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Foraminifera on the Continental Shelf and Slope off Southern Hawke's Bay, New Zealand

by

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ABSTRACT

Foraminiferal populations are described from a continental shelf and slope devoid of strong currents on the eastern side of North Island, New Zealand.

The large numbers of living specimens per unit area suggest that productivity is high. Except on the turbulent inner shelf, the ratio of living to dead specimens correlates well with estimated rates of deposition. A method is evolved of estimating the contribution of each species to sediment accumulation at each site.

Six, depth-controlled biofacies are described and compared with Tertiary foraminiferal biofacies. It appears that the estimated depth of deposition of some Tertiary *neritic* and *bathyal* faunas may have been somewhat underestimated.

INTRODUCTION

Despite the potential value of foraminifera for closely defining the environments of deposition of ancient sediments in New Zealand, the environment in which many species of benthonic foraminifera now live and are incorporated into the sediment is known in only general terms.

Eade (1967) briefly reviewed studies of Recent foraminifera from the seabed around New Zealand and compiled a checklist of Recent New Zealand species. Most studies are either systematic descriptions or lists of species, either from a single sample or from a few closely spaced samples: distribution studies are rare. Kustanowich (1963) described the distribution of planktonic foraminifera in deep-sea sediments and Hulme (1964) gave a detailed account of the variation of shallow water benthonic species in Manukau Harbour. The only distribution study of benthonic species in the open ocean is by Vella (1957), who described the foraminifera of dried dredge samples from Cook Strait and concluded that strong bottom currents had mixed faunas from different depths so that biofacies could not be recognised.

The following investigation is an attempt to quantitatively define the distribution of foraminifera in an area devoid of strong currents and thereby to provide criteria useful for the recognition of specific environments in ancient, indurated sediments.

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COLLECTION AND PROCESSING OF SAMPLES

Sixteen samples (Table 1; Fig. 1) were collected for detailed quantitative analysis. The two shallowest samples were collected with an orange-peel grab, the remainder with a short gravity corer of 47 mm internal diameter, care being taken with both grab and core samples to prevent washing of the surface sediment. For a more detailed description of techniques *see* Lewis (1970). The area sampled by the corer was about 1700 mm^2 and a similar area was sampled at the two shallowest stations by pressing a piece of core liner into the surface of each grab sample. The same volume of sediment, 17 ml, representing a layer about 10 mm thick, was removed from the surface of each core and grab sample and preserved with 90% ethyl alcohol.

In the laboratory each sample was washed on a sieve with a mesh aperture of 0.06 mm, thereby removing alcohol and all material of silt and clay grade, including some juvenile and small foraminifera. The washed sample was steeped for 12–24 hours in Rose Bengal in order to stain protoplasm (Walton 1952), thereby showing which specimens were alive when collected. The stained sample was washed again on the 0.06 mm sieve and soaked in water for 12–24 hours to remove excess stain from the surface of foraminiferal tests. The sample was then washed through a nest of seven sieves with mesh apertures of 0.50 mm, 0.33 mm, 0.25 mm, 0.17 mm, 0.12 mm, 0.08 mm and 0.06 mm. The sieves sort grains, including foraminifera, according to their width, so that foraminifera on the bottom sieve have widths ranging from 0.08 mm to 0.06 mm.

Each sieve fraction was examined on a water-filled counting tray because many fragile specimens are destroyed by drying. Further, many foraminifera are translucent when wet so that stained protoplasm is easily visible. All benthonic foraminifera on randomly selected squares on the tray were identified and counted until between 100 and 200 specimens had been counted. The total number of specimens and percentage of planktonic specimens in the fraction was then calculated. Each living specimen in the whole fraction was identified and counted. Thus, in each fraction, the number of living and dead specimens of each benthonic species is known. The number in the whole sample was found by adding the numbers in each fraction.

Thirteen subsidiary samples (Table 2; Fig 1) were collected by similar techniques but the volume of each sample was not accurately measured and stained fractions were examined dry. The presence of living and dead specimens of each benthonic species was noted.

TABLE 1. Position and depth of 17 ml samples.

Sample	NZOI Stn	Latitude S	Longitude E	Depth	Zone
1	F662	39° 49′	177° 08′	18 m	inner shelf
2	F630	40° 37′	176° 26.3′	18 m	
3	F661	39° 50′	177° 02.5′	48 m	
4	F636	40° 38.5′	177° 30′	71 m	outer shelf
5	F660	39° 50′	177° 05′	91 m	
6	F659	39° 50′	177° 09′	130 m	
7	F861	40° 01.5′	177° 22′	329 m	bank
8	F609	40° 45′	176° 40′	304 m	upper slope
9	F601	40° 50′	176° 44′	375 m	
10	F863	40° 02′	177° 16.5′	479 m	
11	F599	40° 52′	176° 58′	1 240 m	mid slope
12	F673	40° 11′	177° 51′	1 419 m	
13	F683	40° 08′	177° 32′	1 646 m	
14	F679	40° 22′	177° 55.3′	2 329 m	lower slope
15	F592	40° 50′	177° 42′	2 432 m	
16	F590	40° 59′	177° 59′	2 469 m	

TABLE 2. Position and depth of subsidiary samples.

Sample	NZOI Stn	Latitude S	Longitude E	Depth	Zone
A	B865	40° 13.8′	176° 48.8′	40 m	inner shelf
B	B863	40° 31.6′	176° 39.5′	42 m	
C	B866	40° 15.5′	176° 54.2′	113 m	outer shelf
D	B867	40° 16.6′	176° 58.2′	186 m	
E	B154	40° 21′	177° 12′	142 m	Madden Banks
F	B153	40° 37′	177° 02′	183 m	
G	B868	40° 17.8′	177° 01.8′	276 m	upper slope
H	B881	40° 22.0′	176° 50.2′	427 m	
I	B869	40° 19.0′	177° 05.6′	625 m	
J	B884	40° 27.8′	177° 03.8′	1 439 m	mid slope
K	B885	40° 35′	177° 16′	2 028 m	lower slope
L	F594	40° 56.5′	177° 14′	2 063 m	
M	F862	40° 13′	177° 45′	2 127 m	

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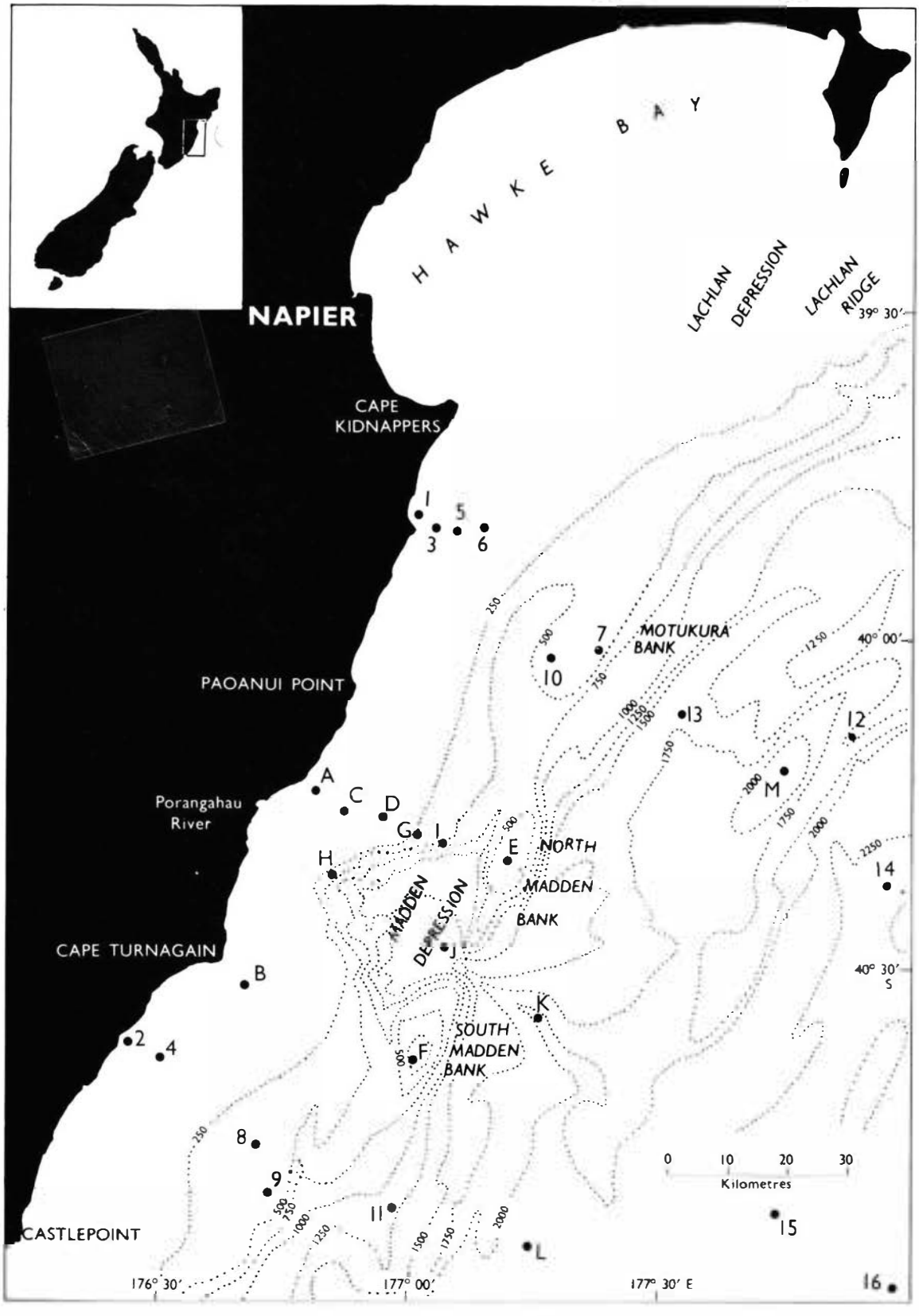

FIG. 1. Map of the continental shelf and slope off Hawke's Bay Land District showing positions of 16 samples used for quantitative analysis (numbers) and 13 subsidiary samples (letters). Depths are in metres.

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THE ENVIRONMENT

The sixteen samples for quantitative analysis consist of three samples from each of five depth zones plus a sample from a bank on the upper continental slope (Table 1). The five depth zones are the inner (continental) shelf at depths of less than 50 m, the outer shelf ranging from 50–200 m deep, the upper slope ranging from 200–1000 m deep, the mid slope ranging from 1000–2000 m deep, and the lower slope at depths of more than 2000 m.

Previous authors have correlated the distribution of foraminiferal species with such environmental factors as hydrostatic pressure, temperature, composition of substrate, turbulence, light intensity, seawater chemistry, availability of food, and effects of predators (Phleger 1960). Many of these factors are either directly or indirectly related to depth. Hydrostatic pressure increases directly with increase in depth and it is known that the distribution of some marine bacteria is limited by hydrostatic pressure (Oppenheimer and Zobell 1952). The depth of each sample was measured with an echo sounder and depths of more than 700 m were corrected with Matthew's (1939) tables (Fig. 2a).

Temperature, at least in a local context, is depth dependent. It was measured on the continental shelf in spring and late summer using a bathythermograph which was allowed to rest briefly on the seabed. Data from the bathythermograph was supplemented by reversing bottle measurements above the continental shelf (Heath 1970) and reversing bottle measurements above the continental slope to the south of the study area (Garner 1961). On the inner shelf the mean annual temperature is about 15°c and the seasonal variation is about 4.5°c (Fig 2b). Mean annual temperature and seasonal variation decrease with increasing depth so that on the mid and lower slope the temperature is less than 5°c and there is virtually no seasonal variation.

Foraminifera live in and on the surface layer of sediment, the composition of which is critical for at least some species. Many fragile species could not survive on sand that is subject to continuous movement. Sediment composition in turn affects food supply; muds, at least those that are well oxygenated, might be expected to harbour a richer supply of food than clean sand. The surface 5–10 mm of all mud cores was yellow-brown and presumably well oxygenated, whereas the underlying mud was greenish-grey and presumably a reducing environment. The grain size of the sediment immediately beneath the layer used for foraminiferal analysis was analysed by normal sieving and pipetting techniques (Fig. 2c). The three samples from the inner shelf are predominantly detrital sand; all other samples contain less than 10% detrital sand. In general the sediment becomes finer offshore but samples from banks and local highs on the continental slope contain as much as 70% sand-sized grains, which include foraminifera, glauconite and volcanic ash. Nearshore sands are generally more dense than porous offshore sediments, the dry weight of the nearshore sand being about three times greater than that of the same volume (17 ml) of mud, and twice as great as that of the same volume of bank sediment rich in low density, non-detrital, sand grains (Fig. 2d).

The non-detrital component of the sediment consists of air-fall ash, authigenic minerals, and skeletons of animals, including foraminifera. It accumulates relatively slowly on the seabed at most places in the study area. Everywhere except on the slope banks and highs, the non-detrital component is greatly diluted by mixing with relatively rapidly deposited detrital sediment (Lewis 1973a). The rate of deposition is most rapid on the middle part of the continental shelf, where mud is deposited at rates of 1–4 m/thousand years (Lewis 1973b) (Fig. 2e). In continental slope depressions, measured rates of deposition range from 0.02–0.35 m/thousand years (Lewis and Kohn 1973), but rates may be greater in some relatively shallow depressions from which piston cores were not obtained. On continental slope banks rates are less than 0.02 m/thousand years. (Lewis 1974a).

DISTRIBUTION OF BENTHONIC SPECIES

The foraminiferal censuses gave the abundance of each species of benthonic foraminifera in the same volume of wet sediment for each station. Walton (1955) pointed out that it is artificial to refer the population to any base other than available living space, and that wet volume is the only natural base for comparison of living marine populations. To compare the results with populations in ancient marine sediments it may be necessary to calculate the number of each species in the same dry weight of sediment using the data in Fig. 2d. The number of specimens in 10 g of dry sediment is the "foraminiferal number" (Schott 1935; Said 1950).

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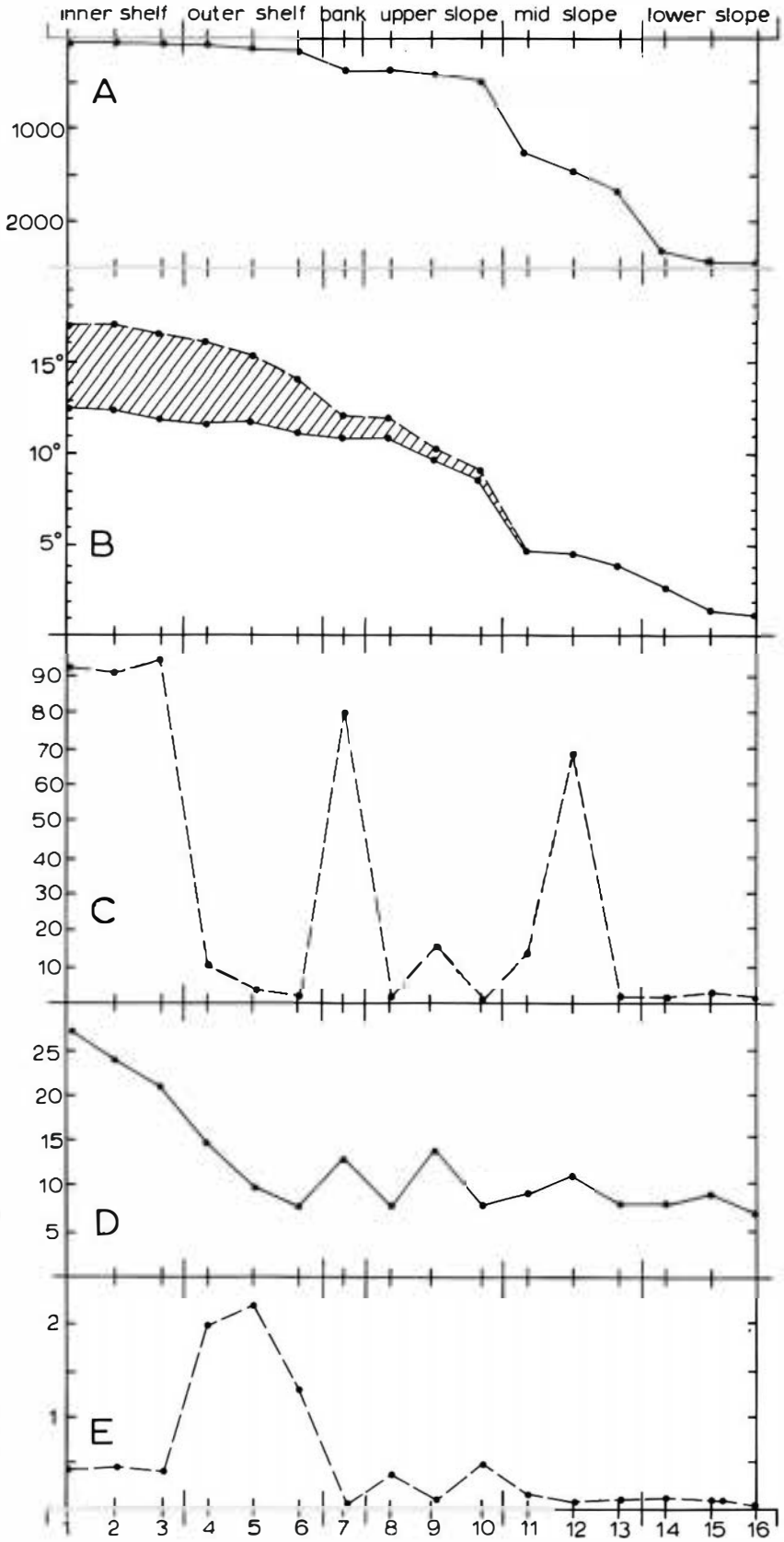

FIG. 2. Frequency polygons showing environmental character at 16 stations. A. Depth in metres. B. Late summer (top) and late winter (lower) temperature on the seabed in degrees centigrade. C. Percentage by weight of sediment coarser than 0.064 mm. D. Dry weight of 17 ml of sediment in grams. E. Estimated rate of sediment deposition in metres per thousand years (from Lewis 1971, 1973b).

Inset 1

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As the foraminifera were sieved into classes of similar width, the mean width of each species may be estimated from the numbers in each class.

Both the abundance and the mean width may be noted conveniently on logarithmic scales (Table 3). The notations for abundance are the $\log_2$, rounded downwards, of the number of foraminfera in 17 ml of wet sediment. The notations for mean width represent classes on $\log_2$ (phi) scale (Krumbein 1936), the class boundaries being at 0.5 ϕ intervals, the same as the mesh diameters of the sieves.

To assess the relative importance of each species to the rate of deposition of sediment, the mean weight of foraminifera in each class was measured using an electrobalance. The mean was calculated using weights from several different stations, with 10 to 100 specimens being weighed from each station. Table 4 shows weights for various sizes and abundances, the mean weight of a single specimen being shown in the left-hand column. Other columns show the mean weight in each abundance class; the second column being the weight of three specimens, the third the weight of six specimens, the fourth the weight of 12 specimens and so on. It is interesting to note that 300-400 small specimens (8a) weigh about as much as a single large specimen (-g).

Table 5 shows the abundance and mean width of each species at each station and by reference to Table 4, the contribution of each species to the sediment. Abundances range from a single specimen (-) to 80,000 specimens (16). There are about 80,000 specimens of *Bolivina robusta* at Station 7, and these 80,000 specimens represent about 100 mg of a sample that weighs 13 g. The depth range and abundance of each species are summarised in the following section. The presence of living specimens is shown in Table 5 by underlining. Actual numbers of living specimens are not shown because the distribution of living populations is patchy (J. V. Eade, pers. comm).

TABLE 3. Notations for foraminiferal abundance and size.

Notation	Number of foraminifera in 17 ml of wet sediment	Notation	Mean width from abundance on sieves
-	1	g	>0.50 mm
1	2–3	f	0.33–0.50 mm
2	4–7	e	0.25–0.33 mm
3	8–15	d	0.17–0.25 mm
4	16–31	c	0.12–0.17 mm
5	32–63	b	0.08–0.12 mm
6	64–127	a	0.06–0.08 mm
7	128–255		
8	256–511		
9	512–1 023		
10	1 024–2 047		
11	2 048–4 095		
12	4 096–8 191		
13	8 192–16 383		
14	16 384–32 767		
15	32 768–65 535	Underlining indicates presence	
16	65 536–131 069	of living specimens.	

TABLE 4. Weight of foraminifera as a function of size and abundance: letters for size and numbers for abundance as in Table 3. Weights at bottom are in micrograms, weights in centre are in milligrams, weights at top right are in grams.

	-	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
g:	140	420	840	1.6	3.4	6.7	13	27	54	108	215	430	860	1.7	3.6	6.9	14
f:	51	153	306	612	1.2	2.4	4.9	10	20	39	78	157	313	627	1.3	2.5	5.0
e:	20	60	120	240	480	960	1.9	3.8	7.7	15	31	61	123	256	492	984	1.9
d:	7.5	22	45	90	180	360	720	1.4	2.8	5.7	12	23	46	92	192	369	738
c:	2.8	8.4	17	34	67	134	269	538	1.1	2.2	4.3	8.6	17	34	72	138	276
b:	1.0	3.0	6.0	12	24	48	96	192	384	768	1.5	3.1	6.1	12	26	49	98
a:	0.4	1.1	2.3	4.6	9.1	18	36	73	146	292	584	1.2	2.3	4.7	9.7	19	37

TABLE 5. Foraminiferal distribution data. Main part shows abundance and mean width of foraminifera at 16 stations, subsidiary part is a list of stations at which each foraminifera occurs. Underlining indicates presence of living specimens, double underlining indicates presence of more than 20 living specimens.

	inner shelf			outer shelf			bank	upper slope			mid slope			lower slope			
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	subsidiary
Adercotryma glomeratum											4a	6a	3b	3a	1b	2b	
Alveolophragmium zealandicum										-g					-g	-g	EGH

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TABLE 5. Continued 2

	inner shelf			outer shelf			bank	upper slope			mid slope			lower slope			subsidiary
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	
Ammobaculites																	
filiformis											1b	3b	2b		2b		
aff. *filiformis*											3b	5c	3b	3b	2b	3b	JKL
Ammodiscus																	
gullmarensis			1c				-a				4c		-c	3b			
planorbis							1d				2f			-d			DGIL
tenuis									-g	-g							G
Ammomarginulina																	
cf. *ensis*							3b			-b		8b	5b	2c			IJKL
cf. *foliaceus*								3e	1e			4c				-d	L
Ammonia																	
aoteanus	2d	2f	2f	-c	1b												ABDG
Ammoscalaria																	
tenuimargo											1g				1f		
Ammosphaeroidina																	
sphaeroidiniformis							-e	-g		2f	3d	4e	1f	1d	-c		J
Amphicoryna																	
hirsuta							6e			1f							GI
separans				2e													EI
Anomalinoides																	
nipponicus					2b	3c	9b										ACDGHIJ
spherica	-a		2d	6b	2d	2a		1b	-b								AB
sp.	3c		1c					6a	7b	5a	5a			5a	1b		ADIM
scabra															2g	1e	J
Astacolus																	
sp.							4d	2c	-c								G
Astrononion																	
novozealandicum	1d	2b		1d	1b	2b	10b	4c	5b	4a	3c		2b				ADGHIK
cf. *tumidum*					-b		8b					-c			1c		
Bathysiphon																	
aff. *argenteus*											-d	-e			3b		KL
globigeriniformis					1g					-g		4g	2f	2g	2g		L
spp.												1c	1g	4d	3f		KL
Biloculinella																	
depressa									1g								BEF
Bolivina																	
pseudo-plicata	4b		3b		4a	3a		4a	6b	4a	1b	3a	2b				BCDG
robusta	2c	1b		3b	1b	-c	16b	5c	7b	6b	5b		2b				PHI
sphenoides									-b		8a	7b	5b	3a	2b		
Bolivina?																	
sp.						2a	9a		-b								BCD
Bolivinita																	
quadrilaterata			2d							2d	4d			1d	3c	-d	IKM
Brachysiphon																	
corbuliniformis															1g	2g	
Brizalina																	
alata							-c		1e		-d						J
cacozela	-a	2b	1b	7a	2a	2a	6a	1a	1b	2a	2a		2a				CDEGH
earlandi					2a				-a		-c	5c	3a	3b	5a	-b	LM
spathulata	3c	1b	1c	6b											2a		G
aff. *subspinescens*						3b	1b	4b	5b		4c	3b	2b	1b			
Brizalina?																	
karreriana			-d	7d	6d	6c	6d	6c	6b	2c	-c	-f					ABCDGHI
Bulimina																	
aculeata							9d	5d	9d	6c	6c	8c	6c	5d	6d	4d	DGIJKLM
marginata	2c	1d	-a	5c	5d	5c	8c	6b	6d	2c							ACDEGHI
nipponica	-d	-e	2c					-c	4d	1c	3d	7d	2e	2d	1c	1d	DGIJKLM
rostrata											7c	3b	7c	1c	2d		L
Buliminella																	
madagascariensis		1c															I
Cancris																	
maoricus							3g										
Cassidulina																	
carinata	3b		2c	2d	6b	3b	11b	5b	9b	5c	8c	7c	4b	3b	-c	-b	ABDEGHIJM

Inset 1*

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TABLE 5. Continued 3

	inner shelf			outer shelf			bank	upper slope			mid slope			lower slope			subsidiary
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	
Chilostomella																	
cushmani	1c						1d	6d	5c	3d	1d		-f				CDGHIJKL
cf. *oolina*										5b	5d	1d	4c	2c	2d	2e	
Cibicides																	
ihungia							-d	1d	7d	-f	1d						L
marlboroughensis	4c	4d	5c	-f	2b		10e	4d	5e	-d	1d	3b	-c		1d	1e	ABDGHIM
wuellerstorfi							6f	4d	4e		-d	3f	1d	2c			GL
Cornuspiroides																	
foliaceous																	GIL
Cribrononion																	
argenteum			1d	4c	2b	2a											ACDHI
charlottensis	6c	4c	5c	1d	3b	3b					1c					1d	ACD
simplex	4c	2c	3c	3b							3b						AIK
Cribrostomoides																	
wiesneri			2d								-b	5b		2b	4b		
sp.				6d	5d	4d		3c	1d								ACD
Cyclammina																	
cancellata										1g			4d				
aff. *pusilla*								1g									
Cystammina																	
pauciloculata												1c		1d	1d	2b	
Dentalina																	
cf. *caudata*							1c		-b								G
aff. *filiformis*		-b	1c					1g	1d		-b						CG
subemaciata							5f	3d	2f		-g	4c			2b		GI
subsoluta							4f			-e							CGI
Discammina																	
compressa															2d		
Discorbinella																	
cf. *bertheloti*			1c				8c		4c	2c							ACDG
Discorbis																	
dimidiatus	5d	4e	4d			-d											A
Dyocibicides																	
primitiva	3d	2d	3d				2f										AB
Eggerella																	
bradyi											4d	7d	3b	3c	1b	1f	ILM
scabra	2c							2d				5b	-e	-a			ADJ
Ehrenbergina																	
mestayeri	-d		1d				-e										EF
Elphidium																	
novozealandicum	3d	3d	3d	2c													A
Entolingulina																	
sp.																2g	
Epistominella																	
exigua	2a	2b	7a	10a	9a	8a	6a	5a	6a	5a	7a	7a	6a	5b	7b		ACDM
Eponides																	
pusillus	-a		1a				11a	5a	8a	6a	8a	3a	6a	6a			GHIKM
tumidulus							1a					4b	2b				
Euuvigerina																	
peregrina		-d					10e	6f	7e	5e	7d	6e	2c	3e	2e	2e	ADGIJKLM
Evolvocassidulina																	
orientalis	2c		3c	4c	5c		11b	7b	7b	6b	-b	1c	3a		-c		ABCDGHI
Fissurina																	
spp.	2c	1a	1b	-b	2b	1b	5c	3c	6d	1c	6c	6d	2d	3b	4b	2d	ABCDGHILM
Florilus																	
scaphum										2a	4a	5b					
Fursenkoina																	
rotundata							-c	1c	3c	4c	4c	3c			-e		GI
squammosa							1c	5c	1c	2a							DG
Gaudryina																	
convexa																	BEF
Gavelinopsis																	
hamatus	4b	5c	3d				7b					-d					AB
lobatulus						-c	7a	4b	5c	3b	5b	4b					DG

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TABLE 5. Continued 4

	inner shelf			outer shelf			bank	upper slope			mid slope			lower slope			subsidiary
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	
Glabratella																	
radiata	3d	4d	1d														
zealandica	5c	4c	3d	-d													
Globobulimina																	
turgida							1e	3d	2e								CDG
hoeglundina							6e		3e							-d	GH
notovata							1d	2e	2c	2d	1e	5e	1f	2e	4d	4e	DG
cf. *pacifica*											-d		2d	1c	3c		D
Globocassidulina																	
canalisuturata							10d			1e							EF
aff. *inflata*	1a				4a	3a	9a			4a	4a	6a	4b				A
minuta							8a					5b	1b			1b	J
producta	1b					2a	4c				1b	6c	3b	5a	-e	5c	
spherica	-a		2d		-c												A
Glomospira																	
charoides												6c		2b			L
cf. *elongata*												1c					
gordialis									-c		2c	6c		2b		1b	DK
Gyroidina																	
orbicularis	2c	1b	3d			2b	7a	3a	4c	3b	4c	8c	4c	3b	3b		ADGIKLM
Gyroidinoides																	
neosoldanii			1d				-d				1f	5d		2e			JKLM
Haplophragmoides																	
canariensis	2c			1c		2d	-c					-c			1c		ABC
cf. *scitulum*									3b			-b					IJ
sphaeriloculus								-c			4b					-e	DI
subtrullissatus					3e				2g	1c							CDJ
trullissatus															1c		
Heterolepa																	
aff. *dutemplei*							9g		1f								DGJ
Hoeglundina																	
elegans									1e	1d	1e				-g	1e	CDEH
Hopkinsina																	
pacifica					4a	3a	3a	4a	5b	1b	4a						CDGHI
Hormosina																	
globulifera							5f		3e		2e	3b	2d		5c	4c	L
Hyperammina																	
friabilis												-g			1f		L
Karreriella																	
apicularis											3c	6d		3b	1d	1c	K
bradyi												4d					ILM
Lagena																	
spp.			1c	5c	2c	3c	6d	4c	2c	2c	3d	5d	3d	2b	4b	3b	CDGHIM
Lagenammina																	
bulbosa															2b	1b	L
difflugiformis											-b	2c	4b	5b	6b	3c	L
sp.													1a		3b	1b	
Laryngosigma																	
hyalascidia																	B
Laticarinina																	
altocamerata							5d					3d	-c				
pauperata													3d		3b		M
Lenticulina																	
spp.	-d	-d	2d	5b	3e	2d	9f	4d	5d	3f	2d	5d	2a	-e	-b		ABCDEFGIM
Marginulina																	
glabra							2e										M
tenuis							6d										G
Marginulinopsis																	
bradyi							1a										E
Marsipella																	
elongata															1g		KL
Martinottiella																	
cf. *communis*																	GJ
Massilina																	
brodiei	1b																A

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TABLE 5. Continued 5

	inner shelf			outer shelf			bank	upper slope			mid slope			lower slope			subsidiary
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	
Melonis																	
cf. *barleeanum*										2a	5c	5d	1d	3b	3c	1c	JKLM
sphaeroides																1b	
Miliolinella																	
subrotunda	3c		2d	2c													ABEF
Nodosaria																	
calomorpha							-a				1b			1b			JM
simplex																	G
Nonionella																	
bradyi									-c	7b	4a		2b	4a			GKM
aff. *translucens*					2d				-a		6a	4a	3a	7b	7b		
turgida			3c	6c	5b	5b	7b	4c	4c	6b	-a	6b	4a				ACDGHIK
Nonionellina																	
flemingi			6b	8b	7b	7b	9c	5c	8b	6c	-b	3b	3b			3b	ACDHJ
Notorotalia																	
aucklandica				1e				-e									A
clathrata																	AB
finlayi			3d	5c	5d	3d		1c	4e	1d	-c						ACDGHI
inomata		-d			-c					-d							AH
profunda			-c		-d	1d	9f	1e	8e	3d							CGI
zelandica		4d	1f	3d	1f	1g	4d	1f									ACDHI
Oolina																	
spp.	2c	2d	2d	2c	-c		1a		-b	2b		2b	5d	1b			ABDGJI
Oridorsalis																	
tenera				3d	4d	5c	11c	6c	6d	4c	2d	5d	5c	4c			CDGHIKLM
Orthomorphina																	
georgiana	2c		2c		1c												H
Osangularia																	
bengalensis											5c	6d	-c	2b			LM
sp.													2b	1c			J
Parafissurina																	
spp.									-c		1c	3b			1c	1d	BL
Pelosina																	
aff. *bicaudata*											1c		2b		5b	1b	L
didera													-d	-f			
Planodiscorbis																	
rarescens							5e		1d		-d	1b					
Planularia																	
tricarinella								1f									CDG
Planulina																	
aff. *ariminensis*							7b	1f	1f	-b		3c					
Praeglobobulimina																	
spinescens						-d		4d	2c	-d		-d					G
Psammosphaera																	
fusca			-e						3e	1f	1f	1g			1f	1e	ACDJIK
parva											-e						K
Pseudobolivina																	
sp.						1b											D
Pullenia																	
bulloides											3d	8d	2b	2c	3b	1c	LM
subcarinata	-a		1c			1d	7d	2d	5c	1c	4c	6d	1c	1d	3b	-d	DGIKLM
Pyrgo																	
murrhyna									-f		-e			1f	2f		L
pisum							-d	-f	-c				-d				E
Pyrgoella																	
spherica																	GI
Quinqueloculina																	
colleenae																	EF
cooki			1e														A
incisa	3b	1d	2c											-c			A
kapitiensis	1d		2d	4b	-a												ABC
lamarkiana		3d		1f	1f												A
aff. *lata*	4c		5c														B
neosigmoilinoides	4c	5d	4d	1c	3e	2c			-b		-f						AHJ
suborbicularis	1d		2c														A

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TABLE 5. Continued 6

	inner shelf			outer shelf			bank	upper slope			mid slope			lower slope			subsidiary
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	
Quinqueloculina—cont'd.																	
triangularis	2e		2d				-c	1e									ABE
wiesneri									-a		-d			1b	5a		
cf. *venusta*													3a		4a		
Ramulina																	
globulifera							6e			-g							
Rectobolivina																	
columnellaris							3d										
Recurvoides																	
contortus										1f	1c	5d	1c		3c	1a	GIJK
sp.											1g		-f	1g	-f		
Reophax																	I
bacillaris																	
dentaliniformis										-a	3d	4b	3c	3e	2c	5d	LM
distans															1g		K
guttifer								-c			-b			2e	3d	1d	JL
aff. *guttifer*											4b	4b	-c		1f		IJ
micaceus																2d	
scorpiurus				1a	-c			1d		2d							CIJK
subfusiformis							1c										
spp.						2b		-f			4c	4b	3c				L
Rhizammina																	
algaeformis												2g	4e	3e	5f		L
sp.											6f	2f	1g	5f	9f	5d	L
Rosalina																	
bradyi	6b	3c	5d	5b		-b											ABDG
irregularis	4d	3c	2e														AB
paupereques				1d													
Saccammina																	
cushmani							5f		3e		2e	3b	2d		5c	4c	L
sphaerica							-b		2f		2e	1e	1c	-g	1d	-g	J
Saracenaria																	
latifrons							3g	-f									DGH
Scuduloris																	
hornibrooki			2c														K
Seabrookia																	
earlandi							8b		1b	-b		4a		3a	2b		D
sp.											2a			2a			
Sigmoilopsis																	
schlumbergeri											4d	6d	-c	2c	-d	-d	M
wanganuiensis							8c										K
Sigmomorphina																	
lacrimosa																	EF
Siphonaperta																	
crassa																	DEF
macbethi							4g										AB
parvaggluta			-b														B
Siphonina																	
cf. *tubulosa*							8c										
Siphotextularia																	
fretensis							9e	3e	6e		1d	-c					DEG
aff. *fretensis*														2c	1d		
mestayerae																	EI
Siphouvigerina																	
asperula			1c				7d	-d	3d						1d		DGH
interrupta							10b	3c	6b		-c						DGJ
Sphaeroidina																	
bulloides	-e			1d	2d	6d	6e	5d	4d	1e	3d	4d		2d	2d		BCDGHJL
Spirillina																	
obconica																	B
vivipara																-c	AB
Spiroloculina																	
acutimargo		-d									-b	1c					A

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TABLE 5. Continued 7

	inner shelf			outer shelf			bank	upper slope			mid slope			lower slope			subsidiary
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	
Spiroplectammina																	
cf. *biformis*											5a	5a	2a	2a	2b	-d	
Stainforthia																	
concava							-a		1b	2a	1b	5b	3a	4a	6b		D
sp.					3a						4a	-b	3b	3c			
Storthosphaera																	
albida												-g	2b				L
Textularia																	
conica																	ABCEFH
earlandi				6b	2b	2a		2a			1b	5b					AI
proxispira	1d							2b									BH
aff. *sagittula*											-e		-d				F
Thurammina																	
albicans											-b		4b		2d		D
compressa												2d				1b	
Tolypammina																	
vagans															1e	2e	
Trifarina																	
angulosa	1b					2a	10b		6b	-c	7b	5b	5b	3a	3b		DGIJKM
bradyi		-c					6d			1b	1c						
gracilis					2b												A
Triloculina																	
trigonula																	EF
Tritaxis																	
conica												1c					A
Trochammina																	
aff. *globigeriniformis*												5a	2a	3a			JK
inflata							1a		-b	3a	1b	-a	3b	2a	2b		DGIJK
ochracea				-b	3c	1a											H
pusilla				2c	1c	1b	1b	3c	3c	2a	6b	5b	4b	4b	6b		CDIJ
sorosa			4a					2b								4b	BH
squamata	2b		1a	5b		3a			1b		-a						ADH
tasmanica			6b		3a	1c	1c	-c			2c	5b	2b				J
sp.			-a		4a												C
Valvulineria																	
aff. *laevigata*									3d	-a	2b	5c	3b	1c			
Virgulopsis																	
turris	5b	3b	4b	6b	5a	2a										-a	H
Zeaflorilus																	
parri	7c	5d	6c	4b	3b												AGHI

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SYSTEMATIC NOTES ON BENTHONIC SPECIES

NOTE: For synonymies see Eade (1967). Where a reference is given it indicates a figure which is not the original for the species but is considered to represent the same species as the specimens from the study area. Many species are illustrated in Brady's (1884) plates, which have been reprinted by Barker (1960).

Order FORAMINIFERIDA
Suborder TEXTULARIINA
Superfamily AMMODISCACEA
Family ASTRORHIZIDAE
Subfamily ASTRORHIZINAE

Rhizammina algaeformis Brady
Brady 1884, pl. 28, figs 2, 6.

REMARKS: Branching tubes of fine sand and coarse silt.

EXTERNAL TUBE DIAMETER: 0.25–0.30 mm.

DEPTH RANGE: 1419–2432 m, living: 1419–2432 m.

OCCURRENCE: Common on mid and lower slope.

Rhizammina sp.

REMARKS: Similar to *R. algaeformis*, but tubes relatively narrow and wall composed of relatively fine grains; tubes repeatedly branching; tectinous lining collapses when dried to form flat ribbon. More coarsely grained and rougher walls than *Psammatodendron arborescens.*

EXTERNAL TUBE DIAMETER: 0.10–0.15 mm.

DEPTH RANGE: 1240–2469 m, living: 1240–2469 m.

OCCURRENCE: Abundant on mid and lower slope, many specimens living.

Bathysiphon aff. **argenteus** Heron-Allen and Earland

REMARKS: Rigid, pale orange-brown tubes, paler at extremities; wall moderately smooth; test straight or gently curved, occasionally twisted. More robust than *B. argenteus.*

EXTERNAL TUBE DIAMETER: Generally 0.05–0.08 mm, rarely 0.10 mm.

DEPTH RANGE: 1240-2432 m, living: 2432 m.

OCCURRENCE: Rare, on mid and lower slope.

Bathysiphon globigeriniformis Hofker

REMARKS: Pale orange-brown tube with many tests of foraminifera attached, attached foraminifera as much as 0.4 mm in length.

EXTERNAL DIAMETER OF ORANGE-BROWN TUBE: About 0.10 mm.

DEPTH RANGE: 19–2469 m, living: 1419–2469 m.

OCCURRENCE: Common on mid and lower slope, rare elsewhere.

Bathysiphon spp.

REMARKS: Several large diameter forms with walls of coarse silt or very fine sand grains, most specimens having rough finish, some specimens tapered.

EXTERNAL TUBE DIAMETER: 0.12–0.25 mm.

DEPTH RANGE: 1419–2469 m, living: 2028–2329 m.

OCCURRENCE: Common on lower slope, rare on mid slope.

Marsipella elongata Norman
Brady 1884, pl. 24, figs 10, 11, 16, 17.

REMARKS: Wall of coarse silt grains without sponge spicules. Broken specimens resemble *Saculella acuta.*

LENGTH: About 0.5 mm, maximum width about 0.12 mm.

DEPTH RANGE: 2432 m, no living specimens.

OCCURRENCE: Rare, on lower slope only.

Subfamily HIPPOCREPININAE

Hyperammina friabilis Brady

REMARKS: Consistent in shape and texture with type specimens, but varying greatly in size.

LENGTH: 1.1–7.5 mm, maximum external diameter: 0.3–1.7 mm.

DEPTH RANGE: 1419–2432 m, no living specimens.

OCCURRENCE: Rare, on mid and lower slope.

Family SACCAMMINIDAE
Subfamily PSAMMOSPHAERINAE

Psammosphaera fusca Schulze
Brady 1884, pl. 18, fig. 1.

LENGTH: 0.2–0.4 mm.

DEPTH RANGE: 40–2469 m, living: 40–2432 m.

OCCURRENCE: A few specimens at most stations.

Psammosphaera parva Flint
Brady 1884, pl. 18, fig. 4.

LENGTH (excluding spicule): About 0.4 mm.

DEPTH RANGE: 1240–2028 m, living: 2028 m.

OCCURRENCE: Single specimens at two stations on mid and lower slope.

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Subfamily SACCAMMININAE

Saccammina cushmani (Collins)

REMARKS: Originally described as *Proteonina*; test tapering to small aperture.

LENGTH: 0.1–0.3 mm.

DEPTH RANGE: 329–2469 m, living: 329–2432 m.

OCCURRENCE: Common at most places on the continental slope.

Saccammina sphaerica Sars

Brady 1884, pl. 18, fig. 15.

REMARKS: Test spherical with slightly protruding aperture.

LENGTH: 0.3–1.0 mm.

DEPTH RANGE: 329–2469 m, living: 329–1419 m

OCCURRENCE: A few specimens at most stations on slope.

Brachysiphon corbuliniformis Chapman

Lewis 1970, frontispiece.

LENGTH: 0.5–1.0 mm.

DEPTH RANGE: 2432–2469 m, no living specimens.

OCCURRENCE: Rare, only at two deepest stations.

Lagenammina bulbosa (Chapman and Parr)

REMARKS: Originally described as *Proteonina*; tiny with fine grained neck; large specimens of similar shape but with coarse grained neck are referred to *Hormosina globulifera*.

LENGTH: About 0.15 mm.

DEPTH RANGE: 2063–2469 m, living: 2063–2432 m.

OCCURRENCE: Rare, on lower slope only.

Lagenammina difflugiformis (Brady)

Brady 1884, pl. 30, fig. 3; see also original figure.

REMARKS: Some specimens more elongate than Brady's figure, and some have delicate phialine lip (*see* original figure).

LENGTH: 0.28–0.65 mm.

DEPTH RANGE: 1240–2469 m, living: 1240–2469 m.

OCCURRENCE: Abundant on lower slope, common on mid slope.

Lagenammina sp.

REMARKS: Test small, delicate, fusiform, pale orange; wall fine grained; little variation.

LENGTH: About 0.20 mm; width: about 0.09 mm.

DEPTH RANGE: 1649–2469 m, living: 1649 m.

OCCURRENCE: Rare, mid and lower slope.

Pelosina didera (Loeblich and Tappan)

REMARKS: Originally described as *Pelosinella*.

EXTERNAL DIAMETER OF CENTRAL CHAMBER: 0.35 mm.

DEPTH RANGE: 1649–2329 m, no living specimens.

OCCURRENCE: Single specimens at two stations on mid and lower slope.

Pelosina aff. **bicaudata** (Parr)

Loeblich and Tappan 1964, fig. 112, no. 8.

REMARKS: Mostly smaller than Loeblich and Tappan's figured specimen.

LENGTH: 0.3–0.5 mm, maximum width: 0.09–0.16 mm.

DEPTH RANGE: 1240–2469 m, living: 1240–2469 m.

OCCURRENCE: Common at one station on lower slope.

Thurammina albicans Brady

Brady 1884, pl. 37, figs 2–7.

REMARKS: Wall slightly rougher than type specimens and generally yellow-brown rather than white; apertures at right angles.

DIAMETER: About 0.20 mm.

DEPTH RANGE: 186–2432 m, no living specimens.

OCCURRENCE: Rare, mainly on mid and lower slope.

Thurammina compressa Brady

Heron-Allen and Earland 1917, pl. 28, figs 4, 6, 10; pl. 26, fig. 15; Brady 1884, pl. 36, figs 13?, 14 only.

REMARKS: Broadly rounded; thin, white wall; few elongate, randomly distributed papillae. Examination of original material in the British Museum (Natural History) shows Brady's *T. compressa* falls well within the range of variation of *T. heusleri*, which is therefore regarded as a junior synonym of *T. compressa*.

DIAMETER: 0.10–0.20 mm.

DEPTH RANGE: 1419–2469 m.

OCCURRENCE: Rare, on mid and lower slope.

Family AMMODISCIDAE

Subfamily AMMODISCINAE

Ammodiscus gullmarensis Höglund

REMARKS: Surface not polished; coiling tending to become irregular.

LENGTH: 0.18–0.22 mm.

DEPTH RANGE: 48–2329 m, living: 48–1240 m.

OCCURRENCE: Rare, but generally distributed.

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Ammodiscus planorbis Höglund

REMARKS: Wall brown and highly polished.

LENGTH: 0.3–0.5 mm.

DEPTH RANGE: 186–2329 m, living: 276–1240 m.

OCCURRENCE: A few specimens at many stations on slope.

Ammodiscus tenuis Brady

Brady 1884, pl. 38. fig. 5.

REMARKS: Tube laterally compressed.

LENGTH: 0.7–1.6 mm.

DEPTH RANGE: 276–479 m, living: 375 m.

OCCURRENCE: Rare, on upper slope only.

Glomospira charoides (Jones and Parker)

Brady 1884, pl. 38, figs 13, 14.

LENGTH: About 0.25 mm.

DEPTH RANGE: 1419–2329 m, no living specimens.

OCCURRENCE: Common at several stations on mid and lower slope.

Glomospira cf. **elongata** Collins

REMARKS: Smaller than original figures.

LENGTH: About 0.15 mm.

DEPTH RANGE: 1419 m, no living specimens.

OCCURRENCE: Rare, on mid slope.

Glomospira gordialis (Jones and Parker)

Loeblich and Tappan 1964, fig. 122, no. 6.

REMARKS: Many specimens even more irregular than Loeblich and Tappan's figure.

DIAMETER OF TEST: 0.15–0.25 mm, maximum diameter of tube: 0.04–0.06 mm.

DEPTH RANGE: 186–2469 m, living: 375–2329 m.

OCCURRENCE: A few specimens at most stations on slope, most common on mid slope.

Subfamily TOLYPAMMININAE

Tolypammina vagans (Brady)

Brady 1884, pl. 24, figs 1–5.

REMARKS: Cemented to other foraminifera.

EXTERNAL DIAMETER OF TUBE: About 0.08 mm.

DEPTH RANGE: 2432–2469 m, living: 2432 m.

OCCURRENCE: Rare, a few specimens on lower slope.

Superfamily LITUOLACEA
Family HORMOSINIDAE
Subfamily ASCHEMONELLINAE

Aschemonella scabra Brady

Brady 1884, pl. 27, figs 1, 2, 4, 5, 7.

REMARKS: Chamber shape as Brady's but chambers smaller, smallest being flexible.

EXTERNAL DIAMETER OF EACH CHAMBER: 0.5–1.0 mm.

DEPTH RANGE: 2439–2469 m, no living specimens.

OCCURRENCE: Rare, at two deepest stations only.

Subfamily HORMOSININAE

Hormosina globulifera Brady

Brady 1884, pl. 39, figs 1–4; Lewis 1970, frontispiece.

LENGTH: 0.4–1.5 mm.

DEPTH RANGE: 329–2469 m, living: 329–2063 m.

OCCURRENCE: Common at most stations on continental slope.

Reophax bacillaris Brady

Brady 1884, pl. 30, figs 23, 24.

LENGTH: 1.0–1.5 mm, width of final chamber: 0.20–0.30 mm.

DEPTH RANGE: 625 m, no living specimens.

OCCURRENCE: Rare, at single station on upper slope.

Reophax dentaliniformis Brady

Brady 1884, pl. 30, figs 21, 22.

REMARKS: Smaller than Brady's figures and consisting of only 2–4 chambers.

LENGTH: 0.6–1.4 mm, width of final chamber: 0.15–0.30 mm.

DEPTH RANGE: 479–2469 m, living: 479–2469 m.

OCCURRENCE: Moderately common at most stations on mid and lower slope.

Reophax distans Brady

Brady 1884, pl. 31, figs 18, 19.

EXTERNAL DIAMETER OF EACH CHAMBER: About 0.5 mm.

DEPTH RANGE: 2028–2432 m, no living specimens.

OCCURRENCE: Rare, on lower slope.

Reophax guttifer Brady

Brady 1884, pl. 31, figs 10–15

REMARKS: Some specimens have a few projecting spicules – these give the test a hispid appearance.

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EXTERNAL DIAMETER OF CHAMBERS: 0.15-0.22 mm.

DEPTH RANGE: 304–2469 m, living: 1439 m.

OCCURRENCE: Rare on upper and mid slope, common on lower slope.

Reophax aff. **guttifer** Brady

REMARKS: Smaller and more delicate than *R. guttifer*; wall fine grained and almost smooth, 2–4 chambers.

EXTERNAL DIAMETER OF CHAMBERS: 0.11–0.14 mm.

DEPTH RANGE: 1240–2432 m, living: 1240–2432 m.

OCCURRENCE: Moderately common on mid slope.

Reophax micaceus Earland

REMARKS: Test wall includes grains other than mica but shape and size as *R. micaceus*; test of 1–5 chambers.

LENGTH: 0.4–0.9 mm, diameter of chamber: 0.14–0.16 mm.

DEPTH RANGE: 2469 m, no living specimens.

OCCURRENCE: Rare, at single station on lower slope.

Reophax scorpiurus Montfort

Hedley *et al.* 1965, pl. 1, fig. 1.

LENGTH: 0.8–1.2 mm.

DEPTH RANGE: 71–2028 m, living: 71–479 m.

OCCURRENCE: Almost ubiquitous, but rare at any station.

Reophax subfusiformis Earland

Höglund 1947, pl. 9, figs 1, 2, 4.

REMARKS: Coarse grained wall, neck fine with phialine lip.

LENGTH: About 0.9 mm.

DEPTH RANGE: 329 m.

OCCURRENCE: Rare, on Motukura Bank only.

Reophax spp.

REMARKS: Several small, thin-walled species of *Reophax*.

LENGTH: 0.3–0.9 mm.

OCCURRENCE: Common on mid slope.

Family LITUOLIDAE
Subfamily HAPLOPHRAGMOIDINAE

Haplophragmoides canariensis (d'Orbigny)

REMARKS: Small, thin-walled, smooth, moderately compressed. Similar size and shape to Brady's (1884) pl. 35 figs 1, 2, but aperture interiomarginal without lower lip.

LENGTH: 0.25–0.35 mm.

DEPTH RANGE: 18–2432 m, living: 18–2432 m.

OCCURRENCE: Common on shelf, rare on slope.

Haplophragmoides aff. **scitulum** (Brady)

REMARKS: Test tiny, well rounded, with wide apertural face and deep umbilicus, 5–6 chambers in whorl; wall pale orange and polished. Similar in shape to *H. scitulum* of Brady (1884) pl. 34, figs 11–13, but much smaller and fewer chambers in the whorl.

LENGTH: 0.11–0.14 mm.

DEPTH RANGE: 375–1439 m, living: 375–1439 m.

OCCURRENCE: Rare, on upper and mid slope.

Haplophragmoides sphaeriloculus Cushman

REMARKS: Specimens from study area smaller than holotype.

LENGTH: 0.30–0.45 mm.

DEPTH RANGE: 186–2469 m, no living specimens.

OCCURRENCE: Rare, at several stations on slope.

Haplophragmoides subtrullissatus Parr

REMARKS: Test with 5–7 chambers in final whorl, large specimens have 7; wall of fairly large grains neatly fitted together to form smooth surface.

LENGTH: 0.5–1.0 mm.

DEPTH RANGE: 91–1439 m, living: 91–1439 m.

OCCURRENCE: Moderately common on outer shelf and upper slope.

Haplophragmoides trullissata (Brady)

Brady 1884, pl. 40, fig. 13.

REMARKS: Wall is not labyrinthic but shows merely "a few slightly raised reticulations" (Brady 1879); finer-grained, more polished, and darker orange-brown in colour than *H. subtrullissata*; periphery relatively angular.

LENGTH: 0.5–0.9 mm.

DEPTH RANGE: 2432 m, no living specimens.

OCCURRENCE: Rare, at single station on lower slope.

Adercotryma glomeratum (Brady)

Brady 1884, pl. 34, figs 15–18.

LENGTH, ALONG AXIS: About 0.15 mm.

DEPTH RANGE: 1240–2469 m, living: 1240–2469 m.

OCCURRENCE: Common on mid and lower slope.

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Cribrostomoides wiesneri Parr

REMARKS: Usually 6–7 chambers in final whorl of test.

LENGTH: 0.30–0.45 mm.

DEPTH RANGE: 48–2432 m, living: 48–2329 m.

OCCURRENCE: Ubiquitous, common at only a few stations on mid and lower slope.

Cribrostomoides sp.

Wiesner 1931, pl. 11, fig. 135.

REMARKS: Test small, white or pale orange; 5–6 globose chambers in final whorl; wall of coarse grains but moderately smooth finish; aperture at base of terminal face with recessed lower lip.

LENGTH: 0.3–0.5 mm.

DEPTH RANGE: 40–375 m, living: 71–375 m.

OCCURRENCE: Common on outer shelf, rare elsewhere.

Discammina compressa (Goes)

Loeblich and Tappan 1964, fig. 136, no. 10.

REMARKS: Specimens are so coarse grained that it is difficult to see sutures.

LENGTH: 0.4–0.6 mm.

DEPTH RANGE: 2432 m, no living specimens.

OCCURRENCE: Rare, at single station on lower slope.

Recurvoides contortus Earland

REMARKS: Wall of moderately coarse grains, but neatly fitted together and surface smooth or polished.

LENGTH: 0.4–0.7 mm.

DEPTH RANGE: 276–2469 m, living: 276–2469 m.

OCCURRENCE: Moderately common on continental slope.

Recurvoides sp.

REMARKS: Test larger and more globose than *R. contortus*, apertural face broader with more slit-like aperture; wall of large grains but smoothly finished. Possibly the same as specimens assigned to *R. turbinatus* by Loeblich and Tappan (1953), pl. 2, fig. 11.

LENGTH: 0.5–0.8 mm.

DEPTH RANGE: 1240–2432 m, no living specimens.

OCCURRENCE: Rare, on mid and lower slope.

Subfamily CYCLAMMININAE

Cyclammina cancellata Brady

Brady 1884, pl. 37, figs 8–16.

REMARKS: Many specimens with chambers more globose than Brady's specimens.

LENGTH: 1.0–1.5 mm.

DEPTH RANGE: 479–1649 m, no living specimens.

OCCURRENCE: Rare, on upper and mid slope.

Cyclammina aff. **pusilla** Brady

Wiesner 1931, pl. 8, fig. 151.

LENGTH: 0.6–0.7 mm.

DEPTH RANGE: 304 m, no living specimens.

OCCURRENCE: Rare, at single station on upper slope.

Alveolophagmium zealandicum Vella

LENGTH: 0.55–0.80 mm.

DEPTH RANGE: 142–2469 m, living: 2432 m.

OCCURRENCE: Rare, on banks and slope.

Subfamily LITUOLINAE

Ammobaculites filiformis Earland

Earland 1934, pl. 3, figs 11, 13; Brady 1884, pl. 32, fig. 22.

REMARKS: Small, with rough surface and moderately globose chambers; growth tends to be irregular.

LENGTH: 0.4–0.7 mm, width: 0.07 mm.

DEPTH RANGE: 1240–2432 m, living: 1240 m.

OCCURRENCE: Moderately common on mid slope.

Ammobaculites aff. **filiformis** Earland

Earland 1934, pl. 3, fig. 12; Brady 1884, pl. 32, fig. 23.

REMARKS: Relatively smooth walled, chambers not globose and sutures not as deep as *A. filiformis*; growth regular. Appears to be quite distinct from *A. filiformis*.

LENGTH: 0.4–0.7 mm, width: 0.07–0.09 mm.

DEPTH RANGE: 1240–2432 m, living: 1240–2432 m.

OCCURRENCE: Common on mid and lower slope.

Ammomarginulina cf. **ensis** Wiesner

REMARKS: Initial coil same size and shape as *A. ensis* but only 1–3 uncoiled chambers; colour pale orange-brown.

LENGTH: 0.20–0.35 mm.

DEPTH RANGE: 329–2329 m, living: 329–2329 m.

OCCURRENCE: Common at a few station on continental slope.

Ammomarginulina cf. **follaceus** (Brady)

cf. Brady 1884, pl. 33, figs 20–25.

REMARKS: Similar to Brady's figure but with thin, fragile keel of fine grains; rest of test coarse grained; central area orange-brown, keel white.

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LENGTH: 0.5–1.2 mm, width: 0.15–0.25 mm.

DEPTH RANGE: 304–2432 m, living: 304–1419 m.

OCCURRENCE: Moderately common on upper and mid slope.

Ammoscalaria tenuimargo (Brady)

Höglund 1947, pl. 31, fig. 2.

REMARKS: Considerable variation in size of initial coil.

LENGTH: 0.9–1.6 mm.

DEPTH RANGE: 1240–2432 m, living: 1240–2432 m.

OCCURRENCE: Rare, on mid and lower slope.

Family TEXTULARIIDAE
Subfamily SPIROPLECTAMMININAE

Spiroplectammina cf. **biformis** Parker and Jones

Brady 1884, pl. 45, fig. 25.

REMARKS: Some specimens are longer than Brady's figure with one or two uniserial chambers.

LENGTH: 0.20-0.40 mm, width: about 0.08 mm.

DEPTH RANGE: 1240–2469 m, living: 1240–1419 m.

OCCURRENCE: Common on mid slope, moderately common on lower slope.

Subfamily TEXTULARIINAE

Textularia conica d'Orbigny

Brady 1884, pl. 43, figs 13, 14.

LENGTH: 0.4–1.0 mm.

DEPTH RANGE: 40–427 m, living: 42–427 m.

OCCURRENCE: Common on inner shelf and Madden Banks, where sediment is relatively coarse.

Textularia earlandi Parker

Höglund 1947, pl. 13, fig. 1, text-figs 154, 155.

LENGTH: 0.3–0.5 mm.

DEPTH RANGE: 40–1419 m, living: 71–1240 m.

OCCURRENCE: Common on outer shelf.

Textularia proxispira Vella

REMARKS: Specimens show large variation in size.

LENGTH: 0.30–0.75 mm.

DEPTH RANGE: 18–427 m, no living specimens.

OCCURRENCE: Rare, on shelf and upper slope.

Textularia aff. **sagittula** Defrance

Brady 1884, pl. 42, fig. 18.

REMARKS: Test compressed with angular periphery; fine grained with glassy nodes in central portion; periphery white, rest orange-brown; some specimens have conspicuous initial coil.

LENGTH: 0.5–1.1 mm.

DEPTH RANGE: 183–1649 m, no living specimens.

OCCURRENCE: Rare, on middle slope.

Subfamily PSEUDOBOLIVININAE

Pseudobolivina sp.

Heron-Allen and Earland 1922, pl. 4, figs 31–35.

REMARKS: Tiny, fragile, pale orange-brown; twisted growth.

LENGTH: About 0.20 mm.

DEPTH RANGE: 130–186 m, no living specimens.

OCCURRENCE: Rare, on outer shelf.

Siphotextularia fretensis Vella

LENGTH: 0.35–0.65 mm.

DEPTH RANGE: 186–1240 m, living: 186–375 m.

OCCURRENCE: Abundant on banks, common on upper slope.

Siphotextularia aff. **fretensis** Vella

REMARKS: Smaller and narrower than *S. fretensis*, with deeper sutures, thinner, more finely grained wall, and aperture on conspicuous protruding neck.

LENGTH: 0.2–0.4 mm.

DEPTH RANGE: 2329–2432 m, no living specimens.

OCCURRENCE: Rare, on lower slope only.

Siphotextularia mestayerae Vella

LENGTH: About 0.75 mm.

DEPTH RANGE: 142–625 m, no living specimens.

OCCURRENCE: Common on North Madden Bank.

Family TROCHAMMINIDAE
Subfamily TROCHAMMININAE

Trochammina ? aff. **globigeriniformis** (Parker and Jones)

REMARKS: Test tiny, smooth-walled, orange-coloured, with a total of 5–6 globose chambers, 3–4 of them in final whorl; chambers too few to be sure that coiling is trochospiral, it may be streptospiral.

LENGTH: 0.09–0.13 mm.

DEPTH RANGE: 1419–2329 m, living: 1439–2028 m.

OCCURRENCE: Moderately common on mid slope.

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Trochammina inflata (Montague)

Hedley *et al.* 1967, pl. 6, fig. 3; Brady 1884, pl. 41, fig. 4.

REMARKS: Wall fine grained and smooth; 5–5.5 chambers in final whorl; sutures clear but not as depressed as those of *T. rotaliformis*.

LENGTH: 0.18–0.35 mm.

DEPTH RANGE: 329–2432 m, living: 329–1619 m.

OCCURRENCE: A few specimens at most stations on continental slope.

Trochammina ochracea (Williamson)

Hedley *et al.* 1964, fig. 2, no. 2.

REMARKS: Considerable variation in shape and height of sutural ridges on umbilical side.

LENGTH: 0.15–0.25 mm.

DEPTH RANGE: 71–427 m, living: 91–427 m.

OCCURRENCE: Moderately common on outer shelf.

Trochammina pusilla Höglund

REMARKS: Test tiny, coarse grained, fragile, with 3–4 globose chambers in final whorl; very pale orange; considerable variation in height of spire.

LENGTH: 0.15–0.30 mm.

DEPTH RANGE: 71–2432 m, living: 71–2432 m.

OCCURRENCE: Occurs at almost every station from outer shelf to lower slope, common on mid and lower slope.

Trochammina sorosa Parr

Hedley *et al.* 1967, text-figs 11–15.

REMARKS: Test small, orange, fairly smooth, with four chambers in final whorl.

LENGTH: 0.20–0.30 mm.

DEPTH RANGE: 42–2469 m, living: 48–427 m.

OCCURRENCE: Moderately common at a few isolated stations on both shelf and slope.

Trochammina squamata Jones and Parker

Hedley *et al.* 1964, fig. 1, no. 1.

REMARKS: Most specimens smaller and more regular than the figures of Hedley *et al.*; low spires with four chambers in final whorl; wall smooth.

LENGTH: 0.12–0.22 mm.

DEPTH RANGE: 18 m–1240 m, living throughout this range.

OCCURRENCE: Moderately common on shelf, rare on slope.

Trochammina tasmanica Parr

REMARKS: Wall coarser than *T. inflata*, sutures deeper, chambers fewer and more globose.

LENGTH: 0.20-0.43 mm.

OCCURRENCE: Moderately common at many places between inner shelf and mid slope.

Trochammina sp.

REMARKS: Test small with flat spiral side and high domed umbilical side; periphery angular; about three whorls on spiral side and about seven chambers in final whorl; wall relatively coarse for test size but smoothly finished; smaller and more finely grained than *T. planoconvexa*.

LENGTH: 0.10-0.15 mm.

DEPTH RANGE: 48-113 m, living: 48-113 m.

OCCURRENCE: Moderately common on outer shelf.

Ammosphaeroidina sphaeroidiniformis (Brady)

Loeblich and Tappan 1964, fig. 174, no. 1.

REMARKS: Considerable variation in size and wall texture.

LENGTH: 0.30–0.75 mm.

DEPTH RANGE: 329–2432 m, living: 479–2329 m.

OCCURRENCE: A few specimens at most stations on continental slope, common only on mid slope.

Cystammina pauciloculata (Brady)

Brady 1884, pl. 41, fig. 1.

LENGTH: 0.25–0.45 mm.

DEPTH RANGE: 1419–2469 m, living: 2329–2469 m.

OCCURRENCE: Moderately common on lower slope.

Tritaxis conica (Parker and Jones)

Brady 1884, pl. 49, fig. 16.

LENGTH (HEIGHT OF CONE): 0.15 mm.

DEPTH RANGE: 40–1419 m, no living specimens.

OCCURRENCE: Single specimens attached to sand grains at two stations, one on inner shelf and the other on mid slope.

Family ATAXOPHRAGMIIDAE
Subfamily VERNEUILININAE

Gaudryina convexa (Karrer)

Burdett *et al.* 1963, figs 2-6.

LENGTH: 0.7–1.2 mm.

DEPTH RANGE: 42–183 m, no living specimens.

OCCURRENCE: Occurs on the inner shelf and on slope banks where sediment is coarse.

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Subfamily GLOBOTEXTULARIINAE

Eggerella bradyi (Cushman)
Brady 1884, pl. 47, figs 4–6.

REMARKS: Specimens white and mainly calcareous, aperture with raised lip.

LENGTH: 0.4–1.1 mm.

DEPTH RANGE: 625–2469 m, living: 625–1419 m.

OCCURRENCE: Common on mid slope, moderately common on lower slope.

Eggerella scabra (Williamson)
Brady 1884, pl. 47, figs 15–17.

REMARKS: Smaller specimens are more fine grained and have a smoother wall than large specimens.

LENGTH: 0.16-0.35 mm.

DEPTH RANGE: 18–2432 m, living: 1419–1649 m.

OCCURRENCE: A few specimens at many stations, moderately common on mid slope.

Karreriella apicularis (Cushman)
Brady 1884, pl. 46, fig. 17.

REMARKS: Wall coarse grained, rough, and orange-brown.

LENGTH: 0.35-0.85 mm.

DEPTH RANGE: 1240–2469 m, living: 1240-2329 m.

OCCURRENCE: Moderately common on mid and lower slope.

Karreriella bradyi (Cushman)
Brady 1884, pl. 46, figs 1-4, also figs 9, 10.

REMARKS: Most specimens resemble Brady's figures 1–4 but some aberrant specimens resemble figures 9, 10 which Brady and subsequent authors have regarded as a separate species. Aperture slit with raised lip.

LENGTH: 0.60–0.95 mm.

DEPTH RANGE: 625–2127 m, living: 1419 m.

OCCURRENCE: Common at a few stations on the continental slope.

Subfamily VALVULININAE

Martinottiella cf. **communis** (d'Orbigny)
cf. Brady 1884, pl. 48, figs 1-8.

REMARKS: Test smaller than Brady's figures and wall composed of even-sized grains; apertural face flattened with aperture at end of distinct neck.

LENGTH: 1.0–1.9 mm, width: 0.40-0.45 mm.

DEPTH RANGE: 276–625 m, no living specimens.

OCCURRENCE: Rare, at only two stations on the upper slope.

Suborder MILIOLINA
Superfamily MILIOLACEA
Family FISCHERINIDAE
Subfamily CYCLOGRYINAE

Cornuspiroides foliaceus (Philippi)
Brady 1884, pl. 11, fig. 6.

LENGTH: About 0.4 mm.

DEPTH RANGE: 276-2063 m, living: 625 m.

OCCURRENCE: Rare, on upper and lower slope.

Family NUBECULARIIDAE
Subfamily SPIROLOCULININAE

Spiroloculina acutimargo (Brady)
Brady 1884, pl. 10, figs 12, 13.

REMARKS: Brady's fig. 12 is the type figure of *S. acutimargo* and cannot, therefore, be referred to *S. elevata* (Wiesner, quoted in Barker 1960). Specimens illustrated by Vella (1957) pl. 6, figs 122, 123 are considered to be *S. acutimargo*, not *S. disparilis* which is a more elongate form from the Pliocene of Greece.

LENGTH: 0.55–0.95 mm.

DEPTH RANGE: 18-1419 m, no living specimens.

OCCURRENCE: Rare, at several stations on inner shelf and upper slope.

Family MILIOLIDAE
Subfamily QUINQUELOCULININAE

Quinqueloculina colleenae Vella

REMARKS: Chambers quadrate with frilled, carinate periphery; possibly a variant of *Q. cooki.*

LENGTH: 0.75–1.10 mm.

DEPTH RANGE: 142–183 m.

OCCURRENCE: Only on Madden Banks, where common.

Quinqueloculina cooki Vella

REMARKS: Chambers quadrate but not carinate.

LENGTH: 0.35–0.95 mm.

DEPTH RANGE: 40–48 m, no living specimens.

OCCURRENCE: Rare, on inner shelf only.

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Quinqueloculina incisa Vella

REMARKS: Distinguished by having perfectly rounded chambers.

LENGTH: 0.30-0.75 mm.

DEPTH RANGE: 18–2329 m, living: 18–48 m.

OCCURRENCE: Moderately common on inner shelf, single specimen from lower slope.

Quinqueloculina kapitiensis Vella

REMARKS: No specimens have the brownish-yellow bands referred to in the original description and some have their aperture on a slight neck.

LENGTH: 0.35–0.50 mm.

DEPTH RANGE: 18–113 m, living: 18–113 m.

OCCURRENCE: Moderately common on inner and outer shelf.

Quinqueloculina lamarkiana d'Orbigny

Vella 1957, pl. 6, figs 105–107.

REMARKS: Similar to *Q. triangularis* but with an angular periphery that is curved towards the direction of growth.

LENGTH: 0.40–0.80 mm.

DEPTH RANGE: 18–91 m, living: 91 m.

OCCURRENCE: Moderately common on shelf.

Quinqueloculina aff. **lata** Terquem

Vella 1957, pl. 6, figs 112–114.

REMARKS: More elongate than *Q. triangularis* with distinct L-shaped chambers.

LENGTH: 0.25–0.40 mm.

DEPTH RANGE: 18-48 m, living: 18–48 m.

OCCURENCE: Common at some stations on inner shelf.

Quinqueloculina neosigmoilinoides Kennett

Vella 1957, pl. 6, figs 116, 117.

REMARKS: Included are all specimens with subangular periphery that appear sigmoidal in apertural view. Shape in side view varies from elongate specimens similar to holotype to specimens that are almost circular.

LENGTH: 0.35–0.60 mm.

DEPTH RANGE: 18–1439 m, living: 18–427 m.

OCCURRENCE: Common on shelf, single specimens at several stations on slope.

Quinqueloculina suborbicularis d'Orbigny

Vella 1957, pl. 6, figs 105–107.

REMARKS: More nearly circular in side view than *Q. triangularis*, but otherwise similar.

LENGTH: 0.20-0.50 mm.

DEPTH RANGE: 18–48 m, no living specimens.

OCCURRENCE: Rare, on inner shelf.

Quinqueloculina triangularis d'Orbigny

Vella 1957, pl. 6, figs 100, 101, 108; Hedley *etal.* 1965, pl. 2, fig. 8.

REMARKS: Specimens of this species have frequently been recorded as *Q. seminulum*, which is distinctly more elongate (cf. Loeblich and Tappan 1964, fig. 349, no. 1).

LENGTH: 0.5–1.2 mm.

DEPTH RANGE: 18–329 m, living: 42–329 m.

OCCURRENCE: Moderately common on inner shelf and on banks.

Quinqueloculina cf. **venusta** Karrer

REMARKS: Test small, triangular, with slightly raised edges in apertural view, aperture rounded with tooth and sometimes on slight neck, no lip.

LENGTH: 0.23–0.40 mm.

DEPTH RANGE: 1649–2432 m, no living specimens.

OCCURRENCE: Common at two stations on mid and lower slope.

Quinqueloculina wiesneri Parr

REMARKS: Described by Parr (1950) as *Q. anguina* var.; small with aperture on neck and phialine lip.

LENGTH: 0.25–0.30 mm.

DEPTH RANGE: 375–2432 m, living: 2432 m.

OCCURRENCE: Common only on lower slope.

Massilina brodiei Hedley, Hurdle and Burdett

LENGTH: 0.35–0.45 mm.

DEPTH RANGE: 18–40 m.

OCCURRENCE: Rare, on inner shelf only.

Pyrgo murrhyna (Schwager)

Brady 1884, pl. 2, figs 10, 11, 15.

REMARKS: Periphery with two points near base, periphery of some specimens is serrated; aperture rounded with bifid tooth.

LENGTH: 0.9–1.6 mm.

DEPTH RANGE: 372–2432 m, living: 2063 m.

OCCURRENCE: Rare, at only a few stations on slope.

Pyrgo pisum (Schlumberger)

Vella 1957, pl. 7, figs 130, 135, 136, 138, 139, 144, 145.

REMARKS: A large number of specimens from the North Madden Bank show that this is a very variable species. There appears to be continuous variation between

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forms recorded by Vella (1957) as *Biloculina pisum, B. anomala, B. guerreri* and *Pyrgo* aff. *ezo*.

LENGTH: 0.75–1.35 mm.

DEPTH RANGE: 142–1649 m, living: 329–375 m.

OCCURRENCE: Common on North Madden Bank, rare elsewhere.

Pyrgoella sphaera (d'Orbigny)

Brady 1884, pl. 2, fig. 4.

LENGTH: 0.30–0.55 mm.

DEPTH RANGE: 276–625 m, no living specimens.

OCCURRENCE: Rare, on upper slope.

Sigmoilopsis schlumbergeri (Silvestri)

Brady 1884, pl. 8, figs 1-4.

LENGTH: 0.25–0.55 mm.

DEPTH RANGE: 1240–2469 m, living: 1419 m.

OCCURRENCE: Common on mid slope, rare on lower slope.

Sigmoilopsis wanganuienesis Vella

LENGTH: About 0.7 mm.

DEPTH RANGE: 329–2028 m, no living specimens.

OCCURRENCE: Abundant on Motukura Bank, rare elsewhere.

Siphonaperta crassa Vella

REMARKS: A few specimens have a fragile neck with phialine lip preserved.

LENGTH: 0.7–1.1 mm.

DEPTH RANGE: 186–329 m, no living specimens.

OCCURRENCE: Common only on Madden Banks.

Siphonaperta macbeathi Vella

REMARKS: Smaller than most fossil specimens.

LENGTH: 0.3–0.4 mm.

DEPTH RANGE: 40–329 m, living: 40 m.

OCCURRENCE: Occurs where sediments are coarse on inner shelf and on banks.

Siphonaperta parvaggluta (Vella)

REMARKS: Recorded as *Quinqueloculina* by Vella (1957).

LENGTH: 0.20–0.35 mm.

DEPTH RANGE: 42–48 m, no living specimens.

OCCURRENCE: Rare, on inner shelf only.

Triloculina trigonula (Lamarck)

Brady 1884, pl. 3, figs 15, 16.

LENGTH: 0.47–0.67 mm.

DEPTH RANGE: 142–183 m, no living specimens.

OCCURRENCE: On Madden Banks only.

Subfamily MILIOLINELLINAE

Miliolinella subrotunda (Montague)

Brady 1884, pl. 4, fig. 3; pl. 5, figs 10, 11, 13, 14. Loeblich and Tappan 1964, fig. 335, no. 1.

REMARKS: Large specimens are typical of *M. subrotunda*, but small specimens, which tend to be flattened with chambers in a planospiral or streptospiral coil, are similar to *M. australis* (Parr).

LENGTH: 0.25–0.55 mm.

DEPTH RANGE: 18–183 m, living: 42–48 m.

OCCURRENCE: Moderately common on inner shelf and on Madden Banks; may occur only where sediment is relatively coarse.

Biloculinella depressa (d'Orbigny)

Vella 1957, pl. 7, figs 137, 140.

LENGTH: 0.75–1.00 mm.

DEPTH RANGE: 42–375 m, living 42 m.

OCCURRENCE: Inner shelf and Madden Banks where sediment relatively coarse.

Scutuloris hornibrooki (Vella)

LENGTH: About 0.3 mm.

DEPTH RANGE: 48–2028 m, living: 48–2028 m.

OCCURRENCE: Rare, occurs at only two stations, one on the inner shelf, the other on the lower slope.

Suborder ROTALIINA

Superfamily NODOSARIACEA

Family NODOSARIIDAE

Subfamily NODOSARIIDAE

Nodosaris calomorpha Reuss

Brady 1884, pl. 61, figs 23–27.

LENGTH: About 0.3 mm.

DEPTH RANGE: 329–2127 m, no living specimens.

OCCURRENCE: A few specimens at many stations on slope.

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Nodosaria simplex (Silvestri)
Brady 1884, pl. 62, fig. 4.
LENGTH: 0.6–0.7 mm.
DEPTH RANGE: 276 m, no living specimens.
OCCURRENCE: Rare, on upper slope.

Amphicoryna hirsuta (d'Orbigny)
Brady 1884, pl. 63, figs 12–15.
LENGTH: 0.50–0.75 mm.
DEPTH RANGE: 276–625 m, no living specimens.
OCCURRENCE: Common on Motukura Bank, rare elsewhere.

Amphicoryna separans (Brady)
Brady 1884, pl. 63, figs 29–31; pl. 64, figs 16–19; pl. 65, figs 7–9.
REMARKS: All of Brady's figured specimens are from the Pacific, and most of these are from New Zealand. Those recorded as *A. scalaris* by Barker (1960) are immature specimens of *A. separans*. *A. scalaris* (Brady 1884, pl. 63, fig. 28) has no ribs around neck and is probably confined to the Atlantic Ocean.
LENGTH: 0.7–1.8 mm.
DEPTH RANGE: 71–625 m, no living specimens.
OCCURRENCE: Rare, on outer shelf and upper slope.

Astacolus sp.
REMARKS: Angular periphery and broad, globose apertural face; tends towards shape of *Saracenaria*; resembles *Lenticulina altifrons* (Parr), but less tightly enrolled initial coil.
LENGTH: 0.6–0.9 mm.
DEPTH RANGE: 276–375 m, living: 329 m.
OCCURRENCE: Common on Motukura Bank, rare on upper slope.

Dentalina cf. **caudata** d'Orbigny
LENGTH: 0.45–0.90 mm.
DEPTH RANGE: 276–329 m, no living specimens.
OCCURRENCE: Rare, on Motukura Bank and upper slope.

Dentalina spp. aff. **filiformis** (d'Orbigny)
Brady 1884, pl. 63, figs 3–5.
LENGTH: 0.5–2.0 mm.
DEPTH RANGE: 18–1240 m, living: 304–375 m.
OCCURRENCE: A few specimens at many stations.

Dentalina subemaciata Parr
LENGTH: 0.8–2.5 mm.
DEPTH RANGE: 276–2432 m, living: 304–1419 m.
OCCURRENCE: Common Motukura Bank and at some places on upper and mid slope, rare on lower slope.

Dentalina subsoluta (Cushman)
Brady 1884, pl. 62, figs 13–16.
LENGTH: 1.0–4.3 mm.
DEPTH RANGE: 113–625 m, no living specimens.
OCCURRENCE: Common on Motukura Bank, rare on outer shelf and upper slope.

Lagena spp.
REMARKS: It was found difficult to group specimens of *Lagena* into well defined species, so they were counted collectively and the presence of some conspicuous forms was noted. These forms are listed below.

Lagena elongata (Ehrenberg)
Brady 1884, pl. 56, figs 27, 29.
OCCURRENCE: Rare, occurs at several stations on slope.

Lagena gracilis Williamson
Brady 1884, pl. 58, figs 1, 2, 23.
OCCURRENCE: Fairly common on outer shelf and slope.

Lagena gracillima (Seguenza)
(Brady 1884, pl. 56, figs 21, 22.
OCCURRENCE: Rare, on inner shelf only.

Lagena hispida Reuss
Brady 1884, pl. 57, figs 2–4.
OCCURRENCE: Rare, on upper slope and Motukura Bank.

Lagena laevis (Montague)
Brady 1884, pl. 56, figs 7, 8.
OCCURRENCE: Moderately common on banks and slope.

Lagena aff. **laevis** (Montague)
Brady 1884, pl. 57, fig. 14.
OCCURRENCE: Rare, on outer shelf and slope.

Lagena plumigera Brady
Brady 1884, pl. 58, figs 18, 25, 27.
OCCURRENCE: Rare, outer shelf and upper slope.

Lagena striata (d'Orbigny)
Brady 1884, pl. 57, figs 22, 24, 28.
OCCURRENCE: Common from inner shelf to mid slope.

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Lagena sulcata (Walker and Jacobs)
Brady 1884, pl. 58, figs 4, 17.
OCCURRENCE: Rare, on Motukura Bank and slope.

Lenticulina spp.
REMARKS: Many species of *Lenticulina* are very variable and it was found difficult to assign many specimens to particular species. Therefore, all specimens of *Lenticulina* were counted collectively and the presence of some conspicuous species was noted. These species are listed below.
OCCURRENCE: Present in most samples, but common on outer shelf and upper slope, and abundant on banks.

Lenticulina calcar (Linnaeus)
Brady 1884, pl. 70, figs 11, 12.
REMARKS: Test with glassy spines around periphery.
OCCURRENCE: Rare, on upper slope only.

Lenticulina cultratis (Montfort)
Hedley *et al.* 1965, pl. 4, fig. 15.
REMARKS: Test with sharp keel, and umbilical plug.
OCCURRENCE: Occurs at most stations from inner shelf to lower slope, common on banks.

Lenticulina gibba (d'Orbigny)
Hedley *et al.* 1965, pl. 3, fig. 11.
REMARKS: Test without keel and umbilical plug or with very small umbilical plug.
OCCURRENCE: Rare, on outer shelf and upper slope.

Lenticulina loculosa (Stache)
Hornibrook 1961, pl. 4, fig. 63.
REMARKS: Test with many chambers in whorl, large umbilical plug, keel.
OCCURRENCE: Rare, outer shelf to mid slope.

Lenticulina peregrina (Schwager)
Brady 1884, pl. 68, figs 11–16.
REMARKS: One of the few really distinctive species.
OCCURRENCE: Common and living on upper slope, common on Motukura Bank, single specimens on outer shelf and on mid slope.

Lenticulina subgibba Parr
Hedley *et al.* 1965, pl. 3, fig. 12.
REMARKS: Test flaring and without keel.
OCCURRENCE: Rare, on outer shelf and upper slope.

Lenticulina suborbicularis (Parr)
Hedley *et al.* 1965, pl. 5, fig. 16.
REMARKS: Test small and with spiral sutures.
OCCURRENCE: Rare, on bank and on inner shelf.

Lenticulina tasmanica (Parr)
Hedley *et al.* 1965, pl. 5, fig. 17.
REMARKS: Test with few chambers, large glassy umbilical plug, and keel.
OCCURRENCE: Rare at isolated stations on inner shelf and on mid slope.

Marginulina glabra d'Orbigny
Loeblich and Tappan 1964, fig. 406, no. 10.
LENGTH: 0.8–1.1 mm, width: 0.40–0.55 mm.
DEPTH RANGE: 329–2127 m, no living specimens.
OCCURRENCE: Rare, at only two stations on upper and lower slope.

Marginulina tenuis Bornemann
Brady 1884, pl. 66, fig. 21.
LENGTH: 1.1–1.6 mm, width: 0.19–0.24 mm.
DEPTH RANGE: 276–329 m, no living specimens.
OCCURRENCE: Common on Motukura Bank, rare on upper slope.

Marginulinopsis bradyi (Goes)
Brady 1884, pl. 65, fig. 12.
REMARKS: Specimens appear to be referable to *Marginulina*, but may be within the range of variation of *Marginulinopsis bradyi*.
LENGTH: 1.6–3.2 mm, width: 0.50–0.55 mm.
DEPTH RANGE: 142–329 m, no living specimens.
OCCURRENCE: Rare, on banks.

Orthomorphina georgiana (Cushman)
REMARKS: Described as *Nodogenerina*.
LENGTH: About 0.6 mm.
DEPTH RANGE: 18–429 m, no living specimens.
OCCURRENCE: Rare, on shelf and upper slope.

Planularia tricarinella (Reuss)
Hedley *et al.* 1965, pl. 4, fig. 13.
LENGTH: 0.5–1.1 mm.
DEPTH RANGE: 113–304 m, living: 113–276 m.
OCCURRENCE: Rare, on outer shelf and upper slope.

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Saracenaria latifrons (Brady)

Brady 1884, pl. 113, fig. 11.

REMARKS: Sharp angles at each of three corners of test.

DEPTH RANGE: 186–427 m, living: 427 m.

OCCURRENCE: Common on Motukura Bank, rare on upper slope.

Family POLYMORPHINIDAE
Subfamily POLYMORPHININAE

Sigmomorphina lacrimosa Vella

LENGTH: 1.2–1.8 mm.

DEPTH RANGE: 142–183 m, no living specimens.

OCCURRENCE: Only on Madden Banks.

Subfamily RAMULININAE

Ramulina globulifera Brady

Brady 1884, pl. 76, figs 22–28.

LENGTH OF INDIVIDUAL CHAMBERS: 0.3–0.5 mm.

DEPTH RANGE: 329–479 m, no living specimens.

OCCURRENCE: Common on Motukura Bank, rare on upper slope.

Family GLANDULINIDAE
Subfamily GLANDULININAE

Entolingulina sp.

REMARKS: Test has three chambers in rectilinear series.

LENGTH: 1.65 mm.

DEPTH RANGE: 2469 m, living: 2469 m.

OCCURRENCE: Only at deepest station.

Laryngosigma hyalascidia Loeblich and Tappan

Loeblich and Tappan 1964, fig. 421, no. 9.

LENGTH: 0.45 mm.

DEPTH RANGE: 42 m, no living specimens.

OCCURRENCE: Rare, at single station on inner shelf.

Subfamily SEABROOKIINAE

Seabrookia earlandi Wright

REMARKS: Final chamber not completely enclosing earlier chambers.

LENGTH: 0.16-0.25 mm.

DEPTH RANGE: 186–2432 m, living: 329–1419 m.

OCCURRENCE: Common at many stations on slope.

Seabrookia sp.

REMARKS: Chambers even less embracing than *S. earlandi*; reminiscent of *Edentostomina*, but wall clear and glassy.

LENGTH: 0.16–0.20 mm.

DEPTH RANGE: 1240–2329 m, living: 1240 m.

OCCURRENCE: Occurs at only two stations on mid and lower slope.

Subfamily OOLININAE

Oolina spp.

REMARKS: As with *Lagena* and *Lenticulina* it was found difficult to assign many specimens to recognised species. Those species that definitely occur are listed below.

OCCURRENCE: Most specimens on the shelf are *O. melo*, those on the slope are referred to many species.

Oolina apicularis Reuss

Brady 1884, pl. 56, fig. 15.

OCCURRENCE: Rare, on outer shelf.

Oolina botelliformis (Brady)

Brady 1884, pl. 56, fig. 6.

OCCURRENCE: Rare, on lower slope.

Oolina felsinea (Fornasini)

Brady 1884, pl. 56, fig. 4.

OCCURRENCE: Rare, on lower slope.

Oolina globosa (Montague)

Brady 1884, pl. 56, figs 1–3.

OCCURRENCE: Ubiquitous but rare.

Oolina hexagona (Williamson)

Loeblich and Tappan 1953, pl. 14, figs 1, 2.

OCCURRENCE: Rare, on shelf, upper slope and banks.

Oolina melo d'Orbigny

Loeblich and Tappan 1953, pl. 12, figs 8–15.

OCCURRENCE: Common on inner shelf, moderately common on outer shelf and rare on upper slope.

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Oolina ovum (Ehrenberg)
Brady 1884, pl. 56, fig. 5.
OCCURRENCE: Rare, on lower slope.

Fissurina spp.
REMARKS: Many specimens of *Fissurina* could not be assigned to known species, but those species that were recognised are listed below.

Fissurina annectens (Burrows and Holland)
Brady 1884, pl. 59, fig. 15.
OCCURRENCE: Ubiquitous but rare at any station.

Fissurina clathrata (Brady)
Brady 1884, pl. 60, fig 4.
OCCURRENCE: Rare, at many stations from inner shelf to mid slope.

Fissurina crebra (Matthes)
Brady 1884, pl. 59, fig. 6.
OCCURRENCE: Rare, on upper slope.

Fissurina aff. **cucullata** Silvestri
Brady 1884, pl. 59, fig. 25.
OCCURRENCE: Rare, on upper slope.

Fissurina earlandi Parr
OCCURRENCE: Ubiquitous but rare.

Fissurina kerguelensis Parr
Brady 1884, pl. 59, figs 8, 9.
OCCURRENCE: Ubiquitous but rare.

Fissurina laevigata Reuss
Brady 1884, pl. 114, fig. 8.
OCCURRENCE: Rare, on slope.

Fissurina lucida (Williamson)
OCCURRENCE: Ubiquitous, fairly common on shelf.

Fissurina aff. **orbignyana** Seguenza
Brady 1884, pl. 59, fig. 18.
OCCURRENCE: Rare, on lower slope.

Fissurina revertens (Heron-Allen and Earland)
Heron-Allen and Earland 1932, pl. 11, figs 26–28.
OCCURRENCE: Ubiquitous but rare.

Fissurina squamoso-marginata (Parker and Jones)
Brady 1884, pl. 60, fig. 24.
OCCURRENCE: Rare, on mid slope.

Fissurina submarginata (Boomgart)
Brady 1884, pl. 59, fig. 22.
OCCURRENCE: Rare, on upper slope.

Fissurina unguiculata (Brady)
Brady 1884, pl. 59, fig. 12.
OCCURRENCE: Rare, on upper slope.

Parafissurina spp.
REMARKS: Some specimens of *Parafissurina* could not be assigned to known species. Those species that were recognised are listed below.

Parafissurina curta Parr
OCCURRENCE: Rare, on slope.

Parafissurina quadrata Parr
OCCURRENCE: Rare, on lower slope.

Parafissurina ventricosa (Silvestri)
Loeblich and Tappan 1964, fig. 425, no. 9.
OCCURRENCE: Rare, on lower slope.

Superfamily BULIMINACEA
Family TURRILINIDAE
Subfamily TURRILININAE

Buliminella madagascariensis (d'Orbigny)
Cushman and Parker 1947, pl. 17, figs 15–18.
LENGTH: 0.15–0.35 mm.
DEPTH RANGE: 18–625 m, no living specimens.
OCCURRENCE: Rare, at only two stations on inner shelf and upper slope.

Family SPHAEROIDINIDAE

Sphaeroidina bulloides d'Orbigny
Brady 1884, pl. 84, figs, 1, 2.
REMARKS: The difference between *S. bulloides* and *S. compressa* is not clear so all specimens are referred to the first described species, *S. bulloides;* wall of most specimens is translucent.
LENGTH: 0.18–0.53 mm.

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DEPTH RANGE: 18–2432 m, living: 42–2063 m.

OCCURRENCE: Common everywhere except inner shelf, most common on outer shelf and on Motukura Bank.

Family BOLIVINITIDAE

Bolivinita quadrilaterata (Schwager)

Brady 1884, pl. 42, figs 8–12.

LENGTH: 0.35–0.95 mm.

DEPTH RANGE: 48–2469 m, living: 1419 m.

OCCURRENCE: Moderately common on mid and lower slope.

Bolivina pseudo-plicata Heron-Allen and Earland

LENGTH: 0.15–0.30 mm, width: 0.10–0.13 mm.

DEPTH RANGE: 18–1649 m, living: 48–375 m.

OCCURRENCE: Common from inner shelf to mid slope.

Bolivina robusta Brady

Brady 1884, pl. 53, figs 7–90.

LENGTH: 0.20–0.45 mm, width: 0.15–0.22 mm.

DEPTH RANGE: 18–1649 m, living: 186–375 m.

OCCURRENCE: Moderately common on shelf, abundant on banks, common on upper and mid slope.

Bolivina sphenoides Chapman and Parr

REMARKS: Specimens were compared with topotype material – there is no adequate figure of this species; it is quadrilateral in apertural view and has raised crenulate sutures.

LENGTH: 0.14–0.35 mm, width: 0.11–0.19 mm.

DEPTH RANGE: 375–2469 m, living: 1240–1649 m.

OCCURRENCE: Abundant on mid slope, common on lower slope.

Bolivina ? sp.

REMARKS: Has areal aperture so is not typical of the genus *Bolivina*; test oval in apertual view, side view varies from moderately flaring to almost parallel sided. Chambers with retral processes similar to those of *B. pseudo-plicata*; aperture areal with lip; large internal tooth plate.

LENGTH: 0.24–0.36 mm.

DEPTH RANGE: 42–479 m, living: 42–329 m.

OCCURRENCE: Abundant on Motukura Bank, rare elsewhere.

Brizalina alata (Seguenza)

Brady 1884, pl. 53, figs 2, 3.

LENGTH: About 0.7 mm.

DEPTH RANGE: 329–1649 m, no living specimens.

OCCURRENCE: Rare, on Motukura Bank and upper and mid slope.

Brizalina cacozela Vella

REMARKS: More rounded periphery than *B. spathulata* and usually narrower.

LENGTH: 0.20–0.45 mm, width: 0.08–0.14 mm.

DEPTH RANGE: 18–2469 m, living: 18–1240 m.

OCCURRENCE: Common at most stations from inner shelf to mid slope, abundant on middle part of shelf and on banks.

Brizalina earlandi Parr

LENGTH: 0.12–0.48 mm.

DEPTH RANGE: 91–2469 m, living: 375–2432 m.

OCCURRENCE: Common only on mid and lower slope.

Brizalina spathulata (Williamson)

Hedley *et al.* 1965, pl. 6, fig. 22, text-fig. 6.

REMARKS: Test distinctly more carinate than *B. cacozela* and usually more flaring.

LENGTH: 0.25–0.49 mm.

DEPTH RANGE: 18–2432 m, living: 48–71 m.

OCCURRENCE: Common on continental shelf at depths of less than 75 m, a few specimens found in two samples from continental slope.

Brizalina aff. **subspinescens** (Cushman)

REMARKS: Pustulose lower part of each chamber, aperture broad, loop-shaped, partly closed by plate formed by incurved part of apertural face; initial growth tends to be twisted; may be referable to genus *Laterostomella* or perhaps to *Stainforthia*.

LENGTH: 0.15–0.46 mm.

DEPTH RANGE: 130–2329 m, living: 130 m.

OCCURRENCE: Common from outer shelf to mid slope.

Brizalina ? **karreriana** (Brady)

Brady 1884, pl. 53, figs 19–21.

REMARKS: Hedley *et al.* (1967) noted that this species has a radial wall structure and belongs with the Bolivinidae. However, its areal aperture is not typical of the genus *Brizalina*.

LENGTH: 0.28–0.80 mm.

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DEPTH RANGE: 40–1419 m, living: 40–427 m.

OCCURRENCE: Common or abundant on outer shelf, banks and upper slope, rare elsewhere.

Rectobolivina columellaris (Brady)

Brady 1884, pl. 75, figs 15–17.

LENGTH: 0.67–0.92 mm, width: 0.20–0.22 mm.

DEPTH RANGE: 329 m, no living specimens.

OCCURRENCE: Moderately common on Motukura Bank.

Family BULIMINIDAE
Subfamily BULIMININAE

Bulimina aculeata d'Orbigny

Brady 1884, pl. 51, figs 7–9.

LENGTH (WITHOUT BASAL SPINE): 0.2–0.7 mm.

DEPTH RANGE: 180–2469 m, living: 276–2469 m.

OCCURRENCE: Abundant and living at almost every station on slope.

Bulimina marginata d'Orbigny

Hedley *et al.* 1965, text-fig. 5.

LENGTH: 0.15–0.55 mm.

DEPTH RANGE: 18–625 m, living: 40–427 m.

OCCURRENCE: Common on shelf and upper slope, range overlaps with that of *B. aculeata* on upper slope.

Bulimina nipponica Asano

Brady 1884, pl. 5, figs 11–13.

REMARKS: Brady's figures are not *B. costata*, which does not have spines.

LENGTH: 0.20–0.93 mm, but mostly about 0.4–0.5 mm.

DEPTH RANGE: 18–2469 m, living: 186–2329 m.

OCCURRENCE: Moderately common everywhere.

Bulimina rostrata Brady

Cushman and Parker 1947, pl. 28, fig. 34.

REMARKS: Similar to *B. truncanella*.

LENGTH: 0.24–0.28 mm.

DEPTH RANGE: 1240–2432 m, living: 1240–1419 m.

OCCURRENCE: Common on mid slope, rare on lower slope.

Globobulimina turgida (Bailey)

Hedley *et al.* 1965, pl. 7, fig. 26; Höglund 1947, pl. 21, figs 4, 8, text-figs 247–257.

LENGTH: 0.4–0.8 mm.

DEPTH RANGE: 113–375 m, living: 186–304 m.

OCCURRENCE: Moderately common on outer shelf and upper slope.

Globobulimina hoeglundi Uchio

Höglund 1947, text-figs 243–246.

LENGTH: 0.32–0.80 mm.

DEPTH RANGE: 276–2469 m, living: 276–2028 m.

OCCURRENCE: Common on Motukura Bank and at some stations on upper slope.

Globobulimina notovata (Chapman)

Brady 1884, pl. 50, figs 9, 13.

LENGTH: 0.38–1.00 mm.

DEPTH RANGE: 186–2469 m, living: 276–2469 m.

OCCURRENCE: Common everywhere on slope.

Globobulimina cf. **pacifica** Cushman

cf. Brady 1884, pl. 50, fig. 10.

REMARKS: Test narrow, almost parallel sided, with all chambers extending to base; three chambers form exterior surface; wall transparent to translucent.

LENGTH: 0.45–0.57 mm, width: 0.18–0.27 mm.

DEPTH RANGE: 186–2432 m, living: 1649–2329 m.

OCCURRENCE: Moderately common on mid and lower slope.

Praeglobulimina spinescens (Brady)

Loeblich and Tappan 1964, fig. 442, nos 12, 13.

LENGTH: 0.22–0.53 mm.

DEPTH RANGE: 130–1419 m, living: 276–479 m.

OCCURRENCE: Moderately common on upper slope.

Stainforthia concava (Höglund)

Loeblich and Tappan 1964, fig. 442, nos 10, 11.

REMARKS: Specimens have been compared with a single, damaged, topotype specimen of *Virgulina davisi* and appear to have more inflated chambers. However, as pointed out by Höglund (1947), the original description and figures of *V. davisi* are completely inadequate.

LENGTH: 0.20–0.40 mm.

DEPTH RANGE: 329–2432 m, living: 2329–2432 m.

OCCURRENCE: Common at most places on slope, most common on mid and lower slope.

Stainforthia sp.

REMARKS: Test small, fusiform, chambers in twisted biserial arrangement. Aperture and apertural face smaller than *S. concava* but otherwise similar.

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LENGTH: 0.36–0.42 mm, width: 0.10–0.11 mm.

DEPTH RANGE: 91–2329 m, living: 91–1649 m.

OCCURRENCE: Common on mid slope, and at some stations elsewhere.

Family UVIGERINIDAE

Euuvigerina peregrina (Cushman)
Brady 1884, pl. 74, figs 11, 12.

REMARKS: Many specimens have ridges on final chamber broken up into spines; some have long spines near proximal edge.

LENGTH: 0.3–1.1 mm.

DEPTH RANGE: 18–2469 m, living: 276-2329 m.

OCCURRENCE: Rare worn specimens occur on shelf. Abundant on upper slope and on Motukura Bank, common on mid and lower slope.

Hopkinsina pacifica Cushman

REMARKS: Immature specimens do not have an areal aperture but have a *Bulimina*-type slit.

LENGTH: 0.18-0.38 mm.

DEPTH RANGE: 91–1241 m, living: 91–479 m.

OCCURRENCE: Common from outer shelf to mid slope.

Siphouvigerina asperula (Czjek)
Brady 1884, pl. 75, figs 6, 7, 8.

LENGTH: 0.23–0.63 mm.

DEPTH RANGE: 48–2432 m, living: 186 m.

OCCURRENCE: Ubiquitous, but common only on Motukura Bank.

Siphouvigerina interrupta (Brady)
Brady 1884, pl. 75, figs 12–14.

LENGTH: 0.42–0.65 mm.

DEPTH RANGE: 186–1240 m, living: 186–375 m.

OCCURRENCE: Abundant on Motukura Bank, common on upper slope.

Trifarina angulosa (Williamson)
Brady 1884, pl. 74, figs 15, 16.

LENGTH: 0.12–0.29 mm.

DEPTH RANGE: 18–2432 m, living: 329–2329 m.

OCCURRENCE: Abundant on Motukura Bank, common on slope, rare on shelf.

Trifarina bradyi Cushman
Brady 1884, pl. 67, figs 1–3.

LENGTH: About 0.4 mm.

DEPTH RANGE: 18–1240 m, no living specimens.

OCCURRENCE: Common on Motukura Bank, rare elsewhere.

Trifarina gracilis Vella

LENGTH: About 0.4 mm.

DEPTH RANGE: 71–91 m, no living specimens.

OCCURRENCE: Rare, on outer shelf.

Virgulinopsis turris (Heron-Allen and Earland)
Hedley *et al.* 1967, pl. 9, fig. 5.

LENGTH: 0.09–0.25 mm.

DEPTH RANGE: 18–625 m, living: 18 m.

OCCURRENCE: Common on shelf, single dead specimen from lower slope, large living population on inner shelf.

Superfamily DISCORBACEA
Family DISCORBIDAE
Subfamily DISCORBINAE

Discorbis dimidiatus (Jones and Parker)
Hedley *et al.* 1967, text-figs 28–43.

LENGTH: 0.25–0.72 mm.

DEPTH RANGE: 18–130 m, living: 18–40 m.

OCCURRENCE: Common on inner shelf.

Discorbinella cf. **bertheloti** (d'Orbigny)
cf. Loeblich and Tappan 1964, fig. 453, no. 3.

REMARKS: Domed side of test more involute than Loeblich and Tappan's figure; some specimens tend towards shape of *D. baconica* var. *baconica* as illustrated by Brady 1884, pl. 90, fig. 1; conspicuous umbilical chamber flaps.

LENGTH: 0.28–0.48 mm.

DEPTH RANGE: 40–479 m, living: 276-375 m.

OCCURRENCE: Rare on shelf, common on Motukura Bank and upper slope.

Epistominella exigua (Brady)

REMARKS: Many specimens have more globose chambers and less angular periphery than type figures (Brady 1884, pl. 10, figs 13, 14); all have conspicuous slit extending from base of apertural face towards periphery.

LENGTH: 0.10–0.27 mm.

DEPTH RANGE: 18–2469 m, living: 18–2469 m.

OCCURRENCE: Abundant on outer shelf, common elsewhere.

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Gavelinopsis hamatus Vella

LENGTH: 0.17–0.50 mm.

DEPTH RANGE: 18–1419 m, living: 18–42 m.

OCCURRENCE: Common on inner shelf and on Motukura Bank, rare elsewhere; occurs where sediment is coarse.

Gavelinopsis lobatulus Parr

Brady 1884, pl. 88, fig. 1.

LENGTH: 0.13–0.41 mm.

DEPTH RANGE: 130–1419 m, living: 186–1240 m.

OCCURRENCE: Common on upper slope and mid slope, abundant on banks.

Laticarinina altocamerata (Heron-Allen and Earland)

Brady 1884, pl. 93, fig. 2.

LENGTH: 0.3–0.4 mm.

DEPTH RANGE: 329–1649 m, no living specimens.

OCCURRENCE: Common on Motukura Bank, rare on upper and mid slope.

Laticarinina pauperata (Parker and Jones)

Brady 1884, pl. 104, figs 3–11; Eade 1967, frontispiece.

LENGTH: About 1–2 mm.

DEPTH RANGE: 1649–2432 m, no living specimens.

OCCURRENCE: Moderately common at three stations on mid and lower slope.

Planodiscorbis rarescens (Brady)

LENGTH: 0.3–0.7 mm.

DEPTH RANGE: 329–1419 m, no living specimens.

OCCURRENCE: Common on Motukura Bank, rare on slope.

Rosalina bradyi (Cushman)

Hedley *et al.* 1967, fig. 2, text-figs 50-55.

LENGTH: 0.18-0.55 mm.

DEPTH RANGE: 18–276 m, living: 18–130 m.

OCCURRENCE: Abundant on inner shelf, common on outer shelf.

Rosalina irregularis (Rhumbler)

Hedley *et al.* 1967, pl. 11, fig. 3.

LENGTH: 0.20–0.45 mm.

DEPTH RANGE: 18–48 m, living: 18–42 m.

OCCURRENCE: Common, on inner shelf.

Rosalina paupereques Vella

LENGTH: 0.27 mm.

DEPTH RANGE: 71 m, no living specimens.

OCCURRENCE: Rare, on outer shelf.

Subfamily BAGGININAE

Cancris maoricus Finlay

LENGTH: 0.6–1.5 mm.

DEPTH RANGE: 329 m, no living specimens.

OCCURRENCE: Common on Motukura Bank only.

Valvulineria aff. **laevigata** Phleger and Parker

REMARKS: Test more flaring and apertural flaps larger than *V. laevigata.*

LENGTH: 0.24–0.30 mm.

DEPTH RANGE: 375–2329 m, living: 479–2329 m.

OCCURRENCE: Common on upper and mid slope, rare on lower slope.

Family GLABRATELLIDAE

Glabratella radiata (Vella)

LENGTH: 0.27–0.52 mm.

DEPTH RANGE: 18–48 m, no living specimens.

OCCURRENCE: Common on inner shelf.

Glabratella zealandica (Vella)

LENGTH: 0.17–0.37 mm.

DEPTH RANGE: 18–71 m, no living specimens.

OCCURRENCE: Common on inner shelf.

Family SIPHONINIDAE

Sipbonina cf. **tubulosa** (Cushman)

Brady 1884, pl. 96, figs 5–7.

REMARKS: Frilled keel not as well developed as in Brady's figures; shell opaque.

LENGTH: 0.43–0.60 mm.

DEPTH RANGE: 329 m, no living specimens.

OCCURRENCE: Common, on Motukura Bank only.

Superfamily SPIRILLINACEA
Family SPIRILLINIDAE
Subfamily SPIRILLININAE

Spirillina obconica Brady

Brady 1884, pl. 85, fig. 6.

LENGTH: 0.25 mm.

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DEPTH RANGE: 42 m, no living specimens.

OCCURRENCE: Rare, at single station on inner shelf only.

Spirillina vivipara Ehrenberg

Brady 1884, pl. 85, fig. 2.

LENGTH: 0.15--0.20 mm.

DEPTH RANGE: 40--2469 m, living: 42 m.

OCCURRENCE: A few specimens on inner shelf and single specimen on lower slope.

Superfamily ROTALIACEA
Family ROTALIIDAE
Subfamily ROTALIINAE

Ammonia aoteanus (Finlay)

Hedley *et al.* 1967, pl. 11, fig. 4, text-figs 56-60.

LENGTH: 0.3--0.7 mm.

DEPTH RANGE: 18-276 m, living: 18--48 m.

OCCURRENCE: Moderately common on inner shelf, rare on outer shelf.

Family ELPHIDIIDAE
Subfamily ELPHIDIINAE

Elphidium novozealandicum Cushman

Hedley *et al.* 1967, pl. 12, fig. 4.

LENGTH: 0.20-0.85 mm.

DEPTH RANGE: 18-71 m, no living specimens.

OCCURRENCE: Common on inner shelf.

Cribrononion argenteum (Parr)

Hedley *et al.* 1967, pl. 12, fig. 2.

LENGTH: 0.20--0.38 mm.

DEPTH RANGE: 40--625 m, living: 48--427 m.

OCCURRENCE: Common on outer shelf, rare elsewhere.

Cribrononion charlottensis (Vella)

Hedley *et al.* 1967, pl. 12, fig. 3.

LENGTH: 0.2–0.5 mm.

DEPTH RANGE: 18–2469 m, living: 18–130 m.

OCCURRENCE: Common on shelf, a few dead specimens on slope.

Cribrononion simplex (Cushman)

Hedley *et al.* 1967, pl. 12, fig. 1.

LENGTH: 0.15--0.45 mm.

DEPTH RANGE: 18–2028 m, living: 18--48 m.

OCCURRENCE: Common on shelf at depths of less than 75 m, rare elsewhere.

Subfamily FAUJASININAE

Notorotalia aucklandica Vella

LENGTH: 0.4--0.7 mm.

DEPTH RANGE: 40–304 m, no living specimens.

OCCURRENCE: Rare, on shelf and upper slope.

Notorotalia clathrata (Brady)

LENGTH: 0.5--0.7 mm.

DEPTH RANGE: 40--42 m, living: 42 m.

OCCURRENCE: Rare, on inner shelf only.

Notorotalia finlayi Vella

LENGTH: 0.20-0.45 mm.

DEPTH RANGE: 40–1240 m, living: 48-427 m,

OCCURRENCE: Common on outer shelf and upper slope.

Notorotalia inornata Vella

LENGTH: 0.35--0.60 mm.

DEPTH RANGE: 18-479 m, no living specimens.

OCCURRENCE: Rare, on shelf and upper slope.

Notorotalia profunda Vella

LENGTH: 0.2--0.6 mm, mainly about 0.35 mm.

DEPTH RANGE: 18–625 m, living: 91–329 m.

OCCURRENCE: Abundant on Motukura Bank, common on upper slope, rare on shelf.

Notorotalia zelandica Finlay

Vella 1957, pl. 2, figs 31, 33, 34.

LENGTH: 0.3--1.1 mm.

DEPTH RANGE: 40-625 m, living: 40–186 m.

OCCURRENCE: Common on shelf, rare on upper slope.

Superfamily ORBITOIDACEA
Family EPONIDIDAE

Eponides pusillus Parr

LENGTH: 0.11--0.21 mm.

DEPTH RANGE: 18–2432 m, living: 48-1240 m.

OCCURRENCE: Rare on shelf, very common on slope, abundant on Motukura Bank.

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Eponides tumidulus (Brady)

Brady 1884, pl. 95, fig. 8.

REMARKS: Small, but with more globose chambers than *E. pusillus*.

LENGTH: 0.10–0.12 mm.

DEPTH RANGE: 329–1649 m, living: 1649 m.

OCCURRENCE: Rare, on upper and mid slope.

Family CIBICIDIDAE
Subfamily PLANULININAE

Planulina aff. **ariminensis** d'Orbigny

REMARKS: Has more pronounced apertural flaps than *P. ariminensis* (Loeblich and Tappan 1964, fig. 552, no. 1)

LENGTH: About 0.35 mm.

DEPTH RANGE: 304–1419 m, living: 375 m.

OCCURRENCE: Common on banks, rare on slope.

Subfamily CIBICIDINAE

Cibicides ihungia Finlay

LENGTH: About 0.5 mm.

DEPTH RANGE: 329–2063 m, no living specimens.

OCCURRENCE: Common on upper slope, rare elsewhere.

Cibicides marlboroughensis Vella

REMARKS: Final chambers are added more loosely than early chambers so that some large specimens resemble *C. delicata* although *C. delicata* is generally flatter than large specimens of *C. marlboroughensis*.

LENGTH: 0.17–0.70 mm.

DEPTH RANGE: 18–2469 m, living: 18–304 m.

OCCURRENCE: Common on shelf and upper slope, abundant on Motukura Bank, moderately common on mid and lower slope.

Cibicides wuellerstorfi (Schwager)

Brady 1884, pl. 93, fig. 9.

LENGTH: 0.3–0.7 mm.

DEPTH RANGE: 304–2329 m, no living specimens.

OCCURRENCE: Common on Motukura Bank and upper slope, moderately common on mid and lower slope.

Dyocibicides primitiva Vella

REMARKS: Early coil similar to small *C. marlboroughensis*.

LENGTH: 0.2–0.8 mm.

DEPTH RANGE: 18–1419 m, living: 42 m.

OCCURRENCE: Moderately common on inner shelf and Motukura Bank, rare elsewhere; may be confined to places where suitable rock or shell substrate present.

Family CAUCASINIDAE
Subfamily FURSENKOININAE

Fursenkoina rotundata Parr

Brady 1884, pl. 52, figs 10, 11.

LENGTH: 0.38–0.62 mm.

DEPTH RANGE: 276–2432 m, living: 479–1240 m.

OCCURRENCE: Common on upper and mid slope.

Fursenkoina squammosa (d'Orbigny)

Loeblich and Tappan 1964, fig. 600, nos 1–4.

LENGTH: 0.35–1.08 mm.

DEPTH RANGE: 186-479 m, living: 186–479 m.

OCCURRENCE: Common on upper slope.

Family CASSIDULINIDAE

Cassidulina carinata Silvestri

Hedley *et al.* 1967, pl. 12, fig. 6; Eade 1967, fig. 2, nos 5–9.

LENGTH: 0.11–0.30 mm.

DEPTH RANGE: 18–2469 m, living: 40–1649 m.

OCCURRENCE: Ubiquitous, abundant on Motukura Bank and at places on upper and mid slope, common everywhere else.

Ehrenbergina mestayeri Cushman

Eade 1967, fig. 8, nos 6, 7.

REMARKS: Specimens from the Madden Banks do not have spines around the margin and may have been eroded from Tertiary mudstone.

LENGTH: 0.4-0.7 mm.

DEPTH RANGE: 18–329 m, no living specimens.

OCCURRENCE: Occurs on shelf and on banks, but only where sediment is relatively coarse.

Evolvocassidulina orientalis (Cushman)

Eade 1967, fig. 4, nos 1, 2; Hedley *et al.* 1967, pl. 12, fig. 5.

LENGTH: 0.2–0.5 mm.

DEPTH RANGE: 18–2469 m, living: 40–479 m.

OCCURRENCE: Abundant on banks, common on outer shelf and upper slope, moderately common on inner shelf and mid slope.

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Globocassidulina canalisuturata Eade
Eade 1967, fig. 3, nos 5–7, fig. 5, nos 7–8.

LENGTH: 0.35–0.55 mm.

DEPTH RANGE: 142–479 m, no living specimens.

OCCURRENCE: Abundant on banks.

Globocassidulina aff. **inflata** (Le Roy)
Eade 1967, fig. 4, no. 4.

LENGTH: 0.10–0.22 mm.

DEPTH RANGE: 18–2469 m, living: 130–2329 m.

OCCURRENCE: Common at many stations between outer shelf and mid slope.

Globocassidulina minuta (Cushman)
Eade 1967, fig. 5, nos 2, 3.

LENGTH: 0.2–0.3 mm.

DEPTH RANGE: 329–2469 m, living: 329 m.

OCCURRENCE: Common on Motukura Bank and at one station on mid slope, rare on rest of slope.

Globocassidulina producta (Chapman and Parr)
Eade 1967, fig. 4, no. 5.

LENGTH: 0.17–0.53 mm.

DEPTH RANGE: 18–2469 m, living: 130 m.

OCCURRENCE: Common on Motukura Bank and on mid and lower slope, rare on shelf.

Globocassidulina spherica Eade
Eade 1967, fig. 7, nos 1–3.

LENGTH: 0.2–0.5 mm.

DEPTH RANGE: 18–91 m, no living specimens.

OCCURRENCE: Rare, on shelf only.

Family NONIONIDAE
Subfamily CHILOSTOMELLINAE

Chilostomella cushmani Chapman
Brady 1884, pl. 56, fig. 13.

LENGTH: 0.20–0.75 mm, width: 0.08–0.47 mm.

DEPTH RANGE: 18–2063 m, living: 113–479 m.

OCCURRENCE: Common on upper slope, rare elsewhere.

Chilostomella cf. **oolina** Schwager
Brady 1884, pl. 55, figs 14, 17.

REMARKS: Test with almost parallel sides and bluntly rounded ends.

LENGTH: 0.40–0.85 mm, width: 0.17–0.40 mm.

DEPTH RANGE: 479–2469 m, living: 479–1649 m.

OCCURRENCE: Common on mid and lower slope, generally occurs deeper than *C. cushmani*.

Subfamily NONIONIDAE

Astrononion novozealandicum Cushman and Edwards
Hedley *et al.* 1965, pl. 7, fig. 28.

REMARKS: Small specimens have less distinct sutures than large specimens.

LENGTH: 0.20–0.47 mm.

DEPTH RANGE: 18–2028 m, living: 40–2028 m.

OCCURRENCE: Abundant on banks, common on upper slope, moderately common everywhere else.

Astrononion cf. **tumidum** Cushman and Edwards
cf. Brady 1884, pl. 109, fig. 5.

REMARKS: Test small with about 6–7 chambers in final whorl, early sutures not as deep as in Brady's figures.

LENGTH: 0.25–0.30 mm.

DEPTH RANGE: 91–2432 m, living: 91 m.

OCCURRENCE: Common on Motukura Bank, rare elsewhere.

Florilus scaphum (Fichtel and Moll)
Brady 1884, pl. 109, figs 14, 15.

LENGTH: 0.2–0.3 mm.

DEPTH RANGE: 479–1419 m, no living specimens.

OCCURRENCE: Common on Motukura Bank and on upper slope.

Nonionella bradyi (Chapman)
Brady 1884, pl. 109, fig. 16.

LENGTH: 0.2–0.3 mm.

DEPTH RANGE: 276–2329 m, living: 2028–2329 m.

OCCURRENCE: Common at some stations on slope.

Nonionella aff. **translucens** Cushman

REMARKS: Small; very thin and translucent wall; 6–7 globose chambers in final whorl, sutures deep.

LENGTH: 0.12–0.25 mm.

DEPTH RANGE: 91–2432 m, living: 91–2432 m.

OCCURRENCE: Common on mid and lower slope, rare on outer shelf and upper slope.

Nonionella turgida (Williamson)
Brady 1884, pl. 109, figs 17–19; Cushman 1939, pl. 9, figs 2, 3.

REMARKS: Some specimens have an inflated final

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chamber that droops down over the umbilical area on one side.

LENGTH: 0.12–0.42 mm.

DEPTH RANGE: 40–2063 m, living: 40–1419 m.

OCCURRENCE: Common at all stations from outer shelf to mid slope.

Nonionella flemingi (Vella)
Lewis and Jenkins 1969, pl. 1, figs 1–9.

LENGTH: 0.14–0.38 mm.

DEPTH RANGE: 40–2469 m, living: 40–625 m.

OCCURRENCE: Abundant from mid shelf to upper slope, rare elsewhere.

Pullenia bulloides d'Orbigny
Brady 1884, pl. 84, figs 12, 13.

LENGTH: 0.16–0.23 mm.

DEPTH RANGE: 1240–2469 m, living: 1419–2432 m.

OCCURRENCE: Common on mid and lower slope.

Pullenia subcarinata (d'Orbigny)
Brady 1884, pl. 84, fig. 14.

LENGTH: 0.22–0.40 mm.

DEPTH RANGE: 18–2469 m, living: 329–2432 m.

OCCURRENCE: Rare on shelf, common on slope.

Zeaflorilus parri (Cushman)
Cushman 1939, pl. 9, fig. 12.

LENGTH: 0.20–0.65 mm.

DEPTH RANGE: 18–625 m, living: 18–48 m.

OCCURRENCE: Abundant on inner shelf, moderately common on outer shelf and rare on upper slope.

Family ALABAMINIDAE

Gyroidina orbicularis d'Orbigny
Brady 1884, pl. 115, fig. 6.

REMARKS: Much smaller and much more compressed than *Gyroidinoides neosoldanii*; sutures recurved in immature specimens and almost radial in adults.

LENGTH: 0.21–0.45 mm.

DEPTH RANGE: 18–2432 m, living: 375–1649 m.

OCCURRENCE: Common everywhere.

Oridorsalis tenera (Brady)
Brady 1884, pl. 95, fig. 11.

LENGTH: 0.18–0.46 mm.

DEPTH RANGE: 71–2329 m, living: 71–2329 m.

OCCURRENCE: Common from outer shelf to mid slope, abundant on Motukura Bank.

Family OSANGULARIDAE

Osangularia bengalensis (Schwager)
Brady 1884, pl. 96, fig. 3.

LENGTH: 0.25–0.55 mm.

DEPTH RANGE: 1240–2329 m, living: 1240–2329 m.

OCCURRENCE: Common on mid and lower slope.

Osangularia sp.

REMARKS: Smaller and more thin-walled than *O. bengalensis;* keel not frilled and sutures curved.

LENGTH: 0.22–0.34 mm.

DEPTH RANGE: 625–2329 m, no living specimens.

OCCURRENCE: Rare, on slope.

Gyroidinoides neosoldanii (Brotzen)
Brady 1884, pl. 107, fig. 6.

LENGTH: 0.6–1.1 mm.

DEPTH RANGE: 48–2329 m, living: 2329 m.

OCCURRENCE: A few specimens at many stations.

Family ANOMALINIDAE
Subfamily ANOMALININAE

Anomalinoides nipponicus (Ishizaki)

REMARKS: Original description as *Gyroidina*.

LENGTH: 0.10–0.29 mm.

DEPTH RANGE: 40–1439 m, living: 91–625 m.

OCCURRENCE: Moderately common on outer shelf and upper slope, very common on Motukura Bank.

Anomalinoides spherica (Finlay)

REMARKS: Many specimens are involute on the spiral side and more compressed than typical *A. spherica*; they closely resemble *A. pinguiglabra*.

LENGTH: 0.25–0.50 mm.

DEPTH RANGE: 18–375 m, living: 40–71 m.

OCCURRENCE: Common on shelf, rare on upper slope.

Anomalinoides sp.

REMARKS: Smaller and more compressed than *A. nipponicus*.

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LENGTH: 0.09–0.21 mm.

DEPTH RANGE: 18–2432 m, living: 375–1240 m.

OCCURRENCE: Common on upper slope, occurs at isolated stations elsewhere.

Heterolepa aff. **dutemplei** (d'Orbigny)

REMARKS: Size, shape and wall structure as *H. dutemplei* of Loeblich and Tappan (1964), fig. 623, no. 3, but with supplementary aperture at proximal, peripheral margin of final chamber; one specimen has stained protoplasm streaming from primary and supplementary aperture and is partially covered with sand grains.

LENGTH: 0.6–1.5 mm.

DEPTH RANGE: 186–625 m, living: 625 m.

OCCURRENCE: Common on Motukura Bank, rare elsewhere.

Melonis cf. **barleeanum** (Williamson)
cf. Brady 1884, pl. 109, fig. 8.

REMARKS: Less open umbilicus than Brady's figure.

LENGTH: 0.2–0.5 mm.

DEPTH RANGE: 479–2469 m, living: 1240 m.

OCCURRENCE: Common on mid and lower slope.

Melonis sphaeroides Voloshinova
Brady 1884, pl. 109, figs 10, 11.

REMARKS: The name *M. pompiloides* is retained for Albanian, Pliocene specimens and the name *M. sphaeroides* is used for more globose, more coarsely perforate, Recent specimens.

LENGTH: About 0.25 mm.

DEPTH RANGE: 2469 m, no living specimens.

OCCURRENCE: Rare, only at deepest station.

Superfamily ROBERTINACEA
Family CERATOBULIMINIDAE
Subfamily EPISTOMININAE

Hoeglundina elegans (d'Orbigny)
Brady 1884, pl. 105, figs 3–5.

LENGTH: 0.5–1.0 mm.

DEPTH RANGE: 113–2469 m, living: 113–375m.

OCCURRENCE: A few specimens at many stations on outer shelf and on slope.

THE FORAMINIFERAL FAUNA

The abundance of benthonic foraminifera in each sample is a function of the rate of reproduction, the preservation of empty tests, and the dilution by other sediment. Thus, in 17 ml of wet sediment, numbers range from 400 to 110 000 specimens (Fig. 3a). Samples from the inner shelf contain less than 1000 specimens, most of the others contain 1000–6000 specimens. Benthonic foraminifera are most abundant on the banks where dilution by detrital sediment is minimal. They are least abundant on the inner shelf where there is a relatively large input of detrital sediment, where fragile tests are likely to be destroyed by turbulence, and where food is likely to be scarce. The number of specimens in 10 ml of sediment, a measure used commonly in distributional studies (Phleger 1960) is shown by the scale on the right of Fig. 3a.

The number of living foraminifera on a surface area of 1700 mm^2 ranges from 17–585 specimens (Fig. 3a). Largest numbers occur on the continental shelf at depths of 48–130 m. Walton (1955) found the largest number at similar depths (36–91 m) on the shelf off Mexico. The smallest numbers occur on the innermost part of the continental shelf and on the lower slope. Samples were collected in November when the number of living specimens on the continental shelf might be expected to be less than later in the summer (Walton 1955).

The "standing crop" of foraminifera is commonly expressed as the living population per square metre of seabed (Phleger 1960). Values in the study area range from 10 000–350 000/m^2. These are high compared with abundances of 1000–100 000/m^2 in the Gulf of Maine but comparable with an average of 90 000/m^2 at the Mississippi Delta (Phleger 1960). The living population of benthonic foraminifera is a partial measure of productivity, which is apparently relatively high in the study area.

The total number of species (living and dead) per sample increases from the inner shelf to a maximum on the mid slope (Fig. 3b): i.e., the benthonic foraminiferal population is more diverse on the continental slope than on the shelf. The number of species that are living at each station shows a similar but less marked trend.

Planktonic foraminifera are rare on the continental shelf (Fig. 4a) except at two stations (Nos 1 and 3)

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where the majority of planktonic foraminifera are worn, broken, and filled with sediment, and are probably derived from Tertiary strata on the adjacent land or seabed. However, the majority of foraminiferal tests on the continental slope belong to planktonic species. It is uncertain whether this is due to slow accumulation of benthonic tests or to relatively rapid accumulation of planktonic tests. Planktonic foraminifera tend to sink during their life (Bé 1965) so that it is likely that more are deposited on the slope than on the shelf.

In the benthonic population the relative proportions of the three main suborders Textulariina, Miliolina and Rotaliina change with depth (Fig. 4b). At all depths Rotaliina are dominant, but specimens of the suborder Miliolina are relatively common on the inner shelf and also on the mid and lower slope, where species are different from those on the inner shelf. Specimens of the suborder Textulariina increase in abundance from 2% on the inner shelf to 43% on the lower slope.

Phleger (1955) showed that, at the Mississippi Delta, the percentage of living specimens in the benthonic population is, in general, directly proportional to the rate of deposition. In the present study area the percentage of living specimens in the benthonic population (Fig. 4b) is, in general, higher on the shelf where deposition is relatively rapid (Fig. 2e) than on the slope where deposition is relatively slow, and it is least on the banks where deposition is almost zero. The correlation does not work well on the inner shelf where dead specimens may be removed by turbulence.

The mean width of planktonic, total benthonic, and living benthonic populations has been estimated at each station from the numbers in each sieve class (Fig. 4c). The mean width of planktonic and benthonic specimens ranges from 0.09–0.18 mm and shows no marked trends with changes of depth. However, there appears to be a significant variation in the mean width of living specimens, which are generally smaller than the total benthonic population on the inner shelf but larger elsewhere. The small size of specimens on the inner shelf may be a seasonal phenomenon: samples were collected in early summer when specimens are likely to be immature. The relatively large difference in size between living and dead populations on the continental slope may be partly a result of small dead specimens being transported downslope and thereby depressing the mean width of the total population, and partly a result of large agglutinated species (that form a considerable part of the living population at some places) tending to disintegrate on death so that they are relatively rare in the total population.

BIOFACIES

The above study of individual species and total populations indicates that different environments have distinct foraminiferal faunas. It is seldom clear which environmental factors are controlling each part of the fauna.

The continental shelf (0–200 m) is characterised by:
1. A planktonic to benthonic ratio of less than 50%,
2. A benthonic foraminiferal fauna of less than 60 species, and
3. A mean width of living specimens less than about 0.15 mm.

Species that are common on the shelf and rare or absent on the slope include – *Ammonia aoteanus*, *Brizalina spathulata*, *Cribrononion* spp., *Elphidium novozealandicum*, *Discorbis dimidiatus*, *Miliolinella subrotunda*, *Quinqueloculina* spp. (excluding *Q.* cf. *venusta* and *Q. wiesneri*), *Virgulopsis turris* and *Zeaflorilus parri*. Species that are common on the shelf and also occur on the upper slope include *Bulimina marginata*, *Nonionellina flemingi*, *Notorotalia finlayi* and *N. zelandica*.

The continental slope is characterised by:
1. A planktonic to benthonic ratio of more than 50%,
2. A benthonic fauna of more than 60 species, and
3. A living population with a mean width of more than 0.15 mm.

Species that are common on most of the continental slope but rare or absent on the continental shelf include *Ammomarginulina* spp., *Ammosphaeroidina sphaeroidiniformis*, *Bulimina aculeata*, *Cibicides wuellerstorfi*, *Cyclammina* spp. *Dentalina* spp., *Eponides pusillus*, *Euuvigerina peregrina*, *Globobulimina* spp., *Glomospira* spp., *Hormosina globulifera*, *Laticarinina* spp., *Melonis* cf *barleeanum*, *Nodosaria* spp., *Nonionella bradyi*, *Pyrgo murrhyna*, *Quinqueloculina wiesneri*, *Recurvoides* spp., *Saccammina* spp., *Seabrookia* spp., *Siphotextularia fretensis*, *Stainforthia concava*, *Valvulineria* aff. *laevigata*.

FIG. 3. Frequency polygons showing abundance of benthonic foraminiferal fauna at each station. A. Numbers of specimens in 17 ml of wet sediment, broken line is numbers of living specimens; scale at right shows number of specimens in 10 ml of wet sediment. B. Number of species at each station, broken line is number of species that were living at each station.

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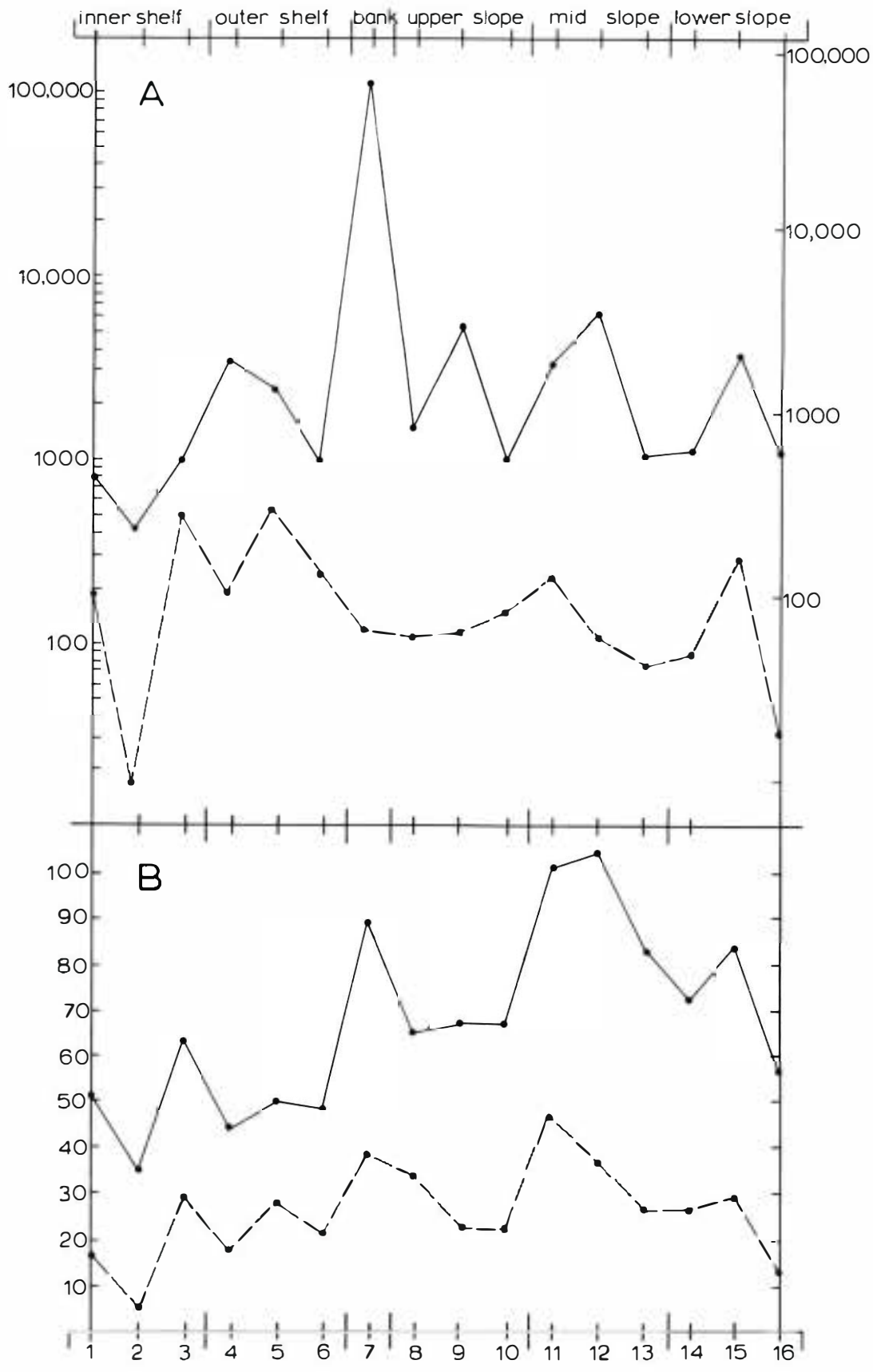

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Different faunas of benthonic foraminifera characterise each of the five depth zones, the inner shelf, outer shelf, upper slope, mid slope and lower slope, as well as the banks on the continental slope. The distribution of most foraminifera appear to be controlled by some factor related to depth, but a few occur only on a particular type of substrate regardless of depth.

Characteristic of the inner shelf are the species *Ammonia aoteanus, Cribrononion simplex, Discorbis dimidiatus, Elphidium novozealandicum, Glabratella* spp., *Massilina brodiei, Virgulopsis turris* and *Zeaflorilus parri.*

The outer shelf is characterised by *Anomalinoides spherica, Cribrononion argenteum*, and the shallowest occurrence of many other species, notably *Oridorsalis tenera* and *Trochammina pusilla.* Many species are common on the outer shelf and on the upper slope including *Brizalina karrerianum, Bulimina marginata, Cribrostomoides* sp., *Discorbinella* cf. *bertheloti, Hopkinsina pacifica, Nonionella turgida, Nonionellina flemingi, Notorotalia finlayi, Notorotalia profunda, Reophax scorpiurus, Saracenaria latifrons*, and *Trochammina ochracea.*

On the upper slope the ranges of *Bulimina marginata* and *B. aculeata* overlap. Species that are common on the upper slope include those mentioned above as being common on the outer shelf and upper slope, and *Chilostomella cushmani, Cibicides ihungia, Fursenkoina* spp., *Gavelinopsis lobatulus, Globobulimina turgida, G. hoeglundina, Praeglobobulimina spinescens, Siphouvigerina* spp.

The mid slope is characterised by many species that are rare or absent at shallower depths, but which continue downslope to the lower slope. These include *Adercotryma glomeratum, Ammobaculites* spp., *Bathysiphon* spp., *Bolivina sphenoides, Bulimina rostrata, Chilostomella oolina, Eggerella bradyi, Globobulimina pacifica, Karreriella* spp., *Lagenammina difflugiformis, Osangularia bengalensis, Pelosina* spp., *Pullenia bulloides, Quinqueloculina* cf. *venusta, Reophax dentaliniformis, R.* aff. *guttifer, Rhizammina* spp., *Sigmoilinopsis schlumbergeri, Spiroplectammina* cf. *biformis, Storthosphaera albida, Thurammina* spp., *Trochammina* aff. *globigeriniformis.* Many of these species have agglutinated walls and belong to the suborder Textulariina which forms 10–20% of the benthonic foraminiferal fauna.

Only a few species are confined to the lower slope. These include *Aschemonella* spp., *Brachysiphon corbuliniformis, Discammina compressa, Lagenammina bulbosa, Melonis sphaeroides, Tolypammina vagans.* Specimens of several species of *Lagenammina* and *Rhizammina* are common and specimens of the suborder Textulariina constitute 28–43% of the benthonic foraminiferal fauna.

Banks on the continental slope have a fauna that includes most of the species occurring commonly at the same depth as the bank, but also includes a few species that do not occur or are comparatively rare on the adjacent muddy slopes. At Station 7 *Bolivina robusta* forms a large part of the benthonic fauna, but also common are *Amphycoryna hirsuta, Astrononion* cf. *tumidum, Globocassidulina canalisuturalis, Laticarinina altocamerata, Marginulina* spp., *Marginulinopsis bradyi, Planodiscorbis rarescens, Ramulina globulifera, Rectobolivina columnellaris, Sigmoilopsis wanganuiensis, Siphonina* cf. *tubulosa.* At Stations E and F on the Madden Banks the fauna includes *Pyrgo pisum, Quinqueloculina colleenae, Sigmomorphina lacrimosa, Siphonaperta crassa, Siphotextularia mestayeri* and *Triloculina trigonula.*

A few species appear to be correlated with a coarse substrate and occur on the inner shelf and on slope banks. These include *Dyocibicides primitiva, Ehrenbergina mestayeri, Gavelinopsis hamatus*, and *Siphonaperta macbethi.* Species that occur wherever sediment is relatively coarse on the continental slope include *Dyocibicides primitiva, Gavelinopsis hamatus, Laticarinina altocamerata* and *Planodiscorbis rarescens.*

Thus some generalisations may be made about the environmental preferences of some species in the study area. However, species that are characteristic of a particular depth range in this area are not necessarily characteristic of the same depths everywhere. A limiting environmental factor that varies with depth may be at a completely different depth range elsewhere. For instance, *Stainforthia concava*, noted in this account as being characteristic of the continental slope, was first described from cold, shallow waters off Scandinavia. It may be limited more by temperature than any other factor.

Until studies show which of the many environmental factors limit the distribution of each species, the depth ranges and biofaces described here should be used with caution in the interpretation of ancient environments. However, some long lived species appear to be useful indicators of relative depth, at least as far back as the Miocene (Vella 1962). For instance, *Elphidium novozealandicum*, diagnostic of Vella's (1962) Elphidium biofacies, remains a useful indicator of depths less than about 75 m. Other species characteris-

FIG. 4. Frequency polygon showing nature of foraminiferal fauna at each station. A. Percentage of planktonic specimens. B. Percentage of benthonic specimens in suborders Textulariina (stippled), Miliolina (cross hatched) and Rotaliina (white). Line shows percentage of benthonic specimens that are living at each station. C. Mean width in millimetres, of living benthonic specimens (broken line), total benthonic population (solid line) and planktonic population (dotted line).

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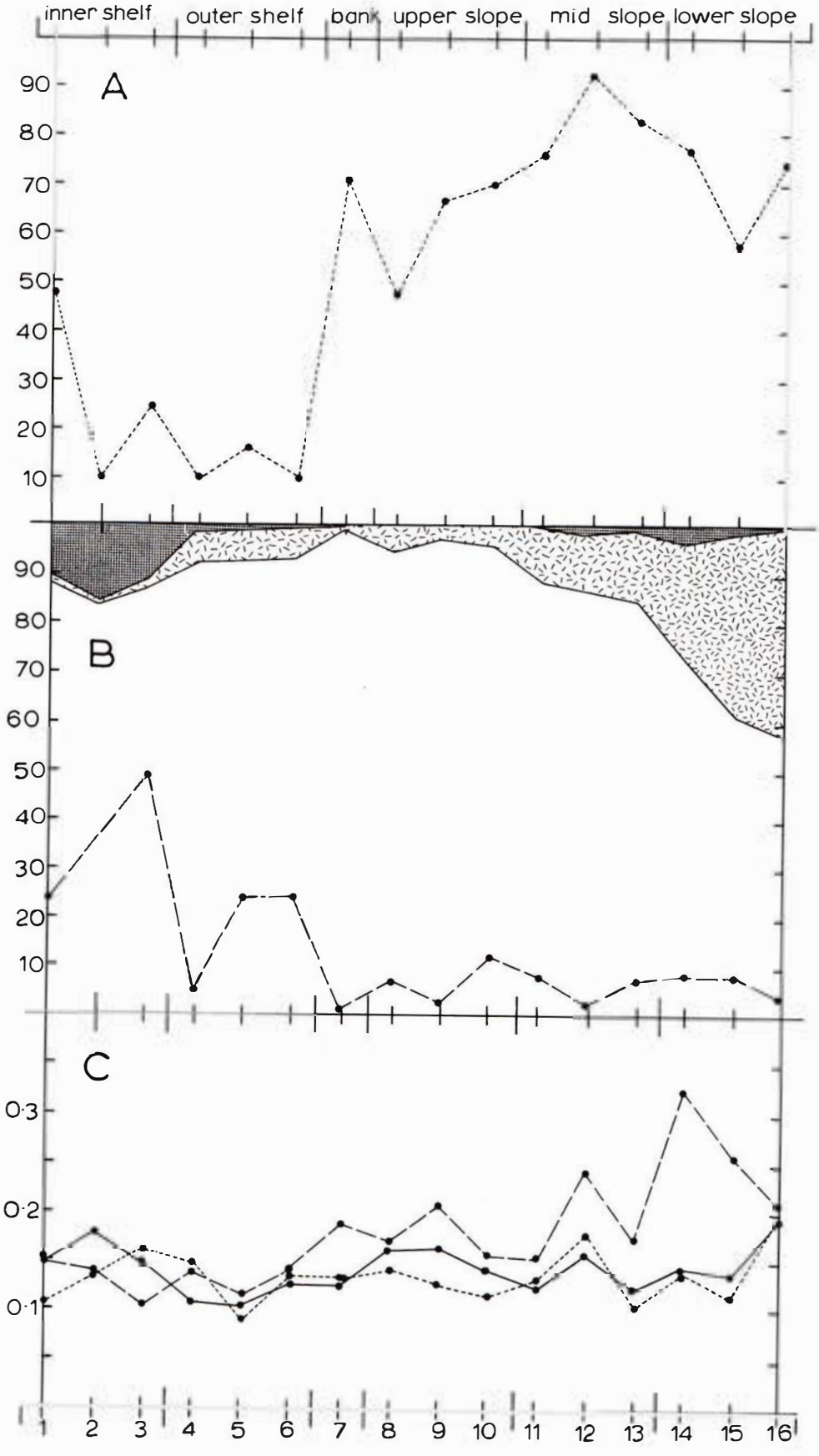

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tic of the Elphidium biofacies, *Ammonia aoteanus, Cribrononion charlottensis, Notorotalia zealandica,* and *Zeaflorilus parri,* all extend out to a depth of 200–300 m. This is considerably deeper than Vella's (1962) estimate of 60 m for the outer limit of the Elphidium biofacies. There seems to be a similar discrepancy for the Haeuslerella biofacies where *neritic* species such as *Bulimina marginata* and *Nonionellina flemingi* coexist with *bathyal* species such as *Bulimina aculeata* and *Cibicides ihungia.* Having access to very limited data, Vella (1962) estimated its depth range to be from 60 m to 300 m, but the present study suggests a range from about 200 m to perhaps 1000 m deep. Again the Robulus, Semipelagic and Eupelagic biofacies, characterised by *Sigmoilopsis* aff. *schlumbergeri* and *Karreriella* spp. are probably deeper than 1000 m, rather than 300 m. Thus, some of Vella's (1962, 1963) estimates of the depths of deposition of Late Tertiary strata and of the amounts and rates of post depositional tectonic uplift may all be somewhat conservative.

It should also be stressed that the proportion of various groups must be used with caution as absolute depth indicators, because the processes of fossilisation and extraction are highly selective. Robust species will be preferentially preserved. Many of the arenaceous species recorded from deeper stations are so fragile that few even survive drying and mounting. They are unlikely to be recorded as fossils.

Finally, a warning about application of the terms *continental shelf* and *continental slope* to ancient biofacies and sediments purely on the basis of estimated depth of deposition. The present continental shelf is a function largely of a geologically very recent rise of sea level. Obviously during the last glacial age, when the sea was about 130 m lower than at present, the continental shelf extended to a depth of only a few tens of metres and following a long period of constant sea level there may well have been no general break between shelf and slope (Lewis 1974b).

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REFERENCES

BARKER, R. W. 1960: Taxonomic notes on the species figured by H. B. Brady in his report on foraminifera dredged by HMS *Challenger* during the years 1873–1876. Accompanied by a reproduction of Brady's plates. *Special Publications. Society of Economic Paleontologists and Mineralogists, Tulsa. 9:* 1–238.

BE, A. W. H. 1965: The influence of depth on shell growth in *Globigerinoides sacculifer* (Brady). *Micropaleonotology 11 (1):* 81–97, pls 1, 2.

BRADY, H. B. 1879: Notes on some of the Reticularian Rhizopoda of the *Challenger* Expedition. *Quarterly Journal of Microscopical Science 19:* 20–61, 261–99, pls iii–v, viii.

BRADY, H. B. 1884: Report on the foraminifera dredged by HMS *Challenger* during the years 1873–1876. *Report of the Scientific Results of the Exploring Voyage of HMS* Challenger, *1873–1876. Zoology 9:* 1–814.

BURDETT, I. D. J.; HEDLEY, R. H.; HORNIBROOK, N. DEB.; HURDLE, C. M. 1963: *Gaudryina convexa* (Karrer) 1865: Upper Eocene to Recent; an example of variation and synonymy among foraminifera. *N.Z. Journal of Science 6 (4):* 513–30.

CUSHMAN, J. A. 1939: A monograph of the foraminiferal family Nonionidae. *Professional Papers. U.S. Geological Survey 191:* 1–100, 20 pls.

CUSHMAN, J. A.; PARKER, F. L. 1947: *Bulimina* and related foraminiferal genera. *Professional Papers. U.S. Geological Survey 210-D:* 55–176.

EADE, J. V. 1967: A checklist of Recent New Zealand foraminifera. *N.Z. Department of Scientific and Industrial Research Bulletin 182:* 1–70. [*N.Z. Oceanographic Institute Memoir No. 44*].

EARLAND, A. 1934: Foraminifera. Part 3 – The Falklands sector of the Antarctic (excluding South Georgia). *Discovery Reports 10:* 1–208.

GARNER, D. M. 1961: Hydrology of New Zealand coastal waters, 1955. *N.Z. Department of Scientific and Industrial Research Bulletin 138:* 1–85. [*N.Z. Oceanographic Institute Memoir No. 8*].

HEATH, R. A. 1970: The oceanic circulation off the east coast of New Zealand between East Cape and Banks Peninsula. Unpublished Ph.D. thesis, lodged in the Library, Victoria University of Wellington, New Zealand.

HEDLEY, R. H.; HURDLE, C. M.; BURDETT, I. D. J. 1964: *Trochammina squamata* Jones and Parker (Foraminifera) with observations on some closely related species. *N.Z. Journal of Science 7 (3):* 417–26.

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HEDLEY, R. H.; HURDLE, C. M.; BURDETT, I. D. J. 1965: A foraminiferal fauna from the western continental shelf, North Island, New Zealand. *N.Z. Department of Scientific and Industrial Research Bulletin 163*: 1–46. [*N.Z. Oceanographic Institute Memoir No. 25*].

HEDLEY, R. H.; HURDLE, C. M.; BURDETT, I. D. J. 1967: The marine fauna of New Zealand: Intertidal foraminifera of the *Corallina officinalis* zone. *N.Z. Department of Scientific and Industrial Research Bulletin 180:* 1–86. [*N.Z. Oceanographic Institute Memoir No. 38*].

HERON-ALLEN, E.; EARLAND, A. 1917: On some foraminifera from the North Sea, etc., dredged by the Fisheries Cruiser *Goldseeker*. V. On *Thurammina papillata* Brady: a study in variation. *Journal of the Royal Microscopical Society, 1917*: 530–57, pls xxvi–xxx.

HERON-ALLEN, E.; EARLAND, A. 1922: Protozoa. Part 2 – Foraminifera. *Natural History Report. British Antarctic Terra Nova Expedition, 1910. Zoology 6:* 25–268.

HERON-ALLEN, E.; EARLAND, A. 1932: Foraminifera. Part I: The ice-free area of the Falkland Islands and adjacent seas. *Discovery Reports 4*: 291–459, pls VI–XVII.

HÖGLUND, H. 1947: Foraminifera in the Gullmar Fjord and the Skagerak. *Zoologiska Bidrag fran Uppsala 26:* 1–328, 32 pls.

HORNIBROOK, N. DEB. 1961: Tertiary foraminifera from Oamaru District (N.Z.) Part 1. Systematics and distribution. *Paleontological Bulletin. N.Z. Geological Survey. 34 (1)*: 1–192.

HULME, S. G. 1964: Recent foraminifera from Manukau Harbour, Auckland, New Zealand. *N.Z. Journal of Science 7 (3)*: 305–40.

KRUMBEIN, W. C. 1936: Application of logarithmic moments to size frequency distributions of sediments. *Journal of Sedimentary Petrology 6:* 35–47.

KUSTANOWICH, S. 1963: Distribution of planktonic foraminifera in surface sediments of the south-west Pacific Ocean. *N.Z. Journal of Geology and Geophysics 6 (4)*: 534–65.

LEWIS, K. B. 1970: A key to the Recent genera of the Foraminiferida. *N.Z. Department of Scientific and Industrial Research Bulletin 196:* 1–88. [*N.Z. Oceanographic Institute Memoir No. 45*].

LEWIS, K. B. 1971: "Marine geology of the Turnagain area". Unpublished Ph.D. thesis, lodged in the Library, Victoria University of Wellington, New Zealand.

LEWIS, K. B. 1973a: Sediments on the continental shelf and slope: Napier to Castlepoint, New Zealand. *N.Z. Journal of Marine and Freshwater Research 7 (3)*: 183–208.

LEWIS, K. B. 1973b: Erosion and deposition on a tilting continental shelf during Quaternary oscillations of sea level. *N.Z. Journal of Geology and Geophysics 16 (2)*: 281–301.

LEWIS, K. B.; KOHN, B. P. 1973: Ashes, turbidites and rates of sedimentation on the continental slope off Hawkes Bay. *N.Z. Journal of Geology and Geophysics 16 (3)*: 439–54.

LEWIS, K. B. 1974a: Upper Tertiary rocks from the continental shelf and slope off southern Hawkes Bay. *N.Z. Journal of Marine and Freshwater Research 8*: 663–70.

LEWIS, K. B. 1974b: The continental terrace. *Earth-Science Reviews 10:* 37–71.

LEWIS, K. B.; JENKINS, C. 1969: Geographical variation of *Nonionellina flemingi*. *Micropaleontology 15 (1)*: 1–12, pl. 1.

LOEBLICH, A. R.; TAPPAN, H. 1953: Studies of Arctic foraminifera. *Smithsonian Miscellaneous Collections 121 (7)*: 1–150, 24 pls.

LOEBLICH, A. R.; TAPPAN, H. 1964: "Treatise on invertebrate paleontology. Part C: Protista 2. Sarcodina (chiefly Thecamoebians and Foraminiferida)". Geological Society of America, University of Kansas Press. 900 p. (2v).

MATTHEWS, D. J. 1939: "Tables of velocity of sound in pure water and seawater for use in echo-sounding and sound ranging". Hydrographic Dept., Admiralty. 52 p.

OPPENHEIMER, C. H.; ZOBELL, C. E. 1952: The growth and viability of sixty-three species of marine bacteria as influenced by hydrostatic pressure. *Journal of Marine Research 11 (1)*: 10–18.

PARR, W. J. 1950: Foraminifera. *Report B.A.N.Z. Antarctic Research Expedition 1929–1931. Series B. (Zoology and Botany) 5 (6)*: 233–92, pls III–XV.

PHLEGER, F. B. 1955: Ecology of foraminifera in southeastern Mississippi Delta area. *Bulletin of the American Association of Petroleum Geologists 39 (5)*: 712–52, 40 figs.

PHLEGER, F. B. 1960: "Ecology and distribution of Recent foraminifera". Johns Hopkins Press, Baltimore. 297 p.

SAID, R. 1950: The distribution of foraminifera in the northern Red Sea. *Contributions from the Cushman Foundation for Foraminiferal Research 1*: 9–29.

SCHOTT, W. 1935: Die Foraminiferen in den aquitorialen Teil des Atlantischen Ozeans. *Wissenschaftliche Ergebnisse der Deutschen Atlantischen Expedition auf dem Vermessungsund Forschungsschiff "Meteor", 1925–27. 3*: 43–134, 57 figs.

VELLA, P. 1957: Studies in New Zealand foraminifera. Part I: Foraminifera from Cook Strait. Part II: Upper Miocene to Recent species of the genus *Notorotalia*. *Paleontological Bulletin. N.Z. Geological Survey. 28*: 1–64.

VELLA, P. 1962: Biostratigraphy and paleoecology of Mauriceville District, New Zealand. *Transactions of the Royal Society of New Zealand, Geology 1 (12)*: 183–99.

VELLA, P. 1963: Foraminifera from Upper Miocene turbidites, Wairarapa, New Zealand. *N.Z. Journal of Geology and Geophysics 6 (5)*: 775–93.

WALTON, W. R. 1952: Techniques for recognition of living Foraminifera. *Contributions from the Cushman Foundation for Foraminiferal Research 3*: 56–60.

WALTON, W. R. 1955: Ecology of living benthonic foraminifera, Todos Santos Bay, Baja California. *Journal of Paleonotology 29 (6)*: 952–1018, pls 99–104, 24 text-figs.

WIESNER, H. 1931: Die Foraminiferen der Deutschen Südpolar-Expedition 1901–1903. *Deutsche Südpolar-Expedition 1901–03, Zoologie 20:* 48–165.

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