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Lower Miocene Foraminifera from CRP-1 Drillhole

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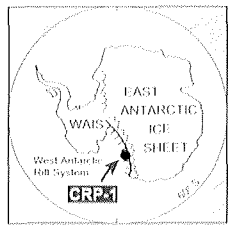
Abstract - A fauna comprising 18 foraminiferal taxa was recovered from a suite of 52 core samples from lower Miocene sandstone, claystone and diamictite in the CRP-1 drillhole, Cape Roberts, Antarctica. The fauna is characterised by low foraminiferal abundance and diversity, the absence of planktics, and typically, the presence of *Cribroelphidium* sp. and/or *McLoinis* spp. These factors indicate deposition in an inner shelf or nearshore environment. Many of the foraminifers found in CRP-1 also occur in the upper Oligocene-Miocene sequences in CIROS-1 and DSDP 270, but the fauna provides no precise indication of age. Typical and distinctive species from CRP-1 are illustrated with SEM photomicrographs.



INTRODUCTION

This report provides a record of the 18 foraminiferal taxa recovered from 52 core samples of lower Miocene rocks in the CRP-1 drillhole, Victoria Land Basin. Distinctive, characteristic species are illustrated with SEM photomicrographs; brief descriptions and stratigraphic occurrence data are provided for all taxa. Based on sedimentological and palaeontological evidence, lower Miocene sediments occur from 43.15 metres below sea floor (mbsf) to 147.69 mbsf (Total Depth) in the CRP-1 drillhole and represent the time interval from 17.5 to 22.4 Ma (Cape Roberts Science Team, 1998). These sediments contain, at best, only moderate numbers of foraminifera, and overall yielded about 40% fossiliferous samples, although there was a trend within the suite for fossils to occur more consistently downhole from about 125 mbsf.

MATERIALS AND METHODS

Three types of samples were used in this study. 1) Fast-track samples, which were selected by the drill site geologist for rapid analysis. These typically included 10 cm of core, of which a small portion was examined for foraminifers. 2) Routine core samples, taken at Crary Laboratory (McMurdo Station) at points selected by a micropalaeontologist, covered a nominal 5-cm interval and averaged about 75 grammes of undried material. 3) Samples of macrofossil matrix, which were examined after completion of the Initial Report, were very small, ranging from about 5 to 20 g. The total suite of 52 samples, of which 21 contained foraminifers, comprised 7 fast-track, 38 routine and 7 macrofossil matrix samples (Tab. 1) and covered the interval from 45.04 mbsf to 147.38 mbsf.

All samples were processed using standard techniques, and wet-sieved into >1mm, >500 µm, >63 µm and <63 µm size fractions. After drying, the first 3 fractions were searched for foraminifers and the last reserved for making smear slides or for other studies.

Samples lacking foraminifers are referred to here as non-fossiliferous, although many contained representatives of other fossil groups. All fossil material, including diatoms, sponge spicules, macrofossil fragments, etc., was recorded during picking, and is listed in table 1. Smaller samples were picked completely. Where there was a large amount of >63 µm residue, the sample was subdivided, using a microsplitter, to yield at least two well covered picking trays of residue (usually at least 1/8 of total sample) for examination, and was considered non-fossiliferous if no foraminifers were recovered.

RESULTS

FAUNA

Eighteen foraminiferal taxa, many of them rare, were encountered in the lower Miocene section of CRP-1. Their stratigraphic occurrences are shown in table 2, and referred to the standard lithostratigraphic classification adopted for the drillhole (See Cape Roberts Science Team, 1998, Appendix 2). Calcareous benthic species of Suborder Rotaliina are strongly dominant, with only a few, poorly preserved agglutinated specimens being observed. A single juvenile planktic, observed in a nannofossil smear slide, was recorded as *Globigerina* sp. indet.

Preservation is generally good, although not pristine, and most specimens are slightly altered and coloured. Persistent occurrence of foraminiferal chamber linings (mainly of tiny, coiled forms) in palynological preparations (Cape Roberts Science Team, 1998, Tab. 11) suggests that smaller, more delicate specimens have been either decalcified during diagenesis or destroyed by abrasion during preparation of foraminiferal samples.

Except for records at CIROS-1 (Webb, 1989) and DSDP 270 (Leckie & Webb, 1985), no similar faunas are

Tab. 1 - Summary of samples examined from CRP-1.

Top of interval	53,50	59,58	62,19	62,34	67,60	78,15	84,64	85,78	86,64	87,42	99,20	113,26	128,20	129,15	133,94	136,92	141,19	142,20	142,59	144,60	145,92
Base of interval	53,60	59,68	62,25	62,36	67,65	78,25	84,68	85,83	86,68	87,47	99,12	113,31	128,25	129,20	133,99	136,97	141,24	142,25	142,64	144,65	145,94
Lithologic unit	5,1	5,2	5,3	5,3	5,4	5,5	5,7	5,7	5,7	5,7	5,8	6,2	6,3	6,3	6,3	6,3	6,3	7,1	7,1	7,1	7,1
Total specimens	9	29	3	11	1	1	2	3	1	1	1	2	3	4	1	3	4	1	1	20	3
FORAMINIFERAL TAXA																					
Ammoelphidiella sp.						*	*			*											
Bathysiphon? sp.											*										
Cibicides cf. *pseudoungerianus*				*																	
Cibicides sp.		*		*																	
Cribroelphidium sp.	*	*			*			*		*		*	*	*			*			*	*
Elphidium megellanicum		*																			
Gaudryina? sp.		*																			
Melonis affinis				*																	
Melonis sp. A	*	*	*	*				*	*				*			*				*	*
Melonis sp. B																					
Nodosaria sp.														*						*	*
Nonionella bradii														*							
Oolina cf. *apiculata*																		*			
Oolina globosa		*	*																		
Pseudonodosari symmetrica																			?		
Pyrgo fornasinii															*						
Pyrulinoides sp.		*					*						*								*
Rosalina cf. *globularis*		*																			

described elsewhere, and the biofacies apparently is poorly represented outside of Antarctica.

Faunal characteristics of the main lithostratigraphic units (Cape Roberts Science Team, 1998, Appendix 2) are briefly summarised below, and the taxa present shown in table 2. The faunal content of the various lithostratigraphic subunits have been previously described (Cape Roberts Science Team, 1998) and will not be repeated here.

No new taxa are proposed, and specimens are either left in open nomenclature or provisionally referrred to existing species.

Unit 5 (43.15 - 103.41 mbsf)

Foraminifers occur in 11 of the 20 routine, 5 macrofossil matrix and 5 fast-track samples examined from Unit 5. This interval consists of sandstone and diamictite, with subordinate siltstone/claystone. Foraminiferal abundance was low to very low in nearly all productive samples, with most assemblages containing 10 or fewer individuals. However, the richest sample seen in the present study (59.58-59.68 mbsf), with 29 specimens representing 8 species, was from a claystone near the base of Unit 5.2.

Melonis sp A. and *Cribroelphidium* sp. were the most characteristic taxa in the interval, with most other forms being confined to single occurrences, often as single specimens.

The only known planktic foraminifer observed in the lower Miocene occurred in Unit 5.8. The single specimen is a juvenile, identified as *Globigerina* sp. indet. (CPS id.), which was first noted by S. Wise in a nannofossil smear slide from 101.31-101.32 mbsf. The specimen is tiny, *c.* 50 µm, and other similar specimens would be unlikely to be retained in foraminiferal residues, which consist of the >63 µm size fraction.

Unit 6 (103.41-141.60 mbsf)

Sixteen (1 fast-track, 13 routine, and 2 macrofossil matrix) samples were examined from the unit, which consists of diamictite and sandstone. Again, there was no obvious relationship between rock type and fossil content. Six samples contained sparse faunas, with foraminifers ocurring most consistently in Unit 6.3. *Cribroelphidium* sp. occurred most frequently, and the highest occurrence of *Melonis* sp. B was recorded at 128.20 mbsf. A single large specimen of *Pyrgo* cf. *fornasinii* was recovered from 133.94 mbsf.

Unit 7 (141.60-147.69 mbsf)

Foraminifers occur in low to moderate abundance, with good to very good preservation, in four of the six samples from this thin claystone unit, the lowest encountered before drilling terminated. *Cribroelphidium* sp., *Melonis* sp. B, and *Pyrulinoides* sp. occur in the lower part of the unit.

Unit 7 represents the first major change in sediment type encountered in the Miocene section of CRP-1, and is interpreted as a more distal facies than any seen in overlying

Tab. 2 - Occurrence of foraminifers in the lower Miocene CRP-1.

Top	Base	Unit	Forams?	Other fossil material
45.04	45.14	5.1	No	spicules
53.50	53.60	5.1	Yes	spicules, echinoderm fragments
54.70	54.75	5.2	No	
56.78	56.83	5.2	No	wood fragments
58.33	58.38	5.2	No	
58.56	58.61	5.2	No	
59.58	59.68	5.2	Yes	diatoms, spicules, echinoderm & mollusc fragments
62.19	62.25	5.3	Yes	diatoms, shell fragments (macrofossil matrix)
62.34	62.36	5.3	Yes	bryozoan, spicules, worm tube (macrofossil matrix)
65.90	65.95	5.4	No	insect? fragments
67.60	67.65	5.4	Yes	sponge spicules
69.90	69.95	5.4	No	diatoms, spicules
72.60	72.65	5.5	No	diatoms
75.94	75.99	5.5	No	diatoms, spicules
77.45	77.50	5.5	No	trace fossils?
78.15	78.25	5.5	Yes	trace fossils?
78.44	78.49	5.5	No	trace fossils?
81.82	81.87	5.7	No	
84.64	84.68	5.7	Yes	echinoid spine (macrofossil matrix)
85.78	85.83	5.7	Yes	diatoms, spicules
86.64	86.68	5.7	Yes	diatoms, spicules (macrofossil matrix)
87.42	87.47	5.7	Yes	diatoms
93.48	93.53	5.8	No	diatoms, mollusc fragments
94.44	94.49	5.8	No	
95.08	95.12	5.8	No	wood fragments (macrofossil matrix)
96.25	96.30	5.8	No	spicules, wood fragments
97.18	97.23	5.8	No	spicules, wood fragments
99.02	99.12	5.8	Yes	diatoms, spicules
99.90	99.95	5.8	No	diatoms
102.05	102.10	5.8	No	diatoms
108.85	108.90	6.2	No	spicules
109.15	109.20	6.2	No	spicules
111.64	111.69	6.2	No	spicules
113.26	113.31	6.2	Yes	spicules
116.43	116.48	6.2	No	spicules
119.15	119.20	6.2	No	spicules
120.40	120.50	6.3	No	spicules
123.84	123.89	6.3	No	
128.20	128.25	6.3	Yes	
129.15	129.20	6.3	Yes	echinoderm fragments
131.80	131.85	6.3	No	spicules, wood fragments
133.94	133.99	6.3	Yes	echinoderm fragments
136.92	136.97	6.3	Yes	
137.66	137.69	6.3	No	(macrofossil matrix)
138.82	138.86	6.3	No	(macrofossil matrix)
141.19	141.24	6.3	Yes	
141.82	141.92	7.1	No	spicules
142.20	142.25	7.1	Yes	diatoms, spicules
142.59	142.64	7.1	Yes	diatoms, spicules
144.60	144.65	7.1	Yes	echinoderm fragments
145.92	145.97	7.1	Yes	echinoderm fragments
147.33	147.38	7.1	No	spicules

strata (Cape Roberts Science Team, 1998). It is possible that the relatively consistent presence of foraminifers, along with slightly increased abundance and diversity, may mark the top of a significant downhole faunal change.

PALAEOENVIRONMENT

Typically sparse faunas, the common occurrence of shallow-water taxa such as *Cribroelphidium* sp., and the almost total absence of planktic individuals suggest deposition in an inshore setting, which is consistent with the depositional depths of 20-80 m suggested by macrofossil evidence (Cape Roberts Science Team, 1998).

Although there is general agreement as to the palaeoenvironmental significance of the lower Miocene foraminiferal faunas in Units 5-7, trends in abundance and diversity observed in the present sample suite differ somewhat from those noted from a second set of 24 samples, 13 of them fossiliferous (Galeotti & Coccioni, this volume). The early results suggest a downhole trend toward more open water marine environents, while the latter samples indicate the opposite. The reasons for these differing results is unclear, but it is likely that the general poorly fossiliferous nature of the sediments, together with serendipitous recovery of richer faunas are factors. Both sample sets have a high proportion of barren samples, and often samples classified as fossiliferous contain only a few specimens.

The upper part of the sequence (43.15-*c.* 120 mbsf), which includes all of Unit 5, and also Units 6.1 and 6.2, is

characterised by samples which are either non-fossiliferous or, less frequently, which contain sparse foraminiferal assemblages with 1-2 species, normally *Cribroelphidium* sp. or *Melonis* spp. The increased proportion of fossiliferous samples below *c.* 125 mbsf may indicate a trend toward somewhat deeper and more offshore conditions in the older part of the sequence. Foraminifers occur more consistently in Units 6.3 and 7.1, with an apparent trend downhole toward both higher abundance and higher diversity. This provides some optimism that more extensive faunas will be recovered in subsequent drillholes just below the maximum level penetrated in CRP-1.

Two factors may account for the absence of foraminifers in many samples: high sedimentation rate/unfavourable bottom environment and dissolution during diagenesis. It is probable that both have played a part. In some cases, few specimens are recovered, but are well preserved, suggesting dilution by rapid sedimentation. In other instances, specimens are etched, suggesting partial dissolution. Furthermore, many palynological preparations from apparently non-fossiliferous intervals contain common foraminiferal test linings, again suggesting possible post-depositional dissolution.

AGE AND CORRELATION

Key diatom taxa, tied into magnetostratigraphy, proved to be the mainstay for dating the sequence in CRP-1. They provided an age of 17.5 Ma for the top, and 22.4 Ma for the base of the Miocene Section respectively, placing it all within the early Miocene. These ages indicate that the section is equivalent to the Otaian to middle Altonian Stages in New Zealand (Morgans et al., 1996).

No age-diagnostic foraminiferal taxa were recovered, although occurrence of *Ammoelphidiella* sp. in Units 5.5 and 5.7 indicates an age of late Pliocene or older.

Although they are, in the main, somewhat younger, the CRP-1 faunas are similar to those recovered from Units 5, 7, 8, 9 and 15 in the upper Oligocene to lower Miocene sequence in the CIROS-1 drillhole (Webb, 1989). They contain an identical form of *Cribrorotalia* sp., and also have other taxa in common The youngest Miocene encountered in the CIROS-1 drillhole was considered to be about 22 Ma (Barrett et al., 1989).

The CRP-1 Miocene faunas, although less diverse, bear a general resemblance to upper Oliogcene - lower Miocene assemblages described by Leckie & Webb (1985) from Unit 2 (especially 2I to 2 B) at DSDP Site 270. The latter faunas, however, probably represent a more offshore depositional setting. *Ammoelphidiella*, which ranges no higher than late Pliocene, is common to both sites.

TAXONOMIC NOTES

Species are discussed below in alphabetical order. Faunal slides and figured specimens are deposited at the Institute of Geological & Nuclear Sciences (GNS), Lower Hutt, New Zealand. Geological Society of New Zealand Fossil Record File number for the CRP-1 drillhole is RS/f682.

Ammoelphidiella sp., plate 1.1 & 2

This species is relatively small for the genus (0.2-0.3 mm), and characterised by its compressed overall form, low spire, and subdued pustular ornament. It most closely resembles *A. pustulosa*, recorded from the upper Oligocene-lower Miocene section of DSDP 270 (Leckie & Webb, 1985), but is considerably more compressed, with finer surface pustulation.

Bathysiphon? sp.

The genus may be represented by a few fragments of a tubular agglutinated form.

Cibicides cf. *pseudoungerianus* (Cushman), plate 1.3

The single specimen recovered from CRP-1 was compared with specimens in the GNS reference collection, and is tentatively assigned to *C. pseudoungerianus*. It is characterised by its plano-convex overall shape and moderate inflation of the ventral chambers.

Cibicides sp., plate 1.4

This small, somewhat compressed species is semi-involute, and slightly concave dorsally. Sutures are flush and slightly reflexed dorsally, ventrally they are curved and become slightly incised in later stages.

Cribroelphidium sp., plate 1.5, 6 & 7

The species has a tightly involute test of medium size, with 5-6 chambers in the final whorl. Sutures are slightly curved and incised, and marked by finely pustulose ornament and poorly visible septal pores. The small umbilicus is often filled with pustulose calcite. The aperture is formed by a row of about 8 pores at the base of the apertural face.

Cribroelphidium sp. occurs persistently throughout the drilled sequence, and is the single most characteristic species.

Elphidium magellanicum Heron-Allen and Earland

The few specimens recovered closely resemble those figured by Leckie & Webb (1985) from DSDP 270, where the species occurs throughout the upper Oligocene and lower Miocene sequence. Characteristic features include the moderately compressed test of about 6 chambers, and gently curved, beaded sutures with relatively obscure retral processes.

Gaudryina? sp.

A single, poorly preserved agglutinated specimen is tentatively identified as a *Gaudryina* on the basis of its overall form.

Melonis affinis (Reuss), plate 1.8

This small, robust species has about 6 chambers in the outer whorl. The periphery is broadly rounded. Specimens from CRP-1 closely resemble those figured from DSDP 270 (Leckie & Webb, 1985).

Melonis sp. A, plate 1.9

Distinguishing characteristics of this species include its compressed, smoothly finished test, narrowly rounded

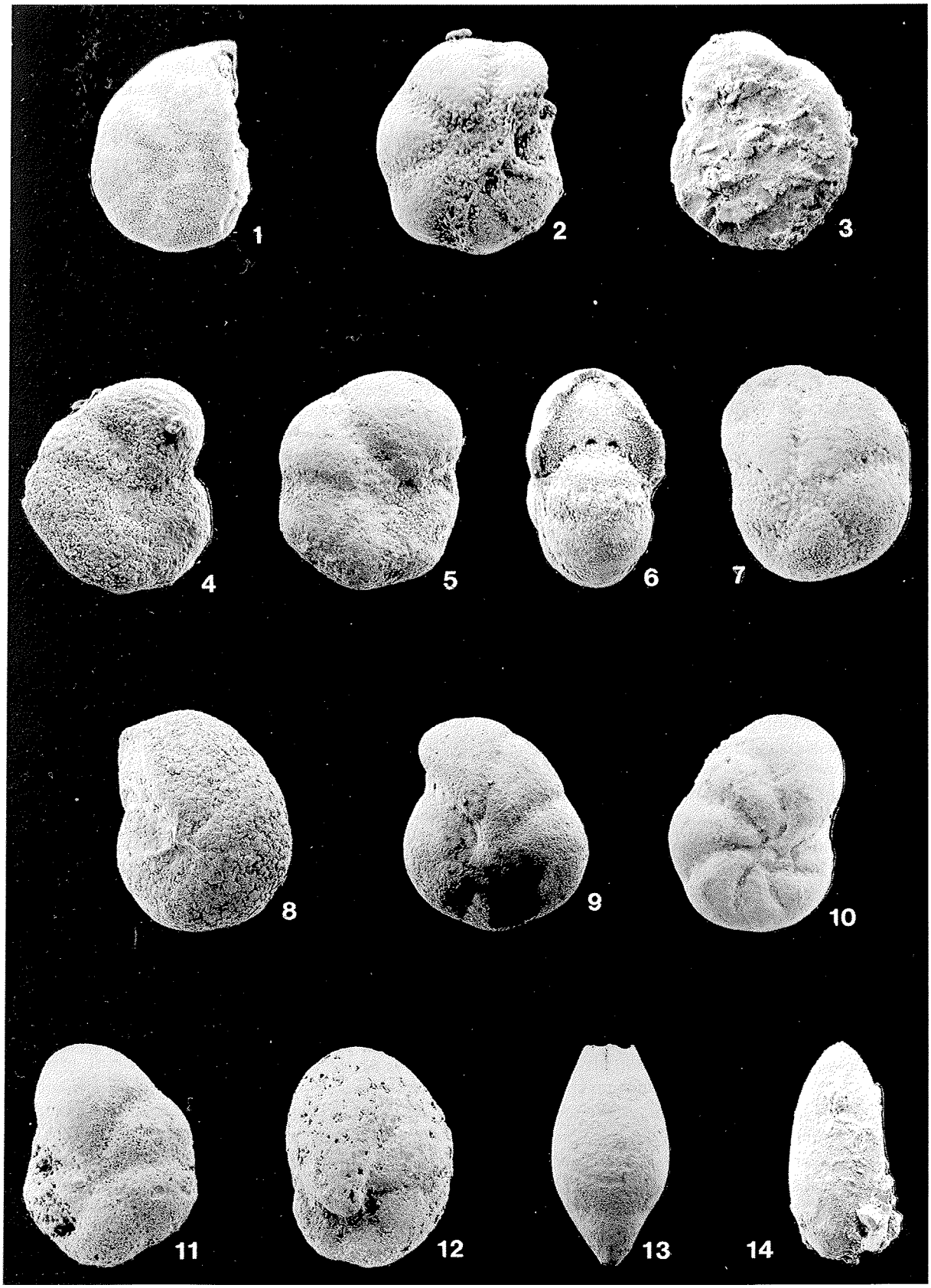


Plate 1 – 1 & 2) Ammoelphidiella sp. 1. FP4778, dorsal view, specimen diameter 0.320 mm. 2. FP4 779, ventral view, specimen diameter 0.240 mm. Both specimens from 87.42-87.47 mbsf. *3) Cibicides* cf. *pseudoungerianus,* FP4780, dorsal view, specimen diameter 0.415 mm. 59.58-59.68 mbsf. *4) Cibicides* sp. FP4781, dorsal view, specimen diameter 0.360 mm. 62.34-62.36 mbsf. *5, 6 & 7) Cribroelphidium* sp. 5. FP4782 , side view, specimen diameter 0.510 mm. 59.58-59.68 mbsf. 6. FP4783, apertural view, thickness 0.200 mm. 7. FP4784, side view, diameter 0.225 mm. 6 and 7 both 85.78-85.83 mbsf. *8) Melonis affinis*, FP4785, side view, specimen diameter 0.455 mm. 62.34-62.36 mbsf. *9) Melonis* sp. A. FP4786, side view, specimen diameter 0.715 mm. 62.34-62.36 mbsf. *10 & 11) Melonis* sp. B. 11., FP4787, side view, specimen diameter 0.425 mm. 128.20-128.25 mbsf. 12. FP4788 side view, specimen diameter 0.265 mm. 144.60-144.65 mbsf. *12) Nonionella bradii.* FP4789, side view, specimen diameter 0.370 mm. 144.60-144.65 mbsf. *13) Pseudonodosaria symmetrica*. FP4790, side view, specimen length 0.875 mm. 144.60-144.65 mbsf. *14) Pyrulinoides* sp. FP4791, side view, specimen length 0.460 mm. 59.58-59.68 mbsf.

periphery, and medium to large size for the genus. There are usually 6-8 chambers in the outer whorl; sutures are thickened, flush to only slightly incised, and nearly straight. The aperture is a low, peripheral arch, extending toward the umbilicus.

The species may be biostratigraphically significant, as it was not observed below Unit 5 in the CRP-1 drillhole.

Melonis sp. B, plate 1.10 & 11

Melonis sp. B has a compressed, medium to large, smoothly finished test. It is differs from *Melonis* sp. A in having curved, deeply incised sutures.

This species may also be biostratigraphically significant, as it was observed only in Units 6 and 7.

Nodosaria spp.

The genus is represented by a few indeterminate, isolated chambers. No complete specimens were recovered.

Nonionella bradii (Chapman), plate 1.12

The species is characterised by its broad, relatively low final chamber, which projects into the umbilicus on the ventral side. Specimens from CRP-1 compare well with those figured by Leckie & Webb (1985).

Oolina cf. *apiculata* Reuss

The single specimen recovered is ovoid in shape, with a short, blunt proximal projection. It closely resembles *O. apiculata*, as figured by Leckie & Webb (1985).

Oolina globosa (Montagu)

This name was assigned to subround *Oolina* individuals.

Pseudonodosaria symmetrica (Stache), plate 1.13

Specimens recovered from CRP-1 were identical to topotypes held in GNS reference collections from Kawhia Harbour, New Zealand. The New Zealand range of the species is Palaeocene to late Pliocene.

Pyrgo cf. *fornasinii* Chapman & Parr

The single, poorly preserved individual obtained is somewhat more oval than specimens of *P. fornassinii* figured from the Pliocene *Pecten* Conglomerate, Cockburn Island, Antarctic Peninsula (Gazdzicki & Webb, 1996), but may be closely related.

Pyrulinoides sp., plate 1.15

The species is characterised by its slender, fusiform shape and strongly embracing final chambers. It occurs sporadically throughout the Miocene section.

Rosalina cf. *globularis* d'Orbigny

R. globularis is possibly represented by single, flattened, trochospiral individual.

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