64-5

GEOLOGICAL SURVEY OF CANADA

DEPARTMENT OF MINES AND TECHNICAL SURVEYS

PAPER 64-5

A PRELIMINARY STUDY OF FORAMINIFERA DISTRIBUTION ON THE ATLANTIC CONTINENTAL SHELF, SOUTHEASTERN NOVA SCOTIA

(Report, 2 tables, figure)

G. A. Bartlett

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ABSTRACT

Bottom sampling at forty-one stations in the shallow waters of the southeast Scotian Shelf (lat. 43°21'25", long. 63°39'00"-65°45'30") was carried out during June and July 1961. Littoral and neritic bottom samples were taken at stations up to 12 miles offshore, in waters up to 150 metres deep. Shallow-water foraminifera did not show a direct relationship to depth or substrate. Salinity, either by itself or in combination with other factors, is directly related to distribution of brackish-water foraminifera. Calcareous species greatly exceeded arenaceous species at most sampling stations. Percentages of pelagic species increased with depth. Most shallow-water benthonic species are indigenous, but the majority of deeper-water benthonic forms indicate transportation or reworking or both. Ninety per cent of more than one hundred species examined are related to Arctic foraminifera previously described. No new species are established. Grouping of species, because of general morphological similarities, was initiated.

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INTRODUCTION

This preliminary survey attempts to relate foraminifera to their environment in terms of sedimentation, temperature, salinity, and depth. The study was carried out during the summer of 1961 over that part of the Scotian Shelf adjacent to southeastern Nova Scotia, (Fig. 1). The Scotian Shelf forms part of the Atlantic Continental Shelf.

Samples were collected along short traverse lines, 12 miles long, extending perpendicular to the coast between Halifax and Cape Sable. Bottom conditions along certain traverse lines were such that satisfactory sampling stations could only be located by sonar sounding with the aid of hydrographic charts. Three different sampling devices were used to collect bottom material: a modified Schmitt corer; a Dietz-Lafonde grab-sampler; and a small butterfly grab-sampler which proved to be most successful, working equally well in gravel, sand and ooze.

Publications dealing with the shallow waters of the Scotian Shelf are few. Species similar to those of the Scotian Shelf have been described by Brady (1884)[1], and by Dawson (1870) from the St. Lawrence River and the Gulf. Cushman described similar forms in various publications (1918-1931, 1944, 1948b). Other papers in which many of the forms are described are by Höglund (1947), Parker (1948, 1952a, 1952b), Phleger (1954), Loeblich and Tappan (1953) and Todd and Low (1961).

This report is part of a thesis[2] submitted to the Geology Department at Carleton University; the work was carried out as a cooperative project of Carleton University and the Geological Survey of Canada. The author expresses sincere thanks to Professor Kenneth Hooper of Carleton University for many suggestions during the course of this work, and to Dr. N.J. Campbell of the Atlantic Oceanographic Group, Fisheries Research Board of Canada, who

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[1] Dates and/or names in parentheses refer to publications listed in the Selected Bibliography.

[2] M.Sc. thesis by G.A. Bartlett (1962): "Foraminifera and their relations to bottom sediments on the Scotian Shelf", Carleton University, Ottawa.

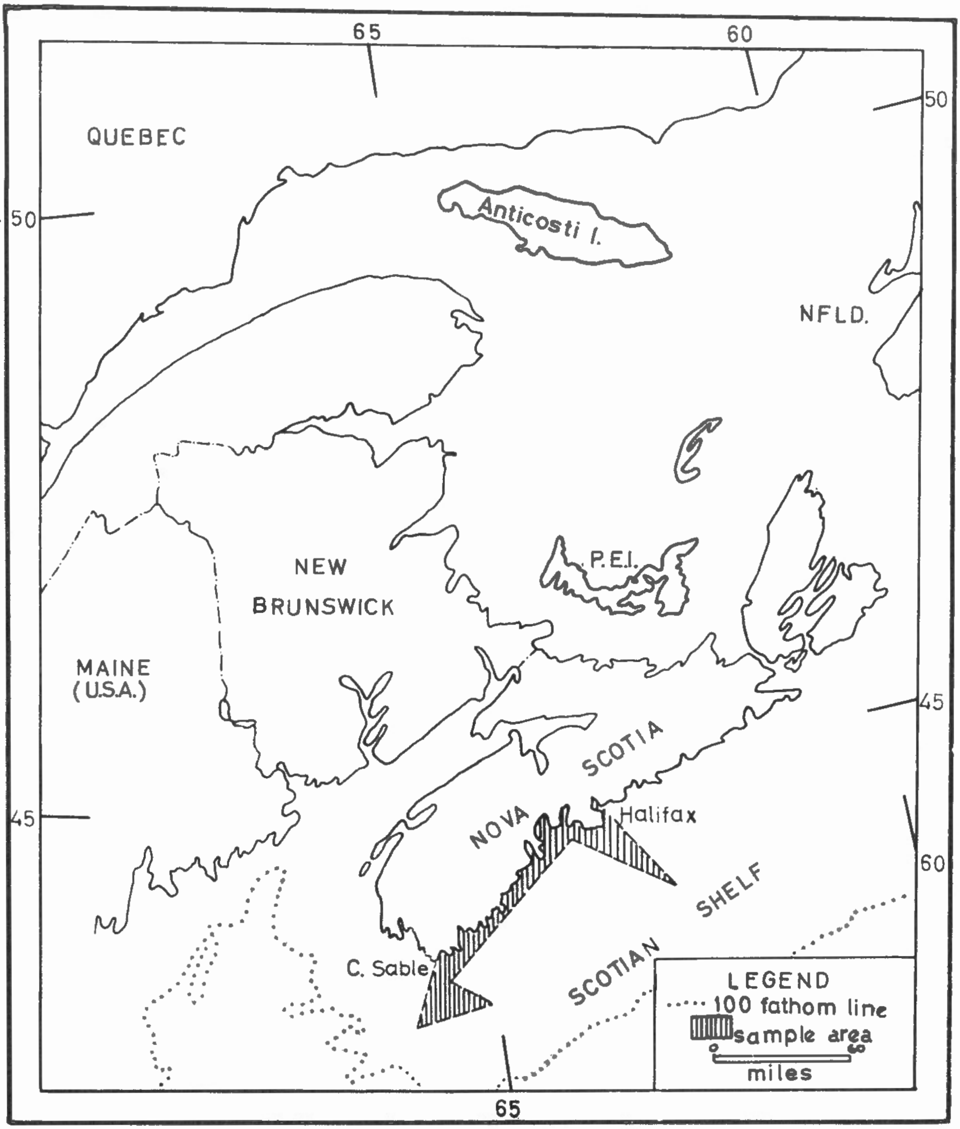

Fig. 1 - Map showing portion of Shelf sampled (shaded area), and outline of Shelf at 100-fathom line (183 m).

TABLE I

Station Data

St. No.	Depth (M.)	North Latitude	West Longitude
1	40	44°24'00"	63°39'00"
2	36	44°25'25"	63°39'30"
3	30	44°25'10"	63°41'27"
4	50	44°24'00"	63°41'00"
5	85	44°23'22"	63°44'50"
6	85	44°23'22"	63°45'10"
7	90	44°22'55"	63°45'00"
8	95	44°22'50"	63°40'10"
9	110	44°21'40"	63°40'10"
10	114	44°20'34"	63°40'10"
11	120	44°19'17"	63°40'10"
12	110	44°18'12"	63°40'10"
13	40	44°17'00"	64°11'30"
14	75	44°15'30"	64°10'00"
15	56	44°14'30"	64°09'00"
16	84	44°13'00"	64°08'00"
17	80	44°12'30"	64°07'00"
18	24	44°05'00"	64°32'00"
19	24	44°04'00"	64°31'00"
20	36	44°03'30"	64°30'00"
21	56	44°02'30"	64°28'30"
22	60	44°01'30"	64°27'30"
23	56	44°00'00"	64°32'00"
24	44	44°01'00"	64°34'00"
25	30	44°01'00"	63°40'00"
26	30	44°02'00"	64°40'00"
27	28	44°01'50"	64°40'00"
28	24	43°56'00"	64°43'30"
29	40	43°55'45"	64°42'45"
30	46	43°55'00"	64°43'00"
31	24	43°56'00"	64°46'45"
32	18	43°55'30"	64°49'00"
33	32	43°50'00"	64°47'00"
34	16	43°56'45"	64°44'00"
35	14	43°27'00"	65°39'50"
36	22	43°26'00"	65°45'30"
37	26	43°22'00"	65°37'00"
38	30	43°20'00"	65°43'00"
39	14	43°24'50"	65°37'40"
40	Shore	Chester	
41	Shore		

helped to organize the field program. Thanks are also extended to Messrs. Baker, Holms and Fitzgerald of the Department of Fisheries, and to Captains Anderson, Ross and Young, and the crews of the Fisheries Patrol boats "Cratena", "Ira John", and "Lacuna". Dr. Brooks F. Ellis and Dr. A.W. McCrone of New York University critically reviewed the manuscript.

PHYSICAL SETTING

Submarine Topography

In a general statement on the submarine topography of the Scotian Shelf, Hachey (1954) described the Shelf as being an irregularly shaped submarine plateau of irregular topography extending 100 to 150 miles out from the coast. Except for several small basins the Scotian Shelf as a whole is less than 600 feet (183 metres) deep. The bottom character follows a more or less definite pattern in that a sandy bottom predominates on the banks, although gravel and boulders are found in many localities; subsidiary deeps and troughs are mud-covered, but samples reveal a considerable number of cobbles mixed with organic, sour-smelling ooze. Inner zones along the shore have a bottom of cobbles or boulders intermixed with sands, silts and clays.

Oceanography

Waters of the Continental Shelf, especially near shore, are generally variable in their temperature and salinity. The cold saline Labrador Current mixes with Gulf of St. Lawrence water and flows southward over the Scotian Shelf. Gulf Stream water, which breaks away from the gulf system and carries with it many forms of marine life associated with more tropical waters, is incorporated in the water masses close to the Nova Scotia coasts and directly affects the characteristics of these waters. Bottom temperatures (ranging from 3 to 9°C) were 2°C higher at Cape Sable than at Halifax in comparable depths. Salinities, however, did not vary more than .85 per cent in the entire study area (from 31.64 to 32.45 per cent).

SEDIMENT CHARACTERISTICS

Values of $\log_{10}$So indicate progressively better sorting of sediments seaward. Large pebbles, apparently glacial erratics, were not considered as normal marine sediments during mechanical analyses. Generally the sediments are very fine to fine sands, with variations ranging between large pebbles and very fine silt. The high sand content is apparent in the freshly collected sample. Sorting of sediments requires relatively short transport, as a major part of the sorting has already taken place on many beaches. Reworking in the wave-base zone produces sediments with well-sorted characteristics; turbulent zones with large quantities of sediment yield rounded and broken foraminifera, while ocean-facing beaches are barren.

Mechanical analysis of the sample show foraminiferal content to be highest in the .124-mm to 150-mm sieve sizes. This is the general range of size of the foraminifera and therefore not directly related to sedimentary texture. However, in any sediment washed through a .063-mm sieve the foraminifera are generally larger than the associated sediment grains retained in the sieve. This relationship of foraminiferal size to sedimentary texture may be due to difference in specific gravity between the lighter tests and the heavier sediments, indicating transportation of the tests. On the other hand the presence of well-preserved, unbroken, or non-rounded shells indicates little if any transportation of the foraminifera. None of the evidence is conclusive owing to lack of information on the life cycles of foraminifera.

FAUNAL STUDY

Shallow-water foraminifera of the southeastern Scotian Shelf are closely related to those described from coastal areas of the Alaskan and Canadian Arctic and the New England States. This is to be expected, because the characteristic low temperatures of the Labrador Current persist as the waters flow southward. A few characteristic warmer-water species are present, probably indicating the effects of mixing of Gulf Stream and Labrador Current waters.

More than one hundred species of foraminifera were found in the southeastern Scotian Shelf area. Thirty species are arenaceous or agglutinated; ten species are calcareous imperforate forms; and the remainder are calcareous perforate forms assigned to Elphidiidae (9 species), Lagenidae (27), Polymorphinidae (9), Buliminidae (15), Nonionidae (4), Cassidulinidae (4) and Anomalinidae (3). Many families with the least number of species, e.g. Anomalinidae (3), Cassidulinidae (4), Elphidiidae (9), and Nonionidae (4), are most abundant in total numbers of individuals (Table II). Similar forms have been described from the coasts of Scotland, England, Denmark, the Scandinavian countries, the Pacific coast of North America, the Arctic and the eastern seaboards of the United States.

Tests varying from heavy opaque through translucent orange or brown to transparent belonging to the same species were present in the same sample. Living and dead forms were not distinguished.

Attached forms such as Cibicides, Rosalina, Patellina, as well as a few species of the attached genera Cassidulina, Trochammina and Fissurina are found where strong currents prevail. Because attached species are abundant in some areas with species that are normally not attached, it is probable that unattached foraminifera inhabit those areas receiving strong currents where food supply and oxygen are abundant. These unattached foraminifera are probably only carried away when the dead test lies on the sea bottom.

Cibicides is universally distributed and is commonly unsuitable for study of ecological conditions. Many of the Buliminidae are characteristic of colder, deeper waters, especially such genera as Virgulina, Uvigerina, Globobulimina, Bulimina and Bolivina. Globobulimina auriculata (Bailey) was rare in depths greater than 100 metres. The Lagenidae, although represented by a wide variety of individuals, are present in very low numbers. Many Elphidiidae are distributed throughout the sample area, but are most abundant in fairly shallow nearshore environments. The Elphidium clavatum Cushman complex is abundant in depths up to 100 metres, and various substrates such as sand, silt and clay. Other species of Elphidium are generally associated with E. clavatum, but are less common. Nonionidae, although represented by four species, is exemplified by Nonion labradoricum (Dawson), characteristic of Pleistocene deposits. This species is most abundant at stations off Halifax in depths to 100 metres. It forms only a minor constituent of the foraminifera assemblage at stations south of Halifax.

Two of the three species of Anomalinidae, Cibicides lobatulus (Walker and Jacob) and C. refulgens Montfort (see Table II) are the most abundant individuals in the collections. The high degree of variation in shape of these forms is attributed to method and substance of attachment, as they conform to the configuration of the substrate. These species are abundant in all types of sediment, with highest frequencies in pebbly or gravelly substrates.

Cassidulina teretis Tappan is abundant in fine sand, silt, and mixtures of both. Highest frequencies are recorded from deeper waters of the Halifax sample stations, with percentages decreasing rapidly southward. C. islandica Nørvang is common at most stations with highest frequencies recorded from fine silt and pebble substrates.

Quinqueloculina seminulum (Linné) is widely distributed, but is most abundant in mildly turbulent, nearshore environments. Buccella frigida (Cushman) occurs in fine silt, mud, and sand substrates in depths from 22 to 110 metres.

Arenaceous species are more abundant in both number and variety at nearshore stations than at great depths. Eggerella advena (Cushman) is the most abundant arenaceous species. High frequencies are recorded from sand, silt, pebble, and macerated shell substrates. It is a characteristic form of shallow depths and the southern area of the Scotian Shelf. Spiroplectammina biformis (Parker and Jones) is most frequent in substrates of silt, sand, and clay. Adercotryma glomeratum (Brady) occurs throughout the study area with highest frequencies recorded in the more northern, deeper-water stations a few miles from shore. Substrates of silty sand, silty clay, and pebbles have approximately equal percentages of this species. Alveolophragmium crassimargo (Norman) is widely distributed. Greatest frequencies are in fine silt and mud in deeper waters, and fine sand and large pebbles in shallow-water areas. Similar conditions in closely associated areas show a marked change in frequency of this species. Reophax curtus Cushman is a cosmopolitan species. Fine silt, silt and sand, and silt and pebbles are characteristic substrates. Miliammina fusca is characteristic of the Zostera and Enteromorpha substrates in the intertidal zone.

Faunal content of samples at any one station is fairly uniform; however, nearby samples in different micro-environments vary considerably. Shallow-water species may be dispersed by various algae, mosses, or other plants. Bottom samples show large quantities of both attached and supposedly free-living foraminifera on such organic substrates. Currents and winds play an important part in the distribution of such plants after they are detached from the bottom. It is questionable if living benthonic foraminifera of this area of the Scotian Shelf, unless very tolerant, can withstand the wide variations of environments that they would pass through during dispersal. Turbidity currents may account for certain faunal displacements.

The influence of temperature and salinity on foraminifera covered in this present study is known in its broader aspects. Information obtained from deeper-water stations having large thermoclines indicates that temperature is probably an important factor in the distribution of foraminifera. Thermal zonation does not seem to exist to as great an extent in the shallow-water stations, and probably does not affect distribution. Because bottom salinities do not vary more than 1 per cent throughout the sample area, the effect of salinity on the fauna is probably negligible. Other factors, either singly or in combination with such variables as depth, temperature, salinity and substrate, are probably more important in controlling distribution of foraminifera.

Apparent intergradation of a number of 'species' warrants further study to determine if single species or assemblages of species are best suited for ecological determinations. Arenaceous and calcareous imperforate foraminifera, although represented by a number of species and varieties, occur less commonly than calcareous perforate forms, in the samples from the Scotian Shelf. However, they were more abundant, and were much more variable at nearshore shallow-water stations than at greater depths farther from shore.

Irregularity of distributions may be attributed to insufficient information from limited sampling stations. More sampling stations to provide a study of micro-environments must be established before definite conclusions can be made.

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TABLE II

FORAMINIFERA DISTRIBUTION %
(commoner species listed)

(Bottom samples were not obtained from the following stations: 1-7, 21, 24, 34, 36, 37, 41)

Station Number	8	9	10	11	12	13	14	15	16	17	18	19	20	22	23	25	26	27	28	29	30	31	32	33	35	38	39	40
Depth in Metres	95	110	114	120	110	40	75	56	84	80	24	24	36	60	56	30	30	28	24	40	46	24	18	32	14	30	14	-
Salinity %	32.30	32.38	31.58	32.41	32.45	31.96	32.10	32.03	32.16	32.23	31.89	31.92	31.85	32.10	31.92	31.85	31.90	32.10	31.91	31.95	31.96	31.89	32.00	31.84	31.64	31.64	31.74	
Foraminifera No.1 Gram of Sample (X = a trace)	435	530	215	194	294	190	960	202	48	863	X	225	X	X	100	683	351	210	356	X	X	68	241	161	100	22	259	200
1 Adercotryma glomeratum (Brady)	4.0	5.1	3.3	3.1	5.5	.8	.8	.5		.1		.47				.29					.29						39	
2 Alveolophragmium crassimargo (Norman)	7.0	1.0	1.8	2.1	2.0		1.3	2.0		.1		2.3				6.6	.28		.28			2.9	4.6			4.5	1.2	
3 A.cf. Jeffresi (Williamson)							.2					.47				.2												
4 Ammodiscus catinus(Höglund)	.67			1.0																								
5 A. minutissimus Cushman & McCulloch)	X						X																					
6 Ammotium cassis (Parker)																							1.3				1.6	
7 Angulogerina angulosa (Williamson)	4.4	1.3	1.5	1.6	2.7	2.1	5.0		1.0							.75	.28											
8 A. fluens (Todd)	X			X		X			X																			
9 Astrononion gallowayi (Loeblich & Tappan)	1.6	1.4	1.4	.5			2.0		.7							1.2		.94										
10 Bolivina pseudo-punctata(Höglund)	.9	.4	.5	1.0			.1	.5								.15											.78	
11 Buccella frigida (Cushman)	4.8	12.	3.7	7.3	18.		3.1	5.		6.3		.47				8.8	6.4	2.4	1.4			2.9	2.9		2.9		7.8	
12 B. inusitata (Anderson)			.5				1.1			X						.15			.56									
13 Bulimina exilis (Brady)			.9	.5			.2	1.5				.47					.28					.4						

TABLE II
(cont'd)

Station Number	8	9	10	11	12	13	14	15	16	17	18	19	20	22	23	25	26	27	28	29	30	31	32	33	35	38	39	40
Depth in Metres	95	110	114	120	110	40	75	56	84	80	24	24	36	60	56	30	30	28	24	40	46	24	18	32	14	30	14	-
Salinity %	32.30	32.38	31.58	32.41	32.45	31.96	32.10	32.03	32.16	32.23	31.89	31.92	31.85	32.10	31.92	31.85	31.90	32.10	31.91	31.95	31.96	31.89	32.00	31.84	31.64	31.64	31.74	-
Foraminifera No.1 Gram of Sample (X = a trace)	435	530	215	194	294	190	960	202	48	863	X	225	X	X	100	683	351	210	356	X	X	68	241	161	100	22	259	200
14 B. inflata (d'Orbigny)	.2																											
15 Buliminella elegantisima (d'Orbigny)	.2						.2																					
16 Cassidulina islandica (Norvang)		19.	.9	1.0	10.		19.	13.		47.		10.				7.6	6.0	6.6	13.			2.9		12.			2.7	
17 C. norcrossi (Cushman)	.7	.5	6.															.47									3.1	
18 C. teretis (Tappan)	19.	12.	21.	41.	12.		14.	13.		7.		.47	X	X	X	.75			1.7					1.3			1.2	
19 Cibicides lobatulus (Walker & Jacob)	1.8	.7	1.4		1.0			1.5				22.	X	X	X	1.2	16.	9.5	14.	X				10.	13.			
20 C. refulgens (Montfort)	5.3	8.7	2.8	7.8	40.		13.	12.	X	27.	X	51.			X	19.	32.	36.	37.	X	X	38.	1.3	42.	29.	45.	45.	3.0
21 Dentalina frobisherensis (Loeblich & Tappan)							.2			.1						.10												
22 Eggerella advena (Cushman)	1.8	9.8	3.7	3.6	.68		3.5			.46		1.4				11.	2.2	.47	.56			21.	13.	2.5	24.		20.	
23 Elphidiella arctica (Parker & Jones)					.34		.62	1.0		2.8																		
24 E. cf. groenlandica (Cushman)																.29												
25 Elphidium advenum (Cushman)																.15											3.5	25.
26 E. bartletti (Cushman)	.67	.7					1.9			.23						7.0		1.9						13.				

TABLE II
(cont'd)

Station Number	8	9	10	11	12	13	14	15	16	17	18	19	20	22	23	25	26	27	28	29	30	31	32	33	35	38	39	40
Depth in Metres	95	110	114	120	110	40	75	56	84	80	24	24	36	60	56	30	30	28	24	40	46	24	18	32	14	30	14	-
Salinity ‰	32.30	32.38	31.58	32.41	32.45	31.96	32.10	32.03	32.16	32.23	31.89	31.92	31.85	32.10	31.92	31.85	31.90	32.10	31.91	31.95	31.96	31.89	32.00	31.84	31.64	31.64	31.74	-
Foraminifera No.1 Gram of Sample (X = a trace)	435	530	215	194	294	190	960	202	48	863	X	225	X	X	100	683	351	210	356	X	X	68	241	161	100	22	259	200
27 E. clavatum (Cushman)		12.		3.1	.7		16.	18.		1.2		4.7				19.	18.	26.				4.4		7.7		23.	17.	
28 E. Frigidum (Cushman)		.4			.7							.94					.5	1.4							1.4		.39	
29 E. incertum (Williamson)								.5								.15	.28	.47					X					
30 E. subarcticum (Cushman)	3.6	1.3		1.0			2.2	8.5		1.2						1.0												
31 Epistomina elegans (d'Orbigny)	X							X															.4					
32 Esosyrinx curta (Loeblich & Tappan)				X																								
33 Fissurina cucurbitasema (Loeblich & Tappan)							.1																					
34 F. marginata (Montagu)	2.2	1.3	.9		.34		2.6	3.0	X	1.6		.47				.15	1.1						1.6	2.5	2.9	2.9	2.3	.5
35 F. semimarginata (Reuss)		.18						.21																				
36 Glandulina laevigata (d'Orbigny)							.22	X																				
37 Globigerina bulloides (d'Orbigny)	1.6	2.4	.9				.93	1.0								.57	.94	.47				1.5					5.1	
38 G. pachyderma (Ehrenberg)										.23						3.0												
39 Globobulimina auriculata (Höglund)	4.7	1.7	6.0	4.7	.34		.31					.47																
40 Gyroidina soldani (d'Orbigny)																							.4					

TABLE II
(cont'd)

Station Number	8	9	10	11	12	13	14	15	16	17	18	19	20	22	23	25	26	27	28	29	30	31	32	33	35	38	39	40
Depth in Metres	95	110	114	120	110	40	75	56	84	80	24	24	36	60	56	30	30	28	24	40	46	24	18	32	14	30	14	-
Salinity %	32.30	32.38	31.58	32.41	32.45	31.96	32.10	32.03	32.16	32.23	31.89	31.92	31.85	32.10	31.92	31.85	31.90	32.10	31.91	31.95	31.96	31.89	32.00	31.84	31.64	31.64	31.74	-
Foraminifera No.1 Gram of Sample (X = a trace)	435	530	215	194	294	190	960	202	48	863	X	225	X	X	100	683	351	210	356	X	X	68	241	161	100	22	259	200
41 Hippocrepina indivisa (Parker)								.5																				
42 Hyperammina elongata (Brady)	.22		2.3				.21										.28								2.9			
43 Lagena cf. clavata (d'Orbigny)			X																						1.0			
44 L. flatulenta (Loeblich & Tappan)			.45																									
45 L. gracillima (Sequenza)	1.1		.9																				.4	2.5				
46 L. mollis (Cushman)			.5	.52																								
47 L. parri (Loeblich & Tappan)					.34																							
48 L. semilineata (Wright)	.22																											
49 Miliammina fusca (Brady)																												67.
50 Nonion labradoricum (Dawson)	4.2	4.1	14.	7.3	1.0		2.5	2.5		.23		.94															.39	
51 Nonionella auricula (Heron-Allen & Earland)	.88	.36	.90				.41	1.0											.28									
52 Oolina borealis (Loeblich & Tappan)	.44	.18			1.0		.62	.5		.23		1.4				.15		1.4							2.9		1.2	
53 O. caudigera (Wiesner)	.88	.18		.52			.21			.35						.29												
54 O. cf. hexagona (Williamson)					.34		.11			.12																		

TABLE II
(cont'd)

Station Number	8	9	10	11	12	13	14	15	16	17	18	19	20	22	23	25	26	27	28	29	30	31	32	33	35	38	39	40
Depth in Metres	95	110	114	120	110	40	75	56	84	80	24	24	36	60	56	30	30	28	24	40	46	24	18	32	14	30	14	-
Salinity %	32.30	32.38	31.58	32.41	32.45	31.96	32.10	32.03	32.16	32.23	31.89	31.92	31.85	32.10	31.92	31.85	31.90	32.10	31.91	31.95	31.96	31.89	32.00	31.84	31.64	31.64	31.74	-
Foraminifera No.1 Gram of Sample (X = a trace)	435	530	215	194	294	190	960	202	48	863	X	225	X	X	100	683	351	210	356	X	X	68	241	161	100	22	259	200
55 O. lineata (Williamson)												.47				.15												
56 O. scalariforme -sulcata (Wiesner)							.11																					
57 Patellina corrugata (Williamson)	.22	.18					.21																		1.0	1.0	.78	
58 Pateoris hauerinoides (Rhumbler)	.44																	.94					.4			14.		
59 Proteonina atlantica (Cushman)																.89			.47			10.				1.6	.5	
60 Psammatodendron aborescens (Norman)	2.0		.9		.68		.11																		1.0			
61 Pseudopolymorphina novangliae (Cushman)							.21										.85											
62 Pyrgo subspherica (d'Orbigny)																X												
63 Quinqueloculina agglutinata (Cushman)	.22		X														.28	.47	.28				.4					
64 Q. arctica (Cushman)		.54	2.3	.52			.31					1.4				.15												
65 Q. seminulum (Linné)	.67	.36					.21					3.7				1.9	3.1	2.4				5.9	1.6			13.6	.39	
66 Q. stalkeri (Loeblich & Tappan)							.72									.15							.8					
67 Recurvoides turbinatus (Brady)					.68																							
68 Reophax arctica (Brady)	1.8	2.4					.41																.4					

TABLE II
(cont'd)

Station Number	8	9	10	11	12	13	14	15	16	17	18	19	20	22	23	25	26	27	28	29	30	31	32	33	35	38	39	40
Depth in Metres	95	110	114	120	110	40	75	56	84	80	24	24	36	60	56	30	30	28	24	40	46	24	18	32	14	30	14	-
Salinity ‰	32.30	32.38	31.58	32.41	32.45	31.96	32.10	32.03	32.16	32.23	31.89	31.92	31.85	32.10	31.92	31.85	31.90	32.10	31.91	31.95	31.96	31.89	32.00	31.84	31.64	31.64	31.74	-
Foraminifera No.1 Gram of Sample (X = a trace)	435	530	215	194	294	190	960	202	48	863	X	225	X	X	100	683	351	210	356	X	X	68	241	161	100	22	259	200
69 R. curtus (Cushman)	3.6	1.3	7.4	4.2	2.1		.52			.12						.89	.28		1.1				5.0	1.3				4.0
70 R. gracilis (Kiaer)	.22																											
71 R. nana (Rhumbler)		X																										
72 R. pilulifera (Brady)			X																									
73 R. scorpiurus (Montfort)	1.1																											
74 R. scottii (Chaster)	.67	1.1	1.4	1.0			.10											.94					.4					
75 Robertinoides charlottensis (Cushman)												X																
76 Rosalina columbiensis (Cushman)							.10									.30	1.7	2.4										
77 Scutuloris tegminis (Loeblich & Tappan)																X												
78 Spiroplectammina biformis (Parker & Jones)	1.8	4.1	1.8	2.6			1.1									1.3						1.5	4.1				.39	
79 Triloculina trihedra (Loeblich & Tappan)		X														X						X						
80 Trochammina lobata (Cushman)																2.1	.85					2.9					13.3	
81 T. nana (Brady)																							2.9				.78	
82 T. rotaliformis (Wright)		.72	.9	1.0			.10															2.9			1.0		1.6	

TABLE II
(cont'd)

Station Number	8	9	10	11	12	13	14	15	16	17	18	19	20	22	23	25	26	27	28	29	30	31	32	33	35	38	39	40
Depth in Metres	95	110	114	120	110	40	75	56	84	80	24	24	36	60	56	30	30	28	24	40	46	24	18	32	14	30	14	-
Salinity ‰	32.30	32.38	31.58	32.41	32.45	31.96	32.10	32.03	32.16	32.23	31.89	31.92	31.85	32.10	31.92	31.85	31.90	32.10	31.91	31.95	31.96	31.89	32.00	31.84	31.64	31.64	31.74	-
Foraminifera No.1 Gram of Sample (X = a trace)	435	530	215	194	294	190	960	202	48	863	X	225	X	X	100	683	351	210	356	X	X	68	241	161	100	22	259	200
83 Trochamminella atlantica (Parker)																						1.5	.4		7.0			
84 Virgulina complanata (Egger)		.18																										
85 V. fusiformis (Williamson)	.67	3.9		3.1			1.0									.89											.39	
Percentage hyaline tests	64	70	73	67	74	100	72	88	100	83	X	75	X	71	100	66	72	77	62	X	X	50	48	74	64	60	68	50
Percentage porcelaneous tests	5	7	2				2					6				9	3	4	5			7	12	6	4	20	3	
Percentage arenaceous tests	31	23	25	33	26		26	12		17		19		29		25	25	19	33			43	40	20	32	20	29	50
Number of genera	27	25	27	20	18	3	32	17	3	16		10		6	3	24	21	18	14			13	18	10	17	5	22	6
Number of species	42	43	36	30	23	3	51	24	3	23		16		7	3	37	32	27	18			14	25	15	22	5	29	6

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