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SURFICIAL BIOLOGY OF MARINE AND ESTUARINE DEPOSITS IN THE STATE SUBMERGED LANDS IN THE CORPUS CHRISTI AREA

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SURFICIAL BIOLOGY OF MARINE AND ESTUARINE DEPOSITS IN THE STATE SUBMERGED LANDS IN THE CORPUS CHRISTI AREA

by

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INTRODUCTION

In March 1976, the Bureau of Economic Geology began an extensive program to sample the State submerged lands. The State-owned submerged lands of Texas encompass nearly 6,000 mi^2 (15,540 km^2) and extend from Mexico to Louisiana. The area includes the bays, estuaries, and lagoons as well as the inner continental shelf 10.3 mi (16.6 km) seaward of the Gulf shoreline. Benthic samples were taken on a 1-mi interval and by January 1978, 6,697 samples had been collected. Sample analysis included textural studies (grain size properties), geochemistry (trace elements and total organic carbon), bathymetry, and biological studies.

This report on the biology of the Corpus Christi area provides preliminary information on benthic macroinvertebrate assemblages and diversity. It is a baseline inventory of basic scientific data necessary to predict and assess problems and impacts related to energy production, food production, recreation, and transportation. Planning for many of these activities requires a knowledge of regional biology and geology.

PHYSICAL SETTING

The Corpus Christi study area includes the following bays, rivers, and lagoons: Corpus Christi Bay, Redfish Bay, the southern halves of Copano and Aransas Bays, Aransas River, Mission Bay and Mission River, Port Bay, Nueces Bay and Nueces River, Oso Bay, and northern Laguna Madre from just north of the J.F.K. Causeway Bridge to approximately 15 mi (24 km) south of the bridge. It also includes the inner continental shelf within the designated bay areas 10.3 mi (16.6 km) seaward of the

Gulf shoreline. Bays and estuaries within this study area are interconnected, and they form a continuous water body. All streams within the study area except the Nueces River are small.

Climate

The study area lies within a subhumid climatic zone that extends from the vicinity of Port Lavaca to Corpus Christi. Average annual rainfall is about 35 inches (13.8 cm) for the Corpus Christi area (Brown and others, 1976). Rainfall distribution is bimodal with a late spring and a fall peak. Counties along the Gulf of Mexico in the Rockport area register temperature ranges from average winter lows of 47°F (8.3°C) to average summer highs of 92°F (33.3°C). The prevailing winds in the area are southeasterly from March through September and north northeasterly from October through February (Behrens and Watson, 1973). In the winter, cold fronts cause an abrupt drop in air temperature and a corresponding rapid decrease in temperature of bay waters.

Severe droughts and wet years occur periodically on the central Texas coast. Long-term changes in bay conditions attributed to the cyclic nature of the climate are factors in controlling fish and invertebrate distributions (Collier and Hedgpeth, 1950).

Sediment

A sediment map was plotted using five sediment gradients. Sediments were classified by percent sand, as 0 to 20 percent, 20 to 40 percent, 40 to 60 percent, 60 to 80 percent, and 80 to 100 percent sand. Every biological station examined for benthos was analyzed in the laboratory for percent mud, sand, and gravel.

A separate sediment map for percent gravel was also plotted from data obtained in laboratory analysis. Sediments were classified as less than 5 percent, 5 to 10 percent, 10 to 20 percent, 20 to 30 percent, 40 to 50 percent, and greater than 50 percent gravel. In the analysis for gravel, shell fragments were included as gravel constituent; in fact most gravel particles are shell, and lithoclasts are rare.

Bays

Substrates in the bays are predominantly mud (less than 20 percent sand) with the exceptions of Laguna Madre and the Redfish-Aransas systems. Gravel accumulations generally accounted for less than 5 percent of the sediment.

In the map area, the majority of Laguna Madre is composed of 80 to 100 percent sand. At its northern end near Corpus Christi Bay, Laguna Madre is crossed by a network of intracoastal waterways. Sediments in this area vary in composition. It is presumed that extensive reworking of the sediment in this area has taken place. Only isolated stations in Laguna Madre exhibited any significant gravel content.

Sediment in Nueces Bay is mixed. Sand concentrations tend to be highest near the entry of the Nueces River and along the bay margins. The bay center is primarily 20 to 40 percent sand. Gravel content was less than 5 percent at nearly all stations.

Corpus Christi Bay has high sand content, generally of 80 to 100 percent sand, within one mile of the bay margins. In addition, sand is the principal clastic end member near Alta Vista Reef in the north, Long Reef in the east, and Shamrock Island to the south. The bay center is primarily mud -- less than 20 percent sand. Less than 5 percent gravel is found at the majority of the stations. High concentrations of gravel are associated with an area in and around Alta Vista Reef.

Oso Bay was found to have little or no gravel and sand concentrations ranging from 20 to 80 percent. This is to be expected in an area of moderate sediment influx.

Redfish Bay had the highest concentrations of gravel of the map area, forming a ridge from Dagger Island, following the intracoastal waterway, and turning toward Traylor Island. Accumulations range from 10 to 20 percent gravel, with isolated highs of 30 to 40 percent. Southern parts of the bay were generally less than 5 percent gravel. Sand, however, was significantly higher in the southern bay areas. The northern areas of the bay varied from 20 to 80 percent sand.

Aransas Bay contained accumulations of high sand (80 to 100 percent) at the bay margins and near Mud Island. Sand content altered toward bay center decreasing to 0 to 20 percent sand. Gravel content was greatest between Traylor Island and the intracoastal waterway, with some stations containing more than 30 percent gravel. Isolated larger accumulations were measured, but most stations contained less than 5 percent gravel.

Copano Bay receives abundant sediment. It is similar to other bays, with low sand content at bay center increasing to 80 to 100 percent sand around bay margins. As expected, highest sand accumulations occur near the mouths of streams entering Mission Lake and Mission Bay, Aransas River, and Port Bay. There the bay floors are covered by mixed mud and sand, but generally they have higher sand percentages than might be encountered in a closed system. Nearly half the bottom of Port Bay is composed of sediment containing 80 to 100 percent sand; isolated stations in Copano Bay had high concentrations of gravel.

Inner Shelf

All but one station analyzed from the inner shelf contained less than 5 percent gravel.

The sand substrate of the inner continental shelf is influenced by water depth and varies between sediments more than 80 percent sand and those less than 80 percent sand. Predominantly sand-rich (80 to 100 percent) areas are 42 to 48 ft (12.6 to 14.4 m) deep; in the south, these areas extend to nearly 54 ft (16.2 m). From 48 to 60 ft (14.4 to 18 m), sediments vary in sand content from 20 to 80 percent, with the majority of sediments composed of 60 to 80 percent sand.

Beyond the 60-ft depth, two gradations of sand content are exhibited. The northern parts of this area are dominated by areas comprised of 20 to 40 percent sand, while in the southern part, most sediment contains 0 to 20 percent sand.

Figures 1, 2, 3, and 4 illustrate the percent of stations examined versus the total number of stations by sediment type for all the bay stations. For each sediment type (percent sand), the total number of bay stations and the total number of examined stations are nearly equal; that is, according to the sampling density, the number of examined stations from a particular sediment, in most cases, is representative of the extent of that sediment in the entire system. This is true for all the bays and the inner shelf in the Corpus Christi study area. Figures 5 and 6 illustrate these same variables for the inner shelf with the addition of bathymetry.

Sources of Sediment

The primary sources of sediment for the bays in the Corpus Christi system are rivers, the Gulf of Mexico, Pleistocene deposits forming the mainland shoreline, and biogenic products. Rivers are less important to sedimentation in the Corpus Christi system than to some other Texas bay systems because a climatic gradient causes a decrease in rainfall from east to south across the State (Carr, 1967).

Streams enter Mission, Copano, Corpus Christi, Nueces, and Oso Bays. All streams, except the Nueces River, are small and originate within the Coastal Plain. Most of the suspended sediment from the Nueces River is trapped in Nueces Bay (McGowen and Morton, 1979). Lake Corpus Christi, formed by the damming of the Nueces River approximately 20 mi (32 km) northwest of the city of Corpus Christi, traps much of the sediment before it reaches Nueces Bay.

Sediment from the Gulf of Mexico is transported into the bays through tidal inlets and hurricane washovers. In the recent past, sediment moved through Aransas Pass and Corpus Christi Pass to form extensive flood tidal deltas (McGowen and

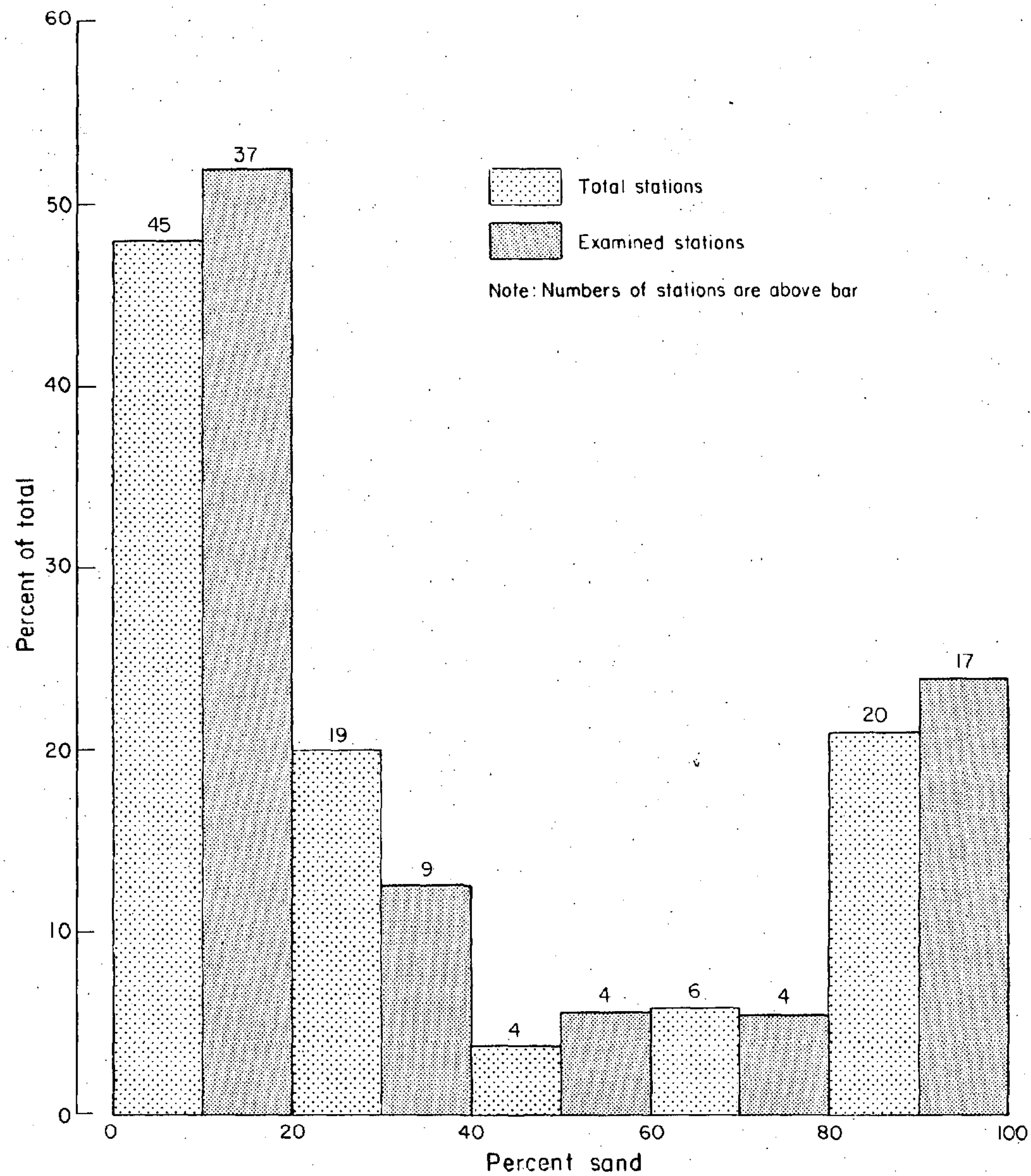


Figure 1. Copano, Port, and Mission Bays and Mission Lake: total versus examined stations in relation to sediment.

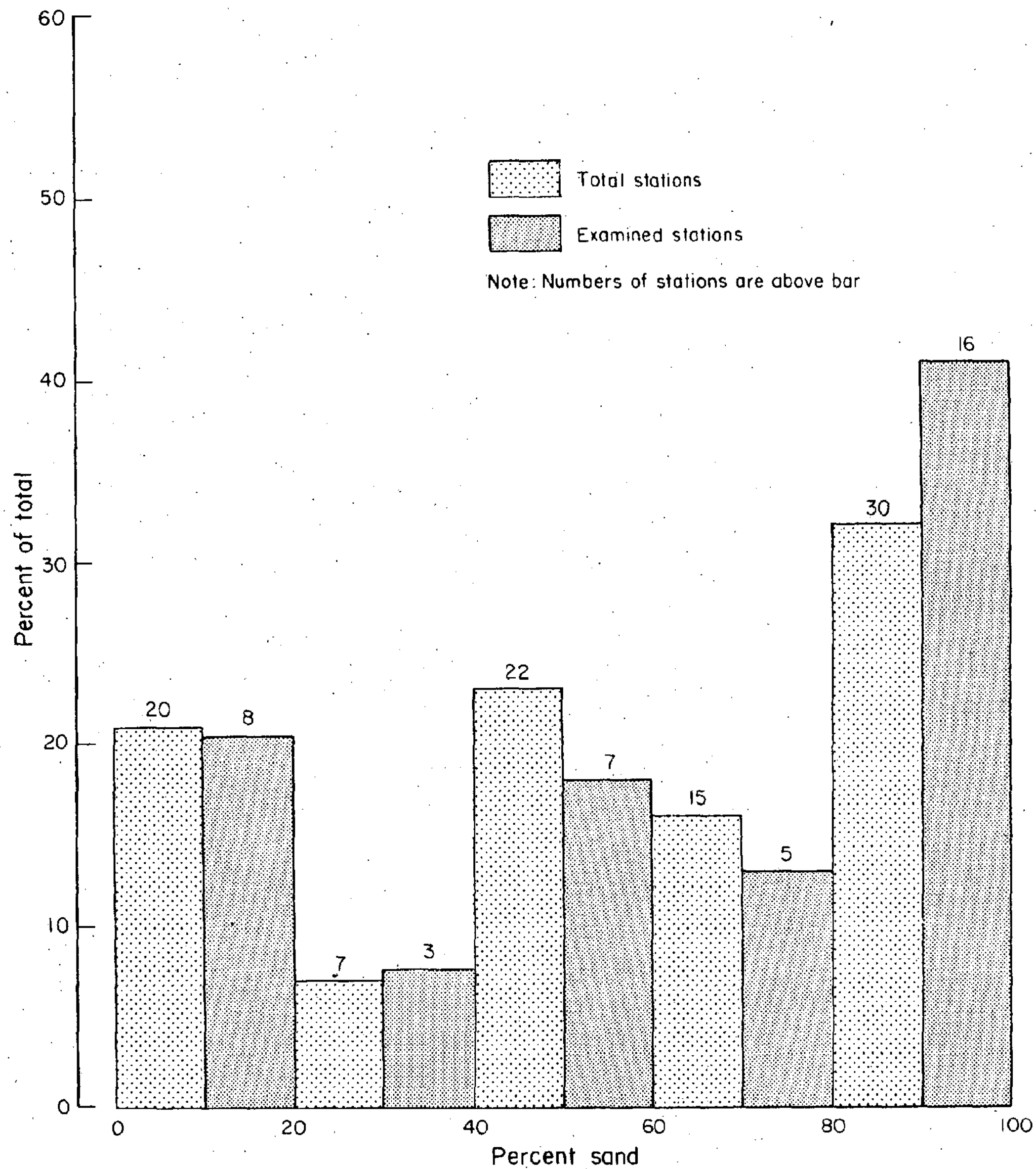


Figure 2. Redfish and Aransas Bays: total versus examined stations in relation to sediment.

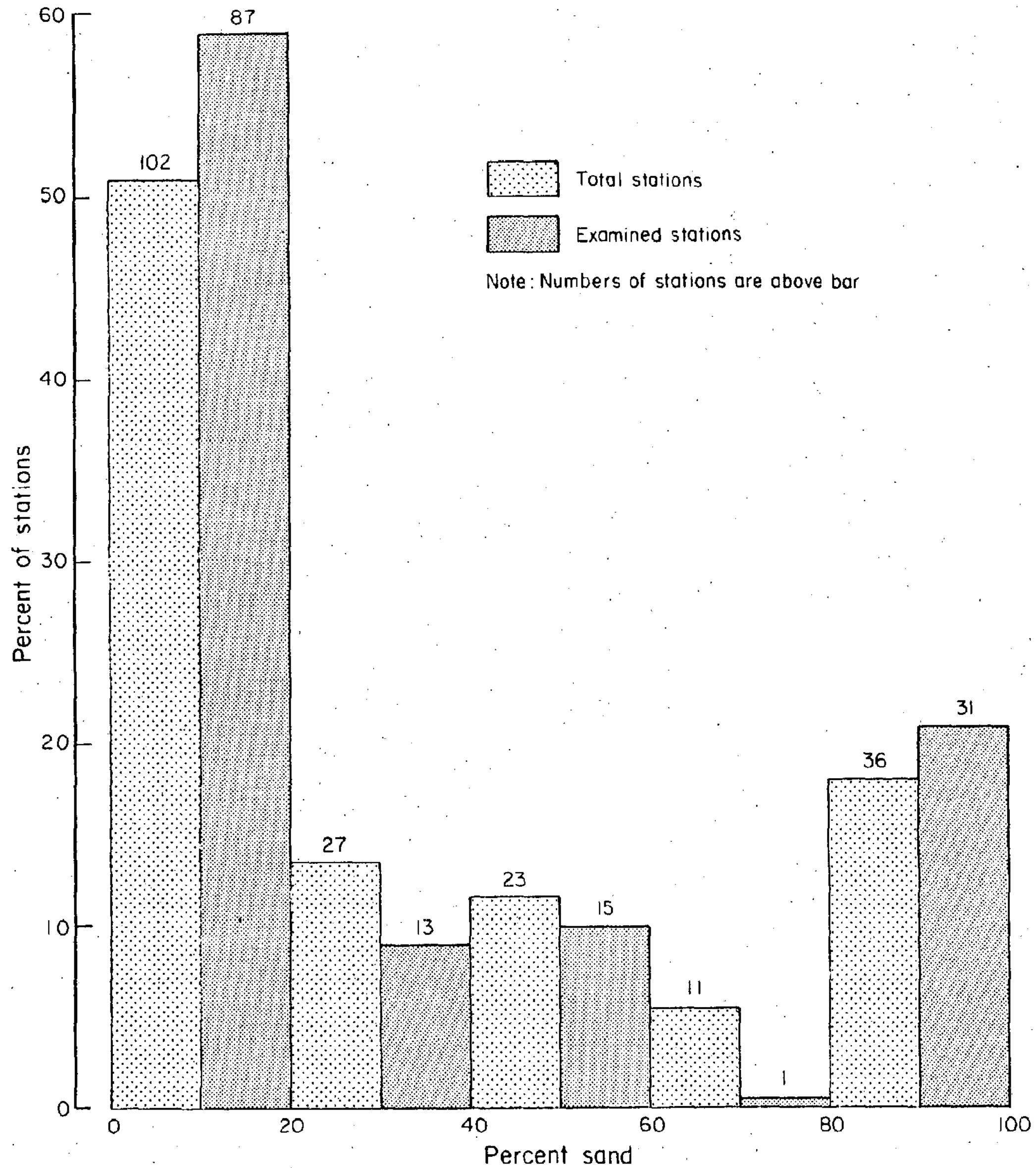


Figure 3. Corpus Christi, Oso, and Nueces Bays: total versus examined stations in relation to sediment.

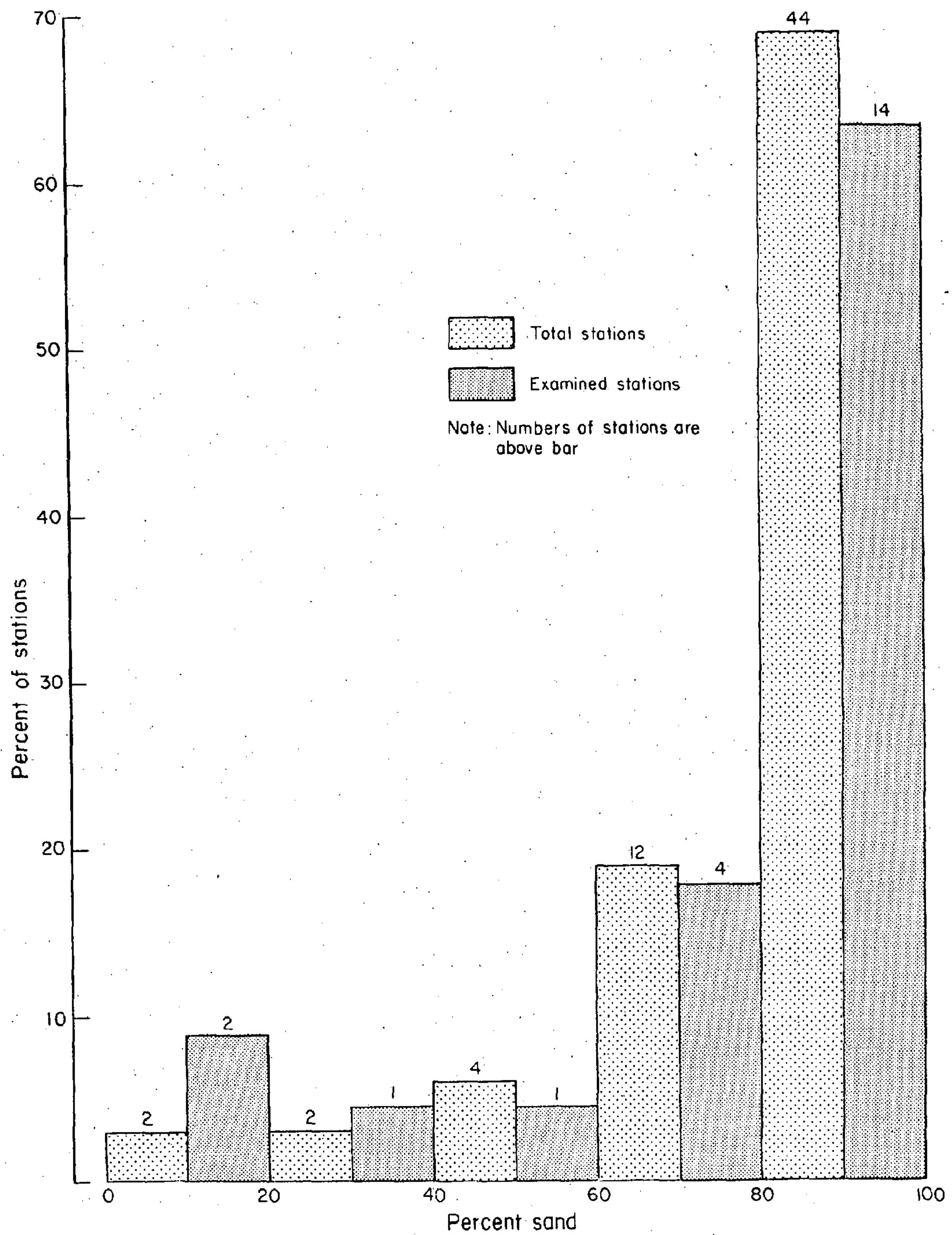


Figure 4. Laguna Madre: total versus examined stations in relation to sediment.

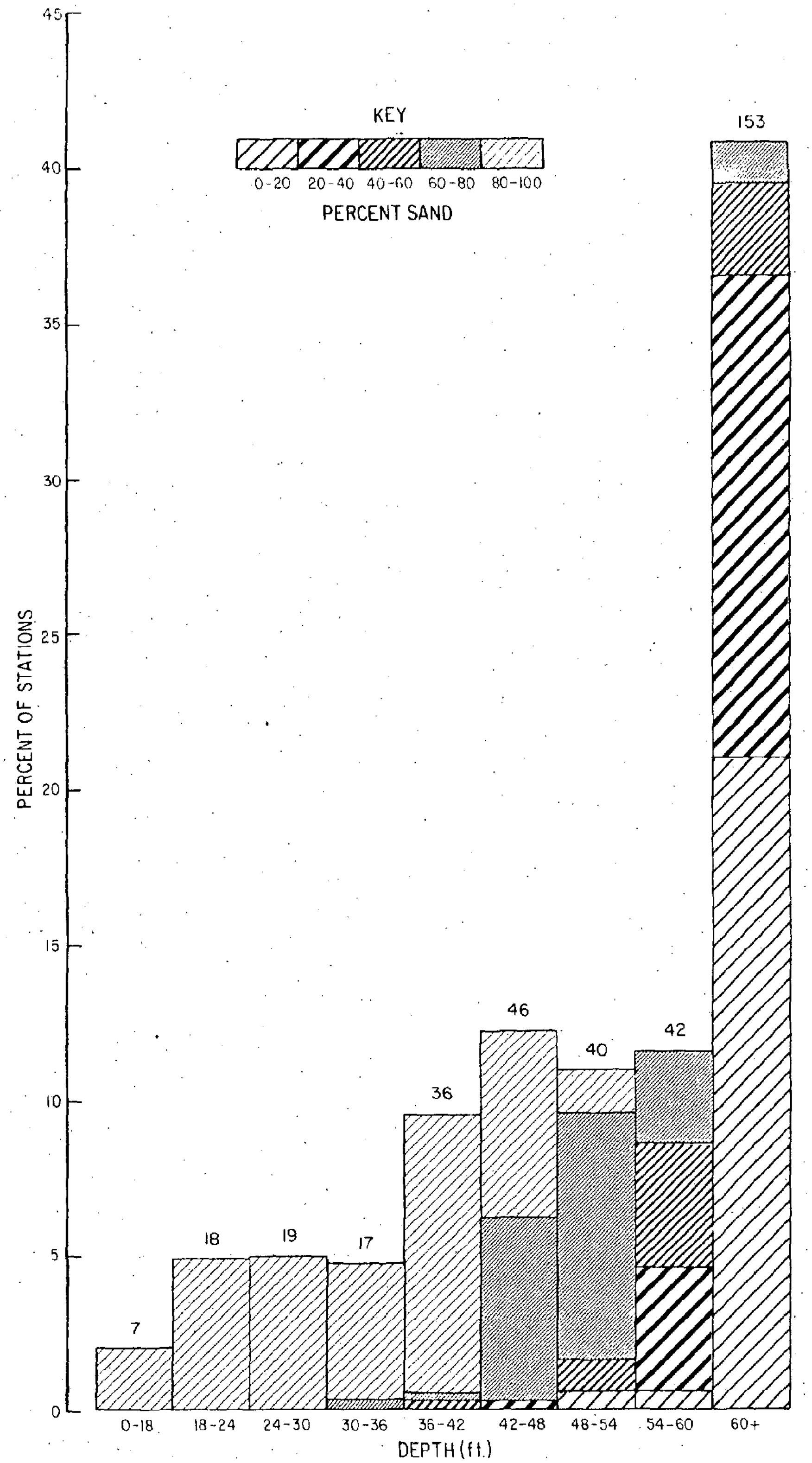


Figure 5. Corpus Christi inner shelf: comparison by sediment type of all stations at various depth ranges.

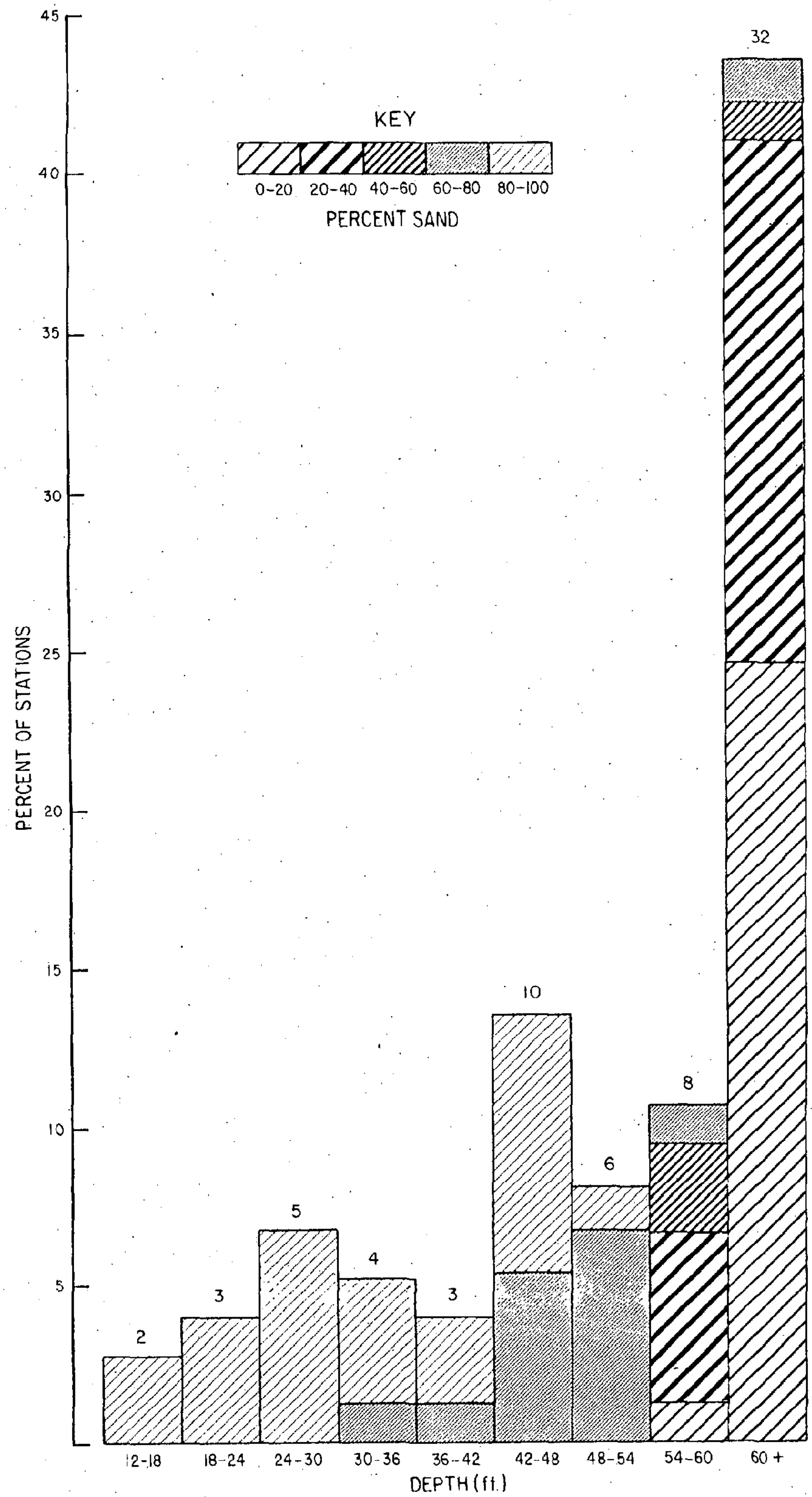


Figure 6. Corpus Christi inner shelf: comparison by sediment type of examined stations at various depths.

Morton, 1979). Jetties at Aransas Pass have reduced the volume of sediment entering the bays. Corpus Christi Pass became inactive in the early 1900's because of a change in bay circulation caused by dredging in Corpus Christi Bay (Price, 1952).

Southeasterly winds have a significant fetch across parts of all the bays in the Corpus Christi study area. Waves generated by the southeast wind severely erode the shorelines that face into the wind and transport sediment westward and northward (Brown and others, 1976). North winds during December, January, and February erode the south and west shorelines of the bays and resuspend some of the bay mud. Resuspended mud in Aransas Bay is transported toward the south bay shore and southward and eastward through Aransas Pass (Brown and others, 1976). Sand along the bay margin adjacent to the mainland shoreline is reworked from Pleistocene deltaic and strandplain deposits (McGowen and Morton, 1979).

The only extensive oyster reefs in the Corpus Christi system are the reefs in Copano Bay. The three most extensive reefs in Copano Bay cover almost 100 acres (Diener, 1975) and are aligned approximately normal to the tidal currents within the bay. Oyster reef distribution within the Corpus Christi study area can be found in the Environmental Geologic Atlas of the Corpus Christi area published by the Bureau of Economic Geology (Brown and others, 1976).

Shell dredging has significantly reduced the amount of Crassostrea shell in Nueces Bay. Between 1959 and 1974, more than 13 million yds^3 was dredged from Nueces Bay (Brown and others, 1976). Most of the economically extractable shell within the area has come from this bay.

Marine Grasses

Marine grasses are found in Laguna Madre, Redfish Bay, Port Bay, and in certain shallow bay-margin areas in Copano and Aransas Bays.

Scattered stands of shoalgrass (Halodule wrightii) and widgeongrass (Ruppia maritima) grow along the northwest shoreline where Copano Creek enters Copano Bay, in a small patch near the town of Bayside, and along the bay margins near Port Bay (West, 1969). Most of Aransas Bay is too deep for vegetative growth, but the shallow flats in the southern part of Aransas Bay from Traylor Island to Corpus Christi Bay are heavily vegetated (West, 1969). Port Bay has moderate to heavy stands of widgeongrass and light stands of shoalgrass along the shallow edges.

Bottom vegetation in upper Laguna Madre is primarily shoalgrass with small stands of widgeongrass along the spoil islands of the intracoastal waterway (Harrington, 1969 and 1970). Redfish Bay has all five species of marine seagrasses that are found on the Texas coast (Edwards, 1976).

The importance of marine grasses to the ecology of marine ecosystems is well documented (Milne, 1951). The grasses form a food base for many fish and waterfowl and breeding grounds for certain fishes. Herbivores feed on their leaves; clams and worms live on the decaying organic matter they deposit on the bay bottoms. The herbivorous gastropods and the clams and worms, in turn, are food for fish and waterfowl. Marine grasses also act as a friction filter for silt and sewage (Milne, 1951).

Bathymetry

Bathymetric data were taken from the Surface Sediment Distribution map, Texas Submerged Lands, Corpus Christi Sheet, published by the Bureau of Economic Geology.

Shelf bathymetry on these maps was taken from U.S. Coast and Geodetic Survey smooth sheets (1938-1939) and bay bathymetry was taken from soundings made at each sampling site. Bathymetric contour interval for the shelf is 6 ft (1.8 m); for the bays, 2 ft (.6 m).

Inner Shelf

Bathymetry on the inner shelf of the Gulf of Mexico increases in depth from the beach to over 78 ft (23.4 m) at the three-league limit. Depths increase most rapidly near shore, reaching 36 ft (10.8 m) at 1.5 to 2 mi (2.4 to 3.2 km) offshore, then increase more gradually at a rate of approximately 6 to 12 ft (1.8 to 3.6 m) per mi reaching to over 78 ft (23.4 m) at 9 to 10 mi (15 to 17 km) offshore.

Figure 7 shows the distribution by depth of the 372 inner shelf sample stations, 73 of which were examined. No stations were established in depths of less than 6 ft (1.8 m) and only three were established at 6 to 12 ft (1.8 to 3.6 m).

Bays

Except for Corpus Christi Bay, Aransas Bay, and the maintained channels, most bays in the study area generally do not exceed 10 ft (3 m) in depth. In most bays maximum depth is reached rather gradually.

Average depth for Laguna Madre is about 4 ft (1.2 m) although in a few areas depths of 6 ft (1.8 m) are reached. Many areas of Laguna Madre are 2 ft (.6 m) or less deep.

Bathymetry for Oso Bay was taken directly from the station field data sheets, which show that most of the bay is 2 ft (.6 m) or less deep. Station 1 at the mouth of Oso Bay was 5.5 ft (1.65 m) deep.

In Corpus Christi Bay, depths of 12 to 14 ft (3.6 to 4.2 m) are reached approximately 1 mi (1.6 km) offshore, then increases more gradually to maximum depths of 16 to 18 ft (4.8 to 5.4 m). The average depth is about 14 ft (4.2 m).

Depths in Nueces Bay dip gradually, reaching 2 to 4 ft (.6 to 1.2 m) within a mile of the shoreline. The average depth in the center of the bay is approximately 4 ft (1.2 m).

In Redfish Bay, depths range to 6 ft (1.8 m), except near the Corpus Christi Ship Channel where they reach 8 to 10 ft (2.4 to 3 m). Most areas of the bay are only 2 to 4 ft (.6 to 1.2 m) deep.

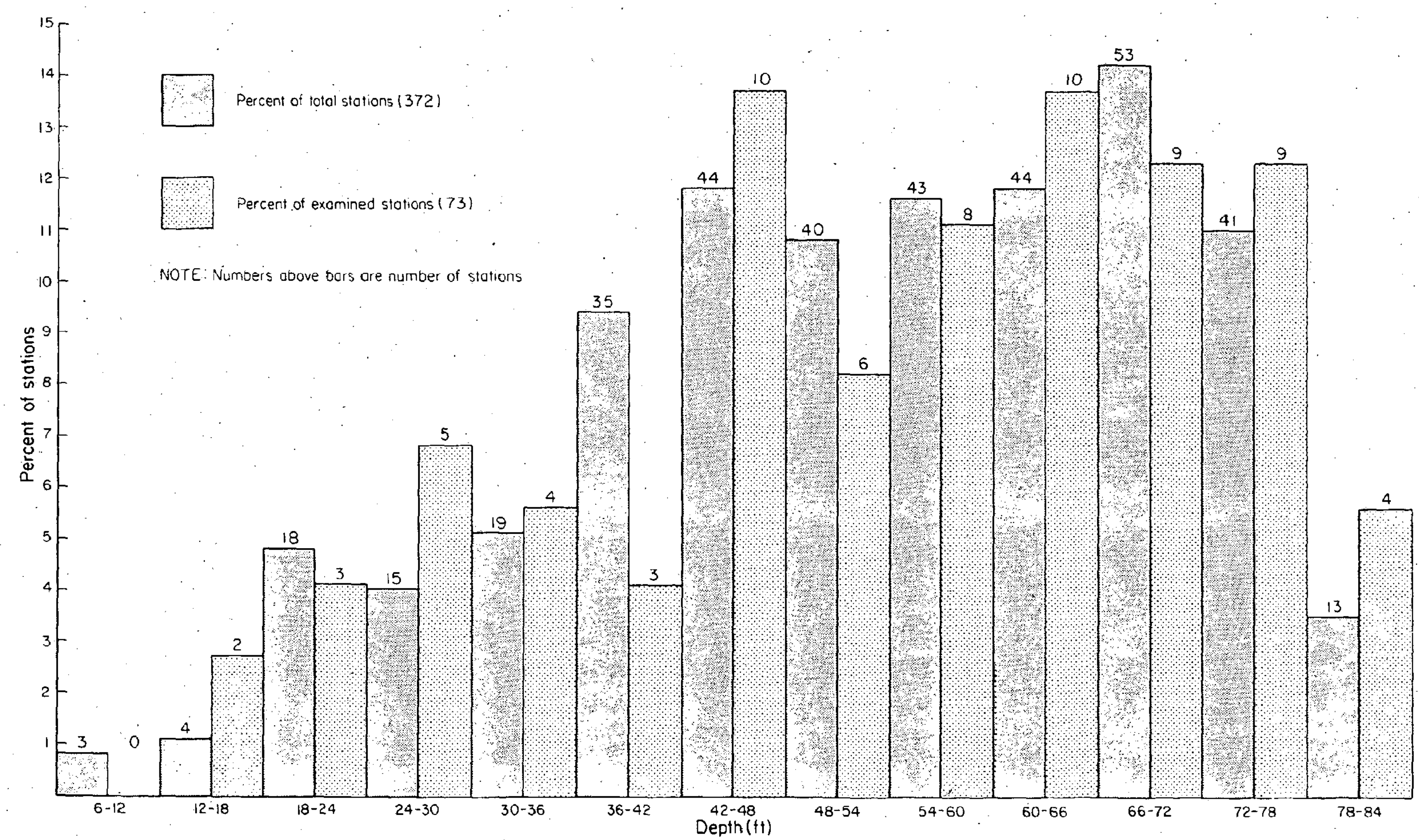


Figure 7. Distribution of total and examined inner shelf stations by depth.

The average depth of Aransas Bay is about 10 ft (3 m), with depths to 14 ft (4.2 m) along the Lydia Ann Channel from the south end of Mud Island to near its junction with the Intracoastal Waterway. A depth of 8 ft (2.4 m) is reached 0.5 to 1 mi (0.8 to 1.6 km) offshore.

Depths in Port Bay are generally 2 to 4 ft (.6 to 1.2 m), with a maximum of about 6 ft (1.8 m) at the mouth of the bay. The average depth is about 3.5 ft (1.5 m).

In Copano Bay, depths along the southern shore are generally greater than those along the northern shore. On the south, depths reach 10 ft (3 m) within 1 mi (1.6 km) of the shoreline, whereas on the north side, depths reach 6 ft (1.8 m) within 1 mi (1.6 km) of the shoreline. Depths in the middle of the bay are generally 8 to 10 ft (2.4 to 3 m).

Average depth in Mission Bay is about 2 to 2.5 ft (.6 to 7.5 m) with a maximum of approximately 4 ft (1.2 m).

Salinity

Salinities were not collected during the sampling periods in 1976 and 1977, but recent salinity records are available for the Nueces-Corpus Christi Bay and Copano-Aransas Bay systems (Holland and others, 1973, 1974, and 1975) and for upper Laguna Madre (Hildebrand and King, 1972-1978).

Holland and others measured conductivity at four stations in Copano and Nueces Bay, two in Redfish Bay, 14 in Corpus Christi Bay, and six in Aransas Bay (figs. 8 and 9). Monthly measurements were taken 1 ft (.3 m) below the surface, mid-water, and 1 ft (.3 m) above the sediment from October 1972 through May 1975.

Holland and others (1973, 1974, and 1975) found that salinities were consistently highest in Corpus Christi and Redfish Bays and lowest in Copano Bay (fig. 10). Salinities in Copano Bay were below 15 ppt and very often below 10 ppt. Average monthly salinities in Aransas and Nueces Bays were generally lower than in Corpus Christi or Redfish Bays.

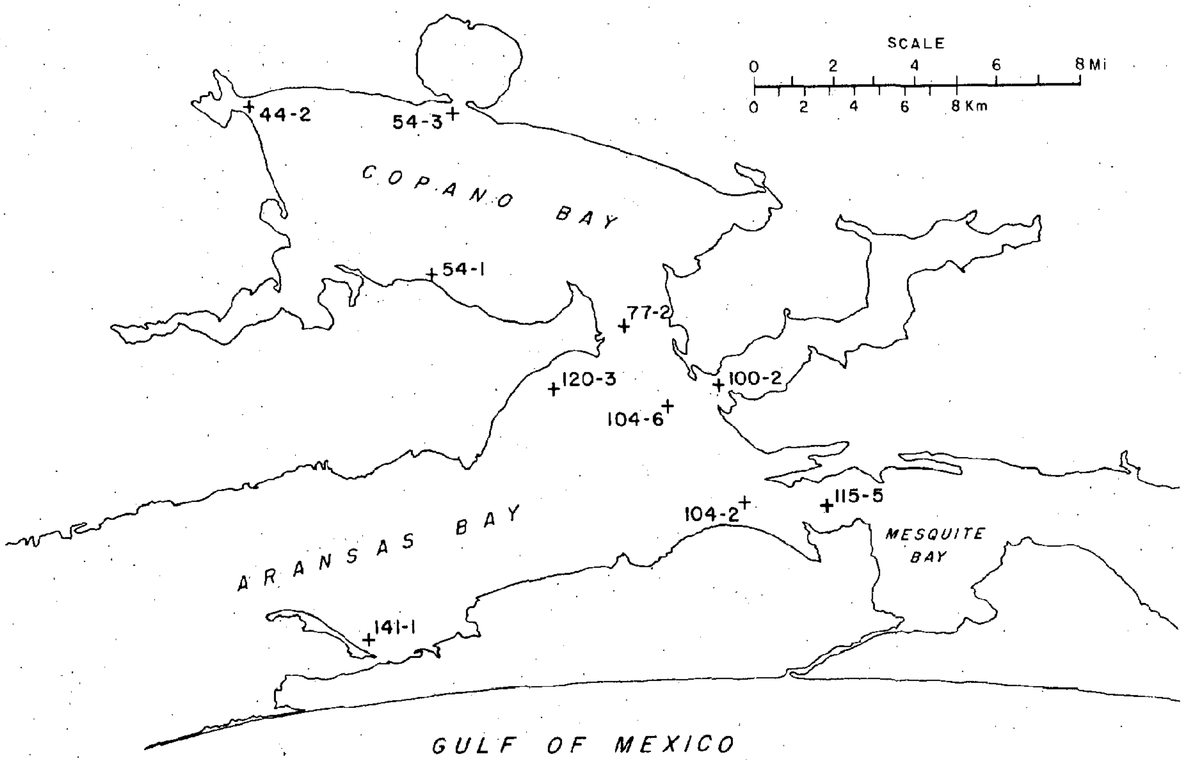


Figure 8. Johnny Holland's Copano-Aransas Bay sampling stations (from Holland and others, 1975).

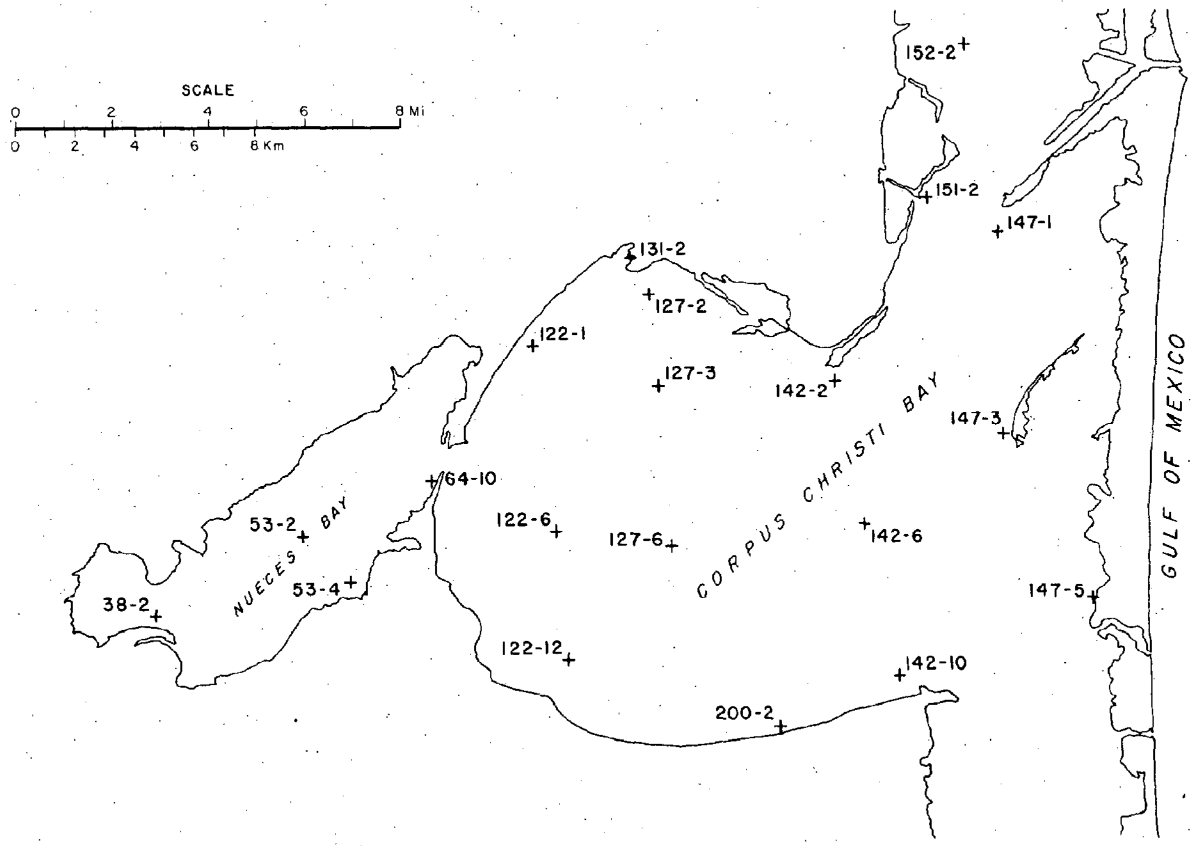


Figure 9. Johnny Holland's Corpus Christi-Nueces Bay sampling stations (from Holland and others, 1975).

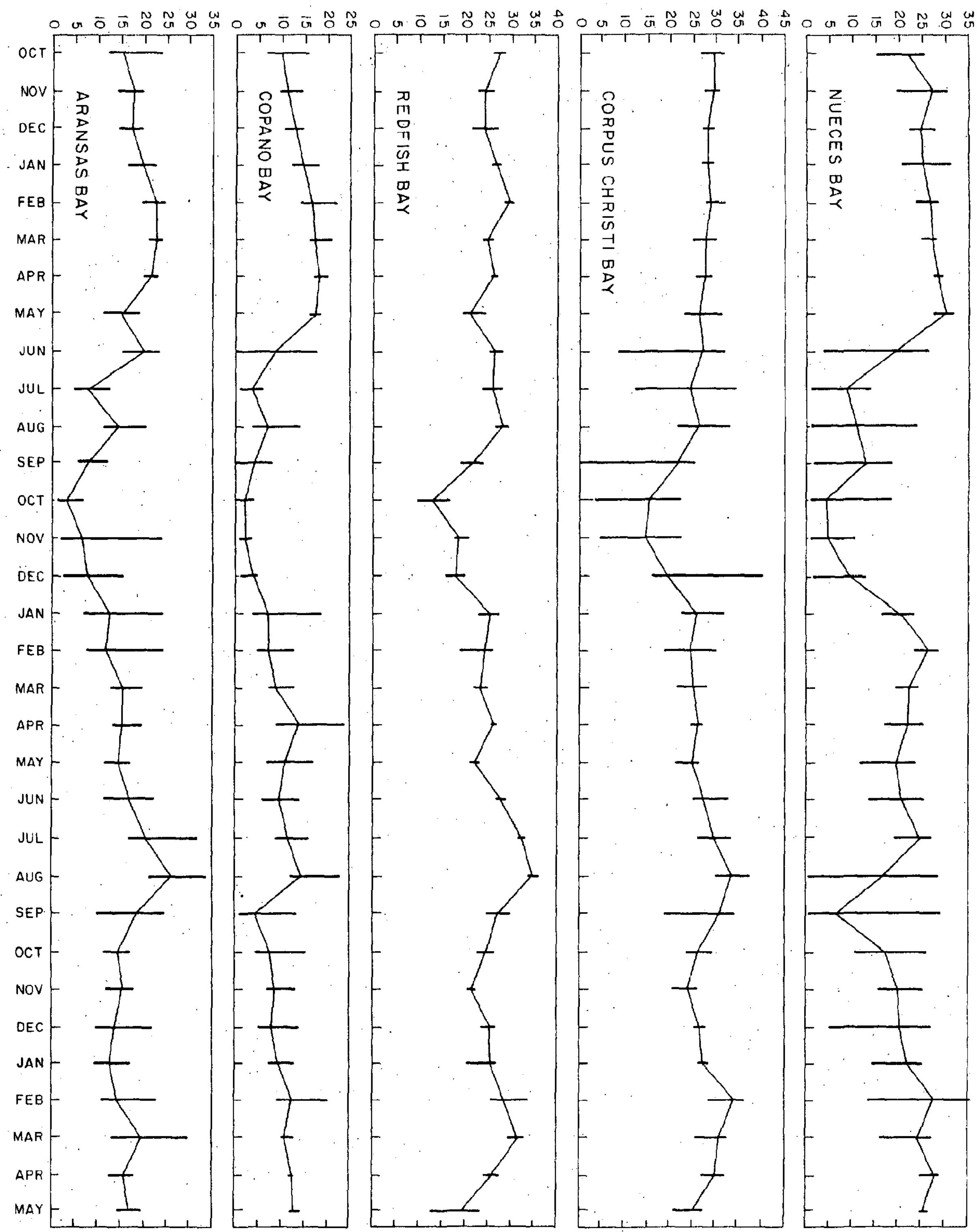


Figure 10. Monthly mean salinities in five bay systems in the Corpus Christi area (from Holland and others, 1975).

Fresh-water inflows from the Nueces River and from Oso Creek were at times considerable and salinity patterns in Corpus Christi and Nueces Bay reflected pulses of fresh-water flooding. Holland and others (1975) reported that lower salinity waters along the Gulf shore of the barrier island were presumably caused by flood outflow in San Antonio Bay. Higher salinity waters enter the bays from Aransas Pass, the Fish Pass, and at times from Oso Bay.

Salinities in upper Nueces Bay varied considerably during the period of Holland and others' study (1973, 1974, and 1975). Salinities at station 38-2 (fig. 9) ranged from .42 ppt in August 1974 to 31.6 ppt in May 1973. Station 53-2 in mid-Nueces Bay was less variable. Stations in mid-Corpus Christi Bay, 122-6, 127-6, and 142-6, had salinities as high as 35 ppt in February to as low as 15.6 ppt at station 142-6 in October 1973. Salinities at shallower bay-margin stations in Corpus Christi Bay varied over a larger range and had lower average salinities than mid-bay stations. Redfish Bay stations were less variable than most of the Corpus Christi Bay stations.

Copano Bay salinities were consistently lower than those in other bays of the study area (Holland and others, 1973, 1974, and 1975). Of the four stations (fig. 8) where Holland took salinity data, station 77-2 at the entrance to Copano Bay generally had the highest salinities. Salinities recorded at station 54-1 were almost as high as station 77-2, and sometimes exceeded it. Monthly readings at stations 44-2 and 54-3, stations closest to fresh-water input, were similar and consistently measured the lowest in salinity.

Salinity readings were taken for the Texas Department of Water Resources on April 19, 1976, just after benthic sampling had been completed in Copano Bay. Salinities were taken at stations 44-2, 54-1, and 77-2, stations occupied by Holland from 1972 through 1975. The average salinity from the three stations was 18.64 ppt, with 77-2 having the highest reading (20.49 ppt).

Salinities were generally higher in upper Laguna Madre than in other bay systems within the study area. Hildebrand and King (1972-1978) reported that yearly salinities in the Pita Island area of Laguna Madre averaged above 30 ppt except during two project years, 1973-74 and 1976-77. Salinity readings were taken monthly at 11 stations in the Pita Island area. Average salinities for the two months in which samples were taken in upper Laguna Madre were 40 ppt (June, 1976) and 43 ppt (October, 1976) (Hildebrand and King, 1972-1978).

FIELD PROCEDURES

Inner Shelf

Surface sediment samples were collected on the Texas inner continental shelf with a Smith-McIntyre grab sampler (capacity 0.013 m^3); samples were spaced 1 mi (1.6 km) apart. Penetration depths ranged from 4 to 16 cm. Shelf samples were collected from May 3 to May 19, 1976. Precision navigation was accomplished primarily with a Motorola Mini Ranger system, but shipboard radar and Loran C also were used.

Shipboard descriptions of the samples were based on visual observations of sediment type, sediment color, shell content, degree of bioturbation, abundance of worms, and preservation of individual sediment layers in a vertical sequence. Sediments were: (1) washed through a .5-mm or 1-mm screen, (2) narcotized with a solution of propylene phenoxytol, and (3) stored in a neutral solution of ten percent formalin. Rose bengal was placed in the formalin to help distinguish live from dead specimens.

Bays

Sediment samples were taken on 1 mi (1.6 km) intervals with a clam shell grab sampler with a capacity of 0.004 m^3. Enough grabs were taken at a station to equal approximately 0.004 m^3; the samples were semiquantitative because the volume was estimated visually. Sampling dates and number of samples for each bay or river are given in table 1.

Shipboard processing was essentially the same as on the inner shelf except that samples were always washed through a 1-mm mesh screen and narcotized with magnesium sulfate.

LABORATORY PROCEDURES

Laboratory processing included further washing of the sample and storing it in 70 percent ethanol. All invertebrates were identified to species level when possible. Live specimens and whole shells were counted. Fragments of shells were counted only if identifiable characters and at least 50 percent of the shell were preserved. Live and paired dead pelecypod valves were counted as one, unpaired valves were counted as one-half.

Gravel/sand/mud proportions in the sediment were determined by oxidation, desaltation, sample drying, and then wet sieving the sediment.

INVERTEBRATE DISTRIBUTIONS

Three hundred and thirty species and 17,887 individuals were found living in the 375 samples examined in the Corpus Christi area (table 2).

Polychaetes had the highest total species count, followed by the mollusks and crustaceans. Species densities or total species counts per station were low throughout most of Corpus Christi, Nueces, Copano, and Aransas Bays. Average total species density per examined station (table 2) was highest in Redfish Bay. High species counts occurred in Corpus Christi Bay between Shamrock Island and Redfish Bay. Also, upper Laguna Madre was uniformly high in total species density per station.

Table 1. Sample collection dates for bays and inner shelf.

	Number of Biological Stations	Number of Biological Stations Examined	Sample Collection Dates
Inner Shelf	255	73	5/3/76-5/19/76
Corpus Christi Bay	158	124	6/8/77-7/15/77
Nueces Bay and Nueces River	39	33	9/76
Upper Laguna Madre	65	22	6/76 and 10/76
Oso Bay	10	7	9/76
Redfish Bay	31	13	7/76
Aransas Bay	66	25	4/2/76-7/6/76
Port Bay	8	4	9/76
Mission Bay and Mission Lake	22	5	9/76
Aransas River	8	3	9/76
Copano Bay	65	65	3/23/76-4/6/76
Totals	727	374	

Table 2. Abundance of the major taxonomic groups within the submerged State lands of the Corpus Christi area.

	Total biological stations	Total examined	Total live species	Total live individuals	Polychaete species	Polychaete individuals	Molluscan species (live)	Molluscan individuals (live)	Crustacean species	Crustacean individuals
Copano Bay	65	65	49 (0.8)	1,052 (14.4)	16 (0.3)	189 (2.9)	12 (0.2)	456 (7)	19 (0.3)	391 (6)
Aransas Bay	66	25	94 (3.9)	354 (14.2)	37 (1.5)	168 (7)	26 (1.0)	98 (3.9)	26 (1)	70 (2.8)
Aransas River	8	3	2 (0.7)	2 (0.7)	1 (0.3)	1 (0.3)	0	0	0	0
Mission Bay & Lake	22	5	5 (1)	19 (3.8)	1 (0.2)	1 (0.2)	3 (0.6)	17 (3.4)	0	0
Port Bay	8	4	12 (3)	113 (28.3)	2 (0.5)	4 (1)	3 (0.8)	62 (15.5)	7 (1.8)	47 (11.8)
Redfish Bay	31	13	107 (8.2)	720 (55.4)	45 (3.5)	253 (19.5)	41 (3.2)	313 (24.1)	16 (1.2)	138 (10.6)
Oso Bay	10	7	18 (2.6)	161 (23)	10 (1.4)	125 (17.9)	7 (1)	35 (5)	1 (0.1)	1 (0.1)
Upper Laguna Madre	65	22	98 (4.5)	2,000 (90.9)	36 (1.64)	456 (20.7)	36 (1.6)	871 (39.6)	21 (1)	650 (29.5)
Nueces Bay & River	40	33	34 (1.0)	254 (7.7)	9 (0.3)	104 (3.1)	10 (0.3)	96 (2.9)	14 (0.4)	44 (1.3)
Corpus Christi Bay	158	125	149 (1.2)	3,186 (25.6)	63 (0.5)	1,025 (8.2)	41 (0.3)	1,388 (11.2)	38 (0.3)	538 (4.3)
Inner Shelf	255	73	213 (2.9)	10,026 (136.5)	94 (1.3)	4,563 (62.6)	48 (0.7)	3,899 (53.4)	59 (0.8)	1,080 (14.9)
TOTALS	727	375	330	17,887	136	6,889	102 live 115 dead	7,235	92	2,959

Numbers in parentheses equal average number of species and individuals per examined station.

Generally, species densities decreased from nearshore to offshore on the Corpus Christi inner shelf. Species densities on the shelf were highest nearshore, from just north of the Aransas Pass jetties to the southern edge of the Corpus Christi area. Only one nearshore station south of the jetties (station 1218 located 1 mi (1.6 km) offshore) had a total species count of less than 30. Except for three stations just north of Aransas Pass, all of the examined stations north of the Pass had less than 30 species.

Few live species or individuals were found in any of the river stations.

Numbers of live individuals per station were low throughout most of the Corpus Christi system. Of the bays, upper Laguna Madre had the highest average number of live individuals per examined station (table 2). Only six of 124 examined stations in Corpus Christi Bay had more than 100 total live individuals. Copano, Aransas, Nueces, and Mission Bays were uniformly low in individual counts per station.

On the inner shelf, live individuals were abundant at stations near Aransas Pass. Station 1406, 4 mi (6.4 km) offshore from Aransas Pass, had the highest count, with 1,915 live individuals. Of the ten examined stations that occurred 1 mi (1.6 km) offshore, six had individual counts of more than 100. However, other than larger live populations close to shore, there was no general trend in numbers of individuals from nearshore to offshore.

Distributions of the polychaetes, mollusks, crustacea, and other phyla will be discussed individually, and their distribution will be related to salinity, bathymetry, and sediment. The invertebrate species collected and their distribution by station can be found in tables on open file at the Bureau of Economic Geology. Maps of total individual and species counts by station are in a separate folio.

Mollusca

Two hundred seventeen species of mollusks were identified from the Corpus Christi Bay area. Of these, there were one polyplacophoran, 125 gastropod, 88 bivalve, and three scaphopod species. The polyplacophoran, Ischnochiton papillosus, 55 gastropod, 44 bivalve, and two scaphopod species were collected live. The species taken and their distribution by station are listed in tables on open file at the Bureau of Economic Geology.

The total numbers of gastropod and bivalve species found on the inner shelf and in the bays were essentially the same, as were the numbers of dead and live gastropod species. Although the number of dead bivalve species found on the shelf exceeded that found in the bays by 32 percent, the number of live bivalve species found on the shelf was 50 percent less than that for bivalve species found live in the bays. The percents of the live species of gastropods and bivalves found on the inner shelf and in the bays are compared in figure 11.

Thirty-one species of gastropods were found only on the shelf, whereas 36 were found only in the bays. Fifteen bivalve species were found only on the shelf and 21 were found only in the bays (tables 3 and 4). Ischnochiton papillosus occurred only in the bays, whereas the scaphopods Dentalium eboreum and Cadulus carolinensis occurred only on the shelf.

The dominant species found on the shelf and in each of the bays are listed in table 5. Generally, only those species that accounted for approximately ten percent of the total number of individuals or of the live individuals were included.

Inner Shelf

One hundred fifty-eight species of mollusks were found on the inner shelf, including 88 gastropods, 67 bivalves, and three scaphopods. Thirty gastropod, 17 bivalve, and one scaphopod species were taken alive. A total of 39,105 individuals were counted, including 642 gastropods, 3,249 bivalves, and eight scaphopods taken live.

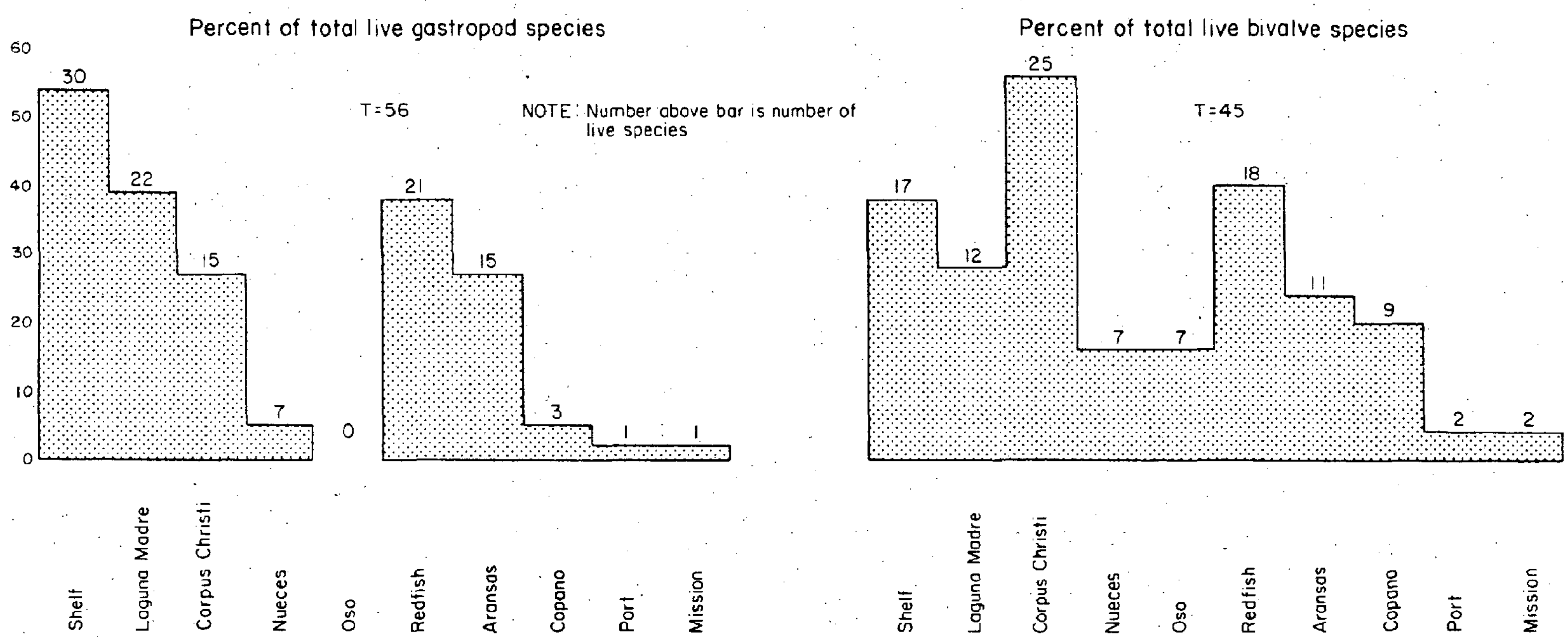


Figure 11. Distribution of the total live gastropod and bivalve species on the inner shelf and in the bays.

Table 3

Mollusk species found only on the shelf

Gastropods		Bivalves	
D	Anticlimax pilsbryi	D	Anadara brasiliana
D	Caecum imbricatum	D	Atrina serrata
D	Heliacus bisulcata	D	Argopecten gibbus
D	Architectonica nobilis	D	Chama congregata
D	Alaba incerta	D	C. macerophylla
D	Litiopa melanostoma	D	Arcinella cornuta
D	Epitonium albidum	L	Raeta plicatella
D	Epitonium novangliae	D	Tellina aequistriata
L	Eulima bilineatus	D	Macoma pullezii
D	Eulima hemphilli	D	Corbula dietziona
D	Balcis arcuata	D	C. krebsiana
D	Strombus alatus	D	Corbula sp.
L	Sinum perspectivum	D	Varicorbula operculata
D	Tonna galea	D	Hiatella arctica
D	Kurtziella cf. atrostyla	D	Martesia cuneiformis
D	K. cf. rubella		
L	Kurtziella sp.		
D	Cryoturris cf. cerinella		
D	Nannodiella cf. vespuciana		
D	Terebra concava		
D	Hastula salleana		
D	Busycon spiratum		
D	Costoanachis lafresnayii		
D	Cosmioconcha calliglypta		
L	Olivella dealbata		
L	O. minuta		
L	Volvulella persimilis		
D	Peristichia toreta		
L	Cyclostremella humilis		
L	Creseis acicula		
L	Cavolina longirostris		

D = Dead L = Live

Table 4

Mollusk species found in the bays only

Gastropoda	LM	CC	O	N	R	A	C	P	M
Lucapinella limatula				D					
Littorina lineolata		D							
Rissoina catesbyana		D	D	D	D		D		
Hydrobia sp.				D					
Helisoma trivolvis				D					
Physa virgata				D					
Texadina barretti				D					
T. sphinctostoma	L		D	L		D	L	L	L
Littoridinops sp.		D		D					
Truncatella caribaeensis	D	D	D	D	D	D	D	D	
Cyclostremiscus jeanae				D					
Episcynia inornata		D		D		D			
Caecum johnsoni		D			D	L			
Cochliolepis parasitica		D							
Cerithiopsis emersoni				D					
Seila adamsi		D		D			D		
Triphora p. nigrocinta	L	D		D	D		D		
Graphis underwoodae				D					
Crepidula maculosa	L	D				D			
Pyrgocythara plicosa	L	D		D	L	D	D		
Pisania tincta					D				
Nassarius vibex	D	D			L	L	D		
Pleuroploca gigantea		D							
Busycon perversum		D				D			
Murex fulvescens		D							
Haminoea antillarum	L	D			D				
H. succinea	L	D			D	D			
Odostomia dux				D					
O. impressa	L	D		D	L	D	L	D	D
O. cf. bisuturalis	L		D		D	D			
Eulimastoma cf. canaliculata		D							

Table 4 (cont.)

	LM	CC	O	N	R	A	C	P	M
Gastropoda (continued)									
Eulimastoma harbisonae	D	D		D	D	D			
Eulimastoma sp. A		D							
Eulimastoma sp. B	D								
Eulimastoma sp. C		D							
Sayella cf. livida	L	D	D	D	L	D	D	D	
Bivalvia									
Barbatia domingensis		D			D				
Iscadium recurvum				L	D	D	L	D	D
Gregariella coralliophaga					D				
Musculus lateralis				D					
Amygdalum papyria	L	D			L		L	D	
Argopecten i. amplicostatus	L	D	D		D	L	D		
Mactra fragilis					L	D			
Rangia cuneata		D		L			D		D
Tellina tampaensis	L	D	L		D	D	D		
Tellina texana	L	L	D	L	L	D	D		L
T. lineata		D							
Macoma constricta							D		
M. mitchelli	D	D		L	D	L	L	L	L
Semele proficua				D	D	D			
Cumingia tellinoides	D	L			D	D	D		
Tagelus divisus		L	D		L	D			
T. plebius	D	D	D	D	D	D	L	D	
Mytilopsis leucophaeta			D	D			D		
Cyrtopleura costata		D	D		D				
Diplothyra smithii		D	L	D					
Lyonsia h. floridana	L	L	L	D	L	L			

LM = Laguna Madre
CC = Corpus Christi Bay
O = Oso Bay
N = Nueces Bay
R = Redfish Bay
A = Aransas Bay
C = Copano Bay
P = Port Bay
M = Mission Bay

D = Dead L = Live

Table 5

Percent of total (T) and live (L) individuals of dominant mollusk species.

Inner Shelf

Gastropoda	T = 13,556	%	L = 642	%
Natica pusilla	6,374	47.0	81	12.6
Nassarius acutus	2,490	18.4	236	36.8
Vitrinella floridana	227	1.7	97	15.1
	9,091	67.1	414	64.5
Bivalvia	T = 25,259	%	L = 3,249	%
Mulinia lateralis	12,362	48.9	13	0.4
Abra aequalis	9,142	36.2	3,042	93.6
	21,504	85.1	3,055	94.0

Upper Laguna Madre

Gastropoda	T = 4,639	%	L = 727	%
Bittium varium	1,701	36.7	31	4.3
Cerithium lutosum	1,032	22.2	486	66.9
Crepidula convexa	302	6.5	69	9.5
	3,035	65.4	586	80.7
Bivalvia	T = 9,183	%	L = 142	%
Anomalocardia auberiana	6,896	75.1	3	2.1
Mulinia lateralis	1,149	12.5	10	7.0
Brachidontes exustus	144	1.6	67	47.2
	8,189	89.2	80	56.3

Corpus Christi Bay

Gastropoda	T = 5,804	%	L = 135	%
Acteocina canaliculata	1,602	27.6	56	41.5
Bittium varium	1,107	19.1	1	0.7
Turbonilla cf. interrupta	529	9.1	34	25.2
Acteon punctostriatus	464	8.0	5	3.7
	3,702	63.8	96	71.1
Bivalvia	T = 24,400	%	L = 1,247	%
Mulinia lateralis	14,100	57.8	655	52.5
Nuculana acuta	5,668	23.2	153	12.3
Brachidontes exustus	372	1.5	187	15.0
Lyonsia h. floridana	140	0.6	107	8.6
	20,280	83.1	1,102	88.4

Oso Bay

Gastropoda	T = 130	%	L = 0	%
Bittium varium	53	40.8	--	--
Acteocina canaliculata	22	16.9	--	--
Acteon punctostriatus	20	15.4	--	--
	95	73.1		

Table 5 (cont.)

Bivalvia	T = 395	%	L = 35	%
Mulinia lateralis	246	62.3	3	8.6
Anomalocardia auberiana	67	16.9	1	0.3
Petricola pholadiformis	15	3.8	11	31.4
Brachidontes exustus	12	3.0	9	25.7
Diplothyra smithii	10	2.5	9	25.7
	350	88.5	33	91.7

Nueces Bay and Nueces River

Gastropoda	T = 2,315	%	L = 3	%
Bittium varium	569	24.6	--	--
Eulimastoma cf. weberi	405	17.5	--	--
Texadina barretti	267	11.5	--	--
Odostomia impressa	221	9.5	--	--
	1,462	63.1		
Bivalvia	T = 7,283	%	L = 93	%
Mulinia lateralis	6,053	83.1	83	89.2

Redfish Bay

Gastropoda	T = 23,657	%	L = 181	%
Cerithium lutosum	13,912	58.8	3	1.7
Bittium varium	3,024	12.8	23	12.7
Crepidula fornicata	1,837	7.8	69	38.1
Odostomia impressa	1,057	4.5	8	4.4
	19,837	83.9	103	56.9
Bivalvia	T = 2,963	%	L = 122	%
Nuculana acuta	460	15.5	10	8.2
Mysella planulata	333	11.2	15	12.3
Chione cancellata	313	10.6	--	--
Anomalocardia auberiana	277	9.3	--	--
Mulinia lateralis	269	9.1	13	10.7
Laevicardium mortoni	238	8.0	10	8.2
Lucina pectinata	95	3.2	14	11.5
Lyonsia h. floridana	42	1.4	31	25.4
	2,027	68.3	93	76.3

Aransas Bay

Gastropoda	T = 2,779	%	L = 55	%
Bittium varium	619	22.2	--	--
Acteocina canaliculata	404	14.5	9	16.4
Caecum pulchellum	367	13.2	5	9.1
Cerithium lutosum	261	9.4	--	--
Acteon punctostriatus	36	1.3	8	14.5
Vitrinella floridana	27	1.0	7	12.7
Caecum johnsoni	21	0.8	7	12.7
	1,735	62.4	36	65.4

Table 5 (cont.)

Bivalvia	T = 1,797	%	L = 43	%
Nuculana acuta	534	29.7	2	4.7
Mulinia lateralis	291	16.2	3	7.0
Mysella planulata	66	3.7	9	20.9
Ensis minor	13	0.7	7	16.3
Macoma mitchelli	13	0.7	6	13.9
Lyonsia h. floridana	8	0.4	7	16.3
	925	51.4	34	79.1
Copano Bay				
Gastropoda	T = 1,308	%	L = 124	%
Odostomia cf. laevigata	375	28.7	31	25.0
O. impressa	201	15.4	51	41.1
Texadina sphinctostoma	157	12.0	42	33.9
	733	56.0	124	100.0
Bivalvia	T = 1,657	%	L = 332	%
Mulinia lateralis	771	46.5	39	11.7
Macoma mitchelli	249	15.0	199	59.9
Ischadium recurvum	246	14.8	57	17.2
	1,266	76.3	295	88.8
Port Bay and Aransas River				
Gastropoda	T = 111	%	L = 1	%
Odostomia cf. laevigata	44	39.6	--	--
Texadina sphinctostoma	14	12.6	1	100.0
Cerithium lutosum	11	9.9	--	--
	69	62.1	1	100.0
Bivalvia	T = 145	%	L = 61	%
Macoma mitchelli	64	44.1	58	95.1
Mulinia lateralis	51	35.2	3	4.9
	115	79.3	61	100.0
Mission Lake and Mission Bay				
Gastropoda	T = 26	%	L = 1	%
Texadina sphinctostoma	18	69.2	1	100.0
Bivalvia	T = 59	%	L = 16	%
Macoma mitchelli	39	66.1	10	62.5
Mulinia lateralis	9	15.3	--	--
Tellina texana	8	13.6	6	37.5
	56	94.9	16	100.0

Three species of gastropods, Vitrinella floridana, Natica pusilla, and Nassarius acutus, accounted for 64.5 percent of the live gastropod individuals. Vitrinella floridana occurred primarily in sediments of 20 to 40 percent sand at depths of over 54 ft (16.2 m), while Natica pusilla and Nassarius acutus occurred primarily in sediments of 80 to 100 percent sand at depths of 36 to 48 ft (10.8 to 14.4 m).

Abra aequalis made up 93.6 percent of the live bivalve individuals. Over 50 percent of these were found at one station (1403). Abra occurred primarily at stations with 60 to 100 percent sand substrates and at depths of 36 to 54 ft (10.8 to 16.2 m).

Cadulus carolinensis was the only scaphopod species collected live. It occurred only at stations with 80 to 100 percent sand substrates and depths of 42 to 48 ft (12.6 to 14.4 m).

The distribution of the average number of live and total gastropod and bivalve species per station by substrate is given in figure 12.

Figures 13 and 14 represent two inner shelf transects approximately 23 mi (36.8 km) apart. Depths in figure 13 range from 18 to 78 ft (5.4 to 23.4 m) and in figure 14 from 12 to 72 ft (3.6 to 21.6 m). Tables 6 and 7 list the live mollusk species and the number of live individuals for each species found along the transects.

Bays

Corpus Christi Bay

One hundred thirty-six species of mollusks, 76 gastropods, 59 bivalves, and one scaphopod were found in Corpus Christi Bay. Of these, 15 species of gastropods, 25 bivalves, and the one scaphopod were taken live. A total of 30,275 individuals were taken, of which 5,804 were gastropods, 24,400 bivalves, and 71 scaphopods. One hundred thirty-five gastropod, 1,247 bivalve, and six scaphopod individuals were taken live.

Acteocina canaliculata and Turbonilla interrupta were the most abundant of the live gastropods, accounting for 66.7 percent of the total live gastropod individuals.

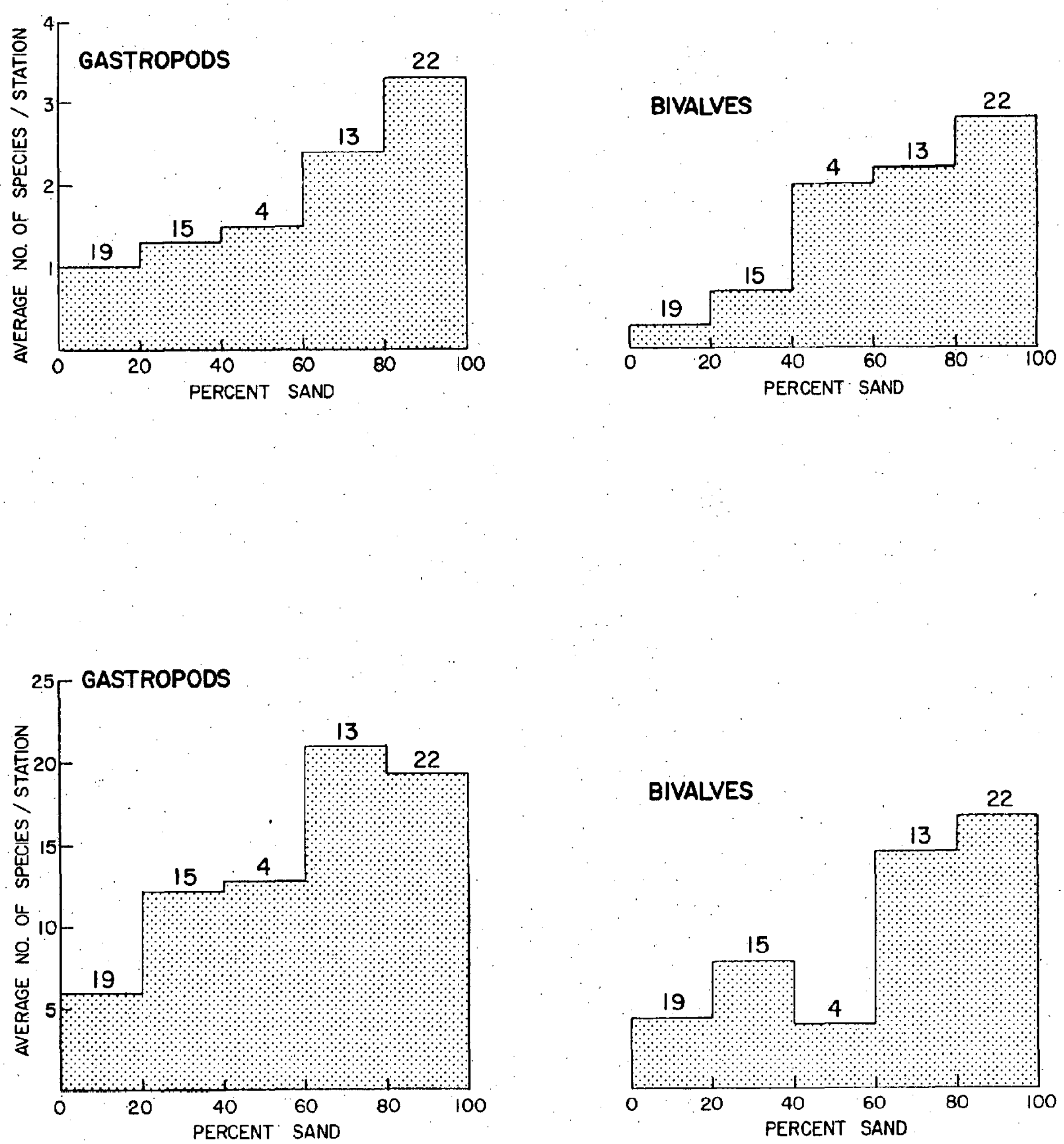


Figure 12. Distribution by substrate of the average number of live (upper) and total (lower) mollusk species per station on the inner shelf. Number above bar is the number of stations.

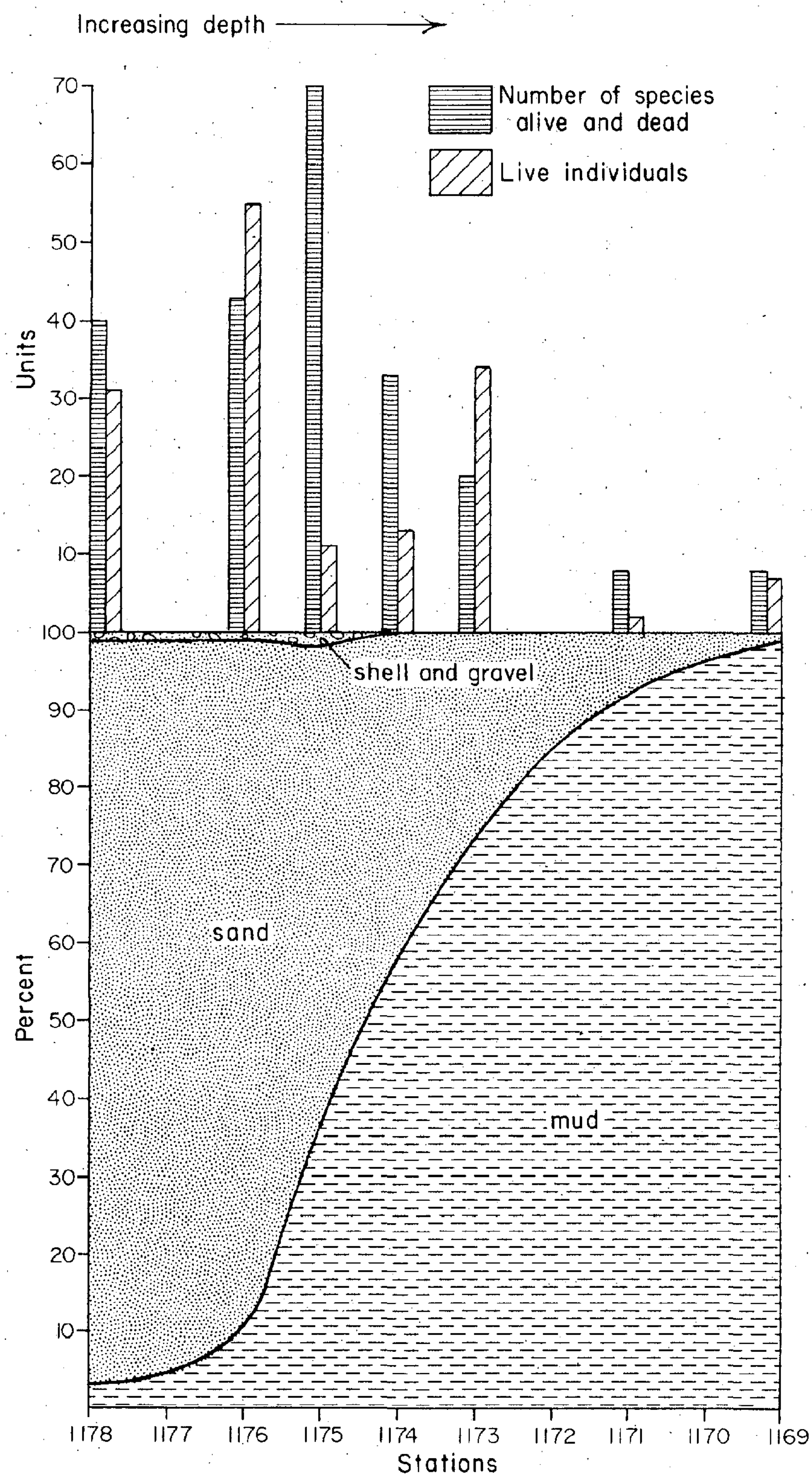


Figure 13. Mollusk and sediment distribution along shelf transect 1178-1169. Stations 1170 and 1172 were not analyzed for mollusks.

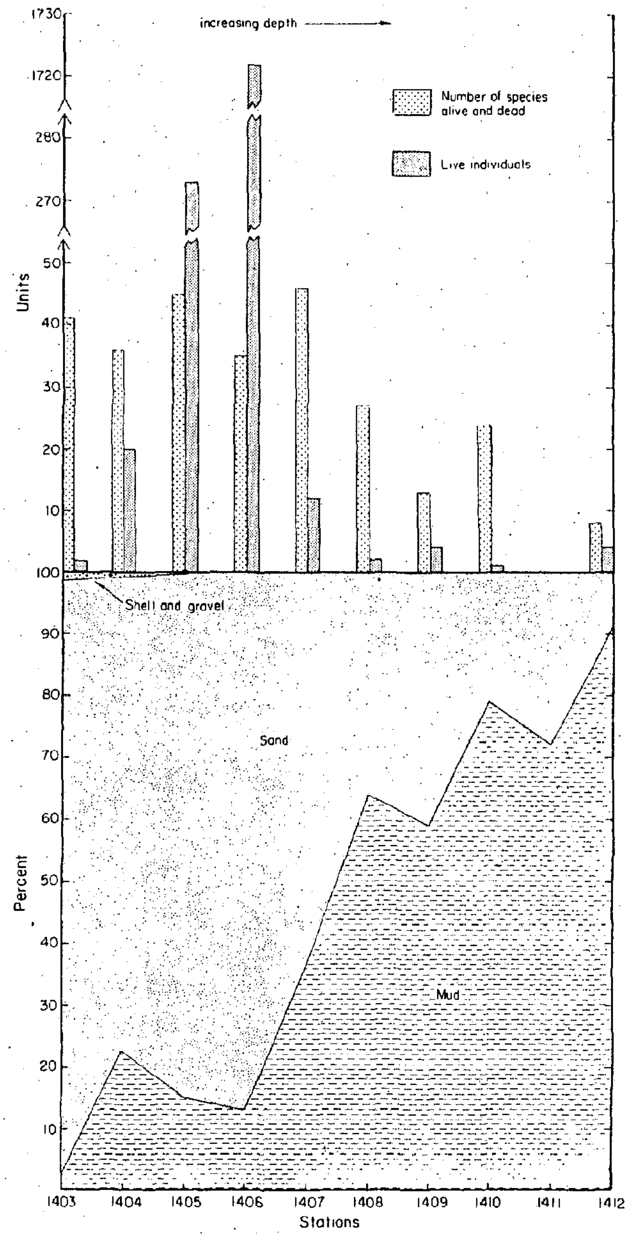


Figure 14. Mollusk and sediment distribution along shelf transect 1403-1412. Station 1411 was not analyzed for mollusks.

Table 6. Live mollusk species and individuals occurring along transect 1178-1169.*

	Stations									
	1178	1177	1176	1175	1174	1173	1172	1171	1170	1169
Vitrinella floridana					2			1		4
Solariorbis infracarinata	3									
Epitonium apiculatum	1									
E. multistriatum	7									
Eulima bilineatus			1							
Crepidula convexa	3									
Polinices duplicatus	1		1							
Natica pusilla	1		5	1						
Sinum perspectivum			1							
Nassarius acutus	1		34							
Olivella minuta	1									
Acteon punctostriatus	4		1							
Volvulella texasiana						1		1		1
Odostomia gibbosa	4									
Nucula proxima				5						
Nuculana concentrica					1					1
Parvilucina multilineata	4		5							
Ensis minor			2							
Tellina iris	1									
Abra aequalis				5	10	33				1
Dosinia discus			1							

*Stations 1177, 1172 and 1170 were not analyzed for mollusks.

Table 7. Live mollusk species and individuals occurring along transect 1403-1412.*

	Stations									
	1403	1404	1405	1406	1407	1408	1409	1410	1411	1412
Vitrinella floridana		1	2		2	1	1			4
Epitonium apiculatum			3							
E. multistriatum				4						
Polinices duplicatus				2						
Natica pusilla		4	7	9				1		
Kurtziella sp.		1								
Terebra protexta							1			
Nassarius acutus		12	86	56	2					
Parvanachis obesa			3	3	1					
Acteon punctostriatus			2	5						
Odostomia gibbosa		1	2							
Cyclostremella humilis			6							
Nucula proxima				2						
Anadara transversa	1									
Parvilucina multilineata				5						
Crassinella lunulata	1									
Mulinia lateralis		1	1							
Raeta plicatella				1						
Tellina versicolor			3			1				
Abra aequalis			158	1635	7		2			

*Station 1411 was not analyzed for mollusks.

Living A. canaliculata and T. interrupta were collected at 15 and ten stations, respectively, and in sediments that were predominantly 80 to 100 percent sand.

Mulinia lateralis, Nuculana acuta, Brachidontes exustus, and Lyonsia hyalina floridana accounted for 88.4 percent of the total live bivalve individuals. Mulinia lateralis alone made up 52.5 percent of the live bivalve individuals and was found at 86 stations, 56.1 percent having 0 to 20 percent sand substrate and 29.8 percent having an 80 to 100 percent sand substrate. Nuculana acuta was found live at 23 stations in sediments predominantly 0 to 20 percent sand. Brachidontes exustus was found live at only four stations, two of which were located on oyster reefs (stations 138 and 150). Ninety-eight percent of the live individuals were found at these two stations, the rest being found in 0 to 40 percent mud with many large shell fragments. Lyonsia hyalina floridana was found live at 18 stations in sediments about evenly divided between 0 to 40 and 60 to 80 percent sand.

Dentalium texasianum was the only scaphopod found in Corpus Christi Bay. It was collected live at two stations in sediments of 60 to 100 percent sand.

Figure 15 shows the distribution of the average number of species per station for live and total gastropod and bivalve species by sediment type.

Figure 16 represents a transect consisting of 17 stations running the length of Corpus Christi Bay and approximately parallel to the Corpus Christi Ship Channel. Figure 17 represents a transect consisting of 13 stations across the width of the bay from the Corpus Christi Naval Air Station to Portland. Stations 18 and 39 in figure 16 and stations 85 and 89 in figure 17 were not analyzed for mollusks. Station 150 in figure 16 was an oyster reef; no sediment data were available since the reef consisted primarily of shell material. Tables 8 and 9 list the live mollusk species and the number of live individuals for each species found along the transects.

Upper Laguna Madre

Eighty-one species of mollusks were found in upper Laguna Madre, including one polyplacophoran, 43 gastropods, 36 bivalves, and one scaphopod. The polyplacophoran,

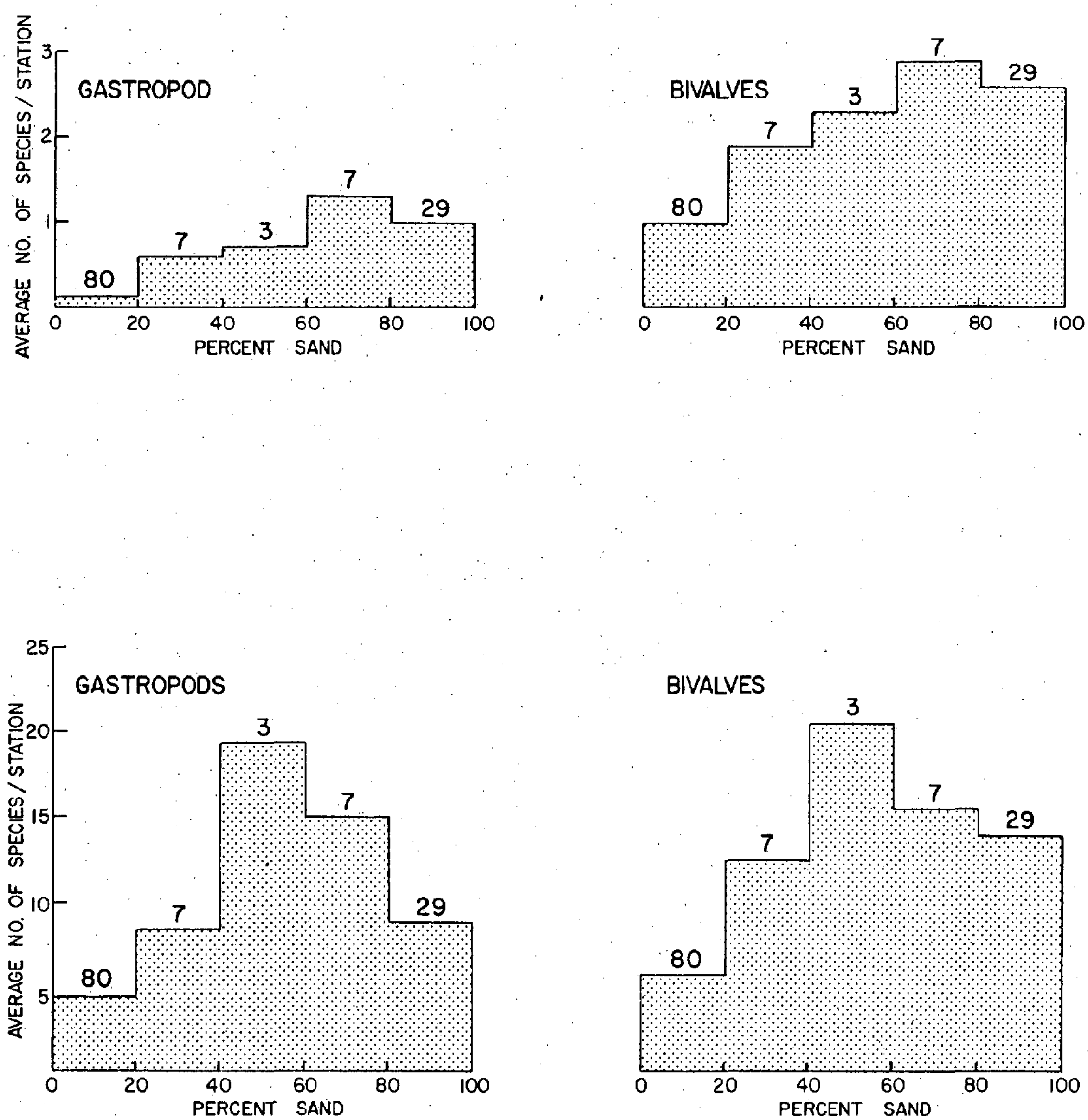


Figure 15. Distribution by substrate of the average number of live (upper) and total (lower) mollusk species per station in Corpus Christi Bay. Number above bar is the number of stations.

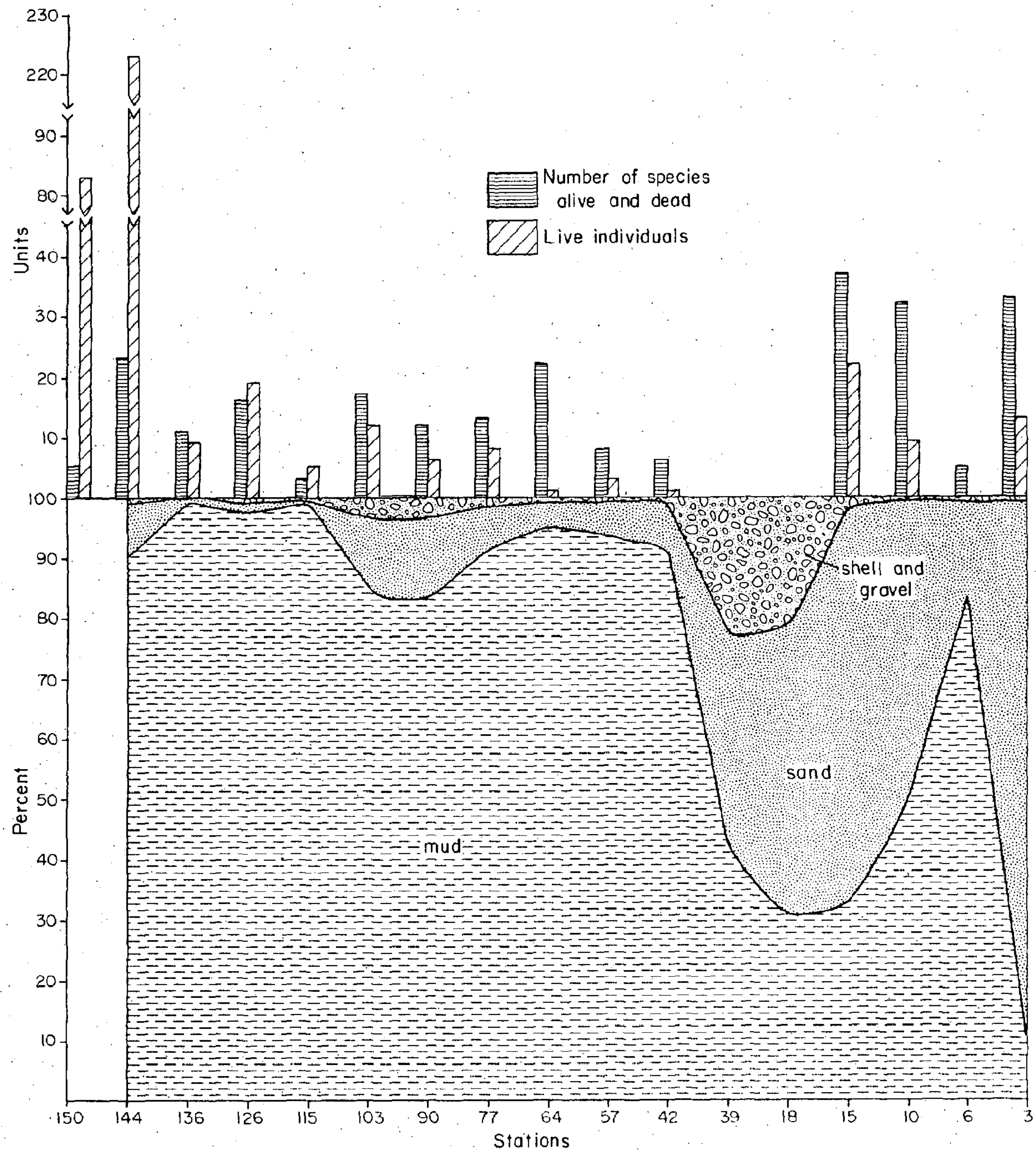


Figure 16. Mollusk and sediment distribution of Corpus Christi Bay transect 150-3. Stations 18 and 39 were not analyzed for mollusks. Station 150 was located on an oyster reef with no sediment data available.

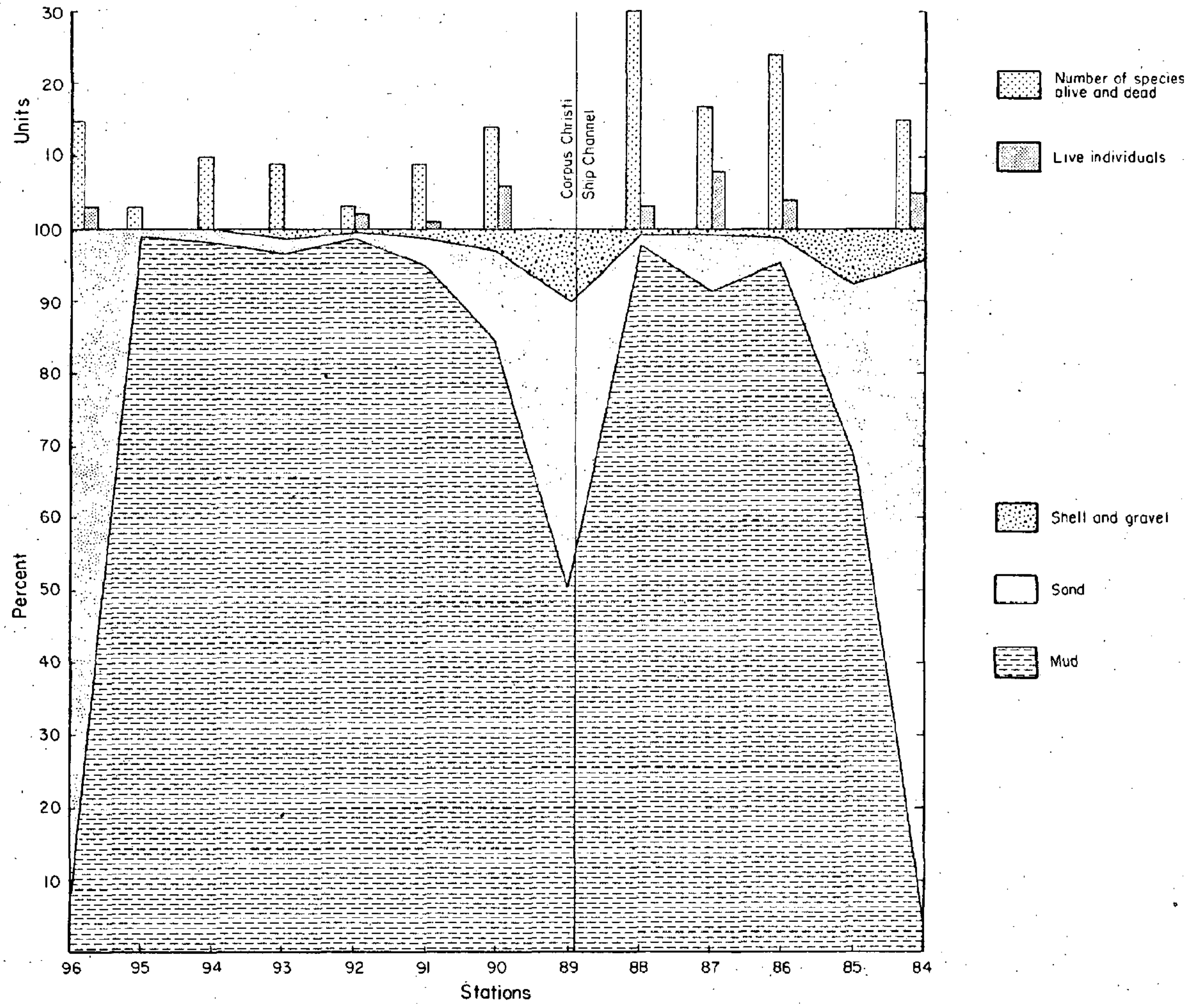


Figure 17. Mollusk and sediment distribution of Corpus Christi Bay transect 96-84. Stations 85 and 89 were not analyzed for mollusks.

Table 8. Live mollusk species and individuals occurring along transect 150-3.*

	Stations																
	150	144	136	126	115	103	90	77	64	57	42	39	18	15	10	6	3
Crepidula plana	2																
Nassarius acutus																	1
Parvanachis obesa					1												
Acteocina canaliculata														2	3		
Turbonilla cf. interrupta																	4
T. cf. hemphilli		1															1
Nuculana acuta		77	1				1							11	3		3
N. concentrica														1	1		
Brachidontes exustus	80																
Aligena texasiana																	2
Mysella planulata			1											1			
Laevicardium mortoni																	1
Mulinia lateralis		123	5	19	4	12	4	7	1	3	1			1			
Pandora trilineata		2						1						1	2		
Lyonsia h. floridana	1	20	2				1							2			1

*Stations 18 and 39 were not analyzed for mollusks.

Table 9. Live mollusk species and individuals occurring along transect 96-84.*

	Stations												
	96	95	94	93	92	91	90	89	88	87	86	85	84
Nuculana acuta							1		1				
N. concentrica									2	2			
Mulinia lateralis	3				2	1	4			4	4		4
Cumingia tellinoides										1			
Lyonsia h. floridana							1			1			

*Stations 85 and 89 were not analysed for mollusks.

(Ischnochiton papillosus), 22 gastropod, 12 bivalve, and the one scaphopod (Dentalium texasianum) species were collected alive. Eighty-three percent of the live individuals were gastropods and 16 percent were bivalves.

Cerithium lutosum accounted for 66.9 percent of the live gastropod individuals found in upper Laguna Madre and Crepidula convexa accounted for 9.5 percent. Probably more significant than sediment type is the fact that all the live Cerithium lutosum and Crepidula convexa were found in areas of abundant seagrass.

The most abundant bivalve was Brachidontes exustus with 47.2 percent of the total live bivalve individuals. As with the gastropods, Brachidontes exustus was found in areas of abundant seagrass.

Figure 18 shows the distribution by sediment type of the average number of live and total species per station.

Oso Bay

A total of 38 species of mollusks were found at seven stations in Oso Bay, including 18 gastropods and 20 bivalves. No gastropod and only seven bivalve species were collected live.

Forty-one percent of the 130 dead gastropod individuals collected was Bittium varium. Both Acteon punctostriatus and Acteocina canaliculata accounted for 15 percent of the individuals. These three species were found in sediments of 20 to 60 percent sand.

Of the live bivalve species, Brachidontes exustus, Petricola pholadiformis and Diplothyra smithii were most abundant, accounting for 92 percent of the total live bivalve individuals. All three of these bivalve species were collected at station 1 in sediment of 40 to 60 percent sand; however, B. exustus was attached to and D. smithii excavated into shell fragments of Crassostrea virginica.

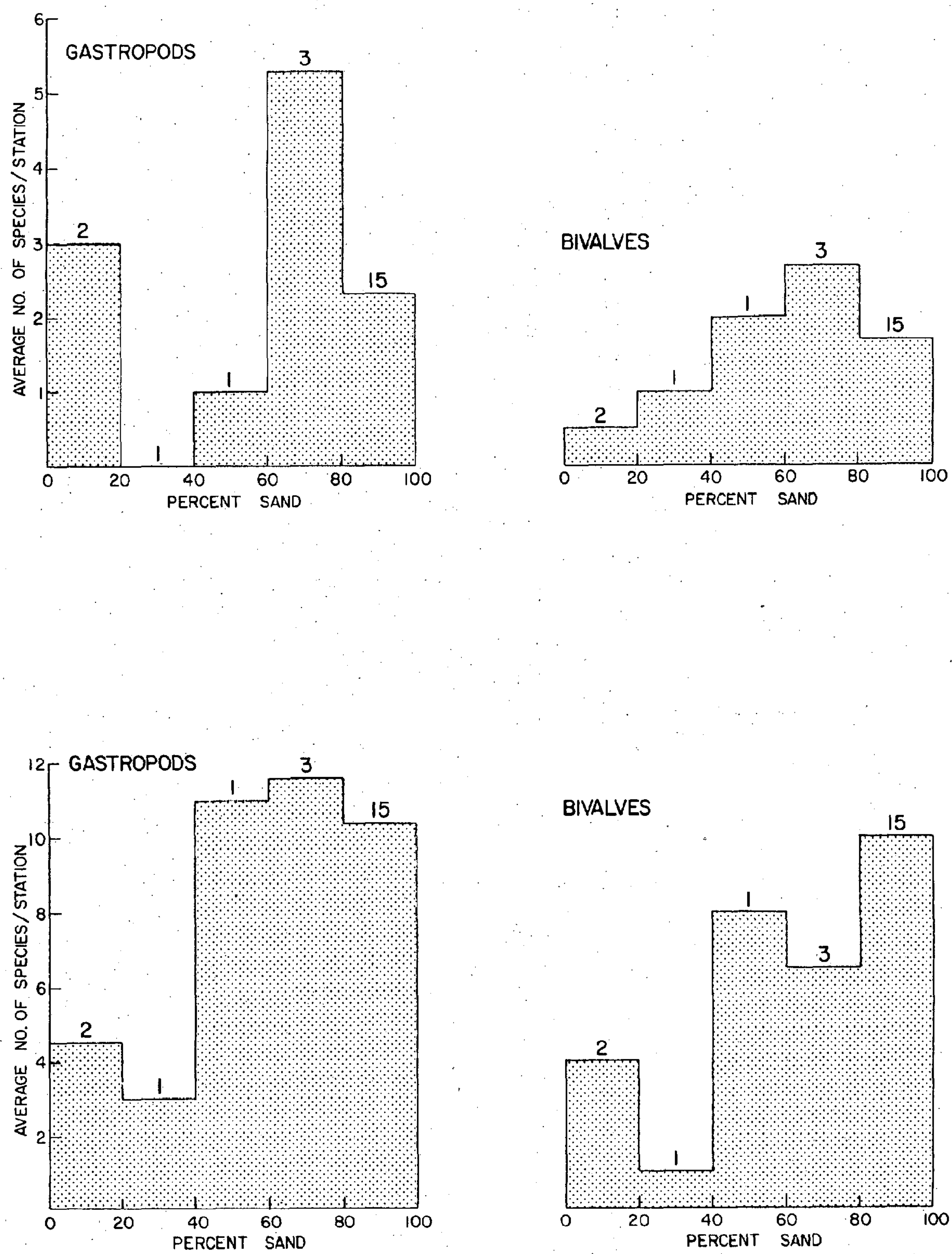


Figure 18. Distribution by substrate of the average number of live (upper) and total (lower) mollusk species per station in upper Laguna Madre. Number above bar is number of stations.

Nueces Bay and Nueces River

In Nueces Bay, 48 species of gastropods and 34 species of bivalves were collected. Three of the gastropod and seven of the bivalve species were taken live. Only three of the 2,318 gastropod and 93 of the 7,376 bivalve individuals were collected live.

Texadina barretti, Bittium varium, Odostomia impressa, and Eulimastoma cf. weberi were the most abundant of the gastropods, accounting for 63.1 percent of the total gastropod individuals. None were collected live. Texadina barretti was found predominantly in sediments of 0 to 40 percent sand, whereas the other three species occurred predominantly in sediments of 20 to 80 percent sand.

Two species of freshwater gastropods were also collected. Helisoma trivolvis was collected at two of the Nueces River stations, and Physa virgata was collected in Nueces Bay, where it had apparently washed from the river.

Mulinia lateralis was by far the most abundant of the bivalves in Nueces Bay, accounting for 83.1 percent of the dead and 89.2 percent of the live bivalve individuals. It was found at every station examined, including three of the Nueces River stations, except station 39. Mulinia was found primarily in sediments of 20 to 80 percent sand.

Figure 19 shows the distribution by sediment type of the average number of live and total species per station in Nueces Bay.

Redfish Bay

One hundred eight species of mollusks were identified from 13 stations in Redfish Bay. One polyplacophoran, 57 gastropod, 49 bivalve, and one scaphopod species were represented. The one polyplacophoran, 21 gastropod, 18 bivalve, and one scaphopod species were taken live. Of the 26,658 individuals taken, only 313 were live, including six polyplacophorans, 181 gastropods, 122 bivalves, and four scaphopods.

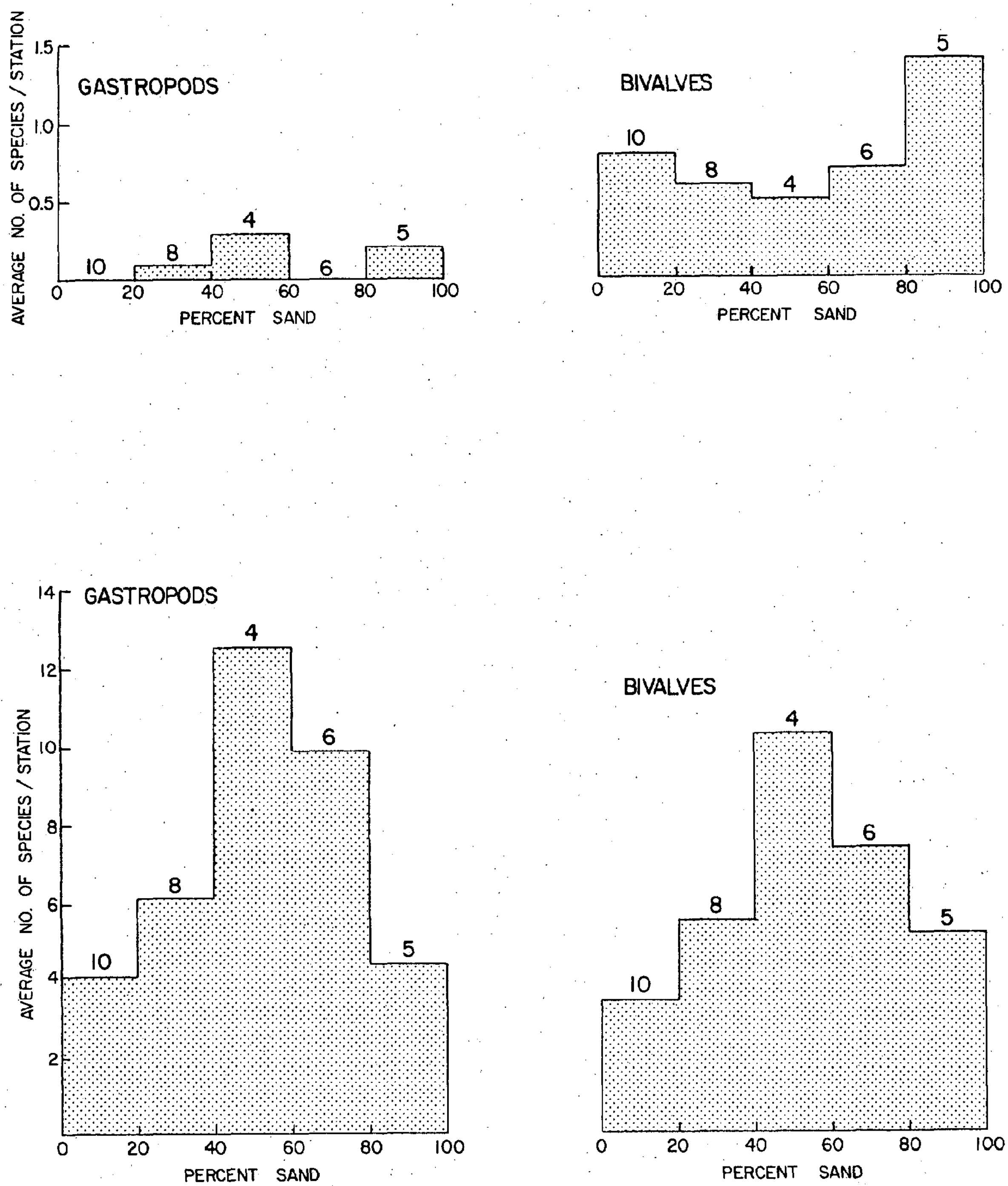


Figure 19. Distribution by substrate of the average number of live (upper) and total (lower) mollusk species per station in Nueces Bay and Nueces River.

Six specimens of Ischnochiton papillosus were taken at two stations where large shell fragments were abundant. These stations, 1 and 17, had substrates of 60 to 80 and 40 to 60 percent sand, respectively.

Bittium varium and Crepidula fornicata accounted for approximately 50 percent of the live gastropod individuals, but along with Cerithium lutosum and Odostomia impressa made up 83.8 percent of the total 23,657 gastropod individuals. Cerithium lutosum alone accounted for 58.8 percent of the total gastropod individuals. Bittium varium, C. lutosum, and O. impressa were found most abundantly at stations with a substrate of 40 to 60 percent sand, whereas living C. fornicata was found at stations with abundant seagrasses.

Although Lyonsia hyalina floridana had the largest number of live bivalve individuals (31), it was Nuculana acuta, Mysella planulata, Laevicardium mortoni, Mulinia lateralis, Chione cancellata, and Anomalocardia auberiana, each with approximately the same number of individuals, which accounted for 63.8 percent of the total number of bivalve individuals taken from Redfish Bay. Lyonsia h. floridana, N. acuta, and M. lateralis were primarily found in sediments of 60 to 80 percent sand, whereas the other four species were usually found in sediments of 40 to 80 percent sand.

The scaphopod, Dentalium texasianum, was found live at stations 3 and 8, each of which had a substrate of 80 to 100 percent sand and abundant grass.

Figure 20 shows the distribution of the average number of live and total species per station by sediment type in Redfish Bay.

Aransas Bay

One hundred four species of mollusks were found at 29 stations in Aransas Bay, including 55 gastropods, 48 bivalves, and one scaphopod (Dentalium texasianum). Fifteen gastropod and 11 bivalve species were taken live. Fifty-five of the 2,779 gastropod individuals and 43 of the 1,797 bivalve individuals were live.

The 55 live gastropod individuals were more or less evenly divided among 15 species. Caecum pulchellum, Cerithium lutosum, Bittium varium, and Acteocina

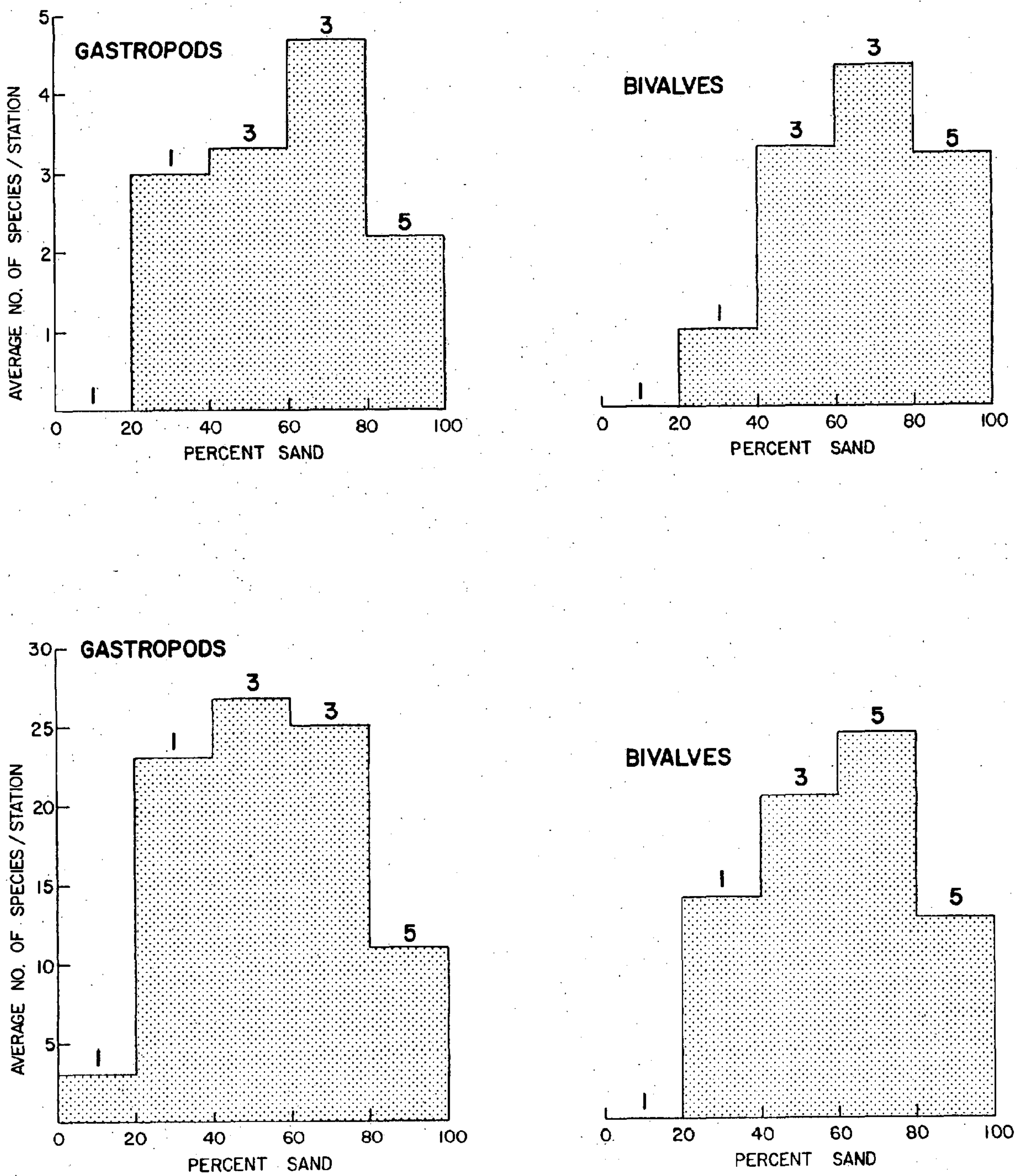


Figure 20. Distribution by substrate of the average number of live (upper) and total (lower) mollusk species per station in Redfish Bay. Number above bar is number of stations.

canaliculata accounted for 59 percent of the total gastropod individuals, with B. varium accounting for 22.2 percent alone. Caecum pulchellum occurred primarily in sediments of 40 to 80 percent sand, whereas C. lutosum and B. varium were found most commonly in sediments of 80 to 100 percent sand and A. canaliculata in 40 to 60 percent sand.

As with the gastropods, the live bivalve individuals were more or less evenly divided among 11 species. Nuculana acuta, Nuculana concentrica, and Mulinia lateralis accounted for 53.6 percent of the total bivalve individuals. Nuculana acuta occurred predominantly in sediments of 40 to 80 percent sand, whereas N. concentrica and M. lateralis were found primarily in 0 to 20 percent sand.

Figure 21 shows the distribution by sediment type of the average number of live and total species per station for bivalves and gastropods.

Copano Bay

Thirty-one gastropod, 27 bivalve, and one scaphopod (Dentalium texasianum) species were taken in Copano Bay; of these, three of the gastropods and nine of the bivalves were taken live. One hundred twenty-four of the 1,308 gastropod and 332 of the 1,657 bivalve individuals were live.

Texadina sphinctostoma, Odostomia cf. laevigata, and O. impressa made up 56 percent of the total gastropod individuals and all of the live individuals. Texadina sphinctostoma and O. cf. laevigata were found primarily in sediments of 20 to 60 percent sand, although the latter species was also often found in 80 to 100 percent sand. Odostomia impressa occurred most abundantly at stations having a substrate of 20 to 40 percent sand.

Ischadium recurvum, Mulinia lateralis, and Macoma mitchelli accounted for 76.4 percent of the total bivalve individuals and 88.9 percent of the live individuals. Macoma mitchelli alone accounted for 59.9 percent of the live individuals. Ischadium recurvum occurred primarily in sediments of 20 to 40 percent sand and M. lateralis in

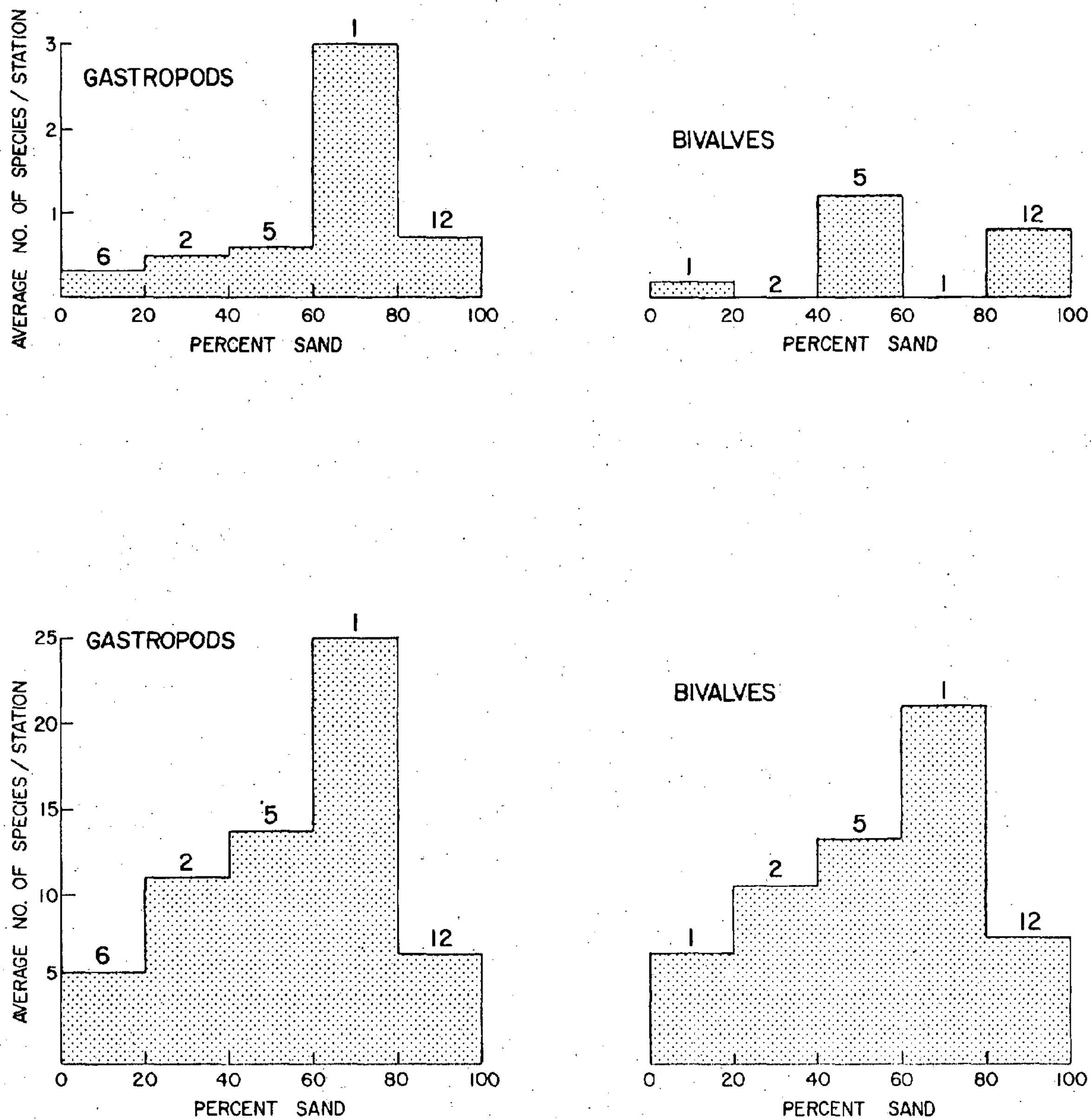


Figure 21. Distribution by substrate of the average number of live (upper) and total (lower) mollusk species per station in Aransas Bay. Number above bar is number of stations.

0 to 20 and 40 to 60 percent sand. Macoma mitchelli was most abundant in 0 to 20 percent sand substrates.

Figure 22 shows the distribution by sediment type of the average number of live and total gastropod and bivalve species per station in Copano Bay.

Port Bay and Aransas River

Seventeen species of gastropods and 12 species of bivalves were collected from Port Bay and the Aransas River, of which one gastropod and two bivalve species were taken live. Only two gastropod species and none of the bivalves were found in the Aransas River.

Texadina sphinctostoma, Cerithium lutosum, and Odostomia cf. laevigata accounted for 62.2 percent of the total gastropod individuals. Texadina sphinctostoma was the only gastropod collected live. All three of the above species were most common in sediments of 60 to 80 percent sand.

Mulinia lateralis and Macoma mitchelli accounted for 79.3 percent of the total and all of the live bivalve individuals. Macoma mitchelli accounted for 95.1 percent of the live individuals. Both species were most abundant in sediments of 60 to 80 percent sand.

Mission Lake and Mission Bay

Only ten species of mollusks, five gastropods and five bivalves, were collected in Mission Lake and Mission Bay. One gastropod species and one individual and two bivalve species with 16 individuals were collected live.

Texadina sphinctostoma, with 18 individuals, accounted for 69.2 percent of the gastropod individuals and was the only gastropod to be collected live. It occurred primarily in sediments of 0 to 20 percent sand.

Mulinia lateralis, Tellina texana, and Macoma mitchelli accounted for 94.9 percent of the total bivalve individuals. Tellina texana made up 37.5 percent and M. mitchelli 62.5 percent of the live individuals. All three species were found in sediments that were primarily 0 to 20 percent sand.

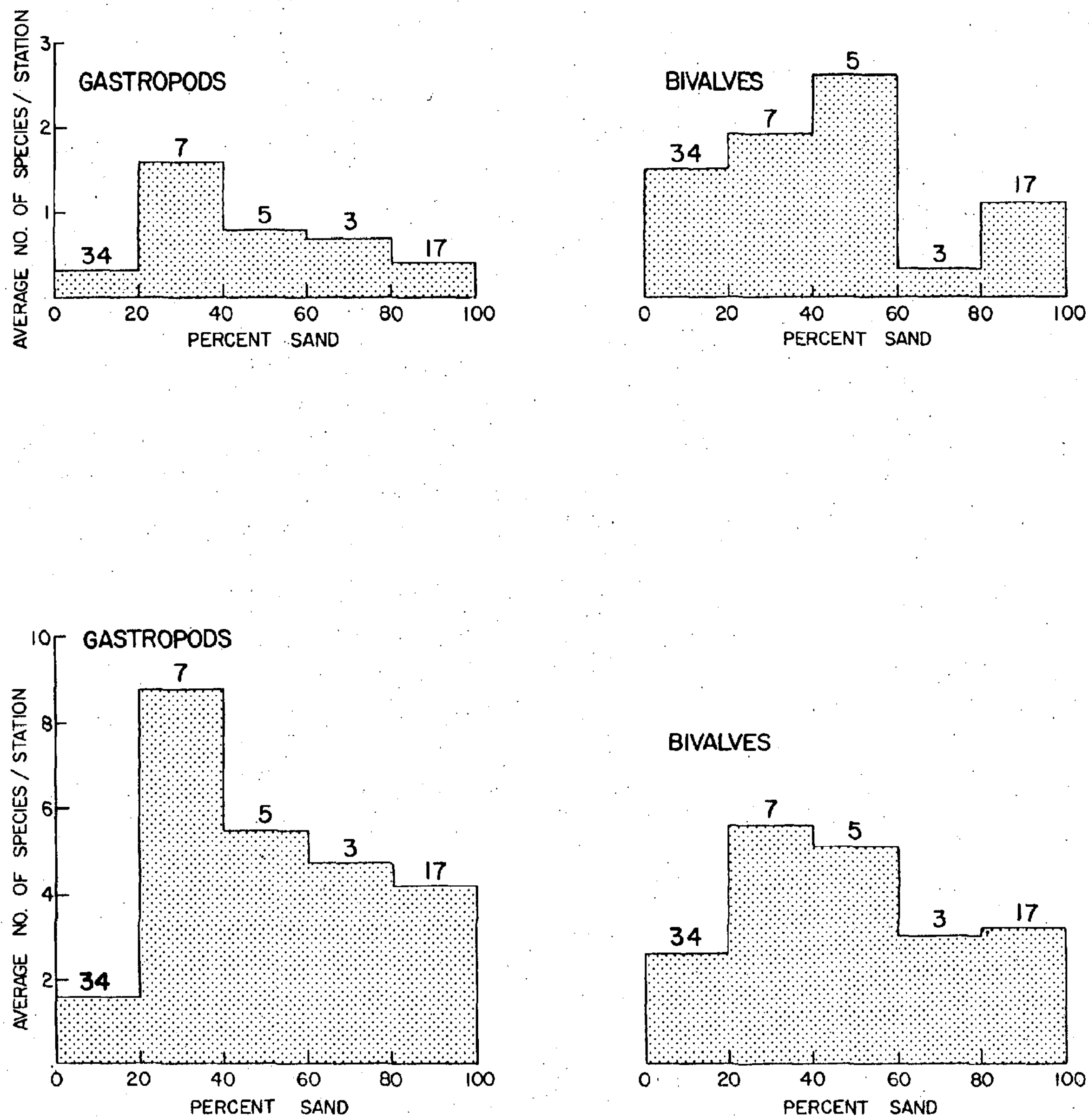


Figure 22. Distribution by substrate of the average number of live (upper) and total (lower) mollusk species per station in Copano Bay. Number above bar is number of stations.

Polychaeta

One hundred thirty-six species and 6,901 individuals were found in the 375 samples from the Corpus Christi area.

The Spionidae, with 14 species, was the most abundant family in the Corpus Christi system, and the spionid, Paraprionospio pinnata, was the most abundant species. No polychaete species occurred in all the bays and the Gulf, but P. pinnata was the most ubiquitous species, occurring on the inner shelf and all the bays except Oso, Mission, and Port Bays.

Polychaete distribution within each bay in the Corpus Christi area except Port and Mission Bays and on the inner shelf will be discussed and their distribution related to sediment and bathymetry.

Bays

Corpus Christi Bay

Sixty-three species and 1,025 individuals were taken from the 125 stations examined in Corpus Christi Bay. The average number of species and individuals per station was 0.5 and 8.2, respectively (table 2). Highest species counts occurred in the relatively deep stations between Shamrock Island and the Corpus Christi Ship Channel, scattered bay-margin stations along Mustang Island, bay-margin near the city of Corpus Christi, and near mid-bay along both sides of the Corpus Christi Ship Channel. Only 26 of the 124 examined stations had five or more polychaete species. The highest species count, 17, occurred at station 9. Station 9 was in 9 ft (2.7 m) of water and in 0 to 20 percent sand.

High individual counts occurred between Shamrock Island and the Corpus Christi Ship Channel, a mid-bay area south of Corpus Christi Ship Channel, and a large area north of the ship channel.

Eighty-six percent of the polychaetes lived in the extremes in sediment type, 55 percent in 0 to 20 percent sand (mud), and 31 percent in 80 to 100 percent sand (fig. 23). The three most abundant species, Paraprionospio pinnata, Branchioasychis americana, and Cossura delta, were found almost entirely in the 0 to 20 percent sands (fig. 23).

Paraprionospio pinnata was the only polychaete species with more than ten percent of the total number of individuals (table 10). Individual counts for P. pinnata were highest at stations near the Corpus Christi-Nueces Bay causeway bridge.

Nueces Bay and Nueces River

Thirty-three of 40 total stations were examined in Nueces Bay and Nueces River. Only nine species and 104 individuals were found for an average of 0.27 species and 3.1 individuals per station. These averages are among the lowest for any bay in the Corpus Christi system (table 2). Sixteen of the 33 stations had no species or only one species. The highest species count was four at station 5.

Individual counts were also low, as only three stations had more than ten individuals. Station 19 with 20 individuals had the highest count, but 16 of the 20 individuals were of one species, Mediomastus californiensis.

Mediomastus californiensis was the dominant polychaete in Nueces Bay with 50 percent of the total number of individuals in the bay. Mediomastus californiensis and the majority of the polychaetes were found in the 60 to 80 percent sands (fig. 24).

Four polychaete species were found in the Nueces River stations but none were abundant.

Oso Bay

Seven of ten total stations were examined in Oso Bay. Ten species and 125 individuals were found, with most of the individuals occurring at stations 1, 2, and 3 near the inlet with Corpus Christi Bay. The average numbers of species and individuals per station were 1.4 and 17.9, respectively.

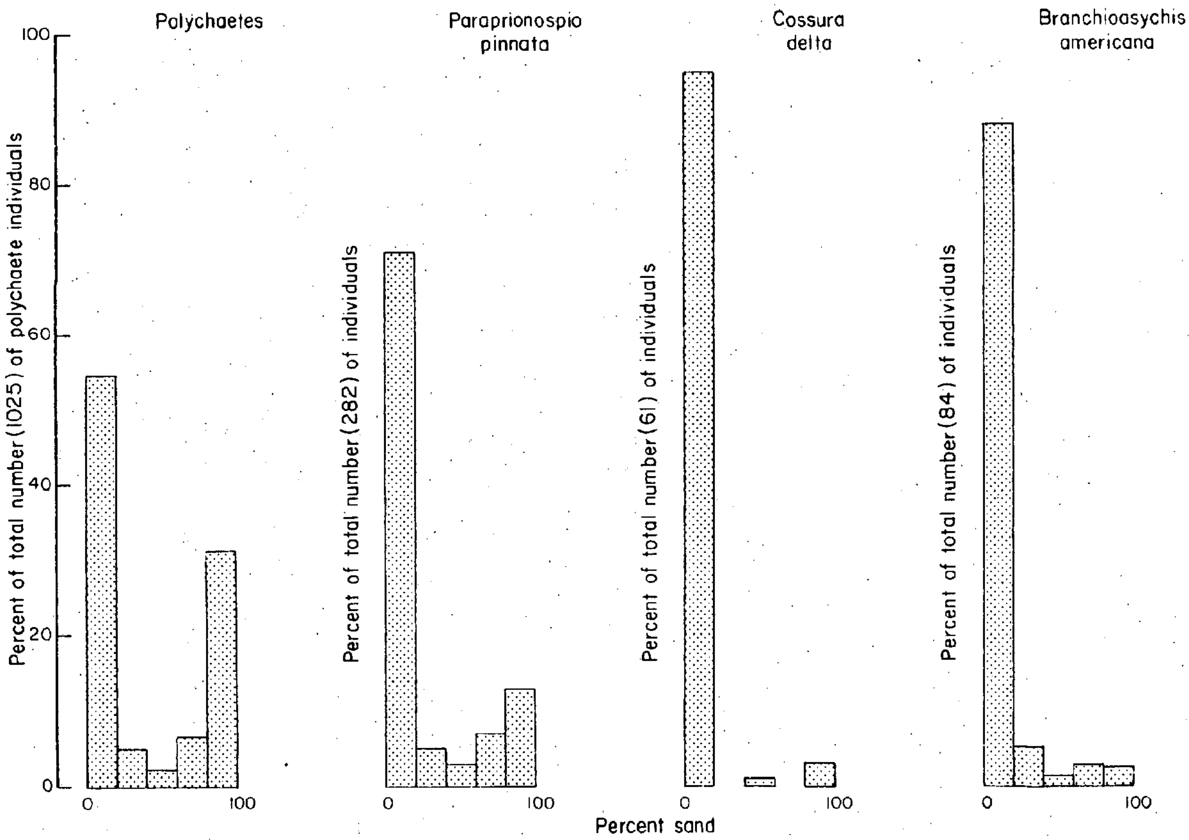


Figure 23. Polychaete distribution by percent sand in Corpus Christi Bay.

Table 10.
Dominant Polychaete Species
(Number of Individuals and Percent of Total)

Species in Gulf	Number of Individuals	Percent of Total Number (4563) of Individuals in Gulf
Owenia fusiformis	1,352	30
Paraprionospio pinnata	1,210	27
Magelona phyllisae	312	7
Lumbrineris parvapedata	277	6
Nereis micromma	185	4
Spiophanes bombyx	170	4
Onuphis eremita	80	2
Cossura delta	53	1
Magelona pettiboneae	51	1
Aricidea cf. fragilis	35	1
Apoprionospio pygmaea	35	1
Totals	3,760	84

Species in Corpus Christi Bay	Number of Individuals	Percent of Total Number (1,025) of Individuals
Paraprionospio pinnata	282	28
Branchioasychis americana	84	8
Cossura delta	61	6
Polydora websteri	36	4
Haploscoloplos fragilis	36	4
Glycinda sp.	34	3
Lumbrineris parvapedata	27	3
Clymenella torquata	23	2
Tharyx sp.	23	2
Harmothoe sp.	19	2
Totals	625	62

Species in Copano Bay	Number of Individuals	Percent of Total Number (201) of Individuals
Nereis cf. succinea	94	47
Streblospio benedicti	21	10
Paraprionospio pinnata	11	5
Haploscoloplos fragilis	11	5
Totals	137	67

Species in Nueces Bay and Nueces River	Number of Individuals	Percent of Total Number (104) of Individuals
Mediomastus californiensis	52	50
Paraprionospio pinnata	19	18
Totals	71	68

Table 10 (cont.)

Species in upper Laguna Madre	Number of Individuals	Percent of Total Number (456) of Individuals
Prionospio heterobranchia	81	18
Melinna maculata	64	14
Syllis cornuta	31	7
Chone cf. americana	30	7
Syllis sp.	24	5
Platynereis dummerlii	21	5
Totals	251	56

Species in Redfish Bay	Number of Individuals	Percent of Total Number (253) of Individuals
Prionospio heterobranchia	34	13
Streblospio benedicti	32	13
Tharyx marioni	20	8
Mediomastus californiensis	19	8
Capitella capitata	17	7
Totals	122	49

Species in Aransas Bay	Number of Individuals	Percent of Total Number (165) of Individuals
Haploscoloplos fragilis	25	15
Paraprionospio pinnata	23	14
Totals	48	29

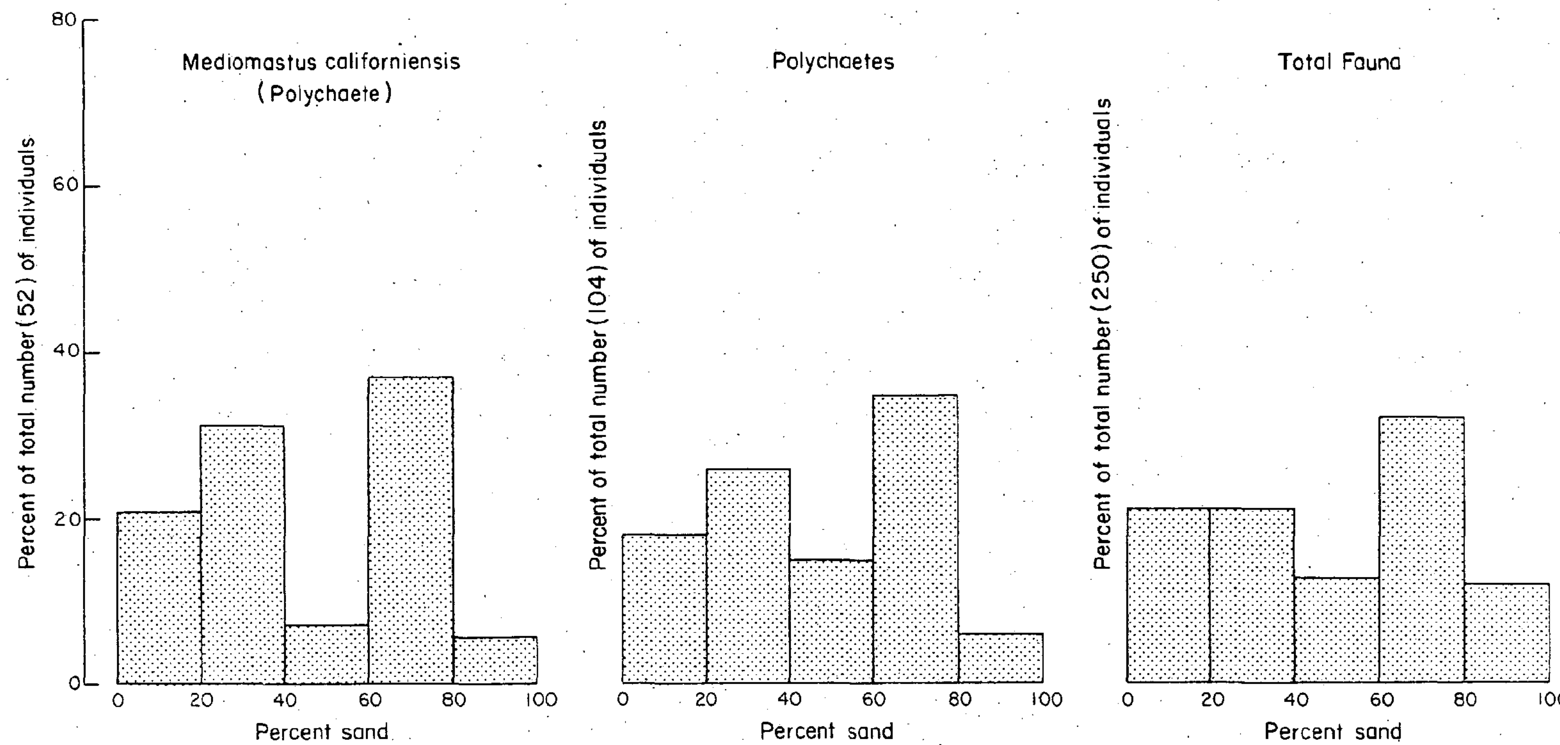


Figure 24. Distribution of the total fauna and the polychaetes by percent sand in Nueces Bay.

The dominant families in the Oso were the Spionidae, Nereidae, and Capitellidae, in that order. A single species, Streblospio benedicti, comprised over 58 percent of the total fauna.

Ninety percent of the total number of individuals was found in the 40 to 60 percent sands at stations 1, 2, and 3. All but two individuals of Streblospio benedicti occurred at stations 1, 2, and 3.

Upper Laguna Madre

Species and individual densities were relatively high in upper Laguna Madre. The average number of individuals per station was 20.7, highest of any bay in the Corpus Christi system. An average of 1.64 species per station was the second highest species average (table 2) in the bays.

Highest species counts occurred at stations from Pita Island south to stations 44 and 45 west of North Bird Island. Station 60, a bay-margin station on the mainland side of the lagoon, had the highest species and individual count, with 12 and 119, respectively. Most of the stations with the highest individual counts occurred from just north of Pita Island (station 17) to station 45 west of North Bird Island.

Prionospio heterobranchia, Melinna maculata, and Syllis cornuta were the dominant species, with almost 40 percent of the total number of individuals (table 10).

Sediment in upper Laguna Madre was predominantly 80 to 100 percent sand and most of the polychaetes occurred in these coarser grained sediments. Seventy-five percent of the total population was living in the 80 to 100 percent sands. All of the individuals of the two most abundant species, Prionospio heterobranchia, and Melinna maculata, were found in either the 60 to 80 or 80 to 100 percent sand category (fig. 25).

Redfish Bay

Of the bays in the Corpus Christi system, Redfish Bay had the highest average number of species per station (3.5) and the second highest average number of

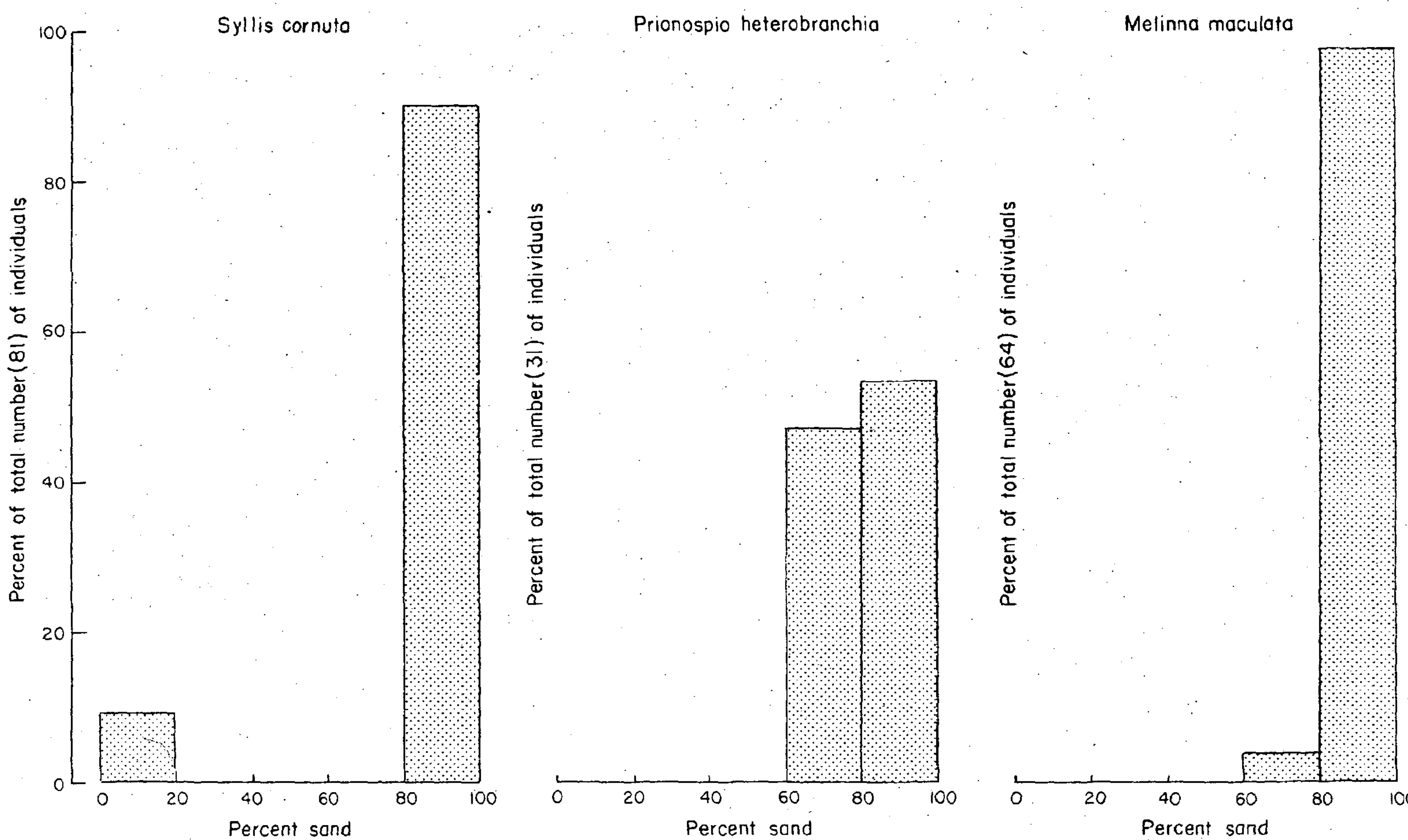


Figure 25. Distribution of three polychaete species by percent sand in upper Laguna Madre.

individuals (19.5). Generally, stations examined south of the Aransas Ship Channel had higher species and individual counts than those north of the channel. Stations 1 and 17 had the highest species counts of any bay stations in the Corpus Christi system.

Only two polychaete species, Prionospio heterobranchia and Streblospio benedicti, composed more than ten percent of the total number of individuals of all species, and only five species had more than five percent of the total.

Sand and gravel amounts varied considerably in Redfish Bay. However, eight of the 13 stations examined had more than 60 percent sand content. Gravel and shell content in Redfish Bay samples was generally higher than in other bays.

More than 55 percent of the total number of polychaete individuals occurred in the 60 to 80 and 80 to 100 percent sand categories (fig. 26). Almost 80 percent of the individuals occurred in greater than two percent gravel-shell.

Aransas Bay

Thirty-seven species and 202 individuals were found in the 25 stations examined in Aransas Bay. The highest species count, eight, occurred at station 17 just north of Mud Island. Except for station 60, stations with high individual and species counts occurred in an area bounded by Mud Island on the south, the Intracoastal Waterway on the west, and San Jose Island to the east. This area was mostly mud.

Haploscoloplos fragilis and Paraprionospio pinnata were the most abundant polychaete species. Both species occurred predominantly in the 0 to 20 percent sands (fig. 27). Fifty-two percent of the total number of individuals of all species were in the 0 to 20 percent sand category.

Copano Bay

Sixteen species and 201 individuals were found in the 65 stations examined in Copano Bay. The average number of species (.25) and individuals (3.1) per examined station was low in comparison to other bays within the system. Nueces Bay had a comparably low species (.27) and individual (3.1) average (table 2).

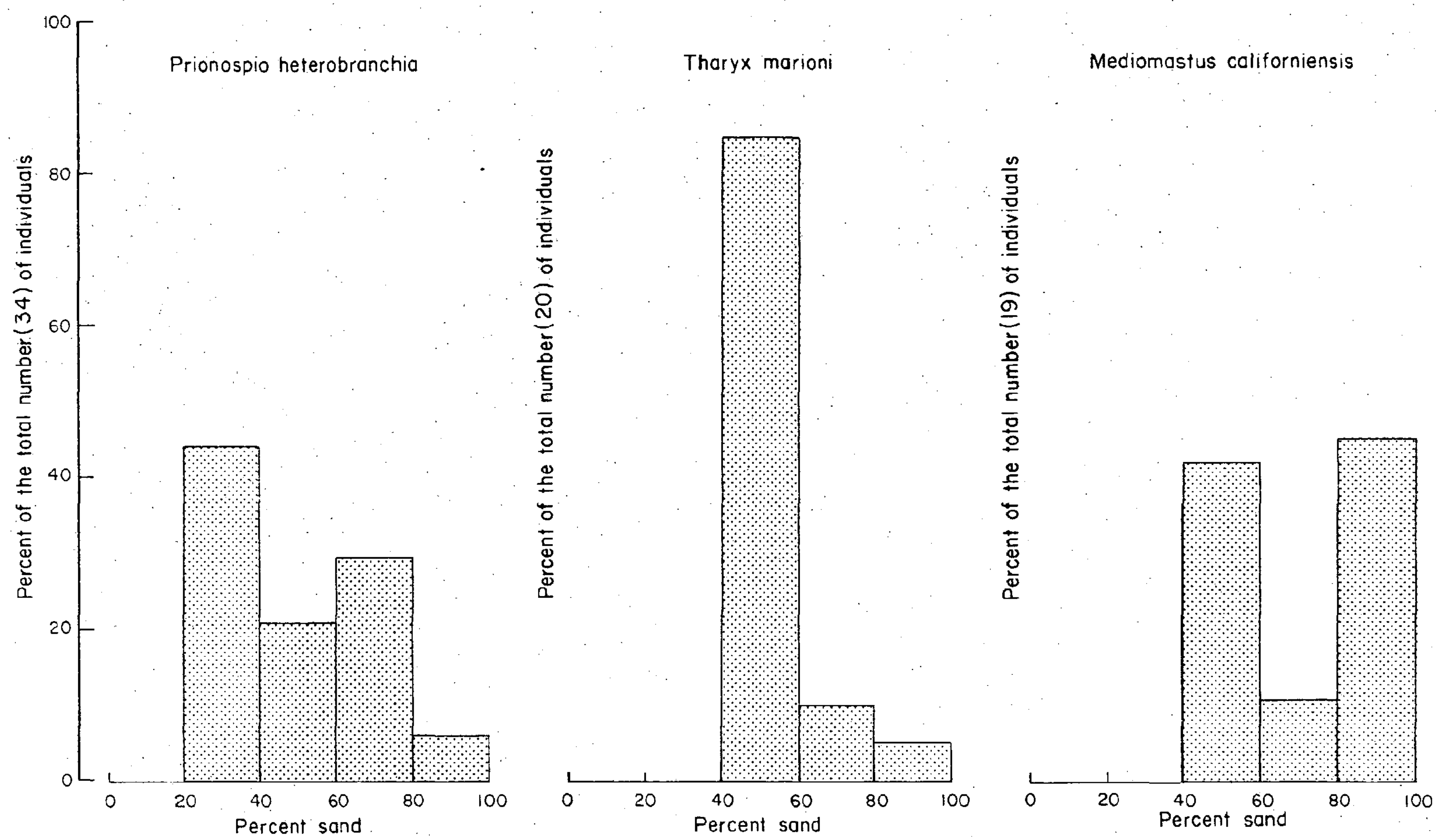


Figure 26. Distribution of three polychaete species by percent sand in Redfish Bay.

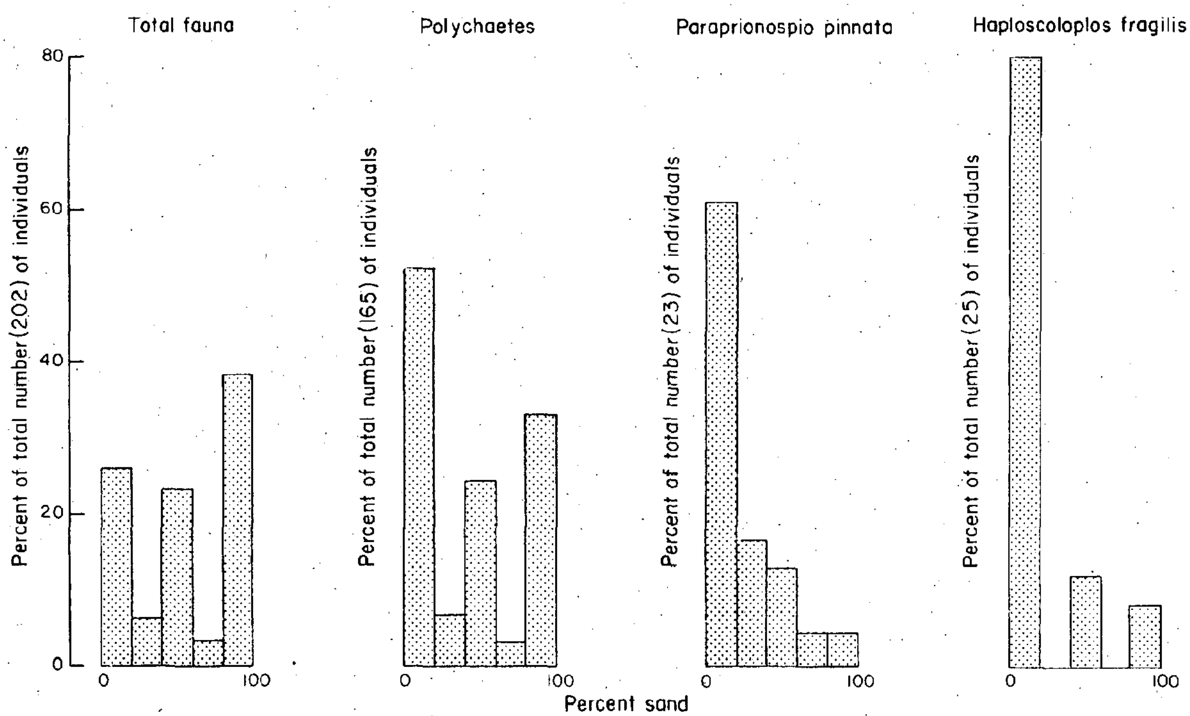


Figure 27. Distribution of the total fauna and the polychaetes by percent sand in Aransas Bay.

Only six of the 65 total stations had four or more species. Station 80 near Port Bay had the highest species count, six total species. Twenty-nine stations or 44 percent of the total had no polychaetes.

Individual counts were also uniformly low. Only seven stations had ten or more individuals. The highest individual count was 42 at station 53.

Most of Copano Bay had fine-grained sediment in the 0 to 20 percent sand range. Thirty of the 65 total stations were 0 to 20 percent sand stations. The highest percentage of individuals lived in the 0 to 20 percent sand habitats (fig. 28). Nereis cf. succinea, the most abundant species (table 10), occurred primarily in 0 to 20 percent sand (fig. 28).

Inner Shelf

Ninety-five polychaete species and 4,563 individuals were found in the 73 shelf samples.

Species counts on a transect generally decrease from nearshore to offshore. The highest species counts on most transects occurred from 3 to 5 mi (4.8 to 8 km) offshore (fig. 29) in depths of 36 to 48 ft (fig. 30). The average number of polychaete species per station was uniformly high in areas less than 48 ft (14.4 m) deep; a big decline in species number occurred (fig. 31) in depths greater than 48 ft (14.4 m). The highest species count, 27, occurred at station 1156. Station 1156 is 3 mi (4.8 km) offshore near the southern boundary of the study area. Stations just offshore and from 4 to 5 mi (9.6 to 10 km) north and south of Aransas Pass had high species counts. Table 11 shows the species and their number occurring on the transect.

Highest individual counts occurred in the 80 to 100 percent sand stations south of Aransas Pass in depths of 36 to 48 ft (10.8 to 14.4 m). Stations one mile offshore south of Aransas Pass were uniformly high in numbers of individuals. Only station 1218 had fewer than 100 individuals.

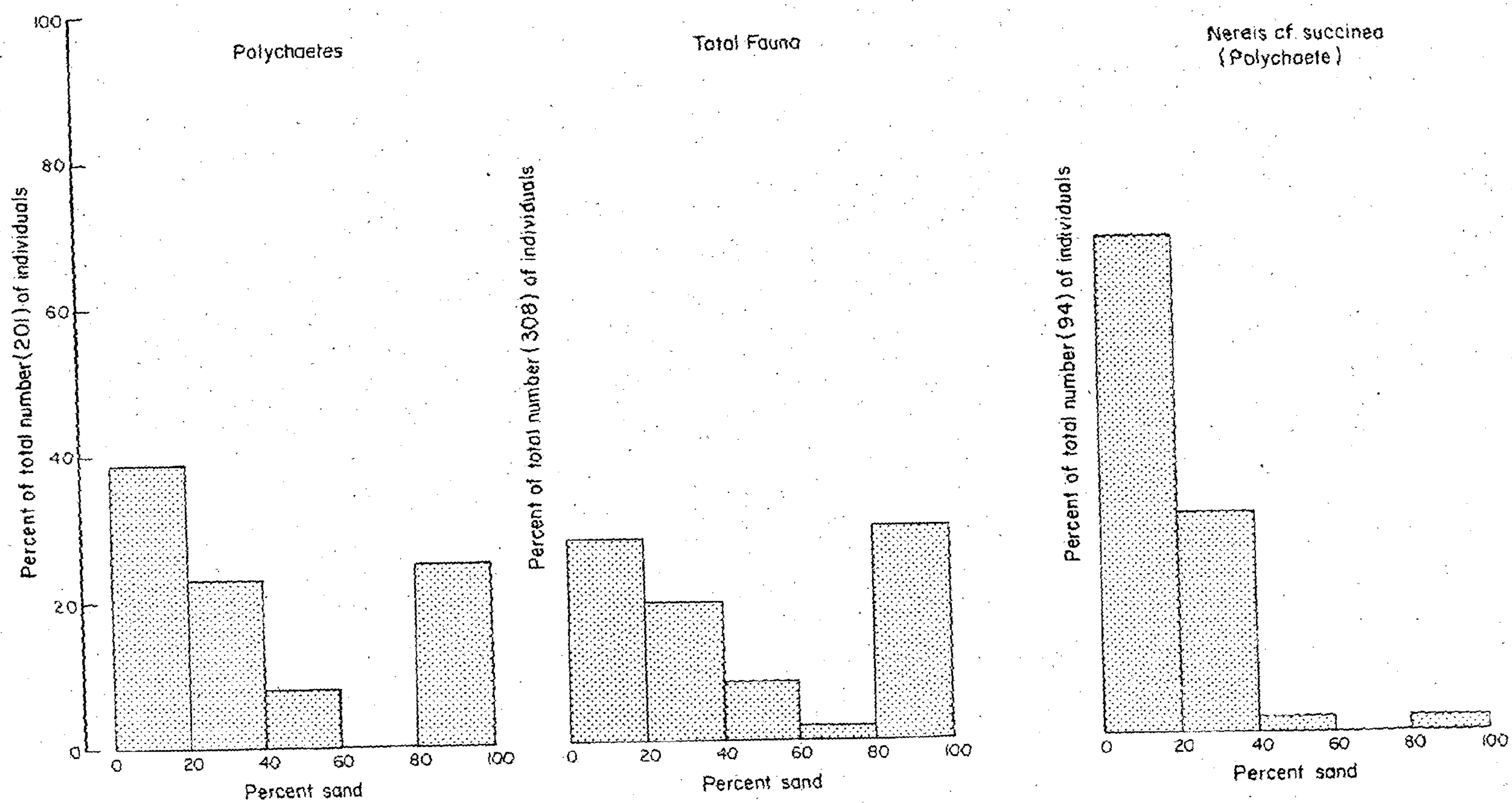


Figure 28. Distribution of the total fauna and the polychaetes by percent sand in Copano Bay.

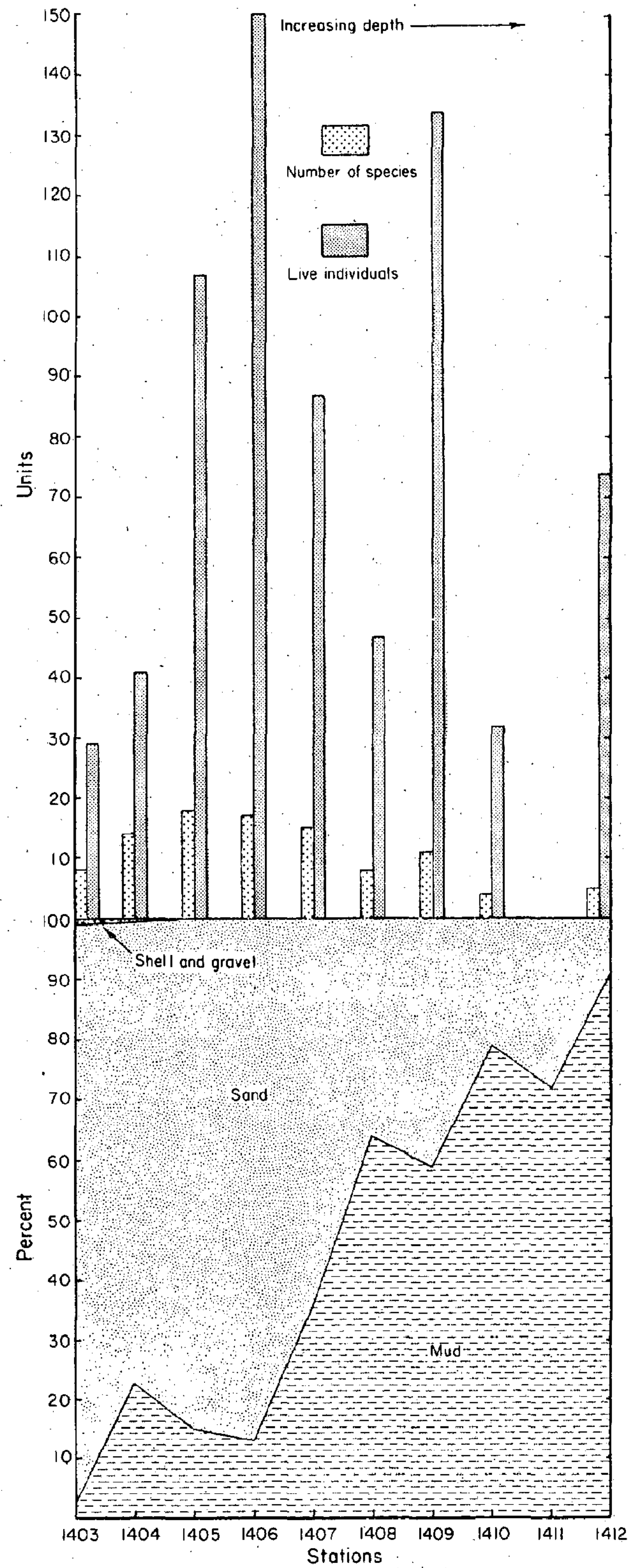


Figure 29. Distribution of polychaetes along transect 1403-1412.

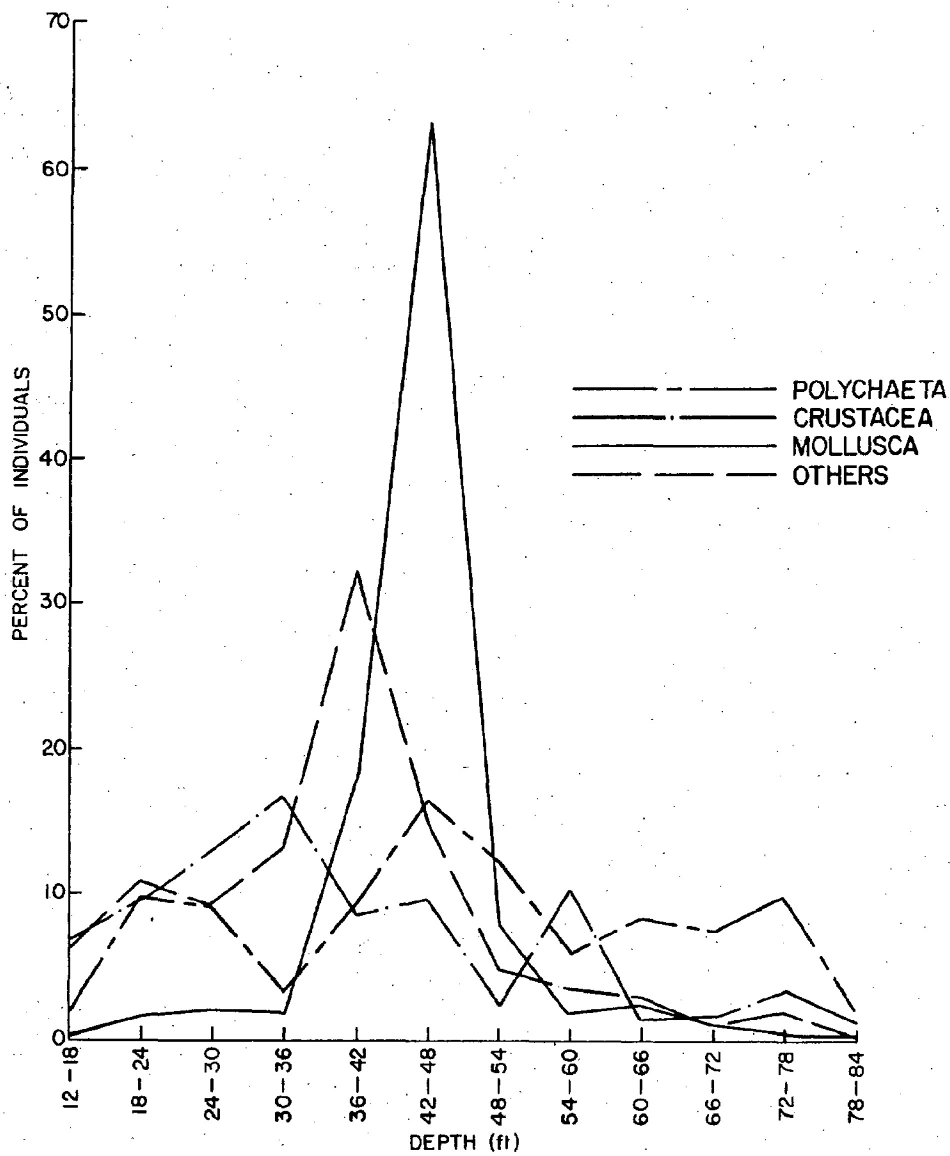


Figure 30. Distribution of live individuals of major groups by depth.

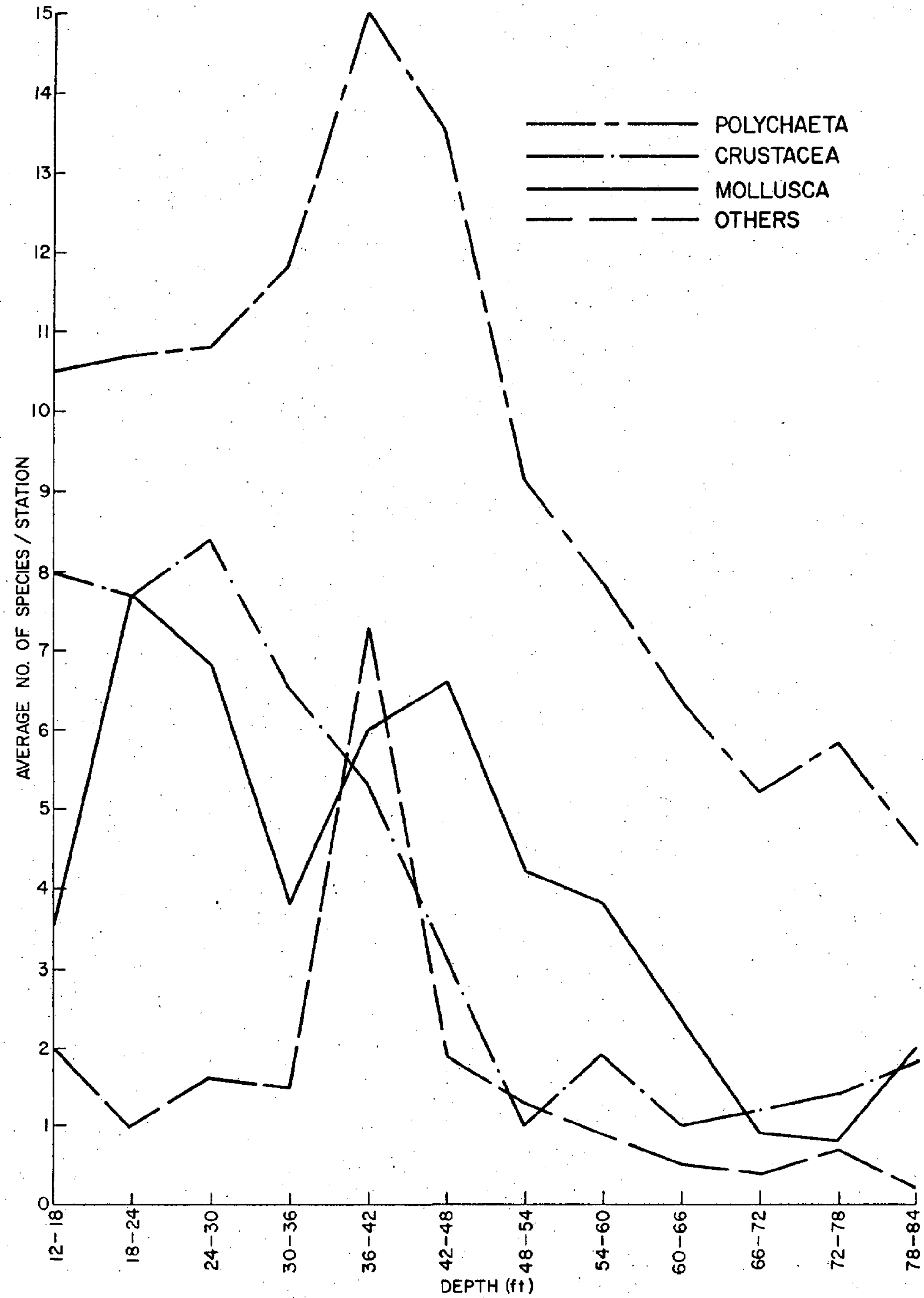


Figure 31. Distribution of the average number of live species per station of the major groups by depth.

Table 11

Polychaete species and individuals occurring along transect 1403-1412.

	Stations									
	1403	1404	1405	1406	1407	1408	1409	1410	1411	1412
Paraprionospio pinnata	2	5	11		6	24	105	18		63
Spiophanes bombyx	3	11	11							
Dispio uncinata	4									
Malacoceros indicus				4						
Malacoceros sp.			1							
Spio pettiboneae			1							
Nereis micromma			9	2	13	10	7	11		1
Nereis succinea		1	1							
Nereis lamellosa				6						
Nereis sp.					1					
Spio sp.				1						
Lumbrineris parvapedata		1	10	21	15		3	1		
Lumbrineris sp. "A"				1	2	1				
Lumbrineris tenuis					1					
Ninoe nigripes										1
Lumbrineris sp.										1
Cossura delta						1				2
Pseudeurythoe ambigua										1
Paramphinome cf. pulchella							1			
Owenia fusiformis	15	5	20	94	33		1			
Nephtys picta		1								
Nephtys incisa							1			
Aglaophamus verrilli		1	2		1		1			
Sthenelais boa			1	1						
Sthenelais sp.					2					
Magelona phyllisae	5	26	4	5	4	12	1		2	
Aricidea cf. fragilis					2		1			
cf. Aedicira sp.				1						
Tharyx marioni						1				
Amphicteus gunneri			1							

Table 11 (cont.)

	Stations									
	1403	1404	1405	1406	1407	1408	1409	1410	1411	1412
Aricidea cf. jeffreysii				1						
Sigambra tentaculata		1								2
Onuphis eremita		2	1	1						
Diopatra cuprea		1	1			1				
Glycera americana			5		1		1			
Capitellid sp.			3							
Haploscoloplos fragilis	1									
Scoloplos rubra					1					
Pectinaria gouldii			1							
Pectinaria sp.				1						
Phyllodoce mucosa		1			1					
cf. Polynoe sp.							1			
Pista sp.			1	3						

Sandier nearshore stations had the highest polychaete population (fig. 32). Two species, Owenia fusiformis and Paraprionospio pinnata, accounted for more than 57 percent of the total number of individuals (table 10). Both species were at the extremes in distribution according to sediment and depth. Owenia fusiformis occurred primarily in depths of 18 to 30 ft (5.4 to 9 m) (fig. 33) and 80 to 100 percent sand (fig. 32), whereas P. pinnata was found most often at 60 to 72 ft (18 to 21.6 m) depths (fig. 33) and 0 to 20 percent sand (fig. 32). Owenia fusiformis was more limited in its distribution, occurring almost exclusively in the 80 to 100 percent sand range. Over 30 percent of the total number of individuals of O. fusiformis were at station 1138. Paraprionospio pinnata was the most ubiquitous species on the shelf, occurring at all but 19 of the 73 stations.

Crustacea

From the 374 biological stations examined, 92 species of crustacea were identified from the Corpus Christi inner shelf and the incorporated bays of this area. These 92 species were composed of 2,862 total individuals. Copepods, ostracods, and larval forms are excluded from these counts.

Thirty-four species were found only on the inner shelf, while 26 species were unique to the bays. These species are listed in table 12.

The most abundant species was the amphipod, Lepidactylus sp., which occurred in Corpus Christi and Copano Bays. The cumacean, Oxyurostylis salinoi, was the most widely distributed species.

Amphipods composed 42 of the taxa, followed by decapods with 32 taxa, and isopods with nine. In addition, there were three mysids, four cumaceans, one tanaid, one apseudid, and one stomatopod noted. A complete listing of all crustacea in this area and their abundance and distribution can be found in table 13.

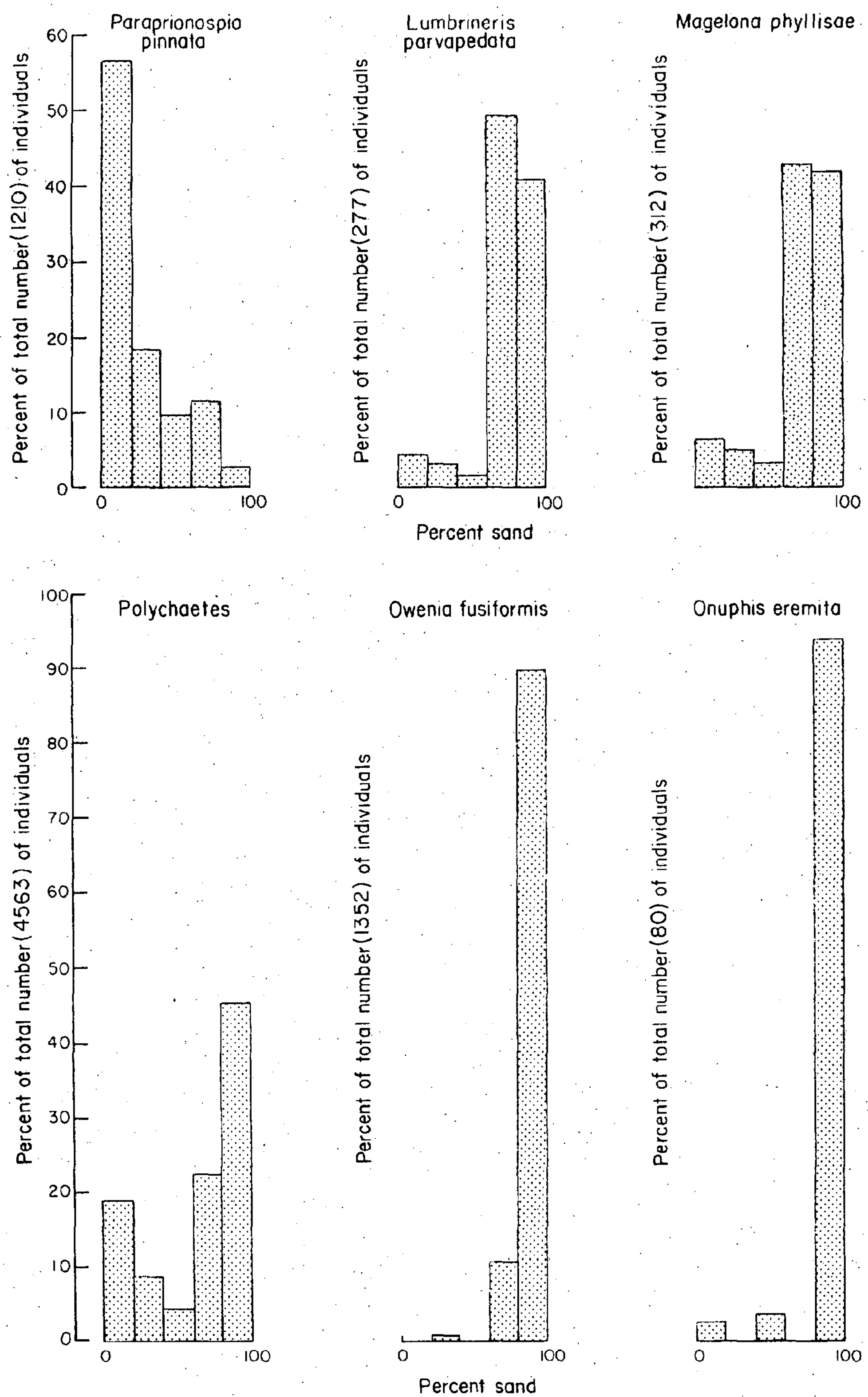


Figure 32. Polychaete distribution by percent sand on the inner shelf.

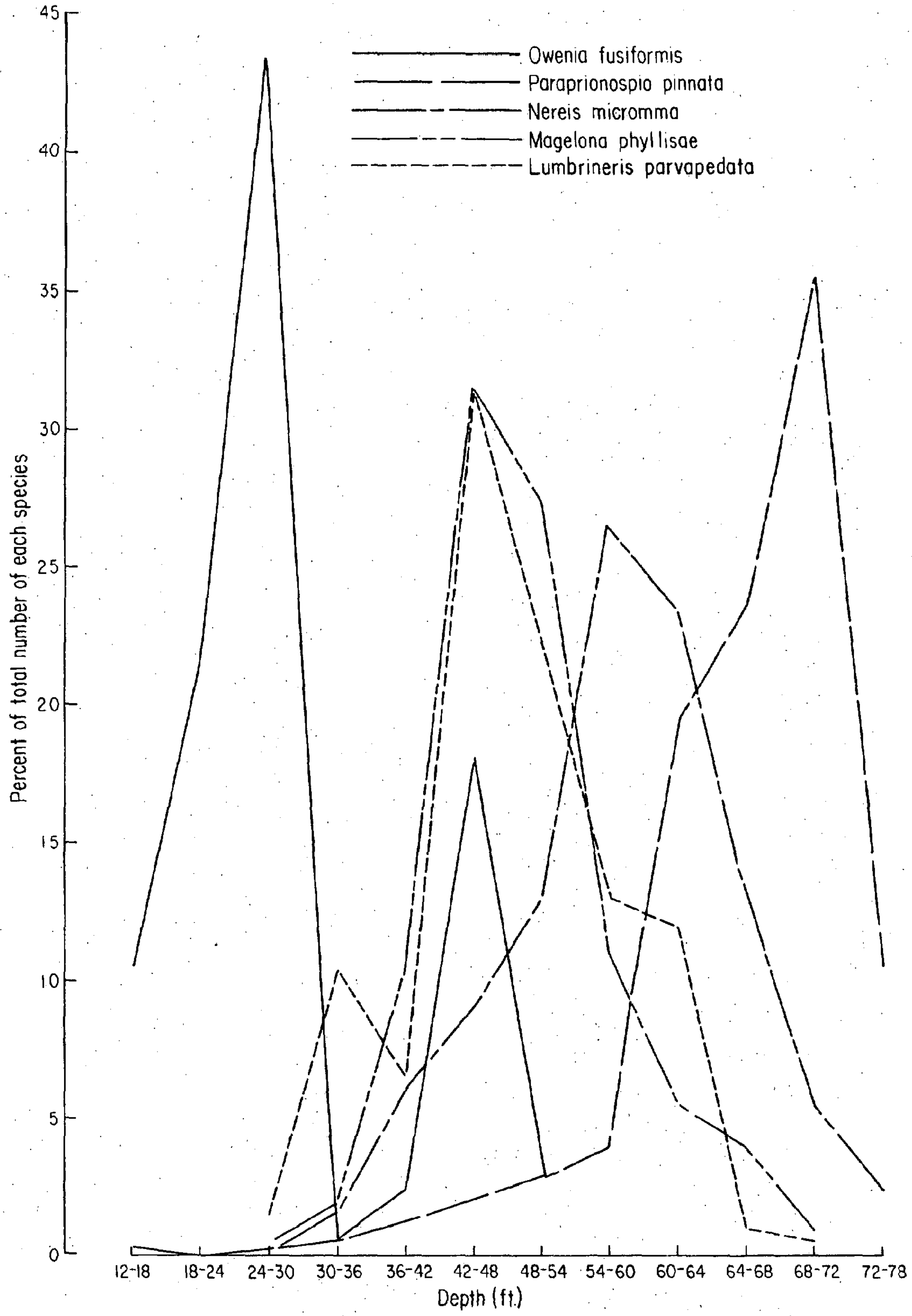


Figure 33. Distribution by depth of five polychaete species from the inner shelf.

Table 12. Crustacean species found only on the inner shelf and only in the bays.

Crustacean species found only on inner shelf	Crustacean species found only in bay systems
Cumacean "A"	Bowmaniella cf. brasiliensis
Apseudes sp.	Mysidopsis almyra
Edotea triloba	Leptochelia rapax
Ptilanthura tricarina	Chirodotea excavata
Ampelisca cf. cristata	Cymodoce faxoni
Ampelisca cristoides	Edotea montosa
Ampelisca venetiensis	Ampelisca vadorum
Platyschnopus "A"	Ampithoe sp.
Protohaustorius cf. bousfieldi	Cymadusa compta
Pseudohaustorius cf. americanus	Amphilocus "B"
Microprotopus raneyi	Grandidierella bonnieroides
Photis sp.	Lembos cf. processifer
Listriella "A"	Erichthonius brasiliensis
Listriella "B"	Gammarus (mucrogammarus) mucronatus
Paraphoxus spinosus	Lepidactylus sp.
Trichophoxus floridanus	Parahaustorius cf. holmesi
Tiron tropakis	Elasmopus levis
Suborder Hyperiidae	Podocerus brasiliensis
Leptochela cf. bermudensis	Pontogeneia cf. bartchi
Leptochela serratorbita	Leuconacia incerta
Alpheus sp.	Lucifer faxoni
Automate sp.	Menippe mercenacia
Callianassa biformis	Micropanope nuttingii
Albunea gibbessi	Panopeus herbstii
Albunea paretii	Palaemonetes pugio
Euceramus praelongus	Hypolyte zostericola
Pilumnus sp.	
Pinnixa sayana	
Pinnixa cf. retinens	
Chasmocarcinus mississippiensis	
Family Grapsidae	
Solenocera atlantidis	
Parapenaeus longirostrus	
Sicyonia brevirostrus	

Table 13.

Crustacea: List of species and their distribution in the Corpus Christi area.

Species	S	N	CC	LM	MB	PB	C	O	R	A	TOTAL
Ostracods	22		10	88					2		122
Order Harpacticoida											
Harpacticoid copepods	10										10
Order Mysidacea			1								
Bowmaniella cf. _brasiliensis_			12	1			4			2	19
Mysidopsis almyra		22	3				13				38
Mysidopsis bigelowi	1	3	13	1					1	3	22
Order Cumacea	1										1
Cyclaspis varians	18	1	31	1			7			4	62
Eudorella monodon	3		3								6
Oxyurostylis salinoi	125		9	144		5	10		2	5	300
Cumacean "A"	7										7
Order Tanaidacea											
Leptochelia rapax		7				25	12				44
Order Apseudidae											
Apseudes sp.	1										1
Order Isopoda											
Ancinus depressus	2		2								4
Cassidinidea lunifrons	5	1					1		4		11
Chirodotea excavata							2				2
Cymodoce faxoni			1	131					54		186
Edotea montosa			2	1		1		1	3	1	9
Edotea triloba	1										1
Erichsonella filiformis isabellensis	3			10		3	4		3		23
Ptilanthusa tricarina	1										1
Xenanthura brevitelson	2	2	3			3				1	11

S = inner shelf; N = Nueces Bay and River; CC = Corpus Christi Bay; LM = Laguna Madre; MB = Mission Bay and Lake; PB = Port Bay and Aransas River; C = Copano Bay; O = Oso Bay; R = Redfish Bay; A = Aransas Bay.

Table 13 (cont.)

Species	S	N	CC	LM	MB	PB	C	O	R	A	TOTAL
Order Amphipoda											
Family Ampeliscidae											
Ampelisca abdita	10		16				1		12	2	39
Ampelisca agassizi	49								4		53
Ampelisca brevisimulata	36		14							12	50
Ampelisca cf. cristata	5										5
Ampelisca cristoides	4										4
Ampelisca sp.	8		1				2				11
Ampelisca vadorum		1	2	8						1	12
Ampelisca venetiensis	23										23
Family Ampithoidae											
Ampithoe sp.				3					13		53
Cymadusa compta				16					18	7	41
Family Amphilochidae											
Amphilocus "B"			1								1
Gitanopsis "A"	7			13					2		22
Family Aoridae									2		2
Grandidierella bonnieroides				4		7	2		2	2	17
Lembos cf. processifer				2							2
Family Corophiidae	1			8			1				2
Cerapus tubularis	1		8	5			5			1	20
Corophium sp.	1	1								1	3
Corophium tuberculatum	10			2							12
Oricthonius brasiliensis			13								13
Family Gammaridae											
Gammarus (mucrogammarus) mucronatus		1	5			3	5			1	10
Family Haustoriidae										1	1
Acanthohaustorius sp.	186		10							3	199
Lepidactylus sp.			250				240				490
Parahaustorius cf. holmesi			39				51				90

Table 13 (cont.)

Species	S	N	CC	LM	MB	PB	C	O	R	A	TOTAL
Platyschnopus "A"	10										10
Protohaustorius cf. *bousfieldi*	26										26
Pseudohaustorius cf. *americanus*	8										8
Family Isaidae											
Microprotopus raneyi	1										1
Photis sp.	2									1	3
Family Liljeborgiidae											
Listriella barnardi	3		21	2						2	28
Listriella "A"			3								3
Listriella "B"			6						2		8
Family Melitidae											
Elasmopus levis			4	258					14		276
Melita nitida	1			5							6
Melita sp.							3				3
Family Oedicerotidae											
Monoculodes cf. *nyei*	18		2				24			8	52
Synchelidium americanum	16		4							1	21
Family Phoxocephalidae											
Paraphoxus spinosus	1										1
Trichophoxus floridanus	56										56
Family Podoceridae											
Podocerus brasiliensis			8								8
Family Pontogeneiidae			1								1
Pontogeneia cf. *bartschi*			2	8						1	11
Family Synopiidae											
Tiron tropakis	14										14
Suborder Caprellidea			13								13
Suconacia incerta			7	26					1		34
Suborder Hyperiidae	2										2
Order Stomatopoda											
Family Squillidae											

Table 13 (cont.)

Species	S	N	CC	LM	MB	PB	C	O	R	A	TOTAL
Squilla empussa	2	1									3
Order Decapoda											
Family Sergestidae											
Acetes americanus	184	1	9				1			6	201
Lucifer faxoni			2								2
Family Pasiphaeidae											
Leptochela cf. *bermudensis*	1										1
Leptochela serratorbita	4										4
Family Alpheidae											
Alpheus sp.	1										1
Automate sp.	2										2
Family Thalassinidea											
Callianassa biformis	1										1
Family Diogenidae											
Paguristes sp.										1	1
Family Paguridae	15		3								18
Pagurus cf. *longicarpus*	37		1								38
Pagurus sp.									1		1
Family Albuneidae											
Albunea gibbessi	1										1
Albunea paretii	6										6
Family Porcellanidae											
Euceramus praelongus	16									1	17
Family Portunidae											
Callinectes sapidus	3		5								8
Family Xanthidae	2										2
Eurypanopeus depressus	7	1									8
Menippe mercenaria		1									1
Micropanope nuttingii							2				2
Panopeus herbstii			2								2
Pilumnus sp.	7										7

Table 13 (cont.)

Species	S	N	CC	LM	MB	PB	C	O	R	A	TOTAL
Phithropanopeus harrisii	2	1									3
Family Pinnotheridae											
Pinnixa sayana	53									1	54
Pinnixa cf. *retinens*	48										48
Pinnixa sp.	3		1								4
Pinnotheres ostreum	11		3								14
Family Gonoplacidae											
Chasmocarcinus mississippiensis	9										9
Family Grapsidae	1										1
Family Palaemonidae											
Palaemonetes pugio				1							1
Family Hippolytidae											
Hypolyte zostericola										1	1
Family Solenoceridae											
Solenocera atlantidis	1										1
Family Penaeidae											
Parapenaeus longirostrus	1										1
Family Sicyoniidae											
Sicyonia brevirostrus	1										1
Brachyuran Zoea			12								12
Nantantian Zoea	2		2				1				5
Brachyuran megalops	5										5

In the following discussion, each bay system, as well as the inner shelf, will be elaborated on, and such factors as diversity, distribution, abundance, species dominance, and species-sediment relations will be examined.

Bays

Upper Laguna Madre

Twenty-two samples were examined from the upper Laguna Madre study area. Fourteen of these stations contained 80 to 100 percent sand, whereas four stations contained 60 to 80 percent sand, one each in 40 to 60 percent sand and 20 to 40 percent sand and two in 0 to 20 percent sand. In eight of the 22 stations, no crustaceans were found. Twenty-one species composed of 650 individuals were identified. Average numbers and percent of species and individuals tended to be higher in areas of higher sand content (table 14 and fig. 34).

Table 15 lists dominant species from Laguna Madre. The amphipod, Elasmopas levis, was the most abundant species, constituting 39.7 percent of the crustacean fauna. Oxyurostylis salinoi, a cumacean, accounted for 22.1 percent of the individuals, and the isopod, Cymodoce faxoni, contained 20.1 percent. All of these species were closely associated with 80 to 100 percent sand (fig. 34). In this particular area, only Oxyurostylis salinoi was found in this sediment range.

Station 60 (80 to 100 percent sand), in the southern part of the study area, contained the highest number of both species (10) and individuals (124). The southern parts of Laguna Madre were more diverse and abundant in crustacean fauna, with amphipods being the most prevalent group. Thirteen of the 21 species found in Laguna Madre were amphipods. The northern part of the area, near its connection with Corpus Christi Bay and around the intracoastal waterways, contained a less diverse crustacean fauna.

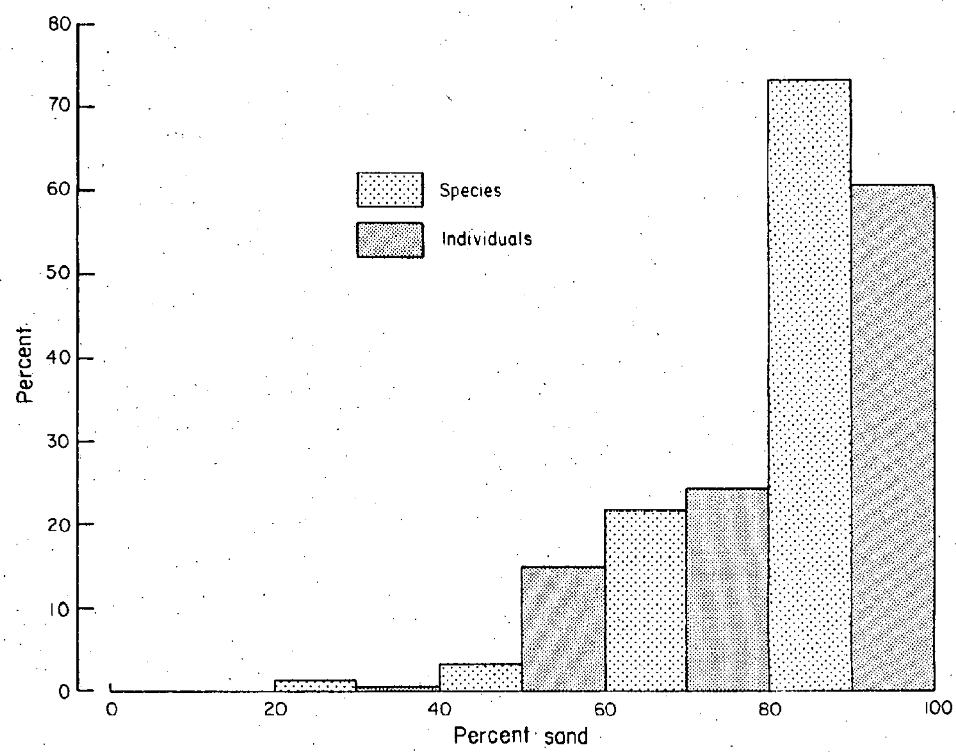
Oso Bay

Oso Bay contained only one isopod from the seven stations examined. No conclusions can be drawn from this datum.

Table 14

Crustacea: Average number of species/average number of individuals by percent sand.

	0-20%	20-40%	40-60%	60-80%	80-100%
Redfish Bay	0/0	8.0/56.0	3.0/3.0	5.0/35.5	2.0/5.0
Aransas Bay	0.8/0.8	0.5/1.0	1.6/2.2	2/2	2.2/3.2
Nueces Bay	1.0/1.2	1.0/1.5	0.75/1.75	0.75/1.87	0.2/0.2
Copano Bay	0.18/0.3	1.3/2.7	0.5/0.5	2.3/5.7	2.6/20.9
Laguna Madre	0/0	1.0/1.0	2.0/99.0	3.2/39.2	3.1/28.1
Corpus Christi	0.9/1.3	5.0/18.0	0.5/0.75	2.2/4.4	2.2/11.7
Inner Shelf	1.5/3.7	1.0/6.7	2.0/5.5	2.1/14.3	6.2/31.9



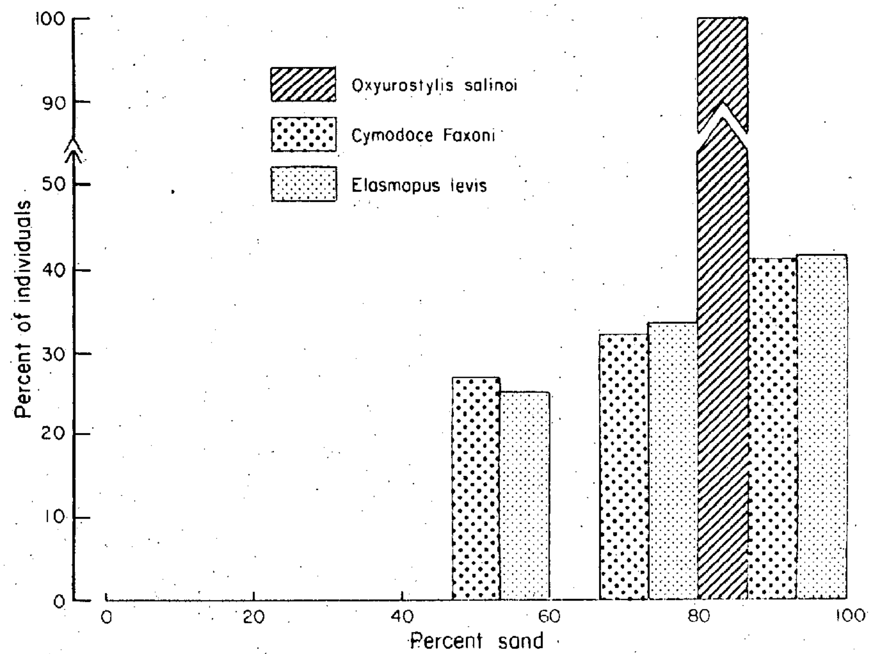


Figure 34. Laguna Madre: crustacean distribution versus sediment.

Table 15. Dominant Crustacean Species.

Species in Gulf	Number of Individuals	Percent of Total Number (1,080) of individuals in Gulf
Acanthohaustorius sp.	186	17.2
Acetes americanus	184	17.0
Oxyurostylis salinoi	125	11.6
Trichophoxus floridanus	56	5.2
Species in Laguna Madre	**Number of Individuals**	**Percent of Total Number (650) of individuals in Laguna Madre**
Elasmopus levis	258	39.7
Oxyurostylis salinoi	144	22.1
Cymodoce faxoni	131	20.1
Species in Corpus Christi Bay	**Number of Individuals**	**Percent of Total Number (514) of individuals in Corpus Christi Bay**
Lepidactylus sp.	250	48.6
Parahaustorius cf. holmesi	39	7.6
Cyclaspis varians	31	6
Species in Nueces Bay	**Number of Individuals**	**Percent of Total Number (44) of individuals in Nueces Bay**
Mysidopsis almyra	22	50
Species in Copano Bay	**Number of Individuals**	**Percent of Total Number (391) of individuals in Copano Bay**
Lepidactylus sp.	240	61.4
Parahaustorius cf. holmesi	51	13.0
Species in Redfish Bay	**Number of Individuals**	**Percent of Total Number (138) of individuals in Redfish Bay**
Cymodoce faxoni	54	40
Cymadusa compta	18	13.3
Species in Aransas Bay	**Number of Individuals**	**Percent of Total Number (70) of individuals in Aransas Bay**
Ampelisca brevisimulata	12	17.1
Monoculodes cf. nyei	8	11.4
Cymadusa compta	7	10.0

Mission Bay and Mission Lake

No crustaceans were found in samples from this area.

Port Bay and Aransas River

Only one of the seven stations in this area was found to contain any crustaceans. This station was well represented, however, with seven species totaling 47 individuals. Twenty-five of the individuals were the tanaid, Leptochelia rapax. It is unknown why no other station contained crustaceans.

Nueces Bay and Nueces River

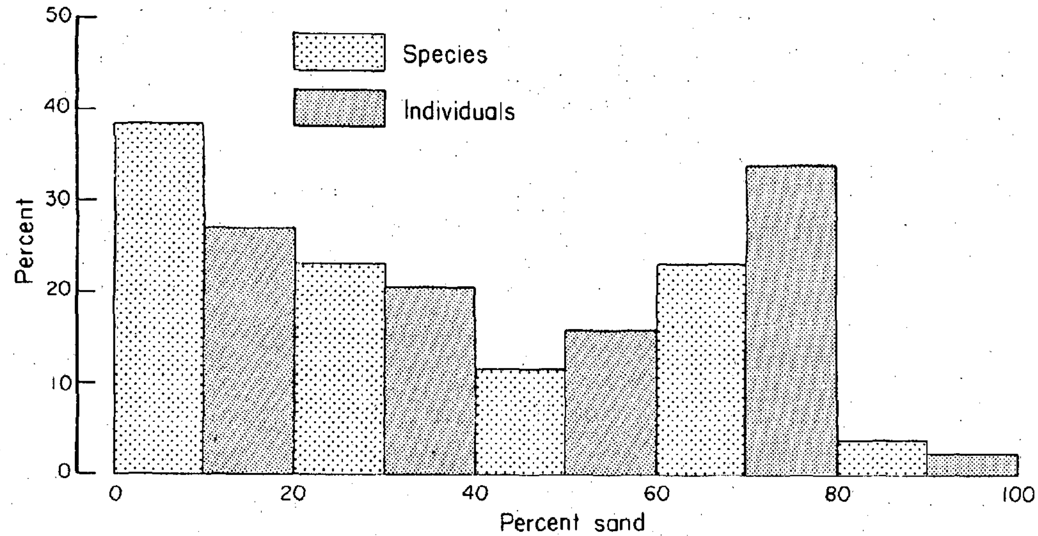
Fourteen species totaling 44 individuals were found in the 33 stations examined from Nueces Bay and Nueces River. Sixteen of the examined stations did not contain crustaceans. Ten stations contained 0 to 20 percent sand, six, 20 to 40 percent sand, four, in the range of 40 to 60 percent, eight, 60 to 80 percent, and five, 80 to 100 percent sand. The average number of species and the average number of individuals per station (table 14) indicate no important sediment preferences. Examination of percent species and individuals versus sediment (fig. 35) also shows no distinct sediment preference trends.

Only one crustacean occurred in any abundance. Mysidopsis almyra constituted 50 percent of all individuals (table 15). Its distribution by sediment is illustrated in figure 35.

No station was very diverse or abundant in species composition. Decapods made up the largest number of species. The entire bay generally lacked crustacean fauna.

Copano Bay

Sixty-five stations were examined in the Copano Bay study area. Most of the stations (48) contained less than 80 percent sand, however, the majority of crustacean species and individuals were found in the 17 stations of higher sand content (fig. 36). The average number of species and individuals was also significantly higher in stations containing 60 percent sand or greater (table 14). Only four of the 32 stations containing 0 to 20 percent sand contained any crustacea.



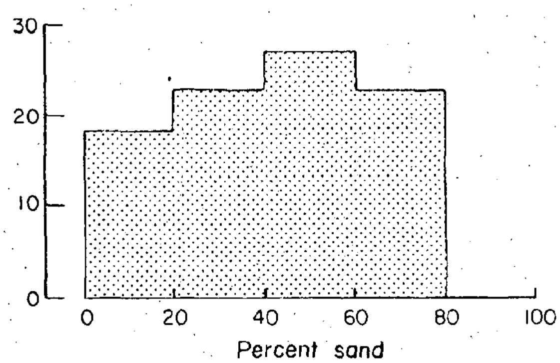
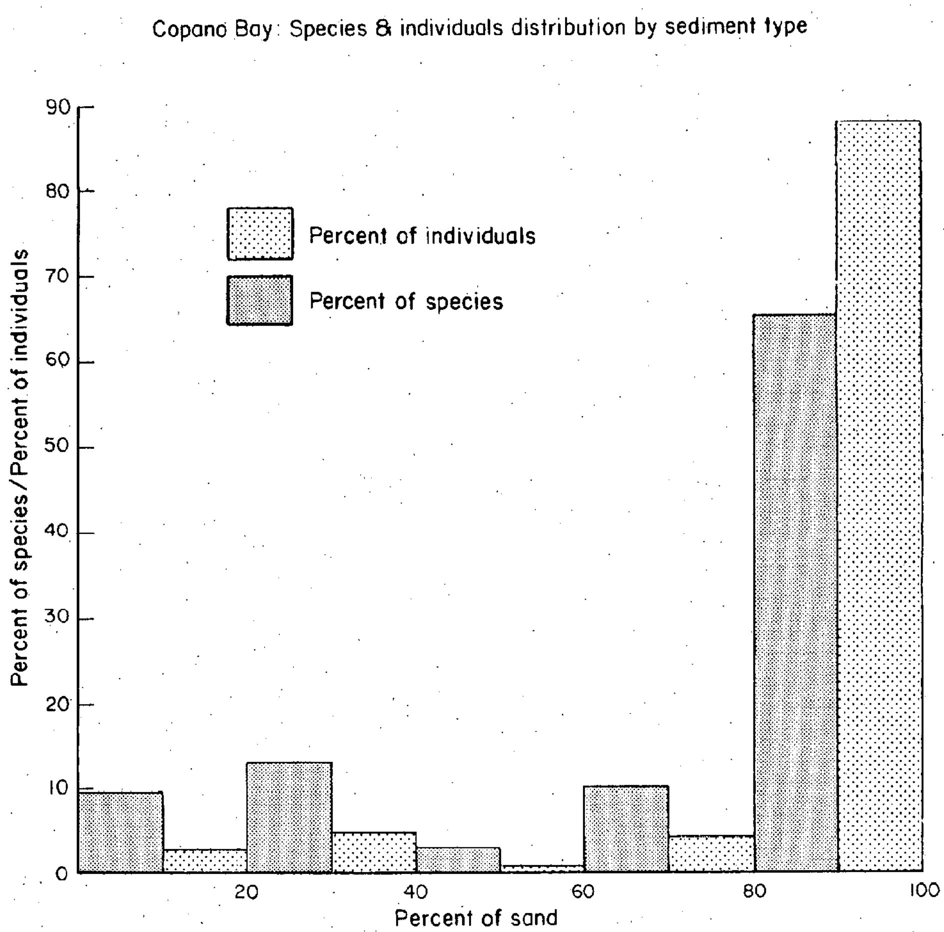


Figure 35. Nueces Bay and Nueces River: crustacean distribution versus sediment.



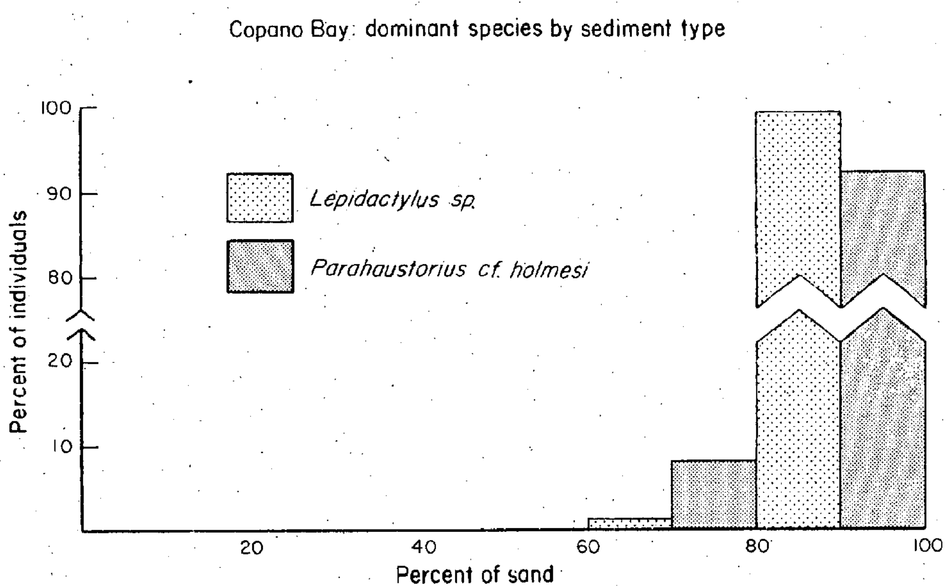


Figure 36. Copano Bay: crustacean distribution versus sediment.

The crustacean fauna of Copano Bay was totally dominated by two species of amphipods, Lepidactylus sp., comprising 61.4 percent of all individuals, and Parahaustorius cf. holmesi, with 13 percent of the individuals (table 15). Their distributions were closely tied to sediment composition. More than 90 percent of the individuals of both species were found in 80 to 100 percent sand (fig. 36).

Stations 81 and 85 contained the most species, with seven each, whereas station 92 contained the most individuals (91). Crustacean fauna was dominated by the nine species of amphipods found in Copano Bay. They constituted 94 percent of all crustaceans found. Copano Bay was fairly diverse and abundant in crustaceans.

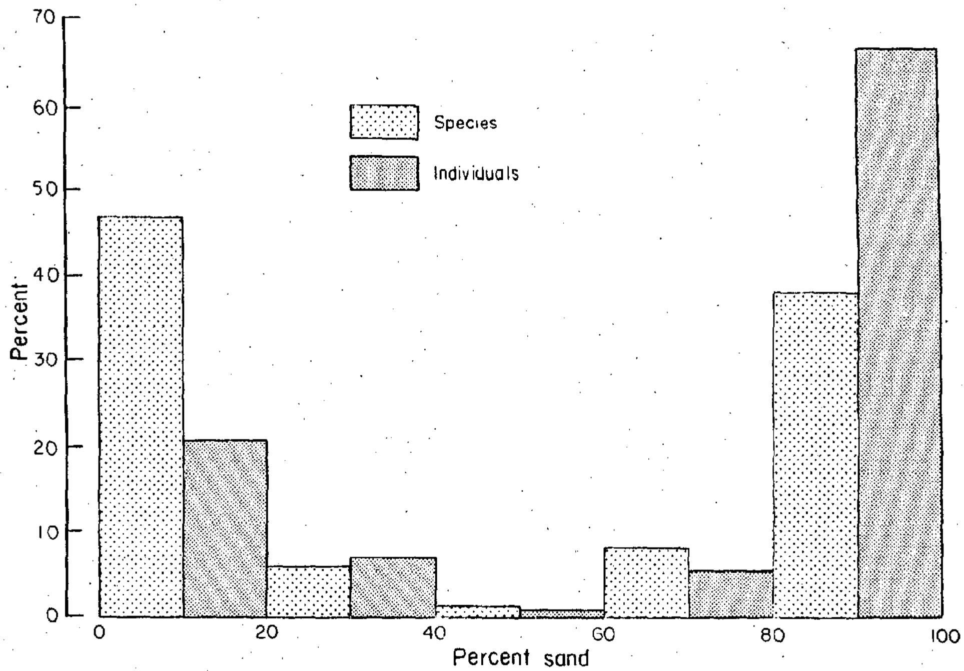
Corpus Christi Bay

Thirty-eight species with a total of 538 individuals were found in the 125 stations examined in Corpus Christi Bay. In 53 of the stations examined, no crustaceans were found. Eighty-four stations were in a range of 0 to 20 percent sand (mud), 38 of which had no crustaceans. Average numbers of species and individuals were very low in this range (table 14), as was the percent of total species and individuals (fig. 37). Species and individuals increased with a rise in sand content, with greatest diversity and abundance in the 29 stations composed of 80 to 100 percent sand, even though nine of these stations lacked crustacea.

The most abundant species by far was the amphipod, Lepidactylus sp., which was also dominant in Copano Bay. It composed 48.6 percent of the crustacean fauna. Parahaustorius cf. holmesi composed 7.6 percent, and the cumacean, Cyclaspis varians occupied 6 percent of the crustacean fauna (table 15).

Of these species, Cyclaspis varians seems to show a preference for low-sand substrates. The two other species obviously fare better in 80 to 100 percent sand (fig. 37).

Diversity and density were fairly low in all areas of Corpus Christi Bay, but nearshore in 80 to 100 percent sand, values rose to more normal levels. The amphipods



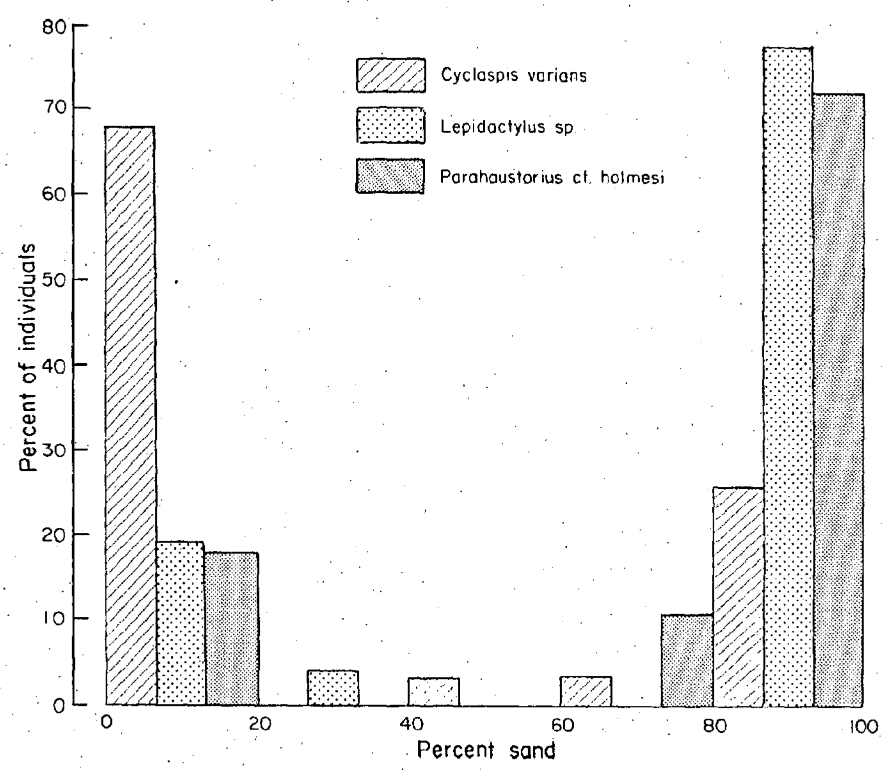


Figure 37. Corpus Christi Bay: crustacean distribution versus sediment.

contained the greatest number of species and individuals of the crustaceans in Corpus Christi Bay.

Aransas Bay

Twenty-four stations were examined from Aransas Bay. Five were of 0 to 20 percent sand, two of 20 to 40 percent, five of 40 to 60 percent, one of 60 to 80 percent, and 12 of 80 to 100 percent sand. Seven stations were lacking in crustaceans. Average numbers of species and individuals increased from low-sand substrates to high-sand substrates (table 14). Percent of species and individuals also follows this trend (fig. 38). In total, 26 species and 70 individuals were identified from Aransas Bay.

Dominant species included Ampelisca brevisimulata, with 17.1 percent, Monoculodes cf. nyei, with 11.4 percent, and Cymadusa compta, with 10 percent (table 15). All three of these species were only found in 80 to 100 percent sand (fig. 38).

Aransas Bay was probably the most diverse bay system studied. The majority of the crustacean species were either amphipods or decapods. Station 26 (80 to 100 percent sand) on the north shore of the bay was the most diverse individual station. It had seven species and eight individuals. This bay showed lower diversity and abundance near bay center, but both factors increased substantially at bay margins.

Redfish Bay

Thirteen stations were examined from Redfish Bay, and from them 16 crustacean species and 138 individuals were found. Since only five of the 13 stations contained crustacea, it is difficult to make any assumptions on general distribution by sediment type. Average numbers of species and individuals (table 14) show no trends, and percent species and individuals (fig. 39) is also not significant.

Of the two dominant species (table 15), Cymodoce faxoni, appears to have no sediment preference, while Cymadusa compta is only found in 60 to 80 percent sand (fig. 39).

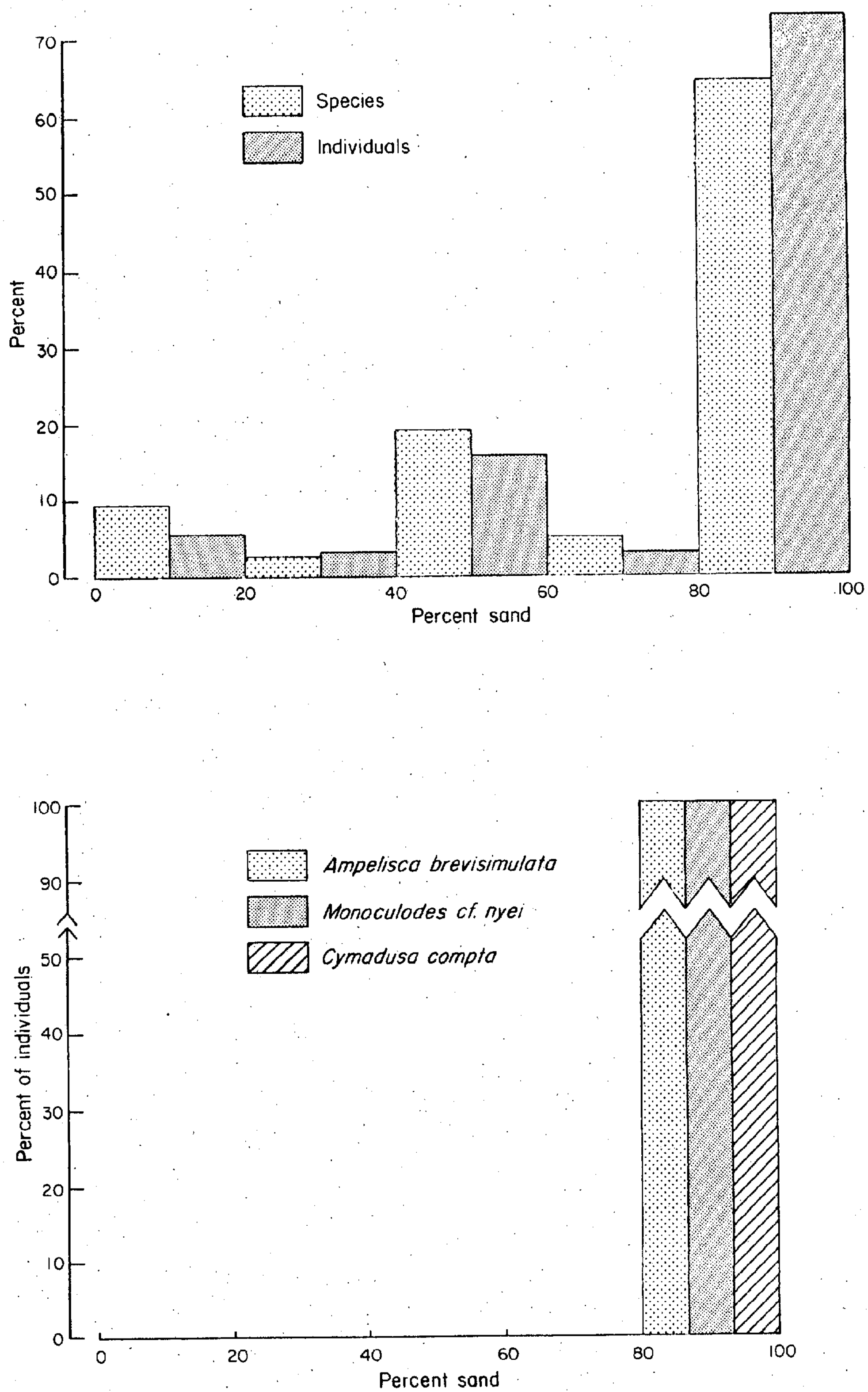


Figure 38. Aransas Bay: crustacean distribution versus sediment.

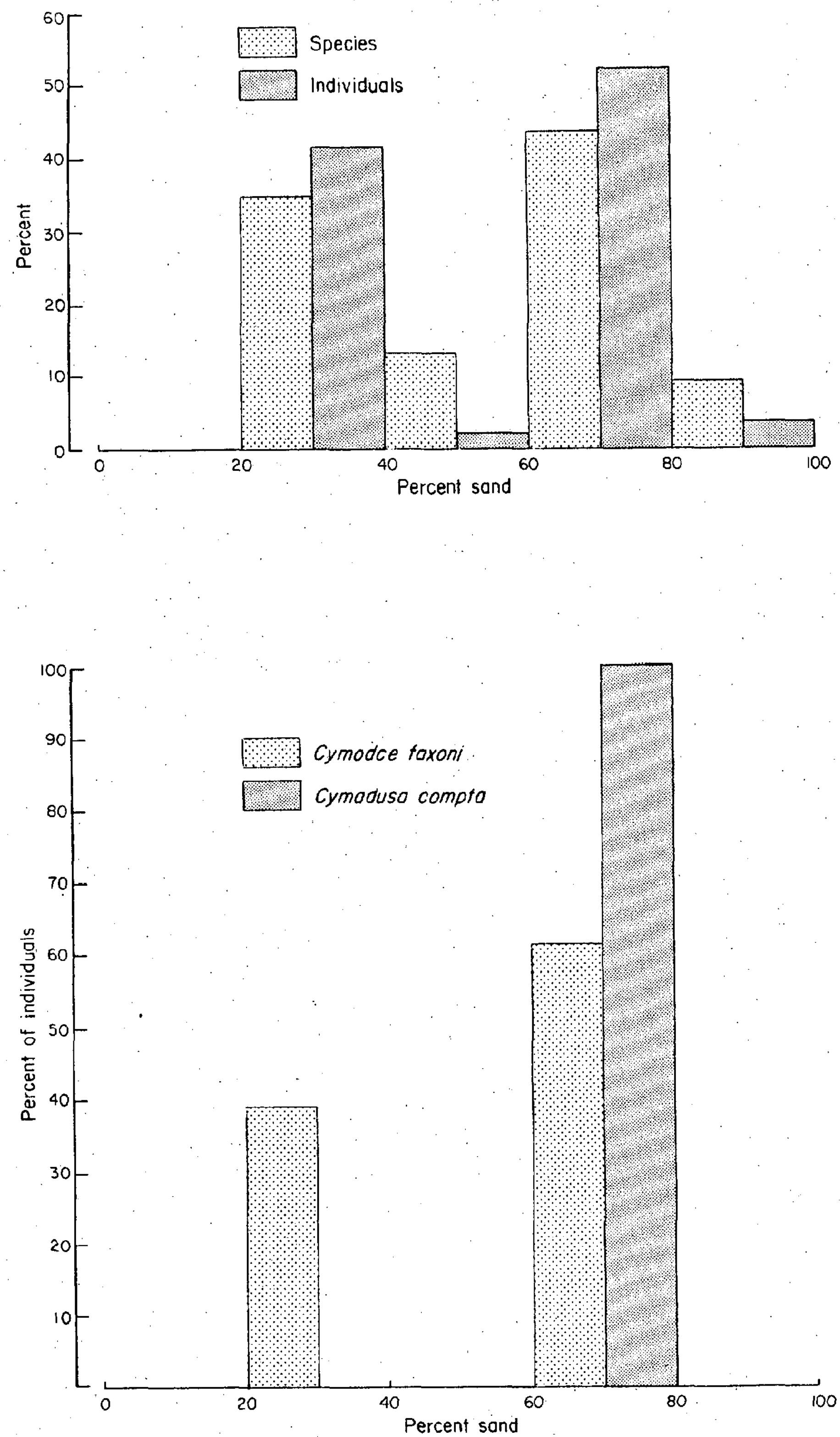


Figure 39. Redfish Bay: crustacean distribution versus sediment.

Most stations were dominated by the amphipod fauna. Probably this is in relation to the grass abundance in Redfish Bay. Station 28, with nine species and 70 individuals, was first in rank for these variables.

Too many gaps exist to make any statements about species distributions. It is unclear why most stations lacked crustacean fauna.

Inner Shelf

Seventy-three stations were examined from the Corpus Christi inner shelf. Fifty-nine species totaling 1,091 individuals were identified. The crustacean fauna shows strong sediment-depth relationships. As has been mentioned, high sand substrates tend to be nearshore and thus in shallow sediments. Upon investigation, it was seen that the average number of species and individuals was highest in the shallower depth ranges (fig. 40). Examination of average number of species and individuals by sediment also shows greater diversity and abundance in areas of higher sand content (fig. 41). These data are numerically illustrated in table 16. A random transect showing number of species and individuals versus sediment type (fig. 42) lends further support to this conclusion.

The three dominant species on the inner shelf (table 15) and their associations with sediment and bathymetry were examined. Acanthohaustorius sp. was only found in 80 to 100 percent sand and in a depth range of 24 to 30 ft (7.2 to 9 m). The other two dominant species, Acetes americanus and Oxyurostylis salinoi (figs. 43 and 44) show similar trends to high sand contents and shallow depth ranges. Many minor species, such as Ampelisca agassizi (fig. 45), which totaled 5.2 percent of the crustacean fauna, were found more often in muddy substrates.

With 59 species, the inner shelf area is by far the most diverse of all the study areas. Twenty-four species of amphipods and 23 species of decapods were identified.

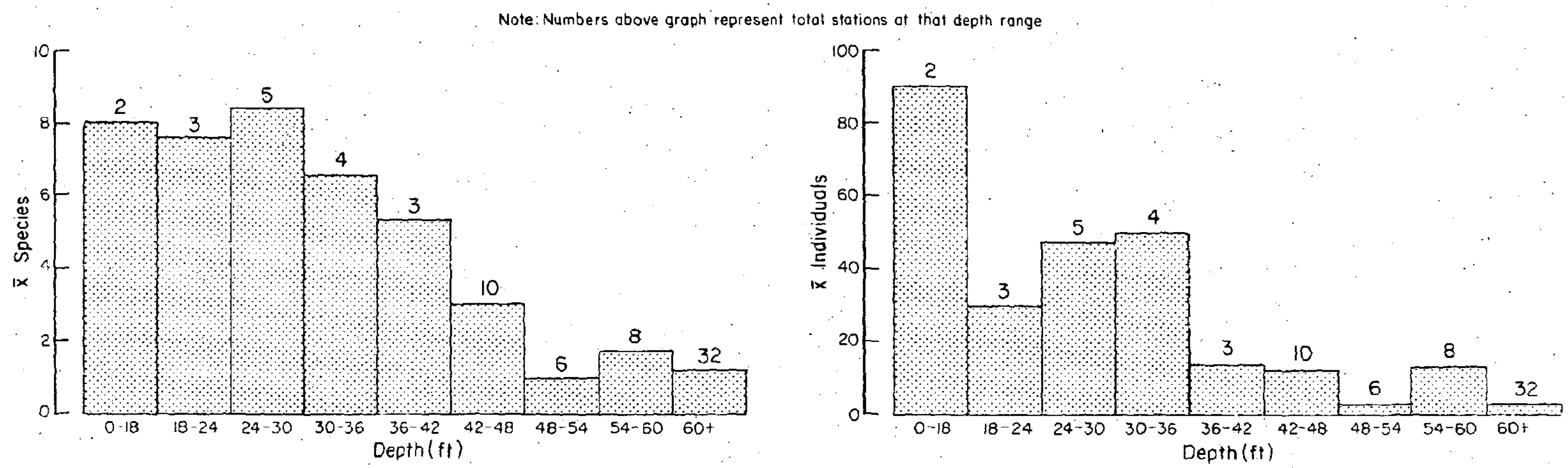


Figure 40. Corpus Christi inner shelf: crustacean distribution versus depth.

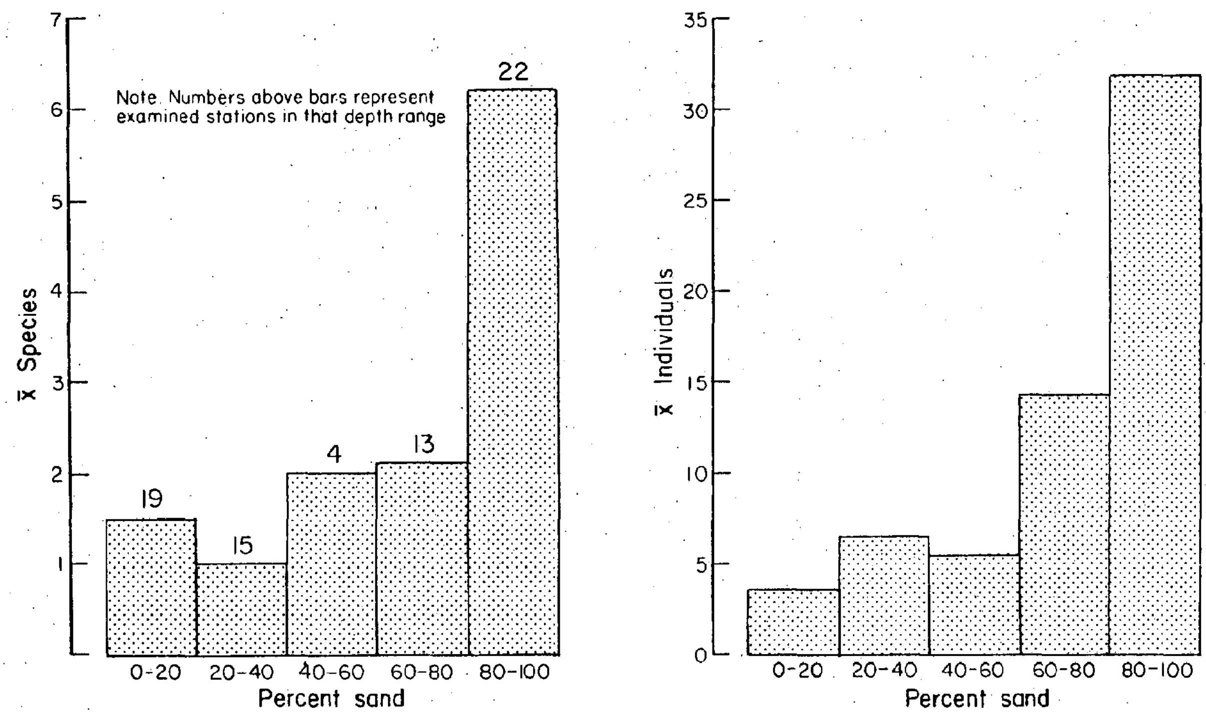


Figure 41. Corpus Christi inner shelf: crustacean distribution versus sediment.

Table 16. Crustacean distribution versus depth on the inner shelf.

Depth (ft)	Average number of species	Average number of individuals
0-18	8.0	90.0
18-24	7.7	29.3
24-30	8.4	46.8
30-36	6.5	49.2
36-42	5.3	13.3
42-48	3.1	12.5
48-54	1.0	3.2
54-60	1.7	12.7
60+	1.3	2.9

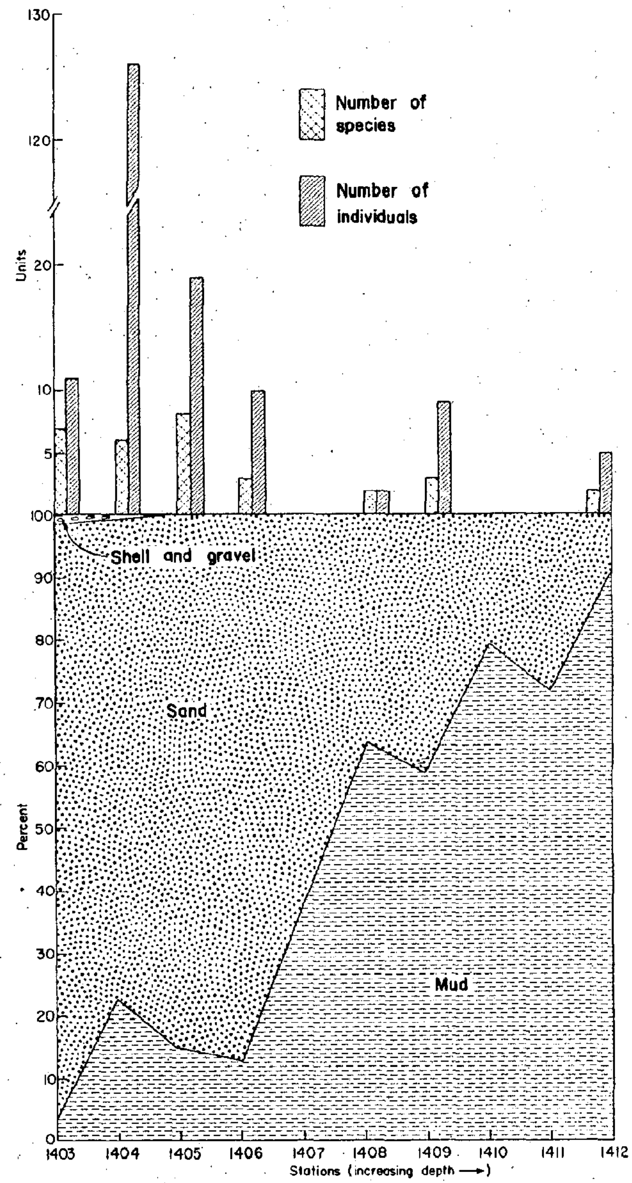


Figure 42. Corpus Christi inner shelf: crustacean distribution along transect 1403-1412.

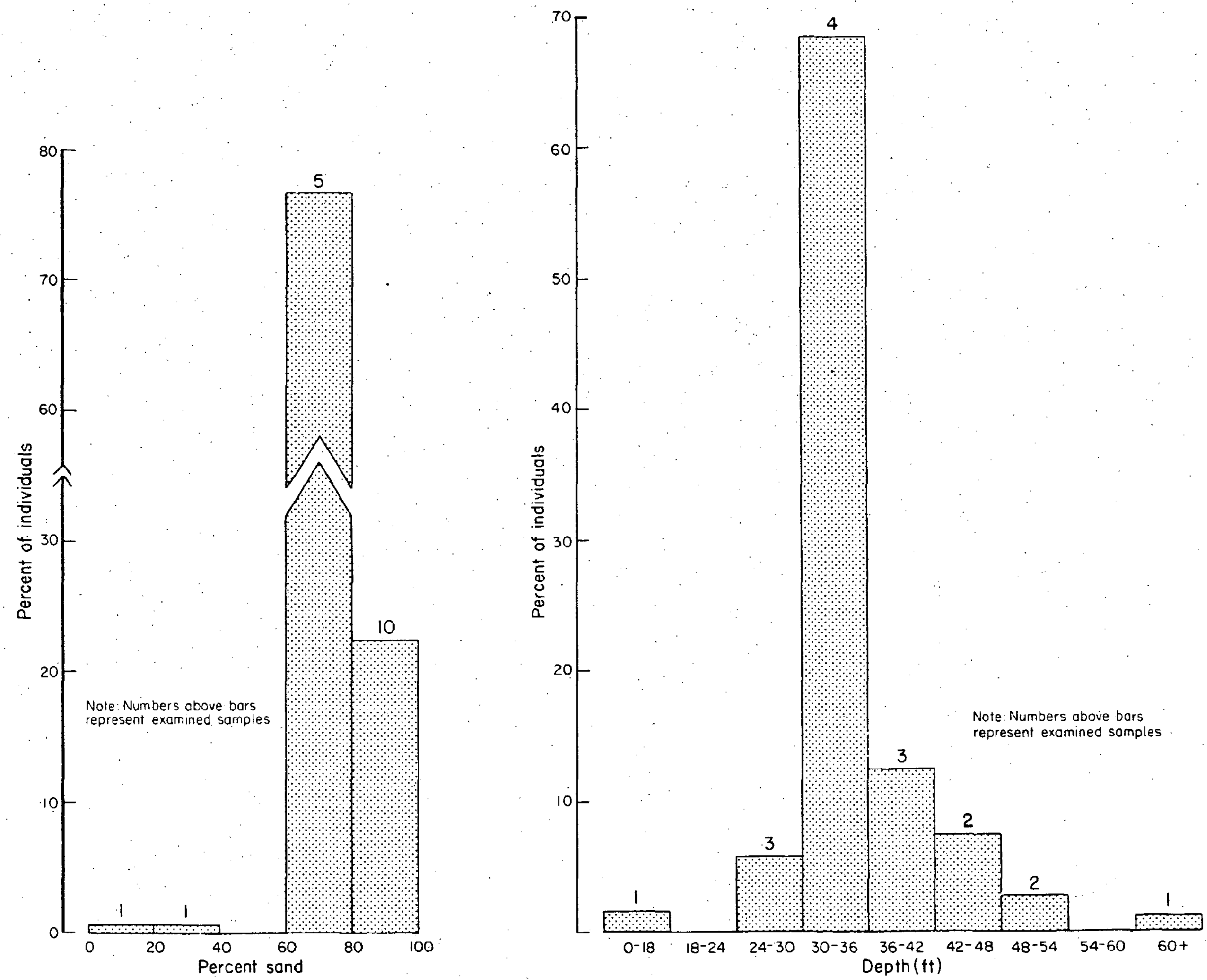


Figure 43. Corpus Christi inner shelf: distribution of Acetes americanus versus sediment and depth.

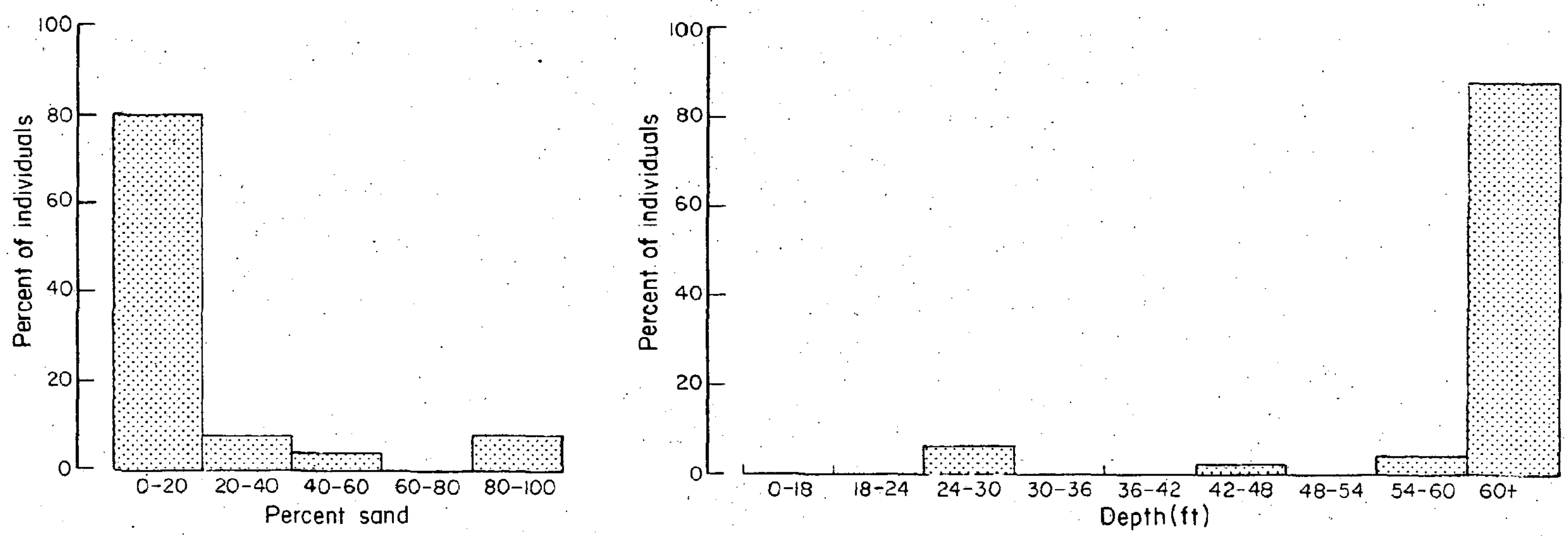


Figure 44. Corpus Christi inner shelf: distribution of Oxyurostylis salinoi versus sediment and depth.

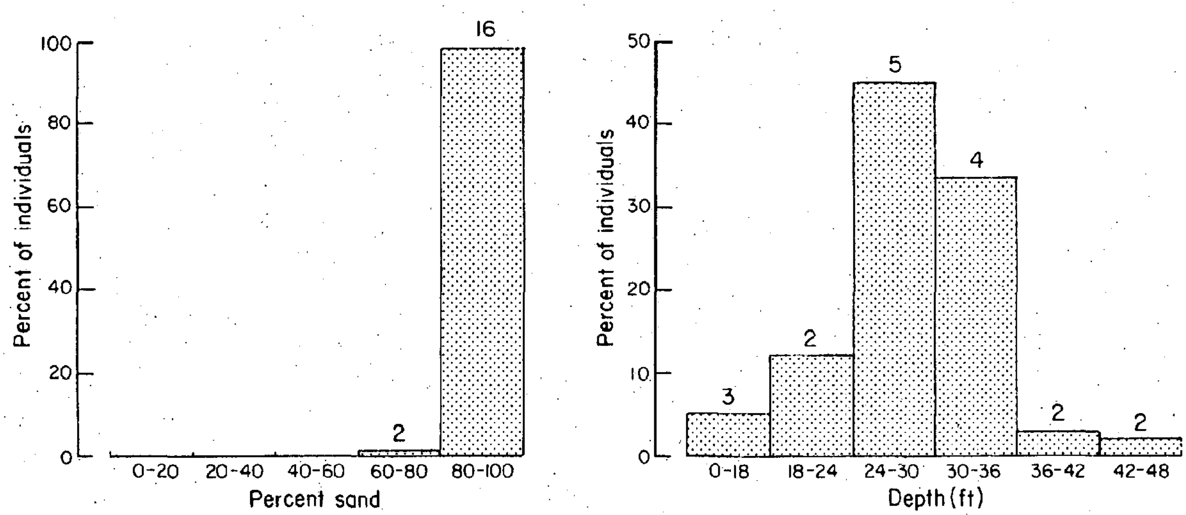


Figure 45. Corpus Christi inner shelf: distribution of Ampelisca agassizi versus sediment and depth.

In almost every station, crustaceans were present. High species counts of 12 were recorded from stations 1138 and 1442, while station 1304 ranked first in number of individuals (126).

Other Phyla

Eight phyla besides the Annelida, Mollusca, and Arthropoda occurred in the Corpus Christi system. They were the Cnidaria, Nemertinea, Platyhelminthes, Phoronida, Sipunculida, Hemichordata, Echinodermata, and Chordata. Certain phyla, Cnidaria, Nemertinea, and the Platyhelminthes, were so little known or difficult to identify that identifications were tentative.

The nemerteans were the most abundant of the eight phyla, occurring in all the bays except Port and Oso. Nemerteans were found at over 45 percent of the examined stations in Corpus Christi Bay. No relationship between sediment and nemertean distribution could be seen in Corpus Christi Bay. However, on the Corpus Christi inner shelf, nemerteans occurred predominantly in the sandier sediments. Sixty-nine percent of all individuals were found at stations with more than 60 percent sand.

Echinoderms occurred in higher salinity bays, Redfish, Laguna Madre, Corpus Christi, and Aransas Bays, and were most abundant on the inner shelf. Three classes of echinoderms, Holothuroidea, Ophiuroidea, and Echinoidea, were found in the Corpus Christi samples. The ophiuroids generally occurred at Gulf stations 1 mi (1.6 km) offshore in the 80 to 100 percent sand range. No holothuroids were found in the Gulf samples.

The sipunculid, Phascolion strombii, was found in Aransas, Redfish, and Corpus Christi Bays and in the Gulf. P. strombii occurred in gastropod shells of the species Nassarius acutus, Anachas cf. avara, Mitrella lunata, Pyramidella crenulata, Cerithium lutosum, Polinices duplicatus, and Acteocina canaliculata. In Corpus Christi Bay, P. strombii was found predominantly between Shamrock Island and the Corpus Christi Ship Channel.

The only other abundant groups were the Cnidaria, specifically the order Actiniaria (sea anemones), and the Phoronida. Sea anemones were most abundant in the Gulf, but also occurred in upper Laguna Madre, Aransas, Redfish, and Corpus Christi Bays. The Phoronida were found at two bay-margin stations along Mustang Island in Corpus Christi Bay, and one specimen occurred in Aransas Bay.

SALINITY AND INVERTEBRATE DISTRIBUTION

Seasonal salinity changes probably vary more in Nueces, Copano, and Mission Bays than in other bays in the Corpus Christi system. Variations in fresh-water inflow from the Nueces, Aransas, Mission, and Guadalupe Rivers probably place more stress on the invertebrates in the adjoining bays than in Laguna Madre or Redfish or lower Corpus Christi Bays.

Diversities, average number of species, and individuals per station were lowest in Nueces, Copano, and Mission Bays where higher salinity stress probably occurs. Holland (1975), also noted that, in general, benthic populations in the Corpus Christi-Nueces and Copano-Aransas Bay systems were directly correlated with salinity; high salinities yielded larger standing crops (numbers of individuals) and greater diversities at all stations.

Live and dead molluscan faunas can be used as indicators of present and past salinity conditions. Long-term climatic changes and the vulnerability of these shallow bays to the resulting salinity variations probably have affected molluscan distributions more than any other environmental factor. These changes govern what populations can become established and remain alive in the bays. For example, if present salinities in a bay are relatively high and stable, then the live molluscan population will consist of mostly stenohaline or euryhaline marine species. If the dead population also consists of mostly stenohaline marine species, then these stable, relatively high-salinity conditions may have existed for some time.

Most of the molluscan species living in Copano Bay were euryhaline marine (Calnan, in press). Their habitat extends from the Gulf into the upper reaches of the bay, and they can tolerate salinities as low as 10 ppt. Ten species are true estuarine. They probably were restricted to the bay and can tolerate neither open Gulf nor freshwater conditions.

From 1971 until 1976 Copano Bay salinities averaged less than 15 ppt (Holland and others, 1973, 1974, 1975, and Texas Department of Water Resources, 1976). Species indicative of high-salinity bays, such as Anomalocardia auberiana, Aligena texasiana, Tellina tampaensis, Chione cancellata, Turbonilla cf. interrupta, and Nuculana acuta were part of the dead population; no live individuals of these species were found. Parker (1959) found live Chione in Copano Bay during the drought of 1950-53.

Variations in salinities in Nueces Bay probably place great stress on the molluscan fauna. Few species were found living in Nueces Bay, but those that were alive were more indicative of a low-salinity environment. Mulinia lateralis, Macoma mitchelli, and Texadina sphinctostoma were some of the most abundant live mollusks. Mulinia lateralis is a ubiquitous species; it abounds on the inner shelf and nearly all bays on the Texas Coast (McGowen and others, 1977). However, Macoma mitchelli and Texadina sphinctostoma are generally restricted to more variable brackish-water bays (Calnan, in press, and Calnan and others, 1979).

The molluscan fauna living in upper Laguna Madre reflects the higher, even at times almost hypersaline, salinity conditions. Tellina tampaensis, Tellina texana, and Anomalocardia auberiana, species tolerant of hypersaline conditions, were found living in upper Laguna Madre. Only two true estuarine species, Texadina sphinctostoma and Amygdalum papyria, were found.

Corpus Christi Bay is larger and hydrographically more complex than other bays in the Corpus Christi system. High-salinity Gulf waters enter the bay through Aransas

Pass and the ship channel. Salinities at stations near Redfish Bay were higher and less variable than in other parts of the bay (Holland and others, 1973, 1974, and 1975). Lower, more variable salinities occurred at bay-margin stations and stations near Nueces Bay.

No true estuarine species were living in Corpus Christi Bay. Stenohaline and euryhaline marine species occurred primarily at stations near Redfish Bay and bay-margin stations near the Corpus Christi-Nueces Bay causeway bridge. Another indication of higher, more stable salinities is the number of species that Corpus Christi Bay and the inner shelf have in common. There were more similarities in molluscan species composition between Corpus Christi Bay and the inner shelf than between Corpus Christi Bay and any other bay in the Corpus Christi system. Eighteen species living in Corpus Christi Bay were also found live on the inner shelf.

High diversity, high species counts, and relatively stable salinity conditions characterize Redfish Bay. Salinities at two stations in Redfish Bay averaged 24 and 26 ppt during the three years of Holland's study (Holland and others, 1973, 1974, and 1975). Station 17 in Redfish Bay had the highest total species count and total molluscan species count of all the bay stations. Molluscan species counts were uniformly high at nearly all Redfish Bay stations.

High-salinity waters enter southern Aransas Bay through Aransas Pass and Lydia Ann Channel. Lower salinity waters from flood outflow in San Antonio Bay also enter Aransas Bay (Holland, 1975). Twenty-six molluscan species were found living in Aransas Bay. The living species were both stenohaline and true estuarine. The dead population was also a mixture of high and low salinity tolerant species. Some of the variability in the salinity tolerance shown in the live population could be the result of seasonality in collecting dates. Field work in Aransas Bay extended over a 3-month period, from April to July 1976.

BATHYMETRY AND INVERTEBRATE DISTRIBUTION

Inner Shelf

Analysis of the bathymetric distribution of invertebrates on the inner continental shelf shows that the average number of live species per station was greatest from shore out to the 42 to 48 ft (12.6 to 14.4 m) depth range, with the largest average number of species found in the 36 to 42 ft (10.8 to 12.6 m) range (fig. 46). The aggregate average number of species per station from 12 to 48 ft (3.6 to 14.4 m) was 26.9, while that for stations in the 48 to 84 ft (14.4 to 25.2 m) depth range was 11.1 per station.

Figure 31 shows that the mollusk species peaked in two depth ranges, 18 to 24 ft (5.4 7.2 m) and 42 to 48 ft (12.6 to 14.4 m), whereas the other groups had only one major peak each. The largest number of crustacean species occurred in depths of 24 to 30 ft (7.2 to 9 m), while the polychaetes and other invertebrate groups peaked at the 36 to 42 ft (10.8 to 12.6 m) depth range (fig. 31).

The greatest percent of the total number of live individuals occurred at the 42 to 48 ft (12.6 to 14.4 m) depth range (fig. 47). Of these, the mollusks made up the greater proportion (fig. 30). Most of the live mollusks occurred at three of the ten stations in this depth range. The peak at the 36 to 42 ft (10.8 to 12.6 m) range was due to large numbers of invertebrates other than mollusks, polychaetes, or crustacea.

Bays

Invertebrate distribution in the bays is probably not affected by bathymetry, due to their overall shallowness. Other factors, such as sediment and salinity, probably play a greater part in invertebrate distribution in the bays.

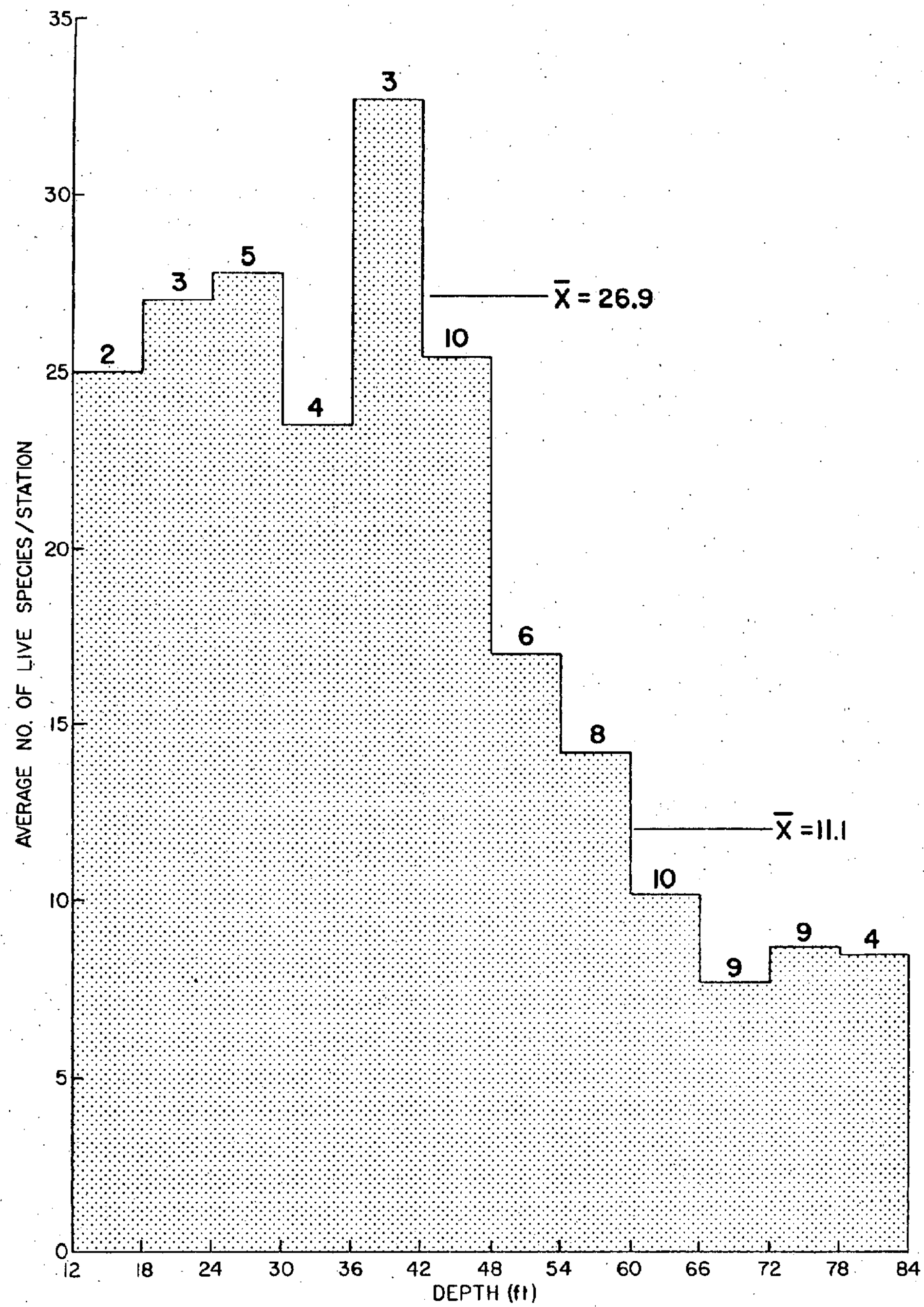


Figure 46. Distribution of the average number of total live species per station by depth.

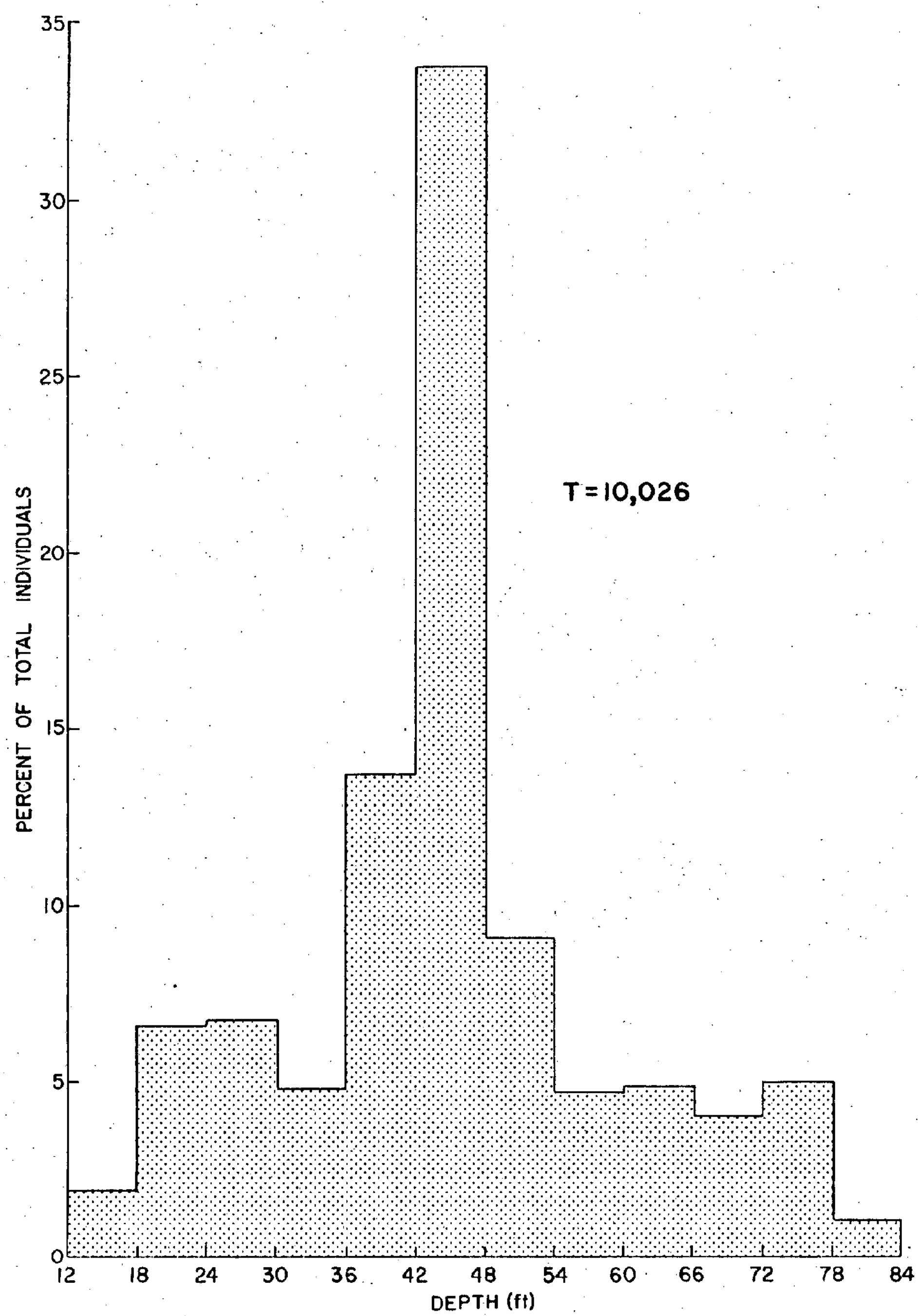


Figure 47. Distribution of live individuals by depth.

SEDIMENT AND INVERTEBRATE DISTRIBUTION

Detailed sediment descriptions for the bays and inner shelf and infaunal-sediment relationships for each of the major phyla have been included in previous sections of this report. In general, sediment at most bay stations was fine grained, and consisted of 0 to 40 percent sand. Only upper Laguna Madre and Redfish Bay had more 60 to 100 than 0 to 40 percent sand stations.

Total faunal-sediment relationships were similar to those of each of the major phyla (Mollusca, Crustacea, and Polychaeta). The dominant bay species for each of the major phyla (except for a few dominant crustacean species) occurred in the dominant sediment type for that bay system. Total faunal distributions were also correlated with the predominant sediment type. Copano, Nueces, and Corpus Christi Bays were characterized by large areas of 0 to 20 percent sand (mud) usually in bay center. Highest total individual and species counts occurred at these muddy 0 to 20 percent sand stations (figs. 24, 28, and 48). Upper Laguna Madre and Redfish Bay had more stations in the 80 to 100 percent sand range and thus had higher total faunal counts at the sandier stations (figs. 25 and 26).

However, in terms of bay systems and total faunal diversity and abundance, bays with more stations in the 60 to 100 percent sand category had higher diversities and total population counts. Diversities and total species counts were highest in upper Laguna Madre and Redfish Bay.

Even in Corpus Christi Bay, where the sediment graph (fig. 3) indicates that there were nearly three times as many stations examined in the 0 to 20 percent sand compared to the 80 to 100 percent sand stations, the total number of individuals and species for 0 to 20 percent sand versus 80 to 100 percent sand was nearly equal (fig. 49).

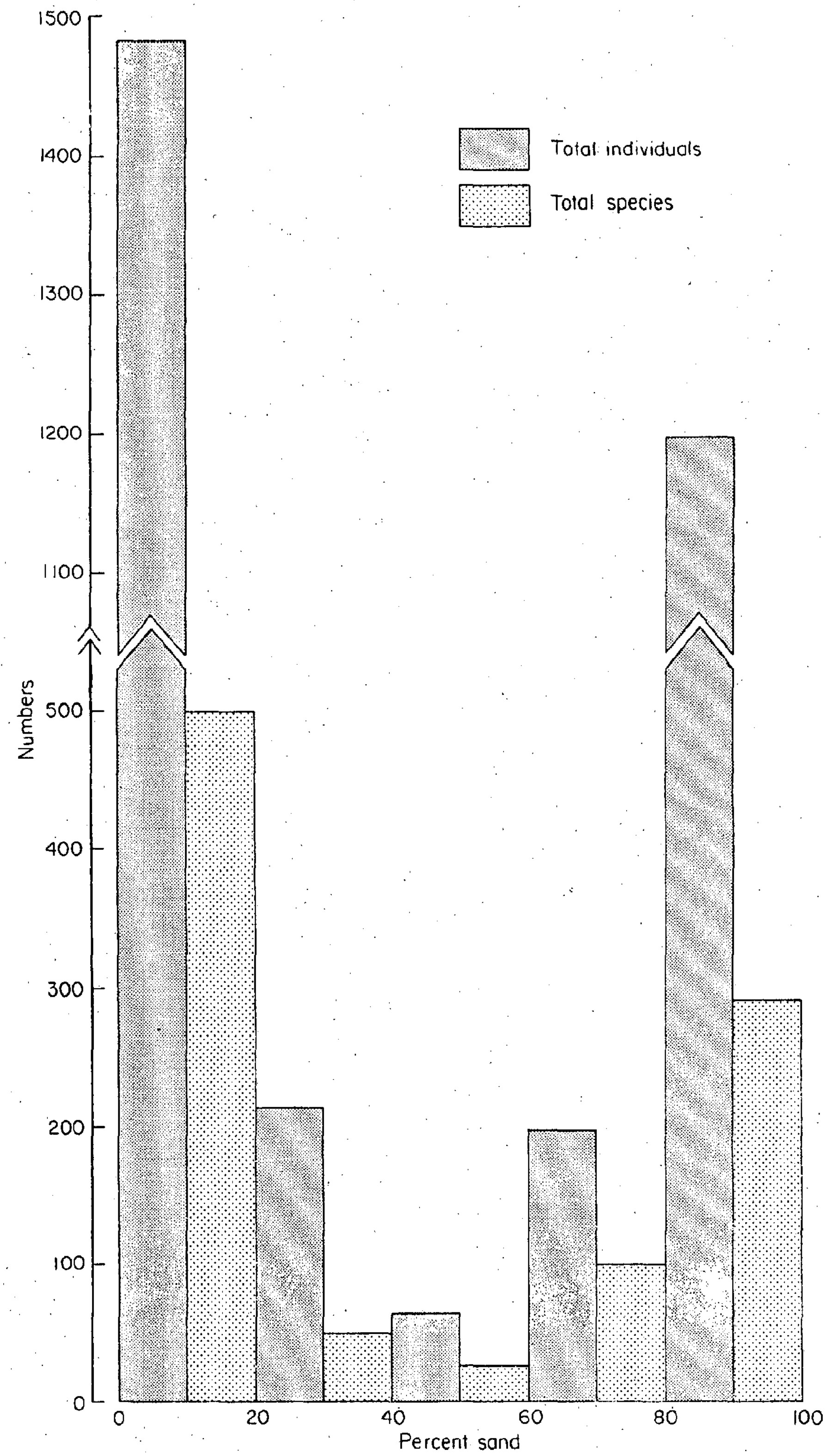


Figure 48. Distribution of total individuals and total species by percent sand in Corpus Christi Bay.

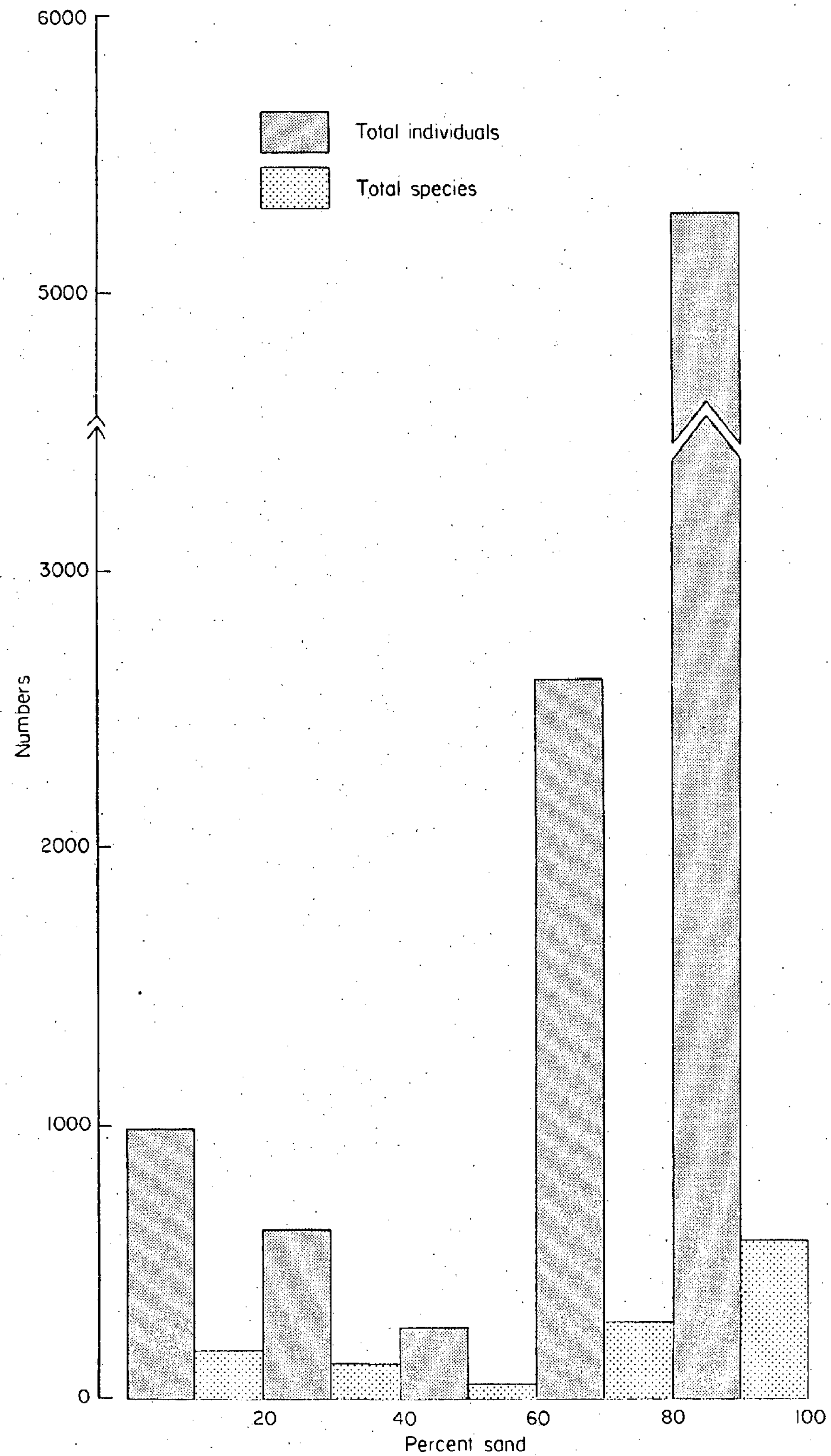


Figure 49. Distribution of total individuals and total species by percent sand on the inner shelf.

On the inner shelf, diversities, species counts, and densities were highest nearshore in the shallower, sandier sediments. The average number of species per station for all taxonomic groups was highest at depths from 24 to 48 ft (7.2 to 14.4 m) and sediment in the 60 to 100 percent sand range (figs. 46 and 49). Selected transects for each of the major taxonomic groups also show this trend (figs. 13, 14, 29, and 42).

High species counts, high total species densities, and high species diversities occur at stations just offshore and to the north and south of Aransas Pass. Sediment at these stations was 80 to 100 percent sand.

TOTAL SPECIES DIVERSITY

To calculate species diversity (H'), the Shannon-Weaver index was used. In this formula, $H' = -\sum_{r=1}^{s} p_r \log_2 p_r$, s = total number of species, and p = observed proportion of individuals that belong to the r th species (r = 1,2...,s). The diversity data were then plotted on the Corpus Christi base map (scale = 1:24,000) and contoured. The diversity index ranged from 0.0 to 3.2, with higher diversity corresponding to higher indices. Average diversitities for the bays are shown in table 17. Diversity as a function of depth and sediment (percent sand) on the shelf is illustrated in table 18. The diversity map is on open file at the Bureau of Economic Geology, The University of Texas at Austin.

Bays

Diversity in the bay systems was generally low, with scattered areas of moderate to high diversity.

Upper Laguna Madre was found to be of medium diversity at its northern end, increasing to moderately high diversity in the south. Delineations and boundaries are rather vague in this area, and further samples need to be studied. Station 45 was found to be the most diverse of those studied in Laguna Madre. The average diversity for all stations studied was 1.573.

Table 17. Average diversity (H') in bay systems.

Bay	Average Diversity (H')
Laguna Madre	1.573
Nueces Bay	0.882
Corpus Christi Bay	1.442
Redfish Bay	1.771
Aransas Bay	1.385
Copano Bay (with adjacent bays)	0.855
(without adjacent bays)	0.958

Table 18. Average diversity (H') by percent sand and depth on the inner shelf.

	Percent Sand				
	0 to 20	20 to 40	40 to 60	60 to 80	80 to 100
Avg. (H')	1.156	1.157	1.763	1.850	2.160

Depth (ft)	Avg. (H')
12-18	2.247
18-24	2.057
24-30	2.230
30-36	2.106
36-42	2.565
42-48	1.868
48-54	1.940
54-60	1.973
60-66	1.504
66-72	1.232
72-78	.984
78-84	1.133

In Oso Bay, diversity was very low, except at its junction with Corpus Christi Bay. At this point, diversity increased to a moderate level.

Nueces Bay was one of the least diverse systems studied. Stability through time is necessary for a diverse fauna to exist (Sanders, 1968). Since Nueces Bay is a high stress area, the fauna is never given time to diversify; throughout the bay, therefore, diversity is usually only moderately low. Highest diversity (1.8) occurred at stations 4 and 5 in the bay. Average diversity for all stations examined was 0.882.

Corpus Christi Bay was found to be a fairly diverse system. Although a large part of the bay was of very low diversity, enough areas of moderate to high diversity existed to give an average H' of 1.442 for all stations examined. Areas of higher diversity were near Shamrock Island, at the junction of Laguna Madre, and in most areas along the Corpus Christi Ship Channel. Along the channel, diversity ranges were 2 to 3. Station 157 was the most diverse studied, with an H' of 2.9. It is interesting to speculate why diversity might be higher in and around the ship channel, but no clear conclusions can be made at this time. The area is probably more stable in salinity than other areas of the bay, since it is deeper and is a tidal inlet. Through dredging, nutrients may also be released to the adjacent organisms, causing increased diversity in this area. At the moment, there are no hard data to support these speculations. Future study should concentrate on this question.

Redfish Bay was found to be very diverse from the Corpus Christi Ship Channel to the Aransas Channel. The highest diversity of any station in the study area (3.2) was found in this area. Again, only speculations can be made at this time to explain this phenomenon. Diversity (H') decreases rapidly north of the Aransas Channel and is extremely low at many stations in this area. Overall diversity was 1.771 for all stations studied, making Redfish Bay the most diverse of all the bay systems.

Aransas Bay can be described as an area of fairly low diversity. H' is found to be very low at most stations, with higher diversity occurring at scattered stations along the Intracoastal Waterway, and in an area bordered by Mud Island and Allyn's Bight. In these areas diversity (H') was approximately 1.6. The highest diversity (2.3) occurred at station 26 near Traylor Island. The H' average for all stations was 1.385.

Copano Bay and its adjacent tributaries, Port Bay and Mission Bay, were found to have the lowest diversity of all systems examined. This confirms a previous study by Holland and others (1975). The average diversity for the entire system was 0.855. If Mission Bay and Port Bay are excluded, Copano Bay has a diversity index average of 0.958. Areas of higher diversity are associated with the bay margin in most instances. Many stations had a diversity value of zero.

Inner Shelf

Many authorities have stated that diversity decreases with distance from the shore (Holland and others, 1977). Our study supports this contention; we found highest H' values nearshore and then a zone of low diversity offshore. Most of the area north of Aransas Pass had high diversity to a distance 9 mi (14.4 km) offshore. South of the pass, the high-diversity zone rarely exceeds 5 mi (8 km) from shore. The average diversity (H') of the shelf was 1.689. Boundaries on the shelf between zones are flexible. Further study will lead to more definite delineation in this area.

INVERTEBRATE ASSEMBLAGES

Numerical analysis methods were used to identify species assemblages and to delineate the spatial distribution of each assemblage. The analysis involved the use of the Canberra-Metric dissimilarity index to aid in computing the dissimilarity between all possible pairs of stations based on the species present. The next step was clustering of individual stations into groups with the greatest affinities; the clustering strategy was the flexible sorting method (Boesch, 1973). Station and species dendrograms were constructed to produce station and species groups. Performing both normal (Q mode) and inverse (R mode) cluster analyses allowed construction of a twoway coincidence table (Holland and others, 1977) to aid in identification of species assemblages characteristic of geographical zones.

Cluster analyses were run on all the bay systems and the inner shelf. No assemblages could be delineated from the data from Port, Mission, and Oso Bays. Species that occured at two stations or less were eliminated from the analysis because elimination of these species reduced computer time and helped prevent clutter in the dendrograms. A map of the station groups is on open file at the Bureau of Economic Geology, The University of Texas at Austin.

Inner Shelf

Normal analyses of infaunal data from all 73 inner shelf stations resulted in three station groups. These groups divide the study area into shallow, transitional or mid-depth, and deep station zones. The boundary between the shallow station group and the transitional group was 2 to 3 mi (3.2 to 4.8 km) offshore from just south of Aransas Pass to 4 to 6 mi offshore (6.4 to 9.6 km) north of Aransas Pass. The transitional zone was from 3 to 5 mi (3.2 to 8 km) wide everywhere except for the area northernmost that included the northernmost transect, stations 1508 to 1518. The transition zone was 8 mi (12.8 km) wide at this transect. Two isolated deep-water stations, 1290 and 1368, clustered with the transition zone stations. Ranges in depth for the three zones were 18 to 54 ft (5.5 to 16.5 m) for the shallow zone, 42 to 78 ft (12.8 to 23.8 m) in the transition zone, and 60 to 84 ft (18.3 to 15.6 m) in the deep-water zone.

Station groups formed from cluster analyses were compared with sediment data (table 19). Sediment at the 23 stations from the nearshore zone ranged from 70 to 98 percent sand and averaged 88 percent sand. Sand percentages averaged 47 percent in the transition zone and 17 percent in the deep-water zone. Sediment in the mid-depth

Table 19. Characteristics of benthic faunal assemblages in the Corpus Christi area.

	Total no. stations	Avg. no. species/station	Avg. no. indiv./station	Avg. % sand	Avg. diversity (H')	Depth range ft (m)
Inner Shelf						
Shallow water	23	26.2	299.3	88.0	1.952	18-54 (5.5-16.5)
Transitional	26	15.3	64.5	47.0	2.030	42-78 (12.8-23.8)
Deep water	24	9.0	60.6	17.2	1.088	60-84 (18.3-15.6)
Copano Bay						
Bay margin	22	5.4	20.9	80.9	1.095	
Oyster reef	9	5.6	22.1	34.6	1.289	
Bay center A	16	1.7	3.7	6.9	0.247	
Bay center B	19	4.8	14.8	12.1	1.232	
Nueces Bay						
Bay margin	13	3.1	7.3	40.3	0.808	
Bay center	20	3.3	7.7	48.2	0.930	
Redfish Bay						
Group A	2	12.0	19.0	89.0	2.300	
Group B	11	15.7	61.6	60.2	1.836	
Aransas Bay						
Bay margin	15	3.5	7.8	84.0	1.327	
Bay center	9	5.3	9.9	31.7	1.644	
Upper Laguna Madre						
Group A	11	13.8	128.2	48.6	1.445	
Group B	11	10.6	54.6	85.6	1.773	
Corpus Christi Bay						
Bay margin A	23	11.3	47.2	53.5	1.252	
Bay margin B	33	8.2	33.2	57.8	1.703	
Bay center A	41	3.8	8.7	9.4	1.073	
Bay center B	28	9.1	18.1	16.4	1.883	

zone represented a transition zone that ranged from mud (less than 29 percent sand) to 90 percent sand.

Species typical of the station groups are present in table 20. Average species number and average number of individuals were highest in the shallow-water zone. Few species present in the shallow-water zone were also present in the deep-water zone. Bivalves and two polychaete species, Owenia fusiformis and Onuphis eremita, were numerically dominant in this shallow water zone. The transitional and deep-water zones had many species in common (table 20). Polychaetes were dominant in the transitional and deep-water zone. Gastropods increase in abundance from the shallow-water to the transitional zone. Crustacea were most abundant in the shallow-water zone. Only one crustacean species, Ampelisca agassizi, was dominant in deep water.

Bays

Copano Bay

The 65 stations in Copano Bay clustered into four groups. The station clusters for the bay margin and the oyster reef groups were well-defined and could readily be separated from themselves and the other groups because of the fauna that were generally restricted to these groups. The sandier, bay-margin group was primarily composed of suspension feeding crustaceans and the bivalve, Macoma mitchelli. The oyster reef assemblage was dominated by the mollusks, Crassostrea virginica, Odostomia impressa, and Ischadium recurvum. The average number of species and individuals was highest at the nine reef-assemblage stations.

Both bay-center groups, A and B (table 20), were dominated by the bivalves, Macoma mitchelli and Mulinia lateralis. However, the 16 group A stations contain only M. mitchelli and M. lateralis, whereas several other species were living at group B stations.

Diversities were highest at some of the shallow bay-margin stations (table 19).

Table 20. Dominant species within the clustered station groups.

INNER SHELF

Shallow-water group (18 to 54 ft)	Transitional group (42 to 78 ft)	Deep-water Group (60 to 84 ft)
Mollusca	Mollusca	Mollusca
Abra aequalis	*Nucula proxima*	*Vitrinella floridana*
Tellina iris	*Nassarius acutus*	Polychaeta
Tellina versicolor	*Natica pusilla*	*Paraprionospio pinnata*
Parvilucina multilineata	*Vitrinella floridana*	*Nereis micromma*
Acteon punctostriatus	Polychaeta	*Magelona phyllisae*
Cyclostremella humilis	*Cossura delta*	*Ninoe nigripes*
Natica pusilla	*Lumbrineris parvapedata*	Crustacea
Nassarius acutus	*Magelona pettiboneae*	*Ampelisca agassizi*
Polychaeta	*Magelona phyllisae*	
Owenia fusiformis	*Nereis micromma*	
Onuphis eremita	*Aricidea fragilis*	
Lumbrineris parvapedata	Crustacea	
Spiophanes bombyx	*Pagurus longicorpus*	
Crustacea	*Euceramus praelongus*	
Oxyurostylis salinoi	*Pinnixa sayana*	
Synchelidium americanum		
Trichophoxus floridanus		
Acanthohaustorius sp.		

Table 20. (cont.)

COPANO BAY

Bay-margin group	Oyster reef group	Bay-center group A	Bay-center group B
Mollusca	Mollusca	Mollusca	Mollusca
Macoma mitchelli	*Crassostrea virginica*	*Mulinia lateralis*	*Mulinia lateralis*
Crustacea	*Ischadium recurvum*	*Macoma mitchelli*	*Macoma mitchelli*
Cassinidea lunifrons	*Odostomia impressa*		*Texadina sphinctostoma*
Monoculodes cf. *nyei*	Polychaeta		Polychaeta
Monoculodes almyra	*Nereis succinea*		*Glycinde solitaria*
			Sigambra bassi

NUECES BAY

Bay-margin group	Bay-center group
Mollusca	Mollusca
Mulinia lateralis	*Mulinia lateralis*
Polychaeta	Polychaeta
Mediomastus californiensis	*Cossura delta*
	Paraprionospio pinnata
	Mediomastus californiensis

REDFISH BAY

Group A (stations 2, 3)	Group B
Mollusca	Mollusca
Nuculana acuta	*Crepidula fornicata*
Mulinia lateralis	*Lyonsia h. floridana*
Nemertinea	*Lucina pectinata*
	Polychaeta
	Mediomastus californiensis
	Nereis succinea
	Prionospio heterobranchia
	Crustacea
	Elasmopus levis
	Cymodoce faxoni

Table 20. (cont.)

UPPER LAGUNA MADRE		ARANSAS BAY	
Group A	Group B	Bay-center group	Bay-margin group
Mollusca	Mollusca	Polychaeta	Mollusca
Cerithium lutosum	*Brachidontes exustus*	*Paraprionospio pinnata*	*Lyonsia h. floridana*
Crepidula convexa	*Tellina texana*	*Gyptis vittata*	*Ensis minor*
Bittium varium	Polychaeta	*Haploscoloplos fragilis*	Polychaeta
Polychaeta	*Melinna maculata*	Crustacea	*Clymenella torquata*
Prionospio heterobranchia	Crustacea	*Leptochela* cf. *bermudensis*	*Glycinde solitaria*
Crustacea	*Oxyurostylis salinoi*		Crustacea
Cymodoce faxoni			*Ampelisca brevisimulata*
Elasmopus levis			

CORPUS CHRISTI BAY			
Bay-margin group A	Bay-margin group B	Bay-center group A	Bay-center group B
Mollusca	Mollusca	Mollusca	Mollusca
Nuculana acuta	*Tellina texana*	*Mulinia lateralis*	*Mulinia lateralis*
Lyonsia h. floridana	*Acteocina canaliculata*	Polychaeta	Polychaeta
Mulinia lateralis	*Mulinia lateralis*	*Branchioasychis americana*	*Lumbrineris parvapedata*
Crustacea	Polychaeta	*Cossura delta*	*Branchioasychis americana*
Lepidactylus sp.	*Paraprionospio pinnata*	*Paraprionospio pinnata*	*Cossura delta*
Nemertinea	Nemertinea	Nemertinea	Nemertinea
Sipunculida			Crustacea
Phascolion strombii			*Listriella barnardi*

Nueces Bay

The two station groups in Nueces Bay differ only in the species present. The average percent sand, average number of species and individuals, and average diversity for each group were very similar (table 19). The bay-center group had more species. Mulinia lateralis and Mediomastus californiensis were dominant in both groups.

Redfish Bay

Group clusters for the 13 stations in Redfish Bay were indistinct. Stations 2 and 3 clustered together because they were dominated by bivalves and had fewer species than the other station group and no crustacea. The larger station group was characterized by high diversity (most stations) and a lower sand content (table 19). Stations 2 and 3 were similar in species content to bay-margin group A in Corpus Christi Bay.

Upper Laguna Madre

Two station groups characterized upper Laguna Madre. Group A stations had lower sand percentages (table 19) and lower species and individual averages. Eight of the 11 group A stations were west of the intracoastal waterway near Pita Island. Group B had sandier, bay-margin stations. Group A was dominated by gastropods (table 20); group B, by bivalves.

Aransas Bay

A bay-center and a bay-margin group were delineated in Aransas Bay. The bay-center group had higher species and individual averages per station and higher diversities (table 19). The bay-center group contained mostly polychaetes and no mollusks. Two bivalve species dominated in the bay-margin assemblage.

Corpus Christi Bay

The 125 stations in Corpus Christi Bay clustered into four station groups. The four groups were two bay-margin and two bay-center groups. The two bay-margin groups were characterized by higher percent sand and higher individual averages per station than the bay-center groups. Bay-margin group A stations occurred primarily along the Corpus Christi Ship Channel near Redfish Bay and along the bay margin near the city of Corpus Christi, from Alta Vista Reef to Indian Point. Bay-margin group B stations were generally along three bay-margin areas: (1) Mustang Island from near Laguna Madre to Coyote Island, (2) Oso Bay to near station 151, and (3) from near Indian Reef on the Portland side of the bay to the Corpus Christi Ship Channel.

Bay-center group A stations were almost entirely in the muddy sediment south of the ship channel. This station group had the lowest average diversity of all four assemblages (table 19) and the lowest percent sand average. Bay-center group B stations were mid-bay stations must north and south of the ship channel. Bay-center group B stations were also in an area between Shamrock Cove and the Corpus Christi Ship Channel. Bay-center group B stations had the highest average diversity, 1.883.

Mulinia lateralis and Paraprionospio pinnata were the most abundant and ubiquitous species. Mulinia occurred in all four station groups (table 20), and P. pinnata was found in three of the four groups. The two bay-margin groups could be distinguished from each other by the almost total absence of gastropods in group A stations and the absence of crustacea in group B stations. The species clusters for the bay-center group A and B stations were similar except for the presence of Listriella barnardi and Lumbrineris parvapedata as dominant species in group B.

SUMMARY

This study develops the biological base for (1) general policies and management criteria for activities affecting Texas submerged lands and U.S. Outer Continental

Shelf lands, and (2) assessments of the environmental impact of non-natural coastal alterations.

The established biological baseline for the Corpus Christi area will aid in defining the limits of natural variability in the ecosystem over space and time. Changes in the ecosystem can then, possibly, be monitored directly. A baseline will also aid in the comparison of similar environments so that non-natural changes in the environment can be detected in ecologically similar ecosystems. The biological community structure can be used to determine the nature and extent of the effects of oil spills, well-site access and construction, drilling, and pipeline construction.

The following areas should be emphasized from the results of this baseline study:

(1) Redfish Bay and upper Laguna Madre were the most diverse bays in the study area. Diversity indices (H') were generally lower at bay-center stations.

(2) Average density indices (H') for Nueces and Copano Bays were the lowest for larger bays in the area. Many Nueces and Copano Bay stations had indices of zero.

(3) Highest diversities and species counts and individual counts generally occurred at Corpus Christi Bay stations in and around the Corpus Christi Ship Channel.

(4) Diversities on the inner shelf generally decrease from 1 mi (1.6 km) offshore to the deeper water stations 11 mi (17.6 km) offshore.

(5) Species counts and number of individuals were highest on the inner shelf in the 42 to 48 ft (12.6 to 14.4 m) depth range.

(6) Highest diversity values generally occur at the sandier stations in the study area.

(7) Highest diversities also occur in bays with historically more stable and generally higher salinities.

(8) Parts of Redfish Bay (south of the Aransas Channel) and Corpus Christi Bay (between Shamrock Island and the Corpus Christi Ship Channel) were diverse in invertebrate community structure and sediment type.

(9) Higher diversities occurred in the bays with more marine grasses, such as Redfish Bay and upper Laguna Madre.

(10) Station groupings from the cluster analyses tended to be divided according to sediment type. Copano, Aransas, Nueces, and Corpus Christi Bays had a sandier bay-margin station group and a muddier bay-center group.

(11) There were definite correlations between sediment type (percent sand and gravel) and species distribution.

(12) *Mulinia lateralis* and *Paraprionospio pinnata* were most abundant in the bays, and *P. pinnata* and *Abra aequalis* on the inner shelf.

(13) Species groupings and individual species distributions will change somewhat temporally; however, no seasonal data were collected to confirm this trend.

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