Seasonal Changes in Foraminifera at Seahorse Key

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LONG term fluctuations in shallow-water foraminiferal populations have received little attention (Phleger, 1960a, 1960b; Parker and Athearn 1959; Lynts, 1966). Our study was initiated in 1963 to determine the seasonal fluctuations in populations of calcareous foraminifers at Seahorse Key, one of a group of small islands comprising the Cedar Keys in the northeast Gulf of Mexico.

Seahorse Key is situated 25 km south of the Suwannee River and 5 km south of the town of Cedar Key, Levy County, Florida (29°07′N, 83°05′W; Fig. 1). The keys are predominantly a series of mangrove islands, sand hills, shell mounds, or complexes of all three separated by tidal channels. Scattered among these islands are oyster-bars and shallow, shifting sand banks.

Topography of the Cedar Keys is controlled by a regular limestone plain, the "Ocala Limestone" of late Eocene age, gently sloping seaward, on which all of the keys rest unconformably. Seahorse Key is composed of relatively pure quartz sand presumably transported to the area during the Pleistocene; sediment analyses indicate that this island is more than likely a remnant windbuilt dune (Brooks, pers. comm.). Alongshore drift currents prevalent in the fall and winter are now the major erosional agents in this region. The presence of this island, as well as others in the group, results largely from the stabilizing influence of vegetation (*Rhizophora* spp.).

PROCEDURES

From September 1963 through August 1964 monthly samples were collected during daylight hours at each of five marked stations selected as being representative of the littoral benthos of this island (Fig. 1). Stations 1-3 were in unconsolidated lutites influenced by circulating tidal currents. Station 4 was adjacent to an oyster-bar comprised wholly of *Crassostrea virginica* Gmelin. Station 5 was on a sandy bank populated by the sand dollar *Mellita quinquiesperforata* (Leske).

Monthly samples from each station were obtained over an area of less than 1 m^2. This method of sampling obviated the problems

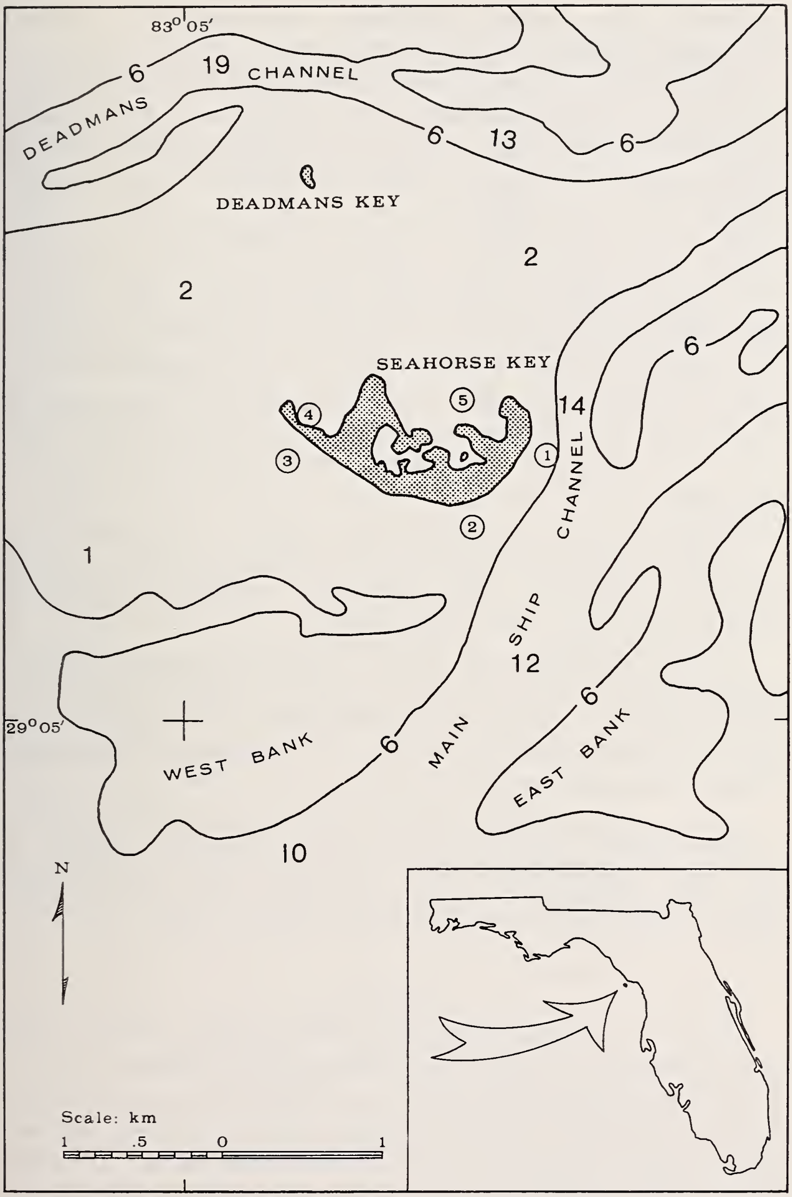

Fig. 1. Collecting stations (circled) at Seahorse Key, Florida. Bottom topography based on U.S.G.S. Seahorse Key Quadrangle (7.5 minute series, 1955). Datum mean low water; soundings in feet.

associated with sampling over larger lateral distances (Shifflett, 1961; Lynts, 1966).

Samples were collected with a punch corer constructed from a beverage can, one end of which was removed and a hole punched in the center of the other. The can was inserted manually into the sediment, open end first, to a depth of about 8 cm. A cork stopper was placed in the punched hole and, as it was lifted, a partial vacuum was created sufficient to retain the sample intact. The open end was then sealed, the cork stopper removed, and about 50 ml of rose bengal solution added through the punched hole (Walton, 1952: 56). In the laboratory the sample was extruded, and the top 3 mm (vol. = 10.0 cm^3) sliced off and wet sieved through standard 5 and 170 mesh sieves. The 170 mesh fraction was washed into an evaporating dish, dried, and then floated in CCl_4 (Glaessner, 1963: 41). The foraminiferal concentrates thus obtained were stored in glass vials.

Temperature was measured with a calibrated centigrade thermometer *in situ* at the substrate-water interface. Salinity was computed from temperature corrected density readings obtained with a hydrometer (Zerbe and Taylor, 1953).

A portable Beckman pH meter was used to measure both Eh and pH, with a calomel reference electrode. A glass electrode was used for pH and a platinum for Eh readings. Readings were obtained at the water-sediment interface by introducing the electrodes directly (Mannheim, 1961).

Light penetration was measured only in the vicinity of Station 1 with a photometer adapted for marine use (Pettersson and Landberg, 1934). Readings were taken at depths of one and two meters with a standard red camera filter, and without a filter.

RESULTS

Maximum tidal range at Seahorse Key normally did not exceed 1.3 m during our period of observation. Tidal variation in excess of 1.6 m at Seahorse Key exposes an area 200-300 meters wide with isolated tide pools. During spring tides Stations 1-3 were exposed, Station 4 was rarely and Station 5 was never exposed. However, when on-shore high winds prevail tidal variation is retarded. Because shallow banks surround the island wave action is minimal.

The pH readings are below the normal range of pH in ocean

TABLE 1

Values of pH and Eh obtained during 1964

Station 4	Salinity ppt	pH	Eh
March	28.5	7.50	–370 mv
April	28.4	7.30	–355 mv
May	31.0	7.90	–380 mv
June	28.8	7.60	–390 mv

waters, which is attributable to the influx of fresh water from the Suwannee River and drainage from mainland tidal marshes. Water in the Suwannee River is comprised principally of highly acidic drainage (pH=5.0-6.0) from the Okefenokee Swamp. Seepage from the Ocala Limestone aquifer directly into the sea may also account in part for variation in pH.

Measurements of Eh give only a general indication of oxidation-reduction activity. Because of difficulties encountered in obtaining measurements, the readings presented may understate natural environmental conditions (Mannheim, 1961). In spite of limitations in technique, it can be said that the bottom at Station 4 is highly reducing, but significantly less so at the other stations.

Water temperature at Seahorse Key ranged from 11.5-31.5 C, with slightly lower and higher temperatures occurring for short periods during the study year (Fig. 2). Temperatures as high as 39 C were recorded at the water-sediment interface at stations exposed during the time of summer spring tides.

Salinity ranged from 28.4 to 34.6 ppt. High salinities were recorded in the winter when flow from the Suwannee River is reduced and northwest winds predominate, pushing water from the Gulf of Mexico shoreward. In the spring and summer the volume of water carried by the Suwannee River increases, the prevailing winds are from the southeast, and precipitation increases thus accounting for reduced salinities during that season.

Light penetration measurements and visual observations indicate that the water is not clear at any time during the year. Since the surrounding banks are very shallow and the substrata are unconsolidated, tidal currents provide enough energy to keep sediments suspended. In addition, a large amount of flocculated organic material is continually introduced by the Suwannee and Waccasassa Rivers.

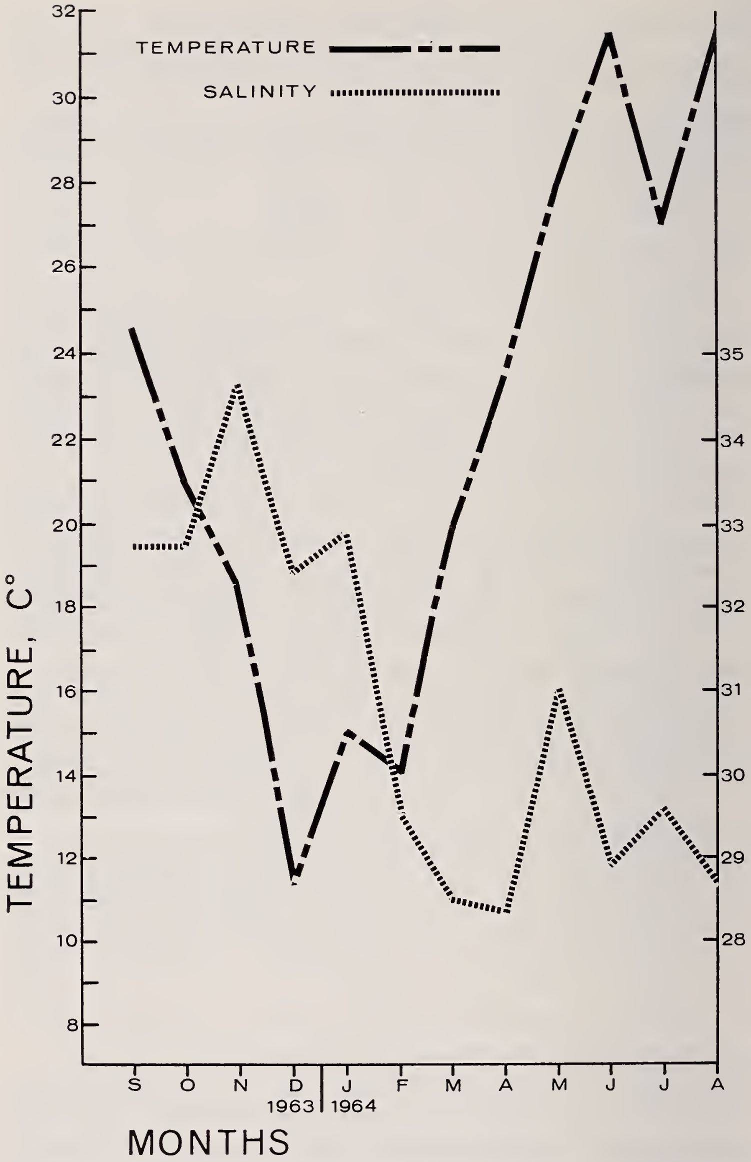

Fig. 2. Averages of monthly temperature and salinity for October 1963 to August 1964.

The data collected relating to dissolved oxygen content revealed no anomalies, and the waters are in approximate equilibrium with the atmosphere. Between January and March 1964 the dissolved oxygen content, measured by the Winkler method (Strickland and Parsons, 1960), varied from 4.1 to 7.2 ppm.

TABLE 2

Light penetration values for east end of Seahorse Key in vicinity of Station 1

	Depth in Meters	Total Light (percentage)	Red Filter (percentage)
May 26, 1964	1	87	85
	2	65	56
June 28, 1964	1	88	85
	2	67	62
February 29, 1965	1	84	83
	2	61	55

FORAMINIFERAL ASSEMBLAGE

The foraminifers collected at the five stations are listed below. All of the species were found at each station, but not always at the same time. No attempt was made to segregate or prepare the samples for recovery of arenaceous types, although many were noted in the samples.

Family Rzehakinidae
  Miliammina fusca (Brady)

Family Miliolidae
  Quinqueloculina compta Cushman
  Quinqueloculina costata (d'Orbigny)
  Quinqueloculina seminula (Linnaeus)
  Massilina peruviana (d'Orbigny)
  Triloculina oblonga (Montagu)

Family Discorbidae
  Discorbis floridanus Cushman

Family Rotaliidae
  Ammonia beccarii parkinsoniana (d'Orbigny)
  Ammonia beccarii tepida (Cushman)

Family Elphidiidae
  Elphidium gunteri galvestonesis Kornfeld
  Elphidium mexicanum Kornfeld
  Elphidium poeyanum (d'Orbigny)
Family Eponididae
  Eponides antillarum (d'Orbigny)
Family Cibicididae
  Cibicides robertsonianus (Brady)
Family Nonionidae
  Nonion depressula matagordana Kornfeld
Family Anomalinidae
  Anomalina io Cushman
  Hanzawaia strattoni (Applin)

DISCUSSION

The Seahorse Key foraminiferal associations found during this survey approximate those reported from other areas bordering on the Gulf of Mexico (Phleger, 1960a: 126; Phleger, 1960b: 267). However, the distribution patterns we encountered contain elements of both an interdistributary bay and a beach fauna which, as Walton (1964: 158) describes, would be considered a marginal marine fauna. The faunal assemblage is dominated by species or varieties of *Elphidium, Quinqueloculina,* and *Ammonia beccarii.* To this assemblage must be added, at least for the Seahorse Key area, the miliolid, *Triloculina oblonga.* This species comprised from 15-45 per cent of the total population at each station throughout the year; in most samples it seasonally replaced *Quinqueloculina* as a dominant element. We infer that seasonal variations in environmental parameters are probably insufficient to cause marked changes in faunal composition between stations, although the area is characterized by gross temperature and salinity fluctuations.

Critical studies of core samples taken at essentially the same stations but at a later date, were found to lack foraminiferal tests (Jenkins, 1966). Although we question, in general, the efficacy of Walton's test for living/dead foraminifers, our studies indicate a standing crop in excess of 85 per cent. Either dissolution, predation, or winnowing accounts for these observations, but which one or combination is most effective has not yet been determined.

Population density and seasonal patterns at Stations 1-3 are essentially similar, with high counts during January-February and

May followed and separated by significant lows. The minor density peaks in May are in synchrony with the peak flow of nutrient rich waters from the Suwannee River in addition to the seasonal outburst of diatoms. Since diatoms constitute one of the major food sources of foraminifers (Meyers, 1943: 441; Bandy, 1956: 188), and optimum reproductive temperatures (Bradshaw, 1957) are reached at this time, the increments are not unexpected. We infer that the low counts from June through September correlate with lower salinity and rising seasonal temperatures that readily affect the alternate drying and wetting of the flats fronting the beach. The major peaks in January and February at these stations and Station 4 are difficult to interpret. Evidently, environmental conditions are more than sufficient to permit reproduction and normal shell growth during this period at least in *Miliammina fusca* and *Ammonia beccarii* (Parker and Athearn, 1959: 388; Phleger, 1960a: 271).

Station 4 differed from other stations in that the sediments surrounding the oyster bar were rarely exposed, and Eh values indicated a reducing environment. However, the population density exceeded greatly that of all other stations, and large numbers of the arenaceous species *Trochamina inflata* (Montagu), *T. inflata mexicana* Kornfeld and *Arennoparrella mexicana* (Kornfeld) were encountered each month, but only rarely at other stations. The most abundant species at this station was *Triloculina oblonga*, the tests of which were, for the most part, extremely small, and constituted during peak periods as much as 45 per cent of the total monthly sample. Small size may be indicative of prevailing optimum parameters necessary for reproduction (Phleger, 1960a: 272). The relationship between the overall high population density and the oyster-bar environment is unclear. Oyster fecal-pellets may serve as a source of year around nutriment that is either utilized directly or broken down into suitable form by bacteria (Clark, pers. comm., 1969). The delayed major peak in April, preceded by a low probably represents unusual environmental conditions, which we failed to monitor during this period.

The psammophilic echinoid *Mellita* is the predominant epi- and in-faunal element at Station 5. The foraminiferal population at this station is perhaps the most stable because it is not exposed at any time during the year. The proximity to a minor ship channel leading to the marine laboratory pier (not shown on map), and the

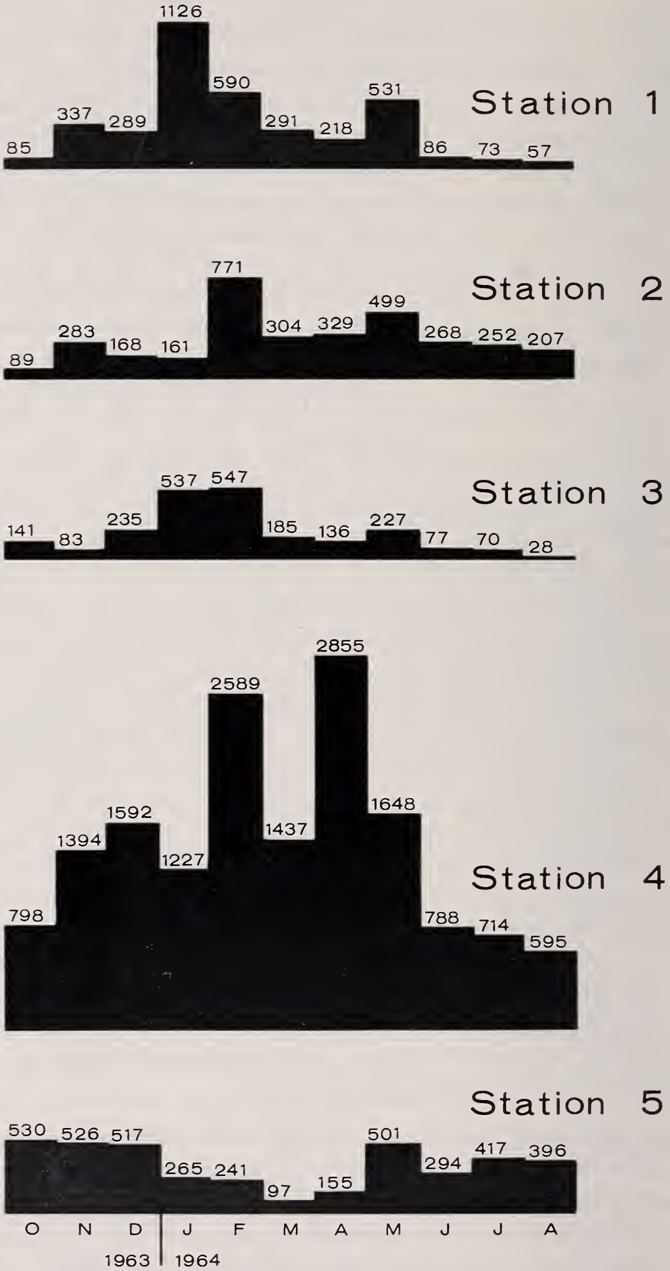

Fig. 3. Histograms of total foraminiferal populations.

reworking of sediments by *Mellita* may contribute to a relatively low overall population density, especially during the summer months.

Shallow-water foraminiferal populations, in general, undergo seasonal density fluctuations (Parker and Athearn, 1959). High density occurs normally in the spring or summer, and lower densities in the fall or winter. These fluctuations are attributable to any one of several factors. However, relative to the Seahorse Key fauna, we believe that the availability of food coupled with lethal summer temperatures are the major factors controlling seasonal densities. The asynchrony in population peaks and lows probably reflects a causal relationship between tidal exposure, salinity, available nutriment and variations in the physical configuration of each of the micro-environments sampled.

ACKNOWLEDGMENTS

We are indebted to H. K. Brooks, and R. A. Edwards, University of Florida, for their suggestions and comments during the course of this study. We thank Francis L. Parker, Scripps Institution of Oceanography, for help in identifying certain species, and Mary Clark, San Diego State College, for information on foraminiferal nutrition. Anne Acevedo, San Diego Natural History Museum, drafted the text figures. Financial support from the San Diego State College Foundation to cover publication costs is gratefully acknowledged.

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Quart. Jour. Florida Acad. Sci. 32(2) 1969 (1970)