OCCURRENCE OF MACROZOOPLANKTON IN TAMPA BAY, FLORIDA, AND THE ADJACENT GULF OF MEXICO[1]

By John A. Kelly, Jr., and Alexander Dragovich, *Fishery Biologists*, Bureau of Commercial Fisheries Biological Laboratory, St. Petersburg Beach, Florida, 33706

ABSTRACT

This report describes a 12-month (September 1961 through August 1962) study. Plankton was collected at 14 locations with a No. 000, one-half meter net, which strained an estimated 35 m.³ of water per tow. Wet plankton volumes varied from < 0.5 to 92.0 ml. and averaged 7.0 ml. per tow. Fifty-two percent (by volume) of the plankton was collected in the summer, 25 percent in the fall, 18 percent in the spring, and 5 percent in the winter. *Lucifer faxoni*, the most numerous organism, accounted for 18.5 percent of the total plankton volume.

Sixteen species, 24 genera, 30 families, and 21 taxonomic categories higher than family were identified. Decapod crustaceans accounted for 87 percent of the total number of zooplankters collected. The most numerous organisms, in descending order were *Lucifer faxoni*, larval porcellanids, brachyurans, chaetognaths, copepods, larval polychaetes, carideans, appendicularids, larval fish, fish eggs, thallassinids, cladocerans, and larval stomatopods. Larval forms of commercially important species were *Penaeus duorarum*, *Brevoortia* spp., *Anchoa* sp., *Trachinotus* spp., *Leiostomus xanthurus*, *Cynoscion* spp., and Soleidae.

Observed temperature ranged from 12.8° to 32.0° C. and salinity from 19.00 to 36.00 p.p.t. In relating the abundance of zooplankton to temperature and salinity the data suggested that low temperatures and salinity values were more restrictive than high ones to most of the organisms.

A study of macrozooplankton was undertaken as part of an investigation of estuarine biology in the eastern Gulf of Mexico. The primary aim was to determine temporal and spatial variations in the abundance of macrozooplankton in the surface waters of Tampa Bay and the adjacent Gulf of Mexico, and to relate the occurrence of frequently collected taxa to water temperature and salinity.

The abundance and composition of zooplankton provide an important index of biological production in estuaries, because zooplankters are the basic food of many marine organisms. Mysids, euphausids, amphipods, larval stomatopods, and fish larvae are frequent in stomachs of commercially important fishes (King, 1954). The bulk of this plankton, however, reaches large fish indirectly through their consumption of foraging organisms.

The literature on zooplankton in the coastal waters of west Florida is limited. No reports deal with the seasonal composition of zooplankton throughout Tampa Bay. Published material includes: a description of certain biological, taxonomic, and ecological aspects of the chaetognaths of the west coast of Florida (Pierce, 1951); notes on chaetognaths from the Gulf of Mexico (Tokioka, 1955); the seasonal distribution of penaeid larvae from the lower portion of Tampa Bay, Fla., and the adjacent Gulf of Mexico waters (Eldred, Williams, Martin, and Joyce, 1965); a qualitative and quantitative seasonal study of the copepods of Alligator Harbor (Grice, 1956); studies of the taxonomy of several calanoid copepods in the eastern Gulf of Mexico (Fleminger, 1957a and 1957b); a preliminary report on the plankton of the west coast of Florida with a discussion of the distribution and occurrence of copepods and other crustaceans (King, 1949); and records of various taxa from the marine and brackish waters of south Florida (Davis, 1947, 1948, 1949, 1950; Davis and Williams, 1950; and Dragovich, 1963).

DESCRIPTION OF THE AREA

Tampa Bay is a shallow embayment consisting of five sub-areas, also identified as bays—

[1] Contribution No. 27, Bureau of Commercial Fisheries Biological Laboratory, St. Petersburg Beach, Fla.

Published April 1967.

Old Tampa Bay, Hillsborough Bay, Tampa Bay, Boca Ciega Bay, and Terra Ceia Bay. Collectively, these areas have a shoreline of 341 km. and cover an area of 896 km.^{2}, 90 percent of which is less than 6.7 m. deep (Olson and Morrill, 1955).[2] The principal tributaries of Tampa Bay are the Hillsborough, Alafia, Manatee, and Little Manatee Rivers. Their discharge is largely influenced by rainfall (Dragovich and May, 1962) and is subordinate to tidal exchange in the circulation of Bay water (Goodell and Gorsline, 1961).

The climate of the Bay area is subtropical. The mean monthly air temperature at Tampa, Fla., averages 22.3° C. annually and varies from 16.2° C. (January) to 27.8° C. (August)[3]. The rainy season in the Tampa Bay area usually extends from June to October. Mean rainfall varies monthly from 3.7 cm. (November) to 21.9 cm. (July) and totals 131.0 cm. annually.

[2] Olson, F. C. W., and John B. Morrill, Jr. 1955. Literature survey of the Tampa Bay area. Armed Serv. Tech. Info. Agency, AD 81621 (Pt. 1): 66 p.p.

[3] The rainfall and temperature data used in this section are climatological normals (1931–60) compiled by the U.S. Department of Commerce, Weather Bureau, and published in the 1964 Annual Summary of Climatological Data For Tampa, Fla.

APPARATUS AND METHODS

FIELD PROCEDURES

Plankton was sampled monthly in Tampa Bay and adjacent waters of the Gulf of Mexico from September 1961 through August 1962 (table 1). Surface samples were collected at 14 stations (fig. 1 and table 2) with a No. 000, ½-m., nylon plankton net (mesh size 1.024 mm.). This net was selected primarily for the collection of larval fishes and invertebrates. Tows were made at 5.6 km. per hour (3 knots) for 2 minutes and randomly with respect to tidal stage. Vessel speed was determined before sampling by clocking elapsed time over a known distance. Net-towing rates were held

TABLE 2.—*Sampling locations in Tampa Bay and the adjacent Gulf of Mexico, September 1961–August 1962*

Station	Latitude N.	Longitude W.	Area description
1	27°35.8′	82°57.1′	10 miles (18.5 km.) offshore
2	27°36.0′	82°50.0′	3½ miles (6.5 km.) offshore
3	27°35.5′	82°45.5′	Egmont Key
4	27°32.7′	82°43.7′	Lower Tampa Bay
5	27°38.8′	82°42.7′	Boca Ciega Bay
6	27°41.5′	82°44.1′	Boca Ciega Bay
7	27°42.2′	82°40.5′	Boca Ciega Bay
8	27°33.0′	82°35.7′	Terra Ceia Bay
9	27°41.3′	82°32.9′	Central Tampa Bay
10	27°47.6′	82°34.4′	Upper Tampa Bay
11	27°56.6′	82°37.0′	Central Old Tampa Bay
12	28°00.9′	82°40.7′	Upper Old Tampa Bay
13	27°48.7′	82°26.8′	Lower Hillsborough Bay
14	27°53.7′	82°26.4′	Upper Hillsborough Bay

TABLE 1.—*Dates and numbers of plankton tows in Tampa Bay and the adjacent Gulf of Mexico, September 1961 through August 1962*

Dates	Stations														All stations
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	
	Number of plankton tows														
Fall															
Sept. 18–27, 1961	1	1	1	1	1	1	1	1	1	1	1	1	1	1	14
Oct. 2–30	1	1	1	1	2	2	2	1	1	1	1	1	1	1	17
Nov. 1–30	2	2	2	1	2	2	2	2	2	2	2	3	2	2	28
Season total	4	4	4	3	5	5	5	4	4	4	4	5	4	4	59
Winter															
Dec. 11–12, 1961	2	2	2	2	2	2	2	2	2	2	2	2	2	2	28
Jan. 8–26, 1962	2	2	2	2	2	2	2	2	1	2	2	2	1	1	25
Feb. 5–10	0	0	0	0	2	2	2	0	0	1	1	2	1	1	12
Season total	4	4	4	4	6	6	6	4	3	5	5	6	4	4	65
Spring															
Mar. 8–29, 1962	1	1	1	1	2	2	2	1	1	1	1	2	1	1	18
Apr. 9–26	2	2	2	2	2	2	2	2	2	2	2	2	2	2	28
May 7–29	1	1	1	1	2	1	2	1	2	2	2	1	2	2	21
Season total	4	4	4	4	6	5	6	4	5	5	5	5	5	5	67
Summer															
Jun. 11–28, 1962	2	2	2	2	2	2	2	2	2	2	2	2	2	2	28
Jul. 9–25	2	2	2	2	2	2	2	1	2	2	2	1	2	2	26
Aug. 6–27	2	2	2	2	2	2	2	2	1	2	2	1	0	0	22
Season total	6	6	6	6	6	6	6	5	5	6	6	4	4	4	76
Total for 12 months	18	18	18	17	23	22	23	17	17	20	20	20	17	17	267

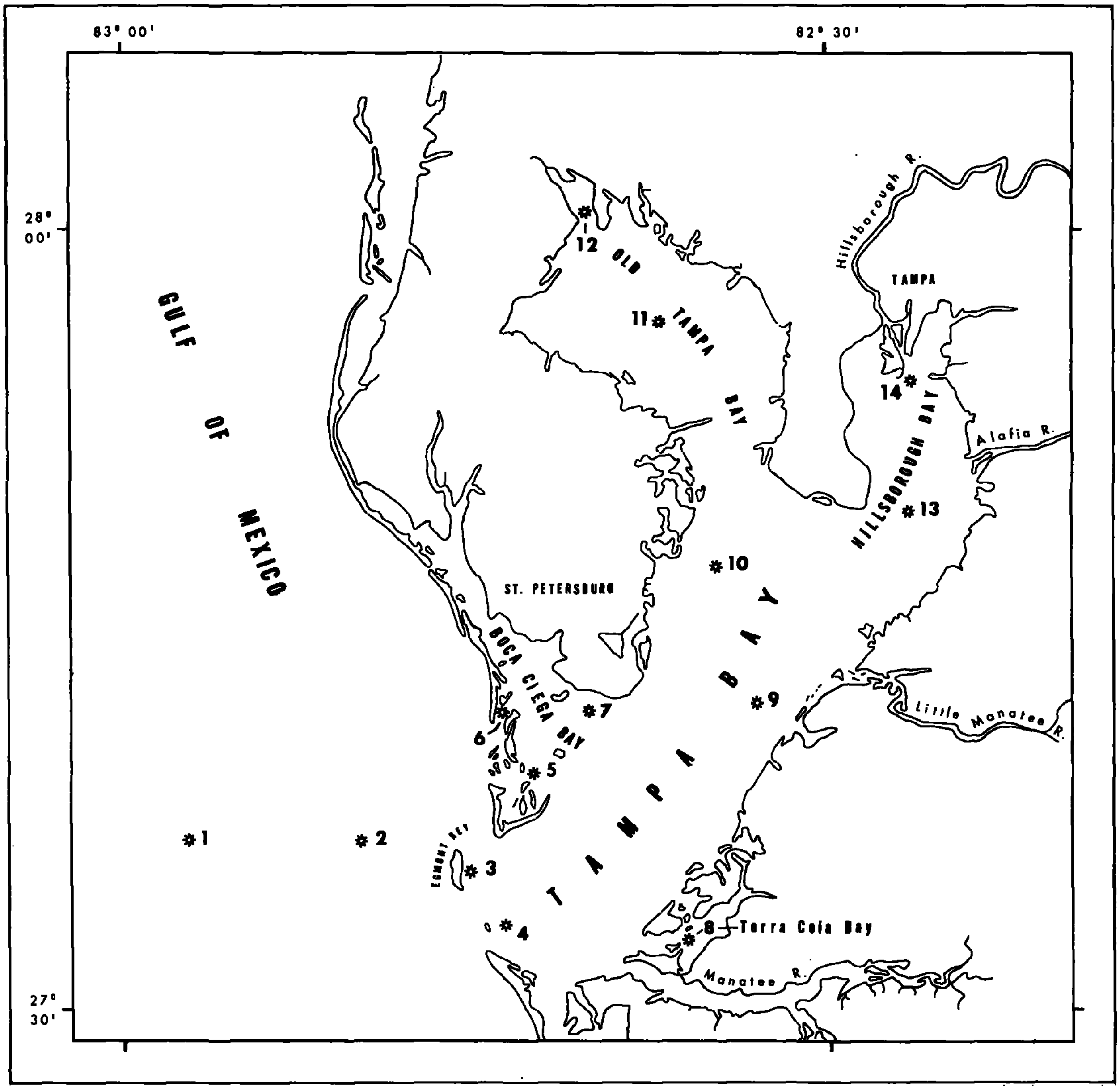

FIGURE 1.—Sampling locations in Tampa Bay and the adjacent Gulf of Mexico.

nearly constant by maintaining a fixed engine speed. The volume of the cylinder of water strained through the net was determined to be 35 $m.^3$ (calculated from the towing distance and the area of the net mouth). Since no correction was made to adjust for the effects of currents and clogging on the flow of water through the net, the quantitative data are not exact.

Plankton samples were preserved immediately after their collection in 5 percent neutralized formalin and stored in 30-oz. jars.

Water temperature and water sample (for salinity titration) were taken at the beginning of each plankton tow. Temperature was read to the nearest 0.1° C. with a thermister (Whitney[4] underwater thermometer, Model TC-5).

[4] References to trade names in this publication do not imply endorsement of commercial products.

LABORATORY PROCEDURES

Plankton samples were placed in enameled photographic trays. Seaweeds and jelly fishes were removed from the samples manually, and the remaining volume was determined in the laboratory by the displacement method described by Thrailkill (1957). Plankton counts were made from aliquots whenever the wet plankton volume of the sample exceeded 0.5 ml. After the sample had been diluted to a known volume, usually 500 ml., four 5-ml. aliquots were withdrawn with a calibrated pipette. They were then transferred into a quadripartitioned petri dish for examination and counting under a binocular dissecting microscope. Samples having a wet volume of 0.5 ml. or less were transferred directly to petri dishes for counting. All samples were examined routinely for unusual organisms that might have been excluded from the aliquots. The mean number of organisms per cubic meter of water was calculated for each taxonomic group.

Body lengths of chaetognaths and fish larvae were measured-chaetognaths from the anterior extermity of the head to the tip of the caudal segment, excluding the caudal fin (Owre, 1960), and fish larvae from the snout to the base of the hypural plate (standard length).

ENVIRONMENTAL FACTORS

HYDROLOGY

The minimum and maximum water temperatures observed were 12.8° and 32.0° C. The smallest range in temperature at individual stations occurred in Boca Ciega Bay (15.3° C.), and the greatest (18.4° C.) in Old Tampa Bay (table 3). Seasonally, the range in mean temperatures between stations located on a traverse from offshore to Hillsborough Bay (stations 1, 2, 3, 4, 9, 10, 13, 14) was greatest in the spring (3.9° C.) and lowest in the winter (1.0° C.). These ranges in the fall and summer were 1.7° and 1.2° C. respectively.

Salinity was determined by Mohr-Knudsen method (Knudsen, 1901). Lowest salinities were usually in the upper area of Hillsborough Bay and highest 18.5 km. (10 nautical miles) offshore (table 3). The seasonal differences in mean salinities between these two areas (stations 1 and 14) were 8.62 p.p.t. (fall), 6.75 p.p.t. (winter), 8.03 p.p.t. (spring), and 13.58 p.p.t. (summer). The range in salinity at individual stations decreased progressively from upper Hillsborough Bay seaward. The smallest range was 18.5 km. offshore and the greatest in upper Hillsborough Bay, where temporal changes in salinity generally followed the dis-

TABLE 3.—*Mean surface water temperature and salinity for Tampa Bay and the adjacent Gulf of Mexico, September 1961 through August 1962*

Seasons	Temperature at stations													
	1	2	3	4	5	6	7	8	9	10	11	12	13	14
	° C.	° C.	° C.	° C.	° C.	° C.	° C.	° C.	° C.	° C.	° C.	° C.	° C.	° C.
Fall	24.9	24.7	24.5	26.2	24.5	24.2	23.9	25.6	25.5	24.7	24.6	23.5	24.8	25.4
Winter	17.7	17.2	17.4	17.5	17.9	18.0	18.2	18.3	17.7	17.2	17.3	18.7	17.2	18.2
Spring	21.2	21.7	22.4	22.0	21.0	19.8	20.9	23.2	22.7	23.4	23.9	21.7	24.1	25.1
Summer	29.3	30.2	30.0	30.3	30.3	30.4	29.7	30.6	30.2	29.7	30.2	30.0	30.4	30.5
12 months	24.0	24.2	24.3	24.6	23.4	23.2	23.2	24.8	24.7	24.0	24.3	22.9	24.1	24.8
Minimum	15.3	15.1	15.4	15.4	14.3	15.2	15.4	15.1	15.4	13.8	13.2	12.8	13.4	13.8
Maximum	30.9	31.2	31.4	31.4	31.9	31.4	30.7	31.5	31.6	30.6	31.6	31.2	31.2	32.0
12-month range	15.6	16.1	16.0	16.0	17.6	16.2	15.3	16.4	16.2	16.8	18.4	18.4	17.8	18.2
	Salinity at stations													
	1	2	3	4	5	6	7	8	9	10	11	12	13	14
	‰	‰	‰	‰	‰	‰	‰	‰	‰	‰	‰	‰	‰	‰
Fall	34.96	34.54	34.03	33.80	32.30	32.94	31.82	31.15	29.53	28.29	25.73	24.66	27.27	26.34
Winter	34.45	33.64	33.82	33.20	33.01	33.22	32.01	31.96	30.52	29.39	27.76	26.86	28.38	27.70
Spring	34.89	34.30	33.76	33.97	33.90	33.79	32.44	31.57	31.19	29.45	29.06	28.52	28.10	26.86
Summer	35.67	35.31	34.99	35.16	33.98	34.62	32.59	30.56	29.46	27.90	28.46	28.05	25.96	22.09
12 months	35.07	34.52	34.23	34.18	33.34	33.67	32.23	31.26	30.17	28.74	27.89	26.96	27.46	25.81
Minimum	33.96	33.04	32.63	32.74	31.29	32.38	30.05	27.63	27.45	24.78	24.11	21.82	24.36	19.00
Maximum	35.93	36.00	35.58	36.00	35.35	35.39	34.33	33.68	33.13	30.79	29.83	29.67	29.85	28.51
12-month range	1.97	2.96	2.95	3.26	4.06	3.01	4.28	6.05	5.68	6.01	5.72	7.85	5.49	9.51

charges of the Hillsborough River [5]—the major source of river water to the bay (fig. 2).

[5] River discharge data (fig. 2) and rainfall data used in this section were taken from the 1961 and 1962 Surface Water Records of Florida, Vol. 1: Streams, compiled by the U.S. Department of the Interior, Geological Survey, and from the 1961 and 1962 Annual Summaries of Local Climatological Data for Tampa, Florida, published by the U.S. Department of Commerce, Weather Bureau.

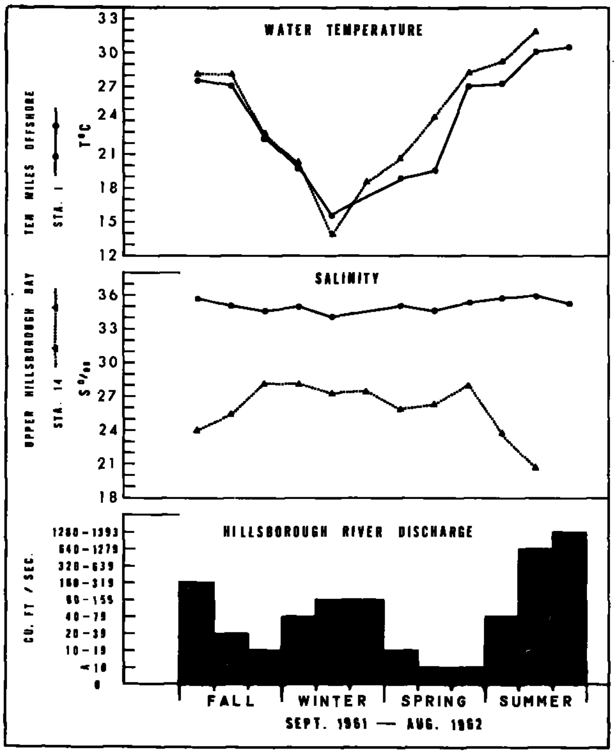

FIGURE 2.—Mean monthly discharge rate for the Hillsborough River and monthly surface water temperature and salinity for upper Hillsborough Bay (station 14) and 10 nautical miles offshore (station 1), September 1961 through August 1962. Mean values for temperature and salinity are given when two measurements of these variables were made in a month.

CLIMATOLOGY

Climatological data were taken from the records of the U.S. Weather Bureau for Tampa, Fla.

Rainfall was abnormally low during the study. From September 1961 through August 1962 total rainfall at Tampa, Fla., was 95.3 cm., 35.7 cm. below the climatological normal. Half of this amount (47.7 cm.) fell during the summer.

Mean monthly air temperatures at Tampa from September 1961 through August 1962 varied from 15.8° C. in January to 28.3° C. in July. Seasonally, mean air temperatures were 23.3° C. (fall), 16.7° C. (winter), 21.9° C. (spring), and 27.4° C. (summer).

ZOOPLANKTON VOLUMES

In 267 plankton tows, the volume of zooplankton per tow ranged from < 0.5 (considered as 0.25 ml. in all statistical treatments) to 92.0 ml. and averaged 7.0 ml. per sample. The greatest concentrations of macrozooplankton were in upper Tampa Bay, central Tampa Bay, lower Hillsborough Bay, central Old Tampa Bay, and 6.5 km. 3-½ nautical miles) offshore (fig. 3.

The abundance and composition of zooplankton varied widely by season and location. Twenty-five percent of the total volume was collected in the fall, 5 percent in the winter, 18 percent in the spring, and 52 percent in the summer (values adjusted for different numbers of tows per season). Coefficients of variation in zooplankton volume were calculated for each station to compare the areal variability of volumes (table 4). These coefficients

TABLE 4.—*Mean zooplankton volumes and the coefficients of variation of individual zooplankton volumes taken in Tampa Bay and the adjacent Gulf of Mexico, September 1961 through August 1962*

Seasons	Stations													
	1	2	3	4	5	6	7	8	9	10	11	12	13	14
	ml.	*ml.*	*ml.*	*ml.*	*ml.*	*ml.*	*ml.*	*ml.*	*ml.*	*ml.*	*ml.*	*ml.*	*ml.*	*ml.*
Fall	3.1	10.4	9.1	1.3	2.2	1.7	5.2	4.8	12.8	28.5	3.8	0.4	5.2	6.9
Winter	0.7	10.1	2.4	1.2	0.7	0.6	0.8	2.4	1.3	0.6	0.2	0.3	0.2	0.3
Spring	1.1	3.8	2.4	4.8	3.8	1.1	7.1	2.6	14.3	31.2	6.7	0.9	29.1	3.5
Summer	4.5	7.4	7.8	6.0	2.4	1.6	4.0	3.0	20.9	46.4	24.8	0.5	11.8	1.1
12 months	2.6	8.3	5.6	3.3	2.3	1.2	4.2	3.2	13.6	27.6	9.9	0.5	12.6	3.0
Minimum	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
Maximum	20.0	35.0	26.0	21.5	10.0	5.0	24.0	12.0	62.0	86.0	50.0	3.0	92.0	25.0
Coefficient of variation	170	120	130	140	110	140	140	100	120	100	150	140	170	190

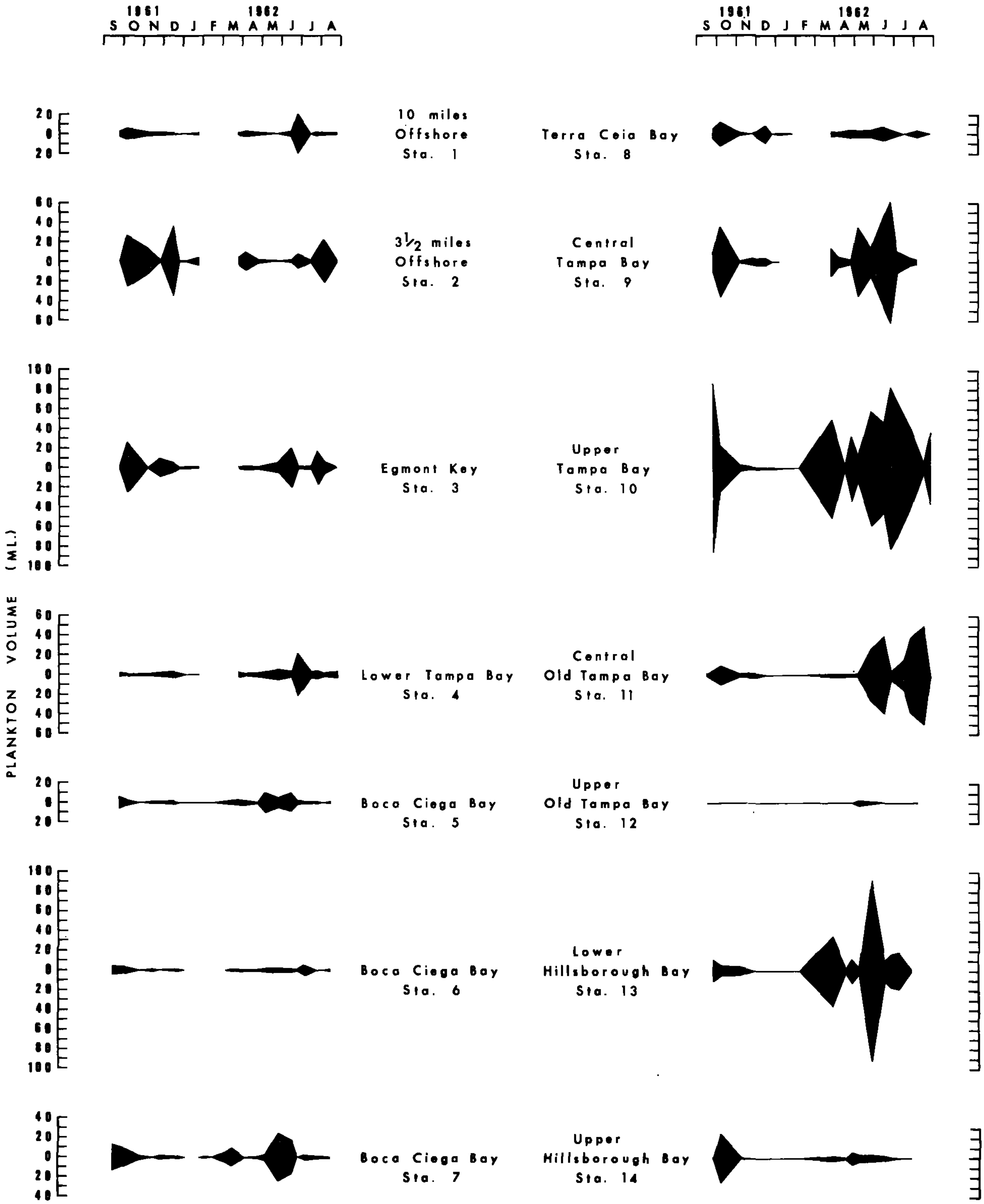

FIGURE 3.—Monthly plankton volumes for the surface waters of Tampa Bay and the adjacent Gulf of Mexico, September 1961 through August 1962. Plankton volume is expressed as milliliters per 35 m.³ of sea water.

varied from 100 to 190 percent. Greatest variations were at Hillsborough Bay and 18.5 km. offshore; minimum variations were in Terra Ceia Bay and in upper Tampa Bay.

CONSTITUENTS OF ZOOPLANKTON

The zooplankton consisted of holoplankton (53.5 percent), meroplankton (46.2 percent), and hypoplankton (0.3 percent). Most (87 percent) of the zooplankters in these categories were decapod crustaceans. Sixteen species, 24 genera, 30 families, and 21 taxonomic divisions higher than family were identified.

On the basis of abundance and frequency of occurrence the plankton is treated in three groups: major plankton; less abundant but frequently occurring and widely distributed organisms; and forms caught rarely.

MAJOR PLANKTON

Lucifer faxoni, larval porcellanids, and larval brachyurans, each of which accounted for 10 percent or more of the total number of organisms, were classified as major plankters. Collectively these taxa represented 83.5 percent of the zooplankton.

L. faxoni constituted 45.6 percent of the total number of zooplankters (table 5). It was the dominant zooplankter in Tampa Bay and was the only sergestid found. Most of the specimens were in the mastigopus phase, although protozoea and acanthosoma types were seen. It was collected at all stations and taken in numbers up to 1,051 per m.³; 52 percent of *L. faxoni* were collected from the upper and central areas of Tampa Bay. This species was the most numerous organism in the fall, winter, and summer (fig. 4). As a result of its large size and numbers, *L. faxoni* accounted for 18.5 percent of plankton biomass. The monthly peaks in its displacement volume corresponded generally with the monthly peaks in the total volume of plankton.

Porcellanid larvae (zoea and megalops stages) formed the second most abundant group of organisms. They accounted for 27.4 percent of the total number of zooplankters and were collected in numbers up to 2,634 per m.³ They were most numerous in upper Tampa Bay and lower Hillsborough Bay and during the spring were the dominant organism in the area of investigation.

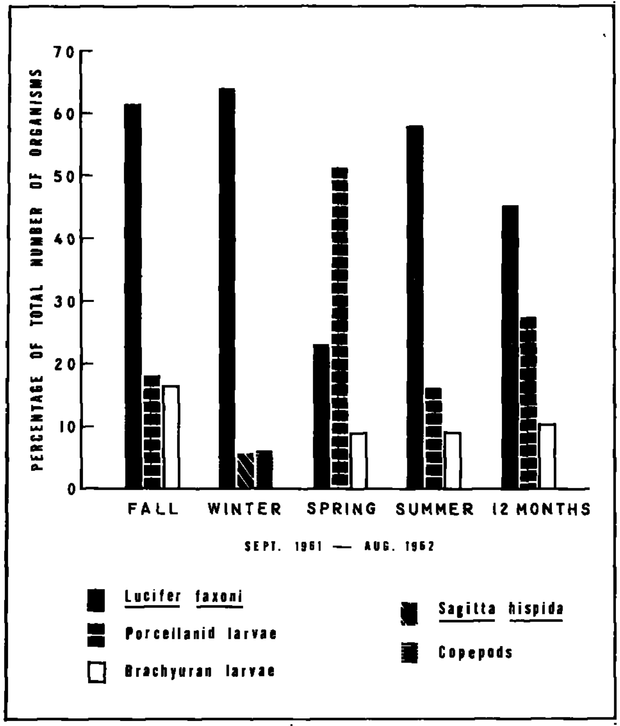

FIGURE 4.—Zooplankton taxa from Tampa Bay and the adjacent Gulf of Mexico that accounted for 5 percent or more of the organisms found during the periods shown, September 1961 through August 1962.

Except for Dromiidae, larval brachyurans were not identified to family and were classed only as zoea or megalops. Collectively they constituted 10.5 percent of the total number of zooplankters, and were the third-most-abundant taxon. Zoea and megalops were collected in numbers up to 251 per m.³ and 51 m.³ respectively. They were found at every station but appeared most abundantly in upper Tampa Bay and least abundantly in upper Old Tampa Bay. During the winter, megalops were absent at all stations in the upper portion of the area (stations 9 through 14).

In another and concurrent study, Dragovich and Kelly (1964) noted 2 species of adult Porcellanidae (*Petrolisthes galathinus* and *P. armatus*), 23 species of adult brachyurans (many of which were gravid), and a large number of juvenile portunids. Of the com-

TABLE 5.—*Frequency of occurrence and abundance (number per cubic meter in parentheses) of major zooplankters accounting for 10 percent or more of the total number of organisms collected in Tampa Bay and the adjacent Gulf of Mexico, September 1961 through August 1962*

Taxon and seasons	Frequency of occurrence and abundance per cubic meter (in parentheses)[1]								
	Stations								
	1	2	3	4	5	6	7	8	9
Lucifer faxoni:	*No.*	*No.*	*No.*	*No.*	*No.*	*No.*	*No.*	*No.*	*No.*
Fall	4 (1.4)	4 (107.8)	4 (56.5)	2 (3.7)	5 (21.0)	4 (15.6)	4 (50.9)	4 (29.2)	4 (343.0)
Winter	3 (1.1)	4 (145.1)	4 (14.8)	3 (11.5)	5 (1.8)	6 (2.4)	6 (7.8)	4 (24.2)	3 (44.5)
Spring	4 (4.4)	4 (55.6)	4 (17.2)	4 (14.8)	6 (16.7)	4 (1.5)	5 (61.8)	4 (15.2)	5 (97.6)
Summer	6 (2.4)	5 (75.2)	6 (23.7)	6 (39.7)	6 (51.7)	6 (19.2)	6 (75.8)	5 (10.0)	5 (273.4)
12 months	17 (2.3)	17 (93.6)	18 (27.6)	15 (20.8)	22 (22.9)	20 (9.8)	21 (49.0)	17 (19.1)	17 (197.7)
Porcellanidae:									
Fall	4 (1.4)	4 (81.4)	3 (6.0)	3 (0.8)	3 (5.5)	3 (0.5)	4 (4.6)	4 (3.5)	4 (8.8)
Winter	1 (0.1)	3 (4.1)	4 (1.2)	2 (0.8)	5 (0.9)	6 (1.3)	4 (0.4)	3 (1.2)	1 (0.2)
Spring	4 (1.2)	4 (6.4)	4 (24.2)	4 (3.8)	6 (24.4)	3 (14.4)	5 (17.9)	4 (30.2)	5 (85.0)
Summer	4 (0.3)	5 (5.9)	6 (72.5)	6 (4.2)	6 (4.9)	5 (3.4)	5 (3.8)	5 (25.4)	4 (6.0)
12 months	13 (0.7)	16 (22.4)	17 (31.2)	15 (2.7)	20 (9.1)	17 (4.7)	18 (6.8)	16 (15.7)	14 (28.8)
Brachyura:									
Fall	4 (2.1)	4 (34.6)	4 (3.9)	3 (4.7)	5 (23.8)	4 (5.7)	5 (38.2)	4 (39.9)	4 (17.0)
Winter	3 (0.4)	3 (3.1)	4 (1.2)	2 (1.9)	3 (0.6)	5 (0.8)	4 (1.0)	4 (1.1)	1 (0.3)
Spring	4 (3.0)	3 (8.2)	4 (8.2)	4 (7.2)	6 (5.1)	2 (1.8)	5 (8.2)	4 (30.1)	5 (35.0)
Summer	6 (3.3)	6 (19.9)	6 (19.5)	6 (8.8)	6 (4.2)	6 (15.9)	6 (7.5)	5 (6.8)	5 (11.2)
12 months	17 (2.3)	16 (16.9)	18 (9.5)	15 (6.1)	20 (7.8)	17 (6.2)	20 (12.6)	17 (18.7)	15 (17.6)

Taxon and seasons	Frequency of occurrence and abundance per cubic meter (in parentheses)[1]						Percentage of total number of organisms collected	Maximum abundance
	Stations					All stations		
	10	11	12	13	14			
Lucifer faxoni:	*No.*	*No.*	*No.*	*No.*	*No.*	*No.*	%	*No./m.*[3]
Fall	4 (315.2)	4 (38.6)	2 (0.3)	4 (40.5)	4 (138.6)	53 (80.2)	61.6	1051
Winter	2 (4.8)	3 (1.0)	0 (0)	3 (0.8)	2 (1.1)	48 (15.8)	64.3	566
Spring	5 (167.4)	5 (11.3)	1 (0.2)	5 (174.6)	4 (7.0)	60 (47.7)	23.2	788
Summer	6 (492.5)	6 (107.3)	3 (0.4)	3 (97.2)	3 (8.0)	72 (94.3)	58.1	826
12 months	17 (253.8)	18 (43.0)	6 (0.2)	15 (83.9)	13 (36.8)	233 (60.4)	45.6	
Porcellanidae:								
Fall	4 (9.6)	1 (0.1)	1 (0.1)	4 (3.9)	4 (7.9)	46 (9.2)	7.1	283
Winter	2 (0.3)	3 (0.3)	0 (0)	3 (0.4)	2 (0.4)	39 (0.8)	3.3	14
Spring	5 (386.0)	5 (8.2)	4 (1.1)	4 (774.6)	5 (44.6)	62 (105.8)	51.5	2634
Summer	6 (128.5)	5 (7.7)	4 (0.8)	4 (104.2)	4 (14.6)	69 (26.6)	16.3	471
12 months	17 (137.0)	14 (4.4)	9 (0.4)	15 (253.4)	15 (18.5)	216 (36.4)	27.4	
Brachyura:								
Fall	4 (65.4)	3 (26.2)	1 (0.2)	4 (17.9)	4 (23.4)	53 (21.6)	16.6	202
Winter	3 (0.4)	3 (0.3)	0 (0)	2 (0.4)	3 (0.4)	40 (0.8)	3.3	11
Spring	5 (109.8)	5 (18.1)	2 (4.7)	5 (17.4)	4 (1.6)	58 (18.6)	9.1	236
Summer	6 (61.3)	6 (28.1)	3 (2.0)	2 (4.5)	3 (3.5)	72 (15.0)	9.2	262
12 months	18 (59.0)	17 (18.3)	6 (1.6)	14 (10.5)	13 (6.9)	223 (13.9)	10.5	

[1] See table 1 for number of samples collected.

mercially important species they caught *Callinectes sapidus* and *Menippe mercenaria.*

LESS ABUNDANT BUT WIDELY DISTRIBUTED AND FREQUENTLY OCCURRING ORGANISMS

This group of organisms consisted of taxa that occurred in 10 percent or more of the samples (table 6). Collectively they accounted for 14 percent of the total number of zooplankters. Most taxa in this category appeared during every season.

Copepods were the fourth-most-numerous group collected. They occurred in highest numbers in the spring, and were the third-most-abundant taxon in the winter (fig. 4). Because of the coarse mesh of the plankton net, only larger specimens were retained consistently. Some of the nauplius and copepodite stages and smaller adults were held in the net only when trapped among larger plankton and detritus. *Labidocera aestiva* appeared to be the dominant form. The caligoids formed only a small part (1.8 percent) of this group.

Caridean shrimp constituted 2.4 percent of the zooplankters. Most of the specimens were advanced postlarvae and were classified only to family. Identified palaemonids were represented by the subfamilies Palaemoninae and Pontiniinae and the genera *Palaemonetes* and *Periclimines;* alpheids were represented by *Alpheus* and *Synalpheus* and hippolytides by *Tozeuma, Hippolysmata,* and *Latreutes fucorum. Tozeuma* ssp., found in stages from mysis to adult, accounted for 64 percent of the hippolytides. *Hippolysmata* sp. appeared only as advanced postlarvae and *Latreutes fucorum* only as adults.

Thalassinids were mostly advanced postlarval stages. Larvae of *Upogebia* sp. and *Callianassa* sp. also appeared in the samples. Some of these larvae possibly were *Upogebia affinis* and *Callianassa atlantica,* for both species are found in Tampa Bay.

Larval stomatopods were collected at every station during the summer. Antizoea, pseudozoea, erichtus, and alima types were in most of the samples. Possibly many of the larvae were *Squilla empusa,* a prominent organism in Tampa Bay (Dragovich and Kelly, 1964).

Twelve percent of the amphipods belonged to the suborder Caprellidea; the remainder belonged to one of the suborders, Gammaridea or Hyperiidea.

TABLE 6.—*Frequency of occurrence of zooplankters found in 10 percent or more of the samples from Tampa Bay and the adjacent Gulf of Mexico (excluding the three most abundant forms shown in Table 5), September 1961 through August 1962*

[Number of tows shown in parentheses]

Taxon	Frequency of occurrence[1]: During 12 months	Season[1]				Stations														Percentage of total number of organisms collected	Maximum abundance
	(267)	F (59)	W (65)	S (67)	S (76)	1 (18)	2 (18)	3 (18)	4 (17)	5 (23)	6 (22)	7 (23)	8 (17)	9 (17)	10 (20)	11 (20)	12 (20)	13 (17)	14 (17)		
Annelida:	*No.*	*No.*	*No.*	*No.*	*No.*	*No.*	*No.*	*No.*	*No.*	*No.*	*No.*	*No.*	*No.*	*No.*	*No.*	*No.*	*No.*	*No.*	*No.*	%	*No./m.*^{3}
Terebellidae	47	6	4	12	25	0	3	8	8	9	4	0	1	0	4	6	0	4	0	1.8	128.0
Spionidae	42	9	11	8	14	1	3	4	2	3	2	0	11	0	4	7	1	4	0	0.4	46.0
Arthropoda:																					
Copepoda	177	38	42	45	52	2	15	17	15	16	12	9	15	13	19	16	4	14	10	2.7	188.0
Palaemonidae	158	35	30	52	41	13	4	12	11	20	13	13	17	8	11	14	8	11	3	1.3	37.0
Alpheidae	116	31	13	36	36	16	8	12	8	6	5	11	13	5	11	8	5	5	3	0.6	11.0
Stomatopoda	89	12	9	36	32	6	8	15	7	4	2	5	6	6	13	7	1	2	7	0.4	37.0
Hippolytidae	85	21	10	25	29	2	2	7	8	14	6	8	11	4	9	7	2	3	2	0.5	23.0
Thalassinidea	79	19	12	24	24	8	5	1	5	9	5	2	14	1	7	13	3	5	1	0.8	28.0
Amphipoda	48	7	17	15	9	0	1	3	4	12	6	1	6	2	5	4	3	1	0	0.1	3.0
Isopoda	35	7	13	7	8	2	0	0	0	2	2	2	6	0	1	1	13	2	4	<0.1	1.0
Penaeidae	26	4	1	1	20	5	4	1	2	2	5	1	1	0	2	1	1	1	0	0.2	34.0
Chaetognatha:																					
Sagitta hispida	133	24	31	38	40	9	12	16	15	10	8	10	13	7	11	9	6	3	4	1.2	34.0
Sagitta spp.[2]	107	19	11	34	43	6	11	8	12	11	7	8	9	8	10	6	4	5	2	1.2	97.0
Chordata:																					
Fish eggs	85	9	21	27	28	17	4	9	9	8	6	6	7	5	10	4	0	0	0	1.0	177.0
Appendiculariidae	83	18	13	27	25	4	9	10	11	10	4	0	14	3	4	7	0	7	0	1.3	37.0
Engraulidae	50	3	2	17	28	1	1	2	0	2	5	9	4	1	7	6	1	6	5	0.4	23.0
Sciaenidae	42	2	7	21	12	5	2	3	3	6	4	4	5	0	4	2	3	1	0	0.1	1.0
Clupeidae	39	3	15	19	2	3	5	2	0	8	8	5	2	1	2	0	2	1	0	0.1	3.0
Syngnatheidae	28	7	4	7	10	0	0	3	4	2	5	3	2	0	6	1	1	0	1	<0.1	0.5

[1] Fall, winter, spring, and summer.
[2] Immature *Sagitta* less than 5 mm long.

Most of the isopods were free-swimming cymothoids and were grouped in the genus *Aegathoa*.

Penaeids were represented by small numbers of larvae of *Sicyonia* spp., *Trachypeneus* spp., and *Penaeus duorarum; Sicyonia* (mainly mysis I and mysis III stages) constituted 36 percent of this family. They were restricted to the offshore area and lower areas of Tampa Bay (stations 1-4). Only two samples contained *Trachypeneus* larvae. The pink shrimp, *P. duorarum*, contributed 16 percent of the total penaeids. Postlarvae III stages of *P. duorarum* appeared most frequently; only occasional postlarvae I and II and mysis III were taken. These larvae were most abundant in the summer and were collected primarily in Boca Ciega Bay (station 6) and the immediately adjacent Gulf waters. Our observation of the temporal occurrence of larval stages of pink shrimp in Tampa Bay agrees generally with the findings of Eldred et al. (1965).

Appendicularia spp. and *Oikopleura* spp. were common appendiculariids and were found at most of the sampling locations.

A number of eggs and larval fish were collected. Many of the fishes were identified as commercially important species. The role of Tampa Bay in the production of species important in Gulf fisheries was discussed by Sykes and Finucane (1965).

Fish eggs were taken most frequently 18.5 km. offshore, but were most abundant at Egmont Key where 54 percent of the total number were collected. They were not identified.

Larval fish accounted for 0.8 percent of the total number of zooplankters. All engraulids were identified as *Anchoa* spp. Identified sciaenids were *Cynoscion* spp. and *Leiostomus xanthurus*. Larvae of *L. xanthurus*, 6 to 15 mm. long, were taken from late fall through early spring in Boca Ciega Bay and 6.5 km. offshore. *Cynoscion* spp. appeared infrequently during the spring and summer at most of the bay stations but were not found in Hillsborough Bay or offshore. Seventy-seven percent of the clupeids (3 to 20 mm. long) were identified as *Brevoortia*. All syngnathid larvae (5 to 44 mm. long) were of the genus *Syngnathus*.

Chaetognaths made up 3 percent of the total number of zooplankters. All undamaged specimens more than 5 mm. long were identified as *Sagitta*. *S. hispida* was the only chaetognath found throughout the area of investigation. It was plentiful in all seasons and was the second most abundant taxon during the winter (fig. 4). The broad dispersal and numerical abundance of immature *Sagitta* less than 5 mm. long suggest that *Sagitta* breed both in Tampa Bay and the adjacent offshore waters. The smallest chaetognath was 2.5 mm. long, but it is likely that smaller ones escaped through the net.

Polychaete larvae made up 2.4 percent of the total number of zooplankters. Terebellids (0.4 to 4 mm. long) were numerous in samples that contained a high proportion of *Bellerochea malleus*. The gut always contained large quantities of chlorophyll. None was identified to genus. Spionids (0.4 to 4 mm. long) were collected at 11 to the 14 sampling locations, but the genera *Polydora* and *Prionospio* were collected only off Egmont Key, in Boca Ciega Bay (station 6), and in Terra Ceia Bay.

FORMS RARELY CAUGHT

This group of organisms consisted of taxa which were in less than 10 percent of the samples (table 7). Only 10 of these taxa accounted for 0.1 percent or more of the total number of zooplankters, though many of them (e.g. pagurids, mollusks, and echinoderms) are common as adults of this area. The paucity of planktonic stages in this study may be ascribed partially to the large mesh of the collecting net and to the fact that only surface samples were taken.

The areal distribution of most of the plankters in this group was limited. Most of the cladocerans (66 percent), cirripedians (61 percent), and lancelets (60 percent) were collected in one sample taken during May from lower Hillsborough Bay. Fifty-three percent of the pagurids were taken in August in a single sample from upper Tampa Bay. Forty-two percent of the larval blennies were collected from the same area; they were present throughout the year but were most abundant in September. *Sagitta helenae* and *S. enflata* occurred fre-

TABLE 7.—*Frequency of occurrence of zooplankters found in less than 10 percent of the samples from Tampa Bay and the adjacent Gulf of Mexico, September 1961 through August 1962*

[Number of tows shown in parentheses]

Taxon	Frequency of occurrence [1]																			Percentage of total number of organisms collected	Maximum abundance
	During 12 months	Season [1]				Stations															
		F	W	S	S	1	2	3	4	5	6	7	8	9	10	11	12	13	14		
	(267)	(59)	(65)	(67)	(76)	(18)	(18)	(18)	(17)	(23)	(22)	(23)	(17)	(17)	(20)	(20)	(20)	(17)	(17)		
Aschelminthes:	*No.*	*No.*	*No.*	*No.*	*No.*	*No.*	*No.*	*No.*	*No.*	*No.*	*No.*	*No.*	*No.*	*No.*	*No.*	*No.*	*No.*	*No.*	*No.*	*%*	*No./m.*[3]
Nematoda	2			2						1					1					<0.1	1.0
Mollusca:																					
Gastropoda	17	5	9	1	2		2	4	2	1	2		4			1	1			<0.1	3.0
Pelecypoda	1				1											1				<0.1	0.5
Annelida:																					
Syllidae	9	1	3	2	3			3		2	1	1			1	1				<0.1	6.0
Nereidae	4	2			2		1			1					1	1				<0.1	3.0
Phyllodocidae	4	1	1	1	1			1	1	1			1							<0.1	1.0
Poecilochaetidae	3			3				1							2					<0.1	0.5
Sabellidae	2		1		1					2										<0.1	1.0
Polynoidae	1		1				1													<0.1	0.5
Polychaetes (unidentified)	5	3		1	1	1		1		1		1				1				0.1	17.0
Arthropoda:																					
Paguridae	21	4	6	6	5			3			1	1	7	1	6		1		1	0.1	8.0
Cladocera	17	3	3	4	7		3	6	2	1			2		1			2		0.8	217.0
Cirripedia	7		2	4	1			1	1	1			1					3		0.1	28.0
Cumacea	4		2		2		1		1				1			1				<0.1	3.0
Scyllaridea	4	2			2	1		2					1							<0.1	0.5
Hippidae	3	2			1	1	1								1					<0.1	8.0
Ostracoda	3		2		1								2			1				<0.1	0.5
Processidae	2		1	1						1					1					<0.1	6.0
Mysidacea	2	1		1						2										<0.1	1.0
Euphausiacea	2	1	1			1		1												<0.1	1.0
Dromiacea	2	1			1	2														<0.1	0.5
Pycnogonida	1		1								1									<0.1	0.5
Chaetognatha:																					
Sagitta helenae	24	3	5	6	10	17	4	1	1					1						0.2	30.0
Sagitta enflata	13	4	4	1	4	12		1												0.1	16.0
Sagitta tenuis	8	2		2	4	6				1								1		<0.1	2.0
Echinodermata:																					
Holothuroidea	1	1														1				<0.1	3.0
Ophiuroidea	1				1						1									<0.1	0.5
Chordata:																					
Blenniidae	25	3	1	20	1			1	1	1	4	1	3	2	6	3	1	2		0.1	7.0
Carangidae	15	3			12			2	1	1	2	1			4	4				<0.1	0.5
Branchiostomidae	8		1	4	3		1	1	1				4					1		0.1	23.0
Thaliacea	8	3	1	2	2	6	2													<0.1	3.0
Soleidae	8	1		2	5					3	1	2			1	1				<0.1	1.0
Triglidae	7	1		3	3			2			2				2	1				<0.1	6.0
Gerridae	4	1			3				1		1	2								<0.1	1.0
Gobiidae	4	1	1	2												2	2			<0.1	0.5
Belonidae	2				2						2									<0.1	0.5
Atherinidae	2			1	1								1			1				<0.1	0.5
Cynoglossidae	1		1									1								<0.1	0.5
Fish larvae (unidentified)	38	4	8	10	16	5	2	3	4	1		4	1	4	5	4	1	1	3	0.1	3.0

[1] Fall, winter, spring, and summer.

quently 18.5 km. offshore where they accounted respectively for 25 and 8 percent of the zooplankters collected in that area.

Forms identified in the samples but not included in the aliquots of samples that were counted were: the euphausiacean (*Euphausia americana*); cumacean (*Oxyurostilis* sp.); decapods (*Scyllarus* sp., *Emerita talpoida*, and *Dromidia antillensis*); lancelet (*Brachiostoma caribeum*); larval fish (*Strongilura timucu*, and *Prionotus* sp.); and polychaetes (*Nereis* sp., *Platynereis dumerilii*, and *Poecilochaetus johnsoni*). The present collection represents the first record of larval *P. johnsoni* from the southeastern United States (Taylor, 1966).

OCCURRENCE OF ZOOPLANKTON IN RELATION TO TEMPERATURE AND SALINITY

TEMPERATURE

To relate water temperature with the occurrence of the most plentiful zooplankton—22 taxa accounting for 98 percent of the total number of zooplankters collected — the temperature data were divided into three ranges (12.8° to 20.9° C., to 21.0° to 27.9° C., and 28.0° to 32.0° C.), each of which included about an equal number of temperature observations (table 8). Occurrences of plankton were adjusted for the differences in numbers of temperature observations in each range and ex-

TABLE 8.—*Percentage frequency of occurrence (adjusted for the difference in numbers of temperature and salinity observations in each range) of the most plentiful zooplankton at three salinity and temperature intervals, each of which includes about an equal number of observations—Tampa Bay and the adjacent Gulf of Mexico, September 1961 through August 1962*

Taxon	Total occurrences	Temperature (° C.)[1]			Salinity (‰)[1]		
		12.8–20.9 (89)	21.0–27.9 (96)	28.0–32.0 (82)	19.0–29.4 (90)	29.5–33.4 (89)	33.5–36.0 (88)
	No.	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*
Annelida:							
Terebellidae	47	16.6	27.0	56.4	23.0	19.1	57.9
Spionidae	42	30.8	30.7	38.5	30.6	45.3	24.1
Arthropoda:							
Lucifer faxoni	233	29.6	34.6	35.8	27.6	36.4	36.0
Brachyura	223	28.1	33.6	38.3	28.8	34.0	37.2
Porcellanidae	216	30.5	32.5	37.0	31.6	31.9	36.5
Copepoda	177	33.2	30.2	36.6	33.0	32.7	34.3
Palaemonidae	158	31.6	33.3	35.1	30.0	36.7	33.3
Alpheidae	116	25.8	34.2	40.0	23.0	34.4	42.6
Stomatopoda	89	25.7	34.3	40.0	26.7	30.2	43.1
Hippolytidae	85	24.4	29.0	46.6	23.2	43.5	33.3
Thalassinidea	79	21.3	32.5	46.2	32.6	34.2	33.2
Amphipoda	48	39.8	35.1	25.1	22.6	43.7	33.7
Isopoda	35	31.7	43.0	25.3	62.6	25.9	11.5
Penaeidae	26	3.6	16.9	79.5	19.0	11.6	69.4
Chaetognatha:							
Sagitta hispida	133	32.8	29.1	38.1	20.0	39.0	41.0
Sagitta, spp.[2]	107	26.6	24.6	48.8	23.1	32.6	44.3
Chordata:							
Fish eggs	85	37.7	31.6	30.7	13.9	35.1	51.0
Appendiculariidae	83	31.2	31.1	37.7	20.2	36.0	43.8
Engraulidae	50	13.8	32.9	53.3	45.6	32.1	22.3
Sciaenidae	42	43.0	31.1	25.9	18.8	42.7	38.5
Clupeidae	39	60.6	36.6	2.8	10.0	53.8	36.2
Syngnatheidae	28	24.8	29.5	45.7	24.7	39.2	36.1

[1] Total number of temperature and salinity observations within each range shown in parentheses.
[2] Immature *Sagitta* less than 5 mm. long.

pressed as percentage frequency of occurrence. Seventeen of the taxa occurred most frequently at the highest range, one at the intermediate range, and four at the lowest range. These observations suggest that for most zooplankton low temperatures were more restrictive than high.

SALINITY

The study of the relation of salinity to the occurrence of zooplankton was similar to that for temperature. The salinity ranges used were 19.0 to 29.4 p.p.t., 29.5 to 33.4 p.p.t., and 33.5 to 36.0 p.p.t. (table 8). Eleven of the 22 taxa occurred most frequently at the highest range, nine at the intermediate range, and two at the lowest range. These comparisons suggest that low salinity restricts the distribution of zooplankton in Tampa Bay.

The zooplankton included both euryhaline and marine forms. *Lucifer faxoni*, porcellanids, copepods, and chateognaths were taken throughout the entire salinity range (19.0 to 36.0 p.p.t.). The range for *L. faxoni* was similar to the range (19.3 to 34.2 p.p.t.) given by Woodmansee (1958) in Biscayne Bay, Fla.

ACKNOWLEDGEMENTS

Bonnie Eldred of the Florida Board of Conservation and Delores E. Dimitrious of the Marine Laboratory, Institute of Marine Science, University of Miami, helped identify larval penaeid shrimp; Thomas E. Bowman and Raymond B. Manning of the U.S. National Museum, Smithsonian Institution, helped identify and verified the sergestids and larval isopods; and Sheldon Dobkin of Florida Atlantic University, Boca Raton, Fla., and Anthony J. Provenzano, Jr., and Anthony Rice of the Institute of Marine Science, University of Miami, helped identify caridean, pagurid, and thalassinid crustaceans. At the Bureau of Commercial Fisheries Biological Laboratory, St. Petersburg Beach, Fla., John L. Taylor identified polychaetes, and John H. Finucane and Gordon R. Rinckey identified fish larvae.

LITERATURE CITED

DAVIS, CHARLES C.
1947. Two monstrilloids from Biscayne Bay, Florida. Trans. Amer. Miscroscop. Soc. 66(4): 390–395.

DAVIS, CHARLES C.
1948. Notes on the plankton of Long Lake, Dade County, Florida, with descriptions of two new copepods. Quart. J. Fla. Acad. Sci. 10(2–3): 79–88.
1949. A preliminary revision of the Monstrilloida, with descriptions of two new species. Trans. Amer. Microscop. Soc. 68(3): 245–255.
1950. Observation of plankton taken in marine waters of Florida in 1947 and 1948. Quart. J. Fla. Acad. Sci. 12(2): 67–103.

DAVIS, CHARLES C., and ROBERT H. WILLIAMS.
1950. Brackish water plankton of mangrove areas in southern Florida. Ecology 31(4): 519–531.

DRAGOVICH, ALEXANDER.
1963. Hydrology and plankton of coastal waters at Naples, Florida. Quart. J. Fla. Acad. Sci. 26 (1): 22–47.

DRAGOVICH, ALEXANDER, and JOHN A. KELLY, JR.
1964. Ecological observations of macro-invertebrates in Tampa Bay, Florida. Bull. Mar. Sci. Gulf Carib. 14(1): 74–102.

DRAGOVICH, ALEXANDER, and BILLIE Z. MAY.
1962. Hydrological characteristics of Tampa Bay tributaries. U.S. Fish Wildl. Serv., Fish. Bull. 62(205): 163–176.

ELDRED, BONNIE, JEAN WILLIAMS, GEORGE T. MARTIN, and EDWIN A. JOYCE, JR.
1965. Seasonal distribution of penaeid larvae and postlarvae of the Tampa Bay area, Florida. Fla. State Bd. Conserv., Tech. Ser. 44: 1–47.

FLEMINGER, ABRAHAM.
1957a. New genus and two new species of Tharybidae (Copepoda Calanoids) from the Gulf of Mexico with remarks on the status of the family. U.S. Fish Wildl. Serv., Fish. Bull. 57(116): 347–354.
1957b. New calanoid copepods of the families Aetideidae, Euchaetidae, and Stephidae from the Gulf of Mexico. U.S. Fish Wildl. Serv., Fish. Bull. 57 (117): 355–363.

GOODELL, H. G., and D. S. GORSLINE.
1961. A sedimentologic study of Tampa Bay, Florida. Int. Geol. Congr., 21st Sess., Norden, 1960, Pt. 23: 75–88.

GRICE, GEORGE D.
1956. A qualitative and quantitative seasonal study of the Copepoda of Alligator Harbor. Pap. Oceanogr. Inst. 2, Fla. State Univ. Stud. 22: 37–76.

KING, JOSEPH E.
1949. A preliminary report on the plankton of the west coast of Florida. Quart. J. Fla. Acad. Sci. 12(2): 109–137.
1954. Variations in zooplankton abundance in the central equatorial Pacific, 1950–1952. Fifth Meeting, Indo-Pac. Fish. Counc., Mar. and Freshwater Plankton in the Indo-Pac., 1954: 10–17.

KNUDSEN, MARTIN.
1901. Hydrographical tables. G.E.C. Gad, Copenhagen, 63 pp.

OWRE, HARDING B.
1960. Plankton of the Florida current. VI. The Chaetognatha. Bull. Mar. Sci. Gulf Carib. 10(3): 255–322.

PIERCE, E. LOWE.
1951. The Chaetognatha of the west coast of Florida. Biol. Bull. (Woods Hole, Mass.) 100 (3): 206–228.

SYKES, JAMES E., and JOHN H. FINUCANE.
1965. Occurrence in Tampa Bay, Florida, of immature species dominant in Gulf of Mexico commercial fisheries. U.S. Fish Wildl. Serv., Fish. Bull. 65(2): 369–379.

TAYLOR, JOHN L.
1966. A Pacific polychaete in southeastern United States. Quart. J. Fla. Acad. Sci. 29(1): 21–26.

THRAILKILL, JAMES R.
1957. Zooplankton volumes off the Pacific coast, 1956. U.S. Fish Wildl. Serv., Spec. Sci. Rep. Fish. 232: 50 pp.

TOKIOKA, TAKASI.
1955. Notes on some chaetognaths from the Gulf of Mexico. Bull. Mar. Sci. Gulf Carib. 5(1): 52–65.

WOODMANSEE, R. A.
1958. The seasonal distribution of the zooplankton off Chicken Key in Biscayne Bay, Florida. Ecology 39(2): 247–262.