Preliminary Paleontologic Report on Cores 19A and 19B, from Russell Bank, Everglades National Park,

Florida Bay

by

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Open-File Report 97-460

1997

TABLE OF CONTENTS

FIGURES

TABLES

Preliminary Paleontologic Report on Cores 19A and 19B, from Russell Bank, Everglades National Park, Florida Bay

ABSTRACT

The fauna and flora preserved in two cores, 19A and 19B, from the south side of Russell Bank (N 25 03.831', W 80 37.486') in north-central Florida Bay, Everglades National Park, Florida, record a history of environmental change over the last century. The benthic foraminifera and molluscs indicate fluctuating salinities with increasing average salinity upcore in core 19B. Shifts from low salinity (12-15 ppt) to higher average salinity (30 ppt) occurred at 70-66 cm and 24-18 cm in core 19B (approximately 1937-1940 and 1975-1980). The inverse, shifts from periods of higher average salinity to periods of lower salinity, occurred at 140 cm, 90 cm, and 42 cm (approximately 1880, 1921, and 1960). Significant changes in the molluscan fauna indicative of specific substrate types occur at 88 cm, 68 cm, and 22 cm. The lower portion of the core is dominated by a mixture of sediment and grass dwellers, the middle portion by sediment dwellers, and the upper portion of the core by grass and finally grass and algae dwellers. Changes occur in the floral assemblages in core 19A, but the significance of these changes is unclear. Three subtle shifts occur in the pollen assemblages indicating the onshore vegetation was responding to some environmental factor. Two peaks in dinocyst abundance occur in core 19A, but the composition of dinocyst assemblages remains relatively stable throughout the core. Correspondence between changes in salinity and onshore vegetation changes is consistent with results from previous cores. The pattern of increased salinity upcore is consistent with patterns seen in core T24 from the mouth of Taylor Creek and in core 6A from Bob Allen mudbank.

INTRODUCTION

The fragile and unique ecosystems of southern Florida, including Florida Bay, the terrestrial Everglades, and Biscayne Bay, have been the focus of a substantial scientific effort in response to environmental, economic and political concerns. These concerns are focused on returning the Everglades to its "natural state" as mandated by the Everglades Forever Act (passed in 1994), while at the same time addressing the conflicting interests of the ever-growing population of southern Florida, the environmentalists, the farmers, and the tourist industry, among others. Consequently, Federal, State, and local jurisdictions are faced with decisions related to the ecosystem restoration goals, mediation of conflicting interests, and monitoring of change.

An essential part of the decision making process is to understand the history of the ecosystem prior to significant human alteration, and to separate natural variability in the ecosystem from human-induced change. The U.S. Geological Survey (USGS), in cooperation with National Oceanic and Atmospheric Administration (NOAA), South Florida Water Management District (SFWMD), the National Park Service (NPS), the Army Corps of Engineers (ACOE), and other Federal, State and local agencies, is conducting research to provide information on the history of the Everglades ecosystem over the last 150-200 years. The distribution of fauna and flora in a series of sediment cores taken throughout the Everglades ecosystem provides information on the biological, physical and chemical parameters of the system over time.

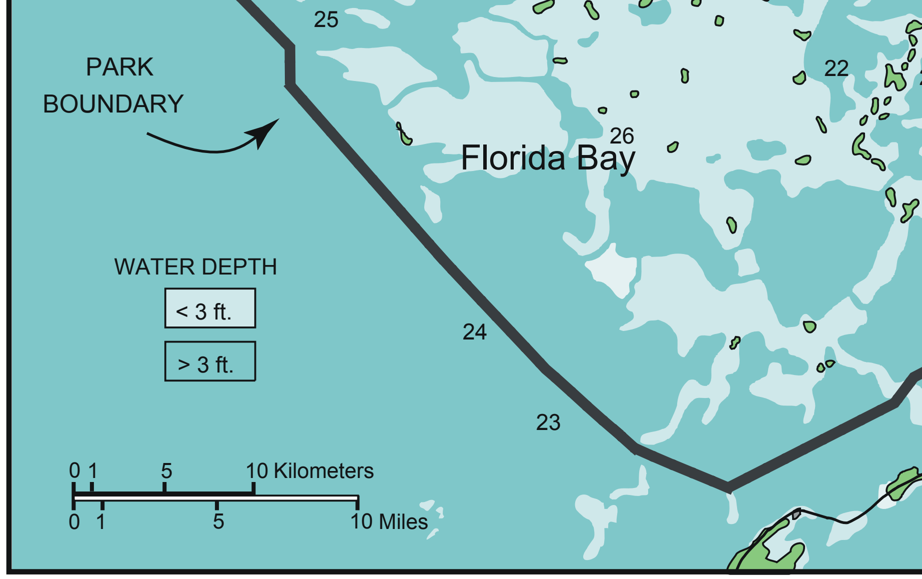
Sediment cores were taken in February of 1995 by researchers from the U.S. Geological Survey (St. Petersburg, FL), in cooperation with South Florida Water Management District (SFWMD) and the Everglades National Park (ENP), for use by USGS investigators conducting research in Florida Bay. Three cores were taken from the south side of Russell Bank (N 25 03.831’, W 80 37.486’) in north-central Florida Bay (Figure 1). Cores 19A and 19B are replicate cores, taken side by side from a grass bed in 0.51 m of water. Core 19C was taken 54 m north of 19A and 19B from a mud flat, on top of the south side of Russell Bank. Core 19A penetrated 140 cm of sediment, spanning approximately 115 years, and has been sampled for ^{210}Pb and palynologic analyses. Core 19B penetrated 144 cm of sediment, spanning approximately 118 years, and has been sampled for ^{210}Pb and calcareous fossil analyses. Core 19C penetrated 158 cm of sediment and has been sampled for ^{210}Pb analysis.

This report is produced by the "Ecosystem History of Florida Bay and the Southwest Coast" component of the U.S. Geological Survey’s Ecosystem Program, and is one of a series of USGS Open-File Reports on the distribution of biogenic components in sediments sampled from the southern Florida region. The data presented in these reports can be used to estimate changes in salinity, substrate, and other critical components of the ecosystem over time.

ACKNOWLEDGMENTS

We would like to thank Robert Halley and Gene Shinn, U.S. Geological Survey, St. Petersburg, FL, for collecting the cores and making them available to us for analysis. We would like to thank our colleagues at South Florida Water Management District, National Oceanic and Atmospheric Administration, and Everglades National Park for their cooperation and assistance in this investigation. We have benefited from discussions with William Lyons, Florida Marine Research Institute, St. Petersburg, FL; and Thomas Scott, Florida Geological Survey, Tallahassee, FL. Our reviewers, Thomas Cronin and John Sutter, U.S. Geological Survey, Reston, VA, provided helpful comments and suggestions to improve this manuscript.

Marci Marot, U.S. Geological Survey, St. Petersburg, FL, prepared the samples for isotopic and calcareous analysis. Assistance in sample processing was provided by Jill D’Ambrosio, Ian Graham, Lisa Weimer, Neil Waibel, Patrick Buchanan, Nancy Carlin, and Steve Wandrei of the U.S. Geological Survey, Reston, VA. Rob Stamm and Patrick Buchanan, U.S. Geological Survey, Reston, VA, assisted in the preparation of illustrations for this report and Jill D’Ambrosio assisted in compiling the final report.



PARK
BOUNDARY
Florida Bay
WATER DEPTH
< 3 ft.
> 3 ft.
0 1 5 10 Kilometers
0 1 5 10 Miles
25
26
22
24
23

METHODS OF INVESTIGATION

Benthic Foraminifers and Molluscs

Sediment samples from core 19B were collected at 2 cm intervals and every other sample, starting with 0-2 cm and totaling 34 samples, was analyzed for calcareous benthic fauna. The samples were washed through a 63µ m sieve and dried at <50 degrees C. When possible, a total of 300 benthic foraminifer specimens were picked from the sample and mounted on gridded micropaleontologic slides. Large samples were put through a sample splitter to randomly reduce the number of specimens. For samples containing fewer than 300 benthic foraminifer individuals, all of the specimens present were picked. Molluscs were picked from the >= 850µ m size fraction. All molluscs, and fragments of molluscs recognizable to the generic level, present in each interval were picked. Species abundances for the benthic fauna were standardized by calculating relative abundances (percent).

Pollen and Dinocysts

Material for palynological analysis was extracted from 1-2 cm sections of core 19A. For each palynological sample, 7-40 g of material (dry weight) was treated in hydrochloric and hydrofluoric acids and processed for palynological studies. All samples were treated with warm KOH for 2-5 minutes, given ultrasonic pulse treatment for 5 seconds, acetolysed, and sieved between 8-200µ m mesh. A tablet of *Lycopodium* marker grains was added to each sample. For most samples, at least 300 pollen grains were counted for calculation of percent abundances and absolute pollen concentration. To calculate absolute concentration of palynomorphs, the marker-grain method was used (Benninghoff, 1962; Maker, 1981, Stockmarr, 1971). For two samples, pollen was sparse enough that fewer than 300 grains were counted. For nine samples, one slide was completely examined for dinocysts and all dinocyst taxa were tabulated. For two samples (0-1 cm and 80-82 cm), two slides were examined completely for dinocysts.

Isotopic Analyses

Samples were collected every 2 cm from cores 19B and 19C and analyzed for ^{210}Pb, Ra, ^{137}Ce, ^{7}Be, and total Pb. Analysis of ^{210}Pb has been completed for 19B and Ra and ^{210}Pb have been completed for 19C. For details of the method see Robbins et al. (in press).

ANALYSIS AND DISCUSSION OF THE BENTHIC FAUNA IN CORE 19B

Benthic Foraminifers

A total of 31 benthic foraminiferal species were identified and counted. The foraminiferal data was standardized to relative abundance (percent of assemblage; Table 1) and was used for all quantitative analyses. Species diversity as measured by Simpson's Index ranged from 0.11 to 0.26, and the number of species ranged from 12 to 19.

The foraminiferal assemblages are dominated by calcareous benthic forms with the dominance patterns alternating between rotaliid taxa, *Ammonia parkinsoniana tepida*, *A. parkinsoniana typica*, *Elphidium galvestonense mexicanum*, *E. galvestonense typica*, and *E. poeyanum*; and miliolid taxa, *Miliolinella cirlcularis*, *M. labiosa*, *Quinqueloculina bosciana*, *Q. seminulum*, *Q. tenagos*, *Q. polygona*, *Q. poeyana*, and *Triloculina tricarinata*. Other significant species include *Archaias angulatus*, *Peneroplis proteus*, *Rosalina floridana* and *Quinqueloculina agglutinans*.

Two dominant assemblages can be identified in the cores, an *Ammonia-Elphidium* (*A-E*) assemblage and a miliolid assemblage. Observations of the foraminiferal faunal changes throughout core 19B show four intervals dominated by the miliolid assemblage (140 cm, 118-90 cm, 70-42 cm, and 18-0 cm), interrupted by three intervals of *A-E* assemblage dominance (140-118 cm, 90-70 cm, and 42-18 cm).

Molluscs

Twenty-six molluscan taxonomic categories were recognized and counted in the Russell Bank 19B core. The number of specimens per sample ranged from 2 to 517, so the faunal counts were standardized to relative percent abundance (Table 2). The Simpson's Diversity Index was calculated for each sample (Table 2). Three sections in the core contained few individual specimens (<40), and few molluscan taxonomic groups (1-9): 122-112cm, 62-52cm, 38-28cm. Two species, *Brachiodontes* sp. and *Transennella* sp. make up greater than 50 percent of the molluscan fauna in the entire core.

A cluster analysis of Pearsons Correlation coefficient values, calculated for the molluscan percent abundance data and plotted using average linkage method (Figure 2), revealed 3 primary divisions of the molluscan assemblages within the core: 142-68 cm, 68-22 cm, and 22-0 cm. The interval from 142-68 cm is dominated by *Transennella* sp., *Brachiodontes* sp., and *Cerithium* spp.; *Bittium varium*, *Rissoina* spp., and *Chione cancellata* also are present in significant amounts (5%) throughout the interval. The interval from 66-22 cm has the lowest within-group similarity of the three molluscan assemblages in the core and is represented by 2 clusters in the anlaysis. This interval from 66-22 cm contains 2 zones of very low molluscan abundance (62-52 cm and 38-28 cm). *Brachiodontes* sp. and *Cerithium* spp. dominate the 66-22 cm interval, with a number of other species present in significant amounts (10%) in individual samples (see Table

Table 1
Russell Bank 19B
Percent Abundance of Benthic Foraminifera

Depth in Core	*Ammonia parkinsoniana tepida*	*Ammonia parkinsoniana typica*	*Archaias angulatus*	*Bolivina lowmani*	*Bolivina pseudoplicata*	*Clavulina tricarinata*	*Cyclogyra planorbis*	*Elphidium delicatulum*	*Elphidium galvestonense typicu*	*Elphidium galvestonense mexic*	*Elphidium poeyanum*	Grass dweller	*Miliolinella circularis*	*Miliolinella fichteliana*	*Miliolinella labiosa*	Nodosariidae	*Peneroplis proteus*	*Quinqueloculina agglutinans*	*Quinqueloculina bosciana*
0-2 cm	0.00	1.07	0.00	0.00	0.00	0.00	0.00	0.00	11.23	1.07	0.00	0.80	12.03	0.00	0.00	0.00	0.27	0.00	17.91
4-6 cm	0.00	0.98	1.64	0.00	0.00	0.00	0.00	0.00	9.18	3.28	0.00	0.33	7.87	0.00	0.00	0.00	0.00	0.66	14.43
8-10 cm	0.00	5.23	0.00	0.00	0.00	0.00	0.00	0.00	14.63	4.18	0.00	0.70	5.92	0.00	0.00	0.00	0.70	0.00	16.72
12-14 cm	0.00	6.42	5.20	0.00	0.00	0.00	0.00	0.00	8.87	13.76	0.00	0.00	6.73	0.00	0.31	0.00	0.92	0.61	7.65
16-18 cm	0.00	7.61	5.43	0.00	0.00	0.00	0.00	0.00	21.74	19.57	0.00	0.00	5.43	0.00	0.00	0.00	0.00	3.26	5.43
24-26 cm	0.00	8.88	1.64	0.00	0.00	0.00	0.00	0.00	5.59	10.86	0.00	0.66	3.29	0.33	0.00	0.00	0.66	3.95	21.71
28-30 cm	0.00	17.38	0.66	0.00	0.00	0.00	0.00	0.00	17.70	27.87	0.00	0.33	4.92	0.00	0.00	0.33	0.33	0.00	4.59
32-34 cm	0.00	12.94	1.29	0.00	0.00	0.00	0.00	0.00	19.74	19.09	0.00	0.00	3.88	0.00	0.00	0.00	0.00	0.00	30.10
36-38 cm	0.00	23.47	1.44	0.00	0.00	0.00	0.72	0.00	10.11	12.27	0.00	0.72	2.17	0.72	0.00	0.00	0.00	0.72	24.55
40-42 cm	0.00	5.56	0.65	0.00	0.00	0.00	0.65	0.00	12.42	0.00	0.00	1.96	7.52	0.00	0.00	0.00	0.00	0.33	35.62
44-46 cm	0.00	5.25	0.31	0.00	0.00	0.00	0.93	0.00	12.65	5.56	0.00	1.54	7.41	0.00	0.00	0.00	0.00	1.85	25.62
48-50 cm	0.00	9.94	0.00	0.00	0.29	0.00	0.29	0.00	0.00	31.29	0.00	1.75	2.92	0.00	0.00	0.00	0.00	0.29	24.27
52-54 cm	0.00	6.64	0.00	0.35	0.00	0.00	1.40	0.00	13.64	6.99	0.00	3.85	6.99	0.00	0.00	0.00	0.00	0.00	25.52
56-58 cm	0.00	2.81	1.12	0.00	0.00	0.00	0.56	0.00	11.80	5.34	0.00	8.71	9.27	0.00	0.00	0.00	0.00	0.56	23.88
60-62 cm	0.00	9.75	1.44	0.00	0.00	0.00	0.36	0.00	9.03	17.33	0.00	3.25	7.22	0.00	0.00	0.00	0.00	0.72	22.74
64-66 cm	0.00	7.67	1.84	0.00	0.00	0.31	0.61	0.00	7.06	16.26	0.00	2.76	7.36	0.00	0.00	0.00	0.61	1.23	14.42
68-70 cm	0.00	15.36	0.31	0.00	0.00	0.63	0.00	0.00	9.72	31.03	0.00	0.63	13.48	0.00	0.00	0.00	0.00	0.00	4.39
72-74 cm	0.00	16.91	3.44	0.00	0.00	0.00	0.00	0.00	12.61	24.36	0.00	0.86	8.02	0.00	0.00	0.00	0.00	1.15	8.60
76-78 cm	0.00	14.67	3.67	0.00	0.00	0.00	0.00	0.00	9.00	37.67	0.00	0.00	5.00	0.00	0.67	0.00	0.00	0.00	2.67
80-82 cm	0.00	19.21	2.13	0.00	0.00	0.00	0.00	0.00	7.93	39.94	0.00	0.00	2.13	0.00	0.00	0.00	0.00	1.22	0.30
84-86 cm	0.00	20.97	0.32	0.00	0.00	0.00	0.00	0.00	8.06	34.19	11.29	0.00	2.26	0.00	0.00	0.00	0.00	0.00	1.61
88-90 cm	0.00	18.64	0.34	0.00	0.00	0.00	0.00	0.00	0.00	39.32	11.53	0.00	2.37	0.00	0.00	0.00	0.34	0.34	1.02
92-94 cm	0.00	3.29	0.33	0.00	0.00	0.00	0.00	0.00	7.57	12.17	23.03	0.00	9.21	0.00	0.00	0.00	0.00	0.33	7.89
96-98 cm	0.00	5.38	0.28	0.00	0.00	0.00	0.00	27.20	6.52	11.33	0.00	0.00	7.37	0.00	0.00	0.00	0.00	0.00	14.16
100-102 cm	0.00	11.48	0.33	0.00	0.00	0.00	0.00	22.30	0.00	25.90	0.00	0.00	5.90	0.00	0.00	0.00	0.00	0.00	2.95
104-106 cm	0.00	6.35	1.59	0.00	0.00	0.00	0.00	20.32	3.17	13.33	0.00	0.00	7.94	0.00	0.00	0.00	0.63	1.27	15.56
108-110 cm	0.00	16.55	3.38	0.00	0.00	0.00	0.00	4.39	2.70	26.01	0.00	0.00	12.50	0.68	0.00	0.00	0.00	3.38	0.00
112-114 cm	0.80	4.79	1.33	0.00	0.00	0.00	0.00	0.00	17.29	10.64	0.00	0.00	15.96	0.27	0.00	0.00	0.53	1.33	19.41
116-118 cm	0.00	11.81	1.39	0.00	0.00	0.00	0.00	0.00	28.47	20.14	0.00	0.00	9.72	0.00	0.00	0.00	0.00	0.00	2.43
120-122 cm	0.00	17.61	0.66	0.00	0.00	0.00	0.00	0.00	20.93	22.92	0.00	0.00	5.32	0.00	0.00	0.00	0.00	0.66	0.00
124-126 cm	0.00	31.42	4.53	0.00	0.00	0.60	0.00	1.21	0.00	43.50	0.00	0.00	2.42	0.00	0.00	0.00	0.00	2.42	0.00
128-130 cm	0.00	27.86	3.52	0.00	0.00	0.00	0.00	5.28	0.00	41.64	0.00	0.00	5.87	0.00	0.00	0.00	0.00	4.11	0.29
132-134 cm	0.00	17.05	1.29	0.00	0.00	0.00	0.00	9.04	2.33	31.78	0.00	0.00	9.56	0.00	0.00	0.00	0.00	0.52	3.10
136-138 cm	0.00	8.43	4.21	0.00	0.00	0.00	0.00	8.99	3.93	12.36	0.00	0.00	24.44	0.00	0.28	0.00	0.84	1.97	4.49
140-142 cm	0.00	20.32	5.81	0.00	0.00	0.00	0.00	0.00	6.45	39.03	0.00	0.00	6.45	0.00	0.00	0.00	0.00	2.90	0.00

Table 1
Russell Bank 19B
Percent Abundance of Benthic Foraminifera

Depth in Core	*Quinqueloculina seminulum*	*Quinqueloculina tenagos*	*Quinqueloculina polygona*	*Quinqueloculina poeyana*	*Rosalina floridana*	*Rosalina globularis*	*Spiroloculina antillarium*	*Triloculina lineiana*	*Triloculina rotunda*	*Triloculina trilocullina*	*Valvulina* sp.	*Valvulineria laevigata*	Number of Species	Simpson's Diversity Index
0-2 cm	13.37	1.07	4.81	32.35	2.14	0.00	0.27	0.00	0.00	1.60	0.00	0.00	14	0.19
4-6 cm	5.25	0.00	12.79	39.34	0.66	0.00	0.98	0.00	0.00	2.62	0.00	0.00	14	0.21
8-10 cm	7.32	2.79	2.44	32.75	0.35	0.00	0.00	0.00	0.00	6.27	0.00	0.00	13	0.18
12-14 cm	3.67	1.53	2.14	28.75	0.92	0.00	0.00	0.00	0.31	10.09	0.00	2.14	17	0.14
16-18 cm	2.17	0.00	6.52	14.13	0.00	0.00	1.09	0.00	0.00	7.61	0.00	0.00	12	0.13
24-26 cm	2.30	9.54	6.91	14.80	0.99	0.00	0.00	0.00	4.93	1.64	0.00	1.32	18	0.11
28-30 cm	8.85	0.00	3.93	10.82	2.30	0.00	0.00	0.00	0.00	0.00	0.00	0.00	13	0.17
32-34 cm	0.00	0.00	6.47	5.83	0.65	0.00	0.00	0.00	0.00	0.00	0.00	0.00	9	0.19
36-38 cm	0.72	2.89	2.17	13.72	0.00	0.00	0.00	0.00	2.17	1.08	0.36	0.00	17	0.16
40-42 cm	10.46	1.63	1.63	19.93	0.65	0.00	0.00	0.00	0.65	0.00	0.00	0.33	15	0.20
44-46 cm	6.48	3.40	3.70	23.77	1.54	0.00	0.00	0.00	0.00	0.00	0.00	0.00	14	0.16
48-50 cm	3.22	1.75	1.17	16.37	2.05	0.00	0.00	0.00	2.05	2.34	0.00	0.00	15	0.20
52-54 cm	2.45	1.40	0.00	27.97	1.40	0.00	0.00	0.00	0.00	1.40	0.00	0.00	13	0.18
56-58 cm	3.65	0.00	1.69	26.69	0.56	0.00	0.00	0.00	0.00	3.37	0.00	0.00	14	0.16
60-62 cm	10.11	1.81	3.97	12.27	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	13	0.13
64-66 cm	5.21	2.15	7.06	19.33	2.45	0.00	0.00	0.00	1.23	2.15	0.00	0.31	19	0.11
68-70 cm	8.78	0.00	0.00	13.17	2.19	0.00	0.00	0.00	0.00	0.31	0.00	0.00	12	0.18
72-74 cm	2.01	0.86	4.01	11.46	1.15	0.00	0.00	0.00	0.00	4.01	0.00	0.57	15	0.14
76-78 cm	6.67	0.00	4.67	11.00	1.33	0.00	0.00	0.00	0.00	2.67	0.00	0.33	13	0.20
80-82 cm	5.49	0.00	6.71	7.32	0.00	0.00	0.00	0.00	2.13	4.88	0.00	0.61	13	0.22
84-86 cm	2.90	0.00	0.32	15.16	0.00	0.00	0.00	0.00	0.97	1.94	0.00	0.00	12	0.21
88-90 cm	8.81	0.00	5.08	7.80	0.00	0.00	0.00	0.00	1.36	2.71	0.00	0.34	14	0.22
92-94 cm	19.08	0.99	2.96	11.84	1.32	0.00	0.00	0.00	0.00	0.00	0.00	0.00	13	0.14
96-98 cm	8.78	0.00	2.27	10.20	1.70	0.00	1.42	0.00	3.40	0.00	0.00	0.00	13	0.14
100-102 cm	15.41	0.00	4.26	7.87	0.33	0.00	0.66	0.00	1.97	0.66	0.00	0.00	13	0.17
104-106 cm	12.38	0.00	2.22	13.97	0.95	0.32	0.00	0.00	0.00	0.00	0.00	0.00	14	0.13
108-110 cm	10.14	0.34	5.74	7.77	0.00	0.00	0.00	0.00	2.36	3.38	0.00	0.68	15	0.14
112-114 cm	9.84	0.00	2.93	10.11	2.13	0.00	0.00	0.00	1.33	0.80	0.00	0.53	17	0.13
116-118 cm	16.32	1.04	2.08	4.86	0.35	0.00	0.00	0.00	0.35	1.04	0.00	0.00	13	0.18
120-122 cm	20.93	0.00	1.66	5.65	1.00	0.00	0.00	0.00	0.33	1.00	1.33	0.00	13	0.18
124-126 cm	0.00	2.72	2.42	3.93	0.00	0.00	0.00	0.30	0.91	3.63	0.00	0.00	13	0.30
128-130 cm	0.00	0.29	2.35	3.23	0.29	0.00	0.00	0.00	0.59	4.11	0.00	0.59	14	0.26
132-134 cm	11.11	0.00	2.07	6.20	0.52	0.00	0.00	0.00	3.36	2.07	0.00	0.00	14	0.17
136-138 cm	9.83	1.40	2.53	9.55	1.69	0.00	0.00	0.00	1.12	2.53	0.00	1.40	18	0.12
140-142 cm	2.58	0.32	4.19	5.48	0.00	0.00	0.65	0.00	0.65	2.58	0.00	2.58	14	0.21

Table 2
Russell Bank 19B
Percent Abundance of Molluscan Fauna

Depth in Core	Gastropods	*Acteocina canaliculata*	*Amaea* spp.	*Bittium varium*	*Bulla* sp.	*Caecum puchellum/floridanum*	*Cerithidea* spp.	*Cerithium* spp.	*Conus* sp.	*Crepidula* sp.	Marginellids	*Modulus modulus*	*Olivella* sp.	*Rissoina* spp.	*Turritella exoleta*	Vitrinellids	Rare Gastropods	Unidentified gastropod fragments, unknown sp., and juveniles
0-2 cm		0.00	0.00	1.28	0.00	1.47	0.00	5.68	0.00	0.73	0.92	1.83	0.00	2.20	0.00	0.37	0.37	0.55
4-6 cm		0.00	0.00	3.47	0.00	0.87	0.00	7.23	0.00	1.16	1.16	3.47	0.00	1.45	0.00	1.16	1.16	2.60
8-10 cm		0.00	0.00	1.72	0.00	0.00	0.00	2.59	0.00	0.00	0.86	5.17	0.00	3.45	0.00	3.45	0.86	3.45
12-14 cm		0.00	0.00	2.44	0.00	2.44	0.00	4.88	0.00	0.00	0.61	2.44	2.44	4.88	2.44	0.00	0.61	3.66
16-18 cm		0.00	0.00	2.44	0.00	0.00	0.00	6.10	0.00	1.22	0.00	1.22	1.22	8.54	0.00	0.00	1.22	3.66
20-22 cm		0.00	0.00	2.70	1.35	1.35	0.00	2.70	0.00	1.35	0.00	0.00	0.00	1.35	0.00	0.00	1.35	2.70
24-26 cm		1.72	0.00	3.45	0.00	3.45	1.72	15.52	0.00	6.90	0.00	0.00	1.72	1.72	0.00	0.00	0.00	1.72
28-30 cm		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
32-34 cm		0.00	0.00	7.14	7.14	0.00	0.00	21.43	0.00	0.00	0.00	7.14	0.00	7.14	0.00	0.00	0.00	0.00
36-38 cm		0.00	0.00	21.43	0.00	0.00	0.00	35.71	3.57	0.00	0.00	3.57	10.71	0.00	0.00	0.00	0.00	10.71
40-42 cm		0.00	0.00	12.37	5.15	0.00	0.00	18.56	0.00	3.09	0.00	1.03	2.06	4.12	0.00	0.00	1.03	4.12
44-46 cm		0.00	0.00	2.15	0.00	0.00	0.00	8.60	0.00	0.00	0.00	6.45	1.08	9.68	0.00	1.08	0.00	4.30
48-50 cm		0.00	0.00	11.11	0.00	0.00	0.00	18.52	0.00	0.00	0.00	5.56	0.00	7.41	0.00	0.00	0.00	7.41
52-54 cm		0.00	0.00	0.00	0.00	0.00	0.00	8.11	0.00	0.00	0.00	43.24	0.00	2.70	0.00	0.00	0.00	5.41
56-58 cm		0.00	0.00	0.00	0.00	10.00	0.00	40.00	0.00	40.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
60-62 cm		0.00	0.00	3.13	0.00	0.00	0.00	0.00	6.25	0.00	0.00	0.00	0.00	6.25	0.00	0.00	3.13	18.75
64-66 cm		0.00	0.00	8.00	2.00	1.00	0.00	14.00	0.00	3.00	1.00	2.00	0.00	3.00	0.00	0.00	0.00	4.00
68-70 cm		0.00	0.00	15.69	0.00	1.96	0.00	17.65	0.00	3.92	1.96	1.96	0.00	9.80	0.00	0.00	3.92	5.88
72-74 cm		0.00	0.00	19.18	0.00	1.37	0.00	19.18	0.00	6.85	0.00	1.37	0.00	0.00	0.00	0.00	0.00	5.48
76-78 cm		0.00	0.00	5.62	0.00	0.00	0.00	11.24	0.00	0.00	5.62	3.37	2.25	5.62	1.12	0.00	0.00	16.85
80-82 cm		0.00	0.00	4.14	0.00	0.00	0.00	5.52	0.00	0.00	1.38	0.69	1.38	0.00	1.38	0.00	0.00	9.66
84-86 cm		0.00	0.00	9.33	0.00	4.00	0.00	13.33	2.67	1.33	0.00	2.67	2.67	5.33	0.00	0.00	0.00	13.33
88-90 cm		0.00	0.00	2.19	0.00	0.00	0.00	16.06	0.00	0.00	0.00	0.00	2.92	8.03	2.19	0.00	1.46	15.33
92-94 cm		0.00	0.00	4.32	0.00	1.44	0.00	10.07	0.00	0.00	0.00	0.72	2.88	5.04	1.44	0.00	0.00	9.35
96-98 cm		3.03	0.00	1.52	0.00	1.52	0.00	13.64	0.00	1.52	0.00	0.00	1.52	7.58	1.52	0.00	3.03	1.52
100-102 cm		0.00	0.00	0.00	0.00	1.38	0.00	4.83	0.00	0.00	0.69	0.00	2.07	3.45	0.00	0.00	0.00	4.83
104-106 cm		0.00	0.67	7.38	0.00	0.67	1.34	16.11	0.67	0.00	1.34	0.00	1.34	4.70	0.67	0.00	1.34	4.70
108-110 cm		0.00	2.38	7.14	0.00	0.00	0.00	9.52	0.00	0.00	0.79	0.00	3.97	11.90	0.79	0.00	1.59	18.25
112-114 cm		2.86	0.00	8.57	0.00	0.00	0.00	17.14	0.00	2.86	0.00	2.86	0.00	0.00	0.00	0.00	0.00	11.43
116-118 cm		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	20.00
120-122 cm		0.00	0.00	3.45	0.00	3.45	0.00	6.90	0.00	0.00	0.00	0.00	3.45	6.90	10.34	0.00	0.00	3.45
124-126 cm		0.75	0.00	9.70	0.00	0.00	1.49	13.43	0.00	0.75	0.00	8.21	2.24	3.73	1.49	1.49	1.49	2.24
128-130 cm		0.00	1.43	2.57	0.00	0.86	0.00	8.57	0.00	1.14	0.86	0.86	0.00	2.86	0.29	0.00	0.29	5.71
132-134 cm		0.00	0.00	7.23	0.00	0.00	0.00	12.05	0.00	0.00	0.00	0.00	1.20	4.82	6.02	0.00	0.00	10.84
136-138 cm		0.51	0.51	7.69	0.51	1.03	1.03	6.15	0.00	0.00	1.03	0.00	1.03	0.00	2.56	1.03	2.56	4.10
140-142 cm		0.55	0.00	6.56	0.00	0.00	0.00	7.10	0.55	1.09	0.00	0.00	3.83	6.01	1.09	0.00	0.00	8.74

Table 2
Russell Bank 19B
Percent Abundance of Molluscan Fauna

Depth in Core	Pelecypods	*Anomalocardia* sp.	*Arcopsis adamsi*	*Brachiodontes* sp.	*Chione cancellata*	*Cumingia tellinoidea*	*Laevecardium* spp.	*Nucula proxima*	Pectinid	*Pinctada radiata*	*Tellina* spp.	*Transennella* spp.	Rare Pelecypods	Unidentified Pelecy. Frags.	Total number of individual specimens	Number of faunal groups	Simpsons Diversity Index
0-2 cm		0.00	0.18	70.33	0.73	0.55	0.00	0.00	0.00	12.64	0.00	0.00	0.18	0.00	517	16	0.52
4-6 cm		0.00	1.16	64.16	0.87	0.00	0.00	0.00	0.00	9.54	0.00	0.00	0.29	0.29	331	16	0.43
8-10 cm		0.00	0.00	73.28	0.86	0.00	0.00	0.00	0.00	2.59	0.00	0.00	0.00	1.72	49	12	0.55
12-14 cm		0.00	1.83	57.32	2.44	0.61	0.00	0.00	0.00	10.37	0.00	0.00	0.00	0.61	145	16	0.35
16-18 cm		0.00	0.00	57.32	3.66	1.22	0.00	0.00	0.00	2.44	0.00	7.32	0.00	2.44	62	14	0.35
20-22 cm		0.00	0.00	77.03	0.00	0.00	0.00	0.00	0.00	0.00	0.00	2.70	0.00	5.41	62	11	0.60
24-26 cm		0.00	0.00	24.14	3.45	0.00	1.72	0.00	0.00	1.72	1.72	17.24	0.00	12.07	50	16	0.14
28-30 cm		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	50.00	0.00	50.00	2	2	0.50
32-34 cm		0.00	0.00	14.29	14.29	0.00	0.00	0.00	0.00	0.00	0.00	21.43	0.00	0.00	12	8	0.15
36-38 cm		0.00	0.00	14.29	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	28	7	0.22
40-42 cm		0.00	1.03	41.24	3.09	0.00	0.00	0.00	1.03	2.06	0.00	0.00	0.00	0.00	97	14	0.23
44-46 cm		0.00	4.30	9.68	46.24	1.08	0.00	0.00	0.00	0.00	1.08	0.00	0.00	4.30	93	13	0.25
48-50 cm		0.00	9.26	9.26	3.70	9.26	0.00	0.00	1.85	9.26	3.70	0.00	0.00	3.70	54	13	0.10
52-54 cm		0.00	0.00	27.03	0.00	2.70	0.00	0.00	0.00	8.11	0.00	0.00	0.00	2.70	37	8	0.28
56-58 cm		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	10.00	10	4	0.34
60-62 cm		0.00	0.00	50.00	0.00	0.00	3.13	0.00	0.00	3.13	0.00	0.00	0.00	6.25	32	9	0.30
64-66 cm		0.00	0.00	29.00	1.00	0.00	1.00	0.00	10.00	9.00	2.00	3.00	1.00	6.00	100	18	0.14
68-70 cm		0.00	0.00	5.88	5.88	1.96	0.00	0.00	1.96	0.00	0.00	9.80	0.00	11.76	51	15	0.10
72-74 cm		0.00	0.00	19.18	5.48	0.00	0.00	2.74	0.00	0.00	0.00	19.18	0.00	0.00	73	10	0.16
76-78 cm		0.00	1.12	19.10	0.00	0.00	0.00	0.00	0.00	3.37	0.00	7.87	0.00	16.85	89	13	0.12
80-82 cm		0.00	2.07	26.90	8.97	0.00	0.00	0.00	0.00	1.38	0.00	24.14	3.45	8.97	145	14	0.16
84-86 cm		0.00	0.00	8.00	9.33	0.00	0.00	0.00	0.00	2.67	0.00	12.00	0.00	13.33	75	14	0.10
88-90 cm		4.38	0.00	4.38	6.57	0.73	0.00	0.00	0.00	0.00	0.73	28.47	0.00	6.57	137	14	0.15
92-94 cm		2.16	2.88	7.19	6.47	0.00	0.72	0.00	0.00	5.04	0.00	27.34	0.00	12.95	139	16	0.13
96-98 cm		1.52	0.00	6.06	4.55	0.00	1.52	0.00	0.00	0.00	0.00	45.45	0.00	4.55	66	16	0.24
100-102 cm		0.00	0.00	12.41	4.83	0.00	0.00	0.00	0.00	0.00	0.00	48.97	0.00	16.55	145	10	0.29
104-106 cm		6.71	0.00	0.67	1.34	0.00	0.00	0.00	0.00	0.67	0.00	36.24	0.00	13.42	149	18	0.19
108-110 cm		0.00	0.00	7.14	2.38	0.00	0.79	1.59	0.00	1.59	0.00	23.02	0.00	7.14	126	16	0.13
112-114 cm		0.00	0.00	0.00	5.71	0.00	0.00	0.00	0.00	0.00	0.00	37.14	0.00	11.43	35	9	0.21
116-118 cm		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	60.00	0.00	20.00	5	3	0.44
120-122 cm		0.00	0.00	27.59	0.00	0.00	0.00	0.00	0.00	0.00	0.00	20.69	0.00	13.79	29	10	0.16
124-126 cm		3.73	0.00	8.21	6.72	0.75	0.75	0.00	0.00	2.24	0.00	24.63	0.00	5.97	134	20	0.12
128-130 cm		0.00	0.29	8.57	3.14	0.57	0.00	0.00	0.00	2.00	0.00	54.29	0.29	5.43	350	19	0.32
132-134 cm		0.00	0.00	6.02	9.64	2.41	0.00	1.20	0.00	2.41	0.00	20.48	0.00	15.66	83	13	0.12
136-138 cm		0.00	1.03	9.23	9.23	0.00	2.56	2.05	0.00	3.08	1.03	31.79	0.00	10.26	195	22	0.14
140-142 cm		0.00	1.09	19.67	6.56	1.09	0.00	0.55	0.00	2.73	0.00	31.15	0.00	1.64	183	17	0.16

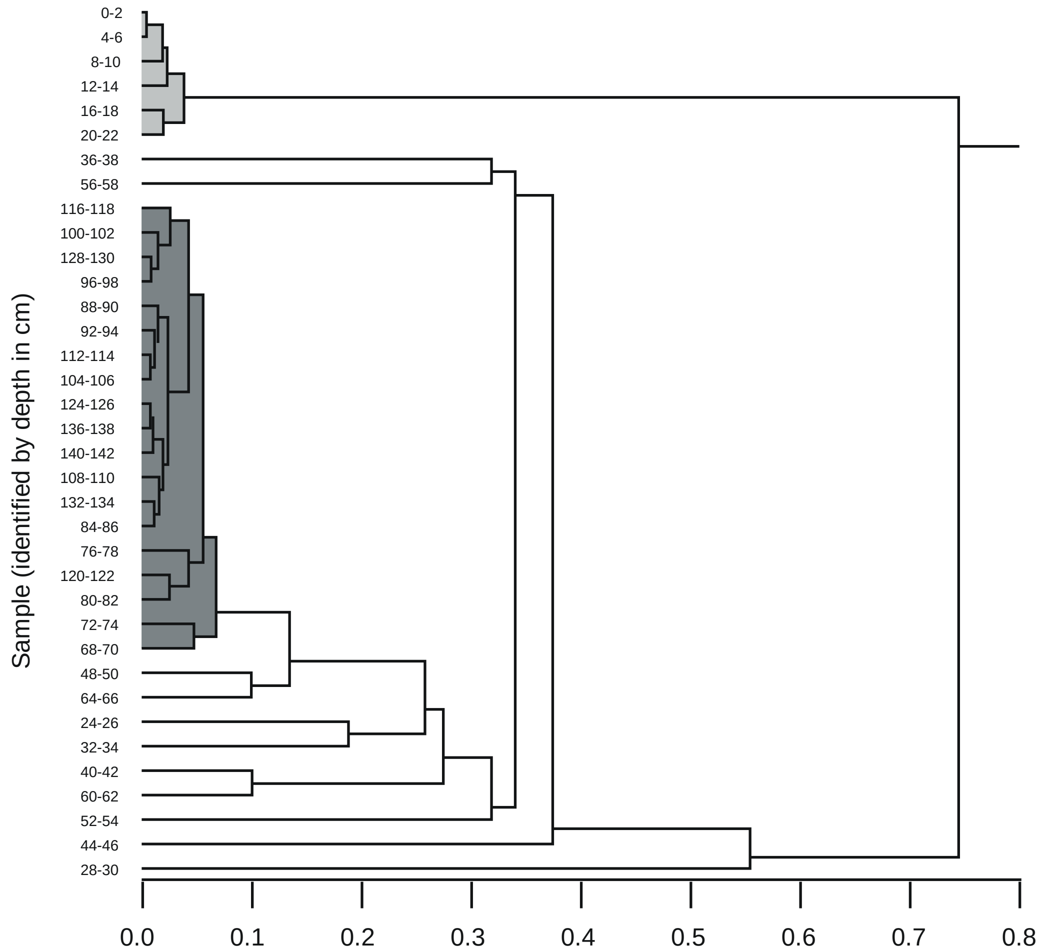


Figure 2: Q-mode cluster diagram of molluscan assemblages from core 19B. Distances are expressed as Pearsons Correlation coefficient values, calculated on the molluscan percent abundance data (see Table 2) and plotted using average linkage method. Shaded areas represent clusters formed by samples from the upper portion of the core (0-22 cm) and the lower portion of the core (68-142 cm).

2). The cluster containing samples from the interval from 22-0 cm has high Pearsons Correlation coefficient values for within-group similarity, and the largest between-group distances (see Figure 2). This upper portion of the core is dominated by *Brachiodontes* sp., which comprises greater than 50% of the molluscan assemblage in each sample from this section. *Pinctada radiata* and *Cerithium* spp. are present in significant amounts (5%) in some samples from 22-0 cm.

Benthic Faunal Patterns

Comparison of the benthic fauna present in core 19B with our modern data set, enables us to interpret the salinity history for the Russell Banks site. The foraminiferal and molluscan records from core 19B show distinct oscillations in salinity, with a gradual increase in salinity toward the top of the core (Figure 3). In addition, a positive correlation (ρ =0.52) exists between increasing Simpson diversity indices and decreasing salinity for the benthic foraminfera.

The two dominant foraminiferal assemblages, *Ammonia-Elphidium* and miliolid, are very similar to the *Ammonia-Elphidium* and *Archaias*-miliolid assemblages described from modern Florida Bay sediments (Brewster-Wingard et al., 1996). The distribution of modern benthic foraminifers in Florida Bay shows a strong association between the occurrence of *A. parkinsoniana* and *E. galvestonense mexicanum* and *typica* with salinities less than 25 ppt (Brewster-Wingard et al., 1996). Conversely, miliolids dominate where salinities are near normal marine values (30 ppt). The intervals dominated by the miliolid assemblage (140 cm, 118-90 cm, 70-42 cm, and 18-0 cm) therefore indicate more stable and relatively higher average salinity (32-35 ppt). These segments are interrupted by three periods of *A-E* assemblage dominance (140-118 cm, 90-70 cm, and 42-18 cm), indicating unstable and relatively low average salinity (<32 ppt).

Molluscs are not as sensitive to variations in salinity as benthic foraminifers, consequently, the molluscan data do not show the degree of fluctuation seen in the foraminiferal data (Figure 3). The general trend of increasing percent abundance of euhaline and euhaline-polyhaline molluscs upcore does follow the general trend of the foraminiferal plot, showing a gradual increase in salinity upcore. No molluscan faunas restricted to terrestrial, fresh water, marsh, or upper estuarine environments are present in core 19B, indicating this area has been relatively open bay over the last century, and the salinity has probably not dropped below 12-15 ppt.

Both the benthic foraminiferal assemblages and the molluscan assemblages show significant changes between 70-66 cm and between 24-18 cm. These zones correspond to shifts from *A-E* dominated assemblages to miliolid dominated assemblages, but the molluscs do not seem to respond significantly to the decreases in salinity that mark the shift from miliolid assemblages back to *A-E* assemblages. Almost all of the molluscs present in this core can be classified as polyhaline and are tolerant of a wide range of salinities (from approximately 12 or 15 ppt to 30-35 ppt), which could explain the patterns seen for the molluscs. If, however, the salinity had dropped below ~15ppt during the periods of *A-E* dominance, then the molluscs would most likely have shown a response. The areas of A-E dominance in the core represent salinities of 15-25 ppt, with the lower number delineated by the absence of species of molluscs found in low salinity waters of Florida Bay and the upper number constrained by the presence of low salinity benthic foraminifera. The miliolid dominated zones represent salinities of 30 ppt or higher.

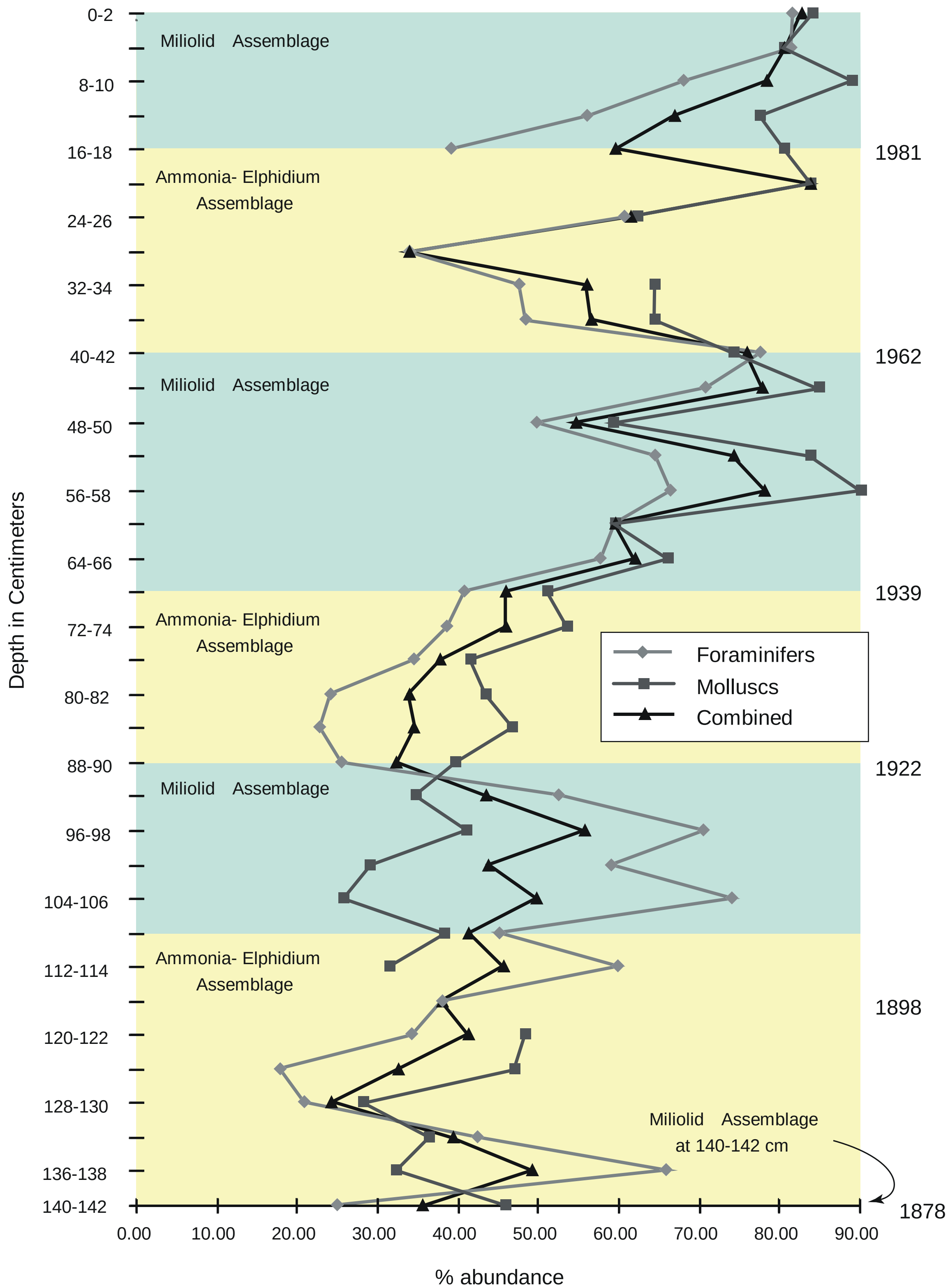


Figure 3: Plot of percent abundance of benthic foraminifers, molluscs and the two data sets combined that indicate increasing salinity for core 19B. The benthic foraminifers indicate salinity > 30 ppt. The mollusc species have wider salinity tolerances; the species illustrated on this plot are classified as euhaline or euhaline/polyhaline and represent salinities of 20-25 ppt or greater. The positions of the benthic foraminiferal assemblages (*Milliolid*-gray; *Ammonia-Elphidium*-white) discussed in the text are shown on the right of the plot.

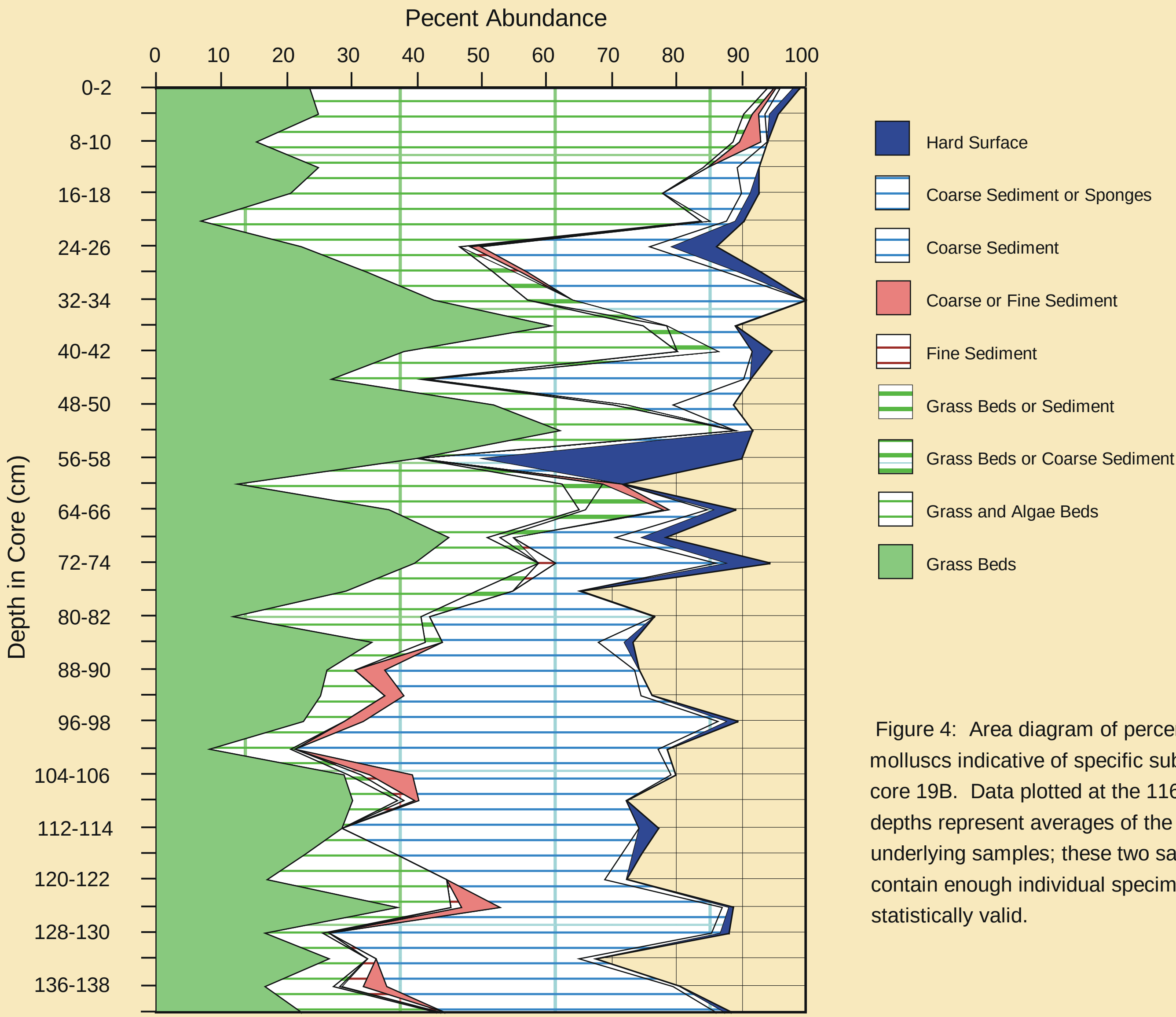


Figure 4: Area diagram of percent abundance of molluscs indicative of specific substrate types for core 19B. Data plotted at the 116 cm and 28 cm depths represent averages of the overlying and underlying samples; these two samples did not contain enough individual specimens to be statistically valid.

The suite of molluscs present in core 19B is more indicative of changes in substrate than changes in salinity. Figure 4 illustrates the substrate patterns within the core, based on the percent abundance of molluscs known to prefer those substrate types. The lowest portion of the core, from 142-110 cm has significant numbers of both sediment dwellers and grass dwellers present, with dominance of either group fluctuating. From 106-88 cm sediment dwellers dominate, although grass dwellers are still present in significant numbers. The segment from 88-22 cm is dominated by grass dwellers; above 68 cm the presence of species indicative of a sediment substrate is negligible. The uppermost portion of the core, from 22 cm to the top, is dominated by species that could live on either algae or grass.

The shifts in abundance of molluscan substrate indicators at 88 cm, 68 cm, and 22 cm correspond to changes seen in the benthic foraminiferal salinity indicators, but at this point the significance of this relationship is not understood. However, since the benthic foraminifers used for salinity indicators are not sensitive to changes in substrate, we believe the changing foraminiferal patterns reflect changing salinity.

ANALYSIS AND DISCUSSION OF THE FLORA IN CORE 19A

Pollen

The percent abundance data on pollen is presented in Table 3. Three pollen zones are distinguishable based on both percent abundance and absolute pollen concentration (pollen grains/gram dry sediment). The bottom zone (140-80 cm) is characterized by the highest percentages of *Pinus* (pine) pollen (80-90%), and the lowest percentages of *Quercus* (oak) (<6%), and pollen of the Chenopodiaceae/Amaranthaceae (pigweed family) and Asteraceae (aster family) (Figure 5). No pollen of the Cyperaceae (sawgrass family) is present in this zone. Total pollen concentration in this zone and the middle zone ranges from about 500-1,200 grains/gram, and the concentration of *Quercus* pollen is lower than the other zones, with <50 grains/gram (Figure 6).

The middle zone (80-32 cm) is characterized by lower percentages of *Pinus* pollen (54-73%), higher percentages of *Quercus* (6-10%), and higher concentrations of *Quercus* pollen (50-100 grains/gram). In both this and the upper zone, pollen of the Chenopodiaceae/Amaranthaceae and Asteraceae are more abundant, comprising 3% and 2% of the assemblages, respectively. Pollen of the Cyperaceae is present in low percentages in this and the upper zone.

The upper zone has the highest pollen concentrations of the core, with most samples ranging from 1,200-4,600 grains/gram. Several taxa contribute to these higher values, including *Pinus*, *Quercus*, *Myrica* (wax myrtle), Chenopodiaceae/Amaranthaceae, and Asteraceae. *Cephalanthus* (buttonbush) is present in low abundances (<1%) in this zone, and *Liquidambar* (sweet gum) is absent from this zone.

Table 3
Russell Bank 19A
Percent Abundance of Pollen

Depth in core	*Alnus*	Apiaceae	Asteraceae	*Avicennia*	*Betula*	*Bumelia*	*Bursera simaruba*	*Carya*	*Casuarina*	*Celtis*	*Cephalanthus*	Chenopodiaceae/ Amaranthaceae	*Conocarpus*	Cyperaceae	*Decodon*	Ericaceae	Euphorbiaceae	Fabaceae	*Fraxinus*	*Ilex*	*Juglans*
0-1 cm	0.00	0.00	2.55	0.00	0.00	0.00	0.00	0.00	4.82	0.00	0.28	4.25	0.00	0.00	0.00	0.00	0.00	1.42	0.00	0.00	0.00
4-5 cm	0.57	0.00	2.01	0.00	0.00	0.00	0.00	0.29	1.15	0.00	0.29	2.87	0.29	1.15	0.00	0.00	0.29	0.57	0.00	0.29	0.29
8-9 cm	0.32	0.00	3.22	0.00	0.00	0.00	0.00	0.00	1.29	0.00	0.32	0.96	0.00	0.64	0.00	0.00	0.00	0.32	0.00	0.00	0.00
20-21 cm	0.00	0.00	4.09	0.31	0.00	0.00	0.00	0.00	3.14	0.00	0.63	5.97	0.00	0.00	0.00	0.00	0.00	2.20	0.00	0.00	0.00
32-34 cm	0.30	0.00	3.32	0.00	0.30	0.30	0.00	0.00	2.11	0.00	0.00	3.32	0.30	0.30	0.00	0.00	0.00	1.21	0.00	0.30	0.30
44-46 cm	0.80	0.00	7.77	0.00	0.00	0.00	0.00	0.27	2.14	0.00	0.00	4.29	0.00	0.80	0.00	0.00	0.27	1.07	0.00	0.54	0.00
56-58 cm	0.31	0.00	4.39	0.00	0.00	0.00	0.00	0.31	1.57	0.00	0.00	6.90	0.00	0.63	0.00	0.63	0.00	0.94	0.31	0.00	0.00
68-70 cm	1.68	0.00	2.51	0.00	0.28	0.00	0.28	0.84	0.56	0.00	0.00	3.07	0.00	0.56	0.00	0.00	0.00	0.84	0.00	0.00	0.00
80-82 cm	0.00	0.00	2.38	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	4.76	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
92-94 cm	0.54	0.00	0.54	0.00	0.00	0.27	0.00	0.82	0.27	0.00	0.00	0.54	0.00	0.00	0.00	0.00	0.00	0.82	0.27	0.00	0.00
104-106 cm	0.00	0.29	1.15	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	2.30	0.00	0.00	0.57	0.00	0.00	1.15	0.00	0.00	0.00
116-118 cm	0.62	0.00	0.62	0.00	0.00	0.00	0.00	0.00	0.00	0.31	0.00	1.85	0.31	0.00	0.00	0.00	0.00	0.62	0.00	0.00	0.00
128-130 cm	0.00	0.00	0.61	0.00	0.00	0.00	0.00	0.30	0.00	0.00	0.00	0.91	0.00	0.00	0.00	0.30	0.00	0.61	0.00	0.00	0.00
136-138 cm	0.60	0.00	0.60	0.30	0.00	0.30	0.60	1.81	0.00	0.00	0.00	0.91	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
138-140 cm	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.81	0.00	0.00	0.00	2.44	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

Table 3
Russell Bank 19A
Percent Abundance of Pollen

Depth in core	*Liquidambar*	*Magnolia*	*Myrica*	*Nyssa*	*Ostrya/ Carpinus*	*Pinus*	*Planera*	Poaceae	*Quercus*	*Rhizophora*	Rutaceae	*Sagittaria*	*Salix*	Taxodiaceae/ Cupressaceae/ Taxaceae	*Typha*	*Ulmus*	Total Pollen Counted
0-1 cm	0.00	0.00	2.83	0.00	0.28	68.56	0.00	0.28	10.76	0.28	0.00	0.28	0.00	0.00	0.00	0.57	353
4-5 cm	0.00	0.00	0.86	0.00	0.00	69.05	0.00	0.29	13.75	0.29	0.00	0.29	0.00	0.00	0.00	0.00	349
8-9 cm	0.00	0.00	2.25	0.00	0.00	73.95	0.00	0.32	9.32	0.96	0.32	0.32	0.32	0.00	0.96	0.32	321
20-21 cm	0.00	0.00	10.69	0.00	0.63	56.60	0.00	0.31	11.01	0.00	0.00	0.00	0.00	0.00	0.31	0.00	321
32-34 cm	0.30	0.00	8.46	0.00	0.00	67.37	0.00	0.30	6.34	0.00	0.00	0.00	0.30	0.30	0.30	0.00	332
44-46 cm	1.07	0.00	4.29	0.27	0.00	54.16	0.00	1.07	10.46	0.27	0.00	0.00	0.27	0.27	0.54	0.54	378
56-58 cm	0.00	0.31	3.76	0.00	0.00	63.95	0.00	0.31	6.90	0.94	0.00	0.31	0.31	0.31	0.63	0.31	320
68-70 cm	0.28	0.28	4.47	0.00	0.00	73.46	0.00	0.00	6.15	0.28	0.00	0.00	0.28	0.00	1.12	0.28	358
80-82 cm	1.19	0.00	3.57	0.00	0.00	79.76	0.00	0.00	5.95	0.00	0.00	0.00	0.00	0.00	0.00	0.00	85
92-94 cm	0.82	0.00	4.08	0.00	0.00	86.96	0.00	0.00	2.45	0.27	0.00	0.00	0.00	0.27	0.00	0.00	371
104-106 cm	0.29	0.00	7.47	0.00	0.00	80.17	0.00	0.29	3.16	0.57	0.00	0.00	0.00	0.29	0.29	0.00	350
116-118 cm	0.00	0.00	3.38	0.00	0.00	89.23	0.00	0.31	1.23	0.31	0.00	0.00	0.31	0.00	0.31	0.00	326
128-130 cm	0.30	0.00	3.96	0.00	0.00	86.28	0.00	0.30	4.57	0.00	0.00	0.00	0.30	0.00	0.00	0.00	331
136-138 cm	0.30	0.00	2.42	0.00	0.00	87.92	0.30	0.00	1.81	0.00	0.00	0.00	0.00	0.00	0.30	0.00	332
138-140 cm	0.81	0.00	1.63	0.00	0.00	88.62	0.00	0.00	5.69	0.00	0.00	0.00	0.00	0.00	0.00	0.00	123

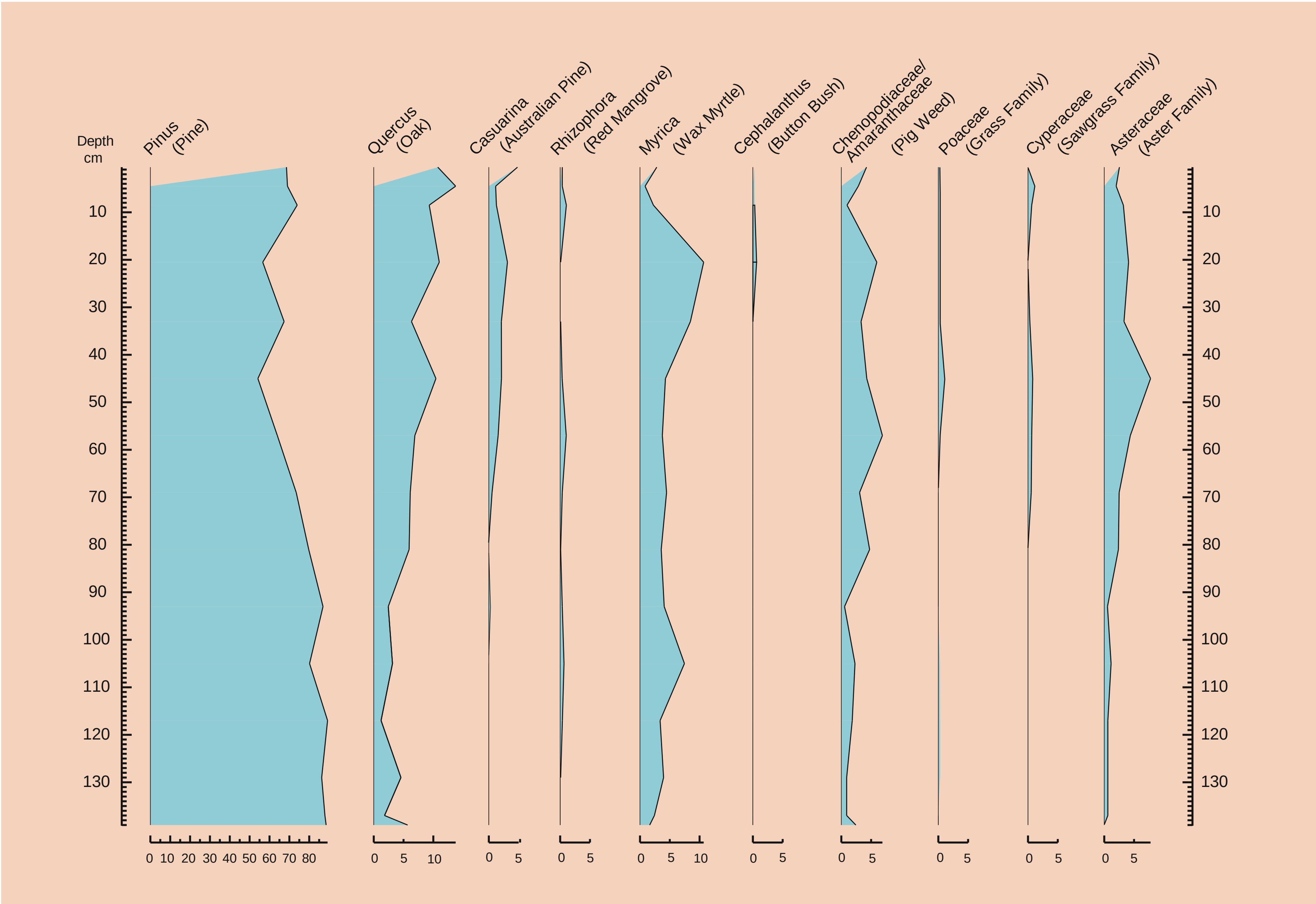


Figure 5. Percent abundance of selected pollen groups for core Russell Bank 19A (note different scales).

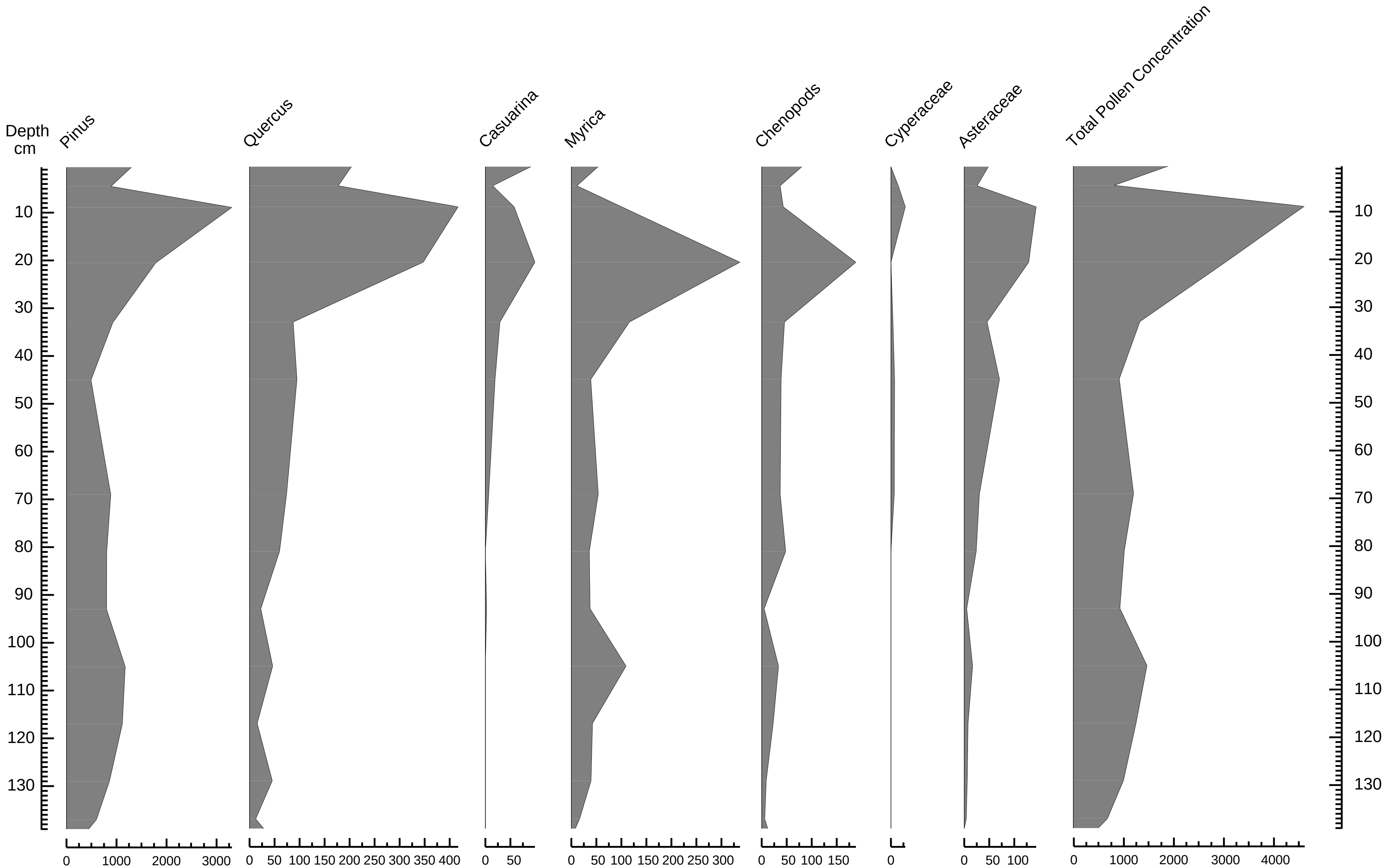


Figure 6: Total concentration of pollen (grains/gram) for core Russell Bank 19A (note different scales).

Dinocysts

Dinocyst recovery in all samples was low. Most microscope slides are heavily dominated by organic debris and the maximum number of specimens observed in any sample was 214. Absolute abundance ranges from 77.9 to 473.6 cysts/gram. These values are one to two orders of magnitude below those reported by Wall et al. (1977) for samples from the Middle Atlantic Bight and western South Africa and are consistent with high sedimentation rates. These absolute abundances in the sediments are far below bloom concentrations, in which the number of living cells per ml of water may exceed 50 million.

The dinocyst assemblages in the Russell Bank 19A core consist of less than 10 taxa (Table 4). Various species of the genus *Spiniferites* Mantell dominate all samples (61 to 79 percent). Due to poor preservation and taxonomic difficulties the individual species of this genus were not differentiated; *S. mirabilis* (Rossignol) Sarjeant, S. *ramosus* (Ehrenberg) Mantell, *S. scabratus* (Wall) Sarjeant, and other forms are present. *Operculodinium* Wall spp. (*O. israelianum* (Rossignol) Wall or *Operculodinium* species undifferentiated) are present in all samples in amounts of 5 to 19 percent. *Polysphaeridium zoharyi* (Rossignol) Bujak et al. is present in all samples and comprises up to 16 percent of the assemblages. Most samples included low numbers of *Lingulodinium machaerophorum* (Deflandre & Cookson) Wall, *Nematosphaeropsis rigida* Wrenn, and (or) *Tectatodinium pellitum* Wall. Only two samples contained a single specimen each of the family Congruentidiaceae.

Most samples from Russell Bank core 19A are quite similar to one another (Figure 7). Throughout the core, the dinocyst *Polysphaeridium zoharyi* ranges in abundance from 0-16 percent, which is considerably lower than in the Bob Allen 6A (Wingard et al., 1995) and Little Madeira Bay T24 (Ishman et al., 1996) cores. With one exception (80-82 cm), increased absolute abundance of *Spiniferites* spp. is accompanied by increased absolute abundance of *P. zoharyi* (Figure 8). This relationship suggests that absolute abundances in this core are a function of sediment supply rather than cyst production. The sample at 80-82 cm is anomalous: the high absolute abundance of cysts is attributable to *Spiniferites* spp. and fewer than 30 total cysts were found on each slide. This sample may represent a case of an increase in *Spiniferites* cyst production and an increase in the amount of organic debris in proportion to sediment supply. The lowest samples (132-134 cm and 136-138 cm) show both low absolute abundances of all cyst types and low percentages of *P. zoharyi*.

Floral Patterns

Changes occur in the pollen and dinocyst assemblages in core 19A, but the significance of these changes is unclear. Three zones are distinguishable for the pollen, but the differences among them are very subtle, and any interpretation of patterns of vegetational change would be premature. However, it is apparent that the vegetation changed in response to some environmental factor at those times; correlation with on-shore cores would be necessary to establish the nature of the changes. Dinocyst abundance fluctuates in the core, with two peaks at 118-104 cm and 82-80 cm, but the assemblages are relatively stable throughout the core.

Table 4. Dinocyst data from Russell Bank 19A

Depth (cm)	Wt (g)	Cysts/g	Slides examined	*Polysphaeridium zoharyi*	*Spiniferites* spp.	*Operculodinium* spp.	*Nematosphaeropsis rigida*	*Lingulodinium machaerophorum*	*Tectatodinium pellitum*	*Tuberculodinium vancampoae*	Congruentidiaceae	Other	TOTAL DINOCYSTS COUNTED
			Species	Percent abundance									
0-1	7.4	77.9	2	12.9	74.2	9.7	0.0	3.2	0.0	0.0	0.0	0.0	31
20-21	11.5	136.3	1	12.3	63.0	7.4	4.9	4.9	6.2	0.0	1.2	0.0	81
44-46	36.3	92.1	1	2.4	75.0	9.5	3.6	4.8	1.2	0.0	0.0	3.6	84
68-70	35.8	145.4	1	11.4	70.5	9.5	1.0	3.8	2.9	0.0	1.0	0.0	105
80-82	33.7	373.2	2	1.9	81.1	13.2	0.0	3.8	0.0	0.0	0.0	0.0	53
92-94	38.5	204.9	1	8.4	72.0	11.9	4.9	2.8	0.0	0.0	0.0	0.0	143
104-106	33.1	473.6	1	12.8	63.6	13.3	7.7	1.0	0.5	0.0	0.0	1.0	195
116-118	35.0	345.1	1	14.1	67.6	10.6	0.7	6.3	0.7	0.0	0.0	0.0	142
128-130	39.0	185.4	1	12.1	61.2	17.8	5.1	2.8	0.5	0.5	0.0	0.0	214
132-134	32.1	128.8	1	3.4	75.4	12.7	6.8	1.7	0.0	0.0	0.0	0.0	118
136-138	37.1	202.8	1	6.6	74.7	11.0	5.5	1.1	1.1	0.0	0.0	0.0	91

Comparison of these data to additional terrestrial and marine cores may lead to a better understanding of the patterns seen here.

^{210}PB AGE MODEL FOR THE RUSSELL BANKS SITE

The activity of ^{210}Pb (dpm/gram) is shown for 19B and 19C in Figures 9 and 10. The sedimentation rate for the Russell Bank site is based on the results from 19C, because both ^{210}Pb and Ra analyses have been completed for that core; the rate equals 1.22 cm/year +/- 0.05. The ^{210}Pb curves for cores 19B and 19C are almost identical, therefore we make the assumption that the rate of sediment accumulation is the same in the two cores. No ^{210}Pb analyses have been done for core 19A to date.

SUMMARY

The fauna and flora present in the Russell Bank cores 19A and 19B record an approximately 120-year history of fluctuating environmental changes. The benthic foraminifera document periods of fluctuating salinity, with a gradual increase in salinity upcore. The molluscan data are consistent with the foraminiferal data, showing increasing salinity upcore, but without the degree of fluctuation indicated by the benthic foraminifera. The benthic fauna show significant changes in the assemblages at 70-66 cm and 24-18 cm, which correspond to approximately 1937-1940 and 1975-1980. A similar shift occurred at 118 cm (approximately 1898), which is not as clearly seen in the molluscan faunal data. These periods represent shifts from low salinity (12-15 ppt) to higher average salinity (30 ppt). In addition, the benthic foraminiferal assemblages shift from periods of higher average salinity, to periods of lower salinity at 140 cm, 90 cm, and 42 cm, which correspond to approximately 1880, 1921, and 1960 respectively.

The molluscan fauna indicate changes occurring in the substrate at the Russell Banks site. Sediment and grass (probably *Thalassia*) apparently were equally available for habitation from 142-110 cm, or approximately 1878-1904. Although grass was still available, bare-sediment dominated the area from 106-88 cm, or approximately 1908-1922. From 88-22 cm, or approximately 1922-1976, grass was the dominant substrate, and from approximately 1939 (68 cm) to the present, the presence of bare-sediment bottoms was negligible at the site. Significantly, from 22 cm, or approximately 1976 to the present, the molluscan fauna is dominated by species that can live equally well on algae or seagrass.

The pollen present in core 19A show three periods of subtle shifts in the onshore vegetation in response to some environmental factor. These changes occur at 80 cm and at 32 cm, or approximately 1929 and 1968. If we assume that core 19A and 19B have similar sedimentation rates, then the shifts in the onshore vegetation indicated by the pollen seen in 19A occur approximately 7-8 years prior to changes in Florida Bay as indicated by the benthic fauna in 19B. However, until we see this pattern repeated in the same core or until a ^{210}Pb analysis is

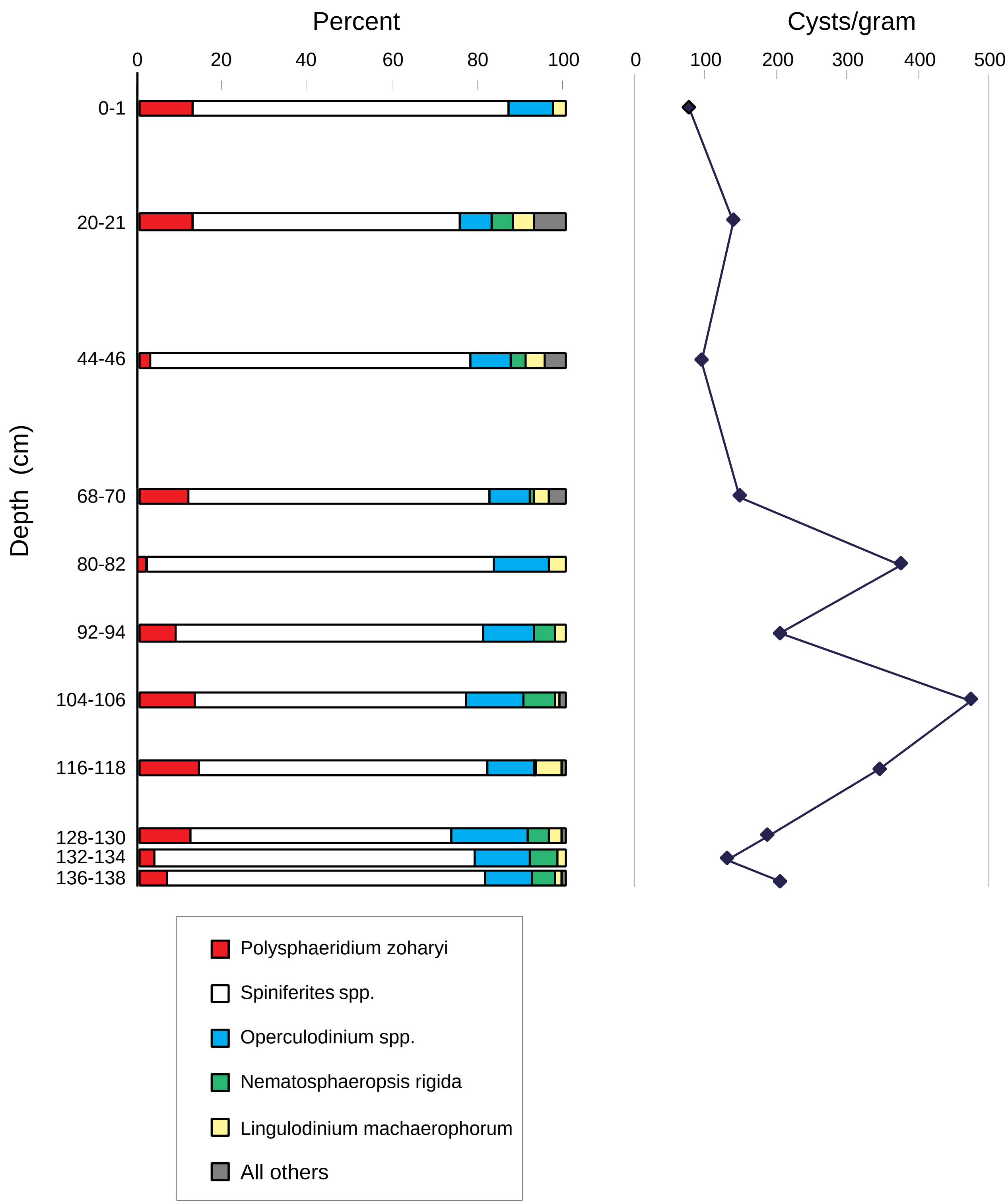


Figure 7. Percent and absolute abundances of dinocysts for core 19A.

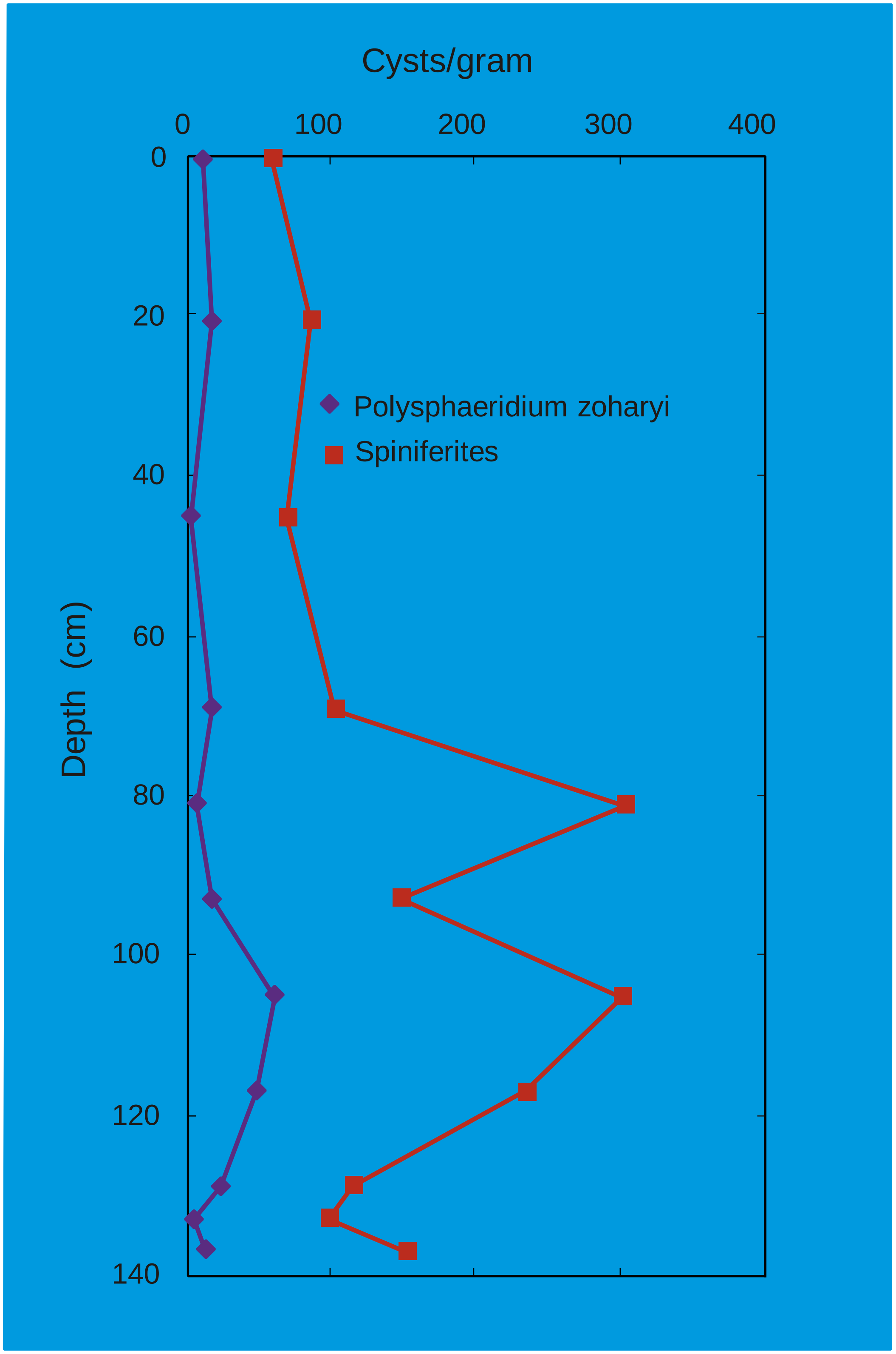


Figure 8. Absolute abundances of *Polysphaeridium zoharyi* and *Spiniferites* spp. in core 19 A

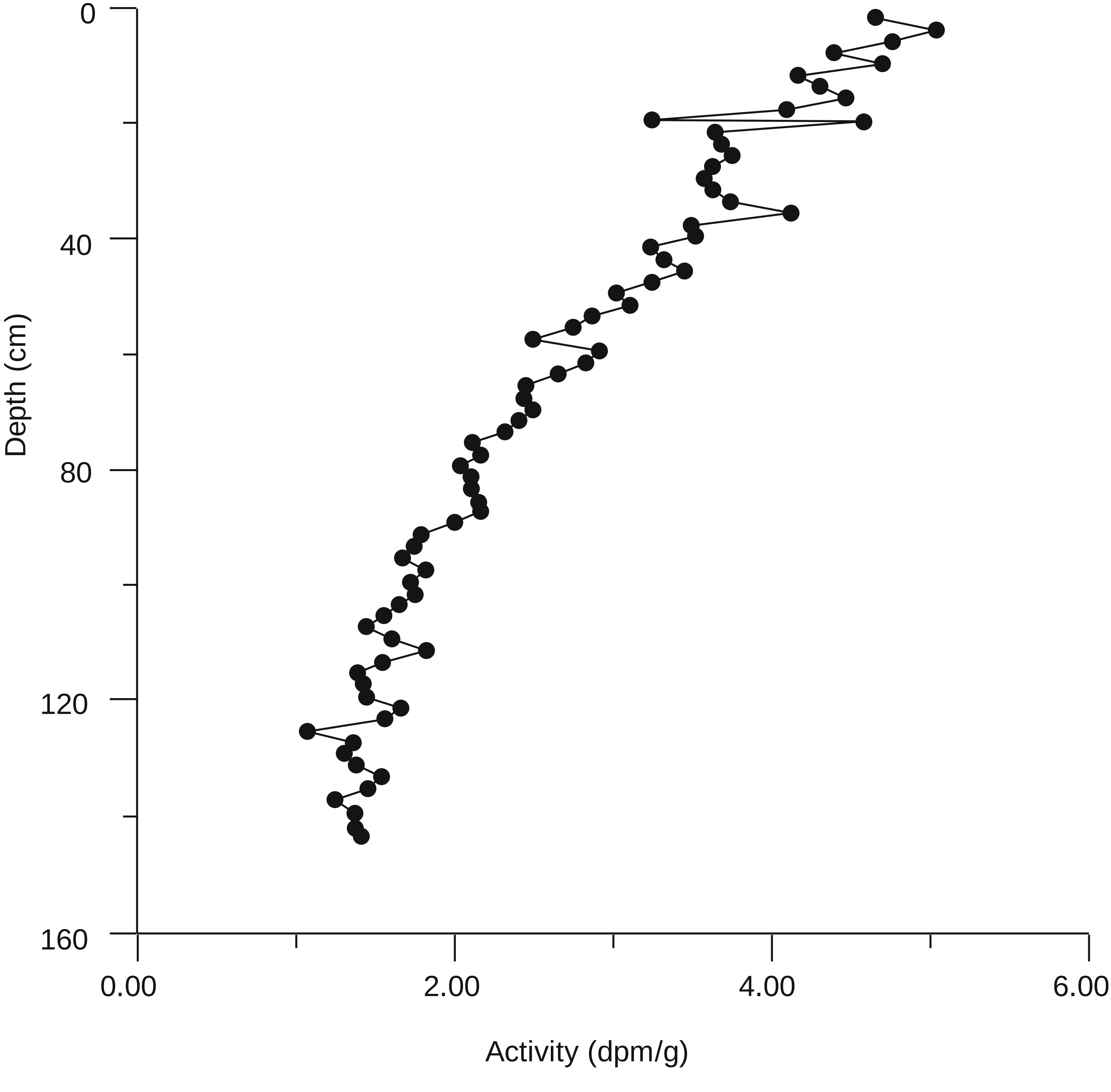


Figure 9: Pb^{210} activity in dpm/g for core 19B

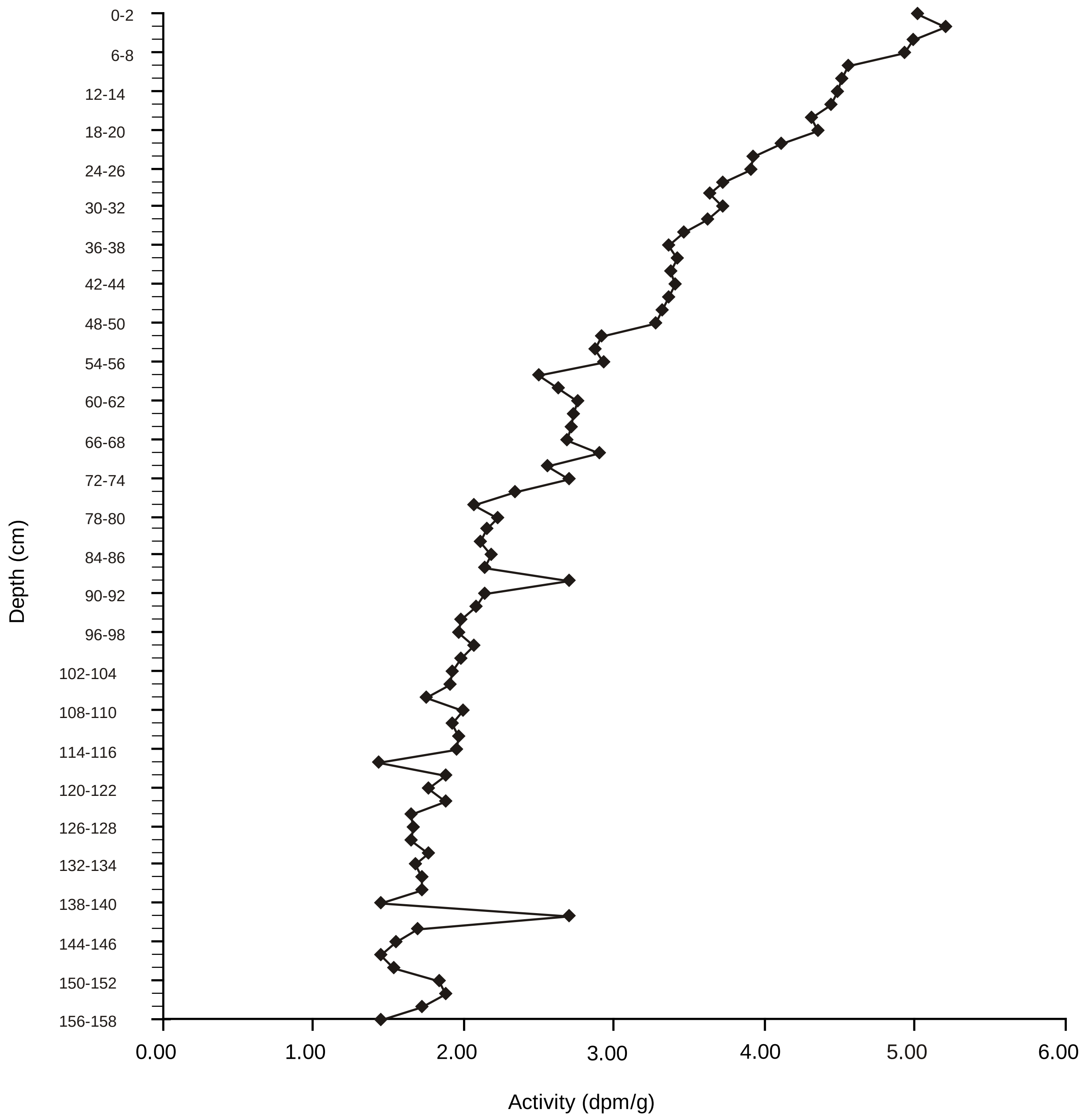


Figure 10: ^{210}Pb activity in dpm/g for core 19C.

completed for core 19A, we can not be certain of its significance because our assumption of similar sedimentation rates for cores 19A and 19B may not be correct.

Two peaks in dinocyst abundance (cysts/gram) occur in the samples examined: 118-104 cm (approximately 1898-1909) and 82-80 cm (approximately 1927-1929). These occur during a period of near normal marine (30 ppt) and stable salinity, as indicated by the benthic foraminifera. These periods may represent increased dinocyst production and decreased sediment supply, but the composition of the dinocyst assemblages remains relatively stable throughout the core.

The pattern of increased salinity upcore, documented here for Russell Banks 19B, is consistent with patterns seen in core T24 from the mouth of Taylor Creek in Little Madeira Bay (Ishman et al., 1996), and in core 6A from Bob Allen mudbank (Wingard et al., 1995). The correspondence between changes in salinity and onshore changes in vegetation is also consistent with results from the previous cores. These patterns will continue to be investigated at additional sites in Florida Bay and the terrestrial Everglades in order to establish the sequence and timing of events throughout the ecosystem, and to determine linkages between the marine and terrestrial systems.

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