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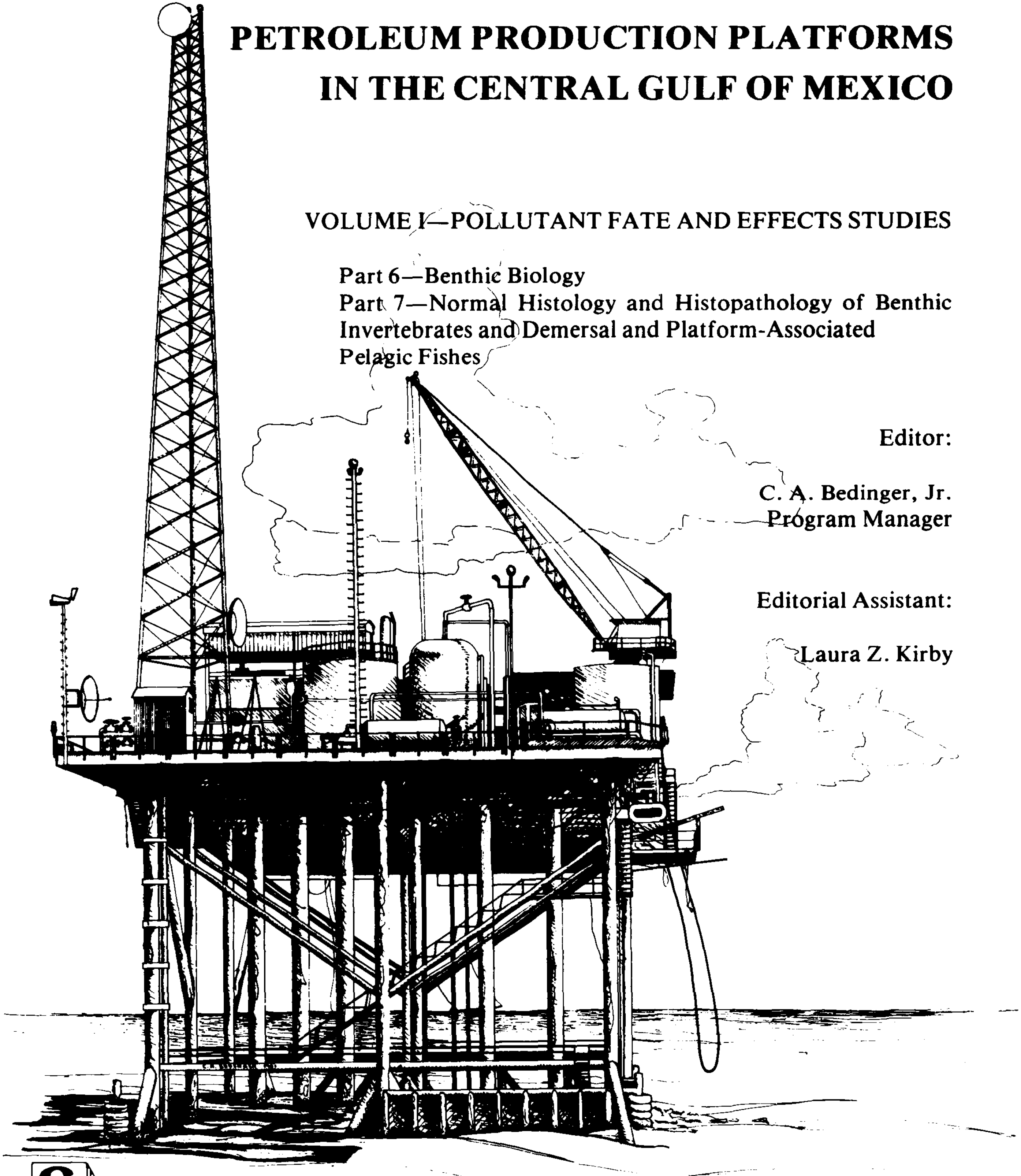
ECOLOGICAL INVESTIGATIONS OF PETROLEUM PRODUCTION PLATFORMS IN THE CENTRAL GULF OF MEXICO



VOLUME I—POLLUTANT FATE AND EFFECTS STUDIES

Part 6—Benthic Biology
Part 7—Normal Histology and Histopathology of Benthic Invertebrates and Demersal and Platform-Associated Pelagic Fishes

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ECOLOGICAL INVESTIGATIONS OF PETROLEUM PRODUCTION PLATFORMS IN THE CENTRAL GULF OF MEXICO

Submitted to:

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SwRI Project 01-5245

In fulfillment of Contract
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VOLUME I—POLLUTANT FATE AND EFFECTS STUDIES
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ABSTRACT

From May, 1978 until January, 1979, the Louisiana continental shelf benthic populations were sampled as part of a large Bureau of Land Management (BLM) Central Gulf of Mexico Petroleum Production Platform Study. A total of 560, 8.0-cm^2 cores for meiofauna, 840, 0.09-m^2 Smith-McIntyre grabs for macroinfauna and 40, 9-m otter trawls for macroepifauna and demersal fish were collected in three separate cruises: Cruise I - May to June, 1978; Cruise II - August to September, 1978; and Cruise III - January, 1979. During each cruise four Primary Platforms and four Control Sites were sampled; during Cruise II, an additional 16 Secondary Platforms were sampled.

A total of 1029 different taxa from 18 phyla were identified: 353 were meiofauna, 576 were macroinfauna, and 284 were macroepifauna and demersal fish; 172 taxa were common to more than one group. Meiofaunal species diversity was higher at the Primary Platforms than at the Controls during Cruises I and II and the reverse was true during Cruise III. Species diversity for macroinfauna and for macroepifauna and demersal fish was higher at the Primary Platforms than at the Control Sites during all cruises. Three meiofaunal Taxa Group Associations consisting of similar species and site preferences over all three cruises were identified and correlated with distance from shore, depth, salinity, dissolved oxygen, temperature, and presence of hypoxic bottom conditions. Four macroinfaunal Taxa Group Associations were identified and correlated with distance from shore, depth, salinity, temperature, percent sand, percent silt, total organic carbon and presence of hypoxic bottom conditions. Only two macroepifaunal and demersal fish Taxa Group Associations were defined; these were correlated with distance from shore, depth, and presence of hypoxic bottom conditions.

The benthic fauna of the Louisiana continental shelf is stressed over much of the area as a result of natural environmental perturbations, namely flooding by the Mississippi River once every 3.6 years and the almost yearly occurrence of a tropical cyclone. It is affected locally by petroleum production activities, as is indicated by sub-lethal chronic levels of hydrocarbons and trace metals.

I. INTRODUCTION

A. Purpose

This BLM Ecological Investigations of Petroleum Production Platforms in the Central Gulf of Mexico was a study of the long-term fate and effects of pollutants associated with or derived from offshore exploration and production. The objective of the Benthic Analysis was to compare benthic communities in the immediate vicinity of platforms with those at control sites, with emphasis on selected indicators. This information is to be used in future monitoring or assessment of the effects of pollutants on benthic organisms (BLM, 1977).

B. Literature Survey

Early biological, chemical, geological, and physical oceanographic investigations done in the Gulf of Mexico have been adequately described by Pequegnat and Chace (1970), Capurro and Reid (1972), and Rezak and Henry (1972). These authors have contributed much to the knowledge of the biological, geological, geophysical, and physical processes in the Gulf of Mexico.

The extensive bibliography of Geyer (1950) provided annotations to references on oceanography, marine biology, geology, geophysics, and meteorology of the Gulf.

Galtsoff (1954) produced the first comprehensive compendium of oceanographic knowledge of the Gulf of Mexico. History, geology, meteorology, physical and chemical oceanography, water pollution, plant and animal communities, and major biological taxa were discussed in detail. In addition, each section provided a fairly complete list of references.

Baker and Beckert (1972) compiled a partial bibliography describing the ecology and biology of the coastal areas of the Gulf of Mexico, with emphasis on the Louisiana coast. Saloman (1975) produced a selected bibliography describing the Florida west coast nearshore environment with references on ecological and coastal engineering and a discussion of the major plant and animal taxa.

Other comprehensive investigations of the Gulf of Mexico were the cooperative estuarine inventories, initiated by the Gulf States Marine Fisheries Commission through its Estuarine Technical Fisheries Commission in cooperation with various state conservation agencies and the National Marine Fisheries Service at St. Petersburg, Florida and Galveston, Texas. As a result of these joint efforts, detailed background information on the coastal and estuarine areas of Florida (McNulty, Lindall, and Sykes, 1972), Mississippi (Christmas, 1973), Alabama (Crance, 1971; Swingle, 1971), Louisiana (Barrett, 1971; Perret, 1971; Perret et al., 1971) and Texas (Diener, 1975) has been published. These inventories present descriptions of area dimensions, vegetation, geology, stream discharge, oyster and clam beds, artificial fishing reefs, human populations, economic development, pollution and dredging in the estuarine and coastal systems of these states.

Another major compendium was that of the State University System of Florida Institute of Oceanography (SUSIO) (Austin, 1970; SUSIO, 1974). It described the physical, chemical, geological, and biological environments, recreational and industrial resources, and environmental quality of the eastern Gulf of Mexico.

C. Previous Work

For over 25 years the petroleum industry has been drilling and producing in the central Gulf off the coast of Louisiana (Sharp and Appan, 1978). Growing energy needs have led to increased activity in this area, with expansion both east and west along the continental shelf of the Gulf of Mexico. Leasing of the outer continental shelf (OCS) areas for oil and gas exploration has led to questions about effects of exploration and production on the marine environment. The following studies are the most important of those which have attempted to assess the effects on benthic organisms and shelf communities.

From 1972 to 1974 the Gulf Universities Research Consortium (GURC) studied the ecological impact of petroleum drilling and production in Timbalier Bay, Louisiana and southward offshore to about 30 m of water (Offshore Ecology Investigation—OEI) (GURC, n.d.; Sharp and Tyson, 1974*a,b*; Sharp and Appan, 1978). Meiofauna, macroinfauna, and demersal fish were included in this investigation (Farrell, 1974*a,b*; Fish et al., 1974; George, 1974; Kritzler, 1974; Ostrom, 1974; Perry, 1974; Thompson, 1974). Then from 1978 to 1979, the logic and rationale employed, the data produced, and conclusions drawn for the GURC OEI were evaluated by several environmentalists not involved in the original study (Bender et al., 1979; Ward, Bender, and Reish, 1979). The individual studies on meiofauna, macroinfauna, and demersal fish were reassessed (Farrell, 1979; Inabinet and Fish, 1979; Kritzler, 1979; Lewis and Fish, 1979; Ostrom, 1979; Thompson, 1979).

From 1976 to 1977 the National Marine Fisheries Service, Southeast Fisheries Center, Galveston, made an environmental assessment of the actively producing Buccaneer oil field and an adjacent unaltered area to identify changes associated with oil and gas exploration and production (Jackson, 1977). Numbers and types of meiobenthic and macrobenthic organisms and demersal fishes and macro-crustaceans were evaluated during this study (Emiliani, Baxter, and Jackson, 1977; Harper, 1977; Jackson, Baxter, and Caillouet, 1978). This study was extended through 1979 (Jackson, 1979; Middleditch, 1981).

As part of the BLM OCS investigations, a benchmark study was initiated in the South Atlantic Georgia Bight (Texas Instruments, Inc., 1979). In addition, two baseline studies were initiated in the Gulf of Mexico; one described the area from the southern tip of Florida around to the Alabama-Mississippi continental shelf (MAFLA OCS Project) (SUSIO, 1975, 1977; Dames and Moore, 1979) and the other described the Texas coast from Port O'Connor to Port Isabel (South Texas OCS Project) (University of Texas Marine Science Institute, 1977, 1979). The present investigation, which describes the fate and effects of petroleum producing platforms in the central Gulf of Mexico off the coast of Louisiana (Central Gulf Platform Study), provides a comprehensive data base for the resource management of the OCS area of the Gulf of Mexico by BLM.

D. Definitions

Marine benthos has been classified and defined on the basis of size, environment occupied by a particular life cycle stage and/or habitat preference of the adult, or a combination of the above (Swedmark, 1964; Fenchel, 1969; McIntyre, 1969; Hulings and Gray, 1971; Schlieper, 1972). Benthos has been divided into macrobenthos, which may be divided into megistobenthos and megabenthos (>2 mm), microbenthos, consisting of mixobenthos and meiobenthos (< 1 mm), nanobenthos (< 0.1 mm), and hypobenthos (< 0.01 mm) (Fenchel, 1969; McIntyre, 1969; Gomoiu, 1971; Schlieper, 1972; Parker, 1975). To minimize confusion, it is necessary to define the terminology used in this report.

1. Meiofauna

This group of organisms has been variously described on the basis of habitat preference or size. The term interstitial fauna was first used by Nicholls (1935) to denote those organisms living in the interstitial waters of sand. Remane (1940) used the term mesopsammon to describe the same group of organisms and Zinn (1968) discussed the current terminology. Mare (1941) first used the term "meiobenthos." Gerlach (1972) states that at present "'microfauna', 'meiofauna', or 'meiobenthos' and 'interstitial fauna' are used as identical terms."

Usually meiofauna are defined on the basis of size as determined by the mesh of the screen used to remove fine grained sediments. Upper size limit may vary from 0.5 mm to 1.0 mm (Hulings and Gray, 1971). Presently, the upper size limit is accepted as 0.5 mm (McIntyre, 1964; Tietjen, 1969, 1971; Coull, 1970; McIntyre and Murison, 1973). The lower limit has been variously defined. While the size category for meiofaunal differentiation has a valid empirical basis, it has little biological meaning (Fenchel, 1969; McIntyre, 1969).

Representatives of the meiofauna may be found in the following taxa: Foraminifera, Ciliata, Coelenterata, Turbellaria, Gnathostomulida, Rhynchocoela, Rotifera, Gastrotricha, Kinorhyncha, Priapulida, Nematoda, Ectoprocta, Brachiopoda, Archiannelida, Polychaeta, Oligochaeta, Mollusca, Mystacocarida, Ostracoda, Copepoda, Amphipoda, Isopoda, Tanaidacea, Cumacea, Palpigradida, Halacaridae, Tardigrada, Echinodermata, and Ascidiacea (Swedmark, 1964; Hulings and Gray, 1971; Gerlach, 1972).

Meiofauna may be further classified as permanent or temporary (McIntyre, 1969; Pequegnat, 1977). Permanent meiofauna includes those species that are numerically more stable and which as adults are small enough to be considered meiofauna. Included as permanent meiofauna are almost all Rotifera, Gastrotricha, Kinorhyncha, Nematoda, Archiannelida, Tardigrada, Harpacticoida, Ostracoda, Mystacocarida, and Halacaridae; many Ciliata and Foraminifera, Turbellaria, and Oligochaeta; some Polychaeta; and a few specialized members of the other taxa listed above (McIntyre, 1969). Temporary meiofauna is a numerically variable group which is composed of benthic macrofaunal juveniles that can be separated on the basis of size (McIntyre, 1969; Pequegnat, 1977).

Pequegnat (1977) states that the Foraminifera were not included in his meiofaunal studies for several reasons, among which is the "difficulty of separating live from dead individuals." Since Foraminifera are often either the most numerous group or second to nematodes, they were included in this study. The problem of identifying live individuals was overcome by proper training of technicians and use of differential stains.

For the purposes of this study, meiofauna were operationally defined as the fauna passed by a 500-μ screen but retained on a 62-μ screen (BLM, 1977). This grouping includes both permanent and temporary elements.

2. Macroinfauna

This group of organisms includes the majority of metazoan phyla. It generally refers to organisms greater than 1.0 mm in length (Ziegelmeier, 1972) and specifically denotes those animals that live within the sediment. Often collected with and included within this group because of the sampling method used are many younger stages of the macroepifauna and demersal fish. As stated above, many of the juvenile stages of the macroinfauna are considered as temporary meiofauna. For this study, macroinfauna refers to those organisms that have a size greater than 0.5 mm (500μ) (BLM, 1977) and actually live within the bottom sediments.

3. Macroepifauna and Demersal Fish

Macroepifauna refers to large invertebrates that live primarily upon the surface of the bottom and are collected in dredges or trawls. Most of the juvenile stages are collected with the macroinfauna group in cores and grabs or may form part of the facultative zooplankton. This group includes some bivalves, gastropods, and cephalopods; some polychaetes (may be found associated with clumps of shell and other debris); most decapods and stomatopods; some asteroides, echinoids, ophiuroids; and other miscellaneous taxa that are accidentally caught.

Demersal fish are those fish species that live and/or feed on the bottom. Some of these species may be caught in grabs because they live in burrows and attempt to escape by retreating into the sediment. However, most demersal fish are collected by trawl or dredge. Some of the larger forms may escape the sampling device and go undetected. In this study, the macroepifauna and demersal fish include those invertebrates and vertebrates that were caught with the 9-m (30-ft) otter trawl.

E. Project Organization

Benthic Analysis, Work Group X, was under the direct supervision of Dr. James H. Baker. Assisting him were Mr. W. David Jobe, Research Scientist; Mrs. Jana B. Janousek, Research Scientist; Ms. Cynthia L. Howard, Senior Technician; and Ms. Patricia R. Chase, Senior Technician. In addition there were a maximum of eight technicians engaged in the project at any one time (Fig. 1).

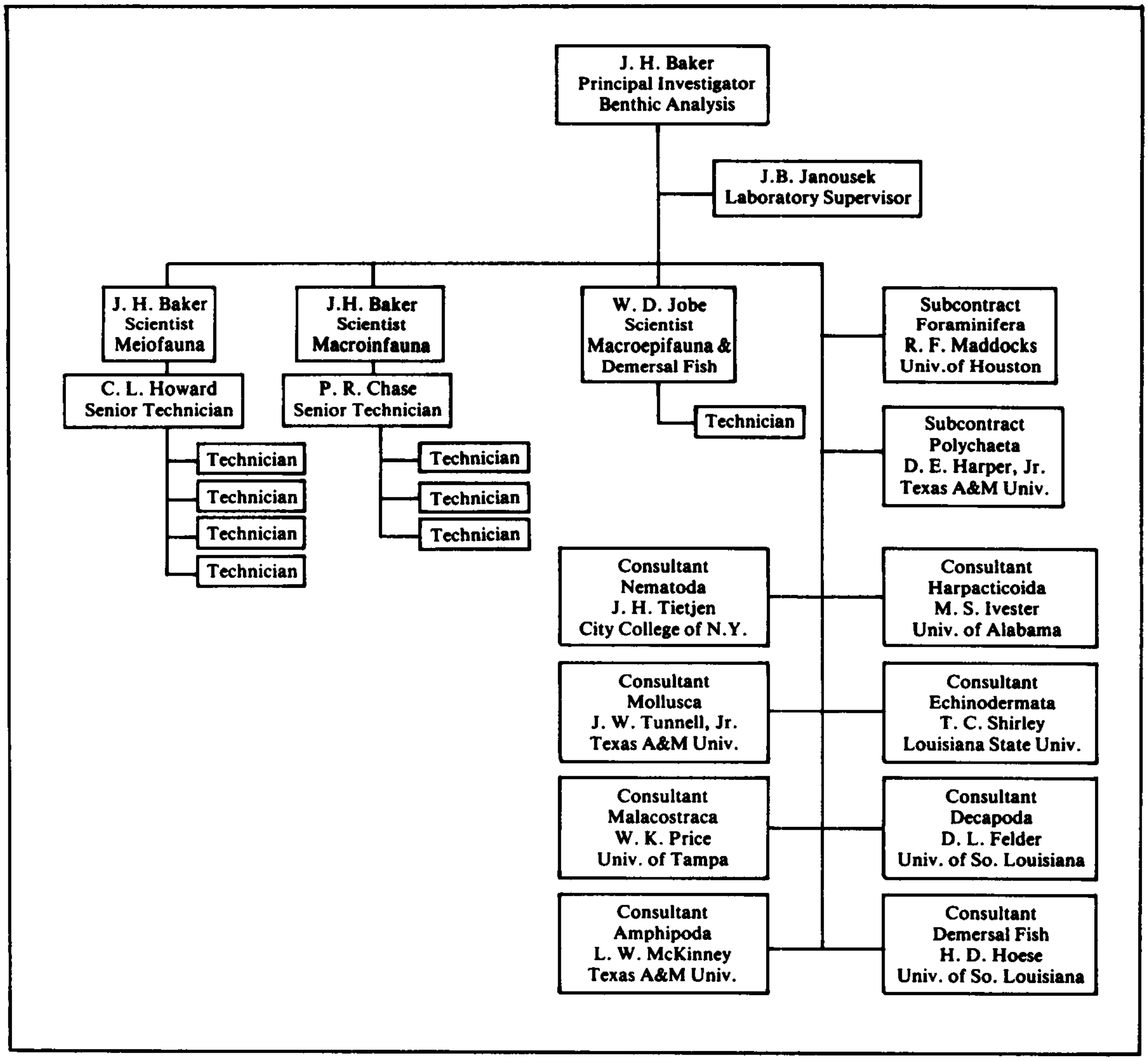
Outside subcontractors and consultants contracted at the beginning of the investigation were as follows:

Foraminifera—Dr. Rosalie F. Maddocks, University of Houston;
Polychaeta—Dr. Donald E. Harper, Texas A&M University (TAMU);
Nematoda—John H. Tietjen, City College of New York;
Mollusca—Dr. John W. Tunnell, Jr., Corpus Christi State University;
Malacostraca—Dr. Wayne Price, University of Tampa;

- Harpacticoida—Dr. M. Susan Ivester, University of Alabama;
- Amphipoda—Dr. Larry D. McKinney, TAMU:
- Decapoda (Crustacea)—Dr. Darryl L. Felder, University of Southwestern Louisiana (USL);
- Echinodermata—Mr. Thomas C. Shirley, Louisiana State University (LSU);
- Pisces—Dr. H. Dickson Hoese, USL.

As need arose, the following consultants were contacted for species verification as indicated:

- Kinorhyncha—Dr. Robert P. Higgins, U.S. National Museum of Natural History;
- Oligochaeta—Dr. Michael S. Loden, LSU;
- Ectoprocta—Mr. Arthur J. J. Leuterman, TAMU.


J. H. Baker
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Meiofauna
J.H. Baker
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Demersal Fish
Subcontract
Foraminifera
R. F. Maddocks
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C. L. Howard
Senior Technician
P. R. Chase
Senior Technician
Technician
Subcontract
Polychaeta
D. E. Harper, Jr.
Texas A&M Univ.
Technician
Technician
Technician
Technician
Technician
Technician
Technician
Consultant
Nematoda
J. H. Tietjen
City College of N.Y.
Consultant
Harpacticoida
M. S. Ivester
Univ. of Alabama
Consultant
Mollusca
J. W. Tunnell, Jr.
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Consultant
Echinodermata
T. C. Shirley
Louisiana State Univ.
Consultant
Malacostraca
W. K. Price
Univ. of Tampa
Consultant
Decapoda
D. L. Felder
Univ. of So. Louisiana
Consultant
Amphipoda
L. W. McKinney
Texas A&M Univ.
Consultant
Demersal Fish
H. D. Hoese
Univ. of So. Louisiana

FIG. 1. Organization chart for Work Group X: Benthic Analysis

II. METHODS AND MATERIALS

A. Field Sampling

1. Study Area and Sampling Cruises

Samples for this program were collected at 20 platforms and four control sites located on the Louisiana OCS. These sites are contained in a roughly rectangular area lying west of the Mississippi Delta and extending from 5 km (3 miles) to 120 km (75 miles) offshore and about 320 km (200 miles) west (Fig. 2).

Meiofauna, macroinfauna, macroepifauna and demersal fish were collected during three sampling cruises: Cruise I—May 20 to June 2, 1978; Cruise II-A—August 21 to September 5, II-B—August 21 to September 6, II-C—September 17 to 24; and Cruise III—January 6 to 15, 1979.

Four Primary Platforms (hereafter denoted as Primary Sites P1-P4) and four Control Sites (C21-C24) were sampled during each cruise. During Cruise II, an additional 16 Secondary Platforms (hereafter denoted as Secondary Sites S5-S20) were sampled. Four transects, one along each compass heading, were established at each Primary Site, a north transect was established at each Secondary Site, and a single sampling station was established at each Control Site. Meiofauna and macroinfauna were collected at distances of 500 and 2000 m from the platform along each transect and at each Control Site during each cruise. Macroepifauna and demersal fish were trawled beginning at the N500 station (station located along the north transect 500 m from the Primary or Secondary Site) at each Primary and Secondary Site and at each Control Site during each cruise.

2. Sediment Sampling

a. Smith-McIntyre Grab

In this project the sampling device used to collect sediments for meiofauna and macroinfauna was a Kahlsico (No. 214WA250) stainless steel, modified Smith-McIntyre grab (Fig. 3). The grab weighed approximately 87 kg and sampled an area of approximately 908.2 cm^2 (or 0.09 m^2) to a depth of between 9 and 16 cm. Depth of penetration varied with sediment type. Sediments in the area consisted of both sands and muds and varying combinations of the two sediment types.

The grab was mounted on a sturdy, stainless steel frame, 75 cm square and 65 cm high, complete with two removable 9-kg lead weights. It was suspended from the lowering wire and had springs to force the two-jaw bucket into the ocean bottom when released, achieving deeper penetration. Two tripping pads, positioned below the square-based frame on which the bucket was suspended, made contact with the bottom first and pushed upward to release two latches holding the spring-loaded bucket jaws. A free-fall from about 2 m above the ocean floor was generally sufficient to allow sampling of even compacted bottoms. After the bucket had been driven into the sediment, raising of the wire exerted tension on cables connected to the end of each bucket jaw arm. Increased pull on the wire caused the jaws to pivot tightly shut. Externally mounted side- and bottom-plates on the jaws pushed stones, gravel, etc., away to prevent jamming.

A removable frame, fitted with a 2.5-mm aperture brass screen, was attached at the top of each jaw. During the lowering operation, rubber flaps fastened to the screen frames lifted to allow water to flow freely through the screens and minimize the shock wave which would have disturbed the surface layers of the sediment. The rubber flaps dropped to completely cover the brass screens during the retrieval operation and prevented entrance of water which could have washed out trapped material. During Cruise III these rubber flaps had to be repaired several times.

A 1-m long stainless steel cocking bar was furnished to provide easy cocking of the strong bucket springs. When released, the springs exerted a force in excess of 35 kg to insure good penetration of the open-mouthed bucket into hard sediments. As part of the sampling procedure, safety pull-pins were used to prevent any premature or accidental release of the cocked assembly.

Prior to Cruise I the Smith-McIntyre grab was thoroughly washed with detergent and rinsed with seawater. The grab was cleaned during descent between successive bites to remove contaminants obtained from shipboard operations. To rinse excess mud from the grab while on the ship's deck, seawater pumped from below the surface was used. In this manner the degree of contamination from any shipboard activities was minimized. It was understood that, because of the length of time oil exploration has been going on in the area, once the grab entered the water it may have become contaminated. Thus, a rinse using the water from the sampling area should not have affected the results.

Major problems encountered with bottom samplers are as follows (Longhurst, 1959; Holme, 1964; Flannagan, 1970; Holme and McIntyre, 1971; Baker, Kimball, and Bedinger, 1977):

- Failure to penetrate uniformly in all sediment types—deeper penetration as sediments become finer
- Inconsistent and/or unsatisfactory bite profile—bite will vary with sediment type and sampler
- In soft sediments, loss of material from overflow as the sampler is raised to the surface, a problem caused by incomplete closure of jaws
- Build-up of a pressure wave as sampler is lowered, disturbing the surface and the attendant organisms.

The Smith-McIntyre grab was originally designed to obtain samples of consistent volume from different bottom sediment types and sample satisfactorily under varying weather conditions (Smith and McIntyre, 1954). A major flaw in the design, recognized by Smith and McIntyre, was that the grab was heavy and difficult to handle in any but calm weather.

Numerous studies have compared the Smith-McIntyre grab and other bottom sampling devices (Beeton, Carr, and Hiltunen, 1965; Gallardo, 1965; Powers and Robertson, 1967; Smith and Howard, 1972;

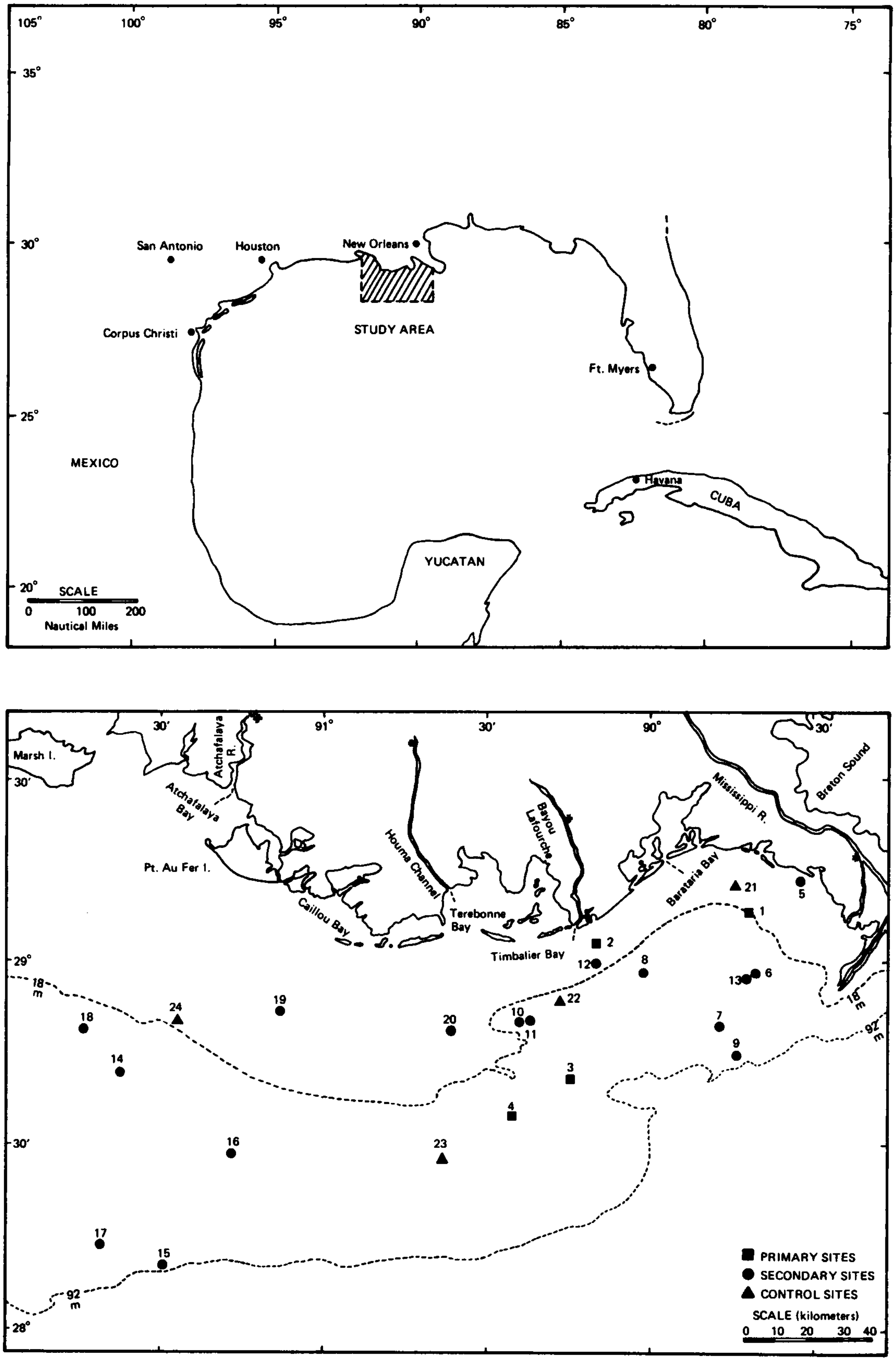
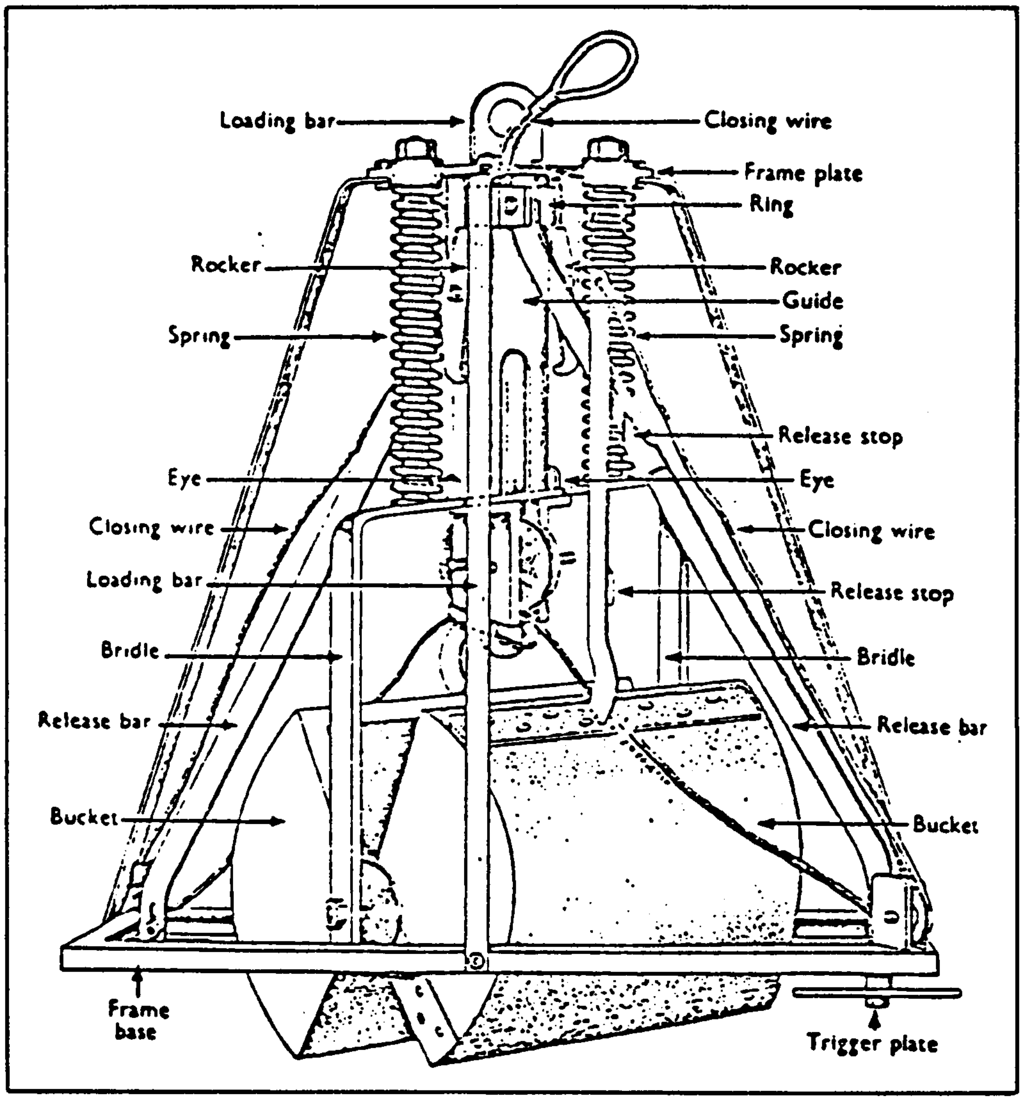

105°
100°
95°
90°
85°
80°
75°
35°
30°
25°
20°
San Antonio
Houston
New Orleans
Corpus Christi
STUDY AREA
Ft. Myers
MEXICO
Havana
CUBA
YUCATAN
SCALE
0 100 200
Nautical Miles
30'
91°
30'
90°
30'
Marsh I.
Atchafalaya R.
Atchafalaya Bay
Pt. Au Fer I.
Caillou Bay
Houma Channel
Terrebonne Bay
Bayou Lafourche
Timbalier Bay
Barataria Bay
Mississippi R.
Breton Sound
29°
28°
18 m
92 m
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24
■ PRIMARY SITES
● SECONDARY SITES
▲ CONTROL SITES
SCALE (kilometers)
0 10 20 30 40

FIG. 2. Maps of the study area—(Top) Location of study area; (Bottom) Study area showing sampling sites.



Loading bar
Closing wire
Frame plate
Ring
Rocker
Rocker
Guide
Spring
Spring
Release stop
Eye
Eye
Closing wire
Closing wire
Loading bar
Release stop
Bridle
Bridle
Release bar
Release bar
Bucket
Bucket
Frame base
Trigger plate

FIG. 3. Diagram of Smith-McIntyre Grab in unloaded position illustrating the component parts (Reproduced from Smith and McIntyre, 1954)

Dickinson and Carey, 1975; Word, Kauwling, and Mearns, 1976; Tyler and Shackley, 1978). The Smith-McIntyre grab was found to be comparable to the other samplers, but was not rated as the best. Word et al. (1976) stated that the Smith-McIntyre was acceptable or marginally acceptable after comparison with a modified Reineck Box Corer, two Van Veens, a Shipek, a Ponar, and an Orange Peel sampler.

Smith and Howard (1972) found the Smith-McIntyre to have an average penetration of 12 cm, with a resultant volume of 7,200 cm^3. Gallardo (1965) found that the bite of the Smith-McIntyre grab was highly affected by the substratum consistency and its bite profile was not a reflection of its closing mechanism. The grab dug deeper in the middle of the area sampled in soft sediments and cut less deeply but more rectangularly in firmer sediments. Any fluctuation in the depth of grab penetration affects the quantity of infauna obtained (Christie, 1975).

Special design of the Smith-McIntyre grab by Kahlsico, i.e., use of externally mounted side- and bottom-plates on the jaws, minimized the possibility of material being lost from overflow when used in any type of sediment. A brass screen fitted with a rubber flap and attached to the top of each jaw reduced the pressure wave and helped to prevent overflow.

The Smith-McIntyre grab used in this study was also used by the University of Texas Marine Science Institute during the South Texas OCS Project. However, a box-corer was used in the MAFLA OCS Project. The Smith-McIntyre grab was chosen, after consultation with BLM representatives, because it was used on the South Texas OCS Project and would therefore provide comparable samples. Cored subsamples could consistently be taken to sufficient depths to be acceptable or marginally acceptable by Word et al. (1976). Any comparisons between the Central Gulf Platform Study and MAFLA OCS Project must consider that different sampling devices were used.

b. *Coring Device*

For meiofaunal analysis five cores were collected from the first four grabs using a core tube of Lexan® 3.2 cm in diameter and 15 cm long. Bureau of Land Management (1977) had specified a core tube with an inside diameter (i.d.) of 3.81 cm, which equals an area of 11.40 cm^2. However, only core tubes with an i.d. of 3.2 cm, providing an area of 8.0 cm^2, were available. Since no sample size was specified by BLM, and four of the five cores collected were to be used for data analysis, the difference in area was not considered a problem. A line was etched on the core tube at a depth of 5 cm so that an exact amount of sediment would be extracted.

In this study a coring device, rather than a scoop or other subsampler, was used since it provides for accurate quantitative samples (Longhurst, 1959; Brinkhurst, Chua, and Batoosingh, 1969; Holme and McIntyre, 1971; Baker et al., 1977; Downing, 1979). The coring device samples a constant surface area and constant volume and supplies an exact profile of the sedimentary column being sampled.

The core tube was easily introduced into the sediment and removed by a slight tilting of the tube. Then the core was extracted. Generally the core of sediment fell by force of gravity from the tube to the collecting jar. In hard compact sediments the core was extracted using a plexiglass plunger. The cores provided accurate subsamples of the grab from which they were removed.

3. *Trawl Sampling*

Trawl samples were obtained using a 9-m (30-ft) otter trawl of 2.5-cm stretched mesh. Trawl boards fitted with a "shoe," i.e., a steel strip running along the leading and bottom edge, measured 0.61 m (height) by 1.22 m (length). These boards, shackled to a 27.4-m bridle and towed by a 9.5-mm steel cable kept the trawl mouth open.

Two complete sets of the sampling gear, in working order, along with additional nets were available on shipboard in case of loss or malfunction. The trawl nets were not coated with tar or plastic but built of virgin nylon, thoroughly washed, and packed in boxes of newly planed wood before the cruise began. The nets were stored in a wooden container when not in use. These precautions were taken to avoid contamination of specimens collected for chemical analyses.

The cod end of the trawl net was tied and the net placed in the water as the vessel approached the station location. By carefully metering out the bridles, the doors were encouraged to spread on the surface. Proper configuration of the rig was assured before the cable was let out. The "scope ratio" (ratio of cable plus bridle length to water depth) was maintained at 4:1 or 5:1 where possible. The net was then towed for a period of 15 min at a constant speed of approximately 2 knots from the time the trawl winch was locked until commencement of "hauling in."

Extrinsic factors such as construction of the gear and the method of operation, intrinsic factors such as behavioral differences among or within species according to sex, size, time and season, and the interaction of these factors all affect the selectivity of a trawl (Pope, 1975). Ability of the trawl to catch and retain demersal organisms depends somewhat on the size of the individual animal. Whether or not a fish is held or can escape through the mesh depends on its dimensions in relation to the opening of the mesh. Large fish or invertebrates may swim faster, or be more wary, so are likely to move out of the path of an oncoming trawl (Pope, 1975). A trawl mesh size of 2.5 cm ensured the retention of most of the young stages and adults of nearly all encountered macroepifauna and demersal fish.

Considering unknown bottom obstructions and a less than ideal trawl configuration, it is difficult to accurately estimate the surface area sampled by the trawl. The trawl was towed for a period of 15 min at an approximate speed of 2 knots. Assuming a constant speed and perfect trawl configuration, a surface area of approximately 4250 m^2 was sampled by the trawl.

There is inherent selectivity in trawling and efficiencies of capturing and retaining animals are very low, probably on the order of 10 to 15% (Mearns and Allen, 1978). By standardizing procedures, i.e., towing speeds and towing times, within the study and maintaining continuity, as much as possible, with similar studies in the Gulf of Mexico, the results are qualitatively comparable and add much to the total ecological description of the coastal macroepifauna and demersal fish (Mackett, 1973).

4. *Quality Control*

For accurate quantitative data to be obtained, it is extremely important that a high degree of quality control be maintained for each sample collected. Experience has shown that the chances of success are improved if, as far as possible, everyone associated with the sampling effort understands the objectives and purposes of the project and how their work fits into the overall plan (Mackett, 1973). Prior to each cruise a briefing was held for the entire scientific party. To prevent serious errors from being made, experienced personnel reviewed routine sampling procedures.Sample quality decreases as the number of sampling personnel increases, as the number of samples increases, and as length of sampling time increases. In this project an added factor was rough weather, which can greatly affect sample quality.

Undisturbed grab samples were evidenced by a 1- to 2-cm layer of light brown sediment on the surface with evident worm tubes and an occasional decapod or asteroid visible on the surface. A similar phenomenon was also observed by Cullen (1973). If the layer was not present or only partially present, either the shock wave produced by the grab was large or the grab failed to land squarely on the bottom. Both of these problems could have been caused by lowering the grab too fast and/or rough seas which would hinder operator control of lowering speed. Tripping of the Smith-McIntyre did not require hitting the bottom with any great force, and, therefore, would not have caused undue disturbance.

The winch operators, after gaining a little experience, usually lowered the grab at a satisfactory speed. Most of the problems were caused by the rough seas. Though not much of a problem during Cruise I or Cruise II-A, rough seas were a factor for the remainder of the sampling and grab surfaces were generally disturbed.

Since most of the benthos live in the upper few centimeters of sediment, disturbance of the grab surface affects species diversity of the meiofaunal and macroinfaunal samples. Because it was impossible to obtain undisturbed samples during rough weather, it is impossible to quantify the degree of disturbance. However, the degree of variability among stations and among samples helped to assess this distrubance which will be discussed below under the section on Sample Representativeness. Regardless of disturbance, meiofauna cores were taken in a somewhat random fashion. Therefore, there should have been a mixture of cores collected from disturbed to non-disturbed sediments.

Another source of error was the ship's relocation at each sampling station. Changes in location from cruise to cruise would have resulted in samples being taken from different habitats. To ensure precise relocation, various navigational instruments were used. During Cruise I, Decca Hi-Fix® was utilized; for Cruises II and III, dual ranging radar and preplotted distances from known structures were used with a high degree of accuracy. Decca Hi-Fix® is a very accurate navigational device. However, Eagle (1975) stated that even using Decca it was frequently not possible to reposition exactly on the same site. All effort was made to return to the same station location as established during Cruise I. However, some variation did occur because of high wind and waves. Sediment texture analysis indicated some sediment variability at certain stations.

B. Shipboard Processing

1. Meiofauna

A total of 560 cores for meiofauna were collected in this study. Five cores were collected from the first four grabs taken at a site: two cores from the first grab (Cores 1.A and 1.B) and one from each of the next three grabs (Cores 2.C, 3.D, and 4.E). Core 1.A was immediately preserved in 5% buffered formalin and Cores 1.B through 4.E were anesthetized with 6% $MgCl_2$ for 10 minutes, then preserved with 5% buffered formalin. Core 1.A was a check on the anesthetization process. Cores 1.A to 3.D were to be taxonomically enumerated and Core 4.E was to be archived. It had been planned that Cores 1.A to 3.D would be washed on shipboard by a special device designed by Howard (*in preparation*). However, there was too much contamination for the use of the No. 230 (62μ) mesh screen because the ship's pumps were not filtering all the organisms out of the seawater. As a result, meiofaunal cores were preserved on shipboard and then washed at the Houston Southwest Research Institute (SRI) laboratories. This delay in sample washing followed by subsequent sediment movement because of shipboard vibrations did not appear to cause mechanical damage to the soft-bodied meiofauna. During Cruise I, a 1:1 mixture of Eosin B and Biebrich Scarlet in a 1:1000 concentration was added to each of the containers (Williams, 1974). Staining on shipboard was found to be time consuming and unnecessary, and thereafter staining was performed in the laboratory. Samples were labeled both inside and outside and inventoried prior to transport to the laboratory.

2. Macroinfauna

A total of 840 grabs for macroinfauna were collected during the study. Grabs 5 through 10 (i.e., six grabs per station) were utilized for macroinfaunal analysis. A sub-core (5 cm in diameter by 5 cm deep or 10.6 cm^2) was removed from each grab for sediment textural analyses. After the subsample was taken, each grab was transferred to a 5-gal plastic bucket, labeled, and held until the sample could be washed (waiting time was for as long as 5 hrs during Cruise I). All effort was made to minimize loss of sediment during transfer.

Since a number of large volume samples were taken during each cruise and animals were to be narcotized before preservation, it was necessary to remove the organisms soon after the samples were collected. There are many possible sieving methods for shipboard use Holme, 1964; Shealy and Boothe, 1975). Because of the large number of samples being collected at one time and the restriction on available manpower, an elutriation apparatus was designed. Holme (1964), Pedrick (1974), Worswick and Barbour (1974), and Koosman and Newburg (1977) describe elutriation devices specifically designed for macroinfauna.

The system designed for this project consisted of six 19-ℓ galvanized steel funnels, each fitted with a 15-cm wide spout on one side and with a water hose connection at the apex. A diagram of the system is presented in Fig. 4. Six funnels were used since that was the number of grabs for macroinfaunal analysis collected from each station at one time. One person was able to process one set of samples from a station in an average of 1 hr or less.

Each funnel was connected by a system of 1.27-cm water hose lines to the ship's fire pump. Over 80 lbs of water pressure was used to provide the optimum amount of water circulation. Water flow adjustors were provided at the point of water entry into the funnel to prevent excessive pressure or uncontrolled overflow.

Before the sample was placed in the funnel, the water system was turned on and filtered sea water filled the funnel. When the sample was emptied into the funnel, water carried fine sediment and organisms over the spout into a No. 35 (500)mesh screen mounted next to the funnel. Agitation by hand helped to break up the sediment but did not cause any undue damage to the organisms. Both funnels and screens were set in 1.27-cm plywood, supported at just below waist level by a wooden framework.

After about 0.50 to 0.75 hr, depending upon the sediment type, washing was usually complete as indicated by clearing of the wash water. Organisms on the screen were then placed in appropriately sized plastic jars for narcotization. Residue in the funnel was then placed on a No. 35 mesh screen to remove the remaining sand and any fine sediments remaining as clumps. Depending upon the amount remaining, the residue was either combined with the organisms or placed in a separate container.

During Cruise I, several problems were encountered which were subsequently overcome. Because the water that was used for washing came from directly below the surface of the Gulf and did not pass through a holding tank, planktonic organisms were caught on the screen. Filters were used at strategic points to minimize the contamination. However, the filters were readily clogged, which slowed the washing process considerably. After the first cruise, no filters were used and all planktonic organisms sorted from the samples were not identified or counted. Obligate zooplankton organisms were thus excluded from the results. However, all zooplankton specimens were kept and deposited in the U.S. National Museum.

During moderately rough seas in Cruise I, there was a problem of overflow from the funnels sloshing

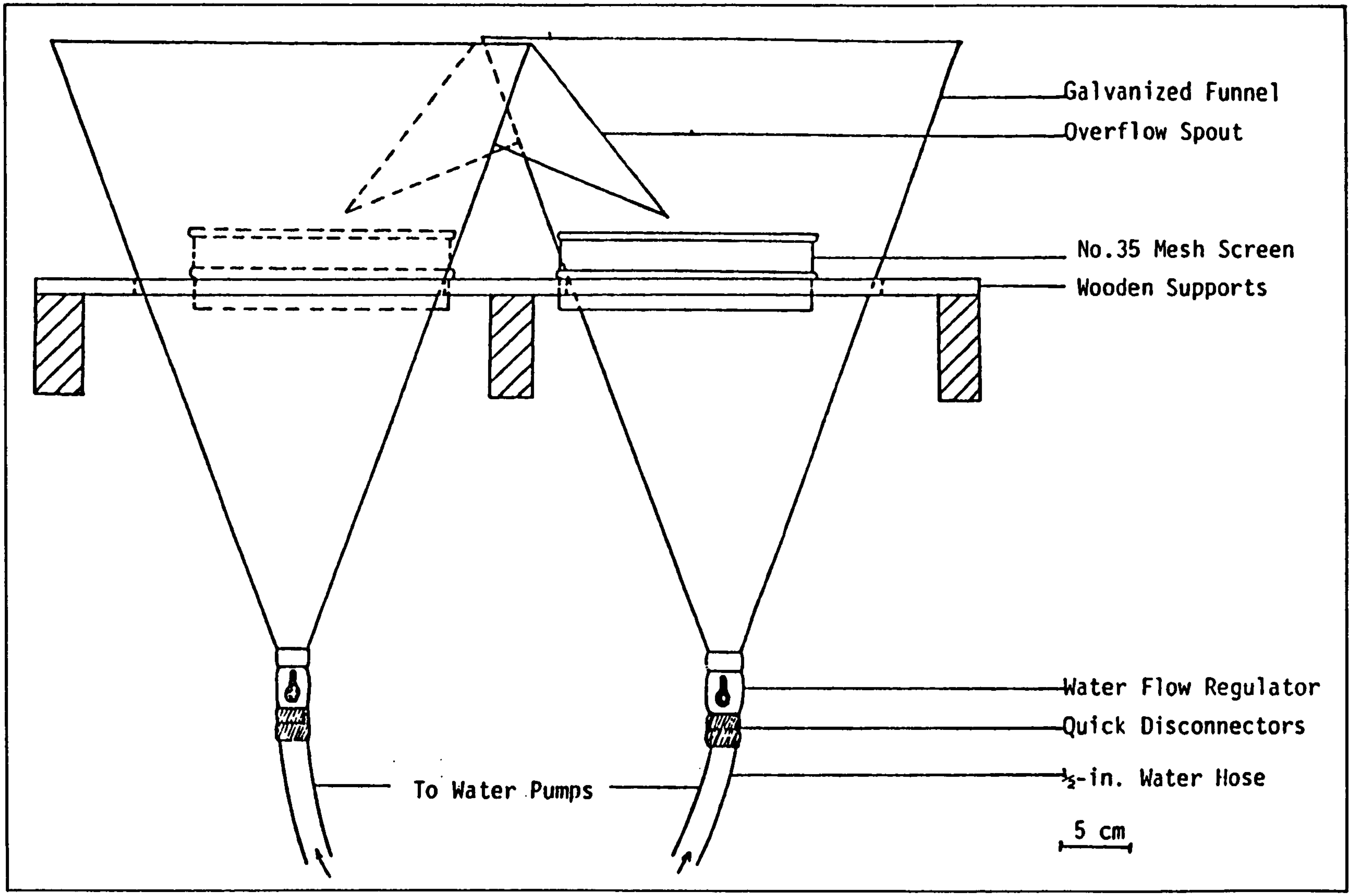

Galvanized Funnel
Overflow Spout
No.35 Mesh Screen
Wooden Supports
Water Flow Regulator
Quick Disconnectors
½-in. Water Hose
To Water Pumps
5 cm

FIG. 4. Diagrammatic representation of a portion of the macroinfauna washing apparatus

out of the screens with subsequent loss of organisms. Closely related to this problem was clogging of the screens with sediment caused by sediment being introduced too fast. The result was overflow of the screens and again loss of organisms. To minimize the loss of sediment and organisms, the mount supporting the funnels and screens was gimbaled to maintain a good horizontal position, except in extremely rough seas. The edges of the screens were also built up to retain all entering material. Previous experience also enabled the person washing the samples to anticipate these accidents and immediately remedy the situation.

During Cruise I, the person washing mud was exceedingly taxed to keep up with sample collection. Often samples would remain unwashed for as much as 5 hrs after collection. However, no ill effects on the samples could be detected. Dean, Rankin, and Hoffman (1964) found live polychaetes and amphipods in closed sediment samples two months after collection. On subsequent cruises problems caused by unwashed samples remaining in the sun for such a long time were prevented by utilizing two people on each watch for mud washing. Eliminating the filters enabled maintenance of a steady water pressure, thus reducing washing time by more than half. As a result, the mud washers were generally ready to wash each group of samples as soon as they were collected.

Material collected on the screen and remaining in the funnel was narcotized for 0.5 hr with 15% $MgSO_4$ in seawater, then preserved in 5% borax-buffered formalin, and stained with a 1:1 mixture of Eosin B and Biebrich Scarlet. The final mixture contained 5 to 10% stain. After Cruise I, staining was done in the laboratory and not on shipboard, and funnel and screen residues were no longer preserved separately. Each sample container was labeled both inside and outside and inventoried prior to transport to the laboratory.

3. Macroepifauna and Demersal Fish

A total of 40 taxonomic trawls were collected for macroepifauna and demersal fish during this study. During Cruise I only, organisms collected in trawls for chemical analysis were saved to complete the species diversity of the study area. At the end of the 15 min trawling period, the net was retrieved and contents transferred to 122 cm (width) by 193 cm (length) by 30 cm (depth) stainless steel dump trays. Each tray was washed with detergent and hexane before use and rinsed with seawater between trawls.

Samples were stored in appropriately sized containers and preserved in 10% borax-buffered formalin. Large fish were slit along the lower right side of the abdominal cavity to ensure preservation of the viscera. Samples were labeled and inventoried according to established practices.

In order to satisfy the requirements for trace metal, hydrocarbon, and histopathological analyses, it was necessary to remove individuals of particular species from the taxonomy trawls during Cruise I and from a few trawls in Cruise II. Organisms removed were identified and measured to the nearest 1 mm. Standard length was taken for fish, carapace width of portunid crabs was measured between the tips of the lateral spines, the carapace and abdomen length were measured for pagurid crabs, total length (tip of rostrum to distal end of telson) for shrimp, and length of the shell for bivalves. During Cruise I, no balance was available onboard ship; therefore, it was necessary at a later date to extrapolate biomass values for the specimens. During Cruise II, weights for specimens removed for chemical and histopathological analyses were obtained using a spring balance. However, obtaining precise weight measurements on shipboard was difficult because of the ship's movements. The individuals removed, and their weights if possible, were included in the taxonomy trawl data for Cruise II.

C. Laboratory Methodology

1. Meiofauna

Upon arrival in the laboratory, all samples were inventoried and the inventory sheet returned to Data Management within one week. Core 4.E from Grab 4 was archived and all other cores were then washed.

a. Sample Washing

Various flotation and elutriation procedures have been devised to separate the meiofauna from the encompassing debris and sediments (Birkett, 1958; Anderson, 1959; Hulings and Gray, 1971; Kingsbury and Beveridge, 1977; Nichols, 1979). The washing device used in this project consisted primarily of the main funnel of a Busch Reactor (Howard, *in preparation*). Figure 5 presents a diagram of the washing assembly. The core sample was washed into the reactor where it was subjected to a continuous flow of water introduced from the side and air from the bottom. The agitation separated fine sediments and soft-bodied and shelled organisms and lifted them upward where they overflowed into a smaller funnel placed within the first. Constant regulated flow of both air and water through the apparatus for about 0.5 hr ensured that the sample was completely washed. The inside funnel carried the organisms over a set of two screens, No. 35 (500-μ mesh) and No. 230 (62-μ mesh). Elutriated material collected on the No. 230 screen was preserved in 5% buffered formalin, stained with a 1:1 mixture of Eosin Band Biebrich Scarlet, and used for the study. The final mixture contained 5 to 10% stain. That collected on the No. 35 screen was preserved in 5% buffered formalin and kept for possible future use. Preliminary data obtained at the beginning of the project indicated that over 95% of the soft-bodied organisms and 90 to 95% of shelled organisms were collected when washing was complete. These positive results prompted use of the system throughout the project.

The number of organisms found in the elutriated portions of the samples was compared with the number of animals remaining in the substrate using 50 Cruise I and Cruise II samples chosen at random. The comparison indicated that greater than 95% of the Foraminifera and 95 to 98% of the soft-bodied meiofauna were recovered in the elutriation procedure (Table 1). The overall recovery rate for the total number of individuals in all taxa was 96%. Using Kendall's Coefficient of Concordance W (Siegel, 1956), at the 95% confidence level, the meiofauna washing apparatus separated both hard and soft-bodied animals from seven different sediment types with the same efficiency, i.e., the numbers of individuals recovered in each of several taxa were not significantly different over seven sediment

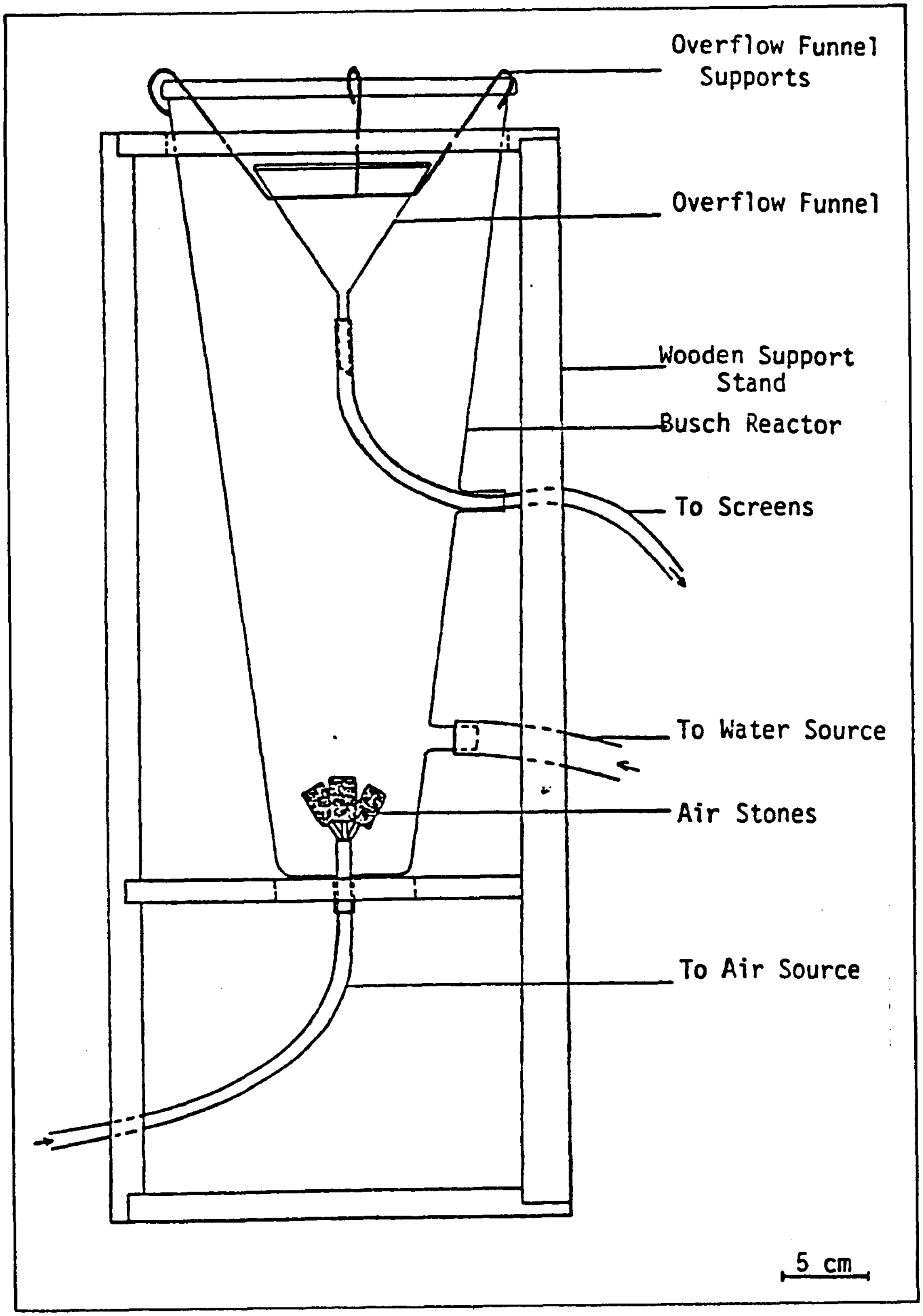

Overflow Funnel Supports
Overflow Funnel
Wooden Support Stand
Busch Reactor
To Screens
To Water Source
Air Stones
To Air Source
5 cm

FIG 5. Diagrammatic representation of the meiofauna washing apparatus (from Howard, *in preparation*)

TABLE 1. Percentage of organisms recovered after elutriation of sediments from 50 samples (from Howard, *in preparation*).

Taxa	Sediment Type (No. of Samples)[1] Sand (5)	Silty Sand (7)	Silty Clayey Sand (6)	Silt (3)	Sandy Silt (10)	Sandy Clayey Silt (9)	Clayey Silt (10)	Total Organisms Remaining in Substrate	Recovery
Foraminifera	94.9	93.2	98.2	97.8	99.6	87.7	99.4	95.5	95.5
Protozoa[2]	100.0	98.8	99.4	97.7	98.3	98.0	100.0	98.5	98.4
Kinorhyncha	100.0	97.7	93.8	92.3	100.0	97.2	100.0	97.0	97.0
Nematoda	99.5	97.9	997.1	98.0	97.0	95.2	97.3	97.1	97.1
Harpacticoida	50.0[4]	97.6	100.0	100.0	100.0	99.3	100.0	95.3	95.3
Other organisms[3]	93.4	97.9	99.0	100.0	100.0	98.0	98.1		98.0

[1] Only sediment types with enough data for statistical analysis were included.

[2] Includes all Protozoa except Foraminifera.

[3] Includes taxa encountered less frequently: Hydrozoa, Turbellaria, Rhynchocoela, Polychaeta, Mollusca, Acarina, Ostracoda, and Amphipoda.

[4] This unusually low rate of recovery was the result of one sample in which 16 of the 17 Harpacticoida were not recovered.

types (P = 0.19). Advantages of this meiofauna washing device are as follows:

- Effective overall separation of greater than 95% of the meiofauna from the sediment
- A sample containing only the meiofauna and small amounts of fine sediment and organic debris, thus reducing the difficulty and time involved in fine sorting under the microscope.

b. Sample Splitting

At the beginning of this project, sorting time for each meiofauna core averaged 3 to 4 days. Consequently, this method was not cost effective. It was felt that sufficient information could be obtained by subsampling the cores, which would also lead to a more efficient utilization of sorter time (Longhurst, 1959; Sokal and Rohlf, 1969; Venrick, 1971). The Folsom plankton splitter was used to subsample cores in this project because this system was readily available and has a longstanding record of use and statistical validity (McEwen, Johnson, and Folsom, 1954; Longhurst and Seibert, 1967). The elutriated portion of each sample that was collected by the No. 230 screen was split into four equal parts. Two potential problems were clumping of the organisms (causing nonrandom distribution) and variation in mixing due to operator's judgement as to when the sample was well mixed and ready to split. Considerable care by the operator minimized the latter problem.

To test the statistical accuracy of the split subsamples used for this study, 75 randomly chosen samples were split; two one-fourth subsamples from each were sorted and all organisms identified and counted. Using the 75 pairs of subsamples as replicate pairs, the Wilcoxon's signed-ranks test was used to test the two subsamples for differences in the number of individuals collected in each of five major taxa. Total count of individuals in the paired subsamples was also tested. With a significance level of 0.05, no significant differences between the two subsamples were found either in numbers of individuals counted in each of the major taxa or in number of individuals counted in each subsample. Table 2 shows the taxa tested, the critical value and probability level for each test, and the sample size for each test. Based on the fact that nonrandom mixing and splitting would have resulted in unequal numbers of individuals in split sections, the statistical test indicated that the Folsom splitter was accurately subsampling these cores.

c. Sample Sorting and Taxonomic Identification

Sorting of each sample was accomplished using a Ward zooplankton wheel and Wild M5 binocular microscope. Only anterior portions and whole organisms were counted (Woodin, 1974). Each specimen was identified to the lowest possible taxon. All precaution was taken to not crush or destroy the individuals as they were removed. As a minimum, one-fourth of each sample was sorted by technicians. If the number of Foraminifera or Nematoda counted was not equal to or greater than 100, then either another one-fourth or the remainder of the sample was sorted.

Examination of the procedures for meiofaunal analyses used in the BLM South Texas Project (Pequegnat, 1977) indicated that from each sample the first 150 nematodes were extracted for taxonomic

TABLE 2. Results of six Wilcoxon's signed ranks tests of total counts of all individuals and total counts of major taxa from selected samples split by the Folsom plankton splitter.

Taxa	K[1]	T[2]	Probability[3]
Gromiidae (Protozoa)	64	898.0	0.34
Foraminifera	67	1035.5	0.52
Nematoda	73	1152.5	0.28
Polychaeta	60	795.0	0.38
Copepoda	48	575.5	0.90
Total Counts	73	1124.5	0.21

[1] K = Sample size (Slightly less than the original 75 pairs, because this test requires omission of ties).

[2] T = Critical value or smaller sums of ranks.

[3] Probability = Probability that pairs of counts are equal. A difference would be indicated if probability was less than 0.05.

identification. All other nematodes were simply counted and identified as Nematoda. Dr. John H. Tietjen, City College of New York (*personal communication*), concurred that this procedure was the accepted and preferred practice and therefore it was adopted for this study.

The first 300 Foraminifera, alive when collected (based upon presence of stained protoplasm within the shell), were picked for identification and all other live individuals in the sample were simply counted. The residue from the counted portion of Core 3.D for the N500 stations and each Control Site was dried and the first 300 dead forams picked for identification and live:dead ratios.

Foraminifera were sent to Dr. Rosalie F. Maddocks for further identification. At Dr. Maddocks' laboratory, the sorted live forams were further stained with Rose Bengal and then dried for more accurate identification. It was discovered that although the Eosin-B:Biebrich Scarlet stain was not visible after the forams were dried, the Rose Bengal was. Dr. Maddocks visited the laboratory to work with and advise the SwRI technicians, ensuring their recognition of live forams. Foraminifera that had been considered as live in Dr. Maddocks' laboratory had also been counted as live by SwRI technicians.

Nomenclatural problems are discussed below under the section on Nomenclature, Voucher Collection, and Sample Storage.

Each subcontractor and consultant, as specified by mutual agreement, verified identifications or identified individuals to the lowest possible taxon, provided counts per taxon, prepared voucher collections for BLM and SwRI, and/or provided assistance in ecological interpretation of the respective data. An inventory of all samples sent to the subcontractors was maintained.

Data for each station were gathered, recorded on a standard data sheet, and submitted to Data Management. Final counts of each Foraminifera and Nematoda taxon for each core were prorated over the total number of Foraminifera and Nematoda counted from each core. To obtain numbers of individuals per m^2, counts per taxa per core were multiplied by a factor of 1243 (derived by dividing area of core into area of 1 m^2). Final data reported included numbers of individuals of each species, live:dead ratios where appropriate for Foraminifera, and numbers of individuals of each species per unit volume of sediment.

2. Macroinfauna

Upon arrival in the laboratory, all samples were inventoried and the inventory sheets returned to Data Management within one week. The residue that had remained in the funnel was washed again over a No. 35 mesh screen to remove clay balls that had failed to break down on board ship and was then stained with a 1:1 mixture of Eosin B and Biebrich Scarlet. After Cruise I, funnel and screen contents were combined on board and separated in the lab by floating off the soft-bodied organisms from the shell debris, etc. Both fractions were again stained.

Both portions of each grab were sorted into major taxa by examining the contents in quadrated, lined petri dishes using Wild M5 binocular microscopes. Only anterior portions and whole organisms were counted (Woodin, 1974). The residue remaining was stored.

Each subcontractor and consultant, as specified by mutual agreement, verified identifications or identified individuals to the lowest possible taxon, provided counts per taxa, prepared voucher collections for BLM and SwRI, and/or provided assistance in ecological interpretation of the respective data. An inventory of all samples sent to the subcontractors was maintained. Data for each station was gathered, recorded on standard data sheets, and submitted to Data Management. To obtain numbers of individuals per m^2, counts per taxa per grab were multiplied by a factor of 11.25 (derived by dividing area of grab, minus the area of the sediment texture core, into area of 1 m^2). Final data reported included numbers of individuals of each species and numbers of individuals of each species per unit area of sediment.

3. Macroepifauna and Demersal Fish

Upon arrival at the lab, all samples were inventoried and the inventory sheets returned to Data Management within one week. Each trawl sample was treated separately. Individuals were sorted into major taxa: Cnidaria, Polychaeta, Mollusca, Arthropoda, Echinodermata, Chordata, and Miscellaneous. Identified macroepifauna were placed in appropriately sized containers, preserved with 70% ethanol and the containers labeled. All fish, including archival species, were stored in 70% ethanol. The taxonomic composition of each sample was determined to the lowest possible taxon. As necessary, specimens were sent to subcontractors and consultants for verification or identification. Approximately 99% of the total number of individuals were identified to genus and species level.

Weights were taken by major taxa (species groups when possible) to the nearest 0.1 g using a Sartorius Model 1100 top-loading balance. Molluscs were weighed intact with their shells. Excess liquid was blotted away with paper towels.

Since a balance was not available on board ship during Cruise I, it was necessary to extrapolate biomass values for the specimens which had been removed for other analyses. Length-weight relationships for fishes, crabs, and shrimps were calculated by the equation $W = aL^b$, where W is weight in grams, L is length in millimeters, and a and b are constants (Pullen and Trent, 1970; Fontaine and Neal, 1971; Bagenal and Tesch, 1978). A logarithmic transformation gives the linear equation $\log W = \log a + b \log L$. Using data obtained from the organisms that had been retained in the trawl samples, log weight was plotted against log length, and a regression line was calculated by method of least squares. Table 3 shows the calculated regression equation for each species, the sample size for each equation and the percentage of total variation explained by each equation. For brown shrimp, *Penaeus aztecus*, white shrimp, *Penaeus setiferus*, and pink shrimp, *Penaeus duorarum*, equations describing length-weight relationships were taken from Fontaine and Neal (1971). Weight estimates for organisms that had been removed were included with the data from their respective station.

Fish length was measured to the nearest millimeter using a conventional measuring board and placing the anterior end of the fish against a stop at the front of the board. Standard length was taken as a straight line,

TABLE 3. Equations describing the length-weight relationship for certain taxa removed from trawl samples for histopathological or chemical analysis.

Species	Equation	Sample Size	[1]r^2
Mollusca			
Noetia ponderosa	$\log Y = -3.26 + 2.87 \log X$	7	0.98
Pitar cordatus	$\log Y = -2.99 + 2.74 \log X$	57	0.89
Arthropoda			
Trachypenaeus spp.	$\log Y = -4.35 + 2.62 \log X$	38	0.86
Sicyonia brevirostris	$\log Y = -5.72 + 3.49 \log X$	10	0.97
Pagurus pollicaris	$\log Y = -2.59 + 2.45 \log X$	17	0.85
Hepatus epheliticus	$\log Y = -3.19 + 2.57 \log X$	7	0.93
Leiolambrus nitidus	$\log Y = -3.01 + 2.42 \log X$	25	0.71
Callinectes similis	$\log Y = -6.49 + 4.35 \log X$	13	0.97
Portunus spinicarpus	$\log Y = -4.47 + 3.09 \log X$	54	0.94
Squilla empusa	$\log Y = -4.59 + 2.86 \log X$	16	0.97
Chordata			
Arius felis	$\log Y = -4.77 + 3.00 \log X$	32	0.91
Etropus crossotus	$\log Y = -2.80 + 2.00 \log X$	35	0.82
Equations from Fontaine and Neal (1971)			
Penaeus aztecus	$\log Y = -4.978 + 2.938 \log X$	3,412	
Penaeus duorarum	$\log Y = -5.113 + 3.029 \log X$	3,298	
Penaeus setiferus	$\log Y = -5.665 + 3.247 \log X$	2,090	

[1] r^2 = Percentage of total variation explained by regression equation.

with the fish lying on its right side and the jaws closed, from the tip of the snout to the tip of the hypural plate (Laevastu, 1965; Hoese and Moore, 1977). The only exception was a skate, *Raja texana*, in which the disc width was measured while it lay flat on its ventral surface. Each individual was measured; no subsampling was done.

For macroepifauna, taxonomic composition and number of individuals of each species were recorded. For demersal fish, the length vs. frequency of occurrence was tabulated by species for each station and total frequency of occurrence of a species for all stations was also recorded. Data were reported to Data Management on standard data sheets. Biomass values of all species for each station were obtained from the weight values for all stations.

4. *Sample Preservation, Narcotization, and Staining*

a. *Preservation*

All meiofauna, macroinfauna, and macroepifauna and demersal fish samples were preserved very soon after collection in, respectively, 5%, 5%, and 10% borax-buffered seawater formalin. On all cruises the formalin was mixed just prior to use and was buffered by adding 373 g borax (sodium borate) to 19 l formalin.

Formalin has the best qualities of a general purpose fixative (Humason, 1967). When future use of the organism is in doubt or it will be stored for an indefinite time, formalin is the preferred choice because it permits post-fixation and will not harden excessively (Humason, 1967). It takes only a small amount of formaldehyde to produce a lot of 5 or 10% formalin; therefore, the preservative requires little storage space and lends itself to space restricted sampling expeditions.

With time, formalin tends to become acidic and must be buffered to prevent breakdown of bone or shelled organisms. Alkaline solutions of formalin may cause autolysis of tissues. Taylor (1977) observed that formaldehyde solutions undergo three shifts in pH after the addition of specimens, with the quantity of specimens added to the solution greatly influencing the resulting pH. Miller (1952) recommended the initial addition of one teaspoon of borax to a half gallon of 10% formalin (i.e., about 1.1 g/900 ml). Weak solutions of borax-buffered formalin usually turn acidic and Taylor (1977) proposed that more borax be added after a day of fixation. Based upon various experiments, Taylor (1977) concluded that long-term storage of specimens in borax-buffered formalin resulted in specimen deterioration and that powdered limestone or marble chips in a saturated solution was equal to borax in preventing loss of bone and was superior in soft tissue fixation.

To offset an increase in pH because of increased numbers of specimens placed into the preservative at time of sampling or an increase over time, the samples were periodically tested for pH reading of seven or above.

All macroinfauna and macroepifauna and demersal fish samples were transferred to 70% undenatured ethanol in the laboratory for long-term storage. Residues of shell and other debris collected with the meiofauna and macroinfauna samples were kept and, except for meiofauna, were also stored in 70% undenatured ethanol. Debris from trawl samples was not kept. The voucher collection was also stored in 70% undenatured ethanol. Ethanol is the best overall preservative for permanent preservation (Russell, 1963). A 70% solution is preferred because that is where the maximum bactericidal action occurs through denaturation of proteins (Smith, 1947; Salle, 1961).

b. *Narcotization*

Both invertebrates and vertebrates suddenly subjected to formalin undergo a violent locomotor activity prior to death called "formalin frenzy" by Gannon and Gannon (1975), with a resultant rejection of gut contents, auto-amputation of limbs, fragmentation of body parts, spilling of eggs from brood pouches or gonads, and body distortion in some species (Hulings and Gray, 1971; Gannon and Gannon, 1975). All of these reactions can and do hinder species identification and further analysis. Therefore, it is essential that the organisms be relaxed as much as possible, without actually killing them, before they are preserved. Most of the permanent meiofauna have developed morphological adaptations, e.g., suckers, adhesive organs, etc., to cling to their surroundings for stabilization. Upon preservation, the organism does not always release its hold, but will tend to do so after narcotization (Hulings and Gray, 1971).

As a check on the efficiency of the meiofaunal anesthetization process used to stimulate the meiofauna to release their hold on surrounding sediments, Core 1.A, a replicate collected from the same grab as 1.B, was immediately preserved in 5% borax-buffered formalin and not narcotized. A Wilcoxon's matched-pairs signed ranks test was used to determine if there was a significant difference in numbers of individuals of major taxa. As indicated by Table 4, there was a significant difference ($p < 0.05$) between Cores 1.A and 1.B for the Foraminifera and total counts for Cruise I and a highly significant difference ($p < 0.01$) for Nematoda and total counts for Cruise III. Note that the probability (*0.05) for total counts for Cruise I is borderline in significance. The results indicate that narcotization apparently only affected certain species which affected total counts for Cruise I and Cruise III, but did not consistently affect major taxa. Therefore, anesthetization appeared to increase the number of recoverable organisms and should be used in meiofaunal studies.

After shipboard washing, macroinfauna samples were placed in appropriately sized plastic jars to which a 15% solution of $MgSO_4$ in seawater was added. After 30 minutes, borax-buffered formaldehyde solution was added to make a 5% solution of formalin. The purpose of this narcotization was to minimize muscle distortion of the worms, body fragmentation by polychaetes and ophiuroides, and limb amputations of decapods.

c. Staining

Even with the development of various flotation techniques (Anderson, 1959; Whitehouse and Lewis, 1966; Hulings and Gray, 1971; Lackey and May, 1971), a mixture of animals and organic debris usually remains after washing. To shorten sorting time, various staining techniques have been developed (Mason and Yevich, 1967; Hamilton, 1969; Lackey and May, 1971; Williams, 1974; Williams and Williams, 1974; Mitterer and Pearson, 1977).

To lessen the difficulty in separating animals from organic debris, a 1:1 mixture of Eosin B and Biebrich Scarlet was added to all samples before sorting. Generally, the final mixture contained 5 to 10% stain. Williams (1974) discovered that this stain had a selective affinity for animal tissue over plant debris. The technique has been used successfully in almost 12,000 benthic samples collected over six years in a large estuarine monitoring study in Trinity Bay, Texas (Baker et al., 1977; Baker, Pugh, and Kimball, 1977). The stain also worked well in this study.

It was discovered that sometimes, depending upon the length of time stain remained in the sample, nematodes would fail to or only partially absorb the stain because of their cuticle. As an estimate, only a few times was it noticed that material other than "live" animal tissue was stained. There were difficulties with the stain being visible in Foraminifera after they were removed and dried for identification. However, this problem was solved by the addition of Rose Bengal to the Foraminifera sample before drying. The Rose Bengal

TABLE 4. Comparison of meiofaunal Cores 1.A and 1.B using a Wilcoxon's signed ranks test.

Cruise	Taxa	K[1]	T[2]	Probability[3]
I	Gromiidae	30	186.5	0.34
	Foraminifera	36	203.5	0.04*
	Turbellaria	17	67.5	0.67
	Kinorhyncha	31	217.0	0.54
	Nematoda	36	289.0	0.49
	Harpacticoida	30	215.0	0.72
	Total Counts	36	208.0	0.05*
II	Gromiidae	52	600.0	0.42
	Foraminifera	62	968.5	0.96
	Turbellaria	20	100.5	0.87
	Kinorhyncha	24	99.5	0.15
	Nematoda	65	939.5	0.39
	Harpacticoida	30	156.5	0.12
	Total Counts	68	1145.0	0.86
III	Gromiidae	30	229.5	0.95
	Foraminifera	36	224.5	0.08
	Turbellaria	15	32.5	0.12
	Kinorhyncha	17	61.0	0.46
	Nematoda	34	129.5	0.004**
	Harpacticoida	22	79.0	0.12
	Total Counts	36	157.0	0.005**

[1] K = sample size.
[2] T = critical value or smaller sum of ranks.
[3] Probability = probability that pairs of counts are equal.

* = significant at $p < 0.05$.
** = significant at $p < 0.001$.

tended to darken the protoplasm already stained by the Eosin B and Biebrich Scarlet so that the stained Foraminifera could be detected after drying. Consultation and comparison between SwRI technicians and Foraminiferal laboratory personnel confirmed that both groups were correctly identifying the same individuals as "live."

5. Nomenclature, Voucher Collection, and Sample Storage

a. Nomenclature

Because of the diverse nature of the benthic samples collected in this project, it was necessary to utilize a large group of specialists for verification and identification; these persons are listed in the section on Project Organization. In-house specialists were also utilized. Protozoans and hydrozoans—Mr. Joseph D. Zotter, and harpacticoids - Mr. Alan Kwok. Both are from SwRI, Houston. All other groups were identified in-house, utilizing the extensive library facilities and experience of the senior author. The junior authors also assisted in taxonomic identifications as needed.

Several taxa have not been verified by outside authorities: poriferans, hydrozoans, anthozoans, turbellarians, rhynchocoels, gastrotrichs, acarins, tanaids, isopods, sipunculids, echiuroids, phoronids, brachiopods, enteropneusts, and ascidians. Of the above groups only the anthozoans, turbellarians, rhynchocoels, sipunculids, and phoronids contained large numbers of individuals. Unfortunately, specialists on these groups were neither readily available nor known to the senior author. Of the above groups, only the hydrozoans, anthozoans, isopods, sipunculids, phoronids, enteropneusts, and ascidians could be identified to genus and/or species. In addition, not all molluscs, decapods, or fishes collected for macroepifauna and demersal fish and harpacticoids for meiofauna have been verified by the respective consultants. Table 5 illustrates the level of identification of each major taxon.

All taxa identified in this study were coded according to the National Oceanographic Data Center (NODC) taxonomic code list (NODC, 1978) (See Appendix A). Of 1029 taxa identified, 376 were new entries into the NODC code list. New species of Amphipoda, Decapoda, Harpacticoida, and Ophiuroidia were identified by the consultants and will be published at a later date. New distribution records also will be reported at a later date for Polychaeta, Mollusca, and Decapoda. See Appendix H for a list of manuscripts and publications using these data.

b. Voucher Collection

As required by the contract, a voucher collection consisting of properly labeled and preserved specimens of all identified taxa was provided to BLM. The voucher collection, composed of assorted representatives of 1029 different taxa, was shipped to the U.S. National Museum of Natural History (USNM) as per instructions of Dr. Richard E. Defenbaugh upon

TABLE 5. Level of identification of various taxa collected in this project.

	Level					
Taxa	Phylum	Class	Order	Family	Genus	Species
Foraminifera						+
Other Protozoa			+	+		
Porifera	+					
Hydrozoa				+		+
Anthozoa					+	+
Turbellaria		+				
Rhynchocoela	+					
Gastrotricha		+				
Kinorhyncha				+	+	
Nematoda				+	+	
Polychaeta						+
Oligochaeta				+	+	
Mollusca						+
Acarina			+			
Ostracoda					+	+
Harpacticoida					+	+
Mysidacea						+
Cumacea						+
Tanaidacea					+	+
Isopoda					+	+
Amphipoda						+
Decapoda					+	+
Sipunculida						+
Echiurida					+	
Phoronida						+
Ectoprocta						+
Brachiopoda					+	
Echinodermata						+
Enteropneusta					+	
Ascidiacea					+	
Osteichthyes					+	+

completion of the draft final report. A second collection was retained by SwRI-Houston and has been given to the University of Texas School of Public Health, Houston, Texas. If only one individual was present, BLM received the specimen. A collection of Harpacticoida was provided Dr. M. Susan Ivester, and University of Southwestern Louisiana (USL) received Crustacea and Osteichthyes collections. In addition, each of the subcontractors and consultants was allowed to retain the remainder of the samples that they worked with for teaching and research purposes. All specimens identified by SwRI personnel, except for the Harpacticoida (retained by Mr. Alan Kwok), have been deposited in the USNM.

c. *Sample Storage*

All meiofauna and macroinfauna sample residues were saved because the many dead shells may be of interest to someone in the future. Each residue was preserved with sufficient 5% formalin or 70% ethanol, respectively, in plastic jars, which were sealed with paraffin. These also have been deposited at the USNM.

D. Statistical Methods

Many statistical techniques have been applied to the study of benthic populations and their relationships to physical or environmental variables (Cairns, Dickson, and Westlake, 1977; Holland, 1977, 1979; Dames and Moore, 1979). Recent use of multivariate statistical techniques have sought patterns of distribution for various faunal assemblages and the relationships of these patterns to environmental gradients. The purpose of statistical treatment in this study was to seek patterns of distribution for benthic assemblages, to relate these to environmental gradients, and further to determine whether benthic distributional patterns were related to measurable levels of petrogenic contaminants.

The statistical strategy for the analysis of benthic data (Fig. 6) consisted of the following steps: (1) characterization of each benthic data set with descriptive measures such as mean, diversity, evenness, dispersion, dominant species, and species ranks, (2) reduction of each benthic data set, with exclusion of almost all taxa above the family level, from the quantitative statistical treatment (final data set included 95 to 98% of the total number of individuals), (3) transformation of data where necessary to meet assumptions or improve efficiency of statistical tests, (4) classification of species (or taxa) into biological assemblages based on co-occurrences at stations using R-mode cluster analysis, (5) classification of stations into ecological classes based on co-occurring species using Q-mode cluster analysis, (6) relating species assemblages to station groups by constructing two-way coincidence tables for each pair of R-mode and Q-mode dendrograms, (7) relating patterns of faunal distribution to environmental gradients and petrogenic contamination, (8) determination of sample representativeness by testing selected species and species groups for variability among samples, stations, and platforms.

Descriptive statistics and data reduction procedures used for each benthic data set (meiofauna, macroinfauna, and macroepifauna and demersal fish) are described in the respective section of RESULTS. Data transformations were performed prior to statistical analysis whenever necessary to meet the assumptions for parametric tests (analysis of variance, correlation, and regression) or to improve the efficiency of a test (cluster analysis). For parametric analyses, the distribution of each variable was determined either from the distribution of data in large samples or from the literature when the sample size was small. In cluster analysis, where distribution of data is not a limiting factor, a logarithmic transformation has the desired effect of reducing the discrepancy between very large and very small values in computing similarity measures (Boesch, 1977). Therefore, with frequency data such as these, the relative contribution of very abundant species is reduced. In all cases where transformation was appropriate, the frequency counts or measurements were transformed to $\log(x + 1)$. The addition of unity to each measurement eliminates the possibility of logarithm of zero. In several tests for variability of sampling techniques and species' ranks, non-parametric statistical tests were performed and data were not transformed.

Cluster analysis is a statistical method of partitioning stations (Q-mode) or species (R-mode) into groups based on their co-occurrences in a sample population. A similarity measure is first calculated between all pairs of entities (species within stations or stations within species) and entities are progressively fused into groups based on the similarity measures to form a dendrogram or tree diagram. The Bray-Curtis similarity coefficient has been widely used in quantitative marine ecology (Boesch, 1977). Examples of its use include Feldhausen and Ali (n.d.); Day, Field, and Montgomery (1971); Stephenson, Williams, and Cooke (1972); Eagle (1975); Warwick and Gage (1975); and Holland and Dean (1977).

The clustering method (unweighted pair group method of Sneath and Sokal (1973)) has also had extensive use in aquatic ecology (see partial list of applications in Boesch (1977)). The CLUSTAN package (Wishart, 1975) was used to perform all cluster analyses for this study employing the clustering measures described above.

After each data set was subjected to R-mode and Q-mode cluster analysis, two-way coincidence tables were routinely constructed as interpretive tools (Clifford and Stephenson, 1975). A two-way coincidence table consisted of the original data matrix (transformed species counts) rearranged by species groups (on the vertical axis) and station groups (on the horizontal axis). From this table, differences in species groups were observed based on their occurrences or nonoccurrences at stations.

Further analyses of the benthic data set were directed at relating benthic abundance to environmental gradients and petrogenic contamination. For purposes of these analyses, environmental variables included all attributes of the environment except benthos (i.e., physical, chemical, geological, microbiological, and histopathological). These relationships were explored in two ways: (1) directly, by relating individual (indicator) species and species assemblages (delineated by the cluster analysis) to environmental variables using a correlation-regression approach and (2) indirectly, by performing cluster analysis on the environmental variables, thereby characterizing each platform or group of stations on the basis of physical, chemical, geological, microbiological and histopathological variables. Faunal assemblages occurring at certain stations or platforms (from cluster

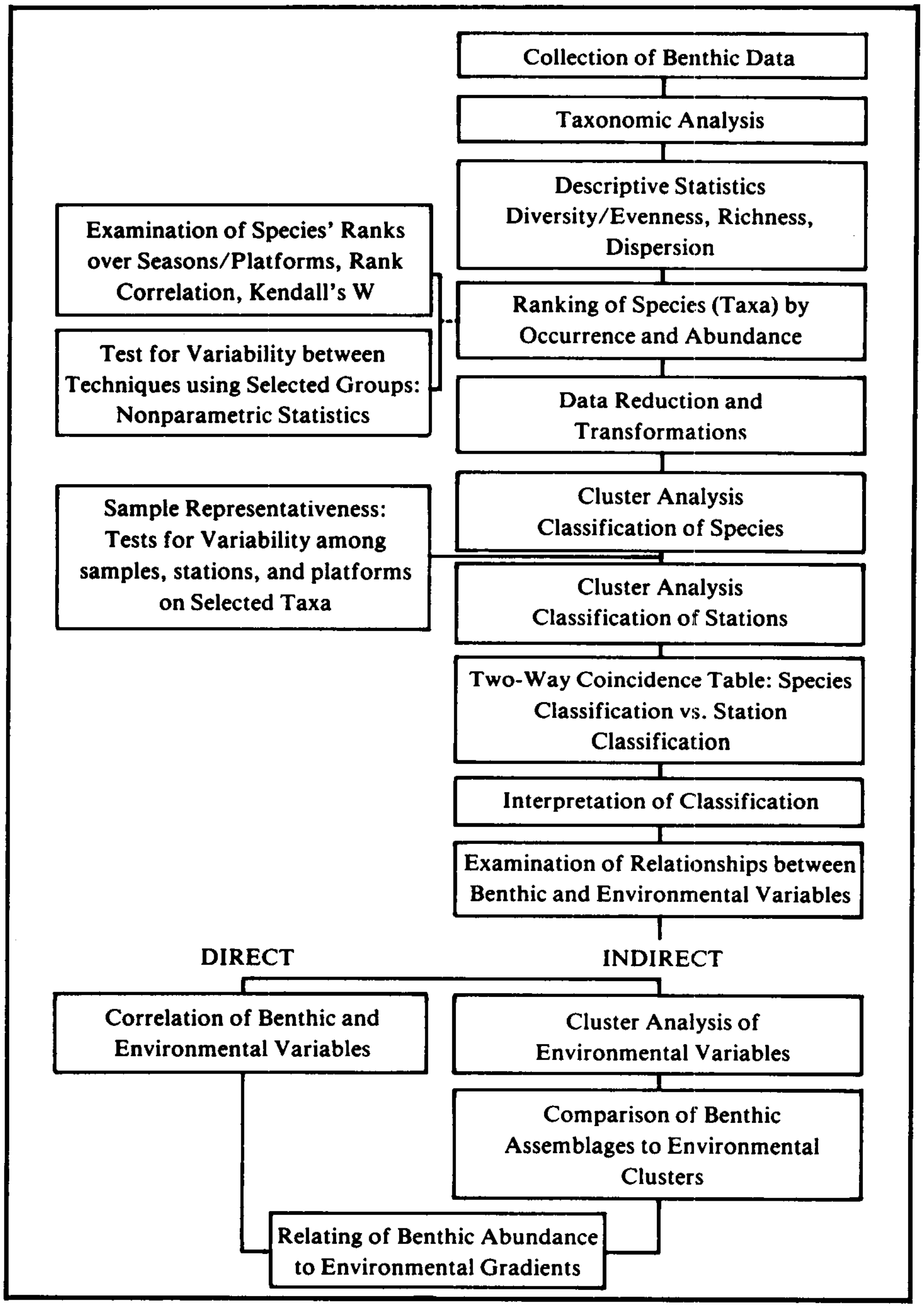

Collection of Benthic Data
Taxonomic Analysis
Descriptive Statistics Diversity/Evenness, Richness, Dispersion
Examination of Species' Ranks over Seasons/Platforms, Rank Correlation, Kendall's W
Ranking of Species (Taxa) by Occurrence and Abundance
Test for Variability between Techniques using Selected Groups: Nonparametric Statistics
Data Reduction and Transformations
Sample Representativeness: Tests for Variability among samples, stations, and platforms on Selected Taxa
Cluster Analysis Classification of Species
Cluster Analysis Classification of Stations
Two-Way Coincidence Table: Species Classification vs. Station Classification
Interpretation of Classification
Examination of Relationships between Benthic and Environmental Variables
DIRECT
INDIRECT
Correlation of Benthic and Environmental Variables
Cluster Analysis of Environmental Variables
Comparison of Benthic Assemblages to Environmental Clusters
Relating of Benthic Abundance to Environmental Gradients

FIG. 6. Biological and multidisciplinary statistical strategy

analyses) were then indirectly related to the environmental variables which characterized stations or platforms.

Clustering procedures for the environmental variables were the same as those described above for benthic analysis (steps 4-6). It was not feasible to include all environmental variables in these comparisons; therefore, some variables were eliminated after preliminary data syntheses were completed. After consultation between the Benthic Analysis Principal Investigator (PI), the PI in each discipline, and appropriate members of the Scientific Advisory Committee (SAC), variables were selected based on absolute levels with respect to detection limits, on relative levels with respect to potential effects, and on presence of some trend or change over the duration of this study.

Correlation analyses (Pearson's product-moment correlation co-efficient) were performed separately for each cruise on all possible pairs of the following variables: individual (indicator) species, species assemblages delineated by cluster analysis, and the environmental variables described above. The result of this analysis was threefold: (1) the relationship of individual species and species assemblages to each environmental variable was shown, (2) it served as a screening procedure, since environmental variables which showed no relationship to benthic variables were revealed, and (3) high correlations between environmental variables were exposed. Environmental variables which showed no relationship to any benthic variables were then eliminated, and in some cases where environmental variables were redundant and highly correlated, one or two variables were selected (e.g., seven variables described sediment texture). Next, backward and forward stepping regression (BMDP2R, Dixon, 1975) was performed with each benthic variable regressed on the remaining set of environmental variables. Since some multicollinearity was still present in the independent variable set, these regression equations were used only as a means of evaluating relative contributions of predictor (environmental) variables and not in any sense to produce predictive equations. Further refinement (such as biased regression procedures) of these 200 or more equations was not within the scope of this study.

Some other statistical procedures were used to test the efficiency of data handling techniques and sampling or subsampling methods and to compare species ranks. These are explained in the METHODS AND MATERIALS or RESULTS where used and are connected to the primary strategy route by a dotted line on the flowchart (Fig. 6).

III. RESULTS

A. Population Abundance and Distribution

1. *Taxonomic Composition and Population Trends*

There were 1029 different taxa identified in this Central Gulf Platform Study. Of the total, 353 were meiofauna, 576 were macroinfauna, and 284 were macroepifauna or demersal fish. Appendix B lists 172 taxa that were common to one or more groups. Over 42% of these taxa were found in meiofauna and macroinfauna (M-M), 50% were found in both macroinfauna and macroepifauna and demersal fish (M-DF), and only about 7% were common to all three groups (M-M-M).

Table 6 lists the percentage of major taxa common to all three groups. Polychaeta had the highest total percentage (32.0) of any of the different taxa, the highest in the M-DF group (14.5%) and the M-M-M group (5.8%) and the second highest in the M-M group (11.6%). Nematoda had the highest percentage in the M-M group (12.2). Of 13 taxa in the M-M-M group, ten were polychaetes (5.8% of total) and two were bivalves (1.2% of total) (Table 7). Of these taxa, four ranked in the top ten macroinfauna taxa during Cruise II only.

a. *Meiofauna*

A total of 353 taxa were identified during all three cruises. Fewer taxa were collected each succeeding cruise (Cruise I - 259 taxa, Cruise II - 210 taxa, Cruise III - 161 taxa). The major taxonomic groups identified were Foraminifera, other Protozoa, Turbellaria, Rhynchocoela, Kinorhyncha, Nematoda, Polychaeta, and Harpacticoida. Table 8 presents the percentage of total number of taxa per cruise for each of the above taxa. Nematoda included the greatest number of different taxa in all three cruises (Cruise I - 22.5%, Cruise II - 29.5%, and Cruise III - 29.6%) and in the total number of taxa (20.9%). Harpacticoida (H) had the second highest number of total taxa (18.9%) followed closely by the Foraminifera (F). However, on an individual cruise basis, the Foraminifera had the second highest number (Cruise I - F, 19.4%, H, 18.6%; Cruise II - F, 18.6%, H, 14.7%; Cruise III - F, 21.7%, H, 18.6%). Polychaeta (all temporary meiofauna) had the fourth highest number of taxa with a total percentage of 10.1%.

There does not appear to be a pronounced seasonal trend in number of taxa of Foraminifera,

TABLE 6. Percent composition of those taxa common to meiofauna, macroinfauna, and/or macroepifauna and demersal fish.

Taxa	Meiofauna Macroinfauna	Macroinfauna Macroepifauna Demersal Fish	Meiofauna Macroinfauna Macroepifauna Demersal Fish	Total
Foraminifera	4.1			4.1
Nematoda	12.2			12.2
Polychaeta	11.6	14.5	5.8	31.9
Gastropoda	1.7	5.2		6.9
Bivalvia	2.3	2.9	1.2	6.4
Decapoda		9.3		9.3
Echinodermata	0.6	4.1		4.7
Osteichthyes	0.6	4.7	0.6	5.9
Other	9.3	9.3		18.6
Total	42.4	50.0	7.6	100.0

TABLE 7. List of species common to meiofauna, macroinfauna, and/or macroepifauna and demersal fish.

		Meiofauna			Macroinfauna			Macroepifauna Demersal Fish		
Taxa		No. Occurrence	No. Individuals	Rank	No. Occurrence	No. Individuals	Rank	No. Occurrence	No. Individuals	Rank
Rhynchocoela		67	1246	32	132	5235	2	6	12	69
Sthenelais boa	(P)[1]	2	6	212	6	530	26	5	61	71
Gyptis vittata	(P)	1	2	305	42	86	54	2	5	129
Nephtys incisa	(P)	17	108	91	106	1798	6	6	24	63
Glycera americana	(P)	1	4	259	64	369	28	2	6	128
Lumbrineris tenuis	(P)	4	12	165	105	1629	8	2	5	130
Paraprionospio pinnata	(P)	23	139	78	137	23121	1	5	15	74
Armandia maculata	(P)	7	45	133	72	322	22	1	1	220
Notomastus latericeus	(P)	58	874	38	103	1053	11	1	4	176
Ampharete acutifrons	(P)	5	20	151	62	649	31	1	1	224
Ampharete americana	(P)	16	282	93	31	4796	66	1	4	177
Nuculana concentrica	(B)	1	4	262	84	1242	16	1	1	235
Corbula contracta	(B)	5	30	147	105	1734	7	4	5	91

[1] (P) denotes Polychaeta (B) denotes Bivalvia

Nematoda, Polychaeta, and Harpacticoida (Table 8). Numbers of individual taxa for the other major taxa, i.e., other Protozoa, Turbellaria, Rhynchocoela, and Kinorhyncha, are so small that a seasonal trend cannot be ascertained. Thus, it appears a seasonal balance is maintained by a change in taxonomic composition and not a change in taxonomic abundance. The taxonomic category "Other" did show a marked reduction from Cruise I to Cruise III (Table 8) and the total taxa under this category indicated little duplication between cruises.

Table 9 lists the ranks of the top 15 meiofauna taxa which were identified in each of the three cruises. Consistently present within the top 15 taxa were 4 species of Foraminifera, 10 Nematoda taxa, and one family of Rhizopoda, Protozoa. The ranks of the top 10 meiofauna taxa among the three cruises were not significantly different, but the ranks of the top 15 taxa were significantly different at the $p < 0.05$ level of significance.

Foraminifera (F) was the most abundant taxon found, having an average abundance of 55.3% over all Cruises (Table 10). Nematoda (N) was the second most abundant taxon with an overall average abundance of 37.4%. Foraminifera were more abundant than Nematoda during Cruise I (F - 59.1%, N - 32.0% and Cruise II (F - 68.7%, N - 26.2%), while Nematoda were more abundant than Foraminifera during Cruise III (N -54.1%, F - 38.1%). Next highest in abundance were other Protozoa with an average abundance of 3.1%. All other taxa had a very low overall average abundance. Based on total percent of the number of individuals for each taxon per cruise, there does not appear to be a seasonal trend (Table 10).

During Cruise I, a low of 324,423 individuals per m^2 was found at P3 N2000 and a high of 4,068,339 individuals per m^2 at C22. During Cruise II, a low of 3,729 individuals per m^2 was collected at S17 N2000 and a high of 4,331,855 individuals per m^2 at P4 S2000. For Cruise III, a low of 43,505 individuals per m^2 was collected at C23 and a high of 1,380,973 individuals per m^2 at P3 E2000.

b. Macroinfauna

A total of 576 different taxa were identified during all three cruises. Fewer taxa were collected each succeeding cruise (Cruise I - 424 taxa, Cruise II - 309 Taxa, Cruise III - 266 taxa). Major taxonomic groups identified were Anthozoa, Rhynchocoela, Polychaeta, Gastropoda, Bivalvia, Decapoda, Crustacea,

TABLE 8. Percent total number of taxa per cruise for the dominant meiofauna.

	Number of Taxa							
	Cruise I		Cruise II		Cruise III		Total	
Taxa	No.	%	No.	%	No.	%	No.	%
Foraminifera	50	19.4	39	18.6	35	21.7	53	15.6
Protozoa[1]	21	8.1	10	4.8	4	2.5	24	7.1
Turbellaria	1	0.4	1	0.5	1	0.6	1	0.3
Rhynchocoela	1	0.4	1	0.5	1	0.6	1	0.3
Kinorhyncha	9	3.5	4	1.9	3	1.9	9	2.6
Nematoda	58	22.5	62	29.5	46	28.6	71	20.9
Polychaeta	19	7.4	23	10.9	22	13.7	34	10.1
Harpacticoida	48	18.6	41	14.7	30	18.6	64	18.9
Other	51	19.7	39	18.6	19	11.8	82	24.2
Total	258	100.0	210	100.0	161	100.0	339	100.0

[1] Designation includes all Protozoa other than Foraminifera.

TABLE 9. Ranks of the top 15 meiofauna taxa by cruise.

Taxa		Rank[2]		
		Cruise I	Cruise II	Cruise III
Sabatieria	(N)[1]	2	1	3
Bolivina lowmani	(F)	11	3	1
Gromiidae	(Pr)	3	2	8
Dorylaimopsis	(N)	8	8	2
Cyatholaimidae	(N)	4	5	7
Theristus	(N)	5	7	4
Buliminella morgani	(F)	9	4	6
Linhomoeidae	(N)	12	6	5
Nonionella basiloba	(F)	1	9	10
Choniolaimidae	(N)	13	10	9
Terschellingia	(N)	10	11	11
Ammonia beccarii	(F)	6	12	12
Chromadoridae	(N)	7	15	14
Tricoma	(N)	14	13	15
Sphaerolaimus	(N)	15	14	13

[1] (N) denotes Nematoda
(F) denotes Foraminifera
(Pr) denotes Rhizopoda, Protozoa

[2] The ranks of the top 15 meiofauna taxa for the three cruises were significantly different at the <0.05 level of significance.

TABLE 10. Percent total number of individuals per cruise for the dominant meiofauna taxa.

Taxa	Percent Total Number of Individuals/Cruise			
	Cruise I	Cruise II	Cruise III	Average
Foraminifera	59.1	68.7	38.1	55.3
Protozoa[1]	4.8	2.2	2.2	3.1
Turbellaria	0.2	0.2	0.7	0.4
Rhynchocoela	0.1	0.6	0.1	0.3
Kinorhyncha	0.9	0.4	0.6	0.6
Nematoda	32.0	26.2	54.1	37.4
Polychaeta	0.8	0.6	1.5	1.0
Harpacticoida	1.3	0.3	2.1	1.2
Other[2]	0.8	0.8	0.6	0.7
Total	100.0	100.0	100.0	100.0

[1] Includes all Protozoa except Foraminifera.

[2] Designation includes allother taxa not listed.

Sipunculida, and Echinodermata. Table 11 presents the percentage of total number of taxa per cruise for each of the above taxa. Polychaeta included the greatest total number of different taxa (28.9%), followed by the Crustacea (14.7%). Polychaeta were also dominant during each cruise (Cruise I - 29.9%, Cruise II - 33.6%, and Cruise III - 39.1%). Bivalvia and Decapoda were third (12.1%) and fourth (10.6%), respectively, in total number of different taxa. There does not appear to be a seasonal trend in numbers of taxa (Table 11), perhaps indicating maintenance of stability through variation in taxonomic composition. The taxonomic category "Other," as with meiofauna, showed a marked reduction from Cruise I to Cruise III. The total number of taxa included under "Other" indicated little duplication of taxa between cruises.

Table 12 lists the ranks of the top ten macroinfauna taxa among the three cruises. The top ten included one taxon of Rhynchocoela, eight species and one genus of Polychaeta, and one species of Bivalvia. The ranks of the top ten macroinfauna taxa among the three cruises were significantly different at the $p < 0.05$ level of significance.

TABLE 11. Percent total number of taxa per cruise for the dominant macroinfauna.

Taxa	Number of Taxa							
	Cruise I		Cruise II		Cruise III		Total	
	No.	%	No.	%	No.	%	No.	%
Anthozoa	8	1.9	7	2.3	6	2.3	9	1.7
Rhynchocoela	3	0.7	3	1.0	2	0.7	4	0.7
Polychaeta	127	29.9	104	33.6	104	39.1	158	28.9
Gastropoda	42	9.9	32	10.3	19	7.2	54	9.9
Bivalvia	44	10.4	37	12.0	36	13.5	66	12.2
Decapoda	47	11.1	25	8.0	32	12.0	58	10.6
Crustacea	65	15.3	34	11.0	30	11.3	80	14.7
Sipunculida	8	1.9	7	2.3	8	3.0	8	1.5
Echinodermata	14	3.3	11	3.6	10	3.8	18	3.3
Other	66	15.6	49	15.9	19	7.1	90	16.5
Total	424	100.0	309	100.0	266	100.0	545	100.0

TABLE 12. Ranks of the top ten macroinfauna taxa by cruise.

Taxa		Rank[2]		
		Cruise I	Cruise II	Cruise III
Paraprionospio pinnata	(P)[1]	1	1	2
Rhynchocoela		2	2	1
Sigambra tentaculata	(P)	4	3	4
Cossura delta	(P)	5	5	8
Magelona phyllisae	(P)	10	4	7
Nephtys incisa	(P)	6	6	10
Corbula contracta	(B)	7	8	5
Lumbrineris tenuis	(P)	8	7	6
Tharyx marioni	(P)	3	9	9
Nereis	(P)	9	10	3

[1] (P) denotes Polychaeta.
(B) denotes Bivalvia.

[2] The ranks of the top ten macroinfauna taxa for the three cruises were significantly different at the <0.05 level of significance.

Polychaeta was the dominant taxon with an average percentage of total number of individuals for all cruises of 68.9% (Table 13). Second in dominance was Bivalvia with 7.2%. All other taxa averaged 7.0%, with individual percentages of 5.0% or less. There appeared to be no marked change in percent of total number of individuals between cruises.

During Cruise I, a low of 1,001 individuals per m^2 was found at P4 E500 and a high of 9,338 individuals per m^2 at P2 W500. During Cruise II, a low of 45 individuals per m^2 was collected at S13 N500 and a high of 2,981 individuals per m^2 at S5 N2000. For Cruise III, a low of 101 individuals per m^2 was collected at P4 W500 and a high of 4,433 individuals per m^2 at P2 E500.

c. *Macroepifauna and Demersal Fish*

A total of 284 different taxa were identified during all three Cruises, (Cruise I - 106 taxa, Cruise II - 218 taxa, and Cruise III - 120 taxa). The greatest number of taxa was collected during Cruise II because of the additional sites visited during that cruise. One hundred ten different taxa were collected at the Primary and Control Sites and 108 taxa at the 16 Secondary Sites. Major taxonomic groups identified were Polychaeta, Mollusca, Decapoda, Echinodermata, and Osteichthyes. Table 14 presents the percentage of total number of taxa per cruise for each of the above taxa. Osteichthyes included the highest total number of different taxa (33.5%) followed by the Decapoda (21.0%). This rank order of dominance between Osteichthyes and Decapoda was maintained during each cruise. Mollusca and Polychaeta were next in total number of different taxa, with 17.6% and 16.9%, respectively. The dominance order between Mollusca and Polychaeta alternated during each cruise (Table 14).

Echinodermata had the highest percentage of total number of individuals (26.9%) for all three cruises (Table 15). However, the Echinodermata was

TABLE 13. Percent total number of individuals per cruise for the dominant macroinfauna taxa.

	Percent Total Number of Individuals/Cruise			
Taxa	Cruise I	Cruise II	Cruise III	Total
Anthozoa	0.5	0.3	0.0[2]	0.3
Rhynchocoela	4.9	3.2	4.6	4.2
Polychaeta	67.7	68.4	70.6	68.9
Gastropoda	1.4	3.7	0.9	2.0
Bivalvia	10.3	6.2	5.2	7.2
Decapoda	0.9	1.3	2.5	1.6
Crustacea	3.4	2.3	3.2	3.0
Sipunculida	3.4	7.6	4.0	5.0
Echinodermata	0.7	1.0	0.8	0.8
Other[1]	6.8	6.0	8.2	7.0
Total	100.0	100.0	100.0	100.0

[1] Designation includes all other taxa not listed.

[2] A value of 0.0 indicates rounding to one decimal place.

TABLE 14. Percent total number of taxa per cruise for the dominant macroepifauna and demersal fish.

	Number of Taxa							
	Cruise I		Cruise II		Cruise III		Total	
Taxa	No.	%	No.	%	No.	%	No.	%
Polychaeta	16	15.1	36	16.5	12	10.0	46	16.9
Mollusca	7	6.6	38	17.4	23	19.2	48	17.6
Decapoda	28	26.4	48	22.0	28	23.4	57	21.0
Echinodermata	4	3.8	6	2.8	1	0.8	8	2.9
Osteichthyes	41	38.7	74	33.9	49	40.8	91	33.5
Other	10	9.4	16	7.4	7	5.8	22	8.1
Total	106	100.0	218	100.0	120	100.0	272	100.0

TABLE 15. Percent total number of individuals per cruise for the dominant macroepifauna and demersal fish taxa.

	Percent Total Number of Individuals/Cruise			
Taxa	Cruise I	Cruise II	Cruise III	Average
Polychaeta	1.8	3.0	3.3	2.7
Mollusca	4.5	4.4	3.2	4.0
Decapoda	48.6	17.5	10.7	25.6
Echinodermata	21.0	21.5	38.2	26.9
Osteichthyes	11.6	19.8	33.3	21.6
Other[1]	12.5	33.8	11.3	19.2
Total	100.0	100.0	100.0	100.0

[1] Designation includes all other taxa not listed.

dominated by a single species of asteroid, *Astropecten duplicatus*, that comprised 97.7% of the individuals in this group. Percentage of total number of individuals of the Echinodermata was relatively constant for Cruises I and II but increased during Cruise III. Percentage of total number of Osteichthyes increased significantly from Cruise I to Cruise III. The opposite trend occurred for Decapoda. This variation in number of individuals may indicate seasonal effects. However, the category "Other" had the same relative percentage for Cruises I and III, which had identical sampling sites. Percentages did increase during Cruise II when there was an increase in sampling sites.

2. *Species Diversity*

a. Meiofauna

Examination of the diversity and evenness values for each station by cruise does not indicate a trend either along a specific transect or in a specific direction from the Primary or Secondary Platforms or at Control Sites (See Appendix C, Tables C1, C2, and C3). Table 16 presents the average diversity and evenness values by Primary, Secondary, and Control Sites for all three cruises.

During Cruise I, diversity and evenness were highest at P2 and lowest at P3; P1 and P4 had similar intermediate diversity and evenness values during Cruise II; P3 and P4 were also similar. During Cruise III, P1 and P2 were again similar in diversity and evenness; although P3 had the highest diversity value, it had the lowest evenness value. At P1, diversity remained fairly stable over all cruises, but evenness increased with each cruise. At P2, diversities fluctuated from a high of 2.99 during Cruise I, to a low of 2.31 during Cruise II, to a value of 2.65 during Cruise III. Evenness values at P2 were very similar for Cruises I and III, but the value decreased for Cruise II. Site P3 had similar diversities for Cruises I and II, but the value increased dramatically for Cruise III; evenness values followed the same pattern. The fluctuation in diversity at P4 appeared to be slight over all cruises but evenness changed dramatically to a high for Cruise III.

During Cruise I, diversities and evenness were very similar at C21, C22, and C23, but markedly different at C24 (Table 16). However, during Cruise II, C21 was different from C22, C23, and C24. For Cruise III, diversity and evenness were similar for C21, C22, and C24, but at C23 the diversity was lower and the evenness value higher than the other sites. Comparison of diversity and evenness for C21 over all cruises indicated an increase in both. For C22, there was a similar increase in diversity and evenness from Cruise I to Cruise III. Diversity during Cruise II dropped while the evenness increased over that of Cruise I. Diversity and evenness at C23 remained fairly constant during Cruises I and II but increased during Cruise III. The diversity and evenness values at C24 dropped to a low of 1.66 during Cruise II, while the values for Cruises I and III were close.

Diversities at S10, S11, S15, S16, S17, S18, and S20 were generally as high as at the Primary and Control Sites during Cruise III (Table 16). The other Secondary Sites had diversities similar to low values obtained for the Primary and Control Sites during Cruises I and II. Sites S5, S7, S9, S12, and S19 had similar

TABLE 16. Average diversity and evenness values for meiofauna by site and cruise.

				Evenness					
	Diversity			Pielou			Heip		
Site	Cruise I	Cruise II	Cruise III	Cruise I	Cruise II	Cruise III	Cruise I	Cruise II	Cruise III
P01	2.35	2.32	2.65	0.590	0.677	0.752	0.197	0.313	0.400
P02	2.99	2.31	2.65	0.705	0.641	0.729	0.281	0.255	0.357
P03	2.07	1.98	2.89	0.559	0.513	0.705	0.154	0.142	0.303
P04	2.44	2.12	2.56	0.602	0.538	0.756	0.188	0.146	0.432
S05		2.00			0.598			0.233	
S06		2.10			0.832			0.629	
S07		1.89			0.599			0.280	
S08		1.24			0.375			0.094	
S09		1.80			0.563			0.230	
S10		2.78			0.709			0.308	
S11		2.65			0.690			0.292	
S12		1.72			0.516			0.172	
S13		1.65			0.688			0.435	
S14		2.04			0.724			0.493	
S15		2.71			0.814			0.527	
S16		2.49			0.645			0.239	
S17		2.32			0.950			0.852	
S18		2.44			0.771			0.488	
S19		2.08			0.622			0.266	
S20		2.35			0.618			0.155	
C21	1.95	2.31	2.92	0.499	0.650	0.793	0.123	0.267	0.452
C22	1.95	1.42	2.82	0.447	0.490	0.780	0.077	0.184	0.437
C23	1.97	1.85	2.55	0.504	0.459	0.851	0.126	0.096	0.622
C24	2.80	1.66	3.12	0.731	0.423	0.806	0.342	0.086	0.461

diversity and evenness values. Diversities at S6, S13, and S14 were similar to the diversities at the above sites but the evenness values were higher. Sites S10 and S11 were very similar to each other in diversity and evenness, as were S16 and S10, but the evenness values were higher. Diversity and evenness at S8 were the lowest of any Secondary Site; the highest diversity was at S15, accompanied by a high evenness value.

Perhaps a better way to compare diversities is by comparing diversities of similar taxonomic groups. Table 17 presents the average diversity and evenness values for seven major meiofauna taxa for all three cruises. Foraminifera diversity appeared to remain constant over all cruises while the distribution of individuals among species, as evidenced by the evenness values, increased from Cruise I to Cruise III. Diversity values for Protozoa (other than Foraminifera) were very low for all three cruises but dropped markedly from Cruise I to Cruises II and III. There is a corresponding decrease in evenness values for the Protozoa. Nematoda diversities for Cruises I and III appeared to be similar, both being different from the diversity found during Cruise II. However, evenness values for the Nematoda did not indicate any difference. Diversity for Polychaeta was higher for Cruise I than for Cruises II and III, whose values were similar. The same trend can be observed in the evenness values. Harpacticoida had a high diversity during Cruise I, it decreased markedly in Cruise II, and finally rose somewhat in Cruise III. A similar trend was noted in the evenness values (Table 17). Generally, the Nematoda had the highest diversity, followed by the Foraminifera. The diversity for each taxa, except Foraminifera, was higher during Cruise I than Cruises II or III.

Generally, the changes in diversities of the major taxa appeared to be in response to changes in evenness and not changes in number of species. However, changes in number of species did affect the diversity values for Foraminifera, Cruise II, and Nematoda, all cruises.

b. Macroinfauna

Examination of the diversity or evenness values for each station by cruise does not indicate a trend either along a specific transect or in a specific direction from the Primary or Secondary Platforms or at Control Sites (See Appendix C, Tables C4, C5, and C6). Table 18 presents the average diversity and evenness values for Primary, Secondary, and Control Sites for all three cruises.

Diversity and evenness values at P2, P3, and P4 for Cruise I were similar to each other, but values at P1 were much lower. During Cruise II, both diversity and evenness at the Primary Sites showed wide fluctuation. For Cruise III, P1 and P3 were similar to each other, P2 was lower, and P4 was higher. Diversity increased at P1 over all three cruises as did evenness. For P2, diversity was high during Cruise I, dropped very low during Cruise II, then rose somewhat during Cruise III. Diversity at P3 was similar during Cruises I and II, but the evenness declined during Cruise II. During Cruise III, diversity at P3 was lower than during the previous two cruises, but the evenness was the highest of all three cruises. At P4, diversities during all three cruises were similar with a marked increase in evenness during Cruise III.

For the Control Sites there was a marked fluctuation in diversity and evenness values (Table 18). During Cruise II, C23 and C24 had similar diversities while the evenness value for C24 was slightly higher than for C23. Diversity for Cruise II was lowest at C21 but it had the highest evenness value of all the Control Sites. Thus, there was a marked reduction in number of species as compared to the other Control Sites. During Cruise III, C22 and C24 had similar diversities and evenness, while C23 was higher and C21 was lower. At C21, there was a marked reduction in number of species during Cruise II as indicated by the low diversity and high evenness in relation to values found during Cruises I and III. At C22, diversity decreased during Cruise II from that found during Cruise I, but the evenness values were similar. Therefore, there was a decrease in number of species from Cruise I to Cruise II, followed by an increase in both number of species and evenness during Cruise III. Diversities at C23 were similar during all three cruises, but there was a marked increase in evenness during Cruise III. It would appear that the increase in evenness during Cruise III offset a decrease in number of species. At C24, diversity and evenness were both low during Cruise I, increased to a high during Cruise II, and then decreased slightly during Cruise III. Fluctuations in diversity at C24 appeared to be closely regulated by changes in evenness.

At the Secondary Sites, diversity and evenness were generally high (Table 18). Site S5 had the lowest diversity and evenness values. The highest diversity and evenness values were found at S15, S17, and S18. Sites S9, S14, and S16 shared similar diversities and evenness. Similar diversities were found at S13, S19, and S20, but S13 was marked by a very large evenness

TABLE 17. Average diversity and evenness values of major meiofauna taxa by cruise.

				Evenness					
	Diversity			Pielou			Heip		
Site	Cruise I	Cruise II	Cruise III	Cruise I	Cruise II	Cruise III	Cruise I	Cruise II	Cruise III
Foraminifera	1.28	1.08	1.45	0.484	0.512	0.658	0.215	0.301	0.417
Protozoa[1]	0.28	0.07	0.03	0.244	0.093	0.035	0.191	0.082	0.030
Kinorhyncha	0.49	0.18	0.09	0.526	0.217	0.120	0.454	0.192	0.114
Nematoda	2.40	2.00	2.23	0.742	0.738	0.761	0.416	0.475	0.473
Polychaeta	1.24	0.67	0.72	0.749	0.575	0.618	0.666	0.534	0.555
Harpacticoida	1.48	0.32	0.82	0.771	0.275	0.527	0.659	0.220	0.471
Other	0.93	0.45	0.34	0.595	0.391	0.427	0.533	0.360	0.414

[1] Designation includes all Protozoa other than Foraminifera.

TABLE 18. Average diversity and evenness values for macroinfauna by site and cruise.

				Evenness					
	Diversity			Pielou			Heip		
Site	Cruise I	Cruise II	Cruise III	Cruise I	Cruise II	Cruise III	Cruise I	Cruise II	Cruise III
P01	2.01	2.20	2.64	0.485	0.673	0.724	0.108	0.327	0.363
P02	3.10	1.52	2.06	0.650	0.469	0.526	0.183	0.162	0.159
P03	3.22	3.11	2.84	0.693	0.554	0.710	0.236	0.369	0.318
P04	3.05	2.83	3.13	0.722	0.739	0.884	0.300	0.362	0.657
S05		1.26			0.397			0.110	
S06		2.53			0.891			0.721	
S07		2.57			0.837			0.594	
S08		2.36			0.727			0.388	
S09		2.90			0.849			0.587	
S10		2.27			0.755			0.451	
S11		2.17			0.653			0.291	
S12		2.29			0.696			0.372	
S13		2.02			0.854			0.691	
S14		3.10			0.801			0.454	
S15		3.38			0.889			0.649	
S16		3.02			0.882			0.508	
S17		3.30			0.882			0.637	
S18		3.45			0.857			0.555	
S19		2.10			0.554			0.166	
S20		1.95			0.569			0.204	
C21	2.02	1.47	1.92	0.485	0.820	0.523	0.103	0.670	0.152
C22	2.48	1.86	2.86	0.584	0.592	0.826	0.159	0.245	0.532
C23	3.25	2.99	3.21	0.770	0.772	0.927	0.370	0.401	0.768
C24	1.22	2.98	2.78	0.353	0.819	0.788	0.077	0.504	0.458

value compared to that found at S15, S17, and S18. Sites S6 and S7 were similar in diversity, with the evenness at S6 slightly higher than that at S7. Diversities and evenness at S8, S10, S11, and S12 were very similar but fluctuated somewhat.

Table 19 presents the average diversity and evenness values by cruise for the ten major macroinfauna taxa. Diversity and evenness values for the Anthozoa taxa were lower during Cruises II and III than during Cruise I. Diversity among the Rhynchocoela was fairly constant with changes only in evenness. This trend is a direct reflection of the taxonomic problems with the group. Polychaeta diversity remained fairly constant, while evenness increased from Cruise I to Cruise III. Gastropoda diversity and evenness declined from Cruise I to Cruise III as did the values for Bivalvia, which had a lower diversity during Cruise II than during Cruise III. Diversity values for both Decapoda and Crustacea fluctuated in a way similar to that seen for Bivalvia, with changes in diversity being caused by changes in evenness and probably coupled with very small changes in number of species. Evenness changes in Sipunculida appeared to influence the reduction in diversity from Cruise I to Cruise III. A similar change was observed in the Echinodermata from Cruise II to Cruise III.

c. *Macroepifauna and Demersal Fish*

Table 20 presents the diversity and evenness values for Primary, Secondary, and Control Sites for all

TABLE 19. Average diversity and evenness values of major macroinfauna taxa by cruise.

				Evenness					
	Diversity			Pielou			Heip		
Taxa	Cruise I	Cruise II	Cruise III	Cruise I	Cruise II	Cruise III	Cruise I	Cruise II	Cruise III
Anthozoa	0.31	0.10	0.06	0.238	0.136	0.056	0.201	0.131	0.056
Rhynchocoela	0.05	0.08	0.01	0.067	0.120	0.015	0.050	0.109	0.012
Polychaeta	2.10	1.94	2.19	0.578	0.686	0.703	0.216	0.425	0.433
Gastropoda	1.30	0.81	0.57	0.713	0.580	0.540	0.576	0.503	0.503
Bivalvia	1.31	0.75	0.96	0.671	0.537	0.617	0.474	0.461	0.516
Decapoda	1.62	0.66	1.17	0.863	0.565	0.803	0.758	0.533	0.711
Crustacea	1.27	0.46	0.60	0.653	0.399	0.496	0.485	0.366	0.447
Sipunculida	0.46	0.20	0.21	0.490	0.243	0.282	0.422	0.218	0.244
Echinodermata	0.82	0.25	0.33	0.649	0.269	0.409	0.582	0.253	0.392
Other	1.28	0.43	0.52	0.648	0.359	0.492	0.439	0.309	0.439

TABLE 20. Average diversity and evenness values for macroepifauna and demersal fish by site and cruise.

				Evenness					
	Diversity			Pielou			Heip		
Site	Cruise I	Cruise II	Cruise III	Cruise I	Cruise II	Cruise III	Cruise I	Cruise II	Cruise III
P01	2.29	2.72	2.70	0.674	0.846	0.874	0.307	0.593	0.661
P02	1.86	2.08	2.56	0.537	0.766	0.886	0.175	0.497	0.704
P03	1.61	0.27	2.36	0.548	0.079	0.583	0.223	0.010	0.171
P04	1.67	2.18	1.71	0.526	0.635	0.530	0.188	0.262	0.188
S05		2.05			0.654			0.308	
S06		2.57			0.660			0.251	
S07		2.38			0.644			0.251	
S08		2.45			0.791			0.502	
S09		1.89			0.511			0.144	
S10		1.85			0.771			0.535	
S11		2.18			0.945			0.868	
S12		1.31			0.811			0.672	
S13		2.43			0.635			0.231	
S14		2.04			0.574			0.197	
S15		2.77			0.706			0.301	
S16		2.76			0.725			0.336	
S17		3.19			0.834			0.518	
S18		2.54			0.675			0.278	
S19		1.60			0.644			0.359	
S20		2.18			0.910			0.786	
C21	2.08	2.08	2.72	0.788	0.683	0.844	0.538	0.350	0.589
C22	1.53	1.52	1.72	0.596	0.781	0.555	0.301	0.596	0.217
C23	1.69	1.13	0.98	0.439	0.305	0.266	0.096	0.053	0.043
C24	1.52	1.17	2.86	0.633	0.430	0.728	0.356	0.158	0.330

three cruises. Note that these values were based on only one trawl at each site.

Diversity and evenness values at P2, P3, and P4 were very similar during Cruise I while P1 had a higher diversity and evenness. During Cruise II, diversities at P2 and P4 were similar but evenness at P2 was higher. Site P1 had high diversity and evenness while P3 had a very low diversity and evenness. Diversities and evenness at P1 and P2 were similar during Cruise III with lower diversities and evenness at P3 and P4. At P1 both diversity and evenness increased from low values during Cruise I to higher and similar values during Cruises II and III. At P2 there was a steady increase in diversity and evenness from Cruise I to Cruise III. Diversity and evenness at P3 were somewhat similar in Cruises I and III, but were very low during Cruise II. Diversities and evenness at P4 were similar for Cruises I and III, and both values increased during Cruise II. Diversities and evenness at P4 were similar for Cruises I and III, and both values increased during Cruise II.

Diversity was very similar at C22, C23, and C24 during Cruise I, but evenness was quite varied (Table 20). At C21 diversity and evenness both were high. During Cruise II, diversity was similar at C23 and C24 but evenness was varied; C22, with a lower diversity than C21, had a higher evenness value than C21. During Cruise III, diversities at C21 and C24 were similar but evenness values were different. Site C23 had a very low diversity and a low evenness. Diversity at C21 was similar during Cruises I and II, but evenness was lower during Cruise II. Cruise III diversity and evenness were high at C21. Comparison of changes at C22 over all cruises indicated similar diversities, but an increase in evenness during Cruise II. Diversity and evenness at C23 both decreased from Cruise I to Cruise III. At Site C24, diversity and evenness during Cruise II decreased somewhat from the value during Cruise I, but increased greatly during Cruise III.

Among the Secondary Sites, S5, S9, S10, S11, S14, and S20 had similar diversities, but were quite varied in evenness (Table 20). Thus, based on similar diversities, as the number of species decreased the evenness increased. Diversities and evenness were similar at S6, S7, S8, S13, and S18 except for a high evenness at S8. Both S12 and S19 had low diversities, but S12 had a high evenness value. The highest diversity was measured at S17 which also had a high evenness.

Table 21 presents the average diversity and evenness values for six major macroepifauna and demersal fish taxa. Osteichthyes had the highest diversities, and evenness over all cruises varied in the same way as the change in diversity. Highest diversity and evenness were measured during Cruise III. Decapoda had similar diversities and evenness during Cruises I and II, and an increase during Cruise III. Polychaeta diversity and evenness decreased from Cruise I to Cruise III, while that for Mollusca increased greatly from Cruise I to Cruise II then decreased slightly in Cruise III. Diversity and evenness for the Echinodermata were similar for Cruises I and II; only one individual of each Echinodermata taxon was collected during Cruise III, which prohibited calculation of diversity and evenness.

3. Macroinfauna:Meiofauna Ratio

The macroinfauna:meiofauna (M:M) ratio, calculated for each station and each cruise, is presented in

TABLE 21. Average diversity and evenness values of major macroepifauna and demersal fish taxa by cruise.

				Evenness					
	Diversity			Pielou			Heip		
Taxa	Cruise I	Cruise II	Cruise III	Cruise I	Cruise II	Cruise III	Cruise I	Cruise II	Cruise III
Polychaeta	0.74	0.60	0.25	0.467	0.456	0.194	0.438	0.388	0.160
Mollusca	0.06	0.78	0.54	0.081	0.490	0.374	0.071	0.391	0.302
Decapoda	1.03	0.95	0.41	0.595	0.554	0.723	0.432	0.422	0.523
Echinodermata	0.06	0.07	--[1]	0.090	0.073	--[1]	0.081	0.054	--[1]
Osteichthyes	1.42	1.39	1.91	0.681	0.538	0.703	0.514	0.355	0.444
Other	0.69	0.51	0.39	0.570	0.427	0.366	0.491	0.358	0.311

[1] Insufficient numbers of individuals per taxa to calculate diversity or evenness.

Appendix D, Tables D1, D2, and D3. No trends along transects or in a particular direction from a site were evident. Table 22 presents the average M:M ratio per site for each cruise. During Cruise I, ratios greater than 100 were calculated at P4 and C22, while C24 had one of the lowest ratios. During Cruise II, C21 had the highest ratio of all sites. In fact, three Control Sites had values higher than the highest value recorded during Cruise I (Table 22). During Cruise III, ratios greater than 100 were calculated at P1, P3, P4, and C22. Comparison of the ratios over all three cruises indicates an increase in the ratio from Cruise I to Cruise III at P1 and P3, with the ratio remaining fairly stable at P2 and C22 (Table 22). At the other Primary and Control Sites, there was a marked increase during Cruise II; the ratio for Cruise III was either slightly above or slightly below Cruise I values.

Table 23 presents the average M:M ratio by depth zonation (less than 30 m, 30 to 90 m, and greater than 91 m) for each cruise. This depth zonation is based primarily upon Defenbaugh (1976). During Cruises I and III, the ratio tended to increase with depth; for Cruise II the ratio showed a marked decline with increased depth. The increase in number of sampling sites during Cruise II, i.e., Secondary Sites, and the resulting high ratios at the Secondary Sites may account for the high ratio during Cruise II at depths less than 20 m. However, the total overall average indicated a decrease in the M:M ratio with depth.

4. *Meiofauna*

a. *Foraminifera*

(1) Population Trends—A total of 53 different taxa of Foraminifera were identified in the meiofauna, 50 during Cruise I, 39 in Cruise II, and 53 in Cruise III (Table 8). Table 24 presents the frequency of observation, abundance, and rank for the meiofaunal Foraminifera collected in this project. ***Bolivina lowmani, Buliminella morgani, Nonionella basiloba,*** and ***Ammonia beccarii*** were among the top 15 meiofauna

TABLE 22. Average macroinfauna:meiofauna ratio by site and cruise.

	Macroinfauna:Meiofauna Ratio[1]			
Site	Cruise I	Cruise II	Cruise III	Average
P01	1:77.48	1:109.31	1:116.53	1:101.11
P02	1:21.89	1:35.27	1:28.55	1:28.57
P03	1:55.44	1:97.42	1:101.05	1:84.30
P04	1:160.79	1:442.50	1:108.81	1:237.37
S05		1:19.85		
S06		1:37.95		
S07		1:220.60		
S08		1:446.54		
S09		1:165.95		
S10		1:236.84		
S11		1:164.01		
S12		1:185.99		
S13		1:88.85		
S14		1:31.92		
S15		1:32.71		
S16		1:71.73		
S17		1:9.27		
S18		1:18.96		
S19		1:50.07		
S20		1:169.05		
C21	1:53.61	1:1,793.08	1:10.75	1:619.15
C22	1:115.17	1:83.97	1:114.63	1:104.59
C23	1:58.77	1:294.82	1:25.78	1:126.46
C24	1:24.47	1:294.85	1:61.39	1:126.90

[1] Ratio based upon numbers per meter^2.

TABLE 23. Average macroinfauna:meiofauna ratio by depth zonation and cruise.

	Macroinfauna:Meiofauna Ratio			
Depth Zone (m)[1]	Cruise I	Cruise II	Cruise III	Average
<30	1:58.52	1:259.98	1:66.37	1:128.29
30 to 90	1:91.33	1:158.79	1:78.55	1:109.56
>91	—	1:32.71	—	1:32.71

[1] Depth zone <30 m included sites P1, P2, S5, S8, S10, S11, S12, S14, S18, S19, S20, C21, C22, and C24.
Depth zone 30 to 90 m included sites P3, P4, S6, S7, S9, S13, S16, S17, and C23.
Depth zone >91 m included only site S15.

TABLE 24. Frequency of observation, abundance, and rank for the meiofauna Foraminifera by cruise.

	Cruise I			Cruise II			Cruise III			Total		
Taxa	Obs[1]	Ind[2]	Rk[3]	Obs	Ind	Rk	Obs	Ind	Rk	Obs	Ind	Rk
Lagenammina comprima	23	601	34	47	925	13	24	1608	21	94	3134	19
Lagenammina diflugiformis	11	155	70	10	91	65	7	64	66	28	310	64
Reophax scottii	22	1142	36	19	927	47	13	54	46	54	2123	41
Haplophragmoides	1	4	196							1	4	241
Ammoscalaria pseudospiralis	17	320	49	11	44	62	7	44	68	35	408	53
Textularia conica	7	45	97							7	45	132
Textularia earlandi	13	97	65	5	21	94	2	4	111	20	122	84
Textularia mayori	1	8	183	11	54	61	4	28	77	16	90	94
Bigenerina irregularis	5	24	117	12	111	57	11	78	51	28	213	67
Siphotextularia affinis	1	10	182	3	14	110				4	24	156
Eggerella bradyi	21	319	38	29	340	32	7	31	70	57	690	40
Miliolacea	24	498	32	16	136	51	5	42	74	45	676	49
Quinqueloculina compta	10	115	77	10	70	67	2	8	103	22	193	80
Quinqueloculina polygona	2	25	152							2	25	189
Quinqueloculina vulgaris	9	328	80	1	2	179				10	330	119
Quinqueloculina poeyana	1	11	181							1	11	230
Quinqueloculina sabulosa	1	2	230				1	4	125	2	6	206
Pyrgo carinata	4	20	124	2	9	132				6	29	142
Pyrgo oblonga	3	23	133							3	23	173
Lenticulina peregrina	5	45	115	1	4	150				6	49	137
Marginulina obesa	1	3	229	1	2	180				2	5	217
Frondicularia compressa	6	28	111	2	158	121	1	4	126	9	190	124
Lagena striata				2	15	128	1	4	127	3	19	175
Lagena spicata	2	14	155							2	14	191
Buliminella elegantissima	15	440	58	25	316	38	13	124	43	53	880	43
Buliminella morgani	35	30021	9	61	43957	4	34	3305	6	130	77283	7
Bolivina lowmani	35	5551	11	63	5870	3	36	2186	1	134	13607	2
Bolivina striatula	19	336	44	27	528	34	12	108	47	58	972	37
Bolivina spinata							1	2	146	1	2	291
Brizalina fragilis	1	7	192	1	2	181				2	9	198
Bulimina marginata	20	527	41	25	177	40	13	97	44	58	801	39
Bulimina elegans	5	59	113				2	12	101		71	131
Uvigerina parvula	3	19	138	6	24	87				9	43	126
Uvigerina bellula	9	141	83	11	84	59	7	40	69	27	265	70
Trifarina bella	3	12	142	7	34	80	11	76	52	21	122	82
Cancris sagra	6	44	106	13	96	56	9	86	57	28	226	66
Rosalina bertheloti	1	2	231							1	2	292
Epistominella							1	2	147	1	2	293
Discorbis squamata	4	23	122	6	33	85	2	13	100	12	69	109
Eponides antillarum	3	20	135	9	53	72	15	118	37	27	191	72
Cibicides concentricus	16	747	51	38	1334	22	27	1709	14	81	3790	26
Cibicides deprimus	4	98	119	6	59	82	1	8	122	11	165	114
Ammonia beccarii	36	4448	6	51	2113	12	27	1814	13	114	8375	12
Elphidium gunteri	16	202	55	9	40	73	12	30	50	37	272	52
Fursenkoina compressa	3	20	136							3	20	174
Fursenkoina complanata	29	7009	23	41	11254	16	14	272	40	84	18535	24
Fursenkoina pontoni	19	252	45	16	503	50	15	157	36	50	912	45
Cassidulina	1	2	232							1	2	294
Florilus atlanticus	14	376	61	18	632	48	13	126	42	45	1134	48
Florilus grateloupi	6	44	107	1	8	145	1	4	128	8	56	128
Nonionella basiloba	36	69656	1	58	47244	9	31	7855	10	125	124755	9
Hanzawaia strattoni	9	483	79							9	483	122
Melonis	2	21	153	3	20	106				5	41	145

[1] Obs — denotes number of observations.
[2] Ind — denotes number of individuals.
[3] Rk — denotes rank.

taxa common to each cruise. Of the taxa selected for cluster analysis, i.e., those taxa which occurred frequently enough and were abundant enough to comprise 98% of the total, 27.5% of Cruise I, 35.3% of Cruise II, and 30.1% of Cruise III were Foraminifera.

Bolivina lowmani was found at all sites except one during Cruise I; during Cruise II at all stations except five; and at all stations during Cruise III (Table 25). For stations at Sites P1, P2, P3, and C22, average numbers of individuals per core were generally higher during Cruise I than during Cruises II or III. At P4, C21, C23 and C24, average numbers of individuals per core were higher during Cruise II than during Cruises I and III. At the Secondary Sites, S11 S2000 had the highest average number of individuals, while values at the other Secondary Stations were comparable to Cruise II values at P1, P2, and P3. The highest average number of individuals per core of *B. lowmani* occurred at C21, Cruise II, while the overall average was also the highest at C21. Total average number of individuals per core per cruise indicated a decrease from Cruise I to Cruise III.

During Cruise I, *Buliminella morgani* was found at all stations except one; during Cruise II at all stations except seven; and during Cruise III at all stations except two (Table 26). Values at P1 and C21 were generally higher during Cruise I than during the other cruises; values at P3, P4, C21, C23, and C24 were higher during Cruise II. Note that at P2 average number of individuals was very low during all three cruises. The highest average number of individuals occurred during Cruise II at P4 S2000, which also had the highest overall average. Most of the values for the Secondary Sites were comparable to values at the Primary Sites, Cruise I. Average number of individuals per core per cruise of *B. morgani* decreased markedly from Cruise I to Cruise III.

Nonionella basiloba occurred at each station during Cruise I; during Cruise II, at all stations except eight; and during Cruise III at all stations except four (Table 27). Generally the values at P1, P2, P3, C21, and C22 were higher during Cruise I than during the other cruises. At P4, C23, and C24, the values were higher during Cruise II. Values at P3 were high over all three cruises with an overall trend toward decreasing from Cruises I to III. Values were markedly low at P1 Cruise I; P2, Cruises II and III; and C21, C22, C23, and C24, Cruise III. Note that at P2 *N. basiloba* was not collected at any 2000-m station during Cruise III. Most Secondary Site values were comparable to P3 values during Cruise III. The overall average number of individuals per core per cruise declined markedly from Cruise I to III.

Ammonia beccarii was present at all stations during Cruise I; during Cruise II, at all except 16 stations; and during Cruise III, at all except eight platform stations and C23 (Table 28). Average numbers of individuals per core at P1, P2, P3, P4, and C22 were generally higher during the other cruises. However, at P1, P2, and C22, Cruise III values were higher than Cruise II values and were comparable to Cruise I values. There was a marked reduction in values at P1, P2, and C22 during Cruise II, and at P3 and P4 during Cruises II and III. Secondary Site values were comparable to Cruise III values at the Primary Sites. The overall averages per cruise decreased after Cruise I and essentially leveled off during Cruises II and III.

Foraminifera comprised 59.1% of the total number of individuals during Cruise I, 68.7% in Cruise II, and 38.1% in Cruise III with an overall average of 55.3% (see Table 10). Table 29 presents the percentage of the total number of individuals by site per cruise for the Foraminifera. The average for all three cruises is plotted in Fig. 7. A higher percentage of Foraminifera occurred at the Control Sites than at the Primary Sites. Primary Site P2 had the lowest percentage of Foraminifera of any Primary or Control Site. At the Secondary Sites, Foraminifera comprised more than 75% of the total number of individuals at Sites S7, S8, S9, S12, and C23 and less than 25% at Sites S5, S17, and S19.

Table 30 indicates that the percentage of total number of meiofauna composed of Foraminifera tended to increase in the depth zone 30 to 90 m and then declined to a percentage slightly lower than that calculated for the depth zone <30 m. Percentages for Cruises I and II were similar, but there was a decline during Cruise III.

During Cruise I, a low of 28,589 individuals per m^2 was found at P2 W500 and W2000 and a high of 3,093,827 individuals per m^2 at C22. During Cruise II, a low of 1,243 individuals per m^2 was collected at S13 N500 and S15 N500, and a high of 3,721,542 individuals per m^2 at P4 S2000. For Cruise III, a low of 9,944 individuals per m^2 was collected at P2 E500 and a high of 886,259 individuals per m^2 at P3 E2000.

Average diversity and evenness values for meiofauna Foraminifera taxa at the Primary and Control Sites were generally higher during Cruise III than during Cruises I or II (Table 31). Two exceptions were P2 and C24. Changes in diversity appeared to be primarily a result of changes in evenness. But changes in numbers of species did seem to affect diversity at P2, P3, S5, S6, S13, S14, S18, and C23.

(2) Live:Total Ratios— The residue from the uncounted portion of the core from the third grab (Core 3.D) at the N500 stations and each Control Site was dried and the first 300 forams were picked for identification and live:dead ratios except for S13 where Core 2.C was picked. In general, the taxa found live in the live:dead samples were the same taxa that occurred in large numbers in the regular samples, i.e., *Nonionella basiloba, Buliminella morgani, Bolivina lowmani,* and *Ammonia beccarii.* These resultant live:dead ratios are presented in Table 32. Both the highest and lowest ratios occurred at the Secondary Sites. Site S10 had a ratio of 0.390, while S7, S13, S14, S15, S17, and S20 had ratios of 0.0 (all Foraminifera dead). The ratio of 0.390 represented a total of 128 live Foraminifera. One-fourth aliquot of the regular sorted sample from the same core at S10 contained only 117 live Foraminifera.

b. Nematoda

(1) Population Trends— A total of 71 different taxa of Nematoda were identified in the meiofauna - 58 during Cruise I, 62 in Cruise II, and 46 in Cruise III (see Table 8). Table 33 presents the frequency of observation, abundance, and rank for the meiofauna Nematoda collected in this project. *Sabatieria, Dorylaimopsis,* Cyatholaimidae, *Theristus,* Linhomoeidae,

TABLE 25. Average number of individuals of *Bolivina lowmani* (Foraminifera) by station and cruise.

Station	Average Number of Individuals/Core			
	Cruise I	Cruise II	Cruise III	Average
01PE0500	15.0	1.0	7.5	7.8
01PE2000	32.0	4.0	25.0	20.3
01PN0500	65.0	.3	9.0	24.8
01PN2000	89.5	1.3	34.0	41.6
01PS0500	2.0	.5	20.5	7.7
01PS2000	13.0	.5	5.0	6.2
01PW0500	36.8	1.5	20.S	19.6
01PW2000	15.8	1.5	12.5	9.9
02PE0500	74.5	1.5	3.0	26.3
02PE2000	34.0	30.5	11.0	25.2
02PN0500	9.5	2.0	13.0	8.2
02PN2000	51.8	1.0	5.0	19.3
02PS0500	75.5		36.5	37.3
02PS2000	40.5	8.8	13.0	20.8
02PW0500	1.5	1.0	1.5	1.3
02PW2000		4.0	23.5	9.2
03PE0500	32.3	24.0	15.0	23.8
03PE2000	7.5	1.5	34.0	14.3
03PN0500	14.0	12.0	6.5	10.7
03PN2000	5.5	13.8	2.5	7.3
03PS0500	16.0	5.0	3.5	8.2
03PS2000	1.0	2.5	4.0	2.5
03PW0500	26.8	46.8	23.0	32.2
03PW2000	9.0	74.8	97.0	60.3
04PE0500	150.5	61.8	8.5	73.6
04PE2000	19.0	24.8	4.0	15.9
04PN0500	22.0	52.3	50.0	14.4
04PN2000	45.3	50.8	12.0	36.0
04PS0500	11.0	88.0	1.0	33.3
04PS2000	22.5	85.5	5.5	37.8
04PW0500	22.3	63.0	3.5	29.6
04PW2000	48.3	21.0	.5	23.3
05SN0500		1.0		
05SN2000		3.0		
06SN0500		3.0		
06SN2000		11.5		
07SN0500		2.0		
07SN2000		1.5		
08SN0500		15.5		
08SN2000		26.0		
09SN0500		5.0		
09SN2000		1.0		
10SN0500		16.0		
10SN2000		62.5		
11SN0500		10.0		
11SN2000		172.8		
12SN0500		28.5		
12SN2000		18.0		
13SN0500		.5		
13SN2000		1.0		
14SN0500		.5		
14SN2000		1.0		
15SN0500				
15SN2000		1.0		
16SN0500		7.5		
16SN2000		3.5		
17SN0500				
17SN2000				
18SN0500		1.5		
18SN2000		3.5		
19SN0500		2.0		
19SN2000				
20SN0500		15.5		
20SN2000		4.5		
21C	260.0	302.0	23.0	195.0
22C	106.3	5.0	6.5	39.3
23C	5.5	45.8	.5	17.3
24C	7.0	9.0	5.5	7.2
Average	38.6	21.6	15.2	

TABLE 26. Average number of individuals of *Buliminella morgani* (Foraminifera) by station and cruise.

Station	Average Number of Individuals/Core			
	Cruise I	Cruise II	Cruise III	Average
01PE0500	231.3	134.0	20.5	128.6
01PE2000	165.5	245.5	14.5	141.8
01PN0500	129.5	75.3	6.0	70.3
01PN2000	246.3	38.8	21.5	102.2
01PS0500	154.0	7.5	19.0	60.2
01PS2000	246.5	99.0	10.5	118.7
01PW0500	359.5	72.8	14.5	148.9
01PW2000	544.5	121.5	18.0	228.0
02PE0500	4.0	2.5		2.2
02PE2000	16.0	18.0	4.5	12.8
02PN0500	3.5	1.0		1.5
02PN2000	6.5	2.5	.5	3.2
02PS0500	13.0	.5	2.5	5.3
02PS2000	19.0	11.8	9.5	13.4
02PW0500	1.5	3.5	.5	1.8
02PW2000		1.0	.5	.5
03PE0500	249.3	260.0	17.0	175.4
03PE2000	98.0	103.0	71.8	90.9
03PN0500	140.8	161.3	27.0	109.7
03PN2000	7.5	143.0	4.0	51.5
03PS0500	193.8	36.0	27.0	85.6
03PS2000	351.8	240.0	132.0	241.3
03PW0500	133.0	223.8	60.0	138.9
03PW2000	155.3	236.5	23.0	138.3
04PE0500	468.0	526.8	8.5	334.4
04PE2000	436.3	253.3	46.5	245.4
04PN0500	280.0	406.8	71.0	252.6
04PN2000	295.8	384.0	67.0	248.9
04PS0500	465.8	544.5	12.0	340.8
04PS2000	439.5	920.3	10.0	456.6
04PW0500	448.8	596.3	37.0	360.7
04PW2000	409.8	350.5	28.5	262.9
05SN0500				
05SN2000		.5		
05SN2000		4.0		
06SN0500		8.0		
06SN2000		11.0		
07SN0500		210.3		
07SN2000		635.5		
08SN0500		645.5		
08SN2000		319.0		
09SN0500		27.5		
10SN0500		33.0		
10SN2000		126.0		
11SN0500		5.5		
11SN2000		112.3		
12SN0500		141.0		
12SN2000		80.0		
13SN0500				
13SN2000		14.0		
14SN0500				
14SN2000		105.5		
15SN0500				
15SN2000		35.0		
16SN0500		127.3		
16SN2000		150.5		
17SN0500		1.0		
17SN2000				
18SN0500		2.5		
18SN2000		81.0		
19SN0500				
19SN2000				
20SN0500		205.5		
20SN2000		68.0		
21C	186.8	216.0	14.5	139.1
22C	274.3	53.0	19.5	115.6
23C	187.8	775.3	6.0	323.0
24C	143.0	575.0	1.5	239.8
Average	208.5	161.6	23.0	

TABLE 27. **Average number of individuals of** *Nonionella basiloba* **(Foraminifera) by station and cruise.**

Station	Average Number of Individuals/Core			
	Cruise I	Cruise II	Cruise III	Average
01PE0500	488.3	25.5		171.3
01PE2000	257.5	42.0	8.5	102.7
01PN0500	269.5	1.0	.5	90.3
01PN2000	424.8	10.8	2.5	146.0
01PS0500	50.5	5.0	4.5	20.0
01PS2000	567.0	39.0	5.5	203.8
01PW0500	1444.8	4.0	3.0	483.9
01PW2000	1762.8	92.0	25.5	626.8
02PE0500	14.5	.5	1.5	5.5
02PE2000	178.0	12.5		63.5
02PN0500	12.5	1.0	1.0	4.8
02PN2000	74.3			24.8
02PS0500	129.5	1.5	2.5	44.5
02PS2000	336.0	21.0		119.0
02PW0500	15.0	.5	1.0	5.5
02PW2000	18.0			6.0
03PE0500	343.5	660.0	160.0	387.8
03PE2000	343.3	177.3	471.8	330.8
03PN0500	656.0	304.0	94.0	351.3
03PN2000	67.0	563.0	21.5	217.2
03PS0500	508.8	68.0	86.5	221.1
03PS2000	862.5	303.0	222.0	462.5
03PW0500	774.0	459.8	337.0	523.6
03PW2000	1051.0	600.8	258.0	636.6
04PE0500	663.0	760.0	1.5	474.8
04PE2000	422.0	394.8	44.5	287.1
04PN0500	374.5	931.8	64.5	456.9
04PN2000	542.0	801.8	27.5	457.1
04PS0500	238.5	696.8	16.0	317.1
04PS2000	493.8	1149.0	7.0	549.9
04PW0500	295.0	582.5	53.0	310.2
04PW2000	398.8	365.0	10.0	257.9
05SN0500		1.0		
05SN2000				
06SN0500		4.0		
06SN2000		6.0		
07SN0500		8.5		
07SN2000		114.8		
08SN0500		368.3		
08SN2000		348.5		
09SN0500		63.0		
09SN2000		5.0		
10SN0500		53.5		
10SN2000		206.5		
11SN0500		9.0		
11SN2000		456.8		
12SN0500		341.5		
12SN2000		154.5		
13SN0500				
13SN2000		5.0		
14SN0500		2.0		
14SN2000		18.5		
15SN0500		.5		
15SN2000		17.5		
16SN0500		117.8		
16SN2000		72.5		
17SN0500		1.0		
17SN2000				
18SN0500				
18SN2000		4.5		
19SN0500				
19SN2000				
20SN0500		331.5		
20SN2000		197.0		
21C	1207.5	117.5	13.5	446.2
22C	1948.8	132.0	9.5	696.8
23C	170.5	402.8	2.0	191.8
24C	11.U	14.0	8.0	11.0
Average	483.7	186.0	54.6	

TABLE 28. Average number of individuals of *Ammonia beccarii* (Foraminifera) by station and cruise.

Station	Average Number of Individuals/Core			
	Cruise I	Cruise II	Cruise III	Average
01PE0500	9.8	6.3	3.5	6.5
01PE2000	11.5	4.5	12.5	9.5
01PN0500	9.0	6.0	8.5	7.8
01PN2000	12.8	2.0	15.0	9.9
01PS0500	9.3	1.5	10.0	6.9
01PS2000	4.5	1.0	2.0	2.5
01PW0500	10.8	.5	10.0	7.1
01PW2000	27.3	2.5	15.0	14.9
02PE0500	36.5	8.0	3.0	15.8
02PE2000	36.0	7.5	75.8	39.8
02PN0500	8.0	2.0	9.5	6.5
02PN2000	165.8	11.5	26.5	67.9
02PS0500	65.3	5.0	58.0	42.8
02PS2000	57.0	4.0	62.0	41.0
02PW0500	2.5	7.0	7.5	5.7
02PW2000	2.5	16.5	25.0	14.7
03PE0500	20.5	3.0		7.8
03PE2000	4.3	2.5	1.3	2.7
03PN0500	15.0	.5	1.0	5.5
03PN2000	3.3		1.5	1.6
03PS0500	15.8	3.0	1.0	6.6
03PS2000	8.5	.5		3.0
03PW0500	20.3	3.3		7.9
03PW2000	4.5	6.0	1.0	3.8
04PE0500	254.5	8.3		87.6
04PE2000	14.0	2.0	.5	5.5
04PN0500	.5		3.0	1.2
04PN2000	72.3	7.5	1.5	27.1
04PS0500	1.3	8.5		3.3
04PS2000	52.3	6.5		19.6
04PW0500	19.5	11.3		10.3
04PW2000	25.3	1.3		8.9
05SN0500		2.5		
05SN2000		7.5		
06SN0500				
06SN2000		2.5		
07SN0500		.5		
07SN2000				
08SN0500		4.0		
08SN2000		18.3		
09SN0500		2.0		
09SN2000				
10SN0500		6.5		
10SN2000		12.5		
11SN0500		5.5		
11SN2000		21.5		
12SN0500		35.0		
12SN2000		21.0		
13SN0500				
13SN2000				
14SN0500				
14SN2000		.5		
15SN0500				
15SN2000				
16SN0500		2.5		
16SN2000		3.5		
17SN0500				
17SN2000				
18SN0500				
18SN2000				
19SN0500				
19SN2000				
20SN0500		5.5		
20SN2000		18.5		
21C	21.5	66.5	14.0	34.0
22C	56.0	4.0	51.5	37.2
23C	2.0	9.3		3.8
24C	32.8	136.0	33.5	67.4
Average	30.9	7.9	12.6	

TABLE 29. Percent total number of individuals per cruise for meiofauna Foraminifera.

Site	Percent Total Number of Individuals/Cruise			
	Cruise I	Cruise II	Cruise III	Average
P01	61.3	41.5	18.0	40.3
P02	19.9	10.6	13.1	16.2
P03	67.6	78.7	56.5	67.6
P04	70.6	82.3	61.0	71.3
S05		2.1		2.1
S06		71.0		71.0
S07		89.4		89.4
S08		93.9		93.9
S09		84.0		84.0
S10		46.7		46.7
S11		51.9		51.9
S12		87.3		87.3
S13		27.8		27.8
S14		68.9		68.9
S15		43.5		43.5
S16		64.9		64.9
S17		12.7		12.7
S18		44.2		44.2
S19		0.2		0.2
S20		57.9		57.9
C21	72.5	63.2	49.7	61.8
C22	76.0	93.2	42.2	70.5
C23	86.2	88.4	51.4	75.3
C24	57.9	82.5	31.5	57.3

TABLE 30. Distribution by depth zonation and cruise of Foraminifera as percent of total number of meiofauna.

Depth Zone (m)[1]	Percent Total Number of Individuals/Cruise			
	Cruise I	Cruise II	Cruise III	Average
<30	57.5	53.2	30.9	47.2
30 to 90	74.8	66.6	56.3	65.9
>91	--	43.5	--	43.5

[1] Depth zone <30 m included sites P1, P2, S5, S8, S10, S11, S12, S14, S18, S19, S20, C21, C22, and C24.

Depth zone 30 to 90 m included sites P3, P4, S6, S7, S9, S13, S16, S17, and C23.

Depth zone >91 m included only site S15.

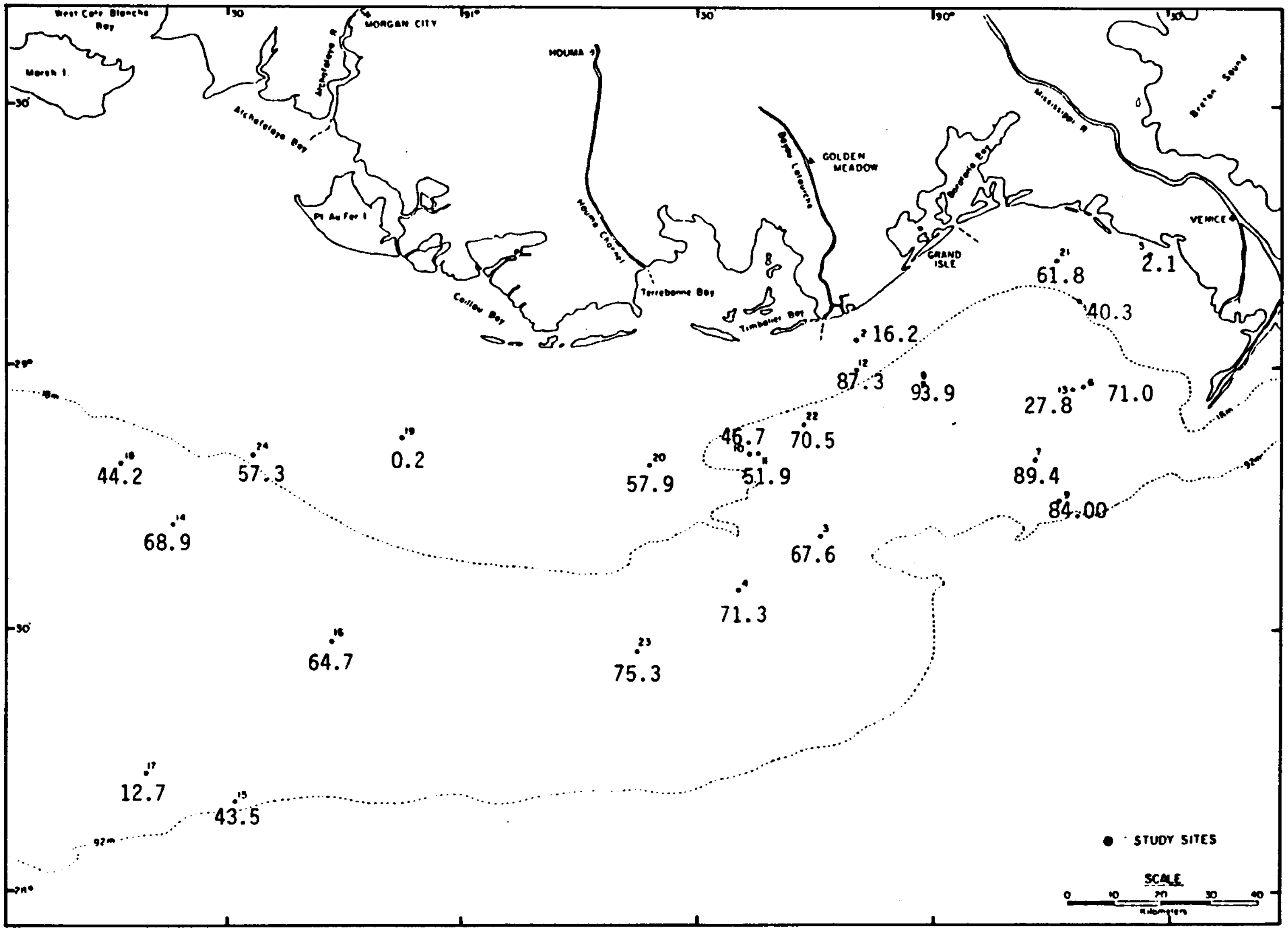

West Cote Blanche Bay
Marsh I.
30'
MORGAN CITY
91°
Atchafalaya R.
Atchafalaya Bay
HOUMA
Pt Au Fer I.
Houma Channel
Caillou Bay
Terrebonne Bay
Timbalier Bay
Bayou Lafourche
GOLDEN MEADOW
Barataria Bay
GRAND ISLE
90°
Mississippi R.
Breton Sound
VENICE
29°
28°
18m
92m
2.1
61.8
40.3
16.2
87.3
93.9
27.8
71.0
46.7
70.5
51.9
89.4
84.00
44.2
57.3
0.2
57.9
68.9
67.6
71.3
64.7
75.3
12.7
43.5
● STUDY SITES
SCALE
0 10 20 30 40
Kilometers

FIG. 7. Distribution map showing by site the percent of total meiofauna composed of Foraminifera

TABLE 31. Average diversity and evenness values of the meiofauna Foraminifera taxa by site and cruise.

Site	Diversity			Evenness					
				Pielou			Heip		
	Cruise I	Cruise II	Cruise III	Cruise I	Cruise II	Cruise III	Cruise I	Cruise II	Cruise III
P01	0.99	0.87	1.43	0.421	0.457	0.743	0.184	0.259	0.542
P02	1.59	1.36	1.05	0.615	0.743	0.625	0.332	0.555	0.438
P03	1.08	1.11	1.55	0.370	0.416	0.554	0.117	0.154	0.248
P04	1.51	1.42	1.64	0.549	0.513	0.667	0.244	0.210	0.413
S05		1.06			0.855			0.767	
S06		1.48			0.807			0.643	
S07		1.27			0.558			0.303	
S08		0.93			0.397			0.164	
S09		0.86			0.447			0.234	
S10		1.55			0.608			0.318	
S11		1.62			0.665			0.405	
S12		1.30			0.498			0.213	
S13		0.38			0.340			0.277	
S14		0.65			0.525			0.384	
S15		0.68			0.272			0.130	
S16		1.30			0.509			0.226	
S17		0.50			0.453			0.426	
S18		1.04			0.662			0.526	
S19		--[1]			--[1]			--[1]	
S20		1.13			0.416			0.154	
C21	0.97	1.37	2.07	0.377	0.552	0.786	0.136	0.267	0.535
C22	0.88	1.20	1.56	0.303	0.456	0.710	0.082	0.179	0.470
C23	1.40	1.29	1.54	0.495	0.465	0.739	0.192	0.176	0.521
C24	1.64	0.89	1.62	0.623	0.302	0.651	0.321	0.080	0.368

[1] Insufficient numbers of individuals per taxa to calculate diversity or evenness.

TABLE 32. Live:dead ratios of Foraminifera by site and cruise.

Site	Live:Dead Ratio			
	Cruise I	Cruise II	Cruise III	Average
P01	0.070	0.004	0.003	0.026
P02	0.144	0.167	0.000	0.104
P03	0.270	0.082	0.034	0.129
P04	0.275	0.196	0.078	0.183
S05		0.032		
S06		0.006		
S07		0.000		
S08		0.285		
S09		0.017		
S10		0.390		
S11		0.067		
S12		0.211		
S13[1]		0.000		
S14		0.000		
S15		0.000		
S16		0.103		
S17		0.000		
S18		0.000		
S19		--[2]		
S20		0.000		
C21	0.330	--	0.067	
C22	0.190	--	0.054	
C23	0.080	0.101	0.008	
C24	0.208	0.203	0.024	

[1] Core 2.C was used for live:dead counts; core 3.D was used in all other cases.

[2] No Foraminifera were found in subsample used for live:dead counts.

TABLE 33. Frequency of observation, abundance, and rank for the meiofauna Nematoda by cruise.

	Cruise I			Cruise II			Cruise III			Total		
Taxa	Obs[1]	Ind[2]	Rk[3]	Obs	Ind	Rk	Obs	Ind	Rk	Obs	Ind	Rk
Nematoda	34	1372	14	29	249	33	15	106	38	78	1727	27
Chromadoria araeolaimida				1	4	152				1	4	252
Campylaimus	10	87	78	11	41	63	4	17	82	25	145	73
Tarvaia	3	12	144	1	4	153				4	16	160
Axonolaimidae	26	528	28	30	525	29	18	195	30	74	1248	28
Axonolaimus	8	34	93	1	2	186	3	7	95	12	43	112
Odontophora	3	14	140	6	31	86	3	48	90	12	93	108
Parodontophora	31	1125	20	31	679	28	30	658	12	92	2462	20
Leptolaimidae	15	11	59	10	71	66	3	10	94	28	292	65
Leptolaimus	8	97	91	21	378	44	4	14	86	33	489	54
Camacolaimidae	1	5	194	3	13	113				4	18	159
Camacolaimus	3	14	141	14	53	55	8	39	65	25	106	75
Tripyloididae	1	7	193	2	20	126				3	27	170
Bathylaimus				1	2	187				1	2	300
Linhomoeidae	35	1654	13	61	1824	6	34	3780	5	130	7258	8
Eleutherolaimus	6	49	103							6	49	138
Terschellingia	35	7635	10	52	3275	11	30	1600	11	117	12510	11
Sphaerolaimidae	2	21	154							2	21	190
Sphaerolaimus	30	535	22	41	304	17	27	217	16	98	1056	15
Monhysteridae	16	269	54	25	201	39	13	96	45	54	566	42
Monhystera	20	411	42	7	49	79				27	460	69
Theristus	36	6870	5	60	4129	7	35	2765	4	131	13764	6
Amphimonhystera	2	4	176	1	4	154	1	4	130	4	12	164
Paramonhystera	20	697	40	4	19	101				24	716	6
Rhynchonema				1	3	175				1	3	288
Xyala				2	31	125	1	4	131	3	35	169
Siphonolaimus	12	91	68	3	8	119	4	17	83	19	116	87
Chromadoria desmodorida				1	3	176				1	3	289
Microlaimidae	2	6	168							2	6	210
Microlaimus	31	1847	19	38	1142	23	17	312	32	86	3301	23
Desmodoridae	28	526	26	45	1034	14	24	292	22	97	1852	17
Metachromadora				3	564	105	1	10	120	4	574	155
Eubostrichus	23	629	33	40	666	19	25	380	20	88	1675	22
Dasynemella				2	70	122				2	70	188
Ceramonematidae	22	415	37	30	354	30	19	150	29	71	919	31
Monoposthiidae	1	2	238	5	34	91				6	36	141
Richtersia	10	154	75	10	120	64	8	263	62	28	537	62
Comesomatidae	8	187	90	6	21	89	18	171	31	32	379	57
Dorylaimopsis	36	2415	8	60	2161	8	36	1319	2	132	5895	4
Sabatieria	36	18543	2	64	13110	1	35	6487	3	135	38140	1
Cervonema	13	249	62	8	66	75	8	65	63	29	382	61
Metacomesoma	32	2731	17	39	2891	20	26	2420	17	97	8042	16
Paracomesoma	29	669	25	22	301	43	14	195	41	65	1165	33
Laimella	10	145	76	20	103	46	12	92	49	42	340	51
Comesoma				2	13	129	1	2	150	3	15	176
Chromadoridae	36	2641	7	38	689	24	26	1853	18	100	5183	13
Euchromadora	1	2	239							1	2	301
Hypodontolaimus	8	372	89	7	57	78				15	429	96
Cyatholaimidae	36	7503	4	61	4956	5	34	3107	7	131	15566	5
Metacyatholaimus	3	26	132							3	26	171
Neotonchus	1	4	208	4	85	98	17	189	33	22	278	79
Choniolaimidae	33	907	16	54	744	10	32	310	9	119	1961	10
Pseudonchus				1	4	155				1	4	253
Desmoscolecidae	1	2	240							1	2	302
Desmoscolex	25	545	30	30	222	31	17	143	34	72	910	30
Tricoma	30	1621	21	43	1871	15	26	488	19	99	3980	14
Ironidae	16	357	52	6	34	84	11	70	54	33	461	55
Anticomidae	2	14	156							2	14	192
Anticoma	7	52	94	3	16	108	3	49	89	13	117	105
Oxystominidae	11	96	71	8	29	77				19	125	86
Halalaimus	34	811	15	36	316	25	27	349	15	97	1476	18
Oxystomina	3	23	134	25	109	41	16	80	35	44	212	50
Thalassolaimus							1	4	132	1	4	254
Phanodermatidae				2	10	131				2	10	196
Enoplidae	6	56	102	4	42	99	4	17	84	14	115	103
Chaetonema				1	3	177				1	3	290
Oncholaimidae	29	1906	24	33	1362	26	21	221	26	83	3489	25
Oncholaimus				3	633	104				3	633	168
Viscosia	1	44	179							1	44	228
Enchelidiidae	4	19	126	7	26	81	6	30	72	17	75	92
Leptosomatidae (nematoda)	1	2	241	1	4	156	2	4	112	4	10	167

[1] Obs —denotes number of observations.
[2] Ind — denotes number of individuals.
[3] Rk — denotes rank.

Choniolaimidae, *Terschellingia*, Chromadoridae, *Tricoma*, and *Sphaerolaimus* were among the top 15 meiofauna taxa common to each cruise. Of the taxa selected for cluster analysis, i.e., those taxa which occurred frequently enough and were abundant enough to comprise 98% of the total, 41.2% of Cruise I, 44.1% of Cruise II, and 43.8% of Cruise III were Nematoda.

Sabatieria was collected at all stations during Cruise I, at all except four stations during Cruise II, and at all except one station during Cruise III (Table 34). Average numbers of individuals per core were generally higher during Cruise I than either Cruises II or III. Both Cruises II and III had comparable values in most cases. Secondary Site values were generally lower than values found at the Primary Sites, with S10 and S11 being noticeable exceptions. The overall average was very high during Cruise I but leveled off for Cruises II and III.

Dorylaimopsis was collected at all stations during Cruises I and III and at all except eight stations in Cruise II (Table 35). There was little pronounced change in average numbers of individuals per core from one cruise to the next. Primary Site P3 did tend to have larger values during Cruise I than during Cruises II or III.

Cyatholaimidae was collected at all stations during Cruise I; at all except seven stations during Cruise II, and at all except two stations during Cruise III (Table 36). Average numbers of the individuals per core were higher during Cruise I at P1, P3, P4, C21, C22, and C24, while at P2 values were higher during Cruise III. Values at P4 were similar for both Cruises I and II. Values at the Secondary Sites were comparable to values at the Primary Sites during Cruise II. The overall average was the highest during Cruise I and markedly low and comparable during Cruises II and III.

Theristus was collected at all stations during Cruise I; at all except seven stations and C22 during Cruise II; and at all except one station in Cruise III (Table 37). At P1, P2, C21, and C22, average numbers of individuals per core were generally higher during Cruise I than during Cruises II or III. Values at P3 and C24 were comparable for all three cruises; at P4 values for Cruises I and II were similar but for Cruise III values were low. Secondary Site values were generally low except for S10, S11, S19, and S20 which were comparable to values at P2, Cruise I. The overall average was the highest during Cruise I and much lower but similar during Cruises II and III.

Linhomoeidae occurred at all stations during Cruise I; during Cruise II at all except seven stations; and during Cruise III at all except two stations (Table 38). Average numbers of individuals per core at P1, P2, and P3 were noticeably higher during Cruise III than during Cruises I or II. Values at P4 were comparable for all three cruises. Secondary Site values were comparable to Primary Site values during Cruises I and II.

Choniolaimidae was collected at all stations except three during Cruise I; at all except fourteen during Cruise II; and at all except four during Cruise III (Table 39). Average numbers of individuals per core per station were generally similar over all cruises except at P2 where values at some stations were higher during Cruise I than Cruises II or III. The overall average was very similar for all cruises.

Terschellingia occurred at all stations during Cruise I; during Cruise II at all except 16 stations; and during Cruise III at all except six stations (Table 40). Average numbers of individuals at P1, P2, C21, C22, and C24 were generally higher during Cruise I than during Cruises II and III. Values at P3 and P4 were slightly higher during Cruise I but were comparable for all three cruises. For all three cruises, P3 and P4 values were much lower than those at P1 and P2. At the secondary sites values were generally low with only S20 having values comparable to P1 or P2 during Cruises I or II. The overall average was the highest during Cruise I and then dropped off, and was the same for both Cruises II and III.

Chromadoridae was collected at all stations during Cruise I; at all except 30 stations during Cruise II; and at all except 10 stations during Cruise III (Table 41). Average numbers of individuals per core at P1, P2, and P4 were generally higher during Cruise I than during Cruises II or III. At P3, values were much higher during Cruise III than Cruises I or II. Values at the Primary Sites during Cruise II were all very low. Few occurrences were noted at the Secondary Sites and values were low. Overall averages were similar for Cruises I and III with the Cruise I value being slightly higher; the Cruise II average was low.

Tricoma was collected at all but six stations during Cruise I; during Cruise II at all except 25 stations; and during Cruise III at all except 10 stations (Table 42). Few *Tricoma* were found at P1 during any of the cruises. Average numbers of individuals per core at P2 and P3 were generally higher during Cruise I than during Cruises II or III. At P4, values tended to be high during Cruise I, increased during Cruise II, and then decreased to very low values during Cruise III. All values at the Control Sites were low except at C22, which had the highest value of any of the Control Sites during all cruises. Secondary Site values tended to be low. In general, all averages showed a marked decrease from Cruise I to Cruise III.

Sphaerolaimus was collected at all but five stations during Cruise I; at all except 27 stations during Cruise II; and at all except nine stations during Cruise III (Table 43). Average numbers of individuals per core per cruise did not appear to demonstrate any trend within a cruise or between cruises because values were very low in all cases. The overall averages did indicate a slightly higher value during Cruise I as compared to Cruises II and III.

Nematoda comprised 32.0% of the total number of individuals during Cruise I, 26.2% in Cruise II, and 54.1% in Cruise III, with an overall average of 37.4% (see Table 10). Table 44 presents the percentage of the total number of individuals by site per cruise for the Nematoda. The averages for all three cruises are plotted in Fig. 8. A higher percentage of Nematoda occurred at the Primary Sites than at the Control Sites. The reverse occurred for the Foraminifera. Control Sites C22 and C23, during Cruise II, had the lowest percentage of Nematoda of any Primary or Control Site in any cruise. At the Secondary Sites, Nematoda comprised less than 15% of the total number of individuals at Sites S6, S7, S8, S9, S12, and S13. The last five of the above six stations had dissolved oxygen (D.O.) values less than 5.0 ppm (see Table 142).

TABLE 34. Average number of individuals of *Sabatieria* (Nematoda) by station and cruise.

	Average Number of Individuals/Core			
Station	Cruise I	Cruise II	Cruise III	Average
01PE0500	105.8	100.8	73.5	93.4
01PE2000	93.8	74.5	47.0	71.8
01PN0500	182.8	70.8	19.5	91.0
01PN2000	160.5	24.3	64.8	83.2
01PS0500	45.8	15.5	31.0	30.8
01PS2000	74.0	34.0	44.0	50.7
01PW0500	129.0	47.3	76.0	84.1
01PW2000	80.8	22.0	66.0	56.3
02PE0500	285.3	78.8	47.0	137.0
02PE2000	320.8	89.5	100.0	170.1
02PN0500	86.5	73.0	54.5	71.3
02PN2000	424.8	86.0	115.8	208.9
02PS0500	329.0	72.5	121.3	174.3
02PS2000	333.0	145.5	59.0	179.2
02PW0500	181.8	63.0	51.3	98.7
02PW2000	111.5	83.5	67.0	87.3
03PE0500	122.0	47.0	65.0	78.0
03PE2000	63.3	28.5	72.0	54.6
03PN0500	25.5	65.3	52.8	47.9
03PN2000	35.0	13.5	24.0	24.2
03PS0500	129.0	16.0		48.3
03PS2000	43.0	6.3	34.0	27.8
03PW0500	113.0	80.5	68.0	87.2
03PW2000	167.3	45.0	53.0	88.4
04PE0500	134.5	71.5	9.5	71.8
04PE2000	50.0	64.0	9.0	41.0
04PN0500	89.0	99.3	28.0	72.1
04PN2000	47.8	35.0	32.0	38.3
04PS0500	79.0	111.0	13.5	67.8
04PS2000	108.0	11.8	6.0	75.3
04PW0500	73.3	77.3	25.5	58.7
04PW2000	89.3	62.0	13.5	54.9
05SN0500		106.8		
05SN2000		246.5		
06SN0500		1.0		
06SN2000				
07SN0500				
07SN2000		2.0		
08SN0500		4.5		
08SN2000		1.0		
09SN0500		25.0		
09SN2000		5.5		
10SN0500		83.5		
10SN2000		90.3		
11SN0500		73.0		
11SN2000		176.0		
12SN0500		15.5		
12SN2000		1.5		
13SN0500				
13SN2000		1.5		
14SN0500		2.5		
14SN2000		11.0		
15SN0500		6.5		
15SN2000		10.0		
16SN0500		12.0		
16SN2000		35.0		
17SN0500		6.0		
17SN2000		5		
18SN0500		7.0		
18SN2000		35.5		
19SN0500		5		
19SN2000				
20SN0500		55.0		
20SN2000		71.5		
21C	150.0	117.5	26.5	98.0
22C	119.3	2.5	30.5	50.8
23C	27.0	36.5	2.5	22.0
24C	26.0	20.0	19.0	21.7
Average	128.8	48.2	45.1	

TABLE 35. Average number of individuals of *Dorylaimopsis* (Nematoda) by station and cruise.

	Average Number of Individuals/Core			
Station	Cruise I	Cruise II	Cruise III	Average
01PE0500	16.5	16.8	8.5	13.9
01PE2000	15.3	15.5	26.3	19.0
01PN0500	9.0	3.8	.5	4.4
01PN2000	7.5	9.0	7.0	7.8
01PS0500	6.3	4.5	4.3	5.0
01PS2000	30.5	24.0	21.5	25.3
01PW0500	1.5	5.8	16.3	7.9
01PW2000	8.0	8.0	13.3	9.8
02PE0500	6.0	2.0	.5	2.8
02PE2000	4.5	12.0	9.0	8.5
02PN0500	5.3	3.0	4.5	4.3
02PN2000	15.3	11.0	8.3	11.5
02PS0500	7.0	5.0	5.8	5.9
02PS2000	19.5	7.0	10.5	12.3
02PW0500	3.8	2.5	4.3	3.5
02PW2000	4.0	10.0	1.0	5.0
03PE0500	40.5	42.0	21.0	34.5
03PE2000	8.5	10.0	24.0	14.2
03PN0500	4.3	23.8	10.5	12.9
03PN2000	12.5	2.0	6.5	7.0
03PS0500	45.0	8.5	9.0	20.8
03PS2000	23.0	2.3	12.0	12.4
03PW0500	59.0	43.5	24.0	42.2
03PW2000	60.3	24.0	8.0	30.8
04PE0500	22.5	8.0	7.5	12.7
04PE2000	1.0	3.0	1.5	1.8
04PN0500	18.3	5.0	3.5	8.9
04PN2000	3.0	3.0	3.0	3.0
04PS0500	6.5	12.0	3.0	7.2
04PS2000	9.0	21.3	2.5	10.9
04PW0500	13.0	5.0	2.0	6.7
04PW2000	2.0	8.0	2.5	4.2
05SN0500		13.3		
05SN2000		13.8		
06SN0500		1.5		
06SN2000		1.0		
07SN0500		5		
07SN2000		5		
08SN0500		12.0		
08SN2000		18.0		
09SN0500		1.0		
09SN2000				
10SN0500		4.0		
10SN2000		19.3		
11SN0500		3.5		
11SN2000		15.3		
12SN0500		3.0		
12SN2000				
13SN0500				
13SN2000				
14SN0500		1.0		
14SN2000		8.5		
15SN0500		1.0		
15SN2000		1.5		
16SN0500		3.0		
16SN2000		1.5		
17SN0500				
17SN2000		.5		
18SN0500		1.5		
18SN2000		13.0		
19SN0500				
19SN2000				
20SN0500		18.5		
20SN2000		10.8		
21C	11.5	2.5	11.5	8.5
22C	76.3		15.5	30.6
23C	3.0	2.0	3.5	2.8
24C	25.0	7.5	17.5	16.7
Average	16.8	8.0	9.2	

TABLE 36. Average number of individuals of Cyatholaimidae (Nematoda) by station and cruise.

Station	Average Number of Individuals/Core			
	Cruise I	Cruise II	Cruise III	Average
01PE0500	43.0	31.0	10.5	28.2
01PE2000	8.5	38.5	6.5	17.8
01PN0500	63.8	7.3	2.5	24.5
01PN2000	128.8	12.8	9.5	50.4
01PS0500	28.0	11.0	13.5	17.5
01PS2000	15.0	25.5	13.0	17.8
01PW0500	51.8	20.0	8.8	26.9
01PW2000	27.0	10.0	23.8	20.3
02PE0500	33.0	9.8	22.5	21.8
02PE2000	66.8	6.0	90.0	54.3
02PN0500	14.0	11.0	64.5	29.8
02PN2000	121.0	16.0	64.5	67.2
02PS0500	65.3	4.5	95.5	55.1
02PS2000	40.8	16.0	63.5	40.1
02PW0500	35.0	7.0	23.5	21.8
02PW2000	11.5	6.5	37.0	18.3
03PE0500	24.8	17.0	20.0	20.6
03PE2000	16.0	.5	17.0	11.2
03PN0500	11.8	10.5	6.3	9.5
03PN2000	8.3	5.5	4.5	6.1
03PS0500	16.0	3.0	7.0	8.7
03PS2000	14.5	8.0	30.0	17.5
03PW0500	24.0	34.0	23.0	27.0
03PW2000	54.5	4.0	11.0	23.2
04PE0500	190.0	35.3		75.1
04PE2000	33.0	23.0	3.0	19.7
04PN0500	95.0	86.3	2.5	61.3
04PN2000	22.5	18.0	41.0	27.2
04PS0500	114.3	66.0	11.5	63.9
04PE2000	65.0	51.5	2.0	39.5
04PW0500	62.3	40.5	22.0	41.6
04PW2000	87.0	37.0	5.5	43.2
05SN0500		17.8		
05SN2000		124.8		
06SN0500				
06SN2000				
07SN0500		1.0		
07SN2000		1.0		
08SN0500		9.0		
08SN2000		4.0		
09SN0500		4.0		
09SN2000		.5		
10SN0500		14.0		
10SN2000		33.3		
11SN0500		23.0		
11SN2000		42.8		
12SN0500		1.0		
12SN2000		.5		
13SN0500				
13SN2000		.5		
14SN0500		.5		
14SN2000		2.0		
15SN0500				
15SN2000		1.5		
16SN0500		1.0		
16SN2000		8.5		
17SN0500				
17SN2000				
18SN0500		4.5		
18SN2000		12.0		
19SN0500		29.3		
19SN2000		1.8		
20SN0500		18.0		
20SN2000		69.3		
21C	174.5	105.0	9.0	96.2
22C	70.0		7.0	25.7
23C	3.0	5.5		2.8
24C	36.5	30.5	5.5	24.2
Average	52.1	18.2	21.6	

TABLE 37. **Average number of individuals of *Theristus* (Nematoda) by station and cruise.**

Station	Average Number of Individuals/Core			
	Cruise I	Cruise II	Cruise III	Average
01PE0500	45.8	66.5	29.0	47.1
01PE2000	47.8	59.0	33.8	46.9
01PN0500	116.3	15.3	1.5	44.4
01PN2000	94.3	4.0	28.8	42.4
01PS0500	23.3	9.0	28.5	20.3
01PS2000	38.5	26.5	26.5	30.5
01PW0500	97.0	14.0	42.8	51.3
01PW2000	71.3	10.0	50.0	43.8
02PE0500	77.8	10.3	8.5	32.2
02PE2000	97.3	14.3	48.8	53.5
02PN0500	37.5	10.0	17.0	21.5
02PN2000	129.8	8.0	50.5	62.8
02PS0500	97.3	5.5	57.5	53.4
02PS2000	148.3	20.5	33.0	67.3
02PW0500	41.0	6.5	14.5	20.7
02PW2000	41.0	11.5	15.0	22.5
03PE0500	27.0	15.0	16.0	19.3
03PE2000	13.5	5.5	29.0	16.0
03PN0500	11.8	21.0	10.3	14.4
03PN2000	8.0	9.0	13.0	10.0
03PS0500	17.0	3.0	15.0	11.7
03PS2000	8.0	3.5	6.0	5.8
03PW0500	27.0	16.5	21.0	21.5
03PW2000	48.0	13.0	21.0	27.3
04PE0500	33.0	10.0		14.3
04PE2000	14.0	15.0	1.5	10.2
04PN0500	24.0	16.0	3.5	14.5
04PN2000	11.8	3.0	8.0	7.6
04PS0500	20.0	29.0	2.5	17.2
04PS2000	39.0	21.3	1.5	20.6
04PW0500	17.0	12.3	2.0	10.4
04PW2000	47.3	4.0	2.0	17.8
05SN0500		2.0		
05SN2000		19.0		
06SN0500				
06SN2000				
07SN0500		1.0		
07SN2000		1.0		
08SN0500		2.0		
08SN2000		1.0		
09SN0500		8.0		
09SN2000		1.5		
10SN0500		36.5		
10SN2000		45.3		
11SN0500		41.0		
11SN2000		107.5		
12SN0500		2.5		
12SN2000		.5		
13SN0500				
13SN2000		2.5		
14SN0500				
14SN2000		3.5		
15SN0500		2.5		
15SN2000		2.5		
16SN0500		6.0		
16SN2000		8.5		
17SN0500				
17SN2000				
18SN0500		.5		
18SN2000		3.5		
19SN0500		143.8		
19SN2000		11.0		
20SN0500		13.5		
20SN2000		39.3		
21C	61.3	23.8	11.0	32.0
22C	62.3		25.5	29.3
23C	4.0	10.5	1.5	5.3
24C	20.0	19.5	15.5	18.3
Average	47.7	15.4	19.2	

TABLE 38. **Average number of individuals of Linhomoeidae (Nematoda) by station and cruise.**

	Average Number of Individuals/Core			
Station	Cruise I	Cruise II	Cruise III	Average
01PE0500	17.0	8.8	47.8	24.5
01PE2000	16.5	17.5	44.5	26.2
01PN0500	20.5	1.5	17.0	13.0
01PN2000	21.8	3.8	48.5	24.7
01PS0500	9.8	1.5	66.0	25.8
01PS2000	19.0	9.0	37.5	21.8
01PW0500	37.3	6.5	73.0	38.9
01PW2000	26.0	4.5	99.5	43.3
02PE0500	5.5	4.0	15.5	8.3
02PE2000	27.8	10.5	85.5	41.3
02PN0500	5.0	3.5	12.0	6.8
02PN2000	17.0	1.5	33.3	17.3
02PS0500	4.0	3.0	69.3	25.4
02PS2000	8.0	9.3	64.5	27.3
02PW0500	5.3	3.0	34.5	14.3
02PW2000	5.0	3.5	38.0	15.5
03PE0500	4.0	7.0	15.0	8.7
03PE2000	7.0	1.0	17.0	8.3
03PN0500	5.0	5.5	10.3	6.9
03PN2000	3.8	6.0	5.5	5.1
03PS0500	8.0	1.0	1.0	3.3
03PS2000	1.5	2.0	14.0	5.8
03PW0500	8.0	5.5	17.0	10.2
03PW2000	16.0	3.0	22.0	13.7
04PE0500	28.5	12.0		13.5
04PE2000	4.0	4.0	.5	2.8
04PN0500	5.0	14.5	.5	6.7
04PN2000	2.5	2.0	9.5	4.7
04PS0500	10.3	7.0	3.5	6.9
04PS2000	17.0	15.0	2.5	11.5
04PW0500	5.0	8.3	2.0	5.1
04PW2000	10.0	2.0	4.5	5.5
05SN0500		3.5		
05SN2000		31.0		
06SN0500				
06SN2000				
07SN0500		.5		
07SN2000		1.0		
08SN0500		8.0		
08SN2000		2.0		
09SN0500		1.0		
09SN2000				
10SN0500		9.0		
10SN2000		23.8		
11SN0500		9.0		
11SN2000		29.8		
12SN0500		29.5		
12SN2000		3.5		
13SN0500				
13SN2000		1.0		
14SN0500				
14SN2000		1.0		
15SN0500		5		
15SN2000		1.0		
16SN0500		1.0		
16SN2000		5.0		
17SN0500		5		
17SN2000				
18SN0500		1.5		
18SN2000		2.5		
19SN0500		15.5		
19SN2000		3.0		
20SN0500		19.5		
20SN2000		15.5		
21C	11.0	40.0	6.0	19.0
22C	9.3		12.5	7.3
23C	3.0	4.0		2.3
24C	12.5	6.0	15.5	11.3
Average	11.6	6.7	26.3	

TABLE 39. Average number of individuals of Choniolaimidae (Nematoda) by station and cruise.

Station	Average Number of Individuals/Core			
	Cruise I	Cruise II	Cruise III	Average
01PE0500	5.0	1.0	1.5	2.5
01PE2000	6.0	2.8		2.9
01PN0500	3.5	.3		1.3
01PN2000	3.3	1.0	2.5	2.3
01PS0500	4.5	.5	1.3	2.1
01PS2000	1.5	3.0	.5	1.7
01PW0500	6.3	2.5	1.3	3.4
01PW2000	10.5	1.0	1.3	4.3
02PE0500	13.0	1.0	1.0	5.0
02PE2000	17.8		7.0	8.3
02PN0500	6.0	1.5	.5	2.7
02PN2000	42.0	3.0	12.3	19.1
02PS0500	27.8	2.5	6.0	12.1
02PS2000	7.5		1.5	3.0
02PW0500	5.0	.5	.5	2.0
02PW2000	8.5	2.0	4.0	4.8
03PE0500	2.0	4.0	2.0	2.7
03PE2000		1.0	3.0	1.3
03PN0500	2.8	5.0	2.5	3.4
03PN2000	4.5	6.5	4.0	5.0
03PS0500		4.0	2.0	2.0
03PS2000	1.0		3.0	1.3
03PW0500	2.0	2.0	4.0	2.7
03PW2000	7.3	2.0	1.0	3.4
04PE0500	5.8	3.0		2.9
04PE2000	1.0		1.5	.8
04PN0500		8.0	1.0	3.0
04PN2000	1.5	5.0	.5	2.3
04PS0500	1.5	12.0	2.5	5.3
04PS2000	3.0	7.0	1.0	3.7
04PW0500	10.0	6.0		5.3
04PW2000	1.0	3.0	1.0	1.7
05SN0500				
05SN2000		1.0		
06SN0500				
06SN2000				
07SN0500		.5		
07SN2000		.5		
08SN0500		1.0		
08SN2000				
09SN0500				
09SN2000				
10SN0500		4.0		
10SN2000		1.5		
11SN0500		5		
11SN2000		7.8		
12SN0500		3.0		
12SN2000				
13SN0500				
13SN2000		.5		
14SN0500				
14SN2000		.5		
15SN0500		.5		
15SN2000		1.0		
16SN0500		1.5		
16SM2000		1.5		
17SN0500		1.5		
17SN2000				
18SN0500		2.0		
18SN2000		2.0		
19SN0500		29.3		
19SN2000		9.5		
20SN0500		1.5		
20SN2000		15.8		
21C	3.5	3.8	1.5	2.9
22C	7.0	.5	3.5	3.7
23C	3.5	2.0	.5	2.0
24C	1.5	2.0	2.0	1.8
Average	6.3	2.7	2.2	

TABLE 40. Average number of individuals of *Terschellingia* (Nematoda) by station and cruise.

	Average Number of Individuals/Core			
Station	Cruise I	Cruise II	Cruise III	Average
01PE0500	122.5	68.0	18.3	69.6
01PE2000	71.0	36.5	22.0	43.2
01PN0500	191.0	19.8	4.0	71.6
01PN2000	217.3	15.8	18.5	83.9
01PS0500	48.3	43.0	14.3	35.2
01PS2000	67.5	23.5	12.0	34.3
01PW0500	210.3	34.3	20.5	88.4
01PW2000	81.0	24.0	10.3	38.4
02PE0500	64.5	46.8	4.5	38.6
02PE2000	97.0	89.0	68.3	84.8
02PN0500	20.5	23.5	7.5	17.2
02PN2000	138.0	15.5	34.8	62.8
02PS0500	55.8	43.0	43.3	47.4
02PS2000	135.0	61.8	24.5	73.8
02PW0500	26.5	24.5	23.5	24.8
02PW2000	47.0	11.0	25.0	27.7
03PE0500	12.5		4.0	5.5
03PE2000	6.0	2.0	2.0	3.3
03PN0500	2.3	1.0	3.5	2.3
03PN2000	1.5			.5
03PS0500	11.0	2.5	2.5	5.3
03PS2000	7.0	3.0		3.3
03PW0500	9.0	5.0	6.0	6.7
03PW2000	32.8	4.0	1.0	12.6
04PE0500	6.8	5.0	.5	4.1
04PE2000	3.0	3.0		2.0
04PN0500	21.5	4.5	10.0	12.0
04PN2000	2.5	4.0	1.0	2.5
04PS0500	13.5	3.0	1.0	5.8
04PS2000	5.0	9.0	1.0	5.0
04PW0500	9.0	13.3		7.4
04PW2000	4.0	5.0		3.0
05SN0500		.5		
05SN2000		3.8		
06SN0500		.5		
06SN2000		.5		
07SN0500		.5		
07SN2000		2.0		
08SN0500		6.0		
08SN2000		1.0		
09SN0500				
09SN2000				
10SN0500		7.0		
10SN2000		15.8		
11SN0500		4.0		
11SN2000		30.8		
12SN0500		4.5		
12SN2000		.5		
13SN0500				
13SN2000				
14SN0500				
14SN2000		.5		
15SN0500				
15SN2000				
16SN0500		2.0		
16SN2000		4.0		
17SN0500				
17SN2000				
18SN0500				
18SN2000		3.0		
19SN0500				
19SN2000				
20SN0500		23.5		
20SN2000		48.5		
21C	73.5	14.0	2.5	30.0
22C	85.5		8.0	31.2
23C	2.0			.7
24C	12.5	2.0	6.0	6.8
Average	53.2	12.0	11.1	

TABLE 41. **Average number of individuals of Chromadoridae (Nematoda) by station and cruise.**

Station	Average Number of Individuals/Core			
	Cruise I	Cruise II	Cruise III	Average
01PE0500	7.5		2.5	3.3
01PE2000	5.5	2.3	2.0	3.3
01PN0500	40.5			13.5
01PN2000	5.5	.3		1.9
01PS0500	7.0		2.3	3.1
01PS2000	2.0	.5	1.5	1.3
01PW0500	3.8	2.0		1.9
01PW2000	13.3	.5	.5	4.8
02PE0500	33.3	1.8	6.5	13.9
02PE2000	44.5	.5	12.0	19.0
02PN0500	17.8	1.0	18.0	12.3
02PN2000	130.3	2.0	16.3	49.5
02PS0500	65.5	1.5	9.0	25.3
02PS2000	33.5	.5	9.0	14.3
02PW0500	24.3		4.5	9.6
02PW2000	18.0	.5	7.0	8.5
03PE0500	14.0		33.0	15.7
03PE2000	13.5	.5	50.0	21.3
03PN0500	28.8	6.0	51.8	28.9
03PN2000	8.0	4.5	26.5	13.0
03PS0500	13.0		25.5	12.8
03PS2000	1.0		4.0	1.7
03PW0500	12.0	4.5	58.0	24.8
03PW2000	15.0		112.0	42.3
04PE0500	12.3	6.0		6.1
04PE2000	3.0	2.0		1.7
04PN0500	26.3	13.3	2.5	14.0
04PN2000	5.0	3.0	6.5	4.8
04PS0500	3.8	11.0		4.9
04PS2000	5.0	2.0		2.3
04PW0500	9.0	1.0	1.0	3.7
04PW2000	21.8	2.0	1.0	8.3
05SN0500				
05SN2000		1.3		
06SN0500				
06SN2000				
07SN0500				
07SN2000				
08SN0500				
08SN2000				
09SN0500				
09SN2000				
10SN0500		18.5		
10SN2000		18.5		
11SN0500		5.0		
11SN2000		15.8		
12SN0500				
12SN2000				
13SN0500				
13SN2000				
14SN0500				
14SN2000		.5		
15SN0500				
15SN2000		1.0		
16SN0500				
17SN0500		1.0		
17SN2000				
18SN0500				
18SN2000		1.0		
19SN0500		17.3		
19SN2000		4.0		
20SN0500		1.0		
20SN2000		3.0		
21C	6.3			2.1
22C	7.8			2.6
23C	2.0	15.5		5.8
24C	1.0		.5	.5
Average	18.4	2.5	12.9	

TABLE 42. Average number of individuals of *Tricoma* (Nematoda) by station and cruise.

Station	Average Number of Individuals/Core			
	Cruise I	Cruise II	Cruise III	Average
01PE0500				.0
01PE2000			3.5	1.2
01PN0500	7.5			2.5
01PN2000	4.3			1.4
01PS0500			.5	.2
01PS2000		1.0	1.0	.7
01PW0500		.5		.2
01PW2000			1.5	.5
02PE0500	6.8			2.3
02PE2000	16.3	1.3	4.0	7.2
02PN0500	.5	.5	1.0	.7
02PN2000	22.0		8.0	10.0
02PS0500	9.0		2.0	3.7
02PS20500	16.0	2.0	.5	6.2
02PW0500	1.3		2.0	1.1
02PW2000	2.0		.5	.8
03PE0500	2.0	3.0	16.0	7.0
03PE2000	6.5	1.5	15.0	7.7
03PN0500	.5	5.5	11.0	5.7
03PN2000	2.0	.5	1.5	1.3
03PS0500	14.0	.5	7.0	7.2
03PS2000	3.0	1.5	5.0	3.2
03PW0500	4.0	2.0	10.0	5.3
03PW2000	9.5	1.0	6.0	5.5
04PE0500	69.8	35.0	1.0	35.3
04PE2000	7.0	39.0		15.3
04PN0500	38.3	44.8	6.5	29.9
04PN2000	28.3	13.0	7.5	16.3
04PS0500	15.5	35.0	2.0	17.5
04PS2000	23.0	65.5		29.5
04PW0500	12.0	47.8	2.0	20.6
04PW2000	45.8	43.0	1.5	30.1
05SN0500		1.0		
05SN2000		2.8		
06SN0500				
06SN2000				
07SN0500		1.0		
07SN2000		10.5		
08SN0500		2.5		
08SN2000				
09SN0500		5.5		
09SN2000		1.5		
10SN0500		3.5		
10SN2000		8.5		
11SN0500		1.0		
11SN2000		21.5		
12SN0500		4.0		
12SN2000				
13SN0500				
13SN2000				
14SN0500				
14SN2000		.5		
15SN0500		.5		
15SN2000		6.0		
16SN0500		17.0		
16SN2000		14.5		
17SN0500				
17SN2000				
18SN0500				
18SN2000		3.5		
19SN0500				
19SN2000				
20SN0500				
20SN2000		2.3		
21C	8.3	3.0		3.8
22C	24.5			8.2
23C	5	11.5		4.0
24C	5.5	2.0	5.5	4.3
Average	11.3	6.9	3.4	

TABLE 43. Average number of individuals of *Sphaerolaimus* (Nematoda) by station and cruise.

Station	Average Number of Individuals/Core			
	Cruise I	Cruise II	Cruise III	Average
01PE0500	2.0	1.0	2.5	1.8
01PE2000	4.0	6.3	3.0	4.4
01PN0500	1.8			.6
01PN2000	12.3	1.3		4.5
01PS0500	.8		1.0	.6
01PS2000	1.5	1.0	2.0	1.5
01PW0500		2.0	1.5	1.2
01PW2000	4.8	1.5	2.3	2.9
02PE0500	.5	.5	1.0	.7
02PE2000	2.3	.8	8.3	3.8
02PN0500	1.5		2.5	1.3
02PN2000	7.0	.5	4.5	4.0
02PS0500	7.3	.5	2.0	3.3
02PS2000	6.3	1.3	2.5	3.4
02PW0500		1.0	1.0	.7
02PW2000	2.5	.5	.5	1.2
03PE0500	3.5	1.0	1.0	1.8
03PE2000	5.0	1.0	5.0	3.7
03PN0500	1.0	2.0	1.3	1.4
03PN2000	1.0		.5	.5
03PS0500			1.0	.3
03PS2000	2.0		2.0	1.3
03PW0500	6.0	2.0		2.7
03PW2000	12.3	1.0		4.4
04PE0500	8.3	1.0		3.1
04PE2000		2.0	1.0	1.0
04PN0500	1.5	2.5		1.3
04PN2000	7.5	1.0	1.5	3.3
04PS0500		8.0	2.5	3.5
04PS2000	2.0	2.0	.5	1.5
04PW0500	11.0	2.0		4.3
04PW2000	5.3	4.0		3.1
05SN0500				
05SN2000		3.0		
06SN0500				
06SN2000				
07SN0500				
07SN2000		2.8		
08SN0500		2.0		
08SN2000				
09SN0500				
09SN2000				
10SN0500				
10SN2000		.5		
11SN0500				
11SN2000				
12SN0500		1.0		
12SN2000				
13SN0500				
13SN2000				
14SN0500				
14SN2000				
15SN0500		1.5		
15SN2000		1.5		
16SN0500		2.0		
16SN2000		2.0		
17SN0500				
17SN2000				
18SN0500		.5		
18SN2000		2.0		
19SN0500				
19SN2000				
20SN0500		2.0		
20SN2000		3.3		
21C	3.0		1.0	1.3
22C	8.8		1.5	3.4
23C	2.0	3.0		1.7
24C	1.5	1.5	1.0	1.3
Average	3.8	1.1	1.5	

TABLE 44. Percent total number of individuals per cruise for meiofauna Nematoda.

Site	Percent Total Number of Individuals/Cruise			
	Cruise I	Cruise II	Cruise III	Average
P01	32.3	54.2	76.9	54.5
P02	61.5	83.0	81.1	75.2
P03	24.9	14.7	34.3	24.6
P04	21.4	13.9	28.7	21.3
S05		88.2		88.2
S06		9.7		9.7
S07		6.8		6.8
S08		4.3		4.3
S09		12.8		12.8
S10		44.0		44.0
S11		42.2		42.2
S12		8.9		8.9
S13		9.3		9.3
S14		22.8		22.8
S15		41.5		41.5
S16		26.2		26.2
S17		48.1		48.1
S18		47.1		47.1
S19		97.7		97.7
S20		37.5		37.5
C21	24.1	31.9	47.5	34.5
C22	18.8	1.8	53.8	24.8
C23	11.2	8.1	25.7	15.0
C24	34.8	14.1	60.0	36.3

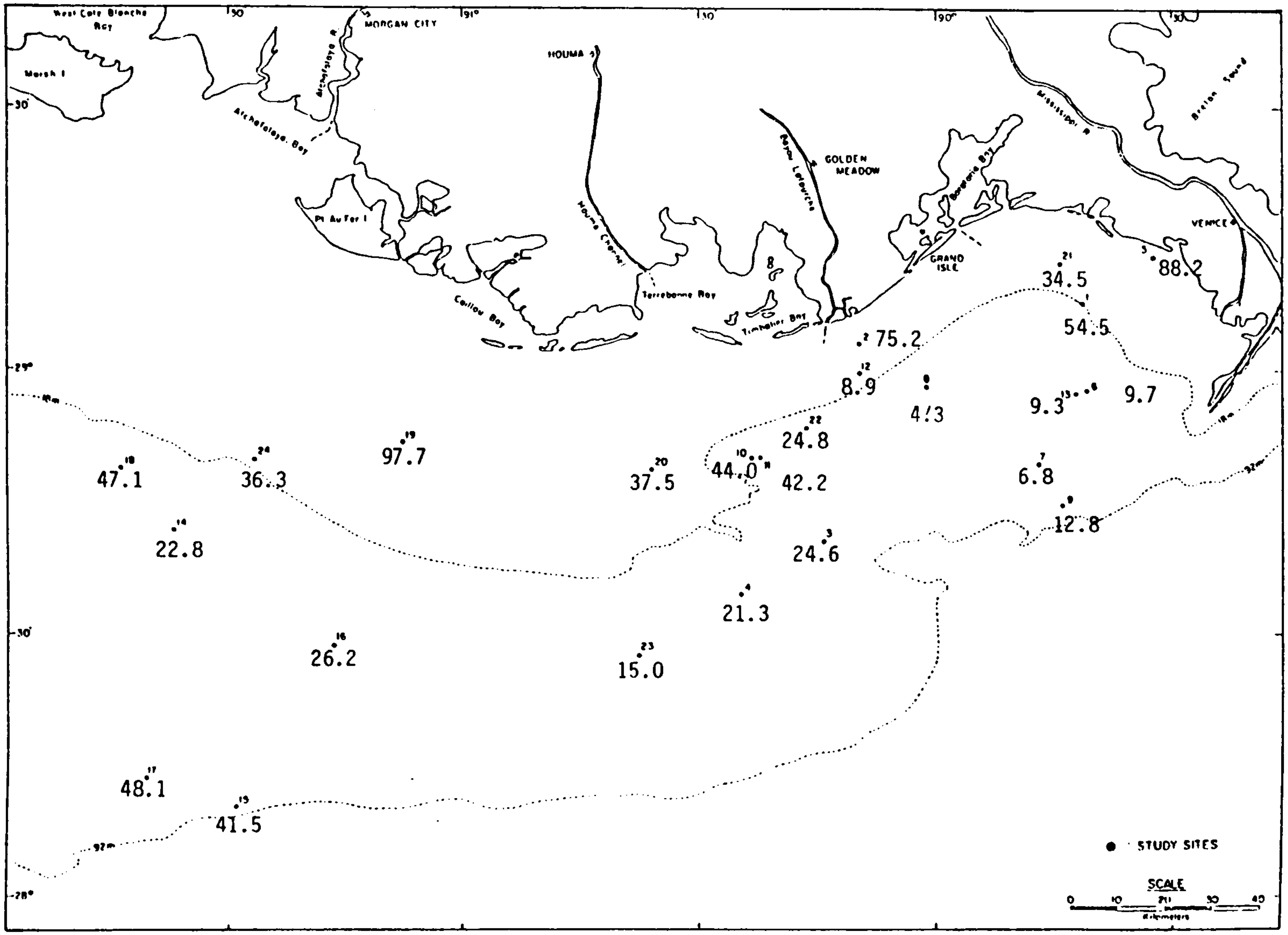

West Cote Blanche Bay
Marsh I
Atchafalaya Bay
Atchafalaya R
MORGAN CITY
Pt Au Fer I
HOUMA
Houma Channel
Caillou Bay
Terrebonne Bay
Timbalier Bay
Bayou Lafourche
GOLDEN MEADOW
GRAND ISLE
Barataria Bay
Mississippi R
Breton Sound
VENICE
30'
91°
90°
29°
28°
18m
92m
47.1
36.3
97.7
37.5
44.0
42.2
24.8
75.2
8.9
4.3
34.5
54.5
88.2
9.3
9.7
6.8
12.8
24.6
21.3
22.8
26.2
15.0
48.1
41.5
STUDY SITES
SCALE
0
10
20
30
40
Kilometers

FIG. 8. Distribution map showing by site the percent of total meiofauna composed of Nematoda

Table 45 indicates that for all three cruises the percentage of total number of individuals comprised of meiofauna Nematoda tended to decrease with depth, with the exception of the depth zone >90 m. However, only one value was available for the depth zone >90 m (S15), and therefore a percentage of 41.5% may not be a true indication of a noticeable increase. There also appeared to be a tendency to increase from Cruise I to Cruise II, perhaps indicating some seasonal effect.

During Cruise I, a low of 69,608 individuals per m^2 was found at C23 and a high of 1,777,490 individuals per m^2 at P2 N2000. During Cruise II, a low of 2,486 individuals per m^2 was collected at S6 N2000 and S17 N2000 and a high of 778,118 individuals per m^2 at S5 N2000. For Cruise III, a low of 11,187 individuals per m^2 was collected at C23 and a high of 692,351 individuals per m^2 at P3 E2000.

Average diversity and evenness values for meiofauna Nematoda were generally similar for all three cruises and similar between the Primary and Control sites (Table 46). Two exceptions were C22 (Cruise II) and C23 (Cruise III). These decreases in diversity were due to a decrease in number of species and not a decrease in evenness. There was no pronounced increase or decrease in diversity or evenness from Cruise I to Cruise II. The six Secondary Sites which had exceptionally low total average percentages of total number of individuals had moderate Nematoda diversities, except S13. Sites S13 and C22, Cruise II, had the lowest Nematoda diversities. Diversity decrease at S13 was probably the result of a decrease in number of species coupled with a decrease in evenness.

(2) Harpacticoida:Nematoda Ratio— The average ratio at each site for all three cruises indicates that the Nematoda far outnumbered the Harpacticoida (Table 47). The lowest ratios were found during Cruise II and at C24 during Cruise I. However, some of the highest values were found at S15, S16, and S17 during Cruise II; one other high value was found at C23 during Cruise III.

Averages for all three cruises at the Primary Sites ranged from 0.0142 to 0.0551, with an overall average for Primary Sites being 0.0297. Averages for all cruises at the Control Sites ranged from 0.0118 to 0.0799 with an overall average of 0.0308. Therefore, the Harpacticoida:Nematoda (H:N) ratio was higher at the Controls than at the Primary Sites, but the ratios appeared to be similar. The average for all Primary and Control Sites for all cruises was 0.0303, which is comparable to the 0.04 ratio reported by Pequegnat (1979) for the BLM South Texas OCS Project.

If the average H:N ratio is examined by depth zone over seasons, one can see a general trend toward increasing ratio with depth regardless of season (Table 48). This increase appeared to be related to a decrease in Nematoda numbers due to a corresponding increase in percent sand. There did not appear to be a seasonal trend within a depth zone.

c. Kinorhyncha

A total of nine taxa of Kinorhyncha were identified in the meiofauna; nine during Cruise I, four in Cruise II, and three in Cruise III (see Table 8). Table 49 presents the frequency of observation, abundance, and rank for the meiofauna Kinorhyncha collected in this project. None of the Kinorhyncha taxa were in the top 15 meiofauna taxa common to each cruise. Of the taxa selected for cluster analysis, i.e., those taxa which occurred frequently enough and were abundant enough to comprise 98% of the total, 3.8% of Cruise I, 2.9% of Cruise II, and 2.7% of Cruise III were Kinorhyncha.

Kinorhyncha comprised 0.9% of the total number of individuals during Cruise I, 0.4% in Cruise II, and 0.6% in Cruise III, with an overall average of 0.6% (see Table 10). Table 50 presents the percentage of the total number of individuals by station per cruise for the Kinorhyncha. A higher percentage of Kinorhyncha occurred at the Primary Sites than at the Control or Secondary Sites. Kinorhyncha were found at 11 Secondary Sites and four Control Sites. Site P2 had the highest percentage of number of individuals of any site for all three cruises. Percentages at the Secondary Sites were similar to those at the Control Sites.

Densities ranging from 1,243 to 139,216 per m^2 were found for the kinorhynchs during Cruise I. During Cruise II, densities ranged from 1,243 to 23, 617 per m^2; for Cruise III, densities ranging from 1,243 to 11,187 per m^2 were observed.

Average diversity and evenness values for meiofauna Kinorhyncha were generally higher at the Control Sites (for sites where diversity could be calculated) than at the Primary Sites (Table 51). The high diversity values at the Control Sites appeared to be the result of increased evenness and not an increase in number of species. At the Primary Sites, diversity generally decreased from Cruise I to Cruise III at P1 and P3, but showed a slight increase at P2 and P4. For Control Sites, where sufficient data were available, diversity remained consistent over all cruises.

d. Harpacticoida

A total of 64 taxa of Harpacticoida were identified in the meiofauna; 48 in Cruise I, 31 in Cruise II, and 30 in Cruise III (see Table 8). Table 52 presents the frequency of observation, abundance, and rank for the meiofauna Harpacticoida collected in this project. None of the Harpacticoida were among the top 15 meiofauna taxa common to each cruise. Of the taxa selected for cluster analysis, i.e., those taxa which occurred frequently enough and were abundant enough to comprise 98% of the total, 10.0% of Cruise I, 2.9% of Cruise II, and 9.6% of Cruise III were Harpacticoida.

Harpacticoida comprised 1.3% of the total number of individuals during Cruise I, 0.2% in Cruise II, and 2.1% in Cruise III with an overall average of 1.2% (see Table 10). Table 53 presents the percentage of the total number of individuals by station per cruise that were Harpacticoida. The highest average percentage,25.3%, was at S17. All other percentages were less than 5%. Site S17 had a high percentage of silts and clays and a D.O. reading of 5.0. There is no apparent explanation for the high percentage of Harpacticoida.

Table 54 indicates that the percentage of meiofauna Harpacticoida tended to increase slightly with depth. Because the percentages were very low, it is difficult to detect trends.

During Cruise I, harpacticoid densities ranging from 1,243 to 125,543 per m^2 were observed. Cruise II densities ranged from 1,243 to 22,374 per m^2; Cruise III densities ranged from 1,243 to 50,963 per m^2.

TABLE 45. Distribution by depth zonation and cruise of Nematoda as percent of total number of meiofauna.

	Percent Total Number of Individuals/Cruise			
Depth Zone (m)[1]	Cruise I	Cruise II	Cruise III	Average
< 30	34.3	41.3	63.9	46.5
30 to 90	19.2	16.6	29.6	21.8
> 91	--	41.5	--	41.5

[1] Depth zone <30 m included sites P1, P2, S5, S8, S10, S11, S12, S14, S18, S19, S20, C21, C22, and C24.
Depth zone 30 to 90 m included sites P3, P4, S6, S7, S9, S13, S16, S17, and C23.
Depth zone >91 m included only site S15.

TABLE 46. Average diversity and evenness values of the meiofauna Nematoda taxa by site and cruise.

				Evenness					
	Diversity			Pielou			Heip		
Site	Cruise I	Cruise II	Cruise III	Cruise I	Cruise II	Cruise III	Cruise I	Cruise II	Cruise III
P01	2.42	2.10	2.13	0.751	0.724	0.741	0.430	0.424	0.444
P02	2.23	1.67	2.25	0.698	0.612	0.721	0.357	0.282	0.391
P03	2.62	2.32	2.57	0.778	0.759	0.785	0.460	0.466	0.477
P04	2.38	2.30	1.98	0.743	0.766	0.780	0.416	0.470	0.545
S05		1.70			0.588			0.264	
S06		1.16			0.934			0.888	
S07		2.07			0.879			0.745	
S08		2.06			0.804			0.589	
S09		1.98			0.797			0.584	
S10		2.34			0.706			0.355	
S11		2.20			0.686			0.340	
S12		1.74			0.776			0.557	
S13		0.80			0.443			0.389	
S14		1.96			0.833			0.639	
S15		2.26			0.854			0.655	
S16		2.45			0.795			0.509	
S17		1.65			0.926			0.829	
S18		2.00			0.774			0.522	
S19		1.99			0.627			0.288	
S20		2.33			0.748			0.431	
C21	2.09	1.98	2.19	0.649	0.661	0.745	0.294	0.328	0.442
C22	2.60	0.80	2.32	0.781	0.725	0.789	0.462	0.609	0.512
C23	2.02	2.41	1.50	0.698	0.804	0.839	0.384	0.532	0.699
C24	2.64	2.41	2.62	0.811	0.791	0.813	0.522	0.506	0.528

TABLE 47. Average Harpacticoida:Nematoda ratio by site and cruise.

Site	Harpacticoida:Nematoda Ratio			
	Cruise I	Cruise II	Cruise III	Average
P01	0.0252	0.0065	0.0110	0.0142
P02	0.0529	0.0002	0.0348	0.0293
P03	0.0619	0.0098	0.0936	0.0551
P04	0.0299	0.0177	0.0129	0.0202
S05		<0.0001		
S06		<0.0001		
S07		<0.0001		
S08		0.0216		
S09		0.0223		
S10		0.0033		
S11		0.0022		
S12		<0.0001		
S13		<0.0001		
S14		0.0069		
S15		0.1008		
S16		0.1211		
S17		0.4314		
S18		0.0053		
S19		0.0018		
S20		0.0020		
C21	0.0297	<0.0001	0.0058	0.0118
C22	0.0423	<0.0001	0.0074	0.0166
C23	0.0360	0.0926	0.1111	0.0799
C24	<0.0001	0.0076	0.0373	0.0149

TABLE 48. Average Harpacticoida:Nematoda ratio by depth zonation and cruise.

Depth Zone (m)[1]	Harpacticoida:Nematoda Ratio			
	Cruise I	Cruise II	Cruise III	Average
<30	0.0300	0.0041	0.0193	0.0178
30 to 90	0.0426	0.0772	0.0725	0.0641
>91	--	0.1008	--	0.1008

[1] Depth zone <30 m included sites P1, P2, S5, S8, S10, S11, S12, S14, S18, S19, S20, C21, C22, and C24.
Depth zone 30 to 90 m included sites P3, P4, S6, S7, S9, S13, S16, S17, and C23.
Depth zone >91 m included only site S15.

TABLE 49. Frequency of observation, abundance, and rank for the meiofauna Kinorhyncha by cruise.

Taxa	Cruise I			Cruise II			Cruise III			Total		
	Obs[1]	Ind[2]	Rk[3]	Obs[1]	Ind[2]	Rk[3]	Obs[1]	Ind[2]	Rk[3]	Obs[1]	Ind[2]	Rk[3]
Kinorhyncha	9	47	85	3	10	114				12	57	110
Homalorhagida	1	4	207							1	4	251
Pycnophyes	13	52	66	10	51	69	2	6	107	25	109	74
Trachydemus	23	158	35	17	86	49	8	40	64	48	284	47
Neocentrophyes	2	4	175							2	4	219
Cyclorhagida	1	1	252							1	1	333
Echinoderes	35	1659	12	33	451	27	21	274	25	89	2384	21
Semnoderidae	2	8	161							2	8	200
Cateria	2	6	167							2	6	209

[1] Obs—denotes number of observations.
[2] Ind—denotes number of individuals.
[3] Rk—denotes rank.

TABLE 50. Percent total number of individuals by site and cruise for meiofauna Kinorhyncha.

	Percent Total Number of Individuals/Cruise			
Site	Cruise I	Cruise II	Cruise III	Average
P01	0.9	0.3	0.2	0.5
P02	2.4	3.1	1.0	2.2
P03	0.5	0.1	0.7	0.4
P04	0.6	0.4	0.3	0.4
S05		--[1]		--
S06		--		--
S07		--		--
S08		--		--
S09		--		--
S10		0.1		0.1
S11		0.1		0.1
S12		--		--
S13		--		--
S14		--		--
S15		0.7		0.7
S16		--		--
S17		--		--
S18		0.8		0.8
S19		--		--
S20		0.3		0.3
C21	0.3	0.1	--	0.1
C22	0.4	--	--	0.1
C23	0.4	0.2	--	0.2
C24	0.7	0.2	1.0	0.3

[1](--)Indicates the taxa did not occur at that station.

TABLE 51. Average diversity and evenness values for the meiofauna Kinorhyncha taxa by site and cruise.

				Evenness					
	Diversity			Pielou			Heip		
Site	Cruise I	Cruise II	Cruise III	Cruise I	Cruise II	Cruise III	Cruise I	Cruise II	Cruise III
P01	0.63	0.06	0.08	0.624	0.090	0.115	0.532	0.081	0.111
P02	0.46	0.51	--[1]	0.402	0.556	--	0.291	0.471	--
P03	0.47	0.14	0.26	0.481	0.205	0.311	0.423	0.192	0.292
P04	0.52	0.55	--	0.686	0.601	--	0.643	0.540	--
S05									
S06									
S07									
S08									
S09									
S10		0.35			0.500			0.500	
S11		--			--			--	
S12									
S13									
S14									
S15		--			--			--	
S16									
S17									
S18		--			--			--	
S19									
S20		--			--			--	
C21	--[1]	--		--	--		--	--	
C22	0.51			0.463			0.332		
C23	0.64	0.64		0.918	0.918		0.890	0.890	
C24	--	0.64	0.64	--	0.918	0.918	--	0.890	0.890

[1](--) denotes insufficient numbers of individuals per taxa to calculate diversity or evenness.

TABLE 52. Frequency of observation, abundance, and rank for the meiofauna Harpacticoida by cruise.

	Cruise I			Cruise II			Cruise III			Total		
Taxa	Obs[1]	Ind[2]	Rk[3]	Obs	Ind	Rk	Obs	Ind	Rk	Obs	Ind	Rk
Harpacticoida	8	44	92	3	10	116	4	28	78	15	82	98
Longipedia helgolandica	13	139	63	2	6	138				15	145	97
Ectinosomidae	5	44	116	2	12	130	3	36	91	10	92	121
Ectinosoma	4	164	118	2	46	123				6	210	135
Pseudobradya hirsuta							1	8	123	1	8	232
Halectinosoma	27	497	27	16	88	52	19	238	28	62	823	35
Harpacticidae	1	8	185							1	8	233
Tigropus	1	1	255							1	1	336
Zausodes arenicolus	2	6	172							2	6	214
Peltidium							1	2	157	1	2	322
Tisbidae	1	4	217							1	4	266
Euterpina acutifrons	1	8	186				1	2	158	2	10	197
Laophontidae							1	4	139	1	4	267
Paralaophonte	2	8	163				1	4	140	3	12	179
Paralaophonte pacifica							1	4	141	1	4	268
Laophonte cornuta	1	2	248							1	2	323
Normanella	1	4	218							1	4	269
Normanella mucronata	1	4	219							1	4	270
Normanella serrata	6	48	104							6	48	139
Normanella confluens	4	32	121	6	46	83	4	16	85	14	94	104
Ameiridae	2	4	177							2	4	224
Nitocra				1	4	161				1	4	271
Ameira	12	94	67				2	36	97	14	30	101
Pseudameira	1	4	220	1	4	162				2	8	202
Pseudameira perplexa	1	8	187							1	8	234
Cletodidae	21	164	39	2	8	134	4	22	80	27	194	71
Cletodes	2	3	178	2	16	127	2	8	106	6	27	143
Cletodes longicaudatus	1	4	221	3	10	117				4	14	163
Cletodes dissimilis	3	18	139	1	2	203	7	56	67	11	76	115
Cletodes limicola limicola	1	4	222	1	4	163				2	8	203
Cletodes tenuipes	7	26	100	3	14	111	1	2	159	11	42	118
Cletodes latirostris	1	4	223							1	4	272
Cletodes carthaginiensis				1	2	204				1	2	324
Enhydrosoma	9	95	84				5	22	75	14	117	102
Enhydrosoma longifurcatum	4	34	120				1	4	142	5	38	146
Enhydrosoma propinguum	3	8	149							3	8	186
Enhydrosoma uniarticulatum	1	8	188				1	4	143	2	12	195
Enhydrosoma hopkinsi	10	210	73	6	24	88	12	102	48	28	336	63
Enhydrosoma sarsi	1	8	189							1	8	235
Enhydrosoma lacunae				1	2	205				1	2	325
Enhydrosoma A				2	4	143				2	4	225
Enhydrosomella	1	22	180							1	22	229
Diosaccidae	18	116	48	4	32	100	6	40	71	28	188	68
Amphiascus				1	4	164				1	4	273
Amphiascus minutus	7	48	96	2	8	135	4	40	76	13	96	106
Haloschizopera	26	338	29	11	64	60	11	74	53	48	476	46
Robertgurneya							1	4	144	1	4	274
Robertgurneya ecaudata	1	2	249							1	2	326
Robertgurneya rostrata	2	8	164	1	4	165	1	8	124	4	20	158
Robertgurneya ilievecensis	1	4	224							1	4	275
Robertgurneya diversa				1	4	166				1	4	276
Schizopera	1	1	256							1	1	337
Stenhelia	10	178	74				9	204	56	19	382	85
Stenhelia longicaudata finmarchica	3	20	137	2	8	136	4	18	81	9	46	125
Stenhelia mastigochaeta	6	30	110	3	16	109	2	16	99	11	62	117
Stenhelia unisetosa	9	190	82	1	2	206				10	192	120
Stenhelia reflexa				1	2	207				1	2	327
Typhlamphiascus lamellifer	3	10	147	9	36	74	9	50	60	21	96	83
Pseudomesochra				1	8	148				1	8	236
Mesochra							3	24	92	3	24	172
Mesochra lilljeborgi	1	1	257							1	1	338
Diarthrodes dissimilis							1	2	160	1	2	328
Tetragonicipitidae				1	4	167				1	4	277
Tetragoniceps	1	1	258							1	1	339

[1] Obs — denotes number of observations.
[2] Ind — denotes number of individuals.
[3] Rk — denotes rank.

TABLE 53. Percent total number of individuals by site and cruise for meiofauna Harpacticoida.

Site	Percent Total Number of Individuals/Cruise			
	Cruise I	Cruise II	Cruise III	Average
P01	0.6	0.5	0.9	0.7
P02	3.2	0.0[1]	2.7	2.0
P03	1.6	0.2	2.7	1.5
P04	0.6	0.2	0.5	0.4
S05		--[2]		--
S06		--		--
S07		--		--
S08		0.1		0.1
S09		0.4		0.4
S10		0.2		0.2
S11		0.2		0.1
S12		--		--
S13		1.3		1.3
S14		0.5		0.5
S15		4.1		4.1
S16		2.8		2.8
S17		25.3		25.3
S18		0.4		0.4
S19		0.2		0.2
S20		0.1		0.1
C21	0.7	--	0.6	0.4
C22	0.8	--	0.4	0.4
C23	0.4	0.7	2.9	1.3
C24	--	0.1	2.5	0.9

[1] A value of 0.0 indicates rounding to one decimal place.

[2] (--) indicates that the taxa did not occur at that station.

TABLE 54. Distribution by depth zonation and cruise of Harpacticoida as percent of total number of meiofauna.

Depth zone (m)[1]	Percent Total Number of Individuals/Cruise			
	Cruise I	Cruise II	Cruise III	Average
<30	1.2	0.2	1.4	1.0
30 to 90	0.9	4.4	2.0	2.4
>91	--	4.1	--	4.1

[1] Depth zone 30 m included sites P1, P2, S5, S8, S10, S11, S12, S14, S18, S19, S20, C21, C22, and C24.
Depth zone <30 to 90m included sites P3, P4, S6, S7, S9, S13, S16, S17, and C23.
Depth zone >91 m included only site S15.

Average diversity and evenness values for meiofauna Harpacticoida generally decreased from Cruise I to Cruise III at the Primary Sites and increased at the Control Sites (Table 55). Changes in diversity were related primarily to changes in evenness. But at Sites P4, S8, S15, S16, S18, C23, and C24, diversity changes were probably more related to changes in number of taxa.

e. Cluster Analysis

For meiofauna cluster analysis, the taxa identified for each cruise were ranked first by frequency of occurrence and second by abundance within equally occurring taxa (Appendix F, Tables F1, F2, and F3). From this ranked list, the top 98% of the total number of individuals (abundance) were chosen for use in cluster analysis (98% of meiofauna by abundance were included in the first 80, 68, and 73 taxa for Cruises I, II, and III, respectively, of the 353 meiofauna taxa collected). Included in this list were several taxa at the level of Order and above, e.g., Rhynchocoela, Nematoda, Copepoda, etc.; these were eliminated because many different species were probably included and subsequent interpretation could only be vague. After these higher level taxa were eliminated, the remaining taxa were submitted to cluster analysis by classification of taxa (inverse classification). Taxa which did not cluster with other groups at greater than about 50% similarity (50% dissimilarity) were eliminated, and taxa classification cluster analysis was rerun. The resulting dendrogram for Cruise I meiofauna is presented in Fig. 9.

As a result of the cluster analysis by classification of taxa, eight Taxa Groups composed of 59 different taxa were delimited. Taxa Group 1 was composed of 25 different taxa and was further divided into three subgroups. Nematodes comprised 64% of Taxa Group 1, with forams representing 24%, Gromiidae 4%, kinorhynchs 4%, and polychaetes 4%. Most of the taxa in Taxa Subgroup 1A were found to be widely distributed in this study and to include opportunistic species, e.g., *Ammonia beccarii.* Taxa Group 2 was composed of four different taxa, all nematodes. Taxa Group 3 was comprised of ten taxa and was further divided into two subgroups. Sixty percent of the taxa of Taxa Group 3 were forams, 30% nematodes, and 10% harpacticoids. Taxa Group 4 was composed of one foram, one nematode, and one kinorhynch. Taxa Group 5 contained one

TABLE 55. Average diversity and evenness values of the meiofauna Harpacticoida taxa by site and cruise.

				Evenness					
	Diversity			Pielou			Heip		
Site	Cruise I	Cruise II	Cruise III	Cruise I	Cruise II	Cruise III	Cruise I	Cruise II	Cruise III
P01	1.22	0.12	0.66	0.798	0.231	0.557	0.729	0.225	0.516
P02	1.99	--[1]	0.80	0.877	--	0.563	0.731	--	0.480
P03	1.55	0.30	1.80	0.704	0.366	0.899	0.533	0.362	0.787
P04	1.40	1.00	0.34	0.786	0.725	0.242	0.708	0.706	0.235
S05									
S06									
S07									
S08		0.35			0.500			0.500	
S09		--			--			--	
S10		--			--			--	
S11		--			--			--	
S12									
S13		--			--			--	
S14		--			--			--	
S15		1.00			0.913			0.865	
S16		1.45			0.806			0.666	
S17		0.73			0.375			0.275	
S18		0.35			0.500			0.500	
S19		--			--			--	
S20		--			--			--	
C21	0.68		--	0.617		--	0.485		--
C22	2.05		--	0.826		--	0.617		--
C23	1.39		--	0.617		--	0.485	--	
C24		0.69	0.96		1.000	0.878		1.000	0.812

[1](--) denotes insufficient numbers of individuals per taxa to calculate diversity or evenness.

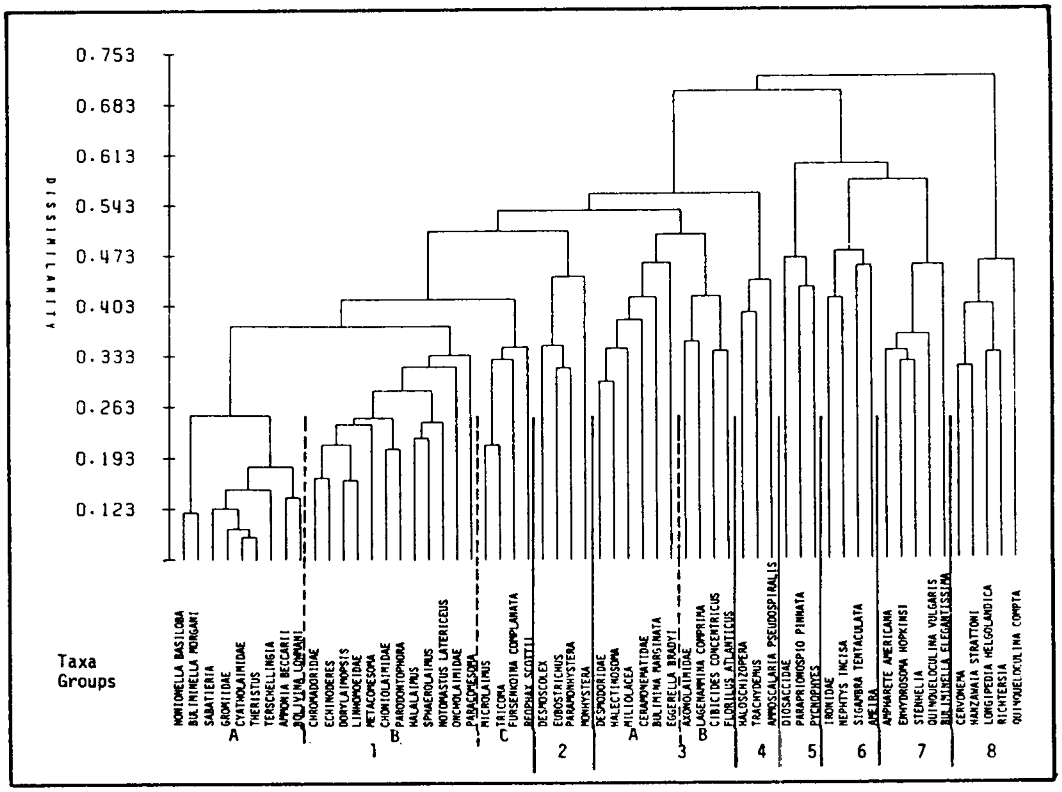


FIG. 9. Dendrogram of Cruise I meiofauna cluster analysis classified by taxa.

foram, one kinorhynch, and the temporary meiofauna species, *Paraprionospio pinnata*. This polychaete was one of the dominant macroinfauna taxa found in this study. Taxa Group 6 contained one nematode and one harpacticoid taxa plus two temporary meiofauna polychaetes, *Nephtys incisa* and *Sigambra tentaculata*. Both of these polychaetes were among the dominant macroinfauna taxa found in this study. Taxa Group 7 was comprised of two forams, two harpacticoids, and one polychaete. Taxa Group 8 was formed by two forams, two nematodes, and one harpacticoid.

Using the reduced set of taxa, cluster analysis by classification of stations (normal classification) was run. The resulting dendrogram for Cruise I meiofauna is presented in Fig. 10. Four Station Groups were delimited and are indicated in this figure. The stations within each group appear to be related on the basis of sediment type (Table 56). Station Group 1 was composed of P1 stations, C21, C22, and C24, which shared a common sediment of sandy clayey silt. Station Group 2 was separated into two subgroups. Station Subgroup 2A was comprised of five P3 stations with a common sediment type of silty sand. Station Subgroup 2B consisted entirely of P4 stations which had primarily silt sediments. Station Group 3 consisted only of P2 stations which basically had sediments of clayey silt with some sand. Station Group 4 contained three P3 stations plus C23 and was characterized by sand sediments with some silt.

Table 57 presents a two-way coincidence table of the Taxa and Station Groups for Cruise I meiofauna. Based upon relative abundance, Taxa Subgroup 1A tended to be well represented in all Station Groups, with Station Group 1 appearing to have the best conditions. Taxa Subgroup 1B was favored in Station Group 3 while Station Subgroup 2B provided the best conditions for Taxa Subgroup 3C. Station Group 1 provided the necessary environment for Taxa Group 2. Taxa Subgroup 3A had the best conditions at Station Subgroup 2A while Station Subgroup 2B provided the best habitat for Taxa Subgroup 3B. Taxa Group 4 appeared to be favored equally at Station Groups 1 and 3 while Station Group 3 favored Taxa Groups 5, 6, and 7. Taxa Group 8 had the best environmental conditions at Station Subgroup 2A.

The taxa classification cluster analysis dendrogram for Cruise II meiofauna is presented in Fig. 11. Five Taxa Groups of 40 taxa were delimited and are indicated. Taxa Group 1 was composed of 13 taxa all of which, except for one, had been members of Cruise I Taxa Subgroups 1A or 1B. Thus, Taxa Group 1 had 92% of the same taxa included in Cruise I Taxa Group 1. Five of the nine members of Taxa Group 2 were together with Cruise I Taxa Group 1 and three were together in Cruise I Taxa Group 3. For Taxa Group 3, three of the members had been included in Cruise I Taxa Group 1. Three of the five members of Taxa Group 4 had been together as members of Cruise I Taxa Group 3. Three of the six members of Taxa Group 5 had been grouped as members of Cruise I Taxa Group 3.

Figure 12 presents the dendrogram of the cluster analysis by classification of stations for Cruise II meiofauna. Eight Station Groups were delimited; stations within each group appear to be related on the basis

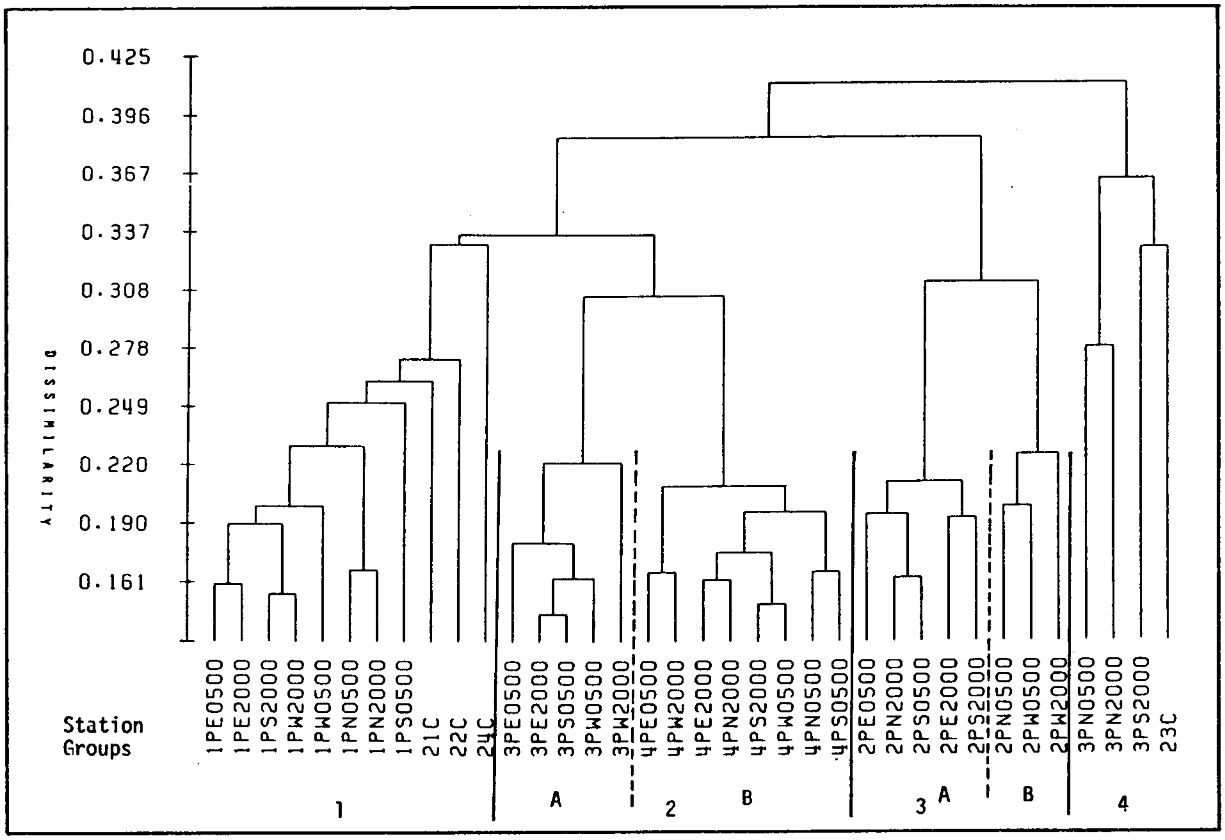


FIG. 10. Dendrogram of Cruise I meiofauna cluster analysis classified by station

TABLE 56. Average percent sediment composition for each Primary, Secondary, and Control Site by cruise.

	% Gravel			% Sand			% Silt			% Clay			% Smectite[1]		Classification		
	Cruise			Cruise			Cruise			Cruise			Cruise		Cruise		
Site	I	II	III	I	II	III	I	II	III	I	II	III	I	II	I	II	III
P01	0.0	0.1	0.2	19.8	14.9	15.0	63.8	70.9	63.9	16.3	14.0	20.7	11.6		Sandy Clayey Silt	Sandy Clayey Silt	Sandy Clayey Silt
P02	0.3	0.4	0.6	36.1	34.3	28.8	44.4	44.7	44.5	19.1	20.4	25.9	13.9		Sandy Clayey Silt	Sandy Clayey Silt	Sandy Clayey Silt
P03	0.9	0.6	0.3	73.1	67.0	72.2	19.2	19.6	16.4	6.8	12.6	11.0	5.2		Silty Sand	Silty Clayey Sand	Silty Clayey Sand
P04	0.3	0.1	0.2	9.8	8.4	7.7	77.6	77.4	70.4	12.2	14.0	21.6	8.4		Clayey Silt	Clayey Silt	Clayey Silt
S05		1.3			38.3			47.4			12.8			9.6		Sandy Clayey Silt	
S06		0.2			3.1			58.7			38.0			34.0		Clayey Silt	
S07		0.1			5.3			59.3			35.2			28.8		Clayey Silt	
S08		0.0			5.7			67.3			27.0			18.2		Clayey Silt	
S09		0.0			3.3			87.5			9.1			6.7		Silt	
S10		1.3			49.0			44.0			5.6			2.6		Silty Sand	
S11		0.9			63.2			30.0			5.8			3.7		Silty Sand	
S12		0.0			2.3			87.3			10.3			5.9		Silt	
S13		0.1			6.5			65.8			27.5			22.7		Clayey Silt	
S14		0.1			11.3			77.1			11.3			10.3		Sandy Clayey Silt	
S15		0.0			4.8			85.6			9.5			6.6		Silt	
S16		0.0			4.1			81.2			14.6			13.7		Silt	
S17		0.3			7.6			78.2			13.8			10.5		Clayey Silt	
S18		0.0			6.2			75.2			18.5			11.7		Clayey Silt	
S19		0.0			95.1			2.7			2.1			1.5		Sand	
S20		0.1			39.7			45.8			14.3			10.9		Sandy Clayey Silt	
C21	0.0	0.1	0.3	45.5	10.1	30.5	37.2	63.9	45.9	17.1	25.7	23.2	12.1		Silty Clayey Sand	Sandy Clayey Silt	Sandy Clayey Silt
C22	0.0	0.0	0.2	28.5	22.0	19.5	63.9	63.2	57.2	7.3	14.7	23.0	4.7		Sandy Silt	Sandy Clayey Silt	Sandy Clayey Silt
C23	0.0	0.0	0.0	7.9	5.8	7.5	77.7	70.3	68.7	14.3	23.8	23.7	8.1		Clayey Silt	Clayey Silt	Clayey Silt
C24	0.0	0.0	0.0	3.6	3.0	4.0	76.5	74.6	73.1	19.7	22.3	22.8	12.0		Clayey Silt	Clayey Silt	Clayey Silt

[1] Clay mineralogy samples were not collected during Cruise III.

TABLE 57. Cruise I meiofauna: two-way coincidence table of stations versus taxa used in cluster analysis.

TAXA GROUPS			Station Groups[1]																																			
			1											2												3									4			
														A					B							A						B						
			01PE0500	01PE2000	01PS2000	01PW2500	01PW0500	01PN0500	01PN2000	01PS0500	21C	22C	24C	03PE0500	03PE2000	03PS0500	03PW0500	03PW2000	04PE0500	04PW2000	04PE2000	04PN2000	04PS2000	04PW0500	04PN0500	04PS0500	02PE0500	02PN2000	02PS0500	02PE2000	02PS2000	02PN0500	02PW0500	02PW2000	03PN0500	03PN2000	03PS2000	23C
1	A	Nonionella basiloba	2	2	2	3	3	2	2	1	3	3	1	2	2	2	2	3	2	2	2	2	2	2	2	2	1	1	2	2	2	1	1	1	2	1	2	2
		Buliminella morgani	2	2	2	2	2	2	2	2	2	2	2	2	1	2	2	2	2	2	2	2	2	2	2	2	.	.	1	1	1	.	.		2	.	2	2
		Sabatieria	2	1	1	1	2	2	2	1	2	2	1	2	1	2	2	2	2	1	1	1	2	1	1	1	2	2	2	2	2	1	2	2	1	1	1	1
		Gromiidae	1	1	1	1	2	1	1	1	1	1	1	1	1	1	1	1	2	2	1	1	1	1	1	1	1	2	1	2	2	.	.	.	.	1	1	.
		Cyatholaimidae	1	.	1	1	1	1	2	1	2	1	1	1	1	1	1	1	2	1	1	1	1	1	1	2	1	2	1	1	1	1	1	1	1	.	1	.
		Theristus	1	1	1	1	1	2	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	2	1	1	2	1	1	1	1	.	.	.
		Terschellingia	2	1	1	1	2	2	2	1	1	1	1	1	.	1	.	1	.	.	.	.	.	.	1	1	1	2	1	1	2	1	1	1	.	.	.	.
		Ammonia beccarii	.	1	.	1	1	.	1	.	1	1	1	1	.	1	1	.	2	1	1	1	1	1	.	.	1	2	1	1	1	.	.	.	1	.	.	.
		Bolivina lowmani	1	1	1	1	1	1	1	.	2	2	.	1	.	1	1	.	2	1	1	1	1	1	1	1	1	1	1	1	1	.	.		1	.	.	.
	B	Chromadoridae	.	.	.	1	.	1	.	.	.	.	.	1	1	1	1	1	1	1	.	.	.	.	1	.	1	2	1	1	1	1	1	1	1	.	.	.
		Echinoderes	.	.	.	.	1	1	1	.	.	1	.	.	.	.	.	1	.	.	.	.	1	.	1	.	.	2	1	1	1	.	.	1	.	.		.
		Dorylaimopsis	1	1	1	.	.	.	.	.	1	1	1	1	.	1	1	1	1	.	.	.	.	1	1	.	.	1	.	.	1	.	.	.	.	1	1	.
		Linhomoeidae	1	1	1	1	1	1	1	.	1	.	1	.	.	.	.	1	1	1	.	.	1	.	.	1	.	1	.	1	.	.	.	.	.	.	.	.
		Metacomesoma	1	1	.	1	1	1	1	1	.	1	.	.	.	.	.	1		.	.	.	.	.	.	.	1	1	1	1	1	1	1	1	.			
		Choniolaimidae	.	.	.	1	.	.	.	.	.	.	.	.			.	.	.	.	.	.	.	1		.	1	1	1	1	.	.	.	.	.	.	.	.
		Parodontophora	.	.	.	1	1	1	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.			.	1	1	.	1	.	.	1	.			
		Halalaimus	.	.	.	.	.	1	.	.		1	.	.	.	.	.	1	.	1	.	.	.	.	.	.	.	1	.	.	1	.		.	.	.	.	.
		Sphaerolaimus	.	.	.	.		.	1	.	.	.	.	.	.		.	1	.	.		.	.	1	.		.	.	.	.	.	.		.	.	.	.	.
		Notomastus latericeus			.	.		.	.		.	.	.	.	.	.	1	.	.	.	.	.	.	1	.	.	.	1	.	.	1	.	.	.	.	1	.	.
		Oncholaimidae		.		.	.	.	.	.	.	.		.	.	.	.	.			.	.		.	.	.	1	2	1	1	1	1	1	1	.	.		.
		Paracomesoma	1	.	1	1	.	.	1	.	.	.	.	.	.	.	.	.			.			.		.	1	1	1	.	.	.	1	.			.	
	C	Microlaimus	.	.	.	1			.	.	.	.	1	1	1	1	1	1	1	1	1	1	1	1	1	1	.	.		.	.	.	.	.			.	.
		Tricoma						.	.		.	1	.	.	.	1	.	.	1	1	.	1	1	1	1	1	.	1	.	1	1	.	.	.	.	.	.	.
		Fursenkoina complanata		1	1	1	1				.	.	.	.	.	.	.	.	2	2	2	1	2	1	1	2	.	.	.		.	.			.	.	1	1
		Reophax scottii			1	1	1			.	.	.	.						1	1	1	.	1	1	1	1	.		.	.	1	.	.					.
2		Desmoscolex	.	.	.	.	1	.	.	.		.	.		.	.	.	.	.	.	.	.	.		.	.		.	.					.			.	
		Eubostrichus	1	1	1	.	1	1	1	.	.	1	.	.				.			.	.	.		1	.	.	.				.			.	.		
		Paramonhystera	1	1	.	1	1	.	.	1	.	1			.		.	.	.		.	.		.	.	.					.							
		Monhystera	.	1	.	1	.	.	.	.	.		.					.	.							.	.			.		.				.		.
3	A	Desmodoridae	.	.				.	.		.	.	.	1	1	1	.	.	.	.	.	.	.		.	.		.	.	.		.		.	1	.	.	.
		Halectinosoma			.			.	.	.		1		1	.	1	.	.	.	.		.	.	.	.	.	.	.	.	.	.	.	.	.	.	.		
		Miliolacea					.					.		.	.	.	.	.	1	.	.	.	.	.			1	1	1	.	.	.		.	.	.	.	.
		Ceramonematidae			.	.	.	.		.		.	.		.	1	1	.	1	1	.	.	.	.	.	.			.						.			.
		Bulimina marginata	.						.			.	1	.	.	.	.		.	.	.	.	.	.	.	.	.	.			.				.			
		Eggerella bradyi		.	.	.	.	.	.		.	1	.		.	.	.			.	.	.					.	.	.		.				.		.	
	B	Axonolaimidae	.	.	.		.		.				.	.	.	.	.	.	1	.	.	.	1	.	1	.	.	.				.		.	.	.		.
		Lagenammina comprima		.			.	.	.			1	1	.	.	.	.	.	.	.	.	.	.	1	.	.						.				.	.	.
		Cibicides concentricus										.		.		.			1	1	.	1	1	1	.	.	.	.		.	.							.
		Florilus atlanticus											.	.	.		.		.	.	.	1	1	.	.	1									.			1
4		Haloschizopera		.	.	.	.	.	.	.	1	.		.	.	.	.		.	.			.	.	.	.	.	.	.	.	1			.				.
		Trachydemus			.	.	.	.	.	.		.		.		.	.		.	.	.	.		.	.	.		.		.	.			.			.	.
		Ammoscalaria pseudospiralis	.			.	.	1	.	.		.		.			.			.		.		.			.	.	.	.	1		.					
5		Diosaccidae		.	.		.		.	.				.	.	.			.				.				.		.	.	.	.	.	.	.			
		Paraprionospio pinnata		.					.			.		.	.		.		.	.						.	.	.	.		.	.	.	.	.			
		Pycnophyes		.			.		.	.		.					.		.								.		.		.	.			.	.		
6		Ironidae						.			.			.	.	1	.	.									.	1		.	1	.	.	.	.		.	
		Nephtys incisa		.							.			.	.	.	.	.										.			.	.	.	.				
		Sigambra tentaculata		.	.			.						.	.	.		.			.	.					.	.	.			.	.	.	.			
		Ameira												.	.			.							.		.	.	.		.	.	.	.		.		
7		Ampharete americana	.		.			.	.	.	.			.				.									.	1	.	.	.	.	.	.				
		Enhydrosoma hopkinsi									.												.				.	1	.	.	1	.	.	.				
		Stenhelia							.			.															.	1	.		.	.	.	.				.
		Quinqueloculina vulgaris									.	.					.										.	1	1	.	.	.						
		Buliminella elegantissima	.	.			.		.		1	.	.														.	1	1	1	.	.	.		.			
8		Cervonema								.		.		1	.	1	1	1							.		.				.		.		.	.		
		Hanzawaia strattoni						.						1	.	.	1	.																	.	.	.	
		Longipedia helgolandica												.	.	.	.	.		.		.	.	.	.										.	.		.
		Richtersia												.	.	.	.	.	.	.					.	.									.			
		Quinqueloculina compta										.		.	.	.	.											.		.	.					.	.	

[1] Average number of individuals per core:

(•) denotes 1 to 9

(1) denotes 10 to 99

(2) denotes 100 to 999

(3) denotes ≥1000

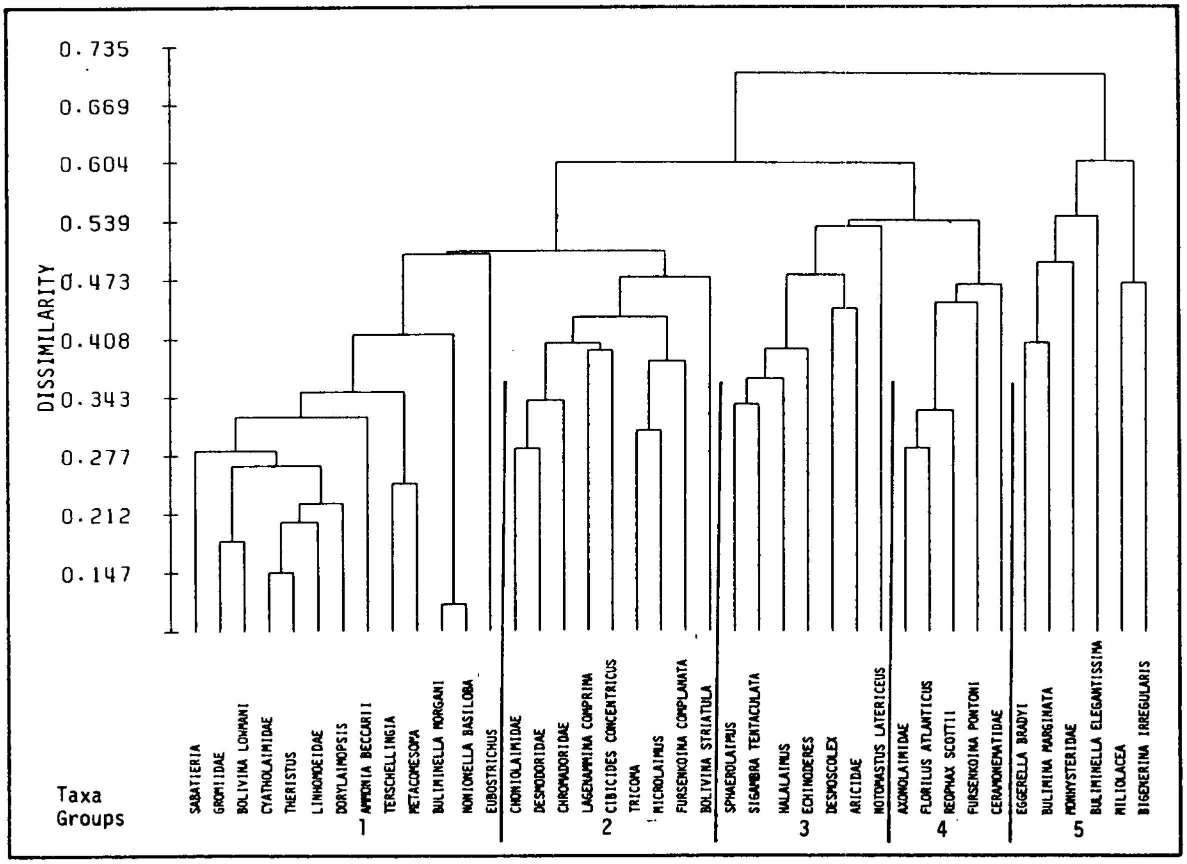


FIG. 11. Dendrogram of Cruise II meiofauna cluster analysis classified by taxa

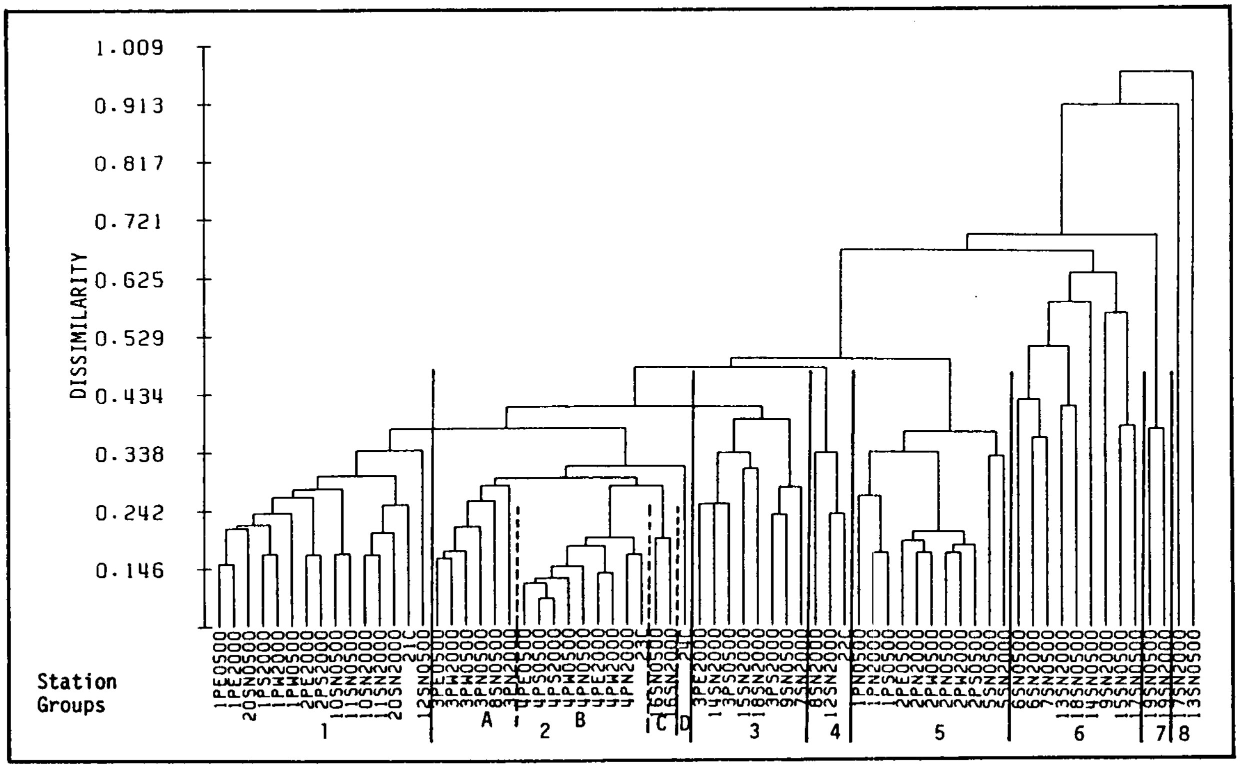


FIG. 12. Dendrogram of Cruise II meiofauna cluster analysis classified by station

of sediments (see Table 56). These are indicated in this figure. Station Group 1 was composed of five P1 stations, two P2 stations, S10, S11, one S12 station, S20, and C21, all characterized by sandy silt sediments. In Cruise I, all P1 stations and three of four Controls had been grouped together. Station Group 2, which was divided into four subgroups, was comprised of five P3 stations, P4, one S8 station, S16, C23 and C24, all basically clayey silt sediments. As in Cruise I, most P3 and P4 stations were grouped together. Station Group 3 was formed by three P3 stations and one station each of S7, S9, S14, S15, and S18 with sediments of silt, some clay, and sand. This Station Group essentially had no counterpart in Cruise I. Station Group 4 was composed of one station each of S8 and S12 plus C22, which had predominantly silt sediments with some clay. This group also had no counterpart in Cruise I; C22 had been grouped with Station Group 1 in Cruise I. Station Group 5 was formed by three P1, six P2, and both S5 stations and had basically silt-sand sediments with some clays. This station group corresponds to Station Group 3 of Cruise I. Note the inclusion of some P1 and P2 stations that were not grouped together during Cruise I. The remaining Station Groups do not have Cruise I counterparts. Station Group 6 had mainly clayey silt sediments while Station Group 7 had sand sediments. Station Group 8, consisting of two stations, provided little information and will not be discussed further.

Table 58 presents a two-way coincidence table of the Taxa and Station Groups for Cruise II meiofauna. Taxa Group 1, which contained many widely distributed taxa, occurred at almost all station groups. However, it probably had the best environmental conditions at Station Group 1, which was the case during Cruise I. Taxa Groups 2, 3, and 4 were favored at Station Subgroup 2B. Station Group 1 provided the best conditions for Taxa Group 5.

The taxa classification cluster analysis dendrogram for Cruise III meiofauna is presented in Fig. 13. Five taxa groups of 45 taxa were delimited and are indicated in this figure. Taxa Group 1 was composed of 15 taxa and was further divided into three subgroups. All but two of the taxa were also members of Taxa Group 1 during both Cruises I and II. Taxa Group 2 was comprised of 12 different taxa and was also further divided into three subgroups. Eight of the taxa had been included in Cruise I Taxa Group 1, and four taxa had been in Cruise II Taxa Group 2. Taxa Group 3 was formed by 12 taxa which had been in Cruise I Taxa Groups 1, 2, and 3 and Cruise II Taxa Groups 2, 3, 4, and 5. Taxa Group 4 was composed of six taxa which had been in Cruise I Taxa Groups 6 and 7 and Cruise II Taxa Group 5. Taxa Group 5 consisted of only one taxon, which gave very little information, and will not be discussed further.

Figure 14 presents the dendrogram of the cluster analysis by classification of stations for Cruise III meiofauna. Four Station Groups were delimited and are so indicated. Stations within each group were related through sediment type (see Table 56). Station Group 1 consisted of all P1 and P2 stations; they had sandy clayey silts. During Cruise I, P1 was not grouped with P2, but during Cruise II, several P1 and P2 stations were grouped together. Note the exclusion of any Control Site from Station Group 1. Station Group 2 was formed by seven of the eight P3 stations and had silty sand sediments. In Cruises I and II, P3 stations were grouped with P4. Station Group 3 contained one P3 station, six P4 stations, C22, C23, and C24 and had sediments basically of clayey silt. Note the grouping of three Control Sites with P4. During Cruise II, C23 and C24 had been grouped with P4. Station Group 4 was comprised of two P4 stations and C21; these also had clayey silt sediments. This group did not have a counterpart during Cruises I and II. Note that C21 had been included in Station Group 1 with P1 during Cruises I and II.

Table 59 presents a two-way coincidence table of the Taxa Groups and Station Groups for Cruise III meiofauna. Taxa Subgroup 1A, because of its widely distributed taxa, occurred at Station Groups 1, 2, and 3 but appeared to be favored at Station Group 1. Station Group 1 had also provided the best conditions for Taxa Group 1A in Cruise I and Taxa Group 1 in Cruise II. Station Group 1 also had the best conditions for Taxa Subgroup 1B. During Cruise I, this taxa group had been favored at Station Group 3. Taxa Subgroup 1C was favored at Station Group 2, but also occurred at Station Group 3. Station Group 2 also provided the best habitat for all subgroups of Taxa Group 2. Thus, perhaps this taxa group need not be divided even though the dendrogram might indicate otherwise. The relationship between Taxa Group 2 and Station Group 2 was the same as that found during Cruise II. Taxa Group 3 had the best environment at Station Group 3; this was similar to the relationship between Cruise II Taxa Group 3 and Cruise II Station Group 2. Station Group 1 favored Taxa Group 4.

Many of the taxa consistently clustered together and also consistently demonstrated a preference for the environment at certain sites. This is summarized in Table 60. Members of Cruise I Taxa Groups 1A and 1B, Cruise II Taxa Group 1, and Cruise II Taxa Groups 1A and 1B were essentially the same and demonstrated a preference for P1, P2, and C21. Cruise I Taxa Groups 1C and 3 appeared to be almost the same as Cruise II Taxa Groups 2, 3, and 4 and Cruise III Taxa Groups 1C, 2, and 3; these occurred in greatest density at P3, P4, C23, and C24. Members of Cruise I Taxa Group 7 and Cruise III Taxa Group 4 were generally the same and were consistently found in greatest numbers at P2. There appeared to be little relation between other Taxa Groups and sites not listed in Table 60.

Figure 15 presents the meiofauna similarity between stations. Note that most station groupings tend to parallel the Louisiana coastline and therefore follow major sediment depositional patterns.

5. Macroinfauna

a. Polychaeta

A total of 158 different taxa of Polychaeta were identified in the macroinfauna; 127 during Cruise I, 104 in Cruise II, and 104 in Cruise III (see Table 11). Table 61 presents the frequency of observation, abundance, and rank for the macroinfauna Polychaeta collected in this project. *Paraprionospio pinnata, Sigambra tentaculata, Cossura delta, Magelona phyllisae, Nephtys incisa, Lumbrineris tenuis, Tharyx marioni,* and *Nereis* were among the top 10 macroinfauna taxa common to each cruise. Of the taxa selected for cluster analysis, i.e., those taxa which occurred frequently

TABLE 58. Cruise II meiofauna: two-way coincidence table of stations versus taxa used in cluster analysis.

TAXA GROUPS	Taxa	Station Groups[1] 1	2 A	2 B	2 C	2 D	3	4	5	6	7	8
		002000001111221 1101111220101012 PPSPPPPPSSSSSCS EENSWWESNNNNN N 0202202200222 0 5050050055000 5 0000000000000 0 0000000000000 0	000000 333383 PPPPSP EWWNNN 020002 505550 000000 000000	0000000002 4444444443 PPPPPPPPPC ESSWNEWN 00200222 55055000 00000000 00000000	11 66 SS NN 02 50 00 00	2 4 C	010110000 34358397 PSPSSPSSS ENSNNSNN 22022202 00500050 00000000 00000000	012 822 SSC NN 22 00 00 00	00000000000 11122222255 PPPPPPPPPSS NNSENWNWSNN 02002002002 50550550550 00000000000 00000000000	000111011 667384957 SSSSSSSSS NNNNNNNNN 020200200 505055055 000000000 000000000	11 99 SS NN 02 50 00 00	11 73 SS NN 20 05 00 00
1	Sabatieria	+211111121112121	1111.1	1221411111	11	1	11111.1..	...	11111111122	. ...	.	. +
	Gromiidae	+.1111..11.1111.	111111	1111111111	11	1	1.1..1.1	.11	1......... .	....	..	+
	Bolivina lowmani	+..1...1.1112.21	111111	111111111	1.	.	....	11.	....	.1.....	.	. +
	Cyatholaimidae	+111111.1111112.	1.11..	11111111.	..	1	....1....	..	.11.1.1..12	.....	1.	+
	Theristus	+11111111111211.	1111..	111111..1	..	1	....	..	1..1..11..1	... ..	21	+
	Linhomoeidae	+.11...1...11111	......	1.1.1....	..	.	....	..	1	... ..	1.	+
	Dorylaimopsis	+1111..1...111..	11111.	.11......	..	.	1...1...	1	....1..1.11	... .. .		. +
	Ammonia beccarii	+..........11111	.....	...1	..	2	... ..	11.	....1.1....	..		+
	Terschellingia	+11111111..1111.	....	...1.....	..	.	... .. .	..	111111111...	...		+
	Metacomesoma	+1111.1111111111	..1..	....	..	.	...		...1111111..			+
	Buliminella morgani	+22212111.22122	222222	2222222222	22	2	22111222	211	11........ .	..11. 1 .		+
	Nonionella basiloba	+11211.111.22222	222222	2232222222	21	1	2111.212	222	.1..	....		+
	Eubostrichus	+111... ....11...	.. ...	....	..	.	...	.	.... .	..	.	+
2	Choniolaimidae	+...... ....1..	......	.1.1.1. ..1.	1.	.	..... .	.	....	... ..	1.	+
	Desmodoridae	+... ......1..	. ..	.111.1...1	11	.	.....	..	. ...	. ...	1.	. +
	Chromadoridae	+.......1.11.	..	.1..1...1	1	.	.. ..		. .. .		1.	+
	Lagenammina comprima	+1....1...	..1...	11111. 1.	.	1	....	..	... . .	.. .		+
	Cibicides concentricus	+.. . ..11. .	1111..	11.1.....	..	.	... ..	..	. ..	. .		+
	Tricoma	+ . ...1...	......	111111111	11	.	1		. ..	. ..		+
	Microlaimus	+	.... ..	11111111..	11	1	.... ..	.	. . .	. . .	.	+
	Fursenkoina complanata	+......	111.11	2222222121	1	.	 111	...	. . .	.		+
	Bolivina striatula	+. 1	. . .	11. ..11	1	.	. .	.	. .	.		+
3	Sphaerolaimus	+........ . . .	....	....	.	.	.. ..	.	. ...	. .		+
	Sigambra tentaculata	+.......... ...	....	....		.	. .		. ...			+
	Halalaimus	+..	. .	... .	.	.	. ...		. ....	...	.	+
	Echinoderes	+..	..	... 1....		.	...		. .1....			+
	Desmoscolex	+	.....	....	.	.	. .....			. .		+
	Aricidea	+.	....	....	.	.	. ..		.	..		+
	Notomastus latericeus	+	. .	....	.	.	... .		.. ... .	..		+
4	Axonolaimidae	+	..	11111....	.	.	.....		. .	. .	.	. +
	Florilus atlanticus	+	.	1111.1...1	.	.	.. ..					+
	Reophax scottii	+	. ...	11111111..	.	.	. . .			.		+
	Fursenkoina pontoni	+	.	...1..	.	.	. ...			.		+
	Ceramonematidae	+	..	.....1...	.	.	... .		. .	...1	.	+
5	Eggerella bradyi	+. . . ...1...	1	.. .. .	.	.	.. .	...	.			+
	Bulimina marginata	+	....	.. ..		.	. ..	...				+
	Monhysteridae	+	... ..	. .	.	.	..	.	.. .	..		+
	Buliminella elegantissima	+ . .....11..	.	. .	.	.	.	...	. .	... .		+
	Miliolacea	+ . ..1.	..	. . .	.	.	.		.. .			+
	Bigenerina irregularis	+ . .1.	.	. .	.	.	. .	.				+

[1] Average number of individuals per core:
(•) denotes 1 to 9
(1) denotes 10 to 99
(2) denotes 100 to 999
(3) denotes ≥1000

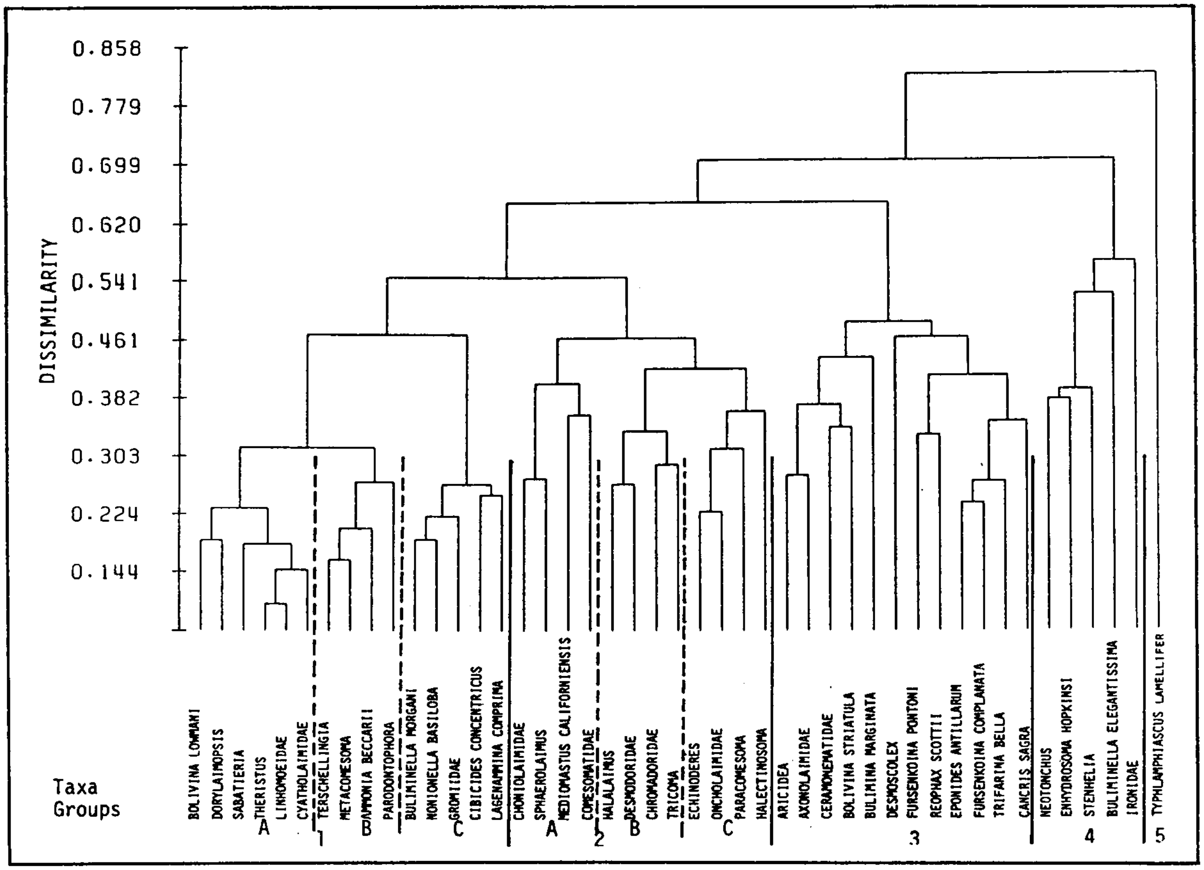


FIG. 13. Dendrogram of Cruise III meiofauna cluster analysis classified by taxa

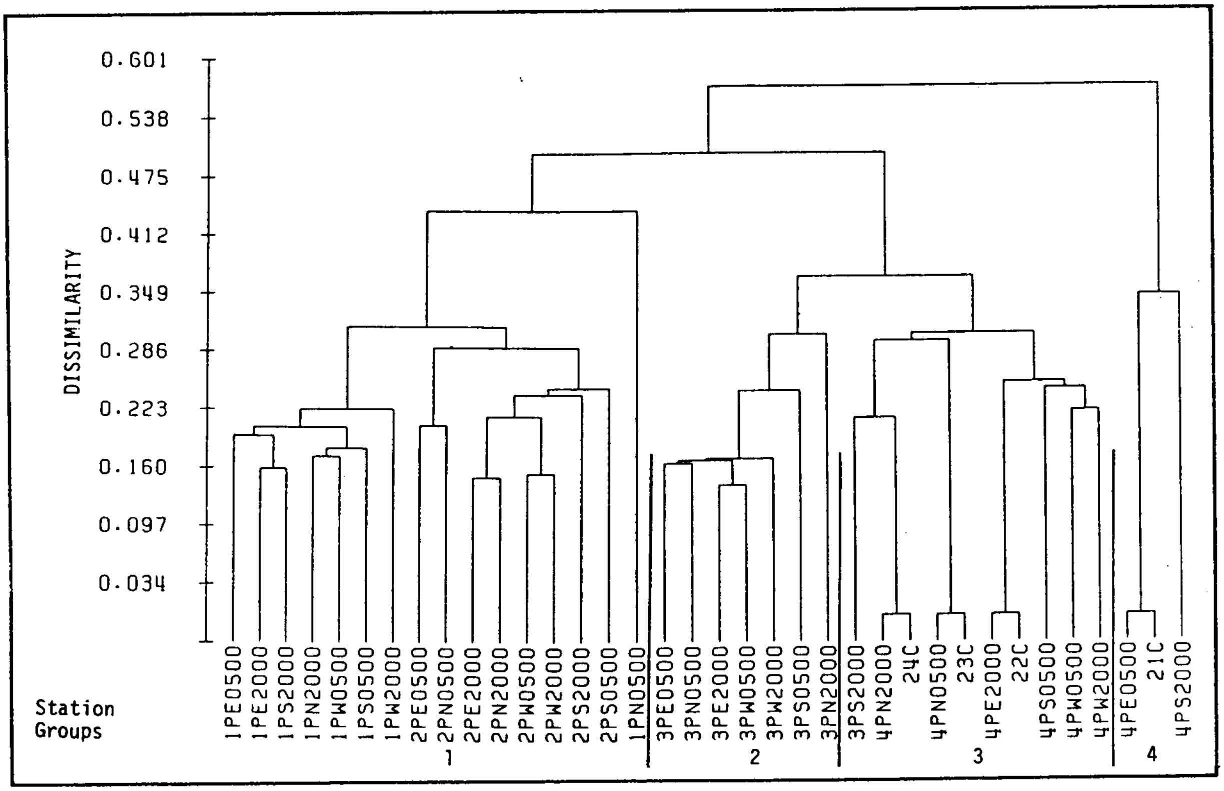


FIG. 14. Dendrogram of Cruise III meiofauna cluster analysis classified by station

TABLE 59. Cruise III meiofauna: two-way coincidence table of stations versus taxa used in cluster analysis.

```
                               |              Station Groups¹
                               |        1        |   2   |    3     | 4
                               | 0000000000000000|0000000|0020202000|020 |
                               | 1111111222222221|3333333|3444342444|414 |
                               | PPPPPPPPPPPPPPPP|PPPPPPP|PPCPCPCPPP|PCP |
    TAXA GROUPS                | EESNWSWENENWWSSN|ENEWWSN|SN N E SWW|E S |
                               | 0222002002202200|0020202|22 0 2 002|0 2 |
                               | 5000550550050055|5505050|00 5 0 550|5 0 |
                               | 0000000000000000|0000000|00 0 0 000|0 0 |
                               | 0000000000000000|0000000|00 0 0 000|0 0 |
                               |                 |       |          |    |
    Bolivina lowmani           |+.1.1111.11..111.|1.111..|.1.1......|.1.+|
    Dorylaimopsis              |+.11.1.1......1..|1111...|1.1...1...|.1.+|
  A Sabatieria                 |+1111111112211121|11111 1|1111..1111|.1.+|
    Theristus                  |+1111111.1111111.|1111111|..1...1...| 1.+|
    Linhomoeidae               |+1111111111111111|11111..|1.1. .1...| ..+|
    Cyatholaimidae             |+1.1..1111111111.|1.111..|11.  ..11.| ..+|
1   Terschellingia             |+1111111..111111.|...... | ..1  ..  |...+|
  B Metacomesoma               |+111111111111111.|.1.....|  .   1   | . +|
    Ammonia beccarii           |+.1.1111..11.111.| .. ...| .1. .1   | 1 +|
    Parodontophora             |+....1...11.1....|.......|...   ....| . +|
    Buliminella morgani        |+1111111  .......|111111.|21.1.11111|.11+|
    Nonionella basiloba        |+ .....1..  .  ..|2122211|21.1.1.111|.1.+|
  C Gromiidae                  |+.......  .... . |111111.|1..1.1..1.|...+|
    Cibicides concentricus     |+ .. .      .. ..|111111.|...1....11|1..+|
    Lagenammina comprima       |+  .   .  .   .  |111111.|11...1..1.|...+|
    Choniolaimidae             |+. ........1.... |.......|........ .| ..+|
  A Sphaerolaimus              |+... ........... |...  ..|...  ...  | ..+|
    Mediomastus californiensis |+..............  |..... .|      .  .| . +|
    Comesomatidae              |+ .. .... ...... | . .   |. .   .   | . +|
2   Halalaimus                 |+...  .........  |....1..|.... .. ..|   +|
  B Desmodoridae               |+...   .....     |1...1..|....    ..|...+|
    Chromadoridae              |+...  ...111.... |1111211|....    ..|   +|
    Tricoma                    |+ ..  .. ....... |1111...|...   ....|.  +|
    Echinoderes                |+     .......... |.......| ...     .|   +|
  C Oncholaimidae              |+  . ..... ... . |.......| ...  .   |   +|
    Paracomesoma               |+    .  ...... . | ......|          |   +|
    Halectinosoma              |+  . .  .....  . |1......|.   .    .| . +|
    Aricidea                   |+...       .     |.......|... ..... | ..+|
    Axonolaimidae              |+  . . . . .     |.......|...  .  ..|   +|
    Ceramonematidae            |+.     .      . .|1......|..   .....| . +|
    Bolivina striatula         |+      . .     . |...... |..   .    |   +|
    Bulimina marginata         |+   .         . .|.....  |..    .   | ..+|
3   Desmoscolex                |+ .         .. . |..1.  .|....  . ..| . +|
    Fursenkoina pontoni        |+  .   .         |  .... |.... . ...| . +|
    Reophax scottii            |+      .         | ....  |.. . . ...| . +|
    Eponides antillarum        |+                |.......|.  ... ...|  .+|
    Fursenkoina complanata     |+      .         |..1....|. .. .   .| . +|
    Trifarina bella            |+                |...... |.  ...   .|   +|
    Cancris sagra              |+                |.. ... |.  .    ..|   +|
    Neotonchus                 |+   .  . ....1...|.  ..  |. .   .   | . +|
    Enhydrosoma hopkinsi       |+       ...1...  |. ... .|          |   +|
4   Stenhelia                  |+     .. ..1.1   |.    . |          |   +|
    Buliminella eleqantissima  |+ ... ..  .....1 |    .  |  .       |   +|
    Ironidae                   |+       ...  . . |... ...|          |   +|
5   Typhlamphiascus lamellifer |+ ... .          | .   ..|  .   .   |   +|
```

[1] Average number of individuals per core:
(•) denotes 1 to 9
(1) denotes 10 to 99
(2) denotes 100 to 999
(3) denotes >1000

TABLE 60. Relationship between meiofauna Taxa Groups and site preference.

Taxa Group Associations			Site Preference
1.	Cruise I	Taxa Groups 1A, 1B	P1, P2, C21
	Cruise II	Taxa Group 1	
	Cruise III	Taxa Groups 1A, 1B	
2.	Cruise I	Taxa Groups 1C, 3	P3, P4
	Cruise II	Taxa Groups 2, 3, 4	C23, C24
	Cruise III	Taxa Groups 1C, 2, 3	
3.	Cruise I	Taxa Group 7	P2
	Cruise III	Taxa Group 4	

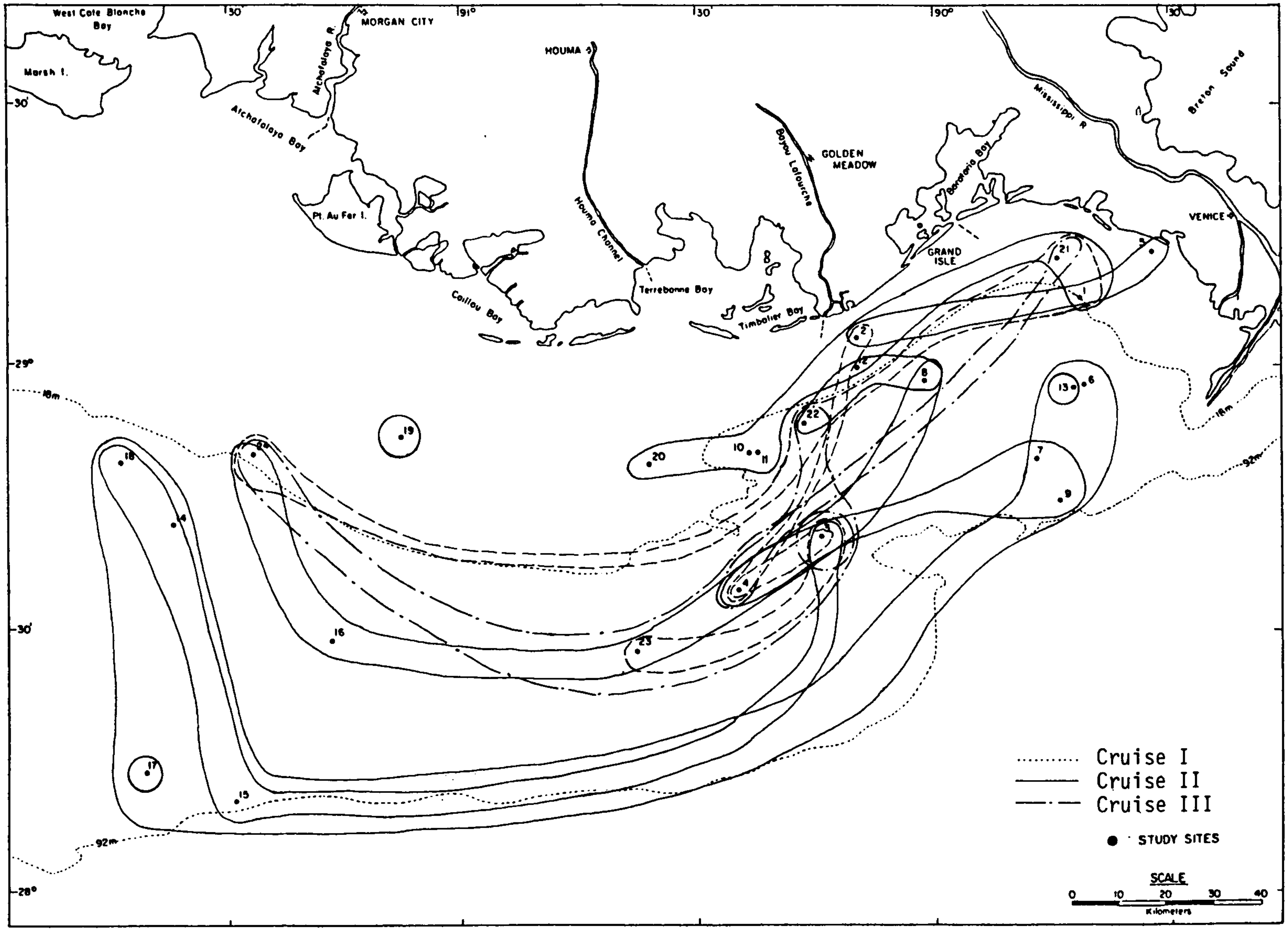

West Cote Blanche Bay
Marsh I.
Atchafalaya R.
Atchafalaya Bay
MORGAN CITY
Pt. Au Fer I.
Caillou Bay
HOUMA
Houma Channel
Terrebonne Bay
Timbalier Bay
Bayou Lafourche
GOLDEN MEADOW
Barataria Bay
GRAND ISLE
Mississippi R.
Breton Sound
VENICE
91°
90°
30'
29°
28°
18m
92m
1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
17
18
19
20
21
22
23
24
Cruise I
Cruise II
Cruise III
STUDY SITES
SCALE
0
10
20
30
40
Kilometers

FIG. 15. Meiofauna similarity between stations

TABLE 61. Frequency of observation, abundance, and rank for the macroinfauna Polychaeta by cruise.

	Cruise I			Cruise II			Cruise III			Total		
Taxa	Obs[1]	Ind[2]	Rk[3]	Obs	Ind	Rk	Obs	Ind	Rk	Obs	Ind	Rk
Aedicira belgicae	2	4	253							2	4	329
Aglaophamus verrilli	6	45	153	6	38	96	5	96	85	17	179	107
Amaeana trilobata	18	88	54	4	6	129	2	4	135	24	98	86
Ampharete acutifrons	21	277	38	21	132	33	20	241	20	62	650	31
Ampharetidae	1	1	355							1	1	461
Anaitides mucosa	1	2	319	2	2	193	1	1	203	4	5	267
Ancistrosyllis hartmanae	7	7	150							7	7	192
Ancistrosyllis jonesi	23	79	35	29	124	21	12	23	48	64	226	29
Aonides							2	2	153	2	2	354
Arabella irricolor							2	2	151	2	2	352
Aricidea cerruti	5	11	172							5	11	228
Aricidea suecica	34	855	10	28	422	22	14	37	37	76	1314	19
Boccardia hamata	1	1	352							1	1	456
Capitella capitata	1	4	308							1	4	396
Ceratonereis irritabilis	13	120	79	13	196	59	12	130	43	38	446	59
Chaetopterus variopedatus	1	2	324	1	2	231				2	4	330
Chaetozone setosa	12	48	88	1	4	219	1	3	174	14	55	127
Chone duneri	1	1	361							1	1	466
Cirrophorus lyriformis	16	87	64	25	66	29	3	5	114	44	158	50
Clymenella zonalis	15	61	72	7	50	83	1	1	214	23	112	88
Diopatra cuprea	31	890	15	42	259	12	24	170	18	97	1319	14
Diplocirrus	16	40	67	3	3	161	8	12	63	27	55	77
Dispio uncinata				2	7	175				2	7	320
Dorvillea caeca	2	3	261							2	3	340
Dorvilleidae	1	2	322							1	2	415
Drilonereis longa	4	4	203	4	5	132				8	9	176
Eteone heteropoda	1	1	347							1	1	447
Eunicidae				1	1	255				1	1	452
Fabrisabella	1	2	325							1	2	420
Glycera (polychaeta)							1	1	207	1	1	450
Glycera americana	25	201	27	20	103	38	18	65	24	63	369	30
Glycinde solitaria	10	20	113	7	10	92	4	6	99	21	36	98
Goniada maculata							1	2	182	1	2	414
Goniadidae	3	4	299	2	2	194				5	6	240
Gyptis brevipalpa							4	7	98	4	7	259
Gyptis vittata	16	45	66	13	24	63	13	17	41	42	86	54
Hesionidae	1	1	348							1	1	448
Hydroides protulicola	2	4	255							2	4	331
Laonice cirrata	4	8	91							4	8	257
Lepidonotus sublevis	9	16	124							9	16	167
Lepidonotus variabilis	3	7	222							3	7	284
Loimia medusa	3	8	220							3	8	283
Lumbrineris tenuis	31	740	16	46	547	7	28	332	9	105	1619	8
Magelona rosea	28	142	23	27	146	24	17	46	28	72	334	21
Magelonidae							1	3	173	1	3	403
Maldanidae	2	2	276	4	6	128				6	8	215
Marphysa belli				4	9	124				4	9	255
Marphysa sanguinea	5	7	176	5	8	110	2	2	150	12	17	149
Megalomma bioculata	10	216	106	3	4	141	1	1	216	14	231	122
Melinna maculata	1	1	356							1	1	462
Naineris laevigata	1	1	350							1	1	454
Nephtys bucera	6	20	156	4	7	125	2	2	149	12	29	144
Nephtys incisa	33	906	11	47	750	6	26	142	16	106	1798	6
Nephtys magellanica	6	15	162	3	3	160				9	18	166
Nephtys picta							3	6	112	3	6	285
Nereidae	25	123	29	17	42	47	6	9	79	48	174	44
Nereis succinea	11	130	97	12	32	65	1	1	206	24	163	85
Ninoe nigripes	13	152	78	39	298	14	14	69	35	66	519	27
Notomastus latericeus	36	478	6	42	484	11	25	93	17	103	1055	11
Onuphis eremita				1	1	254				1	1	451

TABLE 61. Frequency of observation, abundance, and rank for the macroinfauna Polychaeta by cruise. (Cont'd)

	Cruise I			Cruise II			Cruise III			Total		
Taxa	Obs[1]	Ind[2]	Rk[3]	Obs	Ind	Rk	Obs	Ind	Rk	Obs	Ind	Rk
Ophiodromus obscura	9	18	123	5	8	109	2	2	147	16	28	116
Orbiniidae				1	2	229				1	2	417
Owenia fusiformis	12	491	84	7	641	81	8	14	62	27	1146	75
Paleanotus heteroseta	7	9	147	1	1	250	4	4	102	12	14	150
Paranaitis speciosa							2	3	138	2	3	337
Paraonidae	7	17	143	9	25	73				16	42	114
Paraonis gracilis	15	101	70	14	33	56	18	40	25	47	174	46
Paraprionospio pinnata	36	18453	1	66	3834	1	35	1026	2	137	23313	1
Pectinaria gouldii	12	25	93	2	2	197	3	5	116	17	32	111
Phyllodocidae				1	1	251				1	1	446
Pista cristata	4	6	194	2	5	177				6	11	206
Pista palmata	2	3	264	1	1	265	3	14	109	6	18	197
Polychaeta	1	311	296	1	1	249	2	7	132	4	319	247
Polycirrus eximius	1	1	358							1	1	464
Polydora ligni	8	80	126				5	10	88	13	90	137
Polydora socialis	10	268	105				5	8	91	15	276	118
Polynoidae	19	41	49	7	11	90				66	52	80
Prionospio cirrifera	36	907	4	30	184	20	28	223	10	94	1314	15
Prionospio cirrobranchiata	21	111	41	16	53	48	15	44	32	52	208	40
Prionospio pygmaea	19	132	45	6	18	98	1	1	210	26	151	79
Sabella microphthalma				1	1	266				1	1	467
Sabellaria vulgaris	1	1	354							1	1	460
Sabellidae	12	75	87	2	5	178				14	80	124
Scolelepis squamata	1	3	314							1	3	402
Scoloplos fragilis				1	1	258				1	1	455
Sigambra tentaculata	36	476	7	58	550	3	31	371	5	125	1397	3
Sigambra wassi	8	17	130	9	11	76	2	2	148	19	30	104
Spio pettiboneae	1	1	351				1	1	211	2	2	353
Spionidae	3	7	223	1	1	260				4	8	256
Spiophanes bombyx	16	1398	61	4	13	120	6	8	81	26	1419	78
Sternaspis scutata				4	6	127	1	1	213	5	7	234
Sthenelais boa	27	343	24	9	11	75	30	176	8	66	530	26
Syllidae	3	4	228	3	5	147				6	9	209
Terebellides stroemii	4	7	192	4	13	121	2	6	133	10	26	157
Tharyx setigera	12	41	90	12	86	64	14	31	38	38	158	60
Ampharete americana	21	4772	36	4	5	133	6	62	72	31	4839	68
Anaitides erythrophyllus	29	275	22	6	7	103	6	11	78	41	293	56
Ancistrosyllis papillosa	1	3	313				1	1	204	2	4	328
Aricidea fragilis	21	715	37	18	40	44	12	229	42	51	984	41
Armandia agilis	1	1	353							1	1	459
Armandia maculata	24	112	32	21	69	34	27	141	13	72	322	22
Asychis elongata	12	19	96	25	208	27	10	28	55	47	255	45
Ceratocephale cf. *C. loveni*	4	5	197	4	6	126	7	193	66	15	204	119
Cirratulus cf. *C. hedgpethi*	10	17	114	8	11	79	1	2	184	19	30	105
Clymenella torquata calida	18	94	52	14	63	54	8	19	60	40	176	57
Cossura delta	35	588	9	51	322	5	27	187	12	113	1097	4
Dorvillea sociabilis							2	3	140	2	3	341
Drilonereis cf. *D. filum*							1	1	208	1	1	453
Eupolymnia crassicornis	1	1	357							1	1	463
Glycinde nordmanni	17	41	60	16	28	52	20	45	21	53	114	39
Goniada teres	7	15	144	1	4	218	1	5	171	9	24	164
Grubeulepis	1	1	362	2	3	187	1	1	217	4	5	268
Haploscoloplos fragilis				1	2	230				1	2	418
Harmothoe trimaculata							1	1	202	1	1	445
Loimia viridis	1	1	359				6	82	71	7	83	180
Magelona filiformis	17	129	59	25	108	28	18	87	22	60	324	32
Magelona phyllisae	29	4331	21	54	5080	4	27	7258	11	110	16669	5
Malacoceros vanderhorsti	4	5	198				2	2	152	6	7	217
Marphysa aransensis	3	3	236							3	3	303

TABLE 61. Frequency of observation, abundance, and rank for the macroinfauna Polychaeta by cruise. (Cont'd)

	Cruise I			Cruise II			Cruise III			Total		
Taxa	Obs[1]	Ind[2]	Rk[3]	Obs	Ind	Rk	Obs	Ind	Rk	Obs	Ind	Rk
Mediomastus californiensis	36	7015	2	30	418	19	31	461	4	97	7894	13
Microspio pigmentata	2	4	254	1	1	261	3	4	119	6	9	210
Myriowenia californiensis	4	55	183	3	33	139	3	82	107	10	170	154
Myriowenia cf. *M. californiensis*							2	2	155	2	2	355
Nereis falsa	1	2	320	1	12	214				2	14	318
Notomastus hemipodus	2	2	275				1	3	175	3	5	290
Onuphis eremita oculata							2	3	139	2	3	339
Onuphis nebulosa	10	23	112	14	33	55	6	15	75	30	71	70
Paralacydonia				4	22	118				4	22	250
Parandalia ocularis	1	1	349	1	1	252	1	1	205	3	3	302
Poecilochaetus johnsoni	11	28	102	2	2	196	1	1	212	14	31	131
Polyodontes lupina				3	3	159	2	2	146	5	5	243
Prionospio cristata	20	394	42	7	19	88	16	141	30	43	554	51
Pseudeurythoe ambigua	16	142	62	27	146	23	13	297	40	56	585	36
Schistomeringos							1	2	183	1	2	416
Schistomeringos cf. *S. caeca*	5	15	170	1	1	257				6	16	198
Scoloplos rubra	2	3	263	2	4	181	1	3	172	5	10	230
Spiochaetopterus oculatus	9	32	120	1	1	262	3	5	115	13	38	139
Synelmis albini	2	3	260							2	3	338
Terebella rubra	1	1	360							1	1	465
Tharyx marioni	36	866	5	43	318	10	26	192	15	105	1376	9
Timarete	9	61	119				10	62	53	19	123	102
Nereidae B	1	2	321							1	2	413
Aricidea	4	14	184	1	1	259	1	1	209	6	16	199
Boccardia	1	2	323							1	2	419
Chaetozone	16	142	63	4	11	122				20	153	99
Chone	6	68	152	3	5	148	1	1	215	10	74	155
Cirratulus				1	1	263				1	1	457
Clymenella	4	4	204	5	7	112	2	2	154	11	13	152
Cossura				1	1	264				1	1	458
Eunoe	2	2	274							2	2	351
Exogone							1	2	181	1	2	412
Harmothoe							6	7	82	6	7	216
Lepidasthenia	23	125	33	13	35	61	9	24	56	45	184	48
Nereis	30	758	20	41	689	13	32	1148	3	103	2595	10
Paleanotus				1	2	228				1	2	411
Polydora	10	368	104	2	2	195				12	370	141
Sphaerodoropsis				1	1	253				1	1	449
Schistomeringos rudolphii	2	3	262	1	1	256	2	5	134	5	9	231

[1] Obs — denotes number of observations.
[2] Ind — denotes number of individuals.
[3] Rk — denotes rank.

enough and were abundant enough to comprise 95% of the total, 44.2% of Cruise I, 46.1% of Cruise II, and 49.0% of Cruise III were Polychaeta.

Paraprionospio pinnata was collected at all stations during Cruise I; during Cruise II at all except two stations; and during Cruise III, at all except one station (Table 62). In general, average numbers of individuals per core were much higher during Cruise I than during Cruises II or III. Average numbers for Cruises II and III were similar, but Cruise II values were slightly higher. Secondary values were similar to Cruise II values at the Primary Sites. During Cruise I, average numbers were higher at P1, P2, C22, and C24 than at P3, P4, C21, and C23.

Sigambra tentaculata was collected at all stations during Cruise I; during Cruise II at all except 10 stations; and during Cruise III, at all except five stations (Table 63). Average numbers of individuals at all sites were similar at each station over all three cruises. However, values at P1 and P2 tended to be higher than values at P3 and P4 during all three cruises. Secondary Site values were comparable to P3, Cruise I, values. The highest average was obtained at C21, Cruise III.

Cossura delta was collected at all Cruise I stations except one; at all Cruise II stations except seventeen; and at all Cruise III stations except nine (Table 64). Average numbers of individuals per core tended to be slightly higher during Cruise I than Cruises II and III; *C. delta* was almost completely absent from P1 during Cruise II and from P2 during Cruises II and III. Secondary Site values were similar to values found at the Primary Sites during Cruise II.

Magelona phyllisae was found at all but seven stations during Cruise I; during Cruise II, at all

TABLE 62. Average number of individuals of *Paraprionospio pinnata* (Polychaeta) by station and cruise.

Station	Average Number of Individuals/Grab			
	Cruise I	Cruise II	Cruise III	Average
01PE0500	172.3	13.3	2.7	62.8
01PE2000	130.2	7.7	3.2	47.0
01PN0500	72.8	11.2	.8	28.3
01PN2000	187.8	6.5	4.8	66.4
01PS0500	184.2	4.2	2.8	63.7
01PS2000	292.0	20.3	3.8	105.4
01PW0500	136.3	22.2	.5	53.0
01PW2000	67.5	13.0	.7	27.1
02PE0500	74.3	33.5	18.0	41.9
02PE2000	147.7	4.3	13.5	55.2
02PN0500	91.8	30.0	8.5	43.4
02PN2000	88.5	28.5	4.2	40.4
02PS0500	136.5	15.2	22.7	58.1
02PS2000	99.7	24.3	22.0	48.7
02PW0500	193.5	17.0	10.3	73.6
02PW2000	81.5	18.5	5.3	35.1
03PE0500	39.7	1.0	2.2	14.3
03PE2000	51.8	2.5	2.2	18.8
03PN0500	21.0	1.5	2.2	8.2
03PN2000	4.3	3.8	1.2	3.1
03PS0500	24.7	3.5	1.5	9.9
03PS2000	84.5	15.5	2.0	34.0
03PW0500	16.7	1.7	3.2	7.2
03PW2000	8.0	20.2	2.7	10.3
04PE0500	17.8	9.5	.5	9.3
04PE2000	28.3	12.7	.5	13.8
04PN0500	66.0	10.2	2.7	26.3
04PN2000	36.0	6.2	2.8	15.0
04PS0500	31.3	6.7	.2	12.7
04PS2000	27.8	22.2	1.2	17.1
042PW0500	31.0	7.5		12.8
04PW2000	36.5	3.8	.2	13.5
05SN0500		61.0		
05SN2000		92.3		
06SN0500		1.2		
06SN2000		.7		
07SN0500		.8		
07SN2000		1.7		
08SN0500		10.0		
08SN2000		5.2		
09SN0500		1.2		
09SN2000		1.0		
10SN0500		.2		
10SN2000		2.5		
11SN0500		.3		
11SM2000		.2		
12SN0500		.7		
12SN2000		1.0		
13SN0500		.2		
13SN2000		.2		
14SN0500		6.0		
14SN2000		1.2		
15SN0500		2.0		
15SN2000		3.2		
16SN0500		2.5		
16SN2000		15.0		
17SN0500				
17SN2000		.3		
18SN0500		1.2		
18SN2000		3.0		
19SN0500		.3		
19SN2000		1.8		
20SN0500		4.3		
20SN2000		4.5		
21C	54.0		13.8	22.6
22C	133.7	1.0	1.0	45.2
23C	19.5	9.8	1.2	10.2
24C	186.2	4.7	6.2	65.7
Average	85.4	9.4	4.8	

TABLE 63. Average number of individuals of *Sigambra tentaculata* (Polychaeta) by station and cruise.

Station	Average Number of Individuals/Grab			
	Cruise I	Cruise II	Cruise III	Average
01PE0500	.7	1.3	1.3	1.1
01PE2000	.8	.8	.2	.6
01PN0500	.5	2.5	.5	1.2
01PN2000	1.0	.5	.7	.7
01PS0500	1.5	1.8	3.2	2.2
01PS2000	.7	2.3	3.2	2.1
01PW0500	1.0	1.7	.8	1.2
01PW2000	.3	.7	.5	.5
02PE0500	4.5	5.2	3.8	4.5
02PE2000	4.8	.2	1.8	2.3
02PN0500	7.8	1.8	1.2	3.6
02PN2000	5.0	5.5	2.2	4.2
02PS0500	9.5	.8	4.8	5.0
02PS2000	2.3	1.5	7.7	3.8
02PW0500	2.8	1.2	5.5	3.2
02PW2000	6.5	4.0	3.7	4.7
03PE0500	1.2	.2		.5
03PE2000	1.3	.3		.5
03PN0500	1.8	.3	.2	.8
03PN2000	.2	.2	.2	.2
03PS0500	.8	.3	.2	.4
03PS2000	2.2		.7	1.0
03PW0500	.7	.3	.2	.4
03PW2000	.5	1.0	.5	.7
04PE0500	.7	.3		.3
04PE2000	1.3	.2	.5	.7
04PN0500	.7	.8	1.0	.8
04PN2000	.3	.2	1.0	.5
04PS0500	.8	.5	.2	.5
04PS2000	.5			.2
04PW0500	1.2	1.0		.7
04PW2000	.3		.2	.2
05SN0500		3.7		
05SN2000		1.7		
06SN0500				
06SN2000		.5		
07SN0500		.3		
07SN2000				
08SN0500				
08SN2000		.2		
09SN0500		.3		
09SN2000				
10SN0500		7.0		
10SN2000		2.7		
11SN0500		4.2		
11SN2000		2.0		
12SN0500		3.7		
12SN2000		5.7		
13SN0500				
13SN2000				
14SN0500		.2		
14SN2000				
15SN0500		2.0		
15SN2000		.7		
16SN0500		.3		
16SN2000		1.2		
17SN0500		1.0		
17SN2000		.5		
18SN0500		.7		
18SN2000		.3		
19SN0500		1.5		
19SN2000		5.3		
20SN0500		2.2		
20SN2000		2.7		
21C	1.5	.8	14.7	5.7
22C	9.8	.5	.5	3.6
23C	1.2	.3	.8	.8
24C	2.5	2.2	.2	1.6
Average	2.2	1.4	1.7	

TABLE 64. Average number of individuals of *Cossura delta* (Polychaeta) by station and cruise.

Station	Average Number of Individuals/Grab			
	Cruise I	Cruise II	Cruise III	Average
01PE0500	6.2		2.3	2.8
01PE2000	7.0		2.3	3.1
01PN0500	1.8	.2	.2	.7
01PN2000	2.8	.2		1.0
01PS0500	9.3	.5	3.5	4.4
01PS2000	7.3		2.5	3.3
01PW0500	7.0	.2	.2	2.5
01PW2000	2.8		.3	1.0
02PE0500	.2			.1
02PE2000	1.2		.2	.5
02PN0500	.3			.1
02PN2000	.2			.1
02PS0500	.2			.1
02PS2000	.7		.3	.3
02PW0500		.5	.3	.3
02PW2000	.3			.1
03PE0500	2.7	2.2	.5	1.8
03PE2000	1.2	.8	1.3	1.1
03PN0500	2.5	.8	.3	1.2
03PN2000	.2		.2	.1
03PS0500	3.2	1.5	.2	1.6
03PS2000	3.3	2.0	.8	2.0
03PW0500	2.2	.5	1.0	1.2
03PW2000	.5	1.3		.6
04PE0500	1.8	1.8	.3	1.3
04PE2000	2.2	1.3	1.2	1.6
04PN0500	6.8	1.2	5.8	4.6
04PN2000	.7	1.5	2.7	1.6
04PS0500	2.8	1.8	1.5	2.0
04PS2000	3.2	2.7		2.0
04PW0500	3.3	1.7	.5	1.8
04PW2000	1.7	.7	.3	.9
05SN0500		1.8		
05SN2000		.5		
06SN0500		.7		
06SN2000		1.7		
07SN0500		1.5		
07SN2000		.7		
08SN0500		.2		
08SN2000		.5		
09SN0500		1.0		
09SN2000		1.2		
10SN0500		.5		
10SN2000		.7		
11SN0500		.3		
11SN2000		1.0		
12SN0500				
12SN2000		.3		
13SN0500		.5		
13SN2000		.5		
14SN0500		.7		
14SN2000		.2		
15SN0500		.8		
15SN2000		.7		
16SN0500		1.8		
16SN2000		2.8		
17SN0500		2.0		
17SN2000		1.2		
18SN0500		1.2		
18SN2000		.7		
19SN0500				
19SN2000				
20SN0500				
20SN2000		1.8		
21C	.5			.2
22C	5.7	1.2	.5	2.5
23C	3.5	1.2	1.2	2.0
24C	2.8	.7	.7	1.4
Average	2.7	.8	.9	

except 14 stations; and during Cruise III, at all except nine stations (Table 65). Average numbers of individuals per core tended to be similar during Cruises I and II, but higher during Cruise III at P2. At P1 and P3, values were similar for all three cruises. At P4, *M. phyllisae* was virtually absent during Cruise I, occurred in very low numbers during Cruise II, and disappeared again during Cruise III. Values at S5 were high and similar to values found at P2 during Cruise III. Other Secondary Site values were comparable to values at P1 during Cruise II. Values were high at C21 during Cruises I and III. Other Control Site values were low during all three cruises.

Nephtys incisa was found at all but three stations during Cruise I; at all but 21 stations during Cruise II; and at all but nine stations during Cruise III (Table 66). Average numbers of individuals per core tended to be low for the entire study, although values during Cruise I were higher than during Cruises II and III. Sites P2 and P3 either had no *N. incisa* or had low values over all three cruises. Values at Secondary Sites were similar to those at P1 during Cruise II. Control Site values were similar to P1 and P4 values during Cruise I.

Lumbrineris tenuis was collected at all except five stations during Cruise I; during Cruise II, at all except 22 stations; and during Cruise III, at all except eight stations (Table 67). Average numbers of individuals per core were similar over all three cruises. Note that *L. tenuis* was almost completely absent from P1 and had low averages at P2 during all three cruises. At P4, averages tended to decrease from Cruise I to III while values at P3 remained similar for all cruises. Secondary Site averages were generally lower than P3 or P4 values but higher than averages found at P1 and P2. Control Site values were slightly higher during Cruise I than during Cruises II or III. Note the complete absence of *L. tenuis* from C21.

Tharyx marioni was collected at all stations during Cruise I; during Cruise II at all except 25 stations; and during Cruise III at all except 10 stations (Table 68). Average numbers of individuals were generally low over all three cruises, but the overall average for Cruise I was higher than the averages for Cruises II and III, which were similar. At P1 and P2, *T. marioni* was all but absent during Cruise II and did not increase greatly during Cruise III. Values at P3 were the highest of any averages during Cruise I, while averages during Cruises II and III were high as compared to values at P4 during the same cruises. Values at Secondary and Control Sites were similar to averages at P1, P2, and P4 during Cruise III.

Nereis was collected at all but six stations during Cruise I; at all but 27 stations during Cruise II; and at all but four stations during Cruise III (Table 69). Average numbers of individuals per core were highest during Cruise III, with Cruise II averages lower than Cruises I or III. Values at P1 and P3 were similar for all three cruises. At P4 *Nereis* was virtually absent during Cruise I and then increased slightly from Cruises II to III. Secondary Site values were similar to averages at P1 and P2 during Cruise II. *Nereis* was absent from all Control Sites during Cruise II, absent from C23 during Cruise III, and from C24 during all three cruises.

Polychaeta comprised 67.7% of the total number of individuals during Cruise I, 68.4% in Cruise II, and 70.6% in Cruise III with an overall average of 68.9% (see Table 11). Table 70 presents the percentage of the total number of individuals by station per cruise for the Polychaeta. Average values are plotted in Fig. 16. Essentially, the percentages of Polychaeta were the same for both Primary and Control Sites. The percentages were very similar for each cruise except at P1, P2, C22, and C24. Percentages decreased at P1, C22, and C24 and increased at P2 from Cruise I to Cruise II. The highest percentage of Polychaeta was at S5, followed closely by C24 (Cruise I) and S20. At only 10% of the sites sampled for all three cruises was the percentage of total number of individuals 50% or less. Percentages at the Secondary Sites were similar to those at the Primary and Control Sites.

Table 71 indicates a decrease in percentage of total number of individuals comprised of Polychaeta with an increase in depth. Note that for depth zone <30 m, the percentage was relatively high during Cruise I, then decreased during Cruise II, and remained essentially the same during each of the cruises.

During Cruise I, a low of 495 individuals per m^2 was found at P4 E500 and a high of 6,525 individuals per m^2 at P2 W500. During Cruise II, a low of 23 individuals per m^2 was collected at S13 N500 and a high of 2,903 individuals per m^2 at S5 N2000. For Cruise III, a low of 56 individuals per m^2 was collected at P4 W500 and a high of 3,836 individuals per m^2 at P2 E500.

Average diversity and evenness values for macroinfauna Polychaeta taxa at the Primary and Control Sites were generally higher during Cruise III than during Cruises I or II (Table 72). Two exceptions were P2 and C21. Diversity values were highest at S17 and S18 which had very low percentages of sand. Sites P1, S5, and C21, which were most often influenced by the Mississippi, were characterized by low diversity values during all three cruises. Sites P2, S8, and S12, which might be influenced by Bayou Lafourche, had low to moderate diversities. The predominantly sandy S19 had a low diversity. There appeared to be no explanation for the lowest diversity value, found at C24, Cruise I.

b. Cluster Analysis

For macroinfauna cluster analysis, the taxa identified from each cruise were ranked first by frequency of occurrence and second by frequency of abundance within equally occurring taxa (Appendix F, Tables F4, F5, and F6). From this ranked list, the top 95% of the total number of individuals (abundance) were chosen for use in cluster analysis (95% of macroinfauna by abundance were included in the first 154, 125, and 96 taxa for Cruises I, II, and III, respectively, of the 576 macroinfauna taxa collected). Included in this list were several taxa at the level of order and above, e.g., Brachyura, Bivalvia, Gastropoda, etc.; these were eliminated because many different species were probably included and subsequent interpretation could only be vague. After these higher level taxa were eliminated, the remaining species or taxa were submitted to cluster analysis by classification of taxa (inverse classification). Taxa which did not cluster with other groups at greater than 50% similarity (50% dissimilarity) were eliminated and taxa classification cluster analysis was rerun. The resulting dendrogram for Cruise I macroinfauna is presented in Fig. 17.

TABLE 65. Average number of individuals of *Magelona phyllisae* (Polychaeta) by station and cruise.

Station	Average Number of Individuals/Grab			
	Cruise I	Cruise II	Cruise III	Average
01PE0500	25.0	8.5	11.3	14.9
01PE2000	22.0	6.3	23.5	17.3
01PN0500	44.2	27.7	15.3	29.1
01PN2000	21.7	11.7	18.3	17.2
01PS0500	18.2	3.0	14.0	11.7
01PS2000	10.5	3.2	4.7	6.1
01PW0500	15.8	5.5	3.0	8.1
01PW2000	7.3	2.8	1.5	3.9
02PE0500	128.2	93.5	268.7	163.5
02PE2000	41.5	9.7	105.3	52.2
02PN0500	45.3	41.8	118.7	68.6
02PN2000	62.0	80.7	23.5	55.4
02PS0500	25.3	16.3	215.7	85.8
02PS2000	14.5	59.7	180.3	84.8
02PW0500	112.2	39.3	61.5	71.0
02PW2000	6.5	8.0	40.7	18.4
03PE0500	2.2	1.3	1.0	1.5
03PE2000	1.0	.3	.7	.7
03PN0500	3.0	.2	.8	1.3
03PN2000	5	1.8	.8	1.0
03PS0500	1.0	1.5	.2	.9
03PS2000	.8	.7	.2	.6
03PW0500	.3		.5	.3
03PW2000	.3	.5	1.5	.8
04PE0500	.2	.3		.2
04PE2000				.0
04PN0500		.8		.3
04PN2000		.3		.1
04PS0500		.5		.2
04PS2000		.8		.3
04PW0500		.8		.3
04PW2000		.3		.1
05SN0500		139.2		
05SN2000		140.3		
06SN0500				
06SN2000				
07SN0500				
07SN2000				
08SN0500		.5		
08SN2000		1.3		
09SN0500		.8		
09SN2000				
10SN0500		3.3		
10SN2000		1.7		
11SN0500		17.0		
11SN2000		11.7		
12SN0500		6.5		
12SN2000		22.2		
13SN0500				
13SN2000				
14SN0500				
14SN2000				
15SN0500				
15SN2000				
16SN0500		1.3		
16SN2000		2.0		
17SN0500		.7		
17SN2000				
18SN0500		1.2		
18SN2000		1.7		
19SN0500		1.5		
19SN2000		1.0		
20SN0500		27.2		
20SN2000		29.2		
21C	100.2	3.0	93.3	65.5
22C	9.0	4.7	2.3	5.3
23C	.3	.2		.2
24C	2.8	.7	2.3	1.9
Average	20.1	12.5	33.6	

TABLE 66. Average number of individuals of *Nephtys incisa* (Polychaeta) by station and cruise.

Station	Average Number of Individuals/Grab			
	Cruise I	Cruise II	Cruise III	Average
01PE0500	5.3	2.3	.5	2.7
01PE2000	5.0	.7	.3	2.0
01PN0500	1.5	2.2	.7	1.5
01PN2000	10.0	3.5	.5	4.7
01PS0500	6.7	1.0	.5	2.7
01PS2000	7.3	1.2	.8	3.1
01PW0500	5.0	1.5		2.2
01PW2000	5.2	1.0	.5	2.2
02PE0500	.5	.3		.3
02PE2000	1.0			.3
02PN0500	1.0			.3
02PN2000	.3			.1
02PS0500	.8		.2	.3
02PS2000				.0
02PW0500	.8	1.2		.7
02PW2000	.5			.2
03PE0500		.5	.2	.2
03PE2000	.3		.2	.2
03PN0500	.2		.2	.1
03PN2000	.2	.2	.2	.2
03PS0500	.5			.2
03PS2000	9.2	4.7	1.2	5.0
03PW0500		.3	.2	.2
03PW2000	.3	.7	.2	.4
04PE0500	6.7	7.5	1.3	5.2
04PE2000	8.0	7.0	1.2	5.4
04PN0500	10.5	7.7	1.2	6.5
04PN2000	7.5	5.5	2.0	5.0
04PS0500	6.8	6.3	1.3	4.8
04PS2000	6.0	8.7	1.5	5.4
04PW0500	6.2	5.7	.3	4.1
04PW2000	8.8	4.3	1.0	4.7
05SN0500				
05SN2000				
06SN0500		.5		
06SN2000		.8		
07SN0500		.5		
07SN2000		.7		
08SN0500		2.5		
08SN2000		2.3		
09SN0500		.3		
09SN2000		.5		
10SN0500				
10SN2000				
11SN0500				
11SN2000				
12SN0500				
12SN2000		.2		
13SN0500		.3		
13SN2000		.3		
14SN0500		2.8		
14SN2000		2.2		
15SN0500		1.2		
15SN2000		1.3		
16SN0500		4.7		
16SN2000		7.0		
17SN0500		1.0		
17SN2000		3.2		
18SN0500		2.7		
18SN2000		4.8		
19SN0500				
19SN2000				
20SN0500				
20SN2000				
21C	.2			.1
22C	3.7	1.2	.5	1.8
23C	5.2	7.8	.8	4.6
24C	19.8	2.3	6.3	9.5
Average	4.2	1.8	.7	

TABLE 67. Average number of individuals of *Lumbrineris tenuis* (Polychaeta) by station and cruise.

Station	Average Number of Individuals/Grab			
	Cruise I	Cruise II	Cruise III	Average
01PE0500	.2			.1
01PE2000	.2			.1
01PN0500	.2		.2	.1
01PN2000				.0
01PS0500				.0
01PS2000	.2			.1
01PW0500		.3		.1
01PW2000				.0
02PE0500	.7	.3	.3	.4
02PE2000	.3	.2	.3	.3
02PN0500	.7		.3	.3
02PN2000	1.0	.5	.2	.6
02PS0500	.5		.7	.4
02PS2000	.8	.2	.7	.6
02PW0500	.5	.5	.8	.6
02PW2000	1.2		.2	.5
03PE0500	8.2	6.3	5.5	6.7
03PW2000	13.0	5.3	5.2	7.8
03PN0500	7.8	5.3	5.3	6.1
03PN2000	5.0	3.0	5.5	4.5
03PS0500	7.2	4.3	4.3	5.3
03PS2000	13.7	2.3	2.2	6.1
03PW0500	7.2	3.7	6.3	5.7
03PW2000	4.0	9.2	6.5	6.6
04PE0500	2.5	2.5	1.5	2.2
04PE2000	3.2	1.5	.7	1.8
04PN0500	7.8	3.8	1.3	4.3
04PN2000	6.5	5.0	2.8	4.8
04PS0500	4.5	2.8	.8	2.7
04PS2000	3.7	1.2	.7	1.9
04PW0500	5.7	2.5	.5	2.9
04PW2000	4.0	.5	.2	1.6
05SN0500				
05SN2000				
06SN0500				
06SN2000				
07SN0500		.2		
07SN2000		.2		
08SN0500		.3		
08SN2000				
09SN0500		1.2		
09SN2000		.5		
10SN0500				
10SN2000		.2		
11SN0500				
11SN2000		.7		
12SN0500		.7		
12SN2000		1.7		
13SN0500				
13SN2000				
14SN0500		.8		
14SN2000		.7		
15SN0500		.5		
15SN2000		.8		
16SN0500		2.3		
16SN2000		4.0		
17SN0500		.5		
17SN2000		.7		
18SN0500		1.2		
18SN2000		1.5		
19SN0500				
19SN2000				
20SN0500		1.7		
20SN2000		2.7		
21C				.0
22C	1.7	.3	.7	.9
23C	8.5	6.0	1.0	5.2
24C	3.0	.7	.7	1.5
Average	3.4	1.3	1.5	

TABLE 68. Average number of individuals of *Tharyx marioni* (Polychaeta) by station and cruise.

Station	Average Number of Individuals/Grab			
	Cruise I	Cruise II	Cruise III	Average
01PE0500	1.7			.6
01PE2000	2.0			.7
01PN0500	2.7	.2	.3	1.1
01PN2000	1.5	.2	1.0	.9
01PS0500	.7		.7	.5
01PS2000	.5	.2	.3	.3
01PW0500	1.5			.5
01PW2000	.8			.3
02PE0500	2.7		.2	1.0
02PE2000	2.7		.7	1.1
02PN0500	1.7			.6
02PN2000	5.3		.3	1.9
02PS0500	2.0		.5	.8
02PS2000	.7	.2	1.2	.7
02PE0500	1.3		.5	.6
02PW2000	2.0			.7
03PE0500	23.5	5.3	1.3	10.0
03PE2000	10.3	2.3	2.8	5.1
03PN0500	4.5	2.7	1.8	3.0
03PN2000	3.3	7.2	5.0	5.2
03PS0500	29.3	4.8	1.5	11.9
03PS2000	5.5			1.8
03PW0500	7.7	1.7	4.3	4.6
03PW2000	4.5	4.3	4.8	4.5
04PE0500	.3	.8	.2	.4
04PE2000	2.2	.7	.2	1.0
04PN0500	8.2	1.8	1.8	3.9
04PN2000	2.0	.7	1.2	1.3
04PS0500	2.7	.5	.3	1.2
04PS2000	.8	1.0	.2	.7
04PW0500	3.2	.5		1.2
04PW2000	1.8			.6
05SN0500		.3		
05SN2000		4.5		
06SN0500		.2		
06SN2000				
07SN0500				
07SN2000				
08SN0500		.3		
08SN2000				
09SN0500		.7		
09SN2000		.2		
10SN0500		.3		
10SN2000		.7		
11SN0500		2.0		
11SN2000		.3		
12SN0500		.3		
12SN2000		3		
13SN0500		.2		
13SN2000				
14SN0500		.8		
14SN2000		.2		
15SN0500		1.5		
15SN2000		.7		
16SN0500		.5		
16SN2000		.7		
17SN0500		1.5		
17SN2000				
18SN0500				
18SN2000		.2		
19SN0500		.2		
19SN2000				
20SN0500		.2		
20SN2000				
21C	1.3		.2	.5
22C	2.0	.2	.5	.9
23C	1.2	1.2		.8
24C	.3		.2	.2
Average	4.0	.8	.9	

TABLE 69. Average number of individuals of *Nereis* (Polychaeta) by station and cruise.

Station	Average Number of Individuals/Grab			
	Cruise I	Cruise II	Cruise III	Average
01PE0500	.5	.3	.3	.4
01PE2000	.8	.2	.5	.5
01PN0500	7.5	.2	.3	2.7
01PN2000	.2		.8	.3
01PS0500	.5	.3	.7	.5
01PS2000	.3	1.0	1.3	.9
01PW0500	.2	.2		.1
01PW2000	.2	.2	.3	.2
02PE0500	11.2	.3	16.2	9.2
02PE2000	6.8	.2	4.8	3.9
02PN0500	7.7		16.0	7.9
02PN2000	5.7	.8	6.8	4.4
02PS0500	5.2	.3	10.5	5.3
02PS2000	3.8	1.0	11.7	5.5
02PW0500	4.2	.2	3.5	2.6
02PW2000	.8		3.3	1.4
03PE0500	16.2	18.0	19.8	18.0
03PE2000	8.5	10.5	16.8	11.9
03PN0500	9.2	5.7	19.0	11.3
03PN2000	.7	3.5	3.0	2.4
03PS0500	12.2	19.8	22.0	18.0
03PS2000	.3	1.5	.8	.9
03PW0500	10.0	6.0	16.7	10.9
03PW2000	6.8	25.2	1.8	11.3
04PE0500	.3		.2	.2
04PE2000		.2	.5	.2
04PN0500		.3	.3	.2
04PN2000		.5	.7	.4
04PS0500	.3	.3	.2	.3
04PS2000				.0
04PW0500	.2		.2	.1
04PW2000			.3	.1
05SN0500		.2		
05SN2000		2.8		
06SN0500				
06SN2000				
07SN0500				
07SN2000				
08SN0500		.8		
08SN2000		.3		
09SN0500		.2		
09SN2000		.2		
10SN0500				
10SN2000				
11SN0500				
11SN2000				
12SN0500				
12SN2000				
13SN0500				
13SN2000				
14SN0500		8		
14SN2000		.2		
15SN0500				
15SN2000				
16SN0500		2		
16SN2000		.5		
17SN0500				
17SN2000				
18SN0500		1.2		
18SN2000		3.7		
19SN0500		1.3		
19SN2000		1.7		
20SN0500		2.8		
20SN2000		1.3		
21C	2.5		11.2	4.6
22C	3.5		.7	1.4
23C	.2			.1
24C				.0
Average	3.5	1.7	5.3	

TABLE 70. Percent total number of individuals by cruise for macroinfauna Polychaeta.

Site	Percent Total Number of Individuals/Cruise			
	Cruise I	Cruise II	Cruise III	Average
P01	85.1	76.9	60.2	74.1
P02	63.5	71.6	81.1	72.1
P03	55.4	61.5	50.8	55.9
P04	61.7	56.5	64.8	61.0
S05		96.3		96.3
S06		62.9		62.9
S07		68.1		68.1
S08		81.7		81.7
S09		44.3		44.3
S10		49.3		49.3
S11		34.7		34.7
S12		83.6		83.6
S13		52.6		52.6
S14		66.4		66.4
S15		54.4		54.4
S16		73.4		73.4
S17		67.6		67.6
S18		55.3		55.3
S19		62.6		62.6
S20		90.2		90.2
C21	88.5	87.8	81.4	85.9
C22	73.6	39.6	54.9	56.0
C23	68.2	67.0	68.2	67.8
C24	92.1	52.2	69.8	71.4

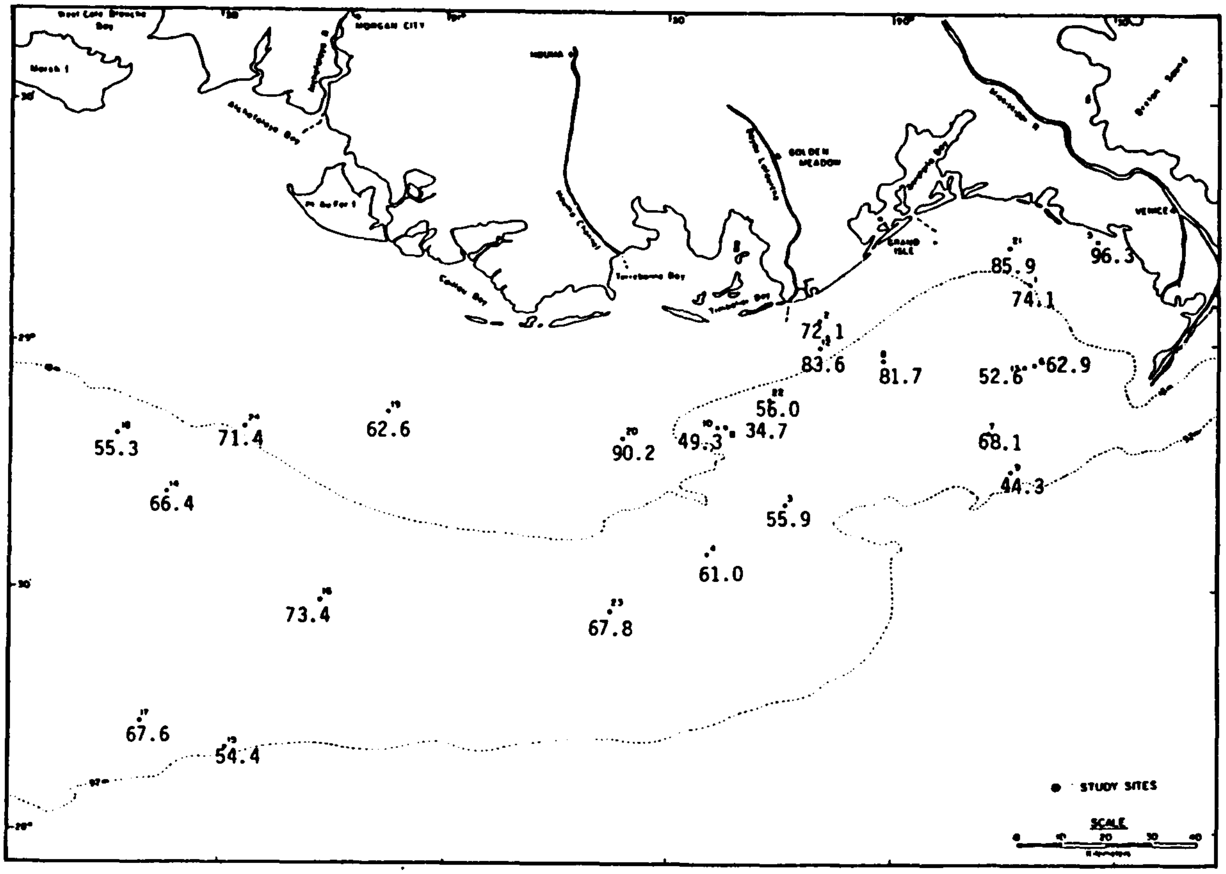

MORGAN CITY
HOUMA
GOLDEN MEADOW
GRAND ISLE
VENICE
85.9
96.3
74.1
72.1
83.6
81.7
52.6
62.9
56.0
34.7
49.3
90.2
62.6
71.4
55.3
66.4
68.1
44.3
55.9
61.0
73.4
67.8
67.6
54.4
STUDY SITES
SCALE

FIG. 16. Distribution map showing by site the percent of total macroinfauna comprised of Polychaeta

TABLE 71. Distribution by depth zonation and cruise of Polychaeta as percent of total number of macroinfauna.

Depth Zone (m)[1]	Percent Total Number of Individuals/Cruise			
	Cruise I	Cruise II	Cruise III	Average
<30	80.6	70.2	69.5	73.4
30 to 90	61.8	61.5	61.3	61.5
>91	--	54.4	--	54.4

[1] Depth zone <30 m included sites P1, P2, S5, S8, S10, S11, S12, S14, S18, S19, S20, C21, C22, and C24.

Depth zone 30 to 90 m included sites P3, P4, S6, S7, S9, S13, S16, S17, and C23.

Depth zone >91 m included only site S15.

TABLE 72. Average diversity and evenness values for the macroinfaunal Polychaeta by site and cruise.

				Evenness					
	Diversity			Pielou			Heip		
Site	Cruise I	Cruise II	Cruise III	Cruise I	Cruise II	Cruise III	Cruise I	Cruise II	Cruise III
P01	1.47	1.55	2.07	0.428	0.597	0.690	0.116	0.310	0.400
P02	2.34	1.09	1.44	0.595	0.457	0.454	0.191	0.206	0.157
P03	2.57	2.66	2.60	0.672	0.770	0.753	0.286	0.440	0.425
P04	2.25	2.22	2.63	0.659	0.723	0.889	0.290	0.410	0.706
S05		1.08			0.414			0.156	
S06		1.82			0.905			0.800	
S07		2.11			0.833			0.633	
S08		1.83			0.712			0.440	
S09		2.40			0.896			0.740	
S10		1.76			0.719			0.461	
S11		1.54			0.564			0.259	
S12		1.80			0.645			0.347	
S13		1.70			0.907			0.811	
S14		2.28			0.746			0.434	
S15		2.65			0.863			0.641	
S16		2.42			0.799			0.514	
S17		2.84			0.884			0.677	
S18		2.82			0.863			0.625	
S19		1.33			0.436			0.142	
S20		1.58			0.545			0.224	
C21	1.54	1.08	1.36	0.436	0.777	0.479	0.110	0.645	0.181
C22	1.80	2.19	2.57	0.494	0.774	0.890	0.136	0.497	0.711
C23	2.48	2.19	2.73	0.716	0.745	0.910	0.353	0.443	0.752
C24	0.89	2.32	2.22	0.320	0.819	0.755	0.095	0.575	0.457

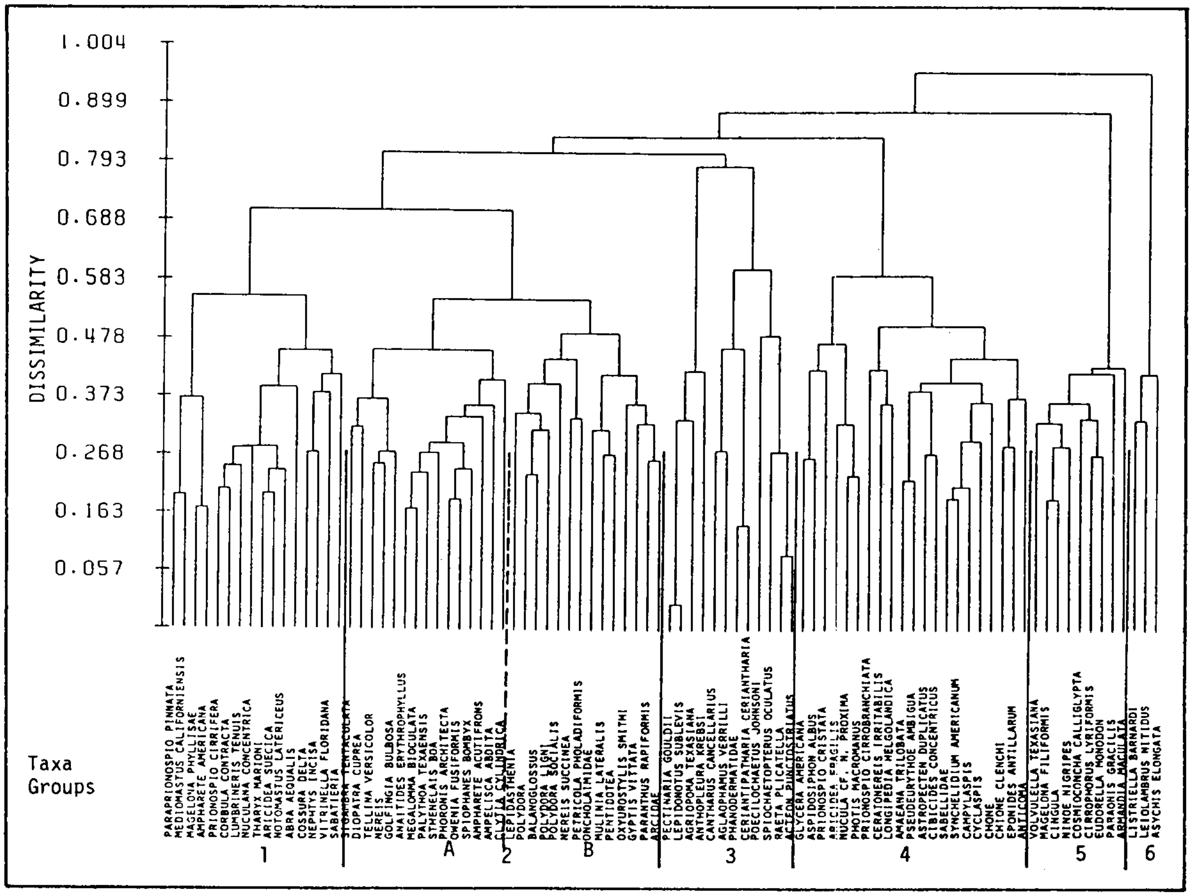


FIG. 17. Dendrogram of Cruise I macroinfauna cluster analysis classified by taxa

Six Taxa Groups of 90 taxa were delimited and are indicated. Taxa Group 1 consisted of 16 different taxa; 1 nematode, 11 polychaetes, 1 gastropod, and 3 bivalves. Taxa Group 2 was comprised of 29 taxa and was subdivided into two subgroups. Members of Taxa Group 2 consisted of 15 polychaetes, 4 bivalves, 3 anthozoa, and one each of Nematoda, Isopoda, Amphipoda, Cumacea, Sipunculida, Phoronida, and Hemichordata. Taxa Group 3 was formed by 12 taxa; 5 polychaetes, 2 bivalves, 2 anthozoans, 2 gastropods, and 1 nematode. Taxa Group 4 consisted of 21 different taxa; 9 polychaetes, 2 bivalves, 2 amphipods, 2 cumaceans, 2 forams, 1 sipunculid, 1 harpacticoid, 1 asteroid, and 1 nematode. Taxa Group 5 was composed of 9 taxa; 5 polychaetes, 3 gastropods, and 1 cumacean. The last group, Taxa Group 6, consisted of 1 polychaete and 2 amphipods.

Using the reduced set of taxa, cluster analysis by classification of stations (normal classification) was run. The resulting dendrogram for Cruise I macroinfauna is presented in Fig. 18. Four Station Groups were delimited and are indicated. Station Group 1 was composed of P1, C22, and C24, and had sediments of sandy silt with some clay (see Table 56). Station Group 2 was formed by one P3 station, P4, and C23, which had basically silt sediments with some clay and sand. Station Group 3 consisted of P2 and C21, which had sediments of sandy clayey silt. Station Group 4 contained the remaining seven stations of P3, which consisted of silty sand sediments with some clay.

A two-way coincidence table of Taxa and Station Groups of Cruise I macroinfauna is presented in Table 73. Taxa Group 1, which contained several opportunistic and ubiquitous species, was found at all Station Groups. However, the best conditions for Taxa Group 1 were apparently provided by Station Group 3. Station Group 3 also provided the best environment for Taxa Groups 2 and 3. Station Group 4 was most conducive to Taxa Group 4 and Station Group 2 provided the best environment for Taxa Group 5. Station Group preference by Taxa Group 6 appeared to be weak, which may indicate that the Taxa Group was not ecologically sound because of small sample size.

Figure 19 presents the dendrogram for taxa classification cluster analysis for Cruise II macroinfauna. A total of 53 taxa were included in six Taxa Groups which are indicated in this figure. Taxa Group 1 was divided into two subgroups. Taxa Subgroup 1A consisted of taxa from Cruise I Taxa Groups 1 and 2A. Taxa Subgroup 1B was composed of seven members from Cruise I Taxa Group 1 and four from Cruise I Taxa Group 5. Taxa Group 2 was divided into three subgroups. Some members of Taxa Group 2 had been included in Cruise I Taxa Groups 1, 2A, and 4. Five taxa, not previously included in the Cruise I clustering, included two polychaetes, one bivalve, one ectoproct, one decapod, and one

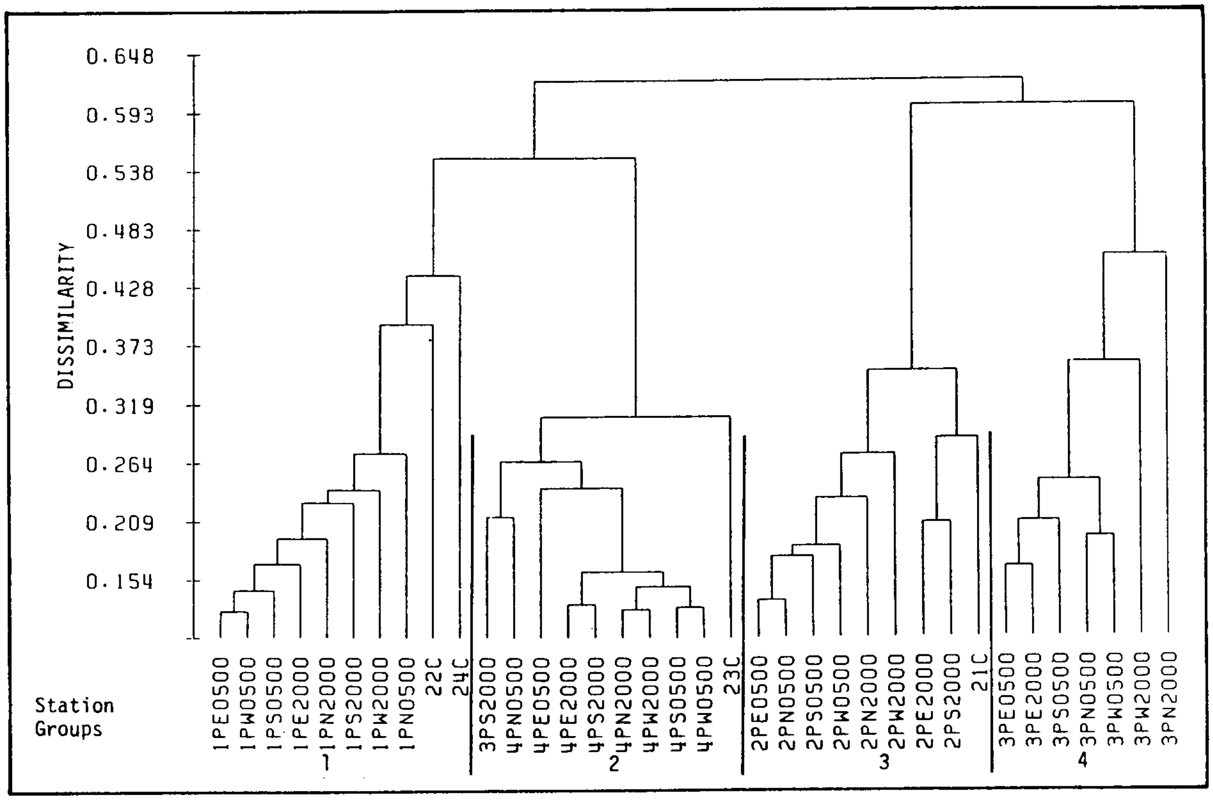


FIG. 18. Dendrogram of Cruise I macroinfauna cluster analysis classified by station.

TABLE 73. Cruise I macroinfauna: two-way coincidence table of stations versus taxa used in cluster analysis.

	Taxa Groups	Station Groups[1]																																			
		1										2										3									4						
		0 1 P E 0 5 0 0	0 1 P W 0 5 0 0	0 1 P S 0 5 0 0	0 1 P E 2 0 0 0	0 1 P N 2 0 0 0	0 1 P S 2 0 0 0	0 1 P w 2 0 0 0	0 1 P N 0 5 0 0	2 2 C	2 4 C	0 3 P S 2 0 0 0	0 4 P N 0 5 0 0	0 4 P E 0 5 0 0	0 4 P E 2 0 0 0	0 4 P S 2 0 0 0	0 4 P N 2 0 0 0	0 4 P w 2 0 0 0	0 4 P S 0 5 0 0	0 4 P w 0 5 0 0	2 3 C	0 2 P E 0 5 0 0	0 2 P N 0 5 0 0	0 2 P S 0 5 0 0	0 2 P W 0 5 0 0	0 2 P N 2 0 0 0	0 2 P W 2 0 0 0	0 2 P E 2 0 0 0	0 2 P S 2 0 0 0	2 1 C	0 3 P E 0 5 0 0	0 3 P E 2 0 0 0	0 3 P S 0 5 0 0	0 3 P N 0 5 0 0	0 3 P W 0 5 0 0	0 3 P w 2 0 0 0	0 3 P N 2 0 0 0
	Paraprionospio pinnata	2	2	2	2	2	2	1	1	2	2	1	1	1	1	1	1	1	1	1	1	1	1	2	2	1	1	2	1	1	1	1	1	1	1	•	•
	Mediomastus californiensis	1	1	1	1	1	1	1	1	1	•	1	1	•	•	•	•	•	•	•	•	1	1	1	1	2	1	1	1	1	1	1	1	1	1	•	•
	Magelona phyllisae	1	1	1	1	1	1	•	1	•	•	•		•							•	2	1	1	2	1	•	1	1	2	•	•	•	•	•	•	•
	Ampharete americana	1	•	•	1	1	•	•	•	•											•	1	1	1	1	1	1	1	1	2	•	•					
	Prionospio cirrifera	•	•	•	•	•	•	•	•	•	•	1	1	•	•	1	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	1	•	•	•
	Corbula contracta	•	•	•	•	•			•			•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	1
	Lumbrineris tenuis	•			•		•		•	•	•	1	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•		•	1	•	•	•	•	•
1	Nuculana concentrica	•	•		•	•		•	•	•	•	•	•	•	•	•	•	•	•	•		•	•	1	•	1	1	1	1	•	•	•	•	•	•	•	
	Tharyx marioni	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	1	1	1	•	•	•	•
	Aricidea suecica	•	•	•	•	•	•	•	•	1	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•		•	•	•		1	1	•	•	•	•	•
	Notomastus latericeus	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•
	Abra aequalis	•		•		•			•	•		1	1	•	1	1	•	•	•	1	•	1	2	1	1	1	1	1	•	•	•	•	•	•	•		•
	Cossura delta	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•		•	•	•	•	•	•	•	•	•	•	•	•
	Nephtys incisa	•	•	•	•	1	•	•	•	•	1	•	1	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•		•		•	•	•		•	•
	Vitrinella floridana	•	•	•	•	•	•	•	•	•	•	•	•		•	•	•	•	•	•	•	•	•	•	•	•	•	•	•		•	•	•		•		
	Sabatieria	•	•	1	•	•	•	•	•	•		•	•		•	•	•		•		•	•	•	•	•	•	•	•		•	•	•	•	•	1	•	•
	Sigambra tentaculata	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•
	Diopatra cuprea	•	•	•	•	•	•	•	•	•	•	•		•	•			•	•	•	•	1	1	1	1	•	1	•	•	•	•	•	•		•		•
	Tellina versicolor	•	•	•	•	•	•	•	•	•		•	•	•	•	•	•	•	•	•	•	•	1	1	1	1	1	1	1	•	•	•	•	•	•	•	•
	Nereis	•	•	•	•	•	•	•	•	•		•		•					•	•	•	1	•	•	•	•	•	•	•	•	1	•	1	•	1	•	•
	Golfingia bulbosa	•	•	•	1	•	•	•	•	1		•				•	•	•	•	•		1	1	1	•	1	•	1	1	•	•	•	•	•	•	•	1
	Anaitides erythrophyllus	•	•	•	•	•	•	•	•	•		•	•	•	•	•			•	•	•	•	•	•	•	•	•	•	•	•				•	•		•
A	Megalomma bioculata																					•	•	•	•	•	•	•	•	•		•					
	Palythoa texaensis	•	•		•	•	•	•	•													•	•	•	•	•	•	•	•	•							•
	Sthenelais boa		•	•	•	•	•	•		•			•			•		•			•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•
	Phoronis architecta	•					•			•		•										1	1	•	•	•	•	•	•	•	•	•	•			•	•
	Owenia fusiformis														•							1	1	1	•	•	•	•	•		•	•					•
	Spiophanes bombyx				•							•								•	•	1	1	1	1	1	•	•	•	•			•	•			•
	Ampharete acutifrons	•	•	•	•	•	•		•	•											•	•	•	•	•	•	•	•	•	•				•	•		•
	Ampelisca abdita	•	•		•	•			•	1	•	•	•					•		•	•	1	1	•	•	•	•	1	1	•		•		•	•	•	
2	Clytia cylindrica																					1	•	•			1	•	•	•							
	Lepidasthenia	•		•	•	•	•		•	•			•			•			•		•	•	•	•	•	•	•	•	•	•		•			•		•
	Polydora						•															•	1	•	•	•	1	•	•	•							
	Balanoglossus					•																1	•	•	•	•	•	•	•								
	Polydora ligni																					•	•	•	•		•	•	•	•							
	Polydora socialis					•																•	•	•	•	•	1	•	•							•	
	Nereis succinea									•		•										•	•	•	•		•				•	•	•			•	
B	Petricola pholadiformis																					•	•	1			•		•							•	
	Oncholaimidae		•		•	•	•		•	•		•										•	•	•	•	•	•	•		•	•	•	•	•	•		•
	Mulinia lateralis												•									•	•	•	•	1	•	•	•								
	Pentidotea	•																				•	•	•	•	1	•	•	•								
	Oxyurostylis smithi				•	•	•		•	•												•	•	•	•	•	•	•			•	•	•	•		•	•
	Gyptis vittata									•						•	•		•			•	•	•	•	•	•	•		•	•			•	•		•
	Paranthus rapiformis		•							•												•	•	•	•	•	•	•	•	•							
	Arcidae																					•	•	•	•	•	•	•	•								
	Pectinaria gouldii								•			•										•	•		•	•	•			•	•	•			•		•
3	Lepidonotus sublevis												•							•			•		•		•	•				•		•	•		
	Agriopoma texasiana		•																				•	•		•	•	•		•				•			
	Anthopleura krebsi						•					•											•	•		•	•	•	•				•		•		•

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[1] Average number of individuals per grab:
(•) denotes 1 to 9
(1) denotes 10 to 99
(2) denotes 100 to 999
(3) denotes >1000

TABLE 73. Cruise I macroinfauna: two-way coincidence table of stations versus taxa used in cluster analysis. (Cont'd)

	Taxa Groups		Station Groups¹																																			
			1										2										3									4							
			0	0	0	0	0	0	0	0	2	2	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0	
			1	1	1	1	1	1	1	1	2	4	3	4	4	4	4	4	4	4	4	3	2	2	2	2	2	2	2	2	1	3	3	3	3	3	3	3	
			P	P	P	P	P	P	P	P	C	C	P	P	P	P	P	P	P	P	P	C	P	P	P	P	P	P	P	P	C	P	P	P	P	P	P	P	
			E	W	S	E	N	S	W	N			S	N	E	E	S	N	W	S	W		E	N	S	W	N	W	E	S		E	E	S	N	W	W	N	
			0	0	0	2	2	2	2	0			2	0	0	2	2	2	2	0	0		0	0	0	0	2	2	2	2		0	2	0	0	0	2	2	
			5	5	5	0	0	0	0	5			0	5	5	0	0	0	0	5	5		5	5	5	5	0	0	0	0		5	0	5	5	5	0	0	
			0	0	0	0	0	0	0	0			0	0	0	0	0	0	0	0	0		0	0	0	0	0	0	0	0		0	0	0	0	0	0	0	
			0	0	0	0	0	0	0	0			0	0	0	0	0	0	0	0	0		0	0	0	0	0	0	0	0		0	0	0	0	0	0	0	
3	Cantharus cancellarius	+		•												•							•	•	•	•		•	•		•	•	•						+
	Aglaophamus verrilli	+																					•	•	•	•			•									•	+
	Phanodermatidae	+																			•			•	•	•	•	•	•	•			•	•					+
	Ceriantipatharia ceriantharia	+																					•	•	•	•	•		•	•	•							•	+
	Poecilochaetus johnsoni	+	•			•																	•	•	•	•		•		•			•	•				•	+
	Spiochaetopterus oculatus	+			•														•				•	•		•	•	•		•	•								+
	Raeta plicatella	+																					•	•	•	•	•			•		•	•						+
	Acteon punctostriatus	+																					•	•	•	•	•			•			•	•					+
4	Glycera americana	+	•			•	•			•	•		•		•		•	•			•		•	•		•	•	•	•	•	•	•	•	•	•	•	•	•	+
	Aspidosiphon albus	+	•	•		•	•	•	•	•	•		•										•	•	•	•	•	•	•	•	•	•	•	•	•	•		•	+
	Prionospio cristata	+		•	•	•	•				•									•			1	1	•	•	•	•	•			•	•	•	•	•	•	•	+
	Aricidea fragilis	+				•					•	•	•	•			•	•	•		•	•	•			•		•		•		1	1	1	1	1	•	•	+
	Nucula cf. N. proxima	+									•			•	•	•		•					•	•	•	•		•	•	•		•	•	1	•	•	•	•	+
	Photis macromanus	+					•				•			•									•	•	•	•		•	•	•		1	1	•	•	1	•	1	+
	Prionospio cirrobranchiata	+	•		•	•	•	•	•		•		•	•										•	•		•	•		•		•	•	•	•	•	•	•	+
	Ceratonereis irritabilis	+																			•		•	•		•		•	•	•		•	•	•	•	•	•		+
	Longipedia helgolandica	+											•	•		•				•		•										•	•	•	•	•	•	•	+
	Amaeana trilobata	+						•	•			•		•	•	•		•	•	•	•		•									•	•	•	•	•	•	•	+
	Pseudeurythoe ambigua	+									•		•	•		•		•	•	•	•							•				•	•	•	•	•	•	•	+
	Astropecten duplicatus	+											•		•	•		•			•	•	•		•	•				•		•	•	•	•	•	•	•	+
	Cibicides concentricus	+											•	•				•							•							1	1	•	•	•		•	+
	Sabellidae	+											•	•									•		•		•					•	•	•	•	•	•	•	+
	Synchelidium americanum	+															•				•	•						•				•	•	•	•	•	•	•	+
	Campylaspis	+																														•	•	•	•	•	•	•	+
	Cyclaspis	+																														•	•	•	•	•		•	+
	Chone	+																									•					•	•	•			•	•	+
	Chione clenchi	+				•							•		•										•	•		•	•	•		•	•	•	•	•	•	•	+
	Eponides antillarum	+																			•											•	•	•	•	•		•	+
	Anticoma	+	•																				•	•	•	•	•					•		•	•	•	•	•	+
5	Volvulella texasiana	+	•		•		•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•			•			•	•	•			•	•		•			+
	Magelona filiformis	+					•						•	•	•	•	•	•	•	•	•	•	•							•		•	•		•	•			+
	Cingula	+											•	•	•	•	•	•	•	•	•	•																	+
	Ninoe nigripes	+				•					•	•	•	•	•	•	•	•	•	•	•	•																	+
	Cosmioconcha calliglypta	+							•	•		•	•	•	•	•	•	•	•	•	•	•	•	•	•	•							•			•			+
	Cirrophorus lyriformis	+									•		•	•	•	•	•	•	•	•	•	•			•								•		•	•	•		+
	Eudorella monodon	+											•	•	•	•	•	•	•	•	•	•																	+
	Paraonis gracilis	+	•		•	•		•					•	•		•	•		•	•	•											•	•		•		•		+
	Armandia maculata	+	•	•		•		•	•	•	•		•	•	•	•	•	•	•	•	•	•			•	•		•		•			•			•	•		+
6	Listriella barnardi	+		•				•		•	•			•		•	•		•		•	•										•	•		•	•	•	•	+
	Leiolambrus nitidus	+						•			•					•	•			•		•													•				+
	Asychis elongata	+		•		•					•			•				•	•								•	•				•			•	•		•	+

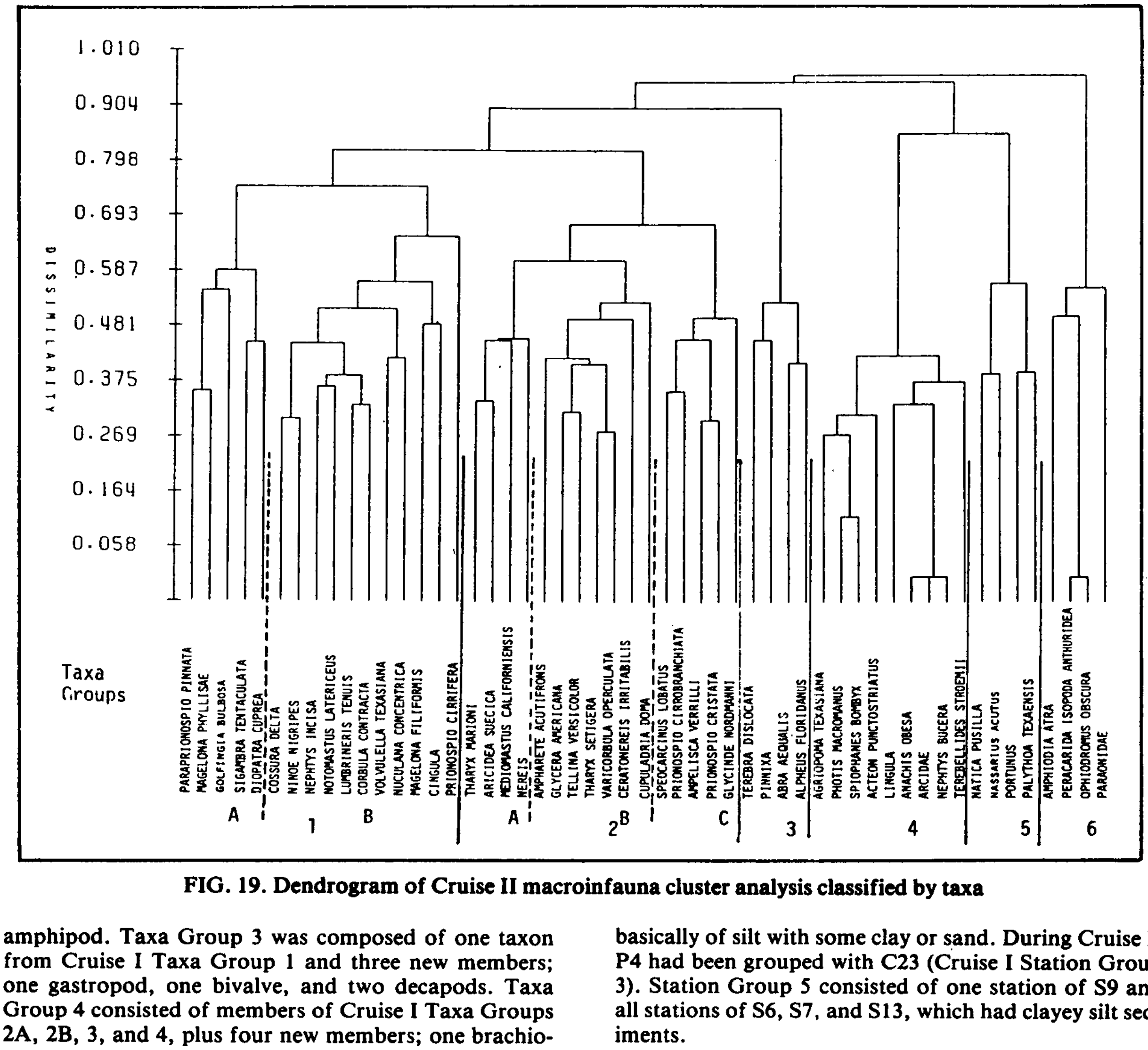

FIG. 19. Dendrogram of Cruise II macroinfauna cluster analysis classified by taxa

amphipod. Taxa Group 3 was composed of one taxon from Cruise I Taxa Group 1 and three new members; one gastropod, one bivalve, and two decapods. Taxa Group 4 consisted of members of Cruise I Taxa Groups 2A, 2B, 3, and 4, plus four new members; one brachiopod, two polychaetes, and one gastropod. Taxa Group 5 was comprised of one taxon from Cruise I Taxa Group 2A plus three taxa not included in Cruise I clustering, two gastropods and one decapod. Taxa Group 6 consisted of all new members; two polychaetes, one isopod, and one ophiuroid.

Figure 20 presents the dendrogram of the cluster analysis by classification of stations (normal classification) for Cruise II macroinfauna. Five Station Groups were delimited and are indicated. Station Group 1 was composed of stations from P1, P2, S5, S10, S11, S12, C21, C22, and C24, which were all characterized by similar sand-clay-silt combinations (see Table 56). During Cruise I, P1 had been grouped with C22 and C24 (Cruise I Station Group 1) while P2 and C21 comprised a separate group (Cruise I Station Group 3). Station Group 2 was formed by S19 only, which was over 95% sand. Station Group 3 consisted of seven P3 stations which had sediments of silty sand with some clay. During Cruise I these same stations had been grouped together as Station Group 4. Station Group 4 consisted of one station each of P3 and S9 and all stations of P4, S8, S14, S15, S16, S17, and C23, which had sediments basically of silt with some clay or sand. During Cruise I, P4 had been grouped with C23 (Cruise I Station Group 3). Station Group 5 consisted of one station of S9 and all stations of S6, S7, and S13, which had clayey silt sediments.

Table 74 presents a two-way coincidence table of the Taxa and Station Groups for Cruise II macroinfauna. Taxa Group 1A, which included many widely distributed taxa, was found at all Station Groups, but was favored by Station Group 1. Taxa Group 2 encountered the best environment at Station Group 3 while Taxa Group 3 appeared to be favored by Station Group 4. Relationships between Taxa Groups 4, 5, and 6 and the various station groups appeared to be weak. However, on the basis of available data, Station Groups 3, 2, and 4 seemed to provide the best habitat for Taxa Groups 4, 5, and 6, respectively.

Figure 21 presents the dendrogram for taxa classification cluster analysis for Cruise III macroinfauna. Six Taxa Groups of 53 taxa were delimited and are indicated in this figure. Taxa Group 1 was subdivided into two subgroups. Members of Taxa Group 1 had been included in Cruise I Taxa Groups 1, 2A, 2B, and 4 and Cruise II Taxa Groups 1A, 2, and 3. Taxa Group 2 consisted of members from Cruise I Taxa Groups 1, 2B, and 4 and Cruise II Taxa Group 5. The gastropod *Anadara ovalis* had not been included in the previous clustering for Cruises I and II. Taxa Group 3

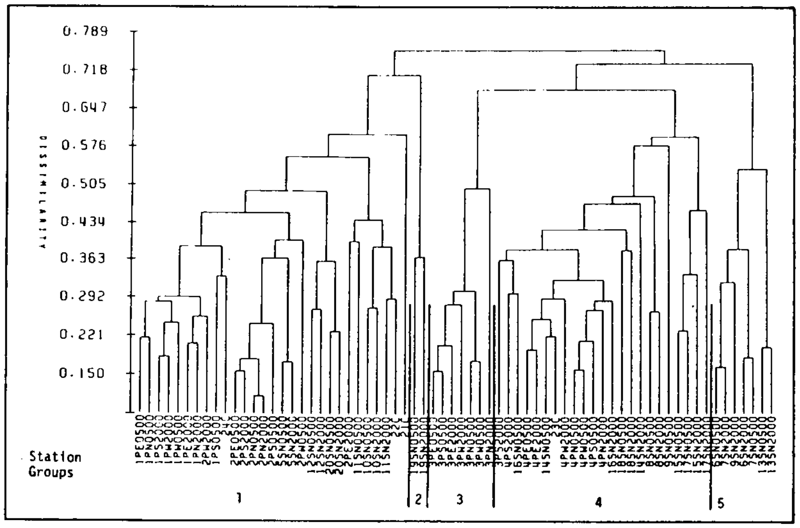

FIG. 20. Dendrogram of Cruise II macroinfauna cluster analysis classified by station

TABLE 74. Cruise II macroinfauna: two-way coincidence table of stations versus taxa used in cluster analysis.

```
                                                    Station Groups¹
                                            1                  2  3          4              5
                                 000000000200000000011220111122 11 0000000 0010012000001111000111 0000011
                                 111111121422222255222002100121 99 3333333 3464443444446884889575 7679673
                                 PPPPPPPPPCPPPPPSSPSSSSPSSSSCCS SP PPPPPPP PPSPPSCPPPPPSSSSSSSSSS SSSSSSS
                                 ENSWWENWS ESNNSNNWNNNNENNNN    NN ESEWNWN SSNEEN WNWSNNNNNNNNNNNN NNNNNNN
        Taxa Groups              002202220 020200200202200022   02 0022002 220020 20002202220200022 0222002
                                 550050005 505055055050055 00   50 5500550 005505 05550050050555000 5000550
                                 000000000 000000000000000000   00 0000000 000000 000000000000000000 0000000
                                 000000000 000000000000000000   00 0000000 000000 000000000000000000 0000000

     Paraprionospio pinnata      +11111..1..11111111..........  ..|....1..|11..1...1...1...1... ..|.......+
     Magelona phyllisae          +.1....1...11111221.111.1..1.  ..|......  |....  ........ ... .  |       +
  A  Golfingia bulbosa           +..........11......  .  .21...1  |.......|.  ... .  .  .. .  . | .     +
     Sigambra tentaculata        +..............................  |.......|  ..... ....... ......|  ..   +
   --Diopatra cuprea-------------+..........................  ....|.. ...|. . .. . ..... ......|. . ..+
     Cossura delta               + .  .  . ..    ... .  . .....   |......|..........................|.......+
     Ninoe nigripes              +  .    .      . .        .     .|.  ...|..........................|.......+
  1  Nephtys incisa              +....... ...   . .        .      |.  ...|........................ .|.......+
     Notomastus latericeus       +..... .     .. .   .          ..|.......|..........................|.......+
  B  Lumbrineris tenuis          +   .   ... .  ...... ...        |.......|.........................| .. .  +
     Corbula contracta           +...... . . ...  .               |.......|........11..1........ ...| ...  .+
     Velvulella texasiana        +......   .      ... .           |...... |......................   |  .    +
     Nuculana concentrica        +....... ..      ....          . |..... .| . .... ....... ..       | .     +
     Magelona filiformis         +.                .     .      . |.. .   |............ ...       . | .. .  +
     Cingula                     +                .               |       |............ .  ...    . | ...   +
     Prionospio cirrifera        +          .     .     .. .     .|...... |...  .. . .....  .... . | . ..  +
     Tharyx marioni              +  ..   .    .  .. ...  .....   .|.......|...... ..... ... ....   |.  .  .+
  A  Aricidea suecica            +                 ..    .....   .|11.....|.. .  .  .  . ....   .. |   .   +
     Mediomastus californiensis  +  .... .  .   . .1  .     .     |...1...|.  .. .  .  ...  .  .   | .. .  +
   --Nereis----------------------+.......  . .. ....   ...      ..|1111...|. . ..  . .........     |  .    +
     Ampharete acutifrons        +.... ..          ....      .    |.......|        .   .          |   .   +
     Glycera americana           +     .             .          . |.......|  .   . ... ...     .  | .     +
  2  Tellina versicolor          +..   .                        ..|.......|     .  .  .. ..    .  |       +
  B  Tharyx setigera             +                                |.......| .      .  ..        . |       +
     Varicorbula operculata      +                                |....  .|     .    .            |       +
     Ceratonereis irritabilis    +     .             .            |.....1.|       ..  .  .        |       +
   --Cupuladria doma-------------+                                |1.1   1|                         |       +
     Speocarcinus lobatus        +  .                .            |...... |. .    . ..   .     .  | . ..  +
     Prionospio cirrobranchiata  +     .         .              . |...... |. .    ...     .      |      .+
  C  Ampelisca verrilli          +                                |. .  ..|          .  .    .    |       +
     Prionospio cristata         +                                |...... |                         |   .   +
     Glycinde nordmanni          +  .  .                          |. .. . |  .     .....    .   . |.      +
     Terebra dislocata           +. . . .  .   ..   .             |      ..| . . ... .      .     |    .  +
  3  Pinnixa                     +     . .                        |       |.. . ....... ....      | .  .  +
     Abra aequalis               +          ... .  .              | .     |. .    .......  . .  . |       +
     Alpheus floridanus          +         .                      | ..  . | .  .    .....         |.  .  .+
     Agriopoma texasiana         +         .           ..         |.. .  ..|  .  . ..  .  ..    .  |       +
     Photis macromanus           +                                |.  .  ..|                         |       +
     Spiophanes bombyx           +                                |      .|           .  .  .       |       +
     Acteon punctostriatus       + .     . .                      |      .|              ..     .   |       +
  4  Lingula                     +                   .            |.     ..|      .. .   ..     ..  |       +
     Anachis obesa               +          .  .                . |      .|..     .                 |       +
     Arcidae                     +       .                        |      .|.     .                  |       +
     Nephtys bucera              +                                |...   .|                         |       +
     Terebellides stroemii       +                                |      .|              ..       . |       +
     Natica pusilla              +      .. .. ..   .            ..|      .|              .          |       +
     Nassarius acutus            + .   .       .. .             ..|       |                         |       +
  5  Portunus                    +          .   .               ..| .     |                         |       +
     Palythoa texaensis          +          .                   ..|      .|                         |       +
     Amphiodia atra              +         .                    ..|   ..  .|.  .  .. ..  ..        | . .   +
     Peracarida isopoda anthuridea +                              |      .|     .    .  ..         |       +
  6  Ophiodromus obscura         +                                |   .   |             .  . .    . |       +
     Paraonidae                  +                                |       |.. ..     .  ..   .    . |       +
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¹Average number of individuals per grab:

(•) denotes 1 to 9 (2) denotes 100 to 999

(1) denotes 10 to 99 (3) denotes ≥1000

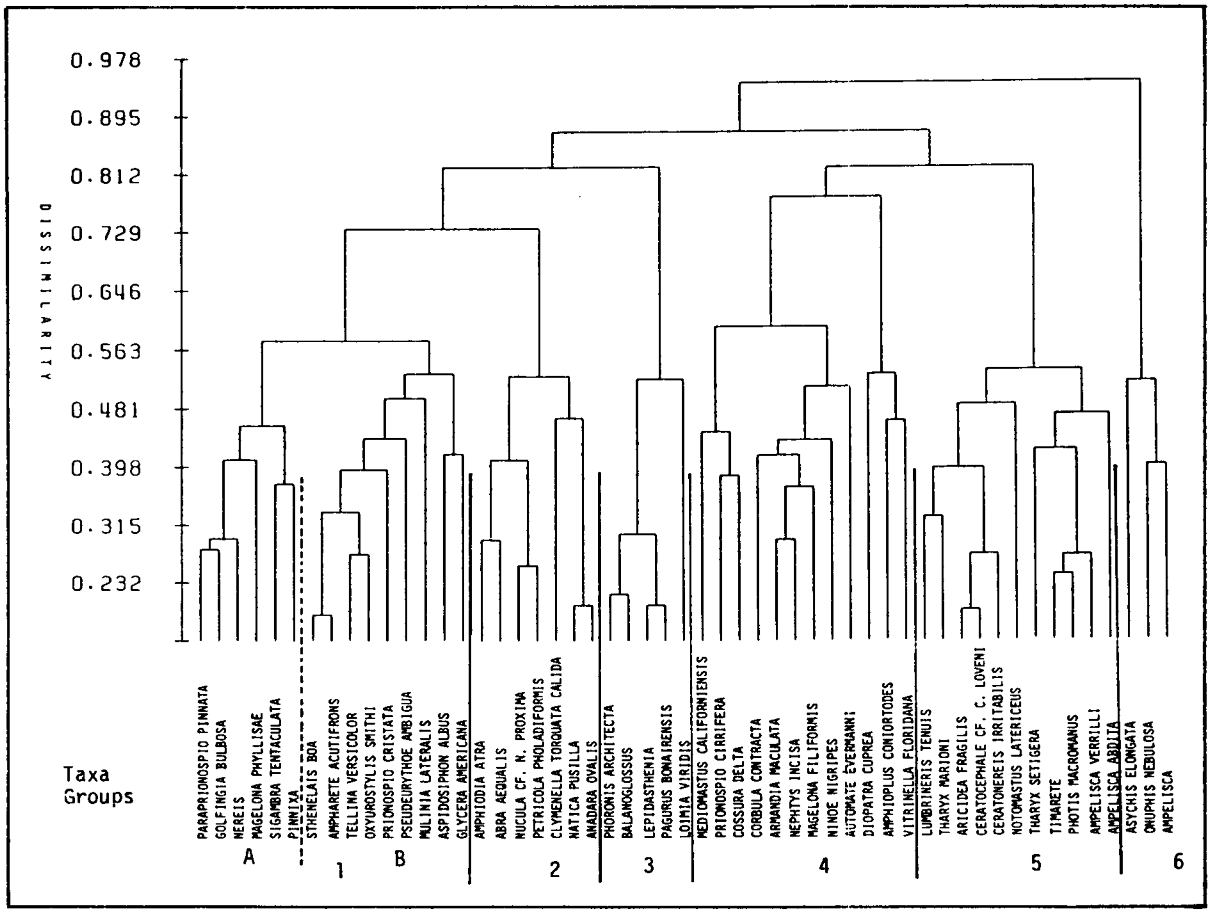

FIG. 21. Dendrogram of Cruise III macroinfauna cluster analysis classified by taxa

was formed by members of Cruise I Taxa Group 2 and two taxa not previously used in clustering; the decapod *Pagurus bonairensis* and the polychaete *Loimia viridis*. Taxa Group 4 was composed of taxa from Cruise I Taxa Groups 1 and 5 and Cruise II Taxa Groups 1A, 1B, and 2. The decapod *Automate evermanni* and the ophiuroid *Amphioplus coniortodes* had not been used in clustering during Cruises I and II. Taxa Group 5 consisted of members from Cruise I Taxa Groups 1, 2A, and 4, Cruise II Taxa Groups 1B, 2, and 4, and two taxa that had not been used in previous clustering; the polychaetes *Ceratocephale* cf. *C. loveni* and *Timarete*. Taxa Group 6 was contributed to by one member from Cruise I Taxa Group 6 and two taxa new to clustering; the polychaete *Onuphis nebulosa* and the amphipod *Ampelisca*.

Figure 22 presents the dendrogram of Cruise III macroinfauna Station Groups. Four Station Groups were delimited and are indicated. Cruise III Station Groups consisted of the same station and site combinations as were encountered during Cruises I and II. P1 grouped with C22 and C24 as Station Group 1. Station Group 2 consisted of P2 plus C21 and Station Group 3 consisted entirely of seven P3 stations. Station Group 4 was composed of one P3 station, P4, and C23.

Table 75 presents a two-way coincidence table of the Taxa and Station Groups of Cruise III macroinfauna. Because of the ubiquity of most of the taxa, Taxa Subgroup 1A was found in some numbers at all Station Groups; however, Station Group 2 appeared to provide the best environment. Taxa Subgroup 1B was also favored by Station Group 2. Station Group 2 was also conducive to Taxa Groups 2 and 3, while Station Group 4 favored Taxa Group 4. Taxa Group 5 seemed to have the best habitat at Station Group 3. Station group preference by Taxa Group 6 appeared to be weak, which may indicate that the taxa group might be erroneous because of insufficient data.

Many of the macroinfauna taxa remained clustered together over more than one cruise and also consistently demonstrated a preference for the habitat characterized by certain sites. This is summarized in Table 76. Members of Cruise I Taxa Group 1 and 2A, Cruise II Taxa Group 1A, and Cruise III Taxa Group 1A were essentially the same and appeared to prefer the environment at P1, P2, C21, C22, and C24. Cruise I Taxa Group 2B and Cruise II Taxa Group 3 generally contained the same taxa and were usually found together at P2 and C21. Cruise I Taxa Group 4, Cruise II Taxa Group 2, and Cruise III Taxa Group 5 contained similar taxa and preferred most stations at P3 except P3 S2000. Cruise I Taxa Group 5, Cruise II Taxa Group 1B, and Cruise III Taxa Group 4 all shared common members and generally were collected in greatest numbers at P3 S2000, P4, and C23. There appeared to be

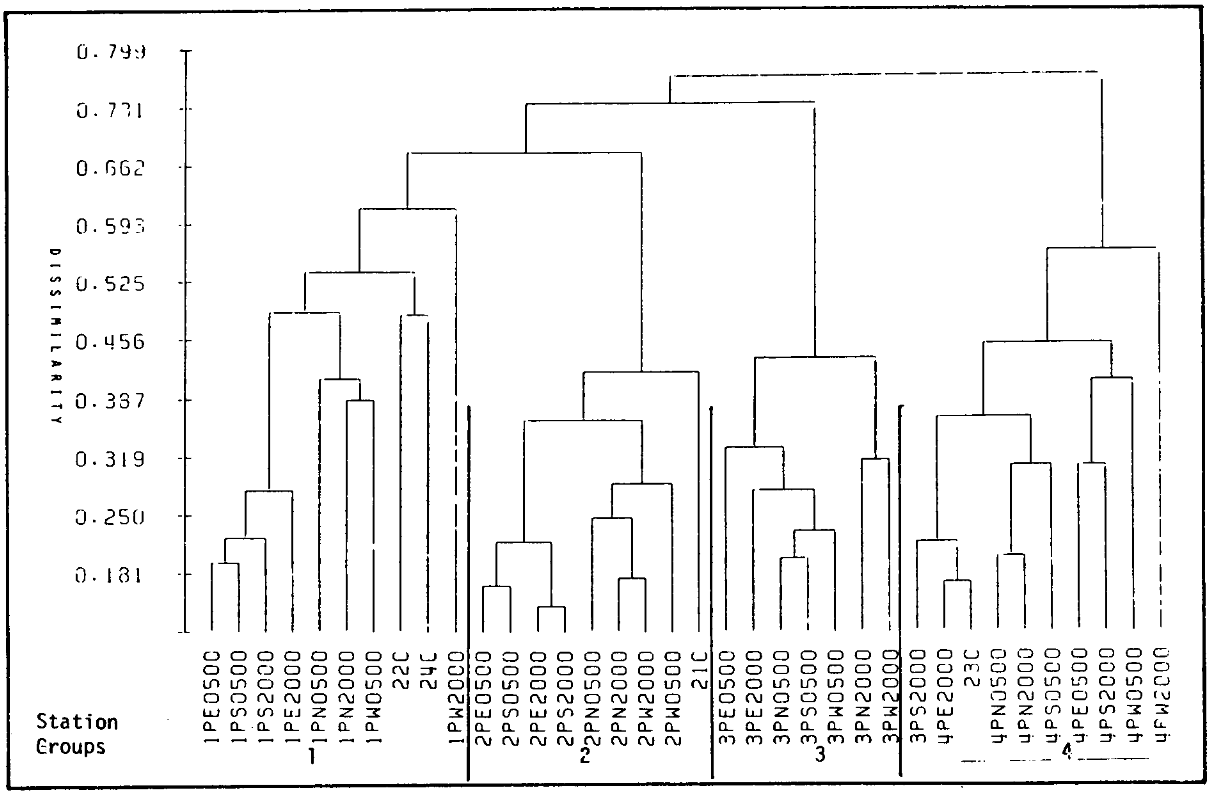

FIG. 22. Dendrogram of Cruise III macroinfauna cluster analysis classified by station.

TABLE 75. Cruise III macroinfauna: two-way coincidence table of stations versus taxa used in cluster analysis.

			Station Groups[1]																																	
			1										2									3								4								
		Taxa Groups	01PE0500	01PS0500	01PS2000	01PE2000	01PN0500	01PN2000	01PW0500	22C	24C	01PW2000	02PE0500	02PS0500	02PE2000	02PS2000	02PN0500	02PN2000	02PW2000	02PW0500	21C	03PE0500	03PE2000	03PN0500	03PS0500	03PW0500	03PN2000	03PW2000	03PS2000	04PE2000	23C	04PN0500	04PN2000	04PS0500	04PE0500	04PS2000	04PW0500	04PW2000
		Paraprionospio pinnata	•	•	•	•	•	•	•	•	•	•	1	1	1	1	•	•	•	1	1	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•		•
		Golfingia bulbosa	•	•		•	•	•	•	•		•	1	•	1	1	•	•	•	•	1	•	•	•	•	•	•	•	•				•					
	A	Nereis	•	•	•	•	•	•		•		•	1	1	•	1	1	•	•	•	1	1	1	1	1	1	•	•	•	•		•	•	•	•		•	•
		Magelona phyllisae	1	1	•	1	1	1	•	•	•	•	2	2	2	2	2	1	1	1	1	•	•	•	•	•	•	•	•									
		Sigambra tentaculata	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	1			•	•	•	•	•	•	•	•	•	•	•				•
1		Pinnixa	•	•		•	•	•	•	•	•		1		•	•	•	•	•	•	•	•				•	•			•	•	•	•	•	•	•		•
		Sthenelais boa	•	•	•	•	•	•		•	•	•	•	•	•	•	•	•	•	•	•	•	•		•	•	•	•		•	•	•	•		•		•	
		Ampharete acutifrons	•	•	•	•		•		•			•	•	•	•	•	•	•	•		•	•	•		•	•	•										
		Tellina versicolor	•			•		•					•	•	•	•	•	•	•	•			•	•	•	•	•	•										
		Oxyurostylis smithi									•		•	•	•	•	•	•	•	•						•												
	B	Prionospio cristata		•		•					•		•	•	•	•	•	•		•		•	•	•		•	•	•										
		Pseudeurythoe ambigua											•	•		•	•	•	•	1	•	•	•	•	•	•												
		Mulinia lateralis											•	•	•		•	•	1	1																		
		Aspidosiphon albus				•	•	•		•			•	•	•	•	•	•	•	•	•			•	•	•	•	•										
		Glycera americana				•							•	•	•	•	•	•	•	•	•	•	•	•	•	•	•							•		•		
		Amphiodia atra									•		•	•	•	•	•	•	•	•		•					•		•			•	•					
		Abra aequalis											•	•	•	•	•	•	•	•																		
		Nucula cf. N. proxima											•	•		•	•	•	•	•	•		•	•		•		•										
2		Petricola pholadiformis															•	•	•	•																		
		Clymenella torquata calida	•				•	•			•						•	•	•			•																
		Natica pusilla	•									•			•		•	•	•																			
		Anadara ovalis														•	•	•	•		•																	
		Phoronis architecta						•					•	•	•	•	•	•		•					•		•											
		Balanoglossus											•	•	•	•			•	•																		
3		Lepidasthenia			•					•			•	•	•	•	•	•		•																		
		Pagurus bonairensis											•	•			•	•		•																		
		Loimia viridis											•	•	•	•	•		•																			
		Mediomastus californiensis	•	•	•	•			•		•	•	•	•	•	•	•		•	1	•	•	•	•	•	•	•	•	•	•	•	•	•	•		•	•	•
		Prionospio cirrifera	•	•	•	•		•	•	•	•	•	•	•	•	•			•	•		•	•	•	•	•		•	•	•	•	•	•	•		•		
		Cossura delta	•	•	•	•	•		•	•	•	•			•	•				•		•	•	•	•	•	•		•	•	•	•	•	•	•		•	•
		Corbula contracta		•	•	•	•	•	•		•			•	•		•	•	•	•	•		•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•
		Armandia maculata	•	•	•	•	•	•	•	•	•	•				•					•	•	•	•			•	•	•	•	•	•	•	•	•	•	•	•
4		Nephtys incisa	•	•	•	•	•	•		•	•	•		•								•	•	•		•	•	•	•	•	•	•	•	•	•	•	•	•
		Magelona filiformis		•		•		•	•														•	•		•	•		•	•	•	•	•	•	•	•	•	•
		Ninoe nigripes	•								•															•		•	•	•	•	•	•	•	•	•	•	•
		Automate evermanni			•		•				•						•					•		•	•		•		•	•	•	•	•	•	•	•		•
		Diopatra cuprea	•	•	•	•		•	•	•	•	•	•	•			•	•	•	•	•			•	•	•			•	•	•	•						•
		Amphioplus coniortodes	•	•	•	•	•	•	•	•		•									•								•	•				•	•	•	•	
		Vitrinella floridana	•	•		•	•	•	•	•	•	•				•		•			•										•		•					
		Lumbrineris tenuis					•			•	•		•	•	•	•	•	•	•	•		•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•
		Tharyx marioni		•	•		•	•		•	•		•	•	•	•		•		•	•	•	•	•	•	•	•	•		•		•	•	•	•	•		
		Aricidea fragilis														•						•	•	1	•	•	•	•				•	•	•		•		
5		Ceratocephale cf. C. loveni																				•	•	•	•	•	•	•										
		Ceratonereis irritabilis															•	•	•			•	•	•	•	•	•	•							•		•	
		Notomastus latericeus		•	•		•	•	•	•			•		•		•	•					•	•	•	•	•	•		•	•	•	•	•	•	•	•	•
		Tharyx setigera	•			•			•						•								•	•	•	•		•	•	•	•	•				•		
		Timarete													•				•			•	•	•	•	•	•	•				•						
		Photis macromanus																				•	•	•		•	•	•										
		Ampelisca verrilli						•															•	•	•	•	•	•										
		Ampelisca abdita																			•	•		•	•	•	•	•	•		•	•				•		•
		Asychis elongata	•		•					•		•													•		•	•	•	•							•	
6		Onuphis nebulosa																				•	•	•	•	•	•											
		Ampelisca																				•	•	•			•			•								

[1] Average number of individuals per grab:
(•) denotes 1 to 9
(1) denotes 10 to 99
(2) denotes 100 to 999
(3) denotes ≥1000

TABLE 76. Relationship between macroinfauna Taxa Groups and site preference

Taxa Group Associations		Site Preference
1. Cruise I	Taxa Groups 1, 2A	P1, P2
Cruise II	Taxa Group 1A	C21, C22, C24
Cruise III	Taxa Group 1A	
2. Cruise I	Taxa Group 2B	P2, C21
Cruise III	Taxa Group 3	
3. Cruise I	Taxa Group 4	P3 (except P3 S2000)
Cruise II	Taxa Group 2	
Cruise III	Taxa Group 5	
4. Cruise I	Taxa Group 5	P3 S2000
Cruise II	Taxa Group 1B	P4
Cruise III	Taxa Group 4	C23

little association among the other Taxa Groups and sites not listed in Table 76.

Figure 23 presents the macroinfauna similarity between sites for Cruises I, II, and III. As mentioned above, the combination of Primary Stations and Control Sites was consistent during all three cruises. Station similarity closely corresponded to sediment patterns and depth zonation as indicated by Defenbaugh (1976).

6. Macroepifauna and Demersal Fish

a. Decapoda

A total of 57 different taxa of Decapoda were identified in the macroepifauna; 28 during Cruise I, 48 during Cruise II, and 28 in Cruise III (see Table 14). Table 77 presents the frequency of observation, abundance, and rank for the macroepifauna Decapoda collected in this project. Only *Penaeus aztecus* was consistently among the top 15 macroepifauna and demersal fish taxa common to each cruise. Of the taxa selected for cluster analysis, i.e., those taxa which occurred frequently enough and were abundant enough to comprise 95% of the total, 31.3% of Cruise I, 24.0% of Cruise II, and 23.5% of Cruise III were Decapoda.

Penaeus aztecus was collected at all but five sites during Cruise I; during Cruise II at all but 10 sites; and during Cruise III, at all but three sites (Table 78). Average numbers of individuals per trawl were highest at P2, Cruise I, and second highest at P3, Cruise III.

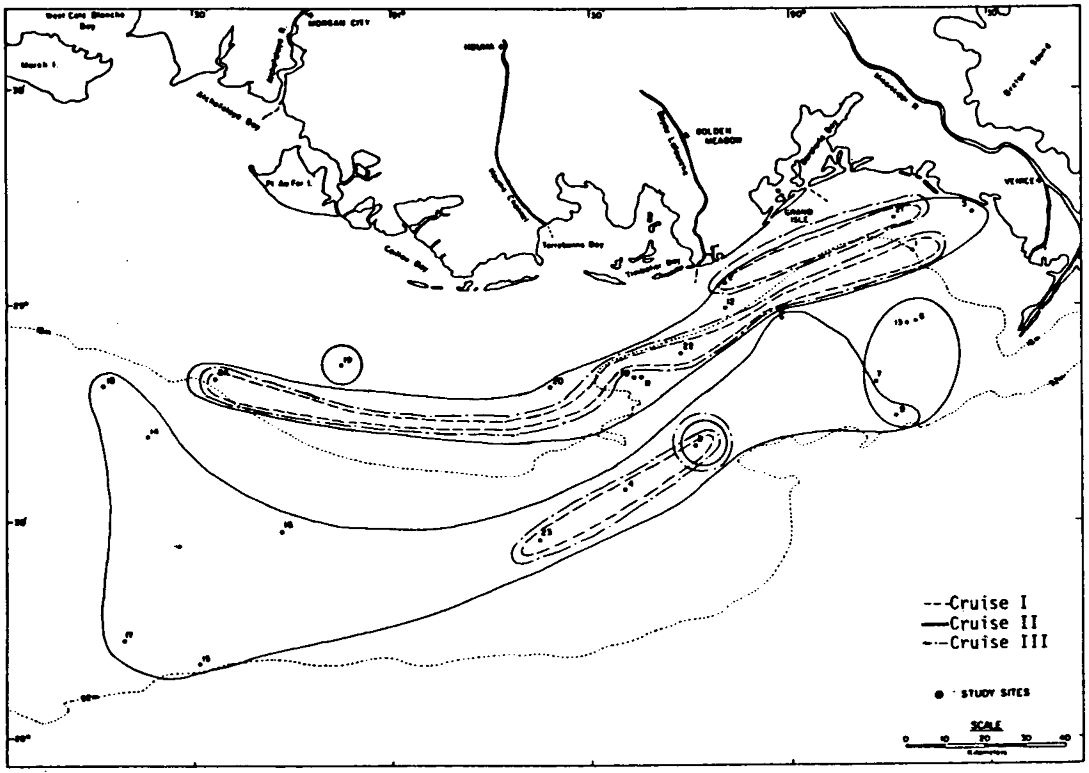

FIG. 23. Macroinfauna similarity between stations

TABLE 77. Frequency of observation, abundance, and rank for the macroepifauna Decapoda by cruise.

	Cruise I			Cruise II			Cruise III			Total		
Taxa	Obs[1]	Ind[2]	Rk[3]	Obs	Ind	Rk	Obs	Ind	Rk	Obs	Ind	Rk
Penaeus aztecus	3	273	11	14	176	2	5	136	11	22	585	2
Penaeus duorarum	1	2	73							1	2	192
Penaeus setiferus	2	40	28	2	179	87	5	15	16	9	234	33
Trachypenaeus	3	19	17				1	1	96	4	20	83
Trachypenaeus constrictus							1	2	70	1	2	193
Trachypenaeus similis	4	912	5	8	439	19	5	128	12	17	1479	9
Sicyonia brevirostris	2	8	39	3	9	74	3	19	29	8	36	48
Sicyonia dorsalis	2	15	30	6	275	32	3	3	34	11	293	25
Parapenaeus longirostris				4	17	59				4	17	86
Solenocera vioscai				2	13	94				2	13	121
Solenocera atlantidis							1	5	62	1	5	175
Xiphopeneus kroyeri				1	1	191				1	1	241
Acetes americanus carolinae	1	2	74	4	15	60				5	17	73
Leptochela bermudensis				1	1	192				1	1	242
Alpheus floridanus	4	45	9	6	68	34	1	3	66	1	116	27
Alpheus amblyonyx				1	1	193				1	1	243
Latreutes parvulus							1	1	97	1	1	244
Processa bermudensis	1	4	61	1	3	139				2	7	127
Processa hemphilli				1	2	148				1	2	194
Stenopus scutellatus				2	2	119				2	2	155
Paguristes oxyophthalmus				1	1	194				1	1	245
Pagurus (decapoda)							1	1	98	1	1	246
Pagurus pollicaris	4	22	10	3	4	82	4	23	23	11	49	29
Pagurus brevidactylus				1	2	149				1	2	195
Pagurus bullisi				1	2	150				1	2	196
Clibanarius vittatus				1	1	195				1	1	247
Petrochirus diogenes	1	1	94	2	3	108	1	1	99	4	5	92
Porcellana sigsbeiana	1	2	75	3	4	83	1	3	67	5	9	77
Porcellana sayana	1	2	76	1	1	196	1	2	71	3	5	106
Albunea paretii				1	1	197				1	1	248
Dromia erythropus				1	1	198				1	1	249
Ethusa microphthalma				1	1	199				1	1	250
Calappa flammea							1	1	100	1	1	251
Calappa sulcata	1	4	62	6	8	40	3	7	33	10	19	32
Hepatus epheliticus	2	9	36	4	6	64	2	2	48	8	17	51
Acanthocarpus alexandri				1	3	140				1	3	182
Persephona crinita	1	11	52	4	9	62	1	6	61	6	26	62
Myropsis quinquespinosa				2	4	105				2	4	133
Raninoides louisianensis	1	2	77	6	48	36				7	50	56
Majidae				2	3	109				2	3	138
Libinia emarginata	1	1	95	2	4	106	3	3	35	6	8	70
Podochela lamelligera				2	2	120				2	2	156
Anasimus latus	1	12	51	3	44	68				4	56	81
Coelocerus spinosus	1	2	78	2	3	110				3	5	107
Stenorhynchus seticornis				1	2	151				1	2	197
Leiolambrus nitidus	5	71	1	10	175	9	2	3	42	17	249	10
Callinectes sapidus	1	16	49	8	153	20				9	169	34
Callinectes similis	5	41	3	9	243	16	5	47	13	19	331	6
Ovalipes guadulpensis	3	4	22	1	1	200	1	1	101	5	6	78
Portunus gibbesii	2	69	27	10	90	11	7	141	3	19	300	7
Portunus spinicarpus	2	129	25	6	1008	31				8	1137	43
Portunus spinimanus							1	3	68	1	3	183
Hexapanopeus paulensis							1	2	72	1	2	198
Menippe mercenaria				1	1	201	1	1	102	2	2	157
Pilumnus				1	1	202				1	1	252
Speocarcinus lobatus	3	27	14	5	19	47	1	1	103	9	47	37
Pseudorhombila quadridentata				1	9	129				1	9	172

[1] Obs — denotes number of observations.

[2] Ind — denotes number of individuals.

[3] Rk — denotes rank.

TABLE 78. Number of individuals of *Penaeus aztecus* (Decapoda) by station and cruise.

Station	Number of Individuals/Trawl			
	Cruise I	Cruise II	Cruise III	Average
01PN0500				.0
02PN0500	269.0		1.0	90.0
03PN0500	2.0	4.0	104.0	36.7
04PN0500		4.0	6.0	3.3
05SN0500		2.0		
06SN0500		67.0		
07SN0500		7.0		
08SN0500		4.0		
09SN0500		8.0		
10SN0500				
11SN0500				
12SN0500				
13SN0500		39.0		
14SN0500		12.0		
15SN0500		3.0		
16SN0500		14.0		
17SN0500		7.0		
18SN0500				
19SN0500				
20SN0500				
21C		1.0	1.0	.7
22C				.0
23C	2.0	4.0	24.0	10.0
24C				.0
Average	34.1	7.3	17.0	

Comparably large numbers were collected at S6, S13, and C23, Cruise III. The overall average number of individuals tended to be higher during Cruise I, dropped very low during Cruise II, and then rose to a mid-level during Cruise III.

Penaeus setiferus was collected at only two sites during Cruise I; at two sites during Cruise II; and at five sites during Cruise III (Table 79). Based on the overall average per cruise, the number of individuals peaked during Cruise II.

Decapoda comprised 48.6% of the total number of individuals during Cruise I, 17.5% in Cruise II, and 10.7% in Cruise III with an overall average of 25.6% (see Table 15). Table 80 presents the percentage of the total number of individuals by station per cruise for the Decapoda. Percentages at the Primary and Control Sites were generally higher during Cruise I than during Cruises II and III. This trend was especially marked at P2, P3, and C23. Percentages were similar for all three cruises at P1 and P4, but similar only for Cruises I and III at C21 and C24. The low percentages at C22, Cruise I and at P2, P3, C21 and C23, Cruise II may be a result of the low D.O. values (see Table 142). The low percentage at P4 may not be due to a low D.O. value, since the percentage during the other cruises was also low. Note that at C21 the percentages during Cruises I and III were much higher than during Cruise II, and a low D.O. had been measured at C21 during Cruise I. Percentages greater than 50% had been calculated at S7, S9, and S16.

Examination of the percentage of Decapoda compared to the total number of individuals by depth zone indicated a slight increase with depth during Cruises I and II; total cruise averages also increased with depth (Table 81). During Cruise III, the percentage of Decapoda in the 30 to 90 m zone was much reduced. There did appear to be some changes over cruises, thus implying some seasonal effect.

Average diversity and evenness values for macroepifauna Decapoda at the Primary and Control Sites consistently increased from Cruise I to Cruise III except at P1, P3, and P4 (Table 82). The variation in diversity at P1 and P4 was probably due to decreases in number of taxa; at P3 the changes in diversity appeared to be due to changes in evenness. Low diversities at S5, S9, S10, S14, and S19 did not appear to be related to the low D.O. values (see Table 142).

b. *Osteichthyes*

A total of 91 different taxa representing 38 different families of Osteichthyes were identified in the demersal fish; 41 during Cruise I, 74 during Cruise II, and 49 in Cruise III (see Table 14). Table 83 presents the frequency of observation, abundance, and rank for the demersal fish collected in this project. Only *Prionotus rubio* and *Halieutichthys aculeatus* were consistently among the top 15 macroepifauna and demersal fish taxa common to each cruise. Of the taxa selected for cluster analysis, i.e., those taxa which occurred frequently enough and were abundant enough to comprise 95% of the total, 43.8% of Cruise I, 37.2% of Cruise II, and 58.8% of Cruise III were Osteichthyes.

Prionotus rubio occurred at all but three sites during Cruise I; during Cruise II at all but eight sites; and during Cruise III at all but four sites (Table 84). Average numbers of individuals per trawl were generally higher during Cruise II than Cruises I or III, except at

TABLE 79. Number of individuals of *Penaeus setiferus* (Decapoda) by station and cruise.

Station	Number of Individuals/Trawl			
	Cruise I	Cruise II	Cruise III	Average
01PN0500			2.0	0.7
02PN0500	34.0		2.0	12.0
03PN0500				0.0
04PN0500				0.0
05SN0500		175.0		
06SN0500				
07SN0500				
08SN0500				
09SN0500				
10SN0500				
11SN0500				
12SN0500				
13SN0500				
14SN0500				
15SN0500				
16PN0500				
17SN0500				
18SN0500				
19SN0500				
20SN0500				
21C		4.0	2.0	2.0
22C	6.0			2.0
23C			4.0	1.3
24C			5.0	1.7
Average	5.0	7.5	1.9	

TABLE 80. Percent total number of individuals by cruise for macroepifauna and demersal fish Decapoda.

Site	Percent Total Number of Individuals/Cruise			
	Cruise I	Cruise II	Cruise III	Average
P01	20.7	20.5	30.5	23.9
P02	82.2	2.5	20.4	35.0
P03	70.4	0.3	13.7	28.1
P04	2.0	3.6	4.4	3.3
S05		38.3		38.3
S06		36.0		36.0
S07		56.3		56.3
S08		15.2		15.2
S09		67.4		67.4
S10		9.8		9.8
S11		6.7		6.7
S12		--[1]		--
S13		32.5		32.5
S14		7.5		7.5
S15		34.5		34.5
S16		53.0		53.0
S17		10.6		10.6
S18		9.8		9.8
S19		30.7		30.7
S20		16.7		16.7
C21	35.9	3.0	31.2	23.4
C22	9.8	--	3.1	4.3
C23	61.5	9.0	2.6	24.4
C24	36.3	0.8	34.7	23.9

[1] (--) indicates that the taxa did not occur at that station.

TABLE 81. Distribution by depth zonation and cruise of macroepifauna Decapoda as percent of total number of macroepifauna.

Depth Zone (m)[1]	Percent Total Number of Individuals/Cruise			
	Cruise I	Cruise II	Cruise III	Average
<30	37.0	11.5	24.0	24.2
30 to 90	44.6	29.9	6.9	27.1
>91	--	34.5	--	34.5

[1] Depth zone <30 m included sites P1, P2, S5, S8, S10, S11, S12, S14, S18, S19, S20, C21, C22, and C24.
Depth zone 30 to 90 m included sites P3, P4, S6, S7, S9, S13, S16, S17, and C23.
Depth zone >91 m included only site S15.

TABLE 82. Average diversity and evenness values for the macroinfauna Decapoda taxa by site and cruise

				Evenness					
	Diversity			Pielou			Heip		
Site	Cruise I	Cruise II	Cruise III	Cruise I	Cruise II	Cruise III	Cruise I	Cruise II	Cruise III
P01	2.19	1.00	1.49	0.880	0.913	0.763	0.718	0.863	0.569
P02	1.09	1.10	1.36	1.524	1.000	0.845	0.282	1.000	0.723
P03	0.68	1.65	1.43	0.328	0.920	0.596	0.140	0.840	0.318
P04	1.17	1.35	1.24	0.843	0.977	0.769	0.739	0.958	0.612
S05		0.21			0.132			0.059	
S06		1.79			0.646			0.333	
S07		1.07			0.404			0.146	
S08		1.01			0.729			0.582	
S09		0.71			0.277			0.086	
S10		0.69			1.000			1.000	
S11		--[1]			--			--	
S12									
S13		1.68			0.606			0.291	
S14		0.78			0.434			0.235	
S15		1.21			0.445			0.167	
S16		1.23			0.480			0.202	
S17		1.53			0.784			0.600	
S18		1.24			0.595			0.349	
S19		0.55			0.501			0.367	
S20		1.33			0.959			0.927	
C21	0.30	1.15	1.58	0.426	0.832	0.814	0.344	0.723	0.645
C22	0.81		0.94	0.737		0.678	0.623		0.520
C23	0.92	1.59	1.79	0.326	0.663	0.778	0.095	0.390	0.555
C24	1.11	--	1.42	0.693	--	0.539	0.512	--	0.242

[1] Insufficient numbers of individuals per taxa to calculate diversity or evenness.

TABLE 83. Frequency of observation, abundance, and rank for the demersal fish Osteichthyes by cruise.

	Cruise I			Cruise II			Cruise III			Total		
Taxa	Obs[1]	Ind[2]	Rk[3]	Obs	Ind	Rk	Obs	Ind	Rk	Obs	Ind	Rk
Raja texana				1	1	205				1	1	257
Hoplunnis macrurus	1	1	99	1	2	152				2	3	140
Congrina flava				1	1	206				1	1	258
Paraconger caudilimbatus				1	1	207				1	1	259
Dysommidae							1	1	104	1	1	260
Clupeidae							2	3	43	2	3	141
Brevoortia patronus	1	2	79							1	2	199
Dorosoma petenense	1	1	100	1	1	208				2	2	158
Etrumeus teres				1	90	124				1	90	164
Sardinella anchovia				1	3	141				1	3	184
Anchoa hepsetus	3	24	16	3	130	65				6	154	59
Anchoa mitchilli	3	29	13	3	95	66				6	124	60
Anchoa nasuta	1	7	56	3	8	76				4	15	88
Anchoviella perfasciata	2	4	43	2	24	90				4	28	82
Synodus foetens	1	1	101	7	51	27	2	15	37	10	67	31
Synodus poeyi				1	3	142				1	3	185
Saurida brasiliensis	1	3	68	11	117	4	1	1	105	13	121	20
Bagre marinus				1	34	125				1	34	165
Arius felis	2	10	35	7	157	23	5	168	10	14	335	15
Porichthys porosissimus	2	8	40	5	26	45	1	1	106	8	35	49
Antennarius radiosus	2	11	33	6	64	35				8	75	45
Ogcocephalus							1	2	74	1	2	200
Ogcocephalus radiatus				2	10	97				2	10	125
Halieutichthys aculeatus	3	26	15	11	181	3	7	318	2	21	525	4
Bregmaceros atlanticus	1	2	80	1	2	153				2	4	134
Urophycis cirratus	1	4	64	3	16	70				4	20	84
Urophycis floridanus				1	1	209	1	1	107	2	2	159
Brotula barbata				3	9	75				3	9	99
Lepophidium graellsi	1	4	65	1	1	210	1	2	75	3	7	103
Scorpaena calcarata				1	1	211	2	9	39	3	10	98
Prionotus tribulus							2	3	44	2	3	142
Prionotus ophryas				1	2	154				1	2	201
Prionotus paralatus				2	17	92				2	17	119
Prionotus rubio	5	16	4	16	373	1	4	101	19	25	490	1
Prionotus stearnsi	1	2	81	5	51	42	1	1	108	7	54	55
Centropristis philadelphicus	3	3	23	8	59	22	2	16	36	13	78	21
Diplectrum formosum							1	1	109	1	1	261
Diplectrum bivittatum	1	1	102	8	109	21	3	24	27	12	134	23
Serranus atrobranchus	1	9	55	7	46	28				8	55	46
Serranus phoebe	1	1	103							1	1	262
Priacanthus arenatus				2	3	112				2	3	143
Rachycentron canadum							1	1	110	1	1	263
Trachurus lathami	2	92	26	4	22	57	1	1	111	7	115	54
Caranx fusus				1	2	155				1	2	202
Chloroscombrus chrysurus				7	107	25	1	1	112	8	108	44
Vomer setapinnis				1	7	130				1	7	174
Decapterus punctatus				2	16	93				2	16	120
Lutjanus campechanus				2	2	121	3	11	32	5	13	75
Lutjanus synagris	2	3	44							2	3	144
Rhomboplites aurorubens				1	3	143				1	3	186
Pristipomoides aquilonaris				6	16	38				6	16	65
Eucinostomus gula							2	9	40	2	9	126
Haemulon aurolineatum							1	1	113	1	1	264
Stenotomus caprinus	3	47	12	9	591	15	3	59	26	15	697	12
Lagodon rhomboides				3	3	86				3	3	111
Cynoscion nothus				5	11	50	4	26	22	9	37	40
Cynoscion arenarius	2	2	46	4	37	55	3	24	28	9	63	36
Bairdiella chrysura							1	1	114	1	1	265

TABLE 83. Frequency of observation, abundance, and rank for the demersal fish Osteichthyes by cruise (Cont'd).

Taxa	Cruise I			Cruise II			Cruise III			Total		
	Obs[1]	Ind[2]	Rk[3]	Obs	Ind	Rk	Obs	Ind	Rk	Obs	Ind	Rk
Leiostomus xanthurus	1	7	57	4	83	53	6	65	7	11	155	26
Larimus fasciatus	1	2	82				2	12	38	3	14	95
Menticirrhus americanus	1	1	104	2	5	102	5	7	18	8	13	52
Micropogon undulatus	1	14	50	6	111	33	6	444	5	13	569	18
Pogonias cromis							1	1	115	1	1	266
Stellifer lanceolatus				2	3	113	4	12	24	6	15	68
Equetus umbrosus				1	1	212	1	1	116	2	2	160
Chaetodipterus faber				1	2	156	5	14	17	6	16	66
Polydactylus octonemus	1	3	69	3	10	73	2	3	45	6	16	67
Lonchopisthus lindneri				1	1	213				1	1	267
Kathetostoma albigutta	1	1	105	2	11	96				3	12	96
Gobionellus boleosoma	2	2	47							2	2	161
Microgobius				1	1	214				1	1	268
Bollmannia communis	1	19	48	5	199	41	1	1	117	7	219	53
Trichiurus lepturus				3	47	67	2	2	49	5	49	72
Scomber japonicus	1	1	106							1	1	269
Scomberomorus cavalla				1	1	215				1	1	270
Peprilus paru				1	2	157				1	2	203
Peprilus burti	2	14	31	4	9	63				6	23	64
Citharichthys spilopterus	2	9	37	10	74	13	5	47	14	17	130	11
Etropus crossotus	3	7	21	9	117	17	8	120	1	20	244	5
Paralichthys lethostigma				1	1	216	1	1	118	2	2	162
Ancylopsetta dilecta				1	2	158				1	2	204
Ancylopsetta quadrocellata							1	1	119	1	1	271
Cyclopsetta chittendeni	2	9	38	9	61	18	3	17	31	14	87	17
Syacium gunteri				7	129	24	6	93	6	13	222	19
Trichopsetta ventralis				1	19	126				1	19	166
Gymnachirus texae				6	31	37	1	1	120	7	32	57
Symphurus plagiusa				4	26	56	5	21	15	9	47	38
Symphurus civitatus	2	6	41	3	7	79	4	32	21	9	45	39
Balistes capriscus				1	1	217	2	2	50	3	3	112
Lagocephalus laevigatus				1	1	218				1	1	272
Sphoerides parvus	3	8	20	1	6	131	6	55	8	10	69	30

[1] Obs — denotes number of observations.
[2] Ind — denotes number of individuals.
[3] Rk — denotes rank.

TABLE 84. Number of individuals of *Prionotus rubio* (Osteichthyes) by station and cruise

Station	Number of Individuals/Trawl			
	Cruise I	Cruise II	Cruise III	Average
01PN0500	2.0	6.0		2.7
02PN0500	1.0			.3
03PN0500	1.0	2.0	30.0	11.0
04PN0500	1.0	5.0	8.0	4.7
05SN0500		2.0		
06SN0500				
07SN0500		8.0		
08SN0500		1.0		
09SN0500		9.0		
10SN0500				
11SN0500				
12SN0500				
13SN0500				
14SN0500		106.0		
15SN0500		2.0		
16SN0500		13.0		
17SN0500		23.0		
18SN0500		2.0		
19SN0500		1.0		
20SN0500				
21C		2.0		.7
22C				.0
23C	11.0	14.0	59.0	28.0
24C		177.0	4.0	60.3
Average	2.0	15.5	12.6	

P3 and C23, Cruise III. Note the complete absence of *P. rubio* at C22 during all three cruises.

Halieutichthys aculeatus was collected at three sites during Cruise I; during Cruise II at all but 13 sites; and during Cruise III at all but one site (Table 85). Average numbers of individuals per trawl were generally higher at the Secondary Sites except for the very high average found at P3, Cruise III. The overall average was highest during Cruise III with the average increasing slightly from Cruises I to II.

Ten species of the Family Sciaenidae, important in the sport and commercial fisheries, were collected in this project. The number of species and number of individuals in the Sciaenidae exceeded all other families, constituting 15.4% of the total number of demersal fish taken. In most studies of shallow water fishes of the Gulf Coast, the Sciaenidae is generally the predominant family of fishes taken (Perret, 1971). Roithmayr (1965) found that sciaenids comprised the bulk of the annual industrial bottom fish landings from the north central Gulf of Mexico from 1959 to 1963. The most important of the Sciaenids collected in this project were *Cynoscion arenarius, C. nothus, Leiostomus xanthurus, Menticirrhus americanus,* and *Micropogon undulatus.*

Cynoscion arenarius occurred only at two sites during Cruise I; at four sites during Cruise II; and at three sites during Cruise III (Table 86). This species was not collected at most of the Secondary Sites. Numbers of individuals collected per cruise tended to increase from Cruise I to Cruise III; this may be related to the hypoxic bottom conditions encountered during Cruises I and II.

Cynoscion nothus was not collected during Cruise I, was collected at five sites during Cruise II, and at four sites in Cruise III (Table 87). As with *C. arenarius,* there was an increase in numbers collected from Cruise I to Cruise III, which may be related to the hypoxic bottom conditions.

Leiostomus xanthurus was collected at only one site during Cruise I; at four sites during Cruise II; and at six sites during Cruise III (Table 88). Numbers of individuals collected increased from Cruise I to Cruise III; this may be related to hypoxic bottom conditions. Note the almost complete absence of L. *xanthurus* at the Secondary Sites.

Menticirrhus americanus was collected at only one site during Cruise I, at two sites during Cruise II, and at five sites during Cruise III (Table 89). There was an almost complete absence of *M. americanus* at the Secondary Sites. Numbers of individuals increased slightly from Cruise I to Cruise III, which may be in response to the hypoxic bottom conditions encountered during Cruises I and II.

Micropogon undulatus was collected at only one site during Cruise I, at six sites during Cruise II, and at six sites during Cruise III (Table 90). There was a gradual increase in numbers collected from Cruise I to II and then a large increase during Cruise III, which also may be related to the hypoxic bottom conditions. *Micropogon undulatus* has been reported to be the dominant fish species, not only offshore Louisiana, but in the entire Gulf of Mexico (Ragan et al., 1978). However, in this study *M. undulatus* ranked 50th during Cruise I, 33rd in Cruise II, and 5th in Cruise III. It was collected a total of only 13 times for a total of 569

TABLE 85. Number of individuals of *Halieutichthys aculeatus* (Osteichthyes) by station and cruise.

	Number of Individuals/Trawl			
Station	Cruise I	Cruise II	Cruise III	Average
01PN0500			1.0	.3
02PN0500			2.0	.7
03PN0500	21.0	9.0	281.0	103.7
04PN0500	1.0	3.0	21.0	8.3
05SN0500				
06SN0500		1.0		
07SN0500		1.0		
08SN0500				
09SN0500		43.0		
10SN0500				
11SN0500				
12SN0500				
13SN0500				
14SN0500		27.0		
15SN0500		43.0		
16SN0500		1.0		
17SN0500		25.0		
18SN0500		1.0		
19SN0500				
20SN0500				
21C				.0
22C			11.0	3.7
23C	4.0	27.0	1.0	10.7
24C			1.0	.3
Average	3.3	7.5	39.8	

TABLE 86. Number of individuals of *Cynoscion arenarius* (Osteichthyes) by station and cruise.

	Number of Individuals/Trawl			
Station	Cruise I	Cruise II	Cruise III	Average
01PN0500				0
02PN0500	1.0	7.0		2.7
03PN0500			1.0	.3
04PN0500				.0
05SN0500		23.0		
06SN0500		1.0		
07SN0500				
08SN0500				
09SN0500				
10SN0500				
11SN0500				
12SN0500				
13SN0500				
14SN0500				
15SN0500				
16SN0500				
17SN0500				
18SN0500				
19SN0500				
20SN0500				
21C		6.0	1.0	2.3
22C	1.0			.3
23C			22.0	7.3
24C				.0
Average	.3	1.5	3.0	

TABLE 87. Number of individuals of *Cynoscion nothus* (Osteichthyes) by station and cruise.

	Number of Individuals/Trawl			
Station	Cruise I	Cruise II	Cruise III	Average
01PN0500		1.0	8.0	3.0
02PN0500				.0
03PN0500				.0
04PN0500				.0
05SN0500				
06SN0500		1.0		
07SN0500				
08SN0500				
09SN0500				
10SN0500				
11SN0500				
12SN0500				
13SN0500				
14SN0500		1.0		
15SN0500				
16SN0500				
17SN0500				
18SN0500				
19SN0500		1.0		
20SN0500				
21C			12.0	4.0
22C			4.0	1.3
23C				.0
24C		7.0	2.0	3.0
Average	.0	.5	3.3	

TABLE 88. Number of individuals of *Leiostomus xanthurus* (Osteichthyes) by station and cruise.

Station	Number of Individuals/Trawl			
	Cruise I	Cruise II	Cruise III	Average
01PN0500			2.0	0.7
02PN0500	7.0	10.0		5.7
03PN0500			20.0	6.7
04PN0500		1.0	4.0	1.7
05SN0500		2.0		
06SN0500				
07SN0500				
08SN0500				
09SN0500				
10SN0500				
11SN0500				
12SN0500				
13SN0500				
14SN0500				
15SN0500				
16SN0500				
17SN0500				
18SN0500				
19SN0500				
20SN0500				
21C		70.0	1.0	23.7
22C			17.0	5.7
23C			21.0	7.0
24C				.0
Average	0.9	3.5	8.1	

TABLE 89. Number of individuals of *Menticirrhus americanus* (Osteichthyes) by station and cruise.

Station	Number of Individuals/Trawl			
	Cruise I	Cruise II	Cruise III	Average
01PN0500				.0
02PN0500	1.0		3.0	1.3
03PN0500			1.0	.3
04PN0500				.0
05SN0500		1.0		
06SN0500				
07SN0500				
08SN0500				
09SN0500				
10SN0500				
11SN0500				
12SN0500				
13SN0500				
14SN0500				
15SN0500				
16SN0500				
17SN0500				
18SN0500				
19SN0500		4.0		
20SN0500				
21C				.0
22C			1.0	.3
23C			1.0	.3
24C			1.0	.3
Average	.1	.2	.9	

TABLE 90. Number of individuals of *Micropogon undulatus* (Osteichthyes) by station and cruise.

Station	Number of Individuals/Trawl			
	Cruise I	Cruise II	Cruise III	Average
01PN0500			3.0	1.0
02PN0500	14.0	17.0		10.3
03PN0500			14.0	4.7
04PN0500		15.0	244.0	86.3
05SN0500		39.0		
06SN0500		7.0		
07SN0500				
08SN0500				
09SN0500				
10SN0500				
11SN0500				
12SN0500				
13SN0500		2.0		
14SN0500				
15SN0500				
16SN0500				
17SN0500				
18SN0500				
19SN0500				
20SN0500				
21C		31.0	9.0	13.3
22C			74.0	24.7
23C			100.0	33.3
24C				.0
Average	1.8	4.6	55.5	

individuals; it comprised only 2.2% of the total number of individuals of macroepifauna and demersal fish collected.

Osteichthyes comprised 11.6% of the total number of individuals during Cruise I, 19.6% in Cruise II, and 33.3% in Cruise III, with an overall average of 22.8% (see Table 15). Table 91 presents the percentage of the total number of individuals by station per cruise for the Osteichthyes. All percentages found during Cruise I increased during either Cruise II or Cruise III. Percentages increased from Cruise I to Cruise III at P1, P4, C22, and C23. At P2, C21, and C24 there was a pronounced increase and at P3 a large decrease during Cruise II. Overall, the average percentage at the Primary Sites was similar to the percentage at the Control Sites. Percentages greater than 50% were recorded at S5, S14, S17, and S19. Low percentages at C24, Cruise I, and P3, S8, and C23, Cruise II, may be accounted for by the low D.O. values (see Table 142).

Examination of the percentage of total number of individuals by depth zonation indicated a decrease in percentage of Osteichthyes with depth during Cruises II and III; averages also decreased with depth. During Cruise I, there was only a very slight increase with depth (Table 92). There also was an increase in the percentage from Cruise I to Cruise III, which may indicate seasonal influences.

Average diversity and evenness values increased from Cruise I to Cruise III at P1, P3, C21, C22, and C24 with the reverse being true at C23 (Table 93). During Cruise II, there was a decrease in diversity at P2 and an increase at P4. These diversity changes appeared to be primarily the result of changes in number of taxa and not changes in evenness. Diversity and evenness at the Secondary Sites were comparable to similar values at the Primary and Control Sites.

c. *Biomass Distribution*

The total weight of all macroepifauna and demersal fish caught per trawl is presented by site and cruise in Table 94. The weight per sample ranged from a low of 60.9 g at S11, Cruise II, to a high of 37,706.0 g at C22, Cruise III. There was a trend toward increased biomass with each successive cruise. This increase was probably related to the return to normal D.O. levels. The heaviest tows were made during Cruise III at C22, C23, and P3 at depths of 21, 37, and 30 m, respectively. Catches were smallest during Cruise I, averaging less than one-fifth of Cruise III weights. The largest variation in catch weight for a single site occurred at C22, where values ranged from 93.9 g (Cruise I) to 37,706.0 g (Cruise III). The majority of this increased weight can be accounted for by the large number of *Arius felis*, sea catfish, caught during Cruise III.

Catch weights were grouped according to depth zones similar to those established for the Louisiana coast by Moore, Brusher, and Trent (1970) and Ragan et al. (1978). The average catch of demersal fish and macroepifauna was largest by weight in the outer zone, where depths reached 65 m or more. Smallest average catches came from trawling in the inner zone, where depths were less than or equal to 18 m.

The weight of the demersal fish made up 66% of the total catch weight. Species that made up at least 1% of the weight of the total bottomfish catch appear in Table 95. The top five species accounted for two-thirds of the total fish catch weight. The heaviest contributor, the sea catfish, *Arius felis*, comprised 32.9% of the

TABLE 91. Percent total number of individuals per cruise of macroepifauna and demersal fish that are Osteichthyes.

Site	Percent Total Number of Individuals/Cruise			
	Cruise I	Cruise II	Cruise III	Average
P01	1.2	24.1	62.2	29.2
P02	11.6	79.0	61.2	50.6
P03	24.9	0.6	41.4	22.4
P04	25.6	70.4	74.9	57.0
S05		61.5		61.5
S06		20.9		20.9
S07		20.4		20.4
S08		0.8		0.8
S09		10.1		10.1
S10		--[1]		--
S11		--		--
S12		--		--
S13		13.5		13.5
S14		51.9		51.9
S15		25.2		25.2
S16		29.2		29.2
S17		54.1		54.1
S18		3.3		3.3
S19		69.3		69.3
S20		--		--
C21	37.5	93.5	37.1	56.0
C22	26.8	--	95.3	40.7
C23	6.3	6.6	14.9	9.3
C24	0.6	81.0	15.0	32.2

[1] (--) indicates that the taxa did not occur at that station.

TABLE 92. Distribution by depth zonation and cruise of Osteichthyes as percent of total number of macroepifauna and demersal fish.

Depth Zone (m)[1]	Percent Total Number of Individuals/Cruise			
	Cruise I	Cruise II	Cruise III	Average
< 30	15.5	33.2	54.2	34.3
30 to 90	18.9	25.1	43.9	29.3
>91	--	25.2	--	25.2

[1] Depth zone <30 m included sites P1, P2, S5, S8, S10, S11, S12, S14, S18, S19, S20, C21, C22, and C24.

Depth zone 30 to 90 m included sites P3, P4, S6, S7, S9, S13, S16, S17, and C23.

Depth zone >91 m included only site S15.

TABLE 93. Average diversity and evenness values for the demersal fish (Osteichthyes) taxa by site and cruise

				Evenness					
	Diversity			Pielou			Heip		
Site	Cruise I	Cruise II	Cruise III	Cruise I	Cruise II	Cruise III	Cruise I	Cruise II	Cruise III
P01	1.04	1.31	2.13	0.946	0.729	0.857	0.914	0.539	0.674
P02	2.20	1.72	2.10	0.813	0.825	0.875	0.574	0.651	0.715
P03	1.40	1.51	1.95	0.717	0.841	0.579	0.506	0.702	0.216
P04	1.72	1.93	1.26	0.620	0.617	0.434	0.305	0.269	0.148
S05		2.10			0.740			0.447	
S06		2.08			0.654			0.304	
S07		2.56			0.871			0.666	
S08		--[1]			--			--	
S09		1.53			0.617			0.330	
S10									
S11									
S12									
S13		2.04			0.720			0.418	
S14		1.72			0.556			0.218	
S15		2.15			0.743			0.445	
S16		2.47			0.872			0.677	
S17		2.65			0.858			0.629	
S18		1.66			0.854			0.711	
S19		1.17			0.535			0.280	
S20									
C21	1.05	1.83	2.20	0.760	0.735	0.858	0.623	0.474	0.670
C22	1.39		1.52	0.714		0.562	0.503		0.256
C23	2.54	2.41	2.37	0.879	0.835	0.735	0.686	0.597	0.402
C24	--	0.56	1.74	--	0.314	0.727	--	0.151	0.472

[1] Insufficient numbers of individuals per taxa to calculate diversity or evenness.

TABLE 94. Total weight (in grams) of all species caught per trawl.

Site	Cruise I	Cruise II	Cruise III	Average
P01	814.9	2070.3	1626.1	1503.8
P02	5411.2	7689.7	4530.9	5877.3
P03	676.3	1882.7	15360.9	5973.2
P04	2608.6	5560.4	9387.7	5852.2
S05		10449.6		
S06		10153.1		
S07		7749.9		
S08		837.9		
S09		15379.3		
S10		781.9		
S11		60.9		
S12		110.2		
S13		7455.4		
S14		11403.2		
S15		10374.5		
S16		4987.2		
S17		16069.9		
S18		1958.9		
S19		14023.3		
S20		1146.2		
C21	2086.1	17438.9	2288.9	7271.3
C22	1184.6	93.9	37706.0	12994.8
C23	4883.1	8455.7	20431.9	11256.9
C24	243.0	3226.4	3672.9	2380.8
Average	2238.5	6640.0	11875.7	

TABLE 95. List of demersal fish taxa which contributed at least 1% of the weight of the total bottomfish catch.

Taxa	Percent of Demersal Fish Weight			
	Cruise I	Cruise II	Cruise III	Total
Arius felis	25.3	29.0	37.6	32.9
Micropogon undulatus	7.6	7.8	24.9	15.9
Leiostomus xanthurus	8.3	8.9	6.3	7.6
Prionotus rubio	3.2	5.4	5.7	5.5
Stenotomus caprinus	1.0	8.0	1.4	4.6
Synodus foetens	0.3	6.5	2.1	4.1
Cynoscion sp.	2.1	2.2	3.3	2.7
Pogonias cromis	--[1]	--	4.6	2.2
Anchoa hepsetus	1.7	2.0	--	1.7
Etropus crossotus	1.3	1.3	1.6	1.4
Syacium gunteri	--	1.4	1.5	1.3
Halieutichthys aculeatus	1.0	1.2	1.5	1.3
Citharichthys spilopterus	2.2	1.4	0.6	1.0
Diplectrum bivittatum	0.5	1.3	0.5	1.0

[1] (--) indicates taxa not collected.

weight. The Atlantic croaker, *Micropogon undulatus*, was next with 15.9%, followed by the spot, *Leiostomus xanthurus*, the blackfin searobin, *Prionotus rubio*, and the longspine porgy, *Stenotomus caprinus*.

Fish weights were adjusted to catch per hour for comparison purposes; this is given in Table 96. The average for the entire study area over all cruises was 19.6 kg per hour. The average catch was much smaller than catches reported elsewhere. Roithmayr (1965) reported the average catch by industrial bottom fishery from 1959-1963 as 408 kg per hour in 13 to 55 m of water off central Louisiana (89° to 91° W Longitude). Ragan et al. (1978) reported an adjusted one hour mean of 142 kg for trawl samples off the Louisiana Shelf from 1975 to 1976. Moore et al. (1970) found the average catch of bottomfish off Louisiana from 1962 to 1964 to be 93 kg per hour. The much lower values obtained in the present project may be attributed to differences in fishing gear used in research projects and to the fact that commercial trawlers seek out and work the concentrations of fish and shrimp. However, the Southeast Fisheries Center, National Marine Fisheries Service, reported that since January, 1976 there has been marked reduction in the availability of bottomfishes on the traditional fishing grounds, with croaker at an apparent all-time low (Juhl et al., 1976, in Ragan et al., 1978).

TABLE 96. Weights of demersal fish adjusted to catch per hour and given in kilograms.

Site	Cruise I	Cruise II	Cruise III	Average
P01	0.4	8.1	5.7	4.7
P02	11.8	30.1	17.1	19.6
P03	0.5	1.5	51.9	17.9
P04	6.2	41.4	35.9	27.8
S05		27.0		
S06		11.9		
S07		12.2		
S08		0.0		
S09		11.2		
S10		--		
S11		--		
S12		--		
S13		5.7		
S14		31.2		
S15		24.0		
S16		8.3		
S17		32.7		
S18		0.6		
S19		74.4		
S20		--		
C21	8.2	68.7	6.9	27.9
C22	11.6	--	150.3	50.6
C23	5.1	4.7	70.2	26.7
C24	0.0	12.0	4.5	5.5

[1] (--) indicates no fish were taken.

Species constituting at least 4% of the weight of the total invertebrate catch appear in Table 97. The portunid crab, *Portunus spinicarpus*, made up 10.5% of the total invertebrate weight; it was followed by the blue crab, *Callinectes sapidus*, which made up 9.6%. The brown shrimp, *Penaeus aztecus*, was third with 8.9%. Combined weights of the commercially important species *P. aztecus*, *P. setiferus* (white shrimp), and *C. sapidus* made up 25% of the total catch of invertebrates by weight and less than 8% of the total weight of the entire trawl catch.

d. Cluster Analysis

For macroepifauna and demersal fish cluster analysis, the taxa identified for each cruise were ranked first by frequency of occurrence and second by frequency of abundance within equally occurring taxa (Appendix F, Tables F7, F8, and F9). From this ranked list, the top 95% of the total number of individuals (abundance) were chosen for use in cluster analysis (95% of macroepifauna and demersal fish by abundance were included in 49, 112, and 52 taxa for Cruises I, II and III respectively, of the 284 taxa collected). Included in this list were several taxa at the level of Order and above, e.g., Rhynchocoela; these were eliminated because many different species were probably included and subsequent interpretation could only be vague. After these taxa were eliminated, cluster analysis was done by classification of taxa (inverse classification). Taxa which did not cluster with other groups at greater than 50% similarity (50% dissimilarity) were eliminated, and taxa classification cluster analysis was rerun.

The resulting dendrogram from Cruise I macroepifauna and demersal fish is presented in Fig. 24. Four Taxa Groups of 49 taxa were delimited and are indicated in this figure. Taxa Group 1 was composed of the largest number of taxa; two stomatopods, nine decapods, one asteroid, and 10 demersal fish. Taxa Group 2 was composed of one polychaete, one cephalopod, and four demersal fish. Taxa Group 3 consisted of four decapods and four demersal fish. Taxa Group 4, which was second in size to Taxa Group 1, was formed by two anthozoans, four polychaetes, three decapods, and three demersal fish.

Using the reduced set of taxa, cluster analysis by classification of stations (normal classification) was run. The resulting dendrogram for Cruise I macroepifauna and demersal fish is presented in Fig. 25. Two Station Groups consisting of eight loosely related stations were delimited and are indicated. Station Group 1 was formed by P1, C21, and C24 which had sediments of clayey silt with some sand (see Table 56). Station Group 2 was composed of P2, P3, P4, C22, and C23, which had sediments of silt with some clay or sand.

Table 98 presents a two-way coincidence table of the Taxa and Station Groups for Cruise I macroepifauna and demersal fish. Station Group 2 appeared to provide the best environment for Taxa Groups 1, 2, and 3. Taxa Group 4 encountered the best habitat at Station Group 1.

Figure 26 presents a dendrogram of Cruise II macroepifauna and demersal fish Taxa Groups. Eight Taxa Groups of 78 taxa were delimited and are indicated in this figure. Taxa Group 1 consisted of members of Cruise I Taxa Groups 1, 2, 3, and 4 and three demersal fish which were not included in Cruise I clustering. Taxa Group 2 included only two taxa from Cruise I Taxa Groups 1 and 2; the remainder were taxa new to the clustering. Taxa Group 3 also had only two taxa used in Cruise I (Cruise I Taxa Groups 1 and 4); the remainder of the taxa had not been previously used in clustering. Taxa Group 4 was comprised of members of Cruise I Taxa Groups 2 and 3 and two new taxa. Only one member each of Taxa Groups 5 and 6 had occurred in Cruise I clustering (both in Cruise I Taxa Group 1); the remainder of the taxa had not been clustered for Cruise I. Taxa Group 7 consisted of members of Cruise I Taxa Groups 1, 2 and 4 plus one new taxon. Taxa Group 8 was comprised of members of Cruise I Taxa Groups 3 and 4 and five taxa new to clustering.

Figure 27 presents the dendrogram of Cruise II macroepifauna and demersal fish Station Groups. Four Station Groups consisting of 24 loosely related stations were delimited and are indicated. Station Group 1 was comprised of P1, S8, S18, and C24, which were characterized by silt sediments with some clay (see Table 56). Station Group 2 was formed by P3, P4, S6, S7, S9, S13, S14, S15, S16, S17, and C23, which had sediments of clayey silt with some sand. Station Group 3 consisted of P2, S5, S19, and C21, which had basically sand with some clay and silt. S10, S11, S12, S20, and C22 formed Station Group 4, which had silty sand sediments with some clay. Note that P1 and C24 were grouped together in Cruises I and II as were P3, P4, and C23.

Table 99 presents a two-way coincidence table of Taxa and Station Groups for Cruise II. Station

TABLE 97. Invertebrate taxa that comprised at least 4% of the sample weight of all invertebrates taken in trawls.

Taxa	Cruise I	Cruise II	Cruise III	Average
Portunus spinicarpus (D)[1]	1.7	13.4	--[2]	10.5
Callinectes sapidus (D)	0.3	12.5	--	9.6
Penaeus aztecus (D)	17.1	6.3	17.6	8.9
Loligo pealei (C)	16.1	7.6	--	7.8
Squilla chydaea (S)	0.6	8.7	--	6.7
Penaeus setiferus (D)	12.1	5.8	4.0	6.4
Callinectes sapidus (D)	1.5	7.1	7.0	6.4
Trachypenaeus similis (D)	24.4	3.1	2.9	5.7
Squilla empusa (S)	3.7	4.4	3.0	4.1

[1] D denotes Decapoda
C denotes Cephalopoda
S denotes Stomatopoda

[2] (--) indicates taxa not collected

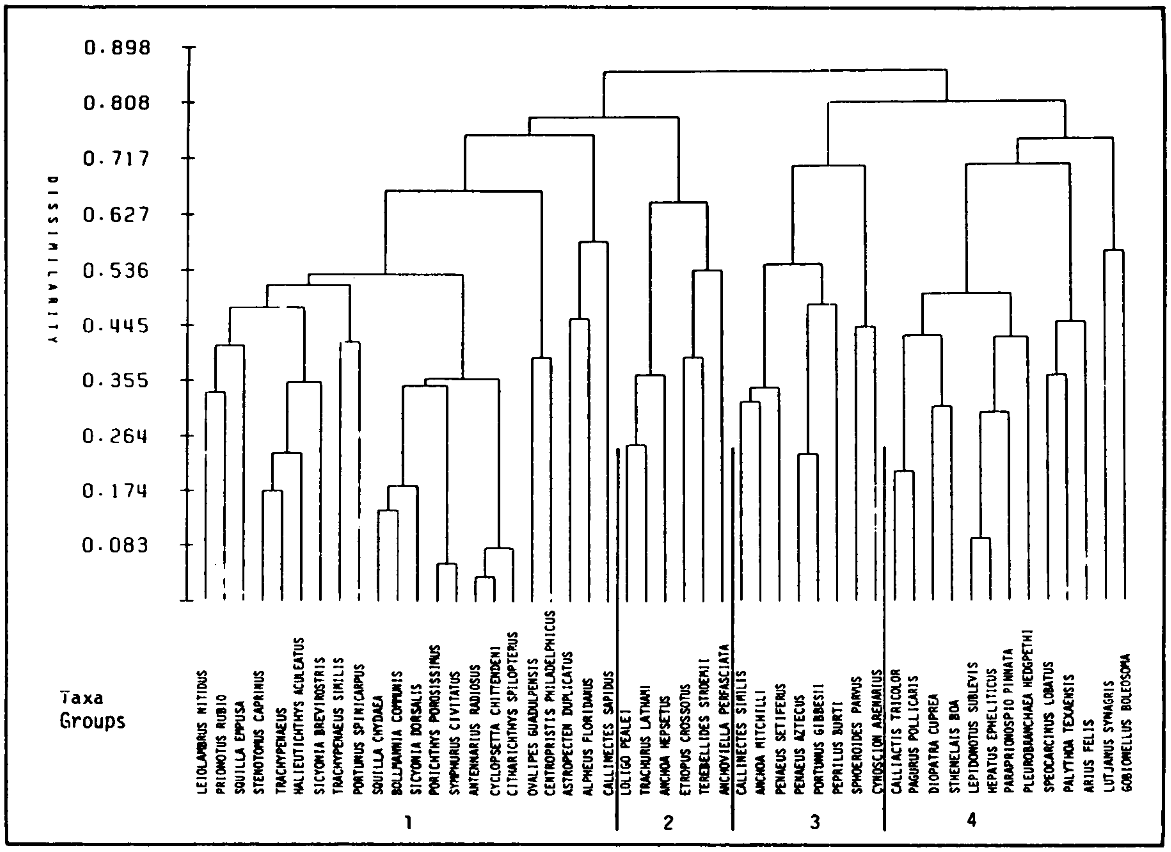

FIG. 24. Dendrogram of Cruise I macroinfauna and demersal fish cluster analysis classified by taxa

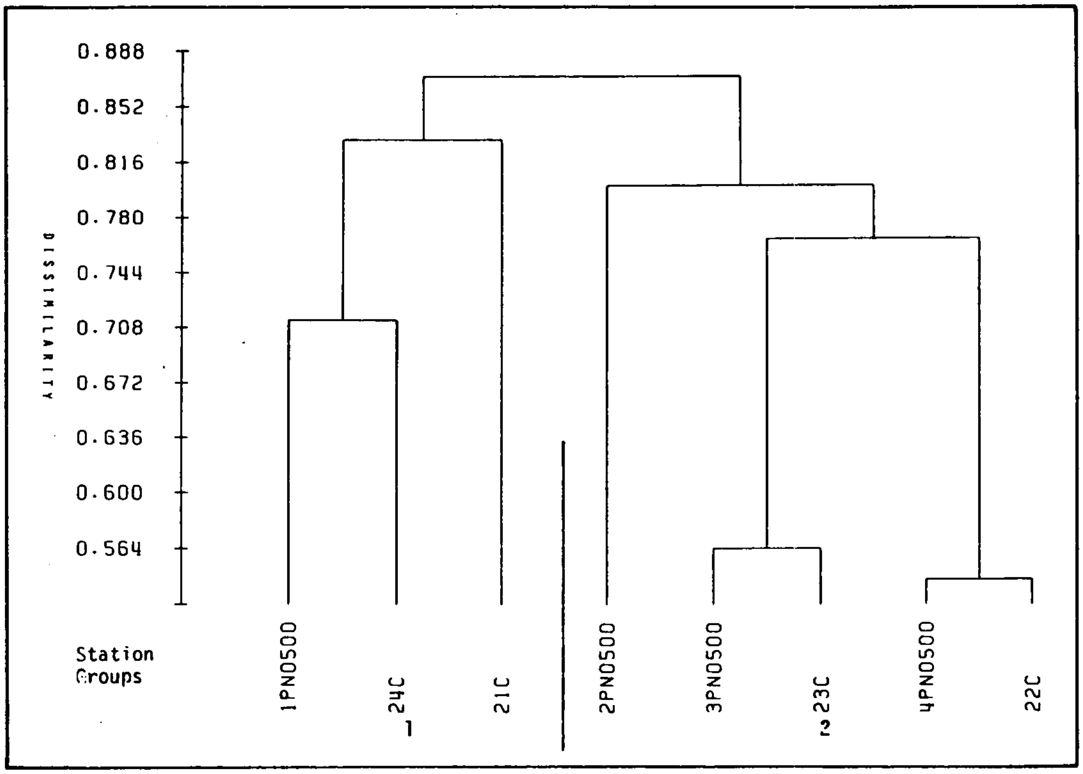

FIG. 25. Dendrogram of Cruise I macroinfauna and demersal fish cluster analysis classified by station

TABLE 98. Cruise I macroepifauna and demersal fish: two-way coincidence table of stations versus taxa used in cluster analysis.

		Station Groups[1]							
		1			2				
Taxa Groups		01PN0500	24C	21C	02PN0500	03PN0500	23C	04PN0500	22C
1	Leiolambrus nitidus	1				•	1	•	•
	Prionotus rubio	•			•	•	1	•	
	Squilla empusa	1		•		•	•	•	
	Stenotomus caprinus					1	1	1	
	Trachypenaeus					•	•	•	
	Halieutichthys aculeatus					1	•	•	
	Sicyonia brevirostris					•	•		
	Trachypenaeus similis				1	2	2	•	
	Portunus spinicarpus					•	2		
	Squilla chydaea		•				1		
	Bollmannia communis						1		
	Sicyonia dorsalis	•					1		
	Porichthys porosissimus				•		•		
	Symphurus civitatus				•		•		
	Antennarius radiosus						•	•	
	Cyclopsetta chittendeni						•	•	
	Citharichthys spilopterus						•	•	
	Ovalipes quadulpensis		•			•	•		
	Centropristis philadelphicus				•	•	•		
	Astropecten duplicatus		1				2	2	•
	Alpheus floridanus	•	1				•	•	
	Callinectes sapidus		1						
2	Loligo pealei					•	•	2	2
	Trachurus lathami							1	1
	Anchoa hepsetus				•			1	1
	Etropus crossotus						•	•	•
	Terebellides stroemii						•	•	
	Anchoviella perfasciata							•	•
3	Callinectes similis	•		•	1		•		1
	Anchoa mitchilli			1	•				1
	Penaeus setiferus				1				•
	Penaeus aztecus				2	•	•		
	Portunus gibbesii				1		•		
	Peprilus burti				1			•	
	Sphoeroides parvus				•	•			•
	Cynoscion arenarius				•				•
4	Calliactis tricolor	1	1		•		•		
	Pagurus pollicaris	1	•		•		•		
	Diopatra cuprea	•		•			•		
	Sthenelais boa	•	•						
	Lepidonotus sublevis	•			•		•		
	Hepatus epheliticus	•			•				
	Paraprionospio pinnata	•			•				
	Pleurobranchaea hedgpethi	2			•				
	Speocarcinus lobatus	•	•	1					
	Palythoa texaensis	•		•					
	Arius felis			•	•				
	Lutjanus synagris	•						•	
	Gobionellus boleosoma	•	•						

[1] Average number of individuals per trawl:
(•) denotes 1 to 9
(1) denotes 10 to 99
(2) denotes 100 to 999
(3) denotes ≥1000

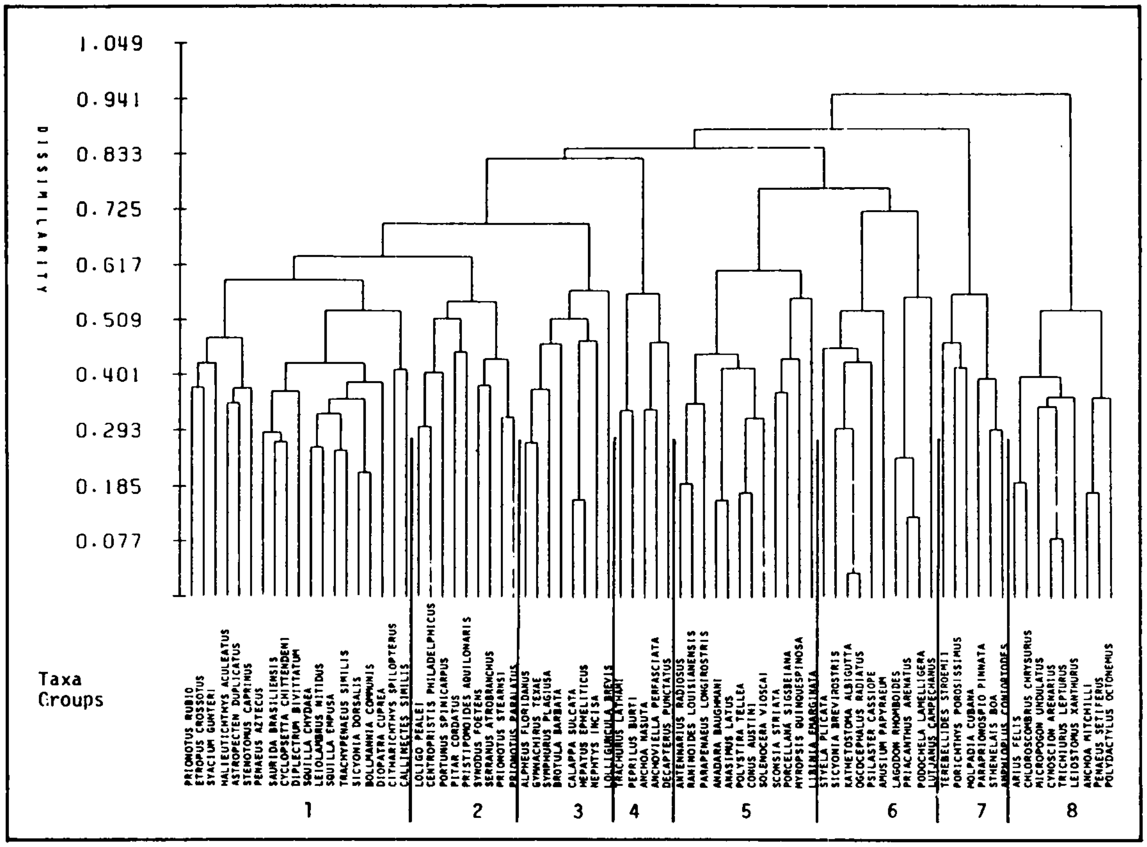

FIG. 26. Dendrogram of Cruise II macroinfauna and demersal fish cluster analysis classified by taxa

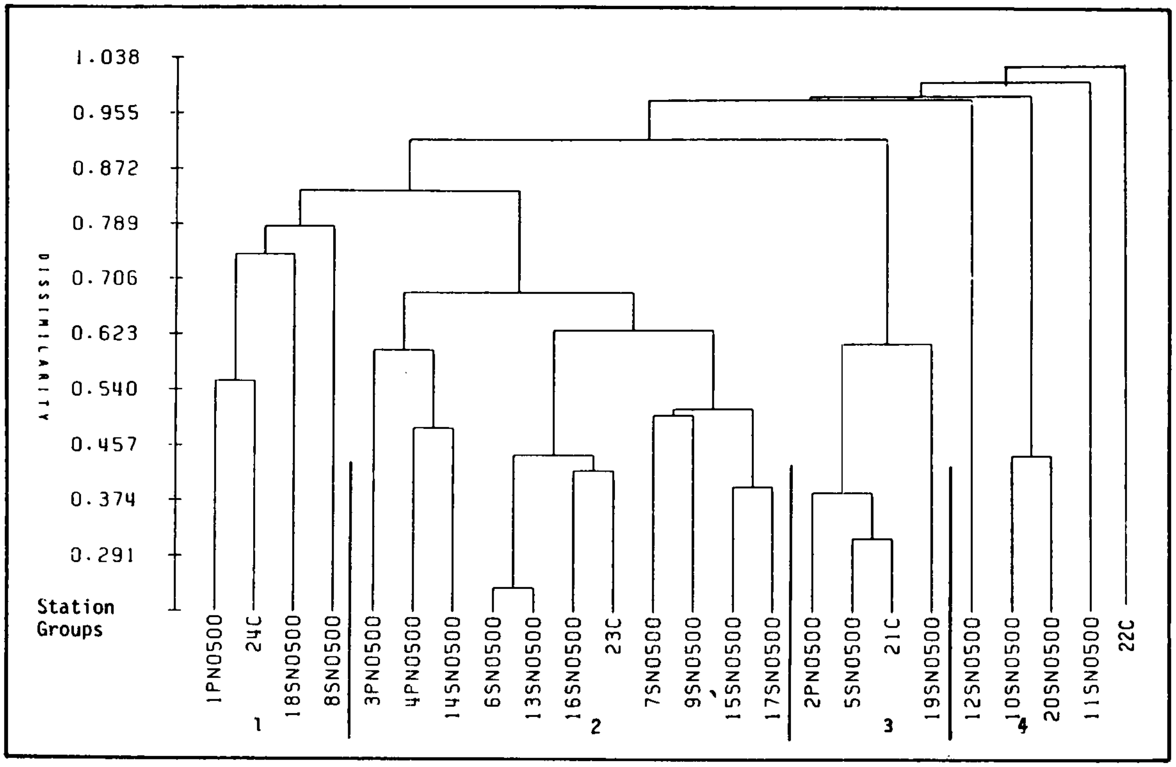

FIG. 27. Dendrogram of Cruise II macroinfauna and demersal fish cluster analysis classified by station

TABLE 99. Cruise II macroepifauna and demersal fish: two-way coincidence table of stations versus taxa used in cluster analysis.

Taxa Groups		Station Groups[1]																							
		1				2											3				4				
		0	2	1	0	0	0	1	0	1	1	2	0	0	1	1	0	0	2	1	1	1	2	1	2
		1	4	8	8	3	4	4	6	3	6	3	7	9	5	7	2	5	1	9	2	0	0	1	2
		P	C	S	S	P	P	S	S	S	S	C	S	S	S	S	P	S	C	S	S	S	S	S	C
		N		N	N	N	N	N	N	N	N		N	N	N	N	N	N		N	N	N	N	N	
		0		0	0	0	0	0	0	0	0		0	0	0	0	0	0		0	0	0	0	0	
		5		5	5	5	5	5	5	5	5		5	5	5	5	5	5		5	5	5	5	5	
		0		0	0	0	0	0	0	0	0		0	0	0	0	0	0		0	0	0	0	0	
		0		0	0	0	0	0	0	0	0		0	0	0	0	0	0		0	0	0	0	0	
1	Prionotus rubio	•	2	•	•	•	•	2			1	1	•	•	•	1		•	•	•					
	Etropus crossotus	•	1	•			•	1			•	1				•				•					
	Syacium gunteri			•			•	2	•		1	•	•												
	Halieutichthys aculeatus			•		•	•	1	•		•	1	•	1	1	1									
	Astropecten duplicatus			1		2	2	2			1	3		1	1	1									
	Stenotomus caprinus		•				1	2	•		1	1	•		•	1									
	Penaeus aztecus				•	•	•	1	1	1	1	•	•	•	•	•		•	•						
	Saurida brasiliensis					•	•	•	•	1	•	1	1	•	•	1									
	Cyclopsetta chittendeni					•	•	1	•	1	•	•	•			•									
	Diplectrum bivittatum					1	•	•	1	•	•	1		•											
	Squilla chydaea			•	•				2	2	1	1	1	1	•	•									
	Leiolambrus nitidus			•			•	•	1	1	•	1	1	1	•										
	Squilla empusa	•					•		1	1	•	1	•	•								•	•		
	Trachypenaeus similis	•		•				•	2	2	•	1	•												
	Sicyonia dorsalis							1	2	1	2	1	•												
	Bollmannia communis			•					2	1	1	1													
	Diopatra cuprea	1	•	1	•				1	1	•	1			•				•						
	Citharichthys spilopterus	•					•	•	1	1	•	•				1		•	•						
	Callinectes similis			1	•	•	•	1	1	•	1					1									
2	Loligo pealei							1	•	1	•	•	1	1	•	1					•				
	Centropristis philadelphicus							•		•		•	1	•	•	1			•						
	Portunus spinicarpus								1	1			2	2	2	1									
	Pitar cordatus				1		•		•	•	•	1	•	1	•	1									
	Pristipomoides aquilonaris								•			•	•	•	•	•									
	Synodus foetens						•	1			•		•	•	1	1									
	Serranus atrobranchus						•		•	•	•		1		•	1									
	Prionotus stearnsi										•		•	•	•	1									
	Prionotus paralatus												•			1									
3	Alpheus floridanus								1	1	•	•	•	•											
	Gymnachirus texae								1	•	•	•	•			•									
	Symphurus plagiusa							•	1	•	•														
	Brotula barbata								•	•		•													
	Calappa sulcata								•	•	•		•		•	•									
	Hepatus epheliticus								•	•	•		•												
	Nephtys incisa			•					•	1	•				•										
	Lolliguncula brevis					•			•	•	•								•						
4	Trachurus lathami						1	•			•		•												
	Peprilus burti						•	•		•			•												
	Anchoa nasuta						•	•										•							
	Anchoviella perfasciata						1	1																	
	Decapterus punctatus							1		•															
5	Antennarius radiosus								•	•			•	1	•	•									
	Raninoides louisianensis								•	•	•		•	1	•										
	Parapenaeus longirostris								•				•	•	•										
	Anadara baughmani												•	2	1	•									
	Anasimus latus												•	1	1										
	Polystira tellea													1	•										
	Conus austini													1	•										
	Solenocera vioscai								•					1											

[1] Average number of individuals per trawl:
(•) denotes 1 to 9
(1) denotes 10 to 99
(2) denotes 100 to 999
(3) denotes ≥1000

TABLE 99. Cruise II macroepifauna and demersal fish: two-way coincidence table of stations versus taxa in cluster analysis (cont'd)

	Taxa Groups		Station Groups^1																							
			1				2											3				4					
			0	2	1	0	0	0	1	0	1	1	2	0	0	1	1	0	0	2	1	1	1	2	1	2	
			1	4	8	8	3	4	4	6	3	6	3	7	9	5	7	2	5	1	9	2	0	0	1	2	
			P	C	S	S	P	P	S	S	S	S	C	S	S	S	S	P	S	C	S	S	S	S	S	C	
			N		N	N	N	N	N	N	N	N		N	N	N	N	N	N		N	N	N	N	N		
			0		0	0	0	0	0	0	0	0		0	0	0	0	0	0		0	0	0	0	0		
			5		5	5	5	5	5	5	5	5		5	5	5	5	5	5		5	5	5	5	5		
			0		0	0	0	0	0	0	0	0		0	0	0	0	0	0		0	0	0	0	0		
			0		0	0	0	0	0	0	0	0		0	0	0	0	0	0		0	0	0	0	0		
	Sconsia striata	+													•	•	•										+
	Porcellana sigsbeiana	+										•			•	•											+
5	Myropsis quinquespinosa	+													•	•											+
	Libinia emarginata	+											•		•												+
	Styela plicata	+					•									•	•										+
	Sicyonia brevirostris	+											•			•	•										+
	Kathetostoma albigutta	+														•	•										+
	Ogcocephalus radiatus	+														•	•										+
6	Psilaster cassiope	+										•				•	•										+
	Amusium papyraeum	+														1	1										+
	Lagodon rhomboides	+												•		•		•									+
	Priacanthus arenatus	+												•		•											+
	Podochela lamelligera	+												•		•											+
	Lutjanus campechanus	+						•								•											+
	Terebellides stroemii	+			1	•			•			•	•														+
	Porichthys porosissimus	+		•	•				1			•	•														+
	Molpadia cubana	+			•				•				•				•										+
7	Paraprionospio pinnata	+			•											•		•									+
	Sthenelais boa	+			•							•															+
	Amphioplus coniortodes	+	•		•																						+
	Arius felis	+	1	•						•								1	1	1	1						+
	Chloroscombrus chrysurus	+	•		•					•								1	1	1	1						+
	Micropogon undulatus	+						1		•	•							1	1	1							+
	Cynoscion arenarius	+								•								•	1	•							+
8	Trichiurus lepturus	+																•	1	•							+
	Leiostomus xanthurus	+						•										1	•	1							+
	Anchoa mitchilli	+								•									1	•							+
	Penaeus setiferus	+																	2	•							+
	Polydactylus octonemus	+								•									•	•							+

Group 2 appeared to provide the best environment for Taxa Groups 1, 2, 3, 4, 5, 6, and 7, while Station Group 3 was most conducive to Taxa Group 8. Note that the relationship between Taxa Groups 4, 5, 6, and 7 and Station Group 2 was weak, thus indicating that the Taxa Groups may not be ecological groups but the result of small sample size.

Figure 28 presents the dendrogram of Cruise III macroepifauna and demersal fish Taxa Groups. Five Taxa Groups of 52 taxa were delimited and are indicated in this figure. Taxa Group 1 was divided into two subgroups. Taxa Subgroup 1A included members from Cruise I Taxa Groups 1, 2, and 3 and Cruise II Taxa Groups 1 and 8. Taxa Subgroup 1B consisted of members from Cruise I Taxa Groups 1 and 4 and Cruise II Taxa Groups 1, 3, 6, and 8. Also included were one ectoproct and two demersal fish that had not been previously included in clustering. Taxa Group 2 was composed of members from Cruise I Taxa Group 1 and Cruise II Taxa Groups 1, 2, and 3. Three new demersal fish were also included. Taxa Group 3 included taxa from Cruise I Taxa Groups 1, 3, and 4, Cruise II taxa Groups 1 and 3, and one fish and one gastropod new to clustering. Cruise I Taxa Groups 1 and 4 and Cruise II Taxa Groups 1, 5, and 8 contributed members to Taxa Group 4. Also included were four taxa that had not been included in Cruises I or II. Taxa Group 5 consisted of three new taxa plus one taxon that had been in Cruise I Taxa Group 4 and Cruise II Taxa Group 3.

Figure 29 presents the dendrogram for Cruise III macroepifauna and demersal fish station groups. Two Station Groups of loosely related sites were delimited and are indicated. Station Group 1 was composed of P1, P2, C21, C22, and C24, which had sediments of clayey silt with some sand (see Table 56). Again P1, C21, and C24 were grouped together. Station Group 2 consisted of P3, P4, and C23, which had sediments of silt with some clay or sand. These sites were again grouped together as during Cruises I and II.

Table 100 presents a two-way coincidence table of the Taxa and Station Groups of Cruise III macroepifauna and demersal fish. Taxa Subgroup 1A was found at both Station Groups but Station Group 2 was more conducive to the taxa. Taxa Subgroups 1B and 2

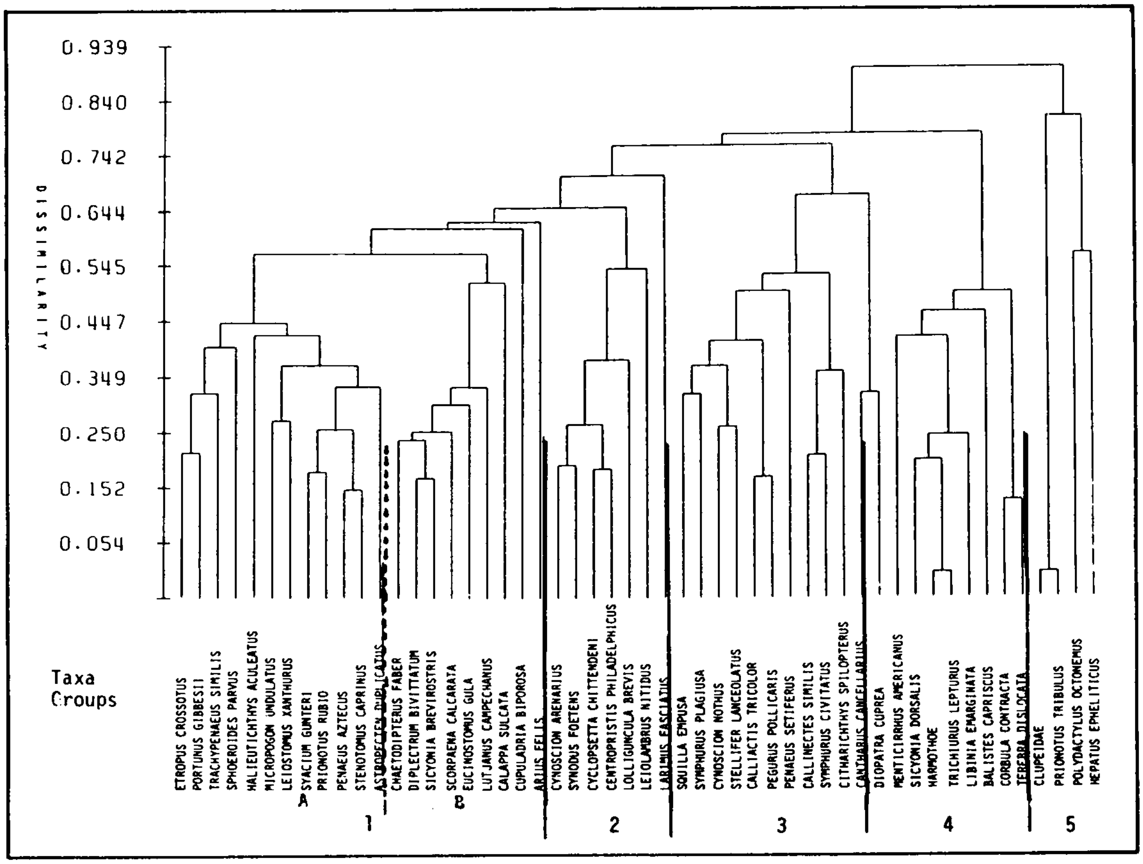

FIG. 28. Dendrogram of Cruise III macroinfauna and demersal fish cluster analysis classified by taxa

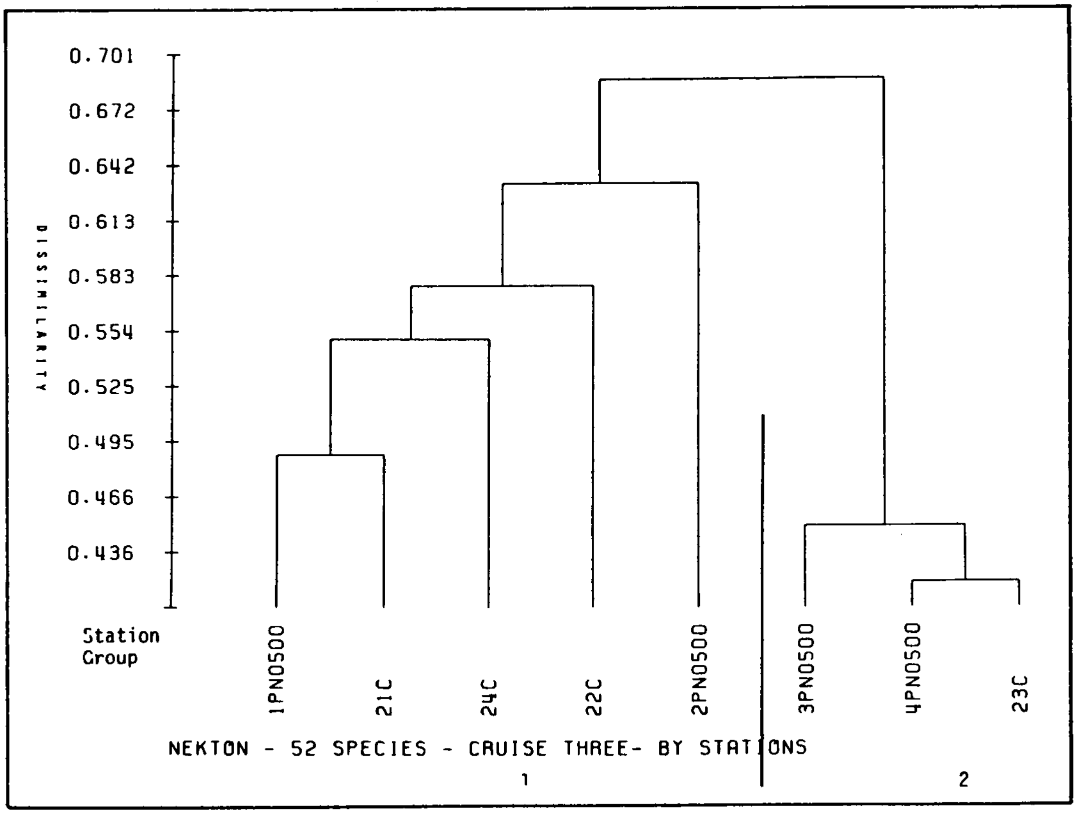

FIG. 29. Dendrogram of Cruise III macroinfauna and demersal fish cluster analysis classified by station

TABLE 100. Cruise III macroepifauna and demersal fish: two-way coincidence table of stations versus taxa used in cluster analysis.

Taxa Groups			Station Groups[1]							
			1				2			
			01PN0500	21C	24C	22C	02PN0500	03PN0500	04PN0500	23C
1	A	Etropus crossotus	1	•	1	1	•	1	•	1
		Portunus gibbesii	1	1	1		•	1	1	•
		Trachypenaeus similis		1	1	•		1		•
		Sphoeroides parvus	•	•			•	1	•	•
		Halieutichthys aculeatus	•		•	1	•	2	1	•
		Micropogon undulatus	•	•		1		1	2	2
		Leiostomus xanthurus	•	•		1		1	•	1
		Syacium gunteri	•		•	•		1	1	1
		Prionotus rubio			•			1	•	1
		Penaeus aztecus		•			•	2	•	1
		Stenotomus caprinus						1	•	1
		Astropecten duplicatus		•	•			1	1	3
	B	Chaetodipterus faber		•			•	•	•	•
		Diplectrum bivittatum						•	•	1
		Sicyonia brevirostris						1	•	•
		Scorpaena calcarata						•		•
		Eucinostomus gula						•	•	
		Lutjanus campechanus						•	•	•
		Calappa sulcata	•		•			•		
		Cupuladria biporosa						2		
		Arius felis	•			2	•	•	•	
2		Cynoscion arenarius		•				•		1
		Synodus foetens						•		1
		Cyclopsetta chittendeni						•	•	1
		Centropristis philadelphicus							•	1
		Lolliguncula brevis		•	•					1
		Leiolambrus nitidus							•	•
		Larimus fasciatus						•	1	
3		Squilla empusa	•	1	•	•	•	•	•	
		Symphurus plagiusa	•	1		•	•	•		
		Cynoscion nothus	•	1	•	•				
		Stellifer lanceolatus	•	•	•	•				
		Calliactis tricolor		1	1	•	•			
		Pagurus pollicaris		1	•	•	•			
		Penaeus setiferus	•	•	•		•			•
		Callinectes similis		•	1	•			•	1
		Symphurus civitatus			1	•			•	•
		Citharichthys spilopterus	•	•	1	•			•	
		Cantharus cancellarius	•		1			•		
4		Diopatra cuprea			1					
		Menticirrhus americanus			•	•	•	•		•
		Sicyonia dorsalis			•			•		•
		Harmothoe			•			•		
		Trichiurus lepturus			•			•		
		Libinia emarginata			•		•	•		
		Balistes capriscus						•		•
		Corbula contracta			•					•
		Terebra dislocata			•					•
5		Clupeidae		•			•			
		Prionotus tribulus		•			•			
		Polydactylus octonemus		•		•				
		Hepatus ephelititicus	•			•				

[1] Average number of individuals per core:

(•) denotes 1 to 9

(1) denotes 10 to 99

(2) denotes 100 to 999

(3) denotes >1000

were also favored by Station Group 2. Note the almost complete absence of the latter two taxa groups at Station Group 1. Taxa Group 3 found the best habitat at Station Group 1. Station Group preference by Taxa Groups 4 and 5 appeared to be weak, which may indicate that the Taxa Groups were erroneous because of insufficient data.

Many of the macroepifauna and demersal fish taxa remained clustered together over more than one cruise and also consistently demonstrated a preference for the habitat characterized by certain sites. This is summarized in Table 101. Members of Cruise I Taxa Group 1, Cruise II Taxa Group I, and Cruise III Taxa Groups 1A, 1B, and 2 were essentially the same and tended to occur in greatest numbers at P3, P4, and C23. Cruise I Taxa Group 4 and Cruise III Taxa Group 3 contained similar taxa which appeared to prefer the environment afforded by P1, C21, and C24. There appeared to be little relationship among the other Taxa Groups and sites not listed in Table 101.

TABLE 101. Relationship between macroepifauna and demersal fish Taxa Groups and site preference.

Taxa Group Associations		Site Preference
1. Cruise Cruise II Cruise III	I Taxa Group 1 Taxa Group 1 Taxa Groups 1A, 1B, 2	P3, P4, C23
2. Cruise I Cruise III	Taxa Group 4 Taxa Group 3	P1, C21, C24

Figure 30 presents the similarity between stations during Cruises I, II, and III for macroepifauna and demersal fish. Station similarity not only appears to be related to sediment texture, but also to water depth. Note the marked differentiation between station similarity at the shallow stations and that at deeper stations. This depth boundary (about 24 to 26 m) was crossed by the Cruise I similarity between P2, P3, P4, C22, and C23.

B. Factors Affecting Distribution

Correlation analysis, the measurement of the amount of association between two variables, was performed on the 39 abiotic variables listed in Table 102 and on 123 biotic variables. Over 12,000 correlations were calculated, and with such a large number of correlations, at least 5% would be expected to be spurious. Consistency of a correlative relationship over more than one cruise and the logical trend of the correlation were measures used to determine the credibility of the correlation.

1. Species Diversity Correlations

a. Meiofauna

Tables 103, 104, and 105 present the significant correlations between diversity and evenness and selected abiotic variables. Median grain size was inversely correlated with number of species over all three cruises. For Cruises I and III, percent sand was directly correlated and chromium, copper, nickel, lead, and zinc inversely correlated with number of species. None of the abiotic variables was significantly correlated with number of individuals, diversity, and Pielou evenness for more than one cruise. Nickel was directly correlated with Heip evenness during Cruises I and III.

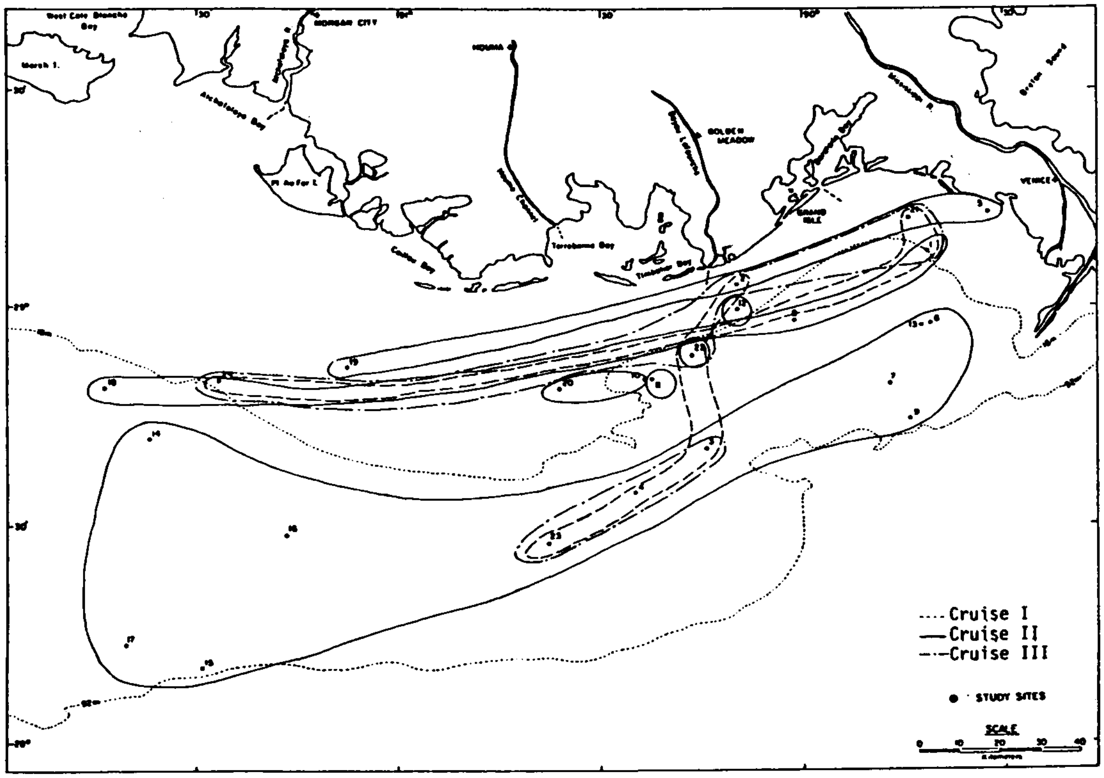

FIG. 30. Similarity between stations for macroepifauna and demersal fish

TABLE 102. List of variables used in correlation and regression analysis.

Variable	Code
Distance from Shore	DSHORE
Distance from Mississippi River	DMISS
Presence of Dead Bottom[1]	BDEAD
Water Depth	DEPTH
Salinity	SALIN
Water Temperature	TEMP
Dissolved Oxygen	DO
Sediment:	
% Sand	SAND
% Silt	SILT
% Clay	CLAY
Absolute % Smectite	SMECT
Median Grain Size[2]	MEDIAN
Sorting Coefficient	STD
Skewness	SKEW
Total Organic Carbon	TOC
Water Hydrocarbons:	
Ethane	ETHANE
Propane	PROPANE
Contamination Index	CI
Sediment Hydrocarbons	
Total Saturated Hydrocarbons	LT1
Total Unsaturated Hydrocarbons	LT2
Carbon Preference Index, C_{20}-C_{28}	CP1A
Carbon Preference Index, C_{24}-C_{32}	CP1B
Carbon Preference Index, C_{14}-C_{20}	CP1C
Sediment Trace Metals:	
Cadmium	LCD
Chromium	LCR
Copper	LCU
Iron	LFE
Nickel	LNI
Lead	LPB
Zinc	LZN
Barium	LBA
Vanadium	LVA
Microbiology:	
Counts, Oil Agar	LOA
Counts, Marine Agar	LMA
Counts, Sulfate Reducing Bacteria	LS04
Chitin	LCHI
Heterotrophic Activity	LHET
Protein Degradation	LPRO
Sulfur Oxidation	LSOX

[1] A plus sign indicates that the variable increased at live bottoms or decreased at dead bottoms, and a negative sign indicates the reverse.

[2] Median grain size was calculated in phi units. As the units increase, grain size decreases.

TABLE 103. **Significant correlation coefficients between Cruise I meiofauna diversity and evenness and selected physical and chemical variables.**

Variable[1]	Number of Species	Number of Individuals	Diversity	Evenness	
				Pielou	Heip
DEPTH					-0.45**
SALIN			-0.51***	-0.48**	-0.49**
TEMP			0.47**	0.47**	0.51***
SAND	0.68***				
CLAY				0.41*	0.48**
SMECT					0.42*
MEDIAN	-0.67***				
SKEW	0.51***				
TOC	-0.59***				
LT1	-0.45**		-0.42*		
LT2	-0.49**				
LCHI	-0.51**		-0.44**		
LSOX	0.42**				
LCR	-0.65***				
LCU	-0.60***				
LFE	-0.41*				
LNI	-0.52***				0.41*
LPB	-0.72***				
LZN	-0.69***				

[1] See Table 102 for explanation of the variable code.
*Denotes level of significance ≤ 0.05.
**Denotes level of significance ≤ 0.01.
***Denotes level of significance ≤ 0.001.

TABLE 104. **Significant correlation coefficients between Cruise II meiofauna diversity and evenness and selected physical and chemical variables.**

Variable[1]	Number of Species	Number of Individuals	Diversity	Evenness	
				Pielou	Heip
DSHORE					0.47***
SMECT	-0.45***				
MEDIAN	-0.45***				
LSO4	-0.41**				
LCHI	0.69***	0.58***		-0.62***	-0.66***
LSOX	0.41*			-0.46**	-0.55***
LCD	-0.42***				
LCR					0.46***
LPB					0.41***

[1] See Table 102 for explanation of the variable code.
*Denotes level of significance ≤ 0.05.
**Denotes level of significance ≤ 0.01.
***Denotes level of significance ≤ 0.001.

TABLE 105. Significant correlation coefficients between Cruise III meiofauna diversity and evenness and selected physical and chemical variables.

Variable[1]	Number of Species	Number of Individuals	Diversity	Evenness	
				Pielou	Heip
SAND	0.75***	0.67***	0.46**		
SILT	-0.72***	-0.66***	-0.44**		
CLAY	-0.52***	-0.41*			
MEDIAN	-0.72***	-0.65***	-0.48**		
SKEW					0.45**
TOC	-0.62***	-0.67***			
CI	-0.42**				
LT1		-0.41*			
CP1A					0.41*
LOA	-0.44**	-0.45**		-0.41*	
LHET	-0.73***	-0.61***			0.40*
LCR	-0.49**	-0.58***			
LCU	-0.54***	-0.50**			
LFE		-0.48**			
LNI	-0.50**	-0.54***		0.41*	0.41*
LPB	-0.59***	-0.57***			
LZN	-0.60***	-0.57***			0.44**

[1] See Table 102 for explanation of the variable code.
*Denotes level of significance ≤ 0.05.
**Denotes level of significance ≤ 0.01.
***Denotes level of significance ≤ 0.001.

b. Macroinfauna

Tables 106, 107, and 108 present the significant correlations between macroinfauna diversity and evenness and selected abiotic variables. During Cruises I and III, percent sand was directly correlated and percent silt, median grain size, chromium, and lead were inversely correlated with number of species. Both TOC and zinc were inversely correlated with number of species over all three cruises. Chitin degradation was inversely correlated during Cruise I and directly correlated in Cruise II with number of species.

Distance from shore, salinity, chromium, and lead were inversely correlated with number of individuals during Cruises I and III. Both depth and percent silt were inversely correlated with number of individuals over more than one cruise. Temperature and sulfate reduction were directly correlated during Cruise I and inversely correlated during Cruise III with number of individuals; the reverse was true for marine agar counts.

Distance from shore and salinity were directly correlated with macroinfauna diversity during Cruises II and III and D.O. was directly correlated with it in Cruises I and III. Temperature was inversely correlated during Cruise II and chitin degradation and lead were both inversely correlated during Cruise I with diversity. Temperature and lead were directly correlated with diversity during Cruise III and chitin degradation was directly correlated with it in Cruise II.

Distance from shore, salinity, TOC, chromium, and lead were directly correlated with Pielou evenness during Cruises II and III; they were directly correlated with depth over all three cruises. Presence of hypoxic bottom conditions was directly correlated with Pielou evenness over Cruises I and II; D.O. was directly correlated with it during Cruises I and III. Temperature, chitin degradation, and heterotrophic activity were inversely correlated with Pielou evenness during Cruise II but directly correlated with it in Cruise III.

Distance from shore and depth were both directly correlated with Heip evenness over all three cruises. Salinity, median grain size, TOC, chromium, and lead were directly correlated and percent sand inversely correlated with Heip evenness during Cruises II and III. During Cruises I and III, D.O. was directly correlated with it. Temperature was inversely correlated with Heip evenness during Cruises I and II and heterotrophic activity was inversely correlated with it during Cruise II; both were directly correlated with it in Cruise III.

c. Macroepifauna and Demersal Fish

Tables 109, 110, and 111 present the significant correlations between macroepifauna and demersal fish diversity and evenness and selected abiotic variables. Distance from shore was directly correlated with number of species during Cruises II and III. Presence of hypoxic bottom conditions was inversely correlated with number of species during Cruise I and directly correlated with that in Cruise II. Median grain size and zinc were directly correlated with number of species during Cruise II but inversely correlated with that in Cruise III. Temperature and percent clay were both directly correlated with number of species in Cruise I but temperature was inversely correlated with that in Cruise II as was percent clay in Cruise III. Percent sand was inversely correlated with number of species during Cruise II and directly correlated in Cruise III.

Dissolved oxygen was directly correlated with number of individuals in Cruises I and III, and both copper and nickel were inversely correlated with number of individuals during Cruises II and III. Percent sand was inversely correlated with number of individuals in Cruise I and directly correlated with number of individuals in Cruises II and III; the reverse was true for percent silt. Median grain size was directly correlated with number of individuals in Cruise I and inversely correlated with number of individuals in Cruise III.

TABLE 106. Significant correlation coefficients between Cruise I macroinfauna diversity and evenness and selected physical and chemical variables.

Variable[1]	Number of Species	Number of Individuals	Diversity	Evenness Pielou	Evenness Heip
DSHORE	-0.41*	-0.76***			0.57***
DMISS					0.53***
BDEAD		-0.60***	0.43**	0.57***	0.71***
DEPTH		-0.76***		0.48**	0.64***
SALIN	-0.55***	-0.84***			
TEMP	0.42**	0.83***			-0.53***
DO			0.72***	0.76***	0.73***
SAND	0.64***		0.42*		
SILT	-0.71***	-0.43**			
MEDIAN	-0.60***				
STD		0.48**		-0.47**	-0.60***
SKEW		0.42*			
TOC	-0.66***		-0.48**		
LT1	-0.62***	-0.41*	-0.58***	-0.45**	
LT2	-0.54***		-0.52***	-0.41*	
LMA		-0.46**			
LSO4		0.53***			
LCHI	-0.70***		-0.82***	-0.72***	-0.53***
LHET			-0.48**	-0.49**	-0.49**
LPRO		0.49**	-0.47**	-0.65***	-0.76***
LSOX			0.57***	0.55***	0.45**
LCD				-0.41*	-0.46**
LCR	-0.67***	-0.44**	-0.54***		
LCU			-0.53***	-0.49**	-0.41*
LFE	-0.44**				
LNI			-0.45**	-0.44**	
LPB	-0.73***	-0.51***	-0.43**		
LZN	-0.70***		-0.66***	-0.51**	

[1] See Table 102 for explanation of the variable code.
*Denotes level of significance ≤ 0.05. ***Denotes level of significance ≤ 0.001.
**Denotes level of significance ≤ 0.01.

TABLE 107. Significant correlation coefficients between Cruise II macroinfauna diversity and evenness and selected physical and chemical variables.

Variable[1]	Number of Species	Number of Individuals	Diversity	Evenness Pielou	Evenness Heip
DSHORE			0.68***	0.62***	0.59***
DMISS	0.47***		0.53***		
BDEAD				0.40***	0.43***
DEPTH		-0.43***	0.55***	0.64***	0.68***
SALIN			0.53***	0.54***	0.50***
TEMP			-0.58***	-0.62***	-0.61***
SAND		0.56***			-0.47***
SILT		-0.51***			
CLAY	-0.42***				
SMECT					0.51***
TOC	-0.53***			0.46***	0.59***
CP1B	0.42***				
LMA	-0.51***				
LCHI	0.76***	0.84***	0.84***	0.55***	
LHET				0.43**	0.46**
LCD	-0.58***				
LCR				0.61***	0.72***
LCU	-0.63***				
LNI	-0.54***				
LPB				0.48***	0.59***
LZN	-0.43***				0.51***

[1] See Table 102 for explanation of the variable code.
*Denotes level of significance ≤ 0.05. ***Denotes level of significance ≤ 0.001.
**Denotes level of significance ≤ 0.01.

TABLE 108. Significant correlation coefficients between Cruise III macroinfauna diversity and evenness and selected physical and chemical variables.

Variable[1]	Number of Species	Number of Individuals	Diversity	Evenness Pielou	Evenness Heip
DSHORE		-0.59***	0.71***	0.70***	0.67***
DMISS					0.42*
DEPTH		-0.59***	0.75***	0.74***	0.74***
SALIN		-0.77***	0.65***	0.70***	0.64***
TEMP		-0.69***	0.53***	0.55***	0.45**
DO		-0.49**	0.58***	0.60***	0.58***
SAND	0.68***				-0.49**
SILT	-0.72***	-0.47**		0.47**	0.56**
MEDIAN	-0.66***	-0.43**		0.46**	0.55***
TOC	-0.66***	-0.52**		0.51**	0.57***
ETHANE		-0.41*	0.50**	0.58***	0.67***
PROPANE		-0.41*	0.50**	0.59***	0.67***
CI				0.47**	0.58***
LOA	-0.60***				
LMA		0.46**	-0.44**	-0.52***	-0.56***
LSO4		-0.45**		0.42**	0.42**
LHET	-0.50**				
LCD			-0.41*		
LCR	-0.49**	-0.46**		0.47**	0.50**
LPB	-0.62***	-0.55***	0.48**	0.63***	0.70***
LZN	-0.49**				

[1] See Table 102 for explanation of the variable code.
*Denotes level of significance $\leq$ 0.05.
**Denotes level of significance $\leq$ 0.01.
***Denotes level of significance $\leq$ 0.001.

TABLE 109. Significant correlation coefficients between Cruise I macroepifauna and demersal fish diversity and evenness and selected physical and chemical variables.

Variable[1]	Number of Species	Number of Individuals	Diversity	Evenness Pielou	Evenness Heip
DSHORE			-0.53***		
DMISS			-0.82***	-0.61***	
BDEAD	-0.47**		-0.77***	-0.55***	
DEPTH	-0.43**		-0.56***		
TEMP	0.53***		0.44**		
DO	0.41*	0.62***	-0.40*	-0.80***	-0.82***
SAND		-0.44**			
SILT		0.42*			
CLAY	0.41*				
MEDIAN		0.44**			
ETHANE		0.60***			
PROPANE		0.57***			
CI		0.60***			
LT1				0.45**	0.46**
LT2			0.40*		
LCHI			0.64***	0.79***	0.74***
LHET		-0.50**	0.55***	0.50**	
LPRO			0.46**	0.64**	0.61***
LSOX	-0.59***		-0.81***	0.52***	
LCD				0.45**	
LCU			0.56***	0.43**	
LNI			0.50**		
LZN			0.59***	0.57***	0.47**

[1] See Table 102 for explanation of the variable code.
*Denotes level of significance $\leq$ 0.05.
**Denotes level of significance $\leq$ 0.01.
***Denotes level of significance $\leq$ 0.001.

TABLE 110. Significant correlation coefficients between Cruise II macroepifauna and demersal fish diversity and evenness and selected physical and chemical variables.

Variable[1]	Number of Species	Number of Individuals	Diversity	Evenness	
				Pielou	Heip
DSHORE	0.72***				
BDEAD	0.66***				
DEPTH	0.76***				
SALIN					-0.41***
TEMP	-0.78***				0.52***
SAND	-0.42***	0.43***	-0.61***		
SILT		-0.46***	0.59***	0.42***	
MEDIAN	0.47***		0.59***		
TOC			0.58***		
LT1			0.48***		
LCHI	0.83***	0.58***	-0.48**	-0.65***	-0.76***
LHET			0.47**		
LPRO	-0.51**		0.68***	0.54***	0.42*
LSOX			-0.49**	-0.43**	-0.53***
LCR	0.64***		0.55***		
LCU		-0.45***	0.42***	0.44***	
LFE		-0.48***	0.56***	0.51***	
LNI	0.61***		0.46***		
LPB	0.44***		0.57***		

[1]See Table 102 for explanation of the variable code.
*Denotes level of significance < 0.05.
**Denotes level of significance < 0.01.
***Denotes level of significance < 0.001.

TABLE 111. Significant correlation coefficients between Cruise III macroepifauna and demersal fish diversity and evenness and selected physical and chemical variables.

Variable[1]	Number of Species	Number of Individuals	Diversity	Evenness	
				Pielou	Heip
DSHORE	0.53***	0.60***	-0.59***	-0.81***	-0.84***
DMISS		0.45**	-0.54***	-0.65***	-0.65***
DEPTH		0.52***	-0.81***	-0.89***	-0.88***
SALIN			-0.41**	-0.50**	-0.59**
DO	0.46**	0.46**	-0.51**	-0.70***	0.75***
SAND	0.70***	0.52***			
SILT	-0.64***	-0.46**			
CLAY	-0.56***	-0.44**			
SMECT	-0.48***	-0.48**		0.49**	0.54***
MEDIAN	-0.64***	-0.43**			
ETHANE			-0.71***	-0.54**	-0.49**
PROPANE			-0.71***	-0.54**	-0.49**
CI			-0.66***	-0.42**	
LT1		-0.52***			
LT2	-0.41*			0.41*	0.41*
LOA	-0.70***	-0.67***			
LMA			0.46**	0.49**	0.42*
LHET	-0.88***	-0.72***			0.43**
LPRO			0.44**		
LSOX					-0.44**
LCD	-0.58***	-0.59***	0.43**	0.65***	0.71***
LCU	-0.73***	-0.71***		0.49**	0.56***
LNI	-0.70***	-0.67***		0.49***	0.57***
LZN	-0.55***	-0.52***			
LBA	-0.43**				

[1]See Table 102 for explanation of the variable code.
*Denotes level of significance < 0.05.
**Denotes level of significance < 0.01.
***Denotes level of significance < 0.001.

Distance from shore, distance from the Mississippi River, depth, and D.O. were inversely correlated with diversity during Cruises I and III. Copper, nickel, and zinc were directly correlated with diversity during Cruises I and II and protein degradation was directly correlated with it during all three cruises. Temperature was directly correlated with diversity in Cruise I and inversely correlated in Cruise II.

Distance from the Mississippi River and D.O. were both inversely correlated with Pielou evenness during Cruises I and III and cadmium was directly correlated with it. Copper was directly correlated with Pielou evenness during all three cruises. Protein degradation was directly correlated with Pielou evenness during Cruises I and II and nickel was directly correlated with it during Cruises II and III. Both chitin degradation and sulfate oxidation were directly correlated with Pielou evenness in Cruise I and inversely correlated with it in Cruise II.

Salinity and sulfate oxidation were inversely correlated with Heip evenness during Cruises II and III and protein degradation was directly correlated with it in Cruises I and II. Chitin degradation was directly correlated with Heip evenness in Cruise I but inversely correlated in Cruise II; D.O. was inversely correlated with Heip evenness in Cruise I and directly correlated with it in Cruise III.

2. *Correlations with Dominant Taxa*

a. *Meiofauna*

Tables 112, 113, and 114 present the significant correlations between the top 15 meiofauna taxa and selected abiotic variables. The distribution for each of these taxa except Gromiidae was presented above under the sections on Foraminifera and Nematoda.

Distance from shore and depth were both inversely correlated with the nematode *Sabatieria* during all three cruises. During Cruises I and II the presence of hypoxic bottom conditions was inversely correlated and sorting coefficient was directly correlated with *Sabatieria.* Salinity was found to be inversely correlated with *Sabatieria* during Cruises I and III. Therefore, as distance from shore, depth, and salinity decreased and the sediments became more sorted, *Sabatieria* increased. Under hypoxic bottom conditions, which were encountered during Cruises I and II, *Sabatieria* increased.

None of the abiotic variables were found to be significantly correlated with *Bolivina lowmani* for more than one cruise. This was also the case for the Gromiidae. In fact during Cruises I and II there was little correlation with any variable. Fewer Gromiidae were collected in Cruise III, which may account for the increase in significant correlations; these appear to be spurious.

A similar situation was found for the nematode *Dorylaimopsis.* No abiotic variable was consistently correlated with *Dorylaimopsis* except median grain size, which was inversely correlated with this taxon during Cruises II and III. Depth was inversely correlated with the nematode family Cyatholaimidae during Cruises II and III, and ethane and propane were inversely correlated with this family during Cruises I and III. Thus, as depth, ethane, and propane increased, Cyatholaimidae density decreased.

The nematode *Theristus* was inversely correlated with hypoxic bottom conditions and directly correlated with temperature during Cruises I and II. During Cruises I and III distance from shore, distance from the Mississippi River, salinity, ethane, propane, and the contamination index were inversely correlated with *Theristus.* For all three cruises, depth was inversely correlated with this taxon. During Cruises II and III median grain size and lead were inversely correlated with *Theristus.* Therefore, as distance from shore and the Mississippi River, depth, salinity, median grain size, ethane, propane, the contamination index, and lead decreased and temperature increased, the number of *Theristus* individuals increased. Note that *Theristus* appeared to increase in numbers under hypoxic bottom conditions.

Distance from shore, depth, and salinity were all directly correlated with the foram *Buliminella morgani* in Cruises I and III, as was chitin degradation. Temperature was inversely correlated with *B. morgani* in Cruise I and directly correlated in Cruise III. The heterotrophic process was directly correlated with this species during Cruise II and inversely correlated with it in Cruise III. Thus, as distance from shore, depth, salinity, and the presence of chitin degradation increased, *B. morgani* increased.

The nematode family Linhomoeidae was inversely correlated with depth during Cruises II and III; it was directly correlated with distance from shore in Cruise II and inversely correlated in Cruise III. Depth was directly correlated with the foram *Nonionella basiloba* in Cruises I and III. Choniolaimidae was found not to be consistently correlated with any abiotic variable for more than one cruise.

Both distance from shore and depth were inversely correlated with *Terschellingia* density during all three cruises. Distance from the Mississippi River, salinity, and D.O. were inversely correlated with this taxon during Cruises I and III. Temperature was directly correlated in Cruises I and II but inversely correlated in Cruise III. Cadmium was directly correlated with *Terschellingia* in Cruises I and III, and presence of hypoxic bottom conditions was inversely correlated with it during Cruises I and II. Therefore, as distance from shore and the Mississippi River, depth, salinity, and D.O. decreased and hypoxic bottom conditions and cadmium increased, the density of *Terschellingia* increased.

During all three cruises, the density of *Ammonia beccarii* was inversely correlated with distance from shore and depth. Salinity was inversely correlated with this taxon during Cruises I and III, and hypoxic bottom conditions were inversely correlated during Cruises I and II. Temperature was directly correlated with *A. beccarii* during Cruises I and II, but inversely correlated in Cruise III. As distance from shore, depth, and salinity decreased and presence of hypoxic bottom conditions increased, the density of *A. beccarii* increased.

Percent sand and marine agar counts were directly correlated and percent silt was inversely correlated with Chromadoridae during Cruises I and III. Chromium, lead, and zinc were inversely correlated during Cruises I and III. Thus, as percent silt, chromium, lead, and zinc decreased and percent sand and marine agar counts increased, Chromadoridae density increased.

TABLE 112. Significant correlation coefficients between Cruise I top meiofauna taxa and selected physical and chemical variables

	Taxa												
Variable[1]	*Sabatieria*	*Bolivina lowmani*	Gromiidae	*Dorylaimopsis*	Cyatholaimidae	*Theristus*	*Buliminella morgani*	Linhomoeidae	*Nonionella basiloba*	Choniotaimidae	*Terschellingia*	*Ammonia beccarii*	Chromadoridae
DSHORE	-0.52***					-0.65***	0.55***				-0.77***	-0.44**	-0.55***
DMISS						-0.46**					-0.66***		
BDEAD	-0.45**					-0.68***				-0.50**	-0.88***	-0.43**	
DEPTH	-0.47**					-0.65***	0.61***		0.41*		-0.77***	-0.50**	-0.45**
SALIN	-0.50**					-0.48**	0.78***		0.53***		-0.43**	-0.45**	-0.65***
TEMP	0.45**					0.57***	-0.75***		-0.52***		0.67***	0.44**	0.56***
DO				-0.46**							-0.45**		
SAND													0.42*
SILT				0.45**									-0.51**
CLAY											0.40*		
STD	0.44**					0.50**					0.65***		
SKEW												0.49***	
TOC													0.49**
ETHANE					-0.79*	-0.79*							
PROPANE					-0.78*	-0.77*							
CI					0.77*	-0.77*							
LT1							0.59***						-0.56***
LT2													-0.42**
CP1A								0.45**					
LMA													0.55*
LCHI							0.50*				0.46*		-0.57**
LHET			0.56*		0.54*	0.60**					0.58**		
LSOX				0.44*									
LCD						0.52***					0.62***		
LCR						0.42*	0.47**	0.41*					-0.58***
LCU											0.49**		
LNI											0.46**		
LPB							0.52***						-0.64***
LZN													-0.40*
LBA	0.43**				0.53***								0.50**

[1] See Table 102 for explanation of the variable code.

*Denotes level of significance ≤ 0.05.

**Denotes level of significance ≤ 0.01.

***Denotes level of significance ≤ 0.001.

TABLE 113. Significant correlation coefficients between Cruise II top meiofauna taxa and selected physical and chemical variables.

	Taxa													
Variable[1]	*Sabatieria*	*Bolivina lowmani*	Gromiidae	*Dorylaimopsis*	Cyatholaimidae	*Theristus*	*Buliminella morgani*	Linhomoeidae	*Nonionella basiloba*	Choniolaimidae	*Terschellingia*	*Ammonia beccarii*	Chromadoridae	*Tricoma*
DSHORE	-0.42***							0.45***			-0.56***	-0.43***		
BDEAD	-0.42***			-0.42***		-0.43***					-0.62***	-0.47***		
DEPTH	-0.45***			-0.44***	-0.47***	-0.49***		-0.53***			-0.55***	-0.45***		
TEMP						0.41***		0.48***			0.56***	0.47***		-0.46***
SAND						0.52***								
CLAY						-0.44***								
SMECT						-0.45***							-0.42***	
MEDIAN				-0.41***		-0.57***								
STD	0.43***			0.41***										
LT2													-0.50***	
LMA			-0.50**							-0.46**				
LSO4				-0.87**			-0.79**							
LCHI				0.55*			0.59**		0.57**	0.73***				
LHET							0.57**							
LSOX		0.44**												
LCR	-0.44***					-0.51***								
LPB						-0.49***								

[1] See Table 102 for explanation of the variable code.

*Denotes level of significance ≤ 0.05.

**Denotes level of significance ≤ 0.01.

***Denotes level of significance ≤ 0.001.

TABLE 114. Significant correlation coefficients between Cruise III top meiofauna taxa and selected physical and chemical variables.

Variable[1]	Taxa														
	Sabatieria	*Bolivina lowmani*	Gromiidae	*Dorylaimopsis*	Cyatholaimidae	*Theristus*	*Buliminella morgani*	Linhomoeidae	*Nonionella basiloba*	Choniolaimidae	*Terschellingia*	*Ammonia beccarii*	Chromadoridae	*Tricoma*	*Sphaerolaimus*
DSHORE	-0.63***		0.64***		-0.62***	-0.66***	0.41*	-0.67***	0.52***		-0.78***	0.74**			-0.45**
DMISS						-0.42*		-0.54***			-0.46**				
DEPTH	-0.65***		0.65***		-0.61***	-0.75***	0.50**	-0.77***	0.51***		-0.81***	-0.82***			-0.45**
SALIN	-0.53***		0.44**		-0.78***	-0.48**	0.67***	-0.41*		-0.46**	-0.57***	-0.57***			-0.46**
TEMP			0.42*		-0.65***		0.70***				-0.43**	-0.44**			
DO	-0.51**		0.50**		-0.47**	-0.46**		-0.54***			-0.60***	-0.41*			
SAND				0.47**				0.63***					0.88***	0.66***	
SILT									-0.55***	-0.41*			-0.89***	-0.60***	
CLAY			-0.43**	-0.54***					-0.57***				-0.51***	-0.54***	
SMECT			-0.46**						-0.54***					-0.42*	
MEDIAN				-0.52***		-0.42**			-0.59***				-0.85***	-0.65***	
STD			-0.41*		0.41*							0.47**			
TOC					-0.52***					-0.41*			-0.81***	-0.61***	
ETHANE	-0.54***			-0.50**	-0.42**	-0.72***		-0.66***			-0.52***	-0.50**			
PROPANE	-0.54***			-0.50**	-0.42**	-0.72***		-0.66***			-0.52***	-0.50**			
CI	0.46**			-0.59***		-0.66***		-0.59***							
CP1A													-0.41*		
LOA									-0.44**				-0.61***	-0.44**	
LMA					0.67***	0.47*		0.51*			0.45**		0.42**		0.46**
LSO4					-0.49*										-0.41*
LHET			-0.57**	-0.48*			-0.45*		-0.67***			0.41*	-0.75***	-0.67***	
LSOX														0.43**	
LCD			-0.62***				-0.43**	0.47**	-0.60***		0.50**	0.61***		-0.52***	
LCR					-0.45**								-0.70***	-0.50**	
LCU			-0.51***						-0.72***			0.41*	-0.61***	-0.72***	
LFE													-0.51**	-0.42*	
LNI			-0.60***				-0.48**		-0.70***			0.40*	-0.53***	-0.72***	
LPB					-0.44***	-0.50*							-0.82***	-0.45**	
LZN									-0.46**				-0.81***	-0.67***	

[1] See Table 102 for explanation of the variable code.

*Denotes level of significance ≤ 0.05.

**Denotes level of significance ≤ 0.01.

***Denotes level of significance ≤ 0.001.

None of the abiotic variables was significantly correlated with the nematodes *Tricoma* and *Sphaerolaimus* during more than one cruise.

b. Macroinfauna

Tables 115, 116, and 117 present the significant correlations between the top ten macroinfauna taxa and selected abiotic variables. Distribution for each of the taxa, except Rhynchocoela and *Corbula contracta*, was presented above under the section on Polychaeta.

Distance from shore and depth were inversely correlated and smectite was directly correlated with the polychaete *Paraprionospio pinnata* during Cruises I and III. Salinity was inversely correlated with this species during Cruises II and III. Thus, as distance from shore, depth, and salinity decreased and smectite increased, the number of *P. pinnata* increased.

Distance from shore and salinity were inversely correlated with the polychaete *Sigambra tentaculata* during Cruises I and III, as was depth for all three cruises. Presence of hypoxic bottom conditions was inversely correlated with *S. tentaculata* during Cruises I and II. During Cruises I and II temperature was directly correlated with this species but inversely correlated during Cruise III. Therefore, as the distance from shore, depth, and salinity decreased, the number of individuals of *S. tentaculata* increased. This polychaete also appeared to increase under hypoxic bottom conditions.

The polychaete *Cossura delta* was directly correlated with salinity during Cruises I and III. Temperature was inversely correlated with this taxon during Cruises I and II but inversely correlated in Cruise III. During Cruises I and II, *C. delta* was directly correlated with the chitinous degrading processes.

Distance from shore and depth were inversely correlated with *Magelona phyllisae* during Cruises II and III. This species was inversely correlated with salinity during all three cruises. Temperature was directly correlated with *M. phyllisae* during Cruises I and II but inversely correlated during Cruise III.

The polychaete *Nephtys incisa* was directly correlated with distance from shore and TOC during Cruises I and III and inversely correlated with temperature during Cruises I and II. For all three cruises, *N. incisa* was inversely correlated with percent sand and median grain size and directly correlated with percent silt. As distance from shore, percent silt, and TOC increased and percent sand decreased, the number of *N. incisa* increased.

Corbula contracta, a bivalve, was directly correlated with distance from shore, depth, and D.O. during Cruises I and III and inversely correlated with cadmium during Cruises I and II. As distance from shore, depth, and D.O. increased and presence of cadmium decreased, the density of *C. contracta* increased.

Distance from shore and depth were directly correlated and percent clay, smectite, and the heterotrophic bacterial process were inversely correlated with the polychaete *Lumbrineris tenuis* during Cruises I and III. Salinity was directly correlated with *L. tenuis* during

TABLE 115. Significant correlation coefficients between Cruise I top nine macroinfauna taxa and selected physical and chemical variables.

	Taxa								
Variable[1]	*Paraprionospio pinnata*	*Sigambra tentaculata*	*Cossura delta*	*Magelona phyllisae*	*Nephtys incisa*	*Corbula contracta*	*Lumbrineris tenuis*	*Tharyx marioni*	*Nereis*
DSHORE	-0.53***	-0.64***			0.50**	0.45**	0.73***		
DMISS							0.63***		
BDEAD	-0.70***	-0.49**				0.65***	0.91***	0.46**	
DEPTH	-0.66***	-0.64***				0.55***	0.83***	0.45**	
SALIN		-0.74***	0.66***	-0.67***	0.53***		0.49**		
TEMP	0.57***	0.67***	-0.43**	0.83***	-0.43**	-0.44**	-0.70***		
DO			-0.41*			0.54***			
SAND	-0.43**				-0.76***			0.66***	0.80***
SILT			0.47**		0.83***			-0.56***	-0.80***
CLAY	0.44**						-0.51**	-0.44**	
SMECT	0.42*					-0.40*	-0.51**	-0.45**	
MEDIAN	0.42**				0.72***			-0.60***	-0.78***
STD	0.53***			0.63***		-0.50**	-0.49**		
TOC					0.70***	-0.42**		-0.65***	-0.68***
SKEW					-0.53***				0.72***
LT1			0.48**		0.59***				-0.40**
LT2			0.46**		0.49**			-0.47**	-0.51**
CP1C				-0.41*					
LOA								0.46*	
LMA		-0.70***	0.45*	-0.46**					
LSO4				0.48**					
LCHI			0.57**			-0.78***			-0.41*
LHET	0.53*						-0.50*		
LPRO	0.46*			0.67***		-0.67***	-0.53*		
LSOX						0.55*			
LCD				0.63***		-0.55***	-0.76***	-0.55***	
LCR			0.47**		0.78***		-0.47**	-0.80***	
LCU	0.47**					-0.47**	-0.69***	-0.80***	-0.61***
LFE					0.51***			0.42*	-0.57***
LNI							-0.69***	-0.65***	-0.49***
LPB					0.86***			-0.48**	-0.82***
LZN	0.41*				0.60***	-0.43**	-0.52***	-0.61***	-0.65***

[1]See Table 102 for explanation of the variable code.
*Denotes level of significance ≤ 0.05.
**Denotes level of significance ≤ 0.01.
***Denotes level of significance ≤ 0.001.

TABLE 116. Significant correlation coefficients between Cruise II top nine macroinfauna taxa and selected physical and chemical variables.

Variable[1]	Taxa								
	Paraprionospio pinnata	*Sigambra tentaculata*	*Cossura delta*	*Magelona phyllisae*	*Nephtys incisa*	*Corbula contracta*	*Lumbrineris tenuis*	*Tharyx marioni*	*Nereis*
DSHORE			0.47***	-0.59***					
BDEAD		-0.42***	0.42***	-0.47***	0.50***				
DEPTH		-0.44***	0.43***	-0.58***					
SALIN	-0.60***			-0.60***			0.42***		
TEMP		0.57***	-0.58***	0.68***	-0.41***				
SAND					-0.52***			0.50***	0.61***
SILT					0.58***			-0.43***	-0.60***
MEDIAN					0.44***			-0.52***	-0.61***
TOC								-0.44***	-0.60***
CPIB								0.42***	
LMA						-0.54***		-0.42**	-0.44**
LCHI			0.68***	-0.68***	0.52*	0.83***	0.82***	0.84***	0.65**
LHET					0.54*				
LPRO					0.60**				
LCD						-0.45***	-0.48***		
LCR				-.045***					-0.45***
LCU							-0.49***		-0.54***
LFE									-0.46***
LNI							-0.53***		-0.55***
LPB			0.40***						
LZN									-0.49***

[1]See Table 102 for explanation of the variable code.
*Denotes level of significance ≤ 0.05.
**Denotes level of significance ≤ 0.01.
***Denotes level of significance ≤ 0.001.

TABLE 117. Significant correlation coefficients between Cruise III top nine macroinfauna taxa and selected physical and chemical variables.

Variable[1]	Taxa								
	Paraprionospio pinnata	*Sigambra tentaculata*	*Cossura delta*	*Magelona phyllisae*	*Nephtys incisa*	*Corbula contracta*	*Lumbrineris tenuis*	*Tharyx marioni*	*Nereis*
DSHORE	-0.62***	-0.65***		-0.85***	0.67***	0.47***	0.44***		
DMISS				-0.43**	0.46***	0.51***			
DEPTH	-0.72***	-0.65***		-0.87***	0.45**	0.41*	0.45**		
SALIN	-0.76***	-0.49**	0.46**	-0.72***					-0.59***
TEMP	-0.66***	-0.42*	0.41*	-0.60***					-0.50**
DO	-0.45**	-0.58***		-0.69***	0.81***	0.47**			
SAND					-0.47**		0.79***	0.80***	0.71***
SILT					0.54***		-0.73***	-0.76***	-0.76***
CLAY							-0.62***	-0.59***	
SMECT	0.42*	0.49**		0.49**			-0.47**		
MEDIAN					0.44**		-0.72***	-0.78***	-0.73***
TOC	-0.41*				0.53***		-0.58***	-0.64***	-0.78***
ETHANE			0.91**						
PROPANE			0.91**						
C1			0.84**						
ET2							-0.58***		-0.42*
LOA							-0.59**		
LMA					-0.64**				0.53*
LSO4					0.51*				
LHET						0.45*	-0.83***		-0.59**
LCD		0.52***		0.58***			-0.61***		
LCR					0.52***		-0.51**	-0.44**	-0.74***
LCU							-0.80***	-0.57***	-0.48**
LFE						0.42*	-0.47**	-0.40*	-0.48**
LNI		0.52***		0.44**			-0.74***	-0.46**	
LPB					0.73***		-0.46**	-0.53***	-0.79***
LZN							-0.71***	-0.51***	-0.69***

[1]See Table 102 for explanation of the variable code.
*Denotes level of significance ≤ 0.05.
**Denotes level of significance ≤ 0.01.
***Denotes level of significance ≤ 0.001.

Cruises I and II. Cadmium, copper, and nickel were inversely correlated with this species during all three cruises and zinc was inversely correlated during Cruises I and III. Therefore, as distance from shore, depth, and salinity increased and percent clay, smectite, heterotrophic bacterial processes, cadmium, copper, nickel, and zinc decreased, the density of *L. tenuis* increased.

Percent sand was directly correlated and percent silt, median grain size, and TOC were inversely correlated with the polychaete *Tharyx marioni* during all three cruises. Percent clay was inversely correlated during Cruises I and III. Chromium, copper, iron, lead, and zinc were inversely correlated with *T. marioni* during Cruises I and III. Therefore, as percent sand increased and percent silt, percent clay, median grain size, TOC, chromium, copper, iron, lead, and zinc decreased, the density of *T. marioni* increased.

The polychaete genus *Nereis* was directly correlated with percent sand and inversely correlated with percent silt, median grain size, TOC, chromium, copper, iron, and zinc during all three cruises. Nickel was inversely correlated with this genus during Cruises I and II and lead was inversely correlated with it during Cruises I and III. Total unsaturated hydrocarbons were also inversely correlated with *Nereis* during Cruises I and III. As percent sand increased and percent silt, median grain size, TOC, total unsaturated hydrocarbons, chromium, copper, iron, lead, nickel, and zinc decreased, density of *Nereis* increased.

c. *Macroepifauna and Demersal Fish*

Tables 118, 119, and 120 present the significant correlations between selected dominant and commercially important macroepifauna and demersal fish taxa and selected abiotic variables. Distribution for each of the taxa was presented above under the sections on Decapoda and Osteichthyes.

The demersal fish *Prionotus rubio* was directly correlated with D.O., percent silt, median grain size, ethane, propane, the contamination index, and iron and inversely correlated with marine agar counts during Cruises I and III. Heterotrophic activity was

TABLE 118. Significant correlation coefficients between Cruise I selected dominant and commercially important macroepifauna and demersal fish and selected physical and chemical parameters

	Taxa							
Variable[1]	*Prionotus rubio*	*Halieutichthys aculeatus*	*Micropogon undulatus*	*Leiostomus xanthurus*	*Cynoscion arenarius*	*Menticirrhus americanus*	*Penaeus aztecus*	*Penaeus setiferus*
DSHORE		0.48**	-0.69***	-0.69***	-0.75***	-0.69***	-0.65***	-0.74***
BDEAD		0.72***	-0.53***	-0.53***	-0.58***	-0.53***	-0.44***	-0.57***
DEPTH		0.71***	-0.75***	-0.75***	-0.74***	-0.75***	-0.67***	-0.76***
SALIN		0.45**	-0.95***	-0.95***	-0.88***	-0.95***	-0.92***	-0.93***
TEMP		-0.55***	0.87***	0.87***	0.81***	0.87***	0.83***	0.85***
DO	0.65***							
SAND		0.70***						
SILT	0.52***	0.63***	-0.65***	0.66***	-0.78***		-0.65***	
CLAY		-0.54***	0.48**	0.48**		0.48**	0.40*	0.44**
SMECT		-0.53***						
MEDIAN	0.47**	0.61***	-0.69***	0.61***	-0.77***		-0.61***	
STD					0.42*			0.40*
TOC		-0.60***						
ETHANE	0.64***	0.51**						
PROPANE	0.64***	0.44**						
CI	0.56***	0.44**						
LT1			0.50**	-0.50**		-0.50**		
LT2					-0.47**		-0.62***	
LOA		0.57***	-0.54***		-0.62**		0.60**	
LMA	-0.44**			-0.57***		0.48**		
LCHI			-0.58***	-0.58***	-0.48***	-0.58***	-0.65***	-0.53***
LHET		-0.51*						
LSOX	-0.73***							
LCD							-0.63***	0.57***
LCR		-0.45**	-0.41*	-0.41*	-0.41*	-0.41*	-0.54***	-0.41*
LCU			-0.47**		-0.65***		-0.77***	0.47**
LFE	0.44**	0.45**				-0.41*		
LNI			-0.47**		-0.58***		-0.72***	0.50**
LPB							-0.50**	
LZN		-0.64***					-0.42*	
LBA					0.42*			0.41*

[1] See Table 102 for explanation of the variable code.

*Denotes level of significance ≤ 0.05. ***Denotes level of significance ≤ 0.001.

**Denotes level of significance ≤ 0.01.

TABLE 119. Significant correlation coefficients between Cruise II selected dominant and commercially important macroepifauna and demersal fish and selected physical and chemical variables.

	Taxa							
Variable[1]	*Prionotus rubio*	*Halieutichthys aculeatus*	*Micropogon undulatus*	*Leiostomus xanthurus*	*Cynoscion arenarius*	*Menticirrhus americanus*	*Penaeus aztecus*	*Penaeus setiferus*
DSHORE		0.69***					0.51***	
DMISS		0.44***						
BDEAD							0.64***	
DEPTH		0.70***					0.64***	
SALIN		0.52***					0.46***	-0.60***
TEMP		-0.66***					-0.74***	
DO			-0.58***	-0.48***	-0.47***			
SAND						0.44***		
CLAY							0.43***	
SMECT							0.43***	
MEDIAN							0.40***	
TOC						0.41***		
LMA								0.49***
LCHI	0.50**	0.83***		-0.70**	-0.70***		0.80***	-0.46**
LHET	0.68***			-0.63***	-0.60***			
LPRO	0.77***			-0.43**				
LSOX	-0.52***		0.48**				0.49**	
LCD							0.60***	0.47***
LPB							0.52***	
LZN							0.48***	

[1]See Table 102 for explanation of the variable code.
*Denotes level of significance ≤ 0.05.
**Denotes level of significance ≤ 0.01.
***Denotes level of significance ≤ 0.001.

TABLE 120. Significant correlation coefficients between Cruise III selected dominant and commercially important macroepifauna and demersal fish and selected physical and chemical variables.

	Taxa							
Variable[1]	*Prionotus rubio*	*Halieutichthys aculeatus*	*Micropogon undulatus*	*Leiostomus xanthurus*	*Cynoscion arenarius*	*Menticirrhus americanus*	*Penaeus aztecus*	*Penaeus setiferus*
DSHORE	0.69***					-0.51***	0.53***	-0.51***
DMISS	0.59***							
DEPTH	0.76***	0.55***		0.48**		-0.54***	0.56***	-0.77***
SALIN				0.69***		-0.94***		
TEMP			0.43**	0.49**		-0.94***		
DO	0.65***							
SAND	-0.46**	-0.60***	0.70***	0.59***			0.69***	
SILT	0.52***	0.63***	-0.65***	0.66***	-0.78***	-0.48**	-0.65***	
CLAY			-0.55***		-0.54***		-0.52***	
SMECT					-0.42*		-0.52***	0.52***
MEDIAN	0.47**	0.61***	-0.69***	0.61***	-0.77***		-0.61***	
TOC		0.42*		0.76***	-0.59***	-0.58***	-0.50**	
ETHANE	0.96***	0.90***	-0.46**	0.51***		-0.50**		-0.55***
PROPANE	0.96***	0.90***	-0.46**	0.51***		-0.51**		-0.56***
CI	-0.93***	0.93***	-0.59***	0.44*	-0.44*			-0.47**
LT2					-0.47**		-0.62***	
LOA		0.57***	-0.54***		-0.62***		-0.60***	
LMA	-0.44**			-0.57***		0.48**		
LSO4						-0.51***		
LHET	0.45**	0.66***	-0.89***	0.42*	-0.89***		-0.81***	0.45**
LPRO		-0.41*	0.51***			-0.61***		
LSOX								-0.60***
LCD							-0.63***	0.57***
LCR	0.55***	0.51**		0.52***	-0.48**	-0.70***	-0.44**	
LCU			-0.47**		-0.65***		-0.77***	0.47**
LFE	0.44**	0.45**				0.41*		
LNI			-0.47**		-0.58***		-0.72***	0.50**
LPB	0.67***	0.61***	-0.44**	0.59***	-0.49**	-0.59***		
LZN				0.50**	0.55***	-0.61***	-0.66***	
LBA		0.56***	-0.53***					

[1]See Table 102 for explanation of the variable code.
*Denotes level of significance ≤ 0.05. ***Denotes level of significance ≤ 0.001.
**Denotes level of significance ≤ 0.01.

directly correlated with *P. rubio* during Cruises II and III and sulfate oxidation was inversely correlated with it in Cruises I and II.

Percent silt, median grain size, oil agar counts, iron, ethane, propane, and the contamination index were directly correlated with *Halieutichthys aculeatus* during Cruises I and III. Depth was directly correlated with this species during all three cruises. Distance from shore and salinity were directly correlated and temperature inversely correlated during Cruises I and II. Heterotrophic activity and chromium were inversely correlated with *H. aculeatus* during Cruise I but directly correlated in Cruise III. Sand was directly correlated with this species in Cruise I but inversely correlated in Cruise III; the reverse was true for TOC.

Micropogon undulatus was directly correlated with temperature and inversely correlated with percent silt, median grain size, oil agar counts, copper, and nickel during Cruises I and III. Temperature, percent silt, and median grain size were directly correlated and marine agar counts were inversely correlated with *Leiostomus xanthurus* during Cruises I and III. Chitin degradation was inversely correlated with this species during Cruises I and III.

Percent silt, median grain size, oil agar counts, copper, nickel, and total unsaturated hydrocarbons were inversely correlated with *Cynoscion arenarius* during Cruises I and III. Chitin degradation was inversely correlated with *C. arenarius* during Cruises I and II and heterotrophic activity was inversely correlated with it during Cruises II and III.

Marine agar counts were directly correlated and distance from shore, depth, salinity and iron were inversely correlated with *Menticirrhus americanus* during Cruises I and III. Temperature and TOC were directly correlated with *M. americanus* during Cruises I and II, respectively, but both were inversely correlated during Cruise III.

Penaeus aztecus was inversely correlated with percent silt, total unsaturated hydrocarbons, oil agar counts, cadmium, copper, and nickel during Cruises I and III. Median grain size was inversely correlated with *P. aztecus* during Cruises I and III but was directly correlated during Cruise II. Distance from shore, presence of hypoxic bottom conditions, depth, and salinity were inversely correlated with *P. aztecus* during Cruise I, but directly correlated in Cruise II. The reverse was true for temperature. Percent clay was directly correlated with *P. aztecus* in Cruises I and II, but inversely correlated in Cruise III. Smectite was directly correlated with this species in Cruise II, but inversely correlated in Cruise III. Chitin degradation, chromium, lead, and zinc were inversely correlated with *P. aztecus* during Cruise I; all except chromium were directly correlated in Cruise II, and chromium and zinc were inversely correlated during Cruise III.

Distance from shore and depth were inversely correlated and copper and nickel directly correlated with *P. setiferus* during Cruises I and III. Cadmium was directly correlated with this species during all three cruises, and salinity and chitin degradation were inversely correlated in Cruises I and II.

3. Correlations with Taxa Groups Delimited in Cluster Analysis

Tables 60, 76, and 101 above present the associations between meiofauna, macroinfauna, and macroepifauna and demersal fish Taxa Groups (delimited in Cluster Analysis above) over all cruises and the respective site preferences. In general, most of the taxa in these associated Taxa Groups tended to group together over all cruises and to prefer the same environment as exemplified by certain site preferences. Therefore, it has been assumed that the response of these related Taxa Groups to the various abiotic variables should be similar. Again, consistency of a correlation over more than one cruise was assumed to imply credibility of the correlation.

a. Meiofauna

Tables 121, 122, and 123 present the significant correlations between the meiofauna Taxa Groups (from cluster analysis) and selected abiotic variables. Taxa Group Association No. 1 (see Table 60 above) was inversely correlated with depth and salinity in Cruises I and III and inversely correlated with distance from shore during all three cruises. Thus, as distance from shore, depth, and salinity decreased, the density of members of Taxa Group Association No. 1 increased. Note that no significant correlations were calculated for Cruise I Taxa Group 1A.

Taxa Group Association No. 2 (see Table 60) was directly correlated with distance from shore, depth, and D.O. in Cruises I and III. During Cruises I and II, the number of individuals of the Taxa Group Association No. 2 decreased under hypoxic bottom conditions. Temperature was inversely correlated during Cruises I and II, but directly correlated in Cruise III. Percent sand was inversely correlated with Taxa Group Association No. 2 in Cruise I but directly correlated in Cruise III. The reverse was true for percent silt. Counts of marine agar bacteria were inversely correlated during Cruise II, but directly correlated in Cruise III. Note that no significant correlations were calculated for Cruise I Taxa Group 3 and few abiotic variables were significantly correlated with Cruise II Taxa Groups 1, 2, and 4. As distance from shore, depth, and D.O. increased and temperature decreased, the density of Taxa Group Association No. 2 increased. Hypoxic bottom conditions tended to decrease density.

Taxa Group Association No. 3 (see Table 60) was inversely correlated with distance from shore, depth, and salinity during Cruises I and III. Temperature was directly correlated in Cruise I but inversely correlated in Cruise III. The reverse was true for marine agar counts. As distance from shore, depth, and salinity decreased, the density of Taxa Group Association No. 3 increased.

b. Macroinfauna

Tables 124, 125, and 126 present the significant correlations between the macroinfauna Taxa Groups (from cluster analysis) and selected abiotic variables. Table 76 above presents the associations between Taxa Groups and site preferences.

Taxa Group Association No. 1 was inversely correlated with distance from shore, depth, and salinity over all three cruises and inversely correlated with the presence of hypoxic bottom conditions for Cruises I and II. Temperature was directly correlated with Taxa Group Association No. 1 during Cruises I and II but inversely correlated during Cruise III. Therefore, as distance from shore, depth, and salinity decreased and

TABLE 121. Significant correlation coefficients between Cruise I meiofauna taxa groups and selected physical and chemical variables.

	Taxa												
Variable[1]	1	1A	1B	1C	2	3	3A	3B	4	5	6	7	8
DSHORE			-0.71•••	0.56•••				0.67•••		-0.41••		-0.77•••	
DMISS				0.43••	-0.52•••		0.46••	0.63•••	-0.42•				
BDEAD			-0.62•••	0.52•••				0.62•••	-0.43••			-0.74•••	0.56•••
DEPTH			-0.65•••	0.52•••				0.61•••				-0.88•••	0.55•••
SALIN			-0.59•••					0.48••			0.56•••	-0.84•••	
TEMP			0.67•••	-0.57•••				-0.63•••			0.44••	0.87•••	-0.43••
DO				0.45••	-0.64•••								
SAND				-0.41•							0.56•••		-0.67•••
SILT				0.54•••				0.42••			-0.65•••		-0.56•••
CLAY												0.52•••	-0.53•••
SMECT												0.42•	-0.52•••
MEDIAN											-0.51•		-0.66•••
STD			0.52•••									0.60•••	
SKEW											0.57•••		
TOC											-0.44••		-0.62•••
ETHANE			-0.83••										
PROPANE			-0.84••										
CI			-0.85••										
LT1											-0.60•••		
LT2											-0.56•••		
CP1A					0.41•								
CP1C					0.42•								
LOA													0.40•
LMA												-0.72•••	
LSO4							-0.48•	-0.58••					
LCHI					0.69•••				0.45•	0.62••	-0.50•		
LHET			0.56•		0.52•								
LPRO				-0.74•••				-0.63••				0.61••	
LSOX							0.46•						
LCD			0.44••					-0.43••				0.55•••	-0.55•••
LCR											-0.71•••		-0.44••
LCU													-0.77•••
LFE											-0.49•••		
LNI													-0.71•••
LPB			-0.43••	0.53•••				0.45••		-0.41•	-0.74•••		-0.49••
LZN					0.52•••						-0.57•••		-0.63•••

[1] See Table 102 for explanation of the variable code.
•Denotes level of significance ≤ 0.05.
••Denotes level of significance ≤ 0.01.
•••Denotes level of significance ≤ 0.001.

TABLE 122. Significant correlation coefficients between Cruise II meoifauna taxa groups and selected physical and chemical variables.

	Taxa Groups				
Variable[1]	1	2	3	4	5
DSHORE	-0.42***				
BDEAD				0.45***	
TEMP				-0.50***	
SMECT		-0.48**			
ETHANE					0.50**
PROPANE					0.42*
CI					0.54**
LMA		-0.46**			
LCHI	0.55*	0.73***	0.58**	0.73***	
LCR	-0.45*	-0.47**			

[1] See Table 102 for explanation of the variable code.
*Denotes level of significance ≤ 0.05.
**Denotes level of significance ≤ 0.01.
***Denotes level of significance ≤ 0.001.

TABLE 123. Significant correlation coefficients between Cruise III meiofauna taxa groups and selected physical and chemical variables.

	Taxa Groups						
Variable[1]	1	1A	1C	2	2A	3	4
DSHORE		-0.72***	0.65***		-0.65***	0.50**	-0.65***
DMISS		-0.49**					
DEPTH		-0.76***	0.68***		-0.66***	0.46**	-0.68***
SALIN		-0.54***	0.58***	-0.51***	-0.60***		-0.79***
TEMP			0.57***		-0.45**		-0.69***
DO		-0.56***	0.46**		-0.49**	0.41*	-0.49**
SAND	0.47**			0.75***			
SILT	-0.48**			-0.74***		-0.50**	-0.44**
CLAY			-0.52***	-0.46**		-0.50**	
STD	-0.47**			-0.75***		-0.51***	
TOC	-0.58***	-0.40*		-0.78***	-0.43**		-0.58***
LT2				-0.47**			
CP1A				-0.47**			
LMA	0.56**	0.60**		0.52*	0.58**		0.58**
LSO4					-0.60*		
LHET			-0.61**			-0.64**	

[1] See Table 102 for explanation of the variable code.
*Denotes level of significance ≤ 0.05.
**Denotes level of significance ≤ 0.01.
***Denotes level of significance ≤ 0.001.

TABLE 124. Significant correlation coefficients between Cruise I macroinfauna taxa groups and selected physical and chemical variables.

	Taxa Groups				
Variable[1]	1	2	3	4	5
DSHORE	-0.74***	-0.78***	-0.62***		0.67***
DMISS	-0.43**				0.62***
BDEAD	-0.76***	-0.56***	-0.41*		0.60***
DEPTH	-0.81***	-0.70***	-0.62***		0.58***
SALIN	-0.64***	-0.82***	-0.85***		0.43***
TEMP	0.76***	0.79***	0.74***		-0.60***
DO					0.40*
SAND		0.46***		0.90***	-0.52***
SILT		-0.60***	-0.44***	-0.90***	0.63***
MEDIAN		-0.42*		-0.84***	0.47**
STD	0.57***	0.45**			
SKEW		0.42*		0.49**	-0.45*
TOC		-0.45**		-0.84***	0.42**
ETHANE	-0.80*				
PROPANE	-0.82*				
CI	-0.72*				
LT1		-0.55***	-0.55***	-0.50**	
LT2			-0.51***	-0.53***	
LMA		-0.48*			
LSO4	0.51*		0.47*		-0.47*
LCHI			-0.60**	-0.64**	
LPRO	0.65**	0.47*			-0.72***
LSOX				0.50*	
LCD					-0.44**
LCR		-0.64***	-0.50**	-0.75***	
LCU				-0.68***	
LFE				-0.54***	
LNI				-0.59***	
LPB		-0.70***	-0.54***	-0.80***	0.70***
LZN		-0.44**	-0.43**	-0.82***	

[1] See Table 102 for explanation of the variable code.
*Denotes level of significance ≤ 0.05.
**Denotes level of significance ≤ 0.01.
***Denotes level of significance ≤ 0.001.

TABLE 125. Significant correlation coefficients between Cruise II macroinfauna taxa groups and selected physical and chemical variables.

	Taxa Groups						
Variable[1]	1A	1B	2	3	4	5	6
DSHORE	-0.63***	0.46***					
DMISS							0.55***
BDEAD	-0.53***	0.45***					0.40***
DEPTH	-0.67***						
SALIN	-0.59***						
TEMP	0.69***	-0.51***					
SAND			0.57***			0.52***	
SILT			-0.51***			-0.49***	
SMECT	-0.43*						
MEDIAN			-0.59***				
TOC			-0.57***			-0.52***	
CP1A					0.56***		
CP1B					0.79***		
LMA		-0.42**			-0.44**		
LCHI	-0.50*	0.84***	0.63**	0.44*	0.65*		
LHET						-0.57**	
LCD						-0.42*	-0.41*
LCR	-0.64***		-0.57***			-0.56***	
LCU					-0.48***	-0.58***	-0.45**
LFE	-0.44*		-0.52**			-0.73***	
LNI						-0.65***	
LPB	-0.48**						
LZN						-0.47**	

[1] See Table 102 for explanation of the variable code.
*Denotes level of significance ≤ 0.05.
**Denotes level of significance ≤ 0.01.
***Denotes level of significance ≤ 0.001.

TABLE 126. Significant correlation coefficients between Cruise III macroinfauna taxa groups and selected physical and chemical variables.

	Taxa Groups						
Variable[1]	1	1A	1B	2	3	4	5
DSHORE	-0.78***	-0.78***	-0.69***	-0.64***	-0.59***		0.41*
DEPTH	-0.82***	-0.82***	-0.69***	-0.63***	-0.54***		0.43**
SALIN	-0.79***	-0.77***	-0.85***	-0.88***	-0.78***		
TEMP	-0.65***	-0.63***	-0.76***	-0.83***	-0.76***		
DO	-0.63***	-0.63***	-0.56***	-0.48**	-0.43**		
SAND						-0.56***	0.80***
SILT	-0.46**	-0.43**	-0.48**			0.53***	-0.74***
CLAY				0.46**			-0.62***
STD						0.53***	-0.75***
SKEW				0.42*			
TOC	0.54***	-0.51***	-0.61***	-0.42**			-0.59***
LT2							-0.54***
LOA							-0.57**
LMA	0.54*	0.53*	0.52*	0.49*			
LSO4	-0.49*		-0.55*	-0.49*			
LHET						0.46*	-0.85***
LPRO				-0.45*			

[1] See Table 102 for explanation of the variable code.
*Denotes level of significance ≤ 0.05.
**Denotes level of significance ≤ 0.01.
***Denotes level of significance ≤ 0.001.

hypoxic bottom conditions increased, density of Taxa Group Association No. 1 increased.

Distance from shore, depth, and salinity were inversely correlated with Taxa Group Association No. 2 during Cruises I and III. Temperature was directly correlated during Cruise I and inversely correlated during Cruise III. No Taxa Group indicated in Cruise II was similar to Taxa Group Association No. 2 (see Table 76). As distance from shore, depth, and salinity decreased, the number of individuals of Taxa Group Association No. 2 increased.

Taxa Group Association No. 3 was directly correlated with sand and inversely correlated with silt and TOC during all three cruises. Chromium and iron were inversely correlated in Cruises I and II and chitin degradation was inversely correlated in Cruise I but directly correlated in Cruise II. Thus, as percent sand increased and percent silt, TOC, chromium, and iron decreased, the density of Taxa Group Association No. 3 increased.

Distance from shore and presence of hypoxic bottom conditions were directly correlated and temperature was inversely correlated with Taxa Group Association No. 4 during Cruises I and II. Percent sand was inversely correlated while percent silt was directly correlated in Cruises I and III. As distance from shore and percent silt increased and temperature, percent sand, and hypoxic bottom conditions decreased, the density of Taxa Group Association No. 4 increased.

c. Macroepifauna and Demersal Fish

Tables 127, 128, and 129 present the significant correlations between the macroepifauna and demersal fish Taxa Groups (from cluster analysis) and selected abiotic variables. Table 101 above presents the association between Taxa Groups and site preference. There were few significant correlations between the macroepifauna and demersal fish Taxa Groups and the abiotic variables.

Distance from shore and depth were directly correlated with Taxa Group Association No. 1 during all three cruises. Presence of hypoxic bottom conditions was directly correlated during Cruises I and II. Therefore, as distance from shore and depth increased and presence of hypoxic bottom conditions decreased, the density of Taxa Group Association No. 1 increased.

There were few significant correlations and no consistent correlations over more than one cruise for any of the Taxa Groups composing Taxa Group Association No. 2.

TABLE 127. Significant correlation coefficients between Cruise I macroepifauna and demersal fish taxa groups and selected physical and chemical variables.

	Taxa Groups			
Variable[1]	1	2	3	4
DSHORE	0.82*		-0.81*	
BDEAD	0.84**			
DEPTH	0.78*			
SALIN			-0.71*	
CLAY				0.76*
SMECT				0.80*
STD	0.74*			
SKEW		-0.80*		
PROPANE	0.72*			
LT2		0.77*		
CP1A		-0.79*		
LSO4			0.72*	
LPRO		-0.77*		
LCD				0.78*
LZN				0.81*

[1] See Table 102 for explanation of the variable code.

*Denotes level of significance ≤ 0.05.

**Denotes level of significance ≤ 0.01.

***Denotes level of significance ≤ 0.001.

TABLE 128. **Significant correlation coefficients between Cruise II macroepifauna and demersal fish taxa groups and selected physical and chemical variables.**

	Taxa Groups							
Variable[1]	1	2	3	4	5	6	7	8
DSHORE	0.54**	0.62***			0.54**	0.78***		
DMISS						0.46*	0.64***	
BDEAD	0.66***	0.66***	0.48*		0.48*			
DEPTH	0.54**	0.87***	0.49*		0.91***	0.66***		-0.42*
SALIN		0.44*	0.46*					-0.61**
TEMP	-0.69***	-0.82***	-0.62***		-0.20***	-0.61***		
SAND	-0.47*	-0.55**						
SILT		0.45*					0.41*	
CLAY			0.44*					
SMECT	0.52*		0.54*					
MEDIAN	0.51*	0.62***	0.44*		0.43*			
TOC		0.46*	0.42*		0.41*			
PROPANE							0.49*	
LTI	0.57*		0.47*					
LCHI	0.78*							
LCR	0.68**	0.66**	0.70**		0.57*	0.50*		
LPB	0.56*	0.70**			0.65**	0.85***		
LZN	0.51*	0.75***	0.53*		0.69**	0.62**		

[1] See Table 102 for explanation of the variable code.
*Denotes level of significance ≤ 0.05.
**Denotes level of significance ≤ 0.01.
***Denotes level of significance ≤ 0.001.

TABLE 129. **Significant correlation coefficients between Cruise III macroepifauna and demersal fish taxa groups and selected physical and chemical variables.**

	Taxa Groups			
Variable[1]	1	2	3	4
DSHORE	0.77*			
DEPTH	0.72*	0.76*		
TEMP				-0.76*
SKEW	-0.76*			
LOA	-0.86**			
LSO4			0.82*	
LCHI			0.72*	

[1] See Table 102 for explanation of the variable code.
*Denotes level of significance ≤ 0.05.
**Denotes level of significance ≤ 0.01.
***Denotes level of significance ≤ 0.001.

IV. DISCUSSION

A. Factors Affecting Population Estimates

1. Sieving

Only recently has the mesh size used to wash benthic samples been considered important (Reish, 1959; Driscoll, 1964; de Bovee, Soyer, and Alber, 1974). For macroinfauna, some studies have used a screen mesh opening as large as 2.2 mm and as small as 0.2 mm. For meiofauna, mesh sizes of 37 to 100μ have been used (de Bovee et al., 1974). As the size of the mesh opening increases the number of organisms decreases, and vice versa. As more organisms are retained, more time is involved in processing the sample, with a resultant increase in cost. Reish (1959), Driscoll (1964), and de Bovee et al. (1974) recommended various screen sizes depending upon the requirements of the study.

Reish (1959), who considered mainly the macroinfauna and the larger meiofauna, found that with a screen mesh size of 1.4 mm, 92% of the biomass was collected. The percentage increased as mesh size decreased. With a screen mesh of 0.50 mm, 68.8% of the number of individuals were collected and with a mesh of 0.27 mm, 92% of the number of individuals were retained. Driscoll (1964) reported that 98% of the organisms that were larger than a mesh of 0.25 mm were retained. De Bovee et al. (1974) found that over 90% of the meiofauna was retained by the 63-, 80-, and 100-μ screens and recommended the routine use of the 63-μ mesh for a quantitative survey of both numbers and biomass. Furthermore, 100% of all taxa except Nematoda and Kinorhyncha were collected on the 63-μ screen.

Requirements of this study dictated a quantitative determination of the benthic infaunal populations. For meiofauna, the size range was 0.062 to 0.500 mm. Two U.S.A. Standard Testing Sieves made by Neward Wire Cloth Co., No. 230 (0.062 mm) and No. 35 (0.500 mm) were used. For macroinfauna, a U.S.A. Standard Testing Sieve made by Fisher Scientific Co., No. 35 (0.50 mm - Tyler Equivalent No. 32), was utilized. Therefore, based primarily upon the work of Reish (1959), we may assume that 93% of the species, but only about 70% of the number of individuals, were retained for macroinfauna using a screen mesh size of 0.5 mm (No. 35). Based primarily upon the work of de Bovee et al. (1974), 90% of the number of individuals and 100% of the number of species, except Nematoda and Kinorhyncha, were collected for meiofauna analysis.

2. Depth of Faunal Penetration and Sediment Texture Characteristics

Swedmark (1964), Jansson (1971), and McIntyre (1969, 1971) provide excellent discussions of the parameters affecting depth of faunal penetration. Subtidally, both the meiofauna and macroinfauna tend to concentrate at the surface in response to higher oxygen concentrations and greater food availability (McIntyre, 1969). However, both groups may be found at varying depths within the sediment in response to these and other variables.

Sediments with a large percentage of sand tend to be more porous and allow for deeper penetration by the overlying water column. Porosity depends not only on grain size but also on sorting of the particles (Jansson, 1971). Thus, in high energy areas, the interstitial water, even at depth, may be highly oxygenated, have a high salinity, and in general, closely resemble the overlying water column (Christie, 1975).

As the energy level decreases and the grain size decreases and/or sorting increases, thus reducing available pore space, there is a decrease in penetration by the overlying water (Christie, 1975). Therefore, in deep water silty sediments, the properties of the interstitial water rapidly change with depth in the sediment from those of the overlying water. That is, the dissolved oxygen rapidly decreases with depth and anaerobic conditions may occur only a few centimeters below the surface (Reise and Ax, 1979). Different intensities of water content, water circulation, and oxygen content caused by grain size distribution appear to be more important than the space-restricting property of finer sediments (Fenchel, Jansson, and von Thun, 1967; Jannson, 1967; Christie, 1975; McLachlan, 1978).

Wieser (1959) reported that a grain size of 200μ represented a barrier for most meiofauna, except nematodes, and that 120μ may eliminate nematodes. Ward (1975) found nematodes in sediments of 102-μ median grain size, while Martinez (1975) found nematodes as a group to be most abundant where median grain size was between 360 and 380μ. Hulings and Gray (1976) state that interstitial fauna can be found in intertidal sands with a median grain size of 125 to 500μ. McLachlan, Winter, and Botha (1977) report that McIntyre and Murison (1973) set the lower limit of interstitial fauna at 125μ and suggested an optimum grain size of 230μ.

Depth of burrowing appears to be related to morphology (McLachlan et al., 1977) and Swedmark (1964) provided a good discussion of morphological variation and mode of locomotion of the meiofauna. Sliders appear to function well down to a 200-μ grain size, but only burrowers, e.g., nematodes, can penetrate the finer sediments.

In subtidal sediments, most of the meiofauna is concentrated in the upper 2 cm, but the greatest concentration may extend down to 5 cm in muds and down to 10 cm in sands (Mare, 1941; McIntyre, 1961, 1969, 1971; Buzas, 1965; Fenchel and Jansson, 1966; Tietjen, 1969, 1971; Schafer, 1971; Coull et al., 1977; Hogue, 1978; Yingst, 1978). Usually only the Foraminifera and Nematoda extend deeper than 10 cm, with the Nematoda extending deeper than the Foraminifera (Tietjen, 1969; Schafer, 1971; Coull et al., 1977; Yingst, 1978). Deeper penetration by the nematodes appears to be related to their ability to exist anaerobically for long periods (Fenchel and Riedl, 1970; McLachlan et al., 1977; Reise and Ax, 1979).

In sandier sediments, meiofauna penetration has been reported to extend as deep as 35 to 50 cm (Fenchel et al., 1967; McIntyre, 1971; McLachlan et al., 1977). Oxygen availability appears to be the critical factor allowing for this deep penetration (McLachlan et al., 1977).

Little has been reported on the depth of penetration by the macroinfauna, although the same limiting factors discussed above for the meiofauna certainly affect the depth of penetration by the macroinfauna. The macroinfauna will also be concentrated in the upper 2 to 5 cm, but some Anthozoa, Polychaeta, Bivalvia, Decapoda (Crustacea), and Echiurida may extend to depths greater than 5 cm (Virnstein, 1979). Christie (1975) found 25% of the species and almost 60% of the specimens in sandy sediments below 10 cm.

Harper (1973) found that in San Antonio Bay, Texas, most of the macroinfauna (washed over a screen size of 0.25 mm) were found in the upper 5 cm of sediment. Baker et al. (1977) observed a similar phenomenon in Trinity Bay, Texas, with the exception of two deeper burrowing species. Rosenberg (1974) found that for macroinfauna (washed over a 1-mm mesh screen) collected from a silt-clay estuarine locality in Sweden, 64% of the individuals and 74% of the biomass were found in the upper 5 cm. From his data, it is evident that 90 to 95% of the fauna occurred in the upper 10 cm.

In this study, no cores of great length were taken specifically to ascertain the depth of organism penetration. However, at each Primary Platform N500 Station and Control Site during Cruise I, downcore sediments of up to 1 m in length and 5 cm in diameter were collected with a Kahlsico No. 217WA260 toggle-clamp, wide barrel piston corer; these were to be used in Lead-210 dating and subsequent trace metal and hydrocarbon analyses. These downcores were obtained with considerable difficulty and therefore extra cores were not collected. However, not all of each downcore obtained was used for the intended chemical analyses, and as a result, half cores (split down the middle), were available. Station P3 N500, predominantly sand (79.3%), and P4 N500, predominantly silt (80.4%), represented two extremes. Only one half core from each station was available, thus precluding any statistical analysis.

The same washing procedure that was used to process the regular meiofauna cores was used to process the sections of the downcore. This procedure separated any macroinfauna (No. 35 mesh screen) from meiofauna. However, after the downcore sections were washed, no live organisms were found on the No. 35 mesh screen (0.5 mm). Thus, depth of penetration was ascertained for the meiofauna but not the macroinfauna.

The core from P3 was moist and relatively undisturbed and the original sediment surface was still intact. As expected in sediments that are predominantly sand, more organisms were concentrated near the surface (Table 130). Over 80% of the meiofauna was found in the upper 2 cm, and over 90% in 5 cm, which was the depth of cores collected in this study. Nematoda, with over 91% of the individuals in the top 6 cm, indicated the greatest depth of penetration. The Polychaeta and Copepoda individuals found at depth were most likely contamination from handling.

The P4 core was dry and disturbed, and there was some doubt as to the sediment surface still being intact. Because of the condition of the downcore at the time of receipt, the results are difficult to interpret (Table 131). Only Nematoda were found. Twenty-four of twenty-eight individuals were in the upper 2 cm; the others were found at the 11- to 12- cm depth. Generally fewer organisms are found in silts and there is reduced depth penetration; this, and the fact that the P4 downcore was received dry, were factors affecting the taxa found. Nematoda are very hardy (see above discussion) and of the taxa found in the P3 sand core, they would probably be expected to be the only organisms found in the P4 silt core.

Thus, although only one core from each sediment type was analyzed, it would appear that the coring device used in this study generally collected over 90% of the meiofauna population. No macroinfauna were available for this analysis. However, based upon average depth of penetration of the Smith-McIntyre grab (8 to 12 cm in sand and 12 to 16 cm in silt) and the expected values as reported by the literature, about 85 to 90% of the macroinfauna population was collected.

TABLE 130. Depth of meiofauna penetration in sand (from P3 N500, Down Core No. 1).

	Number of Individuals per 8.04 cm^2 Sample															
	Depth from Surface (cm)															
Taxa	2	4	6	8	10	12	14	16	18	20	22	24	26	28	Total	%
Foraminifera	84														84	34.1
Protozoa		2													2	0.8
Turbellaria		2													2	0.8
Nematoda	106	22	4		2		6	4							144	58.5
Polychaeta	6											2			8	3.3
Copepoda	4						2								6	2.4
Totals	200	26	4	0	2	0	8	4	0	0	0	2	0	0	246	100%
Cumulative Percent	81.3	91.8	93.5	93.5	94.3	94.3	97.6	99.2	99.2	99.2	99.2	100	100	100	100	

TABLE 131. Depth of meiofauna penetration in silt (from P4 N500, Down Core No. 1).

	Number of Individuals per 8.04 cm^2 Sample									
	Depth from Surface (cm)									
Taxa	2	4	6	8	10	12	14	16	Total	%
Nematoda	24					4			28	100
Totals	24	0	0	0	0	4	0	0	28	100
Cumulative Percent	85.7	85.7	85.7	85.7	85.7	100	100	100	100	

3. *Sample Representativeness*

Many different factors can contribute to sample variability. Samples collected at the same station may be significantly different from each other and thus not provide an accurate subsample of the population. To detect and possibly identify sampling error or differences due to natural causes, it is necessary to test for variability within samples from a station and between stations, and to estimate representativeness of samples collected.

a. *Sample Replication*

The number of samples needed to adequately represent the number of species and individuals in a population is important in any ecological study. Generally the population structure at any locality is composed of a small number of very abundant species and a much larger number of increasingly rare species (Longhurst, 1959). Each replicate will add to the species list and total number of individuals, up to an optimum level (Gray, 1971). Above this optimum, additional replicates provide little added information. More samples must be taken with small samplers and more samples must be taken at low density in order to obtain the same level of precision (Downing, 1979). Cost of both collection of additional replicates and subsequent processing must also enter into the choice of replicate number (Longhurst, 1959; Baker et al., 1977; Vanderhorst et al., 1978).

Rarefaction, a useful statistical technique, can be used to infer whether samples are drawn from the same community and also to estimate "minimum feasible sample size" (Gaufin, Harris, and Walter, 1956; Simberloff, 1978). The latter use can be applied to determine the number of replicates necessary to collect a certain percentage of the number of species and number of individuals present in the studied population. Rarefaction assumes that there is a random spatial dispersion of individuals, but most organisms tend to be clumped. The more clumped the populations in a community are, the more rarefaction overestimates the number of species expected in a sample collected in nature (Simberloff, 1978). In general, the larger the sample sizes to be compared by rarefaction, the less likely it is that results are affected by underdispersion. A large sample is effectively stratified in that it tends to collect from several clumps instead of just one or two (Simberloff, 1978).

In this study, a modification of the rarefaction technique was used to determine what percentage of species and individuals were collected in a predetermined number of replicates. Figures 31, 32, and 33 are the resultant curves of the average cumulative number of species and number of individuals for all stations collected in four cores for meiofauna during Cruises I, II, and III, respectively. If the curve in Fig. 31 is extended to reach a projected asymptote similar to that illustrated by Simberloff (1978), then four cores collected approximately 93% of the number of species in the area. For the first four cores, the mean number of individuals increased by about the same number of individuals with the addition of each core. Theoretically, the number of individuals decreases as more cores are collected and fewer species are added. Therefore, using the above imagined point for 93% of the number of species, four cores collected only about 60% of the number of

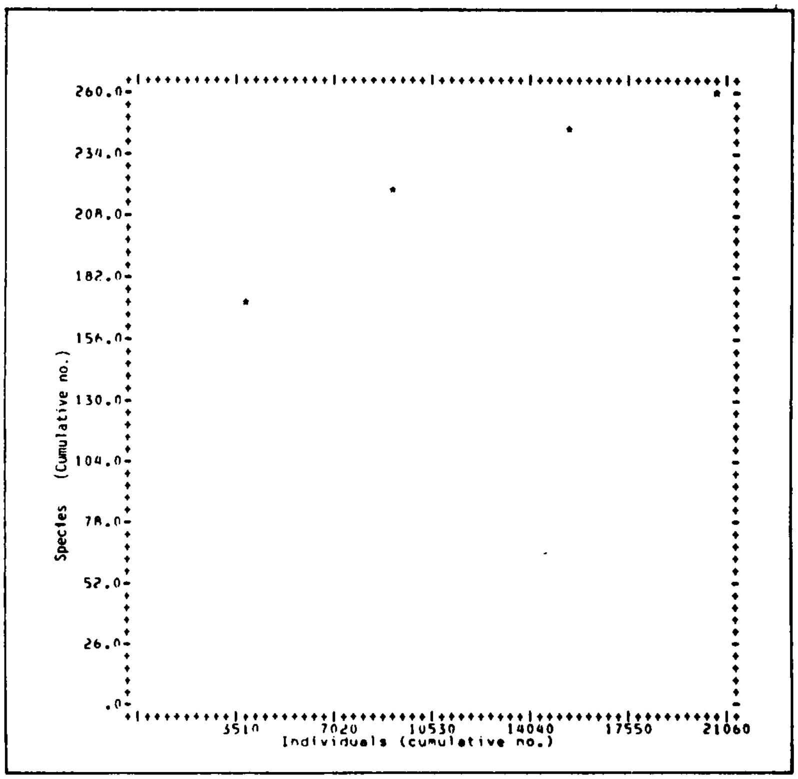

FIG. 31. Average cumulative number of species and number of individuals for all stations collected in four cores for meiofauna during Cruise I

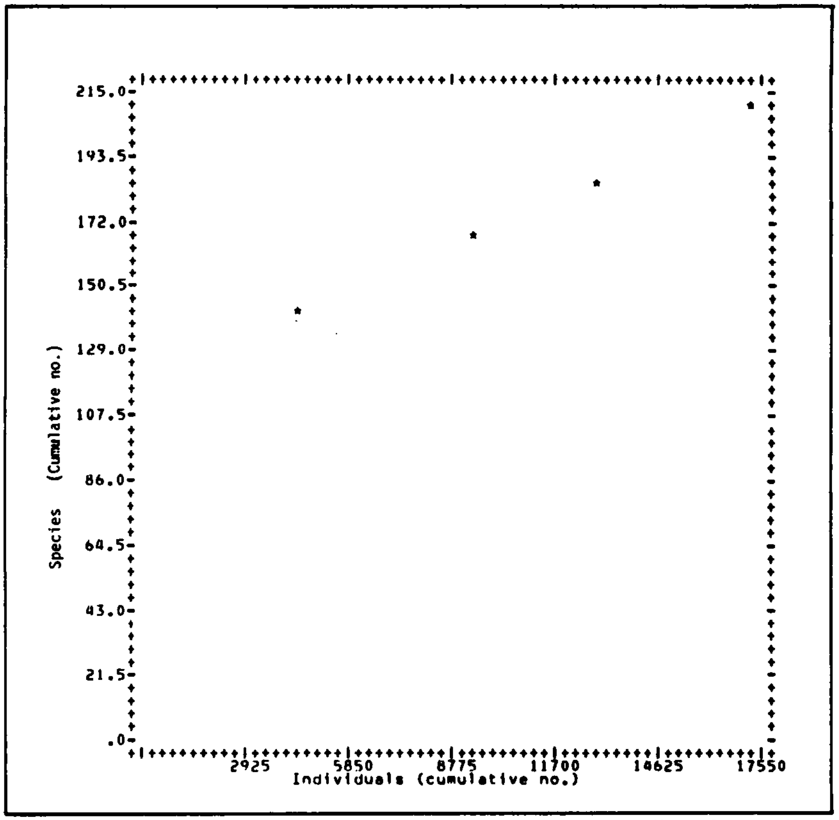

FIG. 32. Average cumulative number of species and number of individuals for all stations collected in four cores for meiofauna during Cruise II

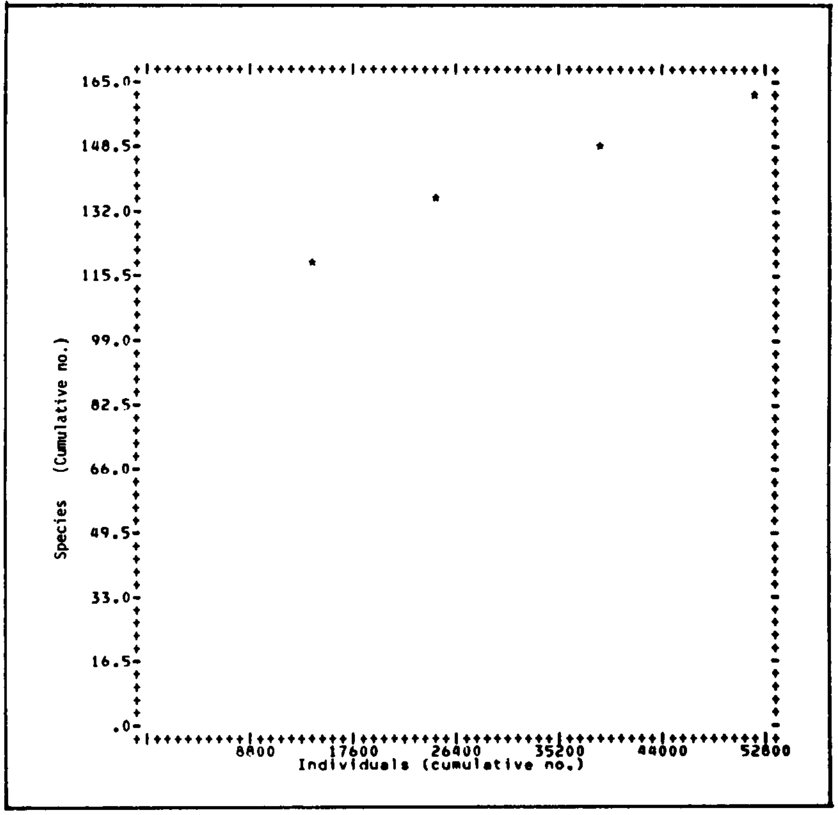

FIG. 33. Average cumulative number of species and number of individuals for all stations collected in four cores for meiofauna during Cruise III

individuals during Cruise I. This latter value is probably conservative. Gray (1971) found that four cores per 0.25 m^2 gave a reasonably accurate estimate of the meiofauna density for one area of a sandy beach, but that eight samples per 0.25 m^2 gave the greatest precision.

Based on the same assumptions, about 85% of the number of species and approximately 48% of the number of individuals were collected by four cores for meiofauna during Cruise III (Fig. 33). Thus, 85 to 93% of the number of species and 48 to 60% of the number of individuals were collected for meiofauna by four cores.

Figures 34, 35, and 36 present similar curves for macroinfauna for Cruises I, II, and III, respectively. Based on the same assumptions as for meiofauna, 81% of the species and 38% of the individuals were collected by six grabs for macroinfauna during Cruise I (Fig. 34). About 96% of the species and 62% of the individuals were collected during Cruise II (Fig. 35) and 89% of the species and 47% of the individuals were collected during Cruise III (Fig. 36). Therefore, 81 to 96% of the number of species and 38 to 62% of the number of individuals were collected for macroinfauna by six grabs.

b. Dispersion

Most benthic organisms, both meiofauna and macroinfauna, tend to not be randomly distributed, but may demonstrate a clumped (patchy or contagious) or a repulsed (uniform, regular, or infradispersed) distribution (Sokal and Rohlf, 1969; Gertz, 1978). Typically, contagion is in response to physical and biological parameters, often at a microenvironmental level. Physical parameters may include median particle size, sediment sorting, amount of dissolved oxygen, salinity, and/or sediment temperature (Fenchel et al., 1967; McIntyre, 1969). Other parameters, often not measured, may include pore water content, pore size, bottom current velocity, rate of sediment deposition, and rate of sediment resuspension. Patchiness also appears to be related to sediment disturbance caused by bioturbation and storm effects (McCall, 1978). Biological parameters which are not measured are available food source (Meadows and Anderson, 1966; Gerlach, 1977; Lee et al., 1977; McLachlan et al., 1977; Lopez and Levinton, 1978; Coull, 1979; Tietjen, 1980*b*), predation and competition (Woodin, 1974; Hogue, 1978; Roughgarden, 1978; Bernstein and Meador, 1979), amensalism or commensalism (Gray and Johnson, 1970; Rhoades and Young, 1970), and reproduction of non-planktonic young (Olsson and Eriksson, 1974; Lee et al., 1977). Meiofauna are also known to clump in response to structural heterogeneities within the sediments, e.g., plant culms, crab burrows, root biomass, polychaete tubes, and amphipod tubes (Lee et al., 1977; Aller and Yingst, 1978; Bell, Watzin, and Coull, 1978; Reise and Ax, 1979). This response to burrowing structures may be correlated with changes in physical parameters such as increased D.O. and biological parameters such as increased food supply or stabilization of the sediments by polychaete, amphipod, or phoronid tubes (Rhoads, 1974; Ronan, 1978; Biernbaum, 1979; Virnstein, 1979). Stabilization minimizes sediment resuspension and subsequent disturbance of the sediment

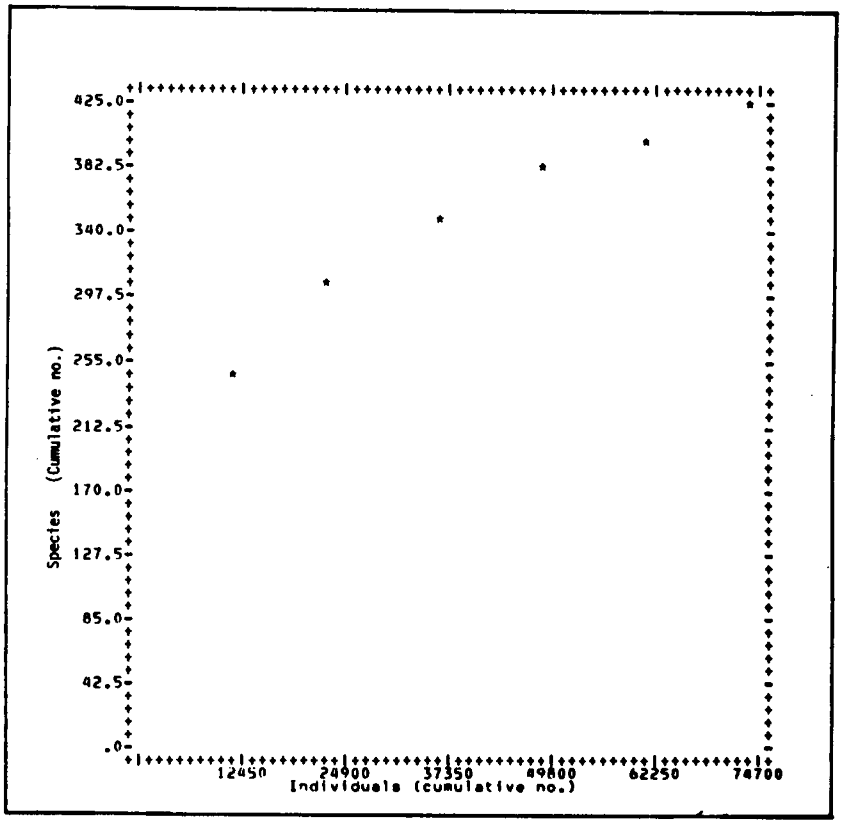

Fig. 34. Average cumulative number of species and number of individuals for all stations collected in six grabs for macroinfauna during Cruise I

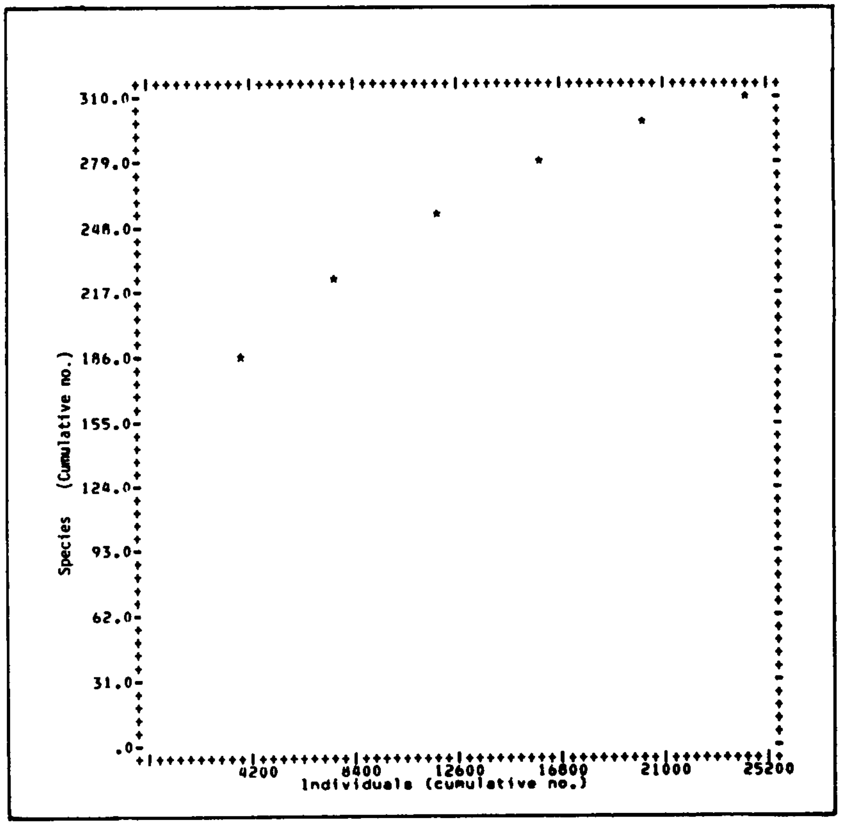

FIG. 35. Average cumulative number of species and number of individuals for all stations collected in six grabs for macroinfauna during Cruise II

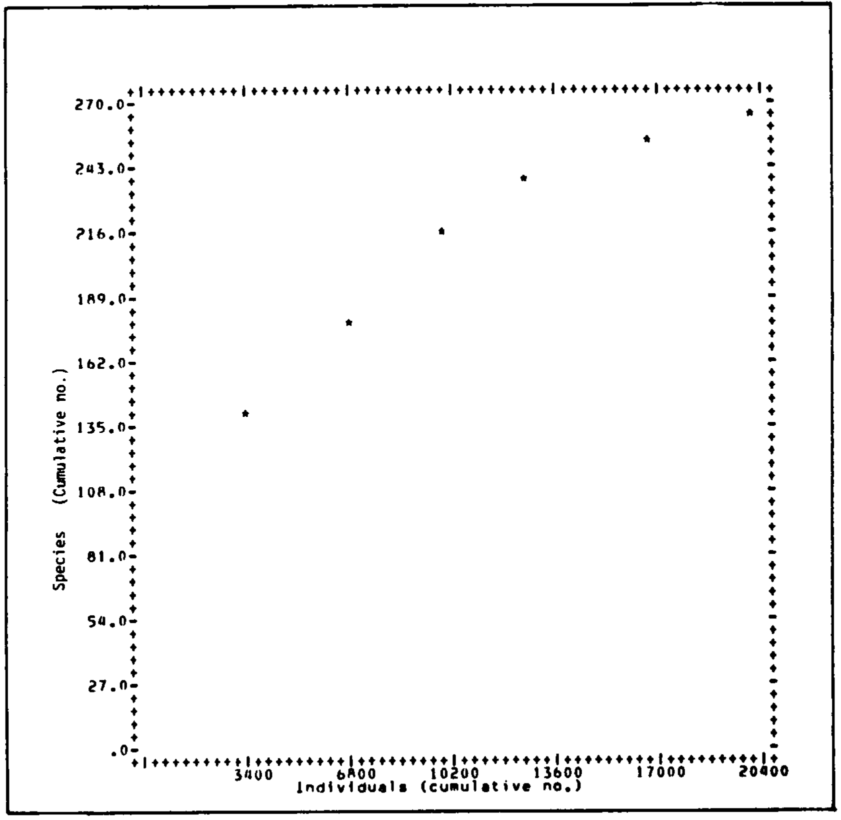

FIG. 36. Average cumulative number of species and number of individuals for all stations collected in six grabs for macroinfauna during Cruise III

and associated organisms. Each of the physical and biological parameters just discussed also have vertical dimension, some of which have been discussed in above sections. Contagion has been reported to extend vertically down into the sediment (Meadows and Anderson, 1968), and Hogue (1978) reports vertical segregation of gastrotrich species.

Small-scale gregariousness in benthic infaunal populations has been suggested, but the scales of this gregariousness have not been well documented. Eckman (1979), based upon experiments with organism dispersion patterns, hypothesized *a posteriori* that organisms may be affected by locally varying hydrodynamic environments produced by bed ripples. Apparently, the resulting periodic dispersion pattern persists after ripples have disappeared. Therefore, scales of environmental heterogeneity relevant to an individual, from one to several centimeters, may be too small to detect by traditional methods. As a consequence, samples which are collected at arbitrary scales "homogenize spatial patterns that reflect smaller-scale interactions, responses and processes, and could seriously affect between-sample variability, thereby leading to spurious conclusions regarding the pattern and control of community structure" (Eckman, 1979).

The type of sampler used has little effect on the contagion of the benthos. However, the Smith-McIntyre grab may give rise to a higher degree of aggregation, possibly because of intermittent loss of some surface sediments from pressure wave effects (Downing, 1979). Although all sediments "hold animals aggregated to approximately the same extent", there is a tendency for the benthos to be less clumped in clays and more clumped in gravel (Downing, 1979).

Because most organisms are not randomly distributed, abundance data must be transformed before parametric statistical analysis can be performed (See section on Statistical Methods above). This tendency of organisms to clump will bias abundance data unless sufficient samples have been collected (Gray, 1971) (See section on Sample Replication above). In seasonal faunal studies, sampling methods may not collect clumped organisms which may be present, and the assumed faunal changes may not be real but due simply to shifts in patch size and distribution of the major species (Watling, Kinner, and Maurer, 1978). McIntyre (1969) states that for meiofauna, because of their small size and sensitivity to very slight physical changes, contagion is so important that the community concept is not as meaningful. Therefore, incorporation of meiofauna into existing community descriptions should be treated with caution. This will be discussed in more detail below (See section on Meiofauna, Cluster Analysis).

Many different indices have been proposed to compare the different patterns of dispersion in populations (Elliot, 1971). The best index of dispersion should possess the following attributes:

- "It should provide real and continuous values over the range from maximum regularity (equal numbers in each sampling unit), through randomness ($s^2 = \bar{x}$), to maximum contagion (all individuals are in one sampling unit).
- "It should not be influenced by variation in the size of the sampling unit (quadrat size), the number of sampling units (n), the sample mean ($\bar{x}$), and the total number in the sample (Σx).
- "It should be easy to calculate from large amounts of data.
- "It should enable differences between samples to be tested for significance."

There is no index of dispersion that fulfills these conditions, but the most commonly used index of dispersion for marine benthos is Morisita's I_δ (Holme, 1950; Gage and Geekie, 1973; Gerlach, 1977; Watling et al., 1978). Morisita's index of dispersion (Morisita, 1959) is a ratio of the observed probability of drawing two individuals randomly without replacement from the same (over q samples) sample, to the expected probability of the same event for individuals randomly dispersed over the samples (Hubbell, 1979). This index is independent of the sample mean and total numbers in the sample, but it is a strong function of the number of sampling units at both ends of its range (Elliot, 1971). Therefore, Morisita's index is a good comparative index of dispersion when each sample contains the same number of sampling units, as was the case in this study.

Morisita's index is influenced by sample size when the population dispersion pattern is regular or uniform. When the dispersion is contagious and individuals are randomly distributed in each clump, the index is fairly stable, but is less stable when the intra-clump distribution is uniform. The index is unity when individuals are randomly dispersed, regardless of quadrat size or mean density of individuals per square meter (Elliot, 1971; Hubbell, 1979). Values greater than one indicate clumping, and values less than one indicate uniformity. An F statistic can be computed to test for significant departure of the index from unity (randomness) (Hubbell, 1979).

To determine the dispersion patterns exhibited by the meiofauna and macroinfauna, Morisita's index of dispersion was calculated for the top 98 and 95%, respectively, of those taxa most frequently observed and abundant in each of the three cruises (see also Watling et al., 1978). Only the top ten species of each group are presented here.

Table 132 gives the percentage of times that one of the dominant meiofauna taxa demonstrated either a random or a contagious distribution. None of the taxa for which Morisita's index was calculated indicated a uniform distribution. It can be seen that 90% of the listed taxa demonstrated a clumped distribution at least 75% of the time. Exceptions were *Bolivina lowmani* (Foraminifera) in Cruise II and Choniolaimidae (Nematoda) in Cruises II and III. The latter taxon had only 75.8% contagious distribution during Cruise I. For *B. lowmani*, the distribution was 88.6% clumped during Cruise I and 91.6% clumped during Cruise III. Generally, each of the taxa showed a higher percentage of contagion during Cruise I than in either Cruise II or Cruise III. This tendency toward contagion by the top ten taxa was also demonstrated by the remaining top 95% of the meiofauna taxa. Gray (1971) stated that four core samples per 0.25 m² did not give a reliable estimate of the dispersion pattern of the meiofauna in one of two study areas on a sandy beach. Upwards of eight samples were necessary to encompass the variations in spatial distribution patterns in both study areas. Coull

TABLE 132. Distribution patterns of the top ten meiofauna taxa for each cruise based upon Morisita's index of dispersion (Iδ).

			Distribution Patterns				
			No. of Occurrences				
						Clumped	
Cruise	Taxa		Total	Uniform	Random	No.	%
I	*Sabatieria*	(N)[1]	36	0	1	35	97.2
	Bolivina lowmani	(F)	35	0	4	31	88.6
	Gromiidae	(Pr)	36	0	4	32	88.9
	Dorylaimopsis	(N)	36	0	1	35	97.2
	Cyatholaimidae	(N)	36	0	3	33	91.6
	Theristus	(N)	36	0	1	35	97.2
	Buliminella morgani	(F)	35	0	4	32	91.4
	Linhomoeidae	(N)	36	0	4	32	88.9
	Nonionella basiloba	(F)	36	0	1	35	97.2
	Choniolaimidae	(N)	33	0	8	25	75.8
II	*Sabatieria*	(N)	64	0	8	56	87.5
	Bolivina lowmani	(F)	63	0	20	43	68.3
	Gromiidae	(Pr)	64	0	16	48	75.0
	Dorylaimopsis	(N)	60	0	15	45	75.0
	Cyatholaimidae	(N)	61	0	9	52	85.2
	Theristus	(N)	61	0	13	48	78.7
	Buliminella morgani	(F)	61	0	8	53	86.9
	Linhomoeidae	(N)	61	0	13	48	78.7
	Nonionella basiloba	(F)	60	0	8	52	86.7
	Choniolaimidae	(N)	54	0	26	28	51.9
III	*Sabatieria*	(N)	35	0	4	31	88.6
	Bolivina lowmani	(F)	36	0	3	33	91.6
	Gromiidae	(Pr)	32	0	6	26	81.3
	Dorylaimopsis	(N)	36	0	8	28	77.8
	Cyatholaimidae	(N)	34	0	5	29	85.3
	Theristus	(N)	35	0	7	28	80.0
	Buliminella morgani	(F)	34	0	6	28	82.3
	Linhomoeidae	(N)	34	0	4	30	88.2
	Nonionella basiloba	(F)	31	0	3	28	90.3
	Choniolaimidae	(N)	32	0	16	16	50.0

[1] N denotes Nematoda   Pr denotes Rhizopoda, Protozoa
F denotes Foraminifera

(1979), in the Georgia Bight, found the meiofauna to be quite patchy, based on 175 values determined by Green's index; four of these values indicated a uniform distribution and none a random distribution.

Table 133 presents the percentage of times that one of the dominant macroinfauna taxa demonstrated either a random or a contagious distribution. None of the taxa for which Morisita's index was calculated indicated a uniform distribution. It can be seen that 80% of the listed taxa demonstrated a 75% or greater degree of random dispersion 60% of the time. All the taxa had a 25% or greater degree of random dispersion 96.7% of the time. Generally, each of the taxa in Table 133 showed a higher degree of randomness

TABLE 133. Distribution patterns of the top ten macroinfauna taxa for each cruise based upon Morisita's index of dispersion (Iδ).

		% Random		
Taxa		Cruise I	Cruise II	Cruise III
Paraprionospio pinnata	(P)[1]	8.3	50.0	74.3
Rhynchocoela		25.0	71.7	77.8
Sigambra tentaculata	(P)	91.7	77.6	87.1
Cossura delta	(P)	85.7	82.4	100.0
Magelona phyllisae	(P)	48.3	53.7	48.1
Nephtys incisa	(P)	87.9	76.6	96.2
Corbula contracta	(B)	50.0	54.5	83.3
Lumbrineris tenuis	(P)	96.8	91.3	92.9
Tharyx marioni	(P)	61.1	88.4	92.3
Nereis	(P)	66.7	82.9	87.5

[1] (P) denotes Polychaeta
(B) denotes Bivalvia

during Cruise III than in either Cruise I or Cruise II. The high degree of randomness shown by these top ten taxa was also demonstrated by the remaining top 95% of the macroinfauna taxa. Levinton (1977) found *Nephtys incisa* from Quisset Harbor, Massachusetts, to have a dispersion index of 1.12 and 1.26 at two channel stations while Botton (1979) calculated a dispersion value of 1.25 in the inshore New York Bight. *Lumbrineris tenuis* had a dispersion index of 0.67 and 0.84 at two eelgrass stations in Quisset Harbor and a dispersion index of 3.15 in New York Bight.

Eight of the top ten macroinfauna taxa were polychaetes which probably maintain a certain distance between individuals to minimize intraspecific competition. Each of these taxa probably do tend to clump; but, in general, the patches were of such size that the grab usually sampled between patches.

Woodin (1974) hypothesized that for several polychaeta species from a tidal mud flat off San Juan Island, Washington, the patch size was less than 0.5 m^2. Eckman (1979) conclusively demonstrated that clustering at scales of one to several centimeters commonly occurred within populations of several small macrofaunal species. Buzas (1976) found that for unispecies Foraminifera populations, aggregate size may be as small as 100 m^2 or as large as 1,600 m^2. Coull et al. (1977) found that deep sea meiofauna densities were homogeneous within large areas at particular depths and that contagion was a small-scale phenomenon at the level of the 10-cm sub-sampler. Gerlach (1977) reported that ostracods had a patch radius of about 13 cm. Hogue (1978) found that a subtidal sand flat gastrotrich was only slightly to moderately aggregated and formed clumps on the order of 4 to 10 cm in size. Bernstein and Meador (1979) found, in their analysis of the dispersion of a foram population, that a lack of significant spatial autocorrelation among subcores, combined with a demonstration of significant contagion, indicated that the patch structure was smaller than 100 cm^2 , which was the size of their study area.

From the analysis of abundance data using Morisita's index of dispersion, it appears that, based upon the high percentage of contagion found in the top ten meiofauna taxa from each cruise, meiofauna clumps were generally on the order of 8.0 cm^2 (0.0008 m^2) (area of the core) in area. Because of the high percentage of randomness exhibited by the top ten macroinfauna taxa, macroinfauna clumps were probably greater than 908.2 cm^2 (0.09 m^2) (area of the grab) in area. The other limit to macroinfauna patch size cannot be determined at present. This observed patch size for macroinfauna is much larger than that described by Woodin (1974) for several polychaetes.

c. *Sample Variability*

Analysis of Variance (ANOVA) was used to test for significant differences among samples at a station (within station variability) and among stations (Sokal and Rohlf, 1969). Each species was tested separately for differences in each of the three cruises. The top ten ranked species over all cruises for meiofauna and macroinfauna were selected for these tests. A logarithmic transformation ($\log_{10} (X + 1)$) was applied to the number of individuals in each sample to meet the assumptions for the test.

Four meiofauna samples collected at each station were the replicates within each station. The benthic collecting sites N500, N2000, E500, E2000, S500, S2000, W500, W2000 at each of the four Primary Platforms plus the Control Sites C21, C22, C23, and C24 were the 36 stations used for these tests for Cruises I and III. ANOVA's for Cruise II included these stations plus collecting sites N500 and N2000 at the Secondary Platforms, for a total of 68 stations. Table 134 gives the results of ANOVA for meiofauna taxa in Cruises I, II, and III. All of the taxa showed significantly more variation among stations than among samples within stations. The tests were all significant at the 0.05 probability level and most were significant at the 0.001 level.

Six macroinfauna samples were collected at each of these stations and ANOVA's were performed to determine within-station and among-station variability for each of ten taxa on each cruise. Table 135 shows the results of these ANOVA. All of the tests were significant at the 0.001 probability level, which means the variation among samples within stations was significantly less than variation among the stations (same as meiofauna above). These results were to be expected because the four cores and six grabs for meiofauna and macroinfauna, respectively, were considered to be replicate samples. In view of the repeated patchy distribution of some benthic species, however, these tests were made to verify replicability for this sampling effort.

4. *Biomass Estimates*

Precision in biomass determinations can be affected by the following factors:

TABLE 134. Results of ANOVA for within-station and among-station variability for ten meiofauna taxa (36 stations in Cruises I and III, 68 stations in Cruise II; 4 samples per station).

Taxa	Cruise I		Cruise II		Cruise III	
	F-Value	Probability[1]	F-Value	Probability	F-Value	Probability
Sabatieria	3.86	0.000	11.45	0.000	3.12	0.000
Bolivina lowmani	2.30	0.001	5.93	0.000	3.26	0.000
Gromiidae	3.37	0.000	6.35	0.000	7.03	0.000
Dorylaimopsis	2.37	0.000	4.44	0.000	3.66	0.000
Cyatholaimidae	3.58	0.000	5.90	0.000	3.82	0.000
Theristus	4.24	0.000	5.11	0.000	3.42	0.000
Buliminella morgani	4.24	0.000	11.55	0.000	10.73	0.000
Linhomoeidae	5.94	0.000	3.18	0.000	1.71	0.019
Nonionella basiloba	7.64	0.000	13.12	0.000	7.23	0.000
Choniolaimidae	1.60	0.035	2.41	0.000	2.25	0.001

[1] All probability values are below the 0.05 significance level which is approximately 1.5 for 36 stations and 1.4 for 68 stations.

TABLE 135. Results of ANOVA for within-station and among-station variability for macroinfauna taxa (36 stations in Cruises I and III, 68 stations in Cruise II; 6 samples per station).

Taxa	Cruise I		Cruise II		Cruise III	
	F-Value	Probability[1]	F-Value	Probability[1]	F-Value	Probability[1]
Paraprionospio pinnata	11.72	0.000	12.00	0.000		
Mediomastus californiensis	9.93	0.000			20.24	0.000
Rhynchocoela	9.94	0.000	4.12	0.000	9.29	0.000
Prionospio cirrifera	3.91	0.000			6.33	0.000
Tharyx marioni	5.63	0.000	8.67	0.000		
Notomastus latericeus	7.25	0.000				
Sigambra tentaculata	4.23	0.000	5.01	0.000	7.48	0.000
Tellina versicolor	23.40	0.000				
Cossura delta	11.21	0.000	3.29	0.000		
Aricidea suecica	4.47	0.000				
Magelona phyllisae			24.25	0.000		
Nephtys incisa			11.35	0.000		
Lumbrineris tenuis			16.84	0.000		
Golfingia bulbosa			23.09	0.000		
Corbula contracta			7.16	0.000	2.55	0.000
Nereis					14.18	0.000
Pinnixa					10.46	0.000
Sthenelais boa					3.65	0.000

[1] All probability values are below the 0.05 significance level which is approximately 1.4 for 36 stations and 1.3 for 68 stations.

- variations in stomach contents
- amounts of water engulfed at capture
- degree of wetness at the time of weighing (Lagler, 1978)
- method of preservation of fish (Parker, 1963; Stobo, 1972) and invertebrates (Howmiller, 1972).

Parker (1963) observed that, in salt-water formalin, weight initially fell to between 87 and 91% of live weight for the first few days but then rose to 91 to 95% of live weight. An initial short period of decreasing weight was followed by a protracted period of increase. The magnitude of change was also associated with size, i.e., larger relative changes occurring in smaller fish.

For this study biomass was measured only for the macroepifauna and demersal fish. All samples were treated in the same manner and procedures were held constant throughout the study. Specimens were weighed after the initial weight loss period described by Parker (1963), normally within 2 to 8 weeks after delivery to the laboratory to minimize this source of error. Therefore, based upon values reported in the literature, the biomass values measured in this project are approximately 91 to 95% of the true live weight.

5. *Length Estimates*

Factors that can contribute to error or inconsistency in length measurements are:

- muscular relaxation after death
- shrinkage of fish during preservation (Parker, 1963)
- variations in the pressure applied to put the jaws into a normal closed position at the time of measurement
- inaccurate judgement of the base of the caudal fin
- technician skill and consistency (Lagler, 1978).

According to Parker (1963), fish preserved in formalin shrink to 97% of original length in less than 24 hours. Length continues to diminish to about 96% in 30 to 40 days and stabilizes at that level.

Length was measured for all fish caught in the otter trawl. Trawl samples were normally worked in consecutive order within 2 to 8 weeks after their delivery to the lab. All specimens were treated in the same manner and technicians' measurements were compared for repeatability of results. Therefore, in view of Parker's study on length measurements, those taken in this study should be within 96% of the actual live length.

6. *Diel Variability*

Diel variations in benthic fish habits are well known and of great importance to fisheries (Parrish, Blaxter, and Hall, 1964; Stickney, Taylor, and Heard, 1974; Ragan et al., 1978). However, Ragan et al. (1978) quoted Moore et al. (1970) as stating that in Louisiana waters diel variation in the capture of fish (species combined) was not significant. Hoese et al. (1968) reported that Roessler (1965) and Miller (1965) found more species at night and that Hobson (1965) concluded that most predators were nocturnal whereas most herbivores and omnivores were diurnal. Diel differences were found to be related to activity, aggregational associations, food habits, and feeding tactics (Parrish et al., 1964; Wohlschlag, 1977). Daily behavioral changes along with variations in light intensity, turbidity, and life cycle stages result in reduced or enhanced susceptibility of fish to trawling (Parrish et al., 1964; Hoese et al., 1968). Hildebrand (1954) distinguished between two penaeid faunal areas: the nearshore, diurnal, white shrimp grounds and the offshore, nocturnal, brown shrimp grounds. However, Hildebrand's sampling strategy was suited for shrimp capture and appeared to bias his results.

In the South Texas OCS Project, Wohlschlag (1977) found that in most cases a pronounced day-night difference occurred throughout the year. Pooled yearly comparisons indicated that species caught during the day were ordinarily those that demonstrated schooling propensities, while primarily nocturnal species tended to be solitary. Statistically significant day-night differences were at a maximum in the spring and at a minimum in the autumn. This was demonstrated on a seasonal basis for those fish not showing day-night prevalence in numbers or weights for pooled data.

In the present study, 40 trawls were collected during three sampling cruises (Table 136). Of these trawls, 64% were collected during the day and 35% during the night. Of the day trawls made, 15.4% were in Cruise I, 80.8% in Cruise II, and 3.8% in Cruise III. For each of the Primary and Control Sites at least one trawl was collected during the night. Not enough data are available for statistical analyses, but a few comments can be made.

Comparisons can be made between fish species caught in this Central Gulf Platform Study and species captured in the South Texas OCS. Table 137 lists those species collected in this project which were most frequently collected in day trawls in the South Texas OCS. Table 138 provides a similar listing for night trawls and Table 139 lists those species with no diel variations. Comparison of these three tables reveals that only 10 species were caught in day trawls and 32 in night trawls; 10 species demonstrated no diel variation. Examination of Wohlschlag's (1977) statistical analysis of the South Texas OCS project results indicated that nine of the day trawl species in this project showed a significant ($p < 0.05$) preference for the daytime and 24 of the night trawl species demonstrated a significant ($p < 0.5$) preference for the nighttime. Significance at $p < 0.05$ is indicated by an asterisk preceding the species names in Tables 137, 138, and 139.

Activity, associations, food habits, and feeding tactics as defined by Wohlschlag (1977) are listed in Table 140. Seventy percent of the day trawl species listed in Table 137 formed large schools and 60% were planktivores. Of the night trawl species (Table 138), 95% were solitary and 54% were burrowers; 66% were carnivorous and 30% were carnivorous and scavengers; 59% were ambushers and 41% were stalkers. Those species showing no diel variation (Table 139) were quite varied in activity and associations; 70% of the species were carnivorous and 75% were stalkers. There was no consistent pattern in food habits or feeding tactics over all cruises.

Hoese et al. (1968) in their study of the diel and seasonal variations in trawlable organisms in the Aransas Pass Inlet, Texas, determined the diel preference of 9 species of invertebrates and 20 species of fish (Table 141). Of the fish species 11 showed nocturnal preference, five diurnal preference, and four appeared to show no preference. Several of the organisms (both invertebrates and vertebrates) were found to increase in numbers in turbid waters, but still responded to changes between night and day. Hoese et al. (1968) could not explain the response to turbid water, i.e., whether turbid waters allow less trawl escapement or reduce light below inhibiting levels. Their data indicated that both responses occurred. There was also a difference in

TABLE 136. Collection times of trawl samples taken in this project.

	Time of Trawl (hrs.)[1]		
Station	Cruise I	Cruise II	Cruise III
P01	1726-1756-D	0817-0832-D	2158-2213-N
P02	2020-2032-N	1450-1505-D	2215-2230-N
P03	0015-0030-N	0750-0805-D	0135-0150-N
P04	1920-1935-D	1350-1357:30-D	0045-0100-N
S05		1305-1320-D	
S06		1928-1943-D	
S07		1506-1522-D	
S08		1755-1810-D	
S09		1218-1233-D	
S10		[2] 1530-1550 1601-1622-D 1704-1744	
S11		0907-0922-D	
S12		1802-1822-D	
S13		0934-0949-D	
S14		1552-1607-D	
S15		0652-0707-D	
S16		0855-0910-D	
S17		1622-1637-D	
S18		1950-2010-N	
S19		2005-2012:30-N	
S20		1337-1352-D	
C21	0202-0217-N	1045-1100-D	2300-2315-N
C22	0854-0909-D	[2] 1320-1340 1350-1411-D 1419-1438	2205-2220-N
C23	2118-2133-N	1813-1828-D	1130-1145-D
C24	1500-1515-D	2249-2305-N	1945-2000-N

[1] Times taken from chief scientist's log.
(D denotes day; N denotes night).

[2] Taxonomy sample comprised of a composite of three trawls.

TABLE 137. Demersal fish species collected in this project which were most frequently collected in day trawls in the BLM South Texas OCS Project (from Wohlschlag, 1977) and their ranking by cruise.

Species	Activity and Associations[1]	Food Habits[1]	Feeding Tactic[1]	Ranking		
				Cruise I	Cruise II	Cruise III
*Anchoa mitchilli	B3	C6		13	66	--
*Saurida brasiliensis	B1	C1	D2	68	4	105
*Priacanthus arenatus	B1--B2	C1	D1	--	112	--
*Chloroscombrus chrysurus	B3	C6		--	25	112
*Trachurus lathami	B3	C6		26	57	111
*Vomer setapinnis	B3	C6		--	130	--
Trichiurus lepturus	B3	C1		--	67	49
*Scomber japonicus	B3	C6		106	--	--
*Peprilus burti	B3	C6		31	63	--
*Lagocephalus laevigatus	B1	C2		--	218	--

*denotes comparison at P <0.05 (Wohlschlag, 1977).

[1] For explanation of symbols see TABLE 140.

TABLE 138. Demersal fish species collected in this project which were most frequently collected in night trawls in the BLM South Texas OCS Project (from Wohlschlag, 1977) and their ranking by cruise.

Species	Activity and Associations[1]	Food Habits[1]	Feeding Tactic[1]	Ranking		
				Cruise I	Cruise II	Cruise III
*Hoplunnis macrurus	A1,B1	C4	D1	99	152	
*Congrina flava	A1,B1	C4	D1	--	206	--
Synodus poeyi	A2,B1	C4	D2	--	142	--
*Porichthys porosissimus	A1,B1	C4		40	45	106
*Antennarius radiosus	A2,B1	C4	D2	33	35	--
*Halieutichthys aculeatus	A3,B1			15	3	2
*Bregmaceros atlanticus				80	153	--
*Urophycis cirratus		C4	D2	64	70	--
*Urophycis floridanus		C4	D2	--	209	107
*Brotula barbata	A1,A5,B1	C1	D2	--	75	--
*Lepophidium graellsi	A1,B1	C1	D2	65	210	75
*Centropristis philadelphicus		C1		23	22	36
*Serranus atrobranchus		C7		55	28	--
*Pristipomoides aquilonaris		C1		--	38	--
Lutjanus campechanus	B1-B2	C1		--	121	32
*Stenotomus caprinus		C4-C5	D4	12	15	26
Cynoscion arenarius	B2	C1	D1	46	55	28
Larimus fasciatus		C1		82	--	38
Menticirrhus americanus		C1		104	102	18
Polydactylus octonemus	B1-B2	C1	D4	69	73	45
Kathetostoma albigutta		C1	D2	105	96	--
*Bollmannia communis	B1	C1		48	41	117
Prionotus ophryas	B1	C1	D4	--	154	--
*Prionotus paralatus	B1	C1	D4	--	92	--
*Prionotus rubio	B1	C1	D4	4	1	19
*Citharichthys spilopterus	A3, B1	C1	D1,D2	37	13	14
*Cyclopsetta chittendeni	A3,B1	C1	D1,D2	38	18	31
*Etropus crossotus	A3,B1	C1	D1,D2	21	17	1
*Syacium gunteri	A3,B1	C1	D1,D2	--	24	6
*Trichopsetta ventralis	A3,B1	C1	D1,D2	--	126	--
*Symphurus plagiusa	A3,B1	C1	D1,D2	--	56	15
*Sphoeroides parvus	B1-B2	C2,C4-5	D4	20	131	8

*denotes comparison at P<0.05 (Wohlschlag, 1977).

[1] For explanation of symbols see TABLE 140.

TABLE 139. Demersal fish species collected in this project which indicated little or no diel variation in the BLM South Texas OCS Project (from Wohlschlag, 1977) and their ranking by cruise.

Species	Activity and Associations[1]	Food Habits[1]	Feeding Tactic[1]	Ranking		
				Cruise I	Cruise II	Cruise III
Anchoa hepsetus	B3	C6		16	65	--
Synodus foetens	A2,B1	C1	D2	101	27	37
Diplectrum bivittatum	A2,B1-B2	C4	D1,D2	102	21	27
Lagodon rhomboides		C1	D1	--	86	--
Cynoscion nothus	B2-B3	C1	D1	--	50	22
Leiostomus xanthurus		C1		57	53	7
Micropogon undulatus	B2-B3	C4	D1,D4	50	33	5
Prionotus stearnsi		C1	D4	81	42	108
Ancylopsetta dilecta	A3,B1	C1	D1,D2	--	158	--
Gymnachirus texae	A3,B1	C1	D1,D2	--	37	120

[1] For explanation of symbols see TABLE 140.

TABLE 140. List of activity and association tendencies, food habits, and feeding tactics of fish species compiled by Wohlschlag (1977).

1. Activity (A)
    - A1. Burrower
    - A2. Sedentary
    - A3. Shallow Burrower
    - A4. Somewhat Sedentary
    - A5. Secretive
2. Associations (B)
    - B1. Solitary
    - B2. Forms Small Schools
    - B3. Forms Large Schools
3. Food Habits (C)
    - C1. Carnivore
    - C2. Specialized Carnivore (Invoicing distinctive structural specialization, such as the chemosensory barbels of *Upeneus parvus*).
    - C3. Molluscivore
    - C4. Carnivore and Scavenger
    - C5. Omnivore
    - C6. Planktivore (Includes filter feeders as well as zooplanktivores)
4. Feeding Tactics (D)
    - D1. Stalker (Generally visually oriented)
    - D2. Ambusher
    - D3. Cryptic Angler
    - D4. Searcher (May use other than visual means to locate prey, as in the Mullidae and Triglidae and Polynomidae)

TABLE 141. Diel preference of macroepifauna and demersal fish taxa collected in this project (based upon Hoese et al., 1968).

Taxa		Diel Variation			Remarks[2]
		Nocturnal	Both	Diurnal	
Polinices duplicatus	(B)[1]	X			T, August
Callinectes similis	(D)	X			
Pagurus pollicaris	(D)			X	
Squilla empusa	(S)	X			
Penaeus setiferus	(D)				
Penaeus aztecus	(D)	X			
Penaeus duorarum	(D)	X			
Trachypenaeus similis	(D)	X			
Lolliguncula brevis	(C)			X	
Sicyonia dorsalis	(O)		X		D, Gulf at 11 m; N, Gulf at 16.5 m
Anchoa mitchilli	(O)	X			D, Bay during October
Brevoortia patronus	(O)	X			
Synodus foetens	(O)			X	
Bagre marinus	(O)	X			
Chloroscombrus chrysurus	(O)	X			
Eucinostomus gula	(O)		X		
Vomer setapinnis	(O)			X	
Trichiurus lepturus	(O)			X	
Stellifer lanceolatus	(O)			X	
Cynoscion arenarius	(O)	X			
Cynoscion nothus	(O)	X			
Leiostomus xanthurus	(O)	X			T, August
Micropogon undulatus	(O)	X			T, August
Larimus fasciatus	(O)			X	Only in Gulf at 16.5 m
Prionotus tribulus	(O)	X			Nocturnal preference not significant
Citharichthys spilopterus	(O)		X		N, Bay in fall; D, Gulf at 16.5 m
Etropus crossotus	(O)		X		N, October and February; D, April; D, Gulf in November at11 m; N, Gulf in November at 16.5 m
Symphurus plagiusa	(O)	X			T, August
Porichthys porosissimus	(O)	X			T, August

[1] B denotes Bivalvia, C denotes Cephalopoda, D denotes Decapoda, S denotes Stomatopoda, O denotes Osteichthyes.

[2] T denotes diurnal in turbid waters, D denotes diurnal, N denotes nocturnal.

response at different depth zones. Total number of organisms captured per trawl was always higher at night than during the day. The difference was significant for fish except during the very turbid conditions in August, and always significant for invertebrates (Hoese et al., 1968).

Thirteen of the fish captured by Hoese et al. (1968) (see Table 141) were also caught by Wohlschlag (1977). Both Wohlschlag and Hoese et al. agreed on the diel preference of *Vomer setapinnis, Trichiurus lepturus, Porichthys porosissimus, Cynoscion arenarius, and Symphurus plagiusa.* However, for *Anchoa mitchilli* and *Chloroscombrus chrysurus* Wohlschlag reported a diurnal preference, while Hoese et al. found a nocturnal preference for both with a diurnal preference for *A. mitchilli* in the bay during October. Wohlschlag found nocturnal preference by *Citharichthys spilopterus* and *Etropus crossotus* but Hoese et al. reported no diel variation. For *Synodus foetens* Wohlschlag reported no diel variation and Hoese et al. found diurnal preference. For *Cynoscion nothus, Leiostomus xanthurus,* and *Micropogon undulatus* Wohlschlag found no diel variation but Hoese et al. found nocturnal preference. Both *L. xanthurus* and *M. undulatus* were diurnal in turbid water during August (Hoese et al., 1968).

Based upon the literature, nine invertebrates and 59 fish collected in this project exhibited either a nocturnal, diurnal, or no diel preference. Species with questionable diel preference were eliminated, and of the remainder 64.3% were nocturnal, 21.4% were diurnal, and 14.3% indicated no diel preference. Thus, a majority of the fish and invertebrate species collected in this project appear to be nocturnal.

Complex factors that affect the day trawl catch indicate that relative abundance data based only on day trawls may be inaccurate, and that trawl catches may be affected more by seasonal variations in turbidity than by true seasonal density differences (Hoese et al., 1968). Therefore, all day trawls collected in this project probably underestimate the relative abundance of those species caught and do not clearly reflect the species composition of the macroepifauna and demersal fish in the area. Night trawls are a better estimate of the relative abundance and species composition in the areas sampled.

7. Catastrophic Mortalities

During the course of the present study, two conditions occurred which appeared to have caused catastrophic mortalities among the benthic fauna: Tropical

Storm *Debra* and hypoxic bottom conditions. Both are discussed below. Depending on the severity of such catastrophes, certain areas may be partially or completely defaunated. The rate at which recolonization takes place is dependent upon the severity of the perturbation and resulting defaunation and the time of year that it occurs.

Recolonization by the benthos may occur very rapidly (Scheibel, 1974; Simon and Dauer, 1977). Scheibel found harpacticoids to be the initial colonizers of test substrates and to settle even before the nematodes. Simon and Dauer found that polychaetes were the initial macrofauna colonizers after defaunation caused by the Florida red tide. This early colonization by harpacticoids and polychaetes may be related to their having planktonic larvae. Slow appearance of molluscs and amphipods appeared to be related to their lesser abilities of dispersal as adults (Simon and Dauer, 1977). Rhoads, Aller, and Goldhaber (1977) reported that the molluscs followed the polychaetes in recolonization of a dredge-spoil dump. Farrell (1974*a*) reported that populations of Crustacea and Cephalochordata destroyed by low D.O. in July 1973 showed little sign of recovery by January 1974. McKinney, Harper, and Salzer (1980) reported that recovery from hypoxic bottom conditions by polychaetes was fairly rapid over a two month period, while crustaceans, particularly the amphipods, were slower to recover. Bank populations of hydroids and fishes also recovered rapidly. Sea urchin populations remained depressed throughout the year.

Simon and Dauer (1977) found that, after defaunation by the Florida red tide, an "equilibrium" level of species was reached by the 11th month. However, some species present before defaunation had not returned after 24 months. Boesch, Diaz, and Virnstein (1976) reported that the deep mud bottom community in the lower York estuary, Chesapeake Bay, had not recovered from Tropical Storm *Agnes* after 2.5 years. In the Minas Basin, Bay of Fundy, the hardest hit areas had not recovered initial population densities after two years. Woodin (1978) reported disturbance to be a significant mortality source and thus an important community structuring force. Susceptibility is in part a function of the organism's position in time and space relative to the disturbance process and in part a function of refuges from the disturbance as exemplified by availability of substrate heterogeneities. McCall (1978) believed storm-generated waves and predators were two primary sources of bottom disturbance and that they controlled benthos distribution. Heterogeneous predation may easily generate a patchy distribution and storm-generated waves act in part upon the patchiness in substratum mass properties (McCall, 1978).

Thus, existing data indicate that a tropical cyclone may cause a perturbation from which benthos takes over two years to recover, while hypoxic bottom conditions (assumed to be related to effects of a red tide) may only affect the benthos for slightly over one year. Frequent occurrence of tropical cyclones and hypoxic bottom conditions may result in permanently impoverished benthic fauna, in both number of species and number of individuals, off the coast of Louisiana. Sharp and Appan (1978) stated that "natural phenomena such as floods and turbid layers" have much greater impact upon the ecosystem than do man's activities, e.g., petroleum drilling and production activities.

a. Tropical Cyclones

From 1871 through 1977 a total of 850 tropical cyclones of different intensities have been recorded over the North Atlantic area including the Gulf of Mexico (Neumann et al., 1978). Tropical cyclones are nonfrontal low pressure large-scale weather systems that develop over tropical or subtropical waters and have a definite organized circulation. They are the most powerful and destructive of all storms as reported by Dunn and Miller (1960) and Tannehill (1956) in Hayes (1978). They can be further classified on the basis of wind speed: tropical depression (<33 knots), tropical storm (34 to 63 knots), and hurricane (>64 knots).

From 1899 until 1977, 140 hurricanes and 117 tropical storms crossed or passed immediately offshore the United States. Since 1899, 20 tropical cyclones of hurricane strength have directly hit the Louisiana coast; 11 had sustained winds of at least 111 miles per hour. The area from Lake Charles, Louisiana to Biloxi, Mississippi has the highest frequency of hurricanes of any area from Texas to Maine except for three locations: south of Galveston, Texas; east of Pensacola, Florida; and north of Miami, Florida (Neumann et al., 1978). The Louisiana continental shelf is also affected by numerous tropical cyclones which do not directly hit Louisiana. These tropical cyclones may begin as early as May, reach a peak in early September, and end in December.

Tropical cyclones bring high winds causing high waves and often are accompanied by a large amount of rainfall (Taylor, 1974; Hayes, 1978). The effects of wind and storm surge are typically greatest in the right semicircle of a storm where the storm's motion and wind are complementary and may extend for more than 160 km along the coastline (Hayes, 1978; Neumann et al., 1978). The path of a single storm may be 300 to 500 km wide. At one point Hurricane *Carla's* (1961) circulation enveloped the entire Gulf of Mexico, and fringe effects were felt in all the Gulf coast states (Cooperman and Sumner, 1962, in Hayes, 1978). Duration of tropical cyclones may be from 1 to 31 days with an average of 8 to 9 days. Very brief storms, as exemplified by Tropical Cyclone *Bob*, 1979, which formed and hit land within 24 to 48 hours, typically form in the Gulf of Mexico.

High waves cause disturbance of the bottom sediments. Of great importance in this disturbance of the sediments are:

- at what water depths the disturbance is felt
- how deep within the sediment the disturbance penetrates
- how much sediment resuspension and/or deposition occurs
- how long this sediment disturbance lasts.

In conjunction with high waves, strong bottom currents add considerably to sediment disturbance. Murray (1970) measured currents up to 160 cm per sec in 6.3 m of water off the coast of northwest Florida during Hurricane *Camille* (1969). McCall (1978) stated that most fine-grained natural sediments are entrained from the bottom at such stresses that the combined effect of storms and tidal currents had little influence on the bottom at depths greater than 20 m. About one week after the passage of Hurricane *Belle* (1976), storm effects at

20-m depths in Long Island Sound were difficult to see below 0.5 cm. At 27-m depths no storm effects of any kind could be seen (McCall, 1978).

McCall (1978) found disturbance as deep as 4.5 to 5 cm within the sediments in 13 m of water in Long Island Sound. Yeo and Risk (1979) reported that in Minas Basin, Bay of Fundy, the large bivalves *Macoma balthica* that were buried 12 cm below the surface survived Hurricane *Beulah* (September, 1967). The burrowing amphipod *Corophium volutator*, which rarely burrowed deeper than 4 cm, was greatly depleted by Hurricane *Beulah*. As a result of the hurricane, sediment erosion occurred as deep as 9 cm at some stations.

Disturbance of the sediments is reduced somewhat by the stabilizing effect of polychaete tubes, amphipod tubes, phoronid tubes (Rhoads, 1974; Ronan, 1978; Biernbaum, 1979; Virnstein, 1979) and mucilaginous matrices by microorganisms in shallow waters (Ginsburg and Lowenstam, 1959; Frankel and Mead, 1973; Holland, Zingmark, and Dean, 1974; Rhoads, Yingst, and Ullman, 1978; Yingst and Rhoads, 1978). Stabilization of bay sediments by the green alga *Vaucheria* has been observed in Trinity Bay, Texas, for several years (J. Thomas Ivy, *personal communication*). Areas between the patches of *Vaucheria* were often scoured to depths of 7.6 cm. Stabilization minimizes sediment resuspension and subsequent disturbance of the sediment and associated organisms as the first vestiges of the storm or hurricane approach the area (Woodin, 1978). In some areas, these stabilizing structures may remain intact but are covered by deposits which may subsequently smother the entombed organisms.

As a result of the sediment disturbance, the associated organisms may be exposed, swept into the water column, and subsequently reburied or buried in place by deposited sediments. Either way, the organism must regain its "normal" position and have access to an oxygen supply. As determined by Trevor (1978), burrowing, as a means of locomotion, is relatively expensive energetically. Continuous burying of the organisms may result in smothering because the accumulation is more rapid than the organism can handle. Rhoads (1974) reported that Moore and Scruton (1957) intimated that sedimentation rates greater than 12 cm per year tended to be stressful to the benthos. Zabawa and Schubel (1974) in Hayes (1978) stated that after Hurricane *Agnes* (1972), 17 cm of new sediment had been deposited in the upper reaches of Chesapeake Bay. Such sediment redeposition due to tropical cyclones can be stressful or harmful to the benthos. If deposition is too rapid the animal may become exhausted because of the tremendous energy output and subsequently die. Robins (1957) found that, as a result of persistent onshore winds and turbulent conditions, the suspended sand clogged and tore the gills of fish and forced them onto broad shoals, resulting in death.

Often associated with tropical storms and hurricanes are tremendous rainfalls (Behrens, 1969; Parker and Baker, 1969; Scott, Hoover, and McGowen, 1969; Taylor, 1974; Boesch et al., 1976; Hayes, 1978). The result is flooding, in this case by the Mississippi River and its tributaries, the Atchafalaya River and Bayou Lafourche. Large amounts of detritus are then emptied into the coastal bays and the Gulf of Mexico. Effects of the inflow of large amounts of organic material is discussed below under the section on Hypoxic Bottom Conditions.

Because of Tropical Storm *Debra*, Cruise II-A was aborted after partial completion of sampling at Primary Site P3. As a result of the storm, the water column was well mixed, eliminating the pycnocline that had caused hypoxic conditions over the study area for several months. More macroepifauna and demersal fish returned to stations where there had been very few numbers of individuals before *Debra* (Seltzer and Bedinger, 1978). No direct assessment of the effects of *Debra* on the meiofauna and macroinfauna can be made. Removal of the hypoxic conditions would have reduced the stress on the meiofauna and macroinfauna. Any damage due to sediment disturbance was probably disruptive and had a negative effect. Therefore, it is assumed that the overall effect of Tropical Storm *Debra* on the meiofauna and macroinfauna was reduction.

b. *Hypoxic Bottom Conditions*

Bedinger (1979), in a preliminary report of this study, noted that during Cruises I and II several stations were marked by very small trawl catches and very low dissolved oxygen (D.O.) (no values given) levels. A map drawn by Bedinger which characterized this hypoxic area included Sites P1, P2, S7, S11, S12, S20, and C22, with C24 appearing to be a westerly extension of this hypoxic area (the area probably included S19; see below).

Rate of oxygen consumption is influenced by activity, health of the organism, temperature, body size, nutrition, stage in life cycle, time of day, and season, as well as by previous oxygen requirements and genetic background (Prosser and Brown, 1961; Kemp, Abrams, and Overbeck, 1971). Therefore, oxygen requirements for the benthos, in general, are quite varied and it is difficult to assign a D.O. value below which stress or death will occur. Sverdrup, Johnson, and Fleming (1942) state that in general, 100% oxygen saturation of seawater, at temperatures (25 C) and salinities (32.5‰) similar to the Gulf of Mexico, occurs at 6.54 ppm. Thus, any D.O. values less than 6.54 ppm might cause stress or death. The Environmental Protection Agency (1976, p. 224) and McKee and Wolf (1963) stated that the minimum concentration of D.O. necessary to maintain good freshwater fish populations was 5 ppm. Garlo, Milstein, and Jahn (1979) found reduced numbers and dead benthic organisms between Sandy Hook and Cape May, New Jersey, at D.O. readings of 4.8 ppm and less. Therefore, a D.O. measurement of 5 ppm or less may be considered as causing stress, with possible death at lower values. A low level of D.O. may also cause increased susceptibility to other environmental stresses (Kemp et al., 1971).

Table 142 presents D.O. values measured from 1 to 10 m from the bottom at each Primary, Secondary, and Control Site for each Cruise. Since D.O. recordings were not always measured directly on the bottom, actual bottom D.O. values may have been lower. Dissolved oxygen readings of 3 ppm or less were measured at P1, C21, C22, and C24 during Cruise I and at P2, P4, S16, and C21 during Cruise II. Readings of 5 ppm or less were recorded at 63% of the locations during Cruise I and at 54% during Cruise II. Therefore, a large area was experiencing stress. These hypoxic conditions lasted from May through September, when conditions were brought back to "normal" by Tropical

TABLE 142. Near-bottom dissolved oxygen measurements at each Primary, Secondary, and Control Site for each cruise.

	Dissolved Oxygen(ppm)[1]		
Site	Cruise I	Cruise II	Cruise III
P01	3.1	9.6	5.8
P02	6.2	2.4	5.6
P03	4.4	4.2	6.8
P04	6.8	3.0	7.4
S05		8.4	
S06		6.0	
S07		4.6	
S08		5.0	
S09		4.4	
S10		6.3	
S11		6.0	
S12		4.4	
S13		5.0	
S14		6.0	
S15		4.2	
S16		2.7	
S17		5.0	
S18		6.6	
S19		6.2	
S20		6.1	
C21	3.0	2.4	5.6
C22	1.6	6.0	7.2
C23	7.6	4.6	7.4
C24	1.3	6.2	10.4

[1] All dissolved oxygen values were measured within 10 m of the bottom.

Storm *Debra*. No D.O. values of 5 ppm or less were recorded during Cruise III. Brown's microbiological analyses of selected sediment samples, preliminarily reported by Bedinger (1979), indicated a decrease in sulfate-reducing, hydrocarbon-utilizing bacteria as distance from the Mississippi Cone increased westward.

During the expedition to the Gulf of Mexico by the *Atlantis* in 1935, low D.O. values of 3.9 ppm were recorded off the Mississippi Delta at depths around the 180-m contour (Richards, 1957). This area of low D.O. at similar depths extended west to off the coast of Corpus Christi, Texas, and east to off the coast of Alabama. Recently, hypoxic bottom conditions have been reported in the area 8 to 20 km east of Freeport, Texas (McKinney et al., 1980).

Oetking (1974) recorded bottom D.O. values of 2 to 7 ppm on the Louisiana shelf near Timbalier Bay during portions of 1972 to 1974. Farrell (1974*a*), in assessing the effects of producing oil wells on the benthos, commented that the low D.O. in 1972 did not cause widespread mortality; but low oxygen values in July, 1973 had "catastrophic" effects on the biota of most stations. Farrell also noted little sign of recovery by January, 1974. In 1973 a Nicholls State University (Thibodaux, Louisiana) research team discovered hypoxic bottom waters 2 to 7 m thick at depths from 6 to 33 m on the central Louisiana shelf (from Flowers, Miller, and Gann, 1975; Harris, Ragan, and Kilgen, 1976 as reported by Ragan, Harris, and Green, 1978). This situation persisted from May, 1973 through March, 1974 and covered from 27% (December) to 93% (July) of the area under study. Almost half of the D.O. readings were anoxic, i.e., 0.0 ppm. Adjacent bottom waters with normal oxygen regimes had temperature and salinity characteristics of the area under study (Ragan et al., 1978). Anoxic waters were again encountered from May, 1974 through August, 1975. Ragan et al. (1978) found hypoxic waters during 1975 and 1976 in an area from just west of the Mississippi Cone to just east of Cameron, Louisiana, at depths of about 6 to 37 m, which included a good portion of the area for this project. Ragan et al. (1978) in a study of the bottomfishes of the Louisiana shelf reported oxygen concentrations averaging 1.3 to 1.7 ppm at 18- to 24-m depths during the warmer months of 1975 and 1976 from just west of the Mississippi Delta to offshore Morgan City.

Fotheringham and Weissburg (1979) also reported on this hypoxic area off the coast of Louisiana, west of the Mississippi Cone. Their study area was further west than the main part of the area for this project; it extended south of Morgan City and included Ship Shoal (Secondary Site P19, this Central Gulf Platform Study). Dissolved oxygen concentration was commonly less than 0.1 ppm in a water layer 3 to 8 m above the bottom. This phenomenon was observed in March and for about three weeks during July and August, 1978. This later period corresponds to the interval between Cruise I and Cruise II of this study.

The primary cause of the hypoxic layer appeared to be a large discharge of low salinity, organic-laden water from the Mississippi and its tributaries, i. e., Bayou Lafourche and the Atchafalaya River (Fotheringham and Weissburg, 1979). During Cruise I the high level of flood stage of the Mississippi River was personally observed by the senior author at Venice, Louisiana. Gunter (1952), in documentation of the changes in the Mississippi, noted that in 1543 a rise in the River caused extensive lateral flooding often extending "several leagues" or up to "50 miles" from the river banks. As levees began to be constructed in 1717 and extended for great distances along the Mississippi, floods were confined to the channel and water levels rose. The lateral flooding allowed for sediment deposition which greatly reduced the amount of sediment carried by the Mississippi into the Gulf of Mexico. Channeling caused by the levees increased the flow rate and reduced sediment deposition in the channel so that now large amounts of sediment and organic debris are introduced directly into the Gulf of Mexico. Wright (1972) reported that the Mississippi River transported about 500 million tons of sediment to the Gulf annually; almost 29% of this was funneled through the Southwest Pass. Henry (1961) as stated by Wright (1972), found that the suspended load of the Mississippi typically consisted of 40% silt, 50% clay, and 5 to 10% very fine sand. The increased channeling has also funneled more water down the Atchafalaya River (Gunter, 1952), thereby extending the large input of sediment considerably westward of the mouth of the Mississippi. Murray (1976) as quoted by Ragan et al. (1978) stated that the freshwater discharge from the Atchafalaya diluted coastal waters all the way to the Texas border. The combined discharge of the Mississippi and Atchafalaya Rivers amounts to 90% of the total average discharge along the Louisiana coast (Gaidry and White, 1973, from Ragan et al., 1978).

Flooding on the Mississippi, i.e., water levels high enough to overflow the natural levees or banks, usually occurs once every 3.6 years based upon 58 major floods recorded from 1717 to 1929, as stated by Elliot

(1932) in Gunter (1952). The high water crest usually arrives from March to May, but may be as early as January. Data from this project and Fotheringham and Weissburg (1979) indicate that the hypoxic layer was present at various locations along the Louisiana coast from March until August, 1978. Oxygen depletion probably resulted from the decomposition of debris imported by terrestrial runoff and isolated from the sea surface by a pronounced pycnocline. During Cruise I, large red-water blooms of the protozoan ciliate *Mesodinium* (Joseph D. Zotter, Sr., *personal communication*) were observed on the water surface in the study area by the senior author and others in the scientific party. This increased secondary productivity coupled with prolonged and relatively undisturbed stratification may have contributed to the continued oxygen depletion, which was similar to that found by Indrebo, Pengerud, and Dundas (1979) for primary productivity in a permanently stratified estuary. Garlo et al.(1979) describes a similar condition off the New Jersey coast in the New York Bight.

The 1978 occurrence was intensified and prolonged by the intrusion of high salinity bottom water from a Loop Current eddy during a time of low vertical mixing (Fotheringham and Weissburg, 1979). Production of an hypoxic area off the coast of Louisiana appears to be only a recent phenomenon, probably beginning around 1885 with the initiation of extensive levee building, and reaching a maximum soon after 1927, when the "whole *levee*" system was greatly extended and "more or less stabilized" (Gunter, 1952). With the extensive building of the levee system, more Mississippi River water was diverted down the Atchafalaya, which extended the effects of Mississippi flood stages considerably westward of the mouth of the Mississippi. Such prolongation and extent of the hypoxic conditions appeared to be primarily controlled by the occurrence of vertical mixing. A pronounced and prolonged pycnocline was observed by Garlo et al. (1979) to cause the extensive benthic mortalities between Sandy Hook and Cape May, New Jersey. However, Ragan et al. (1978) observed that the apparent reduction in the extent and intensity of the reduced D.O. from 1973 to 1976 was accompanied by a decline in the volume of river discharges, e.g., the Mississippi and Atchafalaya Rivers. Harris et al. (1978), in Ragan et al. (1978), found a direct correlation between discharge rates and the incidence of oxygen-deficient readings on a monthly basis. Appearance of a tropical storm or hurricane in late summer may resume vertical mixing, thus reducing hypoxic conditions; but it may also foster additional river discharge as a result of heavy rainfall, therefore adding more nutrient-rich runoff (Taylor, 1974).

Such intensity as demonstrated in 1978 appears not to have been experienced since 1973 or 1974, as evidenced by the sudden death of large bivalves, 4 to 5 years old, and the study of Green (1978) (from Fotheringham and Weissburg, 1979), who found hypoxic bottom water in the same area off Morgan City. Recently deceased bivalves, *Dinocardium robustum, Atrina serrata, Mercenaria campechiensis;* the gastropod *Polinices duplicatus*; decapods *Callinectes sapidus* and *Albunea paretii*, and various polychaetes were observed (Fotheringham and Weissburg, 1979). Reduced densities were observed for the anthozoan *Paranthus rapiformis*; the bivalve *Mulinia lateralis*; and polychaetes *Spiophanes bombyx* and *Mediomastus californiensis*. However, *Nassarius acutus*, a scavenging gastropod, increased dramatically in density. Garlo et al. (1979) found greater than 50% mortalities for the bivalves *Nucula proxima* and *Mulinia lateralis* in the area from Sandy Hook to Cape May, New Jersey. Sharp and Appan (1978) reported that the 1973 Mississippi River flood imposed much greater variation on copepod distribution, diversity, and composition than any other "natural event".

As a result of increased organic input and low dissolved oxygen, reducing conditions result in the subsequent formation of H_2S. Oxygen-deficient and H_2S-containing areas are characterized by a decline in numbers of species (Theede et al., 1969). There are a few representatives of different systematic groups, Protozoa, Rotifera, Gastrotricha, Turbellaria, Nematoda, Polychaeta, Oligochaeta, Lamellibranchia, Gastropoda, Copepoda, other Crustacea, and Tardigrada, which have a relatively high resistance to oxygen deficiency.

With the disappearance of oxygen, there is an initial reduction of nitrates and nitrites by bacterial break-down of organics, followed by a corresponding reduction of sulphates, which in turn leads to the formation of sulfides and H_2S (Theede et al., 1969). Smaller amounts of H_2S are formed by the putrefaction of protein. Sediments of silt and clay mixtures, which are often aerated, tend to be rich in sulfides and H_2S.

Hydrogen sulfide is an extremely potent metabolic poison which is lethal to most vertebrates and invertebrates at low concentrations (<1 ppm) (Powell, Crenshaw, and Rieger, 1979). It is almost ubiquitous and occurs at varying depths in marine sediments at concentrations well above this lethal limit (1 to 300 ppm). Fenchel and Riedl (1970) state that an anaerobic sulfide system of great complexity underlies the oxidized layer of all marine bottoms, except at narrow "high-energy windows" along surf-stressed beaches.

The principal effect of H_2S at low concentrations is believed to be inhibition of the iron containing oxidative enzymes (Smith and Gosselin, 1964, 1966, in Caldwell, 1975). Resistance to H_2S toxicity appears to be related to the degree of facultative anaerobiosis of which an organism is capable (Caldwell, 1975). Resistance to H_2S by polychaetes, lamellibranchs, gastropods, crustaceans, and echinoderms parallels that to oxygen deficiency alone (Theede, 1973). This resistance to H_2S is significantly higher at low temperatures and at reduced pH values. Bivalves have a pronounced ability to resist oxygen deficiency and H_2S by reduced mechanical and metabolic activity through responses of the entire animal and by cellular reactions (Theede et al., 1969; Theede, 1973). Inhabitants of soft substrates are more resistant than those of hard or sandy bottoms, and active organisms are less resistant than sessile or slow moving forms. Caldwell (1975) suggested that most estuarine organisms live very close to their tolerance limits for hydrogen sulfide. Temporary increases in oxygen consumption at "normal" oxygen tensions after subjection to oxygen-deprived seawater indicate adaptations to oxygen deficiency (Theede, 1973). Powell et al. (1979) found that a sulfide detoxification system existed in the body wall of interstitial metazoans.

Off the coast of Louisiana this annual hypoxic condition, with periodic high intensity, will have an effect upon composition, age structure, and variation in the benthic fauna, both invertebrate and vertebrate (Fotheringham and Weissburg, 1979). The long period of reduced D.O. observed in the water column in 1978 appeared to be the result of continued input of organic rich runoff, continued stratification, and increased primary productivity. An already extensive period of stress was prolonged by a lag time between decreased D.O. in the water, 1 to 10 m above the bottom, and decreased D.O. in the upper sediment layers similar to that found by Indrebo et al. (1979) in a permanently stratified estuary.

It is difficult to assess this effect of hypoxic conditions on the benthic populations, but an effect is mirrored in reduced diversity (Nichols, 1976; Nichols-Driscoll, 1976). Long-term and stable hypoxic conditions lead to a diverse community with the optimal strategy being to use available energy to maintain a high reproductive rate by mainenance of small bodies, early reproduction, and a short life span. Such stable long-term hypoxic conditions do not occur off the coast of Louisiana. Nichols (1976) stated that Rhoads and Morse (1971), in a study of the Black Sea, Gulf of California, and continental borderland basins of California, concluded that water containing less than 0.1 ppm oxygen was azoic, oxygen concentrations between 0.3 and 1.0 ppm supported a low diversity assemblage of small, soft-bodied fauna, and as the oxygen concentration exceeded 1.0 ppm, species diversity increased significantly, especially for calcareous species. Tables 16, 18, and 20 (See section on Species Diversity above) summarize these data for meiofauna, macroinfauna, and macroepifauna and demersal fish at each Primary, Secondary, and Control Site for all three cruises. As indicated by the tables, some stations which had low D.O. values (as defined above) were accompanied by relatively low diversities.

During Cruise I, meiofauna diversities were low at P3, C21, C22, and C23 (See Table 16 above). Three of these four sites had D.O. levels of 4.4 and lower. The anomalies were P1 and C24, where low D.O. values were measured, but where diversity was relatively high. At all the Primary Sites, diversities were lower during Cruise II than during Cruise I, with three of these sites having D.O. values of 4.2 ppm and below. Diversities less than 2.0 were calculated for S7, S8, S9, S12, and S13, which all had correspondingly low D.O. measurements. Low D.O.'s were measured at S15, S16, and S17, which had high diversities. These high diversities at low D.O. stations may reflect the lag period between reduced D.O. in the water, 1 to 10 m above the bottom, and reducing conditions in the sediment as mentioned by Indrebo et al. (1979). All Cruise III diversities were relatively high and no low D.O. values were recorded.

Macroinfauna diversity results from Cruise I showed a low diversity at P1 and the highest diversity at P3, both sites with low D.O.'s (See Table 18). Control Sites with low D.O. values had correspondingly low diversities. During Cruise II, there was no consistent pattern of low D.O. and low diversity except at P2 and C21. Again the lag time between hypoxia in the water, 1 to 10 m above the bottom, and reducing conditions in the sediment may partially explain these inconsistencies; however, there may have been other factors not evident at this time. During Cruise III the diversities were generally high.

Low diversities for macroepifauna and demersal fish corresponded to low D.O. values at P3, C22, and C24, Cruise I (See Table 20 above). However, low D.O.'s were also measured at P1 and C21, both of which had the highest diversities for Primary and Control Sites, respectively, during Cruise I. Since D.O. readings were not taken in conjunction with the trawl samples during Cruise II, caution should be exercised in comparing these diversity and D.O. values. Although there was no consistent pattern, low diversities were recorded at several sites and organisms were evidently stressed because of hypoxic conditions. Relative to other diversity values calculated for Cruise III, low diversities were obtained at P4, C22, and C23, but low D.O. was not recorded. In areas of hypoxia, the fish and larger non-sessile macroepifauna can move out of the area to better oxygenated areas depending upon the extent and severity of hypoxia (Garlo et al., 1979). This movement, rather than death, may be reflected in the low diversities for macroepifauna and demersal fish.

Thus, it appears that the hypoxic water layer did have an effect on the benthos as evidenced by the number of corresponding low diversities at 45% of the low D.O. stations. High diversities at low D.O. locations may be partially explained by the lag in time between an hypoxic water layer, 1 to 10 m off the bottom, and reducing conditions in the sediments (Indrebo et al., 1979). This hypoxic water layer also affected the number of species and number of individuals of meiofauna, macroinfauna, and macroepifauna and demersal fish, as reflected by reduced diversities.

Since at least 1959, the National Marine Fisheries Service (NMFS) has been gathering statistical data on the total shrimp catch (interview and non-interview) landed at Gulf coast ports (Caillouet, Patella, and Jackson, 1979; NMFS, 1971, 1972, 1973, 1976, 1977*a,b*). To facilitate reporting of this data, the Gulf of Mexico has been divided into Fishing Grid Zones. The area from the Mississippi River to the Texas-Louisiana border has been divided into the following zones: 13-Mississippi River to Bayou Lafourche, 14-Bayou Lafourche to Atchafalaya River, and 15-Atchafalaya River to Tigre Point.

Table 143 presents pounds of *Penaeus aztecus, P. setiferus,* and total catch of all shrimp for each of the above three zones from 1971 to 1977 and presents only those data readily available to the authors. From this information, it can be seen that total shrimp catch in Zone 14 was much lower than in adjacent Zones 13 and 15. This reduction was equally mirrored in both brown and white shrimp except in 1971 and 1972 when the catch of *P. aztecus* in Zone 14 was higher than in Zone 15.

The senior author is not aware of how many years the shrimp catch in Zone 14 has been lower than in the adjacent zones. Fishing Grid Zone 14 includes much of the area of reported hypoxic conditions and has one of the highest concentrations of petroleum production platforms in the Gulf of Mexico (Charles W. Caillouet, personal communication). McKinney et al. (1980) reported that commercial shrimping, in the area of hypoxic bottom conditions offshore Freeport, Texas, was greatly affected as shrimp populations apparently moved offshore to escape the low oxygen conditions.

TABLE 143. Pounds of shrimp in National Marine Fisheries Service (NMFS) fishing grid zones from the Mississippi River to Texas (NMFS, 1971, 1972, 1973, 1976, 1977*a, b*)

Fishing Grid Zones	13 (Mississippi to Bayou Lafourche)			14 (Bayou Lafourche to Atchafalaya River)			15 Atachafalaya River to Tigre Point)		
	Pounds of Shrimp								
Date	*P. a.*[1]	*P. s.*[1]	Total[2]	*P. a.*	*P. s.*	Total[2]	*P. a.*	*P. s.*	Total[2]
1971[3]	3,476,733	3,084,266	6,582,947	2,702,499	1,306,417	4,030,175	2,520,187	6,785,839	9,403,096
1972[3]	5,101,224	1,908,667	7,316,585	3,232,648	862,359	4,181,159	2,773,950	7,129,825	10,688,692
1973[3]	4,253,700	1,654,489	6,162,158	1,535,903	539,520	2,260,000	2,297,264	3,969,160	7,054,800
1976[3]	7,028,094	2,845,745	9,992,047	1,967,996	386,965	2,420,296	4,010,220	7,463,895	11,564,982
Feb. 1977	65,772	40,488	106,260	50,936	16,760	67,696	105,655	123,164	228,819
June 1977	2,460,987	28,866	2,489,853	977,033	136,532	1,130,175	2,034,809	249,323	2,284,132

[1] P. a. = Penaeus aztecus
P. s. = Penaeus setiferus
[2] Totals for all shrimp.
[3] Data represents annual summary.

Low shrimp catch in Zone 14 cannot be attributed to hypoxic bottom conditions and/or the presence of the platforms alone, but may be the result of a combination of the two.

8. *Summary of Population Estimates*

The primary purpose of this section is to discuss the limits that circumscribe the benthic population under study. With this information, that portion of the benthic population being analyzed can be defined with some degree of accuracy and statistical analyses can be interpreted and compared to other studies within proper limits. Emphasis in this section has been placed mainly on the meiofauna and macroinfauna, since trawling efforts were not directed at specifically quantifying the macroepifauna and demersal fish.

Table 144 summarizes population estimates for meiofauna, macroinfauna, and macroepifauna and demersal fish. The sieve sizes used for meiofauna and macroinfauna tended to provide good estimates of the respective populations except for the number of macroinfaunal individuals. Depth of penetration of the core and Smith-McIntyre grab also provided good estimates of the meiofauna and macroinfauna populations, respectively. However, the number of sample replicates provided low estimates for the number of individuals of both the meiofauna and macroinfauna. Biomass and length values tended to reflect good population estimates of the macroepifauna and demersal fish. Based upon the literature and the diversity index, Tropical Storm *Debra* and the hypoxic bottom conditions probably caused a reduction in number of species and number of individuals of each population group. Because of the sampling pattern, the meiofauna exhibited a clumped distribution and the macroinfauna exhibited a random dispersion pattern.

B. Population Abundance and Distribution

1. *Taxonomic Composition and Population Trends*

a. *Meiofauna*

Nematoda or Harpacticoida tend to dominate most meiofauna studies (Coull, 1979). Rank order and percent abundance of dominant meiofauna taxa are presented for eleven studies in Table 145. In three studies Harpacticoida were second, in two localities Foraminifera were second, and Polychaeta and Kinorhyncha were second in one study each. In this project, Foraminifera were the most abundant taxa and were followed by the Nematoda. In previous studies nematode abundance was the largest and ranged from 51 to 99% of the total number of individuals (Table 145).

TABLE 144. Summary of population estimates.

	Percent of Population									
	Meiofauna		Macroinfauna		Macroepifauna			Demersal Fish		
Population Estimate	No. Species	No. Individuals	No. Species	No. Individuals	No. Species	No. Individuals	Biomass/ Length	No. Species	No. Individuals	Biomass/ Length
Sieving	100	90	>93	0	NA	NA	NA	NA	NA	NA
Depth of Penetration[1]	>90	>90	85 to 90	85 to 90	NA	NA	NA	NA	NA	NA
Sample Replication[1]	85 to 93	48 to 60	81 to 96	38 to 62	NA	NA	NA	NA	NA	NA
Dispersion	Clumped	Clumped	Random	Random	NA	NA	NA	NA	NA	NA
Biomass Estimates	NA[2]	NA	NA	NA	NA	NA	87 to 95	NA	NA	87 to 95
Length Estimates	NA	NA	NA	NA	NA	NA	NA	NA	NA	96 to 100
Diel Variability	NA	NA	NA	NA	UE[2]	UE	NA	UE	UE	NA
Tropical Cyclones	Reduced	Reduced	Reduced	Reduced	Reduced	Reduced	Reduced	Reduced	Reduced	Reduced
Hypoxic Bottom Conditions	Reduced	Reduced	Reduced	Reduced	Reduced	Reduced	Reduced	Reduced	Reduced	Reduced

[1] Percent meiofauna based upon three cores at each station and macroinfauna based upon ten grabs at each station.
[2] NA denotes Not Applicable or Not Analyzed for that particular group.
UD denotes population predominantly nocturnal in preference, and thus Underestimated.

TABLE 145. Rank order and percent abundance of dominant meiofauna taxa based upon the literature.

Locality	Nematoda	Harpacticoida	Foraminifera	Polychaeta	Kinorhyncha	Reference
Offshore South Texas	1/		2/			Pequegnat (1977)
Buccaneer Oil Field, Offshore Texas	1/		2/			Harper (1977)
Offshore Alabama, Mississippi, West Florida	1/70%	2/14%		3/		Dames and Moore (1979)
Georgia Bight	1/60%	2/16.4%	3/9.8%			Tenore et al. (1978)
Georgia Bight, South Atlantic	1/51%	2/19.1%				Coull (1979)
North Inlet Estuary, South Carolina	1/67 to 98%					Sikora et al. (1977)
North Carolina	1					Tietjen (1971)
Niantic and Pettaquamscutt Estuaries, New England	1/58 to 90%					Tietjen (1969)
Martha's Vineyard, Massachusetts	1/			2/	3/	Wigley and McIntyre (1964)
Buzzard's Bay, Massachusetts	1/89 to 99%				2/	Wieser (1960)
North Sea	1/				4/	McIntyre (1964)

Meiofaunal densities of 10^6 per m^2 may occur worldwide and decrease with increasing depth (Coull, 1979). Densities as high as 2.6 x 10^7 per m^2 have been reported from mud flats. Compendia of meiofauna densities from various studies were prepared by Thorson (1966), McIntyre (1969), and Tietjen (1971). Worldwide sublittoral meiofauna densities ranged from 4 to 3,163 per 10 cm^2. Table 146 presents the meiofauna densities from selected localities from the Gulf of Mexico and eastern United States. Meiofauna densities ranged from 7 to 186,000 per 10 cm^2. Meiofauna densities found in the present project ranged from 3.7 to 4,331.8 per cm^2; these values tend toward the low end of densities previously reported for both the Gulf of Mexico and the eastern coast of the United States.

In this project, meiofauna populations had the highest numbers during Cruise I (May), dropped by two-thirds during Cruise II (August to September), and to almost one-half of Cruise II values in Cruise III (January). This differs from the macroinfauna populations, which tended to increase slightly in Cruise III. Harper (1977) found Buccaneer Oil Field meiofauna populations to be the lowest in October to November, and then to increase in April. Apparently both Buccaneer and Central Gulf Platform Study meiofauna populations exhibit similar seasonal trends.

b. Macroinfauna

A total of 546 different macroinfauna taxa were identified in this study. Holland (1977) identified 715 different taxa in the BLM South Texas OCS Project, and in the BLM MAFLA OCS Project 1,250 different taxa were collected (Dames and Moore, 1979). Harper (1977) found from 400 to 420 different macrofauna taxa in the Buccaneer Oil Field offshore Galveston, Texas. Therefore, the number of different macroinfauna taxa collected in this project was lower than that collected in the South Texas and MAFLA Projects, which included more subtropical organisms, but higher than that collected in the Buccaneer Oil Field. Note also that the collecting area in the Buccaneer Oil Field was much smaller than in this project, thus limiting the number of different habitats sampled.

As in this project, Polychaeta was found to be the dominant taxonomic group in the BLM South Texas, MAFLA, and South Atlantic OCS Projects (Holland, 1977; Dames and Moore, 1979; Tenore, 1979). Polychaeta comprised 65 to 75% of the macrofauna at the Buccaneer Oil Field (Harper, 1977) and were dominant along the upper Delaware coast (Maurer et al., 1979) and in Cape Cod Bay, Massachusetts (Young and Rhoads, 1971). Harper (1977) found the Amphipoda to rank second in dominance and comprise 10 to 20% of the total population at the Buccaneer Oil Field.

Table 147 presents macroinfauna densities from selected localities in the Gulf of Mexico and the eastern United States. Densities ranged from 6 to 12,576 per m^2. Macroinfauna population densities encountered in the present project ranged from 45 to 9,338 per m^2 and compare well with other studies from the Gulf of Mexico and eastern United States.

Macroinfauna populations in this project were highest during Cruise I (May), lowest during Cruise II (August to September), and increased slightly in Cruise III (January). In the BLM South Texas OCS Project the largest populations were collected in April and September, and then increased slightly in December and January (Holland, 1976). Populations in the Buccaneer Oil Field decreased between July and January concomitant with temperature decrease and then increased in April as temperature increased (Harper, 1977). Seasonal population highs and lows found in this study tend to agree with those found in the BLM South Texas OCS Project. Differences between Buccaneer and South Texas seasonal population trends, according to Harper (1977), may be a result of geographic distance between the two study areas, latitudinal differences, or annual differences in temperature trends. The above logic does not explain the differences between the Central Gulf Platform Study and Buccaneer Oil Field Study. The primary difference between the Buccaneer and South Texas projects and Central Gulf Platform Study is the failure of the Buccaneer populations to show increases in January. This difference might be one of sampling

TABLE 146. Some meiofauna densities from the Gulf of Mexico and the eastern United States.

Location	Density	Reference
Offshore South Texas	14 per 10 cm^2 to >700 per 10 cm^2	Pequegnat (1977)
Offshore Louisiana	4 to 4,332 per cm^2	Present Study
Offshore Alabama, Mississippi, West Florida	65 to 3,952 per 10 cm^2	Dames and Moore (1979)
Georgia Bight	853 per 10 cm^2	Tenore et al. (1978)
Georgia Bight, South Atlantic	7 to 2,649 per 10 cm^2	Coull (1979)
North Carolina	40 to 1,174 per 10 cm^2	Tietjen (1971)
Long Island Sound	87 to 1,366 per 10 cm^2	Yingst (1978)
Niantic and Pettaquamscutt Estuaries, New England	1,184 to 5,163 per 10 cm^2	Tietjen (1969)
Martha's Vineyard, Massachusetts	16,900 to 186,000 per 10 cm^2	Wigley and McIntyre (1964)
Buzzard's Bay, Massachusetts	11.7 to 98.8 per 10 cm^2	Wieser (1960)

TABLE 147. Some macroinfauna densities from the Gulf of Mexico and the eastern United States.

Location	Density	Reference
Offshore South Texas	130 to 9,460 per m^2	Holland (1977)
Buccaneer Oil Field, Offshore Texas	2,902 to 10,937 per m^2	Harper (1977)
Offshore Louisiana	6 to 12,576 per m^2	Present Study
Offshore Alabama, Mississippi, West Florida	82 to 9,195 per m^2	Dames and Moore (1979)
Georgia Continental Shelf	236 to 7,629 per m^2	Frankenburg and Leiper (1977)
Georgia Bight, South Atlantic	650 to 7,683 per m^2	Tenore (1979)
Delaware Coast	6 to 6,920 per m^2	Maurer et al. (1979)
Delaware Bay	rarely >10 per 0.1 m^2	Kinner, Maurer, and Leathem (1974)
Long Island Sound	238 to 10,454 per m^2	Yingst and Rhoads (1978)
Buzzard's Bay, Massachusetts	1,064 to 12,576 per m^2 ave. of 4,430 per m^2	Sanders (1958)
Cape Cod Bay, Massachusetts	787 to 3,015 per 0.1 m^2	Young and Rhoads (1971)
Martha's Vineyard, Massachusetts	700 to 5,500 per m^2	Wigley and McIntyre (1964)

since not as much area, and subsequently not as many different habitats, were studied in the Buccaneer project.

c. *Macroepifauna and Demersal Fish*

There does not appear to be a seasonal difference in numbers of macroepifauna and demersal fish taxa, since the increase in numbers of taxa during Cruise II was simply a reflection of the increase in sampling sites. Macroepifauna and demersal fish populations (per trawl) were low during Cruise I (April to May) because of the extensive hypoxic bottom conditions. In Cruise II (August to September) populations reached a peak with the return of the fauna. This was followed by a slight reduction in Cruise III (January), probably a response to low temperatures.

2. *Species Diversity*

The ecosystem is the basic functional unit in ecology and includes both biotic and abiotic elements, each interacting and both necessary for maintenance of life (Odum, 1959; Wilhm and Dorris, 1968). Actions of the abiotic elements and co-actions between the biotic components result in characteristic assemblages of organisms. The populations of different species that belong to an assemblage and occupy a given area form the community. Natural biotic communities are characterized by the presence of a few species with many individuals and many species with only a few individuals.

One method of describing a species' individual relationship within a community is by use of a diversity index. Diversity indices permit large amounts of information about individual-species relationships to be summarized in mathematical terms. Various types of diversity indexes have been proposed; information theory (Margalef, 1968) and rarefaction are two (Sanders, 1968). Several indexes have been based upon information theory: Shannon (Pielou, 1969) and Brillouin (Kaesler and Mulvany, 1977; Kaesler, Herricks, and Crossman, 1978).

It has been shown that a high degree of correlation exists among the different indices of diversity in spite of theoretical distinctions (Livingston, 1976). Heip and Engels (1974) compared fifteen indices of diversity and evenness with respect to the statistical significance of their differences and similarities and concluded that community diversity was best measured by using the Shannon-Weiner information function (Pielou, 1969). Recently Kaesler and Mulvany (1977) and Kaesler et al. (1978) championed the use of Brillouin's equation because it is not biased and does not require unrealistic assumptions about the populations being sampled. Brillouin's equation provides greater insight into the structure of communities, particularly those from stressed environments.

Tropical regions, for the most part, support a more diverse fauna than do regions of higher latitude (Sanders, 1968). In the aquatic environment, marine habitats have a larger number of species than do estuarine habitats. Wilhm and Dorris (1966, 1968) state that, based upon a study of benthic macrofauna in a freshwater stream receiving domestic and oil refinery effluents, diversity values less than 1 indicate areas of heavy pollution, values from 1 to 3 indicate areas of moderate pollution, and values exceeding 3 indicate clean water areas. Copeland and Bechtel (1971) reported that macrofauna diversity was inversely related to pollution in Galveston Bay, Texas. Marcotte and Coull (1974) found harpacticoid diversity to decrease with increased nearness to a waste effluent disposal site. Botton (1979) discovered that macrofauna diversity was lower at a sludge site in the inshore New York Bight, reflecting decreased species evenness. Gray (1978) found meiofaunal diversity and evenness to be lower at "polluted" localities. However, the blanket statement that low diversities indicate pollution cannot be supported. A more accurate statement would be that low diversities appear to indicate areas of stress, be it man-made or natural (Sanders, 1968; Marcotte and Coull, 1974; Rosenberg, 1975). However, this "stress" on the community populations may be a result of changes over time, i.e., climatic stability, spatial heterogeneity, competition, predation, or productivity (Sanders, 1968).

a. *Meiofauna*

Diversity at P1 remained fairly stable over all cruises but evenness increased, indicating that between Cruises I and III the individuals were more evenly distributed among the collected species. The difference in diversity at P2 in Cruises I and III appeared to be the result of more species being collected during Cruise I, since the evenness values were similar. The dramatic increase in diversity at P3 during Cruise III, based on a corresponding increase in evenness, appeared to be a result of more even distribution of individuals and not an increase in number of species. More species were collected at P4 during Cruise I, but the diversity remained similar through a more even distribution of individuals among species.

Increase in diversity at C21 was probably a result of more even distribution of individuals among species and not an increase in number of species. The drop in diversity at C22 during Cruise II was perhaps a result of a decrease in species; the high diversity during Cruise III probably reflects both an increase in species and a more even distribution of individuals among species. Because of the high evenness values at C23, the increase in diversity during Cruise III may only be a result of a more even distribution of individuals among species and not an increase in species. Changes in the diversity at C24 appeared to be more related to the changes in evenness and not to changes in numbers of species.

Differences in diversity at some sites may be related to several factors. Reduced diversities may be due to hypoxic bottom conditions as discussed above. Correlation analysis determined that as median grain size, chromium, copper, nickel, lead, and zinc decreased and percent sand increased the number of species increased. None of the abiotic variables was significantly correlated with number of individuals, diversity, and Pielou evenness value for more than one cruise. Nickel was found to be directly correlated with Heip evenness value. Coull (1979), in the South Atlantic Georgia Bight, found that depth explained most variations in meiofauna density and that the relationship was always negative.

Diversity changes over cruises at the same sites were the result of changes in evenness and not due entirely to changes in number of species. During Cruises I and II diversities at the Primary Sites were generally higher than at the Control Sites. The reverse was true during Cruise III.

Because of the frequent bottom disturbances in the area, many microhabitats are probably created. The increase in diversity at the Primary Sites may be a reflection of the increase in number of microhabitats created as a result of platform construction, pipeline laying, etc.

Diversities for all taxa, except Foraminifera, were higher during Cruise I than Cruises II or III, perhaps indicating a seasonal trend. Generally, the changes in diversity for the major taxa appeared to be in response to changes in evenness and not changes in number of species. However, changes in number of species did affect the diversity values for Foraminifera, Cruise II, and Nematoda, all cruises.

b. Macroinfauna

Diversity at P1 increased over all cruises as a result of increased evenness. The sporadic behavior at P2 was probably also a prime result of changes in evenness. Changes in diversity over time at P3 appeared to be mainly a result of changes in number of species and not changes in evenness. Diversity differences at the Control Sites appeared to reflect changes in evenness and not changes in number of species. Comparison of changes in diversity among the major macroinfauna taxa for all three cruises indicated that diversity differences were the result of changes in evenness and not in number of species.

Diversity differences may be related to other factors. Reduced diversities at some sites may be caused by hypoxic conditions as discussed above. As percent silt, median grain size, TOC, chromium, lead, and zinc decreased, the number of macroinfauna species decreased. Lie (1978) found a weak but significant correlation between number of macrobenthic species and median grain size. As distance from shore, salinity, depth, percent silt, chromium, and lead decreased, number of individuals increased. As distance from shore, salinity, and D.O. increased macroinfauna diversity increased. Pielou evenness increased as distance from shore, salinity, D.O., TOC, depth, chromium, and lead increased. Note that as hypoxic bottom conditions increased, Pielou evenness decreased. As distance from shore, depth, salinity, D.O., median grain size, percent sand, TOC, chromium, and lead increased, the Heip evenness increased. Kinner et al. (1974) found macrofauna diversities in Delaware Bay to be higher in low silt-clay or sand bottoms than on mud bottoms. Relationship of diversity to sediment texture was not very evident in the present study.

Harper (1977) found diversity at the Buccaneer Oil Field to decrease from July to January concomitant with the temperature decrease, then to increase by April as the temperature increased. Any seasonal changes in diversity in this project appear to be closely tied to the seasonal pattern of hypoxic bottom conditions. Holland (1977) reported that diversity and equitability increased with depth in the BLM South Texas Project. High equitability at deep stations, coupled with high numbers of species at inshore stations, produced a pattern of relatively even diversity over the entire study area.

In the BLM South Atlantic OCS Project only 1% of the diversity values in excess of 3.0 were calculated for 89% of the station data sets and over 22% of the data sets had values greater than 5.0. There was little seasonal variation in percentage distribution of diversity except for the summer, when diversity on the continental slope was lower.

c. Macroepifauna and Demersal Fish

Most changes in diversity at the Primary Sites appeared to be the result of changes in evenness. The extreme low measured at P3 during Cruise II also reflected a drop in number of species. Changes in diversity at the Control Sites were probably attributable to changes in evenness. Low diversity at C23 during Cruise III was probably also influenced by a decrease in number of species. Changes in diversity among the major macroepifauna and demersal fish taxa appeared to be the result of changes in evenness.

Diversity differences, again, may be related to other factors. Reduced diversities at some sites may be caused by hypoxic conditions. Changes in diversity in the macroepifauna and demersal fish were primarily the result of changes in evenness, but were also affected strongly by changes in number of species. Only distance from shore was found to be consistently significantly correlated with number of species and the relationship was positive. As D.O. increased and copper and nickel decreased, the number of individuals increased. Macroepifauna and demersal fish diversity increased as distance from shore, distance from the Mississippi River, depth and D.O. decreased and copper, nickel, zinc, and protein degradation increased. As distance from the Mississippi River and D.O. decreased and cadmium, copper, nickel, and protein degradation increased, Pielou evenness increased. Heip evenness decreased as salinity and sulfate oxidation increased; it increased as protein degradation increased.

3. Macroinfauna:Meiofauna Ratio

The Macroinfauna:Meiofauna (M:M) ratio has been examined by McIntyre (1968, 1969) in an effort to determine any significant interaction or to see if each group operates independently, each controlled differently by various environmental factors. Buzas (1978) found little interaction between dominant macrofauna Mollusca and the dominant meiofauna Foraminifera in their responses to abiotic and biotic variables. Harper (1977) reported no correlation between population densities of meiofauna or macroinfauna. Permanent meiofauna and macrofauna abundance data from several subtidal studies were compared to provide a range in the ratio in relation to depth, sediment type, and salinity distribution (Mare, 1941; Sanders, 1958; Wieser, 1960; McIntyre, 1964; Wigley and McIntyre, 1964; Muus, 1967; McIntyre, 1968). Subtidal areas with higher ratios were mostly muds in comparatively deep water which suggests that meiofauna may be favored in such environments (McIntyre, 1969). Low values were found to be associated with larger numbers of young macrofauna, which indicates that the low values were a temporary seasonal feature.

The high ratios at P4 and C22 during Cruise I seemed to indicate better conditions for the meiofauna at these stations. These high ratios are not necessarily just the result of the increase in fine sediments at these stations. The lowest ratio during Cruise I was at C24 which was characterized by an average of 3.5% sand over all three cruises.

The highest ratio was recorded during Cruise II at C21. A high percentage of fine grained sediment and a low D.O. of 2.4 ppm were measured there. Thus, the macroinfauna may have been reduced or excluded by the low D.O. values. Cruise II conditions appeared to be more favorable to the meiofauna as indicated by the high ratios (greater than 100 as based upon McIntyre (1969)) at 50% of the sites. The M:M ratio tended to decrease with depth, perhaps indicating that the macroinfauna was more favored as depth increased.

Wigley and McIntyre (1964) found the M:M ratio to vary from 1:35 to 1:770 in their study offshore Martha's Vineyard, Massachusetts. Most previously reported subtidal values fall within this same range. The average M:M ratio off Martha's Vineyard was 1:170 and was remarkably consistent from station to station in spite of faunal and environmental variations. Cullen (1973) reported M:M ratios of 1:70 off the east coast of the United States; this was similar to the ratio reported by Wigley and McIntyre (1964). Ratios recorded in this Central Gulf Platform Study are comparable to ratios reported from the east coast of the United States.

4. *Meiofauna*

a. *Foraminifera*

(1) Population Trends— Four species of Foraminifera were among the top 15 meiofauna taxa common to each cruise: *Bolivina lowmani, Buliminella morgani, Nonionella basiloba,* and *Ammonia beccarii.* Increased dominance by a few taxa indicates stressed conditions (Gray and Mirza, 1979). Several of the abiotic variables were found to be significantly correlated with the above species.

In this project *Bolivina lowmani* occurred at 96% of the stations sampled. In the central Texas areas of Aransas, Mesquite, and San Antonio Bays, Phleger (1956) rarely found *B. lowmani.* This species was found in Buras-Scofield Bayou (Warren, 1957) and Timbalier Bay, Louisiana (Fish et al., 1974). In the BLM South Atlantic OCS Project, *B. lowmani* had the highest mean density of all the foram species (Sen Gupta, 1979).

Buliminella morgani was collected from 9% of the stations occupied in this project. As depth, distance from shore, salinity, and the presence of chitin degradation increased, *B. morgani* increased. *Nonionella basiloba* was collected from 91% of the stations and was found to increase in density as depth increased.

Ammonia beccarii occurred at 82% of the stations sampled in this project. As distance from shore, depth, and salinity decreased and presence of hypoxic bottom conditions increased, the density of *A. beccarii* increased. *Ammonia beccarii* has been reported from the open Gulf off Texas to Nantucket Bay, Massachusetts (Table 148). Phleger (1956) reported *A. beccarii* in frequencies of 10 to 25% at stations 4 to 37 m in depth, common (no frequencies given) at 38 to 75 m, and present as deep as 77 m. In the BLM MAFLA OCS, *A. beccarii* was a stress indicator species and a characteristic component of Faunal Group IV. *Ammonia beccarii* occurred in moderate to high numbers in inshore waters in the Georgia Bight (Sen Gupta, 1979).

Average foram densities recorded in this project tend to be slightly higher than the 2000 to 105,000 individuals per m^2 reported by McIntyre (1964) for the North Sea. Comparable figures for the Gulf of Mexico were not readily available in the literature. In the BLM South Atlantic OCS Project, Sen Gupta (1979) reported densities of 1 to 6,524 per cm^2 with high inshore and slope densities seemingly related to the clay-silt factor.

TABLE 148. Reported occurrence of the Foraminifera *Ammonia beccarii.*

Locality	Reference
Aransas, Mesquite, and San Antonio Bays, Texas Continental Shelf	Phleger (1956)
Texas to Mississippi River	Kornfeld (1931)
Buras - Scofield Bayou, Louisiana	Warren (1957)
Timbalier Bay, Louisiana	Fish et al. (1974)
Grand Isle, Louisiana	Behre (1950)
Offshore Alabama, Mississippi, West Florida	SUSIO (1976), Dames and Moore (1979)
Nantucket Bay, Massachusetts	Lidz (1965)

Variation in Foraminifera diversity appeared to be primarily a result of changes in evenness, with the number of species affecting a few diversity values. Fish et al. (1974) found a remarkable similarity in foram species diversity for all study sites in Timbalier Bay, with two exceptions. The indexes at two stations near the oil production sites were lower than those for control sites. Fish et al. (1974) believed that this low foram diversity "might indicate that organisms living close to the production sites were experiencing environmental stress."

In the BLM South Atlantic OCS Project, seasonal diversity values were less than 3 except at one station (Sen Gupta, 1979). Diversities lower than 1.5 occurred almost exclusively in the inner shelf and slope assemblages. Diversity along most transects increased on the inner shelf, reached a plateau on the middle and outer shelves, and decreased at 200 m.

The average percentage of the total number of individuals for all three cruises is plotted by site in Fig. 6 above. Those sites with percentages greater than 75% were generally, with the exception of C23, in the area right off the mouth of the Mississippi River. Current data indicate that this area is not directly affected by the Mississippi. Those sites with percentages lower than 25%, P2, S5, S17, and S19, do not appear to be related to each other through any physical feature or low D.O. values. Sen Gupta (1979) stated that the "routine effects of oil and gas production" should be negligible with regard to the broad features of foram distribution, including seasonal and annual population densities.

(2) Morphological Abnormalities— Nearly every Foraminifera population contains several individuals which are abnormal or beyond the range of normal morphological variation. These abnormalities which develop during the life span of the individual may be due either to mechanical or ecological causes (Boltovskoy and Wright, 1976).

The foram test may suffer several kinds of mechanical abrasions which can be patched or healed by the organism. These fractures commonly occur in the last formed, more fragile, chambers. Foraminifera protoplasm immediately begins to swell, filling the break in the test with newly secreted shell material and healing the injury. This new portion of the shell wall is very delicate initially but eventually thickens, possibly even regaining some of the original ornamentation. This reconstructed wall is identifiable by its abnormal contours and thinness (Boltovskoy and Wright, 1976). Laboratory studies of *Heterostegina depressa* indicated that healthier, more rapidly growing individuals have thinner walls in the last few chambers and were more susceptible to being broken (Rottger and Berger, 1972). When the broken part of the last chamber is not healed, a second, and even third, aperture is created (Cushman and Jarvis, 1930; Ellison, 1953; Dhillon, 1969, 1970). Several specimens of *Buliminella morgani* were noted with two and three apertures in this Central Gulf Platform Study.

The foram test may also show morphological deformation due to ecological factors. Many of these kinds of irregularities are related to attachment to the substrate (Boltovskoy and Wright, 1976). Some of the *Cibicides concentricus* specimens from this project show this kind of deformation.

Any rapid change in the physio-chemical environment (such as salinity, nutrient supply, temperature, trace element concentration) may also be reflected in the normal rate and nature of test growth. Myers (1943) noted that chambers added in the summer are often larger than those formed during the winter, giving the test somewhat irregular form. Several large specimens of *Nonionella basiloba* and *Florilus atlanticus* collected in this project had this type of shell structure. Murray (1963) also noted changes in the smoothness of the periphery of *Elphidium crispum* as a response to changes in salinity.

Boltovskoy (1958) noted deformation of the aperture, while others (Arnal, 1957, 1958; Forti and Roettger, 1967) have noted deformation of the entire test. Watkins (1961) and Lidz (1965), studying populations around sewage outfall areas, found large numbers of monstrous specimens.

The small number of abnormal individuals found in this project did not seem excessive, and it appeared that most of these deformities could be explained by mechanical causes. *Buliminella morgani* seemed susceptible to abrasion of the final chamber and creation of new apertures was common in this species. The winter sampling showed a frequency of smaller chambers in *Nonionella* and *Florilus* adjacent to the larger chambers formed in summer.

(3) Decalcification— The relationship between pH and substrate type and the effect this relationship has on Foraminifera distribution was discussed by Miller (1953) who noted that clay sediments rich in decaying organic matter (low pH) supported fewer Foraminifera than clean sands. Zobell (1946) thought that poorly sorted fine grained sediments had a pH lower than that of the water above them and would contain fewer organisms than well sorted, coarse grain sediments with a relatively high pH (probably equal to that of the water above them). Arnal (1961), studying the Foraminifera fauna of the Salton Sea, California, concluded that the most important ecological factor influencing distribution of the specimens was the pH. He found that the pH of the bottom sediments varied between 6.74 and 7.96 and that of the bottom waters varied between 7.34 and 8.41. The combination of reduced pH, increased depth and smaller grain size caused Foraminifera to decrease in quantity. Fish et al. (1974), in af forams of Timbalier Bay, Louisiana, found few calcareous species in mud environments where low pH was caused by decaying organic matter.

At a pH less than 7.8, calcareous tests will begin to dissolve (Boltovskoy and Wright, 1976). Phleger and Bradshaw (1966) found a daily variation in the pH in a Mission Bay, California marsh; values ranged from 6.8 during the night to 8.5 during the daylight hours. This means that half of the time the Foraminifera were dissolving. Culture experiments on *Rosalina floridana* indicated that the organism was capable of living in a low pH environment and could easily recalcify (Angell, 1967). Empty tests, however, did not survive long in the low pH reducing zone.

Parker (1954), in a study of live Foraminifera, found that a few of the samples taken from shallow depths showed decalcification, possibly due to the increasing acidity of the samples after collection. She also found that frequent checks of the pH of the samples had to be made in order to maintain the most satisfactory pH of 7 to 8. Lankford (1959), in his study of live Foraminifera, found that three samples which contained an abundance of fine woody material contained no Foraminifera tests and only the protoplasm molds of the forams remained.

The pH of the formalin used to preserve the meiofauna samples in this project was checked several times during the sorting and was found to be around 8 in almost all samples. Those samples in which the pH was 7 or less were not those in which Foraminifera were found to be dissolved. Specimens of *Nonionella* and *Quinqueloculina* were most commonly affected.

The low Foraminifera counts for Cruise II at sites P1 and P2 may be due to an area of hypoxia extending over these sites prior to collection (see above section on Hypoxic Bottom Conditions). Many of the samples from P2 were decalcified and others were extremely poorly preserved and partially decalcified. The amount of silt and clay in the sediment (50% or more silt and clay) did not appear to be a primary cause of the low Foraminifera concentration. Site P4, which had similar amounts of clay and silt in the sediment around it, had Foraminifera counts comparable to or higher than those of Cruise I samples.

(4) Live:Total Ratios— Live:total ratios of benthonic Foraminifera are used as a crude measure of standing crop and a partial measure of the rate of production. Because it is reasonable to assume that production rates of benthonic Foraminifera should be definitely related to total organic production in an area, relative production rates of Foraminifera can be used to predict total organic production.

Phleger (1960*a*) found that large standing crops are found off some active deltas, in hypersaline lagoons, in areas of upwelling of nutrients, and in thickly vegetated areas, all of which are environments having high rates of organic production. He suggested that the principal factor governing the size of the standing crop of living Foraminifera was the quantity of available food. Experimental studies of Bradshaw (1955) indicated that an increase in food caused an increase in population growth.

Walton (1964) found that there did not appear to be any direct relationship between zones of maximum productivity of living benthonic Foraminifera and zones of maximum abundances of empty tests. The zones of maximum productivity always occurred in shallower nearshore waters; this appeared to be due to the fact that areas of high productivity occurred in areas of active sedimentation.

Relative rates of sediment deposition may also be obtained from live:total ratios of benthonic Foraminifera. A large number of living Foraminifera relative to the total population indicated relatively rapid sediment deposition while a small number of living Foraminifera relative to the total population indicated a slow rate of sediment supply (Phleger, 1960*b*). This was based on the assumption that the rate of production was constant over the period of time that the sediment accumulated. Relative rates of sediment deposition determined by this method applied only to the surface sediment.

Because the productivity rate is different for different species, and because sedimentation rates are diverse, live:total ratios for different areas are not reliable indicators of true foraminiferal productivity. Also, because Foraminifera live in microhabitats, live:total ratios for the same station at different seasons of the year may not be valid unless stations are relocated exactly (Bock, 1974).

Live:total ratios are also used to determine whether there has been significant postmortem transportation of the tests and whether this process has affected the apparent faunal associations. If distributions of the living populations are quite similar to the distributions of empty tests of the same species, then probably no significant transportation of empty tests has taken place.

At many places, dead populations extend into deeper water than the living populations for most species. Although it is possible that these faunas move downslope because of waves, water currents, or turbidity currents, it is more probable that these were relict faunas, residual from a previous environment when sea level was lower and ecological factors were similar to those now found in the area of the living faunas (Phleger, 1960*a*).

Because many of the live:dead samples contained species which have not been found alive in any of the material, it is possible that these species represent organisms which no longer live at the site but which were living there during the Pleistocene glacial age. Sea level rose to its present stand approximately 5,000 to 6,000 years ago, moving nearshore environments nuch further inland and leaving behind sediment containing empty tests of organisms which no longer lived that far out. It is also possible that, due to changing climatic conditions, some of these species no longer lived in this area.

In this present study, the live:dead samples usually contained fewer than 7.5% live Foraminifera. The drying process may destroy the shells of the juveniles, which are delicate, and which composed a large percentage of the specimens in the regular wet samples. Small tests were not abundant in the dead material.

Preservation of the total sample was also reflected in the number of live Foraminifera in the live:dead samples. Specimens of Foraminifera in the regular meiofauna samples from S7, S13, S14, S15, and S17 were decalcified. No live Foraminifera were found in the live:dead samples from these sites.

Sen Gupta (1979) reported live:total ratios of less than ten at most of the stations in the BLM South Atlantic OCS Project. Ratios of inshore stations were generally higher; the highest recorded ratio was 30.4.

b. Nematoda

(1) Population Trends— Ten of the top 15 meiofauna taxa common to each cruise were Nematoda: *Sabatieria, Dorylaimopsis,* Cyatholaimidae, *Theristus,* Linhomoeidae, Choniolaimidae, *Terschellingia,* Chromadoridae, *Tricoma,* and *Sphaerolaimus.* Increased dominance by a few taxa indicates stressed environmental conditions (Gray and Mirza, 1979). Several of the abiotic variables were found to be significantly correlated with the above taxa.

Sabatieria was collected at over 99% of the stations in this project. As distance from shore, depth and salinity decreased and the sediments became more sorted, *Sabatieria* increased. Under hypoxic bottom conditions, which were encountered during Cruises I and II, *Sabatieria* increased. *Sabatieria* is widely distributed in both the Gulf of Mexico and along the Atlantic seaboard of the United States (Table 149). *Sabatieria* has been collected at some depth and prefers sand and mud and low D.O.

In this project, *Dorylaimopsis* was also collected at over 99% of the stations. No abiotic variable was found to be consistently correlated with *Dorylaimopsis* except sorting coefficient. *Dorylaimopsis* was found in moderate numbers offshore in the BLM South Texas OCS Project (Pequegnat, 1977). The genus prefers sand and was reported from Long Island Sound, the Niantic and Pettaquamscutt estuaries, and Buzzards Bay (Wieser, 1960; Tietjen, 1969, 1977).

Cyatholaimidae was collected at 94% of the stations in this project. As depth, ethane, and propane increased, Cyatholaimidae density decreased. Cyatholaimidae was found by Fish et al. (1974) in all biotopes in Timbalier Bay, Louisiana, and occurred infrequently in both the inshore and offshore areas of the BLM South Texas OCS Project (Pequegnat, 1977).

TABLE 149. Reported occurrence of the nematode *Sabatieria*

Locality	Remarks	Reference
Offshore South Texas	Abundant inshore and offshore	Pequegnat (1977)
Offshore North Carolina	From depths of 50 to 2500 m	Tietjen (1971)
New York Bight Apex	Preferred medium sand and low D.O.	Tietjen (1980a)
Long Island Sound	Preferred both sand and mud	Tietjen (1977)
Buzzard's Bay, Massachusetts	Abundant in silt-clay	Wieser (1960)

Theristus was collected at 94% of the stations occupied in this project. As distance from shore and the Mississippi River, depth, salinity, median grain size, contamination index, ethane, propane, and lead decreased and temperature increased, the density of *Theristus* individuals decreased. *Theristus* appeared to increase in numbers under hypoxic bottom conditions. *Theristus* prefers sand and has been found at depths of 50 to 2500 m (Table 150). It has been reported from offshore south Texas to Buzzards Bay, Massachusetts.

TABLE 150. Reported occurrence of the nematode *Theristus*

Locality	Remarks	Reference
Offshore South Texas	Abundant inshore and offshore	Pequegnat (1977)
New York Bight Apex	Preferred sand	Tietjen (1971)
Long Island Sound	Preferred sand	Tietjen (1977)
Offshore North Carolina	At 50 to 2500 m	Tietjen (1980*a*)
Niantic and Pettaquamscutt Estuaries, New England		Tietjen (1969)
Buzzard's Bay, Massachusetts		Wieser (1960)

Linhomoeidae was collected at 94% of the stations in this project. As depth decreased the density of Linhomoeidae increased. This nematode family was found to be moderate in abundance in both inshore and offshore areas of the BLM South Texas OCS Project (Pequegnat, 1977). Fish et al. (1974) found the family in the mud-sand biotope in the midtide region near an oil production station in Timbalier Bay, Louisiana. Tietjen (1980*a*) reported its preference for silty sand in the New York Bight Apex.

Choniolaimidae was found at 85% of the stations sampled in this project. Choniolaimidae was found not to be consistently correlated with any abiotic variable for more than one cruise. Previous occurrence of Choniolaimidae was not reported in the literature available to the senior author.

Terschellingia was collected at 84% of the stations occupied in this project. As distance from shore and the Mississippi River, depth, salinity, and D.O. decreased and hypoxic bottom conditions and cadmium increased, the density of *Terschellingia* increased. This nematode genus has been collected from offshore south Texas to Buzzards Bay and prefers medium to silty sands (Table 151).

Chromadoridae was collected at 71% of the stations occupied in this project; few occurrences were at the Secondary Sites. As percent silt, chromium, lead, and zinc decreased and percent sand and marine agar counts increased, Chromadoridae density increased. Pequegnat (1977) found Chromadoridae infrequently in both the inshore and offshore areas of the BLM South Texas OCS Project. The family has also been reported in medium sands in the New York Bight Apex (Tietjen, 1980*a*).

Tricoma occurred at 71% of the stations occupied in this project and was noticeably rare at P1 stations. None of the abiotic variables significantly correlated with *Tricoma* during more than one cruise. Previous occurrence of *Tricoma* was not reported in the literature available to the senior author.

TABLE 151. Reported occurrence of the nematode *Terschellingia*

Locality	Remarks	Reference
Offshore South Texas	Abundant inshore; moderately abundant offshore	Pequegnat (1977)
New York Bight Apex	Medium to silty sands	Tietjen (1977)
Long Island Sound		Tietjen (1980*a*)
Niantic and Pettaquamscutt Estuaries, New England		Tietjen (1969)
Buzzard's Bay, Massachusetts		Wieser (1960)

Sphaerolaimus was collected at only 71% of the stations. None of the abiotic variables was significantly correlated with *Sphaerolaimus* during more than one cruise. *Sphaerolaimus* has been reported from offshore south Texas to Buzzards Bay, Massachusetts, and to prefer silty clays (Table 152).

TABLE 152. Reported occurrence of the nematode *Sphaerolaimus*

Locality	Remarks	Reference
Offshore South Texas	Moderate numbers inshore; abundant offshore	Pequegnat (1977)
Offshore North Carolina	Depths of 600 to 2500 m	Tietjen (1971)
Niantic and Pettaquamscutt Estuaries, New England		Tietjen (1969)
Buzzard's Bay, Massachusetts	Moderately abundant in silty clays	Wieser (1960)

Figure 7 presented the average percent of the total number of nematode individuals for all three cruises by site. Those Secondary Sites with percentages of nematodes less than 15% were in a region sometimes influenced by the Mississippi River. At Sites S7, S8, S9, and S12, the Foraminifera occurred in percentages greater than 75%. Perhaps the hypoxic conditions measured during Cruise II at the above Secondary Sites favored the Foraminifera over the Nematoda, which is contrary to what would be expected (see section on Hypoxic Bottom Conditions above). Total average percentage of Nematoda greater than 75% was found at P2, S5, and S19 (see Table 44 and Fig. 7). Both P2 and S5 were shallow inshore sites with moderate percentages of sand and were easily affected by terrestrial and river runoff. A low D.O. was measured at P2 during Cruise II. Site S19 (Ship Shoal), which had the highest percentage of sand of any site, had the highest total average percentage of Nematoda. John H. Tietjen (*personal communication*) stated that the composition and diversity of the Nematoda fauna at S19 were indicative of non-polluted sand.

Nematode densities from the Gulf of Mexico and the eastern United States ranged from 32 to 6,240 per 10 cm^2 (Table 153). Off North Carolina densities

TABLE 153. Some nematode densities from the Gulf of Mexico and the eastern United States.

Locality	Density	Reference
North Inlet Estuary, South Carolina	0.21 to 6.24 × 10 per m^2	Sikora et al. (1977)
Offshore North Carolina	32 to 593 per 10 cm^2	Tietjen (1971)
New York Bight Apex	221 to 1,381 per 10 cm^2	Tietjen (1980*a*)
Niantic and Pettaquamscutt Estuaries, New England	802 to 4,811 per 10 cm^2	Tietjen (1969)
Martha's Vineyard, Massachusetts	805 per 10 cm^2 in sand	Wigley and McIntyre (1964)
Buzzard's Bay, Massachusetts	250 to 1,800 per 10 cm^2 in mud	Wieser (1960)

peaked at 60 to 1026 per 10 cm^2 at a depth of 250 to 500 m; they then began to decrease with increasing depth (Tietjen, 1971). High nematode densities were recorded in both sand and mud (Table 153) and lowest densities were recorded in sandy gravel by Wigley and McIntyre (1964). Nematode densities in this Central Gulf Platform Study ranged from 2,486 to 1.77 million per m^2; these values are comparable to nematode densities found along the eastern United States.

Average diversity and evenness values for meiofauna Nematoda were generally similar for all three cruises and similar between the Primary and Control Sites. Tietjen (1980*a*) found that in the New York Bight Apex, in medium sands with low organic carbon and low heavy metal concentrations, the nematode fauna had a high species diversity. In silty sands and also in medium sands with high organic carbon and/or heavy metal concentrations the nematode fauna had low diversity. Tietjen (1980a) found that in medium sands species diversity was inversely correlated with increased heavy metal concentration of Cr, Cu, Pb, and Zn.

(2) *Trophic Composition*—Table 154 presents the feeding types, based upon the literature, of Nematoda taxa found in this project. Although 71 Nematoda taxa were identified, feeding type information was available for only 32.3% of the taxa. There was some disagreement among authors as to the feeding type of *Odontophora* and *Monhystera*. Both of these taxa are generic designations, and the feeding types stated by Wieser (1960), King (1962), Tietjen (1969), and Tietjen and Lee (1977) could apply to any of the species within the respective genus. Of the taxa shown in Table 154, 39.1% were deposit feeders, 39.1% were epigrowth feeders, 17.4% were either predators or both predators and omnivores, and 4.4% were algae and bacterial ingesters. Thus, Nematoda are predominantly either deposit feeders (detritivores) or epigrowth feeders, followed closely by predators and/or omnivores.

Alongi and Tietjen (1980) experimentally demonstrated significant competitive interactions among nematodes with near-identical buccal morphologies which may partially explain the low species diversity among the nematodes inhabiting muddy sediments where competition for low-variety food resources may be intense. In sandy sediments, there is a more diverse food supply and nematodes feeding on the same resource may spatially partition their environment to avoid excessive competition.

(3) *Harpacticoida:Nematoda Ratio*—Parker (1975) suggested using the ratio of benthic Copepoda to Nematoda as an index of pollution. Under disturbed or stressed conditions, Copepoda will predominate at their trophic level, and under "normal" conditions Nematoda predominate. Parker noted that the ratio needed testing in other stressed areas. Tenore et al. (1978) found nematodes to be inversely correlated and harpacticoids directly correlated with increasing mean grain size.

Since most benthic copepods belong to the Harpacticoida, the ratio used here is based upon the Harpacticoida and Nematoda. As the number of Harpacticoida increase, the ratio approaches one and will be greater than one when the number of Harpacticoida exceeds the Nematoda. The average Harpacticoida:Nematoda (H:N) ratio for all cruises was 0.0297 at the Primary Sites and 0.0308 at the Control Sites. Although the H:N ratio was higher at the Controls than at the Primary Sites, the ratios were similar. There appears to be no true difference between the H:N ratio at the Primary Sites and that at the Control Sites. The average for all Primary and Control Sites for all cruises was 0.0303 which was comparable to the 0.04 ratio reported by Pequegnat (1979) for the BLM South Texas OCS Project.

c. *Kinorhyncha*

Kinorhyncha densities of 1 to 139 per 10 cm^2, calculated for Cruise I, tended to be higher than densities of 1 to 30 found by Pequegnat (1977) in the BLM South Texas OCS Project. Densities of 1 to 23 per cm^2 and 1 to 11 per 10 cm^2 for Cruises II and III, respectively, were comparable to Pequegnat's figures. Most Kinorhyncha are deposit feeders, but a few feed on diatoms (Barnes, 1968). All the Kinorhyncha taxa have basically the same trophic requirements.

d. *Harpacticoida*

Harpacticoida densities of 1 to 125 per 10 cm^2 determined in this project were comparable to the densities of 3.5 to 150 per 10 cm^2 found by Pequegnat (1977) in the BLM South Texas OCS Project. Changes in harpacticoid diversity were related primarily to changes in evenness. Coull (1970) and Hartzband (1971) as reported by Marcotte and Coull (1974) found low harpacticoid diversities associated with unstable, shifting sand environments. Marcotte and Coull found copepod diversity, in both summer and winter, to decrease in response to increased enrichment provided by waste effluent.

e. *Cluster Analysis*

Descriptions of benthic community structure along the continental shelf have been based upon the macroinfauna; this community structure is well discussed in Thorson (1957). Meiofauna "community" population structure has often been kept separate from that of macroinfauna; the main difference is one of scale (McIntyre, 1969). Because of the extreme

TABLE 154. Feeding types, based upon the literature, of some Nematoda taxa found in this project.

Taxa	Feeding Type[1]			
	Wieser (1960)	King (1962)	Tietjen (1969)	Tietjen & Lee (1977)
Axonolaimus		D-NS	D-NS	
Odontophora	E	D-NS		
Tripylodidae		P		
Terschellingia	D		D-S	
Sphaerolaimus			P/O	
Monhystera				A=B
Theristus			D-NS	
Paramonhystera			D-NS	
Microlaimus		E	E	
Metachromadora		E	E	
Dasynemella		D-S		
Richtersia		E		
Dorylaimopsis	E		E	
Eubostrichus	E		E	
Sabatieria	D		D-NS	
Cervonema			E	
Chromadoridae		E		
Euchromadora			E	
Hypodontolaimus			E	
Anticoma			D-S	
Enoplidae		D-S		
Oncholaimus		P	P/O	
Viscosia			P/O	

[1] D-S = selective deposit feeder
D-NS = non-selective deposit feeder
E = epigrowth feeder
P = predator
A=B = ingests algae and bacteria
P/O = predator and omnivore
D = deposit feeder

patchiness of the meiofauna, the community concept is less meaningful and the incorporation of meiofauna into existing community descriptions should be done with caution. The most useful approach is one in which only those meiofauna species whose addition would lead to a greater precision in community definition are included (McIntyre, 1969).

Meiofauna populations collected in the BLM South Texas OCS Project were not examined using cluster analysis or other similar procedures (Pequegnat, 1977). Ostrom (1974) described five faunal groups of benthic forams in his study of Timbalier Bay, Louisiana. He found that Timbalier Bay groups included infiltrations from open Gulf species. Fish et al. (1974) established three Foraminifera biofacies in Timbalier Bay, barrier island, mud, and bay biofacies, which overlapped the biotopes of Ostrom (1974).

In the BLM MAFLA OCS Project five Foraminifera assemblages were characterized: 100- to 200-m association, mid-shelf, shifting sand region, disturbance indicator, and mixed depth (Dames and Moore, 1979). Meiofauna group associations tended to be very localized, with very low temporal continuity and no compelling geographic pattern to the groups.

In the BLM South Atlantic OCS Project Sen Gupta (1979) identified three Foraminifera thanatotopes. Thanatotope 1 included the inner shelf and part of the middle shelf and extended to a depth of 25 m; thanatotope 2 was limited to the middle shelf and extended to a depth of 40 m; and thanatotope 3 comprised the area along the shelf edge. Meiofauna clustering in the Georgia Bight gave no consistent patterns because the lowest taxonomic level used was the family level (Coull, 1979). However, a distinct slope assemblage was delimited from the shelf stations.

Community structure defined by individual taxa can be expressed as a measure of constancy and fidelity (Stephenson, Williams, and Lance, 1970). Constancy is a measure of the extent to which a given taxon may be expected to occur at similar stations. The number of stations in a station group in which a given species occurs, expressed as a percentage of the total number of stations available, is a measure of constancy. A species has very high constancy if found at all stations within a station group, although it need not occur at only one station group. Fidelity is the extent to which a taxon is confined to a set of stations. It is the ratio of the frequency of occurrence within a station group to the overall frequency of occurrence in the whole experimental area, expressed as a percentage. A species has high fidelity if it occurs in only one station group, although it may not occur at every station within the group.

Table 155 lists those taxa which characterize the meiofauna Taxa Group Associations. Primary indicators are those taxa which occurred in at least one subcomponent, i.e., a Taxa Group, during each cruise. Secondary indicators are those taxa which occurred in at least one subcomponent during two of the three cruises. Taxa Group Association No. 3 had no primary indicators since the Cruise II subcomponent was missing. Measures of constancy and fidelity are also given.

Meiofauna Taxa Group Association No. 1 (Table 155) was composed of nine primary indicators and four secondary indicators. These taxa are widely distributed and some are individually discussed under the sections on Foraminifera and Nematoda. This Taxa Group Association occurred in greatest density at P1, P2, and C21 over all cruises. The primary indicators demonstrated high constancy but medium to low fidelity. The secondary indicators showed a moderate degree of constancy and a low degree of fidelity. A prominent member of this Taxa Group Association was *Ammonia beccarii*, which appears to be an opportunistic species. In the BLM MAFLA OCS Project, *A. beccarii* was a member of the disturbance indicator assemblage (Dames and Moore, 1979). *Ammonia beccarii* was an abundant component of the inshore part of thanatotope 1 in the BLM South Atlantic OCS Project (Sen Gupta, 1979). Correlation analysis indicated that as distance from shore, depth, and salinity decreased, the density of members of Taxa Group Association No. 1 increased.

Meiofauna Taxa Group Association No. 2 (Table 155) was composed of several more common taxa. This Taxa Group Association had the greatest densities at P3, P4, C23, and C24 during all three cruises. The primary indicators showed high constancy and a moderate degree of fidelity. Secondary indicators included a wider variety of taxa, including the Kinorhyncha and Polychaeta. Most of the secondary indicators showed moderate constancy and moderate fidelity. *Cibicides concentricus*, a foram included in this Taxa Group Association, was reported by Dames and Moore (1979) to be included in their mixed depth foram assemblage in the BLM MAFLA OCS Project. Correlation analysis indicated that as distance from shore, depth, and D.O. increased and temperature decreased, the density of Taxa Group Association No. 2 increased. Hypoxic bottom conditions tended to decrease density.

Taxa Group Association No. 3 (Table 155) was comprised of fewer taxa which appeared to consistently prefer the conditions provided by P2 during all cruises. No primary indicators were identified and only three secondary indicators with moderate to high constancy and fidelity were characterized. None of the members of this Taxa Group Association have been reported as members of similar assemblage groups. Correlation analysis indicated that as distance from shore, depth, and salinity decreased, the density of Taxa Group Association No. 3 increased.

TABLE 155. Characteristic taxa of meiofauna Taxa Group Associations.

Taxa Group Association	Site Preference	Primary Indicators[1]	Constancy (%)	Fidelity (%)	Secondary Indicators[1]	Constancy (%)	Fidelity (%)
No. 1	P1	*Sabatieria* (N)	100	39	*Nonionella basiloba* (F)	64	35
	P2	Cyatholaimidae (N)	98	39	*Buliminella morgani* (F)	68	37
	C21	*Theristus* (N)	100	40	Gromiidae (Pr)	68	36
		Terschellingia (N)	100	45	*Parodontophora* (N)	51	45
		Ammonia beccarii (F)	100	46			
		Bolivina lowmani (F)	98	39			
		Linhomoeidae (N)	100	40			
		Dorylaimopsis (N)	100	40			
		Metacomesoma (N)	100	55			
No. 2	P3	*Tricoma* (N)	94	44	*Microlaimus* (N)	64	28
	P4	*Fursenkoina complanata* (F)	94	53	*Bulimina marginata* (F)	40	58
	C23	*Reophax scottii* (F)	77	67	*Florilus atlanticus* (F)	51	72
		Desmodoridae (N)	85	41	Chromadoridae (N)	55	58
		Ceramonematidae (N)	83	56	*Bolivina striatula* (F)	47	43
		Lagenammina comprima (F)	96	47	*Sphaerolaimus* (N)	60	42
		Cibicides concentricus (F)	91	53	*Halalaimus* (N)	60	44
					Echinoderes (K)	51	44
					Desmoscolex (N)	55	41
					Aricidea (P)	64	52
					Axonolaimidae (N)	57	56
					Fursenkoina pontoni (F)	51	77
No. 3[2]	P2				*Enhydrosoma hopkinsi* (H)	60	68
					Stenhelia (H)	56	74
					Buliminella elegantissima (F)	72	47

[1] (F) denotes Foraminifera
(Pr) denotes Rhizopoda, Protozoa
(N) denotes Nematoda
(K) denotes Kinorhyncha
(P) denotes Polychaeta
(H) denotes Harpacticoida

[2] Constancy and fidelity values based upon Cruises I and III only.

Meiofauna similarity between stations (Fig. 14) tended to almost parallel the Louisiana coast line. This pattern appeared to follow the major sediment depositional patterns. Moore (1979) found that meiobenthic faunal variation paralleled substrate composition. Wigley and McIntyre (1964) reported three meiobenthic zones or species groupings, geographically similar to those described for the macrobenthos: an inner continental shelf group, an outer continental shelf group, and a continental slope group. Moore (1979) also found that meiofaunal associations corresponded to those previously described for the macroinfauna, but that uniformity was greater within the macroinfauna community. Moore (1979) concluded that meiofauna exhibit a finer degree of preference along environmental gradients determining distributional patterns but the gradients involved appeared to be the same for the macroinfauna "resulting in an equivalence of community pattern where limits are set by localized steepening of environmental gradients."

Defenbaugh (1976) defined five macrofauna assemblage groups offshore Louisiana based primarily upon depth. Four of those assemblages apply to this study: inner shelf, 4 to 20 m; intermediate shelf, 20 to 60 m; outer shelf, 60 to 120 m; and pro-delta fan, 4 to 20 m. Meiofauna similarity between stations appeared to follow the assemblage groups of Defenbaugh (1976) fairly closely. However, there were some station similarities which crossed over these arbitrary depth zones. Sites P1, P2, S5, S8, S10, S11, S12, S19, S20, C22, and C24 tended to group within the inner shelf assemblage. Sites P3, P4, S16, and C23 tended to group within the intermediate shelf assemblage along with P2, S8, C21, C22, and C24 from the inner shelf. Sites S6, S7, S9, S13, S14, S15, S17, and S18 tended to group within the outer shelf assemblage, which sometimes included P3 and P4 from the intermediate shelf.

Taxa Group Association No. 1, occurring primarily at P1, P2, and C21, appeared to be included in the inner shelf assemblage. Taxa Group Association No. 2, at sites P3, P4, C23, and C24, appeared to be related to the intermediate shelf assemblage. No Taxa Group Association was identified that was related to the outer shelf assemblage. Taxa Group Association No. 3, occurring at P2, was also related to the inner shelf assemblage.

5. Macroinfauna

a. Polychaeta

(1) Population Trends—Eight polychaeta taxa were among the top 10 macroinfauna taxa common to each cruise: *Paraprionospio pinnata, Sigambra tentaculata, Cossure delta, Magelona phyllisae, Nephtys incisa, Lumbrineris tenuis, Tharyx marioni,* and *Nereis.* Increased dominance by a few taxa indicates stressed environmental conditions (Gray and Mirza, 1979). Several of the abiotic variables were found to be significantly correlated with the above taxa.

Paraprionospio pinnata was the most abundant macroinfauna taxon identified in this project. *Paraprionospio pinnata* occurred at 98% of the stations and was most abundant during Cruise I (April to May). As distance from shore, depth, and salinity decreased and smectite increased, the density of *P. pinnata* increased. This species has been reported from south Texas to the state of Mississippi (Table 156). It was most abundant in summer and least abundant in early spring.

Sigambra tentaculata occurred at 90% of the stations in this project and was third in overall abundance. Correlation analysis determined that as distance from shore, depth, and salinity decreased, the number of individuals of *S. tentaculata* increased. This species also increased under hypoxic bottom conditions. *Sigambra tentaculata* has been reported from south Texas to offshore South Carolina and may occur as deep as 4,000 m (Table 157).

Cossura delta occurred at 85% of the stations in this project and ranked fourth in overall abundance. Holland (1977) reported *C. delta* to rank as eighth with a 4.3% abundance and to be ubiquitous in the BLM South Texas OCS Project. Offshore Galveston, Texas, in the Buccaneer Oil Field, *C. delta* was found to be abundant during April and least abundant during January and February (Harper, 1977). Correlation analysis determined that as salinity and chitin degradation increased, the density of *C. delta* increased.

Magelona phyllisae occurred at 79% of the stations in this project and was fifth in overall abundance. *M. phyllisae* did not usually occur at P4 stations. Holland (1977) found *M. phyllisae* to be the numerical dominant in the BLM South Texas OCS Project and to occur at depths of 10 to 49 m with a 22.18% abundance. In this project, as distance from shore, depth, and salinity decreased, the density of *M. phyllisae* increased.

Nephtys incisa occurred at 80% of the stations in this project and was sixth in overall abundance. Correlation analysis indicated that as distance from shore, salinity, percent silt, and TOC increased and percent sand decreased, the density of *N. incisa* increased. This species was widely distributed from south Texas to Massachusetts and occurred as deep as 200 m (Table 158).

Lumbrineris tenuis occurred at 84% of the stations occupied in this project and ranked eighth in overall abundance. As distance from shore, depth, and salinity increased and percent clay, smectite, heterotrophic activity, cadmium, copper, nickel, and zinc decreased, the density of *L. tenuis* increased. This species was widely distributed from south Texas to Massachusetts and occurred at great depth (Table 159).

Tharyx marioni occurred at 79% of the stations sampled in this project and ranked ninth in overall abundance. Holland (1977) reported *T. marioni* to be ubiquitous in the BLM South Texas OCS Project. Offshore South Carolina it has been collected from the intertidal areas to 1000 m (Zingmark, 1978). Correlation analysis determined that as percent sand increased and percent silt, percent clay, TOC, median grain size, chromium, copper, iron, lead, and zinc decreased, the number of individuals of *T. marioni* increased.

The genus *Nereis* was identified at 74% of the stations occupied in this project and ranked tenth in overall abundance. As percent sand increased and percent silt, median grain size, TOC, total unsaturated hydrocarbons, chromium, copper, lead, iron, nickel, and zinc decreased, the density of *Nereis* increased. Members of the genus *Nereis* are widely distributed in the Gulf of Mexico and along the Atlantic coast of North America. Harper (1977) reported the genus to be abundant in October and least abundant in July in the Buccaneer Oil Field offshore Galveston, Texas.

TABLE 156. Reported occurrence of the polychaete *Paraprionospio pinnata.*

Locality	Remarks	Reference
Offshore South Texas	Second in abundance (18.25%)	Holland (1977)
Buccaneer Oil Field, Offshore Texas	July—most abundant; April—least abundant	Harper (1977)
Timbalier Bay, Louisiana	64 to 78% of total macrofauna	Kritzler (1974)
St. Louis Bay, Mississippi	Common, least abundant from February to June	Guy (1973)

TABLE 157. Reported occurrence of the polychaete *Sigambra tentaculata.*

Locality	Remarks	Reference
Offshore South Texas	Ubiquitous	Holland (1977)
Buccaneer Oil Field, Offshore Texas		Harper (1977)
Timbalier Bay, Louisiana	Abundant	Kritzler (1974)
Offshore South Carolina	Intertidal to 4,000 m	Zingmark (1978)

TABLE 158. Reported occurrence of the polychaete *Nephtys incisa.*

Locality	Remarks	Reference
Offshore South Texas	Rank—ninth; Ubiquitous	Holland (1977)
Buccaneer Oil Field, Offshore Texas		Harper (1977)
South Carolina	Intertidal to 200 m	Zingmark (1978)
Virginia Coast		Wass (1965)
Hampton Roads, Virginia		Boesch (1973)
Delmarva Peninsula		Maurer et al. (1976)
New York Bight	Rank—25th in abundance; Density—31.24 per m^2; Rank - 3rd in biomass	Pearce (1972) from Maurer et al. (1976); Botton (1979)
Quisset Harbor, Massachusetts		Levinton (1977)
Cape Cod Bay, Massachusetts		Young and Rhoads (1971)
Buzzard's Bay, Massachusetts	17% of total number of individuals; Rank—2nd	Sanders (1960)

TABLE 159. Reported occurrence of the polychaete *Lumbrineris tenuis.*

Locality	Remarks	Reference
Offshore South Texas	10 to 49 m	Holland (1977)
Buccaneer Oil Field, Offshore Texas	October—abundant; July—least abundant	Harper (1977)
Sabine Pass to Galveston, Texas	Mud-sand sediments	Keith and Hulings (1965)
Virginia Coast	Intertidal to abyssal	Zingmark (1978)
Hampton Roads, Virginia		Boesch (1973)
Assateague Island, Delmarva Peninsula		Woodin (1978)
Delaware Bay	11 to 25% and 51 to 75% silt clay	Kinner et al. (1974)
New York Bight	Density—272.87 per m^2; Rank—9th	Botton (1979)
Quisset Harbor, Massachusetts		Levinton (1977)
Buzzard's Bay, Massachusetts		Sanders (1960)
Hadley Harbor, Massachusetts	Sandflats and channels	Parker (1975)

Average percentage of total number of individuals of macroinfaunal Polychaeta by site for all three cruises is given in Fig. 15 above. Sites P1, S5, and C21, which are most influenced by the Mississippi River, had higher percentages of Polychaeta than did Sites S6, S7, S9, and S13 which were near the river mouth. Bayou Lafourche appeared to affect P2, S8, and S12. It was not apparent what caused the high percentage of polychaetes at S20. The high percentage of sand at S19 (Ship Shoal) did not appear to encourage a high percentage of Polychaeta.

Average diversity and evenness values for macroinfauna are presented in Table 72 above. Diversity was highest at S17 and S18 which had very low percentages of sand. Sites P1, S5, and C21, which were most often influenced by the Mississippi River, were characterized by low diversity values during all three cruises. Sites P2, S8, and S12, which might be influenced by Bayou Lafourche, had low to moderate diversities. The predominantly sandy S19 had a low diversity. Kritzler (1974) reported polychaete diversities of 2.26 to 3.23 at a production platform in a seasonal study in Timbalier Bay, Louisiana. Diversities at the Control ranged from 0.82 to 1.30. At the Gulf Field site in Timbalier Bay diversities ranged from 0.64 to 0.86 while at the Gulf Field Control diversities ranged from 1.40 to 3.84. Changes in diversity appeared to be the direct result of changes in number of species and not equitability.

(2) Trophic Composition— Table 160 presents the feeding types, based upon the literature, for 21 Polychaeta species found in this project. This information was obtained for only 13.2% of the Polychaeta taxa identified. There was conflicting information for *Eteone heteropoda, Nereis succinea, Glycera americana,* and *Clymenella torquata calida* (Young and Rhoads, 1971; Bloom, Simon, and Hunter, 1972; Levinton, 1977; Myers, 1977; Botton, 1979; Virnstein, 1979). Of the species in Table 160, 82.3% were detritivores and 17.7% were predators, scavengers, or carnivores.

b. Cluster Analysis

The classic study on the zoogeography of the invertebrates of the northwestern Gulf of Mexico remains that of Hedgpeth (1953). His work described the Transatlantic faunal province which encompasses most of the eastern coast of the United States (Cape Cod to Cape Canaveral) and much of the Gulf of Mexico (Texas to Sanibel Island or Tampa). At Cape Hatteras, the Transatlantic province can be divided into the Virginia (Cape Cod to Cape Hatteras) and Carolinian (Hatteras to Florida and the Northern Gulf of Mexico). The southern end of Florida and the southern part of the Gulf lie within the caribbean province.

The most comprehensive study of macroinvertebrates of the continental shelf of the Gulf of Mexico was that of Defenbaugh (1976). Based upon the bivalve mollusc distribution study of Pulley (1952) as taken from Defenbaugh, the Gulf of Mexico can be divided into five faunal provinces: Mexican, Texas-Transitional, Northwestern Gulf, Northeastern Gulf, and Southwestern Florida. Furthermore Defenbaugh divided the entire shelf of the Gulf of Mexico into 12 assemblage groups based upon depth, sediment type and salinity: inner shelf, Texas-Louisiana shelf, 4 to 20 m; pro-delta fan, 4 to 20 m; pro-delta sound, 4 to 20 m; inner shelf, west Florida shelf, 4 to 20 m; intermediate shelf, Texas-Louisiana, 20 to 60 m; intermediate shelf, west Florida shelf, 20 to 60 m; outer shelf, Texas-Louisiana shelf, 60 to 120 m; outer shelf, west Florida shelf,

TABLE 160. Feeding types, based upon the literature, of some Polychaeta taxa found in this project.

Taxa	Feeding Type[1]						
	Sanders (1960)	Young & Rhoads (1971)	Bloom et al. (1972)	Levinton (1977)	Myers (1977)	Botton (1979)	Virnstein (1979)
Eteone heteropoda			C,D-NS				AP
Gyptis vittata					?		
Nereis succinea			C,S				AB, D
Nephtys incisa		D		D-F		D	
Glycera americana			C, D-NS		C?		
Glycinde solitaria							AB
Onuphis eremita			D-NS				
Diopatra cuprea			C, S			C	
Drilonereis longa						C	
Dorvillea caeca	C?						
Lumbrineris tenuis	D-NS					D	
Scoloplos rubra			D-NS				
Paraonis gracilis	D-S	D					
Polydora ligni							TD
Scolelepis squamata							AB, PM, D-S
Spiochaetopterus oculatus							TS
Capitella capitata		D			D	D	
Clymenella torquata calida		D?		S		D	
Pectinaria gouldii			D-S	D-NS			
Polycirrus eximius					D-S		
Terebellides stroemii		D					

[1] C = carnivore
S = Scavenger
D-S = selective deposit feeder
D-NS = non-selective deposit feeder
D = deposit feeder
AB = active burrower
AP = active predator
PM = predator on meiofauna
TD = tube-dwelling surface deposit feeder
TS = tube-dwelling surface feeder
D-F = facultative deposit feeder
S = swallower
? = questionable based on literature source

60 to 120 m; upper slope, Texas-Louisiana shelf, 120 to 200 m; upper slope, west Florida shelf, 120 to 200 m; submarine bank, Texas-Louisiana shelf, 20 to 100 m; and Florida Middle Ground, 30 to 60 m. These assemblage groups were based not only upon the work of Defenbaugh (1976) but also previous studies. Therefore, the study area for the present project is included within the Northwestern Gulf Province and contains four reported assemblage groups: inner shelf, intermediate shelf, outer shelf, and the pro-delta.

Stanton and Evans (1972), in a study of molluscan biofacies from Southwest Pass to eastward of the Mississippi delta, reported the extension of the inner shelf and outer shelf biofacies (herein equated to assemblage groups of Defenbaugh (1976)) to south of the delta with the absence of the intermediate shelf assemblage.

Farrell (1974*a, b*), in his study of the benthic communities in the vicinity of producing oil wells on the shallow Louisiana continental shelf concluded that his study area belonged to a common biocoenosis. This biocoenosis appeared to the senior author to be included within our inner shelf assemblage. Farrell (1974*a, b*) also reported an exchange of species between the shelf and Timbalier Bay. The shallow shelf (5 m) demonstrated a high degree of similarity to central regions of the Bay as indicated by the distribution of the bivalve *Mulinia lateralis.*

In the BLM South Texas OCS Project, five station groups based upon infauna data could be identified by depth: shallow, 10 to 27 m; shallow-intermediate, 18 to 24 m; intermediate, 34 to 49 m; deep-intermediate, 69 to 100 m; and deep, 106 to 134 m (Holland, 1979).

Harper (1970), in a study of the macroinfauna offshore Galveston, Texas, identified three animal communities in relation to substrate type: sandy bottom, mixed bottom, and muddy bottom. Harper's communities fall within the inner shelf assemblage of Defenbaugh (1976). Harper (1977) in his study of the Buccaneer Oil Field offshore Galveston, Texas, identified four site groups and six species groups. Again, this area lies within the inner shelf assemblage.

In the BLM MAFLA OCS Project, seven species associations were defined by cluster analysis. The clusters followed depth contours and the four principal clusters represented faunas along contours of 20, 40, 100, and 200 m (Dames and Moore, 1979). These clusters correspond closely to the assemblages established by Defenbaugh (1976).

Community structure defined by individual taxa can be expressed as a measure of constancy and fidelity (Stephenson et al., 1970). This is discussed above in the section on Meiofauna Cluster Analysis. Table 161 lists those taxa which characterize the macroinfauna Taxa Group Associations. Primary indicators are those taxa which occurred in at least one subcomponent or Taxa Group during each cruise. Secondary indicators are those taxa which occurred in at least one subcomponent during two of the three cruises. Taxa Group Association No. 2 had no primary indicators since the Cruise II subcomponent was missing. Measures of constancy and fidelity are also given.

Macroinfauna Taxa Group Association No. 1 was composed of several ubiquitous taxa, some of which are individually discussed under the section on Polychaeta above. This Taxa Group Association appeared to prefer Sites P1, P2, C21, C22, and C24 over all cruises. Both primary and secondary indicators showed high constancy and moderate fidelity. All of the indicators but one were polychaetes. Correlation analysis indicated that as distance from shore, depth, and salinity decreased and hypoxic bottom conditions increased, density of Taxa Group Association No. 1 increased.

Table 162 presents previously reported associations of the characteristic taxa of macroinfauna Taxa Group Associations. In the past, *Paraprionospio pinnata* has been grouped with *Sigambra tentaculata* and *Diopatra cuprea*. In previous studies some of the members of Taxa Group Association No. 1 have been grouped with members of other Taxa Group Associations, but with little consistency. The exception was *D. cuprea*, which was grouped by Harper (1977) and Sanders (1958, 1960) with *Glycera americana*.

Macroinfauna Taxa Group Association No. 2 was composed of several more common taxa. This Taxa Group Association occurred in greatest densities at P2 and C21 during all three cruises. Secondary indicators showed high constancy and moderate to high fidelity. The secondary indicator *Balanoglossus* was the sole member of Cluster IV in the Buccaneer Oil Field (Harper, 1977). Correlation analysis indicated that as distance from shore, depth, and salinity decreased, the number of individuals of Taxa Group Association No. 2 increased.

Taxa Group Association No. 3 consisted of several taxa which appeared to prefer the environment provided at P3, except for Station S2000. Only one primary indicator was defined, but it showed high constancy and moderate fidelity. Eight secondary indicators, mostly polychaetes, were defined and demonstrated high constancy and low to high fidelity. Secondary indicators did not tend to be grouped together or with members of other Taxa Group Associations except for *G. americana* which is discussed above (Table 160). Correlation analysis indicated that as percent sand increased and percent silt, TOC, chromium, and iron decreased, the density of Taxa Group Association No. 3 increased.

Taxa Group Association No. 4 preferred sites P3 S2000, P4, and C23 over all three cruises. Correlation analysis indicated that as distance from shore and percent silt increased and temperature, percent sand, and hypoxic bottom conditions decreased, the density of Taxa Group Association No. 4 increased. Again only one primary indicator was defined, but it showed high constancy and moderate fidelity. Eight secondary indicators included gastropods, a bivalve, and polychaetes which demonstrated high constancy and low to high fidelity. Three of the secondary indicators and the primary indicator were members of other

TABLE 161. Characteristic taxa of macroinfauna Taxa Group Associations.

Taxa Group Association	Site Preference	Primary Indicators[1]	Constancy (%)	Fidelity (%)	Secondary Indicators[1]	Constancy (%)	Fidelity (%)
No. 1	P1	*Paraprionospio pinnata* (P)	99	48	*Nereis* (P)	78	51
	P2	*Golfingia bulbosa* (Si)	91	60	*Diopatra cuprea* (P)	85	56
	C21	*Magelona phyllisae* (P)	100	61			
	C22	*Sigambra tentaculata* (P)	100	54			
	C24						
No. 2[2]	P2				*Balanoglossus* (Ce)	78	93
	C21				*Lepidasthenia* (P)	89	50
No. 3	P3	*Ceratonereis irritabilis* (P)	95	53	*Glycera americana* (P)	95	32
					Prionospio cristata (P)	91	58
					Aricidea fragilis (P)	100	38
					Photis macromanus (A)	81	63
					Prionospio cirrobranchiata (P)	93	36
					Tharyx marioni (P)	100	20
					Tharyx setigera (P)	86	46
					Ampelisca verrilli (A)	79	73
No. 4	P3 S2000	*Ninoe nigripes* (P)	100	65	*Volvulella texasiana* (G)	88	48
	P4				*Magelona filiformis* (P)	82	60
	C23				*Cingula* (G)	79	87
					Armandia maculata (P)	95	39
					Cossura delta (P)	98	37
					Nephtys incisa (P)	100	40
					Corbula contracta (B)	95	39
					Prionospio cirrifera (P)	74	31

[1] (P) denotes Polychaeta
(G) denotes Gastropoda
(B) denotes Bivalvia
(A) denotes Amphipoda
(Si) denotes Sipunculida
(Ce) denotes Cephalochordata

[2] Constancy and fidelity value based upon Cruises I and III only.

TABLE 162. Previously reported associations of the characteristic taxa of macroinfauna Taxa Group Associations.

Taxa[1]	Taxa Group Association	Offshore South Texas (Holland, 1979)			Buccaneer Oil Field, Offshore Texas (Harper, 1977)		Offshore Galveston, Tx (Harper, 1970)			Texas-Louisiana Shelf (Defenbaugh, 1976)		Hampton Roads, VA (Boesch, 1973)				Buzzards Bay, MA (Sanders, 1958, 1960)		Hadley Harbor, MA (Parker, 1975)			
		Species Groups			Clusters		Animal Communities			Assemblages		Associations				Communities		Habitats			
		I Ubiquitous, High Constancy, Low Fidelity	II High Constancy, Deep and Intermediate Deep Stations	III High Constancy and Fidelity, Shallow Stations	I	IV	Sandy Bottom	Mixed Bottom	Muddy Bottom	Inner Shelf	Intermediate Shelf	Elizabeth River	Mud	Muddy Sand	Sand	Soft Bottom *Nephthys incisa* *Nucula proxima*	Sand Bottom *Ampelisca*	Inner Harbor	Sand Flats	Channels	Eel Grass
Paraprionospio pinnata **(P)**	1	X			X							X	X	X							
Magelona phyllisae **(P)**	1			X																	
Sigambra tentaculata **(P)**	1	X			X																
Diopatra cuprea **(P)**	1				X					X	X					X	X		X		
Balanoglossus **(Ce)**	2					X															
Glycera americana **(P)**	3				X											X	X	X		X	
Prionospio cristata **(P)**	3			X																	
Tharyx marioni **(P)**	3	X																			
Ampelisca verrilli **(P)**	3		X												X						
Volvulella texasiana **(G)**	4	X							X												
Cossura delta **(P)**	4				X																
Nephtys incisa **(P)**	4	X														X	X	X		X	X
Ninoe nigripes **(P)**	4															X	X				

[1] (P) denotes Polychaeta
(G) denotes Gastropoda
(Ce) denotes Cephalochordata

associations in other studies (Table 162). *Nephtys incisa* and *Ninoe nigripes* were grouped together in Buzzards Bay. *Nephtys incisa* also tended to be grouped with *G. americana* in Buzzards Bay and Hadley Harbor (Sanders, 1958, 1960; Parker, 1975).

None of the indicators of the macroinfauna Taxa Group Associations were also indicators of the meiofauna Taxa Group Associations. Sites P3, P4, S14, S15, S16, S17, S18, and C23 tended to group within the intermediate shelf assemblage. Sites S6, S7, S9, and S13 may correspond to the pro-delta assemblage, but with different depth limits. However, the above sites are probably more closely related to the intermediate shelf assemblage. There was no crossover of depth zones in station similarity.

Taxa Group Association Nos. 1 and 2 should be included in the inner shelf assemblage. Taxa Group Association Nos. 3 and 4 appeared to be related to the intermediate shelf assemblage.

6. Macroepifauna and Demersal Fish

a. Decapoda

Only two decapod taxa were among either the top ten or commercially important macroepifauna taxa collected in this project: *Penaeus aztecus* and *P. setiferus*. Note that increased dominance by a few taxa indicates a stressed environment (Gray and Mirza, 1979). Several of the abiotic variables were found to be significantly correlated with the above taxa.

Penaeus aztecus occurred at only 55% of the sites sampled in this project. It was not collected at P1, C22, or C24 during any of the three cruises. As percent silt, total unsaturated hydrocarbons, oil agar counts, cadmium, copper, and nickel decreased, the density of *P. aztecus* increased. This species has been reported over much of the Gulf of Mexico by Hedgpeth (1953), Farfante (1967), and Thompson (1974); Farfante (1967) lists collecting localities from Florida to Massachusetts. *Penaeus aztecus* has been readily caught from south Texas to the Desoto Canyon in depths of 0 to 120 m (Table 163).

Penaeus setiferus was collected at only seven sites in this project. As distance from shore, depth, salinity, and chitin degradation decreased and copper, nickel, and cadmium increased, the density of *P. setiferus* increased. The National Marine Fisheries Service (NMFS) Gulf of Mexico Statistical Area No. 14 extends seaward and includes the area from Bayou Lafourche to the Atchafalaya River. Dr. Charles W. Caillouet (*personal communication*) and NMFS (1971, 1972, 1973, 1976, 1977*a,b*), reported that little commercial shrimping was done in Statistical Area No. 14 and that shrimp density was low. The largest concentration of oil producing platforms in the Gulf of Mexico is located in Statistical Area No. 14. See the section on Hypoxic Bottom Conditions above.

b. Osteichthyes

Seven species of demersal fish were either among the top 15 or commercially important macroepifauna and demersal fish collected: *Prionotus rubio, Halieutichthys aculeatus, Cynoscion arenarius, C. nothus, Leiostomus xanthurus, Menticirrhus americanus,*

TABLE 163. Reported occurrence of the decapod *Penaeus aztecus.*

Locality	Remarks	Reference
Offshore South Texas	1 to 90 m	Holland (1977)
Offshore Mexico	0 to 90 m	Defenbaugh (1976)
Texas to Mississippi Delta	0 to 200 m	
Delta to Desoto Canyon	0 to 90 m	
Texas to Louisiana Inner Shelf Assemblage	4 to 20 m; Sand-mud, 36%	Defenbaugh (1976)
Intermediate Shelf Assemblage	20 to 60 m; Sand-mud, 36%	
Outer Shelf Assemblage	60 to 120 m; Mud, 36%	
Pro-delta Assemblage	4 to 20 m; Silty muds, 24 to 34%	
Buccaneer Oil Field, Offshore Texas		Emiliani et al. (1977)
Grand Isle, Louisiana		Behre (1950)
Offshore Louisiana		Ragan et al. (1978)
Georgia Bight, South Atlantic	Patchily distributed over entire shelf	George and Staiger (1979)

and *Micropogon undulatus*. Increased dominance by a few taxa indicates a stressed environment (Gray and Mirza, 1979).

Prionotus rubio occurred at 63% of the sites in this project and ranked first in overall abundance. As sulfate oxidation and marine agar counts decreased and D.O., percent silt, median grain size, ethane, propane, the contamination index, iron, and heterotrophic activity increased, the density of *P. rubio* increased. This species has been collected from south Texas to offshore Alabama, Mississippi, and West Florida (Table 164).

Halieutichthys aculeatus occurred at only 53% of the sites sampled in this project and ranked fourth in overall abundance. As temperature decreased and distance from shore, salinity, depth, percent silt, median grain size, oil agar counts, iron, ethane and propane in the water column, and the contamination index increased, the density of *H. aculeatus* increased. This species has been reported from South Texas to Louisiana (Table 165).

Micropogon undulatus was collected at only 33% of the sites sampled in this project and ranked 18th in overall abundance. As percent silt, median grain size, oil agar counts, copper, and nickel decreased and temperature increased, the density of *M. undulatus* increased. This species has been reported to be the dominant fish, not only offshore Louisiana, but in the entire Gulf of Mexico (Ragan et al., 1978). It has been reported from the south Texas shelf to the Louisiana continental shelf (Behre, 1950; Perry, 1974; Thompson, 1974; Emiliani et al., 1977; Wohlschlag, 1977) and in the Georgia Bight (George and Staiger, 1979).

Leiostomus xanthurus occurred at 28% of the sites sampled in this project and ranked 26th in overall abundance. As marine agar counts and chitin degradation decreased and temperature, percent silt, and median grain size increased, the density of *L. xanthurus* increased. This species has been reported from offshore Louisiana (Behre, 1950; Perry, 1974; Thompson, 1974), the Buccaneer Oil Field (Emiliani et al., 1977), and the Georgia Bight (George and Staiger, 1979).

Cynoscion arenarius occurred at only 23% of the sites sampled in this project and ranked 36th in overall abundance. As chitin degradation, percent silt, median grain size, oil agar counts, copper, nickel, heterotrophic activity, and total unsaturated hydrocarbons decreased, the density of *C. arenarius* increased. *Cynoscion nothus* occurred at 23% of the sites and ranked 40th in overall abundance. Both *C. arenarius* and *C. nothus* have demonstrated the same distribution pattern, being collected from south Texas to the Louisiana shelf (Table 166). However, only *C. nothus* was reported by George and Staiger (1979) in the BLM South Atlantic OCS Project.

Menticirrhus americanus occurred at only 20% of the sites sampled in this project and ranked 52nd in overall abundance. As distance from shore, depth, salinity, and iron decreased and marine agar counts increased, the density of *M. americanus* increased. This species has been reported from south Texas to the Louisiana shelf (Behre, 1950; Perry, 1974; Thompson, 1974; Emiliani et al., 1977; Wohlschlag, 1977) and the Georgia Bight (George and Staiger, 1979).

TABLE 164. Reported occurrence of the demersal fish *Prionotus rubio*.

Locality	Remarks	Reference
Offshore South Texas	Predominant-night, during fall	Holland (1977), Wohlschlag (1977)
Buccaneer Oil Field, Offshore Texas		Emiliani et al. (1977)
Timbalier Bay, Louisiana		Perry (1974)
Offshore Louisiana Shelf		Ragan et al. (1978)
Offshore Alabama, Mississippi, West Florida		Dames and Moore (1979)

TABLE 165. Reported occurrence of the demersal fish *Halieutichthys aculeatus*.

Locality	Remarks	Reference
Offshore South Texas	Predominant-night and during fall	Holland (1977), Wohlschlag (1977)
Buccaneer Oil Field, Offshore Texas		Emiliani et al. (1977)
Timbalier Bay, Louisiana		Perry (1974)
Offshore Louisiana Shelf		Ragan et al. (1978)

TABLE 166. Reported occurrence of the demersal fish *Cynoscion arenarius* and *C. nothus*.

Locality	Remarks	Reference
Offshore South Texas	Predominant-night	Wohlschlag (1977)
Buccaneer Oil Field, Offshore Texas		Emiliani et al. (1977)
Timbalier Bay, Louisiana		Perry (1974)
Grand Isle, Louisiana		Behre (1950)
Offshore Louisiana		Thompson (1974)

c. Cluster Analysis

Faunal assemblages for macroepifauna are essentially the same as those proposed by Defenbaugh (1976) and are discussed above in the section on Macroinfauna Cluster Analysis. Chittenden and McEachran (1976) provide a good discussion of the demersal fish communities in the Gulf of Mexico. At least four distinct demersal fish communities can be recognized: white shrimp grounds, 3.5 to 22 m in terrigenous muds; brown shrimp grounds, 22 to 91 m terrigenous muds; pink shrimp grounds, less than 45 to 64 m in biogenic calcareous sediments; and a superimposed broken relief fauna composed primarily of tropical reef fishes. The predominant fishes of the white shrimp grounds are in the family Sciaenidae and *Micropogon undulatus* is the dominant species. *Stenotomus caprinus* of the family Sparidae is dominant on the brown shrimp grounds. Bathymetric distribution of the white and brown shrimp grounds is affected by salinity and/or associated factors (Chittenden and McEachran, 1976). The white shrimp grounds and brown shrimp grounds roughly correspond to the inner shelf and intermediate shelf assemblages, respectively, of Defenbaugh (1976).

In the BLM South Texas OCS Project, the following station groups based upon seasonal epifauna data were defined: shallow, 10 to 15 m; shallow-intermediate, 22 to 45 m; deep-intermediate, 47 to 100 m; and deep, 106 to 134 m (Holland, 1979). Based upon the demersal fish data, three station groups were identified: Group 1, shallow, <30 m; Group 2, mid-depth, 31 to 90 m; and Group 3, deep, >91 m (Wohlschlag, 1979). Based upon characteristic species, two other depth zones, which reflected crossover between groups 1 and 3 above, were identified: shallow to mid-depth and mid-depth to deep.

In the BLM South Atlantic OCS Project, both the macroepifauna and demersal fish were divided by cluster analysis into inner-shelf, midshelf, outer-shelf, and deep-slope zones with the shelf zones longitudinally parallel to the shore and shelf break (George and Staiger, 1979). There were definite seasonal shifts in the major shelf zone boundaries and the winter faunal assemblage was generally dominant in the inner shelf. The northern part of the inner-shelf zone contains faunal elements of the Virginia province while the southern part merges with the tropical caribbean faunal province. The BLM South Atlantic OCS study area belongs to the Carolinian province and contains a transitional fauna with a mixture of northern and southern species and some endemic species (George and Staiger, 1979).

Community structure defined by individual taxa can be expressed as a measure of constancy and fidelity (Stephenson et al., 1970). This is discussed above in the section on Meiofauna Cluster Analysis. Table 167 lists those taxa which characterize the macroepifauna and demersal fish Taxa Group Associations. Primary indicators are those taxa which occurred in at least one subcomponent or Taxa Group during each cruise. Secondary indicators are those taxa which occurred in at least one subcomponent during two of the three cruises. Taxa Group Association No. 2 had no primary indicators since the Cruise II subcomponent was missing. Measures of constancy and fidelity are also given.

Macroepifauna Taxa Group Association No.1 (Table 167) was composed of several ubiquitous taxa some of which are individually discussed under the sections on Decapoda and Osteichthyes above. This Taxa Group Association appeared to prefer Sites P3, P4, and C23 over all cruises. Correlation analysis indicated that as distance from shore and depth increased and presence of hypoxic bottom conditions decreased, the density of Taxa Group Association No. 1 increased. Six primary indicators with high constancy and fidelity were defined and included two decapods, one asteroid, and three demersal fish (Table 167). Twelve secondary indicators had low to high constancy and medium to high fidelity. Note the low constancy of *Bollmannia communis* and the 100% fidelity of *Sicyonia brevirostris*, *Cyclopsetta chittendeni*, and *Diplectrum bivittatum*. Fifty-eight percent of the secondary indicators were demersal fish.

Table 168 lists previously reported associations of the characteristic taxa of macroepifauna and demersal fish Taxa Group Associations. *Trachypenaeus similis*, *Squilla empusa*, *Sicyonia dorsalis*, and *Penaeus aztecus* tended to be grouped together or occur together on the Texas-Louisiana shelf from south Texas to east of the Mississippi River. *Astropecten duplicatus* and *S. brevirostris* were occasionally associated with the above species. Depth distribution ranged from 1 to 120 m. *Squilla chydaea* occurred as deep as 200 m.

Taxa Group Association No. 2 (Table 167) was composed of several more common taxa which occurred in greatest densities at P1, C21, and C24. Correlation analysis did not indicate any significant correlation with the abiotic variables. Only two secondary indicators were defined and both had high constancy and fidelity. *Pagurus pollicaris* has been reported from the inner shelf and pro-delta sound assemblages on the Texas-Louisiana shelf (Table 168).

None of the indicators of the macroepifauna and demersal fish Taxa Group Associations were also

TABLE 167. Characteristic taxa of macroepifauna and demersal fish Taxa Group Association.

Taxa Group Associations	Site Preference	Primary Indicators[1]	Constancy (%)	Fidelity (%)	Secondary Indicators[1]	Constancy (%)	Fidelity (%)
No. 1	P3	*Leiolambrus nitidus* (D)	79	88	*Squilla empusa* (S)	63	55
	P4	*Prionotus rubio* (O)	84	64	*Sicyonia brevirostris* (D)	42	100
	C23	*Stenotomus caprinus* (O)	4	93	*Squilla chydaea* (S)	56	75
		Halieutichthys aculeatus (O)	84	80	*Bollmannia communis* (O)	31	83
		Trachypenaeus similis (D)	63	71	*Sicyonia dorsalis* (D)	47	82
		Astropecten duplicatus (As)	74	82	*Cyclopsetta chittendeni* (O)	74	100
					Citharichthys spilopterus (O)	53	59
					Centropristis philadelphicus (O)	63	92
					Etropus crossotus (O)	58	55
					Syacium gunteri (O)	64	69
					Penaeus aztecus (D)	90	77
					Diplectrum bivittatum (O)	79	100
No. 2[2]	P1 C21 C24				*Calliactis tricolor* (An)	75	75
					Pagurus pollicaris (D)	75	75

[1](An) denotes Anthozoa
(D) denotes Decapoda
(S) denotes Stomatopoda
(As) denotes Asteroidea
(O) denotes Osteichthyes
[2]Constancy and fidelity values based upon Cruises I and III only.

TABLE 168. Previously reported associations of the characteristic taxa of macroepifauna and demersal fish Taxa Group Associations.

		Offshore South Texas (Wohlschlag, 1979)			Offshore South Texas (Holland, 1977)			Offshore Mississippi, Alabama, and West Florida (Dames and Moore, 1979)
		Depth Zones			Depth Zones			Clusters
Taxa	Taxa Group Associations	Shallow	Mid-Depth	Mid-Depth to Deep	Shallow (1 to 30m)	Shallow—Intermediate (20 to 60m)	Deep—Intermediate (30 to 90m)	III (33 to 50m)
Leiolambrus nitidus (D)[1]	1							
Stenotomus caprinus (O)	1			X				
Trachypenaeus similis (D)	1				X	X		
Astropecten duplicatus (As)	1					X	X	
Squilla empusa (S)	1				X	X		
Sicyonia brevirostris (D)	1							X
Squilla chydaea (S)	1					X	X	
Sicyonia dorsalis (D)	1							
Citharichthys spilopterus (O)	1	X						
Centropristis philadelphicus (O)	1		X					
Pagurus pollicaris (D)	2							
Penaeus aztecus (D)	1							

[1](D) denotes Decapoda
(S) denotes Stomatopoda
(As) denotes Asteroidea
(O) denotes Osteichthyes

TABLE 168. Previously reported associations of the characteristic taxa of macroepifauna and demersal fish Taxa Group Associations (Cont'd).

		Texas—Louisiana Shelf (Defenbaugh, 1976)						Georgia Bight (George and Staiger, 1979)			
		Assemblage						Depth Zones/Assemblages			
Taxa	Taxa Group Associations	Inner Shelf (4 to 20m)	Pro-Delta Fan (4 to 20m)	Pro-Delta Sound (4 to 20m)	Intermediate Shelf (20 to 60m)	Outer Shelf (60 to 120m)	Upper Slope (120 to 200m)	Inner Shelf	Mid Shelf	Outer Shelf	Deep Slope
Leiolambrus nitidus (D)[1]	1					X					
Stenotomus caprinus (O)	1										
Trachypenaeus similis (D)	1	X	X	X	X	X					
Astropecten duplicatus (As)	1				X	X					
Squilla empusa (S)	1	X	X	X	X						
Sicyonia brevirostris (D)	1	X			X	X			X	X	
Squilla chydaea (S)	1				X		X				
Sicyonia dorsalis (D)	1	X	X	X	X						
Citharichthys spilopterus (O)	1										
Centropristis philadelphicus (O)	1								X	X	
Pagurus pollicaris (D)	2	X		X							
Penaeus aztecus (D)	1	X	X	X	X	X		X			

[1](D) denotes Decapoda
(S) denotes Stomatopoda
(As) denotes Asteroidea
(O) denotes Osteichthyes

indicators for meiofauna or macroinfauna Taxa Group Associations.

Macroepifauna and demersal fish similarity between stations is presented in Fig. 29 above. Station similarity patterns closely corresponded to sediment patterns and to the macrofauna assemblages of Defenbaugh (1976). Sites P1, P2, S5, S8, S10, S11, S12, S18, S19, S20, C21, C22, and C24 tended to group within the inner-shelf assemblage. Sites P3, P4, S6, S7, S9, S13, S14, S15, S16, S17, and C23 tended to group within the intermediate-shelf assemblage. Crossover between these depth zones occurred at Sites P2, P3, P4, C22, and C23.

Taxa Group Association No. 1 should be included in the intermediate shelf assemblage and Taxa Group Association No. 2 should be included with the inner shelf assemblage group.

C. Effects of Petroleum Production Platform Activity on Benthic Populations on the Louisiana Continental Shelf

1. Factors Affecting Population Trends

Of 39 physical, chemical, sediment, organic, trace metal, and microbiological variables (Table 102) identified as possibly affecting population trends, all but seven consistently demonstrated a correlative relationship over more than one cruise with 44 biological variables (Tables 103-129). Tables 169, 170, and 171 summarize the significant correlations for meiofauna, macroinfauna, and macroepifauna and demersal fish, respectively.

a. Physical, Chemical, Sediment, and Microbiological Variables

McKee and Wolf (1963), Kemp et. al.(1971), and the U.S. Environmental Protection Agency (EPA) (1976) have described the effects of physical, chemical, and sediment abiotic variables upon various organisms. Under certain conditions, depth, salinity, temperature, dissolved oxygen, hypoxic bottom conditions, and sediment type can become critical to the survival of marine organisms. Distance from shore and from the mouth of the Mississippi River is reflected in the amount of freshwater runoff and associated sediment and organic load. Continued input of organic rich runoff results in extensive turbidity plumes, which can cause high sedimentation and reduced D.O. The EPA (1976) recommended a minimum concentration of 5.0 mg/l D.O. to maintain good fish populations. No minimum values were recommended for the other abiotic variables.

As shown in Table 169, *Ammonia beccarii*, *Sabatieria*, *Theristus*, *Terschellingia*, and Meiofauna Taxa Group Association Nos. 1 and 3 all tended to

TABLE 169. Summary of significant correlations between meiofauna biotic variables and selected abiotic variables over all cruises[1].

	Biotic Variables[2]												
Abiotic Variables[3]	Number of Species	Heip Evenness	*Buliminella morgani*	*Ammonia beccarii*	*Sabatieria*	Cyatholaimidae	*Theristus*	Linhomoeidae	*Terschellingia*	Chromadoridae	Meiofauna Taxa Group Association No. 1	Meiofauna Taxa Group Association No. 2	Meiofauna Taxa Group Association No. 3
DSHORE			+	-	-		-		-		-	+	-
DMISS							-		-				
BDEAD[4]				+	+		+		+	-		+	
DEPTH			+	-	-	-	-	-	-		-	+	-
SALIN			+	-	-		-		-		-		-
TEMP							-					-	
D.O.									-			+	
SAND										+			
SILT										-			
MEDIAN[5]	-						-						
STD					+								
ETHANE						-	-						
PROPANE						-	-						
CI							-						
LMA										+			
LCHI			+										
LCD									+				
LCR	-									-			
LCU	-												
LNI	-	+											
LPB	-						-			-			
LZN	-									-			

[1] Consistency of a correlative relationship over more than one cruise and the logical trend of the correlation were measures used to determine the credibility of the correlation.

[2] A plus sign indicates that the biotic variable increased as the abiotic variable increased. A negative sign indicates that the biotic variable increased as the abiotic variable decreased.

[3] See TABLE 102 for explanation of the variable code.

[4] A plus sign indicates that the biotic variable increased in the presence of hypoxic bottom conditions. A negative sign indicates that the biotic variable decreased in hypoxic bottom conditions.

[5] Median grain size was calculated in phi units. As phi units increased, grain size decreased.

TABLE 170. Summary of significant correlations between macroinfauna biotic variables and selected abiotic variables over all cruises.[1]

	Biotic Variables[2]																
Abiotic Variables[3]	Number of Species	Number of Individuals	Diversity	Pielou Evennes	Heip Evenness	*Paraprionospio pinnata*[1]	*Sigambra tentaculata*[1]	*Cossura delta*[4]	*Magelona phyllisae*[1]	*Nephtys incisa*[4]	*Lumbrineris tenuis*	*Tharyx marioni*[5]	*Nereis*[1]	Macroinfauna Taxa Group Association No. 1	Macroinfauna Taxa Group Association No. 2	Macroinfauna Taxa Group Association No. 3	Macroinfauna Taxa Group Association No. 4
DSHORE		-	+	+	+	-	-		-	+	+			-	-		+
BDEAD[4]				-			+							+			-
DEPTH		-		+	+	-	-		-		+			-	-		
SALIN		-	+	+	+	-	-	+	-	+	+			-	-		
TEMP																	-
D.O.			+	+	+												
SAND					+					-		+	+			+	-
SILT	+	-								+		-	-			-	+
CLAY											-	-					
SMECT						+					-						
MEDIAN[5]	+				+							-	-				
TOC	+			+	+					+		-	-			-	
LT2													-				
LCHI								+									
LHET											-						
LCD											-						
LCR	+	-		+	+							-	-			-	
LCU											-	-	-				
LFE												-	-			-	
LNI											-		-				
LPB	+	-		+	+							-	-				
LZN	+										-	-	-				

[1] Consistency of a correlative relationship over more than one cruise and the logical trend of the correlation were measures used to determine the credibility of the correlation.

[2] A plus sign indicates that the biotic variable increased as the abiotic variable increased. A negative sign indicates that the biotic variable increased as the abiotic variable decreased.

[3] See TABLE 102 for explanation of the variable code.

[4] A plus sign indicates that the biotic variable increased in the presence of hypoxic bottom conditions. A negative sign indicates that the biotic variable decreased in hypoxic bottom conditions.

[5] Median grain size was calculated in phi units. As phi units increased, grain size decreased.

TABLE 171. Summary of significant correlations between macroepifauna and demersal fish biotic variables and selected abiotic variables over all cruises.[1]

Abiotic Variables[3]	Biotic Variables[2]													
	Number of Species	Number of Individuals	Diversity	Pielou Evenness	Heip Evenness	*Penaeus aztecus*[1]	*Penaeus setiferus*	*Prionotus rubio*[1]	*Halieutichthys aculeatus*[1]	*Micropogon undulatus*	*Leiostomus xanthurus*	*Cynoscion arenarius*	*Menticirrhus americanus*	Macroepifauna and Demersal Fish Taxa Group Association No. 1
DSHORE	+		-				-		+				-	+
DMISS			-	-										
BDEAD[4]														-
DEPTH			-				-		+				-	+
SALIN					-		-		+				-	
TEMP									-	+	+			
D.O.		+	-	-				+						
SILT						-		+	+	-	+	-		
MEDIAN[5]								+	+	-	+	-		
ETHANE								+	+					
PROPANE								+	+					
CI								+	+					
LT2						-						-		
LOA									+	-		-		
LMA								-			-		+	
LSO4								-						
LCHI							-				-	-		
LHET								+				-		
LPRO			+	+	+									
LSOX					-									
LCD			+		-	+								
LCU		-	+	+		-	+			-		-		
LFE								+	+				-	
LNI		-	+	+		-	+			-		-		
LZN			+											

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[1] Consistency of a correlative relationship over more than one cruise and the logical trend of the correlation were measures used to determine the credibility of the correlation.

[2] A plus sign indicates that the biotic variable increased as the abiotic variable increased. A negative sign indicates that the biotic variable increased as the abiotic variable decreased.

[3] See TABLE 102 for explanation of the variable code.

[4] A plus sign indicates that the biotic variable increased in the presence of hypoxic bottom conditions. A negative sign indicates that the biotic variable decreased in hypoxic bottom conditions.

[5] Median grain size was calculated in phi units. As phi units increased, grain size decreased.

increase in density nearshore (DSHORE), close to the mouth of the Mississippi (DMISS), in shallow depths, lower salinities, lower temperatures, and lower dissolved oxygen (D.O.). All of the above appeared to prefer coarser sediments even though there was no significant correlation with sand. *Sabatieria* did increase as skewness (STD) increased and *Theristus* increased as the median diameter decreased. *Buliminella morgani* and Meiofauna Taxa Group Association No. 2 increased as distance from shore, depth, salinity, and D.O. increased. This trend appears to be related to a preference for finer sediments found typically offshore. However, there was not a significant correlation with silt. *Ammonia beccarii, Sabatieria, Theristus,* and *Terschellingia* all had higher densities in the vicinity of hypoxic bottom conditions. Note that *Terschellingia* density was greater in low D.O. and hypoxic bottom conditions, while Meiofauna Taxa Group Association No. 2 had an opposite reaction to these conditions. The correlation of *B. morgani* and Chromadoridae with chitin degradation (LCHI) and marine agar counts (LMA) may indicate a preference for these bacterial types as a food source or a relatedness to their nutrient source. In summary, distance from shore, presence of hypoxic bottom conditions, depth, and salinity appeared to have the greatest effect upon seven of the members of Meiofauna Taxa Group Association No. 1, *Buliminella morgani, A. beccarii, Sabatieria,* Cyatholaimidae, *Theristus,* Linhomoeidae, and *Terschellingia,* which preferred sites P1, P2, and C21 (Table 60).

Examination of Table 170 indicates that macroinfaunal diversity, Pielou evenness, and Heip evenness all increased as distance from shore, salinity, and D.O. increased. Depth increased as Pielou and Heip evenness increased; percent sand and median grain size increased as Heip evenness increased. Number of individuals increased as distance from shore, depth, salinity, and percent silt decreased. Number of species increased as percent silt and median grain size increased. *Paraprionospio pinnata, Sigambra tentaculata, Magelona phyllisae,* and *Nereis* are all members of Macroinfauna Taxa Group Association No. 1. Both the above species, with the exception of *Nereis,* and Taxa Group Association No. 1 reacted similarly to the same abiotic variables. As distance from shore, depth, and salinity decreased, the density of *P. pinnata, S. tentaculata, M. phyllisae* and Macroinfauna Taxa Group Association No. 1 increased at Sites P1, P2, C21, C22, and C24. Both *Sigambra tentaculata* and Taxa Group Association No. 1 increased in hypoxic bottom conditions. Why *Nereis* did not demonstrate the same correlations as Macroinfauna Taxa Group Association No. 1 is not apparent. *Tharyx marioni* and Macroinfauna Taxa Group Association No. 3, of which it was a member, both increased in density as percent sand increased and percent silt decreased. *Nephtys incisa* and Macroinfauna Taxa Group Association No. 4, of which it was a member, increased in density as distance from shore and percent silt increased and percent sand decreased.

The densities of *S. tentaculata* and Macroinfauna Taxa Group Association No. 1 increased and Taxa Group Association No. 4 decreased in the presence of hypoxic bottom conditions. Both Taxa Group Association Nos. 1 and 2 were inversely correlated with distance from shore, depth, and salinity. Both *T. marioni* and *Nereis* increased in density as percent sand increased and percent silt decreased. In summary, distance from shore, depth, and salinity had the greatest effect on the dominant macroinfauna taxa and Taxa Group Associations.

Examination of Table 171 indicates that diversity and Pielou evenness of Macroepifauna and demersal fish increased as distance from the Mississippi and D.O. decreased. Number of individuals also increased as D.O. increased. As distance from shore increased, number of species increased and diversity decreased. Only *Halieutichthys aculeatus* and Macroepifauna and Demersal Fish Taxa Group Association No. 1 increased in density as distance from shore and depth increased. In summary, distance from shore, depth, D.O., percent silt, and median diameter had the greatest effect upon *Penaeus aztecus, Prionotus rubio,* and *H. aculeatus* and Taxa Group Association No. 1 at sites P3, P4, and C23.

b. Total Organic Carbon and Hydrocarbon Variables

Biological effects of oil pollution have been summarized by Evans and Rice (1974):

- direct kill of organisms through coating and asphyxiation
- direct kill through contact poisoning of organisms
- direct kill through exposure to the water-soluble toxic components of oil at some distance in space and time from the accident
- destruction of the generally more sensitive juvenile forms of organisms
- destruction of the food sources of higher species
- incorporation of sublethal amounts of oil and oil products into organisms, resulting in reduced resistance to infection and other stresses
- incorporation of carcinogenic and potentially mutagenic chemicals into marine organisms
- low-level effects that may interrupt any of numerous behavioral events necessary for the propagation of marine species higher in the food web.

McKee and Wolf (1963) and the EPA (1976) have also compiled literature concerning the effects of various petroleum products upon various organisms.

In this study, ethane and propane were inversely correlated with Cyatholaimidae and *Theristus* and the contamination index was inversely correlated with *Theristus* (Table 169). None of the other meiofauna variables were significantly correlated with the hydrocarbon variables nor were they significantly correlated with total organic carbon (T.O.C.).

Table 170 indicates that T.O.C. increased as number of species and Pielou and Heip evenness for macroinfauna increased. As Macroinfauna Taxa Group Association No. 3 and its member *Tharyx marioni* increased, T.O.C. decreased. As *Nereis* increased total unsaturated hydrocarbons decreased.

Examination of Table 171 indicates that as *Prionotus rubio* and *Micropogon undulatus* increased, ethane, propane, and the contamination index increased. Both of the above were members of Macroepifauna and Demersal Fish Taxa Group Association No. 1. Total unsaturated hydrocarbons decreased as *Penaeus aztecus* and *Cynoscion arenarius* increased. T.O.C. was not significantly correlated with any of the macroepifauna and demersal fish variables.

In this study, Bohnstedt, in Nulton et al. (1980), found the sediment T.O.C. average for all sites to be 0.65% with a high of 1.08% at S13 and a low of 0.11% at S19. This average compared favorably with the 0.68% value found by Gearing et al. (1976) offshore Mississippi and Alabama and with the 0.63% T.O.C. value of an idealized Gulf of Mexico sediment of Parker Scalan, and Winters (1979). Brent et al. (1979) reported an "ecosystem rich in organic carbon" in the water column on the Louisiana continental shelf. T.O.C. values averaging 5 mg/ℓ (0.50%) were reported, while waters of the open gulf averaged 1.5 to 2 mg/ℓ (0.15 to 0.20%). Certainly the primary source of this organic matter is the Mississippi River (Brent et al., 1979; Nulton et al., 1980). Runoff from the extensive coastal marsh lands adjacent to the Louisiana continental shelf supplies large quantities of organic matter. This high organic load contributes significantly to oxygen depletion in Louisiana coastal waters, resulting in hypoxic bottom conditions (see section above on Hypoxic Bottom Conditions).

Nulton et al. (1980) reported that the entire study area had baseline levels of C_1—C_4 saturated hydrocarbons 30-fold higher than open sea levels. Five sites, S8, S16, and S18 during Cruise II and P2 and P4 during Cruise III, were found to have levels of low molecular weight hydrocarbons (LMW-HC) well above the apparent baseline level (Contamination Index - LCI>3.5). Pipeline breaks, discharged brine, and flared gas probably contributed to these high levels (Nulton et al., 1980). Petrogenic hydrocarbons arising from platform-related activities were identified in sediments from P1, S6, S7, S11, S13, and S16 and in biota from P4, S9, S11, S16, S19, and S20. There were concentration gradients of hydrocarbons from sites P1, S6, S7, S10, S11, S12, S13, S14, S16, and S17. The decreasing concentration with distance implied that the platforms and/or their related activities were the source of elevated levels of hydrocarbons in the surrounding environment. This led to an ordering of platforms on the basis of level of indicated platform-related effects (Nulton et al., 1980):

- high: P1, S7, S11, S16
- medium: P4, S5, S8, S9, S15, S17, S18, S19, S20
- low: P2, P3, S6, S10, S12, S13, S14.

Statistical analyses of the data did not show a significant association between levels of hydrocarbons and number of wells drilled, age or production level of the platform.

Bohnstedt, in Nulton et al. (1980), reported that total hydrocarbon concentrations in the sediments reached highs of 200 ppm (S11), >100 ppm (S6, S13, and S16), and 96 to 370 ppm (P1) at the 100-m stations during Cruise I. Armstrong et al. (1977), in a study of separator platform effluent in Galveston Bay, Texas, reported hydrocarbon concentrations of 96 ppm (34 ppm were aromatics) beneath the platform. These concentrations resulted in reduced numbers of species and individuals of benthic organisms living within 152 m of the separator platform. Carr and Reish (1976) found 96-hr LC_{50} values of 12.0 and 12.5 mg/ℓ for the effects of south Louisiana crude oil on *Capitella capitata* and *Neanthes arenaceodentata,* respectively. There is evidence that once oil pollutants become incorporated into sediments below the aerobic surface layer, petroleum oil can remain unchanged and toxic for long periods, since its rate of bacterial degradation is slow (EPA, 1976).

Levels of polynuclear aromatic compounds (PAH) generally measured less than 20 ppb in the biota from this study (Nulton et al., 1980). These levels of PAH's are higher than in other areas of the Gulf of Mexico, especially since aromatics were rarely found in biota of the BLM South Texas and MAFLA OCS Projects (Nulton et al., 1980). The present data showed that both alkyl and unsubstituted aromatics were present, indicating petroleum and pyrogenic sources. Lower molecular weight aromatics (benzene, alkylbenzenes, and naphthalene) were also found, which suggests petroleum sources.

Cimato (1980), examining a wide variety of benthic marine invertebrates exposed to various types of petroleum derived hydrocarbons, reported values of 0.0001 to 230 ppm (wet weight) in "presumably contaminated" samples. For marine fish the values ranged from 4 to 860 ppm (wet weight). Laboratory exposure produced wet weight concentrations of 0.96 to 2,840 ppm for invertebrates and 7 to 622 ppm for fish. Natural wet weight tissue hydrocarbon levels reported by Anderson, Clark, and Stegeman (1974) (in Cimato, 1980) were 0.1 to 57.0 ppm for invertebrates and 8 to 345 ppm for fish. Mironov (1971) (in National Academy of Science (NAS) and National Academy of Engineering (NAE), 1972) found some copepods to be sensitive to a 1-ppm suspension of fresh or weathered crude oil and of diesel oil. Mironov (1967) (in NAS and NAE, 1972) reported 100% mortality of developing flounder spawn in three types of oil in concentrations ranging from 1 to 100 ppm. He found increased abnormal development at longer periods of time in concentrations as low as 0.01 ppm. Kuhnhold et al. (1978) found that direct exposure of *Pseudopleuronectes americanus* (winter flounder) eggs to 100-ppb water-accommodated No. 2 fuel oil resulted in reduced viable hatch when the exposure duration included both fertilization and embryonic development. Mironov (1968) (in Davis, 1972) reported that for developing eggs of *Rhombus maeoticus* (plaice) exposed to 10 to 100 ppm concentrations of oils, from 40 to 100% of the hatchlings degenerated and died. The above discussion indicates that low levels of hydrocarbon contamination can cause harmful effects on the benthos. The EPA (1976) stated that the levels of individual petrochemicals in the water column should not exceed 0.01 of the lowest continuous flow 96-hr LC_{50} for important marine species having a demonstrated susceptibility to oils and petrochemicals.

Anderson, Riley, and Bean (1978) reported that factors apparently controlling the rate of recovery (recruitment) were total oil levels, percent of aromatics, and position on the tide level. About 11 months were required to reduce hydrocarbon concentrations in sediment from about 1% (about 10,000 ppm) to background, and after 15 months the meiofauna were present at "normal" population levels. Krebs and Burns (1977) (in Anderson et al., 1978) found that recovery of "normal" crab populations in the oiled marsh was not complete seven years after the spill occurred. Michael (1977) and Michael, Van Raalte, and Brown (1975) (both in Anderson et al., 1978) reported that it took seven years for the benthic populations at West Falmouth, Massachusetts, to recover. Linden, Elmgren, and Boehm (1979) found that even after one year there was no sign of recovery from the acute damage of the *Tsesis* oil spill, indicating that the deeper soft bottoms were more vulnerable to oil pollution than the other systems studied. Mann and Clark (1978) state that, in most cases, within 10 years of a single incident the community structure had returned to something approaching its normal state.

In summary, ethane, propane, total unsaturated hydrocarbons, the contamination index, and T.O.C. were significantly correlated with several biotic variables identified in this project. Sediment T.O.C. averages from this study compared favorably to values measured elsewhere in the Gulf of Mexico (Gearing et al., 1976; Parker et al., 1979). At five sites for this study, sediment hydrocarbons, measured by Nulton et al. (1980) were higher than hydrocarbon concentrations previously reported to have an adverse effect upon the benthos. Benthic populations may take as long as ten years to recover from hydrocarbon contamination (Mann and Clark, 1978).

c. *Trace Metal Variables*

Heavy metals are present in petroleum, formation waters (oil field brines) and drilling fluids (Cimato, 1980). Nickel and vanadium are generally the most abundant trace metals in crude, but iron and zinc may also be abundant in some crudes. Filky and Shah (1971) (in Cimato, 1980) reported the following trace metal concentrations ($\mu g/g$) from Louisiana crude: vanadium - 25, iron - <5, zinc - <0.0007, chromium - <0.1, and copper - <0.2. Most organisms can concentrate trace metals by several orders of magnitude above concentrations found in their environment (Cimato, 1980). Halstead (1972) reported the following concentration factors for various marine organisms: cadmium - 4,500, copper - 7,500, lead - 1,400, and zinc - 32,500. These concentrations become toxic if they are ingested or taken up at sufficiently high levels for long enough periods. Based upon various toxicity data the toxicity ranking of some trace metals is as follows (Waldichuk, 1974): copper>zinc>nickel>lead>cadmium>chromium >iron.

McKee and Wolf (1963), Waldichuk (1974), and the EPA (1976) have compiled ecotoxicology data for each of the trace metals analyzed in this study. Halstead (1972) reported that cadmium was lethal to certain marine life at levels of 0.01 to 1 ppm and that chromium lethality may range from 18 to more than 200 ppm (varying with the valency state). Toxicity of lead for marine organisms appears to be in excess of 1 ppm for short term exposures for some organisms.

Reported 48-hr LC_{50} values (ppm) for *Crangon crangon* (shrimp) were as follows: chromium - 100, copper - 10 to 33, iron - 33 to 100, nickel -100 to 330, and zinc - 100 to 330 (Waldichuk, 1974). Reish et al. (1974) found that 0.01 to 0.05 mg/ℓ of copper and 0.05 to 0.1 mg/ℓ of zinc were sufficient to cause abnormal larvae in second generation polychaetes. Reish et al. (1976) measured the 28-day LC_{50} values (mg/ℓ) for *Neanthes arenaceodentata* and *Capitella capitata*, respectively, as follows: copper - 0.25 and 0.2, zinc - 1.4 and 3.5, chromium - 0.55 and 5.0, lead - 3.2 and 6.8, and cadmium -3.0 and 7.5. McLusky and Phillips (1975) found the 96-hr LC_{50} for copper's effect on the polychaete *Phyllodoce maculata* to be 0.12 mg/ℓ. Oshida et al. (1976), from Reish and Carr (1978), found a 96-hr LC_{50} of 2.2 to 4.3 mg/ℓ of hexavalent chromium for *N. arenaceodentata*, with reproductive cessation at 0.1 mg/ℓ and reproductive suppression at 0.0125 mg/ℓ. Raymont and Shields (1964) (in EPA, 1976) reported chromium threshold toxicity levels of 5 mg/ℓ for *Leander squilla* (prawn) and 1 mg/ℓ for *Nereis virens* (polychaete). Zinc concentrations up to 0.4 mg/ℓ may be lethal to estuarine mollusc larvae with toxic levels for adult shellfish and fish at about 10 ppm (Portmann, 1968, in Halstead, 1972).

Roberts and Maguire (1976) found that of the surface sand meiofauna, the harpacticoids, followed by the Turbellaria, showed the greatest sensitivity to lead at concentrations of 100μg/ℓ. The remaining fauna, archiannelids, nematodes, and ostracods, showed no apparent difference. However, sub-surface sand nematodes were more sensitive to the lead, despite the fact that there was probably a lower concentration of lead in the interstitial water from sub-surface sand than from surface sand.

Waldichuk (1974) reported the following 48 hr LC_{50} values (ppm) for various fish species: cadmium - *Fundulus heteroclitus*, 27.0; chromium - *Agonus cataphractus*, 33-100 and *Oncorhynchus kisutch*, 17.8; copper - *F. heteroclitus*, 3.2 and *Pleuronectes flesus*, 1.0-3.3; iron -*Squalus* sp., 5.0; lead - *F. heteroclitus*, 188; nickel - *Gasterasteus aculeatus*, 0.8; and zinc - *Salmo gairdneri*, 3.3. The EPA (1976) set up the following criteria for trace metal contamination in marine waters: cadmium -5.0μg/ℓ, chromium 100μg/ℓ, and zinc - 0.01 of the 96-hr LC_{50} as determined through bioassay using a sensitive resident species.

In this project the number of meiofauna species increased as chromium, copper, nickel, lead, and zinc decreased (Table 169). Lead decreased as *Theristus* and Chromadoridae increased. Zinc and chromium decreased as Chromadoridae increased. Cadmium increased as *Terschellingia* increased. None of the trace metal variables were significantly correlated with more than three meiofauna variables.

Table 170 indicates that chromium and lead were directly correlated with number of macroinfauna species and Pielou and Heip evenness but inversely correlated with number of macroinfauna individuals. *Lumbrineris tenuis, Tharyx marioni*, and *Nereis* were inversely correlated with one or more of the following trace metals: cadmium, chromium, copper, iron, nickel, lead, and zinc. Macroinfauna Taxa Group Association No. 3 was also inversely correlated with chromium and iron as was its member *T. marioni.*

Cadmium, copper, nickel, and/or zinc were directly correlated with macroepifauna and demersal fish diversity and Pielou evenness (Table 171). Cadmium, copper, and nickel were inversely correlated with *Penaeus aztecus* but directly correlated with *P. setiferus*. Iron was directly correlated with *Prionotus rubio* and *Halieutichthys aculeatus* but inversely correlated with *Menticirrhus americanus*. Copper and nickel were inversely correlated with *Micropogon undulatus* and

Cynoscion arenarius. Macroepifauna and Demersal Fish Taxa Group Association No. 1 was not significantly correlated with any trace metal variables.

Tillery, Windom, and Thomas (1980) in the trace metals analyses for this study, found Sites P1, S6, S7, S11, S17, S18, and S19 probably affected by decreasing gradients in the relative concentrations of trace metals. These gradients were not explained by relationships between the trace metals and percent clay or percent iron. Strongest indications of trace metal contamination "due to production" were at platforms S7, S11, and S17. At site S7, barium, chromium, copper, lead, and zinc demonstrated a gradient with distance from the platform; at the 100-m stations, observed ratios for lead:iron and barium:iron were more than 100. At S11, barium, cadmium, copper, lead, and zinc were cited as probable pollutants, with barium, copper, lead, and zinc concentrations relative to iron exceeding 100 at 100 m from the platform. At S17 the same five metals were pollutants of production, with barium, lead, and zinc ratios relative to iron in excess of 100 at the 100-m station. Platform-related activities indicated nickel, lead, and barium as pollutants at P1, chromium and nickel at S6, copper and zinc at S18, and zinc at S19.

At Sites P2, P3, P4, S13, S14, S15, S16, and S20 trace metal gradients were observed in relative concentrations but a possible explanation unrelated to the platform existed (Tillery et al., 1980). No meaningful tendencies in trace metal gradients were observed at S5, S8, S9, S10, and S12.

Windom et al. (1980) found that no statistical relationship could be established between platform age, level of activity, or level or type of production and metal contamination. They proposed the following as sources of trace metals:

- exhaust of internal combustion engines,
  - located on platform
  - boats
    - supply
    - service
    - pleasure
- flaring of natural gas
- petroleum seepages
- airborne terrestrial sources
- riverine inputs
- sacrificial electrodes.

Trefry and Presley (1976) (in Tillery et al., 1980) reported that cadmium and lead had increased on the Louisiana shelf due to the input from the Mississippi River, but found no increases in nickel, zinc, chromium, and copper. This could possibly explain the lead and cadmium concentrations at P1, S7, S11, and S17. Platform-related concentrations of chromium, nickel, copper, zinc, and barium in the sediments remain unexplained. However, the concentration gradients of lead and cadmium at the platforms suggest a platform-related source and are not due solely to the Mississippi River. Any masking effect by the Mississippi decreases with distance from the mouth.

Examination of Table 172 indicates close similarity between mean trace metal concentrations of surficial sediments for this study (Tillery and Thomas, 1980; Windom et al., 1980) and values for the northwest Gulf of Mexico (Trefry and Presley, 1976), the Buccaneer Oil Field Project (Anderson Schwarzer, and Wheeler, 1981), and the BLM South Texas OCS Project (Berryhill et al., 1979). Trace metal concentrations at Weeks Island tended to be lower than at the other locations.

In summary, chromium, lead, cadmium, copper, nickel, iron and zinc were found to be significantly correlated with several biotic variables identified in this study. Windom et al. (1980) stated that there was no statistical relationship between platform age, level of activity, or level or type of production and sediment trace metal concentration. Sediment trace metal concentrations from this study were similar to other values reported in the Gulf of Mexico. Average sediment trace metal concentrations listed in Table 172 for chromium, copper, lead, and zinc in this study are above those values previously reported to cause adverse effects in some benthic organisms.

d. Drilling Fluids and Drill Cuttings

A drilling fluid is a thixotropic colloidal suspension with barite (barium sulfate) added to increase density, bentonite to increase viscosity, and other components to control other mud properties (Gettleson, 1980; Gray, Darley, and Rogers, 1980; Perricone, 1980). Drilling fluids are used in various ways in rotary drilling: to cool; to provide lubrication for the drilling bit and drill pipe; to remove formation cuttings from the hole; to insure controlled and efficient drilling through maintenance of well pressures and well properties of the borehole; to permit logging and geological evaluations; and to minimize corrosion. Drilling fluids may be of three types; water, oil, or gas or a combination thereof (Gray et al., 1980; McGlothlin, 1980; McMordie, 1980). There are at present 1,594 drilling fluid products which perform 16 different functions; these

TABLE 172. Comparison of mean trace metal concentrations (μg/g dry wt) in surficial sediments with other Gulf of Mexico studies (from Tillery and Thomas, 1980; Windom et al., 1980; and Anderson, Schwarzer, and Wheeler, 1981)

	Mean Trace Metal Concentrations (μg/g dry wt)									
Locality	Barium	Cadmium	Chromium	Copper	Iron	Nickel	Lead	Zinc	Vanadium	Reference
Offshore Louisiana (present study area)										
Mean	77	0.30	8.9	11	0.69	10.2	18.8	44	9.8	Tillery and Thomas (1980)
Range	0-1515	0.01-0.92	2.3-19.0	1-45	0.15-2.00	3.9-17.2	0-136	14-193	0-44	Tillery et al. (1980)
Northwest Gulf of Mexico										
Mean	N.A.[1]	0.3	N.A.	11.4	2.18	22.6	16.5	73.8	N.A.	Trefry and Presley (1976)
Range		0.02-0.70		2.0-24.8	0.53-3.34	5.1-38.8	4.9-34.4	17.6-132.3		
Offshore Louisiana, Weeks Island										Tillery (1979)
Mean	37	0.05	5.09	2.0	0.45	6.2	5.7	22	N.A.	
Offshore Texas, Buccaneer Oil Field										Anderson, Schwarzer, and Wheeler (1981)
Platform	403	1.1	13.3	4.3	0.69	14.7	10.4	29.6	N.A.	
Control	151	0.8	9.7	4.7	0.85	17.3	9.4	29.0	N.A.	
Offshore South Texas										Berryhill et al., (1979)
Control	168	0.1	24.2	7.4	2.22	20.2	9.0	28.8	N.A.	

[1] N.A.—denotes metal not determined.

are produced by 87 different companies (Leonard, 1980).

The environmental effects of drilling fluids and cuttings have been examined by the EPA (1975); McAuliffe and Palmer (1976); Monaghan, McAuliffe, and Weiss (1976); Ray, 1978; American Petroleum Institute (1980*a*,*b*); and Cimato (1980). Drilling fluids impact the environment in the following ways (George, 1975):

- they cause "burial effect" on the sea-floor benthos
- drilling fluid components may possibly accumulate or magnify in the food chain
- turbidity plumes of drilling fluids have an effect on the filter-feeding fouling organisms.

Ray and Shinn (1975) determined theoretically that for a current of 0.5 ft/sec and a discharge rate of 40 and 250 barrels per hour, dilutions of 1,000:1 would be expected at approximately 1,000 and 10,000 feet. This dilution not only reduces turbidity but also dilutes any toxicants within the drilling fluid. The finer materials are driven away by the current and the larger hole cuttings form a pile under the platform. In areas of low current speed, such as the Gulf of Mexico, piles up to 30 m in diameter and 1 m in height have formed from surface discharges (Zingula, 1975; Zingula and Larsen, 1977; Gettleson, 1980). When cuttings are shunted to within 10 m of the bottom, the pile height is 2 to 3 m, but its radius is only 9 to 11 m (Continental Shelf Associates, 1975; Miller, 1976). Tropical cyclones and natural weathering, through settling, compaction, and current dispersion, combine to scatter this accumulation, so that the sediment underneath the platform appears to be similar to the surrounding environment within a very short time (Gettleson, 1980). Thus, any "burial effect" is localized, probably to within 300 m of the platform, and the fauna probably recovers soon after disposal of drilling fluids ceases (Shinn, 1974; George, 1975; Zingula, 1975; Gray et al., 1980).

Zingula (1975), Zingula and Larsen (1977), and Gettleson (1980) have discussed the effect of accumulation of drill cuttings on the benthos. Rapid accumulation probably smothers the less mobile benthic organisms, with the extent of the effect depending on the mobility and size of the organism relative to the depth of accumulation. Examinations of piles of cuttings have shown them to be relatively nontoxic as the piles are quickly colonized by a variety of organisms (George, 1975; Zingula, 1975; Zingula and Larsen, 1977). Many of these organisms are capable of living only on hard substrates and therefore may be new.

Gettleson (1980) reported that benthic samples collected before drilling operations in the MAFLA OCS contained a significantly greater number of meiofauna individuals than samples collected during and after drilling. Greatest decreases in number of individuals were noted at 100 m from the platform, but reduced populations extended to 1,000 meters. There was partial recovery of the populations three months after drilling was completed. Holland (1977) in the BLM South Texas OCS found a decrease in the number of species and individuals between pre- and post-drilling samples taken at the actual drill site, but found no noticeable changes in the populations at distances of 100 m and greater. Dames and Moore (1978) (in Gettleson, 1980) reported that in lower Cook Inlet, drilling operations had no major effect on the infauna at distances of 100 and 200 m from the drillsite.

Tagatz and Tobia (1978) and Tagatz et al. (1978) studied the effect of barite and a lignosulfonate drilling mud on the colonization and development of estuarine benthic communities. Total numbers of animals and species were significantly less in a 0.5-cm cover of barite than in the control or the 1:10 barite mixture. Number of individuals also differed in the 1:3 barite mixture when compared to the control but the number of species was not significantly different. Total numbers of individuals and the mean number of species per aquarium were significantly less in the aquaria with the drilling mud cover than in the aquaria with sand only. Numbers of individuals were also significantly less in mixtures of drilling mud and sand than in controls though the total number of species did not differ. Annelids were found to be the taxon most affected by the barite and drilling mud.

Menzie, Maurer, and Leathem (1980) studied the effects of drilling discharges on the megabenthos and macrobenthos in the shelf break region off Atlantic City, New Jersey. Visible accumulations of drilling discharges covered a region approximately 150 m in diameter around the well site, and there was burial of immobile or sessile benthos in the immediate vicinity of the well. However, there was a markedly increased micro-relief which afforded more microhabitats and may explain the patches of high macrobenthic density at and around the well site. Beyond the immediate vicinity of the well site, there was a reduction in abundance of macrobenthos which appeared to be related to increased clay content of the sediments. There was a significant negative correlation between abundance of annelids, molluscs, and crustaceans located beyond the immediate vicinity of the well site and the amount of clay found during the post-drilling survey (Menzie et al., 1980).

Perry (1979) found the lowest biomass and lowest species diversity among demersal fish at an offshore production site. He attributed this to being "symptomatic of an adverse effect caused by the discharge of drilling mud solutions which form a hard crust on the bottom to the detriment of the infauna...." Strong currents, frequent storms, and in some cases rapid sedimentation should remove or cover the drilling muds and the fauna should be able to reestablish themselves.

Barium from barium sulfate and chromium from chromium lignosulfonates or sodium chromate are the two trace metals most commonly found in drilling fluids (Montalvo and McKown, 1975; Chow, 1976; Chow et al., 1978; Newbury, 1979; Chow and Snyder, 1980). Other metals such as iron, lead, zinc, cadmium, nickel, and copper may also occur with the barite (Kramer, Grundy, and Hammer, 1980).

In a benthic study of barium levels in the vicinity of six drill sites in the Gulf of Mexico, Gettleson and Laird (1980) found detectable quantities as far as

1,000 m from both shunted and unshunted wells. At one site, at distances of 100, 300, 500, and 1,000 meters, mean barium concentrations of 2,924; 1,953; 1,750; and 989 mg/kg, respectively, were measured after drilling. Pre-drilling values ranged from 12 to 1,514 mg/kg. Cimato (1980) reported that during and after drilling operations near the East Flower Garden Bank, offshore Galveston, Texas, barium increased from 22 to 425 ppm, iron increased from 8.5 to 13,000 ppm, and lead increased from 4.6 to 12.7 ppm at the drill site. Near the West Flower Garden Bank, pre-drilling barium concentrations within 300 m of the drill site ranged from less than 50 to 1,300 ppm; post-drilling levels ranged from 4.6 to 7,800 ppm.

Near Baker Bank, offshore Texas, drilling fluids were disposed of at the sea surface. Pre-drilling barium levels ranged from 344 to 419 ppm (Cimato, 1980). Post-drilling levels were as high as 1,618 ppm at 500 m from the drill site and 678 ppm at 1,000 m (Continental Shelf Associates, 1976) (in Cimato, 1980). Near Stetson Bank, offshore Texas, pre-drilling barium concentrations ranged from 609 to 658 ppm and post-drilling concentrations from 803 to 2,763 ppm.

Toxicity and environmental properties of drilling fluid compounds have been studied or reviewed by Falk and Lawrence (1973); Land (1974); Chesser and McKenzie (1975); Hollingsworth and Lockhart (1975); Weir and Moore (1975); Zitko (1975); Cimato (1980); Gerber et al. (1980); Gettleson (1980); and Neff et al. (1980). Tests on the effects of various whole drilling muds on selected invertebrates and fish gave 96-hr LC_{50} values ranging from 1,000 to 2,000 ppm to 680,000 ppm (Falk and Lawrence, 1973; Cimato, 1980). Barite was found to have a 96-hr LC_{50} value of 216 ppm for the American oyster, *Crassostrea virginica* (Daugherty, 1957). Grantham and Sloan (1975) reported a 96-hr LC_{50} value of 100,000 ppm for the sailfin molly, *Mollienisias latipinna*. Falk and Lawrence (1973) reported a 96-hr LC_{50} value of 7,500 ppm for the rainbow trout, *Salmo gairdneri*.

In this study, benthic samples were taken no nearer than 500 m from a platform. The above literature indicates that there should have been no burial effect from the drill cuttings or drilling fluids at that distance. Tillery and Thomas (1980) and Tillery et al. (1980) reported average barium and chromium concentrations of 77 and 8.9 mg/g dry weight in offshore Louisiana sediments (see Table 173). Barium occurred in average concentrations of 100 mg/g dry weight at 100 m, 60 to 65 at 500, 1000, and 2000 m. Chromium concentrations remained very similar at each of the stations and did not show a pronounced gradient with distance. These barium levels were lower but similar to pre-drilling levels at sites near the East and West Flower Garden Banks, Baker Bank, and Stetson Bank (Cimato, 1980). In this study, barium was not found to be significantly correlated with any biotic variable for more than one cruise. Chromium was correlated with Chromadoridae (Table 170) *Tharyx marioni*, Nereis, and Macroinfauna Taxa Group Association No. 1 (Table 171). These significant correlations with chromium may point to possible build-up caused by chromium treated lignosulfonates. However, Page et al. (1980) states that toxic effects due to chromium arising from the release of used drilling muds may be mitigated by the decreased bioavailability of the form in which chromium is found in this material. Therefore, any contamination from drilling fluids is probably contained within 500 m of the platform. Gettleson (1980) reported that drilling fluid effects are usually restricted to within 1,000 m of the platform.

Barite and other suspended components of the drilling mud affect the environment physically through turbidity plumes (Zitko, 1975). In general, background levels of suspended solids in sea water are reached within 200 m of the discharge source when the discharge rate is 10 barrels/hr and within 1,000 m of the source when the discharge rate is 750 barrels/hr (Cimato, 1980). McKee and Wolf (1963), Kemp et al. (1971), and EPA (1976) discussed the toxic effects of suspended solids. The NAS and NAE (1972) recommended that the depth of light penetration not be reduced by more than 10% to avoid stress to the environment. Zitko (1975) states that a concentration of up to 500 mg/l may be encountered in river runoffs, but normally the levels are approximately 30 mg/l. The average Mississippi River discharge is about 1 million tons per day (Monaghan et al., 1976). A well drilled in the Gulf of Mexico might reach 20,000 ft in 150 days and would produce about 18,500 cu ft or almost 1,500 tons of cuttings over the period of drilling, or about 10 tons/day average. Thus, the effects of turbidity from the drilling fluids are local and overshadowed by the effects of the Mississippi River.

In summary, based upon the literature, there should have been no burial effect from the drill cuttings or drilling fluids at the station closest to the platform (500 m). Only chromium was found to be correlated with several biotic variables, indicating a possible buildup due to chromium-treated lignosulfonates. However, the chromium probably remains bound and is not available for uptake by the organisms. Gettleson (1980) reported that drilling fluid effects are primarily restricted to within 1,000 m of the platform; they did not appear to directly affect the benthos sampled in this study.

e. Summary of Effects from Platform Related Variables

The exhaustive statistical analysis of a large number of biotic and abiotic factors determined in this program has shown numerous apparent correlations between faunal characteristics and single abiotic parameters. For example, Tables 169, 170 and 171 show several instances of particular indicator organisms or taxa groups being either positively or negatively correlated with individual trace metals. This may indicate a cause and effect relationship when evaluated from a narrow perspective. These relatively few and unconnected relationships, however, are insignificant when the overall trend of influence from the physical environment on populations is realized. The most significant set of factors influencing the fauna of the benthos were distance from shore, depth, salinity, sediment characteristics, D.O. and distance from the Mississippi River. Taken together these parameters may be subjectively described as indicating changes in populations with the lessening of terrestrial influences as sampling proceeded seaward and away from the mouth of the Mississippi.

Several important examples of overall biotic/abiotic interactions found in data analysis are reiterated here for clarity. Several hydrocarbons parameters and T.O.C. were significantly correlated with several biotic factors and the sediment hydrocarbons at five sites were higher than levels previously reported to cause adverse effect on the benthos; however, this study did not show those five sites or other sampling areas to be significantly different, due to hydrocarbon effects, from similar sites. Similarly, several trace metals were shown to be correlated with biotic variables and absolute levels in sediments and some platforms were higher than have been cited as causing adverse effects; but this study did not show any cause and effect relationship from trace metals on the benthos at the 500-m sampling sites or beyond, indicative of the regional assessment which this program was designed to do. Finally, the drilling fluid effects are apparently confined to within 500 m of the platforms and did not affect the benthos sampled in this study.

2. *Natural Environmental Perturbations*

a. *Catastrophic Mortalities*

As described above, the Louisiana continental shelf is regularly subjected to two natural environmental perturbations: tropical cyclones and anoxic to hypoxic bottom conditions. Tropical cyclones of varying intensities directly hit the Louisiana coast once every four years (average). Each year the effects of one or more cyclones can be felt on the Louisiana shelf. Every three to four (average 3.6) years the Mississippi River floods its banks or natural levees and empties into the Gulf of Mexico huge quantities of fresh water, silt, organic matter, and various man-made pollutants. The huge quantities of silt and organic matter, combined with stratification, produce anoxic to hypoxic bottom conditions. It may take over two years for an area to return to normal after a tropical cyclone and at least one year for the area to recover from hypoxic bottom conditions. Because of the time period necessary for recovery and the periodic nature of "normal" perturbations on the Louisiana continental shelf, the benthic fauna probably remains stressed as compared with a similar fauna offshore Texas.

b. *Indicator Organisms*

(1) Opportunistic Species—Gaufin and Tarzwell (1952) and Wass (1967) defined certain criteria to be used in identifying possible indicators of pollution:

- high biotic potential
- small size
- few species in the fauna
- primarily scavenger feeding type
- toleration for low D.O. or some adaptation to a low D.O. environment.

Use of community structure to assess pollution is conditioned by these four assumptions (Cairns, 1974):

- natural systems, given the opportunity, will evolve toward greater and greater complexity of species
- thus, the number of cause-effect pathways for energy and nutrient translocation increase, with increasing functional complexity of the system
- highly diverse communities are more stable than simple communities
- pollutional stress will simplify a complex community by eliminating the more sensitive species and will also increase the disproportion in numbers of individuals per species.

Benthic species and communities have often been regarded as the best indicators of organic pollution because of the following (Reish, 1957, 1972, 1973; Wass, 1967):

- constant presence, reflecting water conditions at the time of collection and for some time previously
- relatively long lives
- sedentary habits
- differing tolerances to stress.

Species that can rapidly respond to open or "unexploited" habitats have been called opportunistic, fugitive, colonizing, weedy, or *r*-selected (Grassle and Grassle, 1974). Characteristics are:

- lack of equilibrium population size
- density-independent mortality
- ability to increase rapidly or high *r*
- high birth rate
- poor competitive ability
- high dispersal ability
- large proportion of resources devoted to reproduction.

None of the above characteristics alone adequately defines an opportunistic species (Grassle and Grassle, 1974). Thus, what have in the past been considered indicator organisms are now considered opportunistic species.

Opportunistic species may be found among the meiofauna and macroinfauna, as well as among macroepifauna and demersal fish. Among the meiofauna, nematodes certainly may indicate areas of stress (Wass, 1967). Bandy, Ingle, and Resig (1965) examined the Foraminifera population in the Hyperion outfall area off Los Angeles where forams were 10 to 20 times more abundant than in unaffected areas. Sen Gupta (1979), as a result of the BLM South Atlantic OCS Project in the Georgia Bight, recommended *Bolivina lowmani* and *Ammonia beccarii,* both found in this project, as particularly suitable for monitoring the state of the benthic environment. However, taxonomic problems of the meiofauna must be reduced further before they can be more seriously considered as indicators (Coull, 1979; Dames and Moore, 1979).

Certain species of the Sedentaria Polychaeta of the families Capitellidae and Spionidae and a few other polychaetes have been considered as indicators or opportunistic species. The most well-known and probably the most opportunistic species, which is also a cosmopolitan indicator of unpredictability, is *Capitella capitata* (Reish, 1959; Grassle and Grassle, 1974, 1977; Warren, 1977). *Capitella capitata* probably adapts to a continuous disturbance and not to low oxygen tolerance (Gray, 1980).

Other reported opportunists, some of which have been found in this project, are listed in Table 173. Forty-eight different species have been identified by previous workers as indicating polluted or semi-polluted conditions. Many of these species tend to be either cosmopolitan or ubiquitous on a smaller scale. Other species of these same genera may be opportunistic but to a varying degree. Virnstein (1979) reported several of these species to be largely controlled by predators and not be competitors.

Grassle and Grassle (1974) state and show proof that less predictable environments should contain more opportunistic species than more predictable environments. Certainly, based solely upon the periodic flooding of the Mississippi River and the regularity of tropical cyclones, the Louisiana continental shelf should be considered an unpredictable environment and should support a large opportunistic fauna. Sixteen known opportunistic or indicator species were collected in this study (Table 173). Other possible opportunists may be other species of those genera listed. Many more species tend to exhibit the characteristics of opportunism and therefore could be considered as opportunists, but vary in degree of opportunism. This clearly indicates that the Louisiana continental shelf is a highly disturbed, stressed, and very unpredictable environment.

(2) Future Environmental Monitoring— It has been fashionable to make judgements on the condition of the environment through the use of rather limited information, i.e., biological indicators (Oglesby, 1967). Determining the significance of the absence of a species is considerably more difficult (Cairns, 1974). A species may not be present because:

- unsuitable environmental conditions exist
- no opportunity exists for the species to get into the area, but it might survive if introduced
- another species has assumed the functional role.

Absence of a species is less useful than its presence (Cairns, 1974). The patchy nature of most benthos often poses a problem in actual organism collection unless many samples are collected (Callahan and Palmer, 1978). It is also difficult to determine if density changes are due to natural variations in the population or to the effects of a pollutant (Walker, Saila, and Anderson, 1979). Density changes can be related to a detailed knowledge of life history, age or stage-specific fecundity and mortality, and survival strategies of species under consideration. The absence of an entire group of species with similar requirements provides more assurance that the group has been excluded rather than failing to be present through lack of opportunities or because of sampling problems.

Thus, future monitoring of the study area should include collections of meiofauna, macroinfauna, and macroepifauna and demersal fish since all three groups are closely interrelated. Then the presence or absence of certain groups of species may indicate that the system has been disrupted.

TABLE 173. List of reported opportunistic or pollution indicator organisms

Taxa[1]	References[2]
Foraminifera	a, g
*Ammonia beccarii (F)	b
*Nematoda	g
*Spionidae (P)	g
Polydora ciliata (P)	g
Polydora cirrosa (P)	g
*Polydora ligni (P)	c, g
Polydora nuchalis (P)	g
Polydora paucibranchiata (P)	g
*Polydora sociabilis (P)	g
Polydora websteri (P)	g
*Paraprionospio pinnata (P)	h
Streblospio benedicti (P)	c, d, g, h, i
Scolelepis fuliginosa (P)	e
Capitellidae (P)	g
*Capitella capitata (P)	c, d, e, f, g, i
Heteromastus filiformis (P)	g, h
Mediomastus ambiseta (P)	c
Syllides verrilli (P)	c
*Pectinaria (Cistenides) gouldii (P)	g
*Spiochaetopterus occulatus (P)	g
*Glycera sp. (P)	c
*Glycinde solitaria (P)	h
*Nereis succinea (P)	c, d, g, h
Neanthes arenaceodentata (P)	e, f
Dorvillea articulata (Stauronereis rudolphi) (P)	e, f
*Pista cristata (P)	g
Pseudeurythoe sp. (P)	h
Nassarius vibex (G)	g
Acteocina canaliculata (G)	h
*Mulinia lateralis (B)	h, i
Tagelus devisus (B)	g
Laevicardium mortoni (B)	g
Modiolus demissus (B)	g
Mytilus edulis (B)	g
Macoma inconspicua (B)	d
Mya arenaria (B)	d
Neomysis americana (M)	h
Leucon americanus (C)	h
*Corophium acherusicum (A)	g
Corophium insidiosum (A)	g
Corophium lacustre (A)	g
Jassa falcata (A)	g
*Ericthonius brasiliensis (A)	g
Rhithropanopeus harrisii (D)	g
*Phoronis sp. (Ph)	h
*Ampelisca abdita (A)	i
*Owenia fusiformis (P)	i

[1] * denotes those taxa found in this study.
(F) denotes Foraminifera
(P) denotes Polychaeta
(G) denotes Gastropoda
(B) denotes Bivalvia
(M) denotes Mysidacea
(C) denotes Cumacea
(A) denotes Amphipoda
(D) denotes Decapoda
(Ph) denotes Phoronida

[2] References:
a — Bandy et al. (1965)
b — Dames and Moore (1979)
c — Grassle and Grassle (1974)
d — Reish (1957)
e — Reish (1972)
f — Reish (1973)
g — Wass (1967)
h — Boesch et al. (1976)
i — McCall (1978)

Biological indicators have been used for different purposes, e.g., "*detection* of pollution" and "estimation of overall *effects* on the community" (Oglesby, 1967). However, there is little data supporting the indicator assessment of pollution and the results are difficult if not impossible to quantify (Cairns, 1974).

Future environmental monitoring should consider the use of biological monitors at selected petroleum production platform sites to determine local environmental impact. Cairns and van der Schalie (1980) describe in detail the principles and methods necessary to implement a successful biological monitoring program. DiSalvo, Guard, and Hunter (1975) found mussels to be a potential monitor of environmental hydrocarbon insult. Certain organisms, e.g. oysters, can be used as indicators by placing them in cages at strategic locations (Wass, 1967).

Criteria such as behavioral responses or activity, i.e., mass die-offs and physical conditions of certain macroinvertebrates and fishes, may also indicate environmental disturbance (Wass, 1967). Oglesby (1967) stated that more recently measurements of community metabolism have been used as a means of detecting pollution. Condition of the organism can be checked by underwater weighing, checking pumping rates, output of feces and pseudofeces, and sacrifice of some organisms to obtain a condition index of the meat (Wass, 1967).

Therefore, future monitoring must include sampling the entire community (Simon and Dauer, 1977). The basic environmental cycle of the area must also be defined to better understand changes in community structure (Glover, 1979). Investigative procedures which are used should be evaluated in terms of effort required to quantitatively estimate effects of specific magnitudes (Vanderhorst et al., 1978). As true indications of perturbation are detected, additional measurements must be made to positively identify the cause of the perturbation.

3. *Health of the Benthic Populations on the Louisiana Continental Shelf*

The capacity of a system to resist shock loadings of contaminants without significant damage is a function of complex environmental factors (Cairns, Dickson, and Crossman, 1972). Physical factors in a lake, stream, estuary, or the open ocean, such as "flow velocity, volume of water, bottom contour, rate of water exchange, currents, depth, light penetration, temperature, etc., as well as the biological factors, govern in part the ability of a system to receive and assimilate waste or spills of hazardous materials." It is common for areas subjected to chronic pollution, whether industrial, domestic, or natural (freshwater runoff, organics and silt from a river, etc.), to support a less diverse population than similar unpolluted sites, although the density of the few resistant species may be very large (Nelson-Smith, 1970). A catastrophic pollution incident results in a similar selection of resistant species, but the system has no time in which to reach a new balance.

The Louisiana continental shelf benthos has indeed been stressed by natural environmental perturbations for many years. Tropical cyclones have been occurring for eons and flooding by the Mississippi River has been affecting the shelf since at least 1885 (Gunter, 1952). The work of Nulton et al. (1980), Tillery et al. (1980), and Tillery and Thomas (1980) indicates that the study area suffers from sub-lethal chronic exposure to hydrocarbons and trace metals. Some effects of drill cuttings and drilling fluids have been felt since the 1950's (Sharp and Appan, 1978). Some of the contamination has its input from the Mississippi River, but some of the contamination appears to be platform derived. Brooks, Bernard, and Sackett (1977) determined, after six years of work, that offshore petroleum operations were contaminating most of the Gulf of Mexico coastal waters with low-molecular-weight hydrocarbons. The primary input from petroleum operations offshore Louisiana was the underwater venting of gases, which was three orders of magnitude higher than the input from brine discharges. The brines now being discharged into the Gulf of Mexico are major contributors of aromatics such as benzene and toluene. It may take up to 10 years for populations to recover from hydrocarbon contamination (Mann and Clark, 1978).

In this study, average total organic carbon content tended to be higher at the Controls than at the Primary Sites. Average total, saturated, and unsaturated hydrocarbons, as well as the hydrocarbon contamination index tended to be higher at the Controls than at Primary Sites. Average trace metal concentrations tended to be the same or higher at Control Sites than at Primary Sites. Higher concentrations of hydrocarbons and trace metals at the Controls are probably the result of only one station being sampled at the Controls as opposed to 16 stations at the Primary Sites.

Gettleson (1980) stated that over 20,000 wells have been drilled in the Gulf of Mexico. If it is assumed that the maximum mean area affected by a drilling operation is 3.14 km^3 (1,000-m radius), which takes into account the areas of effect for hydrocarbons, trace metals, drill cuttings, and drilling fluids, then a possible 62,800 km^2 or 20% of the U.S. continental shelf in the Gulf of Mexico has been directly influenced by drilling operations (Gettleson, 1980). The area affected by drilling activities is probably much smaller since a number of wells are usually drilled from a platform.

The number of indicator organisms collected in this study indicates a highly disturbed and very unpredictable environment, which results in a stressed community structure. Cairns et al. (1972) found that the number of component species in the energy-system remained remarkably constant from one river basin to the next, and at various points within a basin as well, despite the fact that the types of species which comprise the system may differ at various sampling points. Straughan (1977) stated that marine invertebrates can live and breed in areas, namely Coal Oil Point, where chronic exposure to petroleum is higher than that recorded in oil producing areas in the Santa Barbara Channel. Spies, Davis, and Stuermer (1978) found a diverse *Nothria-Tellina* assemblage in sediments with 3,300 to 10,200 ppm of crude oil at the Isla Vista seep, Coal Oil Point area. The faunas at both the seep area and a nearby non-seepage area were similar, except for the high abundance of oligochaetes in the seep sediments. Several measures of community structure indicated relatively less community stability at the seep station.

The Louisiana shelf benthos has maintained a community structure similar to that offshore Texas; but as Spies et al. (1978) found in southern California, the community stability may be somewhat precarious and highly susceptible to perturbations of whatever nature. Unfortunately this study was designed prior to a general knowledge of the chronically stressed condition of the Louisiana OCS. As a consequence, the sampling design did not incorporate enough Control Sites and sampling redundancies to differentiate and quantitate the very large area of riverine effect, the cyclonic storm results and oil production activities.

As stated above, meiofaunal species diversity was higher at the Primary Sites than at the Controls during Cruises I and II and the reverse was true during Cruise III. Species diversity for macroinfauna and macroepifauna and demersal fish was higher at the Primary Sites than at the Control Sites during all cruises. These higher values at the Primary Platforms may reflect sample replication since only one station was occupied at the Controls while eight stations were sampled at each Primary Site. There may also be more microhabitats at the Primary Sites because of the production activity. Taxa Group Associations were identified at both Primary and Control Sites.

D. Problems Encountered in Sampling

Cruise I—All samples for Benthic Biology were collected during Cruise I. However, a problem was encountered with the meiofauna cores collected at P3 N500. The individual taking the cores was rushed at that moment and forgot to collect meiofauna cores from Grabs 1 and 2. By Grab 3 the mistake was noted. The Benthic Biology Principal Investigator was present and made the decision to collect cores 1 through 4 from Grab 3. All previous cores from Grabs 1 and 2 would have had to be repeated, and this would have caused problems in container availability and contamination.

Cruise II—As a result of very rough seas during Cruise II-A, the following samples for sediment texture, meiofauna, and macroinfauna analysis were lost overboard:

Sediment Texture	
P3 N2000	#7
P3 S2000	#5
S5 N1000	#1
S7 N100	#4
Meiofauna	
P3 E500	#3.D, 4.E
P3 S2000	#1.A, 1.B, 3.D, 4.E
P3 W500	#1.B, 3.D
Macroinfauna	
P3 S500	#5, 6
P3 S2000	#5, 6, 10

Later, in conversations with the Project Leader and Dr. Richard E. Defenbaugh (BLM-COAR), it was decided to reoccupy the following stations during Cruise II-C and collect the indicated grabs for sediment texture and meiofauna and macrofauna analysis:

P3 N2000	#7
P3 E500	# 1 to 10
P3 S500	#1 to 10
P3 S2000	#1 to 10

Where duplicate samples occurred, those collected during Cruise II-C were processed. However, duplicate samples for macroinfauna collected on Cruise II-A were processed and the data are available for interested persons.

E. Recommendations for Further Studies

Future monitoring studies in the area should have clear and well-defined objectives (Sharma, 1975). These objectives should be addressed through the use of statistical procedures to determine sampling locations and number of samples needed to detect a change (Dickson, Cairns, and Livingston, 1978). Multivariate statistical procedures should be utilized where possible in analyzing the data following recommended procedures of Dickson et al. (1978).

Over the years certain measurements, e.g. temperature, salinity, and D.O., have characteristically been made. These measurements are relatively simple to make now and continue to be made even though these parameters may not be significantly related to population changes (Jumars and Fauchald, 1977). Some parameters that are more difficult to measure, but that should be measured because they more readily affect the organisms, are bottom currents (Kornicker, 1958), amount of sediment resuspension and deposition (Jumars and Fauchald, 1977), sediment permeability or cohesiveness (Stanton and Evans, 1972), individual species foraging areas (Jumars and Fauchald, 1977), local fluxes of foods (Jumars and Fauchald, 1977), amount of interstitial D.O., depth of redox discontinuity, and sediment pH.

V. CONCLUSIONS

The benthic fauna of the Louisiana continental shelf is stressed, as indicated by the large number of opportunistic species and the pronounced dominance of some taxa. Natural environmental perturbations, namely tropical cyclones and flooding by the Mississippi River, contribute to this stress. Approximately once every four years, a tropical cyclone directly hits the coast of Louisiana. Annually, the effects of one or more cyclones can be felt on the shelf. Every 3.6 years the Mississippi River floods its banks or natural levees. The offshore effects of leveeing of the Mississippi were probably first noticed in 1885 and reached a peak after 1927. It may take over two years for an area to return to normal after a tropical cyclone and at least a year for it to recover from hypoxic bottom conditions. Because of the time period necessary for recovery and the periodic nature of "normal" perturbations on the Louisiana shelf, the fauna probably remains in a depressed state as compared with a similar fauna offshore Texas.

The fauna encountered in this study closely resembles that found offshore Texas. As the fauna approaches Port Isabel it assumes certain tropical components. Much of the fauna on the Louisiana shelf also resembles that of the eastern United States as far north as Cape Cod, Massachusetts. There is substantial evidence that the Carolinian province extends along the Louisiana coast, forms part of the Northwestern Gulf Province and contains four reported assemblage groups: inner shelf, intermediate shelf, outer shelf, and pro-delta.

Meiofauna and macroinfauna diversities were higher at the Primary Sites than at the Control Sites, probably because the Primary Sites provided more and different microhabitats. Correlation analysis indicated that distance from the mouth of the Mississippi River, depth, temperature, salinity, D.O., percent sand, percent silt, T.O.C., and the presence of hypoxic bottom conditions were significantly correlated with species diversity, evenness, and number of individuals of selected taxa or taxa groups. Ethane, propane, total unsaturated hydrocarbons, the contamination index, chromium, lead, cadmium, copper, nickel, iron, and zinc were also found to be significantly correlated with selected biotic variables. Level of impact of the significant abiotic variables cannot be determined at this time. This information should be available through regression analysis. However, the independent variable data set used for regression in this program contained considerable multicollinearity and the results could not be usd to produce predictive equations. Further refinement of the regression equations was not considered to be within the scope of this study.

Hydrocarbon and trace metals analyses indicate that the study area suffers from sub-lethal chronic exposure to hydrocarbons and trace metals. Any effects from drill cuttings or drilling fluids were restricted to within less than 500 m of a platform. Some of the contamination has its input from the Mississippi River, but some of the contamination appears to be platform derived.

The benthic fauna of the Louisiana continental shelf is indeed stressed over much of the area by natural environmental perturbations and locally by petroleum production activities. Several indicator organisms were identified in this project and can be very useful in future monitoring. However, it is extremely important that these indicators, that is, their presence or absence, be evaluated within the context of the entire community. The health of the community should be determined based upon as much information as possible and not on limited knowledge.

VI. ACKNOWLEDGEMENTS

Mr. John W. Cooper, Chief Scientist, was in charge of the sampling program. The sampling crew, which included John M. Hosenfeld, Daniel J. Krueger, Philip J. Krueger, W. Scott Pennington, John B. Tillery, Chester R. Wuest, and Joseph D. Zotter, Sr., spent many long hours, sometimes under adverse conditions, collecting the samples necessary for this study. Special thanks is extended to Captain Howard Anderson, the Chief Engineer, and the crew of the M/V *Sea Transporter* for the enthusiasm, support, and excellent service that they provided during sample collection.

Samples for this investigation were sorted by Kim Ceaser, Gladys M. George, Peggy U. Grangaard, Frances R. Harris, Camille A. Hill, Lazette M. Jackson, Nancy Levit, James F. Nappier, W. Scott Pennington, Mary C. Ruisinger, Kalli Safos, Michele E. Scott, and William P. Wampler IV. Many thanks are extended to these people for their diligence and perseverance. Ms. Jenny C. Seltzer spent many hours obtaining the necessary literature. Her assistance in this area was most valuable.

Several specialists provided many hours of species identification and verification: Protozoa and Hydrozoa - Mr. Joseph D. Zotter, Sr., Southwest Research Institute-Houston (SwRI-Houston); Foraminifera - Dr. Rosalie F. Maddocks, University of Houston; Nematoda - Dr. John H. Tietjen, City College of New York; Kinorhyncha - Dr. Robert P. Higgins, U.S. National Museum of Natural History; Ectoprocta - Mr. Arthur J. J. Leuterman, Texas A&M University (TAMU); Oligochaeta -Dr. M. S. Loden, Louisiana State University (LSU); Polychaeta - Dr. Donald E. Harper, TAMU: Mollusca -Dr. John W. Tunnell, Jr., Corpus Christi State University; Malacostraca - Dr. Wayne Price, University of Tampa; Harpacticoida - Dr. M. Susan Ivester, University of Alabama and Mr. Alan Kwok, SwRI-Houston; Amphipoda - Dr. Larry D. McKinney, TAMU; Decapoda (Crustacea) - Dr. Darryl L. Felder, University of Southwestern Louisiana (USL); Echinodermata - Mr. Thomas C. Shirley, LSU; and Pisces -Dr. H. Dickson Hoese, USL.

Mr. Ralph E. Childers, Data Manager, spent many long hours providing data in a format for analysis. Dr. Rosalie F. Maddocks and her assistant, Ms. Jo Ann C. Locklin, provided much of the text for the discussion section on Foraminifera. Valuable criticism and encouragement were provided by Drs. C. A. Bedinger, Jr., SwRI-Houston, John D. Walker, U.S. Food and Drug Administration, and Sammy M. Ray, TAMU-Galveston, and Messrs. Richard D. Kalke, University of Texas-Port Aransas, and J. Thomas Ivy, SwRI-Houston. A special thanks is extended to Ms. Patsy D. Crossley, Mrs. Linda S. Walker, and Mrs. Janice M. Kunkel for the typing of this report and to Laura Z. Kirby for her many hours of editing.

Appreciation is extended to the Bureau of Land Management for the opportunity to participate in this investigation.

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APPENDICES

APPENDIX A
List of Taxa Identified in the BLM Central Gulf Platform study.

APPENDIX A

List of Taxa Identified in the BLM Central Gulf Platform study.

Because of the need to meet deadlines, this list was closed to additions or corrections in order to begin data synthesis. Therefore, Tables A1 and A2 of this Appendix list, in alphabetical and phylogenetic order, respectively, those taxa (total of 973) used for data synthesis. Tables A3, A4, and A5 present the taxonomic additions, corrections, and deletions, respectively, made after the file was closed. The total of all taxa identified, including additions, corrections, and deletions, was 1029.

Each taxa is preceded by the National Oceanographic Data Center (NODC) code. The following designations were also used based upon NODC (1978, 1979):

G denotes a genus name
* denotes a name new to NODC
A denotes an alternate name
? denotes taxonomic identification is not complete.

Genera are denoted by a G and/or an 8-digit code number preceding the name. Species are preceded by a 10-digit number.

APPENDIX A

List of Publications and Presentations Resulting from this Project.

The following is a list of publications and presentations that have utilized or will utilize the Benthic Biology data collected during the BLM Central Gulf Platform Study.

1. Publications

Bedinger, C.A., Jr. 1979. Ecological investigations of petroleum production platforms in the central Gulf of Mexico -- Preliminary findings, p. 2149-2161. *In* Proceedings, 11th Annual Offshore Technology Conference, Houston, Texas, April 30-May 3, 1979. Vol. 4.

Harper, D.E., Jr. 1979. *Nereis (Neanthes) micromma* n. sp. (Polychaeta:Nereididae) from the northern Gulf of Mexico with a note on the structure of nereidid palps. Contrib. Mar. Sci. 22: in press.

Harper, D.E., Jr. The family Owenidae (Polychaeta) in the northwestern Gulf of Mexico. In manuscript.

Harper, D.E., Jr. The family Sternaspidae (Polychaeta) in the northwestern Gulf of Mexico. In manuscript.

Howard, C.L. A simple elutriator for sorting meiobenthos. In manuscript.

Locklin, J.A. 1980. Effects of petroleum platform activity on Recent Foraminifera on the Louisiana shelf. Masters Thesis, University of Houston, Houston, Texas.

Baker, J.H., and C.A. Bedinger, Jr. Case for a depressed benthic fauna on the Louisiana continental shelf. In manuscript.

Baker, J.H., K.T. Kimball, W.D. Jobe, J.B. Janousek, C.L. Howard, and P.R. Chase. Benthic community structure on the continental shelf. In manuscript.

Baker, J.H., K.T. Kimball, W.D. Jobe, J.B. Janousek, C.L. Howard, and P.R. Chase. Effects of petroleum production platform activity on benthic populations on the Louisiana shelf, Gulf of Mexico. In manuscript.

2. Presentations

James H. Baker and C.A. Bedinger, Jr. "Case for a depressed benthic fauna on the Louisiana Continental Shelf," 43rd Annual Meeting, American Society of Limnology and Oceanography, Inc., University of Tennessee, Knoxville, 16-19 June 1980.

TABLE A1. List of taxa, in alphabetical order, identified in this BLM Central Gulf Platform study.

1.	5515350201		Abra aequalis
2.	6186020301	*	Acanthocarpus alexandri
3.	6169220605	*	Acanthohaustorius cf. A. millsi
4.	5922		Acarina
5.	61182901	G	Acartia
6.	6118290104		Acartia tonsa
7.	6177020101		Acetes americanus
8.	617702010101		Acetes americanus carolinae
9.	5110040104	*	Acteocina candei
10.	51100101	G	Acteon
11.	5110010102	*	Acteon candens
12.	5110010101		Acteon punctostriatus
13.	61132501	*	Actinocythereis
14.	5001410102		Aedicira belgicae
15.	78060101	G	Aeverrillia
16.	5001250303		Aglaophamus verrilli
17.	5515471801	*	Agriopoma texasiana
18.	61831302	*	Albunea
19.	6183130201	*	Albunea paretii
20.	617914		Alpheidae
21.	61791404	*	Alpheopsis
22.	61791401	G	Alpheus
23.	6179140104	*	Alpheus amblyonyx
24.	6179140103	*	Alpheus floridanus
25.	51032001	G	Alvania
26.	5103500301	*	Amaea mitchilli
27.	5001682301		Amaeana trilobata
28.	61191802	*	Ameira
29.	611918		Ameiridae
30.	3454250101		Ammonia beccarii
31.	3450320401	*	Ammoscalaria pseudospiralis
32.	61690201	G	Ampelisca
33.	6169020108		Ampelisca abdita
34.	6169020111		Ampelisca agassizi
35.	6169020116	*	Ampelisca cristodes
36.	6169020117	*	Ampelisca neopolitanus
37.	6169020110		Ampelisca verrilli
38.	50016702	G	Ampharete
39.	5001670208		Ampharete acutifrons
40.	5001670211	*	Ampharete americana
41.	500167		Ampharetidae
42.	61192804	G	Amphiascus
43.	6119280402	*	Amphiascus minutus
44.	61690302		Amphilochus
45.	47040404	*	Amphimonhystera
46.	8129030102		Amphiodia atra
47.	8129030105	*	Amphiodia trychna
48.	81290309	G	Amphioplus
49.	8129030902	*	Amphioplus coniortodes
50.	6168	A	Amphipoda
51.	812903		Amphiuridae
52.	5509051101	*	Amusium papyraeum

TABLE A1 (Cont'd).

53.	5105030303	*	Anachis obesa
54.	55060102	G	Anadara
55.	5506010203	*	Anadara baughmani
56.	5506010202		Anadara ovalis
57.	5506010201		Anadara transversa
58.	5515010401	*	Anadontia alba
59.	5001130110	*	Anaitides erythrophyllus
60.	5001130104		Anaitides mucosa
61.	6187011701	*	Anasimus latus
62.	8747020201		Anchoa hepsetus
63.	8747020202		Anchoa mitchilli
64.	8747020206		Anchoa nasuta
65.	8747020304		Anchoviella perfasciata
66.	50012201	G	Ancistrosyllis
67.	5001220102		Ancistrosyllis hartmanae
68.	5001220103		Ancistrosyllis jonesi
69.	5001220105	*	Ancistrosyllis papillosa
70.	8857030503		Ancylopsetta dilecta
71.	8857030506		Ancylopsetta quadrocellata
72.	8740	A	Anguilliformes
73.	50		Annelida
74.	6183	A	Anomura
75.	8787020203		Antennarius radiosus
76.	3760010204	*	Anthopleura krebsi
77.	3740		Anthozoa
78.	616001		Anthuridae
79.	47110401	G	Anticoma
80.	471104		Anticomidae
81.	5105040501	*	Antillophos candei
82.	50014322		Aonides
83.	50010101	G	Aphrodita
84.	61580101	*	Apseudes
85.	5001330201		Arabella irricolor
86.	5002		Archiannelida
87.	5103310101	*	Architectonica nobilis
88.	550601		Arcidae
89.	55060199	?	Arcidae A
90.	50014102	G	Aricidea
91.	5001410211		Aricidea cerruti
92.	5001410214	*	Aricidea fragilis
93.	5001410201		Aricidea suecica
94.	8777180202		Arius felis
95.	5001580203	*	Armandia agilis
96.	5001580204	*	Armandia maculata
97.	8401		Ascidiacea
98.	7200030101	*	Aspidosiphon albus
99.	7200030103	*	Aspidosiphon cumingii
100.	7200030102	*	Aspidosiphon spinalis
101.	8104		Asteroidea
102.	61110302	*	Asteropella
103.	8106010502	*	Astropecten duplicatus
104.	5001630103	*	Asychis elongata

TABLE A1 (Cont'd).

105.	5103730104	*	Atlanta peronii
106.	5507020101	*	Atrina seminuda
107.	6179140301	*	Automate cf. A. rectifrons
108.	6179140302	*	Automate evermanni
109.	470304		Axonolaimidae
110.	47030401	G	Axonolaimus
111.	8777180101		Bagre marinus
112.	8835440301		Bairdiella chrysura
113.	82010201		Balanoglossus
114.	61340201	G	Balanus
115.	8860020201		Balistes capriscus
116.	5518010401		Barnea truncata
117.	47031001	G	Bathylaimus
118.	3450450201	*	Bigenerina irregularis
119.	55		Bivalvia
120.	5598	?	Bivalvia #2
121.	5597	?	Bivalvia #3
122.	5519		Bivalvia anomalodesmata
123.	50014308	G	Boccardia
124.	5001430806		Boccardia hamata
125.	3453420109	*	Bolivina lowmani
126.	3453420111	*	Bolivina spinata
127.	3453420110	*	Bolivina striatula
128.	8847011601		Bollmannia communis
129.	885703		Bothidae
130.	80		Brachiopoda
131.	6184	A	Brachyura
132.	8500010101		Branchiostoma caribaeum
133.	8791020101		Bregmaceros atlanticus
134.	8747010403		Brevoortia patronus
135.	3453420201	*	Brizalina fragilis
136.	8792010401		Brotula barbata
137.	78152501	G	Bugula
138.	3453460203	*	Bulimina elegans
139.	3453460202		Bulimina marginata
140.	3453380101		Buliminella elegantissima
141.	3453380103	*	Buliminella morgani
142.	5520080301	*	Bushia elegans
143.	5105070104	*	Busycon contrarium
144.	510507010501	*	Busycon perversum pulleyi
145.	510507010601	*	Busycon spiratum plagosum
146.	6118	A	Calanoida
147.	6186020101		Calappa flammea
148.	6186020102		Calappa sulcata
149.	61230101	G	Caligus
150.	3760040101	*	Calliactis tricolor
151.	6183040206	*	Callianassa biformis
152.	6189010301		Callinectes sapidus
153.	6189010302		Callinectes similis
154.	51021001	G	Calliostoma
155.	470307		Camacolaimidae
156.	47030703	G	Camacolaimus

TABLE A1 (Cont'd).

157.	370401		Campanulariidae
158.	47030201	*	Campylaimus
159.	61540701	G	Campylaspis
160.	3453530101	*	Cancris sagra
161.	5105040401	*	Cantharus cancellarius
162.	5001600101		Capitella capitata
163.	8835280302		Caranx fusus
164.	551522		Cardiidae
165.	55201001	G	Cardiomya
166.	6179	A	Caridea
167.	34545701	G	Cassidulina
168.	46020301	*	Cateria
169.	5113020106		Cavolina longirostris
170.	6118170104		Centropages furcatus
171.	8835020305		Centropristis philadelphicus
172.	470505		Ceramonematidae
173.	6169150102		Cerapus tubularis
174.	5001240603	*	Ceratocephale cf. C. loveni
175.	5001240103		Ceratonereis irritabilis
176.	4303020209		Cerebratulus lacteus
177.	4303020210		Cerebratulus luridus
178.	3743		Ceriantipatharia ceriantharia
179.	47051003	*	Cervonema
180.	3960		Cestoda
181.	8835520101		Chaetodipterus faber
182.	47111204	*	Chaetonema
183.	5001490101		Chaetopterus variopedatus
184.	50015004	G	Chaetozone
185.	5001500401		Chaetozone setosa
186.	5515510102	*	Chama congregata
187.	6189050301	*	Chasmocarcinus mississippiensis
188.	7814	A	Cheilostomata
189.	55154714	*	Chione
190.	5515471499	?	Chione A
191.	5515471401	*	Chione clenchi
192.	8178020103		Chirodota laevis
193.	8835280401		Chloroscombrus chrysurus
194.	50017001	G	Chone
195.	5001700104		Chone duneri
196.	470513		Choniolaimidae
197.	4703		Chromadoria araeolaimida
198.	4705		Chromadoria desmodorida
199.	470511		Chromadoridae
200.	3453670104	*	Cibicides concentricus
201.	3453670105	*	Cibicides deprimus
202.	3513		Ciliatea
203.	3514		Ciliatea holotrichia
204.	3520		Ciliatea holotrichia apostomatida
205.	3516		Ciliatea holotrichia gymnostomatida rhabdophorina
206.	3529		Ciliatea peritrichia
207.	3530		Ciliatea peritrichia peritrichida
208.	3534		Ciliatea suctoria suctorida

TABLE A1 (Cont'd).

209.	51032003	G	Cingula
210.	500150		Cirratulidae
211.	50015001	G	Cirratulus
212.	5001500105	*	Cirratulus cf. C. hedgpethi
213.	5001500106	*	Cirratulus hedgpethi
214.	5001410601		Cirrophorus lyriformis
215.	8857030110		Citharichthys spilopterus
216.	6108	A	Cladocera
217.	61192701	G	Cletodes
218.	6119270106	*	Cletodes carthaginiensis
219.	6119270102	*	Cletodes dissimilis
220.	6119270105	*	Cletodes latirostris
221.	611927010301	*	Cletodes limicola limicola
222.	6119270101		Cletodes longicaudatus
223.	6119270104	*	Cletodes tenuipes
224.	611927		Cletodidae
225.	6183060701		Clibanarius vittatus
226.	874701		Clupeidae
227.	50016302	G	Clymenella
228.	500163020201	*	Clymenella torquata calida
229.	5001630203		Clymenella zonalis
230.	37040105	G	Clytia
231.	3704010501		Clytia cylindrica
232.	6187011801	*	Coelocerus spinosus
233.	35180101	*	Coelosomides
234.	351801	*	Coelosomididae
235.	47051007	*	Comesoma
236.	470510		Comesomatidae
237.	8741120302		Congrina flava
238.	5106030101	*	Conus austini
239.	5106030102	*	Conus clarki
240.	6117		Copepoda
241.	5517020201		Corbula contracta
242.	551702		Corbulidae
243.	616915		Corophiidae
244.	61691502	G	Corophium
245.	6169150201		Corophium acherusicum
246.	61200401	G	Corycaeus
247.	370306		Corynidae
248.	5105160101	*	Cosmioconcha calliglypta
249.	50015201	G	Cossura
250.	5001520103	*	Cossura delta
251.	5515200102	*	Crassinella lunulata
252.	5103640205		Crepidula convexa
253.	5103640204		Crepidula fornicata
254.	6154	A	Cumacea
255.	7815040402	*	Cupuladria biporosa
256.	7815040403	*	Cupuladria doma
257.	470512		Cyatholaimidae
258.	61540902	G	Cyclaspis
259.	6154090202		Cyclaspis varians
260.	6120	A	Cyclopoida

TABLE A1 (Cont'd).

261.	8857030801		Cyclopsetta chittendeni
262.	4602		Cyclorhagida
263.	5110040401	*	Cylichnella bidentata
264.	510378		Cymatiidae
265.	51037802	*	Cymatium
266.	8835440106		Cynoscion arenarius
267.	8835440103		Cynoscion nothus
268.	61110298	?	Cypridinidae B
269.	5518010301		Cyrtopleura costata
270.	61140101	*	Cytherella
271.	61131902	G	Cytheromorpha
272.	611313		Cytheruridae
273.	55070105	G	Dacrydium
274.	47050401	*	Dasynemella
275.	6175	A	Decapoda (arthropoda)
276.	8835281202		Decapterus punctatus
277.	3660		Demospongia
278.	470503		Desmodoridae
279.	470602		Desmoscolecidae
280.	47060201	*	Desmoscolex
281.	6119310401	*	Diarthrodes dissimilis
282.	344502	*	Difflugiidae
283.	5001290201		Diopatra cuprea
284.	611928		Diosaccidae
285.	8835021005		Diplectrum bivittatum
286.	8835021002		Diplectrum formosum
287.	50015404		Diplocirrus
288.	5515050103	*	Diplodonta soror
289.	7815150202	*	Discoporella doma
290.	7815150203	*	Discoporella umbellata
291.	3453540601	*	Discorbis squamata
292.	5001431901		Dispio uncinata
293.	5103780301	*	Distorsio clathrata
294.	50020302	*	Diurodrilus
295.	8747010502		Dorosoma petenense
296.	5001360102		Dorvillea caeca
297.	5001360108	*	Dorvillea sociabilis
298.	500136		Dorvilleidae
299.	47051001	G	Dorylaimopsis
300.	5515470901		Dosinia discus
301.	5001330107	*	Drilonereis cf. D. filum
302.	5001330103		Drilonereis longa
303.	6185020101	*	Dromia erythropus
304.	874117		Dysommidae
305.	6113250201	*	Echinocythereis garretti
306.	46020101	*	Echinoderes
307.	73		Echiura
308.	730102		Echiuridae
309.	61190902	G	Ectinosoma
310.	611909		Ectinosomidae
311.	78		Ectoprocta
312.	61620207	G	Edotea

TABLE A1 (Cont'd).

313.	37590101	G	Edwardsia
314.	3450540102	*	Eggerella bradyi
315.	47040101	G	Eleutherolaimus
316.	3454300109	*	Elphidium gunteri
317.	471116	*	Enchelidiidae
318.	61192702	*	Enhydrosoma
319.	6119270299	?	Enhydrosoma A
320.	6119270204	*	Enhydrosoma hopkinsi
321.	6119270206	*	Enhydrosoma lacunae
322.	6119270201	*	Enhydrosoma longifurcatum
323.	6119270202	*	Enhydrosoma propinquum
324.	6119270205	*	Enhydrosoma sarsi
325.	6119270203	*	Enhydrosoma uniarticulatum
326.	61192703	*	Enhydrosomella
327.	471112		Enoplidae
328.	8201		Enteropneusta
329.	34535403	G	Epistominella
330.	353001	*	Epistylidae
331.	3453560104	*	Eponides antillarum
332.	8835441206		Equetus umbrosus
333.	61200501	G	Ergasilus
334.	6120050106	*	Ergasilus megaceros
335.	6120050105	*	Ergasilus versicolor
336.	6169150302		Ericthonius brasiliensis
337.	6169210402	*	Eriopisa incisa
338.	5001130207		Eteone heteropoda
339.	6186010101		Ethusa microphthalma
340.	8857030201		Etropus crossotus
341.	8747010601		Etrumeus teres
342.	47050305	*	Eubostrichus
343.	6183120301		Euceramus praelongus
344.	47051102	G	Euchromadora
345.	8835390102		Eucinostomus gula
346.	6111050301	*	Euconchoecia chierchiae
347.	6189021401	*	Eucratodes agassizi
348.	6154040213	*	Eudorella monodon
349.	344503	*	Euglyphidae
350.	500130		Eunicidae
351.	50010205	G	Eunoe
352.	5001680206	*	Eupolymnia crassicornis
353.	6119140101		Euterpina acutifrons
354.	50012307	G	Exogone
355.	50017016		Fabrisabella
356.	5105090201	*	Fasciolaria lilium
357.	3704020301		Filellum serpens
358.	6161	A	Flabellifera (isopoda)
359.	3454610104	*	Florilus atlanticus
360.	3454610105	*	Florilus grateloupi
361.	6189050501	*	Frevillea barbata
362.	3453030802	*	Frondicularia compressa
363.	3454520203	*	Fursenkoina complanata
364.	3454520201		Fursenkoina compressa

TABLE A1 (Cont'd).

365.	3454520204	*	Fursenkoina pontoni
366.	51		Gastropoda
367.	50012701		Glycera (polychaeta)
368.	5001270104		Glycera americana
369.	5001280106	*	Glycinde nordmanni
370.	5001280104		Glycinde solitaria
371.	6189050401	*	Glyptoplax smithii
372.	40		Gnathostomulida
373.	884701		Gobiidae
374.	8847011201		Gobioides broussonneti
375.	8847010501		Gobionellus boleosoma
376.	72000201	G	Golfingia
377.	7200020106	*	Golfingia bulbosa
378.	7200020108	*	Golfingia pellucida
379.	7200020107	*	Golfingia trichocephala
380.	618905		Goneplacidae
381.	61890501	*	Goneplax
382.	5001280202		Goniada maculata
383.	5001280206	*	Goniada teres
384.	500128		Goniadidae
385.	6183040301	*	Gourretia latispina
386.	6169150901	*	Grandidierella bonneroides
387.	344501	*	Gromiidae
388.	50017501	*	Grubeulepis
389.	8858010303		Gymnachirus texae
390.	7801		Gymnolaemata
391.	7802		Gymnolaemata ctenostomata
392.	5001210102		Gyptis brevipalpa
393.	5001210103		Gyptis vittata
394.	8835400101		Haemulon aurolineatum
395.	47110901	G	Halalaimus
396.	37040601	G	Halecium
397.	3704060114	*	Halecium bermudense
398.	3704060115	*	Halecium nanum
399.	61190904	*	Halectinosoma
400.	8787040301		Halieutichthys aculeatus
401.	61192806	*	Haloschizopera
402.	3454650102	*	Hanzawaia strattoni
403.	34503001	G	Haplophragmoides
404.	5001400105	*	Haploscoloplos fragilis
405.	6111070101	*	Harbansus paucichelatus
406.	50010208	G	Harmothoe
407.	5001020812	*	Harmothoe trimaculata
408.	611910		Harpacticidae
409.	6119	A	Harpacticoida
410.	6120060102	*	Hemicyclops americanus
411.	8129020301	*	Hemipholas elongata
412.	61860202	G	Hepatus
413.	6186020201		Hepatus epheliticus
414.	500121		Hesionidae
415.	4303		Heteronemertea
416.	6189020601		Hexapanopeus angustifrons

TABLE A1 (Cont'd).

417.	6189020602	*	Hexapanopeus paulensis
418.	61693414	G	Hippomedon
419.	351601	*	Holophryidae
420.	8170		Holothuroidea
421.	4601		Homalorhagida
422.	8741080102		Hoplunnis macrurus
423.	5001730902		Hydroides protulicola
424.	3701		Hydrozoa
425.	3703		Hydrozoa hydroida anthomedusae
426.	3704		Hydrozoa hydroida leptomedusae
427.	47051104	G	Hypodontolaimus
428.	616202		Idoteidae
429.	471103		Ironidae
430.	6158	A	Isopoda
431.	5518010801	*	Jouannetia quillingi
432.	8840140301		Kathetostoma albigutta
433.	46		Kinorhyncha
434.	51060211	*	Kurtziella
435.	5515220402	*	Laevicardium laevigatum
436.	3453030915	*	Lagena spicata
437.	3453030908		Lagena striata
438.	3450120401	*	Lagenammina comprima
439.	3450120402	*	Lagenammina diflugiformis
440.	8861010101		Lagocephalus laevigatus
441.	8835430201		Lagodon rhomboides
442.	47051006	*	Laimella
443.	6154010105		Lamprops quadriplicata
444.	5001430201		Laonice cirrata
445.	6119150201	*	Laophonte cornuta
446.	611915		Laophontidae
447.	8835440501		Larimus fasciatus
448.	551507	*	Lasaeidae
449.	55150799	?	Lasaeidae A
450.	6179160602	*	Latreutes parvulus
451.	6187020201	*	Leiolambrus nitidus
452.	8835440401		Leiostomus xanthurus
453.	61690603	G	Lembos
454.	6169060304	*	Lembos brunneomaculatus
455.	6169060303		Lembos smithi
456.	34530301	G	Lenticulina
457.	3453030107	*	Lenticulina bowdensis
458.	3453030104		Lenticulina calcar
459.	3453030108	*	Lenticulina iota
460.	3453030105		Lenticulina peregrina
461.	50010218	G	Lepidasthenia
462.	5001021104		Lepidonotus sublevis
463.	5001021105		Lepidonotus variabilis
464.	8792010504		Lepophidium graellsi
465.	61790502		Leptochela (decapoda)
466.	6179050202	*	Leptochela bermudensis
467.	470305		Leptolaimidae
468.	47030501	G	Leptolaimus

TABLE A1 (Cont'd).

469.	55150999	?	Leptonidae A
470.	55150998	?	Leptonidae B
471.	471117	*	Leptosomatidae (nematoda)
472.	8178010204	*	Leptosynapta multipora
473.	6187010901		Libinia dubia
474.	6187010902		Libinia emarginata
475.	5509100104	*	Lima locklini
476.	5009020701	*	Limnodriloides medioporus
477.	5515010501	*	Linga amiantus
478.	80020101	*	Lingula
479.	470401		Linhomoeidae
480.	6169330399	?	Listriella A
481.	6169330301		Listriella barnardi
482.	5507011301	*	Lithophaga bisculata
483.	5001682001		Loimia medusa
484.	5001682002	*	Loimia viridis
485.	5706010102		Loligo pealei
486.	5706010201		Lolliguncula brevis
487.	8840020102		Lonchopisthus lindneri
488.	6119040101	*	Longipedia helgolandica
489.	37041101	G	Lovenella
490.	3704110102	*	Lovenella grandis
491.	61131901	G	Loxoconcha
492.	6113190103	*	Loxoconcha sarasotana
493.	551501		Lucinidae
494.	50013101	G	Lumbrineris
495.	5001310113		Lumbrineris tenuis
496.	8835360107		Lutjanus campechanus
497.	8835360112		Lutjanus synagris
498.	552005020601	*	Lyonsia hyalina floridana
499.	55153101	G	Macoma
500.	5515310122	*	Macoma pulleyi
501.	5515310121	*	Macoma tageliformis
502.	4401		Macrodasyoida
503.	5001440107	*	Magelona filiformis
504.	5001440106	*	Magelona phyllisae
505.	5001440104		Magelona rosea
506.	500144		Magelonidae
507.	618701		Majidae
508.	5001431403	*	Malacoceros vanderhorsti
509.	50016303	G	Maldane
510.	500163		Maldanidae
511.	3453030303	*	Marginulina obesa
512.	3453080101	*	Marginulinopsis marginulinoides
513.	5001300204	*	Marphysa aransensis
514.	5001300202		Marphysa belli
515.	5001300201		Marphysa sanguinea
516.	5001600402	*	Mediomastus californiensis
517.	5001700402		Megalomma bioculata
518.	5001670504		Melinna maculata
519.	34546502	G	Melonis
520.	6189021101	*	Menippe mercenaria

TABLE A1 (Cont'd).

521.	8835440601		Menticirrhus americanus
522.	551547110101	*	Mercenaria mercenaria texana
523.	61192901	*	Mesochra
524.	6119290101	*	Mesochra lilljeborgi
525.	47050301	G	Metachromadora
526.	47051004	*	Metacomesoma
527.	47051204	*	Metacyatholaimus
528.	88470107	G	Microgobius
529.	470502		Microlaimidae
530.	47050201	*	Microlaimus
531.	8835440701		Micropogon undulatus
532.	6119090101		Microsetella norvegica
533.	5001432301	*	Microspio pigmentata
534.	345201		Miliolacea
535.	8179010103	*	Molpadia cubana
536.	47040402	G	Monhystera
537.	470404		Monhysteridae
538.	6169370820		Monoculodes edwardsi
539.	470506		Monoposthiidae
540.	5515250301		Mulinia lateralis
541.	5105011001	*	Murex fulvescens
542.	510501		Muricidae
543.	6111	A	Myodocopa
544.	5001640302	*	Myriowenia californiensis
545.	5001640303	*	Myriowenia cf. M. californiensis
546.	8741130802		Myrophis punctatus
547.	6186030201		Myropsis quinquespinosa
548.	6151	A	Mysidacea
549.	6153012101		Mysidopsis bigelowi
550.	6153012102	*	Mysidopsis furca
551.	5515370201	*	Mytilopsis leucophaeta
552.	5001400203		Naineris laevigata
553.	6183061201	*	Namatopaguroides fagei
554.	5105030501	*	Nassarina glypta
555.	51050801	G	Nassarius
556.	5105080106	*	Nassarius acutus
557.	5103760204	*	Natica pusilla
558.	510376		Naticidae
559.	47		Nematoda
560.	46010201	*	Neocentrophyes
561.	8741020201		Neoconger mucronatus
562.	47051205	*	Neotonchus
563.	5001250114		Nephtys bucera
564.	5001250115		Nephtys incisa
565.	5001250116		Nephtys magellanica
566.	5001250117		Nephtys picta
567.	500124		Nereidae
568.	50012499	?	Nereidae B
569.	50012404	G	Nereis
570.	5001240414	*	Nereis falsa
571.	5001240410		Nereis succinea
572.	6161060601	*	Nerocila acuminata

TABLE A1 (Cont'd).

573.	5001310204		Ninoe nigripes
574.	5103530401	*	Niso aeglees
575.	61191801		Nitocra
576.	3453031004	*	Nodosaria albatrossi
577.	3453031005	*	Nodosaria fusta
578.	5506010301		Noetia ponderosa
579.	3454610206	*	Nonionella basiloba
580.	61191503	*	Normanella
581.	6119150303	*	Normanella confluens
582.	6119150301	*	Normanella mucronata
583.	6119150302	*	Normanella serrata
584.	5001600307	*	Notomastus hemipodus
585.	5001600306		Notomastus latericeus
586.	5502020207	*	Nucula cf. N. proxima
587.	5502040204		Nuculana acuta
588.	5502040213	*	Nuculana concentrica
589.	550204		Nuculanidae
590.	37040102	G	Obelia
591.	3704010207	*	Obelia hyalina
592.	51050102	G	Ocenebra
593.	3752		Octocorallia pennatulacea
594.	5708010202	*	Octopus vulgaris
595.	47030402	G	Odontophora
596.	51080101	G	Odostomia
597.	5108010199	?	Odostomia C
598.	616937		Oedicerotidae
599.	87870401	G	Ogcocephalus
600.	8787040106		Ogcocephalus radiatus
601.	6179150102		Ogyrides limicola
602.	84130101	G	Oikopleura
603.	6120090109	*	Oithona colcarva
604.	5004		Oligochaeta
605.	5105100201	*	Oliva sayana
606.	61200103	G	Oncaea
607.	6120010312		Oncaea venusta
608.	72000202		Onchnesoma
609.	471114		Oncholaimidae
610.	47111405	G	Oncholaimus
611.	500129		Onuphidae
612.	5001290107		Onuphis eremita
613.	500129010701	*	Onuphis eremita oculata
614.	5001290112	*	Onuphis nebulosa
615.	8129020201	*	Ophiactis savignyi
616.	5001210402		Ophiodromus obscura
617.	8120		Ophiuroidea
618.	500140		Orbiniidae
619.	8717		Osteichthyes
620.	6110		Ostracoda
621.	5510020202		Ostrea equestris
622.	6189010501		Ovalipes guadulpensis
623.	5001640102		Owenia fusiformis
624.	47110902	G	Oxystomina

TABLE A1 (Cont'd).

625.	471109		Oxystominidae
626.	354301	*	Oxytrichidae
627.	6154050801		Oxyurostylis smithi
628.	618306		Paguridae
629.	6183060103	*	Paguristes oxyophthalmus
630.	61830602	G	Pagurus (decapoda)
631.	6183060237	*	Pagurus bonairensis
632.	6183060235	*	Pagurus brevidactylus
633.	6183060236	*	Pagurus bullisi
634.	6183060232		Pagurus pollicaris
635.	50010801	G	Paleanotus
636.	5001080103		Paleanotus heteroseta
637.	3756010101	*	Palythoa texaensis
638.	5520020109	*	Pandora bushiana
639.	61180401	G	Paracalanus
640.	6118040105	*	Paracalanus aculeatus
641.	6118040102		Paracalanus crassirostris
642.	6171010901		Paracaprella tenuis
643.	47051005	*	Paracomesoma
644.	8741120501		Paraconger caudilimbatus
645.	61132001	G	Paradoxostoma
646.	50011601	*	Paralacydonia
647.	61191501	G	Paralaophonte
648.	6119150103	*	Paralaophonte pacifica
649.	8857030304		Paralichthys lethostigma
650.	6169480703	*	Parametopella texansis
651.	47040405	*	Paramonhystera
652.	5001130801		Paranaitis speciosa
653.	5001220702	*	Parandalia ocularis
654.	3760020201	*	Paranthus rapiformis
655.	500141		Paraonidae
656.	5001410301		Paraonis gracilis
657.	6177010501	*	Parapenaeus longirostris
658.	8172040301	*	Paraphyllophorus parvus
659.	61890605	*	Parapinnixa
660.	6189060501	*	Parapinnixa hendersoni
661.	5001431701		Paraprionospio pinnata
662.	47030404	G	Parodontophora
663.	618702		Parthenopidae
664.	5515010102	*	Parvilucina multilineata
665.	5001660302		Pectinaria gouldii
666.	61132003	*	Pellucistoma
667.	61191102	*	Peltidium
668.	617701		Penaeidae
669.	6177010101		Penaeus aztecus
670.	617701010101		Penaeus aztecus aztecus
671.	6177010102		Penaeus duorarum
672.	6177010103		Penaeus setiferus
673.	375402		Pennatulidae
674.	8172060303	*	Pentamera pulcherrima
675.	61620208	G	Pentidotea
676.	8851030104		Peprilus burti

TABLE A1 (Cont'd).

677.	8851030102		Peprilus paru
678.	6160		Peracarida isopoda anthuridea
679.	61791105	*	Periclimenes
680.	55154719	*	Periglypta
681.	55200701	G	Periploma
682.	5520070106	*	Periploma cf. P. orbicularis
683.	6186030102	*	Persephona crinita
684.	35400901	*	Petalotricha
685.	5515480102		Petricola pholadiformis
686.	551548		Petricolidae
687.	6183061101	*	Petrochirus diogenes
688.	471111		Phanodermatidae
689.	7200020401		Phascolion strombi
690.	51100501	G	Philine
691.	5110050106	*	Philine sagra
692.	611107		Philomedidae
693.	7700010203		Phoronis architecta
694.	61692602	G	Photis
695.	6169260299	?	Photis B
696.	6169260211	*	Photis macromanus
697.	500113		Phyllodocidae
698.	61890212	*	Pilumnus
699.	550702		Pinnidae
700.	61890604	G	Pinnixa
701.	500107		Pisionidae
702.	5001680701		Pista cristata
703.	5001680707		Pista palmata
704.	5515471202	*	Pitar cordatus
705.	5515110101	*	Planktomya henseni
706.	511412		Planorbidae
707.	5126020302	*	Pleurobranchaea hedgpethi
708.	5105090301	*	Pleuroploca gigantea
709.	6187011601	*	Podochela lamelligera
710.	6113	A	Podocopa
711.	5001460101	*	Poecilochaetus johnsoni
712.	8835440801		Pogonias cromis
713.	5103760407		Polinices duplicatus
714.	5001		Polychaeta
715.	5001680804		Polycirrus eximius
716.	8838010101		Polydactylus octonemus
717.	50014304	G	Polydora
718.	5001430411		Polydora ligni
719.	5001430402		Polydora socialis
720.	5002050102	*	Polygordius appendiculatus
721.	500102		Polynoidae
722.	5001030201	*	Polyodontes lupina
723.	5106021202	*	Polystira albida
724.	5106021201	*	Polystira tellea
725.	5001731301	*	Pomatoceros americanus
726.	61831205	G	Porcellana
727.	6183120502	*	Porcellana sayana
728.	6183120501		Porcellana sigsbeiana

TABLE A1 (Cont'd).

729.	8783010106		Porichthys porosissimus
730.	5520090105	*	Poromya rostrata
731.	61890106	G	Portunus
732.	6189010601		Portunus gibbesii
733.	6189010603		Portunus spinicarpus
734.	6189010604		Portunus spinimanus
735.	8835170101		Priacanthus arenatus
736.	5001430502		Prionospio cirrifera
737.	5001430508		Prionospio cirrobranchiata
738.	5001430510	*	Prionospio cristata
739.	5001430511	*	Prionospio dayi
740.	5001430507		Prionospio pygmaea
741.	8826020113		Prionotus ophryas
742.	8826020114		Prionotus paralatus
743.	8826020118		Prionotus rubio
744.	8826020121		Prionotus stearnsi
745.	8826020104		Prionotus tribulus
746.	8835360701		Pristipomoides aquilonaris
747.	61650406	G	Probopyrus
748.	61791701	*	Processa
749.	6179170101	*	Processa bermudensis
750.	6179170102	*	Processa hemphilli
751.	6153012401	*	Promysis atlantica
752.	3516010101	*	Prorodon marinus
753.	81780103	G	Protankyra
754.	6113110101	*	Protocytheretta daniana
755.	34		Protozoa I
756.	61191803	*	Pseudameira
757.	6119180301	*	Pseudameira perplexa
758.	61202001	*	Pseudanthessius
759.	5001100302	*	Pseudeurythoe ambigua
760.	61190903		Pseudobradya
761.	6119090301	*	Pseudobradya hirsuta
762.	61181902	G	Pseudodiaptomus
763.	6169221303	*	Pseudohaustorius americanus
764.	6189021301	*	Pseudomedeus agassizi
765.	61192811	*	Pseudomesochra
766.	47051301	*	Pseudonchus
767.	6189050601	*	Pseudorhombila quadridentata
768.	8106010303	*	Psilaster cassiope
769.	8202		Pterobranchia
770.	61130901	*	Pterygocytheris
771.	3454610403		Pullenia bulloides
772.	46010101	*	Pycnophyes
773.	510503		Pyrenidae
774.	3452140508	*	Pyrgo carinata
775.	3452140509	*	Pyrgo oblonga
776.	5110130301	*	Pyrunculus caelatus
777.	3452140112	*	Quinqueloculina compta
778.	3452140115	*	Quinqueloculina poeyana
779.	3452140113	*	Quinqueloculina polygona
780.	3452140116	*	Quinqueloculina sabulosa

TABLE A1 (Cont'd).

781.	3452140114	*	Quinqueloculina vulgaris
782.	8835260101		Rachycentron canadum
783.	5515250501	*	Raeta plicatella
784.	8713040133		Raja texana
785.	61860402	*	Raninoides
786.	6186040201	*	Raninoides louisianensis
787.	3450250107		Reophax scottii
788.	6189020901		Rhithropanopeus harrisii
789.	3443		Rhizopodea filosia
790.	8835360501		Rhomboplites aurorubens
791.	43		Rhynchocoela
792.	47040406	*	Rhynchonema
793.	47050701	*	Richtersia
794.	61192807	*	Robertgurneya
795.	6119280704	*	Robertgurneya diversa
796.	6119280701	*	Robertgurneya ecaudata
797.	6119280703	*	Robertgurneya ilievecensis
798.	6119280702	*	Robertgurneya rostrata
799.	3453540105	*	Rosalina bertheloti
800.	3453540104		Rosalina floridana
801.	47051002	G	Sabatieria
802.	5001700803		Sabella microphthalma
803.	5001650202		Sabellaria vulgaris
804.	500165020201	*	Sabellaria vulgaris beautortensis
805.	500170		Sabellidae
806.	612018		Sabelliphilidae
807.	61200602		Saphirella
808.	8747011003		Sardinella anchovia
809.	61110401		Sarsiella (ostracoda)
810.	6111040199	?	Sarsiella C
811.	6111040103	*	Sarsiella disparalis
812.	6111040104	*	Sarsiella gettlesoni
813.	8762020301		Saurida brasiliensis
814.	50013601	*	Schistomeringos
815.	5001360107	*	Schistomeringos cf. S. caeca
816.	5001360104	S	Schistomeringos rudolphii
817.	8163020101	*	Schizaster orbignyanus
818.	61192808	*	Schizopera
819.	5001432001		Scolelepis squamata
820.	5001400303		Scoloplos fragilis
821.	5001400307	*	Scoloplos rubra
822.	8850030301		Scomber japonicus
823.	8850030501		Scomberomorus cavalla
824.	5103770101	*	Sconsia striata
825.	8826010606		Scorpaena calcarata
826.	353101	*	Scyphidiidae
827.	460202	*	Semnoderidae
828.	617702		Sergestidae
829.	883502		Serranidae
830.	8835022302		Serranus atrobranchus
831.	8835022308		Serranus phoebe
832.	37040503	G	Sertularia

TABLE A1 (Cont'd).

833.	370405		Sertulariidae
834.	6177010301	*	Sicyonia brevirostris
835.	6177010302	*	Sicyonia dorsalis
836.	50012202	G	Sigambra
837.	5001220201		Sigambra tentaculata
838.	5001220203		Sigambra wassi
839.	5103760501		Sinum perspectivum
840.	47040501	*	Siphonolaimus
841.	3450460101	*	Siphotextularia affinis
842.	72		Sipuncula
843.	61530126	*	Siriella
844.	5515290202		Solen viridis
845.	6177010602	*	Solenocera atlantidis
846.	6177010601	*	Solenocera vioscai
847.	6189050201	*	Speocarcinus lobatus
848.	50012602	G	Sphaerodoropsis
849.	470403		Sphaerolaimidae
850.	47040301	G	Sphaerolaimus
851.	8861010210		Sphoeroides parvus
852.	5001430706		Spio pettiboneae
853.	5001490303	*	Spiochaetopterus oculatus
854.	500143		Spionidae
855.	5001431001		Spiophanes bombyx
856.	61910101	G	Squilla
857.	6191010102	*	Squilla chydaea
858.	6191010101		Squilla empusa
859.	6191010103	*	Squilla surinamica
860.	8835441001		Stellifer lanceolatus
861.	61192809	*	Stenhelia
862.	611928090101	*	Stenhelia longicaudata finmarchica
863.	6119280902	*	Stenhelia mastigochaeta
864.	6119280904	*	Stenhelia reflexa
865.	6119280903	*	Stenhelia unisetosa
866.	6180010101	*	Stenopus scutellatus
867.	6187011901	*	Stenorhynchus seticornis
868.	61694810	G	Stenothoe
869.	8835430102		Stenotomus caprinus
870.	5001590101		Sternaspis scutata
871.	5001060302		Sthenelais boa
872.	6191		Stomatopoda
873.	5103530204	*	Strombiformis bilineatus
874.	5103530203	*	Strombiformis hemphilli
875.	8406010510	*	Styela plicata
876.	8857031301		Syacium gunteri
877.	500123		Syllidae
878.	5001230302		Syllis gracilis
879.	88580201	G	Symphurus
880.	8858020102		Symphurus civitatus
881.	8858020101		Symphurus plagiusa
882.	6169371401		Synchelidium americanum
883.	5001220502	*	Synelmis albini
884.	876202		Synodontidae

TABLE A1 (Cont'd).

885.	8762020101		Synodus foetens
886.	8762020104		Synodus poeyi
887.	6155	A	Tanaidacea
888.	47030202	*	Tarvaia
889.	5103230503	*	Teinostoma biscaynense
890.	5103230502	*	Teinostoma parvicallum
891.	5515310301	*	Tellidora cristata
892.	55153102	G	Tellina
893.	5515310209	*	Tellina aequistriata
894.	5515310208	*	Tellina cristata
895.	5515310206	*	Tellina versicolor
896.	551531		Tellinidae
897.	6118200304		Temora turbinata
898.	6153012501	*	Tephromysis louisianae
899.	5001682203	*	Terebella rubra
900.	500168		Terebellidae
901.	5001690101		Terebellides stroemii
902.	5106040101		Terebra dislocata
903.	47040103	G	Terschellingia
904.	61193401	*	Tetragoniceps
905.	611934	*	Tetragonicipitidae
906.	3450450103	*	Textularia conica
907.	3450450104	*	Textularia earlandi
908.	3450450105	*	Textularia mayori
909.	510501080101		Thais haemastoma floridana
910.	47110903	*	Thalassolaimus
911.	5001500307	*	Tharyx marioni
912.	5001500304		Tharyx setigera
913.	47040403	G	Theristus
914.	552008		Thraciidae
915.	5515020311		Thyasira pygmaea
916.	551502		Thyasiridae
917.	61191003	*	Tigropus
918.	50015007	*	Timarete
919.	35400201	*	Tintinnopsis
920.	3540020103	*	Tintinnopsis cf. T. ovalis
921.	3540020101	*	Tintinnopsis subacuta
922.	3540020102	*	Tintinnopsis tocatinensis
923.	611913		Tisbidae
924.	5103800101	*	Tonna galea
925.	351602	*	Tracheliidae
926.	8835280102		Trachurus lathami
927.	46010102	*	Trachydemus
928.	61770102	G	Trachypenaeus
929.	6177010201		Trachypenaeus constrictus
930.	6177010202	*	Trachypenaeus similis
931.	3930		Trematoda
932.	8850020201		Trichiurus lepturus
933.	8857031404		Trichopsetta ventralis
934.	47060401	*	Tricoma
935.	3453480203	*	Trifarina bella
936.	470310		Tripyloididae

TABLE A1 (Cont'd).

937.	500902		Tubificidae
938.	370303		Tubulariidae
939.	3901		Turbellaria
940.	51080102	G	Turbonilla
941.	5108010299	?	Turbonilla B
942.	5108010212	*	Turbonilla cf. T. portoricana
943.	510602		Turridae
944.	51060299	?	Turridae B
945.	51060298	?	Turridae C
946.	6119281001	*	Typhlamphiascus lamellifer
947.	6169150703		Unciola irrorata
948.	6183040102		Upogebia affinis
949.	73020101		Urechis
950.	8791031005		Urophycis cirratus
951.	8791031007		Urophycis floridanus
952.	3453480104	*	Uvigerina bellula
953.	3453480103	*	Uvigerina parvula
954.	5516010101	*	Varicorbula operculata
955.	551547		Veneridae
956.	510335		Vermetidae
957.	55201103	*	Verticordia
958.	47111406	G	Viscosia
959.	51032302	G	Vitrinella
960.	5103230203	*	Vitrinella floridana
961.	5103230204	*	Vitrinella helicoidea
962.	5110130201	*	Volvulella persimilis
963.	5110130203	*	Volvulella recta
964.	5110130202	*	Volvulella texasiana
965.	8835281001		Vomer setapinnis
966.	5114020201	*	Williamia krebsii
967.	618902		Xanthidae
968.	6160010701	*	Xenanthura brevitelson
969.	6177010701		Xiphopeneus kroyeri
970.	47040407	*	Xyala
971.	5502040514	*	Yoldia solenoides
972.	6119100401	*	Zausodes arenicolus
973.	3758		Zoantharia actiniaria

TABLE A2. List of taxa, in phylogenetic order, identified in this BLM Central Gulf Platform study.

1.	34		Protozoa I
2.	3443		Rhizopodea filosia
3.	344501	*	Gromiidae
4.	344502	*	Difflugiidae
5.	344503	*	Euglyphidae
6.	3450120401	*	Lagenammina comprima
7.	3450120402	*	Lagenammina diflugiformis
8.	3450250107		Reophax scottii
9.	34503001	G	Haplophragmoides
10.	3450320401	*	Ammoscalaria pseudospiralis
11.	3450450103	*	Textularia conica
12.	3450450104	*	Textularia earlandi
13.	3450450105	*	Textularia mayori
14.	3450450201	*	Bigenerina irregularis
15.	3450460101	*	Siphotextularia affinis
16.	3450540102	*	Eggerella bradyi
17.	345201		Miliolacea
18.	3452140112	*	Quinqueloculina compta
19.	3452140113	*	Quinqueloculina polygona
20.	3452140114	*	Quinqueloculina vulgaris
21.	3452140115	*	Quinqueloculina poeyana
22.	3452140116	*	Quinqueloculina sabulosa
23.	3452140508	*	Pyrgo carinata
24.	3452140509	*	Pyrgo oblonga
25.	34530301	G	Lenticulina
26.	3453030104		Lenticulina calcar
27.	3453030105		Lenticulina peregrina
28.	3453030107	*	Lenticulina howdensis
29.	3453030108	*	Lenticulina iota
30.	3453030303	*	Marginulina obesa
31.	3453030802	*	Frondicularia compressa
32.	3453030908		Lagena striata
33.	3453030915	*	Lagena spicata
34.	3453031004	*	Nodosaria albatrossi
35.	3453031005	*	Nodosaria fusta
36.	3453080101	*	Marginulinopsis marginulinoides
37.	3453380101		Buliminella elegantissima
38.	3453380103	*	Buliminella morgani
39.	3453420109	*	Bolivina lowmani
40.	3453420110	*	Bolivina striatula

TABLE A2 (Cont'd).

41.	3453420111	*	Bolivina spinata
42.	3453420201	*	Brizalina fragilis
43.	3453460202		Bulimina marginata
44.	3453460203	*	Bulimina elegans
45.	3453480103	*	Uvigerina parvula
46.	3453480104	*	Uvigerina bellula
47.	3453480203	*	Trifarina bella
48.	3453530101	*	Cancris sagra
49.	3453540104		Rosalina floridana
50.	3453540105	*	Rosalina bertheloti
51.	34535403	G	Epistominella
52.	3453540601	*	Discorbis squamata
53.	3453560104	*	Eponides antillarum
54.	3453670104	*	Cibicides concentricus
55.	3453670105	*	Cibicides deprimus
56.	3454250101		Ammonia beccarii
57.	3454300109	*	Elphidium gunteri
58.	3454520201		Fursenkoina compressa
59.	3454520203	*	Fursenkoina complanata
60.	3454520204	*	Fursenkoina pontoni
61.	34545701	G	Cassidulina
62.	3454610104	*	Florilus atlanticus
63.	3454610105	*	Florilus grateloupi
64.	3454610206	*	Nonionella basiloba
65.	3454610403		Pullenia bulloides
66.	3454650102	*	Hanzawaia strattoni
67.	34546502	G	Melonis
68.	3513		Ciliatea
69.	3514		Ciliatea holotrichia
70.	3516		Ciliatea holotrichia gymnostomatida rhabdophorina
71.	351601	*	Holophryidae
72.	3516010101	*	Prorodon marinus
73.	351602	*	Tracheliidae
74.	351801	*	Coelosomididae
75.	35180101	*	Coelosomides
76.	3520		Ciliatea holotrichia apostomatida
77.	3529		Ciliatea peritrichia
78.	3530		Ciliatea peritrichia peritrichida
79.	353001	*	Epistylidae
80.	353101	*	Scyphidiidae

TABLE A2 (Cont'd).

81.	3534		Ciliatea suctoria suctorida
82.	35400201	*	Tintinnopsis
83.	3540020101	*	Tintinnopsis subacuta
84.	3540020102	*	Tintinnopsis tocatinensis
85.	3540020103	*	Tintinnopsis cf. T. ovalis
86.	35400901	*	Petalotricha
87.	354301	*	Oxytrichidae
88.	3660		Demospongia
89.	3701		Hydrozoa
90.	3703		Hydrozoa hydroida anthomedusae
91.	370303		Tubulariidae
92.	370306		Corynidae
93.	3704		Hydrozoa hydroida leptomedusae
94.	370401		Campanulariidae
95.	37040102	G	Obelia
96.	3704010207	*	Obelia hyalina
97.	37040105	G	Clytia
98.	3704010501		Clytia cylindrica
99.	3704020301		Filellum serpens
100.	370405		Sertulariidae
101.	37040503	G	Sertularia
102.	37040601	G	Halecium
103.	3704060114	*	Halecium bermudense
104.	3704060115	*	Halecium nanum
105.	37041101	G	Lovenella
106.	3704110102	*	Lovenella grandis
107.	3740		Anthozoa
108.	3743		Ceriantipatharia ceriantharia
109.	3752		Octocorallia pennatulacea
110.	375402		Pennatulidae
111.	3756010101	*	Palytnoa texaensis
112.	3758		Zoantharia actiniaria
113.	37590101	G	Edwardsia
114.	3760010204	*	Anthopleura krebsi
115.	3760020201	*	Paranthus rapiformis
116.	3760040101	*	Calliactis tricolor
117.	3901		Turbellaria
118.	3930		Trematoda
119.	3960		Cestoda
120.	40		Gnathostomulida

TABLE A2 (Cont'd).

121.	43		Rhynchocoela
122.	4303		Heteronemertea
123.	4303020209		Cerebratulus lacteus
124.	4303020210		Cerebratulus luridus
125.	4401		Macrodasyoida
126.	46		Kinorhyncha
127.	4601		Homalorhagida
128.	46010101	*	Pycnophyes
129.	46010102	*	Trachydemus
130.	46010201	*	Neocentrophyes
131.	4602		Cyclorhagida
132.	46020101	*	Echinoderes
133.	460202	*	Semnoderidae
134.	46020301	*	Cateria
135.	47		Nematoda
136.	4703		Chromadoria araeolaimida
137.	47030201	*	Campylaimus
138.	47030202	*	Tarvaia
139.	470304		Axonolaimidae
140.	47030401	G	Axonolaimus
141.	47030402	G	Odontophora
142.	47030404	G	Parodontophora
143.	470305		Leptolaimidae
144.	47030501	G	Leptolaimus
145.	470307		Camacolaimidae
146.	47030703	G	Camacolaimus
147.	470310		Tripyloididae
148.	47031001	G	Bathylaimus
149.	470401		Linhomoeidae
150.	47040101	G	Eleutherolaimus
151.	47040103	G	Terschellingia
152.	470403		Sphaerolaimidae
153.	47040301	G	Sphaerolaimus
154.	470404		Monhysteridae
155.	47040402	G	Monhystera
156.	47040403	G	Theristus
157.	47040404	*	Amphimonhystera
158.	47040405	*	Paramonhystera
159.	47040406	*	Rhynchonema
160.	47040407	*	Xyala

TABLE A2 (Cont'd).

161.	47040501	*	Siphonolaimus
162.	4705		Chromadoria desmodorida
163.	470502		Microlaimidae
164.	47050201	*	Microlaimus
165.	470503		Desmodoridae
166.	47050301	G	Metachromadora
167.	47050305	*	Eubostrichus
168.	47050401	*	Dasynemella
169.	470505		Ceramonematidae
170.	470506		Monoposthiidae
171.	47050701	*	Richtersia
172.	470510		Comesomatidae
173.	47051001	G	Dorylaimopsis
174.	47051002	G	Sabatieria
175.	47051003	*	Cervonema
176.	47051004	*	Metacomesoma
177.	47051005	*	Paracomesoma
178.	47051006	*	Laimella
179.	47051007	*	Comesoma
180.	470511		Chromadoridae
181.	47051102	G	Euchromadora
182.	47051104	G	Hypodontolaimus
183.	470512		Cyatholaimidae
184.	47051204	*	Metacyatholaimus
185.	47051205	*	Neotonchus
186.	470513		Choniolaimidae
187.	47051301	*	Pseudonchus
188.	470602		Desmoscolecidae
189.	47060201	*	Desmoscolex
190.	47060401	*	Tricoma
191.	471103		Ironidae
192.	471104		Anticomidae
193.	47110401	G	Anticoma
194.	471109		Oxystominidae
195.	47110901	G	Halalaimus
196.	47110902	G	Oxystomina
197.	47110903	*	Thalassolaimus
198.	471111		Phanodermatidae
199.	471112		Enoplidae
200.	47111204	*	Chaetonema

TABLE A2 (Cont'd).

201.	471114		Oncholaimidae
202.	47111405	G	Oncholaimus
203.	47111406	G	Viscosia
204.	471116	*	Enchelidiidae
205.	471117	*	Leptosomatidae (nematoda)
206.	50		Annelida
207.	5001		Polychaeta
208.	50010101	G	Aphrodita
209.	500102		Polynoidae
210.	50010205	G	Eunoe
211.	50010208	G	Harmothoe
212.	5001020812	*	Harmothoe trimaculata
213.	5001021104		Lepidonotus sublevis
214.	5001021105		Lepidonotus variabilis
215.	50010218	G	Lepidasthenia
216.	5001030201	*	Polyodontes lupina
217.	5001060302		Sthenelais boa
218.	500107		Pisionidae
219.	50010801	G	Paleanotus
220.	5001080103		Paleanotus heteroseta
221.	5001100302	*	Pseudeurythoe ambigua
222.	500113		Phyllodocidae
223.	5001130104		Anaitides mucosa
224.	5001130110	*	Anaitides erythrophyllus
225.	5001130207		Eteone heteropoda
226.	5001130801		Paranaitis speciosa
227.	50011601	*	Paralacydonia
228.	500121		Hesionidae
229.	5001210102		Gyptis brevipalpa
230.	5001210103		Gyptis vittata
231.	5001210402		Ophiodromus obscura
232.	50012201	G	Ancistrosyllis
233.	5001220102		Ancistrosyllis hartmanae
234.	5001220103		Ancistrosyllis jonesi
235.	5001220105	*	Ancistrosyllis papillosa
236.	50012202	G	Sigambra
237.	5001220201		Sigambra tentaculata
238.	5001220203		Sigambra wassi
239.	5001220502	*	Synelmis albini
240.	5001220702	*	Parandalia ocularis

TABLE A2 (Cont'd).

241.	500123		Syllidae
242.	5001230302		Syllis gracilis
243.	50012307	G	Exogone
244.	500124		Nereidae
245.	5001240103		Ceratonereis irritabilis
246.	50012404	G	Nereis
247.	5001240410		Nereis succinea
248.	5001240414	*	Nereis falsa
249.	5001240603	*	Ceratocephale cf. C. loveni
250.	50012499	?	Nereidae B
251.	5001250114		Nephtys bucera
252.	5001250115		Nephtys incisa
253.	5001250116		Nephtys magellanica
254.	5001250117		Nephtys picta
255.	5001250303		Aglaophamus verrilli
256.	50012602	G	Sphaerodoropsis
257.	50012701		Glycera (polychaeta)
258.	5001270104		Glycera americana
259.	500128		Goniadidae
260.	5001280104		Glycinde solitaria
261.	5001280106	*	Glycinde nordmanni
262.	5001280202		Goniada maculata
263.	5001280206	*	Goniada teres
264.	500129		Onuphidae
265.	5001290107		Onuphis eremita
266.	500129010701	*	Onuphis eremita oculata
267.	5001290112	*	Onuphis nebulosa
268.	5001290201		Diopatra cuprea
269.	500130		Eunicidae
270.	5001300201		Marphysa sanguinea
271.	5001300202		Marphysa belli
272.	5001300204	*	Marphysa aransensis
273.	50013101	G	Lumbrineris
274.	5001310113		Lumbrineris tenuis
275.	5001310204		Ninoe nigripes
276.	5001330103		Drilonereis longa
277.	5001330107	*	Drilonereis cf. D. filum
278.	5001330201		Arabella irricolor
279.	500136		Dorvilleidae
280.	50013601	*	Schistomeringos

TABLE A2 (Cont'd).

281.	5001360102		Dorvillea caeca
282.	5001360104	S	Schistomeringos rudolphii
283.	5001360107	*	Schistomeringos cf. S. caeca
284.	5001360108	*	Dorvillea sociabilis
285.	500140		Orbiniidae
286.	5001400105	*	Haploscoloplos fragilis
287.	5001400203		Naineris laevigata
288.	5001400303		Scoloplos fragilis
289.	5001400307	*	Scoloplos rubra
290.	500141		Paraonidae
291.	5001410102		Aedicira belgicae
292.	50014102	G	Aricidea
293.	5001410201		Aricidea suecica
294.	5001410211		Aricidea cerruti
295.	5001410214	*	Aricidea fragilis
296.	5001410301		Paraonis gracilis
297.	5001410601		Cirrophorus lyriformis
298.	500143		Spionidae
299.	5001430201		Laonice cirrata
300.	50014304	G	Polydora
301.	5001430402		Polydora socialis
302.	5001430411		Polydora ligni
303.	5001430502		Prionospio cirrifera
304.	5001430507		Prionospio pygmaea
305.	5001430508		Prionospio cirrobranchiata
306.	5001430510	*	Prionospio cristata
307.	5001430511	*	Prionospio dayi
308.	5001430706		Spio pettiboneae
309.	50014308	G	Boccardia
310.	5001430806		Boccardia hamata
311.	5001431001		Spiophanes bombyx
312.	5001431403	*	Malacoceros vanderhorsti
313.	5001431701		Paraprionospio pinnata
314.	5001431901		Dispio uncinata
315.	5001432001		Scolelepis squamata
316.	50014322		Aonides
317.	5001432301	*	Microspio pigmentata
318.	500144		Magelonidae
319.	5001440104		Magelona rosea
320.	5001440106	*	Magelona phyllisae

TABLE A2 (Cont'd).

321.	5001440107	*	Magelona filiformis
322.	5001460101	*	Poecilochaetus johnsoni
323.	5001490101		Chaetopterus variopedatus
324.	5001490303	*	Spiochaetopterus oculatus
325.	500150		Cirratulidae
326.	50015001	G	Cirratulus
327.	5001500105	*	Cirratulus cf. C. hedgpethi
328.	5001500106	*	Cirratulus hedgpethi
329.	5001500304		Tharyx setigera
330.	5001500307	*	Tharyx marioni
331.	50015004	G	Chaetozone
332.	5001500401		Chaetozone setosa
333.	50015007	*	Timarete
334.	50015201	G	Cossura
335.	5001520103	*	Cossura delta
336.	50015404		Diplocirrus
337.	5001580203	*	Armandia agilis
338.	5001580204	*	Armandia maculata
339.	5001590101		Sternaspis scutata
340.	5001600101		Capitella capitata
341.	5001600306		Notomastus latericeus
342.	5001600307	*	Notomastus hemipodus
343.	5001600402	*	Mediomastus californiensis
344.	500163		Maldanidae
345.	5001630103	*	Asychis elongata
346.	50016302	G	Clymenella
347.	500163020201	*	Clymenella torquata calida
348.	5001630203		Clymenella zonalis
349.	50016303	G	Maldane
350.	5001640102		Owenia fusiformis
351.	5001640302	*	Myriowenia californiensis
352.	5001640303	*	Myriowenia cf. M. californiensis
353.	5001650202		Sabellaria vulgaris
354.	500165020201	*	Sabellaria vulgaris beautortensis
355.	5001660302		Pectinaria gouldii
356.	500167		Ampharetidae
357.	50016702	G	Ampharete
358.	5001670208		Ampharete acutifrons
359.	5001670211	*	Ampharete americana
360.	5001670504		Melinna maculata

TABLE A2 (Cont'd).

361.	500168		Terebellidae
362.	5001680206	*	Eupolymnia crassicornis
363.	5001680701		Pista cristata
364.	5001680707		Pista palmata
365.	5001680804		Polycirrus eximius
366.	5001682001		Loimia medusa
367.	5001682002	*	Loimia viridis
368.	5001682203	*	Terebella rubra
369.	5001682301		Amaeana trilobata
370.	5001690101		Terebellides stroemii
371.	500170		Sabellidae
372.	50017001	G	Chone
373.	5001700104		Chone duneri
374.	5001700402		Megalomma bioculata
375.	5001700803		Sabella microphthalma
376.	50017016		Fabrisabella
377.	5001730902		Hydroides protulicola
378.	5001731301	*	Pomatoceros americanus
379.	50017501	*	Grubeulepis
380.	5002		Archiannelida
381.	50020302	*	Diurodrilus
382.	5002050102	*	Polygordius appendiculatus
383.	5004		Oligochaeta
384.	500902		Tubificidae
385.	5009020701	*	Limnodriloides medioporus
386.	51		Gastropoda
387.	51021001	G	Calliostoma
388.	51032001	G	Alvania
389.	51032003	G	Cingula
390.	51032302	G	Vitrinella
391.	5103230203	*	Vitrinella floridana
392.	5103230204	*	Vitrinella helicoidea
393.	5103230502	*	Teinostoma parvicallum
394.	5103230503	*	Teinostoma biscaynense
395.	5103310101	*	Architectonica nobilis
396.	510335		Vermetidae
397.	5103500301	*	Amaea mitchilli
398.	5103530203	*	Strombiformis hemphilli
399.	5103530204	*	Strombiformis bilineatus
400.	5103530401	*	Niso aeglees

TABLE A2 (Cont'd).

401.	5103640204		Crepidula fornicata
402.	5103640205		Crepidula convexa
403.	5103730104	*	Atlanta peronii
404.	510376		Naticidae
405.	5103760204	*	Natica pusilla
406.	5103760407		Polinices duplicatus
407.	5103760501		Sinum perspectivum
408.	5103770101	*	Sconsia striata
409.	510378		Cymatiidae
410.	51037802	*	Cymatium
411.	5103780301	*	Distorsio clathrata
412.	5103800101	*	Tonna galea
413.	510501		Muricidae
414.	51050102	G	Ocenebra
415.	510501080101		Thais haemastoma floridana
416.	5105011001	*	Murex fulvescens
417.	510503		Pyrenidae
418.	5105030303	*	Anachis obesa
419.	5105030501	*	Nassarina glypta
420.	5105040401	*	Cantharus cancellarius
421.	5105040501	*	Antillophos candei
422.	5105070104	*	Busycon contrarium
423.	510507010501	*	Busycon perversum pulleyi
424.	510507010601	*	Busycon spiratum plagosum
425.	51050801	G	Nassarius
426.	5105080106	*	Nassarius acutus
427.	5105090201	*	Fasciolaria lilium
428.	5105090301	*	Pleuroploca gigantea
429.	5105100201	*	Oliva sayana
430.	5105160101	*	Cosmioconcha calliglypta
431.	510602		Turridae
432.	51060211	*	Kurtziella
433.	5106021201	*	Polystira tellea
434.	5106021202	*	Polystira albida
435.	51060298	?	Turridae C
436.	51060299	?	Turridae B
437.	5106030101	*	Conus austini
438.	5106030102	*	Conus clarki
439.	5106040101		Terebra dislocata
440.	51080101	G	Odostomia

TABLE A2 (Cont'd).

441.	5108010199	?	Odostomia C
442.	51080102	G	Turbonilla
443.	5108010212	*	Turbonilla cf. T. portoricana
444.	5108010299	?	Turbonilla B
445.	51100101	G	Acteon
446.	5110010101		Acteon punctostriatus
447.	5110010102	*	Acteon candens
448.	5110040104	*	Acteocina candei
449.	5110040401	*	Cylichnella bidentata
450.	51100501	G	Philine
451.	5110050106	*	Philine sagra
452.	5110130201	*	Volvulella persimilis
453.	5110130202	*	Volvulella texasiana
454.	5110130203	*	Volvulella recta
455.	5110130301	*	Pyrunculus caelatus
456.	5113020106		Cavolina longirostris
457.	5114020201	*	Williamia krebsii
458.	511412		Planorbidae
459.	5126020302	*	Pleurobranchaea hedgpethi
460.	55		Bivalvia
461.	5502020207	*	Nucula cf. N. proxima
462.	550204		Nuculanidae
463.	5502040204		Nuculana acuta
464.	5502040213	*	Nuculana concentrica
465.	5502040514	*	Yoldia solenoides
466.	550601		Arcidae
467.	55060102	G	Anadara
468.	5506010201		Anadara transversa
469.	5506010202		Anadara ovalis
470.	5506010203	*	Anadara baughmani
471.	5506010301		Noetia ponderosa
472.	55060199	?	Arcidae A
473.	55070105	G	Dacrydium
474.	5507011301	*	Lithophaga bisculata
475.	550702		Pinnidae
476.	5507020101	*	Atrina seminuda
477.	5509051101	*	Amusium papyraeum
478.	5509100104	*	Lima locklini
479.	5510020202		Ostrea equestris
480.	551501		Lucinidae

TABLE A2 (Cont'd).

481.	5515010102	*	Parvilucina multilineata
482.	5515010401	*	Anadontia alba
483.	5515010501	*	Linga amiantus
484.	551502		Thyasiridae
485.	5515020311		Thyasira pygmaea
486.	5515050103	*	Diplodonta soror
487.	551507	*	Lasaeidae
488.	55150799	?	Lasaeidae A
489.	55150998	?	Leptonidae B
490.	55150999	?	Leptonidae A
491.	5515110101	*	Planktomya henseni
492.	5515200102	*	Crassinella lunulata
493.	551522		Cardiidae
494.	5515220402	*	Laevicardium laevigatum
495.	5515250301		Mulinia lateralis
496.	5515250501	*	Raeta plicatella
497.	5515290202		Solen viridis
498.	551531		Tellinidae
499.	55153101	G	Macoma
500.	5515310121	*	Macoma tageliformis
501.	5515310122	*	Macoma pulleyi
502.	55153102	G	Tellina
503.	5515310206	*	Tellina versicolor
504.	5515310208	*	Tellina cristata
505.	5515310209	*	Tellina aequistriata
506.	5515310301	*	Tellidora cristata
507.	5515350201		Abra aequalis
508.	5515370201	*	Mytilopsis leucophaeta
509.	551547		Veneridae
510.	5515470901		Dosinia discus
511.	551547110101	*	Mercenaria mercenaria texana
512.	5515471202	*	Pitar cordatus
513.	55154714	*	Chione
514.	5515471401	*	Chione clenchi
515.	5515471499	?	Chione A
516.	5515471801	*	Agriopoma texasiana
517.	55154719	*	Periglypta
518.	551548		Petricolidae
519.	5515480102		Petricola pholadiformis
520.	5515510102	*	Chama congregata

TABLE A2 (Cont'd).

521.	5516010101	*	Varicorbula operculata
522.	551702		Corbulidae
523.	5517020201		Corbula contracta
524.	5518010301		Cyrtopleura costata
525.	5518010401		Barnea truncata
526.	5518010801	*	Jouannetia quillingi
527.	5519		Bivalvia anomalodesmata
528.	5520020109	*	Pandora bushiana
529.	552005020601	*	Lyonsia hyalina floridana
530.	55200701	G	Periploma
531.	5520070106	*	Periploma cf. P. orbicularis
532.	552008		Thraciidae
533.	5520080301	*	Bushia elegans
534.	5520090105	*	Poromya rostrata
535.	55201001	G	Cardiomya
536.	55201103	*	Verticordia
537.	5597	?	Bivalvia #3
538.	5598	?	Bivalvia #2
539.	5706010102		Loligo pealei
540.	5706010201		Lolliguncula brevis
541.	5708010202	*	Octopus vulgaris
542.	5922		Acarina
543.	6108	A	Cladocera
544.	6110		Ostracoda
545.	6111	A	Myodocopa
546.	61110298	?	Cypridinidae B
547.	61110302	*	Asteropella
548.	61110401		Sarsiella (ostracoda)
549.	6111040103	*	Sarsiella disparalis
550.	6111040104	*	Sarsiella gettlesoni
551.	6111040199	?	Sarsiella C
552.	6111050301	*	Euconchoecia chierchiae
553.	611107		Philomedidae
554.	6111070101	*	Harbansus paucichelatus
555.	6113	A	Podocopa
556.	61130901	*	Pterygocytheris
557.	6113110101	*	Protocytheretta daniana
558.	611313		Cytheruridae
559.	61131901	G	Loxoconcha
560.	6113190103	*	Loxoconcha sarasotana

TABLE A2 (Cont'd).

561.	61131902	G	Cytheromorpha
562.	61132001	G	Paradoxostoma
563.	61132003	*	Pellucistoma
564.	61132501	*	Actinocythereis
565.	6113250201	*	Echinocythereis garretti
566.	61140101	*	Cytherella
567.	6117		Copepoda
568.	6118	A	Calanoida
569.	61180401	G	Paracalanus
570.	6118040102		Paracalanus crassirostris
571.	6118040105	*	Paracalanus aculeatus
572.	6118170104		Centropages furcatus
573.	61181902	G	Pseudodiaptomus
574.	6118200304		Temora turbinata
575.	61182901	G	Acartia
576.	6118290104		Acartia tonsa
577.	6119	A	Harpacticoida
578.	6119040101	*	Longipedia helgolandica
579.	611909		Ectinosomidae
580.	6119090101		Microsetella norvegica
581.	61190902	G	Ectinosoma
582.	61190903		Pseudobradya
583.	6119090301	*	Pseudobradya hirsuta
584.	61190904	*	Halectinosoma
585.	611910		Harpacticidae
586.	61191003	*	Tigropus
587.	6119100401	*	Zausodes arenicolus
588.	61191102	*	Peltidium
589.	611913		Tisbidae
590.	6119140101		Euterpina acutifrons
591.	611915		Laophontidae
592.	61191501	G	Paralaophonte
593.	6119150103	*	Paralaophonte pacifica
594.	6119150201	*	Laophonte cornuta
595.	61191503	*	Normanella
596.	6119150301	*	Normanella mucronata
597.	6119150302	*	Normanella serrata
598.	6119150303	*	Normanella confluens
599.	611918		Ameiridae
600.	61191801		Nitocra

TABLE A2 (Cont'd).

601.	61191802	*	Ameira
602.	61191803	*	Pseudameira
603.	6119180301	*	Pseudameira perplexa
604.	611927		Cletodidae
605.	61192701	G	Cletodes
606.	6119270101		Cletodes longicaudatus
607.	6119270102	*	Cletodes dissimilis
608.	611927010301	*	Cletodes limicola limicola
609.	6119270104	*	Cletodes tenuipes
610.	6119270105	*	Cletodes latirostris
611.	6119270106	*	Cletodes carthaginiensis
612.	61192702	*	Enhydrosoma
613.	6119270201	*	Enhydrosoma longifurcatum
614.	6119270202	*	Enhydrosoma propinquum
615.	6119270203	*	Enhydrosoma uniarticulatum
616.	6119270204	*	Enhydrosoma hopkinsi
617.	6119270205	*	Enhydrosoma sarsi
618.	6119270206	*	Enhydrosoma lacunae
619.	6119270299	?	Enhydrosoma A
620.	61192703	*	Enhydrosomella
621.	611928		Diosaccidae
622.	61192804	G	Amphiascus
623.	6119280402	*	Amphiascus minutus
624.	61192806	*	Haloschizopera
625.	61192807	*	Robertgurneya
626.	6119280701	*	Robertgurneya ecaudata
627.	6119280702	*	Robertgurneya rostrata
628.	6119280703	*	Robertgurneya ilievecensis
629.	6119280704	*	Robertgurneya diversa
630.	61192808	*	Schizopera
631.	61192809	*	Stenhelia
632.	611928090101	*	Stenhelia longicaudata finmarchica
633.	6119280902	*	Stenhelia mastigochaeta
634.	6119280903	*	Stenhelia unisetosa
635.	6119280904	*	Stenhelia reflexa
636.	6119281001	*	Typhlamphiascus lamellifer
637.	61192811	*	Pseudomesochra
638.	61192901	*	Mesochra
639.	6119290101	*	Mesochra lilljeborgi
640.	6119310401	*	Diarthrodes dissimilis

TABLE A2 (Cont'd).

641.	611934	*	Tetragonicipitidae
642.	61193401	*	Tetragoniceps
643.	6120	A	Cyclopoida
644.	61200103	G	Oncaea
645.	6120010312		Oncaea venusta
646.	61200401	G	Corycaeus
647.	61200501	G	Ergasilus
648.	6120050105	*	Ergasilus versicolor
649.	6120050106	*	Ergasilus megaceros
650.	6120060102	*	Hemicyclops americanus
651.	61200602		Saphirella
652.	6120090109	*	Oithona colcarva
653.	612018		Sabelliphilidae
654.	61202001	*	Pseudanthessius
655.	61230101	G	Caligus
656.	61340201	G	Balanus
657.	6151	A	Mysidacea
658.	6153012101		Mysidopsis bigelowi
659.	6153012102	*	Mysidopsis furca
660.	6153012401	*	Promysis atlantica
661.	6153012501	*	Tephromysis louisianae
662.	61530126	*	Siriella
663.	6154	A	Cumacea
664.	6154010105		Lamprops quadriplicata
665.	6154040213	*	Eudorella monodon
666.	6154050801		Oxyurostylis smithi
667.	61540701	G	Campylaspis
668.	61540902	G	Cyclaspis
669.	6154090202		Cyclaspis varians
670.	6155	A	Tanaidacea
671.	6158	A	Isopoda
672.	61580101	*	Apseudes
673.	6160		Peracarida isopoda anthuridea
674.	616001		Anthuridae
675.	6160010701	*	Xenanthura brevitelson
676.	6161	A	Flabellifera (isopoda)
677.	6161060601	*	Nerocila acuminata
678.	616202		Idoteidae
679.	61620207	G	Edotea
680.	61620208	G	Pentidotea

TABLE A2 (Cont'd).

681.	61650406	G	Probopyrus
682.	6168	A	Amphipoda
683.	61690201	G	Ampelisca
684.	6169020108		Ampelisca abdita
685.	6169020110		Ampelisca verrilli
686.	6169020111		Ampelisca agassizi
687.	6169020116	*	Ampelisca cristodes
688.	6169020117	*	Ampelisca neopolitanus
689.	61690302		Amphilochus
690.	61690603	G	Lembos
691.	6169060303		Lembos smithi
692.	6169060304	*	Lembos brunneomaculatus
693.	616915		Corophiidae
694.	6169150102		Cerapus tubularis
695.	61691502	G	Corophium
696.	6169150201		Corophium acherusicum
697.	6169150302		Ericthonius brasiliensis
698.	6169150703		Unciola irrorata
699.	6169150901	*	Grandidierella bonneroides
700.	6169210402	*	Eriopisa incisa
701.	6169220605	*	Acanthohaustorius cf. A. millsi
702.	6169221303	*	Pseudohaustorius americanus
703.	61692602	G	Photis
704.	6169260211	*	Photis macromanus
705.	6169260299	?	Photis B
706.	6169330301		Listriella barnardi
707.	6169330399	?	Listriella A
708.	61693414	G	Hippomedon
709.	616937		Oedicerotidae
710.	6169370820		Monoculodes edwardsi
711.	6169371401		Synchelidium americanum
712.	6169480703	*	Parametopella texansis
713.	61694810	G	Stenothoe
714.	6171010901		Paracaprella tenuis
715.	6175	A	Decapoda (arthropoda)
716.	617701		Penaeidae
717.	6177010101		Penaeus aztecus
718.	617701010101		Penaeus aztecus aztecus
719.	6177010102		Penaeus duorarum
720.	6177010103		Penaeus setiferus

TABLE A2 (Cont'd).

721.	61770102	G	Trachypenaeus
722.	6177010201		Trachypenaeus constrictus
723.	6177010202	*	Trachypenaeus similis
724.	6177010301	*	Sicyonia brevirostris
725.	6177010302	*	Sicyonia dorsalis
726.	6177010501	*	Parapenaeus longirostris
727.	6177010601	*	Solenocera vioscai
728.	6177010602	*	Solenocera atlantidis
729.	6177010701		Xiphopeneus kroyeri
730.	617702		Sergestidae
731.	6177020101		Acetes americanus
732.	617702010101		Acetes americanus carolinae
733.	6179	A	Caridea
734.	61790502		Leptochela (decapoda)
735.	6179050202	*	Leptochela bermudensis
736.	61791105	*	Periclimenes
737.	617914		Alpheidae
738.	61791401	G	Alpheus
739.	6179140103	*	Alpheus floridanus
740.	6179140104	*	Alpheus amblyonyx
741.	6179140301	*	Automate cf. A. rectifrons
742.	6179140302	*	Automate evermanni
743.	61791404	*	Alpheopsis
744.	6179150102		Ogyrides limicola
745.	6179160602	*	Latreutes parvulus
746.	61791701	*	Processa
747.	6179170101	*	Processa bermudensis
748.	6179170102	*	Processa hemphilli
749.	6180010101	*	Stenopus scutellatus
750.	6183	A	Anomura
751.	6183040102		Upogebia affinis
752.	6183040206	*	Callianassa biformis
753.	6183040301	*	Gourretia latispina
754.	618306		Paguridae
755.	6183060103	*	Paguristes oxyophthalmus
756.	61830602	G	Pagurus (decapoda)
757.	6183060232		Pagurus pollicaris
758.	6183060235	*	Pagurus brevidactylus
759.	6183060236	*	Pagurus bullisi
760.	6183060237	*	Pagurus bonairensis

TABLE A2 (Cont'd).

761.	6183060701		Clibanarius vittatus
762.	6183061101	*	Petrochirus diogenes
763.	6183061201	*	Namatopaguroides fagei
764.	6183120301		Euceramus praelongus
765.	61831205	G	Porcellana
766.	6183120501		Porcellana sigsbeiana
767.	6183120502	*	Porcellana sayana
768.	61831302	*	Albunea
769.	6183130201	*	Albunea paretii
770.	6184	A	Brachyura
771.	6185020101	*	Dromia erythropus
772.	6186010101		Ethusa microphthalma
773.	6186020101		Calappa flammea
774.	6186020102		Calappa sulcata
775.	61860202	G	Hepatus
776.	6186020201		Hepatus epheliticus
777.	6186020301	*	Acanthocarpus alexandri
778.	6186030102	*	Persephona crinita
779.	6186030201		Myropsis quinquespinosa
780.	61860402	*	Raninoides
781.	6186040201	*	Raninoides louisianensis
782.	618701		Majidae
783.	6187010901		Libinia dubia
784.	6187010902		Libinia emarginata
785.	6187011601	*	Podochela lamelligera
786.	6187011701	*	Anasimus latus
787.	6187011801	*	Coelocerus spinosus
788.	6187011901	*	Stenorhynchus seticornis
789.	618702		Parthenopidae
790.	6187020201	*	Leiolambrus nitidus
791.	6189010301		Callinectes sapidus
792.	6189010302		Callinectes similis
793.	6189010501		Ovalipes guadulpensis
794.	61890106	G	Portunus
795.	6189010601		Portunus gibbesii
796.	6189010603		Portunus spinicarpus
797.	6189010604		Portunus spinimanus
798.	618902		Xanthidae
799.	6189020601		Hexapanopeus angustifrons
800.	6189020602	*	Hexapanopeus paulensis

TABLE A2 (Cont'd).

801.	6189020901		Rhithropanopeus harrisii
802.	6189021101	*	Menippe mercenaria
803.	61890212	*	Pilumnus
804.	6189021301	*	Pseudomedeus agassizi
805.	6189021401	*	Eucratodes agassizi
806.	618905		Goneplacidae
807.	61890501	*	Goneplax
808.	6189050201	*	Speocarcinus lobatus
809.	6189050301	*	Chasmocarcinus mississippiensis
810.	6189050401	*	Glyptoplax smithii
811.	6189050501	*	Frevillea barbata
812.	6189050601	*	Pseudorhombila quadridentata
813.	61890604	G	Pinnixa
814.	61890605	*	Parapinnixa
815.	6189060501	*	Parapinnixa hendersoni
816.	6191		Stomatopoda
817.	61910101	G	Squilla
818.	6191010101		Squilla empusa
819.	6191010102	*	Squilla chydaea
820.	6191010103	*	Squilla surinamica
821.	72		Sipuncula
822.	72000201	G	Golfingia
823.	7200020106	*	Golfingia bulbosa
824.	7200020107	*	Golfingia trichocephala
825.	7200020108	*	Golfingia pellucida
826.	72000202		Onchnesoma
827.	7200020401		Phascolion strombi
828.	7200030101	*	Aspidosiphon albus
829.	7200030102	*	Aspidosiphon spinalis
830.	7200030103	*	Aspidosiphon cumingii
831.	73		Echiura
832.	730102		Echiuridae
833.	73020101		Urechis
834.	7700010203		Phoronis architecta
835.	78		Ectoprocta
836.	7801		Gymnolaemata
837.	7802		Gymnolaemata ctenostomata
838.	78060101	G	Aeverrillia
839.	7814	A	Cheilostomata
840.	7815040402	*	Cupuladria biporosa

TABLE A2 (Cont'd).

841.	7815040403	*	Cupuladria doma
842.	7815150202	*	Discoporella doma
843.	7815150203	*	Discoporella umbellata
844.	78152501	G	Bugula
845.	80		Brachiopoda
846.	80020101	*	Lingula
847.	8104		Asteroidea
848.	8106010303	*	Psilaster cassiope
849.	8106010502	*	Astropecten duplicatus
850.	8120		Ophiuroidea
851.	8129020201	*	Ophiactis savignyi
852.	8129020301	*	Hemipholas elongata
853.	812903		Amphiuridae
854.	8129030102		Amphiodia atra
855.	8129030105	*	Amphiodia trychna
856.	81290309	G	Amphioplus
857.	8129030902	*	Amphioplus coniortodes
858.	8163020101	*	Schizaster orbignyanus
859.	8170		Holothuroidea
860.	8172040301	*	Paraphyllophorus parvus
861.	8172060303	*	Pentamera pulcherrima
862.	8178010204	*	Leptosynapta multipora
863.	81780103	G	Protankyra
864.	8178020103		Chirodota laevis
865.	8179010103	*	Molpadia cubana
866.	8201		Enteropneusta
867.	82010201		Balanoglossus
868.	8202		Pterobranchia
869.	8401		Ascidiacea
870.	8406010510	*	Styela plicata
871.	84130101	G	Oikopleura
872.	8500010101		Branchiostoma caribaeum
873.	8713040133		Raja texana
874.	8717		Osteichthyes
875.	8740	A	Anguilliformes
876.	8741020201		Neoconger mucronatus
877.	8741080102		Hoplunnis macrurus
878.	8741120302		Congrina flava
879.	8741120501		Paraconger caudilimbatus
880.	8741130802		Myrophis punctatus

TABLE A2 (Cont'd).

881.	874117		Dysommidae
882.	874701		Clupeidae
883.	8747010403		Brevoortia patronus
884.	8747010502		Dorosoma petenense
885.	8747010601		Etrumeus teres
886.	8747011003		Sardinella anchovia
887.	8747020201		Anchoa hepsetus
888.	8747020202		Anchoa mitchilli
889.	8747020206		Anchoa nasuta
890.	8747020304		Anchoviella perfasciata
891.	876202		Synodontidae
892.	8762020101		Synodus foetens
893.	8762020104		Synodus poeyi
894.	8762020301		Saurida brasiliensis
895.	8777180101		Bagre marinus
896.	8777180202		Arius felis
897.	8783010106		Porichthys porosissimus
898.	8787020203		Antennarius radiosus
899.	87870401	G	Ogcocephalus
900.	8787040106		Ogcocephalus radiatus
901.	8787040301		Halieutichthys aculeatus
902.	8791020101		Bregmaceros atlanticus
903.	8791031005		Urophycis cirratus
904.	8791031007		Urophycis floridanus
905.	8792010401		Brotula barbata
906.	8792010504		Lepophidium graellsi
907.	8826010606		Scorpaena calcarata
908.	8826020104		Prionotus tribulus
909.	8826020113		Prionotus ophryas
910.	8826020114		Prionotus paralatus
911.	8826020118		Prionotus rubio
912.	8826020121		Prionotus stearnsi
913.	883502		Serranidae
914.	8835020305		Centropristis philadelphicus
915.	8835021002		Diplectrum formosum
916.	8835021005		Diplectrum bivittatum
917.	8835022302		Serranus atrobranchus
918.	8835022308		Serranus phoebe
919.	8835170101		Priacanthus arenatus
920.	8835260101		Rachycentron canadum

TABLE A2 (Cont'd).

921.	8835280102		Trachurus lathami
922.	8835280302		Caranx fusus
923.	8835280401		Chloroscombrus chrysurus
924.	8835281001		Vomer setapinnis
925.	8835281202		Decapterus punctatus
926.	8835360107		Lutjanus campechanus
927.	8835360112		Lutjanus synagris
928.	8835360501		Rhomboplites aurorubens
929.	8835360701		Pristipomoides aquilonaris
930.	8835390102		Eucinostomus gula
931.	8835400101		Haemulon aurolineatum
932.	8835430102		Stenotomus caprinus
933.	8835430201		Lagodon rhomboides
934.	8835440103		Cynoscion nothus
935.	8835440106		Cynoscion arenarius
936.	8835440301		Bairdiella chrysura
937.	8835440401		Leiostomus xanthurus
938.	8835440501		Larimus fasciatus
939.	8835440601		Menticirrhus americanus
940.	8835440701		Micropogon undulatus
941.	8835440801		Pogonias cromis
942.	8835441001		Stellifer lanceolatus
943.	8835441206		Equetus umbrosus
944.	8835520101		Chaetodipterus faber
945.	8838010101		Polydactylus octonemus
946.	8840020102		Lonchopisthus lindneri
947.	8840140301		Kathetostoma albigutta
948.	884701		Gobiidae
949.	8847010501		Gobionellus boleosoma
950.	88470107	G	Microgobius
951.	8847011201		Gobioides broussonneti
952.	8847011601		Bollmannia communis
953.	8850020201		Trichiurus lepturus
954.	8850030301		Scomber japonicus
955.	8850030501		Scomberomorus cavalla
956.	8851030102		Peprilus paru
957.	8851030104		Peprilus burti
958.	885703		Bothidae
959.	8857030110		Citharichthys spilopterus
960.	8857030201		Etropus crossotus

TABLE A2 (Cont'd).

961.	8857030304		Paralichthys lethostigma
962.	8857030503		Ancylopsetta dilecta
963.	8857030506		Ancylopsetta quadrocellata
964.	8857030801		Cyclopsetta chittendeni
965.	8857031301		Syacium gunteri
966.	8857031404		Trichopsetta ventralis
967.	8858010303		Gymnachirus texae
968.	88580201	G	Symphurus
969.	8858020101		Symphurus plagiusa
970.	8858020102		Symphurus civitatus
971.	8860020201		Balistes capriscus
972.	8861010101		Lagocephalus laevigatus
973.	8861010210		Sphoeroides parvus

TABLE A3. List of taxonomic additions in the taxa.

CODE		TAXA
34502901	*	Alveolophragmium
3450560106	*	Textularia mexicana
3452140117	*	Quinqueloculina lamarckina
3452140303	*	Triloculina tricarinata
3452140510	*	Pyrgo Nasuta
3453030407	*	Dentalina albatrossi
3453420112	*	Bolivina simplex
3453540106	*	Rosalina floridensis
3453540302		Epistominella vitrea
3453540602	*	Discorbis nitida
34545201	G	Virgulinella
34545202	G	Fursenkoina
3454570110		Cassidulina crassa
3454650201		Melonis pompilloides
5001230701		Exogone dispar
5001280203		Goniada cf G. brunnea
50012804	*	Ophioglycera
5001360102	S	Schistomeringos caeca
5103640207		Crepidula plana
5103640210	*	Crepidula maculosa
51060296	?	Turridae D
51060297	?	Turridae A
5108010198	?	Odostomia A
5108010297	?	Turbonilla C
5108010298	?	Turbonilla A
5134040101	*	Scyllaea pelagica
550202		Nuculidae
5515020399	?	Thyasira B
5515210120		Macoma tenta
5515471401	*	Gouldia cerina
5520080102	*	Astenothaerus hemphilli
56000101	G	Dentalium
61131701	G	Leptocythere
6119150104	*	Parataophonte subterranea
6119150304	*	Normanella minuta
6119180101	*	Nitocra reducta
6119270107	*	Cletodes spinulipes
6119270108	*	Cletodes millerorum
6119280601	*	Haloschizopera junodi
6119280999	?	Stenhelia A
6119281201	*	Parameiropsis rapiens
6161060501	*	Cymothoa excisa
6169030203	*	Amphilochus neapolitanus
6169330303	*	Listriella quintana
6179110101		Leander tenuicornis
6179160601		Latreutes fucorum
6183060238	*	Pagurus criniticornis
61830611	*	Solenopagurus
6187011002	*	Collodes leptocheles
6187011601	*	Metaporaphis calcarata
6189010101		Arenaeus cribrarius
6189010602		Portunus sayi
812903062	*	Ophiophragmus pulcher
8741120303		Congrina gracilior
8826010607		Scorpaena dispar
88260201	G	Prionotus

TABLE A4. List of taxonomic corrections in the taxa.

ORIGINAL IDENTIFICATION		IDENTIFICATION CHANGED TO:	
CODE	TAXA	CODE	TAXA
34503001 G	Haplophragmoides	34502901 *	Alveolophragmium
3450450105 *	Textularia mayori	3450450106 *	Textularia mexicana
3450460101 *	Siphotextularia affinis	3450450201 *	Bigenerian irregularis
3452104001 *	Quinqueloculina polygona	3452140303 *	Triloculina tricarinata
3452140115 *	Quinqueloculina poeyana	3452140117 *	Quinqueloculina lararckina
3452140508 *	Pyrgo carinata	3452140510 *	Pyrgo nasuta
3452540105 *	Rosalina bertheloti	3453540106 *	Rosalina floridensis
3453030105	Lenticulina peregrina	34530301 G	Lenticulina
3453030802 *	Frondicularia compressa	3453420112 *	Bolivina simplex
3453031004 *	Nodosaria albatrossi	3453030407 *	Dentalina albatrossi
3453420111 *	Bolivina spinata	3453420110 *	Bolivina striatula
3453420201 *	Brizalina fragilis	3453420110 *	Bolivina striatula
3453460203 *	Bulimina elgans	34545202 G	Fursenkoina
3453480104 *	Uvigerina bellula	34545202 G	Fursenkoina
3453540104 *	Rosalina floridana	3453540106 *	Rosalina floridensis
34535403 G	Epistominella	3453540302	Epistominella vitrea
3453540601 *	Discorbis squamata	3453540602 *	Discorbis nitida
3453670105 *	Cibicides deprimus	3453670104 *	Cibicides concentricus
3454520201 *	Fursenkoina compressa	34545202 G	Fursenkoina
34545701 G	Cassidulina	3454570110	Cassidulina crassa
3454610105 *	Florilus grateloupi	3454610104 *	Florilus atlanticus
3454650102 *	Hanzawaia strattoni	3453670104	Cibicides concentricus
34546502 G	Melonis	3454650201	Melonis pompiloides
470307	Camacolaimidae	47030703 G	Camacolaimus
470403	Sphaerolamidae	47040301 G	Sphacrolaimus
4705	Chromadoria desmodoridae	470511	Chromadoridae
470502	Micorlaimidae	47050201	Microtaimus
47051007	Comesoma	470510	Comesomatidae
50010801 G	Paleanotus	5001080103	Paleanotus heteroseta
5001240414 *	Nereis flasa	5001240410	Nereis succinea
5001240603 *	Ceratocephale loveni	50012406 G	Ceratocephale
5001280202	Gonida maculata	5001280203	Gonida cf G. brunnea
500129010701 *	Onuphis eremita oculata	5001290107	Onuphis eremita
5001300204 *	Marphysa aransensis	5001300201	Marphyea sanguinea
5001360102	Dorvillea caeca	5001360107 *	Schistomeringos caeca
5001360104 S	Schistomeringos rudolphii	5001360107 *	Schistomeringos caeca

TABLE A4 (Cont'd).

ORIGINAL IDENTIFICATION			IDENTIFICATION CHANGED TO:		
CODE		TAXA	CODE		TAXA
5001400105	*	Haploscoloplos fragilis	50010400303		Scoloplos fragilis
5001410102		Aedicira belgicae	5001410214	*	Aricidea fragilis
50015004	G	Chaetozone	50015007	*	Timarete
5001500401		Chaetozone setosa	50015007	*	Timarete
50015201	G	Cossura	5001520103	*	Cassure delta
5001600307	*	Notomastus hemipodus	5001600306		Notomastus latericeus
5001640303	*	Myrowenia cf. M. californiensis	5001640302	*	Myrowenia californiensis
5001682001		Loimia medusa	5001682002		Loimia viridis
5103640204		Crepidula fornicata	5103640210	*	Crepidula maculosa
5103640205		Crepidula convexa	5103640207		Crepidula plana
510602		Turridae	51060297	?	Turridae A
51080102	G	Turbonilla	5108010298	?	Turbonilla A
5110010102		Acteon candens	51100101		Acteon
550204		Nuculanidae	550202		Nuculidae
55153102	G	Tellina	55153101	G	Macoma
5515[illegible]	*	Tellina cristata	5515310301	*	Tellidora cristata
5519		Bivalvia anomalodesmata	5520020109	*	Pandora bushiana
55200701	G	Periploma	5520070106	*	Periploma cf. P. orbicularis
5598	?	Bivalvia #2	5515250301		Mulinia lateralis
61191501	G	Paralaophonte	6119150104	*	Paralaophonte subterranea
6119150302	*	Normanella serrata	6119150303	*	Normanella confluens
61191802	*	Ameira	611918		Ameiridae
61191803	*	Pseudameira	6119180101	*	Nitocra reducta
6119180301	*	Pseudameira perplexa	6119180101		Nitocra reducta
6119270101		Cletodes longicaudatus	6119270108	*	Cletodes millerorum
611927010301	*	Cletodes limicota limicota	6119270107	*	Cletodes spinulipes
6119270106	*	Cletodes carthageniensis	6119270108	*	Cletodes millerorum
61192703	*	Enhydrosomella	6119150304	*	Normanella minuta
61192806	*	Haloschizopera	6119280601	*	Haloschizopera junodi
6119280903	*	Stenhelia unisetosa	6119280999	?	Stenhelia A
6161		Flabellifera	616001		Anthuridae
6169020116	*	Ampelisca cristodes	6169020116	*	Ampelisca cristodes
6169020117	*	Ampelisca neapolitanus	6169030203	*	Amphilochus neapolitanus
61692602	G	Photis	6169[illegible]	*	Photis macromanus

TABLE A4 (Cont'd).

ORIGINAL IDENTIFICATION		IDENTIFICATION CHANGED TO:	
CODE	TAXA	CODE	TAXA
6169269299 ?	Photis B	6169260211 *	Photis macromanus
6169330399 ?	Listriella A	6169330303 *	Listriella quintana
617702010101	Acetes americanus carolinae	6177020101	Acetes americanus
61791401 G	Alpheus	61791404 *	Alpheopsis
6179140301 *	Automate cf. Aierctifrons	6179140302 *	Automate evermani
61791701	Processa	6179170102 *	Processa hemphilli
6183	Anomura	6183-6	Paguridae
6191010103	Squilla surinamica	61910101	Squilla
68131302 *	Albunea	6183130201 *	Albunea paretii
7815150202 *	Discoporella doma	7815040403 *	Cupuladria doma
80	Brachiopoda	80020101 *	Lingula
8021	Enteropneusta	82010201	Balaneglossue
8178010204 *	Leptosynapta multipora	81780103 G	Protankyra

TABLE A5. List of taxonomic deletions in the taxa.

CODE		TAXA
5518010301		Cyrtopleura costata
84130101	G	Oikopleura
551548		Petricolitae
511512		Planorbidae
8202		Pterobranchia
6189020901		Rhithropanopeus harrisii
5103230204	*	Vitrinella helicoidea
6183040301	*	Gourretia latispina

APPENDIX B

Taxa Common to Meiofauna, Macroinfauna, and/or Macroepifauna and Demersal Fish.

TABLE B1. Taxa common to meiofauna, macroinfauna, and/or macroepifauna and demersal fish with frequency of observation, abundance, and rank for all three cruises.

Taxa	Meiofauna			Macroinfauna			Macroepifauna & Demersal Fish		
	[1]Obs	[2]Ind	[3]RK	[1]Obs	[2]Ind	[3]Rk	[1]Obs	[2]Ind	[3]Rk
Ammoscalaria pseudospiralis	35	408	53	2	2	344			
Quinqueloculina compta	22	193	80	1	2	400			
Lenticulina peregrina	6	49	137	14	49	126			
Buliminella morgani	130	77283	7	1	1	430			
Eponides antillarum	27	191	72	8	89	172			
Cibicides concentricus	81	3790	26	13	443	132			
Nonionella basiloba	125	124755	9	1	1	432			
Ciliatea holotrichia gymnostomatida rhabdophorina	1	4	243	1	1	434			
Epistylidae	2	6	207	1	7	386			
Corynidae	5	18	152	1	15	380			
Sertulariidae	1	2	298	3	39	280			
Ceriantipatharia ceriantharia				9	21	163	2	2	145
Pennatulidae				2	2	345	1	1	206
Palythoa texaensis				24	288	84	2	11	122
Zoantharia actiniaria				6	16	199	1	1	207
Anthopleura krebsi				25	62	82	3	17	94
Paranthus rapiformis				21	97	96	2	21	117
Calliactis tricolor				6	7	214	11	112	28
Turbellaria	73	1187	29	5	10	225			
Rhynchocoela	67	1246	32	132	5235	2	6	12	69
Cerebratulus lacteus				24	44	88	1	10	168
Cerebratulus luridus				5	6	237	1	1	208
Nematoda	78	1727	27	7	13	185			
Odontophora	12	93	108	1	1	435			
Linhomoeidae	130	7258	8	32	250	65			
Terschellingia	117	12510	11	1	2	403			
Sphaerolaimidae	2	21	190	5	5	240			
Theristus	131	13764	6	4	9	251			
Desmodoridae	97	1852	17	1	1	436			
Dorylaimopsis	132	5895	4	42	138	53			
Sabatieria	135	38140	1	63	1031	30			
Metacomesoma	97	8042	16	3	5	291			
Paracomesoma	65	1165	33	1	1	437			
Cyatholaimidae	131	15566	5	2	3	331			
Chonjolaimidae	119	1961	10	6	8	212			
Ironidae	33	461	55	4	11	248			
Anticoma	13	117	105	17	49	111			
Oxystominidae	19	125	86	1	1	438			
Phanodermatidae	2	10	196	12	36	142			
Enoplidae	14	115	103	6	6	217			
Oncholaimidae	83	3489	25	25	180	81			

[1] Obs denotes number of observations
[2] Ind denotes number of individuals
[3] Rk denotes Rank

TABLE B1 (Cont'd).

	Meiofauna			Macroinfauna			Macroepifauna & Demersal Fish		
Taxa	[1]Obs	[2]Ind	[3]RK	[1]Obs	[2]Ind	[3]Rk	[1]Obs	[2]Ind	[3]Rk
Enchelidiidae	17	75	92	5	7	232			
Leptosomatidae (nematoda)	4	10	167	7	7	191			
Polychaeta	16	63	95	4	319	245			
Harmothoe				2	2	347	2	2	147
Lepidonotus sublevis				9	16	165	4	11	89
Lepidonotus variabilis				3	7	285	3	7	101
Lepidasthenia				33	141	64	1	11	167
Polyodontes lupina				5	5	241	1	1	210
Sthenelais boa	2	6	212	66	530	26	5	61	71
Pseudeurythoe ambigua	1	4	255	56	585	37			
Hesionidae	1	2	304	1	1	442			
Gyptis vittata	1	2	305	42	86	54	2	5	129
Ophiodromus obscura				16	28	117	1	1	211
Ancistrosyllis jonesi	3	10	181	64	225	29			
Sigambra tentaculata	64	428	34	125	1398	3			
Syllidae	1	2	306	6	9	207			
Nereidae				48	174	45	2	3	135
Ceratonereis irritabilis				38	443	59	3	6	104
Nereis	2	4	220	103	2596	10			
Nereis succinea				24	163	85	8	22	50
Nephtys incisa	17	108	91	106	1798	6	6	24	63
Glycera americana	1	4	257	64	369	28	2	6	128
Goniadidae				5	6	238	1	1	214
Diopatra cuprea				97	1319	14	14	341	14
Lumbrineris tenuis	4	12	165	105	1629	8	2	5	130
Ninoe nigripes				66	519	27	2	2	149
Dorvilleidae	1	2	307	1	2	407			
Schistomeringos cf. S. caeca				6	16	200	1	1	216
Aricidea	60	446	36	7	23	184			
Aricidea suecica	1	4	258	76	1314	19			
Paraonis gracilis	18	68	90	47	174	47			
Spionidae				4	8	253	1	1	217
Polydora				12	370	140	2	3	136
Polydora socialis				15	276	118	1	7	173
Prionospio cirrifera	18	82	89	94	1312	15			
Prionospio dayi	1	6	239	26	151	79			
Paraprionospio pinnata	23	139	78	137	23121	1	5	15	74
Magelona rosea				72	334	21	1	1	218
Magelona phyllisae	12	32	113	110	16620	5			
Cirratulus cf. C. hedgpethi				18	29	109	1	10	169
Tharyx marioni	31	173	58	105	1376	9			

[1] Obs denotes number of observations
[2] Ind denotes number of individuals
[3] Rk denotes Rank

TABLE B1 (Cont'd).

Taxa	Meiofauna			Macroinfauna			Macroepifauna & Demersal Fish		
	[1]Obs	[2]Ind	[3]RK	[1]Obs	[2]Ind	[3]Rk	[1]Obs	[2]Ind	[3]Rk
Cossura delta	30	168	60	113	1098	4			
Armandia maculata	7	45	133	72	322	22	1	1	220
Notomastus latericeus	58	874	38	103	1053	11	1	4	176
Mediomastus californiensis	33	280	56	97	7884	13			
Maldanidae				6	8	213	1	2	188
Asychis elongata				47	255	46	9	134	35
Clymenella torquata calida				46	176	57	1	1	221
Clymenella zonalis				22	108	91	1	1	222
Sabellaria vulgaris	1	112	227	1	1	457			
Ampharete acutifrons	5	20	151	62	649	31	1	1	224
Ampharete americana	16	282	93	31	4796	66	1	4	177
Terebellides stroemii				10	26	155	8	43	47
Sabellidae	1	4	259	14	79	123			
Chone	15	70	100	10	74	154			
Hydroides protulicola				2	4	327	2	4	131
Grubeulepis				4	5	265	1	1	225
Gastropoda	8	52	129	50	160	43			
Vitrinella helicoidea	1	4	260	1	1	468			
Architectonica nobilis				2	2	352	2	2	150
Polinices duplicatus				17	22	114	2	4	132
Sinum perspectivum				12	17	148	2	11	123
Anachis obesa				4	4	271	1	10	170
Cantharus cancellarius				24	49	87	14	190	16
Nassarius acutus				11	34	151	2	3	137
Oliva sayana				5	15	221	3	7	102
Cosmioconcha calliglypta				40	153	58	1	1	234
Terebra dislocata				45	83	48	3	3	110
Volvulella texasiana	1	4	261	77	412	18			
Bivalvia	30	417	59	62	371	32			
Nucula cf. N. proxima	3	8	185	49	409	44			
Nuculana concentrica	1	4	262	84	1242	16	1	1	235
Anadara transversa				6	13	203	3	37	93
Anadara ovalis				6	14	202	2	10	124
Veneridae	1	4	263	1	1	494			
Pitar cordatus				1	1	495	12	82	24
Chione clenchi				30	95	68	5	9	76
Agriopoma texasiana				27	50	77	7	10	58
Corbulidae	7	32	134	1	1	498			
Corbula contracta	5	30	147	105	1734	7	4	5	91
Periploma	1	2	310	1	1	501			
Ostracoda	1	2	311	7	13	186			

[1] Obs denotes number of observations
[2] Ind denotes number of individuals
[3] Rk denotes Rank

TABLE B1 (Cont'd)

Taxa	Meiofauna			Macroinfauna			Macroepifauna & Demersal Fish		
	[1]Obs	[2]Ind	[3]RK	[1]Obs	[2]Ind	[3]Rk	[1]Obs	[2]Ind	[3]Rk
Harbansua paucichelatus	1	2	314	4	5	266			
Pterygocytheris	1	4	265	2	2	360			
Longipedia helgolandica	15	145	97	13	125	134			
Halectinosoma	62	823	35	4	10	250			
Isopoda	1	8	237	1	1	514			
Idoteidae	6	48	140	1	1	516			
Photis macromanus				27	614	76	1	1	240
Synchelidium americanum	1	4	282	14	64	124			
Trachypenaeus				3	5	294	4	20	83
Trachypenaeus similis				9	12	167	17	1479	9
Leptochela bermudensis				4	4	276	1	1	242
Alpheus floridanus				43	82	52	11	116	27
Latreutes parvulus				3	4	301	1	1	244
Processa hemphilli				14	18	131	1	2	194
Pagurus (decapoda)				4	6	262	1	1	246
Pagurus pollicaris				1	1	527	11	49	29
Hepatus epheliticus				2	3	343	8	17	51
Persephona crinita				1	1	528	6	26	62
Raninoides louisianensis				2	2	367	7	50	56
Leiolambrus nitidus				14	19	130	17	249	10
Callinectes similis				1	3	397	19	331	6
Portunus gibbesii				1	1	531	19	300	7
Hexapanopeus paulensis				1	3	398	1	2	198
Speocarcinus lobatus				56	116	38	9	47	37
Stomatopoda				5	7	236	3	4	108
Squilla				5	5	244	2	3	139
Squilla empusa				5	6	239	22	274	3
Squilla chydaea				3	3	306	12	939	22
Aspidosiphon albus				68	499	24	3	8	100
Echiura	1	2	330	7	155	179			
Cupuladria biporosa				9	1910	157	2	4975	113
Asteroidea	1	2	331	1	1	534			
Astropecten duplicatus				29	183	71	18	6371	8
Ophiuroidea				18	46	108	1	1	253
Ophiactis savignyi				1	1	535	1	1	254
Amphiodia atra				44	111	50	1	1	255
Amphioplus coniortodes				67	315	25	3	11	97

[1] Obs denotes number of observations

[2] Ind denotes number of individuals

[3] Rk denotes Rank

TABLE B1 (Cont'd)

Taxa	Meiofauna			Macroinfauna			Macroepifauna & Demersal Fish		
	[1]Obs	[2]Ind	[3]Rk	[1]Obs	[2]Ind	[3]Rk	[1]Obs	[2]Ind	[3]Rk
Schizaster orbignyanus				6	9	211	1	131	163
Molpadia cubana				1	1	537	4	10	90
Balanoglossus	1	2	332	21	301	94			
Osteichthyes	1	4	287	7	8	188			
Paraconger caudilimbatus				1	1	538	1	1	259
Clupeidae				1	1	539	2	3	141
Saurida brasiliensis				1	2	427	13	121	20
Antennarius radiosus				1	1	541	8	75	45
Bregmaceros atlanticus				22	65	93	2	4	134
Gobionellus boleosoma				3	3	309	2	2	161
Bollmannia communis				7	8	190	7	219	53
Symphurus plagiusa				1	1	543	9	47	38

[1] Obs denotes number of observations
[2] Ind denotes number of individuals
[3] Rk denotes Rank

APPENDIX C

Diversity and Evenness Values by Station and by Cruise.

TABLE C1. Meiofauna diversity and evenness values by station for Cruise I.

Station Label	No. Species	No. Individuals	Diversity	Evenness	
				Pielou	Heip
780501PE0500286 T.B	45	1323	2.28	.599	.200
780501PE2000286 T.B	58	942	2.62	.645	.223
780501PN0500286 T.B	62	1451	2.85	.690	.267
780501PN2000286 T.B	60	1689	2.58	.631	.207
780501PS0500286 T.B	46	517	2.71	.708	.312
780501PS2000286 T.B	48	1301	2.13	.551	.158
780501PW0500286 T.B	57	2809	2.00	.494	.114
780501PW2000286 T.B	47	2971	1.65	.428	.091
780502PE0500286 T.B	78	971	2.99	.685	.244
780502PE2000286 T.B	61	1348	2.83	.689	.267
780502PN0500286 T.B	75	438	3.19	.740	.316
780502PN2000286 T.B	85	2282	3.26	.734	.298
780502PS0500286 T.B	71	1526	3.18	.745	.328
780502PS2000286 T.B	66	1938	2.81	.670	.240
780502PW0500286 T.B	59	474	2.55	.625	.203
780502PW2000286 T.B	60	489	3.08	.752	.351
780503PE0500286 T.B	92	1172	2.77	.613	.165
780503PE2000286 T.B	83	835	2.75	.623	.179
780503PN0500286 T.B	87	1116	1.96	.440	.071
780503PN2000286 T.B	61	261	3.07	.748	.344
780503PS0500286 T.B	83	1319	2.65	.599	.160
780503PS2000286 T.B	42	1458	1.42	.380	.077
780503PW0500286 T.B	85	1627	2.49	.560	.131
780503PW2000286 1.B	75	2004	2.20	.509	.108
780504PE0500286 T.B	59	3052	2.63	.644	.221
780504PE2000286 T.B	54	1444	2.03	.509	.125
780504PN0500286 T.B	54	1384	2.61	.655	.239
780504PN2000286 T.B	60	1446	2.35	.574	.160
780504PS0500286 T.B	53	1393	2.37	.596	.186
780504PS2000286 T.B	59	1792	2.42	.593	.177
780504PW0500286 T.B	62	1351	2.50	.607	.184
780504PW2000286 T.B	62	1824	2.63	.638	.212
780521C 286 T.B	50	2368	1.95	.499	.123
780522C 286 T.B	79	3273	1.95	.447	.077
780523C 286 T.B	50	500	1.97	.504	.126
780524C 286 T.B	46	558	2.80	.731	.342

Table C2. Neiofauna diversity and evenness values by station for Cruise II.

Station Label	No. Species	No. Individuals	Diversity	Evenness	
				Pielou	Heip
780801PE05002B6 T.B	36	570	2.46	.687	.306
780801PE20002B6 T.B	37	660	2.37	.656	.269
780801PN05002B6 T.B	31	238	2.07	.602	.230
780801PN20002B6 T.B	24	145	2.41	.758	.440
780801PS05002B6 T.B	24	118	2.26	.710	.372
780801PS20002B6 T.B	31	342	2.44	.709	.347
780801PW05002B6 T.B	33	261	2.41	.689	.316
780801PW20002B6 T.B	35	351	2.16	.608	.226
780802PE05002B6 T.B	37	244	2.30	.637	.249
780802PE20002B6 T.B	36	368	2.35	.656	.271
780802PN05002B6 T.B	40	191	2.36	.639	.245
780802PN20002B6 T.B	39	262	2.33	.637	.245
780802PS05002B6 T.B	34	198	2.22	.631	.250
780802PS20002B6 T.B	39	425	2.30	.629	.237
780802PW05002B6 T.B	34	178	2.33	.659	.280
780802PW20002B6 T.B	34	204	2.27	.643	.263
780803PE05002B6 T.B	58	1264	1.88	.464	.098
780803PE20002B6 T.B	48	401	1.99	.514	.134
780803PN05002B6 T.B	70	814	2.48	.584	.159
780803PN20002B6 T.B	57	901	1.65	.408	.075
780803PS05002B6 T.B	43	202	2.46	.653	.254
780803PS20002B6 T.B	26	663	1.46	.448	.132
780803PW05002B6 T.B	56	1109	2.16	.538	.140
780803PW20002B6 T.B	35	1172	1.77	.497	.143
780804PE05002B6 T.B	57	2064	2.15	.533	.136
780804PE20002B6 T.B	42	1189	2.13	.570	.181
780804PN05002B6 T.B	57	2338	2.28	.564	.157
780804PN20002B6 T.B	53	1587	1.83	.460	.100
780804PS05002B6 T.B	56	2241	2.33	.580	.169
780804PS20002B6 T.B	57	3485	2.01	.498	.116
780804PW05002B6 T.B	48	1979	2.15	.555	.161
780804PW20002B6 T.B	48	1351	2.09	.541	.151
780805SN05002B6 T.B	27	269	2.02	.614	.252
780805SN20002B6 T.B	30	646	1.98	.581	.214
780806SN05002B6 T.B	12	22	2.19	.882	.723
780806SN20002B6 T.B	13	41	2.00	.781	.534
780807SN05002B6 T.B	22	33	2.28	.739	.420
780807SN20002B6 T.B	26	409	1.50	.460	.139
780808SN05002B6 T.B	34	1148	1.33	.378	.085
780808SN20002B6 T.B	22	1105	1.15	.372	.103
780809SN05002B6 T.B	25	496	1.42	.442	.131
780809SN20002B6 T.B	24	59	2.17	.683	.337
780810SN05002B6 T.B	43	390	2.78	.739	.360
780810SN20002B6 T.B	60	864	2.78	.678	.256
780811SN05002B6 T.B	43	268	2.73	.726	.342
780811SN20002B6 T.B	51	1492	2.57	.654	.242
780812SN05002B6 T.B	35	676	1.81	.509	.151
780812SN20002B6 T.B	22	322	1.62	.523	.192
780813SN05002B6 T.B	7	41	1.19	.614	.384
780813SN20002B6 T.B	16	35	2.11	.762	.485
780814SN05002B6 T.B	11	14	2.23	.932	.834
780814SN20002B6 T.B	36	183	1.84	.515	.152
780815SN05002B6 T.B	20	25	2.62	.873	.667
780815SN20002B6 T.B	41	122	2.80	.755	.387
780816SN05002B6 T.B	39	426	2.31	.630	.238
780816SN20002B6 T.B	57	452	2.67	.659	.239
780817SN05002B6 T.B	29	37	3.03	.900	.703
780817SN20002B6 T.B	5	3	1.61	1.000	1.000
780818SN05002B6 T.B	15	33	2.41	.889	.722
780818SN20002B6 T.B	43	209	2.46	.653	.254
780819SN05002B6 T.B	31	591	2.39	.697	.331
780819SN20002B6 T.B	25	439	1.76	.546	.200
780820SN05002B6 T.B	44	805	2.01	.531	.150
780820SN20002B6 T.B	45	754	2.68	.704	.309
780821C 2B6 T.B	35	1136	2.31	.650	.267
780822C 2B6 T.B	18	228	1.42	.490	.184
780823C 2B6 T.B	57	1601	1.85	.459	.096
780824C 2B6 T.B	51	934	1.66	.423	.085

TABLE C3. Meiofauna diversity and evenness values by station for Cruise III.

Station Label	No. Species	No. Individuals	Diversity	Evenness	
				Pielou	Heip
790101PE05002B6 T.B	27	281	2.46	.748	.414
790101PE20002B6 T.B	42	313	2.86	.764	.400
790101PN05002B6 T.B	20	86	2.38	.794	.515
790101PN20002B6 T.B	31	327	2.61	.759	.418
790101PS05002B6 T.B	35	271	2.67	.752	.397
790101PS20002B6 T.B	44	244	2.88	.761	.391
790101Pw05002B6 T.B	34	368	2.58	.730	.368
790101Pw20002B6 T.B	52	438	2.79	.707	.300
790102PE05002B6 T.B	32	163	2.50	.722	.361
790102PE20002B6 T.B	44	687	2.73	.720	.332
790102PN05002B6 T.B	36	274	2.65	.740	.376
790102PN20002B6 T.B	51	630	2.91	.740	.347
790102PS05002B6 T.B	34	644	2.57	.728	.365
790102PS20002B6 T.B	31	429	2.53	.736	.383
790102PW05002B6 T.B	40	252	2.58	.700	.314
790102Pw20002B6 T.B	39	354	2.74	.747	.379
790103PE05002B6 T.B	57	648	3.10	.767	.378
790103PE20002B6 T.B	64	1111	2.63	.631	.203
790103PN05002B6 T.B	73	501	3.15	.734	.311
790103PN20002B6 T.B	55	194	3.31	.827	.490
790103PS05002B6 T.B	55	394	3.12	.778	.401
790103PS20002B6 T.B	50	629	2.30	.588	.183
790103PW05002B6 T.B	57	886	2.60	.644	.224
790103PW20002B6 T.B	74	910	2.89	.672	.233
790104PE05002B6 T.B	18	103	1.93	.668	.347
790104PE20002B6 T.B	30	181	2.24	.658	.289
790104PN05002B6 T.B	40	366	2.57	.698	.311
790104PN20002B6 T.B	44	301	2.79	.737	.355
790104PS05002B6 T.B	24	106	2.71	.852	.608
790104PS20002B6 T.B	21	56	2.65	.871	.659
790104Pw05002B6 T.B	32	245	2.61	.754	.408
790104Pw20002B6 T.B	41	135	3.01	.611	.482
790121C 2B6 T.B	40	179	2.92	.793	.452
790122C 2B6 T.B	37	249	2.82	.780	.437
790123C 2B6 T.B	20	35	2.55	.851	.622
790124C 2B6 T.B	48	200	3.12	.806	.461

TABLE C4. Macroinfauna diversity and evenness values by station for Cruise I.

Station Label	No. Species	No. Individuals	Diversity	Evenness	
				Peilou	Heip
760501PE05002B7 T.B	64	340	1.93	.465	.094
780501PE20002B7 T.B	74	316	2.41	.559	.138
780501PN05002B7 T.B	71	219	2.54	.595	.166
780501PN20002B7 T.B	65	329	1.90	.455	.089
780501PS05002B7 T.B	58	353	1.86	.458	.095
780501PS20002B7 T.B	69	443	1.52	.359	.053
780501PW05002B7 T.B	57	266	1.92	.475	.104
780501PW20002B7 T.B	53	132	2.03	.510	.127
780502PE05002B7 T.B	138	818	3.29	.667	.188
780502PE20002B7 T.B	97	539	2.83	.618	.165
780502PN05002B7 T.B	131	783	3.27	.672	.196
780502PN20002B7 T.B	106	645	3.11	.666	.203
780502PS05002B7 T.B	139	709	3.25	.659	.180
780502PS20002B7 T.B	105	438	2.88	.619	.162
780502PW05002B7 T.B	128	830	2.91	.600	.137
780502Pw20002B7 T.B	112	535	3.29	.697	.233
780503PE05002B7 T.B	119	368	3.38	.708	.242
780503PE20002B7 T.B	131	494	3.29	.675	.199
780503PN05002B7 T.B	108	278	3.45	.738	.286
780503PN20002B7 T.B	139	390	3.34	.677	.198
780503PS05002B7 T.B	100	329	3.17	.687	.229
780503PS20002B7 T.B	78	285	2.75	.632	.191
780503Pw05002B7 T.B	102	229	3.48	.752	.310
780503Pw20002B7 T.B	78	147	2.93	.672	.229
780504PE05002B7 T.B	66	89	3.11	.742	.329
780504PE20002B7 T.B	65	115	3.08	.737	.323
780504PN05002B7 T.B	83	237	2.99	.678	.231
780504PN20002B7 T.B	67	124	3.00	.714	.290
780504PS05002B7 T.B	70	131	3.11	.731	.310
780504PS20002B7 T.B	61	121	3.04	.740	.332
780504Pw05002B7 T.B	77	141	3.22	.741	.316
780504Pw20002B7 T.B	61	107	2.84	.691	.269
780521C 2B7 T.B	65	488	2.02	.485	.103
780522C 2B7 T.B	70	314	2.48	.584	.159
780523C 2B7 T.B	68	94	3.25	.770	.370
780524C 2B7 T.B	32	252	1.22	.353	.077

TABLE C5. Macroinfauna diversity and evenness values by station for Cruise II.

Station Label	No. Species	No. Individuals	Diversity	Evenness	
				Pielou	Heip
780801PE05002B7 T.B	21	33	1.96	.645	.306
780801PE20002B7 T.B	36	35	2.71	.756	.400
780801PN05002B7 T.B	30	60	2.02	.593	.225
780801PN20002B7 T.B	29	38	2.42	.719	.367
780801PS05002B7 T.B	17	16	2.28	.803	.546
780801PS20002B7 T.B	28	42	2.13	.641	.276
780801PW05002B7 T.B	31	42	1.96	.571	.204
780801PW20002B7 T.B	26	26	2.12	.652	.295
780802PE05002B7 T.B	36	171	1.55	.434	.107
780802PE20002B7 T.B	15	133	.55	.202	.052
780802PN05002B7 T.B	29	95	1.69	.501	.157
780802PN20002B7 T.B	30	137	1.48	.436	.118
780802PS05002B7 T.B	16	42	1.45	.524	.218
780802PS20002B7 T.B	20	109	1.35	.450	.150
780802PW05002B7 T.B	34	74	1.80	.510	.153
780802PW20002B7 T.B	28	51	2.31	.694	.338
780803PE05002B7 T.B	66	124	3.19	.761	.358
780803PE20002B7 T.B	62	106	2.78	.673	.247
780803PN05002B7 T.B	58	60	3.34	.824	.480
780803PN20002B7 T.B	95	165	3.37	.739	.297
780803PS05002B7 T.B	56	101	3.11	.773	.390
780803PS20002B7 T.B	39	50	2.76	.753	.389
780803PW05002B7 T.B	58	82	3.29	.811	.454
780803PW20002B7 T.B	60	134	3.04	.742	.337
780804PE05002B7 T.B	46	47	2.90	.757	.380
780804PE20002B7 T.B	38	42	2.67	.733	.362
780804PN05002B7 T.B	63	73	3.18	.767	.371
780804PN20002B7 T.B	54	84	2.79	.699	.287
780804PS05002B7 T.B	51	56	3.22	.818	.479
780804PS20002B7 T.B	45	56	2.45	.643	.240
780804PW05002B7 T.B	47	50	3.04	.789	.431
780804PW20002B7 T.B	29	33	2.37	.703	.346
780805SN05002B7 T.B	23	233	1.27	.406	.117
780805SN20002B7 T.B	25	265	1.25	.387	.103
780806SN05002B7 T.B	17	7	2.62	.925	.796
780806SN20002B7 T.B	17	11	2.43	.857	.646
780807SN05002B7 T.B	20	12	2.39	.798	.523
780807SN20002B7 T.B	23	11	2.75	.876	.664
780808SN05002B7 T.B	26	33	2.37	.726	.386
780808SN20002B7 T.B	25	24	2.34	.727	.390
780809SN05002B7 T.B	30	19	2.75	.809	.505
780809SN20002B7 T.B	31	15	3.05	.888	.669
780810SN05002B7 T.B	18	26	2.21	.765	.478
780810SN20002B7 T.B	23	31	2.33	.744	.424
780811SN05002B7 T.B	32	88	2.22	.641	.265
780811SN20002B7 T.B	24	56	2.11	.665	.317
780812SN05002B7 T.B	25	26	2.61	.811	.526
780812SN20002B7 T.B	29	42	1.96	.581	.217
780813SN05002B7 T.B	11	4	2.22	.924	.817
780813SN20002B7 T.B	10	6	1.81	.784	.565
780814SN05002B7 T.B	55	60	3.10	.773	.391
780814SN20002B7 T.B	42	33	3.10	.829	.516
780815SN05002B7 T.B	44	24	3.37	.890	.653
780815SN20002B7 T.B	45	25	3.38	.887	.644
780816SN05002B7 T.B	32	26	2.93	.846	.572
780816SN20002B7 T.B	49	80	3.10	.797	.443
780817SN05002B7 T.B	40	24	3.32	.901	.687
780817SN20002B7 T.B	44	22	3.27	.863	.586
780818SN05002B7 T.B	52	46	3.37	.852	.549
780818SN20002B7 T.B	60	77	3.53	.862	.560
780819SN05002B7 T.B	50	107	2.18	.556	.159
780819SN20002B7 T.B	39	124	2.02	.551	.172
780820SN05002B7 T.B	36	50	2.00	.559	.183
780820SN20002B7 T.B	26	52	1.89	.579	.224
780821C 2B7 T.B	6	7	1.47	.820	.670
780822C 2B7 T.B	23	30	1.86	.592	.245
780823C 2B7 T.B	48	60	2.99	.772	.401
780824C 2B7 T.B	38	35	2.98	.819	.504

TABLE C6. Macroinfauna diversity and evenness values by station for Cruise III.

Station Label	No. Species	No. Individuals	Diversity	Evenness Pielou	Evenness Heip
790101PE05002B7 T.B	44	61	2.80	.740	.359
790101PE20002B7 T.B	46	80	2.54	.663	.259
790101PN05002B7 T.B	35	28	2.18	.612	.230
790101PN20002B7 T.B	45	52	2.66	.698	.301
790101PS05002B7 T.B	46	68	2.65	.692	.292
790101PS20002B7 T.B	48	57	2.69	.694	.291
790101PW05002B7 T.B	27	15	2.76	.836	.567
790101PW20002B7 T.B	27	13	2.82	.856	.608
790102PE05002B7 T.B	51	394	1.51	.383	.070
790102PE20002B7 T.B	54	189	2.04	.512	.126
790102PN05002B7 T.B	54	199	1.91	.478	.108
790102PN20002B7 T.B	48	78	2.81	.727	.334
790102PS05002B7 T.B	51	313	1.54	.391	.073
790102PS20002B7 T.B	44	281	1.67	.441	.100
790102PW05002B7 T.B	43	178	2.54	.674	.277
790102PW20002B7 T.B	57	163	2.42	.598	.183
790103PE05002B7 T.B	48	75	2.35	.606	.201
790103PE20002B7 T.B	50	65	2.96	.758	.375
790103PN05002B7 T.B	53	108	2.67	.673	.259
790103PN20002B7 T.B	65	196	2.68	.641	.212
790103PS05002B7 T.B	41	55	2.52	.680	.287
790103PS20002B7 T.B	43	33	3.29	.875	.615
790103PW05002B7 T.B	64	88	3.17	.761	.361
790103PW20002B7 T.B	87	165	3.06	.684	.235
790104PE05002B7 T.B	31	16	3.11	.904	.711
790104PE20002B7 T.B	39	19	3.33	.909	.708
790104PN05002B7 T.B	48	41	3.09	.797	.444
790104PN20002B7 T.B	43	45	3.18	.846	.549
790104PS05002B7 T.B	37	24	3.19	.884	.648
790104PS20002B7 T.B	34	17	3.21	.911	.722
790104PW05002B7 T.B	23	9	2.90	.925	.780
790104PW20002B7 T.B	29	11	3.01	.895	.691
790121C 2B7 T.B	39	184	1.92	.523	.152
790122C 2B7 T.B	32	24	2.86	.826	.532
790123C 2B7 T.B	32	15	3.21	.927	.768
790124C 2B7 T.B	34	36	2.78	.788	.458

APPENDIX D

Macroinfauna:Meiofauna Ratio by Station for each Cruise.

TABLE D1. Macroinfauna:Meiofauna ratio by station for Cruise I.

Station Label	[1]Mean No. Individuals		Macroinfauna: Meiofauna
	Meio	Macr	
780501PE05002B7 T.B.	164449	3825	1: 42.9932
780501PE20002B7 T.B.	117091	3555	1: 32.9369
780501PN05002B7 T.B.	180359	2462	1: 73.2052
780501PN20002B7 T.B.	209943	3701	1: 56.7221
780501PS05002B7 T.B.	64263	3971	1: 16.1821
780501PS20002B7 T.B.	161714	4984	1: 32.4483
780501PW05002B7 T.B.	349159	2993	1:116.6779
780501PW20002B7 T.B.	369295	1485	1:248.6837
780502PE05002B7 T.B.	120695	9202	1: 13.1155
780502PE20002B7 T.B.	167556	6064	1: 27.6325
780502PN05002B7 T.B.	54443	8809	1: 6.1806
780502PN20002B7 T.B.	283653	7256	1: 39.0908
780502PS05002B7 T.B.	189682	7976	1: 23.7808
780502PS20002B7 T.B.	240893	4928	1: 48.8875
780502PW05002B7 T.B.	58918	9337	1: 6.3098
780502PW20002B7 T.B.	60783	6019	1: 10.0989
780503PE05002B7 T.B.	145680	4140	1: 35.1883
780503PE20002B7 T.B.	103791	5558	1: 18.6758
780503PN05002B7 T.B.	138719	3127	1: 44.3545
780503PN20002B7 T.B.	32442	4387	1: 7.3943
780503PS05002B7 T.B.	163952	3701	1: 44.2963
780503PS20002B7 T.B.	181229	3206	1: 56.5238
780503PW05002B7 T.B.	202236	2576	1: 78.5002
780503PW20002B7 T.B.	249097	1654	1:150.6257
780504PE05002B7 T.B.	379364	1001	1:378.8900
780504PE20002B7 T.B.	179489	1294	1:138.7356
780504PN05002B7 T.B.	172031	2666	1: 64.5218
780504PN20002B7 T.B.	179738	1395	1:128.8443
780504PS05002B7 T.B.	173150	1474	1:117.4893
780504PS20002B7 T.B.	222746	1361	1:163.6331
780504PW05002B7 T.B.	167929	1586	1:105.8656
780504PW20002B7 T.B.	226723	1204	1:188.3474
780521C 2B7 T.B.	294342	5490	1: 53.6143
780522C 2B7 T.B.	406834	3533	1:115.1688
780523C 2B7 T.B.	62150	1057	1: 58.7707
780524C 2B7 T.B.	69359	2835	1: 24.4654

[1] *Meio* denotes meiofauna
Macr denotes macroinfauna

TABLE D2. Macroinfauna:Meiofauna ratio by station for Cruise II.

Station Label		[1]Mean No. Individuals		Macroinfauna: Meiofauna
		Meio	Macr	
780801PE05002B7	T.B.	70851	371	1: 190.8444
780801PE20002B7	T.B.	82038	394	1: 208.3505
780801PN05002B7	T.B.	29583	675	1: 43.8273
780801PN20002B7	T.B.	18023	428	1: 42.1602
780801PS05002B7	T.B.	14667	180	1: 81.4856
780801PS20002B7	T.B.	42511	472	1: 89.9695
780801PW05002B7	T.B.	32442	472	1: 68.6610
780801PW20002B7	T.B.	43629	292	1: 149.1600
780802PE05002B7	T.B.	30329	1924	1: 15.7657
780802PE20002B7	T.B.	45742	1496	1: 30.5714
780802PN05002B7	T.B.	23741	1069	1: 22.2141
780802PN20002B7	T.B.	32567	1541	1: 21.1300
780802PS05002B7	T.B.	24611	472	1: 52.0876
780802PS20002B7	T.B.	52827	1226	1: 43.0805
780802PW05002B7	T.B.	22125	832	1: 26.5771
780802PW20002B7	T.B.	25357	574	1: 44.1956
780803PE05002B7	T.B.	157115	1395	1: 112.6274
780803PE20002B7	T.B.	49844	1193	1: 41.7982
780803PN05002B7	T.B.	101180	675	1: 149.8966
780803PN20002B7	T.B.	111994	1856	1: 60.3336
780803PS05002B7	T.B.	25109	1136	1: 22.0978
780803PS20002B7	T.B.	82411	563	1: 146.5083
780803PW05002B7	T.B.	137849	923	1: 149.4295
780803PW20002B7	T.B.	145680	1507	1: 96.6366
780804PE05002B7	T.B.	256555	529	1: 485.2108
780804PE20002B7	T.B.	147793	472	1: 312.7888
780804PN05002B7	T.B.	290613	821	1: 353.8672
780804PN20002B7	T.B.	197264	945	1: 208.7451
780804PS05002B7	T.B.	278556	630	1: 442.1529
780804PS20002B7	T.B.	433186	630	1: 687.5960
780804PW05002B7	T.B.	245990	563	1: 437.3150
780804PW20002B7	T.B.	167929	371	1: 452.3348
780805SN05002B7	T.B.	33437	2621	1: 12.7560
780805SN20002B7	T.B.	80298	2981	1: 26.9343

[1]*Meio* denotes meiofauna
Macr denotes macroinfauna

TABLE D2 (Cont'd).

Station Label	[1]Mean No. Individuals		Macroinfauna: Meiofauna
	Meio	Macr	
780806SN05002B7 T.B.	2735	79	1: 34.7251
780806SN20002B7 T.B.	5096	124	1: 41.1822
780807SN05002B7 T.B.	4102	135	1: 30.3844
780807SN20002B7 T.B.	50839	124	1: 410.8178
780808SN05002B7 T.B.	142696	371	1: 384.3674
780808SN20002B7 T.B.	137351	270	1: 508.7093
780809SN05002B7 T.B.	61653	214	1: 288.4342
780809SN20002B7 T.B.	7334	169	1: 43.4590
780810SN05002B7 T.B.	48477	292	1: 165.7333
780810SN20002B7 T.B.	107395	349	1: 307.9432
780811SN05002B7 T.B.	33312	990	1: 33.6489
780811SN20002B7 T.B.	185456	630	1: 294.3740
780812SN05002B7 T.B.	84027	292	1: 287.2711
780812SN20002B7 T.B.	40025	472	1: 84.7081
780813Sn05002B7 T.B.	5096	45	1: 113.2511
780813SN20002B7 T.B.	4351	68	1: 64.4519
780814SN05002B7 T.B.	1740	675	1: 2.5781
780814SN20002B7 T.B.	22747	371	1: 61.2711
780815SN05002B7 T.B.	3108	270	1: 11.5093
780815SN20002B7 T.B.	15165	281	1: 53.9186
780816SN05002B7 T.B.	52952	292	1: 181.0318
780816SN20002B7 T.B.	56184	900	1: 62.4262
780817SN05002B7 T.B.	4599	270	1: 17.0337
780817SN20002B7 T.B.	373	247	1: 1.5067
780818SN05002B7 T.B.	4102	518	1: 7.9264
780818SN20002B7 T.B.	25979	866	1: 29.9898
780819SN05002B7 T.B.	73461	1204	1: 61.0270
780819SN20002B7 T.B.	54568	1395	1: 39.1166
780820SN05002B7 T.B.	100062	563	1: 177.8871
780820SN20002B7 T.B.	93722	585	1: 160.2089
7808210 2B7 T.B.	141205	79	1:1793.0768
780822C 2B7 T.B.	28340	338	1: 83.9716
780823C 2B7 T.B.	199004	675	1: 294.8212
780824C 2B7 T.B.	116096	394	1: 294.8475

[1]*Meio* denotes meiofauna
Macr denotes macroinfauna

TABLE D3. Macroinfauna:Meiofauna ratio by station for Cruise III.

Station Label	[1]Mean No. Individuals		Macroinfauna: Meiofauna
	Meio	Macr	
790101PE05002B7 T.B.	34928	686	1: 50.8973
790101PE20002B7 T.B.	38906	900	1: 43.2288
790101PN05002B7 T.B.	10690	315	1: 33.9359
790101PN20002B7 T.B.	40646	585	1: 69.4805
790101PS05002B7 T.B.	33685	765	1: 44.0331
790101PS20002B7 T.B.	30329	641	1: 47.2970
790101PW05002B7 T.B.	45742	169	1: 271.0661
790101PW20002B7 T.B.	54443	146	1: 372.2626
790102PE05002B7 T.B.	20261	4433	1: 4.5710
790102PE20002B7 T.B.	85394	2126	1: 40.1618
790102PN05002B7 T.B.	34058	2239	1: 15.2130
790102PN20002B7 T.B.	78309	877	1: 89.2410
790102PS05002B7 T.B.	80049	3521	1: 22.7332
790102PS20002B7 T.B.	53325	3161	1: 16.8682
790102PW05002B7 T.B.	31324	2002	1: 15.6422
790102PW20002B7 T.B.	44002	1834	1: 23.9957
790103PE05002B7 T.B.	80546	844	1: 95.4624
790103PE20002B7 T.B.	138097	731	1: 188.8510
790103PN05002B7 T.B.	62274	1215	1: 51.2546
790103PN20002B7 T.B.	24114	2205	1: 10.9361
790103PS05002B7 T.B.	48974	619	1: 79.1502
790103PS20002B7 T.B.	78185	371	1: 210.5985
790103PW05002B7 T.B.	110130	990	1: 111.2422
790103PW20002B7 T.B.	113113	1856	1: 60.9363
790104PE05002B7 T.B.	12803	180	1: 71.1272
790104PE20002B7 T.B.	22498	214	1: 105.2552
790104PN05002B7 T.B.	45494	461	1: 98.6315
790104PN20002B7 T.B.	37414	506	1: 73.9048
790104PS05002B7 T.B.	13176	270	1: 48.7993
790104PS20002B7 T.B.	6961	191	1: 36.3963
790104PW05002B7 T.B.	30454	101	1: 300.7753
790104PW20002B7 T.B.	16781	124	1: 135.6000
790121C 2B7 T.B.	22250	2070	1: 10.7486
790122C 2B7 T.B.	30951	270	1: 114.6322
790123C 2B7 T.B.	4351	169	1: 25.7807
790124C 2B7 T.B.	24860	405	1: 61.3827

[1] *Meio* denotes meiofauna
Macr denotes macroinfauna

APPENDIX E

Harpacticoida:Nematoda Ratio by Station for Each Cruise.

TABLE E1. Harpacticoida:Nematoda ratio by station for Cruise I.

Station Label	[1]Mean No. Individuals		Harpacticoida: Nematoda
	Harp	Nema	
780501PE05002B6 T.B	2	1948	.0010
780501PE20002B6 T.B	20	1490	.0134
780501PN05002B6 T.B	106	3120	.0339
780501PN20002B6 T.B	28	3152	.0088
780501PS05002B6 T.B	62	977	.0634
780501PS20002B6 T.B	18	1334	.0134
780501Pw05002B6 T.B	72	2938	.0245
780501Pw20002B6 T.B	8	1834	.0043
780502PE05002B6 T.B	154	2722	.0565
780502PE20002B6 T.B	68	3275	.0207
780502PN05002B6 T.B	74	1053	.0702
780502PN20002B6 T.B	406	5722	.0709
780502PS05002B6 T.B	140	3647	.0383
780502PS20002B6 T.B	216	3765	.0573
780502Pw05002B6 T.B	50	1633	.0306
780502Pw20002B6 T.B	118	1480	.0797
780503PE05002B6 T.B	114	1430	.0797
780503PE20002B6 T.B	62	1005	.0616
780503PN05002B6 T.B	66	823	.0801
780503PN20002B6 T.B	40	482	.0829
780503PS05002B6 T.B	160	1580	.1012
780503PS20002B6 T.B	4	472	.0084
780503Pw05002B6 T.B	56	1608	.0348
780503Pw20002B6 T.B	112	2371	.0472
780504PE05002B6 T.B	56	2819	.0198
780504PE20002B6 T.B	4	640	.0062
780504PN05002B6 T.B	44	1819	.0241
780504PN20002B6 T.B	36	731	.0492
780504PS05002B6 T.B	26	1413	.0184
780504PS20002B6 T.B	48	1424	.0337
780504Pw05002B6 T.B	44	1074	.0409
780504PW20002B6 T.B	84	1780	.0471
780521C 2B6 T.B	68	2284	.0297
780522C 2B6 T.B	104	2458	.0423
780523C 2B6 T.B	8	222	.0360
780524C 2B6 T.B	0	778	.0000

[1]Harp denotes Harpacticoida
Nema denotes Nematoda

TABLE E2. Harpacticoida:Nematoda ratio by station for Cruise II.

Station Label	[1]Mean No. Individuals		Harpacticoida: Nematoda
	Harp	Nema	
780801PE05002B6 T.B	28	1455	.0192
780801PE20002B6 T.B	14	1282	.0109
780801PN05002B6 T.B	4	533	.0075
780801PN20002B6 T.B	0	341	.0000
780801PS05002B6 T.B	0	402	.0000
780801PS20002B6 T.B	0	720	.0000
780801PW05002B6 T.B	2	644	.0031
780801PW20002B6 T.B	2	446	.0044
780802PE05002B6 T.B	0	869	.0000
780802PE20002B6 T.B	0	1116	.0000
780802PN05002B6 T.B	0	668	.0000
780802PN20002B6 T.B	0	870	.0000
780802PS05002B6 T.B	0	696	.0000
780802PS20002B6 T.B	2	1391	.0014
780802PW05002B6 T.B	0	600	.0000
780802PW20002B6 T.B	0	662	.0000
780803PE05002B6 T.B	8	752	.0106
780803PE20002B6 T.B	2	282	.0070
780803PN05002B6 T.B	10	818	.0122
780803PN20002B6 T.B	10	338	.0295
780803PS05002B6 T.B	2	184	.0108
780803PS20002B6 T.B	0	118	.0000
780803PW05002B6 T.B	0	888	.0000
780803PW20002B6 T.B	4	450	.0088
780804PE05002B6 T.B	14	1027	.0136
780804PE20002B6 T.B	12	780	.0153
780804PN05002B6 T.B	36	1662	.0216
780804PN20002B6 T.B	24	484	.0495
780804PS05002B6 T.B	24	1476	.0162
780804PS20002B6 T.B	36	1595	.0225
780804PW05002B6 T.B	4	1157	.0034
780804PW20002B6 T.B	0	844	.0000
780805SN05002B6 T.B	0	723	.0000
780805SN20002B6 T.B	0	2505	.0000
780806SN05002B6 T.B	0	14	.0000
780806SN20002B6 T.B	0	8	.0000
780807SN05002B6 T.B	0	26	.0000
780807SN20002B6 T.B	0	93	.0000
780808SN05002B6 T.B	4	244	.0163
780808SN20002B6 T.B	4	148	.0270
780809SN05002B6 T.B	4	204	.0196
780809SN20002B6 T.B	2	80	.0250
780810SN05002B6 T.B	6	922	.0065
780810SN20002B6 T.B	0	1282	.0000
780811SN05002B6 T.B	2	796	.0025
780811SN20002B6 T.B	4	2170	.0018
780812SN05002B6 T.B	0	328	.0000
780812SN20002B6 T.B	0	28	.0000
780813SN05002B6 T.B	2	09	99999999.9999
780813SN20002B6 T.B	0	26	.0000
780814SN05002B6 T.B	0	36	.0000
780814SN20002B6 T.B	2	144	.0138
780815SN05002B6 T.B	10	74	.1351
780815SN20002B6 T.B	10	168	.0595
780816SN05002B6 T.B	72	377	.1909
780816SN20002B6 T.B	28	546	.0512
780817SN05002B6 T.B	36	68	.5294
780817SN20002B6 T.B	2	6	.3333
780818SN05002B6 T.B	0	76	.0000
780818SN20002B6 T.B	4	380	.0105
780819SN05002B6 T.B	0	2313	.0000
780819SN20002B6 T.B	6	1714	.0035
780820SN05002B6 T.B	0	836	.0000
780820SN20002B6 T.B	6	1500	.0040
780821C 2B6 T.B	0	1448	.0000
780822C 2B6 T.B	0	14	.0000
780823C 2B6 T.B	48	518	.0926
780824C 2B6 T.B	4	526	.0076

[1] Harp denotes Harpacticoida
Nema denotes Nematoda

TABLE E3. Harpacticoida:Nematoda ratio by station for Cruise III.

Station Label	[1]Mean No. Individuals		Harpacticoida: Nematoda
	Harp	Nema	
790101PE05002B6 T.B	0	954	.0000
790101PE20002B6 T.B	12	883	.0135
790101PN05002B6 T.B	0	232	.0000
790101PN20002B6 T.B	6	961	.0062
790101PS05002B6 T.B	18	792	.0227
790101PS20002B6 T.B	26	766	.0339
790101Pw05002B6 T.B	2	1226	.0016
790101Pw20002B6 T.B	14	1350	.0103
790102PE05002B6 T.B	28	566	.0494
790102PE20002B6 T.B	42	2228	.0188
790102PN05002B6 T.B	40	890	.0449
790102PN20002B6 T.B	152	2101	.0723
790102PS05002B6 T.B	10	2048	.0048
790102PS20002B6 T.B	2	1298	.0015
790102Pw05002B6 T.B	16	918	.0174
790102Pw20002B6 T.B	76	1096	.0693
790103PE05002B6 T.B	164	1036	.1583
790103PE20002B6 T.B	68	1272	.0534
790103PN05002B6 T.B	46	892	.0515
790103PN20002B6 T.B	60	494	.1214
790103PS05002B6 T.B	104	440	.2363
790103PS20002B6 T.B	24	528	.0454
790103Pw05002B6 T.B	20	1164	.0171
790103Pw20002B6 T.B	92	1404	.0655
790104PE05002B6 T.B	0	82	.0000
790104PE20002B6 T.B	0	82	.0000
790104PN05002B6 T.B	0	292	.0000
790104PN20002B6 T.B	14	548	.0255
790104PS05002B6 T.B	2	180	.0111
790104PS20002B6 T.B	0	78	.0000
790104Pw05002B6 T.B	0	274	.0000
790104Pw20002B6 T.B	12	180	.0666
790121C 2B6 T.B	2	340	.0058
790122C 2B6 T.B	4	536	.0074
790123C 2B6 T.B	4	36	.1111
790124C 2B6 T.B	18	482	.0373

[1] Harp denotes Harpacticoida
Nema denotes Nematoda

APPENDIX F

List of Taxa Selected for Cluster Analysis with Frequency of Observation, Abundance, and Rank for all Three Cruises.

TABLE F1. List of meiofauna taxa selected for cluster analysis wfth frequency of observation, abundance, and rank for Cruise I.

	[1]No. Obs.	[2]No. Ind.	[3] %	[4]Cum. %
Nonionella basiloba	36	69656	33.1	33.1
Sabatieria	36	18543	8.8	41.9
Gromiidae	36	9579	4.5	46.4
Cyatholaimidae	36	7503	3.6	50.0
Theristus	36	6870	3.3	53.3
Ammonia beccarii	36	4448	2.1	55.4
Chromadoridae	36	2641	1.3	56.6
Dorylaimopsis	36	2415	1.1	57.8
Buliminella morgani	35	30021	14.3	72.0
Terschellingia	35	7635	3.6	75.7
Bolivina lowmani	35	5551	2.6	78.3
Echinoderes	35	1659	.8	79.1
Linhomoeidae	35	1654	.8	79.9
Nematoda	34	1372	.7	80.5
Halalaimus	34	811	.4	80.9
Choniolaimidae	33	907	.4	81.3
Metacomesoma	32	2731	1.3	82.6
Notomastus latericeus	32	708	.3	83.0
Microlaimus	31	1847	.9	83.9
Parodontophora	31	1125	.5	84.4
Tricoma	30	1621	.8	85.2
Sphaerolaimus	30	535	.3	85.4
Fursenkoina complanata	29	7009	3.3	88.7
Oncholaimidae	29	1906	.9	89.7
Paracomesoma	29	669	.3	90.0
Desmodoridae	28	526	.2	90.2
Halectinosoma	27	497	.2	90.5
Axonolaimidae	26	528	.3	90.7
Haloschizopera	26	338	.2	90.9
Desmoscolex	25	545	.3	91.1
Turbellaria	25	419	.2	91.3
Miliolacea	24	498	.2	91.6
Eubostrichus	23	629	.3	91.9
Lagenammina comprima	23	601	.3	92.1
Trachydemus	23	158	.1	92.2
Reophax scottii	22	1142	.5	92.8

[1]denotes Number of Observations
[2]denotes Number of Individuals
[3]denotes Percent
[4]denotes Cumulative Percent

TABLE F1 (Cont'd).

	[1] No. Obs.	[2] No. Ind.	[3] %	[4] Cum. %
Ceramonematidae	22	415	.2	93.0
Eggerella bradyi	21	319	.2	93.1
Cletodidae	21	164	.1	93.2
Paramonhystera	20	697	.3	93.5
Bulimina marginata	20	527	.3	93.8
Monhystera	20	411	.2	94.0
Bivalvia	19	379	.2	94.1
Bolivina striatula	19	336	.2	94.3
Fursenkoina pontoni	19	252	.1	94.4
Copepoda	18	626	.3	94.7
Rhynchocoela	18	142	.1	94.8
Diosaccidae	18	116	.1	94.8
Ammoscalaria pseudospiralis	17	320	.2	95.0
Paraprionospio pinnata	17	119	.1	95.1
Cibicides concentricus	16	747	.4	95.4
Ironidae	16	357	.2	95.6
AmphArete americana	16	282	.1	95.7
Monhysteridae	16	269	.1	95.8
Elphidium gunteri	16	202	.1	95.9
Holophryidae	16	148	.1	96.0
Sigambra tentaculata	16	98	.0	96.1
Buliminella elegantissima	15	440	.2	96.3
Leptolaimidae	15	211	.1	96.4
Tharyx marioni	15	91	.0	96.4
Florilus atlanticus	14	376	.2	96.6
Cervonema	13	249	.1	96.7
Longipedia helgolandica	13	139	.1	96.8
Aricidea	13	120	.1	96.8
Textularia earlandi	13	97	.0	96.9
Pycnophyes	13	52	.0	96.9
Ameira	12	94	.0	96.9
Siphonolaimus	12	91	.0	97.0
Nephtys incisa	12	86	.0	97.0
Lagenammina diflugiformis	11	155	.1	97.1
Oxystominidae	11	96	.0	97.1
Prionospio cirrifera	11	42	.0	97.2
Enhydrosoma hopkinsi	10	210	.1	97.3
Stenhelia	10	178	.1	97.3
Richtersia	10	154	.1	97.4
Laimella	10	145	.1	97.5
Quinqueloculina compta	10	115	.1	97.5
Campylaimus	10	87	.0	97.6
Hanzawaia strattoni	9	483	.2	97.8
Quinqueloculina vulgaris	9	328	.2	98.0

[1] denotes Number of Observations
[2] denotes Number of Individuals
[3] denotes Percent
[4] denotes Cumulative Percent

TABLE F2. List of meiofauna taxa selected for cluster analysis with frequency of observation, abundance, and rank for Cruise II.

Taxa	[1] No. Obs.	[2] No. Ind.	[3] %	[4] Cum. %
Sabatieria	64	13110	7.6	7.6
Gromiidae	64	3830	2.2	9.9
Bolivina lowmani	63	5870	3.4	13.3
Buliminella morgani	61	43957	25.6	38.9
Cyatholaimidae	61	4956	2.9	41.7
Linhomoeidae	61	1824	1.1	42.8
Theristus	60	4129	2.4	45.2
Dorylaimopsis	60	2161	1.3	46.5
Nonionella basiloba	58	47244	27.5	74.0
Choniolaimidae	54	744	.4	74.4
Terschellingia	52	3275	1.9	76.3
Ammonia beccarii	51	2113	1.2	77.5
Lagenammina comprima	47	925	.5	78.1
Desmodoridae	45	1034	.6	78.7
Tricoma	43	1871	1.1	79.8
Fursenkoina complanata	41	11254	6.6	86.3
Sphaerolaimus	41	304	.2	86.5
Rhynchocoela	40	1040	.6	87.1
Eubostrichus	40	666	.4	87.5
Metacomesoma	39	2891	1.7	89.2
Sigambra tentaculata	39	298	.2	89.3
Cibicides concentricus	38	1334	.8	90.1
Microlaimus	38	1142	.7	90.8
Chromadoridae	38	689	.4	91.2
Halalaimus	36	316	.2	91.4
Oncholaimidae	33	1362	.8	92.2
Echinoderes	33	451	.3	92.4
Parodontophora	31	679	.4	92.8
Axonolaimidae	30	525	.3	93.1
Ceramonematidae	30	354	.2	93.3
Desmoscolex	30	222	.1	93.5
Eggerella bradyi	29	340	.2	93.7
Nematoda	29	249	.1	93.8
Bolivina striatula	27	528	.3	94.1
Turbellaria	27	400	.2	94.3

[1]denotes Number of Observations
[2]denotes Number of Individuals
[3]denotes Percent
[4]denotes Cumulative Percent

TABLE F2 (Cont'd).

Taxa	[1]No. Obs.	[2]No. Ind.	[3] %	[4]Cum. %
Notomastus latericeus	26	166	.1	94.4
Aricidea	26	158	.1	94.5
Buliminella elegantissima	25	316	.2	94.7
Monhysteridae	25	201	.1	94.8
Bulimina marginata	25	177	.1	94.9
Oxystomina	25	109	.1	95.0
Copepoda	23	580	.3	95.3
Paracomesoma	22	301	.2	95.5
Leptolaimus	21	378	.2	95.7
Acarina	20	240	.1	95.9
Laimella	20	103	.1	95.9
Reophax scottii	19	927	.5	96.5
Florilus atlanticus	18	632	.4	96.8
Trachydemus	17	86	.1	96.9
Fursenkoina pontoni	16	503	.3	97.2
Miliolacea	16	136	.1	97.3
Halectinosoma	16	88	.1	97.3
Acartia tonsa	14	170	.1	97.4
Paracalanus crassirostris	14	71	.0	97.5
Camacolaimus	14	53	.0	97.5
Cancris sagra	13	96	.1	97.5
Bigenerina irregularis	12	111	.1	97.6
Oithona colcarva	12	70	.0	97.6
Uvigerina bellula	11	84	.0	97.7
Haloschizopera	11	64	.0	97.7
Textularia mayori	11	54	.0	97.8
Ammoscalaria pseudospiralis	11	44	.0	97.8
Campylaimus	11	41	.0	97.8
Richtersia	10	120	.1	97.9
Lagenammina diflugiformis	10	91	.1	97.9
Leptolaimidae	10	71	.0	98.0
Quinqueloculina compta	10	70	.0	98.0
Tharyx marioni	10	58	.0	98.0

[1] denotes Number of Observations
[2] denotes Number of Individuals
[3] denotes Percent
[4] denotes Cumulative Percent

TABLE F3. List of meiofauna taxa selected for cluster analysis with frequency of observation, abundance, and rank for Cruise III.

Taxa	[1] No. Obs.	[2] No. Ind.	[3] %	[4] Cum. %
Bolivina lowmani	36	2186	4.1	4.1
Dorylaimopsis	36	1319	2.5	6.6
Sabatieria	35	6487	12.3	18.9
Theristus	35	2765	5.2	24.2
Linhomoeidae	34	3780	7.2	31.3
Buliminella morgani	34	3305	6.3	37.6
Cyatholaimidae	34	3107	5.9	43.5
Gromiidae	32	1122	2.1	45.6
Choniolaimidae	32	310	.6	46.2
Nonionella basiloba	31	7855	14.9	61.1
Terschellingia	30	1600	3.0	64.1
Parodontophora	30	658	1.2	65.4
Ammonia beccarii	27	1814	3.4	68.8
Cibicides concentricus	27	1709	3.2	72.1
Halalaimus	27	349	.7	72.7
Sphaerolaimus	27	217	.4	73.1
Metacomesoma	26	2420	4.6	77.7
Chromadoridae	26	1853	3.5	81.2
Tricoma	26	488	.9	82.2
Eubostrichus	25	380	.7	82.9
Lagenammina comprima	24	1608	3.0	85.9
Desmodoridae	24	292	.6	86.5
Mediomastus californiensis	23	236	.4	86.9
Turbellaria	21	368	.7	87.6
Echinoderes	21	274	.5	88.1
Oncholaimidae	21	221	.4	88.6
Aricidea	21	168	.3	88.9
Halectinosoma	19	238	.5	89.3
Ceramonematidae	19	150	.3	89.6
Axonolaimidae	18	195	.4	90.0
Comesomatidae	18	171	.3	90.3
Microlaimus	17	312	.6	90.9
Neotonchus	17	189	.4	91.3
Desmoscolex	17	143	.3	91.5
Oxystomina	16	80	.2	91.7

[1] denotes Number of Observations
[2] denotes Number of Individuals
[3] denotes Percent
[4] denotes Cumulative Percent

TABLE F3 (Cont'd).

Taxa	[1]No. Obs.	[2]No. Ind.	[3]%	[4]Cum. %
Fursenkoina pontoni	15	157	.3	92.0
Eponides antillarum	15	118	.2	92.2
Nematoda	15	106	.2	92.4
Cossura delta	15	72	.1	92.5
Fursenkoina complanata	14	272	.5	93.1
Paracomesoma	14	195	.4	93.4
Florilus atlanticus	13	126	.2	93.7
Buliminella elegantissima	13	124	.2	93.9
Bulimina marginata	13	97	.2	94.1
Monhysteridae	13	96	.2	94.3
Reophax scottii	13	54	.1	94.4
Bolivina striatula	12	108	.2	94.6
Enhydrosoma hopkinsi	12	102	.2	94.8
Laimella	12	92	.2	94.9
Elphidium gunteri	12	30	.1	95.0
Bigenerina irregularis	11	78	.1	95.1
Trifarina bella	11	76	.1	95.3
Haloschizopera	11	74	.1	95.4
Ironidae	11	70	.1	95.6
Bivalvia	11	38	.1	95.6
Stenhelia	9	204	.4	96.0
Cancris sagra	9	86	.2	96.2
Copepoda	9	78	.1	96.3
Rhynchocoela	9	64	.1	96.5
Typhlamphiascus lamellifer	9	50	.1	96.5
Sigambra tentaculata	9	32	.1	96.6
Richtersia	8	263	.5	97.1
Cervonema	8	65	.1	97.2
Trachydemus	8	40	.1	97.3
Camacolaimus	8	39	.1	97.4
Lagenammina diflugiformis	7	64	.1	97.5
Cletodes dissimilis	7	56	.1	97.6
Ammoscalaria pseudospiralis	7	44	.1	97.7
Uvigerina bellula	7	40	.1	97.8
Eggerella bradyi	7	31	.1	97.8
Diosaccidae	6	40	.1	97.9
Enchelidiidae	6	30	.1	98.0
Tharyx marioni	6	24	.0	98.0

[1]denotes number of observations
[2]denotes number of individuals
[3]denotes percentage
[4]denotes cumulative percentage

TABLE F4. List of macroinfauna taxa selected for cluster analysis with frequency of observation, abundance, and rank for Cruise I.

Taxa	[1]No. Obs.	[2]No. Ind.	[3] %	[4]Cum. %
Paraprionospio pinnata	36	18453	24.7	24.7
Mediomastus californiensis	36	7015	9.4	34.2
Rhynchocoela	36	3614	4.8	39.0
Prionospio cirrifera	36	907	1.2	40.2
Tharyx marioni	36	866	1.2	41.4
Notomastus latericeus	36	478	.6	42.0
Sigambra tentaculata	36	476	.6	42.7
Tellina versicolor	35	1187	1.6	44.3
Cossura delta	35	588	.8	45.0
Aricidea suecica	34	855	1.1	46.2
Nephtys incisa	33	906	1.2	47.4
Nuculana concentrica	32	1037	1.4	48.8
Corbula contracta	32	741	1.0	49.8
Golfingia bulbosa	31	2029	2.7	52.5
Diopatra cuprea	31	890	1.2	53.7
Lumbrineris tenuis	31	740	1.0	54.7
Sabatieria	31	714	1.0	55.7
Vitrinella floridana	31	343	.5	56.1
Abra aequalis	30	3385	4.5	60.7
Nereis	30	758	1.0	61.7
Magelona phyllisae	29	4331	5.8	67.5
Anaitides erythrophyllus	29	275	.4	67.8
Magelona rosea	28	142	.2	68.0
Sthenelais boa	27	343	.5	68.5
Brachyura	27	118	.2	68.7
Ampelisca abdita	25	689	.9	69.6
Glycera americana	25	201	.3	69.9
Volvulella texasiana	25	185	.2	70.1
Nereidae	25	123	.2	70.3
Aspidosiphon albus	24	252	.3	70.6
Pinnixa	24	116	.2	70.8
Armandia maculata	24	112	.2	70.9
Lepidasthenia	23	125	.2	71.1
Dorylaimopsis	23	91	.1	71.2
Ancistrosyllis jonesi	23	79	.1	71.3
Ampharete americana	21	4772	6.4	77.7
Aricidea fragilis	21	715	1.0	78.7
Ampharete acutifrons	21	277	.4	79.0
Oncholaimidae	21	176	.2	79.3
Linhomoeidae	21	148	.2	79.5
Prionospio cirrobranchiata	21	111	.1	79.6
Prionospio cristata	20	394	.5	80.1
Alpheus floridanus	20	43	.1	80.2
Nucula cf. N. proxima	19	302	.4	80.6
Prionospio pygmaea	19	132	.2	80.8
Bivalvia	19	112	.2	80.9

[1] denotes Number of Observations
[2] denotes Number of Individuals
[3] denotes Percent
[4] denotes Cumulative Percent

TABLE F4 (Cont'd).

Taxa	[1] No. Obs.	[2] No. Ind.	[3] %	[4] Cum. %
Cosmioconcha calliglypta	19	104	.1	81.1
Automate evermanni	19	48	.1	81.1
Polynoidae	19	41	.1	81.2
Phoronis architecta	18	374	.5	81.7
Oxyurostylis smithi	18	96	.1	81.8
Clymenella torquata calida	18	94	.1	82.0
Amphioplus coniortodes	18	89	.1	82.1
Amaeana trilobata	18	88	.1	82.2
Acetes americanus	18	86	.1	82.3
Photis macromanus	17	593	.8	83.1
Palythoa texaensis	17	267	.4	83.5
Astropecten duplicatus	17	172	.2	83.7
Magelona filiformis	17	129	.2	83.9
Glycinde nordmanni	17	41	.1	83.9
Spiophanes bombyx	16	1398	1.9	85.8
Pseudeurythoe ambigua	16	142	.2	86.0
Chaetozone	16	142	.2	86.2
Cirrophorus lyriformis	16	87	.1	86.3
Amphiodia atra	16	58	.1	86.4
Gyptis vittata	16	45	.1	86.4
Diplocirrus	16	40	.1	86.5
Speocarcinus lobatus	16	32	.0	86.5
Listriella barnardi	16	28	.0	86.6
Paraonis gracilis	15	101	.1	86.7
Chione clenchi	15	68	.1	86.8
Clymenella zonalis	15	61	.1	86.9
Golfingia trichocephala	14	95	.1	87.0
Monoculodes edwardsi	14	52	.1	87.1
Penaeidae	14	29	.0	87.1
Cerebratulus lacteus	14	26	.0	87.1
Terebra dislocata	14	24	.0	87.2
Ninoe nigripes	13	152	.2	87.4
Ceratonereis irritabilis	13	120	.2	87.5
Ampelisca verrilli	13	106	.1	87.7
Bregmaceros atlanticus	13	51	.1	87.7
Gastropoda	13	37	.0	87.8
Amphiuridae	13	29	.0	87.8
Owenia fusiformis	12	491	.7	88.5
Euconchoecia chierchiae	12	201	.3	88.8
Longipedia helgolandica	12	87	.1	88.9
Sabellidae	12	75	.1	89.0
Chaetozone setosa	12	48	.1	89.0
Anticoma	12	42	.1	89.1
Tharyx setigera	12	41	.1	89.2
Amphiodia trychna	12	31	.0	89.2
Listriella A	12	26	.0	89.2
Pectinaria gouldii	12	25	.0	89.3

[1] denotes Number of Observations
[2] denotes Number of Individuals
[3] denotes Percent
[4] denotes Cumulative Percent

TABLE F4 (Cont'd).

Taxa	[1] No. Obs.	[2] No. Ind.	[3] %	[4] Cum. %
Odostomia	12	25	.0	89.3
Chasmocarcinus mississippiensis	12	20	.0	89.3
Asychis elongata	12	19	.0	89.4
Nereis succinea	11	130	.2	89.5
Paranthus rapiformis	11	74	.1	89.6
Synchelidium americanum	11	60	.1	89.7
Anthopleura krebsi	11	34	.0	89.8
Cantharus cancellarius	11	34	.0	89.8
Poecilochaetus johnsoni	11	28	.0	89.8
Cibicides concentricus	10	465	.6	90.5
Polydora	10	368	.5	91.0
Polydora socialis	10	268	.4	91.3
Megalomma bioculata	10	216	.3	91.6
Cingula	10	166	.2	91.8
Eudorella monodon	10	43	.1	91.9
Pentamera pulcherrima	10	32	.0	91.9
Macoma pulleyi	10	31	.0	92.0
Phanodermatidae	10	25	.0	92.0
Onuphis nebulosa	10	23	.0	92.0
Glycinde solitaria	10	20	.0	92.1
Cirratulus cf. C. hedgpethi	10	17	.0	92.1
Phascolion strombi	10	15	.0	92.1
Balanoglossus	9	238	.3	92.4
Mulinia lateralis	9	237	.3	92.7
Pentidotea	9	168	.2	93.0
Timarete	9	61	.1	93.0
Spiochaetopterus oculatus	9	32	.0	93.1
Amphipoda	9	22	.0	93.1
Ceriantipatharia ceriantharia	9	19	.0	93.1
Ophiodromus obscura	9	18	.0	93.2
Lepidonotus sublevis	9	16	.0	93.2
Alpheopsis	9	13	.0	93.2
Polydora ligni	8	80	.1	93.3
Arcidae	8	49	.1	93.4
Raeta plicatella	8	28	.0	93.4
Acteon punctostriatus	8	19	.0	93.4
Sigambra wassi	8	17	.0	93.5
Agriopoma texasiana	8	15	.0	93.5
Processa hemphilli	8	12	.0	93.5
Natica pusilla	8	10	.0	93.5
Lyonsia hyalina floridana	8	9	.0	93.5
Cardiomya	8	9	.0	93.5
Naticidae	8	8	.0	93.6
Clytia cylindrica	7	346	.5	94.0
Eponides antillarum	7	88	.1	94.1
Campylaspis	7	41	.1	94.2

[1] denotes Number of Observations
[2] denotes Number of Individuals
[3] denotes Percent
[4] denotes Cumulative Percent

TABLE F4 (Cont'd)

Taxa	[1] No. Obs.	[2] No. Ind.	[3] %	[4] Cum. %
Teinostoma parvicallum	7	31	.0	94.2
Diplodonta soror	7	20	.0	94.3
Ophiuroidea	7	18	.0	94.3
Paraonidae	7	17	.0	94.3
Goniada teres	7	15	.0	94.3
Pagurus bonairensis	7	13	.0	94.3
Leiolambrus nitidus	7	10	.0	94.4
Paleanotus heteroseta	7	9	.0	94.4
Periploma cf. P. orbicularis	7	8	.0	94.4
Myrophis punctatus	7	8	.0	94.4
Ancistrosyllis hartmanae	7	7	.0	94.4
Petricola pholadiformis	6	287	.4	94.8
Chone	6	68	.1	94.9
Aglaophamus verrilli	6	45	.1	94.9
Cyclaspis	6	32	.0	95.0
Unciola irrorata	6	30	.0	95.0
Nephtys bucera	6	20	.0	95.0

[1] denotes Number of Observations
[2] denotes Number of Individuals
[3] denotes Percent
[4] denotes Cumulative Percent

TABLE F5. List of macroinfauna taxa selected for cluster analysis with frequency of observation, abundance, and rank for Cruise II.

Taxa	[1] No. Obs.	[2] No. Ind.	[3] %	[4] Cum. %
Paraprionospio pinnata	66	3834	15.4	15.4
Rhynchocoela	60	740	3.0	18.3
Sigambra tentaculata	58	550	2.2	20.6
Magelona phyllisae	54	5080	20.4	40.9
Cossura delta	51	322	1.3	42.2
Nephtys incisa	47	750	3.0	45.2
Lumbrineris tenuis	46	547	2.2	47.4
Golfingia bulbosa	44	1686	6.8	54.2
Corbula contracta	44	823	3.3	57.5
Iharyx marioni	43	318	1.3	58.8
Notomastus latericeus	42	484	1.9	60.7
Diopatra cuprea	42	259	1.0	61.7
Nereis	41	689	2.8	64.5
Ninoe nigripes	39	298	1.2	65.7
Volvulella texasiana	37	198	.8	66.5
Nuculana concentrica	35	184	.7	67.2
Vitrinella floridana	34	185	.7	68.0
Amphioplus coniortodes	34	133	.5	68.5
Mediomastus californiensis	30	418	1.7	70.2
Prionospio cirrifera	30	184	.7	70.9
Ancistrosyllis jonesi	29	124	.5	71.4
Aricidea suecica	28	422	1.7	73.1
Pseudeurythoe ambigua	27	146	.6	73.7
Magelona rosea	27	146	.6	74.3
Aspidosiphon albus	26	169	.7	75.0
Bivalvia	26	83	.3	75.3
Asychis elongata	25	208	.8	76.1
Magelona filiformis	25	108	.4	76.6
Cirrophorus lyriformis	25	66	.3	76.8
Brachyura	22	27	.1	76.9
Sabatieria	21	267	1.1	78.0
Cingula	21	202	.8	78.8
Ampharete acutifrons	21	132	.5	79.3
Armandia maculata	21	69	.3	79.6
Ampelisca abdita	21	62	.2	79.9
Cosmioconcha calliglypta	21	51	.2	80.1
Automate evermanni	21	44	.2	80.2
Glycera americana	20	103	.4	80.7
Tellina versicolor	19	95	.4	81.0
Terebra dislocata	19	38	.2	81.2
Nucula cf. N. proxima	18	71	.3	81.5
Abra aequalis	18	51	.2	81.7
Speocarcinus lobatus	18	44	.2	81.9
Aricidea fragilis	18	40	.2	82.0
Pinnixa	18	39	.2	82.2
Gastropoda	17	54	.2	82.4
Nereidae	17	42	.2	82.6

[1] denotes Number of Observations
[2] denotes Number of Individuals
[3] denotes Percent
[4] denotes Cumulative Percent

TABLE F5 (Cont'd).

Taxa	[1]No. Obs.	[2]No. Ind.	[3] %	[4]Cum. %
Prionospio cirrobranchiata	16	53	.2	82.8
Ampelisca agassizi	16	49	.2	83.0
Agriopoma texasiana	16	34	.1	83.1
Amphiodia atra	16	29	.1	83.2
Glycinde nordmanni	16	28	.1	83.3
Phoronis architecta	14	83	.3	83.7
Clymenella torquata calida	14	63	.3	83.9
Onuphis nebulosa	14	33	.1	84.0
Paraonis gracilis	14	33	.1	84.2
Alpheus floridanus	14	25	.1	84.3
Chasmocarcinus mississippiensis	14	19	.1	84.4
Ceratonereis irritabilis	13	196	.8	85.1
Dorylaimopsis	13	41	.2	85.3
Lepidasthenia	13	35	.1	85.4
Anthopleura krebsi	13	27	.1	85.6
Gyptis vittata	13	24	.1	85.7
Tharyx setigera	12	86	.3	86.0
Nereis succinea	12	32	.1	86.1
Natica pusilla	11	38	.2	86.3
Lingula	11	20	.1	86.4
Paranthus rapiformis	10	23	.1	86.5
Eudorella monodon	10	20	.1	86.5
Cerebratulus lacteus	10	18	.1	86.6
Astropecten duplicatus	10	11	.0	86.6
Apseudes	9	35	.1	86.8
Paraonidae	9	25	.1	86.9
Polinices duplicatus	9	12	.0	86.9
Sthenelais boa	9	11	.0	87.0
Sigambra wassi	9	11	.0	87.0
Cantharus cancellarius	9	11	.0	87.1
Ampelisca verrilli	8	27	.1	87.2
Cirratulus cf. C. hedgpethi	8	11	.0	87.2
Acetes americanus	8	9	.0	87.3
Owenia fusiformis	7	641	2.6	89.8
Varicorbula operculata	7	64	.3	90.1
Clymenella zonalis	7	50	.2	90.3
Decapoda (arthropoda)	7	41	.2	90.5
Nassarius acutus	7	39	.2	90.6
Lenticulina	7	34	.1	90.7
Acteon punctostriatus	7	20	.1	90.8
Prionospio cristata	7	19	.1	90.9
Anachis obesa	7	12	.0	90.9
Polynoidae	7	11	.0	91.0
Chione clenchi	7	11	.0	91.0
Glycinde solitaria	7	10	.0	91.1
Listriella barnardi	7	10	.0	91.1
Penaeidae	7	9	.0	91.2

[1]denotes Number of Observations
[2]denotes Number of Individuals
[3]denotes Percent
[4]denotes Cumulative Percent

TABLE F5 (Cont'd).

Taxa	[1] No. Obs.	[2] No. Ind.	[3] %	[4] Cum. %
Linhomoeidae	6	97	.4	91.5
Aglaophamus verrilli	6	38	.2	91.7
Balanoglossus	6	34	.1	91.8
Prionospio pygmaea	6	18	.1	91.9
Zoantharia actiniaria	6	16	.1	92.0
Ophiuroidea	6	9	.0	92.0
Amphipoda	6	8	.0	92.0
Phascolion strombi	6	8	.0	92.1
Anaitides erythrophyllus	6	7	.0	92.1
Sinum perspectivum	6	6	.0	92.1
Hemipholas elongata	5	36	.1	92.3
Lyonsia hyalina floridana	5	13	.1	92.3
Peracarida isopoda anthuridea	5	12	.0	92.4
Portunus	5	10	.0	92.4
Ophiodromus obscura	5	8	.0	92.4
Marphysa sanguinea	5	8	.0	92.5
Anticoma	5	7	.0	92.5
Clymenella	5	7	.0	92.5
Macoma pulleyi	5	5	.0	92.5
Processa hemphilli	5	5	.0	92.6
Cupuladria doma	4	425	1.7	94.3
Golfingia trichocephala	4	47	.2	94.5
Photis macromanus	4	23	.1	94.5
Paralacydonia	4	22	.1	94.6
Palythoa texaensis	4	19	.1	94.7
Spiophanes bombyx	4	13	.1	94.8
Terebellides stroemii	4	13	.1	94.8
Chaetozone	4	11	.0	94.9
Arcidae	4	11	.0	94.9
Marphysa belli	4	9	.0	94.9
Nephtys bucera	4	7	.0	95.0
Ceratocephale cf. C. loveni	4	6	.0	95.0
Sternaspis scutata	4	6	.0	95.0
Maldanidae	4	6	.0	95.0

[1] denotes Number of Observations
[2] denotes Number of Individuals
[3] denotes Percent
[4] denotes Cumulative Percent

TABLE F6. List of macroinfauna taxa selected for cluster analysis with frequency of observation, abundance, and rank for Cruise III.

Taxa	[1] No. Obs.	[2] No. Ind.	[3] %	[4] Cum. %
Rhynchocoela	36	939	4.6	4.6
Paraprionospio pinnata	35	1026	5.0	9.6
Nereis	32	1148	5.6	15.3
Mediomastus californiensis	31	461	2.3	17.5
Sigambra tentaculata	31	371	1.8	19.4
Pinnixa	30	264	1.3	20.7
Corbula contracta	30	177	.9	21.5
Sthenelais boa	30	176	.9	22.4
Lumbrineris tenuis	28	332	1.6	24.0
Prionospio cirrifera	28	223	1.1	25.1
Magelona phyllisae	27	7258	35.6	60.8
Cossura delta	27	187	.9	61.7
Armandia maculata	27	141	.7	62.4
Golfingia bulbosa	26	731	3.6	66.0
Tharyx marioni	26	192	.9	66.9
Nephtys incisa	26	142	.7	67.6
Notomastus latericeus	25	93	.5	68.1
Diopatra cuprea	24	170	.8	68.9
Speocarcinus lobatus	22	39	.2	69.1
Ampharete acutifrons	20	241	1.2	70.3
Glycinde nordmanni	20	45	.2	70.5
Magelona filiformis	18	87	.4	70.9
Aspidosiphon albus	18	79	.4	71.3
Glycera americana	18	65	.3	71.6
Paraonis gracilis	18	40	.2	71.8
Tellina versicolor	17	155	.8	72.6
Automate evermanni	17	62	.3	72.9
Magelona rosea	17	46	.2	73.1
Nuculana concentrica	17	29	.1	73.2
Prionospio cristata	16	141	.7	73.9
Amphioplus coniortodes	16	95	.5	74.4
Prionospio cirrobranchiata	15	44	.2	74.6
Volvulella texasiana	15	29	.1	74.8
Vitrinella floridana	14	83	.4	75.2
Ninoe nigripes	14	69	.3	75.5
Amphiodia atra	14	43	.2	75.7
Aricidea suecica	14	37	.2	75.9
Tharyx setigera	14	31	.2	76.1
Listriella barnardi	14	17	.1	76.1
Pseudeurythoe ambigua	13	297	1.5	77.6
Gyptis vittata	13	17	.1	77.7
Aricidea fragilis	12	229	1.1	78.8
Ceratonereis irritabilis	12	130	.6	79.4
Ampelisca abdita	12	65	.3	79.8
Sabatieria	12	56	.3	80.0

[1] denotes Number of Observations
[2] denotes Number of Individuals
[3] denotes Percent
[4] denotes Cumulative Percent

TABLE F6 (Cont'd).

Taxa	[1] No. Obs.	[2] No. Ind.	[3] %	[4] Cum. %
Nucula cf. N. proxima	12	38	.2	80.2
Acetes americanus	12	31	.2	80.4
Ancistrosyllis jonesi	12	23	.1	80.5
Chasmocarcinus mississippiensis	12	19	.1	80.6
Decapoda (arthropoda)	11	17	.1	80.7
Alpheus floridanus	11	16	.1	80.7
Oxyurostylis smithi	10	159	.8	81.5
Timarete	10	62	.3	81.8
Phoronis architecta	10	31	.2	82.0
Asychis elongata	10	28	.1	82.1
Lepidasthenia	9	24	.1	82.2
Terebra dislocata	9	16	.1	82.3
Agriopoma texasiana	9	11	.1	82.4
Abra aequalis	8	48	.2	82.6
Clymenella torquata calida	8	19	.1	82.7
Chione clenchi	8	18	.1	82.8
Owenia fusiformis	8	14	.1	82.9
Diplocirrus	8	12	.1	82.9
Amphiuridae	8	11	.1	83.0
Mulinia lateralis	7	469	2.3	85.3
Ceratocephale cf. C. loveni	7	193	.9	86.2
Ampelisca verrilli	7	101	.5	86.7
Ampelisca agassizi	7	50	.2	87.0
Gastropoda	7	9	.0	87.0
Macoma pulleyi	7	7	.0	87.0
Loimia viridis	6	82	.4	87.4
Ampharete americana	6	62	.3	87.7
Photis macromanus	6	45	.2	88.0
Balanoglossus	6	29	.1	88.1
Onuphis nebulosa	6	15	.1	88.2
Bregmaceros atlanticus	6	15	.1	88.3
Natica pusilla	6	12	.1	88.3
Anaitides erythrophyllus	6	11	.1	88.4
Nereidae	6	9	.0	88.4
Bivalvia	6	9	.0	88.5
Spiophanes bombyx	6	8	.0	88.5
Harmothoe	6	7	.0	88.5
Caridea	6	7	.0	88.6
Dorylaimopsis	6	6	.0	88.6
Aglaophamus verrilli	5	96	.5	89.1
Ampelisca	5	26	.1	89.2
Anadara ovalis	5	13	.1	89.3
Polydora ligni	5	10	.0	89.3
Cingula	5	10	.0	89.4

[1] denotes Number of Observations
[2] denotes Number of Individuals
[3] denotes Percent
[4] denotes Cumulative Percent

TABLE F6 (Cont'd).

Taxa	[1]No. Obs.	[2]No. Ind.	[3] %	[4]Cum. %
Pagurus bonairensis	5	10	.0	89.4
Polydora socialis	5	8	.0	89.4
Brachyura	5	6	.0	89.5
Linhomoeidae	5	5	.0	89.5
Cupuladria biporosa	4	1060	5.2	94.7
Petricola pholadiformis	4	43	.2	94.9
Anadara transversa	4	11	.1	95.0
Diplodonta soror	4	9	.0	95.0
Gyptis brevipalpa	4	7	.0	95.0

[1] denotes Number of Observations

[2] denotes Number of Individuals

[3] denotes Percent

[4] denotes Cumulative Percent

TABLE F7. List of macroepifauna and demersal fish taxa selected for cluster analysis with frequency of observation, abundance, and rank for Cruise I.

Taxa	[1] No. Obs.	[2] No. Ind.	[3] %	[4] Cum. %
Leiolambrus nitidus	5	71	2.0	2.0
Squilla empusa	5	57	1.6	3.6
Callinectes similis	5	41	1.1	4.7
Prionotus rubio	5	16	.4	5.2
Trachypenaeus similis	4	912	25.4	30.6
Astropecten duplicatus	4	746	20.8	51.4
Loligo pealei	4	306	8.5	59.9
Calliactis tricolor	4	48	1.3	61.2
Alpheus floridanus	4	45	1.3	62.5
Pagurus pollicaris	4	22	.6	63.1
Penaeus aztecus	3	273	7.6	70.7
Stenotomus caprinus	3	47	1.3	72.0
Anchoa mitchilli	3	29	.8	72.8
Speocarcinus lobatus	3	27	.8	73.6
Halieutichthys aculeatus	3	26	.7	74.3
Anchoa hepsetus	3	24	.7	75.0
Trachypenaeus	3	19	.5	75.5
Diopatra cuprea	3	11	.3	75.8
Lepidonotus sublevis	3	10	.3	76.1
Sphoeroides parvus	3	8	.2	76.3
Etropus crossotus	3	7	.2	76.5
Ovalipes quadulpensis	3	4	.1	76.6
Centropristis philadelphicus	3	3	.1	76.7
Pleurobranchaea hedgpethi	2	142	4.0	80.7
Portunus spinicarpus	2	129	3.6	84.3
Trachurus lathami	2	92	2.6	86.8
Portunus gibbesii	2	69	1.9	88.7
Penaeus setiferus	2	40	1.1	89.9
Squilla chydaea	2	16	.4	90.3
Sicyonia dorsalis	2	15	.4	90.7
Peprilus burti	2	14	.4	91.1
Palythoa texaensis	2	11	.3	91.4
Antennarius radiosus	2	11	.3	91.7
Sthenelais boa	2	10	.3	92.0
Arius felis	2	10	.3	92.3
Hepatus epheliticus	2	9	.3	92.5
Citharichthys spilopterus	2	9	.3	92.8
Cyclopsetta chittendeni	2	9	.3	93.0
Sicyonia brevirostris	2	8	.2	93.3
Porichthys porosissimus	2	8	.2	93.5
Symphurus civitatus	2	6	.2	93.6
Paraprionospio pinnata	2	5	.1	93.8
Anchoviella perfasciata	2	4	.1	93.9
Lutjanus synagris	2	3	.1	94.0
Terebellides stroemii	2	2	.1	94.0
Cynoscion arenarius	2	2	.1	94.1
Gobionellus boleosoma	2	2	.1	94.1
Rollmannia communis	1	19	.5	94.7

[1] denotes Number of Observations
[2] denotes Number of Individuals
[3] denotes Percent
[4] denotes Cumulative Percent

TABLE F8. List of macroepifauna and demersal fish taxa selected for cluster analysis with frequency of observation, abundance, and rank for Cruise II.

Taxa	[1] No. Obs.	[2] No. Ind.	[3] %	[4] Cum. %
Prionotus rubio	16	373	2.1	2.1
Penaeus aztecus	14	176	1.0	3.1
Halieutichthys aculeatus	11	181	1.0	4.2
Saurida brasiliensis	11	117	.7	4.8
Squilla chydaea	10	923	5.3	10.1
Diopatra cuprea	10	243	1.4	11.5
Loligo pealei	10	231	1.3	12.8
Squilla empusa	10	185	1.1	13.9
Leiolambrus nitidus	10	175	1.0	14.9
Cantharus cancellarius	10	111	.6	15.5
Portunus gibbesii	10	90	.5	16.0
Pitar cordatus	10	76	.4	16.4
Citharichthys spilopterus	10	74	.4	16.9
Astropecten duplicatus	9	3613	20.6	37.5
Stenotomus caprinus	9	591	3.4	40.9
Callinectes similis	9	243	1.4	42.3
Etropus crossotus	9	117	.7	42.9
Cyclopsetta chittendeni	9	61	.3	43.3
Trachypenaeus similis	8	439	2.5	45.8
Callinectes sapidus	8	153	.9	46.7
Diplectrum bivittatum	8	109	.6	47.3
Centropristis philadelphicus	8	59	.3	47.6
Arius felis	7	157	.9	48.5
Syacium gunteri	7	129	.7	49.2
Chloroscombrus chrysurus	7	107	.6	49.9
Asychis elongata	7	103	.6	50.4
Synodus foetens	7	51	.3	50.7
Serranus atrobranchus	7	46	.3	51.0
Murex fulvescens	7	21	.1	51.1
Nereis succinea	7	20	.1	51.2
Portunus spinicarpus	6	1008	5.8	57.0
Sicyonia dorsalis	6	275	1.6	58.6
Micropogon undulatus	6	111	.6	59.2
Alpheus floridanus	6	68	.4	59.6
Antennarius radiosus	6	64	.4	59.9
Raninoides louisianensis	6	48	.3	60.2
Gymnachirus texae	6	31	.2	60.4
Pristipomoides aquilonaris	6	16	.1	60.5
Agriopoma texasiana	6	9	.1	60.5
Calappa sulcata	6	8	.0	60.6
Bollmannia communis	5	199	1.1	61.7
Prionotus stearnsi	5	51	.3	62.0
Terebellides stroemii	5	40	.2	62.2
Noetia ponderosa	5	28	.2	62.4
Porichthys porosissimus	5	26	.1	62.5
Nephtys incisa	5	23	.1	62.7
Speocarcinus lobatus	5	19	.1	62.8

[1] denotes Number of Observations
[2] denotes Number of Individuals
[3] denotes Percent
[4] denotes Cumulative Percent

TABLE F8 (Cont'd).

Taxa	[1]No. Obs.	[2]No. Ind.	[3]%	[4]Cum. %
Lolliguncula brevis	5	12	.1	62.9
Rhynchocoela	5	11	.1	62.9
Cynoscion nothus	5	11	.1	63.0
Chione clenchi	5	9	.1	63.0
Anadara baughmani	4	140	.8	63.8
Leiostomus xanthurus	4	83	.5	64.3
Macoma tageliformis	4	72	.4	64.7
Cynoscion arenarius	4	37	.2	64.9
Symphurus plagiusa	4	26	.1	65.1
Trachurus lathami	4	22	.1	65.2
Distorsio clathrata	4	17	.1	65.3
Parapenaeus longirostris	4	17	.1	65.4
Acetes americanus carolinae	4	15	.1	65.5
Molpadia cubana	4	10	.1	65.5
Persephona crinita	4	9	.1	65.6
Peprilus burti	4	9	.1	65.6
Hepatus epheliticus	4	6	.0	65.7
Anchoa hepsetus	3	130	.7	66.4
Anchoa mitchilli	3	95	.5	67.0
Trichiurus lepturus	3	47	.3	67.2
Anasimus latus	3	44	.3	67.5
Anthopleura krebsi	3	17	.1	67.6
Urophycis cirratus	3	16	.1	67.7
Styela plicata	3	13	.1	67.7
Paraprionospio pinnata	3	10	.1	67.8
Polydactylus octonemus	3	10	.1	67.9
Sicyonia brevirostris	3	9	.1	67.9
Brotula barbata	3	9	.1	68.0
Anchoa nasuta	3	8	.0	68.0
Lepidonotus variabilis	3	7	.0	68.0
Oliva sayana	3	7	.0	68.1
Symphurus civitatus	3	7	.0	68.1
Calliactis tricolor	3	6	.0	68.2
Sconsia striata	3	6	.0	68.2
Pagurus pollicaris	3	4	.0	68.2
Porcellana sigsbeiana	3	4	.0	68.2
Stomatopoda	3	4	.0	68.3
Psilaster cassiope	3	4	.0	68.3
Lagodon rhomboides	3	3	.0	68.3
Penaeus setiferus	2	179	1.0	69.3
Amusium papyraceum	2	153	.9	70.2
Polystira tellea	2	56	.3	70.5
Anchoviella perfasciata	2	24	.1	70.7
Conus austini	2	18	.1	70.8
Prionotus paralatus	2	17	.1	70.9
Decapterus punctatus	2	16	.1	70.9
Solenocera vioscai	2	13	.1	71.0

[1] Denotes Number of Observations
[2] Denotes Number of Individuals
[3] Denotes Percent
[4] Denotes Cumulative Percent

TABLE F8 (Con't).

Taxa	[1]No. Obs.	[2]No. Ind.	[3]%	[4]Cum. %
Sinum perspectivum	2	11	.1	71.1
Kathetostoma albigutta	2	11	.1	71.1
Ogcocephalus radiatus	2	10	.1	71.2
Sthenelais boa	2	9	.1	71.3
Aspidosiphon albus	2	7	.0	71.3
Amphioplus coniortodes	2	7	.0	71.3
Ceratonereis irritabilis	2	5	.0	71.4
Menticirrhus americanus	2	5	.0	71.4
Hydroides protulicola	2	4	.0	71.4
Anadara transversa	2	4	.0	71.4
Myropsis quinquespinosa	2	4	.0	71.5
Libinia emarginata	2	4	.0	71.5
Nereidae	2	3	.0	71.5
Petrochirus diogenes	2	3	.0	71.5
Majidae	2	3	.0	71.5
Coelocerus spinosus	2	3	.0	71.6
Squilla	2	3	.0	71.6
Priacanthus arenatus	2	3	.0	71.6
Stellifer lanceolatus	2	3	.0	71.6
Octocorallia pennatulacea	2	2	.0	71.6
Lumbrineris	2	2	.0	71.6
Crepidula fornicata	2	2	.0	71.6
Anadontia alba	2	2	.0	71.6
Corbula contracta	2	2	.0	71.7
Stenopus scutellatus	2	2	.0	71.7
Podochela lamelligera	2	2	.0	71.7
Lutjanus campechanus	2	2	.0	71.7

[1]denotes Number of Observations
[2]denotes Number of Individuals
[3]denotes Percent
[4]denotes Cumulative Percent

TABLE F9. List of macroepifauna and demersal fish taxa selected for cluster analysis with frequency of observation, abundance, and rank for Cruise III.

Taxa	[1] No. Obs.	[2] No. Ind.	[3] %	[4] Cum. %
Symphurus civitatus	3	7	.0	68.1
Calliactis tricolor	3	6	.0	68.2
Sconsia striata	3	6	.0	68.2
Pagurus pollicaris	3	4	.0	68.2
Porcellana sigsbeiana	3	4	.0	68.2
Stomatopoda	3	4	.0	68.3
Psilaster cassiope	3	4	.0	68.3
Lagodon rhomboides	3	3	.0	68.3
Penaeus setiferus	2	179	1.0	69.3
Amusium papyraeum	2	153	.9	70.2
Polystira tellea	2	56	.3	70.5
Anchoviella perfasciata	2	24	.1	70.7
Conus austini	2	18	.1	70.8
Prionotus paralatus	2	17	.1	70.9
Decapterus punctatus	2	16	.1	70.9
Solenocera vioscai	2	13	.1	71.0
Sinum perspectivum	2	11	.1	71.1
Kathetostoma albigutta	2	11	.1	71.1
Ogcocephalus radiatus	2	10	.1	71.2
Sthenelais boa	2	9	.1	71.3
Aspidosiphon albus	2	7	.0	71.3
Amphioplus coniortodes	2	7	.0	71.3
Ceratonereis irritabilis	2	5	.0	71.4
Menticirrhus americanus	2	5	.0	71.4
Hydroides protulicola	2	4	.0	71.4
Anadara transversa	2	4	.0	71.4
Myropsis quinquespinosa	2	4	.0	71.5
Libinia emarginata	2	4	.0	71.5
Nereidae	2	3	.0	71.5
Petrochirus diogenes	2	3	.0	71.5
Majidae	2	3	.0	71.5
Coelocerus spinosus	2	3	.0	71.6
Squilla	2	3	.0	71.6
Priacanthus arenatus	2	3	.0	71.6
Stellifer lanceolatus	2	3	.0	71.6
Octocorallia pennatulacea	2	2	.0	71.6
Lumbrineris	2	2	.0	71.6
Crepidula fornicata	2	2	.0	71.6
Anadontia alba	2	2	.0	71.6
Corbula contracta	2	2	.0	71.7
Stenopus scutellatus	2	2	.0	71.7
Podochela lamelligera	2	2	.0	71.7
Lutjanus campechanus	2	2	.0	71.7

[1] denotes Number of Observations
[2] denotes Number of Individuals
[3] denotes Percent
[4] denotes Cumulative Percent

APPENDIX G

Distribution of Taxa by Station for Each Cruise.

TABLE G1. Distribution of meiofauna taxa by station for Cruise I.

Taxa	01PN0500	01PN2000	01PE0500	01PE2000	01PS0500	01PS2000	01PW0500	01PW2000	02PN0500	02PN2000	02PE0500	02PE2000	02PS0500	02PS2000	02PW0500	02PW2000	03PN0500	03PN2000	03PE0500	03PE2000	03PS0500	03PS2000	03PW0500	03PW2000	04PN0500	04PN2000	04PE0500	04PE2000	04PS0500	04PS2000	04PW0500	04PW2000	21C	22C	23C	24C
Nonionella basiloba	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
Sabatieria	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
Gromiidae	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
Cyatholaimidae	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
Theristus	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
Ammonia beccarii	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
Chromadoridae	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
Dorylaimopsis	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
Buliminella morgani	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x		x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
Terschellingia	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
Bolivina lowmani	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x		x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
Echinoderes	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x		x	x	x	x	x	x	x	x	x	x	x	x	x	x
Linhomoeidae	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
Nematoda	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x		x	x	x	x	x	x	x	x	x	x	x	x		x
Halalaimus	x	x	x	x	x	x	x	x	x	x	x	x	x	x		x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x		x	x	x
Choniolaimidae	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x			x	x	x		x	x	x	x	x	x	x	x	x	x	x
Metacomesoma	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x		x	x	x		x	x	x	x		x	x	x	x	x	x	x		x
Notomastus latericeus	x	x				x		x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
Microlaimus		x	x	x	x	x		x	x	x	x		x	x	x	x			x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
Parodontophora	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x		x	x	x		x	x		x	x	x		x	x	x	x	x		x

[1] An *x* indicates occurrence in at least one core per station.

TABLE G1 (Cont'd).

	Stations[1]																																			
Taxa	01PN0500	01PN2000	01PE0500	01PE2000	01PS0500	01PS2000	01PW0500	01PW2000	02PN0500	02PN2000	02PE0500	02PE2000	02PS0500	02PS2000	02PW0500	02PW2000	03PN0500	03PN2000	03PE0500	03PE2000	03PS0500	03PS2000	03PW0500	03PW2000	04PN0500	04PN2000	04PE0500	04PE2000	04PS0500	04PS2000	04PW0500	04PW2000	21C	22C	23C	24C
Tricoma	x	x							x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
Sphaerolaimus	x	x	x	x	x	x		x	x	x	x	x	x	x		x	x	x	x	x		x	x	x	x	x	x			x	x	x	x	x	x	x
Fursenkoina complanata				x		x	x	x	x	x	x		x	x			x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
Uncholaimidae	x	x		x	x		x	x	x	x	x	x	x	x	x	x	x	x	x	x	x		x	x	x	x		x	x		x		x	x	x	
Paracomesoma	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x			x	x	x	x	x	x				x	x	x	x		x	x		x
Desmodoridae	x	x	x	x					x	x		x	x			x	x	x	x	x	x	x	x	x	x	x	x	x	x	x		x	x	x	x	x
Halectinosoma	x	x			x	x			x	x	x	x	x	x	x	x	x	x	x	x	x		x	x	x	x	x		x	x	x	x		x		
Axonolaimidae		x	x	x		x	x		x	x	x					x	x	x	x	x	x		x	x	x	x	x	x	x	x	x	x			x	x
Haloschizopera	x	x		x	x	x	x	x		x	x	x	x	x		x			x	x	x		x		x		x		x	x	x	x	x	x	x	
Desmoscolex	x	x	x	x	x	x	x	x		x			x			x				x	x	x	x	x	x	x	x	x	x	x		x		x		x
Turbellaria	x	x		x		x			x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x			x				x	x	x			x
Miliolacea							x		x	x	x	x	x	x		x	x	x	x	x	x	x	x	x		x	x	x		x	x	x		x	x	
Eubostrichus	x	x	x	x	x	x	x	x	x	x	x						x	x	x					x	x	x		x	x	x			x	x		x
Lagenammina comprima	x	x		x			x		x									x	x	x	x	x	x	x	x	x	x	x	x	x	x	x		x	x	x
Trachydemus	x	x			x	x	x	x		x		x		x		x			x		x	x	x		x	x	x	x	x		x	x		x	x	
Reophax scottii					x	x	x	x	x		x	x	x	x	x										x	x	x	x	x	x	x	x	x	x	x	x
Ceramonematidae	x				x	x	x	x					x				x			x	x		x	x	x	x	x	x	x	x	x	x		x	x	x
Eggerella bradyi	x	x		x		x	x	x		x	x		x	x			x			x	x	x	x			x		x				x	x	x		x
Cletodidae	x			x				x	x	x		x	x	x	x	x		x	x	x	x			x		x			x	x		x	x	x		
Paramonhystera	x	x	x	x	x	x	x	x						x						x			x	x	x	x	x	x	x		x		x	x		

[1] An *x* indicates occurrence in at least one core per station.

TABLE G1 (Cont'd).

	Stations[1]																																			
Taxa	01PN0500	01PN2000	01PE0500	01PE2000	01PS0500	01PS2000	01PW0500	01PW2000	02PN0500	02PN2000	02PE0500	02PE2000	02PS0500	02PS2000	02PW0500	02PW2000	03PN0500	03PN2000	03PE0500	03PE2000	03PS0500	03PS2000	03PW0500	03PW2000	04PN0500	04PN2000	04PE0500	04PE2000	04PS0500	04PS2000	04PW0500	04PW2000	21C	22C	23C	24C
Bulimina marginata		x	x							x	x			x			x		x	x	x		x		x	x	x	x	x	x	x	x		x		x
Monhystera	x	x	x	x	x	x	x	x	x		x	x						x	x	x				x			x		x				x		x	x
Bivalvia	x	x			x	x			x	x	x	x	x	x	x	x	x								x	x	x	x			x	x				
Bolivina striatula	x								x	x	x	x	x	x	x	x		x		x	x		x		x	x		x		x		x	x			
Fursenkoina pontoni				x			x	x		x							x		x	x	x	x	x	x	x		x	x		x	x	x		x	x	
Copepoda	x			x	x				x	x	x	x	x	x	x	x			x	x	x							x			x		x	x		
Rhynchocoela	x	x	x	x				x	x		x	x	x	x				x		x			x	x		x					x		x	x		
Diosaccidae		x		x	x	x	x		x		x	x	x	x	x	x	x		x	x	x						x			x						
Ammoscalaria pseudospiralis	x	x	x		x		x	x		x	x	x	x	x	x				x				x			x					x	x		x		
Paraprionospio pinnata		x		x					x	x	x		x	x	x	x	x		x	x			x				x		x			x		x		
Cibicides concentricus										x	x	x		x					x		x				x	x	x	x	x	x	x	x		x	x	
Ironidae	x								x	x	x	x		x	x	x	x		x	x	x	x	x	x									x			
Ampharete americana	x	x	x		x	x			x	x	x	x	x	x	x	x			x					x									x			
Monhysteridae	x	x										x					x			x			x	x	x	x	x	x	x	x		x	x			x
Elphidium gunteri		x					x	x		x		x	x	x	x				x	x	x			x	x						x	x				x
Holophryidae		x						x		x		x								x	x			x	x	x	x		x	x	x	x		x	x	
Sigambra tentaculata	x			x		x			x	x	x		x		x	x	x		x	x	x			x		x		x								
Buliminella elegantissima		x	x	x			x		x	x	x	x	x	x	x		x																x	x		x
Leptolaimidae			x	x		x				x		x			x		x		x	x	x		x	x			x	x					x			
Tharyx marioni		x	x							x					x		x		x			x			x	x	x		x	x	x		x	x		

[1] An x indicates occurrence in at least one core per station.

TABLE G1 (Cont'd).

Taxa	01PN0500	01PN2000	01PE0500	01PE2000	01PS0500	01PS2000	01PW0500	01PW2000	02PN0500	02PN2000	02PE0500	02PE2000	02PS0500	02PS2000	02PW0500	02PW2000	03PN0500	03PN2000	03PE0500	03PE2000	03PS0500	03PS2000	03PW0500	03PW2000	04PN0500	04PN2000	04PE0500	04PE2000	04PS0500	04PS2000	04PW0500	04PW2000	21C	22C	23C	24C
Florilus atlanticus																	x		x	x			x		x	x	x	x	x	x	x	x			x	x
Cervonema					x						x			x	x		x	x	x	x	x		x	x	x									x		
Longipedia helgolandica																	x	x	x	x	x		x	x	x	x				x	x	x			x	
Aricidea		x										x							x	x	x		x	x			x		x		x	x		x	x	
Textularia earlandi		x	x	x	x	x	x	x	x		x								x		x					x							x			
Pycnophyes		x		x	x		x		x		x		x	x			x	x					x				x							x		
Ameira									x	x	x		x	x	x	x		x	x	x				x	x											
Siphonolaimus	x	x	x	x	x	x	x					x											x									x		x		x
Nephtys incisa				x					x	x				x	x	x			x	x	x		x	x									x			
Lagenammina difflugiformis	x																			x		x			x	x		x	x	x	x	x			x	
Oxystominidae		x	x	x	x		x	x		x							x	x						x				x								
Prionospio cirrifera	x															x		x		x	x			x		x	x				x		x			x
Enhydrosoma hopkinsi									x	x	x	x	x	x	x	x														x			x			
Stenhelia		x							x	x	x		x	x	x	x																		x	x	
Richtersia																	x		x	x	x		x	x	x		x		x			x				
Laimella				x		x	x	x		x													x			x			x	x						x
Quinqueloculina compta										x		x		x				x	x	x	x	x	x											x		
Campylaimus			x				x					x											x	x					x	x	x	x		x		
Hanzawaia strattoni	x																x	x	x	x	x	x	x	x												
Quinqueloculina vulgaris									x	x	x	x	x	x									x										x	x		

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[1] An x indicates occurrence in at least one core per station.

TABLE G1 (Cont'd).

Taxa	01PN0500	01PN2000	01PE0500	01PE2000	01PS0500	01PS2000	01PW0500	01PW2000	02PN0500	02PN2000	02PE0500	02PE2000	02PS0500	02PS2000	02PW0500	02PW2000	03PN0500	03PN2000	03PE0500	03PE2000	03PS0500	03PS2000	03PW0500	03PW2000	04PN0500	04PN2000	04PE0500	04PE2000	04PS0500	04PS2000	04PW0500	04PW2000	21C	22C	23C	24C
Rhizopodea filosia	x													x						x	x	x	x	x							x			x		
Stenhelia unisetosa									x	x	x	x	x	x	x	x																		x		
Uvigerina bellula							x	x		x	x	x	x	x	x																		x			
Enhydrosoma	x								x	x	x		x		x	x	x																	x		
Kinorhyncha			x			x		x		x			x	x		x	x				x															
Polychaeta							x	x		x							x	x		x	x		x												x	
Hydrozoa				x	x					x	x		x			x	x														x			x		
Chone											x			x		x	x	x		x	x		x	x												
Hypodontolaimus																	x	x	x	x	x		x	x										x		
Comesomatidae				x		x					x		x		x		x	x															x			
Leptolaimus						x				x	x		x			x													x			x				x
Harpacticoida	x								x		x						x	x						x						x					x	
Axonolaimus									x			x			x		x		x						x	x							x			
Anticoma									x				x				x	x	x	x	x															
Cossura delta	x		x			x														x				x					x	x						
Amphiascus minutus																	x	x	x	x	x			x							x					
Textularia conica																			x							x				x	x	x			x	x
Gastropoda							x				x				x				x		x						x	x								
Sabelliphilidae									x	x	x		x	x	x	x																				
Cletodes tenuipes																				x	x		x							x	x	x		x		

[1] An *x* indicates occurrence in at least one core per station.

TABLE G1 (Cont'd).

Taxa	01PN0500	01PN2000	01PE0500	01PE2000	01PS0500	01PS2000	01PW0500	01PW2000	02PN0500	02PN2000	02PE0500	02PE2000	02PS0500	02PS2000	02PW0500	02PW2000	03PN0500	03PN2000	03PE0500	03PE2000	03PS0500	03PS2000	03PW0500	03PW2000	04PN0500	04PN2000	04PE0500	04PE2000	04PS0500	04PS2000	04PW0500	04PW2000	21C	22C	23C	24C
Ciliatea holotrichia				x					x		x					x			x											x					x	
Enoplidae																	x	x	x	x	x		x													
Eleutherolaimus													x	x	x	x				x					x											
Normanella serrata	x	x	x		x		x																											x		
Idoteidae							x			x	x	x			x	x																				
Cancris sagra																	x	x	x			x	x									x			x	
Florilus grateloupi																	x				x	x	x	x												x
Armandia maculata																	x		x					x		x			x			x				
Paraonis gracilis																										x	x	x		x	x					x
Stenhelia mastigochaeta																		x	x		x					x		x				x				
Frondicularia compressa						x							x								x					x				x					x	
Campanulariidae			x						x	x		x		x	x																					
Bulimina elegans	x						x	x															x											x		
Difflugiidae										x		x								x				x										x		
Lenticulina peregrina																		x			x		x				x				x					
Ectinosomidae									x		x				x							x												x		
Bigenerina irregularis									x					x					x	x			x													
Ectinosoma										x	x		x			x																				
Cibicides deprimus																			x		x	x	x													
Enhydrosoma longifurcatum	x			x	x		x																													

[1] An *x* indicates occurrence in at least one core per station.

TABLE G1 (Cont'd).

Taxa	[1] Stations																																			
	01PN0500	01PN2000	01PE0500	01PE2000	01PS0500	01PS2000	01PW0500	01PW2000	02PN0500	02PN2000	02PE0500	02PE2000	02PS0500	02PS2000	02PW0500	02PW2000	03PN0500	03PN2000	03PE0500	03PE2000	03PS0500	03PS2000	03PW0500	03PW2000	04PN0500	04PN2000	04PE0500	04PE2000	04PS0500	04PS2000	04PW0500	04PW2000	21C	22C	23C	24C
Normanella confluens							x																				x					x		x		
Discorbis squamata	x									x			x				x																			
Clytia		x		x							x		x																							
Pyrgo carinata																	x			x			x					x								
Corbulidae																			x		x		x	x												
Enchelidiidae									x									x			x													x		
Oligochaeta									x			x												x										x		
Prorodon marinus								x													x				x						x					
Podocopa														x	x				x															x		
Cyclopoida	x									x								x						x												
Ciliatea peritrichia				x					x				x																						x	
Metacyatholaimus																		x					x	x												
Pyrgo oblonga																				x	x		x													
Oxystomina										x	x					x																				
Eponides antillarum																			x				x								x					
Fursenkoina compressa			x									x	x																							
Stenhelia longicaudata finmarchica																			x								x		x							
Uvigerina parvula																						x	x							x						
Cletodes dissimilis																	x		x												x					
Odontophora																		x	x	x																

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[1] An *x* indicates occurrence in at least one core per station.

TABLE G1 (Cont'd).

Taxa	Stations[1]																																			
	01PN0500	01PN2000	01PE0500	01PE2000	01PS0500	01PS2000	01PW0500	01PW2000	02PN0500	02PN2000	02PE0500	02PE2000	02PS0500	02PS2000	02PW0500	02PW2000	03PN0500	03PN2000	03PE0500	03PE2000	03PS0500	03PS2000	03PW0500	03PW2000	04PN0500	04PN2000	04PE0500	04PE2000	04PS0500	04PS2000	04PW0500	04PW2000	021C	022C	023C	024C
Camacolaimus											x														x							x				
Trifarina bella																	x		x																x	
Macrodasyoida																	x		x															x		
Tarvaia																		x		x														x		
Diurodrilus	x	x																						x												
Ampharete		x	x	x																																
Typhlamphiascus lamellifer	x				x		x																													
Cytherella																	x			x		x														
Enhydrosoma propinquum							x		x										x																	
Magelona phyllisae									x	x					x																					
Acartia tonsa									x													x														
Quinqueloculina polygona																				x			x													
Melonis										x																							x			
Sphaerolaimidae																	x											x								
Lagena spicata																			x													x				
Anticomidae																	x		x																	
Ciliatea suctoria suctorida																			x				x													
Acarina	x												x																							
Corynidae										x			x																							
Cestoda		x																						x												

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[1] An *x* indicates occurrence in at least one core per station.

TABLE G1 (Cont'd).

Taxa		Stations[1]																																				
		01PN0500	01PN2000	01PE0500	01PE2000	01PS0500	01PS2000	01PW0500	01PW2000	02PN0500	02PN2000	02PE0500	02PE2000	02PS0500	02PS2000	02PW0500	02PW2000	03PN0500	03PN2000	03PE0500	03PE2000	03PS0500	03PS2000	03PW0500	03PW2000	04PN0500	04PN2000	04PE0500	04PE2000	04PS0500	04PS2000	04PW0500	04PW2000	21C	22C	23C	24C	
Semnoderidae	•													x			x																					•
Calanoida	•									x							x																					•
Paralaophonte	•											x													x													•
Robertgurneya rostrata	•																							x	x													•
Gymnolaemata ctenostomata	•																					x													x			•
Tubulariidae	•										x	x																										•
Cateria	•									x	x																											•
Microlaimidae	•																														x					x		•
Annelida	•																		x	x																		•
Sthenelais boa	•										x		x																									•
Lumbrineris tenuis	•																									x										x		•
Zausodes arenicolus	•															x	x																					•
Corycaeus	•																			x															x			•
Ergasilus versicolor	•									x													x															•
Neocentrophyes	•					x				x																												•
Amphimonhystera	•				x														x																			•
Ameiridae	•											x				x																						•
Cletodes	•																	x			x																	•
Viscosia	•													x																								•
Enhydrosomella	•	x																																				•

[1] An x indicates occurrence in at least one core per station.

TABLE G1 (Cont'd).

Taxa		01PN0500	01PN2000	01PE0500	01PE2000	01PS0500	01PS2000	01PW0500	01PW2000	02PN0500	02PN2000	02PE0500	02PE2000	02PS0500	02PS2000	02PW0500	02PW2000	03PN0500	03PN2000	03PE0500	03PE2000	03PS0500	03PS2000	03PW0500	03PW2000	04PN0500	04PN2000	04PE0500	04PE2000	04PS0500	04PS2000	04PW0500	04PW2000	21C	22C	23C	24C	
Quinqueloculina poeyana	•																							x														•
Siphotextularia affinis	•																																		x			•
Textularia mayori	•																										x											•
Ampharete acutifrons	•		x																																			•
Harpacticidae	•																																		x			•
Euterpina acutifrons	•																											x										•
Pseudameira perplexa	•																																		x			•
Enhydrosoma uniarticulatum	•																					x																•
Enhydrosoma sarsi	•																											x										•
Isopoda	•											x																										•
Golfingia	•																							x														•
Brizalina fragilis	•																	x																				•
Tripyloididae	•										x																											•
Camacolaimidae	•									x																												•
Euglyphidae	•																			x																		•
Haplophragmoides	•																																			x		•
Ciliatea holotrichia gymnostomatida rhabdophorina	•																					x																•
Trachelidae	•																														x							•
Coelosomididae	•																								x													•

[1] An x indicates occurrence in at least one core per station.

TABLE G1 (Cont'd).

	[1] Stations																																			
Taxa	01PN0500	01PN2000	01PE0500	01PE2000	01PS0500	01PS2000	01PW0500	01PW2000	02PN0500	02PN2000	02PE0500	02PE2000	02PS0500	02PS2000	02PW0500	02PW2000	03PN0500	03PN2000	03PE0500	03PE2000	03PS0500	03PS2000	03PW0500	03PW2000	04PN0500	04PN2000	04PE0500	04PE2000	04PS0500	04PS2000	04PW0500	04PW2000	21C	22C	23C	24C
Epistylidae																	x																			
Scyphidiidae											x																									
Tintinnopsis subacuta							x																													
Tintinnopsis tocatinensis																									x											
Tintinnopsis cf. T. ovalis																																		x		
Petalotricha																												x								
Trematoda																			x																	
Homalorhagida							x																													
Neotonchus																											x									
Syllis gracilis																												x								
Vitrinella helicoidea																						x														
Volvulella texasiana																			x																	
Nucula cf. N. proxima																			x																	
Nuculana concentrica				x																																
Cladocera																					x															
Pterygocytheris																							x													
Loxoconcha																							x													
Tisbidae																													x							
Normanella																			x																	

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[1] An x indicates occurrence in at least one core per station.

TABLE G1 (Cont'd).

Taxa	[1] Stations																																			
	01PN0500	01PN2000	01PE0500	01PE2000	01PS0500	01PS2000	01PW0500	01PW2000	02PN0500	02PN2000	02PE0500	02PE2000	02PS0500	02PS2000	02PW0500	02PW2000	03PN0500	03PN2000	03PE0500	03PE2000	03PS0500	03PS2000	03PW0500	03PW2000	04PN0500	04PN2000	04PE0500	04PE2000	04PS0500	04PS2000	04PW0500	04PW2000	21C	22C	23C	24C
Normanella mucronata																					x															
Pseudameira							x																													
Cletodes longicaudatus																											x									
Cletodes limicola limicola																					x															
Cletodes latirostris																															x					
Robertgurneya ilievecensis																								x												
Oithona colcarva																																		x		
Onchnesoma																							x													
Ectoprocta																					x															
Oikopleura																					x															
Marginulina obesa																	x																			
Quinqueloculina sabulosa														x																						
Rosalina bertheloti										x																										
Cassidulina										x																										
Coelosomides																				x																
Tintinnopsis					x																															
Oxytrichidae											x																									
Sertulariidae											x																									
Gnathostomulida				x																																
Monoposthiidae																	x																			

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[1] An *x* indicates occurrence in at least one core per station.

TABLE G1 (Cont'd).

Taxa		01PN0500	01PN2000	01PE0500	01PE2000	01PS0500	01PS2000	01PW0500	01PW2000	02PN0500	02PN2000	02PE0500	02PE2000	02PS0500	02PS2000	02PW0500	02PW2000	03PN0500	03PN2000	03PE0500	03PE2000	03PS0500	03PS2000	03PW0500	03PW2000	04PN0500	04PN2000	04PE0500	04PE2000	04PS0500	04PS2000	04PW0500	04PW2000	21C	22C	23C	24C	
Euchromadora	•																		x																			•
Desmoscolecidae	•																	x																				•
Leptosomatidae (nematoda)	•																	x																				•
Periploma	•																				x																	•
Myodocopa	•																		x																			•
Philomedidae	•																		x																			•
Cytheruridae	•									x																												•
Paracalanus crassirostris	•																x																					•
Acartia	•										x																											•
Laophonte cornuta	•																	x																				•
Robertgurneya ecaudata	•																			x																		•
Echiura	•																				x																	•
Asteroidea	•									x																												•
Cyclorhagida	•																	x																				•
Tubificidae	•																	x																				•
Limnodriloides medioporus	•																	x																				•
Tigropus	•																	x																				•
Schizopera	•																	x																				•
Mesochra lilljeborgi	•																	x																				•
Tetragoniceps	•																	x																				•

[1] An *x* indicates occurrence in at least one core per station.

TABLE G2. Distribution of meiofauna taxa by station for Cruise II.

Taxa	[1]Stations																																																																		
	01PN0500	01PN2000	01PE0500	01PE2000	01PS0500	01PS2000	01PW0500	01PW2000	02PN0500	02PN2000	02PE0500	02PE2000	02PS0500	02PS2000	02PW0500	02PW2000	03PN0500	03PN2000	03PE0500	03PE2000	03PS0500	03PS2000	03PW0500	03PW2000	04PN0500	04PN2000	04PE0500	04PE2000	04PS0500	04PS2000	04PW0500	04PW2000	05SN0500	05SN2000	06SN0500	06SN2000	07SN0500	07SN2000	08SN0500	08SN2000	09SN0500	09SN2000	10SN0500	10SN2000	11SN0500	11SN2000	12SN0500	12SN2000	13SN0500	13SN2000	14SN0500	14SN2000	15SN0500	15SN2000	16SN0500	16SN2000	17SN0500	17SN2000	18SN0500	18SN2000	19SN0500	19SN2000	20SN0500	20SN2000	21CN0500	22CN2000	23CN0500	24CN2000
Sabatieria	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x			x	x	x	x	x	x	x	x	x	x	x		x	x	x	x	x	x	x	x	x	x	x	x		x	x	x	x	x	x
Gromiidae	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x		x	x	x	x	x	x	x	x		x	x	x	x	x	x		x	x	x	x	x	x	x	x		x	x	x	x	x	x	x	x	x	x
Bolivina lowmani	x	x	x	x	x	x	x	x	x	x	x	x		x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x		x	x	x			x	x	x		x	x	x	x	x	x
Buliminella morgani	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x		x	x	x	x	x	x	x	x	x	x	x	x	x	x	x		x		x		x	x	x	x		x	x			x	x	x	x	x	x
Cyatholaimidae	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x			x	x	x	x	x	x	x	x	x	x	x	x		x	x	x		x	x	x			x	x	x	x	x	x	x		x	x
Linhomoeidae	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x			x	x	x	x	x		x	x	x	x	x	x		x		x	x	x	x	x	x		x	x	x	x	x	x	x		x	x
Theristus	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x			x	x	x	x	x	x	x	x	x	x	x	x		x		x	x	x	x	x			x	x	x	x	x	x	x		x	x
Dorylaimopsis	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x		x	x	x	x	x				x	x	x	x	x	x		x	x	x			x	x	x		x	x
Nonionella basiloba	x	x	x	x	x	x	x	x	x		x	x	x	x	x		x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x		x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x		x	x	x	x	x	x	x	x			x			x	x	x	x	x	x
Choniolaimidae	x	x	x	x	x	x	x	x	x	x	x		x		x	x	x	x	x	x	x		x	x	x	x	x		x	x	x	x		x			x	x	x				x	x	x	x	x			x		x	x	x	x	x	x		x	x	x	x	x	x	x	x	x	x
Terschellingia	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x			x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x			x	x	x	x	x	x				x			x	x				x			x	x	x			x
Ammonia beccarii	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x		x	x	x	x	x	x		x	x	x	x	x	x	x	x	x		x	x		x	x	x		x	x	x	x	x	x					x			x	x							x	x	x	x	x	x
Lagenammina comprima	x	x	x	x	x	x	x	x		x		x	x	x			x	x	x	x	x	x	x	x	x	x	x	x	x	x	x					x	x	x	x			x	x	x		x	x	x				x		x		x				x			x	x	x	x	x	x
Desmodoridae			x	x			x		x		x	x	x	x		x	x	x	x	x	x		x		x	x	x	x	x	x	x	x					x	x		x		x	x	x	x	x						x	x	x	x	x	x	x		x	x	x	x	x	x		x	x
Tricoma						x	x		x			x		x			x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x			x	x	x		x	x	x	x	x	x	x					x	x	x	x	x				x				x	x		x	x
Fursenkoina complanata	x		x	x		x		x			x	x				x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x						x	x	x	x	x		x		x	x	x				x		x	x	x							x			x	x	x
Sphaerolaimus		x	x	x		x	x	x		x	x	x	x	x	x	x	x		x	x			x	x	x	x	x	x	x	x	x	x		x				x	x					x			x							x	x	x	x			x	x			x	x			x	x
Rhynchocoela									x	x	x		x		x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x					x	x	x			x	x	x	x	x						x	x		x			x	x	x			x			x	x
Eubostrichus	x	x	x	x	x	x	x	x			x				x			x	x	x	x			x	x	x	x	x		x	x	x				x	x		x				x	x	x	x	x	x				x			x	x					x		x	x	x		x	x
Metacomesoma	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x			x		x	x							x	x					x				x	x	x	x	x					x			x	x							x	x	x		x	x
Sigambra tentaculata	x		x	x		x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x		x	x	x	x	x		x	x	x	x	x										x	x	x		x												x			x	x	x		x	x
Cibicides concentricus	x			x						x	x	x					x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x			x				x				x	x	x	x	x	x				x			x	x			x	x			x	x		x	x	
Microlaimus						x		x	x		x		x				x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x			x				x	x	x		x		x	x					x	x		x	x	x	x				x		x	x			x	x
Chromadoridae		x		x		x	x	x	x	x	x	x	x	x		x	x	x		x			x		x	x	x	x	x	x	x	x		x									x	x	x	x						x		x		x				x	x	x	x	x			x	
Halalaimus	x		x	x		x	x		x	x	x	x			x		x	x	x	x	x				x	x	x		x	x		x											x	x	x	x	x								x	x	x	x	x			x	x			x			x	x
Oncholaimidae	x			x		x	x	x	x				x	x		x	x	x	x	x	x		x		x	x			x		x		x	x									x	x	x	x										x	x			x	x	x	x	x	x			
Echinoderes	x		x	x			x	x	x	x	x	x	x	x	x	x	x	x			x		x		x	x	x	x	x	x		x													x		x								x						x			x	x	x		x	x
Parodontophora		x	x	x	x		x	x	x	x	x	x	x	x	x	x		x					x	x	x		x						x	x					x	x	x	x	x	x		x										x				x					x			x
Axonolaimidae							x							x		x	x					x	x	x		x	x	x	x	x	x	x	x		x								x	x	x									x		x	x	x	x			x	x	x	x				x	x
Ceramonematidae						x	x				x			x			x	x		x			x		x	x	x	x	x	x	x	x											x	x	x	x									x	x	x	x	x			x	x	x		x				x
Desmoscolex				x								x					x		x	x	x	x	x	x	x	x	x	x	x	x	x	x					x		x		x	x	x	x	x	x									x	x	x				x								x
Eggerella bradyi			x					x									x		x		x		x	x	x	x	x		x		x					x		x	x	x			x	x	x	x	x	x				x				x							x	x	x	x		x
Nematoda		x	x		x	x		x			x		x	x	x		x	x	x	x				x	x		x		x	x	x	x		x									x	x	x	x												x	x		x					x
Bolivina striatula			x			x		x			x	x		x	x		x	x	x	x						x	x	x	x	x	x	x				x		x							x			x	x								x								x			x	x

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[1] An *x* indicates occurrence in at least one core per station.

TABLE G2 (Cont'd).

Taxa	01PN0500	01PN2000	01PE0500	01PE2000	01PS0500	01PS2000	01PW0500	01PW2000	02PN0500	02PN2000	02PE0500	02PE2000	02PS0500	02PS2000	02PW0500	02PW2000	03PN0500	03PN2000	03PE0500	03PE2000	03PS0500	03PS2000	03PW0500	03PW2000	04PN0500	04PN2000	04PE0500	04PE2000	04PS0500	04PS2000	04PW0500	04PW2000	05SN0500	05SN2000	06SN0500	06SN2000	07SN0500	07SN2000	08SN0500	08SN2000	09SN0500	09SN2000	10SN0500	10SN2000	11SN0500	11SN2000	12SN0500	12SN2000	13SN0500	13SN2000	14SN0500	14SN2000	15SN0500	15SN2000	16SN0500	16SN2000	17SN0500	17SN2000	18SN0500	18SN2000	19SN0500	19SN2000	20SN0500	20SN2000	21C	22C	23C	24C
Turbellaria												x					x	x	x		x	x			x	x	x		x	x	x	x	x	x			x		x					x	x		x			x					x					x	x	x					x	x
Notomastus latericeus				x		x			x	x	x		x			x					x		x		x	x		x	x	x		x		x					x		x	x				x	x					x	x	x		x											x	
Aricidea	x		x														x		x		x	x	x	x	x	x	x	x	x	x	x	x											x	x									x			x	x			x			x	x			x	x
Buliminella elegantissima											x	x		x			x										x	x						x	x	x	x			x			x	x	x	x	x	x						x		x	x						x	x	x	x		x
Monhysteridae		x			x	x		x				x						x	x		x		x	x			x	x	x				x	x					x	x				x	x	x							x	x									x	x			x
Bulimina marginata								x				x						x	x				x	x		x			x	x		x							x	x				x		x	x	x				x		x		x				x			x	x	x	x		x
Oxystomina	x	x	x	x	x		x	x	x	x			x						x	x			x						x	x	x		x	x									x									x				x	x			x					x		x	
Copepoda									x								x	x		x					x								x	x	x						x	x		x	x				x	x	x	x			x		x		x	x	x	x					x	
Paracomesoma				x		x	x	x	x	x	x	x	x	x	x	x	x	x					x										x										x	x	x	x															x	x						
Leptolaimus					x				x	x	x		x	x		x			x						x					x	x		x	x				x	x			x		x			x					x														x		x	
Acarina	x						x			x						x	x	x		x			x		x				x	x		x											x		x		x		x	x		x					x											x	
Laimella		x	x	x				x	x		x		x					x		x																						x	x	x	x	x	x				x				x				x	x			x					
Reophax scottii																	x		x		x	x	x		x	x	x	x	x	x	x	x					x	x	x															x	x										x	
Florilus atlanticus																	x	x		x					x	x	x	x	x	x	x	x																				x		x	x	x				x							x	x
Trachydemus					x		x		x	x	x				x	x					x				x	x	x	x	x		x													x																							x	x
Fursenkoina pontoni																	x					x			x			x	x	x	x	x						x			x	x											x	x	x											x	x
Miliolacea										x			x		x		x														x	x							x					x	x	x								x	x								x		x		x	x
Halectinosoma																		x							x	x	x		x	x										x									x					x	x	x	x			x		x					x	x
Acartia tonsa									x	x						x	x				x				x							x	x	x	x						x			x					x	x																			
Paracalanus crassirostris	x	x							x	x						x	x	x		x													x					x			x								x			x																x
Camacolaimus					x		x		x	x		x		x	x			x	x										x															x		x													x				x				
Cancris sagra																		x	x				x	x			x		x	x	x	x						x			x			x												x												
Bigenerina irregularis																							x					x			x													x		x						x		x		x							x	x		x		x
Oithona colcarva									x							x	x	x		x													x												x		x	x	x	x								x										
Uvigerina bellula								x						x			x																											x		x	x	x															x	x	x			x
Haloschizopera																	x								x	x	x	x		x									x															x		x	x										x	
Textularia mayori																		x		x			x	x	x	x				x							x		x					x															x									
Ammoscalaria pseudospiralis			x							x					x								x		x																			x		x		x						x												x	x	
Campylaimus			x						x	x	x			x			x																x														x																x	x		x	
Richtersia						x											x	x	x	x			x		x	x																																			x							x	
Lagenammina diflugiformis								x									x									x		x	x		x						x								x																					x	x	
Leptolaimidae									x								x	x					x				x				x			x										x		x													x								
Quinqueloculina compta	x				x													x	x		x			x	x		x			x	x																																				
Tharyx marioni																									x		x		x	x	x														x									x		x							x	x				

[1] An x indicates occurrence in at least one core per station.

TABLE G2 (Cont'd).

[1]Stations

Taxa	01PN0500	01PN2000	01PE0500	01PE2000	01PS0500	01PS2000	01PW0500	01PW2000	02PN0500	02PN2000	02PE0500	02PE2000	02PS0500	02PS2000	02PW0500	02PW2000	03PN0500	03PN2000	03PE0500	03PE2000	03PS0500	03PS2000	03PW0500	03PW2000	04PN0500	04PN2000	04PE0500	04PE2000	04PS0500	04PS2000	04PW0500	04PW2000	05SN0500	05SN2000	06SN0500	06SN2000	07SN0500	07SN2000	08SN0500	08SN2000	09SN0500	09SN2000	10SN0500	10SN2000	11SN0500	11SN2000	12SN0500	12SN2000	13SN0500	13SN2000	14SN0500	14SN2000	15SN0500	15SN2000	16SN0500	16SN2000	17SN0500	17SN2000	18SN0500	18SN2000	19SN0500	19SN2000	20SN0500	20SN2000	21C	22C	23C	24C
Pycnophyes		x								x		x		x	x	x	x									x	x					x																																										
Mediomastus californiensis			x														x		x		x					x						x																								x	x			x								x
Paraonis gracilis																	x						x		x					x		x					x					x		x	x	x																							
Eponides antillarum																	x		x	x	x		x				x	x	x																																						x	
Elphidium gunteri												x				x								x																x				x				x															x	x				x
Typhlamphiascus lamellifer			x	x				x									x							x																	x	x											x	x														
Cervonema														x			x		x	x			x	x																						x																	x					
Cossura delta																										x	x	x			x							x												x										x							x	
Oxystominidae																																		x											x					x	x	x				x				x					x			
Hypodontolaimus																																											x	x	x						x			x		x					x							
Monhystera	x		x	x																																						x	x	x																					x			
Trifarina bella																			x		x	x			x			x	x																											x												
Enchelidiidae																			x	x			x										x												x		x										x											
Cibicides deprimus														x			x		x								x		x	x																																						
Normanella confluens			x	x			x														x									x																																					x	
Ironidae																	x		x	x		x							x																														x								
Discorbis squamata																				x			x																					x		x	x																x					
Odontophora															x			x			x																					x																			x	x						
Uvigerina parvula																						x		x														x									x																	x	x				
Enhydrosoma hopkinsi																		x																									x		x	x									x					x								
Comesomatidae																x	x	x	x		x																																											x				
Chone																	x	x	x	x			x																																													
Monoposthiidae																																																						x		x	x					x	x						
Corbula contracta																	x										x				x																									x											x	
Prionospio cirrifera				x																			x		x				x	x																																						
Textularia earlandi																			x				x																		x																								x			x
Polychaeta																	x	x	x							x	x																																									
Holophryidae							x											x							x							x											x																										
Magelona phyllisae									x		x	x		x	x																																																					
Neotonchus																																																															x	x	x			x
Enoplidae																	x		x																																										x	x						
Diosaccidae														x						x																																	x				x											
Paramonhystera																			x																												x																		x		x		
Paraprionospio pinnata	x			x	x						x																																																									

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[1] An *x* indicates occurrence in at least one core per station.

TABLE G2 (Cont'd).

	Stations[1]																																																																		
Taxa	01PN0500	01PN2000	01PE0500	01PE2000	01PS0500	01PS2000	01PW0500	01PW2000	02PN0500	02PN2000	02PE0500	02PE2000	02PS0500	02PS2000	02PW0500	02PW2000	03PN0500	03PN2000	03PE0500	03PE2000	03PS0500	03PS2000	03PW0500	03PW2000	04PN0500	04PN2000	04PE0500	04PE2000	04PS0500	04PS2000	04PW0500	04PW2000	05SN0500	05SN2000	06SN0500	06SN2000	07SN0500	07SN2000	08SN0500	08SN2000	09SN0500	09SN2000	10SN0500	10SN2000	11SN0500	11SN2000	12SN0500	12SN2000	13SN0500	13SN2000	14SN0500	14SN2000	15SN0500	15SN2000	16SN0500	16SN2000	17SN0500	17SN2000	18SN0500	18SN2000	19SN0500	19SN2000	20SN0500	20SN2000	21C	22C	23C	24C
Ciliatea holotrichia														x		x																														x																					x	
Oncholaimus																																																													x	x	x					
Metachromadora																																																													x	x	x					
Melonis														x	x																																																	x			
Nephtys incisa									x	x								x																																																		
Anticoma																	x	x	x																																																	
Stenhelia mastigochaeta																										x			x		x																																					
Siphotextularia affinis																																											x																							x		x	
Cletodes tenuipes																										x				x																							x															
Cyclopoida																|x|																	|x|																																|x|
Camacolaimidae				x								x	x																																																							
Kinorhyncha															x											x	x																																									
Ancistrosyllis jonesi																	x		x	x																																																
Harpacticoida																														x																											x										x	
Cletodes longicaudatus																				x									x																																						x	
Calanoida	x									x																																										x																
Siphonolaimus													x																														x																				x				
Archiannelida																																														x								x	x													
Frondicularia compressa																							x					x																																								
Dasynemella																																																													x	x						
Ectinosoma																																																							x	x												
Hydrozoa																				x																								x																								
Xyala																																																													x	x						
Tripyloididae																																																													x	x						
Cletodes																			x							x																																											
Lagena striata																											x					x																																				
Comesoma																																											x			x																						
Ectinosomidae																																																							x	x												
Phanodermatidae																											x																										x															
Pyrgo carinata																			x																																																x	
Corynidae																														x		x																																				
Cletodidae																																																									x							x				
Amphiascus minutus																										x																																									x	

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[1] An x indicates occurrence in at least one core per station.

TABLE G2 (Cont'd).

	[1]Stations																																																																			
Taxa	01PN0500	01PN2000	01PE0500	01PE2000	01PS0500	01PS2000	01PW0500	01PW2000	02PN0500	02PN2000	02PE0500	02PE2000	02PS0500	02PS2000	02PW0500	02PW2000	03PN0500	03PN2000	03PE0500	03PE2000	03PS0500	03PS2000	03PW0500	03PW2000	04PN0500	04PN2000	04PE0500	04PE2000	04PS0500	04PS2000	04PW0500	04PW2000	05SN0500	05SN2000	06SN0500	06SN2000	07SN0500	07SN2000	08SN0500	08SN2000	09SN0500	09SN2000	10SN0500	10SN2000	11SN0500	11SN2000	12SN0500	12SN2000	13SN0500	13SN2000	14SN0500	14SN2000	15SN0500	15SN2000	16SN0500	16SN2000	17SN0500	17SN2000	18SN0500	18SN2000	19SN0500	19SN2000	20SN0500	20SN2000	21C	22C	23C	24C
Stenhelia longicaudata finmarchica																											x	x																																								
Protozoa I						x																																								x																						
Longipedia helgolandica	x																																																																			x
Saphirella										x				x																																																						
Nucula cf. N. proxima										x																																			x																							
Paradoxostoma																																																					x				x											
Pellucistoma													x					x																																																		
Enhydrosoma A																																																				x			x													
Scyphidiidae			x																																																																	
Florilus grateloupi																																																																				x
Gastropoda																													x																																							
Loxoconcha sarasotana																							x																																													
Pseudomesochra																																																								x												
Prionospio dayi													x																																																							
Lenticulina peregrina																													x																																							
Ciliatea																														x																																						
Chromadoria araeolaimida																																																									x											
Tarvaia																			x																																																	
Amphimonhystera																																																													x							
Pseudonchus																																																																			x	
Leptosomatidae (nematoda)				x																																																																
Armandia maculata																																																								x												
Ampharete																																									x																											
Corbulidae																											x																																									
Cytherella																											x																																									
Nitocra																														x																																						
Pseudameira																														x																																						
Cletodes limicola limicola																											x																																									
Amphiascus																												x																																								
Robertgurneya rostrata																																																									x											
Robertgurneya diversa																																																							x													
Tetragonicipitidae																	x																																																			

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[1] An *x* indicates occurrence in at least one core per station.

TABLE G2 (Cont'd).

	Stations[1]																																																																			
Taxa	01PN0500	01PN2000	01PE0500	01PE2000	01PS0500	01PS2000	01PW0500	01PW2000	02PN0500	02PN2000	02PE0500	02PE2000	02PS0500	02PS2000	02PW0500	02PW2000	03PN0500	03PN2000	03PE0500	03PE2000	03PS0500	03PS2000	03PW0500	03PW2000	04PN0500	04PN2000	04PE0500	04PE2000	04PS0500	04PS2000	04PW0500	04PW2000	05SN0500	05SN2000	06SN0500	06SN2000	07SN0500	07SN2000	08SN0500	08SN2000	09SN0500	09SN2000	10SN0500	10SN2000	11SN0500	11SN2000	12SN0500	12SN2000	13SN0500	13SN2000	14SN0500	14SN2000	15SN0500	15SN2000	16SN0500	16SN2000	17SN0500	17SN2000	18SN0500	18SN2000	19SN0500	19SN2000	20SN0500	20SN2000	21C	22C	23C	24C
Oncaea																																																															x					
Ergasilus																															x																																				
Ergasilus megaceros																															x																																				
Pseudanthessius																						x																																														
Synchelidium americanum																															x																																				
Rhithropanopeus harrisii																								x																																											
Osteichthyes																																											x																									
Rhynchonema																																																														x						
Chromadoria desmodorida																																																														x						
Chaetonema																																																														x						
Difflugiidae										x																																																											
Quinqueloculina vulgaris																				x																																																	
Marginulina obesa																	x																																																				
Brizalina fragilis														x																																																							
Ciliatea holotrichia apostomatida																x																																																				
Ciliatea peritrichia																																												x																								
Epistylidae												x																																																								
Hydrozoa hydroida anthomedusae																	x																																																				
Axonolaimus								x																																																													
Bathylaimus																																																								x												
Hesionidae																x																																																				
Gyptis vittata																																																								x												
Ancistrosyllis			x																																																																		
Syllidae																																																						x														
Nereis														x																																																							
Dorvilleidae																																		x																																						
Vermetidae																																																													x								
Petricolidae									x																																																												
Harbansus paucichelatus																	x																																																				
Cytheromorpha																						x																																															
Paracalanus	x																																																																			
Paracalanus aculeatus																																																															x					
Centropages furcatus																																																				x																
Pseudodiaptomus									x																																																												
Temora turbinata																																	x																																						
Cletodes dissimilis																																																							x												
Cletodes carthaginiensis																																																																		x	
Enhydrosoma lacunae																																																									x											
Stenhelia unisetosa																																							x																																	
Stenhelia reflexa																																																									x											
Ergasilus versicolor																				x																																																	
Sabelliphilidae																																																						x														
Balanoglossus													x																																																								

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[1] An *x* indicates occurrence in at least one core per station.

TABLE G3. Distribution of meiofauna taxa by station for Cruise III.

	[1]Stations																																			
Taxa	01PN0500	01PN2000	01PE0500	01PE2000	01PS0500	01PS2000	01PW0500	01PW2000	02PN0500	02PN2000	02PE0500	02PE2000	02PS0500	02PS2000	02PW0500	02PW2000	03PN0500	03PN2000	03PE0500	03PE2000	03PS0500	03PS2000	03PW0500	03PW2000	04PN0500	04PN2000	04PE0500	04PE2000	04PS0500	04PS2000	04PW0500	04PW2000	21C	22C	23C	24C
Bolivina lowmani	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Dorylaimopsis	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Sabatieria	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X		X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Theristus	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X		X	X	X	X	X	X	X	X	X
Linhomoeidae	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X		X	X	X	X	X	X	X		X
Buliminella morgani	X	X	X	X	X	X	X	X		X		X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Cyatholaimidae	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X		X	X	X	X	X	X	X		X
Gromiidae		X	X	X	X	X	X	X		X		X	X		X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Choniolaimidae		X	X		X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X		X	X	X		X	X	X	X	X
Nonionella basiloba	X	X		X	X	X	X	X	X		X		X		X		X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Terschellingia	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X		X	X	X		X	X	X	X	X		X	X			X	X		X
Parodontophora	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X		X	X	X		X			X		X	X	X	X		X
Ammonia beccarii	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X		X	X			X	X	X		X					X	X		X
Cibicides concentricus	X			X		X	X						X		X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Halalaimus			X	X	X	X		X	X	X	X	X		X	X	X	X	X	X	X	X	X	X	X	X	X		X			X	X		X		X
Sphaerolaimus			X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X				X		X	X	X			X	X		X
Metacomesoma	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X		X	X									X	X		X
Chromadoridae			X	X	X	X		X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X					X	X				X
Tricoma				X	X	X		X	X	X		X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X		X		X	X				X
Eubostrichus	X	X	X	X	X	X	X	X		X			X	X					X			X	X	X	X	X	X	X			X	X	X	X	X	X

[1] An x indicates occurrence in at least one core per station.

TABLE G3 (Cont'd).

Taxa	01PN0500	01PN2000	01PE0500	01PE2000	01PS0500	01PS2000	01PW0500	01PW2000	02PN0500	02PN2000	02PE0500	02PE2000	02PS0500	02PS2000	02PW0500	02PW2000	03PN0500	03PN2000	03PE0500	03PE2000	03PS0500	03PS2000	03PW0500	03PW2000	04PN0500	04PN2000	04PE0500	04PE2000	04PS0500	04PS2000	04PW0500	04PW2000	21C	22C	23C	24C
Lagenammina comprima						x		x				x		x			x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
Desmodoridae			x	x		x		x	x	x	x	x					x	x	x	x	x	x	x	x	x	x	x			x	x	x	x			x
Mediomastus californiensis		x	x	x	x	x	x	x	x	x	x	x		x	x	x	x	x	x	x			x	x								x	x	x		
Turbellaria				x	x							x			x		x	x	x	x	x	x	x	x	x	x	x		x	x	x	x	x		x	
Echinoderes					x			x	x	x	x	x	x	x	x	x	x	x	x	x	x		x	x	x	x						x				x
Oncholaimidae					x	x	x	x	x	x	x		x		x	x	x	x	x	x	x		x	x	x	x								x		x
Aricidea			x	x		x				x							x	x	x	x	x	x	x	x		x		x	x	x	x		x	x	x	x
Halectinosoma						x	x		x	x	x	x	x		x		x	x	x	x	x	x	x	x								x	x		x	
Ceramonematidae	x		x					x						x			x	x	x	x	x	x	x	x		x		x	x		x	x	x	x		
Axonolaimidae						x	x	x	x	x							x	x	x	x	x	x	x	x		x		x			x	x				x
Comesomatidae				x	x	x	x	x		x	x	x	x	x	x	x	x					x	x										x	x		x
Microlaimus									x							x	x	x	x	x	x	x	x	x	x	x			x			x	x	x		x
Neotonchus	x	x						x	x	x		x	x	x	x	x			x			x	x	x									x	x		x
Desmoscolex				x									x		x	x	x	x	x	x		x	x		x	x					x	x	x	x		x
Oxystomina		x			x	x	x	x		x		x				x	x	x	x	x			x	x		x										x
Fursenkoina pontoni						x		x												x	x	x	x	x	x	x		x	x		x	x	x			x
Eponides antillarum																	x	x	x	x	x	x	x	x	x			x	x	x	x	x			x	
Nematoda						x		x		x		x			x	x	x	x	x	x		x	x	x		x										x
Cossura delta		x	x			x	x	x		x							x			x		x	x		x		x					x			x	x
Fursenkoina complanata								x									x	x	x	x	x	x	x	x	x			x				x	x			x
Paracomesoma							x		x	x	x	x	x		x	x	x	x		x	x		x	x												

[1] An *x* indicates occurrence in at least one core per station.

TABLE G3 (Cont'd).

Taxa	[1]Stations																																			
	01PN0500	01PN2000	01PE0500	01PE2000	01PS0500	01PS2000	01PW0500	01PW2000	02PN0500	02PN2000	02PE0500	02PE2000	02PS0500	02PS2000	02PW0500	02PW2000	03PN0500	03PN2000	03PE0500	03PE2000	03PS0500	03PS2000	03PW0500	03PW2000	04PN0500	04PN2000	04PE0500	04PE2000	04PS0500	04PS2000	04PW0500	04PW2000	21C	22C	23C	24C
Florilus atlanticus																	x	x		x	x	x	x	x		x		x		x	x	x	x			
Buliminella elegantissima		x		x	x	x		x		x		x	x	x	x	x								x												x
Bulimina marginata	x	x												x			x		x	x		x	x	x		x				x			x	x		
Monhysteridae	x	x	x	x		x	x		x			x			x	x	x							x												x
Reophax scottii								x									x			x		x	x	x	x	x		x	x		x	x	x			
Bolivina striatula								x	x				x				x		x	x	x	x	x	x		x		x								
Enhydrosoma hopkinsi									x	x	x	x		x	x	x		x	x	x			x	x												
Laimella		x	x	x	x	x	x	x						x								x				x								x		x
Elphidium gunteri				x				x					x		x	x	x	x						x		x							x	x	x	
Bigenerina irregularis								x									x							x	x	x	x	x			x		x	x		x
Trifarina bella																	x		x	x	x	x	x	x	x			x				x			x	
Haloschizopera		x		x		x		x									x	x			x	x				x						x				x
Ironidae									x		x	x	x			x	x	x	x	x	x			x												
Bivalvia				x		x		x			x	x			x			x	x			x											x	x		
Stenhelia					x			x	x	x		x			x	x			x		x															
Cancris sagra																	x		x		x	x	x	x	x						x	x				
Copepoda							x	x	x	x		x				x	x		x	x																
Rhynchocoela		x					x	x	x	x	x						x						x									x				
Typhlamphiascus lamellifer		x		x	x	x											x	x			x													x		x
Sigambra tentaculata		x		x	x	x	x	x					x																				x	x		
Richtersia																	x	x	x	x	x		x	x		x										

[1]An *x* indicates occurrence in at least one core per station.

TABLE G3 (Cont'd).

		[1]Stations																																			
		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	2	2	2	
		1	1	1	1	1	1	1	1	2	2	2	2	2	2	2	2	3	3	3	3	3	3	3	3	4	4	4	4	4	4	4	4	1	2	3	4	
		P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	C	C	C	C	
		N	N	E	E	S	S	W	W	N	N	E	E	S	S	W	W	N	N	E	E	S	S	W	W	N	N	E	E	S	S	W	W					
		0	2	0	2	0	2	0	2	0	2	0	2	0	2	0	2	0	2	0	2	0	2	0	2	0	2	0	2	0	2	0	2					
		5	0	5	0	5	0	5	0	5	0	5	0	5	0	5	0	5	0	5	0	5	0	5	0	5	0	5	0	5	0	5	0					
		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0					
Taxa		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0					
Cervonema	•												x		x			x		x	x	x		x	x													•
Trachydemus	•			x			x		x												x	x							x			x					x	•
Camacolaimus	•										x		x			x					x		x		x	x										x		•
Lagenammina difflugiformis	•				x													x		x						x			x			x	x					•
Cletodes dissimilis	•																	x	x	x	x	x	x		x													•
Ammoscalaria pseudospiralis	•		x						x									x				x	x		x			x										•
Uvigerina bellula	•				x	x		x	x				x		x																						x	•
Eggerella bradyi	•							x	x									x		x	x			x													x	•
Diosaccidae	•				x				x									x			x	x		x														•
Enchelidiidae	•				x					x	x					x					x				x													•
Tharyx marioni	•			x	x		x		x									x			x																	•
Miliolacea	•																	x						x	x	x		x										•
Enhydrosoma	•									x	x	x				x	x																					•
Amphiascus minutus	•										x									x		x		x														•
Textularia mayori	•														x						x			x		x												•
Harpacticoida	•					x													x	x					x													•
Hydrozoa hydroida anthomedusae	•																				x	x										x					x	•
Cletodidae	•					x	x						x									x																•
Stenhelia longicaudata finmarchica	•																					x					x			x			x					•
Campylaimus	•										x		x				x																x					•
Siphonolaimus	•										x					x							x										x					•

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[1] An *x* indicates occurrence in at least one core per station.

TABLE G3 (Cont'd).

	[1] Stations																																			
	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	2	2	2
	1	1	1	1	1	1	1	1	2	2	2	2	2	2	2	2	3	3	3	3	3	3	3	3	4	4	4	4	4	4	4	4	1	2	3	4
	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	C	C	C	C
	N	N	E	E	S	S	W	W	N	N	E	E	S	S	W	W	N	N	E	E	S	S	W	W	N	N	E	E	S	S	W	W				
	0	2	0	2	0	2	0	2	0	2	0	2	0	2	0	2	0	2	0	2	0	2	0	2	0	2	0	2	0	2	0	2				
	5	0	5	0	5	0	5	0	5	0	5	0	5	0	5	0	5	0	5	0	5	0	5	0	5	0	5	0	5	0	5	0				
	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0				
Taxa	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0				
Enoplidae																	x	x		x		x														
Normanella confluens																		x	x			x				x										
Leptolaimus												x	x			x																	x			
Magelona phyllisae								x	x	x						x																				
Ampharete acutifrons	x									x		x					x																			
Anticoma										x								x						x												
Odontophora																		x					x	x												
Ectinosomidae																	x		x					x												
Mesochra																	x	x						x												
Hydrozoa hydroida leptomedusae							x				x																									x
Leptolaimidae											x												x	x												
Axonolaimus		x									x				x																					
Acartia tonsa				x		x																														
Ameira																					x			x												
Prionospio cirrifera									x												x															
Stenhelia mastigochaeta																			x	x																
Discorbis squamata																				x				x												
Bulimina elegans																			x						x											
Polychaeta										x																	x									
Quinqueloculina compta													x					x																		
Nuculanidae										x												x														

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[1] An *x* indicates occurrence in at least one core per station.

TABLE G3 (Cont'd).

Taxa	Stations[1]																																			
	01PN0500	01PN2000	01PE0500	01PE2000	01PS0500	01PS2000	01PW0500	01PW2000	02PN0500	02PN2000	02PE0500	02PE2000	02PS0500	02PS2000	02PW0500	02PW2000	03PN0500	03PN2000	03PE0500	03PE2000	03PS0500	03PS2000	03PW0500	03PW2000	04PN0500	04PN2000	04PE0500	04PE2000	04PS0500	04PS2000	04PW0500	04PW2000	21C	22C	23C	24C
Corbulidae				x																				x												
Cletodes																	x															x				
Pycnophyes																		x		x																
Ancistrosyllis			x	x																																
Lumbrineris tenuis																								x										x		
Hemicyclops americanus																												x			x					
Textularia earlandi																	x																x			
Leptosomatidae (nematoda)										x	x																									
Nephtys incisa																														x				x		
Paraonis gracilis							x																		x											
Paraprionospio pinnata										x		x																								
Cyclopoida																																		x		x
Photis														x				x																		
Sabellaria vulgaris																					x															
Ciliatea holotrichia																								x												
Metachromadora																																	x			
Acarina	x																																			
Cibicides deprimus													x																							
Pseudobradya hirsuta																				x																
Robertgurneya rostrata																					x															
Quinqueloculina sabulosa																			x																	

[1] An *x* indicates occurrence in at least one core per station.

TABLE G3 (Cont'd).

Taxa		01PN0500	01PN2000	01PE0500	01PE2000	01PS0500	01PS2000	01PW0500	01PW2000	02PN0500	02PN2000	02PE0500	02PE2000	02PS0500	02PS2000	02PW0500	02PW2000	03PN0500	03PN2000	03PE0500	03PE2000	03PS0500	03PS2000	03PW0500	03PW2000	04PN0500	04PN2000	04PE0500	04PE2000	04PS0500	04PS2000	04PW0500	04PW2000	21C	22C	23C	24C	
Frondicularia compressa	•																								x													•
Lagena striata	•																									x												•
Florilus grateloupi	•																					x																•
Prorodon marinus	•																								x													•
Amphimonhystera	•																								x													•
Xyala	•																								x													•
Thalassolaimus	•		x																																			•
Pseudeurythoe ambigua	•																							x														•
Glycera americana	•																				x																	•
Aricidea suecica	•																									x												•
Sabellidae	•																								x													•
Oligochaeta	•												x																									•
Veneridae	•																								x													•
Laophontidae	•																					x																•
Paralaophonte	•										x																											•
Paralaophonte pacifica	•																								x													•
Enhydrosoma longifurcatum	•																										x											•
Enhydrosoma uniarticulatum	•																						x															•
Robertgurneya	•																				x																	•
Saphirella	•										x																											•

[1] An *x* indicates occurrence in at least one core per station.

TABLE G3 (Cont'd).

		[1]Stations																																			
Taxa		01PN0500	01PN2000	01PE0500	01PE2000	01PS0500	01PS2000	01PW0500	01PW2000	02PN0500	02PN2000	02PE0500	02PE2000	02PS0500	02PS2000	02PW0500	02PW2000	03PN0500	03PN2000	03PE0500	03PE2000	03PS0500	03PS2000	03PW0500	03PW2000	04PN0500	04PN2000	04PE0500	04PE2000	04PS0500	04PS2000	04PW0500	04PW2000	21C	22C	23C	24C	
Bolivina spinata	•																	x																				•
Epistominella	•																	x																				•
Coelosomides	•		x																																			•
Corynidae	•					x																																•
Comesoma	•																		x																			•
Pisionidae	•				x																																	•
Nereis	•																		x																			•
Chone	•																	x																				•
Ostracoda	•					x																																•
Loxoconcha	•											x																										•
Cytheromorpha	•																	x																				•
Peltidium	•																																				x	•
Euterpina acutifrons	•						x																															•
Cletodes tenuipes	•																	x																				•
Diarthrodes dissimilis	•																	x																				•
Oncaea venusta	•																																			x		•

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[1] An *x* indicates occurrence in at least one core per station.

TABLE G4. Distribution of macroinfauna taxa by station for Cruise I.

Taxa	Stations[1]																																			
	01PN0500	01PN2000	01PE0500	01PE2000	01PS0500	01PS2000	01PW0500	01PW2000	02PN0500	02PN2000	02PE0500	02PE2000	02PS0500	02PS2000	02PW0500	02PW2000	03PN0500	03PN2000	03PE0500	03PE2000	03PS0500	03PS2000	03PW0500	03PW2000	04PN0500	04PN2000	04PE0500	04PE2000	04PS0500	04PS2000	04PW0500	04PW2000	21C	22C	23C	24C
Paraprionospio pinnata	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
Mediomastus californiensis	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
Rhynchocoela	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
Prionospio cirrifera	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
Tharyx marioni	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
Notomastus latericeus	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
Sigambra tentaculata	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
Tellina versicolor	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	
Cossura delta	x	x	x	x	x	x	x	x	x	x	x	x	x	x		x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
Aricidea suecica	x	x	x	x	x	x	x	x	x		x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x		x	x	x
Nephtys incisa	x	x	x	x	x	x	x	x	x	x	x	x	x		x	x	x	x		x	x	x		x	x	x	x	x	x	x	x	x	x	x	x	x
Nuculana concentrica	x	x	x	x			x	x	x	x	x	x	x	x	x	x	x		x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x		x
Corbula contracta	x	x	x	x	x		x		x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x		x	
Golfingia bulbosa	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x		x			x	x	x	x	x	x		
Diopatra cuprea	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x		x	x	x	x	x	x				x	x	x		x	x	x	x	x	x
Lumbrineris tenuis	x		x	x		x			x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x		x	x	x
Sabatieria	x	x	x	x	x	x	x	x	x	x	x	x	x		x	x	x	x	x	x	x	x	x	x	x	x		x	x	x			x	x	x	
Vitrinella floridana	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x			x	x	x	x	x		x	x		x	x	x	x	x		x	x	x
Abra aequalis	x	x	x		x				x	x	x	x	x	x	x	x	x	x	x	x	x	x	x		x	x	x	x	x	x	x	x	x	x	x	
Nereis	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x			x		x		x		x	x	x	
Magelona phyllisae	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x			x						x	x	x	x
Anaitides erythrophyllus	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x				x	x		x		x	x	x	x	x		x	x	x	
Magelona rosea	x	x	x	x	x			x	x	x	x	x	x	x	x	x	x	x	x		x	x	x	x	x	x	x	x			x			x	x	
Sthenelais boa		x		x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x		x	x	x					x		x	x	x	x	
Brachyura	x		x	x		x	x	x	x		x	x	x	x	x	x	x		x	x	x		x	x	x	x	x	x		x	x	x	x			
Ampelisca abdita	x	x	x	x			x		x	x	x	x	x	x	x	x	x			x		x	x	x	x						x	x	x	x	x	x
Glycera americana	x	x	x	x					x	x	x	x		x	x	x	x	x	x	x	x	x	x	x		x	x			x	x		x	x		
Volvulella texasiana	x	x	x		x	x		x				x	x	x		x				x	x	x	x		x	x	x	x	x	x	x	x		x	x	x
Nereidae	x	x	x		x		x					x	x	x	x			x	x	x	x	x			x	x	x	x	x	x	x	x		x	x	

[1] An *x* indicates occurrence in at least one grab per station.

TABLE G4 (Cont'd).

	Stations[1]																																			
Taxa	01PN0500	01PN2000	01PE0500	01PE2000	01PS0500	01PS2000	01PW0500	01PW2000	02PN0500	02PN2000	02PE0500	02PE2000	02PS0500	02PS2000	02PW0500	02PW2000	03PN0500	03PN2000	03PE0500	03PE2000	03PS0500	03PS2000	03PW0500	03PW2000	04PN0500	04PN2000	04PE0500	04PE2000	04PS0500	04PS2000	04PW0500	04PW2000	21C	22C	23C	24C
Aspidosiphon albus	x	x	x	x		x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x										x	x		
Pinnixa	x	x					x	x	x	x	x	x	x	x	x	x						x	x	x		x	x	x	x	x	x	x		x	x	
Armandia maculata	x		x	x		x	x	x					x	x	x	x				x		x	x	x	x	x	x	x	x	x	x	x		x	x	
Lepidasthenia	x	x	x	x	x	x			x	x	x	x	x	x	x	x		x		x			x		x				x	x			x	x	x	
Dorylaimopsis		x	x	x	x	x			x	x	x	x			x		x	x	x	x	x	x	x	x			x	x				x	x	x		
Ancistrosyllis jonesi	x	x	x	x	x	x	x	x	x	x	x	x	x		x	x	x	x	x	x	x		x	x										x		
Ampharete americana	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x			x	x													x	x	x	
Aricidea fragilis				x							x			x	x	x	x	x	x	x	x	x	x	x	x	x				x	x	x		x	x	x
Ampharete acutifrons	x	x	x	x	x	x	x		x	x	x	x	x	x	x	x	x	x					x										x	x	x	
Oncholaimidae	x	x		x		x	x		x	x	x	x	x		x	x	x	x	x	x	x	x	x										x	x		
Linhomoeidae	x	x	x	x	x	x	x		x	x	x	x	x	x	x		x	x		x	x		x					x						x		
Prionospio cirrobranchiata		x	x	x	x	x		x	x	x			x	x		x	x	x	x	x	x	x	x	x	x									x		
Prionospio cristata		x		x	x		x		x	x	x	x	x		x	x	x	x	x	x	x		x	x					x					x		
Alpheus floridanus	x			x	x	x	x	x									x	x				x	x	x		x	x	x	x	x	x	x		x	x	
Nucula cf. N. proxima									x		x	x	x	x	x	x	x	x	x	x	x		x	x	x	x	x	x						x		
Prionospio pygmaea	x								x	x	x		x	x		x	x	x	x	x	x	x	x	x			x	x					x		x	
Bivalvia			x	x	x		x	x	x		x	x	x		x		x		x	x	x	x			x		x	x			x					
Cosmioconcha calliglypta	x							x	x		x		x		x					x		x	x		x	x	x	x	x	x	x	x			x	x
Automate evermanni						x					x	x	x			x	x	x		x	x	x		x	x	x	x	x	x	x	x	x				
Polynoidae	x	x	x	x	x	x		x	x	x	x		x	x		x			x			x		x	x			x					x			
Phoronis architecta			x			x			x	x	x	x	x	x	x	x		x	x	x	x	x		x									x	x		
Oxyurostylis smithi	x	x		x		x			x	x	x	x	x		x	x	x	x	x	x	x			x										x		
Clymenella torquata calida	x	x	x	x		x	x	x	x	x	x	x	x	x	x	x							x										x	x		
Amphioplus coniortodes	x	x	x	x	x	x	x	x					x	x			x					x			x		x	x	x			x			x	
Amaeana trilobata						x		x			x						x	x	x	x	x		x	x	x	x	x	x	x		x	x				x
Acetes americanus	x	x	x	x	x	x	x	x	x	x	x		x	x	x						x								x				x	x		
Photis macromanus		x							x		x	x	x	x	x	x	x	x	x	x	x		x	x	x									x		
Palythoa texaensis	x	x	x	x		x	x	x	x	x	x	x	x	x	x	x		x															x			
Astropecten duplicatus											x		x	x	x		x	x	x	x	x	x	x	x		x	x	x			x				x	

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[1] An *x* indicates occurrence in at least one grab per station.

TABLE G4 (Cont'd).

	Stations[1]																																			
Taxa	01PN0500	01PN2000	01PE0500	01PE2000	01PS0500	01PS2000	01PW0500	01PW2000	02PN0500	02PN2000	02PE0500	02PE2000	02PS0500	02PS2000	02PW0500	02PW2000	03PN0500	03PN2000	03PE0500	03PE2000	03PS0500	03PS2000	03PW0500	03PW2000	04PN0500	04PN2000	04PE0500	04PE2000	04PS0500	04PS2000	04PW0500	04PW2000	21C	22C	23C	24C
Magelona filiformis		x									x			x			x		x	x		x	x		x	x	x	x	x	x	x	x			x	
Glycinde nordmanni									x	x		x					x	x			x		x	x	x	x	x	x	x	x		x		x	x	
Spiophanes bombyx				x					x	x	x	x	x	x	x	x	x	x			x	x									x		x		x	
Pseudeurythoe ambigua																x	x	x	x	x	x	x	x	x	x	x		x	x		x	x		x		
Chaetozone	x	x		x	x	x		x	x	x	x		x		x					x			x	x				x					x			
Cirrophorus lyriformis													x				x			x		x	x	x	x	x	x	x	x	x	x	x		x	x	
Amphiodia atra			x			x			x	x	x		x	x	x	x		x					x			x	x			x	x		x			
Gyptis vittata									x	x	x	x	x		x	x	x	x	x				x			x			x	x			x	x		
Diplocirrus									x	x	x		x	x					x	x		x	x		x	x		x	x	x	x	x				
Speocarcinus lobatus						x	x	x					x	x			x	x	x	x	x		x		x		x		x			x	x			
Listriella barnardi	x					x	x										x	x	x	x			x	x	x			x		x	x	x		x	x	
Paraonis gracilis			x	x	x	x											x		x	x		x		x	x			x	x	x	x	x				
Chione clenchi				x								x	x	x	x	x	x	x	x	x	x	x	x	x			x									
Clymenella zonalis	x				x				x	x	x	x	x	x		x	x			x			x	x										x	x	
Golfingia trichocephala	x			x					x		x	x	x	x			x	x		x			x								x	x		x		
Monoculodes edwardsi						x			x								x	x	x	x	x		x		x	x			x	x	x			x		
Penaeidae						x		x	x	x			x		x	x		x				x			x					x		x	x	x		
Cerebratulus lacteus	x	x	x	x		x		x		x	x				x	x						x											x	x		x
Terebra dislocata										x	x			x				x	x	x				x		x	x		x			x	x		x	x
Ninoe nigripes				x																		x			x	x	x	x	x	x	x	x		x	x	x
Ceratonereis irritabilis									x		x	x		x	x	x	x		x	x	x		x	x							x					
Ampelisca verrilli																	x	x	x	x	x	x	x		x	x	x		x	x	x					
Bregmaceros atlanticus					x	x	x													x	x	x		x	x		x		x		x	x			x	
Gastropoda			x		x			x	x	x	x		x		x	x				x		x			x				x							
Amphiuridae	x	x	x		x									x	x		x			x					x	x	x			x					x	
Owenia fusiformis									x	x	x	x	x	x	x	x		x	x	x								x								
Euconchoecia chierchiae														x						x	x	x			x	x	x	x		x	x	x			x	
Longipedia helgolandica																	x	x	x	x	x	x	x	x	x			x	x						x	
Sabellidae										x	x		x				x	x	x	x	x	x	x	x	x											

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[1] An *x* indicates occurrence in at least one grab per station.

TABLE G4 (Cont'd).

Taxa	[1] Stations																																			
	01PN0500	01PN2000	01PE0500	01PE2000	01PS0500	01PS2000	01PW0500	01PW2000	02PN0500	02PN2000	02PE0500	02PE2000	02PS0500	02PS2000	02PW0500	02PW2000	03PN0500	03PN2000	03PE0500	03PE2000	03PS0500	03PS2000	03PW0500	03PW2000	04PN0500	04PN2000	04PE0500	04PE2000	04PS0500	04PS2000	04PW0500	04PW2000	21C	22C	23C	24C
Chaetozone setosa					X				X	X	X	X	X				X		X	X				X									X		X	
Anticoma			X						X	X	X		X		X		X	X	X		X		X	X												
Iharyx setigera													X				X	X	X	X	X		X		X	X	X	X					X			
Amphiodia trychna	X		X	X	X	X				X				X				X		X					X			X			X					
Listriella A						X		X												X		X			X	X	X	X	X	X	X	X				
Pectinaria gouldii	X								X	X	X				X	X		X	X	X		X	X										X			
Odostomia										X	X	X	X		X	X	X		X		X							X			X		X			
Chasmocarcinus mississippiensis			X	X		X								X								X			X			X		X	X	X		X	X	
Asychis elongata				X			X			X						X	X	X	X				X		X	X						X		X		
Nereis succinea									X		X		X		X	X			X	X	X	X		X										X		
Paranthus rapiformis							X		X	X	X	X	X	X	X	X																	X	X		
Synchelidium americanum																X	X	X	X	X	X		X	X						X	X				X	
Anthopleura krebsi						X			X	X		X	X	X		X		X			X	X	X													
Cantharus cancellarius							X		X		X	X	X		X	X			X	X								X					X			
Poecilochaetus johnsoni			X	X					X		X		X	X	X	X		X		X	X															
Cibicides concentricus													X				X	X	X	X	X	X	X		X	X										
Polydora						X			X	X	X	X	X	X	X	X																	X			
Polydora socialis		X							X	X	X	X	X	X	X	X								X												
Megalomma bioculata									X	X	X	X	X	X	X	X				X													X			
Cingula																						X			X	X	X	X	X	X	X	X			X	
Eudorella monodon																						X			X	X	X	X	X	X	X	X			X	
Pentamera pulcherrima									X	X	X	X	X	X	X	X		X															X			
Macoma pulleyi							X			X	X		X		X	X		X	X			X													X	
Phanodermatidae									X	X		X	X	X	X	X				X	X										X					
Onuphis nebulosa	X	X	X	X													X	X	X	X														X	X	
Glycinde solitaria									X	X		X	X	X	X	X	X							X					X							
Cirratulus cf. C. hedgpethi		X						X		X			X		X		X		X	X	X												X			
Phascolion strombi											X		X			X			X				X		X		X	X		X	X					
Balanoglossus		X							X	X	X	X	X	X	X	X																				

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[1] An x indicates occurrence in at least one grab per station.

TABLE G4 (Cont'd).

	Stations[1]																																			
Taxa	01PN0500	01PN2000	01PE0500	01PE2000	01PS0500	01PS2000	01PW0500	01PW2000	02PN0500	02PN2000	02PE0500	02PE2000	02PS0500	02PS2000	02PW0500	02PW2000	03PN0500	03PN2000	03PE0500	03PE2000	03PS0500	03PS2000	03PW0500	03PW2000	04PN0500	04PN2000	04PE0500	04PE2000	04PS0500	04PS2000	04PW0500	04PW2000	21C	22C	23C	24C
Mulinia lateralis										x	x	x	x	x	x	x	x									x											
Pentidotea			x						x	x	x	x	x	x	x	x																				
Timarete						x			x			x	x		x		x			x			x										x			
Spiochaetopterus oculatus					x				x	x	x			x	x	x															x	x			
Amphipoda				x					x				x	x	x	x	x										x						x			
Ceriantipatharia ceriantharia									x	x	x	x	x	x	x			x															x			
Ophiodromus obscura										x			x		x			x	x	x					x						x	x				
Lepidonotus sublevis									x			x			x	x	x			x			x		x						x					
Alpheopsis		x				x												x	x			x	x	x			x							x	
Polydora ligni									x		x	x	x	x	x	x																	x			
Arcidae									x	x	x	x	x	x	x	x																				
Raeta plicatella									x	x	x		x	x	x				x	x																
Acteon punctostriatus									x	x	x		x	x	x					x	x															
Sigambra wassi			x		x				x	x	x	x	x																			x			
Agriopoma texasiana							x		x	x		x	x			x	x																	x			
Processa hemphilli									x		x		x		x	x			x											x							x	
Natica pusilla				x				x	x	x					x	x																	x			x
Lyonsia hyalina floridana									x	x	x	x	x	x					x	x																
Cardiomya							x				x		x				x	x	x									x				x			
Naticidae													x		x	x	x				x									x	x							x
Clytia cylindrica									x		x	x	x	x		x																	x			
Eponides antillarum																	x	x	x	x	x		x									x					
Campylaspis																	x	x	x	x	x		x	x												
Teinostoma parvicallum																							x			x	x	x			x	x	x				
Diplodonta soror												x			x		x	x			x									x		x			
Ophiuroidea				x			x		x			x	x				x						x													
Paraonidae				x			x	x																			x	x	x	x						
Goniada teres									x								x	x	x	x	x		x														
Pagurus bonairensis									x	x	x	x			x	x	x																			

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[1] An *x* indicates occurrence in at least one grab per station.

TABLE G4 (Cont'd).

Taxa	01PN0500	01PN2000	01PE0500	01PE2000	01PS0500	01PS2000	01PW0500	01PW2000	02PN0500	02PN2000	02PE0500	02PE2000	02PS0500	02PS2000	02PW0500	02PW2000	03PN0500	03PN2000	03PE0500	03PE2000	03PS0500	03PS2000	03PW0500	03PW2000	04PN0500	04PN2000	04PE0500	04PE2000	04PS0500	04PS2000	04PW0500	04PW2000	21C	22C	23C	24C
Leiolambrus nitidus						x											x											x	x	x				x	x	
Paleanotus heteroseta	x	x	x					x		x					x			x																		
Periploma cf. P. orbicularis		x															x								x	x	x		x		x					
Myrophis punctatus				x		x	x	x											x						x							x				
Ancistrosyllis hartmanae	x						x			x							x				x		x											x		
Petricola pholadiformis									x		x		x	x		x								x												
Chone										x								x	x	x	x			x												
Aglaophamus verrilli									x		x	x	x		x			x																		
Cyclaspis																	x	x	x	x	x		x													
Unciola irrorata											x			x		x		x				x							x							
Nephtys bucera									x		x		x	x	x			x																		
Solen viridis									x	x	x	x		x	x																					
Sarsiella disparalis				x								x					x	x	x	x																
Hemipholas elongata									x		x	x	x	x	x																					
Ampelisca agassizi																		x		x			x						x						x	x
Lenticulina																			x	x	x		x						x		x					
Nephtys magellanica									x	x	x				x			x		x																
Amphioplus		x	x			x												x				x				x										
Sarsiella gettlesoni															x		x	x	x	x											x					
Euceramus praelongus				x					x		x		x		x			x																		
Polinices duplicatus								x		x	x					x			x	x																
Echiura									x		x		x	x		x																				
Barnea truncata									x		x		x	x		x																				
Aspidosiphon cumingii											x							x	x				x	x												
Schistomeringos cf. S. caeca			x			x	x										x					x														
Lembos						x											x		x	x	x															
Aricidea cerruti																										x	x			x	x	x				
Pandora bushiana													x	x					x	x	x															
Trachypenaeus similis											x						x								x					x				x		

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[1] An *x* indicates occurrence in at least one grab per station.

TABLE G4 (Cont'd).

	[1]Stations																																			
Taxa	01PN0500	01PN2000	01PE0500	01PE2000	01PS0500	01PS2000	01PW0500	01PW2000	02PN0500	02PN2000	02PE0500	02PE2000	02PS0500	02PS2000	02PW0500	02PW2000	03PN0500	03PN2000	03PE0500	03PE2000	03PS0500	03PS2000	03PW0500	03PW2000	04PN0500	04PN2000	04PE0500	04PE2000	04PS0500	04PS2000	04PW0500	04PW2000	21C	22C	23C	24C
Portunus									x			x	x		x	x																				
Marphysa sanguinea											x		x				x	x						x												
Edwardsia									x		x		x		x			x																		
Lima locklini																	x			x	x		x	x												
Enoplidae																	x	x	x		x			x												
Leptosomatidae (nematoda)	x					x		x																										x		x
Parametopella texansis									x		x	x	x											x												
Cupuladria biporosa																		x	x	x	x															
Myriowenia californiensis											x	x	x		x																					
Aricidea		x															x	x							x											
Ironidae																	x		x				x	x												
Leptonidae A	x	x									x			x																						
Hexapanopeus angustifrons											x		x		x	x																				
Halectinosoma							x		x		x			x																						
Turbellaria									x				x		x	x																				
Sinum perspectivum										x			x	x		x																				
Laonice cirrata																		x	x			x				x										
Terebellides stroemii																			x	x	x					x										
Choniolaimidae									x		x		x	x																						
Pista cristata	x		x						x									x																		
Linga amiantus										x			x						x	x																
Goneplacidae		x				x													x											x						
Ceratocephale cf. C. loveni											x								x	x	x															
Malacoceros vanderhorsti				x					x																									x	x	
Nassarius acutus									x	x				x		x																				
Harbansus paucichelatus																		x		x	x		x													
Squilla empusa	x						x								x																			x		
Gobioides broussonneti				x																											x	x				x
Drilonereis longa															x												x	x		x						

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[1] An *x* indicates occurrence in at least one grab per station.

TABLE G4 (Cont'd).

Taxa	Stations[1]																																		
	01PN0500	01PN2000	01PE0500	01PE2000	01PS0500	01PS2000	01PW0500	01PW2000	02PN0500	02PN2000	02PE0500	02PE2000	02PS0500	02PS2000	02PW0500	02PW2000	03PN0500	03PN2000	03PE0500	03PE2000	03PS0500	03PS2000	03PW0500	03PW2000	04PN0500	04PN2000	04PE0500	04PE2000	04PS0500	04PS2000	04PW0500	04PW2000	21C	22C	23C	24C
Clymenella			x		x			x							x																					
Strombiformis bilineatus	x									x	x			x																						
Niso aeglees																			x	x	x				x											
Philine sagra											x			x					x		x															
Volvulella persimilis																	x		x				x					x								
Ostracoda																		x			x				x						x					
Cumacea					x						x	x									x															
Neoconger mucronatus				x				x														x				x										
Cupuladria doma																	x	x		x																
Sipuncula				x	x													x																		
Sertulariidae				x	x																															x
Lovenella					x																					x					x					
Ampelisca cristodes																		x		x	x															
Halecium			x	x																									x							
Decapoda (arthropoda)					x															x			x													
Nematoda					x						x			x																						
Loimia medusa									x						x	x																				
Crassinella lunulata																		x		x	x															
Lepidonotus variabilis											x		x		x																					
Spionidae			x															x									x									
Paracaprella tenuis												x			x	x																				
Paguridae										x	x				x																					
Trachypenaeus																								x										x		x
Calliactis tricolor											x				x	x																				
Syllidae									x								x				x															
Goniadidae										x																	x				x					
Pyrunculus caelatus																			x	x					x											
Thyasiridae																		x	x	x																
Verticordia										x		x	x																							

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[1] An *x* indicates occurrence in at least one grab per station.

TABLE G4 (Cont'd).

Taxa	[1] Stations																																			
	01PN0500	01PN2000	01PE0500	01PE2000	01PS0500	01PS2000	01PW0500	01PW2000	02PN0500	02PN2000	02PE0500	02PE2000	02PS0500	02PS2000	02PW0500	02PW2000	03PN0500	03PN2000	03PE0500	03PE2000	03PS0500	03PS2000	03PW0500	03PW2000	04PN0500	04PN2000	04PE0500	04PE2000	04PS0500	04PS2000	04PW0500	04PW2000	21C	22C	23C	24C
Cerapus tubularis								x									x					x														
Bollmannia communis					x																		x			x										
Sphaerolaimidae								x																						x				x		
Marphysa aransensis																	x		x	x																
Vitrinella																						x								x	x					
Dosinia discus											x	x					x																			
Mysidopsis bigelowi					x							x						x																		
Corophiidae																	x	x										x								
Leptochela bermudensis													x										x											x		
Lingula										x									x						x											
Gobionellus boleosoma			x																					x	x											
Bivalvia #2									x						x																					
Grandidierella bonneroides																	x	x																		
Mysidacea					x																							x								
Obelia hyalina	x			x																																
Anomura									x						x																					
Theristus								x														x														
Ericthonius brasiliensis								x															x													
Heteronemertea									x				x																							
Enchelidiidae												x										x														
Aedicira belgicae																								x						x						
Microspio pigmentata																x			x																	
Hydroides protulicola										x							x																			
Amphilochus																	x								x											
Photis B								x								x																				
Schizaster orbignyanus																										x	x									
Metacomesoma														x				x																		
Synelmis albini																					x				x											
Dorvillea caeca																		x															x			

[1] An *x* indicates occurrence in at least one grab per station.

TABLE G4 (Cont'd).

	Stations[1]																																			
Taxa	01PN0500	01PN2000	01PE0500	01PE2000	01PS0500	01PS2000	01PW0500	01PW2000	02PN0500	02PN2000	02PE0500	02PE2000	02PS0500	02PS2000	02PW0500	02PW2000	03PN0500	03PN2000	03PE0500	03PE2000	03PS0500	03PS2000	03PW0500	03PW2000	04PN0500	04PN2000	04PE0500	04PE2000	04PS0500	04PS2000	04PW0500	04PW2000	21C	22C	23C	24C
Schistomeringos rudolphii																					x								x							
Scoloplos rubra																		x			x															
Pista palmata									x							x																				
Vitrinella helicoidea					x		x																													
Oliva sayana	x			x																																
Williamia krebsii													x		x																					
Lucinidae	x																			x																
Apseudes																		x				x														
Pagurus (decapoda)															x	x																				
Stomatopoda	x																								x											
Ammoscalaria pseudospiralis													x							x																
Sphaerolaimus							x																x													
Eunoe									x	x																										
Notomastus hemipodus																		x					x													
Maldanidae																											x		x							
Architectonica nobilis										x							x																			
Strombiformis hemphilli																												x		x						
Muricidae																										x					x					
Varicorbula operculata													x					x																		
Pterygocytheris																				x	x															
Actinocythereis																			x	x																
Balanus																							x									x				
Ampelisca	x												x																							
Sergestidae					x								x																							
Alpheus																			x				x													
Gourretia latispina		x									x																									
Namatopaguroides fagei																		x	x																	
Raninoides louisianensis																						x										x				
Libinia dubia											x		x																							

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[1] An *x* indicates occurrence in at least one grab per station.

TABLE G4 (Cont'd).

Taxa	01PN0500	01PN2000	01PE0500	01PE2000	01PS0500	01PS2000	01PW0500	01PW2000	02PN0500	02PN2000	02PE0500	02PE2000	02PS0500	02PS2000	02PW0500	02PW2000	03PN0500	03PN2000	03PE0500	03PE2000	03PS0500	03PS2000	03PW0500	03PW2000	04PN0500	04PN2000	04PE0500	04PE2000	04PS0500	04PS2000	04PW0500	04PW2000	21C	22C	23C	24C
Xanthidae									x		x																									
Goneplax											x							x																		
Frevillea barbata											x						x																			
Urechis														x									x													
Holothuroidea			x																				x													
Polychaeta																								x												
Discoporella umbellata																		x																		
Aeverrillia													x																							
Halecium nanum																									x											
Sertularia																													x							
Gymnolaemata											x																									
Xenanthura brevitelson																		x																		
Bugula																									x											
Ampelisca neopolitanus																		x																		
Epistylidae																					x															
Ciliatea peritrichia peritrichida																					x															
Halecium bermudense				x																																
Capitella capitata															x																					
Nassarius															x																					
Mysidopsis furca																			x																	
Glyptoplax smithii																		x																		
Cheilostomata																									x											
Ancistrosyllis papillosa															x																					
Scolelepis squamata																		x																		
Cyrtopleura costata									x																											
Sarsiella (ostracoda)																				x																
Squilla surinamica		x																																		
Quinqueloculina compta																																			x	
Anaitides mucosa															x																					

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[1] An *x* indicates occurrence in at least one grab per station.

TABLE G4 (Cont'd).

	Stations[1]																																			
Taxa	01PN0500	01PN2000	01PE0500	01PE2000	01PS0500	01PS2000	01PW0500	01PW2000	02PN0500	02PN2000	02PE0500	02PE2000	02PS0500	02PS2000	02PW0500	02PW2000	03PN0500	03PN2000	03PE0500	03PF2000	03PS0500	03PS2000	03PW0500	03PW2000	04PN0500	04PN2000	04PE0500	04PE2000	04PS0500	04PS2000	04PW0500	04PW2000	21C	22C	23C	24C
Nereis falsa																		x																		
Nereidae B		x																																		
Dorvilleidae																				x																
Boccardia														x																						
Chaetopterus variopedatus															x																					
Fabrisabella																														x						
Atrina seminuda										x																										
Jouannetia quillingi																								x												
Asteropella																	x																			
Echinocythereis garretti																																			x	
Lembos smithi																			x																	
Hippomedon																																			x	
Processa																					x															
Porcellana											x																									
Parapinnixa hendersoni																		x																		
Pterobranchia		x																																		
Saurida brasiliensis																																			x	
Buliminella morgani																		x																		
Rosalina floridana																		x																		
Nonionella basiloba																							x													
Ciliatea holotrichia																			x																	
gymnostomatida rhabdophorina																								x												
Anthozoa																		x																		
Zoantharia actiniaria																			x																	
Odontophora																					x															
Desmodoridae																	x																			
Cyatholaimidae	x																																			
Oxystominidae																		x																		
Eteone heteropoda																																				

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[1] An *x* indicates occurrence in at least one grab per station.

TABLE G4 (Cont'd).

Taxa	01PN0500	01PN2000	01PE0500	01PE2000	01PS0500	01PS2000	01PW0500	01PW2000	02PN0500	02PN2000	02PE0500	02PE2000	02PS0500	02PS2000	02PW0500	02PW2000	03PN0500	03PN2000	03PE0500	03PE2000	03PS0500	03PS2000	03PW0500	03PW2000	04PN0500	04PN2000	04PE0500	04PE2000	04PS0500	04PS2000	04PW0500	04PW2000	21C	22C	23C	24C
Hesionidae																			x																	
Parandalia ocularis																						x														
Naineris laevigata																										x										
Spio pettiboneae	x																																			
Boccardia hamata													x																							
Armandia agilis																											x									
Sabellaria vulgaris																x																				
Ampharetidae																		x																		
Melinna maculata												x																								
Eupolymnia crassicornis													x																							
Polycirrus eximius																															x					
Loimia viridis											x																									
Terebella rubra											x																									
Chone duneri															x																					
Grubeulepis																		x																		
Polygordius appendiculatus									x																											
Calliostoma																	x																			
Alvania																			x																	
Teinostoma biscaynense												x																								
Atlanta peronii											x																									
Cymatiidae																										x										
Cymatium	x																																			
Turridae																			x																	
Kurtziella																													x							
Turbonilla																									x											
Acteocina candei																					x															
Cylichnella bidentata										x																										
Philine													x																							
Volvulella recta																											x									

[1] An *x* indicates occurrence in at least one grab per station.

TABLE G4 (Cont'd).

Taxa	Stations[1]																																			
	01PN0500	01PN2000	01PE0500	01PE2000	01PS0500	01PS2000	01PW0500	01PW2000	02PN0500	02PN2000	02PE0500	02PE2000	02PS0500	02PS2000	02PW0500	02PW2000	03PN0500	03PN2000	03PE0500	03PE2000	03PS0500	03PS2000	03PW0500	03PW2000	04PN0500	04PN2000	04PE0500	04PE2000	04PS0500	04PS2000	04PW0500	04PW2000	21C	22C	23C	24C
Planorbidae									x																											
Nuculana acuta																							x													
Anadara transversa																									x											
Anadara ovalis															x																					
Dacrydium																				x																
Planktomya henseni																																				x
Cardiidae															x																					
Macoma	x																																			
Tellina	x																																			
Chione A																x																				
Bivalvia anomalodesmata									x																											
Thraciidae															x																					
Protocytheretta daniana																				x																
Microsetella norvegica																				x																
Pseudobradya																	x																			
Promysis atlantica						x																														
Lamprops quadriplicata												x																								
Isopoda																																x				
Flabellifera (isopoda)																																			x	
Idoteidae																		x																		
Edotea																								x												
Probopyrus																		x																		
Corophium																x																				
Corophium acherusicum									x																											
Stenothoe																								x												
Penaeus aztecus aztecus													x																							
Caridea																													x							
Leptochela (decapoda)																		x																		
Automate cf. A. rectifrons																		x																		

[1] An x indicates occurrence in at least one grab per station.

TABLE G4 (Cont'd).

Taxa	Stations[1]																																			
	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	2	2	2
	1	1	1	1	1	1	1	1	2	2	2	2	2	2	2	2	3	3	3	3	3	3	3	3	4	4	4	4	4	4	4	4	1	2	3	4
	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	C	C	C	C
	N	N	E	E	S	S	W	W	N	N	E	E	S	S	W	W	N	N	E	E	S	S	W	W	N	N	E	E	S	S	W	W				
	0	2	0	2	0	2	0	2	0	2	0	2	0	2	0	2	0	2	0	2	0	2	0	2	0	2	0	2	0	2	0	2				
	5	0	5	0	5	0	5	0	5	0	5	0	5	0	5	0	5	0	5	0	5	0	5	0	5	0	5	0	5	0	5	0				
	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0				
	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0				
Callianassa biformis											x																									
Pagurus pollicaris															x																					
Hepatus epheliticus													x																							
Persephona crinita													x																							
Portunus gibbesii											x																									
Parapinnixa																		x																		
Squilla																x																				
Golfingia pellucida														x																						
Aspidosiphon spinalis																x																				
Echiuridae																								x												
Ectoprocta											x																									
Asteroidea					x																															
Ophiactis savignyi																					x															
Paraphyllophorus parvus									x																											
Clupeidae																	x																			
Synodontidae																																			x	
Antennarius radiosus																		x																		
Gobiidae																															x					
Symphurus															x																					

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[1] An *x* indicates occurrence in at least one grab per station.

TABLE G5. Distribution of macroinfauna taxa by station for Cruise II.

Taxa	Stations[1]																																																																			
	01PN0500	01PN2000	01PE0500	01PE2000	01PS0500	01PS2000	01PW0500	01PW2000	02PN0500	02PN2000	02PE0500	02PE2000	02PS0500	02PS2000	02PW0500	02PW2000	03PN0500	03PN2000	03PE0500	03PE2000	03PS0500	03PS2000	03PW0500	03PW2000	04PN0500	04PN2000	04PE0500	04PE2000	04PS0500	04PS2000	04PW0500	04PW2000	05SN0500	05SN2000	06SN0500	06SN2000	07SN0500	07SN2000	08SN0500	08SN2000	09SN0500	09SN2000	10SN0500	10SN2000	11SN0500	11SN2000	12SN0500	12SN2000	13SN0500	13SN2000	14SN0500	14SN2000	15SN0500	15SN2000	16SN0500	16SN2000	17SN0500	17SN2000	18SN0500	18SN2000	19SN0500	19SN2000	20SN0500	20SN2000	21C	22C	23C	24C
Paraprionospio pinnata	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x		x	x	x	x	x	x	x		x	x	x
Rhynchocoela	x	x	x	x	x	x	x	x	x		x				x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x		x		x	x		x	x	x	x	x	x	x	x	x	x	x	x	x	x	x		x	x	x
Sigambra tentaculata	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x		x	x	x	x	x	x	x		x		x	x		x	x			x	x		x	x	x	x	x	x			x		x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
Magelona phyllisae	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x		x	x	x	x		x	x	x	x	x	x					x	x	x		x	x	x	x	x	x							x	x	x		x	x	x	x	x	x	x	x	x	x
Cossura delta	x	x			x		x								x		x		x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x		x	x	x	x	x	x	x	x	x	x	x	x	x				x		x	x	x
Nephtys incisa	x	x	x	x	x	x	x	x			x				x			x	x			x	x	x	x	x	x	x	x	x	x	x			x	x	x	x	x	x	x	x						x	x	x	x	x	x	x	x	x	x	x	x	x	x					x	x	x
Lumbrineris tenuis							x			x	x	x		x	x		x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x					x	x	x		x	x		x		x	x	x			x	x	x	x	x	x	x	x	x	x			x	x		x	x	x
Golfingia bulbosa	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x		x					x	x	x	x						x		x	x	x	x	x		x			x	x					x			x				x		x	x	x
Corbula contracta	x		x	x		x	x	x	x	x				x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x				x		x	x	x		x							x	x	x	x	x	x	x	x		x	x							x	x
Tharyx marioni	x	x				x								x			x	x	x	x	x		x	x	x	x	x	x	x	x	x		x	x	x				x		x	x	x	x	x	x	x	x	x		x	x	x	x	x	x	x			x	x		x			x	x	
Notomastus latericeus	x	x	x			x	x	x							x		x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x		x					x	x	x				x			x			x	x	x	x	x	x	x	x	x	x	x	x					x	
Diopatra cuprea	x	x	x	x	x	x	x	x	x	x	x	x				x	x		x		x	x	x	x	x			x					x	x	x	x			x									x	x	x	x	x	x			x	x			x	x	x		x	x	x	x		x
Nereis	x		x	x	x	x	x	x		x	x	x	x	x	x		x	x	x	x	x	x	x	x	x	x		x	x				x	x					x	x	x	x									x	x			x	x			x	x	x	x	x	x				
Ninoe nigripes						x								x		x		x			x	x	x	x	x	x	x	x	x	x	x			x	x	x	x	x	x	x	x						x	x	x	x	x		x	x	x	x	x	x	x	x						x	x	x
Volvulella texasiana	x		x	x		x	x	x									x	x	x	x	x	x		x	x	x	x	x	x	x	x	x							x	x	x	x			x		x	x			x	x			x	x			x	x			x				x	x
Nuculana concentrica	x	x	x	x	x	x	x	x							x		x	x	x	x	x			x	x	x	x	x	x	x	x						x	x	x							x	x			x					x			x	x			x		x		x	x
Vitrinella floridana	x	x		x		x	x	x							x						x	x	x	x	x		x		x	x		x						x	x				x		x	x	x			x	x				x			x	x	x		x	x	x	x	x	x
Amphioplus coniortodes	x	x	x	x	x	x	x	x	x		x			x					x				x	x	x	x	x	x	x	x								x			x		x		x	x			x	x				x		x	x	x			x	x			x	
Mediomastus californiensis	x	x				x	x	x		x							x		x	x	x	x	x	x	x	x	x	x	x				x	x			x	x	x			x		x				x								x	x										x	x
Prionospio cirrifera																	x		x	x	x	x	x	x	x	x			x	x				x		x	x	x					x		x	x					x		x	x	x	x	x	x	x	x		x					x	x
Ancistrosyllis jonesi	x	x		x		x	x	x	x	x	x	x	x	x	x	x	x										x					x	x					x	x	x		x	x	x	x	x	x																		x		x
Aricidea suecica																	x	x	x	x	x	x	x	x	x	x	x		x	x							x							x	x	x	x	x	x					x			x	x	x	x		x						x	x	
Pseudeurythoe ambigua					x												x	x	x	x	x	x	x	x	x		x			x			x			x		x			x	x			x		x			x			x			x	x			x	x	x				x		
Magelona rosea			x	x	x		x								x		x	x	x		x	x	x	x	x		x		x										x					x		x						x	x	x	x	x	x	x				x			x		
Aspidosiphon albus	x	x		x					x	x	x	x		x	x	x	x	x	x	x			x	x																			x	x	x	x	x	x			x								x				x			x		
Bivalvia			x					x		x						x	x	x	x	x	x	x	x	x	x	x	x	x	x	x										x							x			x			x			x		x	x						x	
Asychis elongata		x									x	x		x			x		x	x				x	x	x	x				x								x				x			x	x			x	x					x	x	x			x	x		x	x	
Magelona filiformis			x																x		x	x		x	x	x	x	x	x	x	x	x					x	x				x									x	x			x			x	x	x				x		x	x	
Cirrophorus lyriformis											x				x		x		x	x				x	x	x	x	x	x	x														x	x	x	x				x	x				x			x	x				x			x	x
Brachyura									x			x					x		x	x	x		x	x	x		x	x	x		x	x			x	x			x	x														x					x		x										x
Sabatieria	x																x		x	x	x			x							x		x												x	x	x	x					x		x			x			x	x			x	x		x		x
Cingula															x						x			x	x	x	x	x	x	x	x				x		x			x	x									x	x	x		x	x	x											x	
Ampharete acutifrons	x	x	x	x		x		x									x	x	x	x	x		x	x													x		x									x	x								x							x	x		x		
Armandia maculata							x		x		x		x		x	x							x	x			x	x	x	x					x			x																x	x	x	x	x	x									x
Ampelisca abdita				x										x		x		x	x	x		x		x	x	x		x		x		x			x																			x	x	x			x			x	x						x	x
Cosmioconcha calliglypta				x	x												x				x				x	x		x	x					x	x	x												x		x		x		x	x		x		x	x						x	x
Automate evermanni							x	x	x								x			x		x		x	x	x	x			x	x	x			x			x																	x	x	x	x	x				x					
Glycera americana				x													x	x	x	x	x		x	x	x				x		x						x															x	x	x			x	x		x	x				x	
Tellina versicolor	x		x	x													x	x	x	x	x		x	x	x	x			x																								x			x					x	x	x	x						
Terebra dislocata		x	x			x	x		x	x					x			x					x		x	x		x			x	x								x										x						x												x	x
Nucula cf. N. proxima				x					x	x	x			x		x	x	x	x	x	x			x		x			x																	x										x		x	x								
Abra aequalis									x		x		x	x	x						x	x				x	x	x		x		x										x															x	x	x	x	x									
Speocarcinus lobatus						x											x		x	x	x		x	x	x	x	x		x	x							x	x	x													x					x						x				
Aricidea fragilis																	x	x	x	x	x			x							x											x				x						x		x		x		x			x			x		x	x	x
Pinnixa		x					x														x			x	x	x		x	x	x	x				x		x	x													x	x							x	x								x	
Gastropoda	x			x				x						x	x			x			x	x							x		x								x				x					x		x								x	x									x	x								

[1] An x indicates occurrence in at least one grab per station.

TABLE G5 (Cont'd).

	Stations[1]																																																																		
Taxa	01PN0500	01PN2000	01PE0500	01PE2000	01PS0500	01PS2000	01PW0500	01PW2000	02PN0500	02PN2000	02PE0500	02PE2000	02PS0500	02PS2000	02PW0500	02PW2000	03PN0500	03PN2000	03PE0500	03PE2000	03PS0500	03PS2000	03PW0500	03PW2000	04PN0500	04PN2000	04PE0500	04PE2000	04PS0500	04PS2000	04PW0500	04PW2000	05SN0500	05SN2000	06SN0500	06SN2000	07SN0500	07SN2000	08SN0500	08SN2000	09SN0500	09SN2000	10SN0500	10SN2000	11SN0500	11SN2000	12SN0500	12SN2000	13SN0500	13SN2000	14SN0500	14SN2000	15SN0500	15SN2000	16SN0500	16SN2000	17SN0500	17SN2000	18SN0500	18SN2000	19SN0500	19SN2000	20SN0500	20SN2000	21C	22C	23C	24C
Nereidae						x				x	x											x			x	x	x			x	x																					x	x			x	x	x	x	x	x								
Prionospio cirrobranchiata				x														x		x	x	x	x	x	x	x		x		x		x																	x			x			x								x								
Ampelisca agassizi															x			x	x	x				x	x	x		x			x	x																			x	x				x			x	x								x	
Agriopoma texasiana																			x	x		x		x	x	x	x	x					x																				x		x						x	x			x	x				x
Amphiodia atra																	x	x						x	x	x		x	x	x		x					x					x									x							x	x	x					x
Glycinde nordmanni				x		x													x	x			x	x	x	x			x		x	x								x															x	x	x	x										
Phoronis architecta									x	x	x	x	x	x	x		x	x	x															x	x	x													x																					
Clymenella torquata calida	x	x		x		x		x								x	x						x																												x	x							x	x			x	x				
Onuphis nebulosa			x	x														x		x	x	x	x	x																												x	x	x	x				x		x								
Paraonis gracilis																								x		x		x	x	x		x										x									x		x	x	x	x	x		x									
Alpheus floridanus																				x	x		x		x	x	x		x	x	x					x	x																	x							x												x
Chasmocarcinus mississippiensis				x			x																x				x	x		x									x												x	x		x	x		x	x		x									
Ceratonereis irritabilis				x													x	x	x	x	x		x	x	x	x						x																											x			x					
Dorylaimopsis																			x		x			x									x	x											x	x	x						x	x								x			x	x				
Lepidasthenia							x		x							x	x					x													x													x			x										x	x	x		x				x
Anthopleura krebsi										x							x	x	x						x		x				x							x																x	x					x	x					x	
Gyptis vittata									x		x										x				x				x				x	x									x		x	x						x												x	x				
Tharyx setigera																	x	x	x	x	x		x	x	x	x			x	x																											x										
Nereis succinea									x	x	x		x				x			x	x		x	x																					x							x																x
Natica pusilla		x							x	x	x				x	x		x																																												x		x	x					x
Lingula																		x	x				x			x																											x		x	x		x			x					x			x	
Paranthus rapiformis									x	x	x				x	x				x													x	x	x								x																												
Eudorella monodon																									x		x	x		x	x					x			x																			x	x											x	
Cerebratulus lacteus	x	x			x	x									x						x	x					x					x							x																																	
Astropecten duplicatus																		x	x	x			x	x	x	x			x	x																																						x	
Apseudes																		x																		x	x	x			x	x															x	x											x	
Paraonidae																												x		x											x									x	x			x	x		x		x								
Polinices duplicatus										x																x						x			x					x										x				x						x						x	
Sthenelais boa																		x								x			x			x																								x			x	x		x								x
Sigambra wassi		x			x					x	x	x																				x	x											x																						x			
Cantharus cancellarius						x	x		x						x	x		x																						x						x																x							
Ampelisca verrilli																	x	x	x	x			x																												x		x					x										
Cirratulus cf. C. hedgpethi																			x	x		x																										x			x										x	x	x						
Acetes americanus				x				x										x		x																	x											x																				x				x
Owenia fusiformis																x		x	x				x																																								x	x		x				
Varicorbula operculata																		x	x	x	x			x																										x								x												
Clymenella zonalis																					x																					x					x					x							x	x	x								
Decapoda (arthropoda)		x									x				x			x								x																	x																	x									
Nassarius acutus	x			x					x	x																										x																														x	x						
Lenticulina																										x				x											x	x											x	x				x										
Acteon punctostriatus	x																x		x																																								x		x	x									x
Prionospio cristata																	x		x	x	x		x	x													x																															
Anachis obesa										x	x								x				x								x		x																															x						
Polynoidae					x																	x			x															x																					x				x	x					
Chione clenchi																		x	x		x		x	x		x					x																																								
Glycinde solitaria							x											x	x	x	x															x																																			x	

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TABLE G5 (Cont'd).

	Stations[1]																																																																		
Taxa	01PN0500	01PN2000	01PE0500	01PE2000	01PS0500	01PS2000	01PW0500	01PW2000	02PN0500	02PN2000	02PE0500	02PE2000	02PS0500	02PS2000	02PW0500	02PW2000	03PN0500	03PN2000	03PE0500	03PE2000	03PS0500	03PS2000	03PW0500	03PW2000	04PN0500	04PN2000	04PE0500	04PE2000	04PS0500	04PS2000	04PW0500	04PW2000	05SN0500	05SN2000	06SN0500	06SN2000	07SN0500	07SN2000	08SN0500	08SN2000	09SN0500	09SN2000	10SN0500	10SN2000	11SN0500	11SN2000	12SN0500	12SN2000	13SN0500	13SN2000	14SN0500	14SN2000	15SN0500	15SN2000	16SN0500	16SN2000	17SN0500	17SN2000	18SN0500	18SN2000	19SN0500	19SN2000	20SN0500	20SN2000	21C	22C	23C	24C
Listriella barnardi																									x		x			x	x				x		x																															x	
Penaeidae															x										x		x																																			x			x			x	x
Linhomoeidae																					x																						x	x	x	x																		x					
Aglaophamus verrilli										x							x	x																																												x	x	x					
Balanoglossus											x			x																			x	x																												x	x						
Prionospio pygmaea																						x		x					x																													x			x		x					
Zoantharia actiniaria									x		x				x	x														x																		x																				
Ophiuroidea				x								x							x					x																		x																		x								
Amphipoda																						x	x						x		x											x												x														
Phascolion strombi																							x		x			x																x									x											x					
Anaitides erythrophyllus																							x							x								x															x			x	x										
Sinum perspectivum																							x						x									x			x																		x		x							
Hemipholas elongata																																																											x	x	x	x						x
Lyonsia hyalina floridana																		x	x		x		x				x																																									
Peracarida isopoda anthuridea																		x								x																									x	x								x								
Portunus											x		x							x																																									x	x						
Ophiodromus obscura																								x																x													x						x		x								
Marphysa sanguinea													x													x																				x							x						x										
Anticoma																	x		x		x																							x		x																						
Clymenella		x		x			x																																						x														x								
Macoma pulleyi																									x												x			x														x		x												
Processa hemphilli													x				x																																									x	x	x								
Cupuladria doma																		x	x	x	x																																															
Golfingia trichocephala																		x				x																							x																					x		
Photis macromanus																		x	x	x			x																																													
Paralacydonia																																																					x	x			x	x										
Palythoa texaensis											x							x																																											x	x						
Spiophanes bombyx																		x											x																							x				x												
Terebellides stroemii																		x																																								x	x	x								
Chaetozone																		x	x					x	x																																											
Arcidae																x		x				x																													x																	
Marphysa belli																																									x	x						x									x											
Nephtys bucera																		x	x	x	x																																															
Ceratocephale cf. C. loveni																	x	x																								x															x											
Sternaspis scutata																											x		x																								x	x														
Maldanidae										x						x		x																																													x					
Amaeana trilobata																				x					x																												x	x														
Thyasira pygmaea																																									x												x	x			x											
Bregmaceros atlanticus																																									x	x										x						x										
Drilonereis longa																										x	x					x																																			x	
Ampharete americana																		x		x			x	x																																												
Acteon			x			x	x																																																					x							
Gourretia latispina																																																					x	x			x						x					
Leiolambrus nitidus				x				x																							x				x																																	
Oncholaimidae																			x	x																							x		x																						
Bothidae													x				x																															x									x										

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TABLE G5 (Cont'd).

	[1] Stations																																																																				
Taxa	01PN0500	01PN2000	01PE0500	01PE2000	01PS0500	01PS2000	01PW0500	01PW2000	02PN0500	02PN2000	02PE0500	02PE2000	02PS0500	02PS2000	02PW0500	02PW2000	03PN0500	03PN2000	03PE0500	03PE2000	03PS0500	03PS2000	03PW0500	03PW2000	04PN0500	04PN2000	04PE0500	04PE2000	04PS0500	04PS2000	04PW0500	04PW2000	05SN0500	05SN2000	06SN0500	06SN2000	07SN0500	07SN2000	08SN0500	08SN2000	09SN0500	09SN2000	10SN0500	10SN2000	11SN0500	11SN2000	12SN0500	12SN2000	13SN0500	13SN2000	14SN0500	14SN2000	15SN0500	15SN2000	16SN0500	16SN2000	17SN0500	17SN2000	18SN0500	18SN2000	19SN0500	19SN2000	20SN0500	20SN2000	21C	22C	23C	24C
Myriowenia californiensis											x	x			x																																																					
Petricola pholadiformis									x	x						x																																																				
Megalomma bioculata																		x		x			x																																													
Oliva sayana																		x																																												x	x							
Mulinia lateralis																																		x																										x	x							
Ostracoda																								x																				x								x															
Nodosaria fusta																																																					x	x				x										
Cibicides concentricus																		x							x																					x																							
Syllidae																			x							x		x																																								
Chone																	x	x	x																																																	
Diplodonta soror										x								x																																																	x	
Golfingia pellucida											x																																											x	x														
Cerebratulus luridus								x																																x											x																
Stomatopoda																			x																			x																x												
Schizaster orbignyanus																											x	x																															x								
Osteichthyes																														x																														x	x							
Anthozoa																x																x																	x																	
Edwardsia													x																																	x																				x
Nematoda																					x												x											x																						
Enchelidiidae																	x							x																																						x					
Polyodontes lupina																				x																																							x			x					
Nephtys magellanica																		x		x																																										x					
Diplocirrus																														x	x																												x								
Cavolina longirostris																		x								x																							x																	
Cyclaspis varians																							x		x					x																																						
Monoculodes edwardsi																					x																																					x							x	
Squilla		x															x							x																																											
Neoconger mucronatus																																																				x			x										x	
Symphurus																	x																											x			x																				
Acanthohaustorius cf. A. millsi																																																													x	x							
Sipuncula		x											x																																																						
Lenticulina calcar																																																						x			x											
Lenticulina bowdensis																																																					x	x														
Pentamera pulcherrima																		x												x																																						
Lenticulina iota																																																					x	x														
Strombiformis bilineatus																																																											x	x								
Dispio uncinata																																																													x	x							
Eucratodes agassizi																																																									x	x										
Pista cristata																		x																																	x																	
Sabellidae																		x										x																																								
Philine sagra																		x			x																																															
Leptonidae B																																																					x				x											
Scoloplos rubra																																																													x	x							
Turbonilla cf. T. portoricana																																																			x	x																
Pyrunculus caelatus																		x																																	x																	
Atrina seminuda											x					x																																																				

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[1] An x indicates occurrence in at least one grab per station.

TABLE G5 (Cont'd).

	[1] Stations																																																																		
Taxa	01PN0500	01PN2000	01PE0500	01PE2000	01PS0500	01PS2000	01PW0500	01PW2000	02PN0500	02PN2000	02PE0500	02PE2000	02PS0500	02PS2000	02PW0500	02PW2000	03PN0500	03PN2000	03PE0500	03PE2000	03PS0500	03PS2000	03PW0500	03PW2000	04PN0500	04PN2000	04PE0500	04PE2000	04PS0500	04PS2000	04PW0500	04PW2000	05SN0500	05SN2000	06SN0500	06SN2000	07SN0500	07SN2000	08SN0500	08SN2000	09SN0500	09SN2000	10SN0500	10SN2000	11SN0500	11SN2000	12SN0500	12SN2000	13SN0500	13SN2000	14SN0500	14SN2000	15SN0500	15SN2000	16SN0500	16SN2000	17SN0500	17SN2000	18SN0500	18SN2000	19SN0500	19SN2000	20SN0500	20SN2000	21C	22C	23C	24C
Ogyrides limicola											x																																																			x						
Amphiuridae				x														x																																																			
Grubeulepis																			x																																										x							
Parvilucina multilineata																		x																																											x							
Ampelisca																																																						x												x	
Synchelidium americanum																							x																																												x	
Stenothoe																		x																															x																			
Leptosomatidae (nematoda)																																																					x							x								
Anaitides mucosa																		x																																												x						
Goniadidae						x																									x																																					
Polydora																x																													x																							
Poecilochaetus johnsoni																																																					x					x										
Pectinaria gouldii																		x					x																																													
Niso aeglees																										x																																									x	
Atlanta peronii																											x															x																										
Turridae B																																										x														x										
Leptonidae A				x																																																										x						
Mercenaria mercenaria texana											x																																																				x					
Ericthonius brasiliensis																	x					x																																														
Hippomedon																																x																			x																	
Trachypenaeus similis											x																										x																															
Albunea																																																													x							
Aspidosiphon cumingii																																											x	x																								
Cupuladria biporosa																		x																																																		
Lovenella grandis																																																													x							
Halecium	x																																																																			
Echiura																x																																																				
Corynidae																																																								x												
Nodosaria albatrossi																																																						x														
Nereis falsa																							x																																													
Branchiostoma caribaeum																																																														x						
Leptosynapta multipora																																																																				x
Linga amiantus																		x																																																		
Goniada teres																		x																																																		
Chaetozone setosa																				x																																																
Cymatiidae							x																																																													
Unciola irrorata																																																						x														
Pseudohaustorius americanus																																																														x						
Discoporella doma																												x																																								
Theristus																																														x																						
Corophiidae																					x																																															
Terschellingia																																														x																						
Cyatholaimidae																																														x																						
Paleanotus																																																													x							
Orbiniidae																																																						x														
Haploscoloplos fragilis																																																													x							

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[1] An *x* indicates occurrence in at least one grab per station.

TABLE G5 (Cont'd).

	Stations[1]																															
Taxa	01PN0500	01PN2000	01PE0500	01PE2000	01PS0500	01PS2000	01PW0500	01PW2000	02PN0500	02PN2000	02PE0500	02PE2000	02PS0500	02PS2000	02PW0500	02PW2000	03PN0500	03PN2000	03PE0500	03PE2000	03PS0500	03PS2000	03PW0500	03PW2000	04PN0500	04PN2000	04PE0500	04PE2000	04PS0500	04PS2000	04PW0500	04PW2000
Chaetopterus variopedatus														x																		
Lasaeidae																																
Crassinella lunulata																		x														
Cypridinidae B																																
Longipedia helgolandica											x																					
Eriopisa incisa																																
Pseudomedeus agassizi																													x			
Brachiopoda																		x														
Marginulinopsis marginulinoides																																
Eponides antillarum																																
Pullenia bulloides																																
Lovenella																																
Pennatulidae								x																								
Turbellaria																		x														
Paracomesoma																				x												
Choniolaimidae		x																														
Phanodermatidae																																
Enoplidae																																
Polychaeta																																
Paleanotus heteroseta																																
Phyllodocidae																																
Parandalia ocularis																														x		
Sphaerodoropsis																																
Onuphis eremita																																
Eunicidae	x																															
Schistomeringos rudolphii																																
Schistomeringos cf. S. caeca																													x			
Scoloplos fragilis																																
Aricidea																																
Spionidae																																
Microspio pigmentata																		x														
Spiochaetopterus oculatus														x																		
Cirratulus																														x		
Cossura								x																								
Pista palmata																																
Sabella microphthalma																					x											
Teinostoma biscaynense																										x						
Nassarina glypta																		x														
Polystira albida																																
Turridae C																		x														
Udostomia C																															x	
Turbonilla B																															x	
Acteon candens	x																															
Volvulella persimilis																		x														
Yoldia solenoides																																
Anadara transversa										x																						

	Stations[1]																																			
Taxa	05SN0500	05SN2000	06SN0500	06SN2000	07SN0500	07SN2000	08SN0500	08SN2000	09SN0500	09SN2000	10SN0500	10SN2000	11SN0500	11SN2000	12SN0500	12SN2000	13SN0500	13SN2000	14SN0500	14SN2000	15SN0500	15SN2000	16SN0500	16SN2000	17SN0500	17SN2000	18SN0500	18SN2000	19SN0500	19SN2000	20SN0500	20SN2000	21C	22C	23C	24C
Chaetopterus variopedatus																																				
Lasaeidae										x																										
Crassinella lunulata																																				
Cypridinidae B																						x														
Longipedia helgolandica																																				
Eriopisa incisa									x																											
Pseudomedeus agassizi																																				
Brachiopoda																																				
Marginulinopsis marginulinoides																					x															
Eponides antillarum																					x															
Pullenia bulloides									x																											
Lovenella								x																												
Pennatulidae																																				
Turbellaria																																				
Paracomesoma																																				
Choniolaimidae																																				
Phanodermatidae																									x											
Enoplidae																					x															
Polychaeta													x																							
Paleanotus heteroseta													x																							
Phyllodocidae												x																								
Parandalia ocularis																																				
Sphaerodoropsis																						x														
Onuphis eremita																													x							
Eunicidae																																				
Schistomeringos rudolphii																															x					
Schistomeringos cf. S. caeca																																				
Scoloplos fragilis																													x							
Aricidea												x																								
Spionidae																										x										
Microspio pigmentata																																				
Spiochaetopterus oculatus																																				
Cirratulus																																				
Cossura																																				
Pista palmata																														x						
Sabella microphthalma																																				
Teinostoma biscaynense																																				
Nassarina glypta																																				
Polystira albida									x																											
Turridae C																																				
Udostomia C																																				
Turbonilla B																																				
Acteon candens																																				
Volvulella persimilis																																				
Yoldia solenoides																					x															
Anadara transversa																																				

[1] An x indicates occurrence in at least one grab per station.

TABLE G5 (Cont'd).

	Stations[1]																															
Taxa	01PN0500	01PN2000	01PE0500	01PE2000	01PS0500	01PS2000	01PW0500	01PW2000	02PN0500	02PN2000	02PE0500	02PE2000	02PS0500	02PS2000	02PW0500	02PW2000	03PN0500	03PN2000	03PE0500	03PE2000	03PS0500	03PS2000	03PW0500	03PW2000	04PN0500	04PN2000	04PE0500	04PE2000	04PS0500	04PS2000	04PW0500	04PW2000
Anadara ovalis									x																							
Pinnidae																		x														
Lima locklini																																
Macoma																																
Tellina aequistriata																		x														
Tellidora cristata																		x														
Chione																x																
Pandora bushiana																																
Periploma cf. P. orbicularis																																
Poromya rostrata																																
Bivalvia #3																										x						
Sarsiella C																																
Caligus																									x							
Mysidacea																																
Tanaidacea																																
Lembos																																
Lembos brunneomaculatus																																
Oedicerotidae																	x															
Processa																											x					
Upogebia affinis																										x						
Paguridae																																
Pagurus bonairensis																																
Hepatus									x																							
Raninoides																																
Frevillea barbata																	x															
Squilla chydaea																									x							
Chirodota laevis									x																							
Molpadia cubana																																
Enteropneusta							x																									
Paraconger caudilimbatus																				x												
Serranidae														x																		
Gobiidae																			x													
Gobioides broussonneti																															x	

	Stations[1]																																			
Taxa	05SN0500	05SN2000	06SN0500	06SN2000	07SN0500	07SN2000	08SN0500	08SN2000	09SN0500	09SN2000	10SN0500	10SN2000	11SN0500	11SN2000	12SN0500	12SN2000	13SN0500	13SN2000	14SN0500	14SN2000	15SN0500	15SN2000	16SN0500	16SN2000	17SN0500	17SN2000	18SN0500	18SN2000	19SN0500	19SN2000	20SN0500	20SN2000	21C	22C	23C	24C
Anadara ovalis																																				
Pinnidae																																				
Lima locklini																						x														
Macoma																			x																	
Tellina aequistriata																																				
Tellidora cristata																																				
Chione																																				
Pandora bushiana							x																													
Periploma cf. P. orbicularis																				x																
Poromya rostrata																						x														
Bivalvia #3																																				
Sarsiella C																									x											
Caligus																																				
Mysidacea																		x																		
Tanaidacea										x																										
Lembos																														x						
Lembos brunneomaculatus																												x								
Oedicerotidae																																				
Processa																																				
Upogebia affinis																																				
Paguridae																													x							
Pagurus bonairensis																																			x	
Hepatus																																				
Raninoides																										x										
Frevillea barbata																																				
Squilla chydaea																																				
Chirodota laevis																																				
Molpadia cubana																								x												
Enteropneusta																																				
Paraconger caudilimbatus																																				
Serranidae																																				
Gobiidae																																				
Gobioides broussonneti																																				

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[1] An x indicates occurrence in at least one grab per station.

TABLE G6. Distribution of macroinfauna taxa by station for Cruise III.

Taxa	[1]Stations																																			
	01PN0500	01PN2000	01PE0500	01PE2000	01PS0500	01PS2000	01PW0500	01PW2000	02PN0500	02PN2000	02PE0500	02PE2000	02PS0500	02PS2000	02PW0500	02PW2000	03PN0500	03PN2000	03PE0500	03PE2000	03PS0500	03PS2000	03PW0500	03PW2000	04PN0500	04PN2000	04PE0500	04PE2000	04PS0500	04PS2000	04PW0500	04PW2000	21C	22C	23C	24C
Rhynchocoela	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
Paraprionospio pinnata	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x		x	x	x	x	x
Nereis	x	x	x	x	x	x		x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x		x	x	x	x		
Mediomastus californiensis			x	x	x	x	x	x	x		x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x		x	x	x	x	x	x		x	x
Sigambra tentaculata	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x			x	x	x	x	x	x		x	x			x	x	x	x	x
Pinnixa	x	x	x	x	x		x		x	x	x	x	x	x	x	x		x	x				x	x	x	x	x	x	x	x	x	x	x	x	x	x
Corbula contracta	x	x		x	x	x	x		x	x		x	x		x	x	x	x		x	x	x	x	x	x	x	x	x	x	x	x	x	x		x	x
Sthenelais boa	x	x	x	x	x	x		x	x	x	x	x	x	x	x	x		x	x	x	x		x	x	x	x	x	x			x		x	x	x	x
Lumbrineris tenuis	x								x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x		x	x	x
Prionospio cirrifera		x	x	x	x	x	x	x			x	x	x	x	x	x	x		x	x	x	x	x	x	x	x		x	x	x				x	x	x
Magelona phyllisae	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x									x	x		x
Cossura delta	x		x	x	x	x	x	x				x		x	x		x	x	x	x	x	x	x		x	x	x	x	x		x	x		x	x	x
Armandia maculata	x	x	x	x	x	x	x	x						x			x	x	x	x		x		x	x	x	x	x	x	x	x	x	x	x	x	x
Golfingia bulbosa	x	x	x	x	x		x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x		x							x	x		
Tharyx marioni	x	x			x	x				x	x	x	x	x	x		x	x	x	x	x		x	x	x	x	x	x	x	x			x	x		x
Nephtys incisa	x	x	x	x	x	x		x					x				x	x	x	x		x	x	x	x	x	x	x	x	x	x	x		x	x	x
Notomastus latericeus	x	x			x	x	x		x	x	x	x					x	x		x	x		x	x	x	x	x	x	x	x	x	x		x	x	
Diopatra cuprea		x	x	x	x	x	x	x	x	x	x		x		x	x	x				x	x	x		x			x				x	x	x	x	x
Speocarcinus lobatus	x	x		x		x	x		x		x	x		x	x		x		x	x	x		x		x	x	x		x		x			x		x
Ampharete acutifrons		x	x	x	x	x			x	x	x	x	x	x	x	x	x	x	x	x			x	x										x		
Glycinde nordmanni												x			x	x		x	x	x	x		x	x	x	x	x	x	x	x	x	x	x	x	x	
Magelona filiformis		x		x	x		x										x	x		x		x	x		x	x	x	x	x	x	x	x			x	
Aspidosiphon albus	x	x		x					x	x	x	x	x	x	x	x	x	x			x		x	x									x	x		
Glycera americana				x					x	x	x	x	x	x	x	x	x	x	x	x	x		x						x	x			x			
Paraonis gracilis			x	x	x	x						x					x		x	x		x	x		x	x	x	x	x	x		x			x	
Tellina versicolor		x	x	x					x	x	x	x	x	x	x	x	x	x		x	x		x	x												
Automate evermanni	x					x			x								x	x	x		x	x			x	x	x	x	x	x		x			x	x
Magelona rosea	x	x	x	x	x	x											x		x	x	x	x	x	x	x	x				x						x
Nuculana concentrica	x			x		x						x		x	x	x			x	x			x	x			x		x	x		x	x	x		

[1] An x indicates occurrence in at least one grab per station.

TABLE G6 (Cont'd).

Taxa	Stations[1]																																			
	01PN0500	01PN2000	01PE0500	01PE2000	01PS0500	01PS2000	01PW0500	01PW2000	02PN0500	02PN2000	02PE0500	02PE2000	02PS0500	02PS2000	02PW0500	02PW2000	03PN0500	03PN2000	03PE0500	03PE2000	03PS0500	03PS2000	03PW0500	03PW2000	04PN0500	04PN2000	04PE0500	04PE2000	04PS0500	04PS2000	04PW0500	04PW2000	21C	22C	23C	24C
Prionospio cristata				x	x				x	x	x	x	x	x	x		x	x	x	x			x	x												x
Amphioplus coniortodes	x	x	x	x	x	x	x	x														x					x	x	x	x	x		x	x		
Prionospio cirrobranchiata			x	x	x	x			x			x	x	x	x	x	x		x			x				x							x			
Volvulella texasiana			x	x	x	x	x	x														x			x	x	x		x	x	x	x				x
Vitrinella floridana	x	x	x	x	x		x	x		x				x												x							x	x	x	x
Ninoe nigripes			x																			x	x	x	x	x	x	x	x	x	x	x			x	x
Amphiodia atra									x	x	x	x	x	x	x	x		x	x			x			x	x										x
Aricidea suecica												x		x	x		x			x	x		x	x	x	x		x	x						x	x
Tharyx setigera			x	x			x					x					x			x	x	x	x	x	x			x		x					x	
Listriella barnardi	x	x	x	x	x		x										x			x		x				x		x	x			x			x	
Pseudeurythoe ambigua									x	x	x		x	x	x	x	x		x	x	x		x										x			
Gyptis vittata		x	x		x						x			x				x	x				x	x				x				x		x	x	
Aricidea fragilis														x			x	x	x	x	x		x	x	x	x			x	x						
Ceratonereis irritabilis									x	x						x	x	x	x	x	x		x	x			x				x					
Ampelisca abdita																	x	x	x		x	x	x	x	x					x		x	x		x	
Sabatieria		x	x		x	x		x				x		x											x					x		x		x		x
Nucula cf. N. proxima									x	x	x		x	x	x	x	x			x			x	x									x			
Acetes americanus	x		x	x	x	x	x	x		x									x				x	x									x			
Ancistrosyllis jonesi		x	x	x	x	x				x		x		x		x							x										x		x	
Chasmocarcinus mississippiensis	x		x	x	x		x												x			x			x	x			x		x			x		
Decapoda (arthropoda)	x	x		x	x	x	x										x			x					x			x		x						
Alpheus floridanus	x		x		x														x			x			x		x	x				x		x	x	
Oxyurostylis smithi									x	x	x	x	x	x	x	x							x													x
Timarete												x				x	x	x	x	x	x		x	x	x											
Phoronis architecta		x							x	x	x	x	x	x	x			x			x															
Asychis elongata			x			x		x										x			x	x		x				x			x			x		
Lepidasthenia						x			x	x	x	x	x	x	x																			x		
Terebra dislocata	x	x	x		x			x			x		x			x																	x			
Agriopoma texasiana		x				x				x														x			x	x			x		x	x		
Abra aequalis									x	x	x	x	x	x	x	x																				

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[1] An *x* indicates occurrence in at least one grab per station.

TABLE G6 (Cont'd).

Taxa	[1]Stations																																			
	01PN0500	01PN2000	01PE0500	01PE2000	01PS0500	01PS2000	01PW0500	01PW2000	02PN0500	02PN2000	02PE0500	02PE2000	02PS0500	02PS2000	02PW0500	02PW2000	03PN0500	03PN2000	03PE0500	03PE2000	03PS0500	03PS2000	03PW0500	03PW2000	04PN0500	04PN2000	04PE0500	04PE2000	04PS0500	04PS2000	04PW0500	04PW2000	21C	22C	23C	24C
Clymenella torquata calida	x	x	x						x	x						x			x																	x
Chione clenchi									x		x						x	x		x			x	x							x					
Owenia fusiformis										x	x		x			x	x		x				x	x												
Diplocirrus			x			x													x			x				x	x		x	x						
Amphiuridae	x			x				x					x	x				x						x		x										
Mulinia lateralis									x	x	x	x	x		x	x																				
Ceratocephale cf. C. loveni																	x	x	x	x	x		x	x												
Ampelisca verrilli		x															x	x		x	x		x	x												
Ampelisca agassizi																	x	x				x	x	x		x									x	
Gastropoda	x		x			x																		x							x		x	x		
Macoma pulleyi																x		x						x	x	x		x							x	
Loimia viridis									x		x	x	x	x		x																				
Ampharete americana					x							x			x	x							x	x												
Photis macromanus																	x	x	x	x			x	x												
Balanoglossus											x	x	x	x	x	x																				
Onuphis nebulosa																	x	x	x	x	x		x													
Bregmaceros atlanticus					x	x																				x	x	x							x	
Natica pusilla			x					x	x	x		x				x																				
Anaitides erythrophyllus					x														x			x				x	x					x				
Nereidae						x														x		x			x	x				x						
Bivalvia		x		x		x				x								x														x				
Spiophanes bombyx											x		x	x							x		x	x												
Harmothoe		x		x	x		x																							x			x			
Caridea																		x				x	x		x				x							x
Dorylaimopsis					x			x								x										x		x								x
Aglaophamus verrilli											x						x	x					x	x												
Ampelisca																	x	x	x	x								x								
Anadara ovalis									x	x				x		x																	x			
Polydora ligni					x	x			x							x																	x			

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[1] An *x* indicates occurrence in at least one grab per station.

TABLE G6 (Cont'd).

	Stations[1]																																			
Taxa	01PN0500	01PN2000	01PE0500	01PE2000	01PS0500	01PS2000	01PW0500	01PW2000	02PN0500	02PN2000	02PE0500	02PE2000	02PS0500	02PS2000	02PW0500	02PW2000	03PN0500	03PN2000	03PE0500	03PE2000	03PS0500	03PS2000	03PW0500	03PW2000	04PN0500	04PN2000	04PE0500	04PE2000	04PS0500	04PS2000	04PW0500	04PW2000	21C	22C	23C	24C
Cingula																											x	x	x	x		x				
Pagurus bonairensis									x	x	x		x		x																					
Polydora socialis				x					x		x				x	x																				
Brachyura		x		x				x														x						x								
Linhomoeidae		x	x			x						x																								x
Cupuladria biporosa																	x	x	x					x												
Petricola pholadiformis									x	x					x	x																				
Anadara transversa									x	x						x								x												
Diplodonta soror		x							x														x	x												
Gyptis brevipalpa												x			x	x																	x			
Glycinde solitaria							x		x		x									x																
Portunus												x				x			x					x												
Ophiuroidea												x										x		x						x						
Paleanotus heteroseta					x							x	x	x																						
Anachis obesa		x								x																x						x				
Euceramus praelongus									x		x					x								x												
Neoconger mucronatus	x							x														x												x		
Bollmannia communis						x	x																		x				x							
Myriowenia californiensis											x		x											x												
Apseudes																		x				x		x												
Pista palmata											x			x				x																		
Lingula																		x					x	x												
Lembos brunneomaculatus																	x	x						x												
Nephtys picta																		x		x			x													
Hemipholas elongata									x	x																							x			
Cirrophorus lyriformis																							x		x				x							
Spiochaetopterus oculatus				x	x								x																							
Pectinaria gouldii									x				x											x												
Nassarius acutus											x		x																				x			

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[1] An *x* indicates occurrence in at least one grab per station.

TABLE G6 (Cont'd).

Taxa	01PN0500	01PN2000	01PE0500	01PE2000	01PS0500	01PS2000	01PW0500	01PW2000	02PN0500	02PN2000	02PE0500	02PE2000	02PS0500	02PS2000	02PW0500	02PW2000	03PN0500	03PN2000	03PE0500	03PE2000	03PS0500	03PS2000	03PW0500	03PW2000	04PN0500	04PN2000	04PE0500	04PE2000	04PS0500	04PS2000	04PW0500	04PW2000	21C	22C	23C	24C
Pentamera pulcherrima											x							x						x												
Microspio pigmentata																		x					x	x												
Lima locklini																	x			x	x															
Latreutes parvulus									x						x									x												
Upogebia affinis										x	x				x																					
Leiolambrus nitidus																						x			x			x								
Palythoa texaensis									x				x							x																
Lyonsia hyalina floridana																		x		x				x												
Eudorella monodon																										x	x	x								
Phascolion strombi												x	x					x																		
Cupuladria doma																		x						x												
Discoporella umbellata																		x						x												
Amphipoda						x												x																		
Xenanthura brevitelson																		x						x												
Polychaeta						x		x																												
Terebellides stroemii																		x						x												
Schistomeringos rudolphii			x																			x														
Amaeana trilobata									x															x												
Anadara															x	x																				
Mysidopsis bigelowi		x																															x			
Paranaitis speciosa																								x												x
Onuphis eremita oculata			x																				x													
Dorvillea sociabilis		x	x																																	
Sinum perspectivum											x		x																							
Mysidacea		x								x																										
Pagurus (decapoda)																x								x												
Calliactis tricolor									x				x																							
Cerebratulus luridus						x				x																										
Polyodontes lupina												x											x													

[1] An *x* indicates occurrence in at least one grab per station.

TABLE G6 (Cont'd).

	[1] Stations																																			
Taxa	01PN0500	01PN2000	01PE0500	01PE2000	01PS0500	01PS2000	01PW0500	01PW2000	02PN0500	02PN2000	02PE0500	02PE2000	02PS0500	02PS2000	02PW0500	02PW2000	03PN0500	03PN2000	03PE0500	03PE2000	03PS0500	03PS2000	03PW0500	03PW2000	04PN0500	04PN2000	04PE0500	04PE2000	04PS0500	04PS2000	04PW0500	04PW2000	21C	22C	23C	24C
Ophiodromus obscura										x				x																						
Sigambra wassi					x			x																												
Nephtys bucera																	x	x																		
Marphysa sanguinea															x						x															
Arabella irricolor																											x			x						
Malacoceros vanderhorsti																					x														x	
Aonides					x	x																														
Clymenella			x																	x																
Myriowenia cf. M. californiensis												x											x													
Polinices duplicatus												x				x																				
Cantharus cancellarius													x											x												
Arcidae												x																					x			
Monoculodes edwardsi	x																																			x
Synchelidium americanum												x												x												
Trachypenaeus similis																	x							x												
Ogyrides limicola													x			x																				
Hexapanopeus angustifrons										x						x																				
Frevillea barbata											x													x												
Squilla chydaea																					x	x														
Brachiopoda				x																				x												
Astropecten duplicatus																					x								x							
Enteropneusta					x							x																								
Filellum serpens				x																																
Varicorbula operculata																								x												
Goniada teres																		x																		
Scoloplos rubra																								x												
Magelonidae																								x												
Chaetozone setosa		x																																		
Notomastus hemipodus																																				x

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[1] An *x* indicates occurrence in at least one grab per station.

TABLE G6 (Cont'd).

Taxa	01PN0500	01PN2000	01PE0500	01PE2000	01PS0500	01PS2000	01PW0500	01PW2000	02PN0500	02PN2000	02PE0500	02PE2000	02PS0500	02PS2000	02PW0500	02PW2000	03PN0500	03PN2000	03PE0500	03PE2000	03PS0500	03PS2000	03PW0500	03PW2000	04PN0500	04PN2000	04PE0500	04PE2000	04PS0500	04PS2000	04PW0500	04PW2000	21C	22C	23C	24C
Teinostoma biscaynense																x																				
Lembos smithi																						x														
Hexapanopeus paulensis									x																											
Obelia				x																																
Metacomesoma																x																				
Exogone																				x																
Goniada maculata																		x																		
Schistomeringos																			x																	
Cirratulus cf. C. hedgpethi																								x												
Pyrenidae		x																																		
Acteocina candei																								x												
Dosinia discus																								x												
Anthuridae																								x												
Hepatus									x																											
Aspidosiphon cumingii											x																									
Protankyra												x																								
Lenticulina																													x							
Lenticulina iota																									x											
Anthozoa													x																							
Pennatulidae				x																																
Anthopleura krebsi																x																				
Paranthus rapiformis													x																							
Nematoda																							x													
Theristus														x																						
Choniolaimidae			x																																	
Phanodermatidae																x																				
Harmothoe trimaculata									x																											
Anaitides mucosa		x																																		
Ancistrosyllis papillosa									x																											

[1] An *x* indicates occurrence in at least one grab per station.

TABLE G6 (Cont'd).

	Stations[1]																																			
Taxa	01PN0500	01PN2000	01PE0500	01PE2000	01PS0500	01PS2000	01PW0500	01PW2000	02PN0500	02PN2000	02PE0500	02PE2000	02PS0500	02PS2000	02PW0500	02PW2000	03PN0500	03PN2000	03PE0500	03PE2000	03PS0500	03PS2000	03PW0500	03PW2000	04PN0500	04PN2000	04PE0500	04PE2000	04PS0500	04PS2000	04PW0500	04PW2000	21C	22C	23C	24C
Parandalia ocularis																													x							
Nereis succinea									x																											
Glycera (polychaeta)																					x															
Drilonereis cf. D. filum																			x																	
Aricidea																	x																			
Prionospio pygmaea						x																														
Spio pettiboneae																										x										
Poecilochaetus johnsoni						x																														
Sternaspis scutata																											x									
Clymenella zonalis																x																				
Chone																									x											
Megalomma bioculata																								x												
Grubeulepis																						x														
Niso aeglees																				x																
Nassarina glypta																																	x			
Kurtziella						x																														
Acteon punctostriatus																														x						
Volvulella persimilis																								x												
Parvilucina multilineata													x																							
Linga amiantus										x																										
Lasaeidae A																									x											
Tellinidae																		x																		
Tellina cristata																		x																		
Tellina aequistriata										x																										
Tellidora cristata																								x												
Mytilopsis leucophaeta																																				x
Veneridae																																	x			
Mercenaria mercenaria texana											x																									
Pitar cordatus																													x							

[1] An *x* indicates occurrence in at least one grab per station.

TABLE G6 (Cont'd).

Taxa	01PN0500	01PN2000	01PE0500	01PE2000	01PS0500	01PS2000	01PW0500	01PW2000	02PN0500	02PN2000	02PE0500	02PE2000	02PS0500	02PS2000	02PW0500	02PW2000	03PN0500	03PN2000	03PE0500	03PE2000	03PS0500	03PS2000	03PW0500	03PW2000	04PN0500	04PN2000	04PE0500	04PE2000	04PS0500	04PS2000	04PW0500	04PW2000	21C	22C	23C	24C
Periglypta																																	x			
Periploma																									x											
Periploma cf. P. orbicularis																												x								
Bushia elegans													x																							
Cardiomya																									x											
Caligus				x																																
Tephromysis louisianae																									x											
Siriella																									x											
Cumacea																				x																
Cyclaspis varians												x																								
Corophium											x																									
Parametopella texansis																	x																			
Leptochela bermudensis																							x													
Periclimenes	x																																			
Alpheidae																										x										
Alpheopsis																			x																	
Processa hemphilli																								x												
Hepatus epheliticus																x																				
Parthenopidae																			x																	
Xanthidae																																			x	
Goneplacidae						x																														
Glyptoplax smithii																								x												
Squilla																														x						
Squilla empusa	x																																			
Golfingia trichocephala			x																																	
Aspidosiphon spinalis											x																									
Echiura																							x													
Schizaster orbignyanus																									x											

[1] An *x* indicates occurrence in at least one grab per station.

TABLE G6 (Cont'd).

Taxa	01PN0500	01PN2000	01PE0500	01PE2000	01PS0500	01PS2000	01PW0500	01PW2000	02PN0500	02PN2000	02PE0500	02PE2000	02PS0500	02PS2000	02PW0500	02PW2000	03PN0500	03PN2000	03PE0500	03PE2000	03PS0500	03PS2000	03PW0500	03PW2000	04PN0500	04PN2000	04PE0500	04PE2000	04PS0500	04PS2000	04PW0500	04PW2000	21C	22C	23C	24C
Holothuroidea																							x													
Osteichthyes																		x																		
Anguilliformes							x																													
Gobioides broussonneti						x																														
Symphurus plagiusa																								x												

[1] An x indicates occurrence in at least one grab per station.

TABLE G7. Distribution of macroepifauna and demersal fish taxa by station forCruise I.

Taxa	01PN0500	01PN2000	01PE0500	01PE2000	01PS0500	01PS2000	01PW0500	01PW2000	02PN0500	02PN2000	02PE0500	02PE2000	02PS0500	02PS2000	02PW0500	02PW2000	03PN0500	03PN2000	03PE0500	03PE2000	03PS0500	03PS2000	03PW0500	03PW2000	04PN0500	04PN2000	04PE0500	04PE2000	04PS0500	04PS2000	04PW0500	04PW2000	021C	022C	023C	024C
Leiolambrus nitidus	x																x								x									x	x	
Squilla empusa	x																x								x								x		x	
Callinectes similis	x								x																								x	x	x	
Prionotus rubio	x								x								x								x										x	
Trachypenaeus similis									x								x								x										x	
Astropecten duplicatus																									x									x	x	x
Loligo pealei																	x								x									x	x	
Calliactis tricolor	x								x																										x	x
Alpheus floridanus	x																								x										x	x
Pagurus pollicaris	x								x																										x	x
Penaeus aztecus									x								x																		x	
Stenotomus caprinus																	x								x										x	
Anchoa mitchilli									x																								x	x		
Speocarcinus lobatus	x																																x			x
Halieutichthys aculeatus																	x								x										x	
Anchoa hepsetus									x																x									x		
Trachypenaeus																	x								x										x	
Diopatra cuprea	x																																x		x	
Lepidonotus sublevis	x								x																										x	
Sphoeroides parvus									x								x																	x		
Etropus crossotus																									x									x	x	
Ovalipes quadulpensis																	x																		x	x
Centropristis philadelphicus									x								x																		x	
Pleurobranchaea hedgpethi	x								x																											
Portunus spinicarpus																	x																		x	
Trachurus lathami																									x									x		
Portunus gibbesii									x																										x	
Penaeus setiferus									x																									x		

[1] An *x* indicates occurrence in at least one trawl per station.

TABLE G7 (Cont'd).

Taxa	01PN0500	01PN2000	01PE0500	01PE2000	01PS0500	01PS2000	01PW0500	01PW2000	02PN0500	02PN2000	02PE0500	02PE2000	02PS0500	02PS2000	02PW0500	02PW2000	03PN0500	03PN2000	03PE0500	03PE2000	03PS0500	03PS2000	03PW0500	03PW2000	04PN0500	04PN2000	04PE0500	04PE2000	04PS0500	04PS2000	04PW0500	04PW2000	21C	22C	23C	24C
Pitar cordatus																																			x	
Ampharete americana									x																											
Cantharus cancellarius																																				x
Processa bermudensis	x																																			
Calappa sulcata	x																																			
Amphioplus coniortodes	x																																			
Urophycis cirratus																																			x	
Lepophidium graellsi																																			x	
Paranthus rapiformis																																	x			
Lolliguncula brevis									x																											
Saurida brasiliensis																									x											
Polydactylus octonemus									x																											
Nereis succinea									x																											
Polydora									x																											
Terebellidae																																	x			
Penaeus duorarum																	x																			
Acetes americanus carolinae	x																																			
Porcellana sigsbeiana																																			x	
Porcellana sayana	x																																			
Raninoides louisianensis																																			x	
Coelocerus spinosus									x																											
Brevoortia patronus																																	x			
Bregmaceros atlanticus																	x																			
Prionotus stearnsi																	x																			
Larimus fasciatus									x																											
Ceriantipatharia ceriantharia																																	x			
Pennatulidae	x																																			
Rhynchocoela																																	x			
Ophiodromus obscura																																			x	

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[1] An *x* indicates occurrence in at least one trawl per station.

TABLE G7 (Cont'd).

	Stations[1]																																			
Taxa	01PN0500	01PN2000	01PE0500	01PE2000	01PS0500	01PS2000	01PW0500	01PW2000	02PN0500	02PN2000	02PE0500	02PE2000	02PS0500	02PS2000	02PW0500	02PW2000	03PN0500	03PN2000	03PE0500	03PE2000	03PS0500	03PS2000	03PW0500	03PW2000	04PN0500	04PN2000	04PE0500	04PE2000	04PS0500	04PS2000	04PW0500	04PW2000	21C	22C	23C	24C
Squilla chydaea	x																																		x	x
Sicyonia dorsalis	x																																		x	
Peprilus burti									x																x											
Palythoa texaensis	x																																x			
Antennarius radiosus																									x										x	
Sthenelais boa	x																																			x
Arius felis									x																								x			
Hepatus epheliticus	x								x																											
Citharichthys spilopterus																									x										x	
Cyclopsetta chittendeni																									x										x	
Sicyonia brevirostris																	x																		x	
Porichthys porosissimus									x																										x	
Symphurus civitatus									x																										x	
Paraprionospio pinnata	x								x																											
Anchoviella perfasciata																									x									x		
Lutjanus synagris	x																								x											
Terebellides stroemii																									x										x	
Cynoscion arenarius									x																									x		
Gobionellus boleosoma	x																																			x
Bollmannia communis																																			x	
Callinectes sapidus																																				x
Micropogon undulatus									x																											
Anasimus latus																																			x	
Persephona crinita	x																																			
Cirratulus cf. C. hedgpethi	x																																			
Noetia ponderosa																																		x		
Serranus atrobranchus																																			x	
Anchoa nasuta																									x											
Leiostomus xanthurus									x																											

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[1] An *x* indicates occurrence in at least one trawl per station.

TABLE G7 (Cont'd).

Taxa	01PN0500	01PN2000	01PE0500	01PE2000	01PS0500	01PS2000	01PW0500	01PW2000	02PN0500	02PN2000	02PE0500	02PE2000	02PS0500	02PS2000	02PW0500	02PW2000	03PN0500	03PN2000	03PE0500	03PE2000	03PS0500	03PS2000	03PW0500	03PW2000	04PN0500	04PN2000	04PE0500	04PE2000	04PS0500	04PS2000	04PW0500	04PW2000	21C	22C	23C	24C
Sigambra	x																																			
Glycera americana	x																																			
Goniadidae																																	x			
Asychis elongata																																			x	
Ampharete acutifrons	x																																			
Murex fulvescens																																			x	
Photis macromanus																	x																			
Petrochirus diogenes																																			x	
Libinia emarginata																																			x	
Aspidosiphon albus																	x																			
Ophiuroidea									x																											
Amphiodia atra	x																																			
Hoplunnis macrurus																																			x	
Dorosoma petenense																																	x			
Synodus foetens																																			x	
Diplectrum bivittatum																																			x	
Serranus phoebe																									x											
Menticirrhus americanus									x																											
Kathetostoma albigutta																																			x	
Scomber japonicus																									x											

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[1] An *x* indicates occurrence in at least one trawl per station.

TABLE G8. Distribution of macroepifauna and demersal fish taxa by station forCruise II.

	Stations[1]																																																																			
Taxa	01PN0500	01PN2000	01PE0500	01PE2000	01PS0500	01PS2000	01PW0500	01PW2000	02PN0500	02PN2000	02PE0500	02PE2000	02PS0500	02PS2000	02PW0500	02PW2000	03PN0500	03PN2000	03PE0500	03PE2000	03PS0500	03PS2000	03PW0500	03PW2000	04PN0500	04PN2000	04PE0500	04PE2000	04PS0500	04PS2000	04PW0500	04PW2000	05SN0500	05SN2000	06SN0500	06SN2000	07SN0500	07SN2000	08SN0500	08SN2000	09SN0500	09SN2000	10SN0500	10SN2000	11SN0500	11SN2000	12SN0500	12SN2000	13SN0500	13SN2000	14SN0500	14SN2000	15SN0500	15SN2000	16SN0500	16SN2000	17SN0500	17SN2000	18SN0500	18SN2000	19SN0500	19SN2000	20SN0500	20SN2000	21C	22C	23C	24C
Prionotus rubio	x																x								x								x				x		x		x										x		x		x		x		x		x				x		x	x
Penaeus aztecus																	x								x								x		x		x		x		x								x		x		x		x		x								x		x	
Halieutichthys aculeatus																	x								x										x		x				x										x		x		x		x		x									x	
Saurida brasiliensis																	x								x										x		x				x								x		x		x		x		x										x	
Squilla chydaea																																			x		x		x		x								x				x		x		x		x									x	
Diopatra cuprea	x																																		x				x										x				x		x				x						x		x	x
Loligo pealei																																			x		x				x						x		x		x		x		x		x										x	
Squilla empusa	x																								x										x		x				x		x						x						x								x				x	
Leiolambrus nitidus																									x										x		x				x								x		x		x		x				x								x	
Cantharus cancellarius	x								x																														x		x		x		x		x																x			x		x
Portunus gibbesii	x								x								x								x										x														x						x				x		x						x	
Pitar cordatus																									x										x		x		x		x								x				x		x		x										x	
Citharichthys spilopterus	x																								x								x		x														x		x				x		x								x		x	
Astropecten duplicatus																	x								x																x										x		x		x		x		x										x	
Stenotomus caprinus																									x										x		x														x		x		x		x										x	x
Callinectes similis																	x								x										x				x										x		x				x		x		x										
Etropus crossotus	x																								x																										x				x		x		x		x						x	x
Cyclopsetta chittendeni																	x								x										x		x												x		x				x		x										x	
Trachypenaeus similis	x																																		x		x												x		x				x				x								x	
Callinectes sapidus									x								x																x		x																								x		x				x		x	
Diplectrum bivittatum																	x								x										x						x								x		x				x												x	
Centropristis philadelphicus																																					x				x								x		x		x				x								x		x	
Arius felis	x								x																								x		x																										x				x			x
Syacium gunteri																									x										x		x														x				x				x								x	
Chloroscombrus chrysurus	x								x																								x		x																								x		x				x			
Asychis elongata																																							x		x												x				x		x				x					x
Synodus foetens																									x												x				x										x		x		x		x											
Serranus atrobranchus																									x										x		x												x				x		x		x											
Murex fulvescens																	x																						x		x		x		x																		x			x		
Nereis succinea	x								x								x																								x												x		x				x									
Portunus spinicarpus																																			x		x				x								x				x				x											
Sicyonia dorsalis																																			x		x												x		x				x												x	
Micropogon undulatus									x																x								x		x														x																		x			
Alpheus floridanus																																			x		x				x								x						x												x	
Antennarius radiosus																																			x		x				x								x				x				x											
Raninoides louisianensis																																			x		x				x								x				x		x													
Gymnachirus texae																																			x		x												x						x		x										x	
Pristipomoides aquilonaris																																			x		x				x												x				x										x	
Agriopoma texasiana	x																																		x		x		x																		x									x		
Calappa sulcata																																			x		x												x				x		x		x											
Bollmannia communis																																			x														x						x				x								x	

[1]An *x* indicates occurrence in at least one trawl per station.

TABLE G8 (Cont'd).

	[1]Stations																																																																		
Taxa	01PN0500	01PN2000	01PE0500	01PE2000	01PS0500	01PS2000	01PW0500	01PW2000	02PN0500	02PN2000	02PE0500	02PE2000	02PS0500	02PS2000	02PW0500	02PW2000	03PN0500	03PN2000	03PE0500	03PE2000	03PS0500	03PS2000	03PW0500	03PW2000	04PN0500	04PN2000	04PE0500	04PE2000	04PS0500	04PS2000	04PW0500	04PW2000	05SN0500	05SN2000	06SN0500	06SN2000	07SN0500	07SN2000	08SN0500	08SN2000	09SN0500	09SN2000	10SN0500	10SN2000	11SN0500	11SN2000	12SN0500	12SN2000	13SN0500	13SN2000	14SN0500	14SN2000	15SN0500	15SN2000	16SN0500	16SN2000	17SN0500	17SN2000	18SN0500	18SN2000	19SN0500	19SN2000	20SN0500	20SN2000	21C	22C	23C	24C
Prionotus stearnsi																																					x				x												x		x		x											
Terebellides stroemii																																							x												x				x				x								x	
Noetia ponderosa																																							x								x												x							x		x
Porichthys porosissimus																																																			x				x				x								x	x
Nephtys incisa																																			x														x				x		x				x									
Speocarcinus lobatus																	x																		x		x		x																												x	
Lolliguncula brevis																	x																		x														x						x										x			
Rhynchocoela																																																	x						x		x		x								x	
Cynoscion nothus	x																																		x																x										x							x
Chione clenchi																	x																						x								x																x				x	
Anadara baughmani																																					x				x												x				x											
Leiostomus xanthurus									x																x								x																																x			
Macoma tageliformis																																			x		x		x		x																											
Cynoscion arenarius									x																								x		x																														x			
Symphurus plagiusa																																			x														x		x				x													
Trachurus lathami																									x												x														x				x													
Distorsio clathrata																																							x				x				x																					x
Parapenaeus longirostris																																			x		x				x												x															
Acetes americanus carolinae	x																																x																x																x			
Molpadia cubana																																																			x						x		x								x	
Persephona crinita																																			x				x																		x									x
Peprilus burti																									x												x												x		x																	
Hepatus epheliticus																																			x		x												x						x													
Anchoa hepsetus																									x								x																x																			
Anchoa mitchilli																																	x		x																														x			
Trichiurus lepturus									x																								x																																x			
Anasimus latus																																					x				x												x															
Anthopleura krebsi	x																																						x										x																				
Urophycis cirratus																																			x						x																x											
Styela plicata																	x																																				x				x											
Paraprionospio pinnata									x																																												x						x									
Polydactylus octonemus																																	x		x																														x			
Sicyonia brevirostris																																																					x				x										x	
Brotula barbata																																			x														x																		x	
Anchoa nasuta																									x								x																		x																	
Lepidonotus variabilis																	x																												x																		x					
Oliva sayana	x																																						x				x																									
Symphurus civitatus																									x																																x										x	
Calliactis tricolor																																													x						x								x									
Sconsia striata																																									x												x				x											
Pagurus pollicaris																																																											x		x		x					
Porcellana sigsbeiana																																									x												x		x													
Stomatopoda	x								x																																																								x			
Psilaster cassiope																																																					x		x		x											
Lagodon rhomboides									x																												x																x															
Penaeus setiferus																																	x																																x			

[1]An *x* indicates occurrence in at least one trawl per station.

TABLE G8 (Cont'd).

	Stations[1]																																																																		
Taxa	01PN0500	01PN2000	01PE0500	01PE2000	01PS0500	01PS2000	01PW0500	01PW2000	02PN0500	02PN2000	02PE0500	02PE2000	02PS0500	02PS2000	02PW0500	02PW2000	03PN0500	03PN2000	03PE0500	03PE2000	03PS0500	03PS2000	03PW0500	03PW2000	04PN0500	04PN2000	04PE0500	04PE2000	04PS0500	04PS2000	04PW0500	04PW2000	05SN0500	05SN2000	06SN0500	06SN2000	07SN0500	07SN2000	08SN0500	08SN2000	09SN0500	09SN2000	10SN0500	10SN2000	11SN0500	11SN2000	12SN0500	12SN2000	13SN0500	13SN2000	14SN0500	14SN2000	15SN0500	15SN2000	16SN0500	16SN2000	17SN0500	17SN2000	18SN0500	18SN2000	19SN0500	19SN2000	20SN0500	20SN2000	21C	22C	23C	24C
Amusium papyraeum																																																					x				x												
Polystira tellea																																									x											x																
Anchoviella perfasciata																									x																									x																		
Conus austini																																									x											x																
Prionotus paralatus																																					x																			x												
Decapterus punctatus																																																	x		x																				
Solenocera vioscai																																			x					x																												
Sinum perspectivum																																													x																					x		
Kathetostoma albigutta																																																					x				x												
Ogcocephalus radiatus																																																					x				x												
Sthenelais boa																																																							x				x										
Aspidosiphon albus	x																x																																																				
Amphioplus coniortodes	x																																																										x										
Ceratonereis irritabilis																																																			x							x										
Menticirrhus americanus																																	x																											x								
Hydroides protulicola																	x																											x																								
Anadara transversa																																													x																			x			
Myropsis quinquespinosa																																									x											x																
Libinia emarginata																																									x																									x	
Nereidae	x																																					x																														
Petrochirus diogenes																																											x		x																								
Majidae																																																					x									x						
Coelocerus spinosus																																					x					x																										
Squilla																																																											x									x
Priacanthus arenatus																																					x															x																
Stellifer lanceolatus									x																																																							x			
Octocorallia pennatulacea	x																																																															x			
Lumbrineris																	x																																																	x	
Crepidula fornicata																																													x													x										
Anadontia alba																																							x																													x
Corbula contracta																																																	x									x										
Stenopus scutellatus																																																	x						x														
Podochela lamelligera																																					x															x																
Lutjanus campechanus																									x																											x																
Cupuladria biporosa																	x																																																		
Schizaster orbignyanus																																																											x										
Etrumeus teres																									x																																										
Bagre marinus																																	x																																		
Trichopsetta ventralis																																																					x																
Paranthus rapiformis																																											x																								
Lepidasthenia																																																											x										
Pseudorhombila quadridentata																																									x																										
Vomer setapinnis																																	x																																		
Sphoeroides parvus																																																			x																		
Glycera americana																																																											x										

[1] An x indicates occurrence in at least one trawl per station.

TABLE G8 (Cont'd).

	Stations[1]																																																																			
Taxa	01PN0500	01PN2000	01PE0500	01PE2000	01PS0500	01PS2000	01PW0500	01PW2000	02PN0500	02PN2000	02PE0500	02PE2000	02PS0500	02PS2000	02PW0500	02PW2000	03PN0500	03PN2000	03PE0500	03PE2000	03PS0500	03PS2000	03PW0500	03PW2000	04PN0500	04PN2000	04PE0500	04PE2000	04PS0500	04PS2000	04PW0500	04PW2000	05SN0500	05SN2000	06SN0500	06SN2000	07SN0500	07SN2000	08SN0500	08SN2000	09SN0500	09SN2000	10SN0500	10SN2000	11SN0500	11SN2000	12SN0500	12SN2000	13SN0500	13SN2000	14SN0500	14SN2000	15SN0500	15SN2000	16SN0500	16SN2000	17SN0500	17SN2000	18SN0500	18SN2000	19SN0500	19SN2000	20SN0500	20SN2000	21C	22C	23C	24C
Amaes mitchilli																																																																			x		
Crepidula convexa																																																											x									
Polinices duplicatus																																											x																										
Thais haemastoma floridana																																	x																																			
Antillophos candei																																																					x															
Busycon contrarium																																											x																										
Nassarius acutus	x																																																																			
Cosmioconcha calliglypta																																																	x																			
Terebra dislocata	x																																																																			
Nuculana concentrica																																																	x																			
Arcidae A																																													x																							
Lithophaga bisculata																	x																																																			
Octopus vulgaris																																																									x											
Nerocila acuminata																									x																																											
Xiphopeneus kroyeri																																																	x																			
Leptochela bermudensis																																																																				x	
Alpheus amblyonyx																																																	x																			
Paguristes oxyophthalmus																																									x																											
Clibanarius vittatus																																	x																																			
Porcellana sayana																																																			x																	
Albunea paretii									x																																																										
Dromia erythropus																																																							x													
Ethusa microphthalma																																																					x															
Ovalipes quadulpensis																	x																																																			
Menippe mercenaria																																																															x					
Pilumnus																																																					x															
Ophiactis savignyi																	x																																																			
Ascidiacea																																																									x											
Raja texana																																																									x											
Congrina flava																																																					x															
Paraconger caudilimbatus																	x																																																			
Dorosoma petenense																																																													x							
Urophycis floridanus																																									x																											
Lepophidium graellsi																																									x																											
Scorpaena calcarata																																																			x																	
Equetus umbrosus																																																					x															
Lonchopisthus lindneri																																																																				x	
Microgobius																																					x																																
Scomberomorus cavalla																									x																																												
Paralichthys lethostigma																																																	x																			
Balistes capriscus																																																													x							
Lagocephalus laevigatus																																																																				x	

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[1] An *x* indicates occurrence in at least one trawl per station.

TABLE G9. Distribution of macroepifauna and demersal fish taxa by station forCruise III.

		[1]Stations																																				
Taxa		01PN0500	01PN2000	01PE0500	01PE2000	01PS0500	01PS2000	01PW0500	01PW2000	02PN0500	02PN2000	02PE0500	02PE2000	02PS0500	02PS2000	02PW0500	02PW2000	03PN0500	03PN2000	03PE0500	03PE2000	03PS0500	03PS2000	03PW0500	03PW2000	04PN0500	04PN2000	04PE0500	04PE2000	04PS0500	04PS2000	04PW0500	04PW2000	21C	22C	23C	24C	
Etropus crossotus	•	x								x								x								x								x	x	x	x	•
Halieutichthys aculeatus	•	x								x								x								x									x	x	x	•
Portunus gibbesii	•	x								x								x								x								x		x	x	•
Squilla empusa	•	x								x								x								x								x	x		x	•
Micropogon undulatus	•	x																x								x								x	x	x		•
Syacium gunteri	•	x																x								x									x	x	x	•
Leiostomus xanthurus	•	x																x								x								x	x	x		•
Sphoeroides parvus	•	x								x								x								x								x		x		•
Astropecten duplicatus	•																	x								x								x		x	x	•
Arius felis	•	x								x								x								x									x			•
Penaeus aztecus	•									x								x								x								x		x		•
Trachypenaeus similis	•																	x																x	x	x	x	•
Callinectes similis	•																									x								x	x	x	x	•
Citharichthys spilopterus	•	x																								x								x	x		x	•
Symphurus plagiusa	•	x								x								x																x	x			•
Penaeus setiferus	•	x								x																								x		x	x	•
Chaetodipterus faber	•									x								x								x								x		x		•
Menticirrhus americanus	•									x								x																	x	x	x	•
Prionotus rubio	•																	x								x										x	x	•
Calliactis tricolor	•									x																								x	x		x	•
Symphurus civitatus	•																									x									x	x	x	•
Cynoscion nothus	•	x																																x	x		x	•
Pagurus pollicaris	•									x																								x	x		x	•
Stellifer lanceolatus	•	x																																x	x		x	•
Cantharus cancellarius	•	x																x																			x	•
Stenotomus caprinus	•																	x								x										x		•
Diplectrum bivittatum	•																	x								x										x		•
Cynoscion arenarius	•																	x																x		x		•

[1] An *x* indicates occurrence in at least one trawl per station.

TABLE G8 (Cont'd).

Taxa	Stations[1]																																																																			
	01PN0500	01PN2000	01PE0500	01PE2000	01PS0500	01PS2000	01PW0500	01PW2000	02PN0500	02PN2000	02PE0500	02PE2000	02PS0500	02PS2000	02PW0500	02PW2000	03PN0500	03PN2000	03PE0500	03PE2000	03PS0500	03PS2000	03PW0500	03PW2000	04PN0500	04PN2000	04PE0500	04PE2000	04PS0500	04PS2000	04PW0500	04PW2000	05SN0500	05SN2000	06SN0500	06SN2000	07SN0500	07SN2000	08SN0500	08SN2000	09SN0500	09SN2000	10SN0500	10SN2000	11SN0500	11SN2000	12SN0500	12SN2000	13SN0500	13SN2000	14SN0500	14SN2000	15SN0500	15SN2000	16SN0500	16SN2000	17SN0500	17SN2000	18SN0500	18SN2000	19SN0500	19SN2000	20SN0500	20SN2000	21C	22C	23C	24C
Gyptis vittata																																																										x										
Lumbrineris tenuis																																																										x										
Notomastus latericeus																																																						x														
Anadara ovalis																																																														x						
Laevicardium laevigatum																																																								x												
Conus clarki																																																				x																
Processa bermudensis																																																								x												
Acanthocarpus alexandri																																																				x																
Sardinella anchovia																								x																																												
Synodus poeyi																																																								x												
Rhomboplites aurorubens																																																x																				
Cirratulidae																x																																																				
Maldanidae																																																		x																		
Maldane																																																																		x		
Pomatoceros americanus																x																																																				
Processa hemphilli																																																										x										
Pagurus brevidactylus																																																														x						
Pagurus bullisi																																																								x												
Stenorhynchus seticornis																																																x																				
Hoplunnis macrurus																																		x																																		
Bregmaceros atlanticus																																		x																																		
Prionotus ophryas																																																		x																		
Caranx fusus																																																												x								
Chaetodipterus faber																																x																																				
Peprilus paru																																x																																				
Ancylopsetta dilecta																																																								x												
Cerlantipatharia ceriantharia																																																																			x	
Zoantharia actiniaria																x																																																				
Aphrodita																																																								x												
Lepidonotus sublevis																																																										x										
Polyodontes lupina																																										x																										
Nereidae B																																																										x										
Onuphidae																																								x																												
Ninoe nigripes																																																x																				
Spionidae																x																																																				
Polydora																x																																																				
Magelona rosea																																						x																														
Cirratulus hedgpethi																																																										x										
Armandia maculata																																																						x														
Clymenella torquata calida	x																																																																			
Clymenella zonalis																																																										x										
Sabellaria vulgaris beautortensis																x																																																				
Grubeulepis																																																																	x			
Architectonica nobilis	x																																																																			

[1] An x indicates occurrence in at least one trawl per station.

TABLE G9 (Cont'd).

	Stations[1]																																			
Taxa	01PN0500	01PN2000	01PE0500	01PE2000	01PS0500	01PS2000	01PW0500	01PW2000	02PN0500	02PN2000	02PE0500	02PE2000	02PS0500	02PS2000	02PW0500	02PW2000	03PN0500	03PN2000	03PE0500	03PE2000	03PS0500	03PS2000	03PW0500	03PW2000	04PN0500	04PN2000	04PE0500	04PE2000	04PS0500	04PS2000	04PW0500	04PW2000	21C	22C	23C	24C
Sicyonia brevirostris																	x								x										x	
Lolliguncula brevis																																	x		x	x
Cyclopsetta chittendeni																	x								x										x	
Lutjanus campechanus																	x								x										x	
Calappa sulcata	x																x																			x
Sicyonia dorsalis																	x																		x	x
Libinia emarginata									x								x																			x
Centropristis philadelphicus																									x										x	
Synodus foetens																	x																		x	
Larimus fasciatus																	x								x											
Scorpaena calcarata																	x																		x	
Eucinostomus gula																	x								x											
Corbula contracta																																			x	x
Leiolambrus nitidus																									x										x	
Clupeidae									x																								x			
Prionotus tribulus									x																								x			
Polydactylus octonemus																																	x	x		
Harmothoe																	x																			x
Terebra dislocata																																			x	x
Hepatus epheliticus	x																																	x		
Trichiurus lepturus																	x																			x
Balistes capriscus																	x																		x	
Cupuladria biporosa																	x																			
Diopatra cuprea																																				x
Sthenelais boa																																				x
Anadara transversa																	x																			
Asychis elongata																																				x
Cerebratulus lacteus																																				x

[1] An *x* indicates occurrence in at least one trawl per station.

TABLE G9 (Cont'd).

Taxa		[1]Stations																																			
		01PN0500	01PN2000	01PE0500	01PE2000	01PS0500	01PS2000	01PW0500	01PW2000	02PN0500	02PN2000	02PE0500	02PE2000	02PS0500	02PS2000	02PW0500	02PW2000	03PN0500	03PN2000	03PE0500	03PE2000	03PS0500	03PS2000	03PW0500	03PW2000	04PN0500	04PN2000	04PE0500	04PE2000	04PS0500	04PS2000	04PW0500	04PW2000	21C	22C	23C	24C	
Anachis obesa	•																																				x	•
Fasciolaria lilium	•																	x																				•
Polydora socialis	•																																				x	•
Anadara ovalis	•																																				x	•
Persephona crinita	•	x																																				•
Solenocera atlantidis	•																	x																				•
Busycon perversum pulleyi	•																																				x	•
Chama congregata	•																	x																				•
Polinices duplicatus	•																																				x	•
Alpheus floridanus	•																																				x	•
Porcellana sigsbeiana	•																	x																				•
Portunus spinimanus	•																	x																				•
Nassarius acutus	•																																				x	•
Trachypenaeus constrictus	•																																				x	•
Porcellana sayana	•																																				x	•
Hexapanopeus paulensis	•	x																																				•
Styela plicata	•																	x																				•
Ogcocephalus	•																	x																				•
Lepophidium graellsi	•																	x																				•
Demospongia	•																	x																				•
Cerebratulus luridus	•																																				x	•
Gyptis vittata	•																																				x	•
Ceratonereis irritabilis	•																																				x	•
Nephtys incisa	•																																				x	•
Lumbrineris tenuis	•																																				x	•
Ninoe nigripes	•																																				x	•
Schistomeringos cf. S. caeca	•																	x																				•
Terebellides stroemii	•																																				x	•

---

[1] An *x* indicates occurrence in at least one trawl per station.

TABLE G9 (Cont'd).

	Stations[1]																																			
Taxa	01PN0500	01PN2000	01PE0500	01PE2000	01PS0500	01PS2000	01PW0500	01PW2000	02PN0500	02PN2000	02PE0500	02PE2000	02PS0500	02PS2000	02PW0500	02PW2000	03PN0500	03PN2000	03PE0500	03PE2000	03PS0500	03PS2000	03PW0500	03PW2000	04PN0500	04PN2000	04PE0500	04PE2000	04PS0500	04PS2000	04PW0500	04PW2000	21C	22C	23C	24C
Architectonica nobilis																	x																			
Ionna galea																																		x		
Ocenebra																	x																			
Thais haemastoma floridana	x																																			
Murex fulvescens																	x																			
Busycon spiratum plagosum																																				x
Pleuroploca gigantea																	x																			
Arcidae A																	x																			
Ostrea equestris																	x																			
Pitar cordatus																																			x	
Agriopoma texasiana																																	x			
Trachypenaeus																																	x			
Latreutes parvulus																																				x
Pagurus (decapoda)																																				x
Petrochirus diogenes																																			x	
Calappa flammea																																			x	
Ovalipes guadulpensis																																				x
Menippe mercenaria	x																																			
Speocarcinus lobatus																	x																			
Dysommidae																																			x	
Saurida brasiliensis																																			x	
Porichthys porosissimus																																			x	
Urophycis floridanus										x																										
Prionotus stearnsi																	x																			
Diplectrum formosum																	x																			
Rachycentron canadum																	x																			
Trachurus lathami																																			x	
Chloroscombrus chrysurus	x																																			

---

[1] An *x* indicates occurrence in at least one trawl per station.

TABLE G9 (Cont'd).

Taxa		01PN0500	01PN2000	01PE0500	01PE2000	01PS0500	01PS2000	01PW0500	01PW2000	02PN0500	02PN2000	02PE0500	02PE2000	02PS0500	02PS2000	02PW0500	02PW2000	03PN0500	03PN2000	03PE0500	03PE2000	03PS0500	03PS2000	03PW0500	03PW2000	04PN0500	04PN2000	04PE0500	04PE2000	04PS0500	04PS2000	04PW0500	04PW2000	21C	22C	23C	24C	
Haemulon aurolineatum	•																	x																				•
~~Bairdiella chrysura~~	•																																		x			•
Pogonias cromis	•									x																												•
Equetus umbrosus	•																	x																				•
Bollmannia communis	•																																			x		•
~~Paralichthys lethostigma~~	•																																				x	•
Ancylopsetta quadrocellata	•																																			x		•
Gymnachirus texae	•																																		x			•

[1] An *x* indicates occurrence in at least one trawl per station.

VOLUME I—POLLUTANT FATE AND EFFECTS STUDIES
Part 7—Normal Histology and Histopathology and Benthic Invertebrates and Demersal and Platform-Associated Pelagic Fishes

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ABSTRACT

This work was part of a multidisciplinary project which also included studies of hydrography, hydrocarbons, sedimentology, trace metals, microbiology, benthic biology, and biofouling. At least six tissues (muscle, liver, stomach, gonad, excretory/kidney, gill) were examined for histopathological conditions in three species of benthic invertebrates, one species each of bivalves, shrimps, and crabs, and two species of demersal or platform-associated pelagic fishes from each site. Specimens were collected from 20 production platforms and four control sites in the north-central Gulf of Mexico. The objectives were to describe pathological conditions and to ascertain any correlation with the proximity of specimens to production platforms.

Among invertebrates, the most commonly observed histopathological conditions were protozoan and metazoan symbioses. Other common lesions included inflammation, focal and general leukocytoses, degeneration, necroses, and pigment accumulation. Much variation occurred in the invertebrate species which were available because of depleted bottom populations. At 10 of the 24 sites, including three of the four control sites, either no benthic organisms were present or those that were collected were severely stressed by the low oxygen conditions. Low oxygen conditions were apparently related to the influence of the Mississippi River. Because of the overriding effect of the "dead bottom," valid correlations of the invertebrate pathology with production platforms could not be made.

The following conditions were observed in all six vertebrate tissues: protozoa, helminths, and acidophilic granular cells. Less frequent observations included hyperplasia of the gill filaments, vasocongestion (gill), edema (gill), leukocytosis (liver, gill), fatty infiltration (liver), and chromatophores (liver, kidney, stomach). Much variation occurred between sites in the vertebrate species which were available because of differences in species associated with platforms and those associated with the control areas which did not have a platform. However, a correlation is shown by a comparison of study sites with the total number of histopathological conditions found in the fish from the sites.

Three platform sites strongly implicated as contaminated by hydrocarbons and/or trace metals occurred among the top six in total number of histopathological conditions. All eight of the platform sites which ranked high in histopathological conditions were located in the eastern part of the study area and had spadefish as one of the species sampled. Two of these eight platform sites ranked low in effects of hydrocarbons and were "probably not" affected by trace metals.

The four control sites occurred among the bottom seven in number of histopathological conditions. All four ranked medium in effects of hydrocarbons and were "possibly" affected by trace metals. Three were located in the eastern and one in the western part of the study area. Spadefish were not among the species sampled.

Two platform sites which occurred among the bottom four in number of histopathological conditions ranked high in effects of hydrocarbons. One, "probably" affected by trace metals, was located in the eastern part of the study area and one, "possibly" affected by trace metals, was located in the western part of the study area. All the sites in the western part of the study area ranked either medium or low in number of conditions.

This suggests that the platforms in the eastern part of the study area which consistently show contamination, whether from production or other sources, are those locations where stress is greatest on fish. Conversely, the supposedly least stressed sites show the fewest histopathological conditions.

I. INTRODUCTION

This is one of a series of studies sponsored by the Bureau of Land Management (BLM), Department of the Interior, to describe the offshore environments which might be detrimentally affected by exploration and production. The BLM is given, by law, the responsibility of regulating leasing of tracts on the United States Outer Continental Shelf (OCS). Further need to better understand the effects of long-term production leading to chronic, cumulative contamination predicated study of the most heavily-developed offshore area in the world. This comprehensive assessment of physical, chemical, and biological features of the Louisiana OCS has attempted to show any effects from drilling fluids used in development of the area and from long-term cumulative petroleum discharges from platforms.

The overall objectives of this ecological investigation are:

- determination of the distribution and concentration of petroleum hydrocarbons, selected trace metals, and well-drilling related substances in surficial sediments and tissues of commercially and/or ecologically important benthic and demersal species;
- examination of the microbial hydrocarbon degradation and nutrient cycling processes and related nutrient chemistry in surficial sediments;
- comparison of benthic communities, with emphasis on selected "indicators," in the immediate vicinity of platforms with those at control sites;
- examination of the distribution with depth in sediments of petroleum hydrocarbons, selected trace metals, and well-drilling related substances (i.e., to provide some measure of persistence);
- investigation of the biofouling communities and "artificial reef" effect associated with selected platforms representing a variety of production types and durations.

The results of this program and in depth discussions are given in Volume I, Pollutant Fate and Effects Studies, and Volume II, Artificial Reef Studies.

The objectives of this work unit were to collect and prepare histologic samples of tissues from invertebrates and vertebrates, to describe any pathologic conditions observed in these tissues, and to ascertain any correlation between incidence of histologic abnormalities in the organisms and the proximity of organisms to production platforms. All specimens were collected on the Louisiana Outer Continental Shelf, near producing oil and gas platforms and in appropriate control areas. The methods of procedure were in accordance with the outline of work requested by the Bureau of Land Management.

With the proposed leasing of the outer continental shelf areas for oil and gas exploration, questions arise concerning the effect of exploration and production of oil and gas on the shelf fauna. Little previous research has been conducted to help predict the effects on the benthic organisms and communities of the shelf. Two baseline studies, one on the South Texas OCS and the other on the Eastern Gulf, were recently completed. One study off the Louisiana Coast, conducted by several scientists and coordinated by Gulf Universities Research Consortium (GURC), gave varied results. Waller (1974) found his control stations more productive than his oil platform stations, with invertebrates presenting a "rather bleak picture" around the offshore production platform. Others, however, could find no deleterious effects on benthic fauna at production platforms when compared to control stations (Farrell, 1974*a*, *b*; Fish et al., 1974; Kritzler, 1974).

Other field studies have been conducted on the effects of oil on marine organisms, most dealing with acute catastrophic spills of oil into intertidal areas. Results indicate that although many organisms in affected areas may die, the areas generally completely recover in one to three years (Nelson-Smith, 1970; Straughan, 1971; Chan, 1975). The effects appear to be more long term, however, if the oil incorporates into sediments and slowly leaches out over an extended period of time (Michael, Van Raalte, and Brown, 1975). Studies conducted in Texas bays at oil separator platforms, which continuously release low levels of oil into the water, have demonstrated a pronounced zone of effect on habitation in the immediate vicinity (up to 150 m) of the separators (Mackin, 1971; Armstrong et al., 1979). Because these separators were located in very shallow (3 m maximum depth), turbid estuaries, the results of the studies cannot be applied to the deeper, clearer outer continental shelf areas. Some of the platforms located in shallow waters off Louisiana may be exceptions, provided the methods of discharge and other physical factors are similar.

The specific tasks of the work were: (1) to collect and prepare histologic samples from six tissues of five marine organisms (2 fish, 3 invertebrates) from each of 24 sites, (2) to examine, record, and photographically document the attributes of the prepared tissues (both normal and pathologic), and (3) to ascertain whether either the presence or the rate of incidence of pathologic conditions could be correlated with the proximity of the organisms to petroleum production platforms.

Muscle, liver, gut, gonad (when sufficiently developed), excretory tissue, and gill were collected for histopathologic analyses. These organs are considered sensitive indicators and were selected for the following reasons:

(1) Muscle tissue, besides being consumed by man, is a site of parasitism.
(2) The liver is a detoxifying organ.
(3) The gut is the first site of the digestive tract where sensitive absorptive cells are found. These cells are fairly sensitive to toxicants brought into the intestinal tract by means of the ingesta.
(4) The gonads are known to be sensitive to physiologic disturbances and serve as an early warning system.

(5) Kidney tubules (excretory tissue) are sensitive to certain stresses. The kidney has a relatively high incidence of parasitism in marine fish and the hemopoietic tissue is sensitive to stress.

(6) The sensitive epithelial surface of the gill is in contact with the aquatic environment and thus is exposed early to potential contaminants.

II. STUDY AREA AND SAMPLING DESIGN

A. The Study Area

The 20 platforms and four control sites located on the Louisiana OCS visited during this program are contained in a roughly rectangular area lying west of the Mississippi Delta and extending from 5 km (3 miles) to 120 km (75 miles) offshore and about 320 km (200 miles) west (Appendix A). Within this region platform depths range from 6-75 m and waters at the surface span the spectrum from low salinity, highly productive, estuarine in character to extremely clear and oceanic. Currents are extremely variable as a result of the complex combination of winds, river outflow, and deep oceanic intrusion from the south.

Part of the study area was influenced by Mississippi River outflow. The result of the river outflow was a smothering of the bottom from loss of oxygen in the deep layers and a subsequent emigration or death of the bottom fauna.

B. Sampling Design

Three cruises were made to include three climatic seasons: Cruise I, May 20-June 2, 1978; Cruise II, August 21-September 6, 1978; Cruise III, January 4-16, 1979. This work unit collected vertebrate and invertebrate samples on Cruise I and Cruise II only.

Four platforms (P1-4) were selected as primary sampling locations. They were complemented by four control sites (C21-24) selected to be as far away from production as practicable yet with similar environment, and by sixteen secondary platforms (S5-20) (Appendix A). All sites were designated by the Bureau of Land Management. It is well known that platforms cause effects in the immediate vicinity of the structure; therefore, this program was designed to sample at some distances from platforms in order to show any long-term buildup of contaminants in the sediments and whether these had found their way into the food web.

Samples for this work unit were collected at each primary and secondary platform site and at each control site as designated by BLM. The species studied included two species of demersal or platform-associated pelagic fishes and three species of benthic invertebrates from each site. A sample is defined as a lot of five (5) individuals of the same species. The minimal sampling effort was 120 samples (4 primary platform sites × 5 samples per site × 1 spring season + 16 secondary platform sites × 5 samples per site × 1 summer season + 4 control sites × 5 samples per site × 1 spring season) or 600 specimens (4 primary platform sites × 5 species × 5 specimens per species × 1 spring season + 16 secondary platform sites × 5 species × 5 specimens per species × 1 summer season + 4 control sites × 5 species × 5 specimens per species × 1 spring season).

Samples for histopathological analyses of fish were taken from each of the sites, yielding a minimum of 240 specimens (24 sites × 2 species × 5 individuals). Each specimen was dissected in order to recover six organs for fixation. The subsequent histological workup produced a minimum of 1440 total tissue samples (240 specimens × 6 organs).

Samples for histopathological analyses of invertebrates were taken from each of the sites, yielding a minimum of 360 specimens (24 sites × 3 species × 5 individuals). Each specimen was dissected in order to acquire a minimum of 2160 total tissue samples (360 specimens × 6 organs).

Ideally to make a comparison between control and platform sites, the samples collected at both types of sites would be of the same species, collected at the same time of year, of equivalent age, sex and reproductive status and of non-transient resident habit. Unfortunately, the study design did not permit all of these criteria to be met. The variation in habitat between a site with a platform, which acts as an artificial reef, and a control site without a platform resulted in a variation of species available. Another physical problem encountered in the field was the low-oxygen condition found at the dead bottom areas. Dead bottom occurred at ten of the 24 sites, including three of the four control sites. Low-oxygen conditions were apparently related to the influence of the Mississippi River. A third major physical variable was the differences among the platform sites selected by the sponsor with regard to production practices, e.g., oil or gas or both, amount of produced water, age, and whether flaring was above or below the surface of the water.

III. METHODS AND MATERIALS

A. Vertebrates

1. Field Sampling and On-Board Processing

Vertebrate samples for this work unit were collected by trawl at each control site and at approximately 500 m north of each primary and secondary platform. When specimens could not be collected at the location north of the platform, alternate methods (hook and line, and spear) were employed at the actual platform. Vertebrate samples included two species, with five individuals of each species, of benthic or platform-associated fish from each site. Specimens were collected at four primary and four control sites during Cruise I, May 20-June 2, 1978. Specimens were collected from the 16 secondary sites during Cruise II, August 21-September 6, 1978.

Living organisms were placed in an aerated holding tank and organ sample processing began immediately aboard ship to prevent postmortem changes. The organs sampled from each specimen within each species were stomach, kidney, muscle, liver, gill, and gonad. Small fish from three species at two sites were fixed whole by incising the abdomen. Samples of each organ, approximately 5 mm in all directions, as well as any whole specimens, were placed in tissue capsules with identification information and the capsules placed in a fixative solution. All samples were fixed in both Helly's solution (Humason, 1979) and 10% phosphate buffered formalin.

Some kidney samples had to be collected *in situ* by including a segment of vertebrae which lies dorsal to the kidney. Fish kidney tissue cannot readily be collected since it disintegrates when touched with instruments. In some cases, the kidney samples had to be decalcified after fixation and before dehydration. Fixed samples were transported to the histopathology laboratories at Texas A&M University.

2. Laboratory Analysis

In the laboratory, organs from the small fish were dissected using a dissecting microscope. All organ samples were washed in running tap water, dehydrated in increasing concentrations of ethyl alcohol, cleared in xylene, and embedded in paraffin. Sections 4-6 μm thick were cut from tissue fixed in Helly's solution and mounted on glass slides. Section size permitting, six sections of fixed tissues were mounted per slide. At least two slides were prepared for each organ. Slides were stained with Harris hematoxylin/eosin stain. Formalin-fixed tissue was held in reserve for sectioning when the results from tissue fixed in Helly's solution needed to be reaffirmed.

B. Invertebrates

1. Field Sampling and On-board Processing

The proposal called for the attempted collection of 360 invertebrate organisms. One hundred and twenty invertebrates (5 individuals of each of 3 species—including a bivalve, crab, and shrimp—from 8 sites—4 primary and 4 control) were to be collected during Cruise I, May 20-June 2, 1978. Two hundred and forty invertebrates (5 individuals of each of 3 species from 16 sites—secondaries) were to be collected during Cruise II, August 21-September 6, 1978.

As many as three collection methods were employed to acquire the invertebrates to be examined for histopathologies (trawls, grabs and divers). The method of choice was trawling. A 9.2-m (30-ft.) otter trawl was towed from 15 to 45 minutes near platform stations N500 and at the control sites to collect organisms for epifaunal, trace metal, hydrocarbon, and histopathological studies. Several tows were often necessary to acquire a full complement of crustacean and bivalve specimens. If sufficient numbers of bivalves were not obtained by trawling, they were sought from infaunal grab samples. A modified Smith-McIntyre grab was lowered at station N500 to acquire specimens for sediment, chemical, microbiological, meiofaunal and histopathological studies. As many as 13 attempts were made to obtain the required samples. If both of the above methods failed to produce a full complement of molluscs, divers were deployed to collect epifaunal bivalves directly from the platforms.

Living organisms were removed from the collecting equipment and placed in an aerated holding tank for immediate processing. Whenever possible, extra specimens were collected to allow fixation of live specimens in case some mortalities occurred in the holding tank. Usually six individuals were fixed in case one of the five required proved to be unsuitable for analysis. Each specimen was measured, and appropriate information concerning its gross condition and maturity was recorded. The six required organs (muscle, digestive gland, gut, gonad, excretory tissue and gills) were dissected if the organism was large enough. If the organism was too small to dissect properly, it was opened (crustacean exoskeletons were punctured, clams were pegged) to allow rapid penetration of the fixative and fixed *in toto*. Dissected organs and prepared organisms were labeled and placed in tissue capsules or wrapped in cheesecloth. Small organs (e.g., gut) were often wrapped in lens paper to prevent their loss through the perforations in tissue capsules. Bivalves from the primary platforms were collected by the Biofouling work unit divers and were fixed whole in 10% formalin by personnel from that work unit.

Helly's solution was used as the primary fixative because it elicits superior cell definition. Dissected tissues or whole organisms remained in Helly's for 24 hours. The fixed tissues were then washed in five changes of seawater and two changes of freshwater and ultimately stored in 70% ethanol. Mercury-contaminated washes were stored in 5-gallon plastic carboys or 55-gallon barrels and properly disposed of ashore. Whenever possible, five additional individuals of each type of invertebrate were fixed and stored (dissected or *in toto*) in Bouin's fixative or in buffered formalin (non-mercuric secondary fixatives). Specimens so fixed were to be used only to replace specimens fixed in Helly's in the event that they were rendered useless by failure to remove excesses of mercury and dichromate. The wash process outlined above was a critical step since substantial concentrations of mercury retained in the tissues from Helly's renders tissue too brittle for sectioning. Normally, tissues are washed in running water for 24 hours. Since this is impossible aboard ship, tissues were placed in several changes of seawater instead. Tissues fixed in Bouin's and formalin were to be substituted for any tissues which did not respond to static washings. Other Bouin's and formalin-fixed tissues were held in reserve for sectioning if the results from Helly's fixed tissues needed to be reaffirmed.

2. *Laboratory Analyses*

Fixed specimens were transported to the histopathology laboratories at Texas A&M University. There some of the specimens fixed *in toto* were dissected under a dissecting microscope. Other specimens were so small that they were embedded whole. Crabs too small for proper dissection were cut in half along a mid-sagittal plane and embedded whole. Shrimp excretory organs (antennal glands) were obtained by dissecting the cephalothorax along a frontal plane at the mouth and then dissecting the residual anterior portion of the cephalothorax along a mid-sagittal plane. The resulting halves were embedded whole. Small bivalves were cut into transverse sections. A similar method was employed for crab green glands. Specimens requiring decalcification were placed in a bone decalcifier with a formic acid/sodium citrate solution (Putt, 1972). Solutions were changed at 24-hour intervals until the supernate failed to show a positive test for calcium ions.

All tissues were dehydrated with ethanol and infiltrated and embedded in paraffin by a schedule similar to that presented in Humason (1979). The initial steps of this series were executed in an automatic tissue processor. A vacuum oven was utilized for final infiltration, and embedding was done by hand. Sections were cut at 6-8 μ and affixed to cleaned, labeled slides with Mayer's Albumen or gelatin (Humason, 1979). Section size permitting, at least six sections of fixed tissues were mounted per slide and at least two slides (12 sections) were prepared for each organ. Sections with large surface areas and those containing transections of crustacean exoskeleton were dipped in a celloidin solution prior to staining to prevent tissue loss (Putt, 1972). Samples fixed in Helly's were washed in iodine solution to remove residual mercury. Initial slides (12 sections) were stained with a standard Harris hematoxylin/eosin series (Humason, 1979). Additional slides were stained with two alternative series, Alcian Blue PAS and Masson's Trichrome.

IV. RESULTS

A. Vertebrates

Vertebrate species collected are given in Table 1. Vertebrate histopathology samples collected during Cruise I are described in Table 2. In Table 3 is a description of the samples from Cruise II. Numbers of specimens per species per site are given in Table 4.

TABLE 1. Vertebrate species collected

+*	A	Atlantic croaker *(Micropogon undulatus)*
+*	B	Rock sea bass *(Centropristis philadelphica)*
+*	C	Red snapper *(Lutjanus campechanus)*
*	D	Sand seatrout *(Cynoscion arenarius)*
*	H	Longspine porgy *(Stenotomus caprinus)*
+*	M	Sea catfish *(Arius felis)*
+	P	Rough scad *(Trachurus lathami)*
+ +	Q	Batfish *(Halieutichthys aculeatus)*
+	S	Pinfish *(Lagodon rhomboides)*
+*	T	Mexican (fringe) flounder *(Cyclopsetta chittendeni)*
+*	W	Sheepshead *(Archosargus probatocephalus)*
+*	X	Spadefish *(Chaetodipterus faber)*

A—X Indicates species code used in report.
+ Indicates species collected on spring cruise only.
* Indicates species collected on summer cruise only.
+* Indicates species collected on both cruises.

1. Muscle

a. Normal Microscopic Features

Muscle tissues were examined primarily in sections which were transverse to the longitudinal axis of the specimen, so that most of the fibers were viewed cross sectionally. On cross section, the fibers were irregularly shaped and the cross-sectional area varied somewhat even within the same muscle mass. On staining, the fiber was slightly basophilic and homogenous with multiple small, dense, darkly basophilic nuclei around the fiber perimeter. Mean cross sectional area of fibers in one muscle mass sometimes varied considerably from that in an adjacent but separate mass. Longitudinal fibers were sometimes seen where adjacent muscle masses coursed in different directions.

The arrangement of connective tissue in and around the muscle tissue appeared to be within three categories analogous to those used to classify mammalian muscle. Surrounding an entire muscle mass was a relatively thick sheet of connective tissue (epimysium). A considerably thinner sheet (perimysium) penetrated the body of the muscle, dividing the fibers into groups called fascicles. Finally, a very delicate sheet (endomysium) surrounded each individual fiber. Connective tissue was strongly acidophilic. Blood vessels traveled in the connective tissue, ending in capillaries at the fiber level.

b. *Histopathological Conditions*

Throughout the study only parasitic conditions, both protozoa and helminths, were observed in muscle tissue. Protozoa predominated by far, appearing in clusters in two locations: (1) within muscle fibers; (2) between muscle fibers.

Protozoa within fibers were neatly contained as a somewhat cylindrical collection of round, basophilically staining bodies (Fig. 1A,B). [Magnification notes (e.g., 775X) in the figure captions indicate the magnification of the actual image on the printed page. This includes the magnifications of the microscope, camera and printing enlarger.] A definite capsule surrounding the group was not discernible. On the other hand, protozoa found between muscle fibers (Fig. 1C) were contained by a capsule two to three layers thick. Individual protozoa were, again, round and stained basophilic.

Overall, the incidence of parasitism in muscle tissue was low. Among the four control sites,

TABLE 2. Characterization of vertebrate histopathology samples collected during Cruise I.

Site	Species	N*	Methods of Acquisition	Total Length (cm)	Numbers of M/F/H/U$^{\Delta}$	Sexual Maturity^{+}
P 1	*A. probatocephalus*	5	Spear	23.0-27.4	3/2/0/0	U
	C. faber	5	4 Spear, 1 Trawl	24.0-33.6	1/4/0/0	U
P 2	*M. undulatus*	5	Trawl	13.1-14.5	0/1/0/4	U
	A. felis	5	Trawl	21.2-29.0	0/5/0/0	U
P 3	*L. campechanus*	5	Hook	8.4-24.4	3/1/0/1	U
	L. rhomboides	4	Trawl	19.3-26.0	3/1/0/0	U
P 4	*L. rhomboides*	5	Trawl	23.0-29.7	2/2/0/1	U
	C. chittendeni	5	Trawl	8.6-11.1	1/3/0/1	U
C21	*A. felis*	5	Trawl	20.0-27.2	0/0/0/5	U
C22	*T. lathami*	3	Trawl	6.8-9.0	0/0/0/3	U
	H. aculeatus	5	Trawl	4.1-5.0	1/2/0/2	U
C23	*L. rhomboides*	5	Trawl	4.5-5.0	0/1/0/4	U

*N = number of individual organisms examined
+M = mature, I = immature, U = unknown
ΔM = males, F = females, H = hermaphrodites.

TABLE 3. Characterization of vertebrate histopathology samples collected during Cruise II.

Site	Species	N*	Methods of Acquisition	Total Length (cm)	Number of M/F/H/U[Δ]	Sexual Maturity+
S 5	*M. undulatus*	5	Trawl	16.0-20.0	2/3/0/0	I,M,U
	A. felis	5	Trawl	24.0-33.0	1/4/0/0	I,M
S 6	*C. faber*	5	Spear	30.0-34.0	1/4/0/0	M
	M. undulatus	5	Trawl	18.0-23.0	2/3/0/0	I,M
S 7	*C. philadelphica*	5	Trawl	18.0-23.0	1/4/0/0	I
	C. chittendeni	5	Trawl	21.0-22.0	4/1/0/0	M,U
S 8	*M. undulatus*	5	Trawl	18.0-20.0	3/2/0/0	I,M
	C. faber	5	Spear	26.0-35.0	2/3/0/0	M,U
S 9	*M. undulatus*	5	Hook	22.0-26.0	1/4/0/0	I,M
	C. philadelphica	5	Trawl	19.0-25.0	2/3/0/0	U
S10	*A. probatocephalus*	3	Spear	24.0-28.0	0/3/0/0	M,U
	C. faber	5	Spear	26.0-30.0	2/3/0/0	M
S11	*A. probatocephalus*	5	Spear	26.0-31.0	2/3/0/0	I,M,U
	C. faber	5	Spear	25.0-33.0	2/3/0/0	M
S12	*A. probatocephalus*	5	Spear	25.0-30.0	4/1/0/0	I,M
	C. faber	5	Spear	26.0-37.0	4/0/0/0	M
S13	*M. undulatus*	5	Trawl	17.0-21.0	2/3/0/0	M,I
	C. faber	5	Trawl	32.0-34.0	1/4/0/0	M
S14	*C. faber*	5	Spear	25.0-38.0	5/0/0/0	M
	C. chittendeni	5	Trawl	10.0-12.0	4/1/0/0	I
S15	*C. philadelphica*	5	Trawl	20.0-26.0	2/3/0/0	M,I
	S. caprinus	5	Trawl	13.0-16.0	4/0/0/1	U
S16	*S. caprinus*	5	Trawl	8.0-9.0	0/2/0/3	I
	C. chittendeni	5	Trawl	21.0-24.0	2/3/0/0	M,U
S17	*C. philadelphica*	5	Trawl	15.0-23.0	3/1/0/1	U
	S. caprinus	5	Trawl	14.0-16.0	4/0/0/1	U
S18	*L. campechanus*	5	Spear	20.0-25.0	2/3/0/0	I,U
	C. faber	5	Spear	27.0-38.0	2/3/0/0	M
S19	*C. faber*	5	Spear	9.0-10.0	1/4/0/0	I
	A. felis	5	Trawl	29.0-30.0	0/5/0/0	M
S20	*A. probatocephalus*	5	Spear	28.0-38.0	3/2/0/0	U
	C. faber	5	Spear	30.0-37.0	0/5/0/0	M
C21	*M. undulatus*	5	Trawl	18.0-20.0	3/2/0/0	U
C23	*S. caprinus*	5	Trawl	7.0-8.0	0/4/0/1	U
C24	*C. arenarius*	5	Trawl	21.0-22.0	1/4/0/0	U
	A. felis	5	Trawl	25.0-30.0	5/0/0/0	U

*N = number of individual organisms examined
+ M = mature, I = immature, U = unknown
ΔM = males, F = females, H = hermaphrodites.

TABLE 4. Vertebrate collection activity

Species	Total	Primary Sites P1-P4	Secondary Sites S5-S20	Control Sites C21-C24
Spadefish	55	5	50	--
Atlantic croaker	35	5	25	5
Sea catfish	25	5	10	10
Rock sea bass	20	--	20	--
Longspine porgy	20	--	15	5
Sheepshead	23	5	18	--
Mexican flounder	20	5	15	--
Red snapper	10	5	5	--
Sand seatrout	5	--	--	5
Pinfish	14	9	--	5
Batfish	5	--	--	5
Rough scad	3	--	--	3
TOTALS	235	39	158	38

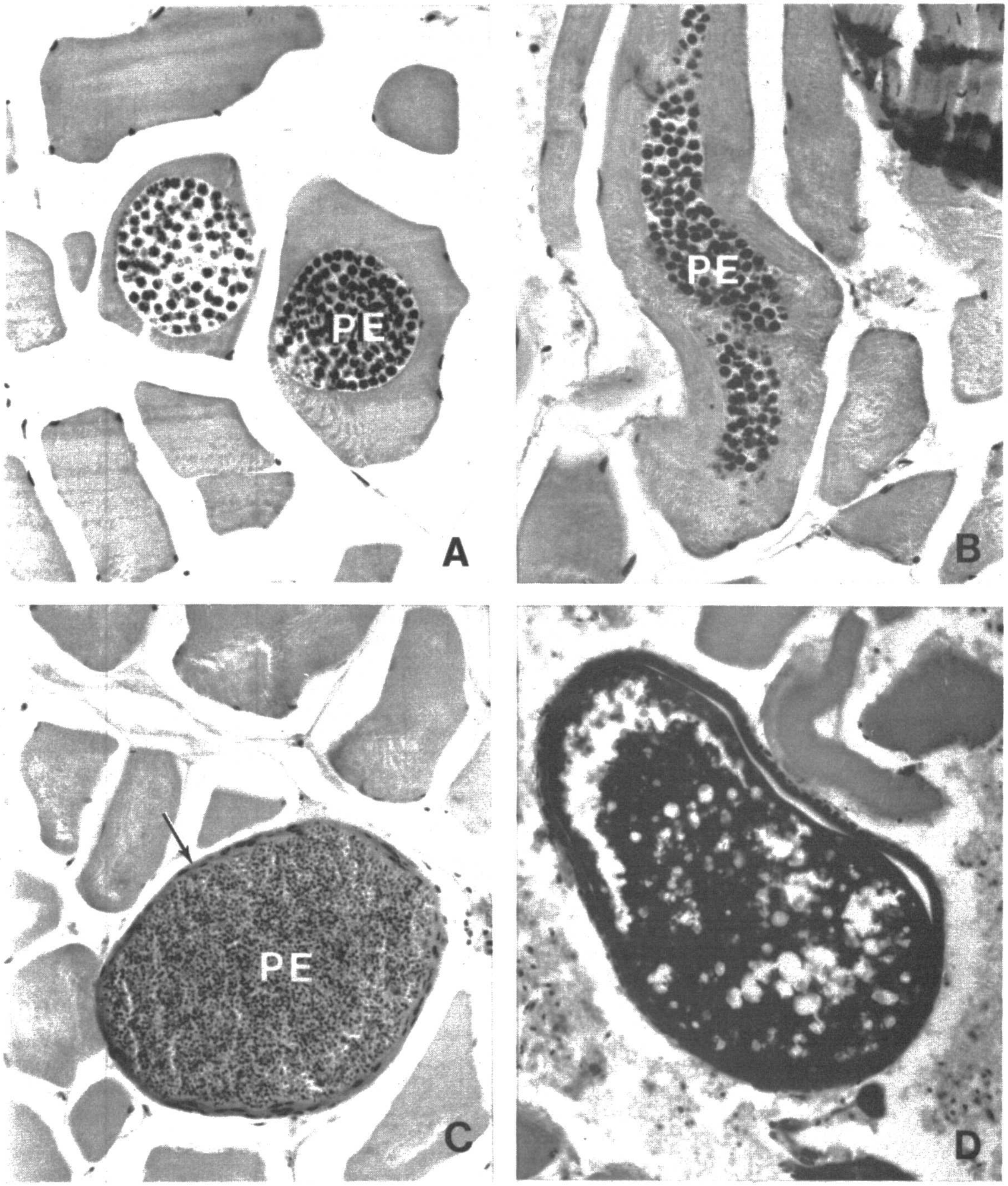

Fig. 1. Muscle. A. *A. felis.* Protozoa clusters (PE) within cross sectioned muscle fiber. 340X. B. *A. felis.* Protozoa cluster (PE) within longitudinally sectioned muscle fiber. 340X. C. *S. caprinus.* Protozoa cluster (PE) between muscle fibers. Note capsule (arrow). 340X. D. *A. felis.* Helminth between muscle fibers. 336X.

encapsulated protozoa were found at Sites C21 and C24. The sea catfish was the affected species at both of these locations. Of the 38 tissues examined at the control sites, parasitism was found in seven (3 at Site C21; 4 at Site C24) for an incidence of 18%.

Protozoa encapsulation occurred at three of the four primary sites (P1, P2, P3). Affected specimens were two sheepshead at Site P1, four sea catfish and one Atlantic croaker at Site P2, and one red snapper at Site P3. Of the 36 tissues examined from the primary sites, eight contained these encapsulations (2 at Site P1, 5 at Site P2, 1 at Site P3) for an incidence of 22%.

Encapsulated protozoa were found at six of the secondary Sites (S5, S11, S15, S18, S19, S20). Affected specimens were one Atlantic croaker and one sea catfish at Site S5, one red snapper at Site S18, and four sea catfish at Site S20. Of the 158 tissues examined, 11 had encapsulated protozoa, for an incidence of 7%.

Noteworthy was the predominance of encapsulated protozoa in the sea catfish; of the 10 specimens examined among the control sites, seven (70%) contained this lesion. At the primary sites, all four (100%) sea catfish tissues were positive. Among the secondary sites, five (50%) of the 10 sea catfish had protozoa.

Helminths (Fig. 1D) were found in one specimen of sea catfish at Site P2, one specimen of spadefish at Site S11, and one specimen of rock sea bass at Site S15.

2. *Liver*

Random samples of 5 μm sections of hepatic tissue were examined microscopically. The total of 235 liver specimens studied represented five individuals of two fish species each from 24 collecting sites in the Gulf of Mexico. Hepatic tissues were evaluated for symbiotic and nonsymbiotic conditions, which were then graded in terms of incidence.

a. *Normal Microscopic Features*

Liver tissue had an ill-defined lobular arrangement of anastomosing double cell lamina or muralia (Fig. 2A). Central veins were randomly situated in the parenchyma, and portal triads often lacked hepatic arteries. Sinusoids were frequently collapsed or engorged with blood, depending on the method used to sacrifice the fish. Kupffer cells lining the sinusoids were difficult to identify. The biliary system of ducts had cuboidal to columnar epithelium, surrounded by a basal lamina and supporting connective tissue. In many fishes, various quantities of hepatopancreatic tissue surrounded portal vessels but not the central or hepatic veins (Fig. 2A). Hepatopancreas was found in all species but not in all specimens. The cytoplasm of hepatic parenchymal cells varied in degree of vacuolation, granularity, and staining intensity among fishes.

b. *Histopathological Conditions*

Nonsymbiotic conditions identified in liver specimens were leukocytic infiltration, acidophilic granular cells, chromatophore pigmentation, pericholangial fibrosis, degeneration, and lipid accumulation. Symbiotic conditions were protozoa, helminths, cysts and granulomas.

Most liver specimens had an isolated or patchy mono-nuclear leukocytic infiltration (Fig. 2B). Individual blood vessels, hepatopancreas, cysts, bile ducts, or muralia of hepatic parenchyma were involved. Sheepshead liver had the highest incidence of connective tissue white cell densities.

Acidophilic granular cells (Fig. 2C) were profuse in the hepatic stroma of many fishes and absent in others. These large cells assumed various shapes and contained granules of numerous sizes, densely packed into the cell cytoplasm. In various specimens, these cells were adjacent to blood vessels, cysts, bile ducts, and hepatopancreas, as well as beneath the serosa. Occasionally they stained basophilic. Acidophilic granular cell incidence was high in all sheepshead and most Atlantic croaker. These cells were notably absent in all Mexican flounder and sand seatrout and in 19 of 20 sea catfish. They occurred frequently with cysts, helminths, blood vessels, chromatophores, hepatopancreas, and bile ducts.

Various pigmentations (Fig. 2B, D) were found in fish livers and were categorized as chromatophores. The colors ranged from yellow to gold, tan to brown, and black. Chromatophore clumping usually occurred adjacent to or within hepatopancreatic tissue but small clumps were also seen adjacent to bile ducts and blood vessels. Chromatophore clusters varied in size from several cells to large irregular masses separated from adjacent tissues by a thin, almost inconspicuous, membrane. Within chromatophore cells, a granular material predominated, although black melanin granules were occasionally present. All sea catfish and sheepshead and most spadefish livers contained a varying incidence of chromatophores. Pigmentation was sometimes so dense that it was difficult to identify the hepatopancreas. Chromatophore pigmentation was absent in all rough scad and batfish and in all but one Mexican flounder.

Pericholangial fibrosis (Fig. 3A,B) consisted of a thickening of the biliary duct connective tissue layers with generalized to heavy leukocytic infiltration in some cases. Not all bile ducts were affected throughout the liver specimen; rather, a spotty or focal fibrosis was generally seen. The most severe cases were seen in spadefish, while a few livers of other fishes had a varying incidence of pericholangial fibrosis in the small to medium sized ducts.

Spotty or focal liver degeneration was seen in 44% of the fish (Fig. 3C). This was evidenced by focal sites of a light pale zone surrounded by normal liver parenchyma not attributed to fixation artifact, postmortem change, or irregular affinity of the stain. The degenerative sites were rather small. Several spadefish had a higher incidence of this condition than other fishes.

Extracellular lipid accumulation (Fig. 3D) pervaded 48 of the 49 livers of spadefish, excluding those from Site S19. Spadefish collected at Site S19 were comparatively small (9-10 cm), while fatty-livered spadefish collected at other sites were larger (20-38 cm). There was a large accumulation of fat in the livers of these larger fish, fat which appeared to occupy from 40-70% of the liver volume. Fat lobules were present around blood vessels and bile ducts and beneath the serosa. Even hepatopancreatic tissue was partially encased by fat in many cases. All red snapper, sand seatrout, rock sea bass, Mexican flounder, and batfish were free of fatty tissue. Other fishes had little or no fat in their livers.

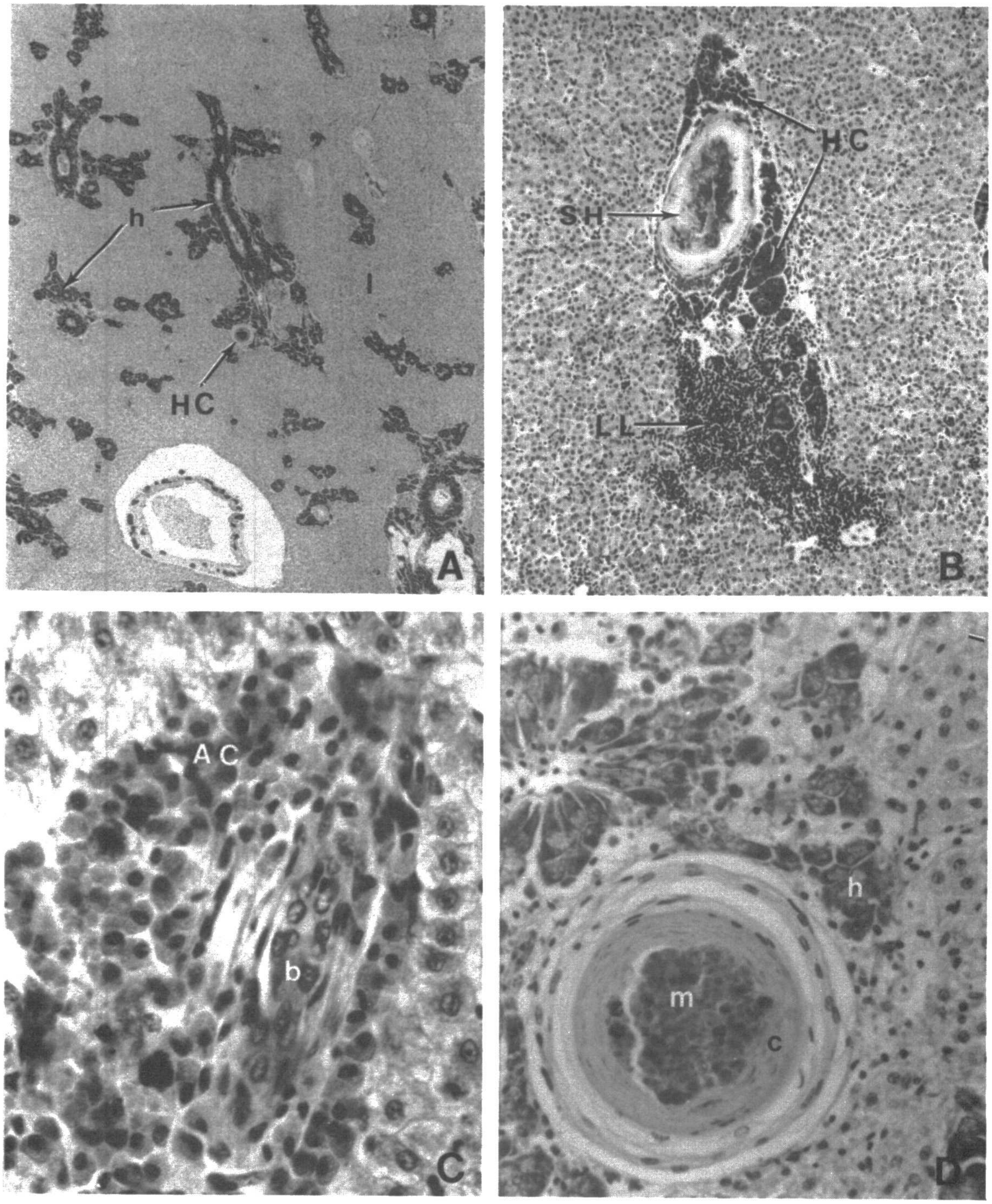

Fig. 2. Liver. A. *A. probatocephalus.* Relative quantity of hepatopancreatic tissue (h) compared to liver parenchyma (1) and a residing pigmentary encapsulation (HC). 34X B. *A. felis.* An encysted degenerated helminth (SH) surrounded by chromatophores (HC) and mono-nuclear lueukocytes (LL). 85X. C. *A. probatocephalus.* Acidophilic granular cells (AC) form a dense aggregation around a small bile duce (b). 755X. D. *A. probatocephalus.* An enlargement of the pigmentary encapsulation in A with its black melanin granules (m) and capsule (c) situated adjacent to hepatopancreas (h). 472X.

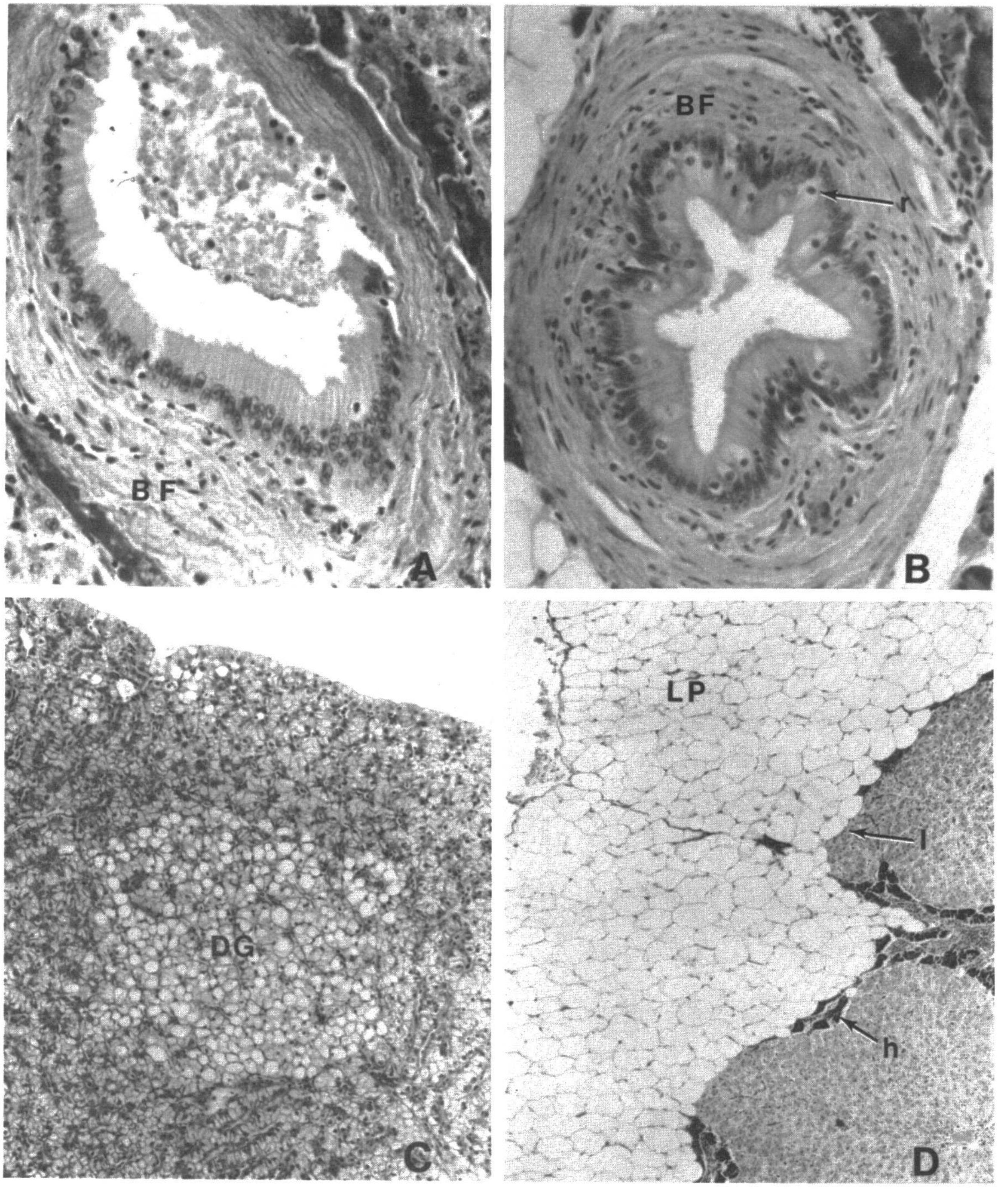

Fig. 3. Liver. A *S. caprinus.* **Pericholangial fibrosis (BF) in a large bile duct. 472X. B.** *C. philadelphica.* **A bile duct with moderate pericholangial fibrosis (BF) and rodlet cells (protozoa) (r) in the epithelium. 472X. C.** *M. undulatus.* **Focal hepatocellular fatty metamorphosis (DG). 136X. D.** *C. faber.* **Dense fatty tissue deposition (LP) around the liver surface (1) and hepatopancreas (h). 85X.**

Protozoa were infrequently found in hepatic tissue. These symbionts were located in nests within chromatophore clusters (Fig. 4A), hepatopancreas (Fig. 4B), and/or hepatic tissue. Rodlet cells (or protozoans) (Fig. 3B) were occasionally present in the biliary epithelium.

Various types of cysts and granulomas were infrequent in liver specimens. Some cysts were classed as degenerated helminths (Fig. 2B) based on fragmentary remains. Granulomas (Fig. 4C) contained dense, thick walls of fibrous connective tissue, with mononuclear leukocytes adjacent to the capsule in some cases. This condition was random throughout the fishes studied and did not have a significant frequency of occurrence in a particular species of fish or at a particular collecting site.

Helminths were rarely seen and occurred in only 13 of the 235 fish. These symbionts were located in liver parenchyma, peribiliary space, or subserosal layer (Fig. 4D). One liver in each of the five Atlantic croaker and longspine porgy had a severe infestation of helminths with some associated leukocytic infiltration.

Fish from Sites S12, S20, S11, and P1, where sheepshead and spadefish were exclusively collected, had the highest average number of conditions per liver of the 12 species studied. The lowest average number of conditions per liver occurred at Sites C23, S7, S16, and C22, where pinfish, longspine porgy, rock sea bass, Mexican flounder, rough scad, and batfish were collected. Symbiosis was most frequent at Site S12 and absent at Site C21.

The average number of conditions per liver in the various species, in decreasing order of frequency, were: sheepshead 5.2; spadefish 4.5; pinfish 3.3; sea catfish 3.0; longspine porgy 2.8; sand seatrout 2.8; red snapper 2.7; Atlantic croaker 2.6; rock sea bass 2.4; rough scad 2.0; Mexican flounder 0.6; batfish 0.6.

Fish collected from control Sites C21-C24 had an average of 1.5 conditions in 38 livers; those from primary Sites P1-P4 had an average of 3.4 conditions in 39 livers; and those from secondary sites S5-S20 had an average of 3.4 conditions in 158 livers. Fish from around the oil-producing wells at Sites P1, P2, and P3 had an average of 3.6 conditions per liver, while fish from around the gas well at Site P4 had an average of 2.8 conditions per liver.

3. *Gut*

Tissue from 235 fish stomachs or regions of anterior intestine was examined histologically. These specimens represented 12 species of fish collected from 24 sites in the Gulf of Mexico.

a. *Normal Microscopic Features*

The wall of the stomach or anterior intestine consisted of mucosa, submucosa, muscularis, and serosa. Fish stomachs filled with organic material had a less folded and undulating mucosa than did empty stomachs. The mucosa consisted of tall columnar epithelium lining the gastric pits. The gastric glands, continuous with the epithelium at the gastric pits, were variable in thickness depending on the species of fish and the region sampled. The tunica propria was a delicate connective tissue stroma providing support for the epithelium and glands. No muscularis mucosa was apparent. The underlying submucosa consisted of loose connective tissue between the gastric glands and the muscularis layer.

Submucosal projections extended into underlying folds of mucosa, thus altering the thickness of the submucosa at various regions. Nerves and numerous blood vessels, either filled with blood cells or nearly empty depending on the method of animal sacrifice, lay in the connective tissue stroma of the submucosa. The muscularis coat consisted of two separate muscle layers, an inner circular, and an outer longitudinal. Both layers had different thicknesses in different species. Layers of connective tissue enclosed various muscle fasciculi and also separated the two layers of muscle. External to the muscularis was a layer of flattened mesothelial cells, the serosa. It surrounded the entire stomach section except at the site of vessel and nerve entry where the mesentery attached.

b. *Histopathological Conditions*

The nonsymbiotic conditions identified in stomach sections of the 12 species of fish were leukocytic infiltration, acidophilic granular cells, and chromatophore pigmentation. Symbiotic conditions were protozoa, helminths, cysts, and granulomas.

Localized mononuclear leukocytic infiltration in stomach tissue was common in most fish, either in one of the stomach wall layers or in all layers, depending on the degree of white cell response. The criteria for scoring the intensity of the condition was based on the distribution and density of white cells. Generalized leukocytic infiltrations of the entire stomach section were less common and the submucosa was most frequently affected (Fig. 5A). In some cases, the mucosa appeared eroded or reduced with a dense leukocytic infiltration (Fig. 5B), while in other cases isolated areas of the muscularis were infiltrated with leukocytes. Leukocytic infiltrations frequently, but not always, surrounded cysts (Fig. 5C), granulomas, and parasites. Most spadefish had a high incidence of this condition, while it was not seen in Mexican flounder, sand sea trout, batfish, and rough scad.

Acidophilic granular cells were defined as connective tissue cells that contained cytoplasmic pink to bright red granules of various sizes. (The eosin in Harris hematoxylin eosin stain turns these granules pink to bright red.) These cells had various shapes depending on their location in the gastric wall. They occurred in all layers of the stomach or anterior intestinal wall, in the epithelial layer of the mucosa (Fig. 5D) and even occasionally in the gastric lumen of a couple of specimens. Acidophilic granular cells were found in association with blood vessels, cysts, granulomas, and parasites in some cases but were not associated with symbionts in others. These cells were found in zones of normal tissue distant from other types of stomach conditions. Acidophilic granular cells were not seen in any red snapper, rough scad, batfish, or sand seatrout, nor were they found in 14 of the 15 sea catfish and Mexican flounder. Most spadefish, pinfish, longspine porgy and Atlantic croaker had large numbers of these cells, while several other fish showed a few to moderate numbers of acidophilic granular cells.

Chromatophores were infrequently found in the submucosa and were defined as small, inconspicuous clusters of pigment primarily located nearer to the

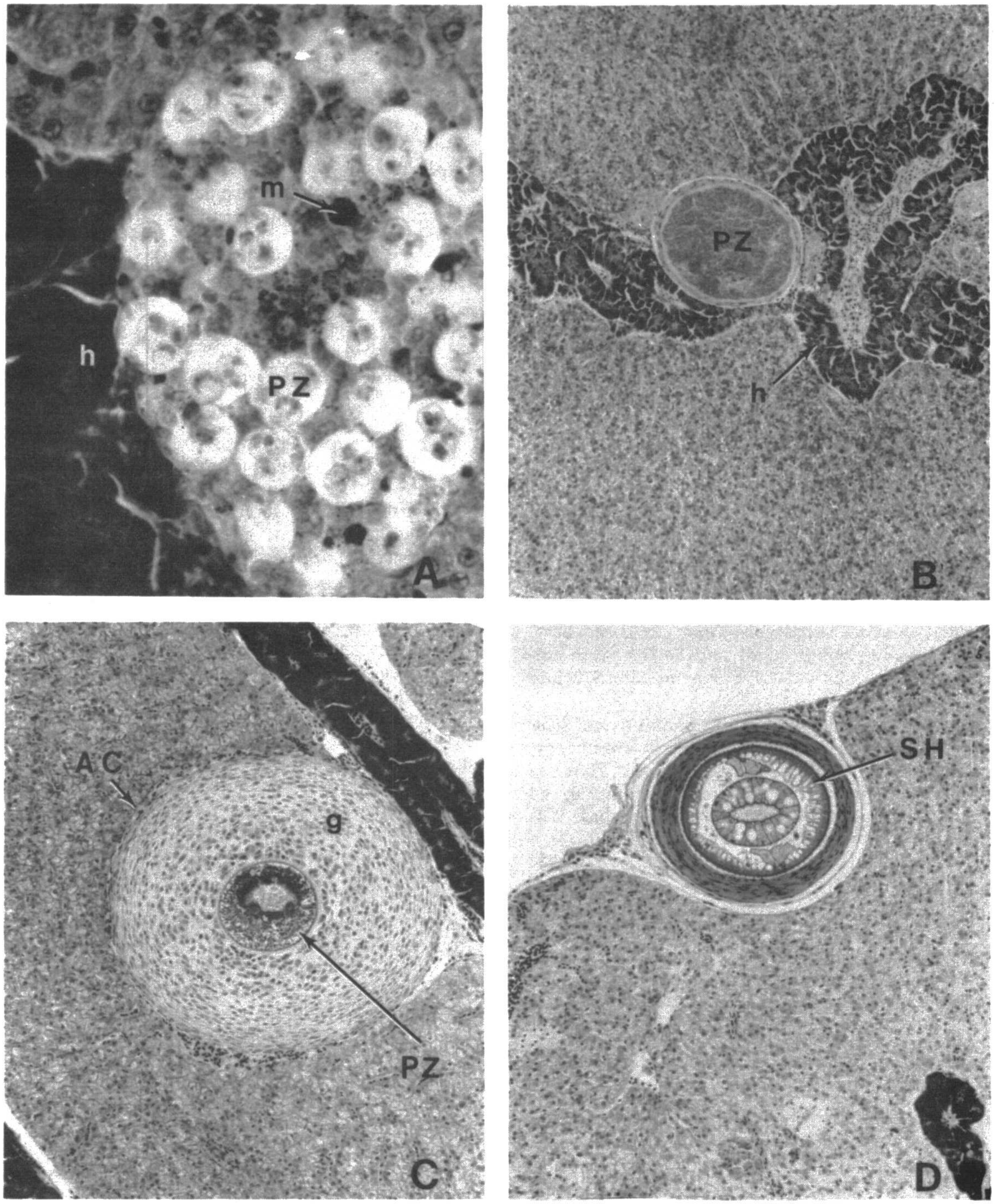

Fig. 4. Liver. A. *S. caprinus*. A melanotic myxosporidium cyst (PZ) containing a few black maelanin granules (m) adjacent to hepatopancreas (h). 755X. B. *C. faber*. A microsporidium cyst (PZ) within a ribbon of hepatopancreas (h). 136X. C. *M. undulatus*. An early stage of a degenerated protozoan granulomatous cyst (PZ) with a thick wall (g) surrounded by acidophilic granular cells (AC). The cyst is extrahepatic and indents the hepatic surface. 136X. D. *S. caprinus*. An encapsulated nematode (SH) situated within the liver capsule and impinging on hepatic space. 136X.

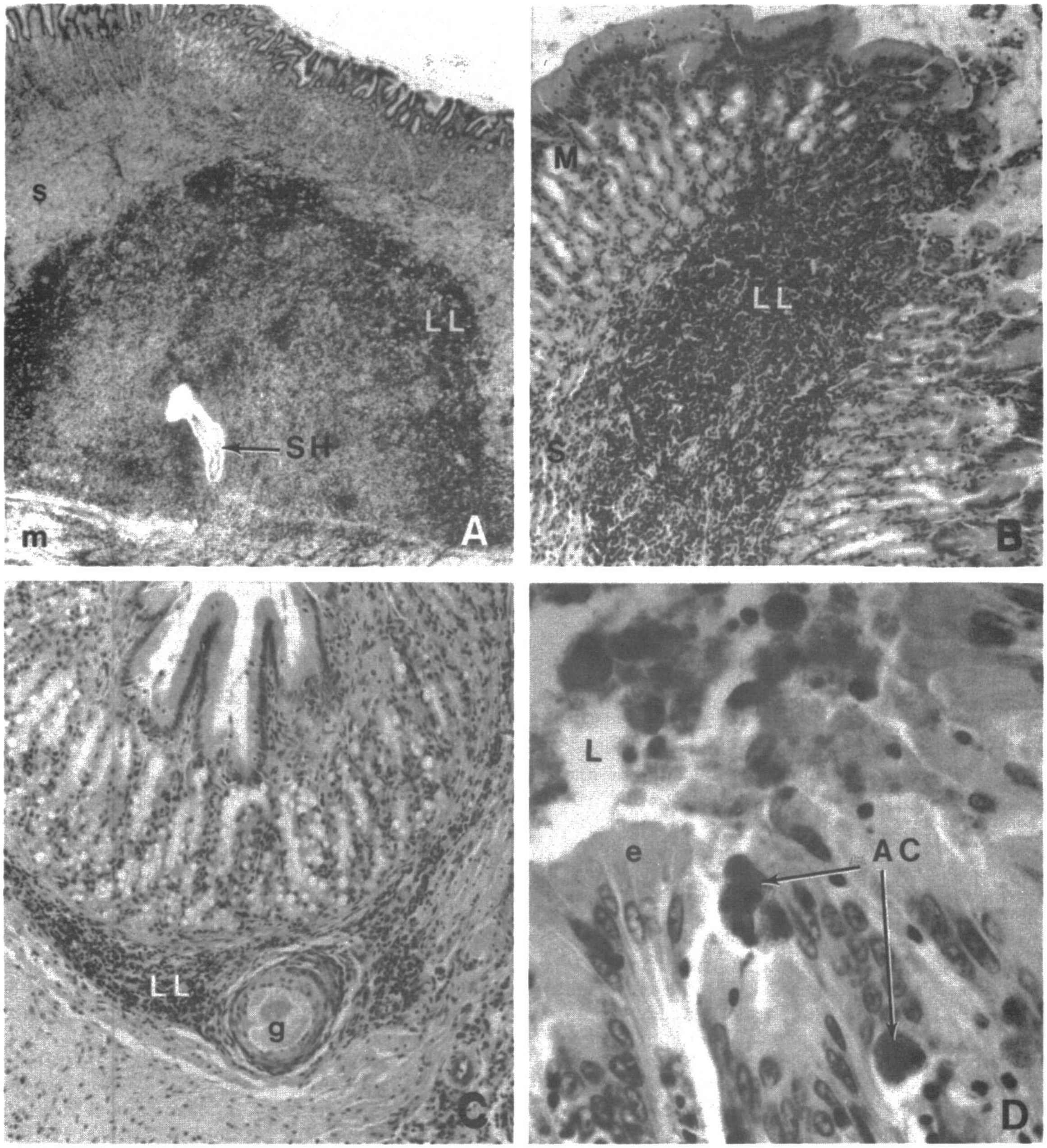

Fig. 5. Gut. A. *L. campechanus*. Mononuclear leukoctyic (LL) response to renmant of a helminthic symbiont (SH) in the submucosa (s) and muscolaris externa (m). 47X. B. *C. faber*. Host response (LL) in the mucosa (M) and submucosa (S) with partial destruction. 188X. C. *C. faber*. A degenerated helminthic granulomatous cyst (g) with a localizing submucosal response (LL) containing a few acidophilic granular cells. 47X. D. *S. caprinus*. Acidophilic granular cells (AC) within the gut epithelium (e) and lumen (L). 755X.

mucosa than the muscularis layer (Fig. 6A,B). Usually only a single small cluster of chromatophores was present in a specimen. All Atlantic croaker from Site S5 and spadefish from Site S8 were pigmented, with a high intensity in the stomach wall of one fish. Several species contained no pigmentation.

Protozoa (rodlet cells) were located in the gastric epithelium and were elliptical or oval (Fig. 6C). The nucleus of the protozoa or rodlet cell was eccentric and directed toward the basal lamina. Cytoplasmic filaments or rodlets extended along the long axis of the cell. Other types of protozoa were rarely seen in the submucosa as minute clusters with or without encapsulation. Most spadefish contained a few to many protozoa, while rough scad and rock sea bass were free of protozoa. Various fish of other species showed a wide range of protozoan involvement. All collecting sites contained fish with some protozoal symbionts.

Encapsulated cysts and granulomas (Fig. 6D) were the most frequently encountered of the conditions in the gut and were noted in gross dissection of the fish body cavity. In some specimens, as many as seven large encapsulated structures were noted microscopically in a single section of stomach wall. They occurred in all layers of the stomach, with or without leukocytic infiltration. Some cysts and granulomas were extremely small, while others were large and produced deformations of the adjacent stomach wall tissues. Rough scad and batfish from Site C22 were the only two species without this condition. Nearly all other species showed numerous to few cystic structures.

Helminths were scattered in the various layers of the stomach wall with no predilection for one layer over another (Fig. 7A,B,C,D). In this condition some symbionts were associated with a mononuclear leukocytic reaction, while others showed an adjacent fibrous tissue response. Several spadefish from Sites P1, S6, S10, and S20 had numerous helminths. Helminths were noted in some live fish upon opening the body cavity. Stomach tissues of most fish, however, showed no histological evidence of helminthic parasitism.

Spadefish from Sites S14, S18, S20, S10, and S6 had the highest average number of stomach conditions. The lowest average number of conditions per stomach occurred in fish from Sites C22, S14, C21, and S7, where rough scad, rock sea bass, sea catfish, and Mexican flounder were collected. Symbiosis was most frequent in fish (sheepshead, spadefish) from Site P1 and was absent in fish from Site C22 (rough scad).

4. Gonad

a. Normal Microscopic Features

(1) Male— The fish testicle had some of the features of the mammalian testicle, such as cortex, medulla, outer capsule, and radiating trabeculae or septula extending from the outer capsule to a central hilus or mediastinum (Fig. 8A). The cortex from immature fish consisted of cords of epithelial cells, two to three cells in diameter, extending parallel with the septula from cortex toward medulla (Fig. 8B). As the testicle matured, the cords of cells canalized and various stages of spermatogenesis were observed in any one tubular structure. All stages of spermatogenesis were commonly seen in the testicle (Fig. 8C,D). The percentage of each stage of cells present varied from all spermatogonia to nearly all spermatozoa. In the latter case, the rete testis was often dilated with morphologically mature spermatozoa. In some species, the rete testis appeared much better developed than in others. In rock sea bass, the rete testis appeared scattered, with some parts subcapsular (Fig. 8D).

The capsule varied greatly in thickness. In rock sea bass and the sea catfish it was very thick, whereas in other fishes, such as sand seatrout, fringe flounder, sheepshead, and spadefish, the capsule was much thinner. In all fish examined, the seminiferous tubules were similar, generally with one layer of cells lining the tubule. The cells in any particular segment were usually in the same developmental phase within a mature testicle (Fig. 8C,D).

In this investigation, the spermatogenic cycle was divided into only four phases, each with its characteristic cells (Fig. 11C): (1) spermatogonia, light staining cells with large, light staining nuclei; (2) primary spermatocytes, with minimal cytoplasm and prominent chromatin clumps or chromosomes; (3)spermatids, initially the same size as spermatocytes and containing light staining nuclei, but later with more condensed nuclei and minimal cytoplasm; and (4) spermatozoa, with much more condensed nuclei and typical sperm characteristics.

(2) Female— The fish ovary had only a few features of the mammalian ovary. It was a capsular sack made of muscular and connective tissue and filled with tubules that contained ova in various stages of development (Fig. 9A,C). There was a hilus or medullary region through which the vessels entered and left the ovary. The immature fish ovary consisted of a series of straight tubules converging from the thickened ovarian capsule toward the hilus (Fig. 9B). Each of these tubules was lined with ovigenic cells, generally just one cell deep. Sections of blood vessels were observed within the tubules and between the rows of ova and developing follicles.

Ovaries from different species of fish were different only in size, stage of development of ova and follicles, and disruption of the uniform tubular pattern as large follicles developed.

For simplicity, the development of the ovum was divided into four phases (Fig. 9C): (1) primary ovum, (2) secondary ovum, (3) growing follicle, and (4) mature follicle. The primary ova were small cells, 20-30 μm in diameter, with dark staining cytoplasm and a nucleus about 15 μm in diameter. The secondary ova were larger but similar in appearance, up to 80 μm in diameter with a 15-20 μm nucleus. The nucleus contained light staining vesicular nucleoplasm, 3-6 chromatin clumps and a prominent, spherical, eosinophilic nucleolus. Up to this size, germ cells with no surrounding cells were termed ova (Fig. 9D). The growing follicle, the next larger structure, was 0.7-1.0 mm in diameter with a thin, discernible vitelline membrane, the beginning zona pellucida; one layer of cuboidal follicular cells; a basement membrane; one or two layers of fibroblast-like thecal cells (Fig. 10A); and some small blood vessels. The follicular cytoplasm was lighter staining than in the smaller ova and had begun to vacuolate randomly. The nucleus in these cells was a much less prominent, lighter staining structure than in the younger ova. Mature follicles varied in diameter (up to 2 mm) in the specimens

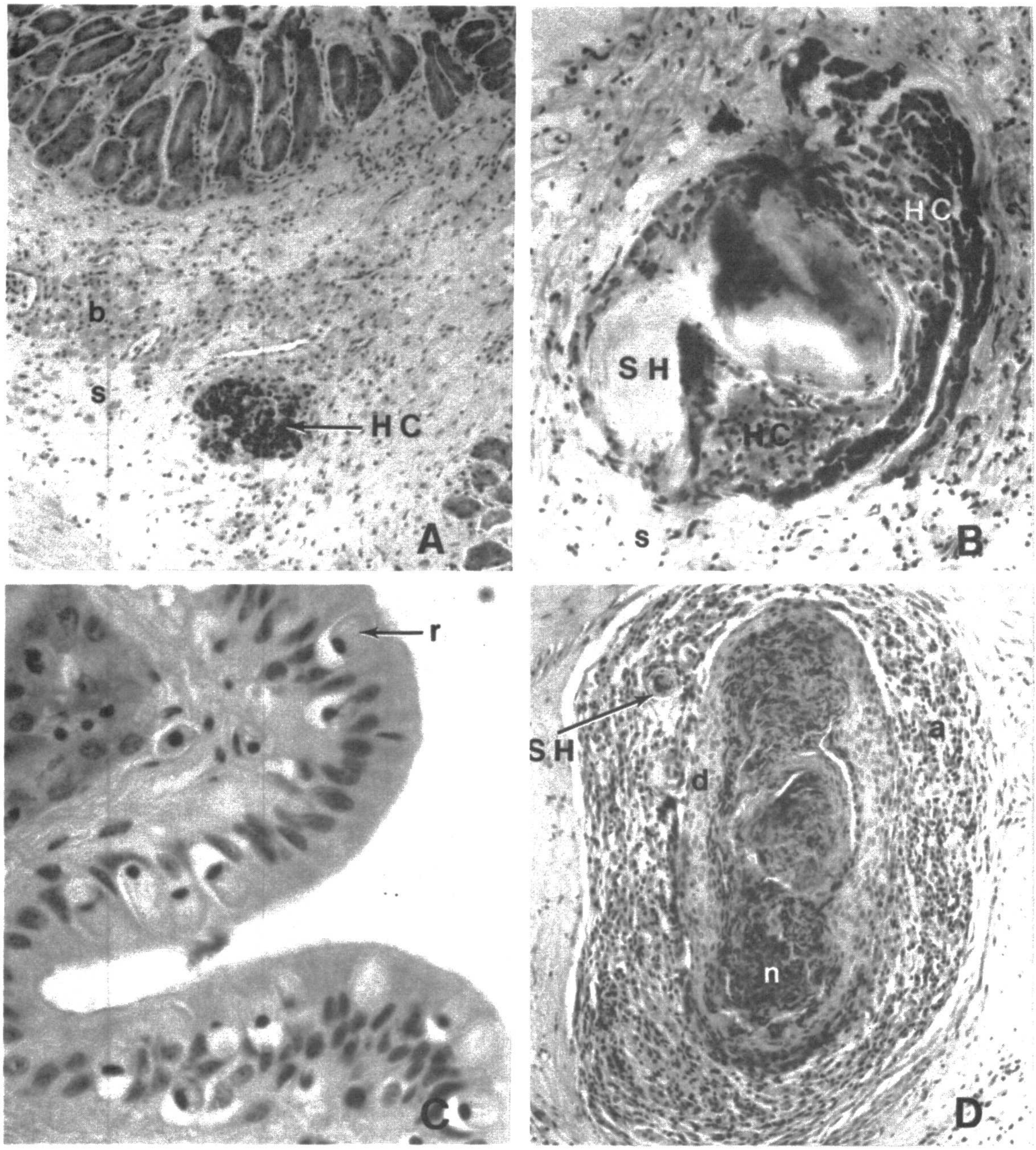

Fig. 6. Gut. A. *M. undulatus*. Unencapsulated cluster of chromatophores (HC) with basophilic granular cells (b) in the submucosa (s). 188X. B. *A. felis*. Chromatophores (HC) partially envelop a degenerated symbionet (SH) in the submucosa (s). 188X. C. *C. chittendeni*. A dense population of rodlet cells (protozoa) (r) occupy the intestinal epithelium. 755X. D. *C. philadelphica*. A complex granulomatous host response composed of a central area of caseous necrosis (n) surrounded by dense (d) and areloar (a) fibrous connective tissue capsules with a larval nematode (SH). 188X.

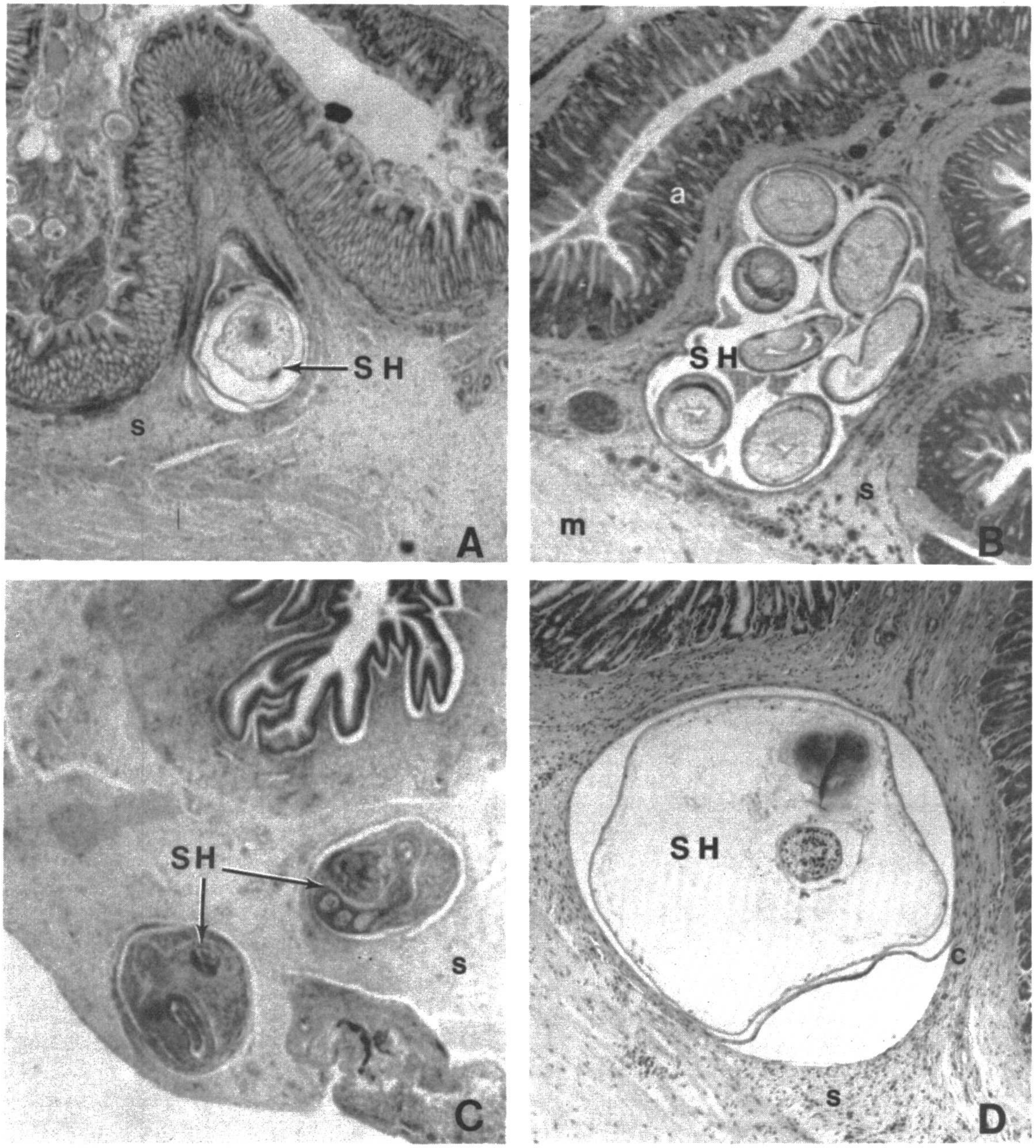

Fig. 7. Gut. A. *C. faber*. An encapsulated immature cestode (SH) with a mild response in the submucosa (s). A few acidophilic granular cells are present in the capsule. 47X. B. *M. undulatus*. An encysted nematode (SH) in the submucosa (s) with a mild fibrophasia by the host. Muscularis externa (m) and mucosa (a) are normal. 47X. C. *C. philadelphica*. A degenerated nematodic granulomatous cyst (SH) in the submucosa (s). At high power many acidophilic granular cells are seen within the cyst. 47X. D. *M. undulatus*. An encapsulated cestode (SH) enveloped by fibrous connective tissue (c) in the submucosa (s). 47X.

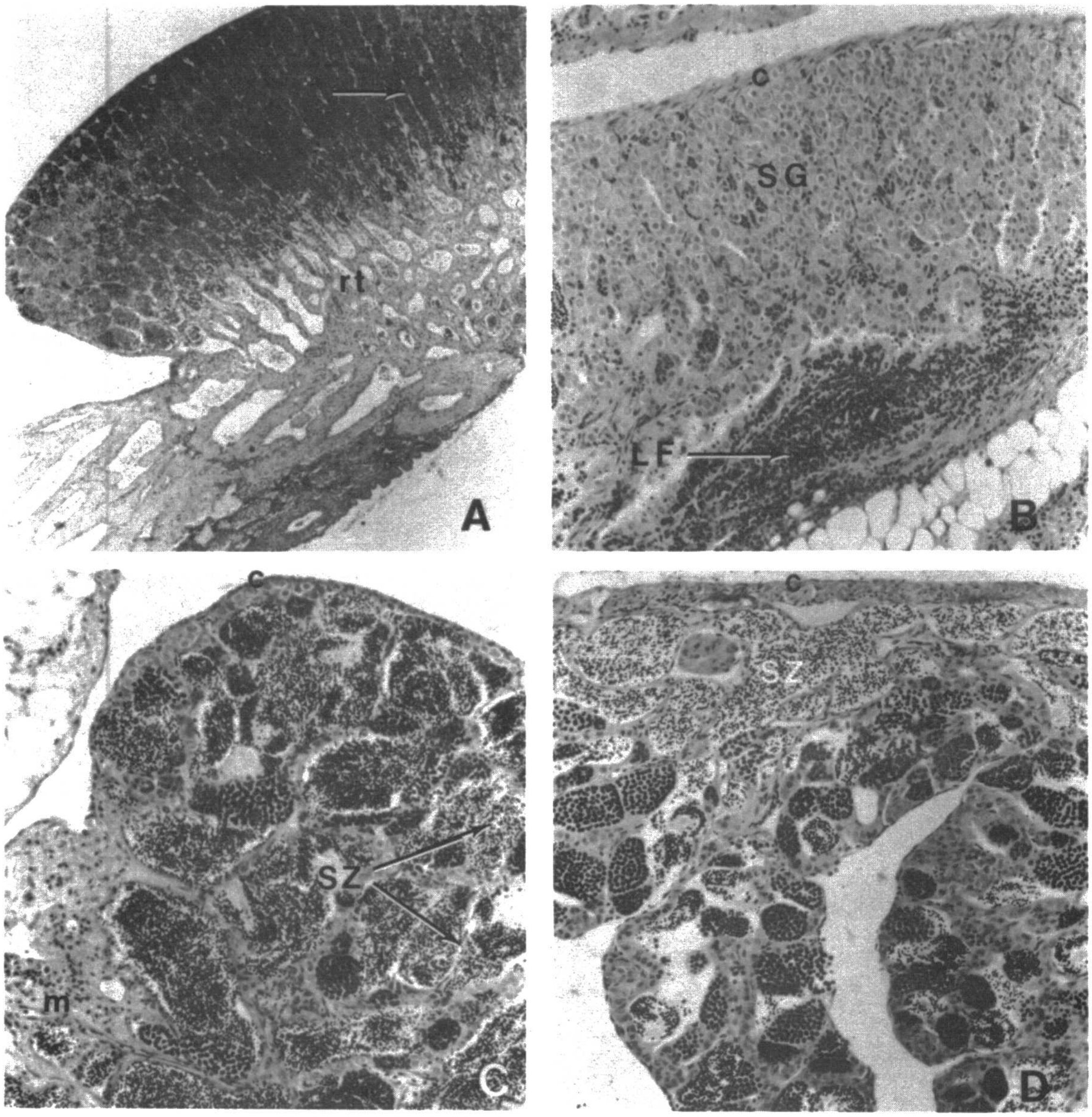

Fig. 8. Gonads. Physiologic morphology of the testis. A. *C. chittendeni.* Radiating septula (arrow) extending from capsule to medulla between seminiferous tubules. Rete testis (rt) of medulla. 47X. B. *L. campechanus.* Immature testis showing mostly spermatogonia (SG), a prominent capsule (c), and focal leukocytosis (LF) in the medulla. 185X. C. *L. campechanus.* All stages of spermatogenesis, with spermatozoa (SZ) throughout cortex but mostly in the medullary region (m). 185X. D. *C. philadelphica.* Testis similar to C in physiologic state but with most of the more mature spermatozoa (SZ) directly under the capsule (c). 185X.

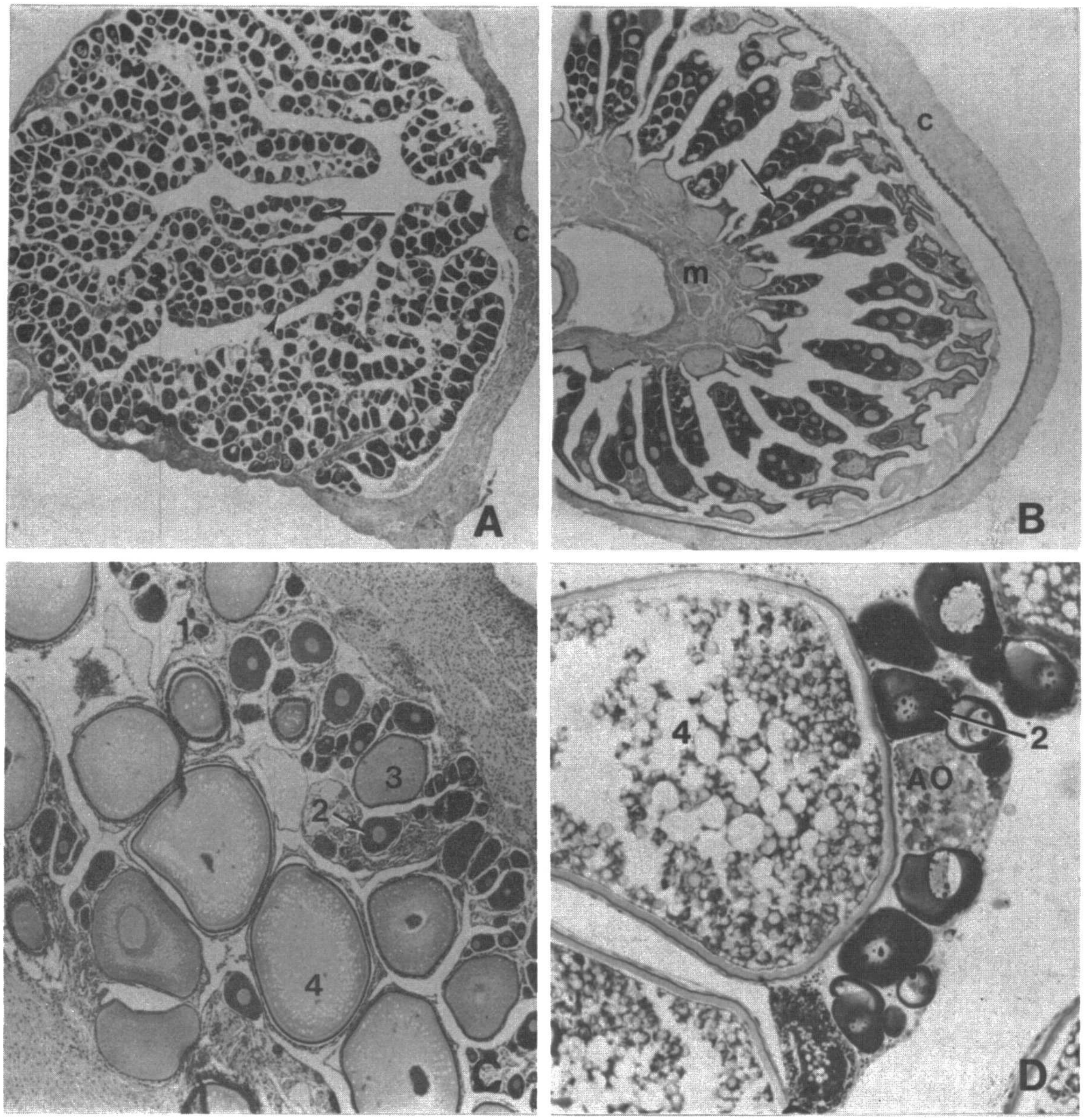

Fig. 9. Gonads. Physiologic and pathologic conditions of the ovary. A. *M. undulatus*. Mature ovary, out of season, showing the capsule (c) and undulating tubules which contain only primary ova (arrowhead) and secondary ova (arrow). 47X. B. *H. aculeatus*. Less development than A. Tubules containing ova (arrow) extending from capsule (c) to medulla (m). 47X. C. *A. felis*. Maturing ovary with primary ova (1), secondary ova (2), growing follicles (3), and nearly mature follicles (4). 47X. D. *M. undulatus*. Maturing ovary showing secondary ova (2), mature follicles (4), and an atretic follicle (AO). 185X.

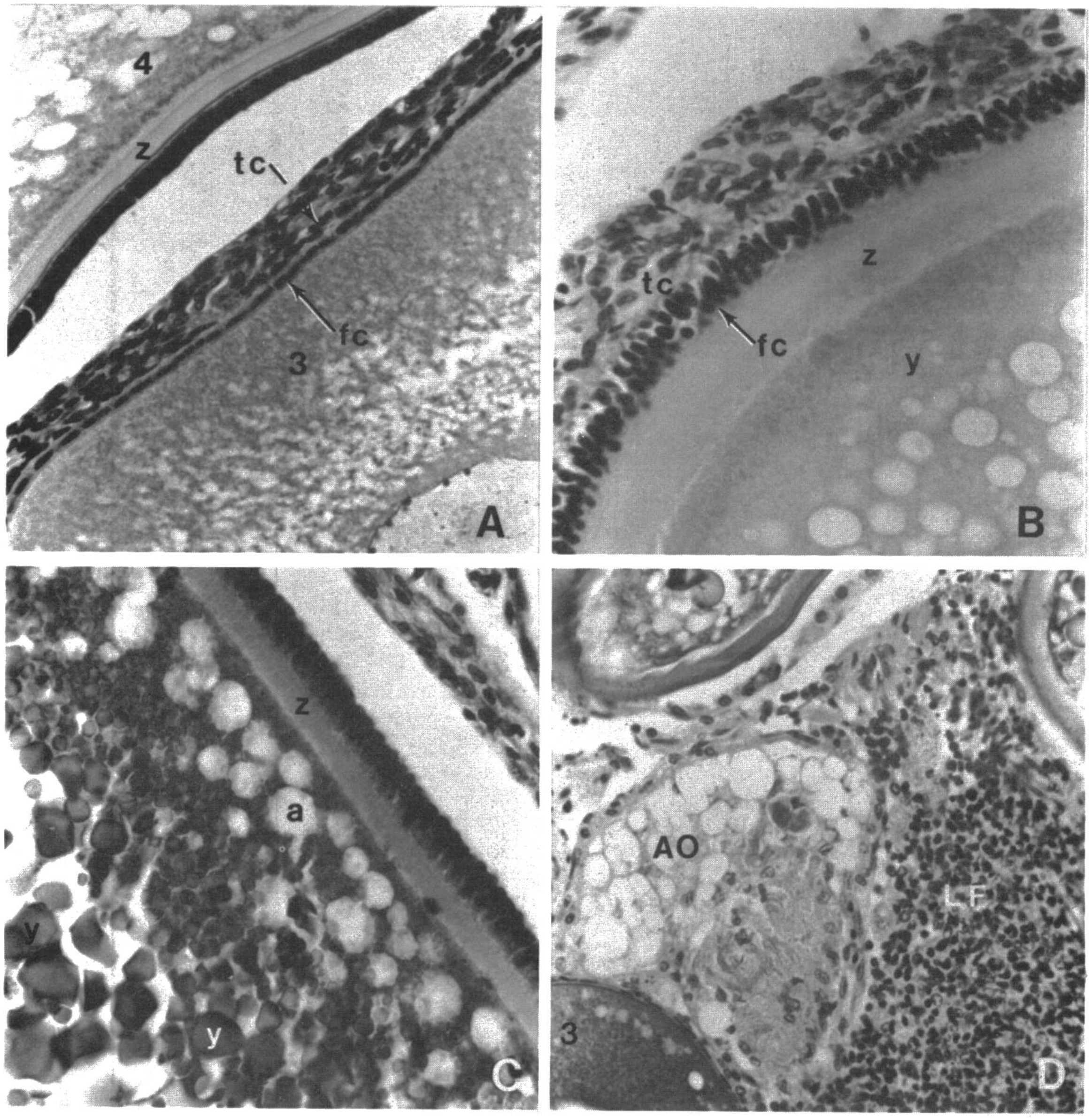

Fig. 10. Gonads. Physiologic and pathologic conditions of the ovary. A. *A. felis*. Growing follicle (3) with follicular cells (fc) and thecal cells (tc). Early mature follicle (4) with prominent zona pellucida (z). 470X. B. *A. felis*. Early mature follicle with adipose yolk droplets in the yolk (y), a thick zona pellucida (z), follicular cells (fc), and thecal cells (tc). 470X. C. *A. felis*. Mature follicle with yolk granules (y), adipose yolk droplets (a), and zona pellucida (z). 470X. D. *C. faber*. Growing follicle (3), artertic follicle (AO), and focal leukocytosis (LF). 470X.

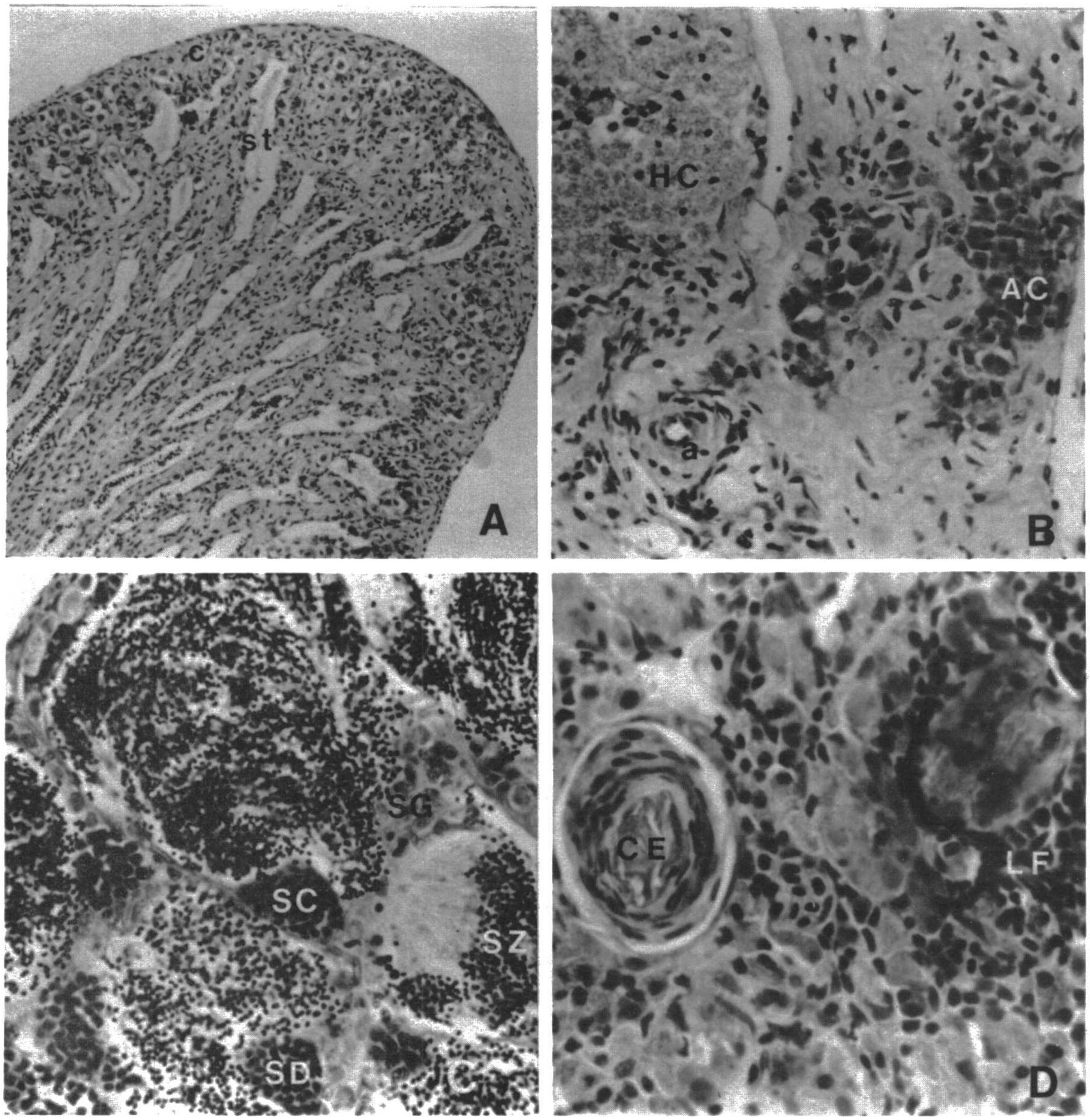

Fig. 11. Gonads. Physiologic and pathologic conditions of the testis. A. *A. probatocephalus.* Degeneration, involution of seminiferous tubules (st), capsule (c). 185X. B. *A. probatocephalus.* Acidophilic granular cells (AC) and chromatophores (HC) in the medulla. 470X. C. *L. campechanus.* Regeneration, active spermatogenesis, all phases. Spermatogonia (SG), spermatocytes (SC), spermatids (SD), and spermatozoa (SZ). 185X. D. *L. rhomboides.* Encapsulated cyst (CE) and focal leukocytosis (LF) in the medulla. 730X.

studied in this investigation. Mature follicles contained a poorly defined-nucleus, vacuolated cytoplasm that contained 10-15 μm spheres of yolk material, a thin vitelline membrane, a 10-μm thick zona pellucida, a layer of follicular cells, a basement membrane, and several layers of fibroblast-like thecal cells and vessels (Fig. 10B,C).

Atretic follicles and ova were difficult to detect in the early stages. Later, such signs as dissolution of the thecal and follicular cells, collapse of the zona pellucida, fatty degeneration and breakdown of the yolk material, and leukocyte infiltration were indications of atresia (Fig. 10D).

b. Histopathological Conditions

(1) Male

(a) Control Sites—A total of 11 fish representing four species taken from three control sites made up the control specimens. (Tables 2, 3, Sites C21, C22, C23, C24. Note gonads were not collected in every case and in some cases all five fish were females.) The testicles of Atlantic croaker and sea catfish, which made up eight of the 11 fish of this group, contained only cells in the early stages of spermatogenesis. The other fish, sand seatrout and batfish, had active spermatogenesis. Over 70% of the spermatogenic cells were spermatozoa.

The term "degeneration" was used to refer to the overall appearance of the testis (Fig. 11A). It was sometimes difficult to discern between degeneration (a physiologically normal phenomenon) and autolysis (a postmortem change) in testicular and ovarian tissue. Acidophilic granular cells were similar in appearance to the mammalian eosinophil, inasmuch as they contained numerous acidophilic staining granules (Fig. 11B). They were most often located in the medullary or hilus region and were found singly or in large clusters of cells. In many cases single cells or small groups of cells were found in the cortical area in the interstitial tissues. Chromatophores were cells, probably macrophagic, that contained a yellowish pigment (Fig. 11B). Sometimes they were observed as single cells, located anywhere in the testicle. In most cases there was a cluster of cells, often circumscribed and generally in the hilus region, although even large clumps of chromatophores were observed in the cortical region. In the testicle, the chromatophore clumps were up to 80 μm in diameter, whereas in the ovary, these clusters were up to 250 μm in diameter.

In the males from control sites, pathological conditions were limited to degeneration in eight of the 11 fish. Acidophilic granular cells and chromatophores were found in three and five of the testicles, respectively, with no overlap.

(b) Primary Platform Sites— There were 11 fish representing five species taken from three primary collection sites (Table 2, Sites P1, P3, P4). The testicles from rough scad, pinfish, fringe flounder, and spadefish from these sites were in a stage of early regeneration and most of the spermatogenic cells were spermatogonia and primary spermatocytes. "Regeneration" refers to the cyclic redevelopment of the testicles or ovary as the gonad changes from an involuted state (Fig. 11C). The germinal cells become more active mitotically and meiotically, which results in an enlarged, functional sperm producing testicle or ova producing ovary. "Involution" refers to the cyclic changes that take place in the mature fish gonads from year to year. In the involuted state, the organ is shrunken and has the basic morphological features of a testicle or ovary but without evidence of spermatogenesis or oogenesis. Only the sheepshead testicles were involuted. Degeneration was evident in 25% of the testicles. Acidophilic granular cells were prominent in 50% and chromatophores in 33% of the specimens.

Leukocytes were observed in foci or as individually scattered cells (Fig. 11D). Most often they were found in the hilus region and were associated closely with blood vessels whether in the cortical or medullary regions. Leukocytic foci, other than the eosinophilic cells, were found in 75% of the specimens. Evidence of protozoa (Fig. 12A,B) was seen in only three of the 11 fish from primary collection sites. There were only three cases of helminths in the fish gonad (Fig. 12C). The encapsulated remnants were so degenerated in walled-off structures that the diagnosis was not certain (Fig. 11D).

(c) Secondary Platform Sites— Seventy fish of eight different species were obtained from 16 secondary collection sites (Table 3, all Sites except C21, C22, C23, C24). Early stages of regeneration and growth of the testicle were seen in longspine porgy, sea catfish, and sheepshead. More advanced stages of spermatogenesis were seen in Atlantic croaker and fringe flounder. Rock sea bass and spadefish testicles were mature with prominent concentrations of spermatozoa. None were involuted or degenerated. The most prominent histopathological feature was the presence of acidophilic cells in 74% of the specimens. Some stage of degeneration was observed in only 22% of the testicles. Chromatophores and leukocytic foci were seen in 28% and 16% of the gonads, respectively. There was evidence of parasites in only 6% of the testicles and none of these cases was acute. All were walled off and degenerated.

(2) Female

(a) Control Sites— A total of 18 fish representing seven species taken from four control sites made up the control specimens (Tables 2, 3, Sites C21, C22, C23, C24). Atlantic croaker, longspine porgy, sea catfish, batfish, pinfish, and fringe flounder were all in early stages of ovogenesis only. Their ovaries appeared to contain only primary and secondary ova (Fig. 9A,B). The ovary of the sand seatrout contained ova in all four stages of development, with mature follicles covering up to 60% of the cross-sectional area of a slide. In the fish ovary, the ova and/or follicles can undergo degeneration at any stage of development. "Atresia" refers to this process and was observed in individual ova and follicles of all sizes and in all degrees of degeneration (Fig. 12D). In the regenerating ovary there are relatively few atretic ova, while in the mature ovary after spawning, there are many. Atretic ova may also result from anything that would upset the hormonal balance of the fish. Pathological conditions in control fish were: acidophilic cells in 17% of the specimens, atretic ova in 89%, chromatophores in 11%, and degeneration in 11%.

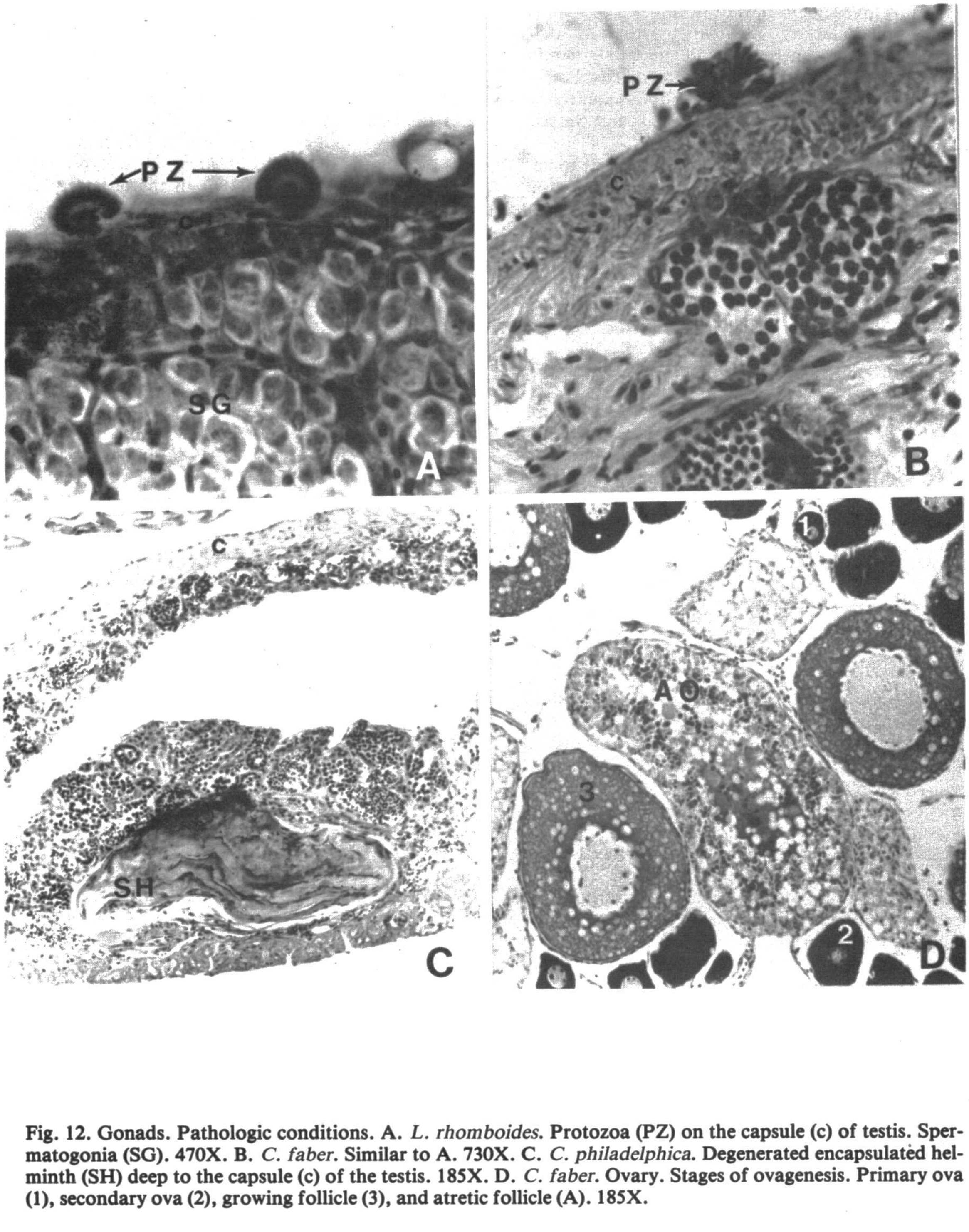

Fig. 12. Gonads. Pathologic conditions. A. *L. rhomboides*. Protozoa (PZ) on the capsule (c) of testis. Spermatogonia (SG). 470X. B. *C. faber*. Similar to A. 730X. C. *C. philadelphica*. Degenerated encapsulated helminth (SH) deep to the capsule (c) of the testis. 185X. D. *C. faber*. Ovary. Stages of ovagenesis. Primary ova (1), secondary ova (2), growing follicle (3), and atretic follicle (A). 185X.

(b) Primary Platform Sites—Fourteen fish representing six species were taken from four primary collection sites (Table 2, Sites P1, P2, P3, P4). The ovaries from sheepshead, Atlantic croaker, red snapper, and pinfish contained only primary and secondary ova which appeared histologically sound, healthy, and active. Histopathological features were: atretic ova in 86% of the specimens, acidophilic cells in 43%, chromatophores in 29%, focal leukocytosis in 21%, and encapsulated cysts (small, circular structures surrounded by a few layers of fibroblasts and collagen and filled with amorphous material) in 7%. Histopathological conditions were observed in the ovaries from all except red snapper. The spadefish had many mature follicles, as did the fringe flounder, but there was much follicular atresia noted in the flounder, especially in the mature follicles.

(c) Secondary Platform Sites— There were 77 fish from eight different species obtained from 16 secondary collection sites (Table 3, all Sites except C21, C22, C23, C24). Early stages of growth and regeneration were observed in longspine porgy and sheepshead. These contained numerous primary and secondary ova. The ovaries from some of the spadefish and red snapper contained growing follicles as well. The sea catfish and fringe flounder had all four developmental stages in about equal amounts. Only the spadefish (19 out of 29) had a preponderance of mature follicles. Advanced atresia of the mature follicles was prominent in three of the spadefish ovaries.

Two histopathological features, acidophilic granular cells and atretic ova, were prominent in fish from secondary sites and were found in 68% of the specimens. Degeneration was observed in 12%, chromatophores in 57% and leukocytic foci or leukocytosis in 30%.

5. Kidney

a. Normal Microscopic Features

The normal kidney structures can be divided into two basic components: (1) glomerular and tubular structures (i.e., nephrons) and (2) tissue between the tubules (i.e., parenchyma).

Glomeruli, which represented the beginning of the nephron, were found scattered throughout the kidney tissue. They were seen as somewhat irregular, circular, slightly basophilic masses. Bowman's space, between the glomerular substance and its surrounding capsule, was usually readily apparent.

The tubules of the nephron were usually viewed in cross section. They varied somewhat in diameter and in the morphology of their composite cells in accordance with their positions along the nephron. Generally, however, the cells lining the tubules were cuboidal with acidophilic cytoplasm containing a loosely-packed basophilic nucleus. The tubules emptied into the collecting (mesonephric) ducts of the kidney. The lumina of the mesonephric ducts were bigger than those of the primary nephron tubules and were lined by cells which tended to be columnar. The nuclei of the cells appeared very similar to those of the tubules but tended to occupy the portion of the cell farthest from the lumen.

Between the tubules, the parenchyma was largely filled with hematopoietic tissue. Thus, many blood stem cells were found, as well as mature red blood cells. Other blood cell types were seen in much fewer numbers but their classification remains in dispute. Scattered in the parenchyma were what have been termed "melanin-macrophage systems." These consisted of clumps of dark granular pigment which were apparently contained within the cytoplasm of cells whose nuclei could be seen within the body of the cluster. The number, size, and color intensity of these aggregations varied with species.

Blood channels, both arterial and venous, penetrated the kidney parenchyma and were ensheathed by varying amounts of acidophilic connective tissue.

In a few species, a corpuscle of Stannius was occasionally seen (Fig. 13A). This tissue is of the endocrine type and is believed to be involved in calcium metabolism. It was located at the kidney's periphery and was basophilic, highly vascular, and surrounded by a fibrous capsule.

b. Histopathological Conditions

The following conditions were noted for fish kidney: chromatophores, protozoa, helminths, xenomas, acidophilic granular cells, tubular degeneration, and hyperplasia of arterial endothelium.

Chromatophores, broadly defined here as pigment laden cells within the parenchyma, were more frequently observed than any of the other conditions. While their appearance under the optical microscope varied between species, there was a great deal of constancy within species. The chromatophores occurred as aggregations dispersed randomly throughout the parenchyma, giving the appearance of brown to black granular clusters due to their pigmented cytoplasm (Fig. 13B,C). Within these clusters the numerous darkly staining nuclei of these cells were visible.

Chromatophores were very common and constituted the predominant finding at all test sites, both platforms and controls. Of the 31 tissues examined for the control group, 26 contained this condition for an incidence of 84%. Species examined included the Atlantic croaker (Site C21), sea catfish (Sites C21, C24), longspine porgy (Site C23), pinfish (Site C23), sand seatrout (Site C24), batfish (Site C22), and rough scad (Site C22). All except the five batfish had chromatophores.

Chromatophores were also prevalent at the primary sites. Here, 24 of the 37 tissues examined were positive for this condition, an incidence of 65%. Included in this group were sheepshead (Site P1), spadefish (Site P1), Atlantic croaker (Site P2), sea catfish (Site P2), red snapper (Site P3), pinfish (Sites P3, P4), and fringe flounder (Site P4). Chromatophores were found in only two of the five fringe flounder, one of the five Atlantic croaker, and none of the red snapper. All other specimens had this condition.

At the secondary sites, chromatophores were seen in 144 of 155 specimens, an incidence of 93%. Species examined included Atlantic croaker (Sites S5, S6, S8, S9, S13), sea catfish (Sites S5, S19), spadefish (Sites S6, S8, S10-S14, S18-S20), rock sea bass (Sites S7, S9, S15, S17), fringe flounder (Sites S7, S16), sheepshead (Sites S10-S12, S20), longspine porgy (Site S15), and red snapper (Site S18). Chromatophores were found in 19 of the 20 rock sea bass (absent in one specimen at

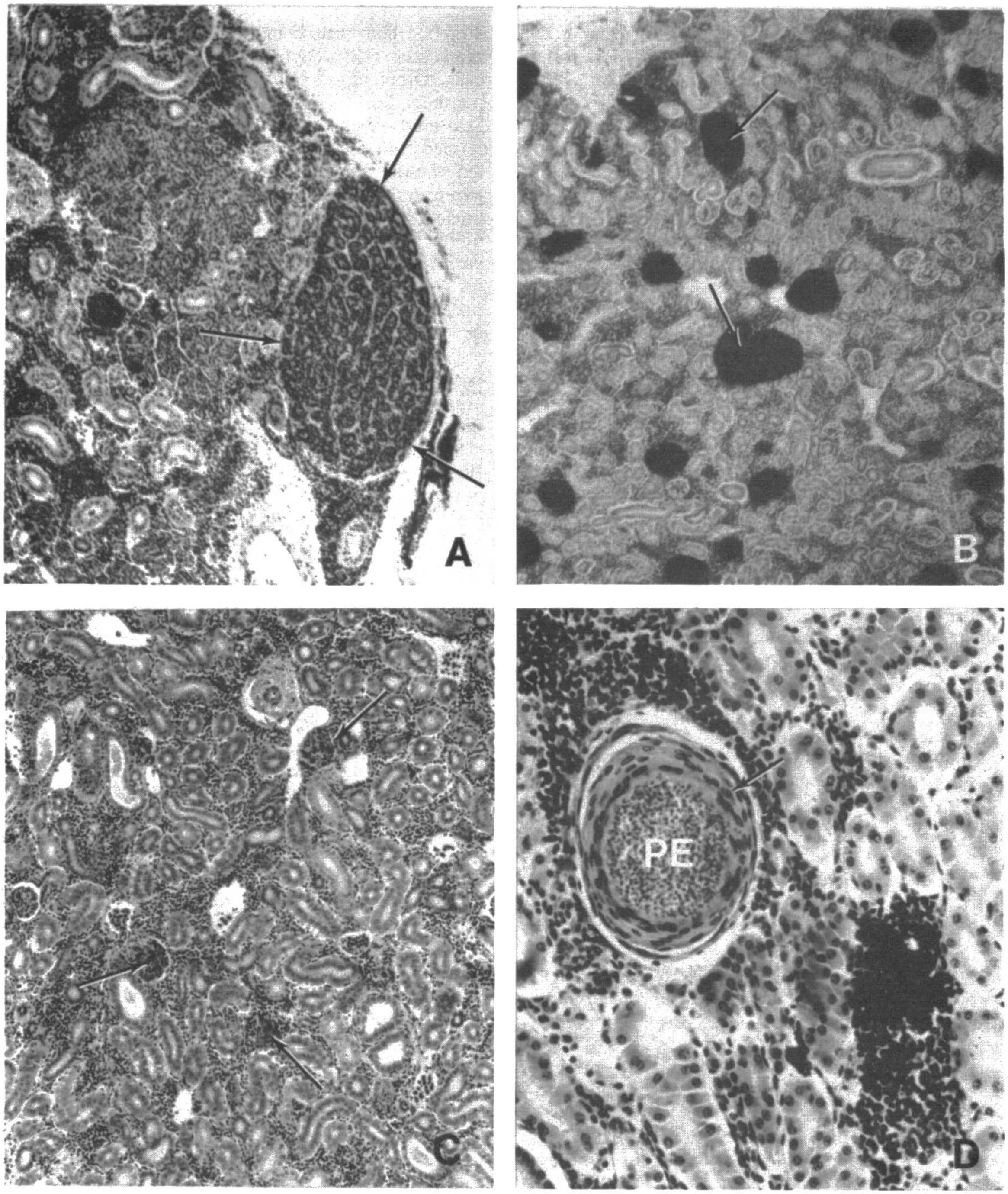

Fig. 13. Kidney. A. *A. felis*. Stannius corpuscle (arrows). 84X. B. *A. probatocephalus*. Chromatophores (arrows). 136X. C. *C. faber*. Chromatophores (arrows). 136X. D. *A. probatocephalus*. Encapsulated protozoa (PE). Arrow denotes capsule. 340X.

Site S7), nine of 10 sea catfish (absent in one specimen at Site S19), seven of nine fringe flounder (absent in two specimens at Site S7), and in one of three red snapper (absent in two specimens at Site S18). All other specimens contained chromatophores.

The second most commonly observed kidney condition was protozoa, which were reported in three different forms: (1) encapsulated within the parenchyma, (2) within the lining of the mesonephric duct, (3) within the vascular lumen.

Encapsulated protozoa in the parenchyma of the kidney was the second most common protozoan condition seen (Fig. 13D; 14A). At the control sites, however, none were observed.

From the primary sites, encapsulated protozoa were seen in 11 of 37 tissues examined, an incidence of 30%. This lesion occurred in four of five sheepshead (Site P1), one of five spadefish (Site P1), three of five Atlantic croaker (Site P2), two of four red snapper (Site P3), and one of five fringe flounder (Site P4). No encapsulated protozoa were found in sea catfish or pinfish.

Of the 155 tissues from the secondary sites, 17 specimens had encapsulated protozoa, for an incidence of 11%. This lesion was seen in five of 25 Atlantic croaker (Sites S5, S6, S9, S13), in three of 50 spadefish (Sites S6, S12, S13), in one of 20 rock sea bass (Site S17), and in one of 18 sheepshead (Sites S10, S11, S12, S20). No encapsulated protozoa were found in the 14 fringe flounder, 15 longspine porgy, 10 sea catfish or three red snapper examined.

Protozoa found within the mesonephric duct lining were elongated cells with clear, nongranular cytoplasm (Fig. 14C,D). The basophilic nucleus tended to be located toward the pole of the cell distal to the duct lumen. The long axis of the cell was generally parallel to that of the columnar cells lining the duct. This was by far the most common of the three protozoan conditions described.

From the control sites, however, protozoa in the mesonephric duct were noted in only five of the 31 tissues examined, an incidence of 16%. Specimens positive for this condition included one specimen of sea catfish (Site C21), three specimens of longspine porgy (Site C23), and one specimen of sand seatrout (Site C24).

Of the 37 tissues examined from the primary sites, thirteen had this protozoan condition, an incidence of 35%. Positive specimens included two spadefish at Site P1, two Atlantic croaker at Site P2, two red snapper and two pinfish at Site P3, and three pinfish and two fringe flounder at Site P4.

From the secondary sites, 96 of the 155 tissues examined contained this protozoan condition, an incidence of 62%. It was seen in 17 of 25 Atlantic croaker (Sites S5, S6, S9, S13), in 47 of 50 spadefish (Sites S6, S8, S10-S14, S18-S20), in 16 of 20 rock sea bass (Sites S7, S9, S15, S17), in five of 14 fringe flounder (Sites S7, S16), in two of 18 sheepshead (Site S20), and in nine of 15 longspine porgy (Sites S15, S16, S17). None were seen in the three red snapper or 10 sea catfish specimens examined.

Although not tabulated as a separate condition, encapsulations entirely filled with pigment were occasionally found within the parenchyma (Fig. 14B).

The third form of protozoa, found in the lumen of an artery, was observed in only one specimen, a red snapper at Site P3.

Helminths were identified as "double-walled" encapsulations. That is, the outer wall represents the host capsule response to the helminth, while the inner wall is actually the exterior of the helminth (Fig. 15A, B). A viable helminth was defined as one for which internal structure was discernible. Some encapsulations appeared to contain degenerating material which could have been the remains of helminths or other foreign invaders (e.g., protozoa, bacteria, or fungi). The degenerating material was not an artifact of poor fixation because it was possible to find well defined encapsulated material along with the degenerated form in the same slide.

From the control sites, helminths were seen in three of the 31 specimens, an incidence of 10%. Affected specimens included one of five Atlantic croaker (Site C21), one of three rough scad (Site C22), and one of six sea catfish (Site C24). No helminths were seen in the five longspine porgy, three pinfish, four sand seatrout, or five batfish examined.

Eight of the 37 tissues at the primary sites contained helminths, an incidence of 22%. Specimens included were two of five spadefish and two of five sheepshead (Site P1), two of five sea catfish (Site P2), one of seven pinfish (Site P3), and one of five fringe flounder (Site P4). No helminths were found among the five Atlantic croaker or five red snapper examined.

At the secondary sites, 21 of the 155 tissues were positive for helminths, giving an incidence of 14%. Affected specimens included 12 of 25 Atlantic croaker (Sites S5, S6, S8, S9, S13), two of 10 sea catfish (Sites S5, S19), five of 50 spadefish (Sites S6, S8, S13), and two of 18 sheepshead (Site S20). None of the 20 rock sea bass, 14 fringe flounder, 15 longspine porgy, or three red snapper contained helminths.

Xenomas were represented by excessive encapsulation responses to foreign material within the kidney parenchyma (Fig. 15C). This was a relatively rare lesion. At the control sites it was seen in one specimen of the 31 tissues examined (in 1 of 4 sand seatrout at Site C24). This gave an incidence of 3%. It was not seen at the primary sites. Twelve of the 155 tissues at the secondary sites were positive for this condition. Included were six of 14 specimens of fringe flounder (Sites S7, S14, S16), one of 50 specimens of spadefish (Site S11), four specimens of longspine porgy (Sites S15, S17), and one of five specimens of sea catfish (Site S19).

Acidophilic granular cells are considered host cells with granular cytoplasm and a basophilic, epicentric nucleus. They are somewhat larger than parenchymal stem cells and are round to oval. They were located in the lining of the mesonephric duct, in the lumen of this duct, in the connective tissue surrounding it (Fig. 15D), and in the kidney parenchyma (Fig. 16A).

This condition was seen in six of the 31 control tissues, an incidence of 19%. Affected specimens included one of five Atlantic croaker (Site C21), one of five longspine porgy (Site C23), and four of four sand seatrout (Site C24). At the primary sites it was observed in only two of the 36 specimens (2 of 5 spadefish at Site P1). This gave a 6% incidence. Of the 155 tissues at the secondary sites, 74 contained these cells, an incidence of 48%. Included were two of 25 Atlantic croaker (Site S5), seven of 14 fringe flounder (Sites S7, S16), 33 of 50 spadefish (Sites S8, S10-S14, S18, S20), seven of 18 sheepshead (Sites S12, S20), three of 10 sea catfish

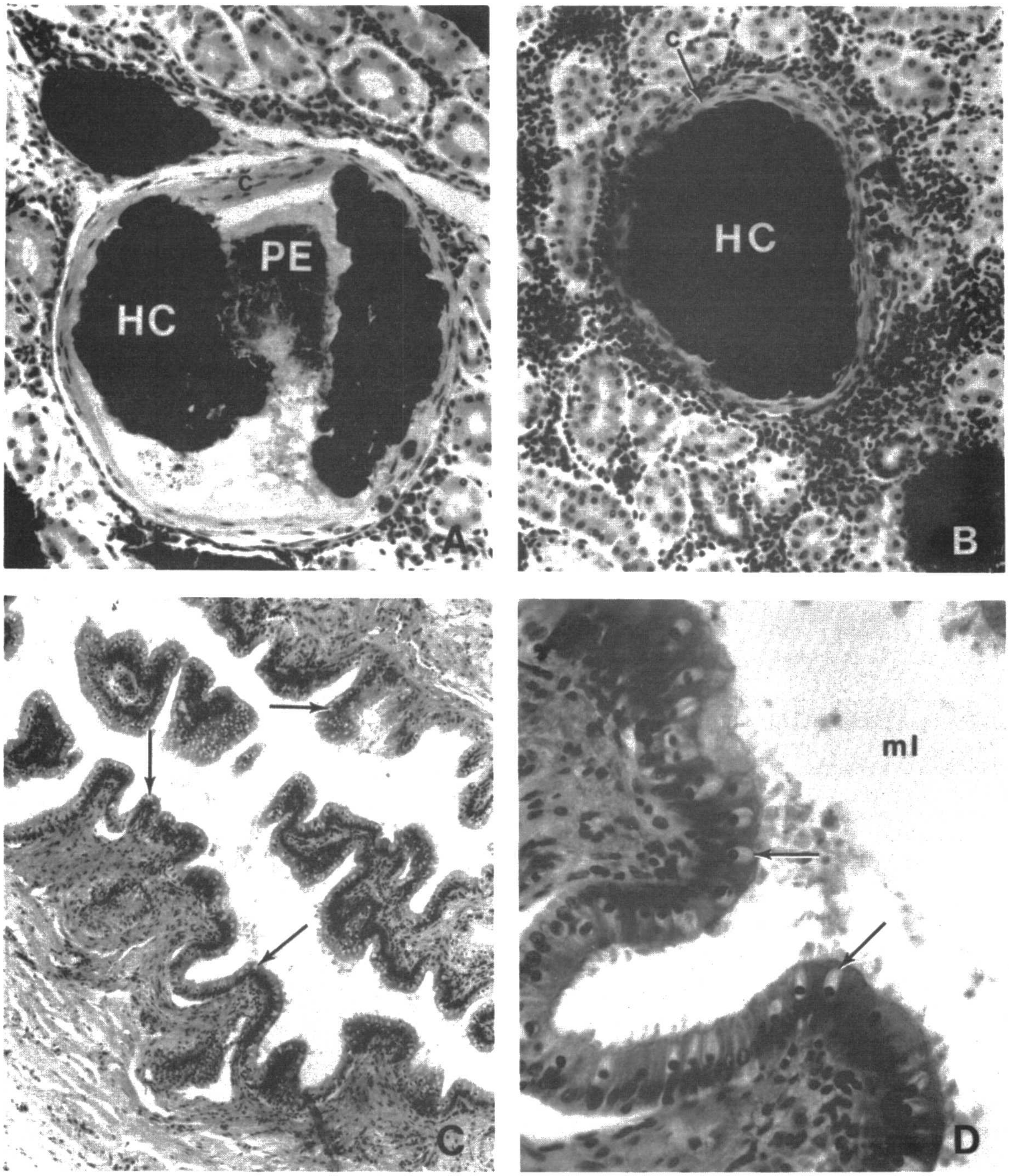

Fig. 14. Kidney. A. *A. probatocephalus.* Host encapsulation (c) enclosing protozoa (PE) and chromatophores (HC). 340X. B. *A. probatocephalus.* Host encapsulation (c) enclosing chromatophores (HC). 340X. C. *C. faber.* Note numerous protozoa (arrows) in lining of mesonephric duct. 136X. D. *C. faber.* Protozoa (arrows) in lining of mesonephric duct. Lumen of duct indicated (ml). 540X.

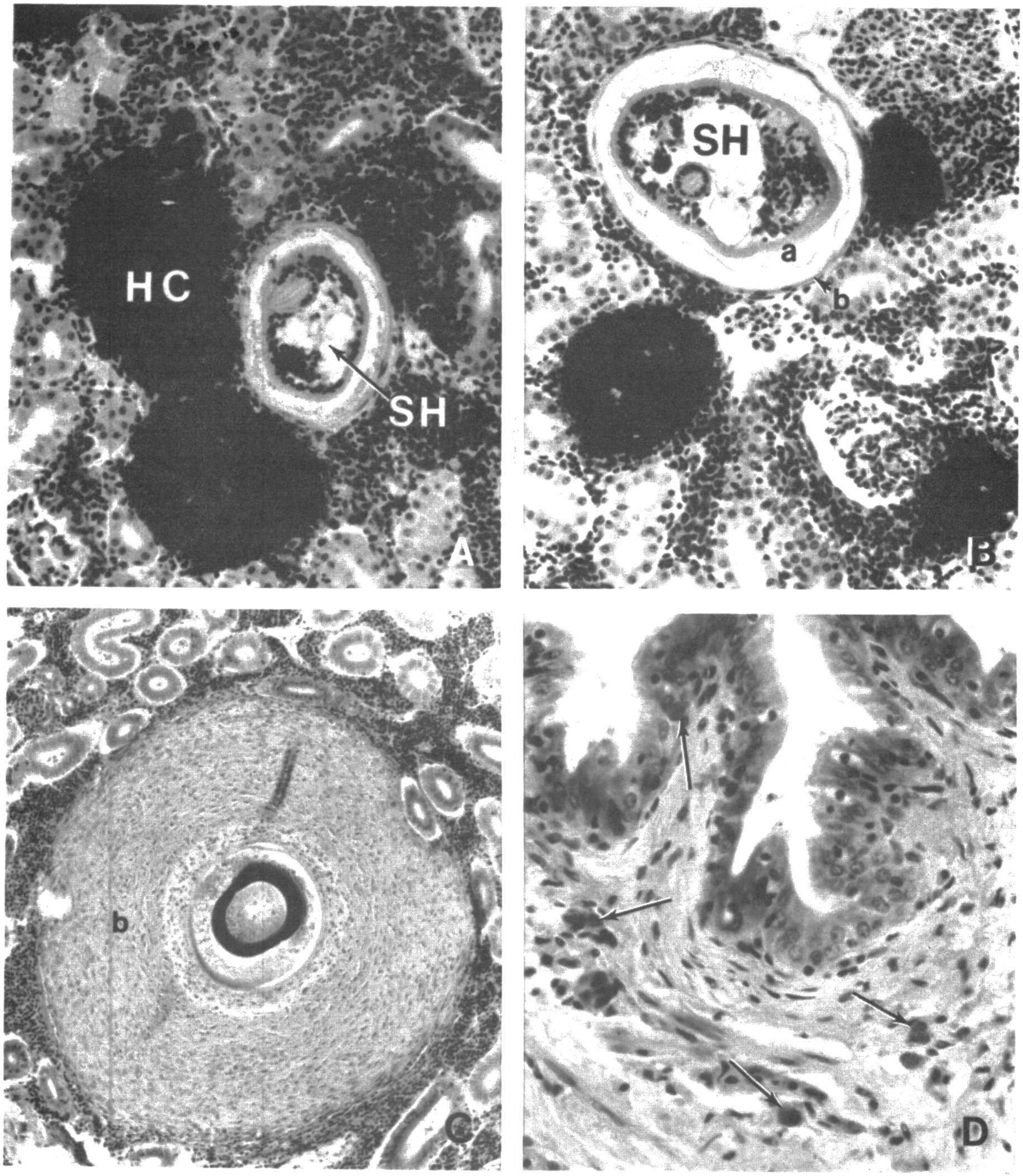

Fig. 15. Kidney. A. *A. probatocephalus*. Helminth (SH). Note chromatophores (HC). 336X. B. *A. probatocephalus*. Helminth (SH). Note exterior wall of helminth (a) and host encapsulation (b). 540X. C. *C. chittendeni*. Xenoma. Note heavy capsule (b). 136X. D. *C. faber*. Acidophilic granular cells (arrows) in connective tissue around mesomephric duct. 540X.

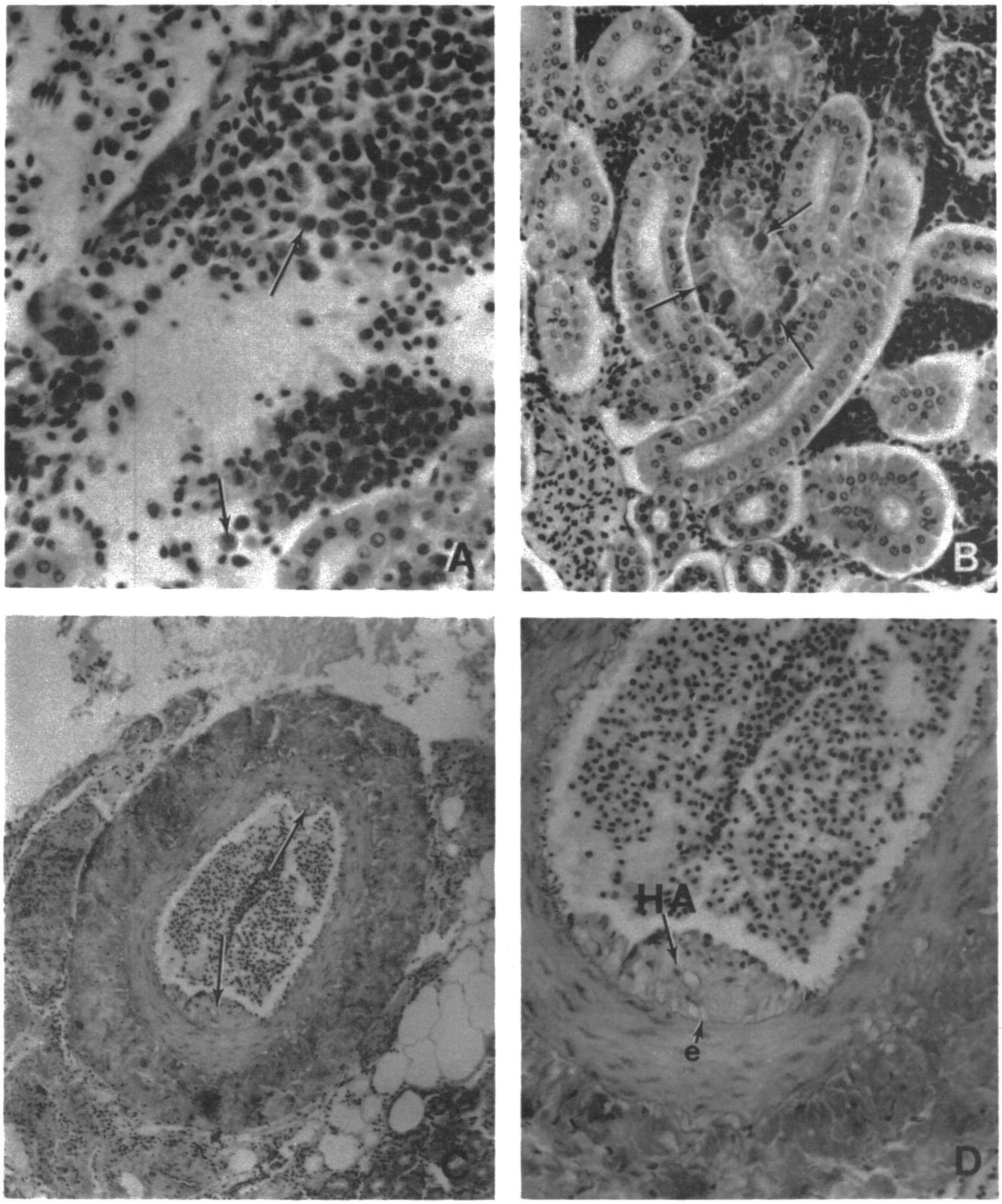

Fig. 16. Kidney. A. *M. undulatus*. Acidophilic granular cells (arrows). 540X B. *M. undulatus*. Tubular degeneration (arrows). 540X. C. *C. faber*. Hyperplasia of arterial endothelium (arrows). 136X. D. Enlargement of C. Note hyperplasia (HA) and intact internal elastic membrane (e). 336X.

(Site 19), 13 of 15 longspine porgy (Sites S15-S17), one of three red snapper (Site S18), and eight of 20 rock sea bass (Sites S7, S9, S15, S17). Thus, at the secondary sites, acidophilic granular cells were seen in at least some specimens of all species studied.

Tubular degeneration, a rarely observed condition, was recognized as an acidophilic, homogenous change of the cytoplasm of the cells lining the tubule (Fig. 16B). At the control sites, it was seen in only one of the 31 tissues (1 of 1 sea catfish at Site C21). This gave an incidence of 3%. It was seen in three of the 36 tissues at the primary sites for an incidence of 8%. Included were one of five spadefish (Site P1), and two of five sea catfish (Site P2). At the secondary sites, four of 155 tissues contained this condition, an incidence of 3%. The only specimens affected were four of 25 Atlantic croaker (Sites S6, S13).

Hyperplasia of the arterial endothelium was very rare. It was recognized as an endothelial proliferation of the artery confirmed by the presence of an intact internal elastic membrane (Fig. 16C,D). No specimens among the control or primary sites had this condition, which was seen in two of 50 specimens of spadefish at the secondary sites (S11, S13). For the 155 specimens in the secondary group this yielded an incidence of 1%.

6. *Gill*

a. *Normal Microscopic Features*

Gills located on the lateral side of the head medial to the operculum were composed of a number of gill arches with finger- like gill rakers on the medial surface and a series of filaments which protrude from the gill arch. The filaments had numerous lateral outfoldings, the gill lamellae. The gill lamellae are the respiratory portions of the gill.

The gill arch, which supports the gill and anchors it to the body wall, had a bony or cartilaginous central arch which was covered with stratified squamous epithelium, with mucous or goblet cells, taste buds, and keratinized gill rakers protruding from its surface (Fig. 17A). Several nerves and large arteries passed through the gill arch.

The gill filament, which has a supporting cartilaginous core, was attached proximally to the gill arch. It contained the afferent and efferent branchial arteries and had a prominent basement membrane under the epithelial surface. The filament was surrounded by stratified squamous epithelium with mucous cells (Fig. 18D) interspersed among the epithelial cells and a few eosinophilic chloride cells at the base or proximal end of the gill lamellae. The branchial muscles attached to the filament cartilage and bone and to the cartilage of the gill arch for adduction and abduction of the gill filament.

The gill lamellae (Fig. 17B) protruded from the gill filament and were lined by a single layer of squamous to low cuboidal epithelium with an occasional mucous cell and eosinophilic chloride cell interspersed among and beneath the epithelial cells. The mucous and eosinophilic chloride cells were most numerous in the stratified squamous epithelium between the base of adjacent lamellae as they projected from the filament. The epithelial cell basement membrane was in direct contact or fused with the basement membrane of the capillary endothelial cells. The endothelial cells were thinnest where they contacted the epithelial cells, allowing for most efficient gas exchange between the marine environment and the blood of the lamellar capillaries.

b. *Histopathological Conditions*

The only lesion observed in the surface epithelial cells of the gill arches and filaments was slight to moderate lymphocytic infiltration (Fig. 18D) of the basal layer of the epithelium in some individuals. When present, this condition was more marked in gill filament epithelium than in the gill arch. At the primary sites, 29 of 39 specimens had slight to moderate lymphocytic infiltration of the epithelium and underlying connective tissue, while 109 of 158 specimens from secondary sites and 13 of 38 specimens from control sites had some lymphocytic infiltration. The differences in lymphocytic infiltration were more evident between species than between stations. Sheepshead and spadefish had the highest incidence of lymphocytic infiltration and Atlantic croaker, sand seatrout, rough scad and batfish had the lowest.

Mucous cell concentrations varied greatly from specimen to specimen and from station to station. An occasional myxosporidian cyst was found in a few specimens in the basal epithelium of the filament between adjacent lamellae. These cysts were most often seen in the lamellae (Fig. 18D). The taste buds, cartilage, and/or bone of the gill arches and filaments appeared normal in all specimens. The prominent Periodic Acid-Schiff positive staining basement membrane had no lesions or thickening in any of the specimens. There were no histopathological changes in longitudinal and transverse sections of the arteries and veins or in nerve fibers and bundles. The cells of the branchial muscles appeared normal although there were occasional encapsulated helminth larvae in the muscle or adjacent connective tissue. Tissue reaction to the helminths was minimal. Fourteen of the 235 specimens examined had helminth larvae: 13 of these had one larva and one had two.

Eosinophilic chloride cells were not pathologic and there was only slight variation in numbers between individuals of the same species. No differences could be detected between stations.

Only rarely could the vasocongestion (Fig. 18A) in the various specimens be attributed to a physiologically pathological condition and, when present, only localized areas of single or adjacent lamellae were involved. Most of the vasocongestion could be attributed to decompression changes and changes due to the time between capture and fixation of the gills.

The edema-like condition in gill lamellae, if present at all, could not be attributed to anything other than individual variation. Only rarely was the classic sign of edema, eosinophilic proteinaceous material in the spaces, observed (Fig. 18D). Tissue separation, although seen in some specimens, was never seen in all lamellae of a given gill and was attributed to artifact rather than lesion.

True hyperplasia was not seen in gill lamellae or filaments. In rare instances, the cell and tissue changes observed and documented occurred primarily in response to parasites in adjacent areas. These changes never involved more than two lamellae, usually only one.

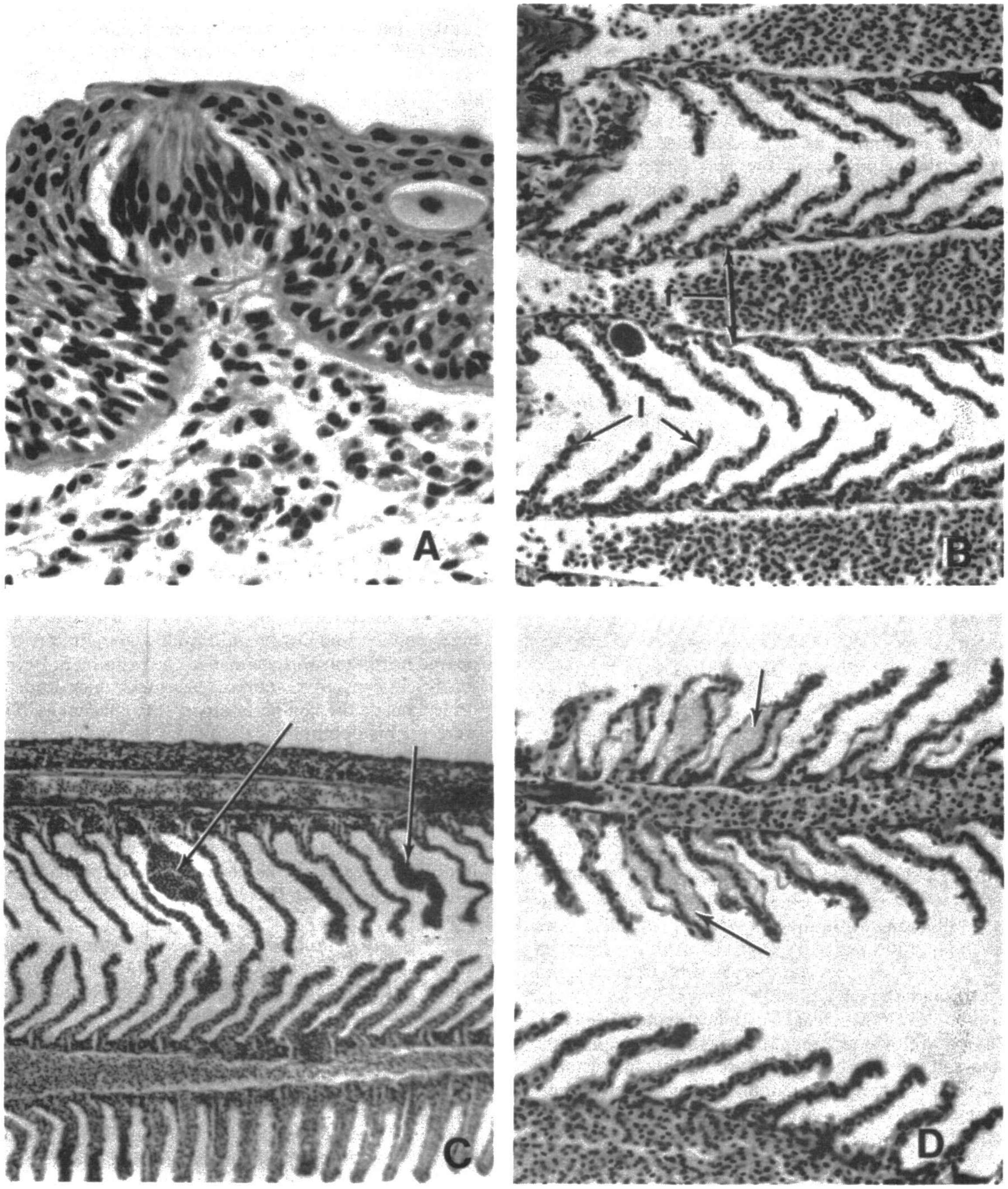

Fig. 17. Gill. A. *A. felis*. Normal taste bud on gill raker. 126X. B. *M. undulatus*. Normal gill filament (F) and lamellae (1) with single protozoan cluster between two lamellae. 80X. C. *M. undulatus*. Vasocongestion of gill lamellae (arrows). 126X. D. *M. undulatus*. Note proteinaceous material representing edema of gill lamellae (arrows). 126X.

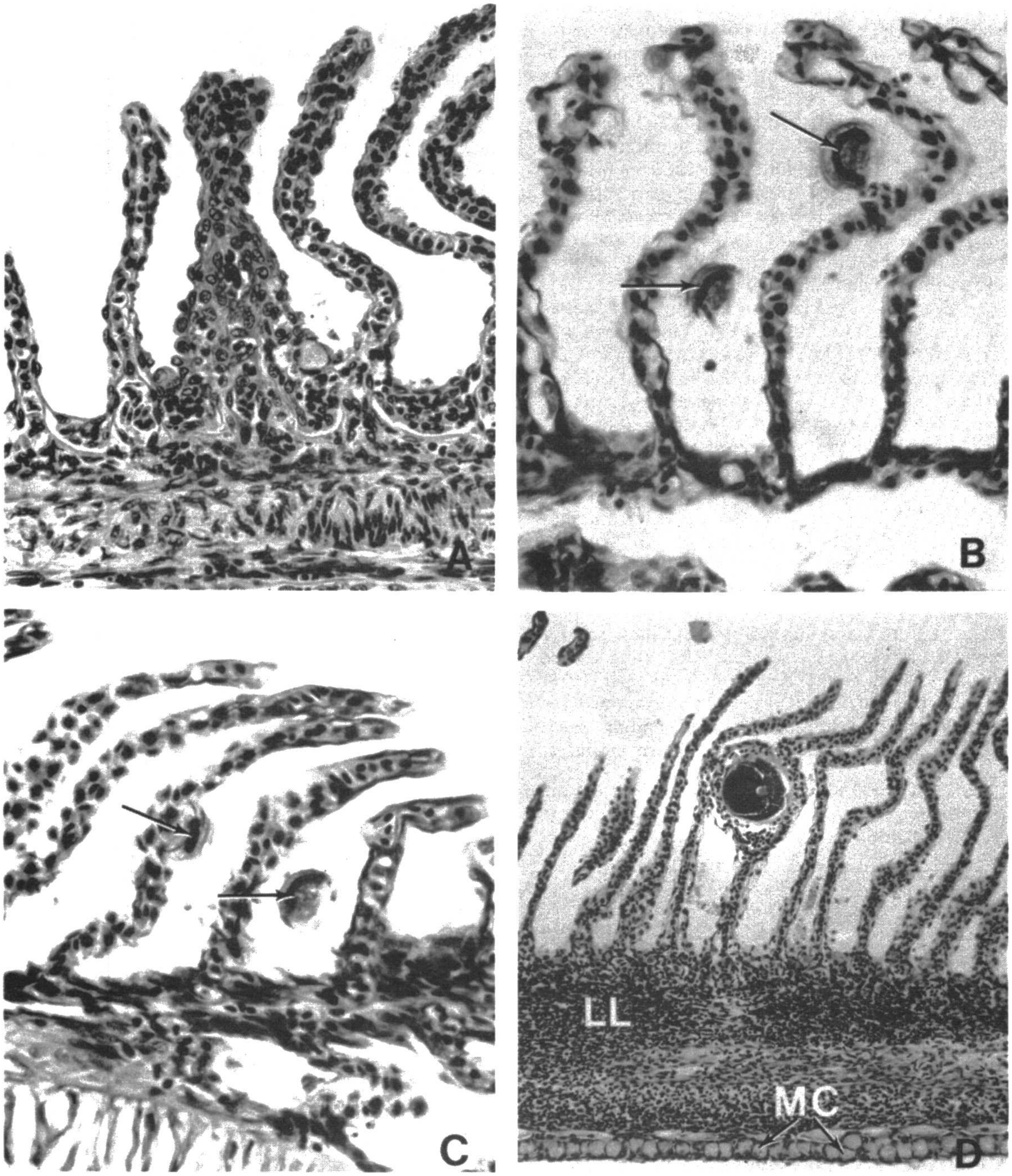

Fig. 18. Gill. A. *M. undulatus*. Hyperplasia of gill lamella. 510X. B. *C. chittendeni*. Protozoan condition represented by ciliates (arrows). 510X. C. *C. chittendeni*. Ciliates (arrows). 510X. D. *L. rhomboides*. Protozoan cluster, probably myxosporidian, involving gill lamella. Note lymphocytic infiltration (LL) and mucous cells (MC). 320X.

Parasitism was seen in and on gill lamellae and was the primary cause of lesions. The major parasites were protozoans; ciliates (Fig. 18B, C) and myxosporidians were most prevalent, followed by copepods (Fig. 19A) and trematodes (Fig. 19B, C, D). Of the 235 gill specimens, 101 were parasitized. Sixty eight had protozoan parasites, 19 had copepods, 13 had trematodes, and 14 had helminth larvae. Of the 29 fish from primary sites, 23 were parasitized and one had two different parasites. Of the 158 secondary site specimens, 59 were parasitized. Ten specimens had two different parasites and one had three. Of the 38 control specimens, 19 were parasitized and one had a dual infection.

There were no gill parasites in either species of fish collected at Sites S13 and S16. One species was not parasitized at Sites P3, S7, S8, S12, S18, and C24. Protozoan parasites were seen in fish from all sites except S13 and S16, with the highest incidence at Sites P2 and P4. Fish from Sites S6, S18, S19, and S20 had trematodes, with the highest incidence at Sites S18 and S20. Fish from Sites P2, S6, S8, S10, S11, S12, S14, S15, S17, and C24 had copepods, with the highest incidence at Site S14. Helminths were seen in fish from Sites P4, S6, S9, S10, S11, S14, S15, S17, and C21, with the highest incidence at Sites S10, S11, and C21.

B. Invertebrates

The results of sampling efforts during Cruise I (20 May-2 June 1978) and the first Biofouling Cruise and during Cruise II (21 August-6 September 1978) yielded 17 species of invertebrates to be examined for histopathological conditions. Included among these were the following eight species of bivalve molluscs: *Arca imbricata* (mossy ark), *Anadara ovalis* (blood ark), *Noetia ponderosa* (ponderous ark), *Isognomon radiatus* (Lister's tree oyster), *Crassostrea virginica* (American or eastern oyster), *Ostrea equestris* (horse or crested oyster), *Tellina* sp. (a tellin), and *Pitar cordata* (chordate venus). The six species of brachyuran crabs collected included *Portunus gibbesii, Portunus spinicarpus, Callinectes sapidus* (blue crab), *Callinectes similis* (lesser blue crab), *Speocarcinus lobatus,* and *Leiolambrus nitidus.* The following three species of penaeid shrimps were also collected: *Penaeus aztecus* (brown shrimp), *Penaeus setiferus* (white shrimp), and *Trachypenaeus similis* (broken-necked shrimp). The distribution of these species among sampling sites and the characterization of the samples acquired at each site are presented in Tables 5 and 6.

The contract called for the collection of 360 invertebrates to be examined for histopathological changes. Paucities of organisms prevented the acquisition of full complements of desired species at eight of the 24 sites sampled (Tables 5 and 6). Approved bivalve species were absent from Site C24; crab species from Sites S10, S11, S12, and S20; the shrimp species from Sites P1, C21, C24, S10, S11, S12, S19, and S20. Therefore, a total of 295 invertebrates were examined.

The six target organs selected for histopathological examination were striated muscle, digestive gland (hepatopancreas), gut, gonad, excretory organs, and gills. The hearts of crabs and shrimps were also examined and lesions were noted when present among other tissues, organs, or body cavities (e.g., nerves, connective tissues, the molluscan foot, and the hemocoel).

TABLE 5. Characterization of invertebrate histopathology samples collected during Cruise I.

Site	Sample Type	Species	N*	Methods of Acquisition	Total Length (cm)	Numbers of M/F/H$^{\Delta}$	Sexual Maturity^{+}
P1	Bivalve	*C. virginica*	5	Diver	10.1-14.3	1/4/0	M
	Crab	*S. lobatus*	5	Trawl	0.9-1.4	4/1/0	I
	Shrimp	None	0	--	--	--	--
P2	Bivalve	*C. virginica*	5	Diver	5.4-6.8	2/1/2	I,M
	Crab	*C. similis*	5	Trawl	3.9-5.4	4/1/0	I
	Shrimp	*P. aztecus*	5	Trawl	9.5-10.9	1/4/0	M,U
P3	Bivalve	*A. imbricata*	5	Diver	6.9-10.5	2/3/0	I,M
	Crab	*P. spinicarpus*	5	Trawl	2.7-3.3	1/4/0	I
	Shrimp	*T. similis*	5	Trawl	7.8-9.5	0/5/0	U
P4	Bivalve	*A. imbricata*	5	Diver	9.2-9.8	1/4/0	M
	Crab	*L. nitidus*	5	Trawl	1.4-2.3	2/3/0	M,U
	Shrimp	*T. similis*	5	Trawl	8.0-9.1	0/5/0	M,I
C21	Bivalve	*Tellina* sp.	5	Grab	0.7-1.2	3/2/0	M
	Crab	*C. similis*	5	Trawl	3.5-5.7	3/2/0	M,I
	Shrimp	None	0	--	--	--	--
C22	Bivalve	*N. ponderosa*	5	Trawl	3.2-3.6	2/3/0	M
	Crab	*C. similis*	5	Trawl	4.0-4.6	2/3/0	I
	Shrimp	*T. similis*	5	Trawl	6.8-7.0	0/5/0	I,M
C23	Bivalve	*P. cordata*	5	Trawl	2.3-4.5	2/3/0	M
	Crab	*P. spinicarpus*	5	Trawl	3.9-4.4	4/1/0	I,M
	Shrimp	*P. aztecus*	5	Trawl	14.0-17.4	3/2/0	I,U
C24	Bivalve	None	0	--	--	--	--
	Crab	*C. similis*	5	Trawl	3.6-4.5	2/3/0	I
	Shrimp	None	0	--	--	--	--

*N = number of individual organisms examined.

$^{+}$M = mature, I = immature, U = unknown.

$^{\Delta}$M = males, F = females, H = hermaphrodites.

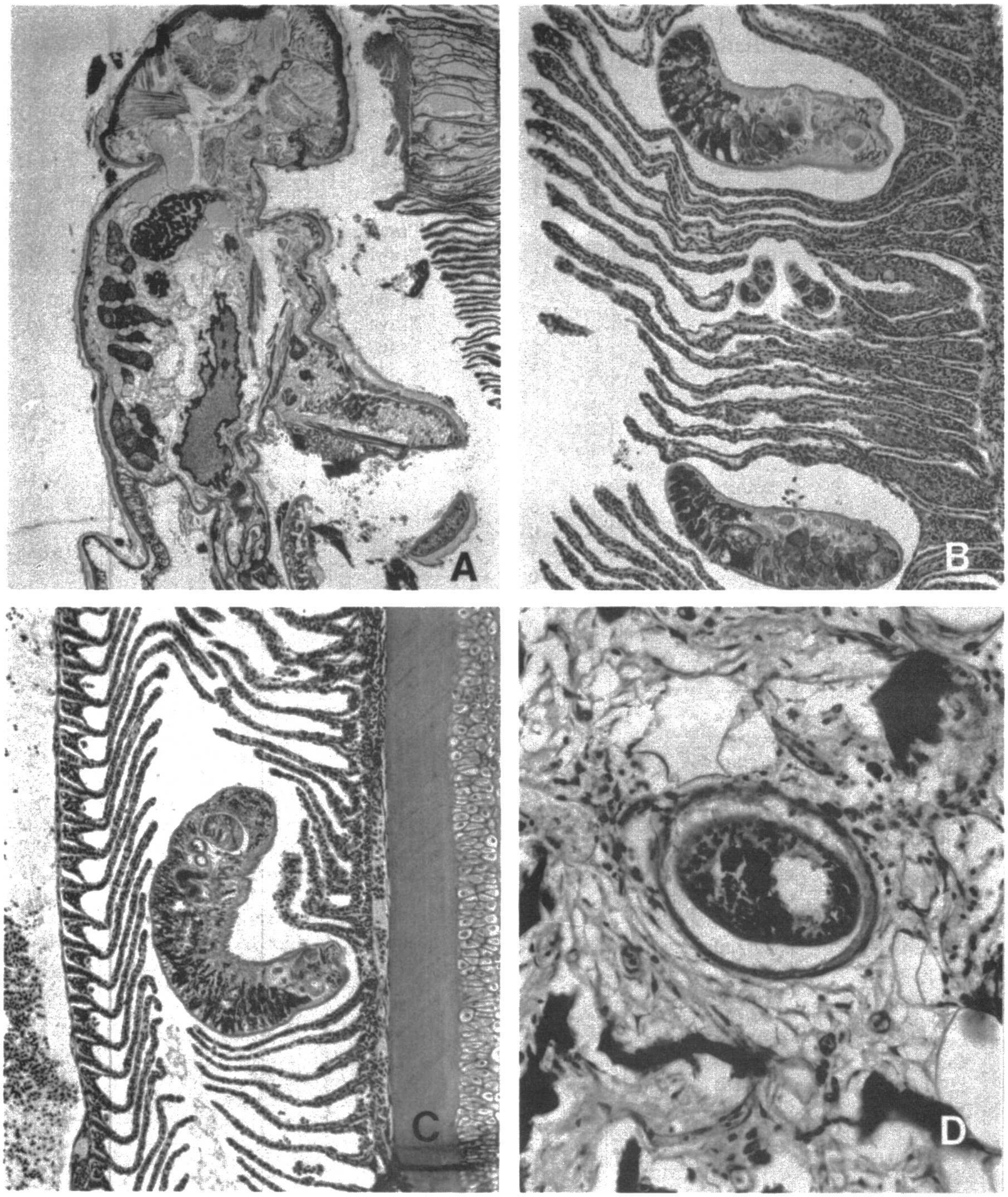

Fig. 19. Gill. A C. faber. Copepod adjacent to gill structure. 80X. B. *C. faber*. Trematodes. Note absence of marked host tissue response. 320X. C. *C. faber*. Trematode. 126X. D. *A. probatocephalus*. Trematode in connective tissue of fill raker. 320X.

TABLE 6. Characterization of invertebrate histopathology samples collected during Cruise II.

Site	Sample Type	Species	N*	Methods of Acquisition	Total Length (cm)	Numbers of M/F/HΔ	Sexual Maturity+
S5	Bivalve	*C. virginica*	5	Diver	6.5-10.4	3/2/0	M
	Crab	*C. sapidus*	5	Trawl	6.7-11.2	4/1/0	I,M,U
	Shrimp	*P. spetiferus*	5	Trawl	12.6-16.1	3/2/0	I,M
S6	Bivalve	*P. cordata*	5	Trawl	3.5-4.4	1/4/0	M
	Crab	*C. similis*	5	Trawl	7.1-9.8	4/1/0	M,U
	Shrimp	*P. aztecus*	5	Trawl	13.5-14.5	1/4/0	I,M
S7	Bivalve	*P. cordata*	5	Trawl	3.2-3.5	5/0/0	M
	Crab	*P. spinicarpus*	5	Trawl	4.8-6.0	4/1/0	M,U
	Shrimp	*P. aztecus*	5	Trawl	14.2-15.0	4/1/0	I,M
S8	Bivalve	*P. cordata*	5	Trawl	3.3-3.8	4/1/0	M
	Crab	*P. gibbesii*	5	Trawl	4.0-4.8	5/0/0	M
	Shrimp	*P. aztecus*	5	Trawl	10.9-14.2	2/3/0	I
S9	Bivalve	*P. cordata*	5	Trawl	3.3-3.9	1/4/0	M
	Crab	*P. spinicarpus*	5	Trawl	5.4-6.2	3/1/0	M,U
	Shrimp	*P. aztecus*	5	Trawl	13.5-16.6	4/1/0	I
S10	Bivalve	*O. equestris*	5	Diver	3.2-5.4	0/1/4	M,U
	Crab	None	0	--	--	--	--
	Shrimp	None	0	--	--	--	--
S11	Bivalve	*O. equestris*	5	Diver	3.5-5.6	2/0/2	M,U
	Crab	None	0	--	--	--	--
	Shrimp	None	0	--	--	--	--
S12	Bivalve	*N. ponderosa*	5	Trawl	2.7-3.6	1/4/0	M
	Crab	None	0	--	--	--	--
	Shrimp	None	0	--	--	--	--
S13	Bivalve	*P. cordata*	5	Trawl	4.0-4.3	0/5/0	M
	Crab	*C. similis*	5	Trawl	5.8-9.2	1/4/0	I,M,U
	Shrimp	*P. aztecus*	5	Trawl	13.6-16.0	0/5/0	I,M
S14	Bivalve	*I. radiatus*	5	Diver	1.5-2.0	1/4/0	M
	Crab	*C. similis*	5	Trawl	8.4-9.5	5/0/0	M
	Shrimp	*P. aztecus*	5	Trawl	11.0-12.8	3/2/0	I
S15	Bivalve	*P. cordata*	5	Trawl	3.3-3.9	2/2/0	M,U
	Crab	*C. similis*	5	Trawl	6.3-7.5	4/1/0	M,U
	Shrimp	*P. aztecus*	5	Trawl	15.6-21.9	3/2/0	I,M
S16	Bivalve	*P. cordata*	5	Trawl	2.4-3.3	3/2/0	M
	Crab	*C. similis*	5	Trawl	8.4-9.2	5/0/0	U
	Shrimp	*P. aztecus*	5	Trawl	12.4-14.5	3/2/0	I,M
S17	Bivalve	*P. cordata*	5	Trawl	3.3-3.8	3/2/0	M
	Crab	*C. similis*	5	Trawl	7.1-10.3	5/0/0	M,U
	Shrimp	*P. aztecus*	5	Trawl	16.4-20.7	3/2/0	M
S18	Bivalve	*A. ovalis*	5	Trawl	2.7-3.8	1/4/0	M
	Crab	*C. similis*	5	Trawl	6.2-7.5	3/2/0	I,M,U
	Shrimp	*T. similis*	5	Trawl	6.3-8.2	1/4/0	U
S19	Bivalve	*C. virginica*	5	Diver	4.4-10.5	4/1/0	M
	Crab	*C. sapidus*	5	Trawl	13.6-16.8	0/5/0	I,M
	Shrimp	None	0	--	--	--	--
S20	Bivalve	*A. ovalis*	5	Trawl	2.2-2.7	2/2/0	M,U
	Crab	None	0	--	--	--	--
	Shrimp	None	0	--	--	--	--

*N = number of individual organisms examined.

+M = mature, I = immature, U = unknown

ΔM = males, F = females, H = hermaphrodites.

The contract called for the examination of 1770 organs (six organs from each of the 295 individuals collected). In some instances, the very small size and/or immaturity of specimens collected made the location of certain organs (notably gut, gonads, and excretory organs) difficult or impossible. Tables 7 and 8 present the distribution of the 1859 organs examined among the sites and species sampled.

1. Bivalves

Selected organs of 115 specimens representing eight species of bivalve molluscs (*Arca imbricata, Anadara ovalis, Noetia ponderosa, Isognomon radiatus, Crassostrea virginica, Ostrea equestris, Tellina* sp., and *Pitar cordata*) were examined for histopathologies. This constituted a total of 679 organs. Two of the 45 (4%) *P. cordata* examined were very thin in gross appearance. This was apparently due to their reproductive cycle as microscopic analyses of gonadal tissue revealed that both specimens had spawned. Six of the 45 (13%) *P. cordata* examined were abnormal in color and texture. Whole, fixed specimens were distinctly pinkish-translucent and very slippery compared to other fixed specimens of *P. cordata* which were brownish-white and opaque. Five of the discolored specimens were from Site S17 and the sixth from Site S15. This condition apparently was not related to reproductive cycle or health of the organisms. One of the ten *O. equestris* examined was very thin and "watery" in gross appearance with distinct white veins in the mantle. Microscopic analyses of tissues revealed this specimen was heavily parasitized by *Bucephalus* sporocysts. Six per cent (7 of 115, i.e. three *I. radiatus*, three *P. cordata* and one *C. virginica*) of the individual bivalves were free of pathologies. Of the 679 organs examined, 320 (47.1%) bore one or more cases of the 20 histopathology types reported below. There were 264 (55.2%) cases of histopathologies which were various types of symbioses or directly caused by symbioses (i.e., inflammation) and 232 (46.8%) cases of histopathologies which were not apparently correlated with symbioses.

Tables 9 and 10 show the distribution of histopathologies among sampling sites as mean number of nonsymbiotic versus symbiotic types. When control, primary and secondary sites are grouped, the primary and secondary sites show approximately the same mean number of nonsymbiotic and symbiotic pathologies per mollusc. The control sites, however, show almost twice the mean number of nonsymbiotic pathologies per mollusc and a greater number of symbiotic pathologies than the primary and secondary site groups. Almost all of the control group's pathologies are contributed by molluscs from Sites C22 and C23. *Noetia ponderosa* from Site C22 can be compared with *N. ponderosa* from Site S12. *Pitar cordata* can be compared with *P. cordata* from Sites S6, S7, S8, S9, S13, S15, S16, and S17. Pathologies and their distribution among species and organs are described below. Table 11 gives a ranking of sampling sites by mean number of histopathologies.

a. Muscle

Muscle tissues were examined from 115 bivalves. Samples for microscopic analysis were dissected from the adductor muscle and both fast and catch muscles were examined when possible. Generally, two muscle samples were taken and oriented to give both longitudinal and cross sections.

TABLE 7. Numbers of invertebrate organs collected during Cruise I which were examined for histopathologies.

		Organs						
Site	Species	Muscle	Digestive Gland	Gut	Gonad	Excretory	Gill	Other*
P1	*C. virginica*	5	5	5	5	5	5	
	S. lobatus	5	5	5	5	0	5	
P2	*C. virginica*	5	5	5	5	4	5	
	C. similis	5	5	3	3	5	3	C-5
	P. aztecus	5	5	5	3	5	5	C-5
P3	*A. imbricata*	5	5	5	5	5	5	
	P. spinicarpus	5	5	4	5	3	5	C-5,N-5
	T. similis	5	1	3	5	3	5	C-5
P4	*A. imbricata*	5	5	5	5	3	5	
	L. nitidus	5	5	4	4	3	4	C-5,N-5
	T. similis	5	5	4	5	5	5	C-5
C21	*Tellina* sp.	5	5	5	5	5	5	
	C. similis	5	5	4	3	4	5	C-5
C22	*N. ponderosa*	5	5	5	5	5	5	
	C. similis	5	5	2	0	5	5	C-4
	T. similis	5	5	4	5	5	5	C-3
C23	*P. cordata*	5	5	5	5	5	5	
	P. spinicarpus	5	5	5	5	5	5	C-5,N-4
	P. aztecus	5	5	5	5	5	5	C-5
C24	*C. similis*	5	5	5	0	0	5	C-4
	Total	100	96	88	83	80	97	70 =614

*C = heart (cardiac), N = nerve.

TABLE 8. Numbers of invertebrate organs collected during Cruise II which were examined for histopathologies.

		Organs						
Site	Species	Muscle	Digestive Gland	Gut	Gonad	Excretory	Gill	Other*
S5	*C. virginica*	5	5	5	5	5	5	
	C. sapidus	5	5	5	4	5	5	C-5
	P. setiferus	5	5	5	2	5	5	C-4
S6	*P. cordata*	5	5	5	5	5	5	F-1
	C. similis	5	5	4	3	5	5	C-5
	P. aztecus	5	5	5	5	5	5	C-5
S7	*P. cordata*	5	5	5	5	5	5	F-1
	P. spinicarpus	5	5	4	2	4	5	C-5
	P. aztecus	5	5	5	5	5	5	C-5
S8	*P. cordata*	5	5	5	5	5	5	F-2
	P. gibbesii	5	5	4	5	4	5	C-5
	P. aztecus	5	5	5	5	4	5	C-5
S9	*P. cordata*	5	5	5	5	5	5	
	P. spinicarpus	3	5	4	3	5	5	C-4
	P. aztecus	5	4	5	4	3	5	C-4
S10	*O. equestris*	5	5	5	5	5	5	
S11	*O. equestris*	5	5	5	5	5	5	
S12	*N. ponderosa*	5	5	5	5	5	5	
S13	*P. cordata*	5	5	5	5	5	5	F-1
	C. similis	5	5	3	3	5	5	C-5
	P. aztecus	5	5	5	5	5	5	C-5
S14	*I. radiatus*	5	5	5	5	0	5	
	C. similis	5	5	5	5	5	5	C-5
	P. aztecus	5	5	5	5	5	5	B-2,C-5
S15	*P. cordata*	5	5	5	4	5	5	
	C. similis	5	5	5	5	5	5	C-5
	P. aztecus	5	5	5	5	5	4	C-4
S16	*P. cordata*	5	5	5	5	5	5	F-1
	C. similis	5	5	5	1	3	5	C-5
	P. aztecus	5	5	5	5	5	5	C-5
S17	*P. cordata*	5	5	5	5	5	5	
	C. similis	5	5	5	5	5	4	C-5
	P. aztecus	5	5	5	5	5	5	C-5,T-1
S18	*A. ovalis*	5	5	5	5	5	5	F-2
	C. similis	5	5	4	5	5	5	C-5
	T. similis	5	5	5	5	4	5	C-5
S19	*C. virginica*	5	5	5	5	4	5	
	C. sapidus	5	5	4	5	5	5	C-5
S20	*A. ovalis*	5	5	5	4	5	5	
	Total	193	194	187	175	181	193	122=1245

*B = hemocoel, C = heart (cardiac), F = foot, T = connective tissue.

TABLE 9. Distribution of histopathologies of bivalve molluscs among sampling sites.

	Mean Number of Nonsymbiotic / Symbiotic Histopathologies						
Site	Muscle	Digestive Gland	Gut	Gonad	Excretory	Gill	Per Organism
Control							
C21	0.0/0.4	0.0/0.0	0.0/0.4	0.0/0.0	0.0/0.0	0.0/0.4	0.0/1.2
C22	1.6/0.4	1.0/1.2	0.0/0.4	0.6/1.6	0.8/1.0	0.4/0.4	4.4/5.0
C23	1.0/0.2	0.4/0.6	0.2/0.0	0.4/0.0	0.6/0.4	1.8/1.2	4.4/2.4
Primary							
P1	0.0/0.8	0.2/0.2	0.0/0.0	0.2/0.0	0.0/0.0	1.4/1.4	1.8/2.6
P2	0.0/1.0	0.4/0.6	0.4/0.2	0.0/0.0	0.0/0.0	0.8/1.0	1.4/2.6
P3	0.0/1.0	0.0/0.2	0.2/0.0	0.6/0.0	0.2/0.0	0.6/0.2	1.6/1.4
P4	0.0/1.0	0.0/0.8	0.0/0.0	0.0/0.0	0.4/0.0	1.3/0.3	1.2/2.0
Secondary							
S5	0.2/1.0	0.2/1.2	0.6/1.0	0.8/0.6	0.0/0.0	0.0/1.0	1.8/4.8
S6	0.0/0.0	1.0/1.4	0.8/0.6	0.2/1.0	0.0/0.0	1.0/0.6	3.0/3.6
S7	0.0/0.0	0.4/1.6	0.6/0.2	0.0/0.2	0.4/0.4	1.0/1.2	2.4/3.6
S8	0.4/0.0	0.8/1.2	0.6/0.0	0.4/1.0	0.4/0.0	1.2/0.6	3.8/2.8
S9	0.0/0.0	0.0/0.6	0.6/0.0	0.4/0.2	0.0/0.2	0.8/1.0	1.8/2.0
S10	0.6/0.4	0.0/1.0	0.8/0.8	0.0/0.0	0.0/0.0	0.0/0.4	1.4/2.6
S11	0.6/1.2	0.0/1.2	1.0/1.0	0.0/0.4	0.2/0.2	0.4/0.6	2.2/4.6
S12	0.0/0.0	0.4/1.0	0.0/0.4	0.0/0.2	0.0/0.0	0.0/0.0	0.4/2.0
S13	0.2/0.0	1.4/1.2	1.4/0.8	0.4/0.8	0.2/0.0	0.0/0.0	3.6/2.8
S14	0.6/0.0	0.8/0.0	0.0/0.2	0.0/0.0	0.0/0.0	0.0/0.0	1.4/0.2
S15	0.2/0.8	0.0/0.8	0.8/0.0	0.3/0.0	0.2/0.0	0.4/0.0	1.8/1.6
S16	0.0/0.2	0.2/0.4	0.8/0.0	0.0/0.0	0.2/0.4	0.2/0.2	1.2/1.2
S17	0.0/0.2	0.2/0.2	1.0/0.0	0.0/0.0	0.0/0.0	0.0/0.0	1.2/0.4
S18	0.0/0.0	0.0/0.8	0.0/0.8	0.2/0.8	0.6/0.0	0.4/1.4	1.2/3.8
S19	0.0/0.0	0.0/0.0	0.0/0.0	0.0/0.0	0.0/0.0	0.0/0.0	0.0/0.0
S20	0.0/0.0	0.0/1.4	0.0/0.0	0.0/0.3	0.0/0.0	0.6/0.0	0.6/1.6

TABLE 10. Distribution of histopathologies of bivalve molluscs among combined control, primary and secondary sampling sites.

	Mean Number of Nonsymbiotic / Symbiotic Histopathologies						
Combined Sites	Muscle	Digestive Gland	Gut	Gonad	Excretory	Gill	Per Organism
Control	0.9/0.3	0.5/0.6	0.1/0.3	0.3/0.5	0.5/0.1	0.7/0.7	2.9/2.9
Primary	0.0/1.0	0.2/0.5	0.2/0.1	0.2/0.0	0.2/0.0	1.0/0.8	1.5/2.1
Secondary	0.2/0.2	0.3/0.9	0.6/0.4	0.2/0.3	0.1/0.1	0.4/0.4	1.7/2.4

TABLE 11. Ranking of sampling sites by mean number of histopathologies per bivalve.

Site	Species	Mean Number of Histopathologies per Bivalves.
C22	*N. ponderosa*	9.4
S11	*O. equestris**	6.8*
C23	*P. cordata*	6.8
S5	*C. virginica**	6.6*
S6	*P cordata*	6.6
S8	*P. cordata*	6.6
S13	*P. cordata*	6.4
S7	*P. cordata*	6 0
S18	*A. ovalis*	5.0
P1	*C. virginica**	4.2*
P2	*C. virginica**	4.0*
S10	*O. equestris**	4.0*
S9	*P. cordata*	3.8
S15	*P. cordata*	3.4
P4	*A. imbricata**	3.2*
P3	*A. imbricata**	3.0*
S12	*N. ponderosa*	2.4
S16	*P. cordata*	2.4
S20	*A. ovalis*	2.2
S14	*I. radiatus**	1.6*
S17	*P. cordata*	1.6
C21	*Tellina* sp.	1.2

*platform associated

(1) Normal Microscopic Features— In longitudinal section, muscle tissues were composed of long cylindrical cells with tapered ends. The eosinophilic cytoplasm contained numerous slender fibrils which were oriented parallel to the longitudinal axis in relaxed muscle but were somewhat obliquely oriented in contracted muscle. The peripheral nuclei were oval to elongate in shape, stained lightly, and contained several small nucleoli. Each muscle cell was surrounded by endomysium, a very delicate connective tissue membrane. Bands of muscle were ensheathed in a heavier connective tissue sheet, the epimysium. A heavier connective tissue, the perimysium, ran between and connected muscle bands.

In cross section, the muscle cells were arranged in bands which were sometimes compact. Individual cells were irregular in cross section and varied considerably in width. The nuclei stained more densely than in longitudinal section and were irregularly spaced.

Catch muscle was more acidophilic, had heavier connective tissue and the individual cells were generally wider than in fast muscle. Nerve tissue and free hemocytes were present in muscle sections.

(2) Histopathological Conditions— Histopathologies occurred in 43.5% (50 of 115) of the muscle samples examined. There were a total of 70 cases of the nine different types of conditions discussed below. The distribution of these pathologies among sampling sites is presented in Table 12.

Abnormally high numbers of eosinophilic leucocytes were evident in 9.6% (11 of 115) of the muscle samples examined. Six *O. equestris*, three *P. cordata*, and two *I. radiatus* displayed this condition. Leucocytes were generally spread throughout the muscle rather than being in focal concentrations.

Six per cent (7 of 115) of the muscle samples analysed displayed evidence of degeneration or liquefaction. This occurred in three *N. ponderosa*, three *P. cordata* and one *C. virginica*. In some instances, the muscle apparently broke down and liquefied, disrupting the normal structure and leaving only an amorphous, light staining mass of fibers. Liquefied areas were confined to a few individual muscles or covered an extensive area. No nuclei were present in liquefied areas. In other instances, the muscles were shrunken and greatly reduced in size, leaving large open areas surrounded by connective tissue (Fig. 20A). This was also sometimes extensive.

Five per cent (6 of 115) of the muscle samples analysed possessed areas of focal necrosis (Fig. 20B). This condition occurred in five *N. ponderosa*, all from Site C22, and one *P. cordata*. This condition was characterized by breakdown or liquefaction of muscle accompanied by pyknotic nuclei, acidophilic and basophilic cellular debris and in some cases leucocytes.

Two (1.7%) of the muscle samples examined contained focal concentrations of leucocytes. This condition was characterized by abnormally high numbers of leucocytes occurring in clumps, sometimes concentrically arranged around a core of pyknotic nuclei, rather than being dispersed throughout the tissue. This occurred in one *P. cordata* and one *I. radiatus*. These concentrations were apparently not the results of symbioses.

The muscles of one *P. cordata* had darkly staining pyknotic nuclei in focal areas. No leucocytes were associated with this condition.

Three types of symbioses were observed in bivalve adductor muscle. The most prevalent was the fungal parasite (Order Plasmodiophorales) Dermocystidium marinum or *Dermocystidium*-like organisms. *Dermocystidium marinum* or *D. marinum*-like

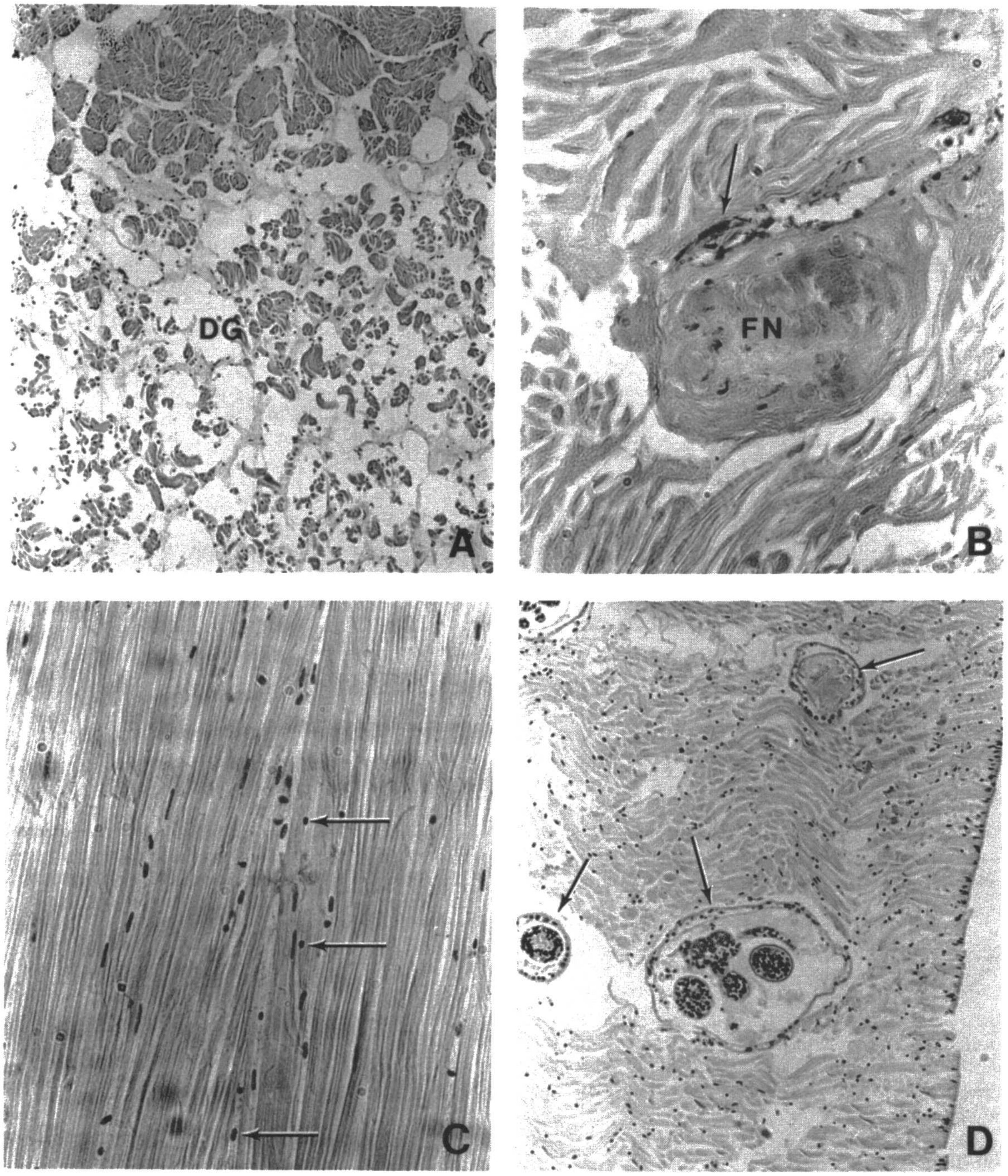

Fig. 20. Bivalve muscoe. A. *C. virginica.* Degeneration (DG), 130X. B. *N. ponderosa.* Focal necrosis (FN) with leucocytic invasion and debris (arrow). 340X. C. *O. equestris. Dermocystidium*-like symbionts (arrows). 340X. D. *Ostrea equestris. Bucephalus* sporocysts (arrows). 136X.

TABLE 12. Distribution of histopathologies of bivalve musculature among sampling sites. Each site represents five muscle samples unless otherwise noted.

	Site																						
Pathology	P1	P2	P3	P4	S5	S6	S7	S8	S9	S10	S11	S12	S13	S14	S15	S16	S17	S18	S19	S20	C21	C22	C23	C24*
Leucocytosis (general)	--	--	--	--	--	--	--	1	--	3	3	--	--	2	--	--	--	--	--	--	--	--	2	--
Degeneration	--	--	--	--	1	--	--	1	--	--	--	--	--	--	--	--	--	--	--	--	--	3	2	--
Focal necrosis	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	5	1	--
Leucocytosis (focal)	--	--	--	--	--	--	--	--	--	--	--	--	1	1	--	--	--	--	--	--	--	--	--	--
Pyknotic nuclei	--	--	--	--	--	--	--	--	--	--	--	--	--	--	1	--	--	--	--	--	--	--	--	--
Plasmodiophorales	4	5	5	5	5	--	--	--	--	2	4	--	--	--	1	1	--	--	--	--	2	--	--	--
Amoeba	--	--	--	--	--	--	--	--	--	--	--	--	--	--	3	--	1	--	--	--	--	--	--	--
Sporozoa	--	--	--	--	--	--	--	--	--	--	1	--	--	--	--	--	--	--	--	--	--	2	1	--
Bucephalus	--	--	--	--	--	--	--	--	--	--	1	--	--	--	--	--	--	--	--	--	--	--	--	--
Total Number	4	5	5	5	6	0	0	2	0	5	9	0	1	3	5	1	1	0	0	0	2	10	6	--

*no bivalves collected

organisms were present in 29.6% (34 of 115) of the muscle samples examined (Fig. 20C). Fourteen C. virginica, ten *A. imbricata*, six *O. equestris*, two *P. cordata*, and two *Tellina* sp. were infected. The spindle cell stage of this parasite was apparent as dense, round to oval bodies which stained solid black.

Unidentified amoebae were seen in 3.5% (4 of 115) of the muscle samples examined. This condition was limited to *P. cordata* from Sites S15 and S17. Each amoeba had a single, lightly basophilic nucleus and cytoplasm filled with dark, acidophilic granules. Amoebae were numerous and appeared to displace the muscle cells.

Unidentified sporozoans were present in 3.5% (4 of 115) of the muscle tissues examined. Single plasmodial or sporocyst stages were noted in the adductor muscle of one *N. ponderosa*, one *O. equestris*, one *P. cordata* and in the body musculature of one *N. ponderosa*.

A single *O. equestris* bore numerous *Bucephalus* sporocysts in the adductor muscle and musculature of the body (Fig. 20D).

b. Digestive Gland

The digestive glands of 115 bivalves were examined.

(1) Normal Microscopic Features— The digestive glands of the eight species of bivalves examined were similar in microscopic structure, with some minor variation. In living specimens, the digestive gland was light yellow or brown to dark green to dark brown in color. It was composed of many blind tubules, the digestive diverticulae, which emptied into larger collecting ducts. In cross section, the diverticulae were round to oval with a cross-shaped or circular lumen. Diverticulae were composed of a connective tissue basement membrane and cuboidal and columnar epithelial cells. Epithelial cells were non-ciliated, generally large, sometimes highly vacuolated with light staining cytoplasm and a large basophilic basal nucleus. In *C. virginica* and *O. equestris*, four clumps of crypt or regenerative cells occupied the "corners" of the diverticulae. These cells were strongly basophilic with large compact nuclei. In other species, the regenerative cells were situated along one or two sides (*P. cordata* and *Tellina* sp.) or more or less evenly distributed along the diverticulae (*N. ponderosa, A. ovalis,* and *A. imbricata*). Mucous cells and phagocytes were lightly scattered in the epithelium. In a few species (*N. ponderosa, P. cordata, A. ovalis*) the epithelial cells sometimes contained a heavy concentration of yellow crystals or secretions.

The ducts which connected the diverticulae to the stomach were circular to ovate in cross section with irregular to circular lumina. They were composed of ciliated columnar cells on a connective tissue basement membrane, with light staining cytoplasm and a basal nucleus. Mucous cells and phagocytes were present in the epithelia.

The diverticulae and connecting ducts were either compact or loosely arranged and were surrounded by connective tissue, some smooth muscle strands and hemocytes.

(2) Histopathological Conditions—Histopathologies were noted in 69.6% (80 of 115) of the digestive gland samples examined. There were a total of 125 cases of the 12 types of pathologies described below. Thirty-seven of the cases or 29.6% were not apparently attributable to symbioses, while 88 cases were a type of symbiotic relationship or were clearly attributable to

TABLE 13. Distribution of histopathologies of bivalve musculature among sampling sites. Each site represents five muscle samples unless otherwise noted.

	Site																							
Pathology	P1	P2	P3	P4	S5	S6	S7	S8	S9	S10	S11	S12	S13	S14	S15	S16	S17	S18	S19	S20	C21	C22	C23	C24*
Leucocytosis (focal)	--	1	--	--	--	4	2	2	--	--	--	2	3	--	--	1	--	--	--	--	--	1	1	--
Leucocytosis (general)	1	1	--	--	1	--	--	2	--	--	--	--	2	--	--	--	--	--	--	--	--	4	1	--
Yellow Cells	--	--	--	--	--	--	--	--	--	--	--	--	2	4	--	--	1	--	--	--	--	--	--	--
Degeneration	--	--	--	--	--	1	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Sporozoans	1	--	--	4	2	2	4	3	3	--	--	--	2	--	2	1	1	--	--	--	--	--	2	--
Cestodes	--	2	--	--	--	1	2	1	--	--	--	5	3	--	2	--	--	3	--	3	--	4	--	--
Plasmodiophorales	--	--	--	--	4	--	--	--	--	5	5	--	--	--	--	--	--	--	--	--	--	--	--	--
Nematodes	--	--	--	--	--	4	1	2	--	--	--	--	1	--	--	--	--	1	--	--	--	1	--	--
Amoebae	--	--	--	--	--	--	1	--	--	--	--	--	--	--	--	1	--	--	--	1	--	1	--	--
Trematodes	--	--	--	--	--	--	--	--	--	--	1	--	--	--	--	--	--	--	--	3	--	--	--	--
Spores (?)	--	1	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	1	--
Copepod	--	--	1	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Total Number	2	5	1	4	7	12	10	10	3	5	6	7	13	4	4	3	2	4	0	7	0	11	5	--

*no bivalves collected

symbioses (i.e., inflammation). The distribution of these histopathologies among sampling sites is presented in Table 13.

Focal aggregations of leucocytes were present in digestive gland samples of 14.8% (17 of 115) of the bivalves examined (Fig. 21A). This condition was present in 15 *P. cordata*, three *N. ponderosa* and one *C. virginica*. The extent varied from a single small clump to several scattered aggregations to a large massive aggregation. None were apparently associated with helminth parasitism.

Abnormally high numbers of eosinophilic leucocytes were dispersed throughout the tissues of 10.4% (12 of 115) of the digestive gland samples studied (Fig. 21B). This occurred in six *P. cordata*, four *N. ponderosa* and two *C. virginica*.

Concentrations of a peculiar yellow pigmented cell were observed in 6.0% (7 of 115) of the digestive gland samples examined (Fig. 21C). These cells had the appearance of leucocytes but were seldom seen except in focal and general accumulations in the digestive gland and focally in the gut. They were somewhat amoeboid, usually goblet-shaped to round in form, had dense spherical nuclei and a very dense appearing cytoplasm filled with yellow granules. Yellow pigmented cells were present in moderate to very heavy aggregations in the digestive glands of four *P. cordata* and were distributed rather evenly and lightly in the digestive glands of three other *P. cordata*.

One *P. cordata* displayed some evidence of degeneration in a small focal area of diverticulae. Cellular structure was lost in this area with accumulation of some debris.

The digestive gland was a common site for parasitism. This organ contained 88 cases, over twice as many as any other organ except gill. Twenty-three percent (27 of 115) of the digestive glands examined contained one or more types of sporozoans. Two *C. virginica*, both from Site S5 contained *Nematopsis* spores in the connective tissue near the edge of the digestive gland. A third *C. virginica* contained an unidentified protozoan. Four *N. ponderosa* from Site C22 bore unidentified sporozoans in the connective tissue in and around the digestive gland. Most were single, oval cells which resembled macro-gametocytes of marine coccidia. The light, basophilic nucleus of these cells contained a single endosome and was surrounded by light eosinophilic-basophilic cytoplasm. A second type of sporozoan in *N. ponderosa* somewhat resembled the plasmodium stage of the haplosporidian *Minchinia*. These basophilic spherical bodies were present in the connective tissue and contained several small, spherical nuclei, each with a prominent endosome adjacent to the nuclear membrane. An intracellular stage of an unidentified sporozoan was present in the hepatocytes of twenty *P. cordata* (Fig. 21D). It somewhat resembled a micro-gametocyte of some marine coccidia. These sporozoans were spherical in form, basophilic and were multinucleate or contained coarse chromatin granules. Hepatocytes appeared not to be harmed.

Larval trypanorhynchan cestodes were present in 22.6% (26 of 115) of the digestive glands studied. Nine of the ten *N. ponderosa* examined bore one to several larvae in the lumina of the digestive diverticulae. In some instances, an increased number of mucous cells were present in the epithelium surrounding the cestodes. Two *Noetia* each bore a cestode in the connective tissue between diverticulae; one cestode elicited no host response while the other was surrounded by a connective tissue capsule. Larval cestodes were encysted in the

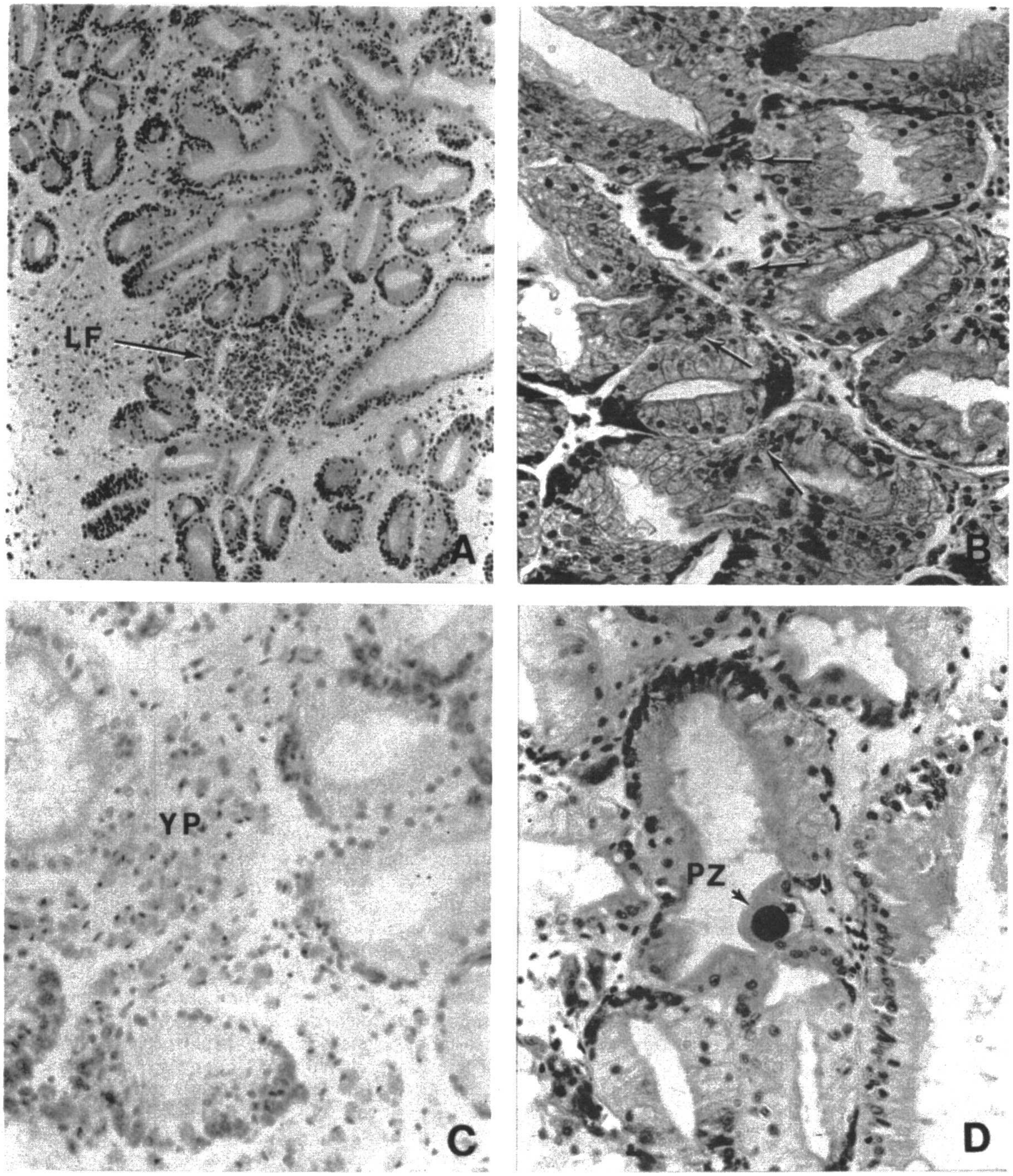

Fig. 21. Bivalve digestive gland. A. *P. cordata*. Focal aggregation of leucocytes (LF) between digestive diverticula. 136X. B. *P. cordata*. Abnormally high number of circulating leucocytes (arrows). 240X. C. *P. cordata*. Concentration of yellow pigmented cells (YP) between digestive diverticula. 340X. D. *P. cordata*. Sporozoan (PZ) in a hepatocyte of the digestive epithelium. 340X.

the digestive gland of 11 *P. cordata*. All cestodes were surrounded by connective tissue capsules, sometimes quite thick. Aggregations of eosinophilic leucocytes were observed to surround cestode cysts in three of the 11 *Pitar* (Fig. 22A). Lumina of the diverticulae were also the site for cestode infection in six of ten *A. ovalis*.

Plasmodiophorales-like organisms, tentatively identified as *Dermocystidium marinum*, were incident in 12% (14 of 115) of the digestive gland samples. Ten *O. equestris* and four *C. virginica* bore infections as previously described for muscle. No tissue damage was noted.

Nematode larvae were present in 8.7% (10 of 115) of the tissues examined. Nine *P. cordata* and one *A. ovalis* harbored these helminths, apparently a single worm each. Half of the above molluscs showed no host response either in the form of encystment or inflammation by leucocytic infiltration. No tissue damage was noted to the hosts, except for some displacement of tissue. Nematodes in five of the above *Pitar*, however, elicited moderate to heavy host inflammatory response (Fig. 22B). Aggregations of eosinophilic leucocytes were present adjacent to the helminths. Some aggregates were large and breakdown of diverticulae was observed in some cases.

Protozoans, tentatively identified as amoebae, were present in 3.5% (4 of 115) of the digestive glands examined. Three *P. cordata* and one *N. ponderosa* were infected. Amoebae were enclosed by a thin layer of connective tissue. These organisms were spherical with a spherical basophilic nucleus and eosinophilic cytoplasm containing basophilic granules. One was observed to be undergoing binary fission. The amoebae in *N. ponderosa* were present in a very large aggregation of leucocytes.

Trematode larvae were found in 3.5% (4 of 115) of the digestive glands examined. Three *A. ovalis* bore metacercaria which were surrounded by layers of connective tissue. A single *O. equestris* was host to *Bucephalus* sporocysts. Damage by the sporocysts was heavy as only a few diverticulae of the digestive gland remained.

A single *P. cordata* bore numerous strongly basophilic, oval-shaped, spore-like structures in the hepatocytes. No detail of these structures could be seen. Infected hepatocytes were often enlarged. A similar spore-like object was observed in the connective tissue of the digestive gland of a single *C. virginica*.

The digestive gland of one *A. imbricata* contained a copepod. No damage to the host was noted.

Abnormally heavy concentrations of mucous cells were observed in the diverticula epithelium of 14.8% (17 of 115) of the bivalves examined. In some cases, this occurred in epithelium adjacent to cestode symbionts and was probably a response to them. In some bivalves, no cestodes were found in association with large concentrations of mucous cells. Concentrations of mucous cells are not herein considered a pathology, but their presence in perhaps unusually high numbers has been noted.

c. Gut

Samples consisting of stomach, intestine and often esophageal and rectal tissues were studied from 115 individual molluscs.

(1) Normal Microscopic Features— The digestive tract was lined by a simple columnar epithelium on a basement membrane of collagen fibers and some smooth muscle. With the exception of the area under the gastric shield, the columnar epithelium was ciliated throughout. Ciliation was especially pronounced on some portions of the stomach and in the style sac. The cytoplasm of the epithelial cells was lightly eosinophilic and finely granular. The nuclei were large and oval with chromatin in the form of sparse, basophilic granules. Nuclei were located from about the middle to the base of the cells. Mucous cells were interspersed among the ciliated epithelium cells and were especially common in the rectum. Mucous cells were generally elongate or goblet-shaped with coarsely vesicular, strongly eosinophilic mucous droplets almost filling the cell and pushing the nucleus to the side. Phagocytes and eosinophilic leucocytes were sparsely scattered between the ciliated cells and were more common in the connective tissue surrounding the digestive tract. A gastric shield, ranging from a chitinous-like membrane to a thick, laminated layer covered a small part or almost all of the stomach, depending on the species. A layer of connective tissue consisting of elongate to somewhat spherical, multiangular Leydig cells surrounded most of the digestive tract. The nucleus of Leydig cells was centrally or peripherally located.

(2) Histopathological Conditions— Histopathologies were noted in 44.3% (51 of 115) of the gut samples examined. There were 85 cases of the nine conditions discussed below. Forty-nine were nonsymbiotic and 36 were symbiotic or symbiotic related. The distribution of these histopathologies among sampling sites is presented in Table 14.

Aggregations of yellow-pigmented cells (Fig. 22C) were present in the epithelial lining of 21.7% (25 of 115) of the gut samples examined. All cases were restricted to *P. cordata*, of which 55.5% (25 of 45) had this condition. Yellow-pigmented cells were round to goblet-shaped or often anomalous. The hyaline cytoplasm was often so packed by coarse, yellow granules that the dense, rounded nucleus appeared to be pushed to the periphery of the cell. Yellow-pigmented cells were mostly restricted to the lower, feces-filled intestine but were occasionally observed very sparsely in the epithelium in other parts of the gut. They were also occasionally present in the digestive gland as described earlier. Disruption of the epithelium was associated with this condition but leucocytic infiltration was evident in only one incident. In heavy cases, yellow-pigmented cells aggregated in one focal area, causing the epithelium to become greatly distended, apparently detaching from the basement membrane and ballooning into the lumen of the intestine.

Abnormally high numbers of eosinophilic leucocytes were noted in the epithelial lining or below the basement membrane of 13% (15 of 115) of the tissues examined. This condition was observed in five *C. virginica*, two *P. cordata* and eight *O. equestris*. Leucocytes were generally spread through the tissue in one area rather than being in focal aggregations.

Focal aggregations of eosinophilic leucocytes were observed in 5.2% (6 of 115) of the gut samples examined. Aggregations of leucocytes were noted in five *P. cordata* and *A. imbricata*.

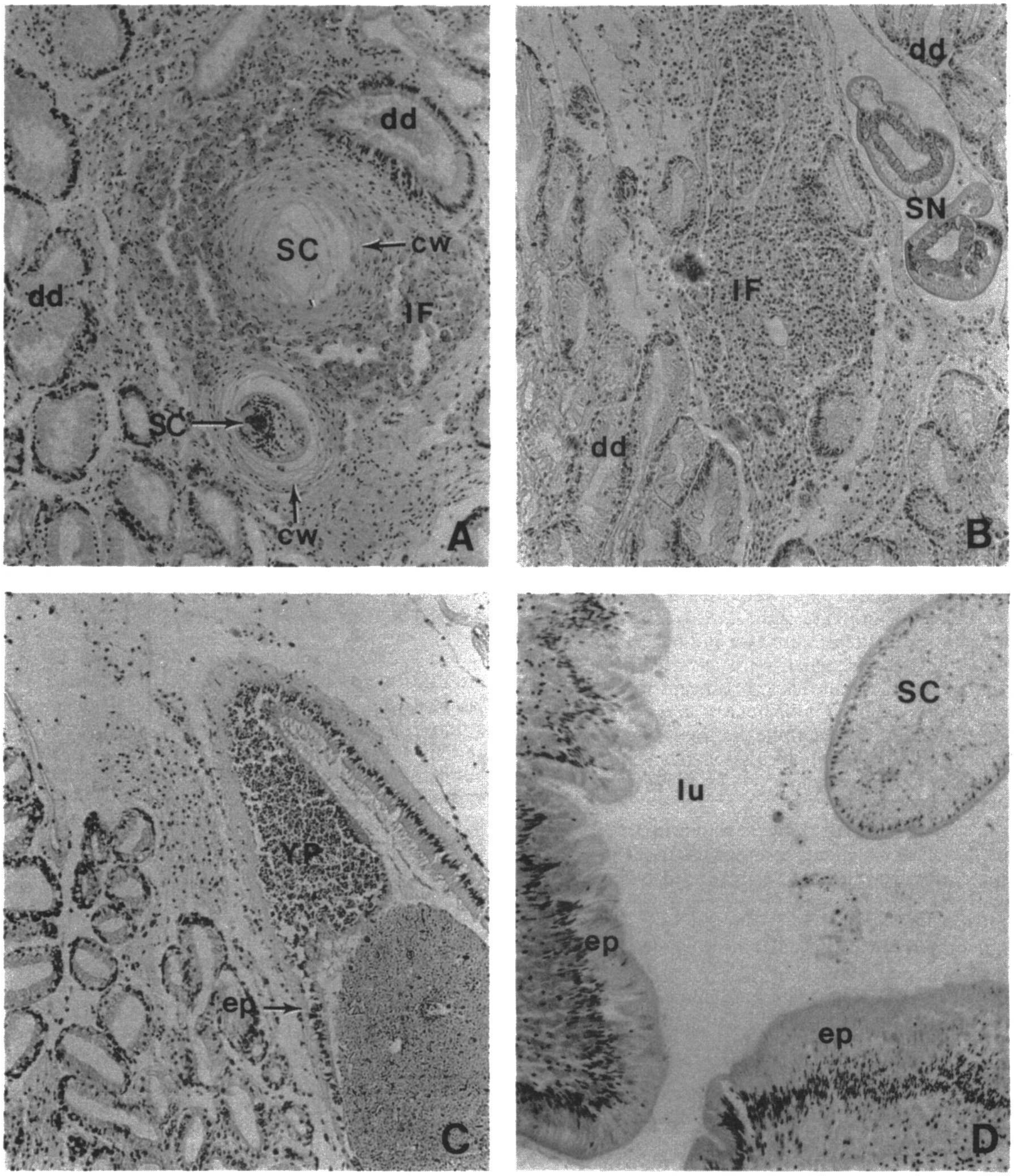

Fig. 22. Bivalve digestive gland (A&B) and gut (C&D). A. *P. cordata*. Cestodes (SC) encysted between digestive diverticula (dd) accompanied by inflammatory response (IF). Note connective tissue wall (cw). 136X. B. *P. cordata*. Larval nematodes (SN) between digestive diverticula (dd) accompanied by inflammation (IF). 136X. C. *P. cordata*. Concentration of yellow pigment cells (YP) in epithelium of gut (ep). 136X. D. *N. ponderosa*. Cestode (SC) in lumen (lu) of stomach; stomach epithelium (ep). 136X.

TABLE 14. Distribution of histopathologies of bivalve gut among sampling sites. Each site represents five gut samples unless otherwise noted.

	Site																						
Pathology	P1	P2	P3	P4	S5	S6	S7	S8	S9	S10	S11	S12	S13	S14	S15	S16	S17	S18	S19	S20	C21	C22	C23	C24*
Yellow Cells	--	--	--	--	--	3	3	2	3	--	--	--	5	--	4	1	4	--	--	--	--	--	--	--
Leucocytosis (general)	--	2	--	--	3	1	--	1	--	3	5	--	--	--	--	--	--	--	--	--	--	--	--	--
Leucocytosis (focal)	--	--	1	--	--	--	--	--	--	--	--	--	2	--	--	2	--	--	--	--	--	--	1	--
Necrosis	--	--	--	--	--	--	--	--	--	1	--	--	--	--	--	1	1	--	--	--	--	--	--	--
Plasmodiophorales	--	--	--	--	5	1	1	--	--	4	5	--	3	--	--	--	--	--	--	--	--	--	--	--
Cestodes	--	--	--	--	--	--	--	--	--	--	--	4	--	--	--	--	--	4	--	--	2	2	--	--
Sporozoans	--	1	--	--	--	--	--	--	--	--	--	--	1	--	--	--	--	--	--	--	--	--	--	--
Copepods	--	--	--	--	--	1	--	--	--	--	--	--	--	1	--	--	--	--	--	--	--	--	--	--
Amoeba	--	--	--	--	--	1	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Total Number	0	3	1	0	8	7	4	3	3	8	10	4	11	1	4	4	5	4	0	0	2	2	1	--

*no bivalves collected

Evidence of necrosis was displayed in 2.6% (3 of 115) of the gut samples. In the single *O. equestris* and two *P. cordata*, this condition was limited to a single, small, focal area each.

Plasmodiophorales-like organisms, as described under muscle, were incident in 16.5% (19 of 115) of the gut tissue samples collected. This parasite was found in five *C. virginica*, five *P. cordata* and nine *O. equestris*.

Ten per cent of the gut tissue samples examined contained tetraphyllidean cestodes. With the exception of one encysted in connective tissue, all were free in the gut lumen (Fig. 22D). Cestodes were found in six *N. ponderosa*, four *A. ovalis*, and two *Tellina* sp. In some instances, heavy concentrations of mucous cells in the epithelium were associated with the presence of cestodes.

Plasmodium-like stages of unidentified sporozoans were present in two samples. One *C. virginica* contained a single, spherical plasmodium-like structure in the connective tissue surrounding the intestine. A *P. cordata* bore numerous spherical, intracellular, basophilic structures in the epithelium of the gut.

Copepods were incident in the intestine of one *P. cordata* and one *I. radiatus*. No host inflammatory response was noted. One *C. virginica* contained unidentified amoebae in the gut lumen.

Abnormally high numbers of mucous cells were aggregated in the gut epithelium of 19% (22 of 115) of the tissues examined. In some incidences this was associated with the presence of cestodes, but not all. Ten *A. ovalis*, seven *C. virginica*, four *N. ponderosa* and one *A. imbricata* displayed heavy aggregations of mucous cells in the gut epithelium. In heavy cases, the epithelium appeared to have been almost replaced by large, strongly eosinophilic mucous cells. These concentrations of mucous cells are not herein considered to be a pathology, but their presence in perhaps unusually high numbers has been noted.

d. Gonad

Gonadal tissues of 113 specimens were examined. These included 58 samples of ovarian tissue, 46 samples of testicular tissue and eight samples from hermaphroditic specimens. No gonadal tissue was found in one specimen because of parasitism as described below.

(1) Normal Microscopic Features—The bivalve ovary consisted of many branching tubular follicles. In cross section, the follicles appeared as irregularly round or elongate units bounded by a basement membrane of collagen fibers. Depending on maturation stage, the follicles were either butted together or were separated by Leydig cells. In some samples, the walls of the follicles were lined by small ovocytes and other small, somewhat flattened cells, both of which were deeply basophilic. In other samples, from more mature specimens, ovocytes and other cells were less numerous along the periphery of the follicles and portions of the follicle wall were devoid of such cells. Free ova were present in the lumina or were attached to the wall by a peduncle. The shape of the ova varied greatly. The cytoplasm of the ova was basophilic and sometimes contained droplets, vacuoles and granules. The nuclei were large with a spherical nucleolus which was eccentrically located. Follicles along the surface of the gonad were lined by a ciliated cuboidal epithelium along the outer side. Follicles from spawned ovaries contained only a few ova. Muscle strands, nervous tissue and hemocytes were present between follicles.

The testes were divided into spermaries, tubular units bounded by collagen fibers. In cross section the spermaries varied considerably in shape. The arrangement of cells in a spermary was similar to that in the ovary. The walls of the spermaries were lined by spermatogonia, small basophilic cells with large nuclei. The lumina of the spermaries were filled with spermatocytes and spermatozoa. Most of the lumina were filled by the spermatozoa which were smaller than the spermatogonia and spermatocytes. The flagellar tails of the spermatozoa were eosinophilic and trailed toward the center of the spermary. Spermaries along the surface of the gonad were lined by ciliated cuboidal epithelium along the outer side. Muscle strands, nervous and connective tissues were present between spermaries.

(2) Histopathological Conditions—Histopathologies were noted among 32.7% (37 of 113) of gonad samples examined. There were a total of 57 cases of the 10 conditions discussed below. Thirty-five of the cases (61.4%) were attributable to symbioses. The distribution of histopathologies among sampling sites is presented in Table 15.

Ten per cent (11 of 113) of the gonads examined were undergoing degeneration to some degree (Fig. 23A). All cases except one were occurring in ovarian tissue. The extent of degeneration varied from one or two follicles to almost all of the follicles. Some or all ova in affected follicles were lysed into amorphous cellular debris. Some, but not all, degenerating follicles were being invaded by eosinophilic leucocytes and in one case the follicles were ringed by leucocytes. Degeneration of ovarian follicles occurred in five *P. cordata*, three *N. ponderosa* and one *A. imbricata*. One spermary in a single *P. cordata* was disrupted and being invaded by eosinophilic leucocytes (Fig. 23B).

Pyknotic nuclei were noted in ciliated epithelium cells in 3.5% (4 of 113) of the tissues examined. This condition was restricted to *C. virginica* from Site S5.

Focal aggregations of eosinophilic leucocytes were noted in 3.5% (4 of 113) of the gonadal tissues examined. This condition was present in two *P. cordata*, one *C. virginica* and one *A. imbricata*. Abnormally high numbers of leucocytes were present in the gonadal tissues of two other *P. cordata*. This condition differs from focal aggregates in that the leucocytes are dispersed throughout the tissues rather than being in isolated clumps.

Heavy concentrations of yellow-pigmented cells as earlier described were present in several spermaries of a single *A. ovalis*.

The majority of pathologies in the gonadal tissues examined were symbiotic in nature. The most prevalent of the types of symbioses was parasitism by larval nematodes. One or more nematodes were incident in the gonads of 11.5% (13 of 113) of the bivalves examined (Fig. 23C). Only one nematode appeared to be encysted. The others were free in the gonad and elicited a host inflammatory response in only two cases. Inflammation was in the form of large aggregates of eosinophilic leucocytes. Nine *P. cordata*, three *A. ovalis* and one *N. ponderosa* were infected.

Ten per cent (11 of 113) of the bivalves examined bore unidentified sporozoans in gonadal tissues. Five *N. ponderosa* from Site C22 harbored stages resembling macro- and micro-gametocytes of coccidia (Fig. 23D) and a plasmodium resembling that of the haplosporidian *Minchinia*. Very small morula-like structures composed of 10-12 dense nuclei were observed in gonadal tissues of five *P. cordata*. They are thought to be sporozoa. A morula, spherical and composed of cuboidal cells surrounding a hollow center, was noted in one *C. virginica*.

Larval cestodes were incident in the gonads of 6.2% (7 of 113) of the molluscs examined (Fig. 24A). With the exception of one tetraphyllidean, all appeared

TABLE 15. Distribution of histopathologies of bivalve gonad among sampling sites. Each site represents five gonad samples unless otherwise noted.

	Site																							
Pathology	P1	P2	P3	P4	S5	S6	S7	S8	S9	S10	S11	S12	S13	S14	S15^{+}	S16	S17	S18	S19	S20^{+}	C21	C22	C23	C24*
Degeneration	--	--	2	--	--	--	--	1	1	--	--	--	2	--	1	--	--	--	--	--	--	3	1	--
Pyknotic nuclei	--	--	--	--	4	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Leucocytosis (focal)	1	--	1	--	--	1	--	1	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Leucocytosis (general)	--	--	--	--	--	--	--	--	1	--	--	--	--	--	--	--	--	--	--	--	--	--	1	--
Yellow Cells	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	1	--	--	--	--	--	--
Nematodes	--	--	--	--	--	3	1	2	--	--	--	1	3	--	--	--	--	3	--	--	--	--	--	--
Sporozoans	--	--	--	--	1	1	--	3	1	--	--	--	--	--	--	--	--	--	--	--	--	5	--	--
Cestodes	--	--	--	--	--	1	--	--	--	--	--	--	1	--	--	--	--	1	--	1	--	3	--	--
Plasmodiophorales	--	--	--	--	2	--	--	--	--	--	1	--	--	--	--	--	--	--	--	--	--	--	--	--
Trematodes	--	--	--	--	--	--	--	--	--	--	1	--	--	--	--	--	--	--	--	--	--	--	--	--
Total Number	1	0	3	0	7	6	1	7	3	0	2	1	6	0	1	0	0	5	0	1	0	11	2	--

*no bivalve collected
$^{+}$ four gonad samples

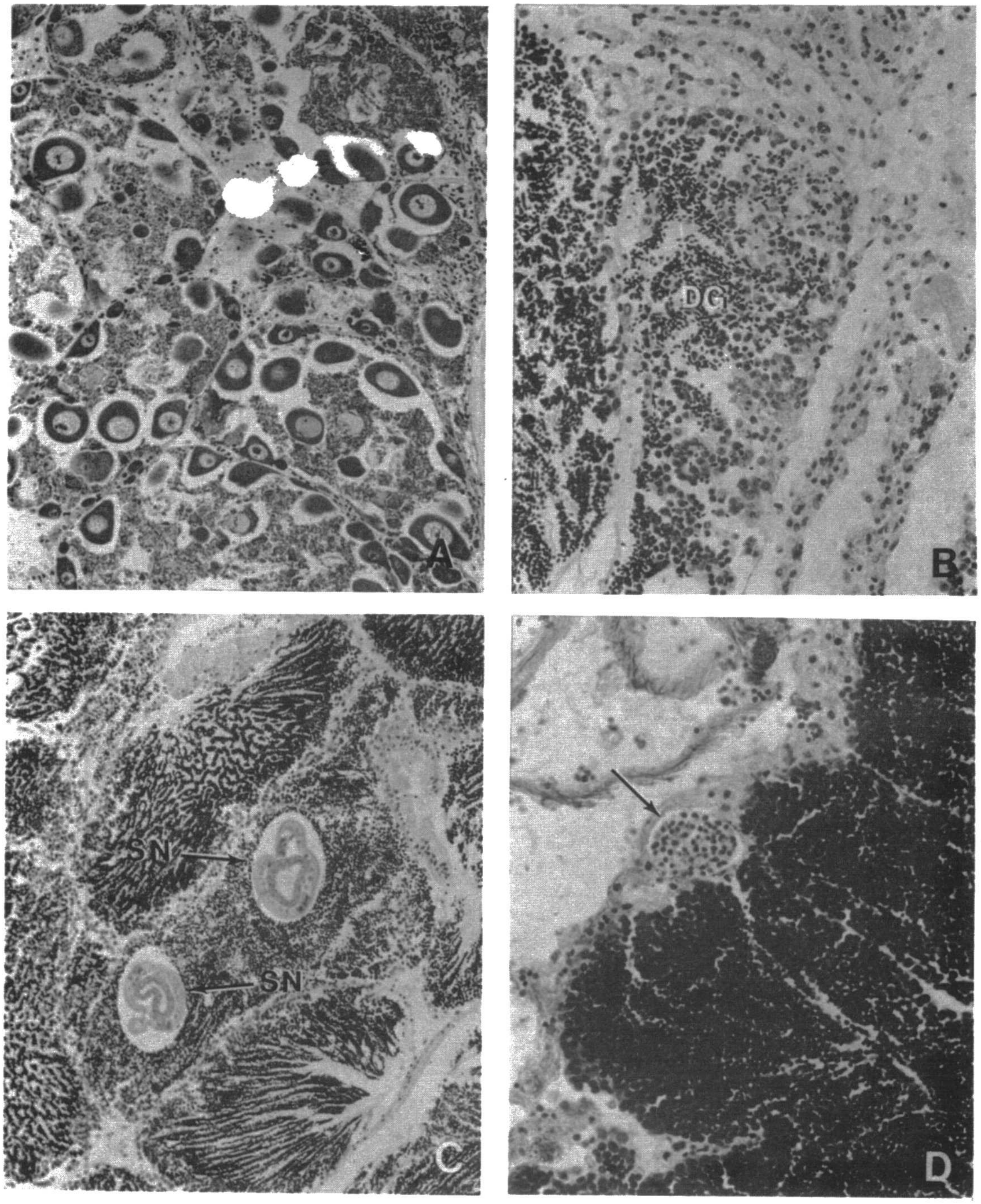

Fig. 23. Bivalve gonad. A. *N. ponderosa*. Degeneration of ovarian follicles. 136X. B. *P. cordata*. Degeneration (DG) of a spermary and invasion by leucocytes (arrows). 340X. C. *P. cordata*. Nematodes (SN) in a spermary. Note absence of capsules. 136X. D. *N. ponderosa*. Sporozoan (arrow) at edge of spermary. This resembles a coccidian micro-gametocyte. 340X.

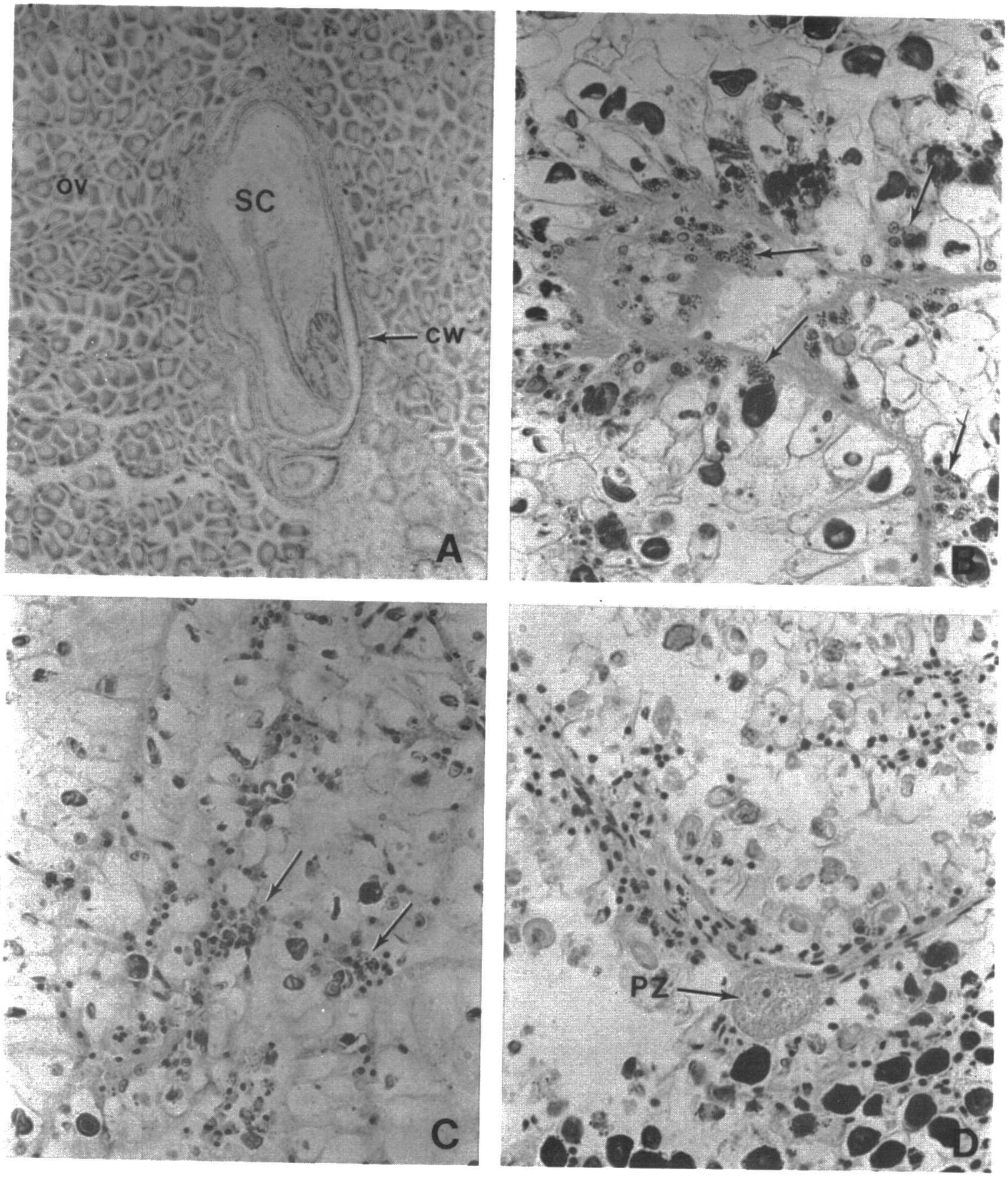

Fig. 24. Bivalve gonad (A) and kidney (B-D). A. *A. ovalis*. Cestode (SC) encysted in ovary (ov), note cyst wall (cw). 86X. B. *P. cordata*. Abnormally high number of circulating leucocytes (arrows). 340X. C. *P. cordata*. Focal aggregates of leucocytes (arrows). 340X. D. *N. ponderosa*. Sporozoan (PZ) which resembles macrogametocyte of a coccidian. 340X.

to be trypanorhynchan larvae and all were encysted in layers of connective tissue. Cestodes were found in three *N. ponderosa*, two *P. cordata* and two *A. ovalis.*

Plasmodiophorales-like organisms were incident in the gonads of two *C. virginica* and one *O. equestris.*

One *O. equestris* had such a heavy infection of *Bucephalus* sporocysts that the larvae completely replaced the gonads of the host.

e. Excretory Organ

Excretory tissue was examined from 106 bivalves. Samples for microscopic analysis were dissected from between the adductor muscle and dorso-posterior portion of the visceral mass.

(1) Normal Microscopic Features— Histology of the excretory tissue differed between species but all basically fell into one of three groups. The excretory tissue of *C. virginica* and *O. equestris* was composed of loosely arranged tubules separated by broad areas of Leydig cells. Portions of the bladder were also present in some samples. The tubules and bladder were lined by either cuboidal cells or tall columnar cells on a thin basement membrane. The cuboidal cells were vacuolated with a basal, oval nucleus. Columnar cells had a fine, granular cytoplasm.

Pitar cordata, N. ponderosa, A. ovalis and Tellina sp. had large, dark-colored nephridia in contrast to the above. Excretory tissue was composed of cuboidal, columnar and irregular cells packed together and divided into irregular "compartments" by basophilic collagen fibers which formed basement membranes. Excretory cells had vacuolate or clear cytoplasm and contained large concretions or granules, some of which appeared square, flat and clear while others were golden to black and ovate. Nuclei were small, oval and dense. Tubules were lined by cuboidal cells. Eosinophilic granular leucocytes and other hemocytes were present in the excretory tissues.

The excretory tissues of *A. imbricata* consisted of a network of tubules lined by cuboidal or columnar epithelium. Epithelial cells contained large vacuoles, light, eosinophilic droplets and a dense, coarsely granular nucleus at the base of the cell. No concretions or granules were present.

(2) Histopathological Conditions— Histopathologies were noted among 25.5% (27 of 106) of the excretory tissues examined. There were a total of 34 cases of the seven types of conditions. Sixty-two per cent of the cases were nonsymbiotic or not apparently the result of symbioses. The remainder were symbiotic in nature. The distribution of the histopathologies among sampling sites is presented in Table 16.

Ten per cent (11 of 106) of the excretory tissue examined displayed abnormally high numbers of eosinophilic leucocytes dispersed throughout the tissues (Fig. 24B). This condition was present in three *A. ovalis,* three *N. ponderosa,* two *P. cordata,* two *A. imbricata* and one *O. equestris.*

Focal aggregations of eosinophilic leucocytes were noted in 4.7% (5 of 106) samples examined (Fig. 24C). These were not apparently correlated with symbioses. Aggregates were either in the form of a tight clump of leucocytes or a discrete core of concentrically arranged leucocytes with pyknotic nuclei. Three *P. cordata,* one *A. imbricata* and one *N. ponderosa* displayed this condition.

Unidentified cyst-like objects were present in 2.8% (3 of 106) of the tissues. Only one or two were found in each of three *P. cordata.* Cysts were spherical and stained basophilic with no internal structure discernible.

One *P. cordata* displayed massive lysing of the excretory cells (irregular and columnar cells of "compartments"). Cuboidal cells lining tubules remained intact. Nuclei of the lysed cells also appeared normal.

TABLE 16. Distribution of histopathologies of bivalve kidney among sampling sites. Each site represents five kidney samples unless otherwise noted.

	Site																							
Pathology	P1	P2	P3	P4	S5	S6	S7	S8	S9	S10	S11	S12	S13	S14	S15	S16	S17	S18	S19	S20	C21	C22	C23	C24*
Leucocytosis (general)	--	--	--	2	--	--	--	--	--	--	1	--	--	--	--	--	--	3	--	--	--	3	2	--
Leucocytosis (focal)	--	--	1	--	--	--	--	1	--	--	--	--	1	--	--	--	--	--	--	--	--	1	1	--
Cysts	--	--	--	--	--	--	2	1	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Lysis	--	--	--	--	--	--	--	--	--	--	--	--	--	--	1	--	--	--	--	--	--	--	--	--
Sporozoans	--	--	--	--	--	--	2	--	1	--	--	--	--	--	--	2	--	--	--	--	--	5	2	--
Trematode	--	--	--	--	--	--	--	--	--	--	1	--	--	--	--	--	--	--	--	--	--	--	--	--
Mucous cells	--	--	--	--	--	--	--	--	--	--	1	--	--	--	--	--	--	--	--	--	--	--	--	--
Total Number	0	0	1	2	0	0	4	2	1	0	3	0	1	0	1	2	0	3	0	0	0	9	5	--

*no bivalves collected

Numerous mucous cells were present in the epithelial lining of the excretory tubules in one *O. equestris*. In some areas they appeared to outnumber the columnar cells. This was the only specimen in which mucous cells were present in any numbers in excretory tissues.

Eleven per cent (12 of 106) of the excretory tissues examined had one or more different sporozoa. Sporozoa occurred in five *N. ponderosa* and seven *P. cordata*. The most prevalent were oval with a light basophilic-eosinophilic cytoplasm and a light basophilic nucleus with a single endosome (Fig. 24D). These resembled macro-gametocytes of marine coccidia, some of which are parasitic in molluscan kidney. A second type was spherical, basophilic, and was multinucleate or had coarse chromatin granules (Fig. 25A). It resembled micro-gametocytes of some marine coccidia. The third type resembled the plasmodium state of the haplosporidian *Minchinia*. Spherical plasmodia contained several small, spherical nuclei with a prominent endosome adjacent to the nuclear membrane.

One specimen of *O. equestris* had *Bucephalus* sporocysts throughout the excretory tissues.

f. Gill

Gill samples from 115 bivalves were examined. Gills were oriented (when possible) so both longitudinal and transverse sections could be studied.

(1) Normal Microscopic Features— The structure of the molluscan gill varied with species, orientation and angle of the cut. Basically, gills were composed of tubular filaments perpendicular to the gill axis. Filaments were composed of an outer ciliated columnar epithelium supported by chitinous rods. Many of the filaments of *Noetia*, *Anadara* and *Arca* were covered by flattened epithelium. The central portion of the filaments were occupied by tubules divided by septa. Mucous cells were scattered among the outer epithelial cells and along the tubules within the filaments. Connective tissue was abundant within the filaments and muscle cells were found throughout. Hemocytes were more numerous in *Noetia* and *Anadara* than the others.

(2) Histopathological Conditions— Histopathologies were noted among 57.3% (66 of 115) of the molluscan gills. There were a total of 116 cases of the 12 conditions described below. Fifty-one per cent (60 of 117) of the cases were not symbiotic in nature and not apparently related to a symbiotic condition. The distribution of the pathologies among sampling sites is presented in Table 17.

Gills from 22.6% (26 of 115) of the molluscs displayed abnormally high numbers of eosinophilic leucocytes dispersed throughout the tissues (Fig. 25B). This condition was displayed by thirteen *P. cordata*, five *C. virginica*, four *A. imbricata*, three *O. equestris* and one *A. ovalis*.

Focal aggregates of eosinophilic leucocytes were present in 12.2% (14 of 115) of the gill samples examined. This condition was displayed as loose or tight clumps (Fig. 25C) of concentrically arranged leucocytes,

TABLE 17. Distribution of pathologies of bivalve gill among sampling sites. Each site represents five gill samples unless otherwise noted.

	Site																						
Pathology	P1	P2$^+$	P3$^\Delta$	P4	S5	S6	S7	S8	S9	S10	S11	S12	S13	S14°	S15	S16	S17	S18	S19$^+$	S20	C21	C22	C23	C24•
Leucocytosis (general)	4	1	2	2	--	--	2	4	2	--	2	--	--	--	2	--	--	1	--	--	--	--	4	--
Leucocytosis (focal)	3	2	1	--	--	1	--	1	1	--	--	--	--	--	--	1	--	--	--	3	--	--	1	--
Pyknotic nuclei	--	--	--	--	--	3	3	1	1	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Cysts	--	--	--	--	--	1	--	--	--	--	--	--	--	--	--	--	--	1	--	--	--	--	4	--
Necrosis	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	2	--	--
Pigment accumulation	--	--	--	2	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	
Amoebocytes	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	1	--	--	--	--	--	--
Plasmodiophorales	5	4	1	1	3	--	2	1	--	2	3	--	--	--	--	--	--	--	--	--	2	--	3	--
Sporozoans	2	--	--	--	2	2	2	2	4	--	--	--	--	--	--	1	--	4	--	--	--	2	--	--
Bacteria	--	--	--	--	--	1	2	--	1	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Amoebae	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	3	--
Trematodes	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	2	--	--	--	--	--	--
Total Number	14	7	4	5	5	8	11	9	9	2	5	0	0	--	2	2	0	9	0	3	2	4	15	--

•no bivalves collected
°no gill samples
$^\Delta$three gill samples
$^+$ four gill samples

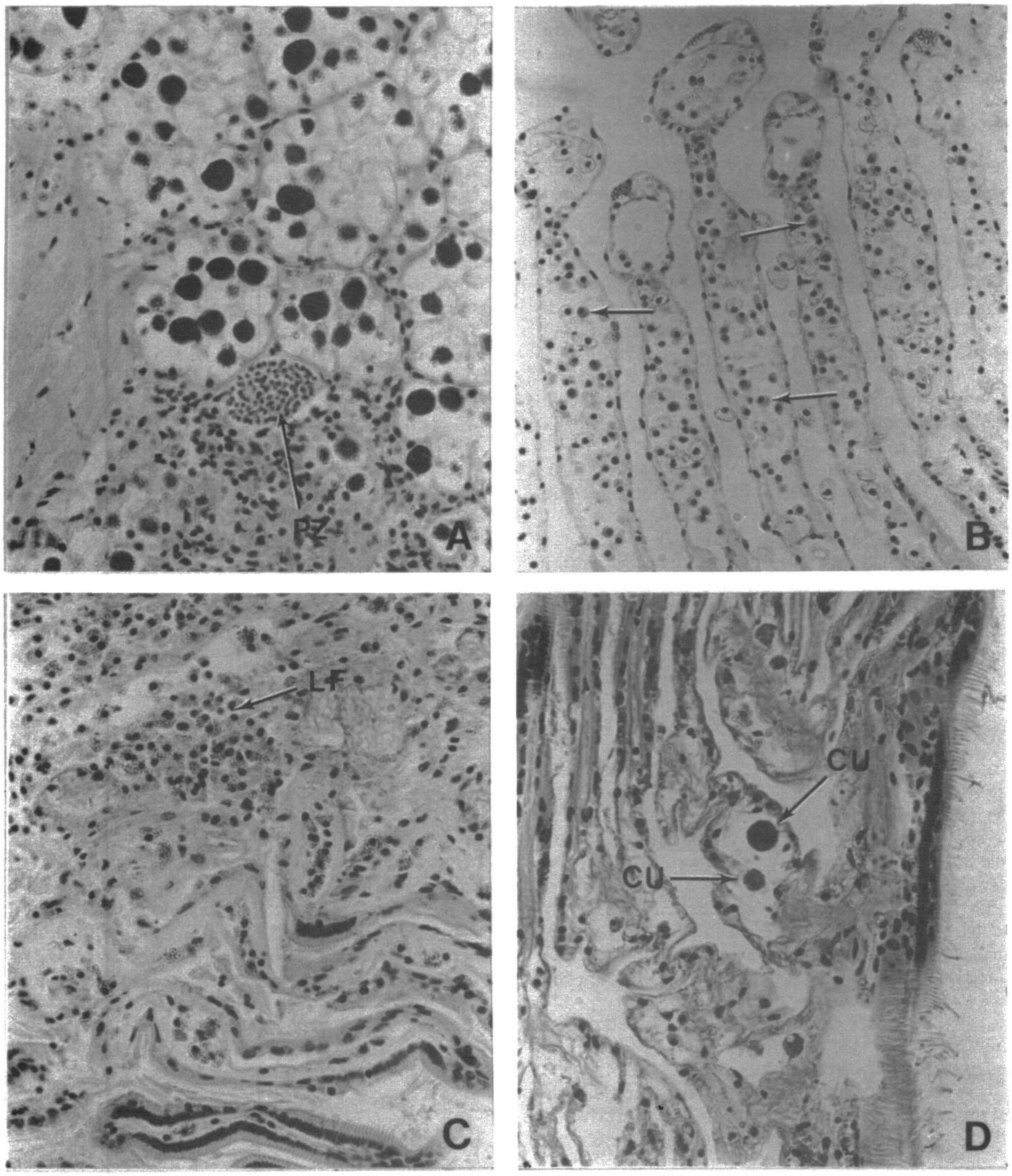

Fig. 25. Bivalve kidney (A) and gill (B-D). A. *N. ponderosa*. Sporozoan (PZ) which resembles micro-gametocyte of a coccidian. 340X. B. *A. ovalis*. Abnormally high number of circulating leucocytes (arrows) in filaments. 340X. C. *P. cordata*. Focal aggregate of leucocytes (LF). 340X. D. *P. cordata*. Cysts of unknown etiology (CU). 340X.

some with pyknotic nuclei, around a dense core rather than generally dispersed as in the preceding condition. Focal aggregates were found in five *C. virginica*, three *A. ovalis*, five *P. cordata* and one *A. imbricata*.

Ten per cent of the gills examined had focal areas of pyknotic nuclei. This condition was limited to eight specimens of *P. cordata*.

Dense, spherical, basophilic cysts of unknown etiology (Fig. 25D) were present in 5.2% (6 of 115) of the gills examined. No internal structure could be discerned. These were present in five *P. cordata*, all from Site C23, and one *A. ovalis*.

Necrotic filaments were observed in 1.7% (2 of 115) of the samples examined (Fig. 26A). This condition was limited to two *N. ponderosa* from Site C22. Necrosis was spotty. Necrotic filaments were reduced to what appeared to be chitinous rods with much eosinophilic and brownish-gold debris. Inflammation (leucocytosis) and sloughing of the epithelium of adjacent filaments was evident.

Two *A. imbricata* from Site P3 had a dark, finely granular pigment accumulation in the gill filaments. Filaments were only very lightly coated.

A heavy, focal concentration of amoebocytes was present in a filament of a single *A. ovalis*.

A plasmodiophorales-like organism, tentatively identified as *D. marinum*, was present in the gills of 23.5% (27 of 115) of the molluscs examined. Parasites were the same as those described in muscle. This organism was present in twelve *C. virginica*, four *O. equestris*, three *P. cordata*, two *A. imbricata* and two *Tellina* sp.

Sporozoans were incident in 18.3% (21 of 115) of the gill samples examined. Spores of the gregarine sporozoan *Nematopsis* (Fig. 26B) were present in 11.3% (13 of 115) of the gill samples. The spherical to ovate spores were found in the connective tissue and muscle portions of the gills. A coiled, vermiform sporozoite was visible in most spores. Nine *P. cordata* and four *C. virginica* harbored *Nematopsis*. Plasmodia of unidentified sporozoa were present in 7% of the gills examined. Most were found in the epithelium (Fig. 26C). Plasmodia were found in four *A. ovalis*, all from Site S18, two *N. ponderosa* and two *P. cordata*.

Bacteria were present on the interlamellar septa of 3.4% (4 of 115) of the gills. This condition was confined to *P. cordata*.

Gills of three *P. cordata* from Site C23 harbored amoebae (Fig. 26D). Most were in connective tissue but some were in the tubules. Amoebae were ovate with a large, dense nucleus and a small, spherical inclusion body adjacent to the nucleus.

Trematode metacercariae were encysted in gills of two *A. ovalis* from Site S18.

g. Other Organs

Other organs or tissues were included in most histological sections, especially the transverse sections of whole specimens. Nervous tissue was common among samples and was routinely studied. No pathologies were found in nerves of the 115 bivalves examined.

Part of or an entire transverse section of the foot was routinely examined for pathologies when possible. Samples from 40 *Pitar*, eight *Anadara*, five *Noetia* and five *Tellina* sp. were studied. Encysted cestodes were incident in foot muscle of six *P. cordata* and two *A. ovalis* and a trematode metacercaria was encysted in the foot of a single *Pitar*.

2. Crabs

Selected organs of 98 specimens representing six species of brachyuran crabs (*Callinectes sapidus, Callinectes similis, Leiolambrus nitidus, Portunus gibbesii, Portunus spinicarpus,* and *Speocarcinus lobatus*) were examined for histopathologies. This constituted a total of 636 organs. No crabs were collected from Sites S10, S11, S12, and S20. Nineteen of the 98 specimens examined, i.e., three *L. nitidus*, seven *C. similis*, seven *P. spinicarpus*, one *P. gibbesii*, and one *S. lobatus* were free of pathologies. The L. nitidus were from Site P4. The *C. similis* were collected at Sites P2 and C22 (one specimen each), C24 (two specimens), and C21 (three specimens). The *P. spinicarpus* were from Sites P3 (2 specimens) and C23 (five specimens). The *S. lobatus* was collected at Site P1. Of the 636 organs examined, 161 (25.3%) bore one or more of the 20 histopathology types reported below for a total of 222 recorded cases of the 20 types. There were 42 cases (18.9%) of histopathologies which were various types of symbioses or which were clearly elicited directly by symbioses (e.g., inflammation). One hundred and eighty cases (81.1%) were not apparently correlated with symbioses. Tables 18 and 19 give the distribution of pathologies in terms of mean number of nonsymbiotic versus symbiotic cases per organ at each site. Table 20 gives a ranking of sampling sites by mean number of histopathologies.

a. Muscle

Muscle samples from 98 individual crabs were examined for histopathologies. Samples were obtained from the last thoracic segment, usually from the proximal muscles of the fifth pereiopod.

(1) Normal Microscopic Features— Crab voluntary muscle displayed striations in its contracted state. The sarcoplasm was acidophilic and contained many fibrils running the length of the cell. Nuclei were peripheral and lightly basophilic with scattered chromatin granules. Muscle cells were arranged into bundles bound by connective tissue sheaths. Connective tissue sheets also ran between bundles and joined bundles. Sections of nerves, skeletal apodemes, and circulating hemocytes were commonly included in muscle sections.

(2) Histopathological Conditions— Histopathologies were noted in 34.7% (34 of 98) of the muscle samples examined. There were a total of 47 cases of the eight pathology types described below. Ninety-two per cent (43 of 47) of the cases were not attributable to symbioses, while 8% (4 of 47) of the cases were symbiotic. The distribution of these histopathologies among sampling sites is presented in Table 21.

Degeneration or liquefaction of muscle tissue was evident in 21.4% (21 of 98) of the samples examined. Most cases of liquefaction were confined to small focal areas in which muscle bundles would lose their cellular and structural integrity and break down into an amorphous mass of fibers (Fig. 27A). Light eosinophilic debris was present and a few pyknotic nuclei in some cases, but no granular debris or eosinophilic leucocytes. This condition was found in 11 *C. similis*, four *C. sapidus*, four *P. spinicarpus*, and two *P. gibbesii*.

TABLE 18. Distribution of histopathologies of crabs among sampling sites.

Site	Mean Number of Nonsymbiotic / Symbiotic Histopathologies							
	Muscle	Digestive Gland	Gut	Gonad	Excretory	Gill	Heart	Per Organism
Control								
C21	0.2/0.0	0.0/0.0	0.0/0.0	0.0/0.0	0.0/0.0	0.0/0.0	0.2/0.0	0.4/0.0
C22	0.4/0.0	0.0/0.0	0.0/0.0	-/-	0.2/0.0	0.0/0.0	0.4/0.0	1.0/0.0
C23	0.0/0.0	0.0/0.0	0.0/0.0	0.0/0.0	0.0/0.0	0.0/0.0	0.0/0.0	0.0/0.0
C24	0.2/0.0	0.2/0.0	0.0/0.0	-/-	-/-	0.0/0.0	0.0/0.0	0.4/0.0
Primary								
P1	0.0/0.0	0.0/0.2	0.0/0.0	0.0/0.6	-/-	0.4/0.0	-/-	0.4/0.8
P2	1.0/0.0	0.2/0.0	0.0/0.0	0.0/0.0	0.0/0.0	0.0/0.0	0.8/0.0	2.0/0.0
P3	0.0/0.0	0.0/0.0	0.0/0.0	0.0/0.0	0.0/0.0	0.3/0.0	0.0/0.0	0.3/0.0
P4	0.0/0.0	0.2/0.2	0.0/0.0	0.0/0.0	0.0/0.0	0.0/0.0	0.0/0.0	0.2/0.2
Secondary								
S5	1.8/0.2	0.4/0.4	0.2/0.2	0.3/0.0	0.6/0.2	0.6/0.8	0.0/0.0	3.8/1.8
S6	1.2/0/0	0.0/0.2	0.0/0.2	0.7/0.3	0.4/0.0	0.2/0.2	0.2/0.0	2/6/1.0
S7	0.6/0.0	0.0/0.0	0.5/0.0	0.0/0.0	0.8/0.0	0.2/0.0	0.0/0.0	2.0/0.0
S8	0.8/0.0	0.4/0/0	0.0/0.2	0.0/0.0	0.5/0.2	1.2/0.4	0.0/0.0	2.9/0.9
S9	0.3/0.0	0.6/0.2	0.5/0.2	0.7/0.0	0.2/0.0	0.2/0.0	0.0/0.0	2.5/0.4
S13	0.8/0.2	0.2/0.2	0.0/0.0	0.3/0.0	0.4/0.0	0.4/0.0	0.2/0.0	2.3/0.4
S14	0.0/0.0	0.4/0.0	0.0/0.0	0.2/0.0	0.2/0.0	0.8/0.0	0.2/0.0	1.8/0.0
S15	0.4/0.2	0.2/0.0	0.0/0.0	0.0/0.0	0.6/0.0	0.4/0.0	0.6/0.0	2.2/0.2
S16	0.2/0.0	0.0/0.0	0.2/0.0	0.0/0.0	1.3/0.0	1.8/0.0	0.2/0.0	3.6/0.0
S17	0.0/0.0	0.0/0.0	0.2/0.0	0.0/0.0	1.0/0.0	0.5/0.0	0.0/0.0	1.7/0.0
S18	0.6/0.2	0.6/0.0	0.0/0.0	0.0/0.0	0.8/0.0	0.4/0.0	0.4/0.0	2.8/0.2
S19	0.2/0.0	0.6/0.6	0.5/0.0	0.0/0.0	2.2/0.0	1.0/2.2	0.0/0.0	4.5/2.8

TABLE 19. Distribution of histopathologies of crabs among combined control, primary and secondary sampling sites.

Site	Mean Number of Nonsymbiotic / Symbiotic Histopathologies							
	Muscle	Digestive Gland	Gut	Gonad	Excretory	Gill	Heart	Per Organism
Control	0.2/0.0	0.1/0.0	0.0/0.0	0.0/0.0	0.1/0.0	0.0/0.0	0.2/0.0	0.5/0.0
Primary	0.2/0.0	0.1/0.1	0.0/0.0	0.0/0.1	0.0/0.0	0.2/0.0	0.2/0.0	0.7/0.2
Secondary	0.6/0.6	0.3/0.1	0.2/0.8	0.2/0.0	0.7/0.0	0.6/0.4	0.2/0.0	2.7/0.6

TABLE 20. Ranking of sampling sites by mean number of histopathologies per crab

Site	Species	Mean Number of Histopathologies per Crab
S19	*C. sapidus*	7.3
S5	*C. sapidus*	5.6
S8	*P. gibbesii*	3.8
S6	*C. similis*	3.6
S16	*C. similis*	3.6
S18	*C. similis*	3.0
S9	*P. spinicarpus*	2.9
S13	*C. similis*	2.7
S15	*C. similis*	2.4
P2	*C. similis*	2.0
S7	*P. spinicarpus*	2.0
S14	*C. similis*	1.8
S17	*C. similis*	1.7
P1	*S. lobatus*	1.2
C22	*C. similis*	1.0
P4	*L. nitidus*	0.4
C21	*C. similis*	0.4
C24	*C. similis*	0.4
P3	*P. spinicarpus*	0.3
C23	*P. spinicarpus*	0.0

TABLE 21. Distribution of pathologies of crab musculature among sampling sites. Each site represents five samples unless otherwise noted.

	Site																						
Pathology	P1	P2	P3	P4	S5	S6	S7	S8	S9Δ	S10*	S11*	S12*	S13	S14	S15	S16	S17	S18	S19	S20*	C21	C22	C23	C24
Degeneration	--	4	--	--	4	2	3	2	1	--	--	--	--	--	2	--	--	--	--	--	1	1	--	1
Pyknotic nuclei	--	--	--	--	2	2	--	2	--	--	--	--	3	--	--	1	--	2	--	--	--	--	--	--
Leucocytosis (focal)	--	1	--	--	2	--	--	--	--	--	--	--	--	--	--	--	--	1	1	--	--	1	--	--
Leucocytosis (general)	--	--	--	--	--	1	--	--	--	--	--	--	1	--	--	--	--	--	--	--	--	--	--	--
Focal necrosis	--	--	--	--	1	1	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	
Deteriorating symbionts	--	--	--	--	--	--	--	--	--	--	--	--	1	--	--	--	--	1	--	--	--	--	--	--
Amoeba	--	--	--	--	--	--	--	--	--	--	--	--	--	--	1	--	--	--	--	--	--	--	--	--
Trematode	--	--	--	--	1	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Total Number	0	5	0	0	10	6	3	4	1	--	--	--	5	0	3	1	0	4	1	--	1	2	0	1

*no crabs collected

Δthree crabs sampled

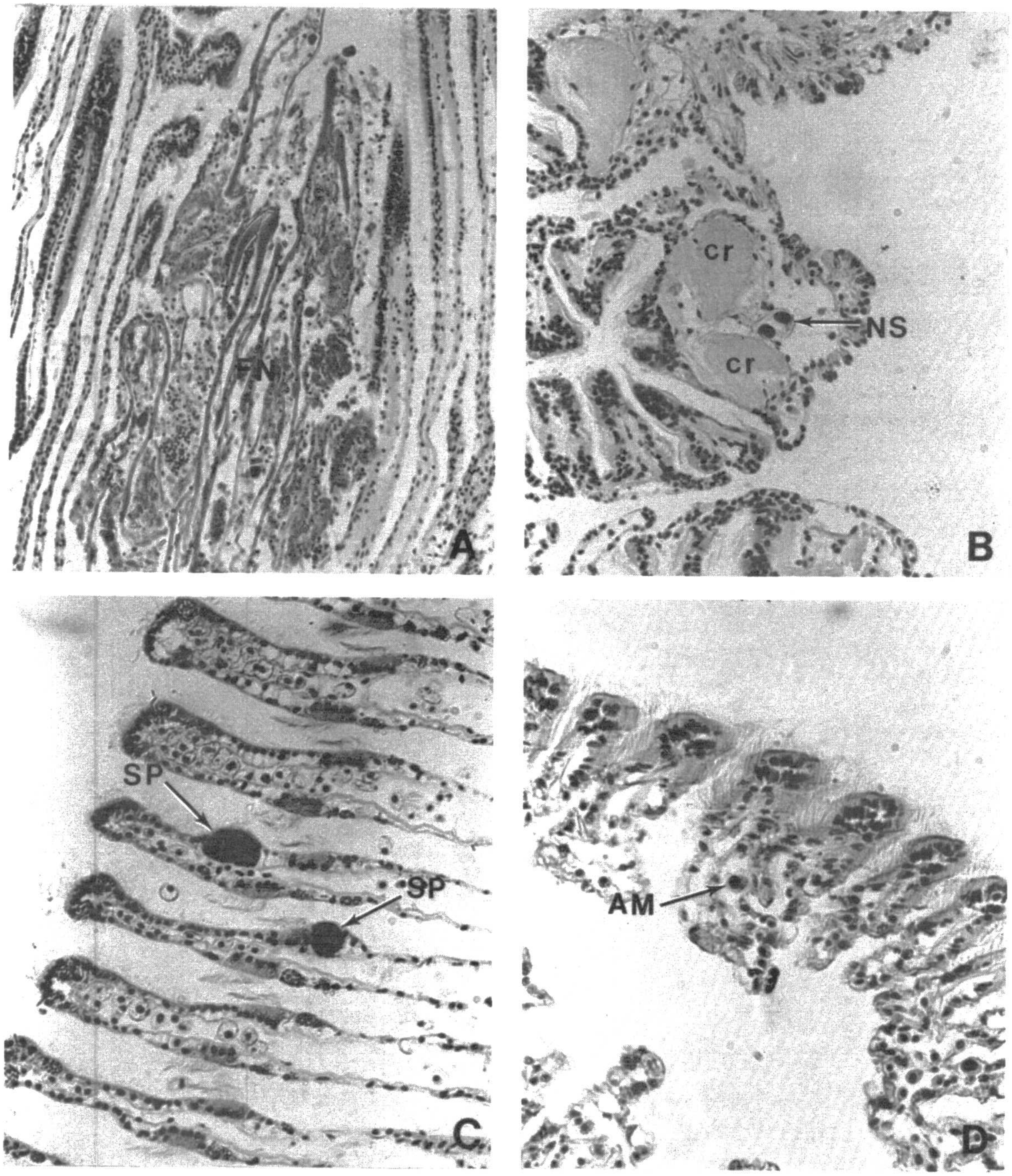

Fig. 26. Bivalve gill. A. *N. ponderosa*. Large area of necrotic gill filaments (FN). Note remains of chitinous rods and debris. 136X. B. *C. virginica*. *Nematopsis* spores (NS) encysted near chitinous rods (cr). 340X. C. *A. ovalis*. Sporozoa (SP) in epithelium of gill filaments. 340X. D. *P. cordata*. Amoeba (AM) in connective tissue of filament. 340X.

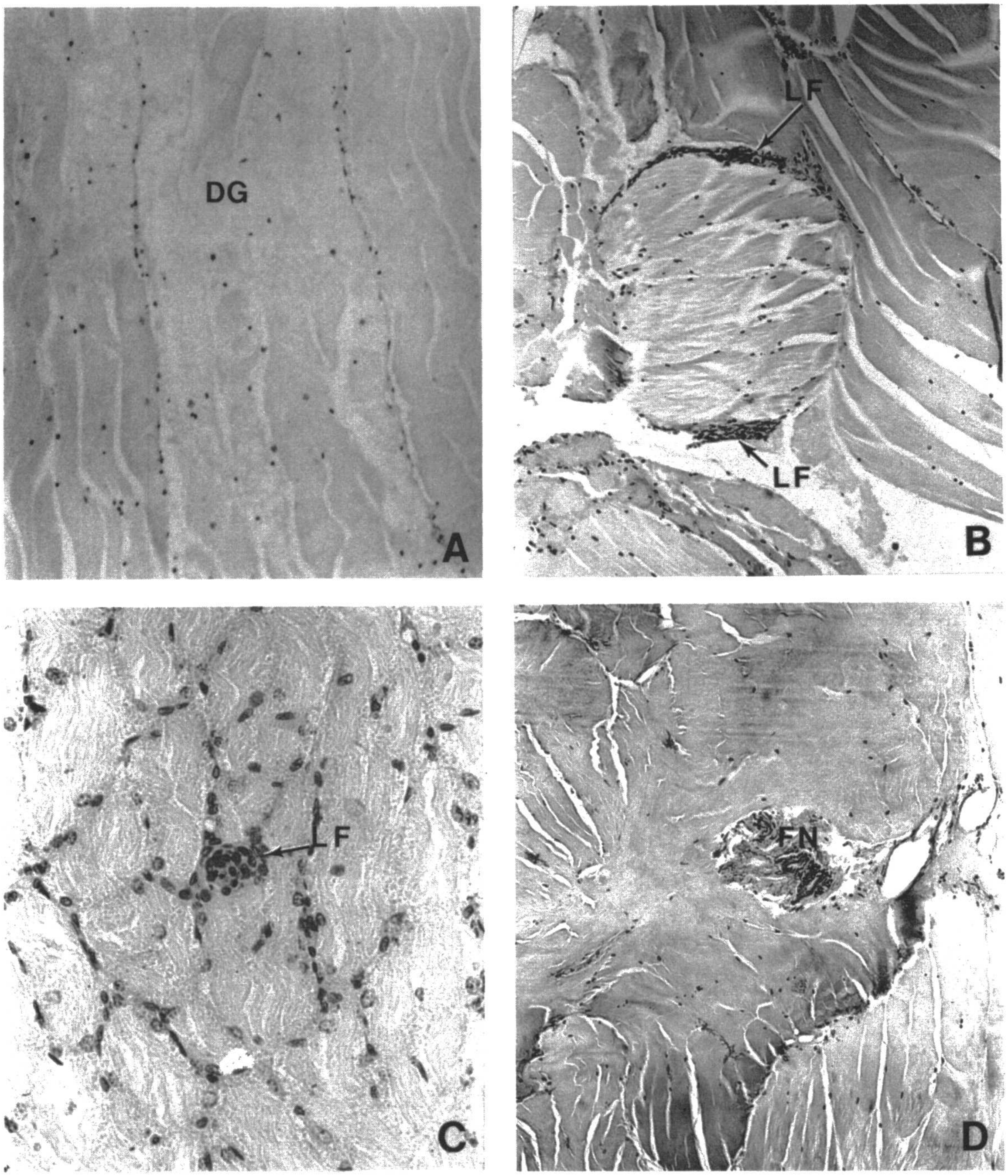

Fig. 27. Crab muscle. A. *C. similis*. Degeneration (DG). 136X. B. *C. sapidus*. Focal aggregation of clumped leucocytes (LF). 136X. C. *C. similis*. Focal aggregation of concentrically arranged leucocytes (LF). 340X. D. *C. similis*. Focal necrosis (FN). 136X.

Twelve per cent (12 of 98) of the muscle tissues examined contained pyknotic nuclei. Pyknotic nuclei stained darkly, were smaller than normal and were often misshapen. This condition was limited to small, focal areas in eight *C. similis*, two *C. sapidus*, and two *P. gibbesii.*

Focal aggregations of eosinophilic leucocytes were present in 6.1% (6 of 98) of the muscle samples. Leucocytes were either randomly clumped (Fig. 27B) or concentrically arranged around a core of pyknotic nuclei (Fig. 27C). This condition was found in three *C. similis* and three *C. sapidus.*

Abnormally high numbers of eosinophilic leucocytes were found in 2% (2 of 98) of the muscle samples examined. Leucocytes were spread throughout the tissues rather than occurring in focal aggregations as described above. This condition was found only in *C. similis.*

Two per cent (2 of 98) of the muscles examined displayed evidence of focal necrosis (Fig. 27D). This conditon was characterized by the breakdown of muscle accompanied by eosinophilic and basophilic debris, granules and leucocytes. Areas of focal necrosis were present in one *C. similis* and one *C. sapidus.*

Remains of two deteriorating symbionts were present in two *C. similis.* Debris and eosinophilic leucocytes were present in and around the nearly absorbed symbionts.

Muscle from a single *C. similis* contained unidentified amoebae in a large area of muscle liquefaction. Amoebae were subspherical and had a large central vacuole which occupied most of the cell and an eccentrically placed oval nucleus.

A trematode metacercaria was incident in the muscle of a single *C. sapidus.* A large area of inflammation, packed eosinophilic leucocytes and other hemocytes encompassed the metacercaria.

b. *Digestive Gland*

Samples of the digestive glands of 98 individual crabs were examined.

(1) Normal Microscopic Features— Crab digestive glands (hepatopancreases) were composed of a mass of blunt-ended tubules lined by basophilic columnar and cuboidal cells. The epithelium consisted of absorptive cells, enzyme secreting cells and storage cells. Nuclei were oval to slightly irregular in shape and were usually located at the base of the cells. The basement membrane was eosinophilic. Some cells contained many small vacuoles, while in others (ferment cells) a large vacuole occupied most of the cell. Size and shape of the tubule lumina varied greatly as did the space between tubules. Connective tissue and hemocytes were found between tubules. Sections of gonad and gut were sometimes included in digestive gland samples.

(2) Histopathological Conditions— Histopathologies were noted in 21% (21 of 100) of the digestive glands examined. There were a total of 30 cases of the seven pathology types described below. Twenty of the cases (66.6%) were nonsymbiotic. The distribution of pathologies among sampling sites is presented in Table 22.

Fourteen per cent (14 of 100) of the digestive glands examined displayed focal aggregates of leucocytes, either arranged concentrically around a small central core of pyknotic nuclei or randomly in a clump (Fig. 28A). Three of the cases were suggestive of final stages of symbiont degeneration and absorption or tubular necrosis. Focal leucocytoses were present in five *C. similis,* four *C. sapidus,* two *P. spinicarpus,* two *P. gibbesii* and one *L. nitidus.*

Eosinophilic leucocytes in abnormally high numbers were dispersed throughout the digestive gland tissues of 4% (4 of 100) of the samples examined (Fig. 28B). This condition was massive in a *P. spinicarpus* collected at Site P4. General leucocytosis was present in two *C. similis,* one *C. sapidus* and one *P. spinicarpus.*

Focal necrosis involving several tubules was evident in two *C. similis.* One case appeared to be extensive. Necrosis was marked by cellular debris and inflammation, groups of eosinophilic leucocytes and other

TABLE 22. Distribution of pathologies of crab digestive gland among sampling sites. Each site represents five samples unless otherwise noted.

	Site																						
Pathology	P1	P2	P3	P4	S5	S6	S7	S8	S9	S10*	S11*	S12*	S13	S14	S15	S16	S17	S18	S19	S20	C21	C22	C23	C24
Leucocytosis (focal)	--	1	--	1	2	--	--	2	2	--	--	--	1	1	1	--	--	--	2	--	--	--	--	1
Leucocytosis (general)	--	--	--	--	--	--	--	--	1	--	--	--	--	--	--	--	--	2	1	--	--	--	--	--
Focal necrosis	--	--	--	--	--	--	--	--	--	--	--	--	--	1	--	--	--	1	--	--	--	--	--	--
Microbial symbionts	--	--	--	--	1	--	--	--	--	--	--	--	--	--	--	--	--	--	3	--	--	--	--	--
Nematodes	--	--	--	1	--	1	--	--	1	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Sporozoans	1	--	--	--	--	--	--	--	--	--	--	--	1	--	--	--	--	--	--	--	--	--	--	--
Trematodes	--	--	--	--	1	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Total Number	1	1	0	2	4	1	0	2	4	--	--	--	2	2	1	0	0	3	6	--	0	0	0	1

*no crabs collected

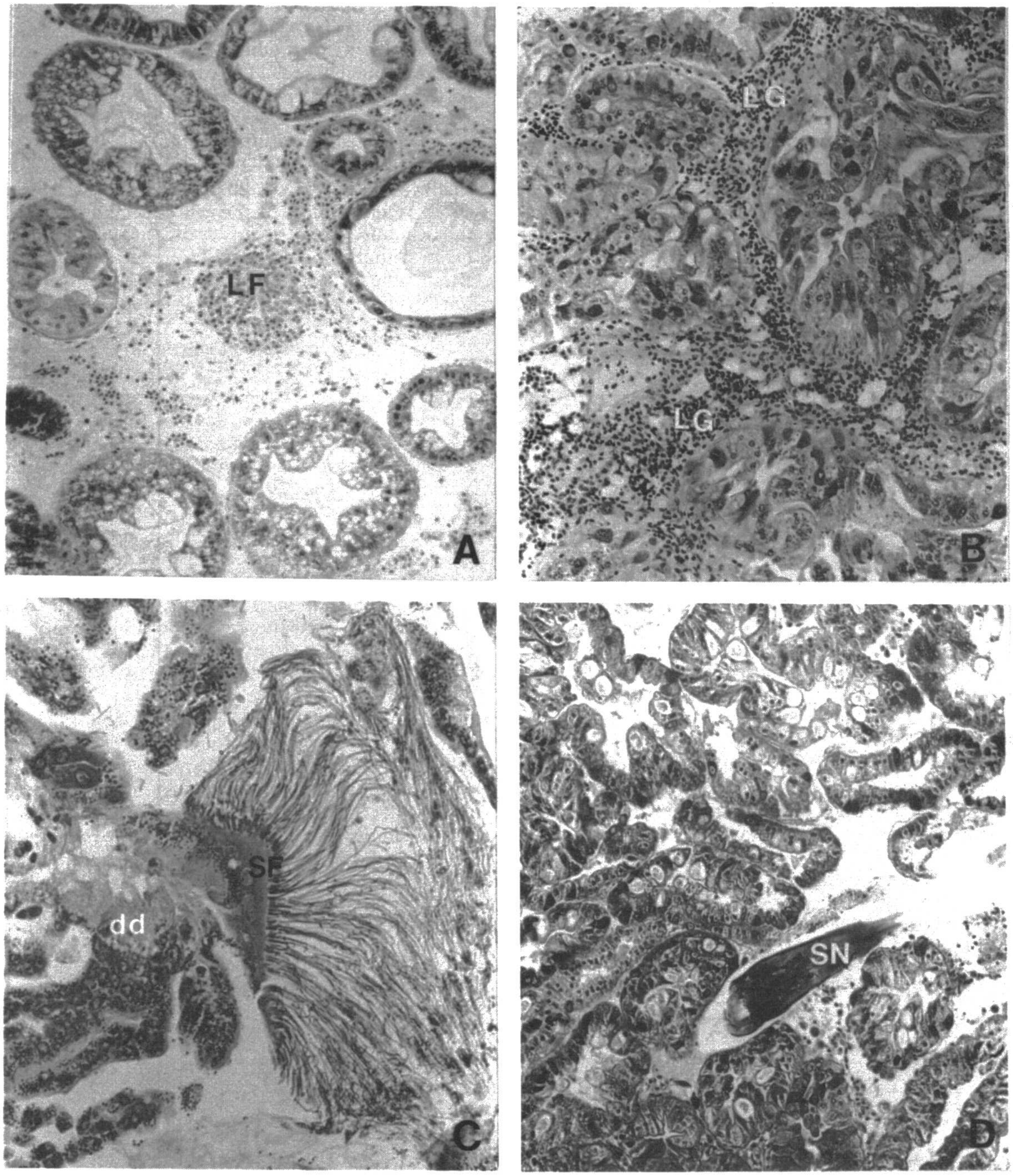

Fig. 28. Crab digestive gland. A. *C. similis*. Focal aggregation of leucocytes (LF) between digestive diverticula. 136X. B. *P. spinicarpus*. Abnormally high number of circulating leucocytes (LG). 136X. C. *C. sapidus*. Microbial symbionts (SF) in lumen of digestive diverticula (dd). 340X. D. *D. Similis*. Nematode (SN) between digestive diverticula. Note the absence of a host inflammatory response. 136X.

hemocytes along the tubules. Both cases could possibly be the final stage of degeneration and absorption of large symbionts.

Four per cent (4 of 100) of the crabs examined, all *C. sapidus*, contained microbial symbionts, bacteria or fungi, in the digestive tubules (Fig. 28C). The symbionts, in the form of long, segmented filaments, were attached in mass to the wall of the tubules at a focal spot. The areas of attachment were devoid of the normal hepatocytes. Filaments of the symbionts trailed into the lumina.

Nematode larvae were incident in the digestive glands of 3% (3 of 100) of the crabs examined (Fig. 28D). In the infected *C. similis* and *P. spinicarpus*, the worms were not encysted and elicited no host inflammatory response. The nematode in the *L. nitidus* was surrounded by a thin connective tissue sheath and encompassed by eosinophilic leucocytes.

Sporozoans were incident in the digestive glands of two of the crabs examined. A specimen of *L. nitidus* had sporoblasts of a *microsporidian*, possibly of the genus *Thelohania*. Each sporoblast contained at least six and possibly eight spores. A single sporoblast which contained many spores, possibly belonging in the microsporidian genus *Pleistophora*, was found in *C. similis.*

A trematode metacercaria was encysted in the digestive gland of one *C. sapidus.* A strong host inflammatory response was elicited by the parasite.

c. Gut

Gut samples from 84 individual crabs were examined for histopathologies. The hindgut was usually the portion of the gut collected. Portions of the midgut and foregut were sometimes included with the digestive gland samples.

(1) Normal Microscopic Features— The tubular hindgut was lined with basophilic columnar and cuboidal epithelial cells, each with an ovate, basal nucleus. Peripheral to the epithelium were layers of muscle and connective tissue. The hindgut was also lined by a thin cuticle.

(2) Histopathological Conditions— Histopathologies were noted among 11.9% (10 of 84) of the crab hindgut samples examined. There were a total of 13 cases of the five pathologies described below. Sixty-nine per cent (9 of 13) of the cases were nonsymbiotic. The distribution of hindgut histopathologies among sampling sites is presented in Table 23.

Six per cent (5 of 84) of the gut samples examined had abnormally high numbers of eosinophilic leucocytes in the connective tissue layer proximal to the epithelium (Fig. 29A). Leucocytes were dispersed rather than focally aggregated. This condition was present in two *C. sapidus*, two *P. spinicarpus* and one *C. similis.*

Focal aggregates of eosinophilic leucocytes and other hemocytes were present in the connective tissue proximal to the epithelium of 4.8% (4 of 84) of the samples examined (Fig. 29B). Aggregates were either composed of leucocytes randomly arranged in a clump or concentrically arranged around a pyknotic core (Fig. 29B).

Amoebae were incident in the hindgut lumina of 2.4% (2 of 84) of the samples examined. Amoebae, in one each of *C. similis* and *P. gibbesii*, were spherical to subspherical with a single large, spherical eccentric nucleus (Fig. 29C).

Trematode metacercariae were encysted in the connective tissue of the hindgut in one *C. sapidus.* Metacercariae elicited a light host inflammatory response.

One *P. spinicarpus* bore gregarine gametocysts in the lumen of its hindgut.

d. Gonad

Gonad samples from 71 individual crabs, 50 males and 21 females, were examined for histopathologies.

(1) Normal Microscopic Features— Crab testes and vas deferentia were slender tubular structures. The testes were composed of packed follicles lined with basophilic, flattened germinal epithelium and large basophilic nutritive cells. Follicles of mature specimens were filled with spermatogonia and developing spermatocytes. The upper portions of the vas deferentia were lined by columnar epithelium. The lumina of mature specimens were packed by spermatozoa formed into spherical, oval or elongate masses and were surrounded by eosinophilic secretions of the epithelial cells.

TABLE 23. Distribution of pathologies of crab hindgut among sampling sites. Each site represents five samples unless otherwise noted.

	Site																						
Pathology	P1	P2Δ	P3+	P4+	S5	S6+	S7+	S8+	S9+	S10•	S11•	S12•	S13Δ	S14	S15	S16	S17	S18+	S19+	S20•	C21+	C22†	C23	C24
Leucocytosis (general)	--	--	--	--	--	--	1	--	1	--	--	--	--	--	--	1	--	--	2	--	--	--	--	--
Leucocytosis (focal)	--	--	--	--	1	--	1	--	1	--	--	--	--	--	--	--	1	--	--	--	--	--	--	--
Amoeba	--	--	--	--	--	1	--	1	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Trematode	--	--	--	--	1	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Sporozoan	--	--	--	--	--	--	--	--	1	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Total Number	0	0	0	0	2	1	2	1	3	--	--	--	0	0	0	1	1	0	2	--	0	0	0	0

•no crabs collected
†two crabs sampled
Δthree crabs sampled
+ four crabs sampled

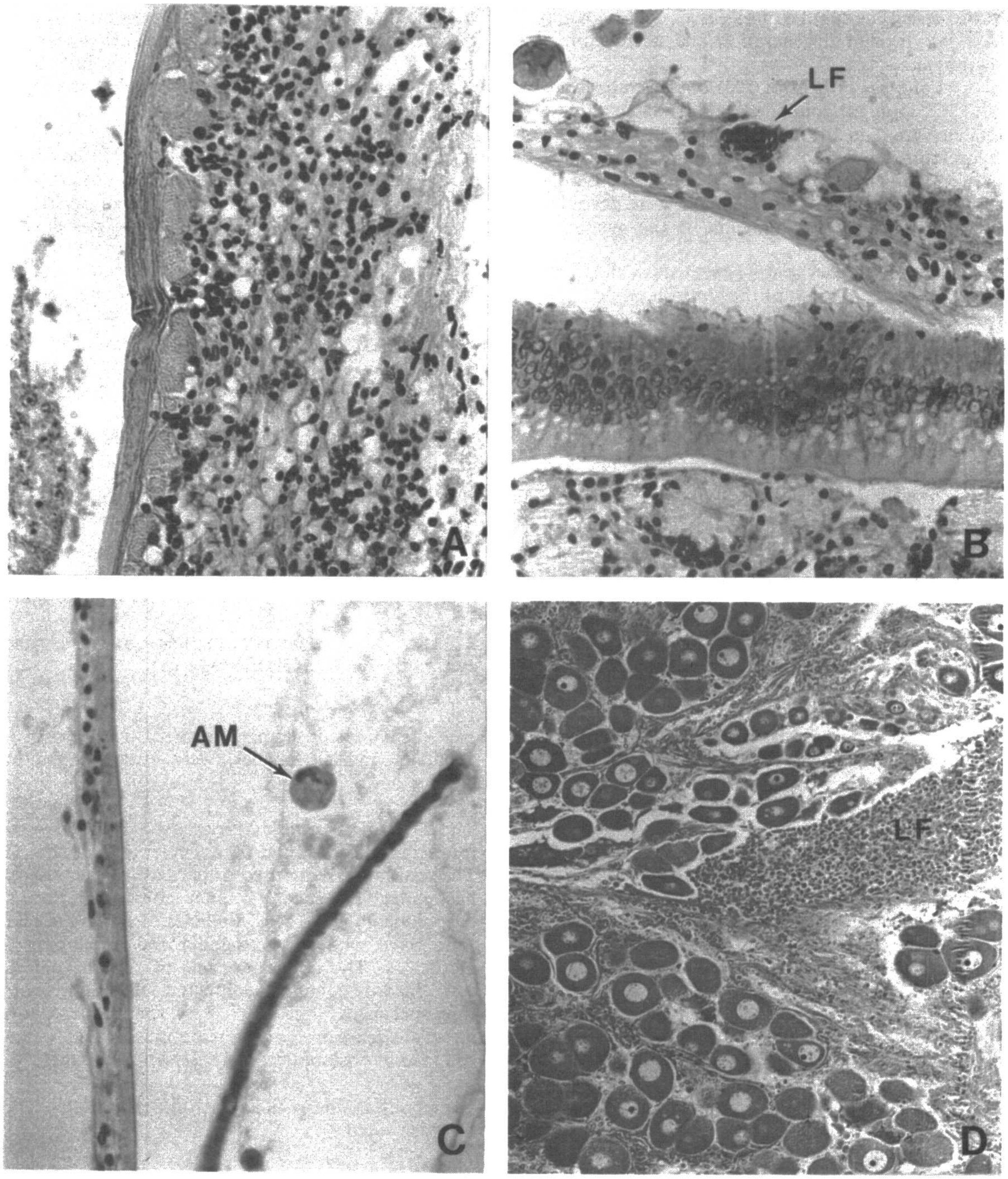

Fig. 29. Crab gut (A-C) and gonad (D). A. *C. sapidus*. Abnormally high number of leucocytes in connective tissue surrounding gut. 340X. B. *P. gibbesii*. Focal aggregation of leucocytes (LF) in concentric aggangement. 340X. C. *P. gibbesii*. Amoeba (AM) in lumen of gut. 340X. D. *C. similis*. Focal aggregation of leucocytes (LF) between ovarian follicles. 136X.

The lower parts of the vas deferentia were lined by columnar or cuboidal epithelium. The lumina were filled by spermatophores and secreted fluids. Spermatozoa of *L. nitidus* were basophilic and oval. Spermatozoa of *P. spinicarpus*, *P. gibbesii*, and *C. similis* were shaped like thick spindles with a large dark basophilic nucleus and slender eosinophilic processes.

Ovaries of developing crabs were composed of numerous follicles lined by flattened epithelium and follicle cells. Follicles were filled with multishaped ova, each with basophilic cytoplasm, a large lightly-stained nucleus and a small, dark nucleolus. Ovaries of spent crabs were composed of numerous thin-walled follicles with a few scattered ova. Spent follicles were filled with eosinophilic fluid. Spaces between developing follicles and spent follicles were filled with connective tissue and circulating hemocytes.

(2) Histopathological Conditions— Histopathologies were found in 12.7% (9 of 71) of the gonads examined. There were a total of 11 cases of the four pathologies described below. Seven of the cases (63.6%) were nonsymbiotic. The distribution of gonadal pathologies among sampling sites is presented in Table 24.

Focal aggregates of leucocytes were found in 5.6% (4 of 71) of the gonads examined (Fig. 29D). Some aggregates were massive. Focal aggregates were found in two *C. similis* and two *C. sapidus.*

Abnormally high numbers of leucocytes were spread throughout the gonadal tissue of 4.2% (3 of 71) of the crabs examined (Fig. 30A). In one case the whole ovary appeared inflamed. General leucocytosis occurred in two *C. similis* and one *P. spinicarpus.*

Sporozoans were incident in the gonads of 4.2% (3 of 71) of the crabs examined (Fig. 30B). All cases occurred in *S. lobatus.* The sporozoans were microsporidians, possibly of the genus *Thelohania.* Lumina of the gonadal tubules were partially occluded by spores.

The gonad of one *C. similis* bore a larval nematode. The nematode was not encysted and there was no evidence of host inflammatory response.

e. *Excretory Organ*

Crab excretory organs (green glands) were examined from 81 individual crabs.

(1) Normal Microscopic Features— Green glands consisted of a labyrinth of tubules lined by highly vacuolated cuboidal cells. Walls of the labyrinth were highly folded. The cytoplasm of the epithelial cells were eosinophilic. Nuclei were located either in the center or near the base of the cells.

(2) Histopathological Conditions— Histopathologies were found in 43.2% (35 of 81) of the green glands examined. There was a total of 45 cases of the four pathologies described below. Forty-three of the cases (95.5%) were nonsymbiotic. The distribution of gonadal pathologies among sampling sites is presented in Table 25.

Abnormally high numbers of eosinophilic leucocytes were found throughout the excretory tissue of 35.5% (29 of 81) of the crabs examined. This condition occurred in nineteen *C. similis*, seven *C. sapidus* and three *P. spinicarpus.*

Eleven per cent (9 of 81) of the green glands examined contained focal aggregates of eosinophilic leucocytes (Fig. 30C). Some were in loose clumps while others were concentrically arranged around a central core of pyknotic nuclei. Focal aggregates were found in the green glands of five *C. sapidus*, three *C. similis* and one *P. spinicarpus.*

Pyknotic nuclei were present in the green glands of 6.2% (5 of 81) of the crabs examined. These were not associated with a leucocytic condition as above. Three *C. similis* and two *C. sapidus* had this condition.

Trematode metacercariae were incident in the green glands of 2.5% (2 of 81) of the crabs examined. These encysted larvae were present in one *C. sapidus* and one *P. gibbesii* (Fig. 30D).

f. *Gill*

Gills from 96 individual crabs were examined for histopathologies.

(1) Normal Microscopic Features— Crab gills had a central branchial septum from which numerous gill lamellae projected in an alternate arrangement. A thin layer of gill epithelium, surrounding hemal sinuses, was covered by a thin cuticle. Gill lamellae terminated in a bulbous swelling. Hemocytes were present in the hemal sinuses.

TABLE 24. Distribution of pathologies of crab gonad among sampling sites. Each site represents five samples unless otherwise noted.

	Site																						
Pathology	P1	P2$^{\Delta}$	P3	P4^{+}	S5^{+}	S6$^{\Delta}$	S7†	S8	S9$^{\Delta}$	S10•	S11•	S12•	S13$^{\Delta}$	S14	S15	S16	S17	S18	S19	S20•	C21$^{\Delta}$	C22°	C23	C24°
Leucocytosis (focal)	--	--	--	--	1	1	--	--	1	--	--	--	--	1	--	--	--	--	--	--	--	--	--	--
Leucocytosis (general)	--	--	--	--	--	1	--	--	1	--	--	--	1	--	--	--	--	--	--	--	--	--	--	--
Sporozoans	3	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Nematode	--	--	--	--	--	1	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Total Number	3	0	0	0	1	3	0	0	2	--	--	--	1	1	0	0	0	0	0	--	0	--	0	--

•no crabs collected
°no gonads sampled
†two gonads sampled
$^{\Delta}$three gonads sampled
$^{+}$ four gonads sampled

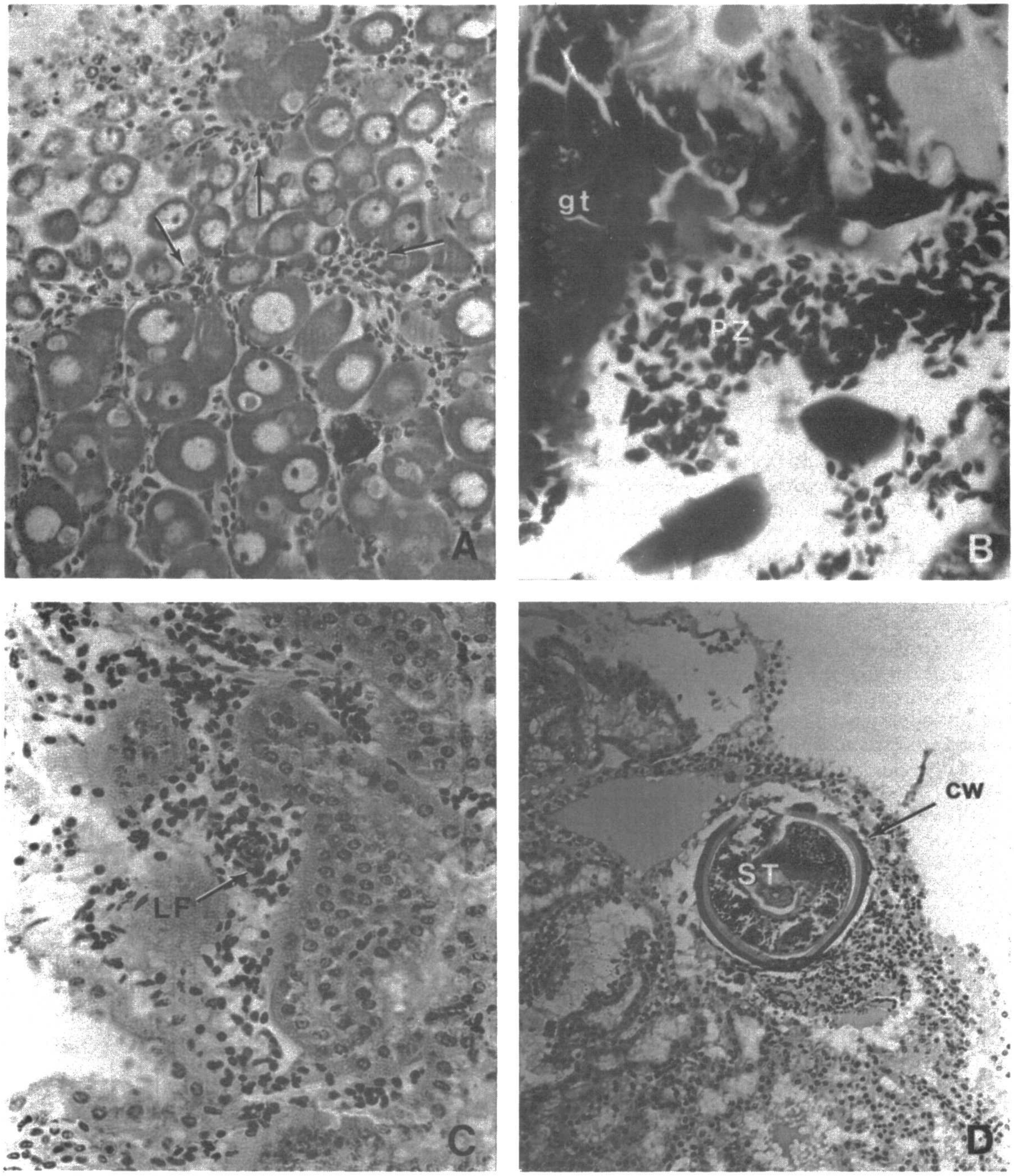

Fig. 30. Crab gonad (A&B) and green gland (C-D). A. *C. similis.* Abnormally high number of circulating leucocytes (arrows). 340X. B. *S. lobatys.* Sporozoans (PZ) in lumen of gonadal tubules (gt). 340X. C. *C. sapidus.* Focal aggregation of leucocytes (LF) in concentric arrangement. 340X. D. *P. gibbesii.* Trematode metacercaria (ST). Note cyst wall (cw). 136X.

TABLE 25. Distribution of pathologies of crab green gland among sampling sites. Each site represents five samples unless otherwise noted.

Pathology	Site P1°	P2	P3$^{\Delta}$	P4$^{\Delta}$	S5	S6	S7^{+}	S8^{+}	S9	S10•	S11•	S12•	S13	S14	S15	S16^{+}	S17	S18	S19	S20•	C21^{+}	C22	C23	C24°
Leucocytosis (general)	--	--	--	--	2	1	2	2	1	--	--	--	2	--	3	4	5	1	5	--	--	1	--	--
Leucocytosis (focal)	--	--	--	--	1	1	1	--	--	--	--	--	--	1	--	1	--	--	4	--	--	--	--	--
Pyknotic nuclei	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	3	2	--	--	--	--	--
Trematode	--	--	--	--	1	--	--	1	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Total Numbers	--	0	0	0	4	2	3	3	1	--	--	--	2	1	3	5	5	4	11	--	0	1	0	--

•no crabs collected.
°no excretory samples.
$^{\Delta}$three excretory samples.
$^{+}$ four excretory samples.

(2) Histopathological Conditions— Histopathologies occurred in 38.5% (37 of 96) of the gills examined. There was a total of 59 cases of the 11 pathologies described below. Forty-one of the cases (69.5%) were not attributable to symbioses. The distribution of pathologies of crab gills among sampling sites is presented in Table 26.

Hyperplasia, an abnormal increase in the number of cells in an organ or tissue, was evident in the gills of 12.5% (12 of 96) of the crabs examined (Fig. 31A). This condition was usually localized in a single lamella but several on each gill would exhibit this condition. Hyperplasia was accompanied by a slight swelling of the affected area and an increase in number of leucocytes, occasionally pyknotic nuclei and granular debris, as if the area was becoming necrotic. Ten *C. similis* and two *C. sapidus* had lamellae with areas of hyperplasia.

Edematous lamellae were found in 8.3% (8 or 96) of the crab gills examined (Fig. 31B). Affected lamellae were distended in width and filled with hemolymph. In most, the cuticle separated from the underlying epithelium. This condition was present in three

TABLE 26. Distribution of pathologies of crab gills among sampling sites. Each site represents five samples unless otherwise noted.

Pathology	Site P1	P2	P3$^{\Delta}$	P4^{+}	S5	S6	S7	S8	S9	S10•	S11•	S12•	S13	S14	S15	S16	S17^{+}	S18	S19	S20•	C21	C22	C23	C24
Hyperplasia	--	--	--	--	1	--	--	--	--	--	--	--	1	3	2	3	1	--	1	--	--	--	--	--
Edema	1	--	--	--	--	--	--	3	--	--	--	--	--	--	--	1	--	--	3	--	--	--	--	--
Leucocytosis (focal)	1	--	--	--	1	--	1	1	--	--	--	--	--	--	--	1	--	1	1	--	--	--	--	--
Leucocytosis (general)	--	--	--	--	1	--	--	2	1	--	--	--	--	--	--	--	--	1	--	--	--	--	--	--
Focal necrosis	--	--	--	--	--	1	--	--	--	--	--	--	--	1	--	2	1	--	--	--	--	--	--	--
Nodule	--	--	--	--	--	--	--	--	--	--	--	--	1	--	--	2	--	--	--	--	--	--	--	--
Deformity	--	--	1	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Ciliates	--	--	--	--	4	1	--	2	--	--	--	--	--	--	--	--	--	--	4	--	--	--	--	--
Nemertines	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	5	--	--	--	--	--
Barnacles	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	1	--	--	--	--	--
Trematodes	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	1	--	--	--	--	--
Total Number	2	0	1	0	7	2	1	8	1	--	--	--	2	4	2	9	2	2	16	--	0	0	0	0

•no crabs collected.
$^{\Delta}$three gill samples.
$^{+}$ four gill samples.

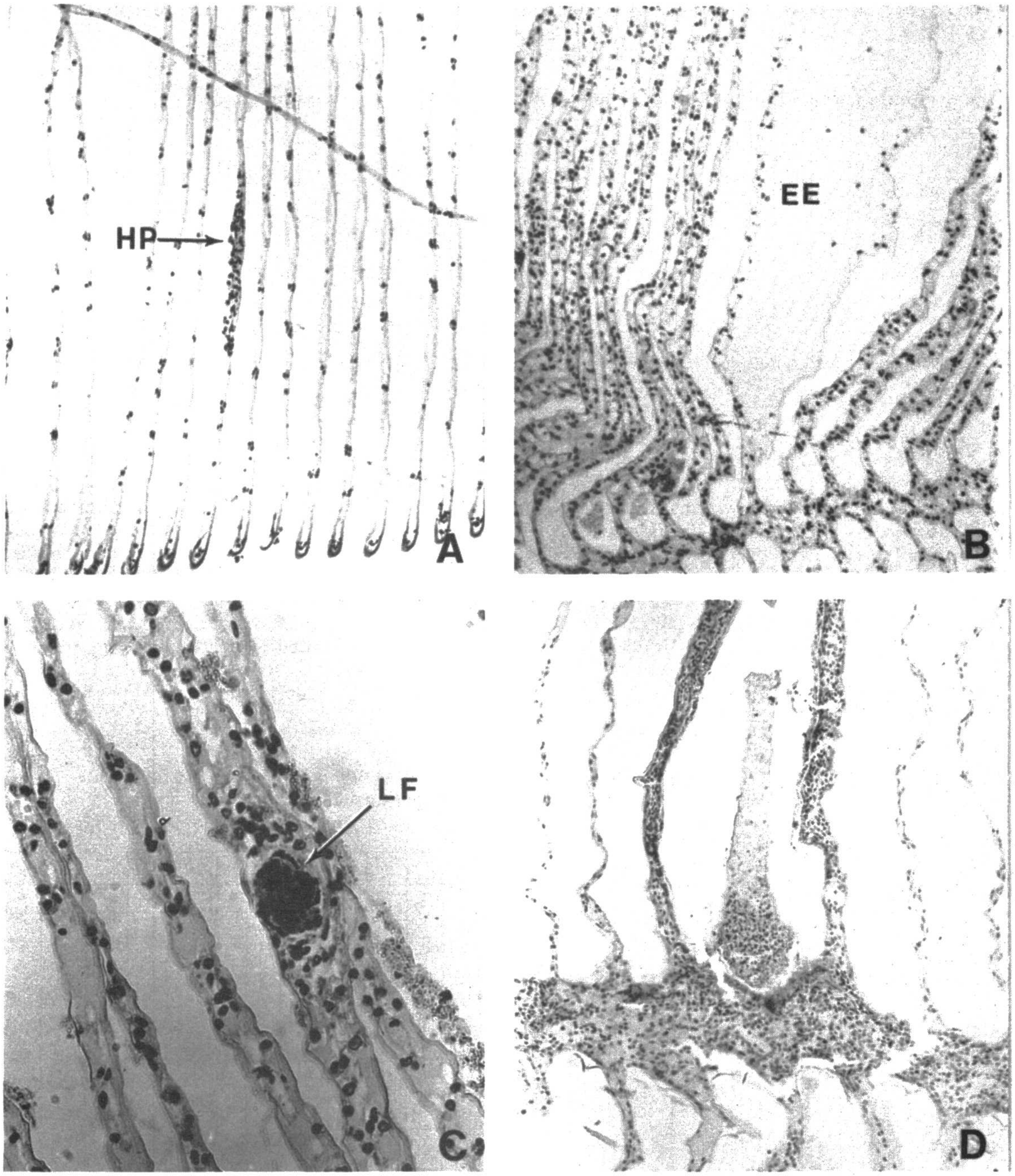

Fig 31. Crab gill. A. *C. sapidus.* Hyperplasia (HP) of a single lamella. 136X. B. *P. gibbesii.* Edema (EE) of a single lamella. Lamella is filled with hemolymph. 136X. C. *P. gibbesii.* Focal concentration of leucocytes (LF) around a pyknotic core. 340X. D. *C. similis.* Necrotic lamellae and stem. Note inflammation. 136X.

C. sapidus, three *P. gibbesii*, one *C. similis* and one *S. lobatus*.

Focal aggregates of hemocytes were present in the gill stem and lamellae of 7.3% (7 of 96) of the crabs examined. Leucocytes were concentrically arranged around a small eosinophilic core. Pyknotic nuclei were often included in the core (Fig. 31C). Aggregates occluded the hemal sinuses and in some a slight swelling of the lamella at the aggregate was evident. This condition was noted in two *C. sapidus*, two *C. similis* and one each of *P. gibbesii*, *P. spinicarpus*, and *S. lobatus*.

Abnormally high numbers of eosinophilic leucocytes were observed in 5.2% (5 of 96) of the gills examined. Leucocytes were dispersed throughout the gills rather than being in aggregates as above. Two *P. gibbesii* and one each of *P. spinicarpus*, *C. similis* and *C. sapidus* had general leucocytosis in the gills.

Necrotic lamellae were found in 5.3% (5 of 96) of the gills examined (Fig. 31D). All cases were on gills of *C. similis*. One to three adjacent lamellae were involved at each necrotic area. Extent of necrosis varied from only the terminal half of a single lamella to the entire lamella and a portion of the gill stem. Necrotic areas were highly inflamed (swelling and invasion by leucocytes) and contained some granular debris. The immediate area was highly eosinophilic and hyperplastic. Sloughing of a portion or the entire lamella was evident.

Nodules (solid microscopic spheres) were present in the lamellae of 3.1% (3 of 96) of the crabs examined. Nodules were eosinophilic and had no cellular structure. They were found only in *C. similis*.

Lamellae on the gills of a single *P. spinicarpus* appeared to have been deformed by a foreign object pressing against them in life, which could have been an external symbiont or a piece of debris.

Ciliate protozoans were found in 11.5% (11 of 96) of the gills examined. Eight *C. sapidus*, two *P. gibbesii* and one *C. similis* were infected. Most specimens had light infections of a stalked ciliate, possibly *Epistylis* sp., which did no apparent harm to the gills. Four *C. sapidus* were also host to a loricate ciliate tentatively indentified as *Lagenophrys callinectes*, a sessile ciliate which lived in attached loricae on the lamellae. Heavy numbers of this ciliate appeared to damage the gills (Fig. 32A).

The nemertine worm *Carcinoneonertes carcinophila* was incident on 5.2% (5 of 96) of the gills examined (Fig. 32B). This symbiont was found only on the five *C. sapidus* from Site S19. Worms were found between lamellae and apparently did no harm to the gills.

A single *C. sapidus* from Site S19 bore a stalked barnacle, probably *Octolasmis muelleri*.

Trematode metacercariae were encysted in the gills of one *C. sapidus* from Site S19.

g. Heart

Samples of heart from 92 individual crabs were examined for histopathologies.

(1) Normal Microscopic Features— Crab heart was composed of anastomosing striated muscle interrupted by small sinuses. The periphery of the heart was surrounded by connective tissue. Large neural cells were often included in cardiac sections.

(2) Histopathological Conditions— Histopathologies occurred in 16.4% (16 of 96) of the crab hearts examined. There were a total of 16 cases, all focal aggregates of leucocytes. In six of the hearts, eosinophilic leucocytes and basophilic hemocytes were pressed around a central core of pyknotic cells. This type of aggregation occupied a small focal spot. In 10 of the hearts, leucocytes and other hemocytes were clumped in a tight mass of cells. Included in the clump of hemocytes were pyknotic cells and granular debris (Fig. 32C). Such clumps occupied a much larger area than the focal aggregates. Aggregation of leucocytes in the heart occurred in four *C. similis* from Site P2, two *C. similis* from each of Sites S18 and C22, one *C. similis* from each of Sites S6, S13, S14, S16 and C21, and three *C. sapidus* from Site S5.

h. Other Organs

The thoracic ganglionic mass was either included in cross sections of whole crabs (five *L. nitidus* from Site P4) or dissected out and examined in others (five *P. spinicarpus* from Site P3 and four *P. spinicarpus* from Site C23). Portions of nerves were included in most sections and routinely examined. The only histopathology of nervous tissue observed was invasion of the thoracic ganglionic mass by eosinophilic leucocytes in one *L. nitidus*.

One *S. lobatus* from Site P1 contained a large abnormal mass of cells in the hemocoel posterior to the digestive gland (Fig. 32D). The core was composed of pyknotic cells. Outer cells had normal nuclei but no clear form. Compressed connective tissue surrounded the mass.

Immature nematodes were incident in the hemocoel of one *S. lobatus* from Site P1.

3. Shrimps

The organs of 80 individuals of three species of penaeid shrimps (*P. aztecus*, *P. setiferus*, and *T. similis*) were examined for histopathologies. Gross gregarine protozoan and/or trypanorhynchan cestode symbioses were noted among 7.5% (6 of 80) of those individuals during initial processing. Seventy-nine of the 80 (98.8%) individual shrimps examined and 220 of the 536 (41.1%) organs examined bore one or more cases of the 20 different types of histopathologies reported below. There were 181 cases (52.8%) of histopathologies which were various types of symbioses or which were elicited directly by symbioses (e.g., inflammation). One hundred and sixty-two cases (47.2%) were not apparently correlated with symbioses.

The distributions of the histopathologies of *P. aztecus*, *T. similis*, and *P. setiferus* among sampling sites are presented in Tables 27, 28, and 29. The highest mean incidence of nonsymbiotic histopathologies was found in *P. aztecus* (2.3/shrimp); the lowest, in *T. similis* (1.1/shrimp). The highest mean incidence of symbiotic histopathologies was found in *P. setiferus* (2.3/shrimp); the lowest, in *T. similis* (1.2/shrimp). Gills typically bore high incidences of nonsymbiotic histopathologies; while gill, digestive gland, and gut samples bore high incidences of symbioses and related histopathologies.

The following observations were made concerning the incidence of histopathologies among sampling site types (e.g., control, primary, and secondary). Since *P. setiferus* were collected only from one site (secondary

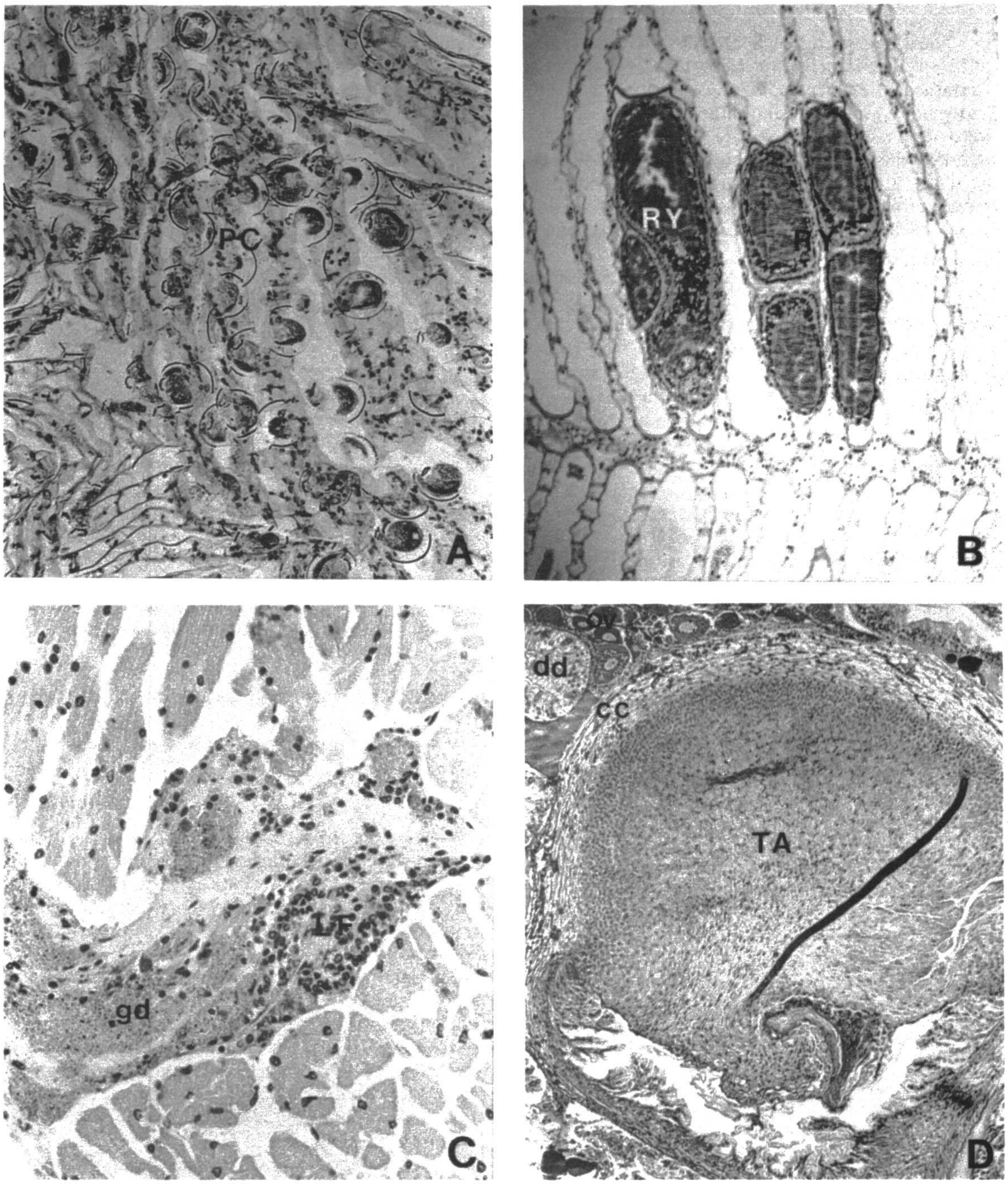

Fig. 32. Crab gill (A&B), heart (C) and hemocoel (D). A. *C. similis*. Heavy concentration of *Lagenophrys* (PC). 136X. B. *C. sapidus*. The nemertine *C. carcinophila* (RY) between lamellae. 86X. C. *C. sapidus*. Focal aggregation of leucocytes (LF). Note granular debris (GD). 340X. D. *S. lobatus*. Abnormal growth (TA). Note compressed connective tissue cells (cc); ovary (ov), digestive diverticula (dd). 34X.

TABLE 27. Distribution of histopathologies of *P. aztecus* among sampling sites.

Site	Mean Number of Nonsymbiotic / Symbiotic Histopathologies								
	Muscle	Digestive Gland	Gut	Gonad	Excretory	Gill	Heart	Other Organs	Per Organism
Control									
C23	1.2/0.2	0.0/0.4	0.2/1.0	0.2/0.8	0.0/0.0	1.4/1.2	0.4/0.0	0.0/0.0	3.6/3.4
Primary									
P2	1.6/0.0	0.6/0.8	0.0/0.8	0.0/0.0	0.0/0.0	2.6/1.4	0.0/0.0	0.0/0.0	4.8/3.0
Secondary									
S6	0.2/0.0	0.2/1.4	0.2/0.4	0.4/0.2	0.0/0.0	0.4/0.8	0.4/0.0	0.0/0.0	1.8/2.8
S7	0.2/0.4	0.4/0.6	0.0/2.6	0.0/0.8	0.0/0.2	1.4/0.8	0.0/0.0	0.0/0.0	2.4/5.0
S8	1.0/0.0	0.0/0.4	0.4/0.8	0.2/0.2	0.0/0.3	1.6/0.2	0.0/0.0	0.0/0.0	3.2/1.8
S9	0.0/0.0	0.3/0.8	0.0/1.2	0.0/0.3	0.0/0.0	0.4/0.8	0.3/0.0	0.0/0.0	0.8/2.6
S13	0.6/0.2	0.0/0.4	0.0/0.0	0.2/0.2	0.2/0.2	0.4/0.4	0.2/0.0	0.0/0.0	1.6/1.4
S14	0.6/0.2	0.6/0.4	0.0/0.0	0.2/0.0	0.0/0.0	1.2/0.6	0.2/0.0	0.0/1.0	2.8/1.6
S15	0.0/0.0	0.4/1.0	0.4/0.6	0.0/0.2	0.0/0.0	0.5/0.0	0.3/0.0	0.0/0.0	1/4/1.8
S16	0.0/0.0	0.0/0.8	0.2/0.6	0.0/0.2	0.2/0.0	0.2/0.8	0.0/0.0	0.0/0.0	0.4/2.4
S17	0.0/0.0	0.2/0.8	0.0/0.8	0.0/0.0	0.4/0.0	1.0/0.0	0.4/0.0	0.0/1.0	2.0/1.8
Secondary Totals	0.3/0.1	0.2/0.7	0.1/0.8	0.1/0.2	0.1/0.1	0.8/0.5	0.2/0.1	0.0/1.0	1.8/2.4
Total for *P. aztecus*	0.5/0.1	0.2/0.7	0.1/0.8	0.1/0.2	0.1/0.1	1.0/0.7	0.2/0.0	0.0/1.0	2.3/2.5

TABLE 28. Distribution of histopathologies of *T. similis* among sampling sites.

Site	Mean Number of Nonsymbiotic / Symbiotic Histopathologies							
	Muscle	Digestive Gland	Gut	Gonad	Excretory	Gill	Heart	Per Organism
Control								
C22	0.6/0.0	0.0/0.2	0.0/0.0	0.4/0.0	0.0/0.0	0.6/1.0	0.0/0.0	1.6/1.2
Primary								
P3	0.6/0.2	0.0/1.0	0.0/0.0	0.0/0.0	0.0/0.0	0.6/1.0	0.0/0.0	1.2/1.4
P4	0.2/0.0	0.0/0.6	0.0/0.8	0.2/0.0	0.0/0.0	0.6/0.8	0.0/0.0	1.0/2.0
Primary Total	0.4/0.1	0.0/0.7	0.0/0.4	0.1/0.0	0.0/0.0	0.6/0.9	0.0/0.0	1.1/1.7
Secondary								
S18	0.2/0.0	0.4/0.2	0.0/0.2	0.0/0.0	0.5/0.0	0.8/0.0	0.4/0.0	2.4/0.2
Total for *T. similis*	0.4/0.1	0.1/0.4	0.0/0.3	0.2/0.0	0.1/0.0	0.7/0.7	0.1/0.0	1/6.1/2

TABLE 29. Distribution of histopathologies of *P. setiferus* among sampling sites.

Site	Mean Number of Nonsymbiotic / Symbiotic Histopathologies							
	Muscle	Digestive Gland	Gut	Gonad	Excretory	Gill	Heart	Per Organism
Secondary								
S5	0.4/0.0	0.4/0.8	0.2/1.2	0.0/0.0	0.0/0.0	0.8/0.8	0.3/0.0	2.0/2.8

Site S5), only *P. aztecus* and *T. similis* are discussed. The mean incidence of nonsymbiotic histopathologies among *P. aztecus* was highest at primary sites (4.8/shrimp) and lowest at secondary sites (1.8/shrimp); the mean incidence of symbiotic histopathologies was highest at control sites (3.4/shrimp) and lowest at secondary sites (2.4/shrimp). Among *T. similis*, the highest mean incidence of nonsymbiotic histopathologies was at secondary sites (2.4/shrimp); the lowest, at primary sites (1.1/shrimp). The highest mean incidence of symbiotic histopathologies in *T. similis* was at primary sites (1.7/shrimp); the lowest, at secondary sites (0.2/shrimp).

A ranking of sampling sites by mean number of histopathologies (both nonsymbiotic and symbiotic) is presented in Table 30. All three types of sampling sites (control, primary, and secondary) were represented in the three sites having both the highest and the lowest incidences of histopathologies.

TABLE 30. Ranking of sampling sites by mean number of histopathologies per shrimp

Site	Species	Mean Number of Histopathologies per Shrimp
P2	*P. aztecus*	7.8
S7	*P. aztecus*	7.4
C23	*P. aztecus*	7.0
S8	*P. aztecus*	5.0
S5	*P. setiferus*	4.8
S6	*P. aztecus*	4.6
S14	*P. aztecus*	4.0
S9	*P. aztecus*	3.6
S17	*P. aztecus*	3.6
S15	*P. aztecus*	3.2
P4	*T. similis*	3.0
S13	*P. aztecus*	3.0
S16	*P. aztecus*	3.0
C22	*T. similis*	2.8
P3	*T. similis*	2.6
S18	*T. similis*	2.6

a. Muscle

Muscle samples from 80 individual shrimps were examined. Samples were obtained from the first abdominal segment and were oriented (when possible) to present both transverse and longitudinal sections.

(1) Normal Microscopic Features— Shrimp voluntary muscle displayed pronounced striation in longitudinal section. The sarcoplasm and its contents were acidophilic; the peripheral nuclei were basophilic. Connective tissue analogues of vertebrate endomysium and perimysium were present, and muscle fibers aggregated into fascicle-like units.

(2) Histopathological Conditions— Histopathologies were noted among 35% (28 of 80) of the muscle samples examined. There was a total of 43 cases of the eight different types of conditions discussed below. The distribution of these histopathologies among sampling sites is presented in Table 31.

Twenty-five per cent (20 of 80) of the muscle samples analysed displayed evidence of degeneration. Individuals of two species, *P. aztecus* and *T. similis*, possessed this particular condition. In some instances, focal areas of musculature were apparently liquefied, obscuring the normal orderly substructure of skeletal muscle (Fig. 33A). In other instances normal musculature graded into a granular material of rather random substructure (Fig. 33B).

Ten per cent (8 of 80) of the muscle samples examined displayed focal aggregations of hemocytes (focal leucocytoses). Individuals of both *P. aztecus* and *T. similis* possessed this condition. Various morphotypes of hemocytes were concentrated in rather discrete and compact aggregates (Fig. 33C). Sections sometimes revealed an amorphous core of variable texture and staining properties.

Six per cent (5 of 80) of the muscle samples studied possessed focal necroses. This condition was

TABLE 31. Distribution of histopathologies of shrimp musculature among sampling sites. Each site represents 5 muscle samples unless otherwise noted.

	Site																						
Pathology	P1*	P2	P3	P4	S5	S6	S7	S8	S9	S10*	S11*	S12*	S13	S14	S15	S16	S17	S18	S19*	S20*	C21*	C22	C23	C24*
Degeneration	--	4	3	--	--	1	1	1	--	--	--	--	3	--	--	--	--	--	--	--	--	3	4	--
Leucocytosis (focal)	--	2	--	1	--	--	--	1	--	--	--	--	--	2	--	--	--	--	--	--	--	--	2	--
Focal necrosis	--	2	--	--	1	--	--	1	--	--	--	--	--	--	--	--	--	1	--	--	--	--	--	--
Pigment	--	--	--	--	1	--	--	1	--	--	--	--	--	1	--	--	--	--	--	--	--	--	--	--
Leucocytosis (general)	--	--	--	--	--	--	--	1	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Ciliates	--	--	--	--	--	--	--	--	--	--	--	--	1	--	--	--	--	--	--	--	--	--	--	--
Unidentified Protozoan	--	--	1	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	1	--
Nematodes	--	--	--	--	--	--	2	--	--	--	--	--	--	1	--	--	--	--	--	--	--	--	--	--
Total Number	--	8	4	1	2	1	3	5	0	--	--	--	4	4	0	0	0	1	--	--	--	3	7	--

*no shrimp collected.

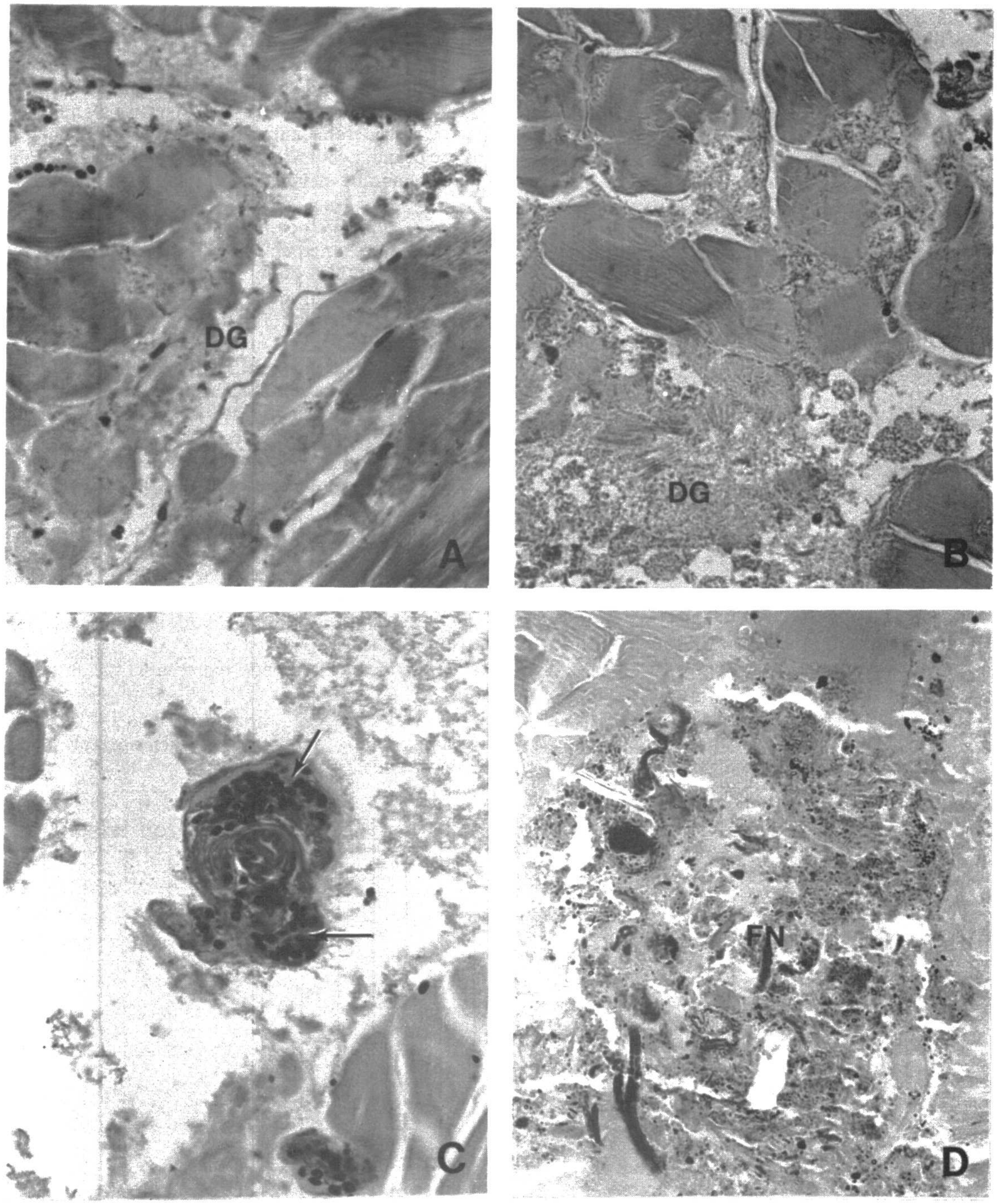

Fig. 33. Shrimp musculature. A. *P. aztecus*. Liquefactive degeneration (DG). 340X. B. *P. aztecus*. Granular degeneration (DG). 340X. C. *P. aztecus*. Focal aggregations of hemocytes (arrows). 340X. D. *P. setiferus*. Focal necrosis (FN). 340X.

incident in all three of the shrimp species studied. Most cases displayed areas of heavy liquefaction accompanied by the possession of basophilic fibers and/or amorphous masses, pyknotic nuclei, accumulations of brown pigment, and debris (Fig. 33D).

Accumulations of pigments were observed in 4% (3 of 80) of the muscle samples analyzed. Individuals of both *P. aztecus* and *P. setiferus* possessed this condition. As mentioned above, concentrations of pigments often accompanied focal necroses. In one case, a mass of blackish-brown pigment occurred in the connective tissue immediately peripheral to striated musculature (Fig. 34A).

An abnormally high concentration of hemocytes (general leucocytosis) was evident in the musculature of one *P. aztecus* (Fig. 34B). In this particular case, the hemocytes were distributed rather evenly throughout the tissues rather than displaying the focal distribution described above.

Three types of symbioses were observed in shrimp musculature. Unidentified protozoans were found in one *P. aztecus* and in one *T. similis*; a ciliate, in one *P. aztecus*; and nematodes, in three *P. aztecus*. The nematode encountered appeared to be an anisakid, probably of the genus *Thynnascaris.*

b. Digestive Gland

Samples of the digestive glands of 75 individual shrimps were examined.

(1) Normal Microscopic Features— Shrimp digestive glands (hepatopancreases) were composed of multitudes of blind tubules. The tubules themselves were constructed of columnar and cubo-columnar, basophilic cells and vacuolated ferment cells. The powerful enzymes elaborated by the digestive gland often effected considerable autolysis, especially near the center of the organ. Sections of the gastric mill and the gonads were commonly included in digestive gland samples.

(2) Histopathological Conditions— Histopathologies were noted among 57% (43 of 75) of the digestive gland samples examined. There was a total of 65 cases of the 12 types of histopathologies discussed below. The distribution of these histopathologies among sampling sites is presented in Table 32.

Eleven per cent (8 of 75) of the hepatopancreas samples collected displayed focal aggregations of hemocytes (focal leucocytoses) (Fig. 34C). Individuals of all three shrimp species possessed this condition. The nature and appearance of these aggregations in digestive gland samples were similar to those observed in the musculature.

Five per cent (4 of 75) of the hepatopancreas samples analyzed displayed evidence of degeneration. This condition was incident in all three of the shrimp species studied. Two cases of degeneration were associated with cyst formation, and another case was associated with a microbial symbiosis (all described below). The fourth case apparently represented the initial stages

TABLE 32. Distribution of histopathologies of shrimp digestive glands among sampling sites. Each site represents 5 digestive gland samples unless otherwise noted.

	Site																						
Pathology	P1*	P2	P3Δ	P4	S5	S6	S7	S8	S9+	S10*	S11*	S12*	S13	S14	S15	S16	S17	S18	S19*	S20*	C21*	C22	C23	C24*
Leucocytosis (focal)	--	3	--	--	1	1	--	--	--	--	--	--	--	1	--	--	--	1	--	--	--	--	--	--
Degeneration	--	--	--	--	1	--	1	--	--	--	--	--	--	--	--	--	1	1	--	--	--	--	--	--
Leucotytosis (general)	--	--	--	--	--	--	--	--	--	--	--	--	--	2	--	--	1	--	--	--	--	--	--	--
Cysts	--	--	--	--	--	--	1	--	1	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Pyknosis	--	--	--	--	1	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Cestodes	--	2	1	2	1	2	1	--	1	--	--	--	1	1	--	2	--	1	--	--	--	1	--	--
Nematodes	--	--	--	1	--	2	2	2	1	--	--	--	--	--	2	1	--	--	--	--	--	--	--	--
Degenerating helminths	--	1	--	--	1	1	--	--	1	--	--	--	1	--	--	--	2	--	--	--	--	--	2	--
Microbes	--	--	--	--	--	--	--	--	--	--	--	--	--	--	3	--	1	--	--	--	--	--	--	--
Trematodes	--	--	--	--	--	1	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	
Inflammation	--	1	--	--	1	1	--	--	--	--	--	--	--	1	--	1	--	--	--	--	--	--	--	--
Pigment	--	--	--	--	--	--	--	--	--	--	--	--	--	--	1	--	--	--	--	--	--	--	--	--
Total Number	--	7	1	3	6	8	5	2	4	--	--	--	2	5	7	4	5	3	--	--	--	1	2	--

*no shrimp collected.
Δone digestive gland sample.
+ four digestive gland samples.

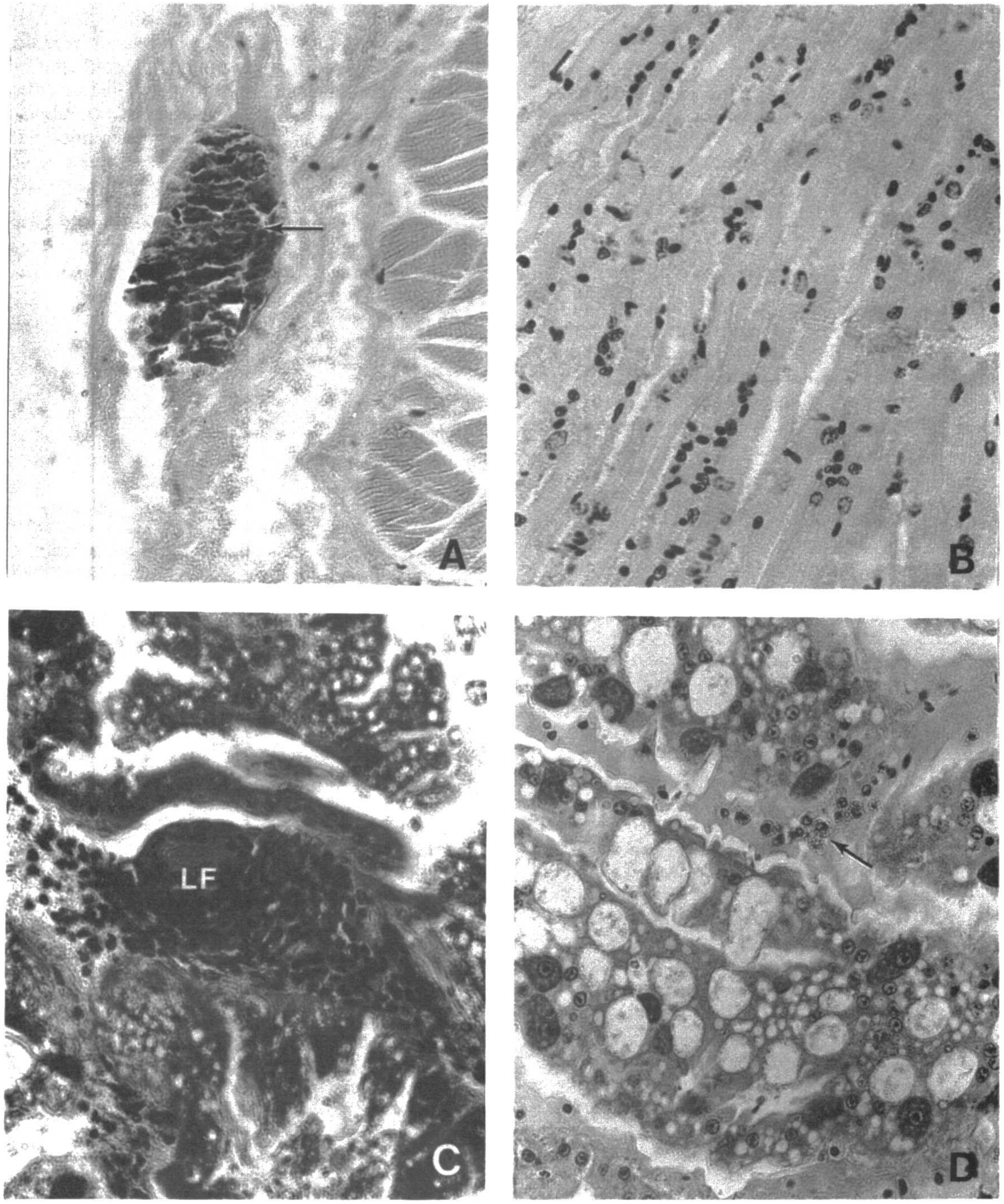

Fig. 34. Shrimp musculature (A&B) and digestive gland (C&D). A. *P. aztecus*. Accumulation of pigment (arrow) in perimuscular connective tissue. 340X. B. *P. aztecus*. High concentration of circulating hemocytes. 340X. C. *P. aztecus*. Focal aggregation of hemocytes (LF). 340X. D. *P. aztecus*. High concentration of circulating hemocytes especially eosinophilic granular hemocytes (arrow). 340X.

of liquefactive necrosis, displaying considerable diminution of both cytoplasmic and nuclear detail.

Abnormally high concentrations of hemocytes (general leucocytoses) were evident in the digestive glands of 4% (3 of 75) of the samples studied. This type of histopathology was observed only among *P. aztecus*. Various morphotypes of hemocytes were concentrated in the inter-tubular sinuses, but the concentration of eosinophilic granular hemocytes was particularly obvious (Fig. 34D). In these cases, hemocytes appeared to be freely circulating rather than to be aggregated into organized foci.

Cysts occurred in the digestive glands of two *P. aztecus*. The cyst periphery was composed of lightly basophilic fibers; the lining, of yellow, refringent fibers (Fig. 35A). There was a capacious central lumen housing lightly-stained, amorphous contents.

The digestive gland of one *P. setiferus* was considerably pyknotic. The entire organ was autolysed to an advanced degree; and pyknotic areas occurred not only near the periphery, but also near the center.

Four types of symbioses occurred in shrimp hepatopancreases. Larval trypanorhynchan cestodes (Fig. 35B) were incident in 21% (16 of 75) of the samples analyzed, being present in ten *P. aztecus*, five *T. similis*, and one *P. setiferus*. Immature nematodes (Fig. 35C) were incident in 15% (11 of 75) of the samples examined. They were observed in ten *P. aztecus* and in one *T. similis*. Degenerating or moribund helminths (Fig. 35D) were found in 12% (9 of 75) of the samples. They were incident in eight *P. aztecus* and in one *P. setiferus*. These helminths, probably trypanorhynchs, were in varying stages of degeneration or necrosis and were often surrounded by evidence of strong host-inflammatory response. Microbial symbioses were incident in 5% (4 of 75) of the hepatopancreas samples, being present only in *P. aztecus*. These symbionts appeared as basophilic filaments and were associated in one case with a focal degeneration (Fig. 36A). One *P. aztecus* bore a single trematode symbiont in its hepatopancreas (Fig. 36B).

Seven per cent (5 of 75) of the digestive glands studied bore evidences of host inflammatory responses. These inflammations occurred in both *P. aztecus* and *P. setiferus* and were associated with trypanorhynch symbioses or degenerating or moribund helminthic symbioses. The nature of the response varied from hemocytic infiltration to the construction of elaborate connective tissue walls (Fig. 35D). One case of a massive accumulation of pigment was associated with a nematode symbioses in *P. aztecus*.

c. Gut

Gut samples from 76 individual shrimps were examined for histopathologies. The portion of mesenteron (midgut) which transverses the first one or two abdominal segments was excised, as were the rectum and rectal gland. Sections of the gastric mill and other parts of the foregut (stomodaeum) were often obtained with digestive gland samples.

(1) Normal Microscopic Features—The mesenteron was lined with a moderately basophilic, columnar epithelium. In certain regions strongly acidophilic unicellular exocrine glands were interspersed between the columnar cells. Peripheral to the epithelium were layers of muscle and connective tissue. The rectal gland was a sinuous labyrinth lined with an intensely basophilic epithelium. Acidophilic and vacuolated unicellular glands were also present in this epithelium. The rectal plicae were glandular in nature. The thin cuticular lining of this portion of the proctodaeum (hindgut) was sometimes evident as was intrinsic striated musculature. Gut samples from sexually mature shrimps often included sections of the abdominal lobes of the gonads.

(2) Histopathological Conditions— Histopathologies were noted among 55% (42 of 76) of the gut samples examined. There was a total of 62 cases of the 11 types of histopathologies discussed below. The distribution of these histopathologies among sampling sites is presented in Table 33.

Eight per cent (6 of 76) of the gut samples studied displayed focal aggregates of hemocytes. This condition was observed in both *P. aztecus* and *P. setiferus*. These aggregates were found only in sections of rectum (Fig. 36C) and rectal gland. Two cases of this condition were associated with host inflammatory response to gregarine symbioses.

Seven per cent (5 of 76) of the gut samples examined possessed abnormally high concentrations of hemocytes. This condition was observed only among *P. aztecus*. Two cases were peripherally associated with host inflammatory responses to gregarine symbioses. Three cases could not be directly correlated with symbioses. Two of these were particularly interesting because of the extremely high concentrations of eosinophilic granular hemocytes in the mesenteric muscularis (Fig. 36D).

The rectum of one *P. aztecus* bore necrotic areas of an amorphous basophilic coagulum (Fig. 37A).

Seven types of symbioses were observed in gut samples. Gregarine trophozoites were found in the foregut of one *P. aztecus* (Fig. 37B). Gregarine gametocysts were found in 42% (32 of 76) of the shrimp recta examined, being present in 26 *P. aztecus*, five *P. setiferus*, and one *T. similis* (Fig. 38B). One of each of the following protozoans was observed among the mesenteric samples from *P. aztecus*: an amoeba (Fig. 37C), a ciliate, and an unidentified protozoan. Lecanicephalids were found in 5% (4 of 76) of the mesenterons studied (Fig. 37D). They were distributed among three *T. similis* and one *P. aztecus*. Immature nematodes were observed in 5% (4 of 76) of the gut samples collected. They were incident exclusively in *P. aztecus*, with two associated with the foregut and two associated with the rectal gland. Larval helminths, probably cyclophyllidean cestodes, were incident in 4% (3 of 76) of the gut samples studied. They infected the rectal glands of *P. aztecus* (Fig. 38A).

Four per cent (3 of 76) of the recta examined bore evidence of inflammatory responses to symbioses. All affected individuals were *P. aztecus*. These responses appeared to be most closely associated with gregarine gametocysts (Fig. 38B).

d. Gonad

Gonad samples from 74 individual shrimps were examined for histopathologies. Samples were acquired from the area ventral to the heart and dorsal to the digestive gland. Gonads also often accompanied gut and hepatopancreas samples taken from sexually mature shrimp.

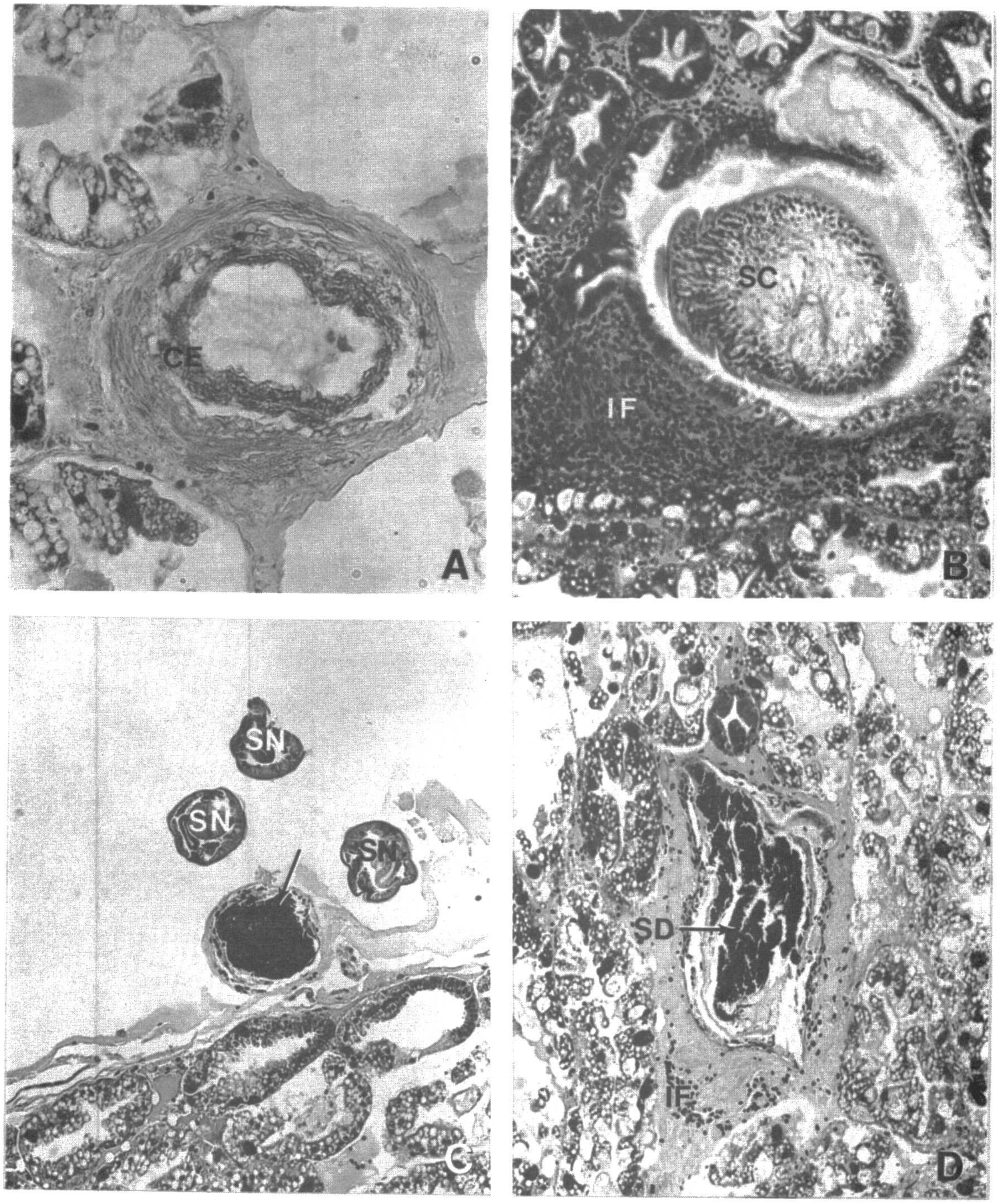

Fig. 35. Shrimp digestive gland. A. *P. aztecus.* Cyst (CE). 340X. B. *P. aztecus.* Trypanorhynchid cestode symbiosis (SC) accompanied by inflammatory response (IF). 136X. C. *P. aztecus.* Nematode symbiosis (SN) accompanied by an accumulation of pigment (arrow). 136X. D. *P. aztecus.* Degenerating helminth (SD) accompanied by inflammatory response (IF). 136X.

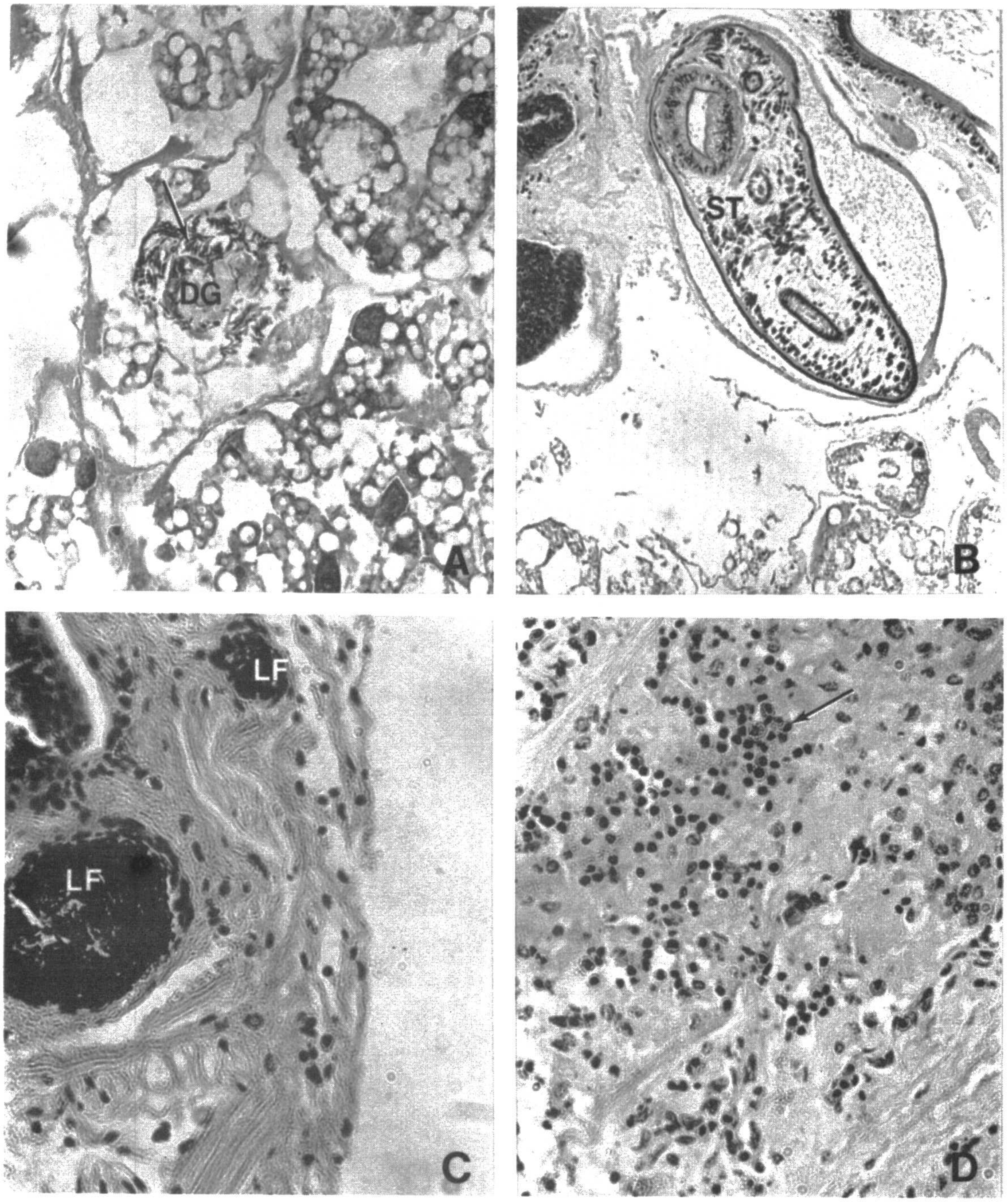

Fig. 36. Shrimp digestive gland (A&B) and gut (C&D). A. *P. aztecus.* Microbial symbiosis (arrow) associated with focal degeneration (DG). 340X. B. *P. aztecus.* Trematode symbiosis (ST). 136X. C. *P. aztecus.* Focal aggregations of hemocytes (LF) in rectum. 340X. D. *P. aztecus.* High concentration of hemocytes, especially eosinophilic granular hemocytes (arrow), in mesenteric muscularis. 340X.

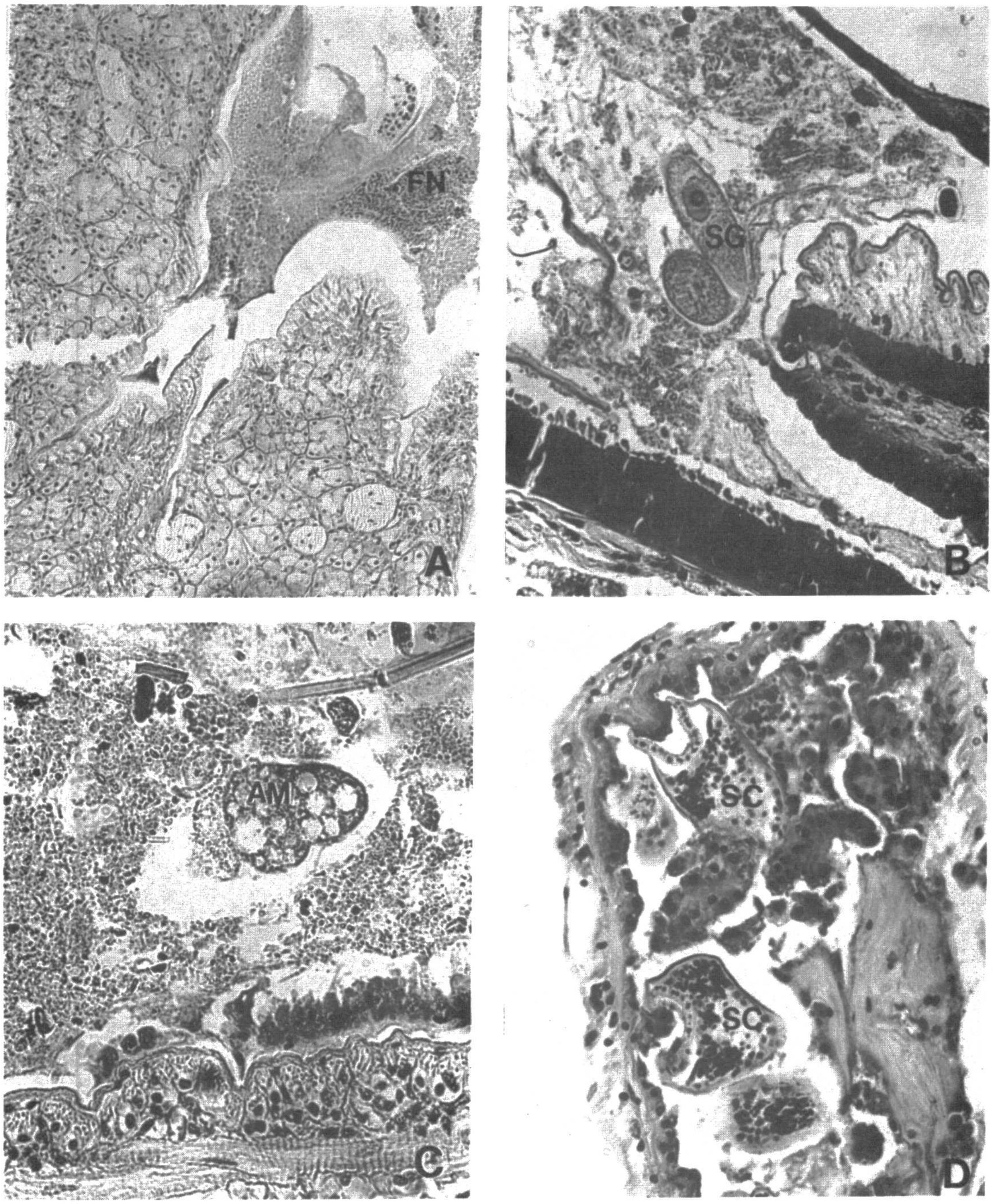

Fig. 37. Shrimp gut. A. *P. aztecus.* Necrotic mass (FN) in rectum. 136X. B. *P. aztecus.* Gregarine trophozoite (SG) in lumen of stomach. 340X. C. *P. aztecus.* Amoeba (AM) in mesenteric lumen. 340X. D. *T. similis.* Leconicephalids (SC) attached to mesenteric mucosa. 340X.

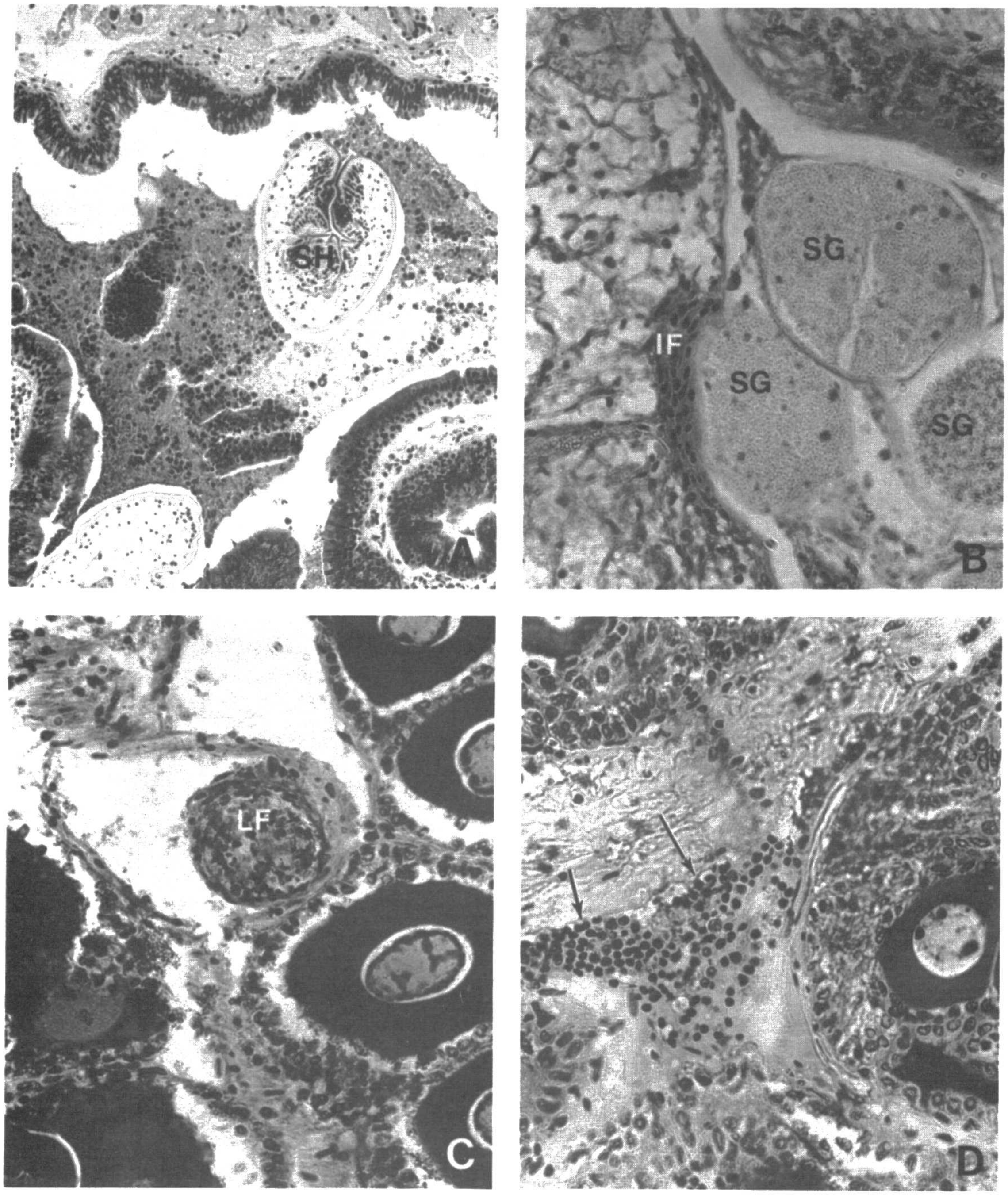

Fig. 38. Shrimp gut (A&B) and gonad (C&D). A. *P. aztecus*. Larval helminth (SH) in rectal gland. 136X. B. *P. aztecus*. Inflammatory response (IF) associated with gregarine gametocysts (SG) in rectum. 340X. C. *T. similis*. Focal aggregation of hemocytes (LF) in ovary, 340X. D. *P. aztecus*. High concentration of circulating hemocytes (arrow) in ovary. 340X.

TABLE 33. Distribution of histopathologies of shrimp gut samples among sampling sites. Each site represents 5 gut samples unless otherwise noted.

	Site																							
Pathology	P1*	P2	P3Δ	P4+	S5	S6	S7	S8	S9	S10*	S11*	S12*	S13	S14	S15	S16	S17	S18	S19*	S20*	C21*	C22+	C23	C24*
Leucocytosis (focal)	--	--	--	--	2	--	1	1	--	--	--	--	--	--	1	--	--	--	--	--	--	--	1	--
Leucocytosis (general)	--	--	--	--	--	1	1	1	--	--	--	--	--	--	1	--	1	--	--	--	--	--	--	--
Necrosis	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	1	--	--	--	--	--	--	--	--
Gregarines	--	2	--	--	5	1	5	3	3	--	--	--	--	--	3	3	3	1	--	--	--	--	4	--
Amoeba	--	--	--	--	--	--	--	--	1	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Ciliates	--	--	--	--	--	1	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Unidentified protozoan	--	1	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Lecanicephalids	--	1	--	3	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Nematodes	--	--	--	--	--	--	3	--	1	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Helminth larvae	--	--	--	--	--	--	1	--	1	--	--	--	--	--	--	--	--	--	--	--	--	--	1	--
Inflammation	--	--	--	--	--	--	2	1	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Total Number	--	4	0	3	7	3	13	6	6	--	--	--	0	0	5	4	4	1	--	--	--	0	6	--

*no shrimp collected.
Δthree gut samples.
+ four gut samples.

(1) *Normal Microscopic Features*— Shrimp testes were tubular. The testes and vas deferentia examined contained all stages of developing gametes (spermatogonia, primary and secondary spermatocytes, spermatids, and spermatozoa) and follicle or nurse cells. Shrimp ovaries were lobular with the lobules often separated by connective tissue partitions. The ovaries examined displayed a full range of development. The basophilic staining properties of undeveloped and developed ova were noted as was the progressive change towards acidophilic staining in ripe ova. Rod-shaped peripheral bodies were present in the ova which were ripe. Nurse or follicle cells also attended these gametes.

(2) *Histopathological Conditions*— Histopathologies were found among 26% (19 of 74) of the gonad samples examined. There were a total of 23 cases of the eight types of histopathologies discussed below. The distribution of these histopathologies among sampling sites is presented in Table 34.

Five per cent (4 of 74) of the gonads analyzed possessed focal aggregates of hemocytes (Fig. 38C). This condition was incident in both *P. aztecus* and *T. similis* and was associated, in one case, with the periphery of a host inflammatory response to nematode symbioses.

There were two cases of degeneration among gonad samples, their incidence being confined to *P. aztecus*. These cases included areas of liquefaction and foci of pyknosis.

Abnormally high concentrations of hemocytes were found in the gonads of two *P. aztecus* (Fig. 38D). The large numbers of eosinophilic granular cells were particularly noticeable.

There were two cases of focal necrosis observed in shrimp gonads, one from *P. aztecus* and one from *T. similis*. These cases were characterized by liquefaction and accumulation of debris (Fig. 39A).

One case of host inflammatory response was noted in *P. aztecus*. There was a considerable accumulation of hemocytes and an advanced elaboration of connective tissue associated with a nematode symbiosis.

Three types of symbioses were observed in gonad samples. Immature nematodes infected 14% (10 of 75) of the samples. They occurred exclusively in *P. aztecus* (Fig. 39B). A larval trematode and a larval trypanorhynch each infected a single *P. aztecus*.

e. *Excretory Organ*

Samples of the excretory organs (antennal glands) from 74 individual shrimps were examined for histopathologies. Since this organ is grossly indistinct, midsagittal sections of the anterior cephalothorax were taken to insure sample acquisition.

(1) *Normal Microscopic Features*—Excretory organs were tubular, being constructed of simple, cuboidal epithelium. Many of the cuboidal cells of this tissue were ruptured. This may have occurred during fixation. However, these organs were still suitable for histopathological study.

(2) *Histopathological Conditions*— Histopathologies were observed among 10% (7 of 74) of the excretory organs collected. There were a total of nine cases of the four types discussed below. The distribution of these histopathologies among sampling sites is presented in Table 35.

Focal aggregates of hemocytes were noted in 5% (4 of 75) of the green glands examined (Fig. 39C).

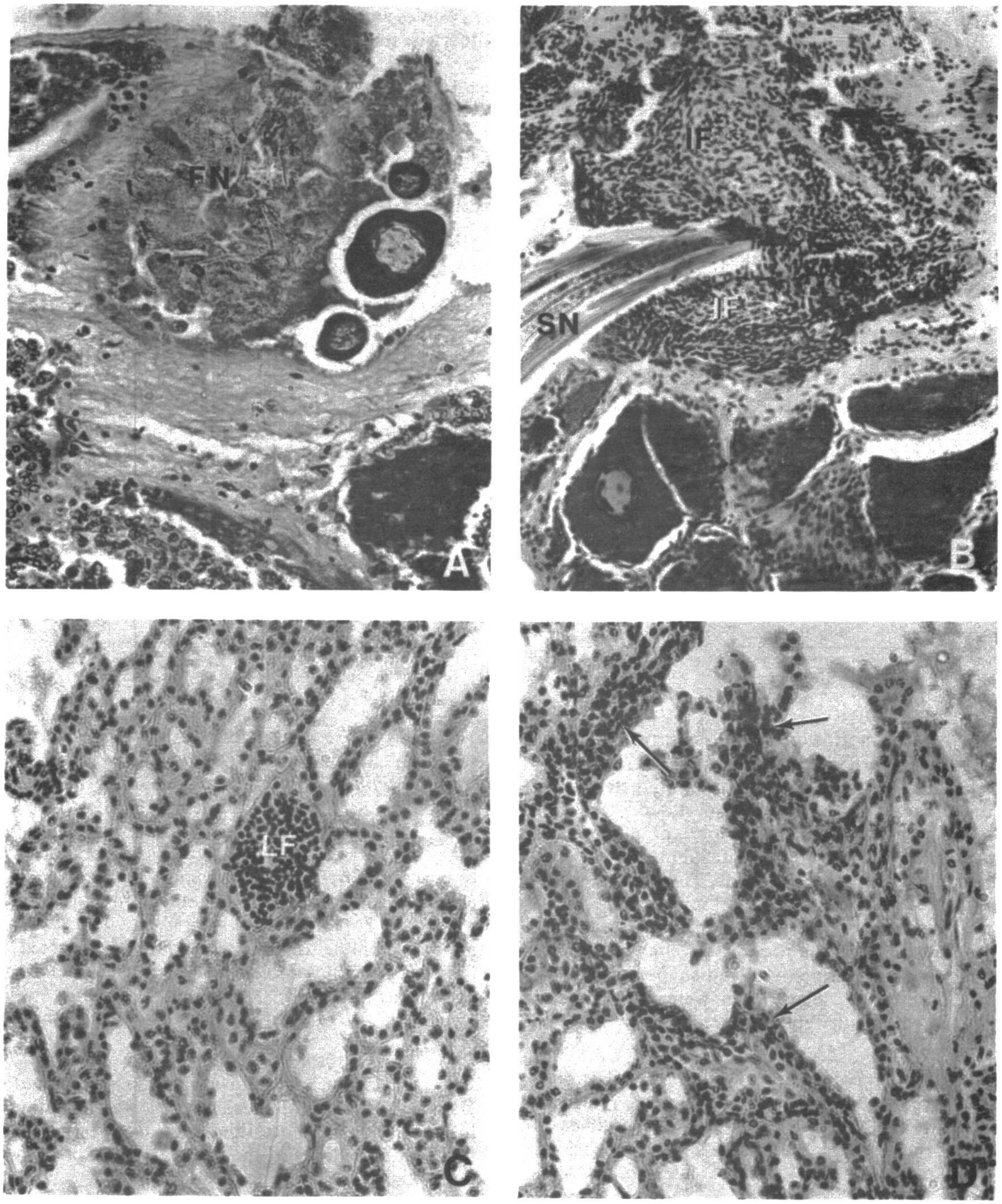

Fig. 39. Shrimp gonad (A&B) and excretory organ (C&D). A. *T. similis*. Focal necrosis (FN) in ovary. 340X. B. *P. aztecus*. Inflammatory response (IF) associated with a nematode symbioses (SN). 136X. C. *T. similis*. Focal aggregation of hemocytes (LF). 340X. D. *T. similis*. High concentration of hemocytes (arrow). 340X.

TABLE 34. Distribution of histopathologies of shrimp gonads among sampling sites. Each site represents 5 gonad samples unless otherwise noted.

	Site																							
Pathology	P1*	P2Δ	P3	P4	S5†	S6	S7	S8	S9+	S10*	S11*	S12*	S13	S14	S15	S16	S17	S18	S19*	S20*	C21*	C22	C23	C24*
Leucocytosis (focal)	--	--	--	1	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	1	2	--
Degeneration	--	--	--	--	--	2	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Leucocytosis (general)	--	--	--	--	--	--	--	--	--	--	--	--	1	1	--	--	--	--	--	--	--	--	--	--
Focal necrosis	--	--	--	--	--	--	--	1	--	--	--	--	--	--	--	--	--	--	--	--	--	1	--	--
Inflammation	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	1	--
Nematodes	--	--	--	--	--	1	3	1	1	--	--	--	1	--	1	--	--	--	--	--	--	--	2	--
Cestodes	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	1	--	--	--	--	--	--	--	--
Trematodes	--	--	--	--	--	--	1	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Total Number	--	0	0	1	0	3	4	2	1	--	--	--	2	1	1	1	0	0	--	--	--	2	5	--

*no shrimp collected.
†two gonad samples.
Δthree gonad samples.
+ four gonad samples.

TABLE 35. Distribution of histopathologies of shrimp excretory samples among sampling sites. Each site represents 5 excretory samples unless otherwise noted.

	Site																							
Pathology	P1*	P2	P3Δ	P4	S5	S6	S7	S8+	S9Δ	S10*	S11*	S12*	S13	S14	S15	S16	S17	S18+	S19*	S20*	C21*	C22	C23	C24*
Leucocytosis (focal)	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	1	2	1	--	--	--	--	--	--
Leucocytosis	--	--	--	--	--	--	--	--	--	--	--	--	1	--	--	--	--	1	--	--	--	--	--	--
Nematodes	--	--	--	--	--	--	1	1	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Unidentified helminth	--	--	--	--	--	--	--	--	--	--	--	--	1	--	--	--	--	--	--	--	--	--	--	--
Total Number	--	0	0	0	0	0	1	1	0	--	--	--	2	0	0	1	2	2	--	--	--	0	0	--

*no shrimp collected.
+ four excretory samples.
three excretory samples.

This condition was observed in both *P. aztecus* and *T. similis.*

High concentrations of hemocytes were observed in one *P. aztecus* and one *T. similis* (Fig. 39D). These were basophilic hemocytes in the latter.

Two types of symbioses were found in excretory organs. Immature nematodes infected two *P. aztecus*, and an unidentified helminth infected one *P. aztecus.*

f. Gill

Samples of gills to be histologically analyzed were collected from 79 individual shrimps. Gills were oriented (when possible) so as to present sections both parallel and perpendicular to the gill axis.

(1) Normal Microscopic Features— Shrimp gills possessed a central axis (branchial septum or rachis) from which numerous lamellae projected in a pinnate and opposite arrangement. The branchial epithelium was covered with a thin cuticle. Both lamellae and branchial septa had capacious hemal sinuses.

(2) Histopathological Conditions— Histopathologies were observed in 84% (66 of 79) of the gill samples analyzed. There were a total of 125 cases of the nine types of histopathologies discussed below. The distribution of these histopathologies among sampling sites is presented in Table 36.

Focal aggregates of hemocytes were found in 37% (29 of 79) of the gill samples collected. This condition occurred among all three shrimp species (Fig. 40A). These aggregates were often associated with accumulations of pigments (Fig. 40B), focal necroses and infestations of peritrichous ciliates.

Accumulations of pigments were noted in 25% (20 of 79) of the gill samples examined (Fig. 40B). This condition was incident in all shrimp species studied and often occurred concomitantly with focal hemocytoses and focal necroses. The pigments observed were dark brown on slides prepared in a hemotoxylin/eosin series.

Focal necroses were observed in 22% (17 of 79) of the gill samples, being present in all three of the shrimp species collected (Fig. 40C). These necroses were often accompanied by focal aggregates of hemocytes and accumulations of pigment.

Abnormally high concentrations of hemocytes were found in 4% (3 of 79) of the gill samples examined. This condition was incident in both *P. aztecus* and *P. setiferus.*

Degeneration was observed in 4% (3 of 79) of the gill samples analyzed, being incident in *P. aztecus* and *T. similis.* These particular gills were apparently in the initial stages of liquefaction, and the cytoplasm of the respiratory epithelium stained unevenly producing a mottled appearance.

Four types of symbioses were noted among gill samples. Infestations of peritrichous ciliates were incident in 58% (46 of 79) samples (Fig. 40D). They were found among 28 *P. aztecus*, 14 *T. similis*, and four *P. setiferus.* Unidentified protozoa were observed in five *P. aztecus.* One unidentified ectosymbiont and one unidentified helminth were each found in *P. aztecus.*

g. Heart

Heart samples from 75 individual shrimps were examined for histopathologies. Even though the heart was not a contractually required organ, cardiac

TABLE 36. Distribution of histopathologies of shrimp gills among sampling sites. Each site represents 5 gill samples unless otherwise noted.

	Site																							
Pathology	P1*	P2	P3	P4	S5	S6	S7	S8	S9	S10*	S11*	S12*	S13	S14	S15^{+}	S16	S17	S18	S19*	S20*	C21*	C22	C23	C24*
Leucocytosis (focal)	--	5	1	2	1	1	3	2	--	--	--	--	1	5	2	--	1	3	--	--	--	1	1	--
Pigment	--	4	1	--	1	--	2	2	1	--	--	--	1	1	--	1	2	--	--	--	--	1	3	--
Focal necrosis	--	4	1	1	1	--	1	4	1	--	--	--	--	--	--	--	--	--	--	--	--	1	3	--
Leucocytosis (general)	--	--	--	--	1	1	1	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Degeneration	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	2	1	--	--	--	--	--	--
Peritrichs	--	5	5	4	4	4	3	1	4	--	--	--	2	2	--	2	--	--	--	--	--	5	5	--
Unidentified protozoans	--	2	--	--	--	--	1	--	--	--	--	--	--	--	--	1	--	--	--	--	--	--	1	--
Unidentified Ectosymbiont	--	--	--	--	--	--	--	--	--	--	--	--	--	1	--	--	--	--	--	--	--	--	--	--
Unidentified helminth	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	1	--	--	--	--	--	--	--	--
Total Number	--	20	8	7	8	6	11	9	6	--	--	--	4	9	2	5	5	4	--	--	--	8	13	--

*no shrimp collected.

$^{+}$ four gill samples.

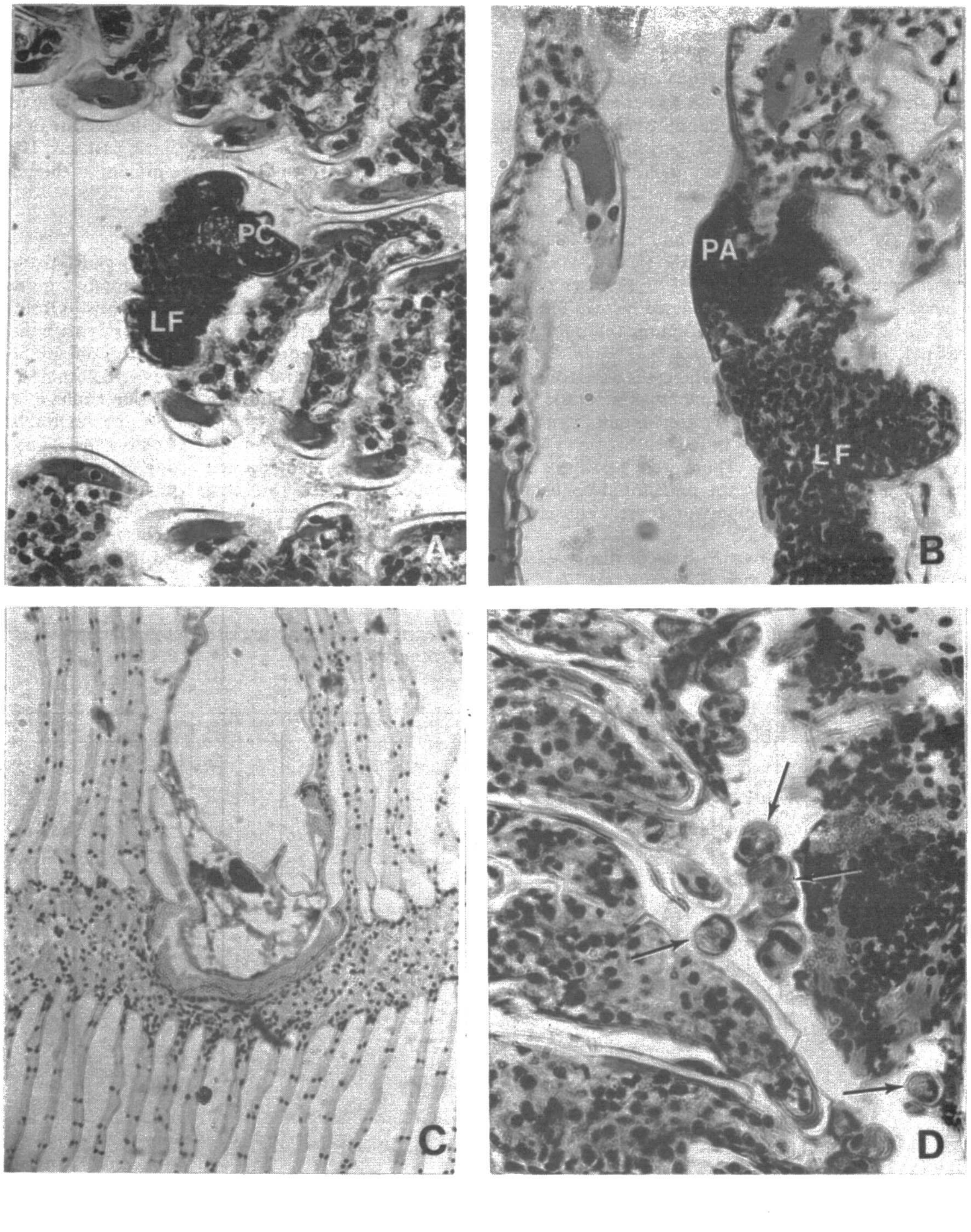

Fig. 40. Shrimp gill. A. *P. aztecus*. Focal aggregation of hemocytes (LF) associated with a ciliate (PC). 340X. B *P. aztecus*. Pigment accumulation (PA) associated with a focal aggregation of hemocytes (LF). 340X. C. *P. aztecus*. Focal necrosis. 136X. D. *P. aztecus*. Infestation of peritrichous ciliates (arrows). 340X.

analyses were included to broaden the histological characterization of the decapods collected.

(1) Normal Microscopic Features— The myocardium was composed of an anastomosis of striated muscle surrounded by a connective tissue sheath analagous to vertebrate visceral pericardium. Intrinsic neural structures were often included in cardiac sections.

(2) Histopathological Conditions— Histopathologies were observed among 16% (12 of 75) of the hearts examined. There was a total of 13 cases of the five types of histopathologies discussed below. The distribution of these histopathologies among sampling sites is presented in Table 37.

Focal aggregates of hemocytes were found in 9% (7 of 75) of the hearts examined (Fig. 41A). This condition was incident in both *P. aztecus* and *T. similis.*

Cysts were present in the hearts of one *P. aztecus* and one *P. setiferus.* These were relatively thin walled and were incident in the pericardial connective tissue (Fig. 41B). The etiology of these cysts is unknown.

The hearts of two *P. aztecus* displayed abnormally high concentrations of hemocytes. A focal necrosis was present in the heart of a single *P. aztecus* (Fig. 41C). Tubercle-like growths were observed in the heart of one *P. aztecus.* Constituent cells of the growth had intensly basophilic nuclei and intensly eosinophilic cytoplasm and were arranged in concentric patterns (Fig. 41D). There appeared to be degenerate or necrotic areas in the foci of these concentric patterns. High concentrations of hemocytes were present at the periphery of these growths.

h. Other Organs

As referred to above, organs, tissues, and structures other than those contractually required were included in histopathological sections. Observations were recorded from these concomitantly with the analyses of required organs. As previously mentioned, sections of the ventral nerve chord were common among muscle samples. Sections of major cephalic nervous structures were present in all of the sagittal sections prepared for analysis of excretory organs. Thus, observations were made on nervous tissues of most shrimps collected. Only two cases of histopathologies were found among the tissues so examined. Immature nematodes were incident in the hemocoels of two *P. aztecus,* and a larval trematode occurred in the perineural connective tissue of one *P. aztecus.*

TABLE 37. Distribution of histopathologies of shrimp hearts among sampling sites. Each site represents 5 cardiac samples unless otherwise noted.

	Site																							
Pathology	P1*	P2	P3	P4	S5+	S6	S7	S8	S9+	S10*	S11*	S12*	S13	S14	S15+	S16	S17	S18	S19*	S20*	C21*	C22Δ	C23	C24*
Leucocytosis (focal)	--	--	--	--	--	1	--	--	1	--	--	--	1	--	1	--	--	2	--	--	--	--	1	--
Cysts	--	--	--	--	1	1	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Leucocytosis (general)	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	2	--	--	--	--	--	--	--
Focal necrosis	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	1	--
Tubercle	--	--	--	--	--	--	--	--	--	--	--	--	--	1	--	--	--	--	--	--	--	--	--	--
Total Number	--	0	0	0	1	2	0	0	1	--	--	--	1	1	1	0	2	2	--	--	--	0	2	--

*no shrimp collected.
Δthree cardiac samples.
+ four cardiac samples.

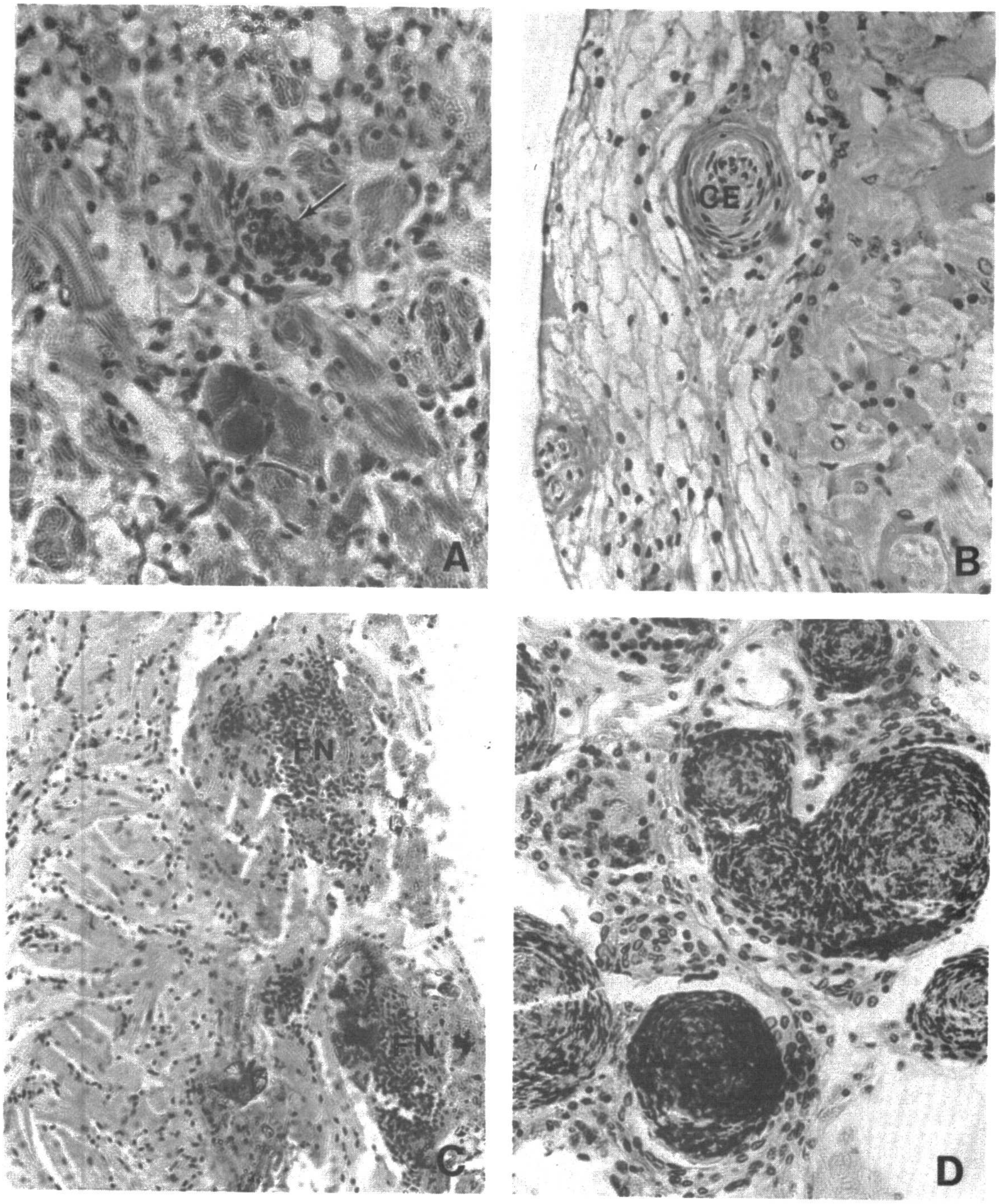

Fig. 41. Shrimp heart. A. *P. aztecus*. Focal aggregate of hemocytes (arrow). 340X. B. *P. setiferus*. Cyst (CE) in pericardial connective tissue. 340X. C. *P. aztecus*. Focal necrosis (FN). 136X. D. *P. aztecus*. Tubecle-like growths. 340X.

V. DISCUSSION

A. Vertebrates

The study design did not permit an ideal comparison between control and platform sites. Platforms act as an artificial reef habitat which in most instances attracts different species than the control sites without a platform. The unavailablity of the same benthic species at all sites necessitated the use of alternate sampling techniques at the platforms. This resulted in a variety of species being obtained from the different sites. The variability of species at all sites was compounded by cruises being taken during different seasons. Primary platform and control sites were sampled in the spring and secondary platform sites were sampled in the summer. The criteria for making comparisons are further complicated by the marked variation among the platforms and in their production practices. While the variability of species made it impossible to do statistical analysis, comparisons can be made between histopathological conditions in organs. It must be kept in mind that the averages of all species examined may not be representative of a given species.

Platform Sites P1, S11, and S6, strongly implicated as contaminated by hydrocarbons (Nulton et al., 1980) and/or trace metals (Tillery and Windom, 1980), occurred among the top six in total number of histopathological conditions (Table 38). All eight of the platform sites which ranked high in histopathological conditions (Table 39) were located in the eastern part of the study area (Fig. 42) and had spadefish as one of the species sampled (Table 39). Two of these eight platform sites (S10, S12) ranked low in effects of hydrocarbons (Table 39) and were "probably not" affected by trace metals.

TABLE 38. Ranking of collecting sites, based on the species and their average number of conditions per fish specimen.

Site	—	Species[1]	Average Number of Conditions
P1	—	W + X	= 19.5
S20	—	W + X	= 18.5
S10	—	W + X	= 17.0
S11	—	W + X	= 16.7
S12	—	W + X	= 16.3
S6	—	A + X	= 15.1
S13	—	A + X	= 15.0
S8	—	A + X	= 14.8
P3	—	C + S	= 14.0
S15	—	B + H	= 14.0
S17	—	B + H	= 13.5
S19	—	M + X	= 13.3
S18	—	C + X	= 13.1
P4	—	S + T	= 12.7
P2	—	A + M	= 12.6
S5	—	A + M	= 12.1
S9	—	A + B	= 11.2
C21	—	A + M	= 11.0
S14	—	T + X	= 10.9
C24	—	D + M	= 9.7
S16	—	H + T	= 8.7
C23	—	S + H	= 8.2
S7	—	B + T	= 6.7
C22	—	P + Q	= 6.5

[1] Refer to Table 1 for explanation of code.

The four control sites (C21, C22, C23, C24) occurred among the bottom seven in number of histopathological conditions (Table 38). All four ranked medium in effects of hydrocarbons (Table 39) and were "possibly" affected by trace metals. Three were located in the eastern and one in the western part of the study area (Fig. 42). Spadefish were not among the species sampled.

Two platform sites (S16, S7) which occurred among the bottom four in number of histopathological conditions (Table 38) ranked high in effects of hydrocarbons (Table 39). Site S7, "probably" affected by trace metals, was located in the eastern part of the study area and Site S16, "possibly" affected by trace metals, was located in the western part of the study area (Fig. 42).

In assessing the disparate information on the platform sites which ranked high in histopathological conditions, one must consider the fish species which showed the highest levels of histopathological conditions. During this study, the spadefish consistently had a high level of histopathologies. This may be due to the fact that the spadefish lives most of its adult life in association with a structure such as a production platform, or it may reflect a natural proclivity of this schooling species to acquire parasites and disease conditions.

All of the sites high in histopathological conditions were located in the eastern part of the study area, and all the sites in the western part of the study area ranked either medium or low in number of conditions.

Rankings and comparisons of condition frequencies are shown in Appendix B and Tables 38-43. The data presented in Table 40 summarize the number of conditions in each organ for each species at each site. There were 17 sites at which either fish specimens or organ samples were insufficient for an overall average analysis. In those cases where organ samples were incomplete, the average number of conditions per organ per species per site was calculated and the total average adjusted for a full complement of organs. These averages were not based on a pooled sample between species or within species across sites, with the two exceptions for gonads. For example, 1W, muscle = 2/4. This was adjusted to 3/5. Thus the average number of conditions (22) could be determined.

The gonads of two species were unavailable at Sites C21 and C22. In this case the gonad value (2.081) was based on the overall average number of conditions per gonad per fish. This gave 21M a gonad value of 10.4/5 and 22P a gonad value of 10.4/5. This allowed for an estimated average number of conditions per fish. These values were necessary to make comparisons between site catagories (primary, secondary, control) and to make correlations of hydrocarbon effects levels and levels of histopathological conditions.

The liver, gill, and gut contain 69% of the total histopathological conditions. Kidney and gonad contain 30% while muscle tissue is relatively free of disease and is affected only 1% of the time. Gills represent the respiratory system and gut the digestive system. Liver is the first order organ for storage of nutrients and detoxification of contaminants in the blood stream. These three organs should offer an index of health and status of the organism.

TABLE 39. Correlation of sites based on histopathologies in species and levels of indicated platform-related hydrocarbon effects.

Sites	Species	Histopathologic Levels	Hydrocarbon Effect Levels[Δ]
P1	Sheepshead & Spadefish	H[*]	H[+]
S6	Spadefish & Atlantic croaker	H	L[+]
S8	Spadefish & Atlantic croaker	H	M[+]
S10	Sheepshead & Spadefish	H	L
S11	Sheepshead & Spadefish	H	H
S12	Sheepshead & Spadefish	H	L
S13	Spadefish & Atlantic croaker	H	L
S20	Spadefish & Sheepshead	H	M
P2	Sea catfish & Atlantic croaker	M[*]	L
P3	Pinfish & Red snapper	M	L
P4	Pinfish & Mexican flounder	M	M
S5	Atlantic croaker & Sea catfish	M	M
S9	Atlantic croaker & Rock seabass	M	M
S14	Spadefish & Mexican flounder	M	L
S15	Longspine porgy & Rock seabass	M	M
S17	Longspine porgy & Rock seabass	M	M
S18	Spadefish & Red snapper	M	M
S19	Spadefish & Sea catfish	M	M
C21	Sea catfish & Atlantic croaker	M	M
S7	Rock seabass & Mexican flounder	L[*]	H
S16	Longspine porgy & Mexican flounder	L	H
C22	Rough scad & Batfish	L	L
C23	Longspine porgy & Pinfish	L	L
C24	Sand seatrout & Sea catfish	L	L

[Δ] Ecological Investigations of Petroleum Production Platforms in the Central Gulf of Mexico, Volume I: Pollutant Fate and Effects Studies, Part 3 - Organic Chemical Analysis, Draft Final Report, Page 91.

[*] Averaged number of histopathologic conditions. H = high (19.5 to 14.8), M = medium (14.0 to 10.9), L = low (9.7 to 6.5).

[+] H = high, M = medium, L = low.

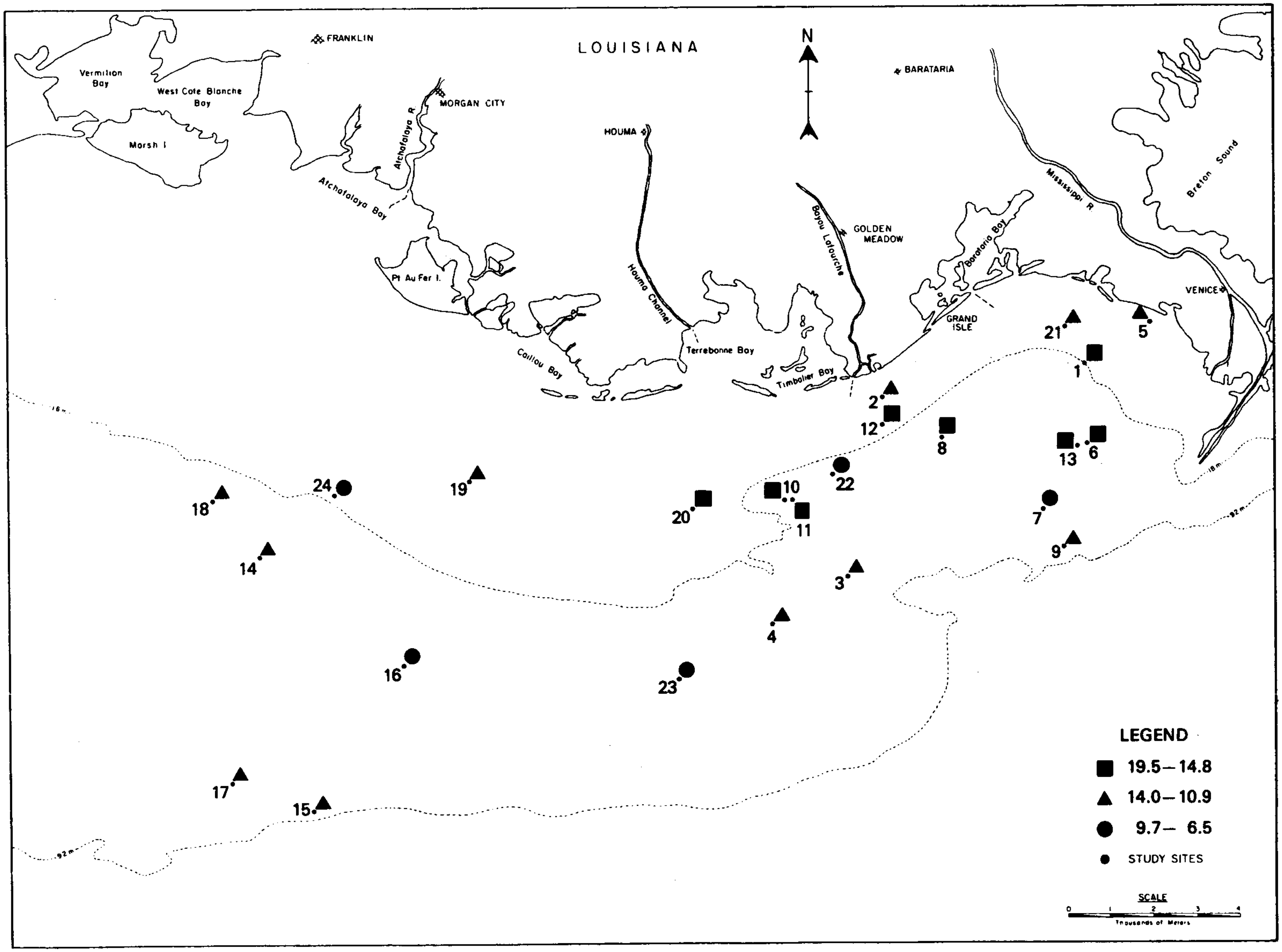
LOUISIANA
N
FRANKLIN
BARATARIA
Vermilion Bay
West Cote Blanche Bay
Marsh I
Atchafalaya R
MORGAN CITY
Atchafalaya Bay
Pt Au Fer I.
Caillou Bay
HOUMA
Houma Channel
Terrebonne Bay
Timbalier Bay
Bayou Lafourche
GOLDEN MEADOW
Barataria Bay
GRAND ISLE
Mississippi R
Breton Sound
VENICE
18m
92m
1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
17
18
19
20
21
22
23
24
LEGEND
■ 19.5–14.8
▲ 14.0–10.9
● 9.7– 6.5
● STUDY SITES
SCALE
0 1 2 3 4
Thousands of Meters

FIG. 42. Map of study sites showing average number* of conditions/fish specimen.

TABLE 40. Number of conditions for each organ of all fish at each site.

Site—Fish	Gut	Kidney	Gill	Liver	Muscle	Gonad	Total cond.	Avg. No. cond./ fish
P1—W[°]	21[+]	11	28	27	2/4[Δ]	20	109	*22.0
P1—X	20	13	30	18	0	4	85	17.0
P2—A	8	6	26	12	1	2/1	55	*12.6
P2—M	5	9	23	13	5/4	7	62	*12.6
P3—C	5	6	21	17	1	4/4	52	*11.0
P3—S	11/4	6/4	22/4	19/4	1/4	9/4	68	17.0
P4—S	15	7/3	25	25	0	11/3	83	*19.0
P4—T	9	6	10	3	0	3/4	31	* 6.4
S5—A	21	15	8	12	1	10	67	13.4
S5—M	11	6	10	14	1	12	54	10.8
S6—A	15	11	7	14	0	12	59	11.8
S6—X	23	12	20	28	0	9	92	18.4
S7—B	4	10	3	13	0	14	44	8.8
S7—T	9	8	4	0	0	2	23	4.6
S8—A	19	8	9	19	0	7	62	12.4
S8—X	22	16	12	22	0	14	86	17.2
S9—A	16	16	12	14	0	16	74	14.8
S9—B	5	10	4	10	0	9	38	7.6
S10—W	9/3	4/3	17/3	16/3	0/3	9/3	55	18.3
S10—X	23	16	18	16	0	6	79	15.8
S11—W	9	6	21	21	1	16	74	14.8
S11—X	22	16	13	25	1	16	93	18.6
S12—W	18	10	17	30	0	11	86	17.2
S12—X	18	14	15	23	0	7	77	15.4
S13—A	13	17	9	14	0	14	67	13.4
S13—X	19	19	12	24	0	9	83	16.6
S14—T	3	6/4	4	1	0	5	21	* 4.2
S14—X	25	8	17	28	0	10	88	17.6
S15—B	8	11	4	12	1	13	49	9.8
S15—H	18	16	13	27	1	13/4	88	*18.2
S16—H	9	9	11	4	0	4/2	37	* 8.6
S16—T	8	13	10	7	0	6	44	8.8
S17—B	10	11	9	13	0	10/4	53	*11.2
S17—H	16	16	11	24	0	12	79	15.8
S18—C	8	2/3	15	10	1	4	40	* 8.2
S18—X	25	14	10	28	0	13	90	18.0
S19—M	19	8	6	20	4	7	64	12.8
S19—X	25	14	10	28	0	16	69	13.8
S20—W	18	18	16	26	2	16	96	19.2
S20—X	24	15	14	23	0	13	89	17.8
C21—M	3	3/1	20	16	3	0/0[#]	45	*13.4
C21—A	15	7	8	4	0	9	43	8.6
C22—P	0/3	4/3	9/3	6/3	0/3	0/0[#]	19	8.3
C22—Q	8	0	8	3	0	4/4	23	* 4.8
C23—S	13	3/3	11	1	0	2/1	30	* 8.0
C23—H	8	9	16	1	0	6/4	40	* 8.4
C24—D	7	10/4	12	14	0	7	50	*10.6
C24—M	7	6	5	12	4	10	44	8.8
Total Cond.	639	477	639	741	30	433	2959	
No. Organs	235	223	235	235	233	208	1369	
Avg. No. Cond./Fish	2.719	2.139	2.719	3.153	0.128	2.081	2.161	
% Cond./Fish	22	16	22	25	1	14		

[+] Number of conditions observed per 5 organs.

[Δ] Number of conditions observed per number of organs.

[°] Refer to table 1 for explanation of Fish code.

*Adjusted value, assuming equal numbers of each organ.

[#] Numerator adjusted to average value of gonad for all species.

In Table 41 a comparison of site categories shows the total average number of conditions for each organ. Overall, the four primary sites gave higher average conditions than the four control and 16 secondary sites. Gill conditions ranked the highest of all the organs in the control and primary sites. But, in the secondary sites gill conditions were comparable to control sites.

TABLE 41. Site comparisons of condition frequencies in fish organs.

	Control Sites		Primary Sites		Secondary Sites	
Organs	Cond./no. organs = avg.	% total cond.	Cond./no. organs = avg.	% total cond.	Cond./no. organs = avg.	% total cond.
Gut	61/38 = 1.61	20.7	94/39 = 2.41	17.2	484/158 = 3.06	22.9
Kidney	42/31 = 1.35	14.3	64/37 = 1.73	11.7	371/155 = 2.39	17.5
Gill	89/38 = 2.34	30.3	185/39 = 4.74	33.8	365/158 = 2.31	17.2
Liver	57/38 = 1.50	19.4	134/39 = 3.44	24.5	550/158 = 3.48	25.9
Muscle	7/38 = 0.18	2.4	10/37 = 0.27	1.8	13/158 = 0.08	0.6
Gonad	38/24 = 1.58	12.9	60/31 = 1.94	10.9	335/153 = 2.19	15.8
TOTALS	294/207 = 1.42		547/222 = 2.46		2118/940 = 2.25	

The liver had more than twice as many conditions per organ in the primary and secondary sites than the controls. This may reflect a toxic effect of environmentally contaminated food products available to fish. Likewise the gut shows more histopathology in the primary and secondary sites as compared to the control sites. It might be speculated that hydrocarbon contaminated food in the gut could have a deleterious effect, manifested by inflammatory changes in the gut wall.

The kidney averaged more conditions per organ in the secondary sites than the primary or control sites. This excretory organ may be indirectly affected by pollutants which enter the blood stream and glomeruli and become incorporated into the ultrafiltrate of the kidney, thereby influencing the tubular system and vascular rete. Data from studies on hydrocarbons' effect on the kidney are practically nonexistent, therefore this remains speculation.

The gonads showed higher numbers of conditions per organ in the primary and secondary sites as compared to the controls, 1.9, 2.2 and 1.6, respectively. Numerous factors affect gonadal functions so that histological changes such as atretic ova, regenerations and degeneration could well be attributed to either environmental, seasonal or hormonal changes. Fish that are chronically stressed due to hydrocarbon pollution may not demonstrate normal cyclic gonadal changes.

Individual species of fish at collecting sites were ranked in Table 42 in a descending order of frequency based on the average number of conditions per fish. Species with incomplete organ samples were adjusted as previously mentioned for Table 40.

Several species have a broad range of average numbers of conditions depending on the capture site. Sheepshead and spadefish from numerous sites were relatively high in histopathological conditions and ranked in the upper half. However, none were caught at control sites. Longspine porgy and pinfish presented high, medium and low conditions at three sites which reflect site differences. Pinfish presented high, medium and low conditions at two primary and one control site, respectively. This suggests that the sites where pinfish and longspine porgy were obtained may have a major influence on the health of these fish. Site C23 for both species represented a low condition environment for these fish. Other species analyzed from this site would help to verify the status of Site C23. The Atlantic croaker contained a moderate number of conditions at six primary and secondary sites and a relatively low number at the control sites. Also, rock sea bass from four sites showed a medium to low number of conditions.

Sea catfish from Site C21 had more conditions than those from Sites S19, P2 and S8, while control Site C24 showed a low number of conditions per fish. This suggests a cleaner environment at Site C24 than Site C21. Mexican flounder from three secondary sites had medium to low numbers of conditions.

The 24 collecting sites and their two species were ranked in Table 38 according to the average number of conditions per specimen. The values for missing organs in some fish were adjusted as mentioned for Table 40. The collecting sites were separated into three groups based on a high, medium, or low average number of conditions per fish specimen and charted on a map of study sites (Fig. 42). Seven secondary sites and one primary site in the northeast region of the study area contained fish with the highest average number of histopathological conditions. Three species comprise this group—sheepshead, spadefish and Atlantic croaker. In this same general vicinity is Site C22, but it was represented by two other species of fish. Site C22 is an open water area where sheepshead and spadefish were not found since they are platform-associated fish.

Sites with a medium average number of conditions consisted of three primaries, seven secondaries, and one control. Three sites were nearer the north and east coastline, three were southerly and the other five were westerly. A total of eight species represented these sites, two of which were Atlantic croaker and spadefish.

The sites with low conditions consisted of three control sites and two secondary sites. Eight species were collected from these five sites which were widely scattered throughout the area of study. Mexican flounder was caught at three of the low condition sites.

Table 43 lists the species, sites of capture and the average number of conditions per fish. Species comparisons and site comparisons (Table 38) show the

TABLE 42. Ranking of the species based on average number of conditions/ fish specimen at sites indicated.

Species	—	Site	Average Number of Conditions
Sheepshead	—	P1	22.0
Sheepshead	—	S20	19.2
Pinfish	—	P4	19.0
Spadefish	—	S11	18.6
Spadefish	—	S6	18.4
Sheepshead	—	S10	18.3
Longspine porgy	—	S15	18.2
Spadefish	—	S18	18.0
Spadefish	—	S20	17.8
Spadefish	—	S14	17.6
Spadefish	—	S8	17.2
Sheepshead	—	S12	17.2
Spadefish	—	P1	17.0
Pinfish	—	P3	17.0
Spadefish	—	S13	16.6
Spadefish	—	S10	15.8
Longspine porgy	—	S17	15.8
Spadefish	—	S12	15.4
Sheepshead	—	S11	14.8
Atlantic croaker	—	S9	14.8
Spadefish	—	S19	13.8
Atlantic croaker	—	S5	13.4
Atlantic croaker	—	S13	13.4
Sea catfish	—	C21	13.4
Sea catfish	—	S19	12.8
Sea catfish	—	P2	12.6
Atlantic croaker	—	P2	12.6
Atlantic croaker	—	S8	12.4
Atlantic croaker	—	S6	11.8
Rock sea bass	—	S17	11.2
Red snapper	—	P3	11.0
Sea catfish	—	S5	10.8
Sand seatrout	—	C24	10.6
Rock sea bass	—	S15	9.8
Rock sea bass	—	S7	8.8
Sea catfish	—	C24	8.8
Mexican flounder	—	S16	8.8
Longspine porgy	—	S16	8.6
Atlantic croaker	—	C21	8.6
Longspine porgy	—	C23	8.4
Rough scad	—	C22	8.3
Red snapper	—	S18	8.2
Pinfish	—	C23	8.0
Rock sea bass	—	S9	7.6
Mexican flounder	—	P4	6.4
Batfish	—	C22	4.8
Mexican flounder	—	S7	4.6
Mexican flounder	—	S14	4.2

TABLE 43. Ranking of the species based on the average number of conditions for each fish per species.

Species	Collecting Sites	No. of Fish	Average Number of Conditions/Fish
Sheepshead	P1, S10, S11, S12, S20	23	18.3
Spadefish	P1, S6, S8, S10, S11, S12 S13, S14, S18, S19, S20	55	16.9
Longspine porgy	S15, S16, S17, C23	20	12.7
Atlantic croaker	P2, S5, S6, S8, S9, S13, C21	35	12.4
Sea catfish	P2, S5, S19, C21, C24	25	11.6
Pinfish	P3, P4, C23	14	11.3
Sand seatrout	C24	5	10.6
Red snapper	P3, S18	10	9.6
Rock sea bass	S7, S9, S15, S17	20	9.3
Rough scad	C22	3	8.3
Mexican flounder	P4, S7, S14, S16	20	6.0
Batfish	C22	5	4.8

interdependence of the two species, sheepshead and spadefish, at Sites P1, S10, S11, S12 and S20. Low numbers of fish at Site C22 and the adjustment of the overall average value (explained for Table 40) for the inadequate organ samples show these fish to have few conditions. Mexican flounder, captured at four sites, has a relatively low average number of conditions per fish.

Appendix B compares the study site with the number of times each condition occurs in an organ, for each species of fish. Fish caught at the primary, secondary, and control sites were Atlantic croaker and sea catfish. Overall, fewer conditions occurred in the Atlantic croaker at control Site C21 than primary or secondary sites. The histological conditions in organs vary at the different sites. For instance, the gill and liver have more conditions in the primary site than at the control site while the stomach shows the reverse situation (Table 41). Table 44 summarizes the types and frequencies of occurrence of the various conditions found for each organ. Leucocytic infiltration (LL), acidophilic cells (AC), and chromatophore pigmentation (HC) are the most frequently occurring conditions in the organs (Table 44). These three conditions, in general, are present in more fish at secondary sites than either primary or control sites. However, each organ has its own specific histopathologies which may more accurately reflect the overall status of the organ.

Other species-site comparisons were: secondary; control and secondary; control; primary and control; and primary and secondary. Spadefish from Site S19 were small fish (fingerlings) and showed fewer conditions than larger fish at the other sites. Spadefish from Site S19 had chromatophores in only one liver but not in stomachs. This contrasts greatly with the larger spadefish at other sites.

The five red snappers at Site P3 had more conditions than those at Site S18, primarily due to the kidney, gill and liver.

The longspine porgy had twice as many organs with conditions at Site S15 than at control Site C23. The stomach had cysts, a helminth and leucocytic inflammation; kidneys had xenomas; liver contained fibrotic liver ducts, pigment, mononuclear leucocytes, fat, and parasites; muscle contained protozoa; and the gonads demonstrated degeneration, pigmentation and focal leucocytosis, which was not seen in any of the control site organs.

The pinfish at the primary sites contained more than twice the number of affected organs as compared to the control site. All organs, especially kidney, gill, liver and gonad, showed major differences in numbers of conditions.

At Site S7 the Mexican flounder had a condition-free liver and muscle, and only one gill condition. Site S14 showed an overall reduced number of involved organs, especially stomach, kidney and liver. Table 44 lists the number of organs which contained histopathological conditions. For example, 136 of the 235 stomachs contained acidophilic granular cells. There was a total of 639 stomach conditions. These data also compare the condition-organ frequency studies. There were three conditions of the 31 total that were common to all organs while 11 rare conditions were seen in one to three organs. The gill demonstrated the widest variety of conditions while muscle demonstrated only two types of conditions.

The study sites, species and their average number of conditions are listed in Table 39 against the hydrocarbon effect levels for each site (see Vol. I, Part 3, p. 176). The average number of conditions, arranged in descending order of frequency in Table 38, was divided into high (19.5 to 14.8), medium (14.0 to 10.9) and low (9.7 to 6.5) values or levels.[1] These data suggest that there is an influence of hydrocarbons on the fish in terms of the histopathological conditions observed.

1. Muscle

Muscle had few lesions and those found were parasitic. While the host may sustain a certain parasitic load without immediate life threat, some investigators (Bauer, 1959) note that any parasitism, however slight

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[1] A contingency coefficient was computed between scores (H,M,L) on the two sets of categories, level of histopathologic conditions and hydrocarbon effects level. The contingency coefficient is a measure of the extent of association or relation between two sets of attributes. The chi-square test applied to these values demonstrated a significant correlation (4 d.f., $\chi^2 = 8.47$) at the .08 level (4 d.f., $\chi^2 = 8.46$).

TABLE 44. Number of organs containing histologic conditions.

Histopathologic Conditions	No. of Organs Examined	235	223	235	235	233	208
	Organs	Stomach	Kidney	Gill	Liver	Muscle	Gonad
Acidophilic granular cells		136	82	109	110		131
Atretic ova							75
Biliary duct fibrosis					138		
Encapsulated cysts		129		2	22		8
Degeneration					55		39
Edema				63			
Glomerular sclerosis			2				
Hyperplasia of arterial endothelium			2				
Chromatophores		65	194	2	160		113
Hyperplasia				23			
Involution							3
General leucocytosis							5
Focal leucocytosis							38
Leucocytic infiltration		131		151	120		5
Lipid accumulation					74		
Macrophage infiltration							1
Mucous cells				72			
Protozoan ciliates				4			
Protozoa-encapsulation			28	7		27	
Protozoa in tubular lumen			1				
Protozoa in lining of mesonephric duct			116				
Protozoa		127		49	49		6
Regeneration							5
Copepod symbiosis				18			
Nematode symbiosis			4				
Helminths		49	28	13	13	3	4
Trematode symbiosis				13			
Myxosporidian symbiosis				9			
Tubular degeneration			8				
Vascular congestion		2		104			
Xenoma			12				
Total conditions		639	477	639	741	30	433

quantitatively, negatively affects its host and thus is pathogenic. To the extent that unfavorable environmental stresses weaken the host and thereby enhance its susceptibility to parasitic assault, parasitic lesions seem logical indicators of such stress.

The incidences of encapsulated protozoa for the three categories (controls 18%, primaries 22%, secondaries 7%) examined in this study must be viewed with caution and may be misleading when considered apart from other variables which undoubtedly influence them. One such variable might be the representation of any given species relative to the total specimens examined. For example, of the 38 tissues examined at the control sites, 10 were of sea catfish. Seven of these 10 had protozoan lesions. None of the other species examined at these sites had protozoa. At the primary sites, four of the 36 tissues were from sea catfish. All four had protozoan lesions (half of the protozoan complement for these sites). Among the secondary sites, only 10 of the 158 tissues were from sea catfish, yet protozoan lesions were found in five of these 10 (out of the 11 total tissues containing protozoa). Thus it appears that certain species (e.g., sea catfish) are more likely to contain this lesion than are others. A disproportionate use of the sea catfish in one test group will yield a likewise disproportionate number of such lesions.

Obviously, then, maintaining species constancy among test sites becomes important in the reduction of this variable and would expedite valid correlations between sites. Further, size constancy within a collected species would be another important aspect of variable control.

In general, the rarity of parasitic lesions in the muscle tissues examined (even in those specimens evidencing more overt parasitism among other organs) suggests that in most species, muscle is less valuable than other tissues for evaluation of pathologic conditions.

2. Liver

Symbiont and nonsymbiont liver conditions in the 12 species of fish studied reflected pathologic responses to various noxious agents. Symbionts were examined in a previous baseline study by Haensly and Shively (1977), who concluded that the stomach and liver had the highest incidence of lesions in the 10 species examined. In our study, helminths and protozoa were present but generally were less frequent. Since the rodlet cell, a component of the biliary epithelium, was included in the protozoan category, the frequency of symbiosis per liver specimen increased. Morrison and Odense (1978) reported that the rodlet cell may be a normal cell rather than a protozoan. We could not determine whether the rodlet cell was a normal, specialized cell of the epithelium or a protozoan. Sheepshead from Sites P1, S12, and S20 had the highest incidence of liver symbionts. This may have been due partly to age of the fish (a reflection of length) and partly to feeding activity around the infrastructure of oil producing platforms.

Organic material exposed to noxious chemical compounds in the ocean and taken in as food will affect hepatic tissue. Roberts (1975*b*) reported that responses of the liver to bacteria, viruses, chemicals, and symbionts include increased mononuclear leukocytic infiltration and phagocytosis.

The cytoplasm of hepatic parenchymal cells varied among fishes in degree of vacuolation, granularity, and staining intensity. This was probably due to many factors, including postmortem changes, decompression influences, dissection and fixation times, methods of animal collection (trawling, spearing, hooking), species, age, season and sex. Thus, no reliable, consistent criteria could be established to identify pathological conditions in the cytoplasm.

Acidophilic granular cells were seen in most fish and were very numerous in some. Roberts (1975*b*) suggested that acidophilic granular cells may be mast cells and that their presence may mark the first change in a fibrosis formation. He also conducted systematic analyses to determine what correlation, if any, exists between acidophilic granular cells, their incidence, and symbiosis. However, these cells were present as often as they were absent in the capsules or granulomas of symbionts; so the symbiont, depending on its degenerative stage and type, may produce various host responses. On the other hand, acidophilic cells may respond to other agents and their simultaneous response to symbionts may be incidental.

Acidophilic cells also tended to be related to the chromatophores, particularly during the formative stages of a melanin-macrophage center around blood vessels, bile ducts, or hepatopancreas. Roberts (1975*a*) indicated that degree of pigmentation depended on the species, age, and state of health of the fish. Melanin, purine, and pteridine pigments are thought to be derived from melanophores, iridophores, and erythrophores, respectively (Bagnara et al., 1979). Pigment mixtures in the three kinds of chromatophores may depend on whether both Golgi apparatus and endoplasmic reticulum are involved in pigment formation. Accordingly, acidophilic granular cells appeared to represent an early response either prior to or in association with chromatophores of the melanin- macrophage system. In several fish in which myxosporidia were found throughout the liver, various stages of chromatophore pigmentation were associated with these protozoa. In the large protozoan clusters, variously colored pigments, including melanin granules, were dispersed between the protozoa. The entire protozoan-chromatophore cluster was surrounded by an inconspicuous capsule. In other areas of the liver parenchyma there were few protozoa without associated pigment or a capsule. Carefully controlled laboratory experiments are needed for study of both acidophils and chromatophores in relation to fish age, phagocytosis, and disease in those species known to show acidophilic granular cell responses.

The layering of fat cells around the liver of larger fish was probably a function of age. This was apparent in spadefish; larger fish had fat-encased and fat-infiltrated livers, while the smaller spadefish were fat free. Accumulation of fat did not appear to represent lipidosis, for marginal hepatic cells looked like the rest of the liver parenchyma. Hepatopancreas was also enveloped by fat and appeared compressed, although no degenerated tissue or inflammatory responses were present. While various fish showed varying degrees of extrahepatic and intrahepatic accumulation of fat, this fat seems to be stored fuel, perhaps due to excessive food consumption.

3. Gut

Normal histological features of the digestive tract of various species of fish have been described by numerous investigators, including Blake (1930), Rogick (1937), Ashley (1975), Ciullo (1975), and Sis et al. (1979). Haensly and Shively (1977) described normal and pathological features of the stomach in 10 species of fish from the southern Gulf of Mexico. In the present study, all fish except rough scad had symbionts, cysts, or granulomas.

We characterized rodlet cells as protozoa, although Morrison and Odense (1978) believe they are normal cells of the epithelium. Ciullo (1975) noted the differences in staining intensity of the rodlet cells and suggested that they may have different physiological states or that there are different species of rodlet cells.

Acidophilic granular cells varied greatly in number and location in the stomach and anterior intestine. In the stoneroller sucker, Ashley (1975) defined a granular layer of mast cells or tissue eosinophilia in the gut submucosa. Roberts (1975*b*) said that a large increase in the number of acidophilic granular cells (mast cells) was the initial change in a replacement fibrosis that is more obvious in certain species. Ciullo (1975) studied granular cells in the common mummichog and noted density variations throughout the layers of the gut. These cells were alkaline phosphatase positive and the granules had a protein core enveloped by a lipid-phospholipid shell and a trace of nonacid mucopolysaccharides. They stained pink with buffered azure-eosinate at a pH of 3.5-5.5 and were unstained at pH 6-6.6. In the white sucker, Charcharn and Bullock (1967) found the granules light pink at pH 4 and blue at pH 5. Ciullo (1975) said that the granular cells in the epithelium and submucosa of the mummichog were similar and that the granular cells of the epithelium were derived from the submucosa. Results from the present study showed variations among the 12 species in granular cell density, in stain intensity or affinity, and in gut wall location. These granular cells appeared similar to those described by Ciullo (1975) and others. The acidophilic granular cells may be a type of fish mast cell which responds to nutritional (health) and symbiont (pathologic) conditions.

4. Gonad

Since there is only limited information on the gonad morphology of fish used in this investigation, these fish were described and compared in terms of the descriptions for other fish (Ahsan, 1966; Braekevelt and McMillan, 1967; Brylinska and Dlugosz, 1970; Bieniarz and Epler, 1976; Fuller and Scott, 1976; Campbell, 1977; Bhatti and Al-Daham, 1978; Htun-Han, 1978; Smith, 1978; Van den Hurk et al., 1978; Whitehead, Bromage, and Forster, 1978; Wootton, Evans, and Mills, 1978). Basic mammalian ovarian and histological terms were also used. Of the six stages used to describe the spermatogenic cycle of *Barkus luteus* (Bhatti and Al-Daham, 1978), four were selected to describe the male testicular cycle in this study. Six stages were used to describe the ovarian cycle in *Limanda limanda* (Htun-Han, 1978) but only four were used in this investigation.

Spawning times in different species vary from spring in *Cyprinus carpio* (Bieniarz and Epler, 1976) to summer in *Gasterosteus aculeatus* (Wootton et al., 1978), to fall and winter in *Salmo trutte* (Campbell, 1977). In fish used in this investigation, spawning took place in summer and fall in two species, rock sea bass and pinfish; and in spring or spring and early summer in six species: rough scad, longspine porgy, sand seatrout, sheepshead, sea catfish, and spadefish.

The spawning time was not determined in batfish or fringe flounder. Gonads from control site fish were normal for the time of year, except in Atlantic croaker from Site C21 caught during September. In these fish, both ovaries and testes were degenerated and contained numerous acidophilic cells. They should have been in a middle to late developmental phase since spawning takes place during fall and winter in this species. Primary site specimens caught in May or June were as expected, as were secondary site specimens caught in August-September. Testes from sea catfish were in an early regenerative phase, while ovaries from the same species contained many mature follicles. Since this species spawns in June and July, by August these fish should have been degenerated or involuted. Other fish taken at the same site had typical morphology for that time of year. At Site S11, both ovaries and testes of sheepshead were in an early regenerative phase. They were expected to be involuted since this species usually spawns in the spring. A similar condition was noted in longspine porgy caught at Sites S16 and S17.

Some of the pathological conditions observed in the gonads of the fish studied were observed in fish from every site. Acidophilic cells and chromatophores were most common, with focal leukocytosis third most common. These conditions were more commonly observed in specimens undergoing or in a state of involution. Parasitism was minimal in fish gonads. In at least some cases the parasites were on the capsule only and were not invasive. These may have been from adjacent organs and may have been secondarily attached to and growing on the ovarian and testicular capsule or hilar tissues.

Other than the few differences already discussed, no particular collection site or species of fish was more affected than another.

There have been a number of investigations into the effect on fish of various toxic substances such as arsenic, lead, mercury, and selenium (Weir and Hine, 1970); oil refinery effluents (Jenkins, 1964); cadmium, copper, mercury, zinc, and the chlorinated pesticide methoxichlor on estuarine and marine teleosts (Gardner, 1975); petroleum dissolved in sea water (Gruger et al., 1977); mixtures of copper, phenol, zinc and nickel (Brown and Dalton, 1970); and salts of the heavy metals, cadmium, copper, zinc, nickel, and lead (Pickering and Henderson, 1966). These studies involved the effects of pollutants on behavior, physiology, or morphology but did not include those on reproduction or the reproductive organs. Similar long-term investigations of the effects of these pollutants on reproduction need to be done.

5. Kidney

Conditions reported for the fish kidney include chromatophores, protozoa, helminths, xenomas, acidophilic granular cells, hyperplasia of arterial endothelium, and tubular degeneration.

Chromatophores were designated as pigment containing cells in accordance with Bagnara et al. (1979). This term does not indicate the specific pigment involved, however. For further clarification, kidney sections of one specimen of sheepshead were subjected to a melanin bleach procedure and a variety of staining techniques designed to demonstrate hemosiderin, ferrous iron, ferric iron, and hemofuchsin. Results showed the pigment to be predominantly (perhaps entirely) melanin. Since these techniques were used only on one species (sheepshead), a generalization cannot be made for other species. However, morphological characteristics imply that the chromatophores reported represent the "melanin-macrophage systems" described by Roberts (1975*a*). Herein lies the possible significance of this condition in histological assessments. Should the cells containing melanin possess macrophage capabilities, their activity might reflect an insult to the tissue requiring the phagocytic process. The pigment (presumably melanin) within the cytoplasm of the macrophages serves then as a marker for the position of these phagocytic cells.

By and large these melanin-macrophage systems appeared to be inactive, with the clusters distributed randomly throughout the parenchyma. In some cases, however, the pigment was within a capsule enclosing a foreign invader (protozoa, helminth, fungi, or bacteria). In still more extreme situations, pigment entirely filled the space within a capsule (Fig. 14B). The macrophages containing melanin may be involved in a "clean up" process against the invading organism(s), continually penetrating the surrounding capsule until they fill the space and break down its contents. Should this be the case, the most significant pigment for pathological evaluation would be that found in association with foreign invasion and/or the surrounding capsule. This study, however, reported quantitative estimates for the melanin- macrophage systems as a whole, including the apparently inactive clusters, since the number of such systems developing may reflect the need by the host for such accumulations (e.g., in response to foreign insult).

Overall, chromatophores were the most frequently observed condition for all three test groups (controls, primaries, and secondaries—for which the incidence levels were 84%, 63%, and 93%, respectively). Variation in these percentages can perhaps be attributed to species difference between sites. That is, pigment levels were more constant within species than between species. Thus, since several of the species used at the primary sites were those which were characteristically low for pigment, chromatophore quantities for these sites were decreased.

Parasitism was the second most commonly observed condition. In general, the host response to parasitic invasion seemed very slight. A degree of parasitism may be well tolerated by these fish species. However, as noted by Bauer (1959), parasitic invasion is foreign and creates stress for the host which may increase as the host is exposed to other stress factors in the environment.

For this reason, parasitic lesions seem valid indicators of health. Of the three forms of protozoa found, those in the lining of the mesonephric duct were most frequent. This form is difficult to interpret, however. Traditionally, it has been identified as the protozoan, *Rhabdospora thelohani* (Bannister, 1966; Flood, Nigrelli, and Gennaro, 1975; Morrison and Odense, 1978). More recently, several investigators have suggested that it is not a parasite at all but rather a host cell which has been termed the "rodlet cell" (Morrison and Odense, 1978). Until the status of this cell is clarified, its role in histological evaluations remains tenuous. The traditional interpretation has been used in this study pending research findings which could alter the status of this condition.

Incidences for mesonephric duct protozoa were: at the control sites, 16%; at the primary sites, 25%; at the secondary sites, 63%. Part of this difference could be due, as suggested for chromatophores, to differential use of species among the sites.

Encapsulated protozoa within the parenchyma were less frequent overall. None were found among the controls, while at the primary and secondary sites the incidences were 31% and 12%, respectively. As with other conditions, lack of species constancy between sites and the small number of controls necessitate caution in interpreting incidences.

Protozoa were found within an arterial lumen in only one specimen and thus there can be no site comparisons.

Helminths were the least common of the parasitic invaders observed but were found to some extent among all three test sites (control, primary, and secondary). Incidences were 10% for the controls, 22% for the primaries, and 13% for the secondaries. These figures seem to indicate a greater helminth load among the noncontrols and, in absolute numbers of such conditions, this is the case. But there are problems in interpretation. For example, it is difficult to compare the data of control and primary sites. While both contained similar numbers of specimens for examination, half of the helminth conditions found in the primaries occurred in two species which were not available for evaluation at the controls. Furthermore, the incidence for the secondaries (13%) is likely to be more accurate since the sample size was approximately 4.5 times that of either primaries or controls. As a result, the 3% difference between the controls and secondaries seems less important. The two sites containing the highest number of helminths (1 and 13) are also among those with high concentrations of total hydrocarbons (50 μg/g). On the other hand, there are other sites of high hydrocarbon content which had a very low incidence of helminths.

Xenomas have been said to represent excessive encapsulation responses to protozoan invaders (Haensly and Shively, 1977) (Fig. 15C). Generally, the type of organism contained within the encapsulation could not be identified. However, to the extent that encapsulated protozoa are found, this condition adds to the protozoan complement mentioned earlier.

Xenoma was a relatively rare condition, with incidences of 3% for the controls, 0% for the primaries, and 8% for the secondaries. The condition seemed to be much more frequent among some species (e.g., fringe flounder and longspine porgy) than among others. The greater use of these two species in the secondary site group may account for the incidence there.

It is interesting to examine the incidence of parasitism as a single category by totaling, for each site, the different parasitic conditions described. However, an initial difficulty is the decision to include or exclude the protozoa of the mesonephric duct since several investigators, as previously mentioned, view these as normal host cells. Additionally, the occurrence of xenomas seemed highly dependent upon the species collected. Therefore, several analyses of the data were conducted using different combinations of parasitic conditions to compute a total which was then used in a site ranking.

Regardless of the approach used in parasitic analysis, it is interesting to note the consistency with which Sites P1, S6, S9, S13, and S20 have high incidences, while Sites S14, C21, C22, C23, and C24 tend generally toward the lower range of incidence. This is true in absolute terms when all five possible parasitic conditions are totaled. Site S15 varied a great deal with different analytical approaches, perhaps because only mesonephric duct protozoa and xenomas were found there.

But there is at least one other major variable which advises caution in interpretations: the variation in species used from the different sites. Thus, the greater use of spadefish at sites of high incidence might explain to some extent the lower incidence among the other sites mentioned. Further study using the same species at all sites would help clarify this situation.

The origin, nature, and function of acidophilic granular cells have not been defined. Suggestions as to their analogues in mammals include plasma cells, mast cells, and eosinophilic white blood cells. To the extent that they may represent tissue response cells, their presence or accumulation could have significance in histological evaluations.

Incidence rates for the control, primary, and secondary sites were 19%, 6%, and 48%, respectively. No particular pattern of occurrence emerged. While there were variations between species there were also marked differences within them, even at the same site.

Tubular degeneration and hyperplasia of the arterial endothelium were rare conditions overall. While both are interesting lesions as potential environmental evaluators, their scarcity in this study negates their usefulness for correlations. It is perhaps of value as an aid to further study, however, to note the tendency toward species specificity of these lesions. Tubular degeneration tended to occur in sea catfish, although it was also found in Atlantic croaker and spadefish. Arterial hyperplasia was found in only two specimens, both spadefish.

6. Gill

The most notable gill condition was parasitism, which could not be correlated with the proximity of oil or gas wells. The lymphocytic infiltration found could be species dependent. Sheepshead and spadefish at all sites routinely had a few more lymphocytes in the epithelium than other species.

Workgroup 5 reported high concentrations of hydrocarbons at Sites P1, S6, S7, S11, S16, and C21, but gills from fish at these sites were normal. Any abnormal responses observed were localized, not general. Fish from Sites S11 and C21 had only a few parasites, while those from Site S6 were moderately afflicted with a variety of parasites. Only one fish from Site S7 had protozoan parasites, and Site S16 was clean. Since fish from Sites S7 and S16 were almost all normal, none of the conditions reported from this group of sites could be correlated with the presence of hydrocarbons. Otherwise, all sites would have been similarly affected.

Gill morphology, then, was normal, with the exception of parasitism and host response to parasites.

B. Invertebrates

1. Bivalves

The paucity of benthic bivalves at some sites (P1, P2, P3, P4, S5, S10, S11 and S14) necessitated the collection of specimens from the superstructure of the platform at those sites. The bivalves examined were therefore acquired from two very different ecological niches, niches which are exposed, probably radically so in some cases, to different types and degrees of environmental parameters. Such different ecological niches will also influence the types and degrees of parasitic symbioses. A review of Tables 12-17 shows that, with the exception of *Bucephalus* in one oyster, all metazoan parasites were incident in benthic bivalves only, as were amoebae. Sporozoans were incident in both benthic and platform-associated molluscs, although incidence was higher in benthic species (mean of 1.9 per platform specimen compared to 4.2 per benthic specimen). Such being the case, the two niches should be considered separately. Since some species may characteristically harbor a heavier parasite load than other species, each species collected should also be considered separately when possible. Wardle (1974) found that 89 of 89 *Noetia ponderosa* from Galveston, Texas, contained cestode larvae which he believed to be a species of *Echeneibothrium* which is adult in stingrays. In the present study, 10 of 10 *N. ponderosa* contained a similar cestode larvae. With the exception of *A. ovalis* from Site S18, incidence of cestode infection in benthic bivalves from other sites was below 50%.

Table 11 shows that, of the platform associated species, *O. equestris* at Site S11 and *C. virginica* at Site S5 have over 30% more conditions (mean number per bivalve) than specimens from other sites. *Ostrea equestris* from Site S11 had 37% more conditions than did *O. equestris* from Site S10. *Crassostrea virginica* from Site S5 had 39% more conditions than did those specimens from Sites P1 and P2. Table 9 shows that symbioses accounted for 73% and 68% of the bivalve conditions at Sites S5 and S11, respectively. *Isognomon radiatus*, a small oyster-like bivalve from Site S14, contained the lowest mean number of conditions (1.6) followed by *A. imbricata* from Sites P3 and P4 (3.0 and 3.2, respectively).

Of the benthic sites, Site C22 stands apart from the others (Table 11). Specimens of *N. ponderosa* from Site C22 contained 75% more conditions per specimen than did *N. ponderosa* from Site S12 and 27% more than did *P. cordata* from Site C23. Specimens from Site C22 contained about an equal proportion of nonsymbiotic to symbiotic conditions. These specimens had a much higher number of cases of liquefaction and necrosis (total of 13 observed), especially of the muscle, than did bivalves from other sites (Tables 12, 15 and 17). While cestodes were recorded from an equal number of organs at Sites S12 and C22, sporozoans were recorded from 14 organs at Site C22 and were not present in *N. ponderosa* at Site S12. From the number of conditions in bivalves at Site C22, it would appear that those specimens were stressed and in poor health when compared to those from Site S12. This seems odd, for when specimens from Site C22 were collected (Cruise I), both shrimps and crabs were collected also. When specimens from Site S12 were collected (Cruise II), the bottom was "dead"—no shrimps or crabs were collected and very little else in the trawl catch was alive except for *Noetia*. Site C22 (about 17 km from Site S12) was revisited during Cruise II and the bottom was also "dead" at that time.

Considering the *P. cordata* examined, specimens from Sites S6, S8, S13 and C23 contained about an equal number of conditions (an average of 6.5 conditions per specimen). This could be considered high as specimens from four other sites (S9, S15, S16, S17) averaged only 2.8 conditions per specimen.

It appears that Sites C21, C22, C23 and C24 are not satisfactory control sites. When sites are grouped (Table 10), the control site bivalves contained a higher mean number of conditions than did primary and secondary site specimens (38% and 29%, respectively). *Tellina* sp. (Site C21) contained the lowest mean number of conditions of the bivalves examined. Those specimens were collected from four epifaunal grab samples. No bivalves were caught in the trawls at Site C24.

The highest incidences of parasitic symbiosis of bivalves in the present study were attributable to the fungal parasite *Dermocystidium marinum* or *Dermocystidium*-like organisms and unidentified sporozoans. *Dermocystidium marinum* is a common parasite of oysters in some areas of Louisiana and often produces high seasonal mortalities (Mackin, 1962; Mackin, *personal communication*). *Dermocystidium*-like organisms were found in bivalves at 15 sites and were especially prevalent in *C. virginica* and *O. equestris.* Related species are known to occur in other bivalves also, though little is known about their pathogenicity (Overstreet, 1978; Mackin, *personal communication*).

Both general and focal leucocytoses were frequently encountered in benthic and platform-associated bivalves. Leucocytosis is a part of the bivalve cellular inflammatory response to metazoan parasites, fungi, bacteria, foreign particles, injury and environmental stress (Cheng, 1967; Cheng and Rifkin, 1970; Sparks, 1972).

Degeneration and necrosis of tissues were occasionally observed. These conditions occurred primarily in the adductor muscle and gonads but gut and gill were also occasionally involved. Gonadal degeneration and necrosis did not appear to be related to the reproductive cycle.

Of the six organs examined, excretory and gonadal tissues contained the least number of total conditions (34 and 57, respectively). Muscle, gut, gill and digestive gland contained 70, 85, 116 and 125 conditions, respectively. Symbiotic conditions accounted for 55.6% of the conditions reported. By organ, symbioses accounted for 38% of the conditions in kidney, 42.4% in gut, 49% in gill, 61.4% in each of muscle and gonad, and 70.4% in digestive gland tissues.

It is notable that no tumors or neoplasms were found by gross and microscopic examination. Possible neoplasms have been reported from the pericardium (Mix and Riley, 1977), mantle (Sparks et al., 1964; Dix, 1972), siphon (Pauley and Cheng, 1968; Des Voigne, Mix and Pauley, 1970) and foot (Pauley, 1967) of various marine bivalves. Yevich and Barszcz (1977) reported neoplasms in *Mya arenaria* which were collected at oil contaminated sites.

Two recent BLM sponsored studies dealt with histopathology of invertebrates in baseline areas. Neff and Ernst (1977) reported findings from their study of the South Texas Outer Continental Shelf area. Methodology used in their study was the same as that used in the present study. Unfortunately, the only bivalves collected were two species of scallops and a species of *Macoma*. They reported trematode symbioses was the most common pathology found, occurring in 50% of the specimens examined. Nematodes and cestodes each occurred in 25% of their specimens. Relatively few pathologies other than symbionts were found, although leucocytosis and cysts occurred in 20% and 48% of their specimens, respectively.

Tripp (1978*a, b*) examined two scallop species for the South Atlantic Benchmark Program. He reported only helminth and protozoan symbionts.

In the present study, 31% of the bivalves harbored cestode larvae while 17% and 6% harbored nematode and trematode larvae, respectively.

2. *Crabs*

Crabs were collected from 20 of the 24 sites. With the exception of *S. lobatus* (Site P1) and *L. nitidus* (Site P4) all crabs were swimming (portunid) crabs. This prevents associating the specimens collected with a particular site (except Sites P1 and P4) with any certainty. It is not known if the specimens collected were recent immigrants to the site or old residents. *Callinectes similis* was seen clinging to and swimming with *Sargassum* in the study area and after a storm *P. gibbesii* were plentiful at Site S12, where a week earlier (before the storm) no crabs were collected.

Callinectes sapidus from Sites S5 and S19 contained over 32% and 48% more conditions (mean number) than crabs from other sites (Table 20). This probably reflects a naturally occurring higher incidence of symbionts in *C. sapidus* over *C. similis* and other species rather than platform association. This is evident in *C. sapidus* at Site S19 which bore ciliates, nemertines and barnacles which only infrequently occur on other species of crabs.

In comparing sites, no one site (except Sites S5 and S19) stands out from the others in numbers of conditions (Tables 18 and 20). It is evident, however, that specimens from control sites have a lower number of conditions than specimens from other sites, especially the secondary sites (Tables 19 and 20). The mean number of conditions from all *C. similis* at secondary sites is 2.6 compared to 0.6 for all *C. similis* from control sites, an increase of 73%.

Leucocytosis, both general and focal, accounted for a major portion of the conditions. Liquefaction of muscle was quite noticeable in some crabs as were hyperplasia, edema and necrosis of gill lamellae. These conditions have been reported from *C. sapidus* in association with viral disease (Johnson, 1977*a*), bacterial infection (Johnson, 1976*b*), gas bubble disease and hypoxia (Johnson, 1976*a*), and paramoebiasis (Johnson, 1977*b*).

Crabs had fewer symbionts than did bivalves. Only 19% of the conditions in crabs were symbiotic. Protozoans (amoebae, sporozoans, and ciliates) accounted for most of the symbiotic conditions. Amoebae found were not *Paramoeba pernicios* reported by Sawyer (1969) and Sprague, Beckett and Sawyer, (1969) from *C. sapidus*. The peritrichous ciliate, *Lagenophrys callinectes*, is apparently host specific for *C. sapidus* from Chesapeake Bay. Overstreet (1978) reported three species of ciliates from gills and one from the hemolymph of crabs in the northern Gulf of Mexico. Three of the *S. lobatus* examined bore large numbers of sporoblasts in the gonads. Because of the low number of spores (6-8), they are probably a *Thelohania*. One *C. similis* contained a sporoblast, probably a *Pleistophora*. Sprague (1950) reported *Thelohania* sp. in the muscles of *Petrolisthes armatus* in Louisiana. Sprague (1966) also reported *Pleistophora cargoi* in *C. sapidus* from the Atlantic Coast. A *Minchinia*-like haplosporidian occurs in Atlantic Coast blue crabs (Newman, Johnson and Pauley, 1976) and Overstreet (1978) reported the microsporidian, *Ameson michaelis* to occur in muscles of *C. sapidus* in Louisiana.

No cestode larvae were found in crabs examined, although Overstreet (1978) reported them to be common in *C. similis*. Nemertines were found only on the gills of *C. sapidus* at Site S19. These worms are only rarely found on other crabs and are seasonal in occurrence.

Gonadal and intestinal tissues had the least number of conditions (11 and 13), while kidney, muscle and gill had the most (45, 47 and 59, respectively). One *S. lobatus* contained an abnormal growth in the hemocoel, possibly on the intestine. *Speocarcinus lobatus* is a benthic species and therefore this specimen probably spent its entire postlarval life at Site P1. The etiology of the growth could not be determined.

Tripp (1978*b*) examined three species of portunid crabs, two of which were *P. gibbesii* and *P. spinicarpus*, for histopathologies during the South Atlantic Benchmark Program. He reported a cercaria at the base of a gill and gill damage due to copepods and other parasites, inflammatory responses and foreign bodies.

Neff and Ernst (1977) examined six crab species, four of which this study examined (*C. sapidus, C. similis, P. gibbesii*, and *P. spinicarpus*), during their histopathological investigation of fauna off the South Texas Coast. They found nematodes to be the most common internal symbiont, being incident in 29% of the specimens they examined with most cases occurring during the summer season. No trematodes were found and only one cestode. Myxosporidian cysts were found only in *C. similis*, but were the most common internal symbiont (34% infection rate) of that species. Unknown symbionts were found on the gills of 34% of the crabs examined.

In the present study, nematodes were found in only four specimens (4%), two of which were *C. similis*, and trematodes were incident in three of ten *C. sapidus*. No myxosporidian cysts were found. Symbionts were found on 69.5% of the crab gills. Therefore, while present specimens had far fewer internal symbionts, they had twice the number of gill symbionts found in crabs from the South Texas Outer Continental Shelf.

With the exception of one condition, crabs examined had fewer nonsymbiotic pathologies than did those Neff and Ernst (1977) examined. They found cysts in the gills of 33% of the crabs they examined and concentric cell aggregates in 79%. This study found cysts in only 3% of the gills examined and concentric cell aggregates in 7%. Thirty- one per cent of the crabs Neff and Ernst (1977) examined had edematous gills, and necrotic lamellae were found in 66% of the *C. similis*. Leucocytosis was found in 55% of the crabs examined in this study but was found in only 17% of those examined by Neff and Ernst (1977).

3. Shrimp

Penaeid shrimps form the basis of a substantial commercial fishery and during their migratory life history they are exposed to a wide variety of ecological situations. Their commercial import generates a deep concern about the health of their populations. Their migratory nature, however, makes them less than ideal subjects for field studies on the impact of localized and chronic pollution. This fact, especially when coupled with the unsatisfactory sampling results from control sites, attenuates the usefulness of the data collected in this study for pinpointing specific sources of low-level, chronic pollution. These data are more applicable to an assessment of the overall ecological health of major subunits of the sampling area and to the compilation of baseline data or invertebrate histopathology in general.

Several authors (e.g., Williams, 1965) record the differences in the specific ecological niches of penaeids. Therefore the direct comparison of histopathologies among penaeid species should be approached with caution. The unavailability of a single penaeid species from all sampling sites during this and other studies further complicates site and study comparisons.

Shrimp were collected from only three (P2, S8, and C22) of the nine sampling sites (P1, P2, S8, S10, S11, S12, S20, C22, and C24) associated with "dead bottoms." Those collected from "dead bottom" Site P2 possessed the highest total number of histopathologies per shrimp; those collected from "dead bottom" Site S8 also possessed high numbers of histopathologies. No shrimps were collected from Site S19 (associated with Ship Shoal) or from Site C21 (associated with hydrocarbon contamination via Mississippi River discharge). Although there was considerable variation in the incidences and intensities of histopathologies at other sites, no obvious correlation between them and pollution could be made.

The observations made on normal shrimp histology during this study correlate for the most part with previously published accounts, (e.g., King, 1948; Young, 1959; Roberts, 1966; Lightner, 1973; Foster, 1976; Rigdon and Mensik, 1976; and Tripp, 1978*a,b*). Observations related to penaeid symbiology revealed many of the symbioses reviewed by authors such as Corkern (1977), Couch (1978), Johnson (1978), and Overstreet (1978).

Observations concerning nonsymbiotic histopathologies previously reported include the following. Degeneration of abdominal musculature has been described by Rigdon and Baxter (1970) as spontaneous necrosis. Rinaldo and Yevich (1974) and Couch (1977) studied black lesions on the gills of *Pandalus borealis* and *Penaeus duorarum*. Lightner and Redman (1977) later identified melanin to be one of the dark pigments elaborated during penaeid inflammatory responses. The responses of penaeids to foreign bodies and injuries as described in this study have also been noted by Fontaine and Dyjak (1973), Fontaine and Lightner (1973, 1974), Fontaine et al. (1975), Solangi and Lightner (1976), and Sparks and Fontaine (1973). Although tumor-like growths have previously been reported from penaeids by Sparks and Lightner (1973) and Overstreet and Van Devender (1978), the tubercle-like growth described from cardiac tissue during this study has not been previously described.

The studies published by Neff and Ernst (1977), Tripp (1978*a* and 1978*b*) and Dames and Moore (1979), most closely parallel this study in design. Tripp's observations were almost exclusively confined to symbiotic histopathologies. Neff and Ernst included data on both symbiotic and nonsymbiotic histopathologies from *P. aztecus, P. setiferus, T. similis* and other penaeids. In most cases the incidences and diversity of these were lower in their study than in this one. No occurrence of pathologies and very few incidents of internal parasites were found in 19 bivalve, eight crab and seven shrimp species examined during the MAFLA study (Dames and Moore, 1979).

C. Problems Encountered

In a field study of this magnitude, many variables will inevitably be encountered which lead to difficulties in the analysis and interpretation of the final data. Ideally to make a comparison between control and platform sites, the samples collected at both types of sites would be of the same species, collected at the same time of year, of equivalent age, sex and reproductive status and of non-transient resident habit. Unfortunately, the study design did not permit all of these criteria to be met. The variation in habitat between a site with a platform, which acts as an artificial reef, and a control site without a platform resulted in a variation of species available. Also the migratory nature of some species (shrimps, some fishes and portunid crabs) makes their usefulness questionable as there is no way of knowing if they were old residents at the sites or recent immigrants. Because of extreme difference in niches, comparisons between benthic and platform associated bivalves is questionable.

Time limitation made it impossible to collect samples of uniform size and sex ratios and sometimes prevented obtaining an equal sample size from all sites. Sampling from more than one season added to variability in reproductive status even within a species.

Another physical problem encountered in the field was the low-oxygen condition found at the dead bottom areas. Dead bottom occurred at 10 of the 24 sites, including three of the four control sites. Low-oxygen conditions were apparently related to the influence of the Mississippi River. A third major physical variable was the differences among the platform sites selected by the sponsor with regard to production practices, e.g., oil or gas or both, amount of produced water, age, and whether flaring was above or below the surface of the water.

D. Recommendations for Further Studies

Results from this investigation indicate that histopathological analysis holds potential as an indicator in ecological evaluations. Future field studies should:

(1) Utilize selected indicator species for assay to assure a standard complement of species.
(2) Sample a smaller number of sites and increase the number of specimens sampled.
(3) Utilize non-migratory species whenever possible.
(4) Increase the size of the control group.

The use of vertebrate and invertebrate species in laboratory studies designed to simulate environmental exposure to potential stressors (with the added advantage of variable control) should be used to complement field investigations.

1. Indicator Species

The data from this investigation suggest that certain species of fish utilized in this study were more valuable than other fish as biological indicators of marine environmental quality. No single species has the advantage of being the indicator of all diseases and pollutants; therefore, several species must be considered as candidates to meet the requirements of any large study. The characteristics of any fish, for an overall evaluation, include their availability, required method of capture, game fish status, frequency of histopathologic conditions and behavioral qualities (e.g., dietary habits, ocean habitat and position in the food chain). Based on these guidelines, the species which appear to possess an overall potential as indicators are sheepshead, spadefish, sea catfish, Atlantic croaker and Mexican flounder.

Sheepshead and spadefish were readily available for spearing at the oil-production platforms. Both species are taken as game fish and prepared for human consumption, which makes their analysis even more critical. Their relatively large size makes them suitable for the on-board practicalities of gross observation and organ dissection. This study determined that these two species contained the greatest frequency of conditions (Table 43). The feeding habits of these fish should be considered when an environmental pollutant is being studied. The carnivorous sheepshead preys on barnacles and small shellfish, while the omnivorous spadefish feeds on macroplankton and other floating organic material. Thus a chemical compound, acting as a pollutant, may reside in some part of the food chain for one fish and not for the other. One disadvantage for the sheepshead and spadefish was that they were rarely captured by trawling. This limited their availability in the open water, where no production platforms existed, for a control site comparison analysis.

The sea catfish and Atlantic croaker, also classed as gamefish, were likewise among those fish with a high incidence of conditions (Table 43). Their capture was usually by trawling, which was advantageous for harvesting specimens in the open waters, where no oil production platforms existed.

The Mexican flounder's habitat, lying on the ocean floor, enhances the probability of a direct contact of the skin with environmental pollutants as they settle to the bottom. This characteristic of the flounder and their availability by trawling suggests that they should be considered when identifying features of indicator fish.

Therefore, not every desirable advantage for an indicator species is present in any one species; consequently in future studies, a species should be carefully considered for its seasonal, size, site, dietary and water depth differences.

Various species of fish that are examined from the ocean should be studied concurrently in controlled laboratory experiments that are designed to simulate exposure to potential stressors. Such experiments could determine condition variability in an organ as a function of a given environmental manipulation.

2. Indicator Organ

The incidence of histopathological conditions among the six organs in this study indicated that some organs held a greater advantage for health assessment than others. An organ was used as an ecological evaluator on the basis of the number of conditions or changes which it displayed in response to environmental fluctuations as well as its particular role in metabolic processing of a pollutant.

Data analysis in this study made possible a quantitative comparison of the organs examined (total conditions per organ). The resulting rank (from organ of highest to organ of lowest condition incidence) was: the liver, gill, stomach, kidney, gonad, and muscle (Table 40). Thus, when the indicator organ was chosen on the basis of total number of conditions observed, the liver, gill and stomach had the greatest value. Gill and stomach have a direct contact with the environment while liver metabolizes the compounds assimilated from the environment.

The kidney is a very important excretory organ and thus its metabolic functions would be influenced by pollutants that enter the blood stream. Tissue of the kidney would be altered by such environmental pollutants and therefore this organ should be considered for collection. While a number of conditions were reported for the gonad, the variables inherent in the collection of this organ (season, maturity, sex, difficulty in sampling) tend to reduce the reliability for useful comparisons between specimens. Muscle was relatively free of conditions and did not appear to hold much value as an indicator of fish health. In future studies, e.g., those relating to hydrocarbon sediments, the examination of skin from benthic fish species (e.g., Mexican flounder) would be valuable in assessing the influence of body contact with heavy crude or a fraction of it.

Of bivalves, the digestive gland and gill tissues contained a larger number of pathologies than the other tissues. Excretory tissue contained the least. The gill and muscle tissues of crabs bore a larger number of pathologies than other tissues while the heart, gut and gonad contained the least number. In shrimps, gill and digestive gland tissues had a larger number of pathologies than the other tissues. Heart, excretory and gonad contained the least number of pathologies.

VI. CONCLUSIONS

A. Vertebrates

Three platform sites strongly implicated as contaminated by hydrocarbons and/or trace metals occurred among the top six in total number of histopathological conditions. All eight of the platform sites which ranked high in histopathological conditions were located in the eastern part of the study area and had spadefish as one of the species sampled. Two of these eight platform sites ranked low in effects of hydrocarbons and were "probably not" affected by trace metals.

The four control sites occurred among the bottom seven in number of histopathological conditions. All four ranked medium in effects of hydrocarbons and were "possibly" affected by trace metals. Three were located in the eastern and one in the western part of the study area. Spadefish were not among the species sampled.

Two platform sites which occurred among the bottom four in low number of histopathological conditions ranked high in effects of hydrocarbons. One, "probably" affected by trace metals, was located in the eastern part of the study area and one, "possibly" affected by trace metals, was located in the western part of the study area.

In assessing the disparate information on the platform sites which ranked high in histopathological conditions, one must consider the fish species which showed the highest levels of histopathological conditions. During this study, the spadefish consistently had a high level. This may be due to the fact that the spadefish lives most of its adult life in association with a structure such as a production platform, or it may reflect a natural proclivity of this schooling species to acquire parasites and disease conditions.

All of the sites high in histopathological conditions were located in the eastern part of the study area, and all the sites in the western part of the study area ranked either medium or low in number of conditions. This suggests that the set of platforms in the eastern part of the study area which consistently show contamination, whether from production or other sources, are those locations where stress is greatest on fish. Conversely, the supposedly least stressed sites show the fewest histopathological conditions.

1. Muscle

A total of 29 muscle conditions was reported in 233 specimens examined. Of these conditions, 27 were encapsulated protozoa and the rest were helminths. There was an average of 0.12 conditions per muscle specimen, which comprises .97% of the 2959 conditions reported for the entire study.

2. Liver

Nonsymbiotic conditions in fish hepatic tissue consisted of mononuclear leukocytosis, acidophilic granular cells, chromatophore pigmentations, pericholangial fibrosis, necrosis, and lipid accumulation. These conditions were widespread in samples of the 12 species studied. Nonsymbiotic conditions were generally most intense in sheepshead and spadefish.

Symbiotic conditions consisted of protozoa, cysts, granulomas, and helminths. Approximately one third of all livers sampled had a symbiotic condition. Many livers were free of symbionts, while some species contained several infestations.

The average number of all (symbiotic and nonsymbiotic) conditions for each liver specimen was: 1.5 at the control sites, 3.4 at the primary sites, and 3.4 at the secondary sites.

3. Gut

Stomachs of 235 fish specimens from 12 species were examined microscopically for symbiotic and nonsymbiotic conditions. There was an average of 2.7 conditions per specimen. The average number of symbionts per specimen was 1.2. In general, spadefish had the largest average number of conditions per specimen (4.3), while rough scad had the smallest (0.0). Sites S20 and P1 had the highest average number of conditions per site (20.7), while Sites C22, C24, and P2 had the lowest (1.2). The average number of all (symbiotic and nonsymbiotic) conditions for each gut specimen was: 1.6 at the control sites, 2.4 at the primary sites, and 3.0 at the secondary sites.

4. Gonad

In fish, both ovarian and testicular cycles can be readily divided into four phases for evaluation of histopathological conditions. Acidophilic cells, atretic ova, encapsulated cysts, degeneration, chromatophores, leukocytosis, helminths, and protozoa were observed in or associated with fish gonads. Acidophilic cells, chromatophores, and leukocytic condition(s) were the most frequently observed for any particular collection site. The status of the ovogenic and spermatogenic cycles at the time specimens were collected correlated well with the known spawning times for respective species of fish.

5. Kidney

In the kidney, chromatophores and parasites (primarily protozoa) were the most frequently encountered conditions. To the extent that these can serve as indicators of environmental stress, such conditions seem to lend themselves most valuably to the health assessment of this organ. Chromatophores directly associated with foreign invaders appear most important for this analysis and would thus serve to index such invasion. An overview of parasite activity in this study generally indicates a higher incidence among primary and secondary sites than at the controls. Substantiation or clarification of this finding, however, must await studies for which species examined are the same for all sites. The variables must be controlled if more definitive correlations are to be made.

6. Gill

Parasites were commonly seen in gill tissue, but the condition could not be correlated with the proximity of oil or gas wells or with high concentrations of hydrocarbons.

B. Invertebrates

1. Bivalves

From the standpoint of bivalves, the control sites selected are not satisfactory sites to determine the effects of platforms on biota. No bivalves were collected at Site C24 and Sites C22 and C23 appear to be highly stressed by factors unrelated to petroleum industry activities.

Metazoan parasites were almost entirely restricted to benthic bivalves. Very few were found in platform associated bivalves. The extreme difference in niches makes comparisons of sites where benthic species were collected with sites where platform associated species were collected difficult.

Incidence of symbioses differs considerably between species. This makes comparisons between species difficult. Incidences of some symbioses may be seasonal.

Excretory and gonadal tissues contained the least number of conditions for bivalve organs while gills and digestive glands contained the highest number of conditions.

Bivalves at Sites S6, S8, S13, C22 and C23 appeared to be stressed.

2. Crabs

Because most of the species studied were swimming crabs, it is not known if the specimens studied were recent immigrants to the sites or old residents, making their usefulness questionable.

Portunid (swimming) crabs at control sites had fewer conditions than those from secondary sites.

Callinectes similis contained more conditions per specimen than the other species examined.

Some symbiotic conditions are influenced by host specificity and season. Crabs contained fewer symbionts than bivalves.

With the exception of gill symbionts and leucocytoses, crabs from platform sites off Louisiana contained fewer symbiotic and nonsymbiotic conditions than the same species from predevelopment areas along the South Texas Outer Continental Shelf.

3. Shrimps

The migratory nature of penaeids limits the usefulness of data collected from them for determining sources of low-level, chronic pollution.

The failure to obtain penaeid samples from two of the four control sites and one of the four primary sites adversely influenced the comparative utility of data collected during Cruise I. This situation was further complicated by the fact that a single penaeid species could not be obtained from all sampling sites.

Variation in the incidences of histopathologies (both symbiotic and nonsymbiotic) were noted among the three penaeid species examined.

Penaeids collected from Sites P2, S7, and C23 displayed the highest incidence of histopathologies.

VII. ACKNOWLEDGEMENTS

Scientific Consultants:
- Gilberto S. Trevino—Pathologist
- Raymond A. Bendele, Jr.—Pathologist
- William E. Haensly—Histologist
- John G. Mackin—Pathologist

Technicians:
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Biomedical Learning Resources—Photography

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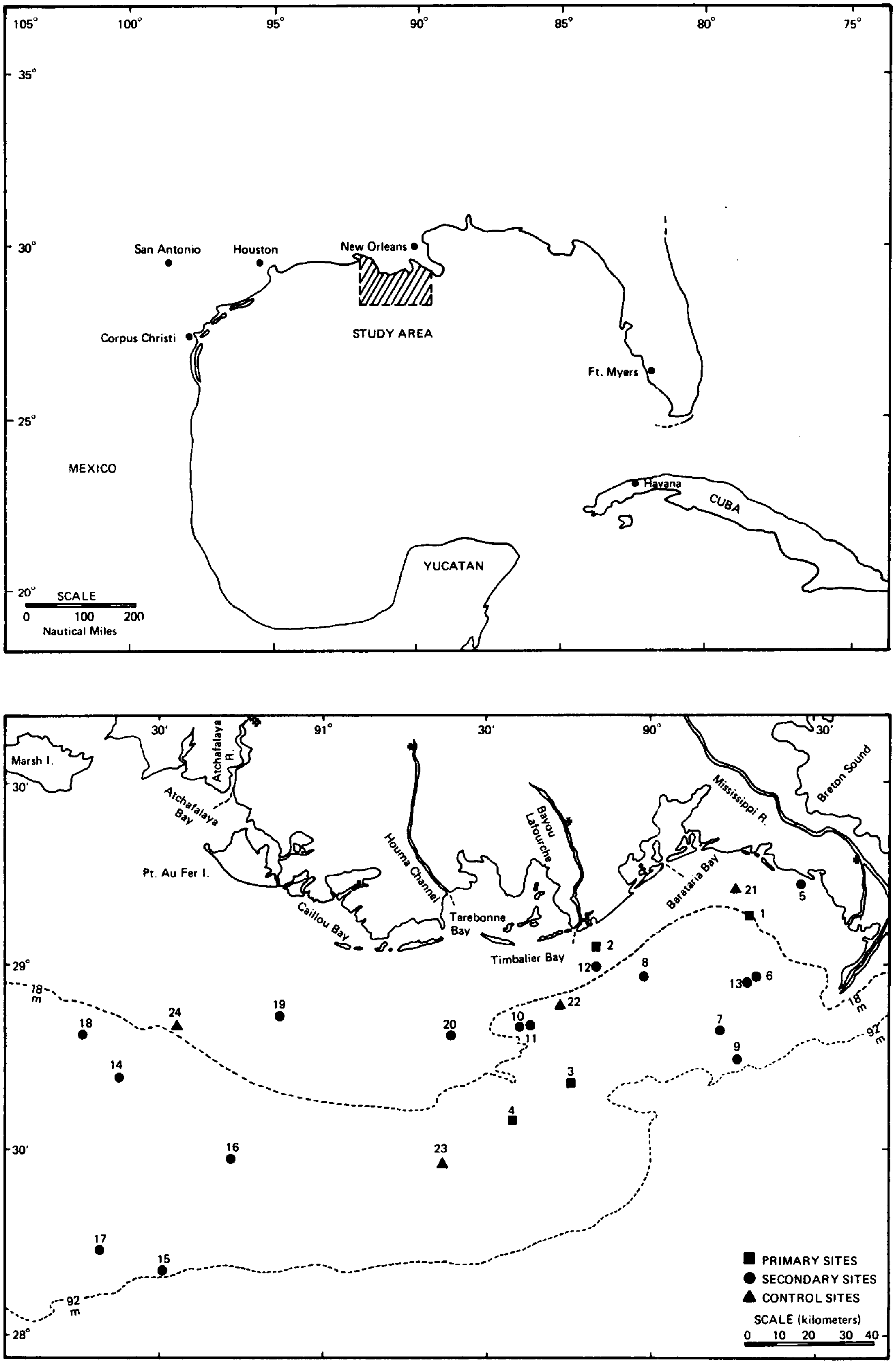
APPENDIX A

Maps of the Study Area



105°
100°
95°
90°
85°
80°
75°
35°
30°
25°
20°
San Antonio
Houston
New Orleans
Corpus Christi
STUDY AREA
Ft. Myers
MEXICO
Havana
CUBA
YUCATAN
SCALE
0 100 200
Nautical Miles
Marsh I.
30'
Atchafalaya R.
91°
90°
Atchafalaya Bay
Pt. Au Fer I.
Houma Channel
Bayou Lafourche
Mississippi R.
Breton Sound
Barataria Bay
Caillou Bay
Terebonne Bay
Timbalier Bay
29°
28°
18 m
92 m
1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
17
18
19
20
21
22
23
24
■ PRIMARY SITES
● SECONDARY SITES
▲ CONTROL SITES
SCALE (kilometers)
0 10 20 30 40

FIG. A1. Maps of the study area - (Top) Location of study area (Bottom) Study area showing sampling sites.

APPENDIX B

Distribution of Histopathologies in each Organ at Collecting Sites for each Species

Atlantic Croaker (*Micropogon undulatus*)

Sites	P2	S5	S6	S8	S9	S13	C21	Subtotal	Total
Organs									
Stomach		5AC	5AC	4AC	1AC	2AC	4AC	21AC	107
	2CE	4CE	4CE	3CE	5CE	3CE	2CE	23CE	
		5HC		5HC	4HC	1HC	1HC	16HC	
	3LL	4LL	3LL	5LL	3LL	4LL	3LL	25LL	
	1PZ	2PZ	3PZ	1PZ	1PZ	2PZ	3PZ	13PZ	
	2SH	1SH		1SH	2SH	1SH	2SH	9SH	
Kidney		2AC					1AC	3AC	80
	1HC	5HC	5HC	5HC	5HC	5HC	5HC	31CH	
			1TD			3TD		4TD	
	3PE	1PE	1PE		2PE	1PE		8PE	
		2SH	2SH	1SH	4SH	3SH	1SH	13SH	
	2PM	5PM	2PM	2PM	5PM	5PM		21PM	
Gill	5AC		1AC		3AC	3AC		12AC	79
	1EE	3EE		2EE	1EE		1EE	8EE	
	1HP		1HP		1HP			3HP	
	3LL	1LL		3LL		5LL	3LL	15LL	
	5MC	2MC		2MC				9MC	
			1PE		1PE			2PE	
	5PZ	2PZ			1PZ		1PZ	9PZ	
	1SA		1SA					2SA	
			1SH					1SH	
	5VG		2VG	2VG	5VG	1VG	3VG	18VG	
Liver	5AC	4AC	4AC	5AC	5AC	5AC	1AC	29AC	89
		1BF	1BF	2BF	2BF	4BF		10BF	
	1DG	1DG	1DG	1DG	1DG			5DG	
					2CE			2CE	
	2HC	3HC	5HC	5HC	5HC	4HC	1HC	25HC	
	3LL	1LL	2LL	1LL	1LL	1LL	1LL	10LL	
		1LP						1LP	
	1PZ	1PZ	1PZ	1PZ				4PZ	
				2SH			1SH	3SH	
Muscle	1PE	1PE	0	0	0	0	0	2PE	2
Gonads	1AC	5AC	3AC	4AC	5AC	5AC	3AC	26AC	70
	1HC		4HC	2HC	5HC	5HC		17HC	
		3AO	2AO		4AI	3AO	2AO	14AO	
		2LL						2LL	
			1CE			1CE		2CE	
			2LF	1LF	2LF			5LF	
							4DG	4DG	
Total	55	67	59	62	74	67	43		

See Appendix C for list of histopathologies codes

Rock Seabass (*Centropristis philadelphica*)

Sites	S7	S9	S15	S17	Subtotal	Total
Organs						
Stomach	2AC	2AC		3AC	7AC	27
	1CE	1CE	3CE	2CE	7CE	
	1HC		1HC		2HC	
		1LL	1LL	2LL	4LL	
		1SH	3SH	3SH	7SH	
Kidney	2AC	1AC	2AC	3AC	8AC	42
	4HC	5HC	4HC	4HC	17HC	
	4PM	4PM	5PM	3PM	16PM	
				1PE	1PE	
Gill	2LL	1LL	1LL	2LL	6LL	20
	1SX	1SX			2SX	
		1SH	1SH		2SH	
		1VG	2VG		3VG	
				5MC	5MC	
				1PZ	1PZ	
				1SA	1SA	
Liver	2AC	2AC	2AC	2AC	8AC	43
	3BF	5BF	5BF	4BF	17BF	
	1CE	1CE		1CE	3CE	
	2DG				2DG	
			4HC	4HC	8HC	
	4LL	1LL	1LL	2LL	8LL	
	1SH	1SH			2SH	
Muscle	0	0	1SH	0	1SH	1
Gonad	4AC	4AC	4AC	4AC	16AC	46
		1CE		1CE	2CE	
	3AO		2AO		5AO	
				2DG	2DG	
	4HC	3HC	5HC	3HC	15HC	
	2LC				2LG	
			2SH		2SH	
	1LF	1LF			2LF	
Total	44	38	49	53		

Red Snapper (*Lutjanus campechanus*)

Sites	P3	S18	Subtotal	Total
Organs Stomach	2CE	2CE	4CE	13
	3PZ	1PZ	4PZ	
		5LL	5LL	
Kidney		1AC	1AC	8
	1GS		1GS	
		1HC	1HC	
	2PE		2PE	
	1PL		1PL	
	2PM		2PM	
Gill	5AC		5AC	36
		5ST	5ST	
	2EE	1EE	3EE	
	5LL	5LL	10LL	
		3PZ	3PZ	
	5MC		5MC	
		1PC	1PC	
	4VG		4VG	
Liver	1AC		1AC	27
	4BF	5BF	9BF	
	1DG		1DG	
	4HC		4HC	
	4LL	2LL	6LL	
		3LP	3LP	
	3PZ		3PZ	
Muscle	1PE	1PE	2PE	2
Gonad	4RG		4RG	8
		2AC	2AC	
		2DG	2DG	
Total	54	40		

	Sand seatrout (*Cyanoscion arenarius*)		Rough scad (*Trachurus lathami*)		Batfish (*Halieutichthus aculeatus*)	
Sites	C24	Total	C22	Total	C22	Total
Organ						
Stomach	1CE	7	0	0		8
	1HC					
	4PZ				4PZ	
	1SH				4SH	
Kidney	4AC	10		4	0	0
	4HC		3HC			
	1PM					
	1XX					
			1SH			
Gill	4LL	12		9		8
	3PZ				1PZ	
	2SA					
	3VG		3VG		1VG	
			3EE		2EE	
			3SX			
					2MC	
					2PC	
Liver	4BF	14		6	1BF	3
	2CE					
	5HC					
	3PZ		1PZ			
			3AC		1AC	
			1LL			
			1LP			
					1SH	
Muscle	0	0	0	0	0	0
Gonad	4AO	7	0	0	2AO	4
	1CE					
	2HC					
					2DG	
Total	50		19		23	

Longspine porgy (*Stenotomus caprinus*)

Sites	S15	S16	S17	C23	Subtotal	Total
Organ						
Stomach	5AC	3AC	5AC	5AC	18AC	51
	4CE	1CE	3CE		8CE	
		1HC	1HC		2HC	
	4LL	3LL	5LL		12LL	
	4PZ	1PZ	2PZ	3PZ	10PZ	
	1SH				1SH	
Kidney	5AC	3AC	5AC	1AC	14AC	50
	5HC	5HC	5HC	5HC	20HC	
	3PM	1PM	5PM	3PM	12PM	
	3XX		1XX		4XX	
Gill	5AC	5AC	5AC	5AC	20AC	51
	1EE			4EE	5EE	
	4LL	5LL	5LL	2LL	16LL	
	1PZ			2PZ	3PZ	
	1SA				1SA	
			1SH		1SH	
	1VG	1VG		3VG	5VG	
Liver	5AC	3AC	5AC	1AC	14AC	56
	3BF		4BF		7BF	
			1CE		1CE	
	5HC		5HC		10HC	
			1DG		1DG	
	5LL	1LL	3LL		9LL	
	3LP		2LP		5LP	
	5PZ		2PZ		7PZ	
	1SH		1SH		2SH	
Muscle	1PE	0	0	0	1PE	1
Gonad	4AC	2AC	4AC	2AC	12AC	35
	4DG	2DG	4DG		10DG	
	4HC		4HC		8HC	
	1LF				1LF	
				4AO	4AO	
Total	88	37	79	40		

Sea Catfish (*Arius felis*)

Sites	P2	S5	S19	C21	C24	Subtotal	Total
Organ							
Stomach	4CE	4CE	5CE	3CE	5CE	21CE	45
	1LL	3LL	5LL		1LL	10LL	
		1AC			1AC	2AC	
		3PZ	3PZ			6PZ	
			1SH			1SH	
			5HC			5HC	
Kidney	1GS					1GS	33
	5HC	5HC	4HC	1HC	5HC	20HC	
	2SH	1SH	1SH		1SH	5SH	
	2TD			1TD		3TD	
			3AC			3AC	
				1PM		1PM	
Gill	3AC					3AC	64
	2EE			4EE	5EE	11EE	
		2HC				2HC	
	3HP	1HP				4HP	
	2LL	3LL	5LL	3LL		13LL	
	5MC			5MC		10MC	
		2PE	1PE			3PE	
	3PZ			1PZ		4PZ	
				2SH		2SH	
	5VG	2VG		5VG		12VG	
Liver				1AC		1AC	75
	2BF	1BF	4BF	2BF	3BF	12BF	
	2DG		3DG	3DG	1DG	9DG	
	5HC	5HC	4HC	5HC	5HC	24HC	
	4LL	3LL	5LL	5LL	1LL	18LL	
		2CE			1CE	3CE	
		1SH				1SH	
		2LP	4LP		1LP	7LP	
Muscle	4PE	1PE	4PE	3PE	4PE	16PE	17
	1SH					1SH	
Gonad	1AO	3AO		0		4AO	36
	4HC	5HC	5HC		5HC	19HC	
	1LL					1LL	
	1MA					1MA	
		3AC	2AC			5AC	
		1LF				1LF	
					5DG	5DG	
Total	63	54	64	45	44		

Pinfish (*Lagodon rhomboides*)

Sites	P3	P4	C23	Subtotal	Total
Organs					
Stomach	4AC	4AC	4AC	12AC	39
	2CE	3CE	1CE	6CE	
	1LL	3LL	1LL	5LL	
	4PZ	2PZ	4PZ	10PZ	
		1VG		1VG	
		2SH	3SH	5SH	
Kidney		1HA		1HA	16
	3HC	3HC	3HC	9HC	
	2PM	3PM		5PM	
	1SH			1SH	
Gill	4AC	5AC		9AC	58
	2EE	1EE	5EE	8EE	
	1HP	1HP		2HP	
	4LL	5LL		9LL	
	4MC	5MC		9MC	
	3PZ	3PZ		6PZ	
			3SX	3SX	
	4VG	5VG	3VG	12VG	
Liver	4AC	5AC		9AC	45
	3BF	5BF		8BF	
		1DG		1DG	
	4HC	5HC		9HC	
	3LL	3LL	1LL	7LL	
	3LP	2LP		5LP	
	1PZ	3PZ		4PZ	
	1SH	1SH		2SH	
Muscle	1PE	0	0	1PE	1
Gonad	3AC	3AC	1AC	7AC	22
	1AO	2AO		3AO	
		2CE		2CE	
	2HC	3HC		5HC	
			1DG	1DG	
	2LG	1LG		3LG	
	1LL			1LL	
Total	68	83	30		

Mexican flounder (*Cyclopsetta chittendeni*)

Sites	P4	S7	S14	S16	Subtotal	Total
Organ						
Stomach	2CE	2CE		2CE	6CE	29
	1LL				1LL	
	2PZ	5PZ	1PZ	5PZ	13PZ	
	4SH			1SH	5SH	
		2HC			2HC	
			2AC		2AC	
Kidney	2HC	3HC	4HC	2HC	11HC	33
	1PE				1PE	
	2PM	2PM		3PM	7PM	
	1SH				1SH	
		2AC		5AC	7AC	
		1XX	2XX	3XX	6XX	
Gill	3EE				3EE	28
				5LL	5LL	
	4PZ				4PZ	
	1SH		1SH		2SH	
	2VG				2VG	
		4MC		5MC	9MC	
			1PC		1PC	
			1SX		1SX	
			1SA		1SA	
Liver	1LL	0			1LL	11
	1SH				1SH	
			1HC		1HC	
				4BF	4BF	
				1DG	1DG	
	1PZ			2PZ	3PZ	
Muscle	0	0	0	0	0	0
Gonad	3AO	1AO	1AO	3AO	8AO	16
		1AC	1AC	3AC	5AC	
			3IN		3IN	
Total	31	23	19	44		

Sheepshead (*Archosargus probatocephalus*)

Sites	P1	S10	S11	S12	S20	Subtotal	Total
Organ							
Stomach	5AC	3AC	5AC	5AC	5AC	23AC	75
	5CE	1CE	1CE	3CE	3CE	13CE	
		3HC			3HC	6HC	
	4LL	1LL	3LL	5LL	5LL	18LL	
	4PZ	1PZ		4PZ	1PZ	10PZ	
	2SH			1SH	1SH	4SH	
	1VG					1VG	
Kidney	5HC	3HC	5HC	5HC	5HC	23HC	48
	4PE	1PE		3PE	4PE	12PE	
	2SN					2SN	
				2AC	5AC	7AC	
					2PM	2PM	
					2SH	2SH	
Gill	5AC	3AC	5AC	5AC	5AC	23AC	99
	2EE					2EE	
	5HP	2HP	2HP			9HP	
	5LL	2LL	5LL	5LL	5LL	22LL	
	5MC	2MC	2MC	5MC		14MC	
	1PZ	2PZ	2PZ		3PZ	8PZ	
	5VG	3VG	5VG	2VG	1VG	16VG	
		1CE				1CE	
					2ST	2ST	
		2SH				2SH	
Liver	5AC	3AC	5AC	5AC	5AC	23AC	120
	4BF	3BF	4BF	5BF	4BF	20BF	
	2DG	1DG	1DG	1DG	4DG	9DG	
	2CE			4CE		6CE	
					1SH	1SH	
	5HC	3HC	5HC	5HC	5HC	23HC	
	5LL	3LL	5LL	5LL	4LL	22LL	
	1LP		1LP	1LP		3LP	
	3PZ	3PZ		4PZ	3PZ	13PZ	
Muscle							5
	2PE	0	1PE	0	2PE	5PE	
Gonad	5AC	3AC	5AC	5AC	5AC	23AC	82
	2AO	3AO	3AO		1AO	9AO	
	3DG				3DG	6DG	
	3HC	2HC	3HC	4HC	4HC	16HC	
	5LF	1LF	4LF		2LF	12LF	
	1PZ					1PZ	
	1RG					1RG	
			1LL			1LL	
				2SH		2SH	
					1CE	1CE	
Total	109	55	74	86	96		

Spadefish (*Chaetodipterus faber*)

Sites	P1	S6	S8	S10	S11	S12	S13	S14	S18	S19	C20	Sub-total	Total
Organ													
Stomach	5AC	5AC	5AC	5AC	4AC	5AC	2AC	5AC	5AC	5AC	5AC	51AC	238
	4CE	3CE	4CE	2CE	5CE	3CE	3CE	5CE	5CE	2CE	4CE	40CE	
	3LL	5LL	4LL	5LL	5LL	4LL	5LL	5LL	5LL	5LL	5LL	51LL	
	5PZ	5PZ	5PZ	5PZ	5PZ	5PZ	4PZ	5PZ	5PZ	5PZ	4PZ	53PZ	
	3SH	3SH		4SH			1SH				1SH	12SH	
		2HC	4HC	2HC	3HC	1HC	4HC	5HC	5HC		5HC	31HC	
Kidney	2AC		5AC	5AC	5AC	3AC	5AC	1AC	4AC		5AC	35AC	153
							1HA					1HA	
	5HC	5HC	5HC	5HC	5HC	5HC	5HC	5HC	5HC	5HC	5HC	55HC	
	1PE	1PE				1PE	1PE					4PE	
	2PM	5PM	5PM	5PM	5PM	5PM	5PM	2PM	5PM	5PM	5PM	49PM	
	2SN											2SN	
	1TD											1TD	
					1XX							1XX	
		1SH	1SH	1SH			2SH					5SH	
Gill	5AC			5AC		5AC	2AC	5AC	5AC	5AC	5AC	37AC	175
				1CE								1CE	
	5EE	3EE		4EE	2EE		2EE	2EE				18EE	
	2HP	1HP								1HP	1HP	5HP	
		1ST								2ST	3ST	6ST	
	5LL	5LL	2LL	5LL	4LL	5LL	5LL	5LL	5LL	5LL	5LL	51LL	
		1SH			2SH							3SH	
	5MC	3MC	1MC									9MC	
		1PE						1PE				2PE	
	3PZ		2PZ			2PZ						7PZ	
		2SA	2SA	2SA	1SA	1SA		3SA				11SA	
	5VG	3VG	5VG	1VG	4VG	2VG	3VG	1VG		1VG		25VG	
Liver	3AC	2AC	4AC				3AC	2AC	4AC		3AC	21AC	247
	4BF	5BF	4BF	1BF	5BF	5BF	4BF	5BF	4BF	5BF	4BF	46BF	
		1CE		1CE	1CE				1CE		1CE	5CE	
	1DG	5DG	1DG		5DG	2DG	1DG	5DG	3DG	1DG	2DG	26DG	
	5HC	5HC	5HC	5HC	5HC	5HC	5HC	5HC	5HC	1HC	5HC	51HC	
	1LL	4LL	3LL	4LL	4LL	3LL	4LL	5LL	4LL	4LL	2LL	38LL	
		1PZ				3PZ	2PZ	1PZ	2PZ	1PZ	1PZ	11PZ	
	4LP	5LP	5LP	5LP	5LP	5LP	5LP	5LP	5LP		5LP	49LP	
Muscle	0	0	0	0	1SH	0	0	0	0	0	0	1SH	1
Gonad	4AC	2AC	3AC	1AC	5AC	3AC		5AC	3AC	5AC	4AC	35AC	117
		2AO	2AO	3AO	3AO		4AO		4AO		4AO	22AO	
		1DG		1DG						5DG		7DG	
		2HC	5HC		5HC	3HC	3HC	1HC	5HC	4HC	3HC	31HC	
							1PZ	4PZ				5PZ	
		2LF	4LF	1LF	3LF	1LF	1LF		1LF	2LF	2LF	17LF	
Total	85	92	86	79	93	77	83	88	90	69	89		

APPENDIX C

Key to Histopathology Computerized Raw Data

Column	Information	Characters	Comments
1-2	Year	78	
3-4	Month	01-12	01 = Jan. -12 = Dec.
5-6	Site Number		Assigned by BLM
7	Site Type	C	Control Sites
		P	Primary Platform
		S	Secondary Platform
8	Transect	N	North
		P	Platform
9-12	Distance	0100-2000	In meters (0500)
13-15		2BA	Assigned by SwRI
16	Invertebrate	I	
	Vertebrate	V	
17	Fixative	P	Primary (Helly's)
		S	Secondary (Bouin's, Formalin)
18-20		BS	Assigned by SwRI
21	Specimen Type	B	Bivalve
		C	Crab
		F	Fish
		S	Shrimp
22-23	Specimen Species	AO	*Anadara ovalis*
		AZ	*Arca imbricata*
		CA	*Pitar cordata*
		CV	*Crassostrea virginica*
		IR	*Isognomon radiatus*
		NP	*Noetia poderosa*
		OE	*Ostrea equestris*
		TE	*Tellina* sp.
		CS	*Callinectes similis*
		LN	*Leiolambrus nitidus*
		PG	*Portunus gibbesii*
		PS	*Portunus spinicarpus*
		SA	*Callinectes sapidus*
		SL	*Speocarcinus lobatus*
		A	*Micropogon undulatus*
		B	*Centropristis philadelphica*
		C	*Lutjanus campechanus*
		D	*Cynoscion arenarius*
		H	*Stenotomus caprinus*
		M	*Arius felis*
		P	*Trachurus lathami*

Column	Information	Characters	Comments
22-23 (cont'd)		Q	*Halieutichthys aculeatus*
		S	*Lagodon rhomhoides*
		T	*Cyclopsetta chittendeni*
		W	*Archosargus probatocephalus*
		X	*Chaetodipterus faber*
		PA	*Penaeus aztecus*
		PS	*Penaeus setiferus*
		SE	*Squilla empusa*
		TS	*Trachypenaeus similis*
24-26	Specimen Number	001-999	
27	Specimen Sex	F	Female
		H	Hermaphrodite
		M	Male
		U	Unknown
28	Sexual Maturity	I	Immature
		M	Mature
		U	Unknown
29-31	Specimen Length	001-999	CM x 10^{-1}
32	Specimen Condition	A	Alive
		C	Discovered
		D	Dead
		G	Gaper
		P	Parasitized
		T	Thin, sick-looking
		U,X	Unknown
33	Condition Intensity	0	Normal
	*Used with Condition D	1*	Hours Postmortem
		2*	" "
		3*	" "
		4*	" "
		5*	" "
	+Used with other Condition	7+	Light
		8+	Medium
		9+	Heavy
34	Organ	B	Body Cavity (Hemocoel)
		C	Cardiac (Heart)
		D	Digestive (Gut)
		E	Excretory (Kidney)
		F	Foot
		G	Gill

Column	Information	Characters	Comments
34 (cont'd)		L	Liver (Digestive Gland)
		M	Muscle
		N	Nerve
		R	Reproductive (Gonads)
		T	Connective tissue
35	Organ Condition	A	Autolysis
		N	Normal
		0	No tissue
		P	Parasitizes
		U	Unknown
		V	Very little tissue on slide
36	Condition Intensity	6	Excellent
		7	Light
		8	Medium
		9	Heavy
		0	Not assessed
37-39, 41-43, 45-47, etc.	Histopathologies	AC	Acidophilic granular cells
		AM	Amoeba
		AO	Artretic ova
		BA	Barnacle
		BF	Biliary duct fibrosis
		CE	Encapsulated cysts
		CU	Unencapsulated cysts
		DE	Deformation
		DG	Degeneration
		DM	Dermocystidium
		EE	Edema
		FI	Fibrosis
		FN	Focal necrosis
		GR	Granuloma
		GS	Glomerular sclerosis
		HA	Hyperplasia of arterial endothelium
		HC	Chromatophores
		HE	Hemorrhage
		HL	Hemolymph accumulation
		HM	Hyperplasia of mesonephric duct
		HP	Hyperplasia
		HT	Hypertrophy
		IF	Inflammation
		IN	Involuted
		LE	Lesion

Column	Information	Characters	Comments
37-39 etc. (cont'd)		LF	Focal leucocytosis
		LG	General leucocytosis
		LL	Leucocytic infiltration
		LP	Lipid accumulation
		MA	Macrophage infiltration
		MC	Mucous cells
		NP	Neoplasm
		NS	Nematopsis spores
		PA	Pigment accumulation
		PC	Protozoan ciliates
		PE	Protozoa - encapsulated
		PL	Protozoa - in tubular lumen
		PM	Protozoa - in lining of mesonephric duct
		PN	Pycnotic nuclei
		PZ	Protozoa
		RG	Regeneration
		RY	Nemertine
		SA	Copepod symbiosis
		SB	Bacterial symbiosis
		SC	Cestode symbiosis
		SD	Degenerate symbiont
		SE	Ectosymbiont (algae, etc.)
		SF	Fungal (Plasmodiophoralid) symbiont
		SG	Gregarine symbiosis
		SH	Helminths
		SJ	Cnidarian symbiosis
		SM	Microsporidian symbiosis
		SN	Nematode symbiosis
		SP	Sporozoan symbiosis
		ST	Trematode symbiosis
		SX	Myxosporidian symbiosis
		TA	Tumor
		TD	Tubular degeneration
		VG	Vascular congestion
		YP	Yellow pigment cells
		XX	Xenoma
40, 44, 48, etc.	Intensity	1	Very Light
		2	Light
		3	Moderate
		4	Heavy
		5	Very Heavy
		9	Questionable

APPENDIX D

Sample of Histopathology Data Reporting Form

HISTOPATHOLOGY DATA REPORTING FORM

BLM CONTRACT 551-CT8-17 SwRI PROJECT 01-5245 WORK GROUP XI

YEAR _ _ MONTH _ _ STATION NUMBER _ _ STATION TYPE _ TRANSECT _ DISTANCE _ _ _ _
1 3 5 7 8 9

SAMPLING STUDY 2 PARAMETER GROUP, SUBGROUP B A VERTEBRATE/INVERTEBRATE _ FIXATIVE _
13 14 16 17

ANALYSIS B. LABORATORY S
18 20

SPECIES _ _ _ SPECIMEN NUMBER _ _ _ SEX _ MATURITY _ LENGTH _ _._ cm SPECIMEN CONDITION _ _
22 26 30 31 32 36

ORGAN	CONDITION	HISTOPATHOLOGIES										
39	41	44	48	52	56	60	64	68	72	76	80	84
_	_ _	_ _ _	_ _ _	_ _ _	_ _ _	_ _ _	_ _ _	_ _ _	_ _ _	_ _ _	_ _ _	_ _ _
_	_ _	_ _ _	_ _ _	_ _ _	_ _ _	_ _ _	_ _ _	_ _ _	_ _ _	_ _ _	_ _ _	_ _ _
_	_ _	_ _ _	_ _ _	_ _ _	_ _ _	_ _ _	_ _ _	_ _ _	_ _ _	_ _ _	_ _ _	_ _ _
_	_ _	_ _ _	_ _ _	_ _ _	_ _ _	_ _ _	_ _ _	_ _ _	_ _ _	_ _ _	_ _ _	_ _ _
_	_ _	_ _ _	_ _ _	_ _ _	_ _ _	_ _ _	_ _ _	_ _ _	_ _ _	_ _ _	_ _ _	_ _ _
_	_ _	_ _ _	_ _ _	_ _ _	_ _ _	_ _ _	_ _ _	_ _ _	_ _ _	_ _ _	_ _ _	_ _ _

The Department of the Interior Mission

As the Nation's principal conservation agency, the Department of the Interior has responsibility for most of our nationally owned public lands and natural resources. This includes fostering sound use of our land and water resources; protecting our fish, wildlife, and biological diversity; preserving the environmental and cultural values of our national parks and historical places; and providing for the enjoyment of life through outdoor recreation. The Department assesses our energy and mineral resources and works to ensure that their development is in the best interests of all our people by encouraging stewardship and citizen participation in their care. The Department also has a major responsibility for American Indian reservation communities and for people who live in island territories under U.S. administration.

The Minerals Management Service Mission

As a bureau of the Department of the Interior, the Minerals Management Service's (MMS) primary responsibilities are to manage the mineral resources located on the Nation's Outer Continental Shelf (OCS), collect revenue from the Federal OCS and onshore Federal and Indian lands, and distribute those revenues.

Moreover, in working to meet its responsibilities, the **Offshore Minerals Management Program** administers the OCS competitive leasing program and oversees the safe and environmentally sound exploration and production of our Nation's offshore natural gas, oil and other mineral resources. The MMS **Minerals Revenue Management** meets its responsibilities by ensuring the efficient, timely and accurate collection and disbursement of revenue from mineral leasing and production due to Indian tribes and allottees, States and the U.S. Treasury.

The MMS strives to fulfill its responsibilities through the general guiding principles of: (1) being responsive to the public's concerns and interests by maintaining a dialogue with all potentially affected parties and (2) carrying out its programs with an emphasis on working to enhance the quality of life for all Americans by lending MMS assistance and expertise to economic development and environmental protection.