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DISTRIBUTION OF MODERN BENTHIC FORAMINIFERA OF MCMURDO SOUND, ANTARCTICA

Submitted for the degree of Doctor of Philosophy
in Geology at the Victoria University
of Wellington

January 1984

ABSTRACT

This thesis presents the results of a study of benthic foraminifera from McMurdo Sound, Antarctica. The sound is 50 km across and more than 900 m deep, and is ice-covered for at least 9 months of the year. However, salinity and temperature of the bottom waters are constant (35‰ and -1.8° C). Sea floor sediment is mainly fine sand and mud with a little ice-rafted gravel.

The aim of the study was to document the distribution of living and dead foraminifera and to determine the factor(s) controlling it. The twenty-six sites in water from 76 to 856m deep were sampled by gravity corer and grab, and nearly 40,000 specimens (2334 living and 36,875 dead) were identified. Three present day assemblages can be recognised:

1. Shallow open water assemblage (SWA): *Trochammina glabra*, *Cribrostomoides jeffreysii*, *Trifarina earlandi*, *Ehrenbergina glabra*, *Fursenkoina earlandi* and *Globocassidulina crassa*.

2. Deep open water assemblage (DWA): *Reophax pilulifer*, *Reophax subdentaliniformis*, *Portotrochammina antarctica*, *Textularia antarctica* and *Miliammina arenacea*.

3. Harbour/enclosed basin assemblage (HA): *Reophax subdentaliniformis*, *Portotrochammina antarctica*, *Textularia antarctica*, *Fursenkoina earlandi* and *Globocassidulina crassa*.

The composition of the assemblages is controlled largely by the calcium carbonate compensation depth (CCD). Calcareous species are abundant and varied (84 calcareous species) in the SWA above 620m, but are virtually absent from the DWA, which is found in deeper water. The dominance of agglutinated foraminifera in the HA indicates an even shallower CCD (about 230m) in restricted coastal settings.

Death assemblages have a similar species diversity to corresponding life assemblages and are reasonably representative of them, except for the 200m zone above the offshore CCD, where death assemblages are

depleted in calcareous taxa. The diversity of the agglutinated component of each assemblage remains nearly constant in all habitats and at all water depths, even though shallow water samples include a range of calcareous species. Thus competition from calcareous species appears not to be a stress factor for agglutinated species, which are considered to have reached the limit of their evolutionary potential in these waters.

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ACKNOWLEDGEMENTS

Many people contributed a great deal of time and effort to the successful progress and completion of this thesis. My supervisors Dr.Peter Barrett and Prof.Paul Vella provided constructive criticism, editorial expertise, and useful discussion. Dr.John Collen provided introductory instruction on the Philips 505 Scanning Electron Microscope. The expertise of the Electron Microscope Facility personnel is gratefully acknowledged. For assistance in collection of samples I would like to thank: Alex Pyne, Alan Ross, Dave Waghorn, Dr.Peter Barrett, Barry Walker, Bryan Sissons, Ian Wright, Paul Fitzgerald, Mike Cattley, Bruce Garrick, Brent Alloway, Drs.Dave Bennett and Fred Davey, Tony Macpherson, Malcolm MacLeod; also, from Rice University, Drs.John B. Anderson and Dennis Kurtz, as well as Kathy Balshaw, Susan Davis and Chuck Dunning, who were assisted by the Marine Science Technicians of Deep Freeze 80 on the USCGC Glacier, also Captain R.Taylor, Marine Science Technicians and crew of the USCGC Glacier during Deep Freeze 83. For transport to and from Antarctica and helicopter support while in the field, VXE-6 Hercules and helicopter crews and pilots are gratefully acknowledged. For assistance with bathymetric data accumulation I am grateful to Dr.Dave Bennett, Prof.David Christoffel, Nathan C. Myers, Dr.Dennis Kurtz, Dr.Lyle McGinnis and Captain R.Taylor and crew of the USCGC Glacier. Special thanks go to the Physics Department Mechanical Workshop personnel, Ernie Millington, Graham Hewitt and Denis Thompson for all their willing help with the gravity sphincter corer, ice auger and other equipment on which they worked so diligently. I am indebted to Dr.Arthur DeVries and Dr.Jere Lipps for the original plans for the gravity sphincter corer, which Alex Pyne modified for use in the sediment sampling program. Logistic and backup support was supplied by the D.S.I.R. Antarctic Division and the personnel of Scott Base 1980-81, 1981-82 and 1982- 83 field seasons. The financial support of the New Zealand University Grants Committee, Victoria University Internal Research Committee and Golden Kiwi Lottery Board is gratefully acknowledged.

Assistance with draughting of figures and diagrams by hand and on the IBM 4341 computer was very adeptly provided by A.R.Pyne and B.P.Roser. Assistance with proof-reading and corrections by P.Morris, B.P.Roser, A.R.Pyne and A.Palmer is gratefully acknowledged. Miss E.Finlayson and Ms.V.Hibbert kindly provided typing assistance and access to materials for thesis compilation. Their encouragement and support is gratefully acknowledged.

Members of the Research School who supplied moral support, advice, listening ears and good company are Alex Pyne, Barry Roser, Paul Morris, Ian and Barbara Wright, Alan and Julie Palmer, Jeffrey Ashby, Isobel Gabites, Harry Keys, Karen Williams and Fraka Harmsen.

CHAPTER 1

INTRODUCTION

The area of this investigation is McMurdo Sound, Antarctica, a body of water 50km across and more than 900m deep between Ross Island and the south Victoria Land coast (Figure 1). The study was stimulated by the writer's M.Sc. project (Ward 1979), a study of foraminifera in gravelly sand now 60m above sea level at Cape Royds on the eastern side of the sound. The assemblage was of Late Pleistocene age and highly varied, containing 86 species, of which 83 were calcareous. I concluded from the study that the assemblage had been transported from some part of McMurdo Sound above the carbonate compensation depth, but could say little more because of lack of data on the distribution of modern foraminifera in the area. The study presented here was planned to fill this gap and to identify if possible the factor(s) controlling faunal composition.

The distinction between life and death assemblages was considered at the outset to be very important, for it seemed possible, even likely, that differences due to preservation could be misinterpreted as ecological in origin. Therefore considerable effort was put into collecting undisturbed samples and preserving them so that the living animals could be identified.

The aims of this thesis then are threefold:

1. to determine the distribution of modern living benthic foraminifera in McMurdo Sound.

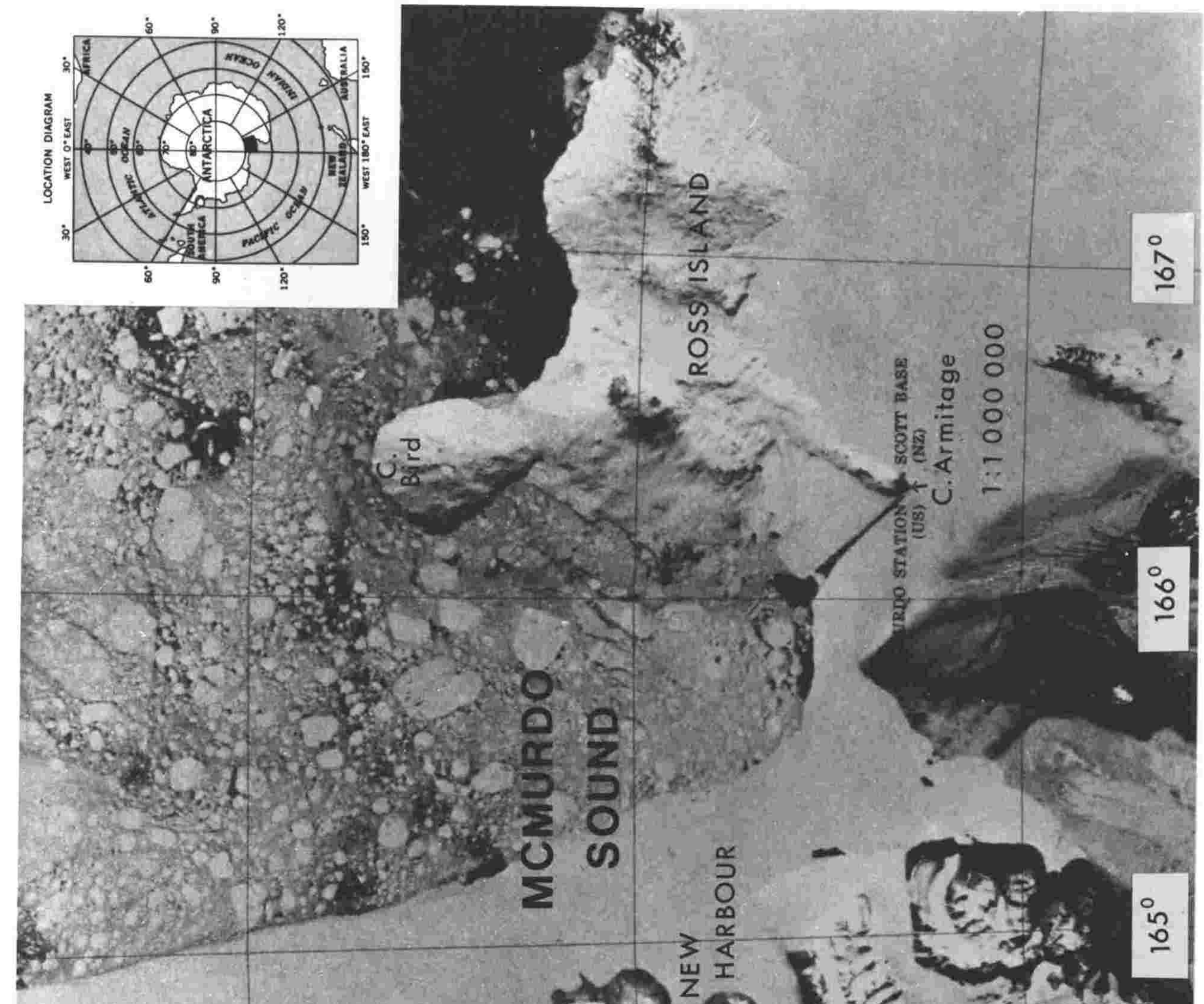
2. to determine the distribution of death assemblages of modern benthic foraminifera in the sound, and compare them with life assemblages from the same location.

3. to identify the main factor(s) controlling the distribution of life and death assemblages.

An especially designed corer was developed to recover large undisturbed samples, including the water-sediment interface, from the sea floor to depths of 1000m. This failed to work because of the sensitivity of the trigger mechanism to the cold, but was successfully modified for the second and third seasons. We had hoped to collect some oceanographic data along with the cores, but attempts to measure pH, temperature and salinity in the water column failed because of instrument problems in the cold field conditions, where air temperatures were as low as -20°C. The lack of oceanographic data gave some cause for concern, but we believe there is enough from the year round observations of Littlepage (1965) near McMurdo Station and the more wide-ranging summer measurements of Jacobs et al.(1981) to define broadly the physical and chemical features of the waters of McMurdo Sound, reviewed in the next section.

Although the study area is McMurdo Sound, the results and conclusions should be of wider interest. The range in water depth is large, and covers several physiographic settings. Also, the conclusions should apply to the rest of the Ross continental shelf, where there is a similar range in depth, salinity and temperature, and whose waters are in free circulation with those of McMurdo Sound.

Figure 1. Satellite image location map for McMurdo Sound (see inset) and referenced sites within the McMurdo Sound-Granite Harbour area. (Map is from USGS Experimental Printing; Sheet: McMurdo Sound, Antarctica 1973.


LOCATION DIAGRAM
ANTARCTICA
ATLANTIC OCEAN
INDIAN OCEAN
PACIFIC OCEAN
SOUTH AMERICA
AFRICA
AUSTRALIA
NEW ZEALAND
GRANITE HARBOUR
MCMURDO SOUND
NEW HARBOUR
ROSS ISLAND
C. Bird
URDO STATION (US)
SCOTT BASE (NZ)
C. Armitage
1:1 000 000
77°
77°30'
78°
163°
164°
165°
166°
167°

Oceanographic features of McMurdo Sound

Introduction

Polar investigations over the last 35 years have provided useful information on the distribution and limiting environmental features of foraminiferal genera and species.

The Arctic polar environment is similar to that of the Antarctic in that it is cold, seasonally ice-covered and has great seasonal changes in sunlight, but differs in that instead of being a continent surrounded by seas, it is a sea surrounded by continents. There is enough similarity in the sea-floor environments, though, that numerous species of foraminifera (50% of those studied by Todd and Low 1966) are bipolar. General aspects of the Antarctic marine environment have been reviewed by Holdgate (1967), Knox (1970) and Hedgepeth(1977). The Arctic marine environment has been studied in much greater detail by petroleum exploration companies interested in drilling for oil in the Canadian Arctic and other areas (Dome et al. 1982). Water temperatures of Beaufort Sea are very slightly warmer than those of McMurdo Sound, but equivalent to Ross Sea as a whole (1° C to -1.5°C) and salinity is more variable (30‰ to 35.2‰) than that of McMurdo Sound, which is probably due to run-off from rivers in the Arctic. The continental shelf of Beaufort and Chukchi Seas is shallower (100m at 80km offshore) than that in Ross Sea, which averages 500m in depth.

Water Mass Properties

The properties of McMurdo Sound waters have been studied by Littlepage (1965), Heath (1971a,b; 1977), Gordon (1971), Gilmour (1975) and Jacobs et al. (1981). Bottom waters are similar in temperature and salinity (-1.95°C to -1°.40 C; 33.96‰ to 34.99‰) to those of Ross Sea (-1.94°C to 0.6°C, 33.12 to 34.86‰) (Littlepage 1965, McKnight 1962). The observed differences of temperature and salinity are insufficient to affect Antarctic benthic foraminifera communities (McKnight 1962). The major water masses defined for Ross Sea area are: Antarctic Bottom Water, Ross Sea Shelf Water, Circumpolar Deep Water, Pacific Ocean Deep Water and Bottom Water, and Antarctic Surface Water (Figure 2). Ross Sea Shelf Water is formed by the freezing of water at the base of Ross Ice Shelf, and the resulting saline water sinking to the shelf floor, and making its way north along the sea floor.

Glacial meltwater from the floating Erebus Ice Tongue forms stratified layers averaging 17m thick in step-like fashion within a few hundred metres of the melting ice (Jacobs et al. 1981). Salinity and density increase with depth to about 400m, and temperature initially increases just below the surface, then decreases slightly to about 220m. Salinities of deeper stations converge near 500m (Jacobs et al. 1981,Fig.5) perhaps marking the lower limit of glacial melting in the Ross Sea.

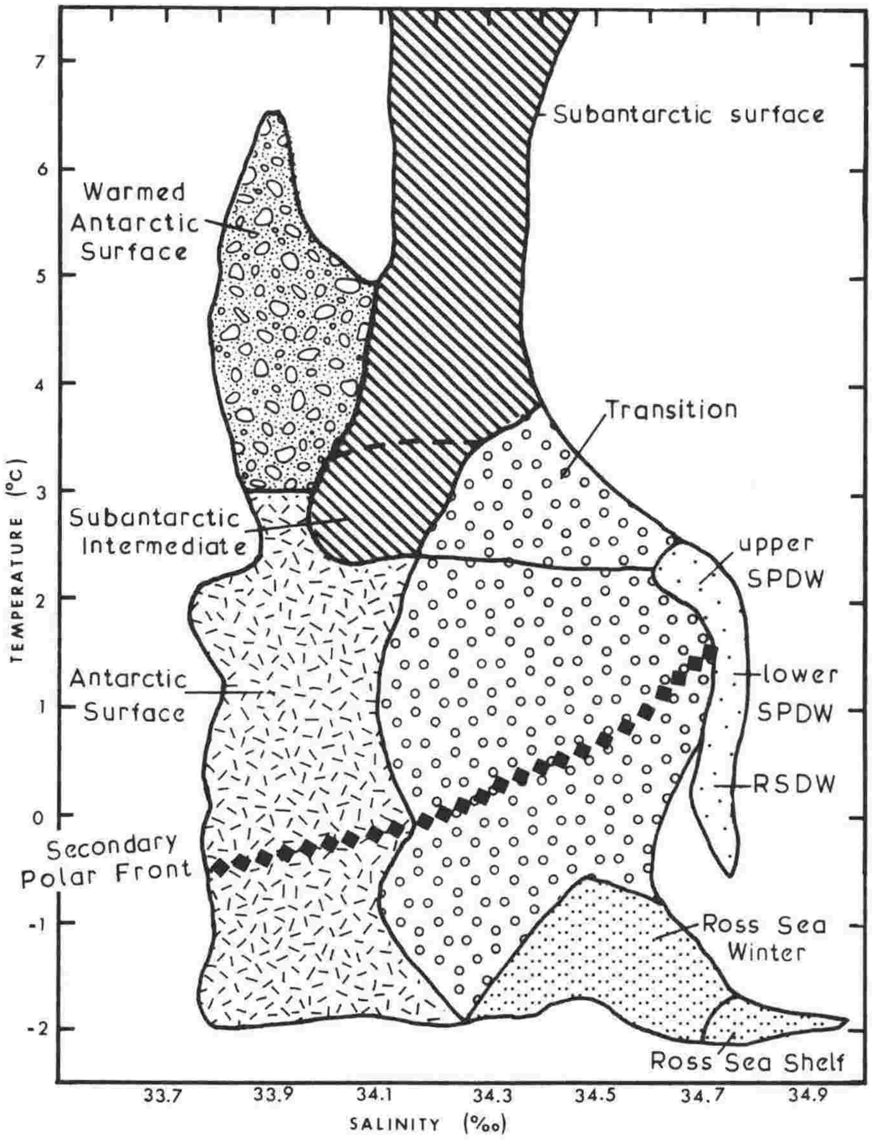


Figure 2. Water properties (salinity and temperature) of the Ross Sea (from Gordon 1971, Figure 5).

SPDW - Southeast Pacific Basin Deep Water

RSDW - northern Ross Sea Deep Water

Nutrients

The essential plant nutrients, phosphate, silicate, oxygen and nitrate occur in the upper layers of Antarctic waters in sufficient concentrations to allow abundant phytoplankton growth (Knox 1970, Hedgpeth 1977, Holm-Hansen et al.1977). The most comprehensive data collected to date from McMurdo Sound are those of Littlepage (1965), who sampled four locations near Cape Armitage, Hut Point Peninsula (Figure 3) for eleven months during 1961 (March excluded). Littlepage (1965) measured concentrations of dissolved inorganic phosphate, and found that the lowest mean was 1.4um/l in October (Figure 4). Values of dissolved oxygen varied from 8.59ml/l to 6.08ml/l (Figure 5), and dissolved silicate from 47.25ug/l to 40.5ug/l in May (Figure 6), all of sufficient concentration to pose no limit to phytoplankton production. Nitrate concentrations were not investigated.

Currents

Currents play an important role in the environment of McMurdo Sound, mixing the waters to distribute essential nutrients (Hedgpeth 1977). They also play a part in the distribution of sediment, including that brought in by glacier ice, and that blown onto the sea ice and then released when the sea ice melts. The highest velocities recorded in McMurdo Sound are about 39cm/sec, near Cape Armitage (Littlepage 1965), where water from beneath Ross Ice Shelf enters McMurdo Sound (Figure 7) (Hicks 1974). In the centre of the sound the flow is about 2cm/sec in the top 150m of water and increases to 11cm/sec at greater depths. This flow is southwards towards the McMurdo Ice Shelf. On the western side the flow is between 4 and 6cm/sec, faster at the northern part (Heath

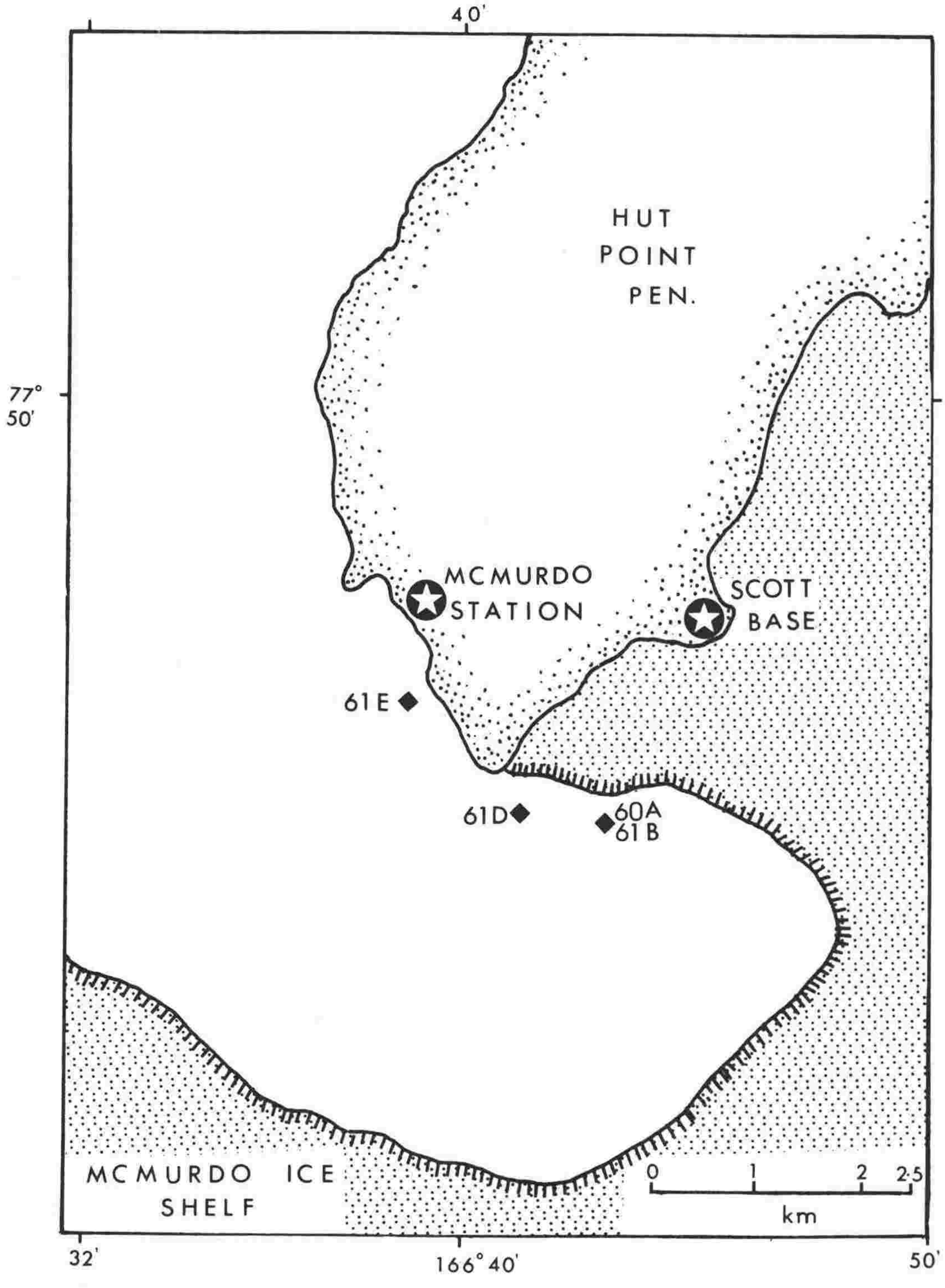


Figure 3. Locations of sample sites off Cape Armitage occupied by Littlepage (1965) during 1961. Refer to following Figures 4-7.

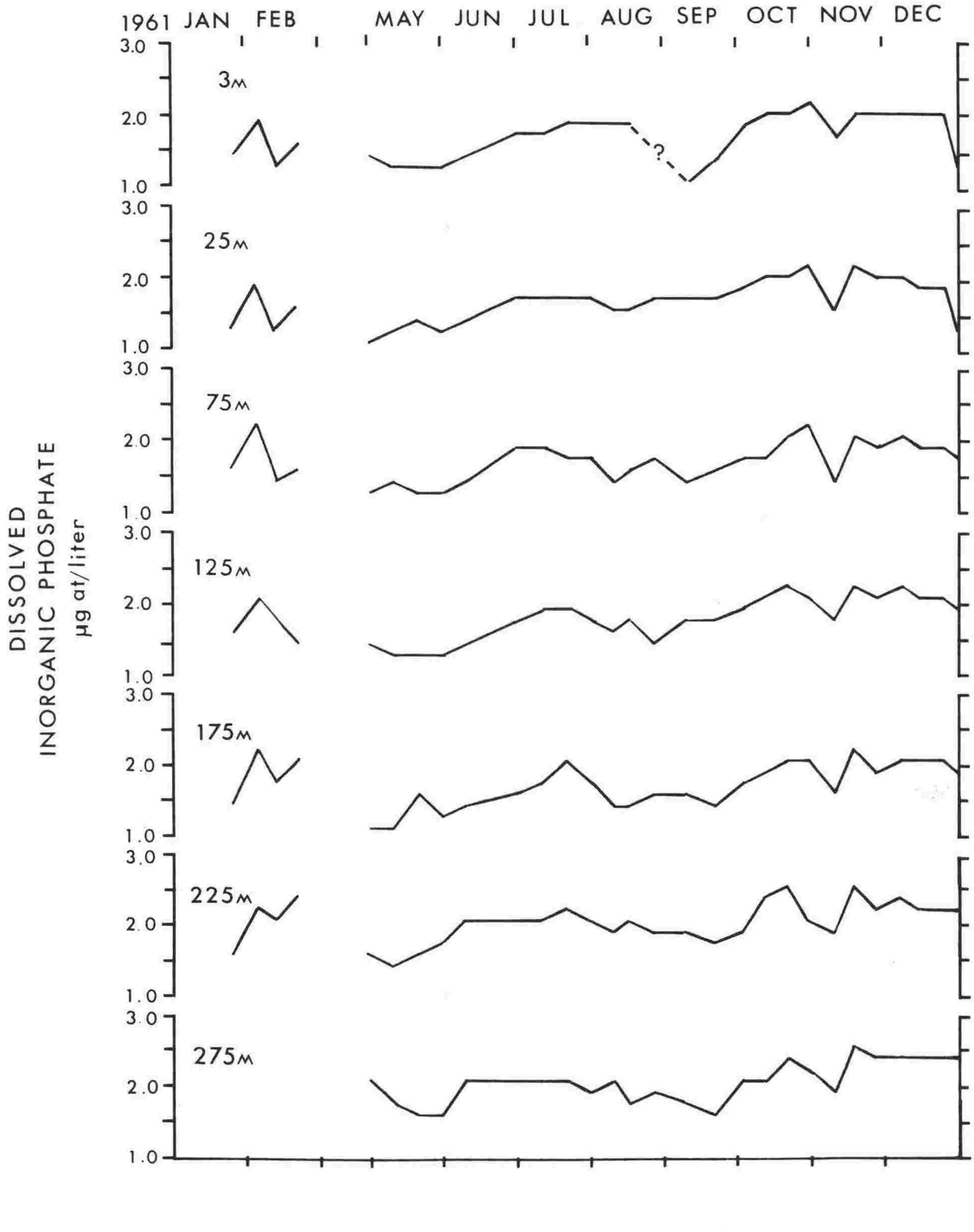


Figure 4. Mean distribution of dissolved inorganic phosphate from four Cape Armitage sample sites, measured at stated water depths (after Littlepage 1965).

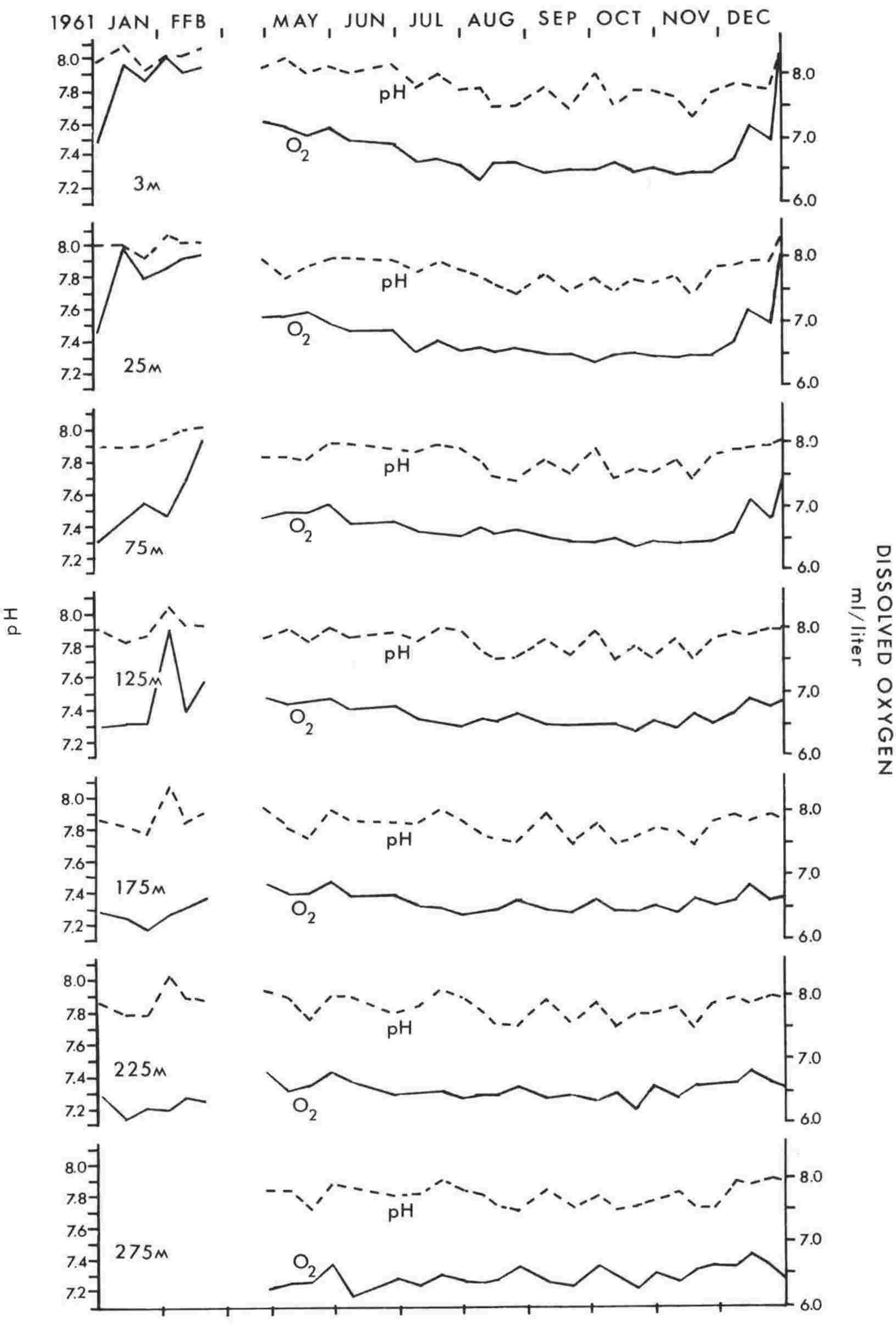


Figure 5. Mean distribution of dissolved oxygen and pH at four Cape Armitage sample sites, measured at stated water depths (after Littlepage 1965).

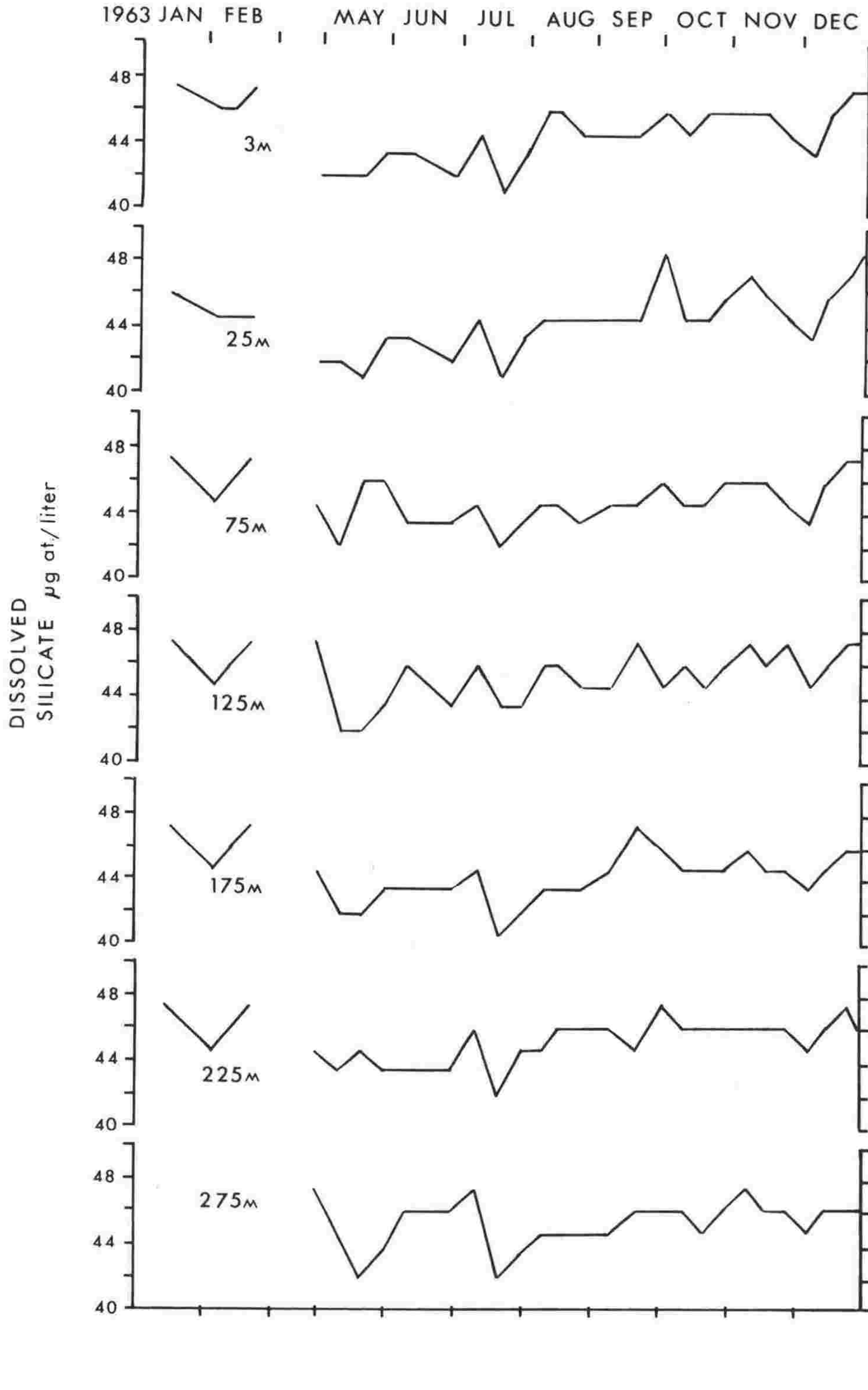


Figure 6. Mean distribution of dissolved silicates from four Cape Armitage sample sites, measured at stated water depths (after Littlepage 1965).

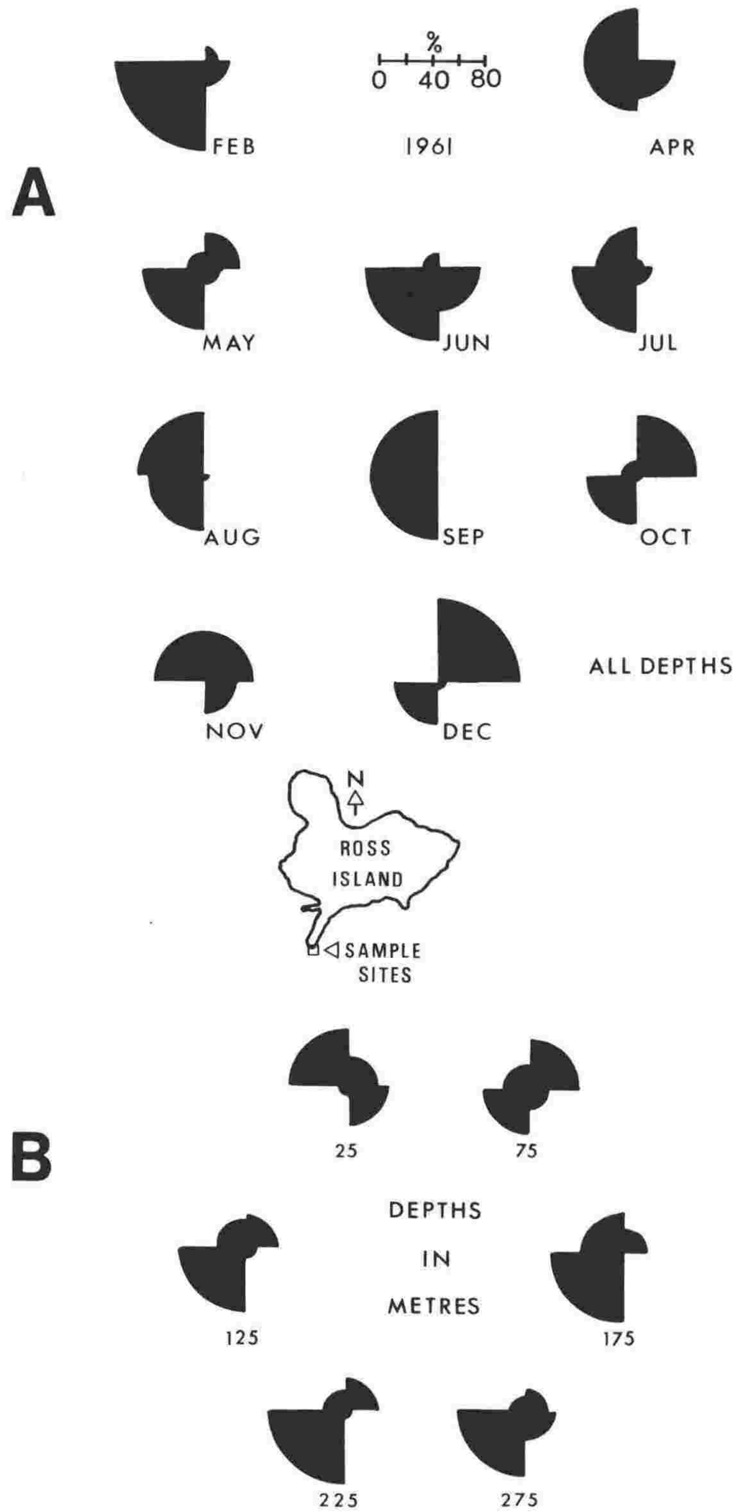


Figure 7. A. Mean distribution of current flow by quadrant from four Cape Armitage sample sites, measured at water depths indicated in part B, below.

B. Distribution of annual current flow from the Cape Armitage sites, measured at stated water depths. (A and B after Littlepage 1965).

1971b, Gilmour 1975). This flow is north-northwesterly, out of the sound (Heath 1977), and is part of the Ross Sea gyre system that flows westward around the tip of Cape Bird into the sound.

Special note should be made of the effect currents can have on the distribution of foraminiferal tests. Live benthic foraminifera, even those species that do not attach themselves to rocks or plants, can generally maintain their position on soft substrate by means of root-like pseudopodia (filamentous extensions of the protoplasm). Dead tests, however, can be transported on a sandy bottom by currents with velocities as low as 5cm/sec (Kontrovitz et al.1978). Post-mortem transport of foraminiferal tests alters dead assemblages to a greater or lesser extent, depending on current velocities and test sizes. Only by differentiating the living from the dead specimens can one be sure of determining the living assemblage for a particular sample site.

Calcium Carbonate Compensation Depth (CCD)

The CCD in the ocean is the depth at which the rate of solution of calcium carbonate balances the rate of deposition. Above this depth carbonate-rich sediments can accumulate and below it carbonate-poor sediments accumulate. Above it the water is saturated or nearly saturated in calcium carbonate and planktonic and benthic carbonate shells accumulate on the sea bed, while below it the water is undersaturated enough to dissolve all carbonate shells that are not protected. The average depth of the CCD in Pacific Ocean is 4.2km and in the Atlantic 4.7km (Weyl 1970, p.344-345). Extending for several hundred meters above the CCD is the lysocline in which planktonic organisms reaching the sea floor have species diversity decreasing with depth owing to preferential solution of the less resistant species during their descent through the water column.

In Ross Sea, the CCD is extraordinarily shallow by comparison, being about 620m deep (Kennett 1968,p.34,Fig.10, Fillon 1974,p.138). Below the CCD, the biogenic sediment consists mainly of agglutinated foraminifera, radiolaria, diatom frust~ules (generally deposited in fecal pellets) and siliceous sponge spicules. In water down to 430m, calcite foraminiferal tests and, locally, mollusc shells, are abundant. Between 430m and 620m Kennett (1968) distinguished a so-called mixed faunal zone, in which calcareous foraminifera tests decrease in proportion to agglutinated tests, more or less with increasing depth. Within this zone lies the foraminiferal lysocline, the level at which 80% by weight of foraminifera is lost by dissolution (Kennett 1982, p.466). Osterman and Kellogg (1979) found the CCD to be as low as 800m in some areas of the Ross Sea, based on total (living plus dead) foraminifera distribution. In the open part of McMurdo Sound the writer has found the CCD to be about 620m, as in the main part of Ross Sea, (Kennett 1968), thus confirming free interchange of water between the two areas. In harbours and enclosed basins, it is much shallower, about 230m (Chapter 4).

In the large ocean basins the chief cause of increasing solubility of calcium carbonate with depth is decreasing pH (Weyl 1970). In sea water pH is controlled mainly by dissolved CO2, decreasing with increasing CO2 concentration according to the following equation:

$$H_2O + CO_2 \rightleftharpoons H_2CO_3 \rightleftharpoons H^+ + HCO_3^- \rightleftharpoons 2H^+ + CO_3^{--}.$$

The solubility of gases in water increases with increasing pressure and decreases with increasing temperature. At the ocean-atmosphere interface the amount of CO_2 in solution varies almost entirely with temperature because the pressure is constant at approximately one atmosphere. As McMurdo Sound water is very cold (-1.9 °C to -1.6°C) at the surface, CO_2 concentration is high relative to that in lower latitude surface waters. The high carbon dioxide concentration accounts for the slightly lower pH values (7.65-8.1) recorded by Littlepage (1965, Figure 5) compared with the world ocean average between 7.8 and 8.3 (Hood 1966,p.798).

The solubility of a gas increases logarithmically with pressure, which increases roughly one atmosphere for every 10m of depth. In McMurdo Sound the bottom water temperature is little different from that of the surface water, so at the CCD depth of 600m, CO_2 solubility, controlled almost entirely by pressure, is roughly 60 times greater than at the surface. High plankton productivity (Littlepage 1965,p.27) ensures high organic input to the bottom water where high oxygen concentration (cold temperature increases oxygen solubility as well as CO_2 solubility) ensures rapid oxidation of organic matter, producing carbon dioxide which goes into solution. This could reduce the pH of the water and make it more corrosive to calcium carbonate, which appears to be the case in McMurdo Sound.

Effects of seasonal sea ice cover

In the open ocean, the photic zone (lower limit of effective penetration of sunlight and the depth to which photosynthesis can occur) usually extends to about 100m (Smayda 1966,p.714). According to

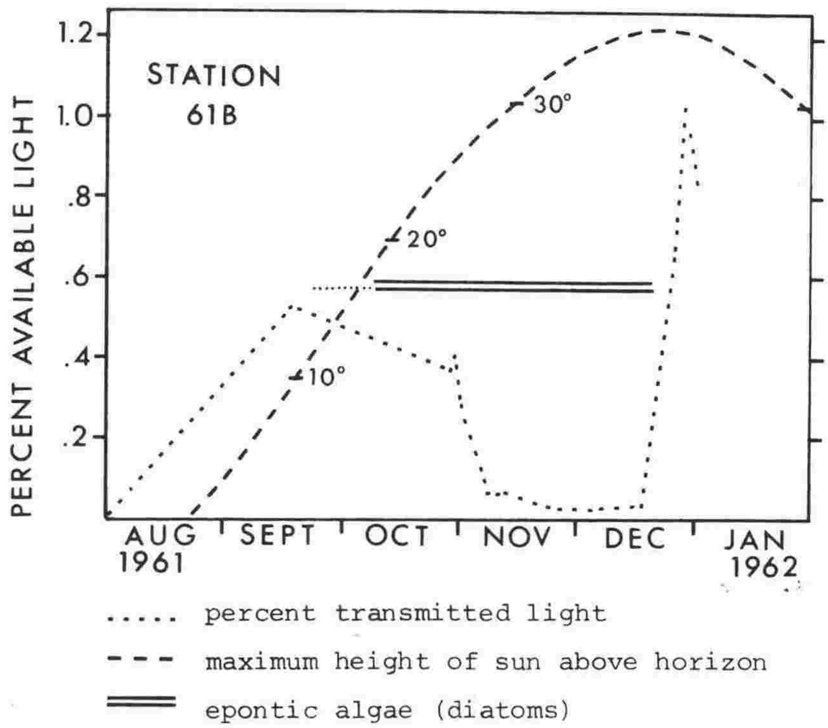


Figure 8. Proportion of transmitted light detected below sea ice at Station 61B off Cape Armitage during 1961. Note relationship with maximum sun height, and development of epontic algae (after Littlepage 1965).

Littlepage (1965), the 2m thick sea ice in McMurdo Sound, when present, reduces the photic zone to nearly zero; that is, the sea ice comprises the full extent of the photic zone during the time it covers the water surface in the sound. Littlepage (1965) made daily measurements of light intensities immediately below the ice off Cape Armitage, Ross Island, from 17 September to 31 December, 1961 (Figure 8). The amount of light penetrating to the top of the water column was very low, ranging from a minimum of 0.06% on 8-12 November, to a maximum of 1.0% on 31 December. High opacity was continuous from 8 November to 7 December due to the annual bloom of epontic diatoms in the lower ice layers. No deeper measurements of light intensity have been made in McMurdo Sound when covered by sea ice, and no measurements have been made when the ice is not present.

Even when the Sound becomes clear of ice in late January, the photic zone must be shallow because of the angle of incidence of the sunlight (maximum 30°) which declines until the sun at midday remains below the horizon in late April. Polar seas without ice cover are thought to have shallower photic zones than tropical seas not only because of the low angle of incidence of sunlight and the amount of atmosphere the sunlight has to penetrate, but also because high fertility promotes high productivity, causing turbidity in the water (Littlepage 1965).

Bathymetry and Physiography

McMurdo Sound can be divided into four physiographic areas: 1) the steep slopes (6°) off the Ross Island Coast, 2) the Erebus and Bird Basins, relatively flat-floored and about 600m and 900m deep, respectively, 3) the Western Slope, rising at 1° to the west from 850m to 250m, and 4) the Western Shelf, a broad platform with an average depth of about 200m, deepening slightly to the north (Barrett et al. 1983) (Figure 9).

The basins around Ross Island and the Western Slope and Shelf have water in free circulation with the rest of Ross Sea. Some areas along the coast may behave as restricted basins because of their submarine topography. Granite Harbour, a glacially scoured basin, reaches a depth of over 900m, but has a submarine constriction at the harbour mouth, and creates a basin that is contained by a sill 600m below sea level, preventing circulation of deep Granite Harbour water into Ross Sea. New Harbour also is a basin closed at about 200m, and reaching a depth of 250m near the snout of Ferrar Glacier.

Sea floor character (substrate)

The feature of the McMurdo Sound substrate most likely to influence benthic foraminiferal distribution is grain size, which ranges from mud in the deep basins and harbours through sand on the Western Slope and Shelf to gravel in a few places (Figure 10). The boundary between mud and sand approximately parallels the 800m depth contour in the main part of the sound but in the harbours is much shallower, being about 400m in Granite Harbour and 200m in New Harbour. The reason for this apparent depth control is not known. A gravelly substrate is known to occur off Cape Roberts, along the edge of McMurdo Ice Shelf and in Erebus Basin, possibly because the currents there are relatively strong.

Off Cape Armitage in McMurdo Sound, part of the sea floor is covered by a thick mat of siliceous sponge spicules (Littlepage 1965).

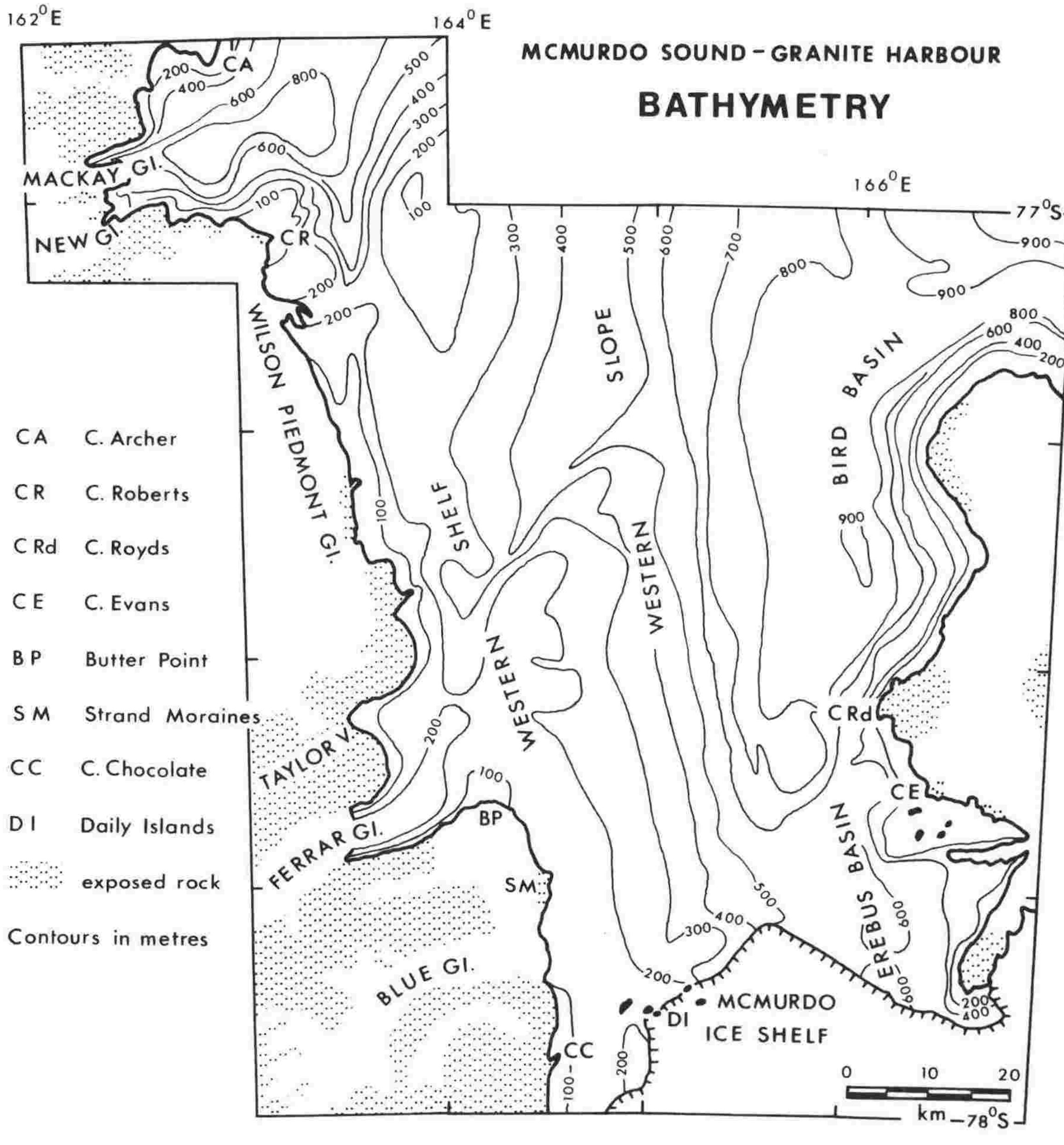


Figure 9. Bathymetry and physiographic areas of the McMurdo Sound-Granite Harbour area (from Pyne <u>et al</u>. 1984).

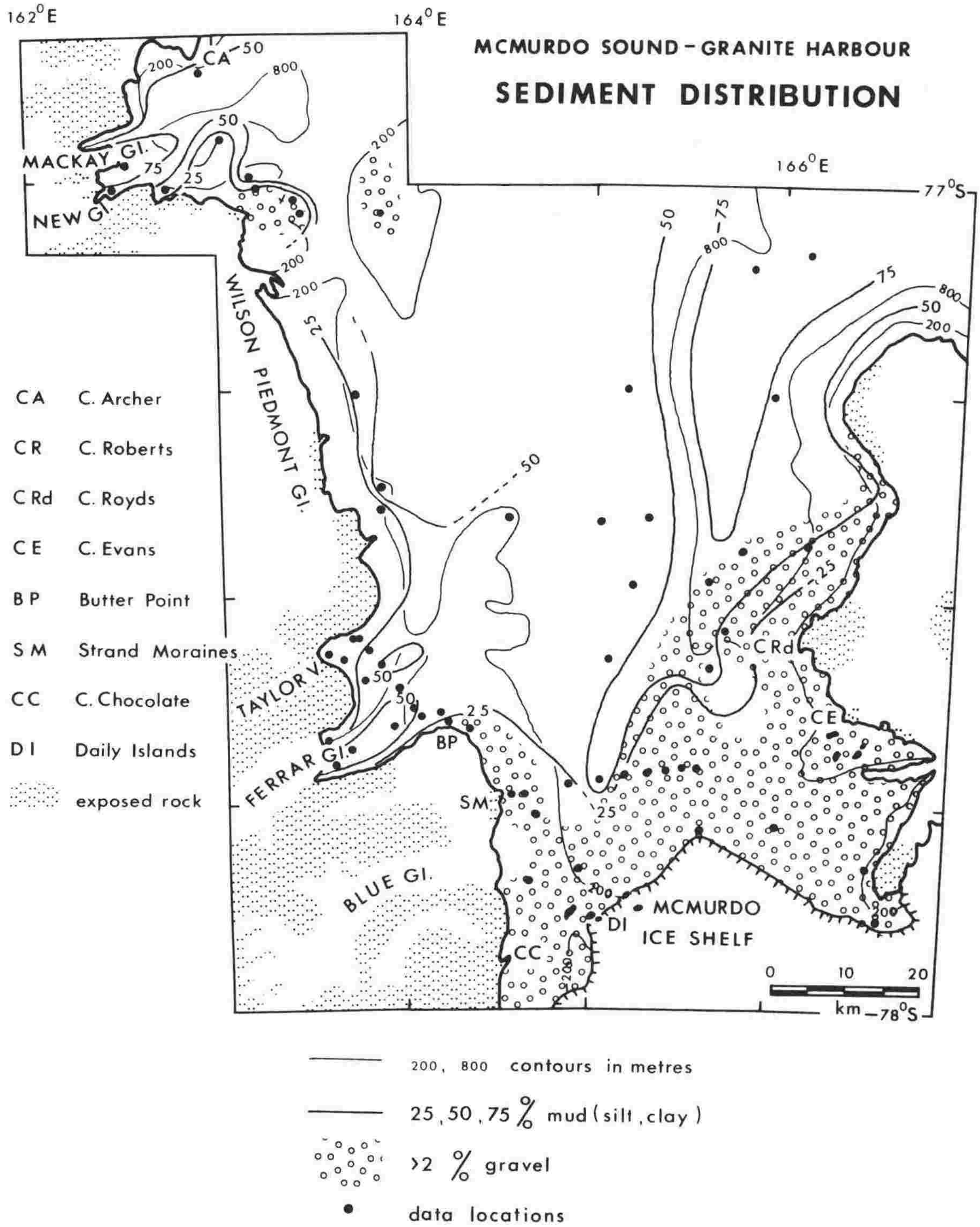


Figure 10. Sediment distribution in the McMurdo Sound-Granite Harbour area, showing percentage mud (25%, 50% and 75% contours) and areas with greater than or equal to 2% gravel. Note close correlation of increased percentage mud with greater water depth (e.g. Bird Basin area).

Littlepage (1965) did not provide details on depth range, percent of floor covered or other information. Dayton et al. (1974) mention that heavy sponge mat is present starting at depths of 33m in McMurdo Sound, and varies in thickness from a few cm to more than 2m. Several samples collected for this thesis contained quantities of sponge spicules, some up to 6cm in length. The spicules form a felted mat that traps coarse and fine sediment, and provide a firm substrate for attached species of foraminifera. The sponge mats found during the present sampling programme all occur in water shallower than 560m.

Chapter 2: METHODS

Field collection

Several methods of sediment retrieval were used over four seasons. During the 1979-1980 field season, eleven samples were collected with a small (5cm internal diameter) piston corer, using the sea ice as an operating platform. The cores varied from three to 15cm in length. The piston corer was difficult to operate in the cold conditions and could not penetrate pebbly substrates or heavy sponge mats. In February, a scientific party headed by Dr. Dennis Kurtz of Rice University, Texas, kindly collected 22 grab samples with a Dietz-LaFond grab, working from the USCGC Glacier while it was cruising in and near McMurdo Sound.

In preparation for the 1980-1981 field season, a large diameter (22cm) gravity sphincter corer was designed by Alex Pyne and built at Victoria University of Wellington for use on the project (Figure 11). It was expected to be able to obtain 30-50cm long cores with the water/sediment interface intact. In tests in Wellington Harbour it operated satisfactorily, but in Antarctica the trigger mechanism did not operate satisfactorily, and the corer was sent back to New Zealand before the end of the season. Sampling continued with an orange-peel grab with which 27 samples were obtained. They were frozen in the field, and later at Scott Base subsamples were placed in ethyl alcohol prior to shipment to New Zealand for laboratory analysis.

During February, 1981, Drs.F.Davey and D.Bennett collected five gravity piston cores in McMurdo Sound while on board the MV Benjamin Bowring. These were not preserved at the time, but were transported in the ship's hold to Christchurch, New Zealand from where they were flown to Wellington. The cores were then frozen for three weeks prior to splitting and subsampling. Subsamples were placed in ethyl alcohol until they could be processed in the lab.

Before the 1981-1982 field season the gravity sphincter corer was modified to improve the trigger and weight system (Figure 11). It operated well in McMurdo Sound and provided the writer's most useful samples. Its advantages are its wide diameter which helps prevent distortion of sediment layers, its sphincter-sleeve closure (core-catcher), and its open top which obviates a hydrostatic head of water building up ahead of the corer as it falls through the water, thus leaving the water/sediment interface intact during collection, an important objective for this study. Twenty sediment cores were collected using it. Firm or rocky substrate still proved to be a problem, resulting in six samples being disturbed during retrieval, but 14 were intact cores six to 56cm in length. The longest were taken from Granite Harbour and New Harbour, where the sediment is muddy and homogeneous, and contains only a few scattered pebbles.

The general sampling plan for the project was to retrieve sediment samples from as many depths and geographic locations within the sound as possible. The 1979 short piston cores were taken on an opportunity basis from existing holes in the sea ice drilled for fishing studies and other purposes. The 1980 grabs from the USCGC Glacier were taken in conjunction with piston cores for the Rice University party, and were also on an opportunity basis. The 1980 orange-peel grabs were retrieved from areas of the sea floor accessible from the sea ice, and were limited to the McMurdo Station brine effluent and New Harbour due to time and weather limitations. The 1981 sphincter cores, used in this study, covered a line from Cape Evans to the Strand Moraines, Granite Harbour and the Ferrar Glacier snout. The February 1981 gravity piston

Figure 11. Gravity sphincter corer built at Victoria University for soft-sediment coring in McMurdo Sound. Height of corer (excluding trigger mechanism) approximately 1.5m.

cores retrieved from the MV Benjamin Bowring proved not to be particularly useful. Sphincter cores taken during the 1982 season from Granite Harbour, the Blue Glacier snout and Cape Chocolate were used in this study, as were several orange-peel grabs taken in February 1983 from the USCGC Glacier. Figures 12 and 13 are maps showing the locations and type of gear used in retrieving the various samples. Figure 12 shows all the sample sites, and Figure 13 shows the sites at which foraminiferal counts were made.

The gravity sphincter core samples were split longitudinally at the sample sites, one half sliced horizontally into 5cm thick archive subsamples representing the full vertical length of the sample, and the other half into two to three centimeter thick subsamples which were each preserved in ethyl alcohol. Colour photographs were taken of the core tops and of all surfaces made when slicing the cores. Subsamples for sediment analysis were taken separately from the side of the archive splits as they did not have to be preserved. Sediment size analyses were carried out at the Geology Department, Victoria University, Wellington by sieving at 0.5 phi intervals in the sand range, and by pipette or Sedigraph in the mud range (Barrett et al. 1983). Appendix 1 contains sample descriptions, photographs and/or sketches of all the samples collected. The 26 samples selected for this study are listed in Table 0.

Preparation of Foraminiferal Samples

All sediment samples were washed on a 63 micron sieve to remove clay and silt-sized particles. Residues of preserved samples were then soaked in rose bengal for 45 to 60 minutes to stain any protoplasm present (Walton 1952, Murray 1973). The samples were then dried, and foraminiferal tests were concentrated by flotation using carbon tetrachloride. A subsample of each float containing what was estimated

Table 0: List of samples used in this study, with depth and substrate type. More detailed descriptions and locations given in Appendix 1, page 159.

Sample No.	Sample Type	Depth(m)	Substrate
1980-6	Orange-peel grab	79	pebbly sand
1981-1	Gravity core	850	mud
1981-2	"	370	muddy sand
1981-3	"	560	pebbly muddy sand
1981-4	"	560	muddy pebbly sand
1981-5,5A	"	496	pebbly sand
1981-6	"	460	coarse pebbly sand
1981-7	"	420	pebbly sand
1981-8,8A	"	289	pebbly sand,sponge mat
1981-9	"	213	pebbly sand
1981-10	"	173	pebbly sand, sponge mat
1981-12	"	110	pebbly sand, sponge mat
1981-13	"	537	mud, diatomaceous ooze
1981-14	"	345	sandy mud
1981-15	"	550	sandy mud
1981-16	"	266	sandy mud
1981-17	"	358	pebbly sandy mud
1981-18	"	254	sandy mud
1982-1	"	303	mud
1982-2	"	796	mud
1982-3	"	139	muddy fine to med sand
1982-4	"	212	muddy fine to med sand
1983-2	Orange-peel grab	660	gravelly sandy mud
1983-3	"	856	slightly sandy mud
1983-4	"	854	slightly sandy mud
1983-22	"	128	slightly muddy coarse sand
1983-26	"	620	shelly muddy pebbly sand

by eye to contain about 300 specimens of foraminifera was prepared using a sediment splitter based on a design by Humphries (1961). Under a Leitz binocular microscope the foraminifera were extracted and mounted on gummed faunal slides. Residue that did not float in carbon tetrachloride was also searched for any remaining tests, and these specimens were added to the collections on the slides. Stained and non-stained specimens of each species were counted separately. The stained specimens are considered to have been part of the living population at the time of sampling. The unstained specimens are assumed to represent empty foraminiferal tests, but opaque tests are ambiguous because they may contain stained protoplasm that is invisible unless the test is broken. Breaking tests was necessary to determine live specimens of Psammosphaera fusca and Pelosina bicaudata.

Approximately 40,000 foraminiferal tests were counted. They represent 123 species and varieties, from 31 families. Approximately 10% of the species in each sample were stained, with significant exceptions in New Harbour (Core 81-18, 0-2cm,28.3% live) and central McMurdo Sound samples 1981-2 (1.9%), 1981-8A (0.5%), 1981-10 (1.1%) and 1981-12 (2.7%).

Treatment of planktonic tests

Planktonic tests were extracted at the same time as other foraminifera. These were kept on separate slides, and do not comprise part of the foraminifera counts of the benthic species. Two forms of Neogloboquadrina pachyderma are present in McMurdo Sound and one reworked test of Globorotalia inflata was found in Core 81-6.

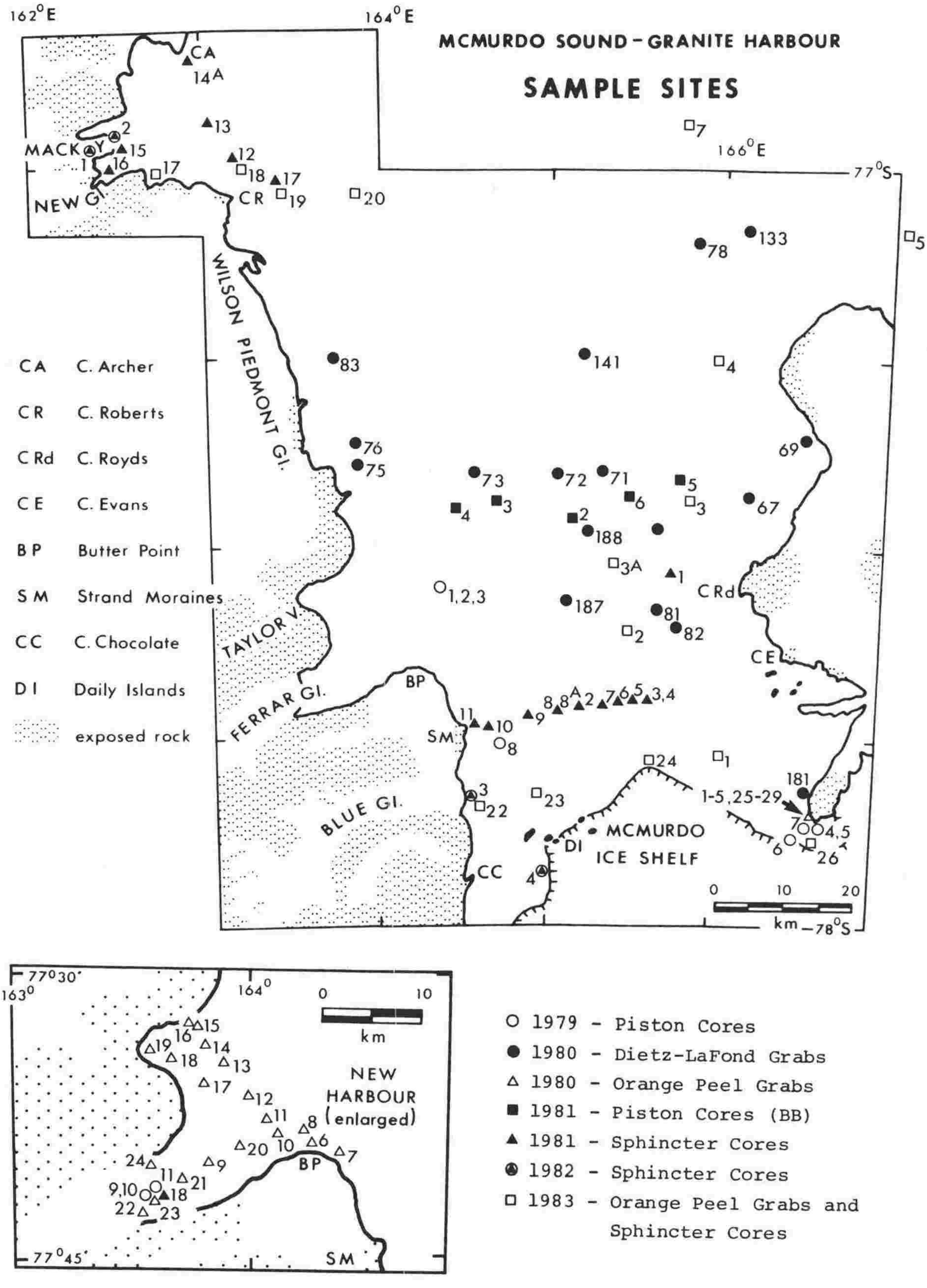
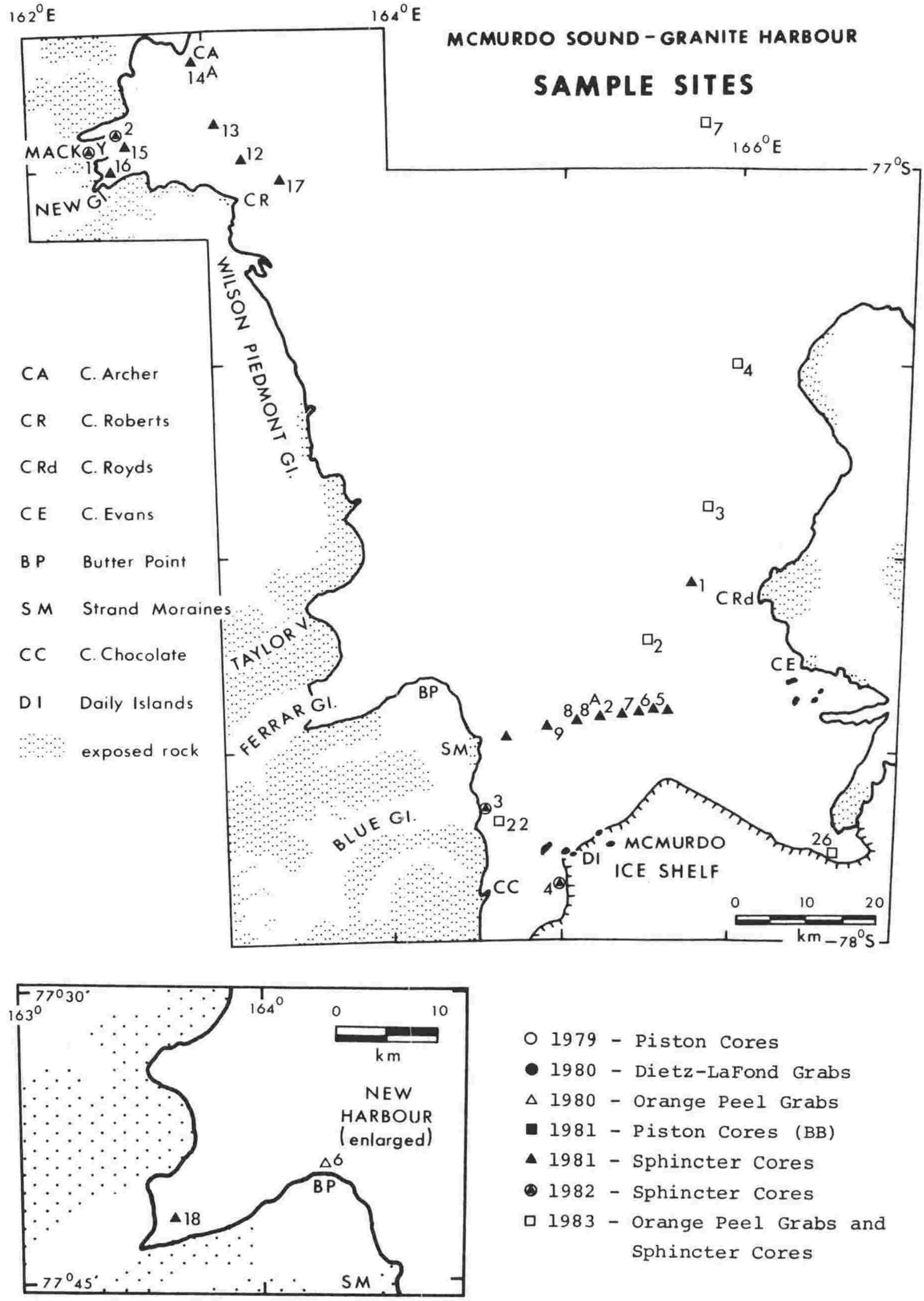


Figure 12. Location map for all sediment samples taken in McMurdo Sound area. Appendix 1 contains descriptions of the sediment samples and gives exact locations.



○ 1979 - Piston Cores
● 1980 - Dietz-LaFond Grabs
△ 1980 - Orange Peel Grabs
■ 1981 - Piston Cores (BB)
▲ 1981 - Sphincter Cores
◉ 1982 - Sphincter Cores
□ 1983 - Orange Peel Grabs and Sphincter Cores

Figure 13. Location map for sediment samples used in this foraminiferal study.

CHAPTER 3

SYSTEMATIC NOTES

Introductory Remarks

General Foraminiferal Taxonomy

The generic and higher classification used by the writer is that of the Sarcodina part of the Treatise of Invertebrate Paleontology (Loeblich and Tappan 1964) and Loeblich and Tappan's (1974, 1984) revised foraminiferal classification system. Early descriptions of foraminifera from various parts of the world, including those by d'Orbigny (1839a,b,1826,1846), Carpenter (1856), Williamson (1858), Brady (1884), Pearcey (1914), Chapman (1916), Heron-Allen and Earland (1922,1929,1930,1932a,b), Wiesner (1931), Earland (1933,1934), Buchner (1940,1942), Cushman (1947), Höglund (1947) and Parr (1950) have all been useful for taxonomic determinations. Antarctic references that were especially useful included McKnight (1962), Pflum (1966) and Anderson (1975).

All species listed from McMurdo Sound in this thesis are set out in taxonomic order in this chapter. Brief synonomies are presented with remarks and/or descriptions where needed. Notes on the distribution of each species follow the synonomy, with a mention of in which of the present samples the species was found, the range of water depths from which the samples were taken, and percent mud the samples contained. Some author's names have been abbreviated for convenience: Loeblich and Tappan appears as L & T, and Heron-Allen and Earland as H-A & E. Scanning electron photomicrographs of most species are included, taken on the Philips 505 Scanning Electron Microscope at Victoria University of Wellington. The coating used was platinum or gold. The SEM stubs used and reference slide collection are deposited with Mr.S.Eager, Curator of Paleontology, Victoria University of Wellington. Access to this material is provided through the Department of Geology.

LIST OF ABBREVIATIONS OF SPECIES NAMES

		Page where located in Chapter 3
ASTR SPH	ASTRAMMINA SPHAERICA	31
RHAB ABYS	RHABDAMMINA ABYSSORUM	31
BATH SP.		31
BATH HIR(A,B)	BATHYSIPHON HIRUDINEA (A,B)	31
HYP CYL	HYPERAMMINA CYLINDRICA	32
HYP MAL	HYPERAMMINA MALOVENSIS	32
HYP SUBN	HYPERAMMINA SUBNODOSA	32
PSAM FUSCA	PSAMMOSPHAERA FUSCA	33
SAC SPH	SACCAMMINA SPHAERICA	33
SAC JUV	SACCAMMINA SPHAERICA JUVENILE?	33
PELO BIC	PELOSINA BICAUDATA	33
THUR ALB	THURAMMINA ALBICANS	~~43~~ 34
THUR PROT	THURAMMINA PROTEA	~~43~~ 34
HEMI BRAD	HEMISPHAERAMMINA BRADYI	34
AMMOP SP	AMMOPEMPHIX SP	35
GLOM CHAR	GLOMOSPIRA CHAROIDES	36
GLOM GORD	GLOMOSPIRA GORDIALIS	36
TUR SHON	TURITELLELLA SHONEANA	36
HORM OVIC	HORMOSINA OVICULA	38
HORM SP	HORMOSINA SP	38
REO PIL	REOPHAX PILULIFER	38
REO PSEU(A,B)	REOPHAX PSEUDODISTANS VAR. TENUIS (A,B)	38
REO SUBD	REOPHAX SUBDENTALINIFORMIS	39
MIL ARE	MILIAMMINA ARENACEA	40
MIL LATA	MILIAMMINA LATA	40
CRIB JEF	CRIBROSTOMOIDES JEFFREYSII	41
CRIB SUB	CRIBROSTOMOIDES SUBGLOBOSUS	41
CRIB WIE	CRIBROSTOMOIDES WIESNERI	41
TEXT ANT	TEXTULARIA ANTARCTICA	43
TEXT EAR	TEXTULARIA EARLANDI	43
SPIRO FIL	SPIROPLECTAMMINA FILIFORMIS	43
TROC GLABRA	TROCHAMMINA GLABRA	44
TROC GABO	TROCHAMMINA GABOENSIS	44
TROC A	TROCHAMMINA SP A	44
TROC B	TROCHAMMINA SP B	44
PORT ANTA	PORTOTROCHAMMINA ANTARCTICA	45
PORT ELT	PORTOTROCHAMMINA ELTANINAE	45
CONO BULL	CONOTROCHAMMINA BULLATA	45
VERN MIN	VERNUILINA MINUTA	46
VERN ADV	VERNUILINA ADVENA	46
EGGE BRAD	EGGERELLA BRADYI	46
CYCL INVO	CYCLOGYRA INVOLVENS	47
MIL SPP (A,B)	MILIOLIDAE SPECIES A,B	49
PLAN BUC	PLANISPIRINOIDES BUCCULENTUS	48
CRUC TRI	CRUCILOCULINA TRIANGULARIS	49
PYRG DEP	PYRGO DEPRESSA	49
PYRG ELO	PYRGO ELONGATA	50
PYRG MUR	PYRGO MURHINNA	50
PRGOL SPH	PYRGOELLA SPHAERA	50
SIG UMB	SIGMOILINA UMBONATA	50
DENT COM	DENTALINA COMMUNIS	52

?*Bathysiphon* sp
Plate 1, Figure 11

Remarks: Tubular tests consist of smoothly cemented fine sand grains, very similar to *Bathysiphon hirudinea* (Plate 1, Figures 9,10). Lack of closed end and rougher appearance prevent placing it in *B.hirudinea* here.

Order: FORAMINIFERIDA Eichwald 1830

Family: ASTRORHIZIDAE Brady 1881

Genus: ASTRAMMINA Rhumbler in Wiesner 1931
Genotype: A.rara Heron-Allen & Earland 1932b

Astrammina sphaerica (Heron-Allen & Earland)

Armorella sphaerica H-A & E,1932b,p.257,pl.2,figs.4-11.
Armorella sphaerica H-A & E.HÖGLUND,1947,p.55,pl.5,figs.1-9.

Description: Test free, large, up to 1mm across; coarsely agglutinated, reddish orange in colour, several necks protruding from central chamber; apertures several, at ends of necks. No photograph available.

Distribution: Common in Gullmar Fiord area, Denmark, in waters deeper than 32m (Höglund 1947); seven S.Georgia stations, 93-344m, & 3647m (H-A & E 1932a). Rare in McMurdo Sound, occurring at 420m (81-7,16% mud) and at 8-10cm & 12-16cm in 81-15 (550m, 50% mud, Granite Harbour).

Genus: RHABDAMMINA M.Sars in Carpenter 1869
Genotype: R. abyssorum M.Sars 1869

Rhabdammina cf. abyssorum M.Sars
Plate 1, Figure 2.

Rhabdammina abyssorum M.Sars.SARS,1869,p.248.
Rhabdammina abyssorum M.Sars.BARKER,1960,p.42,pl.21,figs.1-13.

Description: Test free, large (up to 3mm), coarsely agglutinated. Broken, branching pieces only. Small pieces of tests such as these are difficult to identify, but appear similar to Brady's figures (1884,pl.21,figs.1-13).

Distribution: Rare in McMurdo Sound and Granite Harbour, occurring from 254-496m in 81-14A, 81-16 (both 59% mud, Granite Harbour), 82-1 (Granite Harbour) and 81-5 (10% mud, central McMurdo Sound).

Genus: BATHYSIPHON M.Sars in G.O.Sars 1872
Genotype: B.filiformis M.Sars in G.O.Sars 1872
→ Insert Bathysiphon sp.

Bathysiphon cf. hirudinea A,B (Heron-Allen & Earland)
Plate 1, Figures 9,10.

Hippocrepinella hirudinea H-A & E,1932b,p.258,pl.1,figs.7-15.

Description: (A) Test free, elongate (1.2mm), very finely agglutinated, wall very thin, aperture at one end, other end rounded and closed; pale yellow in colour.

Description: (B) Test free, elongate (1.25mm), very finely agglutinated, pale grey in colour. Differs from B.hirudinea A only in colour.

Distribution: Originally described from S.Georgia, 110-273m (Heron-Allen

Remarks: Figures 4 and 5 of Plate 1 show specimens that have sediment grains cemented together to form a smooth outer surface. Identification of these tubular agglutinated forms is difficult due to the risks of working with broken fragments. The slight curve of the test in Figure 4 is exaggerated due to the magnification; the two specimens in Figures 4 and 5 appear very similar under a light microscope.

& Earland 1932b, Earland 1933). (A) Rare in present samples, deep water (81-1,850m,48% mud) and harbour samples only (81-13,537m,81-15,550m, and 81-18,254m,0-6cm). (B) Rare in three present McMurdo Sound samples, two from Granite Harbour,345m(59% mud) and 537m(23% mud) and one from New Harbour, Ferrar Glacier snout,254m,8-10cm,about 60% mud).

Genus: HYPERAMMINA Brady 1878
Genotype: H.elongata Brady 1878

Hyperammina cylindrica Parr
Plate 1, Figure 3.

Hyperammina elongata Brady (non H.elongata Brady 1878) 1884,p.257, pl.23,figs.4-7 (non 8-10).
Hyperammina cylindrica PARR,1950,p.254,pl.3,fig.5.
Hyperammina cylindrica Parr.HERB,1971,p.274,pl.5,fig.3.

Distribution: Four Antarctic stations, 219-474m (Parr 1950). three Antarctic stations, 330m,1335m & 2195m, Ross Sea (Kennett 1968); nine Drake Passage stations, 3550-4758m (Herb 1971). Rare in present samples, few tests in each of nine samples from 139-850m, central McMurdo Sound; more common near Cape Chocolate (83-7, 755m, 33% mud) and near Ferrar Glacier snout (81-18, 254m, 8-10cm [58.7% mud] & 14-16cm).

Hyperammina malovensis Heron-Allen & Earland
Plate 1, Figures 4,5.

Hyperammina malovensis H-A & E,1932a,p.333,pl.8,figs.12-14.
Hyperammina malovensis H-A & E.PFLUM,1966,p.169,pl.13,fig.6.
→Insert Remarks.
Distribution: Two Bellingshausen Sea stations, 460 and 668m, (Pflum 1966); four McMurdo Sound and Ross Sea stations, 348-3570m (Kennett 1968). Present in seven McMurdo Sound samples, 173-755m (59-77% mud) and down Core 81-18 (2-4, 8-10, 12-14,& 18-20cm).

Hyperammina subnodosa Brady
Plate 1, Figure 6.

Hyperammina subnodosa BRADY,1884,p.259,pl.23,figs.11-14.

Description: Test free, large(up to 4.5mm long, 0.9mm diameter), agglutinated wall of siliceous sponge spicules.

Distribution: Recorded from N.Atlantic, East Indies and Pacific (Brady 1884); thirteen S.Georgia Stations,100-270m (Earland 1933); two stations, at 300m (Antarctic) and 150m (Kerguelen)(Parr 1950). In present McMurdo Sound samples, found in three harbour stations, 212m (82-4), 254m (81-18) and 266m (81-16), 60-77% mud; in two open water stations: 420m (81-7), 16% mud and 660m (83-2), 20.5% mud; and in one Cape Chocolate station, 755m (83-7), 33.4% mud.

Family: SACCAMMINIDAE Brady 1884

Genus: PSAMMOSPHAERA Schulze 1875
Genotype: P. fusca Schulze 1875

Psammosphaera fusca Schulze
Plate 2, Figure 14.

Psammosphaera fusca SCHULZE,1875,p.259,pls.4,6.figs.8-10.
Psammosphaera fusca Schulze.HERB,1971,p.259,pl.4,fig.1.

Distribution: 21 stations south of Antarctic Convergence, 223-4176m; northern deep sea basin of Drake Passage, 3733-3927m (Herb 1971); 16 samples, 330m and 3570m, McMurdo Sound and Ross Sea (Kennett 1968). Common in 22 present McMurdo Sound samples, open sound and harbour sites, 110-850m, 8%-85.7% mud.

Genus: SACCAMMINA M.Sars in Carpenter 1869
Genotype: S.sphaerica Brady 1871

Saccammina sphaerica Brady
Plate 2,Figure 8,9.

Saccammina sphaerica BRADY,1871,p.183.
Saccammina sphaerica G.O.SARS,1872,p.250.
Saccammina sphaerica M.Sars.BRADY,1884,p.253,pl.18,figs.11-17.
Saccammina sphaerica Sars.HERB,1971,p.271,pl.4,fig.3.

Description: Test free, large (0.6mm), coarsely agglutinated. Wall closely constructed of fine sand grains,aperture slightly produced on neck.

Remarks: As they all use S.sphaerica as the name, here are listed the various authors and references, and credit is given to Brady (1871) as author of the earliest published work to use the name.

Distribution: 219-300m, Antarctica (Parr 1950). "Deep water", North Atlantic, 732-914m, Hardanger Fiord, Norway; and 37-97m, Kerguelen Island, S.Pacific (Brady 1884). 5 Ross Sea samples,330m-612m (Kennett 1968). In the present samples, this robust species is rare, occurring in New Harbour, 254m (81-18, 77% mud), Granite Harbour, 550m (81-15, 85.7% mud) and off Cape Roberts, 358m (81-17, 19.7% mud, 79.6% sand).

Saccammina sphaerica (juvenile ?)

Description: Test free, small (0.2-0.35mm), relatively coarsely agglutinated for size; wall composed of various rock and mineral grains with little cement; aperture single, at end of produced neck at one end of test. Identification uncertain, so counted separately from S.sphaerica. No ph otograph.

Genus: PELOSINA Brady 1879
Genotype: P.variabilis Brady 1879

Pelosina bicaudata (Parr)
Plate 2, Figures 10,11.

Pelosinella bicaudata PARR,1950,p.261,pl.4,figs.1,2.
Pelosina bicaudata (Parr).HERB,1971,p.270,pl.6,fig.4,pl.9,fig.5.

Distribution: This large (1.1-1.7mm) species is rare in the Antarctic. One station, 20-30m, Kerguelen Islands (Parr 1950). Not found in most present McMurdo Sound samples, rare in 420m (81-7, 16% mud) and 550m (81-15, 2-4cm, 85.7% mud); common in New Harbour, 254m (81-18, 0-20cm, 22-24cm, 60-77% mud).

Genus: THURAMMINA Brady 1879
Genotype: T.papillata Brady 1879

Thurammina albicans Brady
Plate 1, Figures 7,8.

Thurammina albicans BRADY,1884,p.323,pl.37,figs.2-7.
Thurammina albicans Brady.KENNETT,1968,Table 4.

Description: Test usually free, rarely attached, large (0.45-0.9mm), finely agglutinated; produced necks common, rarely without.

Distribution:Three Ross Sea and McMurdo Sound samples, 470-865m (Kennett 1968). In present samples, found from 289-850m, 8-77% mud.

Thurammina protea Earland
Plate 1, Figures 13,14.

Thurammina irregularis WIESNER (non Moreman,1930),1931,p.83,pl.6, figs.62-64.

Thurammina protea EARLAND,1933,p.67,pl.2,figs.3-10.

Thurammina protea Earland.PARR,1950,p.259,pl.3,figs.22-24.

Distribution: S.Georgia, 150-450m (Earland 1933); Falkland Is., 50-300m (Earland 1934); one Kerguelen site, 150m and nine Antarctic sites, 220-640m (Parr 1950). Common in present McMurdo Sound sites, 1981-2,5,7,10,12,1982-1, 1982-2 (40-43cm), 1981-15(8-10cm), and 1981-18(2-4,10-12cm); 110-550m.

Genus: HEMISPHAERAMMINA Loeblich & Tappan 1957
Genotype: H.batalleri L & T 1957

Hemisphaerammina bradyi Loeblich & Tappan
Plate 1, Figure 12.

Hemisphaerammina bradyi L & T,1957,p.224,pl.72,fig.2.

Description: Up to 0.5mm in diameter, finely agglutinated, light grey colour.

Distribution: Scotia Sea area (no location or depth given) (Echols 1971); two Ross Sea stations, 348m and 790m (Kennett 1968). Rare in five present samples,213-560m, also found down Cores 81-18(254m, 16-18cm) and 81-15(550m,8-10 and 12-14cm).

Genus: AMMOPEMPHIX
Genotype: Urnula quadrupla Wiesner 1931

? Ammopemphix sp
Plate 1, Figure 1.

Description: Test attached, large (up to 1.3mm) very finely agglutinated, grey colour; either three chambers grouped around a central point or linear; no aperture apparent in these forms.

Distribution: Rare in present McMurdo Sound samples, one test only in each of 81-4 (560m, 8% mud) and 81-17 (358m, 20% mud).

Family: AMMODISCIDAE Reuss 1862

Genus: GLOMOSPIRA Rzehak 1885
Genotype: Trochammina squamata var gordialis Jones & Parker

Glomospira charoides (Jones & Parker)
Plate 2, Figure 15.

Trochammina squamata var charoides JONES & PARKER,1860,p.304.
Ammodiscus charoides (Jones & Parker).BRADY,1884,p.333,pl.38, figs.10-16.
Glomospira charoides (Jones & Parker).CUSHMAN,1918,p.99,pl.36,figs. 11-15.
Glomospira charoides (Jones & Parker).PARKER,1954,p.466,pl.1,fig.14.
Glomospira charoides (Jones & Parker).KENNETT,1968,Table 4.

Description: Test free, small(0.18mm), finely agglutinated, surace very smoothly finished, shiny in well preserved specimens; colour yellow to orange.

Distribution: Originally described from Mediterranean Sea area, 165-3,109m, Mediterranean Sea (J & P 1860); 130-150m,180-220m,Site 36, Gulf of Mexico (Parker 1954); and five stations, 523-3570m, McMurdo Sound and Ross Sea (Kennett 1968). Rare in five of present samples, 420-620m, 8-16% & 45% mud.

Glomospira gordialis (Jones & Parker)
Plate 2, Figure 16.

Trochammina squamata var gordialis JONES & PARKER,1860,p.304.
Ammodiscus gordialis (Jones & Parker).BRADY,1884,p.333,pl.38, figs.7-9.
Glomospira gordialis (Jones & Parker).HERON-ALLEN & EARLAND,1932, p.343,pl.8,figs.21 & 22.
Glomospira gordialis (Jones & Parker).MCKNIGHT,1962,p.101,pl.9, fig.14.
Glomospira gordialis (Jones & Parker).KENNETT,1968,Table 4.

Description: Test small (0.22mm), generally free, rarely attached; coiling flat to streptospiral, often irregular. Very finely agglutinated, yellow to orange in colour.

Distribution: Type locality Indian and Arctic Seas (Jones & Parker 1860); 5008m, Canary Islands, Atlantic Ocean and 1115m, Fiji Islands, Pacific Ocean (Brady 1884); 12 McMurdo Sound and Ross Sea samples, 90-2195m (Kennett 1968). In present McMurdo Sound samples, common 79-755m, 8-77% mud.

Genus: TURITELLELLA Rhumbler 1904
Genotype: Trochammina shoneana Siddall 1878

Turitellella shoneana Siddall
Plate 2, Figure 6.

Trochammina shoneana SIDDALL,1878,text-figs.1 & 2.
Ammodiscus shoneana (Siddall).BRADY,1884,pl.38,figs.7-9.
Turitellella shoneana (Siddall).EARLAND,1933,p.84,pl.3,figs.9,10.

Turitellella shoneana (Siddall).LOEBLICH & TAPPAN,1964,p.C212, fig.122,no.7.

Distribution: Four Ross Sea samples,90-110m,790 and 720m (Kennett 1968); Kerguelen Islands, 219m (Brady 1884); Found in nine present McMurdo Sound samples, 110-620m, 23%-69% mud, from open sound waters, Granite Harbour and Cape Armitage.

Family: HORMOSINIDAE Haeckel 1894

Genus: HORMOSINA Brady 1879
Genotype: H.globulifera Brady 1879

Hormosina ovicula Brady
Plate 2, Figure 7.

Hormosina ovicula Brady,1884,p.326,pl.38,figs.7-9.
Hormosina ovicula Brady.CUSHMAN,1910,p.95,fig.138.

Description: Test free, large (up to 1.1mm per chamber) usually 2-3 elongate chambers with slender connecting necks, easily broken into single chamber segments. Wall finely agglutinated, aperture at open end of neck, yellow in colour, necks generally orange.

Distribution: 3430-7224m, Challenger stations, N.Pacific(Brady 1884). 1443m and 3436m, off Central America and Mexico (Goes in Cushman 1910). Nineteen samples from between 270-865m and 2100m, McMurdo Sound and Ross Sea, most abundant at at 573m(8%) and 2100m(11%) (Kennett 1968); present author found this taxon in deep water (850m) and shallower areas (560-173m), but it was most abundant in New Harbour (254m, 81-18,0-2cm) at 6.9% of death assemblage.

Hormosina sp
Plate 2, Figure 13.

Description: Test free, elongate (0.3mm), finely agglutinated, open and tapering to both ends, single chambers only found.

Distribution: Rare in present Mcmurdo Sound samples,420,620 and 755m and 34-36cm in Core 81-15 (550m,85.7% mud, Granite Harbour).

Genus: REOPHAX Montfort 1808
Genotype: R.scorpiurus Montfort 1808

Reophax pilulifer Brady
Plate 2, Figure 4.

Reophax pilulifer BRADY,1884,p.292,pl.30,figs.18-20.
Reophax pilulifer Brady.CUSHMAN,1910,p.85,figs.117-118.

Remarks: Size up to 2mm in length. Common through out the samples, one of twelve species used to define foraminiferal assemblages.

Distribution: 3429 and 5304m, east of Japan, N.Pacific (Brady 1884); 1412m, eastern tropical Pacific (Göes in Cushman 1910); one sample, 542m, Ross Sea (Kennett 1968). In present samples, common throughout McMurdo Sound, forming up to 7.4% (460m) of the death assemblage and 22.2% (854m) of the life assemblage. It is found from deep to shallow depths (79-850m) on coarse and fine substrate.

Reophax pseudodistans var. tenuis (A & B) Parr
Plate 2, Figures 1,2,3.

Reophax pseudodistans var. tenuis Parr,1950,p.268,pl.4,figs.17,18.

(A) Description: Test free, elongate (0.8-1.4mm), uniserial chambers increasing slightly in size, wall agglutinated of siliceous sponge spicules arranged in radiating manner for each chamber.

(B) Description: Test similar to (A), 0.6-3.6mm, spicules arranged in parallel manner, separate chambers not apparent unless test dissected.

Distribution: 117-145m, east coast Tasmania (Parr 1950). Both a and b rare in McMurdo Sound. (a) in 850m, 550-560m, 254m and 460m, 8-77% mud; (b) in 850m and 213m, 18.2% and 50% mud. Prefer fine, sandy substrate.

<u>Reophax</u> <u>subdentaliniformis</u> Parr
<u>Plate 2, Figure 5.</u>

<u>Reophax</u> <u>dentaliniformis</u> EARLAND, non BRADY, 1934 (pars) p.81, pl.3, figs.32-35.
<u>Reophax</u> <u>subdentaliniformis</u> PARR, 1950, p.269, pl.4, fig.20.

Description: Average size 1.65mm, juveniles 0.5mm. Common throughout most of the samples, one of twelve species used to define foraminiferal assemblages.

Distribution: 64 Falkland Island stations, up to 4773m, most common in shallower waters (Earland 1934); 17 samples, Ross Sea and McMurdo Sound, 90-110m, 362-295m, 548m, 470m, 520-2100m (Kennett 1968); common in present samples, occurs throughout McMurdo Sound on fine and coarse substrate, and comprises an average of 2% of the death assemblage (0.01-6.1%) and up to 54% (Core 81-18, New Harbour, 254m, 77% mud) of the life assemblage; most abundant in the Mixed Assemblage Zone (425m-630m) defined by Kennett (1968) for the Ross Sea. One of the more common agglutinated species in present McMurdo Sound samples, a wide size range present; found in 24 present sites, openwater samples and harbour samples, 79-856m, 7%-85.7% mud, also down Core 81-15, 550m, to 36cm and down Core 81-18, 254m, to 34cm.

Remarks: *M.lata* similar to *M.arenacea* in over all test appearance (see above) and size (0.15-0.6mm); these two taxa usually occur together. *M.lata* is plumper and rounder than *M.arenacea*. In some assemblages the two species tend to grade into one another, though the larger tests are easy to separate. Study of these to determine if they are megalospheric and microspheric generations of the same species would be interesting. For present purposes, they are kept as separate taxa.

Family: RZEHAKINIDAE Cushman 1933

Genus: MILIAMMINA Heron-Allen & Earland 1930
Genotype: Miliolina oblonga (Montagu) var arenacea
Chapman 1916

Miliammina arenacea (Chapman)
Plate 4, Figure 4.

Vermiculum oblongum MONTAGU,1803,p.522,pl.14,fig.9.
Miliolina oblonga (Montagu).BRADY,1884,p.160,pl.5,figs.4a,b.
Miliolina oblonga (Montagu) var arenacea CHAPMAN,1916,p.59,pl.1, fig.7.
Miliammina arenacea (Chapman).EARLAND,1934,p.110,pl.4,figs.20-24.

Description: Test free, 0.2-0.9mm size range; very finely agglutinated, light grey colour. One of twelve species used to define foraminiferal assemblages.

→ Insert Remarks.

Distribution: Common throughout the Antarctic: six Antarctic stations, 219-474m (Parr 1950), 26 Ross Sea and McMurdo Sound stations,110-2100m (Kennett 1968). Common in 24 present samples,79-856m,7%-85,7% mud, but more abundant in finer substrates; persistant to 56cm down Core 81-15 (550m,Granite Harbour) and to 41cm down Core 81-18 (254m,New Harbour).

Miliammina lata Heron-Allen & Earland
Plate 4, Figure 5.

Miliammina lata H-A & E,1930,p.43,pl.1,figs.13-17.
Miliammina lata H-A & E,1933,p.93,pl.5,figs.15-19.
Miliammina lata H-A & E.PARR,1950,p.253,pl.3,fig.4.
Miliammina lata H-A & E.MCKNIGHT,1962,p.106,pl.11,fig.32.

Remarks: Similar to M.arenacea in appearance and size(0.15-0.6mm) usually occurs with M.arenacea.

Distribution: Seven S.Georgia stations,183-318m; one Palmer Peninsula station (no depth) (H-A & E 1930); 19 S.Georgia stations,26-727m (associated with M.oblonga var arenacea and M.oblonga) (H-A & E 1933); three Antarctic stations,177-474m,found with M.arenacea (Parr 1950) 15 Ross Sea stations,450-1670m (McKnight 1962). In 17 present McMurdo Sound open water and harbour samples,213-856m,8%-85.7% mud, persistant to 56cm in Core 81-15(550m, Granite Harbour) and to 41cm in Core 81-18(254m,New Harbour).

Family: LITUOLIDAE de Blainville 1825

Genus: CRIBROSTOMOIDES Cushman 1910
Genotype: C.bradyi Cushman 1910

Cribrostomoides jeffreysii (Williamson)
Plate 4, Figure 1.

Nonionina jeffreysii WILLIAMSON,1858,p.34,figs.72,73.
Haplophragmoides canariensis (d'Orbigny).CUSHMAN,1920,p.6, 1948, p.26,pl.2,fig.15.
Labrospira jeffreysii (Williamson).HÖGLUND,1947,p.146,pl.11,fig.3.
Alveophragmium jeffreysii (Williamson).LOEBLICH & TAPPAN,1953,p.31, pl.3,figs.4-7.
Cribrostomoides jeffreysii (Williamson).MURRAY,1971,p.23,pl.4, figs.1-5.
Cribrostomoides jeffreysii (Williamson).ANDERSON,1975,p.76,pl.2, fig.6.
Cribrostomoides jeffreysii (Williamson).THOMPSON,1978,p.244,pl.1, figs.3,4.

Remarks: Abundant in most samples; one of twelve species used to define foraminiferal assemblages for McMurdo Sound.

Distribution: Cosmopolitan, from Alaska (35 stations, 13-223m) (Loeblich & Tappan 1953); to Great Britain (inner shelf to 480m) (Murray 1971), Tierra del Fuego (intertidal to 55.2m) (Thompson 1978) and Weddell Sea (Anderson 1975); 30 Antarctic samples, Ross Sea and McMurdo Sound, 90-1335m (Kennett 1968). Common in present samples, forming up to 12.8% (81-6, 460m) of the death assemblage. Most abundant at shallower stations. Size ranges from 0.15mm to 0.7mm.

Cribrostomoides subglobosus (Sars)
Plate 4, Figure 3.

Lituola subglobosa M.SARS,1869,p.250 (nom nud)G.O.SARS,1872,p.253.
Haplophragmium latidorsatum GOES,1894 (non Borneman) p.21,pl.5, figs.102-120 (not 121-123).
Haplophragmoides subglobosum CUSHMAN,1910,p.105,figs.162-164.
Haplophragmoides subglobosus EARLAND,1933,p.78,& 1934,p.89.
Labrospira subglobosa (G.O.Sars).HÖGLUND,1947,p.144,pl.11,fig.2, text-fig.126.
Cribrostomoides subglobosus (G.O.Sars).HERB,1971,p.266,pl.3,fig.3.

Distribution: 20 stations north of Antarctic Convergence, 2013-4209m & 110m; 20 stations south of Antarctic Converence, 73m,507m,1120m & 1437-4758m (Herb 1971); four Ross Sea site, 1290-3570m, most abundant (24% of tests counted) at 3570m (Kennett 1968); found in 14 present samples, 128-856m, 8%-85.7% mud.

Cribrostomoides wiesneri (Parr)
Plate 4, Figure 2.

Trochammina trullissata BRADY (non T.trullissata Brady 1879) 1884 (pars) p.342,pl.40,figs.14,15 (not 13,16).
Haplophragmoides trullissata CUSHMAN,1910,p.100,text-fig.148.
Labrospira wiesneri PARR,1950,p.272,pl.4,figs.25,26.
Alveophragmium wiesneri (Parr).BARKER,1960,p.82,pl.40,figs.14,15.

Alveophragmium wiesneri (Parr).MCKNIGHT,1962,p.102,pl.10,fig.17.
Cribrostomoides wiesneri (Parr).KENNETT,1968,Table 4.

Distribution: Nine Ross Sea stations, 384-2995m (McKnight 1962); 13 Ross Sea samples, 348m-612m,1335m and 3570m (Kennett 1968); two samples, 2924 and 3697m, S.Georgia (Echols 1971), eight samples, 490-3642m, S.Orkney (Echols 1971), three samples from S.Sandwich Islands, 2976-4493m (Echols 1971), seven Scotia Sea samples, 2937-3678m (Echols 1971) and one Weddell Sea sample, 2796m (Echols 1971); one Tierra del Fuego intertidal site (Thompson 1978). Rare in four present McMurdo Sound samples: one open water site,560m (81-4,8% mud); three harbour samples (81-15,550m,44-46cm,74.5% mud; 81-18,254m,0-6,8-10,12-14 & 18-20cm, about 60% mud; 82-1,303m).

Family: TEXTULARIIDAE Ehrenberg

Genus: TEXTULARIA de France 1824
Genotype: T. sagittula de France in de Blainville 1824

Textularia antarctica (Wiesner)
Plate 3, Figure 1.

Bolivina punctata var arenacea HERON-ALLEN & EARLAND,1922,p.133, pl.4,figs.21 & 22.
Pseudobolivina antarctica WIESNER,1931,p.99,pl.21,figs.257 & 158, pl.23,fig.C.
Textularia antarctica (Wiesner).EARLAND,1934,p.116,pl.4,figs.39-43.

Remarks: Common throughout most samples; one of twelve species used to define foraminiferal assemblages.

Distribution: This small species (0.15-0.4mm) common throughout Ross Sea and McMurdo Sound. 16 samples from eastern Ross Sea, 384-1670m (McKnight 1962); 24 Ross Sea & McMurdo Sound samples, 110-3570m, 24% of total population at 720m,865m & 1015m (Kennett 1968). Common in 27 of present samples, 79-850m, 8%-85.7% mud, open water and harbour samples.

Textularia earlandi Parker
Plate 3, Figure 2.

Textularia tenuissima EARLAND (non Hausler 1881) 1933,p.95,pl.3, figs.21-30.
Textularia tenuissima Earland.HÖGLUND,1947,p.176,pl.13,fig.1.
Textularia earlandi PARKER,1952,p.458.
Textularia earlandi Parker.PARKER,1954,p.490,pl.2,fig.12.

Distribution: 16 Ross Sea samples, 384-2620m (most common at 2620m) (McKnight 1962); 12 Ross Sea samples, 90m & 395-865m (Kennett 1968). 23 present McMurdo Sound samples, 79-856m, 7%(79m)-85.7%(550m) mud. Most abundant in 254m (81-18, New Harbour, 77% mud).

Genus: SPIROPLECTAMMINA Cushman 1927
Genotype: Textularia agglutinans d'Orbigny var. biformis Parker & Jones 1865

Spiroplectammina filiformis Earland
Plate 3, Figure 3.

Spiroplectammina filiformis EARLAND,1934,p.112,pl.4,figs.30-32.
Spiroplectammina filiformis Earland.KENNETT,1968,Table 4.

Distribution: Rare (1 sample) at 3570m,E.Pennell Bank, Ross Sea (Kennett 1968). In present samples, this small species (0.15-0.275mm) is rare in nine samples, 370-850m, 8-50% mud, harbour and open water samples. Also 6-8cm, 81-15(550m), 0.35% of dead fauna, 54-56cm (81-15) 0.47% of fauna, 85%(top)-75%(bottom) mud.

Family: TROCHAMMINIDAE Schwager 1877

Genus: TROCHAMMINA Parker & Jones, 1859
Genotype: Nautilus inflatus Montagu 1808

Trochammina glabra Heron-Allen & Earland
Plate 4, Figures 6,7,8.

Trochammina glabra H-A & E,1932,p.344,pl.7,figs.26-28.
Trochammina glabra H-A & E.MCKNIGHT,1962,p.110,pl.13,fig.50.
Trochammina glabra H-A & E.ECHOLS,1971,p.151,pl.10,figs.1,2.

Remarks: Abundant throughout most samples; one of twelve species used to define foraminiferal assemblages.

Distribution: Small (0.1mm) agglutinated species common throughout the samples, averages 7.35% of the dead assemblage in the open Sound waters (1.8-15.0%) and 14.5% of the dead assemblage in the harbour samples (0.18-42.1%),79-850m,7%-85.7% mud, most common at 266m,81-16, 69% mud,New Glacier,Granite Harbour.

Trochammina gaboensis Parr
Plate 4, Figures 9,10.

Trochammina gaboensis PARR,1950,p.278,pl.5,figs.11-13.
Trochammina gaboensis Parr.KENNETT,1968,Table 4.

Remarks: This species and the one preceeding have similar characteristics, though T.gaboensis is larger (0.25-0.3mm) on the average. Scanning electron photomicrographs show a degree of similarity between T.gaboensis and T.glabra that indicates they may be the same species.

Distribution: One Tasmania station, 122-155m (Parr 1950); 27 Antarctic samples, McMurdo Sound & Ross Sea, 90-1015m (Kennett 1968). Common in 27 present McMurdo Sound samples, usually associated with T.glabra,forms up to 11% of the dead assemblage (81-12,110m) and 6.3% of the live populations (81-12, 110m);79-856m,7%-85.7% mud, open water and harbour samples.

Trochammina sp A
Plate 3, Figure 11.

Description: Test free, small (0.1-0.2mm), finely agglutinated, wall smoothly finished, flattened chambers arranged in low trochospiral whorl, three chambers in final whorl with umbilical aperture covered by flap; colour a distinctive gold.

Distribution: Rare in 14 present Mcmurdo Sound samples, 79-620m, as well as Core 81-18 (254m,New Harbour,0-2,4-6,8-10,14-16 and 30-32cm) and Core 81-15 (550m,Granite Harbour, to 56cm).

~~Trochammina sp B~~ Adercotryma glomerata
Plate 4, Figure 11.

Description: Test free, small (0.15mm), finely agglutinated, elongate chambers arranged in very low trochospiral whorl, giving test appearance of being composed of separate segments, similar to an orange; aperture not apparent even under magnification.

Distribution: Rare to frequent in nine present McMurdo Sound samples, 79-796m, to 32cm in Core 81-18(254m,New Harbour), to 36cm in Core 81-15(550m, Granite Harbour), to 30cm in Core 82-1(303m,MacKay Glacier) and to 43cm in Core 82-2 (796m,MacKay Glacier,Granite Harbour).

Genus: PORTOTROCHAMMINA Echols 1971
Genotype: Portotrochammina eltaninae Echols 1971

Portotrochammina antarctica (Parr)
Plate 3, Figures 6,7.

Trochammina antarctica PARR,1950,p.280,pl.5,figs.2-4.
Trochammina antarctica Parr.KENNETT,1968,Table 4.
Portotrochammina antarctica (Parr).ECHOLS,1971,p.148,pl.7,figs.4-7.

Remarks: Most abundant species in McMurdo Sound; one of twelve species used to define foraminiferal assemblages.

Distribution: Five Antarctic stations, 193-300m (Parr 1950); 30 Ross Sea and McMurdo Sound stations, 90-2100m (56% benthic population at 520m) (Kennett 1968); five S.Sandwich and two S.Georgia stations, 201-1244m (Echols 1971). Most common species in present McMurdo Sound samples. Abundant in deep, shallow and harbour samples, forming up to 43.8% of the dead assemblage, and up to 27.3% of the live population,79-856m,8%-85.7% mud.

Portotrochammina eltaninae Echols
Plate 3, Figures 8,9.

Portrochammina eltaninae ECHOLS,1971,p.145,pl.8,figs.1 & 2.

Remarks: Common throughout samples; one of twelve species used to define foraminiferal assemblages.

Distribution: Common throughout Drake Passage area,490-6167m (Echols 1971); abundant in present samples,79-856m,8%-85.7% mud.

Genus: CONOTROCHAMMINA Finlay 1940
Genotype: C.whangaia Finlay 1940

Conotrochammina bullata (Höglund)
Plate 3, Figure 10.

Trochamminella bullata HÖGLUND,1947,p.213,pl.17,fig.5,text-figs.194-195.
Conotrochammina bullata (Höglund).ECHOLS,1971,p.144,pl.5,figs.11,12.

Distribution: Fifteen samples, S.Georgia, S.Sandwich, S.Orkney, Scotia and Weddell Seas, 490-6076m (Echols 1971). Abundant in present samples,79-856m, 7%-85.7% mud, harbour and open water sites.

Family: ATAXOPHRAGMIIDAE Schwager 1877

Genus: VERNEUILINA d'Orbigny 1839

Verneuilina minuta Wiesner
Plate 3, Figure 5.

Verneuilina minuta WIESNER,1931,p.99,pl.13,fig.155.
Verneuilina minuta Wiesner.MCKNIGHT,1962,p.105,pl.11,fig.28.
Verneuilina minuta Wiesner.ECHOLS,1971,p.144,pl.5,fig.9.

Description: Test free, small (0.005mm diameter), wall agglutinated of angular to subangular grains, randomly orientated, closely packed, aperture is smoothly finished, no lip, chambers numerous; does not disaggregate in hydrochloric acid.

Distribution: Widely distributed in Antarctic region: seven Ross Sea and one Weddell Sea sites,384-690m (McKnight 1962); three S.Orkney, three Scotia Sea, two S.Sandwich and two Weddell Sea sites,560-4196m (Echols 1971); five Ross Sea stations,362-542m (Kennett 1968). Rare to common in 26 present harbour and open water samples,79-856m, 7%-85.7% mud.

Verneuilina advena Cushman 1922
Plate 3, Figure 4.

Verneuilina advena CUSHMAN,1922,p.57,pl.9,figs.7-9.
Verneuilina advena Cushman.HÖGLUND,1947,p.185,pl.13,fig.11,text-fig. 169.

Distribution: Five Falkland Island stations, 80-1035m (H-A & E 1932); 14 Falkland Island stations, 30-1542m (Earland 1934). Rare in 14 present samples, 79-856m, 7%-85.7% mud.

Genus: EGGERELLA Cushman, 1933
Genotype: Verneuilina minuta bradyi Cushman 1911

Eggerella bradyi (Cushman)
Plate 3, Figures 12,13.

Verneuilina bradyi CUSHMAN,1911,p.54,pl.55,fig.87.
Eggerella bradyi (Cushman).PARKER,1954,p.494,pl.3,fig.17.
Eggerella bradyi bradyi (Cushman).HERB,1971,p.296,pl.4,fig.5.
Eggerella bradyi (Cushman).KENNETT,1968,Table 4.

Distribution: Gulf of Mexico, 150m (Parker 1954); one Ross Sea station, 523m (Kennett 1968); 18 stations north of Antarctic Convergence, 1953-4099m and four stations south of Antarctic Convergence, 3550-4758m (Herb 1971).

Family: FISCHERINIDAE Millett 1898

Genus: CYCLOGYRA Wood 1842
Genotype: C.multiplex Wood 1842
Loeblich & Tappan (1964) treated
Cornuspira as a junior synonym of Cyclogyra.

Cyclogyra involvens (Reuss)
Plate 5, Figure 11.

Operculina involvens REUSS,1850,p.370,pl.14,fig.20.
Cornuspira involvens (Reuss).BRADY,1884,p.200,pl.11,figs.1-3.
Cornuspira involvens (Reuss).CHAPMAN,1916,p.29,pl.2,fig.8,p.43.
Cornuspira involvens (Reuss).CHAPMAN & PARR,1937,p.128.
Cornuspira involvens var corticata Chapman & Parr.CHAPMAN & PARR,1937,p.128,pl.9,fig.32.
Cornuspira corticata Chapman & Parr.PARR,1950,p.284-285.
Cornuspira corticata Chapman & Parr.MCKNIGHT,1962,p.109,pl.13, fig.46.
Cornuspira involvens (Reuss).PFLUM,1966,p.178,pl.16,fig.22.
Cyclogyra corticata (Chapman & Parr).KENNETT,1968,Table 4.

Remarks: There is some confusion in the earlier literature as to whether two species actually exist. When Chapman and Parr (1937) proposed var corticata, they illustrated only one view of a broken test, which is not sufficient to show any significant difference from the typical C.involvens. Parr (1950) later raised variety corticata to species level, but provided no illustration. Chapman and Parr's (1937) verbal description bases the differentiation of the two forms on an exterior coating of dried protoplasm in C. corticata. Parr (1950) later stated that this coating is dried mud, and that a more angular periphery and different test shape in C. corticata are the basis for separating the two species. McKnight (1962) and Pflum (1966) reported both forms present in the assemblages they studied, but their figures do not show significant differences. Kennett (1968) recognized only C.corticata. Loeblich & Tappan (1953) and Todd & Low (1967) list this same form from Alaska under the name Cornuspira involvens. Because the lack of illustrations and inadequate illustrations in previous authors' accounts, corticata is here treated as a junior synonym of Cyclogyra involvens.

Distribution: Four Ross Sea stations, 165-475m (McKnight 1962); two Ross Sea shelf samples, both 274m (Pflum 1966); thirteen Ross Sea and McMurdo Sound stations, 90-720m (Kennett 1968). 25 Arctic stations, 12.8-233m (Loeblich and Tappan 1953); three Alaska stations, 86-174m (Todd & Low 1967). Rare in eight present McMurdo Sound samples,173-850m, including Core 82-1(303m, 25-30cm).

Family: NUBECULARIIDAE Jones 1875

Genus: PLANISPIRINOIDES Parr 1950
Genotype: Miliolina bucculenta Brady 1884

Planispirinoides bucculentus (Brady)
Plate 5, Figures 9,10.

Miliolina bucculenta BRADY,1884,p.170,pl.114,fig.3.
Planispirina bucculenta (Brady).SCHLUMBERGER,1892,p.194,pl.8, figs.6,7.
Miliolinella subrotunda (Montagu) var trigonia (Wiesner). WIESNER,1931,p.107,pl.15,fig.178.
Planispirina bucculenta (Brady).CHAPMAN,1916,p.42,pl.5,fig.4.
Planispirinoides bucculentus (Brady).PARR,1950,p.287,pl.6,figs.1-6, text-figs.1-5.
Planispirinoides bucculentus (Brady).MCKNIGHT,1962,p.109,pl.13, fig.48.

Distribution: One station, North Atlantic, 346m (type locality, Brady 1884); Reported occurrences (Chapman 1916) in Arctic, N.Atlantic, off Australia and around the subantarctic islands of New Zealand. First reported from Antarctica by Pearcey (1914), one Burwood Bank station, 4791m. Eight Antarctic stations, 193m-640m, three Kerguelen stations, 20-50m, three Australian stations, 62m-128m (Parr 1950); four Ross Sea samples, 164m-475m (McKnight 1962); one Ross Sea station, 466m (Kennett 1968). Rare in three present McMurdo Sound samples, 173m(81-10),81-7(420m) and 620m (83-26), 17%-45% mud.

Family: MILIOLIDAE Ehrenberg 1839

Genus: CRUCILOCULINA d'Orbigny in de la Sagre 1839
Genotype: C.trianglularis d'Orbigny 1839

Cruciloculina triangularis d'Orbigny
Plate 5, Figure 4.

Cruciloculina triangularis D'ORBIGNY,1839,p.72.
Miliolina tricarinata (d'Orbigny) var cruciformis WIESNER,1931, p.105.
Miliolina tricarinata (d'Orbigny).EARLAND,1933,p.48.
Triloculina triangularis (d'Orbigny).PARR,1950,p.295.
Cruciloculina triangularis d'Orbigny.MCKNIGHT,1962,p.107,pl.12, fig.40.
Cruciloculina triangularis d'Orbigny.FILLON,1974,p.139,pl.3, figs.9,10.

Remarks: McKnight's illustration (p.107,pl.12,fig.40) represents a form very similar to that described by Ward (1979).

Distribution: Eight S.Georgia stations 132-2549m (Earland 1933); three Antarctic stations, 300-540m (Parr 1950); one Ross Sea station 475m (McKnight 1962), six Ross Sea and McMurdo Sound stations, 110-395m (Kennett 1968). Rare in six present samples, 128-560m (above CCD), 8%-21.6% mud.

Miliolidae sp A
Plate 5,Figure 2.

Description:Test minute (0.15mm), clear, hyaline, calcareous, sigmoiline coiling; two chambers visible in last whorl, aperture terminal on last chamber, slightly produced on short neck with narrow rim.

Distribution: Most common in Core 1981-18, from 38-41cm (bottom of core); also found in 1981-12,10,9,8A,7,5 and 1982-3, 110-496m, 10%-61% mud.

Miliolidae sp B
Plate 5, Figure 1.

Description:Test small (0.3mm), opaque, calcareous, porcelanous, sigmoiline coiling, three chambers visible in last whorl, aperture terminal at end of last chamber.

Distribution: Rare in six McMurdo Sound samples, 1980-6,1981-5, 1982-2,3,4(25-30cm) and 1983-26, 79-620m, 7%-45% mud.

Genus: PYRGO DeFrance 1824
Genotype: Biloculina bulloides d'Orbigny 1826

Pyrgo depressa (d'Orbigny)
Plate 5, Figure 5.

Biloculina depressa D'ORBIGNY,1826,p.298,no.7,fig.91.
Pyrgo depressa (d'Orbigny). EARLAND,1934,p.46.

Pyrgo depressa (d'Orbigny). MCKNIGHT,1962,p.108,pl.13,fig.43.

Distribution: One Arctic sample (Clarence Strait), 393m (Todd and Low 1967); six Ross Sea stations, 274-805m (McKnight 1962); eight Ross Sea stations, 90-548m (Kennett 1968). Rare in two present McMurdo Sound samples, 173m (81-10) and 289m (81-8A, 59% mud).

Pyrgo elongata d'Orbigny
Plate 5, Figure 7.

Biloculina elongata D'ORBIGNY,1826,p.298,no.4.
Biloculina elongata d'Orbigny.CHAPMAN,1916,p.28,pl.2,fig.6.
Pyrgo elongata (d'Orbigny).CUSHMAN,1929,p.70.
Pyrgo elongata (d'Orbigny).CHAPMAN & PARR,1937,p.136.
Pyrgo elongata (d'Orbigny).MCKNIGHT,1962,p.108,pl.13,fig.42.

Distribution: Three Ross Sea stations, 164-475m, one Weddell Sea station, 164-475m (McKnight 1962). Rare in eight present samples, 173-560m, open water and harbour sites.

Pyrgo murrhina (Schwager) 1866
Plate 5, Figure 6.

Biloculina murrhina SCHWAGER,1866,p.203,pl.4,fig.15.
biloculina murrhina Schwager.WIESNER,1931,p.110,pl.17,fig.195.
Pyrgo murrhyna (Schwager).CHAPMAN & PARR,1937,p.136.
Pyrgo murrhina (Schwager).PARR,1950,p.297.
Pyrgo murrhina (Schwager).MCKNIGHT,1962,p.108,pl.13,fig.44.
Pyrgo murrhina (Schwager).KENNETT,1968,Table 4.

Distribution: Two Antarctic sites, 385 and 3410m (Wiesner 1931); one test in one Antarctic mud sample, 1718m (Parr 1950); two Ross Sea stations, 384 and 2620m (McKnight 1962); one Pennell Bank (Ross Sea) station, 1335m (Kennett 1968). Very rare in McMurdo Sound samples, one test from core 81-18, 254m, 38-41cm, 46% mud.

Genus: PYRGOELLA Cushman & E.M.White 1936
Genotype: Biloculina sphaera d'Orbigny 1839

Pyrgoella sphaera (d'Orbigny)
Plate 5, Figure 8.

Biloculina sphaera D'ORBIGNY,1839,p.66.
Biloculina sphaera d'Orbigny.BRADY,1884,p.141,pl.2,fig.4.
Miliolinella sphaera (d'Orbigny).WIESNER,1931,p.107,pl.15,fig.117.
Pyrgoella sphaera (d'Orbigny).CUSHMAN & WHITE,1936,p.90.
Pyrgoella sphaera (d'Orbigny).HERON-ALLEN & EARLAND,1932,p.322,pl.4, figs.41,42.
Pyrgoella sphaera (d'Orbigny).MCKNIGHT,1962,p.108.pl.13,fig.45.

Distribution: One Alaska sample, 174m (Todd and Low 1967); they remarked that it is widely distributed in deep and moderately deep waters; one dredging, Falkland Islands, 146m (Heron-Allen & Earland 1932) five Antarctic stations, 193-540m and one Macquarie Island station, 69m (Parr 1950); three Ross Sea stations, 164-475m, (McKnight 1962); nine Ross Sea and McMurdo Sound stations, 90-1335m (Kennett 1968). Rare in three present samples: 173m (81-10, most abundant), 213m (81-9) and 370m

(81-2), above CCD, about 20% mud.

Genus: SIGMOILINA Schlumberger 1887
Genotype: Planispirina sigmoidea Schlumberger 1887

Sigmoilina umbonata Heron-Allen and Earland
Plate 5, Figure 3.

Sigmoilina umbonata H-A & E,1922,p.71,pl.1,figs.7,8.
Sigmoilina umbonata H-A & E.MCKNIGHT,1962,p.106,pl.12,fig.35.

Distribution: Seven Antarctic stations,256-2648m (Heron-Allen & Earland 1922); seven Ross Sea and Weddell Sea sites,164-2450m (McKnight 1962); six Ross Sea stations,110-339m (Kennett 1968). Rare in present McMurdo Sound open water samples,420-620m,8%-16% & 45% mud.

Family: NODOSARIIDAE Ehrenberg 1838

Genus: DENTALINA Risso 1826
Genotype: Nodosaria (Dentaline) cuvieri d'Orbigny 1826

Dentalina communis (d'Orbigny)
Plate 6, Figure 10.

Nodosaria (Dentalina) communis D'ORBIGNY,1826,p.254.
Nodosaria communis d'Orbigny.EARLAND,1934,p.167.
Dentalina communis (d'Orbigny).BARKER,1960,p.130,pl.62,figs.21,22.
Dentalina communis (d'Orbigny).KENNETT,1968,Table 4.

Distribution: Seven deep Scotia Sea and Drake Passage stations,3638-4773m, and one S.Sandwich site,329m (Earland 1934); four Ross Sea sites, 270-466m (Kennett 1968). Rare in two present McMurdo Sound samples, Core 81-10(173m) and Core 81-18(254m,77% mud).

Genus: NODOSARIA LaMarck 1812
Genotype: Nautilus radicula Linne' 1758

Nodosaria mariae d'Orbigny
Plate 7,Figures 5,6.

Nodosaria mariae D'ORBIGNY,1846,p.33,pl.1,figs.15,16.

Distribution: Originally described from the Tertiary of the Vienna Basin (d'Orbigny 1846). Rare in three present McMurdo Sound samples from shallow open sound locations, 81-12(110m), 81-10(173m) and 81-8A(289m), about 60% mud.

Nodosaria sp
Plate 7, Figures 7,8.

Description: Test free (0.6mm),consisting of at least two uniserial, ovoid chambers, the second strongly overlapping the first, wall calcareous, hyaline, aperture terminal, radiate, slightly produced.

Distribution: Rare in three present McMurdo Sound samples,303m(82-1, 25-20cm),537m(81-13,23% mud) and 856m(83-3,72% mud).

Genus: LAGENA Walker and Jacob in Kammacher 1798
Genotype: Serpula (Lagena) sulcata Walker & Jacob 1798

Lagena distoma (Parker & Jones)
Plate 6, Figure 3.

Lagena sulcata distoma PARKER & JONES,1865,p.356,pl.13,fig.20.
Lagena distoma Parker & Jones.BRADY,1884,p.461,pl.58,figs.11-15.
Lagena distoma Parker & Jones.HERON-ALLEN & EARLAND,1932,p.366.
Lagena distoma Parker & Jones.ECHOLS,1971,p.165.

Distribution: One Kerguelen site, 219m, two N.Atlantic sites, 117-137m (Brady 1884); ten Falkland Islands sites, 145-1035m (Heron-Allen and Earland 1932); four S.Georgia sites, 674-680m, one S.Orkney site, 503m, one S.Sandwich site, 651m (Echols 1971). Rare in present McMurdo Sound samples, one test each in 1981-5, 496m and 1981-12, 110m.

Lagena elongata (Ehrenberg)
Plate 6, Figure 1.

Miliola elongata EHRENBERG,1844,p.274,1845,p.371,1854,pl.25,fig.1.
Lagena elongata (Ehrenberg).BRADY,1884,p.457,pl.56,fig.29.
Lagena elongata (Ehrenberg).HERON-ALLEN & EARLAND,1932,p.363.
Lagena elongata (Ehrenberg).BUCHNER,1940,p.413,pl.2,figs.23,24.

Distribution: Two S.Pacific sites,67 & 1926m and one Southern Ocean site, 4080m (Brady 1884); two Falkland Island sites,146 & 660m (H-A & E 1932); Gulf of Naples,100-400m (Buchner 1940). Rare in six present McMurdo Sound samples, from 110-496m, also 82-1(303m,25-30cm),81-18(154m,30-32cm,38-41cm), 10%-21% and 61% mud.

Lagena gracilis Williamson
Plate 6, Figures 4,5.

Lagena gracilis WILLIAMSON,1848,p.13,pl.1,fig.5.
Lagena gracilis Williamson.BRADY,1884,p.464,pl.58,figs.2,3,7-10, 22-24.
Lagena gracilis Williamson.PFLUM,1966,p.180,pl.16,fig.27.

Distribution: Three Antarctic stations,31-1446m (Pearcey 1914); two stations,4298-4435m (Brady 1884); four Antarctic stations,265-410m (Pflum 1966). Rare in six present McMurdo Sound samples,79-660m, 7%-61% mud.

Lagena gracillima (Seguenza)
Plate 6, Figure 2.

Amphorina gracillima SEGUENZA,1862,p.51,pl.1,fig.37.
Amphorina distorta SEGUENZA,1862,p.52,pl.1,fig.38.
Lagena gracillima (Seguenza).BRADY,1884,p.456,pl.56,figs.20-24.
Lagena gracillima (Seguenza).LOEBLICH & TAPPAN,1953,p.60,pl.11, figs.1-11.

Distribution: S.Pacific, 45-1980m (Brady 1884); 14 Alaska stations, 21-6-146.3m (Loeblich & Tappan 1953); Gulf of Naples and Palermo, Italy, 100-900m (Buchner 1940). Rare in present samples 81-5,2,8A, 82-3, 82-1(25-30cm),81-18(32-34cm), 139-496m,10%-60% mud.

Lagena nebulosa Cushman
Plate 6, Figures 7,8,9.

Lagena laevis (Montagu).BRADY,1884,p.455,pl.56,fig.12.
Lagena laevis (Montagu) var nebulosa CUSHMAN,1923,p.29,pl.5, figs.4,5.
Lagena nebulosa CUSHMAN.BUCHNER,1940,p.421,pl.2,figs.31,32.

Distribution: One station off Tahiti,Pacific,1116m (Brady 1884); Gulf of Naples and Sicily,60-900m (Buchner 1940). Rare in two present samples,81-10(173m), 81-18(254m,4-6,38-41cm). 46%-60% mud.

Lagena striata (d'Orbigny) 1839
Plate 6, Figure 6.

Oolina striata D'ORBIGNY,1839,p.21,pl.5,fig.12.
Lagena striata BRADY,1884,p.456,pl.57,figs.19,28,22?,24?.
Lagena striata (d'Orb).BUCHNER,1940,p.424,pl.4,figs.54-61.

Distribution: D'Orbigny described this from the Americas (1869) Pacific Ocean, 68-4343m (Brady 1884); Gulf of Naples,28-900m (Buchner 1940). Rare in present McMurdo Sound samples, 81-6(live),81-4,7,2, 370-560m,8%-22% mud.

Genus: LINGULINA d'Orbigny 1826
Genotype: L.carinata d'Orbigny 1826

Lingulina vitrea Heron-Allen & Earland
Plate 6, Figure 11.

Lingulina vitrea HERON-ALLEN & EARLAND,1932,p.387,pl.12,figs.12-14.

Distribution: Very rare in elevated marine deposits, Capes Barne-Royds area, Ross Island, Antarctica. Very rare in present McMurdo Sound samples, one test only in 1981-10, 173m.

Family: VAGINULINIDAE Reuss 1860

Genus: LENTICULINA LaMarck 1804
Genotype: Lenticulites rotulata LaMarck 1804

Lenticulina gibba (d'Orbigny) 1839
Plate 6, Figures 12,13.

Cristellaria gibba D'ORBIGNY in de la Sagre,1839,p.63,pl.7, figs.20,21.
Cristellaria gibba d'Orbigny.CHAPMAN,1916,p.44,pl.5,fig.8.
Lenticulina gibba (d'Orbigny).BARKER,1960,p.144,pl.69,figs.8,9.

Distribution: Cuba (d'Orbigny 1839b); elevated marine muds from Cape Barne-Royds area, Ross Island (Chapman 1916, Ward 1979). Rare in six present McMurdo Sound samples,110-850m,16%-61% mud.

Family: POLYMORPHINIDAE

Genus: POLYMORPHINA d'Orbigny 1826
Genotype: P.burdigalensis d'Orbigny 1826

Polymorphina sp
Plate 7, Figure 4.

Description: Test free,small(0.1mm), loosely biserial, strongly overlapping chambers, wall calcareous, hyaline, aperture terminal, radial.

Distribution: Rare in three present McMurdo Sound samples,110m(81-12, 61% mud),213m(81-9,18% mud) and 289m(81-8A,22% mud).

Family: GLANDULINIDAE Reuss 1860

General remarks: This family contains three genera, Fissurina, Parafissurina and Oolina, which show a high degree of variability, often making positive identifications difficult. In the following section, the most common species are identified as well as possible, and others are referred to Fissurina spp or Oolina spp.

Genus: ENTOLINGULINA Loeblich & Tappan 1961
Genotype: Lingulina aselliformis Buchner 1942

Entolingulina biloculi (Wright)
Plate 9, Figures 1,2.

Lingulina carinata var biloculi WRIGHT,1911,p.13,pl.2,fig.10.
Lingulina biloculi (Wright).HERON-ALLEN & EARLAND,1913,p.94,pl.8, fig.6 (not 5,7).
Lingulina biloculi (Wright).H-A & E,1922,p.174.
Lingulina biloculi (Wright).BUCHNER,1942,p.132,fig.12.

Remarks: Placed in Entolingulina due to presence of entosolenian tube.

Distribution: Gulf of Naples, 90-900m (Buchner 1942); one McMurdo Sound site,548m (H-A & E 1922). Very rare in two present samples, 110-620m(81-12,61% mud,83-26,45% mud).

Entolingulina bicarinata Sidebottom
Plate 9, Figure 3.

Lingulina carinata var bicarinata SIDEBOTTOM,1907,p.3,pl.1,fig.20.
Lingulina carinata var bicarinata Sidebottom.HERON-ALLEN & EARLAND 1913,p.94,pl.8,figs.3,4.
Lingulina bicarinata (Sidebottom).CUSHMAN,1923,p.97,pl.17,figs.5-7, pl.18,figs.6,7.
Lingulina bicarinata (Sidebottom).BUCHNER,1942,p.124,fig.6.

Distribution: Found in Atlantic Ocean (Cushman 1923); off Ireland (H-A & E 1913); Gulf of Naples, 270m (Buchner 1940). Rare in two present Mcmurdo Sound samples, 81-12(110m,61% mud) and 81-8A(289m, 59% mud).

Genus: GLANDULINA d'Orbigny in de la Sagre 1839
Genotype: Nodosaria laevigata d'Orbigny 1826

Glandulina antarctica Parr
Plate 7, Figures 2,3.

Glandulina rotundata WIESNER (non Reuss),1931,p.115.
Glandulina laevigata WIESNER (non Nodosaria (Glandulina) laevigata d'Orbigny) 1931,p.115.
Glandulina antarctica PARR,1950,pl.12,figs.8,9.
Glandulina antarctica Parr.MCKNIGHT,1962,p.117,pl.17,p.92.

Discussion: Chapman (1916) listed the two generations of this form under Nodosaria (Glandulina) rotundata (megalosphaeric) and Nodosaria (Glandulina) laevigata (microsphaeric). Thin sections of G. antarctica (microspheric and megalospheric generations) prepared by Ward (1979) revealed that both forms have entosolenian tubes and vestigial walls of early chambers which were not evident in exterior examination of the tests.

Distribution: Five Antarctic stations,300-640m; one Kerguelen station, 150m; two Tasmania stations,122 & 128m (Parr 1950). The holotype is from Parr's Antarctic Station 30 (540m). Five Ross Sea stations,365-800m (McKnight 1962); ten Ross Sea and McMurdo Sound stations,110-1335m (Kennett 1968). Rare in five present McMurdo Sound samples,173-560m,8%-22% mud, also 254m(81-18,Ferrar Glacier snout,New Harbour,dead tests only: 8-10cm,26-30cm,32-34cm and 38-41cm,46%-60% mud).

Glandulina laevigata (d'Orbigny)
Plate 7, Figure 4.

Nodosaria (Glandulina) laevigata D'ORBIGNY,1826,p.252,pl.10,figs.1-3
Glandulina laevigata D'ORBIGNY,1846,p.29,pl.1,figs.4,5.
Pseudoglandulina laevigata (d'Orbigny).CUSHMAN & McCULLOCH,1950, p.325,pl.42,fig.4.
Glandulina laevigata d'Orbigny.LOEBLICH & TAPPAN,1953,p.81,pl.16, figs.2-5.

Distribution: Eight Alaska stations, 23.8-100.5m (L & T 1953); rare in one present McMurdo Sound sample, 81-12(110m,61% mud).

Genus: LARYNGOSIGMA Loeblich & Tappan
Genotype: L.hyalascidea Loeblich & Tappan 1953

Laryngosigma hyalascidia Loeblich & Tappan
Plate 7, Figure 1.

Laryngosigma hyalascidia L & T,1953,p.83,pl.15,figs.6-8.

Distribution: Twelve Alaska stations,31-223.2m (L & T 1953). Rare in one present sample: 81-12,110m,61% mud.

Genus: FISSURINA Reuss 1850
Genotype: F.laevigata Reuss 1850

Fissurina cornigera (Buchner)
Plate 8, Figure 8.

Lagena cornigera BUCHNER,1940,p.514,pl.22,figs.445-452.

Distribution: Recent tests from 70-820m, Gulf of Naples (Buchner 1940). Very rare in McMurdo Sound samples, one test in 1981-10, 173m

Fissurina foliformis (Buchner)
Plate 8, Figures 1,2,3.

Lagena formosa Schwager.BRADY,1884,p.480,pl.60,fig.20.
Lagena foliformis BUCHNER,1940,p.454,pl.8,figs.128-132.
Fissurina foliformis (Buchner).BARKER,1960,p.126,pl.60,fig.20.

Distribution: One S.Pacific ("Challenger") station,3795m (Brady 1884);

250-900m, Gulf of Naples area (Buchner 1940). Very rare in present McMurdo Sound samples,496m(81-5,10% mud) and 620m(83-26,45% mud).

Fissurina marginata (Montagu)
Plate 8, Figure 9.

Vermiculum marginatum MONTAGU,1803,p.524.
Fissurina marginata (Montagu).LOEBLICH & TAPPAN,1953,p.77,pl.14, figs.6-9.
Fissurina marginata (Montagu).MURRAY,1971,p.97,pl.39,figs.4-6.

Distribution: 26 Alaska stations,23.8-223.2m (Loeblich & Tappan 1953); continental shelf of Great Britain,10-138m (Murray 1971); five Scotia Sea stations,329-2288m (Echols 1971). Rare in present Ross Sea stations,173-620m, Granite Harbour, Cape Armitage and open sound waters,16%-59% mud.

Fissurina mennellae (Buchner)
Plate 8, Figure 7.

Lagena mennellae BUCHNER,1940,p.458,pl.9,fig.148-151.

Distribution: Fossil tests in Gulf of Naples area (Buchner 1940). Rare in present McMurdo Sound samples, 81-10,12(110-173m), 61% mud.

Fissurina semimarginata (Reuss)
Plate 8, Figure 6.

Lagena sp (Nos. 64 & 65),VON SCHLICT,1870,p.11,pl.4,figs.4-6,10-12.
Lagena marginata Williamson var semimarginata REUSS,1870,p.468.
Fissurina semimarginata (Reuss) LOEBLICH & TAPPAN,1953,p.78,pl.14, fig.3.
Fissurina semimarginata (Reuss).BARKER,1960,p.122,pl.59,figs.17,19.

Distribution: Brady (1884,p.446,pl.59,figs.17,19) illustrated a variety of forms attributed to this species; eleven Alaska stations, 24-223m (Loeblich & Tappan 1953); common in two Cape Barne-Royds elevated marine mud sites (Ward 1979); eleven Ross Sea and McMurdo Sound stations,110-1335m (Kennett 1968). Four Scotia Sea stations, 329-1032m (Echols 1971). Rare in three present McMurdo Sound samples,173-496m,10%-59% mud.

Fissurina spathiformis (Buchner)
Plate 8, Figure 10.

Lagena spathiformis BUCHNER,1940,p.467,pl.20,figs.210,211.

Distribution: One fossil test from Pietra del Cantariello, Italy (Buchner 1940). Very rare in present McMurdo Sound samples,1981-2,8A (289-370m), 22% (1981-2) and 59% (1981-8A) mud.

Fissurina subformosa Parr
Plate 8, Figure 4.

Fissurina subformosa PARR,1950,p.312,pl.9,fig.9.

Distribution: One Antarctic station,193m (Parr 1950); nine Ross Sea and McMurdo Sound stations,110-1335m (Kennett 1968). Rare in three present

McMurdo Sound stations,110-289m,about 60% mud.

Fissurina subtilis (Buchner)
Plate 8, Figure 5.

Lagena subtilis BUCHNER,1940,p.493,pl.17,figs.343-345.

Distribution: Found to 900m in Gulf of Naples (Buchner 1940). Rare in present McMurdo Sound samples 81-9,10,12 (110-270m). 18% (1981-9) and 61% (1981-12) mud.

Fissurina texta (Wiesner)
Plate 8, Figure 11.

Lagena texta WIESNER,1931,p.121,pl.19,fig.230.
Lagena texta Wiesner.EARLAND,1934,p.165,pl.7,figs.31-35.
Lagena texta Wiesner.MCKNIGHT,1962,p.116,pl.16,fig.90.
Fissurina texta (Wiesner).KENNETT,1968,Table 4.
Fissurina texta (Wiesner).ANDERSON,1975,p.85,pl.6,fig.14.

Distribution: Four Falkland Island stations, 100-345m (Earland 1934); one Weddell Sea station,384m (McKnight 1962); one Ross Sea station, 330m (Kennett 1968); and one Weddell Sea core,320m (Anderson 1975). rare in five present McMUrdo Sound sites,79-560m,7-16% mud.

Fissurina trigona-marginata (Parker & Jones)

Lagena trigono-marginata PARKER & JONES,1865,p.348,pl.18,fig.1.
Lagena sp E, MCKNIGHT,1962,p.113,pl.15,fig.69.
Fissurina trigono-marginata (Parker & Jones).PFLUM,1966,p.182,pl.17, fig.41.

Distribution: One Antarctic station, 210m (Pflum 1966); one Ross Sea station, 322m (Kennett 1968). Very rare in one present sample,Core 81-18(254m,38-41cm,46% mud). Disintegrated when moved to faunal slide, no photograph.

Fissurina tingellifera (Buchner)
Plate 8, Figure 12.

Lagena tingillifera BUCHNER,p.511,pl.22,figs.479,480.

Description: Test free, small(0.1mm), hyaline, single chamber, ribs.

Distribution: Rare to frequent in 81-4,12,10(most common),8A,5,7,83-26. 560-110m,8%-61% mud.

Fissurina sp
Plate 7, Figures 10,11.

Description: Test free, small, calcareous, one chamber with produced neck and single aperture at end of neck, entosolenian tube. Possibly belongs to Oolina.

Distribution: Occasionally found in McMurdo Sound samples 1981-2, 1981-6,1981-9,1981-12,1981-8A,1981-18,1982-3, 110-460m, up to 60% mud.

Genus: PARAFISSURINA Parr 1947
Genotype: Lagena ventricosta Silvestri 1904

Parafissurina curta PARR 1950
Plate 9, Figure 8.

Parafissurina curta PARR,1950,p.318,pl.10,figs.6,7.

Distribution: Six Antarctic samples, 193-640m (Parr 1950); three S. Georgia sites, 750-1900m, one S.Sandwich site, 659m, one Weddell Sea sample, 2968m (Echols 1971); ten Ross Sea and McMurdo Sound sites, 110-1335m (Kennett 1968). Common in present samples, 1981-10,12,8A, 110-289m, about 60% mud; 1983-26, 620m and 45% mud.

Parafissurina fusuliformis Loeblich & Tappan
Plate 9, Figure 4

Parafissurina fusuliformis LOEBLICH & TAPPAN,1953,p.79,pl.14,figs. 18,19.
Parafissurina fusuliformis L & T.FEYLING-HANSSEN et al. p.232, pl.18,fig.6.
Parafissurina fusuliformis L & T.LAGOE,1977,p.122,pl.3,fig.7.

Distribution: Three Arctic stations, 24-43m (Loeblich & Tappan 1953); Scandinavia sites (no depths) (Feyling-Hanssen et al. 1971) five Scotia Sea stations, 490-3784m (Echols 1971); 22 central Arctic sites, 1288-3808m (Lagoe 1977). Rare in elevated marine deposits from Capes Barne-Royds area of Ross Island, Antarctica (Ward 1979). Rare in present McMurdo Sound samples, 1981-5,10,12, 496,173 and 110m, respectively, and 10% mud (1981-5) and 61% mud (1981-12).

Parafissurina lateralis (Cushman)
Plate 9, Figure 7.

Lagena apiculata BRADY,1884 (pars),p.453,pl.56,figs.17,18.
Lagena quadrata SIDEBOTTOM,1906 (pars),p.8,pl.1,fig.21.
Lagena lateralis CUSHMAN,1913,p.9,pl.1,fig.1.
Ellipsolagena lateralis WIESNER,1931,p.126,pl.20,figs.242,243 pl.24,stereo-fig.1.
Lagena lateralis Cushman.BUCHNER,1940 (pars),p.520,pl.23,figs. 487-594.
Parafissurina lateralis (Cushman).PARR,1950,p.316.

Distribution: Wiesner (1931) found it in the Antarctic; Gulf of Naples area, 10-900m (Buchner 1940); one Antarctic station, 1718m, three Kerguelen sites, 40-150m (Parr 1950). Found in four present McMurdo Sound samples,1981-10,12; 80-6; 83-26. 61% (1981-12), 45% (1983-26) and 7% (1980-6) mud.

Parafissurina marginata (Wiesner)
Plate 9, Figure 5.

Ellipsolagina marginata WIESNER,1931,p.126,pl.20,fig.245.
Parafissurina marginata (Wiesner).PARR,1950,p.316,pl.9,fig.19.

Distribution: 385m in the Arctic (Wiesner 1931); two Antarctic stations, 193 and 300m, one Kerguelen site, 150m (Parr 1950).

Rare in present samples, 1981-7,420m,16% mud; 1981-2,370m,22% mud; and 1980-6,79m,7% mud.

Parafissurina pseudoorbigyana Buchner
Plate 9,Figure 9.

Fissurina pseudoorbigyana BUCHNER,1940,p.556,pl.10,figs.157-159.

Remarks: Similar to Fissurina orbigyana Seguenza, but with hooded aperture characteristic of Parafissurina.

Distribution:Five Gulf of Naples sites,Recent material,60-450m (Buchner 1940). Rare in present McMurdo Sound samples,110-620m, Cape Armitage (83-26), open sound waters and Granite Harbour entrance, 110-620m,45-61% mud.

Parafissurina pustulata (Buchner)
Plate 9, Figure 6.

Lagena pustulata BUCHNER,1940,p.503,pl.19,fig.400,401.

Distribution: Rare in one present McMurdo Sound sample,1981-10,173m.

Parafissurina staphyllearia (Buchner)
Plate 9, Figure 11.

Fissurina staphyllearis SCHWAGER,1866,p.209,pl.5,fig.24.
Lagena staphyllearia BRADY,1884,p.474,pl.59,figs.8-11.
Fissurina schlichti SILVESTRI,1902,p.142,figs.9-11.
Lagena staphyllearia (Schwager).BUCHNER,1940,p.523,pl.24,figs. 507-521; pl.25,fig.522.

Distribution: Kerguelen and Heard Is.,36-137m, one Southern Ocean site, 4755m (Brady 1884); 60-900m, Gulf of Naples area (Buchner 1940). Rare in one Cape Roberts site,1981-12,110m,61% mud.

Parafissurina subcarinata Parr
Plate 9, Figure 10.

Parafissurina subcarinata PARR,1950,p.318,pl.10,fig.9.

Distribution:Three Antarctic stations, 193-393m (Parr 1950). Rare in present samples: 1981-8A,289m,59% mud.

Genus: OOLINA d'Orbigny 1839
Genotype: O.laevigata Galloway & Wissler 1927

Oolina apiopleura (Loeblich & Tappan)
Plate 10, Figure 4.

Lagena sulcata Walker and Jacob.PARKER & JONES,1865,p.351,pl.13, figs.28-31.
Lagena acuticosta Reuss.BRADY,1884,p.464,pl.58,fig.21.
Lagena apiopleura LOEBLICH & TAPPAN,1953,p.59,pl.10,figs.14,15.
Oolina apiopleura (L & T).TODD & LOW,1967,p.A28,pl.3,fig.24.

Distribution: Type locality: Point Barrow, Alaska, three stations, 23.8-73.2m (Loeblich and Tappan 1953); eight Alaska stations, 21-375m (Todd & Low 1967). Rare in two present McMurdo Sound samples,1981-10,173m and 1983-26,620m,45% mud.

Oolina hexagona (Williamson)
Plate 10, Figure 6.

Entosolenia squamosa (Montagu) var hexagona WILLIAMSON,1848,p.20, pl.2,fig.23.
Lagena hexagona (Williamson).BRADY,1884,p.472,pl.58,figs.32,33.
Oolina hexagona (Williamson).LOEBLICH & TAPPAN,1953,p.69,pl.14, figs.1,2.

Distribution: Eight Alaska stations,21.6-142.6m (L & T 1953); two Arctic stations,174 & 183m (Todd & Low 1967). Rare in two present McMurdo Sound samples, one test each in 81-12,110m,61% mud and 81-9, 213m, 18% mud.

Oolina melo d'Orbigny
Plate 10, Figures 2,3.

Oolina melo D'ORBIGNY,1839,p.20,pl.5,fig.9.
Lagena melo PARKER & JONES,in Brady,1866,p.38,pl.1,fig.35.
Entosolenia squamosa Montagu var. catenulata WILLIAMSON,1858, p.13,pl.1,fig.31.
Lagena squamosa (Montagu).BUCHNER,1940,p.435,pl.5,figs.78-83.
Lagena melo (d'Orbigny).BUCHNER,1940,p.437,pl.6,fig.84.

Distribution: Originally described from S.America (d'Orbigny 1839); three S.Pacific sites (Heard Is.,Kerguelen Is.,Prince Edward Is .), 37-274m (Brady 1884); fossil and Recent tests, Gulf of Naples area, 60-400m (Buchner 1940). Very rare in three McMurdo Sound samples, 1981-2,8A,12, 110-370m, 22%-61% mud.

Oolina squamosa-sulcata (Heron-Allen & Earland)
Plate 10, Figure 7.

Lagena melo (intermediate var) BRADY,PARKER & JONES,1888,p.237, pl.44,fig.25.
Lagena squamosa-sulcata H-A & E,1922,p.151,pl.5,figs.15,19.
Lagena squamosa-sulcata H-A & E.EARLAND,1934,p.162,pl.7,figs.26-28.
Oolina squamosa-sulcata (H-A & E).LOEBLICH & TAPPAN,1953,p.74,pl.12, figs.5,7.
Lagena squamosasulcata H-A & E.MCKNIGHT,1962,p.116,pl.16,fig.88.
Oolina squamosasulcata (H-A & E).KENNETT,1968,Table 4.

Distribution: Four Antarctic stations,25-237m (Heron-Allen & Earland 1922); six Falkland Island stations,152-4344m (Earland 1934); three Alaska stations,66-146m (Loeblich & Tappan 1953). Rare in present McMurdo Sound samples, 81-2 (370m) 22% mud.

<u>Oolina</u> sp A
Plate 9, Figures 12,13.

Description: Test spherical, small flush fissurine aperture, wall calcareous, but opaque so entosolenian tube not visible if present; perhaps better placed in <u>Fissurina</u>.

Distribution: Rare in four present McMurdo Sound samples, 1981-12, 110m, 61% mud, 1981-10, 173m, 1982-1(25-30cm), and 1983-26,620m,45% mud.

<u>Oolina</u> sp B
Plate 10, Figure 5.

Description: Test spherical, calcareous,hyaline,with entosolenian tube and short neck.

Distribution: Found in four present McMurdo Sound samples, 1981-10, 173m, 1981-8A,290m,59% mud, 1980-6,79m,7% mud and 1983-26,620m,45% mud.

<u>Oolina</u> sp C
Plate 10, Figure 1.

Description: Test ovate, round in cross-section, with entosolenian tube, wallclear, calcareous. SEM photo shows traces of attachment of another chamber on apertural end, perhaps better placed in <u>Entolingulina</u>.

Distribution: Rare in two present McMurdo Sound samples,1981-5,496m, 10% mud,and 1982-3,139m, Blue Glacier snout.

Family: SPIRILLINIDAE Reuss 1862

Genus: SPIRILLINA Ehrenberg 1843
Genotype: S.vivipara Ehrenberg 1843

Spirillina radiosa Parr
Plate 10, Figure 10.

Spirillina radiosa PARR,1950,p.350,pl.13,figs.12-14.

Distribution: One Antarctic station,193m (Parr 1950). Very rare in present samples, one test in 173m (81-10),sandy sediment.

Genus: PATELLINA Williamson 1858
Genotype: P.corrugata Williamson 1858

Patellina corrugata Williamson
Plate 10, Figures 8,9.

Patellina corrugata WILLIAMSON,1858,p.46,pl.3,figs.86-89.
Patellina corrugata Williamson.CHAPMAN & PARR,1937,p.102.
Patellina antarctica PARR,1950,p.352,pl.13,figs.19-21.
Patellina corrugata Williamson.MCKNIGHT,1962,p.124,pl.20,fig.131.

Distribution:Three Drake Passage area stations, 82-145m (Heron-Allen & Earland 1932a). Rare to common in seven present McMurdo Sound samples,79-496m, 7%-61% mud.

Genus: PATELLINOIDES Cushman 1933
Genotype: P.conica Heron-Allen & Earland 1932

Patellinoides depressa Heron-Allen & Earland
Plate 10, Figure 11.

Patellinoides depressa HERON-ALLEN & EARLAND,1932,p.407,pl.13, figs.30-33.

Distribution: Four Drake Passage area stations, 118-454m (H-A & E.1932a). Rare in four present McMurdo Sound samples,110-289m(22%-61% mud) and 856m (83-3,72% mud).

Family: ROBERTINIDAE Reuss 1850

Genus: PSEUDOBULIMINA Earland 1934
Genotype: Pseudobulimina chapmani (Heron-Allen & Earland)

Pseudobulimina chapmani (Heron-Allen & Earland)
Plate 10, Figures 12,13.

Bulimina seminuda Terquem.CHAPMAN,1916,p.29,pl.2,fig.9.
Bulimina chapmani H-A & E,1922,p.130,pl.4,figs.18-20.
Robertina chapmani (H-A & E).WIESNER,1931,p.124,pl.20,fig.239.
Pseudobulimina chapmani (H-A & E).EARLAND,1934,p.134,pl.6,
Pseudobulimina chapmani (H-A & E).MCKNIGHT,1962,p.118,pl.18,fig.101.

Distribution: Several tests found in elevated marine deposits, Cape Barne-Royds, Ross Island (Chapman 1916, Ward 1979); Ross Sea, North Victoria Land Coast,164-2450m (most common at 475m,Sta.129) (McKnight 1962); nine Antarctic stations, 193-1266m, one Kerguelen station,150m (Parr 1950); fourteen Ross Sea and McMurdo Sound stations, 90-1335m (Kennett 1968). Rare in five present McMurdo Sound samples, including 82-3(42-45cm),173-850m, 16-48% mud.

Family: TURRILINIDAE Cushman 1927

Genus: BULIMINELLA Cushman 1911
Genotype: Bulimina elegantissima d'Orbigny 1839

Buliminella elegantissima (d'Orbigny) 1839
Plate 11, Figures 1,2.

Bulimina elegantissima D'ORBIGNY,1839,p.51,pl.7,figs.13,14.
Buliminella elegantissima (d'Orbigny).HERB,1971,p.256,pl.1,figs.16, 17.

Distribution: From the Americas (d'Orbigny 1939); one site north of the Antarctic Convergence, Drake Passage,293m (Herb 1971). Rare in three present McMurdo Sound samples,110m(61% mud), 496m(10% mud) and 620m(45% mud).

Family: BOLIVINITINIDAE Cushman 1927

Genus: BOLIVINA d'Orbigny 1839
Genotype: Textilaria quadrilatera Schwager 1866

Bolivina pseudopunctata Höglund
Plate 11, Figure 5.

Bolivina punctata d'Orbigny.GÖES,1894 (non d'Orbigny 1839),p.49, pl.9,figs.478,480.
Bolivina pseudopunctata HÖGLUND,1947,p.273,pl.24,fig.5,pl.32, figs.23,24.
Bolivina pseudopunctata Höglund.CRESPIN,1960,p.28,pl.2,figs.10,11.
Bolivina pseudopunctata Höglund.ECHOLS,1971,p.153,pl.12,fig.11.

Distribution: 37 stations, 26-500m (Höglund 1947); nine Alaska stations, 24-246m (Loeblich & Tappan 1953); Late Quaternay deposits, Vestfold Hills, Antarctica (Crespin 1960); one Scotia Sea station, two Weddell Sea stations, two S.Sandwich stations and five S.Georgia stations, 329-3138m (Echols 1971). Persistant but of low abundance in twelve present McMurdo Sound samples, 79-796m,7%-61% mud.

Bolivina pygmaea Brady 1884
Plate 11, Figure 4.

Bolivina pygmaea BRADY,1884,pl.53,figs.5,6.

Distribution: Very rare in elevated marine muds, Capes Barne-Royds area, Ross Island (Ward 1979). Very rare in one present McMurdo Sound sample,82-3,139m.

Bolivina sp
Plate 11, Figure 3.

Description: Test minute (0.2mm), calcareous, biserial, pustulose ornament over most of test wall.

Distribution: Very rare in one present McMurdo Sound sample,81-7,420m, 16% mud.

Family: ISLANDIELLIDAE Loeblich & Tappan 1964

Genus: CASSIDULINOIDES Cushman 1927
Genotype: Cassidulina parkeriana Brady 1881

Cassidulinoides porrectus (Heron-Allen & Earland)
Plate 11, Figures 7,8,9.

Cassidulinoides parkeriana Wiesner (non Cassidulina parkeriana Brady), WIESNER,1931,p.131,pl.21,fig.260.
Cassidulina crassa d'Orbigny var. porrecta HERON-ALLEN & EARLAND, 1932,p.358,pl.9,figs.34-37.
Cassidulinoides porrectus (H-A & E).PARR,1950,p.344,pl.12,fig.26.

Discussion: 30 Falkland Island stations, 23-1035m (H-A & E 1932); four Ross and Weddell Sea stations, 164-475m (McKnight 1962); sixteen Ross Sea and McMurdo Sound stations, 90-865m (Kennett 1968); three elevated marine muds, Cape Barne-Royds area, Ross Island (Chapman 1916, Ward 1979). Abundant in 18 present McMurdo Sound samples,79-620m, 7%-61% mud.

Cassidulinoides parkerianus (Brady)
Plate 11, Figures 10,11.

Cassidulina parkeriana BRADY,1884,p.432,pl.54,figs.11-16.
Cassidulinoides parkerianus (Brady).PARR,1950,p.344,pl.12,fig.25.
Cassidulinoides parkerianus (Brady).McKnight,1962,p.127,pl.22, fig.141.

Distribution: Four Patagonia stations, 25-289m (Brady 1884); five stations, Ross and Weddell Seas, 365-1670m (McKnight 1962); three Ross Sea stations, 210-1134m (Pflum 1966); eight McMurdo Sound and Ross Sea statons, 270-583m (Kennett 1968); ten Weddell Sea/Scotia Sea stations, 201-2924m (Echols 1971). Very rare in one present McMurdo Sound sample,139m, Blue Glacier snout in southern McMurdo Sound,0-3cm and 42-45cm (top and base of core). Tests are worn and broken.

Family: BULIMINIDAE Jones 1875

Genus: STAINFORTHIA Hofker 1956
Genotype: Virgulina concava Höglund 1947

Stainforthia cf. concava (Höglund)
Plate 11, Figure 6.

Virgulina concava HÖGLUND,1947,p.257,pl.23,figs.3,4,pl.32, figs.4-7, text-figs.273-275.

Remarks: Tests found in present samples vary slightly from V.concava as illustrated by Höglund (1947) in being smaller, straighter and never having more than one spine.

Distribution: Evenly distributed throughout Gullmar Fjord,20-118m, 20 Skagerak samples,68-626m, in the Kattegat and Köster Channel (Höglund 1947). Rare in four present McMurdo Sound samples, 11-856m,including open sound samples, Blue Glacier snout and MacKay Glacier, about 60% mud.

Family: UVIGERINIDAE Haeckel 1894

Genus: TRIFARINA Cushman 1923
Genotype: T. bradyi Cushman 1923

Trifarina earlandi (Chapman & Parr)
Plate 12, Figure 1.

Angulogerina angulosa CHAPMAN & PARR,(non U. angulosa Williamson) 1937,p.97 (pars).

Remarks: Common in most samples; one of twelve species used to define foraminiferal assemblages.

Distribution: Common throughout present McMurdo Sound samples,79-856m, including open water and harbour samples. Most abundant in shallower depths, persistant at several centimeters down cores: 81-15,550m(Granite Harbour),14-19cm and 29-31cm; 81-18,254m(4-6cm, 30-34cm and 38-41cm, bottom of core), 82-2,796m,40-43cm,82-3,139m, 42-45cm, and 82-1,303m,25-30cm.

Trifarina pauperata (Heron-Allen & Earland)
Plate 12, Figure 2.

Uvigerina angulosa var. pauperata HERON-ALLEN & EARLAND,1932, p.398,pl.12,figs.40-43.
Angulogerina angulosa Williamson var. asperrima CHAPMAN & PARR, 1937,p.97,pl.8,fig.20.
Angulogerina pauperata (H-A & E).PARR,1950,p.341.
Trifarina pauperata (H-A & E).KENNETT,1968,Table 4.

Distribution: Six Falkland area stations,454-1035m (H-A & E 1932); two Antarctic stations,393-540m (Parr 1950); Rare in five present McMurdo Sound samples,including three open water sites,420-560m,10%-16% mud, and two harbour sites,81-18,254m, 46% mud,New Harbour,38-41cm (base of core) and 82-1,303m,Granite Harbour, 25-30cm (base of core), where it was most abundant.

Family: DISCORBIDAE Ehrenberg 1838

Genus: EPISTOMINELLA Husezima & Maruhasi 1944
Genotype: E.pulchella Husezima & Maruhasi 1944

Epistominella vitrea Parker
Plate 12, Figures 3,4.

Epistominella vitrea PARKER.PARKER,PHLEGER & PEIRSON,1953,p.9, pl.4.figs.34-36,40,41.
Epistominella vitrea Parker.MURRAY,1971,p.131,pl.54,figs.1-6.

Distribution: Type locality Mississippi Delta, 17m (Parker,Phleger & Peirson 1953); British shelf waters, 14-1002m (Murray 1971); workers in the Antarctic area (Barker 1960, Kennett 1968, Echols 1971) list E.exigua, often in great abundance 19 Ross Sea stations,90-1335m (Kennett 1968). Variable abundance in present samples,most common in shallow open sound waters,79-289m, but found down to 796m (82-2,Granite Harbour),7%-61% mud; also found down Cores 81-15,550m,Granite Harbour,29-31cm and 81-18,254m,New Harbour,30-34cm and 38-41cm(base of core).

Genus: ROSALINA d'Orbigny 1826
Genotype: R.globularis d'Orbigny 1826

Rosalina globularis d'Orbigny
Plate 12, Figures 5,6.

Rosalina globularis D'ORBIGNY 1826,p.271,pl.13,figs.1,2.
Discorbis globularis (d'Orbigny).CUSHMAN,1931,p.22,pl.4,fig.9.
Discorbis globularis (d'Orbigny).PARR,1950,p.353.
Discorbis globularis (d'Orbigny).MCKNIGHT,1962,p.125,pl.20,fig.133.
Rosalina globularis d'Orbigny. KENNETT,1968,Table 4.

Distribution: Eight Antarctic stations,193-640m, three Kerguelen sites, 4-150m, two Macquarie stations,intertidal to 69m and two Tasmania stations, 122-155m (Parr 1950); three Ross Sea stations, 164-475m (McKnight 1962); 18 Ross Sea and McMurdo Sound stations, 90-1335m (Kennett 1968). Rare in twelve present McMurdo Sound samples,79-796m,7%-61% mud, most common(dead tests) at 289m(81-8A), 59% mud.

Family: GLABRATELLIDAE Loeblich & Tappan 1964

Genus: HERONALLENIA Chapman & Parr 1931
Genotype: Discorbina wilsoni Heron-Allen & Earland 1922

Heronallenia kempii (Heron-Allen & Earland)
Plate 12, Figure 7.

Discorbis kempii HERON-ALLEN & EARLAND,1929,p.332,pl.4,figs.40-48.
Heronallenia kempii (H-A & E).HERB,1971,p.265,fig.6,pl.1,fig.13.
Heronallenia kempii (H-A & E).THOMPSON,1978,p.257,pl.2,figs.6,7.

Distribution: Ten Falkland Island stations, 23-191m (H-A & E 1929); three Cape Horn stations north of Antarctic Convergence, 115-641m (Herb 1971); two upper bathyal zone stations, Cape Horn Province, 247-293m (Herb 1971); two elevated marine deposits, Cape Barne-Royds area, Ross Island (VNA-8 & 13) (Ward 1979). Rare in present McMurdo Sound samples, one test in 81-3(139m) and one test in 81-10(173m).

Genus: GLABRATELLA Dorreen 1948
Genotype: Discorbina pulvinata Brady 1884

Glabratella sp
Plate 12, Figures 8,9.

Description: Test free, minute (0.1mm), low trochospiral coil of one whorl, chambers increasing gradually in size; wall calcareous, hyaline and smooth; sutures broadly depressed on spiral side, ventral side centrally umbilicate, apertures of all chambers forming open umbilicus, margin of aperture with fine radial striae. Very similar to following species (Schackoinella antarctica) but with no evidence of spines.

Distribution: Rare in present McMurdo Sound samples, 81-12(110m,61% mud) and 81-10(173m). Also found in elevated marine deposits on Cape Barne-Royds area of Ross Island (VNA-8) (Ward 1979).

Genus: SCHACKOINELLA Weinhandl 1958
Genotype: S.sarmatica Weinhandl 1958

Schackoinella antarctica Ward & Quilty sp nov
Plate 13, Figures 1-9.

Description: Test free, minute (0.1mm), low trochospiral coil of one whorl, three to four chambers per whorl, two to five spines on each chamber, though not all chambers on all tests have spines (Pl.13,Fig.4); wall calcareous, hyaline, finely perforate, slightly reticulose surface texture (Pl.13,Fig.1-4,8,9); spiral sutures broadly depressed, ventral side centrally umbilicate, apertures of all chambers forming open umbilicus, margin of aperture with fine radial grooves or striae, reaching to edge of test (Pl.13,Fig.7); similar to Rosalina imperatoria, figured by d'Orbigny (1846, p.176,Pl.10,figs.16-18) from the Tertiary of the Vienna Basin. His form has more numerous chambers, sutures are flush with the test surface, and test has three whorls; spines are numerous, and umbilical region very similar to that described here for S.antarctica. Not figured in Quilty (1975). (To be described in Journal of Foraminiferal Research, paper in prep.).

Distribution: Rare in present samples,79-620m,7%-59% mud,no live tests found, dead only: 83-26,four tests, 81-8A,one test, 81-10,two tests and 80-6,one test; also recorded from elevated marine deposits from the Cape Barne-Royds area of Ross Island (Ward 1979).

Family: CIBICIDIDAE Cushman 1927

Genus: CIBICIDES de Montfort 1808
Genotype: C.refulgens de Montfort 1808

Cibicides lobatulus (Walker & Jacob)
Plate 14, Figures 3,4.

Nautilus lobatulus WALKER & JACOB (in Kammacher),1798,p.642,pl.14, fig.36.
Truncatulina lobatula (Walker and Jacob).BRADY,1884,p.660,pl.92, fig.10,pl.93,figs.1,4,5.
Cibicides lobatula (Walker and Jacob).CUSHMAN,1918,(1931),p.118, pl.21,fig.3.
Cibicides lobatulus (Walker and Jacob).PARR,1950,p.364.

Distribution: Common to abundant in 18 present McMurdo Sound samples, 79-660m,including 81-18(254m,38-41cm,46% mud,New Harbour),82-1(303m, 25-30cm,MacKay Glacier) and 82-3(139m,0-3cm,Blue Glacier snout).

Remarks: The tests assigned to C.lobatulus here are all quite similar, the greatest variety being in test shape. This is most likely due to substrate, and whether the tests were attached to rocks or sponge spicules during life.

Family: GLOBOROTALIIDAE Cushman 1927

Genus: GLOBOROTALIA Cushman 1927
Genotype: Pulvinulina menardii (d'Orbigny) var tumida Brady

Globorotalia inflata (D'Orbigny) in Barker-Webb & Berthelot 1839
Plate 15, Figure 9.

Globorotalia inflata (d'Orbigny).FINLAY,1939,p.530.
Globorotalia (Turborotalia) inflata (d'Orbigny).JENKINS,1971,p.116, pl.11,figs.282-287.

Distribution:
One small (0.25mm) pyritised test in Core 81-6.460m.
This test is from reworked older sediments; it does not represent contamination.

Family: GLOBIGERINIDAE Carpenter,Parker & Jones 1862

Genus: NEOGLOBOQUADRINA Bandy, Frerichs & Vincent 1967
Genotype: Globigerina dutertrei d'Orbigny in de la Sagre 1839

Neogloboquadrina pachyderma (Ehrenberg)
Plate 15, Figures 8,10,11.

Aristerospira pachyderma EHRENBERG,1861,p.276,277,303.
Aristospira pachyderma EHRENBERG,1873,pl.1,fig.4.
Globigerina pachyderma (Ehrenberg).HERON-ALLEN & EARLAND,1922,p.190.
Globigerina pachyderma (Ehrenberg).TODD & LOW,1967,p.A39,pl.5,fig.22
Neogloboquadrina pachyderma (Ehrenberg).BANDY,FRERICHS & VINCENT, 1967,p.152,pl.14.
Neogloboquadrina pachyderma (Ehrenberg).ANDERSON,1975,p.90.pl.9, fig.4.
Neogloboquadrina pachyderma (Ehrenberg).KELLER,1978,p.208,pl.2, figs.1-9.

Distribution: Common throughout McMurdo Sound and the Ross Sea.

Family: ELPHIDIIDAE Galloway 1933

Genus: ELPHIDIUM de Montfort 1808
Genotype: Nautilus macellus var. β Fichtel & Moll 1798

Elphidium sp
Plate 12, Figure 10.

Description: Test small, calcareous, opaque, last chamber missing on all four tests found; sutures slightly depressed, with pustulose ornament extending to umbilicus on both sides of test.

Distribution: Very rare, found only in 1982-3, 139m, Blue Glacier snout, southern McMurdo Sound.

Family: CAUCASINIDAE Bykova 1959

Genus: FURSENKOINA Loeblich and Tappan 1961
Genotype: Virgulina squamosa d'Orbigny 1826

Fursenkoina earlandi (Parr)
Plate 15, Figure 1.

Bolivina punctata EARLAND (non d'Orb) 1934,p.132,pl.6,figs.5-7.
Bolivina earlandi PARR,1950,p.339,pl.12,fig.16.
Bolivina earlandi Parr.MCKNIGHT,1962,p.123,pl.19,fig.123.
Fursenkoina earlandi (Parr).KENNETT,1968,Table 4.

Remarks: One of twelve species used to define foraminiferal assemblages.

Distribution: 45 subantarctic stations,24-3762m (most common less than 1000m) (Earland 1934); five Antarctic stations,219-1718m (Parr 1950); Ross and Weddell Seas, 164-475m (McKnight 1962); 14 McMurdo Sound and Ross Sea stations,90-1015m(Kennett 1968). Persistant but not abundant in present McMurdo Sound samples,79-856m,7%-85.7% mud. Especially persistant down Cores 81-15(550m,to 56cm,base of core,75% mud) and 81-18(254m, to 41cm,base of core,46% mud).

Family: CASSIDULINIDAE d'Orbigny 1839

Genus: EHRENBERGINA Reuss 1850
Genotype: E.serrata Reuss 1850

Ehrenbergina glabra Heron-Allen & Earland
Plate 14, Figures 1,2.

Ehrenbergina serrata Reuss.CHAPMAN,1916,p.44,pl.2,figs.16,17.
Ehrenbergina hystrix Brady var glabra H-A & E,1922,p.140,pl.5, figs.1-6.
Ehrenbergina glabra H-A & E.MCKNIGHT,1962,p.127,pl.22,fig.142.

Remarks: Common to abundant in most samples; one of twelve species used to define foraminiferal assemblages.

Distribution: 15 Ross Sea and McMurdo Sound stations,82-548m (H-A & E 1922); elevated marine muds from above Drygalski Glacier and from Cape

Barne-Royds area of Ross Island (Chapman 1916); four Falkland Island stations, 1500-4773m (Earland 1934); widely distributed in Ross and Weddell Seas, 165-2620m (McKnight 1962). Common in present McMurdo Sound samples, 79-660m, 7%-61.2% mud; most common in 81-8A(289m, 59% mud) and 81-10(173m).

Genus: GLOBOCASSIDULINA Voloshinova 1960
Genotype: Cassidulina globosa Hantken 1875

Globocassidulina biora (Crespin)
Plate 14, Figures 8,9.

Cassidulina biora CRESPIN, 1960, p.28, pl.3, figs.1-10.
Globocassidulina biora (Crespin). FILLON, 1974, p.133, pl.1, figs.8-15.

Distribution: Type locality, Vestfold Hills, Antarctica (Crespin 1960); 15 Ross Sea and Mcmurdo Sound sites, 90-1335m (most common at 530m) (Kennett 1968); Ross Sea cores, 250-3500m (Gauss and pre-Gauss sediments) (Fillon 1974). Rare in 12 present samples, 79-560m. Especially notable are seven live tests in 81-17 (358m, Cape Roberts). These are the first live G.biora to be reported (Fillon 1974).

Globocassidulina crassa (d'Orbigny)
Plate 14, Figure 7.

Cassidulina crassa D'ORBIGNY, 1839, p.56, pl.7, figs.18-20.
Cassidulina crassa d'Orbigny. BARKER, 1960, p.112, pl.54, figs.4,5.
Cassidulina oblonga Reuss. MARKS, 1951, p.68.
Cassidulina crassa d'Orbigny. CRESPIN, 1960, p.29, pl.3, figs.12,13.
Globocassidulina crassa (d'Orbigny) var rossensis, KENNETT, 1967, p.134, pl.11, figs.4-6.
Globocassidulina crassa rossensis Kennett. FILLON, 1974, p.132, pl.1, figs.1-7.

Remarks: Common in most samples; one of twelve species used to define foraminiferal assemblages.

Distribution: One Heard Island, S.Pacific station, 137m and one site west of Ireland, N.Atlantic, 2981m (Brady 1884); from the Miocene, Vienna Basin (Marks 1951); 17 Ross Sea and McMurdo Sound stations, 90-1335m (Kennett 1968); Ross Sea cores, 250-550m (Brunhes age sediments only) (Fillon 1974). Persistant in present McMurdo Sound samples, occasionally abundant, 79-796m, 7%-85.7% mud, most abundant 11289m (81-8,9,10,12); especially persistant down cores 81-15 (550m, Granite Harbour, to 56cm) and 81-18 (254m, New Harbour, to 41cm).

Globocassidulina subglobosa (Brady)
Plate 14, Figures 5,6.

Cassidulina subglobosa BRADY, 1881, p.60.
Cassidulina subglobosa Brady. H-A & E, 1932, p.359.

Distribution: One Pernambuco site, Atlantic Ocean, 1234m (Brady 1884); 37 Falkland Island stations, 0-612m (H-A & E 1932); 12 Antarctic stations, 210-3545m (most abundant 300-1700m) (Pflum 1966); four stations south of Antarctic Convegence, 73-4176m and five stations north of Antarctic Convergence, 1953-3376m (Herb 1971); 35 Drake

Passage/Scotia Sea stations, 498-4542m (most abundant in shallower sites) (Echols 1971). Rare in present samples,79-560m,7%-61% mud; usually associated with Cassidulinoides porrectus.

Family: NONIONIDAE Schultze 1854

Genus: ASTRONONION Cushman & Edwards 1937
Genotype: Nonionina stelligera d'Orbigny 1839

Astrononion antarcticum (Parr)
Plate 15, Figure 4.

Nonionina stellegerus WIESNER (non N.stelligera d'Orb) 1931,p.123, pl.19,fig.234.
Nonionina stellegera EARLAND (non N.stelligera d'Orb) 1934,p.189.
Astrononion antarcticus PARR,1950,p.371,pl.15,figs.13 & 14.
Astrononion antarcticum (Parr).KENNETT,1968,Table 4.

Distribution: 20 stations, 50-3762m (most common at 200m) (Earland 1934); five Antarctic stations,220-640m and one Kerguelen station,150m (Parr 1950); 20 McMurdo Sound and Ross Sea statons,90-1335m (Kennett 1968). Common in 17 present McMurdo Sound samples, mainly open water, some harbour sites,79-660m,7%-77% mud; also down Core 81-18(254m,New Harbour) to 41cm(base of core,46% mud).

Astrononion echolsi Kennett
Plate 15, Figure 5.

Astrononion echolsi KENNETT,1967,p.134,pl.11,figs.7,8.
Astrononion echolsi Kennett.FILLON,1974,p.139,pl.6,figs.1-3.

Distribution: Twelve stations from S.Georgia,S.Orkney and S.Sandwich Islands (366-3697m) (Echols 1971); seventeen Ross Sea and McMurdo Sound stations,110-790m (Kennett 1968). Common in present samples, open water and harbour sites,79-856m,7%-85.7% mud;in Core 81-15(550m,Granite Harbour,36cm) and Core 81-18 (254m, New Harbour,41cm,46% mud).

Genus: NONIONELLA Cushman 1926
Genotype: N.miocenica Cushman 1926

Nonionella iridea Heron-Allen & Earland
Plate 15, Figures 2,3.

Nonionella iridea H-A & E,1932,pl.16,figs.14-16.
Nonionella iridea H-A & E.ECHOLS,1971,pl.13,fig.4.
Nonionella iridea H-A & E.FILLON,1974,p.140,pl.5,figs.11,14.

Distribution: Twelve Ross Sea and McMurdo Sound stations, 110-1335m (Kennett 1968); one S.Orkney stations,490m (Echols 1971). Common to rare in eight present McMurdo Sound sites,110-856m,18-72% mud. Also in 82-2(796m),40-43cm and 82-1(303m),25-30cm.

Genus: PULLENIA Parker & Jones in Carpenter, Parker & Jones 1862
Genotype: Nonionina bulloides d'Orbigny 1846

Pullenia subcarinata (d'Orbigny)
Plate 15, Figure 7.

Nonionina subcarinata D'ORBIGNY,1839,p.28,pl.5,figs.23,24.
Nonionina quinqueloba REUSS,1851,p.71,pl.5,fig.31.
Pullenia quinqueloba (Reuss).WIESNER,1931,p.132.
Pullenia subcarinata (d'Orbigny).H-A & E,1932,p.403,pl.13,figs.14-18

Pullenia subcarinata (d'Orbigny).PARR,1950,p.347.
Pullenia subcarinata (d'Orbigny).MCKNIGHT,1962,p.128,pl.22,fig.4.
Pullenia subcarinata (d'Orbigny).KENNETT,1968,Table 4.

Distribution: One Kerguelen station, 220m, and one Prince Edward Island station, 91-274m (Brady 1884); seven Antarctic stations,193-1266m, and six Kerguelen stations,2-150m (Parr 1950); eight Ross Sea stations, 164-2620m (McKnight 1962); nineteen Ross Sea and McMurdo Sound stations, 90-1335m (Kennett 1968). Common in 12 present samples,79-560m,7%-61% mud.

Pullenia bulloides (d'Orbigny)
Plate 15,Figure 6.

Nonionina bulloides D'ORBIGNY,1846,p.107,pl.5,figs.9,10.
Pullenia sphaeroides (d'Orbigny).BRADY,1884,pl.84,figs.12,13.
Pullenia bulloides (d'Orbigny).BARKER,1960,p.174,pl.84,figs.12,13.

Distribution: One N.Pacific station, 3383m and one S.Atlantic station, 4023m (Brady 1884); Drake Passage area, six stations north of Antarctic Convergence, three south of Antarctic Convergence, 253-3927m (Herb 1971). Found in one (81-9) present McMurdo Sound sample,270m,18.2% mud.

PLATES 1-15

The format for the caption pages accompanying the SEM plates is as follows: figure number, genus and species name, varietal name (if relevant), magnification and sample number from which the specimen was taken. All tests are from the top two or three centimeters of cores, from grabs (1980 samples and 1983 samples), or from intervals down the longer sphincter cores; if this is the case the interval in centimeters is given with the sample number. Comments on angle of view of tests are noted after the sample number.

PLATE 1

1. Ammopemphix sp x93 (1981-17).

2. Rhabdammina cf. abyssorum x39 (1983-7).

3. Hyperammina cylindrica x71.5 (1981-4).

4,5 Hyperammina malovensis

4. x110 (1981-6).

5. x42.6 (1981-2).

6. Hyperammina subnodosa x106 (1981-6).

7,8. Thurammina albicans

7. x263 (1981-9).

8. x89 (1981-8A); attached to small sponge spicule.

9,10. Bathysiphon hirudinea

9. "A" x170 (1981-16).

10. "B" x186 (1981-16).

12. Hemisphaerammina bradyi x274 (1981-4); attached to large sponge spicule.

13,14. Thurammina protea

13. x203 (1981-9).

14. x106 (1981-2); attached to small mineral grain.

11. Bathysiphon sp. x101 (1983-26)

PLATE 1

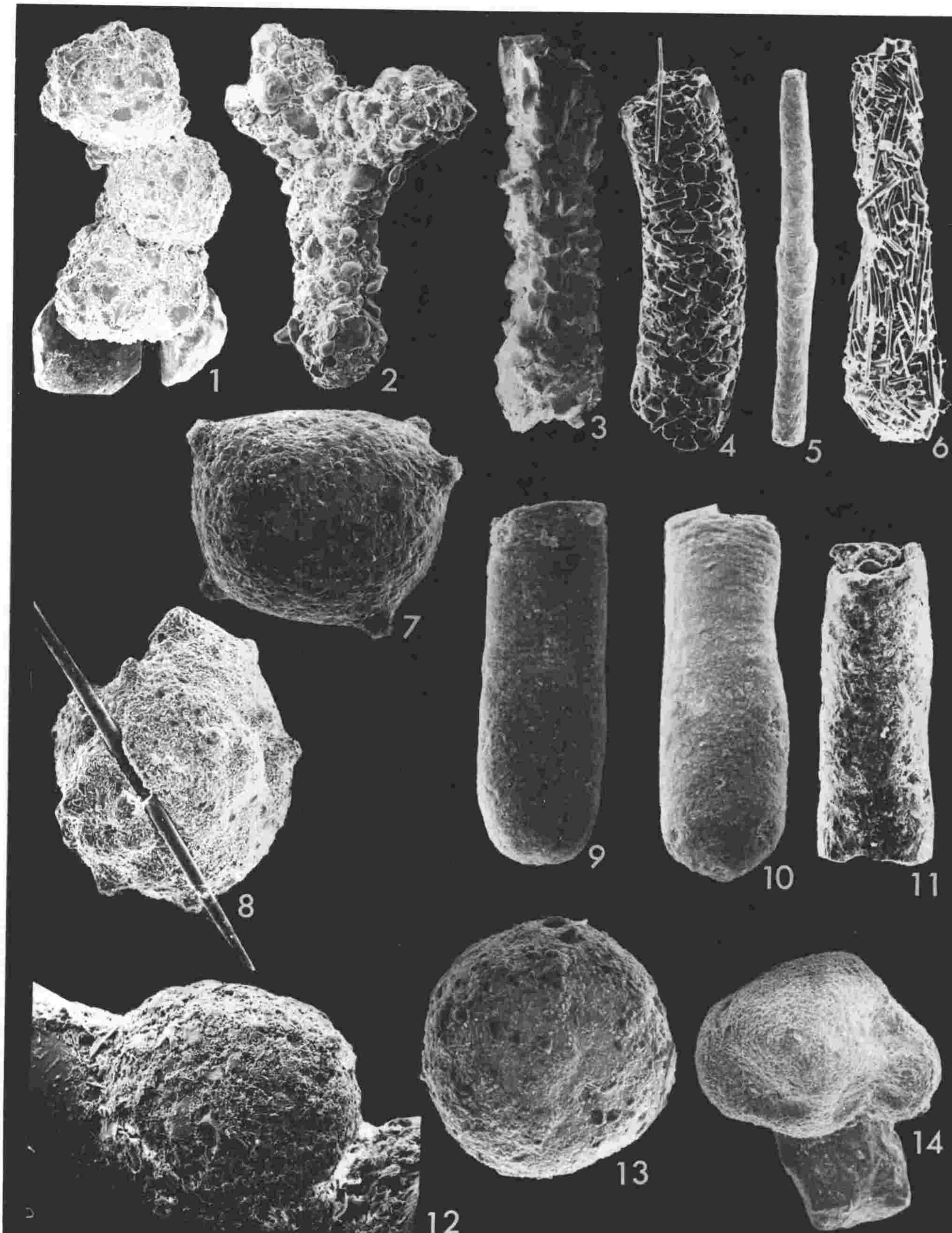


PLATE 2

1,2,3. Reophax pseudodistans var. tenuis

1. "A" x71.5 (1983-7); constructed of siliceous sponge spicules and a few mineral grains.
2. "A" x150 (1983-7).
3. "B" x29 (1981-9).

4. Reophax subdentaliniformis x110 (1981-9).

5. Reophax pilulifer x78 (1981-9).

6. Turitellella shoneana x252 (1981-16).

7,12. Hormosina ovicula

7. x85 (1981-2).
12. x194 (1981-2); proloculus.

8,9. Saccammina sphaerica

8. x150 (1981-16).
9. x120 (1981-9).

10,11. Pelosina bicaudata

10. x89 (1981-18); broken open to show internal organic sac.
11. x63 (1981-18).

13. Hormosina sp x252 (1983-26).

14. Psammosphaera fusca x65.5 (1981-4).

15. Glomospira charoides x503 (1983-26).

16. Glomospira gordialis x252 (1981-9).

PLATE 2

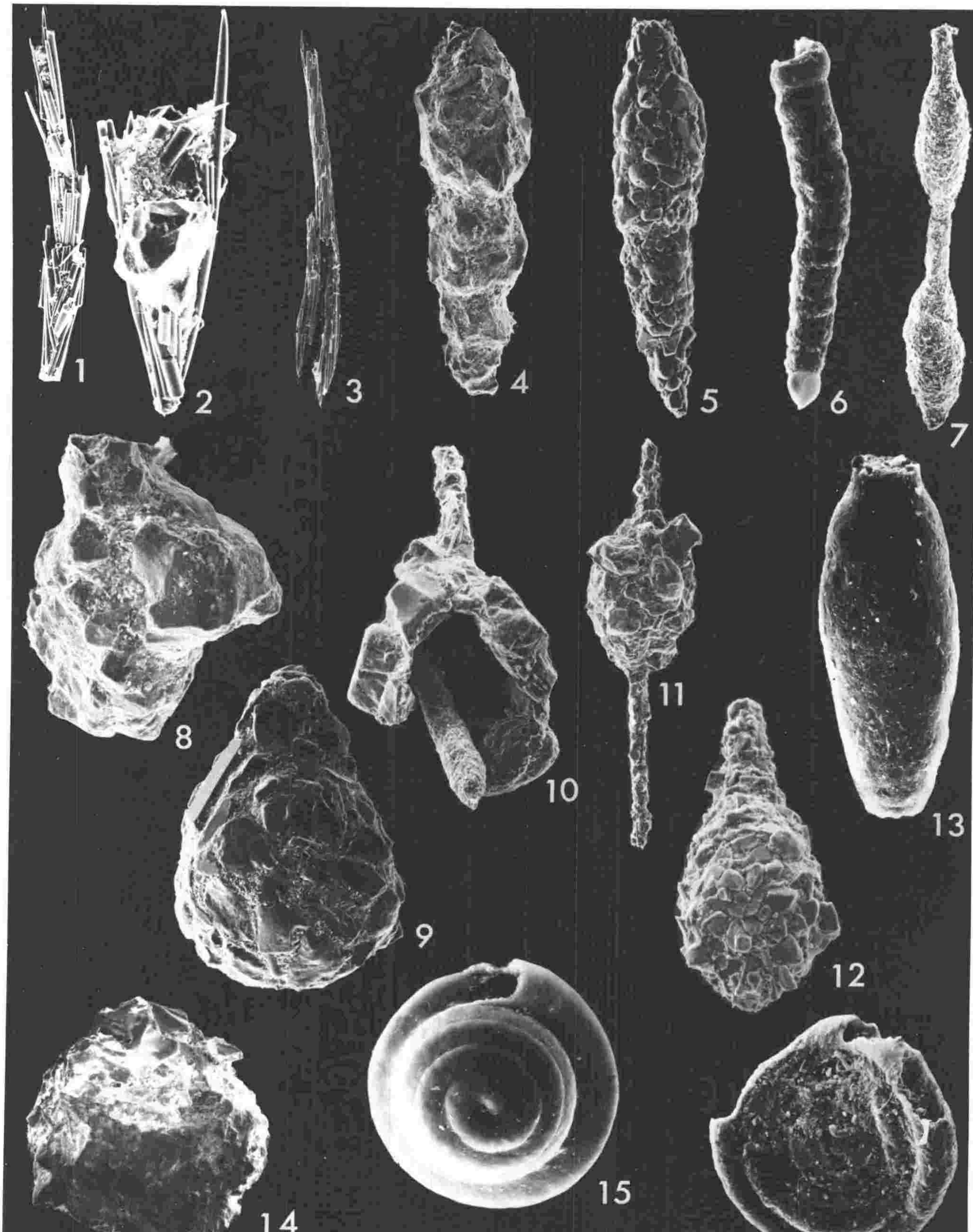


PLATE 3

1. Textularia antarctica x263 (1981-9).

2. Textularia earlandi x287 (1980-8).

3. Spiroplectammina filiformis x372 (1981-16).

4. Verneuilina advena x680 (1981-16).

5. Verneuilina minuta x680 (1981-16).

6,7. Portotrochammina antarctica

   6. x274 (1981-9); ventral view.

   7. x300 (1981-9); dorsal view.

8,9. Portotrochammina eltaninae

   8. x312 (1981-9); dorsal view.

   9. x287 (1981-4); ventral view.

10. Conotrochammina bullata x388 (1981-6); ventral view.

11. Trochammina sp A x287 (1980-8).

12,13. Eggerella bradyi

   12. x170 (1981-2); ventral view.

   13. x231 (1981-2), dorsal view.

PLATE 3

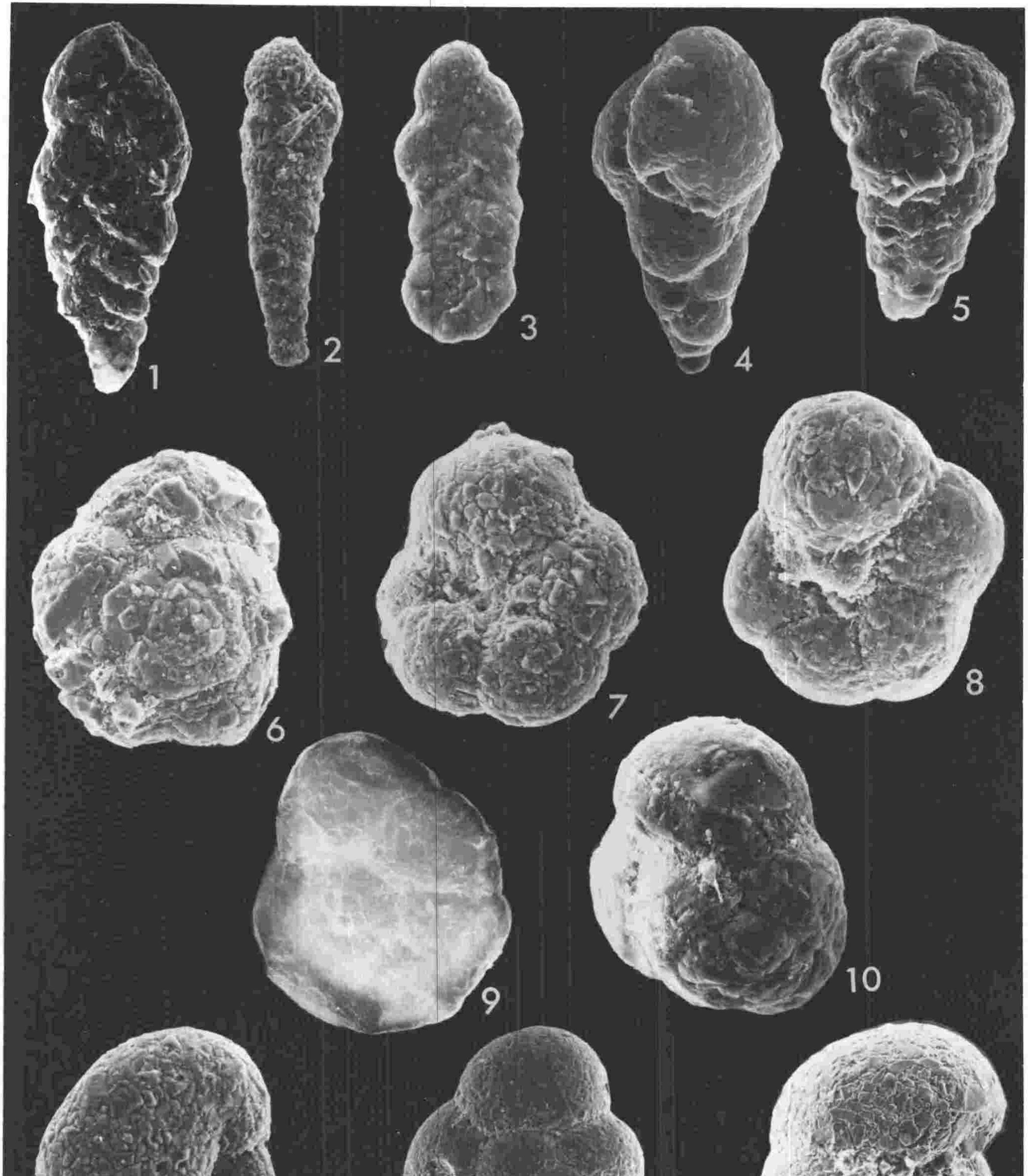


PLATE 4

1. Cribrostomoides jeffreysii x163 (1981-9).
2. Cribrostomoides wiesneri x163 (1981-8A).
3. Cribrostomoides subglobosus x93 (1981-4).
4. Miliammina arenacea x170 (1981-2).
5. Miliammina lata x252 (1981-16).

6,7,8. Trochammina glabra

- 6. x442 (1981-4); ventral view.
- 7. x482 (1981-9); ventral view.
- 8. x503 (1981-4); dorsal view.

9,10. Trochammina gaboensis

- 9. x300 (1981-4); dorsal view.
- 10. x263 (1981-4); ventral view.

11. Trochammina sp B x526 (1981-8A).

PLATE 4

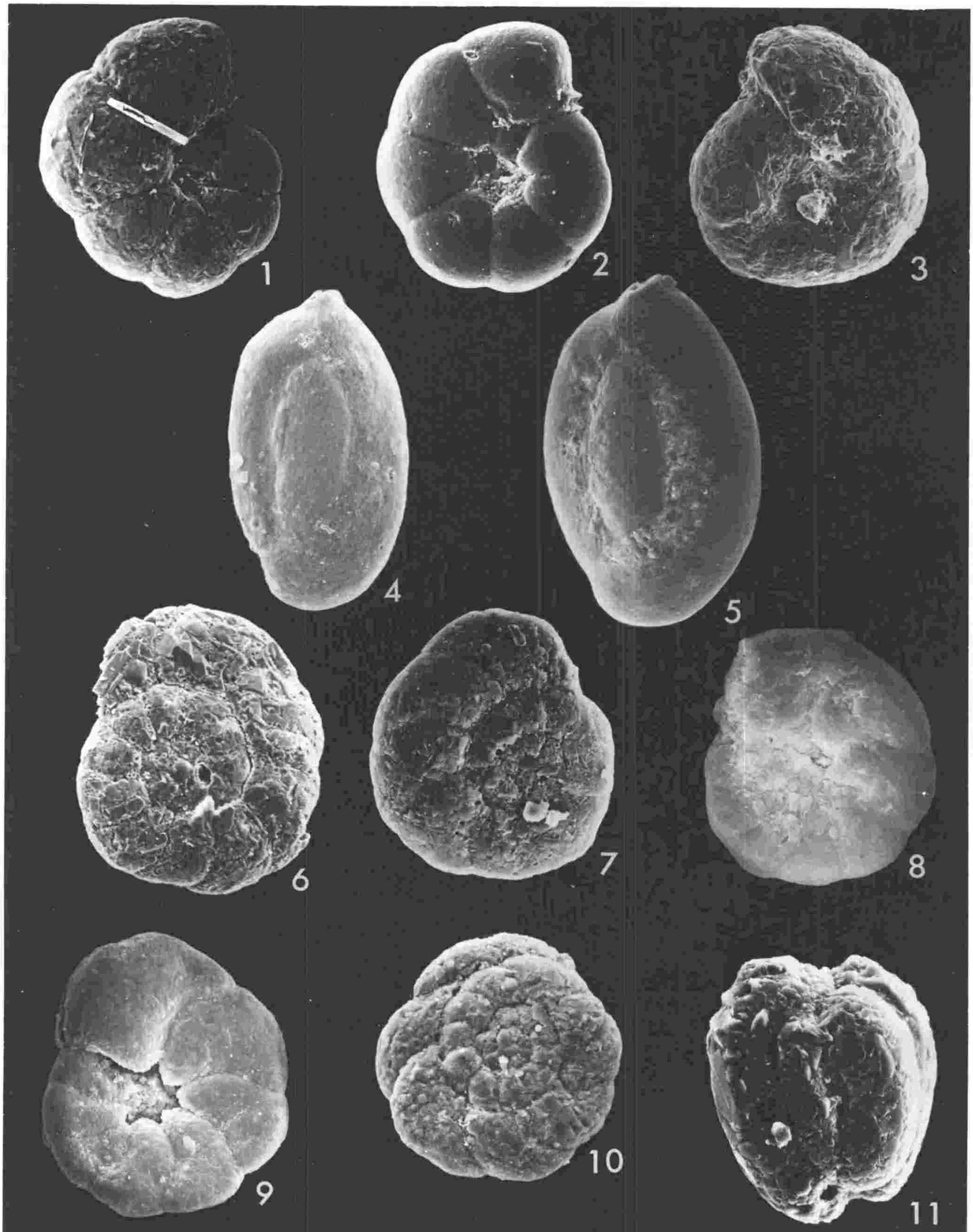


PLATE 5

1. Miliolid sp B x203 (1981-8A).
2. Miliolid sp A x600 (1981-2).
3. Sigmoilina umbonata x178 (1980-8).
4. Cruciloculina triangularis x221 (1981-4).
5. Pyrgo depressa x71.5 (1980-8).
6. Pyrgo murrhyna x341 (1981-18, 38-41cm).
7. Pyrgo elongata x93 (1981-10).
8. Pyrgoella sphaera x93 (1981-10).

9,10. Planispirinoides bucculentus

- 9. x68.5 (1981-8A).
- 10. x221 (1983-26); juvenile ?.

11. Cyclogyra involvens x93 (1981-10).

PLATE 5

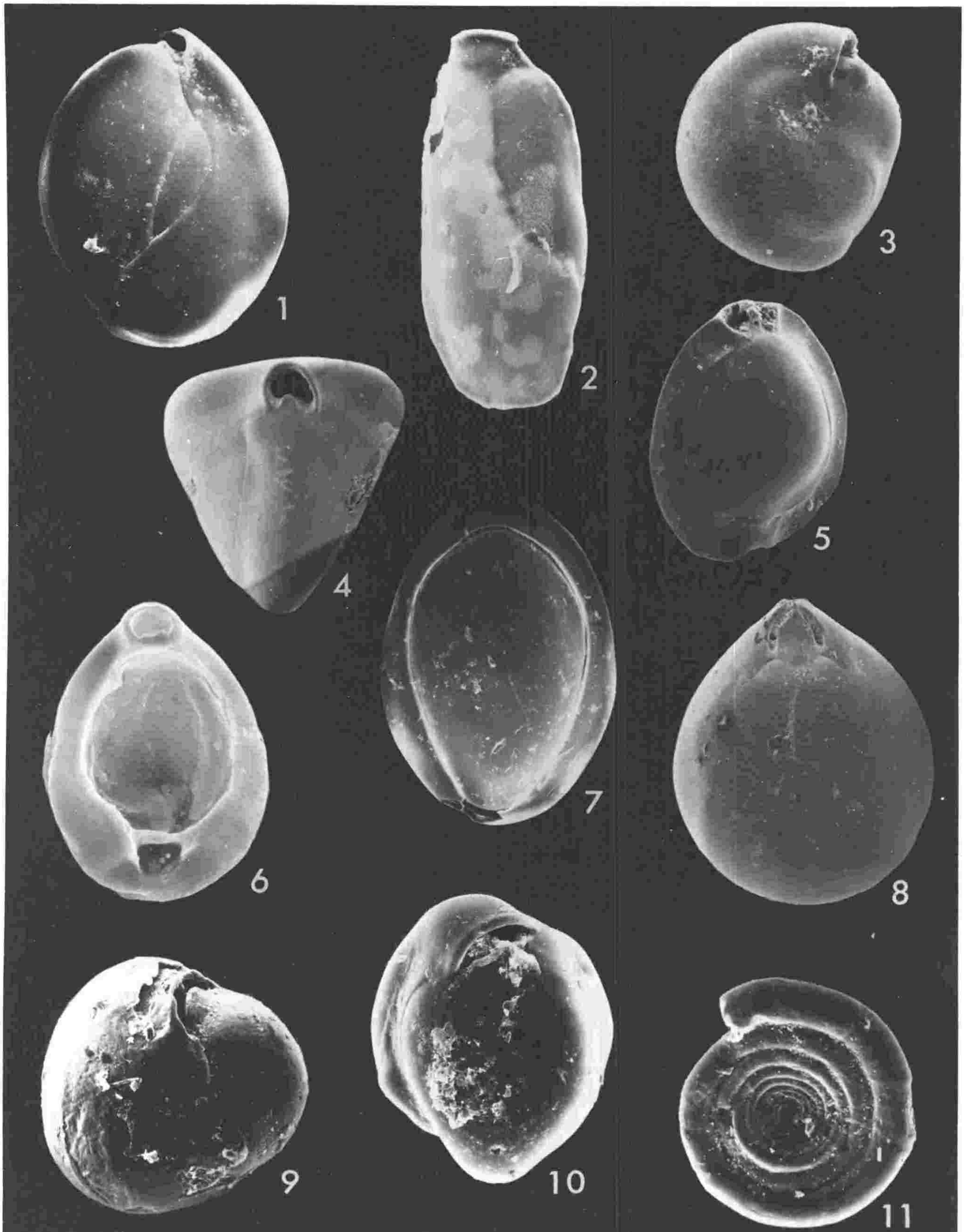


PLATE 6

1. Lagena elongata x274 (1981-5).

2. Lagena gracillima x137 (1981-2).

3. Lagena distoma x163 (1981-16).

4,5. Lagena gracilis

 4. x312 (1981-2).

 5. x372 (1981-2).

6. Lagena striata x101 (1981-8A).

7,8,9. Lagena nebulosa

 7. x356 (1981-8A).

 8. x203 (1981-18, 38-41cm).

 9. x745 (1981-18, 38-41cm).

10. Dentalina communis x115 (1981-2).

11. Lingulina vitrea x326 (1981-10).

12,13. Lenticulina gibba

 12. x142 (1981-8A).

 13. x178 (1981-8A).

PLATE 6

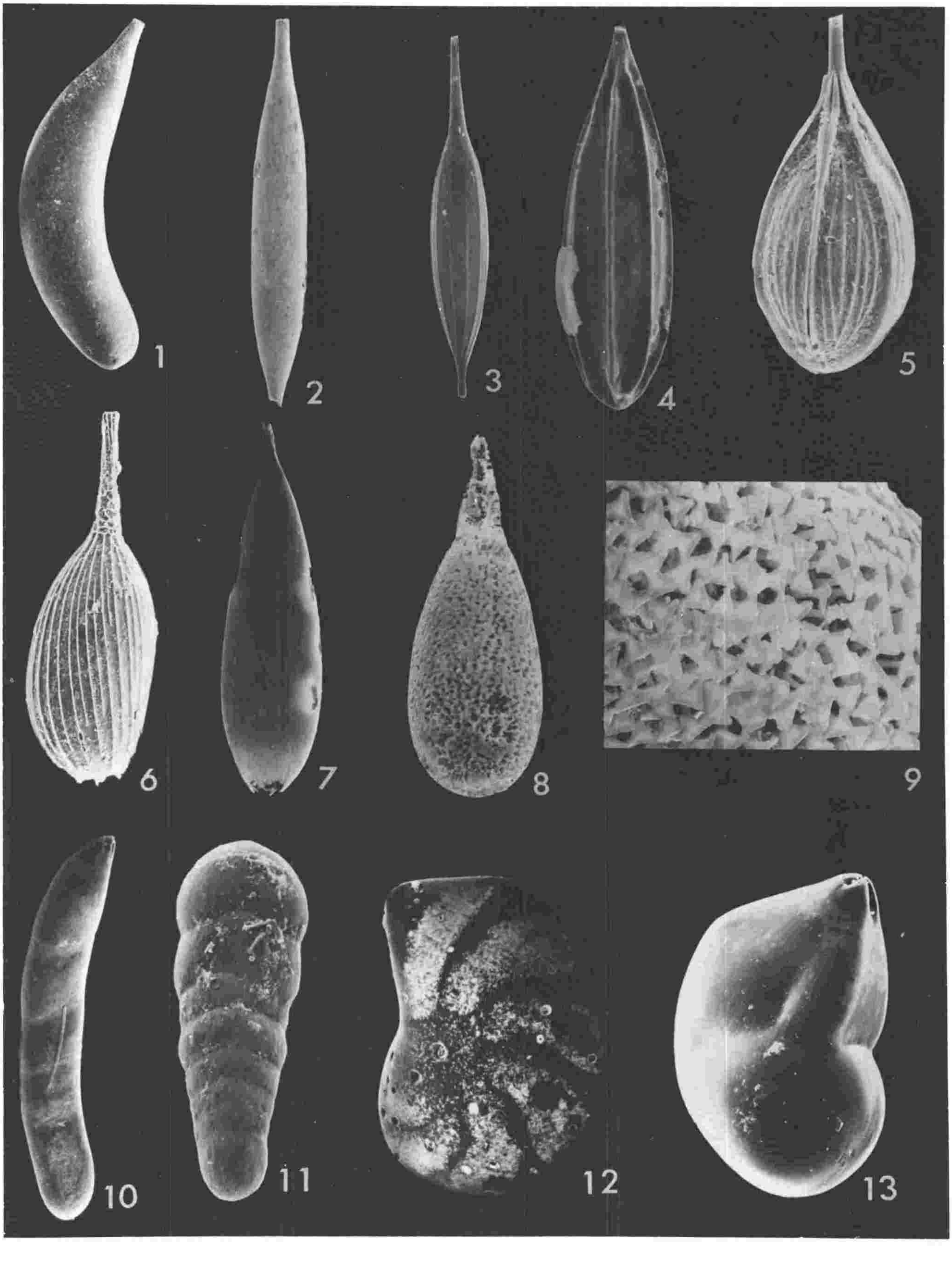


PLATE 7

1. Laryngosigma hyalascidia x526 (1981-8A).

2,3. Glandulina antarctica

    2. x312 (1981-2); megalosphaeric.

    3. x252 (1981-2); microsphaeric.

4. Glandulina laevigata x312 (1982-3).

5,6. Nodosaria mariae

    5. x388 (1981-10).

    6. x1550 (same test); close-up of proloculus.

7,8. Nodosaria sp

    7. x106 (1981-2).

    8. x1010 (same test); close-up of aperture.

9. Polymorphina sp x252 (1981-8A).

10,11. Fissurina sp

    10. x300 (1981-2).

    11. x2400 (same test); close-up of test wall.

PLATE 7

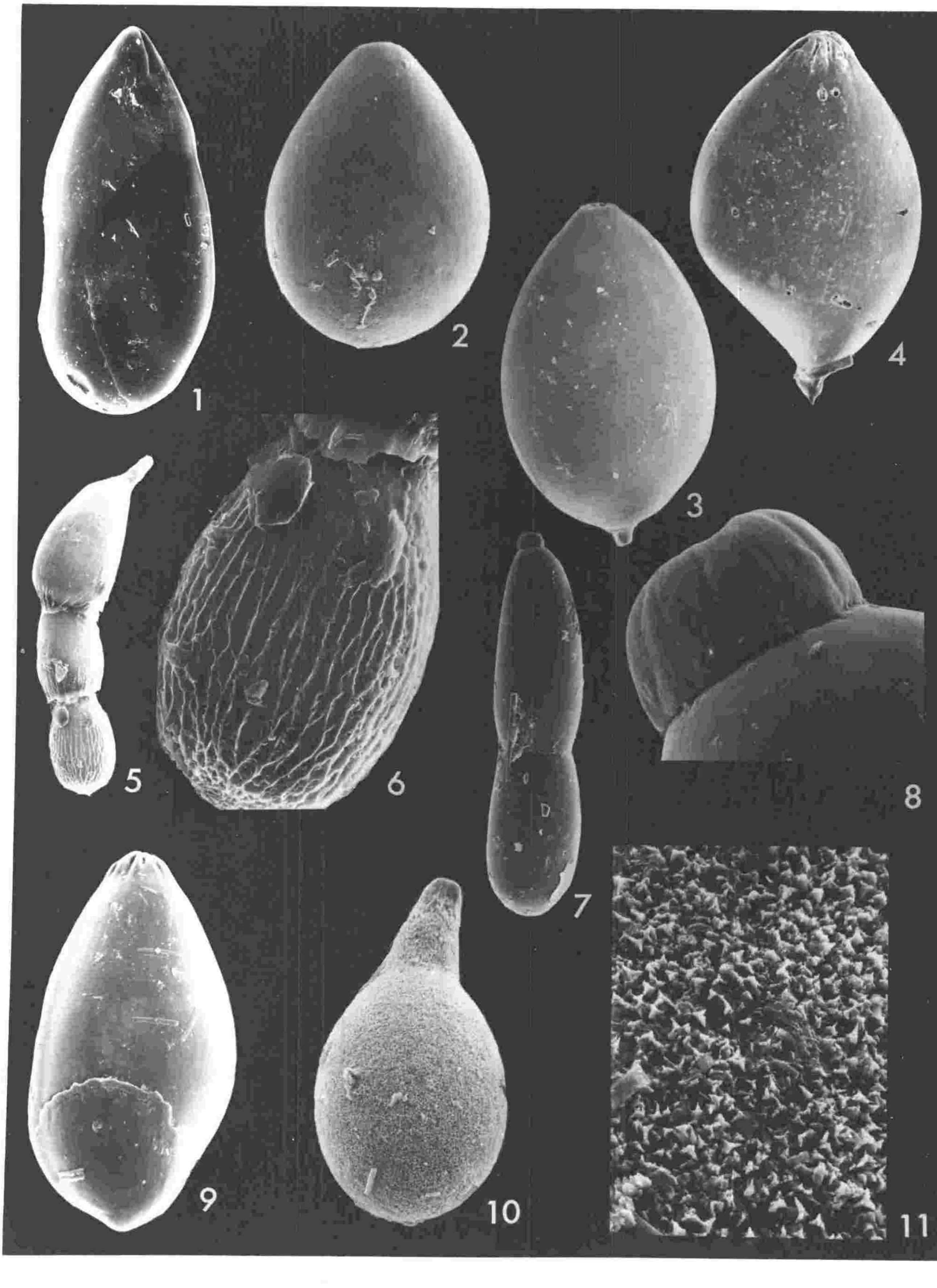


PLATE 8

1,2,3. Fissurina foliformis

1. x300 (1981-2).

2. x300 (1981-2).

3. x573 (1981-10).

4. Fissurina subformosa x203 (1981-2).

5. Fissurina subtilis x341 (1981-9).

6. Fissurina semimarginata x241 (1981-2).

7. Fissurina mennellae x424 (1981-10).

8. Fissurina cornigera x573 (1981-10).

9. Fissurina marginata x326 (1981-10).

10. Fissurina spathiformis x406 (1981-8A).

11. Fissurina texta x170 (1981-10).

12. Fissurina tingellifera x625 (1981-2).

PLATE 8

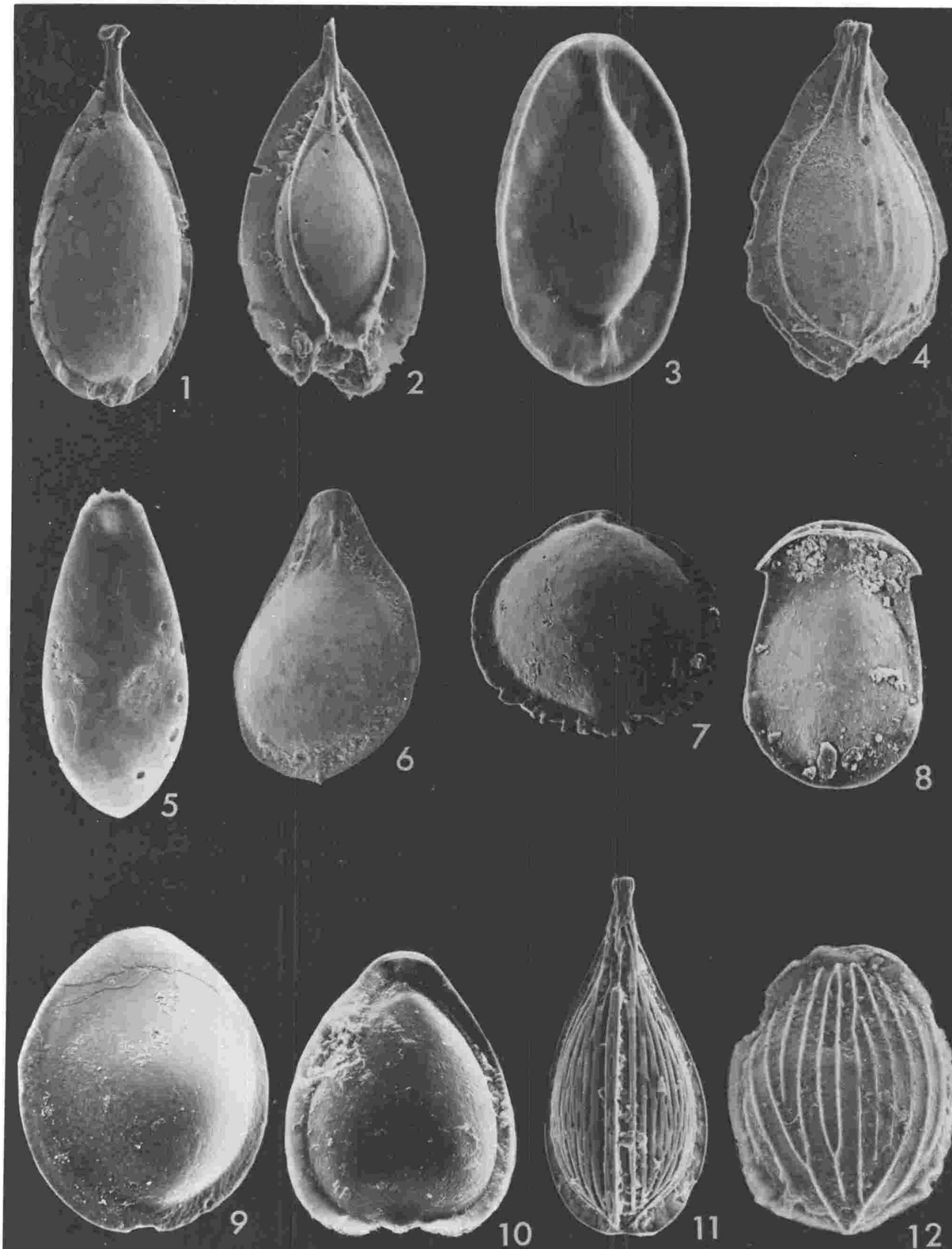


PLATE 9

1,2. Entolingulina biloculi

1. x625 (1981-12).

2. x573 (1980-8).

3. Entolingulina bicarinata x600 (1981-8A).

4. Parafissurina fusuliformis x462 (1980-8).

5. Parafissurina marginata x462 (1980-8).

6. Parafissurina pustulata x300 (1981-10).

7. Parafissurina lateralis x274 (1981-10).

8. Parafissurina curta x143 (1981-2).

9. Parafissurina pseudoorbignyana x231 (1981-10).

10. Parafissurina subcarinata x356 (1981-2).

11. Parafissurina staphyllearia x503 (1981-8A).

12,13. Oolina sp A

12. x231 (1981-10); partially dissolved.

13. x300 (1981-10).

PLATE 9

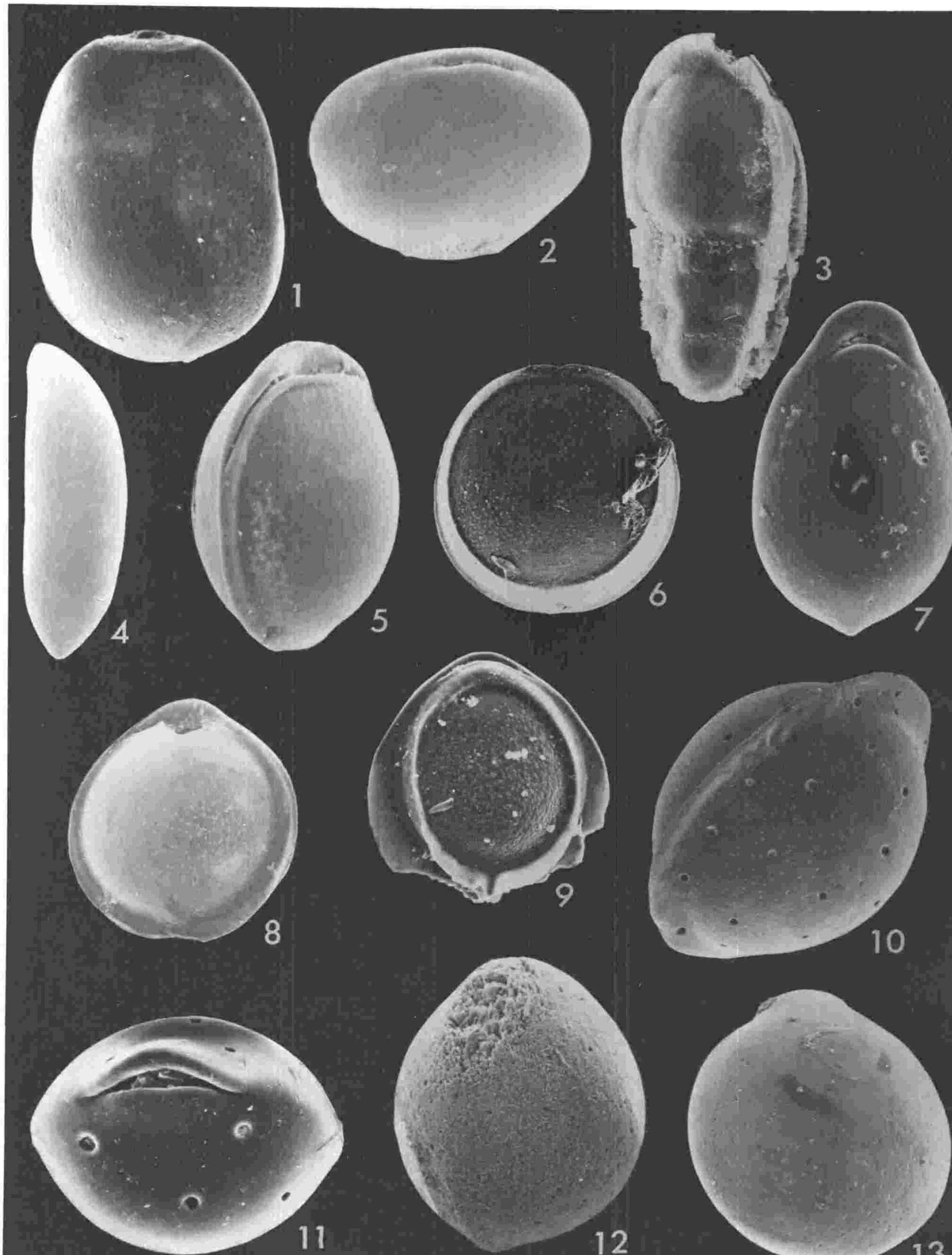


PLATE 10

1. Oolina sp C x287 (1981-5).

2,3. Oolina melo

  2. x341 (1981-6-BB).

  3. x287 (1981-8A).

4. Oolina apiopleura x131 (1981-2).

5. Oolina sp B x150 (1981-2).

6. Oolina hexagona x442 (1981-9).

7. Oolina squamosa-sulcata x424 (1983-26).

8,9. Patellina corrugata

  8. x341 (1980-8); dorsal view.

  9. x178 (1981-10); ventral view.

10. Spirillina radiosa x170 (1981-10).

11. Patellinoides depressa x925 (1981-8A); ventral view.

12,13. Pseudobulimina chapmani

  12. x186 (1981-8A); dorsal view.

  13. x186 (1981-10); side view.

PLATE 10

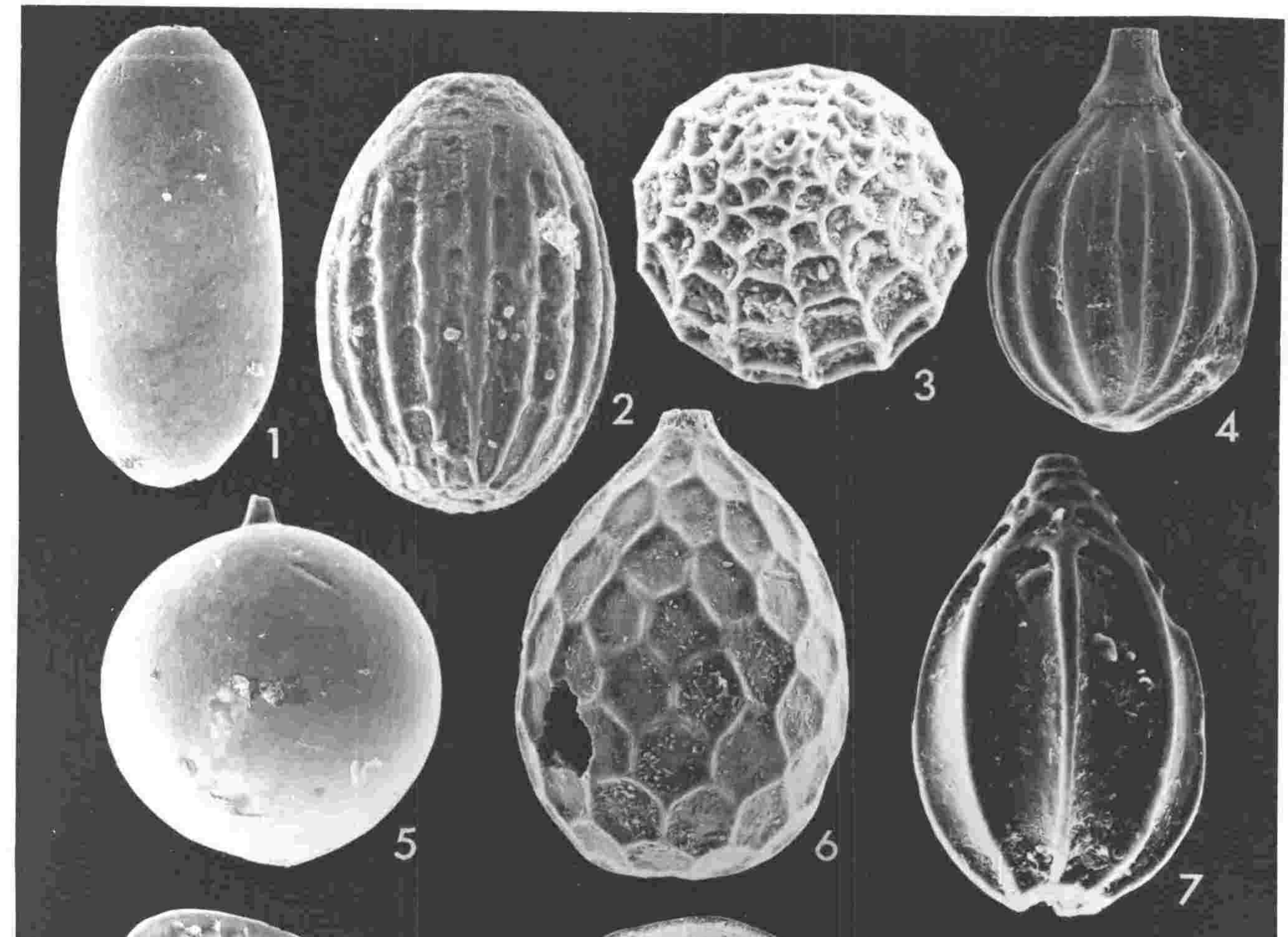


PLATE 11

1,2. Buliminella elegantissima

1. x1050 (1981-12).

2. x885 (1981-12).

3. Bolivina sp x424 (1980-15).

4. Bolivina pygmeae x573 (1982-3).

5. Bolivina pseudopunctata x300 (1981-12).

6. Stainforthia concava x486 (1981-2).

7,8,9. Cassidulinoides porrectus

7. x131 (1981-8A).

8. x143 (1981-9).

9. x655 (1981-9).

10,11. Cassidulinoides parkerianus

10. x212 (1982-3, 42-45cm).

11. x356 (1982-3, 42-45cm).

PLATE 11

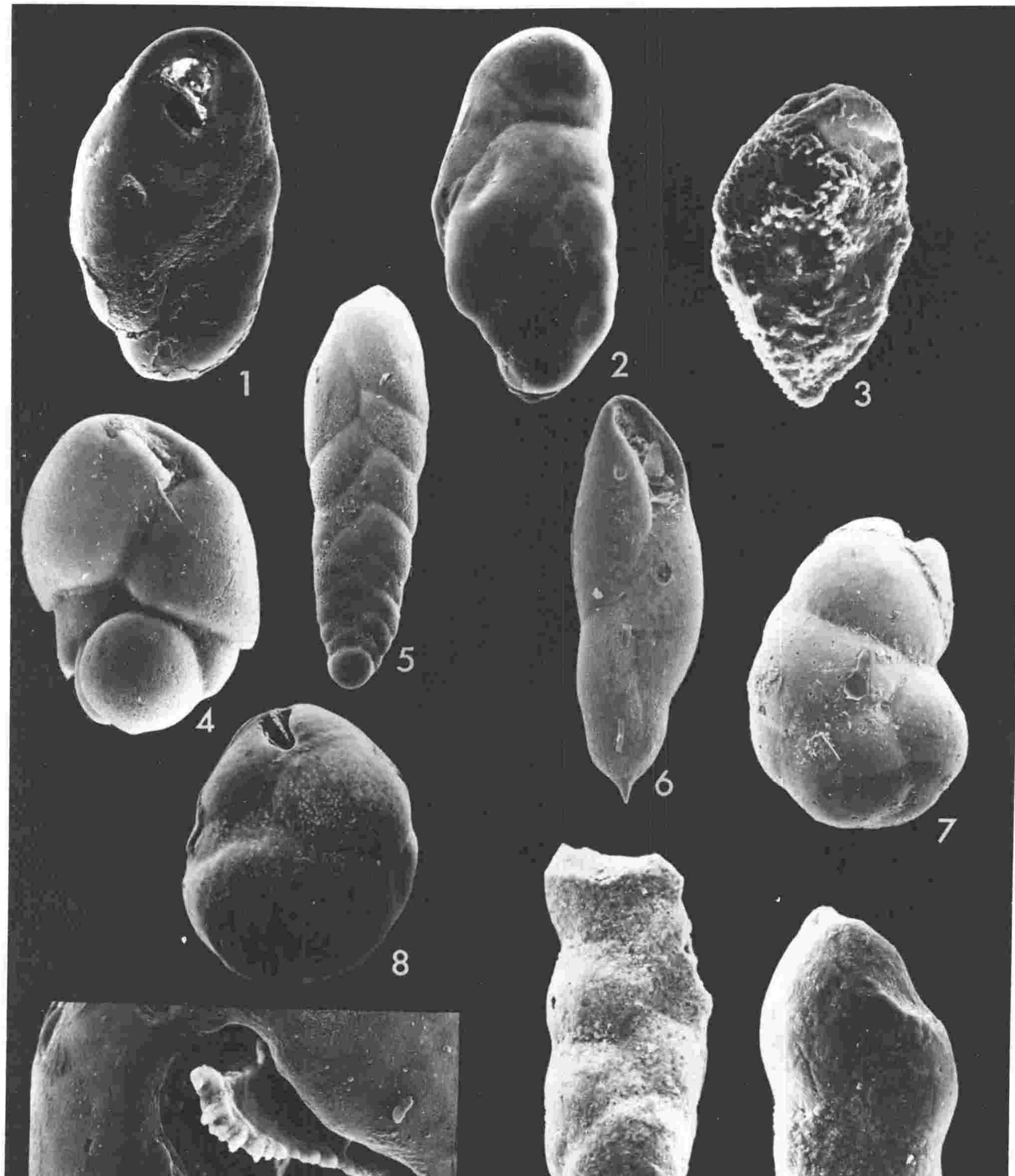


PLATE 12

1. Trifarina earlandi x143 (1981-9).

2. Trifarina pauperata x178 (1981-2).

3,4. Epistominella vitrea

3. x462 (1982-3); ventral view.

4. x482 (1982-3); dorsal view.

5,6. Rosalina globularis

5. x212 (1981-9); ventral view.

6. x326 (1981-9); dorsal view.

7. Heronallenia kempii x300 (1981-10); ventral view.

8,9. Glabratella sp

8. x885 (1981-8A); dorsal view.

9. x625 (1981-8A); ventral view.

10. Elphidium sp x442 (1982-3, 42-45cm).

PLATE 12

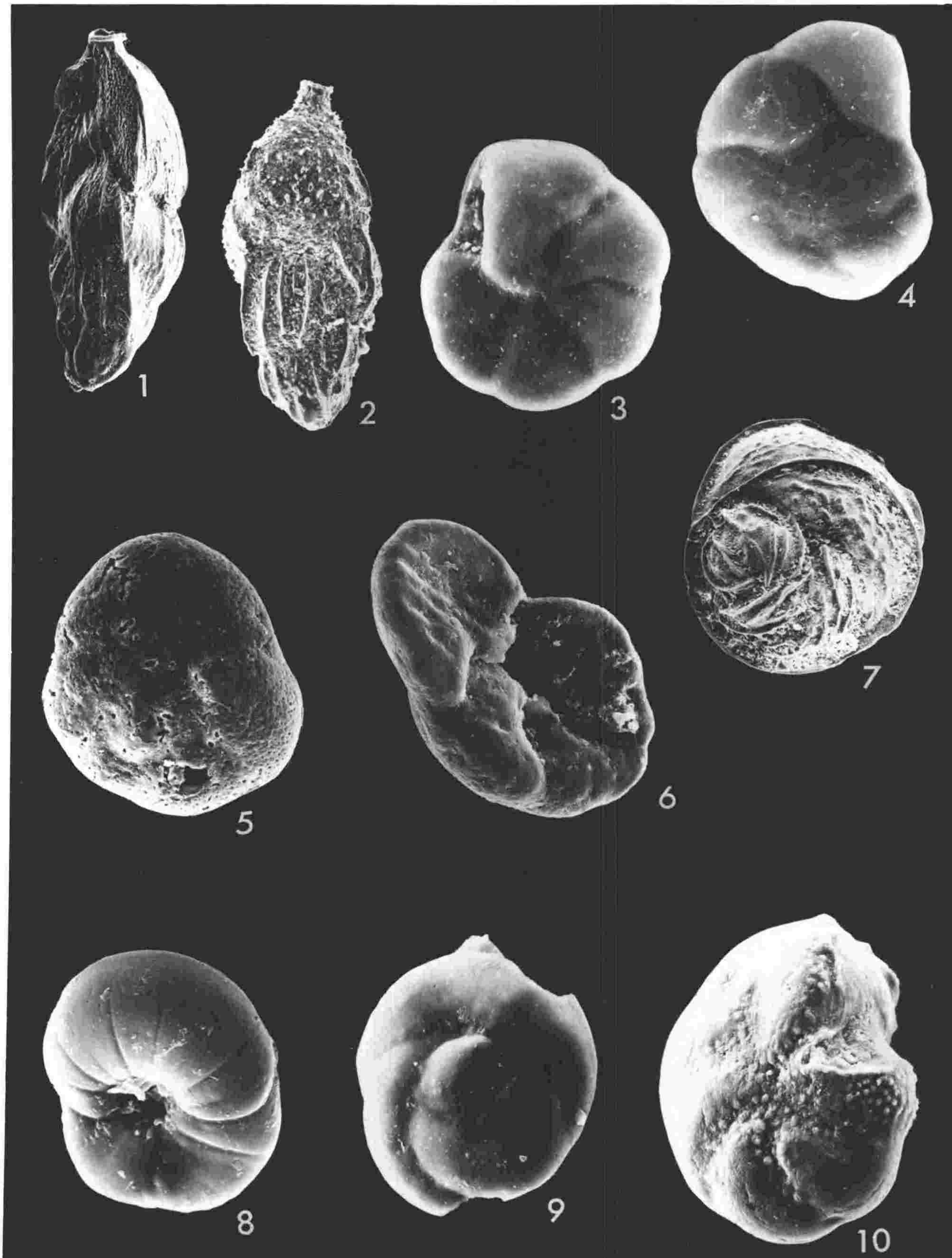


PLATE 13

1-9. *Schackoinella antarctica* n. sp.

1. x625 (1983-26); edge view.
2. x745 (same test as 1); ventral view.
3. x1620 (same test as 1); close-up.
4. x573 (1981-8A); ventral view.
5. x1250 (same test as 4); close-up.
6. x925 (1983-26); dorsal view.
7. x1620 (same test as 6); close-up.
8. x845 (1983-26); ventral view.
9. x1620 (same test as 8); close-up.

PLATE 13

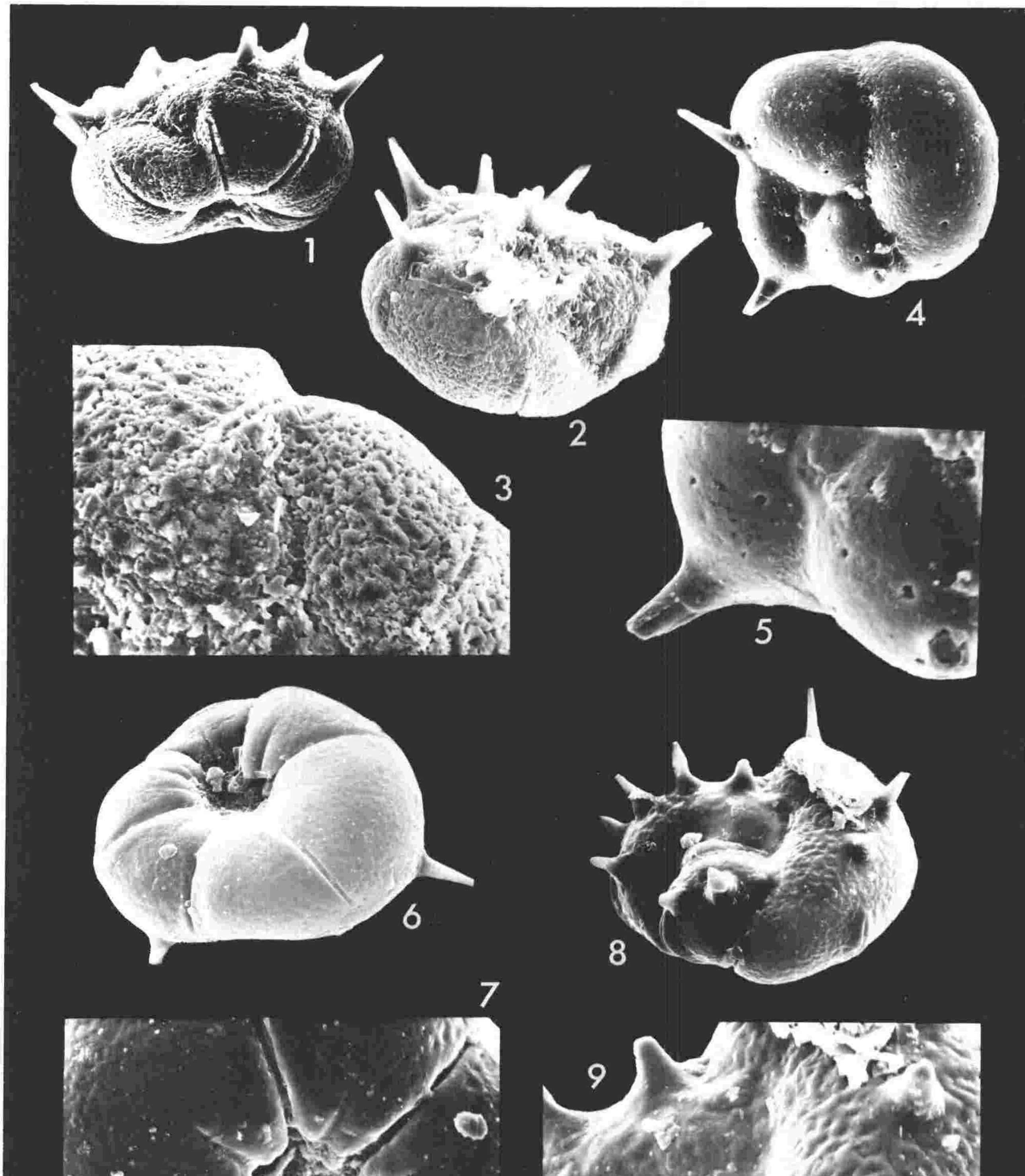


PLATE 14

1,2. Ehrenbergina glabra

1. x194 (1981-9); dorsal view.

2. x163 (1981-9); ventral view.

3,4. Cibicides lobatulus

3. x115 (1981-2); ventral view.

4. x131 (1981-4); dorsal view.

5,6. Globocassidulina subglobosus

5. x341 (1982-3).

6. x356 (1981-9).

7. Globocassidulina crassa x212 (1981-8A).

8,9. Globocassidulina biora

8. x170 (1981-9).

9. x388 (1981-2).

PLATE 14

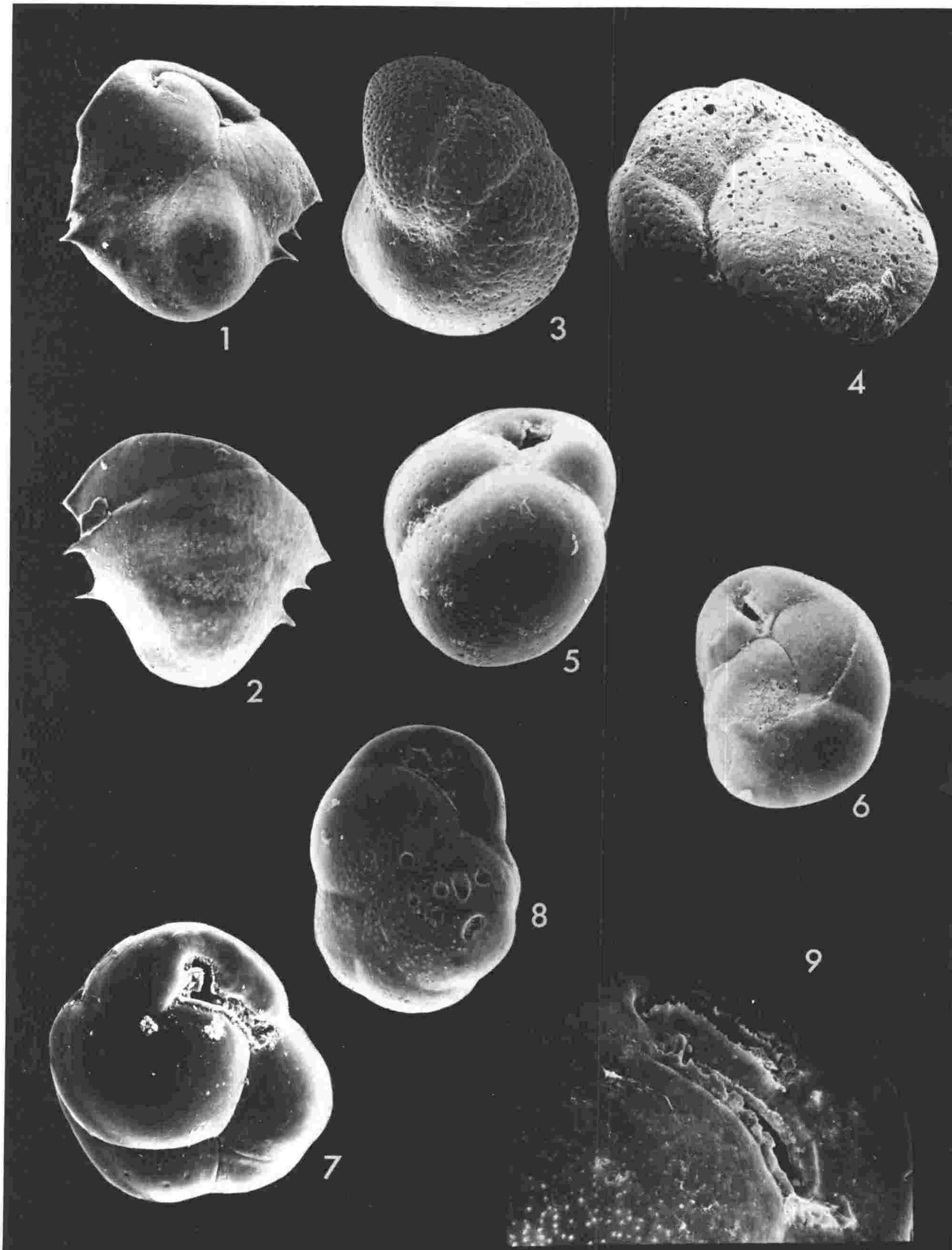


PLATE 15

1. Fursenkoina earlandi x287 (1981-2).

2,3. Nonionella iridea

    2. x388 (1981-2).

    3. x372 (1980-8).

4. Astrononion antarcticum x178 (1981-9).

5. Astrononion echolsi x194 (1981-8A).

6. Pullenia bulloides x212 (1981-9).

7. Pullenia subcarinata x110 (1981-10).

8,10,11. Neogloboquadrina pachyderma

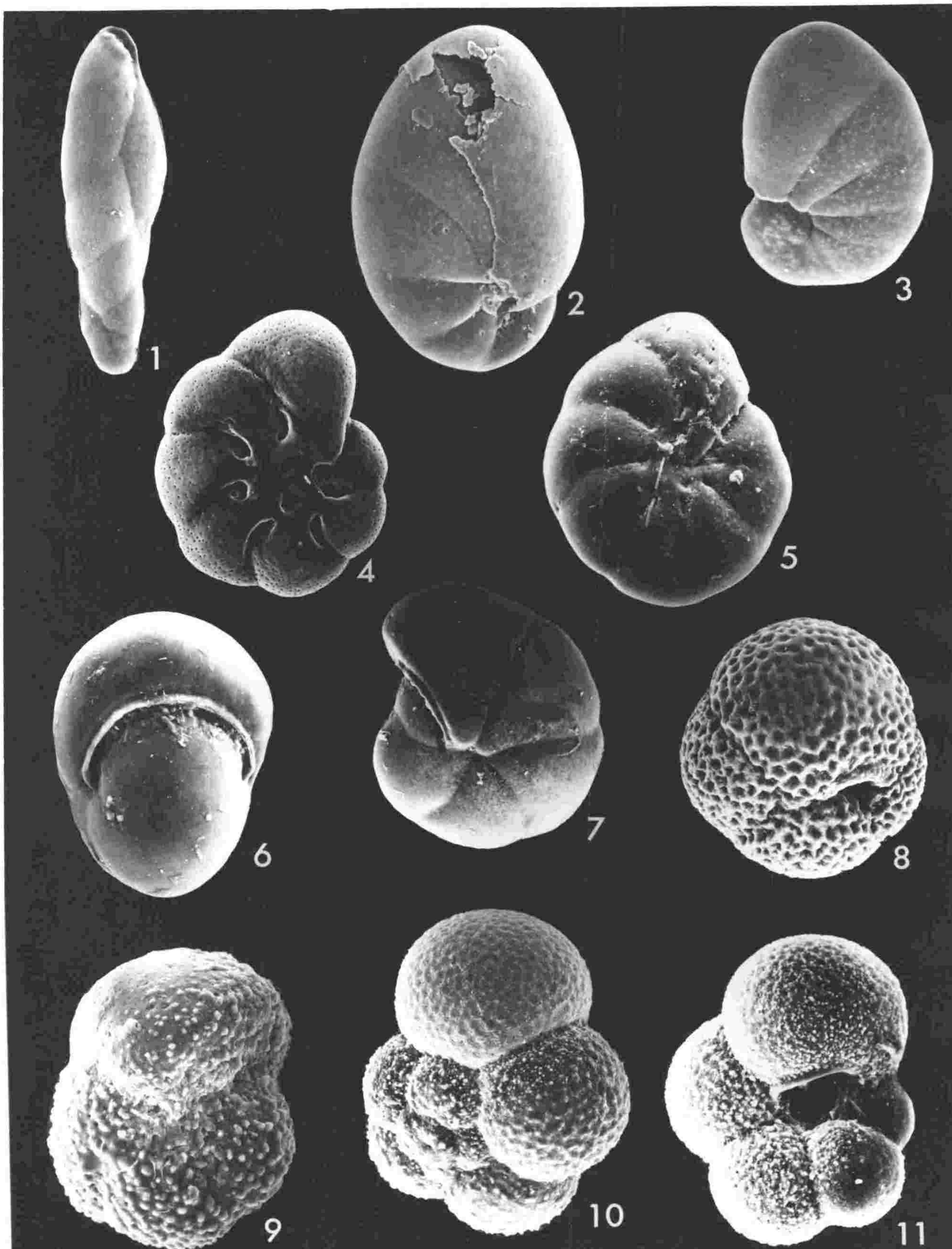
    8. x300 (1981-9); dorsal view.

    10. x287 (1981-9); ventral view.

    11. x341 (1981-8A); dorsal view.

9. Globorotalia inflata x341 (1981-6); dorsal view.

PLATE 15



CHAPTER 4

DEFINITION AND DISTRIBUTION OF RECENT BENTHIC FORAMINIFERAL ASSEMBLAGES

Ecological factors controlling distribution of assemblages

Introduction

Distribution of benthic foraminifera in surface sediments of the Antarctic has been the subject of the now classic works of Brady (1884), Pearcey (1914), Wiesner (1931), Heron-Allen and Earland (1922,1929,1932), Earland (1933,1934,1936), Chapman and Parr (1937) and Parr (1950). These were all concerned with description of species and have been useful in determining proper identification of taxa, depth distribution and areal distribution of foraminifera.

More recently, McKnight (1962) investigated foraminiferal distribution in the surface sediments of the Ross Sea with respect to ecological influences such as temperature, salinity, depth, water currents and mean grain size of substrate. He concluded that water depth, salinity, temperature and grain size had little or no effect on foraminiferal distribution. Organic carbon seemed to affect some agglutinated forms but not calcareous ones. Despite the apparent lack of influence of measured parameters on the foraminifera studied, McKnight established three tentative assemblages with approximate boundaries at: 164-475m, >384m and >/=475m.

He was followed by Pflum (1966), who studied foraminiferal distribution and the effects of water currents previously postulated by McKnight. He also established that temperature and salinity were not important, and stated that water depth MIGHT be important. Pflum also defined three foraminiferal assemblages "that may be related to depth": Shelf I, 210-515m; Shelf II, 604-1134m; and Slope, 1765-3545m.

Kennett (1967,1968), Echols (1971), Herb (1971), Fillon (1972,1974), Anderson (1975), and Osterman and Kellogg (1979) also studied foraminiferal distribution. The Drake Passage and Weddell Sea area, investigated by Echols, Herb and Anderson, has several benthic foraminiferal assemblages associated with water masses. The water masses are distinguished by temperature, salinity, flow direction and depth. This area is responsible for most of the Antarctic Bottom Water formation which circulates to the world's oceans.

Kennett, Fillon and Osterman and Kellogg concentrated on the Ross Sea and McMurdo Sound region. Many of the benthic species found in the Weddell Sea-Drake Passage area are also found in the Ross Sea region. These workers also investigated environmental aspects such as salinity, temperature, substrate and the CCD, and concluded that the only measurable influence was the CCD. Kennett (1968) located the CCD in McMurdo Sound at around 620m. Elsewhere in the Ross Sea it is as deep as 800m (Osterman and Kellogg 1979). From this it was evident that water depth was not as important a control of the CCD as water chemistry (such as pH), and sea-ice cover which controls calcium carbonate dissolution by restricting gas exchange across the air/water interface. The discussions in these works of calcareous, arenaceous and mixed benthic foraminiferal assemblages were quite useful in defining the three assemblages described later in this chapter. Though Echols (1971, p.96) did count live tests in 34 samples stained with rose bengal, his work, as did that of the other investigators mentioned above, concentrated on total populations. In this chapter life assemblages in McMurdo Sound are documented to determine their environmental limitations and are compared with associated death assemblages.

Considerable effort has been spent on investigations in the Arctic regions. Several of these have proved useful as references for this present investigation. Loeblich and Tappan's (1953) taxonomic work provided valuable descriptions and illustrations. Most of the genera listed by them are bipolar. Distribution of Recent benthic foraminifera of the Bering Sea was studied by G.J.Anderson (1963). His was one of the earlier attempts to study living foraminiferal assemblages by staining with rose bengal, but he had difficulties in counting stained arenaceous tests, so abandoned the attempt. Green (1960) collected sediment samples from between 433 and 2760m in the central Arctic Ocean. Agglutinated species were very rare, and faunal assemblages correspond to changes in slope of the sea floor.

<u>Habitat</u>

The living habits of most species of foraminifera are not well known. Although many if not most foraminiferal studies adopt a sampling strategy that implies that individuals are uniformly spread over the sea floor, some studies of benthic foraminifera suggest that they live in colonies or "clumps" (Shifflett 1961, Todd and Low 1966).

Shifflett's conclusions were based on a study of three samples taken within a 30m radius at each of four sites, i.e. a total of twelve sites, on the Heald Bank (10-15m water depth), Gulf of Mexico. Of the total of 50 living species found, the individual samples contained between five and 23, but this was in large part related to the number of tests counted, 18 and 126 respectively. The variability in numbers of species between samples at each site seems to be related to the small number of tests counted (Figure 14). It was not shown conclusively by Shifflett that the variability indicates the true proportions of species present at each site, and consequently does not confirm that these foraminifera live in colonies (Shifflett 1961, p.54). Shifflett's data indicate that one needs at least 20, but preferably 100, specimens to give a reasonable idea of what is at a site in a situation where the total assemblage is 50 species.

One species of foraminifer has been observed to form colonies on the floor of McMurdo Sound, but has quite a different character from the foraminifers described here. It is Notodendroides antarctikos, a large, branching, sessile form, which is known only from very shallow water depths of around 30m (DeLaca et al.1980). It was not identified in the present samples, but could easily be present as broken fragments that are misidentified.

A check on local variability in both living and dead foraminiferal assemblages was carried out in McMurdo Sound by comparing Cores 1981-3 and 1981-4 taken 20m apart (Table 1, Figure 15.) Nine of the twelve most common species occurred in similar proportions in life assemblages from both cores. The remaining three species showed differences of around 6%, but these differences are not significant at the 95% level. In a comparison of the death assemblages from the two cores, only Trifarina earlandi and Textularina antarctica show much difference in the proportions present, but these differences ARE statistically

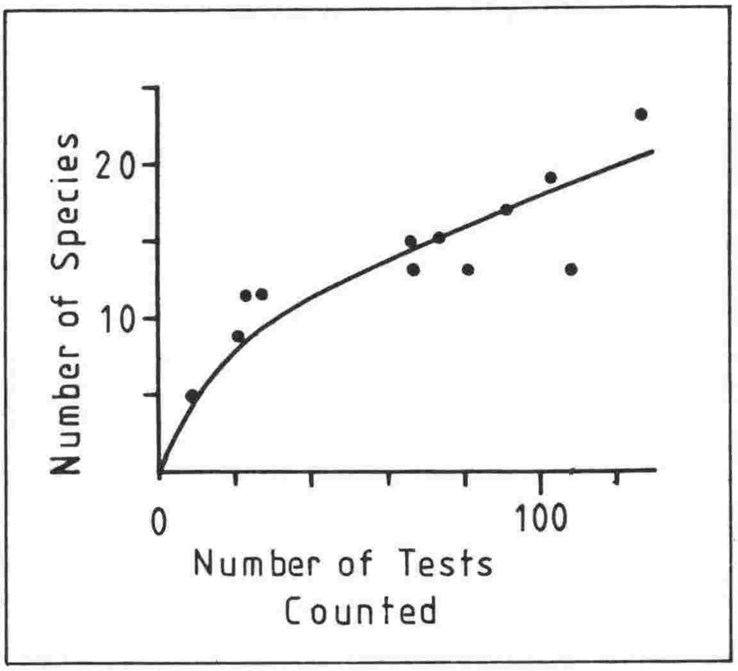


Figure 14. Data from Shifflett (1961) plotted to show relationship between number of living tests counted and number of living species. Taken from each of three subsamples collected at four localities on Heald Bank, Gulf of Mexico. Number of tests counted (total)=786; number of species found (total)=50.

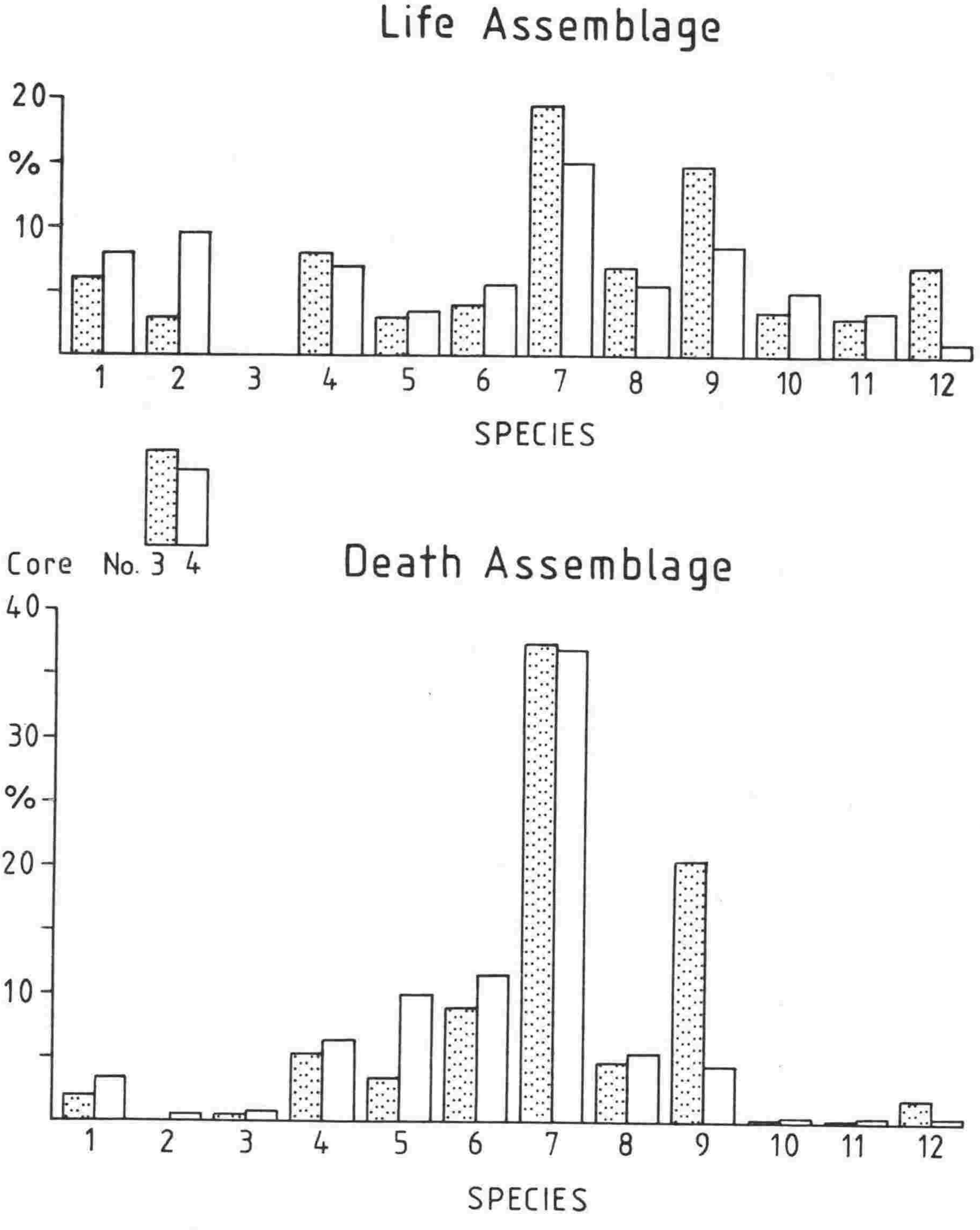


Figure 15. Percentages of twelve selected species from life and death assemblages of Cores 1981-3 and 4, collected from 560m water depth in central McMurdo Sound. Species numbers 1 through 12 correspond with those in Table 1. Species 1 through 8 are agglutinated, species 9 through 12 are calcareous.

CORE	LIVE%	95% CONFIDENCE INTERVAL (+/-)	SPECIES	DEAD%	95% CONFIDENCE INTERVAL (+/-)
3	6.0	(4)	REOPHAX PILULIFER(1)	2.0	(0.6)
4	8.2	(3.8)		3.6	(0.8)
3	3.0	(-)	R.SUBDENTALINIFORMIS (2)	0.1	(<1)
4	9.6	(4)		0.7	(<1)
3	-	(-)	MILIAMINNA ARENACEA (3)	0.6	(<1)
4	-	(-)		0.9	(<1)
3	8.0	(5.2)	CRIBROSTOMOIDES JEFFREYSII (4)	5.4	(1.2)
4	7.2	(3.4)		6.6	(1.1)
3	3.0	(-)	TEXTULARIA ANTARCTICA (5)	3.7	(1.2)
4	3.4	(2.4)		10.0	(1.5)
3	4.0	(4)	TROCHAMMINA GLABRA (6)	9.1	(1.6)
4	5.3	(2.2)		11.8	(1.4)
3	19.6	(8)	PORTOTROCHAMMINA ANTARCTICA (7)	37.3	(3.2)
4	15.0	(5)		37.0	(2.2)
3	6.8	(4.7)	PORTOTROCHAMMINA ELTANINAE (8)	4.9	(1.2)
4	5.7	(3)		5.6	(1)
3	14.7	(7)	TRIFARINA EARLANDI (9)	20.4	(2.5)
4	8.6	(3.9)		4.5	(1)
3	-	(-)	FURSENKOINA EARLANDI (10)	-	(-)
4	3.4	(2.2)		0.2	(<1)
3	3.0	(3.4)	EHRENBERGINA GLABRA (11)	0.1	(<1)
4	3.4	(2.6)		0.4	(<1)
3	6.8	(5)	GLOBOCASSIDULINA CRASSA (12)	2.0	(0.8)
4	1.0	(1.4)		0.5	(<1)
3	n=102 total tests			n= 997 total tests	
4	n=208 total tests			n=1852 total tests	

Table 1: Percentages of live and dead tests for the twelve most common species from Cores 1981-3 and 4, from 560m, central McMurdo Sound. Confidence limits after Van Der Plas & Tobi (1965), Table 1, and Galehouse (1971, Eq.95.4).

significant. However, they may be due to post-depositional processes because both cores are within the lysocline (560m). An overall comparison of the species compositon between the two cores shows much greater similarities than differences, the only major difference being T.earlandi. The similarities are considered to justify proceeding on the assumption that each sample is representative of the location from which it was taken, and that there are no significant effects on the proportions of species from clustering or natural patchiness on the sea floor.

Predation

Predation by fish, decapods, molluscs, polychaetes, marine nematodes and gastropods can influence the standing crop of an area (Sliter 1971, Brand and Lipps 1982). Where there is heavy predation the number of live foraminifera may be low. Study of gut contents of selected invertebrates from Arthur Harbour, Anvers Island, Antarctica revealed that foraminifera comprise from less than 1% to 100% of the diet, but are generally less than 12%. Species of foraminifera most commonly ingested were Rosalina globularis, Cribrostomoides jeffreysii, Patellina corrugata, Saccammina sphaerica, Rotaliammina ochracea, Trochammina spp., Glabratella sp., and Cyclogyra sp. Some species are preyed upon preferentially; for example, the large chiton Nuttalochiton mirandis feeds mainly on Rosalina globularis.

Boring, scraping (as by radulas) and etching by stomach acids can either destroy or damage foraminiferal tests (Hickman and Lipps 1983). When a species is preferentially preyed upon (Brand and Lipps 1982) it may represent a smaller percentage of the assemblage in the fossil record than would normally be the case, as damaged calcite tests would be less likely to be preserved and agglutinated foraminifera would disaggregate to their original grains (Buzas 1982). Where the number of live or dead tests per unit volume or weight of sediment is commonly used for environmental analysis as an indication of standing crop and productivity, reduction by grazing will effect ecological interpretations. Evidence of predation in McMurdo Sound is seen in small bore holes perforating some calcareous tests. These are not to be confused with the natural pores in certain species. The following SEM photos illustrate this type of predation: Plate 6, Figure 4; Plate 7, Figure 4; Plate 8, Figure 5; Plate 9, Figures 10,11; Plate 14, Figure 8.

Oceanographic factors

Temperature and salinity are stable enough not to affect foraminiferal populations severely (Chapter 1). The ruling factor is the shallow CCD, produced by cold temperatures and low pH. Currents seem to play a small role in the distribution of living foraminiferal assemblages. Velocities are generally low, but are moderate at several sites around Cape Armitage into the Erebus Basin, and off Cape Roberts.

Sedimentary factors

The sedimentation rate for the McMurdo Sound area is still under investigation, but is probably quite slow (<1.0mm/year). Windblown sediment seems to contribute the greatest component of terrestrial material, but faecal pellets are also a large component (Barrett *et al*.1983).

Test shapes, ornament and wall thickness of fossil calcareous foraminifera in the Los Angeles and Ventura Basins, California, show a relationship with sediment type (Hendrix 1958). Rounded, keelless unornamented forms occur in finer laminated sediments, while keeled and ornamented forms occur in coarser massive sediments. McMurdo Sound species show little preference for different types of substrate, except for Cribrostomoides jeffreysii, which seems to prefer coarser substrates, as it is relatively less abundant in the harbour areas. At similar depths the proportion of living and dead C.jeffreysii is inversely related to the proportion of mud in each sample (Figure 16).

Distribution of foraminiferal assemblages

In McMurdo Sound agglutinated foraminifera predominate over calcareous forms (Figure 17, Table 2). Deeper than 620m in the open sound a variety of agglutinated species form the life and death assemblages, with virtually no calcareous tests in either. This level, then, is taken to be the CCD. A few living calcareous specimens are found below 620m, and are discussed in more detail below. Above 620m in the open sound, calcareous tests become more frequent. The assemblages still contain a large number of agglutinated tests, though fewer agglutinated species (Figure 18). In harbours and enclosed basins, life assemblages show less variation in proportions of calcareous foraminifera with depth, but death assemblages show a definite change in abundance of calcareous tests between 212m and 254m (Figure 17, Samples 1982-4 and 1981-18). Those deeper than about 230m contain less than 5% calcareous tests; this is taken to mark the CCD in this setting.

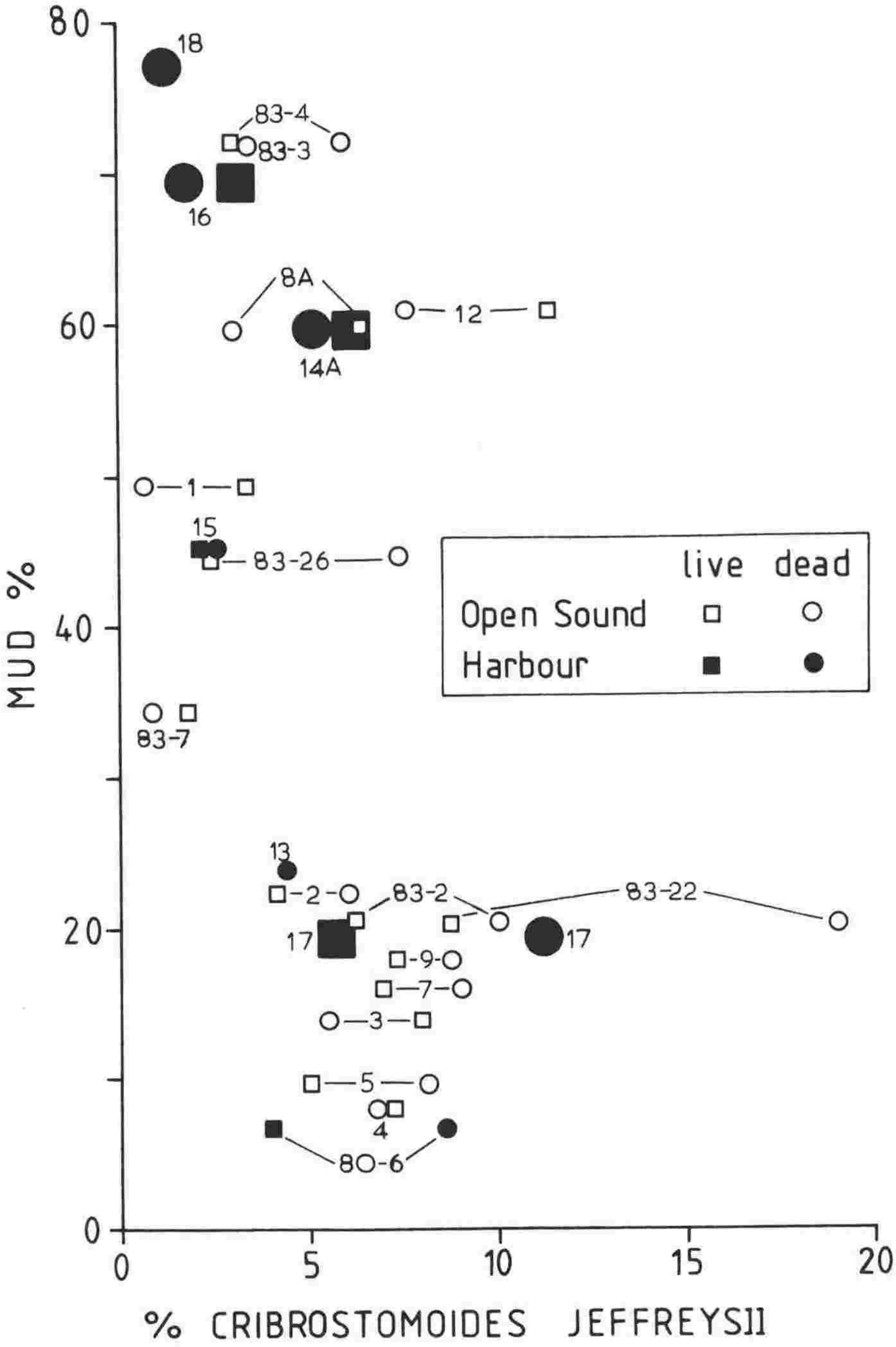


Figure 16. Percentages of Cribrostomoides jeffreysii plotted versus percentage mud in live and dead counts from open water and harbour samples. Harbour samples 1981-14A, 16, 17 and 18 (larger symbols), all from approximately 300m water depth, show the inverse correlation of relative abundance of C.jeffreysii with the amount of mud in associated sediments.

Live calcareous foraminifera below the CCD

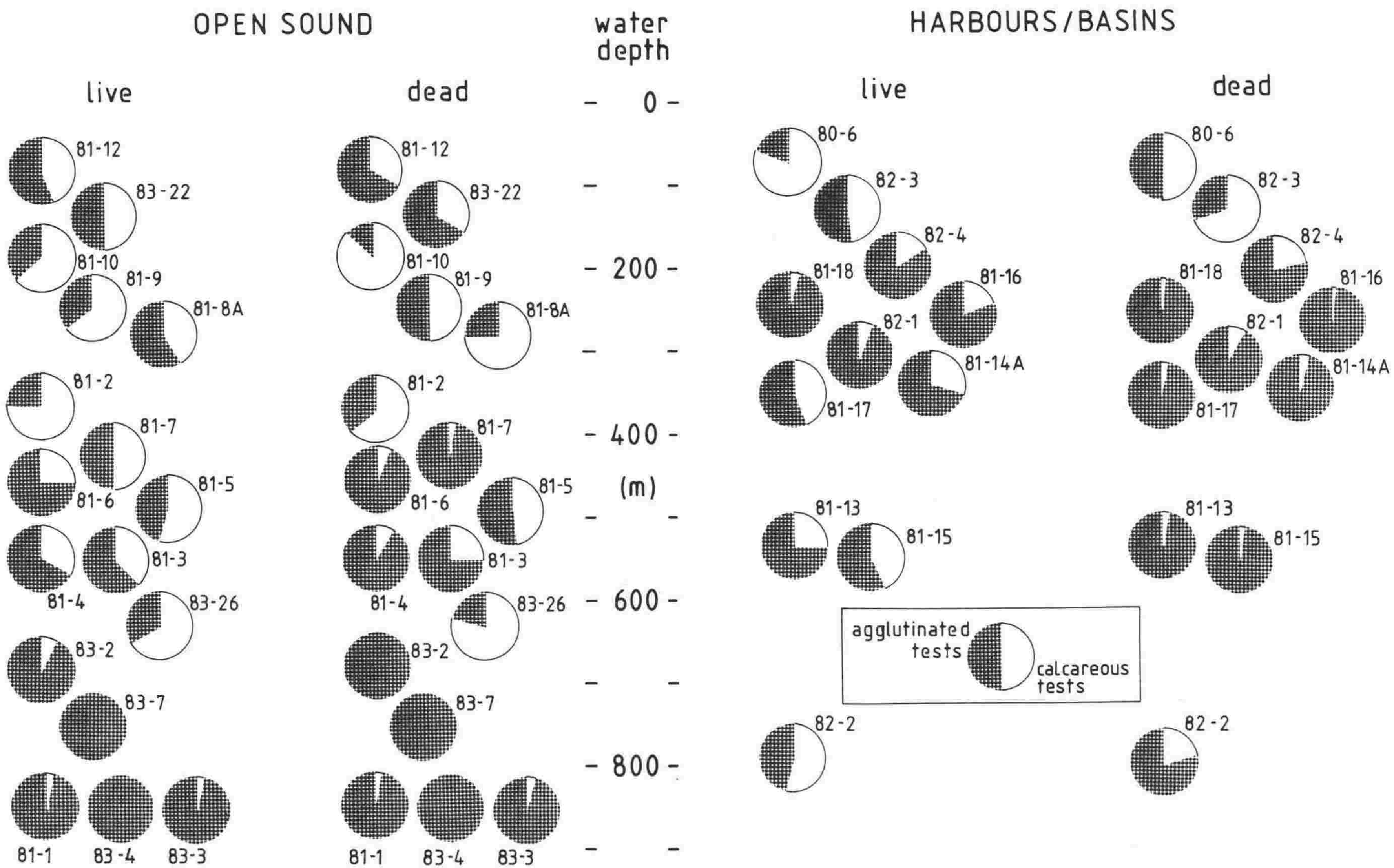
Fursenkoina earlandi and Globocassidulina crassa are exceptional calcareous species that are found living below the CCD in McMurdo Sound, and in Granite Harbour and New Harbour. The associated sediments contain few specimens of their dead shells. It is inferred that these two species have the ability, unusual in calcareous foraminifera, to secrete their tests in water strongly undersaturated in calcium carbonate, and that the tests are quickly dissolved after death in these particular localities. Calcareous specimens reported below the CCD elsewhere in Ross Sea have been explained as being displaced by turbidity currents (Anderson et al.1982). Live specimens of F.earlandi and G. crassa have been found at seven sites (Table 3, sites marked with asterisk) where the remainder of the assemblage is largely agglutinated, and the two species are living within their ecological limits. They are also found in shallow areas above the CCD.

Distribution of life assemblages

The diversity of foraminifera greatly increases in the shallower (<620m) open sound samples due to the increase of calcareous species and tests because the water has a relatively high pH and is saturated in calcium carbonate at those depths (see Chapter 1). Lagenidae and Glandulinidae especially increase in abundance with increasing height above the CCD (Appendix 2, Foraminifera Lists).

The writer has counted a total of 39,209 tests for population studies. Of these 2,334 (6%) were alive when collected, and 36,875 (94%) were dead. There are 123 species and varieties, of which 50 species

Figure 17. Proportions of agglutinated and calcareous, living and dead benthic foraminifera from McMurdo Sound. Samples are arranged by water depth, from shallow at the top to deep at the bottom, and separated into open water samples (left) and harbour samples (right).



OPEN SOUND
live
dead
81-12
83-22
81-10
81-9
81-8A
81-2
81-7
81-6
81-5
81-4
81-3
83-26
83-2
83-7
81-1
83-4
83-3
water depth
0
200
400
(m)
600
800
HARBOURS/BASINS
80-6
82-3
82-4
81-18
81-16
82-1
81-14A
81-17
81-13
81-15
82-2
agglutinated tests
calcareous tests

Table 2: Total numbers of tests counted, living and dead, and percentages of agglutinated and calcareous tests in both fractions.

KEY:

1=Number of tests
2=Number of live tests
3=Number of dead tests
4=Percent live tests
5=Percent dead tests
6=Percent agglutinated live tests
7=Percent calcareous live tests
8=Percent agglutinated dead tests
9=Percent calcareous dead tests
10=Percent gravel
11=Percent sand
12=Percent mud

Samples marked with an asterisk (*) have had additional live tests counted. The percentages of live to dead tests are based on the original counts from split floats, and the percentages of live calcareous and agglutinated tests are based on the additional live tests. Grab 1983-26, marked with a hatch (#), is an unusually calcareous sample for its depth (620m). See text for further discussion of this site.

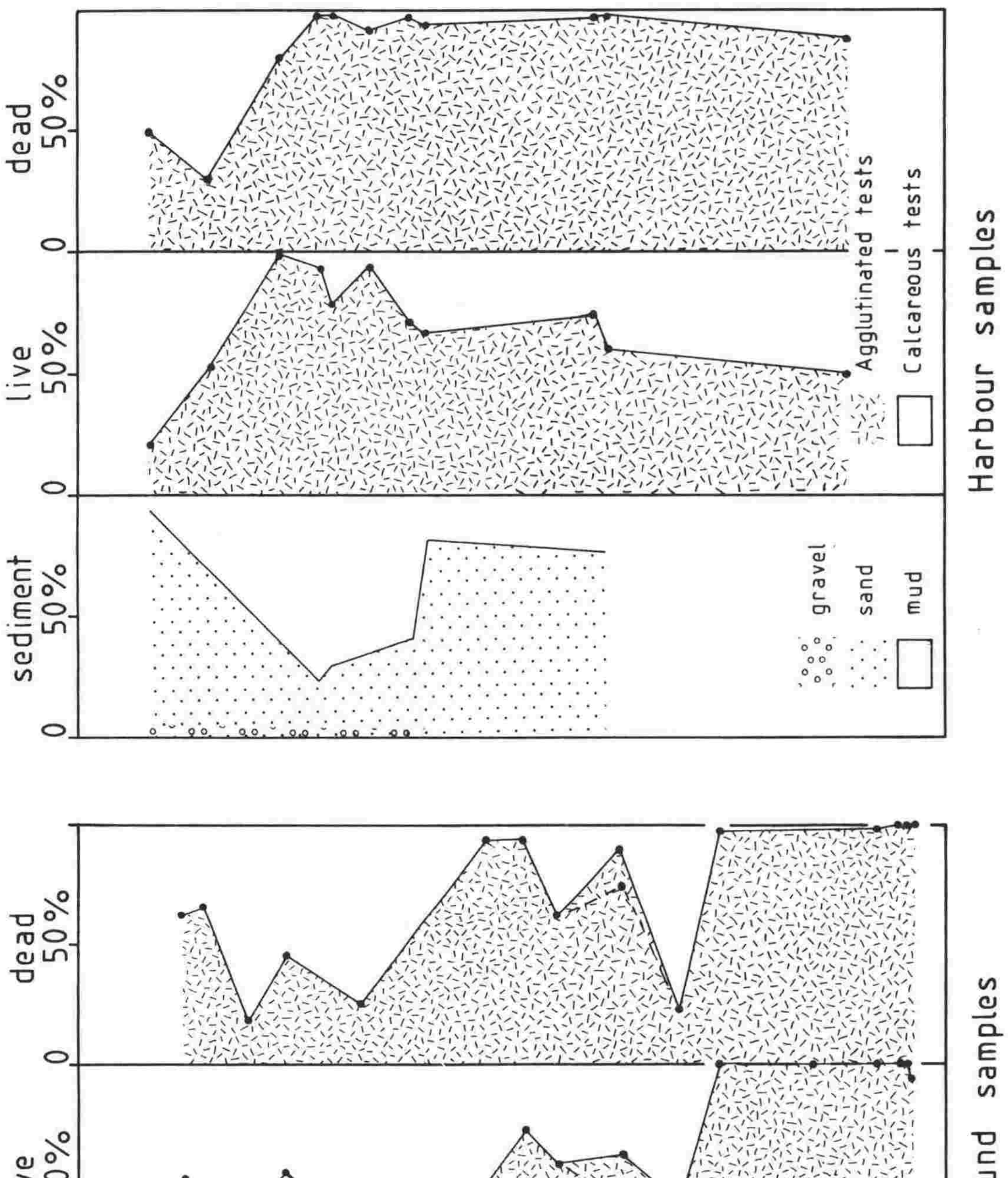
OPEN SOUND

SAMPLE NO.	DEPTH (M)	1	2	3	4	5	6	7	8	9	10	11	12
81-12	110	2948	79	2869	3	97	99	1	99.6	0.4	0.1	38.8	61.2
83-22	128	285	46	249	3	97	50	50	65	35	9.3	69.1	21.6
81-10*	173	1927	59	1868	1	99	36	64	17	83	---	----	----
81-9 *	213	753	110	643	5	95	37	63	45	55	1.6	80.3	18.2
81-8A*	289	1303	31	1272	1	99	68	32	21	79	0.7	40.4	59.0
81-2 *	370	488	122	366	2	98	22	78	32	68	3.4	74.4	22.2
81-7	420	6289	404	5885	6	94	50	50	91	9	18.5	65.5	16.0
81-6 *	460	605	229	376	11	89	75	25	93	7	----	----	----
81-5 *	496	655	211	444	9	91	44	56	61	39	50.5	39.7	9.8
81-4 *	560	2060	208	1852	8	92	63	37	90	10	62.5	29.6	7.9
81-3	560	1099	102	997	9	91	63	37	74	26	34.9	51.2	14.1
83-26#	620	493	44	459	9	91	30	70	20	80	9.2	45.9	44.8
83-2	660	193	33	160	17	83	94	6	98	2	35.0	44.5	20.5
83-7	755	305	58	247	19	81	100	-	100	-	0.4	66.2	33.4
81-1	850	1031	87	944	8	92	99	1	99.6	0.4	11.7	40.4	47.9
83-4	854	187	34	153	18	82	100	-	100	-	0.0	28.0	72.0
83-3	856	245	30	215	12	88	93	7	99	1	2.9	25.0	72.2

HARBOURS AND COASTAL BASINS

SAMPLE NO.	DEPTH (M)	1	2	3	4	5	6	7	8	9	10	11	12
80-6	79	1499	50	1449	3	97	22	78	50	50	1.1	91.9	7.0
82-3	137	378	67	311	18	82	52	48	30	70	---	----	---
82-4	212	171	36	135	21	79	83	17	82	18	---	----	---
81-18	254	802	234	568	41	59	94	6	99	1	0.0	22.9	77.0
81-16	266	507	62	445	12	88	79	21	99	1	0.0	30.4	69.6
82-1	303	438	44	394	10	90	91	9	92	8	---	----	----
81-14A	345	476	80	396	17	83	71	29	98	2	0.0	41.0	59.0
81-17	348	534	35	499	7	93	57	43	94	6	0.8	79.6	19.7
81-13	537	479	55	424	11	89	75	25	98	2	0.0	77.2	23.0
81-15	550	491	48	443	10	90	60	40	99	1	0.0	14.3	45.7
82-2	796	262	35	227	13	87	49	51	89	11	---	----	----

Figure 18. Percentages of gravel, sand, mud and live and dead agglutinated and calcareous benthic foraminifera are plotted against water depth. No grain size data are available for 1982 gravity sphincter cores, and 1981-6 and 10. Foraminiferal counts for these samples are included.


dead
50%
0
live
50%
0
sediment
50%
0
Agglutinated tests
Calcareous tests
gravel
sand
mud
Harbour samples
McMurdo Sound samples
0
200
400
600
800
water depth (m)

(41%) are not represented in the live fraction, and 3 species (2%) are found only in the live fraction. The distribution of samples is shown in Figures 12 and 13, Chapter 2.

Twelve species were selected for close examination in this chapter for the following reasons: 1) each contributed a statistically important percentage to the entire count; 2) they cover a wide range of test sizes and shapes; 3) there are representatives of both agglutinated and calcareous benthic forms; and 4) each occurs in a majority of the samples (Figure 18A).

The selected agglutinated species are *Portotrochammina antarctica*, *Portotrochammina eltaninae*, *Trochammina glabra* , *Textularia antarctica*, *Cribrostomoides jeffreysii*, *Miliammina arenacea*, *Reophax pilulifer* and *Reophax subdentaliniformis*. The selected calcareous species are *Trifarina earlandi*, *Ehrenbergina glabra*, *Fursenkoina earlandi* and *Globocassidulina* ~~crassa~~. The relative proportions of these define the assemblages.

There are three main life assemblages present in McMurdo Sound: 1) DWA: Deep water (>620m) assemblage of central McMurdo Sound; 2) SWA: Shallow water (<620m) assemblage of McMurdo Sound; 3) HA: Harbour assemblage in both New Harbour (maximum depth 250m) and Granite Harbour (maximum depth 800m). The first and third are dominantly agglutinated, and the second, though having a higher number of calcareous species and tests, usually has abundant agglutinated tests as well. Figures 19 through 30 give percentages of each species in each sample, arranged from shallow (top) to deep (bottom) water in each diagram.

The characteristic assemblages are as follows:

DWA: *Reophax pilulifer* (highest percent in live assemblage 23%, at 854m), *Reophax subdentaliniformis* (23%, at 850m), *Portotrochammina eltaninae* (60%, at 660m, average 14%), *Textularia antarctica* (31%, at 850m) and *Miliammina arenacea* (11%, at 755m and 856m).

SWA: *Trochammina glabra* (live peak of 9.4% at 289m, 1981-8A, but common from deeper sites as well), *Cribrostomoides jeffreysii* (gradually increases from deep to shallow areas with 11.4% at 110m, Core 1981-12), *Trifarina earlandi*, (15% at 289m, 1981-8A),*Ehrenbergina glabra* (common to 620m, with live peak of 22% at 173m, 1981-10 and 11.8% at 289m , 1981-8A), *Fursenkoina earlandi* (common to 128m and present from 420m), and *Globocassidulina crassa* (common to 620m, with a live peak of 18% at 620m, 1983-26) and a lesser peak of 15% at 420m, 1981-7).

HA: *R.subdentaliniformis* (live maximum of 38% at 537m), *Portotrochammina antarctica* (peak of 16% at 303m), *Textularia antarctica* (peak of 25% at 266m), *Fursenkoina earlandi* (peak of 35% at 550m), and *Globocassidulina crassa* (peak of 13.8% at 345m).

Near Cape Armitage, Ross Island, is a shelly bottom at the normal level of the CCD (Sample 1983-26, 620m, Figure 13). The surface sediment consists of fragmentary bryozoan and other carbonate skeletal material. Some bryozoans retrieved were in life position, indicating that the strong tidal currents present there (Gilmour 1975, Heath 1977) do not preclude marine life and could be providing extra nutrients to the area. Possibly the CCD is locally depressed by the currents carrying higher pH to a greater depth than usual. The foraminifera reported from the site

Table 3: Percentages of live and dead tests of Globocassidulina crassa and Fursenkoina earlandi. Samples arranged from shallow to deep, open water and harbour sites.

Sample No.	Depth (m)	Globocassidulina crassa Live%	Globocassidulina crassa Dead%	Fursenkoina earlandi Live%	Fursenkoina earlandi Dead%
OPEN WATER					
81-12	110	3.8	5.0	2.53	0.03
83-22	128	6.5	1.2	21.7	0.4
81-10	173	1.7	3.7	--	0.05
81-9	213	7.3	8.4	--	0.5
81-8A	289	--	13.0	--	--
81-2	370	2.5	7.7	--	0.6
81-7	420	15.1	2.7	0.7	0.02
81-6	460	2.2	0.3	0.9	--
81-5	496	11.6	4.0	5.1	0.5
81-4	560	1.0	0.5	3.4	0.2
81-3	560	6.8	2.0	--	--
83-26	620	18.2	11.5	--	--
83-2	660	--	--	--	--
83-7	755	--	--	--	--
81-1	850	--	--	--	0.1
83-4	854	--	--	--	--
83-3*	856	3.3	--	3.3	--
HARBOURS/ENCLOSED BASINS					
80-6	79	6.0	6.6	--	0.1
82-3	139	10.6	20.6	--	--
82-4	212	2.8	0.7	--	0.7
81-18*	254	3.4	0.5	0.4	--
81-16*	266	8.1	--	9.7	0.2
82-1	303	--	0.3	--	--
81-14*	345	13.8	1.0	13.8	0.8
81-17	358	--	0.6	--	--
81-13*	537	3.63	0.2	9.1	0.9
81-15*	550	4.2	--	35.4	0.7
82-2 *	796	11.4	1.8	22.9	1.3

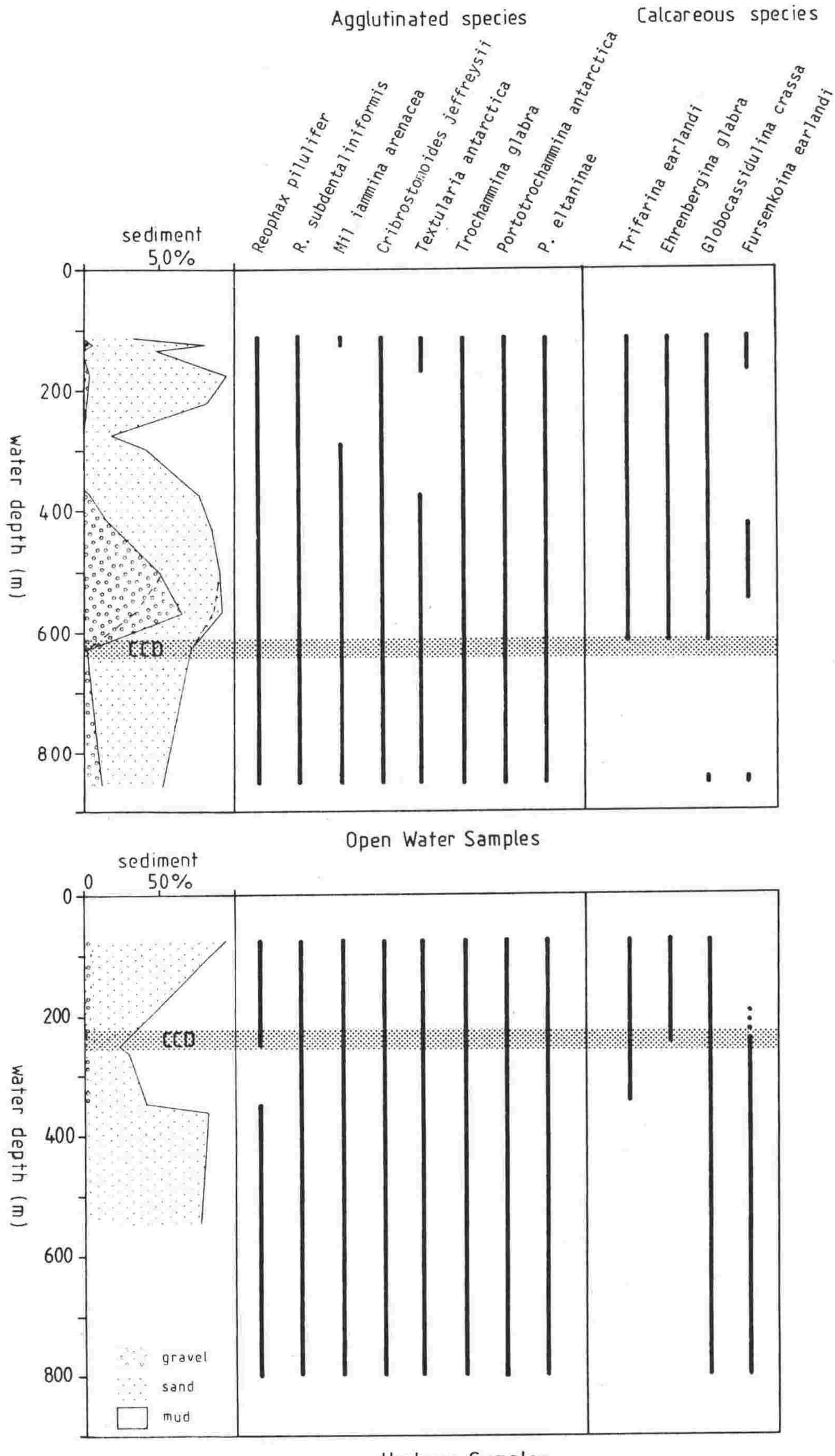


Figure 18A. Depth ranges of twelve species from open water and harbour samples. Sediment size and CCD level are also shown.

Figure 19. Reophax pilulifer: percentages of living and dead tests in open sound and harbour samples. Samples are arranged from shallow (top) to deep (bottom) water. The 95% confidence intervals are indicated by the colours of the symbols: green is plus or minus less than 4%, blue is plus or minus between 4% and 8%, red is plus or minus greater than 8%, and a blank symbol indicates no data or the confidence interval is off the scale used (Van Der Plas and Tobi 1965, Table 1, and Galehouse 1971, Equation 95.4).

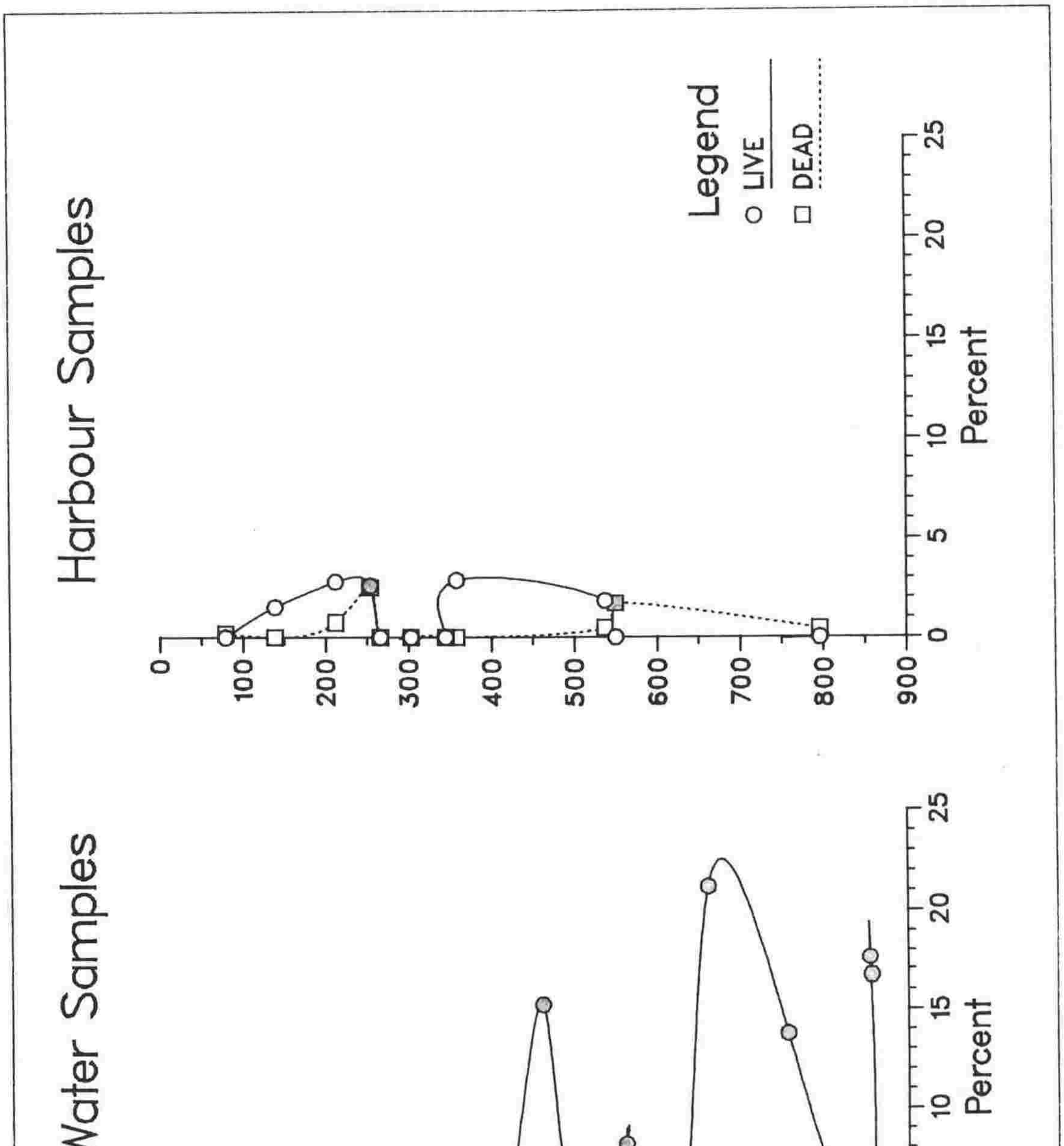
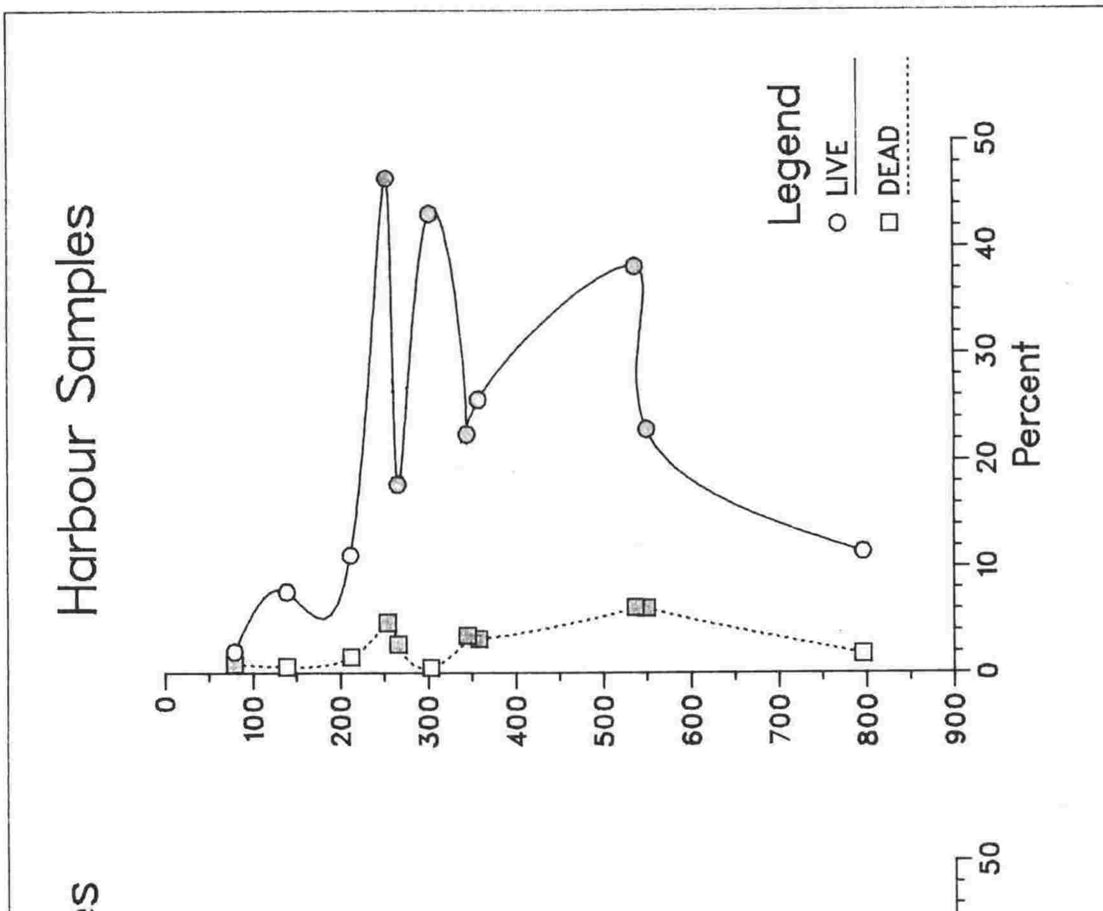

Open Water Samples
Harbour Samples
Legend
LIVE
DEAD
Water Depth in Metres
Percent
0
100
200
300
400
500
600
700
800
900
0
5
10
15
20
25
OPEN1

Figure 20. Reophax subdentaliniformis: percentages of living and dead tests in open sound and harbour samples. Samples are arranged from shallow (top) to deep (bottom) water. The 95% confidence intervals are indicated by the colours of the symbols: green is plus or minus less than 4%, blue is plus or minus between 4% and 8%, red is plus or minus greater than 8%, and a blank symbol indicates no data or the confidence interval is off the scale used (Van Der Plas and Tobi 1965, Table 1, and Galehouse 1971, Equation 95.4).



Open Water Samples
Harbour Samples
Legend
LIVE
DEAD
Water Depth in Metres
Percent
0
100
200
300
400
500
600
700
800
900
0
10
20
30
40
50
OPEN2

Figure 21. *Miliammina arenacea*: percentages of living and dead tests in open sound and harbour samples. Samples are arranged from shallow (top) to deep (bottom) water. The 95% confidence intervals are indicated by the colours of the symbols: green is plus or minus less than 4%, blue is plus or minus between 4% and 8%, red is plus or minus greater than 8%, and a blank symbol indicates no data or the confidence interval is off the scal used (Van Der Plas and Tobi 1965, Table 1, and Galehouse 1971, Equation 95.4).

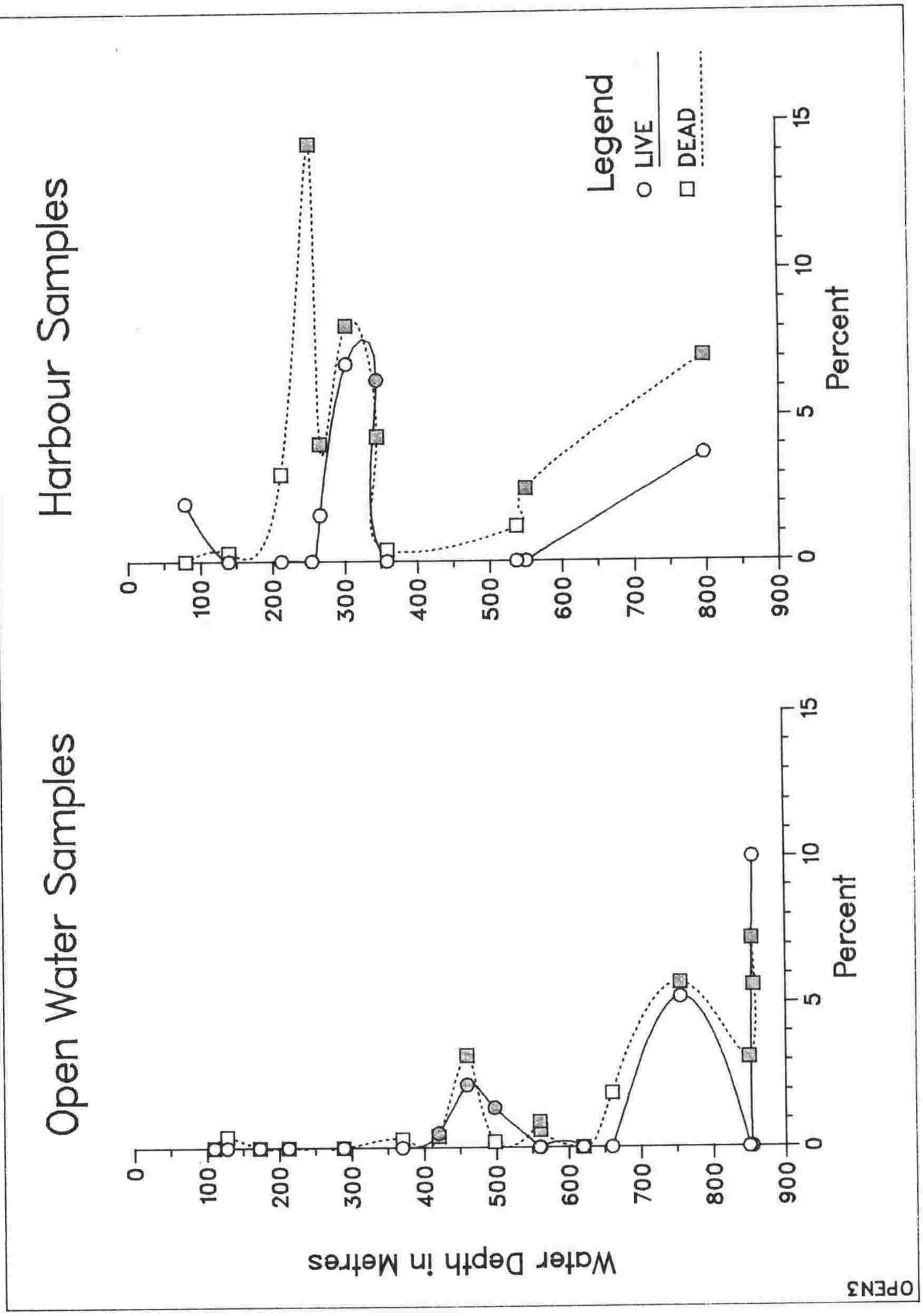

Open Water Samples
Harbour Samples
Water Depth in Metres
Percent
0
100
200
300
400
500
600
700
800
900
0
5
10
15
Legend
LIVE
DEAD
OPEN3

Figure 22. Cribrostomoides jeffreysii: percentages of living and dead tests in open sound and harbour samples. Samples are arranged from shallow (top) to deep (bottom) water. The 95% confidence intervals are indicated by the colours of the symbols: green is plus or minus less than 4%, blue is plus or minus between 4% and 8%, red is plus or minus greater than 8%, and a blank symbol indicates no data or the confidence interval is off the scale used(Van Der Plas and Tobi 1965, Table 1, and Galehouse 1971, Equation 95.4).

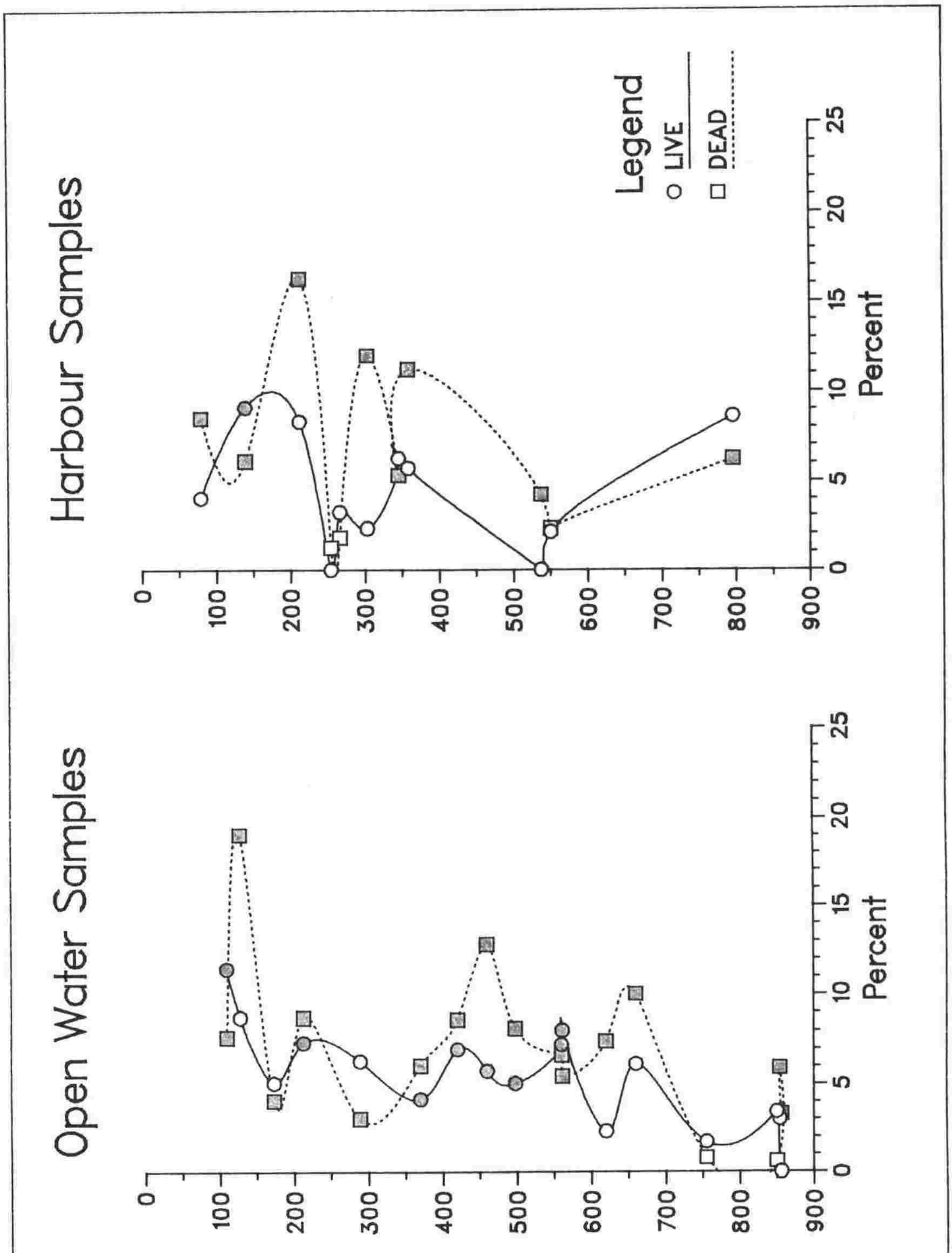

Open Water Samples
Harbour Samples
Water Depth in Metres
0
100
200
300
400
500
600
700
800
900
Percent
0
5
10
15
20
25
Legend
LIVE
DEAD
OPEN4

Figure 23. <u>Textularia</u> <u>antarctica</u>: percentages of living and dead tests in open sound and harbour samples. Samples are arranged from shallow (top) to deep (bottom) water. The 95% confidence intervals are indicated by the colours of the symbols: green is plus or minus less than 4%, blue is plus or minus between 4% and 8%, red is plus or minus greater than 8%, and a blank symbol indicates no data or the confidence interval is off the scale used (Van Der Plas and Tobi 1965, Table 1, and Galehouse 1971, Equation 95.4).

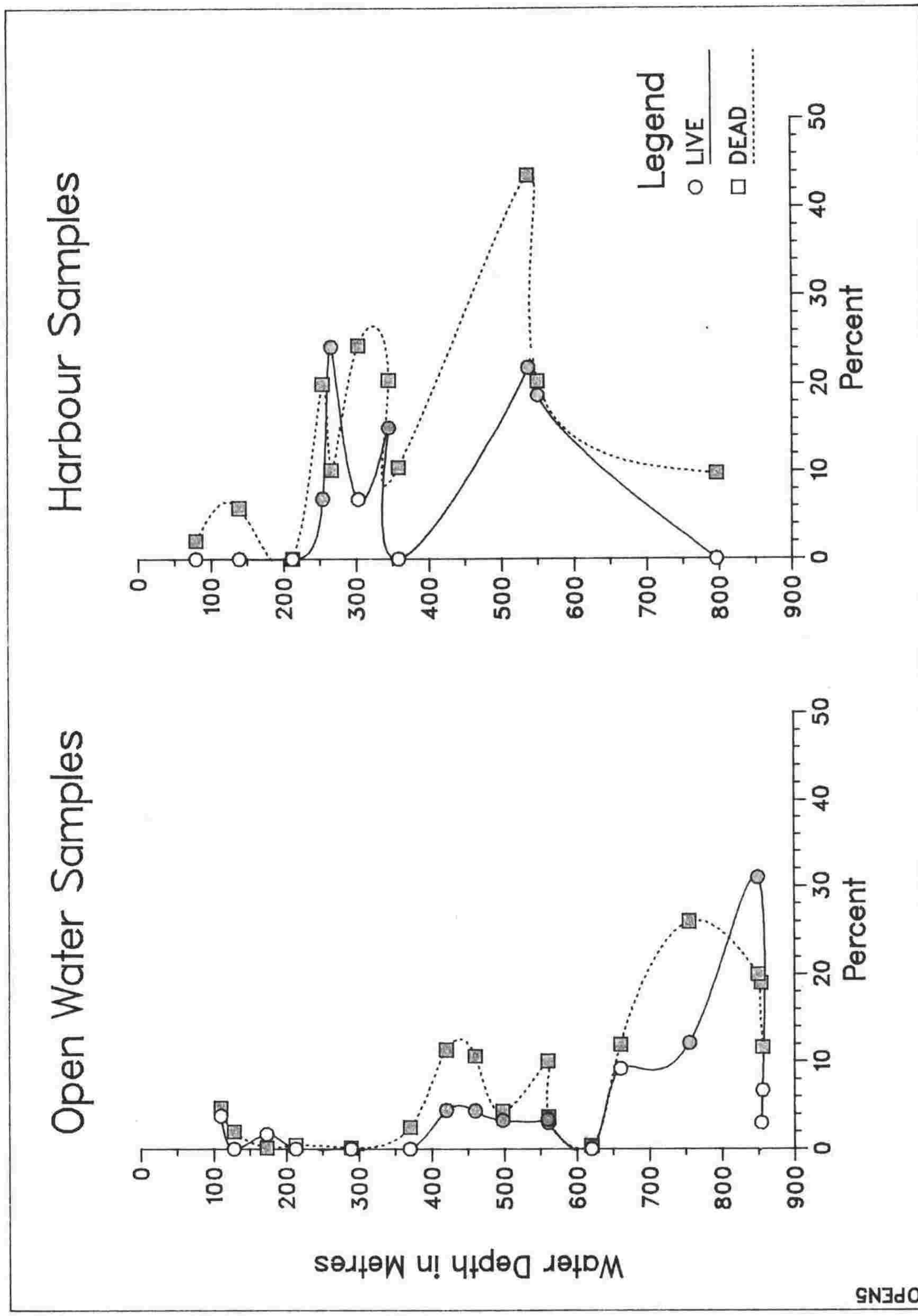
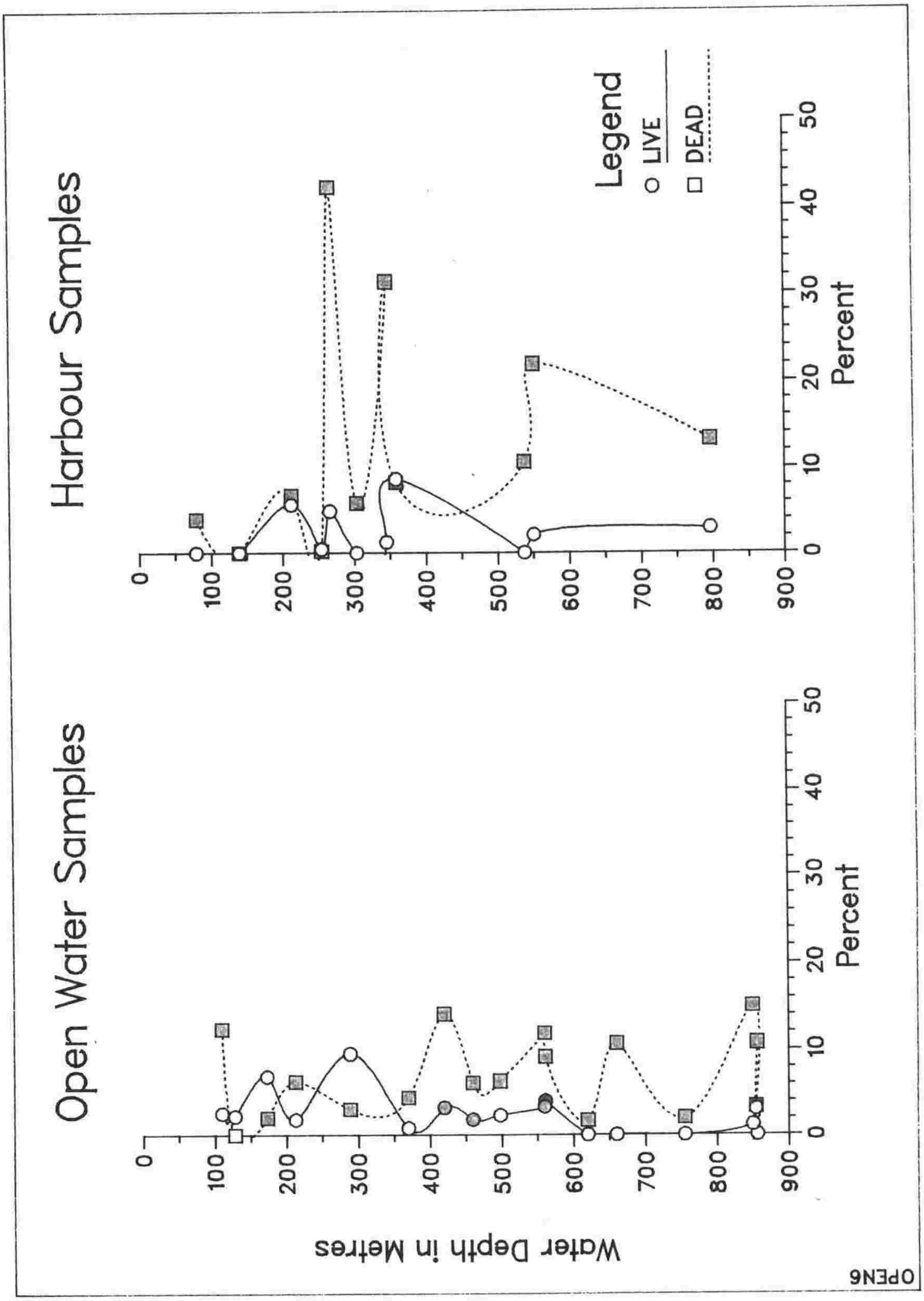

Open Water Samples
Harbour Samples
Legend
LIVE
DEAD
Water Depth in Metres
Percent
0 100 200 300 400 500 600 700 800 900
0 10 20 30 40 50
OPEN5

Figure 24. *Trochammina glabra*: percentages of living and dead tests in open sound and harbour samples. Samples are arranged from shallow (top) to deep (bottom) water. The 95% confidence intervals are indicated by the colours of the symbols: green is plus or minus less than 4%, blue is plus or minus between 4% and 8%, red is plus or minus greater than 8%, and a blank symbol indicates no data or the confidence interval is off the scale used (Van Der Plas and Tobi 1965, Table 1, and Galehouse 1971, Equation 95.4),


Open Water Samples
Harbour Samples
Water Depth in Metres
Percent
Percent
Legend
LIVE
DEAD
0
100
200
300
400
500
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700
800
900
0
10
20
30
40
50
OPEN6

Figure 25. *Portotrochammina antarctica*: percentages of living and dead tests in open sound and harbour samples. Samples are arranged from shallow (top) to deep (bottom) water. The 95% confidence intervals are indicated by the colours of the symbols: green is plus or minus less than 4%, blue is plus or minus between 4% and 8%, red is plus or minus greater than 8%, and a blank symbol indicates no data or the confidence interval is off the scale used (Van Der Plas and Tobi 1965, Table 1, and Galehouse 1971, Equation 95.4).

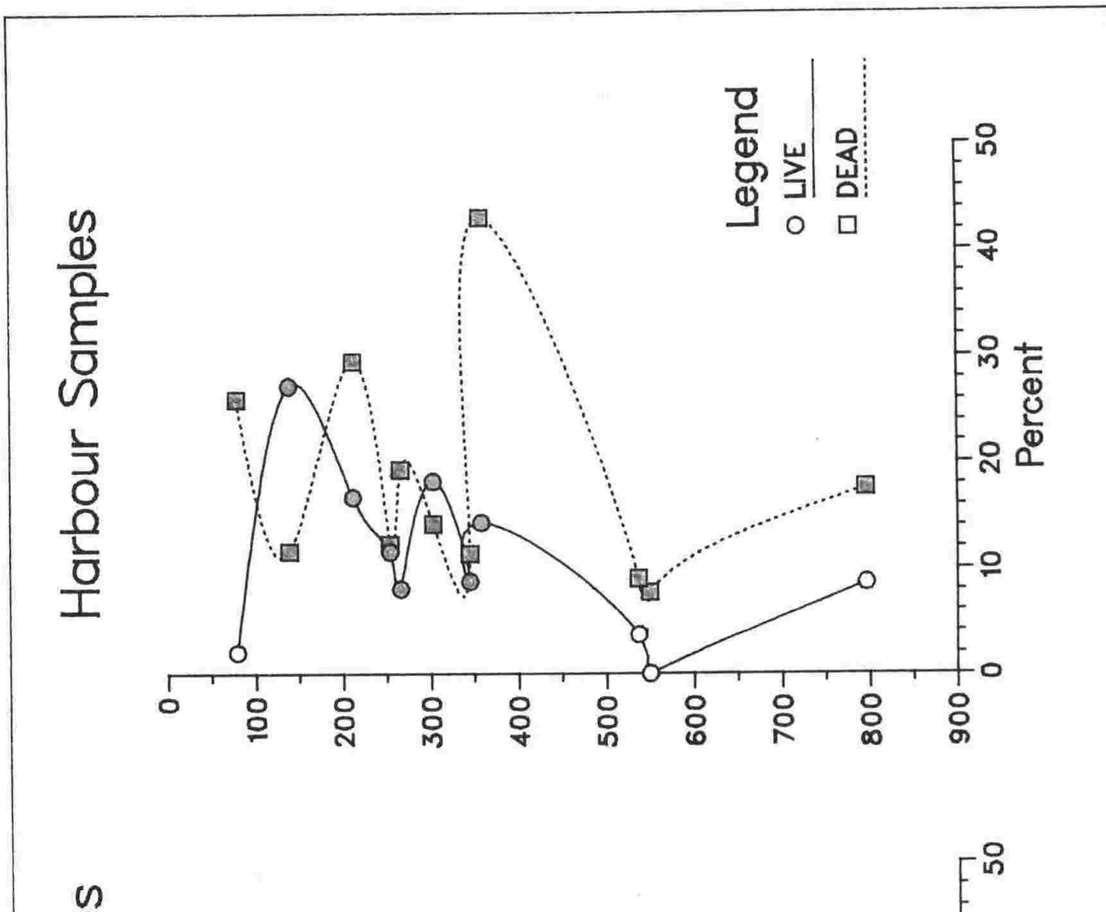
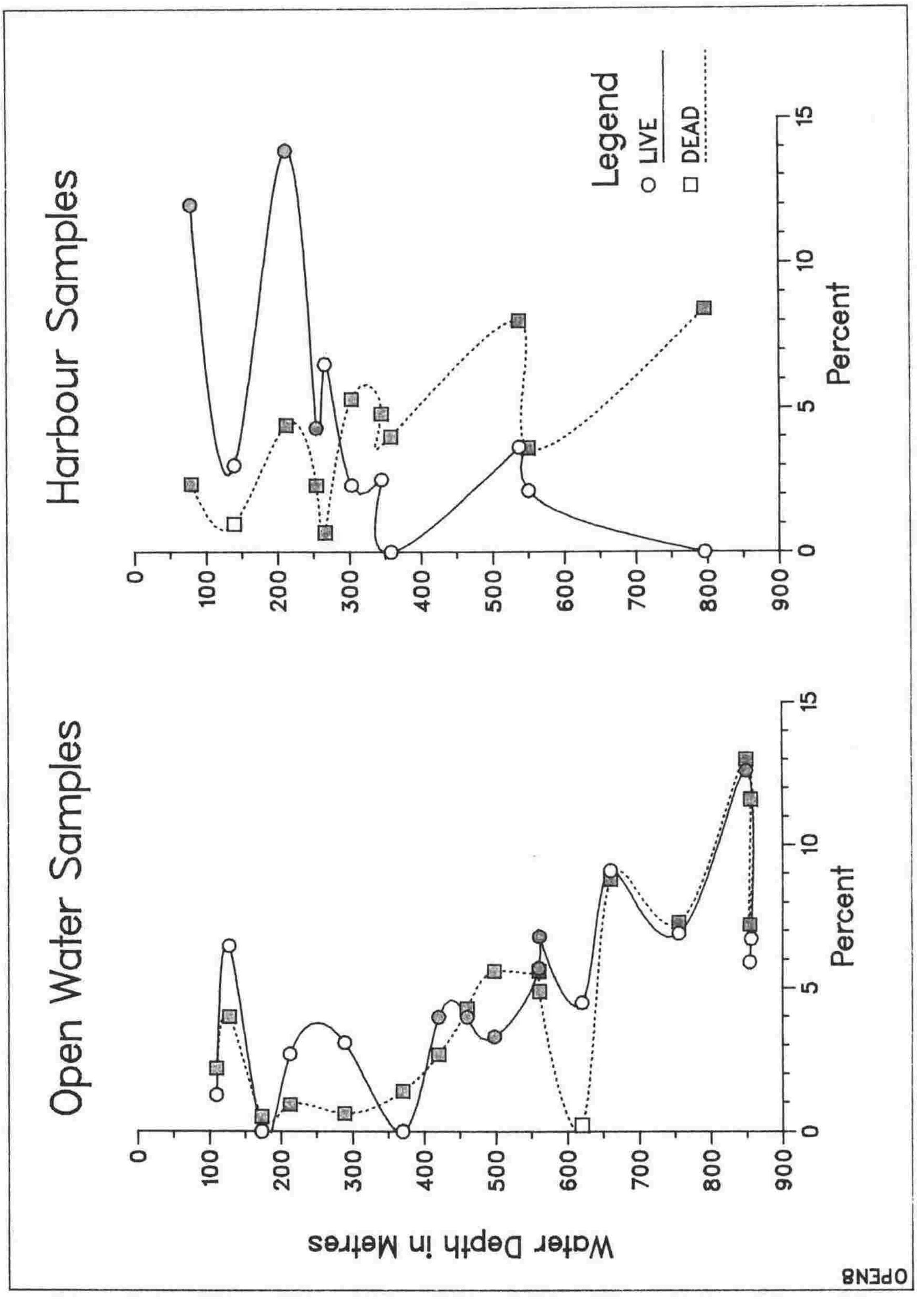

Open Water Samples
Harbour Samples
Legend
LIVE
DEAD
Percent
Percent
Water Depth in Metres
OPEN7

Figure 26. Portotrochammina eltaninae: percentages of living and dead tests in open sound and harbour samples. Samples are arranged from shallow (top) to deep (bottom) water. The 95% confidence intervals are indicated by the colours of the symbols: green is plus or minus less than 4%, blue is blus or minus between 4% and 8%, red is plus or minus greater than 8%, and a blank symbol indicates no data or the confidence interval is off the scal used (Van Der Plas and Tobi 1965, Table 1, and Galehouse 1971, Equation 95.4).


Open Water Samples
Harbour Samples
Legend
LIVE
DEAD
Water Depth in Metres
0
100
200
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400
500
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700
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900
Percent
0
5
10
15
OPEN8

Figure 27. *Trifarina earlandi*: percentages of living and dead tests in open sound and harbour samples. Samples are arranged from shallow (top) to deep (bottom) water. The 95% confidence intervals are indicated by the colours of the symbols: green is plus or minus less than 4%, blue is plus or minus between 4% and 8%, red is plus or minus greater than 8%, and a blank symbol indicates no data or the confidence interval is off the scale used (Van Der Plas and Tobi 1965, Table 1, and Galehouse 1971, Equation 95.4).

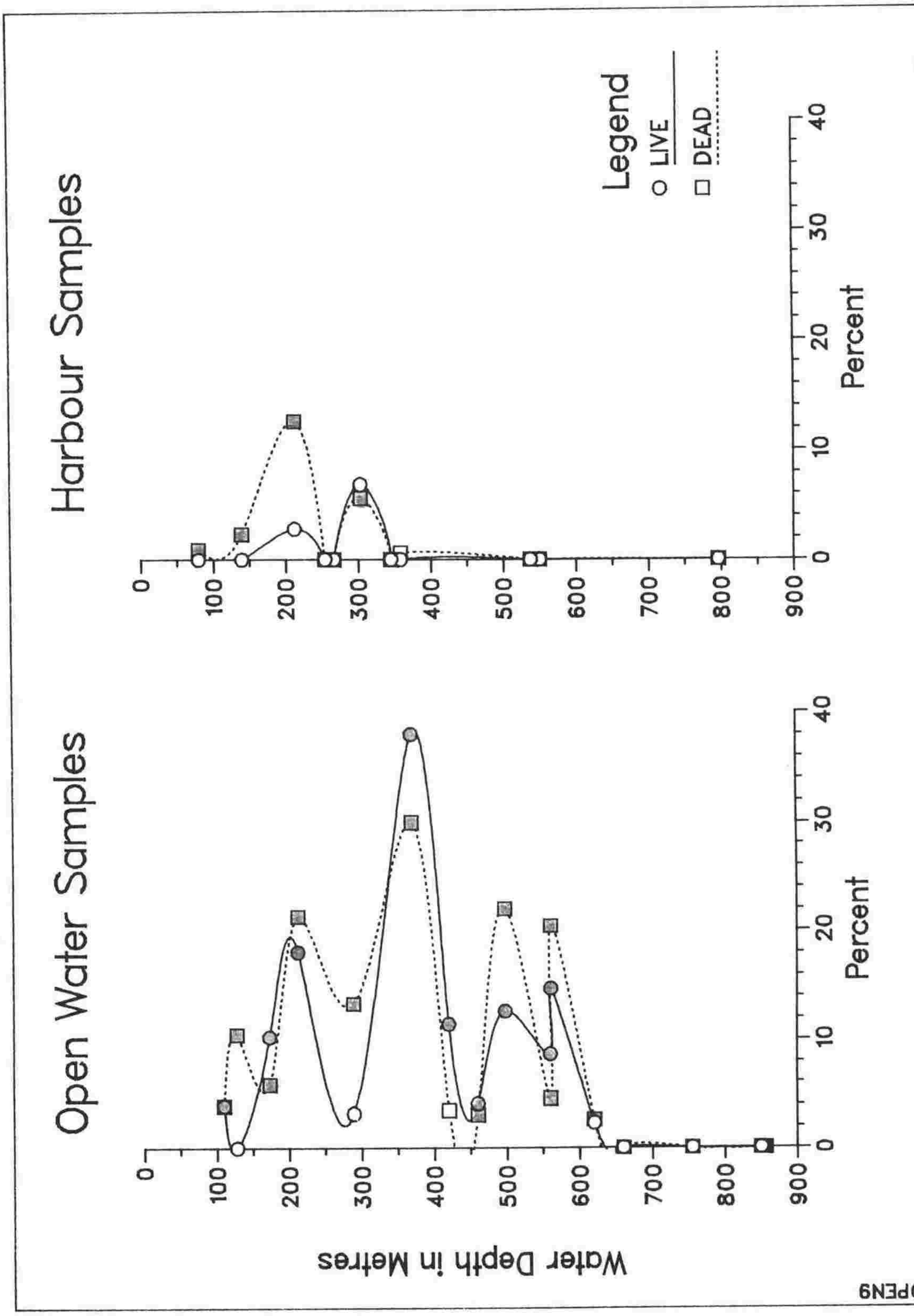

Open Water Samples
Harbour Samples
Water Depth in Metres
Percent
Legend
LIVE
DEAD
0
100
200
300
400
500
600
700
800
900
0
10
20
30
40
OPEN9

Figure 28. *Ehrenbergina glabra*: percentages of living and dead tests in open sound and harbour samples. Samples are arranged from shallow (top) to deep (bottom) water. The 95% confidence intervals are indicated by the colours of the symbols: green is plus or minus less than 4%, blue is plus or minus between 4% and 8%, red is plus or minus greater than 8%, and a blank symbol indicates no data or the confidence interval is off the scale used (Van Der Plas and Tobi 1965, Table 1, and Galehouse 1971, Equation 95.4).

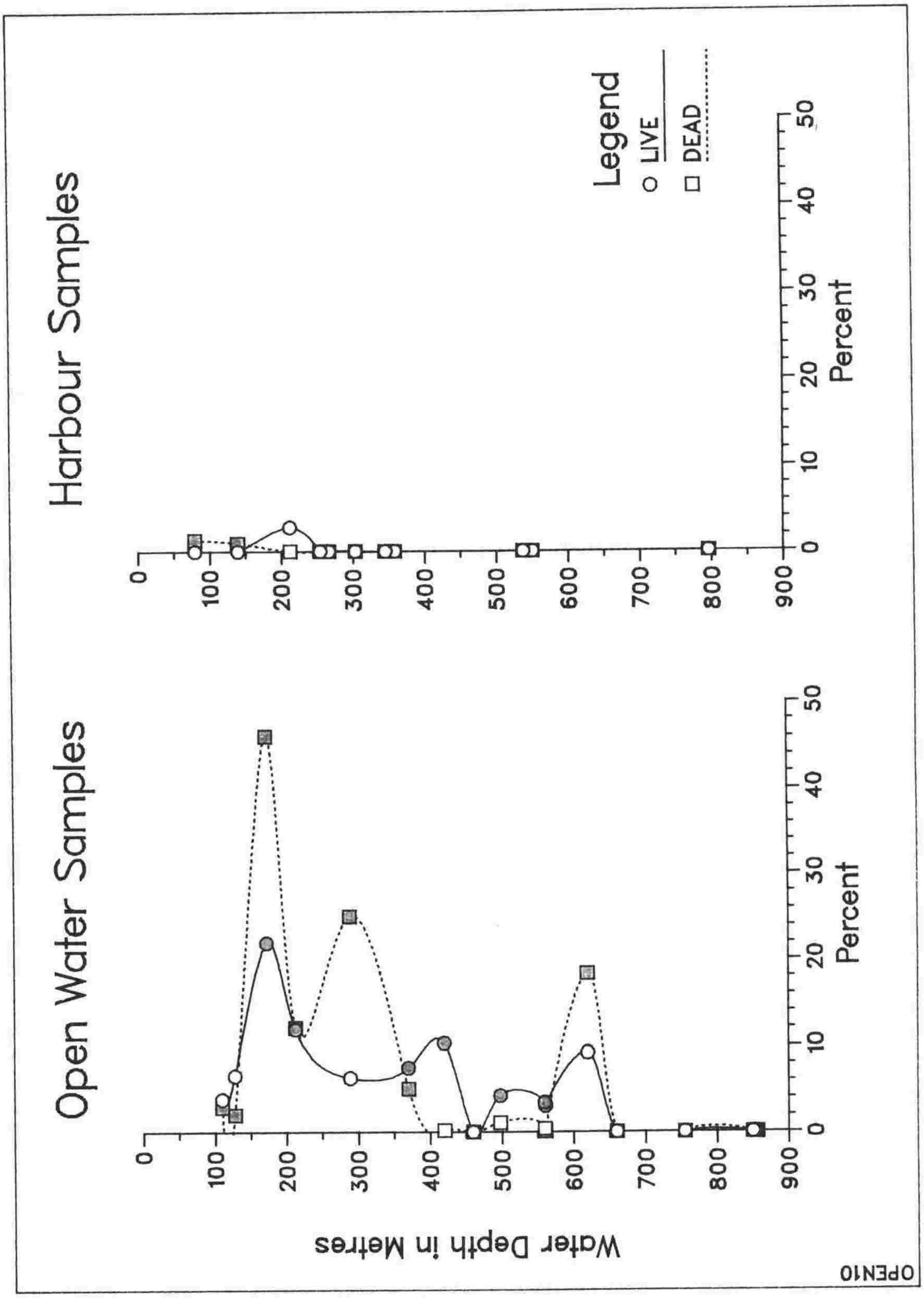

Open Water Samples
Harbour Samples
Legend
LIVE
DEAD
Water Depth in Metres
Percent
0
100
200
300
400
500
600
700
800
900
0
10
20
30
40
50
OPEN10

Figure 29. Globocassidulina crassa: percentages of living and dead tests in open sound and harbour samples. Samples are arranged from shallow (top) to deep (bottom) water. The 95% confidence intervals are indicated by the colours of the symbols: green is plus or minus less than 4%, blue is plus or minus between 4% and 8%, red is plus or minus greater than 8%, and a blank symbol indicates no data or the confidence interval is off the scale used (Van Der Plas and Tobi 1965, Table 1, and Galehouse 1971, Equation 95.4).

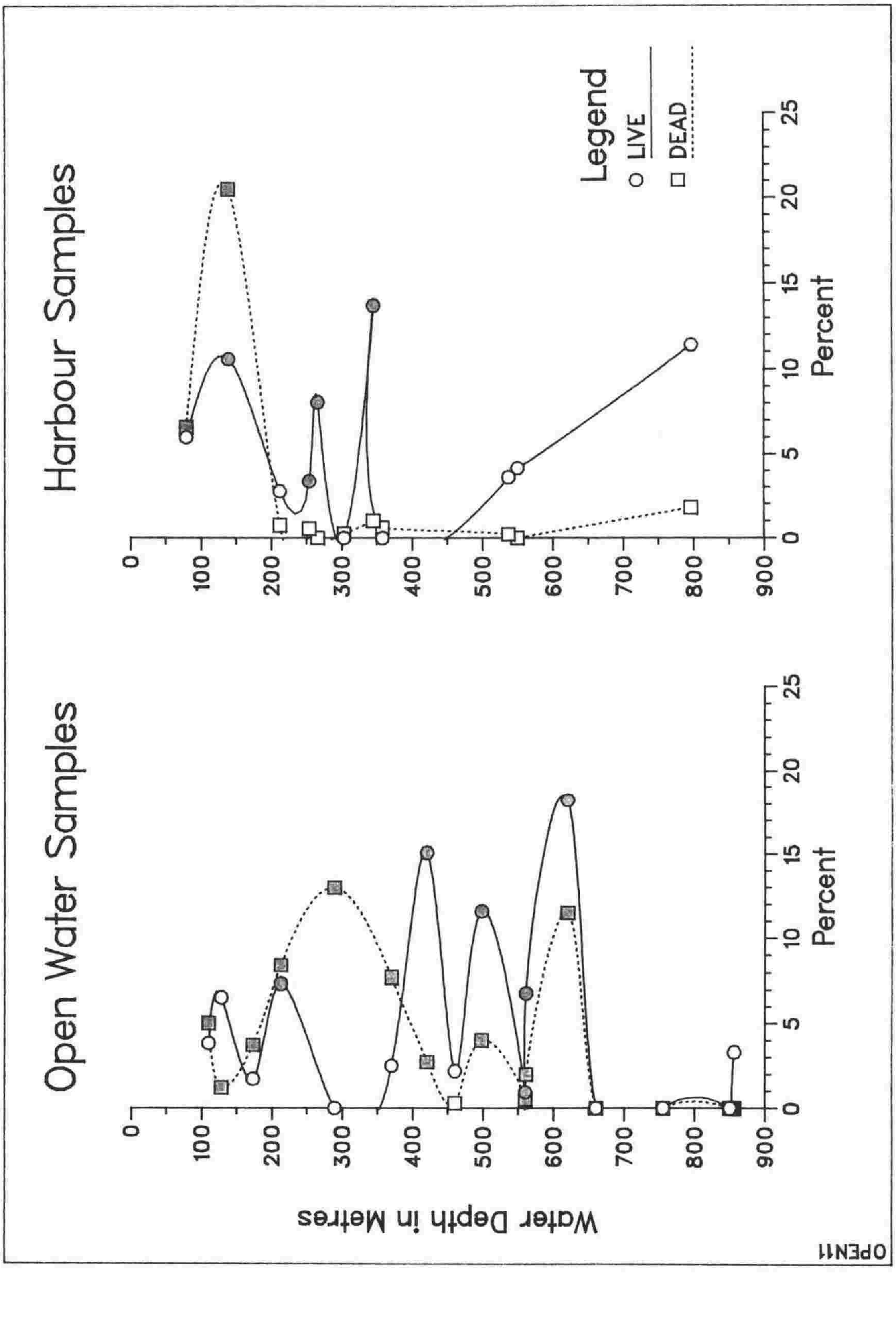
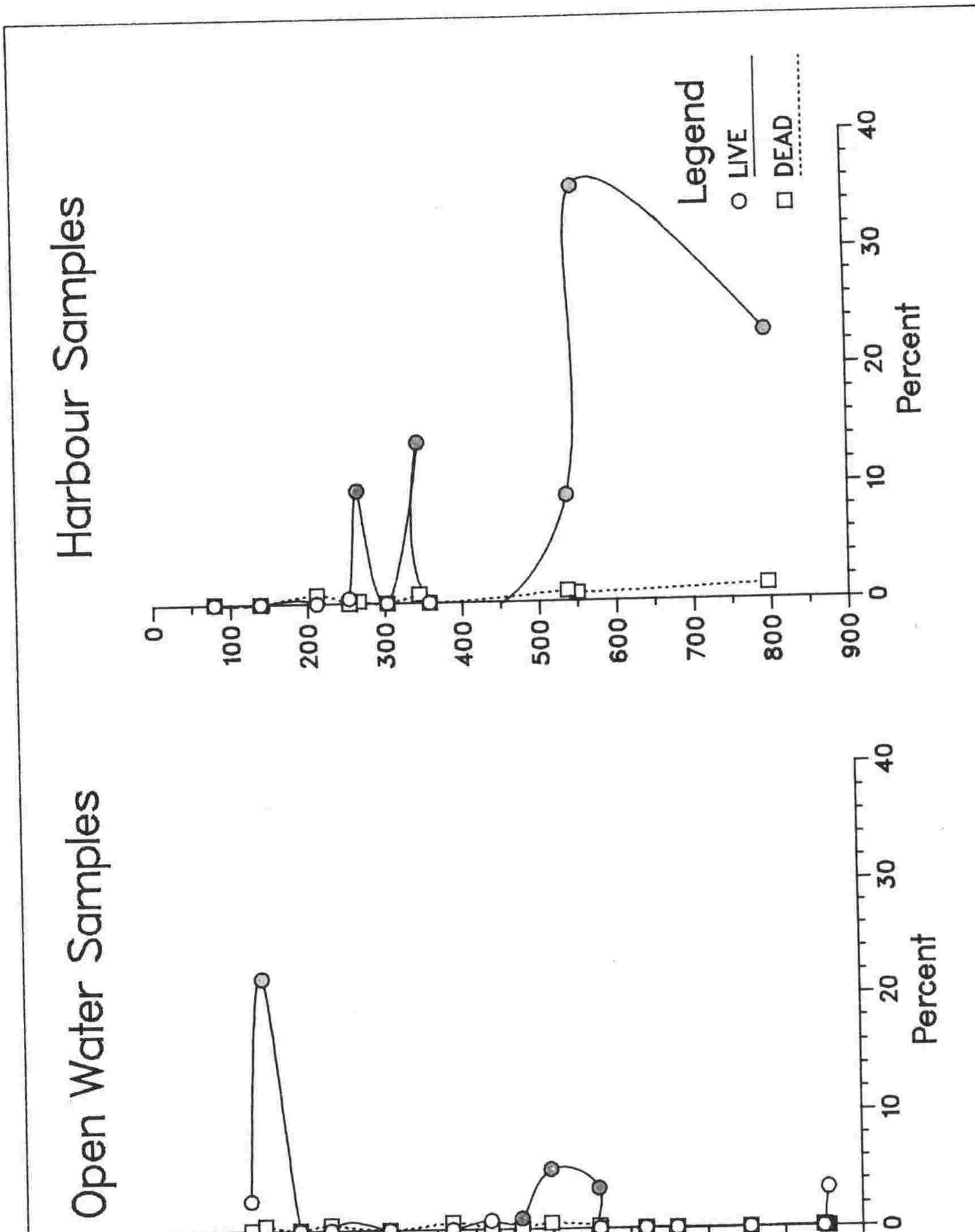

Open Water Samples
Harbour Samples
Legend
LIVE
DEAD
Percent
Water Depth in Metres
0 100 200 300 400 500 600 700 800 900
0 5 10 15 20 25
OPEN11

Figure 30. _Fursenkoina earlandi_: percentages of living and dead tests in open sound and harbour samples. Samples are arranged from shallow (top) to deep (bottom) water. The 95% confidence intervals are indicated by the colours of the symbols: green is plus or minus less than 4%, blue is plus or minus between 4% and 8%, red is plus or minus greater than 8%, and a blank symbol indicates no data or the confidence interval is off the scale used (Van Der Plas and Tobi 1965, Table 1, and Galehouse 1971, Equation 95.4).


Open Water Samples
Harbour Samples
Water Depth in Metres
0
100
200
300
400
500
600
700
800
900
Percent
0
10
20
30
40
Legend
○ LIVE
□ DEAD
OPEN12

are not from the shelly surface deposit but from sandy mud immediately under it. The proportions of calcareous and agglutinated species and of live and dead tests may therefore be anomalous (Figure 18).

Relation of Death Assemblages to Life Assemblages

Open Water Assemblages (DWA and SWA): Above the CCD the agglutinated component averages about 60% of the tests counted, while below it the agglutinated fraction averages 96%, occasionally reduced by a few percent by the occurrences of calcareous species, mainly *Fursenkoina earlandi* and *Globocassidulina crassa*.

The so-called Mixed Faunal Zone between 620m and 420m defined by Kennett (1968) is reflected by death assemblages but not by life assemblages. Life assemblages have a similar proportion of agglutinated tests between 620m and 420m as they do above 420m. In general death assemblages have higher proportions of agglutinated tests. Calcareous tests are eliminated from the death assemblages by dissolution.

The "Mixed Faunal Zone" is poorly named and should be replaced by "Relict Faunal Zone" or lysocline. It is a depth interval through which solution of calcareous tests is occurring, but at a rate less than the rate of production of the tests. The assemblage is not a mixture derived from two or more different environments.

Harbour Assemblage (HA): In New Harbour and Granite Harbour most death assemblages closely resemble their associated life assemblages down to a depth of about 300m, whereas at greater depths the life assemblages have progressively greater proportions of calcareous tests than the death assemblages (Figure 17). There is an extraordinarily shallow CCD clearly defined at about 230m (Figure 18). Above the CCD, calcareous tests can form about 50% of the life assemblage, though the death assemblage tends to contain less, suggesting that post-mortem solution of calcareous tests is occurring. The number of calcareous species is from two (Core 1981-15, 550m) to five (Core 1981-18, 254m and Core 1981-13, 537m).

Below the CCD the main calcareous species are Fursenkoina earlandi and Globocassidulina crassa, though there are very rarely other calcareous species, including: Lenticulina gibba, Cyclogyra involvens, Astrononion echolsi, Astrononion antarcticum, Fissurina spp (Cores 1981-14A and 1981-18), Pullenia subcarinata, Cassidulinoides porrectus, Epistominella vitrea, Rosalina globularis and Globocassidulina biora (Core 1981-17, basin off Cape Roberts, the only live G.biora reported to date from any locality, see Fillon 1974). Specimens of F.earlandi and G.crassa appear to increase relative to agglutinated species with depth, reaching a maximum of 35% +/-13% at 550m (Sample 1981-15) in Granite Harbour, but this conclusion needs to be treated with reservation because the live counts were small (see Appendix 2). Death assemblages contain very few calcareous specimens, presumably because of post-mortem dissolution.

Causes of differences between life assemblages and death assemblages in McMurdo Sound

There is abundant evidence for post-mortem dissolution of calcareous tests in McMurdo Sound. The life assemblage generally resembles the death assemblage in any one sample, except for depletion of calcareous tests. The wide range in test size and the preferential preservation of agglutinated tests, many of which are very fragile, suggests there has been little, if any, post-mortem transport, and it is concluded that all McMurdo Sound foraminiferal assemblages examined are not thanatocoenoses, but are biocoenoses more or less modified by *in situ* processes. Those processes could be:

1. The post-mortem solution of calcareous tests mentioned above.
2. Ingestion of live and dead tests by predaceous and deposit feeding animals.
3. Mechanical breaking caused by burrowing organisms.

The third is more likely to destroy fragile agglutinated tests than the relatively stronger calcareous tests, though some thin-shelled Lagenidae or Glandulinidae might be particularly susceptible as well. The evidence in McMurdo Sound does not support this because the trend is in the opposite direction, i.e. decreasing calcareous tests in the death assemblages. The second possible cause cannot be assessed. Only selective predators of particular foraminiferal species are likely to modify life assemblages, and might possibly be the reason for several instances where a species in the life assemblage is not represented in the death assemblage (e.g. in Core 18, 254m, *Hyperammina malovensis*). The dominant cause of the post-mortem changes clearly is the shallow CCD and consequent dissolution of calcareous tests.

Comparison of McMurdo Sound species and assemblages with those of other polar areas

The foraminiferal fauna of McMurdo Sound has many elements in common with microfaunas previously studied in the Weddell Sea and Antarctic

Peninsula, and even strong links with Arctic assemblages (Table 4A). The cold water temperature, salinity and constant physical conditions of the polar regions should induce similar faunal assemblages to occupy the two areas. In comparing the foraminiferal assemblages of the poles, the types of taxa present are very similar, particularly at the generic level. The percentages of species held in common with the present McMurdo Sound samples are given in Table 4A.

Table 4A: Comparison of species recognised in shallow-water studies of polar foraminifera with those of the present study.

AREA	DEPTH	SPECIES IN COMMON WITH MCMURDO		
ANTARCTICA		CALC	AGG	TOTAL
Scotia Sea area Echols 1971	201-993m	17	12	29(12%)
Drake Passage Herb 1971	42-878m	9	2	11(7%)
Weddell Sea Anderson 1975	320-1079m	7	5	12(8%)
ANTARCTIC AVERAGE				17(9%)
ARCTIC				
Point Barrow area Loeblich and Tappan 1953	3-724m & 1086-2869m	13	5	18(16%)
Bering Sea Anderson 1963	12-250m	7	-	7(10.4%)
Central Arctic Ocean Green 1960	433-899m	13	-	13(12%)
ARCTIC AVERAGE				12(13%)

The preceeding figures represent both agglutinated and calcareous taxa from the water depths shown. The investigations that included water chemistry studies, such as Green (1960) and Anderson (1975) showed that foraminiferal distribution is reliant on the CCD more than actual water depth. This is particularly exemplified in Anderson's (1975) work on the ecology and distribution of foraminifera of the Weddell Sea.

Anderson (1975) defined six foraminiferal assemblages or facies and correlated them with the associated over-lying water masses. Calcareous faunas were found in quite deep water (up to 3777m in the Deep-Water Calcareous-Arenaceous Facies) in the southwestern continental slope area, and only agglutinated species were found in shallow water (250m in Shallow Water Arenaceous Facies in the southeastern slope region, Table 4B). This is consistent with the present study, in which the CCD in the open sound is found to be 620m, and in the enclosed harbours is 230m. Comparing the assemblages with respect to their location either above or below the CCD (as opposed to water depth) with those assemblages defined from McMurdo Sound on the same basis, it is evident that an average of 42% of the species listed in Anderson's facies are held in common with the McMurdo Sound assemblages (Table 4B), though, as in the case of the Abyssal Facies and Harbour Assemblage, the shared species are not necessarily the dominant ones. As the various assemblages are not defined by the same dominant taxa, this could indicate that though CCD has a great influence on the distribution of agglutinated and calcareous taxa, microenvironments probably influence individual species within the greater ecological habitat.

Table 4B. Comparison of species from McMurdo Sound with those in assemblages defined by Anderson (1975) in the Weddell Sea.

ASSEMBLAGES IN WEDDELL SEA	ASSEMBLAGES IN MCMURDO SOUND	SPECIES IN COMMON CALC	AGG	TOTAL
Fresh Shelf Water* Facies (260-713m)	SWA*	7	1	8(53%)
Lysoclinal Facies* (235-659m)	SWA*	7	1	8(53%)
Euryhaline Facies (384-1079m)	DWA	-	6	6(43%)
Shallow Water Arenaceous Facies (490-934m)	DWA	-	4	4(33%)
Calcareous-Arenaceous* Facies (1445-3777m)	SWA*	5	1	6(46%)
Abyssal Facies (2487-4980m)	HA	-	2	2(25%)

Asterisked (*) assemblages are above the CCD; others are below.

Diversity Measurements

Method

Each method used for sampling the sea-floor sediments of McMurdo Sound imposed a certain sample size. The number of foraminifera per unit volume of sediment varied considerably between samples. Two measures have been used to estimate species diversity in foraminifera from McMurdo Sound: Fischer's alpha index (Murray 1973) and Sanders rarefaction index (Sanders 1968). Fischer's alpha index, a widely used method developed in 1943, is plotted for open water and harbour samples against water depth in Figure 31. The data show that in both situations the agglutinated foraminifera have a low alpha diversity index (4 to 6). The total assemblages have much higher diversities due to the presence of the calcareous fraction. Fischer's method is limited because sample size has a strong influence, and this is a major limitation here in view of the small numbers of live foraminifera that were recovered in some samples. Counts of less than 100 tests could not be included as they plotted off the edge of the alpha index diagram. Also, counts of 300 tests cannot be compared easily to counts of 5000 tests. Sanders' method allows for the comparison of samples with large differences in numbers of individuals, and provides the basis for the rest of the discussion on diversity. It is outlined below.

Sanders showed that the rarefacton method is independent of sample size, but that does not mean it can be used reliably with counts of small numbers of individuals. It means that a count of, say, 200 tests at one site can be compared with a count of 400 or 600 or 800 individuals at another site without the difference in the number of counted specimens affecting the estimated diversity.

Sanders commented that the many previously described methods measuring diversity are all logarithmic functions and divided them in two categories, those determining "dominance diversity" and tho determining "species diversity". He also showed (Sanders 1968, Figur 9,10, p.263-264) that species diversity is more directly related environmental parameters than is dominance diversity.

The rarefaction method is graphical. The diversity of a sample indicated by an exponential curve generated by estimating from the know assemblage what the number of species would be in a series of sampl sizes, i.e. samples of 10, 25, 50, 100, 200, 300, ... specimens. Th method applied to the dead and live specimens in McMurdo Sound Cor 1981-6 (Table 4) follows.

The total counted in 1981-6 included 376 dead and 229 live tests. T estimate the number of species represented in a sample of 25 tests Each specimen would represent 4%, therefore every species woul represent 4% or more. The species are ranked by their abundances. Thos that form 4% or more are counted. There are six of them, and they woul be expected to occur in any count of 25 tests. The cumulative percentag of the six species is 66.76%. 99.98% - 66.76% = 33.22%. Divide th unaccounted for 33.22% by the value of one specimen (4%); 33.22 divide by 4 = 8.3. Add the six dominant species to 8.3 = 14.3 species. Sample of 25 tests would have an average of 14.3 species.

For the number of species represented in a sample of 100 tests: Eac specimen would represent 1%, so each species would represent 1% or more

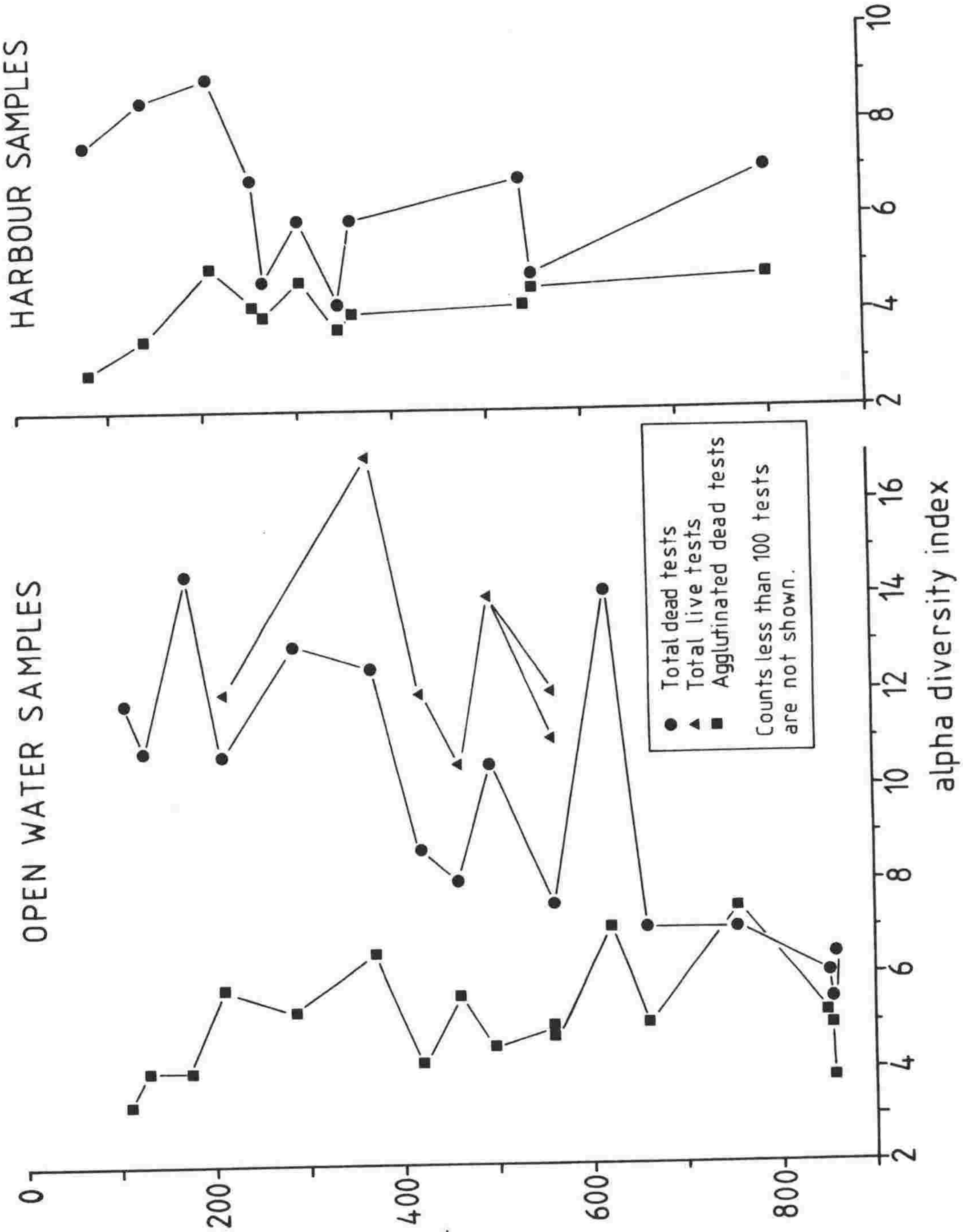


Figure 31. Fischer's alpha index (after Murray 1973) plotted versus water depth for total live, total dead and agglutinated dead foraminiferal counts from open water and harbour samples. Counts of less than 100 tests are not included as they plot off the edge of the alpha index diagram.

Table 4: Example of Sanders (1968) method for determining diversity of benthic foraminiferal life and death assemblages.

SAMPLE 81-6: TOTAL DEAD TESTS COUNTED

	Species	No.	%	Cumulative %
1	Port ant	96	25.53	25.53
2	Crib jef	48	12.77	38.3
3	Text ant	40	10.64	48.94
4	Reo pil	28	7.45	56.39
5	Troch glab	23	6.12	62.51
6	Port elt	16	4.24	66.76
7	Reo sub	14	3.72	70.48
8	Hyp cyl	14	3.72	74.20
9	Troch gabo	13	3.46	77.66
10	Mil aren	12	3.19	80.85
11	Trif ear	11	2.93	83.78
12	Thur alb	5	1.33	85.11
13	Glom gord	5	1.33	86.44
14	Troch A	5	1.33	87.77
15	Con bull	5	1.33	89.10
16	Cib lob	5	1.33	90.43
17	Hyp mal	4	1.06	91.49
18	Text ear	4	1.06	92.55
19	Vern min	4	1.06	93.61
20	Ast ech	4	1.06	94.67
21	Psam fus	3	0.79	95.46
22	Sac (juv)	3	0.79	96.25
23	Horm ovic	3	0.79	97.04
24	Cass por	3	0.79	97.83
25	Glob sub	2	0.53	98.36
26	Tur shon	1	0.27	98.63
27	Reo pse "A"	1	0.27	98.90
28	Crib sub	1	0.27	99.17
29	Cruc tri	1	0.27	99.44
30	Glob cras	1	0.27	99.71
31	Pull sub	1	0.27	99.98

TOTAL 376 TESTS

SAMPLE 81-6: TOTAL LIVE TESTS COUNTED

	Species	No.	%	Cumulative %
1	Reo subd	45	19.65	19.65
2	Reo pil	35	15.28	34.93
3	Port ant	18	7.86	42.79
4	Cass por	16	6.99	49.78
5	Horm ovic	16	6.99	56.77
6	Crib jeff	13	5.68	62.45
7	Ast echo	12	5.24	67.69
8	Spiro fil	10	4.37	72.06
9	Port elt	9	3.93	75.99
10	Trif ear	9	3.93	79.92
11	Glob cras	5	2.18	82.10
12	Mil aren	5	2.18	84.28
13	Troch glab	4	1.75	86.03
14	Glom gord	4	1.75	87.78
15	Pul sub	3	1.31	89.09
16	Cib lob	3	1.31	90.40
17	Con bull	3	1.31	91.71
18	Glob bio	2	0.87	92.58
19	Fur ear	2	0.87	93.45
20	Vern min	2	0.87	94.32
22	Hyp subn	2	0.87	95.19
23	Hyp mal	2	0.87	96.06
24	Cruc tri	1	0.44	96.50
25	Psam fus	1	0.44	96.94
26	Sac (juv)	1	0.44	97.38
27	Thur alb	1	0.44	97.82
28	Bol pse	1	0.44	98.26
29	Fis sp	1	0.44	98.70
30	Gland laev	1	0.44	99.14
31	Gland ant	1	0.44	99.58
32	Dent com	1	0.44	100.02

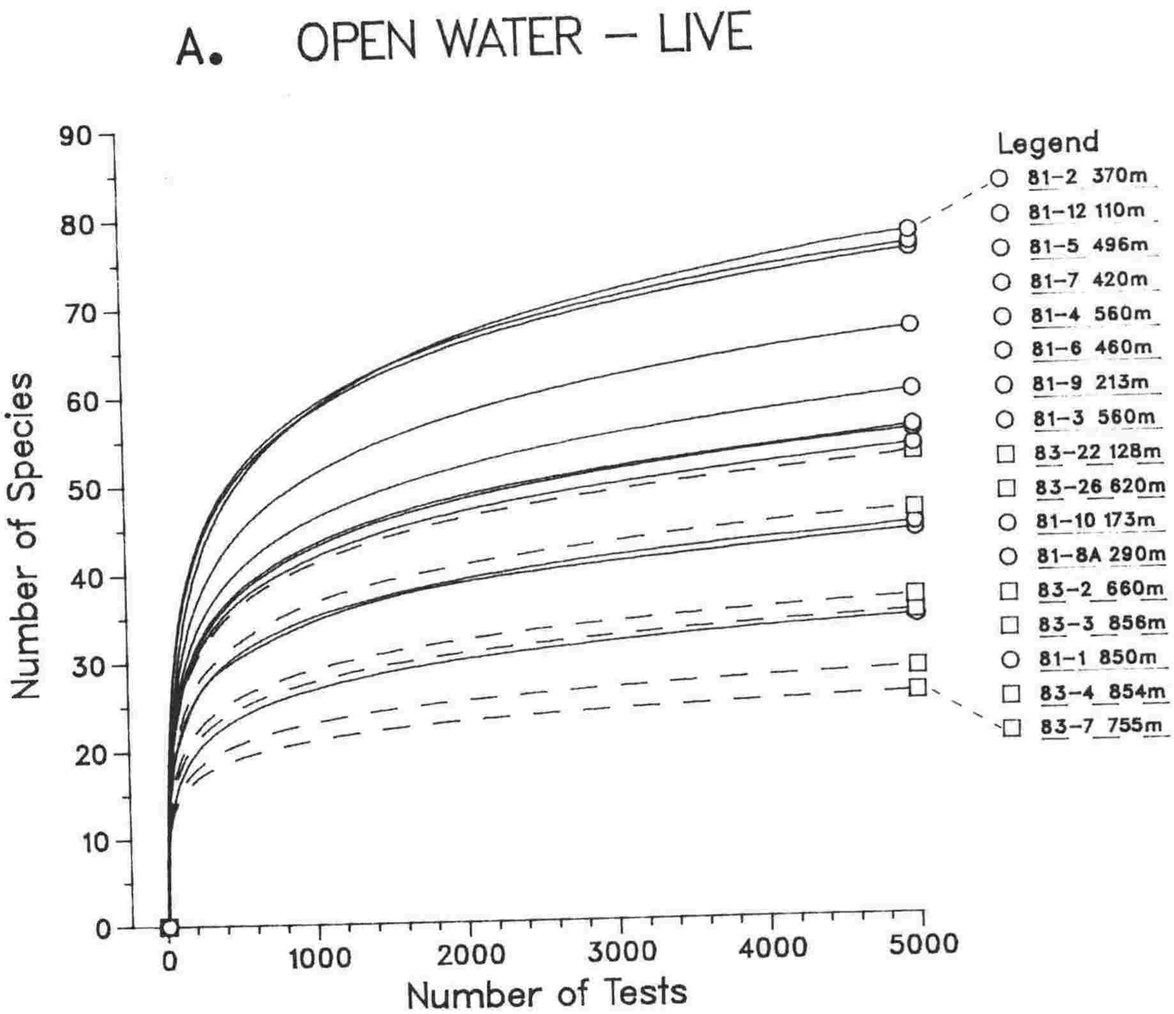
TOTAL 229 TESTS

There are 20 species that form 1% or more of the count, and their cumulative percentage is 94.67. 99.98% - 94.67% = 5.31%. The unaccounted for 5.31% is divided by 1% = 5.31. 20 species + 5.31 species = 25.31 species per 100 tests.

For the number of species represented in a sample of 200 tests: Each test would represent 0.5%, so each species would equal 0.5% or more of the count. There are 25 such species in this sample, and their cumulative percentage is 98.36. 99.98% - 98.36% = 1.62%. The unaccounted for 1.62% divided by 0.5% = 3.24 species + 25 species = 28.24 species per 200 tests counted.

Any number of values can be interpolated for sample sizes up to the actual number of specimens counted, thus describing the shape of the curve (Figure 32). The regression equation can then be calculated to extrapolate the curve to an infinitely large sample size. The curve should become flat at the sample size where the total number of species of the assemblage is represented. The reliability of the extrapolations depends on the number of specimens counted.

Diversities can be expressed numerically as the number of species per any number of specimens up to an infinite number. The estimated number of species in an infinite number of specimens at any one site is the best approximation of the total number of species in the assemblage. In practice, the diversity curves flatten markedly by about the 1000 tests sample size (Figure 32), indicating that nearly all species are represented, and in this thesis diversities are expressed as the number of species per 5000 specimens.



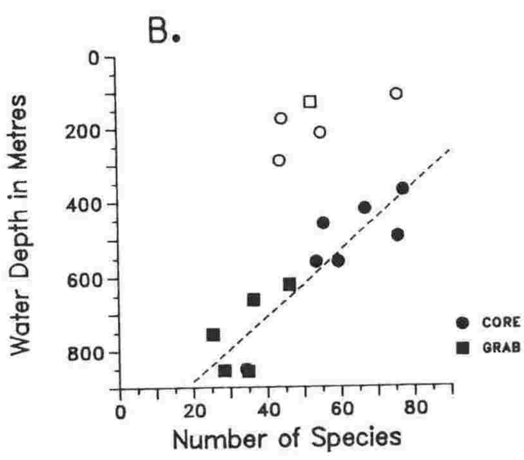


Figure 32 A. Species diversity curves for open water benthic foraminiferal life assemblages in McMurdo Sound. Following Sanders' (1968) rarefaction method, the number of species is estimated per number of tests counted for each sample, all extrapolated to 5000 tests. The legend is listed in the same order as the curves. Circles represent cores, squares represent grabs.

Figure 32 B. Species diversity values (from 5000 tests mark) are plotted versus water depth from which the samples were taken. Regression curve (dashed straight line) based on solid symbols only, blank symbols (above 250m) not incorporated. Correlation coefficient of line = 0.82.

Extrapolation of Diversity Curves

Following the rarefaction method outlined above, the equation of the curve for the sample with the greatest number of tests counted (1981-7) was calculated. The resultant curve is exponential, with a correlation coefficient of 0.999. It was therefore assumed that exponential curves would be the best fit for all other samples. The correlation coefficients of the other samples were >0.955. From the calculated equations for each sample, the curves were extrapolated to 5000 tests. This is not considered to be undue extrapolation as the curves do not cross and are basically parallel after 2000 tests, so the relative positions of the endpoints of the curves do not change.

Results and Discussion

Diversity curves for life assemblages of the open water samples are shown in Figure 32A. Some have been extrapolated from counts of fewer than 50 tests, so tend to be less reliable than those for corresponding death assemblages that follow (see below). A plot of species number versus depth, taken at the 5000 tests mark (Figure 32B), shows that for samples above 350m diversities cluster between 44 to 76 and have no correlation with depth. However, samples below 350m have diversities ranging from 20 to 80, and show a good correlation of decreasing diversity with depth.

The diversity curves in Figure 33A represent death assemblages from the same samples as those shown in Figure 32A. In the open water death assemblages, there is a strong correlation of lower diversity with increasing depth. The estimated diversities range from 24 to 80 (Figure

(Figure 33A). Shallow-water samples from the open sound (SWA) generally have diversities greater than 60. Deep water (DWA, below the CCD) samples have diversities less than 40, and are clearly differentiated from the shallow-water open sound assemblages. The group with intermediate diversity values (41-59) is classed with the shallow water samples (SWA). Figure 33B shows also the correlation of decreasing species diversity with greater water depth for these death assemblages.

Deep water and shallow-water diversities are less well differentiated in the 1983 grab samples, taken from the USCGC Glacier. Grab 1983-26, from the unusually calcareous site off Cape Armitage, plots particularly high and is considered anomalous.

The diversity range for harbour life assemblages clusters below 45, and is therefore similar to the deep water open sound life assemblages (Figure 34A). There is no correlation with depth in the harbour assemblages (Figure 34B).

The harbour death assemblages show very little difference from the corresponding life assemblage diversities (Figure 35A). They cluster below 45, except for sample 1982-3, and again show no depth correlation (Figure 35B). The diversities of open sound deep water assemblages and harbour assemblages are not significantly different.

Post-mortem changes of calcareous assemblages have already been established, and shown to be related to the CCD. Therefore we can assume that there is minimal post-mortem change of agglutinated species with non-calcareous cement, so agglutinated death assemblages are equivalent to agglutinated life assemblages.

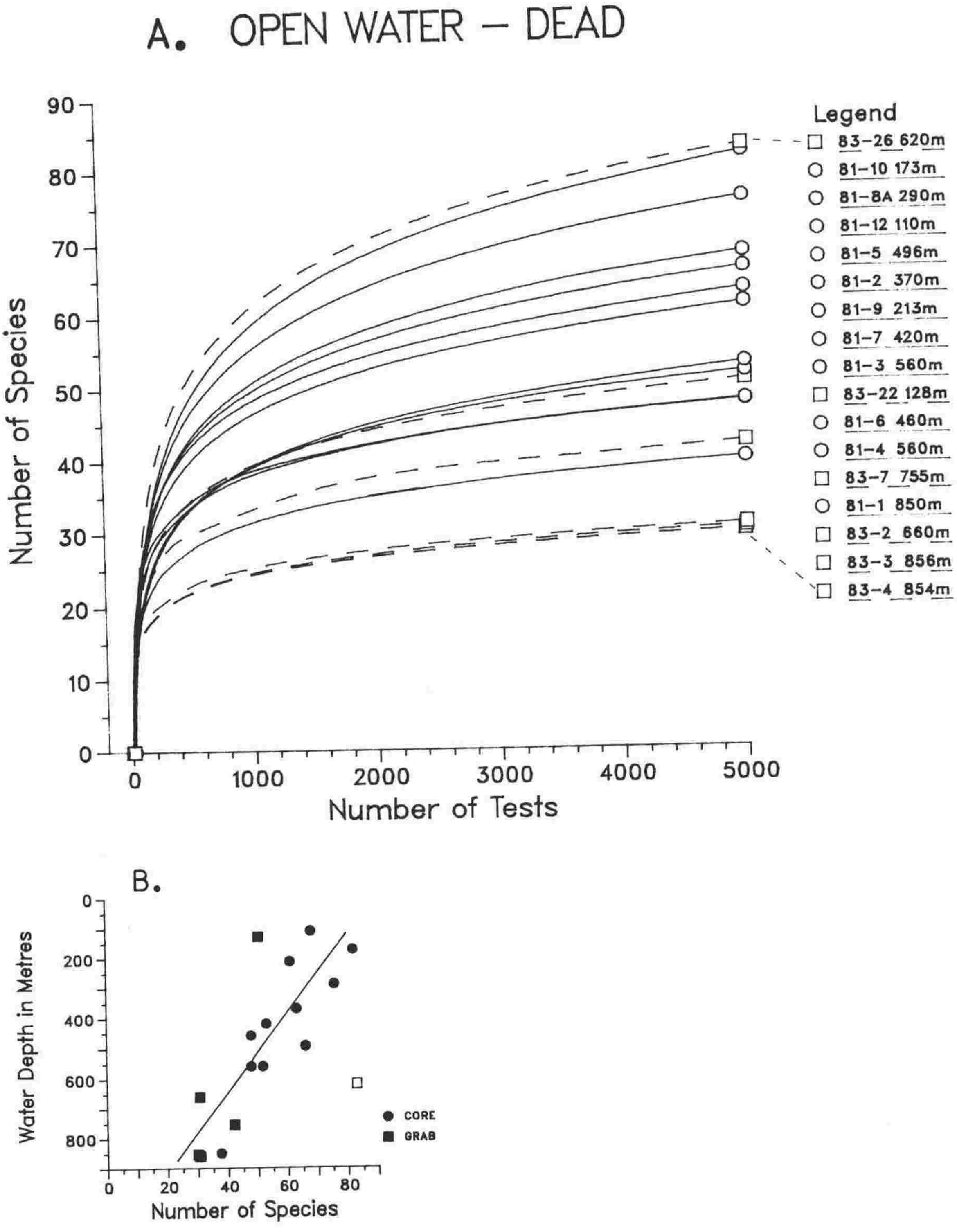


Figure 33 A. Species diversity curves for open water benthic foraminiferal death assemblages in McMurdo Sound. Following Sanders' (1968) rarefaction method, the number of species is estimated per number of tests counts for each sample, all extrapolated to 5000 tests mark. The legend is listed in the same order as the curves. Circles represent cores, squares represent grabs.

Figure 33 B. Species diversity values (from 5000 tests mark) are plotted versus water depth from which the samples were taken. Regression curve (solid straight line) based on solid symbols only, blank symbol (at 620m) was not incorporated. Correlation coefficient of regression line = 0.67.

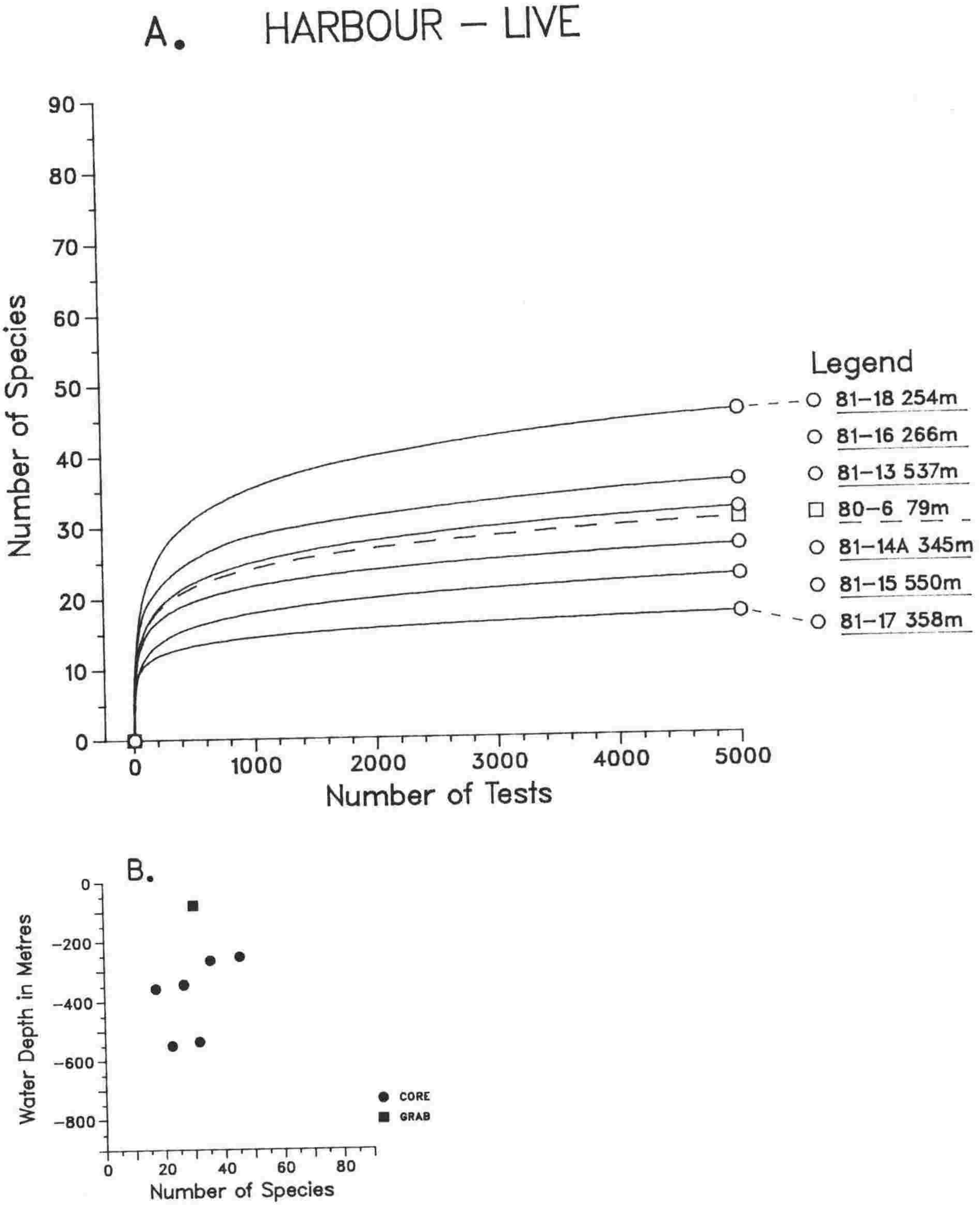


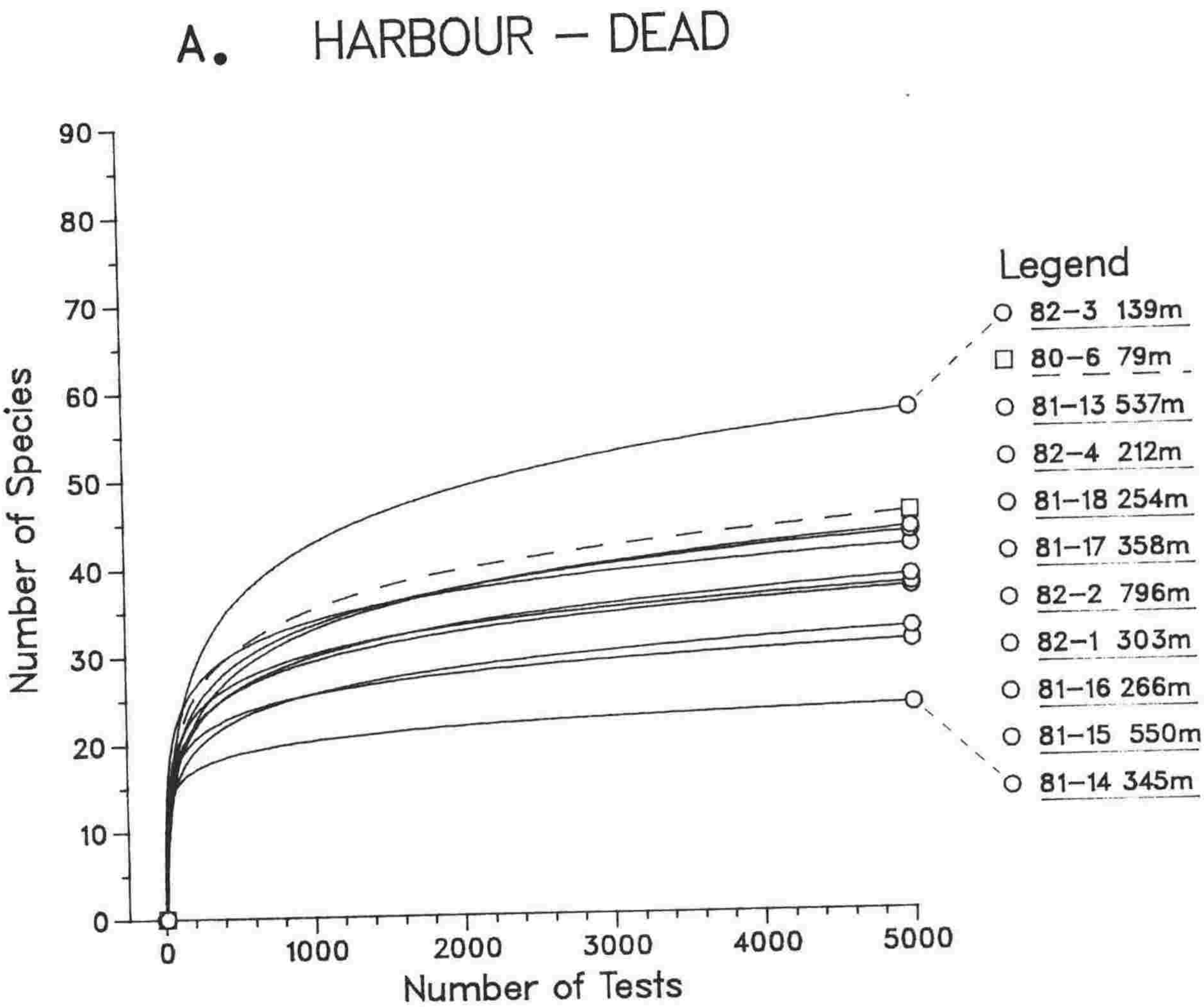
Figure 34 A. Species diversity curves for harbour benthic foraminiferal life assemblages. Following Sanders' (1968) rarefaction method, the number of species is estimated per number of tests counted for each sample, all extrapolated to 5000 tests. The legend is listed in the same order as the curves. Circles represent cores, squares represent grabs. Some samples are not used due to low numbers in life counts.

Figure 34 B. Species diversity values (from 5000 tests mark) are plotted versus water depth from which each sample was taken. No correlation of diversity with water depth shown.

When the open water agglutinated assemblages are plotted using Sanders' (1968) rarefaction method, the diversity values (at 5000 tests level) show little variation and no correlation with depth (Figure 36). All curves plot below 40, similar to those for deep open water and harbour assemblages. Therefore the correlation of higher diversities with shallow water seen in the open sound death assemblages is a result of the increasing number of calcareous species present in shallow water. This is believed to hold true also for the life assemblages, but cannot be tested because insufficient sample size would result if life assemblages were split into calcareous and agglutinated components.

Sanders (1968) considered that high diversities are characteristic of stable environments and attributed low diversities to high stress caused by either physical or biotic factors. Sanders showed that the deep-water bivalve and polychaete assemblage that he analysed has high diversity and attributed that to the very stable physical conditions of deep water.

It would seem to be contradictory to suggest that low diversity foraminiferal assemblages are caused by high stress in the Antarctic marine environment, which is known to be very stable. A point made by Sanders was that diversity differences between various habitats must be assessed using the same group of organisms. It may seem not unreasonable to treat calcareous and agglutinated benthic foraminifera as the same kinds of organisms and to treat them as a single group for ecological study. However, different tolerances to calcium carbonate concentrations are quite different ecological adaptations. The agglutinated foraminifera are much more ancient than the calcareous



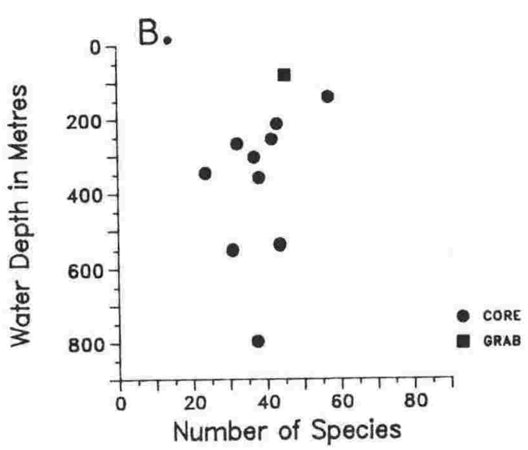


Figure 35 A. Species diversity curves for harbour benthic foraminiferal death assemblages. Following Sanders' (1968) rarefaction method, the number of species is estimated per number of tests counted for each sample, all extrapolated to 5000 tests. The legend is listed in the same order as the curves. Circles represent cores, squares represent grabs.

Figure 35 B. Species diversity values (from 5000 tests mark) are plotted versus water depth from which each sample was taken. No correlation of diversity with water depth shown.

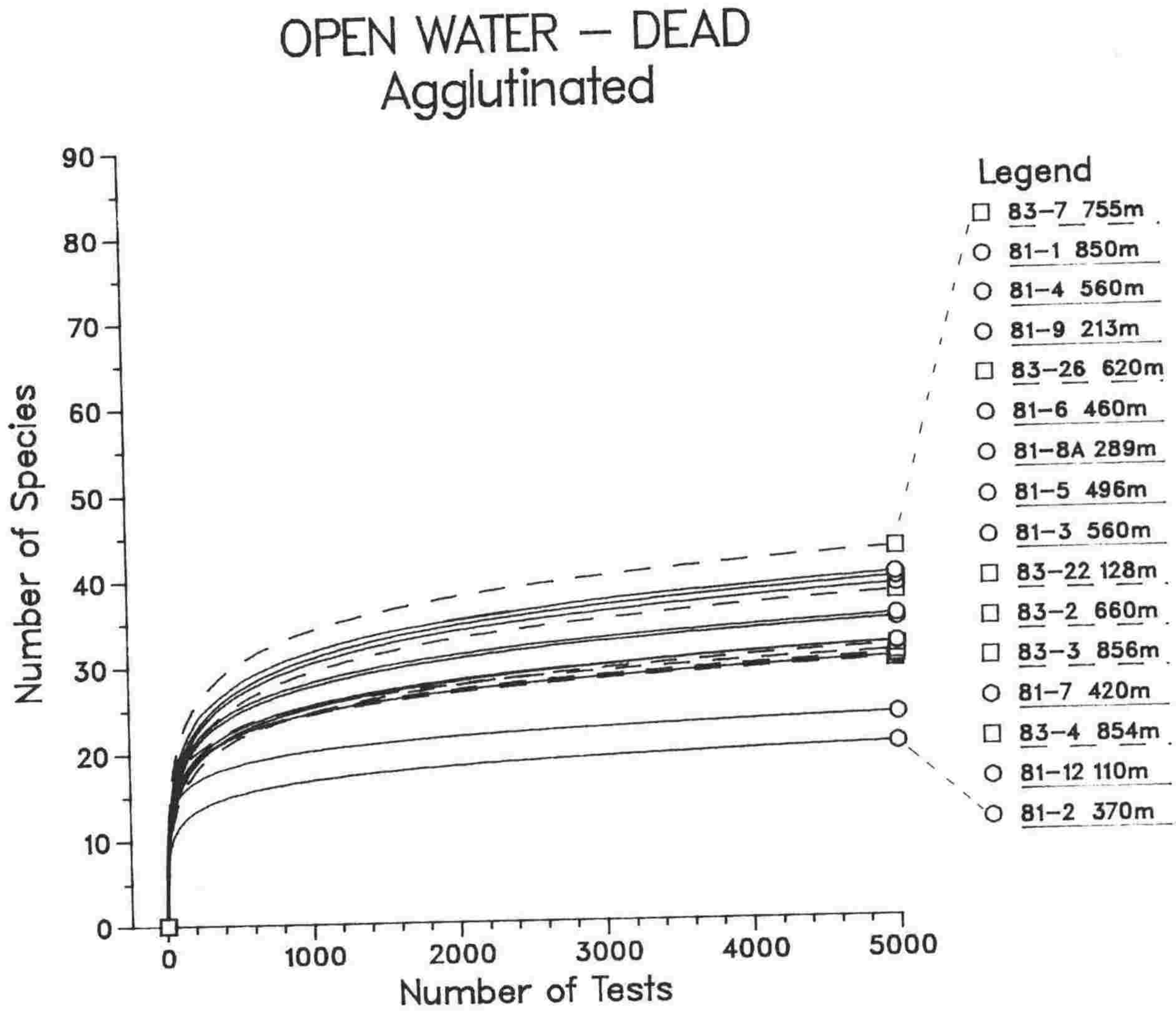


Figure 36. Species diversity curves for open water agglutinated death assemblages. The low diversity values (below 40 at 5000 tests mark) and small spread indicate no variation of diversity with water depth. The legend is listed in the same order as the curves. Circles represent cores, squares represent grabs.

species. Some have calcareous cement and are restricted in the same way as the calcareous species. Those in McMurdo Sound do not have calcareous cement, but have organic or ferruginous cements. Such species have lived in deep ocean water under-saturated in calcium carbonate since at least the Cretaceous, and very likely for the whole of the Phanerozoic. In such a stable environment they have had ample time to evolve a high diversity assemblage. The fact that they have not done so implies lack of evolutionary capacity and not any stress factor in the deep ocean environment. Consequently, it can be concluded that though it is not the best practice to combine agglutinated and calcareous foraminifera to determine diversity patterns of various assemblages, the fact that the agglutinated species have fairly consistent diversity values at different water depths allows the calcareous species to influence the diversity to a greater extent.

The agglutinated assemblages show no significant differences whether from open water or harbour sites. Therefore, these assemblages are interpreted as being stable at all water depths, which indicates that diversity is not affected by habitat (though some species, e.g. Cribrostomoides jeffreysii, may be influenced by grain size). Calcareous assemblages have higher diversities in shallow water samples, but agglutinated ones are consistent and remain the same as in deep water samples. It would appear from this that competition from calcareous species is not a stress factor for agglutinated species in the same habitat. It is concluded that the agglutinated foraminifera in this setting are close to the evolutionary limit of their diversity.

Non-polar deep sea comparisons

Comparison of the McMurdo Sound assemblages to those of deep-sea areas is relevant due to the similarities between the physical and chemical characteristics of the two environments, as well as their constancy. This similarity has been recognised by Dayton and Oliver (1977), who noted the following shared characteristics between the two environments:

1. cold temperature
2. constant physical environment
3. low terrestrial sedimentation

The greatest dissimilarity between relatively shallow McMurdo Sound waters and deep-sea waters is the seasonal productivity associated with the changes in light availability in the Antarctic.

Deep-sea samples (2500-4600m) of the southeast Indian Ocean collected by Corliss (1979) yielded 33 foraminifera taxa, only three of which are agglutinated. The presence of calcareous forms to these depths indicates that the CCD is below 4600m in this area. Comparing this collection to the shallow water assemblage from McMurdo Sound, six (18%) of the species listed by Corliss are also found in McMurdo Sound, not including *Lagena* spp, *Oolina* spp, *Fissurina* spp and *Parafissurina* spp which Corliss did not differentiate.

Benthic foraminifers from the deep water of the Gulf of Mexico were studied by Pflum and Frerichs (1976) to develop a more precise bathymetric zonation. They found some indication that depth limitations of some species could be related to hydrostatic pressure. Of the 328 species found in the deep-water ecologial study, 18(5.5%) are also found in the present McMurdo Sound samples, but 29(9%) genera are held in common. Calcareous genera found at 600-6500 ft (182-1981m) include Bolivina, Bulimina, Uvigerina, Cibicides, Eponides, Oridorsalis, Anomalina and Melonis. Three of these, Bolivina, Bulimina and Cibicides occur in the present McMurdo Sound samples.

The comparisons above show some similarity in faunal composition between McMurdo Sound samples and in the deep-sea collections, but there is an even greater similarity in TYPE of taxa, i.e., on the generic and familial level, found in the two environments. This is exemplified by the Harbour Assemblage defined here and the Abyssal Facies defined by Anderson (1975). The Harbour Assemblage comprises hormosinids, trochamminids and textularids. The Abyssal Facies comprises trochamminids, textularids and lituolids. Chances are comparison of actual tests would reveal more similarity than indicated by a faunal list, considering the variation possible within foraminiferal species and within taxonomists' interpretation of species.

Sequences of Assemblages in Cores 1981-15 and 1981-18

A test of the applicability of Sanders (1968) rarefaction method to fossil foraminiferal assemblages can be accomplished by using subsamples down sediment cores, and comparing the diversities of death assemblages or thanatocoenoses from the various levels in the cores.

Core 81-15, from 550m near the snout of the MacKay Glacier in Granite Harbour, is 56cm long, consists of fine sandy mud at the top, with a gradual increase in sand down the length of the core.

Core 81-18, from 254m near the snout of the Ferrar Glacier in New Harbour, is 41cm long and also fine sandy mud. These two sediment cores were sampled at selected 2cm intervals down their lengths. The subsamples were preserved and examined for foraminifera at Victoria University. The species and numbers of tests extracted, live and dead are listed in Appendix 2, page 184.

Below the top two centimeters, Core 1981-15 has only two dead calcareous species: Fursenkoina earlandi and Trifarina earlandi. Dead agglutinated species which are persistant to the bottom of the core include Miliammina arenacea, M.lata, Cribrostomoides jeffreysii, Trochammina glabra, T. gaboensis, Portotrochammina antarctica, P. eltaninae and Conotrochammina bullata. Trochammina glabra is the most abundant species at the 56cm level in the core (Figure 37).

Below the top two centimeters, Core 1981-18 has two dead calcareous species: Fursenkoina earlandi and Astrononion echolsi. Their tests disappear rapidly down core to the 30cm level, where there is a bright-orange, crumbly sediment layer, about 1.5 to 2cm thick. Beneath this layer, to the bottom of the core, the number of calcareous dead tests increases dramatically. The species content is similar to that found elsewhere in the shallower open parts of the sound, and includes the calcareous species: Trifarina earlandi, Epistominella vitrea, Fursenkoina earlandi, Globocassidulina crassa, Astrononion antarcticum and Astrononion echolsi. This indicates a deeper CCD or lower sea level in New Harbour at that time, possibly a local effect due to glacial activity (Figures 37, 39).

The diversity calculations for Cores 1981-15 and 1981-18 do not show any significant change in numbers of species down core (Figures 38, 39) though the bottom of Core 1981-18 (38-41cm) does have the highest diversity for the core (see below). Above the 30-32cm level, dissolution of calcareous species would not change the diversity to any great extent because of the low numbers of these tests present. The species content varies slightly, but insufficiently to provide evidence of environmental changes throughout the length of the core. The exception to this is the bottom 11cm of Core 1981-18. The calcareous assemblage increases gradually in this region of the core, to 60% of the total assemblage at the 38-41cm level.

Gardner et al. (1982) described a similar oxidized layer in cores from the Bering Sea. Their explanation is that during transition to global interglacial conditions, freezing during the winter seasons formed dense, oxygen-rich waters that sank to recharge oxygen and nutrient depleted bottom waters, which, combined with low organic productivity, allowed oxidized sediment to accumulate. When the interglacial episode was well established, there was insufficient sea ice to affect productivity or dissolved oxygen content of the water, so sea-bottom conditions reverted to reducing again. Barrett et al. (in prep.) conclude from geochemical evidence that the Bering Sea and New Harbour oxidized layers are not similar.

The effect of changes in local ice could account for this oxidized layer and preservation of calcareous foraminifera in New Harbour. These changes may have caused a lower sedimentation rate than elsewhere in the sound. No similar layer was detected in Granite Harbour, probably because the sedimentation rate there is much higher than in New Harbour, and Core 1981-15 would consist of much younger sediments (A.Pyne, pers.comm. 1983).

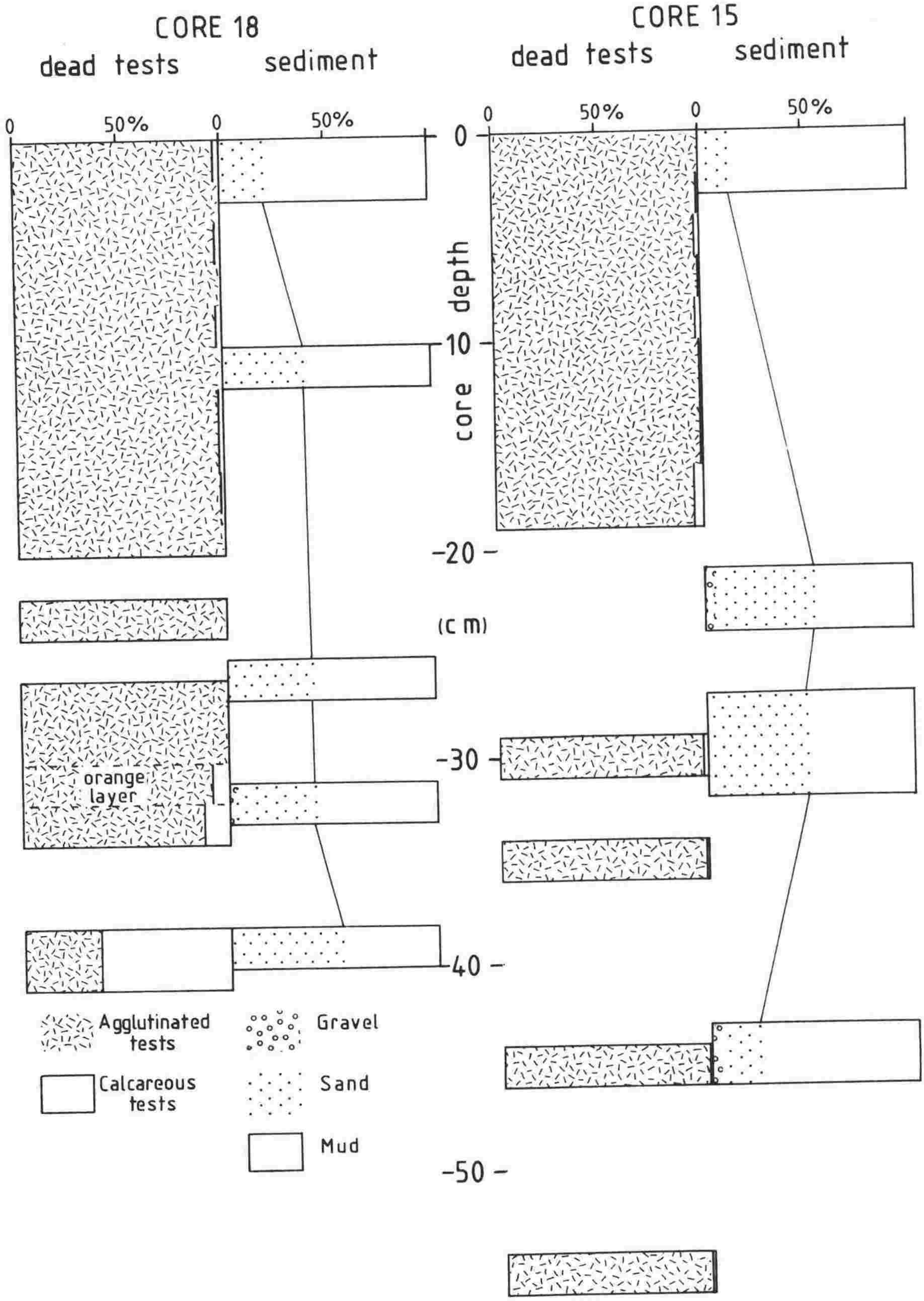


Figure 37. Percentages of agglutinated and calcareous tests in the death assemblages from subsamples down Core 1981-18 (New Harbour, from 254m) and Core 1981-15 (Granite Harbour, from 550m) shown with grain size data. The foraminiferal assemblages are mostly agglutinated, with the exception of the bottom 11cm of Core 18, which has an increasing number of calcareous tests.

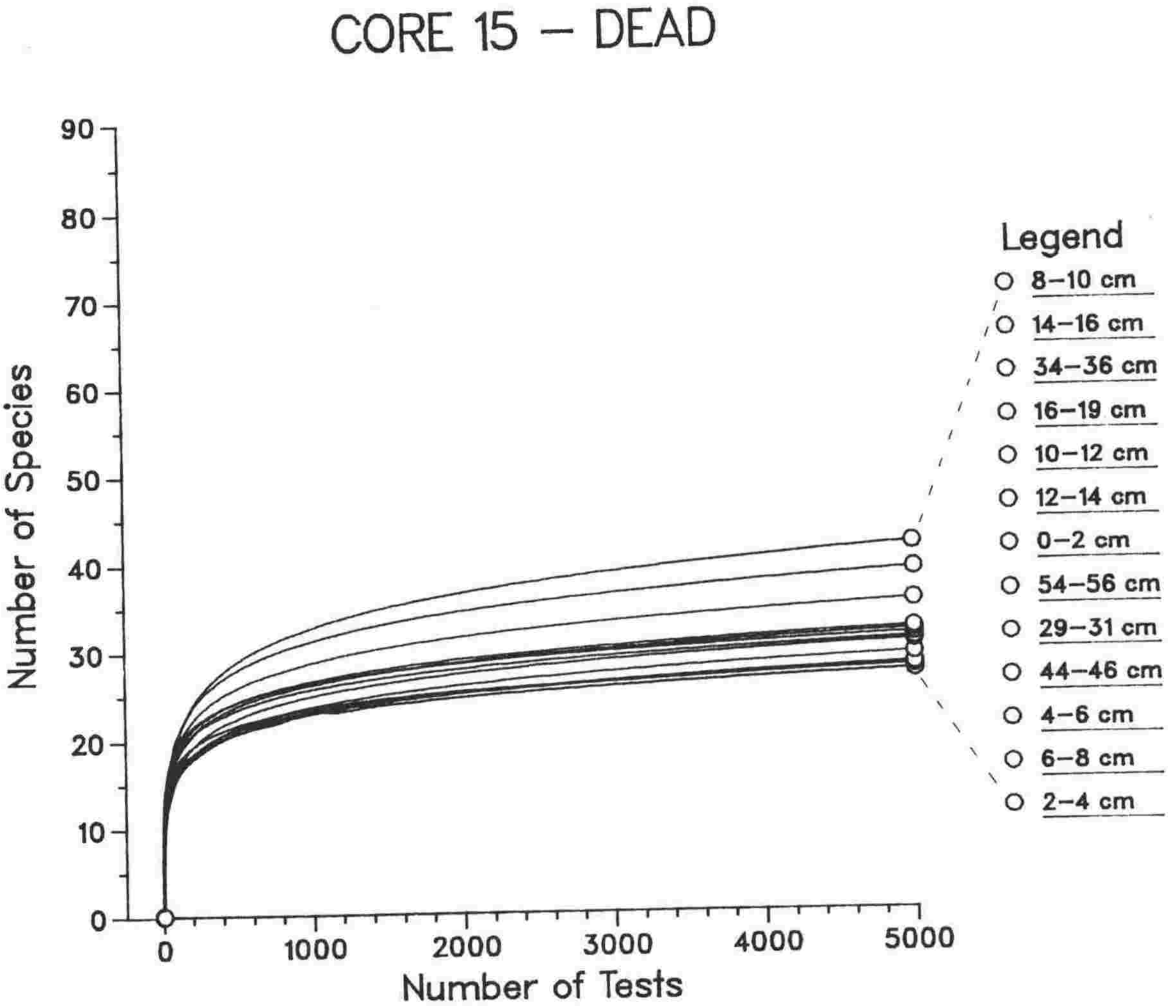


Figure 38. Species diversity curves for benthic foraminiferal death assemblages down Core 1981-15 (Granite Harbour, 550m). The low diversity values (below 40 at 5000 tests mark) and small spread indicate little change in species abundance, which implies similar environment throughout the length of the core. The legend is listed in the same order as the curves.

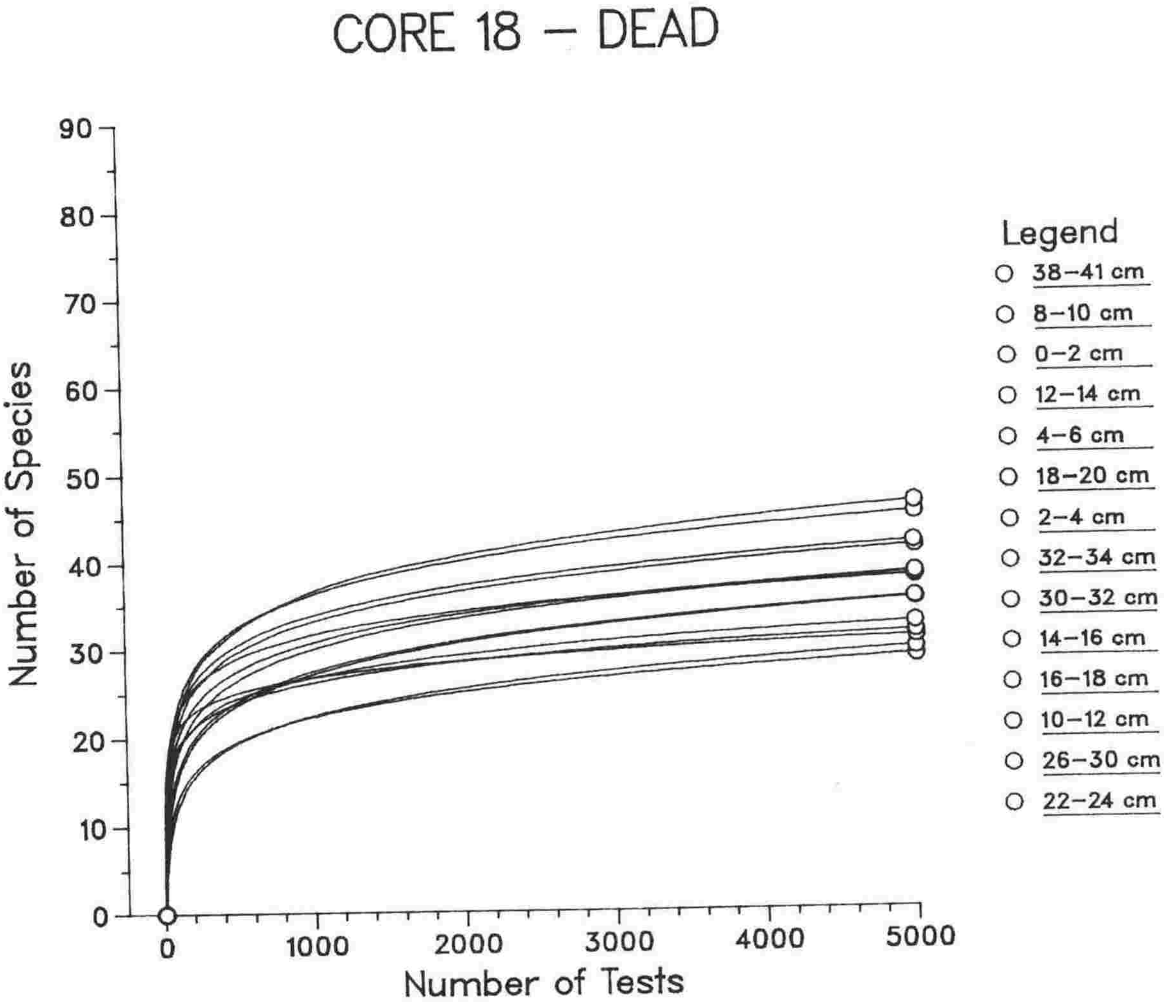


Figure 39. Species diversity curves for benthic foraminiferal death assemblages down Core 1981-18 (New Harbour, 254m). The low diversity values (below 45 at 5000 tests mark) and small spread indicate little change in relative species abundance down the length of the core. The change in species content (to 60% calcareous tests at bottom of core) indicates a change in water chemistry at some time in the past.

Chapter 5: CONCLUSIONS

The distribution of living foraminifera in McMurdo Sound has been shown to depend largely on the CCD, which defines the lower limit of a relatively shallow water high diversity assemblage (SWA) rich in calcareous species at 620m in the open waters of McMurdo Sound. Beneath this exists a deeper water low diversity assemblage (DWA), made up almost entirely of agglutinated species, though one or two calcareous species are occasionally found.

Physiography also effects the distribution of foraminifera, for a low diversity harbour assemblage (HA) can be recognised in New Harbour and Granite Harbour and a shallow basin east of Cape Roberts. This assemblage is mainly agglutinated but includes a few calcareous species, indicating a much shallower CCD in this restricted setting.

Assemblages of dead foraminiferal tests are very similar to life assemblages of the same samples. However, the death assemblage between 420m and 620m contains a greater proportion of agglutinated tests because of post-mortem dissolution of calcareous tests, and is a relict assemblage modified *in situ*, not a mixed faunal assemblage as previously suggested by Kennett (1968) and Fillon (1974).

Species diversity in McMurdo Sound is directly related to the number of calcareous species present in the assemblages, but the diversity of the agglutinated component remains about the same at all depths in the sound. It is concluded from this that the agglutinated foraminifera here are close to the limit of their evolutionary potential.

Although this study shows that death assemblages are reasonably representative of life assemblages in McMurdo Sound (apart from those deposited in the lysocline), it is also clear that fossil assemblages have only limited paleoecological value. They can really only be used to indicate whether strata were deposited above or below the CCD, and whether in open or closed basins. However, this conclusion is partly a consequence of the limited oceanographic data currently available. More information on current patterns, nutrient levels, and the dynamics of sea floor biological foraminiferal assemblages, may well lead to more specific paleoecological inferences.

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APPENDIX 1

Sample Log and Descriptions

Most of these samples were collected with a gravity sphincter corer, using the annual sea ice as an operating platform. Samples from other sources are noted and acknowledged. Photos and sketches of cores and samples are included where available (for 1981 cores only).

<u>Key to sample log lay-out</u>

Sample number	latitude	depth	date	Collected by:
Sample type	longitude			B=Barrett W=Ward
				A=Alloway P=Pyne
				C=Cattley Mc=McLeod
Sph core= sphincter core				P=Paintin F=Fitzgerald
O-p grab= orange-peel grab				Mac=Macpherson

81-1(BLW) $77^{o}32.5'$ 850m 7 Nov.1981 W,P,C.
Sph.core $165^{o}4.5'$
Location: 10km north west of Cape Royds in a line towards King Pin.

Corer scraped top 0-3cm of sea-floor surface; silty mud, green-grey colour, soft. Collected from between lead weights lowered for depth sounding, and small abmount of sediment on closed sphincter sleeve. No sponge mat. Core barrel bowed, metre block seized up, lost three lead weights. Winch under strain with extra weight of wire added for this depth. No photograph.

81-2(BLW) $77^{o}43.1'$ 268m 11 Nov.1981 W,P,C.
Sph. core $165^{o}14.3'$
Location: Along a line across McMurdo Sound from Cape Evans toward Strand Moraines, 28km from Cape Evans.

Retrieved 154mm core that slumped badly when placed in splitting Drawn as seen ofter slump. 0-5cm (top) soft, soupy muddy sand with sponge mat; colour 10Y-3/2. Bryozoans, worm tubes, soft sponges horn coral horn coral and four small brittle star fish on top. Siliceous sponge spicules present 3-4cm long. Small foraminifera seen throughout sediment. From 5- cm: irregualr gradual colour change to 7.5Y-4/3. Bottom 6-7cm: volcanic sand and mud colour N-2/0 (Plate A1-1).

81-3(BLW) $77^{o}42.1'$ 560m 13 Nov.1981 W,P,C,A.
Sph.core $165^{o}32.0'$
Location: Cape Evans-Strand Moraines line, 21km west of Cape Evans.

Pebbly, muddy sand on closed sphincter sleeve (0.25-0.75kg). Dark grey-green colour.No photograph.

81-4(BLW) $77^{o}42.1'$ 560m 13 Nov.1981 W,P,C,A.
Sph.core $165^{o}32.0'$
Location: Cape Evans-Strand Moraines line, 20m north of 81-3.

6cm long pebbly,sandy core. Dark volcanics abundant throughout. Water drained through incompletely closed sphincter sleeve during retrieval. Core frozen in core head over-night prior to photographing and sampling (Plate A1-2).

81-5(BLW) $77^{o}42.4'$ 496m 14 Nov.1981 W,P,C,A.
Sph.core $165^{o}28.0'$
Location: Cape Evans-Strand Moraines line, 23km west of Cape Evans.

0-10cm core.Bryozoans, starfish, worm tubes and sea spider on top surface. Clasts to 1cm in length. Invertebrates saved to check for attached foraminifera (Plate A1-3).

81-5A(BLW) $77^{o}42.4'$ 496m 14 Nov.1981 W,P,C,A.
Sph.core $165^{o}28.0'$
Location: Same as 81-5, second core down same hole.

Retrieved small amount of sediment on sphincter sleeve. Several pebbles up to 3cm longest dimension.Surface invertebrates saved included worms, sea snail, encrusting and ramose bryozoans. Two pottles saved in alcohol (Plate A1-3).

81-6(BLW) 77°42.67 460m 15 Nov.1981 W,P,C,A,B.
Sph core 165°23.4'
Location: Cape Evans-Strand Moraines line,25km west of Cape Evans.

Retrieved small amount coarse pebbly sediment with 1-2cm clasts, fine sand and mud.Corer barrel bent, plastic liner split, lost 2 lead weights. (Plate A1-2).

81-7(BLW) 77°42.7' 420m 15 Nov.1981 W,P,C,A,B.
Sph core 165°19.2'
Location: Cape Evans-Strand Moraines line, 27km west of Cape Evans.

Retrieved small amount coarse sediment on sphincter sleeve. Cobble caught in centre of sleeve, allowing water to drain out during retrieval.Split into one foraminiferal sample, one sediment sample. No photograph.

81-8 77°43 19' 289m 16 Nov.1981 W,P,C,B,A.
Sph core 165°4.8'
Location: Cape Evans-Strand Moraines line, 13km east of Strand Moraines.

Retrieved 8cm core.Heavy sponge mat with abundant invertebrates on top surface,including sea spider, amphipod, foraminifera, worm tubes,bryozoans, and stalked filter feeders. Frozen in its entirety and returned to Scott Base. Small amount taken from base of core and preserved in ethanol (Plate A1-4).

81-8A 77°43.19'81 289m 16 Nov.1981 W,P,C,B,A.
Sph core 165°4.8'
Location: 6.5m west of 81-8.

Top 0-2cm:soft sandy core with heavy sponge mat. Sea centipede, bryozoans present, with shelly material. Foraminiferal samples taken from top 0-4cm and bottom 2cm, preserved in ethanol. Colour 2.5Y-3/3. Archive split consists of 0.25 of core from rim of corer head (Plate A1-4).

81-9 77°44.0' 213m 17 Nov.1981 W,C,B.
Sph core 164°50.5'
Location: Cape Evans-Strand Moraines line, 7.7km east of Strand Moraines.

Small amount of coarse sediment on closed sphincter sleeve,divided into two samples, one each for sedimentary analysis and foraminiferal analysis. No photograph.

81-10(BLW) 77°44.75' 173m 17 Nov.1981 W,C,B.
Sph core 164°36.7'
Location: 2.5km off Strand Moraines.

Retrieved 6-8cm core.Top a hummock of heavy sponge mat. Frozen in toto for transport to Scott Base. There is was thawed, the hummock removed for archive, remainder split and sampled as usual. (Plate A1-5).

81-11 77°44.43' 465m 20 Nov.1981 B,A.
O-p grab 164°32.1'
Location: Directly in front of Strand Moraines.

Preserved top sea-pens in alcohol, one sample for sediment analysis. No photograph.

81-12(BLW) 76°59.6' 110m 26 Nov.,1981 W,P,C.
Sph core 163° 9.4'
Location: 5km north of Cape Roberts,in Granite Harbour.

Short (10cm) core on sphincter sleeve. Heavy sponge mat on top with worm tubes, foraminifera and echinoid spines. Colour at top 7.5Y-4/3 to 7.75cm. Bottom 2.25cm colour is 7.5Y/5/2. This section sandier with angular pebble (2cm) of pink granite. Samples taken of the top 5cm, middle 3cm and bottom 2cm. No photograph.

81-13(BLW) 76°59.4' 537m 27 Nov.,1981 W,P,C,B,A,
Sph core 163° 2.0'
Location: 10km north of Cape Roberts in line to Cape Archer, Granite Harbour.

Short (3-6cm) uneven core of soft sediment on sphincter sleeve. Corer apparently fell on side on sea floor. Top 2mm a green (7.5Y-4/3) diatomaceous ooze. Several clasts present, 3cm longest dimension. Below this core sandier with worm tubes. Colour below 5.5cm to bottom 10Y-3/2(olive-black). Samples taken of top 2mm, entire core, and entire sample minus top 2mm (Plate A1-5).

81-14A 76°52.8' 346m 2 Dec.,1981 W,P,C,B,A.
Sph core 162°55'
Location: 3km south of Cape Archer, Granite Harbour.

Corer retrieved with sediment about half way up inside of barrel. Corer left intact,strapped upright in wannigan and traveled to next sample site (core not frozen). Frozen at camp site, and split 3 Dec.

Archive split 355mm long. Large black area 7-14 cm from top of split (345mm long after splitting- compression from inserting steel blade). Core green mud at top,sandier and greying towards bottom. A few scattered pebbles from 24cm to bottom. Scattered sponge spicules throughout. Colour at top 7.5Y-4/2, from 10 to 12cm, 7.5Y-2/2 (layer 0.5-3cm thick across core), at bottom (34cm) 7.5Y-3/2. Samples taken of top 2cm, 2-4cm, 8-10cm, 10-12cm, 14-16cm, 16-18cm, 27-29cm, and 33-35cm (bottom trimmed in case of contamination (Plate A1-6).

81-15 $76^{o}59.1'$ 550.5m 29 Nov.,1981 W,P,C,B,A.
Sph core $162^{o}30.0'$
Location: Just south of Mackay Glacier Snout, Granite Harbour.

Barrel penetrated to bottom of large weights. Saved mud from outside core barrel.Muddy water drained from bottom of corer through partially-open sphincter. Barrel one-half full of sediment, no water on top. Water apparently drained down one side of core. Worm tubes on top. Colour recored ofter 15 minutes in air. Core then frozen overnight. Core 560mm long after extrusion from barrel. The surface in contact with polythene liner contains small bivalves, (8mm), sponge spicules, angular mud clasts (5mm), mottling (colour 7.5Y-5/1), rock fragments to 7mm, one small laminated medium-sand lens (32-39mm). Below 370mm, number of angular granules (1-10mm) increases. Boundary diffuse but distinct. Archive half similar, colours as follows:7.5Y-4/3 for top 90mm. Below 90mm, to 225mm- 10Y-5/2. In mottles below 90mm to 225-230mm, colour is 10Y-5/1.

In foraminifera split, mottling not as pronounced. Top colour 7.4Y-4/3. 90-160mm, colour 7.5Y-5/2 grading with large mottles to 19Y-5/2 (olive grey). At 380mm grades into 7.5Y-4/2 with faint mottling. Sand lenses start at 270mm and continue to bottom. Granule lens at 320-345mm(centre). Polychaete worm found in centre bottom of core, hanging through sphincter sleeve, and broken off at lower end. Lens of green mud (7.5Y-5/3) just above 400mm.

Samples taken at the following intervals and preserved in alcohol: 0-2cm, 2-4cm, 4-6cm, 6-8cm (top 6-8cm of core slumped during sampling making these measurements approximate), 8-10cm, 10-12cm, 12-14cm, 14-16cm, 16-19cm, 19-21cm, 24-26cm, 29-31cm, 34-36cm, 39-41cm, 44-46cm, 49-51cm, 54-56cm (Plate A1-7).

81-16(BLW) 77^{o} 2.2' 266m 30 Nov.,1981 W,P,C,B,A.
Sph core 162^{o}26.2'
Location: New Glacier Snout, Granite Harbour.

When core retrieved, muddy water draining through bottom. Core head put back under water to drain more slowly. When brought up, opening in sphincer sleeve plugged with paper towels. No water left on core. Frozen over night, extruded from barrel on 1 Dec. Length 450-515mm, sloping on top. Surface in contact with polythene liner: top half of core split and slumped into splitting tray. Some mottling, worms and worm tubes visible in open split, and top of archive split.

Archive split colours grade from 7.5Y-5/3 at top to 10Y-5/2 at about 150mm down from top, to 10Y-4/2 at bottom (510mm). Black mottling present at top (10Y-3/1).

Foraminiferal split, top soft, sloppy. Colours 7.5Y-4/3 grading to 10Y-4/2 80mm from top. Worm tubes present to 160mm (colour 5YR-4/8). Colour change at 180mm to 10Y-5/1. Sediment clasts in lenses from 180-220mm. Reduced area in centre of core at 260-300mm (10Y-3/1). Main core colour still 10Y-4/2. Siliceous sponge spicules scattered throughout core. Slight reducing odour noticed when core sliced at 380mm. One pebble present at 400mm (Plate A1-8).

81-17(BLW) 77^{o} 1.78' 358m 3 Dec.,1981 P,C,A,F.
Sph core 163^{o}24.0'
Location: 5km east of Cape Roberts.

Small amount of sediment on closed sphincter sleeve and up one side of core barrel, indicating corer fell over on sea floor. Invertebrates on top surface include bryozoans, sea spider, small brittle star fish and some sponge spicules. Estimated 30mm penetration of sea bed. Two samples preserved in ethanol, plus one for sediment analysis (Plate A1-9).

81-18(BLW) 77°41.7' 254m 5 Dec.,1981 W,P,C,A,F
Sph core 163°36.6' and K-2
Location: Ferrar Glacier Snout, New Harbour.

Corer retreived one third full of soft sediment. Brought back to camp at Butter Point in back of Snow Trac. This jostled the core and caused it to de-water on the 1.5 hour trip. Core frozen over-night, and split, photographed and measured on 6 Dec. Length after transport 410mm. Sampled full length of core at two centimeter intervals except for 3cm at bottom of core. Section 6-8cm missing due to slumping at top.

Archive spit varies slightly in colours. From 7.5Y-5/2 in mottles near to top (40-70mm) grades to 10YR-3/3 in core centre (60-95mm). Below this, the colour changed to 7.5YR-4/3,then 7.5YR-5/8(340mm). Bottom (380-410mm) is 10Y-4/1. Orange, crumbly sediment present here from 290-330mm.

Top of core soft, 2.5Y-3/3. Uniform to 60-110mm, where mottling appears (10Y-4/2). Below this streaks of 10YR-2/3 present. From 260-300mm, slightly firmer, crumbly sediment layer of bright orange colour(5YR-4/8). Below 300mm, grey very sandy mud with small pebbles (5Y-4/1) (Plate A1-10).

82-1 77°02.2' 303m 16 Nov.,1982 P,Mac,Mc.
Sph core 162°19.0'
Location: Crack in MacKay Glacier Tongue, Granite Harbour, about 500m east of grounding line on south side.

Sample consists of 300mm soft sediment, top sloping. Corer believed to have penetrated sediment at an angle. Splits taken parallel with sloping top. No archive sample or detailed description. Reduced layer 20-30mm from top. Clasts scattered throughout sediment. Sponge spicules all through core in small clumps. Sampled at 0-2,4-8,12-15,18-24,25-30cm.

82-2 76°59.7' 796m 17 Nov.,1982 P,Mac,Mc,Pa.
Sph core 162°26.0'
Location: Northeast tip of MacKay Glacier Tongue, Granite Harbour.

Very soft 430mm core. Top very fine green-yellow mud to about 200mm. Black mottle in left centre of core from 70-120mm. Sandy lens at 110-130mm on right side of core. Yellow-olive colour from 200-220mm, this layer very soft, jelly-like material. Below 220mm, core firmer with colour change to green-yellow as in top. Pale olive mottles in core centre at 320-340mm. Dark olive grey at 360-390mm. Dark grey from 390-430mm, bottom of core. The dark grey material was medium to coarse sand with clasts to 4.5cm. Possible plant material present at 420mm.

Depth unsure, some load released at 757m (original echo sounder depth). Freefall from 790m. May have already penetrated soft core top.

Samples taken at 0-2cm, 5-7cm, 11-13cm, 19-21cm, 31-33cm, 36-40cm, and 40-43cm. Sediment samples taken at 0-2,2-11,11-21,21-27,27-31, 31-36,36-40,40-43cm.

82-3 77°49.8' 139m 5 Dec.,1982 P,Mac,Mc.
Sph core 164°32.0'
Location: Blue Glacier Snout, 170m from ice cliff.

Core 350-450mm long, with sloping top. Worm tubes present in top. Muddy fine to medium sand of a pale yellow-grey from 70-143mm. Worm tubes and calcareous fragments present. Clast 2.5cm in centre at 90-110mm. Gradual colour and texture change at 143mm to muddy fine sand of a pale greenish grey. Echinoid spine at 162mm, clast at 200mm, black mottling 240-265mm, with calcareous foraminifera noted. Mottled layer consists of very fine sand with some silt. Large clast (5-6cm) at 310-350mm, below this soft mud clast(?) with very fine mud centre.

Samples taken at 0-2cm, 8-10cm, 20-22cm, 30-32cm and 42-45cm. Sedimentological samples also taken, at 0-2,2-12,12-22,22-27,27-37, 37-43(mud clast), 37-43(sand), 43-45cm. Some current seen on corer, but it did not register on current meter.

82-4 77°55.1' 212m P,Mac,Mc
Sph core 164°58.0'
Location: 9km east of Cape Chocolate Island.

Sample consists of small amount of muddy fine to medium sand. Sphincter sleeve not completely closed. Core barrel, o-ring and butter-fly valve badly damaged. One pottle of sediment preserved in alcohol.

The following small-diameter piston cores were collected by Pyne, Barrett, Ross, Waghorn, Sissons, Ward, and Walker during the 1979- 1980 field season, using the annual sea ice as an operating platform.

79-1	77°33.4' 164°23'	195.6m
79-2	"	"
79-3	"	"
79-4	77°52' 166°40'	139m
79-5	"	"
79-6	77°52.3' 166°30'	456m
79-7	77°52 166°36'	340m
79-8	77°45.5' 164°42'	168m
79-9	77°41.7 163°31	236m
79-10	"	"
79-11	77°41.3' 163°34.5'	230m

The following orange-peel grabs were collected during the 1980-1981 field season by Ward, Pyne, Fitzgerald and Garrick, using the sea ice as an operating platform. The grab was used due to the malfunction of the gravity sphincter corer.

Sample	Location	Depth(m)	Sediment Type
80-1	1-5, 25-29	17	pebbly sand
80-2	from	17	pebbly sand(col. by R.Wharton)
80-3	McMurdo Station	19	pebbly sand
80-4	Desalination Plant	8	pebbly sand
80-5	Brine Effluent	476	muddy sand
80-25		11	pebbly sand
80-26		16	pebbly sand
80-27		16	
80-28		15	
80-29		14	

Samples 6-24 from New Harbour area

80-6	77°38' 164°15'	79
80-7	77°39.7' 164°24.4'	168
80-8	77°37' 164°11'	126
80-9	77°38' 163°50'	252
80-10	77°37' 164°05'	121
80-11	77°36.7' 164°02'	109
80-12	77°36' 163°58'	213
80-13	77°34' 163°53'	178
80-14	77°34' 163°49'	167
80-15	77°33' 163°45'	116
80-16	77°33' 163°44'	81
80-17	77°36' 163°47'	192
80-18	77°35' 163°40'	128
80-19	77°35 163°38'	113
80-20	77°38.6' 163°55'	242
80-21	77°41' 163°39'	227
80-22	77°42' 163°32'	242
80-23	77°41' 163°34'	227
80-24	77°40' 163°33'	176

These samples were taken by Dietz-LaFond grab from the U.S.C.G.C.<u>Glacier</u> during February, 1980 by Dr.Dennis Kurtz, Kathy Balshaw, Susan Davis and Chuck Dunning, all of Rice University, Texas.

80-67 77°24.3' 827m
166°11.6'
0-11cm: Pebbly sand (olive black 5Y-2/1);sharp contact at 11cm.

80-69 77°21.0' 234m
166°30.1'
0-21cm:graded medium to fine sand (black N1);foraminifera and echinoid spines; sharp contact at 21cm.

80-70 77°24.6' 855m
165°45.0'
0-10cm: Diatomaceous pebbly mud (med.olive brown 5y-4/4);sharp irregular contact at 10cm.

80-71 77°24.0 586m
165°19.0
0-13cm: Graded fine to very fine muddy sand (black N1);sharp contact at 13 cm.

80-72 77°24.5 329m
165° 0.9

80-73 77°24 229m
164°38
0-20cm: Graded medium to very fine sand (black N1); slightly washed.

80-75 77°24 119m
163°51
0-40cm: muddy sand (no colour); gradational contact at 40cm.

80-76 77°21.9 122m (no description)
163°51.7

80-77 77°12 622m
165°12
0-122cm: Sandy mud (olive grey 5Y-3/2); sharp contact at 122cm.

80-78 77°08 414m
165°45
0-42cm: Muddy diatomaceous ooze (med.olive brown 5Y-4/4);slightly sandy; gradational contact at 42cm.

80-79 77°28 462(846??)
165°41
0-11cm: Pebbly sandy mud (med.ove brown 5Y-4/4);sharp contact at 11cm.

80-81 77°36 769m
165°40

80-82 77°38' 714m
165°47'
0-18cm: pebbly sand (dark olive grey 5Y-3/2); sharp contact at 18cm.

80-83 77°15' 271m
163°42'
0-27cm: Sand (greyish black N2); top 20cm washed; sharp contact at 27cm.

80-133 77°05' 897m
166°10'
0-148cm: diatomaceous mud (mod.olive brown 5Y-4/4); sharp contact at 148cm.

80-138 77°11'S 915m
167°37'E
0-4cm: diatomaceous mud (mod.olive brown 5H-4/1); sharp contact at 4cm.

80-141 77°15'S 613m
165°12'
0-3cm: pebbly sandy mud (olive grey 5Y-3/2); sharp contact at 3cm.

80-181 77°48.7' 265m (no description)
166°35'

80-187 77°35' 380
165°07'
0-44cm: muddy sand, crudely stratified sparsely pebbly, gradational contact at 44cm.

80-188 77°27' 631m
165°16'
0-193cm: pebbly muddy sand (greenish black 5G-2/1); upper 40cm slightly washed.

80-189 77°12' 908m
167°53'
0-120cm: diatomaceous mud (mod.olive brown 5Y-4/4); gradational contact at 120cm.

80-191 76°54' 551m
165°04'
0-6cm: muddy sand (med. dark grey N4); sharp irregular contact at 6cm.

These short piston cores were collected by Drs. F.Davey and D.Bennett while on the board the MV <u>Benjamin Bowring</u> during its cruise of McMurdo Sound during February, 1981.

Sample	Location	Depth(m)
BB-2	77°27.0' 165°11.0'	525
BB-3	77°26.0' 164°43.5'	230
BB-4	77°26.4' 164°28.5'	180
BB-5	77°23.6' 165°50.5'	823
BB-6	77°25.0' 165°32.0'	722

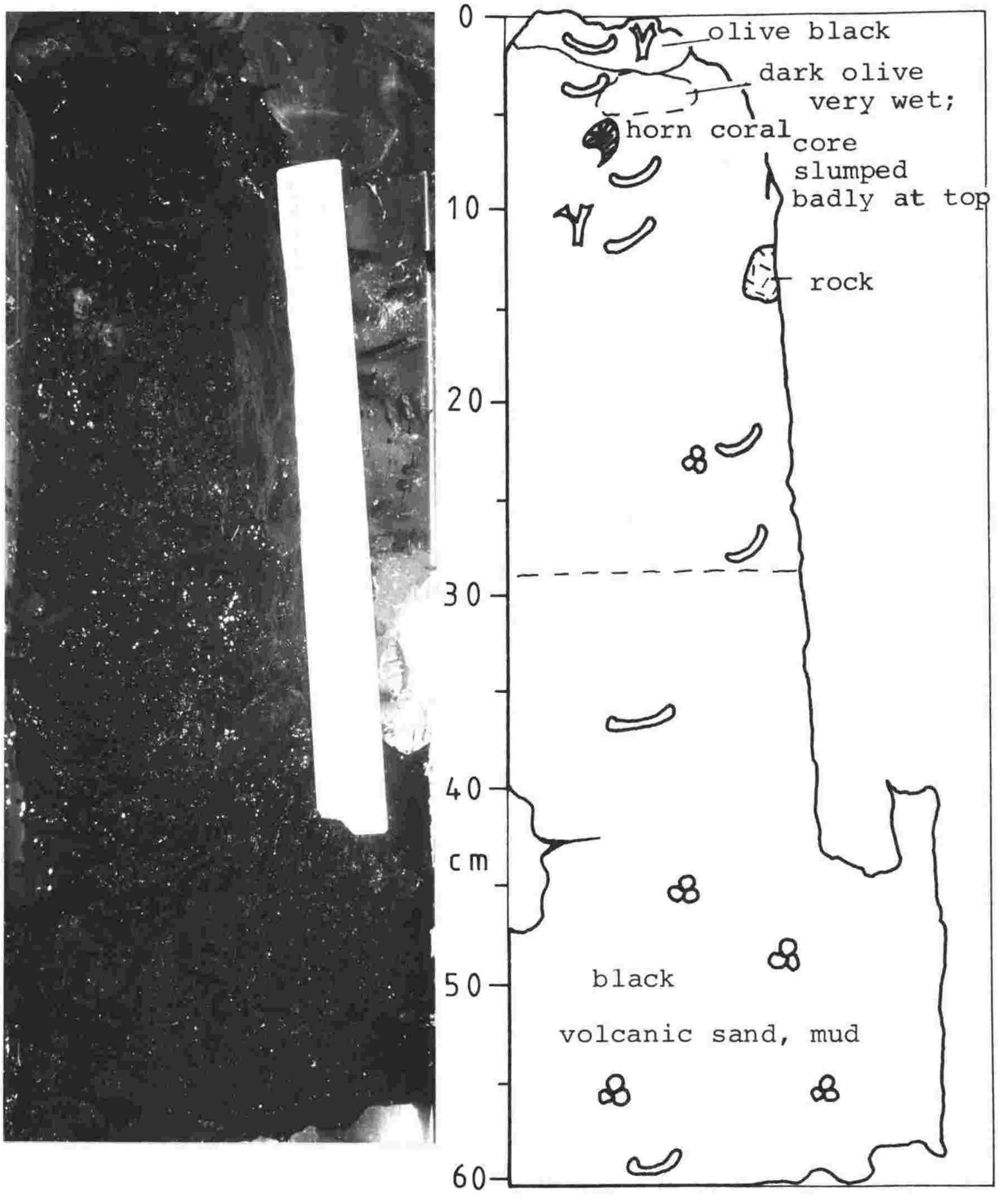
Grab/Core Stations from USCGC <u>Glacier</u> in McMurdo Sound, 12-19 February, 1983, collected by Pyne, Barret and Macpherson. (See Pyne and Barrett 1983 for fuller discussion of these sites).

Station	Location	Depth	Sample Type	Description
83-1	77°46.7' 166°00.8'	558m	grab	gravelly sand
83-2	77°37.7' 165°29.3'	660m	grab	gravelly sandy mud
83-3	77°25.0' 165°29.3'	856m	grab	slightly sandy mud
83-3A	77°31.6' 165°26.6'	719m	core	slightly sandy mud
83-4	77°15.5' 165°57.8'	854m	grab	slightly sandy mud
83-5	77°05.4' 167°09.2'	889m	grab	slightly sandy mud
	77°05.8 167°04.8'		core	
83-6	76°57.2' 166°14.6'	882m	grab core	mud
83-7	76°55.0' 165°44.7'	755m	grab	slightly sandy mud
83-8	76°50.0' 165°20.9'	547m	grab core	slightly gravelly mud
83-9	76°56.7' 163°33.4'	384m	grab	slightly gravelly sandy mud
83-10	76°55.6' 163°23.5'	866m	grab	slightly gravelly sandy mud
83-11	76°55.7' 163°28.3'	715m	grab	a few pebbles
83-12	76°54.8' 163°21.5'	788m	core	slightly sandy mud
83-13	76°52.2 162°57.9'	302m	grab	sandy mud
83-14	76°53.0' 162°45.0'	165m	core	slightly sandy mud

83-15	76°58.3' 162°38.6'	700m	core	slightly sandy mud
83-16	76°55.7 162°55.9'	849m	grab	diatom ooze
83-16A	76°55.6' 163°04.4'	880m	piston core	sandy mud, muddy sand
83-17	77°01.1' 162°43.8'	159m	grab	muddy sand
83-18	77°00.3' 163°10.8'	29m	grab	gravel pavement
83-19	77°02.0' 163°25.2'	486m	grab	boulder 30cm long
83-20	77°2.1' 163°51.6'	108m	grab	gravel pavement
83-22	77°51.2' 164°40.0'	128m	grab	slightly muddy coarse sand
83-23	77°50.2' 164°56.0'	174m	grab	gravelly sand
83-24	77°47.0' 165°37.8'	492m	grab	sandy mud
83-26 (31)	77°53.4' 166°37.3'	620m	grab	shelly muddy pebbly sand

PLATE A1-1

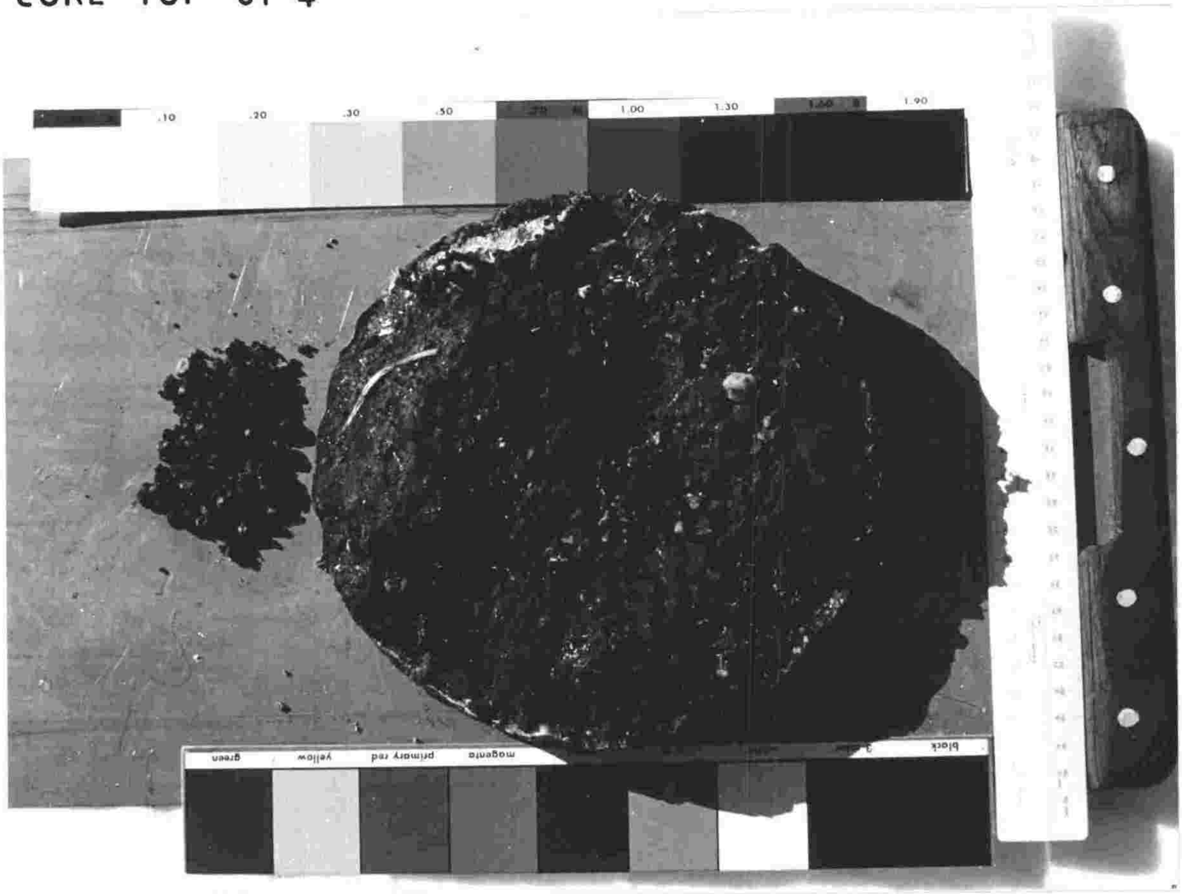
CORE 81-2



- Bryozoa
- Burrows
- Foraminifera
- Sponge Spicules
- Clasts (≥ pebble)

PLATE A1-2

CORE TOP 81-4



CORE TOP 81-6

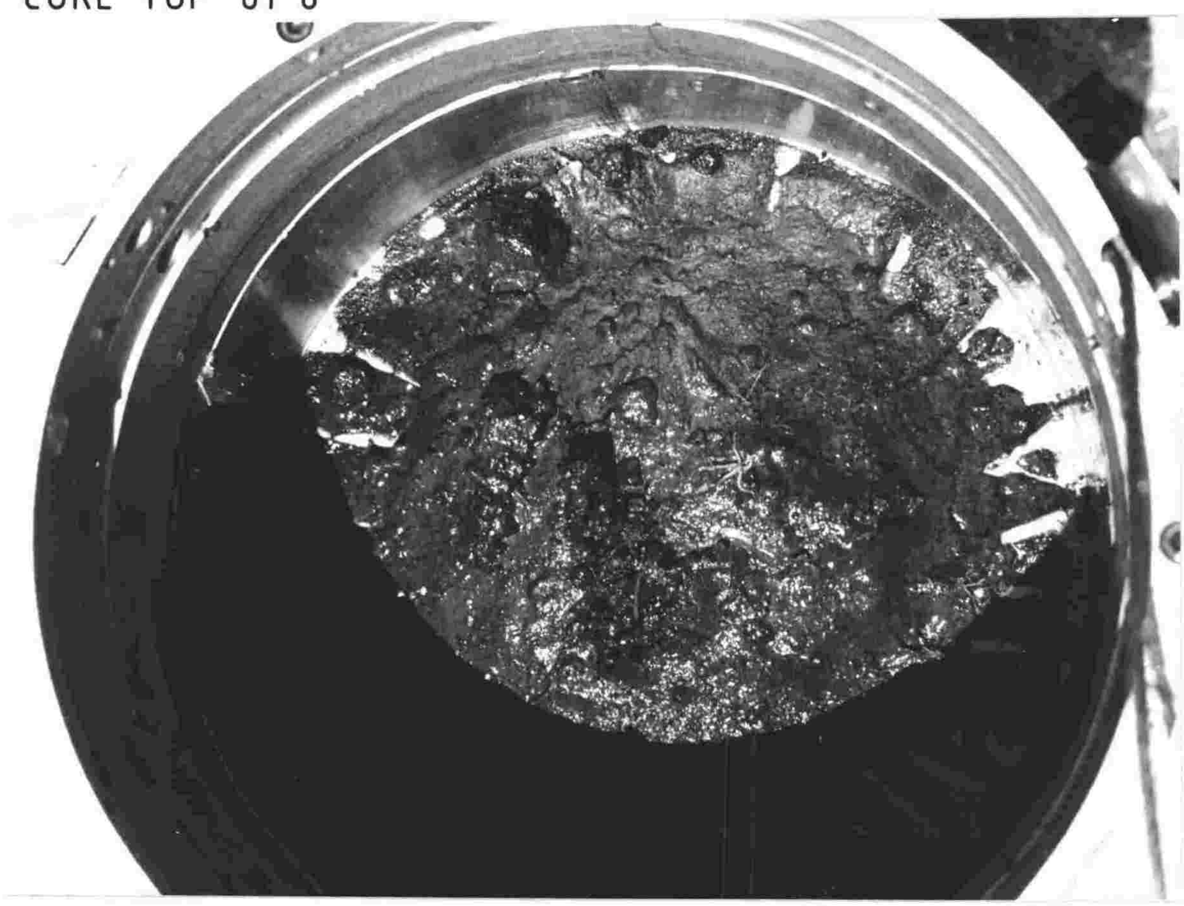
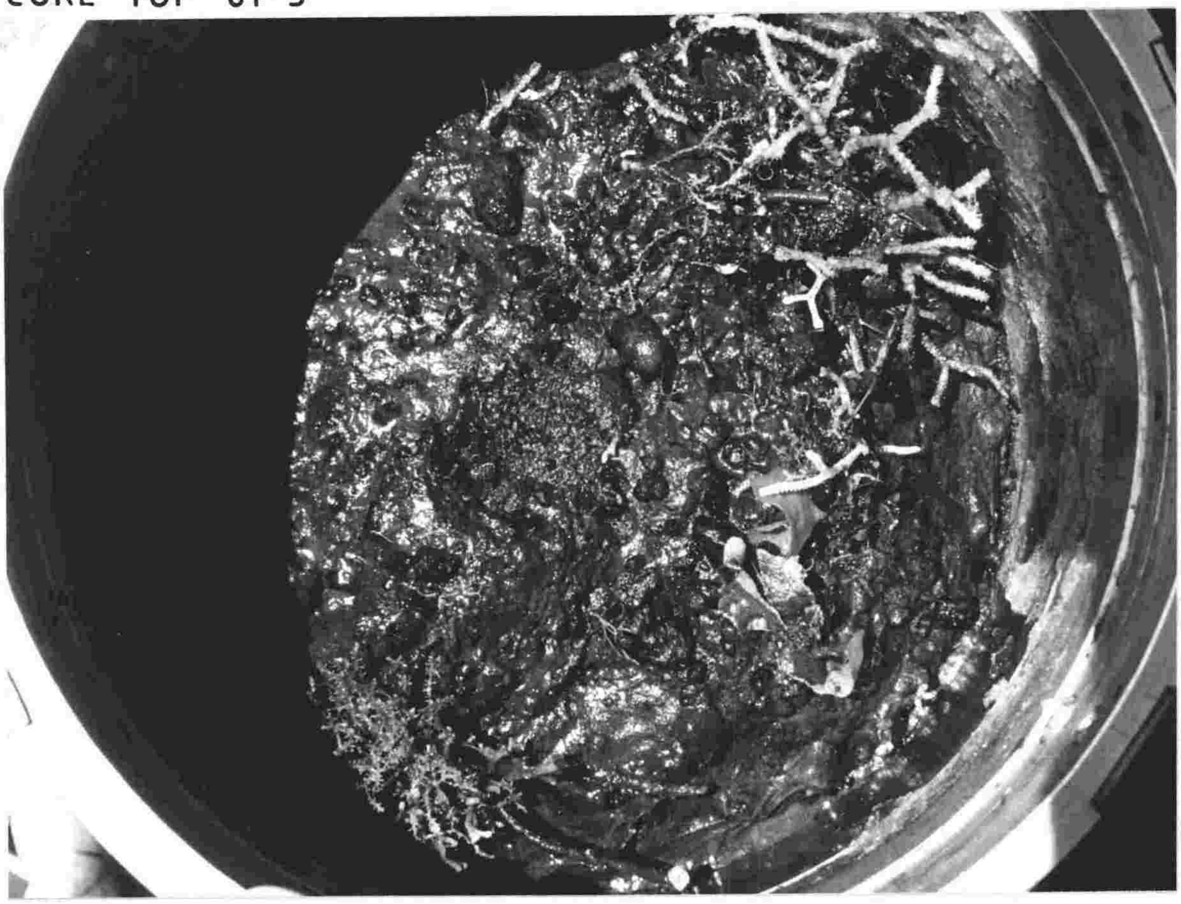


PLATE A1-3

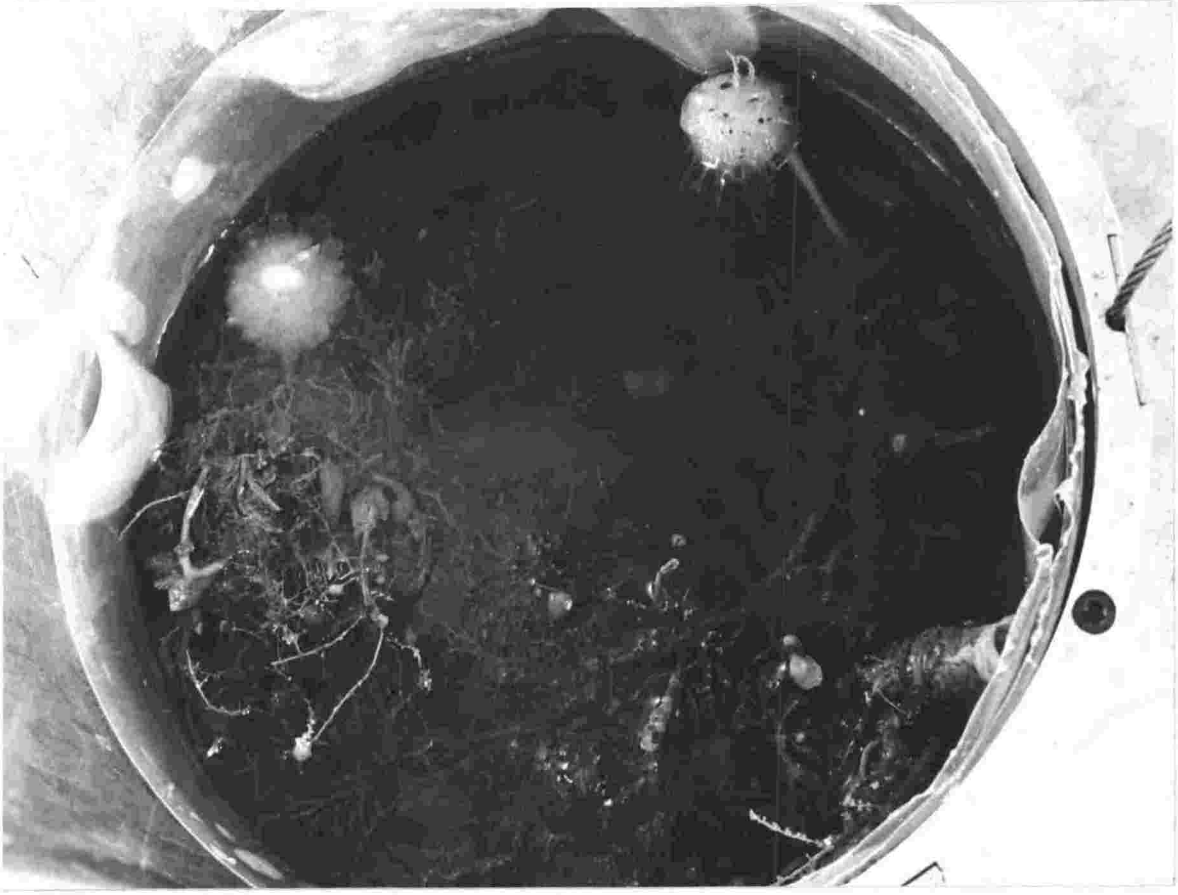
CORE TOP 81-5



CORE TOP 81-5A

PLATE A1-4

CORE TOP 81- 8



CORE TOP 81- 8A

PLATE A1-5

CORE TOP 81-10

CORE TOP 81-13

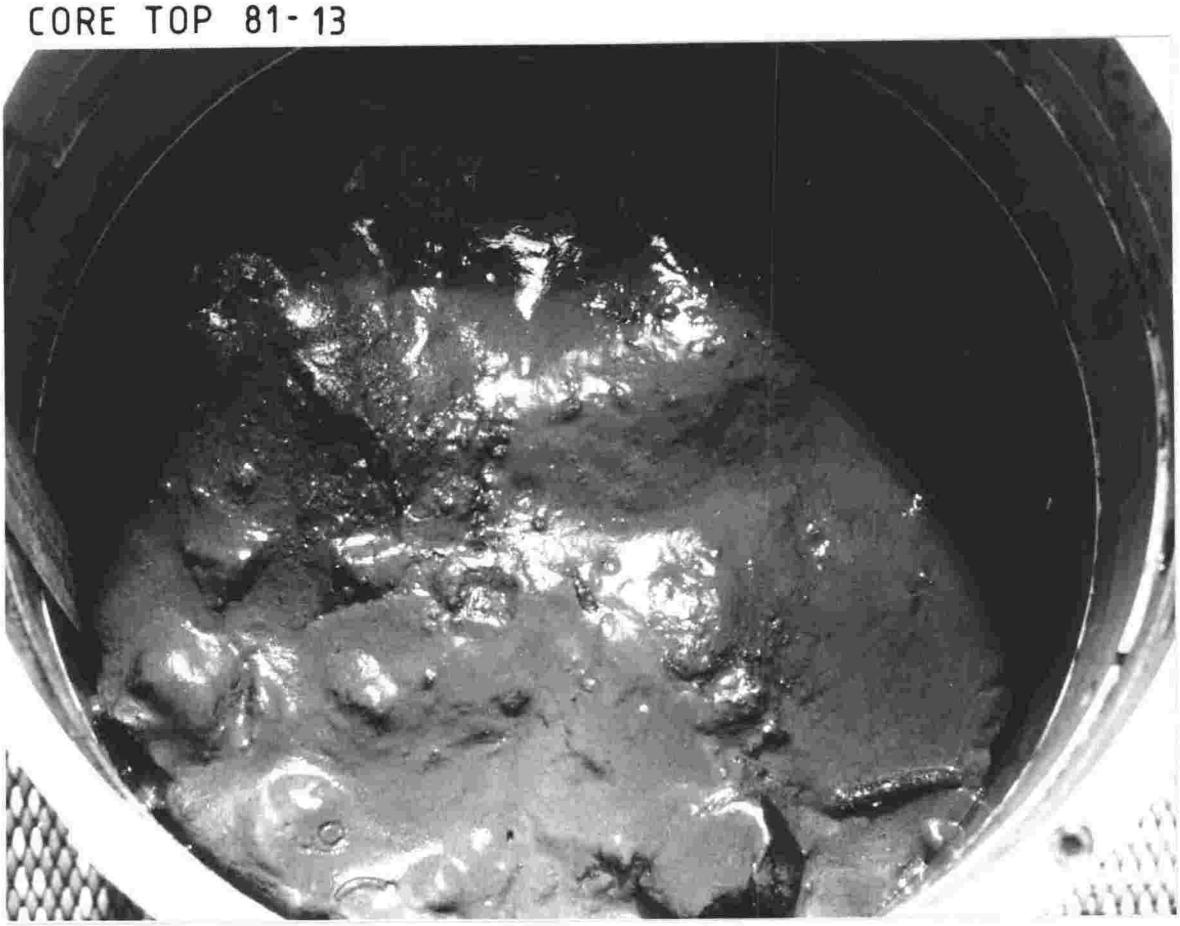


PLATE A1-6
CORE 81-14A

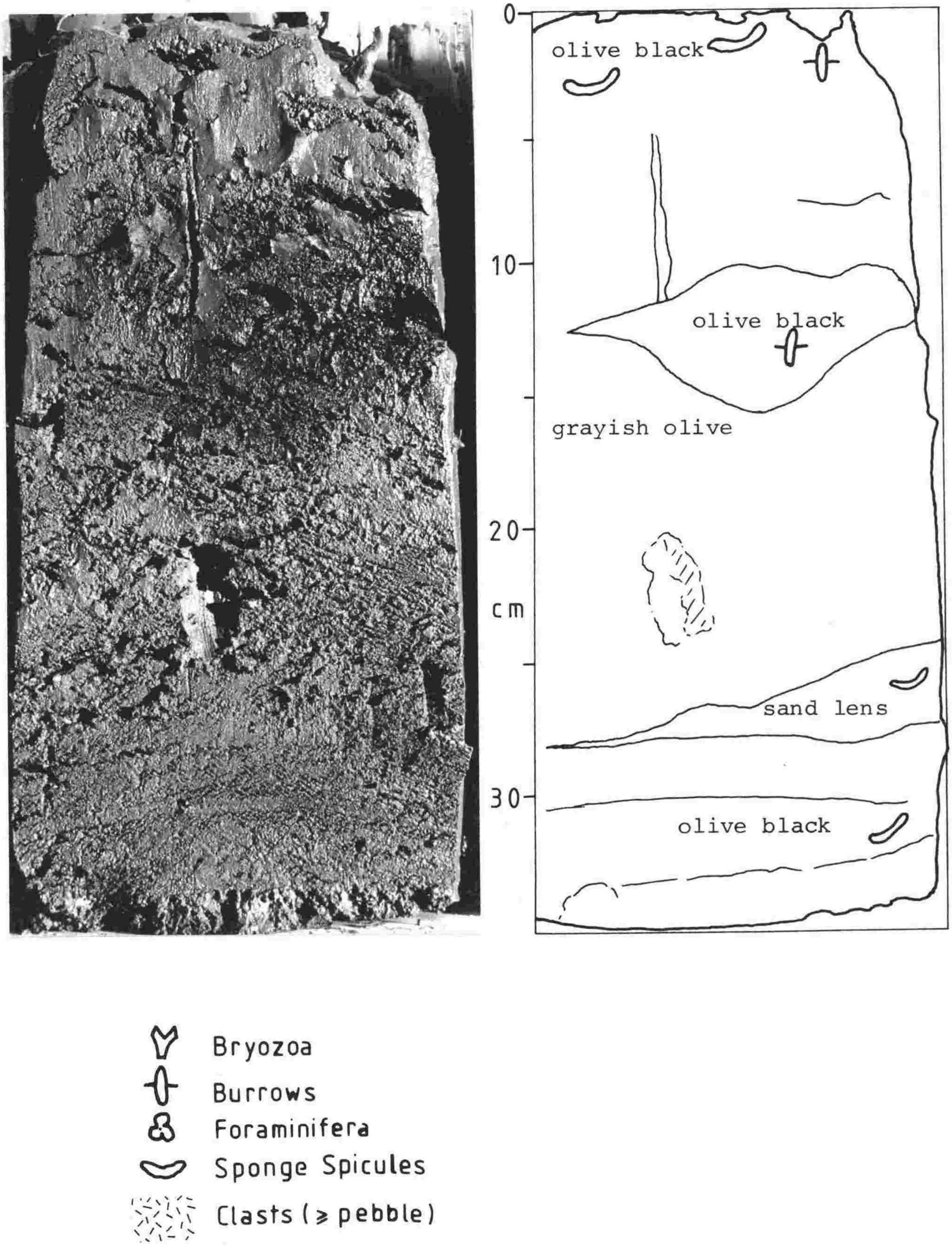
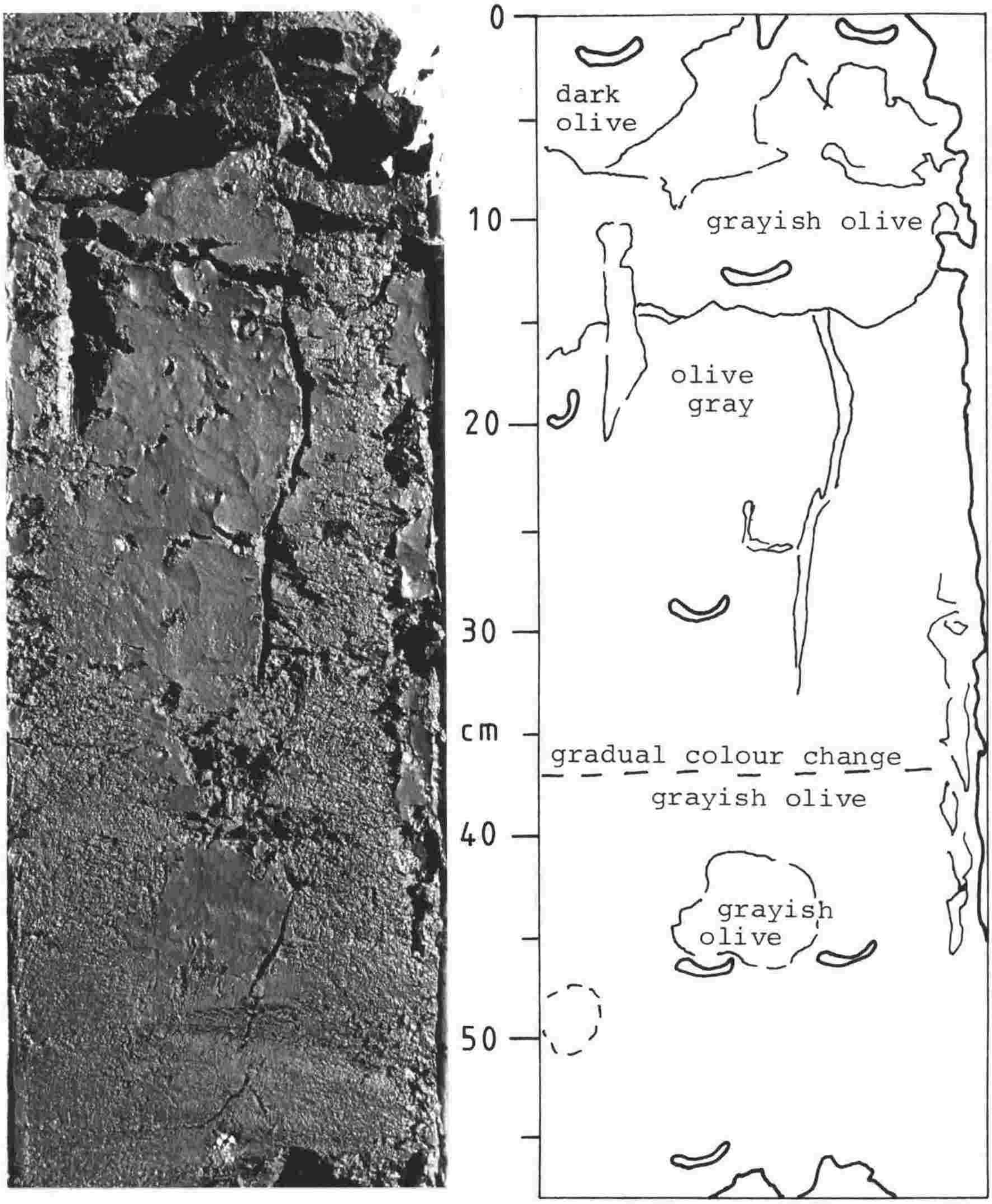


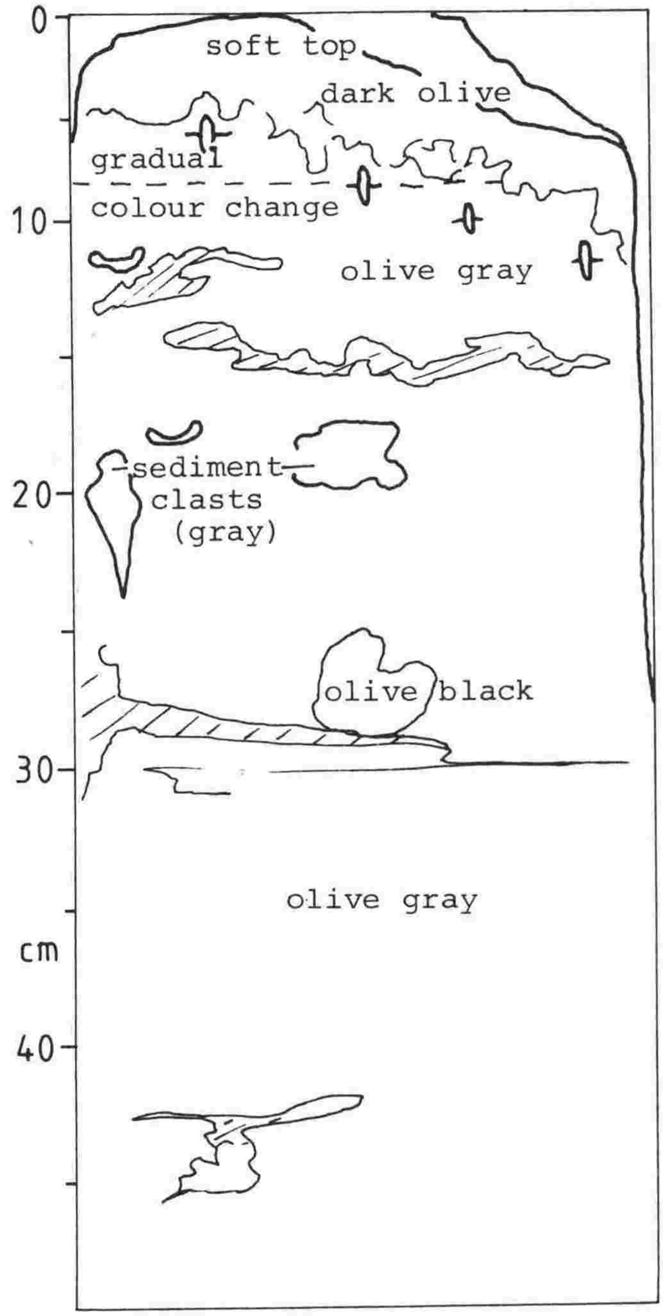
PLATE A1-7

CORE 81-15



Bryozoa
Burrows
Foraminifera
Sponge Spicules
Clasts (≥ pebble)

PLATE A1-8
CORE 81 - 16



Bryozoa

Burrows

Foraminifera

Sponge Spicules

Clasts (≥ pebble)

PLATE A1-9

CORE TOP 81-17

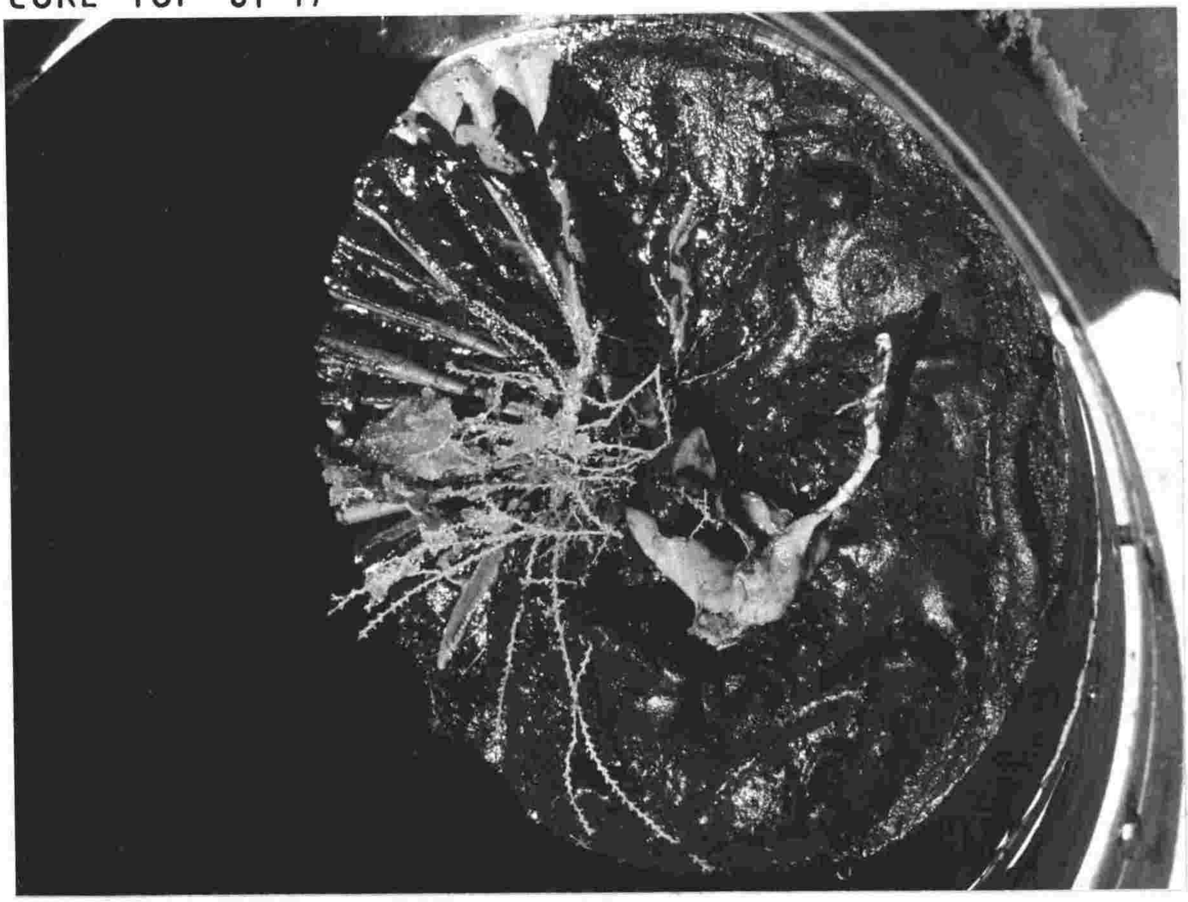
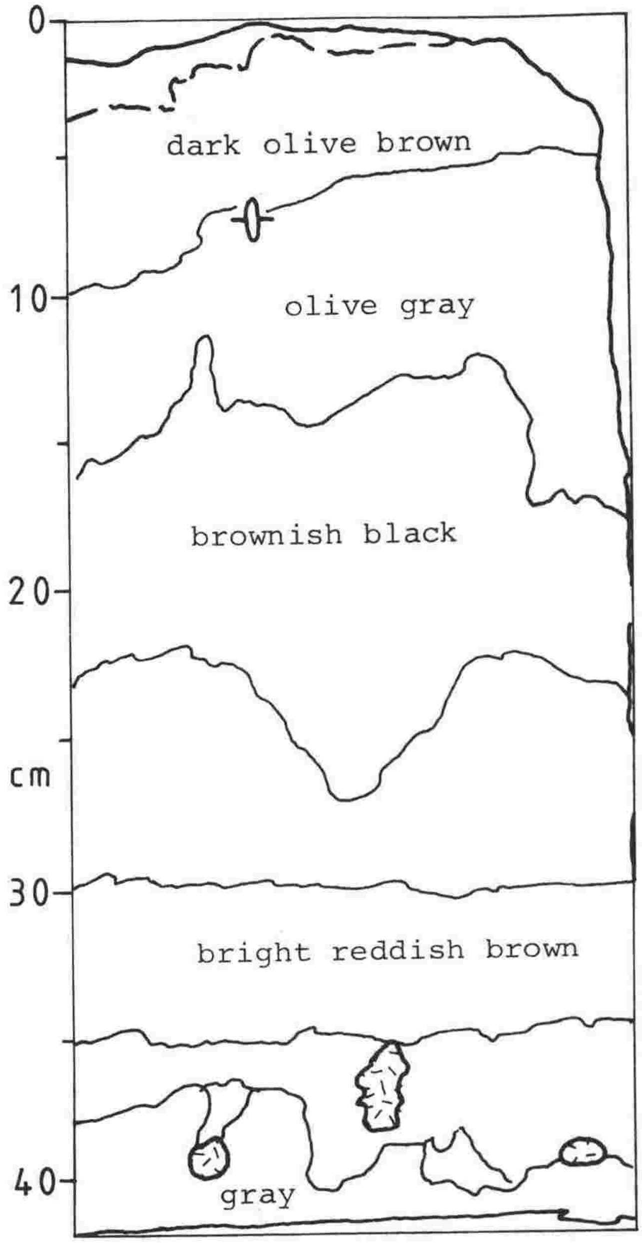


PLATE A1-10
CORE 81-18



Bryozoa
Burrows
Foraminifera
Sponge Spicules
Clasts (≥ pebble)

APPENDIX 2:

This appendix is a compilation of the raw numbers and percents for the living and dead benthic foraminiferal counts discussed in this thesis. Where the number of live tests was statistically low, additional tests were extracted and counted and added to the original counts. The live/dead ratios are based on the original counts, but percentages of live species are based on the subsequent counts. Those samples involved are marked with an asterisk (*). No planktonic tests are included in these counts.

Absolute numbers of live tests

Sample: 1981-	1	3	4*	5*	6*	7	2*	8A*	9*
Depth(m)	850	560	560	496	460	420	370	289	213
ASTR SPH	-	-	-	-	-	-	-	-	-
RHAB ABYS	-	-	-	-	-	-	-	-	-
BATH HIR(A)	-	-	-	-	-	-	-	-	-
BATH HIR(B)	-	-	-	-	-	-	-	-	-
HYP CYL	-	-	6	-	-	2	-	-	-
HYP MAL	-	-	-	-	2	1	-	-	-
HYP SUB	-	1	1	1	2	6	1	-	-
PSAM FUSCA	1	-	-	-	1	1	-	-	-
PELO BIC	-	-	-	-	-	1	-	-	-
SAC SPH	-	-	-	-	-	-	1	-	1
SAC JUV	2	2	1	-	1	13	-	-	-
AMMOP SP	-	-	-	-	-	-	-	-	-
HEMI BRAD	-	-	1	-	-	-	-	-	1
THUR ALB	1	-	-	1	1	-	1	1	1
THUR PROT	-	-	-	1	-	-	2	2	-
GLOM GORD	-	1	2	2	4	5	1	1	1
GLOM CHAR	-	-	-	-	-	-	-	-	-
TUR SHON	-	-	-	-	-	-	-	-	-
HORM OVIC	-	3	1	4	16	10	-	1	-
HORM SP	-	-	-	-	-	1	-	-	-
REO PIL	3	6	17	9	35	23	1	1	4
REO PSE(A)	1	-	-	-	-	-	-	-	-
(B)	-	-	-	-	-	-	1	1	3
REO SUBD	20	3	20	9	45	17	1	1	1
MIL ARE	-	-	-	3	5	2	-	-	-
MIL LATA	3	-	-	-	-	3	-	-	-
CRIB JEFF	3	8	15	11	13	28	5	2	8
CRIB SUB	-	-	2	-	-	1	-	-	-
CRIB WIE	-	-	1	-	-	-	-	-	-
SPIRO FIL	-	-	-	-	-	-	1	-	-
TEXT ANT	27	3	7	7	10	18	-	-	-
TEXT EAR	3	-	-	1	-	-	-	-	-
TROC GLABRA	1	4	8	5	4	13	1	3	2
TROC GABO	-	1	3	3	-	4	-	2	-
TROC A	-	2	1	-	-	5	-	-	-
TROC B	-	-	-	-	-	-	-	-	-
PORT ANTA	2	20	31	25	18	29	9	5	16
PORT ELT	11	7	12	7	9	16	-	1	3
CONO BULL	7	3	-	4	3	3	1	-	-
VERN MIN	1	-	1	-	2	2	-	-	-
VERN ADV	-	-	-	-	-	-	-	-	-
EGGE BRAD	-	-	-	-	-	-	1	-	-
CYCL INVO	-	-	-	-	-	-	2	-	-
PLAN BUC	-	-	-	-	-	1	-	-	1
CRUC TRI	-	1	1	-	1	3	-	-	-
PYRG DEP	-	-	-	-	-	-	-	-	1
PYRG ELO	-	1	1	-	-	-	-	-	-
PYRG MUR	-	-	-	-	-	-	-	-	-
PRGOL SPH	-	-	-	-	-	-	3	-	2
SIG UMB	-	-	-	-	-	-	-	-	-
MIL SP A	-	-	-	-	-	1	-	-	1
SP B	-	-	-	1	-	-	-	-	-
DENT COM	-	-	-	1	1	-	1	-	-
NODS MAR	-	-	-	-	-	-	-	-	-
NODS SP	-	-	-	-	-	-	-	-	-
LAG DIST	-	-	-	-	-	-	-	-	-
LAG ELON	-	-	1	1	-	-	-	-	-
LAG GRAC	-	-	-	-	-	-	-	-	-
LAG GRAS	-	-	-	-	-	-	-	3	-
LAG NEBU	-	-	-	-	-	-	-	-	-
LAG STRI	-	-	-	-	-	2	-	-	-
LING VIT	-	-	-	-	-	-	-	-	-
LENT GIB	1	-	-	-	-	1	-	-	-
POLY SP	-	-	-	-	-	-	-	-	1

ENTO BICA	-	-	-	-	-	-	-	-	-
ENTO BILO	-	-	-	-	-	-	-	-	-
GLAND ANT	-	-	1	-	1	-	-	-	-
GLAND LAEV	-	-	-	1	1	-	-	-	-
LAR HYAL	-	-	-	-	-	-	-	-	-
FIS CORN	-	-	-	-	-	-	-	-	-
FIS FOLI	-	-	-	1	-	-	-	-	-
FIS MARG	-	-	-	-	-	6	1	1	3
FIS MENN	-	-	-	-	-	-	-	-	-
FIS SEM	-	-	-	-	-	-	1	-	-
FIS SPATH	-	-	-	-	-	-	1	-	-
FIS SUBF	-	-	-	1	-	-	1	-	-
FIS SUBT	-	-	-	-	-	-	-	-	-
FIS TING	-	-	1	-	-	1	-	-	-
FIS TEX	-	-	-	1	-	1	-	-	-
FIS TR-M	-	-	-	-	-	-	-	-	-
FIS SP	-	-	-	-	2	-	1	-	-
PARA CURTA	-	-	-	-	-	-	-	1	-
PARA FUS	-	-	-	2	-	-	-	-	-
PARA LATER	-	-	1	-	-	-	1	-	-
PARA MARG	-	-	-	-	-	-	-	-	-
PARA PSE-T	-	-	-	-	-	-	-	-	-
PARA PUST	-	-	-	-	-	-	-	-	-
PARA STAPH	-	-	-	-	-	-	-	-	-
PARA SUBC	-	-	-	-	-	-	-	1	-
OOL API	-	-	-	-	-	-	-	-	-
OOL HEX	-	-	-	-	-	-	-	-	-
OOL MELO	-	-	-	-	-	-	-	-	-
OOL SQUA	-	-	-	-	-	-	-	-	-
OOL A	-	-	-	-	-	-	-	-	-
OOL B	-	-	-	-	-	-	-	-	-
OOL C	-	-	-	-	-	-	-	-	-
PAT COR	-	-	-	2	-	-	-	-	-
PATS DEP	-	-	-	-	-	-	-	-	-
SPIR RAD	-	-	-	-	-	-	-	-	-
PSBU CHP	-	-	-	-	-	-	3	-	-
BUL ELG	-	-	-	1	-	-	-	-	-
BOL PSE	-	-	1	6	1	-	1	-	-
BOL PYG	-	-	-	-	-	-	-	-	-
BOL SP	-	-	-	-	-	-	-	-	-
CAS POR	-	4	25	7	16	14	9	-	9
CAS PARK	-	-	-	-	-	-	-	-	-
STAIN CON	-	-	-	-	-	-	-	-	-
TRIF EAR	-	15	18	27	9	46	46	1	20
TRIF PAUP	-	-	-	1	-	2	-	-	-
EPIS VIT	-	2	1	3	-	-	-	-	4
ROS GLOB	-	1	-	2	-	1	1	-	-
HER KEM	-	-	-	-	-	-	-	-	-
GLAB SP	-	-	-	-	-	-	-	-	-
SCHACK ANT	-	-	-	-	-	-	-	-	-
CIB LOB	-	1	11	7	3	1	1	-	2
ELPH SP	-	-	-	-	-	-	-	-	-
FUR EAR	-	-	3	11	2	3	-	-	-
EHR GLAB	-	3	7	9	-	41	9	2	13
GLOB BIO	-	-	-	-	2	-	2	-	-
GLOB CRAS	-	7	2	25	5	61	3	-	8
GLOB SUBG	-	-	1	-	-	-	-	1	-
AST ANT	-	1	-	2	-	4	2	-	1
AST ECH	-	2	2	3	12	2	4	1	-
NON IRID	-	-	-	-	-	-	-	-	1
PUL SUB	-	-	1	3	3	9	2	-	1
PUL BUL	-	-	-	-	-	-	-	-	1
TOTALS (N)	87	102	208*	211*	229*	404	122*	31*	110*

Absolute numbers of live tests

Sample:	1981-10*	12	15	13	17	14	16	18
Depth(m)	173	110	550	537	358	345	266	254
ASTR SPH	-	-	-	-	-	-	-	-
RHAB ABYS	-	-	-	-	-	-	2	-
BATH HIR(A)	-	-	-	-	-	-	-	-
BATH HIR(B)	-	-	-	-	-	2	1	5
HYP CYL	-	-	-	-	-	-	-	12
HYP MAL	-	-	-	-	-	3	-	1
HYP SUBN	-	-	-	-	-	-	-	1
PSAM FUSCA	-	-	1	-	-	-	-	4
PELO BIC	-	-	-	-	-	-	-	1
SAC SPH	-	-	-	-	-	-	-	-
SAC JUV	-	-	4	1	-	-	2	2
AMMOP SP	-	-	-	-	-	-	-	-
HEMI BRAD	-	-	-	-	-	-	1	3
THUR ALB	-	-	-	-	-	-	1	1
THUR PROT	-	-	-	-	-	-	-	-
GLOM GORD	1	-	-	-	-	-	-	2
GLOM CHAR	-	-	-	-	-	-	-	-
TUR SHON	-	-	-	-	-	-	-	-
HORM OVIC	1	-	-	-	-	-	-	3
HORM SP	-	-	-	-	-	-	-	-
REO PIL	-	2	-	1	1	-	-	6
REO PSE(A)	-	-	-	-	-	-	-	6
(B)	-	-	-	-	-	-	-	3
REO SUBD	10	6	11	21	9	18	11	109
MIL ARE	-	-	-	-	-	5	1	-
MIL LATA	-	-	-	-	-	2	-	-
CRIB JEF	3	9	1	-	2	5	2	-
CRIB SUB	-	-	-	-	-	-	-	-
CRIB WIE	-	-	-	-	-	-	-	-
SPIRO FIL	-	-	-	-	-	-	-	-
TEXT ANT	1	3	9	12	-	12	15	16
TEXT EAR	-	-	-	-	-	-	-	3
TROC GLABRA	4	2	1	-	3	1	3	1
TROC GABO	-	5	-	-	-	-	-	-
TROC A	-	1	-	-	-	-	-	-
TROC B	-	-	-	-	-	-	-	-
PORT ANTA	1	11	-	2	5	7	5	27
PORT ELT	-	1	1	2	-	2	4	10
CONO BULL	-	1	-	1	-	-	-	5
VERN MIN	-	1	1	1	-	-	1	-
VERN ADV	-	-	-	-	-	-	-	-
EGGE BRAD	-	-	-	-	-	-	-	-
CYCL INVO	-	-	-	-	-	-	1	-
PLAN BUC	-	-	-	-	-	-	-	-
CRUC TRI	-	-	-	-	-	-	-	-
PYRG DEP	-	-	-	-	-	-	-	-
PYRG ELO	-	-	-	1	-	-	-	-
PYRG MUR	-	-	-	-	-	-	-	-
PRGOL SPH	-	1	-	-	-	-	-	-
SIG UMB	-	-	-	-	-	-	-	-
MIL SPP	-	-	-	-	-	-	-	-
DENT COM	1	-	-	-	-	-	-	-
NODS MAR	-	-	-	-	-	-	-	-
NODS SP	-	-	-	-	-	-	-	-
LAG DIST	-	-	-	-	-	-	-	-
LAG ELON	-	-	-	-	-	-	-	-
LAG GRAC	-	-	-	-	-	-	-	-
LAG GRAS	-	-	-	-	-	-	-	-
LAG NEBU	-	-	-	-	-	-	-	-
LAG STRI	-	-	-	-	-	-	-	-
LING VIT	-	-	-	-	-	-	-	-
LENT GIB	-	2	-	-	-	-	-	-
POLY SP	-	-	-	-	-	-	-	-

ENTO BICA	-	-	-	-	-	-	-	-
ENTO BILO	-	-	-	-	-	-	-	-
GLAND ANT	-	-	-	-	-	-	-	-
GLAND LAEV	-	1	-	-	-	-	-	-
LAR HYAL	-	-	-	-	-	-	-	-
FIS CORN	-	-	-	-	-	-	-	-
FIS FOLI	-	-	-	-	-	-	-	-
FIS MARG	4	-	-	-	-	-	-	-
FIS MENN	-	-	-	-	-	-	-	-
FIS SEM	-	-	-	-	-	-	-	-
FIS SPATH	-	-	-	-	-	-	-	-
FIS SUBF	-	-	-	-	-	-	-	-
FIS SUBT	-	-	-	-	-	1	-	-
FIS TEX	-	-	-	-	-	-	-	-
FIS TING	3	-	-	-	-	-	-	-
FIS TR-M	-	-	-	-	-	-	-	-
FIS SP	-	4	-	-	-	-	-	1
PARA CURTA	-	-	-	-	-	-	-	-
PARA FUS	-	-	-	-	-	-	-	-
PARA LATER	-	1	-	-	-	-	-	-
PARA MARG	-	-	-	-	-	-	-	-
PARA PSE-T	1	-	-	-	-	-	-	-
PARA PUST	-	-	-	-	-	-	-	-
PARA STAPH	-	1	-	-	-	-	-	-
PARA SUBC	-	-	-	-	-	-	-	-
OOL API	-	-	-	-	-	-	-	-
OOL HEX	-	-	-	-	-	-	-	-
OOL MELO	-	-	-	-	-	-	-	-
OOL SQUA	-	-	-	-	-	-	-	-
OOL A	-	-	-	-	-	-	-	-
OOL B	-	-	-	-	-	-	-	-
OOL C	-	-	-	-	-	-	-	-
PAT COR	-	3	-	-	-	-	-	-
PATS DEP	-	1	-	-	-	-	-	-
SPIR RAD	-	-	-	-	-	-	-	-
PSBU CHP	-	-	-	-	-	-	-	-
BUL ELG	-	1	-	-	-	-	-	-
BOL PSE	1	1	-	-	-	-	-	-
BOL PYG	-	-	-	-	-	-	-	-
BOL SP	-	-	-	-	-	-	-	-
CAS POR	3	1	-	-	4	-	1	-
CAS PARK	-	-	-	-	-	-	-	-
STAIN CON	-	-	-	-	-	-	-	-
TRIF EAR	6	3	-	-	-	-	-	-
TRIF PAUP	-	-	-	-	-	-	-	-
EPIS VIT	-	4	-	4	-	-	-	-
ROS GLOB	1	1	-	-	-	-	-	2
HER KEM	-	-	-	-	-	-	-	-
GLAB SP	-	-	-	-	-	-	-	-
SCHACK ANT	-	-	-	-	-	-	-	-
CIB LOB	-	-	-	-	-	-	-	-
ELPH SP	-	-	-	-	-	-	-	-
FUR EAR	-	2	17	5	-	11	6	1
EHR GLAB	13	3	-	-	-	-	-	-
GLOB BIO	-	1	-	-	7	-	-	-
GLOB CRAS	1	3	2	2	-	11	5	8
GLOB SUBG	-	-	-	-	-	-	-	-
AST ANT	1	1	-	-	1	-	-	-
AST ECH	-	-	-	2	-	-	-	1
NON IRID	-	1	-	-	-	-	-	-
PUL SUB	3	1	-	-	3	-	-	-
PUL BUL	-	-	-	-	-	-	-	-
TOTALS (N)	59*	79	48	55	35	80	62	234

Percent live tests from McMurdo Sound open water cores

Sample: 1981-	1	3	4*	5*	6*	7
Depth(m)	850	560	560	496	460	420
ASTR SPH	-	-	-	-	-	-
RHAB ABYS	-	-	-	-	-	-
BATH HIR(A)	-	-	-	-	-	-
BATH HIR(B)	-	-	-	-	-	-
HYP CYL	-	-	2.9	-	-	0.5
HYP MAL	-	-	-	-	0.9	0.25
HYP SUB	-	1.0	0.48	0.45	0.9	1.5
PSAM FUSCA	1.2	-	-	-	0.4	0.25
PELO BIC	-	-	-	-	-	0.25
SAC SPH	-	-	-	-	-	-
SAC JUV	2.3	2.0	0.48	-	0.4	3.2
AMMOP SP	-	-	-	-	-	-
HEMI BRAD	-	-	0.48	-	-	-
THUR ALB	1.2	-	-	0.45	0.4	-
THUR PROT	-	-	-	0.45	-	-
GLOM GORD	-	1.0	0.96	0.9	1.8	1.24
GLOM CHAR	-	-	-	-	-	-
TUR SHON	-	-	-	-	-	-
HORM OVIC	-	3.0	0.48	1.85	6.9	2.5
HORM SP	-	-	-	1.4	-	0.25
REO PIL	3.4	5.9	8.2	4.2	15.3	5.7
REO PSE (A)	1.2	-	-	-	-	-
(B)	-	-	-	-	-	-
REO SUBD	23.0	3.0	9.6	4.2	19.7	4.2
MIL AREN	-	-	-	1.4	2.2	0.5
MIL LATA	3.4	-	-	-	-	0.74
CRIB JEF	3.4	8.0	7.2	5.0	5.7	6.93
CRIB SUB	-	-	0.96	-	-	0.25
CRIB WIE	-	-	0.48	-	-	-
SPIRO FIL	-	-	-	-	-	-
TEXT ANT	31.0	3.0	3.4	3.3	4.4	4.45
TEXT EAR	3.4	-	-	0.45	-	-
TROC GLABRA	1.2	4.0	3.3	2.3	1.8	3.2
TROC GABO	-	1.0	2.0	1.4	-	1.0
TROC A	-	2.0	0.48	6.8	-	1.2
TROC B	-	-	-	-	-	-
PORT ANTA	2.3	19.6	15.0	11.6	7.8	7.18
PORT ELT	12.6	6.8	5.7	3.3	4.0	4.0
CONO BULL	8.0	3.0	-	1.9	1.3	0.74
VERN MIN	1.2	-	0.48	-	0.9	0.5
VERN ADV	-	-	-	-	-	-
EGGE BRAD	-	-	-	-	-	-
CYCL INVO	-	-	-	-	-	-
PLAN BUC	-	-	-	-	-	0.25
CRUC TRI	-	1.0	0.48	-	0.4	0.74
PYRG DEP	-	-	-	-	-	-
PYRG ELO	-	1.0	0.5	-	-	-
PYRG MUR	-	-	-	-	-	-
PRGOL SPH	-	-	-	-	-	-
SIG UMB	-	-	-	-	-	-
MIL SP A	-	-	-	-	-	0.25
SP B	-	-	-	0.45	-	-
DENT COM	-	-	-	0.45	0.4	-
NODS MAR	-	-	-	-	-	-
NODS SP	-	-	-	-	-	-
LAG DIST	-	-	-	-	-	-
LAG ELON	-	-	0.48	0.45	-	-
LAG GRAC	-	-	-	-	-	-
LAG GRAS	-	-	-	-	-	-
LAG NEBU	-	-	-	-	-	-
LAG STRI	-	-	-	-	-	0.5
LING VIT	-	-	-	-	-	-
LENT GIB	1.2	-	-	-	-	0.25
POLY SP	-	-	-	-	-	-

ENTO BICA	-	-	-	-	-	-
ENTO BILO	-	-	-	-	-	-
GLAND ANT	-	-	0.48	0.45	0.4	-
GLAND LAEV	-	-	-	-	0.4	-
LAR HYAL	-	-	-	-	-	-
FIS CORN	-	-	-	-	-	-
FIS FOLI	-	-	-	0.45	-	-
FIS MARG	-	-	-	-	-	1.5
FIS MENN	-	-	-	-	-	-
FIS SEM	-	-	-	-	-	-
FIS SPATH	-	-	-	-	-	-
FIS SUBF	-	-	-	0.45	-	-
FIS SUBT	-	-	-	-	-	-
FIS TEX	-	-	-	0.45	-	0.25
FIS TR-M	-	-	-	-	-	-
FIS TING	-	-	0.48	-	-	0.25
FIS SP	-	-	-	-	2.8	-
PARA CURTA	-	-	-	-	-	-
PARA FUS	-	-	-	0.9	-	-
PARA LATER	-	-	0.48	-	-	-
PARA MARG	-	-	-	-	-	-
PARA PSE-T	-	-	-	-	-	-
PARA PUST	-	-	-	-	-	-
PARA STAPH	-	-	-	-	-	-
PARA SUBC	-	-	-	-	-	-
OOL API	-	-	-	-	-	-
OOL HEX	-	-	-	-	-	-
OOL MELO	-	-	-	-	-	-
OOL SQUA	-	-	-	-	-	-
OOL A	-	-	-	-	-	-
OOL B	-	-	-	-	-	-
OOL C	-	-	-	-	-	-
PAT COR	-	-	-	-	0.9	-
PATS DEP	-	-	-	-	-	-
SPIR RAD	-	-	-	-	-	-
PSBU CHP	-	-	-	-	-	-
BUL ELG	-	-	-	0.45	-	-
BOL PSE	-	-	0.48	2.8	0.4	-
BOL PYG	-	-	-	-	-	-
BOL SP	-	-	-	-	-	-
CAS POR	-	4.0	12.0	3.3	7.0	3.46
CAS PARK	-	-	-	-	-	-
STAIN CON	-	-	-	-	-	-
TRIF EAR	-	14.7	8.6	12.6	4.0	11.4
TRIF PAUP	-	-	-	0.45	-	0.5
EPIS VIT	-	2.0	0.48	1.4	-	-
ROS GLOB	-	1.0	-	0.9	-	0.25
HER KEM	-	-	-	-	-	-
GLAB SP	-	-	-	-	-	-
SCHACK ANT	-	-	-	-	-	-
CIB LOB	-	1.0	6.0	3.3	1.3	0.25
ELPH SP	-	-	-	-	-	-
FUR EAR	-	-	1.4	5.1	0.9	0.74
EHR GLAB	-	3.0	3.4	4.2	-	10.1
GLOB BIO	-	-	-	-	0.9	-
GLOB CRAS	-	6.8	0.96	11.6	2.2	15.1
GLOB SUBG	-	-	0.48	-	-	-
AST ANT	-	1.0	-	0.9	-	1.0
AST ECH	-	2.0	0.96	1.4	5.0	0.5
NON IRID	-	-	-	-	-	-
PUL SUB	-	-	0.48	1.4	1.3	2.2
PUL BUL	-	-	-	-	-	-
TOTALS (%)	100.0	100.8	100.0*	98.4*	100.7*	100.09

Percent live tests

Sample: 1981-	2*	8A*	9*	10*	12
Depth(m)	370	289	213	173	110
ASTR SPH	-	-	-	-	-
RHAB ABYS	-	-	-	-	-
BATH HIR (A)	-	-	-	-	-
BATH HIR (B)	-	-	-	-	-
HYP CYL	-	-	-	-	-
HYP MAL	-	-	-	-	-
HYP SUB	0.8	-	-	-	-
PSAM FUSCA	-	-	-	-	-
PELO BIC	-	-	-	-	-
SAC SPH	0.8	-	0.9	-	-
SAC JUV	-	-	-	-	-
AMMOP SP	-	-	-	-	-
HEMI BRAD	-	-	0.9	-	-
THUR ALB	0.8	3.1	0.9	-	-
THUR PROT	1.64	6.25	-	-	-
GLOM GORD	0.8	3.1	0.9	1.7	-
GLOM CHAR	-	-	-	-	-
TUR SHON	-	-	-	-	-
HORM CVIC	-	3.1	-	-	-
HORM SP	-	-	-	-	-
REO PIL	0.8	3.1	3.6	-	2.53
REO PSEU(A)	-	-	-	-	-
(B)	0.8	3.1	2.7	-	-
REO SUBD	0.8	3.1	0.9	17.0	7.6
MIL ARE	-	-	-	-	-
MIL LATA	-	-	-	-	-
CRIB JEF	4.1	6.25	7.32	5.0	11.4
CRIB SUB	-	-	-	-	-
CRIB WIE	-	-	-	-	-
SPIRO FIL	0.8	-	-	-	-
TEXT ANT	-	-	-	1.7	3.8
TEXT EAR	-	-	-	-	-
TROC GLABRA	0.8	9.4	1.8	6.8	2.53
TROC GABO	-	6.25	-	-	6.3
TROC A	-	-	-	-	1.27
TROC B	-	-	-	-	-
PORT ANTA	7.4	15.6	14.5	1.7	14.0
PORT ELT	-	3.1	2.7	-	1.27
CONO BULL	0.8	-	-	-	1.27
VERN MIN	-	-	-	-	1.27
VERN ADV	-	-	-	-	-
EGGE BRAD	0.8	-	-	-	-
CYCL INVO	1.64	-	-	-	-
PLAN BUC	-	-	0.9	-	-
CRUC TRI	-	-	-	-	-
PYRG DEP	-	-	0.9	-	-
PYRG ELO	-	-	-	-	-
PYRG MUR	-	-	-	-	-
PRGOL SPH	2.51	-	1.8	-	1.27
SIG UMB	-	-	-	-	-
MIL SP A	-	-	0.9	-	-
SP B	-	-	-	-	-
DENT COM	0.8	-	-	1.7	-
NODS MAR	-	-	-	-	-
NODS SP	-	-	-	-	-
LAG DIST	-	-	-	-	-
LAG ELON	-	-	-	-	-
LAG GRAC	-	-	-	-	-
LAG GRAS	-	9.4	-	-	-
LAG NEBU	-	-	-	-	-
LAG STRI	-	-	-	-	-
LING VIT					
LENT GIB	-	-	-	-	2.53
POLY SP	-	-	0.9	-	-

ENTO BICA	-	-	-	-	-
ENTO BILO	-	-	-	-	-
GLAND ANT	-	-	-	-	-
GLAND LAEV	-	-	-	-	1.27
LAR HYAL	-	-	-	-	-
FIS CORN	-	-	-	-	-
FIS FOLI	-	-	-	-	-
FIS MARG	0.8	3.1	2.7	6.8	-
FIS MENN	-	-	-	-	-
FIS SEM	0.8	-	-	-	-
FIS SPATH	0.8	-	-	-	-
FIS SUBF	0.8	-	-	-	-
FIS SUBT	-	-	-	-	-
FIS TEX	-	-	-	-	-
FIS TR-M	-	-	-	-	-
FIS TING	-	-	-	5.0	-
FIS SP	0.8	-	-	-	3.8
PARA CURTA	-	0.3	-	-	1.27
PARA FUS	-	-	-	-	-
PARA LATER	0.8	-	-	-	1.27
PARA MARG	-	-	-	-	-
PARA PSE-T	-	-	-	1.7	-
PARA PUST	-	-	-	-	-
PARA STAPH	-	-	-	-	1.27
PARA SUBC	-	3.1	-	-	-
OOL API	-	-	-	-	-
OOL HEX	-	-	-	-	-
OOL MELO	-	-	-	-	-
OOL SQUA	-	-	-	-	-
OOL A	-	-	-	-	-
OOL B	-	-	-	-	-
OOL C	-	-	-	-	-
PAT COR	-	-	-	-	3.8
PATS DEP	-	-	-	-	1.27
SPIR RAD	-	-	-	-	-
PSBU CHP	2.5	-	-	-	-
BUL ELG	-	-	-	-	1.27
BOL PSE	0.8	-	-	1.7	1.27
BOL PYG	-	-	-	-	-
BOL SP	-	-	-	-	-
CAS POR	7.4	-	8.2	5.0	1.27
CAS PARK	-	-	-	-	-
STAIN CON	-	-	-	-	-
TRIF EAR	38.0	3.1	18.02	10.2	3.8
TRIF PAUP	-	-	-	-	-
EPIS VIT	-	-	3.6	-	5.0
ROS GLOB	0.8	-	-	1.7	1.27
HER KEM	-	-	-	-	-
GLAB SP	-	-	-	-	-
SCHACK ANT	-	-	-	-	-
CIB LOB	0.8	-	1.8	-	-
ELPH SP	-	-	-	-	-
FUR EAR	-	-	-	-	2.55
EHR GLAB	7.4	6.25	11.8	22.0	3.8
GLOB BIO	1.64	-	-	-	1.27
GLOB CRAS	2.5	-	7.3	1.7	3.8
GLOB SUBG	-	3.1	-	-	-
AST ANT	1.6	-	0.9	1.7	1.27
AST ECH	3.3	3.1	-	-	-
NON IRID	-	-	-	-	1.27
PUL SUB	1.6	-	0.9	5.0	1.27
PUL BUL	-	-	0.9	-	-
TOTALS (%)	100.2	99.7	99.5	99.6	100.08

Percent live tests in New Harbour and Granite Harbour samples (0-2cm).

Sample:	1981-15	13	17	14A	16	18
Depth(m)	550	537	358	345	266	254
ASTR SPH	-	-	-	-	-	-
RHAB ABYS	-	-	-	-	3.2	-
BATH HIR (A)	-	-	-	-	-	-
BATH HIR (B)	-	-	-	2.5	1.6	2.14
HYP CYL	-	-	-	-	-	5.13
HYP MAL	-	-	-	-	-	0.43
HYP SUB	-	-	-	-	-	0.43
PSAM FUSCA	2.1	-	-	-	-	1.7
AMMOP SP	-	-	-	-	-	-
SAC SPH	-	-	-	-	-	-
SAC JUV	8.3	1.82	-	-	3.2	0.85
PELO BIC	-	-	-	-	-	0.43
THUR ALB	-	-	-	-	1.6	0.43
THUR PROT	-	-	-	-	-	-
HEMI BRAD	-	-	-	-	1.6	1.28
GLOM CORD	-	-	-	-	-	0.85
GLOM CHAR	-	-	-	-	-	-
TUR SHON	-	-	-	-	-	-
HORM OVIC	-	-	-	-	-	1.3
HORM SP	-	-	-	-	-	-
REO PIL	-	1.82	2.87	-	-	2.6
REO PSE(A)	-	-	-	-	-	2.6
(B)	-	-	-	-	-	1.28
REO SUBD	22.9	38.2	25.7	22.5	17.8	46.6
MIL ARE	-	-	-	6.25	1.6	-
MIL LATA	-	-	-	2.5	-	-
CRIB JEF	2.1	-	5.7	6.25	3.2	-
CRIB SUB	-	-	-	-	-	-
CRIB WIE	-	-	-	-	-	-
SPIRO FIL	-	-	-	-	-	-
TEXT ANT	18.7	21.82	-	15.0	24.2	6.84
TEXT EAR	-	-	-	-	-	1.28
TROC GLABRA	2.1	-	8.6	1.25	4.84	0.43
TROC GABO	-	-	-	-	-	-
TROC A	-	-	-	-	-	-
TROC B	-	-	-	-	-	-
PORT ANTA	-	3.63	14.3	8.75	8.06	11.54
PORT ELT	2.1	3.63	-	2.5	6.5	4.3
CONO BULL	-	1.82	-	-	-	2.14
VERN MIN	2.1	1.82	-	-	1.6	-
VERN ADV	-	-	-	-	-	-
EGGE BRAD	-	-	-	-	-	-
CYCL INVO	-	-	-	-	1.6	-
PLAN BUC	-	-	-	-	-	-
CRUC TRI	-	-	-	-	-	-
PYRG DEP	-	-	-	-	-	-
PYRG ELO	-	1.82	-	-	-	-
PYRG MUR	-	-	-	-	-	-
PRGOL SPH	-	-	-	-	-	-
SIG UMB	-	-	-	-	-	-
MIL SPP	-	-	-	-	-	-
DENT COM	-	-	-	-	-	-
NODS MAR	-	-	-	-	-	-
NODS SP	-	-	-	-	-	-
LAG DIST	-	-	-	-	-	-
LAG ELON	-	-	-	-	-	-
LAG GRAC	-	-	-	-	-	-
LAG GRAS	-	-	-	-	-	-
LAG NEBU	-	-	-	-	-	-
LAG STRI	-	-	-	-	-	-
LING VIT	-	-	-	-	-	-
LENT GIB	-	-	-	-	-	-
POLY SP	-	-	-	-	-	-

ENTO BICA	-	-	-	-	-	-
ENTO BILO	-	-	-	-	-	-
GLAND ANT	-	-	-	-	-	-
GLAND LAEV	-	-	-	-	-	-
LAR HYAL	-	-	-	-	-	-
FIS CORN	-	-	-	-	-	-
FIS FOLI	-	-	-	-	-	-
FIS MARG	-	-	-	-	-	-
FIS MENN	-	-	-	-	-	-
FIS SEM	-	-	-	-	-	-
FIS SPATH	-	-	-	-	-	-
FIS SUBF	-	-	-	-	-	-
FIS SUBT	-	-	-	1.25	-	-
FIS TEX	-	-	-	-	-	-
FIS TING	-	-	-	-	-	-
FIS TR-M	-	-	-	-	-	-
FIS SP	-	-	-	-	-	0.43
PAR CURTA	-	-	-	-	-	-
PARA FUS	-	-	-	-	-	-
PARA LATER	-	-	-	-	-	-
PARA MARG	-	-	-	-	-	-
PARA PSE-T	-	-	-	-	-	-
PARA PUST	-	-	-	-	-	-
PARA STAPH	-	-	-	-	-	-
PARA SUBC	-	-	-	-	-	-
OOL API	-	-	-	-	-	-
OOL HEX	-	-	-	-	-	-
OOL MELO	-	-	-	-	-	-
OOL SQUA	-	-	-	-	-	-
OOL A	-	-	-	-	-	-
OOL B	-	-	-	-	-	-
OOL C	-	-	-	-	-	-
PAT COR	-	-	-	-	-	-
PATS DEP	-	-	-	-	-	-
SPIR RAD	-	-	-	-	-	-
PSBU CHP	-	-	-	-	-	-
BUL ELG	-	-	-	-	-	-
BOL PSE	-	-	-	-	-	-
BOL PYG	-	-	-	-	-	-
BOL SP	-	-	-	-	-	-
CAS POR	-	-	11.4	-	1.6	-
CAS PARK	-	-	-	-	-	-
STAIN CON	-	-	-	-	-	-
TRIF EAR	-	-	-	-	-	-
TRIF PAUP	-	-	-	-	-	-
EPIS VIT	-	7.3	-	-	-	-
ROS GLOB	-	-	-	-	-	0.85
HER KEM	-	-	-	-	-	-
GLAB SP	-	-	-	-	-	-
SCHACK ANT	-	-	-	-	-	-
CIB LOB	-	-	-	-	-	-
ELPH SP	-	-	-	-	-	-
FUR EAR	35.42	9.1	-	13.75	9.68	0.43
EHR GLAB	-	-	-	-	-	-
GLOB BIO	-	-	20.0	-	-	-
GLOB CRAS	4.17	3.63	-	13.75	8.06	3.4
GLOB SUBG	-	-	-	-	-	-
AST ANT	-	-	2.87	-	-	-
AST ECH	-	3.63	-	-	-	0.43
NON IRID	-	-	-	-	-	-
PUL SUB	-	-	8.6	-	-	-
PUL BUL	-	-	-	-	-	-
TOTALS (%)	99.9	100.04	100.04	100.0	100.04	100.1

Absolute numbers of dead tests

Sample No:	81-1	3	4	5	6	7	2	8A
Depth (m)	850	560	560	496	460	420	370	289
ASTR SPH	-	-	-	-	-	1	-	-
RHAB ABYS	-	-	-	4	-	-	-	-
BATH HIR(A)	4	-	-	-	-	-	-	-
BATH HIR(B)	-	-	-	-	-	-	-	-
HYP CYL	5	-	-	-	4	3	-	2
HYP MAL	-	-	1	-	-	2	1	4
HYP SUB	-	6	13	3	14	8	-	2
PSAM FUSCA	19	1	9	8	3	6	1	18
PELO BIC	3	-	-	-	-	1	-	-
SAC SPH	-	-	-	-	-	-	-	-
SAC JUV	16	3	7	4	3	82	1	3
AMMOP SP	-	-	1	-	-	-	-	-
HEMI BRAD	-	-	1	-	-	-	1	-
THUR ALB	12	-	5	2	5	6	-	6
THUR PROT	-	-	-	-	-	1	-	-
GLOM GORD	5	6	36	1	5	47	5	13
GLOM CHAR	-	1	1	-	-	1	-	-
TUR SHON	-	-	-	-	1	-	-	-
HORM OVIC	1	4	16	1	3	27	-	1
HORM SP	-	-	-	-	-	-	-	-
REO PIL	25	20	67	8	28	106	3	11
REO PSEU(A)	3	4	-	-	1	-	-	-
(B)	1	-	-	-	-	-	-	-
REO SUBD	17	1	13	8	14	50	1	4
MIL ARE	29	6	16	1	12	24	1	-
MIL LATA	33	3	5	-	-	11	1	-
CRIB JEF	6	54	122	36	48	507	22	40
CRIB SUB	8	4	11	-	1	4	-	-
CRIB WIE	-	-	-	-	-	-	-	-
SPIRO FIL	1	1	6	-	-	16	-	-
TEXT ANT	189	37	181	19	40	666	9	2
TEXT EAR	34	15	35	1	4	75	-	3
TROC GLABRA	141	91	220	28	23	828	16	37
TROC GABO	41	15	35	5	13	304	10	16
TROC A	12	16	15	1	5	96	1	10
TROC B	-	-	-	-	-	-	-	2
PORT ANTA	152	372	686	109	96	2041	31	74
PORT ELT	122	49	103	25	16	157	5	8
CONO BULL	40	8	26	4	5	48	2	1
VERN MIN	18	16	24	1	4	218	5	6
VERN ADV	3	6	16	-	-	46	1	-
EGGE BRAD	-	-	-	-	-	2	-	-
CYCL INVO	1	-	-	-	-	-	-	-
PLAN BUC	-	-	-	-	-	-	-	-
CRUC TRI	-	-	-	-	1	5	-	-
PYRG DEP	-	-	-	-	-	-	-	2
PYRG ELO	-	1	-	-	-	2	-	-
PYRG MUR	-	-	-	-	-	-	-	-
PRGOL SPH	-	-	-	-	-	-	-	-
SIG UMB	-	1	1	5	-	2	-	-
MIL SP A	-	-	-	1	-	4	2	2
DENT COM	-	-	-	-	-	-	1	-
NODS MAR	-	-	-	-	-	-	-	-
NODS SP	-	-	-	-	-	-	1	2
LAG DIST	-	-	-	1	-	-	-	-
LAG ELON	-	-	-	1	-	1	-	-
LAG GRAC	-	-	-	1	-	-	-	-
LAG GRAS	-	-	1	1	-	-	-	2
LAG NEBU	-	-	-	-	-	-	-	2
LAG STRI	-	-	-	-	-	2	1	-
LING VIT	-	-	-	-	-	-	-	-
LENT GIB	-	-	-	-	-	-	-	1
POLY SP	-	-	-	-	-	-	-	4

ENTO BICA	-	-	-	-	-	-	-	-
ENTO BILO	-	-	-	-	-	-	-	-
GLAND ANT	-	-	-	-	-	1	6	-
GLAND LAEV	-	-	-	-	-	-	-	-
LAR HYAL	-	-	-	-	-	-	-	-
FIC CORN	-	-	-	-	-	-	-	-
FIS FOLI	-	-	-	-	-	-	-	-
FIS MARG	-	-	-	-	-	-	-	1
FIS MENN	-	-	-	-	-	-	-	-
FIS SEM	-	-	-	1	-	-	-	1
FIS SUBF	-	-	-	-	-	-	-	1
FIS SUBT	-	-	-	-	-	-	2	2
FIS TEX	-	-	1	-	-	-	-	-
FIS TR-M	-	-	-	-	-	-	-	-
FIS TING	-	-	-	-	-	-	-	3
FIS SPATH	-	-	-	-	-	-	-	3
FIS SP	-	-	-	-	-	-	-	-
PARA CURTA	-	-	-	-	-	-	-	-
PARA FUS	-	-	-	-	-	-	-	-
PARA LATER	-	-	-	-	-	-	-	1
PARA MARG	-	-	-	-	-	1	1	-
PARA PSE-T	-	-	-	-	-	-	-	2
PARA PUST	-	-	-	-	-	-	-	-
PARA STAPH	-	-	-	-	-	-	-	-
PARA SUBC	-	-	-	-	-	-	-	7
OOL API	-	-	-	-	-	-	-	-
OOL HEX	-	-	-	-	-	-	-	-
OOL MELO	-	-	-	-	-	-	2	-
OOL SQUA	-	-	-	-	-	-	-	-
OOL A	-	-	-	-	-	-	-	-
OOL B	-	-	-	-	-	-	-	1
OOL C	-	-	-	1	-	-	-	-
PAT COR	-	-	-	-	-	-	2	17
PATS DEP	-	-	-	-	-	-	-	2
SPIR RAD	-	-	-	-	-	-	-	-
PSBU CHP	-	-	-	-	-	2	-	1
BUL ELG	-	-	-	2	-	-	-	-
BOL PSE	-	-	-	2	-	8	1	1
BOL PYG	-	-	-	-	-	-	-	-
BOL SP	-	-	-	-	-	1	-	-
CAS POR	-	12	32	9	3	23	8	63
CAS PARK	-	-	-	-	-	-	-	-
STAIN CON	-	-	-	-	-	-	-	1
TRIF EAR	-	203	84	97	11	201	108	169
TRIF PAUP	-	1	-	2	-	6	-	-
EPIS VIT	-	2	-	-	-	5	12	60
ROS GLOB	-	-	-	-	-	2	10	54
HER KEM	-	-	-	-	-	-	-	-
GLAB SP	-	-	-	-	-	-	-	8
SCHACK ANT	-	-	-	-	-	-	-	1
CIB LOB	-	2	19	8	5	10	19	60
ELPH SP	-	-	-	-	-	-	-	-
FUR EAR	1	-	4	2	-	1	2	-
EHR GLAB	-	1	8	5	-	12	18	319
GLOB BIO	-	-	1	2	-	2	2	3
GLOB CRAS	-	20	10	18	1	161	28	164
GLOB SUBG	-	6	4	6	2	-	3	8
AST ANT	1	1	4	1	-	20	11	4
AST ECH	1	6	8	8	4	18	3	11
NON IRID	-	-	-	-	-	-	4	27
PUL SUB	-	2	4	2	1	11	2	1
PUL BUL	-	-	-	-	-	-	-	-
TOTALS (N)	944	997	1852	444	376	5885	366	1272

Absolute numbers of dead tests

Sample No:81-	9	10	12	15	13	17	14	16
Depth(m)	213	173	110	550	537	558	345	266
ASTR SPH	-	-	-	-	-	-	-	-
RHAB ABYS	-	-	-	-	-	-	-	9
BATH HIR(A)	-	-	-	1	1	-	-	-
BATH HIR(B)	-	-	1	-	1	-	-	-
HYP CYL	1	-	-	2	1	-	5	-
HYP MAL	-	1	-	-	3	-	1	-
HYP SUB	-	-	-	-	-	-	-	3
PSAM FUSCA	1	6	6	26	2	6	13	5
PELO BIC	-	-	-	-	-	-	-	-
SAC SPH	-	-	-	-	-	1	-	-
SAC JUV	8	3	17	28	3	6	6	3
AMMOP SP	-	-	-	-	-	1	-	-
HEMI BRAD	1	-	-	-	-	-	-	-
THUR ALB	4	-	-	-	-	-	1	-
THUR PROT	-	1	1	-	-	-	-	-
GLOM GORD	7	4	38	-	3	16	-	1
GLOM CHAR	-	-	-	-	-	-	-	-
TUR SHON	-	6	25	-	1	-	-	1
HORM OVIC	3	4	3	-	-	-	-	-
HORM SP	-	-	-	-	-	-	-	-
REO PIL	6	10	-	8	2	-	-	-
REO PSEU(A)	-	-	-	1	-	-	-	-
(B)	6	5	-	-	-	-	-	-
REO SUBD	9	4	8	27	26	16	14	12
MIL ARE	-	-	-	11	5	2	17	18
MIL LATA	1	-	-	10	1	-	9	8
CRIB JEF	56	74	217	10	18	56	21	8
CRIB SUB	-	-	-	6	1	1	-	-
CRIB WIE	-	-	-	-	-	-	-	-
SPIRO FIL	-	-	19	-	-	-	-	3
TEXT ANT	3	3	134	90	185	52	81	45
TEXT EAR	3	1	12	3	1	3	4	5
TROC GLABRA	40	35	352	97	45	41	124	188
TROC GABO	15	79	316	32	20	18	15	23
TROC A	7	-	52	2	-	1	-	2
TROC B	1	-	20	-	-	-	-	-
PORT ANTA	104	80	459	34	38	215	45	86
PORT ELT	6	9	62	16	34	20	19	3
CONO BULL	3	-	5	28	10	4	-	-
VERN MIN	3	-	56	5	13	5	9	18
VERN ADV	2	-	-	3	-	4	5	-
EGGE BRAD	-	-	1	-	-	-	-	-
CYCL INVO	-	4	-	-	-	-	-	-
PLAN BUC	-	11	-	-	-	-	-	-
CRUC TRI	-	4	-	-	-	-	-	-
PYRG DEP	-	3	-	-	-	-	-	-
PYRG ELO	1	2	-	-	-	1	-	1
PYRG MUR	-	-	-	-	-	-	-	-
PRGOL SPH	-	27	-	-	-	-	-	-
SIG UMB	-	-	-	-	-	-	-	-
MIL SP A	1	2	3	-	-	-	-	-
DENT COM	-	1	-	-	-	-	-	-
NODS MAR	-	7	1	-	-	-	-	-
NODS SP	-	-	-	-	1	-	-	-
LAG DIST	-	-	1	-	-	-	-	-
LAG ELON	2	-	-	-	-	-	-	-
LAG GRAC	-	-	-	-	-	-	-	-
LAG GRAS	-	3	3	-	-	-	-	-
LAG NEBU	-	3	-	-	-	-	-	-
LAG STRI	-	-	-	-	-	-	-	-
LING VIT	-	1	-	-	-	-	-	-
LENT GIB	2	1	1	-	-	-	-	-
POLY SP	-	-	2	-	-	-	-	-

ENTO BICA	-	-	1	-	-	-	-	-
ENTO BILO	-	1	2	-	-	-	-	-
GLAND ANT	1	4	-	-	-	-	-	-
GLAND LAEV	-	-	-	-	-	-	-	-
LAR HYAL	-	1	-	-	-	-	-	-
FIS CORN	-	1	-	-	-	-	-	-
FIS FOLI	-	-	-	-	-	-	-	-
FIS MARG	-	6	-	-	-	-	-	-
FIS MENN	-	12	5	-	-	-	-	-
FIS SEM	-	2	-	-	-	-	-	-
FIS SPATH	-	-	-	-	-	-	-	-
FIS SUBF	-	1	1	-	-	-	-	-
FIS SUBT	1	3	5	-	-	-	-	-
FIS TEX	-	1	-	-	-	-	-	-
FIS TING	-	21	1	-	-	-	-	-
FIS TR-M	-	-	-	-	-	-	-	-
FIS A	-	-	4	-	-	-	-	-
OOL API	-	1	-	-	-	-	-	-
OOL HEX	-	-	1	-	-	-	-	-
OOL MELO	-	-	-	-	-	-	-	-
OOL SQUA	1	-	-	-	-	-	-	-
OOL A	-	1	1	-	-	-	-	-
OOL B	-	1	-	-	-	-	-	-
OOL C	-	-	-	-	-	-	-	-
PARA CURTA	-	4	6	-	-	-	-	-
PARA FUS	-	1	1	-	-	-	-	-
PARA LATER	-	3	7	-	-	-	-	-
PARA MARG	-	-	-	-	-	-	-	-
PARA PSE-T	-	1	2	-	-	-	-	-
PARA PUST	-	1	-	-	-	-	-	-
PARA STAPH	-	-	4	-	-	-	-	-
PARA SUBC	-	-	-	-	-	-	-	-
PAT COR	-	41	4	-	-	-	-	-
PATS DEP	-	14	9	-	-	-	-	-
SPIR RAD	-	1	-	-	-	-	-	-
PSBU CHP	-	12	-	-	-	-	-	-
BUL ELG	-	-	4	-	-	-	-	-
BOL PSE	-	1	12	-	-	-	-	-
BOL PYG	-	-	-	-	-	-	-	-
BOL SP	-	-	-	-	-	-	-	-
CAS POR	27	84	98	-	-	5	-	2
CAS PARK	-	-	-	-	-	-	-	-
STAIN CON	-	-	1	-	-	-	-	-
TRIF EAR	137	108	108	-	-	3	-	-
TRIF PAUP	-	-	-	-	-	-	-	-
EPIS VIT	8	19	305	-	3	-	-	-
ROS GLOB	5	39	48	-	-	-	-	-
HER KEM	-	1	-	-	-	-	-	-
GLAB SP	-	15	46	-	-	-	-	-
SCHACK ANT	-	2	-	-	-	-	-	-
CIB LOB	7	64	50	-	-	-	-	-
ELPH SP	-	-	-	-	-	-	-	-
FUR EAR	3	1	1	3	4	-	3	1
EHR GLAB	77	860	82	-	-	-	-	-
GLOB BIO	1	5	1	-	-	7	-	-
GLOB CRAS	54	69	143	-	1	3	4	-
GLOB SUBG	8	-	6	-	-	6	-	-
AST ANT	13	58	81	-	-	3	-	-
AST ECH	2	4	2	-	1	-	-	-
NON IRID	1	3	7	-	-	-	-	-
PUL SUB	2	8	5	-	-	3	-	-
PUL BUL	-	-	-	-	-	-	-	-
TOTALS (N)	643	1868	2869	443	424	499	396	445

Absolute numbers of dead tests

Sample:	1981-18	80-6
Depth(m)	254	79
ASTR SPH	-	-
RHAB ABYS	-	-
BATH HIR(A)	3	-
BATH HIR(B)	2	-
HYP CYL	10	-
HYP MAL	-	-
HYP SUB	8	-
PSAM FUSCA	11	-
PELO BIC	6	-
SAC SPH	-	-
SAC JUV	37	3
AMMOPEM	-	-
HEMI BRAD	1	-
THUR ALB	1	-
THUR PROT	-	-
GLOM GORD	6	5
GLOM CHAR	-	-
TUR SHON	-	-
HORM OVIC	39	-
HORM SP	-	-
REO PIL	14	3
REO PSEU(A)	20	-
(B)	9	-
REO SUBD	27	12
MIL ARE	81	-
MIL LATA	17	-
CRIB JEF	7	123
CRIB SUB	-	-
CRIB WIE	2	-
SPIRO FIL	-	-
TEXT ANT	114	30
TEXT EAR	11	8
TROC GLABRA	1	56
TROC GABO	7	51
TROC A	-	5
TROC B	-	1
PORT ANTA	70	378
PORT ELT	13	34
CONO BULL	41	1
VERN MIN	4	15
VERN ADV	-	2
EGGE BRAD	-	-
CYCL INVO	-	-
PLAN BUC	-	-
CRUC TRI	-	-
PYRG DEP	-	-
PYRG ELO	-	-
PYRG MUR	-	-
PRGOL SPH	-	-
SIG UMB	-	-
MIL SP B	-	2
LENT GIB	-	-
NODS MAR	-	-
NODS SP	-	-
LAG DIST	-	-
LAG ELON	-	-
LAG GRAC	-	-
LAG GRAS	-	1
LAG NEBU	-	-
LAG STRI	-	-
LING VIT	-	-
DENT COM	1	-
POLY SP	-	-

ENTO BICA	-	-
ENTO BILO	-	-
GLAND ANT	-	-
GLAND LAEV	-	-
LAR HYAL	-	-
FIS CORN	-	-
FIS FOLI	-	-
FIS MARG	-	-
FIS MENN	-	-
FIS SEM	-	-
FIS SPATH	-	-
FIS SUBF	-	-
FIS SUBT	-	-
FIS TEX	-	1
FIS TING	-	-
FIS TR-M	-	-
FIS SP	-	-
OOL API	-	-
OOL HEX	-	-
OOL MELO	-	-
OOL SQUA	-	-
OOL A	-	-
OOL B	-	1
OOL C	-	-
PARA CURTA	-	-
PARA FUS	-	-
PARA LATER	-	2
PARA MARG	-	1
PARA PSE-T	-	-
PARA PUST	-	-
PARA STAPH	-	-
PARA SUBC	-	-
PAT COR	-	1
PATS DEP	-	-
SPIR RAD	-	-
PSBU CHP	-	-
BUL ELG	-	-
BOL PSE	-	48
BOL PYG	-	-
BOL SP	-	-
CAS POR	-	154
CAS PARK	-	-
STAIN CON	-	-
TRIF EAR	-	13
TRIF PAUP	-	-
EPIS VIT	1	201
ROS GLOB	-	3
HER KEM	-	-
GLAB SP	-	-
SCHACK ANT	-	1
CIB LOB	-	27
ELPH SP	-	-
FUR EAR	-	1
EHR GLAB	-	19
GLOB BIO	-	13
GLOB CRAS	3	96
GLOB SUBG	-	31
AST ANT	1	104
AST ECH	-	2
NON IRID	-	-
PUL SUB	-	-
PUL BUL	-	-
TOTALS (N)	568	1449

Percent dead tests

Sample:	1981-2	8A	9	10	12
Depth(m)	370	289	213	173	110
ASTR SPH	-	-	-	-	-
RHAB ABYS	-	-	-	-	-
BATH HIR(A)	-	-	-	-	-
BATH HIR(B)	-	-	-	-	0.03
HYP CYL	-	-	0.16	-	-
HYP MAL	0.3	0.3	-	0.05	-
HYP SUB	-	0.16	-	-	-
PSAM FUSCA	0.3	1.42	0.16	0.3	0.2
PELO BIC	-	-	-	-	-
SAC SPH	-	-	-	-	-
SAC JUV	0.3	0.24	1.24	0.16	0.6
AMMOP SP	-	-	-	-	-
HEMI BRAD	0.3	-	0.16	-	-
THUR ALB	-	0.5	0.62	-	-
THUR PROT	-	-	-	0.05	0.03
GLOM GORD	1.4	1.0	1.1	0.2	1.3
GLOM CHAR	-	-	-	-	-
TUR SHON	-	-	-	0.3	0.9
HORM OVIC	-	0.08	0.46	0.2	0.1
HORM SP	-	-	-	-	-
REO PIL	0.8	0.9	0.93	0.5	-
REO PSE(A)	-	-	-	-	-
(B)	-	-	0.93	0.3	-
REO SUBD	0.3	0.3	1.4	0.2	0.3
MIL ARE	0.3	-	-	-	-
MIL LATA	0.3	-	0.16	-	-
CRIB JEFF	6.0	3.0	8.7	4.0	7.6
CRIB SUB	-	-	-	-	-
CRIB WIE	-	-	-	-	-
SPIRO FIL	-	-	-	-	0.7
TEXT ANT	2.5	0.16	0.46	0.16	4.7
TEXT EAR	-	0.2	0.46	0.05	0.4
TROC GLABRA	4.4	3.0	6.2	2.0	12.3
TROC GABO	2.7	1.26	2.3	4.3	11.0
TROC A	-	0.8	1.1	-	1.8
TROC B	-	0.16	0.16	-	0.7
PORT ANTA	8.5	5.8	16.43	4.3	16.0
PORT ELT	1.4	0.6	0.93	0.5	2.2
CONO BULL	0.6	0.08	0.46	-	0.2
VERN MIN	1.4	0.5	0.46	-	2.0
VERN ADV	0.3	-	0.3	-	-
EGGE BRAD	-	-	-	-	0.03
CYCL INVO	-	-	-	0.2	-
PLAN BUC	-	-	-	0.6	-
CRUC TRI	-	-	-	0.2	-
PYRG DEP	-	0.16	-	0.16	-
PYRG ELO	-	-	0.16	0.1	-
PYRG MUR	-	-	-	-	-
PRGOL SPH	-	-	-	1.44	-
SIG UMB	-	-	-	-	-
MIL SP A	0.6	0.16	0.16	0.1	0.1
DENT COM	0.3	-	-	0.05	-
NODS MAR	-	-	-	0.4	0.03
NODS SP	0.3	0.16	-	-	-
LAG DIST	-	-	-	-	-
LAG GRAC	-	-	-	-	-
LAG GRAS	-	0.16	-	0.16	0.1
LAG ELON	-	-	0.3	-	0.03
LAG NEBU	-	0.16	-	0.16	-
LAG STRI	0.3	-	-	-	-
LING VIT	-	-	-	-	-
LENT GIB	-	0.08	0.3	0.05	0.03
POLY SP	-	0.3	-	-	0.07

ENTO BICA	-	-	-	-	0.03
ENTO BILO	-	-	-	0.05	0.07
GLAND ANT	1.6	-	0.16	0.2	-
GLAND LAEV	-	-	-	-	-
LAR HYAL	-	-	-	0.05	-
FIS CORN	-	-	-	-	-
FIS FOLI	-	-	-	-	-
FIS MARG	-	0.08	-	0.3	-
FIS MENN	-	-	-	0.7	0.2
FIS SEM	-	0.08	-	0.1	-
FIS SPATH	-	0.24	-	-	-
FIS SUBF	-	0.08	-	0.05	0.03
FIS SUBT	0.6	0.16	0.16	0.16	0.2
FIS TEX	-	-	-	0.05	-
FIS TING	-	0.2	-	1.1	0.03
FIS TR-M	-	-	-	-	-
FIS SP	-	-	-	-	0.14
PARA CURT	-	-	-	0.2	0.23
PARA FUS	-	-	-	0.05	0.03
PARA LATER	-	0.08	-	0.16	0.27
PARA MARG	0.3	-	-	-	-
PARA PSE-T	-	0.16	-	0.05	0.07
PARA PUST	-	-	-	0.05	-
PARA STAPH	-	-	-	-	0.14
PARA SUBC	-	0.5	-	-	-
OOL API	-	-	-	0.05	-
OOL HEX	-	-	-	-	0.03
OOL MELO	0.6	-	-	-	-
OOL SQUA	-	-	-	-	-
OOL A	-	-	-	0.05	0.03
OOL B	-	0.08	-	-	-
OOL C	-	-	-	-	-
PAT COR	0.6	1.3	-	2.2	0.14
PATS DEP	-	0.16	-	0.75	0.3
SPIR RAD	-	-	-	0.05	-
PSBU CHP	-	0.08	-	0.6	-
BUL ELG	-	-	-	-	0.14
BOL PSE	0.3	0.08	-	0.05	0.4
BOL PYG	-	-	-	-	-
BOL SP	-	-	-	-	-
CAS POR	2.2	5.0	4.2	4.5	3.4
CAS PARK	-	-	-	-	-
STAIN CON	-	0.08	-	-	0.03
TRIF EAR	30.0	13.3	21.3	5.8	3.8
TRIF PUNC	-	-	-	-	-
EPIS VIT	3.27	4.7	1.24	1.0	10.6
ROS GLOB	2.7	4.1	0.78	2.1	1.7
HER KEM	-	-	-	0.05	-
GLAB SP	-	0.63	-	0.8	1.6
SCHACK ANT	-	0.08	-	0.1	-
CIB LOB	5.2	5.0	1.1	3.4	1.7
ELPH SP	-	-	-	-	-
FUR EAR	0.6	-	0.46	0.05	0.03
EHR GLAB	5.0	25.0	12.0	46.03	2.9
GLOB BIO	0.6	0.2	0.16	0.3	0.03
GLOB CRAS	7.7	13.0	8.4	3.7	5.0
GLOB SUBG	0.8	0.63	1.23	-	0.2
AST ANT	3.0	0.3	2.0	3.11	2.8
AST ECH	0.8	0.9	0.3	0.2	0.07
NON IRID	1.1	2.0	0.16	0.16	0.2
PUL SUB	0.6	0.08	0.3	0.43	0.17
PUL BUL	-	-	-	-	-
TOTALS (%)	100.07	100.0	100.15	99.93	100.08

Percent dead tests in 1981 cores

Sample: 1981-	1	3	4	5	6	7
Depth(m)	850	560	560	496	460	420
ASTR SPH	-	-	-	-	-	0.02
RHAB ABYS	-	-	-	0.9	-	-
BATH HIR(A)	0.4	-	-	-	-	-
BATH HIR(B)	-	-	-	-	-	-
HYP CYL	0.5	-	-	-	4.78	0.05
HYP MAL	-	-	0.5	-	-	0.03
HYP SUB	-	0.6	0.5	0.68	-	0.14
PSAM FUSCA	2.0	0.1	0.5	1.8	0.8	0.1
PELO BIC	0.32	-	-	-	-	0.02
SAC SPH	-	-	-	-	-	-
SAC JUV	1.7	0.3	0.4	0.9	0.8	1.4
AMMOP SP	-	-	-	-	-	-
HEMI BRAD	-	-	0.48	-	-	-
THUR ALB	1.3	-	0.3	0.45	1.3	0.10
THUR PROT	-	-	-	-	-	0.02
GLOM GORD	0.5	0.6	1.9	0.2	1.3	0.8
GLOM CHAR	-	0.1	0.05	-	-	0.02
TUR SHON	-	-	-	-	0.3	-
HORM OVIC	0.1	0.4	0.9	0.2	0.8	0.46
HORM SP	-	-	-	-	-	-
REO PIL	2.6	2.0	3.6	1.8	7.45	1.8
REO PSE (A)	0.32	0.4	-	-	0.3	-
(B)	0.1	-	-	-	-	-
REO SUBD	1.8	0.1	0.7	1.8	3.7	0.85
MIL ARE	3.1	0.6	0.9	0.2	3.2	0.4
MIL LATA	3.5	0.3	0.3	-	-	0.19
CRIB JEF	0.6	5.41	6.6	8.1	12.8	8.6
CRIB SUB	0.8	0.4	0.6	-	0.3	0.07
CRIB WIE	-	-	-	-	-	-
SPIRO FIL	0.1	0.1	0.3	-	-	0.27
TEXT ANT	20.02	3.7	10.0	4.3	10.6	11.32
TEXT EAR	3.6	1.5	1.9	0.2	1.0	1.27
TROC GLABRA	15.0	9.1	11.8	6.3	6.1	14.07
TROC GABO	4.34	1.5	2.0	1.1	3.5	5.17
TROC A	1.3	1.6	0.8	0.2	1.3	1.63
TROC B	-	-	-	-	-	-
PORT ANTA	16.1	37.3	37.0	24.5	25.5	34.68
PORT ELT	13.0	4.9	5.6	5.6	4.3	2.67
CONO BULL	4.24	0.8	1.4	0.9	1.3	0.82
VERN MIN	1.91	1.6	1.3	0.2	1.0	3.7
VERN ADV	0.32	0.6	0.9	-	-	0.78
EGGE BRAD	-	-	-	-	-	0.03
CYCL INVO	0.1	-	-	-	-	-
PLAN BUC	-	-	-	-	-	-
CRUC TRI	-	-	-	-	0.3	0.08
PYRG DEP	-	-	-	-	-	-
PYRG ELO	-	0.1	-	-	-	0.03
PYRG MUR	-	-	-	-	-	-
PRGOL SPH	-	-	-	-	-	-
SIG UMB	-	0.1	0.05	1.1	-	0.03
MIL SP A	-	-	-	0.2	-	0.07
DENT COM	-	-	-	-	-	-
NODS MAR	-	-	-	-	-	-
NODS SP	-	-	-	-	-	-
LAG DIST	-	-	-	-	-	-
LAG GRAC	-	-	-	0.2	-	-
LAG GRAS	-	-	0.05	0.2	-	-
LAG ELON	-	-	-	0.2	-	0.02
LAG NEBU	-	-	-	-	-	-
LAG STRI	-	-	-	-	-	0.03
LING VIT	-	-	-	-	-	-
LENT GIB	-	-	-	-	-	-
POLY SP	-	-	-	-	-	-

ENTO BICA	-	-	-	-	-	-
ENTO BILO	-	-	-	-	-	-
GLAND ANT	-	-	-	-	-	0.02
GLAND LAEV	-	-	-	-	-	-
LAR HYAL	-	-	-	-	-	-
FIS CORN	-	-	-	-	-	-
FIS FOLI	-	-	-	-	-	-
FIS MARG	-	-	-	-	-	-
FIS MENN	-	-	-	-	-	-
FIS SEM	-	-	-	0.2	-	-
FIS SPATH	-	-	-	-	-	-
FIS SUBF	-	-	-	-	-	-
FIS SUBT	-	-	-	-	-	-
FIS TEX	-	-	-	-	-	-
FIS TING	-	-	-	-	-	-
FIS TR-M	-	-	-	-	-	-
FIS SP	-	-	-	-	-	-
PARA CURTA	-	-	-	-	-	-
PARA FUS	-	-	-	-	-	-
PARA LATER	-	-	-	-	-	-
PARA MARG	-	-	-	-	-	0.02
PARA PSE-T	-	-	-	-	-	-
PARA PUST	-	-	0.05	-	-	-
PARA STAPH	-	-	-	-	-	-
PARA SUBC	-	-	-	-	-	-
OOL API	-	-	-	-	-	-
OOL HEX	-	-	-	-	-	-
OOL MELO	-	-	-	-	-	-
OOL SQUA	-	-	-	-	-	-
OOL A	-	-	-	-	-	-
OOL B	-	-	-	-	-	-
OOL C	-	-	-	0.2	-	-
PAT COR	-	-	-	-	-	-
PATS DEP	-	-	-	-	-	-
SPIR RAD	-	-	-	-	-	-
PSBU CHP	-	-	-	-	-	0.03
BUL ELG	-	-	-	0.5	-	-
BOL PSE	-	-	-	0.5	-	0.14
BOL PYG	-	-	-	-	-	-
BOL SP	-	-	-	-	-	0.02
CAS POR	-	1.2	1.7	2.0	0.8	0.39
CAS PARK	-	-	-	-	-	-
STAIN CON	-	-	-	-	-	-
TRIF EAR	-	20.4	4.5	22.0	3.0	3.41
TRIF PAUP	-	0.1	-	0.5	-	0.1
EPIS VIT	-	0.2	-	-	-	0.08
ROS GLOB	-	-	-	-	-	0.03
HER KEM	-	-	-	-	-	-
GLAB SP	-	-	-	-	-	-
SCHACK ANT	-	-	-	-	-	-
CIB LOB	-	0.2	1.0	1.8	1.3	0.17
ELPH SP	-	-	-	-	-	-
FUR EAR	0.1	-	0.2	0.5	-	0.02
EHR GLAB	-	0.1	0.4	1.1	-	0.2
GLOB BIO	-	-	0.05	0.5	-	0.03
GLOB CRAS	-	2.0	0.5	4.0	0.3	2.74
GLOB SUBG	-	0.6	0.2	1.4	0.5	-
AST ANT	0.1	0.1	0.2	0.2	-	0.34
AST ECH	0.1	0.6	0.4	1.8	1.0	0.3
NON IRID	-	-	-	-	-	-
PUL SUB	-	0.2	0.2	0.5	0.3	0.19
PUL BUL	-	-	-	-	-	-
TOTALS (%)	99.99	99 91	100.1	99.93	99.93	99.97

Percent dead foraminifera

Sample:	1981-15	13	17	14A	16	18
Depth(m)	550	537	358	345	266	254
ASTR SPH	-	-	-	-	-	-
RHAB ABYS	-	-	-	-	2.02	-
BATH HIR (A)	0.23	0.23	-	-	-	0.53
BATH HIR (B)	-	0.23	-	-	-	0.35
HYP CYL	0.45	0.47	-	1.26	-	1.76
HYP MAL	-	0.47	-	0.25	-	-
HYP SUB	-	-	-	-	0.67	1.4
PSAM FUSCA	5.8	0.47	1.2	3.3	1.12	1.94
AMMOP SP	-	-	0.2	-	-	-
SAC SPH	-	-	0.2	-	-	-
SAC JUV	6.3	0.7	1.2	1.5	0.67	6.5
PELO BIC	-	-	-	-	-	1.06
THUR ALB	-	-	-	0.25	-	0.18
THUR PROT	-	-	-	-	-	-
HEMI BRAD	-	-	-	-	-	0.18
GLOM GORD	-	0.7	3.2	-	0.22	1.06
GLOM CHAR	-	-	-	-	-	-
TUR SHON	-	0.23	-	-	0.22	-
HORM OVIC	-	-	-	-	-	6.9
HORM SP	-	-	-	-	-	-
REO PIL	1.8	0.47	-	-	-	2.5
REO PSE (A)	0.23	-	-	-	-	3.5
(B)	-	-	-	-	-	1.6
REO SUBD	6.1	6.13	3.2	3.53	2.7	4.75
MIL ARE	2.5	1.2	0.4	4.3	4.04	14.3
MIL LATA	2.3	0.23	-	2.3	1.8	3.0
CRIB JEF	2.3	4.2	11.22	5.3	1.8	1.23
CRIB SUB	1.4	0.23	0.2	-	-	-
CRIB WIE	-	-	-	-	-	0.35
SPIRO FIL	-	-	-	-	0.67	-
TEXT ANT	20.3	43.63	10.42	20.45	10.11	20.0
TEXT EAR	0.7	0.23	0.6	1.0	1.12	1.93
TROC GLABRA	21.9	10.6	8.2	31.31	42.25	0.18
TROC GABO	7.2	4.7	3.6	3.79	5.17	1.23
TROC A	0.45	-	0.2	-	0.45	-
TROC B	-	-	-	-	-	-
PORT ANTA	7.7	9.0	43.1	11.36	19.32	12.3
PORT ELT	3.6	8.0	4.0	4.8	0.67	2.3
CONO BULL	6.3	2.4	0.8	-	-	7.2
VERN MIN	1.1	3.1	1.0	2.3	4.04	0.7
VERN ADV	0.7	-	0.8	1.26	-	-
EGGE BRAD	-	-	-	-	-	-
CYCL INVO	-	-	-	-	-	-
PLAN BUC	-	-	-	-	-	-
CRUC TRI	-	-	-	-	0.22	-
PYRG DEP	-	-	-	-	-	-
PYRG ELO	-	-	0.2	-	-	-
PYRG MUR	-	-	-	-	-	-
PROOL SPH	-	-	-	-	-	-
SIG UMB	-	-	-	-	-	-
MIL SPP	-	-	-	-	-	-
DENT DOM	-	-	-	-	-	0.18
NODS MAR	-	-	-	-	-	-
NODS SP	-	0.23	-	-	-	-
LAG DIST	-	-	-	-	-	-
LAG ELON	-	-	-	-	-	-
LAG GRAC	-	-	-	-	-	-
LAG GRAS	-	-	-	-	-	-
LAG NEBU	-	-	-	-	-	-
LAG STRI	-	-	-	-	-	-
LING VIT	-	-	-	-	-	-
LENT GIB	-	-	-	-	-	-
POLY SP	-	-	-	-	-	-

ENTO BICA	-	-	-	-	-	-
ENTO BILO	-	-	-	-	-	-
GLAND ANT	-	-	-	-	-	-
GLAND LAEV	-	-	-	-	-	-
LAR HYAL	-	-	-	-	-	-
FIS CORN	-	-	-	-	-	-
FIS FOLI	-	-	-	-	-	-
FIS MARG	-	-	-	-	-	-
FIS MENN	-	-	-	-	-	-
FIS SEM	-	-	-	-	-	-
FIS SPATH	-	-	-	-	-	-
FIS SUBF	-	-	-	-	-	-
FIS SUBT	-	-	-	-	-	-
FIS TEX	-	-	-	-	-	-
FIS TING	-	-	-	-	-	-
FIS TR-M	-	-	-	-	-	-
FIS SP	-	-	-	-	-	-
PARA CURTA	-	-	-	-	-	-
PARA FUS	-	-	-	-	-	-
PARA MARG	-	-	-	-	-	-
PARA PSE-T	-	-	-	-	-	-
PARA PUST	-	-	-	-	-	-
PARA STAPH	-	-	-	-	-	-
PARA SUBC	-	-	-	-	-	-
OOL API	-	-	-	-	-	-
OOL HEX	-	-	-	-	-	-
OOL MELO	-	-	-	-	-	-
OOL SQUA	-	-	-	-	-	-
OOL A	-	-	-	-	-	-
OOL B	-	-	-	-	-	-
OOL C	-	-	-	-	-	-
PAT COR	-	-	-	-	-	-
PATS DEP	-	-	-	-	-	-
SPIR RAD	-	-	-	-	-	-
PSBU CHP	-	-	-	-	-	-
BUL ELG	-	-	-	-	-	-
BOL PSE	-	-	-	-	-	-
BOL PYG	-	-	-	-	-	-
BOL SP	-	-	-	-	-	-
CAS POR	-	-	1.0	-	0.45	-
CAS PARK	-	-	-	-	-	-
STAIN SP	-	-	-	-	-	-
TRIF EAR	-	-	0.6	-	-	-
TRIF PAUP	-	-	-	-	-	-
EPIS VIT	-	0.7	-	-	-	0.18
ROS GLOB	-	-	-	-	-	-
HER KEM	-	-	-	-	-	-
GLAB SP	-	-	-	-	-	-
SCHACK ANT	-	-	-	-	-	-
CIB LOB	-	-	-	-	-	-
ELPH SP	-	-	-	-	-	-
FUR EAR	0.7	0.9	-	0.76	0.22	-
EHR GLAB	-	-	-	-	-	-
GLOB BIO	-	-	1.4	-	-	-
GLOB CRAS	-	0.23	0.6	1.0	-	0.53
GLOB SUBG	-	-	1.2	-	-	-
AST ANT	-	-	0.6	-	-	0.18
AST ECH	-	0.23	-	-	-	-
NON IRID	-	-	-	-	-	-
PUL SUB	-	-	0.6	-	-	-
PUL BUL	-	-	-	-	-	-
TOTALS (%)	100.06	99.92	99.94	100.03	99.95	100.06

Absolute numbers of live tests.
No live tests in 82-2(40-43cm),82-3(42-45cm) and 82-1(25-30cm)

Sample:	1982-2	82-4	82-3	82-1	80-6
Depth(m)	796	212	139	303	79
ASTR SPH	-	-	-	-	-
RHAB ABYS	-	-	-	-	-
BATH HIR (B)	-	-	-	-	-
BATH HIR (A)	-	-	-	-	-
HYP CYL	-	-	-	-	-
HYP MAL	-	-	-	-	-
HYP SUBN	-	1	-	-	-
PSAM FUSCA	-	-	-	-	-
PELO BIC	-	-	-	-	-
SAC SPH	-	1	1	-	-
SAC JUV	1	1	-	-	-
AMMOP SP	-	-	-	-	-
HEMI BRAD	-	-	-	-	-
THUR ALB	-	1	-	-	-
THUR PROT	-	-	-	1	-
GLOM GORD	-	-	-	-	-
GLOM CHAR	-	-	-	-	-
TUR SHON	-	-	-	-	-
HORM OVIC	-	1	-	2	-
HORM SP	-	-	-	-	-
REO PIL	-	1	1	-	-
REO PSEU(A)	-	-	-	-	-
(B)	-	3	-	-	-
REO SUBD	4	4	5	19	1
MIL ARE	2	-	-	3	1
MIL LATA	1	-	-	-	-
CRIB JEF	3	3	6	1	2
CRIB SUB	-	-	-	-	-
CRIB WIE	-	-	-	-	-
SPIRC FIL	-	-	-	-	-
TEXT ANT	-	-	-	3	-
TEXT EAR	-	-	1	-	-
TROC GLABRA	1	2	-	-	-
TROC GABO	1	-	1	2	-
TROC A	-	-	-	-	-
TROC B	-	1	-	-	-
PORT ANTA	3	6	18	8	1
PORT ELT	-	5	2	1	6
CONO BULL	1	-	-	-	-
VERN MIN	-	-	-	-	-
VERN ADV	-	-	-	-	-
EGGE BRAD	-	-	-	-	-
CYCL INVO	-	-	-	-	-
PLAN BUC	-	-	-	-	-
CRUC TRI	-	-	-	-	-
PYRG DEP	-	-	-	-	-
PYRG ELO	-	-	-	-	-
PYRG MUR	-	-	-	-	-
PRGOL SPH	-	-	-	-	-
SIG UMB	-	-	-	-	-
MIL SP A	-	-	1	-	-
B	-	-	1	-	-
DENT COM	-	-	-	-	-
NODS MAR	-	-	-	-	-
NODS SP	-	-	-	-	-
LAG DIST	-	-	-	-	-
LAG ELON	-	-	-	-	-
LAG GRAC	-	-	-	-	-
LAG GRAS	-	-	-	-	-
LAG NEBU	-	-	-	-	-
LAG STRI	-	-	-	-	-
LING VIT	-	-	-	-	-
LENT GIB	-	-	-	-	-
POLY SP	-	-	-	-	-

ENTO BICA	-	-	-	-	-
ENTO BILO	-	-	-	-	-
GLAND ANT	-	-	-	-	-
GLAND LAEV	-	-	-	-	-
LAR HYAL	-	-	-	-	-
FIS CORN	-	-	-	-	-
FIS FOLI	-	-	-	-	-
FIS MARG	-	-	-	-	-
FIS MENN	-	-	-	-	-
FIS SEM	-	-	-	-	-
FIS SPATH	-	-	-	-	-
FIS SUBF	-	-	-	-	-
FIS SUBT	-	-	-	-	-
FIS TEX	-	-	-	-	-
FIS TING	-	-	-	-	-
FIS TR-M	-	-	-	-	-
FIS SP	-	-	1	-	-
PARA CURTA	-	-	-	-	-
PARA FUS	-	-	-	-	-
PARA LATER	-	-	-	-	-
PARA MARG	-	-	-	-	-
PARA PSE-T	-	-	-	-	-
PARA PUST	-	-	-	-	-
PARA STAPH	-	-	-	-	-
PARA SUBC	-	-	-	-	-
OOL API	-	-	-	-	-
OOL HEX	-	-	-	-	-
OOL MELO	-	-	-	-	-
OOL SQUA	-	-	-	-	-
OOL A	-	-	-	-	-
OOL B	-	-	-	-	-
OOL C	-	-	-	-	-
PAT COR	-	-	-	-	1
PATS DEP	-	-	-	-	-
SPIR RAD	-	-	-	-	-
PSBU CHP	-	-	-	-	-
BUL ELG	-	-	-	-	-
BOL PSE	1	-	-	-	14
BOL PYG	-	-	-	-	-
BOL SP	-	-	-	-	-
CAS POR	-	3	-	-	3
CAS PARK	-	-	-	-	-
STAIN CON	-	-	1	-	-
TRIF EAR	-	1	-	3	-
TRIF PUNC	-	-	-	-	-
EPIS VIT	1	-	19	-	4
ROS GLOB	-	-	-	-	-
HER KEM	-	-	-	-	-
GLAB SP	-	-	-	-	-
SCHACK ANT	-	-	-	-	-
CIB LOB	-	-	-	-	-
ELPH SP	-	-	-	-	-
FUR EAR	8	-	-	-	-
EHR GLAB	-	1	-	-	-
GLOB BIO	-	-	1	-	-
GLOB CRAS	4	1	7	-	3
GLOB SUBG	-	-	-	-	2
AST ANT	-	-	-	-	11
AST ECH	-	-	-	1	-
NON IRID	4	-	-	-	-
PUL SUB	-	-	-	-	1
PUL BUL	-	-	-	-	-
TOTALS (N)	35	36*	67	44*	50

Percent live tests, Cores 1982-1,2,3,4, Granite Harbour, Cape Chocolate and Blue Glacier Snout, and Grab 80-6 (New Harbour).
No live tests found in 82-2(40-43cm),82-3(42-45cm),82-1(25-30cm)

Sample:	1982-2	82-4	82-3	82-1	80-6
Depth(m)	796	212	139	303	79
ASTR SPH	-	-	-	-	-
RHAB ABYS	-	-	-	-	-
BATH HIR (A)	-	-	-	-	-
BATH HIR (B)	-	-	-	-	-
HYP CYL	-	-	-	-	-
HYP MAL	-	-	-	-	-
HYP SUBN	-	2.8	-	-	-
PSAM FUSCA	-	-	-	-	-
PELO BIC	-	-	-	-	-
SAC SPH	-	2.8	1.5	-	-
SAC JUV	2.9	2.8	-	-	-
AMMOP SP	-	-	-	-	-
HEMI BRAD	-	-	-	-	-
THUR ALB	-	2.8	-	-	-
THUR PROT	-	-	-	2.3	-
GLOM GORD	-	-	-	-	-
GLOM CHAR	-	-	-	-	-
TUR SHON	-	-	-	-	-
HORM OVIC	-	2.8	-	4.5	-
HORM SP	-	-	-	-	-
REO PIL	-	2.8	1.5	-	-
REO PSE (A)	-	-	-	-	-
(B)	-	8.3	-	-	-
REO SUBD	11.4	11.1	7.6	43.2	2.0
MIL ARE	5.7	-	-	6.8	2.0
MIL LATA	2.9	-	-	-	-
CRIB JEFF	8.6	8.3	9.1	2.3	4.0
CRIB SUB	-	-	-	-	-
CRIB WIE	-	-	-	-	-
SPIRO FIL	-	-	-	-	-
TEXT ANT	-	-	-	6.8	-
TEXT EAR	-	-	1.5	-	-
TROC GLABRA	2.9	5.6	-	-	-
TROC GABO	2.9	-	1.5	4.5	-
TROC A	-	-	-	-	-
TROC B	-	2.8	-	-	-
PORT ANTA	8.6	16.7	27.3	18.2	2.0
PORT ELT	-	13.9	3.0	2.3	12.0
CONO BULL	2.9	-	-	-	-
VERN MIN	-	-	-	-	-
VERN ADV	-	-	-	-	-
EGGE BRAD	-	-	-	-	-
CYCL INVO	-	-	-	-	-
PLAN BUC	-	-	-	-	-
CRUC TRI	-	-	-	-	-
PYRG DEP	-	-	-	-	-
PYRG ELO	-	-	-	-	-
PYRG MUR	-	-	-	-	-
PRGOL SPH	-	-	-	-	-
SIG UMB	-	-	-	-	-
MIL SP A	-	-	1.5	-	-
SP B	-	-	1.5	-	-
DENT COM	-	-	-	-	-
NODS MAR	-	-	-	-	-
NODS SP	-	-	-	-	-
LAG DIST	-	-	-	-	-
LAG GRAC	-	-	-	-	-
LAG GRAS	-	-	-	-	-
LAG ELON	-	-	-	-	-
LAG NEBU	-	-	-	-	-
LAG STRI	-	-	-	-	-
LING VIT	-	-	-	-	-
LENT GIB	-	-	-	-	-
POLY SP	-	-	-	-	-

ENTO BICA	-	-	-	-	-
ENTO BILO	-	-	-	-	-
GLAND ANT	-	-	-	-	-
GLAND LAEV	-	-	-	-	-
LAR HYAL	-	-	-	-	-
FIS CORN	-	-	-	-	-
FIS FOLI	-	-	-	-	-
FIS MARG	-	-	-	-	-
FIS MENN	-	-	-	-	-
FIS SEM	-	-	-	-	-
FIS SPATH	-	-	-	-	-
FIS SUBF	-	-	-	-	-
FIS SUBT	-	-	-	-	-
FIS TEX	-	-	-	-	-
FIM TING	-	-	-	-	-
FIS TR-M	-	-	-	-	-
FIS SP	-	-	1.5	-	-
PARA CURTA	-	-	-	-	-
PARA FUS	-	-	-	-	-
PARA LATER	-	-	-	-	-
PARA MARG	-	-	-	-	-
PARA PSE-T	-	-	-	-	-
PARA PUST	-	-	-	-	-
PARA STAPH	-	-	-	-	-
PARA SUBC	-	-	-	-	-
OOL API	-	-	-	-	-
OOL HEX	-	-	-	-	-
OOL MELO	-	-	-	-	-
OOL SQUA	-	-	-	-	-
OOL A	-	-	-	-	-
OOL B	-	-	-	-	-
OOL C	-	-	-	-	-
PAT COR	-	-	-	-	2.0
PATS DEP	-	-	-	-	-
SPIR RAD	-	-	-	-	-
PSBU CHP	-	-	-	-	-
BUL ELG	-	-	-	-	-
BOL PSE	2.9	-	-	-	28.0
BOL PYG	-	-	-	-	-
BOL SP	-	-	-	-	-
CAS POR	-	8.3	-	-	6.0
CAS PARK	-	-	-	-	-
STAIN CON	-	-	1.5	-	-
TRIF EAR	-	2.8	-	6.8	-
TRIF PAUP	-	-	-	-	-
EPIS VIT	2.9	-	28.8	-	8.0
ROS GLOB	-	-	-	-	-
HER KEM	-	-	-	-	-
GLAB SP	-	-	-	-	-
SCHACK ANT	-	-	-	-	-
CIB LOB	-	-	-	-	-
ELPH SP	-	-	-	-	-
FUR EAR	22.9	-	-	-	-
EHR GLAB	-	2.8	-	-	-
GLOB BIO	-	-	1.5	-	-
GLOB CRAS	11.4	2.8	10.6	-	6.0
GLOB SUBG	-	-	-	-	4.0
AST ANT	-	-	-	-	22.0
AST ECH	-	-	-	2.3	-
NON IRID	11.4	-	-	-	-
PUL SUB	-	-	-	-	2.0
PUL BUL	-	-	-	-	-
TOTALS (%)	100.3	100.2*	99.9	100.0*	100.0

Absolute numbers of dead tests from 1982 cores (Granite Harbour, Blue Glacier and Cape Chocolate Island)

Sample: Depth(m)	1982-2 (40-3cm)	82-2 796	82-4 212	82-3 139	82-3 (42-45cm)	82-1 303	82-1 (25-30cm)
ASTR SPH	-	-	-	-	-	-	-
RHAB ABYS	-	-	-	-	-	1	-
BATH HIR (A)	-	-	-	-	-	-	-
BATH HIR (B)	-	-	-	-	-	-	-
HYP CYL	-	-	-	1	-	2	-
HYP MAL	-	-	-	1	-	3	-
HYP SUBN	-	-	1	-	-	-	-
PSAM FUSCA	-	-	-	1	-	4	-
PELO BIC	-	-	-	-	-	-	-
SAC SPH	1	1	-	-	-	-	31
SAC JUV	5	2	-	3	-	37	1
AMMOP SP	-	-	-	-	-	-	-
HEMI BRAD	-	-	-	-	-	-	-
THUR ALB	-	-	-	-	-	1	-
THUR PROT	1	-	-	-	-	-	-
GLOM GORD	-	-	2	2	-	5	4
GLOM CHAR	-	-	-	-	-	-	-
TUR SHON	-	-	1	-	-	1	-
HORM OVIC	-	-	1	-	-	7	-
HORM SP	-	-	-	-	-	-	-
REO PIL	-	1	1	-	-	-	2
REO PSEU(A)	-	-	-	-	-	-	-
(B)	-	-	-	-	-	-	-
REO SUBD	-	4	2	2	-	2	1
MIL ARE	6	16	4	1	-	32	14
MIL LATA	7	7	-	-	-	7	8
CRIB JEF	-	14	22	19	1	47	21
CRIB SUB	7	-	-	-	-	-	-
CRIB WIE	-	-	-	-	-	1	-
SPIRO FIL	-	1	-	-	-	-	-
TEXT ANT	4	22	-	18	-	96	75
TEXT EAR	1	3	1	2	-	-	-
TROC GLABRA	7	30	9	-	-	23	4
TROC GABO	7	17	13	4	-	11	5
TROC A	-	-	3	-	-	-	-
TROC B	1	1	2	-	-	3	6
PORT ANTA	8	40	40	36	2	56	52
PORT ELT	1	19	6	3	-	21	16
CONO BULL	3	6	-	-	-	4	6
VERN MIN	2	6	2	2	-	-	1
VERN ADV	1	13	-	-	-	-	-
EGGE BRAD	-	-	-	-	-	-	-
CYCL INVO	-	-	-	-	-	-	-
PLAN BUC	-	-	-	-	-	-	-
CRUC TRI	-	-	-	-	-	-	-
PYRG DEP	-	-	-	-	-	-	-
PYRG ELO	-	-	-	-	-	-	-
PYRG MUR	-	-	-	-	-	-	-
PRGOL SPH	-	-	-	-	-	-	-
SIG UMB	-	-	-	-	-	-	-
MIL SP B	-	1	-	1	-	-	1
DENT COM	-	-	-	-	-	-	-
NODS MAR	-	-	-	-	-	-	-
NODS SP	-	-	-	-	-	-	1
LAG DIST	-	-	-	-	-	-	-
LAG ELON	-	-	-	2	-	-	2
LAG GRAC	-	-	-	-	-	-	-
LAG GRAS	-	-	-	-	-	-	-
LAG NEBU	-	-	-	-	-	-	3
LAG STRI	-	-	-	-	-	-	-
LING VIT	-	-	-	-	-	-	-
LENT GIB	-	-	-	-	-	-	-
POLY SP	-	-	-	-	-	-	-

ENTO BICA	-	-	-	-	-	-	-
ENTO BILO	-	-	-	-	-	-	-
GLAND ANT	-	-	-	-	-	-	-
GLAND LAEV	-	-	-	-	-	-	-
LAR HYAL	-	-	-	-	-	-	-
FIS COR	-	-	-	-	-	-	-
FIS MARG	-	-	-	1	-	-	-
FIS MENN	-	-	-	-	-	-	-
FIS SEM	-	-	-	-	-	-	-
FIS SUBF	-	-	-	-	-	-	-
FIS SPATH	-	-	-	-	-	-	-
FIS SUBT	-	-	-	-	-	-	-
FIS TEX	-	-	-	-	-	-	-
FIS TING	-	-	-	-	-	-	-
FIS TR-M	-	-	-	-	-	-	-
FIS SP	-	-	-	-	-	-	-
PARA CURTA	-	-	-	-	-	-	-
PARA FUS	-	-	-	-	-	-	-
PARA LATER	-	-	-	-	-	-	-
PARA MARG	-	-	-	-	-	-	-
PARA PSE-T	-	-	-	-	-	-	-
PARA PUST	-	-	-	-	-	-	-
PARA STAPH	-	-	-	-	-	-	-
PARA SUBC	-	-	-	-	-	-	-
OOL API	-	-	-	-	-	-	-
OOL HEX	-	-	-	-	-	-	-
OOL MELO	-	-	-	-	-	-	-
OOL SQUA	-	-	-	-	-	-	-
OOL A	-	-	-	-	-	-	-
OOL B	-	-	-	-	-	-	-
OOL C	-	-	-	-	-	-	-
PAT COR	-	-	-	-	-	-	-
PATS DEP	-	-	-	-	-	-	-
SPIR RAD	-	-	-	-	-	-	-
PSBU CHP	-	-	-	-	1	-	-
BUL ELG	-	-	-	-	-	-	-
BOL PSE	-	-	-	-	-	-	-
BOL PYG	-	-	-	1	1	-	-
BOL SP	-	-	-	-	-	-	-
CAS POR	-	-	1	9	11	-	2
CAS PARK	-	-	-	2	8	-	-
STAIN CON	-	-	-	2	-	-	4
TRIF EAR	2	-	17	7	5	22	46
TRIF PAUP	-	-	-	-	-	-	25
EPIS VIT	-	-	1	104	3	-	23
ROS GLOB	-	1	-	1	-	-	-
HER KEM	-	-	-	-	-	-	-
GLAB SP	-	-	-	-	-	-	-
SCHACK ANT	-	-	-	-	-	-	-
CIB LOB	-	1	-	3	1	-	7
ELPH SP	-	-	-	-	4	-	-
FUR EAR	4	3	1	-	-	-	2
EHR GLAB	-	-	-	3	14	-	-
GLOB BIO	-	-	-	7	10	-	5
GLOB CRAS	-	4	1	64	26	1	40
GLOB SUBG	-	-	4	-	17	-	-
AST ANT	1	-	-	8	-	1	18
AST ECH	-	-	-	-	-	6	38
NON IRID	8	14	-	-	-	-	10
PUL SUB	-	-	-	-	-	-	-
PUL BUL	-	-	-	-	-	-	-
TOTALS (N)	69	227	135	311	104	394	475

Percent dead tests,Cores 1982-1,2,3,4 and Grab 1980-6 (New Harbour).

Sample: Depth(m;cm)	1982-2 40-43	82-2 796m	82-4 212m	82-3 139m	82-3 44-45	82-1 303m	82-1 25-30	80-06 79m
ASTR SPH	-	-	-	-	-	-	-	-
RHAB ABYS	-	-	-	-	-	0.25	-	-
BATH HIR (A)	-	-	-	-	-	-	-	-
BATH HIR (B)	-	-	-	-	-	-	-	-
HYP CYL	-	-	-	0.3	-	0.51	-	-
HYP MAL	-	-	-	0.3	-	0.8	-	-
HYP SUBN	-	-	0.74	-	-	-	-	-
PSAM FUSCA	-	-	-	0.3	-	1.0	-	-
PELO BIC	-	-	-	-	-	-	-	-
SAC SPH	1.45	0.44	-	-	-	-	6.5	-
SAC JUV	7.25	0.9	-	0.96	-	9.4	0.22	0.2
AMMOP SP	-	-	-	-	-	-	-	-
HEMI BRAD	-	-	-	-	-	-	-	-
THUR ALB	-	-	-	-	-	0.25	-	-
THUR PROT	1.45	-	-	-	-	-	-	-
GLOM GORD	-	-	1.5	0.6	-	1.3	0.8	0.35
GLOM CHAR	-	-	-	-	-	-	-	-
TUR SHON	-	-	0.74	-	-	0.3	-	-
HORM OVIC	-	-	0.74	-	-	1.8	-	-
HORM SP	-	-	-	-	-	-	-	-
REO PIL	-	0.44	0.74	-	-	-	0.44	0.2
REO PSE (A)	-	-	-	-	-	-	-	-
(B)	-	-	-	-	-	-	-	-
REO SUBD	-	1.8	1.5	0.6	-	0.51	0.22	0.8
MIL ARE	8.7	7.05	3.0	0.3	-	8.1	3.0	-
MIL LATA	10.14	3.1	-	-	0.96	1.8	1.7	-
CRIB JEF	-	6.2	16.3	6.1	-	12.0	4.42	8.5
CRIB SUB	10.14	-	-	-	-	-	-	-
CRIB WIE	-	-	-	-	-	0.25	-	-
SPIRO FIL	-	0.44	-	-	-	-	-	-
TEXT ANT	5.8	9.7	-	5.8	-	24.4	15.8	2.07
TEXT EAR	1.45	1.3	0.74	0.6	-	-	-	0.55
TROC GLABRA	10.14	13.2	6.7	-	-	5.8	0.8	3.9
TROC GABO	10.14	7.5	9.6	1.3	-	2.8	1.0	3.5
TROC A	-	-	2.2	-	-	-	-	0.35
TROC B	1.45	0.44	1.5	-	-	0.8	1.3	0.07
PORT ANTA	11.6	17.6	29.6	11.6	1.9	14.2	11.0	26.09
PORT ELT	1.45	8.4	4.4	0.96	-	5.3	3.4	2.35
CONO BULL	4.35	2.6	-	-	-	1.0	1.3	0.07
VERN MIN	2.9	2.6	1.5	0.6	-	-	0.22	1.03
VERN ADV	1.6	5.7	-	-	-	-	-	0.14
EGGE BRAD	-	-	-	-	-	-	-	-
CYCL INVO	-	-	-	-	-	-	-	-
PLAN BUC	-	-	-	-	-	-	-	-
CRUC TRI	-	-	-	-	-	-	-	-
PYRG DEP	-	-	-	-	-	-	-	-
PYRG ELO	-	-	-	-	-	-	-	-
PYRG MUR	-	-	-	-	-	-	-	-
PRGOL SPH	-	-	-	-	-	-	-	-
SIG UMB	-	-	-	-	-	-	-	-
MIL SP B	-	0.4	-	0.3	-	-	0.22	0.14
DENT COM	-	-	-	-	-	-	-	-
NODS MAR	-	-	-	-	-	-	-	-
NODS SP	-	-	-	-	-	-	0.22	-
LAG DIST	-	-	-	-	-	-	-	-
LAG ELON	-	-	-	0.6	-	-	0.44	-
LAG GRAC	-	-	-	-	-	-	0.6	-
LAG GRAS	-	-	-	-	-	-	-	0.07
LAG NEBU	-	-	-	-	-	-	-	-
LAG STRI	-	-	-	-	-	-	-	-
LING VIT	-	-	-	-	-	-	-	-
LENT GIB	-	-	-	-	-	-	-	-
POLY SP	-	-	-	-	-	-	-	-

ENTO BICA	-	-	-	-	-	-	-	-
ENTO BILO	-	-	-	-	-	-	-	-
GLAND ANT	-	-	-	-	-	-	-	-
GLAND LAEV	-	-	-	-	-	-	-	-
LAR HYAL	-	-	-	-	-	-	-	-
FIS CORN	-	-	-	-	-	-	-	-
FIS FOLI	-	-	-	-	-	-	-	-
FIS MARG	-	-	-	0.3	-	-	-	-
FIS MENN	-	-	-	-	-	-	-	-
FIS SEM	-	-	-	-	-	-	-	-
FIS SPATH	-	-	-	-	-	-	-	-
FIS SUBF	-	-	-	-	-	-	-	-
FIS SUBT	-	-	-	-	-	-	-	-
FIS TEX	-	-	-	-	-	-	-	0.07
FIS TING	-	-	-	-	-	-	-	-
FIS TR-M	-	-	-	-	-	-	-	-
FIS SP	-	-	-	-	-	-	-	-
PARA CURTA	-	-	-	-	-	-	-	-
PARA FUS	-	-	-	-	-	-	-	-
PARA LATER	-	-	-	-	-	-	-	0.14
PARA MARG	-	-	-	-	-	-	-	0.07
PARA PSE-T	-	-	-	-	-	-	-	-
PARA PUST	-	-	-	-	-	-	-	-
PARA STAPH	-	-	-	-	-	-	-	-
PARA SUBC	-	-	-	-	-	-	-	-
OOL API	-	-	-	-	-	-	-	-
OOL HEX	-	-	-	-	-	-	-	-
OOL MELO	-	-	-	-	-	-	-	-
OOL SQUA	-	-	-	-	-	-	-	-
OOL A	-	-	-	0.3	-	-	0.22	-
OOL B	-	-	-	-	-	-	-	0.07
OOL C	-	-	-	-	-	-	-	-
PAT COR	-	-	-	-	-	-	-	0.07
PATS DEP	-	-	-	-	-	-	-	-
SPIR RAD	-	-	-	-	-	-	-	-
PSBU CHP	-	-	-	-	0.95	0.96	-	-
BUL ELG	-	-	-	-	-	-	-	-
BOL PSE	-	-	-	-	0.95	-	-	3.3
BOL PYG	-	-	-	0.3	-	0.96	-	-
BOL SP	-	-	-	-	-	-	-	-
CAS POR	-	-	0.74	3.0	10.6	-	0.44	10.6
CAS PARK	-	-	-	0.6	7.7	-	-	-
STAIN CON	-	-	-	0.6	-	-	0.8	-
TRIF EAR	2.9	-	12.6	2.3	4.81	5.6	9.7	0.9
TRIF PAUP	-	-	-	-	-	-	5.3	-
EPIS VIT	-	-	0.74	33.4	2.9	-	4.8	13.9
ROS GLOB	-	0.44	-	0.3	-	-	-	0.2
HER KEM	-	-	-	-	-	-	-	-
GLAB SP	-	-	-	-	-	-	-	-
SCHACK ANT	-	-	-	-	-	-	-	0.07
CIB LOB	-	0.44	-	0.96	0.95	-	1.5	1.9
ELPH SP	-	-	-	-	3.9	-	-	-
FUR EAR	5.8	1.3	0.74	-	-	-	0.44	0.07
EHR GLAB	-	-	-	0.96	13.5	-	-	1.3
GLOB BIO	-	-	-	2.3	9.6	-	1.0	0.9
GLOB CRAS	-	1.8	0.74	20.6	25.0	0.25	8.4	6.6
GLOB SUBG	-	-	3.0	-	16.3	-	-	2.14
AST ANT	1.45	-	-	2.8	-	0.25	3.8	7.18
AST ECH	-	-	-	-	-	1.5	8.0	0.14
NON IRID	-	6.2	-	-	-	-	2.1	-
PUL SUB	-	-	-	-	-	-	-	-
PUL BUL	-	-	-	-	-	-	-	-
TOTALS (%)	100.01	100.03	100.06	99.94	100.05	100.17	100.1	100.02

Absolute numbers of live tests in 1983 ship grab samples

Sample:	1983-26	3	2	4	7	22
Depth(m)	620	856	660	854	775	128
ASTR SPH	-	-	-	-	-	-
RHAB ABYS	-	-	-	-	-	-
BATH HIR (A)	-	-	-	-	-	-
BATH HIR (B)	-	-	-	-	-	-
HYP CYL	-	-	-	-	-	-
HYP MAL	-	-	-	-	-	-
HYP SUBN	-	-	-	-	-	1
PSAM FUSCA	-	-	-	-	-	-
PELO BIC	-	-	-	-	-	-
SAC SPH	-	1	-	3	2	-
SAC JUV	-	1	-	6	4	1
AMMOP SP	-	-	-	-	-	-
HEMI BRAD	-	-	-	-	-	-
THUR ALB	-	-	-	-	-	-
THUR PROT	1	-	1	-	-	-
GLOM GORD	1	-	1	-	-	1
GLOM CHAR	-	-	-	-	-	-
TUR SHON	-	-	-	-	-	-
HORM OVIC	4	-	2	-	4	4
HORM SP	-	-	-	-	-	-
REO PIL	-	5	7	6	8	-
REO PSEU(A)	-	1	-	3	8	-
(B)	-	-	-	-	-	-
REO SUBD	-	2	4	5	10	1
MIL ARE	-	3	-	-	3	-
MIL LATA	-	-	-	-	-	-
CRIB JEF	1	-	2	1	1	4
CRIB SUB	-	-	2	3	4	-
CRIB WIE	-	-	-	-	-	-
SPIRO FIL	-	-	-	-	-	-
TEXT ANT	-	2	3	1	7	-
TEXT EAR	-	-	-	-	-	1
TROC GLABRA	-	-	-	1	-	1
TROC GABO	-	-	-	-	-	-
TROC A	-	-	-	-	-	-
TROC B	-	-	-	-	-	-
PORT ANTA	4	4	4	1	3	4
PORT ELT	2	2	3	2	4	3
CONO BULL	-	6	1	2	-	-
VERN MIN	-	-	1	-	-	2
VERN ADV	-	1	-	-	-	-
EGGE BRAD	-	-	-	-	-	-
CYL INV	-	-	-	-	-	1
PLAN BUC	-	-	-	-	-	-
CRUC TRI	1	-	-	-	-	-
PYRG DEP	-	-	-	-	-	-
PYRG ELO	-	-	-	-	-	-
PYRG MUR	-	-	-	-	-	-
PRGOL SPH	-	-	-	-	-	-
SIG UMB	-	-	-	-	-	-
MIL SPP	-	-	-	-	-	-
DENT COM	-	-	-	-	-	-
NODS MAR	-	-	-	-	-	-
NODS SP	-	-	-	-	-	-
LAG DIST	-	-	-	-	-	-
LAG ELON	-	-	-	-	-	-
LAG GRAC	-	-	-	-	-	-
LAG GRAS	-	-	-	-	-	-
LAG NEBU	-	-	-	-	-	-
LAG STRI	-	-	-	-	-	-
LING VIT	-	-	-	-	-	-
LENT GIB	-	-	-	-	-	-
POLY SP	-	-	-	-	-	-

ENTO BICAR	-	-	-	-	-	-
ENTO BILOC	-	-	-	-	-	-
GLAND ANT	-	-	-	-	-	-
GLAND LAEV	-	-	-	-	-	-
LAR HYAL	-	-	-	-	-	1
FIS CORN	-	-	-	-	-	-
FIS FOL	-	-	-	-	-	-
FIS MARG	-	-	-	-	-	-
FIS MEN	1	-	-	-	-	-
FIS SEM	1	-	-	-	-	-
FIS SPATH	-	-	-	-	-	-
FIS SUBF	-	-	-	-	-	-
FIS SUBT	-	-	-	-	-	-
FIS TEX	-	-	-	-	-	-
FIS TING	-	-	-	-	-	-
FIS TR-M	-	-	-	-	-	-
FIS SP	-	-	-	-	-	-
PARA CURTA	-	-	-	-	-	-
PARA FUS	-	-	-	-	-	-
PARA LATER	-	-	-	-	-	-
PARA MARG	-	-	-	-	-	-
PARA PSE-OR	-	-	-	-	-	-
PARA STAPH	-	-	-	-	-	-
PARA SUBC	-	-	-	-	-	-
OOL APIO	-	-	-	-	-	-
OOL HEX	-	-	-	-	-	-
OOL MELO	-	-	-	-	-	-
OOL SQUA	-	-	-	-	-	-
OOL A	-	-	1	-	-	-
OOL B	-	-	-	-	-	-
OOL C	-	-	-	-	-	-
PAT COR	6	-	-	-	-	-
PATS DEP	-	-	-	-	-	-
SPIR RAD	-	-	-	-	-	-
PSBU CHP	1	-	-	-	-	-
BUL ELG	1	-	-	-	-	-
BOL PSE	-	-	-	-	-	1
BOL PYG	-	-	-	-	-	-
BOL SP	-	-	-	-	-	-
CAS POR	-	-	-	-	-	1
CAS PARK	-	-	-	-	-	-
STAIN CON	-	-	-	-	-	-
TRIF EAR	1	-	-	-	-	-
TRIF PAUP	-	-	-	-	-	-
EPIS VIT	-	-	-	-	-	1
ROS GLOB	-	-	-	-	-	-
HER KEM	-	-	-	-	-	-
GLAB SP	-	-	-	-	-	-
SCHACK ANT	-	-	-	-	-	-
CIB LOB	-	-	-	-	-	-
ELPH SP	-	-	-	-	-	-
FUR EAR	-	1	-	-	-	10
EHR GLAB	4	-	-	-	-	3
GLOB BIO	-	-	-	-	-	-
GLOB CRAS	8	1	-	-	-	3
GLOB SUBG	-	-	-	-	-	-
AST ANT	3	-	1	-	-	2
AST ECH	2	-	-	-	-	-
NON IRID	2	-	-	-	-	-
PUL SUB	-	-	-	-	-	-
PUL BUL	-	-	-	-	-	-
TOTALS (N)	44*	30*	33*	34*	58*	46*

Percent live tests

Sample:	1983-26	83-3	83-2	83-4	83-7	83-22
Depth (m)	620	856	660	854	755	128
ASTR SPH	-	-	-	-	-	-
RHAB ABYS	-	-	-	-	-	-
BATH HIR (A)	-	-	-	-	-	-
BATH HIR (B)	-	-	-	-	-	-
HYP CYL	-	-	-	-	-	-
HYP MAL	-	-	-	-	-	-
HYP SUBN	-	-	-	-	-	2.2
PSAM FUSCA	-	-	-	-	-	-
PELO BIC	-	-	-	-	-	-
SAC SPH	-	3.3	-	8.8	3.4	-
SAC JUV	-	3.3	-	17.6	6.9	2.2
AMMOP SP	-	-	-	-	-	-
HEMI BRAD	-	-	-	-	-	-
THUR ALB	-	-	-	-	-	-
THUR PROT	2.3	-	3.0	-	-	-
GLOM GORD	2.3	-	3.0	-	-	2.2
GLOM CHAR	-	-	-	-	-	-
TUR SHON	-	-	-	-	-	-
HORM OVIC	9.1	-	6.1	-	6.9	8.7
HORM SP	-	-	-	-	-	-
REO PIL	-	16.7	21.2	17.6	13.8	-
REO PSE (A)	-	3.3	-	8.8	13.8	-
(B)	-	-	-	-	-	-
REO SUBD	-	6.7	12.1	14.7	17.2	2.2
MIL ARE	-	10.0	-	-	5.2	-
MIL LATA	-	-	-	-	-	-
CRIB JEFF	2.3	-	6.1	3.0	1.7	8.7
CRIB SUB	-	-	6.1	8.8	6.9	-
CRIB WIE	-	-	-	-	-	-
SPIRO FIL	-	-	-	-	-	-
TEXT ANT	-	6.7	9.1	3.0	12.1	-
TEXT EAR	-	-	-	-	-	2.2
TROC GLABRA	-	-	-	3.0	-	2.2
TROC GABO	-	-	-	-	-	-
TROC A	-	-	-	-	-	-
TROC B	-	-	-	-	-	-
PORT ANT	9.1	13.3	12.1	3.0	5.2	8.7
PORT ELT	4.5	6.7	9.1	5.9	6.9	6.5
CONO BULL	-	20.0	3.0	5.9	-	-
VERN MIN	-	-	3.0	-	-	4.3
VERN ADV	-	3.3	-	-	-	-
EGGE BRAD	-	-	-	-	-	-
CYCL INV	-	-	-	-	-	2.2
PLAN BUC	-	-	-	-	-	-
CRUC TRI	2.3	-	-	-	-	-
PYRG DEP	-	-	-	-	-	-
PYRG ELO	-	-	-	-	-	-
PYRG MUR	-	-	-	-	-	-
PRGOL SPH	-	-	-	-	-	-
SIG UMB	-	-	-	-	-	-
MIL SPP	-	-	-	-	-	-
DENT COM	-	-	-	-	-	-
NODS MAR	-	-	-	-	-	-
NODS SP	-	-	-	-	-	-
LAG DIST	-	-	-	-	-	-
LAG ELO	-	-	-	-	-	-
LAG GRAC	-	-	-	-	-	-
LAG GRAS	-	-	-	-	-	-
LAG NEB	-	-	-	-	-	-
LAG STRI	-	-	-	-	-	-
LING VIT	-	-	-	-	-	-
LENT GIB	-	-	-	-	-	-
POLY SP	-	-	-	-	-	-

ENTO BILOC	-	-	-	-	-	-
ENTO BICAR	-	-	-	-	-	-
GLAND ANT	-	-	-	-	-	-
GLAND LAEV	-	-	-	-	-	-
LAR HYAL	-	-	-	-	-	2.2
FIS CORN	-	-	-	-	-	-
FIS FOL	-	-	-	-	-	-
FIS MARG	-	-	-	-	-	-
FIS MEN	2.3	-	-	-	-	-
FIS SEM	2.3	-	-	-	-	-
FIS SPATH	-	-	-	-	-	-
FIS SUBF	-	-	-	-	-	-
FIS SUBT	-	-	-	-	-	-
FIS TEX	-	-	-	-	-	-
FIS TING	-	-	-	-	-	-
FIS TR-M	-	-	-	-	-	-
FIS SP	-	-	-	-	-	-
PARA CURTA	-	-	-	-	-	-
PARA FUS	-	-	-	-	-	-
PARA LATER	-	-	-	-	-	-
PARA MARG	-	-	-	-	-	-
PARA PSEU	-	-	-	-	-	-
PARA PUST	-	-	-	-	-	-
PARA STAPH	-	-	-	-	-	-
PARA SUBC	-	-	-	-	-	-
OOL APIO	-	-	-	-	-	-
OOL HEX	-	-	-	-	-	-
OOL MELO	-	-	-	-	-	-
OOL SQUA	-	-	-	-	-	-
OOL A	-	-	3.0	-	-	-
OOL B	-	-	-	-	-	-
OOL C	-	-	-	-	-	-
PAT COR	13.6	-	-	-	-	-
PATS DEP	-	-	-	-	-	-
SPIR RAD	-	-	-	-	-	-
PSBU CHP	2.3	-	-	-	-	-
BUL ELG	2.3	-	-	-	-	-
BOL PSE	-	-	-	-	-	2.2
BOL PYG	-	-	-	-	-	-
BOL SP	-	-	-	-	-	-
CAS POR	-	-	-	-	-	2.2
CAS PARK	-	-	-	-	-	-
STAIN CON	-	-	-	-	-	-
TRIF EAR	2.3	-	-	-	-	-
TRIF PAUP	-	-	-	-	-	-
EPIS VIT	-	-	-	-	-	2.2
ROS GLOB	-	-	-	-	-	-
HER KEM	-	-	-	-	-	-
GLAB SP	-	-	-	-	-	-
SCHACK ANT	-	-	-	-	-	-
CIB LOB	-	-	-	-	-	-
FUR EAR	-	3.3	-	-	-	21.7
EHR GLAB	9.1	-	-	-	-	6.5
GLOB BIO	-	-	-	-	-	-
GLOB CRAS	18.2	3.3	-	-	-	6.5
GLOB SUBG	-	-	-	-	-	-
AST ANT	6.8	-	3.0	-	-	4.3
AST ECH	4.5	-	-	-	-	-
NON IRID	4.5	-	-	-	-	-
PUL SUB	-	-	-	-	-	-
PUL BUL	-	-	-	-	-	-
TOTALS (%)	100.1*	99.9*	99.9*	100.1*	100.0*	100.1*

Absolute numbers of dead tests

Sample:	1983-26	3	2	4	7	22
Depth(m)	620	856	660	854	775	128
ASTR SPH	-	-	-	-	-	-
RHAB ABYS	-	-	-	-	4	-
BATH HIR (A)	-	-	-	-	-	-
BATH HIR (B)	-	-	-	-	-	-
HYP CYL	-	3	2	-	16	6
HYP MAL	1	-	-	-	3	-
HYP SUBN	1	-	1	-	2	-
PSAM FUSCA	-	-	-	5	2	1
PELO BIC	-	-	-	-	-	-
SAC SPH	-	-	6	4	4	-
SAC JUV	-	-	-	-	-	-
AMMOP SP	-	-	-	-	-	-
HEMI BRAD	-	-	-	-	-	-
THUR ALB	-	-	-	-	1	-
THUR PROT	-	-	-	-	-	-
GLOM GORD	-	-	2	-	1	4
GLOM CHAR	1	-	-	-	-	-
TUR SHON	1	-	-	-	-	-
HORM OVIC	1	-	3	3	14	2
HORM SP	2	-	-	-	1	-
REO PIL	3	1	3	5	4	-
REO PSEU(A)	-	-	-	-	15	-
(B)	-	-	-	-	1	-
REO SUBD	-	5	4	9	3	-
MIL ARE	-	12	3	11	14	1
MIL LATA	-	25	-	14	3	-
CRIB JEF	34	7	16	3	2	47
CRIB SUB	-	2	-	6	10	-
CRIB WIE	-	-	-	-	-	-
SPIRO FIL	-	-	-	-	-	1
TEXT ANT	2	25	19	29	64	5
TEXT EAR	3	2	-	-	-	2
TROC GLABRA	8	23	17	5	5	-
TROC GABO	8	11	7	2	5	-
TROC A	1	-	1	-	2	1
TROC B	1	-	-	-	-	7
PORT ANT	25	40	48	25	36	66
PORT ELT	1	25	14	11	18	10
CONO BULL	-	25	9	18	16	6
VERN MIN	-	4	2	2	1	4
VERN ADV	1	2	-	1	-	-
EGGE BRAD	-	-	-	-	-	-
CYCL INVO	1	-	-	-	-	-
PLAN BUC	8	-	-	-	-	-
CRUC TRI	-	-	-	-	-	1
PYRG DEP	-	-	-	-	-	-
PYRG ELO	-	-	-	-	-	-
PYRG MUR	-	-	-	-	-	-
PRGOL SPH	-	-	-	-	-	-
SIG UMB	6	-	-	-	-	-
MIL SP B	1	-	-	-	-	-
DENT COM	-	-	-	-	-	-
NODS MAR	-	-	-	-	-	-
NODS SP	-	1	-	-	-	-
LAG DIST	-	-	-	-	-	-
LAG ELON	-	-	-	-	-	1
LAG GRAC	-	-	-	-	-	-
LAG GRAS	1	-	-	-	-	-
LAG NEBU	-	-	-	-	-	-
LAG STRI	-	-	-	-	-	-
LING VIT	-	-	-	-	-	-
LENT GIB	2	-	-	-	-	1
POLY SP	-	-	-	-	-	-

ENTO BICA	-	-	-	-	-	-
ENTO BILO	1	-	-	-	-	-
GLAND ANT	-	-	-	-	-	-
GLAND LAEV	-	-	-	-	-	-
LAR HYAL	-	-	-	-	-	-
FIS CORN	-	-	-	-	-	-
FIS FOLI	1	-	-	-	-	-
FIS MARG	6	-	-	-	-	-
FIS MENN	-	-	-	-	-	-
FIS SEM	-	-	-	-	-	-
FIS SPATH	1	-	-	-	-	-
FIS SUBF	-	-	-	-	-	-
FIS SUBT	-	-	-	-	-	-
FIS TEX	-	-	-	-	-	-
FIS TR-M	-	-	-	-	-	-
FIS TING	2	-	-	-	-	-
FIS SP	-	-	-	-	-	-
OOL API	1	-	-	-	-	-
OOL HEX	-	-	-	-	-	-
OOL MELO	-	-	-	-	-	-
OOL SQUA	-	-	-	-	-	-
OOL A	1	-	-	-	-	-
OOL B	1	-	-	-	-	-
OOL C	-	-	-	-	-	-
PARA CURTA	2	-	-	-	-	-
PARA FUS	-	-	-	-	-	-
PARA LATER	3	-	-	-	-	-
PARA MARG	-	-	-	-	-	-
PARA PSE-T	1	-	-	-	-	-
PARA PUST	-	-	-	-	-	-
PARA STAPH	-	-	-	-	-	-
PARA SUBC	-	-	-	-	-	-
PAT COR	22	-	-	-	-	-
PATS DEP	-	1	-	-	-	-
SPIR RAD	-	-	-	-	-	-
PSBU CHP	4	-	-	-	-	-
BUL ELG	2	-	-	-	-	-
BOL PSE	-	-	-	-	-	-
BOL PYG	-	-	-	-	-	-
BOL SP	-	-	-	-	-	-
CAS POR	2	-	-	-	-	10
CAS PARK	-	-	-	-	-	-
STAIN CON	-	-	-	-	-	-
TRIF EAR	12	-	-	-	-	26
TRIF PAUP	-	-	-	-	-	-
EPIS VIT	16	-	-	-	-	7
ROS GLOB	17	-	-	-	-	1
HER KEM	-	-	-	-	-	-
GLAB SP	4	-	-	-	-	-
SCHACK ANT	4	-	-	-	-	-
CIB LOB	17	-	1	-	-	2
ELPH SP	-	-	-	-	-	-
FUR EAR	-	-	-	-	-	1
EHR GLAB	84	-	-	-	-	5
GLOB BIO	-	-	-	-	-	-
GLOB CRAS	53	-	-	-	-	3
GLOB SUBG	-	-	-	-	-	23
AST ANT	22	-	-	-	-	3
AST ECH	5	-	2	-	-	3
NON IRID	62	1	-	-	-	-
PUL SUB	-	-	-	-	-	-
PUL BUL	-	-	-	-	-	-
TOTALS (N)	459	215	160	153	247	249

Percent dead tests

Sample:	1983-26	83-3	83-2	83-4	83-7	83-22
Depth(m)	620	856	660	854	755	128
ASTR SPH	-	-	-	-	-	-
RHAB ABYS	-	-	-	-	1.6	-
BATH HIR (A)	-	-	-	-	-	-
BATH HIR (B)	-	-	-	-	-	-
HYP CYL	-	1.4	1.3	-	6.5	2.4
HYP MAL	0.22	-	-	-	1.2	-
HYP SUBN	1.22	-	0.6	-	0.8	-
PSAM FUSCA	-	-	-	3.3	0.8	0.4
PELO BIC	-	-	-	-	-	-
SAC SPH	-	-	3.7	2.6	1.6	-
SAC JUV	-	-	-	-	-	-
AMMOP SP	-	-	-	-	-	-
HEMI BRAD	-	-	-	-	-	-
THUR ALB	-	-	-	-	0.4	-
THUR PROT	-	-	-	-	-	-
GLOM GORD	-	-	1.3	-	0.4	1.6
GLOM CHAR	0.22	-	-	-	-	-
TUR SHON	0.22	-	-	-	-	-
HORM OVIC	0.22	-	1.9	2.0	5.7	0.8
HORM SP	0.4	-	-	-	0.4	-
REO PIL	0.7	0.5	1.9	3.3	1.6	-
REO PSE (A)	-	-	-	-	6.1	-
(B)	-	-	-	-	0.4	-
REO SUBD	-	2.3	2.5	6.0	1.2	-
MIL ARE	-	5.6	1.9	7.2	5.7	0.4
MIL LATA	-	11.6	-	9.2	1.2	-
CRIB JEFF	7.4	3.3	10.0	5.9	0.8	19.0
CRIB SUB	-	0.9	-	-	4.0	-
CRIB WIE	-	-	-	-	-	-
SPIRO FIL	-	-	-	-	-	0.4
TEXT ANT	0.4	11.6	11.9	19.0	26.0	2.0
TEXT EAR	0.7	0.9	-	-	-	0.8
TROC GLABRA	1.7	10.7	10.6	3.3	2.0	-
TROC GABO	1.7	5.0	4.4	1.3	2.0	-
TROC A	0.22	-	0.6	-	0.8	0.4
TROC B	0.22	-	-	-	-	2.8
PORT ANTA	5.5	18.6	30.0	16.3	14.6	26.51
PORT ELT	0.22	11.6	8.8	7.2	7.3	4.02
CONO BULL	-	11.6	5.6	11.8	6.5	2.4
VERN MIN	-	1.9	1.3	1.3	0.4	0.8
VERN ADV	0.22	0.9	-	0.7	-	-
EGGE BRAD	-	-	-	-	-	-
CYCL INVO	0.22	-	-	-	-	-
PLAN BUC	1.7	-	-	-	-	-
CRUC TRI	-	-	-	-	-	0.4
PYRG DEP	-	-	-	-	-	-
PYRG ELO	-	-	-	-	-	-
PYRG MUR	-	-	-	-	-	-
PRGOL SPH	-	-	-	-	-	-
SIG UMB	1.3	-	-	-	-	-
MIL SP B	0.22	-	-	-	-	-
DENT COM	-	-	-	-	-	-
NODS MAR	-	-	-	-	-	-
NODS SP	-	0.5	-	-	-	-
LAG DIST	-	-	-	-	-	-
LAG GRAC	-	-	-	-	-	-
LAG GRAS	0.22	-	-	-	-	-
LAG ELON	-	-	-	-	-	0.4
LAG NEBU	-	-	-	-	-	-
LAG STRI	-	-	-	-	-	-
LING VIT	-	-	-	-	-	-
LENT GIB	0.4	-	-	-	-	0.4
POLY SP	-	-	-	-	-	-

ENTO BICA	-	-	-	-	-	-
ENTO BILO	0.22	-	-	-	-	-
GLAND ANT	-	-	-	-	-	-
GLAND LAEV	-	-	-	-	-	-
LAR HYAL	-	-	-	-	-	-
FIS CORN	-	-	-	-	-	-
FIS FOLI	0.22	-	-	-	-	-
FIS MARG	1.3	-	-	-	-	-
FIS MENN	-	-	-	-	-	-
FIS SEM	-	-	-	-	-	-
FIS SPATH	0.22	-	-	-	-	-
FIS SUBF	-	-	-	-	-	-
FIS SUBT	-	-	-	-	-	-
FIS TEX	-	-	-	-	-	-
FIS TING	0.4	-	-	-	-	-
FIS TR-M	-	-	-	-	-	-
FIS SP	-	-	-	-	-	-
PARA CURTA	0.4	-	-	-	-	-
PARA FUS	-	-	-	-	-	-
PARA LATER	0.7	-	-	-	-	-
PARA MARG	-	-	-	-	-	-
PARA PSE-T	0.22	-	-	-	-	-
PARA PUST	-	-	-	-	-	-
PARA STAPH	-	-	-	-	-	-
PARA SUBC	-	-	-	-	-	-
OOL API	0.22	-	-	-	-	-
OOL HEX	-	-	-	-	-	-
OOL MELO	-	-	-	-	-	-
OOL SQUA	-	-	-	-	-	-
OOL A	0.22	-	-	-	-	-
OOL B	0.22	-	-	-	-	-
OOL C	-	-	-	-	-	-
PAT COR	4.8	-	-	-	-	-
PATS DEP	-	0.5	-	-	-	-
SPIR RAD	-	-	-	-	-	-
PSBU CHP	0.9	-	-	-	-	-
BUL ELG	0.4	-	-	-	-	-
BOL PSE	-	-	-	-	-	-
BOL PYG	-	-	-	-	-	-
BOL SP	-	-	-	-	-	-
CAS POR	0.4	-	-	-	-	4.02
CAS PARK	-	-	-	-	-	-
STAIN CON	-	-	-	-	-	-
TRIF EAR	2.6	-	-	-	-	10.44
TRIF PAUP	-	-	-	-	-	-
EPIS VIT	3.5	-	-	-	-	3.0
ROS GLOB	3.7	-	-	-	-	0.4
HER KEM	-	-	-	-	-	-
GLAB SP	0.9	-	-	-	-	-
SCHACK ANT	0.9	-	-	-	-	-
CIB LOB	3.7	-	0.6	-	-	0.8
ELPH SP	-	-	-	-	-	-
FUR EAR	-	-	-	-	-	0.4
EHR GLAB	18.3	-	-	-	-	2.0
GLOB BIO	-	-	-	-	-	-
GLOB CRAS	11.5	-	-	-	-	1.2
GLOB SUBG	-	-	-	-	-	9.3
AST ANT	4.8	-	-	-	-	1.2
AST ECH	1.1	-	1.3	-	-	1.2
NON IRID	13.5	0.5	-	-	-	-
PUL SUB	-	-	-	-	-	-
PUL BUL	-	-	-	-	-	-
TOTALS (%)	99.9	99.9	100.2	100.4	100.0	99.9

Absolute numbers of live tests in Core 1981-15,550m,Granite Harbour
(No live tests found in subsamples: 4-6,12-16,29-56cm)

Subsample:	2-4	6-8	8-10	10-12	16-19cm
ASTR SPH	-	-	-	-	-
RHAB ABYS	-	-	-	-	-
BATH HIR (A)	-	-	-	-	-
BATH HIR (B)	-	-	-	-	-
HYP CYL	-	-	-	-	-
HYP MAL	-	-	-	-	-
HYP SUB	-	-	-	-	-
PSAM FUSCA	-	-	1	-	-
PELO BIC	-	-	-	-	-
SAC SPH	-	-	-	-	-
SAC JUV	3	-	-	-	-
AMMOP SP	-	-	-	-	-
HEMI BRAD	-	-	-	-	-
THUR ALB	1	-	-	-	-
THUR PROT	-	-	-	-	-
GLOM GORD	-	-	-	-	-
GLOM CHAR	-	-	-	-	-
TUR SHON	-	-	-	-	-
HORM OVIC	-	-	-	-	-
HORM SP	-	-	-	-	-
REO PIL	2	-	-	-	-
REO PSEU(A)	-	-	-	-	-
(B)	-	-	-	-	-
REO SUBD	2	-	-	-	1
MIL ARE	-	-	-	-	-
MIL LATA	-	-	-	-	-
CRIB JEF	-	-	-	-	-
CRIB SUB	-	-	-	-	-
CRIB WIE	-	-	-	-	-
SPIRO FIL	-	-	-	-	-
TEXT ANT	-	-	-	-	-
TEXT EAR	-	-	-	-	-
TROC GLABRA	2	1	-	-	-
TROC GABO	-	1	-	-	-
TROC A	1	-	-	-	-
TROC B	-	-	-	-	-
PORT ANTA	-	-	-	-	-
PORT ELT	1	-	-	-	-
CONO BULL	3	2	-	-	-
VERN MIN	-	1	-	1	-
VERN ADV	-	-	-	-	-
EGGE BRAD	-	-	-	-	-
TOTALS (N)	15	5	1	1	1

NO MORE LIVE TESTS COUNTED
IN THESE SAMPLES

Percent live tests, Core 15

Subsample:	2-4	6-8	8-10	10-12	16-19CM
ASTR SPH	-	-	-	-	-
RHAB ABYS	-	-	-	-	-
BATH HIR (A)	-	-	-	-	-
BATH HIR (B)	-	-	-	-	-
HYP CYL	-	-	-	-	-
HYP MAL	-	-	-	-	-
HYP SUBN	-	-	-	-	-
PSAM FUSCA	-	-	100.0(1)	-	-
PELO BIC	-	-	-	-	-
SAC SPH	-	-	-	-	-
SAC JUV	20.0	-	-	-	-
AMMOP SP	-	-	-	-	-
HEMI BRAD	-	-	-	-	-
THUR ALB	6.7	-	-	-	-
THUR PROT	-	-	-	-	-
GLOM GORD	-	-	-	-	-
GLOM CHAR	-	-	-	-	-
TUR SHON	-	-	-	-	-
HORM OVIC	-	-	-	-	-
HORM SP	-	-	-	-	-
REO PIL	13.3	-	-	-	-
REO PSE (A)	-	-	-	-	-
(B)	-	-	-	-	-
REO SUBD	13.3	-	-	-	100.0(1)
MIL ARE	-	-	-	-	-
MIL LATA	-	-	-	-	-
CRIB JEFF	-	-	-	-	-
CRIB SUB	-	-	-	-	-
CRIB WIE	-	-	-	-	-
SPIRO FIL	-	-	-	-	-
TEXT ANT	-	-	-	-	-
TEXT EAR	-	-	-	-	-
TROC GLABRA	13.3	20.0	-	-	-
TROC GABO	-	20.0	-	-	-
TROC A	6.7	-	-	-	-
TROC B	-	-	-	-	-
PORT ANTA	-	-	-	-	-
PORT ELT	6.7	-	-	-	-
CONO BULL	20.0	40.0	-	-	-
VERN MIN	-	20.0	-	100.0(1)	-
VERN ADV	-	-	-	-	-
EGGE BRAD	-	-	-	-	-
TOTALS (%)	100.0	100.0	100.0	100.0	100.0

NO MORE LIVE IN ANY SAMPLE FROM CORE 15

Absolute numbers of dead tests Core 81-15

Subsample:	2-4	4-6	6-8	8-10	10-12	12-14cm
ASTR SPH	-	-	-	1	-	1
RHAB ABYS	-	-	-	-	-	-
BATH HIR (A)	-	-	-	-	-	-
BATH HIR (B)	-	-	-	-	-	-
HYP CYL	-	-	-	1	-	-
HYP MAL	-	-	-	-	-	-
HYP SUBN	-	-	-	-	-	-
PSAM FUSCA	26	11	7	1	9	13
PELO BIC	1	-	-	-	-	-
SAC SPH	-	3	-	-	1	-
SAC JUV	-	3	4	2	3	1
AMMOP SP	-	-	-	-	-	-
HEMI BRAD	-	-	-	1	-	1
THUR ALB	-	2	-	-	-	-
THUR PROT	-	-	-	1	-	-
GLOM GORD	-	1	-	-	-	-
GLOM CHAR	-	-	-	-	-	-
TUR SHON	-	-	-	-	-	-
HORM OVIC	-	4	2	1	6	8
HORM SP	-	-	-	-	-	-
REO PIL	3	1	-	-	3	5
REO PSEU(A)	-	-	-	-	-	-
(B)	-	-	-	-	-	-
REO SUBD	9	4	-	1	2	3
MIL ARE	26	32	18	8	30	35
MIL LATA	18	23	8	11	22	22
CRIB JEF	7	3	9	-	11	8
CRIB SUB	4	9	3	4	7	16
CRIB WIE	-	-	-	-	-	-
SPIRO FIL	-	-	1	-	-	-
TEXT ANT	30	2	32	2	21	22
TEXT EAR	4	-	5	2	4	4
TROC GLABRA	106	54	79	24	59	56
TROC GABO	-	19	42	14	40	40
TROC A	2	-	2	-	5	5
TROC B	1	-	-	-	-	-
PORT ANTA	33	9	15	2	16	28
PORT ELT	12	13	25	5	17	30
CONO BULL	27	·15	21	1	23	33
VERN MIN	5	-	8	1	7	8
VERN ADV	3	-	-	-	-	4
EGGE BRAD	-	-	-	-	-	-

NO DEAD MILIOLIDAE
NO DEAD NODOSARIIDAE
NO DEAD GLANDULINIDAE

PAT COR	-	-	-	-	-	-
PATS DEP	-	-	-	-	-	-
SPIR RAD	-	-	-	-	-	-
PSBU CHP	-	-	-	-	-	-
BUL ELG	-	-	-	-	-	-
BOL PSE	-	-	-	-	-	-
BOL PYG	-	-	-	-	-	-
BOL SP	-	-	-	-	-	-
CAS POR	-	-	-	-	-	-
CAS PARK	-	-	-	-	-	-
STAIN CON	-	-	-	-	-	-
TRIF EAR	-	-	-	-	-	-
TRIF PAUP	-	-	-	-	-	-
EPIS VIT	-	-	-	-	-	-
ROS GLOB	-	-	-	-	-	-
HER KEM	-	-	-	-	-	-
GLAB SP	-	-	-	-	-	-
SCHACK ANT	-	-	-	-	-	-
CIB LOB	-	-	-	-	-	-
ELPH SP	-	-	-	-	-	-
FUR EAR	2	4	2	2	-	2
EHR GLAB	-	-	-	-	-	-
GLOB BIO	-	-	-	-	-	-
GLOB CRAS	-	-	-	-	-	-
GLOB SUBG	-	-	-	-	-	-
AST ANT	-	-	-	-	-	-
AST ECH	-	-	-	-	2	-
NON IRID	-	-	-	-	-	-
PUL SUB	-	-	-	-	-	-
PUL BUL	-	-	-	-	-	-
TOTALS (N)	319	212	283	85	288	345

Absolute numbers of dead tests in Core 81-15

Subsample:	14-16	16-19	29-31	34-36	44-46	54-56cm
ASTR SPH	2	-	-	-	-	-
RHAB ABYS	-	-	-	-	-	-
BATH HIR (A)	-	-	-	-	-	-
BATH HIR (B)	-	-	-	-	-	-
HYP CYL	1	2	-	-	-	1
HYP MAL	-	-	-	-	-	-
HYP SUBN	-	-	-	-	-	-
PSAM FUSCA	1	2	1	3	6	2
PELO BIC	-	-	-	-	-	-
SAC SPH	8	-	11	11	10	7
SAC JUV	9	4	-	-	3	-
AMMOP SP	-	-	-	-	-	-
HEMI BRAD	-	-	-	-	-	-
THUR ALB	1	1	-	-	1	2
THUR PROT	-	-	-	-	-	-
GLOM GORD	2	-	-	-	-	-
GLOM CHAR	-	-	-	-	-	-
TUR SHON	-	-	-	-	-	-
HORM OVIC	3	5	8	8	-	-
HORM SP	-	-	-	1	-	-
REO PIL	9	-	-	1	-	1
REO PSEU(A)	-	-	-	-	-	3
(B)	-	-	-	-	-	-
REO SUBD	1	2	-	1	-	-
MIL ARE	48	18	20	16	42	23
MIL LATA	14	17	11	14	33	28
CRIB JEF	22	19	4	13	11	32
CRIB SUB	7	5	2	6	9	5
CRIB WIE	-	-	-	-	1	-
SPIRO FIL	-	-	-	-	-	3
TEXT ANT	35	13	-	-	1	5
TEXT EAR	5	7	1	4	-	24
TROC GLABRA	75	117	44	24	25	231
TROC GABO	46	51	23	15	11	65
TROC A	18	22	7	5	1	29
TROC B	1	-	-	4	-	-
PORT ANTA	24	33	5	16	19	68
PORT ELT	36	47	15	21	27	32
CONO BULL	45	42	4	20	32	45
VERN MIN	4	8	-	3	2	25
VERN ADV	2	4	-	-	-	-
EGGE BRAD	-	-	-	-	-	-
	NO DEAD MILIOLIDAE					
	NO DEAD NODOSARIIDAE					
	NO DEAD GLANDULINIDAE					
PAT COR	-	-	-	-	-	-
PATS DEP	-	-	-	-	-	-
SPIR RAD	-	-	-	-	-	-
PSBU CHP	-	-	-	-	-	-
BUL ELG	-	-	-	-	-	-
BOL PSE	-	-	-	-	-	-
BOL PYG	-	-	-	-	-	-
BOL SP	-	-	-	-	-	-
CAS POR	-	-	-	-	-	-
CAS PARK	-	-	-	-	-	-
STAIN CON	-	-	-	-	-	-
TRIF EAR	1	2	1	-	-	-
TRIF PAUP	-	-	-	-	-	-
EPIS VIT	-	-	1	-	-	-
ROS GLOB	-	-	-	-	-	-
HER KEM	-	-	-	-	-	-
GLAB SP	-	-	-	-	-	-
SCHACK ANT	-	-	-	-	-	-
CIB LOB	-	-	-	-	-	-
ELPH SP	-	-	-	-	-	-
FUR EAR	3	10	2	-	1	1
EHR GLAB	-	-	-	-	-	-
GLOB BIO	-	-	-	-	-	-
GLOB CRAS	-	-	-	-	-	1
GLOB SUBG	-	-	-	-	-	-
AST ANT	-	-	-	-	-	-
AST ECH	-	1	-	1	-	-
NON IRID	-	-	-	-	1	7
PUL SUB	-	-	-	1	-	-
PUL BUL	-	-	-	-	-	-
TOTALS (N)	423	432	160	88	211	640

Percent dead tests, Core 81-15

Subsample:	2-4	4-6	6-8	8-10	10-12	12-14cm
ASTR SPH	-	-	-	1.2	-	0.3
RHAB ABYS	-	-	-	-	-	-
BATH HIR (A)	-	-	-	-	-	-
BATH HIR (B)	-	-	-	-	-	-
HYP CYL	-	-	-	1.2	-	-
HYP MAL	-	-	-	-	-	-
HYP SUBN	-	-	-	-	-	-
PSAM FUSCA	8.2	5.2	2.5	1.2	3.1	3.8
AMMOP SP	-	-	-	-	-	-
SAC SPH	-	1.4	-	-	0.35	-
SAC JUV	-	1.4	1.4	2.35	1.0	0.3
PELO BIC	0.3	-	-	-	-	-
THUR ALB	-	0.94	-	-	-	-
THUR PROT	-	-	-	1.2	-	-
HEMI BRAD	-	-	-	1.2	-	0.3
GLOM GORD	-	0.5	-	-	-	-
GLOM CHAR	-	-	-	-	-	-
TUR SHON	-	-	-	-	-	-
HORM OVIC	-	1.9	0.7	1.2	2.1	2.3
HORM SP	-	-	-	-	-	-
REO PIL	0.94	0.5	-	-	1.0	1.4
REO PSE (A)	-	-	-	-	-	-
(B)	-	-	-	-	-	-
REO SUBD	2.8	1.9	-	1.2	0.7	0.9
MIL ARE	8.2	15.0	6.4	9.4	10.4	10.1
MIL LATA	5.6	10.8	2.8	13.0	7.6	6.4
CRIB JEF	2.2	1.4	3.2	-	3.8	2.3
CRIB SUB	1.3	4.2	1.1	4.7	2.4	4.6
CRIB WIE	-	-	-	-	-	-
SPIRO FIL	-	-	0.35	-	-	-
TEXT ANT	9.4	0.94	11.3	2.35	7.3	6.4
TEXT EAR	0.6	-	1.8	2.35	1.4	1.2
TROC GLABRA	33.2	25.5	28.0	28.2	20.5	16.2
TROC GABO	-	9.0	14.8	16.5	14.0	11.6
TROC A	0.6	-	0.7	-	1.7	1.4
TROC B	0.3	-	-	-	-	-
PORT ANTA	10.3	4.2	5.3	2.35	5.6	8.1
PORT ELT	3.8	6.1	8.8	5.9	5.9	8.7
CONO BULL	8.5	7.0	7.4	1.2	8.0	9.6
VERN MIN	1.6	-	2.8	1.2	2.4	2.3
VERN ADV	0.94	-	-	-	-	1.2
EGGE BRAD	-	-	-	-	-	-
	NO DEAD MILIOLIDAE					
	NO DEAD NODOSARIIDAE					
	NO DEAD GLANDULINIDAE					
PAT COR	-	-	-	-	-	-
PATS DEP	-	-	-	-	-	-
SPIR RAD	-	-	-	-	-	-
PSBU CHP	-	-	-	-	-	-
BUL ELG	-	-	-	-	-	-
BOL PSE	-	-	-	-	-	-
BOL PYG	-	-	-	-	-	-
BOL SP	-	-	-	-	-	-
CAS POR	-	-	-	-	-	-
CAS PARK	-	-	-	-	-	-
STAIN SP	-	-	-	-	-	-
TRIF EAR	-	-	-	-	-	-
TRIF PAUP	-	-	-	-	-	-
EPIS VIT	-	-	-	-	-	-
ROS GLOB	-	-	-	-	-	-
HER KEM	-	-	-	-	-	-
GLAB SP	-	-	-	-	-	-
SCHACK ANT	-	-	-	-	-	-
CIB LOB	-	-	-	-	-	-
ELPH SP	-	-	-	-	-	-
FUR EAR	0.6	1.9	0.7	2.35	-	0.6
EHR GLAB	-	-	-	-	-	-
GLOB BIO	-	-	-	-	-	-
GLOB CRAS	-	-	-	-	-	-
GLOB SUBG	-	-	-	-	-	-
AST ANT	-	-	-	-	-	-
AST ECH	-	-	-	-	0.7	-
NON IRID	-	-	-	-	-	-
PUL SUB	-	-	-	-	-	-
PUL BUL	-	-	-	-	-	-
TOTALS (%)	99.38	99.78	100.05	100.25	99.95	100.0

Percent dead tests in Core 15

Subsample:	14-16	16-19	29-31	34-36	44-46	54-56cm
ASTR SPH	0.5	-	-	-	-	-
RHAB ABYS	-	-	-	-	-	-
BATH HIR (A)	-	-	-	-	-	-
BATH HIR (B)	-	-	-	-	-	-
HYP CYL	0.24	0.5	-	-	-	0.16
HYP MAL	-	-	-	-	-	-
HYP SUBN	-	-	-	-	-	-
PSAM FUSCA	0.24	0.5	0.6	1.6	2.5	0.3
PELO BIC	-	-	-	-	-	-
SAC SPH	1.9	-	6.9	6.0	4.7	1.1
SAC JUV	2.1	0.9	-	-	1.3	-
AMMOP SP	-	-	-	-	-	-
HEMI BRAD	-	-	-	-	-	-
THUR ALB	0.24	0.23	-	-	0.4	0.3
THUR PROT	-	-	-	-	-	-
GLOM GORD	0.5	-	-	-	-	-
GLOM CHAR	-	-	-	-	-	-
TUR SHON	-	-	-	-	-	-
HORM OVIC	0.7	1.2	5.0	4.3	-	-
HORM SP	-	-	-	0.5	-	-
REO PIL	2.1	-	-	0.5	-	0.16
REO PSE (A)	-	-	-	-	-	0.47
(B)	-	-	-	-	-	-
REO SUBD	0.24	0.5	-	0.5	-	-
MIL ARE	11.3	4.2	12.5	8.5	17.8	3.6
MIL LATA	3.3	4.0	6.9	7.4	14.0	4.4
CRIB JEF	5.2	4.4	2.5	6.9	4.7	5.0
CRIB SUB	1.7	1.16	1.3	3.2	3.8	0.8
CRIB WIE	-	-	-	-	0.4	-
SPIRO FIL	-	-	-	-	-	0.47
TEXT ANT	8.3	3.0	-	-	0.4	0.8
TEXT EAR	1.2	1.6	0.6	2.1	-	3.8
TROC GLABRA	17.7	27.0	27.5	12.8	10.6	36.0
TROC GABO	10.9	12.0	14.4	8.0	4.7	10.0
TROC A	4.3	5.0	4.4	2.7	0.4	4.5
TROC B	0.24	-	-	2.1	-	-
PORT ANTA	5.7	7.6	3.1	8.5	8.0	10.6
PORT ELT	8.5	10.9	9.4	11.1	11.4	5.0
CONO BULL	10.6	9.7	2.5	10.6	13.6	7.0
VERN MIN	0.95	1.9	-	1.6	0.85	4.0
VERN ADV	0.5	0.9	-	-	-	-
EGGE BRAD	-	-	-	-	-	-
	NO DEAD MILIOLIDS					
	NO DEAD NODOSARIDS					
	NO DEAD GLANDULINIDS					
PAT COR	-	-	-	-	-	-
PATS DEP	-	-	-	-	-	-
SPIR RAD	-	-	-	-	-	-
PSBU CHP	-	-	-	-	-	-
BUL ELG	-	-	-	-	-	-
BOL PSE	-	-	-	-	-	-
BOL PYG	-	-	-	-	-	-
BOL SP	-	-	-	-	-	-
CAS POR	-	-	-	-	-	-
CAS PARK	-	-	-	-	-	-
STAIN CON	-	-	-	-	-	-
TRIF EAR	0.24	0.5	0.6	-	-	-
TRIF PAUP	-	-	-	-	-	-
EPIS VIT	-	-	0.6	-	-	-
ROS GLOB	-	-	-	-	-	-
HER KEM	-	-	-	-	-	-
GLAB SP	-	-	-	-	-	-
SCHACK ANT	-	-	-	-	-	-
CIB LOB	-	-	-	-	-	-
ELPH SP	-	-	-	-	-	-
FUR EAR	0.7	2.3	1.3	-	0.4	0.16
EHR GLAB	-	-	-	-	-	-
GLOB BIO	-	-	-	-	-	-
GLOB CRAS	-	-	-	-	-	0.16
GLOB SUBG	-	-	-	-	-	-
AST ANT	-	-	-	-	-	-
AST ECH	-	0.23	-	0.5	-	-
NON IRID	-	-	-	-	0.4	1.1
PUL SUB	-	-	-	0.5	-	-
PUL BUL	-	-	-	-	-	-
TOTALS (%)	100.09	100.22	100.1	99.9	100.35	99.8

Absolute numbers of live tests in core 18 (1981) 254m,New Harbour.
(No live tests found in subsamples:14-16cm,22-41cm bottom of core).

Subsample No:	2-4	4-6	8-10	10-12	12-14	16-18	18-20
ASTR SPH	-	-	-	-	-	-	-
RHAB ABYS	-	-	-	-	-	-	-
BATH HIR (A)	1	-	-	-	-	-	-
BATH HIR (B)	-	-	-	-	-	-	-
HYP CYL	-	-	-	-	-	-	-
HYP MAL	1	-	-	-	-	-	-
HYP SUB	2	-	-	-	-	-	-
PSAM FUSCA	1	1	-	1	1	-	-
PELO BIC	-	4	4	-	-	-	-
SAC SPH	-	1	-	-	-	-	-
SAC JUV	26	-	11	-	-	-	-
AMMOP SP	-	-	-	-	-	-	-
HEMI BRAD	-	-	-	-	-	-	-
THUR ALB	-	-	-	-	-	-	-
THUR PROT	-	-	-	-	-	-	-
GLOM GORD	-	1	-	-	-	-	-
GLOM CHAR	-	-	-	-	-	-	-
TUR SHON	-	-	-	-	-	-	-
HORM OVIC	-	1	1	-	-	-	-
HORM SP	-	-	-	-	-	-	-
REO PIL	10	3	8	2	2	-	-
REO PSEU(A)	4	2	-	1	-	-	-
(B)	-	2	1	-	1	-	-
REO SUBD	79	6	13	-	1	-	-
MIL ARE	5	6	4	2	-	2	-
MIL LATA	-	-	1	-	1	-	-
CRIB JEF	1	2	2	1	-	-	-
CRIB SUB	-	-	-	-	-	-	-
CRIB WIE	-	-	-	-	-	-	-
SPIRO FIL	-	-	-	-	-	-	-
TEXT ANT	5	7	2	2	-	-	-
TEXT EAR	-	-	1	-	-	-	1
TROC GLABRA	-	5	1	-	2	-	-
TROC GABO	-	-	-	-	-	-	-
TROC A	-	-	-	-	-	-	-
TROC B	1	-	-	-	-	-	-
PORT ANTA	4	4	3	2	-	-	1
PORT ELT	3	9	-	1	2	-	-
CONO BULL	-	9	5	-	1	-	-
VERN MIN	-	-	-	-	-	-	-
VERN ADV	-	-	-	-	-	-	-
EGGE BRAD	-	-	1	1	-	-	-
	NO LIVE MILIOLIDS						
	NO LIVE NODOSARIDS						
	NO LIVE POLYMORPHINIDS						
FIS SP	1	-	-	-	-	-	-
PAT COR	-	-	-	-	-	-	-
PATS DEP	-	-	-	-	-	-	-
SPIR RAD	-	-	-	-	-	-	-
PSBU CHP	-	-	-	-	-	-	-
BUL ELG	-	-	-	-	-	-	-
BOL PSE	-	-	-	-	-	-	-
BOL PYG	-	-	-	-	-	-	-
BOL SP	-	-	-	-	-	-	-
CAS POR	-	-	-	-	-	-	-
CAS PARK	-	-	-	-	-	-	-
STAIN CON	-	-	-	-	-	-	-
TRIF EAR	-	-	-	-	-	-	-
TRIF PAUP	-	-	-	-	-	-	-
EPIS VIT	-	-	-	-	-	-	-
ROS GLOB	-	-	-	-	-	-	-
HER KEM	-	-	-	-	-	-	-
GLAB SP	-	-	-	-	-	-	-
SCHACK ANT	-	-	-	-	-	-	-
CIB LOB	-	-	-	-	-	-	-
ELPH SP	-	-	-	-	-	-	-
FUR EAR	2	-	-	-	1	-	-
EHR GLAB	-	-	-	-	-	-	-
GLOB BIO	-	-	-	-	-	-	-
GLOB CRAS	-	-	-	-	-	-	-
GLOB SUBG	-	-	-	-	-	-	-
AST ANT	-	-	-	-	-	-	-
AST ECH	-	-	1	-	-	-	-
NON IRID	-	-	-	-	-	-	-
PUL SUB	-	-	-	-	-	-	-
PUL BUL	-	-	-	-	-	-	-
TOTALS (N)	146	63	59	13	12	2	2

Percent live tests, Core 81-18
No live tests in 14-16cm, 22-41cm

Subsample:	2-4	4-6	8-10	10-12	12-14	16-18	18-20cm
ASTR SPH	-	-	-	-	-	-	-
RHAB ABYS	-	-	-	-	-	-	-
BATH HIR (A)	0.7	-	-	-	-	-	-
BATH HIR (B)	-	-	-	-	-	-	-
HYP CYL	-	-	-	-	-	-	-
HYP MAL	0.7	-	-	-	-	-	-
HYP SUB	1.4	-	-	-	-	-	-
PSAM FUSCA	0.7	1.6	-	7.7	8.3	-	-
PELO BIC	-	6.3	6.8	-	-	-	-
SAC SPH	-	1.6	-	-	-	-	-
SAC JUV	18.0	-	18.6	-	-	-	-
AMMOP SP	-	-	-	-	-	-	-
HEMI BRAD	-	-	-	-	-	-	-
THUR ALB	-	-	-	-	-	-	-
THUR PROT	-	-	-	-	-	-	-
GLOM GORD	-	1.6	-	-	-	-	-
GLOM CHAR	-	-	-	-	-	-	-
TUR SHON	-	-	-	-	-	-	-
HORM OVIC	-	1.6	1.7	-	-	-	-
HORM SP	-	-	-	-	-	-	-
REO PIL	6.8	4.8	13.6	15.4	16.7	-	-
REO PSE (A)	2.7	3.2	-	7.,7	-	-	-
(B)	-	3.2	1.7	-	8.3	-	-
REO SUBD	54.0	9.5	22.0	-	8.3	-	-
MIL ARE	3.4	9.5	6.8	15.4	-	100(2)	-
MIL LATA	-	-	1.7	-	8.3	-	-
CRIB JEF	0.7	3.2	3.4	7.7	-	-	-
CRIB SUB	-	-	-	-	-	-	-
CRIB WIE	-	-	-	-	-	-	-
SPIRO FIL	-	-	-	-	-	-	-
TEXT ANT	3.4	11.1	3.4	15.4	-	-	-
TEXT EAR	-	-	1.7	-	-	-	50.0(1)
TROC GLABRA	-	7.9	1.7	-	16.7	-	-
TROC GABO	-		-	-	-	-	-
TROC A	-	-	-	-	-	-	-
TROC B	0.7	-	-	-	-	-	-
PORT ANTA	2.7	6.3	5.1	15.4	-	-	50.0(1)
PORT ELT	2.0	14.3	-	7.7	16.7	-	-
CONO BULL	-	14.3	8.5	-	8.3	-	-
VERN MIN	-	-	-	-	-	-	-
VERN ADV	-	-	-	-	-	-	-
EGGE BRAD	-	-	1.7	7.7	-	-	-
	NO LIVE MILIOLIDS						
	NO LIVE NODOSARIDS						
	NO LIVE POLYMORPHINIDS						
FIS SP	0.7	-	-	-	-	-	-
PAT COR	-	-	-	-	-	-	-
PATS DEP	-	-	-	-	-	-	-
SPIR RAD	-	-	-	-	-	-	-
PSBU CHP	-	-	-	-	-	-	-
BUL ELG	-	-	-	-	-	-	-
BOL PSE	-	-	-	-	-	-	-
BOL PYG	-	-	-	-	-	-	-
BOL SP	-	-	-	-	-	-	-
CAS POR	-	-	-	-	-	-	-
CAS PARK	-	-	-	-	-	-	-
STAIN SP	-	-	-	-	-	-	-
TRIF EAR	-	-	-	-	-	-	-
TRIF PAUP	-	-	-	-	-	-	-
EPIS VIT	-	-	-	-	-	-	-
ROS GLOB	-	-	-	-	-	-	-
HER KEM	-	-	-	-	-	-	-
GLAB SP	-	-	-	-	-	-	-
SCHACK ANT	-	-	-	-	-	-	-
CIB LOB	-	-	-	-	-	-	-
ELPH SP	-	-	-	-	-	-	-
FUR EAR	1.37	-	-	-	8.3	-	-
EHR GLAB	-	-	-	-	-	-	-
GLOB BIO	-	-	-	-	-	-	-
GLOB CRAS	-	-	-	-	-	-	-
GLOB SUBG	-	-	-	-	-	-	-
AST ANT	-	-	-	-	-	-	-
AST ECH	-	-	1.7	-	-	-	-
NON IRID	-	-	-	-	-	-	-
PUL SUB	-	-	-	-	-	-	-
PUL BUL	-	-	-	-	-	-	-
TOTALS (%)	99.97	100.0	100.1	100.1	99.9	100.0	100.0

Absolute numbers of dead tests down Core 1981-18

Subsample:	2-4	4-6	8-10	10-12	12-14	14-16	16-18cm
ASTR SPH	-	-	-	-	-	-	-
RHAB ABYS	-	-	-	4	-	-	-
BATH HIR (A)	15	1	-	-	-	-	-
BATH HIR (B)	-	-	5	-	-	-	-
HYP CYL	2	-	2	-	2	-	-
HYP MAL	12	-	12	-	4	-	-
HYP SUBN	20	10	40	9	10	-	9
PSAM FUSCA	9	9	28	18	1	-	10
PELO BIC	4	12	21	6	2	4	2
SAC SPH	-	4	1	-	-	-	-
SAC JUV	60	-	35	13	20	15	24
AMMOP SP	-	-	2	-	-	-	-
HEMI BRAD	-	-	-	-	-	-	1
THUR ALB	3	1	6	-	3	4	-
THUR PROT	1	-	-	2	-	-	-
GLOM GORD	8	4	11	2	2	1	4
GLOM CHAR	-	-	-	-	-	-	-
TUR SHON	-	-	-	-	-	-	-
HORM OVIC	32	57	141	25	11	6	8
HORM SP	-	-	-	-	-	-	-
REO PIL	23	49	69	7	4	17	7
REO PSEU(A)	21	22	31	8	1	4	4
(B)	14	19	34	5	12	-	1
REO SUBD	87	22	80	22	14	5	-
MIL ARE	184	265	343	66	86	95	101
MIL LATA	33	67	100	17	21	30	41
CRIB JEF	16	21	71	14	18	19	21
CRIB SUB	-	1	2	-	2	-	-
CRIB WIE	2	3	4	-	1	-	-
SPIRO FIL	-	-	-	-	-	-	-
TEXT ANT	162	198	328	71	40	25	26
TEXT EAR	41	13	41	9	4	7	3
TROC GLABRA	19	25	20	7	8	3	5
TROC GABO	12	10	12	6	3	9	5
TROC A	-	1	3	-	-	1	-
TROC B	9	-	17	-	-	4	9
PORT ANTA	117	106	106	31	26	15	14
PORT ELT	80	72	127	26	22	16	26
CONO BULL	66	124	181	29	28	39	28
VERN MIN	9	5	5	1	4	1	1
VERN ADV	-	-	1	-	-	-	-
EGGE BRAD	4	6	15	2	-	-	2

NO DEAD MILIOLIDS

DENT COM	-	-	-	-	-	-	-
NODS MAR	-	-	-	-	-	-	-
NODS SP	-	-	-	-	-	-	-
LAG DIST	-	-	-	-	-	-	-
LAG ELON	-	-	-	-	-	-	-

LAG GRAC	-	-	-	-	-	-	-
LAG GRAS	-	-	-	-	-	-	-
LAG NEBU	-	1	-	-	-	-	-
LAG STRI	-	-	-	-	-	-	-
LING VIT	-	-	-	-	-	-	-
LENT GIB	-	-	-	-	-	-	-
POLY SP	-	-	-	-	-	-	-
ENTO BICA	-	-	-	-	-	-	-
ENTO BILO	-	-	-	-	-	-	-
GLAND ANT	-	-	1	-	-	-	-
GLAND LAEV	-	-	-	-	-	-	-
LAR HYAL	-	-	-	-	-	-	-

NO DEAD FISSURINA
NO DEAD OOLINA
NO DEAD PARAFISSURINA

PAT COR	-	-	-	-	-	-	-
PATS DEP	-	-	-	-	-	-	-
SPIR RAD	-	-	-	-	-	-	-
PSBU CHP	-	-	-	-	-	-	-
BUL ELG	-	-	-	-	-	-	-
BOL PSE	-	-	-	-	-	-	-
BOL PYG	-	-	-	-	-	-	-
BOL SP	-	-	-	-	-	-	-
CAS POR	-	-	-	-	-	-	-
CAS PARK	-	-	-	-	-	-	-
STAIN CON	-	-	-	-	-	-	-
TRIF EAR	-	2	-	-	-	-	-
TRIF PAUP	-	-	-	-	-	-	-
EPIS VIT	-	-	-	-	-	-	-
ROS GLOB	-	-	-	-	-	-	-
HER KEM	-	-	-	-	-	-	-
GLAB SP	-	-	-	-	-	-	-
SCHACK ANT	-	-	-	-	-	-	-
CIB LOB	-	-	-	-	-	-	-
ELPH SP	-	-	-	-	-	-	-
FUR EAR	-	-	2	-	-	-	1
EHR GLAB	-	-	-	-	-	-	-
GLOB BIO	-	-	-	-	-	-	-
GLOB CRAS	-	-	-	-	-	1	-
GLOB SUBG	-	-	-	-	-	-	-
AST ANT	1	1	-	-	-	-	-
AST ECH	-	5	3	-	3	1	-
NON IRID	-	-	-	-	-	-	-
PUL SUB	-	-	-	-	-	-	-
PUL BUL	-	-	-	-	-	-	-
TOTALS (N)	1066	1136	1900	400	332	322	353

Absolute numbers of dead tests for Core 18

Subsample:	18-20	22-24	26-30	30-32	32-34	38-41cm
ASTR SPH	-	-	-	-	-	-
RHAB ABYS	-	-	-	-	-	-
BATH HIR (A)	-	-	-	-	-	-
BATH HIR (B)	-	-	-	-	-	-
HYP CYL	-	-	-	-	-	-
HYP MAL	2	-	-	-	-	-
HYP SUB	4	-	2	-	-	-
PSAM FUSCA	1	1	1	-	1	-
PELO BIC	2	1	-	-	-	-
SAC SPH	-	-	2	2	-	-
SAC JUV	1	11	6	-	2	2
AMMOP SP	-	-	-	-	-	-
HEMI BRAD	-	-	-	-	-	-
THUR ALB	1	-	-	-	-	-
THUR PROT	-	-	-	-	-	-
GLOM GORD	-	1	-	-	-	-
GLOM CHAR	-	-	-	-	-	-
TUR SHON	-	-	-	-	-	-
HORM OVIC	11	2	3	1	-	-
HORM SP	-	-	-	-	-	-
REO PIL	14	4	-	-	-	-
REO PSEU(A)	5	2	-	2	-	-
(B)	1	-	-	-	-	-
REO SUBD	-	-	2	-	2	-
MIL ARE	98	155	143	116	54	27
MIL LATA	33	73	41	35	26	17
CRIB JEF	12	4	2	8	4	9
CRIB SUB	-	-	-	-	-	-
CRIB WIE	1	-	-	-	-	-
SPIRO FIL	-	-	-	-	-	-
TEXT ANT	24	6	1	-	1	-
TEXT EAR	1	-	-	-	-	-
TROC GLABRA	2	1	1	2	-	10
TROC GABO	6	4	-	2	-	-
TROC A	-	-	-	1	-	-
TROC B	-	1	-	1	-	-
PORT ANTA	12	9	6	4	4	9
PORT ELT	19	16	4	6	4	5
CONO BULL	18	6	10	13	14	10
VERN MIN	3	-	-	-	-	-
VERN ADV	-	-	-	-	-	-
EGGE BRAD	3	1	-	-	-	-
CYCL INVO	-	-	-	-	-	-
PLAN BUC	-	-	-	-	-	-
CRUC TRI	-	-	-	-	-	-
PYRG DEP	-	-	-	-	-	-
PYRG ELO	-	-	-	-	-	-
PYRG MUR	-	-	-	-	-	1
PRGOL SPH	-	-	-	-	-	-
SIG UMB	-	-	-	-	-	-
MIL SP A	-	-	-	-	-	11
DENT COM	-	-	-	-	-	-
NODS MAR	-	-	-	-	-	-
NODS SP	-	-	-	-	-	-
LAG DIST	-	-	-	-	-	-
LAG ELON	-	-	-	2	-	2
LAG GRAC	-	-	-	-	1	-
LAG GRAS	-	-	-	-	-	-
LAG NEBU	-	-	-	-	-	2
LAG STRI	-	-	-	-	-	-
LING VIT	-	-	-	-	-	-
LENT GIB	-	-	-	-	-	-
POLY SP	-	-	-	-	-	-

ENTO BICA	-	-	-	-	-	-
ENTO BILO	-	-	-	-	-	-
GLAND ANT	-	-	1	-	1	1
GLAND LAEV	-	-	-	-	-	-
LAR HYAL	-	-	-	-	-	-
FIS CORN	-	-	-	-	-	-
FIS FOLI	-	-	-	-	-	-
FIS MARG	-	-	-	-	-	-
FIS MENN	-	-	-	-	-	-
FIS SEM	-	-	-	-	-	-
FIS SPATH	-	-	-	-	-	-
FIS SUBF	-	-	-	-	-	-
FIS SUBT	-	-	-	-	-	-
FIS TEX	-	-	-	-	-	-
FIS TING	-	-	-	-	-	-
FIS TR-M	-	-	-	-	-	1
FIS SP	-	-	-	-	-	-
PARA CURTA	-	-	-	-	-	-
PARA FUS	-	-	-	-	-	-
PARA LATER	-	-	-	-	-	-
PARA MARG	-	-	-	-	-	-
PARA PSE-T	-	-	-	-	-	-
PARA PUST	-	-	-	-	-	-
PARA STAPH	-	-	-	-	-	-
PARA SUBC	-	-	-	-	-	-
OOL API	-	-	-	-	-	-
OOL HEX	-	-	-	-	-	-
OOL MELO	-	-	-	-	-	-
OOL SQUA	-	-	-	-	-	-
OOL A	-	-	-	-	-	-
OOL B	-	-	-	-	-	-
OOL C	-	-	-	-	-	-
PAT COR	-	-	-	-	-	-
PATS DEP	-	-	-	-	-	-
SPIR RAD	-	-	-	-	-	-
PSBU CHP	-	-	-	-	-	-
BUL ELG	-	-	-	-	-	-
BOL PSE	-	-	-	-	-	-
BOL PYG	-	-	-	-	-	-
BOL SP	-	-	-	-	-	-
CAS POR	-	-	-	-	-	-
CAS PARK	-	-	-	-	-	-
STAIN CON	-	-	-	-	-	-
TRIF EAR	-	-	-	4	9	14
TRIF PAUP	-	-	-	-	-	3
EPIS VIT	-	-	-	1	2	56
ROS GLOB	-	-	-	-	-	-
HER KEM	-	-	-	-	-	-
GLAB SP	-	-	-	-	-	-
SCHACK ANT	-	-	-	-	-	-
CIB LOB	-	-	-	-	-	3
ELPH SP	-	-	-	-	-	-
FUR EAR	-	-	-	-	-	15
EHR GLAB	-	-	-	-	-	-
GLOB BIO	-	-	-	-	1	1
GLOB CRAS	-	-	-	2	-	17
GLOB SUBG	-	-	-	-	-	-
AST ANT	-	-	-	2	4	17
AST ECH	-	-	1	6	2	2
NON IRID	1	-	-	-	-	4
PUL SUB	-	-	-	-	-	-
PUL BUL	-	-	-	-	-	-
TOTALS (N)	277	298	226	210	132	241

Percent dead tests, Core 18

Sub-ample:	2-4	4-6	8-20	10-12	12-14	14-16	16-18cm
ASTR SPH	-	-	-	-	-	-	-
RHAB ABYS	-	-	-	1.0	-	-	-
BATH HIR (A)	1.4	0.1	-	-	-	-	-
BATH HIR (B)	-	-	0.26	-	-	-	-
HYP CYL	0.2	-	0.11	-	0.57	-	-
HYP MAL	1.1	-	0.63	-	1.14	-	-
HYP SUBN	1.9	0.9	2.1	2.25	2.8	-	2.5
PSAM FUSCA	0.8	0.8	1.5	4.5	0.28	-	2.8
PELO BIC	0.4	1.1	1.1	1.5	0.57	1.2	0.6
SAC SPH	-	-	-	-	-	-	-
SAC JUV	5.6	-	1.8	3.25	5.7	4.7	6.8
AMMOP SP	-	-	0.11	-	-	-	-
HEMI BRAD	-	-	-	-	-	-	0.28
THUR ALB	0.3	0.1	0.3	-	0.85	1.2	-
THUR PROT	0.09	-	-	0.5	-	-	-
GLOM GORD	0.8	0.4	0.6	0.5	0.57	0.3	1.1
GLOM CHAR	0.09	-	-	-	-	-	-
TUR SHON	-	-	-	-	-	-	-
HORM OVIC	3.0	5.0	7.4	6.3	3.1	1.9	2.3
HORM SP	-	-	-	-	-	-	-
REO PIL	2.2	4.3	3.6	1.75	1.14	5.3	2.0
REO PSE (A)	2.0	2.0	1.6	2.0	0.28	1.2	1.1
(B)	1.3	1.7	1.8	1.25	3.4	-	0.28
REO SUBD	8.2	2.0	4.2	5.5	4.0	1.6	-
MIL ARE	17.3	23.3	18.05	16.5	24.43	30.0	28.6
MIL LATA	3.1	6.0	5.3	4.25	6.0	9.3	11.6
CRIB JEF	1.5	1.8	3.7	3.5	5.1	6.0	6.0
CRIB SUB	-	0.1	0.11	-	0.57	-	-
CRIB WIE	0.2	0.3	0.2	-	0.28	-	-
SPIRO FIL	-	-	-	-	-	-	-
TEXT ANT	15.2	17.4	17.3	17.75	11.36	7.8	7.4
TEXT EAR	3.8	1.1	2.2	2.25	1.14	2.2	0.85
TROC GLAB	1.8	2.2	1.05	1.6	2.25	0.9	1.4
TROC GABO	1.1	0.9	0.63	1.65	0.85	2.8	1.4
TROC A	-	0.1	0.16	-	-	0.3	-
TROC B	0.8	-	0.9	-	-	1.2	2.5
PORT ANTA	11.0	9.3	5.6	7.75	7.4	4.7	4.0
PORT ELT	7.5	6.3	6.7	6.5	6.25	5.0	7.4
CONO BULL	6.2	11.0	9.5	7.25	8.05	12.0	8.0
VERN MIN	0.8	0.4	0.3	0.25	1.14	0.3	0.28
VERN ADV	-	-	0.05	-	-	-	-
EGGE BRAD	0.4	0.5	0.8	0.5	-	-	0.6
	NO DEAD MILIOLIDS						
DENT COM	-	-	-	-	-	-	-
NODS MAR	-	-	-	-	-	-	-
NODS SP	-	-	-	-	-	-	-
LAG DIST	-	-	-	-	-	-	-
LAG ELON	-	-	-	-	-	-	-

LAG GRAC	-	-	-	-	-	-	-
LAG GRAS	-	-	-	-	-	-	-
LAG NEBU	-	0.1	-	-	-	-	-
LAG STRI	-	-	-	-	-	-	-
LAG SUBT	-	-	-	-	-	-	-
LING VIT	-	-	-	-	-	-	-
LENT GIB	-	-	-	-	-	-	-
POLY SP	-	-	-	-	-	-	-
ENTO BICA	-	-	-	-	-	-	-
ENTO BILO	-	-	-	-	-	-	-
GLAND ANT	-	-	0.05	-	-	-	-
GLAND LAEV	-	-	-	-	-	-	-
LAR HYAL	-	-	-	-	-	-	-
	NO DEAD FISSURINA						
	NO DEAD OOLINA						
	NO DEAD PARAFISSURINA						
PAT COR	-	-	-	-	-	-	-
PATS DEP	-	-	-	-	-	-	-
SPIR RAD	-	-	-	-	-	-	-
PSBU CHP	-	-	-	-	-	-	-
BUL ELG	-	-	-	-	-	-	-
BOL PSE	-	-	-	-	-	-	-
BOL PYG	-	-	-	-	-	-	-
BOL SP	-	-	-	-	-	-	-
CAS POR	-	-	-	-	-	-	-
CAS PARK	-	-	-	-	-	-	-
STAIN CON	-	-	-	-	-	-	-
TRIF EAR	-	0.2	-	-	-	-	-
TRIF PAUP	-	-	-	-	-	-	-
EPIS VIT	-	-	-	-	-	-	-
ROS GLOB	-	-	-	-	-	-	-
HER KEM	-	-	-	-	-	-	-
GLAB SP	-	-	-	-	-	-	-
SCHACK ANT	-	-	-	-	-	-	-
CIB LOB	-	-	-	-	-	-	-
ELPH SP	-	-	-	-	-	-	-
FUR EAR	-	-	0.11	-	-	-	0.28
EHR GLAB	-	-	-	-	-	-	-
GLOB BIO	-	-	-	-	-	-	-
GLOB CRAS	-	-	-	-	-	-	-
GLOB SUBG	-	-	-	-	-	-	-
AST ANT	0.09	0.1	-	-	-	-	-
AST ECH	-	0.4	0.16	-	0.85	0.5	-
NON IRID	-	-	-	-	-	-	-
PUL SUB	-	-	-	-	-	-	-
PUL BUL	-	-	-	-	-	-	-
TOTALS (%)	100.17	99.9	99.98	100.05	100.02	100.2	100.07

Percent dead tests, Core 81-18

Subsample:	18-20	22-24	26-30	30-32	32-34	38-41 cm
ASTR SPH	-	-	-	-	-	-
RHAB ABYS	-	-	-	-	-	-
BATH HIR (A)	-	-	-	-	-	-
BATH HIR (B)	-	-	-	-	-	-
HYP CYL	-	-	-	-	-	-
HYP MAL	0.72	-	-	-	-	-
HYP SUBN	1.4	-	0.9	-	-	-
PSAM FUSCA	0.36	0.34	0.44	-	0.8	-
PELO BIC	0.72	0.34	-	-	-	-
SAC SPH	-	-	-	-	-	-
SAC JUV	0.36	3.8	2.7	-	1.5	0.83
AMMOP SP	-	-	-	-	-	-
HEMI BRAD	-	-	-	-	-	-
THUR ALB	0.36	-	-	-	-	-
THUR PROT	-	-	-	-	-	-
GLOM GORD	-	0.34	-	-	-	-
GLOM CHAR	-	-	-	-	-	-
TUR SHON	-	-	-	-	-	-
HORM OVIC	4.0	0.67	1.3	0.5	-	-
HORM SP	-	-	-	-	-	-
REO PIL	5.0	1.34	-	-	-	-
REO PSE (A)	1.8	0.67	-	1.0	-	-
(B)	0.36	-	0.9	-	-	-
REO SUBD	0.72	-	-	-	1.5	-
MIL ARE	35.38	52.0	63.3	55.25	41.0	11.2
MIL LATA	12.0	24.5	18.0	16.7	19.7	7.1
CRIB JEF	4.3	1.3	0.9	3.81	3.0	3.7
CRIB SUB	-	-	-	-	-	-
CRIB WIE	0.36	-	-	-	-	-
SPIRO FIL	-	-	-	-	-	-
TEXT ANT	8.7	2.0	0.44	-	0.8	-
TEXT EAR	0.36	-	-	-	-	-
TROC GLABRA	0.72	1.74	0.44	1.0	-	4.15
TROC GABO	2.28	-	-	1.0	-	-
TROC A	-	-	-	0.5	-	-
TROC B	-	0.34	-	0.5	-	-
PORT ANTA	4.3	3.0	2.7	2.0	3.0	3.7
PORT ELT	6.8	5.4	1.8	3.0	3.0	2.0
CONC BULL	6.5	2.0	4.4	6.2	10.6	4.15
VERN MIN	1.08	-	-	-	-	-
VERN ADV	-	-	-	-	-	-
EGGE BRAD	1.08	0.34	-	-	-	-
CYCL INVO	-	-	-	-	-	-
PLAN BUC	-	-	-	-	-	-
CRUC TRI	-	-	-	-	-	-
PYRG DEP	-	-	-	-	-	-
PYRG ELO	-	-	-	-	-	-
PYRG MUR	-	-	-	-	-	0.41
PRGOL SPH	-	-	-	-	-	-
SIG UMB	-	-	-	-	-	-
MIL SP A	-	-	-	-	-	4.6
DENT COM	-	-	-	-	-	-
NODS MAR	-	-	-	-	-	-
NODS SP	-	-	-	-	-	-
LAG DIST	-	-	-	-	-	-
LAG ELON	-	-	-	1.0	-	0.83
LAG GRAC	-	-	-	-	0.8	-
LAG GRAS	-	-	-	-	-	-
LAG NEBU	-	-	-	-	-	0.83
LAG STRI	-	-	-	-	-	-
LAG SUBT	-	-	-	-	-	-
LING VIT	-	-	-	-	-	-
LENT GIB	-	-	-	-	-	-
POLY SP	-	-	-	-	-	-

ENTO BICA	-	-	-	-	-	-
ENTO BILO	-	-	-	-	-	-
GLAND ANT	-	-	0.44	-	0.8	0.41
GLAND LAEV	-	-	-	-	-	-
LAR HYAL	-	-	-	-	-	-
FIS CORN	-	-	-	-	-	-
FIS FOLI	-	-	-	-	-	-
FIS MARG	-	-	-	-	-	-
FIS MENN	-	-	-	-	-	-
FIS SEM	-	-	-	-	-	-
FIS SPATH	-	-	-	-	-	0.41
FIS SUBF	-	-	-	-	-	-
FIS SUBT	-	-	-	-	-	-
FIS TEX	-	-	-	-	-	-
FIS TING	-	-	-	-	-	-
FIS TR-M	-	-	-	-	-	0.41
FIS SP	-	-	-	-	-	0.41
PARA CURTA	-	-	-	-	-	-
PARA FUS	-	-	-	-	-	-
PARA LATER	-	-	-	-	-	0.41
PARA MARG	-	-	-	-	-	-
PARA PSE-T	-	-	-	-	-	-
PARA PUST	-	-	-	-	-	-
PARA STAPH	-	-	-	-	-	-
PARA SUBC	-	-	-	-	-	-
OOL API	-	-	-	-	-	-
OOL HEX	-	-	-	-	-	-
OOL MELO	-	-	-	-	-	-
OOL SQUA	-	-	-	-	-	-
OOL A	-	-	-	-	-	-
OOL B	-	-	-	-	-	-
OOL C	-	-	-	-	-	-
PAT COR	-	-	-	-	-	-
PATS DEP	-	-	-	-	-	-
SPIR RAD	-	-	-	-	-	-
PSBU CHP	-	-	-	-	-	-
BUL ELG	-	-	-	-	-	-
BOL PSE	-	-	-	-	-	-
BOL PYG	-	-	-	-	-	-
BOL SP	-	-	-	-	-	-
CAS POR	-	-	-	-	-	-
CAS PARK	-	-	-	-	-	-
STAIN CON	-	-	-	-	-	-
TRIF EAR	-	-	-	2.0	6.8	5.8
TRIF PAUP	-	-	-	-	-	1.24
EPIS VIT	-	-	-	0.5	1.5	23.2
ROS GLOB	-	-	-	-	-	-
HER KEM	-	-	-	-	-	-
GLAB SP	-	-	-	-	-	-
SCHACK ANT	-	-	-	-	-	-
CIB LOB	-	-	-	-	-	1.24
ELPH SP	-	-	-	-	-	-
FUR EAR	-	-	-	-	-	6.1
EHR GLAB	-	-	-	-	-	-
GLOB BIO	-	-	-	-	0.8	0.41
GLOB CRAS	-	-	-	1.0	-	7.0
GLOB SUBG	-	-	-	-	-	-
AST ANT	-	-	-	1.0	3.0	7.0
AST ECH	-	-	0.44	3.0	1.5	0.83
NON IRID	0.36	-	-	-	-	1.66
PUL SUB	-	-	-	-	-	-
PUL BUL	-	-	-	-	-	-
TOTALS (%)	100.02	100.12	100.0	99.96	100.1	100.03

BENTHIC FORAMINIFERA OF McMURDO SOUND

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Abstract Sediment samples containing foraminifera have been collected in McMurdo Sound from a range of water depths and physiographic situations, using the sea ice as an operating platform. Splits were treated with rose bengal stain, and tests containing stained protoplasm extracted for further study. Non-stained tests were also separated for comparative purposes. Three areas of varying foraminiferal distribution have been identified as follows: 1) below 560 m there exists an assemblage of agglutinated foraminifera with *Reophax* spp. as the dominant taxa; 2) between 560 and about 210 m there is a mixed assemblage, again with *Reophax* spp. as the dominant agglutinated taxa, and *Trifarina earlandi, Globocassidulina* cf. *subglobosa* and *Cassidulinoides porrectus* as the dominant calcareous taxa; this includes the Granite Harbour area; and 3) the New Harbour area supports and agglutinated population similar to that found below 560 m in the open Sound.

Comparison of living (stained) and dead assemblages from the top 20 mm of five 22 cm-diameter cores indicates that post-mortem alteration of assemblages, specifically, disappearance of calcareous tests, increases progressively with greater water depth until the carbonate compensation depth (CCD) is reached, somewhere between 560 and 850 m. The difference in proportions of calcareous and agglutinated foraminifera in live and dead assemblages increases the difficulty in the ecological interpretation of ancient (dead) assemblages.

McMurdo Sound lies at the southern end of the western Ross Sea between Ross Island on the east and southern Victoria Land on the west. Due to its proximity to McMurdo Station and Scott Base, the Sound is one of the most intensively studied areas of Antarctica. Despite this, surprisingly little is known of the general ecology and physiography of the sea floor. This is exemplified by the fact that no satisfactory bathymetric map of the region was available for the present research.

Previous studies of fossil and Recent foraminifera in and around McMurdo Sound include those by Chapman (1916), Kennett (1968), Webb and Neall (1972), Fillon (1974), Kellogg et al. (1977), Osterman and Kellogg (1979) and Webb and Wrenn (1982). Those dealing with modern faunas did not differentiate between living and dead assemblages or concentrate on McMurdo Sound as an ecological unit.

Purpose

The objective of this project is to establish distribution patterns for living foraminifera in McMurdo Sound by examining sediment samples from a range of water depths and physiographic situations. This data may be useful in: (1) serving as comparative material for ancient sediments that no longer contain complete foraminiferal assemblages, and thus aid in establishing palaeoenvironmental conditions for those sediments; and (2) providing baseline data for the McMurdo Sound area in the event it is modified by future human activities, such as mineral resource exploitation.

Collection of Samples

Sediment samples containing foraminifera were collected from a wide range of water depths (8 to 850 m) during three consecutive field seasons. The annual sea ice was used as an operating platform, restricting the area and time of collection, as the ice becomes soft in mid to late December.

The most useful sediment samples were short cores retrieved with a wide diameter (22 cm) gravity sphincter corer designed and built at Victoria University. The cores are undisturbed sections of the sea floor which were photographed and described before being split and preserved in alcohol for transport to New Zealand. The other methods used to obtain sediment samples were a short 5 cm-diameter piston corer, a McIntyre grab and an orange-peel grab. The piston corer did not operate satisfactorily, and the McIntyre grab required a large access hole (2 m) in the sea ice, thus limiting the number of locations that could be sampled in a given time. The orange-peel grab was efficient, but the sample was washed as it was brought to the surface due to the open nature of the grab, and the top 10 cm of sediment was mixed as the grab closed.

Twenty sediment samples collected during the 1981/82 season using the gravity sphincter corer provided the most useful foraminiferal data. Fourteen were intact 22 cm diameter cores, ranging in length from 6 to 56 cm. Six samples were disturbed when the corer fell over as it penetrated the sea floor. This was in areas of coarse substrate, which inhibited penetration of the corer. The longest cores came from Granite Harbour (Cores 14, 15 and 16) and New Harbour (Core 18), where the sea floor sediment is fine-grained and nearly homogeneous, containing only a few scattered pebble- and cobble-sized clasts. Figure 1 shows the sample site locations of cores discussed below.

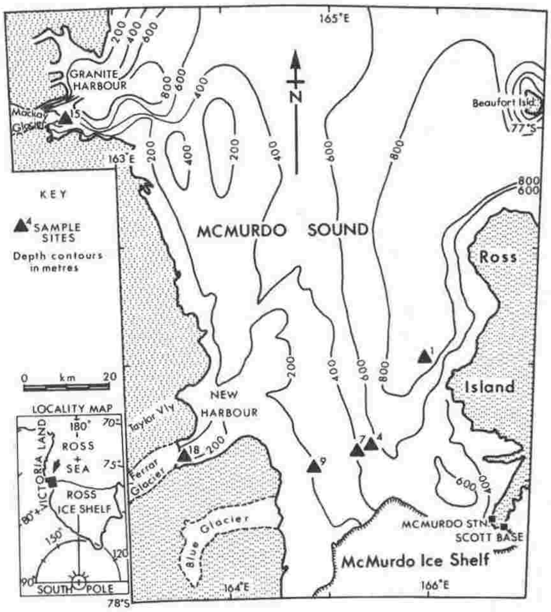

Figure 1. Map of McMurdo Sound region showing sample site locations for cores 1, 4, 7, 9, 15 and 18.

Laboratory Procedures

Portions of the top 20 mm of the sediment samples were washed over a 63 μm brass sieve. The residue retained on the sieve was soaked in a solution of rose bengal stain and ethanol for 45 to 60 minutes (Walton, 1952). The material was rinsed and dried, then floated in carbon tetrachloride (CCl_4) to concentrate the biogenic material (Murray, 1979). The floated fractions were split to a size containing approximately 300 to 500 foraminifera tests, which were sorted under the microscope and mounted on faunal slides. Stained tests (tests containing stained protoplasm, and thus considered to have been alive at time of collection) and unstained tests were mounted on separate slides. The heavy residues that sank in the CCl_4 were also examined for any foraminifera, which were added to the collections on the slides. Population counts were made from these faunal slides.

Problems

There is some discussion in the literature (e.g. Walker et al., 1974) concerning the reliability of the rose bengal staining technique. For example, there is some problem in seeing through the test walls of large miliolids and agglutinated forms, necessitating breaking open each individual test to see if it contained stained protoplasm. As the samples used in the present study contained relatively few of these forms, breaking them the examine the interior did not involve much effort. Another problem is the exterior of the tests often being stained. This is easy to differentiate from stained protoplasm under high (x36 to x72) magnification.

A more serious problem involves the staining of bacteria or algae that might be living inside a dead foraminiferal test. If other chambers of the test contain sediment, it can be discounted as being a live test. Also, if an area around a broken part of the test is stained, these are not counted as living forms. Other factors that can contribute to errors being introduced into the calculation of living/dead ratios are: small numbers of tests counted, splitting technique error, and the apparent "patchiness" in the distribution of living populations on the sea floor (Shifflett, 1961).

FORAMINIFERAL POPULATION COUNTS

Live: Dead Ratios (See Figure 2)

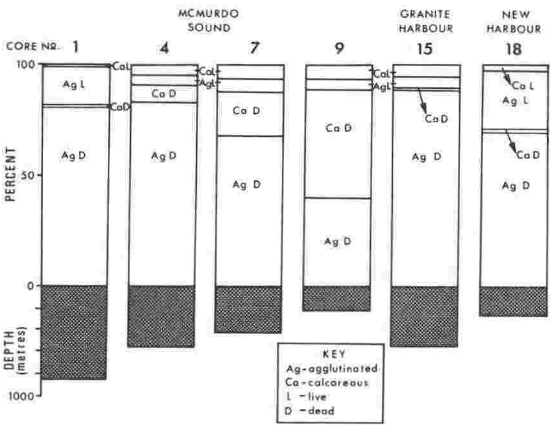

Figure 2. Histogram showing percentages of live and dead foraminiferal assemblages, proportions of calcareous and agglutinated tests for each fraction, and depth of each sample.

Counts of foraminifera from cores 1, 4, 7, 9, 15 and 18 collected in McMurdo Sound, Granite Harbour and New Harbour are consistent with those of Kennett (1968) and confirm the calcium carbonate compensation depth between 560 and 850 m, as elsewhere in the Ross Sea. In Core 1 (850 m) stained tests (representing specimens that were alive when collected) form 18% of the sample and are mainly *Reophax subdentaliniformis* Parr, *R. kerguelenensis* Parr and *Textularia antarctica* (Wiesner), with less common *Reophax pilulifer* Brady. Only one stained calcareous test was found, a two-chambered juvenile of *Lenticulina* sp.

Stained calcareous tests form about 4% of the assemblage in Core 4 (560 m) and include, in order of decreasing abundance, *Cassidulinoides porrectus* (Heron-Allen and Earland), *Globocassidulina subglobosa ?* (Brady), *G. crassa* (d'Orbigny), *Trifarina earlandi* (Parr) and *Cibicides lobatulus* (Walker and Jacob). Stained agglutinated tests present are *R. subdentaliniformis, R. kerguelenensis, R. pilulifer* and *Portotrochammina* spp. The numbers of stained agglutinated and calcareous tests are nearly equal, and together form 8% of the total count. Core 7 (420 m) also has approximately equal numbers of stained agglutinated and calcareous tests. Both of these mixed assemblages are within the range of Kennett's (1968) mixed faunal zone and above his CCD.

Core 15, from 550 m in Granite Harbour, has 9.3% stained tests, similar to the above samples, and has 45% calcareous to 55% agglutinated stained tests. The most numerous living (stained) species are the agglutinated *Textularia antarctica* and the calcareous *Fursenkoina* cf. *davisi* (Chapman and Parr). Core 15 is unusual in that the proportion of calcareous tests in the dead assemblage (0.7%) is much smaller than in the living population (45%).

Stained calcareous and agglutinated tests are again present in nearly equal numbers in Core 9 (213 m), 200 m above the top of Kennett's zone of mixed faunas. The stained tests form about 10% of the total count, again similar to the proportions of stained tests found in Cores 4, 7 and 15. The dominant taxa are the calcareous *Trifarina earlandi* and *Ehrenbergina glabra* Heron-Allen and Earland, and the agglutinated *Portotrochammina antarctica* (Parr).

An agglutinated fauna characterises the embayed area of New Harbour. The dominant stained taxa in Core 18 (254 m) are *Reophax subdentaliniformis* and *R. kerguelenensis*. There is an extremely restricted calcareous fauna comparable to that described from Core 1 (850 m in McMurdo Sound). On the basis of depth, this sample should also fall within the zone of mixed faunas described by Kennett (1968). Calcareous species form 6% of the living tests in this core top, compared to the usual 50% in the sample from the open Sound waters.

The evidence from Cores 15 and 18 implies that the waters in Granite Harbour and New Harbour have a lower pH than in the open waters of McMurdo Sound. The very low numbers of calcareous stained tests in the New Harbour sample would indicate that the pH there is lower than in Granite Harbour but similar to that of the deeper Sound waters, that is, those below the CCD.

SUMMARY

Figure 3 summarises the agglutinated/calcareous test ratios which demonstrate the progressive change of the ratio by loss of calcareous

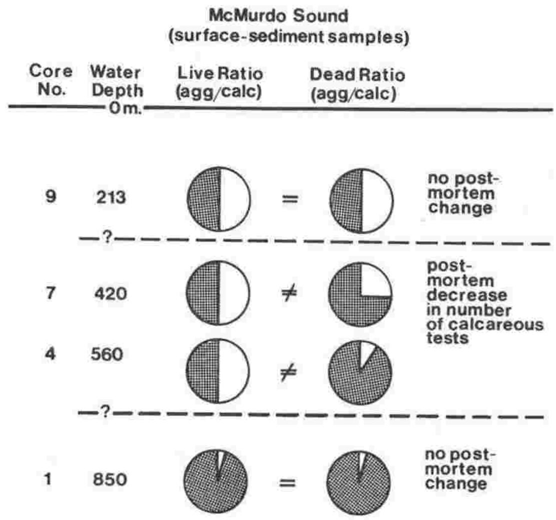

Figure 3. Summary of amount of post-mortem alteration of foraminiferal assemblages with proximity to the CCD.

tests as the CCD, between 850 and 560 m in McMurdo Sound, is approached. Well above this zone and below it the post-mortem alteration of assemblages is minimal. It is evident that study of fossil assemblages must involve consideration of how they might differ from the living populations they represent. The removal of calcareous tests by dissolution or other means evidently occurs quite rapidly among non-living foram tests. Some investigation of the palaeo-CCD should go hand-in-hand with study of fossil collections, since the amount of alteration seems to increase with proximity to the CCD.

CONCLUSIONS

(1) The lower limit of the CCD, as defined by Kennett (1968) lies between 850 and 560 m (supported by the present data), above which living calcareous and agglutinated foraminfera occur in about equal proportions. However, an agglutinated deep water assemblage is also found in 250 m of water in a restricted basin in New Harbour, perhaps due to bottom water of lower pH.

(2) The proportion of calcareous foraminifera in dead assemblages decreases progressively with water depth in the open water of the Sound, clearly a post-depositonal effect. If live and dead assemblages are not distinguished in studies of modern foraminiferal populations, incorrect conclusions on palaeoecology and water depth can be drawn. Furthermore, the difference in proportions of calcareous and agglutinated foraminifera in live and dead assemblages increases the

difficulty in the ecological interpretation of ancient (dead) assemblages.

Acknowledgements Fieldwork was supported by Victoria University Antarctic Expeditions 24, 25 and 26. Professor P. Vella provided assistance with foraminifera identifications and critical discussions of the manuscript. P.J. Barrett and A.R. Pyne offered valuable criticism and discussion. Bathymetric data compiled by B.L. Ward and P.J. Barrett.

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SILICEOUS BIOSTRATIGRAPHY AND THE ROSS SEA EMBAYMENT

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Abstract The water of the Ross Sea has been characterised by: (1) the unusually low temperature; (2) a rather high salinity; (3) the low to zero productivity due to packed ice in the surface water; and (4) the rather shallow calcium carbonate compensation depth caused by gradual accumulation of CO_2.

The development of this water mass is closely related to the tectonic and the glacial history of this part of Antarctica. To evaluate the effects and the timing of oscillation of grounded West Antarctic ice on the Ross Sea sediments and biota, cored sediments along the Pennell Coast margin in north-south direction have been selected and are being analysed for the siliceous microfossil assemblages of radiolarians, silicoflagellates and ebridians.

Such an attempt would bring southern ocean siliceous biostratigraphy inward towards the southern end of the Ross Ice Shelf where subbottom sediments of Neogene age have already been recognised through the attempts of Deep Sea Drilling Project (DSDP), Ross Ice Shelf Project (RISP), and McMurdo Sound Sediments and Tectonic Studies (MSSTS).

MODERN SEDIMENTATION IN McMURDO SOUND, ANTARCTICA

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Abstract McMurdo Sound is 50 km wide, lying between the glaciated coast of southern Victoria Land to the west, the volcanoes of Ross Island to the east, and bounded to the south by the McMurdo Ice Shelf. The Sound's main physiographic features are a western shelf (average depth about 200 m), an eastward slope of about 1° and an elongate basin 900 m below sea level, which is part of a "moat" around Ross Island.

More than 60 samples taken from the floor of the Sound show a wide range of textures, from muddy sandy gravel and sand, mainly on the western shelf and slope, to mud in the deep basins. The samples are compared with a similar number from known situations in an attempt to trace the origins of the seafloor sediment.

The main sources identified are:

(1) Coastal sand blown by wind onto the sea ice.
(2) Basal glacial debris (but only the fine fraction, as the gravel and coarse sand is thought to have melted out near the grounding line).
(3) Silt size diatom debris.
(4) Supraglacial debris from the McMurdo Ice Shelf and ice-cored moraines nearby.

Gravity and bottom currents may be active locally, but appear to be of limited influence.

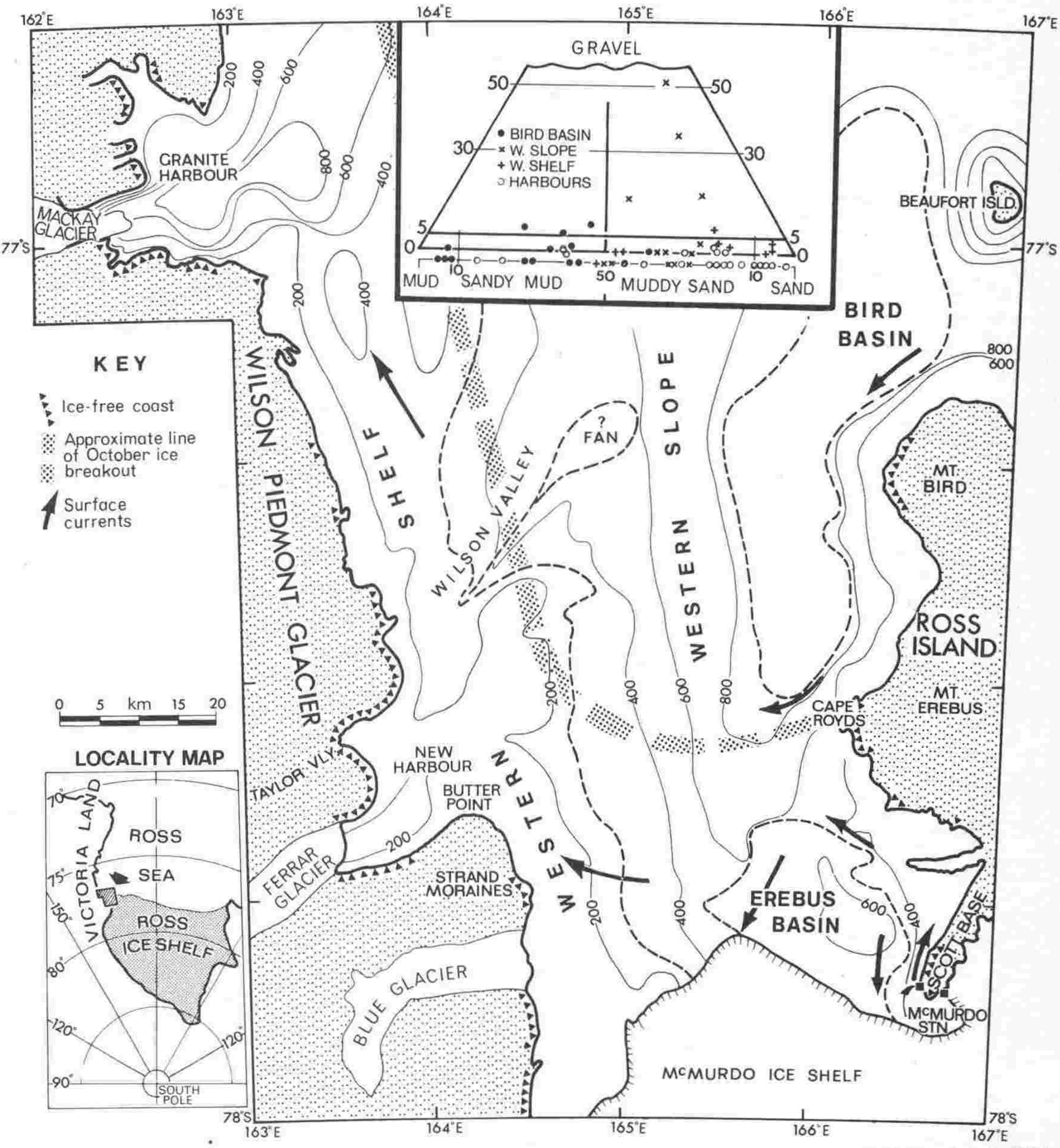

Figure 1 Map of McMurdo Sound, showing bathymetry, surface currents and major physiographic divisions (names informal). Bathymetry is simplified from a compilation by Ward, Barrett and Pyne in Barrett (1982). Inset shows texture of sea floor samples located in Figure 2.

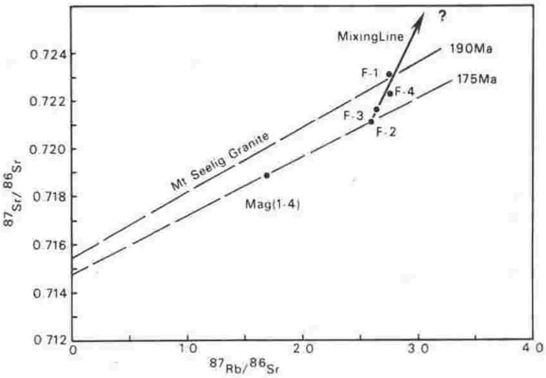

Figure 5. Interpretation of data for feldspars and magnetic fraction of sediment from RISP core 8 (1977/78). The feldspars are mixtures of two components. The older component could be the Mt Seelig granite in the Whitmore Mountains or it could have been derived from the granitic basement rocks of the Transantarctic Mountains whose ages range from 510 to 540 Ma.

a slope corresponding to a date of 175 Ma has been drawn on Figure 5 through F-2 and Mag (1-4), both of which fit this line. The feldspar composites then represent mixtures of grains like those of F-2 with varying amounts of an older component. The older component could have originated from granitic rocks like the Mt Seelig granite whose age is 190± 8 Ma (Webers et al., 1982). However, the data do not exclude the possibility that the older feldspar component originated from the granitic gneisses of the Transantarctic Mountains. The ages of granitic basement rocks from the Transantarctic Mountains range from about 510 to 540 Ma (Faure et al., 1979). The extension of the mixing line in Figure 5 to a 500 Ma isochron indicates that feldspar derived from such a source should have had a Rb/Sr ratio of about 2.6 and an $^{87}Sr/^{86}Sr$ ratio of 0.77 in order to generate the observed mixing array. K-feldspar having such chemical and isotopic compositions do indeed exist in the granitic basement rocks of the Transantarctic Mountains. However, the abundance of feldspar grains derived from this region cannot be more than a few percent.

SUMMARY

This study of sediment taken from beneath the Ross Ice Shelf indicates that the Rb and Sr concentrations and the $^{87}Sr/^{86}Sr$ ratios of <150 μm noncarbonate fractions from core 8 (1977/78) vary very little down the core. In addition, the sediment is colinear on a Sr-isotope mixing diagram with similar sediment from piston cores in the Ross Sea. We conclude from these results that the sediment at RISP site J9 and in *USNS Eltanin* piston cores 32-16, 25 and 36 consists of mixtures in varying proportions of the same two sediment component. The sediment at site J9 may be representative of one of the two components that was presumably derived from igneous and metamorpic rocks of West Antarctica. Previous studies have suggested that the other sediment component is volcanogenic detritus derived from calc-alkaline lavas of Mesozoic age in West Antarctica.

Age determinations of feldspar size fractions of bulk sample PNW-23 yield a date of 174±75 Ma that agrees with the age of granitic rocks that form Mt Chapman in the Whitmore Mountains. Unsieved feldspar composites extracted from core 8 (1977/78) indicate the presence of a small percentage of older feldspar derived either from rocks like the Mt Seelig granite (190±8 Ma) or from the granitic basement rocks of the Transantarctic Mountains (510 to 540 Ma).

Acknowledgements We thank P.N. Webb and T.B. Kellogg for helpful comments in the course of this study. The sediment samples were provided by D.S. Cassidy from collections curated in the Antarctic Research Facility of the Department of Geology, The Florida State University, Tallahassee. This research was supported by the Division of Polar Programmes of the National Science Foundation through grant DPP-7920407.

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This paper examines nearshore marine sedimentation in a glaciated region by relating the character of the seafloor sediment in McMurdo Sound (Figure 1) to known sediment sources and processes there. Modern sediment on the floor of the Sound is highly varied in texture, ranging from muddy sandy gravel to mud, with many samples containing a high proportion of sand. Therefore, we have attempted to follow sediment transport paths by comparing the textures of likely sources with those of the modern seafloor sediment.

Grainsize distribution was determined for about 60 samples from all known possible sources, including glacial debris (basal and supraglacial), beach and shallow sub-tidal sand, and wind blown sand collected from the sea ice, and for a similar number of seafloor samples. Forty-six of the latter were collected by orange peel grab, sampling the top 100 mm, and 20 by sphincter or box corer, from which the top 30 mm was taken. Size distribution was determined by sieving at 0.5 phi intervals in the sand range, and by pipette or Sedigraph in the mud range. Sample size was normally 20 g, except for some gravelly samples, when more than a kilo was required for a representative analysis.

The data have been presented as frequency curves because most of the seafloor sediments are polymodal and the modes are well-developed. We think this feature of sediment texture can be used to trace sediment in McMurdo Sound from source to sink and in some cases to estimate proportions of sediment from different sources. Survival of textural modes from entrainment to deposition is unusual in near-shore marine environments, but has come about here through two aspects of the McMurdo Sound sediment transport system:

(1) Passive transport of sediment by floating ice.
(2) Lack of textural modification by waves or in most places by bottom currents.

There are as yet no reliable sedimentation rates for McMurdo Sound, as no cores have been dated or direct measurements made. However, the present sedimentary regime has been operating for probably the last 5000 years, after the sea reached its present level and the Sound

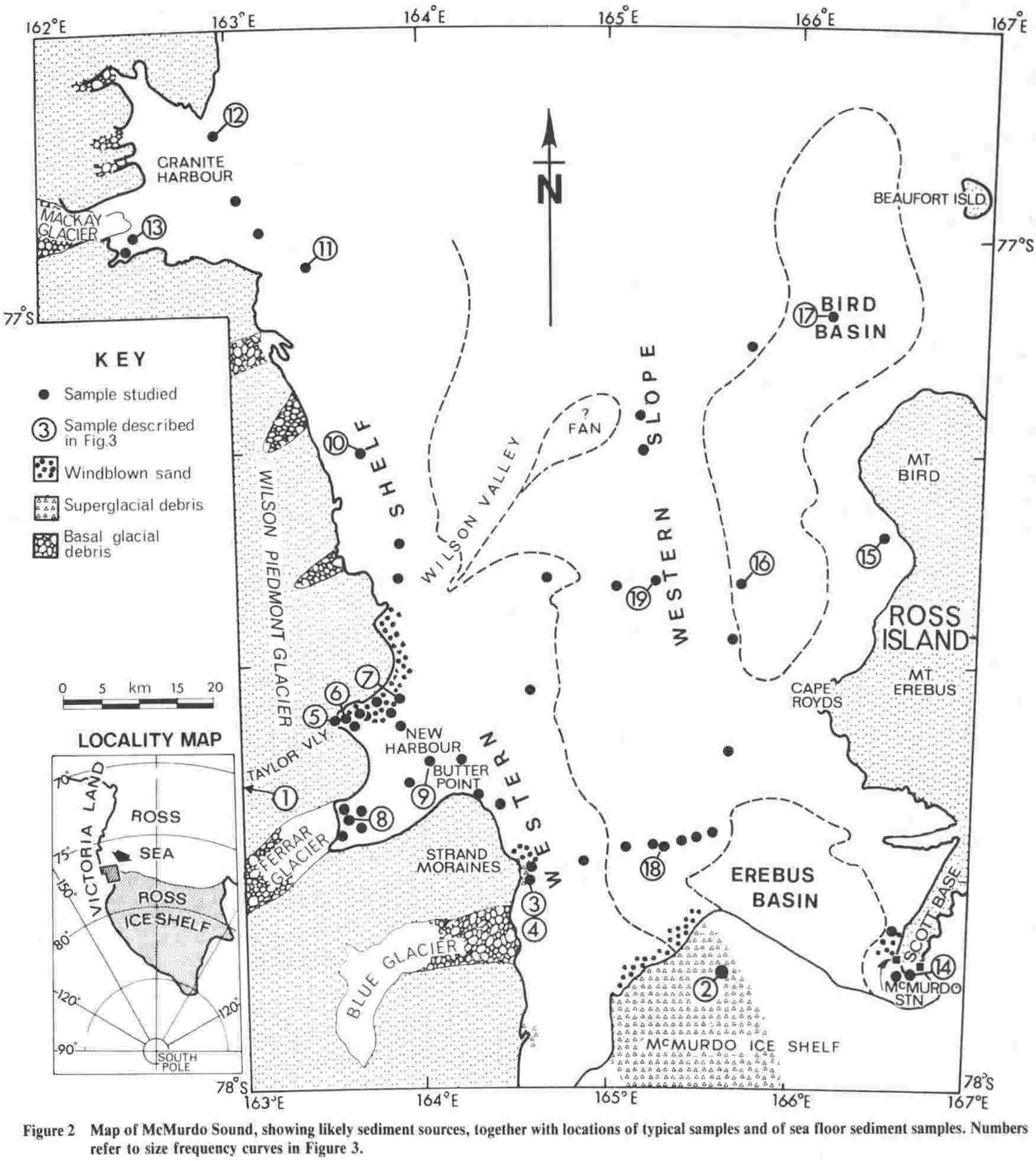

Figure 2 Map of McMurdo Sound, showing likely sediment sources, together with locations of typical samples and of sea floor sediment samples. Numbers refer to size frequency curves in Figure 3.

was cleared of glacial ice (Stuiver et al., 1981). Widespread net deposition of sediment today is shown in bottom photographs and cores by features such as dead shells (Bullivant, 1967, Plate 15b) and spicule mats (our observations) partially buried by fine sediment, and Bullivant (1967, p.60) also noted that for station A538 "the type of bryozoans present and the appearance of the substrate suggests a relatively high sedimentation rate". Bentley (1979) calculated that wind blown sand was accumulating in northern New Harbour at about 1 mm/year. Even if the rate elsewhere is a small fraction of this our samples from the upper 100 mm of the seafloor should be reasonably representative of the present sedimentary regime.

MAIN FEATURES OF McMURDO SOUND

In its geological setting McMurdo Sound lies between two major provinces. The Victoria Land coast to the west is part of a Transantarctic Mountains province with a basement of granitic and metamorphic rocks (Late Precambrian to Early Palaeozoic), overlain further inland by more than 2 km of Beacon sandstone (Devonian to Triassic) intruded by Jurassic dolerite sills totalling about 1 km in thickness. To the east the Sound is bounded by Ross Island, part of a Late Cenozoic basaltic volcanic province. Similar volcanic piles are found to the south, and are almost the sole source of debris on the northward-moving McMurdo Ice Shelf. This simple setting offers potential for an independent line of evidence regarding the source of the seafloor sediment.

The Sound itself can be divided into four areas:

(1) The steep slopes (6°) off the Ross Island coast.
(2) The Erebus and Bird basins, relatively flat-floored at depths of about 600 m and 900 m respectively.
(3) The Western Slope, essentially a planar surface rising at 1° to the west from 850 m to 250 m.
(4) The Western Shelf, a broad platform with an average depth of 200 m in the south, but somewhat greater in the north.

This geometry has most probably developed over the last five million years with the growth of Ross Island and its concomitant depression of the crust (McGinnis, 1973). The Sound also has some smaller scale features of more recent origin, such as the submarine valley (Wilson Valley, Figure 1) that from detailed bathymetry appears to terminate in a small fan.

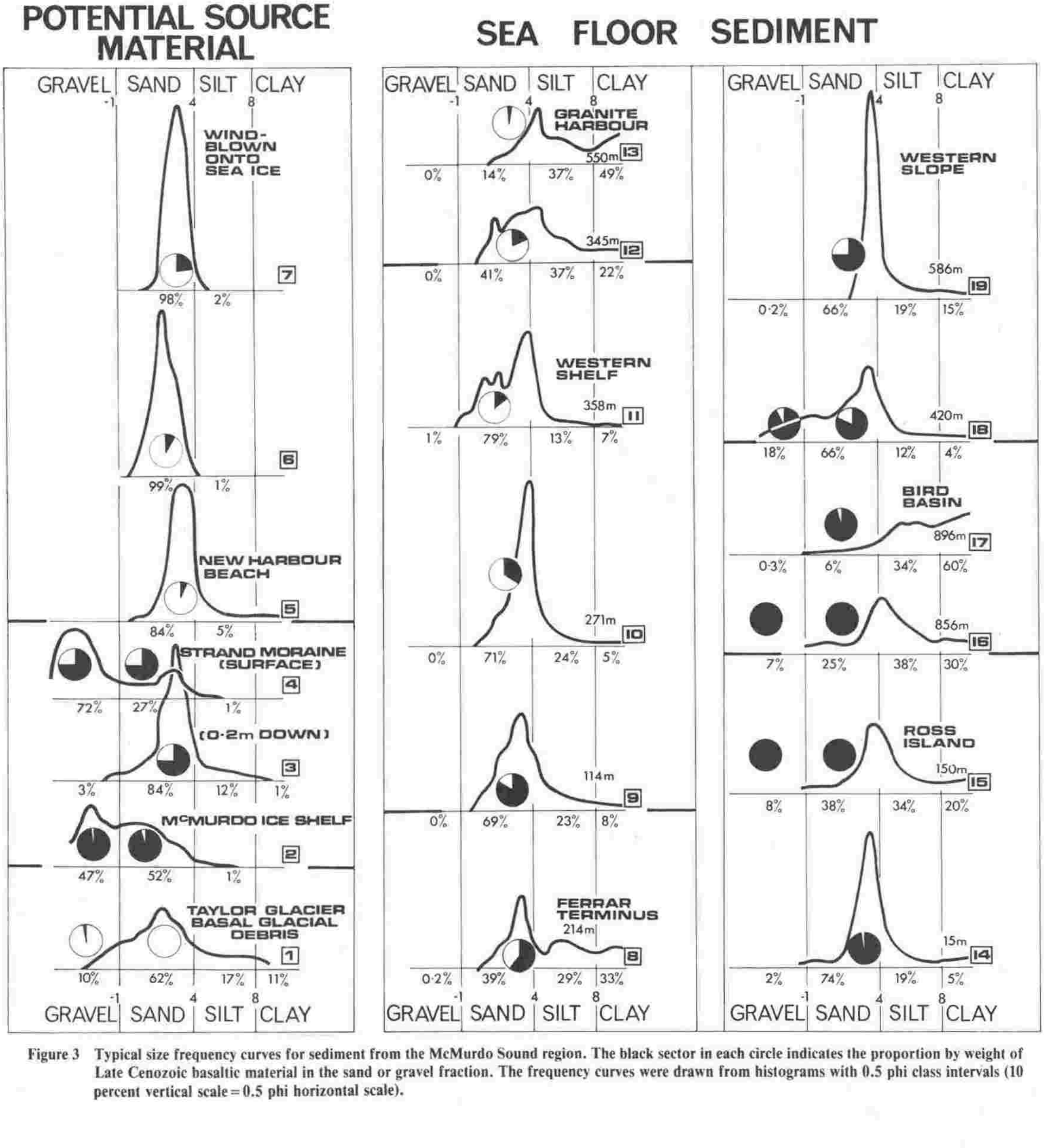

Figure 3 Typical size frequency curves for sediment from the McMurdo Sound region. The black sector in each circle indicates the proportion by weight of Late Cenozoic basaltic material in the sand or gravel fraction. The frequency curves were drawn from histograms with 0.5 phi class intervals (10 percent vertical scale = 0.5 phi horizontal scale).

The climate of the region is harsh, with mean monthly temperature at sea level ranging from – 5°C in January to – 30°C in August (Keys, 1981), and snow and ice cover is extensive. Nevertheless, about a third of the coastline of the Sound is exposed rock or gravel beach. The Sound is completely frozen over from April to October, when the ice (1-3 m thick) breaks out from the centre, leaving a rim about 20 km wide around the southern and western border (Figure 1). This rim itself normally breaks out in January or February, leaving the Sound ice-free for two or three months before freezing begins again. The prevailing wind over most of the Sound is from the south southeast, with velocities recorded in excess of 14 m/sec (Keys, 1981). However, katabatic winds from the Polar Plateau flow down the valleys to the Victoria Land coast, forcing a westerly component on near-shore winds.

Water circulation in McMurdo Sound is mainly clockwise, the flow coming south past Ross Island and flowing north along the Victoria Land coast, though a considerable flow continues south around Ross Island beneath the McMurdo Ice Shelf (Heath, 1977). Velocities are low on the western side of the Sound (a maximum of 0.12 m/sec in the water column and less than 0.02 m/sec near the seafloor, Barrett, 1982), but are much higher off McMurdo Station where the Sound has been constricted, and 0.25 m/sec has been recorded near the seafloor (Carter et al., 1981).

SOURCES AND PROCESSES

Sediment on the floor of McMurdo Sound must all come ultimately from the surrounding landscape or through biological precipitation of silica or carbonate. The terrigenous material may be introduced and distributed by a variety of processes, including rafting by glacier, shelf and sea ice, wind, currents in the watercolumn, and gravity currents, whereas the biogenic material forms mainly within the Sound itself.

Glacial debris is an obvious sediment source for a polar setting. Almost all of this debris is carried on and near the glacier surface, having fallen or been blown from rock faces above, or within a few metres of the glacier sole, after incorporation from the rock or debris-covered floor. The glaciers of the McMurdo Sound region carry very little supraglacial debris. For example, the surface of Taylor Glacier in the lower 10 km has a few small patches of sand and scattered rocks up to boulder size (Robinson, 1979), but on average they would amount to a layer only a fraction of a millimetre thick. In contrast, the basal debris layer in Taylor Glacier, which is exposed for about 5 km around the glacier terminus, is about 4 m thick. This layer consists mainly of ice containing between 20 and 43% debris by volume, but there are also some laminae and lenses of debris-free ice (Robinson, 1979, Appendix 10). The thickness of the basal debris layer on an ice-free basis is estimated at about 1 m, roughly 10^3 times that of the average for supraglacial debris.

Robinson (in press) has calculated from heat flow, frictional heat, surface temperature and ice thickness that the sole of lower Taylor Glacier is at melting point over at least half of its area, thus accounting for the observed similarity in texture between basal debris in Taylor Glacier and temperate or "wet-based" glaciers. The critical ice thickness above which basal melting occurs in ice around McMurdo Sound (assuming accumulation or ablation is low) is about 450 m. Both the Mackay and Ferrar Glaciers exceed this substantially over almost all of their length and to their grounding lines, where they rapidly thin (Calkin, 1974), and so should contain a well-developed basal debris layer. Both glaciers terminate in floating ice tongues calving several kilometres seaward of the grounding line, by which time they will have lost most or all of their debris through basal melting by sea water, if it is proceeding at a rate near the 1.4 m/year calculated by Jacobs et al. (1981) for the Erebus Glacier Tongue across the Sound. However, basal debris may survive longer in bergs from coastal piedmont glaciers, such as the Wilson, that calve directly into the Sound. Several areas are thick enough to be wet-based (shown in Figure 2) and also they may still contain some debris entrained several thousand years ago, when the ice was thicker.

No means has yet been found to sample debris from the base of glaciers calving into McMurdo Sound, but because they are moving over a plutonic terrain similar to that beneath lower Taylor Glacier, we have taken the grainsize distribution of Taylor basal debris (Figure 3, Sample 1), which shows little lateral variation, to represent all basal debris entering McMurdo Sound. The debris has ten percent gravel (subrounded and with some striated pebbles), a broad sand mode, and about 12 per cent clay.

Supraglacial debris is important in two settings in McMurdo Sound. A large area of the McMurdo Ice Shelf is covered by coarse angular basaltic debris (Sample 2) frozen in beneath and moved up through the ice shelf as the surface has ablated (Debenham, 1948, Swithinbank, 1970). The other setting is found at the Strand Moraines, where a blanket of debris only 0.3 m thick covers hummocky ice up to 180 m thick. The debris is gravelly on the surface but sandy beneath (Samples 3 and 4), and has a complex origin; although three quarters is basaltic, the remainder includes a wide range of rock types from the mountains to the west, and some of the stones are subrounded and striated, indicating a period of transport at the base of a glacier. Bergs carrying supraglacial debris similar to that from both settings have been recognised along the western margin of McMurdo Sound, showing them to be potential sources of seafloor sediments.

Beach and shallow subtidal sand is another potential source of seafloor sediment where it is frozen into the sea ice and later rafted out to be deposited as the ice melts. Sand can be incorporated into the ice not only by freezing of the sea surfaces but also by the formation of "anchor ice", which grows as platelets on the seafloor close to the coast to depths of 33 m (Dayton et al., 1969). This sand (Sample 5) is not as well sorted as that from beaches in warmer climates, due to the limited effect of sea ice on wave action, and the higher viscosity of cold water.

The extensive areas of wind blown sand in the sea ice near ice-free parts of the coastline, and our observations of sand grains on the sea ice many kilometres from the coast suggest that the wind may be important in carrying sand offshore. Sand might not travel far when the Sound is ice-free, but could travel tens or even hundreds of kilometres on the surface of drifting sea ice before melting releases it. Bentley's study (1979) of wind blown sand in northern New Harbour showed it to be fine and well sorted and becoming finer with distance from source (Samples 6 and 7). About ten percent of the sand is basaltic. Local bedrock is granitic and metamorphic, but is mantled with moraine containing basaltic debris (in places up to 50 percent, P. Robinson, pers. comm.) transported across the Sound from Ross Island by grounded Ross Sea Ice (Stuiver et al., 1981).

Sediment gravity flows might also distribute sediment in McMurdo Sound, and Kurtz and Anderson (1979) have made a strong case for the importance of gravity flows on the Antarctic Continental Shelf. Distinguishing gravity flow from glacial deposits on textural grounds is difficult, but the muddy character of the basin floors in McMurdo Sound, in comparison to the sandy margins, seems to us incompatible with the widespread gravity flow deposition suggested by Myers (1982), at least for modern seafloor sediment. Nevertheless, the fan-like feature at the mouth of Wilson Valley does point to local gravity flow activity.

The living fauna on the floor of McMurdo Sound is abundant and varied, comprising mainly polychaete worms, bryozoans, sponges and echinoderms (Bullivant, 1967), but their hard parts provide only a small mass contribution to samples from the top 100 mm, normally less than two percent of the sand and gravel fractions we processed. However, high phytoplankton activity has resulted in a much higher biogenic content for the silt fraction, between 30 and 50 percent in the east (Carter et al., 1981) and 10 to 30 percent in the west (Alloway, 1982), where the ice persists for longer. The biogenic material consists largely of diatoms or diatom debris, much of it as fecal pellets.

The main features of sediment from identifiable sources and processes in McMurdo Sound are summarised in Table 1. Ice-rafted sediment may be slightly modified as it passes through the water column, but bottom currents may have a significant effect, where they exceed the entrainment velocity for silt (about 0.25 m/sec, 1 m above the seafloor (Nowell et al., 1981), by inhibiting the accumulation of silt and clay.

SEA FLOOR SEDIMENTS AND THEIR ORIGINS

Key features of seafloor sediment in McMurdo Sound are the well developed fine to very fine sand modes, and the relatively high clay content considering the lack of clay in most potential source sediment (Figure 3). Samples from near the seaward margins of Ferrar and Mackay Glaciers (such as 8 and 13) are mainly terrigenous silt and clay, consistent with our earlier argument that the basal debris is

TABLE 1: Features of debris accumulating in McMurdo Sound from different sources and processes

Source	Process	Features of debris as released into the water column
Basal glacial debris	Ice rafting	Broad size distribution with 10% gravel, medium sand mode and 30% mud.[1]
Supraglacial debris	Ice rafting	Gravel and sand with very little mud. Virtually all basaltic and angular from McMurdo Ice Shelf; Mixture of angular and rounded, basaltic and plutonic from Victoria Land coast.
Beach and subtidal sand	Ice rafting	Moderately sorted sand, little mud.[2]
Exposed rock and beach	Wind blown onto sea ice and rafted out	Well sorted fine to very fine sand, very little mud.[2]
Varied	Gravity currents	Texture and composition depend on source.
Biogenic debris	Settling	Mainly diatomaceous and of silt size.

Notes: [1]Virtually all from Victoria Land, therefore lacking basalt.
[2]Mainly plutonic but 10 to 20% basalt in southwest. Basalt around Ross Island.

melting out before the ice is reaching the calving line. The gravel and sand is presumably accumulating close to the grounding line, the fine fraction being transported out in suspension.

Samples from the Western Shelf and Slope all have the distinctive well-formed fine-very find sand mode, and indeed in samples such as 10 and 19 it comprises more than 70 percent of the entire sediment. Such a mode cannot result from current sorting because current velocities on the Western Shelf (0 to 0.12 m/sec) are too low to entrain sediment. The most likely origin, considering the range of possible sources, is coastal sand wind blown onto the sea ice and released or washed off during the annual ice break-out, though some may be ice-rafted beach or shallow subtidal sand. The mode can also be seen in samples close to Ross Island (such as 14 and 15) but diminishes northward and is absent in Sample 17 from northern Bird Basin.

The other obvious feature of the textural spectrum is the coarse sand and gravel component of samples such as 16 and 18 from the southern end of Bird Basin and the Western Slope. The dominance and angularity of the basaltic material suggest it is supraglacial debris off bergs from the McMurdo Ice Shelf immediately south. Smaller amounts of coarse debris also occur in samples from the Western Slope and Shelf as far north as Granite Harbour (Sample 11). This inferred pattern of distribution for berg debris follows the observed distribution of ice bergs along the Victoria Land coast, probably a consequence of the surface currents (Figure 1) and prevailing winds.

Clay content of sediment in McMurdo Sound is greatest at the distal end of Bird Basin (Sample 17), and declines to the south and west. It is consistently low (less than five percent on either side of Erebus Basin between Samples 14 and 18, perhaps because of relatively strong bottom currents in this most constricted part of the Sound.

CONCLUSIONS

Sediment is accumulating on the floor of McMurdo Sound today mainly from the following sources (in decreasing order of importance):

(1) Coastal sand blown by wind onto the sea ice (though there may be some contribution from ice rafting of beach and shallow subtidal sand).
(2) Basal glacial debris melted out close to the grounding line, the fine fraction being transported out into the Sound in suspension.
(3) Diatomaceous debris produced in the Sound itself.
(4) Supraglacial debris from the McMurdo Ice Shelf and ice-cored moraines in the southwest corner of the Sound.

Acknowledgements We are pleased to acknowledge support for the seafloor sampling programme from the University Grants Committee, the VUW Internal Research Committee and the N.Z. Lottery Board. Antarctic Division, DSIR, provided the necessary logistic support. We are also grateful to Dr J. Anderson and D. Kurtz, Rice University, for splits of their samples from the floor of McMurdo Sound. The typescript was prepared by Val Hibbert and diagrams by E.F. Hardy.

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