysk,1960, Distribution of Foraminifera in the Northeast Pacific, Ph.D. Thesis, U. Wash., pl.5, fig.12.
?Spiropthalmidium (Spiroloculina) pusillum (Earland), Barker, 1960, Taxonomic Notes on Brady's Rept. of the Challenger Exped., Pl.10, fig.9,10.
?Ophthalmidium pusillum (Earland), Smith, 1973, U.S.G.S. Prof. Paper 706, p.14, pl.1 fig, 18; Corliss, 1979, Micropaleontology, V.25(1), p.5, pl.1, fig.7-8.

Synoptic description: Test elongate, planispiral, three pairs of chambers 1/2 coil in length developing over neck of the previous chamber; wall thin, smooth, hyaline; aperture rounded end of chamber on short neck.

Remarks: The placement of this form within Spirolocammina or Spiroloculina is dependent upon whether the wall is silicious, minutely agglutinated or calcium carbonate. This form does not appear porcellaneous and fits Earland's description very closely, therefore it is tentatively placed in Spirolocammina.

Family: Lituolidae de Blainville,1825

Subfamily: Haplophragmoidinae Maync,1952

Genus: Haplophragmoides Cushman,1910

13 Haplophragmoides sphaeriloculus Cushman

Haplophragmoides sphaeriloculum Cushman,1910, U.S. Nat. Mus. Bull. 71 pt.1, p.107, t.f.165; Todd and Low, 1967, U.S.G.S. Prof. Paper 573-A, p.15, pl.1, fig.20.

Synoptic description: Test planispiral, last whorl five chambers, partially involute, chambers globose, sutures depressed; aperture low equatorial basal slit; wall agglutinated, smooth, colour yellow brown.

Remarks: Two different sized specimens were found and one was assumed to be microspheric, the other a megalospheric form which was more compressed and one third smaller.

Genus: Thalmannammina Pokorny,1951

14 Thalmannammina sp.

Synoptic description: Test subglobular, streptospiral coil, few chambers; wall agglutinated, excess of cement, colour light orange brown; aperture interiomarginal slit.

Subfamily: Cyclamminininae Marie,1941

Genus: Cyclammina Brady,1879

15 Cyclammina cancellata Brady

Cyclammina cancellata Brady, 1879, Quat. J. Micr. Sci., n.s. V.19, p.62, [fig. from Rept. Challenger Exped., pl.37, fig.8-9]; Barker,1960, Soc. Econ. Min. Paleo. Spec. Publ. 5, pl.37.fig.8-9; Cushman,1910, U.S. Nat. Mus. Bull. 71, pt.1, p.110, fig. 168-170; Smith,1973, U.S.G.S. Prof. Paper 706, p.14, pl.1, fig.18.

Synoptic description: Test large, planispiral, biconvex, depressed at the umbilius, 18 low broad chambers, depressed sinuate sutures, margin rounded; wall finely agglutinated, reticulate, imperforate outer layer with labyrinthic interior, orange brown colour; aperture broken away.

Remarks: Identification based on two specimens. Some of the sutures are limbate, dark brown in colour (FeO?).

Family: Textulariidae Ehrenberg,1838

Subfamily: Textulariinae Ehrenberg,1838

Genus: Bigenerina d'Orbigny,1826

16 Bigenerina sp.

Synoptic description: Test free, elongate, early portion biserial later uniserial; wall smooth, agglutinated, quartz grains, mica flakes, colour grey white; aperture terminal rounded.

Family: Trochamminidae Schwager,1877

Subfamily: Trochamininae Schwager,1877

Genus: Trochammina Parker and Jones,1859

17 Trochammina sp.

Synoptic description: Test trochospiral, low spire, last 3 chambers forming lobate periphery, sutures indistinct; wall agglutinated, colour white (some mottling); aperture equatorial interiomarginal arch.

Genus: Ammosphaeroidina Cushman,1910

18 Ammosphaeroidina sphaeroidiniformis (Brady)

Haplophragmium sphaeroidiniforme Brady,1884, Rept. challenger Exped., Zool.V.9, p.313.
Ammosphaeroidina sphaeroidiniformis (Brady), Cushman,1910, U.S. Nat. Mus. Bull. 71,pt.1, p.128, fig. 202.

Synoptic description: Test globular, three visible embracing chambers, streptospirally coiled; wall agglutinated, smooth and polished, excess of cement, colour white; aperture low interiomarginal arch.

Remarks: Identification is based on one specimen which is not coarsely arenaceous and is one half the size of the specimen described by Cushman.

Family: Ataxophragmiidae Schwager,1877

Subfamily: Globotextulariinae Cushman,1927

Genus: Dorothia Plummer,1931

19 Dorothia bradyi (Cushman)

Gaudryina bradyi Cushman,1911, U.S. Nat. Mus. Bull. 71 pt.2, p.67, fig.107, not Dorothia bradyana Cushman

Synoptic description: Test small, early portion trochospiral later biserial appearing ovoid in crossection, as broad as long at apertural end, few chambers, inflated; wall finely agglutinated, smooth, colour light grey white; aperture low basal interiomarginal slit in last chamber face.

Remarks: A smaller test than Cushman's description, otherwise identical.

Genus: Eggerella Cushman,1933

20 Eggerella parkerae (Uchio)

Karreriella parkerae Uchio,1960, Cush. Fd. Foram. Res. Spec. Publ.5, p.56, pl.2, fig.21-23.
?Verneuilina bradyi Cushman,1911, U.S.Nat.Mus.Bull.71, pt.2, p.54, fig.87.

Synoptic description: Test small, initially trochospiral later triserial, short and stout with globular chambers, broad at apertural end tapering to blunt initial end, sutures distinct, depressed and nearly horizontal; wall very finely agglutinated, smooth and polished, colour light white grey; aperture, low interiomarginal slit at base of last chamber.

Remarks: Uchio differentiated this species from Verneuilina bradyi Cushman on the basis of E. parkerae being smaller, having more globular chambers and a slightly raised apertural lip. The Juan de Fuca Ridge specimens are of similar size and shape to K. parkerae Uchio but lack the raised lip. V. bradyi Cushman although two to three times larger than the Juan de Fuca specimens also has no raised lip and corresponds in general morphology.

Genus: Karreriella Cushman, 1933

21 Karreriella sp.

Pl.5 fig.7

?Gaudyrina siphonella Reuss,1851 (part) Deutsch. Geol. Ges. Zeitschr. Bd. 3 p.78, fig. 40-41.

Synoptic description: Test small initially trochospiral later biserial and twisted about long axis, chambers overlapping previous highest portion of chamber on outside of test, sutures depressed and indistinct; wall agglutinated, very fine particles, sugary surface texture, colour white; aperture rounded, on short distinct neck in lower middle of final chamber face.

Remarks: This species is closest to Gaudyrina siphonella Reuss,1851 (part) especially in having the outer chamber edge the highest and the aperture on the inner face.

Genus: Martinottiella Cushman,1933

22 Martinottiella sp.

?Clavulina communis d'Orbigny var. pallida Cushman,1927, Calif. Univ. Scripps Inst. Ocean. Bull. Tech. Ser. V.1, p.138, pl.2 fig.1.

Synoptic description: Test initially a curved trochospiral suddenly narrowing to straight uniserial equidiameter chambers; wall agglutinated mostly quartz grains, some mica flakes, sugary texture, colour grey white; aperture terminal, curved slit with raised lip.

Suborder: Miliolina Delage and Hérouard, 1896

Superfamily: Miliolacea Ehrenberg,1839

Family: Fisherinidae Millett, 1898

Subfamily: Cyclogyrinae Loeblich and Tappan, 1961

Genus: Cyclogyra Wood, 1842

23 Cyclogyra sp.

?Cyclogyra sp. Lagoe,1977, J. Foram. Res. V.7(2), p.119, pl.1 fig. 2.

Synoptic description: Test planispiral, globular proloculus followed by undivided chamber of 2 whorls; wall partially hyaline, smooth; aperture terminal open end of tube.

Family: Miliolidae Ehrenberg, 1839

Subfamily: Quinqueloculininae Cushman, 1917

Genus: Quinqueloculina d'Orbigny, 1826

24 Quinqueloculina sp.A

Pl.5 fig.6

Synoptic description: Test small, chambers elongate one half coil in length, coiling in quinqueloculine fashion; wall porcellaneous, some hyaline or partially hyaline, white colour; aperture terminal, a rounded oval with no visible toothplate.

25 Quinqueloculina sp.B

Synoptic description: Test small, almost as broad as long, chambers one half coil in length, quinqueloculine coiling, wall porcellaneous, some partially hyaline, imperforate, colour yellow-white; aperture terminal, semicircular end of tube, single tooth.

Remarks: This species resembles Q. akneriana d'Orbigny.

26 Quinqueloculina sp.C

?Quinqueloculina antarcticiana McCulloch,1977 Qualitative Observations on Recent Foraminiferal Tests With Emphasis on the Eastern Pacific, Univ. S. Calif. p.482, pl. 231, fig. 4,5.

Synoptic description: Test small, quinqueloculine coiling, basal portion of chambers curves back onto previous chamber; wall porcellaneous, imperforate, colour white; aperture terminal, semicircular end of tube with simple tooth.

27 Quinqueloculina sp.D

Synoptic description: Test moderate size, quinqueloculine coiling, chambers one half coil in length with basal portion overlapping previous chamber, chambers with slight keel; wall porcellaneous, imperforate, bright white; aperture terminal, semicircular end of tube, simple tooth.

28 Pyrgo cf. P. murrhina (Schwager) of authors

Biloculina murrhyna Schwager, of Cushman, 1917, U.S. Nat. Mus. Bull. 71, pt.6, p.75, pl.28, fig.3, pl.29, fig.1.
Biloculina lucernula Schwager, 1866 Novara. Exped. Geol. Theil. v.2, p.202, pl.4, fig. 17 (not fig. 14).
Pyrgo rotalaria Loeblich and Tappan, 1953, Smith. Misc. Coll. v.121(7), p.47, pl.6 fig.5,6. Lagoe, 1977, J.Foram. Res. v.7(2), p.119, pl.2., fig.21.

Synoptic description: Test oval, inflated, chambers biloculine coiling, one half coil in length, periphery carinate; wall porcellaneous, glossy white; aperture terminal raised lip with broad simple tooth.

Remarks: Several reported species are interpreted as one which has morphologically varying ontogenetic stages: an advanced ontogenetic form has basal projections which will form the aperture and tooth plate of the next chamber, an early ontogenetic stage with a pronounced and curved neck.

29 Pyrgo sp.

?Pyrgo williamsoni (Silvestri) of Lagoe, 1977, J. Foram. Res. v.7(2), p.119, pl.1, fig. 14.

Synoptic description: Test very elongate, biloculine; wall porcellaneous, hyaline when wet, colour yellow-white; aperture slightly subterminal, rounded with bifed tooth.

Remarks: This single specimen appears the same as that figured by Lagoe, but lacks the basally rotund nature of Biloculina williamsoni Silvestri.

Genus: Pyrgoella Cushman and E.M.White, 1936

30 *Pyrgoella* sp.A

Synoptic description: Test subspherical, slightly oval, two chambers barely distinguishable: wall porcellaneous, imperforate, colour glossy milk white; aperture subterminal, semicircular with large tooth leaving only a crescent slit.

31 *Pyrgoella* sp.B

Synoptic description: Test subglobular, extended apertural termination, two chambers, indistinct sutures, baxal spine; wall porcellaneous, glossy, colour yellow-white, partially hyaline when wet; aperture, terminal, semicircular, large tooth infilling allbut crescentic slit.

Genus: Triloculina d'Orbigny, 1826

32 *Triloculina frigida* Lagoe

Triloculina frigida Lagoe,1977, J. Foram. Res. v.7(2), p.120, fig.6D,6E; pl.1, fig. 12,17,18.

Synoptic description: Test triloculine coiling, chambers one half coil in length, crossectional outline triangular; wall imperforate, porcellaneous, most specimens hyaline, glossy white colour; aperture terminal, rounded, at end of short neck, no visible tooth.

Subfamily: Miliolinellinae Vella, 1957

Genus: Miliolinella Wiesner, 1931

33 *Miliolinella*? sp.

Synoptic description: Test large oval, robust, chamber triloculine and strongly overlapping, distinct sutures; wall porcellaneous, imperforate, colour glossy milk white; aperture terminal, large flap infilling all of aperture except crescentic slit.

Remarks: The apertural flap may be a very broad tooth thereby placing this specimen in *Triloculina*.

Genus: Scutuloris Loeblich and Tappan, 1953

34 Scutuloris sp.

Synoptic description: Test elongate inflated oval, quinqueloculine coiling, chambers strongly embracing, sutures indistinct; wall porcellaneous, imperforate, smooth, milk white colour; aperture terminal, semicircular with large tooth infilling all but crescent slit.

Subfamily: Miliolinae Ehrenberg, 1939

Genus: Ammomassilina Cushman, 1933

35 Ammomassilina? sp.

?Ammomassilina alveoliniformis (Millett) of Barker, 1960 (part) Soc. Econ. Paleo. Min. Spec. Publ. 9, pl.8, fig.14a,b.

Synoptic description: Early portion of test sigmoline, later chambers in one plane; wall agglutinated, calcareous cement, white colour with numerous black micaceous flecks; aperture terminal, rounded on short neck, no evidence of tooth.

Remarks: This form lacks the cribrate aperture of the genus and the specimen figured by Brady (Barker, 1960) is three times the size.

Suborder: Rotaliina Delage and Hérouard, 1896

Superfamily: Nodosariacea Ehrenberg,1838

Family: Nodosariidae Ehrenberg, 1838

Subfamily: Nodosariinae Ehrenberg, 1838

Genus: Nodosaria Lamarck, 1812

36 Nodosaria? sp.A

Remarks: The identification is based on fragmented specimens. Two chambers, uniserial, rectilinear; wall hyaline, finely porous; aperture terminal? (broken open).

37 Nodosaria? sp. B

Synoptic description: Test multivocular, subglobular chambers, rectilinear, sutures horizontal, rounded basal chamber; wall translucent, 8-10 longitudinal ribs; aperture terminal, rounded central.

Remarks: Identification is based on several, two chambered forms and no distinct aperture.

Genus: Astacolus de Montfort, 1808

38 Astacolus cf. A. hyalacrulus Loeblich and Tappan

Astacolus cf. A. hyalacrulus Loeblich and Tappan, 1953, Smith. Misc. Coll., v.121, n.7, p.52, pl.9, fig. 1-4.

Synoptic description: Test large, robust, planispiral, early portion coiled about proloculy, later portion uncoiling, sutures indistinct, chambers increading in size, inflated; wall smooth, opaque; aperture radiate, at peripheral tip, visible in previous chambers procuding deeled affect.

Remarks: This description is based on one specimen which differs from A. hyalacrulus by having more inflated chambers and a less visible proluculum. The two forms are quite similar in gerneral morphology and size.

39 Astacolus sp.

Synoptic description: Test small, arcuate, 6 chambers coiled about proloculum seventh starts to unroll; sutures distinct, oblique and highest on outer margin; wall smooth, finely perforate, some specimens hyaline others white; aperture terminal, radiate at peripheral angle.

Remarks: Loeblich and Tappan worked with only two specimens and suggested the forms were juvenile because of the small number of chambers. Astacolus sp. has the same number of chambers as Loeblich and Tappan's species but is one half the size; the size difference may represent

Genus: Dentalina Risso, 1826

40 Dentalina cf. D. calomorpha (Reuss) of Barker, 1960

Nodosaria cf. N. calomorpha Reuss, of Barker, 1960, Soc. Econ. Paleo. Min. Spec. Publ. 9, p.128, pl.61, fig. 23,24,27. not Reuss, 1866

Synoptic description: Test elongate, uniserial, arcuate, chambers longer than broad, sutures distinct, slightly oblique; wall hyaline, finely perforate; aperuture terminal, radiate.

Remarks: Identification based on two specimens of differing size. The smaller specimen may be the megalospheric generation. These specimens appear identical to the figured specimens of Brady (of Barker, 1960) but are not those of N. calomorpha Reuss which have an enlarged first chamber.

41 Dentalina pauperata d'Orbigny

Dentalina pauperata d'Orbigny, 1846, Foraminiferes fossiles du bassin tertiare Vienne p.46, pl.1, fig.57-58; Lorblich and Tappan, 1953, Smith. Misc. Coll. v.121 n.7, p.57, pl.9, fig.7-9; Barker, 1960, Soc. Econ. Paleo. Min. Spec. Pub. 9, p.X (notes on t. fig.14b).

Synoptic description: Test a series of subglobular chambers, arcuate with an apical spine, sututes are smooth and horizontal; wall partially hyaline; aperture terminal, radiate, eccentric on the concave side of the arc.

Remarks: D'Orbigny's figure and description do not state whether the rounded aperture is radiate.

42 Dentalina? sp. A

Remarks: Identification based on several fragments which indicate a uniserial, arcuate test with terminal cribrate aperture.

43 Dentalina sp. B

Synoptic description: Test multichambered, arcuate, tapering at apical end and at aperature, short neck, sutures oblique; wall hyaline, lower three quarters of chamber frosty or finely perforate; aperture terminal, rounded end of neck.

44 Dentalina? sp. C

Synoptic description: Test small, tear drop shaped, base partially broken but appears joined to preceeding chamber; wall hyaline; aperture terminal, rounded open end of tube.

Remarks: Identification is based on fragmented specimens and is tentatively placed with Dentalina.

Genus: Lagena Walker and Jacob in Kanmacher, 1798

45 Lagena cf. L. auriglobosa McCulloch

Lagena auriglobosa McCulloch, 1977, Qualitative Observations on Recent Foraminiferal Tests With Emphasis on the Eastern Pacific, Univ. S. Calif., p.27, pl.61, fig.2.

Synoptic description: Test elongate oval, slightly inflated, circular crossection, widest in middle tapering to blunt apertural end, tapering slightly to base with a circular keel or 'ear' on each side of base of test; wall hyaline when wet, finely densely perforate, except circular area surrounding ears; aperture broken away.

Remarks: Identification based on one specimen.

46 Lagena catenula (Williamson)

Entosolenia squamosa Montague var. catenula Williamson, 1858 ,Rec. Foram. Great Britain, p.13, pl.1, fig.31. Lagena catenula Reuss, 1862, Sitz. Akad. Wiss., Wien, v.46, pt.1,(1863), p.332, pl.6, fig.74-75; Cushman, 1913, U.S. Nat. Mus. Bull. 71, pt.3, p.18, pl.7, fig.1,2.

Synoptic description: Test subglobose, short neck; wall partially hyaline with 8 vertical ribs and numerous upward arched horizontal costae; aperture terminal, rounded end of neck.

47 Lagena distoma Parker and Jones

Lagena distoma Parker and Jones MS., 1864 in Brady, H.B., Linn. Soc. London, Trans., 1864, v.24, pt.3, p.467, pl.48, fig.6; Loeblich and Tappan, 1953, Smith. Misc. Coll. V.121, n.7, p.63, pl.11, fig.25,26 (not fig.27).

Synoptic description: Test elongate, spindle shaped, cylindrical tube narrowing on one end to an elongate neck and on other to apical spine; wall hyaline with longitudinal striations, delicate; aperture terminal,open end of tube, rounded.

Remarks: Except for the striations this species is similiar to L. elongata (Ehrenberg) which has a cylindrical mid portion of the test that tapers near both ends.

48 Lagena elongata (Ehrenberg)

Miliola elongata Ehrenberg, 1844, K. Preuss. Akad. Wiss. Berlin, p.274 (no fig.)
Lagena elongata (Ehrenberg), Barker, 1960, Soc. Econ. Paleo. Min. Spec. Publ. 9, pl.56, fig.27-29.

Synoptic description: Test elongate, spindle shaped, mid portion cylindrical tapering on both ends to elongate neck; wall smooth, hyaline; aperture terminal, rounded end of neck.

Remarks: Ehrenberg gave no type figure and from his description L. elongata cannot be separated from L. gracillima. L. elongata above is interprited to be that species with a cylindrical mid portion tapering to elongate ends; whereas L. gracillima is interpreted to have one broadest mid point and then tapering to bothe ends.

49 Lagena foveolata Reuss var. paradoxa Sidebottom

Lagena foveolata Reuss var. paradoxa Sidebottom, 1912, Quekett, Micr. Club Jour., London, Ser.2, v.11(1910-12), n.70, p.395, pl.18, fig. 22-23.
Lagena paradoxa McCulloch, 1977, Qualitative Observations on Recent Foraminiferal Tests With Emphasis on the Eastern Pacific, Univ. S. Calif., p.41, pl.50, fig.34.

Synoptic description: Test elongate oval, basally either bluntly rounded or a short spine, aperturally tapering to a short cylindrical neck; wall 20-24 thin longitudinal ribs with either (?) vertical rows of pseudopunctate perforations within the rib or (?) vertical ribs tunnelled by horizontal perforations; aperture terminal, rounded end of neck.

Remarks: The disintigration (?/?) growth of this species removes the ribbing leaving a hispid or partially hispid test. This species is similar to L. sulcata Walker and Jacob var. striato-punctata Parker and Jones; however the latter has half as many as many ribs. L. striato-punctata var. caudata Halkyard, and L . vikensis Hessland may be variations of L. foveolata var. paradoxa.

50 Lagena gibbera Buckner

Lagena gibbera Buckner, 1940, K. Leop. Carol. Deutsch. Akad. Naturf., Abh. (Nova Acta), Halle, v.9, n.62, p.432, fig. 48-50; Barker, 1960, Soc. Econ. Paleo. Min. Spec. Publ.9, pl.57, fig. 8,9.

Synoptic description: Test subglobular sac with short cylindrical neck; wall coarsely hispid and more so on neck; aperture terminal, rounded end of neck.

51 Lagena gracilis Williamson

Lagena gracilis Williamson, 1848, Ann. Mag. Nat. Hist. London, ser.2, v.1, p. 13, fig.5; Enbysk, 1960, Distribution of Foraminifera in the Northeast Pacific, PhD. thesis, Univ. Wash., pl.7. fig.2.

Synoptic description: Test elongate oval with a short neck and basal spine; wall partially hyaline with 10-12 longitudinal ribs from base to neck; aperture terminal, rounded end of tube.

52 Lagena gracillima (Seguenza)

Amphorina gracillima Seguenza, 1862, Dei terreni Terziarii del distretto di Messina, Pt.2, Foram. Mon. Mio. Messina, p.51, pl.1, fig. 37.
Lagena gracillima (Seguenza) Barker, 1960, Soc. Econ. Paleo. Min. Spec. Publ.9, pl.56, fig. 21-22.

Synoptic description: Test elongate spindle shaped, broadest in the middle tapering to both ends with elongated base and neck; wall delicate hyaline and smooth; aperture terminal, rounded, open end of neck.

Remarks: L. gracillima is interpreted to have one short section of broadest mid portion then tapering to both ends, see L. elongata.

53 Lagena hispidula Cushman

Lagena hispidula Cushman, 1913, U.S. Nat. Mus. Bull 71, pt.3, pl.5, fig. 2,3; Barker, 1960, Soc. Econ. Paleo. Min. Spec. Publ.9, pl.56, fig.10-11.

Synoptic description: Test unilocular delicate globular sac with elongate neck; wall hyaline, very finely hispid; aperture terminal, rounded open end of nedk.

54 Lagena laevis (Montagu)

Vermiculum laeve Montagu, 1803, Testacea Britannica, J.S. Hollis, Romsey, Engl. (fig. from Walkera and Boys, 1784, Minute Shells, pl.1 fig.9).
Lagena laevis (Montagu), Cushman, 1913, U.S. Nat. Mus. Bull.71, pt.3, p.5, pl.1, fig.3, pl.38, fig.5; Enbysk, 1960, Distribution of Foraminifera in the Northeast Pacific, PhD. Thesis, Univ. Wash., pl.7, fig.3.

Synoptic description: Test unilocular, delicate, globular sac with elongate neck; wall partially hyaline and smooth, white colour; aperture teminal, rounded end of neck.

55 Lagena laevis (Montagu) var.

Lagena laevis (Montagu) variants, Barker,1960, Soc. Econ. Paleo. Min. Spec. Publ.9, pl.57, fig. 23.
Lagena (Oolina) striata (d'Orbigny) var. substriata Williamson, Cushman, 1913, (part) U.S. Nat. Mus. Bull. 71, pt.3, p.20, pl.8, fig. 2,3 (not fig. 1).

Synoptic description: Test unilocular, globular sac with very long slender neck; wall hyaline with fine longitudinal striations that spiral up neck; aperture terminal rounded end of neck.

56 Lagena meridionalis Wiesner

Lagena gracilis Williamson var. meridionalis Wiesner, 1931, Deut. Sud-polar Exped. 1901-1903, v.20 (Zool. v.12). p.117, pl.18, fig. 211.
Lagena meridionalis Wiesner, Loeblich and Tappan, 1953, Smith. Misc. Coll. v.121, n.7, p.62, pl.12, fig.1; Barker, 1960, Soc. Econ. Paleo. Min. Spec. Publ.9, p.119, pl.58, fig.19 (not fig.22,24).

Synoptic description: Test elongate oval with a short neck and basal spine; wall partially hyaline with 10-12 longitudinal ribs alternating ones extend onto neck; aperture terminal rounded end of tube.

57 Lagena mollis Cushman

Lagena (Amphorina) gracillima (Seguenza) var. mollis Cushman, 1944, Cush. Lab. Foram. Res. Spec. Publ.12, p.21, pl.3, fig.3.
Lagena mollis Cushman, Loeblich and Tappan, 1953 (part) Smith. Misc. Coll. v.121, n.7, p.63, pl.11, fig.27 (not fig. 25,26).

Synoptic description: Morphologically identical to L. gracillima except that it has numberous fine longitudinal striations. L. distoma Parker and Jones, is very similar except the test is cylindrical in the mid portion then tapering on both ends; L. mollis is broadest at one point tapering from that point to both ends.

58 Lagena nebulosa Cushman

Lagena (vermiculum) laevis (Montagu) var. nebulosa Cushman, 1923, U.S. Nat. Mus. Bull. 124, p.29, pl.5, fig. 4,5.
Lagena nebulosa Cushman, Barker, 1960, Soc. Econ. Paleo. Min. Spec. Publ.9, pl.56, fig. 12.

Synoptic description: Test unilocular, cylindrical sac with neck; wall frosted white colour, partially hyaline; aperture terminal, rounded end of neck.

59 Lagena stelligera Brady

Lagena stelligera Brady, 1881, Quat. J. Micr. Sci., London, n.s. v.21, p.60, pl.57, fig. 35,36; Cushman, 1913, U.S. Nat. Mus. Bull. 71 pt.3, p.26, pl.12, fig, 3.

Synoptic descritpion: Test very small unilocular, pyriform, flattened base with ring, aboral end has 9 costae extending 1/3 way up test; wall hyaline, smooth; aperture terminal, rounded, end of tube.

60 Lagena substriata Williamson

Lagena substriata Williamson, 1848, Ann. Mag. Nat. Hist., London, ser. 2, v.1, p.15, pl.2, fig.12.
Lagena (Oolina) striata (d'Orbigny) var. substriata Williamson, Cushman 1913 (part), U.S. Nat. Mus. Bull. 71, pt.3, p.20, pl.8, fig.1 (not fig.2,3).

Synoptic description: Test unilocular, elongate cylindrical sac, basally with bluntly rounded or with spine, apertural end with short nedk; wall partially hyaline with numerous (20-30) fine longitudinal ribs from base to neck; aperture terminal, rounded end of neck.

Remarks: Although morphologically similar to L. gracilis this species has finer and more numerous longitudinal striations.

61 Lagena sulcata (Walker and Jacob) var. apiculata Cushman

Lagina sulcata (Walker and Jacob) var, apiculata Cushman, 1913 (part), U.S.Nat. Mus. Bull. 71 pt.3, p.23, pl.9, fig. 3 (not fig. 4).
Lagena sulcata (Walker and Jacob) var. spicata Cushman and McCulloch, 1950, S. Calif. Univ. Publ. L.A., Allan Hancock Pac. Exped., v.6, n.6, p.360, pl.48, fig. 3-7.

Synoptic description: Test unilocular, globular chamber with basal spine and produced neck; wall partially hyaline with 15-16 longitudinal ribs on chamber not neck; aperture terminal, rounded end of neck.

62 Lagena sp. A

Synoptic description: Test unilicular elongate oval with a produced neck; wall partially hyaline, 10-12 longitudinal highly raised ribs running onto neck; aperture terminal, rounded end of neck.

63 Lagena sp.B

Lagena sp. nov.(1) Barker, 1960, Soc. Econ. Paleo. Min. Spec. Publ. 9, pl.57, fig.31.

Synoptic description: Test an elongate oval with circular crossection, the neck region has a distinct smooth cone narrowing to a short tube; wall is heavily ribbed (9-13), hyaline; aperture terminal, rounded end of neck.

64 Lagena? sp.C

Synoptic description: Test subspherical, compressed, apertural cone; wall hyaline when wet, finely densely perforate; aperture terminal elliptical, ? entosolenian tube through apertural cone.

Remarks: One specimen shows hint of entosolenian tube, which would therefore place the species in Oolina.

Genus: Lenticulina Lamarck, 1804

65 Lenticulina convergens (Bornemann)

Cristellaria convergens Bornemann,1855, Deut. Geol. Ges. Zeitschr., Bd. 7(2), p.327, pl.13, fig.16 (not 17); Cushman, 1913, U.S. Nat. Mus. Bull. 71 pt.3 p.68, pl.34, fig.3.
Lenticulina convergens (Bornemann), Barker, 1960, Soc. Econ. Paleo. Min. Spec. Publ.9, pl.69, fig. 6,7.

Synoptic description: Test lenticular, planispiral biumbonate, chambers triangular; wall smooth; aperture radiate, at top of apertural face.

66 Lenticulina sp.

?Cristellaria reniformis d'Orbigny, of Cushman, 1913(part), U.S. Nat. Mus. Bull. 71, pt.3, p.65, pl.30, fig.4 (not pl.33, fig.1).

Synoptic description: Test planispiral, biumbonate, chambers gradually increasing in size not uncoiling, peripheral keel, flush radial sutures; wall smooth, aperture radial at top of apertural face.

Remarks: This species compares with one of Cushmna's designations for C. reniformis but does not compare with his other nor with the original description of d'Orbigny where successive chambers gain rapidly in height.

Superfamily: Nodosariacea Ehrenberg, 1838

Family: Polymorphinidae d'Orbigny, 1839

Subfamily: Polymorphininae d'Orbigny, 1839

Genus: Polymorphina d'Orbigny, 1826

67 Polymorphina sp.

Polymorphinidae, formae fistulosae, Barker, 1960 (part), Soc. Econ. Paleo. Min. Spec. Publ.9, pl.73, fig.15.
?Polymorphina ovata d'Orbigny, fistulose form of Cushman, 1913, U.S. Nat. Mus. Bull. 71, pt.3, p.87, pl.40, fig.4.

Synoptic description: Test basally fusiform tapering to a point, aperturally fistulose; wall basally smooth and partially hyaline, sutures slightly excavated, aperturally hispid; aperture numerous slender necks with rounded openings.

Family: Glandulinidae Reuss, 1860

Subfamily: Glandulininae Reuss, 1860

Genus: Larynosigma Loeblich and Tappan, 1953

68 Laryngosigma cf. L. hyalascidia Loeblich and Tappan

Laryngosigma hyalascidia Loeblich and Tappan, 1953, Smith. Misc. Coll. v.121(7), pl.15, fig.6-8.
Pyrulina cylindroides (Roemer) of Barker, 1960, Soc. Econ. Paleo. Min. Spec. Publ. 9, pl.72, fig.6.

Synoptic description: Test elongate fusiform, biserial slightly twisting, strongly embracing chambers, sutures flush nearly vertical; wall smooth, hyaline, very finely perforate; aperture terminal, radiate with short curved entosolenian tube.

Remarks: This species closely resembles L. hyalascidia; however, sutures are more oblique in the latter.

Subfamily: Oolininae Loeblich and Tappan, 1961

Genus: Oolina d'Orbigny, 1839

69 Oolina borealis Loeblich and Tappan, 1961

Oolina borealis Loeblich and Tappan, 1954, Wash. Acad. Sci. J. v.44(12), p.384.
Oolina costata (Williamson) of Loeblich and Tappan, 1953, Smith. Misc. Coll. v.121(7), p.68, pl.13, fig.4-6. not (Williamson,1858)
Oolina elegantissima (Bornemann)? Barker, 1960, Soc. Econ. Paleo. Min. Spec. Publ.9, pl.57, fig.32.
Lagena acuticosta Reuss, of Cushman, 1913, U.S. Nat. Mus. Bull.71, pt.3, p.23, pl.8, fig.9 (not pl.8, fig. 10, pl.23, fig.2).

Synoptic description: Test small, subsphaerical, unilocular; wall with 10 longitudinal costae forming ring on base and joining to form smooth collar apically before short neck; aperture terminal, rounded, end of short neck.

Remarks: The taxonomy of this species is most confused; O. costata Williamson, Ovulina elegantissima Bornemann and Lagena acuticosta Reuss are (a ?) species in which the costae rise up to the base of the neck and are described as having no smooth collar just before the neck begins, as in this species.

70 Oolina cf. O. Botelliformis (Brady)

Lagena botelliformis Brady, 1881, Quat. J. Micr. Sci. London, n.s. v.21, p.60, (fig. in Brady, 1884 Rept. Voy. Challenger, Zool. v.9, pl.56, fig.6)
Oolina botelliformis (Brady) of Barker, 1960, Soc. Econ. Paleo. Min. Spec. Publ.9, p.114, pl.56, fig.6.

Synoptic description: Test small, unilocular arcuate, cylindrical elongate chamber; wall hyaline, finely porous; aperture rounded at tip of short terminal constriction.

Remarks: The morphology is the same as Brady's figured specimen but is one half the size.

71 Oolina desmophora (Jones)

Lagena vulgaris Williamson var. desmophora Jones, 1874, Trans. Linn. Soc. v.30, pl.19, fig. 23,24.
Lagena desmophora Rymer-Jones of Cushman, 1913, US. Nat. Mus. Bull. 71, pt.3, pl.13, fig.3.
Oolina desmophora (Rymer-Jones) of Barker, 1960, Soc. Econ. Paleo. Min. Spec. Publ.9, pl.58, fig.42,43.

Synoptic description: Test subglobular, elongate neck; wall partially hyaline obscurred by 8 prominent raised ribs alternating with lower costae, a row of elliptical shaped pores down each raised rib; aperture terminal, rounded open end of neck.

72 Oolina globosa (Montagu)

Vermiculum globosum Montagu, 1803, Testacae Britannica, p.523, (fig from Walker and Boys, 1784, Minute Shells pl.1, fig.8.)
Lagena globosa (Montagu) Cushman, 1913, U.S. Nat. Mus. Bull.71, pt.3, p.3, pl.4, fig.2.
Oolina globosa (Montagu) Barker, 1960, Soc. Econ. Paleo. Min. Spec. Publ.9, pl.56, fig.1-3.

Synoptic description: Test unilocular globular chamber, basally may have spine; wall hyaline (or partially hyaline), smooth; aperture stellate or a fissure.

Remarks: There seem to be several nonspecific varieties: a) perfectly spherical chamber (b) slightly oval chamber (c) rounded, stellate or fissured aperture.

73 Oolina globosa (Montagu) setosa (Earland)

Lagena globosa (Montagu) var. setosa Earland, 1934, Discovery Repts. Cambridge, v.10, (1935), p.150, pl.6, fig.52.
Oolina globosa(Montagu) setosa Earland, Enbysk B.J., 1960 Distribtion of Foraminifera in the Northeast Pacific, PhD. thesis, Univ. Wash., pl.8, fig.7.
Oolina globosa (Montagu) setosa (Earland), Barker, 1960, Soc. Econ. Paleo. Min. Spec. Publ.9, pl.56, fig.33-35.

Synoptic description: Test unilocular, globose with 4 basal spines; wall hyaline, densely and finely perforate; aperture terminal, rounded opening, short, central straight entosolenian tube which curves and attaches to wall.

74 Oolina hexagona (Williamson)

Entosolenia squamosa (Montagu) var. hexagona Williamson, 1848, Ann. Mag. Nat. Hist., London, ser.2, v.1, p.20, pl.2, fig.23
Oolina hexagona (Willaimson), Loeblich and Tappan, 1953, Smith. Misc. Coll. v.121, n.7, p.69, pl.14, fig.1,2.

Synoptic description: Test unilocular, globular sac, apical end bluntly rounded apertural end tapering to short neck; wall covered by hexagonal depressions not aligned in rows; aperture terminal, rounded end of neck.

Remarks: Distinguished from O. melo by the latter having the hexagonal areas aligned in rows.

75 Oolina lineata (Williamson)? of authors

?Entosolenia lineata Williamson, 1848, Ann. Mag. Nat. Hist. London, ser.2, v.1, p.18, pl.2, fig.18.
Oolina lineata (Williamson) Loeblich and Tappan, 1953, Smith. Misc. Coll. v.121(7), p.70, pl.13, fig.11-13; Barker, 1960, Soc. Econ. Min. Paleo. Spec. Publ.9, p.118, pl.57, fig.13.

Synoptic description: Test small, unilocular, globular; wall hyaline, numerous very fine longitudinal striations; aperture rounded with short straight, central entosolenian tube.

Remarks: This species compares with Barker's and Loeblich and Tappan's figures; however, Williamson's figure shows a distinctly oval form. It is possible that the species varies from globular to ovoid.

76 Oolina melo d'Orbigny

Oolina melo d'Orbigny, 1839, Voyage dans l'Amerique Meridional, Foraminifera, Strasbourg, Levrault, t.5, pt.5, p.20, pl.5, fig.9; Loeblich and Tappan, 1953, Smith. Misc. Coll. v.121, n.7, p.71, pl.12, fig.8-15; Todd and Low, 1967, U.S.G.S. Prof. Paper 573A, p.29, pl.3, fig.27.

Synoptic description: Test pear shaped, rounded apically, short neck, circular crossection; wall partially hyaline when wet, longitudinal rows (20) of hexagonal depressions; aperture terminal, rounded end of tube.

77 Oolina cf. O. scalariformis-sulcata (Wiesner)

Lagena (Entosolenia) scalariforme-sulcata Wiesner, 1931, Deut. Sud. Polar Exped. 1901-1903, Bd.20(Zool.Bd.12), p.120, pl.18, fig.219.
Oolina scalariformis-sulcata (Wiesner), Loeblich and Tappan, 1953, Smith. Misc. Coll. v.121, n.7, p.72, pl.13, fig.7.

Synoptic description: Test subglobose, flattened base, tapers apically to short thin neck tube; wall with seven heavy costae at shoulder becoming irregular reticulations; aperture terminal, rounded end of tube.

Remarks: This species differs from O. scalariforme-sulcata in having hexagonal reticulations from the shoulder not the midline upward.

78 Oolina seminuda (Brady)

Lagena seminuda Brady, 1884, Report Foram. Challenger EXped., Zool. pt.22, v.9, p.472, pl.58,fig.34.
Oolina seminuda (Brady), Barker, 1960, Soc. Econ. Paleo. Min. Spec. Publ.9, pl.58, fig.34.

Synoptic description: Test subglobular, basal half covered by hexagonal costae; wall opaque basally upper half hyaline, smooth; aperture subterminal in cup like depression, rounded, short, central entosolenian tube.

79 Oolina striatopunctata (Parker and Jones) var. tricosta (Cushman and Gray)

Lagena striato-punctata Parker and Jones var. tricosta Cushman and Gray, 1946, Cush. Lab. Foram. Res. Spec. Publ.19, p.21, pl.4, fig.5.

Synoptic description: Test unilocular, elongate oval with short neck, circular crossection; wall partially hyaline with longitudinal rows of fine ribs and a triangulate arrangement of longitudinal rows of raised tubular pores; aperture terminal, rounded end of neck.

80 Oolina sp. A

Synoptic description: Test unilocular, elongate oval with short neck, circular crossection; wall partially hyaline with longitudinal rows of fine ribs and two longitudinal rows 180° apart of raised tubular poress; aperture terminal, rounded end of neck.

Remarks: This species is similiar to O. striato-punctata tricostata but has only 2 instead of 3 rows of raised tubulations.

81 Oolina sp.B

?Miliola ovum Ehrenberg, 1843, K. Preuss. Akad., Wiss.,p.166.
?Lagena ovum Cushman, 1913, U.S. Nat. Mus. Bull. 71, pt.3, p.5, pl.2. fig.2.

Synoptic description: Test elongate, cylindrical, circular crossection, basal end bluntly pointed, apertural end blunt and slightly depressed; wall hyaline, thin; aperture terminal, round, in centre of slight depression.

Remarks: This specimen resembles O. ovum (Ehrenberg); however his description is vague and has no figure. O. ovum of Cushman is twice as large.

82 Oolina sp.C

Synoptic description: Test elongate oval, circular crossection, bluntly rounded basally , tapering to cone at apertural end; wall partially hyaline, 8 longitudinal ribs with rectangular to hexagonal depressions, some specimens with depressions only on top half, top cone without ribbing; aperture terminal, rounded.

Remarks: This species most closely resembles O. squamosa-sulcata (Heron-Allen and Earland); however, that species shows a more globose test and nocone about the aperture.

83 Oolina sp. D

Synoptic description: Test tear-drop shaped, widest just below the middle tapering to a blunt base and also tapering up to an apertural cone; wall hyaline, 12 longitudinal costae; aperture rounded end of nonribbed cone, short, straight, central entosolenian tube.

Remarks: This species is virtually identical to Lagena sp.B but the latter lacks an entosolenian tube.

84 Oolina sp. E

Synoptic description: Test subglobular, circular crossection, widest near base tapering to thin apertural cone; wall thin opaque; aperture terminal rounded end of apertural cone.

85 Oolina sp. F

Synoptic description: Test pyriform, broadest basally with central short spine, slowly evenly tapering to apertural end; wall partially hyaline, densely perforate; aperture terminal, small rounded opening in end of test, short, straight, central, entosolenian tube.

86 Oolina sp. G

Synoptic description: Test unilocular pear shaped, some tests irregularly arched; wall smooth finely perforate; aperture terminal oval.

87 Oolina sp. H

Synoptic description: Test unilocular very elongate oval, broadest near base tapering near aperture; wall partially hyaline, smooth; aperture terminal oval slit; entosolenian tube half length of test.

88 Oolina sp. I

Synoptic description: Test unilocular, very elongate oval, broadest near base tapering to blunt apertural end, a few specimens have a basal spine; wall hyaline, when wetted opaque horseshoe around each side of basal end; aperture terminal, rounded, short straight entosolenian tube.

89 Oolina sp. J

Synoptic description: Test unilocular, culindrical, rounded base with trace of central spine, apertural end slightly produced; wall opaque, smooth; aperture terminal, rounded , radiate, short entosolenian tube 1/3 test length at end attached to wall.

Genus: Fissurina Reuss, 1850

90 Fissurina cf. F. alveata McCulloch

Fissurina alveata McCulloch, 1977, Qualitative Observations on Recent Foraminiferal Tests With Emphasis on the Eastern Pacific, Univ. S. Calif., p.90, pl.56, fig.21.

Synoptic description: Test compressed oval with a flatly truncated apertural end; wall opaque, two basal 'auricles' or ears which are shallow in height; aperture terminal , elongate narrow, oval slit.

91 Fissurina alveolata Brady

Lagena alveolata Brady, 1884, Rep. Voy. Challenger Exped., Zool., v.9, pl.60, fig.30,32; Cushman, 1913, U.S. Nat. Mus. Bull. 71, pt.3, p.33, pl.18, fig.1.
Fissurina alveolata (Brady), Barker, 1960, Soc. Econ. Paleo. Min. Spec. Publ.9, pl.60, fig.30,32.

Synoptic description: Test pyriform, apertural end produced or hood-like, basally three carina, middle one most pronounced outer two joining with middle carina centrally, this produces two lateral loops; wall partially hyaline, finely densely perforate; aperture elongate, terminal slit.

92 Fissurina apiculata (Reuss) var. punctulata (Sidebottom)

Fissurina apiculata (Reuss) var. punctulata Sidebottom, 1912, Quekett. Micr. Club. J., London, ser.2, v. 11 (1910-1912), n.70, p.382, pl.14, fig.21-23; McCulloch, 1977 Qualitative Observations on Recent Foraminiferal Tests With Emphasis on the Eastern Pacific, Univ. S. Calif., p.90, pl.68, fig.15.

Synoptic description: Test elongate oval, widest at middle tapering basally to short spine and aperturally to two lips; wall hyaline, thin, few coarse puncta; aperture terminal slit between two lips of equal height.

93 Fissurina cf. F. kerguelenensis Parr

Fissurina kerguelenensis Parr, 1950, Repts. BANZ Antarct. Res. Exped. 1929-31, ser.B, v.5, pt.6, p.305, pl.8, fig.7. Barker, 1960, Soc. Econ. Paleo. Min. Spec. Publ.9, p.122, pl.59, fig.8-11.

Synoptic description: Test small, compressed sphere, slight keel with 4 basal spines; wall hyaline, smooth; aperture terminal slit, short entosolenian tube.

Remarks: F. kerguelenensis Parr has a more arcuate neck is twaice as large and has a longer entosolenian tube.

94 Fissurina cf. F. lucida (Williamson) of authors

?Entosolenia marginata (Montagu) var. lucida Williamson, 1848, Ann. Mag. Nat. Hist., ser.2, v.1, p.17, pl.2, fig.17.
Fissurina lucida (Williamson), Loeblich and Tappan, 1953, Smith. Misc. Coll. v.121, n.7, p.76, pl.14, fig.4.

Synoptic description: Test subspherical with slight convex apertural arch, compressed, two to three short basal spines, very slight rounded peripheral keel; wall opaque, densely perforate in two broad bands inside lateral margins, peripheral band partially hyaline; aperture a slit in the terminal arch.

Remarks: The equating of this species to Entosolenia marginata (Montagu) var. lucida Williamson is queried because the latter is more elongate and is figured as having a short neck surrounded by a hyaline keel. This species closely resembles F. lucida of Loeblich and Tappan but the former has basal spines and an opaque test.

95 Fissurina? marginata (Montagu)

Vermiculum marginatum Montagu, 1803, Testacea Britannica, J.S. Hollis, Romsey, Engl., p.524, (fig. from Walker and Boys, 1784, Minute Shells, pl.1, fig.7)
Fissurina marginata (Montagu), Loeblich and Tappan, 1953, Smith. Misc. Coll. v.121, n.7, p.77, pl.14, fig.6,7,9; Enbysk, 1960, Distribution of Foraminifera in the Northeast Pacific, PhD. thesis, Univ. Wash., pl.9, fig.2. Vilks, 1969, Micropaleo. v.15, p.48, pl.2, fig.24.

Synoptic description: Test spherical to ovate, compressed, slight hood; wall thin hyaline, highly; perforate except for peripherial band; aperture subterminal crescentic slit in hood, entosolenian tube length of test attached to wall.

Remarks: This species has a wide range of form varying from subspherical to oval; has various degrees of compression, some individuals have a full well developed keel. Numerous individuals have inequal lips and it is queried whether this species should be placed with Parafissurina.

96 Fissurina orbignyana Seguenza

Fissurina orbignyana Seguenza, 1862 Foram. Monotal. Mioc. Messina, p.66, pl.2, fig. 25,26; Cushman, 1913, U.S. Nat. Mus. Bull. 71, pt.3, p.42, pl.19, fig.1; Barker, 1960, Soc. Econ. Paleo. Min. Spec. Publ.9, pl.124, p.59, fig. 26.
Lagenosolenia bradyiformata McCulloch, 1977, Qualitative Observations on Recent Foraminiferal Tests With Emphasis on the Eastern Pacific, Univ. S. Calif., p.53, pl.61, fig.15.

Synoptic description: Test oval, compressed, 3 keels with middle keel widest, outer two keels low and blendig with broad neck at the top middle, neck short and stout; wall heavy, opaque, imperforate; aperture terminal rounded end of neck, short central entosolenian tube.

Remarks: Seguenza's figure, although tricarinate, does not correspond well with what later authors have placed in this genus. The specimens of this study lack the width of the middle keel and have a shorter neck than Cushman's and Barker's figures. Lagenosolenia bradyiformata McCulloch may be the same species. Fissurina sp. C with the neck enclosed by a hood, may belong withih this species, being a later ontogenetic stage.

97 Fissurina radiata Seguenza

Fissurina radiata Seguenza, 1862, Dei terrent Terziarii del distretto di Messina, pt.2, Messina, p.70, pl.2, fig.42,43.
Lagena sublagenoides Cushman, 1913, U.S. Nat. Mus. Bull. 71, pt.3, p.40, pl.16, fig.4.

Synoptic description: Test flask shaped slightly compressed neck about 1/4 of test, peripheral keel, basal spine (with tubular perforations) blending into keel; wall hyaline, finely perforated, keel with tubular perforations; aperture terminal, rounded end of neck, entosolenian tube central,short.

98 Fissurina seguenziana (Fornasini)

Lagena seguenziana Fornasini, 1886, Soc. Geol. Ital., Boll. Roma, v.5, p.351, pl.8, fig.1-8.

Fissurina seguenziana (Fornasini) Barker, 1960, Soc. Econ. Paleo. Min. Spec. Publ.9, p.122, pl.59, fig.1.

Synoptic description: Test oval, compressed, one broad keel from which a short neck extends; wall opaque, smooth, white colour; aperture terminal, rounded end of neck.

Remarks: This species resembles F.orbignyana except for the 3 keels of the latter.

99 Fissurina cf. F. spinulata McCulloch

Fissurina spinulata McCulloch, 1977 Qualitative Observations on Recent Foraminiferal Tests With Emphasis on the Eastern Pacific, Univ. S.Calif., p.131, pl.59, fig. 10-12.

Synoptic description: Test small, compressed oval, two short laterobasal spines, apical end with hood; wall hyaline except for 4 longitudinal narrow opaque bands at lateral margins and opaque lip like features in the hood; aperture long terminal, narrow slit along hood.

Remarks: This species compares with F. spinulata except for the latter being one half as large and reported from warm shallow water.

100 Fissurina sp. A

Synoptic description: Test compressed oval or elongate oval with short neck; wall thin, delicate, hyaline, numerous coarse, evenly spaced perforation, snooth, imperforate phlange or keel down about neck and forming very slight keel on top 1/3 of test; aperture terminal, rounded end of nedk, phialine lip, entosolenian tube central, straight, about 1/3 length of test.

Remarks: This specimen closely resembles Lagenosolenia asubtilis McCulloch except the latter species has more marginally placed pores and is nearly twice the size. subtilis Buchner is more oval and also has more marginal perforations.

101 Fissurina sp. B

Synoptic description: Test tear drop shaped chamber, slightly compressed, no keel, indentation at neck before lip, hint of basal spine; wall hyaline, numerous fine

evenly spaced perforations; aperture terminal rounded end short stout neck with phialine lip, long straight central entosolenian tube 3/4 test length where attaches to wall.

Remarks: Fissurina sp. A is similar but this species is larger, less compressed and has a shorter neck with no keel. F. omniperforata McCulloch, is similar but has a narrow marginal hyaline area and a short entosolenian tube.

102 Fissurina sp. C

?Lagena palliolata Earland, 1934, Foram. Pt.3, Falkland Is. Sedt. of Antarctic Discovery Reports, v.10, (1935), p.158, pl.7, fig. 5,6.

Synoptic description: Test oval, inflated with long slender neck 1/3 length of test, neck enclosed in thick hyaline extension of the three basal keels which fuse at the neck to form a hood; wall finely, densely perforate, keels imperforate hyaline, colour glossy white; aperture rounded end of neck.

Remarks: L. palliolata is quite similar, lacking only the more complete development of the outer keels and is half the size. There is a resemblance to F. orbignyana Seguenza but the later is more inflated has a shorter neck and less developed keels. The specimens of this study ma be a late? ontogenetic stage of F. orbignyana.

103 Fissurina sp. D

Synoptic description: Test subspherical, compressed, sight peripheral keel on the lower half of the test with about 6 costae between the keels; wall hyaline when wet, finely perforate, smooth, imperforate keel, opaque arch around aperture; aperture terminal short slit, entosolenian tube length of test attached to wall.

104 Fissurina sp. E

Synoptic description: Test spherical, compressed, short thin neck with very wide keel which divides laterally to form 2 keels joining again at the base; wall hyaline when wet, visible entosolenian tube.

105 ?Fissurina sp. F

Synoptic description: Test subglobular, assymetrical, three 'ears' or flaps trigonally arranged; wall half hyaline half opaque, smooth; aperture?, a short slit at base of an ear?

Remarks: Three specimens which may be abnormal or deformed individuals.

106 *Fissurina* sp. G

Synoptic description: Test spherical, compressed, arcuate neck or hood, oval crossection, short basal spine; wall partially hyaline, four lateral arched opaque bands,; aperture terminal, long thin slit in middle of hood where entosolenian tube drops downward between two liplike features.

Remarks: This species is similar to F. *nudiformis* McCulloch except the latter has thinner opaque lateral bands and a less pronounced basal spine.

107 *Fissurina* sp. H

Synoptic description: Test elongate oval, compressed, neck or hood, lateral mid to basal keel, blunted basal spine; wall hyaline when wet, finely and densely perforate, numerous striations in broad curve around base; aperture terminal, oval slit in hood.

108 *Fissurina* sp. I

Synoptic description: Test elongate oval, compressed, tubular short neck, slight keel about neck and test; wall densely perforate, colour white; aperture terminal, rounded end of neck, some have phialine lip.

Remarks: *Fissurina* sp. I has a keel around the entire test whereas in F. sp. A the keel is on the upper 1/3 of the test. *Lagenosolenia asubtilis* McCulloch is similar but more compressed and has laterally placed pores.

109 *Fissurina* sp. J

Synoptic description: Test flask shaped with tubular neck, keel well developed about neck and base but less so centrally; wall hyaline centrally, dense fine perforations around basal and lateral edges, keel hyaline, imperforate; aperture terminal rounded end of neck, phialine lip.

Remarks: F. sp. J resembles F. sp. P but is more elongate, has a longer neck and has a hyaline keel (without striations) about the neck.

110 *Fissurina* sp. L

Synoptic description: Test flask shaped, compressed, elongate tubular neck, short basal spine; wall smooth opaque and highly perforate except for hyaline peripheral band; aperture terminal, oval end of tube, phialine lip.

Remarks: This species has the same morphological outline as *Lagena marginata* (Montagu) var. *spinifera* Earland however the latter has a distinct keel.

111 Fissurina sp. N

Synoptic description: Test bell shaped inflated nearly circular crossection, basal keel or 'skirt'; wall hyaline when wet, smooth, imperforate or very finely perforate, basal keel very thin, hyaline; aperture terminal, oval with entosolenian tube which twists near aperture then attaches to test near keel.

Remarks: This species lacks the tubulations in the keel of Lagena fimbriata Brady. L. fimbriata polita Chapman and Parr is figured with tubulations in the keel but this is negated in the description. F. affimbriata McCulloch is closely similar but coarsely perforate and from equatorial, shallow water.

112 Fissurina sp. O

Synoptic description: Test inflated bell shaped, basal keel of skirt, circular crossection, short stout neck region; wall partially hyaline, thin; aperture, terminal, oval, in produced neck.

Remarks: This species is similar to Fissurina sp. N but differs by having a distinct, stout neck region. It also lacks the tubular perforations in the keel.

113 Fissurina sp. P

Synoptic description: Test flask shaped, compressed, surrounded by single peripheral keel; wall opaque, smooth, densely perforate, colour white, keel hyaline with (tubular?) striations in neck portion; aperture terminal, rounded end of nedk, phialine lip.

Remarks: This species closely resembles Lagenosolenia fumosa McCulloch but the latter lacks the striations in the neck keel.

114 Fissurina sp. Q.

Synoptic description: Test subcircular, compressed, keel shoulder to shoulder, arched apertural region; wall densely perforate except for a hyaline band on each side of keel which is also hyaline; aperture terminal slit between arched lips.

Remarks: This species may be a late ontogenetic form of F. marginata which has developed a full keel.

115 Fissurina sp. R

Synoptic description: Test subcircular, basal cross formed by a short keel perpendicular to prominant lateral

keel, the lateral keels form a spine on the outer edge and extend 1/2 way up test, apertural end arched; wall hyaline when wet, densely and evenly perforate, keels hyaline, delicate; aperture subterminal slit between two lips of slightly different height.

Remarks: Lagena staphyllearia (Schwager) var. quadricarinata Sidebottom, is similar but has numerous central basal spines and no apertural lips. Fissurina spinosiformis McCulloch is similar but has noncarinate spines and opaque lateral banding.

116 Fissurina sp. S

Synoptic description: Test subcircular, compressed, trimarginate shoulder basal keels, apertural end arched, lower 1/3 test 6-7 costae between keels; wall opaque; aperture terminal slit between two equal lips, short, central, straight entosolenian tube.

117 Fissurina sp. T

Synoptic description: Test very small subcircular, compressed, slight keel, very slightly arched apertural end; wall hyaline, numerous thin longitudinal ribs; aperture elongate oval slit, short straight, central entosolenian tube.

118 Fissurina sp. U

Synoptic description: Test subcircular, compressed, arched apertural lips, two narrow elliptical basal keels or 'ears' on each side of the base of the test; wall hyaline, finely perforate; aperture terminal elongate oval between two equal apertural lips, entosolenian tube length of test attached to wall.

119 Fissurina sp. V

Synoptic description: Test small, compressed oval, slightly assymetrical; wall hyaline smooth; aperture terminal slit, short entosolenian tube.

Remarks: Identification is based on one specimen which may be abherrent (assymetry). Fissurina elamellata McCulloch is similar but more compressed with a narrow opaque peripheral band.

120 Fissurina sp. X

Synoptic description: Test teardrop shaped with pointed apertural end, widest near base, slightly compressed; wall hyaline when wet, finely densely perforate; aperture terminal, thin slit between two pointed equal lips, entosolenian tube short, central straight.

Genus: Parafissurina Parr, 1947

121 Parafissurina kerguelenensis (Parr)

Fissurina kerguelenensis Parr, 1950, Repts. BANZ Antarctic Exped. ser.B, v.5, p.305, pl.8, fig.7; Barker, 1960, Soc. Econ. Paleo. Min. Spec. Publ.9, pl.59, fig.8-10. Parafissurina arctica Green, 1960, Micropaleo.,v.6, p.70, pl.1, fig.2a,b.; Vilks, 1969, Micropaleo., v.15, p.48, pl.2, fig.30.; Lagoe, 1977, J. Foram. Res. v.7, p.122, pl.3, fig.15 (text fig.7).

Synoptic description: Test small, compressed sphere with arcuate apertural neck or hood, four basal spines; wall hyaline, finely perforate; aperture subterminal slit between two lips.

Remarks: Several times smaller than Parr's or Green's specimens. Parr noted that in one specimen the lips were of unequal height and would place the specimen in Parafissurina except for the numerous specimens of equal lips. This writer suggests that the lip height may vary with ontogeny from no lips (early ontogeny? see Fissurina cf. F. kerguelensis, this paper) to equal lips, (F. kergurlenensis of Brady, of Parr, and of Barker), to unequal lips (P. arctica of Green, of Vilks, and of Lagoe).

122 Parafissurina biconicoformis McCulloch

Parafissurina biconicoformis McCulloch, 1977 Qualitative Observations on Recent Foraminiferal Tests With Emphasis on the Eastern Pacific, Univ. S. Calif., p.140, pl.71, fig.19.

Synoptic description: Test broadly oval, biconvex, thin broad central keel with a shorter broader keel to each side, hood; wall hyaline when wet, densely perforate, wider keel hyaline, imperforate; aperture subterminal slit at base of short hood.

123 Parafissurina fusuliformis Loeblich and Tappan

Parafissurina fusuliformis Loeblich and Tappan, 1953, Smith. Misc. Coll. v.121, n.7, p.79, pl.14, fig.18,19; Lagoe,1977, J. Foram. Res. v.7(2), p.122, pl.3, fig.7.

Synoptic description: Test elongate, fusiform, subrounded base, arcuate tapering arched aperture; wall hyaline, finely densely perforate; aperture subterminal rounded opening below upper lip, entosolenian tube 1/2 test length fastened to aboral wall.

124 Parafissurina lateralis (Cushman)

Lagena lateralis Cushman, 1913, U.S. Nat. Mus. Bull. 71, pt.3, p.p.9, pl.1, fig.1.
Parafissurina lateralis (Cushman), Barker, 1960, Soc. Econ. Paleo. Min. Spec. Publ.9, p.116, pl.56, fig.17,18.

Synoptic description: Test elongate oval, compressed, basally blunt, some with short spine, hood; wall hyaline, densely perforate except for band around margin; aperture subterminal, slit at base of hood, entosolenian tube one half length of test, attached to wall and flaring at end.

125 Parafissurina cf. P. neocurta McCulloch

Parafissurina neocurta McCulloch, 1977, Qualitative Observations on Recent Foraminiferal Tests With Emphasis on the Eastern Pacific, Univ. S. Calif., p.151, pl.70, fig.22.

Synoptic description: Test globose with hooded aperture; wall hyaline, densely perforate except hood and a thin area surroundong it; aperture subterminal semicircular opening between upper and lower lips, long entosolenian tube, enlarged at end where fastens to aboral wall.

Remarks: This species is more globular than P. neocurta and has uniformily distributed pores.

126 Parafissurina sp. A

Synoptic description: Test elongate oval, compressed, widest at bottom, basal spine, lower lateral and basal keel, slight hood; wall thin hyaline, finely and densely perforate; aperture subterminal at base of hood, entosolenian tube length of test attached to wall.

Remarks: Similar to P. tectulostoma Loeblich and Tappan except the latter lacks the basal-lateral keel and is not laterally compressed.

127 Parafissurina sp. B

Synoptic description: Test cylindrical rounded base, slight hood, compressed; wall thin hyaline, finely densely perforate except for nonperforate band around periphery; aperture subterminal slit at base of hood, entosolenian tube central straight 1/4 length of test.

128 Parafissurina sp. C

Synoptic description: Test elongate oval, compressed, slight hood; wall thin, hyaline densely and finely perforate; aperture subterminal, slit at base of hood, entosolenian tube length of test attached to wall.

Remarks: Very similar to Parafissurina sp. B except this species is more oval, less compressed and has a very long entosolenian tube.

129 Parafissurina sp. F

Synoptic description: test elongate oval, widest near base then tapering to blunt base, apertural end tapers to short hood; wall hyaline, thin, finely perforate; aperture subterminal arch at base of hood, entosolenian tube 1/2 test length attached to aboral wall.

Superfamily: Buliminacea Jones 1875

Family: Turrilinidae Cushman, 1927

Subfamily: Turrilininae Cushman, 1927

Genus: Buliminella Cushman, 1911

130 Buliminella elegantissima (d'Orbighy)

Bulimina elegantissima d'Orbigny, 1839, Voyage dans l'Amerique Meridionale; Foraminiferes, Strasbourg, Levrault, t.5, pt.5, p.51.
Buliminella elegantissima (d'Orbigny), Barker, 1960, Soc. Econ. Paleo. Min. Spec. Publ.9, pl.50, fig.20,21; Uchio, 1960, Cush. Fd. Foram. Res. Spec. Publ.5, pl.6, fig.2.

Synoptic description: Test elongate oval, two convolutions, chambers long, very low forming tight coil about vertical axis; wall smooth, partially hyalne, finely and densely perforate; aperture curved slit along base of apertural face.

Superfamily: Buliminacea Jones,1875

Family: Sphaeroidinidae Cushman, 1927

Genus: Sphaeroidina d'Orbigny, 1826

131 Sphaeroidina bulloides d'Orbigny
Pl.3 figs.1,2

Sphaeroidina bulloides d'Orbigny, 1826, Ann. Sci. Nat. v.7, n.1, modeles n.65; Barker, 1960, Soc. Econ. Paleo. Min. Spec. Publ.9, pl.84, fig.1-5.

Synoptic description: Test subglobular, strongly embracing hemispherical chambers, spiral coiling, last 3 chambers visible; wall smooth, finely perforate, white colour; aperture crescentic slit above junction of 3 chambers, with broad simple tooth plate.

Family: Bolivinitidae Cushman, 1927

Genus: Brizalina Costa, 1856

132 Brizalina (Bolivina, of authors) pacifica Cushman and McCulloch
Pl.4 figs.6,7

Bolivina acerosa Cushman var. pacifica Cushman and McCulloch, 1942, Publ. Univ. S. Calif., Allan Hancock Pac. Exped., v.6, n.4, p.185.
Bolivina pacifica Cushman and McCulloch, Uchio, 1960, Cush. Fd. Foram. Res. Spec. Publ.5, pl.7, fig.2.
Bolivina pseudopunctata Hoglund, 1947, Foram. in the Gullmar Fjord and the Skagerak, Uppsala, Univ. Zool. Bidrag. Bd.26, p.273.
?Bolivina seminuda Cushman, 1911, U.S. Nat. Mus. Bull. 71, pt.2, p.34, fig.55.
?Bolivina spinescensiformis McCulloch, 1977, Qualitative Observations on Recent Foraminiferal Tests With Emphasis on the Eastern Pacific, Univ. S. Calif., p.259, pl.105, fig.21.

Synoptic description: Test elongate tapering basally biserial with strongly overlapping chambers, oval in crossection; wall hyaline, smooth imperforate in upper portion of chamber, finely perforate in lower half of chamber; aperture slit up face with tooth plate.

133 Brizalina (Bolivina, of authors) peirsonae Uchio

Bolivina peirsonae Uchio, 1960, Cush. Fd. Foram. Res. Spec. Publ.5, p.63, pl.7, fig.3,4.
?Bolivina semiclara McCulloch, 1977, Qualitative Observations on Recent Foraminiferal Tests With Emphasis on the Eastern Pacific, Univ. S. Calif., pl.105, fig.13.

Synoptic description: Test small biserial tapering, chambers inflated and rounded in cross-section, chambers serrate with basal lateral spine, sutures depressed; wall hyaline, finely densely perforate; aperture low arch medilly at base of last chamber face.

134 Brizalina subdepressa (Brady)

Virgulina subdepressa Brady, 1884, Rep. Voy. Challenger Exped., Zool., v.9, pl.52, fig.14-17.

Synoptic description: Test elongate subcylindrical, biserial alternating chambers, periphery smooth, sutures flush, indistinct; wall smooth, densely finely perforate; aperture, broad loop up apertural face.

135 *Brizalina* sp.
Pl.5 figs.10,11

Bolivina sp., Enbysk, 1960, Distribution of Foraminifera in the Northeast Pacific, PhD. Thesis, Univ. Wash., pl.11, fig. 7.

Synoptic description: Test elongate, tapering, compressed, biserial arrangement of overlaping chambers; wall calcareous, sutures limbate with costa creating criss-cross effect; aperture, slit up apertural face with tooth plate.

Remarks: The species always appeats roughened, see SEM photograph.

Family: Islandiellidae Loeblich and Tappan, 1964

Genus: Cassidulinoides Cushman, 1927

136 *Cassidulinoides tenuis* Phleger and Parker

Cassidulinoides tenuis Phleger and Parker, 1951, Geol. Soc. Am. Mem. 46, pt.2, p.27, pl.14, fig.14-17.

Synoptic description: Test elongate subcylindrical, early portion subglobular and coiled, later uncoiling, biserial alternating chambers, sutures distinct, flush; wall smooth, finely perforate; aperture broad loop up apertural face.

Remarks: Phleger and Parker considered this form Late Pleistocene or Recent (transition fauna). It was found with late Pleistocene cold water faunas in the lower parts of cores (Gulf of Mex.) but not in recent bottom samples. The same type of occurrence is noted in this study (Table 6).

Family: Buliminidae Jones, 1875

Subfamily: Bulimininae Jones, 1875

Genus: Bulimina d'Orbigny, 1826

137 Bulimina barbata Cushman

Bulimina barbata Cushman, 1927, Scripps Inst. Ocean. Tech. Ser. v.1, p.151, pl.2, fig.11; Enbysk, 1960, Distribution of Foraminifera in the Northeast Pacific, PhD. thesis, Univ. Wash., pl.11, fig. 8,9; Barker, 1960, Soc. Econ. Paleo. Min. Spec. Publ.9, pl.50, fig.11,12; Bergen and O'Neil, 1979, J. Paleo., v.53, n.6, pl.4, fig.14.

Synoptic description: Test elongate oval, triserial, inflated chambers strongly overlapping, last chamber extends back one half length of test; wall calcareous, hyaline, early portion test spinose, later smooth; aperture loop with internal tooth plate partially covering opening.

Remarks: B. barbata is twice the size of specimens of this study.

138 Bulimina mexicana Cushman

Bulimina striata d'Orbigny mexicana Cushman, of Barker, 1960, Soc. Econ. Paleo. Min. Spec. Publ.9, pl.51, fig.10,12
Bulimina mexicana Cushman, Enbysk, 1960, Distribution of Foraminifera in the Northeast Pacific, PhD. Thesis, Univ. Wash., pl.11, fig.4; Uchio, 1960, Cush. Fd. Foram. Res. Spec. Publ.5, pl.6, fig.4; Bergen and O'Neil, 1979, J. Paleo., v.53, n.6, pl.5, fig.10.

Synoptic description: Test small, compact, triserial chambers with basal spines along edge; wall smooth partially hyaline; aperture low basal interiomarginal arch.

139 Bulimina rostrata Brady
Pl.3 figs.11,12

Bulimina rostrata Brady, 1884, Rep. Voy. Challenger Exped., Zool., v.9, pl.51, fig.14,15; Cushman, 1913, U.S. Nat. Mus. Bull. 71, pt.2, p.87, fig.140,
?Bulimina alazanensis Cushman, of Enbysk, 1960, Distribution of Foraminifera in the Northeast Pacific, PhD. Thesis, Univ. Wash., pl.11, fig.13,14.

Synoptic description: Test ovoid, triangular in cross section, fourteen or more longitudinal costa obscure triserial chamber arrangement except for top portion of

last chamber, widest near apertural end and tapering basally; wall calcareous; aperture small slit up chamber face.

Remarks: B. rostrata, of Brady, is slightly larger and has a basal spine.

Genus: Globobulimina Cushman, 1927

140 Globobulimina hoeglundi? Uchio

Globobulimina hoeglundi Uchio, 1960, Cush. Fd. Foram. Res. Spec. Publ.5, p.63, pl.6, fig.7,8.
?Globobulimina auriculata (Bailey) of Todd and Low, 1967, U.S.G.S. Prof. Paper 573-A, p.15, pl.3, fig.38; Bergen and O'Neil, 1979, J. Paleo., v.53, n.6, pl.5, fig.9.
?Globobulimina cf. G. auriculata (Bailey), of Smith, 1973, U.S.G.S. Prof. Paper 706, p.14, pl.3 fig.10.

Synoptic description: Test fusiform, circular in cross section, triserial, apically pointed or bluntly rounded, broadest just above middle, chambars strongly embracing, sutures almost horizontal at chamber base; wall smooth, partially hyaline, finely perforate, colour white; aperture loop with spoon-shaped tooth.

141 Globobulimina pacifica Cushman

Globobulimina pacifica, Cushman, 1927, Contr. Cush. Fd. Form. Res. v.3(1), p.67, pl.14, fig.12; as above but queried, Barker, 1960, Soc. Econ. Paleo. Min. Spec. Publ.9, pl.50, fig.7-10; Uchio, 1960, Cush. Fd. Foram. Res. Spec. Publ.5, pl.6, fig.9.

Synoptic description: Test ovate, three strongly embracing chambers, broadest just above base; wall smooth, partially hyaline, finely perforate; aperture loop with spoon shaped toothplate.

Genus: Stainforthia Hofker, 1956

142 Stainforthia, (Virgulina of authors) complanata Egger
Pl. 4 fig.8

Virgulina schreibersiana Czjzek complanata Egger, 1893, Akad. Wiss., Math.-Physik., Bd. 18(2), p.292, p.8, fig.91-92.
Virgulina complanata Egger, Uchio, 1960, Cush. Fd. Foram. Res. Spec. Publ.5, pl.6, fig.13.
Cassidella complanata (Egger), Vilks, 1969, Micropaleo. v.15, p.48, pl.3, fig.18; Lagoe, 1977, J. Foram. Res. v.7(2), pl.4, fig.10.
Stainforthia complanata (Egger), Ingle et al., 1980, Micropaleo. v.26(2), pl 5., fig.10,11.

?Virgulina davisi Chapman and Parr, Barker, 1960, Soc. Econ. Paleo. Min. Spec. Publ.9, pl.52, fig.1-3.

Synoptic description: Test elongate, biserial, twisted, chambers inflated and overlapping, higher than broad, apical spine; wall smooth, hyaline; aperture elongate wide slit up chamber face.

143 Stainforthia cf. S. rotunda (Parr)

Virgulina rotunda Parr, 1950, Repts. BANZ Antarctic Exped. ser.B, v.5, p.337, pl.12, fig.14.

Synoptic description: Test elongate, biserial twisted, chambars laterally overlapping; wall hyaline, smooth, very finely perforate; aperture open loop up chamber face.

144 Stainforthia seminuda (Natland)

Virgulina seminuda Natland, 1933, Bull. Scripps Inst. Ocean. Tech. ser.v.3(10), pl.5, fig.12; Uchio, 1960, Cush. Fd. Foram. Res. Spec. Publ.5, pl.6, fig.19.

Synoptic description: Test elongate, triserial, twisted; wall partially hyaline, clear area around upper periphery of each chamber the remainder densely perforate; aperture open loop in face of last chamber.

145 Uvigerina auberiana d'Orbigny

Uvigerina auberiana d'Orbigny, 1839, Ramon de la Sagra, Histoire physique et naturelle de l'Ile de Cuba, Paris, p.106, v.8, pl.2, fig.23,24; (as above but queried by) Uchio, 1960, Cush. Fd. Foram. Res. Spec. Publ.5, pl.7, fig.11.
Uvigerina asperula Czjzek, of Barker, 1960, Soc. Econ. Paleo. Min. Spec. Publ.9, pl.75, fig.8,9.

Synoptic description: Test elongate, biserial, inflated chambers, sutures indistinct, wall coarsely hispid; aperture teminal end of short neck.

Remarks: This form may be an end member of the gradational series of U. senticosa. D'Orbigny described the species as hispid throughout with the short spines being more pronounced on the basal portion of the chambers; this is a characterisic of U.senticosa.

146 Uvigerina juncea Cushman and Todd

Uvigerina juncea Cushman and Todd, 1941, Cush. Lab. Foram. Res. Contr. v.17, p.78, pl 20, fig.4-11; Uchio, 1960, Cush. Fd. Foram. Res. Spec. Publ.5, pl.7, fig.15-16; Bergen and O'Neil, 1979, J. Paleo., v.53, n.6, pl.3, fig.4

Synoptic description: Test elongate, triserial, rounded in section ; wall costate, each chamber having discrete low sharp ribbing, colour white; aperture terminal, short neck, phialine lip.

147 Uvigerina peregrina Cushman var.disrupta Todd

Uvigerina peregrina Cushman var. disrupta Todd, of Enbysk, 1960, Distribution of Foraminifera in the Northeast Pacific, PhD. Thesis, Univ. Wash., pl.12, fig.16.
Uvigerina bradyana Fornasini, of Barker, 1960, Soc. Econ. Paleo. Min. Spec. Publ.9, pl.74, fig.26.

Synoptic description: Test elongate triserial later becoming biserial, early chambers with low narrow costae (10/chamber), last chamber hispid; aperture terminal, end of short hispid neck, phialine lip.

148 Uvigerina senticosa Cushman
Pl.2 fig.4,5,6,7,8,9

Uvigerina enticosa Cushman, 1927, Scripps Inst. Ocean. Tech. ser. v.1, pl.3, fig.14; Bergen and O'Neil, 1979, J. Paleo., v.53, n.6, pl.4, fig.16.
?Uvigerina canariensis d'Orbigny, of Cushman, 1913, U.S. Nat. Mus. Bull. 71, pt.3, p.92, pl.42, fig.6.

Synoptic description: Test elongate, triserial, chambers inflated, sutures depressed, distinct; wall partially hyaline, smooth or very slightly hispid especially near sutures, apex is distinctly hispid, colour white; aperture terminal, end of short nedk with phialine lip.

Remarks: U. senticosa shows much gradation in its hispid nature, see Plate 2. This species may grade into U. auberiana.

149 Uvigerina sp. A

?Uvigerina brunnensis Karrer, of Brady, 1884, Rep. Voy. Challenger Exped., Zool., v.9, pl.75, fig.4,5.

Synoptic description: Test elongate, early triserial later biserial; wall early chambers slightly costate basally, last chamber hispid; aperture terminal end of moderate neck.

Remarks: A ontogenetic stage of U. senticosa?

150 Uvigerina sp. B

Synoptic description: Test elongate, early triserial later biserial; wall partially hyaline, very finely hispid except coasely hispid last chamber; aperture terminal

moderately long neck with phialine lip.

Remarks: An ontogenetic stage of U. senticosa?

Genus: Trifarina Cushman, 1923

151 Trifarina fluens (Todd)

Angluogerina fluens Todd, 1948, Allan Hancock Pac. Exped., v.6, n.5, p.288, pl.36, fig.1; Enbysk, 1960, Distribution of Foraminifera in the Northeast Pacific, PhD. Thesis, Univ. Wash., pl.12, fig.1.
Trifarina fluens (Todd), Bergen and O'Neil, 1979, J. Paleo., v.53, n.6, pl.2, fig.8.

Synoptic description: Test elongate triserial becoming uniserial, triangular in crossection; wall with longitudinal costae which curve with test curvature; aperture oval on very short neck.

Remarks: Identification based on one specimen.

Superfamily: Discorbacea Ehrenberg, 1838

Family: Discorbidae Ehrenberg, 1838

Subfamily: Discorbinae Ehrenberg, 1838

Genus: Bucella Anderson, 1952

152 Bucella frigida (Cushman)

Pulvinulina frigida Cushman, 1922, Can. Biol. Board, Contr. Can. Biol.(1921), n.9, p.12(144), fig. see Parker and Jones, 1865, Phils. Trans. v.155, p.396, pl.14, fig.14,15,17.
Bucella frigida (Cushman), Loeblich and Tappan, 1953, Smith. Misc. Coll. v.121, n.7, pl.22, fig.2,3; Enbysk, 1960, Distribution of Foraminifera in the Northeast Pacific, PhD. Thesis, Univ. Wash., pl.15, fig.11,12.

Synoptic description: Test trochospiral, planoconvex, spirally sutures flush slightly recurved, umbilically secondary infilling in umbilical region spreading out along sutures; wall smooth, hyaline on spiral side; aperture interiomarginal basal slit on chamber face.

Genus: Epistominella Husezima and Maruhasi, 1944

153 Epistominella exigua (Brady)

Pulvinulina exigua Brady, 1884, Rep. Voy. Challenger Exped., Zool., v.9, pl.103 fig.13,14; Epistominella exigua (Brady), Barker, 1960, Soc. Econ. Paleo. Min. Spec. Publ.9, pl.103, fig.13,14; Enbysk, 1960, Distribution of Foraminifera in the Northeast Pacific, PhD. Thesis, Univ. Wash., pl.13 fig.17,18.

Synoptic description: Test small, trochospiral, slightly biconvex, spiral side evolute nearly flat, unbilical side involute, convex, oblique but straight sutures dorsally, slightly recurved ventrally; wall partially hyaline; aperture narrow slit just below and parellel to peripheral keel.

Subfamily: Bagininae Cushman, 1927

Genus: Valvulinera Cushman, 1926

154 Valvulineria? arctica Green
Pl.5 fig.4,5

Valvulineria arctica Green, 1960, Micropaleo. v.6(1), p.71, pl.1, fig.3; Vilks, 1969, Micropaleo. v.15, pl.3, fig.9; Lagoe, 1977, J. Foram. Res. v.7(2), pl.4, fig.9,13,18.

Synoptic description: Test small, trochospiral, lobate periphery, spiral side evolute with very low spire, chambers increasing moderately in size, sutures distinct, depressed, radial to slightly curved, last chamber has valvular projection extending back over umbilical region; wall smooth, hyaline, finely perforate; aperture umbilical-extraumbilical beneath valvular projection.

Remarks: This form is questionably placed with Valvulineria although the high chambers and their moderately rapid enlargement suggest affinities to Cancris. This small species may be a juvenile form of a species of Cancris.

155 Valvulineria cf. V.glabra Cushman

Valvulineria vilardeboana (d'Orbigny) var. glabra Cushman, 1927, Scripps Inst. Ocean. Bull. Tech. ser. v.1, p.161, pl.4, fig.5,6.

Valvulineria glabra Cushman, Uchio, 1960, Cush. Fd. Foram. Res. Spec. Publ.5, pl.8, fig.6,7; Qualitative Observations on Recent Foraminiferal Tests With Emphasis on the Eastern Pacific, Univ. S. Calif. p.351, pl.134, fig.4.
Rotamorphina (Valvulineria) laevigata (Phleger and Parker), Enbysk, 1960, Distribution of Foraminifera in the Northeast Pacific, PhD. Thesis, Univ. Wash., pl.15, fig.16,17.

Synoptic description: Test small, chambers inflated and triangular in shape spieal side evolute, umbilical involute; wall hyaline; aperture umbilical-extraumbilical covered by broad flap.

156 Valvulineria sp. A

Synoptic description: Test low trochospiral, rounded periphery, spirally evolute, last chamber inflated with lobe extending over umbilical region, apertural face high triangular, sutures vary from straight to slightly curved; wall smooth, finely perforate, opaque; aperture low basal arch over periphery extending under flap on umbilical side.

Remarks: This form differs from Valvulineria sp.C by having a high triangular apertural face. A similar form lacking a pronounced flap was placed in Nonionella auricula Heron-Allen and Earland, by Loeblich and Tappan, 1953, (Smith. Misc. Coll. v.121, n.7, pl.16, fig.6,7,10.)

157 Valvulineria sp.B

Synoptic description: Test trochospiral, compressed, open umbilicus chambers rapidly increasing in size; wall smooth, finely perforate; aperture low basal arch over periphery extending onto umbilical side.

158 Valvulineria sp.C

?Valvulineria araucana (d'Orbigny), of Uchio, 1960, Cush. Fd. Foram. Res. Spec. Publ.5, pl.8, fig.3-5;

Synoptic description: Test trochospiral, very low spire, chambers inflated subglobular, last chamber with broad flap over umbilicus, sutures distinct, curved, depressed; wall, thin smooth, hyaline, each chamber coarsely perforate in basal 2/3 the upper 1/3 plus apertural face, and umbilical flap are imperforate; aperture broad arch over periphery and extending into umbilical region under flap.

Remarks: This species may be a more robust form of Valvulineria sp.A. V. araucana in the orginal figure is shown to be much more compressed.

Family: Glabratellidae Loeblich and Tappan, 1964

Genus: Heronallenia Chapman and Pasrr, 1931,

159 Heronallenia? sp.

?Carlfranklinoides procidua McCulloch, 1977, Qualitative Observations on Recent Foraminiferal Tests With Emphasis on the Eastern Pacific, Univ. S.Calif., p.295, pl.128, fig.14,16.

Synoptic description: Trochospiral, compressed, plano-convex, carinate, sutures oblique and flush, apertural indentation in chamber faces for apertue; wall thin hyaline; aperture low interiomarginal arch set down in deep indentation of chamber face.

Remarks: Questioned whether belongs in Heronallenia because the form lacks the grooves on the chamber face.

Superfamily: Globigerinacea Carpenter, Parker and Jones, 1862

Family: Globorotaliidae Cushman, 1927

Subfamily: Globorotaliinae Cushman, 1927

Genus: Globorotalia Cushman, 1927

160 Globorotalia scitula (Brady)
Pl.1 figs.7,8,9

Pulvinulina scitula Brady, 1882, Roy. Soc. Edinbourgh, Proc. v.11, n.3, p.716, (fig. in Challenger Repts. 1884, pl.103, fig.7.)
Globoratalia scitula (Brady), Enbysk, 1960, Distribution of Foraminifera in the Northeast Pacific, PhD. Thesis, Univ. Wash., pl.2, fig.9-12,15; Barker, 1960, Soc. Econ. Paleo. Min. Spec. Publ.9, pl.103, fig.7.

Synoptic description: Test trochospiral, low spire, lobate periphery; wall smooth, finely perforate throughout, except for nonporous periphery; basal aperture, umbilical to extraumbilical, may have fine lip.

Family: Globigerinidae Carpenter, Parker and Jones, 1862

Subfamily: Globigerinidae Carpenter, Parker and Jones,1862

Genus: Globigerina d'Orbigny, 1826

161 Globigerina bulloides d'Orbigny
Plate 1, figs. 4,5

Globigerina bulloides d'Orbigny, 1826, Ann. Sci. Nat., Paris, ser.1, t.7, p.277; Enbysk, 1960, Distribution of Foraminifera in the Northeast Pacific, PhD. Thesis, Univ. Wash., pl.1, fig. 1-4; Barker, 1960, Soc. Econ. Paleo. Min. Spec. Publ.9, pl.79, fig.5,7.

Synoptic description: Test trochospiral, low spire, spherical chambers, four in last whorl, sutures depressed; wall granular; aperture broad arch over widely open umbilicus.

162 Globigerina quinqueloba Natland

Globigerina quinqueloba Natland, 1938, Scripps Inst. Ocean. Bull. Tech. ser. v.4, n.5, p.149, pl.6, fig.7; Enbysk, 1960, Distribution of Foraminifera in the Northeast Pacific, PhD. Thesis, Univ. Wash., pl.2, fig.5,6; Bé, 1977, An Ecological, Zoogeographic and Taxonomic Review of Recent Planktonic Foraminifera, in Oceanic Micropaleontology (Ramsay, A.T. ed.), pl.9, fig.15.

Synoptic description: Test small, trochospiral, low spire, spherical chambers slightly apressed, five in last whorl; wall partially hyaline, smooth, finely perforate; aperture low basal arch umbilical-extraumbilical, lip of varying width.

Remarks: It is questioned whether this species should be placed in Globigerinita, several specimens were found with large modified final chambers or bellas.

163 Globoquadrina dutertrei (d'Orbigny)

Globigerina dutertrei d'Orbigny, 1839, Ramon de la Sagra, Histoire physique et naturelle de l'Ille de Cuba, Paris, p.84, fig. in v.8, pl.4, fig.19-21.
Globoquadrina dutertrei (d'Orbigny), Bé, 1977, An Ecological, Zoogeographic and Taxonomic Review of Recent Planktonic Foraminifera, in Oceanic Micropaleontology (Ramsay, A.T. ed.), pl.10, fig.23a-f.

Globigerina eggeri Rhumbler, 1901, Nordisches Plankton, Kiel, Lief 1, Nr.14, p.19, t.f.20.; Enbysk, 1960, Distribution of Foraminifera in the Northeast Pacific, PhD. Thesis, Univ. Wash., pl.1, fig.5-8; Barker, 1960,

Synoptic description: Test trochospiral, no spire on evolute spiral side, involute umbilical side, globular chambers; wall granular; aperture umbilical-extraumbilical off open umbilicus.

164 Globoquadrina hexagona (Natland)

Globigerina hexagona Natland, 1938, Scripps Inst. Ocean. Bull. Tech. ser. v.4(5), p.149, pl.7, fig.1.
Globoquadrina hexagona (Natland), Be, 1977, An Ecological, Zoogeographic and Taxonomic Review of Recent Planktonic Foraminifera, in Oceanic Micropaleontology (Ramsay, A.T. ed.), pl.10, fig.24.

Synoptic description: Test trochospiral, low spire, periphery lobate, five chambers in last whorl, sutures radial, depressed; wall partially hyaline obscurred by corse dense reticulations; aperture basal arched loop with lip, between umbilicus and periphery.

165 Globoquadrina pachyderma (Ehrenberg)
Pl.1 fig.1,2

?Aristerospira pachyderma Ehrenberg, 1861, K. Preuss. Akad. Wiss. Berlin, p.276,277,303 (fig. in K. Akad. Wiss. Berlin, Abh, Jahrg, 1872, pl.1, fig.4)
Globigerina pachyderma (Ehrenberg), Enbysk, 1960, Distribution of Foraminifera in the Northeast Pacific, PhD. Thesis, Univ. Wash., pl.2, fig.1-4,7,8; Barker, 1960, Soc. Econ. Paleo. Min. Spec. Publ.9, pl.114, fig.19.
Globoquadrina pachyderma (Ehrenberg), Be, 1977, An Ecological, Zoogeographic and Taxonomic Review of Recent Planktonic Foraminifera, in Oceanic Micropaleontology (Ramsay, A.T. ed.), pl.10, fig.22.

Synoptic description: Test small, low trochospiral, chambers strongly embracing giving test rounded appearance, sutures slightly depressed indistinct; wall very granular; aperture small arch over closed umbilicus, some with lip.

Subfamily: Orbulininae Schultze, 1854

Genus: Orbulina d'Orbigny, 1839

166 Orbulina universa d'Orbigny
Pl.1, fig.6

Orbulina universa d'Orbigny, 1839, Ramon de la Sagra, Histoire physique et naturelle de l'Ile de Cuba, Paris, fig in v.8, pl.1, fig.1; Enbysk, 1960, Distribution of Foraminifera in the Northeast Pacific, PhD. Thesis, Univ. Wash., pl.2, fig.17-18; Barker,1960, Soc. Econ. Paleo. Min. Spec. Publ.9, pl.81, fig.8.

Synoptic description: Test spherical, unilocular; wall coarsely perforate; aperture one large pore and numerous areal pores.

Subfamily: Catapsydracinae Bolli, Loeblich and Tappan, 1957

Genus: Globigerinita Bronnimann, 1951

167 Globigerinita glutinata Egger

Globigerina glutinata Egger, 1893, Akad. Wiss. Math-Physik., Cl. Abh. Munich, Bd.18(1895), Abth.2, p.371, pl.13, fig. 19-21; Enbysk, 1960, Distribution of Foraminifera in the Northeast Pacific, PhD. Thesis, Univ. Wash., pl.1, fig.9-13.
Globigerinita glutinata (Egger), Be, 1977, An Ecological, Zoogeographic and Taxonomic Review of Recent Planktonic Foraminifera, in Oceanic Micropaleontology (Ramsay, A.T. ed.), pl.9, fig.18a,b.

Synoptic description: Test small, trochospiral, low spire, spherical chambers with three in last whorl; wall hyaline; aperture low arch umbilical-extraumbilical, no open umbilicus.

168 Globigerinita? uvula (Ehrenberg)
Pl.5 fig.3

Pylodexia uvula Ehrenberg, 1861, K. Preuss. Akad. Wiss. Berlin, Monatsher., p.276,277,308; fig. in K. Akad. Wiss. Berlin, Abh., Jahrg. 1872, pl.2, fig. 24,25.
Globigerina bradyi Wiesner, 1931, Drygalski, E.van., Deut. Sud-polar Exped. 1901-1903, Bd.20 (Zool. Bd.12), p.133, (fig. from Brady, 1884, Rep. Voy. Challenger Exped., Zool., v.9, pl.82, fig.8,9; Barker, 1960, Soc. Econ. Paleo. Min. Spec. Publ.9, pl.82, fig.8,9
Globigerinoides minuta Natland, 1938, Scripps Inst. Ocean. Bull. Tech. ser. v.4(5), p.150, pl.7, fig.2,3.
Globigernita bradyi, Be, 1977, An Ecological, Zoogeographic and Taxonomic Review of Recent Planktonic Foraminifera, in Oceanic Micropaleontology (Ramsay, A.T. ed.), pl.9, fig.19.

Synoptic description: Test minute, trochospiral, high spire, numerous spherical chambers increasing in size;

wall partially hyaline, smooth; aperture basal arch, extraumbilical in face of last chamber.

Remarks: The genus was queried because no evidence of a bella was found.

Superfamily: Orbitoidacea Schager, 1876

Family: Eponididae Hofker, 1951

Genus: Eponides De Montfort, 1808

169 Eponides tumidulus (Brady) var. horvathi Green
Pl.5 figs.1,2,3

Eponides tumidulus (Brady) var. horvathi Green, 1960, Micropaleontology, v.6(1), p.71, pl.1, fig.5.

Synoptic description: Test small, trochospiral, low spire, three whorls, 8 chambers in last whorl, deep open umbilicus, inflated ovoid chambers, sutures distinct, depressed, slightly oblique; wall smooth partially hyaline; aperture basal low interiomarginal arch in apertural face with lip.

Remarks: Scanning electron photograhy showed that some specimens are coarsely perforate around the umbilicus whereas in others there are none and the umbilicus was not as pronounced (pl.5, fig.2,3).

170 Eponides sp.

Synoptic description: Test small trochospiral, low spire, three whorls with 6 chambers in last, rounded periphery, spirally evolute, umbically involute, sutures distinct, flush to slightly depressed; wall, smooth, partially hyaline; aperture low arch interiomarginal at base of apertural face.

Genus: Eilohedra Lipps, 1965

171 Eilohedra levicula (Resig)
pl.2 figs.1,2,3

Epistominella levicula Resig, 1958, Micropaleo. v.4(3), p.304, t.f.16a-c.
Eponides leviculus (Resig), Uchio, 1960,Cush. Fd. Foram. Res. Spec. Publ.5, pl.10, fig.23-25.
Eponides leviculus (Resig), Bergen and O'Neil, 1979, J. Paleo., v.53, n.6, pl.4, fig.22-24.
Eilohedra levicula (Resig), Ingle et al. 1980, Micropaleo., v.26(2), p.134, pl.2, fig. 2,3.

Synoptic description: Test small trochospiral, biconvex, spirally more so, numerous chambers in tight curl, five chambers in last whorl, chambers rhomboidal in spiral view, trigonal in umbilical view, sutures slightly depressed, oblique spiral side; wall thin partially hyaline, smooth, colour spirally yellow brown; aperture thin interiomarginal slit at base of apertural chamber face, (scanning photographs show pustules and bordering lip.)

Remarks: The aperture does not show the extension paralleling the periphery as depicted for the genus; rather there is just a very slight indentation.

Family: Cibicididae Cushman, 1927

Subfamily: Planulininae Bermudez, 1952

Genus: Planulina d'Orbigny, 1826

172 Planulina wuellerstorfi (Schwager)
Pl.4 fig.1,2

Anomalina wuellerstorfi Schwager, 1866, Novara Exped. 1857-59, Wien, 1866, Geol. Theil. Bd.2 Abt.2, p.258, pl.7, fig.105, 107.
Planulina weullerstorfi (Schwager), Cushman, 1913, U.S. Nat. Mus. Bull. 71, pt.5, p.34, pl.12, fig.3; Enbysk, 1960, Distribution of Foraminifera in the Northeast Pacific, PhD. Thesis, Univ. Wash., pl.16, fig.12, pl.17, fig.1,2,5,6; Barker, 1960, Soc. Econ. Paleo. Min. Spec. Publ.9, pl.93, fig.9.

Synoptic description: Test discoidal, low trochospiral, spiral side evolute, umbilical side involute, periphery sharp, imperforate, sutures limbate strongly arched, chambers kidney shaped, inflated; wall coarsely perforate spirally, finely so umbilically; aperture low arch at periphery extending onto spiral side.

Subfamily: Cibicidinae Cushman, 1927

Genus: Cibicides De Montfort, 1808

173 Cibicides sp.

Synoptic description: Test trochospiral, low spire, spiral side flattened to excavated, evolute, umbilical side convex, involute, angular periphery; wall coarsely

perforate spirally, but finely umbilically; aperture narrow basal slit over periphery extending onto spiral side.

Superfamily: Cassidulinacea d'Orbigny, 1839

Family: Cassidulinidae d'Orbigny, 1839

Genus: Cassidulina d'Orbigny, 1826

174 Cassidulina cushmani R.E.and K.C. Stewart
Pl.4 figs.9,10

Cassidulina cushmani R.E. and K.C. Stewart, 1930, J. Paleo., v.4(1), p.71, pl.9, fig.5.
Cassidulina delicata Cushman, of Uchio, 1960, Cush. Fd. Foram. Res. Spec. Publ.5, pl.9, fig.17; Enbysk, 1960, Distribution of Foraminifera in the Northeast Pacific, PhD. Thesis, Univ. Wash., pl.19, fig.14,15.

Synoptic description: Test lenticular, biumbonate, bisearial enrolled, sharply angled periphery; wall thin smooth, polished, partially hyaline; aperture elongate slit near margin that may appear as a crescentic slit with tooth.

Remarks: Uchio considered C. cushmani a form within the range of variation of C. delicata.

Genus: Ehrenbergina, Reuss,1850

175 Ehrenbergina trigona Goes
Pl.3 figs.5,6

Ehrenbergina serrata Reuss var. trigona Goes, 1896, Harvard College Mus. Comp. Zool. Bull., v.29, p.49, pl.6, fig.183-4; Enbysk, 1960, Distribution of Foraminifera in the Northeast Pacific, PhD. Thesis, Univ. Wash., pl.20, fig.1,2,11-13; Barker, 1960, Soc. Econ. Paleo. Min. Spec. Publ.9, pl.55, fig.2,3,5.

Synoptic description: Test biserial slightly enrolled, chambers broad, low, cross section trigonal, base of chambers spinose, chambers meet ventrally to form shallow furrow; wall smooth, polished, aperture elongate slit parallel to periphery and perpendicular to base of apertural face.

Genus: Globocassidulina Voloshinova, 1960

176 Globocassidulina sp.
Pl.2 figs.13,14,15

Cassidulina subglobosa, Brady, of Smith, 1973, U.S. Geol. Survey Prof. Paper 706, p.14, pl.4 fig,3; Bergen and O'Neil, J. Paleo. v.53(6), pl.4, fig.11.

Synoptic description: Test very small, biserial enrolled, subglobular, rounded periphery; wall smooth, finely perforate, hyaline; aperture broad equatorial slit up chamber face.

Remarks: This species resembles C. subglobosa Brady, however Brady's species is very much larger.

Family: Nonionidae Schultze, 1854

Subfamily: Chilostomellinae Brady, 1881

Genus: Chilostomella Reuss in Czjzek, 1849

177 Chilostomella oolina Schwager

Chilostomella oolina Schwager, 1878, in Stohr, R. Comp. Geol. Ital. Boll., v.9, p.513, pl.1, fig.16; Enbysk, 1960, Distribution of Foraminifera in the Northeast Pacific, PhD. Thesis, Univ. Wash., pl.21, fig.21-23; Barker, 1960, Soc. Econ. Paleo. Min. Spec. Publ.9, pl.55, fig.14,17; Ingle et al., 1980, Micropaleo. v.26(2), pl.6, fig.9,10.

Synoptic description: Test oval, planispiral, 2 chambers in last whorl, strongly embracing; wall hyaline, smooth, coarsely perforate; aperture equatorial basal slit in last chamber.

Subfamily: Nonioninae Schultze, 1854

Genus: Astrononion Cushman and Edwards, 1937

178 Astrononion (?) cf. A. bikiniensis McCulloch

Astrononion bikiniensis McCulloch,1977 Qualitative Observations on Recent Foraminiferal Tests With Emphasis on the Eastern Pacific, Univ. S. Calif., p.437, pl.176, fig.27-29.

Synoptic description: Test small, planispiral, compressed, slightly evolute on umbilical side, small umbonal boss on other, periphery slightly lobate, 6-7 chambers in last whorl, sutures radial to curved with some medial thickening; wall smooth, hyaline, relatively coarsely perforate; aperture equatorial basal arch over periphery.

Genus: Florilus De Montfort, 1808

179 Florilus sp. A

Synoptic description: Test planispiral involute symmetrical, rapidly enlarging chambers giving flaring test, last chamber elongate face with lower lobes covering both umbilical regions; wall hyaline; aperture low arch over periphery.

180 Florilus sp. B

Florilus (Nonionina) labradoricus (Dawson) of Todd and Low, 1967, U.S. Geol. Survey Prof. Paper 573-A, pl.15, fig.9; Smith, 1973, U.S. Geol. Survey Prof. Paper 706, pl.4 fig.4;
Nonionina scapha (Fichtel and Moll), of Cushman, 1913, U.S. Nat. Mus. Bull. 71, pt.4, pl.15, fig.1, pl.16, fig.3,4
Nonion scaphum (Fichtel and Moll), of Barker, 1960, Soc. Econ. Paleo. Min. Spec. Publ.9, pl.109, fig.14,15.

Synoptic description: Test planispiral involute, symmetrical rapidly enlarging chabmbers giving flaring test, last chamber broad, not covering umbilical region, triangular face; wall smooth, finely perforate; aperture low arch over periphery.

Remarks: Not Dawson's species which shows the two lobes of the final chamber coming down over the umbilicus and previous whorls.

Genus: Pullenia Parker and Jones in Carpenter, Parker and Jones, 1862

181 Pullenia bulloides (d'Orbigny)
Pl.3 figs.3,4

Nonionina bulloides d'Orbigny, 1846, Foraminiferes fossils du bassin tertiaire de Vienne, Gide et Comp., Paris, p.107, pl.5, fig.9-10.
Pullenia bulloides (d'Orbigny), Enbysk, 1960, Distribution of Foraminifera in the Northeast Pacific, PhD. Thesis, Univ. Wash., pl.21, fig.13-16; Barker, 1960, Soc. Econ. Paleo. Min. Spec. Publ.9, pl.84, fig.12,13.

Synoptic description: Test spheroidal, planispiral involute, 5 chambers in last whorl, sutures radial, flush or slightly depressed; wall smooth, polished; aperture thin slit umbilicus to umbilicus, basally in face of last chamber.

182 Pullenia subcarinata (d'Orbigny)

Pullenia (Nonionina) subcarinata (d'Orbigny), of Smith, U.S.G.S. Prof. Paper 706, pl.4, fig.9;
Pullenia (Nonionina) quinqueloba (Reuss), of Ingle et al., 1980, Micropaleo. v.26(2), pl.5, fig.8.

Synoptic description: Test planispiral, compressed, involute, symmetrical, slightly lobate periphery, 5-6 chambers/whorl, sutures slightly depressed and curved; wall smooth, finely perforate: aperture crescentic slit umbilicus to umbilcus over periphery.

183 Pullenia sp.

Pullenia sp. 2, Enbysk, 1960, Distribution of Foraminifera in the Northeast Pacific, PhD. Thesis, Univ. Wash., pl.21, fig.11,12.
Pullenia salisburyi R.E.and K.C. Stewart, of Bergen and O'Neil, 1979, J. Paleo., v.53, n.6, pl.3, fig.18; pl.4, fig.12,13.

Synoptic description: Test planispiral, compressed, involute, symmetrical, 6 chambers, very slightly lobate periphery, sutures slightly depressed and curved, apertural face rounded (not peaked); wall smooth, finely perforate; alperture a peripheral slit umbilicus to umbilcus, highest over periphery.

Remarks: This species is similar to P. salisburyi except the latter is figured with a narrower peaked apertural face.

Family: Alabaminidae Hofker, 1951

Genus: Gyroidina d'Orbigny, 1826

184 Gyroidina io Resig
Pl.2 figs.10,11,12

Gyroidina io Resig, 1958, Micropaleo. v.4(3), p.304, t.f.15a-c; Uchio, 1960, Cush. Fd. Foram. Res. Spec. Publ.5, pl.8, fig.16-18.

Synoptic description: Test trochospiral, spiral side flat, evolute, umbilical side convex involute, 9/10 chambers /whorl, 2 1/2 whorls; wall smooth, hyaline; aperture, thin basal equatorial slit between last chamber and previous whorl.

185 Gyroidina neosoldanii Brotzen

Gyroidina neosoldanii Brotzen, 1936, Sweden, Sver. Geol. Unders. Avh., Ser.C, n.396, p.158, (fig. from Brady, Report Challenger Exped. pl.107, fig.6,7; Barker, 1960, Soc. Econ. Paleo. Min. Spec. Publ.9, pl.107, fig.6,7; Ingle et al., 1980, Micropaleo. v.26(2), p.7, fig.10,11.

Synoptic description: Test trochospiral, plano-convex, spiral side evolute, flat, umbilical side very convex, involute, last chamber with broad flat apertural face, sutures radial to slightly curved, sutures indistinct; wall smooth, polished, heavily calcified obscurring morphological features; aperture narrow basal equatorial slit between last chamber and previous whorl.

186 Gyroidina sp. A

Gyroidina (Rotalina) lamarckiana (d'Orbibny), of Smith, 1973, U.S.G.S. Prof. Paper 706, pl.4 fig.7.
Gyroidina cf. G. lamarckiana (d'Orbigny), of Enbysk, 1960, Distribution of Foraminifera in the Northeast Pacific, PhD. Thesis, Univ. Wash., pl.14, fig.7,8,14,15.

Synoptic description: Test trochospiral, rounded periphery, umbilical side convex, involute, 7 chambers, spiral side evolute, 2 whorls, very slightly convex; wall smooth, very finely perforate; aperture, low basal equatorial arch in apertural face.

Remarks: This species does not correspond with the distinctly biumbonate specimen originally figured by d'Orbigny.

Genus: Oridorsalis, Anderson, 1961

187 Oridorsalis umbonatus (Reuss)
Pl.3 figs.7,8,9

Rotalina umbonatus Reuss, 1851, Deut. Geol. Ges., Zeitschr., Bd.3, p.75, pl.5, fig.35.
Truncatulina tenera Brady, 1884, Rept. Challenger Exped., Zool., pt.22, v.9, p.665, pl.95, fig.11.
Pseudoeponides umbonatus (Reuss), Uchio, 1960, Cush. Fd. Foram. Res. Spec. Publ.5, pl.8, fig.26-28; Enbysk, 1960, Distribution of Foraminifera in the Northeast Pacific, PhD. Thesis, Univ. Wash., pl.14, fig.5,6.
Oridorsalis tenera (Brady), Ingle et al., 1980, Micropaleo. v.26(2), pl.5, fig.5,6.

Synoptic description: Test trochospiral, low spire on evolute spiral side, strongly convex on involute umbilicate side; wall strongly calcified on spiral side obscuring all but general morpholgy; aperture low basal equatorial slit between last chamber and previous whorl, secondary aperture(s) on spiral side near junction spiral septal sutures.

Remarks: Does not have true elongate aperture of Oridorsalis; however, late ontogenetic stages have secondary apertures. Early ontogenetic stages have been placed within a variety of genera.

Family: Anomalinidae Cushman, 1927

Subfamily: Anomalininae Cushman, 1927

Genus: Cibicidoides Thalmann, 1939

188 Cibicidoides kullenbergi, (Parker)
Pl.4 figs.11,12

Cibicides kullenbergi Parker, 1953, Swedish Deep Sea Exped. 1947-48, Repts., v.7, n.1, p.49, pl.11, fig. 7-8; Enbysk, 1960, Distribution of Foraminifera in the Northeast Pacific, PhD. Thesis, Univ. Wash., pl.17, fig.3,4,8.

Synoptic description: Test low trochospiral, rounded periphery, umbilical side partially evolute, 3 whorls, 12 chambers in last whorl, sutures distinct, depressed; wall on spiral side densely perforate, very finely perforate umbilically, colour yellow orange; aperture low arch with slightly raised lip, at the periphery and slightly extending onto spiral side.

Genus: Melonis De Montfort, 1808

189 Melonis pompilioides (Fichtel and Moll)
Pl.3 fig.10,13

Nautilus pompilioides Fichtel and Moll, 1798, Testacea microscopia alique minuta ex generibus Argnoauta et Nautilus, Wien, Camesina, p.31, pl.2, fig.a-c.
Nonion(?) pompilioides (Fichtel and Moll), Barker, 1960, Soc. Econ. Paleo. Min. Spec. Publ.9, pl.109, fig.10,11.
Melonis pompilioides (Fichtel and Moll), Enbysk, 1960, Distribution of Foraminifera in the Northeast Pacific, PhD. Thesis, Univ. Wash., pl.10, fig.21,22; Ingle et al., 1980, Micropaleo. v.26(2), p.9, fig.14,15.

Synoptic description: Test planispiral, symmetrical,

involute, deeply biumbilicate, half as broad as long; wall thick, very coarsely perforate, sutures flush and indistinct; aperture crescentic slit over periphery umbilicus to umbilicus.

Remarks: This form has less breadth than the described M. pompilioides; however, it does have the random coarse perforations. This may be a gradational form between M. pompilioides and M. zaandamae. Specimens from the SE. Indian Ocean have the same gradation of width (Corliss, B.H., 1977, J.Foram. Res. v.9(1), p.50-60.

190 Melonis zaandamae (van Voorthuysen)
Pl.3 figs.13,14

Anomalinoides barleeanum (Williamson) var. zaandamae Van Voorthuysen, 1952, J. Paleo. v.26(4), p.681.
Nonion zaandamae (van Voorthuysen), Loeblich and Tappan, Smith. Misc. Coll. 121, p.87, pl.16, fig.11,12; Vilks, 1969, Micropaleo. v.15(1), pl.3, fig.21.
Gavelinonion barleeanum (Williamson), Barker, 1960, Soc. Econ. Paleo. Min. Spec. Publ.9, pl.109, fig.8.
Nonion barleanus (Williamson), Enbysk, 1960, Distribution of Foraminifera in the Northeast Pacific, PhD. Thesis, Univ. Wash., pl.10, fig.18.
Melonis barleeanum (Williamson), Ingle et al., 1980, Micropaleo. v.26(2), p.113-150.

Synoptic description: Test planispiral, symmetrically involute, biumbilicate, 10-12 chambers per whorl, periphery smoothly rounded, 2 to 3 times as long as broad, septa double, sutures flush; wall densely and coarsaely perforate, hyaline to opaque white; aperture narrow crescentic slit umbilicus to umbilicus along periphery at base of apertural face.

191 Melonis sp.
Pl.5 figs.8,9

?Pullenia sp.1 Enbysk, 1960, Distribution of Foraminifera in the Northeast Pacific, PhD. Thesis, Univ. Wash., pl.21, fig.7,8.

Synoptic description: Test planispiral, symmetrical, involute, periphery rounded or very slightly lobate, 8 chambers per whorl; wall smooth, very finely perforate, partially hyaline; aperture basal slit umbilicus to umbilicus.

Remarks: This species is very similar to P. elegans Cushman and Todd, but lacks the lobate periphery; and has 8 not 7 chambers. The SEM photograph shows secondary apertures? between chambers on lateral faces of test.

192 Hoeglundina bradyi Galloway and Wissler
Pl.4 figs.3,4,5

Epistomina bradyi Galloway and Wissler, 1927, J. Paleo. v.1, p.60, pl.10, fig.1.
Hoeglundina bradyi (Galloway and Wissler), Enbysk, 1960, Distribution of Foraminifera in the Northeast Pacific, PhD. Thesis, Univ. Wash., pl.14, fig.3,4.

Synoptic description: Test trochospiral, biconvex, spiral side strongly convex, involute, 7 chambers in last whorl, periphery carinate, sutures thickened oblique spiral side, nearly radial umbilically; wall smooth, very finely perforate; aperture (primary) wide slit in chamber face near spiral side and parallel to suture between apertural face and previous whorl, (secondary) latero-marginal aperture in each chamber with forward hook, secondarily closed.

Family: Robertinidae Reuss, 1850

Genus: d'Orbigny, 1846

193 Robertina charlottensis (Cushman)

Cassidulina charlottensis Cushman, 1925, Contr. Cush. Lab. Form. Res. v.1 n.11, p.41, pl.6, fig.6,7.
Robertinoides (?) charlottensis (Cushman), Loeblich and Tappan, 1953, Smith. Misc. Coll. v.121, n.7, pl.20, fig.6,7.
Robertina charlottensis (Cushman), Enbysk, 1960, Distribution of Foraminifera in the Northeast Pacific, PhD. Thesis, Univ. Wash., pl.11, fig.1.
Robertina californica Cushman and Parker, 1936, Contr. Cush. Lab. Foram. Res. v.12(4), p.97, pl.16, fig.14.

Synoptic description: Test high trochospiral, numerous chambers/whorl, large broad flat apertural face; wall thin smooth, hyline; aperture single slit up last chamber face.

APPENDIX B

ALPHABETICAL LIST OF SPECIES

6 Ammodiscus planorbis
7 Ammodiscus sp.
35 Ammomassilina? sp.
18 Ammosphaeroidina sphaeroidiniformis
38 Astacolus cf. A. hyalacrulus
39 Astacolus sp.
178 Astrononion? cf. A. bikiniensis

3 Bathysiphon rufus
4 Bathysiphon sp.
16 Bigenerina sp.
132 Brizalina pacifica Pl.4 figs.6,7
133 Brizalina peirsonae
134 Brizalina subdepressa
135 Brizalina sp. Pl.5 figs.10,11
152 Bucella frigida
137 Bulimina barbata
138 Bulimina mexicana
139 Bulimina rostrata Pl.3 figs.11,12
130 Buliminella elegantissima

174 Cassidulina cushmani Pl.4 figs.9,10
136 Cassidulinoides tenuis
177 Chilostomella oolina
173 Cibicides sp.
188 Cibicidoides kullenbergi Pl.4 figs.11,12
15 Cyclammina cancellata
23 Cyclogyra sp.

40 Dentalina cf. D. calomorpha
41 Dentalina pauperata
42 Dentalina? sp.A
43 Dentalina sp.B
44 Dentalina sp.C
19 Dorothia bradyi

20 Eggerella parkerae
175 Ehrenbergina trigona Pl.3 figs.5,6
171 Eilohedra levicula Pl.2 figs.1 to 3
153 Epistominella exigua
169 Eponides tumidulus horvathi Pl.5 figs.1 to 3
170 Eponides sp.

90 Fissurina cf. F. alveata
91 Fissurina alveolata
92 Fissurina apiculata punctulata
93 Fissurina cf. F. kerguelenensis
94 Fissurina cf. F. lucida
95 Fissurina? marginata
96 Fissurina orbignyana
97 Fissurina radiata

98 Fissurina seguenziana
99 Fissurina cf. F. spinulata
100 Fissurina sp. A
101 Fissurina sp. B
102 Fissurina sp. C
103 Fissurina sp. D
104 Fissurina sp. E
105 Fissurina sp. F
106 Fissurina sp. G
107 Fissurina sp. H
108 Fissurina sp. I
109 Fissurina sp. J
110 Fissurina sp. L
111 Fissurina sp. N
112 Fissurina sp. O
113 Fissurina sp. P
114 Fissurina sp. Q
115 Fissurina sp. R
116 Fissurina sp. S
117 Fissurina sp. T
118 Fissurina sp. U
119 Fissurina sp. V
120 Fissurina sp. X
179 Florilus sp. A
180 Florilus sp. B

161 Globigerina bulloides Pl.1 figs.4,5
162 Globigerina quinqueloba Pl.1 figs.10,11
167 Globigerinita glutinata
168 Globigerinita? uvula Pl.1 fig.3
140 Globobulimina hoeglundi?
141 Globobulimina pacifica
176 Globocassidulina sp. Pl.2 fig.13 to 15
163 Globoquadrina dutertrei
164 Globoquadrina hexagona
165 Globoquadrina pachyderma Pl.1 figs.1,2
160 Globorotalia scitula Pl.1 figs.7 to 9
184 Gyroidina io Pl.2 figs.10 to 12
185 Gyroidina neosoldanii
186 Gyroidina sp.

13 Haplophragmoides sphaeriloculus
159 Heronallenia? sp.
192 Hoeglundina bradyi Pl.4 figs.3 to 5

21 Karreriella sp. Pl.5 fig.7

45 Lagena cf. L. auriglobosa
46 Lagena catenula
47 Lagena distoma
48 Lagena elongata
49 Lagena foveolata paradoxa
50 Lagena gibbera
51 Lagena gracilis
52 Lagena gracillima

53 Lagena hispidula
54 Lagena laevis
55 Lagena laevis var.
56 Lagena meridionalis
57 Lagena mollis
58 Lagena nebulosa
59 Lagena stelligera
60 Lagena substriata
61 Lagena sulcata apiculata
62 Lagena sp. A
63 Lagena sp. B
64 Lagena sp. C
68 Laryngosigma cf. L. hyalascidia
65 Lenticulina convergens
66 Lenticulina sp.

22 Martinottiella sp.
33 Miliolinella? sp.
189 Melonis pompilioides Pl.3 figs.10,13
190 Melonis zaandamae Pl.3 figs.14,15
191 Melonis sp. Pl.5 figs.8,9

36 Nodosaria? sp.A
37 Nodosaria? SP.B

69 Oolina borealis
70 Oolina cf. O. botelliformis
71 Oolina desmophora
72 Oolina globosa
73 Oolina globosa setosa
74 Oolina hexagona
75 Oolina lineata?
76 Oolina melo
77 Oolina cf. O. scalariformis-sulcata
78 Oolina seminuda
79 Oolina striato-punctata tricosta
80 Oolina sp. A
81 Oolina sp. B
82 Oolina sp. C
83 Oolina sp. D
84 Oolina sp. E
85 Oolina sp. F
86 Oolina sp. G
87 Oolina sp. H
88 Oolina sp. I
89 Oolina sp. J
166 Orbulina universa Pl.1 fig.6
187 Oridorsalis umbonatus Pl.3 figs.7 to 9

122 Parafissurina biconicoformis
123 Parafissurina fusuliformis
121 Parafissurina kerguelenensis
124 Parafissurina lateralis
125 Parafissurina cf. P. neocurta
126 Parafissurina sp. A

127 Parafissurina sp. B
128 Parafissurina sp. C
129 Parafissurina sp. F
172 Planulina wuellerstorfi Pl.4 figs.1,2
67 Polymorphina sp.
181 Pullenia bulloides Pl.3 figs.1,2
182 Pullenia subcarinata
183 Pullenia sp.
28 Pyrgo cf. P. murrhina
29 Pyrgo sp.
30 Pyrgoella sp.A
31 Pyrgoella sp.B

24 Quinqueloculina sp.A Pl.5 fig.6
25 Quinqueloculina sp.B
26 Quinqueloculina sp.C
27 Quinqueloculina sp.D

8 Reophax guttifer
9 Reophax longicollis
10 Reophax nodulosus
11 Reophax? sp.
1 Rhabdammina? sp.
2 Rhizammina sp.
193 Robertina charlottensis

5 Saccammina sphaerica
34 Scutuloris sp.
131 Sphaeroidina bulloides Pl.3 figs.1,2
12 Spirolocammina? tenuis
142 Stainforthia complanata Pl.4 fig.8
143 Stainforthia cf. S. rotunda
144 Stainforthia seminuda

14 Thalmannammina sp.
151 Trifarina fluens
32 Triloculina frigida
17 Trochammina sp.

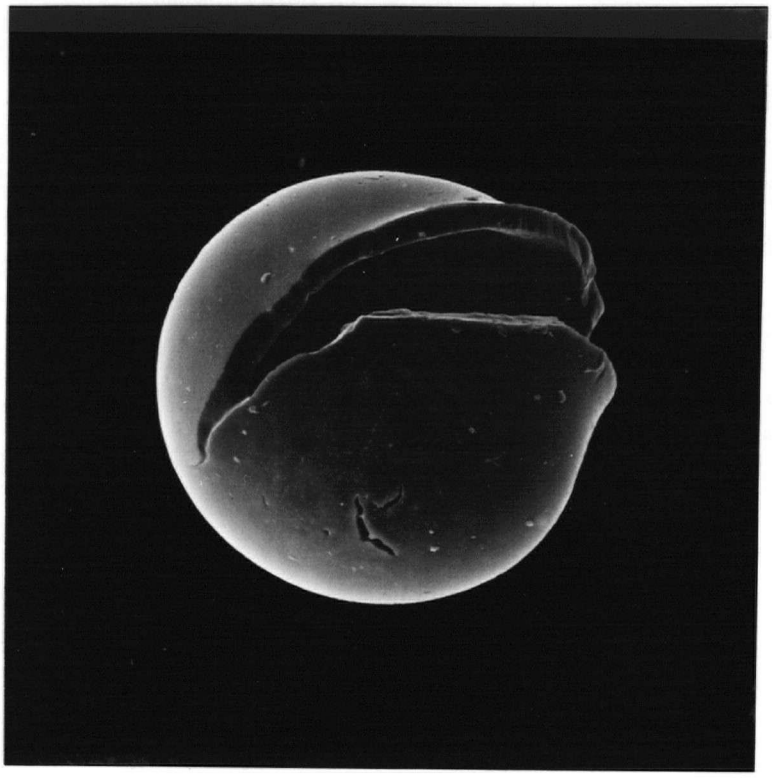
145 Uvigerina auberiana
146 Uvigerina juncea
147 Uvigerina peregrina disrupta
148 Uvigerina senticosa Pl.2 figs.4 to 9
149 Uvigerina sp. A
150 Uvigerina sp. B

154 Valvulineria? arctica Pl.5 figs.4,5
155 Valvulineria cf. V. glabra
156 Valvulineria sp. A
157 Valvulineria sp. B
158 Valvulineria sp. C

APPENDIX C

TENTATIVE LATE PLEISTOCENE BIOSTRATIGRAPHIC MARKER

Plate 6 fig.1



Description:

The above form has been identified as a 'cyst' of an algal Prasinophyte: Pachysphaera sp. (Dr. G. Rouse, pers. comm.). It is 156μ in diameter, transparent and clear to yellow in colour with a single slit opening. None were found still 'encysted'. Some of the perforations which are visible in the SEM photograph do pierce the 'cyst'. The form is untouched by dilute HCl and is believed to be composed of a complex lipoid with little or no cellulose (Wall, D., 1962, Evidence from Recent Plankton Regarding the Biological Affinites of Tasmanites Newton 1875 and Leiosphaeridia Eisenack 1958, Geol. Mag. v.99(4), p.353-362.

*Please note: Pachysphaera sp. has been referred to as a 'dinoflagellate cyst' in line P, Table 3.

APPENDIX D

COMPARISON OF BATHYMETRIC DEPTH ZONES

Bergen and O'Neil, 1979

Neritic
- inner 0 - 50 m.
- middle 49 - 100
- outer 100 - 200

Bathyal
- upper 200 - 600
- middle 600 - 1,600
- lower 1,600 -2,625

Enbysk, 1960

Neritic
- upper and middle 0 - 50m.
- lower 50 - 200

Bathyal
- upper 200 - 500
- mid 500 - 1000
- lower 1000 - 2000

Lower abyssal below 2800 m.

Ingle et al., 1980

Shelf 0 -190 m.

Bathyal
- upper 190 - 800
- upper middle 800 - 1800
- lower middle 1800 - 2550
- lower 2550 - 4500

Abyssal below 4500 m.

APPENDIX E

RADIOCARBON DATING

The ^{14}C dates discussed in this paper were obtained by R. Cook, Dept. Geol. Sci., U.B.C. from:

Dicarb Radioisotope Laboratory
16432 Stone Ridge Rd.
Chagrin Falls, Ohio 44022

The samples were from Core 51, it's location and history are listed in Tables 1 and 2.

Dicarb #1539

-from 0-12 cm.
-20 gms. dry weight containing sand and approximately 7 gms. of foraminifera mostly Globoquadrina pachyderma
-the date obtained was 19,000 BP +840/-930 yrs.

Dicarb #1540

-from 79-82 cm.
-22 gms. dry weight containing sand and approximately 7 gms. of foraminifera mostly Globoquadrina pachyderma
-the date obtained was 23,660 BP +1350/-1620 yrs.