GEOLOGICAL SURVEY OF CANADA

DEPARTMENT OF MINES AND TECHNICAL SURVEYS

PAPER 64-53

FORAMINIFERAL STUDY OF EAST BAY, MACKENZIE KING ISLAND, DISTRICT OF FRANKLIN

(POLAR CONTINENTAL SHELF PROJECT)

(Report and 3 figures)

G. Vilks

Price, 75 cents

1964

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ABSTRACT

The area of this study was chosen to provide information on the Foraminifera of an Arctic inshore environment. Results show that the population is dominated by arenaceous agglutinated forms and that the number of species decreases toward the shore although the number of individuals increases. Each of three bathymetric zones is apparently dominated by a particular species and the whole population is indicative of a cold environment with lengthy annual ice cover.

Prepared for publication from an unpublished manuscript of the Bedford Institute of Oceanography, Dartmouth, Nova Scotia- B.I.O. 64-4, 1964.

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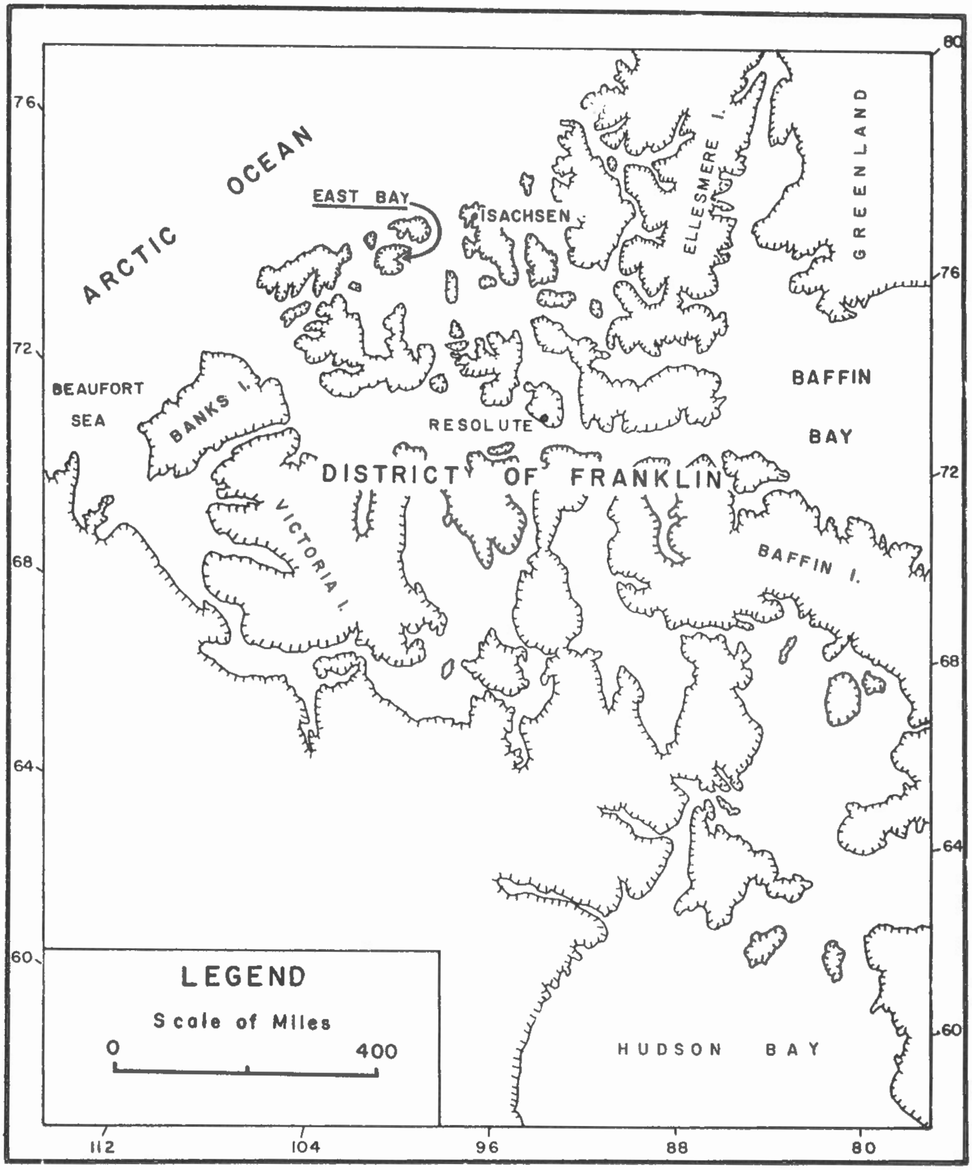

FIGURE I. INDEX MAP

FORAMINIFERAL STUDY OF EAST BAY, MACKENZIE KING ISLAND, DISTRICT OF FRANKLIN.

INTRODUCTION

General

This is a preliminary account of a study of Foraminifera from the bottom sediments of East Bay, Mackenzie King Island (Fig. 1). Samples of sediment were collected during the 1963 field season with logistical support given by the Polar Continental Shelf Project.

The purpose of the sampling program was to provide material for a detailed study of Foraminifera from an Arctic inshore environment. East Bay was selected because 1) the shape of the bay and its geographical orientation provides a sheltered environment with very slight circulation of water from the adjacent seas 2) its size made it possible for the sampling to be completed in one season 3) it lies within the area of activities of the Polar Continental Shelf Project.

The writer wishes to thank C. Grant, field supervisor of the Polar Continental Shelf Project, A. Clark, W. Johnson and J. Stewart all of whom took part in the field work as student assistants, and Miss S.S.M. Pitcher who assisted in laboratory work and compilation of data at the Bedford Institute of Oceanography.

Previous Work

The literature on Arctic Foraminifera deals primarily with regions that are accessible from ships. Parker and Jones

(1865), studied sediments taken from Baffin Bay (Lat. 74°N - 76°N) and Davis Strait (Lat. 68° 50'N) also gave an account on Arctic Foraminifera from Smith Sound, Kane Basin, Kennedy Channel and Hall Basin as far north as Lat. 83° 19'N. Cushman (1947) described Foraminifera from waters around the coasts of Greenland, Hudson Bay, Foxe Basin and Beaufort Sea. Phleger (1952) made a short summary on Foraminifera from Melville and Lancaster Sounds and Baffin Bay. Loeblich and Tappan (1953) published a very extensive work on taxonomy and distribution of the Arctic Foraminifera based on samples collected from various points off Greenland, Foxe Basin, Hudson Bay, North Pacific and Beaufort Sea. Carsola (1952) studied Foraminifera from the Beaufort Sea and Green (1959) from the Arctic Ocean. Wagner (1962) gave an account on Foraminifera from samples collected from the Arctic Ocean adjacent to the Queen Elizabeth Islands. Stschedrina (1958) summarized studies of bathymetric distribution of species in the inshore waters of the Arctic and northwest Pacific Oceans adjacent to the U.S.S.R. Marlowe and Vilks (1963) gave a preliminary account on distribution of Foraminifera in the inshore waters along the western shore of Ellef Ringnes Island.

Working Methods

Field equipment and supplies were brought to the study area by Otter aircraft from the Polar Continental Shelf Project base at Isachsen, Ellef Ringnes Island. For landing on the island the aircraft was able to use the flat lowlands that surround the bay. A number of camp sites were established at convenient locations, thus minimizing the time spent in travel over the ice. Two Alyson and one Autoboggan motor toboggans, each equipped with one draw toboggan, were used to transport men and equipment between the camp sites and sampling stations.

A total of 176 stations were occupied within an area of approximately 60 square miles (see Fig. 2). Each station was located on a traverse line beginning from a point on the shore and extending seaward perpendicular to the shoreline or at a high angle to it. The shore station was located by means of a Decca navigation system mounted in a Sikorsky S-55 helicopter. The distance between the stations within each traverse was measured at logarithmic intervals from the shore (50, 100, 200, 400, 800, 1600, 3200, 6400 feet and 2 miles). At each station bottom grab samples were taken by a modified General Manufacturers mud snapper with a capacity of about 300 cc of sediment. Access holes were drilled through the ice using an electrically powered 5-inch ice auger. A hand winch and a tripod were used to lower and rise the sampler. Samples were stored in polyethylene containers and shipped for analyses to the marine geology laboratories of the Bedford Institute of Oceanography. Preserved samples were treated with Rose Bengal biological stain to determine the number of living Foraminifera present in the sediment at the time of sampling.

In the laboratory, 76 samples were selected for the purpose of making a preliminary investigation. About 20 grams of each of the sample were washed through a 250-mesh sieve (mesh opening 0.063 mm). From the sediment remaining on the sieve, foraminiferal tests were concentrated by means of flotation in which carbon tetrachloride was used as the heavy liquid medium.

After this initial treatment of the samples, the Foraminifera present in each sample were identified and catalogued. The total number of foraminiferal tests of each sample was then determined by a process of scanning the concentrate with the aid of a binocular microscope and counting each test on sight. In instances of large samples the procedure of counting was speeded up by taking into consideration only a representative fraction of the concentrate and multiplying the count by an appropriate number to obtain the total.

The Environment

The environmental factors considered are the distribution and occurrence of the sea ice, water mass below the ice, submarine topography and bottom sediments. In the Prince Gustaf Adolf Sea and the adjacent waters, the sea is covered with solid ice for at least 9 months of the year. During a period of one winter the ice may freeze to a thickness of 7 feet. In the East Bay this relatively thin winter ice was found in a zone less than one mile from shore. The remainder of the bay was covered with pack ice, with thickness ranging from 9 to more than 15 feet. During the spring and summer, extensive shore leads may open, allowing the wind to push the central ice flow against the shore or out of the bay.

The mantle of ice over the water has a two-fold effect on the physical environment: it absorbs a large amount of light, and it prevents turbulence in the surface waters. The lack of light limite photosynthesis which affects the distribution of phytoplankton and indirectly, the chemistry of seawater with respect to the formation of $CaCO_3$ (Carsola, 1952). However, the deposition of $CaCO_3$ either of organic or inorganic origin is also affected inversely by low temperatures and salinities of the seawater (Sverdrup, Johnson and Fleming, 1942). The spring thaw causes the formation of water with extremely low salinity, which remains on the surface as a layer not thicker than about 5 feet and may have a sharp boundary with the oceanic water below (A.E. Collin, personal communication).

According to Collin (1961), Green (1959) and Pelletier (personal communication) the upper zone of the Arctic Ocean is very cold with the temperature of the water almost -2°C. The cold arctic water over-rides the warmer water of Atlantic origin with the temperature curve crossing the barrier from negative to positive temperatures at about 250 metres of depth (see Fig. 3). The bottom temperature of the sampling area of the present study is thus almost isothermal.

The bottom topography of the bay is irregular with a deep region behind a shoaler area at the mouth. The greatest measured depth in the bay is 284 metres which occurs at station 54, about one mile from the north shore. Other soundings indicate that this deep region has an elongated shape, extending along the north shore as a continuous feature which may be connected across the bay to a similar deep region not far from the south shore. An elongated medial rise is parallel to the north-shore deep and is presumably truncated by the deeper waters towards the head of the bay. Bottom profiles along different traverses show a number of common features: 1) very steep gradient between 0 and 200 feet from the shore with the initial slope about 36 per cent and a characteristic concave upward shape, 2) a relatively flat zone approximately 30 metres deep, beginning about 200 feet from the shore and extending seaward to a distance of about one mile. The flat zone is usually terminated by 3) a second steep gradient, about 20 per cent, which generally extends to a depth of 150 to 200 metres. The steep submarine slopes and the deepening towards the head of the bay suggest that it owes its present shape to glacial erosion.

The relationship of bottom sediments to submarine topography is shown in the following occurrences. There is a marked increase in the content of mud in the deep regions along the south shore, and angular pebbles and relatively clean and coarse sands in the bottom of the deep near the northern shore. A zone of sandy silt extends along the shores and is usually associated with the steep shore gradients. Sediment samples close to the shore contain large amounts of organic matter such as fragments of lichen, moss or lignite, and coal. Colour of the sediment varies with the amount of mud that it contains in that sandy silt is light brown, while mud with small amounts of sand present is dark brown.

DISTRIBUTION OF FORAMINIFERA

General

The total amount of sediment inspected (3,095.0 grams dry weight) yielded 84,815 Foraminifera. The average abundance is 2,715 tests per 100 grams of sample, but 10,269 tests per

100 grams is the highest foraminiferal number, and it was obtained in sample 162 from a depth of 7 metres. The general trend of abundance shows higher numbers of tests in the shallow zones as follows:

Zone	Tests/100 gm of sample	Species/sample
0 - 30 metres	4620	8
30 - 60 "	3740	14
60 - 90 "	1400	8
90 - 120 "	1820	17
120 - 150 "	2680	12
150 - 180 "	1810	13
180 - 210 "	2310	18
210 - 240 "	3570	12
240 - 300 "	1100	17

The number of species present in the sample has a tendency to become larger in deeper zones, with a smaller number of individuals present per species.

Species Distribution

The following discussion deals with the manner in which the distribution of Foraminifera in the East Bay sediments is affected by bathymetry and the per cent of mud present in the sediment. In the present study altogether 48 species were identified. From this number 33 species are arenaceous and 15 are calcareous, and all are benthonic. The calcareous species are relatively unimportant in that only 178 individuals were counted against the total of 84,815 Foraminifera. Elphidium orbiculare (Brady) is the most abundant species from the calcareous population and is represented by 110 individuals. The arenaceous Foraminifera are represented by the following families: (number in brackets is the number of species within each family) Rhizaminidae (2), Hyperaminidae (3), Reophacidae (6), Lituolidae (5), Textulariidae (3), Silicinidae (1), Trochamminidae (7), Astrorhizidae (1), Ammodiscidae (1), Saccamminidae (4). Easily the most abundant species is Spiroplectammina biformis (Parker & Jones) which is present in the order of 53 per cent from the total number of Foraminifera. Next in abundance are:

Trochammina nana(Brady)
Textularia earlandi Parker
Reophax nodulosa Brady
Alveolophragmium crassimargo (Norman)
Hyperammina friabilis Brady
Psammosphaera fusca Schulze
Proteonina atlantica Cushman

These species include 35 per cent of the individuals of the entire foraminiferal population. The first four species of the above list are important indicators of certain bathymetric zones and are discussed below.

The relationship of population to the mud content shows a slight tendency towards greater numbers in the coarser sediments. Some species also show this trand more than others, for example, Hyperammina friabilis Brady, Proteonina atlantica Cushman, Alveolophragmium jeffreysi (Williamson),Psammosphaera fusca Schulze show a definite trend to a greater abundance in coarser sediments, while Spiroplectammina biformis (Parker & Jones) prefer sediments that contain 40 - 60 per cent mud[1].

The foraminiferal population of the East Bay is characterized by a high ratio of arenaceous to calcareous species. This ratio does not appear to have any relationship to bathymetry as it is similar at all depths within the study area, therefore, the factors which are responsible for the abundance of calcareous Foraminifera are not effective in the East Bay at the depths studied. However, there are a number of species of the arenaceous population which dominate over the remainder of the arenaceous species at certain depths zones.

The most adaptive species to conditions of shallow inshore waters is Spiroplectammina biformis (Parker & Jones) which is most abundant between 2 and 30 metres of depth, but dominates over other species down to a depth of 90 metres. From stations off the north shore at depths of 120 - 150 metres, a number of samples yielded unusually large percentages of S. biformis. However, samples treated with Rose Bengal stain did not indicate the presence of living S. biformis in this region. Due to steep submarine slopes slumping of sediment may have taken place, thus causing postmortal displacement of S. biformis tests.

The bathymetric zone between 90 and 120 metres is dominated by Reophax nudulosa Brady, Alveolophragmium crassimargo (Norman), Hyperammina fraibilis Brady, Proteonina atlantica Cushman and Alveolophragmium jeffreysi (Williamson). The bottom between depths of 120 and 210 metres is occupied by a wide

1) Mud is defined here as that part of sediment with grain size less than 0.063 mm.

variety of fauna which are slightly dominated by Trochammina nana (Brady). T. nana is found in the East Bay at wide range of depth, both in fine and coarse sediments. Identification was found to be very difficult owing to the small size (on the average 0.2 mm in diameter), usually partly mutilated tests and a large variety of forms. Therefore, it is possible that the population of T. nana in the present study contains several species.

The next bathymetric zone, between 210 and 240 metres, is defined by Textularia earlandi Parker which is associated with Astrorhiza arenaria Norman and Trochammina quadriloba Höglund. Textularia earlandi Parker is also present in small numbers (about 5 per cent) in almost every sample including those obtained from shallow depths. The precise distribution pattern of T. earlandi is difficult to establish owing to some difficulties in distinguishing mutilated tests of Spiroplectammina biformis (Parker & Jones) from Textularia earlandi Parker. Both of these latter species have biserial tests in the adult forms and planispirally coiled early chambers. In S. biformis the planispiral part is present in both the microspheric and megalospheric forms, forming a considerable portion of the test. T. earlandi may be present with planispirally coiled early chambers in its microspheric form only, and although the coiled portion is much smaller, it is still difficult to determine cases where the coiled portion is too small for the test to belong to S. biformis. Therefore, counts of T. earlandi from shallow stations may include megalospheric forms of S. biformis. All the tests with missing initial chambers were classified as Textulariidae indetermined.

A number of species gradually increased in abundance with deeper waters. These species never occur in sufficient numbers to dominate markedly over other species, yet their presence may be signifficant to indicate change in environment. Such species are Trochamminella atlantica F. Parker, Recurvoides turbinatus (Brady), R. laevigatum Hoglund, Bathysiphon filiformis Sars and Reophax guttifer Brady (see Table 1). R. guttifer was not found in waters less than 180 meters deep.

Summary and conclusions

The results of the present study are in good agreement with the results of a previous investigation carried out along the western shore of the Ellef Ringnes Island about 120 miles distant from the East Bay (Marlowe and Vilks, 1963). In both areas the foraminiferal population is dominated by the arenaceous agglutinated forms of which Spiroplectammina biformis (Parker & Jones) is the most abundant species. Owing to the larger number of stations in the present investigation and a greater range of depth, the following conclusions may be added:

1) The number of individuals per gram of sample increases towards the shore as the number of species per sample decreases. (The opposite relationship was found in the deltaic environment of Ellef Ringnes Island, where the number of individuals decreased close to the shore). In the East Bay the deltaic and nondeltaic environments do not differ significantly with respect to abundance of Foraminifera, except at traverse number 6, where fauna is scarce in the sediments of the first two stations. At the remainder of the stations the fauna

is restricted to fewer species in the nearshore waters, but this lack of variation is offset by a larger number of individuals per species. This suggests that the nearshore environment provides more severe conditions and species that are well adapted to it have a tendency to dominate over other forms. The large number of individuals in the near-shore zone may also show that the area is richer in food, as a result of more intensive photosynthesis taking place in the open shore leads during the summer months.

2) Spiroplectammina biformis (Parker & Jones) is a shallow-water nearshore species. The bathymetric zone between 90 and 120 metres is dominated by Reophax nodulosa Brady and Hyperammina friabilis Brady. Textularia earlandi Parker is relatively more abundant in waters that are deeper than 200 metres.

The population of Foraminifera of the East Bay can be considered as indicative of cold environment that is covered with ice for a long period of time. Low salinity, low temperature, restricted circulation of water, activity of phytoplancton limited to short bursts during the summer, and restricted surface turbulence may induce conditions that are inhibiting to calcareous forms.

SELECTED BIBLIOGRAPHY

Barker, W.R.

1960: Taxonomic Notes on the Species Figured by H.B. Brady in his Report on the Foraminifera Dredged by H.M.S. "Challenger" During the years 1873-1876; Soc. Econ. Paleontol. Mineral., Spec. Pub. No. 9.

Brady, H.B.

1881: On some Artic Formainifera from Soundings obtained on the Austro-Hungarian North-Polar Expedition of 1872-1874. Ann. Mag. Nat. Hist., Ser. 5, No. 48, pp. 393-418.

1878: On the reticularian and radiolarian Rhizopoda (Foraminifera and Polycystina) of the North-Polar Expedition of 1875-76., Ann. Mag. Nat. Hist., Ser. 5 Vol. 1, pp. 425-440, pls. 41-42.

1884: Reports on Scientific Results of the Voyage of H.M.S. "Challenger", vol. 9 (Zoology); H.M. Stationery Off., London.

Carsola, A.J.

1952: Marine Geology of the Artic Ocean and Adjacent Seas off Alaska and Northwestern Canada; Univ. Calif., unpubl. doctoral thesis.

Collin, A.E.

1961: Oceanographic activities of the Polar Continental Shelf Project; J. Fish. Research Bd., vol. 18, pp. 253-258.

Cushman, J.A.

1948: Artic Foraminifera; Cushman Lab. Foram. Research. Spec. Pub. No. 23.

Green, K.E.

1959: "Ecology of Some Artic Foraminifera" in Scientific Studies at Fletcher's Ice Island, T-3 (1952-1955); USAF Cambridge Research Centre, Bedford, Mass., Geophys. Research Paper No. 63, vol. 1, pp. 59-81.

Hoglund, H.

1947: Foraminifera in the Gullmar Fjord and the Skagerak, Zool. Bidrag Uppsala, vol. 26, pp. 1-328, pls. 1-32.

Loeblich, A.R. Jr. & Tappan, H.

1953: Studies of Artic Foraminifera; Smithsonian Misc. Coll., vol. 121, No. 7.

Marlowe, J.L. & Vilks, G.

1963: Marine Geology, Eastern Part of Prince Gustaf Adolf Sea, District of Franklin; Geol. Surv. of Canada, Paper 63-22.

Parker, E.L.

1952: Foraminifera species off Portsmouth, New Hampshire; Bull. Harvard Mus. Comp. Zool., vol. 106, pp. 428-473.

Parker, W.K., & Jones, T.R.

1865: On some Foraminifera from the North Atlantic and Artic Oceans, including Davis Straits and Baffin Bay, Philos. Trans. Roy. Soc. London, vol. 155, pp. 342-441, pls. 12-19.

Stschedrina, Z.G.

1958: The dependence of the distribution of Foraminifera in the seas of the U.S.S.R. on the environmental factors; 15th Internat. Congr. Zool., sec. 3, Paper 30, p. 1-3.

Sverdrup, H.U., Johnson, M.W., and Fleming, R.H.

1942: The oceans: New York, Prentice-Hall, Inc.

Wagner, F.J.E.

1962: Faunal Report, Submarine Geology Program, Polar Continental Shelf Project, Isachsen, District of Franklin; Geol. Surv. of Canada, Paper 61-27.

Table I. RELATIVE PERCENTAGES OF FORAMINIFERA

(Actual number of species in parantheses if less than one test per 10 grams of sample present).

Depth (metres)	2	3	4	4	5	5	6	6	7	7	7	8	9	10
Station number	96	97	205	88	130	98	200	99	206	100	162	182	207	46
Spiroplectammina biformis Parker & Jones	75.5	97.8	83.4	79.8	97.7	88.4	85.1	57.1	56.1	36.3	72.0	94.9	76.2	
Textulariidae indet.	10.2				(1)		2.7	11.7	4.5	7.1	0.4		5.0	
Trochammina nana Brady	8.2	0.9	4.2	0.7		7.3	1.1	26.7	20.1	54.2	14.7	1.5	12.1	
Nonionidae indet.	(1)													
Elphidium sp.	(1)				(1)						(1)			
Foraminifera indet.	(1)			0.7							(1)			
Textularia earlandi Parker		1.3	6.1	2.6	1.5	2.5	2.6	1.7	5.4	(2)		2.7	(4)	
Proteonina atlantica Cushman			1.6			1.4	(8)	1.1	5.7		9.3		0.5	
Textularia torquata Parker			(4)				0.5	(2)	(8)	(1)	1.5		(4)	
Reophax gracilis Kiaener			2.6	(1)			(8)	(1)	1.6			0.9		
Storthosphaera albida F.E.Schulze			(1)										0.5	
Cassidulina teretis Tappan			(1)						(1)					
Alveolophragmium crassimargo (Norman)			(5)				1.3		(1)		(1)		0.8	
Cassidulina islandica Norvang			(1)											
Nonionella auricula Heron-Allen & Earland			(1)											
Bucella frigida (Cushman)			(1)				(4)		(8)					
Pelosina variabilis Brady			(1)	15.3										
Glomospira gordialis Jones & Parker			(1)				(4)		(4)		1.1			
Psammosphaera fusca Schulze			(1)						(5)					
?Elphidium orbiculare (Brady)			(2)											
Recurvoides turbinatus (Brady)			(4)						(1)					
Trochamminella atlantica Parker			(8)				(4)							
Dentalina baggi Galloway & Wissler						(1)								
Lagenidae gen. sp. indet.						(1)								
Pninella (?) pulchella Parker							3.6						(8)	
Globulina glacilis Cushman & Ozawa							(5)							
?Aschemonella catenata (Norman)							(4)	(1)					(4)	
Elphidium orbiculare (Brady)							1.9	(2)					3.2	
?Valvulineria arctica Green							(4)							
Trochamminella bullata Hoglund									3.2		0.3			
Hyperammina friabilis Brady									1.4	(1)			(1)	
Trochammina globigeriniformis (Parker & Jones)									(8)		(2)		(4)	
Trochammina quadriloba Hoglund											(2)			
Cassidulina sp.											(1)			
Reophax nodulosa Brady													(8)	
Silicosigmoilina groenlandica (Cushman)													(8)	
Cassidulina nocrossi Cushman													(1)	
Recurvoides laevigatum Hoglund														
Reophax scorpiurus Montfort														
Alveolophragmium jeffreysi (Williamson)														

Table I (cont.)

10 145	11 28	11 52	11 101	12 47	12 51	13 38	14 183	14 146	14 151	14 193	14 50	15 48	16 49	17 187	17 194	18 102	19 184	19 103	20 185	21 40	21 147
98.5	100.	97.0	..	75.0	71.3	..	84.7	96.5	24.1	65.3	85.9	88.5	79.8	21.9	53.0	65.6	85.0	22.5	86.6	93.1	85.6
(4)	...	...	...	...	...	...	8.5	2.7	7.8	(2)	0.3	1.5	11.6	9.5	...	...	13.3	...	...	...	101
(4)	...	1.8	100	..	15.3	..	0.4	..	41.2	(3)	4.7	(1)	(1)	44.4	0.5	29.1	0.6	22.5	4.2	...	...
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...	...	(1)	...	...	6.0	...	5.6	(8)	16.9	26.1	1.8	1.1	1.8	4.5	1.0	4.5	0.8	17.5	3.1	...	1.1
...	...	...	...	...	5.7	...	...	...	0.6	...	4.5	3.8	1.3	4.8	...	(1)	...	...	(1)	...	0.5
...	...	...	...	...	0.2	...	...	...	...	...	0.2	2.0	1.8	...	...	...	...	...	...	...	...
(4)	...	...	...	...	...	...	0.7	..	0.6	6.4	(2)	1.9	1.3	...	0.3	...	...	...	1.7	...	...
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(1)	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
...	...	...	...	...	...	...	...	...	...	...	0.3	...	...	...	...	...	...	...	...	...	...
...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	(1)	...	...	...	...
...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
...	...	...	...	...	...	...	...	...	...	...	(1)	(1)	...	0.7	...	...	...	...	...	...	...
...	...	(1)	...	...	...	...	...	...	0.2	...	...	...	(2)	2.2	42.4	(1)	(1)	12.5	(1)	3.5	...
...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
...	...	...	...	...	(2)	...	...	...	6.6	...	...	...	...	10.1	...	...	(1)	200	...	...	...
...	...	...	...	...	(1)	...	...	...	...	...	0.6	(1)	1.2	...	0.3	(1)	...	...	1.4	...	0.7
...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
...	...	...	...	...	...	(1)	...	...	0.2	...	(1)	...	...	...	...	...	...	...	...	...	...
...	...	...	...	...	...	...	(1)	...	...	1.1	(1)	...	(2)	...	...	...	...	...	...	...	...
...	...	...	...	...	...	...	...	(2)	(4)	...	...	...	...	(1)	...	...	...	...	...	...	...

(cont.)

Table I (cont.)

Depth (metres)	21	28	31	34	39	39	40	41	43	45	46	46
Station number	186	148	150	149	208	20	104	188	179	22	203	189
Spiroplectammina biformis Parker & Jones	35.6	72.2	48.6	51.9	8.3	75.6	2.3	6.0	24.0	82.5	17.1	4.8
Textulariidae indet.	13.2	8.3	5.7	11.7	1.6	10.3	4.9	2.7	...	...	4.8	0.5
Trochammina nana Brady	36.4	3.3	19.5	14.8	61.4	...	28.0	58.2	57.8	0.5	27.7	67.6
Foraminifera indet.	...	...	...	...	...	...	...	...	(1)	...	...	...
Textularia earlandi Parker	7.5	7.7	22.4	16.3	0.9	7.1	6.1	(5)	(4)	3.0	7.2	0.7
Proteonina atlantica Cushan	1.8	3.5	0.5	1.8	1.1	...	(3)	2.0	1.8	1.1	0.5	0.5
Textularia torquata Parker	(1)	...	...	1.0	(1)	...	...	(1)	...	0.7	1.3	...
Reophax gracilis Kiaener	...	...	...	...	...	6.3	...	...	...	5.7	(4)	...
Storthosphaera albida F.E.Schulze	...	1.0	...	...	0.3	...	...	...	...	...	0.6	...
Alveolophragmium crassimargo (Norman)	1.2	0.7	0.4	0.6	3.2	...	1.2	5.0	3.4	3.6	2.0	2.2
Cassidulina islandica Norvang	...	...	...	...	...	...	...	...	...	...	...	...
Bucella frigida (Cushman)	(2)	...	...	...	...	...	...	...	...	...	...	0.6
Pelosina variabilis Brady	...	...	...	...	...	...	...	...	...	...	...	...
Glomospira gordialis (Jones & Parker)	0.5	0.8	0.5	0.9	(3)	...	...	(2)	(1)	...	0.7	...
Psammosphaera fusca F.E.Schulze	...	...	(8)	...	9.9	...	...	4.1	(1)	...	1.3	10.0
Recurvoides turbinatus (Brady)	0.3	0.4	...	...	(4)	(1)	...	(1)	1.2	...	(3)	...
Trochamminella atlantica Parker	0.9	0.2	0.9	0.4	1.7	...	1.4	2.8	1.1	...	2.0	1.5
Phinella (?) puchella Parker	...	...	...	...	(1)	...	...	...	...	...	...	1.7
?Aschemonella catenata (Norman)	...	...	...	...	(1)	...	(1)	...	...	...	(8)	...
Elphidium orbiculare (Brady)	(1)	...	...	...	(3)	...	...	...	...	...	...	0.6
Trochamminella bullata Hoglund	...	0.2	...	...	4.0	...	(2)	...	1.2	...	1.9	(1)
Hyperammina friabilis Brady	(2)	...	(3)	...	1.5	...	1.4	(3)	(4)	2.9	23.8	2.1
Trochammina globigeriniformis (Parker & Jones)	...	...	...	...	(4)	...	...	...	...	...	...	(1)
Trochammina quadriloba Hoglund	...	...	...	...	0.2	...	...	...	...	...	...	0.4
Cassidulina sp.	...	...	...	...	...	...	...	...	(3)	...	...	...
Reophax nodulosa Brady	...	...	(8)	...	1.5	...	42.5	15.1	6.6	...	7.4	1.2
Silicosigmoilina groenlandica (Cushman)	2.0	1.7	0.7	1.2	...	...	1.0	(1)	(2)	...	(9)	...
Cassidulina nocrossi Cushman	...	...	...	...	(2)	...	...	...	...	...	...	0.9
Recurvoides laevigatum Hoglund	(1)	...	...	...	(6)	...	(1)	0.9	...	...	(4)	0.5
Reophax scorpiurus Montfort	...	(1)	...	...	...	...	...	...	...	...	...	...
Alveolophragmium jeffreysi (Williamson)	...	...	...	...	2.5	...	(1)	...	(3)	...	(4)	0.7
Reophax curtus Cushman	...	...	...	...	1.1	...	...	(2)	...	...	...	1.8
Trochammina nitida Brady	...	...	...	...	(1)	...	...	...	...	...	(8)	...
Bathysiphon filiformis Sars	...	...	...	...	(3)	...	...	(4)	...	...	...	...
Cibicides lobatulus (Walker & Jacob)	...	...	...	...	(1)	...	...	...	...	...	...	...
Trochammina squamata Parker & Jones	...	...	...	...	(1)	...	...	...	...	...	...	...
Hyperammina cylindrica Parr	...	...	...	...	...	...	...	...	...	...	(8)	...
Astrononion gallowayi Loeblich & Tappan	...	...	...	...	...	...	...	...	...	...	...	1.4
?Nonion sp.	...	...	...	...	...	...	...	...	...	...	...	(1)
Polymorphida indet.	...	...	...	...	...	...	...	...	...	...	...	0.4
Eggerella advena (Cushman)	...	...	...	...	...	...	...	...	...	...	...	...
Astrorhiza arenaria Norman	...	...	...	...	...	...	...	...	...	...	...	...
Globigerina pachyderma Ehrenberg	...	...	...	...	...	...	...	...	...	...	...	...
?Rhizammina sp.	...	...	...	...	...	...	...	...	...	...	...	...
Reophax guttifer Brady	...	...	...	...	...	...	...	...	...	...	...	...
Saccorhiza ramosa (Brady)	...	...	...	...	...	...	...	...	...	...	...	...
Adercotryma glomeratum (Brady)	...	...	...	...	...	...	...	...	...	...	...	...

Table I (cont.)

51 123	56 198	58 10	62 11	68 35	68 86	75 12	78 124	90 13	102 126a	125 18	130 14	160 18b	161 15	164 18a	168 9	181 190	184 18c	188 210	193 209	196 53	199 16	200 17	201 7	210 25	233 26	284 54
91.8	3.7	90.5	40.6	39.6	39.4	83.1	56.3	85.5	6.9	4.9	97.1	1.1	67.1	5.6	1.5	2.1	1.4	3.9	2.6	10.4	56.5	9.9	11.0	41.0	2.0	2.5
...	...	5.4	3.4	9.2	...	7.1	...	2.4	4.1	1.2	...	1.2	13.4	...	2.6	2.1	...	2.4	1.7	4.2	8.3	...	5.5	0.4	...	1.0
0.7	41.2	...	(8)	32.9	8.0	(1)	3.9	(1)	15.1	49.4	...	64.1	11.0	27.8	28.3	41.8	46.5	40.1	36.1	36.1	8.3	28.3	28.6	27.5	8.6	21.7
...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	(1)	...	...	...	(1)	...	(3)	...	0.8	1.0	1.5
2.4	2.5	2.8	3.5	12.1	7.0	5.4	...	(3)	5.2	2.9	...	0.7	...	...	24.4	2.1	1.9	2.9	6.8	11.9	(4)	29.8	32.3	11.8	63.8	33.1
(1)	...	...	...	2.5	(1)	...	...	...	4.0	...	...	...	...	...	...	(1)	(4)	...	0.5	1.4	(4)	0.8	0.4	(1)	0.7	...
0.5	...	...	(2)	(6)	...	(5)	...	6.0	(1)	0.6	...	...	4.9	...	...	...	1.7	...	...	(2)	11.1	...	0.3	(1)	...	(2)
(2)	...	1.3	(4)	(1)	...	2.6	...	(2)	...	...	...	...	...	...	...	...	...	...	...	...	...	...	(1)	(1)	...	...
...	...	...	...	...	...	...	...	...	(1)	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
3.8	21.3	...	...	(8)	44.2	...	5.8	(1)	9.6	12.3	...	4.2	(1)	3.7	4.9	13.5	4.3	6.1	3.1	7.8	(4)	1.8	1.0	0.7	...	6.2
...	...	...	...	...	...	...	...	...	...	...	...	...	...	1.9	...	...	...	...	...	...	...	...	...	...	...	...
...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
...	...	...	...	...	...	...	320	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
...	16.1	...	...	...	...	...	...	...	...	0.3	...	8.8	...	11.1	(2)	14.2	16.7	23.4	5.9	...	...	(1)	0.3	(2)	(1)	...
...	...	...	...	(3)	...	...	...	...	0.6	1.4	...	(4)	(1)	7.4	2.1	...	0.5	1.9	1.8	11.5	...	9.5	2.4	4.3	2.0	4.2
(2)	0.4	...	...	(3)	...	...	(1)	(3)	1.2	1.2	...	2.3	...	...	1.5	(1)	1.9	1.0	1.7	4.0	(4)	1.4	1.6	4.0	...	8.1
...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
...	...	...	...	...	...	...	...	...	(1)	(4)	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
...	...	...	...	...	...	...	...	...	...	...	...	(1)	...	...	...	...	...	...	...	...	...	...	...	...	...	...
...	...	...	...	1.1	...	...	...	...	(3)	1.2	...	3.7	...	...	2.8	...	5.3	5.3	1.8	2.3	3.3	2.9	...	2.1	...	...
0.6	2.9	...	...	...	...	...	...	...	15.9	7.6	...	...	...	3.7	1.3	1.4	1.7	2.9	0.7	0.5	...	0.9	0.9	1.1	...	...
...	...	...	...	...	...	...	...	...	...	(4)	...	0.4	...	...	(1)	...	...	...	...	(1)	...	0.5	0.4	0.5	...	(4)
...	3.3	...	...	...	...	...	...	...	...	(4)	...	1.2	...	9.3	1.0	...	(4)	(4)	...	(1)	...	5.6	1.0	1.2	3.4	2.5
...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
...	7.4	...	...	...	...	...	...	...	32.6	5.0	...	6.0	...	18.5	16.2	12.8	10.6	3.8	17.7	0.5	...	2.7	2.9	...	4.6	2.3
(1)	...	...	...	1.0	(2)	...	(1)	...	...	...	...	...	...	...	...	...	...	...	(1)	...	6.5	(2)	...	0.9	...	...
...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
...	...	...	...	(1)	...	...	...	...	0.6	2.9	...	2.7	...	...	7.2	7.1	4.3	3.4	9.3	8.1	1.9	...	4.8	(1)	...	7.5
...	...	...	...	...	...	...	...	...	...	0.2	...	...	...	...	...	...	...	...	1.0	...	...	...	...	1.0	...	...
...	...	...	...	...	...	(1)	...	...	2.4	0.7	...	3.2	(1)	...	...	...	(4)	1.0	0.5	...	1.9	(4)	(1)	(2)	...	...
...	1.7	...	...	...	...	...	...	...	...	6.0	...	...	...	11.1	(1)	(1)	1.0	1.5	6.4	(1)	...	(3)	...	(1)	...	...
...	...	...	...	...	...	...	...	...	0.9	0.4	...	...	...	...	...	...	...	...	...	(2)	...	3.5	2.6	(2)	1.2	1.0
...	...	...	...	...	...	...	...	...	...	0.8	...	...	...	...	1.0	...	0.7	...	2.1	...	...	(5)	0.8	...	1.7	2.5
...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
...	...	...	...	...	...	(1)	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
...	...	...	(1)	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
...	...	...	(3)	...	...	(2)	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
...	...	...	...	...	...	...	...	...	...	0.5	...	(4)	...	...	...	...	(4)	...	(1)	...	...	3.4	(2)	...	10.8	...
...	...	...	...	...	...	...	...	...	...	...	(1)	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	4.0	...	...	...	...	...	...	...	...	...	...	...
...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	(4)	...	...	...	...	(1)	...	...	...	2.3
...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	(4)	...	...	...	...	...	...	...	...	...
...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	(1)	...	...	...	(1)	...	...

TRAVERSE	STATION DISTANCE FROM SHORE IN FEET												
	50	100	200	400	800	1,600	3,200	6,400	11,500	15,840	21,120	26,400	
1							7		9				
2	10	11	12	13	14	15	16	17	18	18a	18b	18c	
3		20		22			25	26					
4	28							35					
5		38		40									
6	46	47	48	49	50	51	52	53	54				S
10					86								T
11		88											A
12	96	97	98	99	100	101	102	103	104				T
14						123	124			126a			I
15				130									O
18	145	146	147	148	149	150	151	152					N
19									162				S
22							179						
23	182	183	184	185	186	187	188	189	190				
24			193	194				198					
25	205		206		207		208	209	210				
30	200						203						

Table 2. Distribution of inshore stations.

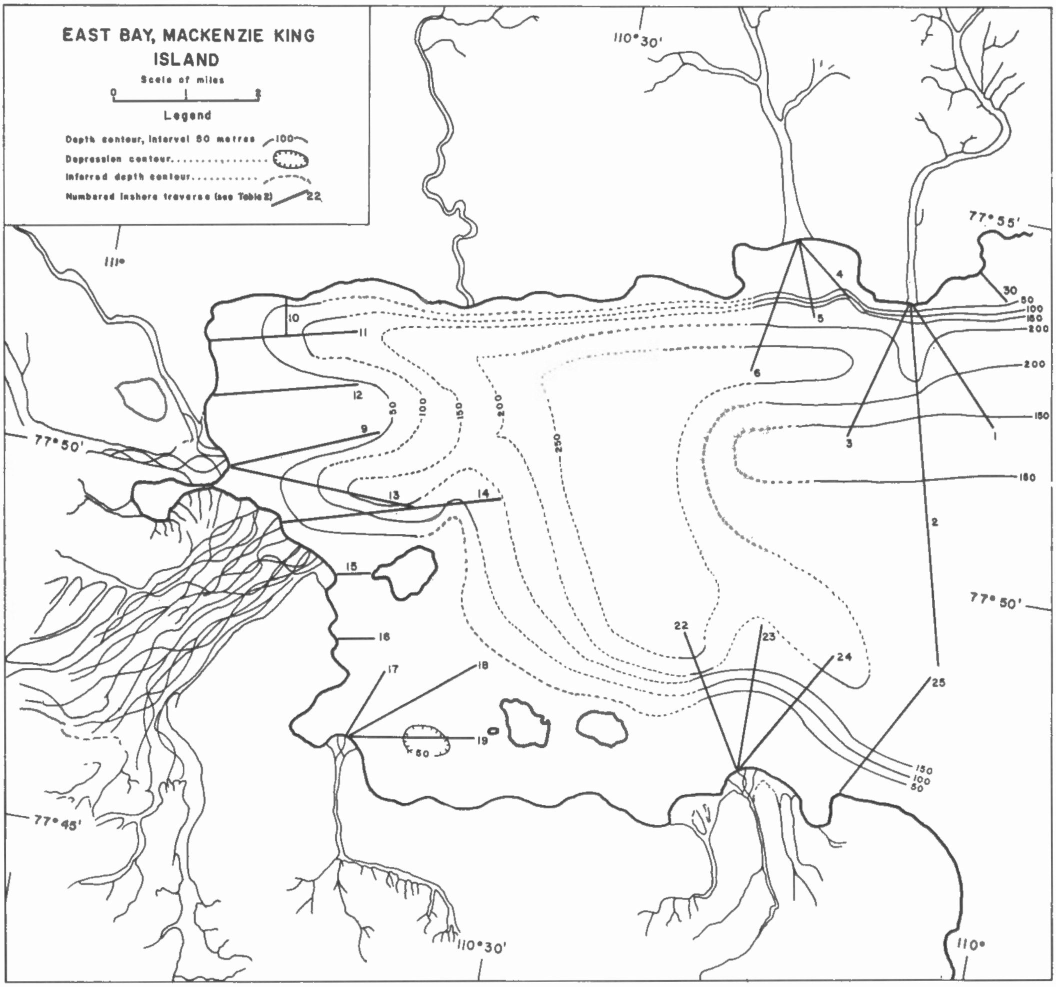

Figure 2. Location of inshore traverses

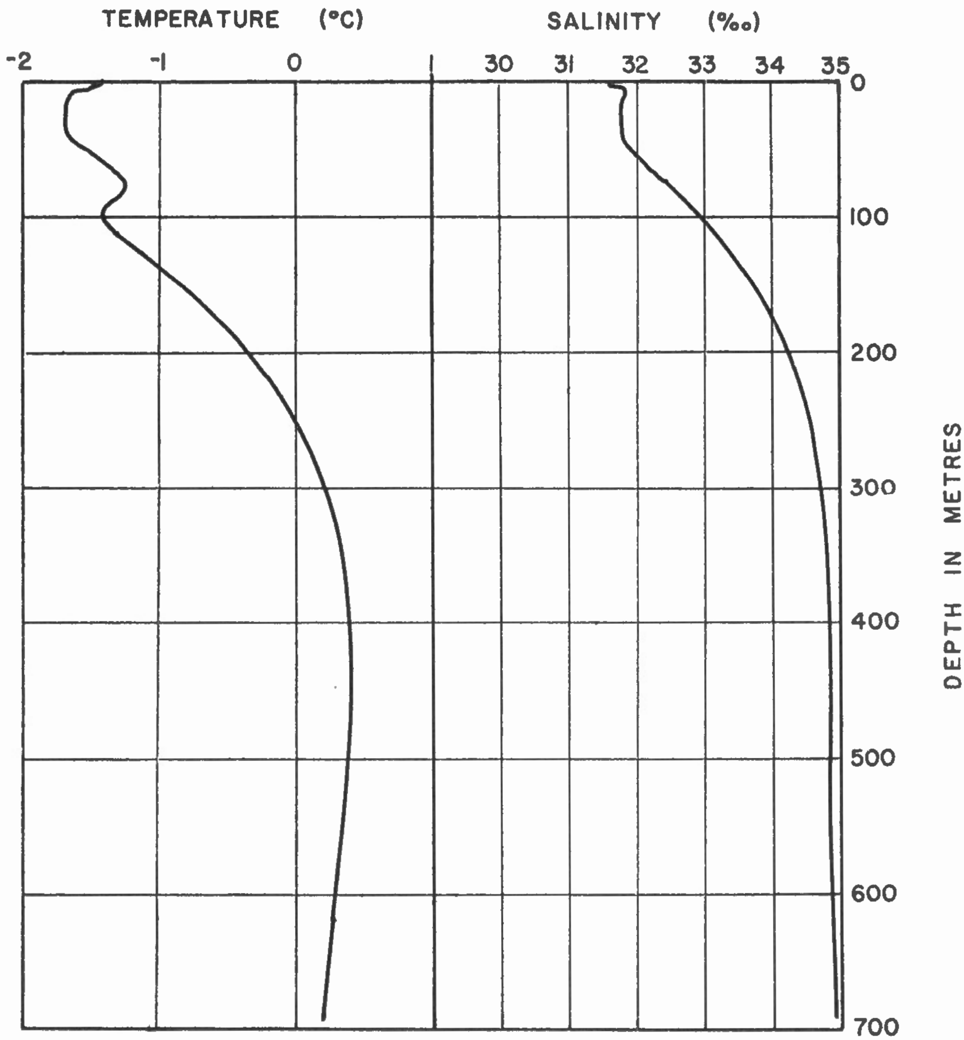

Figure 3. Average temperature and salinity, Arctic Ocean stations, May 1960.

(After Collin, 1961, Fig. 2)

FORAMINIFERA REFERENCE LIST

(Starred references are original to the species)

Adercotryma glomeratum (Brady) - *Lituola glomerata Brady, 1878, Ann. Mag. Nat. Hist., ser. 5, vol. 1, p. 433, pl. 20, figs. 1a-c.

Alveolophragmium crassimargo (Norman) - Loeblich & Tappan, 1953, Smithsonian Misc. Coll., vol. 121, No. 7, p. 29, fig. 1-3.

Alveolophragmium jeffreysi (Williamson) - *Nonionina jeffreysi Williamson, 1858, Recent Foraminifera of Great Britain, p. 34, figs. 72-73.

Aschemorella catenata (Norman) Brady, 1884, Rep. Voy. Challenger, pl. 27, fig. 3.

Astrononion gallowayi Loeblich & Tappan, 1953, *Smithsonian Misc. Coll., vol. 121, no. 7, p. 90, pl. 17, fig. 4-7.

Astrorhiza arenaria Norman, -Cushman, 1948, Cushman Lab. Foram. Research Spec. Pub. No. 23, p. 5, pl. 1, fig. 1.

Bathysiphon filiformis Sars - Brady, 1884, Rep. Voy. Challenger, pl. 26, fig. 15-20.

Bucella frigida (Cushman) - Andersen, 1952, Journ. Washington Acad. Sci., vol. 42, No. 5, p. 144, figs. 4a-c, 5, 6a-c.

Cassidulina islandica Norvang - Loeblich & Tappan, 1953, Smithsonian Misc. Coll., vol. 121, No. 7, p. 118, pl. 24, fig. 1.

Cassidulina nocrossi Cushman -* Cushman, 1933, Smithsonian Misc. Coll., vol. 89, No. 9, p. 7, pl. 2, figs. 7a-c.

Cassidulina teretis Tappan - Loeblich & Tappan, 1953, Smithsonian Misc. Coll., vol. 121, No. 7, p. 121, pl. 24, figs. 3,4.

Cibicides lobatulus Walker & Jacob - Cushman, 1947, Cushman Lab. Foram. Research Spec. Pub. No. 23, p. 78, pl. 8, figs. 14a-c.

Dentalina baggi Galloway & Wissler - Loeblich & Tappan, 1953, Smithsonian Misc. Coll., vol. 121, No. 7, p. 54, pl. 9, figs. 10-15.

Eggerella advena (Cushman) - Loeblich & Tappan, 1953, Smithsonian Misc. Coll. vol. 121, No. 7, p. 36, pl. 3, figs. 8-10.

Elphidium orbiculare (Brady) *Nonianina orbicularis Brady, 1881, Ann. Mag. Nat. Hist., ser. 5, vol. 8, p. 415, pl. 21, figs. 5a, b.

Globulina glacialis Cushman and Ozawa - Cushman, 1947, Cushman Lab. Foram. Res. Spec. Pub. No. 23, p. 50, pl. 5, figs. 15, 16.

Globigerina pachyderma (Ehrenberg) - Cushman & Henbest, 1940, U.S. Geol. Surv. Prof. Paper 196-A, p. 2,pl. 8, fig. 1.

Glomospira gordialis (Jones & Parker) - Cushman, 1947, Cushman Lab. Foram. Res., Spec. Pub. 23, p. 25, pl. 2, figs. 9, 10.

Hyperammina cylindrica Parr -*H. elongata Brady, 1878, Ann. Mag. Nat. Hist. ser 5, vol.1 , pl. 20, fig. 2.

Hyperammina friabilis Brady - Brady, 1884, Rep. Voy. Challenger, pl. 23, figs. 1-3.

Nonionella auricula Heron-Allen & Earland - Loeblich & Tappan, 1953, Smithsonian Misc. Coll., vol. 121, No. 7, p. 92, pl. 16, figs. 6-7.

Pelosina variabilis Brady - Cushman, 1947, Cushman Lab. Foram. Res. Spec. Pub., No. 23, p. 13, pl. 1, figs. 7-9.

Pninella (?) pulchella Parker - *Parker, 1952, Bull. Mus. Comp. Zool., vol. 106, No. 9, p. 420, pl. 6, fig. 18a,b, 19, 20.

Proteonina atlantica Cushman - Parker, 1952, Bull. Mus. Comp. Zool., vol. 106, No. 10, p. 454, pl. 1, figs. 1, 2.

Psammosphaera fusca F.E. Schulze - Cushman, 1947, Cushman Lab. Foram. Res. Spec. Pub. No. 23, p. 8, pl. 1, figs. 2, 3.

Recurvoides laevigatum Hoglund - *Hoglund, 1947, Zool. Bidrag Uppsala, vol. 26, p. 150, pl. 11, fig. 6.

Recurvoides turbinatus (Brady) -*Haplophragmium turbinatum Brady, 1884, Rep. Voy. Challenger, vol. 9, (Zoology) p. 313, figs. 9a-c.

Reophax curtus Cushman -Loeblich & Tappan, 1953, Smithsonian Misc. Coll., vol 121, No. 7., p. 22, pl. 2, fig. 1-4.

Reophax gracilis Kiaener - Parker, 1952, Bull. Mus. Comp. Zool., vol. 106, No. 9, p. 397, pl. 2, fig. 1.

Reophax guttifer Brady -*Brady, 1884, Rep. Voy. Challenger, vol. 9, (Zoology), pl. 31, fig. 10-15.

Reophax nodulosa Brady - Brady, 1884, Rep. Voy. Challenger, vol. 9, (Zoology) pl. 31, fig. 1-9.

Reophax scorpiurus Montfort - Loeblich & Tappan, 1953, Smithsonian Misc. Coll., vol. 121, No. 7, p. 24, pl. 2, fig. 7-10.

Saccorhiza ramosa (Brady) -Brady, 1884, Rep. Voy. Challenger, vol. 9, (Zoology) pl. 23, fig. 15-19.

Silicosigmoilina groenlandica (Cushman) - Loeblich & Tappan, 1953, Smithsonian Misc. Coll., vol. 121, No. 7, pl. 4, figs. 7-9.

Spiroplectammina biformis (Parker & Jones) - Loeblich & Tappan, 1953, Smithsonian Misc. Coll., vol. 121, No. 7, p. 34, pl. 4, figs. 1-6.

Storthosphaera albida F.E. Schulze - Cushman, 1947, Cushman Lab. for For. Res. Spec. Pub. No. 23, p. 17, pl. 1, fig. 16.

Textularia earlandi Parker *1952, Bull. Harvard Mus. Comp. Zool., vol. 106, No. 10, p. 458, (footnote) pl. 2, fig. 4, T. tenuissima Earland, 1933, Discovery Repts. vol. 7, p. 95, pl. 3, figs. 21-30.

Textularia torquata F. Parker, *1952, Bull. Mus. Comp. Zool. vol.106, No. 9, p. 403, pl. 3, figs. 9-11.

Trochammina globigeriniformis Parker & Jones var. pygmaea Hoglund - *1947, Zool. Bidrag Uppsala, vol. 26, p. 200, pl. 17, fig. 3.

Trochammina nana (Brady) - Haplophragmium nanum Brady, 1881, Ann. Mag. Nat. Hist., ser. 5, No. 48, pl. 21, figs. la,b,c.

Trochammina nitida Brady - Brady, 1884, Rep. Voy. Challenger, vol. 9, (Zoology) pl. 41, figs. 5,6.

Trochammina quadriloba Hoglund -*T. pusilla Hoglund, 1947, Zool. Bidrag Uppsala, vol. 26, p. 201, pl. 17, figs. 4a-c.

Trochammina squamata Parker & Jones - Parker, 1952, Bull. Mus. Comp. Zool. vol. 106, No. 9, p. 408, pl. 4, figs. 11-16.

Trochamminella atlantica F. Parker * 1952, Bull. Mus. Comp. Zool. vol. 106, No. 9, p. 409, pl. 4, figs. 17a,b, 18, 19.

Trochamminella bullata Hoglund -*1947, Zool. Bidrag Uppsala, vol. 26, p. 213, pl. 17, fig. 5.

Valvulineria arctica Green -*1958, USAF Cambridge Res. Centre, Geophys. Res. Paper No. 63, vol. 1, p. 78, pl. 1, figs. 3a-c.

ROGER DUHAMEL, F. R. S. C.
QUEEN'S PRINTER AND CONTROLLER OF STATIONERY
OTTAWA, 1964

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