John Murrell

RED TIDE STUDIES,

PINELLAS TO COLLIER COUNTIES,

1963-1966

A SYMPOSIUM

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INTRODUCTION

A variety of studies were conducted on the Red Tide from 1946, when a major outbreak began, until 1963, when substantial financial support was provided to the Florida Board of Conservation. These prior investigations were carried out by the Bureau of Commercial Fisheries of the U. S. Fish and Wildlife Service, the Marine Laboratory of the University of Miami, the University of Florida, and the Board of Conservation.

Although support varied widely in amount from year to year, the resulting studies provided basic background information on the causative organism, *Gymnodinium breve*. Studies on similar phenomena in other parts of the world also contributed substantial amounts of factual material.

The Florida Legislature in 1963 appropriated $250,000 for the 1965 biennium for a thorough investigation of Red Tide. Based on available knowledge, a broad spectrum research program was initiated at that time. Projects were assigned for all factors thought to be of importance. As might be expected, the various projects differed widely in the amount of understanding they produced.

Without reference to any immediate contribution to Red Tide comprehension, all projects that were carried to completion have been summarized. Several Florida Board of Conservation publications have resulted from these studies (Professional Papers Series No. 8 and No. 9, and a series of leaflets).

Aside from any relevance these data may have for Red Tide control they will always provide valuable biological and chemical information on the Gulf of Mexico. Present and future studies, resulting from quickened interest in the Gulf, will be facilitated.

Stations were carefully selected to assure sampling of areas generally associated with Red Tides as well as to provide the necessary samples for phytoplankton, chemical, Vitamin B_{12}, and other analyses. Subsequent to the designation of 11 Red Tide (RT) stations to be sampled monthly, 9 additional weekly sample (WS) stations were chosen to provide additional phytoplankton samples and a means of monitoring for *Gymnodinium breve*.

All RT stations were visited by wading to them from shore. Stations WS 1, 2, 3, 7, 8, and 9 were reached by outboard boat, while Stations WS 4 and 6 were located on a dock and a pier, respectively. A brief description of all stations is given below (Figure 1, page 86).

RT 1. Point Pinellas, Tampa Bay, Pinellas County. This station is situated 200 yards west of the old ferry dock. Samples were collected at a distance of about 75 yards out from the high tide mark. The depth varied from 1½ to 4 feet. Extensive grass flats surrounded the station. RT Stations 1, 2, 10, and 11 were sampled on the Monday of the last week in the month.

RT 2. Mullet Key, Gulf of Mexico, Pinellas County. This station is approximately 50 yards offshore from the northernmost point of Mullet Key, an island at the mouth of Tampa Bay. The surrounding area is protected by an extensive barrier bar and is only 2 to 3 feet in depth. The sand bottom shifted and changed radically from one sampling to the next in response to wind, wave, and current action.

RT 3. Lido Key (Cerol Isles), Sarasota County. Samples were collected from Stations RT 3 and 4 on the third Monday of each month. RT 3 is located inside the harbor between St. Armand Key and Cerol Isles at a point approximately ¼ mile from the Cerol Isles bridge. The surrounding area is one of mangrove thickets, mud bottom, and grass flats. The first sample was taken in 2 feet of water just south of an unmarked day beacon some distance from shore, on December 16, 1963. Later, samples were collected from an area located approximately 15 feet from shore. The sampling depth ranged from 2 to 3 feet.

RT 4. Midnight Pass, Little Sarasota Bay, Sarasota County. This station is approximately ⅔ mile north of Station WS 3 and was reached by wading 65 yards north from the southeast tip of Siesta Key. The station is situated between Siesta Key and Bird Key at the edge of grass flats. The bottom was sandy and the depth ranged from 2½ to 3 feet.

RT 5. Stump Pass, Lemon Bay, Charlotte County. Stations RT 5 and 6 were sampled on the second Monday of the month. RT 5 is located approximately 300 yards inside the mouth of the pass and was reached by wading out 20 feet from the north side of the pass. Typically, there was moderate to heavy current and wave action, resulting in the formation of a loose and shifting sandy bottom. Depth at the station ranged from 2½ to 3 feet.

RT 6. Boca Grande, Charlotte Harbor, Lee County. To reach this station it was necessary to drive ¾ mile north along the beach from the phosphate dock at Port Boca Grande and then to wade a short distance from shore to the inside edge of a grass bed. Current, wind, and wave action combined to produce a shifting bottom. The depth was 2 to 4 feet.

RT 7. Sanibel Island, San Carlos Bay, Lee

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County. Stations RT 7, 8, and 9 were visited on Tuesday of the first week of the month. RT 7 is located approximately 200 feet west of the Sanibel toll bridge where it joins Sanibel Island. Samples were collected from the edge of a grass flat located about 200 feet offshore. A loose, sandy bottom characterized this station. Sampling depth varied from 1 to 3 feet. A dredge operated in the near vicinity of the station during May and June of 1964.

RT 8. Big Carlos Pass, Estero Bay, Lee County. This station is located on the bay side of the southern tip of Estero Island and was reached by wading out 25 feet from the mouth of a small cove to the edge of an oyster bar where the depth varied from 2½ to 3 feet. The bottom was composed of fine mud and shell and the current was sluggish. This station was well protected from wind and wave action.

RT 9. Caxambas Pass, Marco Island, Collier County. This station is approximately 3½ miles south of Marco and is located just inside the mouth of the pass. It was located by wading 14 yards south-southeast from a group of pilings on the beach. At low tide it was necessary to wade 20 to 30 feet farther out in order to reach a suitable sampling depth. The bottom was composed of sand covered by a thick layer of fine sediments inter-mixed with clam and oyster shells. The current is moderately swift at the station. Depths varied from 2 to 3 feet.

RT 10. Weedon Island, Papys Bayou, Pinellas County. This station is approximately 100 yards east of the northern end of the wooden bridge on the Weedon Island Road. The station, which is situated on a point, is surrounded by oyster bars, grass flats, and mangrove thickets. Current action was not noticeable at the station, although it was at times moderately swift in the nearby channel. The bottom was composed of mixed sand, mud, and shells covered with a thin layer of fine sediment. The depth varied from 2½ to 4 feet.

RT 11. Ballast Point, Hillsborough Bay, Hillsborough County. This station is located approximately one mile south of Ballast Point and was reached by wading 300 yards from shore in an easterly direction from a group of pilings near the tide mark. This area is one of shallow, muddy flats surrounded to the north, east, and west by land. Depths from 1½ to 4 feet were recorded during the study. Sewage, poor circulation, and high water temperatures were probably responsible for a characteristic "fetid" odor at the station. The water at RT 11 and WS 6 was usually strongly discolored.

WS 1. New Pass, Sarasota Bay, Sarasota County. Stations WS 1, 2, and 3 were sampled on Tuesday of the second, third, and fourth weeks of each month during the study. Station WS 1 is located just inside New Pass and approximately 200 feet southeast of an old pier. Moderate to swift currents were encountered at the station where the depth varied from 8 to 13 feet. Extensive shallows and grass flats typify the adjacent areas. Samples collected on April 14 and May 12, 1964, were noticeably turbid, probably the result of a dredging operation observed several hundred yards from the station.

WS 2. Big Sarasota Pass, Sarasota Bay. Samples were collected at depths from 9 to 25 feet from the south side of the channel inside and near the mouth of Big Sarasota Pass. A "fix" on the station was obtained by lining up range markers on Cerol Isles and Sarasota Key. Swift currents were commonly encountered and the bottom was composed of loose, shifting sand.

WS 3. Midnight (Musketeers) Pass, Little Sarasota Bay, Sarasota County. This station lies midway between Bird Keys and Casey Keys and is situated approximately 1500 feet southeast of the pass. The depth varied from 6 to 14 feet. The bottom appeared similar to that observed at WS Stations 1 and 2.

WS 4. Bayboro Harbor, Tampa Bay, Pinellas County. Stations WS 4, 5, and 6 were sampled each Wednesday. Station WS 4 is located at the end of the Marine Laboratory dock. Depths were observed to range from 8 to 16 feet. The bottom was composed of mud, sand, and scattered shells. The movement of water in the harbor was generally sluggish. Salt Creek, a brackish stream, enters the harbor less than ½ mile to the south of the station. Following heavy rainfalls, a marked reduction in salinity occurs due to the influx of fresh water from this creek.

WS 5. Point Pinellas, Tampa Bay, Pinellas County. The location of this station is the same as that of RT 1.

WS 6. Ballast Point, Hillsborough Bay, Hillsborough County. This station is located at the end of the fishing pier at Ballast Point, approximately one mile north of Station RT 11. The depth ranged from 4 to 13 feet and the current was moderate. The Hillsborough River empties into the bay approximately two miles to the north of the station. Raw sewage empties into the bay at three points within a two mile radius of the station.

WS 7. Stump Pass (outside), Lemon Bay, Charlotte County. Stations WS 7, 8, and 9 were sampled each Thursday. These stations were reached by means of an outboard boat and are located within a one mile area. WS 7 is located approximately 200 yards outside the mouth of the pass. Depths ranged from 4 to 15 feet. Heavy wave action and current were routinely encountered at this station.

WS 8. Stump Pass (inside). This station, which is located approximately 500 yards inside the mouth of the pass on the south side of the channel, was characterized during the study by moderately heavy currents and a sampling depth of from 4 to 23 feet. Little or no rooted vegetation appears to have been present, although there were extensive grass flats in the surrounding area.

WS 9. Stump Pass (island). This station is located between a large mangrove island in the mouth of the pass and the mainland to the south. Samples were collected on the edge of the shallow channel close to the island at depths from 3 to 17 feet.

DINOFLAGELLATE STUDIES ON THE INSHORE WATERS OF THE WEST COAST OF FLORIDA

KAREN A. STEIDINGER, JOANNE T. DAVIS, AND JEAN WILLIAMS

INTRODUCTION

The dinoflagellate project was initiated as an integral part of the Red Tide program. The primary objectives of this project were to determine the occurrence, distribution, abundance, and diversity of *Gymnodinium breve*, Florida's Red Tide organism, and other dinoflagellates by weekly and monthly samplings.

Selection of our sampling stations was based on locales associated with previous Red Tide outbreaks (Torpey and Ingle, 1966); e.g., Tampa Bay, Sarasota bays, Stump Pass, and Boca Grande area. It was hoped that if a *G. breve* bloom occurred during the study program, it would occur in proximity to one of the twenty stations along the coast (Hillsborough to Collier Counties). In that way, biological, chemical, and physical conditions prior to, during, and following an outbreak could be evaluated.

This was not the case. *G. breve* was observed at several stations, but always in low numbers. No bloom was noted in the inshore areas studied along Florida's west coast from December 1963 to October 1964.

In contrast to this southern scarcity, *G. breve* bloomed in Apalachee Bay during July and August, 1964 (see Professional Papers Series No. 8).

Data presented here represents species diversity, distribution, abundance, and seasonality of dinoflagellates encountered.

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The authors wish to thank Mr. Robert M. Ingle, Director of Research, who initiated and supervised this project and Mrs. Bonnie Eldred (Laboratory Staff), who aided in all phases of the work.

MATERIALS AND METHODS

Two types of sampling stations (described elsewhere in this symposium) are reported upon here: 1) RT (Red Tide) Stations which were sampled on a monthly basis for all Red Tide projects (biological and chemical); 2) WS (Weekly Samples) Stations which were sampled solely for the dinoflagellate and diatom projects. The collection apparatus for surface and bottom water samples was a weighted polyethylene quart container.

All initial observations and counts were made from living material. The concentration-enumeration procedure used was originated (U. S. Fish and Wildlife Service and Florida Board of Conservation) for detection and counting of *G. breve* and other dinoflagellates. This original procedure has since been modified and augmented to accommodate the detection of species (primarily armored) in concentrations of less than 100 per liter.

The positively phototropic organisms were concentrated at the side of a covered quart glass jar with fluorescent cool-white lamps. The concentrated area was then scrutinized for the presence or absence of *G. breve*. This initial observation was followed by identifying and counting the dinoflagellate species present in three 1 ml aliquots of a gently agitated water sample. If the dinoflagellate population was high (>100,000/liter), the actual count would only involve 0.3 ml or 0.03 ml. Individual cells in these aliquots were counted for all the taxa reported upon here with the exception of *Gymnodinium* spp. and *Gymnodinium-Glenodinium* spp. These two recordings were estimated by the following categories, 1 - 10, 10 - 100, 100 - 1,000, and 1,000 - 10,000/ml. A Bausch and Lomb StereoZoom was used for all initial observations. Verifications of species identifications were then made with a Bausch and Lomb DynaZoom compound microscope (brightfield). Care was taken to avoid extreme temperature changes during transportation of samples to the Marine Laboratory and during the period of observations. All samples were examined within 20-30 hours after their collection.

RESULTS AND DISCUSSION

Included here is a list of taxa of dinoflagellates observed in the RT-WS sampling program. Almost all of the compiled species are accompanied by photomicrographs, morphological references to other authors, seasonality trends (if present), relative abundance, and distribution. Pertinent morphological observations are presented for some species where there was need. Observed temperature ranges (OTR) in degrees Centigrade and salinity ranges (OSR) in parts per thousand are also given. Observed temperature (OT) and observed salinity (OS) are given for species noted only once.

Amphidinium spp.

At least two unidentified species represented. Never observed in high numbers. Noted in June, September, and October.

Ceratium furca (Ehrenberg) Claparede and Lachmann Figure 1

Refer to Bohm (1931 a, p. 10, Figure 4). Sporadic from winter through summer, reaching a distribution and abundance peak in March. OTR: 15.3 - 31.4. OSR: 18.6 - 39.0.

Ceratium fusus (Ehrenberg) Dujardin Figure 2
Refer to J. T. Davis (1965a). Wider distribution in July and August than in other months. Never noted in high numbers. OTR: 14.0 - 31.4. OSR: 29.4 - 39.2.

Ceratium trichoceros (Ehrenberg) Kofoid Figure 3
Refer to Schiller (1937, p. 430, Figure 470) and Wood (1954, p. 307, Figure 239a). Oceanic form, primarily occurring from June to September. Observed in low numbers. OTR: 27.5 - 31.5. OSR: 34.4 - 39.2.

Ceratium tripos var. *atlanticum* Ostenfeld Figure 4
Refer to Lebour (1925, p. 239). Wider range in warmer months. Always in low numbers. OTR: 15.6 - 33.5. OSR: 32.4 - 39.1.

Ceratium A (*furca*?) Figure 5
Refer to Schiller (1937, p. 369, Figure 406 of *C. hircus* Schroder). *Ceratium* A differs from *C. hircus;* right horn directed ventrally, antapical horns about the same length. This could be a variety of *C. furca.* If a single armored species were chosen to characterize estuarine waters of the area studied, it would be *Ceratium* A. Observed every month, usually in low numbers. Occasionally bloomed and discolored the water. OTR: 11.0 - 34.8. OSR: 15.6 - 39.3.

Ceratium F (*fusus*?)
Appeared to be a mutant of *C. fusus.* Apical horn was not prominent. Three occurrences, two in association with *C. fusus,* during warm months. OTR: 21.4 - 30.7. OSR: 30.8 - 39.1.

Ceratium spp.
At least five unidentified species represented. Noted from March to August, except April. Observed in low numbers.

Cochlodinium spp.
At least two unidentified species represented. More evident in winter and spring. Not observed in high numbers.

Dinophysis caudata var. *pedunculata* Schmidt Figure 6
Refer to Bohm (1936, p. 24, Figure 9; p. 20, Figure 7b). Bohm refers to this form as a distinct variety, while Kofoid and Skogsberg (1928) do not. Noted in April, August, September, and October. OTR: 25.6 - 31.7. OSR: 24.8 - 37.1.

Dinophysis caudata var. B Figure 7
Observed in association with other *D. caudata* varieties and individually. Occurred in August and September only. Noted in low numbers. OTR: 23.0 - 31.4. OSR: 25.8 - 37.9.

Dinophysis A Figure 8
Observed every month, more prevalent in August and September. Usually in low numbers. OTR: 13.6 - 31.9. OSR: 16.2 - 37.2.

Dinophysis spp.
May include varieties or aberrants of *D. caudata.* Recorded only in September. Noted in low numbers.

Diplopsalis spp.
At least five unidentified species represented. Absent in winter. Most abundant in August and September.

Exuviaella A
Resembles *E. apora* Schiller and *E. mariae-lebouriae* Parke and Ballantine. Absent in summer. Usually observed in low numbers but bloomed in February and September. OTR: 10.5 - 28.5. OSR: 16.7 - 36.2.

Exuviaella spp.
Probably includes *E. marina* Cienkowski, *E. compressa* (Bailey) Ostenfeld, and *E. perforata* Gran, since all three species have been identified in this area from incidental samples. Sporadic all year, usually in low numbers.

Goniodoma sp.
Possibly *G. polyedricum* (Pouchet) Jorgensen, a species identified from Gulf waters in later studies by this Laboratory. Observed in January in low numbers. OT: 13.0. OS: 34.8.

Gonyaulax monilata Howell Figure 9
Refer to Howell (1953, p. 155, Figures 1-5). Known toxic dinoflagellate, occasionally blooming to fish-killing proportions. Observed in April and September, but not in high numbers. OTR: 24.5 - 29.0. OSR: 35.3 - 36.3.

Gonyaulax spinifera (Claparede and Lachmann) Diesing
Some *G. digitale* (Pouchet) Kofoid were included in this recording. Whether or not these two species are separable is questioned by Wood (1954). Occurred in August through October, absent in winter and spring. OTR: 19.3 - 31.5. OSR: 15.6 - 37.5.

Gonyaulax? D
The question arose as to whether this form was a *Gonyaulax* because of the first apical (?) plate, a similar situation existing in *G. monilata.* Adequate reference material was not accumulated for total plate analyses. Plate structure was difficult to discern, also specimens did not mount well. Probably included *Peridinium trochoideum* and similar species. Absent in winter. Bloomed in August. OTR: 26.3 - 36.9. OSR: 15.6 - 37.9.

Gonyaulax spp.
At least five unidentified species represented. A dominant genus occurring all year. High numbers noted in winter and spring.

Gymnodinium breve Davis Figure 10
For varying morphology of this species refer to C. C. Davis (1948); Steidinger (1964a) and Steidinger and Williams (1964). No blooms encountered during this study. Common in waters with high salinity and high temperature (July). Other occurrences in January, April, September, and October; always in low numbers. OTR: 14.9 - 31.2. OSR: 34.1 - 39.1.

Gymnodinium splendens Lebour Figure 11
For general information, refer to Steidinger (1964b). Morphological variability of specimens studied was radical. Elongate, elliptical,

and irregular chromoplasts, as well as nuclear variations, were observed suggesting forms resembling *G. nelsoni* Martin. Usually present in low numbers, except in May. Occasionally reached bloom proportions. OTR: 9.0 - 34.8. OSR: 12.4 - 38.7.

Gymnodinium D

Observed once, in August. OT: 30.0. OS: 37.1.

Gymnodinium spp. and *Gymnodinium-Glenodinium* spp.

At least ten unidentified species represented. Occurred all year in high numbers and constituted the bulk of dinoflagellate populations along with other dominant genera: *Gyrodinium, Gonyaulax,* and *Peridinium.* Early in the study, *Glenodinium* spp. were not detected and, if present, were probably recorded under *Gymnodinium* spp. Later, gymnodinoid forms (<25 μ) that could not be differentiated as to *Gymnodinium* or *Glenodinium*, under brightfield illumination, were grouped (*Gymnodinium-Glenodinium*).

Gyrodinium fissum (Levander) Kofoid and Swezy

May be *G. instriatum* Freudenthal and Lee because no pellicle striations have been detected on the specimens studied. Absent in December, February, March, and October. Reached a peak in August at WS stations.

Gyrodinium spp.

Includes *G. glaucum* (Lebour) Kofoid and Swezy and *G. spirale* (Bergh) Kofoid and Swezy and at least ten unidentified species. Common in high numbers all year.

Noctiluca scintillans (Macartney) Ehrenberg

Refer to Kofoid and Swezy (1921, p. 408, Figure KK). Encountered once in this study in low numbers. OT: 16.4. OS: 19.6.

Peridinium claudicans Paulsen Figure 12

Refer to Schiller (1937, p. 249, Figure 250). The second anterior intercalary plates of our specimens are not consistent. Some specimens had quadra and others penta plates. Occurred spring through fall. OTR: 23.7 - 32.0. OSR: 24.6 - 39.2.

Peridinium conicum (Gran) Ostenfeld and Schmidt Figure 13

Refer to Schiller (1937, p. 232, Figure 229 g-h) and Brunel (1962, p. 339, pl. 56; p. 341, pl. 57). *P. conicum* f. *guardafuiana* Matzenauer has been included. Noted in summer and fall in low numbers. OTR: 19.3 - 31.9. OSR: 17.2 - 39.2.

Peridinium depressum Bailey Figure 14

Refer to Schiller (1937, p. 252, Figure 251d) and Brunel (1962, p. 345, pl. 59). Occurred in low numbers. Absent May through July. OTR: 15.9 - 31.5. OSR: 19.1 - 37.0.

Peridinium divergens Ehrenberg Figure 15

Refer to Schiller (1937, p. 226, Figure 222). Occurred randomly from spring through early fall, widespread in summer but in low numbers. OTR: 26.4 - 31.4. OSR: 22.0 - 39.2.

Peridinium excentricum Paulsen Figure 16

Refer to Paulsen (1908, p. 51, Figure 64b). Absent in December, February, April and May, but frequent in summer. OTR: 15.8 - 31.5. OSR: 25.0 - 38.6.

Peridinium oblongum (Aurivillius) Cleve Figure 17

There are opposing opinions as to whether this species is *P. oblongum* or *P. oceanicum* var. *oblongum* Paulsen. Absent in December and January. Most frequent and widespread in summer and fall. Noted in low numbers, as were most of the larger *Peridinium.* OTR: 15.5 - 32.0. OSR: 17.0 - 39.4.

Peridinium J (*abei*?)

Occurred in August and September. Low numbers. OTR: 28.9 - 34.4. OSR: 34.2 - 35.3.

Peridinium A

Noted in low numbers in August. OTR: 29.5 - 31.2. OSR: 15.6 - 35.4.

Peridinium B

Noted in low numbers in December and January. OTR: 14.0 - 16.0. OSR: 35.0 - 36.2.

Peridinium D Figure 18

Occurred in all months except September. Observed in low numbers. OTR: 13.0 - 31.4. OSR: 18.5 - 38.9.

Peridinium E Figure 19

Absent in February, March, and October. Sporadic occurrence in low numbers. OTR: 14.9 - 31.5. OSR: 14.7 - 39.2.

Peridinium N

Observed in October in low numbers. OTR: 22.1 - 28.1. OSR: 25.4 - 35.3.

Peridinium spp.

At least five small unidentified species represented. A dominant genus occurring all year.

Phalacroma spp.

Encountered in May and June, never in high numbers.

Polykrikos hartmanni Zimmerman

Refer to Schiller (1933, p. 548, Figure 577) and Hulbert (1957, p. 204, Figure 7.) Found in September and October in low numbers with one high count (>10,000/liter) in September. OTR: 21.4 - 31.9. OSR: 17.2 - 31.9.

Polykrikos schwartzi Butschli Figure 20

Refer to Lebour (1925, p. 193, Figure 2). The atypical colonies observed had displaced girdles, but no pellicle ribbings on the hypocone. Colony with slight twist. Nematocysts present. All year in low numbers. OTR: 9.0 - 31.4. OSR: 16.7 - 38.3.

Polykrikos spp.

At least two unidentified species or varieties represented. Present in low numbers during January, February, and July.

Pouchetia spp.

Possibly includes *Nematodinium* spp. Observed in January, February, April, May, June, and September.

Prorocentrum micans Ehrenberg Figure 21

Refer to Lebour (1925, p. 174, Figure 5. Absent in May. Appeared to have a winter buildup and a March peak in distribution and abundance. OTR: 10.0 - 33.5. OSR: 10.6 - 39.0.

Prorocentrum gracile Schutt

Absent in winter. OTR: 22.3 - 31.5. OSR: 34.4 - 39.2.

Prorocentrum spp.

At least two unidentified species, varieties, or forms represented. Absent in June, August, and October.

Protoceratium reticulatum (Clarapede and Lachmann) Butschli

Refer to Lebour (1925, p. 197, Figure 7). Observed only once in moderate numbers (October). OT: 24.3. OS: 28.4.

Pyrodinium bahamense Plate Figure 22

This identification could be questioned as some specimens had characters of both *P. bahamense* and *P. schilleri* (Matzenauer) Schiller. Plate formula: 4', 0a, 6'', 5''', 1p, 1''''. The shape and position of the plates of our specimens differed from the illustrations supplied by Schiller (1937, Figures 329a, b, and c). Observed in September in low numbers. OT: 27.8. OS: 28.0.

Pyrophacus horologicum Stein Figure 23

For plate analysis of this species, refer to Lebour (1925, p. 231, Figure 4). Encountered in July through October in low numbers. OTR: 24.1 - 33.5. OSR: 15.6 - 39.2.

Pyrophacus horologicum var. *steinii* Schiller Figure 24

Refer to Schiller (1937, p. 88, Figures 74a and b). Observed from July to September in low numbers. *P. horologicum* var. *steinii* was always observed in association with *P. horologicum* and *Pyrophacus* B_1. OTR: 26.9 - 30.8. OSR: 17.5 - 37.9.

Pyrophacus spp.

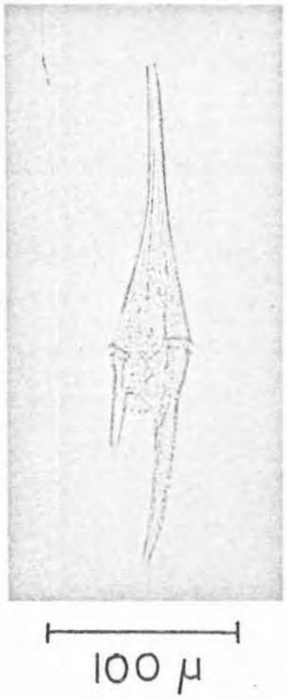
Originally, identification was made only to genus. In later samples, plate structure studies enabled us to designate *P. horologicum* and *P. horologicum* var. *steinii*. A new form (Pyrophacus B_1) has been distinguished and is included. Sporadic occurrence from spring through summer in low numbers.

Torodinium teredo (Pouchet) Kofoid and Swezy Figure 25

Refer to Kofoid and Swezy (1921, p. 389, Figure II 4) and Schiller (1933, p. 546, Figure 576). Absent in winter. Present in May, June, July, and October. OTR: 26.6 - 31.5. OSR: 35.4 - 39.2.

Torodinium spp.

This grouping could include variants of *T. teredo* as well as *T. robustum* Kofoid and Swezy. Occurred in March, July, September, and October.

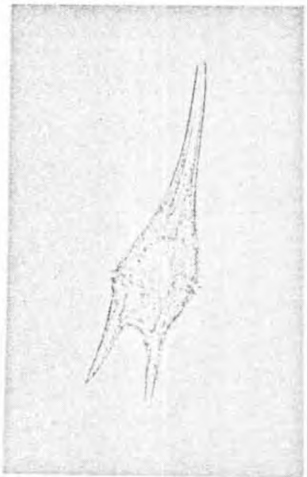
1


2


3


4


Figure 1. *Ceratium furca* (Ehrenberg) Claparede and Lachmann.
Figure 2. *Ceratium fusus* (Ehrenberg) Dujardin.
Figure 3. *Ceratium trichoceros* (Ehrenberg) Kofoid.
Figure 4. *Ceratium tripos* var. *atlanticum* Ostenfeld.



5

100 μ

6

100 μ

7

25 μ

8

50 μ

Figure 5. *Ceratium* A (*furca*?).

Figure 6. *Dinophysis caudata* var. *pedunculata* Schmidt, 2 schizonts still attached.

Figure 7. *Dinophysis caudata* var. B.

Figure 8. *Dinophysis* A.

9

100 μ

10

25 μ

11

50 μ

12

50 μ

Figure 9. *Gonyaulax monilata* Howell.
Figure 10. *Gymnodinium breve* Davis, ventral view.
Figure 11. *Gymnodinium splendens* Lebour.
Figure 12. *Peridinium claudicans* Paulsen, ventral view, ortho 1st apical plate.

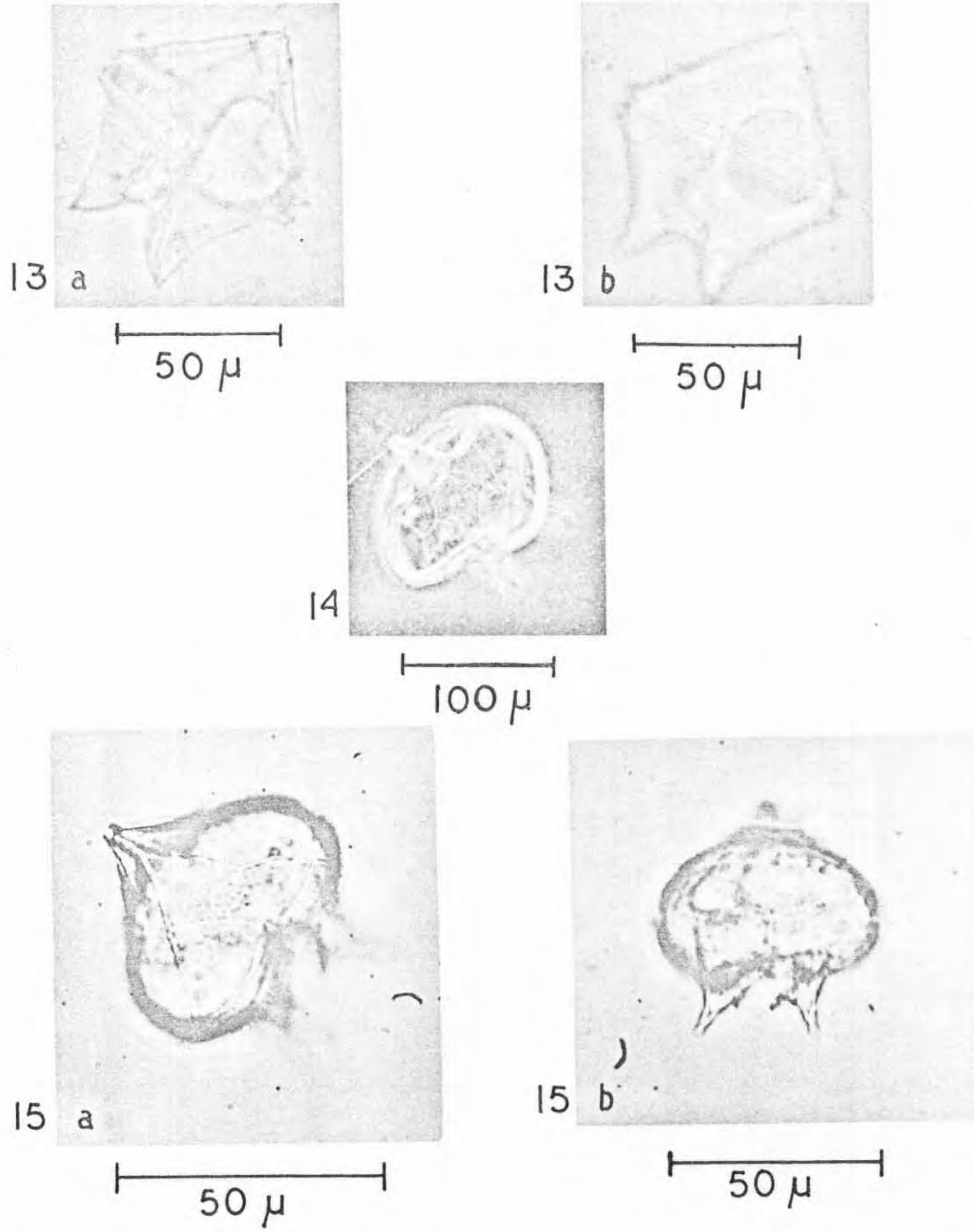


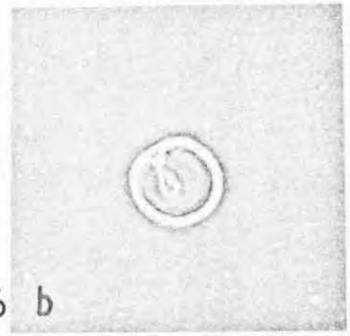
Figure 13. *Peridinium conicum* (Gran) Ostenfeld and Schmidt. *a*- ventral view, ortho 1st apical plate; *b*- dorsal view, hexa second anterior intercalary plate.

Figure 14. *Peridinium depressum* Bailey, epitheca, ortho 1st apical plate.

Figure 15. *Peridinium divergens* Ehrenberg. *a*- ventral epitheca, meta 1st apical plate; *b*- dorsal hypotheca with typical antapical horns.

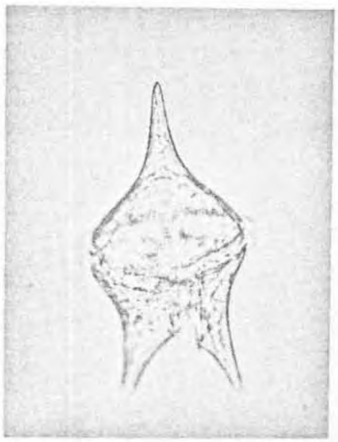
16 a

100 μ



16 b

100 μ



17

50 μ

18

100 μ

Figure 16. *Peridinium excentricum* Paulsen. *a*- one specimen in longitudinal view; *b*- antapical view.
Figure 17. *Peridinium oblongum* (Aurivillius) Cleve, ventral view.
Figure 18. *Peridinium* D, ventral view, ortho 1st apical plate.

19

100 μ

20

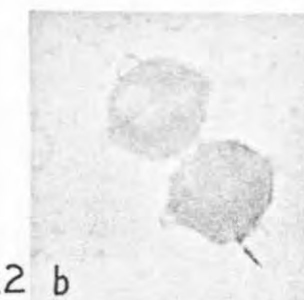
100 μ

21

50 μ

22 a

50 μ



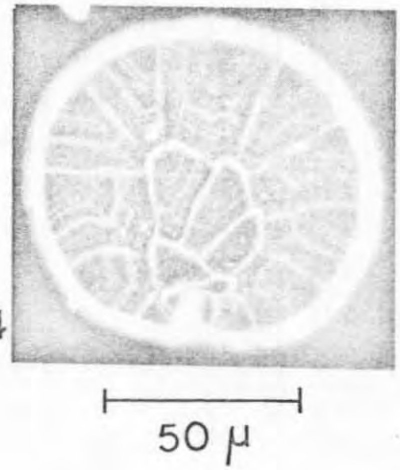
22 b

50 μ

Figure 19. *Peridinium* E, ventral view.
Figure 20. *Polykrikos schwartzi* Butschli, 8 zooids.
Figure 21. *Prorocentrum micans* Ehrenberg.
Figure 22. *Pyrodinium bahamense* Plate. *a*- specimen on left with noticeable displaced 1st apical plate; *b*- longitudinal view of 2 daughter cells.

23

24



25

Figure 23. *Pyrophacus horologicum* Stein, smashed specimen showing separated epitheca and hypotheca and liberated cyst.

Figure 24. *Pyrophacus horologicum* var. *steinii* Schiller, antapical view with 12 postcingular and 6 antapical plates.

Figure 25. *Torodinium teredo* (Pouchet) Kofoid and Swezy.

silicoflagellates, tintinnids, and radiolarians. Microflagellates (less than 5 to 15 μ) and euglenoids were dominant. They even exceeded the dinoflagellates in more than 45 per cent of the WS samples.

The multicellular zooplankton recorded represented typical inhabitants: copepods, rotifers, ostracods, nauplii, medusae, and ascidians. Comparatively, copepods and rotifers were the most commonly observed. With the publication of these studies, the number of dinoflagellate species and varieties found in the Gulf of Mexico has been increased to more than 90 (Davis, 1950; King, 1950; Graham, 1954; Lackey and Hynes, 1955; Curl, 1959; Simmons and Thompson, 1962; Dragovich, 1963; Dragovich and Kelly, 1964; Steidinger *et al.*, 1966).

REFERENCES

ALLEN, W. E.
1928. Review of five years of studies on phytoplankton at southern California piers, 1920-1924 inclusive. *Bull. Scripps. Inst. Oceanogr.*, Tech. Ser., *1*(16): 357-401.

BALECH, E.
1959. Two new genera of dinoflagellates from California. *Biol. Bull.*, *116*(2): 195-203.

BALECH, E.
1963. La familia Podolampaceae (Dinoflagellata). *Inst. Biol. Mar.*, No. 2: 4-33.

BALECH, E.
1964. El Plancton de Mar del Plata durante el periodo 1961-1962. *Inst. Biol. Mar.*, No. 4: 3-49.

BALLANTINE, D.
1956. Two new marine species of *Gymnodinium* isolated from the Plymouth area. *J. Mar. Biol. Ass. U. K.*, *35:* 467-474.

BOHM, A.
1931a. Distribution and variability of *Ceratium* in the northern and western Pacific. *B. P. Bishop Mus.*, Bull. 87: 3-47.

BOHM, A.
1931b. Zur verbreitung einiger Peridineen. *Arch. Prot.*, *75.*

BOHM, A.
1936. Dinoflagellates of the coastal waters of the western Pacific. *B. P. Bishop Mus.*, Bull. 137: 3-54.

BRAAUD, T., K. RINGDALGAARDER and O. NORDLI
1958. Seasonal changes in the phytoplankton at various points off the Norwegian west coast. *Fiskeridir. Skr. Havundersøk.*, *12*(3): 7-77.

BRUNEL, J.
1962. Le phytoplankton de la Baie des Chaleurs. *Minist. Chasse et Pech.*, Contri. No. 91: 1-365.

BURSA, A. S.
1962. Some morphogenetic factors in taxonomy of dinoflagellates. *Grana Palynologica*, *3*(3): 54-66.

BURSA, A. S.
1963. Phytoplankton successions in the Canadian Arctic, p. 625-628. *In* C. H. Oppenheimer, (ed.), Marine Microbiology. Charles C. Thomas, Springfield, Ill.

CURL, H., JR.
1959. The phytoplankton of Apalachee Bay and the northeastern Gulf of Mexico. *Inst. Mar. Sci.*, *6:* 278-312.

DAVIS, C. C.
1948. *Gymnodinium brevis* sp. nov., a cause of discolored water and animal mortality in the Gulf of Mexico. *Bot. Gaz.*, *109*(3): 358-360.

DAVIS, C. C.
1950. Observations of plankton taken in marine waters of Florida in 1947 and 1948. *Quart. Jour. Florida Acad. Sci.*, *12*(2): 67-103.

DAVIS, C. C.
1954. Phytoplankton of the Gulf of Mexico. *U. S. Fish Wildl. Serv.*, Fish Bull. No. 89: 163-169.

DAVIS, J. T.
1964. *Ceratium fusus* (Ehrenberg). *Fla. Bd. Conserv.*, Leaf Ser. *1*(6): 1-3.

DAVIS, J. T.
1965. *Ceratium hexacanthum* Gourret. *Fla. Bd. Conserv.*, Leaf. Ser. *1*(9): 1-3.

DODGE, J. D.
1963. Chromosome numbers in some marine dinoflagellates. *Bot. Mar.*, *5*(4): 121-127.

DODGE, J. D.
1965. Thecal fine-structure in the dinoflagellate genera *Prorocentrum* and *Exuviaella*. *J. Mar. Biol. Ass. U. K.*, *45:* 607-614.

DRAGOVICH, A.
1963. Hydrology and plankton of coastal waters at Naples, Florida. *Quart. Jour. Florida Acad. Sci.*, *26*(1): 22-47.

DRAGOVICH, A. and J. A. KELLY, JR.
1964 Preliminary observations on phytoplankton and hydrology in Tampa Bay and the immediate adjacent offshore waters, p. 4-22. *In* A Collection of Data in Reference to Red Tide Outbreaks During 1963, *Fla. Bd. Conserv.* (mimeo.).

FREUDENTHAL, H. D.
1962. *Symbiodinium* gen. nov. and *Symbiodinium microdriaticum* sp. nov., a zooxanthella: taxonomy, life cycle and morphology. *J. Protozool.*, *9:* 45-52.

FREUDENTHAL, H. D. and J. J. LEE
1963. *Glenodinium halli* n. sp. and *Gyrodinium instriatum* n. sp., dinoflagellates from New York waters. *J. Protozool., 10*(2): 182-189.

GRAHAM, H. W.
1942. Studies in the morphology, taxonomy, and ecology of the Peridiniales. (Scientific results of cruise 7 of the *Carnegie* during 1928-1929). *Carnegie Inst. Wash. Publ.* No. 542: 1-129.

GRAHAM, H. W.
1951. Pyrrophyta, p. 105-118. *In* G. M. Smith, (ed.), Manual of Phycology. Ronald Press, Inc., New York.

GRAHAM, H. W.
1954. Dinoflagellates of the Gulf of Mexico. *U. S. Fish Wildl. Serv.,* Fish. Bull. No. 89: 223-226.

GRAHAM, H. W. and N. BRONIKOVSKY
1944. The genus *Ceratium* in the Pacific and North Atlantic Oceans. (Scientific results of cruise 7 of the *Carnegie* during 1928-1929). *Carnegie Inst. Wash. Publ.* No. 565: 1-209.

HOWELL, J. F.
1953. *Gonyaulax monilata*, sp. nov., the causative dinoflagellate of a Red Tide on the east coast of Florida in August-September, 1951. *Trans. Amer. Micro. Soc., 72*(2): 153-156.

HULBURT, E. M.
1957. The taxonomy of unarmored Dinophyceae of shallow embayments on Cape Cod, Massachusetts. *Biol. Bull.,* 112: 196-219.

HULBERT, E. M.
1965. Three closely allied dinoflagellates. *J. Phycol., 1*(2): 95-96.

HUTNER, S. H. and J. J. A. McLAUGHLIN
1958. Poisonous tides. *Sci. Amer., 199*(2): 92-98.

KIMBALL, J. F., JR. and E. J. F. WOOD
1965. A dinoflagellate with characters of *Gymnodinium* and *Gyrodinium. J. Protozool., 12*(4): 577-580.

KING, J. E.
1950. A preliminary report on the plankton of the west coast of Florida. *Quart. Jour. Florida Acad. Sci., 12*(2):109-137.

KOFOID, C. A.
1906a. A discussion of species characters in *Triposolenia. Univ. Calif. Publ. Zool., 3*(7): 117-126.

KOFOID, C. A.
1906b. Dinoflagellata of the San Diego region. II. On *Triposolenia,* a new genus of the Dinophysidae. *Univ. Calif. Publ. Zool., 3*(6): 93-116.

KOFOID, C. A.
1906c. On the significance of the asymmetry in *Triposolenia. Univ. Calif. Publ. Zool., 3*(8): 127-133.

KOFOID, C. A.
1906d. Dinoflagellata of the San Diego region. I. On *Heterodinium,* a new genus of the Peridinidae. *Univ. Calif. Publ. Zool., 2*(3): 341-368.

KOFOID, C. A.
1907a. Dinoflagellata of the San Diego region. III. Descriptions of new species. *Univ. Calif. Publ. Zool., 3*(13): 299-340.

KOFOID, C. A.
1907b. New species of dinoflagellates. *Bull. Mus. Comp. Zool. Harv., 50*(6): 163-207.

KOFOID, C. A.
1907c. The plates of *Ceratium* with a note on the unity of the genus. *Zool. Anz., 32*(7): 177-183.

KOFOID, C. A.
1908. Exuviation, autonomy and regeneration in *Ceratium. Univ. Calif. Publ. Zool., 4*: 345-383.

KOFOID, C. A.
1909a. Mutations in *Ceratium. Bull. Mus. Comp. Zool. Harv., 52*(13): 213-257.

KOFOID, C. A.
1909b. On *Peridinium steini* Jorgensen, with a note of the nomenclature of the skeleton of Peridinidae. *Arch. Prot., 16*: 25-47.

KOFOID, C. A.
1910. The morphology of the skeleton of *Podolampas. Arch. Prot., 16*: 48-61.

KOFOID, C. A.
1911a. Dinoflagellata of the San Diego region. IV. The genus *Gonyaulax* with notes on its skeletal morphology and a discussion of its generic and specific characters. *Univ. Calif. Publ. Zool., 8*(4): 187-286.

KOFOID, C. A.
1911b. On the skeletal morphology of *Gonyaulax catenata* (Levander). *Univ. Calif. Publ. Zool., 8*(5): 287-294.

KOFOID, C. A. and J. R. MICHENER
1911. New genera and species of dinoflagellates. *Bull. Mus. Comp. Zool. Harv., 54*(7): 267-302.

KOFOID, C. A. and E. J. RIGDEN
1912. A peculiar form of schizogony in *Gonyaulax. Bull. Mus. Comp. Zool. Harv., 54*(10): 335-348.

KOFOID, C. A. and O. SWEZY
1921. The free-living unarmored Dinoflagellata. *Mem. Univ. Calif. 5*:1-562.

KOFOID, C. A. and T. SKOGSBERG
1928. The Dinoflagellata: the Dinophysoidae. *Mem. Mus. Comp. Zool. Harv., 51*: 13-760.

LACKEY, J. B. and J. A. HYNES
1955. The Florida gulf coast Red Tide. *Engng. Progr. Univ. Fla., 9*(2): 3-23.

EXPLANATION OF APPENDIX A

Appendix A includes 11 tables representing continuous monthly data from Stations RT 1 through 11.

Percentages shown for each species indicate the relative abundance in surface or bottom samples compared with all other species at those depths. Therefore, if one reads that *Ceratium fusus* was present in June as 3-2, it means that *C. fusus* constituted 3 per cent of the total species observed in the surface sample(s) and 2 per cent of the total species observed in the bottom sample(s) for that particular month. Values expressed as 1 per cent may be 1 per cent or less. Salinity and temperature data are listed for all months. Those salinities prefixed by an asterisk indicate that they are hydrometer readings; those not prefixed by an asterisk are titrations (Mohr). Titration values represented for bottom samples are actually mid-depth salinities. Because of the shallow stations and the extensive mixing of water in these areas, it was felt that mid-depth salinities were similar to bottom values.

TABLE 1: PINELLAS POINT (RT-1)
Surface-bottom % (0-0) of total organisms, per liter, observed.

NAKED DINOFLAGELLATES	N	D	J	F	M	A	M	J	J	A	S
Cochlodinium sp.			1-0								
Gymnodinium splendens			2-0								1-0
Gymnodinium spp.			46-0	0-7					45-0		
Gyrodinium spp.	0-50		18-41	33-36	23-56	32-25	79-86	72-78	33-100	31-35	16-14
Polykrikos hartmanni											1-1
Polykrikos schwartzi									5-0	3-2	
Pouchetia spp.			1-7								0-1
ARMORED DINOFLAGELLATES											
Ceratium fusus								0-5			
Ceratium A (*furca*?)						5-8			5-0		
Dinophysis A									9-0	0-2	
Diplopsalis sp.										5-0	
Exuviaella A						10-0					
Gonyaulax spp.	100-50		32-52	56-57	66-38	53-67	16-3	28-17			0-1
Peridinium conicum										3-0	1-0
Peridinium oblongum							5-0				1-0
Peridinium spp.					0-6		0-11			15-29	1-4
Prorocentrum spp.			11-0	11-0							
Pyrophacus sp.									3-0		
Gymnodinium-Glenodinium spp.										43-32	81-80
Surface / Bottom Cell Counts	6,700 / 13,400	0 / 0	32,660 / 19,330	9,000 / 14,000	3,030 / 5,330	19,000 / 12,000	6,330 / 9,330	7,000 / 7,660	12,170 / 4,000	12,830 / 17,160	67,660 / 68,990
Surface / Bottom Salinity (‰)	*34.3 / *34.3	31.1 / *31.4	*28.2 / *28.2	*25.9 / *26.1	27.4 / 27.6	28.3 / 28.4	27.8 / 28.3	29.0 / 29.5	29.8 / 29.5	29.1 / 29.9	24.6 / 24.7
Surface / Bottom Temperature (°C)	21.0 / 21.5	14.0 / 14.0	16.9 / 16.5	13.5 / 13.5	19.4 / 19.2	27.0 / 26.9	27.2 / 27.2	30.6 / 30.4	27.4 / 27.8	31.2 / 30.8	27.3 / 27.4

TABLE 2: MULLET KEY (RT-2)
Surface-bottom % (0-0) of total organisms, per liter, observed.

NAKED DINOFLAGELLATES	N	D	J	F	M	A	M	J	J	A	S
Gymnodinium spp.				7-0		0-18				27-0	
Gyrodinium fissum						0-2					1-0
Gyrodinium spp.	100-33		57-50	27-21	21-6	33-39	51-92		67-60	29-41	5-35
Polykrikos hartmanni											1-0
ARMORED DINOFLAGELLATES											
Ceratium fusus								0-100			1-0
Ceratium A (*furca?*)				2-0						2-0	
Ceratium sp.					0-6						
Dinophysis caudata var. B											1-0
Dinophysis A							4-0			2-0	
Diplopsalis spp.						0-2				10-11	1-2
Exuviaella A				0-28							
Exuviaella spp.		20-0	0-6								
Gonyaulax spinifera											1-0
Gonyaulax? D											14-0
Gonyaulax spp.	0-67	60-0	43-44	55-42	59-71	56-19	19-8			2-0	1-7
Peridinium depressum										3-3	
Peridinium oblongum										2-0	
Peridinium J (*abei?*)										3-0	
Peridinium B		20-0									
Peridinium spp.					10-0	7-19	26-0		33-40	20-0	3-20
Prorocentrum micans				9-9							
Prorocentrum spp.					10-17						
Pyrophacus horologicum											1-0
Gymnodinium-Glenodinium spp.						4-0				0-45	74-36
Cell Counts — Surface	3,300	16,600	14,000	14,660	3,360	18,000	15,670	0	9,000	20,160	73,980
Cell Counts — Bottom	10,000	0	18,000	14,330	5,660	30,840	8,670	330	5,000	12,160	15,160
Salinity (‰) — Surface	*30.9	*35.0	*33.2	*33.0	34.7	33.0	33.3	35.0	34.9	34.6	31.9
Salinity (‰) — Bottom	*30.8	*35.2	*33.4	*33.0	34.5	33.2	33.6	34.7	35.3	34.5	32.0
Temperature (°C) — Surface	21.5	14.0	16.7	11.0	16.5	26.0	27.3	30.9	25.4	31.0	27.2
Temperature (°C) — Bottom	22.0	14.5	17.0	10.5	15.2	25.9	27.2	30.8	25.5	31.0	27.5

TABLE 3: LIDO KEY (RT-3)
Surface-bottom % (0-0) of total organisms, per liter, observed.

NAKED DINOFLAGELLATES	J	F	M	A	M	J	J	A	S	O
Cochlodinium spp.			3-2							
Gymnodinium splendens	1-4	0-1		0-1						
Gymnodinium spp.	27-55	29-78	9-4	28-61	12-7	12-13				
Gyrodinium fissum								1-1		
Gyrodinium spp.	26-28	27-12	45-46	30-22	34-51	66-48	18-17	25-15	40-32	15-27
Polykrikos schwartzi			1-0	0-1				2-4		
Pouchetia sp.									0-2	
ARMORED DINOFLAGELLATES										
Ceratium A (*furca*?)							6-10	1-1		
Diplopsalis spp.				2-0					0-2	
Exuviaella spp.	1-0	7-1	3-8	25-0	14-0				0-2	
Glenodinium spp.					20-17					
Gonyaulax? D									0-6	
Gonyaulax spp.	45-13	20-7	27-27	15-9	20-25	0-23	41-34	12-14	5-6	
Peridinium excentricum								1-0	2-0	
Peridinium oblongum						0-8		1-0	2-2	
Peridinium A								0-2		
Peridinium D								1-0		
Peridinium E								1-0		
Peridinium spp.	0-1			0-7		22-8	35-39	0-6	8-13	5-8
Prorocentrum micans		17-2	12-13					1-0		
Gymnodinium- Glenodinium spp.								56-57	43-35	80-65
Cell Counts: Surface	33,000	29,500	22,340	19,830	48,840	45,500	5,660	97,990	12,830	6,830
Cell Counts: Bottom	39,330	73,670	26,000	89,660	78,830	42,100	5,990	97,000	15,820	8,500
Salinity (‰): Surface	*34.5	*33.4	34.2	33.0	35.4	35.4	35.9	35.4	34.5	34.9
Salinity (‰): Bottom	*34.6	*33.9	34.3	34.3	35.8	35.7	36.0	35.4	34.5	34.8
Temperature (°C): Surface	14.5	17.2	24.4	25.9	29.3	31.4	30.5	31.2	27.9	24.2
Temperature (°C): Bottom	14.5	17.2	24.4	24.9	28.0	31.4	30.2	31.2	27.6	24.3

TABLE 4: MIDNIGHT PASS (RT-4)
Surface-bottom % (0-0) of total organisms, per liter, observed.

NAKED DINOFLAGELLATES	J	F	M	A	M	J	J	A	S	O
Cochlodinium spp.			14-8							
Gymnodinium splendens				1-0						
Gymnodinium spp.	75-0	6-0		59-27						
Gyrodinium fissum						0-6		7-0		
Gyrodinium spp.	0-49	35-50	42-46	22-48	45-44	69-58		6-18	40-34	23-18
Polykrikos schwartzi				1-3				0-5		
Pouchetia sp.				0-1						
ARMORED DINOFLAGELLATES										
Ceratium trichoceros						2-0		0-1		
Ceratium A (*furca*?)							40-0	0-2		3-0
Dinophysis caudata var. B										3-0
Dinophysis A									2-0	
Diplopsalis spp.									2-3	
Exuviaella A				3-0						
Gonyaulax spinifera										0-4
Gonyaulax spp.	25-45	53-50	35-38	10-20	0-18	0-8		41-34	2-3	6-0
Peridinium depressum			2-0							
Peridinium excentricum								2-0		
Peridinium oblongum			0-3			2-0		1-0	2-3	0-4
Peridinium E	0-3					2-3				
Peridinium spp.				4-1	55-38	23-25	60-0	28-26	14-8	10-14
Prorocentrum micans	0-3	6-0	7-5	1-0						
Prorocentrum gracile						2-0				
Pyrophacus horologicum									0-3	
Gymnodinium-Glenodinium spp.								15-14	38-46	55-60
Cell Counts: Surface	13,330	5,660	14,330	93,010	9,000	13,320	1,660	36,170	14,820	10,160
Cell Counts: Bottom	20,010	6,000	13,000	20,830	16,000	12,000	0	38,500	11,820	9,160
Salinity (‰): Surface	*34.9	*34.9	34.9	34.2	34.5	34.4	35.9	35.5	35.2	33.8
Salinity (‰): Bottom	34.3	35.4	34.5	34.7	35.0	35.4	36.0	35.2	35.6	33.3
Temperature (°C): Surface	15.5	16.1	21.8	25.0	26.6	29.9	30.0	30.8	27.2	23.0
Temperature (°C): Bottom	15.5	16.2	21.5	24.9	26.5	29.9	29.9	30.8	27.3	23.2

TABLE 5: STUMP PASS (RT-5)
Surface-bottom % (0-0) of total organisms, per liter, observed.

NAKED DINOFLAGELLATES	J	F	M	A	M	J	J	A	S 3rd	S 14th	O
Gymnodinium breve							0-1	N			
Gymnodinium splendens				0-1				O		3-0	
Gymnodinium spp.	100-83	0-40		83-77			23-0				
Gyrodinium fissum							1-2	D			
Gyrodinium spp.			27-46	11-13	79-79	68-31	34-35	A	10-17	8-19	29-10
Polykrikos schwartzi						0-3		T		6-0	
Pouchetia sp.					0-4			A			
Torodinium teredo						3-0	0-2				
ARMORED DINOFLAGELLATES											
Ceratium furca							1-0				
Ceratium fusus							0-2	N			
Ceratium trichoceros							1-2				
Ceratium tripos var. *atlanticum*			9-0					O			
Ceratium A (*furca*?)			37-0		11-0		0-2		0-4		
Diplopsalis spp.			0-9			0-6	0-3	D			0-10
Exuviaella A										17-0	
Gonyaulax? D						9-0		A			
Gonyaulax spp.		100-60	0-18	6-9	5-13	0-21	20-14			8-19	
Peridinium depressum	0-6							T			
Peridinium oblongum					5-0	3-8					
Peridinium D	0-11							A			
Peridinium E					0-4	0-3				3-0	
Peridinium spp.						17-23	20-14		32-17	8-9	17-0
Phalacroma sp.						0-5					
Prorocentrum micans			27-27								
Prorocentrum gracile									0-15		
Gymnodinium-Glenodinium spp.							0-24		58-47	47-53	54-80
Surface — Cell Counts	330	670	3,660	66,000	6,330	11,660	24,490	No Data	9,500	11,830	10,170
Bottom	6,000	1,670	3,670	70,330	7,660	12,660	21,920		11,830	10,500	6,840
Surface — Salinity (‰)	*34.0	*35.3	32.4	33.6	35.2	35.4	36.4	No Data	35.4	31.4	33.9
Bottom	*34.0	*35.8	33.2	34.2	34.6	35.4	36.1		34.7	31.2	33.6
Surface — Temperature (°C)	16.2	15.5	22.8	24.0	27.1	28.9	31.2	No Data	29.5	28.5	24.1
Bottom	16.5	15.6	23.0	23.9	27.0	28.9	31.2		29.5	28.8	24.3

TABLE 6: BOCA GRANDE (RT-6)
Surface-bottom % (0-0) of total organisms, per liter, observed.

NAKED DINOFLAGELLATES	J	F	M	A	M	J	J	A	S 3rd	S 14th	O
Cochlodinium spp.	0-4							N			2-0
Gymnodinium splendens	0-4	4-0						O		1-1	
Gymnodinium spp.	85-0	0-43		44-100	0-65						
Gyrodinium fissum							0-2	D		1-1	
Gyrodinium spp.	0-19	69-39	100-68	40-0	75-35	86-63	52-69	A	24-32	4-2	20-7
								T			
ARMORED DINOFLAGELLATES								A			
Ceratium fusus			0-16					N			
Ceratium A (*furca*?)											2-0
Dinophysis A	0-4							O			
Diplopsalis spp.										1-0	
Exuviaella A										72-90	
Exuviaella sp.	6-0										
Gonyaulax spinifera								D			2-0
Gonyaulax spp.	9-38			16-0		14-0	16-0		12-0	1-1	10-0
Peridinium depressum	0-4	4-8	0-16					A			
Peridinium D		15-10									
Peridinium spp.		8-0			25-0	0-37	32-29	T	0-10	2-2	4-5
Prorocentrum micans	0-27										4-0
Protoceratium reticulatum								A			26-46
Pyrodinium bahamense										0-1	
Pyrophacus horologicum										0-1	
Gymnodinium-Glenodinium spp.									64-58	20-3	30-42
Surface — Cell Counts	11,670	8,660	670	12,500	8,000	4,670	19,000	No Data	8,500	277,340	18,160
Bottom	8,650	12,830	1,990	5,500	8,500	16,000	17,330		9,500	167,820	13,170
Surface — Salinity (‰)	*36.3	*27.2	29.9	31.7	35.0	34.5	34.9	No Data	33.8	28.1	28.4
Bottom	*36.0	*27.7	30.3	31.5	34.4	34.4	35.0		34.3	28.0	29.0
Surface — Temperature (°C)	17.0	16.0	22.3	24.6	27.3	29.3	31.5	No Data	30.0	27.8	24.3
Bottom	17.0	16.1	22.3	26.3	27.0	29.1	31.3		29.8	27.7	24.4

TABLE 7: SANIBEL ISLAND (RT-7)
Surface-bottom % (0-0) of total organisms, per liter, observed.

NAKED DINOFLAGELLATES	D	J	F	M	A	M	J	J	A	S	O
Cochlodinium spp.		0-1						8-0			
Gymnodinium spp.		92-96		0-100	100-94	26-0	0-54	0-49	80-80		
Gyrodinium fissum										15-14	
Gyrodinium spp.		5-1	50-67		0-6	48-83	83-30	46-27		21-27	16-14
ARMORED DINOFLAGELLATES											
Ceratium tripos var. *atlanticum*										2-0	
Ceratium A (*furca*?)						2-0				2-2	7-0
Diplopsalis sp.											10-0
Exuviaella spp.									20-0	2-0	
Gonyaulax spp.		1-3	50-33	100-0		0-10	7-6	15-6	0-20		0-7
Peridinium claudicans							0-4				3-0
Peridinium excentricum							3-0				
Peridinium spp.						24-7	7-6	23-18		15-20	10-21
Prorocentrum micans		2-0								2-0	
Prorocentrum sp.								8-0			
Pyrophacus horologicum										2-0	
Gymnodinium-Glenodinium spp.										39-37	54-58
Surface — Cell Counts	0	54,670	2,000	1,330	5,500	20,830	9,670	4,330	5,000	14,150	10,170
Bottom — Cell Counts	0	52,330	6,000	330	5,830	9,670	10,170	11,170	1,660	14,830	9,500
Surface — Salinity (‰)	*33.8	*31.5	*31.6	33.4	33.4	33.8	36.1	34.8	35.2	32.6	24.6
Bottom — Salinity (‰)	*34.1	*34.2	*32.1	33.5	33.4	34.0	35.1	35.0	35.0	33.0	24.6
Surface — Temperature (°C)	18.2	18.0	17.4	19.0	24.5	25.5	29.4	31.5	31.5	33.5	26.7
Bottom — Temperature (°C)	18.0	17.7	17.5	19.1	24.5	25.5	29.4	31.4	32.0	33.1	26.8

TABLE 8: BIG CARLOS PASS (RT-8)
Surface-bottom % (0-0) of total organisms, per liter, observed.

NAKED DINOFLAGELLATES	D	J	F	M	A	M	J	J	A	S	O
Gymnodinium splendens									1-0	0-3	
Gymnodinium spp.	100-0	84-84	10-10	74-66	58-77	35-41		43-0	95-79		
Gyrodinium spp.		2-0	65-56		32-9	63-59	88-78	46-33		25-21	10-5
Polykrikos schwartzi		1-0	3-3							0-1	
Polykrikos spp.			0-3								
Torodinium sp.								2-0			
ARMORED DINOFLAGELLATES											
Ceratium A (*furca?*)			3-0	4-3		2-0			0-2	3-4	
Dinophysis A										0-6	
Diplopsalis spp.								2-0		9-11	0-5
Exuviaella spp.		8-8							0-4		
Gonyaulax? D											0-5
Gonyaulax spp.		5-8	16-28	13-31	10-14		0-7	0-34	3-13		
Peridinium excentricum									1-0		
Peridinium oblongum										0-6	
Peridinium spp.				9-0			12-11	7-33	0-2	16-0	5-0
Prorocentrum micans			3-0				0-4			25-25	
Gymnodinium-Glenodinium spp.										22-23	85-85
Surface / Bottom Cell Counts	50,000 / 0	59,340 / 59,340	12,320 / 10,660	7,500 / 12,830	9,500 / 7,170	15,830 / 13,500	5,670 / 9,000	13,160 / 9,000	26,320 / 15,820	24,500 / 24,160	6,500 / 6,490
Surface / Bottom Salinity (‰)	*34.7 / *34.3	*32.2 / *34.4	*32.7 / *33.2	33.0 / 33.0	33.4 / 33.1	34.4 / 34.2	35.7 / 35.7	35.1 / 33.8	33.5 / 33.5	32.3 / 31.9	32.8 / 33.3
Surface / Bottom Temperature (°C)	16.3 / 16.7	18.4 / 18.4	17.5 / 17.6	20.1 / 19.9	24.5 / 24.2	24.9 / 24.9	29.4 / 29.3	29.9 / 29.8	31.0 / 30.5	31.4 / 31.2	26.2 / 26.3

TABLE 9: CAXAMBAS PASS (RT-9)
Surface-bottom % (0-0) of total organisms, per liter, observed.

NAKED DINOFLAGELLATES	D	J	F	M	A	M	J	J	A	S	O
Cochlodinium sp.						0-3					
Gymnodinium splendens									0-15		
Gymnodinium D									15-0		
Gymnodinium spp.	100-0	100-0		100-0	100-100		40-0		31-46		
Gyrodinium spp.			50-75			42-30	51-50	0-34		54-0	17-4
Pouchetia sp.							2-0				
ARMORED DINOFLAGELLATES											
Ceratium A (*furca*?)									8-0		
Diplopsalis spp.						14-5		0-4	8-23	14-0	13-0
Gonyaulax spp.			50-25	0-100		21-22	0-30		23-8		
Peridinium claudicans										0-50	
Peridinium divergens							2-0				
Peridinium spp.						21-37	5-20		15-8	27-0	0-22
Pyrophacus horologicum										5-50	0-4
Pyrophacus sp.						2-3					
Gymnodinium- Glenodinium spp.								0-62			70-70
Cell Counts — Surface	25,000	10,000	1,340	330	6,170	14,330	13,830	0	4,310	7,330	7,830
Cell Counts — Bottom	0	0	1,330	1,000	5,500	13,330	3,340	8,830	4,320	660	7,830
Salinity (‰) — Surface	*36.6	*35.8	*35.9	33.4	35.3	35.0	35.4	33.6	34.4	34.5	33.9
Salinity (‰) — Bottom	*36.2	*35.6	*35.9	33.9	35.4	35.2	35.4	33.4	34.8	34.5	33.9
Temperature (°C) — Surface	17.3	19.0	18.2	20.5	25.2	25.9	29.5	30.1	30.0	30.5	26.5
Temperature (°C) — Bottom	17.1	19.0	18.3	20.8	25.2	25.6	29.4	30.0	29.5	30.5	26.5

TABLE 10: WEEDON ISLAND (RT-10)
Surface-bottom % (0-0) of total organisms, per liter, observed.

NAKED DINOFLAGELLATES	J	F	M	A	M	J	J	A	S
Cochlodinium sp.	0-2								
Gymnodinium splendens	5-4	1-0	5-28				1-1	5-0	
Gymnodinium spp.	2-5	16-16		22-29	35-0				
Gyrodinium fissum								0-3	
Gyrodinium spp.	24-16	59-54		32-31	58-100	28-27	31-25	52-42	15-24
Polykrikos schwartzi							1-0		
ARMORED DINOFLAGELLATES									
Ceratium furca			0-36						
Ceratium A (*furca*?)				2-3			1-0	14-9	
Diplopsalis spp.									0-14
Exuviaella sp.									0-3
Gonyaulax spp.	14-33	24-30	95-36	28-21		46-36			0-3
Peridinium conicum									8-0
Peridinium spp.	55-40			16-16	7-0	0-13	0-6		15-0
Gymnodinium-Glenodinium spp.						26-24	67-68	29-46	62-56
Surface — Cell Counts	14,000	33,830	6,330	24,830	15,500	215,000	81,660	19,170	8,830
Bottom — Cell Counts	18,330	33,500	3,660	19,170	3,000	225,000	81,000	11,830	9,820
Surface — Salinity (‰)	*12.4	*18.2	19.1	19.3	24.1	25.7	21.8	22.7	22.0
Bottom — Salinity (‰)	20.1	18.1	19.2	19.4	24.1	25.7	21.7	23.0	22.0
Surface — Temperature (°C)	16.5	16.4	23.0	29.5	29.5	32.8	27.5	34.2	31.1
Bottom — Temperature (°C)	16.5	16.2	23.0	29.2	29.0	32.5	27.5	33.5	30.9

TABLE 11: BALLAST POINT (RT-11)
Surface-bottom % (0-0) of total organisms, per liter, observed.

NAKED DINOFLAGELLATES	J	F	M	A	M	J	J	A	S
Gymnodinium splendens	10-8	1-0	6-9					0-2	
Gymnodinium spp.	38-55	76-0		87-90			48-33		
Gyrodinium spp.	30-0	11-38		13-10		15-13	17-31	5-20	20-7
Polykrikos hartmanni									2-2
Polykrikos schwartzi	1-2								
Pouchetia sp.	1-0								
ARMORED DINOFLAGELLATES									
Ceratium furca			2-9						
Ceratium A (*furca*?)					83-75			0-1	
Dinophysis A	0-2				3-0				
Exuviaella spp.		2-0							0-2
Gonyaulax spp.	19-33	11-62	91-73		7-25		35-18	95-68	44-48
Peridinium depressum			1-9						
Peridinium spp.					7-0		0-18	0-7	
Prorocentrum micans	1-0								
Gymnodinium-Glenodinium spp.						85-87		0-2	34-41
Surface — Cell Counts	26,660	72,330	330,000	63,000	9,670	650,000	115,000	70,000	16,490
Bottom — Cell Counts	17,990	13,000	369,000	61,000	2,670	630,000	16,500	295,400	13,490
Surface — Salinity (‰)	*19.6	*17.0	19.1	19.2	21.5	24.6	17.8	16.3	17.2
Bottom — Salinity (‰)	*19.6	*16.6	19.1	19.1	21.6	24.8	19.2	16.5	17.5
Surface — Temperature (°C)	14.5	17.1	22.0	27.9	29.4	33.6	27.8	36.8	31.0
Bottom — Temperature (°C)	14.5	15.8	21.5	27.9	28.6	33.4	27.5	34.8	30.8

EXPLANATION OF APPENDIX B

Appendix B includes 9 tables representing weekly data, compiled on a monthly basis from Stations WS 1 through 9. To present the WS samples on a monthly basis, weekly species counts were averaged and a percentage calculated. The hydrologic data indicate the minimum and maximum encountered monthly for each station. All salinities were derived from hydrometer readings.

TABLE 12: NEW PASS (WS-1)
Surface-bottom % (0-0) of total organisms, per liter, observed.

NAKED DINOFLAGELLATES	D	J	F	M	A	M	J	J	A	S	O
Amphidinium sp.							1-0				
Cochlodinium spp.		2-0		1-1	0-1	0-1				1-0	
Gymnodinium breve										0-1	
Gymnodinium splendens		2-0			1-0			1-0			
Gymnodinium spp.	81-75	0-29	2-0	23-36	49-65	23-32	38-23				
Gyrodinium fissum							0-1	6-3	26-18	0-1	
Gyrodinium spp.	12-8	52-45	64-51	22-29	23-17	55-46	51-46	23-27	37-38	13-27	49-20
Polykrikos schwartzi					0-1	0-1					1-0
Pouchetia spp.		3-0									
Torodinium teredo						1-4		0-1			
Torodinium spp.				1-0							1-0
ARMORED DINOFLAGELLATES											
Ceratium fusus				0-1				1-1	0-1	1-0	1-0
Ceratium trichoceros							0-1	0-1		0-1	
Ceratium tripos var. *atlanticum*				1-1				1-0			
Ceratium A (*furca*?)				1-0	0-1					1-1	
Dinophysis caudata var. *pedunculata*										0-1	
Dinophysis caudata var. B										1-1	
Diplopsalis spp.				0-1	0-1	1-0			1-4	3-3	0-2
Exuviaella sp.							0-1				
Gonyaulax spinifera										0-1	
Gonyaulax? D									0-2		
Gonyaulax spp.	6-17	41-24	29-34	33-15	15-10	4-12	8-2	16-7	16-11	3-6	4-1
Peridinium claudicans								1-0	1-0		
Peridinium conicum										1-3	0-1
Peridinium depressum				1-0							
Peridinium divergens								0-1			
Peridinium excentricum								1-0			
Peridinium oblongum				1-0	1-0		1-1	1-0	1-0	1-2	0-1
Peridinium J (*abei*?)									1-0	0-1	
Peridinium D					1-0		1-0				
Peridinium E							0-1	0-2	0-1		
Peridinium spp.					12-6	17-4	13-10	27-14	2-1	8-14	5-1
Prorocentrum micans	1-0	0-2	5-15	18-17			2-0		1-0	1-0	0-1
Prorocentrum gracile						0-1	0-1			1-0	
Prorocentrum spp.				1-1		0-1					
Pyrophacus horologicum								0-4	2-1	1-0	
Pyrophacus horologicum var. *steinii*										0-1	
Pyrophacus sp.								1-2			
Gymnodinium-Glenodinium spp.								22-37	13-24	68-38	39-75
Averaged Cell Counts — Surface	20,657	6,663	6,777	20,077	41,273	15,997	7,373	13,070	14,497	26,283	13,995
Averaged Cell Counts — Bottom	22,100	5,667	4,553	18,160	33,777	17,273	11,615	14,830	15,223	14,410	40,240
Salinity (‰) Ranges — Surface	35.8-36.0	34.3-35.1	35.3-35.8	35.2-36.0	33.0-37.4	37.6-38.6	38.1-39.3	37.2-38.7	34.7-37.1	35.2-38.1	35.0-36.4
Salinity (‰) Ranges — Bottom	36.0	34.3-35.1	35.3-35.6	35.4-35.7	33.0-37.4	37.3-38.3	38.2-39.0	37.1-39.1	35.6-37.1	35.3-37.8	34.9-36.0
Temperature (°C) Ranges — Surface	15.0-15.5	12.8-15.8	14.5-16.7	19.5-21.5	24.1-27.4	26.7-27.0	29.2-31.4	28.9-31.2	30.0-31.4	27.6-28.9	22.5-23.9
Temperature (°C) Ranges — Bottom	14.8-15.8	13.0-16.0	14.4-16.7	19.2-21.3	24.2-27.3	26.5-26.8	29.1-31.3	28.8-31.2	29.9-31.1	27.5-28.9	22.5-23.8

TABLE 13: BIG SARASOTA PASS (WS-2)

Bottom	14.8-15.8	13.0-16.0	14.4-16.7	19.2-21.3	24.2-27.3	26.5-26.8	29.1-31.3	28.8-31.2	29.9-31.1	27.5-28.9	22.5-23.8

TABLE 13: BIG SARASOTA PASS (WS-2)
Surface-bottom % (0-0) of total organisms, per liter, observed.

NAKED DINOFLAGELLATES	D	J	F	M	A	M	J	J	A	S	O
Cochlodinium sp.										1-0	
Gymnodinium breve		0-2						0-1		0-1	
Gymnodinium splendens	1-0				0-1					1-2	
Gymnodinium spp.	43-46	40-47	0-3	5-6	22-23	14-39	38-32	19-13	2-2		
Gyrodinium fissum					1-1		0-1	0-2	6-10	2-0	
Gyrodinium spp.	45-14	39-18	64-67	33-37	39-49	63-52	42-39	31-29	33-42	36-26	20-32
Pouchetia sp.		2-0									
Torodinium teredo						1-0					
Torodinium spp.								3-0		0-1	
ARMORED DINOFLAGELLATES											
Ceratium furca								1-0			
Ceratium fusus							1-0	0-1	1-0	1-1	1-0
Ceratium trichoceros							1-0				
Cératium tripos var. *atlanticum*				1-0			1-0	1-2			
Ceratium A (*furca?*)				1-0			0-1	0-1		1-1	1-0
Ceratium sp.									1-0		
Dinophysis caudata var. B									1-0	1-1	
Dinophysis A										1-0	
Diplopsalis spp.				0-1		0-1	1-0	0-1	1-5	3-1	0-5
Exuviaella A				3-0							
Exuviaella spp.										1-1	
Gonyaulax monilata										3-2	
Gonyaulax spinifera										0-1	
Gonyaulax? D						5-2				0-4	
Gonyaulax spp.	11-39	19-31	22-27	28-24	22-20	7-2	6-11	10-10	10-14	3-1	0-3
Peridinium claudicans							1-0		1-2		
Peridinium conicum							1-0		1-0	1-1	1-0
Peridinium depressum											1-0
Peridinium excentricum									0-1	0-1	
Peridinium oblongum				1-0			1-0			2-1	1-2
Peridinium D	0-1			0-1				2-0			
Peridinium E									2-1		
Peridinium N											1-0
Peridinium spp.	0-1	0-2		1-1	16-6	10-5	9-17	13-26	10-1	15-12	4-3
Prorocentrum micans			7-3	29-29							
Prorocentrum gracile									0-1	1-0	0-3
Prorocentrum spp.			7-0	0-1	0-1	1-0				1-0	
Pyrophacus horologicum								1-1	1-0	0-1	
Pyrophacus horologicum var. *steinii*									1-0		
Pyrophacus sp.								0-2			
Gymnodinium-Glenodinium spp.								19-13	32-24	28-43	73-52
Surface / Averaged Cell Counts	19,477	8,220	3,110	10,328	16,443	13,277	11,615	14,830	17,273	14,695	41,560
Bottom	18,087	7,110	4,440	7,745	15,883	14,277	13,458	21,330	15,220	12,905	10,515
Surface / Salinity (‰) Ranges	35.7-36.8	33.8-34.7	34.8-35.4	35.4-35.8	33.3-37.0	37.3-38.1	37.8-38.7	37.0-38.9	35.4-36.9	35.3-37.7	35.3-35.9
Bottom	35.5-37.0	33.9-35.0	34.8-35.0	35.2-36.0	33.2-37.4	37.1-37.9	38.2-39.2	36.9-39.1	35.2-36.9	35.6-37.5	35.3-35.9
Surface / Temperature (°C) Ranges	14.8-15.5	13.2-16.0	14.7-17.5	19.5-21.5	24.3-27.2	26.7-27.4	29.5-31.5	28.9-31.4	30.0-31.2	27.6-28.9	22.1-23.9
Bottom	14.8-15.5	13.1-16.0	14.8-17.2	19.4-21.2	24.2-27.4	26.5-27.0	29.1-31.3	29.5-31.5	30.0-31.6	27.6-29.0	22.3-23.7

TABLE 14: MIDNIGHT PASS (WS-3)
Surface-bottom % (0-0) of total organisms, per liter, observed.

NAKED DINOFLAGELLATES	D	J	F	M	A	M	J	J	A	S	O
Cochlodinium spp.				0-3	0-1						
Gymnodinium breve					0-1						
Gymnodinium splendens					2-1						
Gymnodinium spp.	88-93	65-60	58-0	8-6	20-27	58-46	17-27		8-0		
Gyrodinium fissum		5-0			1-0			2-2	22-24	0-1	
Gyrodinium spp.	6-4	11-19	11-32	44-38	44-42	35-47	53-44	47-28	21-28	24-25	33-52
Polykrikos schwartzi					0-1						
Torodinium teredo							0-1				
ARMORED DINOFLAGELLATES											
Ceratium fusus							1-0	1-0	1-1		
Ceratium trichoceros							2-0	0-1			
Ceratium tripos var. *atlanticum*				0-1			2-0		1-0	0-1	
Ceratium A (*furca*?)	2-0				0-1		0-1		1-2	1-0	
Ceratium sp.							0-1				
Dinophysis caudata var. *pedunculata*									1-0	1-0	
Dinophysis caudata var B.										0-2	
Dinophysis A										1-0	
Diplopsalis spp.		0-1		1-2	1-0	1-0	1-2		0-4	0-1	
Exuviaella spp.			7-41				2-1			1-0	
Goniodoma sp.		1-0									
Gonyaulax spinifera										1-0	
Gonyaulax? D									3-6		
Gonyaulax spp.	4-2	17-18	21-27	29-28	27-26	2-0	12-7	3-11	20-15	5-3	0-2
Peridinium claudicans							1-1		3-0		
Peridinium conicum								1-0		0-1	2-0
Peridinium depressum			3-0		0-1					0-2	
Peridinium divergens					1-0	0-1	0-1		1-0		
Peridinium excentricum		1-0					1-2		1-1	1-0	
Peridinium oblongum				0-1	1-1		1-0			2-2	
Peridinium D							1-1				
Peridinium E					1-0		1-0		0-1	1-0	
Peridinium spp.	0-1	0-2		1-4	2-1	3-7	5-13	12-19	10-12	5-8	8-11
Phalacroma sp.						1-0					
Prorocentrum micans				17-18				0-1	0-1	1-2	0-2
Prorocentrum gracile										1-0	0-2
Prorocentrum sp.					1-0						
Pyrophacus horologicum								1-4	1-2	1-1	
Pyrophacus horologicum var. *steinii*								0-1			
Pyrophacus sp.								1-3	0-3		
Gymnodinium-Glenodinium spp.								32-31	8-1	56-53	57-31
Averaged Cell Counts — Surface	75,333	10,223	3,167	6,830	18,333	9,610	8,025	16,995	23,220	9,908	9,665
Averaged Cell Counts — Bottom	72,267	11,333	7,333	8,910	20,603	12,053	11,073	17,995	17,783	10,413	8,760
Salinity (‰) Ranges — Surface	35.6-36.7	33.3-35.6	34.8-35.4	35.2-36.1	33.3-37.3	37.1-37.6	37.7-38.8	36.8-39.0	36.4-37.1	35.6-37.2	35.4-35.7
Salinity (‰) Ranges — Bottom	35.8-36.7	33.3-35.4	34.8-35.4	35.1-36.6	33.3-37.4	36.8-38.0	37.8-38.7	36.8-39.0	36.2-36.7	35.8-37.4	35.3-35.7
Temperature (°C) Ranges — Surface	15.0-15.5	13.0-16.6	14.8-17.7	19.5-21.9	24.1-27.4	26.6-27.2	29.6-31.4	28.9-31.4	29.9-31.4	27.3-28.9	22.6-23.9
Temperature (°C) Ranges — Bottom	15.3-15.8	13.5-16.5	14.8-18.5	19.5-21.5	24.2-27.3	26.4-27.2	29.8-31.4	28.8-31.4	29.8-31.4	27.3-28.9	22.8-23.9

TABLE 15: BAYBORO HARBOR (WS-4)
Surface-bottom % (0-0) of total organisms, per liter, observed.

NAKED DINOFLAGELLATES	D	J	F	M	A	M	J	J	A	S	O
Amphidinium sp.											3-0
Cochlodinium spp.	8-0				3-2	0-3					0-1
Gymnodinium splendens		0-1								1-0	0-1
Gymnodinium spp.	38-0	13-15	21-11	6-7	63-49	28-45	57-74	67-77	24-0		
Gyrodinium spp.		43-40	46-46	49-57	27-44	40-46	30-22	24-16	7-23	34-20	25-27
Noctiluca scintillans		1-0									
Polykrikos hartmanni										1-1	
Polykrikos schwartzi		0-1	1-2						0-1	1-1	
Polykrikos spp.			0-1								
Pouchetia spp.		0-1					3-0				
ARMORED DINOFLAGELLATES											
Ceratium furca				1-0							
Ceratium A (*furca*?)				0-1	1-0	0-3				1-1	1-0
Ceratium sp.								1-0			
Dinophysis caudata var. *pedunculata*					1-0						
Dinophysis caudata var. B										1-0	
Dinophysis A				1-0						3-1	
Diplopsalis spp.									0-4	1-1	
Exuviaella A				4-0							6-4
Exuviaella spp.	2-0				1-0						
Gonyaulax spinifera											11-0
Gonyaulax? D									66-2		1-0
Gonyaulax spp.	52-100	43-39	32-42	37-33	6-4	19-0	2-1		0-3	7-10	2-1
Peridinium claudicans											1-0
Peridinium conicum										1-0	1-1
Peridinium oblongum										0-1	
Peridinium E		0-1							1-0		
Peridinium N											1-1
Peridinium spp.		0-3		0-1	0-1	13-3	3-3	2-3	1-6	9-8	3-3
Prorocentrum micans			1-0	4-1	1-0						
Prorocentrum spp.				1-1							
Gymnodinium-Glenodinium spp.							5-0	7-4	2-62	43-60	59-63
Averaged Cell Counts — Surface	44,433	9,833	13,500	29,208	23,598	49,850	28,693	16,766	76,610	35,370	34,273
Averaged Cell Counts — Bottom	30,000	16,748	15,872	21,873	32,568	30,408	57,625	28,564	32,497	29,545	34,890
Salinity (‰) Ranges — Surface	27.6-30.7	19.6-29.2	10.6-24.4	17.4-24.3	16.5-24.8	25.3-28.2	26.2-29.2	23.3-29.6	19.2-24.8	24.4-25.8	25.4-27.4
Salinity (‰) Ranges — Bottom	28.8-30.7	22.5-28.5	23.9-24.6	16.9-25.2	20.2-26.8	26.3-27.5	28.4-29.4	27.0-29.8	19.5-28.1	24.9-25.7	25.4-27.6
Temperature (°C) Ranges — Surface	16.0-19.0	13.1-19.8	12.0-18.0	20.7-23.7	21.4-27.5	28.2-29.8	30.3-33.1	30.8-32.5	30.6-33.1	29.2-31.9	23.7-28.1
Temperature (°C) Ranges — Bottom	15.1-18.0	14.0-16.5	15.4-16.5	18.1-22.7	19.9-25.7	25.7-27.8	29.3-31.9	29.4-31.6	30.4-31.4	28.6-30.6	23.6-26.7

TABLE 16: PINELLAS POINT (WS-5)
Surface-bottom % (0-0) of total organisms, per liter, observed.

NAKED DINOFLAGELLATES	D	J	F	M	A	M	J	J	A	S	O
Cochlodinium spp.		1-0		7-1							
Gymnodinium splendens		0-5					0-1	1-0		3-3	
Gymnodinium spp.	79-0		11-0	0-3	61-85	0-51	37-71	59-64	0-14		
Gyrodinium fissum									0-2		
Gyrodinium spp.	10-31	35-27	35-35	39-44	7-7	95-33	38-14	26-23	30-30	27-25	35-54
Polykrikos hartmanni										3-2	0-1
Polykrikos schwartzi		0-1	0-1		0-1					1-0	2-0
ARMORED DINOFLAGELLATES											
Ceratium furca				1-0							
Ceratium fusus									1-0		
Ceratium A (*furca*?)					1-1	3-5	1-1	2-1	1-0	3-3	
Ceratium F (*fusus*?)									1-0		
Dinophysis A					0-1				1-0	2-2	
Diplopsalis spp.									3-2	7-4	0-1
Exuviaella A			2-4								
Exuviaella spp.			8-2								
Gonyaulax spinifera										0-1	2-0
Gonyaulax D						0-8				0-27	
Gonyaulax spp.	11-69	64-67	42-58	38-41	3-5	4-0	4-3	2-2		2-0	
Peridinium claudicans										1-0	
Peridinium conicum										0-2	0-2
Peridinium oblongum										1-1	
Peridinium D					1-0						
Peridinium N											3-2
Peridinium spp.		1-0		3-3	1-1	2-3	20-11	5-4	27-25	3-3	3-6
Prorocentrum micans			2-1	7-1	1-0						
Prorocentrum spp.				5-8	28-2						
Pyrophacus horologicum									1-0		0-1
Pyrophacus horologicum var. *steinii*									1-0	1-0	
Pyrophacus sp.							0-1				
Gymnodinium-Glenodinium								5-6	34-27	46-28	55-33
Averaged Cell Counts — Surface	10,533	10,665	12,625	7,248	47,600	9,753	14,500	18,766	10,883	12,078	6,667
Averaged Cell Counts — Bottom	14,433	15,248	12,915	9,750	34,810	32,008	25,373	19,000	13,280	14,528	11,100
Salinity (‰) Ranges — Surface	29.4-31.8	26.2-30.2	24.8-28.3	27.0-28.7	27.3-28.5	28.6-30.7	31.4-32.5	30.2-31.3	21.4-31.1	26.5-29.2	26.8-30.7
Salinity (‰) Ranges — Bottom	30.7-31.8	26.7-31.3	24.8-28.5	27.0-28.3	27.2-28.9	29.8-31.1	31.9-32.5	30.3-32.0	21.5-31.1	26.8-29.1	26.9-30.7
Temperature (°C) Ranges — Surface	14.0-16.4	9.0-18.3	12.5-16.4	20.5-22.5	18.8-25.2	24.8-27.5	29.7-32.1	29.1-31.1	29.9-30.8	26.7-28.1	18.7-24.1
Temperature (°C) Ranges — Bottom	13.6-15.0	9.0-17.6	12.6-16.4	20.5-22.7	18.6-25.1	24.7-27.6	29.7-32.0	28.9-30.8	29.9-30.7	26.8-28.2	19.2-24.1

TABLE 17: BALLAST POINT (WS-6)
Surface-bottom % (0-0) of total organisms, per liter, observed.

NAKED DINOFLAGELLATES	D	J	F	M	A	M	J	J	A	S	O
Amphidinium spp.										1-0	
Cochlodinium spp.			15-6	1-0						0-1	1-0
Gymnodinium splendens	31-29	17-12	2-3	13-26				1-0	19-10	7-15	1-0
Gymnodinium spp.	7-0	34-33	15-13	1-1	2-6	2-1	45-47	33-58	2-0		
Gyrodinium fissum		5-0									
Gyrodinium spp.		14-19	5-4	5-3		1-1	25-25	1-1	24-33	19-27	44-52
Polykrikos hartmanni										13-9	1-2
Polykrikos schwartzi	3-0	3-1	1-1				5-3	1-1	1-0	1-1	
Polykrikos spp.		0-1						1-1			
Pouchetia spp.		0-1	1-1								
ARMORED DINOFLAGELLATES											
Ceratium furca	3-0			1-11							
Ceratium A (*furca*?)	1-2	1-0	1-1	3-2	1-1	97-97	13-9	47-22	1-0	1-1	3-2
Dinophysis A	2-0		1-0	1-1		1-0	5-2	3-1	2-1	1-1	1-0
Diplopsalis spp.						0-1	1-1	1-1		1-1	
Exuviaella A			52-62								
Exuviaella spp.		1-1	1-3								
Gonyaulax spinifera									2-0	1-2	4-3
Gonyaulax? D										2-5	
Gonyaulax spp.	49-60	25-30	7-6	79-54	76-92			1-0	17-15	29-3	
Peridinium claudicans							1-0	1-0			
Peridinium conicum								1-0			2-4
Peridinium divergens						0-1		1-1			
Peridinium excentricum							0-1				
Peridinium oblongum								1-0	1-0	1-1	
Peridinium D				0-1			0-1				
Peridinium E						1-0	1-0	1-0	1-0	1-1	
Peridinium spp.	2-9	1-1		1-1	1-1	1-1	6-12	11-16	6-2	7-28	11-3
Phalacroma sp.						1-0					
Prorocentrum micans	2-0	1-1	1-1	1-0							
Pyrophacus horologicum									3-2	1-1	
Pyrophacus horologicum var. *steinii*									1-0		
Pyrophacus sp.									2-0		
Gymnodinium-Glenodinium spp.									19-36	12-8	33-33
Averaged Cell Counts — Surface	120,677	37,005	242,675	579,350	564,334	690,915	95,130	397,692	107,357	146,175	11,217
Averaged Cell Counts — Bottom	49,967	30,500	202,240	532,005	206,100	150,968	87,835	211,480	107,843	63,093	11,107
Salinity (‰) Ranges — Surface	23.6-26.9	17.2-20.5	15.6-19.1	16.2-24.0	17.9-25.1	22.0-24.2	24.6-26.4	18.7-25.4	15.6-17.5	14.7-18.5	17.5-24.2
Salinity (‰) Ranges — Bottom	24.6-27.1	17.6-21.3	15.6-19.1	16.2-24.3	18.0-25.6	20.6-24.1	25.0-26.6	18.7-25.5	17.8-19.3	14.8-19.3	17.6-24.0
Temperature (°C) Ranges — Surface	13.6-17.4	10.0-14.2	13.0-16.1	19.1-23.5	18.0-24.6	24.2-27.2	28.5-30.5	27.4-30.1	28.4-29.9	26.2-27.9	19.6-23.7
Temperature (°C) Ranges — Bottom	13.5-16.9	9.6-14.2	13.0-16.0	18.0-22.0	18.3-24.9	24.5-26.5	28.4-30.0	27.5-30.1	28.3-30.1	26.3-28.1	19.3-23.7

TABLE 18: OUTSIDE STUMP PASS (WS-7)
Surface-bottom % (0-0) of total organisms, per liter, observed.

NAKED DINOFLAGELLATES	D	J	F	M	A	M	J	J	A	S	O
Amphidinium spp.											0-6
Cochlodinium spp.		0-1		5-0							
Gymnodinium breve								1-1			
Gymnodinium splendens					0-1		1-0				
Gymnodinium spp.	94-44	71-67	0-7	6-17	93-61	39-40	30-32	11-6			
Gyrodinium fissum		0-1					1-1	3-3	4-6	1-1	
Gyrodinium spp.	6-0	15-24	47-30	40-36	4-2	33-38	33-36	34-34	26-17	20-18	38-30
Polykrikos schwartzi										0-1	
Pouchetia sp.							1-0				
Torodinium teredo						0-2	1-1	3-0			1-0
Torodinium spp.								0-1		0-1	
ARMORED DINOFLAGELLATES											
Ceratium furca					0-1				1-0		
Ceratium fusus		1-0		1-0				2-1	0-1		
Ceratium trichoceros							1-0	0-1	1-0		
Ceratium tripos var. *atlanticum*			1-3					0-1	1-0		
Ceratium A (*furca*?)		1-0				0-1		0-3	2-2	1-1	1-1
Dinophysis caudata var. B									0-6	3-2	
Dinophysis A									11-6	1-0	
Dinophysis sp.										0-1	
Diplopsalis spp.				1-0	1-1	2-0	1-0	1-0		9-7	3-3
Exuviaella A				0-11							
Exuviaella spp.		1-0					1-0				
Gonyaulax spinifera									12-13		
Gonyaulax? D							1-0		6-5		
Gonyaulax spp.	0-53	9-6	49-57	18-24	1-13	16-6	13-12	12-11	3-2	15-17	11-4
Peridinium claudicans										0-2	1-0
Peridinium conicum								1-0		1-0	1-0
Peridinium depressum		1-1		0-1							0-1
Peridinium excentricum		1-0		4-0				1-0	0-2	1-0	0-1
Peridinium oblongum			0-3	1-0		1-1	1-0	1-1	1-0	3-0	0-1
Peridinium D	0-3	0-1		0-1			1-0				
Peridinium E						1-1	1-0	1-0		0-1	
Peridinium spp.				17-4	2-23	9-11	15-19	9-17	14-12	18-15	9-14
Phalacroma sp.							0-1				
Prorocentrum micans		1-0	2-0	8-7					0-11		0-1
Prorocentrum gracile						0-1		1-0	2-5	0-3	
Prorocentrum sp.					1-0						
Pyrophacus horologicum								0-1		0-1	
Pyrophacus sp.					0-1		1-0				
Gymnodinium-Glenodinium spp.								21-21	16-13	28-30	30-45
Surface — Averaged Cell Counts	13,325	18,402	4,415	18,830	186,679	10,450	18,163	13,343	17,410	13,107	13,788
Bottom — Averaged Cell Counts	28,325	22,466	2,498	11,415	203,652	10,288	17,415	13,173	20,195	11,993	12,248
Surface — Salinity (‰) Ranges	35.0-36.7	35.7-36.8	32.8-36.2	35.0-36.5	36.2-37.8	36.9-38.5	37.6-39.2	37.5-39.2	35.4-37.1	36.6-37.2	36.0-36.4
Bottom — Salinity (‰) Ranges	35.0-36.2	36.0-36.7	34.4-36.4	35.0-36.6	36.1-37.9	37.4-38.3	37.9-38.9	37.6-39.1	35.9-36.9	37.4-37.8	35.7-36.2
Surface — Temperature (°C) Ranges	13.3-16.8	14.0-17.9	15.2-18.8	20.0-22.1	20.6-27.3	26.0-27.6	27.0-31.5	28.8-31.1	28.6-31.5	27.4-29.8	21.9-28.3
Bottom — Temperature (°C) Ranges	13.0-16.8	14.0-18.0	15.5-18.8	19.6-22.2	20.6-27.3	26.1-27.5	28.7-31.5	29.5-31.2	28.9-31.4	27.3-30.0	21.4-28.3

TABLE 19: IN STUMP PASS (WS-8)
Surface-bottom % (0-0) of total organisms, per liter, observed.

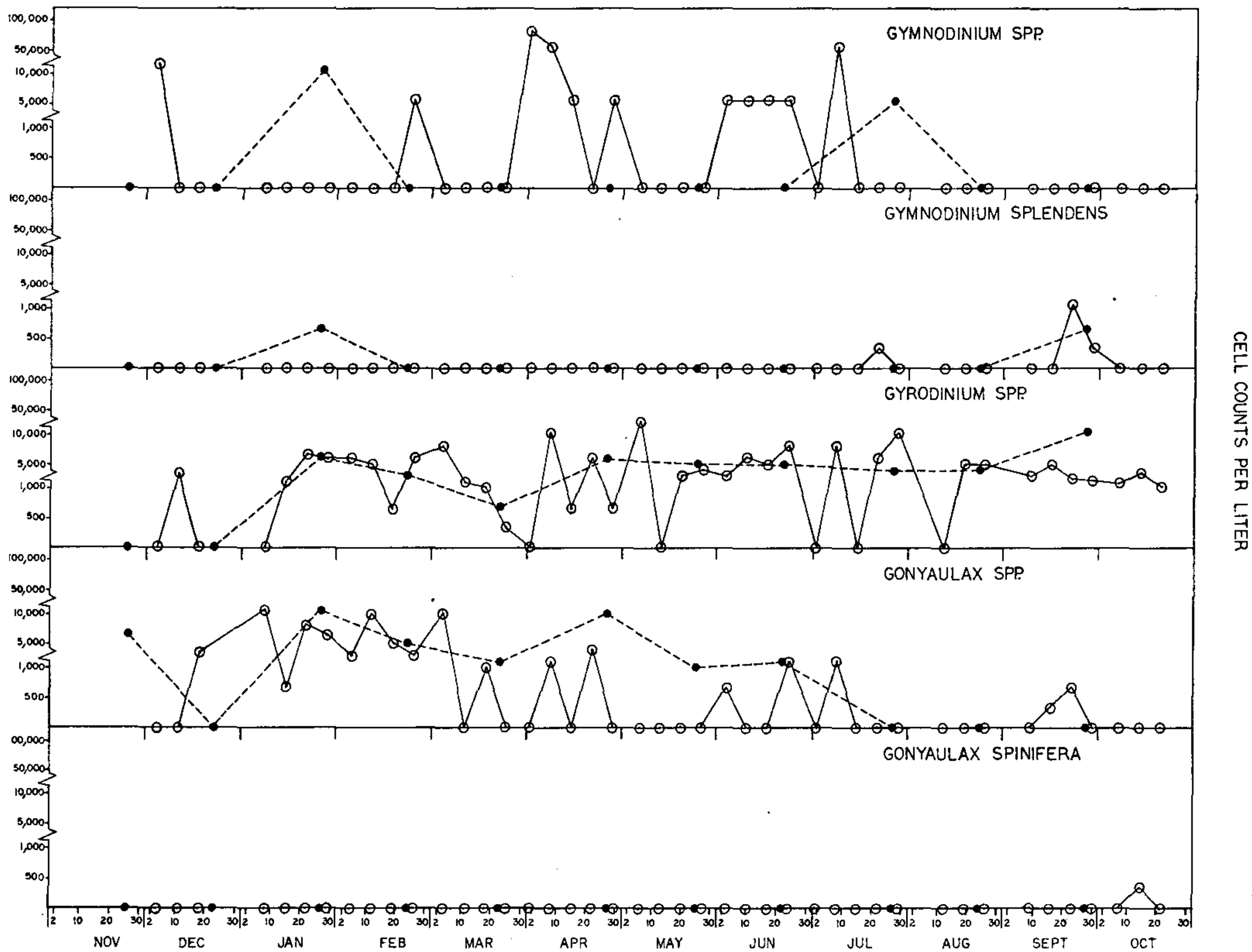
NAKED DINOFLAGELLATES	D	J	F	M	A	M	J	J	A	S	O
Cochlodinium spp.	0-4		3-0	1-1	1-0						
Gymnodinium breve								0-1			0-1
Gymnodinium splendens		0-1			1-1	0-1	0-1				
Gymnodinium spp.	0-60	77-69		6-9	92-91	53-24	25-30	19-15			
Gyrodinium fissum					1-0	0-1		1-2	7-2	2-0	
Gyrodinium spp.	50-12	15-17	40-42	28-43	2-6	27-45	32-38	35-38	18-13	29-19	29-36
Torodinium teredo						1-10		2-1			2-0
Torodinium sp.										1-0	
ARMORED DINOFLAGELLATES											
Ceratium fusus								2-1	0-1		
Ceratium trichoceros							1-1	1-1			
Ceratium tripos var. *atlanticum*							1-0	0-1	0-1	0-1	
Ceratium A (*furca*?)		0-1		1-0			1-1	1-1	1-1	1-0	
Ceratium F (*fusus*?)								0-2		0-1	
Dinophysis caudata var. B									0-1	1-0	
Dinophysis A									7-18		
Diplopsalis spp.				1-1	1-0			0-1	2-2	1-4	1-1
Exuviaella A					1-0						
Exuviaella spp.	0-4				0-1		1-0				
Gonyaulax monilata					0-1						
Gonyaulax spinifera									18-29		
Gonyaulax? D							'0-3		5-2		2-0
Gonyaulax spp.	25-16	7-12	54-58	30-32	2-1	4-4	15-11	3-11	2-2	17-13	5-1
Peridinium claudicans						0-1	1-0	1-0		0-1	
Peridinium conicum								0-1	2-6	1-1	
Peridinium depressum	0-4		3-0	0-2					2-1	0-1	
Peridinium divergens						1-0					
Peridinium excentricum							1-0	2-0	2-0		0-2
Peridinium oblongum							1-1	1-1	0-1	3-1	
Peridinium D						1-1	1-0				2-1
Peridinium E						0-1				1-0	
Peridinium spp.		1-1		31-1	3-1	14-20	22-14	22-15	15-8	25-12	13-8
Prorocentrum micans				4-10					2-12	0-2	1-1
Prorocentrum gracile						0-1	1-1	1-0	2-2		
Prorocentrum spp.	25-0	1-0		0-2	1-1						
Pyrophacus horologicum								0-1			1-0
Pyrophacus horologicum var. *steinii*									1-0		
Pyrophacus spp.						0-1	0-1				
Gymnodinium-Glenodinium spp.								9-8	14-0	18-46	44-52
Averaged Cell Counts — Surface	3,325	19,382	2,915	26,658	199,822	10,418	16,533	14,665	20,085	10,490	12,668
Averaged Cell Counts — Bottom	20,825	21,580	1,583	8,750	169,884	11,580	18,410	17,637	25,670	17,113	10,675
Salinity (‰) Ranges — Surface	35.6-36.6	35.5-36.4	30.8-36.0	34.6-36.6	34.4-37.7	37.5-38.5	37.8-38.7	37.7-39.1	35.8-37.9	37.2-37.5	35.3-36.8
Salinity (‰) Ranges — Bottom	35.6-36.7	35.8-36.2	34.4-36.1	34.9-36.6	36.2-37.6	37.3-38.5	37.8-39.0	37.5-39.2	35.8-37.9	37.0-37.5	35.4-36.3
Temperature (°C) Ranges — Surface	14.0-17.0	14.0-18.0	15.7-18.7	20.1-22.3	20.5-27.3	25.9-27.8	28.8-32.0	28.6-31.2	28.6-31.5	27.4-30.2	21.3-28.4
Temperature (°C) Ranges — Bottom	14.5-17.2	14.0-17.8	15.5-17.8	20.0-22.3	20.5-27.3	25.8-27.8	28.6-31.6	29.4-31.1	28.7-31.4	27.2-30.0	21.1-28.3

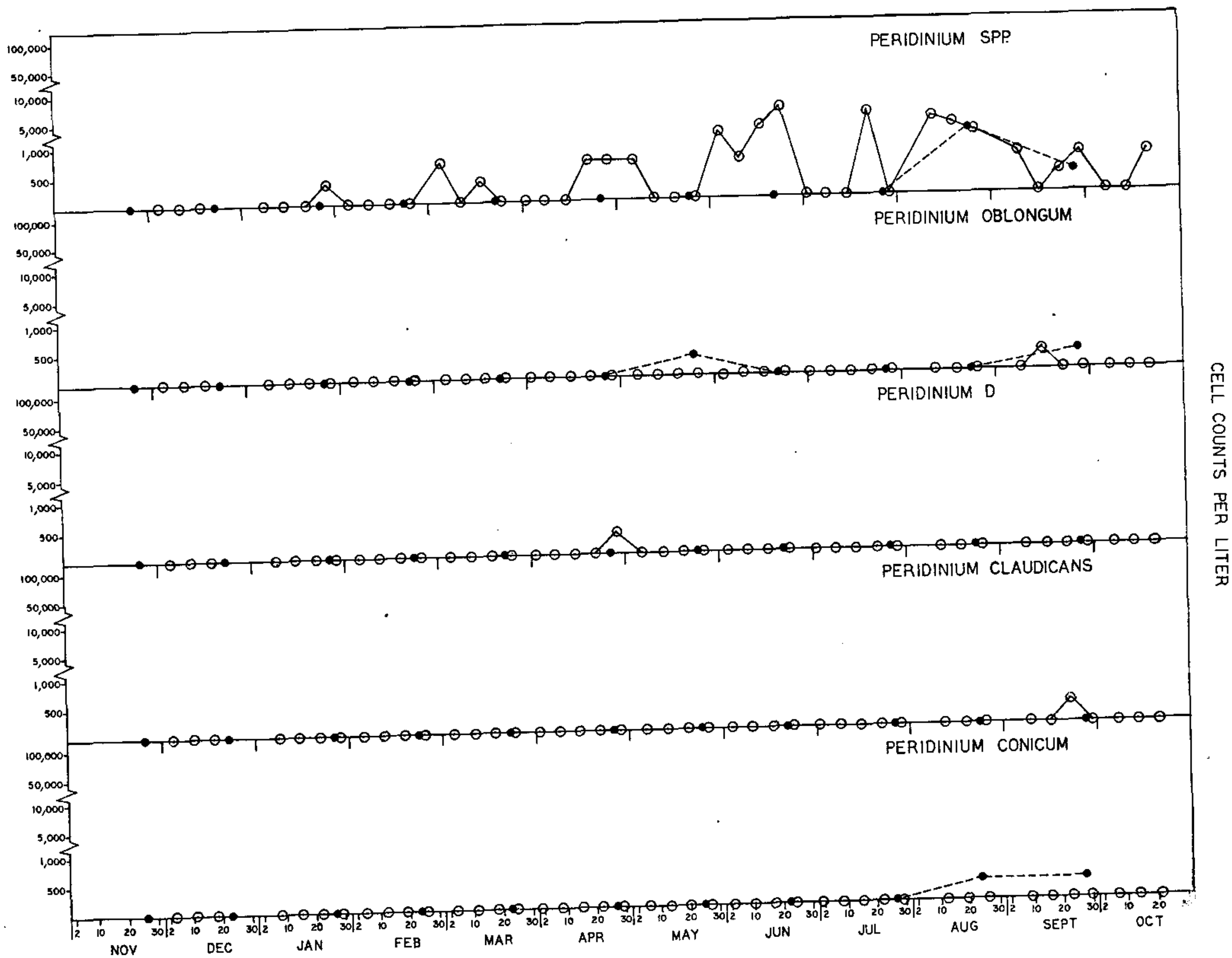
TABLE 20: NEAR ISLAND IN STUMP PASS (WS-9)
Surface-bottom % (0-0) of total organisms, per liter, observed.

NAKED DINOFLAGELLATES	D	J	F	M	A	M	J	J	A	S	O
Cochlodinium spp.	4-0					0-1					
Gymnodinium breve								1-0			
Gymnodinium splendens		0-1		0-1	1-0		1-0				
Gymnodinium spp.	92-0	45-76	0-2	5-5	47-69	32-37	22-26	3-2	25-0		
Gyrodinium fissum							0-1	3-0	9-10		
Gyrodinium spp.		32-10	41-40	32-24	27-21	41-45	39-39	52-50	23-3	17-29	32-26
Polykrikos schwartzi					1-0				0-2		
Torodinium teredo							1-0	1-1			
Torodinium spp.								1-0		0-1	
ARMORED DINOFLAGELLATES											
Ceratium fusus		1-0					0-1	1-5			
Ceratium trichoceros							1-1	0-1			
Ceratium A (*furca?*)					0-1		1-1	1-0	0-1		
Ceratium sp.				1-0							
Dinophysis caudata var. *pedunculata*									3-0		0-1
Dinophysis caudata var. B									0-9	0-3	
Dinophysis A									12-12		
Diplopsalis spp.					0-1			2-2	5-2	5-1	2-5
Exuviaella spp.		1-0						0-2			
Gonyaulax spinifera									0-2	0-1	
Gonyaulax? D							1-2				
Gonyaulax spp.		20-12	59-58	34-40	13-5	12-7	16-9	6-6	9-11	8-18	4-2
Peridinium claudicans								1-0			
Peridinium conicum									0-3	5-5	1-0
Peridinium depressum		0-1		0-1							
Peridinium divergens								1-0			
Peridinium excentricum		0-1					1-0	0-1	2-4	1-0	1-1
Peridinium oblongum						1-1	1-1	1-1			1-1
Peridinium B		1-0									
Peridinium D	4-0			1-1			1-0				
Peridinium E		1-0					1-1				
Peridinium spp.				23-20	12-3	14-9	17-20	16-16	3-13	18-18	11-15
Prorocentrum micans				5-8					9-27		0-1
Prorocentrum spp.					0-1						
Pyrophacus horologicum								0-2			1-0
Pyrophacus horologicum var. *steinii*									0-1		
Pyrophacus sp.						1-0					
Gymnodinium-Glenodinium spp.								11-13		46-24	49-50
Averaged Cell Counts: Surface	20,400	8,966	2,835	18,498	24,444	13,040	18,793	12,375	10,920	7,887	11,335
Averaged Cell Counts: Bottom	0	18,044	3,915	16,240	44,198	11,210	15,873	10,618	16,670	7,830	11,080
Salinity (‰) Ranges: Surface	35.4-36.2	35.0-36.3	31.6-35.9	34.6-36.8	36.3-37.6	36.9-38.5	37.5-39.1	37.5-39.2	35.7-35.8	35.7-37.6	34.4-36.1
Salinity (‰) Ranges: Bottom	35.5-36.1	35.1-36.4	33.4-35.9	34.3-36.6	36.0-37.4	36.9-39.4	37.9-39.3	37.7-39.2	35.9-36.3	37.0-37.2	35.2-36.1
Temperature (°C) Ranges: Surface	12.6-17.4	14.0-18.4	15.5-19.0	20.7-22.6	20.5-27.2	26.1-28.7	29.0-33.7	28.6-32.5	30.2-31.7	27.3-30.1	21.3-28.4
Temperature (°C) Ranges: Bottom	13.2-17.4	13.8-18.0	15.2-17.8	20.7-22.5	20.3-27.2	25.7-28.0	28.7-32.1	30.0-31.2	28.9-31.4	27.4-29.9	21.1-28.4

EXPLANATION OF APPENDIX C

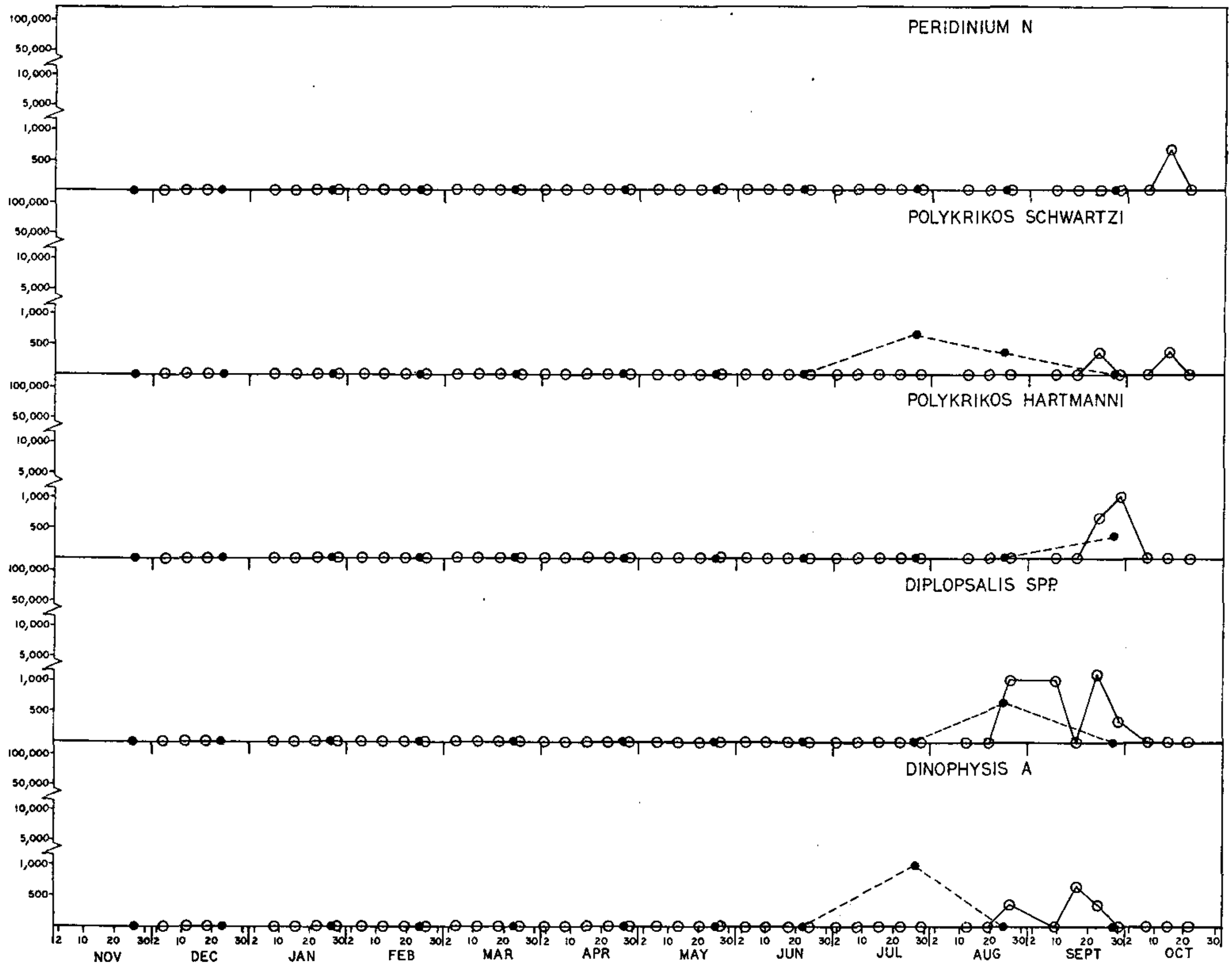
Appendix C includes graphs showing population fluctuations at Stations RT 1 (broken line) and WS 5 (solid line), both of which were located at Pinellas Point, Tampa Bay, Florida.

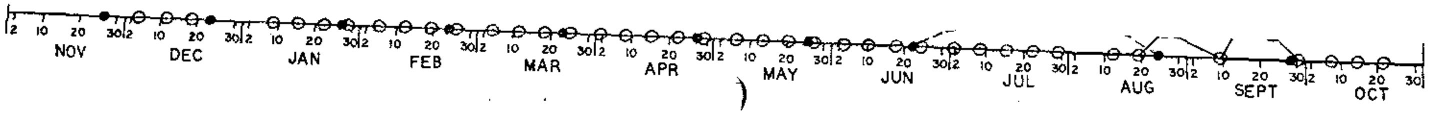

GYMNODINIUM SPP.
GYMNODINIUM SPLENDENS
GYRODINIUM SPP.
GONYAULAX SPP.
GONYAULAX SPINIFERA
100,000
50,000
10,000
5,000
1,000
500
NOV
DEC
JAN
FEB
MAR
APR
MAY
JUN
JUL
AUG
SEPT
OCT
CELL COUNTS PER LITER

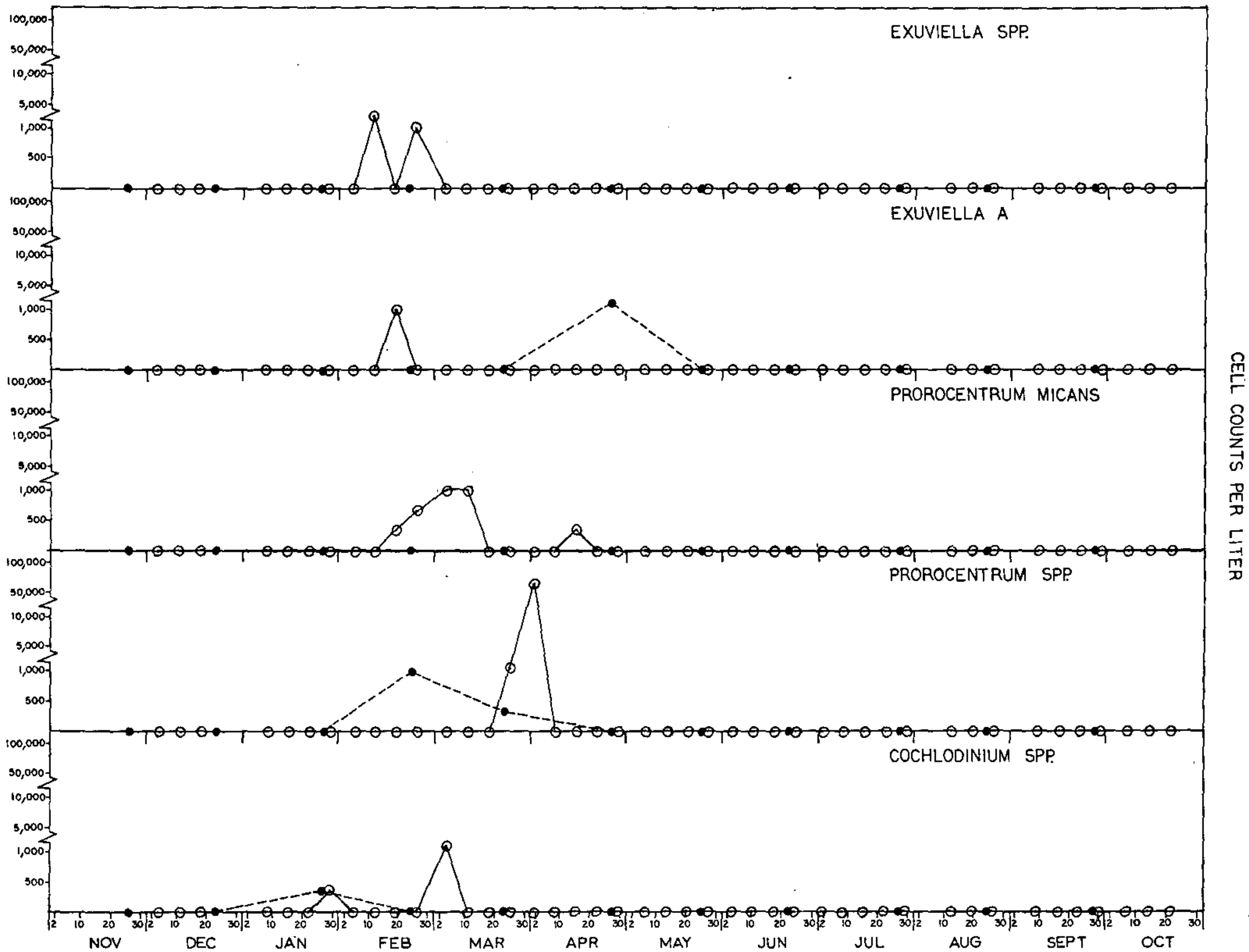


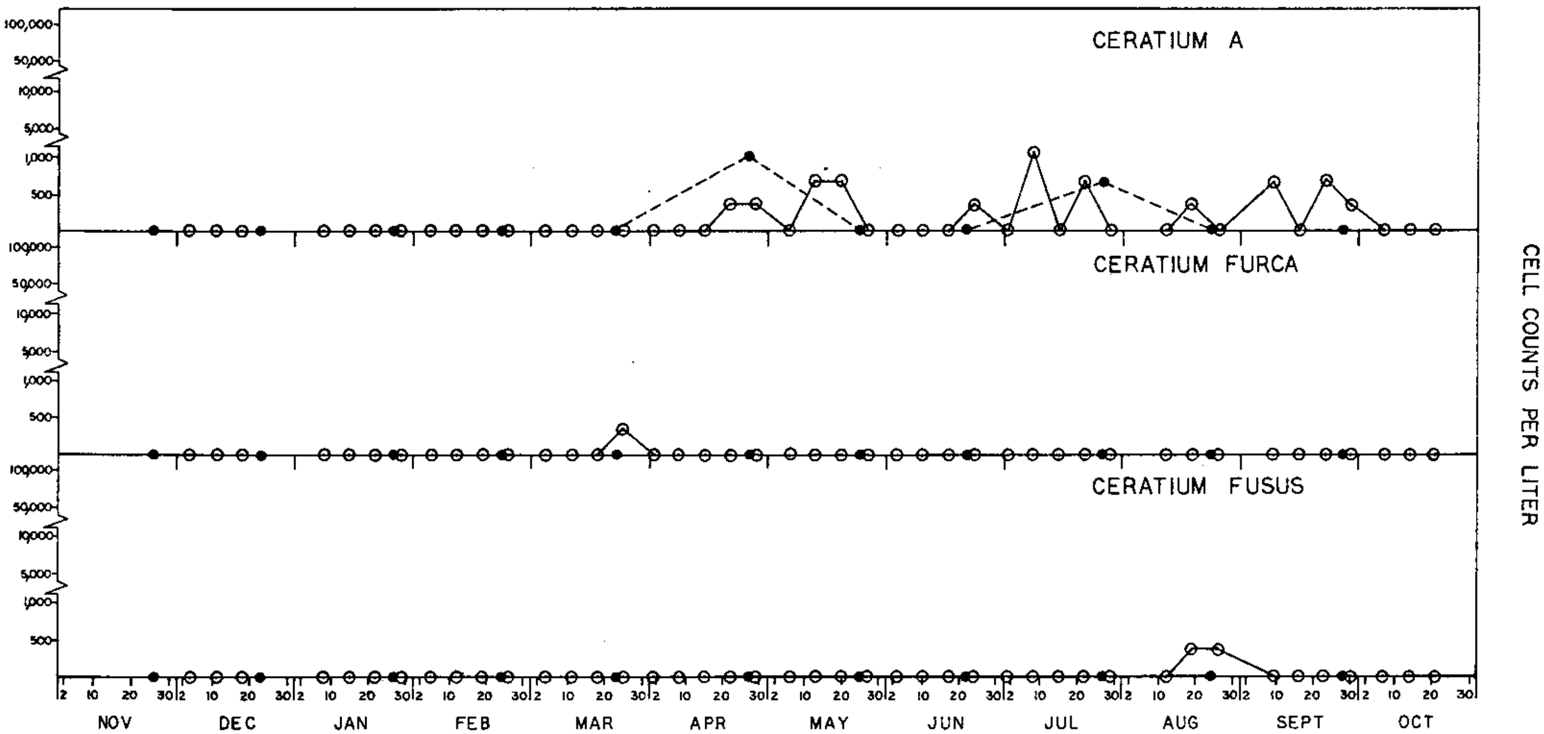
RED TIDE STUDIES, PINELLAS TO COLLIER COUNTIES, 1963-1966

CELL COUNTS PER LITER




NOV
DEC
JAN
FEB
MAR
APR
MAY
JUN
JUL
AUG
SEPT
OCT


EXUVIELLA SPP.
EXUVIELLA A
PROROCENTRUM MICANS
PROROCENTRUM SPP.
COCHLODINIUM SPP.
100,000
50,000
10,000
5,000
1,000
500
CELL COUNTS PER LITER
NOV
DEC
JAN
FEB
MAR
APR
MAY
JUN
JUL
AUG
SEPT
OCT


CERATIUM A
CERATIUM FURCA
CERATIUM FUSUS
CELL COUNTS PER LITER
100,000
50,000
10,000
5,000
1,000
500
NOV
DEC
JAN
FEB
MAR
APR
MAY
JUN
JUL
AUG
SEPT
OCT

SEASONAL DISTRIBUTION OF DIATOMS IN FLORIDA INSHORE WATERS FROM TAMPA BAY TO CAXAMBAS PASS, 1963-1964

RICHARD P. SAUNDERS, BRUCE I. BIRNHAK,
JOANNE T. DAVIS, AND CAROL L. WAHLQUIST

INTRODUCTION

Phytoplankton communities have been investigated extensively in Texas by Freese (1952), in Apalachee Bay (Florida) by Curl (1959), and in the Mississippi delta by Simmons and Thomas (1962). Gunter *et al.* (1948), King (1950), Davis (1950), Lackey and Hynes (1955), Dragovich (1963), and Dragovich and Kelly (1964) have briefly described the phytoplankton communities of the middle and southern west coast of Florida but an extensive analysis of these areas has yet to be accomplished. King, in a portion of his study, described the Fort Myers area during May through October 1949, while Dragovich reported on the genera of phytoplankton at Naples from March 1956, through August 1957. A brief account of the organisms present in the Tampa Bay Red Tide of 1963 (Dragovich and Kelly) appears to be the only description of phytoplankton from this embayment. Our investigation provides new information on diatom abundance and seasonality of the Florida west coast.

This study was initiated in November 1963 as part of an investigation of Red Tide ecology conducted at the Florida Board of Conservation Marine Laboratory. Eleven Red Tide (RT) stations were established at various points along the coast from Tampa and Hillsborough Bays in the north to Caxambas Pass in the south. Nine additional stations (designated WS) were sampled weekly, beginning in December 1963, in order to follow more closely seasonal variations in diatom populations.

METHODS AND MATERIALS

One liter surface and bottom samples were collected from each station (RT and WS). Where possible, samples were taken by immersing a wide-mouth, plastic-capped jar (the sample container) to the desired depth by hand and allowing the water to enter gradually as the cap was unscrewed. RT bottom samples were taken approximately six inches above bottom and in such a way as to avoid agitating the sediments. A weighted polyethylene sampling bottle was used to collect bottom samples at WS stations. Samples were protected from excessive temperature changes and vibration during transport and were returned to the laboratory on the day of collection. These were placed under fluorescent lights and examined within 48 hours.

Salinities utilized in this study were determined with G. M. hydrometer bulbs. Water temperatures were taken with a total immersion -20 to 110°C thermometer and were estimated to the nearest 0.5 degree.

Diatoms were identified and counted in the living state. "Pleurax" permanent slide mounts of selected samples were made beginning in June and these aided in the identification of species. The procedure for enumeration of diatoms was as follows: after a gentle agitation of the sample jar, three 1 ml aliquots were withdrawn and dispensed into the three concavities of a glass spot plate for initial examination under a dissecting microscope. Larger diatoms such as *Melosira sulcata*, *Biddulphia regia*, *Hemidiscus hardmanianus*, and several species of *Coscinodiscus* were counted directly in this manner. Small species such as *Chaetoceros* spp., when their numbers were not excessive, were removed by pipette from the wells to slides and identified under a compound microscope. When a species was very abundant, as was the case with *Skeletonema costatum* in most samples, measured portions of agitated sample were transferred directly from the sample jar to a clean slide and counted at 100 x magnification. Here, best results were obtained by making counts from 0.1 ml portions of sample dispersed in the form of drops on a microscope slide.

In the majority of samples examined, estimates of the number of cells of each species were made, rather than total counts. The use of estimates proved necessary, particularly in the initial stages of the study, in order to handle the large numbers of samples (949 in all) and at the same time to progress in the identification of species. These estimates were derived from rough counts of 1 ml sample aliquots and placed into one of the following ranges: 1) 1 to 10 cells/ml; 2) 11 to 100 cells/ml; 3) 101 to 1,000 cells/ml; 4) 1,001 to 10,000 cells/ml; and 5) 10,001 to 100,000 cells/ml. Where a species appeared to fall between two categories with respect to its abundance, the lesser of the two values was selected. The examination of larger subsamples from time to time indicated that these estimates were fairly reliable.

In order to derive total cell counts for each station, as shown in Figures 1 through 7, estimates of the various species were converted to actual numbers for the purpose of tabulation. The numbers corresponding to the five categories above are: 1) 5 cells/ml; 2) 55 cells/ml; 3) 550 cells/ml; 4) 5,500 cells/ml; and 5) 55,000 cells/ml. For example, in a particular sample in which there were three species numbering 1 to 10, 101 to 1,000, and 10,001 to 100,000, a total cell count of 55,555 would be recorded.

RESULTS AND DISCUSSION

Temperature and Salinity

The salinity or temperature at each station usually varied by less than 1.0‰ or 1.0°C from surface to bottom. Notable exceptions occurred only with regard to salinity at Station WS 4 on January 22, February 5, March 25, April 8, and April 29, when the surface and bottom values were respectively: 19.6 and 26.2‰, 10.6 and 24.0‰, 18.6 and 25.2‰, 21.9 and 25.1‰, and 16.5 and 26.8‰. However, only surface salinity and temperature values are presented in the data (Figures 1-4).

Figure 1. Total diatoms/ml, surface temperatures and salinities at WS Stations 1-5 January 1964 through October 1964. Salinities and temperatures were plotted arithmetically (right ordinate) and total diatoms logarithmically (left ordinate).

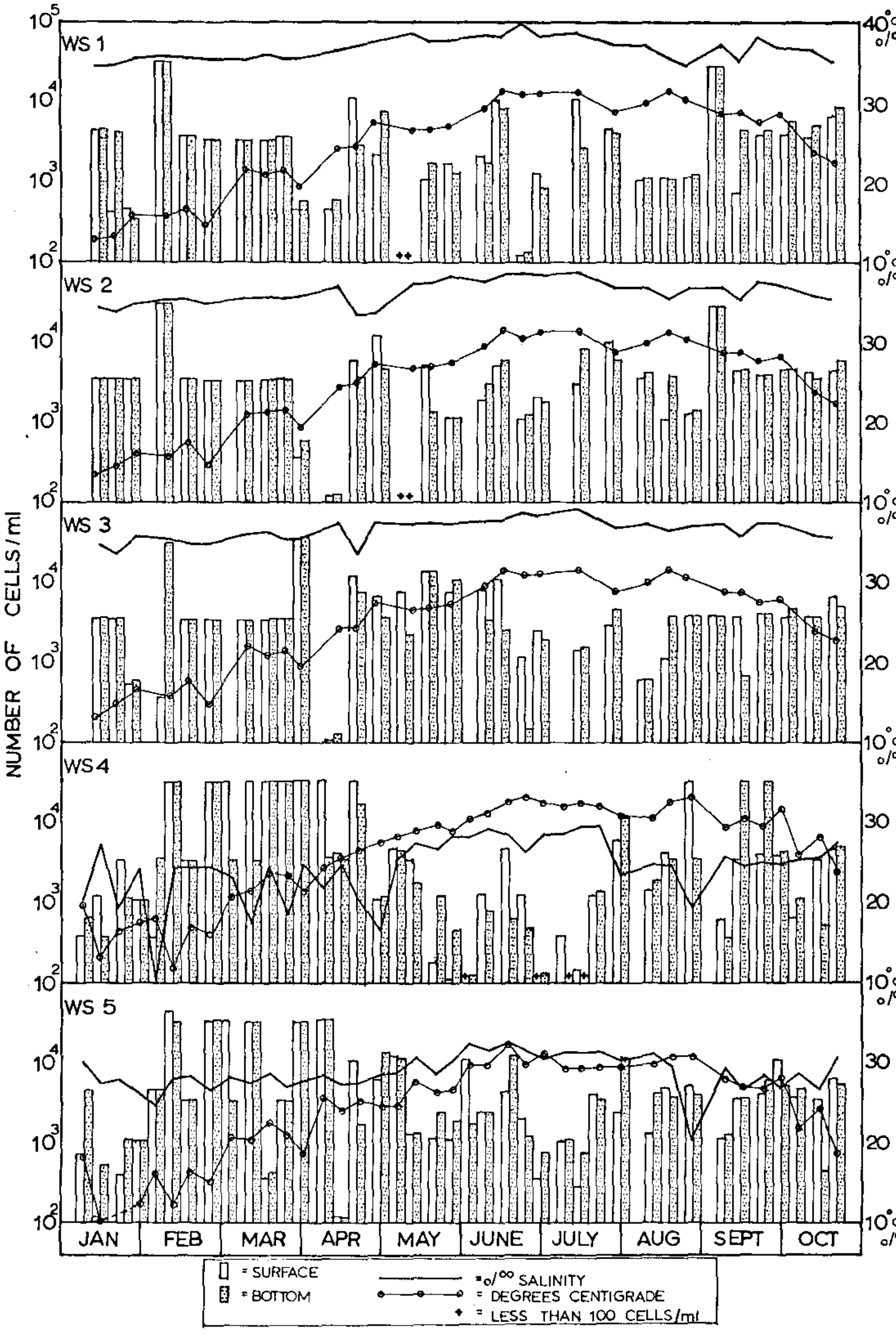


Figure 2. Total diatoms/ml, surface temperatures and salinities at WS Stations 6-9 and RT Station 1 January 1964 through October 1964. Salinities and temperatures were plotted arithmetically (right ordinate) and total diatoms logarithmically (left ordinate).

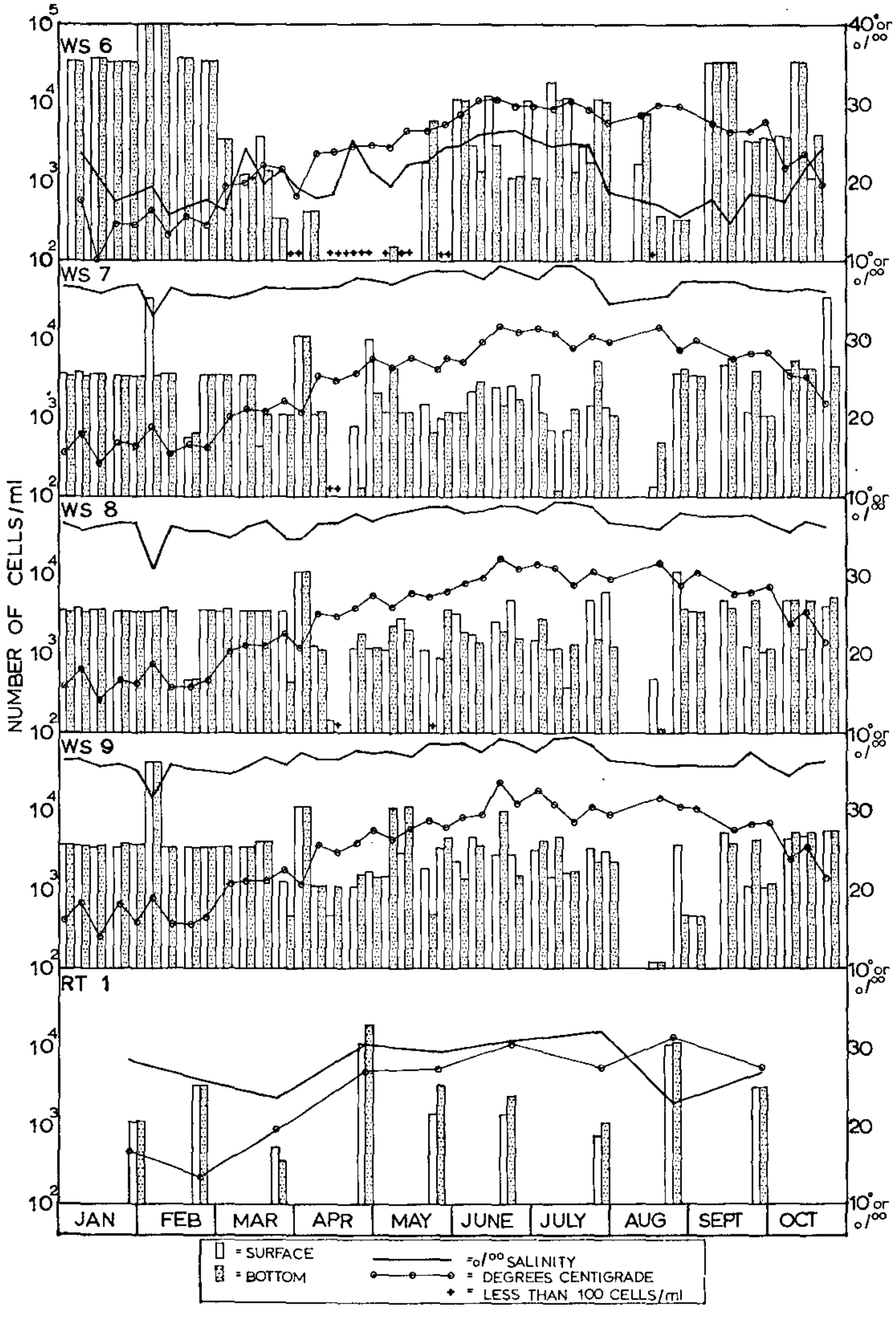


Figure 3. Total diatoms/ml, surface temperatures and salinities at RT Stations 2-6 January 1964 through October 1964. Salinities and temperatures were plotted arithmetically (right ordinate) and total diatoms logarithmically (left ordinate).

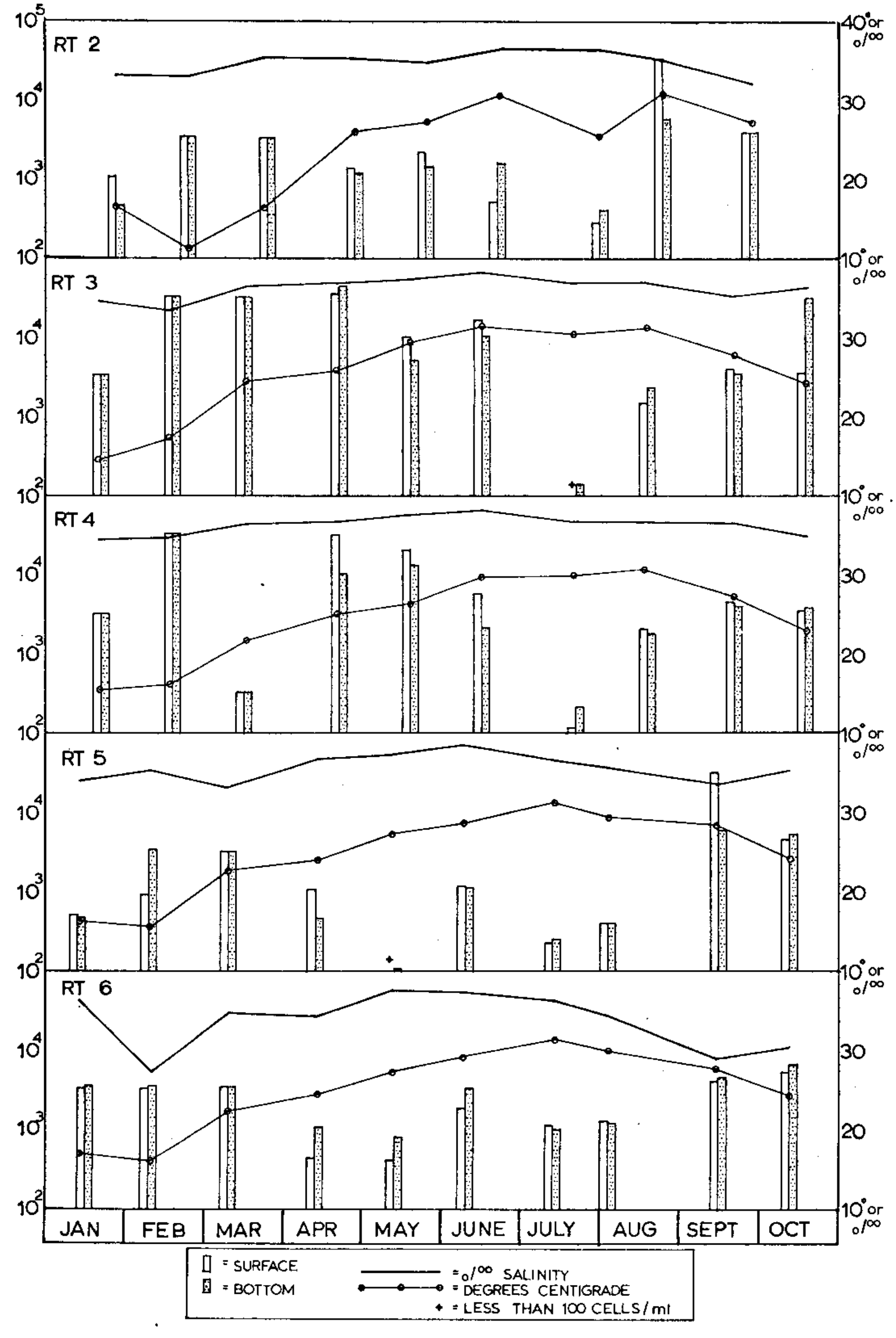
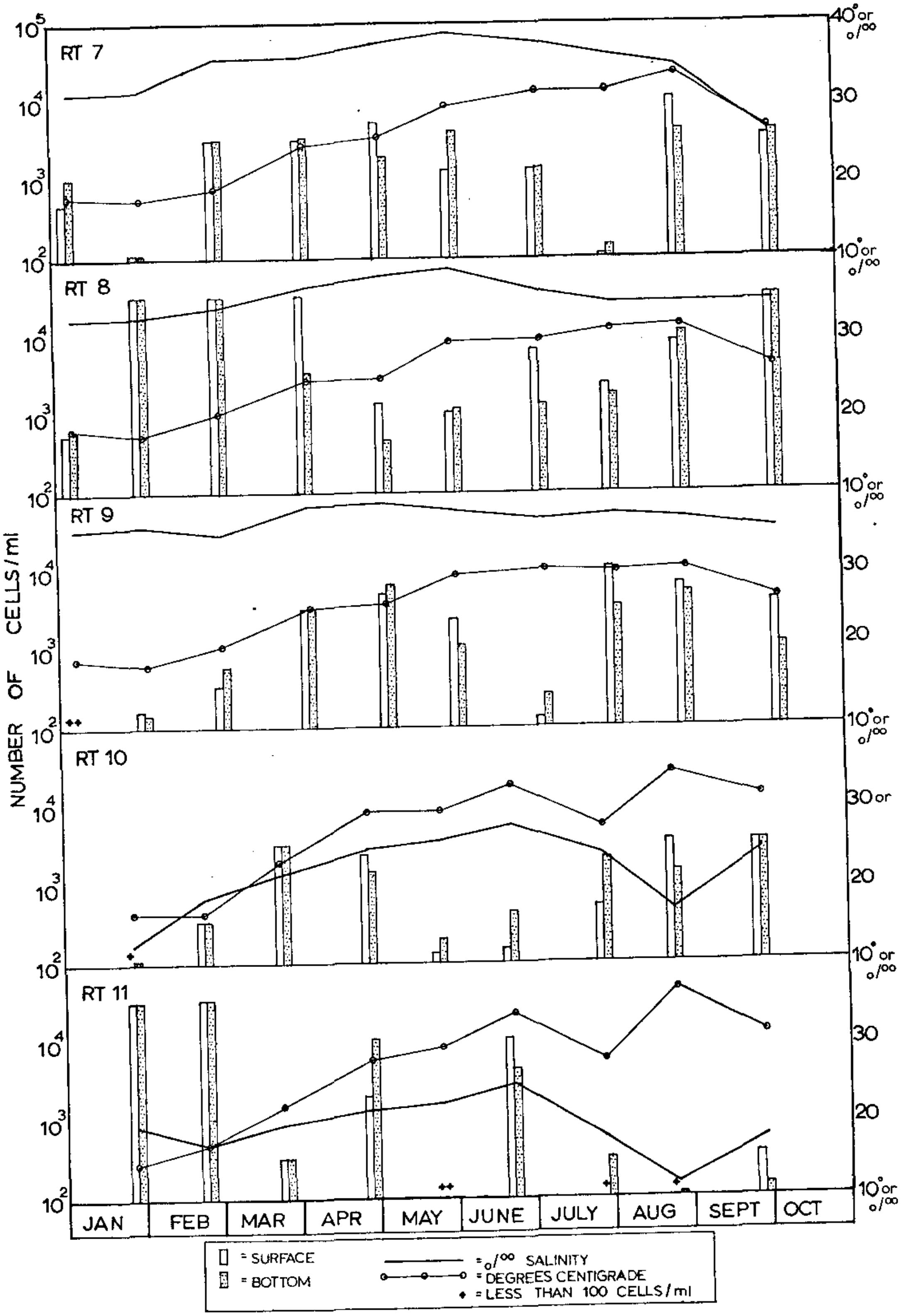


Figure 4. Total diatoms/ml, surface temperatures and salinities at RT Stations 7-11 January 1964 through October 1964. Salinities and temperatures were plotted arithmetically (right ordinate) and total diatoms logarithmically (left ordinate).



For the most part salinities remained above 30‰ at WS Stations 1, 2, 3, 7, 8, and 9, and at RT Stations 2 through 9. The remaining stations were characterized by somewhat lower and more variable salinities. Salinities at most stations were highest in June and lowest in February and March.

The lowest water temperatures were recorded in January or February and the highest temperatures were recorded within the period June through September. The lowest and highest recorded temperatures during the sampling period were 9.0°C and 36.8°C.

Diatom Abundance

A characteristic of most studies of the phytoplankton of the Gulf of Mexico is the lack of quantitative data. In those instances where total cell counts were recorded they were considerably less than those we encountered for diatoms alone.

Samples typically contained more than 1,000 diatoms/ml. This exceptional abundance was the most striking feature of the entire investigation (Figures 1-4). The mean cell number per ml from January through October 1964 was 10,343 at RT stations and 9,697 at WS stations. In no single month did the average for all stations drop below 1,000 cells/ml. These values parallel those obtained by Conover (1956) for Long Island Sound, Smayda (1957) for lower Narragansett Bay, and Pratt (1959) for Narragansett Bay, and exceed considerably those of Lillick (1937) for Vineyard Sound and Riley (1952) for Block Island Sound. Other studies conducted in inshore environments (Cowles, 1930; King, 1950; and Curl, 1959) indicate levels of abundance considerably less than those obtained in this study.

Monthly compilations of cell counts from WS samples (Table 14) reveal: maximum numbers of diatoms occurred from January through April, low numbers prevailed from May through August, and cell numbers rose sharply in September and October. This general pattern of abundance was also evident at the monthly RT stations. Months of highest and lowest counts at WS stations were February (26,266/ml) and May (3,846/ml); at RT stations they were February (22,725/ml) and July (1,277/ml). The degree to which individual WS and RT stations differed from month to month is indicated in Figures 1-4. Sampling in future studies should be more frequent and of longer duration than in the present program to clearly delineate seasonal fluctuations in diatom abundance.

Seasonality of Species

Skeletonema costatum was unquestionably the dominant diatom and its presence in large measure determined the pattern of abundance for total diatoms. Counts were as high as 31,925 cells/ml and estimates of 10,001 to 100,000 cells/ml were recorded (Table 3). Comparable values are seldom encountered in diatom literature. *Skeletonema* exceeded 1,000 cells/ml at all stations from January through April (Table 3) and in February, its peak month, was so profuse at most stations that it appeared to limit the population densities of other species. *Skeletonema* cell counts were low in May, June, and July (a period when *Chaetoceros* and *Rhizosolenia* populations were at a zenith) and increased steadily after July to a level closely approaching that of winter.

The seasonality of *Skeletonema costatum* in Florida west coast waters has been variously reported as present to dominant by Davis (1950), common in the vicinity of Fort Myers from May to October by King (1950), abundant from February through April and August through September in Apalachee Bay by Curl (1959), and dominant in April off Naples by Dragovich (1963). However, in no instance does the recorded abundance approach that of our samples. The seasonal cycle of this species in Apalachee Bay is similar to that found in this study.

Certain diatoms paralleled *Skeletonema* in their seasonality. *Asterionella japonica* and *Melosira sulcata*, for example, were most prevalent during January, February, September, and October, and least abundant in July and August. *Thalassiosira* spp. (Table 2) were associated with heavy concentrations of *Skeletonema*, but did not reach maximum abundance until that species had declined (April). At least two species of *Thalassiosira* were present. The first, which is probably the recently described *Coscinosira floridana* Cooper, was abundant during the winter and spring. The second, *Thalassiosira decipiens*, was moderately abundant from June through October. Curl (1959) recorded *T. decipiens* from Apalachee Bay in January, but listed no other species of *Thalassiosira*.

Nitzschia seriata (?) and *N. closterium* (?) (Tables 6 and 7) surpassed 100 cells/ml at one or more stations during each month from April through October and were regularly recorded in low concentrations in other months. The taxonomy of these species is discussed under "Species Account." Highs of 1,000 or more cells/ml at several stations during July suggest this to have been the peak month for both species.

Rhizosolenia spp. (Table 8) and *Leptocylindrus* spp. (Table 10) attained a maximum abundance of more than 100 cells/ml in summer and spring. *Chaetoceros* spp. (Table 9) were most numerous from April through October.

General Distribution

Species composition and abundance at various stations differed (Tables 1 through 11). The following trends were observed: 1) on the average, diatoms were most numerous at low salinity stations (WS 6 and RT 11) and least abundant at high salinity stations (WS 1, 2, 3, 7, 8 and 9 and RT 2 through 9); 2) extreme fluctuations in abundance were the rule at low salinity stations while they were the exception at high salinity stations; and 3) the greatest number of species was observed in areas of intermediate salinity (WS 4 and 5 and RT 1 and 10).

Low to moderate salinity stations were characteristically inhabited by *Asterionella japonica*, *Skeletonema costatum*, and *Thalassiosira* spp. High salinity stations, on the other hand, were noted for occurrences of *Nitzschia closterium* (?), *N. seriata* (?), *Leptocylindrus* spp., *Rhizosolenia* spp., and *Chaetoceros* spp. *Bellerochea malleus* was considerably more numerous at WS 5 and RT 1 than at other stations. This species persisted in numbers from 101 to 1,000/ml at these stations from May through October.

Frequency of Occurrence

Frequency of occurrence represents the per cent of samples in which a species was present in numbers exceeding 1 cell/ml (effectively the lowest count possible with the method utilized). The frequencies of routinely encountered species are depicted in Tables 12 and 13. Less abundant species are discussed under "Species Account."

Lithodesmium undulatum and *Streptotheca thamensis* were more frequently encountered in winter than at other times of the year. *Guinardia flaccida*, *Leptocylindrus* spp., *Corethron criophylum*, and *Thalassionema nitzschioides* were most often encountered during summer and fall.

Species Dominance

Numerically *Skeletonema costatum* surpassed all other species combined except during May, June, and July. It was exceeded at WS stations in May by *Leptocylindrus* spp., in June by *Chaetoceros* spp., and in July by *Rhizosolenia* spp. (Tables 14 and 15). However, the striking disparity in the size of various species must preclude an accurate analysis of their relation to the phytoplankton biomass. The large size of *Rhizosolenia* spp. in comparison to *Skeletonema*, for example, suggests that the former were dominant during June and July at WS stations (Table 14). Similarly, *Bellerochea malleus*, an extremely large diatom, should be considered as sharing a position of dominance with other species during its peak months of May and June.

SPECIES ACCOUNT

Species	Reference	Remarks
Melosira dubia Kutzing	Curl, p. 285, fig. 2, 1959	Recorded infrequently from January through June. Probably a tychopelagic species. 550/ml in surface samples from RT 4 (April 20) and WS 4 (June 24). Identification tentative. Recorded as rare in Apalachee Bay by Curl (1959).
Melosira sulcata (Ehrenberg) Kutzing Plate III, fig. 15	Hustedt, Pt. I, p. 276-8, fig. 118-9, 1930	Present at least sparingly in every month. Most frequently recorded in February (50% of samples). Generally fewer than 100 cells/ml. Not recorded from Stations WS 6 or RT 11.
Cyclotella spp. Plate II, fig. 11	Hustedt, Pt. I, 1930	Observed only during August and September. Highest count was 2,650 cells/ml.
Skeletonema costatum (Greville) Cleve	Hendey, p. 91-2, Pl. VII, fig. 3, 1964	Present every month at all WS stations. Recorded frequently in numbers exceeding 10,000 cells/ml during January through April and September through October. Highest recorded count was 31,925 cells/ml on July 8 (WS 6). Auxospores of this species were observed on November 14 (WS 4).
Coscinosira polychorda Gran Plate II, fig. 10	Hustedt, Pt. I, p. 317, fig. 154, 1930	In a few samples during February, March, April, and October at WS 1-3 and 7-9. Never more than 10 cells/ml. Observed once by Freese (1952) and as a minor species in October by Simmons and Thomas (1962). Identification tentative.
Stephanopyxis palmeriana (Greville) Grunow	Hustedt, Pt. I, p. 308-9, fig. 147, 1930	Recorded only from WS 9 (June 11). There were 5 cells/ml at surface and 400 on bottom.
Thalassiosira sp. Plate I, fig. 5	Hustedt, Pt. I, p. 321-2, fig. 157	Recorded from April through June. Highest number recorded 12,600/ml at WS 5 (May 6). Closely resembles *Thalassiosira nordenskioldii* Cleve, but probably is *Coscinosira floridana* Cooper.
Thalassiosira decipiens (Grunow) Jorgensen Plate V, fig. 24	Hustedt, Pt. I, p. 322-3, fig. 158, 1930	Recorded from June through October. 5,500/ml at WS 7 and 8 (August 27). Identification based on slide material. Recorded in January by

Thalassiosira decipiens (Grunow) Jorgensen Plate V, fig. 24	Hustedt, Pt. I, p. 322-3, fig. 158, 1930	Recorded from June through October. 5,3[illegible] at WS 7 and 8 (August 27). Identification based on slide material. Recorded in January by Curl, as a minor species by Simmons and Thomas, and as common by Freese.
Coscinodiscus spp. Plate IV, fig. 20 Plate V, fig. 21	Hustedt, Pt. 1, p. 388-91, 406-10, 420-1, 436-8, 444-5, fig. 201-2, 214-17, 225, 237-8, 243, 1930	Generally fewer than 10/ml. Highest count 700/ml in surface sample from WS 4 (April 6). Species recorded were: *Coscinodiscus excentricus* Ehrenberg; *C. curvatulus* Grunow; *C. radiatus* Ehrenberg; *C. grânii* Gough; and *C. centralis* Ehrenberg.
Hemidiscus hardmanianus (Greville) Mann	Curl, p. 287, fig. 17, 1959	Recorded on eight occasions from August through October. 10 or less/ml. Present only at WS 3, 7, 8, 9 and RT 5. Recorded by Curl and Freese.
Actinoptychus spp. Plate III, fig. 14	Hustedt, Pt. I, p. 475-9, fig. 263-6, 1930	Two species, *Actinoptychus undulatus* (Bailey) Ralfs and *A. splendens* (Shadbolt) Ralfs, present in low numbers in January, August, and September.
Eupodiscus radiatus Bailey	Hendey, p. 97, Pl. XXIII, fig. 3, 1964	Recorded twice from bottom samples (WS 1 and 4) during October.
Biddulphia regia (Schultze) Ostenfeld Plate II, fig. 6	Hustedt, Pt. I, p. 838-40, fig. 494, 1930	Present nearly continuously from May through October at WS 4-6. Sporadic at other stations. Always fewer than 10 cells/ml. Not reported by Curl, Freese, or Simmons and Thomas. Apparently previously unrecorded from the Gulf of Mexico.
Biddulphia alternans (Bailey) van Heurck Plate V, fig. 26	Hendey, p. 102, Pl. XXV, fig. 5, 1964	Most abundant in January, February, and October. As many as 100/ml in a few samples but generally less than 10.
Biddulphia aurita (Lyngbye) Brebisson and Godey	Hustedt, Pt. I, p. 846-9, fig. 499 and 500-2, 1930.	Occurred frequently in October samples, 100/ml or fewer. Common in slide material.
Biddulphia mobiliensis Bailey Plate II, fig. 8	Hustedt, Pt. I, p. 840-2, fig. 495, 1930	Recorded from six samples during October. 1 to 10 cells/ml. Also in slides from June through October at WS 1, 5, 8, and RT 2.
Biddulphia pulchella Gray	Hustedt, Pt. I, p. 832-4, fig. 490, 1930	Abundance not known. Recorded only from slide material from RT 7 (July 7), RT 1 (July 27) and WS 5 (October 14).

Species	Reference	Remarks
Biddulphia rhombus (Ehrenberg) W. Smith	Hustedt, Pt. I, p. 842-4, fig. 496-8, 1930	Abundance not known. Observed only in slide material from WS 1 (June 9 and September 8), WS 2 (June 9 and July 14), and RT 1 (August 24).
Biddulphia tuomeyi (Bailey) Roper	Hustedt, Pt. I, p. 834-6, fig. 491, 1930	Abundance not known. Observed only in slide material from WS 1 (June 9) and WS 2 (July 28). The authors know of no previous record of this species from the Gulf of Mexico.
Triceratium favus Ehrenberg	Hustedt, Pt. I, p. 798-801, fig. 463-4, 1930	Abundance not known. Recorded only in slide material from WS 1 (June 9 and September 8) WS 6 (July 8 and 15), and WS 4 (September 9).
Triceratium dubium Brightwell	Hustedt, Pt. I, p. 806, fig. 469, 1930	Abundance not known. Recorded only in slide material from WS 3 (October 13).
Bellerochea malleus (Brightwell) van Heurck Plate II, fig. 9	Hustedt, Pt. I, p. 782-3, fig. 456, 1930	Common from May through October. Most abundant during this period at WS 4, 5, and RT 1. Rare at WS 6 and not recorded from RT 11. Generally less than 100/ml but counts as high as 500/ml not uncommon at WS 4 and 5. This species appears to take two "forms" in our waters — *B. malleus* var. *biangulata* Peragallo and var. *tetragona* van Heurck.
Cerataulina pelagica (Cleve) Hendey	Hendey, p. 113, Pl. IV, fig. 4, 1964	Frequently recorded in February, September, and October; infrequently from May through August. Only occasionally exceeding 100/ml. Highest count 1,775/ml at WS 4 surface (June 24). This species was more frequently encountered and abundant at RT 1 and WS 4 and 5 than at other stations. Curl reported it present throughout the year except in winter in Apalachee Bay.
Lithodesmium undulatum Ehrenberg Plate IV, fig. 17	Hustedt, Pt. I, p. 789-91, fig. 461, 1930	Recorded in January, February, March, and October. Most prevalent during February. Not recorded from RT 10 or 11, rare at WS 4, 5, and 6.
Hemiaulus sinensis Greville	Hustedt, Pt. I, p. 875-6, fig 519, 1930	Observed in February, July, and September.

Plate VI, fig. 27

1,125 cells/ml were recorded from WS 5 bottom (July 8). This species was more wide-

Hemiaulus sinensis Greville	Hustedt, Pt. I, p. 875-6, fig 519, 1930	Observed in February, July, and September.
Plate VI, fig. 27		1,125 cells/ml were recorded from WS 5 bottom (July 8). This species was more widespread at WS 4 and 5 than at other stations.
Hemiaulus membranaceus Cleve Plate I, fig. 2	Cupp, p. 170, fig. 120, 1943	Approximately 5 cells/ml in one sample (WS 7) on July 2. Identity of this species questionable.
Climacodium spp.	Hustedt, Pt. I, p. 776-7, 777-8, fig. 453-4, 1930	Recorded in April, May, June,July, September, and October. Species encountered were: *C. frauenfeldianum* Grunow and *C. biconcavum* (Ostenfeld) Cleve. To our knowledge the former has not been recorded from the Gulf of Mexico.
Eucampia zoodiacus Ehrenberg Plate VI, fig. 28	Hustedt, Pt. I, p. 772-4, fig. 451, 1930	Recorded from one sample (RT 2) collected September 28.
Eucampia cornuta (Cleve) Grunow	Hustedt, Pt. I, p. 774, fig. 452, 1930	Abundance not known. Recorded only from slide material from RT 2 (September 28).
Streptotheca thamensis Shrubsole	Hustedt, Pt. I, p. 779-80, fig. 455, 1930	Recorded sparingly in all months but May, June and July. Most common during February and October. Generally less than 10 cells/ml. A few counts, especially in October, as high as 55/ml.
Ditylum brightwellii (West) Grunow	Hustedt, Pt. I, p. 784-7, fig. 457-9, 1930	Recorded from a few samples in January, August, September, and October. Did not exceed 10 cells/ml.
Chaetoceros spp. (all species)	Hustedt, Pt. I, 1930	One or more species present during each month of study. *Chaetoceros* spp. were very abundant and widely distributed among the stations in April, May, June, and September. Monthly averages were highest of all stations at WS 1 and 2 during September (14,000/ml). Less abundant at WS 4-6 and RT 1 and 10-11 than at other locations. *Chaetoceros* spp. are treated together since identifications to species were not routinely made. Spelling of species names is according to Hendey (1964).
Chaetoceros peruvianum Brightwell	Hendey, p. 123, Pl. IX, fig. 3, 1964	Recorded only once in live material (WS 8, July 2). Common in slide material from May through September. Apparently not present at WS 6 or RT 11.

Species	Reference	Remarks
Chaetoceros lorenzianum Grunow	Hendey, p. 124, Pl. XVI, fig. 1, 1964	Abundance not known. Not recorded in regular samples. Common in slides from May through September.
Chaetoceros compressum Lauder	Hendey, p. 125, Pl. XVI, fig. 5, 1964	Not identified in regular samples. Very abundant in slides from June through September at most stations. Probably the most abundant species of *Chaetoceros* in slides from many samples.
Chaetoceros didymum Ehrenberg	Hendey, p. 125-6, Pl. XVII, fig. 2, 1964	Abundance not known, not identified in samples. Common from June through October in slides.
Chaetoceros affine Lauder	Hendey, p. 127, Pl. XVIII, fig. 3, 1964	Abundance not known. Observed only in slide material, April through September.
Chaetoceros laciniosum Schutt	Hendey, p. 127, Pl. XIII, fig. 2, 1964	Abundance not known. Not recorded in live material. Present in slide material from June through September. Identity of this species questionable.
Chaetoceros galvestonensis Collier and Murphy	Collier and Murphy, 1962	Recorded twice from RT 6 (February 19 and 29). There were approximately 500 cells/ml in these samples.
Bacteriastrum sp. Plate IV, fig. 18	Hendey, p. 139, Pl. VI, fig. 2, 1964	Observed in January and April through October. Highest count 175/ml (RT 8, August 4). Common in slide material. Resembled *Bacteriastrum delicatulum* Cleve.
Rhizosolenia spp. (all species)	Hustedt, Pt. I, 1930	Most abundant from April through July. Monthly averages at WS stations were highest in April (531/ml) and June (656). The highest count was 6,700 at RT 8 (July 7). *Rhizosolenia* spp. are treated together since identifications to species were not routinely made.
Rhizosolenia fragilissima Bergon Plate I, fig. 1	Hustedt, Pt. I, p. 571-2, fig. 324, 1930	Not identified prior to May; recorded from May through October. Period of maximum abundance, June through July. Monthly counts exceeded 1,000/ml in June at WS 5 and 7, and

during July at WS 9. 6,550 cells/ml were present at RT 8 on July 7. Rarely recorded dance, June through July. Monthly counts exceeded 1,000/ml in June at WS 5 and 7, and

during July at WS 9. 6,550 cells/ml were present at RT 8 on July 7. Rarely recorded at RT 10-11 or WS 6. Previously unreported in the Gulf of Mexico.

Rhizosolenia stolterfothii H. Peragallo Plate III, fig. 16	Hustedt, Pt. I, p. 578, fig. 329, 1930	The only species of *Rhizosolenia* identified and counted during the entire study. Recorded in all months at a majority of stations. Peaks of abundance during April, May, June, July, and October. An exceptionally high count of 4,200 cells/ml occurred on April 21 in a surface sample from WS 1. This species was uncommon at WS 6 and RT 10 and 11.
Rhizosolenia robusta Norman	Hustedt, Pt. I, p. 578-80, fig. 330, 1930.	Recorded in low numbers from a few WS samples during March, August, and October. Rare at low salinity stations.
Rhizosolenia imbricata Brightwell	Hustedt, Pt. I, p. 580-4, fig. 331-2, 1930	A count of 5 cells/ml in a single sample (WS 7 surface, August 27). Present in slide material from WS 9 and RT 6 during July.
Rhizosolenia setigera Brightwell Plate V, fig. 23	Hustedt, Pt. I, p. 588, fig. 336, 1930	Not distinguished from other species of *Rhizosolenia* until July. Common in subsequent months and abundant during September. Highest count 1,001-10,000/ml (RT 8, September 1).
Rhizosolenia calcar avis M. Schultze	Hustedt, Pt. I, p. 592-4, fig. 339, 1930	Occasional in live material from July through October. Not identified in prior months. Generally fewer than 10/ml. Present in slides from June through October.
Rhizosolenia alata Brightwell Plate V, fig. 25	Hustedt, Pt. I, p. 600-4, fig. 345-8, 1930	First identified from samples during July. Occurred in over 10% of WS samples from July through October. Highest count 75/ml (RT 5 bottom, July 13). Two forms of this species were recorded — *R. alata* forma *gracillima* (Cleve) Grunow, and *R. alata* forma *indica* (Peragallo) Ostenfeld.

Species	Reference	Remarks
Guinardia flaccida (Castracane) Peragallo Plate III, fig. 13	Hustedt, Pt. I, p. 562-4, fig. 322, 1930	Present throughout most of the study. Peaks in abundance during June, July, and August. Not recorded from RT 1, 10, or 11 and rare at WS 4-6. Absent at all stations during April. Highest count, 250/ml (RT 2, July 27).
Dactyliosolen mediterraneus H. Peragallo	Hustedt, Pt. I, p. 556-7, fig. 317, 1930	Recorded at least once in every month from June through October. Highest count, 75/ml (WS 2, June 30). Identity questionable.
Leptocylindrus spp. Plate I, fig. 3	Hustedt, Pt. I, p. 558-9 and 560-1, fig. 318-19 and 321, 1930	Abundant from May through October. Maximum abundance in May (23% of total diatoms at WS stations). 34,700/ml at RT 4 on May 18. Absent during March at most stations. *L. danicus* Cleve and *L. minimus* Gran appear to have been equally widespread in samples.
Corethron criophylum Castracane	Hendey, p. 144, Pl. VII, fig. 4, 1964	Present in approximately 8% of WS samples and 15% of RT samples. Increasing in frequency and abundance from May until August, its peak month. 1,175/ml at WS 4 bottom on August 12. Absent at Stations WS 6 and RT 10-11.
Lauderia borealis Gran Plate IV, fig. 19	Hustedt, Pt. I, p. 549-50, fig. 313, 1930	Recorded sparingly from April through July and October. May and October were peak months. Never more than 100/ml, usually less than 10. Not recorded from WS 6 or RT 1, 10 and 11.
Plagiogramma vanheurckii Grunow	Hustedt, Pt. II, p. 112-3, fig. 638, 1931	Recorded once in regular samples (RT 4, May 18).
Asterionella japonica Cleve & Moller ex Gran Plate VI, fig. 30	Hendey, p. 158, Pl. XXI, fig. 1, 1964	A dominant species recorded from 50% of all samples. Most abundant in February, September and October, when it frequently exceeded 100/ml. Highest count, 2,100/ml (WS 4, July 29).
Thalassiothrix frauenfeldii Grunow	Hustedt, Pt. II, p. 247-8, fig. 727, 1932	Major period of abundance during March, lesser ones in January-February and September—October. Absent during June and August. Generally fewer than 10/ml. Not observed at WS 5-6 or RT 1, 10 and 11.

An abundant species during June through Oc-

5-6 or RT 1, 10 and 11.

Thalassionema nitzschioides Grunow	Hustedt, Pt. II, p. 244-6, fig. 725, 1932	An abundant species during June through October 2,800/ml (WS 8 surface, July 30). Observed from one or more stations during each month of the study.
Striatella unipunctata (Lyngbye) Agardh Plate I, fig. 4	Hustedt, Pt. I, p. 32-3, fig. 560, 1931	Rare, except during January and February. Highest count 250/ml (WS 4 bottom, May 6). Slightly greater frequency at RT 1 and WS 4 and 5 than at other stations.
Grammatophora marina (Lyngbye) Kutzing	Hustedt, Pt. II, p. 43-4, Fig. 569-70, 1931	Recorded at least once in most months. Typically fewer than 100/ml. 1,000/ml at RT 9 on May 5.
Navicula spp. Plate II, fig. 7, Plate VI, fig. 29	Cupp, p. 193, fig. 142, 1943	Several species routinely encountered from July through October. Only occasionally did their number exceed 10/ml. One species, believed to be *Navicula membranacea* Cleve, occurred from April to October and was recorded most frequently in August (17% of WS samples).
Pleurosigma/Gyrosigma spp. Plate III, fig. 12	Hendey, 1964	Present in over 30% of all samples. Most frequently recorded during January-February and September-October. Rarely more than 10/ml. Not encountered at WS 6.
Amphiprora sp. Plate V, fig. 22	Hendey, 1964	An important component in samples during September and October, especially at RT 1 and WS 4, 5, and 6. There were estimated to be 1,001-10,000/ml at WS 5 on September 30. This species ranged in size from 60-120 microns and occurred commonly in "stellate" clusters of 10 or more cells. It appears to be completely planktonic in habit.
Amphiprora gigantea var. *sulcata*	Cupp, p. 198, fig. 1951, 1943	Occasionally recorded in samples from July through October. Generally less than 10/ml. Identification unsubstantiated. Reported by Freese (1952) from the area of Rockport, Texas.
Amphora spp.	Hendey, 1964	Not identified prior to June; common in live material and slides from June through October. Seldom more than 10/ml.

Species	Reference	Remarks
Nitzschia closterium (?) (Ehrenberg) Wm. Smith	Hendey, p. 283, Pl. XXI, fig. 8, 1964	Present in a majority of samples during summer and fall and in more than 20% of samples in other months. Most abundant during July. Generally fewer than 100/ml but higher counts not uncommon. 2,400/ml at WS 1 on July 14. Infrequent at WS 6. Reimann and Lewin (1964) suggest that this form represents several species of the genus *Cylindrotheca* Rabenhorst.
Nitzschia seriata(?) Cleve	Hendey, p. 284, Pl. XXI, fig. 6, 1964	Present in about 45% of all samples. Peak of abundance during July. 13,750/ml at WS 1 surface on July 14. Usually less than 100/ml. Examination of "Pleurax" slide material revealed the presence, from time to time, of *Nitzschia delicatissima* Cleve and *N. pungens* var. *atlantica* Cleve. In routine counts these were probably counted as *Nitzschia seriata*(?).
Nitzschia longissima (Brebisson) Ralfs	Curl, p. 302, fig. 102, 1959	Present in 11% of RT and 7% of WS samples. Most common during July, August, and September. Never in large numbers. Not recorded from WS 6 or RT 11.
Nitzschia paradoxa (Gmelin) Grunow	Curl, p. 302, fig. 103, 1959	Present in 10% of RT and 6% of WS samples. Recorded in January, February, April, June, and August through October. Most abundant in October. Usually less than 100/ml.
"naviculoid" spp.		Species of *Navicula*, *Stauroneis*, *Cocconeis* and other genera not readily identified because of their small size (less than 50 microns). Recorded from 48% of RT and 37% of WS samples. No particular seasonal trend was evident. Less than 100/ml in most samples.
OTHER ALGAE:		
Pediastrum sp.		Recorded from WS 4 (March 25) and RT 11 (August 25).
Scenedesmus sp.		Only a few cells present at WS 4 on March 25.

Present in 7 samples during the period of June

Scenedesmus sp.		Only a few cells present at WS 4 on March 25.
Anabaena sp.		Present in 7 samples during the period of June through September.
Spirulina sp.		Recorded from WS 9 (July 30), RT 2 (April 20), WS (September 16 and 30, October 7 and 14).
Johannesbaptistia sp.		Common from August through October. Present during this period in 14% of WS and 15% of RT samples. Never abundant. Identification questionable.
Merismopedia sp.		Recorded only from WS 3 (August 18 and 25) and RT 7 (September 1).
Trichodesmium thiebautii Gomont	Curl. p. 307, 1959	Present in nearly 8% of WS samples and 5% of RT samples. Most abundant and frequently encountered during June and July. Seldom more than 10/ml. Only rarely observed at WS 4-6 and RT 1 and 11.
Oscillatoria spp.		Present in nearly 26% of WS and 15% of RT samples from August through October. Highest count, 550/ml (WS 6, September 9).

PLATE I

Figure 1. *Rhizosolenia fragilissima* Bergon
Figure 2. *Hemiaulus membranaceus* Cleve
Figure 3. *Leptocylindrus danicus* Cleve
Figure 4. *Striatella unipunctata* (Lyngbye) Agardh
Figure 5. *Thalassiosira* sp.

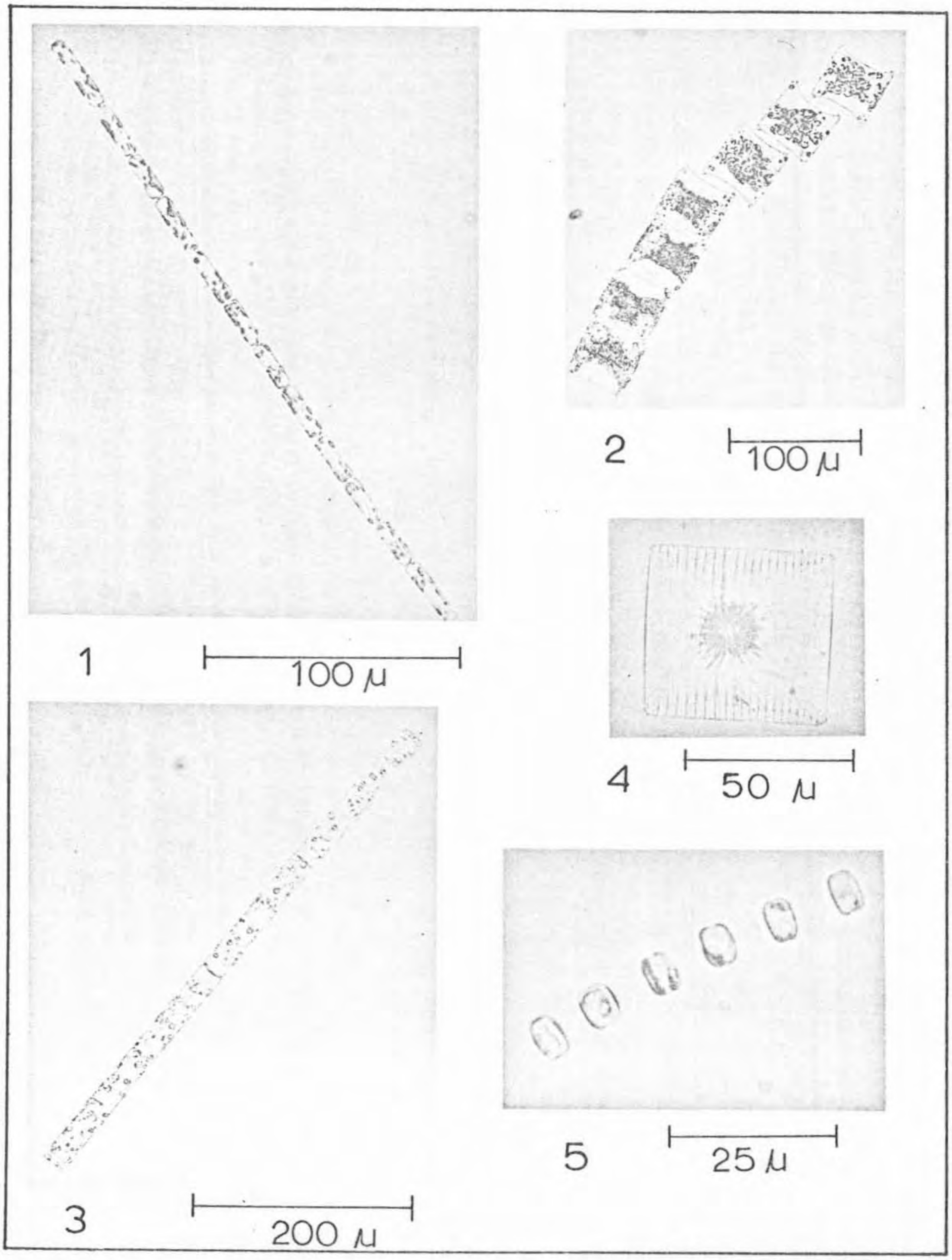
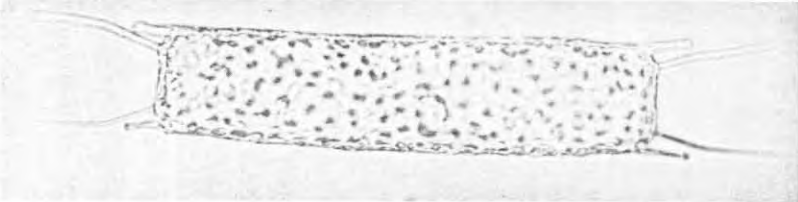


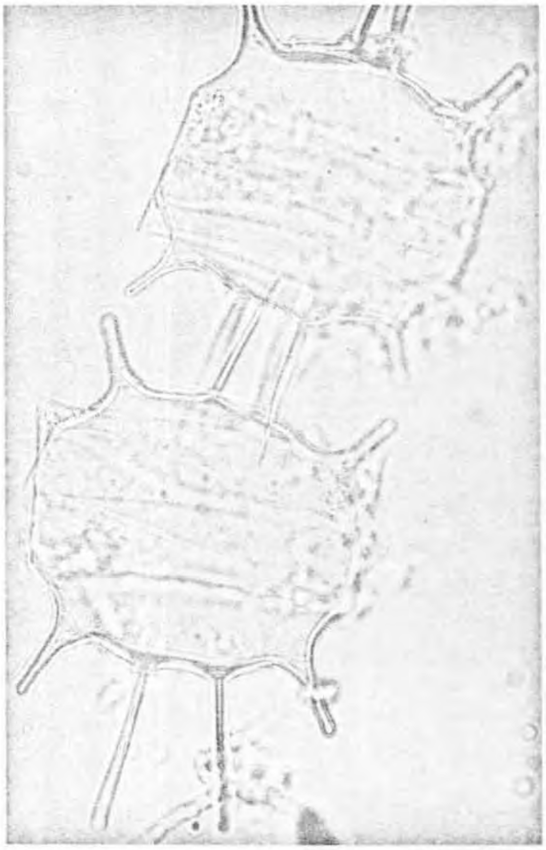
PLATE II

Figure 6. *Biddulphia regia* (Schultze) Ostenfeld
Figure 7. *Navicula* sp.
Figure 8. *Biddulphia mobiliensis* Bailey ("Pleurax" mount)
Figure 9. *Bellerochea malleus* f. *biangulata* Peragallo
Figure 10. *Coscinosira polychorda* Gran
Figure 11. *Cyclotella* sp. ("Pleurax" mount)



6 100 µ

7 100 µ



8 50 µ

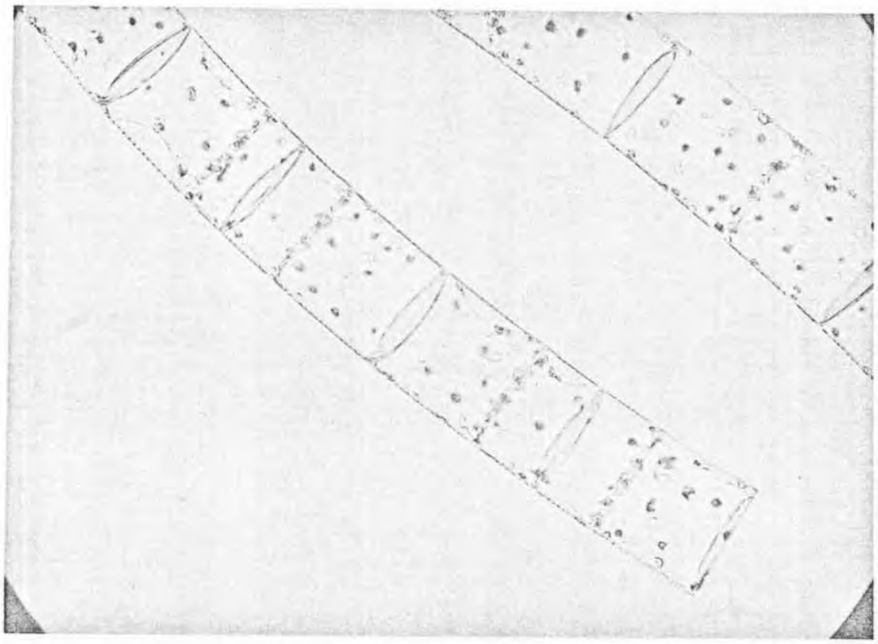
9 200 µ

10 25 µ

25 µ 11

PLATE III

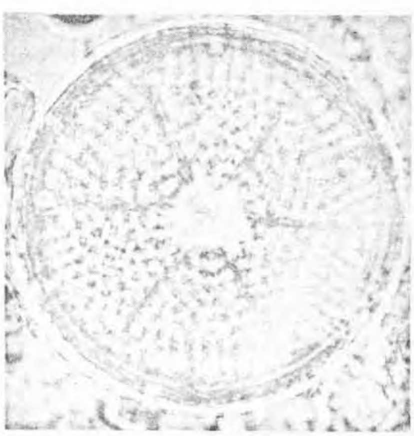
Figure 12. *Gyrosigma* sp. ("Pleurax" mount)
Figure 13. *Guinardia flaccida* (Castracane) Peragallo
Figure 14. *Actinoptychus undulatus* (Bailey) Ralfs ("Pleurax" mount)
Figure 15. *Melosira sulcata* (Ehrenberg) Kutzing
Figure 16. *Rhizosolenia stolterfothii* H. Peragallo



200 μ

13

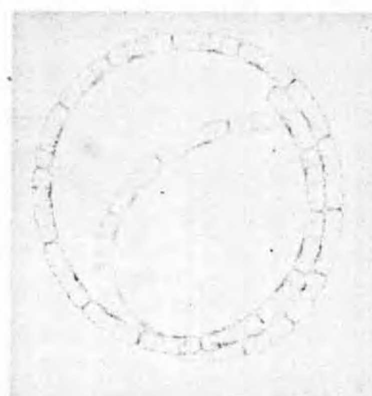
12 50 μ



25μ

100 μ

15



200 μ

16

PLATE IV

Figure 17. *Lithodesmium undulatum* Ehrenberg
Figure 18. *Bacteriastrum* sp.
Figure 19. *Lauderia borealis* Gran
Figure 20. *Coscinodiscus centralis* Ehrenberg

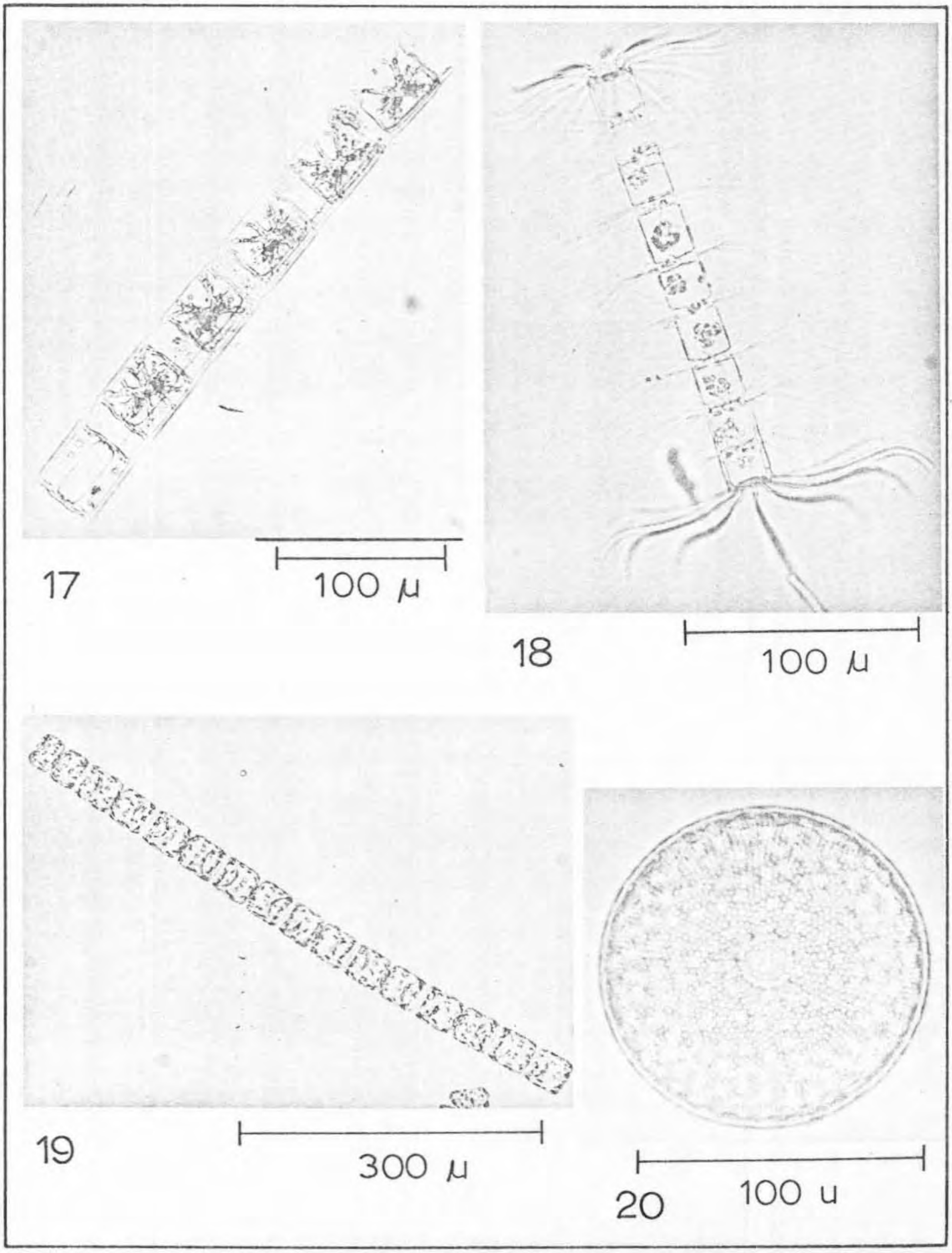


PLATE V

Figure 21. *Coscinodiscus centralis* Ehrenberg ("Pleurax" mount)
Figure 22. *Amphiprora* sp.
Figure 23. *Rhizosolenia setigera* Brightwell
Figure 24. *Thalassiosira decipens* (Grunow) Jorgensen ("Pleurax" mount)
Figure 25. *Rhizosolenia alata* f.*indica* (Peragallo) Ostenfeld
Figure 26. *Biddulphia alternans* (Bailey) van Heurck ("Pleurax" mount)

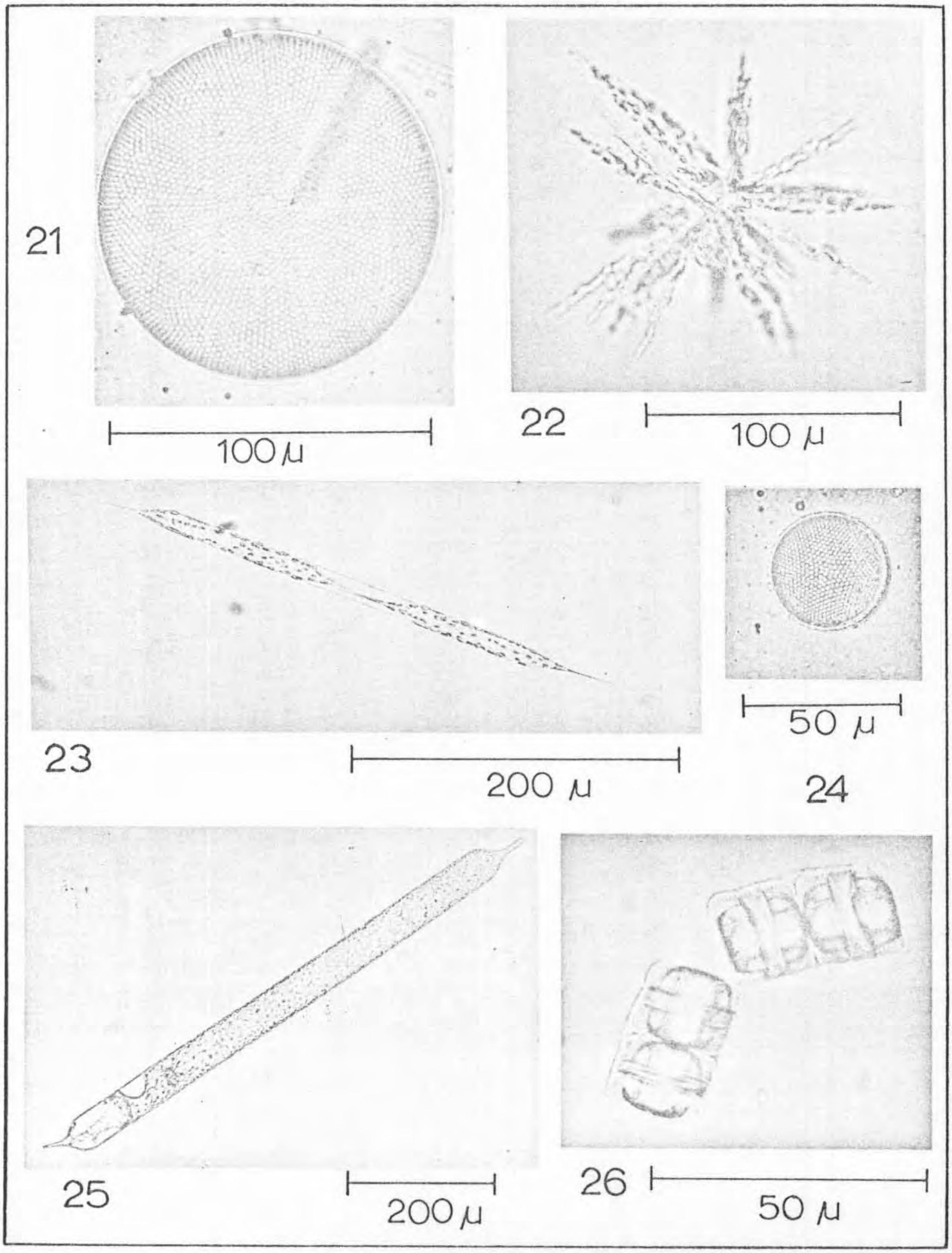
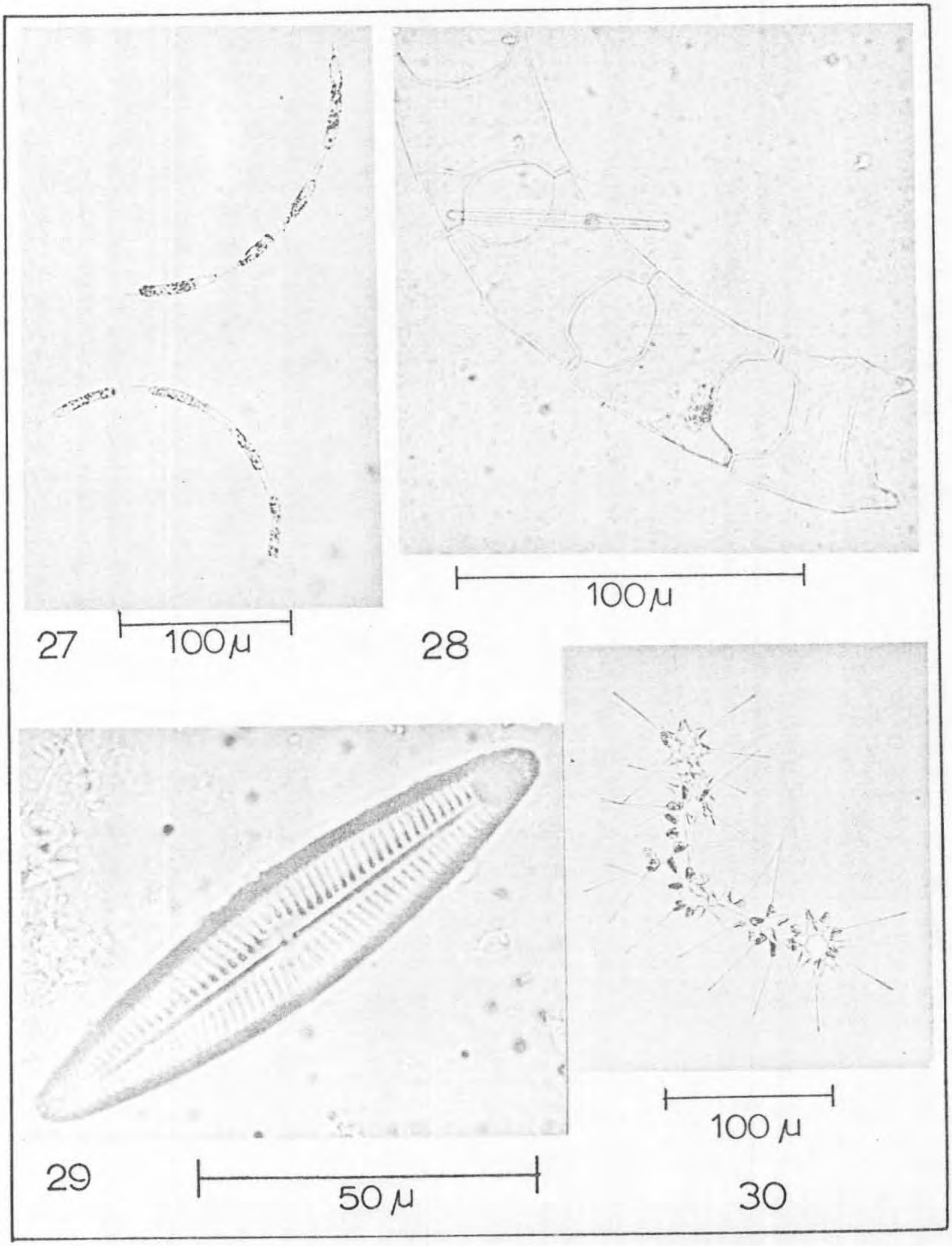


PLATE VI

Figure 27. *Hemiaulus sinensis* Greville
Figure 28. *Eucampia zoodiacus* Ehrenberg ("Pleurax" mount)
Figure 29. *Navicula* sp. ("Pleurax" mount)
Figure 30. *Asterionella japonica* Cleve & Moller ex Gran



Tables 1-4. Relative Abundance of *Melosira sulcata*, *Thalassiosira* spp., *Skeletonema costatum*, and *Bellerochea malleus*

1. *Melosira sulcata*

Stations	J	F	M	A	M	J	J	A	S	O
RT 1	X	X				X		X	X	?
RT 2	X	X		X	X					?
RT 3		X								
RT 4	X	C			X	X		X	X	X
RT 5	X	C				X				X
RT 6	X	C				X				X
RT 7		X	X							
RT 8	X	X	X							
RT 9		X	C							X
RT 10									X	?
RT 11										?
WS 1	C	X	X	X	X		X			C
WS 2	C	C	X	X	X				X	C
WS 3	C	C	X	N					X	C
WS 4	C	C	X	X	X	X	X		X	X
WS 5	X	C	X	X	X	X	X		X	C
WS 6										
WS 7	X	X	X		X		X			X
WS 8	X	X	X	X		X	X			X
WS 9	X	X	X	X	X					

2. *Thalassiosira* spp.

Stations	J	F	M	A	M	J	J	A	S	O
RT 1	X		X	C		C			C	?
RT 2				C	C				C	?
RT 3			X		N	N		N	C	C
RT 4			X		N	N		N	C	C
RT 5		X	X			C			C	C
RT 6								N	C	N
RT 7		X	X	C		N	C	C	C	C
RT 8	X		X	C	C	C			C	N
RT 9		X		C	N	C	X	C	X	N
RT 10			X	C	C		C	C	C	?
RT 11	X				C	N				?
WS 1	X	X	C	X			N	C	C	N
WS 2	X	X	X	X	X	C	N	C	C	N
WS 3	X	X	C	X	C		N	X	C	N
WS 4	X	X		N	A	C	N	X		C
WS 5		X		A	A	N	N	C	C	N
WS 6	C	X		X	C	N	X		C	N
WS 7	X	X	X		X	X		C	N	C
WS 8		X	X	X	C		C	C	N	C
WS 9	X	X	X	X	C			C	C	C

3. *Skeletonema costatum*

Stations	J	F	M	A	M	J	J	A	S	O
RT 1	N	A	N	V	A	A	N	V	A	?
RT 2	N	A	A	N	A	A		V	A	?
RT 3	A	V	V	A	A	A	N	A	A	V
RT 4	A	V	N	A	A	N	C	A	A	A
RT 5	N	A	A	A		N	V	N		A
RT 6	A	A	A	C	C	C		N	A	A
RT 7	N	C	A	A	N	N	N		A	A
RT 8	N	V	V	V	N	N		A	N	V
RT 9	C	C	N	A	N	A	C	N	A	A
RT 10	X	N	A	A	C	N	A	A	A	?
RT 11	V	V	N	C		A	N	C	N	?
WS 1	A	V	A	A	N	N	N	N	A	A
WS 2	A	V	A	A	A	N	N	A	A	A
WS 3	A	V	V	A	A	N	A	A	A	A
WS 4	A	V	V	V	N	N	N	V	V	A
WS 5	A	V	V	V	A	A	A	A	A	A
WS 6	V	V	A	N	C	A	V	A	V	V
WS 7	A	V	A	A	N	N	C	A	A	V
WS 8	A	A	A	A	N	N	C	A	A	A
WS 9	A	V	A	A	N	A	C	A	A	A

4. *Bellerochea malleus*

Stations	J	F	M	A	M	J	J	A	S	O
RT 1				A	N	N	N	N	C	?
RT 2				N	C	C	C	N	C	?
RT 3					X				C	X
RT 4					X	X	X		X	C
RT 5		C	C		C	X			C	C
RT 6						X			X	X
RT 7					X					X
RT 8										
RT 9					C				X	X
RT 10				X	C			X	X	?
RT 11										?
WS 1		C	C	C	X	X	C	C	C	N
WS 2	X	C	C		X	X	X	C	C	N
WS 3	X	X	X	C	X	X	X	C	C	N
WS 4				C	N	X	C	C	C	N
WS 5		C		C	N	N	N	N	N	N
WS 6					X			C		X
WS 7	X	X	X		C	X	X	C	X	C
WS 8	X	C	X	X	C	X	X	X	C	C
WS 9			X	X	C	X		X	X	C

Each symbol represents the average of one surface and one bottom sample at RT stations and an average of two to five surface and two to five bottom samples at WS stations.

X = less than 10/ml; C = 11-100/ml; N = 101-1,000/ml; A = 1,000-10,000/ml;

V = 10,001-100,000/ml; ? = no samples collected in that month. Where no symbol is present the species in question was not observed.

Tables 5-8. Relative abundance of *Cerataulina pelagica*, *Nitzschia seriata* (?), *Nitzschia closterium* (?) and *Rhizosolenia* spp.

5. *Cerataulina pelagica*

Stations	J	F	M	A	M	J	J	A	S	O
RT 1		X				A		N	C	?
RT 2				C		C		C	N	
RT 3		X			C				C	N
RT 4		C	X						C	N
RT 5			X						C	C
RT 6						N			C	C
RT 7		X	C						C	C
RT 8		X	X						N	
RT 9		C								
RT 10			X		C	C		C		?
RT 11								X		?
WS 1	X	C	C	C	C			X	X	N
WS 2	X	C	C		X				C	N
WS 3	C	C	C		N				C	C
WS 4	X	X	X	C	C	C	C	C	C	C
WS 5		X		C		C	C	C	C	C
WS 6						X			X	
WS 7	C	C	X	C		C	X		C	C
WS 8	C	C	X	C	C	X	X		X	C
WS 9	X	C	C	C	C	X	X		C	C

6. *Nitzschia seriata* (?)

Stations	J	F	M	A	M	J	J	A	S	O
RT 1				N	C	C		C	C	?
RT 2					C	C	C	X	C	?
RT 3	C				N	N	X	X	C	N
RT 4	X				N		C	C	N	C
RT 5		X	X	N		C	C	X	N	C
RT 6	C	X	X		X	N	N	C	C	N
RT 7	X				A	N	C	C		N
RT 8					N	C	N	C	C	C
RT 9		X		C		C	C	N		C
RT 10							C		C	?
RT 11										?
WS 1	C	C	X	C	C	N	A	N	N	N
WS 2	X	C	X	C	C	N	A	N	N	N
WS 3	C	C	C	C	C	N	A	C	N	N
WS 4							C	C	C	C
WS 5				N	C	N	C	C	N	C
WS 6							C		C	C
WS 7	C	X	C	N	C		N	X	C	N
WS 8	C	X	X	N	C		N	X	N	N
WS 9	C	C	C	N	N		N	C	N	N

7. *Nitzschia closterium* (?)

Stations	J	F	M	A	M	J	J	A	S	O
RT 1	C		X		C		C	C	C	?
RT 2					C	C	C	C	C	?
RT 3		X	X	A	C	N	X	C	X	C
RT 4		X			C	C	C	N	C	C
RT 5	X	X				C	C	X	C	C
RT 6	X	X	X	X	X	C		C	C	C
RT 7	X	X	X	C		N	C	C	N	C
RT 8	X	X	X	C	N	C	C	C	N	C
RT 9	X	X	C	C	N	C	X	C	C	N
RT 10	X		X	C	C	C	C	C	C	?
RT 11				X	C	C	X		X	?
WS 1	X	X	X	X	C	C	A	C	N	N
WS 2	X	X	X	X	C	N	A	C	N	C
WS 3	X	X	X	X	C	N	N	C	C	C
WS 4	X	X	X	X		X	C	X	C	C
WS 5	X	X	X	X	C	C	C	N	C	N
WS 6									X	C
WS 7	X	X		X	C	C	N	X	C	C
WS 8	X	X			C	C	N	X	C	C
WS 9	X	X	X	X	C	C	N	X	C	C

8. *Rhizosolenia* spp.

Stations	J	F	M	A	M	J	J	A	S	O
RT 1	X	X	C	C	C	C	C	C		?
RT 2	C	X	X	N	X	N	N	C	C	?
RT 3	X	X	X		N		X	N	C	C
RT 4	X	X	X		N	N	C	X	X	C
RT 5	C	C	X	N	X	N	N	C	X	C
RT 6	X	X	X	N	X	C	N	C	C	C
RT 7	X	X	X	C	N	C	A		N	C
RT 8	X	X	X	C	C	N	A	C	A	C
RT 9	X	C	X	C	N	C	N	C	X	X
RT 10	X	X	X		C	C	C	C		?
RT 11	C	N	X			N	X			?
WS 1	C	C	C	N	N	C	N	C	C	N
WS 2	C	C	X	C	N	N	N	C	C	N
WS 3	X	X	X	C	N	N	X	C	C	C
WS 4	C	C	C	C	C	N	X	C	C	C
WS 5	C	X	C	C	C	N	C	C	C	C
WS 6	C	X	N	X	X	N	N	X	X	C
WS 7	C	C	C	A	C	N	N	C	C	C
WS 8	C	C	C	A	C	A	N	C	C	N
WS 9	C	X	C	A	N	N	A	X	C	N

Each symbol represents the average of one surface and one bottom sample at RT stations and an average of two to five surface and two to five bottom samples at WS stations.

X = less than 10/ml; C = 11-100/ml; N = 101-1,000/ml; A = 1,001-10,000/ml;

V = 10,001-100,000/ml; ? = no samples collected in that month. Where no symbol is present the species in question was not observed.

Tables 9-11. Relative abundance of *Chaetoceros* spp., *Leptocylindrus* spp., and *Asterionella japonica*

9. *Chaetoceros* spp.

Stations	J	F	M	A	M	J	J	A	S	O
RT 1	C				C	X	C		C	?
RT 2	C		C	C	C	C	X	N	C	?
RT 3	C	N	X	V	A	V		N	N	C
RT 4	C			V		A	X		N	C
RT 5			C	C		N	C	C	N	N
RT 6	N	C	X	N	N	A	N	N	N	N
RT 7	C	X	X	C	A	N	N	C	N	C
RT 8	C	C	X	N	N	N	N	C	N	N
RT 9		X		C	A	N	X	X	C	C
RT 10	X	C			X	N	X	X	C	?
RT 11	C	X				N			C	?
WS 1	C	X	C	A	N	A	N	N	V	N
WS 2	C	X	C	A	N	A	N	N	V	N
WS 3	C		C	A	A	A	N	C	A	N
WS 4	C	C	C	C	C	C	N	C	C	X
WS 5	N	X		C	C	N	N	C	C	C
WS 6	N	N	N	X	X	C	C	C	C	
WS 7	C	C	C	A	N	A	N	C	N	N
WS 8	C	X	X	N	A	A	N	C	N	N
WS 9	C	X	C	N	A	A	A	X	N	N

10. *Leptocylindrus* spp.

Stations	J	F	M	A	M	J	J	A	S	O
RT 1						N		C	C	?
RT 2				N					C	?
RT 3	C				N	C		C	X	X
RT 4	C				V		C		C	C
RT 5							C	X	C	C
RT 6							C	C	N	C
RT 7					N				N	C
RT 8						N	N		C	C
RT 9		C	C			N			C	C
RT 10					C	C		C		?
RT 11	C					N	C			?
WS 1				C	N	C	C	C	C	N
WS 2	C			N	N	C	N	C	C	C
WS 3	C			N	A	C		X	C	N
WS 4				C	X	N	C	N	C	C
WS 5					C	C	C	N	C	C
WS 6	C				C	A	C		C	C
WS 7	C			C	N	N	C		C	C
WS 8		X		N	N	N	C		C	N
WS 9	X			N	N	N	C	C	C	N

11. *Asterionella japonica*

Stations	J	F	M	A	M	J	J	A	S	O
RT 1	N	C	X	N	C		C	N	N	?
RT 2	N	N	C		N	C		A	C	?
RT 3	C	N	C		N	N			C	C
RT 4	C	N							N	C
RT 5		C	C			C			N	N
RT 6		C	C		X	C	X		C	N
RT 7	C		C	C	X	C	X		A	C
RT 8	C				C				C	C
RT 9	C				C				C	C
RT 10	X		X					C	C	?
RT 11	N	C								?
WS 1	C	N	C		N	N		N	N	N
WS 2	C	N	C	X	X	C		N	N	N
WS 3	C	C	C		X	C			N	N
WS 4	N	N	C	X	C	X	C	N	N	N
WS 5	N	N	C	N	N	N	C	N	N	N
WS 6	N	V	X			C	X	X	X	C
WS 7	C	C	C	C	N	N	C		N	N
WS 8	C	C	C	X	C	N	C		N	N
WS 9	C	C	X	X	C	N	X		N	N

Each symbol represents the average of one surface and one bottom sample at RT stations and an average of two to five surface and two to five bottom samples at WS stations.

X = less than 10/ml; C = 11-100/ml; N = 101-1,000/ml; A = 1,001-10,000/ml;

V = 10,001-100,000/ml; ? = no samples collected in that month. Where no symbol is present the species in question was not observed.

Table 12. Diatom Frequency at WS Stations

	DEC.	JAN.	FEB.	MAR.	APR.	MAY	JUNE	JULY	AUG.	SEPT.	OCT.	Average
Melosira sulcata	10	39	59	22	11	14	7	11	0	12	26	19
Skeletonema costatum	88	91	95	89	46	19	28	35	62	69	82	88
Thalassiosira spp.	28	19	32	37	28	26	19	21	48	53	74	34
Coscinodiscus spp.	18	64	74	60	42	44	26	24	67	42	30	43
Biddulphia spp.	10	58	41	21	18	39	24	26	23	42	70	25
Bellerochea malleus	2	11	27	21	15	53	31	39	54	62	70	34
Cerataulina pelagica	0	22	52	36	27	18	19	17	15	40	48	27
Lithodesmium undulatum	0	22	52	35	4	8	4	0	4	9	26	16
Hemiaulus spp.	36	36	50	10	5	3	18	36	35	59	26	26
Streptotheca thamensis	3	4	47	11	4	0	0	0	4	21	54	12
Chaetoceros spp.	27	79	41	51	59	65	85	81	65	80	78	65
Rhizosolenia spp.	45	81	74	69	65	82	89	86	48	77	93	74
R. stolterfothii	(37)	(29)	(21)	(18)	(9)	(35)	(37)	(28)	(23)	(23)	(43)	(27)
R. setigera	?	?	?	?	?	?	?	(49)	(34)	(53)	(87)	?
R. alata	?	?	?	?	?	?	?	(12)	(2)	(17)	(18)	?
R. fragilissima	?	?	?	?	?	(20)	(29)	(53)	(19)	(12)	(40)	?
Guinardia flaccida	2	7	9	6	0	8	17	32	40	8	11	12
Leptocylindrus spp.	0	24	1	0	19	58	50	49	31	59	81	33
Corethron criophylum	0	1	1	0	4	0	6	8	27	30	17	8
Asterionella japonica	30	74	88	51	17	29	44	25	40	76	73	50
Thalassiothrix frauenfeldii	7	21	12	33	1	4	0	4	0	17	13	10
Thalassionema nitzschioides	22	6	6	11	4	24	36	26	35	73	85	28
Navicula spp.	15	3	0	3	14	6	18	25	40	61	57	20
N. membranacea	?	?	?	?	(3)	(1)	(7)	(7)	(17)	(1)	(4)	?
Pleurosigma/Gyrosigma spp.	15	39	30	42	69	6	26	10	19	51	61	27
Nitzschia closterium (?)	22	26	32	21	21	39	65	75	60	77	91	47
Nitzschia seriata (?)	13	36	32	37	40	42	18	60	56	85	91	44

Numbers indicate the percentage of samples observed to be positive.

Data reflect only occurrence without regard to population density.

Parentheses indicate that a species was also included in the analysis of the genus.

? indicates that a species was not identified in a particular month.

Table 13. Diatom Frequency at RT Stations

	DEC.	JAN.	FEB.	MAR.	APR.	MAY	JUNE	JULY	AUG.	SEPT.	OCT.	Average
Melosira sulcata	10	27	54	18	4	9	14	0	9	14	43	18
Skeletonema costatum	80	95	100	100	100	77	95	64	88	100	100	91
Thalassiosira spp.	20	27	23	54	45	36	50	14	41	64	86	66
Coscinodiscus spp.	10	59	68	32	32	32	27	9	32	45	36	35
Biddulphia spp.	0	32	45	36	14	54	32	9	23	41	57	27
Bellerochea malleus	0	0	9	4	27	59	36	23	27	68	57	27
Cerataulina pelagica	0	4	32	27	4	14	23	0	27	68	50	23
Lithodesmium undulatum	0	14	32	9	4	4	0	0	0	14	36	10
Hemiaulus spp.	10	18	23	9	4	0	18	23	4	41	14	15
Streptotheca thamensis	20	9	14	18	0	0	0	0	9	23	32	11
Chaetoceros spp.	40	73	50	36	73	64	86	68	59	86	100	67
Rhizosolenia spp.	50	100	91	86	59	77	82	91	77	68	86	79
R. stolterfothii	(4)	(14)	(23)	(9)	(4)	(23)	(27)	(23)	(9)	(9)	(43)	(17)
R. setigera	?	?	?	?	?	?	?	(41)	(64)	(59)	(78)	?
R. alata	?	?	?	?	?	?	?	(18)	(4)	(9)	(7)	?
R. fragilissima	?	?	?	?	?	14	18	45	9	9	14	?
Guinardia flaccida	0	0	0	9	0	0	18	36	14	4	7	8
Leptocylindrus spp.	0	23	9	4	9	32	57	27	32	59	79	30
Corethron criophylum	0	0	4	0	0	4	14	14	36	41	50	15
Asterionella japonica	30	59	77	64	27	45	32	18	18	91	100	51
Thalassiothrix frauenfeldti	0	18	4	57	0	0	0	0	4	0	0	7
Thalassionema nitzschioides	14	9	23	4	18	23	45	18	68	77	78	34
Navicula spp.	40	0	4	0	0	4	9	18	27	68	57	21
N. membranacea	?	?	?	?	(0)	(0)	(0)	(0)	(9)	(0)	(0)	?
Pleurosigma/Gyrosigma spp.	40	45	45	23	18	9	18	27	18	64	79	35
Nitzschia closterium (?)	70	50	59	45	45	68	68	73	82	91	100	68
Nitzschia seriata (?)	0	27	18	9	27	59	59	59	54	64	100	43

Numbers indicate the percentage of samples observed to be positive.

Data reflect only occurrence without regard to population density

Parentheses indicate that a species was also included in the anlysis of the genus.

? indicates that a species was not identified in a particular month.

Table 14. WS Stations: Percentages of Selected Diatom Species in Surface and Bottom Samples, 1964

	JAN.	FEB.	MAR.	APR.	MAY	JUNE	JULY	AUG.	SEPT.	OCT.
Skeletonema costatum	89	83	95	66	16	33	32	69	67	84
Chaetoceros spp.	<1	<1	<1	15	21	37	7	1	27	2
Rhizosolenia spp.	<1	<1	<1	6	2	14	8	<1	<1	<1
Leptocylindrus spp.	<1	<1	0	2	24	8	1	<1	<1	1
Asterionella japonica	1	13	<1	<1	1	3	<1	2	1	2
Nitzschia closterium (?)	<1	<1	<1	<1	<1	1	9	<1	<1	<1
Nitzschia seriata (?)	<1	<1	<1	<1	2	2	30	1	<1	1
Bellerochea malleus	<1	<1	<1	<1	2	1	<1	1	<1	1
Thalassiosira spp.	<1	<1	<1	1	10	<1	4	3	<1	1
Average number total diatoms per ml	10,094	26,266	12,312	9,383	3,846	4,506	5,309	4,483	12,400	8,374

Table 15. RT Stations: Percentages of Selected Diatom Species in Surface and Bottom Samples, 1964

	JAN.	FEB.	MAR.	APR.	MAY	JUNE	JULY	AUG.	SEPT.	OCT.
Skeletonema costatum	95	96	99	38	21	25	24	80	75	92
Chaetoceros spp.	1	<1	<1	47	20	34	9	<1	<1	<1
Rhizosolenia spp.	2	<1	<1	<1	3	11	44	<1	6	<1
Leptocylindrus spp.	<1	<1	<1	<1	42	1	<1	<1	<1	<1
Asterionella japonica	2	3	<1	<1	2	4	<1	5	10	<1
Nitzschia closterium (?)	<1	<1	<1	2	1	2	2	<1	1	<1
Nitzschia seriata (?)	<1	<1	<1	<1	4	2	5	<1	1	<1
Bellerochea malleus	0	<1	<1	3	1	4	3	2	<1	<1
Thalassiosira spp.	<1	<1	<1	<1	1	2	<1	2	<1	<1
Average number total diatoms per ml	7,118	22,725	12,813	16,533	5,868	5,340	1,277	6,221	8,514	17,017

REFERENCES

COLLIER, A. and A. MURPHY
1962. Very small diatoms: preliminary notes and the description of *Chaetoceros galvestonensis* n. sp. *Science, 136*(3518): 780-782.

CONOVER, S. A. M.
1956. Oceanography of Long Island Sound, 1952-1954. IV. Phytoplankton. *Bull. Bingham Oceanog. Coll., 15*: 62-112.

COOPER, I. C. G.
1958. A new diatom from Fort Myers, Florida, U. S. A. *Rev. Algol., 2:* 125-128.

COWLES, R. P.
1930. A biological study of the offshore waters of Chesapeake Bay. *Bull. Bur. Fish., 46:* 277-381.

CUPP, E. E.
1943. Marine plankton diatoms of the west coast of North America. *Bull. Scripps Instn. Oceanogr. 5*(1): 1-238.

CURL, H., JR.
1959. The phytoplankton of Apalachee Bay and the northeastern Gulf of Mexico. *Inst. Mar. Sci., 6:* 277-320.

DAVIS, C. C.
1950. Observations of plankton taken in marine waters of Florida in 1947 and 1948. *Quart. Jour. Florida Acad. Sci., 12*(2): 67-103.

DRAGOVICH, A.
1963. Hydrology and plankton of coastal waters at Naples, Florida. *Quart. Jour. Florida Acad. Sci., 26*(1): 22-47.

DRAGOVICH, A. and J. A. KELLY, JR.
1964. Preliminary observations on phytoplankton and hydrology in Tampa Bay and the immediate offshore waters, p. 4-22. *In* A Collection of Data in Reference to Red Tide Outbreaks During 1963. *Fla. Bd. Conserv. Mar. Lab.* (mimeo)

FREESE, L. R.
1952. Marine diatoms of the Rockport, Texas, bay area. *Tex. J. Sci., 4*(3): 331-386.

GUNTER, G., R. H. WILLIAMS, C. C. DAVIS, and F. G. W. SMITH
1947. Mass mortality of marine animals and coincident phytoplankton blooms on the west coast of Florida, November 1946 – August 1947. *Ecol. Monogr., 18*(3): 309-324.

HENDEY, N. I.
1964. An introductory account of the smaller algae of British coastal waters. Part V: Bacillariophyceae (Diatoms). *Fish. Invest.* (Ser. IV), London, xxii + 317 pp.

HUSTEDT, F.
1927-1930. Die Kieselalgen Deutschlands, Osterreichs und der Schweiz. *In* Rabenhorst, L., *Kryptogamen-Flora, 7,* Pt. I: 1-925.

HUSTEDT, F.
1931-1959. Die Kieselalgen Deutschlands, Osterreichs und der Schweiz. *In* Rabenhorst, L., *Kryptogamen-Flora, 7,* Pt. II: 1-845.

KING, J. E.
1950. A preliminary report on the plankton of the west coast of Florida. *Quart. Jour. Florida Acad. Sci., 12*(2): 109-137.

LACKEY, J. B. and J. A. HYNES
1955. The Florida Gulf Coast red tide. *Engng. Progr. Univ. Fla., 9*(2): 1-24.

LILLICK, L. C.
1937. Seasonal studies of the phytoplankton off Woods Hole, Massachusetts. *Biol. Bull., 73*(3): 488-503.

PRATT, D. M.
1959. The phytoplankton of Narragansett Bay. *Limnol. Oceanog., 4*(4): 425-440.

REIMANN, E. F. and J. C. LEWIN
1964. The diatom genus *Cylindrotheca* Rabenhorst (with a reconsideration of *Nitzschia closterium*). *Jour. Roy. Mic. Soc., 83,* (Pt. 3): 283-296.

RILEY, G. A.
1952. Phytoplankton of Block Island Sound, 1949. *Bull. Bingham Oceanog. Coll., 13*(3): 40-64.

SIMMONS, E. G. and W. H. THOMAS
1962. Phytoplankton of the eastern Missisippi delta. *Inst. Mar. Sci., 8:* 269-298.

SMAYDA, T. J.
1957. Phytoplankton studies in lower Narragansett Bay. *Limnol. Oceanog., 2* (4): 342-358.

OCCURRENCE OF VITAMIN B_{12} ALONG THE GULF COAST OF FLORIDA

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INTRODUCTION

Gymnodinium breve Davis, the Florida Red Tide organism, requires vitamin B_{12} for growth (Hutner and Provasoli, 1955 and 1964; Raymont, 1963). Because of recurrent Red Tides along the southwest coast of Florida, sampling stations were established at key points from Tampa Bay south to Cape Romano. Water for bioassay of vitamin B_{12} concentration and utilizable analogues was collected at RT Stations numbered 1 through 6, 8 and 9. A description of each station is provided elsewhere in this volume. (See Introduction).

Sampling for B_{12} began in April 1964, and continued until October 1964. Originally the schedule was planned for a full year but an outbreak of Red Tide in north Florida, and full scale attention to analyses concerning it, forced the cancellation of the last four months.

During the winter of 1965 these RT Stations were visited again (one time each). Approximately one year after the RT sampling program was begun, three rivers, the Manatee, Myakka and Caloosahatchee, were sampled for vitamin B_{12} content. The rivers originate in central Florida and empty into the Gulf of Mexico between Tampa Bay and San Carlos Bay to the south. The descriptions of these river stations are presented in this treatise (Donnelly *et al.*). Although none of the RT Stations sampled were in the direct outflow of these rivers, they would all presumably be affected by the resultant currents and mixing of river waters with salt water.

MATERIALS AND METHODS

Glassware.

All glassware and equipment used in microbiological assay procedures were carefully cleaned to prevent possible vitamin B_{12} contamination. Glassware was soaked in detergent, rinsed in running water and in deionized water. After air drying, it was baked for three hours in 300 °C oven. Pipettes were soaked in detergent overnight, rinsed in tap water in an automatic pipette washer, soaked in concentrated sulfuric acid, washed at least one hour in tap water, and finally rinsed in deionized water. The dry pipettes were baked with other glassware.

Collection of Samples.

All samples to be assayed were collected in sterile polypropylene bottles. Only surface samples were taken because they were collected in shallow areas, usually less then four feet in depth. Samples were taken in duplicate and frozen immediately with dry ice. At the laboratory, the frozen samples were transferred to the freezer and stored at -20 °C.

Assay methods involved the use of a fresh water organism, *Euglena gracilis* strain z, and a marine diatom, *Cyclotella nana*. Samples were diluted so that the B_{12} values would fall within the standard curve, but no concentration, extraction, or filtration techniques were used. The aliquots to be assayed utilizing *C. nana* were diluted with charcoal-treated sea water. The aliquots to be assayed with *Euglena* were diluted with glass distilled water. With the routine dilutions, there was no apparent growth inhibition of *Euglena* due to salinity. Sweeny (1954) noted that the increase in salinity caused by the addition of 10% sea water to the bioassay medium had no appreciable effect on *Euglena*. Hutner *et al.* (1956), recommended that sea water be diluted 10-fold or more to reduce the osmotic pressure when assaying with *Euglena*. The dilutions used in our assays were within these recommended limits.

Bioassay Procedure Utilizing *Cyclotella nana* Hustedt.

The marine diatom *Cyclotella nana* Hustedt, clone 3H, was used to determine true B_{12} in the sea water sample. Guillard and Cassie (1963) reported that the B_{12} requirement for this organism was absolute and not simply stimulatory.

The method was based on work of Guillard and Ryther (1962). Stock cultures were maintained on medium f at 21 °C under continuous fluorescent illumination. For assay, the medium was prepared without vitamin B_{12}, using aged sea water which had been charcoal-treated to adsorb the vitamins (Ryther and Guillard, 1962). Five aliquots of sea water sample were each diluted with charcoal-treated sea water (1 ml of sample diluted to 5 ml). Each diluted aliquot was assayed in three additional dilutions, making a total of 15 sample flasks for each sea water sample. A series of standards ranging from 0.5 to 2.5 $\mu\mu g$ B_{12}/ml was prepared in triplicate. An inoculated blank without added B_{12} was included to determine the growth response at the zero point. An uninoculated blank served as an indicator of contamination.

The inoculum for the assay was depleted in medium f minus vitamin B_{12} for 5 to 7 days. The vitamin depleted cells were suspended in sterile vitamin-free medium and approximately 10,000 cells were inoculated into assay flasks containing 10 ml of standard or sample dilution (as described above). All cultures were incubated at 21°C for 8 or 9 days under continuous fluorescent illumination. After incubation, Lugol's iodine was added to each flask to terminate growth. Cell counts were made in an AO Spencer Bright-Line hemacytometer. The growth responses of the standards were used to construct a linear curve. Sample dilutions were compared with the standard curve, adjusted with the appropriate dilution factor, and the mean value determined from each series of assay flasks. For additional details, refer to Stewart (1966a).

Bio-assay Procedure Utilizing *Euglena gracilis*.

Euglena gracilis, strain *z*, a fresh water flagellate, has a broader specificity than *C. nana*, responding to cyanocobalamin, Factor A and pseudovitamin B_{12} (Hutner *et al.*, 1956).

Stock cultures were maintained on B_{12} *Euglena* assay medium (Baltimore Biological Laboratory, Inc., Cat. No. 01-610) as described by Hutner *et al.* (1956). For assay purposes the medium was prepared without vitamin B_{12}.

Ten aliquots of the sea water to be assayed were diluted with glass distilled water (1 ml of sample diluted to 5 ml). Three additional dilutions were made with each aliquot and each dilution was assayed in triplicate. Thus, 90 dilutions were prepared for each sample.

A standard series ranging from 0.5 to 2.5 μμg B_{12}/ml was prepared in triplicate. An inoculated blank without added B_{12} was included as the experimental blank in the subsequent turbidity measurement. An uninoculated blank was also used as an indicator of contamination.

Inoculum for the assay was from 4-10 day old stock cultures. The cells were washed three times in sterile B_{12}-free medium to reduce carryover of vitamin B_{12} and to remove the inhibitory factor present in aged *Euglena* cultures, as reported by Kristensen (1955). Washed cells were resuspended in sterile B_{12}-free medium, and approximately 100,000 cells were dispensed into each assay tube. The cultures were incubated at 21°C under continuous fluorescent illumination for 6-8 days. During incubation, the tubes were shaken daily to prevent clumping of cells.

Using the pooled inoculated blanks as the zero point, the optical density of each standard and sample dilution was determined with a Beckman DU spectrophotometer at 570 mμ. Growth response of the standard series was used to construct a linear curve. Sample dilutions were compared with the standard curve and adjusted with the appropriate dilution factor. The mean value of 90 dilutions per sample was recorded as μμg B_{12}/ml. For additional details, refer to Stewart (1966b).

RESULTS AND DISCUSSION

With the vitamin B_{12} assay methods described, we have determined the mean values of numerous replicates. These data serve as indicators of vitamin B_{12} activity, they are not absolute units (Stewart *et al.*, 1966).

Table 1. Vitamin B_{12} Data from April to October 1964.

Station and Sample No.		1964 Date	μμg B_{12}/ml *C. nana*	μμg B_{12}/ml *Euglena*	Salinity ‰	°C
RT 1	51*	27 April	71.8	65.6	28.3	27.0
	62	25 May	35.2	27.5	27.8	27.2
	73	22 June	22.1	35.0	29.0	30.6
	84	27 July	21.0	25.0	29.8	27.4
	93	24 August	23.8	29.7	29.1	31.2
RT 2	50	27 April	15.3	15.1	33.0	26.0
	61	25 May	21.8	19.2	33.3	27.3
	72	22 June	16.7	17.1	35.0	30.9
	92	24 August	24.8	15.4	34.6	31.0
	105	28 September	12.9	31.8	31.9	27.2
RT 3	49	20 April	41.1	62.3	33.0	25.9
	60	18 May	59.2	61.3	35.4	29.3
	71	15 June	55.9	55.4	35.4	31.4
	82	20 July	30.5	45.3	35.9	30.5
	91	17 August	38.4	65.8	35.4	31.2
	115	19 October	41.3	32.4	34.9	24.2
RT 4	48	20 April	7.8	24.0	34.2	25.0
	59	18 May	7.2	16.9	34.5	26.6
	70	15 June	13.1	18.1	34.4	29.9
	81	20 July	8.3	11.5	35.9	30.0
	103	21 September	18.7	10.4	35.2	27.2
RT 5	47	13 April	0.0	5.2	33.6	24.0
	58	11 May	4.1	6.3	35.2	27.1
	69	8 June	3.0	22.2	35.4	28.9
	80	13 July	14.0	19.2	36.4	31.2
	100	3 September	11.6	10.6	35.4	29.5
	113	12 October	22.2	22.8	33.9	24.1
RT 6	46	13 April	0.0	---	31.7	24.6
	57	11 May	4.3	7.6	35.0	27.3
	68	8 June	3.0	27.5	34.5	29.3
	79	13 July	13.5	17.6	34.9	31.5
	101	14 September	18.9	28.5	28.1	27.8
RT 8	55	5 May	8.3	8.5	34.4	24.9
	66	2 June	19.2	28.9	35.7	29.4
	77	7 July	24.8	23.9	35.1	29.9
	97	1 September	23.5	12.2	32.3	31.4
RT 9	54	5 May	9.4	8.1	35.0	25.9
	65	2 June	13.3	15.7	35.4	29.5
	76	7 July	18.8	20.8	33.6	30.1
	87	4 August	12.2	23.2	34.4	30.0
	109	6 October	23.4	30.1	33.9	26.5

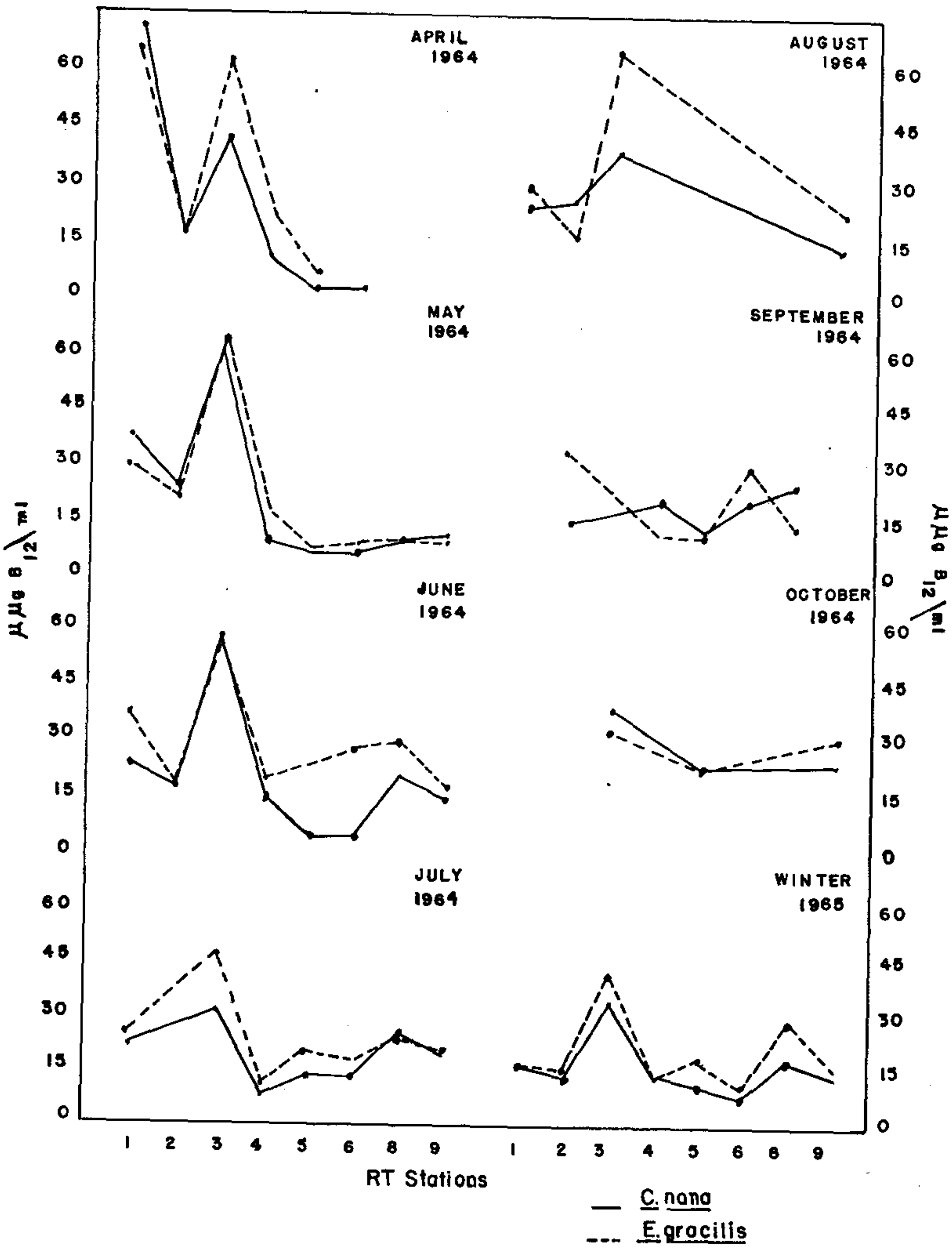
*Surface samples, taken over 2 to 4 foot depths.

Table 2. Vitamin B_{12} Data, Winter 1965.

Station and Sample No.		1965 Date	μμg B_{12}/ml *C. nana*	μμg B_{12}/ml *Euglena*	Salinity ‰	°C
RT 1	120*	29 January	15.8	16.8	**	14.5
2	121	29 January	13.7	15.1	**	11.9
3	123	4 February	33.6	41.4	**	18.5
4	122	4 February	14.0	13.8	**	16.4
5	127	2 April	11.6	18.6	33.39	22.0
6	124	17 February	8.6	11.4	**	22.2
8	125	17 February	21.3	28.0	**	23.8
9	126	17 February	14.6	17.3	**	23.3

*Surface samples, taken over 2 to 4 foot depths.
**Salinity not available.

Figure 1. Vitamin B_{12} data, 1964 and 1965.



The RT data for May, June, July, and August 1964 (Table 1, Figure 1) are similar to the data curves for the winter months of 1965 (Table 2, Figure 1), perhaps indicating a certain constancy in the distribution of B_{12} with only local variations or patchiness. The quiet embayment, rich in organic matter at RT 3 (Lido Key) had greater B_{12} activity than the other stations at any given time. In general, the stations did not vary more than 10 or 15 $\mu\mu g$ B_{12}/ml over the entire sampling period, but an occasional very high or low reading was determined.

Table 3. Vitamin B_{12} in Central Florida Rivers, 1965.

Sample No.*	1965 Date	Water °C	pH	$\mu\mu g$ B_{12}/ml *C. nana*	$\mu\mu g$ B_{12}/ml *E. gracilis*	Time	Stream Flow Direction
MANATEE RIVER							
SF 1-1	14 April	22.1	5.0	7.2	10.5	0945	
SF 2-16	21 April	24.0	4.5	9.1	26.9	1025	
SF 1-15	21 April	22.5	5.0	2.4	11.9	0930	
MYAKKA RIVER							
SF 4-2	14 April	24.0	5.5	15.5	25.6	1010	
SF 3-13	14 April	29.5	5.5	21.4	31.4	1820	
SF 4-44	12 May	26.5	5.5	20.4	25.7	1150	
SF 24-43	12 May	31.5	5.0	25.0	42.6	1030	
CALOOSAHATCHEE RIVER							
SF 19-27	28 April	29.0	6.2	18.5	24.7	1315	
SF 18-26	28 April	29.0	5.5	18.6	20.6	1235	
SF 17-25	28 April	29.3	6.2	19.6	12.0	1215	
SF 16-24	28 April	28.5	6.4	21.3	15.2	1150	

*Surface samples

Data from the central Florida river studies are listed in Table 3. The Manatee River was sampled at two stations on the same day. Vitamin B_{12} values were highest upstream. The Myakka River was sampled at two stations on two occasions. Vitamin B_{12} was less abundant upstream than nearer the mouth of this river. The Caloosahatchee was sampled at four stations in one day. Vitamin values with *Cyclotella nana* were quite consistent at all stations (18.5-21.3 $\mu\mu g$/ml). *Euglena* determinations varied, and appeared to decrease as the waters progressed downstream.

Though this sampling was limited, there was no apparent consistency in the B_{12} contributions of these rivers to the Gulf. Data of Vishniac and Riley (1961) suggested that cobalamin may not be derived from land drainage. In general, the B_{12} values of the previous year in neighboring RT Stations were lower than the river samples.

Studies by other workers on the requirements of organisms have suggested the B_{12} needs may vary under given conditions. Daisley (1957) proposed that "...in a natural environment a concentration of vitamin B_{12} sufficient to support considerable cell division may nevertheless be a limiting concentration, if the rate of cell division as supported is only sufficient to compensate for the losses of cells due to other factors." It seems, however, that the supply of vitamin B_{12} encountered in the sampling program was in excess for even a large bloom of *G. breve*. Guillard and Cassie (1963) suggested that B_{12} concentration is important at given times in the life cycle of certain diatoms. Thus the time at which the vitamin is present in suitable concentration may be more significant than the total quantity present. Again it appears that, except for the April collections from RT 5 and 6 (0.0 µµg B_{12}/ml), all the stations sampled contained abundant supplies of vitamin B_{12} for most of the organisms in the habitat.

It has been noted (Droop *et al.*, 1959) that, ". . .B_{12} analogues are likely to have ecological importance equal to that of the vitamin proper." In general, the B_{12} activity of Euglena was equivalent to or greater than the *C. nana* B_{12} activity. In only one instance, RT 8-97, did the value for *C. nana* assay exceed the *Euglena* value by more than 10 µµg. This deviation may have been due to errors inherent in the methods and technique. Such variants are usually impossible to trace.

Droop (1957) calculated that it would require less than 0.1 µµg/ml of vitamin B_{12} to achieve a crop of 25,000 cells/ml of *Skeletonema costatum,* this number being of bloom proportions. Considering the relative sizes of the species, he concluded that the Florida Red Tide organism, *Gymnodinium breve,* would require at the most 3 µµg of vitamin B_{12}/ml for a bloom population of 60,000 cells/ml. Steidinger (1964) mentioned a *G. breve* count in a Florida Red Tide bloom of 75,000,000 cells/liter (75,000 cells/ml). Considering Droop's calculations, vitamin B_{12} was apparently in sufficient quantity during our sampling period to support a bloom at almost any time, other conditions being favorable.

LITERATURE CITED

DAISLEY, K. W.
1957. Vitamin B_{12} in marine ecology. *Nature, 180* (4594): 1042-1043.

DROOP, M. R.
1957. Vitamin B_{12} in marine ecology. *Nature, 180* (4594): 1041-1042.

DROOP, M. R., J. J. A. McLAUGHLIN, I. J. PINTNER, and L. PROVASOLI
1959. Specificity of some protophytes toward vitamin B_{12}-like compounds. *Internat. Oceanog. Prep. 1959*: 916-918.

GUILLARD, R. R. L. and J. H. RYTHER
1962. Studies of marine planktonic diatoms. I. *Cyclotella nana* Hustedt, and *Detonula confervacea* (Cleve) Gran. *Can. J. Microbiol., 8*: 229-239.

GUILLARD, R. R. L. and V. CASSIE
1963. Minimum cyanocobalamin requirements of some marine centric diatoms. *Limnol. Oceanog., 8*(2): 161-165.

HUTNER, S. H. and C. A. BJERKNES
1948. Volatile preservatives for culture media. *Proc. Soc. Exp. Biol., 67*: 393-397.

HUTNER, S. H. and L. PROVASOLI
1955. Comparative biochemistry of flagellates, p. 17-43. *In* S. H. Hutner and A. Lwoff, (ed.), Biochemistry and Physiology of Protozoa, Vol. 2. Academic Press, N. Y.

HUTNER, S. H., M. K. BACH, and G. I. M. ROSS
1956. A sugar-containing basal medium for vitamin B_{12}-assay with *Euglena;* application to body fluids. *J. Protozool., 3*(3): 101-112.

HUTNER, S. H. and L. PROVASOLI
1964. Nutrition of algae. *Ann. Rev. Plant Physiol., 15*: 37-45.

KRISTENSEN, H. P.
1955. Investigations into the *Euglena gracilis* method for quantitative assay of vitamin B_{12}. *Acta Physiol. Scand., 33*: 232-237.

RAYMONT, J. E. G.
1963. Factors affecting primary production III Organic micro-nutrients and inhibitors, p. 229-238. *In* Plankton and Productivity in the Oceans, The MacMillan Co., New York.

RYTHER, J. H. and R. R. L. GUILLARD
1962. Studies of marine planktonic diatoms. II. Use of *Cyclotella nana* Hustedt for assays of vitamin B_{12} in sea water. *Can. J. Microbiol., 8*: 437-445.

STEIDINGER, K. A.
1964. *Gymnodinium breve* Davis. *Fla. Bd. Conserv.* Leaf. Ser., *1*(1): 1-2.

STEWART, V. N.
1966a. Microbiological assay of vitamin B_{12} with *Cyclotella nana. Fla. Bd. Conserv.*, Leaf. Ser., *6*(4)1: 1-4.

STEWART, V. N.
1966b. Microbiological assay of vitamin B_{12} with *Euglena gracilis* strain z. *Fla. Bd. Conserv.*, Leaf. Ser., *6*(4)2: 1-4.

STEWART, V. N., H. WAHLQUIST, R. BURKET, and C. WAHLQUIST
1966. Observations of vitamin B_{12} distribution in Apalachee Bay, Florida. *In* Observations of an Unusual Red Tide, *Fla. Bd. Conserv.*, Prof. Pap. Ser. No. 8: 34-38.

SWEENEY, B. M.
1954. *Gymnodinium splendens*, a marine dinoflagellate requiring vitamin B_{12}. *Am. J. Bot., 41:* 821-824.

VISHNIAC, H. S. and G. A. RILEY
1961. Cobalamin and thiamine in Long Island Sound: patterns of distribution and ecological significance. *Limnol. Oceanog., 6*(1): 36-41.

CONCENTRATION OF CARBOHYDRATES OF THE COASTAL WATERS OF WEST FLORIDA

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INTRODUCTION

The recurrence of Red Tide along the west coast of Florida from Marco to Tampa Bay led to establishment of regular inshore sampling stations in this area. Samples were collected for biological and chemical observations and analyses. These data would perhaps provide essential background information on the water composition in event of a Red Tide outbreak. Carbohydrate concentrations were included in the chemical determinations since these organic compounds are directly important in the nutrition of some microorganisms and because they may serve as an indicator of land runoff and algal blooms.

In this paper an attempt was made to correlate the concentration of carbohydrates with salinity during the period of May 1964 to October 1964.

MATERIALS AND METHODS

Water samples were collected at assigned stations, (Figure 1) usually at mid-depth, and were frozen immediately by placing the polyethylene sample containers in dry ice.

A modified procedure, based on the anthrone colorimetric assay of Lewis and Rakestraw (1955), was used to estimate the concentration of carbohydrate-like substances. After 20 ml of a 0.1% anthrone reagent was added to 10 ml of the test sample, the sample was allowed to cool, and the optical density of an aliquot was then determined at 630 mμ with a Beckman DU spectrophotometer. To determine the concentration, the optical density of the sample was compared to a glucose standard curve nomograph. The control blank was based on predetermined salinities of each sample. The results were reported as glucose equivalents in mg/-liter, $\pm$ 0.21.

RESULTS AND DISCUSSION

In Table 1, chemical and hydrographic data are cited in tabular form for each sample from the RT Stations. Temperature, tide, and depth were field observations. Salinities were determined by Mohr titration. The lowest concentration of carbohydrate was observed at Station RT-5; the maximum at RT-2 (Table 2.) Mean of each of the nine stations did not differ appreciably. The small number of samples and their narrow range precludes further statistical analyses.

Figure 2 is a graphic illustration of the monthly fluctuation of the carbohydrate values related to the salinity determinations. It should be noted that the carbohydrate concentrations appeared to be independent of the salinity values. There was no apparent correlation of carbohydrate concentration to salinity or to tide stages at these stations.

These data indicate that the concentration of carbohydrates in coastal waters of west Florida do not vary appreciably from that of offshore water. Values of less than 1 mg/liter are usually demonstrable in sea water, but concentrations exceeding 10 mg/liter have been quantitated in bloom waters (Collier, 1958). Although in confined coastal waters higher values would be expected because of the abundance of metabolism and land effluent, these demonstrated carbohydrate levels resulted from high utilization rates and tidal dilution. From this limited data it may be concluded that at these coastal stations high concentrations of carbohydrates do not normally occur.

REFERENCES

ANDERSON, W. W. and J. W. GEHRINGER
1958. Physical oceanographic, biological, and chemical data. South Atlantic Coast of the United States. *M/V Theodore N. Gill* Cruise 6 and 8, *U. S. Fish Wildl. Serv.* Spec. Sci. Rep. Fish No. 265 and No. 303.

COLLIER, A.
1953. The significance of organic compounds in sea water. *Trans. North Amer. Wildl. Conf., 18:* 463-472.

COLLIER, A.
1958. Some biochemical aspects of red tides and related oceanographic problems. *Limnol. Oceanog., 3:* 33-39.

COLLIER, A., S. M. RAY, and A. W. MAGNITZKY
1950. A preliminary note on naturally occurring organic substances in sea water affecting the feeding of oysters. *Science, 111*: 151-152.

COLLIER, A., S. M. RAY, A. W. MAGNITZKY, and J. D. BELL
1953. Effect of dissolved organic substances on oysters, *U. S. Fish and Wildl. Serv.*, Fish Bull., *84*: 167-185.

COLLIER, A., S. M. RAY, and W. B. WILSON
1956. Some effects on specific organic compounds on marine organisms. *Science, 124*: 220.

DONNELLY, P. V. and M. A. BURKLEW
1965. Carbohydrate distribution in the northwest coastal waters of Florida.

In Observations of an Unusual Red Tide--A Symposium, *Fla. Bd. Conserv.*, Prof. Pap. Ser. No. 8: 39-42.

HOOD, D. W.
1963. Chemical oceanography. *Oceanogr. Mar. Biol. Ann. Rev.*, *1*: 129-155.

LEWIS, G. J., and N. W. RAKESTRAW
1955. Carbohydrate in sea water. *J. Mar. Res.*, *14*: 253-248.

PLUNKETT, M. A., and N. W. RAKESTRAW
1955. Dissolved organic matter in the sea. *Deep-Sea Res. Suppl.*, *3*: 12-14.

PROVASOLI, L.
1963. Organic regulation of phytoplankton fertility, p. 165-219. *In* M. N. Hill, (ed.), The Sea, vol. 2. Interscience Publishers, New York.

WANGERSKY, P. J.
1952. Isolation of ascorbic acid and rhamnosides from sea water. *Science*, *115*: 685.

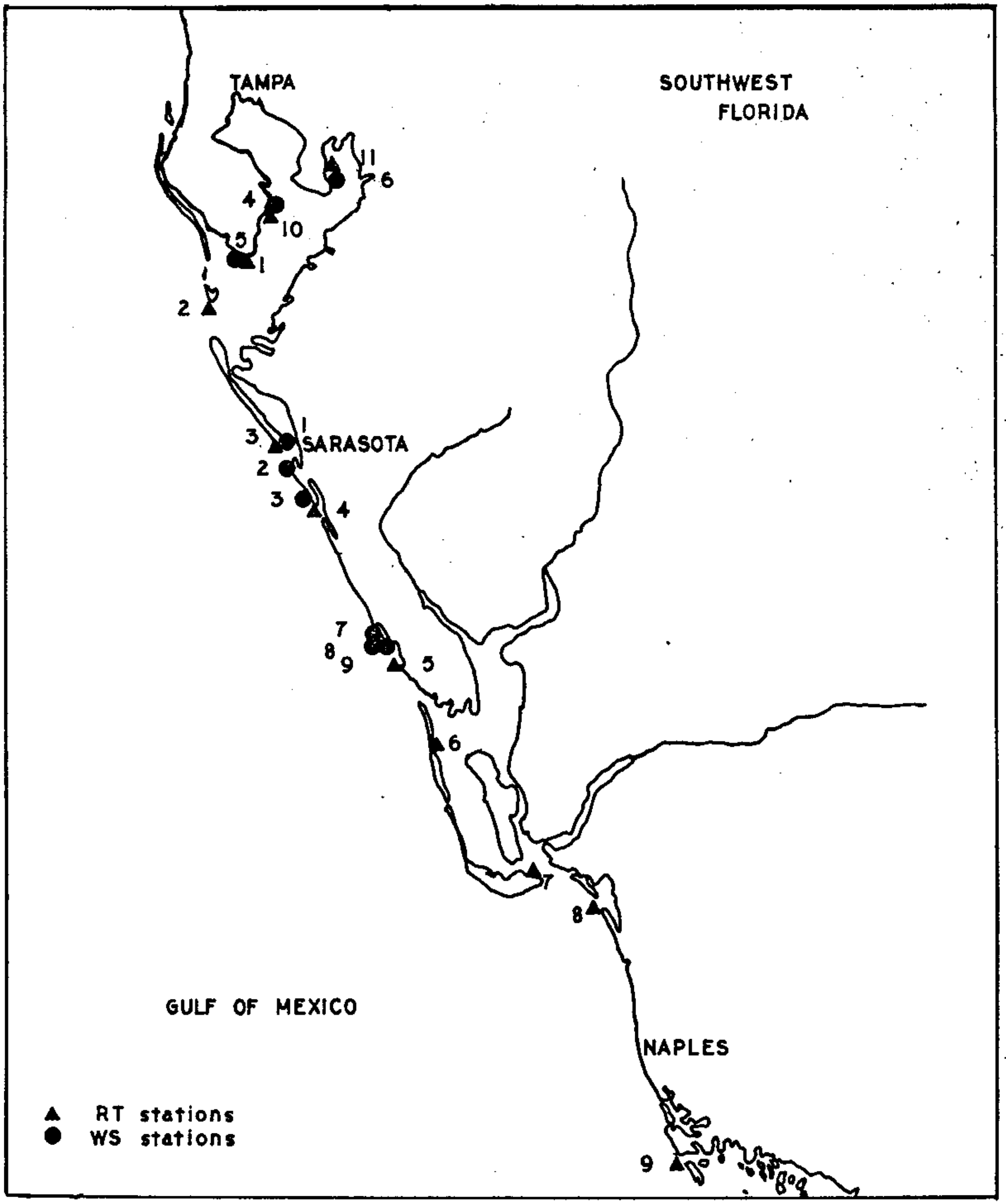

Figure 1. RT and WS estuarine sampling stations.

Figure 2. Monthly fluctuations of carbohydrates and salinities at inshore RT stations of southwest Florida.

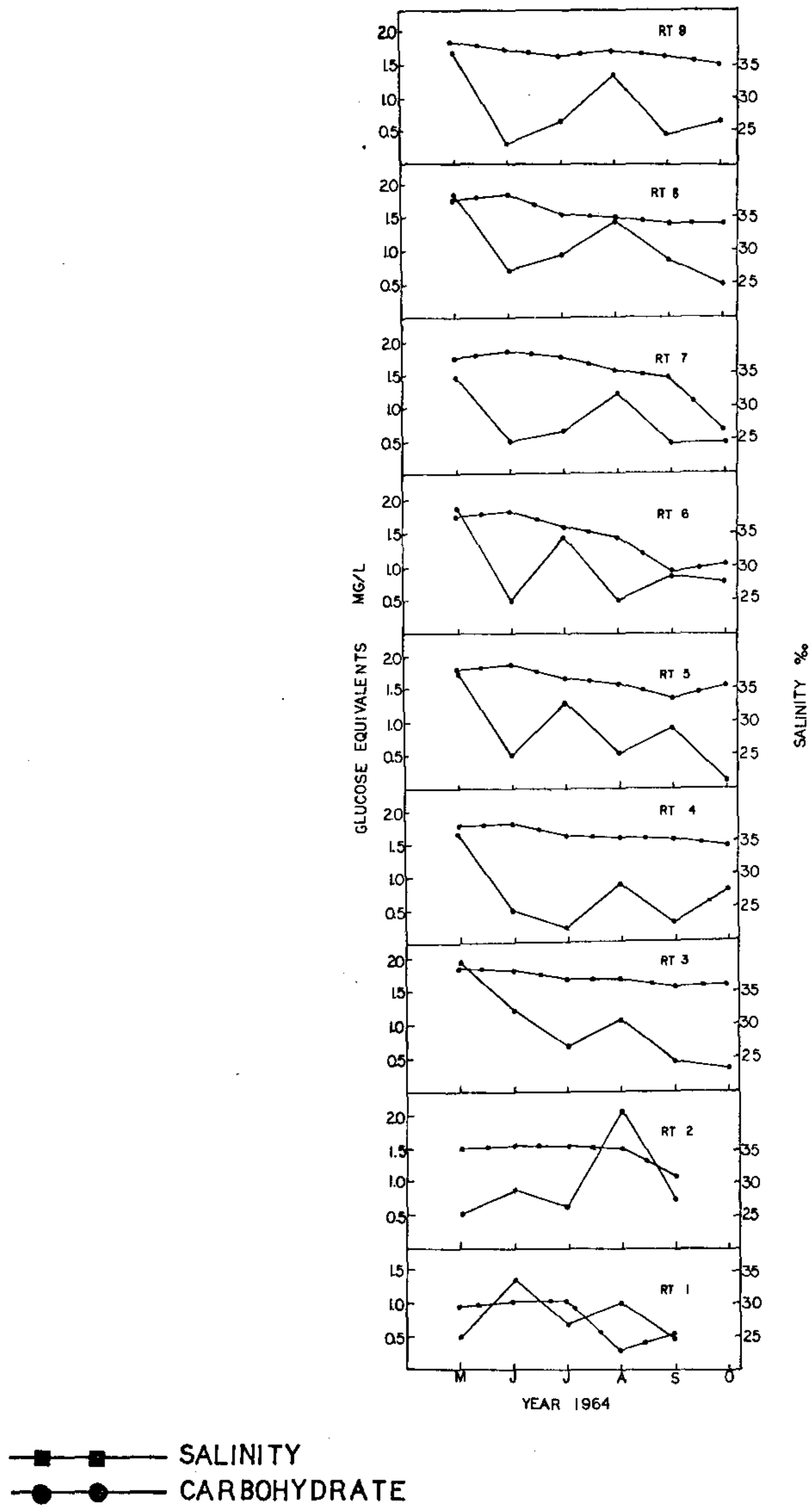

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Table 1. Carbohydrate Values and Hydrographic Data from RT Stations.

Station RT-1	PINELLAS POINT		27°42′05″N	82°38′32″W		
Sample	62M	73M	84M	93M	106M	
$(CHO)_x$	0.56	1.39	0.72	1.04	0.51	
Date	5/25/64	6/22/64	7/27/64	8/24/64	9/28/64	
Temp.	27.2	30.4	27.4	30.8	27.3	
Salinity	29.3	30.9	32.0	22.9	26.9	
Tide	Ebb	Ebb	Ebb	Ebb	Ebb	
Depth	2 1/2′	2 1/2′	2 1/2′	2 1/2′	2′	
Station RT-2	MULLET KEY		27°38′35″N	82°44′30″W		
Sample	61M	72M	83M	92M	105M	
$(CHO)_x$	0.56	0.90	0.63	2.13	0.57	
Date	5/25/64	6/22/64	7/27/64	8/24/64	5/25/64	
Temp.	27.3	30.9	25.4	31.0	27.2	
Salinity	35.0	36.5	36.4	35.4	32.1	
Tide	Ebb	Ebb	Flood	Flood	Ebb	
Depth	2 1/2′	2 1/2′	2 1/2′	2 1/2′	2 1/2′	
Station RT-3	LIDO KEY		27°19′08″N	82°34′52″W		
Sample	60M	71M	82M	91M	104M	115M
$(CHO)_x$	1.98	1.23	0.72	1.13	0.45	0.39
Date	5/18/64	6/15/64	7/20/64	8/17/64	9/21/64	10/19/64
Temp.	28.5	31.4	30.4	31.2	27.9	24.2
Salinity	38.4	38.3	37.0	37.0	36.1	36.5
Tide	Ebb	Flood	Ebb	Ebb	Flood	Flood
Depth	2 1/2′	2 1/4′	3′	2 1/2′	2 1/2′	3′
Station RT-4	MIDNIGHT PASS		27°12′22″N	82°30′38″W		
Sample	59M	70M	81M	90M	103M	114M
$(CHO)_x$	1.66	0.50	0.23	0.87	0.30	0.79
Date	5/18/64	6/15/64	7/20/64	8/17/64	9/21/64	10/19/64
Temp.	26.6	29.9	30.0	30.8	27.2	23.0
Salinity	37.8	38.2	36.8	36.7	36.6	35.0
Tide	Ebb	Flood	Ebb	Ebb	Flood	Flood
Depth	2 1/2′	2 1/2′	3′	3′	2 1/2′	3′
Station RT-5	STUMP PASS		26°53′57″N	82°20′37″W		
Sample	58M	69M	80M	100M	102M	113M
$(CHO)_x$	1.73	0.50	1.32	0.51	0.91	0.13
Date	5/11/64	6/ 8/64	7/13/64	9/ 3/64	9/14/64	10/12/64
Temp.	27.1	28.8	31.2	29.5	28.5	24.1
Salinity	37.5	38.7	36.8	35.9	33.6	35.4
Tide	Flood	Ebb	Flood	Ebb	Ebb	Ebb
Depth	2 1/2′	2 1/2′	2 1/2′	3′	3′	2 1/2′
Station RT-6	BOCA GRANDE		26°43′52″N	82°15′35″W		
Sample	57M	68M	79M	99M	101M	112M
$(CHO)_x$	1.89	0.47	1.45	0.51	0.89	0.80
Date	5/11/64	6/ 8/64	7/13/64	9/ 3/64	9/14/64	10/12/64
Temp.	27.1	29.1	31.5	30.1	27.7	24.3
Salinity	37.7	38.3	36.2	34.5	29.1	30.5
Tide	Flood	Flood	Flood	Flood	Ebb	Ebb
Depth	4′	4′	3′	4′	3′	2 1/2′
Station RT-7	SANIBEL ISLAND		26°27′12″N	82°02′20″W		
Sample	56M	67M	78M	89M	98M	111M
$(CHO)_x$	1.45	0.50	0.64	1.20	0.47	0.50
Date	5/ 5/64	6/ 2/64	7/ 7/64	8/ 4/64	9/ 1/64	10/ 6/64
Temp.	25.5	29.4	31.5	32.0	33.4	26.7
Salinity	37.6	38.8	37.7	35.8	34.5	26.4
Tide	Flood	Flood	Flood	Ebb	Ebb	Flood
Depth	2 1/2′	2 1/2′	2 1/2′	2 1/2′	2 1/2′	2 1/2′

Table 1. (Continued).

Station RT-8	BIG CARLOS PASS		26°24'30"N	82°53'W		
Sample	55M	66M	77M	88M	97M	110M
$(CHO)_x$	1.85	0.73	0.96	1.45	0.87	0.50
Date	5/5/64	6/ 2/64	7/ 7/64	8/ 4/64	9/ 1/64	10/ 6/64
Temp.	24.9	29.4	29.9	30.5	31.3	26.2
Salinity	37.8	38.8	35.7	34.2	34.2	34.3
Tide	Flood	Flood	Flood	Ebb	Ebb	Flood
Depth	2 1/2'	2 1/2'	2 1/2'	2 1/2'	3'	2 1/2'
Station RT-9	CAXAMBAS PASS		25°54'30"N	81°42'W		
Sample	54M	65M	76M	87M	96M	109M
$(CHO)_x$	1.66	0.32	0.64	1.38	0.47	0.63
Date	5/ 5/64	6/ 2/64	7/ 7/64	8/ 4/64	9/ 1/64	10/ 6/64
Temp.	25.6	29.5	30.1	29.5	30.5	26.5
Salinity	38.9	37.9	36.6	37.1	36.8	35.2
Tide	Flood	Ebb	Flood	Flood	Ebb	Ebb
Depth	2 1/2'	2 1/2'	2 1/2'	2 1/2'	3'	2'

M — mid depth; salinity in ‰; date-date of sample collection; carbohydrate values in mg/liter, glucose equivalents.

Table 2. Concentrations* of Carbohydrates in RT Samples from West Coast of Florida.

	Minimum	Maximum	Mean
RT-1	0.51	1.39	0.84
RT-2	0.56	2.13	0.96
RT-3	0.39	1.98	0.98
RT-4	0.23	1.66	0.73
RT-5	0.13	1.73	0.85
RT-6	0.47	1.89	1.00
RT-7	0.47	1.45	0.79
RT-8	0.50	1.85	1.06
RT-9	0.32	1.66	0.85

*mg/liter, glucose equivalents.

AMINO ACIDS AND ORGANIC NITROGEN CONTENT IN FLORIDA GULF COAST WATERS AND IN ARTIFICIAL CULTURES OF MARINE ALGAE

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INTRODUCTION

Nitrogen is a primary limiting factor in the sea for the production of plankton populations (Cooper, 1933; Harvey, 1966). The availability and concentration of the numerous organic and inorganic nitrogenous substances determine the fertility of water masses. The majority of the organic nitrogenous compounds are breakdown products of marine bacterial enzymatic processes on plant and animal proteinaceous materials (Waksman and Carey, 1935). The complete decomposition of these materials results in the formation of ammonia, nitrate, and nitrite. Phytoplankton utilize inorganic sources of nitrogen but certain of these microorganisms can use simple organic nitrogen substances (Nishizawa and Riley, 1962; Parsons and Strickland, 1962; Baylor and Sutcliffe, 1963; and Wilson, 1965).

Amino acids, amino-nitrogen, are of special interest as constituents in sea water because of: 1) their nutritional enhancement to organisms (Lucas, 1947; Saunders, 1957; Provasoli, 1963; and Wilson, 1965; 2) their role in CO_2 transfer, utilization, and deposition (Neuberg *et al.*, 1957; and Smith *et al.*, 1960); and 3) their further possible chemical activity in chelation of ions (Lucas, 1947; Neuberg and Mandl, 1948; Saunders, 1957; and Hood, 1963). The more subtle biological effects of chelation by amino acids should not be underestimated in the complex interactions between an organism and its environment. Chelation not only maintains trace metals in available forms, but may also render more favorable the ratios of the major ions. Because of these apparent importances, characterization of the amino acids in sea water is being made (Jeffrey and Hood, 1958; Park *et al.*, 1962, 1963; Tatsumoto *et al.*, 1961; Palmork, 1963; and Siegel and Degens, 1966).

This study was undertaken to obtain more precise descriptions of the qualitative and quantitative distribution of amino acids and organic nitrogen levels in the eastern Gulf of Mexico. These data are prerequisite for an extensive interpretation of the relationship of organic chemical, environmental factors to the phenomena of Red Tide. Also, since the aquatic communities determine the nitrogenous material present, a study of individuals comprising these communities should enhance our evaluations. Therefore, similar analyses were made of marine algal cultures grown in artificial culture media.

MATERIALS AND METHODS

AMINO ACIDS

Twenty gallons of surface water were collected from each station. Approximately 0.1 g of mercuric chloride, a metabolic inhibitor, was added to each 5 gallons of water. The water was then filtered, usually within four hours after collection, through Millipore filters (2 microfiber glass prefilters, one 0.45 µ and one 0.22 µ membrane filter) using a positive pressure of 20 psi. To each 5 gallon filtrate was added 50-60 ml of 2M ferric chloride and 100 ml of 4N sodium hydroxide. The precipitate was allowed to settle and the water decanted. The ion exchange chromatographic procedure of Tatsumoto *et al.* (1961) was used for the desalting of the dissolved hydrolyzed precipitates. The eluate amino acids were separated by two-dimensional chromotography. The solvents used were phenol:water (80:20) and butanol:acetic acid:water (240:60:250). The resolved amino acids were identified by ninhydrine reaction. Except for a reduction in the sample volume the artificial culture media were analyzed in a similar manner.

ORGANIC NITROGEN

A modified procedure of Strickland and Parsons analysis (1965) was used for the determination of organic nitrogen in sea water. Water samples were collected in clean 500 ml polyethylene bottles with snug-fitting caps and were chilled. Filtration of the sample through a 0.45 µ Millipore filter was usually carried out immediately or within a few hours. The samples were then frozen.

Analysis was performed in an isolated room free from ammonia contamination. Reagents, blanks, and controls were prepared with freshly deionized water. All glassware was rinsed thoroughly in deionized water immediately before use. Samples were thawed and brought to room temperature before hydrolysis.

A Kjeldahl digestion procedure was employed to convert organic nitrogen to the ammonium ion. Duplicate 50 ml sample aliquots were digested. Each resultant residue was then diluted to a 50 ml volume with deionized water.

The ammoniacal concentration was determined colorimetrically by diazotization of NO_2^-. Following the acid hydrolysis, the sample was reacted with alkaline hypochlorite, converting the ammonium ion to nitrite. A coupling of the NO_2^- with sulfanilamide in an acid medium preceded the diazotization with N-1-napthylethylenediamine dihydrochloride. The characteristic pink to deep rose color was developed. The optical density was determined with a DU spectrophotometer at 540 mμ. A deionized water blank, a 3.0 μg-at N/liter control, and a digested water blank were analyzed with each group of samples. Results were reported in μg-at N/liter.

CARBOHYDRATES

Carbohydrate concentrations were determined by the procedure of Lewis and Rakestraw (1955).

SALINITY AND pH

Salinity and hydrogen ion concentrations were determined by the procedures of Strickland and Parsons (1965).

CULTIVATION OF MARINE ALGAE

The culture media from two species of marine algae, *Chlorella* sp. (Erickson, 1964) and *Skeletonema* sp., were analyzed. These microorganisms were isolated and cultured by the Florida Board of Conservation Marine Laboratory. The cells were removed from the medium before analysis.

RESULTS AND DISCUSSION

The geographic locations (Figure 1) and hydrologic data for each of the samples analyzed for amino acids are listed in Tables 1 and 3. With the exception of HC3-SR1, which was taken from the Suwannee River, all samples were taken from estuarine or neritic water masses.

The CK and HC samples (Table 2) were obtained from areas associated with a bloom of the Red Tide dinoflagellate, *Gymnodinium breve*. Sample CK 7-8 was taken during a bloom of *G. breve* and the demonstrated organic nitrogen and carbohydrate values were exceptionally high. Aspartic and glutamic acids were the major amino acids identified. In sample CK 20, which also contained the Red Tide microorganism, an unidentified amino acid-like substance was revealed in heavy concentration. High amounts of leucine and isoleucine were also resolved from this sample. A comparison of the amino acid distribution of these two samples (CK 7-8 and CK 20) with samples HC3-8, HC3-20, HC11-42, and HC11-36, which contained no demonstrable *G. breve*, revealed that only CK 20 exhibited a significant variation (a lower aspartic and glutamic acid content and the unidentified ninhydrin reacting substance). The Suwannee River sample had an amino acid distribution similar to that of the sea water samples. The demonstrated organic nitrogen and carbohydrate concentrations of all samples differed only slightly with the exception of CK 7-8, which was taken from bloom waters. Aspartic acid, glutamic acid, leucine, and isoleucine were found in greatest distribution and concentration.

The RT samples were taken from the southwest estuarine coastal waters of Florida in which Red Tides have occurred (Table 4). There was no *G. breve* bloom during our sampling. Aspartic acid, glutamic acid, leucine, and phenylalanine were demonstrated in all samples. Threonine, proline, methionine, histidine, and cysteine were not detected in these samples. The organic nitrogen levels (Table 5) at these stations were higher than the accepted 1 to 20 μg-at N/liter for sea water. Higher nitrogen levels can usually be demonstrated in coastal waters because of the land effluent and higher productivity.

Three separate cultures of *Chlorella* sp. and one culture of *Skeletonema* sp. were analyzed for biochemical constituents (Table 6). The organic nitrogen content of the *Chlorella* media differed substantially but the carbohydrate concentrations of these three cultures varied only slightly. The *Skeletonema* sp. carbohydrate was almost twice the amount of the *Chlorella* cultures. A comparison of the amino acids indicated that aspartic and glutamic acid were present in all cultures and usually at high levels. Leucine, phenylalenine, and serine were also found in each culture. Histidine was not detected in any of the cultures. This observation is consistent with Fowden (1951) who found histidine below the detection levels in algal cultures. *Chlorella* cultures 215 and 219 were very similar in amino acid content and the *Skeletonema* amino acids varied only slightly from these. It is believed that the low organic nitrogen demonstrated for *Chlorella* culture 233 affected the detection limit of some of the amino acids in this culture medium, resulting in the greater qualitative variation. The demonstrated amino acid composition of these media denotes only a possible distribution since under other cultural conditions the protein composition and liberated substances of a single species may differ more than the differences between species.

A summary of the amino acids resolved, organic nitrogen and carbohydrate means in all samples is given in Table 7. Cysteine and histidine were too low in concentration for detection in any of the samples. Alanine, aspartic acid, glutamic acid, leucine, and phenylalanine were found in the majority of samples, usually in relatively high concentrations. These findings are in agreement with Tatsumoto *et al.*, (1961). The other amino acids varied in concentration and distribution. Even though the organic nitrogen in sea water is exiguous, it should be expected that a definitive study would reveal most, if not all, of the known amino acids in water samples. Tatsumoto (1961) believes that there is a real variation in amino acid composition of sea water. We have found a wide diversity in amino acid composition in our samples but we believe that these variations are more quantitative than qualitative. The amino acids are present but are too low in concentration for us to detect them.

REFERENCES

ABELSON, P. H.
1955. Annual report of the Director of the Geophysical Laboratory, 1954-1955. *Carneg. Inst. Yearbk., 54*: 107-109.

BADER, R. G., D. W. HOOD, and J. B. SMITH
1960. Recovery of dissolved organic matter in sea water and organic sorption by particulate material. *Geochim. et Cosmoch. Acta, 19*: 236-243.

BAYLOR, E. R. and W. H. SUTCLIFFE, JR.
1963. Dissolved organic matter in sea water as a source of particulate food. *Limnol. Oceanog., 8*(4): 369-371.

COOPER, L. H. N.
1933. Chemical constituents of biological importance in the English Channel. Pt. I. Phosphate, silicate, nitrate, nitrite, ammonia. *J. Mar. Biol. Ass. U. K., 18*: 677.

ERDMAN, J. G., E. M. MARLETT, and W. E. HANSON
1956. Survival of amino acids in marine sediments. *Science, 124*: 1026.

ERICKSON, S. J.
1964. The isolation and characteristics of a Chlorella-like green alga from the west coast of Florida. *Fla. Bd. Conserv. Mar. Lab.* Leaf. Ser., *1*(5): 1-2.

FOGG, G. E.
1952. The production of extracellular nitrogenous substances by a blue-green alga. *Proc. Roy. Soc., B139*: 372-397.

FOWDEN, L.
1951. Amino acids of certain algae. *Nature, 167*: 1030-1031.

HARVEY, H. W.
1966. The Chemistry and Fertility of Sea Waters. Cambridge University Press, 240 pp.

HOOD, D. W.
1963. Chemical oceanography. *Oceanogr. Mar. Biol. Ann. Rev., 1*: 129-155.

JEFFREY, L. M. and D. W. HOOD
1958. Organic matter in sea water; and evaluation of various methods for isolation. *J. Mar. Res., 17*: 247-271.

LEWIS, G. J. and N. RAKESTRAW
1955. Carbohydrates in sea water. *J. Mar. Res., 14*: 253-258.

LUCAS, C. E.
1947. The ecological effects of external metabolites. *Biol. Rev., 22*: 270.

NEUBERG, C. and I. MANDL
1948. An unknown effect of amino acids. *Arch. Biochem., 19*: 149-161.

NEUBERG, C., A. GRAUER, M. KREIDAL, and H. LOWY
1957. The role of the carbonate reaction in the calcium and phosphorus cycles in nature. *Arch. Biochem. Biophys., 70*: 70-79.

NISHIZAWA, S. and G. A. RILEY
1962. Research in particulate materials suspended in sea water. p. 150-152. *In* D. S. Gorsline, (ed.), Proceedings of the First National Coastal and Shallow Water Research Conference. National Science Foundation, Office of Naval Research, Tallahassee, Fla.

PALMORK, K. H.
1963. The use of 2,4-dinitro-1-fluorobenzene in the separation and identification of amino acids from sea water. *Acta Chem. Scand., 17*: 1456-1457.

PARK, K., W. T. WILLIAMS, J. M. PRESCOTT, and D. W. HOOD
1962. Amino acids in deep-sea water. *Science, 138*: 531-532.

PARK, K., W. T. WILLIAMS, J. M. PRESCOTT, and D. W. HOOD
1963. Amino acids in Redfish Bay, Texas. *Publ. Inst. Mar. Sci.*, Univ. Tex., *9*: 59-63.

PARSONS, T. R. and J. D. H. STRICKLAND
1962. Oceanic detritus. *Science, 136*: 313-314.

PROVASOLI, L.
1963. Organic regulation of phytoplankton fertility, p. 165-219. *In* M. H. Hill, (ed.), The Sea. Interscience Publ., New York.

SAUNDERS, G. W.
1957. Interrelations of dissolved organic matter and phytoplankton. *Bot. Rev., 23*: 389-409.

SIEGEL, A. and E. T. DEGENS
1966. Concentration of dissolved amino acids from saline waters by ligand-exchange chromatography. *Science, 151*(3713): 1098-1101.

SMITH, T. B., M. TATSUMOTO, and D. W. HOOD
1960. Carbamino carboxylic acid in photosynthesis. *Limnol. Oceanog., 5*(4): 425-431.

STRICKLAND, J. D. H. and T. R. PARSONS
1965. A manual of sea water analysis. *Fish. Res. Bd. Canada*, Bull. No. 125.

TATSUMOTO, M., W. T. WILLIAMS, J. M. PRESCOTT, and D. W. HOOD
1961. Amino acids in samples of surface sea water. *J. Mar. Res., 19*: 89-96.

VALLENTYNE, J. R.
1957. The molecular nature of organic matter in lakes and oceans, with lesser

reference to sewage and terrestrial soils. *J. Fish. Res. Bd. Canada, 14*: 33-82.

WAKSMAN, S. A. and C. L. CAREY
1935. Decomposition of organic matter in sea water by bacteria. *J. Bact., 29*: 531.

WATANABE, A.
1951. Production in cultural solution of some amino acids by atmospheric-nitrogen-fixing blue-green algae. *Arch. Biochem. Biophys., 34*: 50-55.

WILSON, W. B.
1965. The suitability of sea water for the survival and growth of *Gymnodinium breve* Davis; and some effects of phosphorus and nitrogen on its growth. *Fla. Bd. Conserv.*, Prof. Pap. Ser. No. 7: 1-42.

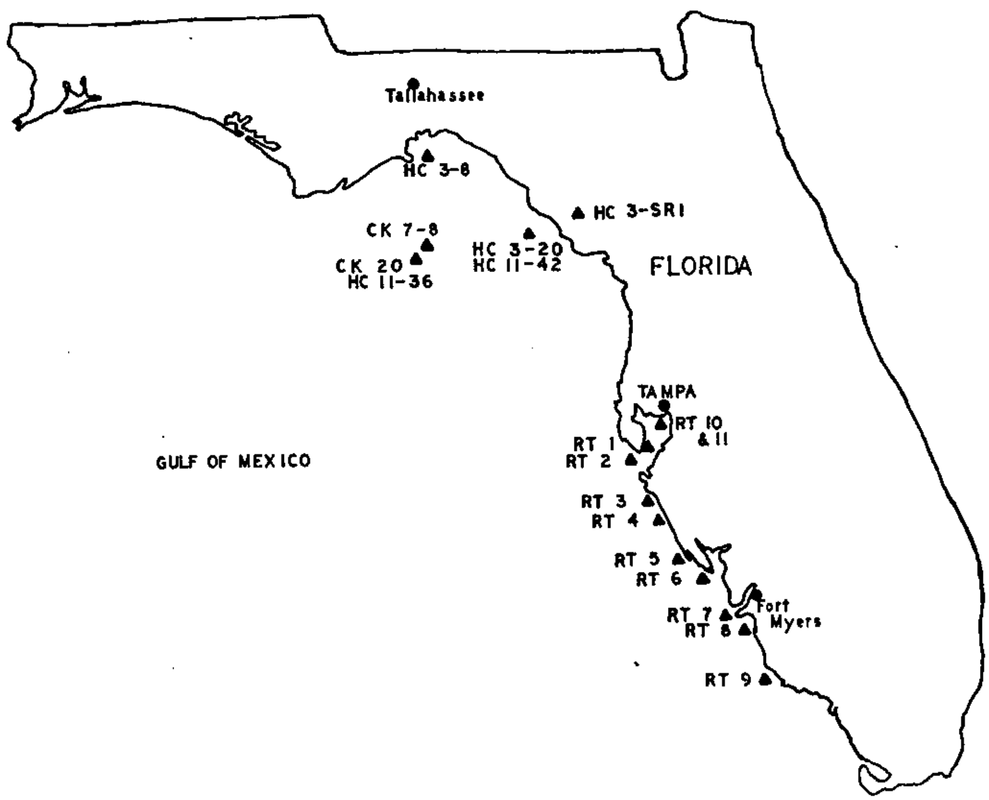


FIGURE 1. AMINO ACID AND ORGANIC NITROGEN SAMPLING STATIONS.

Table 1. Hydrological and Chemical Data from CK and HC Amino Acids Stations

	Location Long.	Location Lat.	Date	Temperature °C	Salinity ‰
CK7-8	84°10′W	29°10′N	7/31/64	32.0	33.6
CK-20	84°18′W	29°04′N	8/ 8/64	27.6	33.4
HC3-8	84°09′W	29°56′N	11/ 6/64	20.5	32.2
HC3-20	83°30′W	29°15′N	11/10/64	21.2	32.8
HC3-SR1	Suwannee River		11/10/64	19.5	*
HC11-36	84°19′W	29°04′N	2/ 6/65	16.8	34.5
HC11-42	83°30′W	29°15′N	2/ 7/65	14.5	31.7

*Fresh water sample.

Table 2. Amino Acids Demonstrated in Samples from CK and HC Stations.

Stations	CK7-8	CK-20	HC3-8	HC3-20	HC3-SR1	HC11-36	HC11-42
Date	7/31/64	8/ 8/64	11/ 6/64	11/10/64	11/10/64	2/ 6/65	2/ 7/65
Alanine	+	±	+	±	+	±	±
Arginine	-	±	-	+	+	±	-
Aspartic Acid	+++	+	+++	+	+++	++	++
Cysteine	-	-	-	-	-	-	-
Cystine	-	-	-	-	±	-	±
Glutamic Acid	+++	+	+	++	++	++	+++
Glycine	±	+	-	±	+	±	+
Histidine	-	-	-	-	-	-	-
Isoleucine	±	++	++	+	+	-	-
Leucine	+	++	++	+	+	+	+
Lysine	±	±	-	±	±	±	-
Methionine	-	-	±	-	-	-	-
Phenylalanine	+	±	-	-	±	+	+
Proline	-	-	-	±	-	-	-
Serine	±	+	-	++	±	-	-
Threonine	-	-	-	+	-	-	-
Tyrosine	-	-	-	-	-	-	-
Valine	-	-	±	-	-	-	±
Other	-	+++*	-	-	-	-	-
Organic nitrogen	870	22	30	102	76	91	42
Carbohydrate	5.2	0.98	0.30	0.38	0.23	0.61	0.86
G. breve count	Bloom	<50,000	0	NS	0	0	0

* One unidentified amino acid—Rf (phenol): 90; Rf (butanol): 70.
- : not detected; ±: trace; + to +++ : gradation of ninhydrin intensity.
Organic nitrogen in μg-at N/liter. Carbohydrate reported in mg/liter.
NS: no sample.

Table 3. Hydrological and Chemical Data from RT Amino Acids Stations

	Location Long.	Lat.	Date	Temperature °C	Salinity ‰
RT1-93	82°38′32″W Pinellas Point	27°42′05″N	8/24/64	31.2	22.9
RT2-92	82°44′30″W Mullet Key	27°38′35″N	8/24/64	31.0	35.3
RT4-90	82°30′38″W Midnight Pass	27°12′22″N	8/17/64	30.8	36.7
RT5-100	82°20′37″W Stump Pass	26°53′57″N	9/ 3/64	29.5	35.9
RT5-102	82°20′37″W Stump Pass	26°53′57″N	9/14/64	28.5	33.6
RT6-79	82°15′35″W Boca Grande	26°43′52″N	7/13/64	31.5	36.2
RT6-99	82°15′35″W Boca Grande	26°43′52″N	9/ 3/64	30.0	34.5
RT6-101	82°15′35″W Boca Grande	26°43′52″N	9/14/64	27.8	29.1
RT7-98	82°02′20″W Sanibel Island	26°27′12″N	9/ 1/64	33.5	34.5
RT8-97	82°53′W San Carlos Pass	26°24′30″N	9/ 1/64	31.4	34.2
RT9-96	81°42′W Caxambas Pass	25°54′30″N	9/ 1/64	30.5	36.8
RT11-4	82°29′05″W Ballast Point	27°53′39″N	8/12/64	*	*

*No determination.

Table 4. Amino Acids Demonstrated in Samples from RT Stations, 1964.

Station	RT1-93	RT2-92	RT4-90	RT5-100	RT5-102	RT6-79	RT6-99	RT6-101	RT7-98	RT8-97	RT9-96	RT11-4
Date	8/24/64	8/24/64	8/17/64	9/ 3/64	9/14/64	7/13/64	9/ 3/64	9/14/64	9/ 1/64	9/ 1/64	9/ 1/64	8/12/64
Alanine	±	±	+	±	+	±	±	-	±	±	+	±
Arginine	+	-	+	-	-	+	-	-	-	-	±	-
Aspartic Acid	++	++	++	+++	++	+++	+	+	±	++	++	+++
Cysteine	-	-	-	-	-	-	-	-	-	-	-	-
Cystine	-	-	±	-	±	-	-	-	-	±	-	-
Glutamic Acid	+	++	++	+	+++	+	+	+	++	++	++	+++
Glycine	±	-	±	±	±	±	±	-	±	±	±	±
Histidine	-	-	-	-	-	-	-	-	-	-	-	-
Isoleucine	++	-	+	-	±	±	-	-	-	-	-	-
Leucine	+++	+	+	+	+	±	+	+	+	+	+	+
Lysine	±	-	±	-	±	±	±	±	-	±	-	±
Methionine	-	-	-	-	-	-	-	-	-	-	-	-
Phenylalanine	+	+	+	±	+	±	+	+	+	+	+	+
Proline	-	-	-	-	-	-	-	-	-	-	-	-
Serine	±	±	±	±	±	±	-	-	-	±	±	±
Threonine	-	-	-	-	-	-	-	-	-	-	-	-
Tyrosine	-	-	±	-	-	-	-	-	-	-	-	-
Valine	±	-	+	-	±	+	-	-	-	±	±	-
Organic nitrogen	28	25	20	20	34	49	16	26	22	30	21	339
Carbohydrate	0.64	2.13	0.87	0.51	0.91	1.45	0.51	0.89	0.47	0.87	0.47	*
G. breve count	0	0	0	0	0	0						

-: Not detected; ±: trace; +-+++: gradation of ninhydrin intensity.
Organic nitrogen reported in μg-at N/liter.
Carbohydrate reported in mg/liter.
* No determination.

Table 5. Chemical and Hydrological Data from RT Stations.

Station	Location Long.	Lat.	Date	Depth	Temperature °C	Salinity ‰	pH	Organic Nitrogen
RT1-93S	82°38′32″W	27°42′05″N	8/24/64	S	31.2	22.9	8.3	27.50
	Pinellas Point							
RT2-83S	82°44′30″W	27°38′35″N	7/27/64	S	25.4	36.4	8.5	17.40
	Mullet Key							
RT2-92S	"	"	8/24/64	S	31.0	35.3	8.5	24.70
RT3-60S	82°34′52″W	27°19′08″N	5/18/64	S	29.3	35.4	*	43.84
	Lido Key							
RT3-60M	"	"	5/18/64	1¼′	28.5	35.8	*	17.80
RT3-82S	"	"	7/20/64	S	30.5	37.0	8.1	41.80
RT3-104S	"	"	9/21/64	S	27.9	35.3	8.3	19.43
RT3-104M	"	"	9/21/64	1¼′	27.9	35.0	8.4	9.43
RT4-59S	82°30′38″W	27°12′22″N	5/18/64	S	26.6	34.5	*	36.60
	Midnight Pass							
RT4-59M	"	"	5/18/64	1¼′	26.6	35.0	*	35.12
RT4-81S	"	"	7/20/64	S	30.0	36.8	8.3	10.10
RT4-90S	"	"	8/17/64	S	30.8	36.7	8.3	19.48
RT5-69S	82°21′34″W	26°53′57″N	6/ 8/64	S	28.9	38.7	8.5	17.84
	Stump Pass							
RT5-100S	"	"	9/ 3/64	S	29.5	35.9	8.1	19.68
RT5-102S	"	"	9/14/64	S	28.5	33.6	8.4	34.24
RT6-68S	82°15′35″W	26°43′52″N	6/ 8/64	S	29.3	38.3	8.6	19.48
	Boca Grande							
RT6-99S	"	"	9/ 3/64	S	30.0	34.5	8.1	15.74
RT6-101S	"	"	9/14/64	S	27.8	29.1	8.3	26.40
RT7-89S	82°02′20″W	26°27′12″N	8/ 4/64	S	31.5	35.8	8.7	18.35
	Sanibel Island							
RT7-98S	"	"	9/ 1/64	S	33.5	34.5	8.1	22.30
RT8-55M	82°53′ W	26°24′30″N	5/ 5/64	1′	24.9	34.2	*	26.21
	Big Carlos Pass							
RT8-55B	"	"	5/ 5/64	2½′	24.9	37.9	*	22.68
RT8-66S	"	"	6/ 2/64	S	29.4	38.8	8.5	36.52
RT8-77S	"	"	7/ 7/64	S	29.9	35.7	8.6	41.46
RT8-88S	"	"	8/ 4/64	S	31.0	34.2	8.8	17.72
RT8-97S	"	"	9/ 1/64	S	31.4	34.2	8.4	30.24
RT9-65S	81°42′W	25°54′30″N	6/ 1/64	S	29.5	37.9	8.3	18.92
	Caxambas Pass							
RT9-76S	"	"	7/ 7/64	S	30.1	36.6	8.4	26.20
RT9-87S	"	"	8/ 4/64	S	30.0	37.1	8.7	18.72
RT9-96S	"	"	9/ 1/64	S	30.5	36.8	8.3	21.36
RT10-75S	82°36′38″W	27°50′35″N	6/22/64	S	32.8	27.5	8.4	36.06
	Weedon Point							
RT10-86S	"	"	7/27/64	S	27.5	23.9	7.6	40.81
RT11-74S	82°29′05″W	27°53′39″N	6/22/64	S	33.6	24.6	8.3	26.75
	Ballast Point							

*No determination.
Organic nitrogen reported in μg-at N/liter.

Table 6. Amino Acids Demonstrated in Artificial Cultures.

Culture Culture No. Count/liter	*Chlorella* sp. 215 24x10^6	*Chlorella* sp. 219 16x10^6	*Skeletonema* sp. 220 4x10^6	*Chlorella* sp. 223 19x10^6
Alanine	++	±	+	-
Arginine	±	-	±	-
Aspartic Acid	+++	+++	+++	++
Cysteine	-	-	-	-
Cystine	±	+	±	-
Glutamic Acid	++	++	+++	+
Glycine	-	±	+	+
Histidine	-	-	-	-
Isoleucine	+	+	++	-
Leucine	+	++	++	+
Lysine	±	±	±	-
Methionine	-	-	-	-
Phenylalanine	+	++	++	+
Proline	-	-	-	-
Serine	±	+	±	±
Threonine	-	-	±	-
Tyrosine	-	-	±	-
Valine	±	+	++	-
Organic nitrogen	6290	480	*	49
Carbohydrate	3.5	6.4	11.2	5.5

-: not detected; ±: trace; +-+++: gradation of ninhydrin intensity.
Organic nitrogen reported in µg-at N/liter.
Carbohydrate reported in mg/liter.
* Not Determined.

Table 7. Summary of Occurrence Totals of Amino Acids, Mean Organic Nitrogen, and Mean Carbohydrate Concentrations.

	CK-HC	RT	AC
Total Samples	7	12	4
Alanine	7	11	3
Arginine	4	4	2
Aspartic Acid	7	12	4
Cysteine	0	0	0
Cystine	2	3	3
Glutamic Acid	7	12	4
Glycine	6	10	3
Histidine	0	0	0
Isoleucine	5	4	3
Leucine	7	12	4
Lysine	5	8	3
Methionine	1	0	0
Phenylalanine	5	12	4
Proline	1	0	0
Serine	4	9	4
Threonine	1	0	1
Tyrosine	0	1	1
Valine	2	6	3
Mean organic nitrogen	0.175	0.043	2.273
Mean carbohydrate	1.22	0.88	6.50

CK-HC: offshore stations; RT: inshore stations; AC: artificial culture media of marine algae.
Carbohydrate reported in mg/liter.
Organic nitrogen reported in µg-at N/liter.

A CHEMICAL STUDY OF SOUTHWEST FLORIDA RIVER WATER, 1965-1966

PATRICIA V. DONNELLY, ROSE A. OVERSTREET, MARY A. BURKLEW, AND JAMES H. VUILLE

INTRODUCTION

The rivers of southwest Florida flow into a region of the Gulf of Mexico frequented by outbreaks of Red Tides. Since the productivity within natural waters may be described by its total dissolved elemental concentrations, this river drainage will enrich and enhance the fertility of these coastal estuarine water masses. Chew (1953), Odum (1953), Lasker and Smith (1954), and Feinstein (1956) have mentioned the possibility of a causal relationship between Red Tide outbreaks and river drainage. But Feinstein (1956) was unable to demonstrate a statistically significant relationship between the Peace River runoff and Red Tide outbreaks. Further attempts to relate Red Tides to land drainage and precipitation have not been made.

It is our belief that comprehensive studies of the chemical makeup of the south Florida rivers should be undertaken. These data would support the studies on the marine waters of this area and provide background for an adequate analysis of the data obtained from them during a bloom of the Red Tide dinoflagellate, *Gymnodinium breve*. The results in this paper involved the chemical analyses for the major elemental and organic constituents of water samples collected from south Florida rivers and their tributaries from April 1965 through June 1966.

METHODS AND MATERIALS

Surface water samples were collected in polyethylene bottles at assigned stations and were kept cool during transport to the laboratory. All analyses were carried out on unfiltered water, except the organic nitrogen procedure. The water used for organic nitrogen determinations was filtered through a 0.45 μ Millipore filter and frozen until analyzed.

Temperature and pH. Water temperature was determined to the nearest tenth °C with a standard thermometer. The *p*H values of the samples were estimated colorimetrically by the employment of narrow range *p*H indicator papers.

Salinity. Salinity values were determined by Mohr titration (Vuille, 1966).

Iron. Particulate iron was determined by the procedures of Strickland and Parsons (1965). The methods described by Sandell (1959) were used to determine soluble iron. The results are reported in μg Fe/liter.

Carbohydrate. The anthrone colorimetric procedure of Lewis and Rakestraw (1955) was used to estimate the concentration of carbohydrate-like substances. The results are reported in mg/liter glucose equivalents.

Organic nitrogen. The organic nitrogen content of water samples was determined by the methods outlined by Strickland and Parsons (1965). The results are reported in μg-at N/liter.

Other Chemical Determinations. The other chemical analyses were performed by the procedures outlined by Hach Chemical Company (Ames, Iowa) for use with their Direct Reading Engineer's Laboratory, Model DR-EL. All of these determinations are reported in ppm or turbidimetric units.

SAMPLING STATIONS

Table 1 lists the sampling stations together with their approximate locations. The original experimental design was to take transect samples from each river for an overall assessment of the water quality. Later in the study, one station on each river was designated as representative of the water flowing into the Gulf. These designated stations (1, 4, 7, 16, and 32) were selected upstream from the mouths of the rivers. Nevertheless in dry seasons there was some salt water encroachment at two of these stations (16 and 32). Figure 1 graphically illustrates the location of all south Florida river stations.

RESULTS AND DISCUSSION

The chemical results obtained from all river water samples are listed in Tables 2 through 32. The results from the major stations (1, 4, 7, 16, and 32) are graphically illustrated in Figures 2 through 17.

Temperature. All of the five major rivers demonstrated a similar temperature fluctuation pattern (Figure 2) with surface water temperatures dropping in November from above 25° C to less than 20° C. Warming of the waters began in February. Yearly temperature variations in south Florida rivers are not of a large magnitude.

*p*H. The low *p*H values (4-6) found for the south Florida rivers (Figure 3), except the Caloosahatchee, probably may be attributed to the organic matter present in the streams. Most of the Florida rivers are heavily discolored with humic substances.

Turbidity. Turbidimetric measurements (Figure 4) of all samples were low, not exceeding 100 Jackson Turbidity Units.

Chloride and Salinity. The chloride content (Figure 5) of the Manatee, Myakka and Peace Rivers usually ranged from 10 to 30 ppm. Salt water encroachment was demonstrable at the selected station on the Alafia and Caloosahatchee except during periods of greatly increased drainage. The low chlorinity demonstrated in the Caloosahatchee was directly due to the opening of the locks from Lake Okeechobee at Moore Haven.

Hardness. Calcium and magnesium (Figures 6 and 7) in the Manatee and Myakka Rivers rarely exceeded 50 ppm. There was a greater variation in the Peace River content with values greater than 100 ppm.

Sulfate. The sulfate content (Figure 8) of the Manatee and Myakka Rivers showed little fluctuation and usually did not exceed 20 ppm. The sulfate in the Peace River varied from 20 to 100 ppm.

Chromate. Chromate was not demonstrable in any of the samples taken from the rivers.

Silica. The silica content (Figure 9) of the Myakka and Caloosahatchee Rivers was relatively low, usually not exceeding 5 ppm. The Alafia River samples contained extremely high silica concentrations (30 ppm). The Peace and Manatee Rivers demonstrated a greater variability in silica content with values exceeding 14 ppm and with other concentrations less than 1 ppm.

Boron. The boron content (Figure 10) in all rivers was low and was usually less than 1 ppm.

Copper. The element copper was found in very low concentrations in all rivers (Figure 11), usually less than 0.1 ppm.

Manganese. Manganese was not demonstrated in the south Florida rivers.

Nitrite. Nitrite nitrogen (Figure 12) was very low in all of the rivers and did not exceed 0.1 ppm.

Nitrate. Nitrate nitrogen (Figure 13) usually exceeded 1 ppm in the rivers but rarely exceeded 5 ppm.

Phosphate. The phosphate content (Figure 14) was extremely high in the Alafia and Peace Rivers; in some samples greater than 30 ppm. Phosphate mines are adjacent to these rivers. The Manatee, Myakka, and Caloosahatchee Rivers have much lower phosphate levels, rarely greater than 3 ppm and usually less than 1 ppm.

Iron. In all of the south Florida rivers the particulate iron greatly influenced the total iron content; the soluble iron remained relatively constant. The mean iron levels (400 µg Fe/liter) of the south Florida rivers (Figure 14) are much lower than the iron values (677 µg Fe/liter) demonstrated in most of the north Florida rivers (Donnelly *et al.*, 1966).

Tannins. Tannic acids were demonstrable in all south Florida rivers. Levels as high as 10 ppm were found in the Myakka and Peace Rivers.

Carbohydrates. The carbohydrate concentration (Figure 16) of the rivers fluctuated greatly and usually the higher levels could be associated with algal blooms in the waters when the samples were taken. The levels usually did not exceed 3 mg/liter but this value is many times the concentration found in sea water.

Organic nitrogen. None of the organic nitrogen levels (Figure 17) demonstrated in the south Florida rivers were excessively high. The high level of organic nitrogen in the rivers in March 1966 may be evidence of a seasonal peak.

REFERENCES

BAYLOR, E. R. and W. H. SUTCLIFFE
1963. Dissolved organic matter in sea water as a source of particulate food. *Limnol. Oceanog.*, *8*(4):369-371.

BILLINGS, G. K. and R. C. HARRISS
1965. Cation analysis of marine waters by atomic absorption spectrometry: Gulf of Mexico coastal waters. *Tex. J. Sci.*, *17*(1): 129-138.

BLACK, A. P. and E. BROWN
1951. Chemical characters of Florida waters — 1951. *Fla. Bd. Conserv.* Water Survey and Research Paper No. 6: 119 pp.

BURKLEW, M. A.
1966. Determination of carbohydrates in sea water. *Fla. Bd. Conserv.* Leaf. Ser., *VI* Pt. 2(1): 1-2.

CHEW, F.
1953. Results of hydrographic and chemical investigations in the region of the "Red Tide" bloom on the west coast of Florida in November 1952. *Bull. Mar. Sci. Gulf. Carib.*, *2*(4): 610-625.

DONNELLY, P. V., J. VUILLE, M. C. JAYASWAL, R. A. OVERSTREET, J. WILLIAMS, M. A. BURKLEW, and R. M. INGLE
1966. A study of contributory chemical parameters to Red Tide in Apalachee Bay. *In* Observations of an Unusual Red Tide. *Fla. Bd. Conserv.*, Prof. Papers Ser. No. 8: 43-84.

DRAGOVICH, A. and B. Z. MAY
1962. Hydrological characteristics of Tampa Bay tributaries. *U. S. Fish Wildl. Serv.* Fish. Bull., *62*(205): 163-176.

FABRICAND, B. R., R. R. SAWYER, S. G. UNGER, and S. ADLER
1962. Trace metal concentrations in the ocean by atomic absorption spectroscopy. *Geochim. et Cosmoch. Acta.*, *26*: 1023-1027.

FEINSTEIN, A.
1956. Correlations of various ambient phenomena with Red Tide outbreaks on the Florida west coast. *Bull. Mar. Sci. Gulf Carib.*, *6*(3): 209-232.

GRILL, E. V. and F. A. RICHARDS
1964. Nutrient regeneration from phytoplankton decomposing in sea water. *J. Mar. Res.*, *22*(1): 51-69.

HARVEY, H. W.
1966. The Chemistry and Fertility of Sea Waters. University Press, Cambridge, England. 234 pp.

HEM, J. D.
1959. Study and Interpretation of the Chemical Characteristics of Natural Water. Geological Survey Water-Supply Paper 1473. U. S. Government Printing Office, Washington, D.C. 269 pp.

HUTTON, R. F.
1956. An annotated bibliography of Red Tides occurring in the marine waters of Florida. *Quart. Jour. Florida Acad. Sci.*, *19*(2-3): 123-146.

KETCHUM, B. H.
1947. The biochemical relations between marine organisms and their environment. *Ecol. Monogr.*, *17*: 309-315.

LASKER, R. and F. G. W. SMITH
1954. Red Tide. *U. S. Fish Wildl. Serv.* Fish. Bull., *55*(89): 173-176.

LEWIS, G. L. and N. W. RAKESTRAW
1955. Carbohydrates in sea water. *J. Mar. Res.*, *14*: 253-258.

ODUM, H. T.
1953. Dissolved phosphorus in Florida waters. *Fla. Bd. Conserv. and Fla. Geol. Surv.*, Rept. of Investig., *9*(1): 1-40.

OVERSTREET, R. A.
1966. Organic nitrogen determination. *Fla. Bd. Conserv.*, Leaf. Ser., *VI* Pt. 2 (2): 1-4.

REDFIELD, A. C.
1958. The biological control of chemical factors in the environment. *Amer. Scient.*, *46*(3): 205-222.

ROUNSEFELL, G. A. and W. R. NELSON
1964. Status of Red Tide research in 1964. *Alabama Marine Resources Lab.*, Tech. Rep. 64-1: 192 pp.

SANDELL, E. B.
1959. Colorimetric Determination of Trace Metals, p. 537-543. Interscience Publishers, Inc., New York.

STRICKLAND, J. D. H. and T. R. PARSONS
1965. A manual of sea water analysis. *Bull. Fish. Res. Bd. Can.* No. 125: 203 pp.

U. S. FISH AND WILDLIFE SERVICE
1954. Gulf of Mexico: its origin, waters, and marine life. *U. S. Fish. Wildl. Serv.* Fish. Bull., *55*(89): 604 pp.

VUILLE, J. H.
1966. Determination of salinity by titration. *Fla. Bd. Conserv.*, Leaf. Ser., *VI* Pt. 1(1): 1-2.

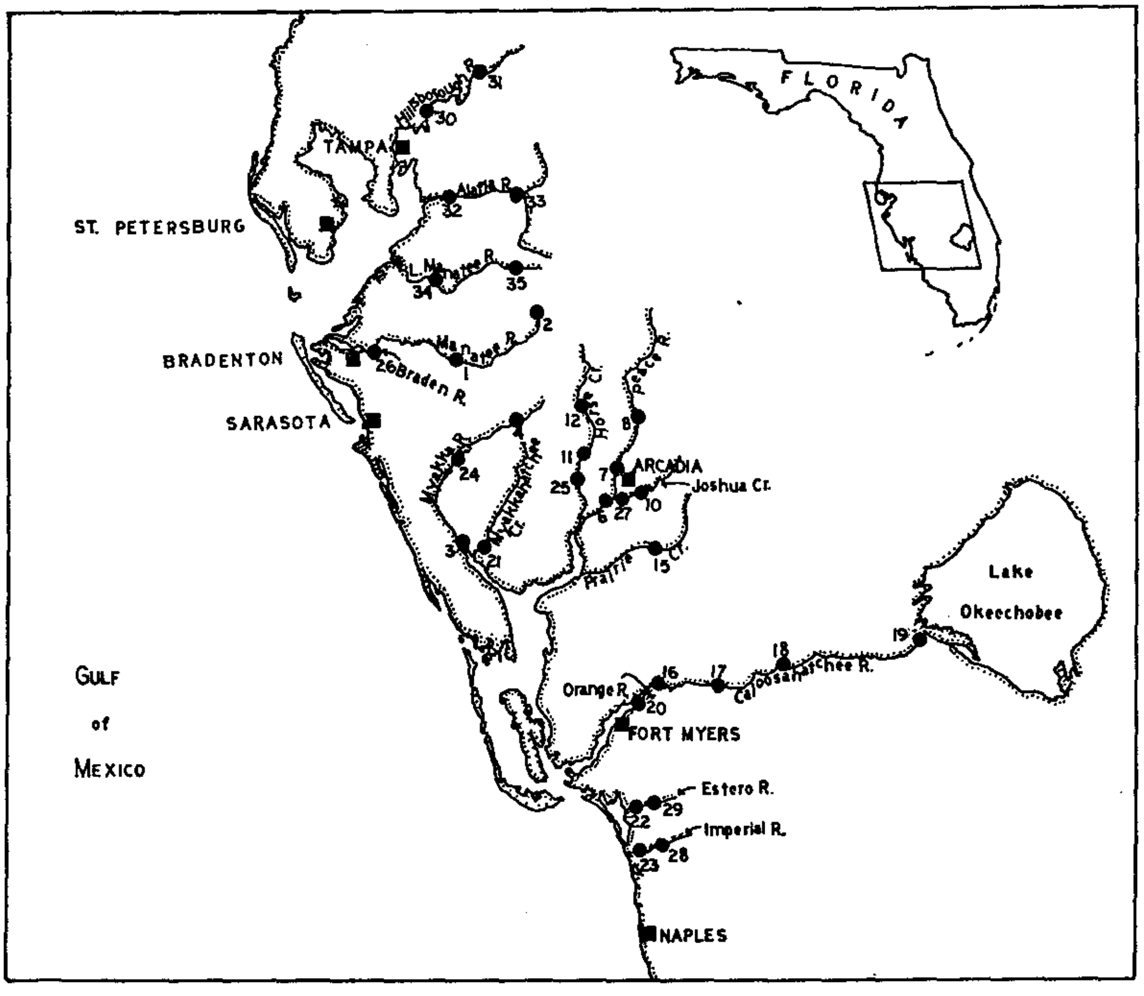


Figure 1. South Florida river stations.

Figure 2. Monthly water temperature variations in south Florida rivers.

Figure 3. Monthly water pH values in south Florida river waters.

Figure 2. Monthly water temperature variations in south Florida rivers.

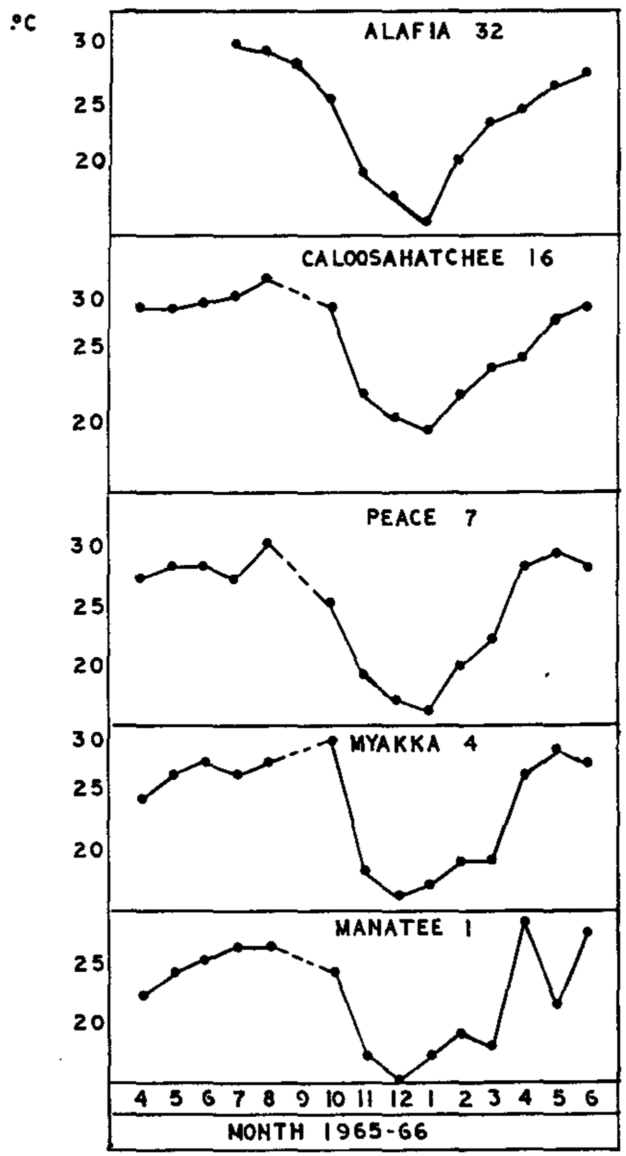


Figure 3. Monthly water *p*H values in south Florida river waters.

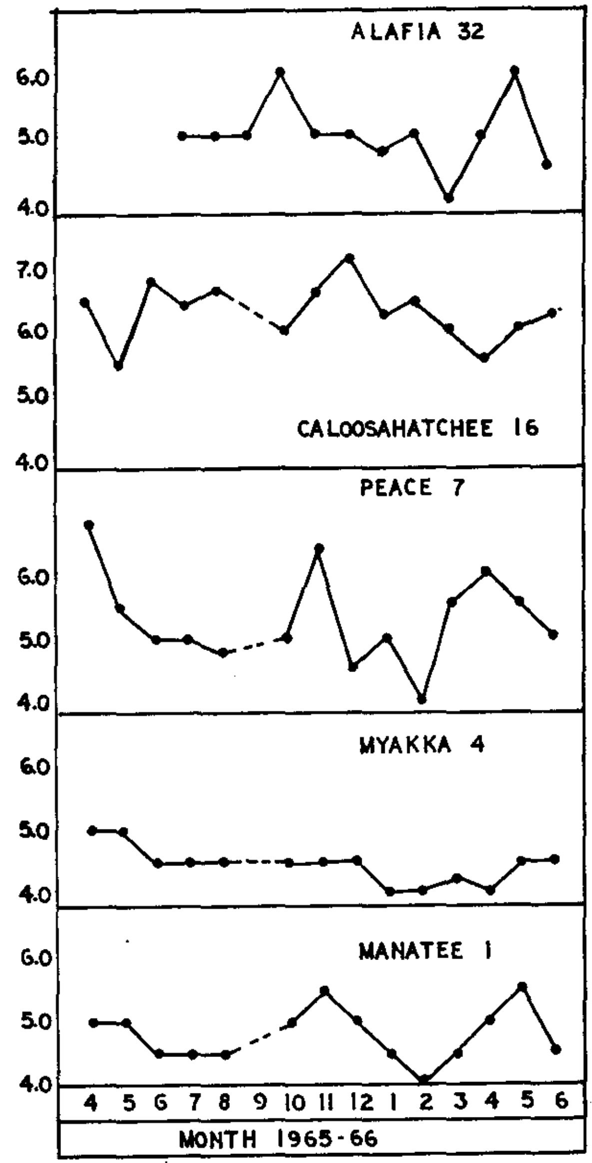


Figure 4. Monthly turbidity readings on south Florida river waters.

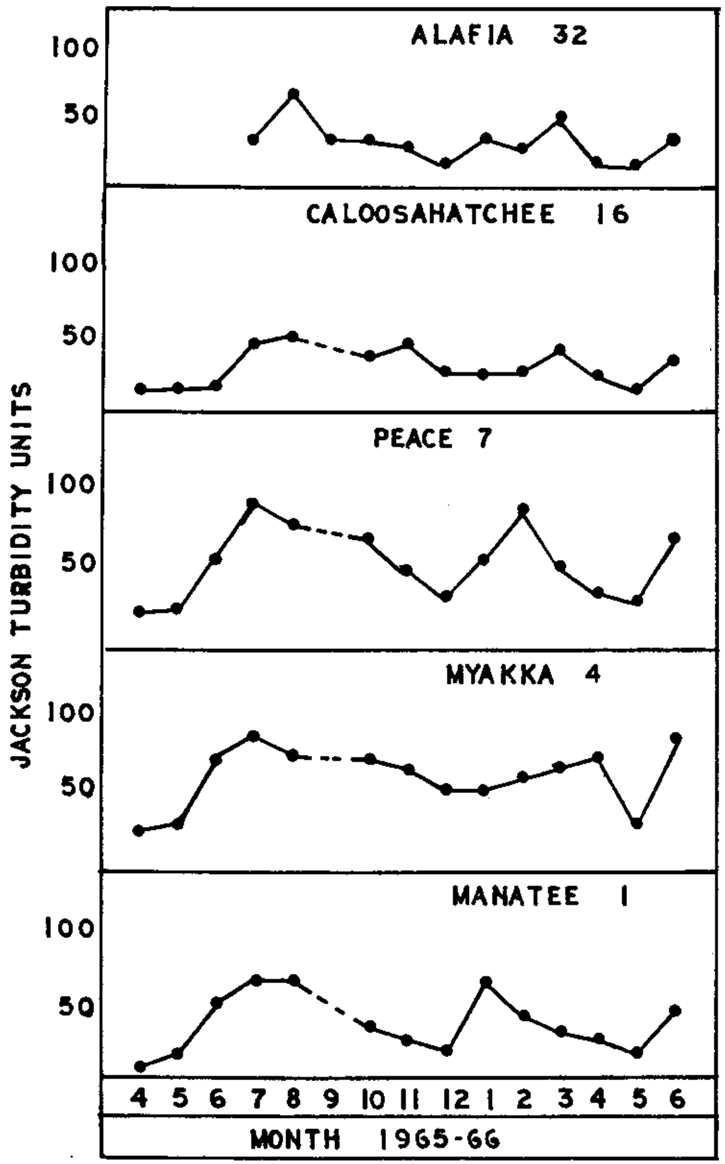


Figure 5. Monthly chloride content of south Florida rivers.

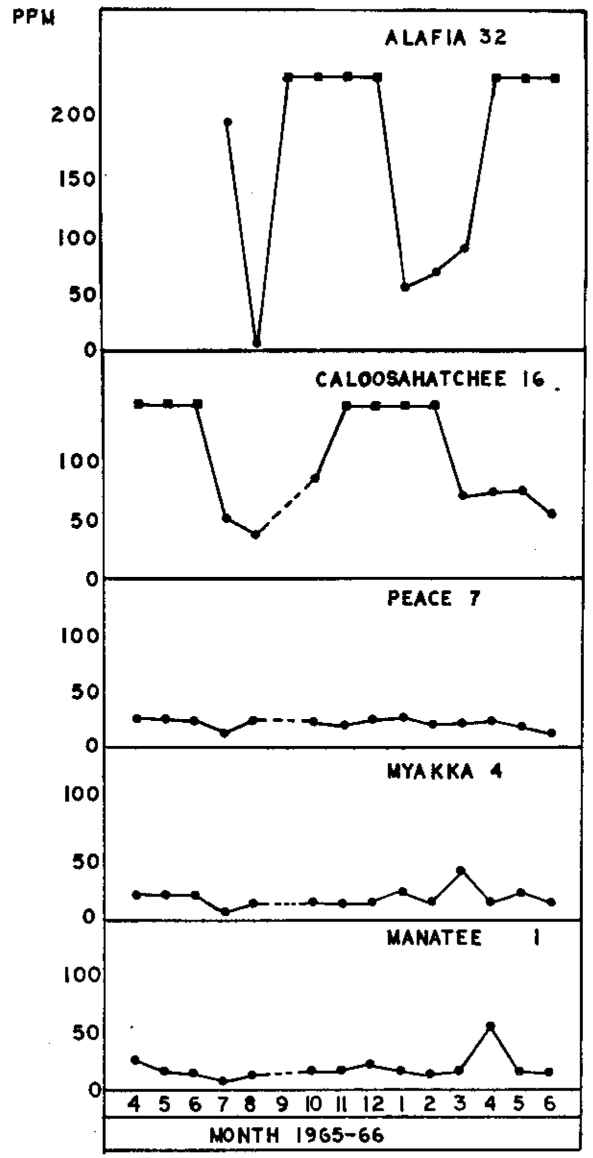


Figure 6. Monthly calcium content in south Florida rivers.

Figure 7. Monthly magnesium content in south Florida rivers.

Figure 6. Monthly calcium content in south Florida rivers.

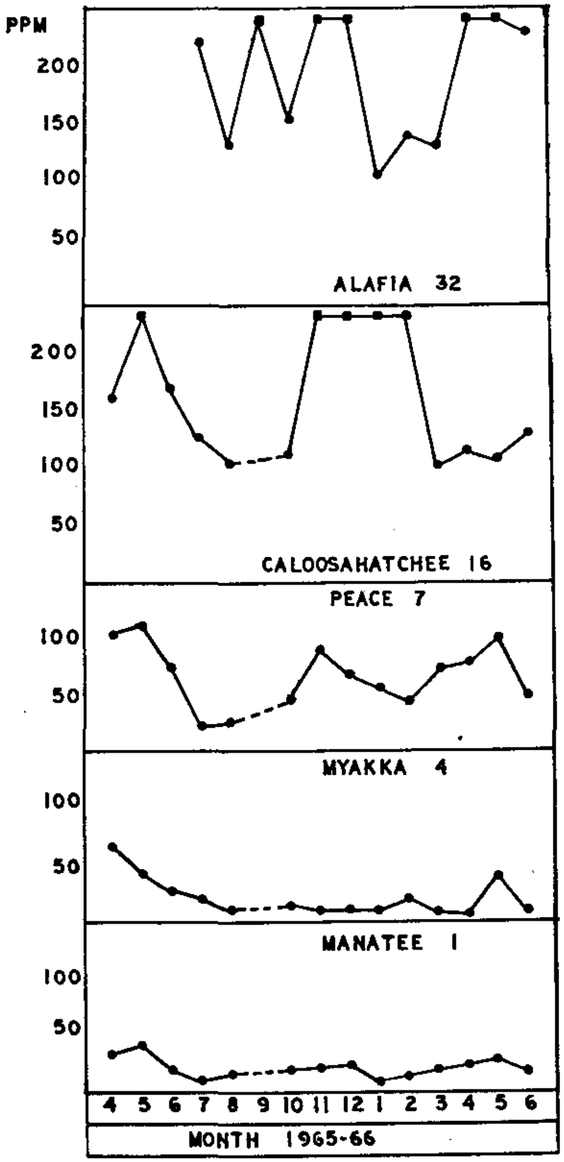


Figure 7. Monthly magnesium content in south Florida rivers.

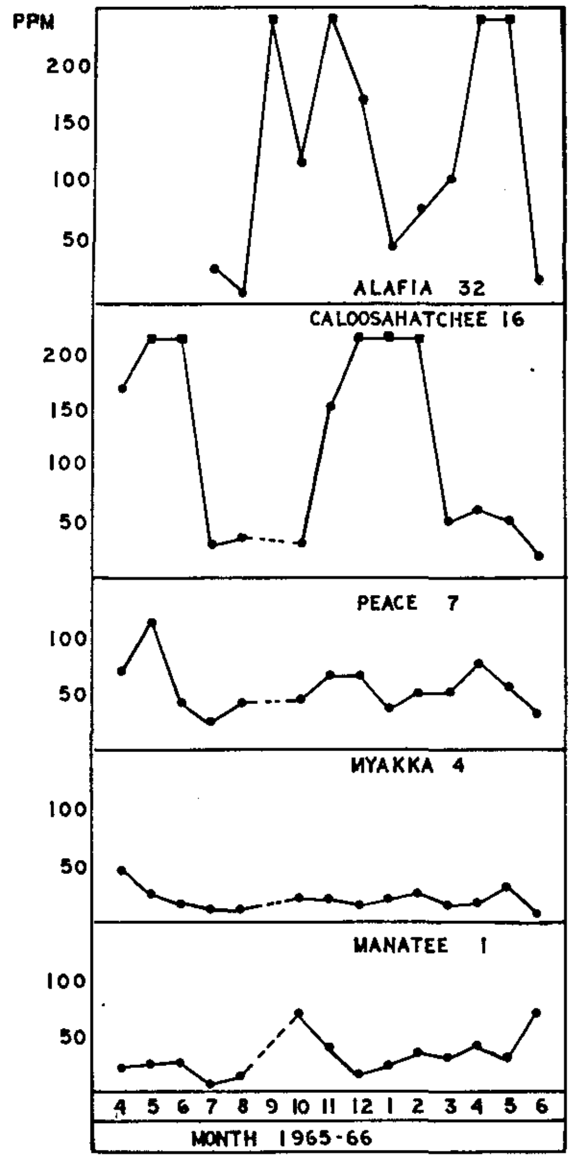


Figure 8. Monthly sulfate levels in south Florida rivers.

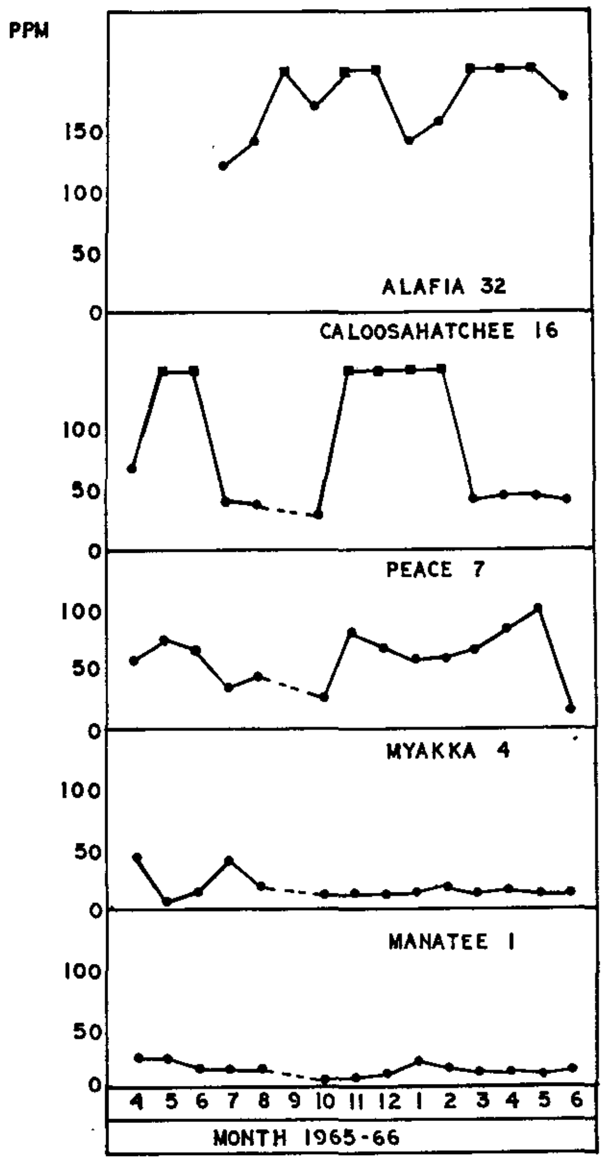


Figure 9. Monthly silica levels in south Florida rivers.

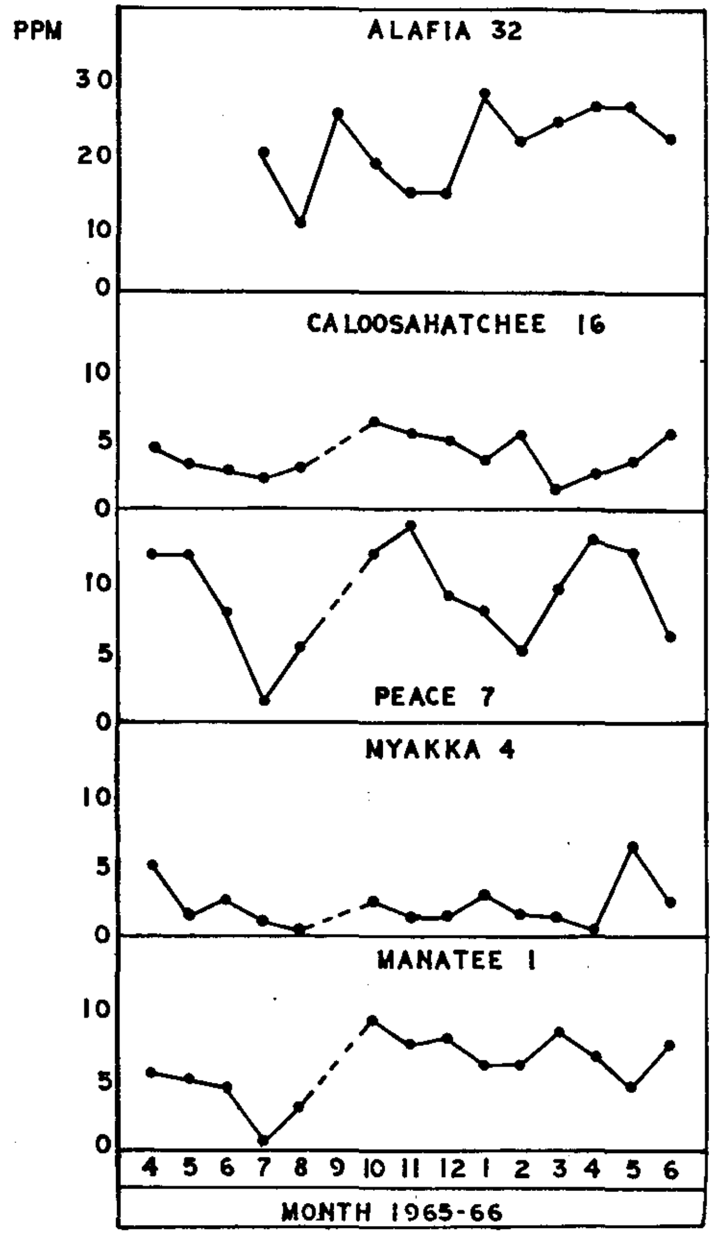
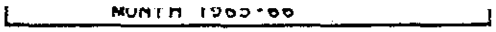


Figure 10. Monthly boron levels in south Florida rivers.

Figure 11. Monthly copper content of south Florida rivers.



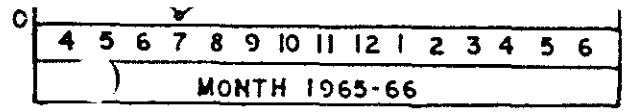


Figure 10. Monthly boron levels in south Florida rivers.

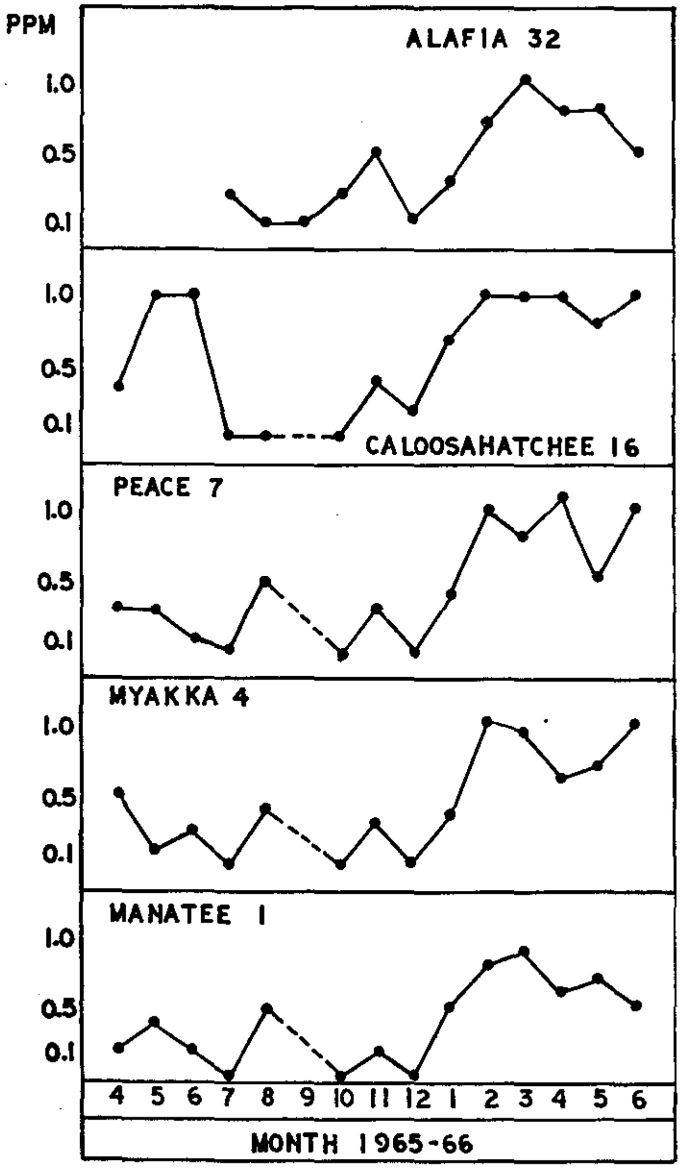


Figure 11. Monthly copper content of south Florida rivers.

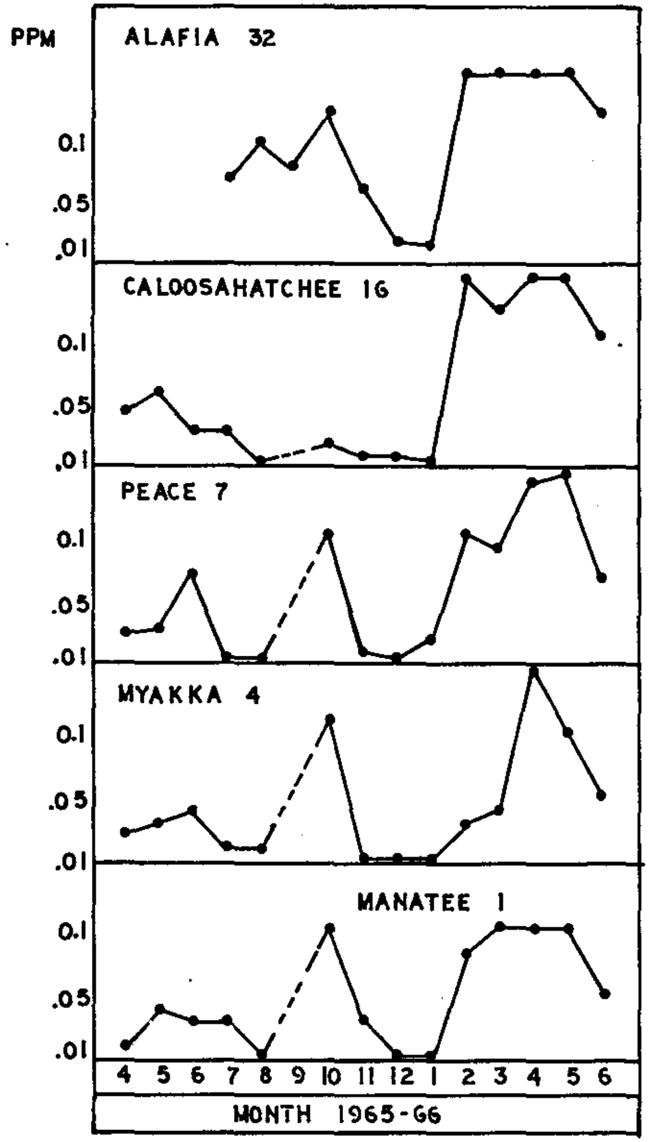


Figure 12. Monthly nitrite levels in south Florida rivers.

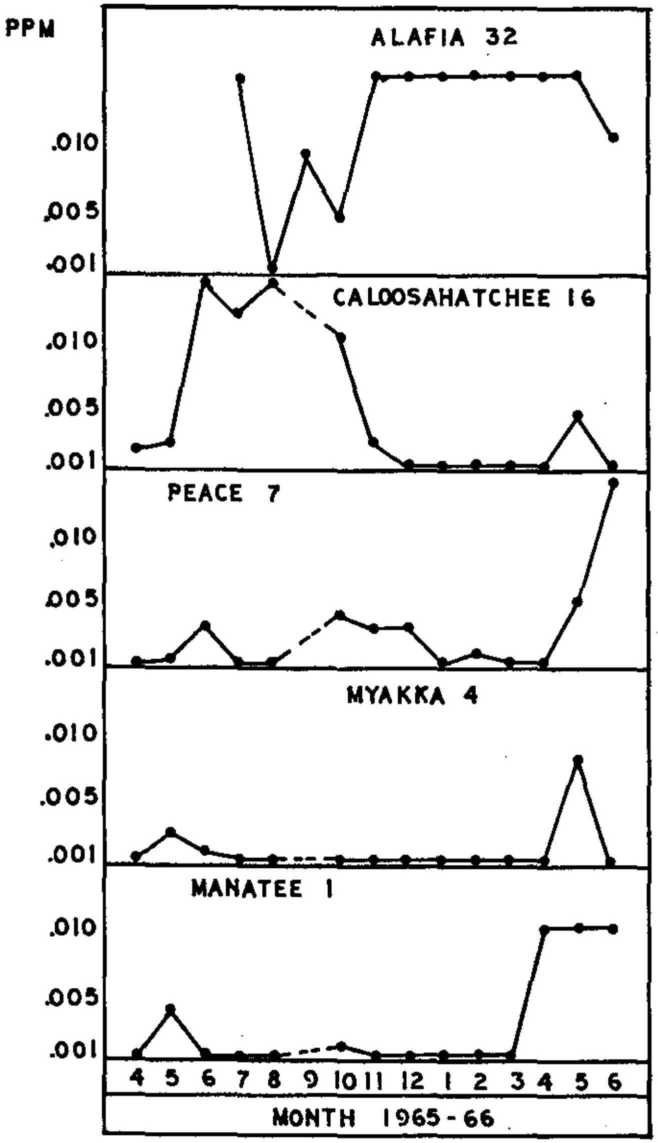
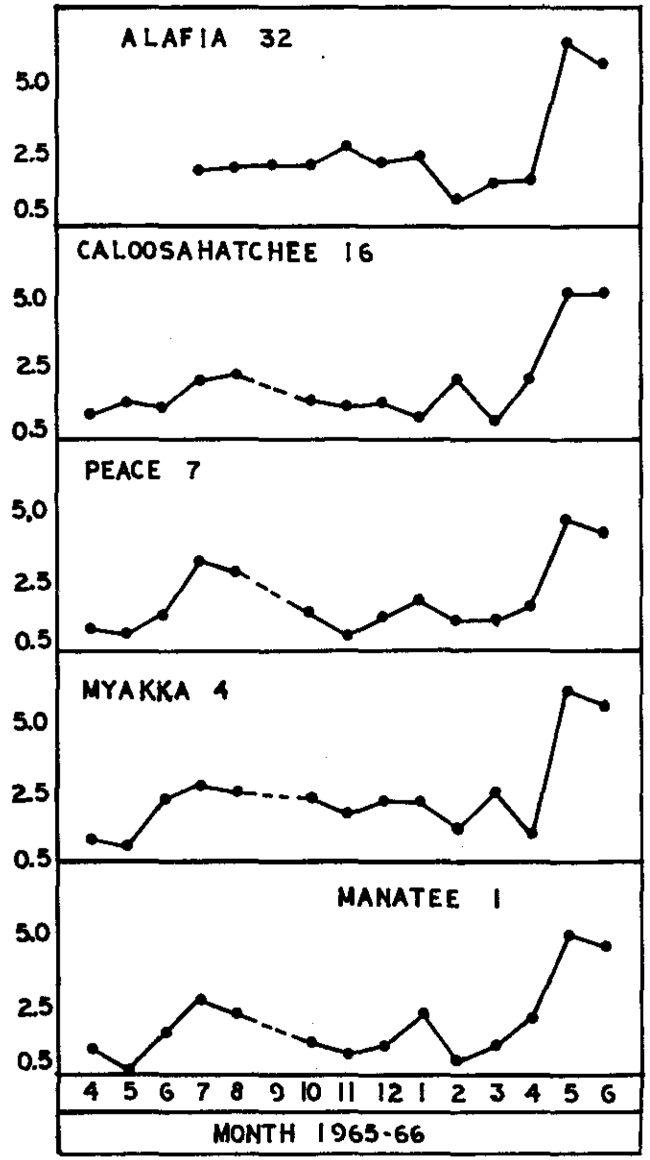


Figure 13. Monthly nitrate levels in south Florida rivers.



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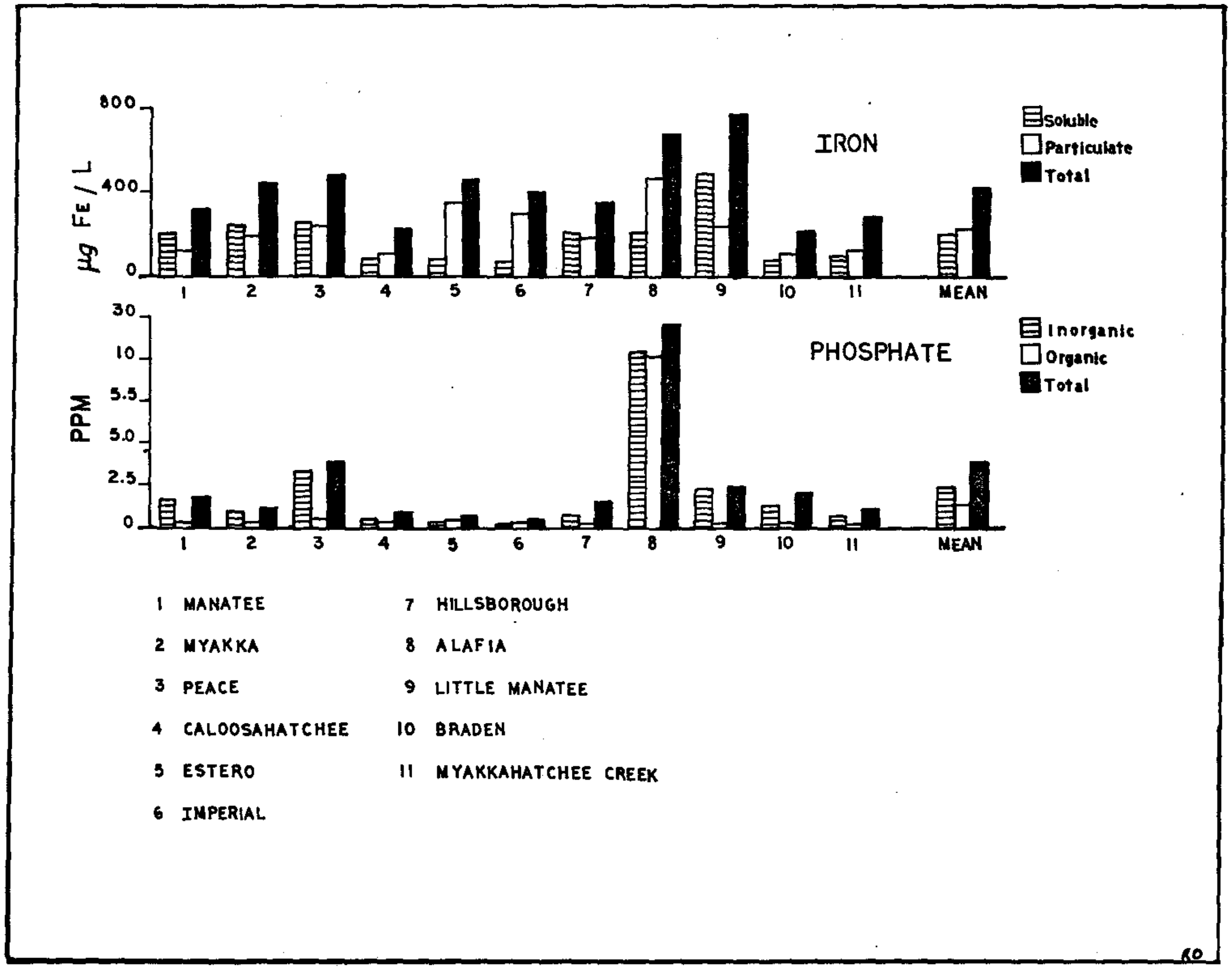


Figure 14. Mean iron and phosphate levels in south Florida rivers.

Figure 15. Monthly tannin levels in south Florida rivers.

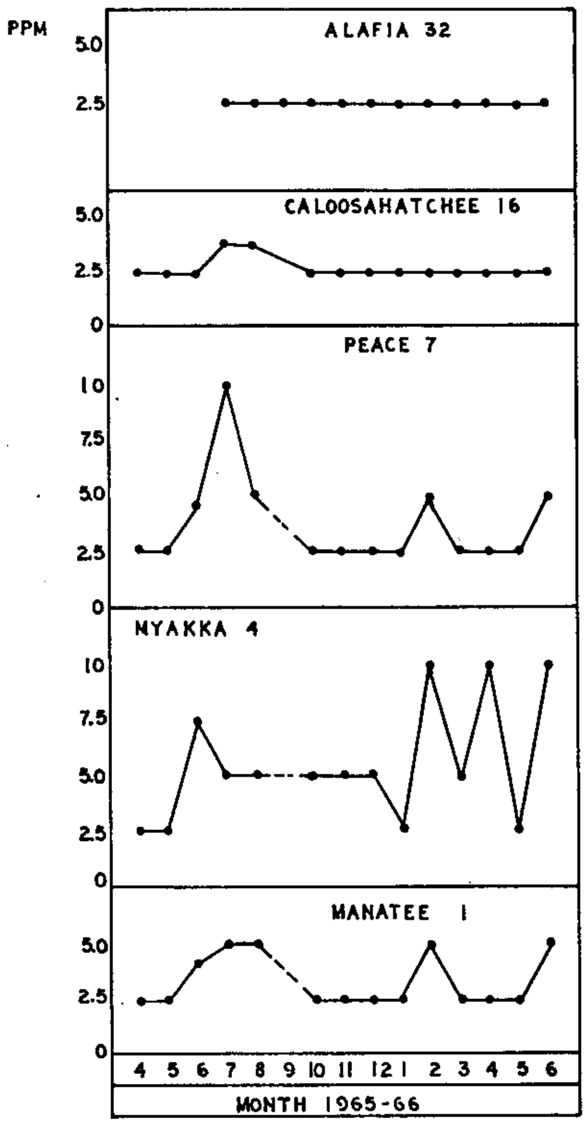


Figure 16. Monthly carbohydrate concentrations in south Florida rivers.

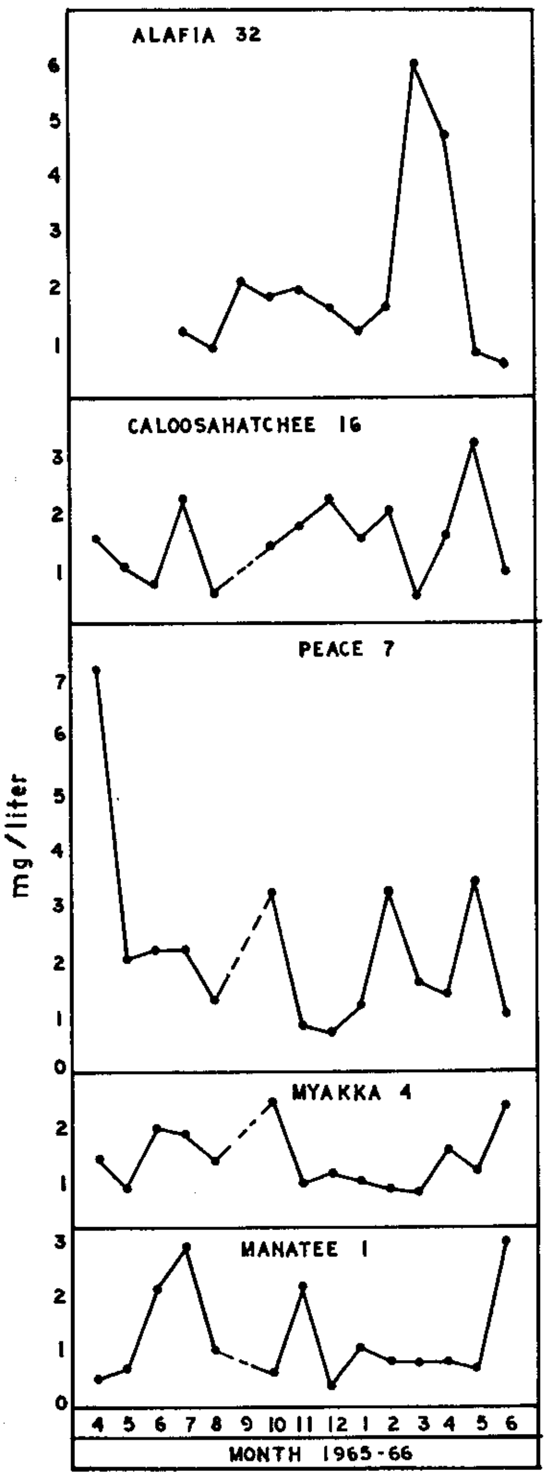


Figure 17. Monthly organic nitrogen levels in south Florida rivers.

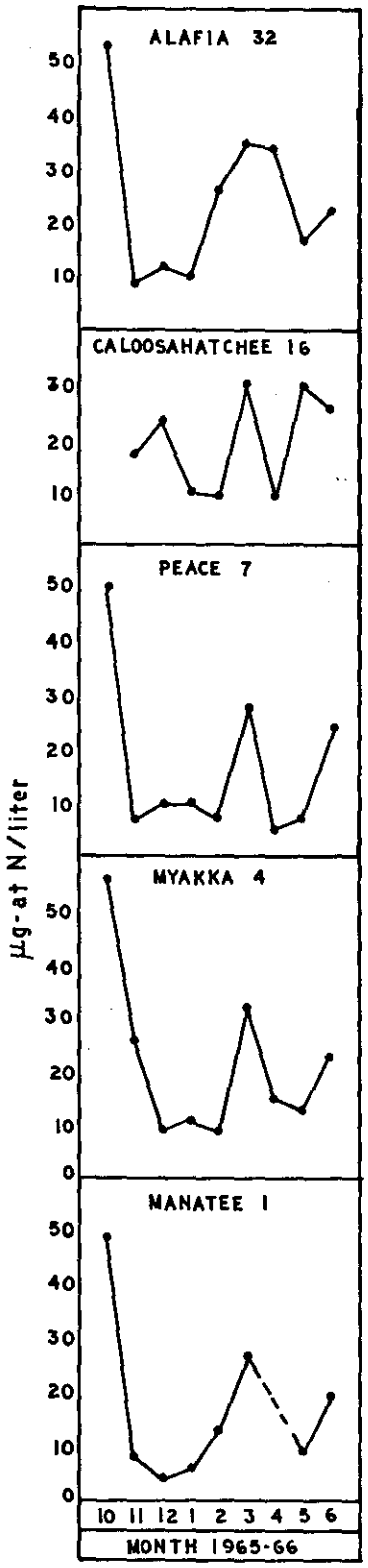


Table 1. River and Tributary Sampling Stations

Station No.	Location	Station No.	Location
1.	Manatee River at junction of SR 64 and 675 (highway bridge)	21.	Myakkahatchee Creek on US 41 south of Venice
2.	Manatee River—3 miles south Duette (highway bridge)	22.	Estero River on US 41 at Estero
3.	Myakka River—11 miles southeast of Venice on US 41 (highway bridge)	23.	Imperial River near Bonita Springs
4.	Myakka River on SR 70 at Myakka City (highway bridge)	24.	Myakka River at Myakka River State Park
6.	Peace River on SR 760 at Nocatee	25.	Horse Creek on SR 72 west of Arcadia
7.	Peace River on SR 70 at Arcadia	26.	Braden River on SR 64 near Bradenton (highway bridge)
8.	Peace River on US 17 at Gardner	27.	Joshua Creek on US 27 near Nocatee (highway bridge)
10.	Prairie Creek on SR 31 south of Arcadia (highway bridge)	28.	Imperial River east of Bonita Springs
11.	Horse Creek on SR 70 near Arcadia (highway bridge)	29.	Estero River east of Estero
12.	Horse Creek on SR 665 near Limestone (highway bridge)	30.	Hillsborough River on SR 582 near Temple Terrace
15.	Joshua Creek on SR 31 south of Arcadia (highway bridge)	31.	Hillsborough River at Hillsborough River State Park
16.	Caloosahatchee River on SR 31 east of Fort Myers (highway bridge)	32.	Alafia River on US 30 at Riverview (highway bridge)
17.	Caloosahatchee River at Alva	33.	Alafia River on SR 39 near Lithia
18.	Caloosahatchee River at LaBelle	34.	Little Manatee River on US 301 south of Riverview
19.	Caloosahatchee River at Moore Haven lock	35.	Little Manatee River on US 39 at Fort Lonesome
20.	Orange River at Tice (highway bridge)		

Table 2. Station No. 1: Manatee River—Junction SR 64 & 675

Date	4/14/65	4/21/65	5/ 5/65	5/12/65	5/26/65	6/ 2/65	6/21/65	6/30/65	7/21/65	8/ 5/65	8/19/65	10/22/65	11/30/65	12/28/65	1/26/66	2/23/66	3/28/66	4/27/66	5/25/66	6/28/66	Mean
Sample	1	15	33	45	56	61	80	91	121	143	174	199	206	211	216	221	226	232	237	242	
Water temperature °C	22.1	22.5	21.5	26.0	24.5	24.5	24.5	26.0	26.0	26.0	27.0	23.5	16.5	15.0	17.0	19.0	18.0	27.5	21.0	26.5	22.7
*p*H	5.0	5.0	5.0	5.5	5.0	4.5	4.5	5.0	4.5	4.5	4.5	5.0	5.5	5.0	4.5	4.0	4.5	5.0	5.5	4.5	4.8
Turbidity	10	5	20	10	10	10	70	70	65	70	60	32	24	18	65	41	32	25	18	47	35
Chloride	10.0	31.0	10.0	12.0	25.0	15.0	15.0	15.0	7.3	12.5	12.5	17.0	17.5	22.5	18.5	15.0	17.5	57.5	17.5	15.0	18.16
Salinity	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Hardness																					
Calcium	30	36	60	30	30	30	13	15	10	5	25	20	23	25	10	15	20	25	30	20	24
Magnesium	20	24	0	20	30	40	22	18	8	5	25	70	40	15	23	35	30	42	30	70	28
TOTAL	50	60	60	50	60	70	35	33	18	10	50	90	63	40	33	50	50	67	60	90	52
Sulfate	4	50	37	7	10	38	15	0	15	28	9	8	9	10	20	16	12	13	10	15	16
Chromate	0	0	0	0	0	0	0	0	0.22	0	0	0	0	0	0	0	0	0	0	0	0
Silica	5.60	5.60	7.40	1.20	6.50	7.00	1.41	6.00	0.52	0.80	5.40	9.20	7.30	8.00	6.00	6.00	8.20	6.50	4.50	7.50	5.53
Boron	0.2	0.2	0.9	0.2	0.2	0.2	0.3	0.2	0	0.05	0.9	0	0.2	0	0.5	0.80	0.90	0.60	0.70	0.50	0.38
Copper	0.030	0.007	0.050	0.050	0.030	0.010	0	0.080	0.030	0	0.01	0.15	0.03	0	0	0.08	0.13	0.13	0.12	0.05	0.05
Magnesium	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Nitrite	0	0	0.002	0.003	0.008	0.005	0	0	0	0	0	0.001	0	0	0	0	0	0.012	0.013	0.010	0.0027
Nitrate	1.0	-	0.4	0.2	0	0.9	1.8	1.8	2.6	3.1	1.1	1.2	0.8	1.0	2.1	0.5	1.0	2.0	5.0	4.5	1.63
Phosphate																					
Inorganic	2.61	2.80	2.40	2.60	2.60	2.40	1.20	1.50	1.20	1.50	1.80	2.20	3.20	2.20	1.35	1.7	1.9	2.7	2.2	3.0	2.15
Organic	0.19	0	0.20	0	0.50	0.40	0.20	0	0.10	0	1.00	0.10	0.10	0.60	0.25	0.6	0.6	0	1.0	1.5	0.37
TOTAL	2.80	2.80	2.60	2.60	3.10	2.80	1.40	1.50	1.30	1.50	2.80	2.30	3.30	2.80	1.60	2.3	2.5	2.7	3.2	4.5	2.52
Iron																					
Soluble	68	43	98	28	31	45	386	354	304	368	288	142	77	155	171	210	57	44	45	255	158
Particulate	155	122	102	145	173	180	66	43	61	119	236	161	102	41	128	59	155	215	284	273	141
TOTAL	223	165	200	173	204	225	452	397	365	487	524	303	179	196	299	269	212	259	329	528	300
Tannins	<2.5	<2.5	<2.5	<2.5	<2.5	<2.5	<5.0	<5.0	<5.0	<5.0	5.0	<2.5	<2.5	<2.5	<2.5	<5.0	<2.5	<2.5	<2.5	<5.0	<2.5
Carbohydrate	0.40	0.60	0.85	0.40	0.70	0.90	2.60	2.90	2.90	0.60	1.40	0.60	2.20	0.40	1.10	0.85	0.85	0.85	0.70	3.00	1.24
Organic nitrogen	-	-	-	-	-	-	-	-	-	-	-	39.10	8.32	3.85	6.25	13.32	26.66	-	8.52	19.68	15.71

Organic nitrogen in µg at-N/liter; iron reported in µg Fe/liter; carbohydrate in mg/liter; turbidity in Jackson Turbidity Units; all other results in ppm.

Table 3. Station No. 2: Manatee River—at Duette.

Date	4/21/65	6/ 2/65	6/30/65	8/18/65	Mean
Sample	16	62	92	161	
Water temperature °C	24.0	25.0	28.0	29.4	26.6
*p*H	4.5	5.5	4.5	4.5	4.8
Turbidity	25	10	72	65	43
Chloride	15.5	20.0	20.0	1.5	14.2
Salinity	-	-	-	-	-
Hardness					
Calcium	40	60	20	10	33
Magnesium	30	30	18	30	27
TOTAL	70	90	38	40	60
Sulfate	17	24	8	12	15
Chromate	0	0	0	0	0
Silica	1.35	2.65	3.00	1.30	2.08
Boron	0.80	0.20	0.15	0	0.29
Copper	0.05	0.05	0.05	0	0.04
Manganese	0	0	0	0	0
Nitrite	0.003	0.010	0	0	0.003
Nitrate	0.3	0.8	1.2	2.9	1.3
Phosphate					
Inorganic	1.65	0.95	0.75	0.90	1.06
Organic	0.15	0.25	0.10	1.30	0.45
TOTAL	1.80	1.20	0.85	2.20	1.51
Iron					
Soluble	44	37	390	391	216
Particulate	184	185	83	283	184
TOTAL	228	222	473	674	400
Tannins	<2.5	<2.5	<5.0	<5.0	<5.0
Carbohydrate	0.75	1.10	1.80	0.70	1.09
Organic nitrogen	-	-	-	-	-

Organic nitrogen in µg at-N/liter; iron reported in µg Fe/liter;

carbohydrate in mg/liter; turbidity in Jackson Turbidity Units; all other results in ppm.

Table 4. Station No. 3: Myakka River—US 41, South of Venice.

Date	4/14/65	5/19/65	6/ 2/65	6/22/65	6/30/65	7/29/65	8/19/65	10/12/65	Mean
Sample	13	46	70	89	114	131	172	196	
Water Temperature °C	29.5	28.5	29.5	33.0	30.0	29.0	30.0	28.0	29.7
*p*H	5.5	5.5	5.0	5.0	5.0	<6.0	4.5	6.0	5.3
Turbidity	10	20	10	60	80	80	73	17	44
Chloride	-	-	-	-	240	25	25	-	97
Salinity	9.20	12.78	15.57	0.22	-	-	-	9.17	9.39
Hardness									
Calcium	-	-	-	-	103	20	20	-	48
Magnesium	-	-	-	-	97	15	30	-	47
TOTAL	-	-	-	-	200	35	50	-	95
Sulfate	>300	>300	>300	170	150	23	18	>300	195
Chromate	0	0	0	0	0	0	0	0	0
Silica	2.85	4.50	4.00	4.00	5.00	0.97	1.20	11.20	4.22
Boron	1.40	1.30	1.40	0.55	0.50	0	0.90	0.40	0.81
Copper	0.10	0.04	0.08	0	0	0.03	0.01	0.09	0.04
Manganese	0	0	0	0	0	0	0	0	0
Nitrite	0	0.001	0	0	0.009	0.001	0	0.004	0.002
Nitrate	0.6	1.2	1.1	1.0	2.6	2.7	2.2	0.4	1.5
Phosphate									
Inorganic	0.60	0.65	0.70	1.60	1.80	1.20	0.97	0.20	0.97
Organic	0	0.25	0.20	0.20	1.00	0.10	0	0.45	0.28
TOTAL	0.60	0.90	0.90	1.80	2.80	1.30	0.97	0.65	1.25
Iron									
Soluble	42	34	21	234	422	238	348	78	177
Particulate	105	61	87	93	130	166	245	200	136
TOTAL	147	95	108	327	552	404	593	278	313
Tannins	<2.5	<2.5	<2.5	<5.0	<2.5	<10.0	<10.0	<2.5	<5.0
Carbohydrate	2.99	1.05	1.50	0.35	1.20	1.40	1.60	0.90	1.37
Organic Nitrogen	-	-	-	-	-	-	-	-	-

Organic nitrogen in μg at-N/liter; iron reported in μg Fe/liter;

carbohydrate in mg/liter; turbidity in Jackson Turbidity Units; all other results in ppm.

Table 5. Station No. 4: Myakka River—SR 70 at Myakka City.

Date	4/14/65	4/21/65	5/ 5/65	5/12/65	5/26/65	6/ 2/65	6/21/65	6/30/65	7/21/65	8/ 5/65	8/19/65	10/22/65	11/30/65	12/28/65	1/26/66	2/23/66	3/28/66	4/27/66	5/25/66	6/28/66	Mean
Sample	2	17	34	44	57	63	81	93	122	144	175	200	207	212	217	222	227	233	238	243	
Water temperature °C	24.0	25.0	23.5	26.5	26.5	27.0	26.0	28.0	26.0	27.0	27.5	29.0	18.0	16.0	17.0	18.5	19.0	25.5	27.0	26.0	24.1
*p*H	5.5	4.5	4.5	5.5	5.3	4.5	4.5	4.5	4.5	4.5	4.5	4.5	4.5	4.5	4.0	4.0	4.25	4.0	4.5	4.5	4.5
Turbidity	30	7	30	15	15	15	100	76	80	65	70	68	59	44	43	52	60	68	30	82	50
Chloride	15	28	20	10	30	20	19	18	8	20	9	15	16.5	17.5	23.5	17.5	42.5	17.5	22.5	15	19.2
Salinity	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Hardness																					
Calcium	60	75	30	30	60	40	25	16	20	5	15	15	10	10	10	20	10	8	40	10	25
Magnesium	40	50	20	20	30	20	13	9	10	8	15	20	20	15	20	25	15	17	30	5	20
TOTAL	100	125	50	50	90	60	38	25	30	13	30	35	30	25	30	45	25	25	70	15	45
Sulfate	48	42	12	8	8	10	35	3	42	25	12	11	12	10	12	19	12	14	12	12	18
Chromate	0	0.07	0	0	0	0	0	0	0.25	0	0	0	0	0	0	0	0	0	0	0	0.01
Silica	6.40	4.20	1.68	0.80	3.00	1.80	2.49	3.20	1.20	0.59	0.3	2.6	1.4	1.45	3.0	1.3	1.5	0.3	6.1	2.2	2.27
Boron	1.00	0	0.20	0	0.20	0.20	0.45	0.10	0	0	0.9	0	0.3	0	0.35	1.0	0.95	0.6	0.7	1.0	0.39
Copper	0.02	0.03	0.02	0	0.05	0.05	0	0.06	0.01	0	0.02	0.11	0	0	0	0.03	0.04	0.15	0.10	0.05	0.03
Manganese	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Nitrite	0.001	0	0.005	0	0	0.004	0	0	0	0	0	0	0	0	0	0	0	0	0.008	0	0.009
Nitrate	0.8	1.0	0.9	0.6	0.2	2.0	2.8	1.9	2.8	3.4	2.25	2.3	1.8	2.2	2.1	1.2	2.5	1.0	6.0	5.5	2.11
Phosphate																					
Inorganic	0.65	0.60	1.00	1.00	0.50	0.50	0.60	0.85	1.00	0.85	0.70	0.75	0.80	0.50	0.40	0.45	0.68	0.78	0.70	0.75	0.70
Organic	0.15	0	0.40	0	0.40	0.18	0.45	0.10	0.05	0.20	0.40	0.05	0	0.05	0.22	0.60	0.24	0.12	0.30	0.20	0.20
TOTAL	0.80	0.60	1.40	1.00	0.90	0.68	1.05	0.95	1.05	1.05	1.10	0.80	0.80	0.55	0.62	1.05	0.92	0.90	1.00	0.95	0.90
Iron																					
Soluble	118	77	149	85	50	56	562	442	360	347	344	250	230	198	154	21	229	260	78	510	233
Particulate	162	114	69	128	164	159	33	18	105	54	56	69	64	17	42	27	39	51	134	50	77
TOTAL	280	191	218	213	214	215	595	460	465	401	400	319	294	215	196	48	268	311	212	560	210
Tannins	<2.5	<2.5	<2.5	<2.5	<2.5	<2.5	<10.0	<10.0	<5.0	<5.0	5.0	<5.0	<5.0	5.0	<2.5	<10.0	<5.0	<10.0	<2.5	<10.0	<5.0
Carbohydrate	0.51	2.36	1.30	0.60	0.90	2.20	1.40	2.41	1.90	0.40	2.45	2.45	1.00	1.20	1.08	0.90	0.85	1.62	1.20	2.40	1.45
Organic nitrogen	-	-	-	-	-	-	-	-	-	-	-	56.7	26.72	8.68	10.52	9.24	32.21	15.32	13.28	23.92	21.94

Organic nitrogen in µg at-N/liter; iron reported in µg Fe/liter; carbohydrate in mg/liter; turbidity in Jackson Turbidity Units; all other results in ppm.

Table 6. Station No. 6: Peace River—SR 760 at Nocatee.

Date	4/21/65	5/ 5/65	6/ 2/65	6/30/65	8/ 6/65	8/19/65	Mean
Sample	21	40	68	101	151	183	
Water temperature °C	29.5	-	32.5	30.5	29.0	30.0	30.3
*p*H	6.8	6.4	6.2	5.0	4.5	5.0	5.7
Turbidity	55	8	15	70	80	69	50
Chloride	24.5	24.0	20.5	16.5	32.5	15.0	22.2
Salinity	-	-	-	-	-	-	-
Hardness							
Calcium	120	90	115	60	23	50	76
Magnesium	60	70	95	25	21	25	49
TOTAL	180	160	210	85	44	75	125
Sulfate	65	70	100	40	45	44	60
Chromate	0	0	0	0	0	0	0
Silica	12.40	9.00	13.00	4.00	4.25	5.00	7.94
Boron	0	0	0	0.40	0	1.00	0.23
Copper	0	0.05	0.07	0	0	0.04	0.02
Manganese	0	0	0	0	0	0	0
Nitrite	0	0	0	0.001	0	0.002	0.0001
Nitrate	-	0.6	1.2	2.5	3.4	2.1	2.0
Phosphate							
Inorganic	7.00	> 8.00	8.00	7.20	6.30	8.00	7.40
Organic	0.60	0	0	0.30	0.30	0.40	0.27
TOTAL	7.60	> 8.00	8.00	7.50	6.60	8.40	7.67
Iron							
Soluble	22	17	7	333	403	294	179
Particulate	160	121	83	107	312	352	189
TOTAL	182	138	90	440	715	646	368
Tannins	<2.5	<2.5	<2.5	<5.0	<10.0	5.0	<5.0
Carbohydrates	7.20	1.30	4.80	1.80	0.70	2.20	3.00
Organic nitrogen	-	-	-	-	-	-	-

Organic nitrogen in µg at-N/liter; iron reported in µg Fe/liter;

carbohydrate in mg/liter; turbidity in Jackson Turbidity Units; all other results in ppm.

Table 7. Station No. 7: Peace River—SR 70 at Arcadia

Date	4/14/65	4/21/65	5/ 5/65	5/26/65	6/ 2/65	6/21/65	6/30/65	7/21/65	8/ 5/65	8/19/65	10/22/65	11/30/65	12/28/65	1/26/66	2/23/66	3/28/66	4/27/66	5/25/66	6/28/66	Mean
Sample	5	18	36	58	65	82	96	123	146	178	202	208	213	218	223	228	234	239	244	
Water temperature °C	28.0	27.0	26.0	29.5	30.0	28.0	29.0	27.0	29.5	30.5	25.0	19.5	17.5	16.0	19.5	21.0	27.0	29.0	28.0	25.6
*p*H	6.8	6.8	5.5	5.5	5.0	4.5	5.0	5.0	4.5	5.0	5.0	6.4	4.5	5.0	4.0	5.5	6.0	5.5	5.0	5.2
Turbidity	10	20	20	15	10	75	70	90	85	68	68	42	25	50	85	48	29	22	65	47
Chloride	20.0	25.0	20.0	32.0	25.0	21.5	20.0	12.5	25.0	20.0	25.0	20.5	25.0	27.5	20.0	22.5	25.0	20.0	16.0	22.0
Salinity	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Hardness																				
Calcium	90	112	100	120	120	53	47	20	20	30	46	90	65	52	45	70	75	100	50	69
Magnesium	80	58	150	70	75	18	28	25	30	50	44	65	65	38	50	50	75	55	30	56
TOTAL	170	170	250	190	195	71	75	45	50	80	90	155	130	90	95	120	150	155	80	125
Sulfate	59	59	78	90	90	75	38	35	50	38	28	82	68	57	58	64	82	100	13	61
Chromate	0	0	0	0	0	0	0	0.2	0	0	0	0	0	0	0	0	0	0	0	0
Silica	10.0	14.0	13.5	9.5	12.0	4.0	9.0	1.8	3.8	7.0	12.0	13.75	9.0	8.2	5.0	9.5	13.0	12.0	6.2	9.12
Boron	0.7	0	0.2	0.4	0	0.30	0.05	0	0	1.00	0	0.3	0	0.4	1.0	0.8	1.1	0.5	1.0	0.4
Copper	0.05	0	0.02	0.05	0.12	0.06	0.02	0	0	0	0.10	0.01	0	0.02	0.10	0.09	0.14	0.15	0.07	0.05
Manganese	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Nitrite	0	0	0	0.001	0.003	0.004	0.001	0	0	0.004	0.003	0.003	0	0.001	0	0	0	0.005	0.200	0.010
Nitrate	1.1	-	1.0	0.1	1.1	1.7	1.3	3.2	3.3	2.0	1.8	0.5	1.2	1.7	1.0	1.0	1.5	4.5	4.0	1.76
Phosphate																				
Inorganic	7.30	7.50	6.00	6.40	8.80	4.60	7.40	4.10	7.90	10.00	4.5	10.5	7.8	6.8	6.0	8.6	9.0	9.25	12.0	7.60
Organic	> 0.70	0.50	1.60	> 1.60	3.00	0.90	0.80	0.10	0.20	1.00	0.5	2.0	3.2	0.6	1.5	2.0	2.0	2.75	3.5	1.47
TOTAL	> 8.00	8.00	7.60	> 8.00	11.80	5.50	8.20	4.20	8.10	11.00	5.0	12.5	11.0	7.4	7.5	10.6	11.0	12.00	15.5	9.08
Iron																				
Soluble	28	14	34	16	15	220	266	358	438	322	128	56	86	110	16	82	33	19	190	128
Particulate	169	141	79	43	43	153	147	222	289	314	270	111	62	202	382	210	92	68	349	176
TOTAL	197	155	113	59	58	373	413	580	727	636	398	167	148	312	398	292	125	87	539	304
Tannins	<2.5	<2.5	<2.5	<2.5	<2.5	< 5.0	< 5.0	< 10.0	< 5.0	5.0	<2.5	<2.5	<2.5	2.5	<5.0	<2.5	< 2.5	< 2.5	< 5.0	< 5.0
Carbohydrate	5.50	8.82	1.80	2.20	3.15	1.00	2.41	2.20	0.60	2.10	3.20	0.85	0.68	1.20	3.25	1.60	1.40	3.42	1.00	2.44
Organic nitrogen	-	-	-	-	-	-	-	-	-	-	50.40	7.72	10.43	10.30	7.92	28.64	5.00	7.68	24.16	16.91

Organic nitrogen in µg at-N/liter; iron reported in µg Fe/liter; carbohydrate in mg/liter; turbidity in Jackson Turbidity Units; all other results in ppm.

Table 8. Station No. 8: Peace River—US 17 at Gardner.

Date	4/21/65	5/ 5/65	6/ 2/65	6/30/65	8/19/65	Mean
Sample	19	37	66	97	179	
Water temperature °C	28.5	28.5	30.0	29.0	30.0	29.2
*p*H	6.4	5.0	5.5	4.5	5.0	5.3
Turbidity	40	18	20	70	75	45
Chloride	25.0	26.0	25.0	20.0	19.5	23.0
Salinity	-	-	-	-	-	-
Hardness						
Calcium	114	90	120	41	35	80
Magnesium	51	70	90	39	35	57
TOTAL	165	160	210	80	70	137
Sulfate	65	72	100	33	36	51
Chromate	0	0	0	0	0	0
Silica	12.4	7.0	13.0	11.0	5.4	9.8
Boron	0.3	0.4	0	0.2	0.9	0.4
Copper	0	0.05	0.11	0	0	0.03
Manganese	0	0	0	0	0	0
Nitrite	0	0	0	0.002	0.003	0.001
Nitrate	-	0.8	1.0	2.2	2.0	1.5
Phosphate						
Inorganic	> 8.0	6.25	8.00	5.60	6.80	6.93
Organic	-	1.75	6.40	0.40	0.40	2.24
TOTAL	> 8.0	8.00	14.40	6.00	7.20	9.17
Iron						
Soluble	14	50	8	334	280	137
Particulate	153	54	107	104	340	152
TOTAL	167	104	115	438	620	289
Tannins	<2.5	<2.5	<2.5	<5.0	5.0	<2.5
Carbohydrate	15.00	1.30	5.70	2.41	2.20	5.32
Organic nitrogen	-	-	-	-	-	-

Organic nitrogen in µg at-N/liter; iron reported in µg Fe/liter;

carbohydrate in mg/liter; turbidity in Jackson Turbidity Units; all other results in ppm.

Table 9. Station No. 10: Prairie Creek—SR 31 South of Arcadia.

Date	4/14/65	6/21/65	6/30/65	8/ 5/65	8/19/65	Mean
Sample	7	84	99	148	181	
Water temperature °C	33.0	30.0	35.0	31.0	32.0	32.2
*p*H	5.5	5.0	5.5	4.5	5.0	5.1
Turbidity	25	28	60	88	80	56
Chloride	35.0	46.5	37.5	22.5	12.5	30.8
Salinity	-	-	-	-	-	-
Hardness						
Calcium	130	150	180	25	35	104
Magnesium	110	20	10	7	15	32
TOTAL	140	170	190	32	50	136
Sulfate	35	12	35	42	13	27
Chromate	0	0	0	0	0	0
Silica	4.4	4.5	11.6	1.7	3.2	5.1
Boron	0.1	0.6	0.3	0	0.8	0.4
Copper	0.05	0.05	0	0	0.05	0.03
Manganese	0	0	0	0	0	0
Nitrite	0.005	0.001	0.54	0	0	0.012
Nitrate	1.4	0.4	1.6	3.2	1.8	1.7
Phosphate						
Inorganic	0.12	0.10	0.22	0.35	0.20	0.20
Organic	0.17	0.40	0.10	0.25	0.20	0.22
TOTAL	0.29	0.50	0.32	0.60	0.40	0.42
Iron						
Soluble	26	102	808	416	360	342
Particulate	326	783	265	426	664	493
TOTAL	352	885	1073	842	1024	835
Tannins	<2.5	< 2.5	<2.5	<10.0	<5.0	< 2.5
Carbohydrate	1.40	1.10	2.20	0.41	2.10	1.44
Organic nitrogen	-	-	-	-	-	-

Organic nitrogen in µg at-N/liter; iron reported in µg Fe/liter;
carbohydrate in mg/liter; turbidity in Jackson Turbidity Units; all other results in ppm.

Table 10. Station No. 11: Horse Creek—SR 70 near Arcadia.

Date	4/14/65	5/ 5/65	6/ 2/65	6/30/65	8/ 5/65	8/19/65	10/22/65	Mean
Sample	4	35	64	95	145	177	201	
Water temperature °C	27.5	27.5	30.0	28.0	29.0	29.5	25.0	28.1
*p*H	5.0	4.5	6.8	4.5	4.5	5.0	4.5	5.0
Turbidity	45	30	40	80	85	-	74	59
Chloride	24.5	20.0	40.0	20.0	20.0	15.0	17.5	22.4
Salinity	-	-	-	-	-	-	-	-
Hardness								
Calcium	32	50	60	35	16	20	20	33
Magnesium	38	10	100	25	5	37	15	33
TOTAL	70	60	160	60	21	57	35	66
Sulfate	32	33	20	8	22	14	15	21
Chromate	0	0	0	0	0	0	0	0
Silica	1.20	0.33	1.69	2.20	3.00	1.30	4.70	1.92
Boron	0.60	0.10	0.20	0.10	0.05	0.90	0.10	0.29
Copper	0	0.01	0.01	0	0	0	0.15	0.02
Manganese	0	0	0	0	0	0	0	0
Nitrite	0	0	0	0	0	0	0	0
Nitrate	1.4	1.2	1.5	2.2	3.3	2.4	2.5	2.1
Phosphate								
Inorganic	1.92	1.90	2.80	2.20	1.90	1.80	1.10	1.95
Organic	0.13	0.10	0.70	0	0	0.10	0.10	0.16
TOTAL	2.05	2.00	3.50	2.20	1.90	1.90	1.20	2.11
Iron								
Soluble	40	143	56	595	495	430	310	296
Particulate	145	108	1050	78	248	226	190	292
TOTAL	190	251	1106	673	743	656	500	588
Tannins	<2.5	<2.5	<2.5	<10.0	<5.0	<10.0	<5.0	<5.0
Carbohydrate	1.63	2.45	6.80	3.10	0.41	1.30	1.50	2.46
Organic nitrogen	-	-	-	-	-	-	-	-

Organic nitrogen in μg at-N/liter; iron reported in μg Fe/liter;

carbohydrate in mg/liter; turbidity in Jackson Turbidity Units; all other results in ppm.

Table 11. Station No. 12: Horse Creek—SR 665 near Limestone.

Date	4/14/65	6/30/65	8/19/65	Mean
Sample	3	94	176	
Water temperature °C	29.5	28.0	29.0	28.8
*p*H	5.5	4.5	5.0	5.0
Turbidity	60	84	89	78
Chloride	15.0	20.0	10.0	15.0
Salinity	-	-	-	-
Hardness				
Calcium	20	16	20	19
Magnesium	10	35	15	20
TOTAL	30	51	35	39
Sulfate	15	0	15	10
Chromate	0	0	0	0
Silica	3.2	6.3	1.2	3.6
Boron	0	0.3	1.0	0.4
Copper	0.03	0.03	0	0.02
Manganese	0	0	0	0
Nitrite	0	0	0	0
Nitrate	1.6	2.4	1.8	1.9
Phosphate				
Inorganic	2.05	2.00	1.65	1.90
Organic	0.13	1.00	0.05	0.39
TOTAL	2.18	3.00	1.70	2.29
Iron				
Soluble	354	484	420	419
Particulate	293	69	202	188
TOTAL	647	553	622	607
Tannins	<2.5	<10.0	<10.0	<10.0
Carbohydrate	0.90	4.30	1.10	2.10
Organic nitrogen	-	-	-	-

Organic nitrogen in µg at-N/liter; iron reported in µg Fe/liter;

carbohydrate in mg/liter; turbidity in Jackson Turbidity Units; all other results in ppm.

Table 12. Station No. 15: Joshua Creek—SR 31 South of Arcadia.

Date	4/14/65	5/ 5/65	6/21/65	6/30/65	8/ 5/65	8/19/65	Mean
Sample	6	38	83	98	147	180	
Water temperature °C	20.0	21.5	27.0	29.0	29.0	29.0	25.9
*p*H	5.5	5.0	5.0	4.5	4.5	5.0	4.9
Turbidity	12	15	25	50	90	80	45
Chloride	40.0	35.0	38.0	34.0	25.0	20.0	32
Salinity	-	-	-	-	-	-	-
Hardness							
Calcium	80	140	120	37	26	30	72
Magnesium	70	120	90	73	10	5	61
TOTAL	150	260	210	110	36	35	133
Sulfate	18	160	155	70	50	18	79
Chromate	0	0	0	0	0	0	0
Silica	12.8	7.0	5.5	8.0	2.3	3.6	6.5
Boron	0	0	0.4	0.6	0	1.0	0.3
Copper	0.05	0.06	0.05	0.01	0	0.01	0.03
Manganese	0	0	0	0	0	0	0
Nitrite	0	0	0.002	0	0	0.001	0.001
Nitrate	1.1	1.0	0.5	1.2	3.1	1.8	1.5
Phosphate							
Inorganic	0.79	0.30	0.60	0.85	2.00	1.25	0.97
Organic	0.11	0.20	0.30	0.10	0.20	0.50	0.24
TOTAL	0.90	0.50	0.90	0.95	2.20	1.75	1.21
Iron							
Soluble	84	100	87	376	528	474	275
Particulate	203	97	150	54	405	645	259
TOTAL	287	197	237	430	933	1119	534
Tannins	<2.5	<2.5	<2.5	2.5	5.0	5.0	2.5
Carbohydrate	1.18	0.60	0.50	2.70	0.70	1.00	1.11
Organic nitrogen	-	-	-	-	-	-	-

Organic nitrogen in μg at-N/liter; iron reported in μg Fe/liter;

carbohydrate in mg/liter; turbidity in Jackson Turbidity Units; all other results in ppm.

Table 13. Station No. 16: Caloosahatchee River—SR 31 East of Ft. Myers

Date	4/14/65	4/28/65	5/19/65	6/ 9/65	6/21/65	6/30/65	7/21/65	7/29/65	8/ 5/65	8/19/65	10/12/65	11/30/65	12/28/65	1/26/66	2/23/66	3/28/66	4/27/66	5/25/66	6/28/66	Mean
Sample	8	24	48	79	85	105	124	133	149	163	192	209	214	219	224	229	235	240	245	
Water temperature °C	29.0	28.5	29.0	29.0	30.0	29.5	30.0	30.0	31.0	32.8	28.5	22.0	20.0	18.5	22.0	24.0	25.0	27.5	29.0	27.0
*p*H	6.6	6.4	5.5	6.4	6.8	7.2	6.0	6.8	6.4	6.8	6.0	6.6	7.1	6.2	6.4	6.0	5.5	6.0	6.2	6.4
Turbidity	29	5	15	10	20	22	50	48	45	60	38	47	28	25	27	42	25	15	25	30
Chloride	13.8	-	-	-	330	380	60	37.5	65	8.5	85	785	-	-	-	70	75	77	57.5	143
Salinity	-	1.40	8.49	9.65	-	-	-	-	-	-	-	-	3.20	3.64	2.33	-	-	-	-	4.74
Hardness																				
Calcium	141	180	-	-	161	185	150	100	93	115	110	260	-	-	-	100	115	110	130	139
Magnesium	59	280	-	-	105	105	40	18	32	35	30	150	-	-	-	50	60	50	20	74
TOTAL	200	460	-	-	266	290	190	118	125	150	140	410	-	-	-	150	175	160	150	213
Sulfate	60	80	> 300	> 300	190	90	50	29	40	38	30	180	> 300	> 300	260	40	47	44	40	127
Chromate	0	0.08	0	0	0	0	0.29	0	0	0	0	0	0	0	0	0	0	0	0	0
Silica	6.20	3.00	3.20	2.60	3.00	3.00	2.00	2.50	3.30	4.20	6.40	5.50	5.00	3.50	5.50	1.60	2.50	3.20	5.30	3.76
Boron	0.4	0.3	1.0	0.8	0.6	1.80	0	0	0	0	0	0.4	0.2	0.7	1.0	1.00	1.00	0.80	1.00	0.58
Copper	0.04	0.05	0.06	0.05	0.04	0.01	0.05	0.02	0	0.01	0.02	0.01	0.01	0	0.15	0.12	0.19	0.20	0.10	0.05
Manganese	0	0.001	0	0	0	0	0	0	0	0	0	0	0.4	0	0	0	0	0	0	0
Nitrite	0	0.003	0.002	0.003	0.023	0.050	0.020	0.005	0.032	0.017	0.010	0.002	0	0	0	0	0	0.004	0	0.009
Nitrate	0.9	0.9	1.1	0.8	0.5	1.8	2.4	1.4	2.4	2.1	1.3	1.0	1.2	0.6	2.0	0.5	2.0	5.0	5.0	1.7
Phosphate																				
Inorganic	0.38	0.35	0.35	0.36	0.30	0.70	0.60	0.50	0.41	0.20	0.25	0.70	0.45	0.35	0.19	0.65	0.28	0.37	0.54	0.42
Organic	0.04	0.15	0.24	0.14	0.30	0.20	0.12	0.28	0.29	0.40	0.25	0.10	0.10	0.20	0.41	0.25	0.32	0.58	0.56	0.20
TOTAL	0.42	0.50	0.59	0.50	0.60	0.90	0.72	0.78	0.70	0.60	0.50	0.80	0.55	0.55	0.60	0.90	0.60	0.95	1.10	0.62
Iron																				
Soluble	25	14	13	11	39	73	129	136	175	180	103	70	35	17	19	33	16	19	64	62
Particulate	59	30	26	37	36	67	144	146	217	222	150	157	153	81	42	71	34	39	148	98
TOTAL	84	44	39	48	75	140	273	282	392	402	253	227	188	98	61	104	50	58	212	160
Tannins	<2.5	<2.5	<2.5	<2.5	<2.5	<2.5	<2.5	<5.0	<2.5	<5.0	<2.5	<2.5	<2.5	<2.5	<2.5	<2.5	<2.5	<2.5	2.5	<2.5
Carbohydrate	1.58	1.46	1.40	0.60	1.00	0.70	3.05	1.30	0.40	0.60	1.35	1.75	2.21	1.46	2.00	0.50	1.62	3.21	0.90	1.42
Organic nitrogen	-	-	-	-	-	-	-	-	-	-	-	16.64	23.24	9.99	8.88	30.18	9.40	29.92	26.12	19.32

Organic nitrogen in µg at-N/liter; iron reported in µg Fe/liter; carbohydrate in mg/liter; turbidity in Jackson Tribidity Units; all other results in ppm.

Table 14. Station No. 17: Caloosahatchee River—at Alva.

Date	4/28/65	5/19/65	6/ 8/65	6/30/65	7/29/65	8/19/65	Mean
Sample	25	49	72	106	134	164	
Water temperature °C	29.3	31.0	29.0	30.0	30.0	31.5	30.1
*p*H	6.2	6.6	6.8	6.8	6.4	6.0	6.5
Turbidity	15	20	10	40	52	52	31
Chloride	95	187	165	70	34	9	93
Salinity	-	-	-	-	-	-	-
Hardness							
Calcium	134	120	155	160	100	110	130
Magnesium	46	80	105	30	30	50	57
TOTAL	180	200	260	190	130	160	187
Sulfate	51	64	55	35	30	47	47
Chromate	0	0	0	0	0	0	0
Silica	4.00	4.00	0.48	6.40	5.00	4.00	4.00
Boron	0	1.20	0.05	1.90	0.10	0	0.50
Copper	0.005	0.030	0.010	0	0.030	0	0.0013
Manganese	0	0	0	0	0	0	0
Nitrite	0.002	0.003	0.004	0.027	0.006	0.003	0.008
Nitrate	0.4	1.9	1.4	2.3	1.6	1.8	1.6
Phosphate							
Inorganic	0.30	0.25	0.20	0.60	0.18	0.50	0.34
Organic	0.10	0.14	0.20	0.30	0.73	0.70	0.36
TOTAL	0.40	0.39	0.40	0.90	0.85	1.20	0.70
Iron							
Soluble	9	16	16	114	187	174	86
Particulate	28	39	20	207	274	213	130
TOTAL	37	55	36	321	461	387	216
Tannins	<2.5	<2.5	<2.5	<2.5	<5.0	<5.0	<2.5
Carbohydrate	1.01	1.61	0.50	1.05	1.05	1.50	1.12
Organic nitrogen	-	-	-	-	-	-	-

Organic nitrogen in µg at-N/liter; iron reported in µg Fe/liter;
carbohydrate in mg/liter; turbidity in Jackson Turbidity Units; all other results in ppm.

Table 15. Station No. 18: Caloosahatchee River—at La Belle.

Date	4/28/65	5/19/65	6/ 8/65	6/30/65	7/29/65	8/19/65	Mean
Sample	26	50	73	107	135	165	
Water temperature °C	29.0	32.0	30.0	31.0	29.5	31.0	30.4
*p*H	5.5	6.8	6.8	6.8	6.9	6.8	6.6
Turbidity	22	30	18	60	54	50	39
Chloride	99	87	63	38	31	7	54
Salinity	-	-	-	-	-	-	-
Hardness							
Calcium	120	40	160	135	103	130	115
Magnesium	50	100	60	25	19	100	59
TOTAL	170	140	220	160	122	230	174
Sulfate	47	52	48	50	32	60	48
Chromate	0	0	0	0	0	0	0
Silica	4.60	7.00	7.00	7.00	4.40	5.10	5.90
Boron	0	0	0.10	1.90	0.10	0	0.04
Copper	0.005	0.50	0.020	0	0	0.030	0.018
Manganese	0	0	0	0	0	0	0
Nitrite	0.005	0	0.008	0.012	0.003	0.003	0.005
Nitrate	0.3	2.3	1.0	2.3	1.7	2.0	1.6
Phosphate							
Inorganic	0.75	0.42	0.34	1.00	0.65	0.40	0.59
Organic	0.25	0.33	0.16	0.90	0.25	0.50	0.40
TOTAL	1.00	0.75	0.50	1.90	0.90	0.90	0.99
Iron							
Soluble	9	11	14	208	185	172	100
Particulate	119	120	100	248	363	205	193
TOTAL	128	131	114	456	548	377	293
Tannins	<2.5	<2.5	<2.5	<2.5	<5.0	2.5	2.5
Carbohydrate	1.68	0.65	0.75	1.05	2.02	0.50	1.11
Organic nitrogen	-	-	-	-	-	-	-

Organic nitrogen in µg at-N/liter; iron reported in µg Fe/liter;

carbohydrate in mg/liter; turbidity in Jackson Turbidity Units; all other results in ppm.

Table 16. Station No. 19: Caloosahatchee River—at Moore Haven.

Date	4/28/65	5/19/65	6/ 8/65	6/30/65	7/29/65	8/19/65	Mean
Sample	27	51	74	108	136	166	
Water temperature °C	29.0	29.0	30.0	31.0	30.5	32.0	30.2
*p*H	6.2	6.0	6.4	6.8	6.2	6.2	6.3
Turbidity	15	20	10	20	82	55	34
Chloride	75	88	88	59	36	8	59
Salinity	-	-	-	-	-	-	-
Hardness							
Calcium	100	90	100	85	50	110	89
Magnesium	70	70	50	45	20	100	59
TOTAL	170	160	150	130	70	210	148
Sulfate	43	48	42	46	31	190	66
Chromate	0	0	0	0	0	0	0
Silica	0.95	0.95	0.60	2.00	1.20	5.50	1.86
Boron	0.	0	2.80	1.60	0.10	0	0.75
Copper	0.006	0.040	0.030	0.040	0.060	0.020	0.030
Manganese	0	0	0	0	0	0	0
Nitrite	0.005	0.001	0.005	0.002	0.002	0.002	0.003
Nitrate	0.6	1.1	1.0	1.3	1.6	2.0	1.3
Phosphate							
Inorganic	0.30	0.20	0.12	0.30	0.45	0.25	0.27
Organic	0.20	0.20	0.23	0.62	0.05	0.10	0.23
TOTAL	0.50	0.40	0.35	0.92	0.50	0.35	0.50
Iron							
Soluble	17	16	15	44	328	162	97
Particulate	42	39	30	68	200	215	99
TOTAL	59	55	45	112	528	377	196
Tannins	<2.5	< 2.5	< 2.5	< 2.5	<10.0	<5.0	< 2.5
Carbohydrate	1.46	1.05	0.60	0.70	1.80	1.50	1.19
Organic nitrogen	-	-	-	-	-	-	-

Organic nitrogen in μg at-N/liter; iron reported in μg Fe/liter;

carbohydrate in mg/liter; turbidity in Jackson Turbidity Units; all other results in ppm.

Table 17. Station No. 20: Orange River—at Tice.

Date	4/14/65	6/ 8/65	6/30/65	7/29/65	8/19/65	10/12/65	Mean
Sample	9	71	104	137	162	193	
Water temperature °C	32.0	32.0	33.0	30.0	33.0	28.5	31.4
*p*H	6.6	5.5	6.9	6.8	6.6	5.2	6.3
Turbidity	15	15	30	35	41	20	26
Chloride	190	-	550	65	7	100	182
Salinity	-	6.76	-	-	-	-	-
Hardness							
Calcium	200	-	180	130	170	150	166
Magnesium	50	-	190	30	60	40	74
TOTAL	250	-	370	160	230	190	240
Sulfate	75	>300	120	44	53	46	106
Chromate	0	0	0	0	0	0	0
Silica	6.60	0.65	6.00	5.90	6.50	7.20	5.48
Boron	0	1.30	1.60	0.10	0	0	0.50
Copper	0.03	0.04	0.12	0.05	0.05	0.05	0.6
Manganese	0	0	0	0	0	0	0
Nitrite	<0.010	0.002	0.045	0.005	0.008	0.006	0.012
Nitrate	0.8	0.9	1.4	1.3	1.6	1.0	1.1
Phosphate							
Inorganic	0.40	0.32	0.60	0.65	0.30	0.30	0.43
Organic	0	0.18	0.18	0.19	0.85	0.25	0.28
TOTAL	0.40	0.50	0.78	0.84	1.15	0.55	0.71
Iron							
Soluble	15	121	100	112	119	83	92
Particulate	65	40	78	170	380	225	160
TOTAL	80	161	178	282	499	308	252
Tannins	<2.5	<2.5	< 2.5	< 2.5	2.5	<2.5	< 2.5
Carbohydrate	2.43	0.60	1.50	1.05	1.00	1.00	1.26
Organic nitrogen	-	-	-	-	-	-	-

Organic nitrogen in μg at-N/liter; iron reported in μg Fe/liter;

carbohydrate in mg/liter; turbidity in Jackson Turbidity Units; all other results in ppm.

Table 18. Station No. 21: Myakkahatchee Creek—US 41 South of Venice.

Date	4/14/65	5/19/65	6/ 2/65	6/22/65	6/30/65	8/19/65	10/12/65	Mean
Sample	12	47	69	88	113	171	197	
Water temperature °C	30.5	28.0	30.0	32.5	31.0	30.0	27.5	29.9
*p*H	6.2	5.5	5.0	5.0	5.3	5.5	5.0	5.4
Turbidity	15	19	10	55	70	34	50	36
Chloride	-	-	-	-	1140	-	32.5	-
Salinity	14.05	13.68	15.15	2.58	-	-	-	11.37
Hardness								
Calcium	-	-	-	-	182	-	25	-
Magnesium	-	-	-	-	318	-	35	-
TOTAL	-	-	-	-	500	-	60	-
Sulfate	>300	>300	>300	>300	>300	>300	14	>300
Chromate	0	0	0	0	0	0	0	0
Silica	8.4	9.2	6.0	4.0	6.8	5.8	2.1	6.0
Boron	-	1.6	1.5	0.9	0.6	1.1	0	1.0
Copper	0.22	0.05	0.08	0	0.01	0.04	0.05	0.64
Manganese	0	0	0	0	0.15	0	0	0.01
Nitrite	0.002	0.002	0	0	0.007	0	0.001	0.002
Nitrate	0.1	0.9	1.1	0.8	1.8	0.5	1.9	1.0
Phosphate								
Inorganic	0.48	0.65	0.65	1.00	1.65	0.50	0.55	0.65
Organic	-	0.13	0.25	0.50	0.55	0.25	0.25	0.32
TOTAL	-	0.78	0.90	1.50	2.20	0.75	0.80	0.97
Iron								
Soluble	24	20	27	185	354	154	253	145
Particulate	86	102	85	131	183	293	200	154
TOTAL	110	122	112	316	537	447	453	299
Tannins	<2.5	<2.5	<2.5	<5.0	<5.0	<2.5	<5.0	<5.0
Carbohydrate	2.43	1.21	3.95	0.05	3.05	3.00	1.80	2.21
Organic nitrogen	-	-	-	-	-	-	-	-

Organic nitrogen in μg at-N/liter; iron reported in μg Fe/liter;

carbohydrate in mg/liter; turbidity in Jackson Turbidity Units; all other results in ppm.

Table 20. Station No. 23: Imperial River—at Stanton's near Bonita Springs

Date	4/14/65	4/28/65	5/19/65	6/ 8/65	6/22/65	6/30/65	7/29/65	8/19/65	10/12/65	Mean
Sample	11	31	55	78	87	112	141	170	195	
Water temperature °C	31.0	31.0	30.0	-	30.0	30.0	29.0	30.0	29.0	30.0
*p*H	6.8	6.2	5.0	6.4	6.4	6.8	6.8	5.0	6.0	6.2
Turbidity	10	0	20	10	27	20	40	39	24	21
Chloride	-	-	-	-	-	-	-	35	33	-
Salinity	14.19	19.18	21.20	19.97	7.98	9.58	4.57	-	-	13.81
Hardness										
Calcium	-	-	-	-	-	-	100	70	65	78
Magnesium	-	-	-	-	-	-	75	10	40	42
TOTAL	-	-	-	-	-	-	175	80	105	120
Sulfate	>300	>300	>300	>300	>300	>300	51	12	7	>300
Chromate	0	0.055	0	0	0	0	0	0	0	0.006
Silica	4.80	2.84	4.50	2.90	4.50	8.00	6.00	6.00	3.60	4.79
Boron	-	2.2	2.4	1.4	1.4	2.6	0	0.8	0	1.4
Copper	0.15	0.12	0.10	0.08	0	0.05	0.05	0.01	0.04	0.07
Manganese	0	0.24	0	-	0	0	0	0	0	0.03
Nitrite	<0.01	0.005	0	0.005	0	0.004	0	0	0.003	0.003
Nitrate	1.0	0.6	0.8	0.4	0	0.8	1.6	4.6	1.2	1.2
Phosphate										
Inorganic	0.35	0.35	0.30	0.15	0.20	0.55	0.25	0.20	0.10	0.27
Organic	0	0.15	0.20	0.08	0	0.25	0.20	0.50	0.40	0.20
TOTAL	0.35	0.60	0.50	0.23	0.20	0.80	0.45	0.70	0.50	0.47
Iron										
Soluble	5	20	19	6	74	49	174	132	73	61
Particulate	99	73	67	85	156	191	315	244	145	153
TOTAL	104	93	86	91	230	240	489	376	218	214
Tannins	<2.5	<2.5	<2.5	<2.5	<2.5	<2.5	<2.5	<2.5	<2.5	<2.5
Carbohydrate	3.50	1.68	0.40	1.40	0.35	2.41	1.00	1.50	1.70	1.55
Organic nitrogen	-	-	-	-	-	-	-	-	-	-

Organic nitrogen in µg at-N/liter; iron reported in µg Fe/liter; carbohydrate in mg/liter; turbidity in Jackson Turbidity Units; all other results in ppm.

Table 21. Station No. 24: Myakka River—at Myakka River State Park

Date	4/21/65	5/ 5/65	5/12/65	5/26/65	6/30/65	8/ 6/65	8/12/65	8/19/65	10/22/65	3/28/66	Mean
Sample	23	42	43	59	103	153	154	185	204	230	
Water temperature °C	28.0	-	31.5	33.0	31.0	28.9	29.5	29.0	26.0	25.0	26.2
*p*H	4.5	4.3	5.0	4.8	4.5	4.5	4.5	5.0	4.5	4.3	4.6
Turbidity	59	40	40	40	90	80	85	50	65	75	62
Chloride	27.5	32.5	25.0	51.5	13.8	17.5	12.5	10.0	18.0	20.0	22.8
Salinity	-	-	-	-	-	-	-	-	-	-	-
Hardness											
Calcium	20	30	30	20	50	18	20	10	15	30	24
Magnesium	25	20	30	50	0	5	5	60	15	20	23
TOTAL	45	50	60	70	50	23	25	70	30	50	47
Sulfate	25	25	30	25	25	35	17	12	16	24	23
Chromate	0	0	0	0	0	0	0	0	0	0	0
Silica	0.75	0.28	0.40	0.62	2.50	1.45	1.80	1.10	4.00	0.50	1.34
Boron	0.4	0.4	0.8	0.2	2.1	0	0.2	0.4	0.1	1.2	0.6
Copper	0.005	0.050	0	0.040	0.002	0	0	0.15	0.06	0.05	0.042
Manganese	0	0	0	0	0	0	0	0	0	0	0
Nitrite	0	0	0	0	0	0	0	0	0.005	0	0
Nitrate	1.0	1.8	1.3	1.0	3.4	3.0	2.4	2.4	2.1	1.0	1.9
Phosphate											
Inorganic	1.5	1.1	1.1	0.16	1.9	1.2	1.25	0.90	1.0	0.78	1.09
Organic	0.2	-	0.1	0.49	1.6	0.3	0.10	0.20	0.1	0.12	0.03
TOTAL	1.7	-	1.2	0.65	3.5	1.5	1.35	1.10	1.1	0.90	1.12
Iron											
Soluble	490	288	170	212	520	412	498	416	318	271	360
Particulate	500	490	655	440	122	154	184	251	191	173	316
TOTAL	990	778	825	652	642	566	682	667	509	444	676
Tannins	<2.5	<2.5	<2.5	<2.5	<10.0	<5.0	<5.0	<5.0	2.5	<5.0	<5.0
Carbohydrate	1.70	1.65	1.20	1.40	1.00	0.40	1.50	1.90	1.30	0.60	1.27
Organic nitrogen	-	-	-	-	-	-	-	-	-	39.20	-

Organic nitrogen in μg at-N/liter; iron reported in μg Fe/liter; carbohydrate in mg/liter; turbidity in Jackson Turbidity Units; all other results in ppm.

Table 22. Station No. 25: Horse Creek—SR 72 West of Arcadia.

Date	4/21/65	5/ 5/65	6/30/65	8/ 6/65	8/19/65	9/21/65	10/22/65	Mean
Sample	22	41	102	152	184	186	203	
Water temperature °C	29.0	-	29.0	28.5	29.0	27.0	25.0	27.9
*p*H	5.5	6.0	4.5	4.5	5.0	6.2	5.0	5.2
Turbidity	29	10	100	95	88	42	72	62
Chloride	25.0	27.0	15.0	22.5	15.0	17.5	14.0	19.4
Salinity	-	-	-	-	-	-	-	-
Hardness								
Calcium	90	80	30	20	30	100	28	54
Magnesium	50	140	15	10	20	10	7	36
TOTAL	140	220	45	30	50	110	35	90
Sulfate	23	23	30	25	14	18	15	21
Chromate	0	0	0	0	0	0	0	0
Silica	2.65	2.25	2.00	3.00	1.80	9.00	3.90	3.51
Boron	0.4	0.3	2.2	0.1	0.8	0	0	0.5
Copper	0.002	0.05	0	0	0.08	0.02	0.11	0.04
Manganese	0	0	0	0	0	0	0	0
Nitrite	0	0	0	0	0	0	0	0
Nitrate	0.6	0.7	3.3	3.4	1.8	1.8	2.4	2.0
Phosphate								
Inorganic	2.40	2.00	2.50	1.90	1.10	1.15	1.30	1.76
Organic	0	0	-	0.40	0.30	0.20	0.10	0.17
TOTAL	2.40	2.00	-	2.30	1.40	1.35	1.40	1.93
Iron								
Soluble	164	48	626	521	420	161	332	325
Particulate	128	110	107	267	291	164	249	188
TOTAL	292	158	733	788	711	325	581	513
Tannins	<2.5	<2.5	<10.0	<10.0	< 10.0	< 5.0	2.5	5.0
Carbohydrate	2.60	1.00	1.70	1.30	1.60	1.20	1.50	1.56
Organic nitrogen	-	-	-	-	-	-	-	-

Organic nitrogen in μg at-N/liter; iron reported in μg Fe/liter;

carbohydrate in mg/liter; turbidity in Jackson Turbidity Units; all other results in ppm.

Table 23. Station No. 26: Braden River—Highway 64 Near Bradenton.

Date	4/21/65	5/ 5/65	6/ 2/65	6/30/65	8/ 5/65	8/19/65	Mean
Sample	14	32	60	90	142	173	
Water temperature °C	26.0	24.5	27.5	29.0	29.0	30.0	27.7
*p*H	5.0	5.0	5.5	5.5	5.0	5.0	5.2
Turbidity	10	10	15	30	75	49	31
Chloride	-	-	-	-	245	-	-
Salinity	22.95	24.14	28.02	21.04	-	4.79	-
Hardness							
Calcium	-	-	-	-	50	-	-
Magnesium	-	-	-	-	63	-	-
TOTAL	-	-	-	-	113	-	-
Sulfate	> 300	> 300	> 300	> 300	130	> 300	> 300
Chromate	0	0	0	0	0	0	0
Silica	1.9	0.79	2.2	2.1	4.8	5.0	2.8
Boron	2.6	3.3	3.9	1.7	0	1.5	2.2
Copper	0.13	0.08	0.02	0.05	0	0.05	0.06
Manganese	0	0	0	0	0	0	0
Nitrite	0.005	0.006	0.025	0.008	0.028	0.012	0.014
Nitrate	0.1	0.4	0.2	0.4	2.9	0.5	0.8
Phosphate							
Inorganic	1.95	1.95	1.40	2.00	2.30	1.70	1.88
Organic	0.05	0.05	0.60	0.15	0.40	0.30	0.26
TOTAL	2.00	2.00	2.00	2.15	2.70	2.00	2.14
Iron							
Soluble	24	18	12	36	326	126	90
Particulate	73	87	93	117	249	143	127
TOTAL	97	105	105	153	575	269	217
Tannins	<2.5	<2.5	< 2.5	<2.5	<5.0	<2.5	<2.5
Carbohydrate	2.70	14.00	2.70	1.20	1.00	2.70	4.05
Organic nitrogen	-	-	-	-	-	-	-

Organic nitrogen in μg at-N/liter; iron reported in μg Fe/liter;

carbohydrate in mg/liter; turbidity in Jackson Turbidity Units; all other results in ppm.

Table 24. Station No. 27: Joshua Creek—US 27 near Nocatee.

Date	4/21/65	5/ 5/65	6/ 2/65	6/30/65	8/ 6/65	8/19/65	Mean
Sample	20	39	67	100	150	182	
Water temperature °C	28.5	-	26.0	31.0	28.0	30.0	28.7
pH	6.4	6.4	6.4	5.5	5.0	5.0	5.8
Turbidity	10	10	5	45	85	70	38
Chloride	47.5	51.0	57.5	33.8	30.0	25.5	40.9
Salinity	-	-	-	-	-	-	-
Hardness							
Calcium	140	110	150	80	30	40	92
Magnesium	42	80	60	60	25	45	52
TOTAL	182	190	210	140	55	85	144
Sulfate	53	54	60	80	42	27	53
Chromate	0	0	0	0	0	0	0
Silica	2.5	2.75	1.0	6.0	4.0	4.8	3.5
Boron	0.4	0.2	0	0.4	0	0.9	0.3
Copper	0.009	0.070	0.040	0.001	0	0.040	0.026
Manganese	0	0	0	0	0	0	0
Nitrite	0.004	0	0.001	0.003	0	0.005	0.002
Nitrate	0.1	1.0	0.45	2.5	3.2	1.7	1.5
Phosphate							
Inorganic	2.1	2.4	2.0	1.19	1.70	1.70	1.9
Organic	0.4	0.2	0.7	0.76	0.20	0.10	0.4
TOTAL	2.5	2.6	2.7	1.95	1.90	1.80	-
Iron							
Soluble	20	74	10	260	456	384	207
Particulate	70	159	62	145	599	608	274
TOTAL	90	233	72	405	1055	992	481
Tannins	<2.5	<2.5	<2.5	<2.5	< 2.5	<2.5	<2.5
Carbohydrate	1.30	2.72	2.70	3.90	0.70	1.80	2.19
Organic nitrogen	-	-	-	-	-	-	-

Organic nitrogen in μg at-N/liter; iron reported in μg Fe/liter;

carbohydrate in mg/liter; turbidity in Jackson Turbidity Units; all other results in ppm.

Table 25. Station No. 28: Imperial River—at Bonita Springs.

Date	4/28/65	5/19/65	6/ 8/65	6/30/65	7/29/65	8/19/65	Mean
Sample	30	54	77	111	140	169	
Water temperature °C	29.0	29.0	-	29.0	26.5	30.0	28.7
*p*H	6.8	6.4	6.8	6.4	6.2	5.0	6.3
Turbidity	25	25	15	25	40	40	28
Chloride	-	1080	-	60	22.7	17.5	295
Salinity	1.5	-	2.84	-	-	-	-
Hardness							
Calcium	285	100	-	230	63	55	147
Magnesium	15	270	-	20	12	5	64
TOTAL	300	370	-	250	75	60	211
Sulfate	135	140	300	18	13	6	102
Chromate	0	0	0	0	0	0	0
Silica	8.72	8.50	8.90	8.50	5.00	5.00	7.44
Boron	0.2	0	0.1	1.6	0	0.8	0.5
Copper	0.006	0.050	0.040	0.090	0.040	0.030	0.043
Manganese	0	0	0	0	0	0	0
Nitrite	0	0	0.005	0.002	0	0	0.001
Nitrate	0.5	1.2	1.2	1.2	1.6	0.9	1.1
Phosphate							
Inorganic	0.25	0.19	0.18	0.30	0.25	0.30	0.25
Organic	0.25	0.11	0.17	0.40	0.45	0.15	0.26
TOTAL	0.50	0.30	0.35	0.70	0.70	0.45	0.51
Iron							
Soluble	38	33	41	222	208	152	116
Particulate	700	580	540	532	370	200	487
TOTAL	738	613	581	754	578	352	603
Tannins	<2.5	<2.5	<2.5	<2.5	<2.5	<2.5	<2.5
Carbohydrate	1.68	1.05	2.70	0.30	1.05	0.60	1.23
Organic nitrogen	-	-	-	-	-	-	-

Organic nitrogen in μg at-N/liter; iron reported in μg Fe/liter;

carbohydrate in mg/liter; turbidity in Jackson Turbidity Units; all other results in ppm.

Table 26. Station No. 29: Estero River—East of Estero.

Date	4/28/65	5/19/65	6/ 8/65	6/30/65	7/29/65	8/19/65	Mean
Sample	29	53	76	110	139	168	
Water temperature °C	35.5	33.0	28.0	32.0	27.5	38.0	32.3
*p*H	6.6	6.8	6.8	6.8	6.0	5.0	6.3
Turbidity	49	60	95	30	25	21	47
Chloride	85.0	112.5	65.0	50.0	10.0	20.0	57.1
Salinity	-	-	-	-	-	-	-
Hardness							
Calcium	58	90	110	148	30	40	79
Magnesium	32	50	35	12	10	20	27
TOTAL	90	140	45	160	40	60	106
Sulfate	11	32	20	10	8	5	14
Chromate	0	0	0	0	0	0	0
Silica	1.03	6.8	9.0	6.9	2.1	4.2	5.0
Boron	0.2	0	0	2.6	0	0.9	0.6
Copper	0.004	0.010	0	0.050	0.090	0.070	0.037
Manganese	0	0	0	0	0	0	0
Nitrite	0	0	0	0.001	0	0	0
Nitrate	1.4	2.7	2.2	1.4	1.1	0.3	1.5
Phosphate							
Inorganic	0.35	0.20	0.50	0.25	0.18	0.25	0.29
Organic	0.25	0.30	0.30	1.10	0.26	0.15	0.39
TOTAL	0.60	0.50	0.80	1.35	0.44	0.40	0.68
Iron							
Soluble	115	73	26	220	112	65	102
Particulate	1048	504	1660	369	122	172	646
TOTAL	1163	577	1686	589	234	237	748
Tannins	<2.5	<2.5	<2.5	<2.5	<2.5	<2.5	<2.5
Carbohydrate	5.65	7.20	10.65	1.50	0.70	0.60	4.38
Organic nitrogen	-	-	-	-	-	-	-

Organic nitrogen in µg at-N/liter; iron reported in µg Fe/liter;

carbohydrate in mg/liter; turbidity in Jackson Turbidity Units; all other results in ppm.

Table 27. Station No. 30: Hillsborough River—SR 582 near Temple Terrace.

Date	7/ 7/65	7/26/65	8/18/65	Mean
Sample	115	125	155	
Water temperature °C	27.0	26.0	28.0	27.0
*p*H	5.5	6.0	5.0	5.5
Turbidity	40	48	65	51
Chloride	22.5	10.5	1.5	11.5
Salinity	-	-	-	-
Hardness				
Calcium	75	20	50	48
Magnesium	35	60	20	38
TOTAL	110	80	70	86
Sulfate	22	10	13	15
Chromate	0	0	0	0
Silica	5.0	4.2	2.0	3.7
Boron	0.05	0	0	0.01
Copper	0	0.02	0	0.008
Manganese	0	0	0	0
Nitrite	0	0	0	0
Nitrate	1.4	2.6	2.2	2.1
Phosphate				
Inorganic	0.80	0.85	1.45	1.03
Organic	0.15	0.10	0.25	0.16
TOTAL	0.95	0.95	1.70	1.19
Iron				
Soluble	188	222	325	245
Particulate	83	148	230	154
TOTAL	271	370	555	399
Tannins	<2.5	2.5	<10.0	<5.0
Carbohydrate	0.70	0.50	1.00	0.73
Organic nitrogen	-	-	-	-

Organic nitrogen in µg at-N/liter; iron reported in µg Fe/liter;
carbohydrate in mg/liter; turbidity in Jackson Turbidity Units; all other results in ppm.

Table 28. Station No. 31: Hillsborough River—Hillsborough River State Park.

Date	7/ 7/65	7/26/65	8/18/65	9/21/65	Mean
Sample	120	130	160	187	
Water temperature °C	27.0	26.0	27.0	26.0	26.5
*p*H	5.5	5.2	5.0	6.4	5.5
Turbidity	23	42	85	32	46
Chloride	20.0	12.5	2.3	20.0	13.7
Salinity	-	-	-	-	-
Hardness					
Calcium	120	86	40	120	92
Magnesium	10	35	50	10	26
TOTAL	130	121	90	130	118
Sulfate	12	12	13	15	13
Chromate	0	0	0	0	0
Silica	12.0	10.4	3.5	13.0	9.7
Boron	0	0.3	0	0	0.07
Copper	0.01	0.01	0	0.02	0.01
Manganese	0	0	0	0	0
Nitrite	0.001	0	0	0	0
Nitrate	0.9	2.1	2.7	1.4	1.8
Phosphate					
Inorganic	1.40	1.50	1.80	1.90	1.65
Organic	0.45	0.25	0.10	0.20	0.25
TOTAL	1.85	1.75	1.90	2.10	1.90
Iron					
Soluble	158	226	348	92	206
Particulate	88	112	213	131	136
TOTAL	246	338	561	223	342
Tannins	<2.5	2.5	<10.0	<2.5	<5.0
Carbohydrate	0.60	0.50	1.00	1.40	0.88
Organic nitrogen	-	-	-	-	-

Organic nitrogen in μg at-N/liter; iron reported in μg Fe/liter;

carbohydrate in mg/liter; turbidity in Jackson Turbidity Units; all other results in ppm.

Table 29. Station No. 32: Alafia River—US 301 at Riverview

Date	7/ 7/65	7/26/65	8/18/65	9/21/65	10/22/65	11/30/65	12/28/65	1/26/66	2/23/66	3/25/66	4/27/66	5/25/66	6/28/66	Mean
Sample	116	126	156	188	198	205	210	215	220	225	231	236	241	
Water temperature °C	29.0	29.5	29.0	28.0	24.5	18.5	17.0	15.0	20.0	23.0	24.0	26.0	27.0	23.9
*p*H	5.0	5.0	5.0	5.0	6.0	5.0	5.0	4.8	5.0	4.0	5.0	6.0	4.5	5.0
Turbidity	25	39	63	30	30	28	15	30	28	49	17	15	30	31
Chloride	375.0	43	5.0	-	320	770	525	57	70	91	-	775	215	-
Salinity	-	-	-	2.19	-	-	-	-	-	-	4.02	-	-	-
Hardness														
Calcium	380	60	130	-	152	330	250	109	140	130	-	295	230	201
Magnesium	0	60	10	-	116	500	170	41	75	100	-	255	10	122
TOTAL	380	120	140	-	268	830	423	150	215	230	-	550	240	323
Sulfate	170	72	140	300	170	>300	280	140	160	230	>300	>300	175	211
Chromate	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Silica	30.0	10.4	1.5	26.0	19.0	14.5	14.0	29.0	22.0	25.0	27.0	27.0	22.0	20.6
Boron	0.35	0.10	0	0	0.20	0.50	0	0.30	0.70	1.80	0.80	0.80	0.50	0.47
Copper	0.07	0.07	0.10	0.08	0.12	0.06	0.02	0.02	0.22	0.28	0.27	0.20	0.12	0.13
Manganese	0.3	0	0	0	0	0	0.40	0	0	0	0.30	0	0	0.07
Nitrite	>0.20	0.004	0	0.009	0.004	0.057	0.020	0.028	0.16	0.316	0.188	0.102	0.010	0.084
Nitrate	2.0	1.5	1.8	2.0	2.0	2.5	2.0	2.3	0.7	1.2	1.8	6.4	5.5	2.4
Phosphate														
Inorganic	12.4	14.0	9.0	15.50	18.0	17.0	16.0	14.5	16.0	13.0	19.0	18.0	22.0	15.7
Organic	17.6	10.0	16.0	0.25	0	1.5	7.0	13.0	19.0	8.0	4.0	2.0	3.5	7.8
TOTAL	30.0	24.0	25.0	15.75	18.0	18.5	23.0	27.5	35.0	21.0	23.0	20.0	25.5	23.5
Iron														
Soluble	22	105	242	42	36	103	19	27	23	17	20	15	47	55
Particulate	93	238	863	184	191	104	106	198	204	164	74	55	263	211
TOTAL	115	343	1105	226	227	207	125	225	227	181	94	70	310	266
Tannins	<2.5	<2.5	2.5	2.5	<2.5	< 2.5	<2.5	<2.5	<2.5	<2.5	<2.5	<2.5	2.5	<2.5
Carbohydrate	1.30	1.00	0.90	2.10	1.80	1.95	1.62	1.20	1.62	6.00	4.70	0.85	0.60	1.97
Organic nitrogen	-	-	-	-	52.90	8.68	11.69	10.25	26.40	34.80	34.00	16.76	21.56	24.11

Organic nitrogen in μg at-N/liter; iron reported in μg Fe/liter; carbohydrate in mg/liter; turbidity in Jackson Turbidity Units; all other results in ppm.

Table 30. Station No. 33: Alafia River—SR 39 near Lithia.

Date	7/ 7/65	7/26/65	8/18/65	9/21/65	Mean
Sample	119	129	159	191	
Water temperature °C	28.0	29.0	29.0	28.5	28.6
*p*H	4.5	5.0	4.0	4.5	4.5
Turbidity	30	42	55	32	40
Chloride	70	27.5	37.5	55.0	47.5
Salinity	-	-	-	-	-
Hardness					
Calcium	210	90	126	80	127
Magnesium	90	56	14	130	73
TOTAL	300	146	140	210	200
Sulfate	230	100	148	175	163
Chromate	0	0	0	0	0
Silica	38.0	8.0	2.8	11.5	15.1
Boron	0	0.2	0	0	0.05
Copper	0.20	0.08	0.16	0.08	0.13
Manganese	0.6	0	0	0	0.15
Nitrite	0.002	0.013	0	0.020	0.009
Nitrate	1.8	2.0	2.0	2.9	2.2
Phosphate					
Inorganic	20.0	13.5	13.0	15.0	15.4
Organic	15.0	16.5	11.0	10.0	13.1
TOTAL	35.0	30.0	24.0	25.0	28.5
Iron					
Soluble	142	196	456	70	216
Particulate	207	146	863	286	376
TOTAL	349	342	1319	356	592
Tannins	<2.5	<2.5	-	2.5	<2.5
Carbohydrate	1.00	0.90	1.30	1.90	1.28
Organic nitrogen	-	-	-	-	-

Organic nitrogen in µg at-N/liter; iron reported in µg Fe/liter;
carbohydrate in mg/liter; turbidity in Jackson Turbidity Units; all other results in ppm.

Organic nitrogen in µg at-N/liter; iron reported in µg Fe/liter; carbohydrate in mg/liter; turbidity in Jackson Turbidity Units; all other results in ppm.

Table 31. Station No. 34: Manatee River—US 301 South of Riverview.

Date	7/ 7/65	7/26/65	8/18/65	9/21/65	Mean
Sample	117	127	157	189	
Water temperature °C	25.5	28.0	29.0	27.5	27.5
*p*H	4.5	4.5	4.5	4.5	4.5
Turbidity	56	75	59	50	60
Chloride	25.0	9.3	1.5	20.0	13.9
Salinity	-	-	-	-	-
Hardness					
Calcium	20	10	30	15	19
Magnesium	5	10	0	7	6
TOTAL	25	20	30	22	25
Sulfate	12	2	12	12	10
Chromate	0	0	0	0	0
Silica	0.55	2.00	2.45	4.40	2.35
Boron	0.10	0.20	0	0	0.07
Copper	0.02	0.06	0.02	0.05	0.03
Manganese	0	0	0	0	0
Nitrite	0	0	0	0	0
Nitrate	0.9	2.3	2.2	2.0	1.9
Phosphate					
Inorganic	1.20	2.00	2.18	1.80	1.80
Organic	0	0.30	0	0.25	0.14
TOTAL	1.20	2.30	2.18	2.05	1.93
Iron					
Soluble	378	496	364	252	373
Particulate	124	126	243	169	167
TOTAL	502	622	607	421	540
Tannins	<2.5	5.0	<5.0	<5.0	<5.0
Carbohydrate	1.20	0.30	0.70	3.00	1.30
Organic nitrogen	-	-	-	-	-

Organic nitrogen in µg at-N/liter; iron reported in µg Fe/liter;

carbohydrate in mg/liter; turbidity in Jackson Turbidity Units; all other results in ppm.

Table 32. Station No. 35: Little Manatee River—SR 39—Fort Lonesome

Date	7/ 7/65	7/26/65	8/18/65	9/21/65	Mean
Sample	118	128	158	190	
Water temperature °C	28.0	27.5	29.0	27.5	28.0
*p*H	4.5	5.0	4.5	4.5	4.6
Turbidity	69	85	75	55	71
Chloride	27.5	8.0	1.5	20.0	14.3
Salinity	0	0	0	0	0
Hardness					
Calcium	20	15	20	15	18
Magnesium	5	10	20	7	10
TOTAL	25	25	40	22	28
Sulfate	12	0	15	14	10
Chromate	0	0	0	0	0
Silica	2.65	1.95	1.18	2.10	1.97
Boron	0.10	0.30	0	0	0.10
Copper	0.10	0.03	0.05	0.08	0.7
Manganese	0	0	0	0	0
Nitrite	0	0	0	0	0
Nitrate	1.9	2.7	2.3	1.8	2.2
Phosphate					
Inorganic	3.0	3.1	2.5	2.2	2.7
Organic	0.3	0	0.3	0.4	0.3
TOTAL	3.3	3.1	2.8	2.6	3.0
Iron					
Soluble	653	576	588	310	532
Particulate	409	124	478	411	356
TOTAL	1062	700	1066	721	888
Tannins	<10.0	<10.0	<5.0	<5.0	<10.0
Carbohydrate	1.05	0.60	0.60	1.15	0.85
Organic nitrogen	-	-	-	-	-

Organic nitrogen in μg at-N/liter; iron reported in μg Fe/liter;

carbohydrate in mg/liter; turbidity in Jackson Turbidity Units; all other results in ppm.

AMINO ACIDS AND ORGANIC NITROGEN CONTENT IN FLORIDA GULF COAST WATERS AND IN ARTIFICIAL CULTURES OF MARINE ALGAE

PATRICIA V. DONNELLY, M. A. BURKLEW, AND ROSE A. OVERSTREET

INTRODUCTION

Nitrogen is a primary limiting factor in the sea for the production of plankton populations (Cooper, 1933; Harvey, 1966). The availability and concentration of the numerous organic and inorganic nitrogenous substances determine the fertility of water masses. The majority of the organic nitrogenous compounds are breakdown products of marine bacterial enzymatic processes on plant and animal proteinaceous materials (Waksman and Carey, 1935). The complete decomposition of these materials results in the formation of ammonia, nitrate, and nitrite. Phytoplankton utilize inorganic sources of nitrogen but certain of these microorganisms can use simple organic nitrogen substances (Nishizawa and Riley, 1962; Parsons and Strickland, 1962; Baylor and Sutcliffe, 1963; and Wilson, 1965).

Amino acids, amino-nitrogen, are of special interest as constituents in sea water because of: 1) their nutritional enhancement to organisms (Lucas, 1947; Saunders, 1957; Provasoli, 1963; and Wilson, 1965; 2) their role in CO_2 transfer, utilization, and deposition (Neuberg *et al.*, 1957; and Smith *et al.*, 1960); and 3) their further possible chemical activity in chelation of ions (Lucas, 1947; Neuberg and Mandl, 1948; Saunders, 1957; and Hood, 1963). The more subtle biological effects of chelation by amino acids should not be underestimated in the complex interactions between an organism and its environment. Chelation not only maintains trace metals in available forms, but may also render more favorable the ratios of the major ions. Because of these apparent importances, characterization of the amino acids in sea water is being made (Jeffrey and Hood, 1958; Park *et al.*, 1962, 1963; Tatsumoto *et al.*, 1961; Palmork, 1963; and Siegel and Degens, 1966).

This study was undertaken to obtain more precise descriptions of the qualitative and quantitative distribution of amino acids and organic nitrogen levels in the eastern Gulf of Mexico. These data are prerequisite for an extensive interpretation of the relationship of organic chemical, environmental factors to the phenomena of Red Tide. Also, since the aquatic communities determine the nitrogenous material present, a study of individuals comprising these communities should enhance our evaluations. Therefore, similar analyses were made of marine algal cultures grown in artificial culture media.

MATERIALS AND METHODS

AMINO ACIDS

Twenty gallons of surface water were collected from each station. Approximately 0.1 g of mercuric chloride, a metabolic inhibitor, was added to each 5 gallons of water. The water was then filtered, usually within four hours after collection, through Millipore filters (2 microfiber glass prefilters, one 0.45 µ and one 0.22 µ membrane filter) using a positive pressure of 20 psi. To each 5 gallon filtrate was added 50-60 ml of 2M ferric chloride and 100 ml of 4N sodium hydroxide. The precipitate was allowed to settle and the water decanted. The ion exchange chromatographic procedure of Tatsumoto *et al.* (1961) was used for the desalting of the dissolved hydrolyzed precipitates. The eluate amino acids were separated by two-dimensional chromotography. The solvents used were phenol:water (80:20) and butanol:acetic acid:water (240:60:250). The resolved amino acids were identified by ninhydrine reaction. Except for a reduction in the sample volume the artificial culture media were analyzed in a similar manner.

ORGANIC NITROGEN

A modified procedure of Strickland and Parsons analysis (1965) was used for the determination of organic nitrogen in sea water. Water samples were collected in clean 500 ml polyethylene bottles with snug-fitting caps and were chilled. Filtration of the sample through a 0.45 µ Millipore filter was usually carried out immediately or within a few hours. The samples were then frozen.

Analysis was performed in an isolated room free from ammonia contamination. Reagents, blanks, and controls were prepared with freshly deionized water. All glassware was rinsed thoroughly in deionized water immediately before use. Samples were thawed and brought to room temperature before hydrolysis.

A Kjeldahl digestion procedure was employed to convert organic nitrogen to the ammonium ion. Duplicate 50 ml sample aliquots were digested. Each resultant residue was should be expected that a definitive study would reveal most, if not all, of the known amino acids in water samples. Tatsumoto (1961) believes that there is a real variation in amino acid composition of sea water. We have found a wide diversity in amino acid composition in our samples but we believe that these variations are more quantitative than qualitative. The amino acids are present but are too low in concentration for us to detect them.

REFERENCES

ABELSON, P. H.
1955. Annual report of the Director of the Geophysical Laboratory, 1954-1955. *Carneg. Inst. Yearbk., 54*: 107-109.

BADER, R. G., D. W. HOOD, and J. B. SMITH
1960. Recovery of dissolved organic matter in sea water and organic sorption by particulate material. *Geochim. et Cosmoch. Acta, 19*: 236-243.

BAYLOR, E. R. and W. H. SUTCLIFFE, JR.
1963. Dissolved organic matter in sea water as a source of particulate food. *Limnol. Oceanog., 8*(4): 369-371.

COOPER, L. H. N.
1933. Chemical constituents of biological importance in the English Channel. Pt. I. Phosphate, silicate, nitrate, nitrite, ammonia. *J. Mar. Biol. Ass. U. K., 18*: 677.

ERDMAN, J. G., E. M. MARLETT, and W. E. HANSON
1956. Survival of amino acids in marine sediments. *Science, 124*: 1026.

ERICKSON, S. J.
1964. The isolation and characteristics of a Chlorella-like green alga from the west coast of Florida. *Fla. Bd. Conserv. Mar. Lab.* Leaf. Ser., *1*(5): 1-2.

FOGG, G. E.
1952. The production of extracellular nitrogenous substances by a blue-green alga. *Proc. Roy. Soc., B139*: 372-397.

FOWDEN, L.
1951. Amino acids of certain algae. *Nature, 167*: 1030-1031.

HARVEY, H. W.
1966. The Chemistry and Fertility of Sea Waters. Cambridge University Press, 240 pp.

HOOD, D. W.
1963. Chemical oceanography. *Oceanogr. Mar. Biol. Ann. Rev., 1*: 129-155.

JEFFREY, L. M. and D. W. HOOD
1958. Organic matter in sea water; and evaluation of various methods for isolation. *J. Mar. Res., 17*: 247-271.

LEWIS, G. J. and N. RAKESTRAW
1955. Carbohydrates in sea water. *J. Mar. Res., 14*: 253-258.

LUCAS, C. E.
1947. The ecological effects of external metabolites. *Biol. Rev., 22*: 270.

NEUBERG, C. and I. MANDL
1948. An unknown effect of amino acids. *Arch. Biochem., 19*: 149-161.

NEUBERG, C., A. GRAUER, M. KREIDAL, and H. LOWY
1957. The role of the carbonate reaction in the calcium and phosphorus cycles in nature. *Arch. Biochem. Biophys., 70*: 70-79.

NISHIZAWA, S. and G. A. RILEY
1962. Research in particulate materials suspended in sea water. p. 150-152. *In* D. S. Gorsline, (ed.), Proceedings of the First National Coastal and Shallow Water Research Conference. National Science Foundation, Office of Naval Research, Tallahassee, Fla.

PALMORK, K. H.
1963. The use of 2,4-dinitro-1-fluorobenzene in the separation and identification of amino acids from sea water. *Acta Chem. Scand., 17*: 1456-1457.

PARK, K., W. T. WILLIAMS, J. M. PRESCOTT, and D. W. HOOD
1962. Amino acids in deep-sea water. *Science, 138*: 531-532.

PARK, K., W. T. WILLIAMS, J. M. PRESCOTT, and D. W. HOOD
1963. Amino acids in Redfish Bay, Texas. *Publ. Inst. Mar. Sci.*, Univ. Tex., *9*: 59-63.

PARSONS, T. R. and J. D. H. STRICKLAND
1962. Oceanic detritus. *Science, 136*: 313-314.

PROVASOLI, L.
1963. Organic regulation of phytoplankton fertility, p. 165-219. *In* M. H. Hill, (ed.), The Sea. Interscience Publ., New York.

SAUNDERS, G. W.
1957. Interrelations of dissolved organic matter and phytoplankton. *Bot. Rev., 23*: 389-409.

SIEGEL, A. and E. T. DEGENS
1966. Concentration of dissolved amino acids from saline waters by ligand-exchange chromatography. *Science, 151*(3713): 1098-1101.

SMITH, T. B., M. TATSUMOTO, and D. W. HOOD
1960. Carbamino carboxylic acid in photosynthesis. *Limnol. Oceanog., 5*(4): 425-431.

STRICKLAND, J. D. H. and T. R. PARSONS
1965. A manual of sea water analysis. *Fish. Res. Bd. Canada*, Bull. No. 125.

TATSUMOTO, M., W. T. WILLIAMS, J. M. PRESCOTT, and D. W. HOOD
1961. Amino acids in samples of surface sea water. *J. Mar. Res., 19*: 89-96.

VALLENTYNE, J. R.
1957. The molecular nature of organic matter in lakes and oceans, with lesser

reference to sewage and terrestrial soils. *J. Fish. Res. Bd. Canada, 14*: 33-82.

WAKSMAN, S. A. and C. L. CAREY
1935. Decomposition of organic matter in sea water by bacteria. *J. Bact., 29*: 531.

WATANABE, A.
1951. Production in cultural solution of some amino acids by atmospheric-nitrogen-fixing blue-green algae. *Arch. Biochem. Biophys., 34*: 50-55.

WILSON, W. B.
1965. The suitability of sea water for the survival and growth of *Gymnodinium breve* Davis; and some effects of phosphorus and nitrogen on its growth. *Fla. Bd. Conserv.*, Prof. Pap. Ser. No. 7: 1-42.

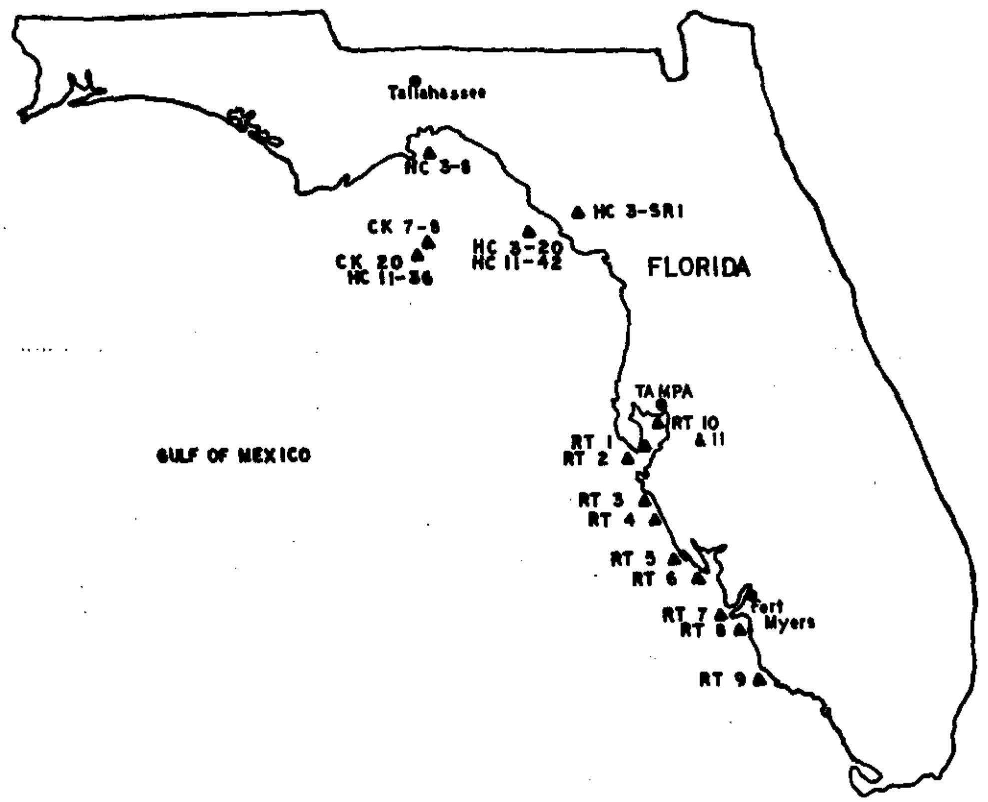


FIGURE I. AMINO ACID AND ORGANIC NITROGEN SAMPLING STATIONS.

Table 1. Hydrological and Chemical Data from CK and HC Amino Acids Stations

	Location Long.	Location Lat.	Date	Temperature °C	Salinity ‰
CK7-8	84° 10′W	29° 10′N	7/31/64	32.0	33.6
CK-20	84° 18′W	29° 04′N	8/ 5/64	27.6	33.4
HC3-6	84° 09′W	29° 56′N	11/ 6/64	20.5	32.2
HC3-20	83° 30′W	29° 15′N	11/10/64	21.2	32.6
HC3-SR1	Suwannee River		11/10/64	19.5	*
HC11-36	84° 19′W	29° 04′N	2/ 6/65	16.8	34.5
HC11-42	83° 30′W	29° 15′N	2/ 7/65	14.5	31.7

*Fresh water sample.

Table 2. Amino Acids Demonstrated in Samples from CK and HC Stations.

Stations	CK7-8	CK-20	HC3-8	HC3-20	HC3-SR1	HC11-36	HC11-42
Date	7/31/64	8/ 8/64	11/ 6/64	11/10/64	11/10/64	2/ 6/65	2/ 7/65
Alanine	+	±	+	±	+	±	±
Arginine	-	±	-	+	+	±	-
Aspartic Acid	+++	+	+++	+	+++	++	++
Cysteine	-	-	-	-	-	-	-
Cystine	-	-	-	-	±	-	±
Glutamic Acid	+++	+	+	++	++	++	+++
Glycine	±	+	-	±	+	±	+
Histidine	-	-	-	-	-	-	-
Isoleucine	±	++	++	+	+	-	-
Leucine	+	++	++	+	+	+	+
Lysine	±	±	-	±	±	±	-
Methionine	-	-	±	-	-	-	-
Phenylalanine	+	±	-	-	±	+	+
Proline	-	-	-	±	-	-	-
Serine	±	+	-	++	±	-	-
Threonine	-	-	-	+	-	-	-
Tyrosine	-	-	-	-	-	-	-
Valine	-	-	±	-	-	-	±
Other	-	+++*	-	-	-	-	-
Organic nitrogen	870	22	30	102	76	91	42
Carbohydrate	5.2	0.98	0.30	0.38	0.23	0.61	0.86
G. breve count	Bloom	<50,000	0	NS	0	0	0

* One unidentified amino acid—Rf (phenol): 90; Rf (butanol): 70.
- : not detected; ±: trace; + to +++ : gradation of ninhydrin intensity.
Organic nitrogen in µg-at N/liter. Carbohydrate reported in mg/liter.
NS: no sample.

Table 3. Hydrological and Chemical Data from RT Amino Acids Stations

	Location		Date	Temperature °C	Salinity ‰
	Long.	Lat.			
RT1-93	82°38′32″W Pinellas Point	27°42′05″N	8/24/64	31.2	22.9
RT2-92	82°44′30″W Mullet Key	27°38′35″N	8/24/64	31.0	35.3
RT4-90	82°30′38″W Midnight Pass	27°12′22″N	8/17/64	30.8	36.7
RT5-100	82°20′37″W Stump Pass	26°53′57″N	9/ 3/64	29.5	35.9
RT5-102	82°20′37″W Stump Pass	26°53′57″N	9/14/64	28.5	33.6
RT6-79	82°15′35″W Boca Grande	26°43′52″N	7/13/64	31.5	36.2
RT6-99	82°15′35″W Boca Grande	26°43′52″N	9/ 3/64	30.0	34.5
RT6-101	82°15′35″W Boca Grande	26°43′52″N	9/14/64	27.8	29.1
RT7-98	82°02′20″W Sanibel Island	26°27′12″N	9/ 1/64	33.5	34.5
RT8-97	82°53′W San Carlos Pass	26°24′30″N	9/ 1/64	31.4	34.2
RT9-96	81°42′W Caxambas Pass	25°54′30″N	9/ 1/64	30.5	36.8
RT11-4	82°29′05″W Ballast Point	27°53′39″N	8/12/64	*	*

*No determination.

Table 4. Amino Acids Demonstrated in Samples from RT Stations, 1964.

Station	RT1-93	RT2-92	RT4-90	RT5-100	RT5-102	RT6-79	RT6-99	RT6-101	RT7-98	RT8-97	RT9-96	RT11-4
Date	8/24/64	8/24/64	8/17/64	9/ 3/64	9/14/64	7/13/64	9/ 3/64	9/14/64	9/ 1/64	9/ 1/64	9/ 1/64	8/12/64
Alanine	±	±	+	±	+	±	±	-	±	±	+	±
Arginine	+	-	+	-	-	+	-	-	-	-	±	-
Aspartic Acid	++	++	++	+++	++	+++	+	+	±	++	++	+++
Cysteine	-	-	-	-	-	-	-	-	-	-	-	-
Cystine	-	-	±	-	±	-	-	-	-	±	-	-
Glutamic Acid	+	++	++	+	+++	+	+	+	++	++	++	+++
Glycine	±	-	±	±	±	±	±	-	±	±	±	±
Histidine	-	-	-	-	-	-	-	-	-	-	-	-
Isoleucine	++	-	+	-	±	±	-	-	-	-	-	-
Leucine	+++	+	+	+	+	±	+	+	+	+	+	+
Lysine	±	-	±	-	±	±	±	±	-	±	-	±
Methionine	-	-	-	-	-	-	-	-	-	-	-	-
Phenylalanine	+	+	+	±	+	±	+	+	+	+	+	+
Proline	-	-	-	-	-	-	-	-	-	-	-	-
Serine	±	±	±	±	±	±	-	-	-	±	±	±
Threonine	-	-	-	-	-	-	-	-	-	-	-	-
Tyrosine	-	-	±	-	-	-	-	-	-	-	-	-
Valine	±	-	+	-	±	+	-	-	-	±	±	-
Organic nitrogen	28	25	20	20	34	49	16	26	22	30	21	339
Carbohydrate	0.64	2.13	0.87	0.51	0.91	1.45	0.51	0.89	0.47	0.87	0.47	*
G. breve count	0	0	0	0	0	0						

-: Not detected; ±: trace; +-+++: gradation of ninhydrin intensity.
Organic nitrogen reported in µg-at N/liter.
Carbohydrate reported in mg/liter.
* No determination.

Table 5. Chemical and Hydrological Data from RT Stations.

Station	Location Long.	Lat.	Date	Depth	Temperature °C	Salinity ‰	pH	Organic Nitrogen
RT1-93S	82°38′32″W	27°42′05″N	8/24/64	S	31.2	22.9	8.3	27.50
	Pinellas Point							
RT2-83S	82°44′30″W	27°38′35″N	7/27/64	S	25.4	36.4	8.5	17.40
	Mullet Key							
RT2-92S	"	"	8/24/64	S	31.0	35.3	8.5	24.70
RT3-60S	82°34′52″W	27°19′08″N	5/18/64	S	29.3	35.4	*	43.84
	Lido Key							
RT3-60M	"	"	5/18/64	1¼′	28.5	35.8	*	17.80
RT3-82S	"	"	7/20/64	S	30.5	37.0	8.1	41.80
RT3-104S	"	"	9/21/64	S	27.9	35.3	8.3	19.43
RT3-104M	"	"	9/21/64	1¼′	27.9	35.0	8.4	9.43
RT4-59S	82°30′38″W	27°12′22″N	5/18/64	S	26.6	34.5	*	36.60
	Midnight Pass							
RT4-59M	"	"	5/18/64	1¼′	26.6	35.0	*	35.12
RT4-81S	"	"	7/20/64	S	30.0	36.8	8.3	10.10
RT4-90S	"	"	8/17/64	S	30.8	36.7	8.3	19.48
RT5-69S	82°21′34″W	26°53′57″N	6/ 8/64	S	28.9	38.7	8.5	17.84
	Stump Pass							
RT5-100S	"	"	9/ 3/64	S	29.5	35.9	8.1	19.68
RT5-102S	"	"	9/14/64	S	28.5	33.6	8.4	34.24
RT6-68S	82°15′35″W	26°43′52″N	6/ 8/64	S	29.3	38.3	8.6	19.48
	Boca Grande							
RT6-99S	"	"	9/ 3/64	S	30.0	34.5	8.1	15.74
RT6-101S	"	"	9/14/64	S	27.8	29.1	8.3	26.40
RT7-89S	82°02′20″W	26°27′12″N	8/ 4/64	S	31.5	35.6	8.7	18.35
	Sanibel Island							
RT7-98S	"	"	9/ 1/64	S	33.5	34.5	8.1	22.30
RT8-55M	82°53′ W	26°24′30″N	5/ 5/64	1′	24.9	34.2	*	26.21
	Big Carlos Pass							
RT8-55B	"	"	5/ 5/64	2½′	24.9	37.9	*	22.6[illegible]
RT8-66S	"	"	6/ 2/64	S	29.4	38.8	8.5	36.5[illegible]
RT8-77S	"	"	7/ 7/64	S	29.9	35.7	8.6	41.4[illegible]
RT8-88S	"	"	8/ 4/64	S	31.0	34.2	8.8	17.7[illegible]
RT8-97S	"	"	9/ 1/64	S	31.4	34.2	8.4	30.2[illegible]
RT9-65S	81°42′W	25°54′30″N	6/ 1/64	S	29.5	37.9	8.3	18.9[illegible]
	Caxambas Pass							
RT9-76S	"	"	7/ 7/64	S	30.1	36.6	8.4	26.[illegible]
RT9-87S	"	"	8/ 4/64	S	30.0	37.1	8.7	18.[illegible]
RT9-96S	"	"	9/ 1/64	S	30.5	36.8	8.3	21.[illegible]
RT10-75S	82°36′38″W	27°50′35″N	6/22/64	S	32.8	27.5	8.4	36.[illegible]
	Weedon Point							
RT10-86S	"	"	7/27/64	S	27.5	23.9	7.8	40.[illegible]
RT11-74S	82°29′05″W	27°53′39″N	6/22/64	S	33.6	24.6	8.3	26.[illegible]
	Ballast Point							

*No determination.
Organic nitrogen reported in μg-at N/liter.

Table 6. Amino Acids Demonstrated in Artificial Cultures.

Culture Culture No. Count/liter	*Chlorella* sp. 215 $24x10^6$	*Chlorella* sp. 219 $16x10^6$	*Skeletonema* sp. 220 $4x10^6$	*Chlorella* sp. 223 $19x10^6$
Alanine	++	±	+	-
Arginine	±	-	±	-
Aspartic Acid	+++	+++	+++	++
Cysteine	-	-	-	-
Cystine	±	+	±	-
Glutamic Acid	++	++	+++	+
Glycine	-	±	+	+
Histidine	-	-	-	-
Isoleucine	+	+	++	-
Leucine	+	++	++	+
Lysine	±	±	±	-
Methionine	-	-	-	-
Phenylalanine	+	++	++	+
Proline	-	-	-	-
Serine	±	+	±	±
Threonine	-	-	±	-
Tyrosine	-	-	±	-
Valine	±	+	++	-
Organic nitrogen	6290	480	*	49
Carbohydrate	3.5	6.4	11.2	5.5

-: not detected; ±: trace; +-+++: gradation of ninhydrin intensity.
Organic nitrogen reported in μg-at N/liter.
Carbohydrate reported in mg/liter.
* Not Determined.

Table 7. Summary of Occurrence Totals of Amino Acids, Mean Organic Nitrogen, and Mean Carbohydrate Concentrations.

	CK-HC	RT	AC
Total Samples	7	12	4
Alanine	7	11	3
Arginine	4	4	2
Aspartic Acid	7	12	4
Cysteine	0	0	0
Cystine	2	3	3
Glutamic Acid	7	12	4
Glycine	6	10	3
Histidine	0	0	0
Isoleucine	5	4	3
Leucine	7	12	4
Lysine	5	8	3
Methionine	1	0	0
Phenylalanine	5	12	4
Proline	1	0	0
Serine	4	9	4
Threonine	1	0	1
Tyrosine	0	1	1
Valine	2	6	3
Mean organic nitrogen	0.175	0.043	2.273
Mean carbohydrate	1.22	0.88	6.50

CK-HC: offshore stations; RT: inshore stations; AC: artificial culture media of marine algae.
Carbohydrate reported in mg/liter.
Organic nitrogen reported in μg-at N/liter.

except during periods of greatly increased drainage. The low chlorinity demonstrated in the Caloosahatchee was directly due to the opening of the locks from Lake Okeechobee at Moore Haven.

Hardness. Calcium and magnesium (Figures 6 and 7) in the Manatee and Myakka Rivers rarely exceeded 50 ppm. There was a greater variation in the Peace River content with values greater than 100 ppm.

Sulfate. The sulfate content (Figure 8) of the Manatee and Myakka Rivers showed little fluctuation and usually did not exceed 20 ppm. The sulfate in the Peace River varied from 20 to 100 ppm.

Chromate. Chromate was not demonstrable in any of the samples taken from the rivers.

Silica. The silica content (Figure 9) of the Myakka and Caloosahatchee Rivers was relatively low, usually not exceeding 5 ppm. The Alafia River samples contained extremely high silica concentrations (30 ppm). The Peace and Manatee Rivers demonstrated a greater variability in silica content with values exceeding 14 ppm and with other concentrations less than 1 ppm.

Boron. The boron content (Figure 10) in all rivers was low and was usually less than 1 ppm.

Copper. The element copper was found in very low concentrations in all rivers (Figure 11), usually less than 0.1 ppm.

Manganese. Manganese was not demonstrated in the south Florida rivers.

Nitrite. Nitrite nitrogen (Figure 12) was very low in all of the rivers and did not exceed 0.1 ppm.

Nitrate. Nitrate nitrogen (Figure 13) usually exceeded 1 ppm in the rivers but rarely exceeded 5 ppm.

Phosphate. The phosphate content (Figure 14) was extremely high in the Alafia and Peace Rivers; in some samples greater than 30 ppm. Phosphate mines are adjacent to these rivers. The Manatee, Myakka, and Caloosahatchee Rivers have much lower phosphate levels, rarely greater than 3 ppm and usually less than 1 ppm.

Iron. In all of the south Florida rivers the particulate iron greatly influenced the total iron content; the soluble iron remained relatively constant. The mean iron levels (400 μg Fe/liter) of the south Florida rivers (Figure 14) are much lower than the iron values (677 μg Fe/-liter) demonstrated in most of the north Florida rivers (Donnelly *et al.*, 1966).

Tannins. Tannic acids were demonstrable in all south Florida rivers. Levels as high as 10 ppm were found in the Myakka and Peace Rivers.

Carbohydrates. The carbohydrate concentration (Figure 16) of the rivers fluctuated greatly and usually the higher levels could be associated with algal blooms in the waters when the samples were taken. The levels usually did not exceed 3 mg/liter but this value is many times the concentration found in sea water.

Organic nitrogen. None of the organic nitrogen levels (Figure 17) demonstrated in the south Florida rivers were excessively high. The high level of organic nitrogen in the rivers in March 1966 may be evidence of a seasonal peak.

REFERENCES

BAYLOR, E. R. and W. H. SUTCLIFFE
1963. Dissolved organic matter in sea water as a source of particulate food. *Limnol. Oceanog.*, *8*(4):369-371.

BILLINGS, G. K. and R. C. HARRISS
1965. Cation analysis of marine waters by atomic absorption spectrometry: Gulf of Mexico coastal waters. *Tex. J. Sci.*, *17*(1): 129-138.

BLACK, A. P. and E. BROWN
1951. Chemical characters of Florida waters — 1951. *Fla. Bd. Conserv.* Water Survey and Research Paper No. 6: 119 pp.

BURKLEW, M. A.
1966. Determination of carbohydrates in sea water. *Fla. Bd. Conserv.* Leaf. Ser., *VI* Pt. 2(1): 1-2.

CHEW, F.
1953. Results of hydrographic and chemical investigations in the region of the "Red Tide" bloom on the west coast of Florida in November 1952. *Bull. Mar. Sci. Gulf. Carib.*, *2*(4): 610-625.

DONNELLY, P. V., J. VUILLE, M. C. JAYASWAL, R. A. OVERSTREET, J. WILLIAMS, M. A. BURKLEW, and R. M. INGLE
1966. A study of contributory chemical parameters to Red Tide in Apalachee Bay. *In* Observations of an Unusual Red Tide. *Fla. Bd. Conserv.*, Prof. Papers Ser. No. 8: 43-84.

DRAGOVICH, A. and B. Z. MAY
1962. Hydrological characteristics of Tampa Bay tributaries. *U. S. Fish Wildl. Serv.* Fish. Bull., *62*(205): 163-176.

FABRICAND, B. R., R. R. SAWYER, S. G. UNGER, and S. ADLER
1962. Trace metal concentrations in the ocean by atomic absorption spectroscopy. *Geochim. et Cosmoch. Acta.*, *26*: 1023-1027.

FEINSTEIN, A.
1956. Correlations of various ambient phenomena with Red Tide outbreaks on the Florida west coast. *Bull. Mar. Sci. Gulf Carib.*, *6*(3): 209-232.

GRILL, E. V. and F. A. RICHARDS
1964. Nutrient regeneration from phytoplankton decomposing in sea water. *J. Mar. Res.*, *22*(1): 51-69.

HARVEY, H. W.
1966. The Chemistry and Fertility of Sea Waters. University Press, Cambridge, England. 234 pp.

HEM, J. D.
1959. Study and Interpretation of the Chemical Characteristics of Natural Water. Geological Survey Water-Supply Paper 1473. U. S. Government Printing Office, Washington, D.C. 269 pp.

HUTTON, R. F.
1956. An annotated bibliography of Red Tides occurring in the marine waters of Florida. *Quart. Jour. Florida Acad. Sci.*, *19*(2-3): 123-146.

KETCHUM, B. H.
1947. The biochemical relations between marine organisms and their environment. *Ecol. Monogr.*, *17*: 309-315.

LASKER, R. and F. G. W. SMITH
1954. Red Tide. *U. S. Fish Wildl. Serv.* Fish. Bull., *55*(89): 173-176.

LEWIS, G. L. and N. W. RAKESTRAW
1955. Carbohydrates in sea water. *J. Mar. Res.*, *14*: 253-258.

ODUM, H. T.
1953. Dissolved phosphorus in Florida waters. *Fla. Bd. Conserv. and Fla. Geol. Surv.*, Rept. of Investig., *9*(1): 1-40.

OVERSTREET, R. A.
1966. Organic nitrogen determination. *Fla. Bd. Conserv.*, Leaf. Ser., *VI* Pt. 2 (2): 1-4.

REDFIELD, A. C.
1958. The biological control of chemical factors in the environment. *Amer. Scient.*, *46*(3): 205-222.

ROUNSEFELL, G. A. and W. R. NELSON
1964. Status of Red Tide research in 1964. *Alabama Marine Resources Lab.*, Tech. Rep. 64-1: 192 pp.

SANDELL, E. B.
1959. Colorimetric Determination of Trace Metals, p. 537-543. Interscience Publishers, Inc., New York.

STRICKLAND, J. D. H. and T. R. PARSONS
1965. A manual of sea water analysis. *Bull. Fish. Res. Bd. Can.* No. 125: 203 pp.

U. S. FISH AND WILDLIFE SERVICE
1954. Gulf of Mexico: its origin, waters, and marine life. *U. S. Fish. Wildl. Serv.* Fish. Bull., *55*(89): 604 pp.

VUILLE, J. H.
1966. Determination of salinity by titration. *Fla. Bd. Conserv.*, Leaf. Ser., *VI* Pt. 1(1): 1-2.

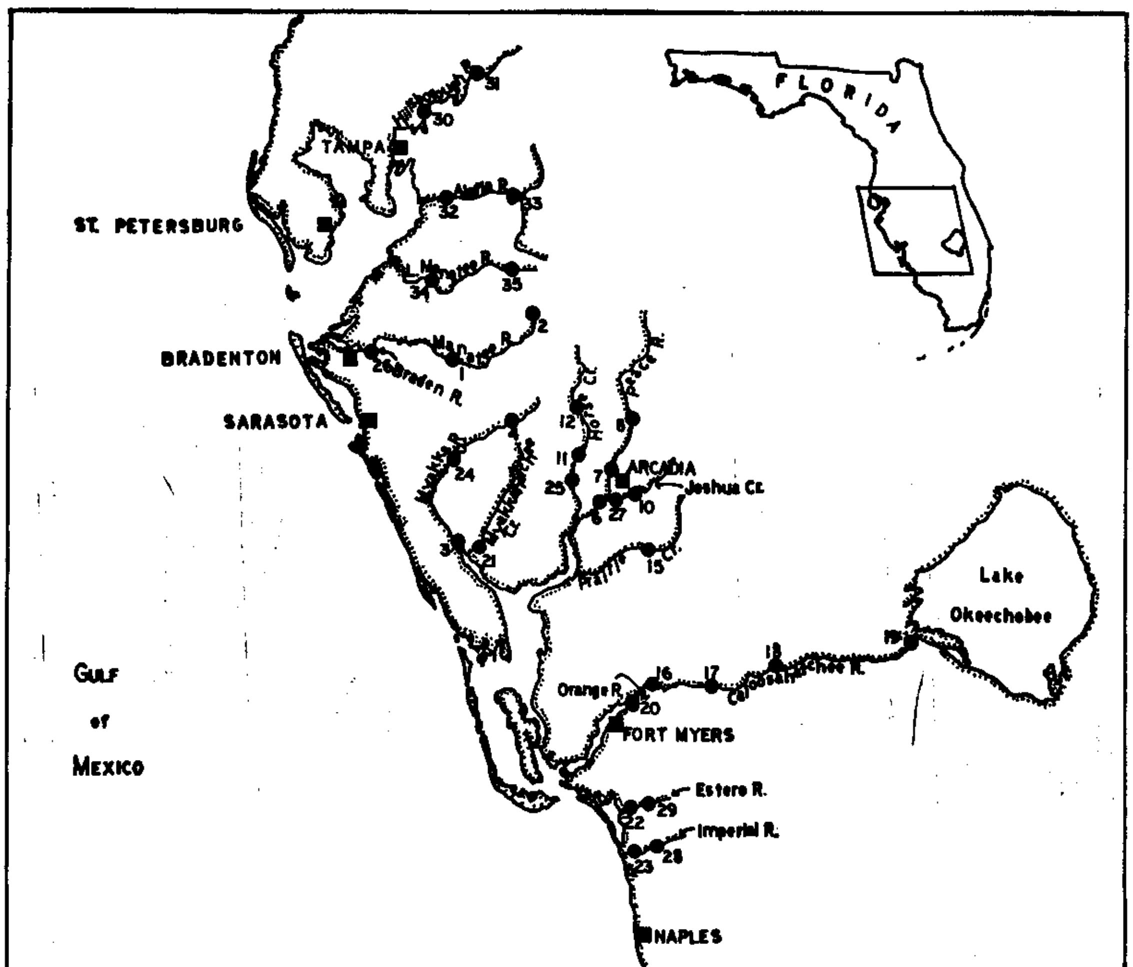


Figure I. South Florida river stations.

Figure 7. Monthly magnesium content in south Florida rivers.

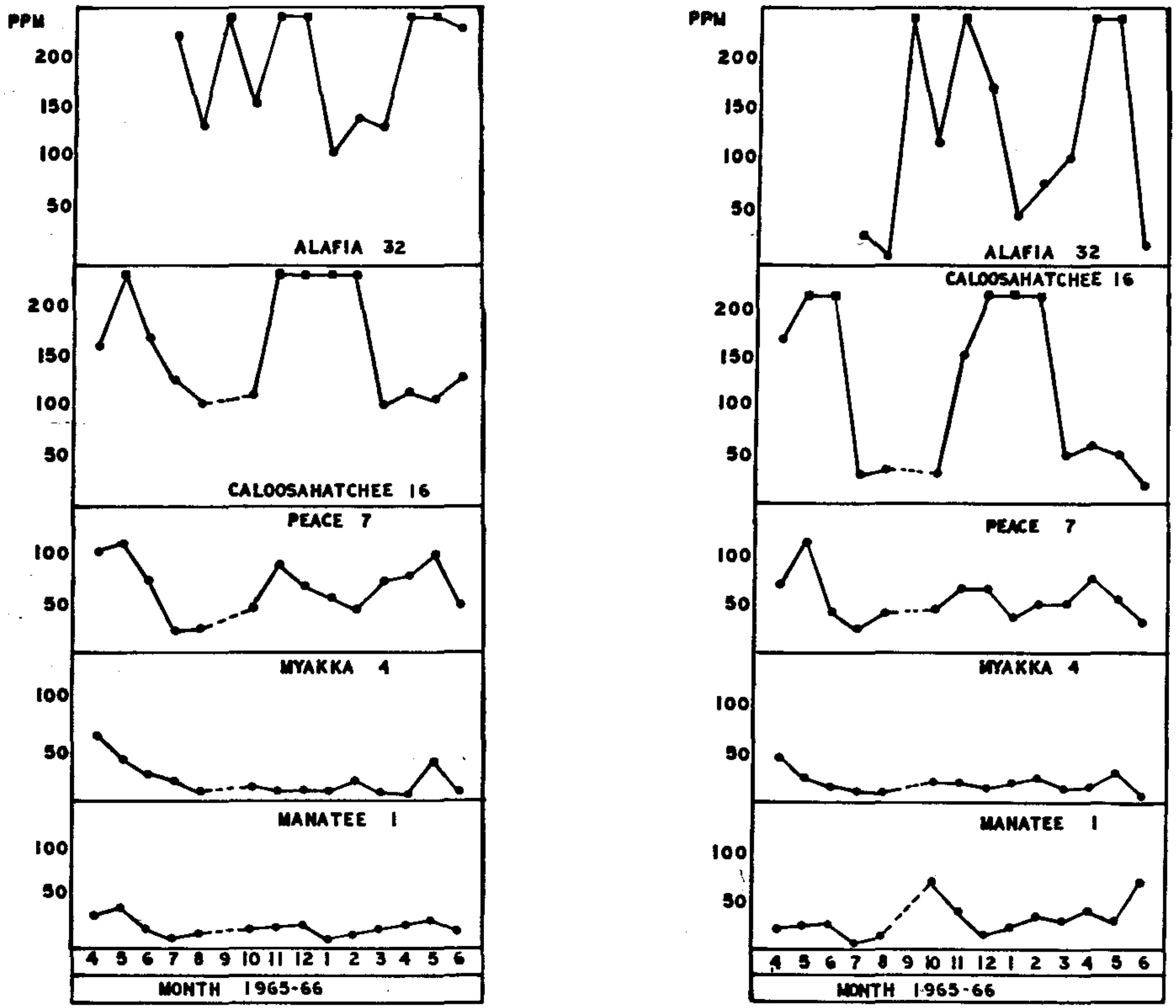


Figure 8. Monthly sulfate levels in south Florida rivers.

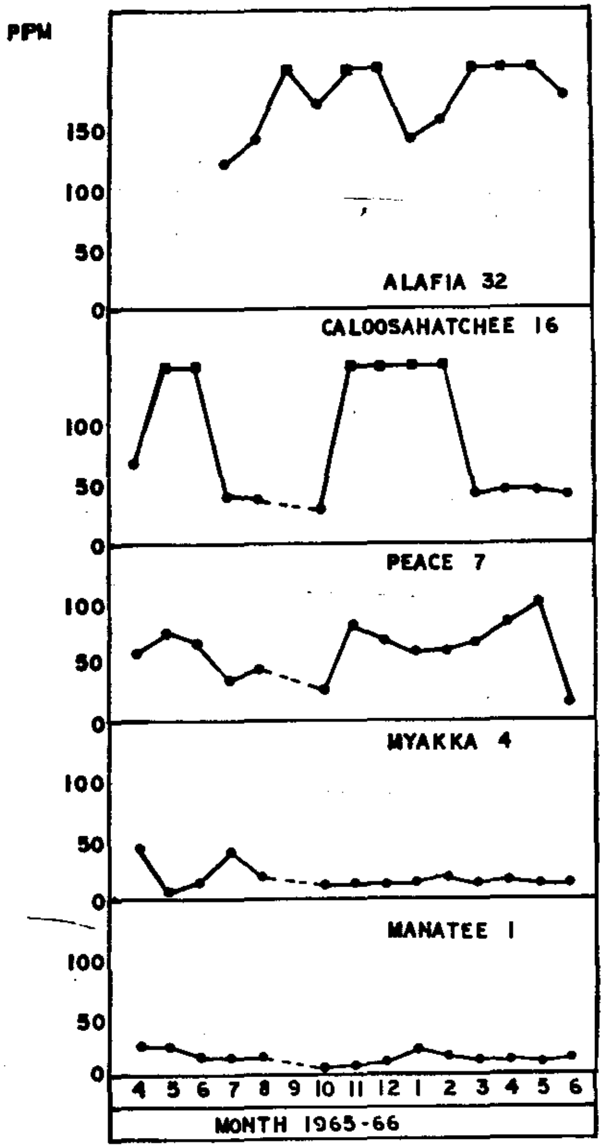


Figure 9. Monthly silica levels in south Florida rivers.

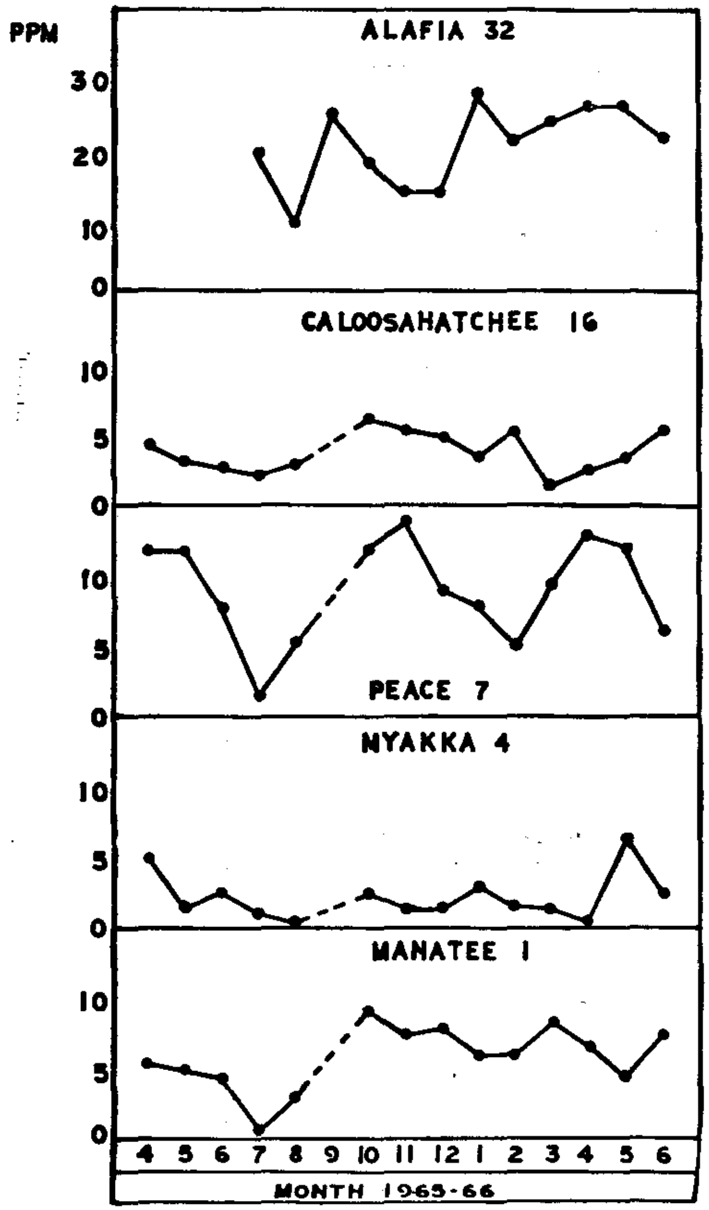


Figure 10. Monthly boron levels in south Florida rivers.

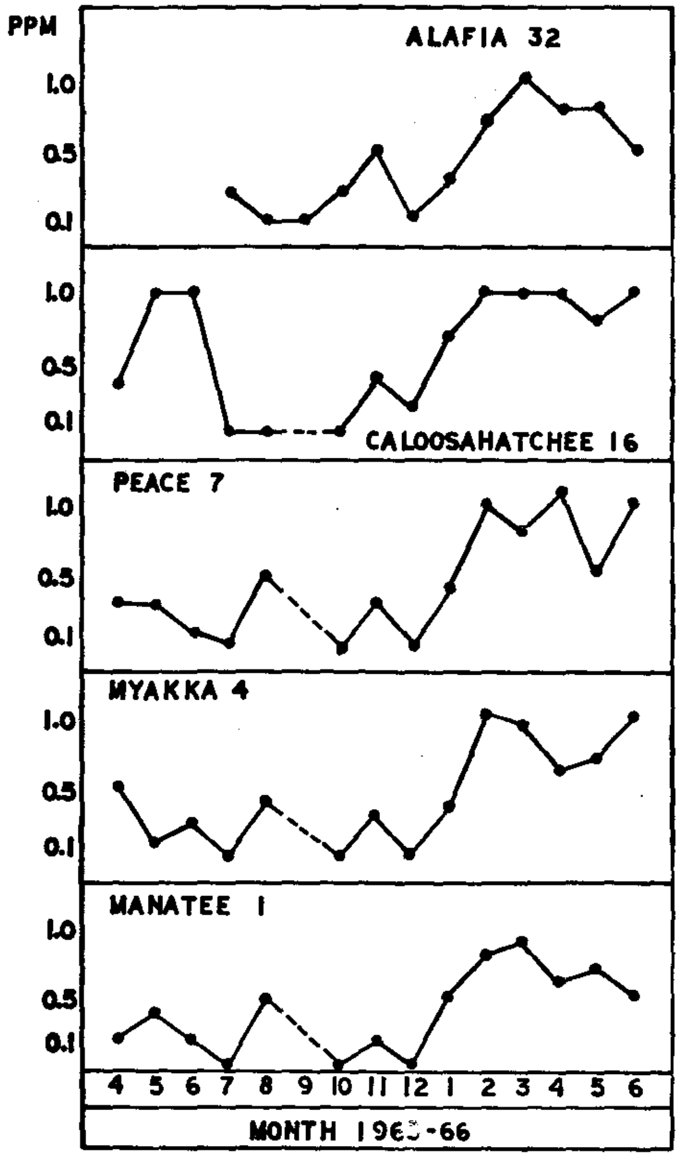


Figure 11. Monthly copper content of south Florida rivers.

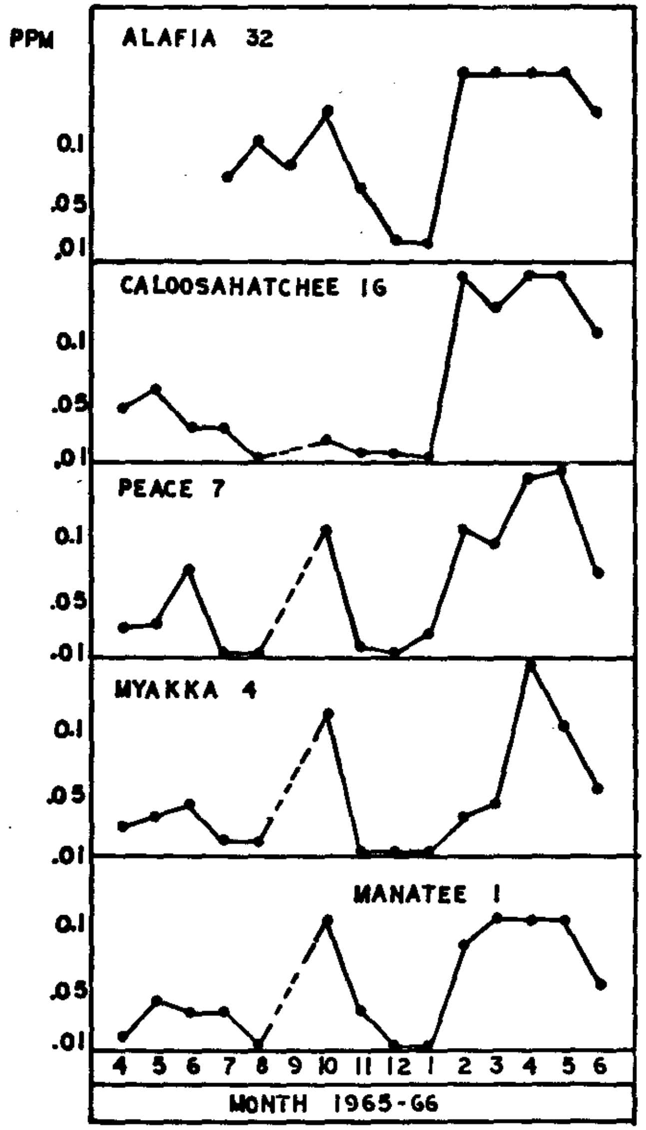


Figure 12. Monthly nitrite levels in south Florida rivers.

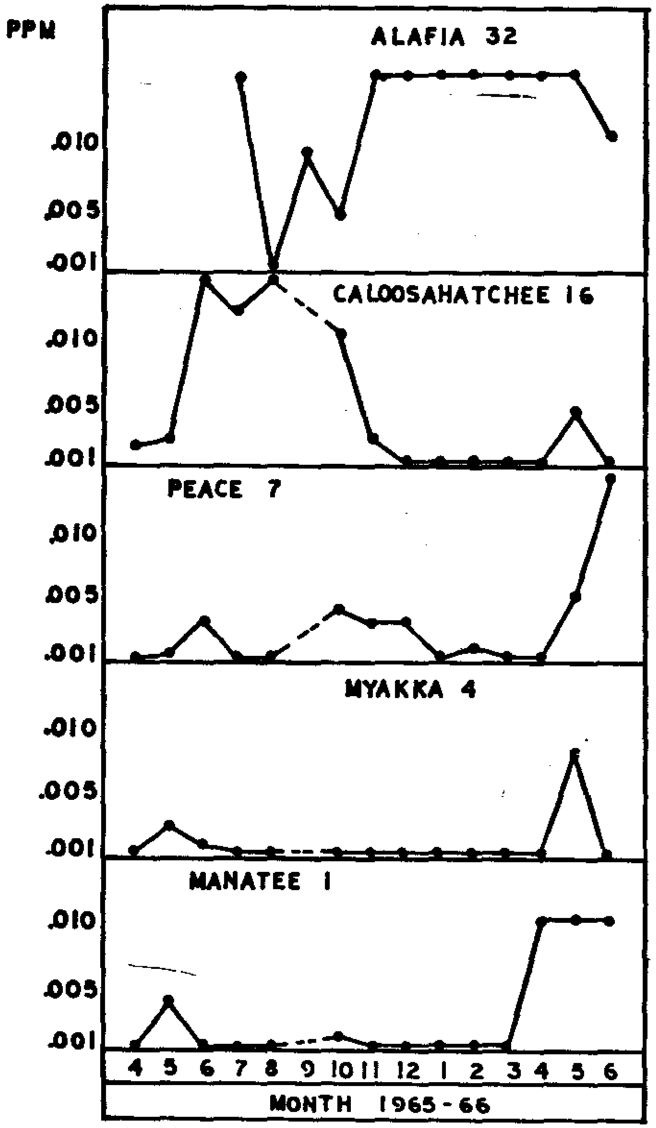
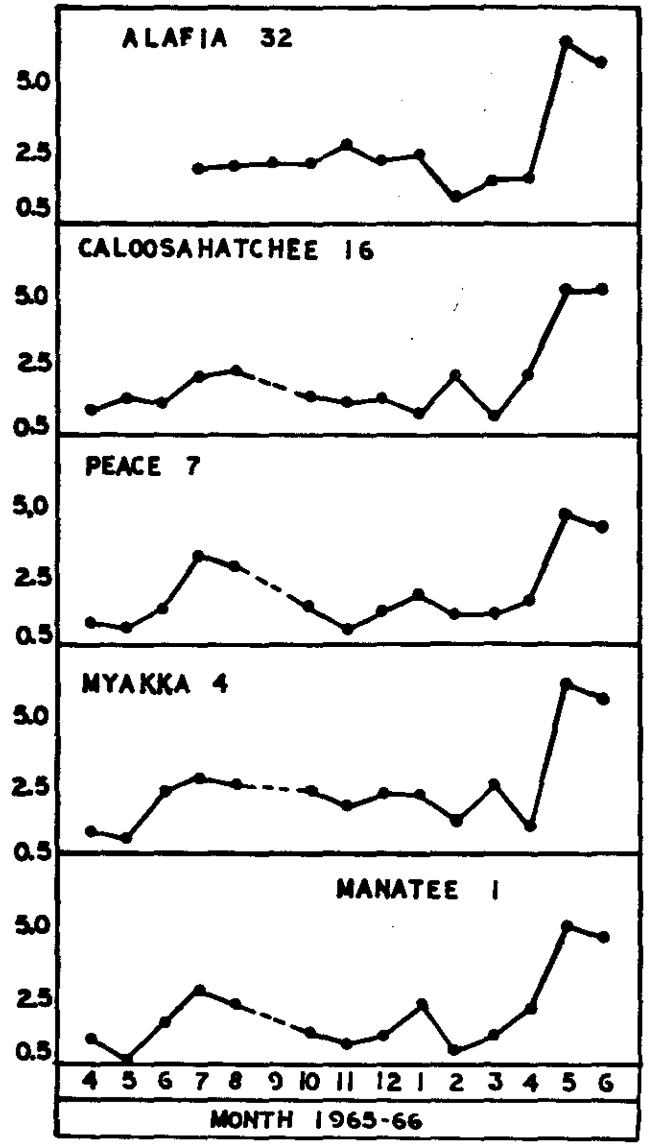


Figure 13. Monthly nitrate levels in south Florida rivers.



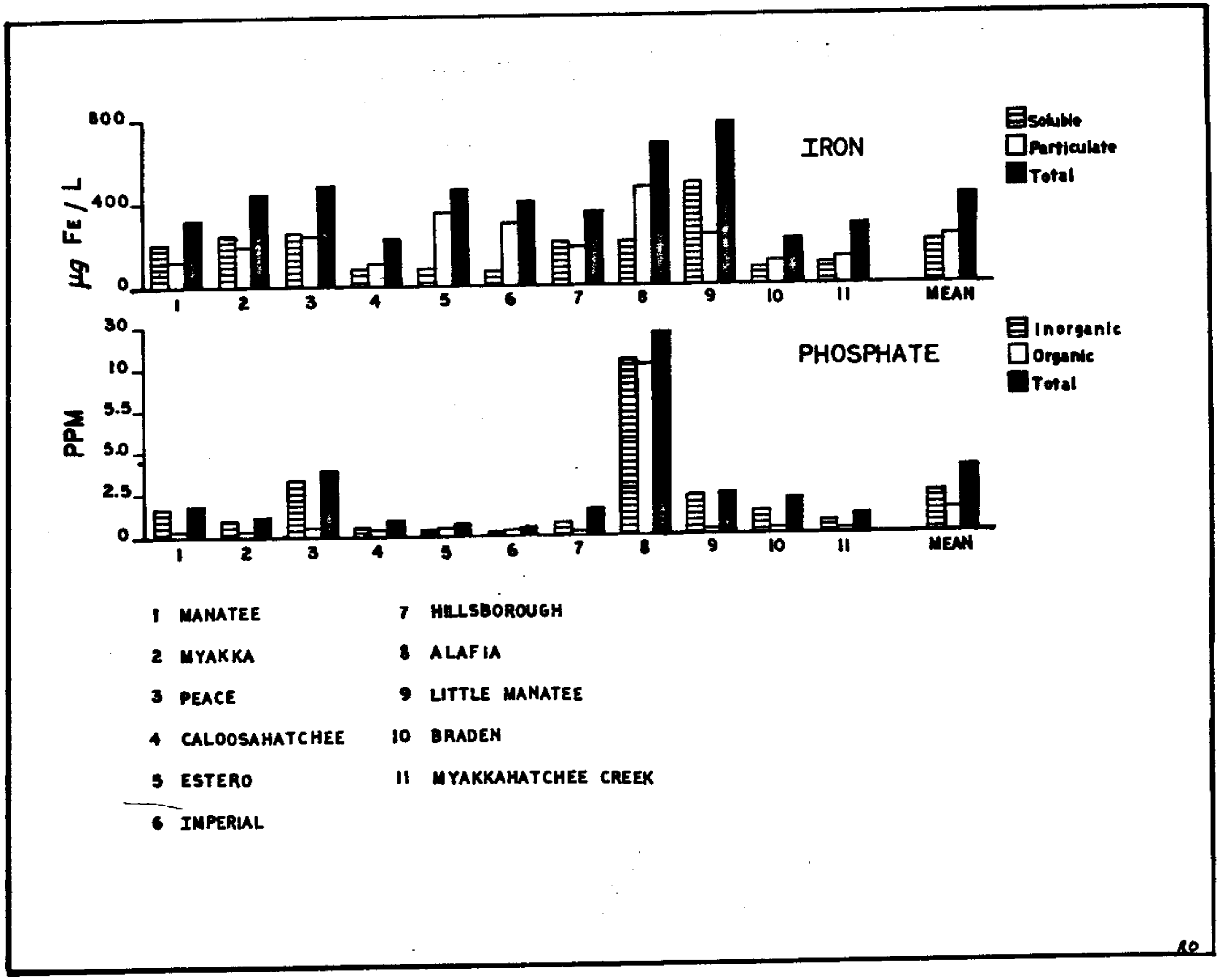


Figure 14. Mean iron and phosphate levels in south Florida rivers.

Figure 15. Monthly tannin levels in south Florida rivers.

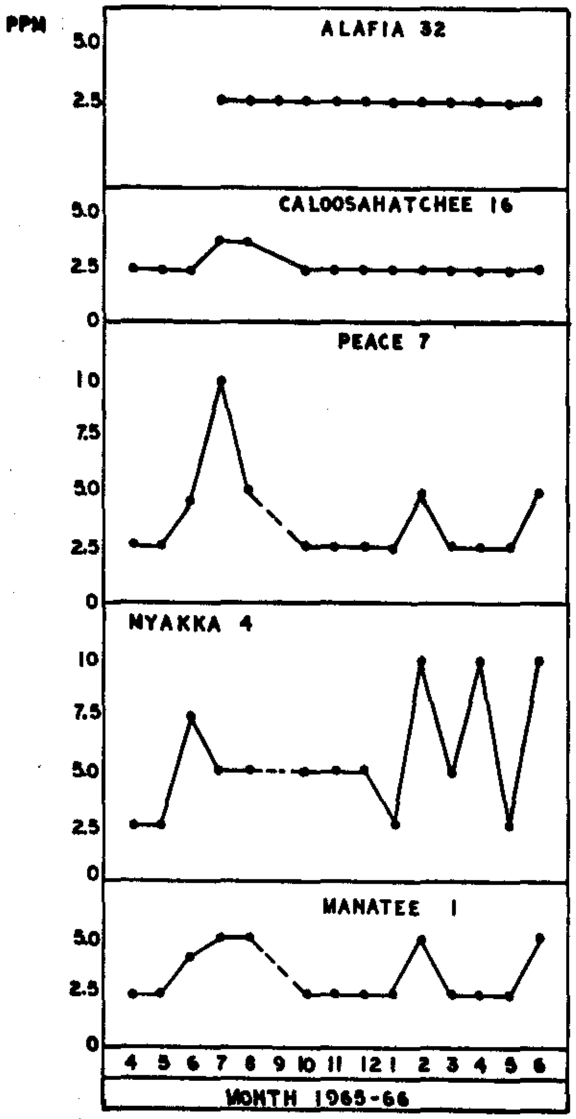


Figure 16. Monthly carbohydrate concentrations in south Florida rivers.

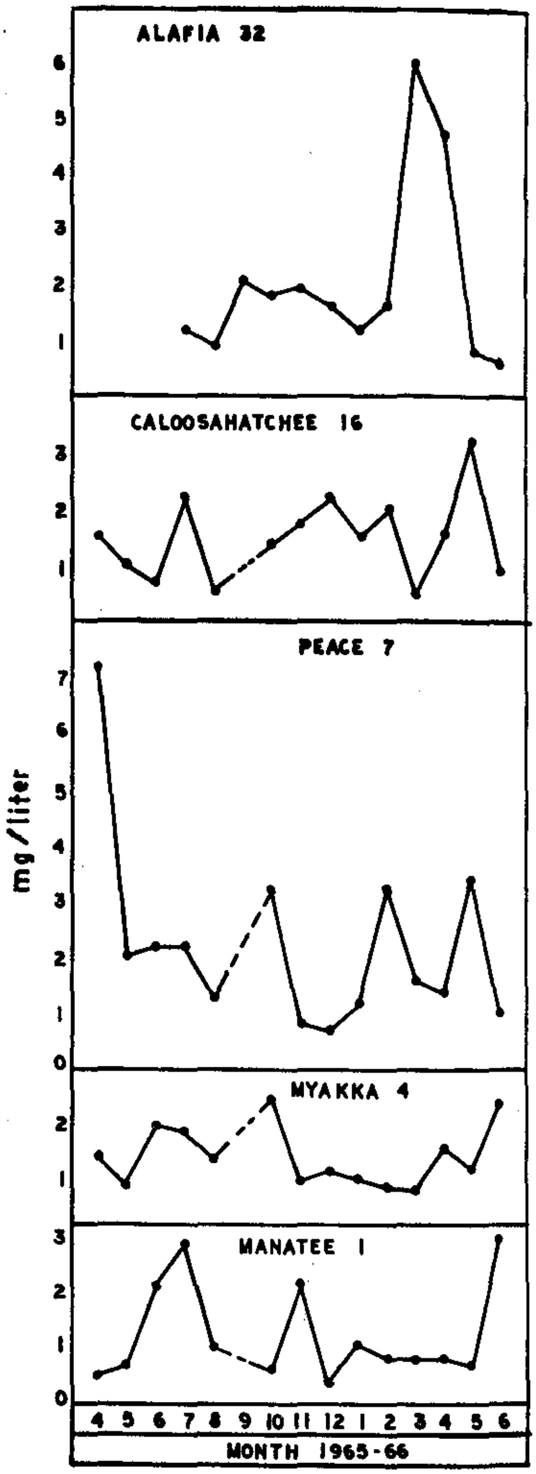
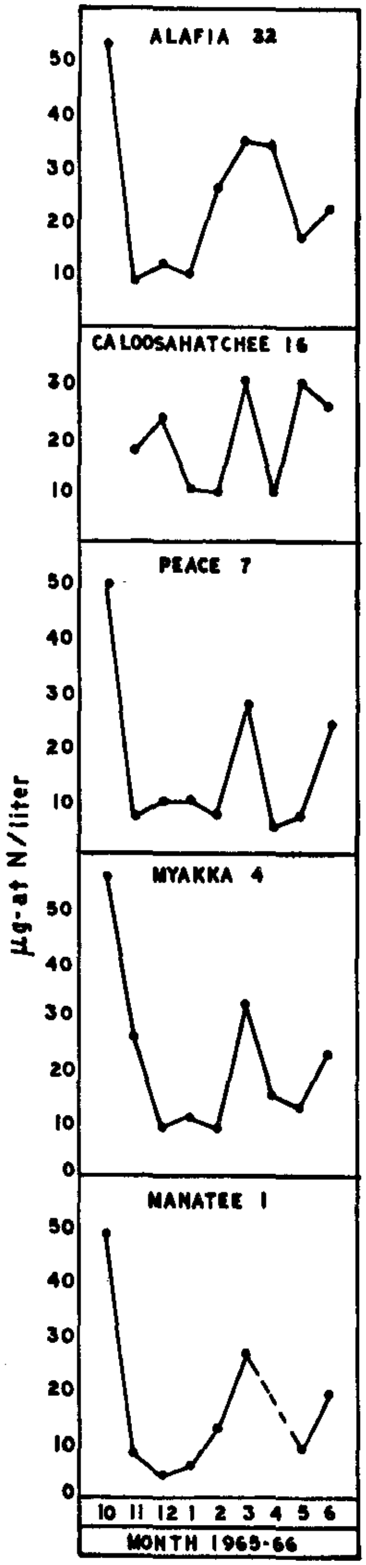


Figure 17. Monthly organic nitrogen levels in south Florida rivers.



CONCENTRATION OF CARBOHYDRATES OF THE COASTAL WATERS OF WEST FLORIDA

PATRICIA V. DONNELLY AND MARY A. BURKLEW

INTRODUCTION

The recurrence of Red Tide along the west coast of Florida from Marco to Tampa Bay led to establishment of regular inshore sampling stations in this area. Samples were collected for biological and chemical observations and analyses. These data would perhaps provide essential background information on the water composition in event of a Red Tide outbreak. Carbohydrate concentrations were included in the chemical determinations since these organic compounds are directly important in the nutrition of some microorganisms and because they may serve as an indicator of land runoff and algal blooms.

In this paper an attempt was made to correlate the concentration of carbohydrates with salinity during the period of May 1964 to October 1964.

MATERIALS AND METHODS

Water samples were collected at assigned stations, (Figure 1) usually at mid-depth, and were frozen immediately by placing the polyethylene sample containers in dry ice.

A modified procedure, based on the anthrone colorimetric assay of Lewis and Rakestraw (1955), was used to estimate the concentration of carbohydrate-like substances. After 20 ml of a 0.1% anthrone reagent was added to 10 ml of the test sample, the sample was allowed to cool, and the optical density of an aliquot was then determined at 630 mμ with a Beckman DU spectrophotometer. To determine the concentration, the optical density of the sample was compared to a glucose standard curve nomograph. The control blank was based on predetermined salinities of each sample. The results were reported as glucose equivalents in mg/-liter, $\pm$ 0.21.

RESULTS AND DISCUSSION

In Table 1, chemical and hydrographic data are cited in tabular form for each sample from the RT Stations. Temperature, tide, and depth were field observations. Salinities were determined by Mohr titration. The lowest concentration of carbohydrate was observed at Station RT-5; the maximum at RT-2 (Table 2.) Mean of each of the nine stations did not differ appreciably. The small number of samples and their narrow range precludes further statistical analyses.

Figure 2 is a graphic illustration of the monthly fluctuation of the carbohydrate values related to the salinity determinations. It should be noted that the carbohydrate concentrations appeared to be independent of the salinity values. There was no apparent correlation of carbohydrate concentration to salinity or to tide stages at these stations.

These data indicate that the concentration of carbohydrates in coastal waters of west Florida do not vary appreciably from that of offshore water. Values of less than 1 mg/liter are usually demonstrable in sea water, but concentrations exceeding 10 mg/liter have been quantitated in bloom waters (Collier, 1958). Although in confined coastal waters higher values would be expected because of the abundance of metabolism and land effluent, these demonstrated carbohydrate levels resulted from high utilization rates and tidal dilution. From this limited data it may be concluded that at these coastal stations high concentrations of carbohydrates do not normally occur.

REFERENCES

ANDERSON, W. W. and J. W. GEHRINGER
1958. Physical oceanographic, biological, and chemical data. South Atlantic Coast of the United States. *M/V Theodore N. Gill* Cruise 6 and 8, *U. S. Fish Wildl. Serv.* Spec. Sci. Rep. Fish No. 265 and No. 303.

COLLIER, A.
1953. The significance of organic compounds in sea water. *Trans. North Amer. Wildl. Conf.*, *18*: 463-472.

COLLIER, A.
1958. Some biochemical aspects of red tides and related oceanographic problems. *Limnol. Oceanog.*, *3:* 33-39.

COLLIER, A., S. M. RAY, and A. W. MAGNITZKY
1950. A preliminary note on naturally occurring organic substances in sea water affecting the feeding of oysters. *Science*, *111:* 151-152.

COLLIER, A., S. M. RAY, A. W. MAGNITZKY, and J. D. BELL
1953. Effect of dissolved organic substances on oysters, *U. S. Fish and Wildl. Serv.*, Fish Bull., *84:* 167-185.

COLLIER, A., S. M. RAY, and W. B. WILSON
1956. Some effects on specific organic compounds on marine organisms. *Science*, *124*: 220.

DONNELLY, P. V. and M. A. BURKLEW
1965. Carbohydrate distribution in the northwest coastal waters of Florida.

In Observations of an Unusual Red Tide—A Symposium, *Fla. Bd. Conserv.*, Prof. Pap. Ser. No. 8: 39-42.

HOOD, D. W.
1963. Chemical oceanography. *Oceanogr. Mar. Biol. Ann. Rev.*, *1*: 129-155.

LEWIS, G. J., and N. W. RAKESTRAW
1955. Carbohydrate in sea water. *J. Mar. Res.*, *14*: 253-248.

PLUNKETT, M. A., and N. W. RAKESTRAW
1955. Dissolved organic matter in the sea. *Deep-Sea Res. Suppl.*, *3*: 12-14.

PROVASOLI, L.
1963. Organic regulation of phytoplankton fertility, p. 165-219. *In* M. N. Hill, (ed.), The Sea, vol. 2. Interscience Publishers, New York.

WANGERSKY, P. J.
1952. Isolation of ascorbic acid and rhamnosides from sea water. *Science*, *115*: 685.

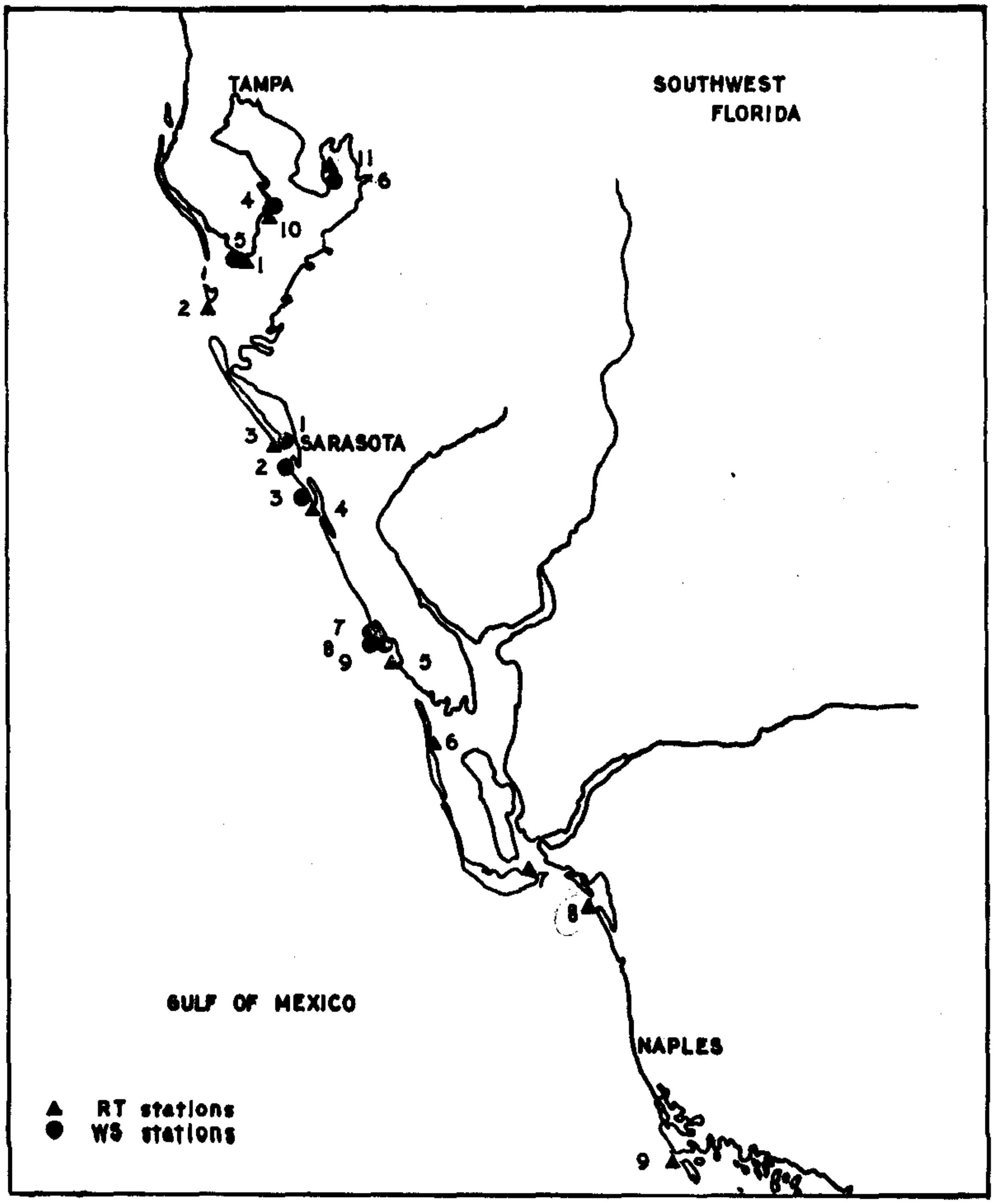
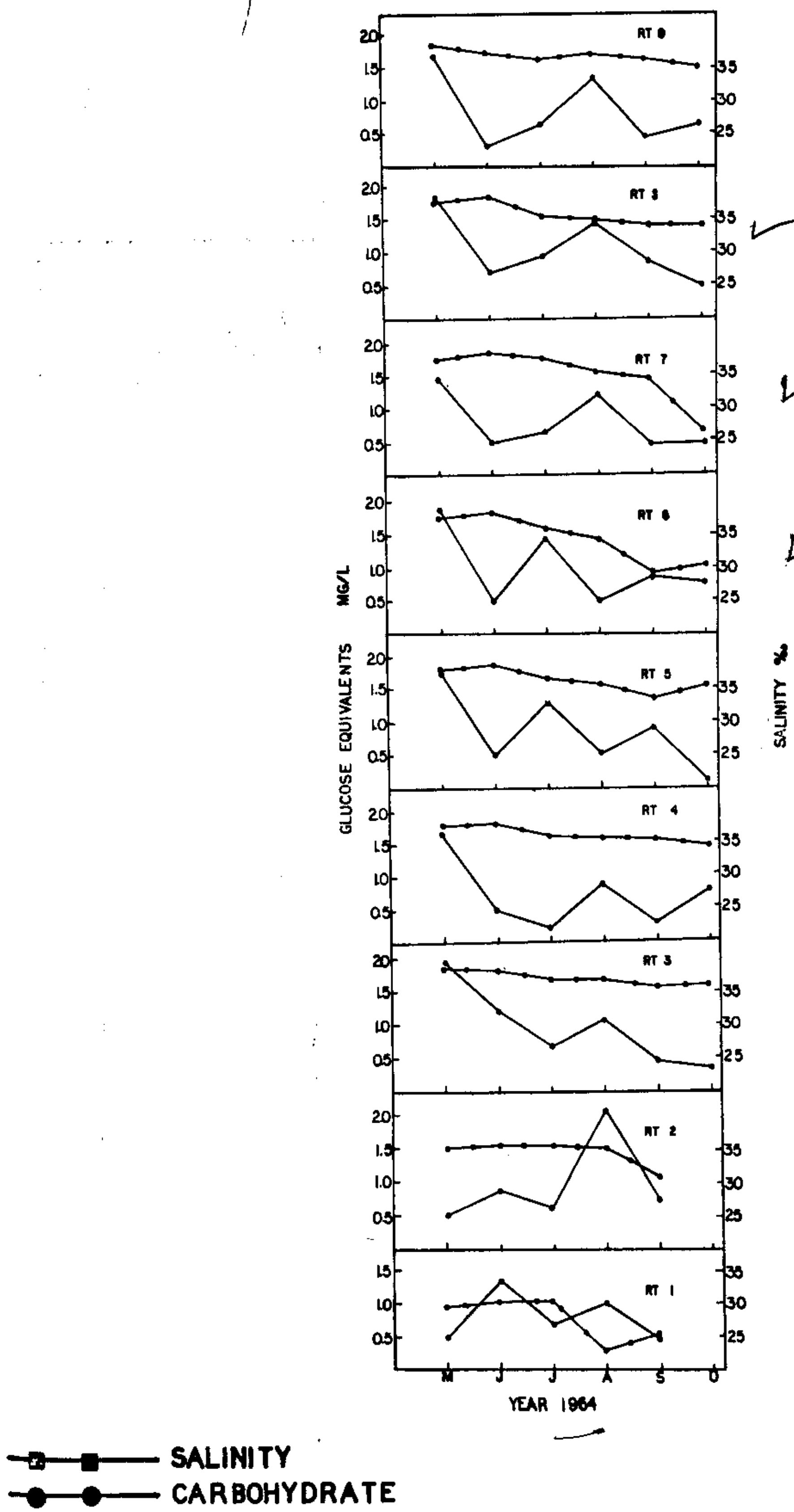


Figure 1. RT and WS estuarine sampling stations.

Figure 2. Monthly fluctuations of carbohydrates and salinities at inshore RT stations of southwest Florida.



Big Carlos Pass

Captiva

Sanibel

Table 1. Carbohydrate Values and Hydrographic Data from RT Stations.

Station RT-1	PINELLAS POINT		27°42′05″N	82°38′32″W		
Sample	62M	73M	84M	93M	106M	
$(CHO)_x$	0.56	1.39	0.72	1.04	0.51	
Date	5/25/64	6/22/64	7/27/64	8/24/64	9/28/64	
Temp.	27.2	30.4	27.4	30.8	27.3	
Salinity	29.3	30.9	32.0	22.9	26.9	
Tide	Ebb	Ebb	Ebb	Ebb	Ebb	
Depth	2 1/2′	2 1/2′	2 1/2′	2 1/2′	2′	
Station RT-2	MULLET KEY		27°38′35″N	82°44′30″W		
Sample	61M	72M	83M	92M	105M	
$(CHO)_x$	0.56	0.90	0.63	2.13	0.57	
Date	5/25/64	6/22/64	7/27/64	8/24/64	5/25/64	
Temp.	27.3	30.9	25.4	31.0	27.2	
Salinity	35.0	36.5	36.4	35.4	32.1	
Tide	Ebb	Ebb	Flood	Flood	Ebb	
Depth	2 1/2′	2 1/2′	2 1/2′	2 1/2′	2 1/2′	
Station RT-3	LIDO KEY		27°19′08″N	82°34′52″W		
Sample	60M	71M	82M	91M	104M	115M
$(CHO)_x$	1.98	1.23	0.72	1.13	0.45	0.39
Date	5/18/64	6/15/64	7/20/64	8/17/64	9/21/64	10/19/64
Temp.	28.5	31.4	30.4	31.2	27.9	24.2
Salinity	38.4	38.3	37.0	37.0	36.1	36.5
Tide	Ebb	Flood	Ebb	Ebb	Flood	Flood
Depth	2 1/2′	2 1/4′	3′	2 1/2′	2 1/2′	3′
Station RT-4	MIDNIGHT PASS		27°12′22″N	82°30′38″W		
Sample	59M	70M	81M	90M	103M	114M
$(CHO)_x$	1.66	0.50	0.23	0.87	0.30	0.79
Date	5/18/64	6/15/64	7/20/64	8/17/64	9/21/64	10/19/64
Temp.	26.6	29.9	30.0	30.8	27.2	23.0
Salinity	37.8	38.2	36.8	36.7	36.6	35.0
Tide	Ebb	Flood	Ebb	Ebb	Flood	Flood
Depth	2 1/2′	2 1/2′	3′	3′	2 1/2′	3′
Station RT-5	STUMP PASS		26°53′57″N	82°20′37″W		
Sample	58M	69M	80M	100M	102M	113M
$(CHO)_x$	1.73	0.50	1.32	0.51	0.91	0.13
Date	5/11/64	6/ 8/64	7/13/64	9/ 3/64	9/14/64	10/12/64
Temp.	27.1	28.8	31.2	29.5	28.5	24.1
Salinity	37.5	38.7	36.8	35.9	33.6	35.4
Tide	Flood	Ebb	Flood	Ebb	Ebb	Ebb
Depth	2 1/2′	2 1/2′	2 1/2′	3′	3′	2 1/2′
Station RT-6	BOCA GRANDE		26°43′52″N	82°15′35″W		
Sample	57M	68M	79M	99M	101M	112M
$(CHO)_x$	1.89	0.47	1.45	0.51	0.89	0.80
Date	5/11/64	6/ 8/64	7/13/64	9/ 3/64	9/14/64	10/12/64
Temp.	27.1	29.1	31.5	30.1	27.7	24.3
Salinity	37.7	38.3	36.2	34.5	29.1	30.5
Tide	Flood	Flood	Flood	Flood	Ebb	Ebb
Depth	4′	4′	3′	4′	3′	2 1/2′
Station RT-7	SANIBEL ISLAND		26°27′12″N	82°02′30″W		
Sample	56M	67M	78M	89M	98M	111M
$(CHO)_x$	1.45	0.50	0.64	1.20	0.47	0.50
Date	5/ 5/64	6/ 2/64	7/ 7/64	8/ 4/64	9/ 1/64	10/ 6/64
Temp.	25.5	29.4	31.5	32.0	33.4	26.7
Salinity	37.6	38.8	37.7	35.8	34.5	26.4
Tide	Flood	Flood	Flood	Ebb	Ebb	Flood
Depth	2 1/2′	2 1/2′	2 1/2′	2 1/2′	2 1/2′	2 1/2′

Table 1. (Continued).

Station RT-8	BIG CARLOS PASS		26°24′30″N	82°53′W		
Sample	55M	66M	77M	88M	97M	110M
$(CHO)_x$	1.85	0.73	0.96	1.45	0.87	0.50
Date	5/5/64	6/ 2/64	7/ 7/64	8/ 4/64	9/ 1/64	10/ 6/64
Temp.	24.9	29.4	29.9	30.5	31.3	26.2
Salinity	37.8	38.8	35.7	34.2	34.2	34.3
Tide	Flood	Flood	Flood	Ebb	Ebb	Flood
Depth	2 1/2′	2 1/2′	2 1/2′	2 1/2′	3′	2 1/2′
Station RT-9	CAXAMBAS PASS		25°54′30″N	81°42′W		
Sample	54M	65M	76M	87M	96M	109M
$(CHO)_x$	1.66	0.32	0.64	1.38	0.47	0.63
Date	5/ 5/64	6/ 2/64	7/ 7/64	8/ 4/64	9/ 1/64	10/ 6/64
Temp.	25.6	29.5	30.1	29.5	30.5	26.5
Salinity	38.9	37.9	36.6	37.1	36.8	35.2
Tide	Flood	Ebb	Flood	Flood	Ebb	Ebb
Depth	2 1/2′	2 1/2′	2 1/2′	2 1/2′	3′	2′

M – mid depth; salinity in ‰; date-date of sample collection; carbohydrate values in mg/liter, glucose equivalents.

Table 2. Concentrations* of Carbohydrates in RT Samples from West Coast of Florida.

	Minimum	Maximum	Mean
RT-1	0.51	1.39	0.84
RT-2	0.56	2.13	0.96
RT-3	0.39	1.98	0.98
RT-4	0.23	1.66	0.73
RT-5	0.13	1.73	0.85
RT-6	0.47	1.89	1.00
RT-7	0.47	1.45	0.79
RT-8	0.50	1.85	1.06
RT-9	0.32	1.66	0.85

*mg/liter, glucose equivalents.

then diluted to a 50 ml volume with deionized water.

The ammoniacal concentration was determined colorimetrically by diazotization of NO_2^-. Following the acid hydrolysis, the sample was reacted with alkaline hypochlorite, converting the ammonium ion to nitrite. A coupling of the NO_2^- with sulfanilamide in an acid medium preceded the diazotization with N-1-napthylethylenediamine dihydrochloride. The characteristic pink to deep rose color was developed. The optical density was determined with a DU spectrophotometer at 540 mμ. A deionized water blank, a 3.0 μg-at N/liter control, and a digested water blank were analyzed with each group of samples. Results were reported in μg-at N/liter.

CARBOHYDRATES

Carbohydrate concentrations were determined by the procedure of Lewis and Rakestraw (1955).

SALINITY AND pH

Salinity and hydrogen ion concentrations were determined by the procedures of Strickland and Parsons (1965).

CULTIVATION OF MARINE ALGAE

The culture media from two species of marine algae, *Chlorella* sp. (Erickson, 1964) and *Skeletonema* sp., were analyzed. These microorganisms were isolated and cultured by the Florida Board of Conservation Marine Laboratory. The cells were removed from the medium before analysis.

RESULTS AND DISCUSSION

The geographic locations (Figure 1) and hydrologic data for each of the samples analyzed for amino acids are listed in Tables 1 and 3. With the exception of HC3-SR1, which was taken from the Suwannee River, all samples were taken from estuarine or neritic water masses.

The CK and HC samples (Table 2) were obtained from areas associated with a bloom of the Red Tide dinoflagellate, *Gymnodinium breve*. Sample CK 7-8 was taken during a bloom of *G. breve* and the demonstrated organic nitrogen and carbohydrate values were exceptionally high. Aspartic and glutamic acids were the major amino acids identified. In sample CK 20, which also contained the Red Tide microorganism, an unidentified amino acid-like substance was revealed in heavy concentration. High amounts of leucine and isoleucine were also resolved from this sample. A comparison of the amino acid distribution of these two samples (CK 7-8 and CK 20) with samples HC3-8, HC3-20, HC11-42, and HC11-36, which contained no demonstrable *G. breve*, revealed that only CK 20 exhibited a significant variation (a lower aspartic and glutamic acid content and the unidentified ninhydrin reacting substance). The Suwannee River sample had an amino acid distribution similar to that of the sea water samples. The demonstrated organic nitrogen and carbohydrate concentrations of all samples differed only slightly with the exception of CK 7-8, which was taken from bloom waters. Aspartic acid, glutamic acid, leucine, and isoleucine were found in greatest distribution and concentration.

The RT samples were taken from the southwest estuarine coastal waters of Florida in which Red Tides have occurred (Table 4). There was no *G. breve* bloom during our sampling. Aspartic acid, glutamic acid, leucine, and phenylalanine were demonstrated in all samples. Threonine, proline, methionine, histidine, and cysteine were not detected in these samples. The organic nitrogen levels (Table 5) at these stations were higher than the accepted 1 to 20 μg-at N/liter for sea water. Higher nitrogen levels can usually be demonstrated in coastal waters because of the land effluent and higher productivity.

Three separate cultures of *Chlorella* sp. and one culture of *Skeletonema* sp. were analyzed for biochemical constituents (Table 6). The organic nitrogen content of the *Chlorella* media differed substantially but the carbohydrate concentrations of these three cultures varied only slightly. The *Skeletonema* sp. carbohydrate was almost twice the amount of the *Chlorella* cultures. A comparison of the amino acids indicated that aspartic and glutamic acid were present in all cultures and usually at high levels. Leucine, phenylalenine, and serine were also found in each culture. Histidine was not detected in any of the cultures. This observation is consistent with Fowden (1951) who found histidine below the detection levels in algal cultures. *Chlorella* cultures 215 and 219 were very similar in amino acid content and the *Skeletonema* amino acids varied only slightly from these. It is believed that the low organic nitrogen demonstrated for *Chlorella* culture 233 affected the detection limit of some of the amino acids in this culture medium, resulting in the greater qualitative variation. The demonstrated amino acid composition of these media denotes only a possible distribution since under other cultural conditions the protein composition and liberated substances of a single species may differ more than the differences between species.

A summary of the amino acids resolved, organic nitrogen and carbohydrate means in all samples is given in Table 7. Cysteine and histidine were too low in concentration for detection in any of the samples. Alanine, aspartic acid, glutamic acid, leucine, and phenylalanine were found in the majority of samples, usually in relatively high concentrations. These findings are in agreement with Tatsumoto *et al.*, (1961). The other amino acids varied in concentration and distribution. Even though the organic nitrogen in sea water is exiguous, it

Table 5. Chemical and Hydrological Data from RT Stations.

Station	Location Long.	Lat.	Date	Depth	Temperature °C	Salinity ‰	pH	Organic Nitrogen
RT1-93S	82°38′32″W	27°42′05″N	8/24/64	S	31.2	22.9	8.3	27.50
	Pinellas Point							
RT2-83S	82°44′30″W	27°38′35″N	7/27/64	S	25.4	36.4	8.5	17.40
	Mullet Key							
RT2-92S	"	"	8/24/64	S	31.0	35.3	8.5	24.70
RT3-60S	82°34′52″W	27°19′08″N	5/18/64	S	29.3	35.4	*	43.84
	Lido Key							
RT3-60M	"	"	5/18/64	1¼′	28.5	35.8	*	17.80
RT3-82S	"	"	7/20/64	S	30.5	37.0	8.1	41.80
RT3-104S	"	"	9/21/64	S	27.9	35.3	8.3	19.43
RT3-104M	"	"	9/21/64	1¼′	27.9	35.0	8.4	9.43
RT4-59S	82°30′38″W	27°12′22″N	5/18/64	S	26.6	34.5	*	36.60
	Midnight Pass							
RT4-59M	"	"	5/18/64	1¼′	26.6	35.0	*	35.12
RT4-81S	"	"	7/20/64	S	30.0	36.8	8.3	10.10
RT4-90S	"	"	8/17/64	S	30.8	36.7	8.3	19.48
RT5-69S	82°21′34″W	26°53′57″N	6/ 8/64	S	28.9	38.7	8.5	17.84
	Stump Pass							
RT5-100S	"	"	9/ 3/64	S	29.5	35.9	8.1	19.68
RT5-102S	"	"	9/14/64	S	28.5	33.6	8.4	34.24
RT6-68S	82°15′35″W	26°43′52″N	6/ 8/64	S	29.3	38.3	8.6	19.48
	Boca Grande							
RT6-99S	"	"	9/ 3/64	S	30.0	34.5	8.1	15.74
RT6-101S	"	"	9/14/64	S	27.8	29.1	8.3	26.40
RT7-89S	82°02′20″W	26°27′12″N	8/ 4/64	S	31.5	35.8	8.7	18.35
	Sanibel Island							
RT7-98S	"	"	9/ 1/64	S	33.5	34.5	8.1	22.30
RT8-55M	82°53′ W	26°24′30″N	5/ 5/64	1′	24.9	34.2	*	26.21
	Big Carlos Pass							
RT8-55B	"	"	5/ 5/64	2½′	24.9	37.9	*	22.68
RT8-66S	"	"	6/ 2/64	S	29.4	38.8	8.5	36.52
RT8-77S	"	"	7/ 7/64	S	29.9	35.7	8.6	41.46
RT8-88S	"	"	8/ 4/64	S	31.0	34.2	8.8	17.72
RT8-97S	"	"	9/ 1/64	S	31.4	34.2	8.4	30.24
RT9-65S	81°42′W	25°54′30″N	6/ 1/64	S	29.5	37.9	8.3	18.92
	Caxambas Pass							
RT9-76S	"	"	7/ 7/64	S	30.1	36.6	8.4	26.20
RT9-87S	"	"	8/ 4/64	S	30.0	37.1	8.7	18.72
RT9-96S	"	"	9/ 1/64	S	30.5	36.8	8.3	21.36
RT10-75S	82°36′38″W	27°50′35″N	6/22/64	S	32.8	27.5	8.4	36.06
	Weedon Point							
RT10-86S	"	"	7/27/64	S	27.5	23.9	7.6	40.81
RT11-74S	82°29′05″W	27°53′39″N	6/22/64	S	33.6	24.6	8.3	26.75
	Ballast Point							

*No determination.
Organic nitrogen reported in μg-at N/liter.

Table 5. Chemical and Hydrological Data from RT Stations.

Station	Location Long.	Lat.	Date	Depth	Temperature °C	Salinity ‰	pH	Organic Nitrogen
RT1-93S	82°38′32″W	27°42′05″N	8/24/64	S	31.2	22.9	8.3	27.50
	Pinellas Point							
RT2-83S	82°44′30″W	27°38′35″N	7/27/64	S	25.4	36.4	8.5	17.40
	Mullet Key							
RT2-92S	"	"	8/24/64	S	31.0	35.3	8.5	24.70
RT3-60S	82°34′52″W	27°19′08″N	5/18/64	S	29.3	35.4	*	43.84
	Lido Key							
RT3-60M	"	"	5/18/64	1¼′	28.5	35.8	*	17.80
RT3-82S	"	"	7/20/64	S	30.5	37.0	8.1	41.80
RT3-104S	"	"	9/21/64	S	27.9	35.3	8.3	19.43
RT3-104M	"	"	9/21/64	1¼′	27.9	35.0	8.4	9.43
RT4-59S	82°30′38″W	27°12′22″N	5/18/64	S	26.6	34.5	*	36.60
	Midnight Pass							
RT4-59M	"	"	5/18/64	1¼′	26.6	35.0	*	35.12
RT4-81S	"	"	7/20/64	S	30.0	36.8	8.3	10.10
RT4-90S	"	"	8/17/64	S	30.8	36.7	8.3	19.48
RT5-69S	82°21′34″W	26°53′57″N	6/ 8/64	S	28.9	38.7	8.5	17.84
	Stump Pass							
RT5-100S	"	"	9/ 3/64	S	29.5	35.9	8.1	19.68
RT5-102S	"	"	9/14/64	S	28.5	33.6	8.4	34.24
RT6-68S	82°15′35″W	26°43′52″N	6/ 8/64	S	29.3	38.3	8.6	19.48
	Boca Grande							
RT6-99S	"	"	9/ 3/64	S	30.0	34.5	8.1	15.74
RT6-101S	"	"	9/14/64	S	27.8	29.1	8.3	26.40
RT7-89S	82°02′20″W	26°27′12″N	8/ 4/64	S	31.5	35.8	8.7	18.35
	Sanibel Island							
RT7-98S	"	"	9/ 1/64	S	33.5	34.5	8.1	22.30
RT8-55M	82°53′W	26°24′30″N	5/ 5/64	1′	24.9	34.2	*	26.21
	Big Carlos Pass							
RT8-55B	"	"	5/ 5/64	2½′	24.9	37.9	*	22.68
RT8-66S	"	"	6/ 2/64	S	29.4	38.8	8.5	36.52
RT8-77S	"	"	7/ 7/64	S	29.9	35.7	8.6	41.46
RT8-88S	"	"	8/ 4/64	S	31.0	34.2	8.8	17.72
RT8-97S	"	"	9/ 1/64	S	31.4	34.2	8.4	30.24
RT9-65S	81°42′W	25°54′30″N	6/ 1/64	S	29.5	37.9	8.3	18.92
	Caxambas Pass							
RT9-76S	"	"	7/ 7/64	S	30.1	36.6	8.4	26.20
RT9-87S	"	"	8/ 4/64	S	30.0	37.1	8.7	18.72
RT9-96S	"	"	9/ 1/64	S	30.5	36.8	8.3	21.36
RT10-75S	82°36′38″W	27°50′35″N	6/22/64	S	32.8	27.5	8.4	36.06
	Weedon Point							
RT10-86S	"	"	7/27/64	S	27.5	23.9	7.6	40.81
RT11-74S	82°29′05″W	27°53′39″N	6/22/64	S	33.6	24.6	8.3	26.75
	Ballast Point							

*No determination.
Organic nitrogen reported in μg-at-N/liter.

Table 5. Chemical and Hydrological Data from RT Stations.

Station	Location Long.	Lat.	Date	Depth	Temperature °C	Salinity ‰	pH	Organic Nitrogen
RT1-93S	82°38′32″W	27°42′05″N	8/24/64	S	31.2	22.9	8.3	27.50
	Pinellas Point							
RT2-83S	82°44′30″W	27°38′35″N	7/27/64	S	25.4	36.4	8.5	17.40
	Mullet Key							
RT2-92S	"	"	8/24/64	S	31.0	35.3	8.5	24.70
RT3-60S	82°34′52″W	27°19′08″N	5/18/64	S	29.3	35.4	*	43.84
	Lido Key							
RT3-60M	"	"	5/18/64	1¼′	28.5	35.8	*	17.80
RT3-82S	"	"	7/20/64	S	30.5	37.0	8.1	41.80
RT3-104S	"	"	9/21/64	S	27.9	35.3	8.3	19.43
RT3-104M	"	"	9/21/64	1¼′	27.9	35.0	8.4	9.43
RT4-59S	82°30′38″W	27°12′22″N	5/18/64	S	26.6	34.5	*	36.60
	Midnight Pass							
RT4-59M	"	"	5/18/64	1¼′	26.6	35.0	*	35.12
RT4-81S	"	"	7/20/64	S	30.0	36.8	8.3	10.10
RT4-90S	"	"	8/17/64	S	30.8	36.7	8.3	19.48
RT5-69S	82°21′34″W	26°53′57″N	6/ 8/64	S	28.9	38.7	8.5	17.84
	Stump Pass							
RT5-100S	"	"	9/ 3/64	S	29.5	35.9	8.1	19.68
RT5-102S	"	"	9/14/64	S	28.5	33.6	8.4	34.24
RT6-68S	82°15′35″W	26°43′52″N	6/ 8/64	S	29.3	38.3	8.6	19.48
	Boca Grande							
RT6-99S	"	"	9/ 3/64	S	30.0	34.5	8.1	15.74
RT6-101S	"	"	9/14/64	S	27.8	29.1	8.3	26.40
RT7-89S	82°02′20″W	26°27′12″N	8/ 4/64	S	31.5	35.8	8.7	18.35
	Sanibel Island							
RT7-98S	"	"	9/ 1/64	S	33.5	34.5	8.1	22.30
RT8-55M	82°53′ W	26°24′30″N	5/ 5/64	1′	24.9	34.2	*	26.21
	Big Carlos Pass							
RT8-55B	"	"	5/ 5/64	2½′	24.9	37.9	*	22.68
RT8-66S	"	"	6/ 2/64	S	29.4	38.8	8.5	36.52
RT8-77S	"	"	7/ 7/64	S	29.9	35.7	8.6	41.46
RT8-88S	"	"	8/ 4/64	S	31.0	34.2	8.8	17.72
RT8-97S	"	"	9/ 1/64	S	31.4	34.2	8.4	30.24
RT9-65S	81°42′W	25°54′30″N	6/ 1/64	S	29.5	37.9	8.3	18.92
	Caxambas Pass							
RT9-76S	"	"	7/ 7/64	S	30.1	36.6	8.4	26.20
RT9-87S	"	"	8/ 4/64	S	30.0	37.1	8.7	18.72
RT9-96S	"	"	9/ 1/64	S	30.5	36.8	8.3	21.36
RT10-75S	82°36′38″W	27°50′35″N	6/22/64	S	32.8	27.5	8.4	36.06
	Weedon Point							
RT10-86S	"	"	7/27/64	S	27.5	23.9	7.6	40.81
RT11-74S	82°29′05″W	27°53′39″N	6/22/64	S	33.6	24.6	8.3	26.75
	Ballast Point							

*No determination.
Organic nitrogen reported in μg-at N/liter.

Table 1. Carbohydrate Values and Hydrographic Data from RT Stations.

Station RT-1	PINELLAS POINT		27°42′05″N	82°38′32″W		
Sample	62M	73M	84M	93M	106M	
$(CHO)_x$	0.56	1.39	0.72	1.04	0.51	
Date	5/25/64	6/22/64	7/27/64	8/24/64	9/28/64	
Temp.	27.2	30.4	27.4	30.8	27.3	
Salinity	29.3	30.9	32.0	22.9	26.9	
Tide	Ebb	Ebb	Ebb	Ebb	Ebb	
Depth	2 1/2′	2 1/2′	2 1/2′	2 1/2′	2′	
Station RT-2	MULLET KEY		27°38′35″N	82°44′30″W		
Sample	61M	72M	83M	92M	105M	
$(CHO)_x$	0.56	0.90	0.63	2.13	0.57	
Date	5/25/64	6/22/64	7/27/64	8/24/64	5/25/64	
Temp.	27.3	30.9	25.4	31.0	27.2	
Salinity	35.0	36.5	36.4	35.4	32.1	
Tide	Ebb	Ebb	Flood	Flood	Ebb	
Depth	2 1/2′	2 1/2′	2 1/2′	2 1/2′	2 1/2′	
Station RT-3	LIDO KEY		27°19′08″N	82°34′52″W		
Sample	60M	71M	82M	91M	104M	115M
$(CHO)_x$	1.98	1.23	0.72	1.13	0.45	0.39
Date	5/18/64	6/15/64	7/20/64	8/17/64	9/21/64	10/19/64
Temp.	28.5	31.4	30.4	31.2	27.9	24.2
Salinity	38.4	38.3	37.0	37.0	36.1	36.5
Tide	Ebb	Flood	Ebb	Ebb	Flood	Flood
Depth	2 1/2′	2 1/4′	3′	2 1/2′	2 1/2′	3′
Station RT-4	MIDNIGHT PASS		27°12′22″N	82°30′38″W		
Sample	59M	70M	81M	90M	103M	114M
$(CHO)_x$	1.66	0.50	0.23	0.87	0.30	0.79
Date	5/18/64	6/15/64	7/20/64	8/17/64	9/21/64	10/19/64
Temp.	26.6	29.9	30.0	30.8	27.2	23.0
Salinity	37.8	38.2	36.8	36.7	36.6	35.0
Tide	Ebb	Flood	Ebb	Ebb	Flood	Flood
Depth	2 1/2′	2 1/2′	3′	3′	2 1/2′	3′
Station RT-5	STUMP PASS		26°53′57″N	82°20′37″W		
Sample	58M	69M	80M	100M	102M	113M
$(CHO)_x$	1.73	0.50	1.32	0.51	0.91	0.13
Date	5/11/64	6/ 8/64	7/13/64	9/ 3/64	9/14/64	10/12/64
Temp.	27.1	28.8	31.2	29.5	28.5	24.1
Salinity	37.5	38.7	36.8	35.9	33.6	35.4
Tide	Flood	Ebb	Flood	Ebb	Ebb	Ebb
Depth	2 1/2′	2 1/2′	2 1/2′	3′	3′	2 1/2′
Station RT-6	BOCA GRANDE		26°43′52″N	82°15′35″W		
Sample	57M	68M	79M	99M	101M	112M
$(CHO)_x$	1.89	0.47	1.45	0.51	0.89	0.80
Date	5/11/64	6/ 8/64	7/13/64	9/ 3/64	9/14/64	10/12/64
Temp.	27.1	29.1	31.5	30.1	27.7	24.3
Salinity	37.7	38.3	36.2	34.5	29.1	30.5
Tide	Flood	Flood	Flood	Flood	Ebb	Ebb
Depth	4′	4′	3′	4′	3′	2 1/2′
Station RT-7	SANIBEL ISLAND		26°27′12″N	82°02′20″W		
Sample	56M	67M	78M	89M	98M	111M
$(CHO)_x$	1.45	0.50	0.64	1.20	0.47	0.50
Date	5/ 5/64	6/ 2/64	7/ 7/64	8/ 4/64	9/ 1/64	10/ 6/64
Temp.	25.5	29.4	31.5	32.0	33.4	26.7
Salinity	37.6	38.8	37.7	35.8	34.5	26.4
Tide	Flood	Flood	Flood	Ebb	Ebb	Flood
Depth	2 1/2′	2 1/2′	2 1/2′	2 1/2′	2 1/2′	2 1/2′

Table 1. Carbohydrate Values and Hydrographic Data from RT Stations.

Station RT-1	PINELLAS POINT		27°42′05″N	82°38′32″W		
Sample	62M	73M	84M	93M	106M	
$(CHO)_x$	0.56	1.39	0.72	1.04	0.51	
Date	5/25/64	6/22/64	7/27/64	8/24/64	9/28/64	
Temp.	27.2	30.4	27.4	30.8	27.3	
Salinity	29.3	30.9	32.0	22.9	26.9	
Tide	Ebb	Ebb	Ebb	Ebb	Ebb	
Depth	2 1/2′	2 1/2′	2 1/2′	2 1/2′	2′	
Station RT-2	MULLET KEY		27°38′35″N	82°44′30″W		
Sample	61M	72M	83M	92M	105M	
$(CHO)_x$	0.56	0.90	0.63	2.13	0.57	
Date	5/25/64	6/22/64	7/27/64	8/24/64	5/25/64	
Temp.	27.3	30.9	25.4	31.0	27.2	
Salinity	35.0	36.5	36.4	35.4	32.1	
Tide	Ebb	Ebb	Flood	Flood	Ebb	
Depth	2 1/2′	2 1/2′	2 1/2′	2 1/2′	2 1/2′	
Station RT-3	LIDO KEY		27°19′08″N	82°34′52″W		
Sample	60M	71M	82M	91M	104M	115M
$(CHO)_x$	1.98	1.23	0.72	1.13	0.45	0.39
Date	5/18/64	6/15/64	7/20/64	8/17/64	9/21/64	10/19/64
Temp.	28.5	31.4	30.4	31.2	27.9	24.2
Salinity	38.4	38.3	37.0	37.0	36.1	36.5
Tide	Ebb	Flood	Ebb	Ebb	Flood	Flood
Depth	2 1/2′	2 1/4′	3′	2 1/2′	2 1/2′	3′
Station RT-4	MIDNIGHT PASS		27°12′22″N	82°30′38″W		
Sample	59M	70M	81M	90M	103M	114M
$(CHO)_x$	1.66	0.50	0.23	0.87	0.30	0.79
Date	5/18/64	6/15/64	7/20/64	8/17/64	9/21/64	10/19/64
Temp.	26.6	29.9	30.0	30.8	27.2	23.0
Salinity	37.8	38.2	36.8	36.7	36.6	35.0
Tide	Ebb	Flood	Ebb	Ebb	Flood	Flood
Depth	2 1/2′	2 1/2′	3′	3′	2 1/2′	3′
Station RT-5	STUMP PASS		26°53′57″N	82°20′37″W		
Sample	58M	69M	80M	100M	102M	113M
$(CHO)_x$	1.73	0.50	1.32	0.51	0.91	0.13
Date	5/11/64	6/ 8/64	7/13/64	9/ 3/64	9/14/64	10/12/64
Temp.	27.1	28.8	31.2	29.5	28.5	24.1
Salinity	37.5	38.7	36.8	35.9	33.6	35.4
Tide	Flood	Ebb	Flood	Ebb	Ebb	Ebb
Depth	2 1/2′	2 1/2′	2 1/2′	3′	3′	2 1/2′
Station RT-6	BOCA GRANDE		26°43′52″N	82°15′35″W		
Sample	57M	68M	79M	99M	101M	112M
$(CHO)_x$	1.89	0.47	1.45	0.51	0.89	0.80
Date	5/11/64	6/ 8/64	7/13/64	9/ 3/64	9/14/64	10/12/64
Temp.	27.1	29.1	31.5	30.1	27.7	24.3
Salinity	37.7	38.3	36.2	34.5	29.1	30.5
Tide	Flood	Flood	Flood	Flood	Ebb	Ebb
Depth	4′	4′	3′	4′	3′	2 1/2′
Station RT-7	SANIBEL ISLAND		26°27′12″N	82°02′20″W		
Sample	56M	67M	78M	89M	98M	111M
$(CHO)_x$	1.45	0.50	0.64	1.20	0.47	0.50
Date	5/ 5/64	6/ 2/64	7/ 7/64	8/ 4/64	9/ 1/64	10/ 6/64
Temp.	25.5	29.4	31.5	32.0	33.4	26.7
Salinity	37.6	38.8	37.7	35.8	34.5	26.4
Tide	Flood	Flood	Flood	Ebb	Ebb	Flood
Depth	2 1/2′	2 1/2′	2 1/2′	2 1/2′	2 1/2′	2 1/2′

Table 1. Carbohydrate Values and Hydrographic Data from RT Stations.

Station RT-1	PINELLAS POINT		27°42′05″N	82°38′32″W		
Sample	62M	73M	84M	93M	106M	
$(CHO)_x$	0.56	1.39	0.72	1.04	0.51	
Date	5/25/64	6/22/64	7/27/64	8/24/64	9/28/64	
Temp.	27.2	30.4	27.4	30.8	27.3	
Salinity	29.3	30.9	32.0	22.9	26.9	
Tide	Ebb	Ebb	Ebb	Ebb	Ebb	
Depth	2 1/2′	2 1/2′	2 1/2′	2 1/2′	2′	
Station RT-2	MULLET KEY		27°38′35″N	82°44′30″W		
Sample	61M	72M	83M	92M	105M	
$(CHO)_x$	0.56	0.90	0.63	2.13	0.57	
Date	5/25/64	6/22/64	7/27/64	8/24/64	5/25/64	
Temp.	27.3	30.9	25.4	31.0	27.2	
Salinity	35.0	36.5	36.4	35.4	32.1	
Tide	Ebb	Ebb	Flood	Flood	Ebb	
Depth	2 1/2′	2 1/2′	2 1/2′	2 1/2′	2 1/2′	
Station RT-3	LIDO KEY		27°19′08″N	82°34′52″W		
Sample	60M	71M	82M	91M	104M	115M
$(CHO)_x$	1.98	1.23	0.72	1.13	0.45	0.39
Date	5/18/64	6/15/64	7/20/64	8/17/64	9/21/64	10/19/64
Temp.	28.5	31.4	30.4	31.2	27.9	24.2
Salinity	38.4	38.3	37.0	37.0	36.1	36.5
Tide	Ebb	Flood	Ebb	Ebb	Flood	Flood
Depth	2 1/2′	2 1/4′	3′	2 1/2′	2 1/2′	3′
Station RT-4	MIDNIGHT PASS		27°12′22″N	82°30′38″W		
Sample	59M	70M	81M	90M	103M	114M
$(CHO)_x$	1.66	0.50	0.23	0.87	0.30	0.79
Date	5/18/64	6/15/64	7/20/64	8/17/64	9/21/64	10/19/64
Temp.	26.6	29.9	30.0	30.8	27.2	23.0
Salinity	37.8	38.2	36.8	36.7	36.6	35.0
Tide	Ebb	Flood	Ebb	Ebb	Flood	Flood
Depth	2 1/2′	2 1/2′	3′	3′	2 1/2′	3′
Station RT-5	STUMP PASS		26°53′57″N	82°20′37″W		
Sample	58M	69M	80M	100M	102M	113M
$(CHO)_x$	1.73	0.50	1.32	0.51	0.91	0.13
Date	5/11/64	6/ 8/64	7/13/64	9/ 3/64	9/14/64	10/12/64
Temp.	27.1	28.8	31.2	29.5	28.5	24.1
Salinity	37.5	38.7	36.8	35.9	33.6	35.4
Tide	Flood	Ebb	Flood	Ebb	Ebb	Ebb
Depth	2 1/2′	2 1/2′	2 1/2′	3′	3′	2 1/2′
Station RT-6	BOCA GRANDE		26°43′52″N	82°15′35″W		
Sample	57M	68M	79M	99M	101M	112M
$(CHO)_x$	1.89	0.47	1.45	0.51	0.89	0.80
Date	5/11/64	6/ 8/64	7/13/64	9/ 3/64	9/14/64	10/12/64
Temp.	27.1	29.1	31.5	30.1	27.7	24.3
Salinity	37.7	38.3	36.2	34.5	29.1	30.5
Tide	Flood	Flood	Flood	Flood	Ebb	Ebb
Depth	4′	4′	3′	4′	3′	2 1/2′
Station RT-7	SANIBEL ISLAND		26°27′12″N	82°02′20″W		
Sample	56M	67M	78M	89M	98M	111M
$(CHO)_x$	1.45	0.50	0.64	1.20	0.47	0.50
Date	5/ 5/64	6/ 2/64	7/ 7/64	8/ 4/64	9/ 1/64	10/ 6/64
Temp.	25.5	29.4	31.5	32.0	33.4	26.7
Salinity	37.6	38.8	37.7	35.8	34.5	26.4
Tide	Flood	Flood	Flood	Ebb	Ebb	Flood
Depth	2 1/2′	2 1/2′	2 1/2′	2 1/2′	2 1/2′	2 1/2′