1976

Aspects of systematics, morphology, life history and feeding of western Atlantic sciaenidae (pisces: perciformes)

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76-25,354

CHAO, Labbish Ning, 1947-
ASPECTS OF SYSTEMATICS, MORPHOLOGY, LIFE HISTORY AND FEEDING OF WESTERN ATLANTIC SCIAENIDAE (PISCES:PERCIFORMES).

The College of William and Mary in Virginia, Ph.D., 1976
Zoology

ASPECTS OF SYSTEMATICS, MORPHOLOGY, LIFE HISTORY AND FEEDING OF WESTERN ATLANTIC SCIAENIDAE (PISCES:PERCIFORMES)

A Dissertation

Presented to

The Faculty of the School of Marine Science

The College of William and Mary in Virginia

In Partial Fulfillment

Of the Requirements for the Degree of

Doctor of Philosophy

by

Labbish Ning Chao

1976

APPROVAL SHEET

This dissertation is submitted in partial fulfillment of

the requirements for the degree of

Doctor of Philosophy

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ACKNOWLEDGMENTS

I thank my graduate committee chairman, J. A. Musick, and members, D. F. Boesch, B. B. Collette, G. C. Grant, P. A. Haefner, Jr., and J. V. Merriner, for their help and guidance throughout the study and their patience to edit my English. Many people helped me to obtain museum specimens and fresh material, especially those who work as museum assistants and crew members of various research vessels. To those who remain anonymous, I would like to express my appreciation.

For permission to examine specimens in their institutions or for making specimens available to the VIMS collection, I thank the following: Marie-Louise Bauchot (MNHN); M. Boeseman (RMNH); James E. and Eugenia B. Böhlke (ANSP); Bruce B. Collette (NMFS, Systematics Laboratory, Washington, D. C.); William E. Eschmeyer (CAS); Karsten E. Hartel (MCZ); Robert K. Johnson (FMNH); Susan Karnella (USNM); Paul Kähsbauer (NHMV); Leslie W. Knapp (Smithsonian Oceanographic Sorting Center, Washington, D. C.); Jørgen G. Nielsen (ZMK); H. Nyssen (ZMA); Theodore W. Pietsch (formerly at MCZ); Donn E. Rosen (AMNH); William G. Saul and William Smith-Vaniz (ANSP); E. Trewavas (BMNH); Stanley H. Weitzman (USNM); and A. Wheeler (BMNH).

Field sampling was essential to this study. I thank D. Flescher, M. Grosslein, H. Jansen and H. Boyer of NMFS, Woods Hole and T. Azarovitz, NMFS, Sandy Hook for inviting me to participate on various oceanographic cruises. I also thank the crew members of R/V *Albatross IV*, Woods Hole, Massachusetts; *Atlantic Twin*, Sandy Hook, New Jersey; R/V *Eastward*, Beaufort, North Carolina; M/V *Oregon I* and *Oregon II*, Miami, Florida; and Pascagoula, Mississippi.

I also express my appreciation to the following personnel from VIMS: R. Bradley, J. Gilley and M. Williams for preparation of graphs; K. E. Thornberry and W. W. Jenkins for photographs; Frank Perkins and his assistants, especially Patricia Berry, for sectioning and staining gonads; William H. Kriete, Jr., James Colvocoresses, Douglas F. Markle, Jerome E. Illowsky and James Green, helped me in field work, including trawling, collecting, and measuring fishes during the study; Deborah A. Sprinkle typed up many drafts of this manuscript; Joice S. Davis answered many questions about different surveys; Genie Shaw retrieved all the hydrographic data from VIMS computer data storage; to my fellow graduate students, Douglas F. Markle, Linda P. Mercer and Charles A. Wenner for allowing me to talk at them about sciaenids and for helpful suggestions; to my major professor, John A. Musick for his courage in bailing me out of trouble and for his good judgment in allowing me freedom to do this work - most of all he is my friend. Large specimens of *Sciaenops ocellata*, which were very important to this study, were caught by Charles A. Wenner.

Early or obscure references vital to this study, were obtained through much appreciated efforts of: Bruce B. Collette and Daniel M. Cohen (NMFS, Systematics Laboratory, Washington, D. C.); Jack Marquardt and his staff at the Smithsonian library; Susan Barrick and her staff at VIMS library; Eugenie B. and James E. Böhlke (ANSP); Loren P. Woods (FMNH).

J. E. Fitch, California Department of Fish and Game, provided valuable comments on the otolith section. E. Trewavase (BMNH) offered advice in all stages of this study. John Wintersteen kindly offered his unpublished information on the genus *Stellifer*.

My greatest appreciation goes to Sara and Bruce Collette; they made me one of their family.

ABSTRACT

Part I. A Basis for Classifying Western Atlantic Sciaenidae (Pisces; Perciformes)

The sciaenids of the western Atlantic consist of 21 genera and 56 species placed in 11 supra-generic groups. They are the *Cynoscion, Larimus, Lonchiurus, Menticirrhus, Micropogonias, Nebris, Pogonias, Sciaena, Sciaenops, Stellifer* and *Umbrina* groups. The phylogenetic relationships of all western Atlantic genera are assessed on the basis of swimbladder, otolith (sagitta and lapillus) and external morphology. The *Stellifer* group differs from all other western Atlantic sciaenids by having a two-chambered swimbladder and an enlarged lapillus. Phylogenetic and ontogenetic trends of the swimbladder is proposed as from simple carrot-shaped to a more complicated structure with anterior diverticula and horns, to a very complicated lateral diverticula system. The sagitta usually is oval or elongated in shape. The thickness and the impression of the sulcus on the inner surface of the inner surface of the sagitta are diagnostic among genera. External morphology, especially related to the feeding habits, habitat, or both are adaptive, but a trend is evident that the closely related genera often have similar body shape, mouth position and other external features. The species of the genus *Stellifer* are unique by having many diverse mouth positions or feeding habits. The synopsis section of the paper includes a diagnosis, a primary synonymy and types of nominal species for each taxonomic category. Four genera and 23 nominal species of New World freshwater sciaenids are also included. A tested field key to species and genera of all western Atlantic sciaenids is included. The range of distribution and some meristic counts are listed under each species. This paper serves as a basis for further revision of western Atlantic sciaenids.

ABSTRACT

Part II. Life history, feeding habits and functional morphology of juvenile sciaenid fishes in the York River estuary, Virginia.

Four abundant sciaenid fishes, *Cynoscion regalis, Bairdiella chrysoura, Micropogonias undulatus* and *Leiostomus xanthurus* use the York River, Virginia as a nursery ground and as an adult seasonal feeding ground. In addition, six species of sciaenids, *Menticirrhus saxatilis, M. americanus, Sciaenops ocellata, Cynoscion nebulosus, Pogonias cromis* and *Larimus fasciatus* are present in the estuary occasionally. Yearling *C. regalis* were first caught in April and young of the year in July or August. Yearling *B. chrysoura* were first caught in March or April and young of the year in July or August. Juvenile *M. undulatus* and *L. xanthurus* may be present in the York River all year round. Young of the year *L. xanthurus* were first caught in April and *M. undulatus* were first caught in August. Small *M. undulatus* (15 to 20 mm TL) were caught from August to June, which may indicate a prolonged spawning season or a late spawning stock. Emigration to the ocean was found in all the four species during late fall or early winter. The relative abundance (catch per unit effort) of these four species indicated that water temperature and dissolved oxygen seemed to be the most important factors in the spatial and temporal distributions of these four species in the York River.

Six sciaenid species, *Larimus fasciatus, Cynoscion regalis, Bairdiella chrysoura, Micropogonias undulatus, Menticirrhus saxatilis* and *Leiostomus xanthurus* were examined for their food habits and functional morphology of feeding apparatus. The mouth position, dentition, gill rakers, digestive tract, pores and barbels, nares and body shape were found to be important for these sciaenids in locating and ingesting prey in the water column. Stomach contents indicated that the food partitioning of these six species was closely correlated with the habitat where each species was adapted to feed in. *Leiostomus fasciatus, Cynoscion regalis,* and *Bairdiella chrysoura* fed mainly above the bottom, whereas *M. undulatus, M. saxatilis* and *L. xanthurus* fed on epifauna, infauna or both.

Juvenile sciaenids are able to coexist in the same area because of differences in spatial and temporal distribution, relative abundance and food habits.

PART I

A BASIS FOR CLASSIFYING WESTERN ATLANTIC SCIAENIDAE (PISCES:PERCIFORMES)

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INTRODUCTION

Sciaenid fishes are characterized by their large otoliths and, with few exceptions, by the large vacuous lateral line pores on the snout and lower jaw, and by the extension of the lateral line to the tip of the caudal fin. They are also characterized by a large and often complex swimbladder and by the presence of well-developed drumming muscles. This paper treats 21 genera and 56 species of Sciaenidae in the western Atlantic Ocean. There are also four genera and 23 nominal species of sciaenid fishes present in freshwater river systems of the New World.

Current concepts of sciaenid classification are largely based on the morphology of swimbladder, otoliths (sagitta and lapillus), snout (rostral) and mental (mandibular) pores and/or barbels (Chu, Lo and Wu, 1963; Trewavas 1962, 1964; Robins and Tabb, 1965; Gilbert, 1966; Mohan, 1969; and Chao and Miller, 1975). Other characters, such as the position of the mouth, dentition, body form, size of the second anal spine, marginal serration of the preopercle, arrangement of lateral line scales, color of peritoneal lining, and numbers of gill rakers, fin ray counts and vertebrae are important in distinguishing species, and have been used by many authors (see section "A brief history of the study of western Atlantic Sciaenidae") to assign species to genera or to assess the generic relationships of western Atlantic Sciaenidae. However, the generic boundaries have not been well-defined and many nomenclatural problems prevail.

The purpose of this paper is to clarify the generic boundaries, to define supra-generic groups, and to describe the evolutionary trends of western Atlantic Sciaenidae primarily on the basis of the morphology of the swimbladder, otolith and snout and mental pore and/or barbel systems.

To classify the taxa above the generic level, the term supra-generic group is used here. Different attempts have been made to group sciaenid genera. Trewavas (1962) grouped eastern Atlantic sciaenids into tribes. Chu, Lo and Wu (1963) grouped sciaenids of the Chinese coasts into subfamilies. Mohan (1969) grouped Indian sciaenids into both subfamilies and tribes. The supra-generic groups used here are comparable to the tribes of Trewavas (1962) and the subfamilies of Chu, Lo and Wu (1963), and avoid the taxonomic problems inherent in utilizing formal taxonomic categories. Like those studies, the present assessment is also a regional study. Variations in swimbladder, otolith, and external morphology are found at different taxonomic levels. Therefore, a comparative study of sciaenids from several geographic regions, especially the eastern Pacific area, is necessary before allocating the western Atlantic sciaenid genera to formal taxonomic categories (tribes or subfamilies).

MATERIALS

Type material and other preserved specimens were examined from the following institutions:

AMNH - American Museum of Natural History, New York, New York.

ANSP - Academy of Natural Sciences, Philadelphia, Pennsylvania.

BMNH - British Museum (Natural History), London, England.

CAS - California Academy of Sciences, San Francisco, California.

FMNH - Field Museum of Natural History, Chicago, Illinois.

LACM - Los Angeles County Museum of Natural History, Los Angeles, California.

MCZ - Museum of Comparative Zoology, Harvard University, Cambridge, Massachusetts.

MNHN - Museum National d'Histoire Naturelle, Paris, France.

NHMV - Naturhistorisches Museum, Vienna, Austria.

NMFS - National Marine Fisheries Service, NOAA, U.S.A.

RMNH - Rijksmuseum van Natuurlijke Historie, Leiden, Netherland.

USNM - United States National Museum, Washington, D. C.

VIMS - Virginia Institute of Marine Science, Gloucester Point, Virginia.

ZMA - Institute voor Taxonomische Zoologie, Universiteit van Amsterdam, Amsterdam, Netherland.

ZMK - Zoological Museum, Copenhagen, Denmark.

Freshly frozen and formalin-preserved specimens were also obtained from various biological surveys, along the Atlantic Seaboard of the U. S. These surveys were conducted by the Virginia Institute of Marine Science on various research vessels, by NMFS, Woods Hole, on R/V *Albatross IV* and Sandy Hook, on R/V *Atlantic Twin*, and by National Science Foundation's R/V *Eastward*, Beaufort. Specimens examined from Gulf of Mexico and Atlantic coast of South America were collected mainly by NMFS research vessels, the M/V *Oregon I* and *Oregon II* from 1962 to 1975. Type-specimens examined are indicated under the synonymy of each species. Numerous additional specimens have been studied, most of which are deposited at VIMS and USNM.

METHODS

The comparative morphology of swimbladder, otolith and pore systems were examined. Other characters important in the recognition of species and genera were the arrangement and size of lateral line scales, serrations of the preopercular margin, size of the second anal fin spines, color of the branchial chamber and peritoneal linings, meristics and morphometrics. The standard methods of Hubbs and Lagler (1958) were used for all counts and measurements except for some modifications described by Chao and Miller (1975). In addition, scales perforated by lateral line tubes or pores were counted as lateral line scales from the upper end of the gill slit to the end of the hypural plate. On those species lacking well-defined lateral line tubules or pores, counts were made on the scale series immediately above the lateral line. Vertebral counts were determined from radiographs and from cleared and stained specimens (Taylor, 1967). The first caudal vertebra was identified by the absence of pleural ribs on the haemal process and usually by a short haemal spine just behind the elongated proximal pterygiophore of the anal fin.

Otoliths of most species were extracted from freshly caught specimens but some came from preserved specimens. The inner surface of the right sagitta and lapillus (in the *Stellifer* group) were illustrated. Ontogenetic changes of otoliths and swimbladder were studied in some species.

METHODS

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All available type-specimens were examined to assure the true identities of species and genera of sciaenids studied in this paper. A primary synonymy is listed for each species to clarify nomenclatural problems.

Morphological terminology used here follows Chu, Lo and Wu (1963), Trewavas (1962, 1964) and Chao and Miller (1975). A modification of the terms used for the snout pores was suggested by Dr. E. Trewavas of BMNH, and for otoliths by Mr. J. Fitch of the California Department of Fish and Game. Snout pores along the margin of the rostral fold are termed marginal (snout) pores and pores in front or above them are termed upper (snout) pores (Fig. 1). The surface of the sagitta, with a "tadpole-shaped" sulcus is the inner surface and the obverse side is the outer surface (Fig. 2) because of the *in situ* position of the sagitta (Fig. 3). Also, the lateral margins of the sagitta are termed dorsal and ventral margins (Frizzell and Dante, 1965). The "head section" of the sulcus is called the "ostium" and the "tail section" is called the "cauda" (Stinton, 1975 and J. Fitch, personal communication).

A BRIEF HISTORY OF THE STUDY OF WESTERN ATLANTIC SCIAENIDAE

Prior to the binominal system of Linnaeus, Catesby in his 1743 edition of "The natural history of Carolina, Florida and the Bahama Islands", illustrated "Perca marina" (= *Micropogonias undulatus*), the croker (plate 3), from Chesapeake Bay and "Alburnus Americanus" (= *Menticirrhus americanus*), the whiting (plate 12), from Charleston, South Carolina. Edwards (1751) in the appendix of "A Natural history of birds" illustrated (plate 210) a "Ribband Fish" (= *Eques lanceolatus*) from the Caribbean Islands. Linnaeus (1758) in his tenth edition of "Systema naturae", Pisces Thoracici, recorded the genus *Sciaena* with five species, none of them from the western Atlantic. However, two species of western Atlantic Sciaenidae were named as *Chaetodon lanceolata* (= *Equetus lanceolatus*) based on Edwards' plate and *Cyprinus* americanus (= *Menticirrhus americanus*) from "the whiting" of Catesby. In the 12th edition of "Systema naturae", 1766, Linnaeus added *Labrus chromis* (= *Pogonias cromis*), *Perca alburnus* (= *Menticirrhus americanus*), *Perca punctata* (= *Bairdiella chrysoura*), *Perca ocellata* (= *Sciaenops ocellata*) and *Perca undulata* (= *Micropogonias undulatus*), although he did not place them with the Sciaenidae of Europe.

Bloch and Schneider (1801) in their "Systema ichthyologiae" reported six genera and nine species of western Atlantic Sciaenidae. They were *Johnius regalis* (= *Cynoscion regalis*), *J. saxatilis* (= *Menticirrhus saxatilis*), *Sciaena chromis* (= *Pogonias cromis*),

(= *Pogonias cromis*), *Lonchurus depressus* (= *Lonchiurus lanceolatus*), *Lonchurus ancylodon* (= *Macrodon ancylodon*), *Eques americanus* (= *Equetus lanceolatus*), *Eques punctatus*, *Grammistes accuminatus* (= *Pareques acuminatus*) and *Bodianus stellifer* (= *Stellifer stellifer*). A year later (1802) Lacépède in volume three of "Historie Naturelle des Poissons" recorded *Dipterodon chrysourus* (= *Bairdiella chrysoura*), *Pogonias fasciatus* (= *P. cromis*) and *Cheilodipterus acoupa* (= *Cynoscion acoupa*) and in volume four (1803) he added *Lutjanus cayennensis* (= *Cynoscion acoupa*), *Lutjanus triangulum* (= *Sciaenops ocellata*), *Centropomus alburnus* (= *Menticirrhus americanus*), *Sciaena croaker* (= *Micropogonias undulatus*) and *Leiostomus xanthurus* of the western Atlantic and also a fresh water sciaenid *Perca furcroi* (= *Pachypops fourcroi*) from Surinam.

The boundaries of the species, genera and family Sciaenidae were not well-defined, until Cuvier. In the first edition of "Régnè Animal" (1817) Cuvier defined limits to the application of some generic names (e.g. *Umbrina* and *Sciaena*). Also four new genera of western Atlantic Sciaenidae were described: scientific names *Stellifer*, *Umbrina*, *Otolithes* and *Ancylodon* were derived from Cuvier's vernacular names by Oken (Isis, 1817). In the second edition, Cuvier (1829) added a new generic name *Corvina*. Cuvier and Valenciennes (1830) in volume five of "Histoire Naturelle des Poissons", described seven genera and 21 species of western Atlantic sciaenids. There were four new genera, i.e., *Larimus*, *Nebris*, *Lepipterus* and *Micropogon* and five freshwater nominal species, *Corvina oscula* (= *Aplodinotus grunniens*), *C. furcroea* (= *Pachypops fourcroi*) and *Lepipterus francisci* (= *Pachyrus francisci*) were included. They also described and illustrated the swimbladders of six western Atlantic sciaenid fishes. Günther (1960) recorded 12 genera and 45 species of Sciaenidae from the western Atlantic including three genera and nine species from freshwater. He used the shape of the swimbladder as one of the diagnostic characters in some of his generic descriptions. Jordan and Eigenmann (1889) listed 22 genera and 60 species, including four genera and 11 species of freshwater sciaenids. Jordan and Everman (1895) included only 21 genera and 50 species of Sciaenidae from the Atlantic in the "Fishes of North and Middle America" including three genera and five species from freshwater. The studies of Desmarest (1823), Agassiz (1829), Castlenau (1855), Steindachner (1863), Bleeker (1865 & 1873), Poey (1881), Berg (1895) and more recently of Miranda Ribeiro (1915), Meek and Hildebrand (1925), Ginsburg (1929), Fowler (1941 & 1954), Schultz (1945 & 1949), Travassos and Paiva (1957), Cervigon (1966a & 1973), Vazzoler (1969), Travassos and Rego-Barros (1971), Roux (1973) and Jardim (1973) have contributed to the knowledge of taxonomy and distribution of western Atlantic sciaenids in different geographic regions. At present, 21 genera and 56 species of sciaenids are recognized from the western Atlantic. In addition, there is one monotypic genus (*Aplodinotus*) recognized from the freshwaters of North America, and three genera (*Pachypops*, *Plagioscion* and *Pachyurus*) from the freshwaters of South America.

Few studies have been made on the relationships of genera, and higher divisions of western Atlantic Sciaenidae. Gill (1861 a,b,c & d) revised the genera and named six subfamilies for North American sciaenids, i.e. Corvininae, Haploidonotinae, Lariminae, Liostominae, Otolithinae and Sciaeninae. Later, only five subfamilies of Sciaenidae were listed, the Corvininae was not mentioned (Gill, 1863a & 1873). Genera and subfamilies were defined by external characters and the boundaries between them were not clear. Bleeker (1876) in part two of "Systema Percarum Revisum" names two phalanxes (= tribes), the Sciaenini and Hemisciaenini for the familiar "Sciaenoidei". He also described three subphalanxes (= subtribes) in the Sciaenini, i.e. Equili, Aplodinoti and Johnii, and two subphalanxes in the Hemisciaenini, i.e. Pseudosciaeni and Otolithi. The western Atlantic sciaenid genera were described under each subphalanx. The diagnostic characters for each taxon were determined from the external morphology, e.g. mouth position, dentition, scales and fin rays.

Jordan and Eigenmann (1889) and Jordan and Evermann (1895) divided the Sciaenidae into two subfamilies, the Otolithinae and Sciaeninae, based on the number of precaudal and caudal vertebrae, lower jaw position, dentition, and size of the second anal spines. In the present study, I did not find these characters useful above the generic level. The first comprehensive studies on the species and generic relationships of sciaenids were published by Trewavas (1962) for tropical west African sciaenids and Chu, Lo and Wu (1963) for Chinese sciaenids. Trewavas (1962) grouped the nine west African sciaenid species into five tribes, based mainly on swimbladder structure; and the diagnostic characters of each tribe were clearly defined. Chu, Lo and Wu (1963) grouped 37 species of Chinese sciaenid fishes into seven subfamilies based on both swimbladder and otolith structure. Relationships among genera and subfamilies were also clearly defined. Because the authors lacked access to type material, the true identity of a few species may be in doubt. Trewavas (1964) discussed the relationships of sciaenid fishes with a single mental barbel. She used the number of barbels and the structure of the swimbladder to assess the relationships of some barbeled sciaenid genera of the New World and suggested possible links of certain genera with Old World sciaenids. Similarly, Mohan (1969) used morphology of the swimbladders and otoliths as diagnostic characters to define each of the 14 genera of Indian Sciaenidae. Although Mohan (1969) placed 14 genera in five subfamilies and recognized two tribes in each of two subfamilies, the restrictions of some subfamilies and tribes remained unclear.

DESCRIPTION AND RELATIONSHIPS

The morphology of the swimbladders, otoliths, snout and mental pores and barbels are diagnostic in the classification of sciaenid fishes. Within each of the characters, there are several structural patterns which may reflect phyletic relationships among groups of genera. The variations within each pattern are important in understanding the boundaries of different taxa. At the species level, the ontogenetic development of certain characters may suggest possible trends in phylogenetic relationships in higher taxa of the family. The presence of drumming muscles in males or in both males and females of certain taxa is also useful in assessing the relationships of sciaenids. Other characters essential for the study of relationships at the genus and species level but not at the family level are described in the key (see section "Field key to the genera and species of western Atlantic Sciaenidae").

Based on swimbladder, otoliths and external morphology of all western Atlantic sciaenid fishes, phyletic relationships are proposed here for 21 marine and two freshwater genera (Fig. 4). The relationships among the supra-generic groups were determined primarily by swimbladder morphology and secondarily by the morphology of the otoliths. External morphology was of some use as long as the adaptive and potentially convergent nature of these characters was kept in mind. By following the tactics used by Bolin (1947) for the marine Cottidae of California, the actual or "convenient" classification level for tribes may be drawn as between dotted lines C and D on Figure 4. The subfamily level may be drawn between lines A and B.

I. Relationships Based on the Morphology of the Swimbladders.

Sciaenid fishes have a physoclistous swimbladder with a single or two inter-connected chambers. The usually well-developed swimbladder is attached very firmly to the ventral surface of the third to sixth vertebrae, under the post cardinal vein. The associated swimbladder (drumming) muscles usually present in males, are extrinsic except in *Pogonias*, in which they are intrinsic. The drumming muscles are composed of red striated fibres with abundant cytoplasm and conspicuous nuclei (Tower, 1908; Jones and Marshall, 1953). Tower (1908) also concluded that contractions of the drumming muscle set up vibrations in the bladder walls, thus producing sounds. Sound production in sciaenid fishes may function as recognition signals associated with spawning, feeding and aggressive behavior (Dijkgraaf, 1947; Knudsen, et. al. 1948; Johnson, 1948, Jones and Marshall, 1953; Chu, Lo and Wu, 1963). The sounds produced by different species of sciaenids also have different ranges of frequencies (Knudsen, et. al. 1948; Fish and Mowbray, 1970). This may result from the different morphology of swimbladders in different sciaenids. Comparison of sciaenid swimbladders in the present study is confined to external morphology and *in situ* position within the fish.

1. The morphological patterns of swimbladders.

All western Atlantic sciaenids have well-developed swimbladders except the genera *Menticirrhus* and *Lonchiurus*. The swimbladders in *Menticirrhus* atrophy during the juvenile stage. Only a vestige remains in adults. In adult *Lonchiurus*, the relative size of the swimbladder is much reduced. Based on swimbladders, western Atlantic sciaenids can be divided into two groups. One group has a single chambered swimbladder (Figs. 5 to 14) and the other has a two chambered swimbladder (Figs. 15 & 16). A total of eight distinct structural patterns of swimbladders are recognized here.

A. The group with a single chambered swimbladder.

1) *Sciaena* pattern:

A simple carrot-shaped swimbladder without well-developed anterior horns or diverticula (Fig. 5), its anterior end slightly in front of septum transversum and never reaching the skull. Swimbladders of nine genera have this pattern: *Aplodinotus, Ctenosciaena, Equetus, Larimus, Leiostomus, Menticirrhus, Pareques, Sciaena* and *Umbrina*. Although the swimbladder of *Larimus breviceps* has an additional pair of anterior projections (Fig. 5,F), *L. fasciatus* (Fig. 5,E) lacks the projections. Thus, *Larimus* should be included in this category. *Pachyurus schomburgkii* has a simple swimbladder and differs from *Pachyurus bonariensis* (Fig. 6). The generic status of *Pachyurus* is discussed in the synopsis section.

The swimbladder of *Menticirrhus* degenerates or atrophies in the adult. *M. saxatilis* has a well-developed simple bottle-shaped swimbladder in young specimens up to 90-100 mm SL (Fig. 7,A & B), but only a trace of the swimbladder remains in the adult (Fig. 7,C & D). Bearden (1963) reported the length and condition of the swimbladders of 420 *M. americanus*. His results showed a gradual atrophy of the swimbladder from specimens of 56 to 60 mm SL (5.6% atrophied) to specimens of 125 to 130 mm SL (100% atrophied) in *M. americanus*. During this study, 28 specimens of *M. littoralis* were examined from 50 to 108 mm SL. Five specimens 71.1 to 108 mm SL had completely atrophied swimbladders and the rest had only a trace of the swimbladder less than 7 mm in length. *M. americanus* and *M. littoralis* have their atrophied swimbladder even in juvenile specimen. The juvenile swimbladder of the genus *Menticirrhus* may also be included in the *Sciaena* pattern.

2) *Nebris* pattern:

The swimbladder has a pair of broad diverticula which originate on the anterio-lateral margin of the main chamber, extend posterior and loop anteriorly near the posterior end of the main chamber (Fig. 8). The diverticula are tapered and terminate anteriorly at the septum transversum. *Nebris* is the only genus with this pattern of swimbladder.

3) *Micropogonias* pattern:

The swimbladder of *Micropogonias* has a pair of tube-like diverticula which originate from the posterior half of the main chamber laterally (Fig. 9). The diverticula extend anteriorly to the septum transversum, but never reach the skull, then curve posteriorly to the anterior border of the swimbladder medially. *Micropogonias* is the only genus with this pattern of swimbladder.

4) *Pogonias* pattern:

A very complex lateral system of diverticula (Fig. 10) characterize the swimbladder of *Pogonias*, the only genus possessing this pattern. A study of the ontogenetic development of this swimbladder pattern (Fig. 10) may reveal the developmental pathway of other swimbladder patterns.

5) *Sciaenops* pattern:

The swimbladder of *Sciaenops* has a pair of tube-like anterior diverticula (Fig. 11,A). In large specimens, the complicated lateral diverticula and a pair of sac-like projections are found dorso-laterally at the anterior portion (Fig. 11,B & C). These diverticula are constructed of numerous small labyrinthine chambers (Fig. 11,c). Sometimes the lateral diverticula are completely covered with fat tissue (Fig. 11,B). A pair of holes is also present dorso-laterally on the body wall, between the third and fourth pleural ribs, to receive the dorsal projections of the swimbladder. *Sciaenops* is the only genus with this pattern of swimbladder.

6) *Cynoscion* pattern:

A pair of prominent horns develops anteriorly from the simple carrot-shaped swimbladder without lateral diverticula (Fig. 12); the well-developed anterior horns sometimes reaching to the back of the skull. Four genera have this pattern: *Cynoscion, Isopisthus, Macrodon,* and *Plagioscion*. Variations among genera and species (Figs. 12 & 13) with this pattern of swimbladder are limited to the extension of the horns, whether they are broad or narrow, straight or curved. These genera, except the freshwater *Plagioscion*, have similar external features, such as an oblique terminal mouth, canine-like dentition, and similar habitats. They form a distinct group among western Atlantic sciaenids.

7) *Lonchiurus* pattern:

The swimbladder has a pair of forked anterior horns, each with a long posteriorly directed branch and a short branch directed anteriorly (Fig. 14). *Lonchiurus, Paralonchurus* and *Pachypops fourcroi* have this pattern. The anterior horns of swimbladders in *Lonchiurus* and *Paralonchurus* are rather stout and short (Fig. 14,A to C). They are thinner and longer in *Pachypops fourcroi* (Fig. 14,D), pierce the septum transversum and curve under the base of the skull. The relative size of the swimbladder in *Lonchiurus* is much reduced (Fig. 14,A, A' & A").

B. The group with a two chambered swimbladder.

8) *Stellifer* pattern:

The swimbladder is divided into two chambers by an anterior constriction. The anterior chamber reaches to the skull, is yoke-shaped and the posterior chamber is carrot-shaped (Fig. 15). *Bairdiella, Odontoscion, Ophioscion,* and *Stellifer* have this pattern. A pair of diverticula is present on the anterior chamber postero-laterally in *Stellifer* (Figs. 15,B & 16). These genera usually have two pairs of enlarged otoliths (Fig. 2,A & B, also see otolith section), a rather strong second anal spine and are relatively small in size.

2, Phylogenetic relationships based on swimbladder patterns.

Western Atlantic sciaenids can be separated into two distinctive groups (Fig. 17), based on the number of the chambers of the swimbladder. The *Stellifer* group differs from all other Sciaenidae by having two chambers (Fig. 15). Single chambered swimbladders are generally carrot-shaped with or without lateral diverticula except for the *Cynoscion* and *Lonchiurus* patterns (Figs. 5 to 14). In the *Cynoscion* pattern, the well-developed anterior horns are unique (Fig. 12). The *Lonchiurus* pattern also develops a pair of posterior diverticula from the base of the anterior horns (Fig. 14).

The genus *Menticirrhus* has only a vestige of the swimbladder in adults (Fig. 7). This trend of swimbladder reduction is also found in fishes with the *Lonchiurus* pattern swimbladders. There is a gradual reduction in size of the swimbladder from *Paralonchurus braciliensis*, to *P. elegans*, then to *Lonchiurus lanceolatus* (Fig. 14), the latter apparently lacking a functional swimbladder. The gradual ontogenetic reduction in the relative size of swimbladders in the species of *Menticirrhus* and in *L. lanceolatus* may indicate close relationships among these fishes.

Further divisions of this character (Fig. 17) rely on the complexity of the swimbladders. *Sciaena* pattern is a simple carrot-shaped swimbladder without well-developed diverticula (Fig. 5). Although *Larimus breviceps* has a pair of small anterior projections (Fig. 5,F), this appears to be a variation within the *Sciaena* pattern. The swimbladder pattern with well-developed diverticula can also be divided into two groups (or more) by the complexity of their lateral diverticula (Fig. 17). *Nebris* and *Micropogonias* have only a pair of tube-like diverticula. The diverticula in *Nebris* originate from the antero-lateral margin of the main chamber (Fig. 8). In *Micropogonias*, the paired tube-like diverticula originate from the posterior half of the main chamber (Fig. 9). Another pattern of a rather simple diverticulated swimbladder is found in *Pachyurus bonariensis* (Fig. 6,A). It has a pair of anterior tube-like diverticula directed posteriorly.

Sciaenops and *Pogonias* have much more complicated lateral diverticula in adults. *Sciaenops* has a simple short pair of diverticula in young specimens (Fig. 11,A) and the "sac-like" projections located dorso-laterally develop in larger specimens (Fig. 11,C). The complicated diverticula on the swimbladder of *Pogonias* also develop ontogenetically (Fig. 10). The ontogenetic development of the swimbladder in *Pogonias* indicates that the diverticula were developed from the simple swimbladder from anterior to posterior portions of the main chamber. This evidence may also reflect the phylogenetic development of the swimbladder in the Sciaenidae.

<u>Specific characters</u>.

There are variations of swimbladder morphology within the general patterns. In the *Stellifer* pattern, the species of *Stellifer* have a pair of "bulb-like" or "tube-like" diverticula at the posterio-lateral margins of the anterior chamber (Figs. 15 & 16). Slight variations are also found in species such as *S. griseus* and *S. microps* (Fig. 16,B & C). *Bairdiella, Odontoscion,* and *Ophioscion* lack diverticula on the anterior chamber of the swimbladder (Fig. 15,A). The anterior horns in the *Stellifer* pattern terminate near the articulation between the opercular and hyomandibular bones (J.

Wintersteen, personal communication). In *Bairdiella* and *Odontoscion*, these horns curve forward abruptly and their tips end just behind the *adductor operculi* muscle and medially to the *dialator* and *levator operculi*. In *Ophioscion* and *Stellifer*, the anterior horns of the swimbladder diverge more laterally and their tips end subcutaneously, and are frequently visible on superficial inspection.

In the *Cynoscion* pattern, variations of the anterior horn morphology was found among different genera (Fig. 12), species and also ontogenetically within species (Fig. 13). There is little variation among the swimbladder morphology of the *Sciaena* pattern (Fig. 5). The anterior projections are present in *Larimus breviceps* and absent in *L. fasciatus*, indicating the possible extent of variation of swimbladder morphology within a genus and/or a pattern.

Although swimbladder morphology has been viewed as basic to the scheme of sciaenid classification (Trewavas, 1962; Chu, *Lo* and *Wu*, 1963; Mohan, 1969), features of some defined swimbladder patterns may vary widely. In setting generic limits, onotgenetic variations and intraspecific variation in certain species (not with growth) are important. Assessing the phyletic relationships of western Atlantic Sciaenidae is limited when complex swimbladders are involved. The criterion of simplicity or complexity is difficult among some taxa, but the evidence does indicate the trend of swimbladder development, i.e., from simple to complex with the diverticula probably evolving from the anterior portion towards the posterior portion of the main swimbladder chambers.

The drumming muscle is also useful in assessing relationships within sciaenid fishes. The development of the drumming muscles seems to be correlated with the size of swimbladders and the sound producing function in some western Atlantic sciaenids. Generally, the drumming muscles are present in male sciaenid fishes with a well-developed swimbladder. In fishes with the *Lonchiurus* pattern swimbladder (Fig. 14), the drumming muscles are well-developed in amles of *Paralonchurus* but absent in *Lonchiurus*, which is correlated with the size (or function) of the swimbladder. *Menticirrhus* has only a vestigial swimbladder and lacks drumming muscles. Drumming muscles are present in both male and female *Micropogonias*. *Pogonias* has a unique drumming muscle among western Atlantic sciaenids, located intrinsically on the complicated swimbladder in both sexes (Fig. 10). The drumming muscles of male *Cynoscion regalis* are only well-developed during the spawning season, and regress after spawning (J. Merriner, personal communication).

Possible relationships of western Atlantic sciaenids to sciaenids of other geographic areas may be revealed by the swimbladder shapes. Trewavas (1964) suggested a possible link of *Pachypops* and *Polyclemus (= Paralonchurus)*, the *Lonchiurus* pattern swimbladder, with the tropical West African tribe Pseudotolithini. And the swimbladder of *Atractoscion aequidens* (Cynoscionini of Trewavas) agrees with the *Cynoscion* pattern of the present study. The diverticula on the swimbladder of *Pachyurus bonariensis* (Fig. 6,A) is also similar to that of *Bahaba flavolabiata* of the Indo-West Pacific (Chu, *Lo* and *Wu*, 1963). The complex swimbladder of the *Pogonias* and *Sciaenops* patterns resemble those of many Indo-Pacific (Chu, *Lo* and *Wu*, 1963; Mohan, 1969) and some East Pacific sciaenids (e.g. *Roncardor stearnsii*). Their relationships are not known at present.

II. Relationships Based on the Morphology of the Otoliths.

The inner ear of sciaenids consists of three semicircular canals and a large sacculus, wherein the sagitta is contained (Fig. 3). The utriculus is an expanded area of the anterior semicircular canal containing the lapillus near the junction with the horizontal semicircular canal. This section is greatly expanded in fishes with a large lapillus (Fig. 3,B & B'). Posteriorly, the lagena is a small sac, located postero-dorsally to the sacculus, where the asteriscus is contained (Parker, 1908; and Chu, Lo and Wu, 1963). The relative size of the three otoliths, particularly the sagitta in all and lapillus in some sciaenids, are larger than in most Perciformes. The discussion here is based on the general morphology of the sagitta and the lapillus. The sagitta lies obliquely in the sacculus with the smooth surface inside (medially) and is oriented ventro-laterally *in situ* (Fig. 3). The lapillus is enclosed in the utriculus obliquely, with the smooth surface inside and is oriented laterally (Fig. 3,B & B').

1. The morphological patterns of otoliths.

The sagitta of Sciaenidae is characterized by having a distinct "tadpole-shaped" sulcus alwasy on its inner surface (Fig. 2). A marginal groove is usually present between the dorsal margin and the sulcus of the sagitta. The anterior portion of the sulcus usually is expanded into a pear or oval shape and is termed the "ostium". The elongated narrow posterior portion is usually bent obliquely and is termed the "cauda" of the sulcus (Frizzell and Dante, 1965;

Stinton, 1975). The sagitta distinguishes sciaenids from other families in that the ostium is merely outlined and never channeled as in other families, whereas the cauda is always channeled (or scooped out) in the Sciaenidae. The outer surface usually has crest-like or blotch-like projections or granulations (Fig. 2, B' & C'). Western Atlantic sciaenids can readily be divided into two groups based on their otoliths: a group with both the lapillus and the sagitta enlarged and a group with only the sagitta enlarged (Fig. 2). Based on the shape, thickness and size of the sagitta and lapillus, and the morphology of the ostium and the cauda of the sulcus, 11 distinct patterns of otoliths are recognized here.

A. The group with only the sagitta enlarged.

1) *Sciaena* pattern:

The sagitta is more or less oval, usually with a smoothly convex ventral margin and a straight or crenulated dorsal margin (Fig. 18). Laterally the outer surface of the sagitta is usually much thicker in the middle. The ostium of the sulcus is usually broad, pear-shaped and reaches the anterior margin of the sagitta. The cauda is J-shaped with a relatively long and naroow distal end. A marginal groove is usually present between the sulcus and dorsal margin of the sagitta. *Ctenosciaena, Equetus, Leiostomus, Pachyurus, Pareques, Plagioscion, Sciaena* and *Umbrina* have this pattern (Fig. 18). Variations in this sagitta pattern are mainly in the position of the ostium and the length and the curvature of the cauda, both of which vary among genera and species. In most species, the ostium is straight or bent ventrally (to the left of Fig. 18). *Leiostomus xanthurus* (Fig. 18,D) is unique in having the ostium bent to the dorsal margin and the sagitta slightly elongated and much thinner. *Plagioscion surinamensis* (Fig. 18,L) has a very long and curved distal end of the cauda. They are included in the *Sciaena* pattern for the convenience of the present study.

2) *Pogonias* pattern:

The sagitta is more or less semi-circular in shape with an evenly curved ventral margin and a straight but finely crenulate dorsal margin (Fig. 19). The ostium of the sulcus is broad and does not reach the anterior margin of the sagitta. The cauda is J-shaped with a pointed distal end and does not reach to the margin. The marginal groove is present between the sulcus and the dorsal margin of the sagitta. *Pogonias* and *Aplodinotus* have this pattern. The relative size of the "tadpole-shaped" sulcus is larger in *Pogonias* than in *Aplodinotus*. The sagitta is more curved laterally in *Pogonias* than *Aplodinotus*, but the latter has more granulations on the outer surface (Fig. 19,B' & b).

3) *Larimus* pattern:

The sagitta is slightly elongate and ovoid with rather straight and slightly crenulate dorsal margin, and convex ventral margin (Fig. 20). The ostium of the sulcus is large, pear-shaped and does not reach the anterior margin of the sagitta. The J-shaped cauda is bent acutely with a pointed distal end. The marginal groove is not distinct. *Larimus* and *Sciaenops* have this pattern. The sagitta of *Larimus* is broader anteriorly than posteriorly (Fig. 20, A & B), both ends are about equal in *Sciaenops* (Fig. 20, C & D). The posterior portion of the sagitta is laterally very thick in *Larimus* (Fig. 20, a & b). *Sciaenops* has a rather thin sagitta (Fig. 20, c) and the shape of the sulcus is different from *Larimus*, therefore, a distinct otolith pattern may also be recognized.

4) *Nebris* pattern:

The sagitta in *Nebris* is very thick and oval with a notch at the posterior margin (Fig. 21). The ostium of the sulcus is large and ovoid and does not reach the anterior margin of the sagitta. The cauda is sharply bent with a very deeply grooved and enlarged distal portion. The marginal groove is absent. The outer surface of the sagitta is extremely elevated and very thick laterally (Fig. 21, a).

5) *Cynoscion* pattern:

The sagitta is elliptical and thin (Figs. 22, A & 23), the inner margin usually smoothly convex and the ventral margin slightly concave and finely crenulate. Laterally, the posterior portion of the sagitta is thicker than the anterior portion. The sulcus is usually elongate, the ostium ovoid or pear-shaped (Figs. 22,A & 24). The anterior end of the ostium may or may not reach the naterior margin of the sagitta. This varies among species and also within species ontogenetically (Fig. 23). The cauda is long and bent with a short distal end (Figs. 22,A & 23). The outer surface usually has a granular appearance, especially in large adult specimens (Fig. 23,a, b & c). *Cynoscion* species have this pattern. Sometimes a notch is present at the middle of the dorsal margin of the sagitta (Fig. 23,C & C') in species of *Cynoscion*.

6) *Menticirrhus* pattern:

The sagitta is elliptical and thin (Fig. 22,B, B' & b), the dorsal margin usually straight and finely crenulate, and the ventral margin slightly convex. Laterally, the middle portion is the thickest. The sulcus is elongate, the ostium in pear-shaped (Fig. 22,B) and does not reach the anterior margin of the sagitta. The cauda is long and J-shaped. The outer surface usually has crests and granulations. *Menticirrhus* species have this pattern.

7) *Lonchiurus* pattern:

The sagitta is usually thin and elongate (Fig. 24), the ventral margin usually smoothly convex and the dorsal margin slightly concave or crenulate. Laterally, the posterior portion of the sagitta is thicker than the anterior portion. The sulcus on the inner surface is elongate (Fig. 24). The ostium is pear-shaped and bent toward the ventral margin of the sagitta anteriorly. The cauda is J-shaped with a rather expanded distal end, close or reaching to the ventral posterior margin of the sagitta. The outer surface has granulations (Fig. 24,a, b &c). *Lonchiurus* and *Paralonchurus* have this pattern. There are two distinctive forms of sulcus on sagittae of this pattern. *Lonchiurus lanceolatus* and *Paralonchurus elegans* have a rather narrow ostium of the sulcus (Fig. 24,A & B). *P. brasiliensis* has a relatively thicker sagitta and the ostium of the sulcus is broader (Fig. 24,C & c).

8) *Isopisthus* pattern:

The sagitta is slightly elongate, rather broad and thick (Fig. 25,A, A' & a). The sulcus is elongate, the ostium is round and reaches to the anterior margin of the sagitta. The cauda is long and slightly bent at the distal end. The outer surface has crest-like elevations, especially thickened at the posterior half (Fig. 25,a). *Isopisthus* has this pattern.

9) *Macrodon* pattern:

The sagitta is elongate and thin (Fig. 25,B, B' & b). The dorsal margin has a deep notch on the posterior half and the ventral margin has a projection in the middle. Laterally, the anterior portion of the sagitta is slightly thicker than the posterior portion. The sulcus is elongate, the ostium is elongate with a broader anterior portion and reaches to the anterior margin of the sagitta. The cauda is rather straight and short with a disc-like distal end (Fig. 25,B). *Macrodon* has this pattern.

10) *Micropogonias* pattern:

The sagitta in *Micropogonias* is very thick and shield-shaped, often with a shelf or flange on the outer surface or on the dorsal margin (Fig. 26). The ostium of the sulcus is large and does not reach the anterior margin of the sagitta. The cauda is oblique and bent only slightly towards the ventral margin with a round disc-like distal end. The sagittal shelf on the outer surface of *M. furneri* and the lateral flange of *M. undulatus* vary ontogenetically (Fig. 26).

Sagittae of *Sciaena, Larimus* and *Nebris* patterns are usually oval in shape and very thick in the middle. *Pogonias* pattern is usually semicircular in shape and thin. Sagittae of the *Cynoscion, Menticirrhus, Lonchiurus* and *Macrodon* patterns are usually more elongate and thin. *Isopisthus* pattern is elongate and thick in the posterior portion. Sagitta of the *Micropogonias* pattern is irregular in shape and very thick.

B. The group with both sagitta and lapillus enlarged:

11) *Stellifer* pattern:

The size of the sagitta is obviously reduced and an enlarged lapillus more than two thirds the size of the sagitta is present (Fig. 27). The ostium of the sulcus lacks its anterior portion and the cauda is well bent in a J-shape reaching almost to the ventral margin of the sagitta. *Bairdiella, Odontoscion, Ophioscion* and *Stellifer* have this pattern. There are considerable morphological variations within this otolith pattern (Fig. 27).

Stellifer and *Ophioscion* have a parallelogram-shaped sagitta and a sub-oval lapillus; both otoliths are about the same size (Fig. 27,A, A', B & B'). The ostium of the sulcus is short and reaches to the anterior margin of the sagitta. The cauda is bent obliquely towards the ventral margin of the sagitta. A marginal groove is evident along the dorsal margin of the cauda. The whole sagitta appears to be truncated at the middle of the ostium. The lapillus is large, sometimes larger than the sagitta (e.g., *Stellifer*, Fig. 28), a deep groove is present at the antero-ventral end of its inner surface with an open end to the dorsal margin (Fig. 28, A', B', C' & D').

The sagitta of *Bairdiella* has an inverse triangular shape with a projection at the anterio-dorsal corner dorsally (Fig. 27,C). The ostium of the sulcus is further reduced. The cauda is J-shaped and broadened at the middle. The marginal groove is well-defined. The lapillus is smaller than the sagitta and is irregular in shape (Fig. 27,C'). The groove along the antero-ventral end of the lapillus opens to the ventral margin.

The sagitta of *Odontoscion* is sub-triangular in shape. The ostium of the sulcus is nearly absent except for a small piece at the anterior margin (Fig. 27,D). The cauda is wide and curves vertically towards the ventral margin. The marginal groove is absent from the sagitta. The lapillus is ovoid and its antero-ventral groove is indistinct (Fig. 27,D').

A total of 11 patterns of otoliths are described here for western Atlantic Sciaenidae. Among them, the *Stellifer* pattern is most different and present only on the Atlantic and Pacific coasts of the American continents. The *Sciaena* pattern is the most generalized and resembles the "*Sciaena*-form" of Indo-West Pacific Sciaenidae (Chu, *Lo* and *Wu*, 1963; Mohan, 1969). The *Macrodon* pattern is similar to the "*Johnius*-form" and the *Micropogonias* pattern shares the disc-like "tail" end (cauda) with the "*Pseudosciaena*-form" of Chu, Lo and Wu (1963). Whether these should be interpreted as convergences or as possible evidence of relationships is not known at present. Many sagitta patterns, such as *Nebris, Micropogonias, Cynoscion, Menticirrhus, Isopisthus* and *Macrodon* are monotypic. These basic patterns are defined here for the convenience of assessing the relationships of western Atlantic Sciaenidae. Further division or grouping will be essential for comparisons with sciaenids of other geographic regions.

2) Phylogenetic relationship based on otolith patterns.

Based on the morphology of otoliths, western Atlantic sciaenids can readily be divided into two groups (Fig. 29 and Chao & Miller, 1975). The *Stellifer* pattern differs from all other sciaenids by having a large lapillus more than one half the size of the sagitta (Fig. 27). The other patterns of the otoliths can be further divided into two groups (Fig. 29), one having a more or less ovoid or oval elongate sagitta and the other having a shield-like sagitta as found in *Micropogonias* (Fig. 26). Within the former group, the *Cynoscion*, *Menticirrhus*, *Lonchiurus*, *Isopisthus* and *Macrodon* patterns usually have thin, elongate sagittae (Figs. 22 to 25) and the rest have a broader and thicker sagitta. In the general outline of the sagitta, the *Cynoscion* and *Menticirrhus* patterns are most similar to each other (Fig. 29) and have the posterior portion of their sagittae slightly thicker than the anterior portion (Fig. 22). The *Lonchiurus* and *Isopisthus* patterns have the posterior portion of their sagittae further thickened (Figs. 24, a, b, c & 26, a), which may be variations among the generally elongated and thin sagittae. The sagitta of *Macrodon* is unique in having the anterior portion of the sagitta thicker than the posterior portion (Fig. 26, b). Among the remaining otolith patterns, the *Nebris* pattern (Fig. 21) is unique in the general outline of its sagitta and the morphology of the sulcus (Fig. 29). The *Larimus* pattern has a rectangular sagitta (Fig. 20), which differs from the more generalized oval-shaped sagitta of the *Sciaena* and *Pogonias* patterns (Figs. 18, 19 & 29).

Specific Characters.

The sizes of the lapillus and sagitta in the *Stellifer* pattern vary among the genera (Fig. 27). The trend of reducing the size of the sagitta and increasing the size of the lapillus is evident from *Stellifer* to *Odontoscion*, then to *Bairdiella* (Fig. 27). *Cynoscion* has the most number of species of western Atlantic sciaenid genera, a total of 12. Therefore, it is not surprising that morphological variation in their sagittae is great (Fig. 23). *Menticirrhus* has a sagitta similar to *Cynoscion* (Fig. 22), but the relative size of the sagitta is smaller. Smith (1905) found the otoliths in *Menticirrhus* are relatively smaller than in other genera of sciaenids he examined. *Micropogonias* has the most distinctive sagitta, with the sagitta further ossified and a lateral flange developed along the dorsal margin (Fig. 26). *Nebris* is also unique in having an oval, thick sagitta (Fig. 21) with a notch on the posterior margin which does not resemble any other western Atlantic sciaenid. Although the *Pogonias* pattern (Fig. 19) has a semicircular sagitta, the sulcus is similar to that of the *Sciaena* pattern (Fig. 18). Variations among the genera of the *Sciaena* pattern are mainly in the position and shape of the sulci. The sagittae of *Larimus* and *Sciaenops* are more or less rectangular (Fig. 20), but the shapes of the sulci differ. *Leiostomus xanthurus* differs from other *Sciaena* pattern by having its sagitta (Fig. 18,D & d) slightly elongated and thin. It is probably an intermediate form between the elongated thin and ovoid thick forms of sagittae.

The morphology of the otoliths appears more variable than that of the swimbladder within a given taxon. Chu, Lo & Wu (1963) relied heavily on the relative position of the "head" (ostium) and "tail" (cauda) sections of the "tadpole-shaped" sulcus to diagnose the subfamilies of Chinese Sciaenidae. In some species of western Atlantic sciaenids, the relative position of the ostium and cauda shift slightly as the fish grows (Figs. 20, 23 & 26). This feature should be viewed cautiously when used to group taxa above the generic level.

Fossil materials of sciaenid otoliths are important in assessing the phyletic relationships of modern sciaenids. John Fitch of the California Department of Fish and Game is currently studying this aspect of sciaenid relationships.

III. Relationships Based on External Morphology.

Prior to Trewavas (1962) and Chu, Lo & Wu (1963), most authors used external morphology to classify sciaenid fishes (also see the section "A brief history of the study of western Atlantic Sciaenidae"). The characters used were body shape, presence or absence of the mental barbel and/or pores, size of the second anal fin spine and position of the mouth. Unfortunately these characters are extremely adaptive, evolutionarily plastic and convergent. They are more indicative of feeding adaptations and habitats rather than phylogenetic relationships (Fig. 30). Even so, these characters do show that the external morphology is also diagnostic at the generic and species levels. The following discussion assesses the limits and usefulness of these characters.

1. Patterns of pore and barbel systems.

The pores at the tip of the snout and lower jaw (mandible) of sciaenids are the openings of the well-developed cavernous lateral-line canals on the head (Fig. 1). The snout (rostral) pores can be divided into upper pores, those present at the tip of snout and marginal pores, those present along the edge of the rostral fold (Fig. 1). Usually, there are three or five distinct upper pores, although some genera lack upper pores and some may have more than five as adults. Typically there are five marginal pores, one median and two pairs of lateral pores (Fig. 31). Some genera have only two marginal pores. The mental (mandibular) pores are most often five (four to six) one median and two pair of lateral pores (Fig. 32), whereas some genera completely lack mental pores. One or more mental barbels may be present in many western Atlantic sciaenid fishes. The number of pores and barbels are correlated with the mouth position and feeding niches of the species (see part II of whole study). The variations are broad among the genera (Fig. 33, 34 & 35) and species (Fig. 36).

A. Structural patterns of snout pores:

There are five snout pore patterns recognized in western Atlantic Sciaenidae (Fig. 31).

1) Two (or no) marginal pores:

This pattern has only two marginal pores and no upper pores (Fig. 31,A). The rostral fold is thin and complete without notches. *Cynoscion, Macrodon, Nebris* and *Plagioscion* have this pattern. All species have a very oblique large mouth, the lower jaw projecting in front of the upper jaw, and sometimes no pores on the snout, except *Plagioscion*, which has a slightly oblique and terminal mouth. Fishes with this snout pore pattern and mouth position are mid- to upper water column feeders.

2) Five marginal pores:

This pattern has five marginal pores with no upper pores. The rostral fold has notches at the openings of the lateral pores (Fig. 31, B). *Aplodinotus* and *Larimus* have this pattern. *Aplodinotus* has a moderate sized mouth, terminal or slightly inferior, a typical lower water column to bottom feeder. *Larimus* has a large mouth, very oblique, and feeds in mid- to the upper water column.

3) Five marginal pores and two upper pores:

This pattern has a slightly indented rostral fold (Fig. 31,C). *Odontoscion* is the only genus of western Atlantic sciaenid with this pattern. *Odontoscion* has a moderate sized terminal mouth, and is typically a mid- and lower water column feeder.

4) Five marginal and three upper pores:

The rostral fold of this pattern is indented at the openings of the marginal pores (Fig. 31,D). *Bairdiella, Ctenosciaena, Menticirrhus, Ophioscion, Paralonchurus, Sciaena* and *Stellifer* have this pattern. The position and size of the mouths in this group of fishes suggests that some feed in midwater and some on the bottom. In bottom feeders such as *Menticirrhus* and *Paralonchurus*, the rostral folds (upper lips) are very deeply indented below the marginal pores (Fig. 33, C & D). For the mid- or lower mid-water feeders, *Stellifer lanceolatus* and *Ophioscion punctatissimus*, the rostral folds are only slightly indented (Fig. 33,A & B). *O. punctatissimus* also has two minute pairs of upper pores present dorso-laterally to the outer lateral marginal pores (Fig. 33,B).

5) Five (or more) marginal and five (or more) rostral pores:

This pattern usually has five distinct rostral and five marginal pores (Fig. 31,E). Sometimes an extra pair or two pairs of minute pores are developed lateral to the upper and marginal pores (Fig. 31,F). The rostral fold is slightly notched or smooth below the openings of the marginal pores. *Equetus, Leiostomus, Lonchiurus, Micropogonias*

Pachyurus, Pareques, Pogonias, Sciaenops and *Umbrina* have this pattern and have a horizontal or inferior mouth, and are typically bottom feeders. Variation within this snout pore pattern is mainly in the presence of additional minute pores (Fig. 33, E to H), which may also vary ontogenetically.

B. Structural patterns of mental pores and barbels:

There are seven mental pore and barbel patterns recognized in western Atlantic Sciaenidae (Fig. 32). Variations are rather common within the genera especially in speciose genera, such as *Stellifer* and *Bairdiella*.

1) No pores:

This pattern has neither pores nor barbels on the lower jaw (Fig. 32,A) and is found in *Cynoscion, Isopisthus, Macrodon* and *Plagioscion*. All fishes with this pattern have a large oblique mouth and are upper or mid-water feeders, although *Plagioscion* has a nearly terminal mouth.

2) Four pores:

This pattern has four pores at the anterior part of the lower jaw (Fig. 32,B) which may vary in arrangement among different genera (Fig. 34,A to D). *Nebris, Odontoscion, Larimus* and *Stellifer lanceolatus* have this pattern and all have a terminal or oblique mouth, and feed in the mid- to upper water column.

3) Five pores:

This pattern has five pores without a barbel, one median pore located at the center of the lower jaw symphysis and two lateral pairs (Fig. 32,C). The arrangement of the five pores vary among genera (Fig. 34,E to H). *Aplodinotus, Equetus, Leiostomus, Ophioscion, Pachyurus, Pareques, Sciaena, Sciaenops* and some species of *Bairdiella (B. ronchus* and *B. sanctaeluciae)* and *Stellifer (S. microps, S. stellifer* and *S. venezuelae)* have this pattern.

4) Six pores:

This pattern has six pores and no barbel, the two median pores usually close together, and two pairs of lateral pores (Fig. 32,D). *Bairdiella chrysoura, Stellifer colonensis, S. griseus* and *S. rastrifer* have this pattern, which is a derivative of the five-pored pattern. Fishes with this pattern of mental pores have a terminal to slightly inferior mouth and feed from lower mid-water to the bottom.

5) Four pores and one barbel:

This pattern has two pairs of lateral pores and a barbel at the anterior tip of lower jaw (Fig. 32,E). *Ctenosciaena, Menticirrhus* and *Umbrina* have this pattern. The morphology of the barbel varies among these three genera (Fig. 35). *Ctenosciaena* has a thin barbel tapering at the end. *Menticirrhus* and *Umbrina* have a short rigid barbel and an apical pore which is also present at the tip of the barbel in *Umbrina*. They all have inferior mouths and are bottom feeders.

6) Four pores and two barbels:

This pattern has two pairs of lateral pores and a pair of thin barbels originating from inside the posterior pair of mental pores (Fig. 32,F). *Lonchiurus* is the only genus with this pattern and has an inferior mouth, typical of bottom feeders.

7) Five pores and many barbels:

This pattern has five pores, one median and four lateral, together with three to 19 pairs of minute barbels at the symphysis of the mandibules and along the rami of the lower jaws (Fig. 31,G & H). *Micropogonias, Paralonchurus* and *Pogonias* have this pattern. The arrangement of the barbels are different among the genera, especially in *Paralonchurus*. Three pairs of minute barbels form a tuft situated lateral to the median pore and 12 to 16 pairs of small barbels are distributed along the rami of the lower jaw (Fig. 32,H). *Micropogonias* and *Pogonias* lack the tufts of barbels at the symphysis of the lower jaw (Fig. 32,G). Fishes with this pore and barbel pattern have an inferior mouth, and are typically bottom feeders.

When comparing the pore and barbel systems of western Atlantic Sciaenidae with the Indo-Pacific (Chu, Lo & Wu, 1963) and East Atlantic and East Pacific Sciaenids, the five marginal and three to five upper pores on the snout seem to be generalized in most sciaenids. Also the five pores on the lower jaw is typical in sciaenids. Sciaenids with a single mental barbel are found in the Indo-West Pacific, on both sides of the Atlantic and in the eastern Pacific (Trewavas, 1964). However, sciaenids with more than one barbel are found only along the Atlantic and Pacific coasts of America.

2) Phylogenetic relationships based on external morphology.

Western Atlantic sciaenids can be readily separated into two groups by the presence or absence of the mental barbels (Fig. 30). The group without barbel can be further divided by their mouth positions and body shape (Fig. 30). *Cynoscion, Isopisthus* and *Macrodon* differ from other barbelless sciaenids by having an elongate body, an oblique mouth with a pair of enlarged canines at the tip of the upper jaw and a protruding lower jaw (Fig. 37,A). Those species that lack canines can be divided into groups by their mouth positions and body shapes. (Fig. 30). *Nebris* and *Larimus* have a very large and oblique mouth (Fig. 37,B). *Bairdiella* and *Odontoscion* both have a terminal mouth (Fig. 37,C). The genus *Stellifer* consists of species with inferior (*S. microps*), terminal (*S. rastrifer*) and oblique (*S. lanceolatus*) mouth (Fig. 38). *Sciaena, Leiostomus, Pareques, Equetus* and *Sciaenops* have inferior mouths. *Sciaenops* differs from these fishes by having an elongate body. *Sciaena* is characterized by a terminal and horizontal mouth.

Sciaenids with a mental barbel usually have an inferior mouth and can be divided into different categories by the number and position of barbels (Fig. 30). *Ctenosciaena* has a thin tapered barbel and a terminal mouth (Fig. 35,A), unique among barbeled western Atlantic sciaenids. Both *Umbrina* and *Menticirrhus* have an apical pore at the tip of the single rigid barbel (Fig. 35,B & C). *Lonchiurus* has a pair of long slender barbels at the symphysis of the lower jaw (Fig. 32,F). *Paralonchurus* has three pairs of minute barbels in a tuft at the symphysis of the lower jaw lateral to the median mental pore and 12 to 16 pairs of small barbels along the rami of the lower jaw

(Fig. 32,H). *Micropogonias* has three to four pairs of small mental barbels and *Pogonias* has 12 to 13 pairs that never form a tuft at the symphysis of the lower jaw (Fig. 32,G).

The combination of morphological characters described above reflects habitat or similarities in feeding habits. The genera listed at the top of Figure 30 generally feed in the upper to mid-water column and the genera listed near the bottom feed in the lower water column to the bottom. Within the different snout pore, mental pore and barbel patterns of western Atlantic Sciaenidae, three different feeding modes may be recognized (Fig. 30). The mid- to upper water column feeders have only marginal pores (two or five) on the snout, and have zero to four mental pores without barbels on the lower jaw. The mid- to lower water column feeders have five marginal pores and two to three upper pores on the snout, and four to five mental pores without barbel(s) on the lower jaw. The third group, bottom feeders, have five marginal and three to five rostral pores on the snout, and have four to five mental pores and one to many barbels on the lower jaw. The number of pores and barbels seem to increase in feeding niches that are closer to the bottom.

Specific characters.

Western Atlantic sciaenids with two marginal snout pores and with neither upper pores (Fig. 31,A) nor mental pores (Fig. 31,A) are upper water column feeders, such as *Cynoscion*. Although *Nebris* has a very oblique mouth (Fig. 37,B) and snout pore arrangement similar to *Cynoscion*, it also has four mental pores (Fig. 34,A) and a rounded body with a flat ventral surface. This suggests that *Nebris* is a bottom dweller feeding from the bottom upward. Sciaenid fishes with five marginal pores and no upper pore on the snout are mid- to upper midwater column feeders, such as *Larimus*, which has four mental pores similar to *Nebris*, (Fig. 34,B). But *Larimus* has a compressed body which may not be adaptive to a bottom habitat as in *Nebris*. *Odontoscion* has five marginal pores and two upper pores on the snout (Fig. 31,C). It also has four mental pores and a terminal mouth (Fig. 37,C) which suggests that it is a mid- to lower midwater column feeder.

Sciaenid fishes with a structural pattern of five marginal pores and three upper pores (Fig. 33,A to D) are rather common among different genera, such as *Bairdiella, Ophioscion, Stellifer* and *Menticirrhus*. Species of *Menticirrhus* all have one barbel and four pores on the lower jaw, and are bottom feeders. But among the genera and species of *Stellifer*, the number of mental pores varies from four to six (Fig. 36). Their feeding niches are mainly correlated with the positions of the mouth. Although the number of mental pores among the species of *Bairdiella* varies from five to six, they all have a terminal mouth and are the mid- to lower mid-water feeders. Species of *Stellifer* not only have a variable number of mental pores, from four to six, but also have different mouth positions, from inferior to slightly oblique (Fig. 38). The species with a slightly oblique mouth, such as *S. lanceolatus, S. stellifer* and *S. rastrifer*, are apparently mid-water column feeders. But each species has a different number of mental pores (Fig. 36): *S. lanceolatus* four, *S. stellifer* five and *S. rastrifer* six. In addition, other genera of western Atlantic sciaenids, *Ctenosciaena, Paralonchurus* and *Sciaena,* also have a similar snout pore pattern. Among them, *Ctenosciaena* and *Sciaena* both have terminal mouths and probably feed in mid-water down to the bottom. *Ctenosciaena* also has one barbel and four pores on the lower jaw (Fig. 35,A). *Sciaena* has five pores and no barbel on the lower jaw. Based on these variations, the three upper and five marginal snout pore pattern is probably the more generalized among western Atlantic sciaenids with different feeding niches.

Sciaenid fishes with five or more upper and marginal pores (Fig. 31,E & F) are all bottom feeders with an inferior mouth. They usually have five pores on the lower jaw with or without mental barbels. *Umbrina* has four pores and a short perforated barbel with an apical pore on the lower jaw (Fig. 35,C). *Lonchiurus* has four pores and two long tapered barbels on the lower jaw (Fig. 32,F).

The external characters described above are sometimes variable within a genus and yet similarities are found among different genera. Neither the differences nor the similarities necessarily reflect phylogenetic relationships. These external morphological characters and those mentioned in the key should be treated as "key characters" only. Their usefulness in assessing relationships of sciaenids is usually not above the species level.

A SYNOPSIS OF THE SUPRA-GENERIC GROUPS, GENERA, AND SPECIES OF WESTERN ATLANTIC SCIAENIDAE

I. Diagnoses and Primary Synonymy of the Supra-generic Groups, Genera and Species

Based on the structural patterns of swimbladder, otolith, and pore and barbel systems, western Atlantic sciaenids can be grouped into 11 supra-generic groups. They are the *Sciaena, Umbrina, Larimus, Sciaenops, Cynoscion, Micropogonias, Lonchiurus, Menticirrhus, Nebris, Pogonias,* and *Stellifer* groups. The freshwater sciaenid genera, *Pachypops* and *Pachyurus* of South America are not included in these groups, due to lack of comparative material. The taxonomic position of these generic groups is between genus and family. Neither tribes nor subfamilies are utilized for western Atlantic Sciaenidae, until comparisons can be made with the sciaenids of other regions.

The following descriptions of western Atlantic sciaenid groups are arranged in order from simple to more complex swimbladder patterns. In each group description, the diagnosis of the supra-generic groups and genera are given and the species are listed after each genus. A primary synonymy is given for each genus and species for nomenclatural purposes. All available type-specimens are listed in the synonymy for each species.

Sciaena Group

Diagnosis: Swimbladder in a simple carrot-shape, without diverticulum (*Sciaena* pattern, Fig. 5); sagitta more or less oval-shaped and thick (Fig. 18), lapillus not enlarged, snout with five marginal pores and three to seven rostral pores (Fig. 31,D to F); lower jaw with five pores and no barbels (Fig. 32,C). There are three genera in this group; *Equetus, Pareques* and *Sciaena*. *Leiostomus* thinner and longer (Fig. 18,D). But, *Leiostomus* is probably closely related to the *Sciaena* group than other western Atlantic sciaenid groups.

Genus *Equetus* Rafinesque

Diagnosis: Body oblong, compressed, back much elevated, rapidly tapering to a narrow caudal peduncle; sides with broad oblique bands; spinous dorsal fin very long and filamentous. Mouth small and inferior, teeth in villiform bands; gill rakers few, short and slender. Vertebrae 10+15=25; no free interneurals anterior to first dorsal fin (McPhail, 1961). Swimbladder simple, carrot or bottle-shaped (Fig. 5,C). Sagitta oval-shaped, the ostium of the sulcus reaching to anterior margin (Fig. 18,B & C); snout with five to seven upper pores; lower jaw without barbel. Tropical western Atlantic endemic. Two species: *E. lanceolatus* and *E. punctatus*. Mainly inhabits coral reefs, sometimes shallow coastal waters.

Eques Bloch, 1793, pt. 7:90 (type-species: *Eques americanus* Bloch, by monotypy = *Chaetodon lanceolatus*, Linnaeus).

Equetus Rafinesque 181:86 (emendation of *Eques* Bloch, 1793 and substitute name for *Eques*, therefore taking the same type-species: *Eques americanus* Bloch; preoccupied by *Eques* Linnaeus, 1758:459, a genus of lepidopteran insect).

Equetus lanceolatus (Linnaeus)

"Ribband Fish" Edwards, 1751, pl. 210, middle figure, Caribbean Islands (non-binomial).

Sciaena edwardi Gronow, 1754 (ed. by Gray 1854):53, (West) Indian Sea (after Edwards).

Chaetodon lanceolatus Linnaeus, 1758:277, Caribbean Islands (after Edwards, pl. 210).

"Serranas" Parra, 1787, pl. 2, upper figure, Cuba (non-binomials).

Eques americanus Bloch, 1793: 91. 347, fig. 1, West Indies.

Eques balteatus Cuvier, 1829:175 (after Edwards and Bloch).

Equetus punctatus (Bloch & Schneider)

"Serranas" Parra, 1787, pl. 2, lower figure, Cuba, (non-binomials).

Eques punctatus Bloch & Schneider, 1801:105, pl. 3, fig. 2 (based on Parra).

Pareques Gill

Diagnosis: Body oblong, compressed, anterior profile steep, back tapering rapidly to a narrow caudal peduncle; sides with longitudinal stripes. Mouth small, inferior; teeth in villiform bands; gill rakers short and blunt. Vertebrae 10+15=25; three free interneurals anterior to first dorsal fin. Swimbladder simple, carrot-shaped. Sagitta oval, the ostium of the sulcus reaching to anterior margin (Fig. 18,E & F), the cauda long, J-shaped. Snout with five to seven upper pores (Fig. 33,H); lower jaw without barbel. Tropical eastern Pacific and western Atlantic, about five species. Two western Atlantic species: *P. acuminatus* and *P. umbrosus*. Inhabits sandy and muddy bottoms of high salinity waters and coral reefs.

Pareques Gill *in* Goode 1876:50 (type-species: *Grammistes acuminatus* Bloch and Schneider 1801, by original designation).

Pareques acuminatus (Bloch & Schneider)

"Chaetodon, lineis fuscis" Seba, 1761:72, pl. 26, fig. 33, no locality (non-binomial).

Grammistes acuminatus Bloch & Schneider, 1801:184 (after Seba).

Eques lineatus Cuvier, 1830:169, Brazil (syntypes: MNHN 7475, one specimen, 135 mm SL; MNHN 43, not located).

Eques pulcher Steindachner, 1867:349, Barbados (type: not located in NHMV, Vienna).

Pareques umbrosus (Jordan & Eigenmann)

Eques acuminatus umbrosus Jordan & Eigenmann, 1889:440, Charleston, South Carolina (holotype: USNM 25981, 165 mm SL).

Remarks: *P. acuminatus* and *P. umbrosus* were thought to be the same species until Jordan & Eigenmann (1889) proposed the subspecies name *E. acuminatus umbrosus*, USNM 25981 was the specimen described by Jordan and Eigenmann (1889) as *Eques acuminatus* (Bloch & Schneider), and collected by C. C. Leslie. These two species can be separated by their coloration and counts (also see "Key to the species of *Pareques*"). The sagittae of these two species differ from each other by the features of the ostium of the sulcus (Fig. 18,E & F). *P. umbrosus* is a more northerly species distributed from Chesapeake Bay to Florida and also recorded from Texas over sandy mud bottom of inshore and offshore waters. *P. acuminatus* is a more southerly species from Florida to Brazil in coral reef and rocky bottom coastal waters. L. Woods (FMNH) and G. Miller (NMFS, Miami) have new species of *Pareques* from western Atlantic in preparation.

Sciaena Linnaeus

Diagnosis: Body elongate, compressed, dorsal profile slightly elevated or evenly arched; spinous dorsal not elongated. Mouth horizontal to inferior; teeth in bands; gill rakers short and slender, widely spaced. Vertebrae 25 (11+14 in *S. bathytatos* and 10+15 in *S. trewavasae*). Swimbladder simple, carrot-shaped (Fig. 5,A). Sagittae oval, the ostium of the sulcus just reaching to the anterior margin (Fig, 18,G & H). Snout with three upper pores (Fig. 31,D); lower jaw without barbel. Two species in the western Atlantic; *S. bathytatos* and *S. trewavasae*, inhabit deeper subtropical waters and one species in East Atlantic, and Mediterranean, *S. umbra*.

Sciaena Linnaeus, 1758:228 (type-species: *Sciaena umbra* Linnaeus, by subsequent designation of International Comission for Zoological Nomenclature (1972), Opinion 988.

Remarks: The nomenclature of the genus *Sciaena* was not stabilized until *S. umbra* Linnaeus, 1758, was designated as the type-species of the genus under the Plenary Powers of the International Commission for Zoological Nomenclature (1972, Opinion 988) and interpreted by the neotype designated by Trewavas (1966). The history of the case and synonymies are not repeated here. This genus is the type-genus of the tribe Sciaenini (Trewavas, 1962). The genus *Sciaena* is still not well-defined and it may contain more species than currently recognized (Chao and Miller, 1975).

Sciaena bathytatos Chao & Miller

Sciaena bathytatos Chao & Miller, 1975:267, fig. 9, Caribbean Sea off Colombia (holotype: USNM 211514, 208 mm SL).

Sciaena trewavasae Chao & Miller

Sciaena trewavasae Chao & Miller, 1975:262, fig. 8, Caribbean Sea off Colombia (holotype: USNM 211513, 155 mm SL).

Leiostomus Lacépède

Diagnosis: Body oblong, compressed, back elevated, sides with oblique stripes and a dark humeral spot behind upper end of gill slit; spinous dorsal fin not elongated. Mouth small and inferior; teeth in villiform band; gill rakers short and slender. Vertebrae 10+15=25. Swimbladder in simple carrot-shape (Fig. 5,B). Sagitta oval and thin, the ostium of the sulcus reaching the anterior margin and bent to the ventral margin (Fig. 18,D). Snout with five rostral pores; lower jaw without barbel. Northwestern Atlantic. Monotypic: *L. xanthurus*. Inhabits sandy and mud bottom in estuarine rivers and inshore waters.

Leiostomus Lacépède, 1803, vol. 4:439 (type-species: *Leiostomus xanthurus* Lacépède, by monotypy).

Liostomus Gill, 1861c:93 (invalid emendation of *Leiostomus* Lacépède 1803, therefore taking the same type-species: *Leiostomus xanthurus* Lacépède).

Leiostomus xanthurus Lacépède

Leiostomus xanthurus Lacépède 1803, vol. 4:439, pl. 10, fig. 1, Carolina (syntypes: MNHN 7599, two specimens, 148 & 163 mm SL).

Mugil obliquus Mitchill, 1814 (ed. by Gill, 1896):16, New York.

Sciaena multifasciata LeSueur, 1822:255, east Florida (no length of the type-specimen reported).

Leiostomus humeralis Cuvier, 1830:141, pl. 110, New York (syntypes: MNHN 9733, one dried stuffed specimen, 146 mm SL; another syntype of Cuvier's description not located).

Umbrina Group

Diagnosis: Swimbladder simple carrot-shaped, without diverticula (*Sciaena* pattern, Fig. 5); sagitta oval, (*Sciaena* pattern, Fig. 18); snout with five marginal pores and three to seven upper pores; lower jaw with four pores and one barbel, an apical pore present. Two genera in this group: *Ctenosciaena* and *Umbrina*.

Ctenosciaena

Diagnosis: Body oblong, moderately compressed, head moderate and blunt with well-developed cavernous canals. Mouth terminal to slightly inferior, snout protruding; lower jaw with a barbel tapering to a fine point without an apical pore at the tip (Fig. 35,A). Vertebrae 10+15=25. Sagitta oval, the ostium of the tadpole-shaped sulcus slightly in contact with the anterior margin. Snout with three upper pores. Tropical western Atlantic. Monotypic, *C. gracilicirrhus* inhabits offshore waters over hard sandy mud bottom.

Sciaena (*Ctenosciaena*) Fowler & Bean, 1924:15 (type-species: *Sciaena dubia* Fowler & Bean, by monotypy).

Ctenosciaena gracilicirrhus

Umbrina gracilicirrhus Metzelaar, 1919:72, fig. 24, Venezuela (holotype: ZMA 113.103, 105 mm SL).

Sciaena (*Ctenosciaena*) *dubia* Fowler & Bean, 1924:16, Wilks Exploring Expedition, no locality (holotype: USNM 83309, 111 mm SL).

Umbrina Cuvier

Diagnosis: Body moderately elongate, back slightly arched. Head oblong, snout thick and protuberant. Mouth small, horizontal to inferior; teeth in villiform bands; gill rakers short. Vertebrae 11+14=25. Swimbladder simple carrot-shaped, without diverticula. Sagitta oval, the ostium of the sulcus reaching to anterior margin (Fig. 18,I & J). Snout with five to seven upper pores (Fig. 31,E & F); lower jaw with four pores and a short, thick barbel, an apical pore present at the tip of the anterior surface. Eastern Pacific and both sides of the Atlantic, about eight species. Four species in western Atlantic; *U. broussonetii, U. canosai, U. coroides* and *U. milliae*. Inhabits inshore and offshore waters with sandy mud bottoms and around coral reefs.

Sciaena Linnaeus, 1758:288 (of Artedi, 1738; in part; includes *S. cirrosa*; type-species: *Sciaena umbra*, by subsequent designation, Cuvier, 1817:297).

Umbrina Cuvier, 1817:297 (type-species: *Sciaena cirrosa* Linnaeus, by original designation).

Attilus Gistel, 1848:109 (type-species, *Sciaena cirrosa* Linnaeus, by original designation).

Remarks: The name *Chromis* in the footnote of Lacépède, 1803, volume 3, p. 546 was from the sketch of Le Pere Plumier, a missionary in Martinique, for the "grygry" or "grogro", which is *Umbrina coroides* Cuvier 1830. The name *Chromis* is older than *Umbrina* but later than *Cromis* Browne (after Jordan 1917). Also see Gilbert (1966) for more detailed synonymy.

Umbrina broussonetii

Umbrina broussonetii Cuvier, 1830:187, Jamaica (holotype: MNHN 7471, 151 mm SL).

Umbrina canosai

Umbrina canosai Berg, 1895:56, Montevideo, Uruguay to Mar del Plata Argentina (no type-specimens nor specific localities mentioned in the original description).

Umbrina coroides

Umbrina coroides Cuvier, 1830:187, pl. 117, Brazil (holotype: MNHN 5343, 174 mm SL).

Umbrina milliae

Umbrina milliae Miller, 1971:303, fig. 1, Colombia (holotype: USNM 204932, 193 mm SL).

Larimus Group

Diagnosis: Swimbladder carrot-shaped with or without a pair of small tube-like diverticula at the anterior end (*Sciaena* pattern, Fig. 5,E & F). Sagitta with broader anterior portion and narrower posterior portion, the sulcus not reaching to the margins (*Larimus* pattern, Fig. 20,A & B). Snout with five marginal pores, no upper pores (Fig. 31,B), lower jaw with four pores, no barbel (Fig. 34,B). *Larimus* is the only genus in this group.

Larimus Cuvier

Diagnosis: Body short and robust, compressed dorsal profile slightly elevated, ventral convex. Head with prominent cavernous canal; snout short. Mouth large and oblique, teeth conical in a single row on both jaws. Gill rakers, long and slender. Vertebrae 11+14=25. Other diagnostic characters as in the *Larimus* group. Tropical eastern Pacific and western Atlantic, about four species. Two western Atlantic species. *L. breviceps* and *L. fasciatus*. Inhabits estuarine and inshore open waters with sandy and muddy bottoms.

Larimus Cuvier, 1830:145 (type-species: *Larimus breviceps* Cuvier, by monotypy).

Amblyscion Gill, 1863b:165 (type-species: *Amblyscion argenteus* Gill by monotypy).

Monosira Poey, 1881:326 (type-species: *Monosira stahli* Poey, by monotypy).

Larimus breviceps Cuvier

Larimus breviceps Cuvier, 1830:146, pl. 140, Saint Dominique & Brazil, (syntypes: MNHN 7578, 1, 139 mm SL, St. Dominique; MNHN 7636, 1, 156 mm SL, Brazil).

Monosira stahli Poey, 1881:326, pl. 6, Puerto Rico (type: 190 mm long, not located in MCZ nor in USNM).

Larimus fasciatus Holbrook

Larimus fasciatus Holbrook, 1855:153, pl. 22, fig. 1, Charleston (type: not located).

Nebris Group

Diagnosis: Swimbladder with carrot-shaped main chamber and a pair of diverticula, which almost extend to the tapering end of the main chamber then loop back (Fig. 8) reaching the septum transversum anteriorly (*Nebris* pattern). Sagitta oval-shaped, with a notched posterior margin, very thick (Fig. 21); the ostium of the sulcus large, ovoid; the cauda J-shaped, with broad and deeply grooved distal end; snout with only two marginal pores, without upper pores; lower jaw with four minute pores and no barbel. One genus in this group: *Nebris*

Nebris Cuvier

Diagnosis: Body elongate, tapering posteriorly. Head extremely cavernous, interorbital space very broad, eye very small. Mouth very large, oblique, nearly vertical; teeth in narrow conical bands. Gill rakers long and slender. Vertebrae 12+13=25. Other diagnostic characters as in the group diagnosis. Tropical eastern Pacific and western Atlantic, two species. One species in the western Atlantic, *N. microps*. Inhabits sandy to muddy bottoms in coastal and estuarine waters.

Nebris Cuvier, 1830:149 (type-species: *Nebris microps* Cuvier, by monotypy).

Nebris microps Cuvier

Nebris microps Cuvier, 1830:149, pl. 112, Surinam (type: in Berlin, not examined).

Micropogonias Group

Diagnosis: Swimbladder carrot-shaped with a pair of tube-like diverticula extending anteriorly from the middle of lateral sides to septum transversum. (*Micropogonias* pattern, Fig. 9). Sagitta very heavy, irregular in shape (*Micropogonias* pattern, Fig. 26), the sulcus not reaching to margins, the ostium broad, the cauda oblique with an expanded distal end. Snout with five marginal pores and five upper pores (Fig. 31,E); lower jaw with five pores and six to eight pairs of minute barbels (Fig. 32,G). One genus in this group, *Micropogonias*.

Micropogonias Bonaparte

Diagnosis: Body elongate, dorsal profile slightly elevated, ventral profile nearly straight. Head conical, preopercular margin with 10 to 14 spines, two to five strong spines at the angle. Mouth inferior, teeth in villiform bands. Gill rakers short. Vertebrae 10+15=25. Other diagnostic characters as in the *Micropogonias* group. Tropical eastern Pacific and western Atlantic, about five species. Two species in western Atlantic; *M. furnieri* and *M. undulatus*. Inhabits estuarine rivers and coastal waters with sandy-muddy bottom.

Micropogon Cuvier, 1830:213 (type-species: *Micropogon lineatus* Cuvier = *Umbrina furnieri* Desmarest, see remarks).

Micropogonias Bonaparte, 1831, 52:170 (substitute name for *Micropogon*, therefore taking the same type-species: *M. lineatus* Cuvier; preoccupied by *Micropogon* Boie, 1826:977, Aves).

Micropogonias furnieri (Desmarest)

Umbrina furnieri Desmarest 1823:182, pl. 17, fig. 3, Havana, Cuba (type: see remarks).

Micropogon lineatus Cuvier, 1830:215, pl. 119 & pl. 138 (swimbladder) (lectotype: MNHN 4968, 109 mm SL, also see remarks).

Micropogon argenteus Cuvier, 1830:218, Surinam (type: not located in MNHN).

Ophioscion woodwardi Fowler 1937:311, figure on p. 312, Haiti (holotype: ANSP 68257, 108 mm SL).

Micropogonias undulatus (Linnaeus)

"Perca marina" Catesby, 1743, "Croker", pl. 3, upper figure, Chesapeake Bay (non-binomial).

Perca undulata Linnaeus, 1766:483, South Carolina (syntypes: Linnaean Society, London no. 112, right side of a dried skin, 212 mm SL and no. 113, left side of a dried skin, 241 mm SL).

Sciaena croker Lacépède, 1802, vol. 4:309, Carolina (type: not located in MNHN).

Bodianus costatus Mitchill, 1815:417, New York.

Sciaena opercularis Quoy & Gaimard, 1824:347, Rio de Janiero.

Micropogon lineatus Cuvier, 1830:215 (syntypes: MNHN 7457, two specimens, 62.8 & 138 mm SL, New York; MNHN 7459, 273 mm SL, Montevideo).

Remarks: Cuvier's (1830) description of *M. lineatus* fits both *M. furnieri* and *M. undulatus*. The type-specimens obtained from New York (MNHN 7457) by Milbert are apparently *M. undulatus* (there is also a specimen of *Leiostomus xanthurus* 87.2 mm SL, in the same jar). The type-specimen from Cuba (MNHN 4968) was labeled as "type de *Umbrina fournieri* Desmarest", and the specimen illustrated on plate 119 and a swimbladder illustrated on plate 138 appeared to be *M. furnieri*. The diverticula on the swimbladder of *M. furnieri* usually originates further back than that of *M. undulatus* (Fig. 9,C & D). MNHN 7456 from Montevideo contains two syntypes in the jar, the smaller specimen, 159 mm SL is *M. furnieri* and the larger one, 273 mm SL is *M. undulatus*. In this case, the MNHN 4968, 109 mm SL of Cuba is selected as the lectotype. Then the type-species of *Micropogonias* is designated as *M. furnieri* (Desmarest). Jordan (1917) designated *M. lineatus* Cuvier = *Perca undulatus* Linnaeus as type-species of *Micropogonias*. His reason was that Cuvier's (1830) description on p. 215, mentioned the New York Specimens (*M. undulatus*) first.

Some morphometrics and meristics of the lectotype MNHN 4968 are listed as follows:

Morphometrics (in mm)	
TL	110
SL	109
Snout to anal fin origin	72.6
Snout to dorsal fin origin	40.5
Snout to pectoral fin origin	34.7
Snout to pelvic fin origin	36.0
Maximum depth	28.2
Head length	33.6
Snout length	9.7
Eye diameter	8.5
Interorbital width	8.1
Pectoral fin lengths	19.5 (left) - 22.5 (right)
Pelvic fin lengths	16.0 (left) - 19.2 (right)
Length of spinous dorsal fin base	20.2
Length of soft dorsal fin base	42.7
Length of anal fin base	12.5
Length of second anal fin spine	13.4
Depth of caudal peduncle	9.2

Meristics

D. X+I, 27

A. II, 8

Pectoral rays, 18-17

Lateral gill rakers on the first right gill arch;

8 (upper arm) + 15 (lower arm)

Medial (or inner) gill rakers on the first right gill arch;

3 (upper arm) + 10 (lower arm)

Lateral line scales (a row above the lateral line);

Left side: 52 scales

Right side: 48 scales

Transverse lateral line scales;

from soft dorsal fin origin to lateral line

vertical: 9

oblique: 12

from lateral line to anal fin origin

vertical: 12

oblique: 15

Other nominal species of this genus were discussed by Roux (1973). The true identity of *M. argenteus* Cuvier and *Sciaena opercularis* Quoy & Gaimard are not certain at present. The distinguishing characters of the two species of *Micropogonias* (see also "Key to the species of *Micropogonias*") used here are only valid for adult specimens. The sagitta morphology of *M. furnieri* usually occurs south of the Antilles and off South America and *M. undulatus* have been reported from the Gulf of Maine to Argentina.

Sciaenops Group

Diagnosis: Swimbladder carrot-shaped with a pair of short tube-like diverticula at the anterior lateral corners of the swimbladder (*Sciaenops* pattern, Fig. 11). In large specimens, a pair of "sac-like" projections which consist of numerous labyrinth chambers (Fig. 11,C) present on the dorsal surface of the swimbladder; a hole present between the third and fourth lateral ribs on both sides of the body wall to receive the paired "sac-like" projections. Sagitta rectangular, sulcus not reaching to the margins (*Larimus* pattern). Snout with five marginal and five upper pores (Fig. 33,F); lower jaw with five pores and no barbel (Fig. 34,F). *Sciaenops* is the only genus in this group.

Sciaenops

Diagnosis: Body elongate, robust, back slightly elevated, ventral surface flat. Head long and low; snout long. Mouth inferior; teeth villiform in bands. Gill rakers short. Vertebrae 10+15=25. Other diagnostic characters as in *Sciaenops* group. Subtropical northwestern Atlantic. Monotypic: *S. ocellata*. Inhabits estuarine and inshore waters with sandy bottoms.

Sciaenops Gill, 1963a:30 (type-species: *Perca ocellata* Linnaeus by monotypy).

Sciaenops ocellata Linnaeus

Perca ocellata Linnaeus, 1766:483, South Carolina (syntypes: Linnaean Society, London, no. 106, one dried right side skin, 394 mm TL and no. 107, one dried right side skin, 399 mm TL).

Lutjanus triangulum Lacépède, 1803, vol. 4:181, figure in vol. 3, pl. 24, fig. 3, Sumatra (type: not located in MNHN).

Sciaena imberbis Mitchill, 1815:411, New York.

Pogonias Group

Diagnosis: swimbladder with very complicated diverticula along the side of main chamber (Fig. 10). Sagitta semi-circular in shape, the "tadpole-shaped" sulcus not reaching to the margins, (Fig. 19,A). Snout with five rostral pores and five marginal pores; (Fig. 31,E); lower jaw with five to seven pores and 12 to 13 pairs of small barbels (Fig. 32,G). Monotypic: *Pogonias*.

Pogonias Lacépède

Diagnosis: Body oblong and deep, dorsal profile elevated, ventral nearly straight. Head large, snout conical not projecting in front of upper jaw. Mouth moderate, horizontal and slightly inferior; teeth in villiform band. Gill rakers very short. Vertebrae 10+14=24. Complexity of swimbladder increases with size (Fig. 10); other diagnostic characters as in group diagnosis. Tropical and temperate western Atlantic. Monotypic: *Pogonias cromis*. Inhabits coastal waters especially in areas with large river runoffs over sandy and sandy-muddy bottoms.

Pogonias Lacépède, 1802:137 (type-species: *Pogonias fasciatus* Lacépède = *Labrus cromis* Linnaeus, by monotypy).

Pogonathus Lacépède, 1803, vol. 5:120 (type-species: *Pogonathus courbina* Lacépède = *Labrus cromis* Linnaeus, by subsequent designation of Jordan, 1917:65).

Pogonias cromis (Linnaeus)

Labrus cromis Linnaeus, 1766:479, Carolina.

Pogonias fasciatus Lacépède, 1802, vol. 3:137, figure in vol. 2, pl. 16, fig. 2, Brazil (syntypes: MNHN 7461, one dried stuffed specimen, 103 mm TL; MNHN 7460, one dried stuffed specimen, 181 mm SL).

Pogonathus courbina Lacépède, 1803, vol. 5:120, Rio de La Plata (from the manuscript of Commerson).

Mugil grunniens Mitchill, 1814:15, New York.

Mugil gigas Mitchill, 1814:16, New York.

Sciaena fusca Mitchill, 1815:409, New York.

Cynoscion Group

Diagnosis: Swimbladder with a pair of well-developed horns (Fig. 12) from anterior-lateral corners of main chamber, tapering forward to the back of skull. Sagitta elongate oval with smooth or notched margins. Snout with only two (or no) marginal pores and without upper pores (Fig. 31,A); lower jaw without pores or barbels (Fig. 32,A). Four genera in this group: *Cynoscion, Isopisthus, Macrodon* and *Plagioscion*.

Cynoscion Gill

Diagnosis: Body elongate, compressed, predorsal outline nearly straight, ventral evenly arched. Head conical, snout pointed. Mouth large, oblique, lower jaw projecting; teeth sharp in narrow ridges, tip of upper jaw with two large canines (no canine teeth in *C. steindachneri*), tapering from base to tip. Preopercular margin membranous or cilliated. Gill rakers short to long slender. Vertebrae usually 13(12)+12(13)=25, except 15+12=27 in *C. nothus*. Swimbladder with a pair of anterior horns, some straight and some curved (Fig. 13). Sagitta oval, the ostium of the sulcus usually not reaching to the anterior margin in most species (Fig. 23); the cauda usually short and expanded. Eastern Pacific and western Atlantic, about 20 species. This genue including four northwestern Atlantic species: *C. arenarius, C. nebulosus, C. nothus* and *C. regalis*; and eight Caribbean and southwestern Atlantic species: *C. acoupa, C. jamaicensis, C. leiarchus, C. microlepidotus, C. similis, C. steindachneri, C. striatus* and *C. virescens*. Inhabits estuarine and inshore waters.

Cestreus Gronow, 1754 (ed. by Gray, 1854):49 (type-species: *Cestreus carolinensis*, by monotypy, preoccupied by *Cestreus* Klein, 1749, type-species: see remarks and not of *Cestreus* McClelland, 1842, type-species: *Cestreus minimus* = *Atherina donius* Hamilton).

Cynoscion Gill, 1861b:81 (type-species: *Otolithus regalis* Cuvier, = *Johnius regalis* Bloch & Schneider, by original designation).

Apseudobranchus Gill, 1862:18 (type-species: *Otolithus toe-roe* Cuvier, by original designation).

Archoscion Gill, 1862:18 (type-species: *Otolithus analis* Jenyns, 1842, by original designation).

Atractoscion Gill, 1862:18 (type-species: *Otolithus aequidens* Cuvier by original designation).

Buccone Jordan & Everman, 1895:394 (type-species: *Cestreus praedatorium* Jordan & Gilbert, by original designation).

Symphysoglyphus Miranda Ribeiro, 1915, Sciaenidae: 43 (type-species: *Otolithus bairdi* Steindachner, by monotypy).

Eriscion Jordan & Evermann, 1927:506 (type-species: *Cynoscion nebulosus* Cuvier, by monotypy).

Remarks: In Klein (1749), page 23 and 24, species of "Mugil" were described and "Sciaena" was described in a footnote. Type-species of *Sciaena*: *Mugil cephalus* Linnaeus = "Cestreus dorso repando" Klein, was subsequently designated by Walbaum (1793).

Cynoscion acoupa (Lacépède)

Cheilodipterus acoupa Lacépède, 1800, vol. 2:540; Cayenne (holotype: MNHN 5502, 262 mm SL, Surinam).

Lutjanus cayennensis Lacépède, 1803, vol. 4:196 (syntypes: MNHN 5502, one specimen, 262 mm SL, Surinam; MNHN A.5617, two specimens, 522 & 567 mm SL, Martinique; MNHN A.4562, two specimens, 278 & 288 mm SL, Brazil).

Otolithus toe-roe Cuvier, 1830:72, pl. 103 (syntypes: MNHN 5500, one specimen, 175 mm SL, Surinam; MNHN 4616, one specimen, 347 mm SL, Cayenne; MNHN A.4518, two specimens, 493 & 485 SL, Cayenne).

Cynoscion maracaiboensis Schultz, 1949:160, fig. 20, Maracaibo, Venezuela (holotype: USNM 12742, 251 mm SL).

Cynoscion arenarius Ginsburg

Cynoscion arenarius Ginsburg 1929:83, Texas (holotype, USNM 89385, 245 mm SL).

Cynoscion jamaicensis (Vaillant & Bocourt)

Otolithus jamaicensis Vaillant & Bocourt, 1915:156, pl. 6, fig. 1, Jamaica (holotype: MNHN A.557, 205 mm SL).

Archoscion petranus Miranda Ribeiro, 1915, Sciaenidae: 42, Brazil (type: not listed in Miranda Ribeiro, 1953).

Cynoscion leiarchus (Cuvier)

Otolithus leiarchus Cuvier, 1830:78, Cayenne, Brazil (syntypes: all from Brazil, MNHN 5503, 2 specimens 152 & 234 mm SL; MNHN A.2690, 1 specimen, 187 mm SL; MNHN A.5422, one dried stuffed specimen, 112 mm SL).

Cynoscion microlepidotus (Cuvier)

Otolithus microlepidotus Cuvier, 1830:79, Surinam (type: in Berlin, not examined).

Otolithus bairdi Steindachner, 1879:40, pl. 1, fig. 2, Santos (NHMV 51130, 152 mm SL, donated by Steindachner, is probably the holotype).

Cynoscion nebulosus (Cuvier)

Labrus squetaeque var. *maculatus* Mitchill, 1815:396, New York (not *Labrus maculatus* Bloch).

Otolithus nebulosus Cuvier, 1830:79, no locality (holotype: MNHN 7527, 233 mm SL).

Otolithus carolinensis Valenciennes, 1833:475, South Carolina (holotype: MNHN 7507, 335 mm SL).

Otolithus drummondi Richardson, 1836:70, New Orleans.

Cynoscion maculatum Jordan & Gilbert, 1882:285, Pensacola, Galveston (after Mitchill).

Cynoscion nothus (Holbrook)

Otolithus nothus Holbrook, 1855:134, pl. 19, fig. 1, South Carolina.

Cynoscion regalis (Bloch & Schneider)

Cestreus carolinensis Gronow, 1754 (ed. by Gray, 1854):49 (holotype: BMNH 1853, 11, 12, 42, a dried skin, 344 mm TL, not of *O. carolinensis* Valenciennes).

Johnius regalis Bloch & Schneider, 1801:75, New York.

Roccus comes Mitchill, 1814:26, New York.

Labrus squeteague Mitchill, 1815:396, pl. 2, fig. 1, New York.

Otolithus thalassinus Holbrook, 1855:132, pl. 18, fig. 2, Charleston South Carolina.

Cynoscion similis Randall & Cervigon

Cynoscion similis Randall & Cervigon, 1968:170, fig. 2, Isla de Margarita, Venezuela (holotype: USNM 201382, 284 mm SL).

Cynoscion steindachneri (Jordan)

Cestrus steindachneri Jordan *in* Jordan & Eigenmann, 1889:372, Curuca (holotype: MCZ 10922, 318 mm SL).

Cynoscion striatus (Cuvier)

"Quatucupa" Marcgrave, 1648 (translated by Taunay, 1914):177 (non-binomial).

Otolithus striatus Cuvier, 1839:173 (after Marcgrave).

Otolithus quatuccupa Cuvier, 1830:75, Montevideo (syntypes: MNHN 7517, two specimens, 366 & 358 mm SL).

Cynoscion virescens (Cuvier)

Otolithus virescens Cuvier, 1830:72, Surinam (type: in Berlin, not examined).

Otolithus microps Steindachner, 1879:38 (type: not located in NHMV, Vienna).

Isopisthus Gill

Diagnosis: Body elongate, compressed, dorsal profile nearly straight, ventral evenly arched. Head pointed, rather compressed. Mouth large, oblique, lower jaw projecting; teeth in narrow band, tip of upper jaw with two enlarged canine-like teeth. Preopercular margin membranous with fine ciliae. Spinous and soft portions of dorsal fin well-separated. Gill rakers moderate. Vertebrae 11+14=25. Swimbladder with a pair of tube-like anterior horns (Fig. 12,B). Sagitta nearly oval, the ostium of the sulcus reaching to anterior margin (Fig. 25,A); the cauda oblique, slightly bent at the distal end. Tropical eastern Pacific and western Atlantic, two species. One western Atlantic species: *I. parvipinnis*. Inhabits inshore waters with sandy to muddy bottoms.

Isopisthus Gill, 1862:18 (type-species: *Ancylodon parvipinnis* Cuvier by monotypy).

Paraplesichthys Bleeker, 1876 (from Kaup's manuscript, 1862): 335 (type-species: *Isopisthus parvipinnis* Gill = *Ancylodon parvipinnis* Cuvier, by monotypy).

Isopisthus parvipinnis (Cuvier)

Ancylodon parvipinnis Cuvier, 1830:84, pl. 105, Cayenne (syntypes: MNHN 745, three specimens, 100-140 mm SL).

Isopisthus affinis Steindachner, 1879:43, pl. 2, fig. 2, Port Alegre, Brazil (syntypes: NHMV 15190, two specimens, 168 & 172 mm SL).

Isopisthus harroweri Fowler, 1916:402, fig. 3, Colon, Panama (holotype: ANSP 45236, 145 mm SL).

Macrodon Schinz

Diagnosis: Body elongate, moderately compressed; dorsal profile slightly arched, ventral evenly arched. Head pointed, compressed. Mouth large, oblique; lower jaw projecting in front of upper jaw; teeth in narrow ridge, upper jaw with a pair of much enlarged canine (Fig. 37,A), lance-shaped; lower jaw with several enlarged canines at the tip, exposed externally when mouth closed. Preopercular margin membranous. Gill rakers slender. Vertebrae 13+12=25. Swimbladder with a pair of anterior fork-like horns (Fig. 12,C). Sagitta oval, lateral margins concave or notched (Fig. 25,B); the ostium of the sulcus reaching to the anterior margin; the cauda nearly straight with an expanded distal end (*Macrodon* pattern). Tropical eastern Pacific and western Atlantic, two species. One western Atlantic species: *M. ancylodon*. Inhabits inshore waters.

Ancylodon Bosc, 1816:497 (type-species: "Lonchures" Schneider = *Lonchurus ancylodon* Bloch & Schneider, by original designation, not of *Ancylodon* Illiger).

"Ancylodons" Cuvier, 1817:299, vernacular name Latinized as *Ancylodon* by Oken, 1817:1182 (type-species: *Lonchurus ancylodon* Bloch & Schneider, by original designation, not of *Ancylodon* Illiger).

Macrodon Schinz, 1822:482 (substitute name for *Ancylodon*, therefore taking the same type-species: *L. ancylodon* Bloch & Schneider; preoccupied by *Ancylodon* Illiger 1811, a genus of mammals).

Nomalus Gistel, 1848, p. VIII (substitute name for *Ancylodon*, therefore taking the same type-species: *L. ancylodon* Bloch & Schneider).

Sagenichthys Berg, 1895:52 (substitute name for *Ancylodon*, therefore taking the same type-species: *L. ancylodon* Bloch & Schneider).

Macrodon ancylodon (Bloch & Schneider)

Lonchurus ancylodon Bloch & Schneider 1801:102, pl. 25, Surinam.

Ancylodon jaculidens Cuvier, 1830:81, Cayenne (syntypes: MNHN 7451, one specimen, 212 mm SL: MNHN 7454, one specimen, 144 mm SL).

Ancylodon atricauda Gunther, 1880:12, Rio de La Plata (type: not located in BMNH).

Lonchiurus Group

Diagnosis: Swimbladder carrot-shaped with a pair of anterior horns, each horn with a long posterior branch (*Lonchiurus* pattern, Fig. 14); sometimes the swimbladder is reduced in size. Sagitta oval elongate to rectangular in shape, the "tadpole-shaped" sulcus elongate;

the ostium reaching to the margin and the cauda long, J-shaped (*Lonchiurus* pattern, Fig. 24). Snout with five marginal pores and three to five upper pores (Fig. 31, D & E); lower jaw with two to many pairs of barbels (Fig. 32,F & H). Two genera of western Atlantic Sciaenidae in this group; *Lonchiurus* and *Paralonchurus*.

Lonchiurus Bloch

Diagnosis: Body long and rounded; dorsal profile evenly arched, ventral nearly flat. Pectoral fin very long, head conical, low and broader than body; snout projecting. Mouth inferior; teeth conical in bands. Gill rakers short. Vertebrae 11+18=29. Swimbladder much reduced in size, but retaining typical shape with anterior horns more prominent, posterior end of the main chamber tapering into a fine point (Fig. 14,A). Snout with five upper pores; lower jaw with four pores and two barbels (Fig. 31,F), longer than eye diameter. Distribute in tropical west Atlantic. Monotypic: *L. lanceolatus*. Inhabits sandy and muddy bottom along the coast and in estuarine waters.

Lonchiurus Bloch, 1793:143 (type-species: *Lonchiurus barbatus* Bloch, by monotypy).

Lonchurus Bloch & Schneider, 1801:102 (invalid emendation of *Lonchiurus*).

Lonchiurus lanceolatus (Bloch)

Perca lanceolata Bloch, 1788:383, fig. 3, India (= West Indies).

Lonchiurus barbatus Bloch, 1793:144, pl. 360, fig. 1, Surinam.

Lonchurus depressus Bloch & Schneider, 1801:102, Surinam.

Paralonchurus Bocourt

Diagnosis: Body elongate, slightly rounded; dorsal profile slightly elevated, ventral nearly flat. Pectoral fin long or short. Head broad, nape slightly convex; snout projecting. Mouth small and inferior, teeth in conical bands. Gill rakers short. Total vertebrae 25 or 29 (see "Key to the species of *Paralonchurus*"). Swimbladder well-developed (Fig. 14,B & C). Sagitta elongate, the ostium of the sulcus reaching to anterior margin; the cauda, J-shaped (Fig. 24,B & C). Snout with three upper pores; lower jaw with 12 to 16 pairs of minute barbels, anterior three pairs form a tuft at the symphysis of lower jaw and other barbels along the rami of lower jaw (Fig. 32,H). Tropical eastern Pacific and western Atlantic, about five species. Two species from the western Atlantic in this genus: *P. brasiliensis* and *P. elegans*. Inhabits estuarine and inshore waters with sandy to muddy bottoms.

Paralonchurus Bocourt, 1869:21 (type-species: *Paralonchurus petersi* Bocourt, by monotypy).

Polycirrhus Bocourt, 1869:22 (type-species: *Polycirrhus dumerili* Bocourt by monotypy, not *Polycirrhus* Grube).

Polyclemus Berg, 1895:54 (substitute name for *Polycirrhus*, therefore taking the same type-species: *P. dumerili*; preoccupied by *Polycirrhus* Grube, 1850, a genus of worms, quote from Neave, 1940).

Paralonchurus (*Zonoscion*) Jordan & Evermann, 1895:401 (type-species: *Polycirrhus rathbuni* Jordan & Bollman, 1889, by monotypy).

Paralonchurus (*Zaclemus*) Gilbert *in* Jordan & Evermann, 1895: 402 (type-species: *Paralonchurus goodei* Gilbert, manuscript name, by monotypy).

Paralonchurus brasiliensis (Steindachner)

Genyanemus brasiliensis Steindachner; 1875a:476, Para, Santos. (type: not located in NHMV).

Micropogon ornatus Günther, 1880:13, pl. 7, fig. A, Rio de La Plata (holotype: BMNH 1879.5. 14. 289, 175 mm SL).

Paralonchurus rathbuni Puyo, 1949:215, fig. 114 (not Jordan & Bollman, 1889:162).

Paralonchurus elegans Boeseman

Paralonchurus elegans Boeseman, 1948:3, Surinam (holotype: RMNH 390, 200 mm SL).

Remarks: *P. elegans* and *L. lanceolatus* have very similar sagittae (Fig. 24) and both have a long black pectoral fin. *P. brasiliensis* has a total vertebrae count of 29 as in *L. lanceolatus*. *P. brasiliensis* and *P. elegans* both have well-developed swimbladders and many minute barbels on the chin. The interrelationship of these three species could not be determined without comparative material of the eastern Pacific species of this group. The reduced size of the swimbladder in *L. lanceolatus* (Fig. 14,A) has been viewed as an important diagnostic character (Günther, 1860), and this may also link this group with *Menticirrhus*. *Paralonchurus brasiliensis* may be considered to belong in a separate genus, *Polyclemus* as in Berg (1895). The type-species of *Paralonchurus* (*P. petersi*) and *Polyclemus* (*P. dumerili*) are eastern Pacific species. Study of these species will be necessary to clarify the generic status of these fishes.

Menticirrhus Group

Diagnosis: Swimbladders atrophy as the fish grow, only a vestige in adult. Sagitta oval, elongate, the sulcus not reaching to the margin (*Menticirrhus* pattern, Fig. 22,B). Snout with three upper pores and five marginal pores, rostral fold deeply indented (Fig. 33,D); lower jaw with a short, rigid barbel, knob-like and four pores (Fig. 35,B). Anal fin with only one weak spine. One genus in this group; *Menticirrhus*.

Menticirrhus Gill

Diagnosis: Body elongate, rounded, dorsal profile slightly arched, ventral nearly flat. Head conical, low and broad, snout projecting. Mouth small and inferior; teeth in villiform bands. Gill rakers short and tubercle-like. Vertebrae 10+15=25. Other diagnostic characters as in the group diagnosis. Tropical and temperate eastern Pacific and western Atlantic, nine species. Three species from the western Atlantic: *M. americanus, M. littoralis* and *M. saxatilis*. Inhabits shallow coastal waters with sandy bottoms, juveniles often found in estuaries.

Menticirrhus Gill, 1861b:86 (type-species: *Perca alburnus* Linnaeus = *Cyprinus americanus* Linnaeus by original designation).

Cirrimens Gill, 1862:17 (type-species: *Umbrina ophiocephalus* Jenyns, 1842:45, by original designation).

Menticirrhus (*Umbrula*) Jordan and Eigenmann, 1889:424 (type-species: *Umbrina littoralis* Holbrook, by subsequent designation of Jordan and Everman, 1898:1469).

M. americanus (Linnaeus)

"Alburnus Americanus" Catesby, 1743, "Carolina whiting", pl. 12, lower figure, Charleston (non-binomial, also see remarks).

Sciaena alburnus Gronow, 1754 (ed. by Gray, 1854):108 (non *Perca alburnus* Linnaeus, holotype BMNH 1853. 11. 12. 75, a dried skin, 228 mm TL).

Cyprinus americanus Linnaeus, 1758:321 (based on Catesby).

Perca alburnus Linnaeus, 1766:482, South Carolina (holotype: Linnaean Society, London, no. 111, a dried left side of skin, 282 mm TL).

Umbrina arenata Cuvier, 1830:190, Brazil (syntype: MNHN 7500, one specimen, 76.4 mm SL; MNHN 7472, one specimen, dried and stuffed, in ethanol, 341 mm TL).

Umbrina martinicensis Cuvier, 1830:186, Martinique (holotype: MNHN 7498, 193 mm SL).

Umbrina gracilis Cuvier, 1830:189, Brazil (syntypes: MNHN 9037, one specimen, 97 mm SL; and MNHN 44 one specimen, 156 mm SL).

Umbrina phalaena Girard, 1859:167, Brazos Santiago, Texas (syntypes: USNM 154721, 88.3 mm SL; other syntypes not located).

Umbrina januaria Steindachner, 1877:170, Rio Janeiro (type-specimens, not located).

Remarks: The description of "Alburnus americanus" by Catesby (1743) stated that "under the lip having five or six fleshy barbels, resembling teeth hanging to it on the outside. It had one small fin on the middle of the back". The lower figure of plate 12, "Alburnus" agrees with this description. Except for these features, the general appearance of the figure is a species of *Menticirrhus* but it is impossible to identify it with any of the *Menticirrhus* species. The name *Cyprinus americanus* Linnaeus, 1758 is based on Catesby. The holotype of *Perca alburnus* Linnaeus, 1766, is designated here as neotype of *Cyprinus americanus* Linnaeus, 1758, to restrict the application of this name to the species to which it is usually applied.

A specimen, MNHN 9037, was catalogued as a type-specimen of *Umbrina gracilis* Cuvier 1830, in MNHN, Paris and was identified by Irwin (1970) as *M. littoralis* (Holbrook). It is not a type of *U. gracilis*, because the locality and the donor of the specimen does not agree with the original description of Cuvier (Dr. M. Bauchot, MNHN, Paris, personal communications).

Menticirrhus littoralis (Holbrook)

Umbrina littoralis Holbrook, 1855:142, South Carolina (holotype: ANSP 11567, 198 mm SL).

Menticirrhus saxatilis (Bloch & Schneider)

Johnius saxatilis Bloch & Schneider, 1801:75, New York. (holotype: HU 8792, Humbold-Universitat, Berlin, a stuffed skin, dried in poor condition, from Irwin, 1970).

Sciaena nebulosa Mitchill, 1815:408, pl. 3, New York.

Menticirrhus focaliger Ginsburg, 1952:97, St. Joseph Bay, Florida (holotype: USNM 144101, 104 mm SL).

Menticirrhus atlanticus McFarland, 1963:98, Mustang Island, Texas (*Nomen nudum*).

Stellifer Group

Diagnosis: Swimbladder separated into two chambers by a contriction; the anterior one yoke-shaped and the posterior one simple carrot-shaped (*Stellifer* pattern, Fig. 15). Sometimes a pair of diverticula present on the anterior chamber posterior-laterally. Otolith with both sagitta and lapillus enlarged (*Stellifer* pattern, Fig. 27). Snout with five marginal pores and two to five upper pores (Fig. 31,C to F); lower jaw with four to six pores and without barbels (Fig. 32,B to D). Four genera of western Atlantic sciaenids in this group; *Bairdiella, Odontoscion, Ophioscion* and *Stellifer*.

Genus *Bairdiella*

Diagnosis: Body oblong, compressed; dorsal profile slightly elevated, ventral nearly straight. Head usually with strong spines at the angle of preopercular margin. Mouth terminal, slightly oblique; upper jaw teeth in conical band, lower jaw teeth in a narrow ridge. Gill rakers long and slender. Vertebrae 12+13=25. Swimbladder in two chambers, without diverticula on anterior chamber (Fig. 15,A). Sagitta triangular; the ostium of the sulcus incomplete; lapillus more than 1/2 the size of sagitta (Fig. 27,C). Snout with five marginal and three upper pores; lower jaw with five or six pores the median pair of pores in six pored form very closely set (Fig. 32,C & D). Tropical eastern Pacific and western Atlantic, about six species. Four species of western Atlantic Sciaenidae in this genus: *B. batabana, B. chrysoura, B. ronchus* and *B. sanctaeluciae*.

Bairdiella Gill, 1861b:83 (type-species: *Bodianus argyroleucus* Mitchill, by original designation).

Bairdiella (*Nector*) Jordan & Evermann, 1898:1432 (type-species: *Bairdiella chrysoleuca* Günther (by original designation).

Corvula Jordan & Eigenmann, 1889:377 (type-species: *Johnius batabanus* Poey, by original designation).

Bairdiella batabana (Poey)

Johnius batabanus Poey, 1860, 2:184, Batabano, Cuba (holotype: MCZ 21957, 189 mm SL).

Corvula sialis Jordan & Eigenmann, 1889:379, Key West, Florida (holotype: USNM 26575, 132 mm SL).

Bairdiella chrysoura (Lacépède)

Perca punctata Linnaeus, 1766:482, South Carolina (a junior homonym of *Perca punctatus* of Linnaeus, 1758:291, = *Bodianus fulvus punctatus*; syntypes?: Linnaean Society of London, no. 108, a left side dried skin, 144 mm TL and no. 109, a left side dried skin, 153 mm TL).

Dipterodon chrysourus Lacépède, 1803, vol. 4:166, South Carolina (type: not located in MNHN).

Bodianus argyro-leucus Mitchill, 1815:417, pl. 6, fig. 9, New York.

Bodianus exiguus Mitchill, 1815:419, New York.

Bodianus pallidus Mitchill, 1815:420, New York.

Homoprion xanthurus Holbrook, 1855:170, pl. 24, fig. 2, South Carolina (not *Leiostomus xanthurus*, Lacépède).

Bairdiella ronchus (Cuvier)

Corvina ronchus Cuvier, 1830:107 (tyntypes: MNHN 95, two specimens, 123 & 149 mm SL, St. Dominique; MNHN 5345, two specimens, 144 & 156 mm SL, Surinam, MNHN 5345, one dried stuffed specimen, 247 mm SL, Maracaibo?).

Corvina subaequalis Poey, 1875:58, Cuba (holotype: 245 mm TL, not located in MCZ nor in USNM).

Sciaena bedoti Regan, 1905:391, pl. 6, fig. 1, Cuba (syntypes; BMNH 1905. 3.182, one specimen, 155 mm SL; Museum d'Histoire Naturelle, Geneve, no. 678.1, not examined).

Bairdiella verae-crucis Jordan & Dickerson, 1908:17, fig. 1, Vera Cruz (holotype; USNM 61676, 194 mm SL).

Bairdiella sanctae-luciae (Jordan)

Corvula sanctae-luciae Jordan, 1889:649, Port Castries, St. Lucia (holotype: USNM 4173, 105 mm SL).

Odontoscion Gill

Diagnosis: Body oblong, compressed; profile evenly arched. Head conical; snout short, blunt; eye large. Mouth large, terminal, slightly oblique; enlarged conical teeth in a single row on both jaws, two teeth at the tip of lower jaw large canine-like (Fig. 37,C). Gill rakers long and stiff. Vertebrae 12+13=25. Swimbladder with two chambers, anterior one yoke-shaped and posterior one carrot-shaped, without diverticula (Fig. 15,A). Sagitta and lapillus both enlarged, only a trace left of the ostium of the sulcus (Fig. 27,D). Snout with five marginal pores and two upper pores (Fig. 31,C); lower jaw with four pores and no barbel (Fig. 34,C). Tropical eastern Pacific and western Atlantic, two species. One species in western Atlantic: *O. dentex*. Inhabits coral reefs and offshore waters over sandy bottoms.

Odontoscion Gill, 1862:18 (type-species: *Corvina dentex* Cuvier, by original designation).

Odontoscion dentex (Cuvier)

Corvina dentex Cuvier, 1830:139, pl. 109, St. Dominica (holotype: MNHN 144, 114 mm SL).

Ophioscion Gill

Diagnosis: Body robust, dorsal profile elevated, ventral slightly convex. Head broad, conical top with prominent cavernous canals (Fig. 39,A); bony interorbital width 3.5 or more in head. Mouth small, inferior, teeth conical in bands. Gill rakers short. Vertebrae 11+14=25. Swimbladder with two chambers, anterior one yoke-shaped and posterior one carrot-shaped, both without diverticula (Fig. 15,A). Both sagitta and lapillus enlarged; the ostium of the "tadpole-shaped" sulcus incomplete (Fig. 27,A). Snout with three large and two to four minute upper pores, and five marginal pores, rostral fold deeply indented (Fig. 32,B). Tropical eastern Pacific and western Atlantic, about 5 species. Three nominal species of this genus from the western Atlantic recognized here: *O. adustus*, *O. panamensis* and *O. punctatissimus*. Inhabits inshore waters over sandy to muddy bottoms.

Ophioscion Gill, 1863b:164 (type-species: *Ophioscion typicus* Gill, by monotypy).

Ophioscion (*Sigmurus*) Gilbert, *in* Jordan & Evermann, 1898:1452 (type-species: *Corvina vermicularis* Günther by monotypy).

Ophioscion adustus (Agassiz)

Corvina (*Sciaena*) *adusta* Agassiz, 1829:126, pl. 70, Montevideo (type: not located in MCZ).

Remarks: Schultz (1945) indicated that the description of *Corvina adusta* by Agassiz (1829) did not agree with the fish figured by Spix (Agassiz, 1829). He compared the descriptions of *Ophioscion adustus* of several authors, then suggested it probably was a senior synonym of *Ophioscion woodwardi* Fowler, 1937 (= *Micropogonias furnieri*). The true identity of this species is doubtful.

Ophioscion panamensis (Schultz)

Ophioscion panamensis Schultz, 1945:134, fig. 8, Fox Bay, Colon, Panama (holotype: USNM 122612, 52 mm SL).

Ophioscion punctatissimus Meek & Hilderbrand

Ophioscion punctatissimus Meek & Hilderbrand, 1925:644, pl. 68, Panama (holotype: USNM 81766, 131 mm SL, Canal Zone).

Remarks: The type-specimens of *O. panamensis* are all juveniles (11, 23.3-52 mm SL) and their true identity will be in doubt until the morphology of the swimbladder can be examined. No specimens have been reported except the types.

Stellifer Oken

Diagnosis: Body robust, back elevated. Head broad, rather flat on top with apparent cavernous canals (Fig. 39,A); interorbital wide, bony interorbital width 3.5 or less in head. Mouth moderate to large, inferior to oblique (Fig. 38); teeth in conical or villiform bands. Gill rakers usually long and slender, some moderate to short. Vertebrae 11+14=25. Swimbladder in two chambers, the anterior chamber yoke-shaped with a pair of diverticula, tube-like or bulb-like (Fig. 16), variation also found within the species and the posterior chamber in simple carrot-shape. Both sagitta and lapillus enlarged, the ostium of sulcus on sagitta incomplete (Fig. 28). Snout with five marginal pores, the median one rounded, separate from rostral fold and arranged rhomboidally with three upper pores at the tip of snout (Fig. 1,B); lower jaw with four to six pores, no barbel (Fig. 26). Tropical eastern Pacific and western Atlantic, about 15 species. Nine species of western Atlantic sciaenids belong to this genus: *S. brasiliensis, S. colonensis, S. griseus, S. lanceolatus, S. microps, S. naso, S. rastrifer, S. stellifer* and *S. venezuelae*. Inhabits inshore waters of sandy bottoms, also in estuaries and around coral reefs.

"Stelliféres" Cuvier, 1817:283, vernacular name Latinized as *Stellifer* by Oken, 1817:1182 (type-species: *Bodianus stellifer* Bloch, by original designation).

Stelliferus Stark, 1828:459 (type-species: *Stellifer capensis* Stark = *Bodianus stellifer* Bloch, by monotypy).

Homoprion Holbrook, 1855:168 (type-species: *Homoprion lanceolatus* Holbrook, by subsequent designation of Gill, 1861b:83).

Stellifer (*Zestis*) Gilbert *in* Jordan & Evermann, 1898:1439 (type-species *Stellifer oscitans* Jordan & Gilbert, by original designation).

Stellifer (*Zestidium*) Gilbert *in* Jordan & Everman, 1898:1439 (type-species: *Stellifer illecebrosus* Gilbert, by original designation).

Stellifer (*Stellicarens*) Gilbert *in* Jordan & Evermann, 1898:1439 (type-species: *Stellifer zestocarus* Gilbert, by original designation).

Stellifer brasiliensis (Schultz)

Ophioscion brasiliensis Schultz, 1945:128, fig. 6, Santos, Brazil (holotype: USNM 87742, 77 mm SL).

Stellifer colonensis Meek & Hilderbrand

Stellifer colonensis Meek & Hilderbrand, 1925:623, pl. 46, fig. 1, Mindi, Panama (holotype: USNM 81729, 99 mm SL).

Stellifer griseus Cervigon

Stellifer sp. Cervigon, 1966a:509, fig. 209, Morro de Puer to Santos, Venezuela.

Stellifer griseus Cervigon, 1966b:1, fig. 1, North Peninsula de Araya (holotype in Museo de Historia Natural La Salle, Venezuela, MHNLS 1.875, 120 mm SL, not examined; paratypes: USNM 200782, two specimens, 108 & 123 mm SL).

Stellifer lanceolatus (Holbrook)

Homoprion lanceolatus Holbrook, 1855:168, pl. 23, Beaufort, South Carolina.

Stellifer microps (Steindachner)

Corvina microps Steindachner, 1864:205, pl. 2, fig. 2, Guiana (type: not located in NHMV).

Stellifer naso (Jordan)

Stelliferus naso Jordan *in* Jordan & Eigenmann, 1889:395, Cachiura, Brazil (syntypes: USNM 130630, 5 specimens, 68-75 mm SL).

Stellifer rastrifer (Jordan)

Stelliferus rastrifer Jordan *in* Jordan & Eigenmann, 1889:393, Brazil (holotype: MCZ 10815, 128 mm SL, Santos).

Stellifer stellifer (Bloch)

Bodianus stellifer Bloch, 1790:55, pl. 231, fig. 1, Cape of Good Hope.

Corvina trispinosa Cuvier, 1830:109, Cayenne, Brazil.

Stellifer mindii Meek & Hilderbrand, 1925:626, pl. 66, fig. 2, Mindi Reef, Panama (holotype: USNM 81730, 93.4 mm SL).

Stellifer venezuelae (Schultz)

Ophioscion venezuelae Schultz, 1945:131, fig. 7, Venezuela (holotype: USNM 121749, 140 mm SL).

Freshwater Sciaenidae of America

Four genera, *Aplodinotus, Pachypops, Pachyurus* and *Plagioscion,* and 23 nominal species of sciaenids are recognized here from the river systems of the Atlantic drainage in America. *Aplodinotus* is the only North America freshwater inhabitant, the other three genera are endemic to continental South America. Because of lack of sufficient material for the South American genera, the diagnosis of these genera are based mainly on the literature and type-specimens. The exact limits of these genera are not clear at present.

Genus *Aplodinotus* Rafinesque

Diagnosis: Body oblong, snout blunt, back elevated and compressed; mouth small, horizontal to inferior; lower pharyngeals very large, completely united. Swimbladder simple carrot-shaped; sagitta more or less semi-circular, the sulcus not reaching the margin (Fig. 19,B); snout without upper pores (Fig. 31,B); lower jaw without mental barbels. Vertebrae 10+14=24. Freshwater North and Central America. Monotypic: *A. grunniens*.

Aplodinotus Rafinesque, 1819:418 (type-species: *Aplodinotus grunniens* Rafinesque, by monotypy).

Haploidonotus Gill, 1861d:102 (invalid emendation of *Aplodinotus,* Rafinesque, 1819, therefore taking the same type-species: *Aplodinotus grunniens* Rafinesque).

Eutychelithus Jordan, 1876:242 (type-species: *Corvina richardsoni* Cuvier, by monotypy = *Aplodinotus grunniens* Rafinesque).

Remarks: The original description of *Amblodon* Rafinesque (1819: 421) included two species of "buffalo-fish" (= Catostomidae), *A. bubalus* and *A. niger*. The unique lower pharyngeal teeth of *Aplodinotus grunniens* were wrongly attributed to these fishes. Rafinesque's (1820: 24) subsequent replacement of *Aplodinotus* with *Amblodon* does not make *Amblodon* an available name in the Sciaenidae.

Aplodinotus grunniens Rafinesque

Aplodinotus grunniens Rafinesque, 1819:419, Ohio River (no type mentioned in the description).

Sciaena oscula LeSueur, 1822:252, pl. 13, Lake Erie (holotype: MNHN A.5696, 308 mm SL).

Sciaena grisea LeSueur, 1822:254, Ohio River (type: "18 to 24 inches in total length", not located in MNHN).

Corvina richardsoni Cuvier, 1830:100, Lake Huron (type: not located in MNHN, Paris).

Amblodon concinnus Agassiz, 1854:307, Tennessee River (no type mentioned in the description).

Amblodon lineatus Agassiz, 1854:307, Osage River (no type mentioned in the description).

Amblodon neglectus Girard, 1859:167, Rio Grande del Norte, Rio Bravo (holotype: USNM 639, 84.3 mm SL).

Remarks: Two catalogue numbers, MNHN A.5696 and MNHN 7536 are indicated to be syntypes of *Corvina oscula* LeSueur, MNHN A.5696, a dried stuffed specimen, 308 mm SL, collected by LeSueur from Lake Erie was examined. MNHN 7536 from New Orleans was not located.

Pachypops Gill

Diagnosis: Body moderately elongate, dorsal profile elevated and descending nearly straight under soft portion of dorsal fin, ventral profile nearly straight. Head oblong, snout convex and projecting; suborbital region much swollen and translucent. Mouth small, inferior, teeth in villiform bands; supramaxillary bones entirely concealed under the suborbitals. Preopercular margin slightly serrated. Snout with five upper pores and five marginal pores; lower jaw with five to six pores and three to many barbels. From Cuvier (1930), pl. 138, and Trewavas' (1964) description, the swimbladders of *P. furcroi* and *P. trifilis* have a pair of anterior appendages each dividing into a longer posterior branch and a shorter anterior one (*Lonchiurus* pattern, Fig. 14,D). Sagitta of a *Pachypops furcroi* (153 mm SL) examined, which has a similar appearance of the sagitta of *Pachyurus schomburgkii* (Fig. 18, K). Four nominal species are recognized here; *P. adspersus, P. camposi, P. furcroi* and *P. trifilis*.

Pachypops Gill, 1861b:87 (type-species: *Micropogon trifilis* Müller & Troschel, by original designation).

Pachypops adspersus (Steindachner)

Pachyurus adspersus Steindachner, 1879:123, Tio San Antonio, Brazil (type: not located in MNHV).

Pachypops camposi Fowler

Pachypops camposi Fowler, 1954, 9:252, Rupununi River, British Guiana (holotype: ANSP 39773, 117 mm SL, labeled as *P. steindachneri*).

Pachypops fourcroi (Lacépède)

Perca fourcroi Lacépède, 1803, vol. 4:398, no locality (holotype: MNHN 7539, 135 mm SL).

Pachypops trifilis

Micropogon trifilis Müller & Troschel, 1848:622, British Guiana (type: not located).

Pachyurus Agassiz

Diagnosis: Body moderately elongate, dorsal profile slightly elevated, ventral nearly straight or slightly arched. Head conical; snout bluntly, swollen and translucent. Eye moderate to large. Mouth horizontal, inferior or terminal; teeth in villiform bands. Snout with five marginal pores and usually without upper pores, some with three to five upper pores; lower jaw with five pores and no barbel. Swimbladder simple, carrot-shaped or with a pair of tube-like diverticula extending from anterior corners of swimbladder, tapering back to the end of main chamber (Fig. 6). Sagitta moderate to large. Second spine of anal fin moderate to strong. This genus may be divisable into two genera based on the above characters. Nine nominal species are here recognized: *P. biloba, P. bonariensis, P. francisci, P. grunniens, P. lundii, P. natteri, P. paranensis, P. schomburgkii* and *P. squamipinnis*.

Pachyurus Agassiz, 1829:125 & 127 (type-species: *Pachyurus squamipinnis* Agassiz, by monotypy).

Lepipterus Cuvier, 1830:152 (type-species: *Lepipterus francisci* Cuvier, by monotypy).

Pachyurus biloba Cuvier

Corvina biloba Cuvier, 1830:112, no locality (holotype: MNHN 7683, 75.6 mm SL).

Pachyurus bonariensis Steindachner

Pachyurus (*Lepipterus*) *bonariensis* Steindachner 1870:80:125, La Plata, Argentine (NHMV 15181, may be one of the syntypes, 188 mm SL, La Plata, Argentine; "cotype": CAS, Indiana University No. 11353, 152 mm SL, Buenos Aires, this specimen probably not a type-specimen).

Pachyurus francisci (Cuvier)

Lepipterus francisci Cuvier, 1830:152, pl. 113, Riviere de Saint-Francois, Brazil (type: not located).

Pachyurus corvina Reinhardt *in* Lütken, 1875:284, Rio das Velhas, Brazil (syntypes: ZMUC 345, three specimens; 217, 243 & 233 mm SL).

Pachyurus grunniens (Schomburgki)

Corvina grunniens Schomburgki, 1843:136, pl. 2, Comacca Island, Essequibo, British Guiana.

Pachyurus lundii Reinhardt

Pachyurus lundii Reinhardt *in* Lütken, 1875:248, pl. 20, Rio das Velhas, Brazil (syntypes: ZMUC, 16-3, 1871, two specimens; 274 & 366 mm SL).

Pachyurus natteri (Steindachner)

Pachyurus natteri Steindachner, 1863:10, pl. 3 (type: not located in MNHV).

Pachyurus paranensis Dameri

Pachyurus paranensis Dameri, 1956:6, fot. 1 (original description not seen, after Travassos & Rego-Barros, 1971:60).

Pachyurus schomburgkii Günther

Pachyurus schomburgkii Günther, 1860:282, rivers of Brazil (holotype: BMNH 49.11.8.22, 197 mm SL).

Pachyurus squamipinnis Agassiz

Pachyurus squamipinnis Agassiz 1839:128, pl. 71, Brazil.

Plagioscion Gill

Diagnosis: A freshwater genus of Sciaenidae from South American rivers, some species occasionally in estuaries, rarely marine. Body elongate, dorsal profile evenly arched, ventral nearly straight. Head slightly conical, snout protuberant. Mouth moderate, terminal, slightly oblique, no enlarged canine-like teeth at the tip of upper jaw. Scales along lateral line of some species, concealed by many smaller scales, appeared as one enlarged scale (Fig. 40). Gill rakers rather long and slender. Swimbladder with a pair of horn-like diverticula, originating from anterior 1/4 of main chamber and hooked at the distal ends (Fig. 12,D). Sagitta sub-oval in shape, the ostium of the "tadpole-shaped" sulcus reaching to anterior margin and the cauda deeply curved in a J-shape (Fig. 18,L). Nine nominal species in this genus: *P. auratus, P. heterolepis, P. macdonaghi, P. microps, P. monacantha, P. pauciradiatus, P. squamosissimus, P. surinamensis* and *P. ternetzi*.

Plagioscion Gill, 1861b:82 (generic description, no species or type indicated, compared with *Corvina* of Cuvier; (type-species: *Sciaena squamosissima* Hekel, by subsequent designation of Jordan & Eigenmann, 1889:380).

Diplolepis Steindachner, 1863:2 (type-species: *Diplolepis squamossissimus* Steindachner = *Sciaena squamosissima* Heckel, by monotypy, spelled *Diplolepsis* on p. 3; preoccupied by *Diplolepis* Geoffroy, 1762, cynipid insect and Fabricius, 1805, calcid insect, quote from Neave, 1940).

Plagioscion auratus (Castelnau)

Johnius auratus Castelnau, 1855:12, pl. 4, fig. 2; Ucayala, Brazil (holotype: MNHN 7622, 203 mm SL).

Plagioscion heterolepis (Bleeker)

Johnius heterolepis Bleeker, 1873:456, Surinam (syntypes: RMNH 6042, two specimens, 123 & 129 mm SL, these type-specimens are similar to the *Stellifer* group).

Plagioscion macdonaghi Dameri

Plagioscion macdonaghi Dameri, 1954:179, fig. 1, Rio de La Plata (holotype in Coleccion Nacional del Instituto Nacional de Investigación de las Ciencias Naturales, Brazil, no. 4197, 147 mm TL, not examined).

Plagioscion microps Steindachner

Plagioscion microps Steindachner, 1917:657, pl. 1, fig. 1, Amazon (one specimen of NHMV 15180, 168 mm SL and 206 mm TL donated by Steindachner, collected from Surinam, may be one of the syntypes: 208 & 214 mm TL of original description).

Plagioscion monacantha (Cope)

Corvina monacantha Cope, 1867:402, near Paramaribo, Surinam (holotype: ANSP 11519, 167 mm SL).

Sciaena magdalenae Steindachner, 1878:22, pl. 1, fig. 1, Magdalenen River (types: 270 to 540 mm TL, not located in NHMV).

Plagioscion pauciradiatus Steindachner

Plagioscion pauciradiatus Steindachner, 1917:660, figure on p. 661, Paramaribo (type: not located in NHMV).

Plagioscion squamossissimus (Heckel)

Sciaena squamosissima Heckel, 1840:438, Amazon.

Sciaena rubella Schomburgk, 1843:133, river of British Guiana.

Johnius courvina Castelnau, 1855:11, pl. 5, fig. 1, Rio Crixas, Rio Arognay, Brazil (holotype: MNHN 7503, 366 mm TL).

Johnius amazonicus Castelnau, 1955:12, pl. 4, fig. 1, Amazon (syntypes: MNHN 7504, two specimens, 96.3 & 145 mm SL).

Plagioscion surinamensis (Bleeker)

Pseudosciaena surinamemsis Bleeker, 1873:458, Surinam (holotype: RMNH 5995, 88.1 mm SL).

Plagioscion ternetzi Boulenger

Plagioscion ternetzi Boulenger, 1895:523, Paraguay (syntypes: BMNH 1895.5.17.1-2, two specimens, 88.4 & 263 mm SL).

II. Phylogenetic Relationships of the Supra-generic Groups and Genera.

The morphological patterns of swimbladders, otoliths and external features of western Atlantic sciaenid fishes are considered together here (Table 1) to assess phylogenetic relationships (Fig. 4). In the following discussion, relationships will be discussed among the genera, then among supra-generic groups.

1. Relationships of the genera within supra-generic groups.

Sciaena group:

The members of this group all have a simple swimbladder (*Sciaena* pattern, Fig. 5) and a thick sagitta (*Sciaena* pattern, Fig. 18). The shape and position of the sulci vary within the genera. *Equetus* and *Paraques* are very similar in having an elevated dorsal profile and dark stripes on the sides. They are both coral reef dwellers. *Sciaena* lives in deeper water (Chao & Miller, 1975) than other sciaenids. Members of *Sciaena* group have enclosed inferior mouths except for *Sciaena* with a terminal and slightly inferior mouth. Habitat diversification of this group is greatest among all western Atlantic supra-generic groups of sciaenids.

Umbrina group

This group is most similar to the *Sciaena* group, except these fishes have a single barbel on the lower jaw. The swimbladder is simple, carrot-shaped (*Sciaena* pattern, Fig. 5). The sagitta of *Ctenosciaena gracilicirrhus* is most similar to *Umbrina millae* and *Sciaena trewavasae* (Fig. 18). This suggests a relationship between the

Sciaena and *Umbrina* groups. Although *Ctenosciaena* has a mental barbel, it lacks an apical pore (Fig. 35,A). It also has a terminal and slightly inferior mouth, and inhabits waters slightly offshore and deeper than *Umbrina* species. The deeper water habitat of *Ctenosciaena* and corresponding morphological adaptations are similar to those of *Sciaena*. This may suggest a convergence between these respective genera.

Lonchiurus group:

Paralonchurus and *Lonchiurus* show a sequence of reduction in swimbladder size (Fig. 14). This is significant in assessing the relationships of the *Menticirrhus* and *Lonchiurus* groups. *Lonchiurus lanceolatus* has the most reduced swimbladder (Fig. 14,A) and lacks drumming muscles in both sexes. It is a coastal and estuarine dweller. Its habitat is similar to that of *Menticirrhus* which has only a vestige of the swimbladder remaining in adults. The reduced swimbladder of *L. lanceolatus* also shows a basic two-horned structure, which resembles that of the *Cynoscion* group (Fig. 12). *Paralonchurus* has a well-developed swimbladder, drumming muscles are present in males and it inhabits deeper inshore waters than *Lonchiurus*. In comparing the sagitta (Fig. 24) and external morphology of *Lonchiurus* and *Paralonchurus*. The similarities among *L. lanceolatus, P. brasiliensis* and *P. elegans* indicate that they might all be validly treated as one genus. The South American freshwater sciaenid genus *Pachypops* may also belong to this group, based on the swimbladder of *P. furcroi* (Fig. 14,D). Few species examined from this genus all have inferior mouths and three to many pairs of barbels.

Cynoscion group:

Although genera of this group have similar swimbladder shapes, (Fig. 12) the sagittae (Figs. 23 & 25) and external morphology are rather variable. *Macrodon ancylodon* has a thin elongate sagitta (Fig. 25,B) similar to *Cynoscion* (Fig. 23), but the general outline and the sulcus differ. The external morphology is also similar, except that *Macrodon* has a pair of large lanceolate canines at the tip of the upper jaw (Fig. 37,A). *Isopisthus* differs from all other sciaenids by having a space between the spinous and soft dorsal fins, but its general body shape resembles *Cynoscion*. The South American freshwater genus *Plagioscion* has a terminal horizontal mouth, and lacks enlarged canines. Its body shape is deeper and is not as fusiform as other genera of this group. This may be an adaptation to the freshwater habitat, whereas, the fast swimming and fusiform *Cynoscion* may be adapted to an open water habitat. The sagittae of the genera in the *Cynoscion* group differ from each other. In *Plagioscion surinamensis* (Fig. 18,L) and *Isopisthus parvipinnis* (Fig. 25,A), the sagittae have a similar thickened posterior half. Sciaenidae usually have a thick sagitta, therefore, this similarity is not indicative of generic relationships.

Stellifer group:

Genera of this group all have a two chambered swimbladder (Fig. 15) and an enlarged lapillus (Fig. 27). The genus *Stellifer* has a pair of diverticula postero-laterally on the anterior chamber of the swimbladder (Fig. 16). The different morphology of these diverticula indicate the range of variation. *Ophioscion* has a sagitta and lapillus shaped similarly to *Stellifer* (Fig. 27,A & B) and the body shape, cavernous head (Fig. 29,A) and swimbladder position are similar. Although *Ophioscion* lacks diverticula on the anterior chamber of the swimbladder, it could be considered as a member of *Stellifer* (Fig. 4). *Bairdiella* and *Odontoscion* (Fig. 37,C) have a terminal mouth, and lack apparent cavernous canals on the head (Fig. 39,B). *Odontoscion* inhabits clear water reefs and has large eyes and large canine-like teeth (Fig. 37,C). Other genera of this group are mainly estuarine inhabitants.

Genus, *Leiostomus*, is similar to *Sciaena* group, but it has a much thinner sagitta (Fig. 18,D). In addition, the ostium of its sulcus is bent toward the dorsal margin (to the right of Fig. 18). The phylogenetic position of this genus is tentatively put with the *Sciaena* and *Umbrina* groups. The North American freshwater *Aplodinotus* has a semi-circular sagitta (*Pogonias* pattern, Fig. 19). Although the swimbladder of *Aplodinotus* is a simple carrot-shaped (*Sciaena* pattern, Fig. 5), it may still be more closely related to *Pogonias* than any other western Atlantic sciaenid genus (Fig. 4). Osteological studies of Topp and Cole (1968) on *Sciaenops* and Mohsin (1973) on four *Cynoscion* species of the Gulf of Mexico are also useful in assessing relationship within the genera. Other monotypic supra-generic groups of western Atlantic sciaenids may contain more genera from other geographic regions, especially the eastern Pacific.

2. Relationships of the supra-generic groups:

The *Sciaena* and *Umbrina* groups are similar in swimbladder (*Sciaena* pattern, Fig. 5) and otolith (*Sciaena* pattern, Fig. 18) morphology. Their external morphology is similar except that the *Umbrina* group has a mental barbel (Fig. 35,A & C). Members of both groups are mainly bottom feeders with inferior mouths. The genus *Sciaena* of the *Sciaena* group and the genus *Ctenosciaena* of the *Umbrina* group have entered deeper waters and both have a relatively larger and more terminal mouth to feed in mid-water. The cluster of *Sciaena* and *Umbrina* groups are in turn most closely related to the *Larimus* group (Fig. 4). The species of *Larimus* have a basic simple swimbladder (Fig. 5,E & F). A pair of anterior projections found on the swimbladder of *L. breviceps* appear to be a modification of the *Sciaena* swimbladder pattern. The sagitta of *Larimus* species (Fig. 20,A & B) has a unique outline and the ostium of the sulcus is much larger and does not reach to the anterior margin of the sagitta. The lack of upper pores on the snout (Fig. 31,B) and four minute mental pores (Fig. 34,B) in *Larimus* are adaptive characters correlated with its large oblique mouth and upper water column feeding habits (Fig. 30 and Table 1).

Among the supra-generic groups, both *Pogonias* and *Sciaenops* have a complicated swimbladder as adults (Figs. 10 & 11), but the structural patterns are different and their sagittae also differ (Figs. 19 & 20). Although *Pogonias* and *Sciaenops* have a similar inferior mouth and inhabit inshore coastal and estuarine waters, the body shape of *Sciaenops* is more elongate and less compressed than *Pogonias*. This may be an adaptation of *Sciaenops* to the shallow water surf zone habitat.

The *Menticirrhus* group is closely related to the *Lonchiurus* group on the basis of their reduced swimbladders (Figs. 7 & 14). In comparison to other diagnostic characters, the *Menticirrhus* and *Lonchiurus* groups, whether this trend of swimbladder reduction may be interpreted as indicating phylogenetic relationships or ecological convergence is unknown. The sagittae of the *Menticirrhus* and *Lonchiurus* groups (Figs. 22,B & 24) are both elongate and thin but the shapes of the sulci are different. The body shape is elongate and rounded in both groups. The flat ventral side of the body is an adaptation for inhabiting the bottom or specifically the surf zone. Both genera have inferior mouths and barbels. Although the *Menticirrhus* group has a pores single barbel (Fig. 35,B) similar to that of *Umbrina* (Fig. 35,C), this probably should be viewed as ecologically convergent for bottom feeding rather than as phylogenetically important.

Other generic groups of western Atlantic sciaenids may not be as closely related as the groups already discussed. Their relationships appear to be above the tribal level (between line C and line D of Figure 4) in the present study. The next higher level of clustering (between line B and line C of Figure 4) indicates that the *Pogonias* and *Sciaenops* are most closely related to the *Larimus, sciaena* and *Umbrina* groups. The generic groups included in this cluster (Z on Figure 4) show a basic carrot-shaped swimbladder with diverticula present or absent. Their sagittae are basically sub-oval shaped and most members are bottom feeders. This cluster (Z) of supra-generic groups is probably the main scheme of the phylogenetic development of western Atlantic Sciaenidae. The trend of swimbladder development in western Atlantic sciaenids is clearly demonstrated from the simple *Sciaena* pattern with extrinsic drumming muscles in the male to the complicated

Pogonias pattern with intrinsic drumming muscles in both sexes. Furthermore, the ontogenetic development of the swimbladder in *Pogonias cromis* (Fig. 10) and *Sciaenops ocellata* (Fig. 11) may also reflect the phylogenetic development of the swimbladder, from simple to complicated with diverticula developing on the swimbladder from the anterior to the posterior end.

Further clustering of the taxa (between line A and line B of Figure 4) is more difficult due to the limitations of a regional sutdy. There are gaps, especially in assessing the relationships of the *Micropogonias* and *Nebris* groups. *Nebris microps* has a pair of well-developed anterior diverticula on its swimbladder (Fig. 8) and a very thick oval-shaped sagitta (Fig. 21). *Micropogonias* species have a pair of posteriorly originating tube-like diverticula on their swimbladders (Fig. 9) and a rather thick and shield-like irregular shaped sagitta (Fig. 26). At present, I suggest that the *Mebris* is more closely related to the Z cluster on Figure 4 than does the *Micropogonias*. This clustering is based mainly on the position of the diverticula. The swimbladder diverticula of *Micropogonias* are developed more posteriorly than that in the *Nebris* group. Both of them have a sagitta different from the members of Z cluster (Fig. 4). *Nebris* group has also evolved a different way of feeding, by having an elongate round body and a very large and oblique mouth (Fig. 37,B). This form of mouth structure and body shape enables them to feed from the bottom upward. The *Micropogonias* has an inferior mouth and four to six pairs of mental barbels (Fig. 37,D). typical structures of bottom feeding sciaenids.

The grouping of the *Cynoscion* group with the *Menticirrhus* and *Lonchiurus* groups (Y on Fig. 4) is based on the basic shape of the main chamber of the swimbladder and their elongate thin sagittae. Although the members of the *Lonchiurus* group have a pair of posteriorly directed diverticula on their swimbladders (Fig. 14), the main chambers have two anterior horns resembling those of the *Cynoscion* group (Fig. 12). Especially in the reduced form of *Lonchiurus lanceolatus* (Fig. 14,A), the anterior horns remain unchanged.

The X and Y clusters on Figure 4 are more closely related to each other phyletically than to the *Stellifer* group, because they all have a single chambered swimbladder and only the sagitta enlarged. The swimbladder of the *Stellifer* group has an additional chamber (Fig. 15) in front of the main carrot-shaped chamber. This yoke-shaped anterior chamber is located in front of the septum transversum and its anterior ends reach the skull. The sagitta of the *Stellifer* group is reduced in size and the lapillus is enlarged (Fig. 27). The sequences of sagitta reduction and lapillus enlargement are evident among the modern genera of the *Stellifer* group. The unique swimbladder and otolith characters of the *Stellifer* group suggest that they are a distinct group from all other western Atlantic sciaenids. The two chambered swimbladder has not been reported in sciaenid fishes of other geographic regions other than the New World. Therefore, the *Stellifer* group could be treated as a subfamily of the Sciaenidae.

In conclusion, western Atlantic Sciaenidae can be readily divided into two groups. One group is characterized by a swimbladder with two chambers and with two pairs of enlarged otoliths (lapillus and sagitta). The other group is characterized by a single chambered swimbladder and only one pair of enlarged otoliths (sagitta). Further divisions are based mainly on swimbladder structure, secondly on the morphology of the sagittae and thirdly on external morphology. Swimbladder structure may be graded from simple to complex. Such a gradation is also reflected in the ontogenetic changes of several species such as *Pogonias cromis* (Fig. 10) and *Sciaenops ocellata* (Fig. 11). The primitive condition of the swimbladder (simple *Sciaena* pattern) exists in juveniles and adults of many species. Further development of the swimbladder is determined by the development of the diverticula from the anterior to the posterior end of the main chamber. Whether the reduction in size or loss of the swimbladder in adults of *Menticirrhus* and *Lonchiurus* groups (Figs. 7 & 14) is attributed to phylogenetic relationships or ecological convergence is undetermined at present.

The general morphology of the sagitta and its sulcus were used to determine relationships of different taxa especially at the generic level. In the primitive condition of this character, the sagitta is thick and the sulcus opens to the anterior margin of the sagitta, i.e. the ostium of the sulcus reaches the anterior margin (*Sciaena* pattern, Fig. 18). This is the most generalized pattern in many groups of western Atlantic sciaenids. The external morphology of the western Atlantic Sciaenidae, especially the mouth positions and body shapes are more diverse than any other perciform family in the region. These characters are more or less adaptive and plastic, but may be used to augment other characters in assessing the relationships of the western

Atlantic sciaenids. Biochemical characters of parvalbumins have been studied by Sullivan, et. al. (1975) and Rao, et. al. (1976) to assess the systematic relationships of some sciaenid species from the Atlantic American coast. Their findings in the future would contribute much more to the current knowledge of phylogenetic relationships of western Atlantic Sciaenidae. There are four genera of Sciaenidae; *Aplodinotus, Pachyurus, Pachypops* and *Plagioscion* which live in freshwater for their entire life history. The freshwater sciaenids are endemic to the Atlantic drainages of the New World. Knowledge of their taxonomy and biology is rather sparse. Further studies on these freshwater sciaenids and on eastern Pacific sciaenids should fill many gaps in the present study.

FIELD KEY TO THE GENERA
AND SPECIES OF WESTERN ATLANTIC SCIAENIDAE

1a Lower jaw with one or more barbels (Fig. 32, E to H)

2a Only one barbel at the tip of lower jaw

3a Anal fin with one spine; body elongate fusiform; swimbladder absent or degenerate in adult. .*Menticirrhus*

3b Anal fin with two spines; body compressed, not fusiform; swimbladder present in adult

4a Mental barbel short, rigid and perforate, with an apical pore (Fig. 35,C); two pairs of large pores at the base of barbel; mouth inferior; body with longitudinal stripes and vertical bars. .*Umbrina*

4b Mental barbel short, flexible and tapered at end, without an apical pore (Fig. 35,A); lateral pores minute; mouth slightly inferior, subterminal; body uniform in color, a black spot at pectoral fin origin. [D.X, I+21-24; A.II, 7-8; gill rakers short, (7-9)+(13-17)=21-25]. .*Ctenosciaena gracilicirrhus* (South Caribbean to Brazil)

2b Tuft of barbels at tip and/or small barbels along rami of lower jaw

5a Second anal fin spine strong and long, more than two-thirds length of first anal ray; eye moderate, five times or less in head

6a Barbels mostly in tuft at tip of chin (Fig. 32, H); eye diameter large (about three to four times in head); freshwater . . . . *.Pachypops* (Freshwater South America)

6b Row of small barbels along rami of lower jaw, not in tuft at tip of chin (Fig. 32, G); eye diameter medium (about five times in head); marine and estuarine

7a Preopercular margin strongly serrate; body covered with relatively small scales, 64 to 72 in the row above lateral line; swimbladder with a pair of tube-like diverticula (Fig. 9); body silvery with pinkish cast, with many oblique stripes along the scale rows . . . . *.Micropogonias*

7b Preopercular margin smooth; body covered with relatively large scales, 41 to 45 in the row above lateral line; swimbladder very complex with many interconnected diverticula (Fig. 10); body gray to dark, juveniles with 4 to 5 broad vertical bars. [D. X+I, 19-21; A. II, 5-6; gill rakers short, (4-6)+(12-16)= 16-21]. . . . . *.Pogonias cromis* (Gulf of Maine to Brazil)

5b Second anal fin spine weak and short less than two-thirds length of first anal ray; eye small about nine times in head

8a Lower jaw with a tuft of three pairs minute barbels at the tip and more than 10 pairs barbels along rami of lower jaw (Fig. 32, H); pectoral fin large or small; swimbladder well-developed (Fig. 14, B & C). . . . . *Paralonchurus*

8b Lower jaw with two barbels only (Fig. 32, F), barbels longer than eye diameter; pectoral fins very large, jet black; swimbladder atrophied in adult (Fig. 14, A). [D. X-XI+I, 37-39, A. II, 7-9; gill rakers short, (4-6)+(11-13)=15-18]. . . . . *Lonchiurus lanceolatus* (Venezuela to Brazil)

1b Lower jaw without barbel (Fig. 32, A to D)

9a Body fusiform; mouth distinctively oblique; a pair of enlarged canine-like teeth usually at tip of upper jaw; preopercular margin entire never serrate; swimbladder with a pair of horns at anterior end (Fig. 12)

10a Spinous and soft portions of dorsal fin well separated; anal fin base about equal to the length of soft dorsal fin base; anal fin rays 16-20. [D. VII+I, 18-20; gill rakers moderate, (2-3)+(7-9)=9-12]. .*Isopisthus parvipinnis* (Guiana to southern Brazil)

10b Spinous and soft portion of dorsal fin, with a deep notch in between, but not separated; soft dorsal fin base much longer than anal fin base; anal fin rays seven to 12

11a Enlarged canine teeth lance-shaped (Fig. 37, A); lower jaw with canine-like teeth exposed externally when mouth closed. [D. X+I, 27-29; A. II, 8-9; gill rakers slender, (2-3)+(7-9)=9-12] . . . .*Macrodon ancylodon* (Guiana to southern Brazil)

11b Enlarged canine teeth not lance-shaped but tapering gradually from base to tip; lower jaw teeth never exposed externally when mouth closed. .*Cynoscion*

9b Body fusiform or deeply compressed, mouth inferior, terminal, horizontal or oblique; no enlarged canine-like teeth at tip of upper jaw; preopercular margin serrate or not; swimbladder with or without anterior horns

12a Preopercular margin serrate, sometimes strong with one or more spines at the angle

13a Scales along lateral line considerably enlarged but almost entirely concealed by small scales (Fig. 40); swimbladder with one chamber and a pair of anterior horns present (Fig. 12, D); lapillus (small earstone) small, less than one-tenth the size of sagitta (large earstone); freshwater and estuarine. . . . .*Plagioscion* (freshwater and estuarine South America)

13b Scales along lateral line about same size as adjacent rows; swimbladder with two chambers anterior one yoke-shaped and separated by a constriction from main posterior chamber (Fig. 15);

lapillus (small earstone) large, more than half the size of sagitta (larger earstone) (Fig. 27); marine and estuarine

14a Anterior horn of swimbladder terminating subcutaneously, frequently visible on superficial inspection in adult and juvenile under the upper end of gill slit. Mouth inferior to oblique; snout usually projecting; dorsal view of head blunt, cavernous (Fig. 39, A); interorbital width usually more than 1.2 times of eye diameter

15a Anterior chamber of swimbladder with a pair of variably developed posterior diverticula (Fig. 16); bony interorbital width 3.5 or less in head. . .*Stellifer*

15b Anterior chamber of swimbladder without posterior diverticula; bony interorbital width 3.5 or more in head. .*Ophioscion*

14b Anterior horn of swimbladder only visible in juvenile externally under the upper end of gill slit. Mouth horizontal to oblique; snout not projecting; dorsal view of head tapered; not cavernous (Fig. 39, B) interorbital width usually less than 1.2 times of eye diameter. . . . .*Bairdiella*

12b Preopercular margin without strong serrations, sometime ciliated but never with spines at the angle

16a Mouth large, oblique or nearly vertical; snout not projecting; lower jaw prominent

17a Mouth slightly oblique, terminal; lower jaw with a row of enlarged canine-like teeth, not projecting beyond upper jaw (Fig. 37, C); swimbladder with two chambers, anterior one yoke-shaped, posterior one in carrot-shape; lapillus (small earstone) large more than two-thirds the size of sagitta (larger earstone); a distinct black blotch at pectoral fin base. [D. XI-XII+I, 23-26; A. II, 8-9; gill rakers long and stiff, (5-9)+(14-17)= 19-25]. . . . . *Odontoscion dentex* (Florida to Brazil)

17b Mouth very oblique or vertical; lower jaw without canine-like teeth, projecting in front of upper jaw (Fig. 37, B); swimbladder in one chamber, lapillus (small earstone) small, less than one-tenth the size of sagitta (large earstone), without a distinct black blotch at pectoral fin base

18a Eye small, about eight to 10 times in head; body elongate; scales small, cycloid, about 90 in the row above lateral line; caudal fin pointed in adult. [D. VIII+I, 31-32; A. II, 9-10; gill rakers long and slender, (5-9)+(14-

15)=20-24]. . . . . . .*Nebris microps*

(Costa Rica to Brazil)

18b Eye large, about three to four times in head; body short; scales large, ctenoid, about 50 in the row above lateral line; caudal fin biconcave in adult. .*Larimus*

16b Mouth small, inferior; snout projecting in front of upper jaw; lower jaw included

19a Body short, deep; dorsal profile elevated anteriorly

20a Body silvery with faint oblique stripes along the oblique scale rows dorsally; a dark spot above upper angle of gill slit; gill rakers more than 30 on first gill arch. [D. IX+I, 29-35; A. II, 12-13; gill rakers (8-12)+(20-23)=30-36]. . . . .*Leiostomus xanthurus*

(U.S. Atlantic and Gulf of Mexico coasts)

20b Body pale to dark brown; with dark longitudinal stripes and/or oblique bars on sides, without a dark spot above gill slit; gill rakers less than 20 on first gill arch

21a Height of spinous dorsal longer than head, usually with long filament; body brownish pale with three oblique bars on sides; third bar running from nape to caudal fin; dorsal fin soft rays more than 45. .*Equetus*

21b Height of spinous dorsal shorter than head; body pale brown to dark brown with longitudinal stripes on sides; dorsal fin soft rays less than 40. . . . .*Pareques*

19b Body elongate, dorsal profile not elevated

22a Snout with peculiar conical appearance, from the preorbital region being swollen and enlarged; maxillary entirely concealed under snout. . . .*Pachyurus* (freshwater South America)

22b Snout rounded, not swollen, maxillary exposed under snout

23a Body elongate; one or more large dark spots (larger than eye) on the base of caudal peduncle and/or side of body. [D. X+I, 23-25; A. II, 8-9; gill rakers (4-5)+(7-9)=12-14]. . . . .*Sciaenops ocellata* (U.S. Atlantic and Gulf of Mexico coasts)

23b Body robust; color uniform, no black spot on caudal base, no dark spots on sides of body. [D. IX-X+I, 27-33; A. II, 7; gill rakers 6+(10-12)=

16-18]. . .*Aplodinotus grunniens*

(freshwater, Canada to Guatamala)

Key to the species of *Bairdiella*

1a Preopercular margin with distinct strong spines at the angle

2a Second anal fin spine very strong, 21-26% of standard length; preopercular margin with strong spine-like serration. D. X+I, 21-26 (usually 23-25); A. II, 7-9 (usually 8); gill rakers slender, (6-10)+(15-18)=21-27 (usually 24-25). .*B. ronchus*

(Caribbean islands to Brazil)

2b Second anal fin spine not as strong, 13-20% of standard length; preopercular margin with distinct strong spines. D. X, I, 19-23; A. II, 8-10 (usually 9); gill rakers slender, (7-8)+(14-16)=22-24. . . . .*B. chrysoura*

(U.S. Atlantic and Gulf of Mexico coasts)

1b Preopercular margin with only weak serrations, no spines at the angle

3a Preopercular margin with strong lateral ridge and weak serrations; second anal fin spine about 2/3 length of first ray; D. X+I, 25-29; A. II, 7-8; gill rakers short, (5-6)+(13-16)=18-22. . . . .*B. batabana*

(Florida to Caribbean islands)

3b Preopercular margin membranous without distinct serrations; second anal fin spine less than 2/3 length of first ray; D. X-IX, I+22-24; A. II, 9 (rarely 8); gill rakers long, (7-8)+(16-18)=23-26. . . . .*B. sanctaeluciae*

(Florida to Guiana)

Key to the Species of *Cynoscion*

1a Scales cycloid on body

2a Soft portion of dorsal fin base covered with small scales; with less than 25 rays

3a Inner row teeth of lower jaw much larger than external ones, some central ones canine-like; small scales cover 2/3 of soft dorsal fin; D. X+I, 22-25 (usually 23-24); A. II, 10-12; gill rakers (2-3)+(6-9)=8-11; 150-160 scales along the row above lateral line; anterior horns of swimbladder long and straight (Fig. 13, A). . . . .*C. microlepidotus*

(Venezuela to Brazil)

3b Inner row teeth of lower jaw slightly enlarged, no canine-like teeth; small scales cover less than 1/3 of soft dorsal fin; D. X+I, 20-24 (usually 21-23); A. II, 8-10; gill rakers (2-3)+(5-8)=7-11; 115-125 scales along the row above lateral line; anterior horns of swimbladder curved (Fig. 13, D & E). .*C. leiarchus*

(Venezuela to Brazil)

2b Soft portion of dorsal fin naked, with 23-31 rays; A. II, 8-9; gill rakers (1-3)+(6-8)=7-11; 120-130 scales along the row above lateral line; anterior horn of swimbladder slightly curved; sagitta with a notch on ventral margin (Fig. 23, C). . . . .*C. virescens*

(Panama to Brazil)

1b Scales ctenoid on body

4a More than 20 gill rakers. [D. X+I, 18-21; A. II, 8-9; gill rakers long, (7-9)+(14-17)=21-26]. . . . .*C. striatus* (Brazil to Argentina)

4b Less than 20 gill rakers

5a Dorsal fin usually with fewer than 21 rays; anal with eight to nine soft rays; gill rakers long, (2-6)+(8-10)= 10-16. . . . .*C. acoupa* (Panama to Brazil)

5b Dorsal fin usually with more than 21 rays; anal fin with eight to 11 soft rays; gill rakers long or short.

6a Pectoral fin short, about two times or more in head

7a A pair of canine-like teeth at the tip of upper jaw; D. IX-X+I, 25-29; A. II, 10-12; gill rakers (3-4)+(9-10)=12-14; about 60 (58-62) scales in the row above lateral line . . . .*C. arenarius* (U.S. Gulf of Mexico coast)

7b Canine-like teeth reduced; D. X+I, 21-24; A. II, 10-12; gill rakers (3-5)+(8-10)= 11-15; about 70 (67-72) scales in the row above lateral line . . . .*C. steindachneri* (Guiana to Brazil)

6b Pectoral fin long, much less than two times in head

8a Soft portion of dorsal fin not covered by small scales

9a Gill rakers long, (3-4)+(6-9)=9-13; D. X+I, 24-29; A. II, 8-10; body color brownish to pale without dark spots on the side. . . . .*C. similis* (Venezuela to Surinam)

9b Gill rakers short, (2-3)+(7-9)=9-12; D. IX-X, 25-28, A. II, 10-11; body with large black spots on the back and sides. . . . .*C. nebulosus* (U.S. Atlantic and Gulf of Mexico coasts)

8b Soft portion of dorsal fin usually densely covered with small scales

10a Anal fin with 11-13 soft rays; body usually with small dark spots forming oblique lines on the side. [D. X+I, 26-29; gill rakers (4-5)+(10-12)=14-17]. . . . .*C. regalis* (Gulf of Maine to Florida)

10b Anal fin with 8-10 soft rays; side of body without distinct spots

11a Soft portion of dorsal fin covered with small scales to about three-fourths of soft dorsal fin height; D. X+I, 23-27; gill rakers (2-3)+(7-10)=9-13; total vertebrae 25. . . . .*C. jamaicensis* (Panama to Argentina)

11b Soft portion of dorsal fin covered with small scales less than two-thirds of soft dorsal fin height; D. X+I, 26-30; gill rakers (3-4)+(8-10)=11-14; total vertebrae 27. . . . .*C. nothus*
(Chesapeake Bay to Texas)

Key to the Species of *Equetus*

1a Body with two narrow longitudinal stripes above and below the third bar; dorsal, anal and caudal fin dark brown with white spots; pectoral dark brown. [D. XI-XII+I, 45-47; A. II, 6-8; gill rakers short, 5+(10-13)=15-18]. . . . .*E. punctatus*
(Florida, Antilles, Panama to Brazil)

1b Body without narrow longitudinal stripes; broad oblique bars with distinct white margins; pectoral, dorsal, and anal fins pale. [D. XII-XIII+I, 47-55; A. II, 6; gill rakers short, (5-6)+(10-13)=14-18]. . . . . .E. lanceolatus
(Florida, Antilles and Venezuela)

Key to the Species of *Larimus*

1a Body dark gray above and silvery below without vertical bars on the sides; [D. X+I, 26-28; gill rakers slender, longer than eye diameter; (9-11)+(19-22)=28-33]. . . . .*L. breviceps*
(Caribbean Islands to Brazil)

1b Body dark with 7 to 9 vertical bars on the sides; [D. X+I, 24-27; gill rakers slender, about equal to eye diameter, (11-13)+(22-25)= 34-36]. . . . .*L. fasciatus* (U.S. Atlantic and Gulf of Mexico coasts)

Key to the Species of *Menticirrhus*

1a Breast scales not uniform in size; those towards head notably smaller than scales along lateral line; molar teeth present on pharyngeal plates; pectoral fins short, not reaching beyond tip of pelvic fins; usually three or more gill rakers on lower limb of first branchial arch; color plain silvery gray; juveniles (less than 100 mm SL) with only a vestige of swimbladder. Lateral line scales 72-74. [D. X=XI+19-26; gill rakers short, 3-5+0-8=3-12]. . . . .*M. littoralis* (Chesapeake Bay to Brazil)

1b Breast scales uniform in size; about as large as those along lateral line; no molar teeth on pharyngeal plates; pectoral fin reaching to or beyond tip of pelvic fin; gill rakers tuberculate or absent on the lower limb of first branchial arch; side with dark oblique bars

2a Anal fin rays usually 7 (6-8); depressed spinous portion of dorsal fin seldom extends past origin of soft portion of dorsal fin; longest dorsal spine 16.2-24.1% of SL; juveniles (less than 100 mm SL) with only a vestige of swimbladder. [D. X, I+20-26; gill rakers short, (2-3)+(0-7)=2-10]. . . . .*M. americanus*
(Chesapeake Bay to Argentina)

2b Anal fin ray usually 8 (7-9); depressed spinous portion of dorsal fin extends past origin of soft portion of dorsal fin; longest dorsal spine 24.6-38.9% of SL; juveniles (less than 100 mm SL) with well-developed swimbladder. [D. X, I+22-27; gill rakers short, (3-5)+(0-7)=3-12]. . . . .*M. saxatilis*
(Gulf of Maine to Mexico)

Key to the Species of *Micropogonias*

1a Dark spots on scales above lateral line forming continuous streaks nearly as wide as interspaces; 6 to 7 scales between dorsal fin origin and lateral line in vertical series; pelvis fin longer, less than 1.6 times in head; D. X+I, 26-30 (usually 26-28); A. II, 7-8; gill rakers short, (7-9)+(12-15)=21-25. . . . . *M. furnieri*
(Venezuela to Brazil)

1b Dark spots on scales above lateral line not forming continuous streaks; 8 to 9 scales between dorsal fin origin and lateral line in vertical series; pelvic fin shorter, more than 1.6 times in head; D. X+I, 27-30 (usually 28-29); A. II, 8-9; gill rakers short, (8-10)+(14-18)=22-29. . . . . *M. undulatus*
(Chesapeake Bay to Brazil)

Key to the Species of *Ophioscion*

1a Dorsal fin with more than 25 rays; anal fin with 9 rays; D. X+I, 28-29; gill rakers 9+17=26; lateral line scales 50-57; body with oblique streaks above lateral line (also see remarks in Synopsis). . . . . *O. adustus*
(Caribbean Islands to Brazil)

1b Dorsal fin with less than 25 rays; anal fin with 7 rays

 2a Lateral line pores 49-52; D. X+I, 20-21; gill rakers (7-9)+14=21-23. . . . . *O. panamensis*

 2b Lateral line pores 54-57; D. X+I, 23-24; gill rakers (7-8)+(13-16)=20-24. . . . . *O. punctatissimus*
 (Panama to Brazil)

Key to the Species of *Paralonchurus*

1a Pectoral fin short and pale, not extending beyond the tip of pelvic fin; eye diameter moderate (about 5 times in head); soft dorsal with 28-31 rays; body with vertical dark stripe and dark humeral spot above the pectoral fin origin; vertebrae 11+18=29; gill rakers short, (3-5)+(6-9)=10-14. . . . .*P. brasiliensis* (Venezuela to Brazil)

1b Pectoral fin very long and jet black, reaching to anal fin origin; eye diameter small (about 9 times in head); soft dorsal 31-33 rays; body uniform brown; vertebrae 10+15=25; gill rakers short, 3+4=7. . . . .*P. elegans* (Surinam to Brazil)

Key to the Species of *Pareques*

1a Side with 7-10 narrow longitudinal stripes narrower than pupil, pectoral fin pale, [D. XI-X+I, 38-40, A.II, 7; gill rakers short, (4-6)+(10-12)=15-18]. . . . .*P. umbrosus*

1b Side with 3 to 5 broad longitudinal stripes wider than pupil; and narrow stripes in between them, pectoral fin dark brown. [D. VIII-IX+I, 37-41, A, II, 7-8, gill rakers short, (5-6)+(9-14)=14-20]. . . . .*P. accuminatus*

Key to the Species of *Stellifer*

1a Preopercular margin with two or three strongly developed spines at the angle

2a Preopercular margin with three strong spines (occasionally four), mouth oblique (Fig. 38, B); gill rakers (12-14)+(20-25)=32-38; [D. XI+I, 18-20; A. II, 8; longer than 2/3 of eye; pectoral fin about 28.5 to 31% of SL (72-106 mm SL specimens)]. . . . . *S. stellifer*
(Venezuela to Brazil)

2b Preopercular margin with two strong spines; mouth horizontal; gill rakers on first arch 40 or more; [D. XI-XII+I, 21-24; A. II, 8-9]

3a Gill rakers 16-20+(24-31)=40-51; pectoral fin length about 26.8 to 28.8% of SL (90-100 mm SL specimens); one to several median predorsal rows of ctenoid scales on nape. . . . . *S. rastrifer*
(Venezuela to Brazil)

3b Gill raker 19-22+(32-35)=51-57; pectoral fin length about 32.5 to 34% of SL (90-100 mm SL specimens); no predorsal ctenoid scales on nape. . . . . *S. griseus*
(Venezuela)

1b Preopercular margin with four or more strongly developed spines at the angle

4a Gill rakers 28 or fewer; upper jaw 2.8 or more in head, mouth more or less ventral in position; when mouth closed, snout projecting in front of premaxillae (upper jaw)

5a Scales on top of head mostly cycloid; tip of pectoral fin extends to about level of tip of pelvic fin; swimbladder with tube-like diverticula

6a Gill rakers (8-9)+(13-14)=21-23; D. X=XI+I, 19-21; A. II, 8-10 (usually 9); diverticula on swimbladder short, digit-like (Fig. 16, C). . . . *S. microps* (Columbia to Brazil)

6b Gill rakers 8+(14-16)=22-24; D. X+I, 22; A. II, 9; diverticula on swimbladder very long, U-shaped (Fig. 16, D). . . . . *S. brasiliensis* (Brazil)

5b Scales on top of head ctenoid; tip of pectoral fin extends beyond tip of pelvic fin; swimbladder with bulb or bean-shaped diverticula (Fig. 16, A)

7a Tip of pelvic fin ends slightly anterior to the tip of pectoral fin; gill rakers (8-9)+(15-16)= 23-25; [D. XI+I, 20-22; A. II, 8]. . . *S. naso* (Venezuela to Brazil)

7b Tip of pelvic fin end far before the tip of pectoral fin; gill rakers (9-10)+(16-19)=26-28; [D. XI=XII+I, 21-22; A. II, 8 (rarely 9)]. . . . . *S. venezuelae* (Venezuela)

4b Gill rakers 29 or more; upper jaw 2.6 or less in head, mouth more or less oblique in position; when mouth closed, snout equal to or projecting slightly in front of premaxillae (upper jaw)

8a Tip of upper lip on horizontal with or above ventral margin of eye; snout not projecting beyond upper lip; D. XI-XII+I, 20-24; gill rakers (10-13)+(22-23)=32-36;

eye 4.7-5.5 times in head . . . .*S. lanceolatus*
(Chesapeake Bay to Gulf of Mexico coasts)

8b Tip of upper lip on horizontal line well below ventral margin of eye; snout projecting beyond upper lip; D. XI+I, 23-24; gill rakers (10-12)+(19-22)=29-33; eye 5.5-6.2 times in head . . . .*S. colonensis*
(Caribbean islands and Central America)

Key to the species of *Umbrina*

1a Anal fin rays 7 to 8; mental (chin) barbel short; total gill rakers 19-20

2a Eye larger, about 9.8 to 10.7% of SL; caudal peduncle circumferential scales 22; mental barbel with an apical pore; D. X, I+24-25; A, II, 7; gill rakers (8-9)+(12-13)= 20-22. . . . .*U. canosai*
(southern Brazil to Argentina)

2b Eye smaller, about 5.9 to 6.2% of SL; caudal peduncle circumferential scales 18 to 19; mental barbel with a pore on the middle anterior surface; D. X., I+22-23; A. II, 8; gill rakers (7-8)+(11-13)=19-20. . . . .*U. milliae*
(offshore Columbia)

1b Anal fin rays 6; mental (chin) barbel relatively long and slender; total gill rakers 13 to 15

3a Scale rows beneath spinous dorsal fin more or less parallel to lateral line; scales in diagonal series from dorsal fin origin to lateral line 5-6; stripes on body less distinct;

D. X+I, 23-26; [gill rakers (5-7)+(7-10)=13-15]. . . . .
. . . .*U. broussonetii*
(Caribbean Sea)

3b Scale rows beneath spinous dorsal fin situated at an angle of about 30° to lateral line; scales in diagonal series of dorsal fin origin to lateral line usually 8, sometimes 7; stripes on body distinct; D. X+I, 26-31. (except for specimens from western Gulf of Mexico, which have slightly lower counts, 24-26); [gill rakers (5-7)+(7-10)-13-15]. . . .
. . . .*U. coroides*
(Florida to Brazil)

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Table 1. Summary of morphological characters of the supra-generic groups of western Atlantic Sciaenidæ

SUPRA-GENERIC GROUPS	MORPHOLOGICAL CHARACTERS: SWIMBLADDERS		OTOLITHS		SNOUT PORES	MENTAL PORES & BARBELS
Micropogonias	swimbladder carrot-shaped	with a pair tube-like diverticula	only sagitta enlarged	sagitta shield-like, very thick	5 upper 5 marginal	5 pores many barbels
Nebris				olive-shaped, cauda of sulcus very deep	no upper 2 marginal	4 pores no barbel
Pogonias		with complicate diverticula in adults		sagitta oval or sub-oval, moderately thin to very thick	5 upper 5 marginal	5 pores many barbels
Sciaenops						5 pores no barbel
Larimus		simple without complicate diverticula, sometime with anterior projection			no upper 5 marginal	4 pores no barbel
Sciaena					3 to 7 upper 5 to 7 marginal	5 pores no barbel
Umbrina						4 pores 1 barbel
Menticirrhus		atrophied in adults		thin and elongate, some partially thickened		
Lonchiurus	with a pair of anterior horns, some also with a pair of tube-like diverticula, some reducing size in adult					5 pores 2 or many barbels
Cynoscion					no upper 2 marginal	no pores no barbel
Stellifer	with two chambers, anterior one yoke-shaped, posterion one carrot-shaped		both sagitta and lapillus enlarged		3 to 7 upper 5 marginal	4 to 6 pores no barbel

Fig. 1

Terminology of pore system on head of western Atlantic sciaenids. Snout; upper pores (above the dotted line) and marginal pores (below the dotted line). Lower jaw; mental pores and barbel(s). A. ventral view of the mouth, *Menticirrhus saxatilis*. B. tip of the snout, *Stellifer lanceolatus*.

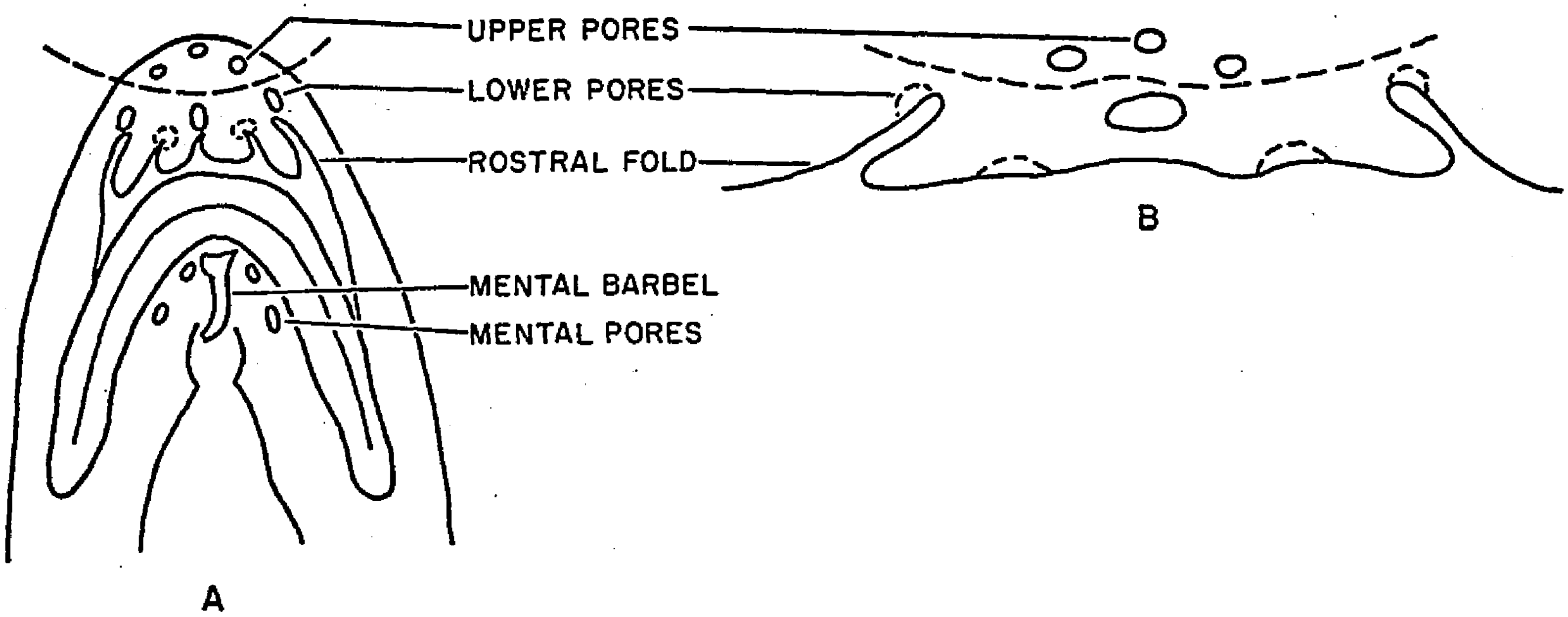

UPPER PORES
LOWER PORES
ROSTRAL FOLD
MENTAL BARBEL
MENTAL PORES
A
B

Fig. 2

Terminology of otoliths. A, A' & a, sagitta and B, B' & b, lapillus of *Bairdiella chrysoura;* C, C' & c, sagitta of *Leiostomus xanthurus*. A, B & C, inner surface; A', B' & C' outer surface; a, b & c, lateral view with inner surface down and anterior end to the left. a.m. anterior margin; a.v. anterior ventral margin; d.m. dorsal margin; c. cauda section of sulcus; m.g. marginal groove; o. ostium section of sulcus; p.d. posterior dorsal margin; s. "tadpole-shaped" sulcus; v.m. ventral margin. All the figures of otoliths (sagittae and lapilli) are oriented the same as this figure.

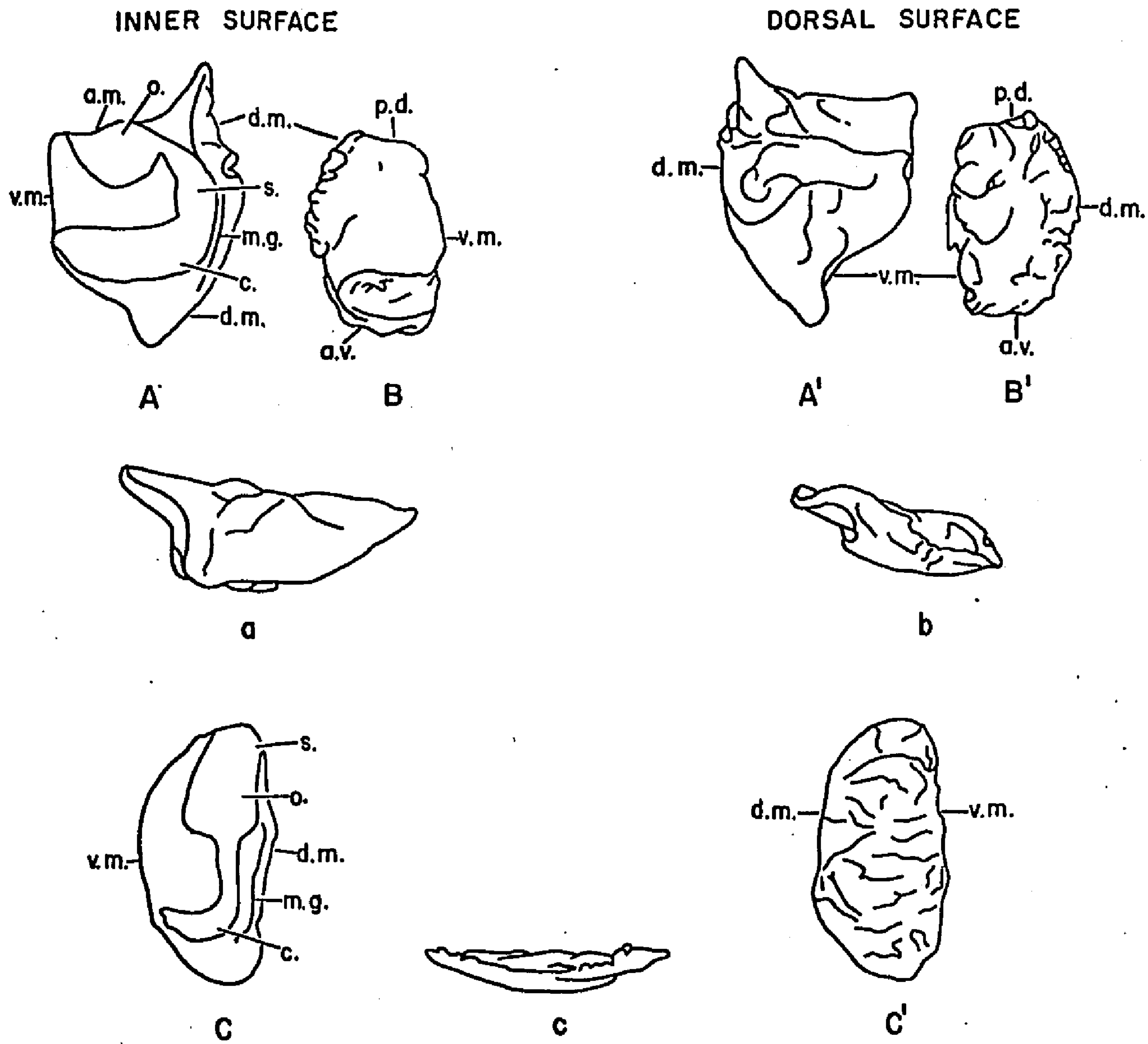

INNER SURFACE
DORSAL SURFACE
a.m.
o.
d.m.
p.d.
v.m.
s.
m.g.
v.m.
c.
d.m.
a.v.
d.m.
p.d.
d.m.
v.m.
a.v.
A
B
A'
B'
a
b
s.
o.
d.m.
v.m.
d.m.
v.m.
m.g.
c.
C
c
C'

Fig. 3

The inner ears of sciaenids. A & A', with only sagitta enlarged, *Pseudosciaena crocea* (Richardson), after Chu, Lo and Wu (1963; fig. 8, A & B). B & B', with both sagitta and lapillus enlarged, *Stellifer lanceolatus* (Holbrook). A & B, dorsal view of right inner ear. A' & B', lateral view of left inner ear. a. asteriscus; am. ampulla; a.s. anterior semicircular canal; c. cerebellum, h.s. horizontal semicircular canal; l. lapillus; la. lagena; m. mesencephalon; m.o. medulla oblongata; o. olfactory nerve; p.s. posterior semicircular canal; s. sagitta; sa. saculus; t. telencephalon; u. utriculus; v. vegus nerve; v.l. vegal lobe.

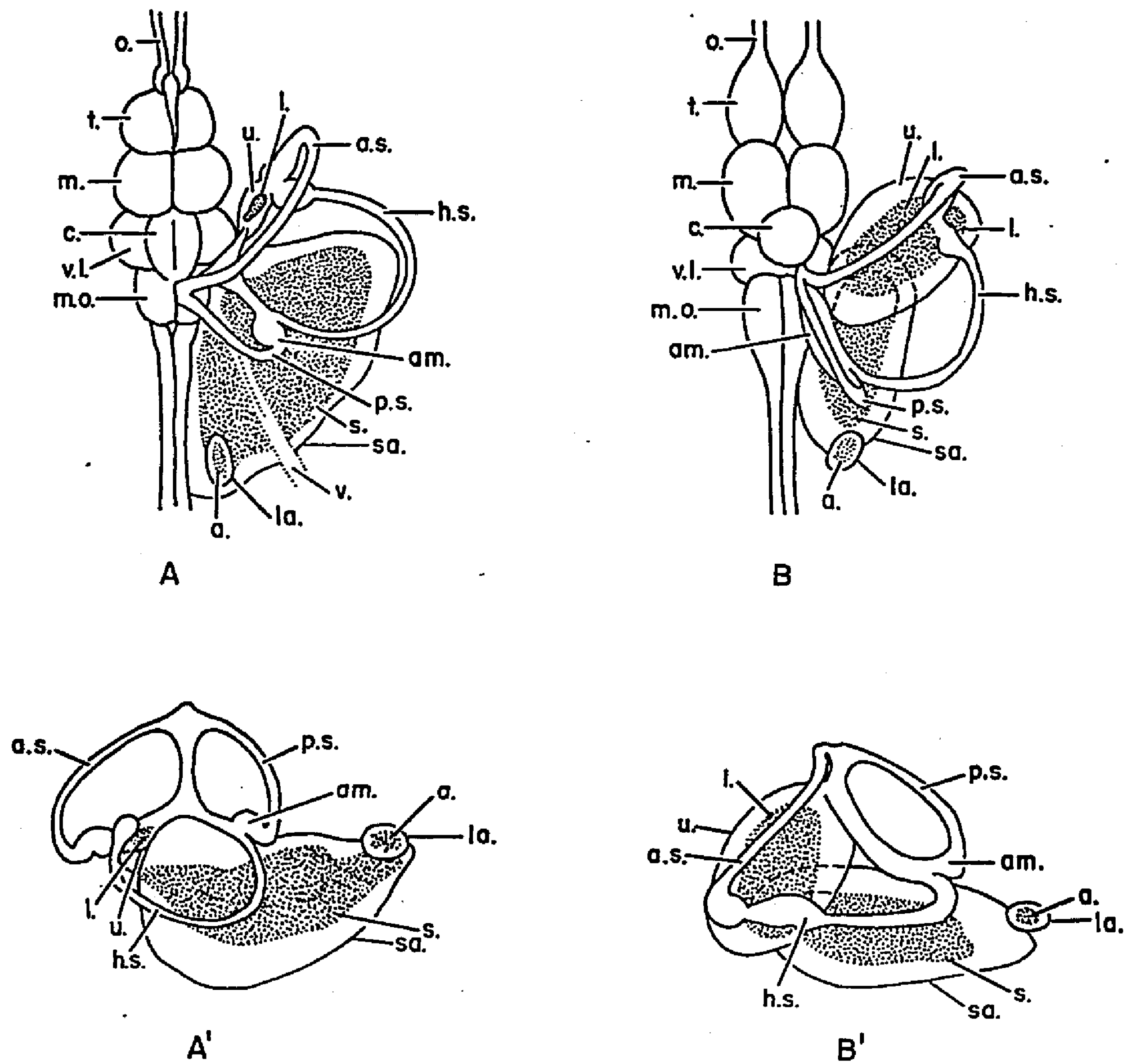
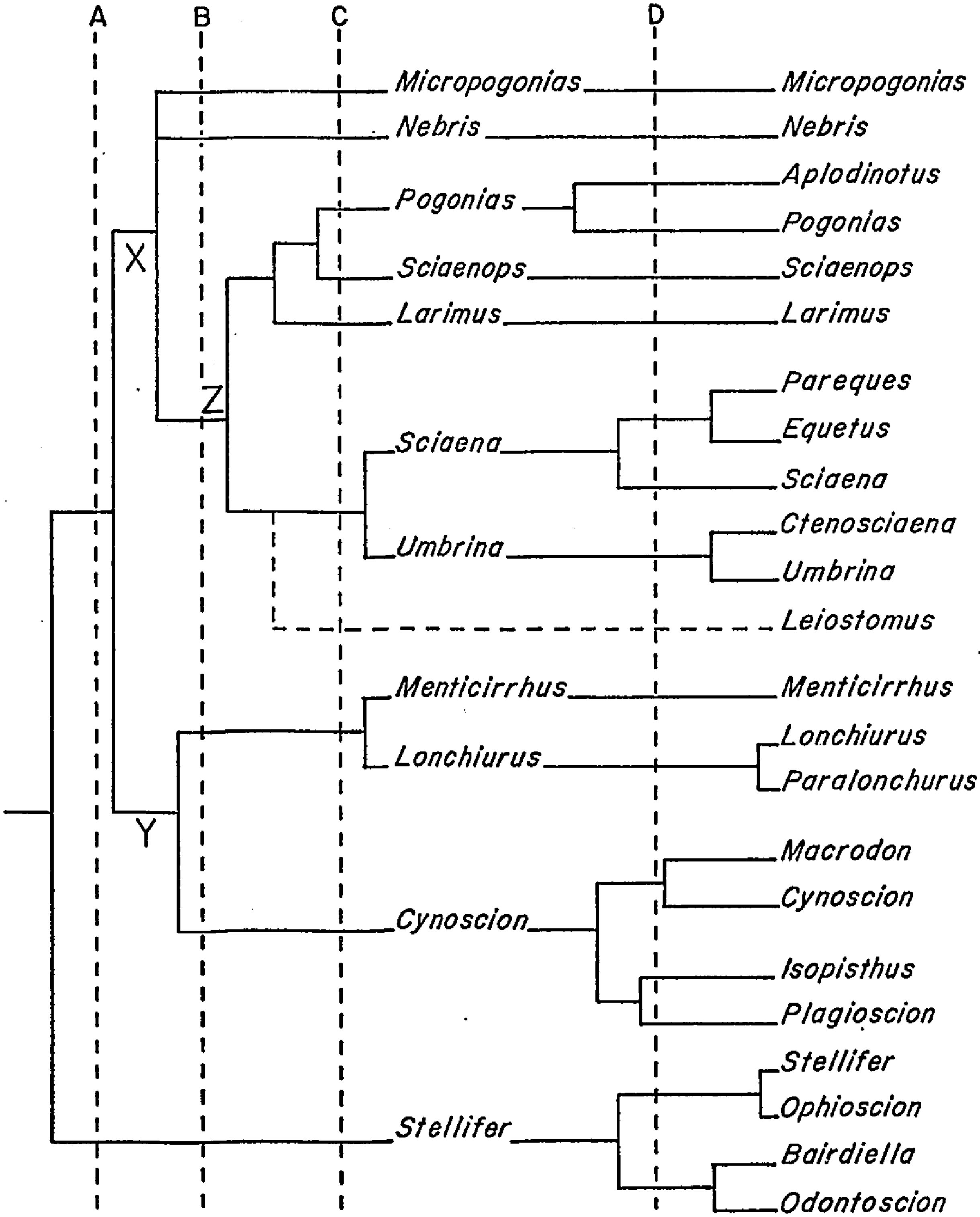

o.
t.
m.
c.
v.l.
m.o.
u.
l.
a.s.
h.s.
am.
p.s.
s.
sa.
v.
la.
a.
A
B
A'
B'

Fig. 4

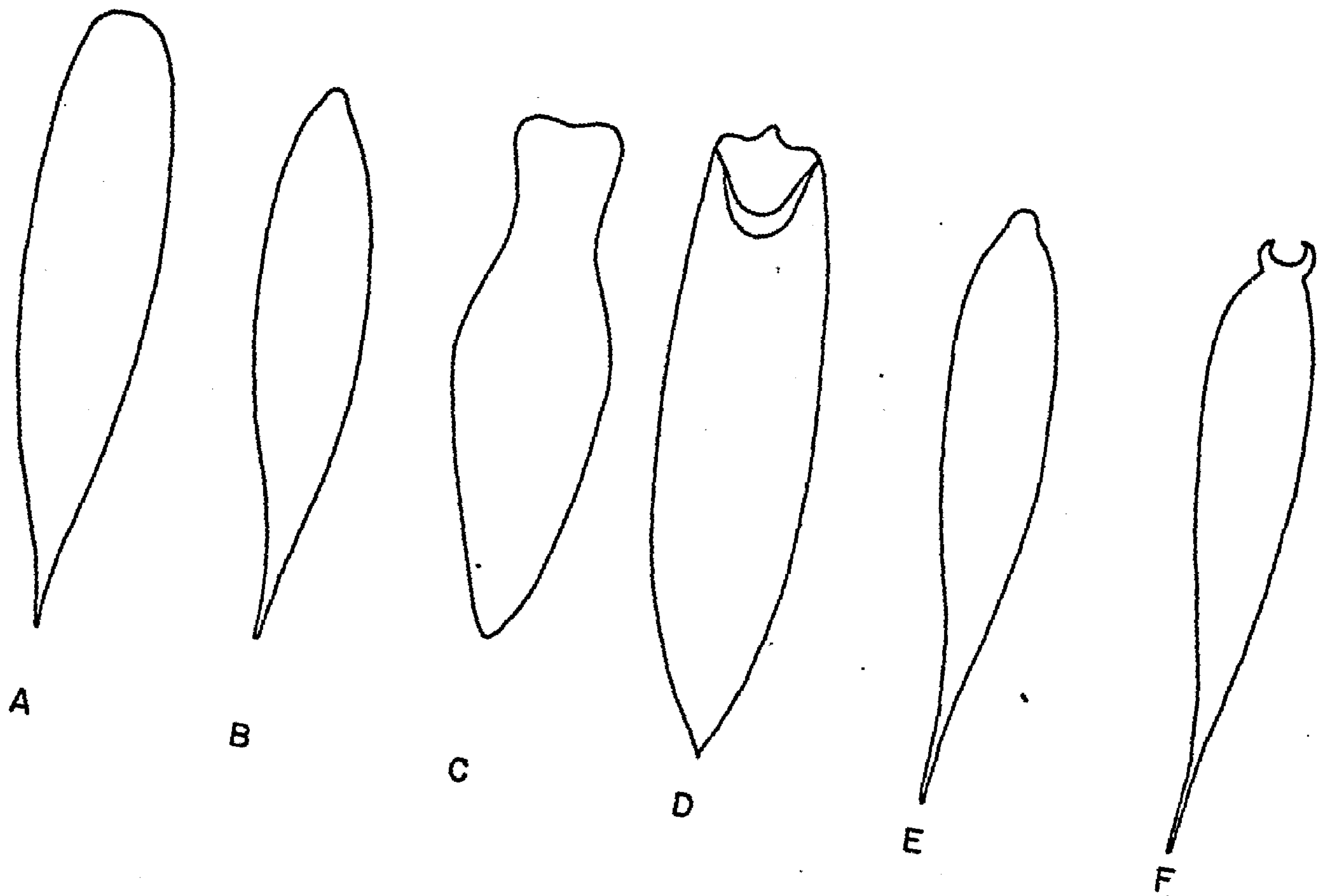
Phylogenetic relationships of genera and supra-generic groups of western Atlantic Sciaenidae. Subfamily level lies between lines A and B; tribal level lies between lines C and D; X, Y, & Z represent clusters discussed in the text.



A
B
C
D
X
Y
Z
Micropogonias
Nebris
Pogonias
Sciaenops
Larimus
Sciaena
Umbrina
Menticirrhus
Lonchiurus
Cynoscion
Stellifer
Micropogonias
Nebris
Aplodinotus
Pogonias
Sciaenops
Larimus
Pareques
Equetus
Sciaena
Ctenosciaena
Umbrina
Leiostomus
Menticirrhus
Lonchiurus
Paralonchurus
Macrodon
Cynoscion
Isopisthus
Plagioscion
Stellifer
Ophioscion
Bairdiella
Odontoscion

Fig. 5

Swimbladders of the *Sciaena* pattern. A. *Sciaena trewavasae*; B. *Leiostomus xanthurus*; C. *Equetus punctatus*; D. *Aplodinotus gruniens*;E. *Larimus fasciatus*; F. *Larimus breviceps*.


A
B
C
D
E
F

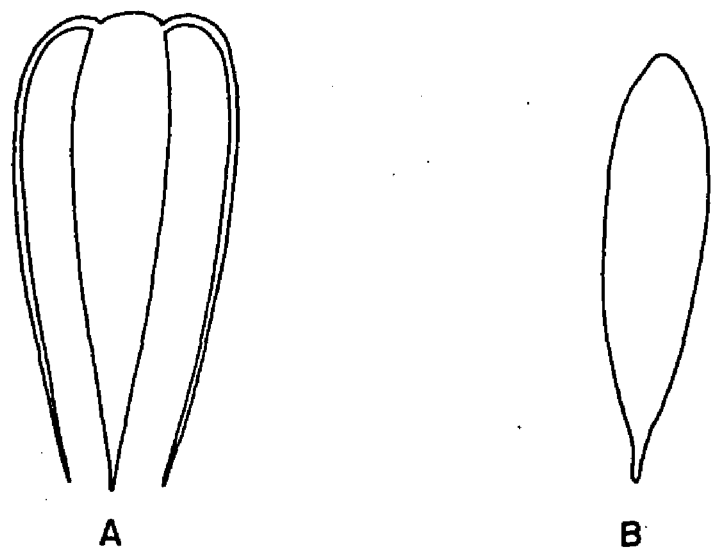


Fig. 6. Swimbladders of two species of *Pachyurus*. A. *P. bonariensis*; B. *P. schomburgkii*.

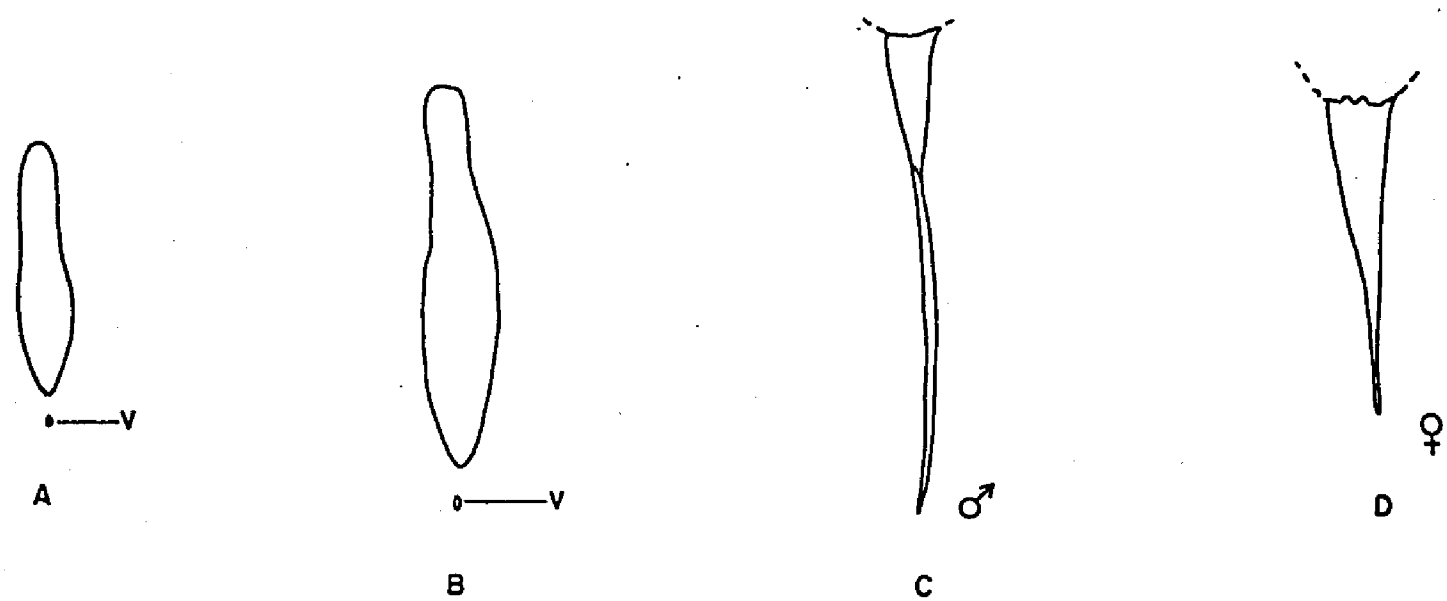


Fig. 7. Swimbladders of *Menticirrhus saxatilis* (x2). A. 58 mm SL; B. 75.5 mm SL; C. 185 mm SL; D. 182 mm SL.

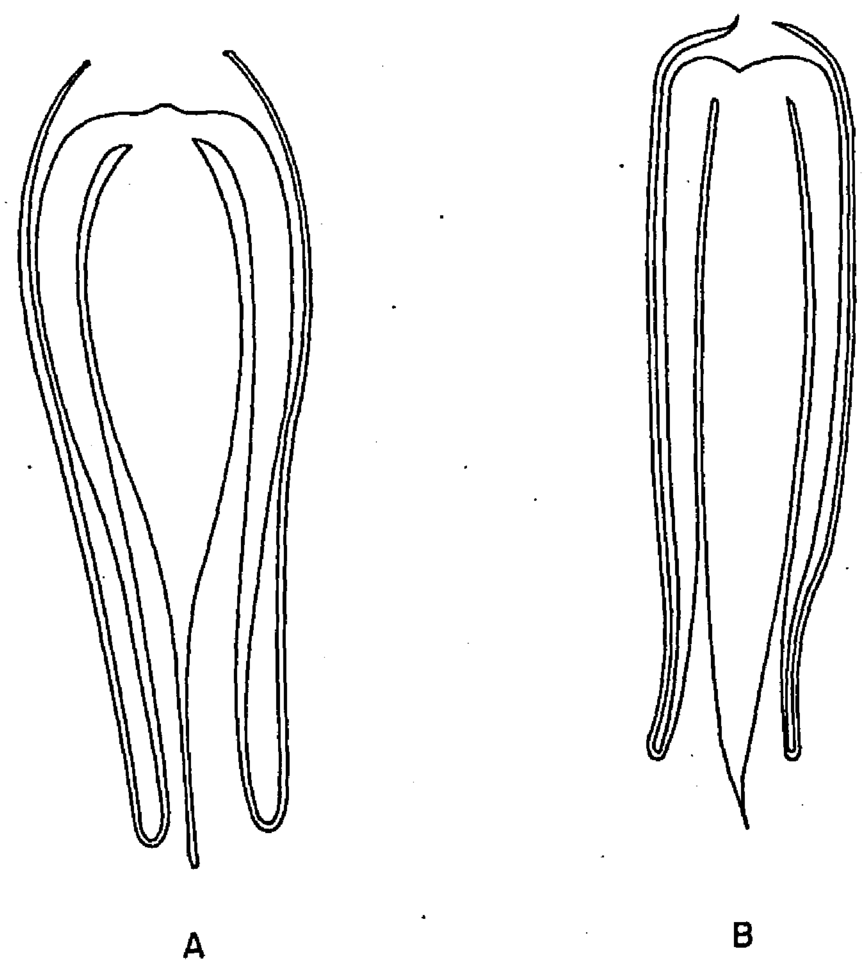


Fig. 8. Development of swimbladder in *Nebris microps*. A. 125 mm SL (x2); B. 273 mm SL (x1).

Fig. 9

Variation and development of swimbladders of the *Micropogonias* (x1). *M. undulatus*, A. 67.1 mm SL; A'. 180 mm SL and *M. furnier*, B. 160 mm SL; B'. 162 mm SL. v. vent.

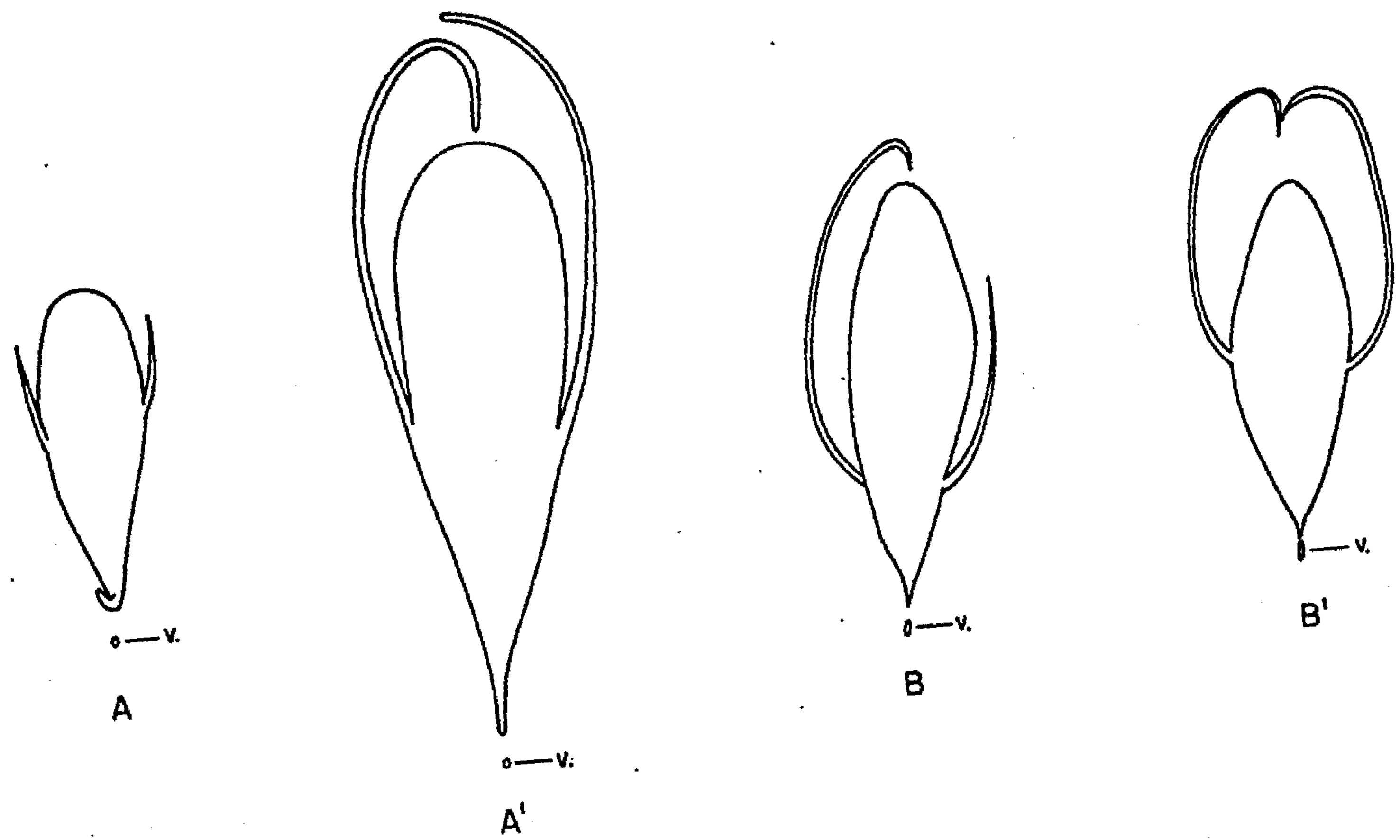

v.
A
v.
A'
v.
B
v.
B'

Fig. 10

Ontogenetic development of swimbladders in *Pogonias cromis*. A. 24 mm TL; B. 57.4 mm TL; C. 150 mm TL; D. 236 mm TL; E. 1090 mm TL. C, D & E on the left sides of dotted line represent dorsal view of the swimbladders (diverticula omitted); the shaded areas represent intrinsic drumming muscles.

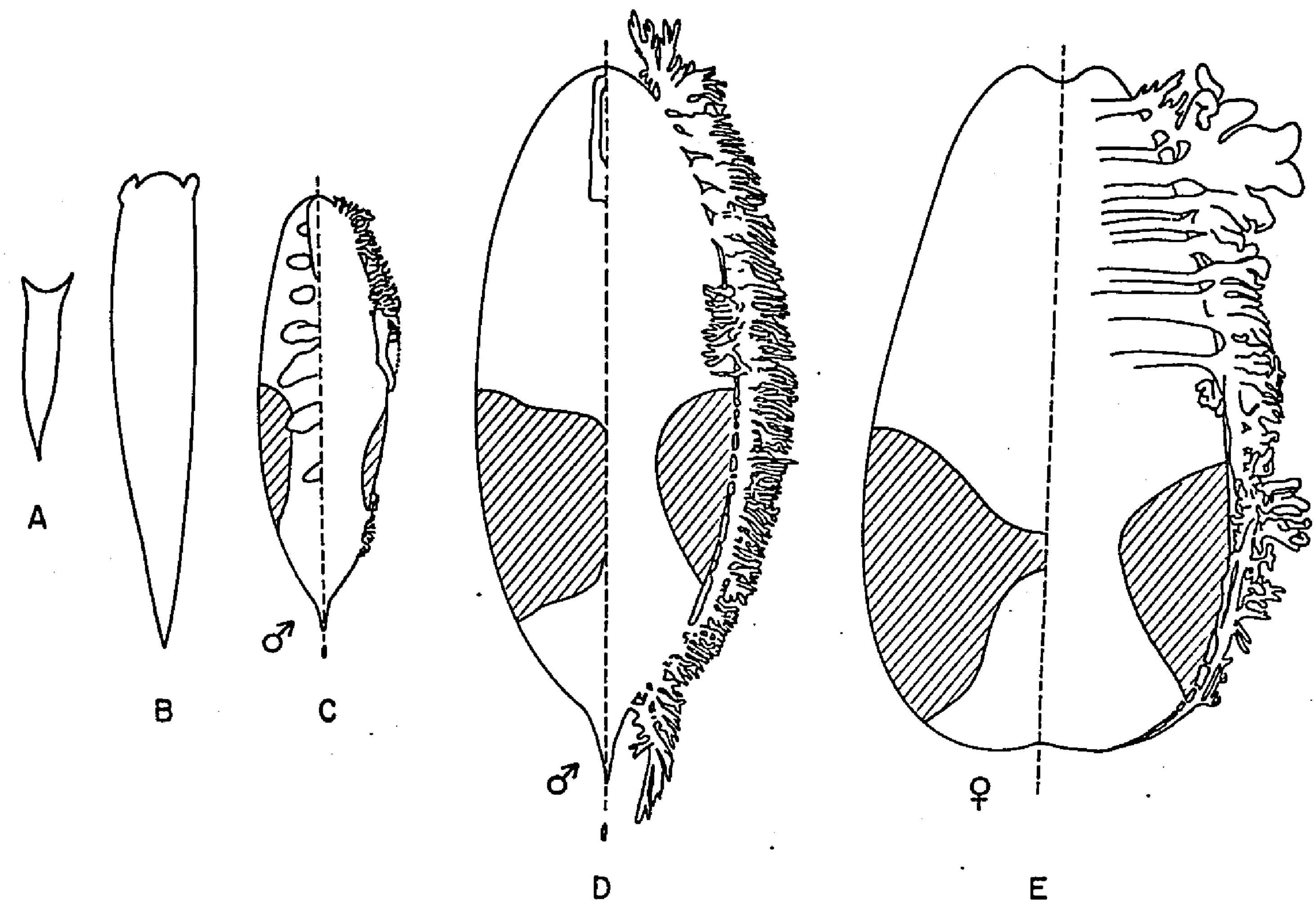

A
B
♂
C
♂
D
♀
E

Fig. 11

Ontogenetic development of swimbladder in *Sciaenops ocellata*. A. 197 mm SL; B. 980 mm SL, shaded area represents fat tissue; C. 1082 mm SL, dorsal view of a portion of the swimbladder with the left side of the "sac-like" projection; c. a cross section of the dorsal projection to show labyrinthine chambers.

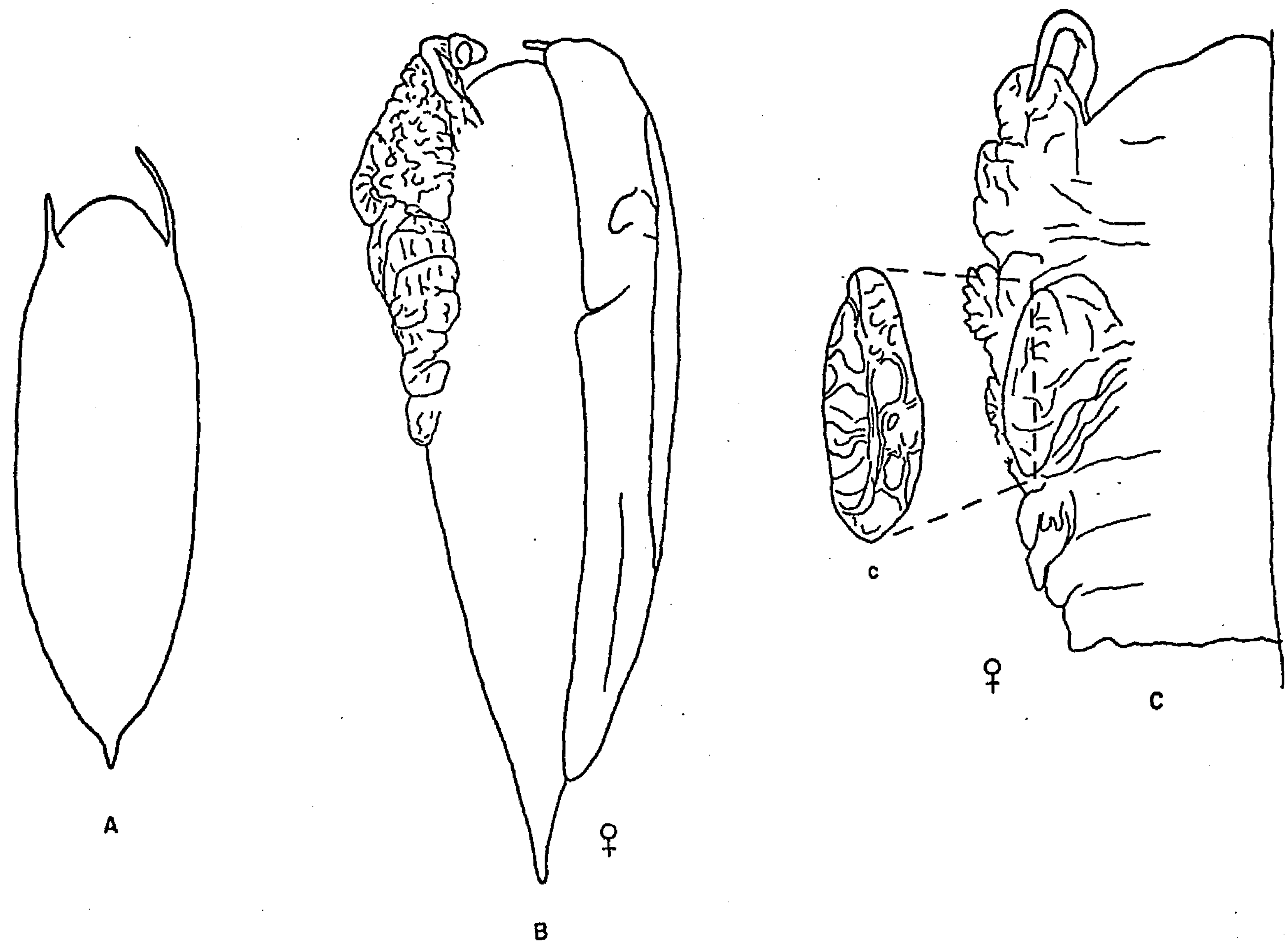

A
B
♀
c
♀
C

Fig. 12

Swimbladders of the *Cynoscion* pattern. A. *Cynoscion regalis*; B. *Isopisthus parvipinnis;* C. *Macrodon ancylodon*; D. *Plagioscion surinamensis*.

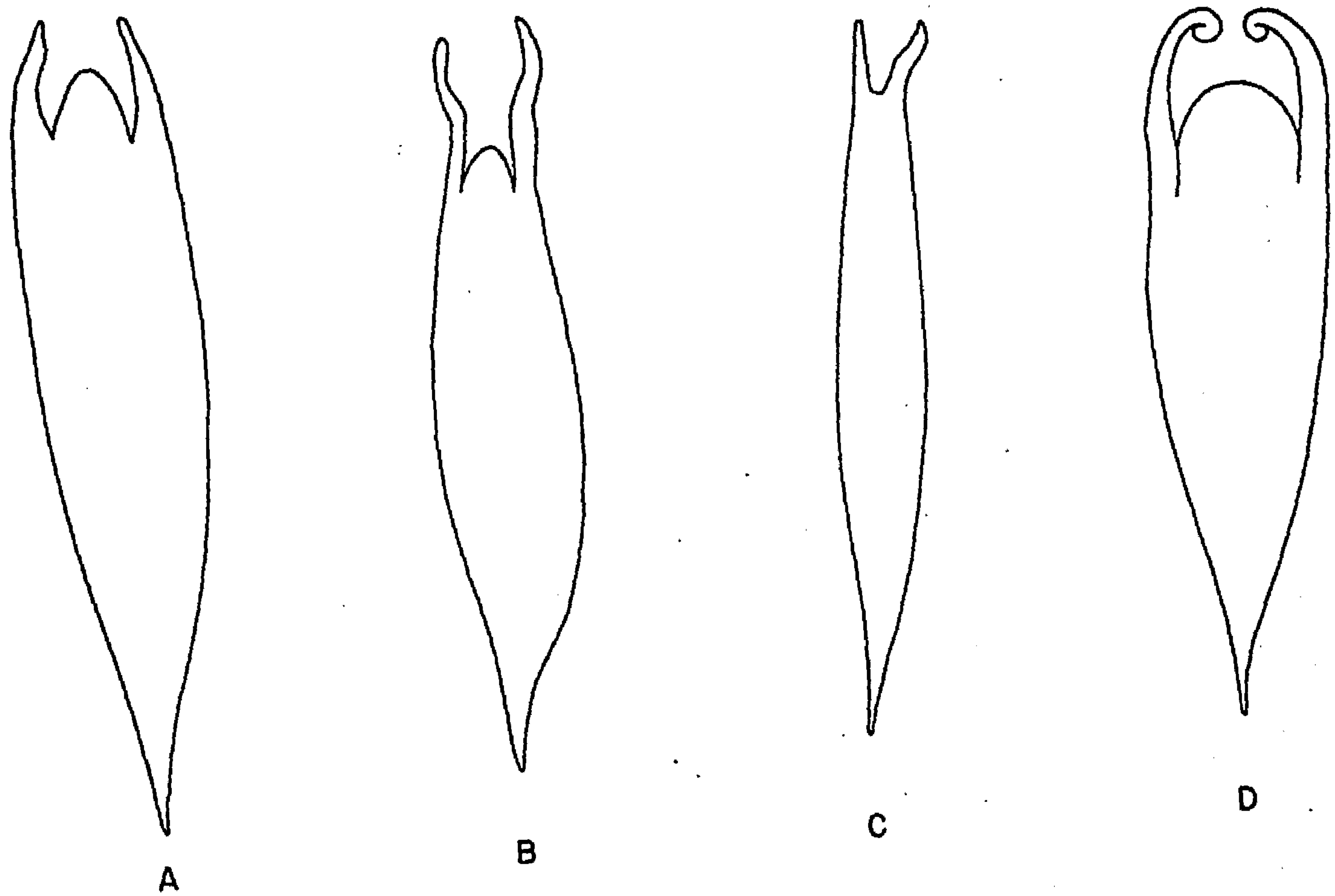

A
B
C
D

Fig. 13

Variation of the swimbladders in the genus *Cynoscion*. A. *C. microlepidtus;* B. *C. nothus;* C. *C. virencens;* D. *C. leiarchus* (395 mm SL) D'. *C. leiarchus* (191 mm SL).

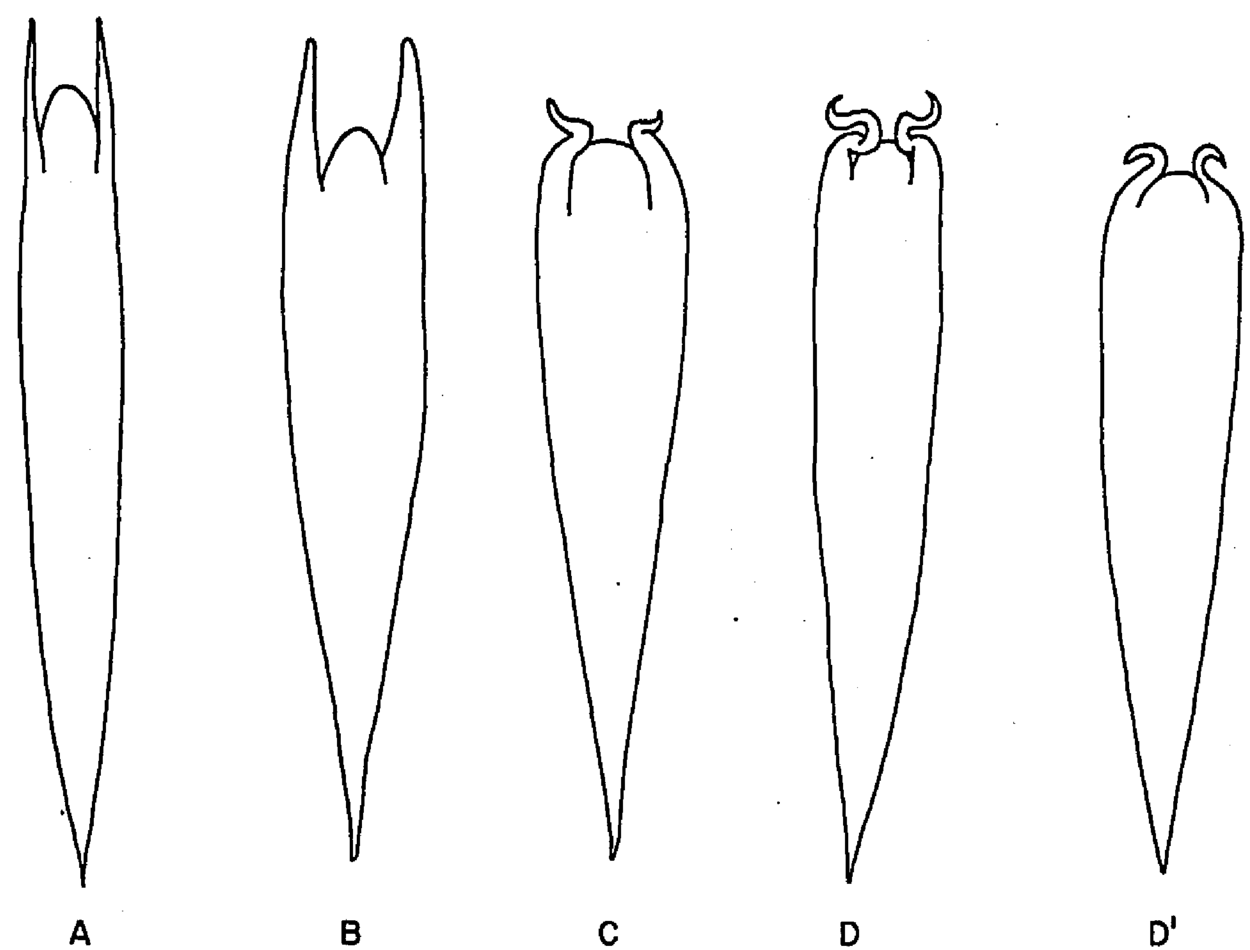
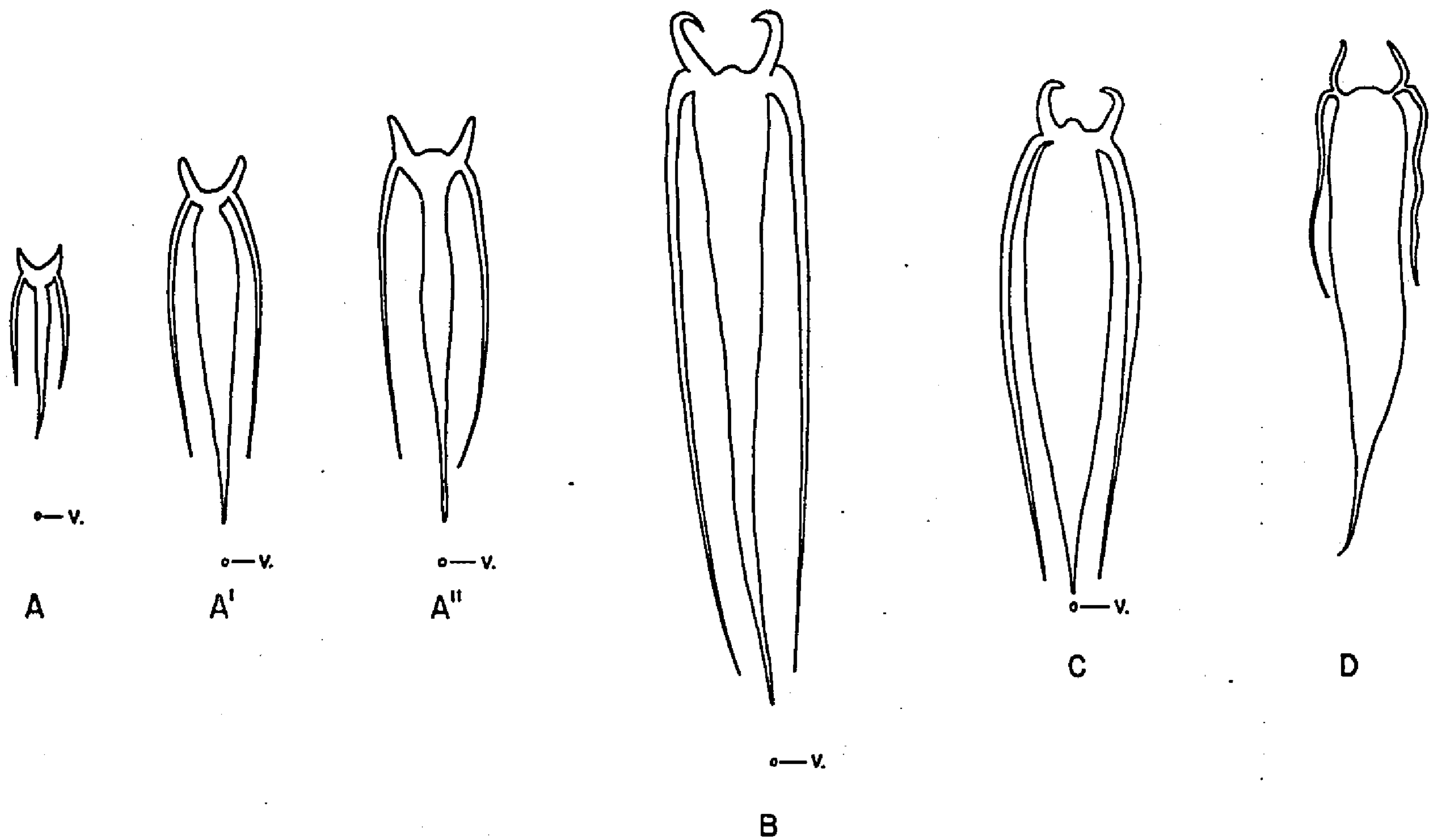

A
B
C
D
D'

Fig. 14

Relative size and development of swimbladders in the *Lonchiurus* pattern (x2). A. *Lonchiurus lanceolatus* (87.7 mm SL); A'. *L. lanceolatus* (103 mm SL); A". *L. lanceolatus* (114 mm SL); B. *Paralonchurus elegans* (180 mm SL); C. *P. brasiliensis* (157 mm SL); D. *Pachypops furcroi*, after Cuvier and Valenciennes (1830; pl. 138, "Corb Fourcroy", x1), original size unknown. v. vent.


v.
v.
v.
v.
v.
A
A'
A''
B
C
D

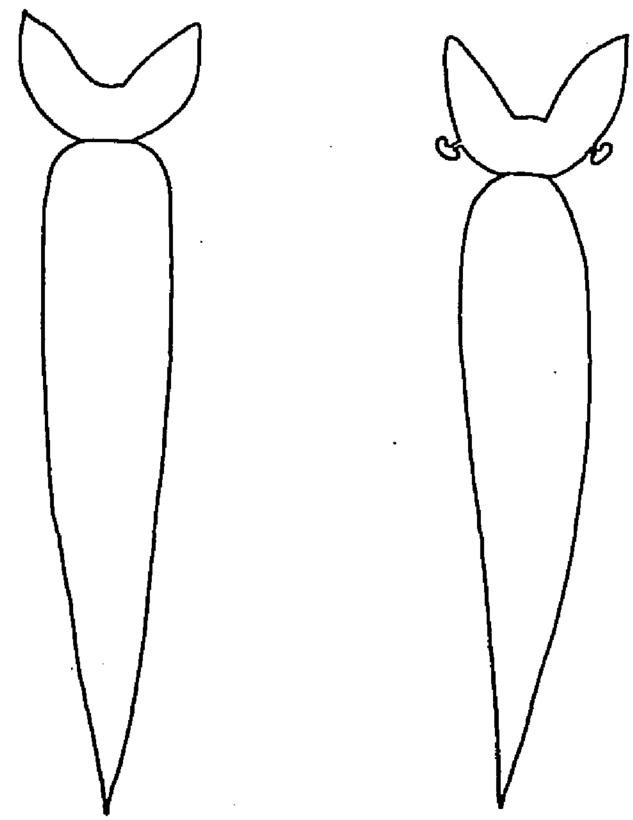
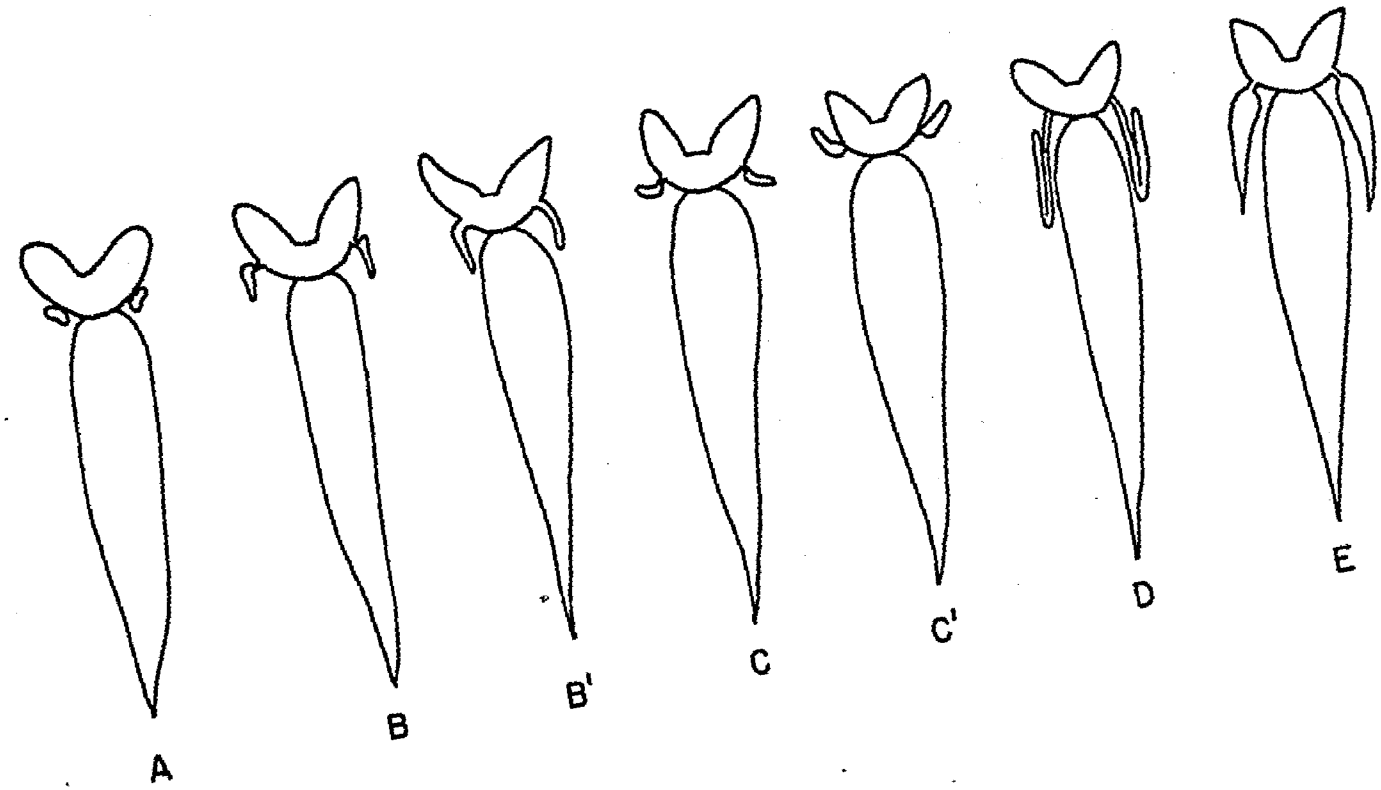


Fig. 15. Swimbladders of the *Stellifer* pattern. A. *Bairdiella, Odontoscion* and *Ophioscion;* B. *Stellifer lanceolatus*.

Fig. 16

Variation of the swimbladder diverticula in the genus *Stellifer*. A. *S. naso;* B. *S. griseus* (84.2 mm SL); B'. *S. griseus* (108 mm SL); C. *S. microps* (129 mm SL); C'. *S. microps* (105 mm SL); D. *S. brasiliensis;* E. *S. rastrifer*.


A
B
B'
C
C'
D
E

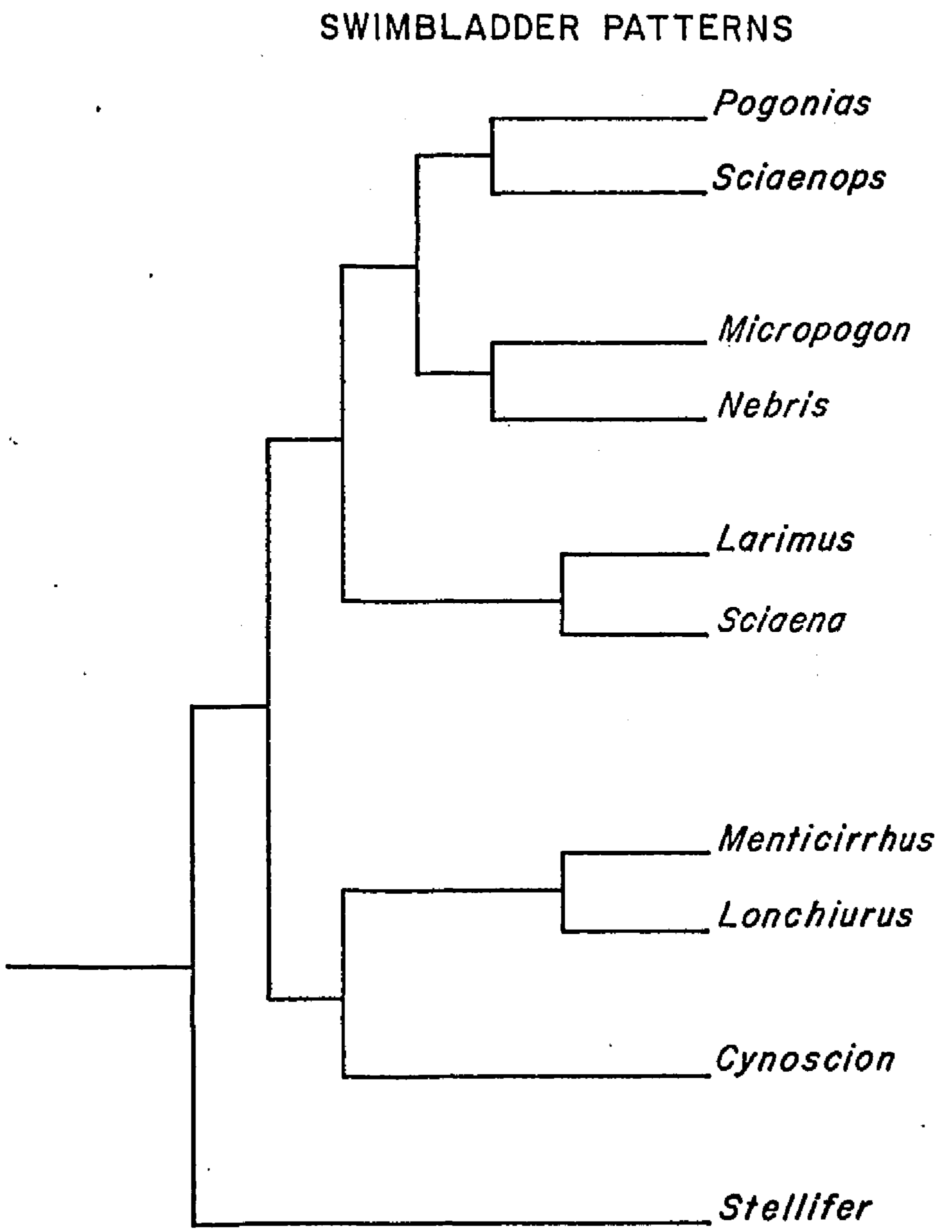


Fig. 17. Phylogenetic relationships of western Atlantic Sciaenidae as shown by swimbladder patterns.

Fig. 18

Inner surface (capital letters) and lateral view (lower case letters) of sagittae of the *Sciaena* pattern. A & a, *Ctenosciaena gracillicirrhus;* B & b, *Equetus lanceolatus;* C & c, *Equetus punctatus;* D & d, *Leiostomus xanthurus;* E & e, *Paraques acuminatus;* F & f, *Pareques umbrosus;* G & g, *Sciaena trewavasae;* H & h, *Sciaena bathytatos;* I & i, *Umbrina coroides;* J & j, *Umbrina millae;* K & k, *Pachyurus schomburgkii;* L & l, *Plagioscion surinamensis.*

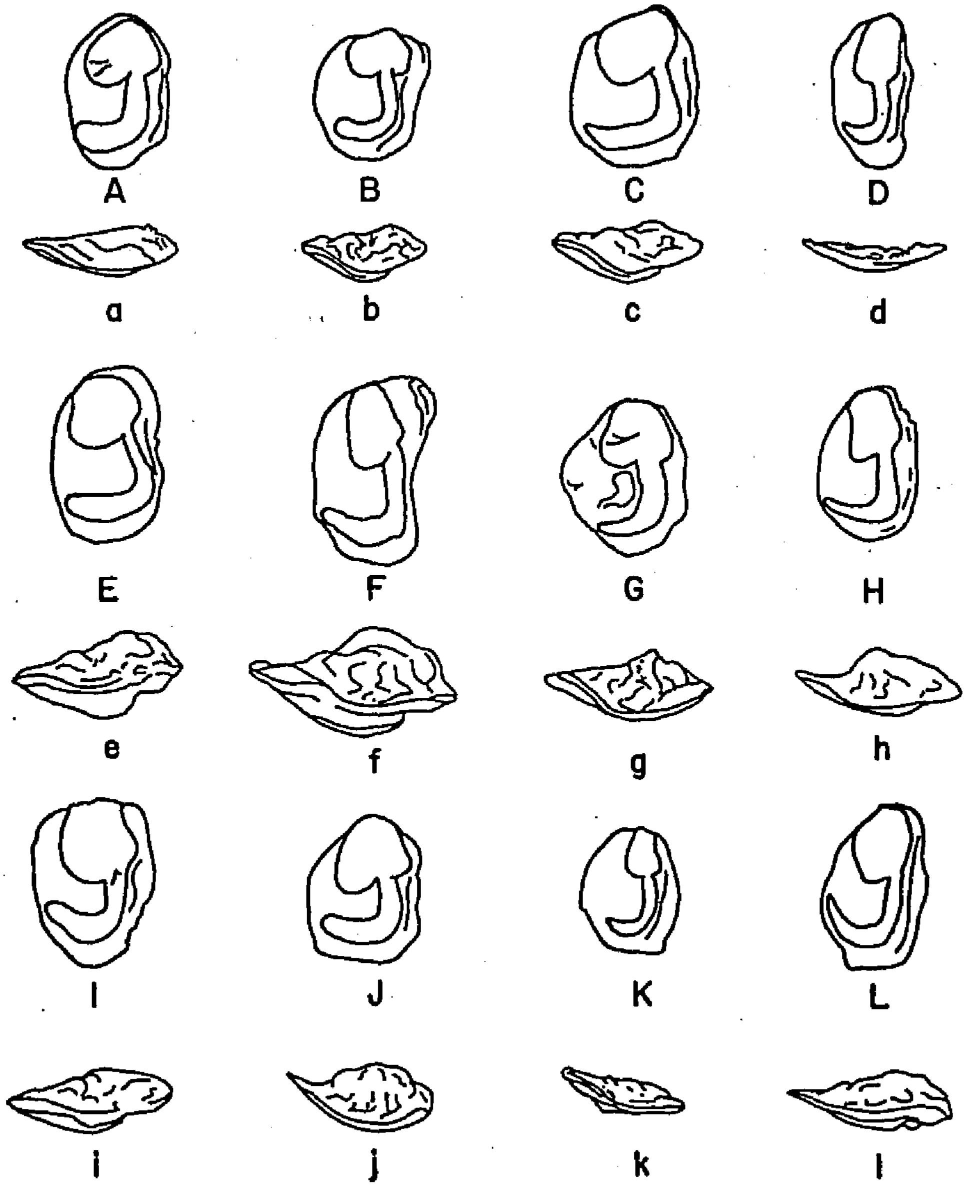

A
B
C
D
a
b
c
d
E
F
G
H
e
f
g
h
I
J
K
L
i
j
k
l

Fig. 19

Sagittae of the *Pogonias* pattern. A, A' & a, *Pogonias cromis*; B, B' & b, *Aplodinotus grunniens*. A & B, inner surface; A' & B', outer surface; a & b, lateral view.

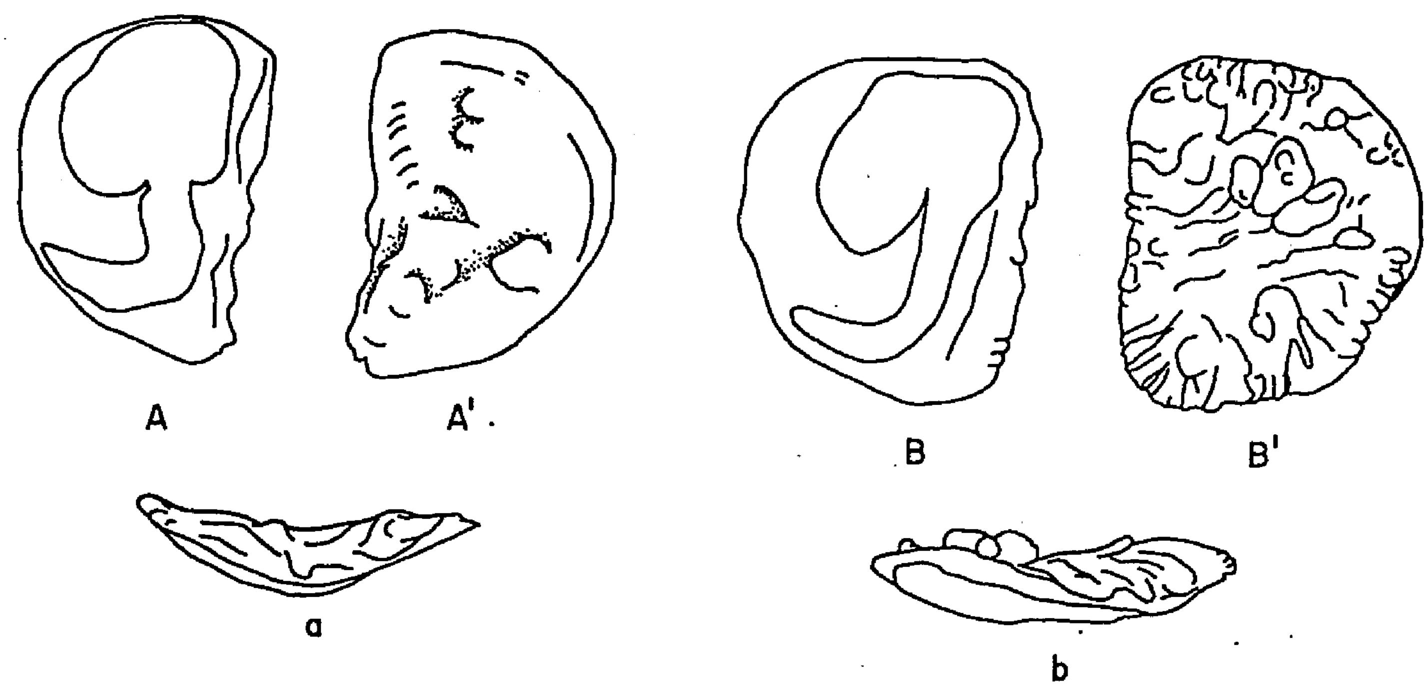
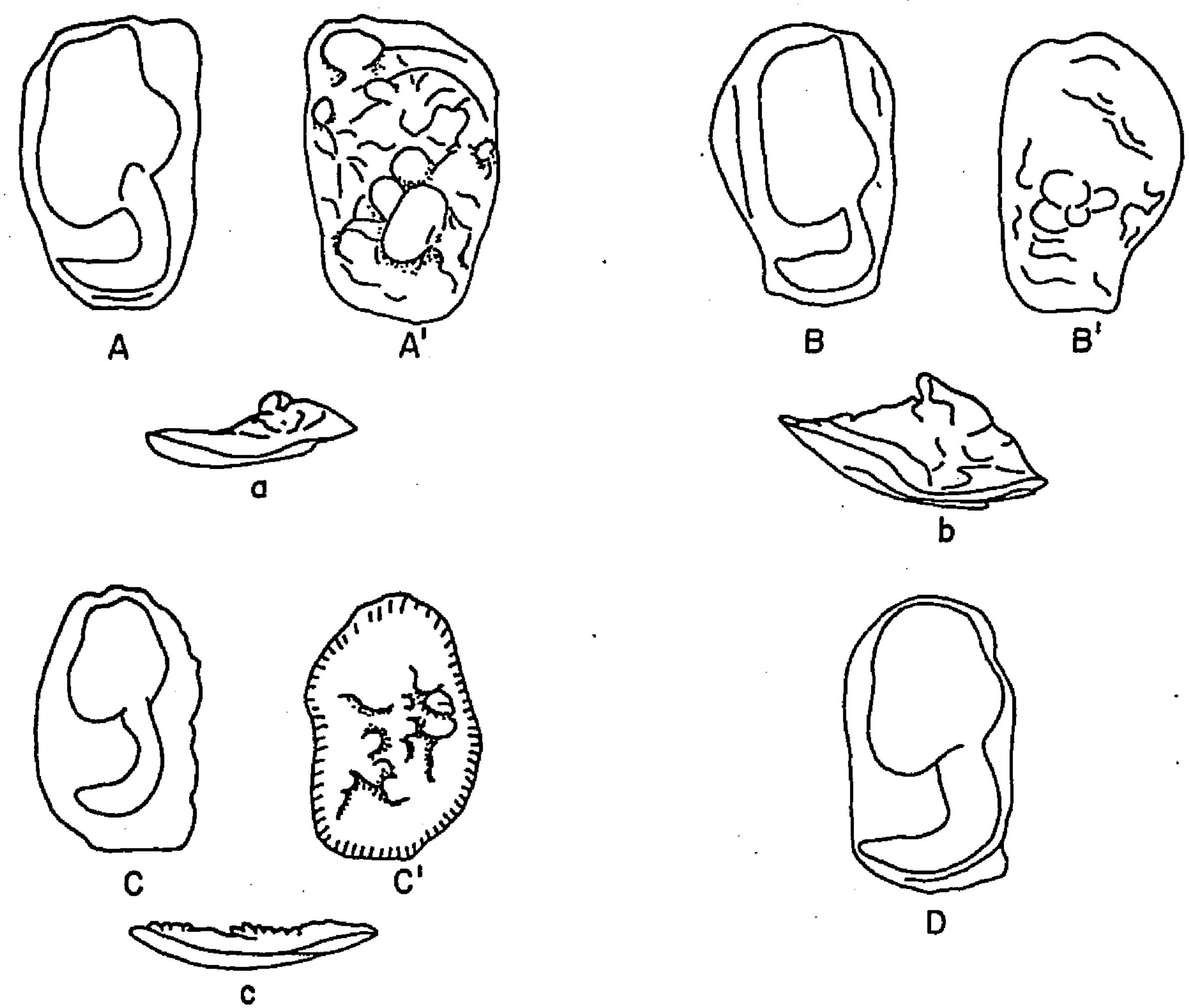

A
A'
a
B
B'
b

Fig. 20

Sagittae of the *Larimus* pattern. A, A' & a, *Larimus fasciatus;* B, B' & b, *Larimus breviceps;* C, C' & c, *Sciaenops ocellata,* 357 mm TL; D. *S. ocellata*, 1100 mm TL. A, B, C & D, inner surface; A', B' & C', outer surface; a, b & c, lateral view.


A
A'
B
B'
a
b
C
C'
D
c

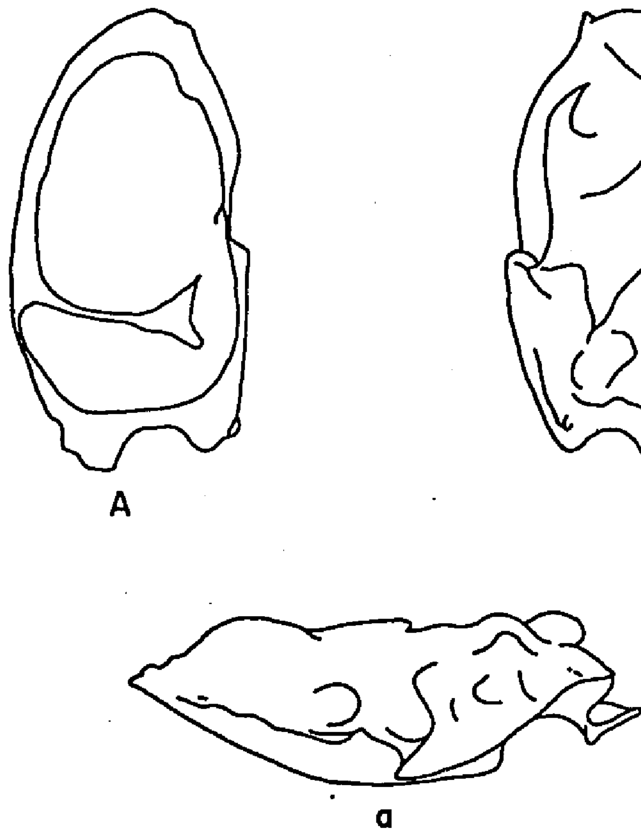


Fig. 21. Sagitta in *Nebris microps*. A. inner surface; A', outer surface; a, lateral view.

Fig. 22

Sagittae of the *Cynoscion* and the *Menticirrhus* patterns. A, A' & a, *Cynoscion nebulosus*; B, B' & b, *Menticirrhus saxatilis*. A & B, inner surface; A' & B', outer surface; a & b, lateral view.

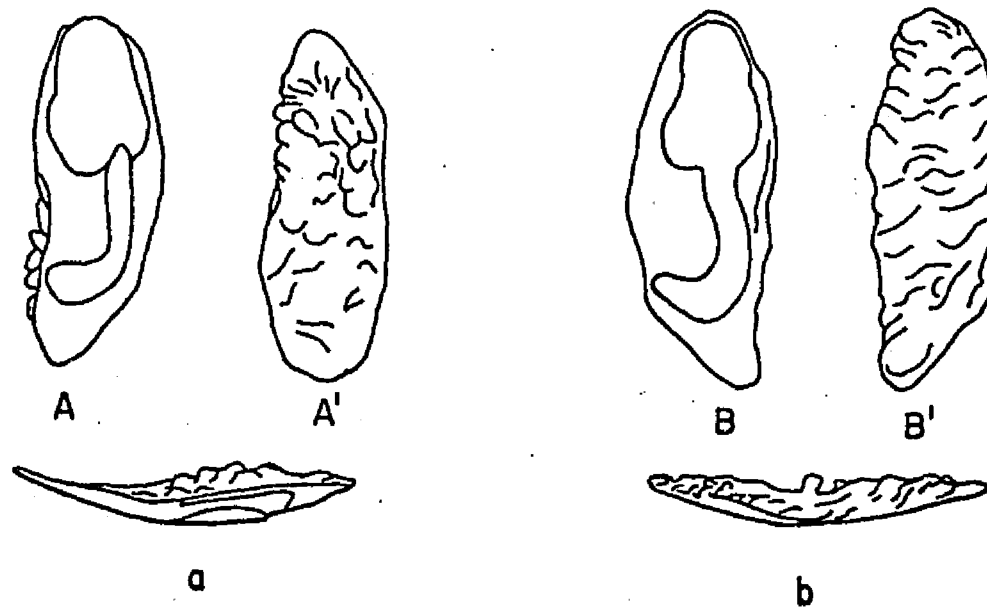
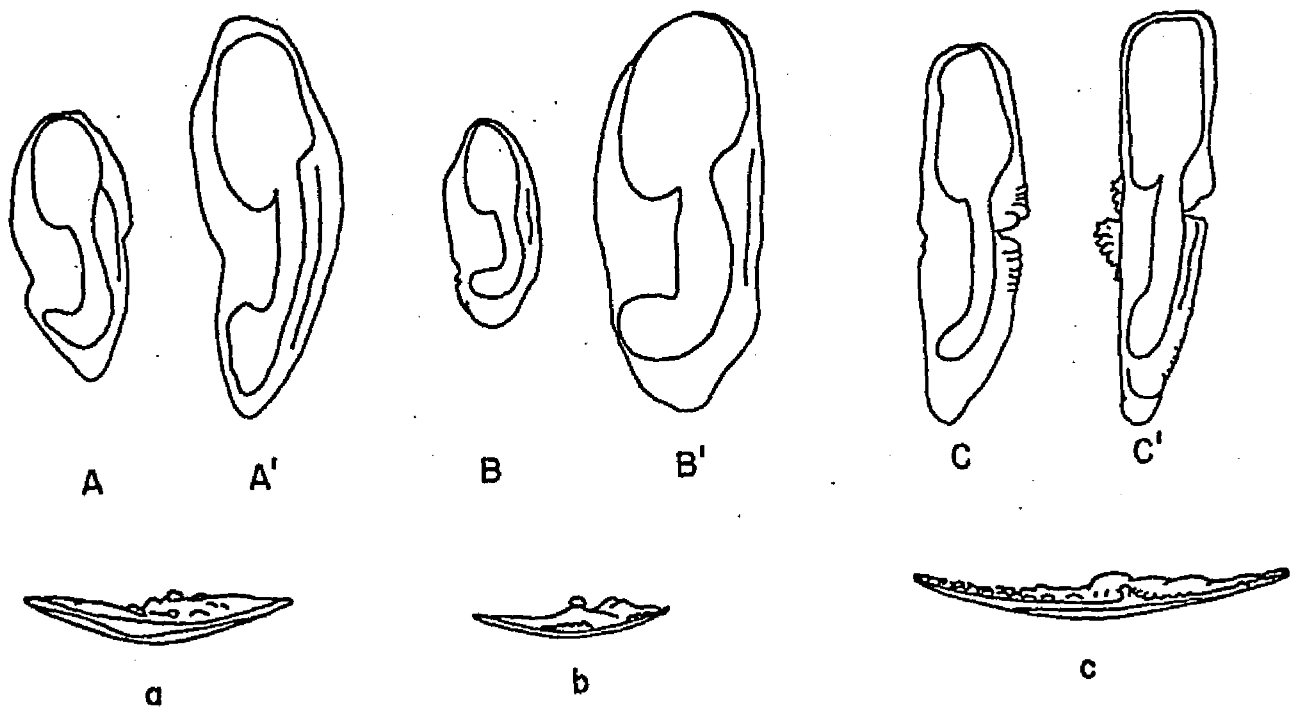

A
A'
B
B'
a
b

Fig. 23

Specific and ontogenetic variations of sagittae in species of *Cynoscion*. *C. regalis*, A & a, 370 mm TL; A', 516 mm TL. *C. similis*, B & b, 166 mm TL; B', 350 mm TL. *C. virenscions*, C & c, 260 mm TL; C', 350 mm TL. A, A', B, B', C, & C', inner surface; a, b & c, lateral view.


A
A'
B
B'
C
C'
a
b
c

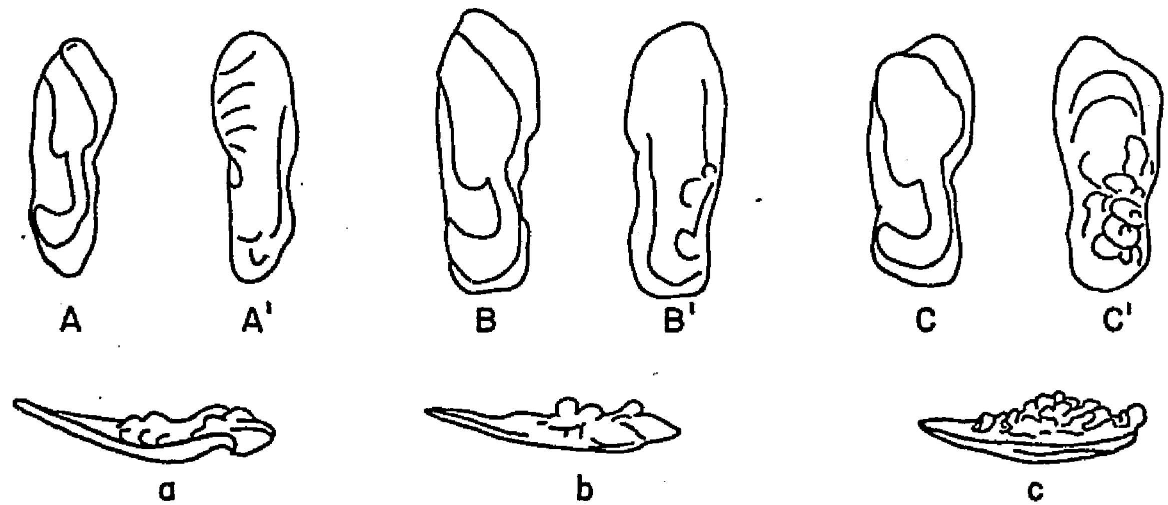


Fig. 24. Sagittae of the *Lonchiurus* pattern. A, A' & a, *Lonchiurus lanceolatus*; B, B' & b, *Paralonchurus elegans*; C, C' & c, *Paralonchurus brasiliensis*. A, B & C, inner surface; A', B' & C', outer surface; a, b & c, lateral view.

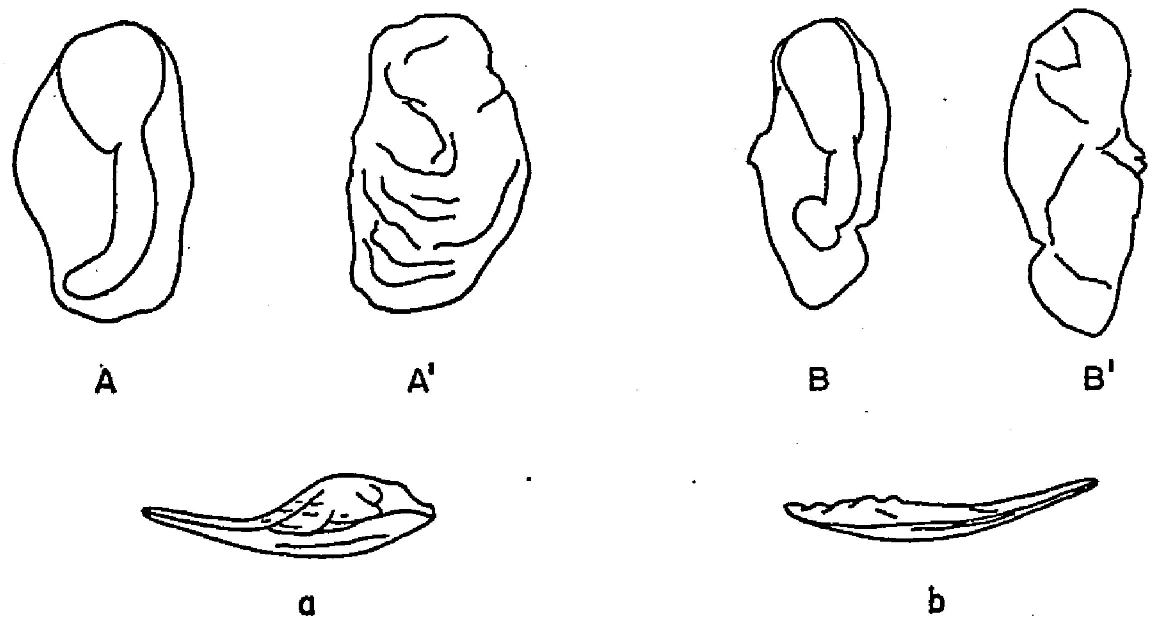


Fig. 25. Sagittae of the *Isopisthus* and the *Macrodon* pattern. A, A' & a, *Isopisthus parvipinnis*; B, B' & b, *Macrodon ancylodon*; A & B, inner surface; A' & B', outer surface; a & b, lateral view.

Fig. 26

Ontogenetic variations of the sagittae of the *Micropogonias*. *M. furnieri*, A, A' & a, 235 mm TL; B, B' & b, 295 mm TL; C, C' & c, 330 mm TL. *M. undulatus*, D, D' & d, 141 mm TL; E, E' & e, 250 mm TL; F, F' & f, 350 mm TL. A, B, C, D, E & F, inner surface; A', B', C', D', E' & F', outer surface; a, b, c, d, e & f, lateral view.

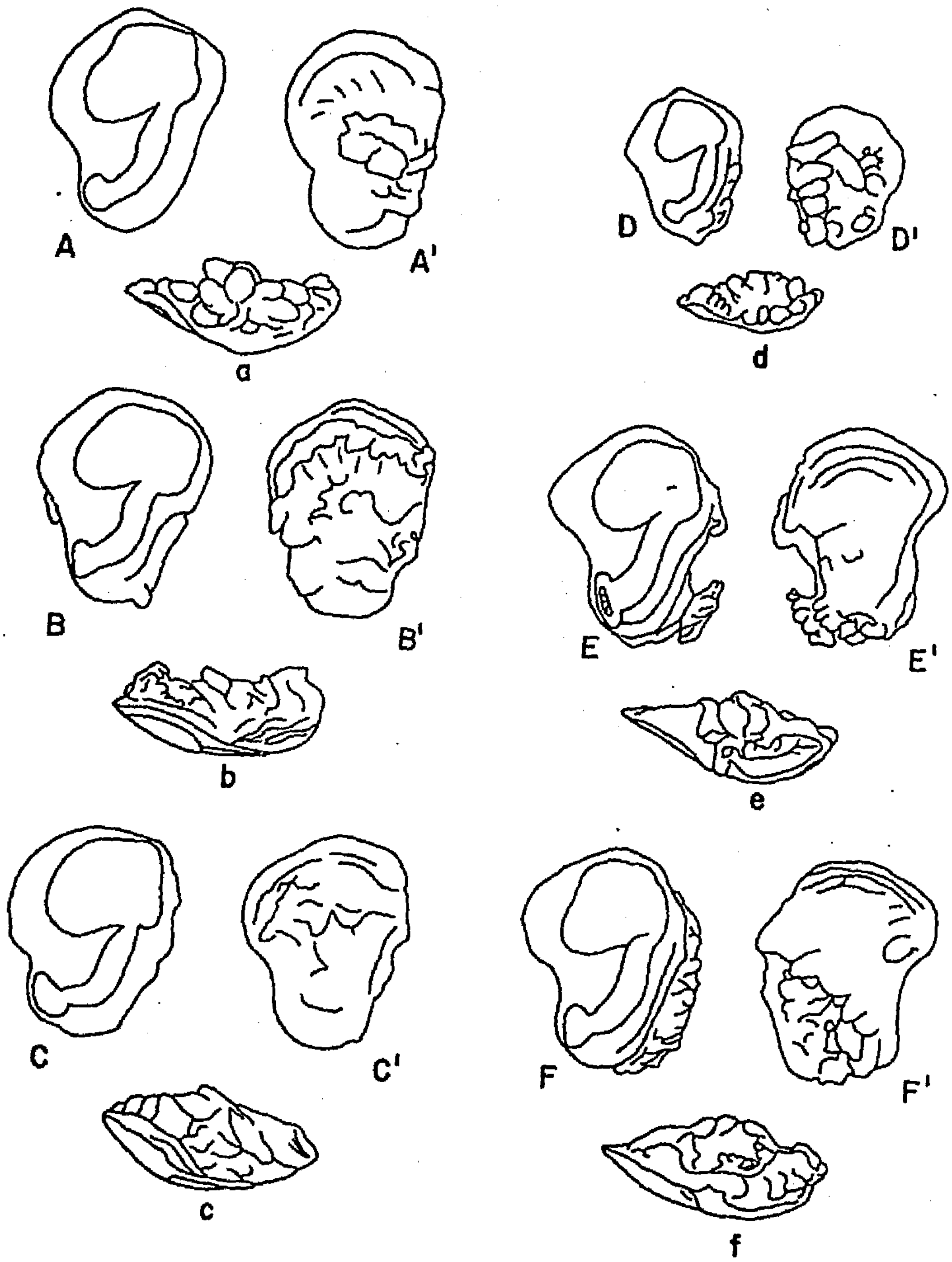

A
A'
a
D
D'
d
B
B'
b
E
E'
e
C
C'
c
F
F'
f

Fig. 27

Inner surface of right sagittae and lapilli of the *Stellifer* pattern. A & A', *Ophioscion punctatissimus*; B & B', *Stellifer lanceolatus;* C & C', *Bairdiella chrysoura*; D & D', *Odontoscion dentex*. A, B, C & D, sagittae; A', B', C' & D', lapilli.

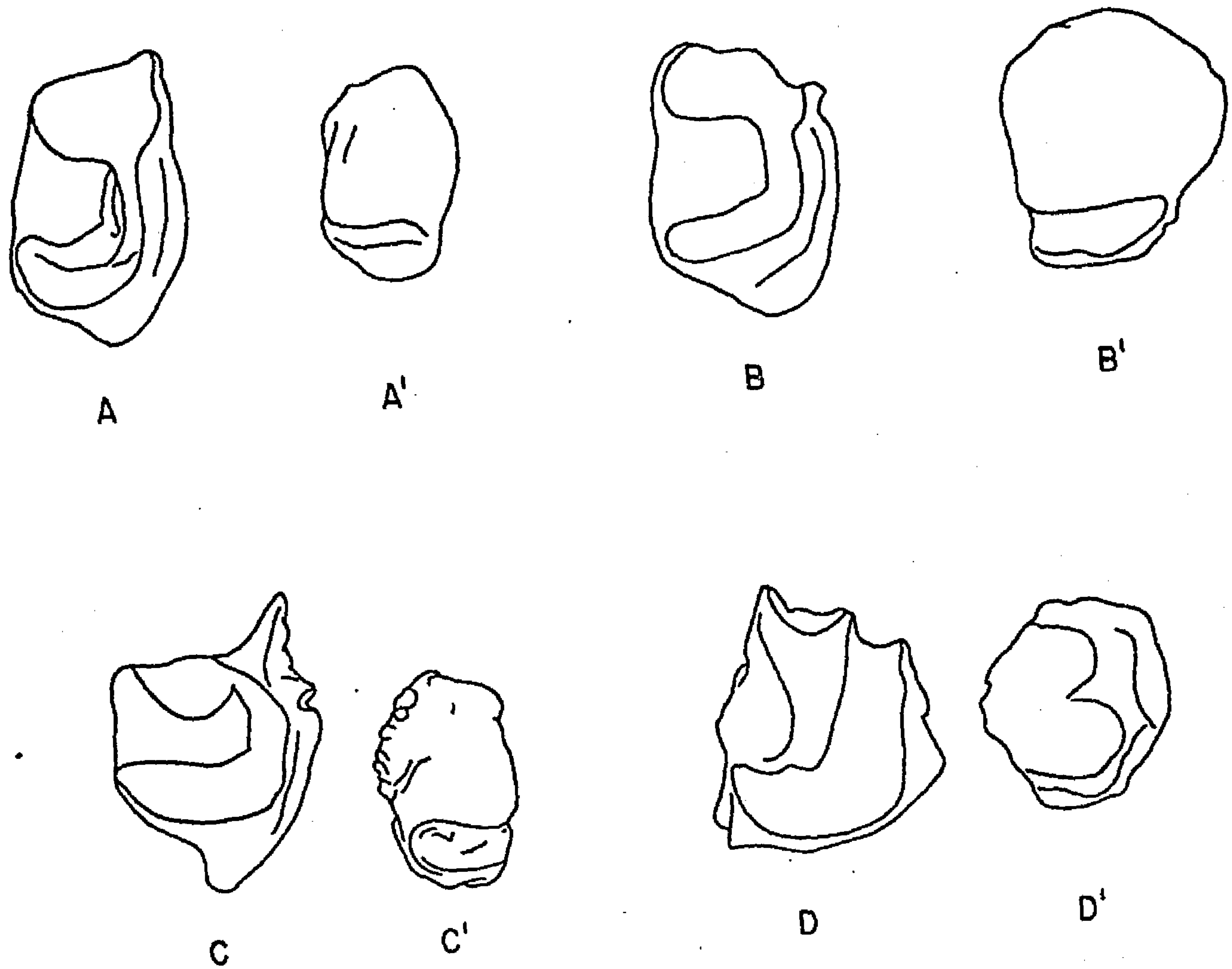
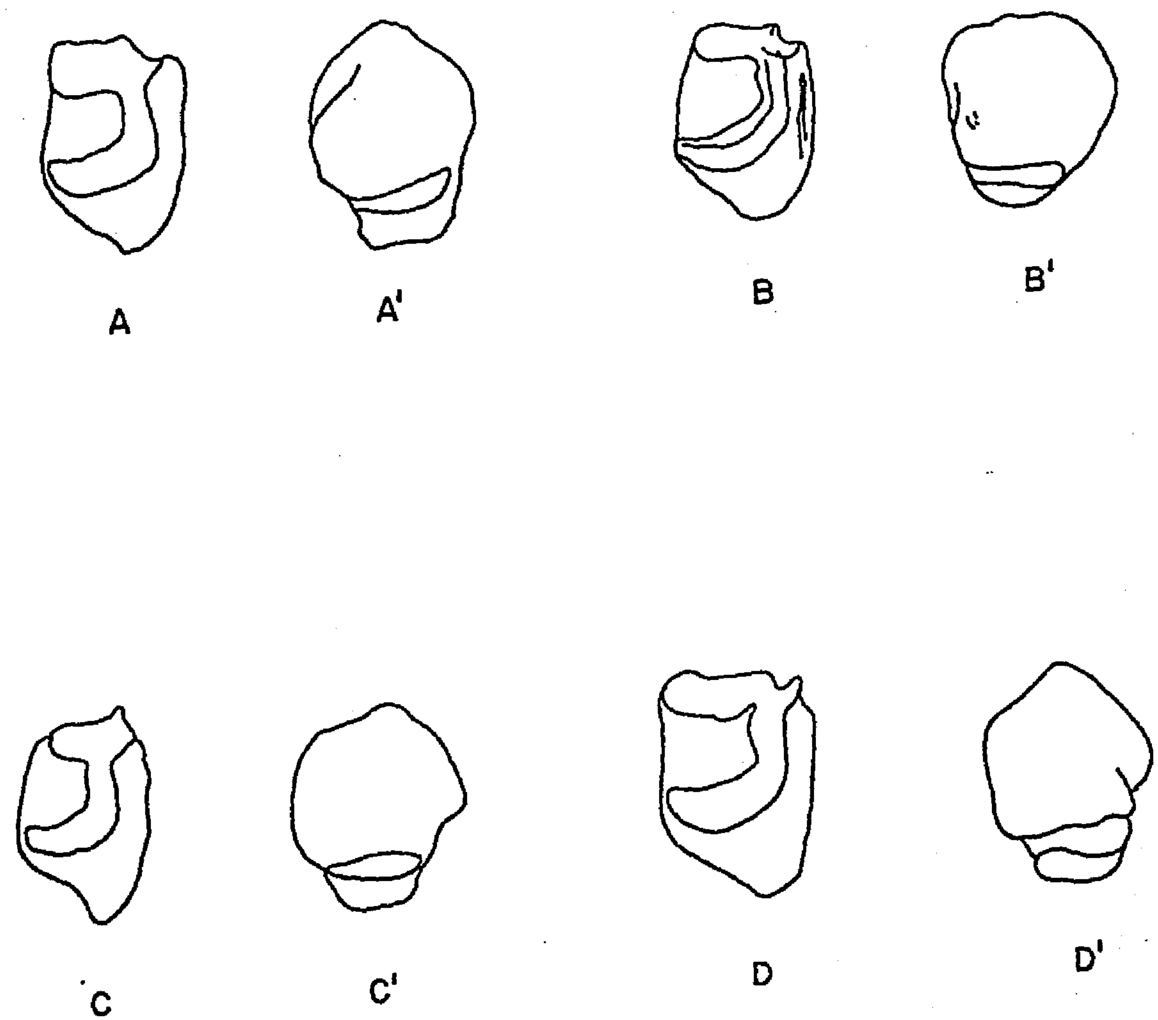

A
A'
B
B'
C
C'
D
D'

Fig. 28

Inner surface of right sagittae and lapilli in species of *Stellifer*. A & A', *S. colonensis;* B & B', *S. griseus*; C & C', *S. microps*; D & D', *S. rastrifer*. A, B, C & D, sagittae; A', B', C' & D', lapilli.


A
A'
B
B'
C
C'
D
D'

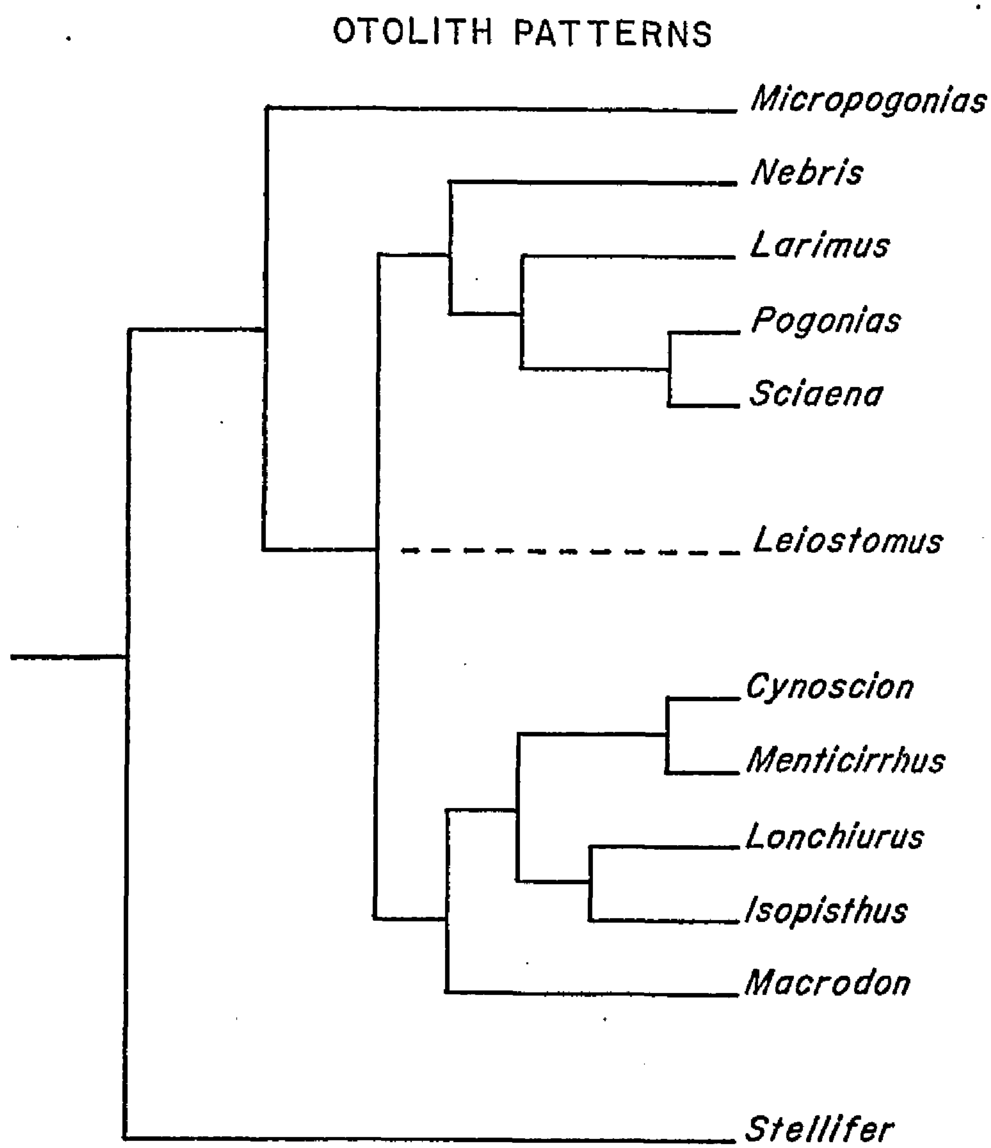


Fig. 29. Phylogenetic relationships of western Atlantic Sciaenidae as shown by otolith patterns.

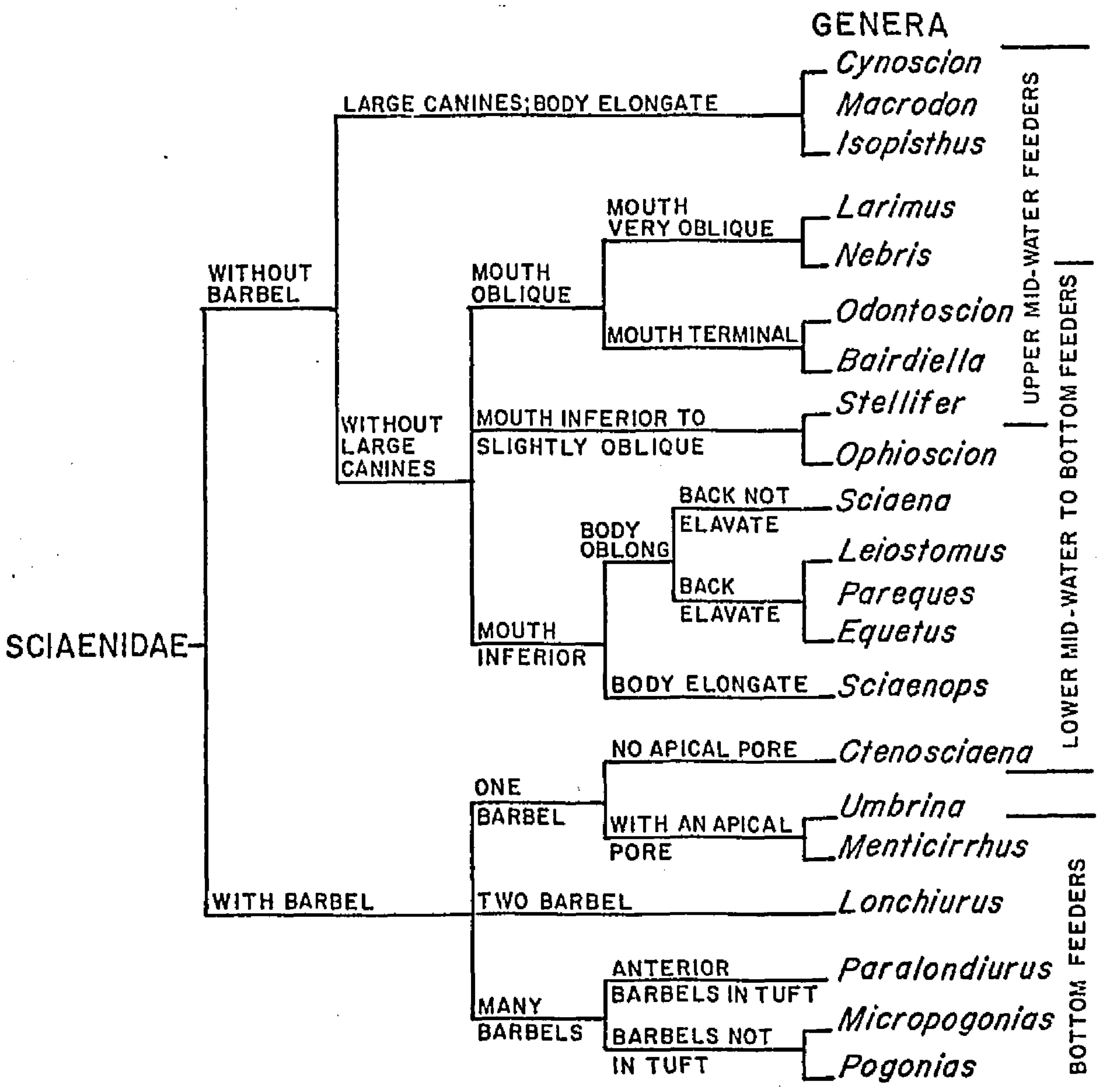


Fig. 30. Phylogenetic relationships of western Atlantic Sciaenidae as shown by external morphology.

Fig. 31

Snout pore patterns (diagramatic) of western Atlantic Sciaenidae. A. no upper and two marginal pores; B. no upper and five marginal pores; C. two upper and five marginal pores; D. three upper and five marginal pores; E. five upper and five marginal pores; F. five or more upper and marginal pores.

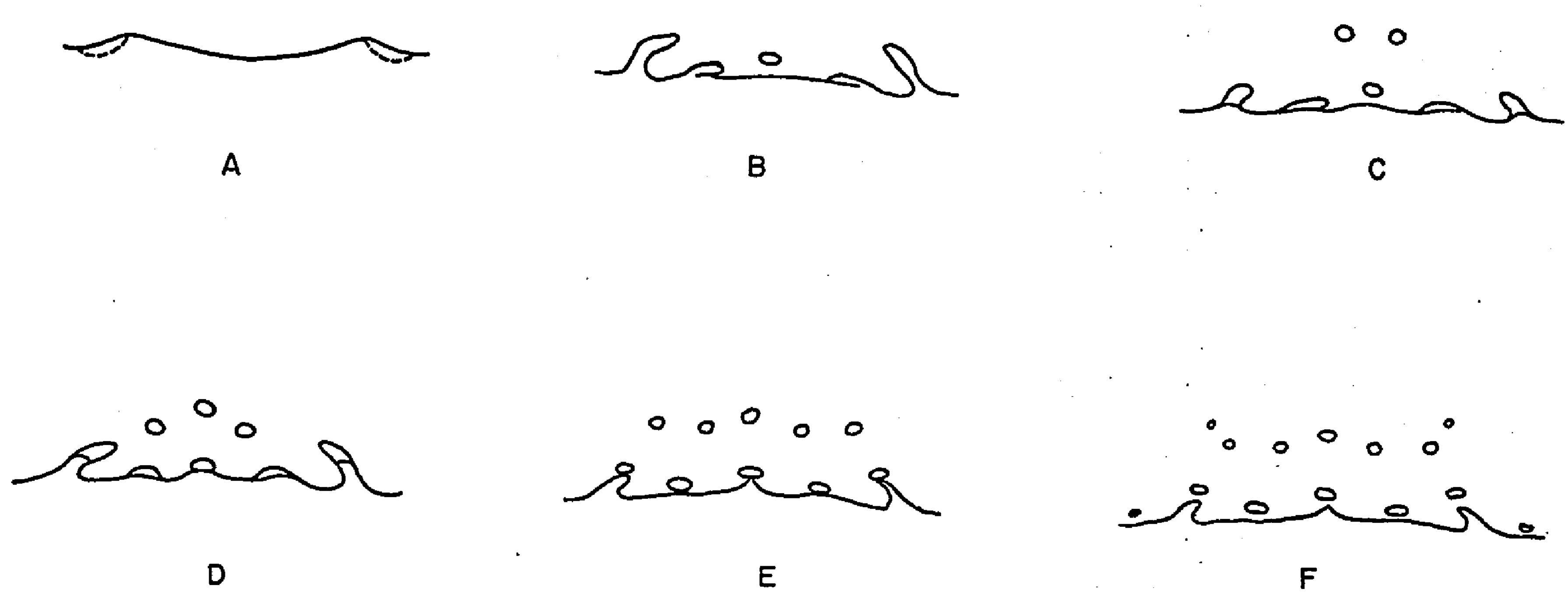

A
B
C
D
E
F

Fig. 32

Mental pore and barbel patterns (diagramatic) on the lower jaw of western Atlantic Sciaenidae. A. no pore and no barbel; B. four pores and no barbel; C. five pores and no barbel; D. six pores and no barbel; E. four pores and one barbel; F. four pores and two barbels; G. five pores and many barbels, not in tuft; H. five pores and many barbels, anterior three pairs of barbels in tuft.

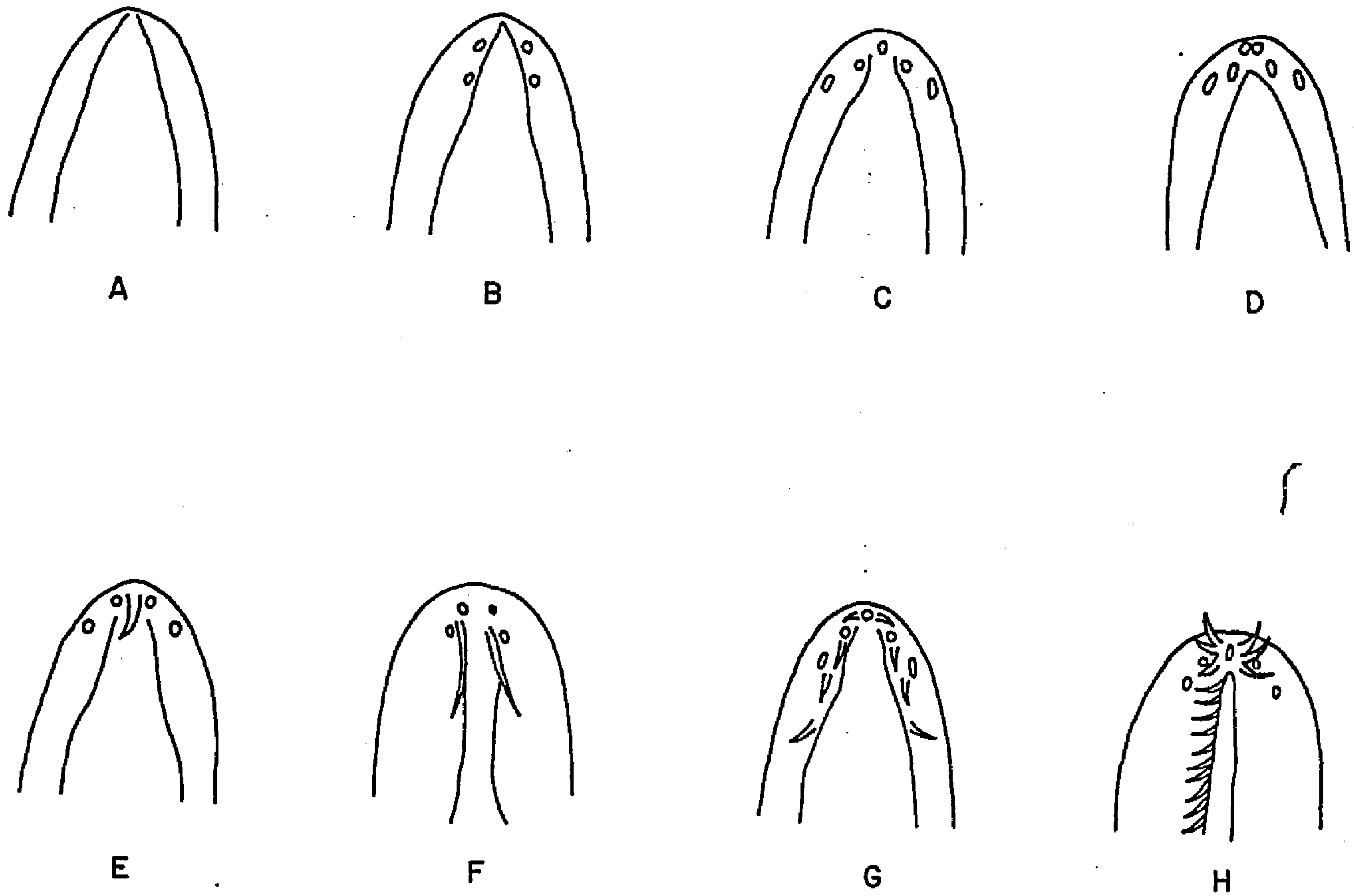

A
B
C
D
E
F
G
H

Fig. 33

Variation in snout pores with five or more marginal pores. A to D, three upper pore pattern; E to H, five upper pore pattern. A. *Bairdiella chrysoura;* B. *Ophioscion punctatissimus* (with additional four minute pores); C. *Paralonchurus elegans;* D. *Menticirrhus americanus;* E. *Pogonias cromis;* F. *Sciaenops ocellata* (with seven marginal pores).

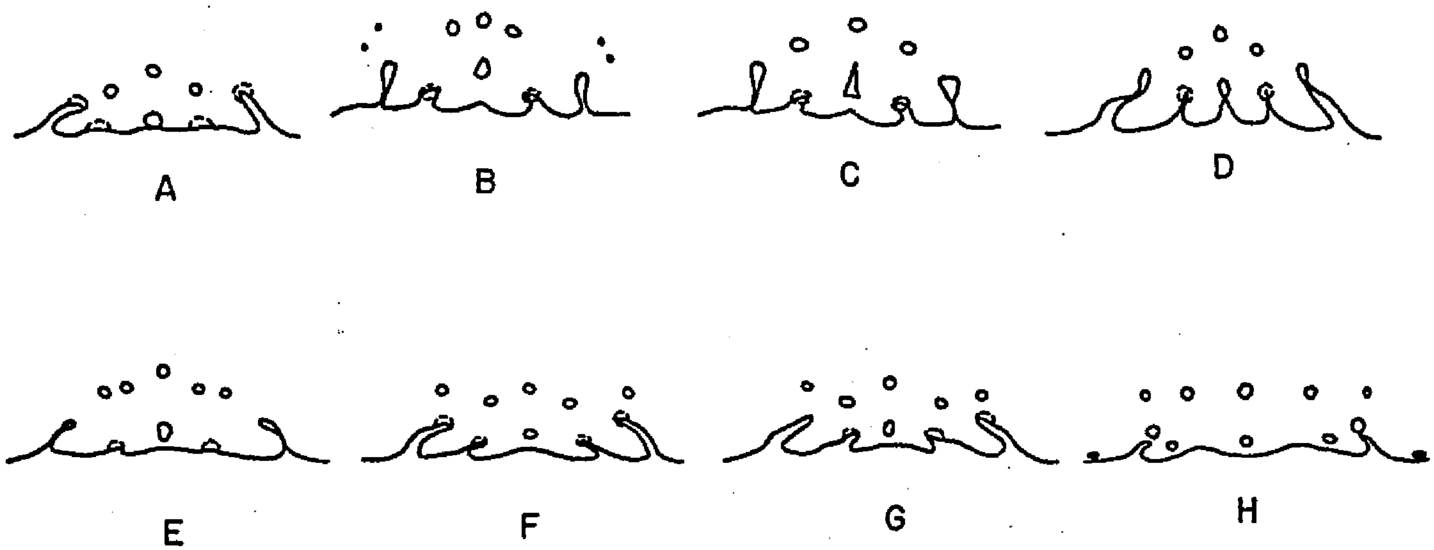
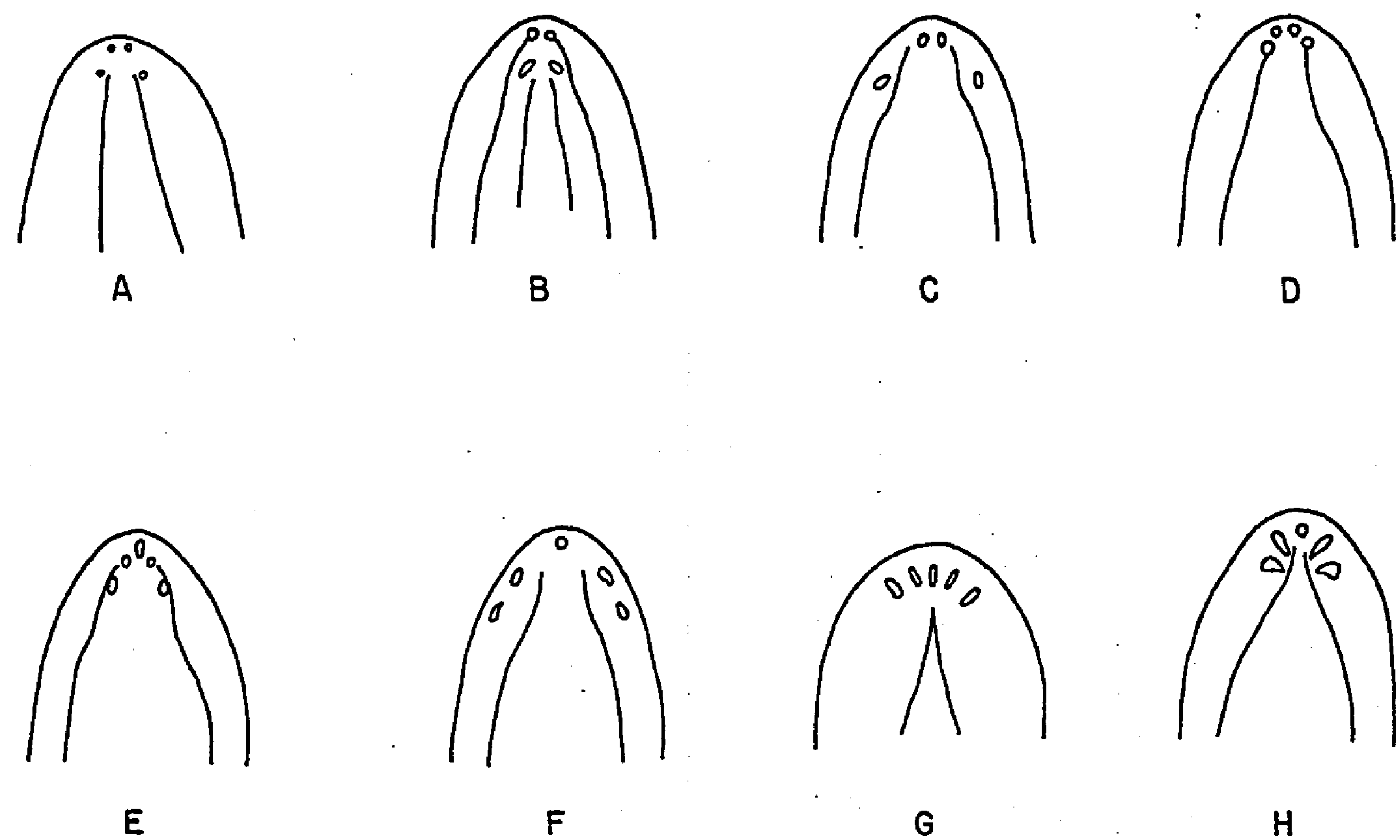
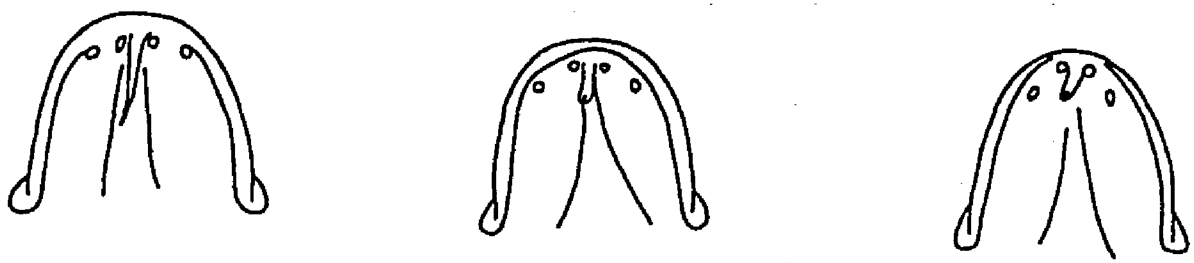

A
B
C
D
E
F
G
H

Fig. 34

Variation in mental pore arrangements on the lower jaw. A to D, four mental pore pattern; E to H, five mental pore pattern. A. *Nebris microps;* B. *Larimus fasciatus;* C. *Odontoscion dentex;* D. *Stellifer lanceolatus;* E. *Aplodinotus grunniens;* F. *Sciaenops ocellata;* G. *Ophioscion punctatus;* H. *Equetus punctatus*.


A
B
C
D
E
F
G
H



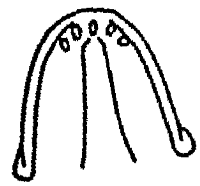
A B C

Fig. 35. Western Atlantic Sciaenidae with one mental barbel on the lower jaw. A. *Ctenosciaena gracillicirrhus* (lack of an apical pore); B. *Menticirrhus* and C. *Umbrina* (with an apical pore).

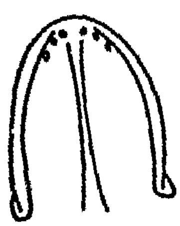
Fig. 36

Variation in mental pore patterns on the lower jaw in the species of *Stellifer*. A. *S. lanceolatus*, four mental pores; B. *S. Stellifer*, five mental pores; C. *S. rastrifer*, six mental pores; D. *S. colonensis*, six mental pores.

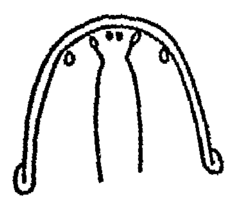
A



B



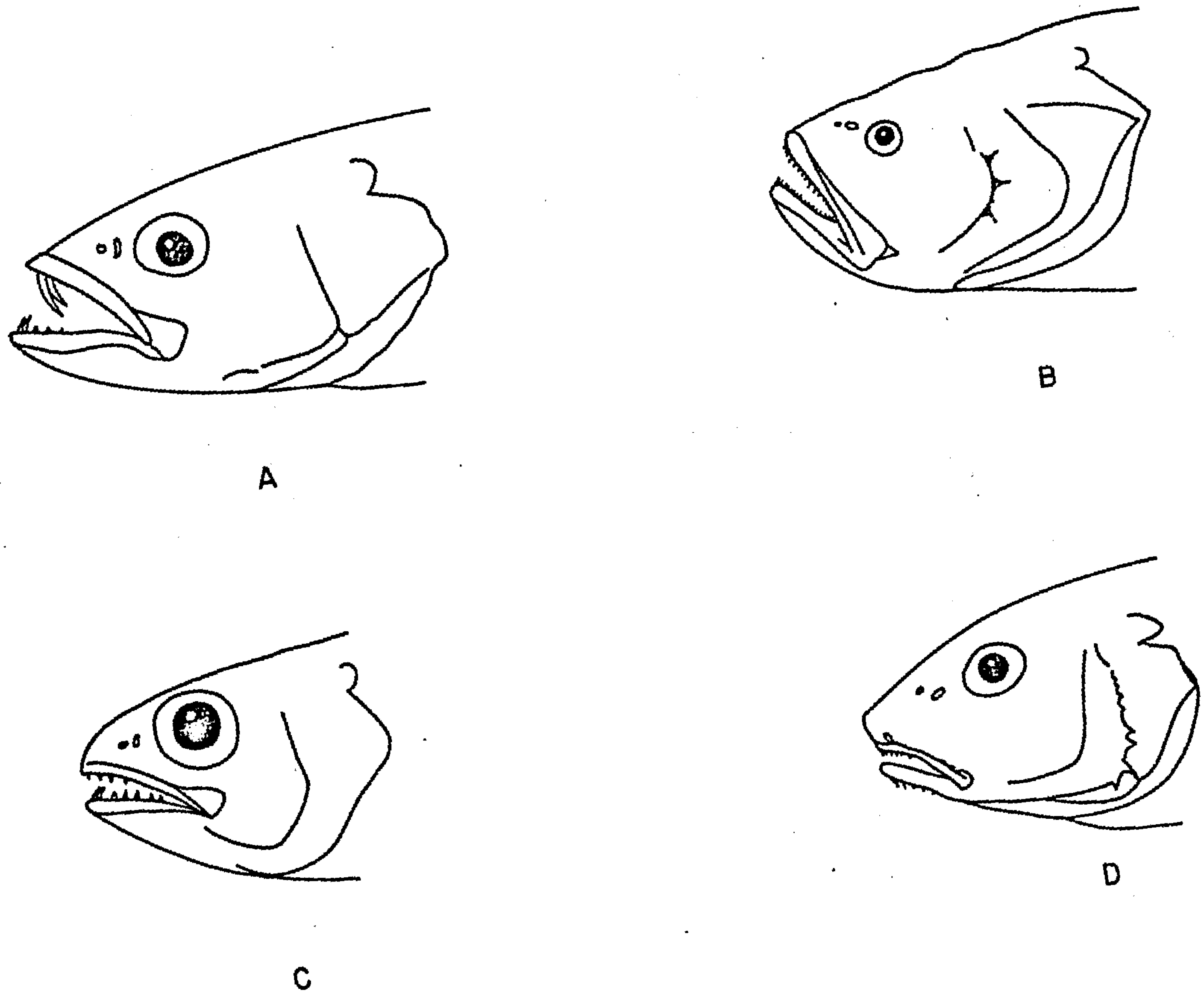
C



D

Fig. 37

Four typical mouth positions and dentitions of western Atlantic Sciaenidae. A. *Macrodon ancylodon;* B. *Nebris microps;* C. *Odontoscion dentex;* D. *Micropogonias undulatus.*


A
B
C
D

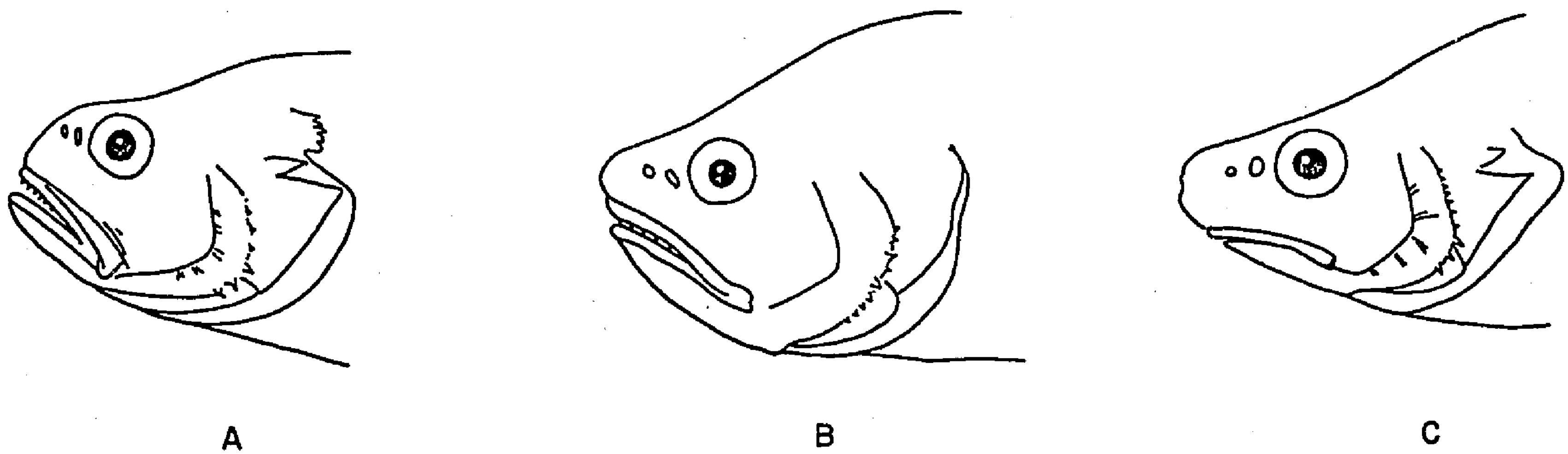


Fig. 38. Three levels of mouth position in the species of *Stellifer*. A. *S. lanceolatus,* oblique; B. *S. rastifer,* terminal; C. *S. microps,* inferior.

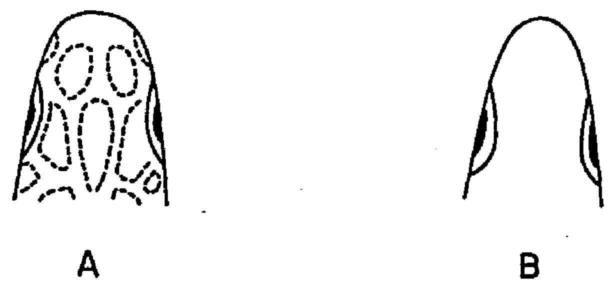


Fig. 39. Dorsal view (diagramatic) of the head of the *Stellifer* group. A. *Ophioscion* and *Stellifer*; B. *Bairdiella* and *Odontoscion*. Dotted lines on A. represent obvious cavernous lateral line canals.

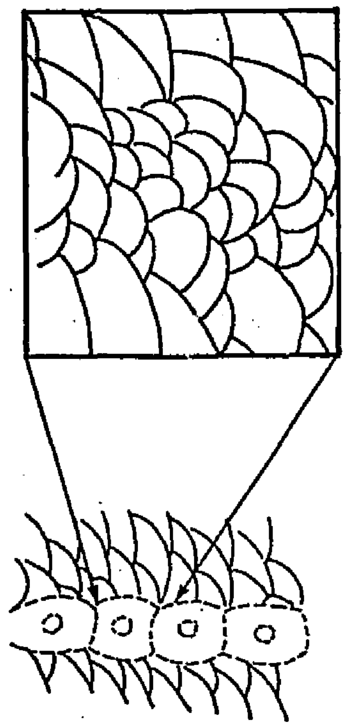


Fig. 40. Portions of lateral line scales of *Plagioscion surinamensis*, enlarged view indicates each unit of lateral line scale group consists of many small scales.

PART II

LIFE HISTORY, FEEDING HABITS AND FUNCTIONAL MORPHOLOGY OF JUVENILE SCIAENID FISHES IN THE YORK RIVER ESTUARY, VIRGINIA

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INTRODUCTION

Sciaenid fishes are among the most important inshore bottom fishery resources of the Atlantic and Gulf of Mexico coasts of the United States (Roithmayr, 1965; Joseph, 1972; Gutherz, et. al., 1975). Sciaenid fishes usually use the estuary as a nursery ground, and as a seasonal feeding ground for part of their lives. Among the 14 species of sciaenids recorded from Chesapeake Bay proper (Musick, 1972), young-of-the-year of ten species of sciaenid fishes enter the York River (Fig. 1, a major Chesapeake estuary) and its tributaries in the course of a year. Among them *Leiostomus xanthurus, Micropogonias undulatus, Bairdiella chrysoura* and *Cynoscion regalis* are the most abundant species. *Menticirrhus saxatilis, M. americanus, Sciaenops ocellata, Cynoscion nebulosus, Pogonias cromis* and *Larimus fasciatus* are caught only occasionally.

Juvenile sciaenids, except croakers (*M. undulatus*), usually enter the York River in late spring and leave in late fall. During this period, young-of-the-year sciaenids dominate bottom trawl catches in the York River (Colvocoresses, 1975; Markle, 1976). The purpose of this study is to determine how these juvenile species coexist in the York River system, Virginia. Several ecological parameters are examined, including relative abundance, temporal and spatial distribution, length frequency, movement, and feeding habits. Morphological structures related to feeding habits and habitats are also examined. Specimens of the banded drum, *Larimus fasciatus* and the northern kingfish, *Menticirrhus saxatilis*, are included in the morphological structure and feeding habit studies to show the spectra of variation in juvenile sciaenids. The distribution and food habit studies are based on York River bottom trawl surveys conducted by the Virginia Institute of Marine Science from January, 1972 to December, 1974. A community study has been partially reported by Colvocoresses, et. al. (1975). Colvocoresses is currently preparing complete results of these surveys. Therefore, description of the sampling program, study area, hydrographic data and relative abundance are greatly simplified for the purposes of the present study.

The study area includes the York River and its major tributaries, the Pamunkey and Mattaponi rivers, an estuarine system which is relatively well known biologically, and is relatively undisturbed (Boesch, 1971). The general trend of geomorphology, hydrography (Salinity, dissolved oxygen and temperature), ecology and alteration by man of the area were described by McHugh (1967), Brehmer (1970) and Boesch (1971).

MATERIALS AND METHODS

1. Survey programs:

All fishes examined were collected from the York River system, Virginia. Seven longitudinal strata (A, B, C, D, C, F and G) and three cross-sectional strata (north shoal, channel and south shoal) within each stratum were sampled monthly (Fig. 1). Randomly numbered square grids (540 m = 600 yard on a side) were assigned as trawl stations. In the lower 16 km (10 miles) of the York River strata A, B, C and D were sampled from March 1972 to December 1974. The upper part of the York River was sampled from January 1972 to March 1974, but the random method was not used until June 1972 and the strata (E, F and G) were not designated until January 1973. One to 12 stations were randomly selected monthly after the random sampling methods were used. Before then, fixed channel station samples were set at 8 km (5 miles) intervals from the mouth of the York River (mile zero) up to 45 km (mile 28). Data from fixed station samples (January to May 1972) were combined within the strata for analyses. Lower portions of the Mattaponi and Pamunkey rivers have been sampled since January 1973. Three strata (1, 2 and 3) were set at 8 km (5 miles) intervals for the lower 24 km (15 miles) upstream from their confluence with the York River (about 45 km from the York River mouth). Four to six gridded stations (540 m on a side) were randomly sampled monthly from each stratum.

2. Gear:

Bottom trawl tows were against the current of five mintues duration with a 4.9 m (16 ft) semi-balloon otter trawl 7 m rope, 1.9 cm bar mesh, 0.63 cm bar mesh cod end liner), 7 m bridle, and 0.6 m weighted otter doors at a speed of approximately 90 m per minute. Nine stations were sampled monthly with beach seines along the shores of lower parts (strata A to D) of the York River (Fig. 1) and three replicate hauls were made with a 15.25 m (50 ft) bag seine (1.8 m deep with a square bag, 0.64 cm bar mesh in the wing and 0.48 cm bar mesh in the bag). Thirteen beach seine stations were selected along the shores of the upper part of the York River (strata E to G, Fig. 1). These stations were only sampled from July to October in 1972 and 1973 with a 30.5 m (100 ft) bag seine. Beach seine data are used only for length frequency analysis in the present study. Hydrographic (salinity, temperature and dissolved oxygen) data were collected from both surface and bottom water. Results are summarized in Figure 2 and the Appendix.

3. Sampling procedure:

All fishes were identified, counted and weighed in the field or laboratory. Total length, measured from snout of the fish to the middle of the caudal fin, was taken to the nearest milimeter. All individuals of each species were measured from each trawl haul, except for very large catches. Then at least 25 individuals were subsampled. Specimens for stomach analyses were randomly selected and preserved in 10% formalin, the stomachs were dissected and transferred to 40% isopropanol or 70% ethanol. Stomach contents were identified to the lowest practical taxon and the frequencies of occurrences were recorded.

The standard methods of Hubbs and Labler (1958) were used for all counts and measurements if applicable. Digestive tracts were removed from the fish and intestines were straightened with slight tension before measuring lengths from the junction of the intestine with the stomach to the anus. Osteological observations were made on cleared and stained specimens, prepared by Taylor's (1967) method.

RESULTS AND DISCUSSIONS

I. Hydrographic Description.

Data on the depth, temperature, salinity and dissolved oxygen samples during this study are given in Appendix. The benthic environment was of principal importance to the present study. The means of bottom temperature, salinity and dissolved oxygen of each stratum from May, 1972 to August, 1973 are summarized in Figure 2, to show seasonal patterns in the York River estuary.

Temperature:

The bottom water temperature of the York River (Fig. 2) was lowest in January and highest in July (1973) or August (1972). The gradual increase of temperature in April to June and the decrease in October to December are most important to the migratory fishes (Markle, 1976). In winter months (December to February), the bottom temperature of the upper portion of the York River (Fig. 2) was lower than that of the lower portion. No apparent differences in temperature were found among the shoal and the channel stations. In spring months (March to May), bottom temperatures increased rapidly, and the upper portion of the York River had slightly higher temperatures than the lower portion (Fig. 2). The shoal stations also showed a slightly higher mean bottom temperature than the channel stations. In summer months (June to August), the bottom temperature of the upper portion of the river was higher than the lower portion (Fig. 2). The shoal stations also showed a higher mean bottom temperature than the channel stations. In fall months (September to November), the bottom temperature decreased rapidly and the upper portion of the river had slightly higher temperatures than the lower portion in the early fall (September). In late fall (November), the bottom water temperature was slightly higher in the lower portion of the river (Fig. 2). No apparent differences were found among the shoal and channel stations.

Salinity:

The salinity decreases toward the upper portion of the York River (Fig. 2). Lower salinities usually are found in the spring (March to May) and the winter (December to February). The extremely low salinities of June to August, 1972, were caused by the hurricane Agnes (Fig. 2). The salinity at channel stations is usually higher than at shoal stations, especially in the lower portion of the river (Fig. 2) from March to June.

Dissolved oxygen:

The dissolved oxygen (D.O.) in the York River (Fig. 2) is generally lower in the warmer months (May to October) and higher in the colder months (November to April). In the warmer months, the D.O. was lowest at the deeper channel stations (Fig. 2). There was no apparent difference between the upper and lower portions of the York River. In the colder months the D.O. was slightly higher in the upper portion of the river (Fig. 2) and no apparent difference was found among shoal and channel stations.

II. Temporal and Spatial Distributions.

Young sciaenids are among the most abundant migratory finfishes in the York River (Massman, 1962; Colvocoresses, 1975; Markle, 1976). Temporal and spatial distributions of juveniles of the four most abundant scaienids, *Cynoscion regalis, Bairdiella chrysoura, Micropogonias undulatus* and *Leiostomus xanthurus* are compared here (Figs. 3 to 5) to determine ecological partitioning during their estuarine life. The relative abundance of each species is expressed by the geometric mean, $\log_{10}(\overline{x}+1)$, of the individual catches per tow within the substrata. Four months (July, October, January and April) were selected to represent the seasonal abundances from different parts of the York River (Fig. 3). Monthly mean catches per tow by river distance (strata) and depths (substrata) were compared (Figs. 3 to 5). Fishes caught from Mattaponi and Pamunkey rivers are compared only by river distance (Fig. 4).

In July (1972 and 1973), all four species of juvenile sciaenids were present in all parts of the estuary except the upper part (Figs. 3 to 5). The relative abundance (mean number of individuals per tow) varied among species (Fig. 3). *B. chrysoura* were more abundant in the lower and middle part of the river, while *C. regalis* and *M. undulatus* were more abundant in the upper part of the river. *L. xanthurus* were abundant in most parts of the river. *M. undulatus* showed a trend of gradual decline in abundance upstream in both the Mattaponi and Pamunkey rivers (Figs. 4 and 5). *L. xanthurus* catches were quite variable in the Pamunkey River. This may be caused by the contagious distribution of this species. Comparing depth distribution, sciaenids were more abundant in shoal stations (Fig. 3) than channel stations, especially in July 1972. Colvocoresses (1975) and Markel (1976) noted a general decline in the mean number of species and individuals of fishes per month in the summer from channel stations. This may be attributed to a reduction in the dissolved oxygen concentration at the bottom of the channel (Brehmer, 1970 and Markle, 1976) and was apparently the case in the present study (Fig. 2). Catches of *C. regalis* did not decline in channel stations, but this species is the best adapted for pelagic life of the four species studied (see sections on "Correlation of feeding structures and food habits").

In October (1972 and 1973) juveniles of all four species of sciaenids were present in all parts of the estuary (Fig. 3) and all reached their highest total abundance (Markle, 1976). *C. regalis* were more abundant in the lower parts of the York River. *B. chrysoura* and *L. xanthurus* were more abundant in the middle part of the river. *M. undulatus* were more abundant in the upper part of the river, and especially in the Mattaponi and Pamunkey rivers (Figs. 4 and 5). Mean catch per tow increased up estuary. Depth distribution of these four species of sciaenids indicated that they were more abundant in the channel stations (Fig. 3). The relative abundance at south shoal stations was higher than at north shoal stations. The area was larger and the sampling depth was greater in the south shoal than the north shoal area (see Appendix). Also, the average size of young sciaenids, especially the young-of-the-year groups, were larger in the channel than in the shoal stations (see section on "Length frequencies and distributions"). Larger sized juvenile sciaenids might use deeper areas to seek food and shelter.

In January (1972 to 1974), the numbers of individual sciaenid fishes were considerably reduced except for *M. undulatus* (Figs. 3 and 5). *C. regalis, B. chrysoura* and *L. xanthurus* were caught only sporadically. During the winter months, the resident fish species were more abundant than transients, especially in the upper tributaries of the York River (Markle, 1976). *M. undulatus* was the most abundant sciaenid fish in the middle part of the York River (Fig. 5). Depth distribution in January, 1973 (Fig. 3), indicated that most fish were caught in the channel. Bottom temperatures of the shoal stations were lower than channel stations (Fig. 2), which might be the major factor causing the concentration of young sciaenids in the channel.

In April (1972 to 1974), *C. regalis, M. undulatus* and *L. xanthurus* were caught (Figs. 3 and 5). *C. regalis* was caught sporadically in 1972 and 1974. *M. undulatus* were more abundant in the upper part of the river and *L. xanthurus* were more abundant in the lower reaches (Figs. 4 and 5), apparently because the young-of-the-year *L. xanthurus* had just entered the estuary (see section on "Length frequencies and distributions"). Depth distribution of these two species (Fig. 3) showed that they were more abundant in shoal areas, especially *M. undulatus*. *B. chrysoura* was completely absent.

The relative abundance of all major dominant fishes (including *C. regalis, M. undulatus* and *L. xanthurus*) are highly variable in the York River from year to year (Colvocoresses 1975 and Markle 1976). The comparisons here are not suitable for assessing the year class strengths of these sciaenid fishes.

III. Length Frequencies and Distributions.

Length frequency distributions (Figs. 6-19) indicate that juvenile *Leiostomas xanthurus, Bairdiella chrysoura, Cynoscion regalis* and *Micropogonias undulatus* enter the York River consecutively from April on, and all but *M. undulatus* leave the York River by December. Seasonal size distributions of these four species in the York River will be discussed individually and compared with studies from other areas.

Leiostomus xanthurus Lacépède

1. Early life history in the York River:

Young-of-the-year spot, *L. xanthurus,* entered the trawl and beach seine catches in early April and most left by December (Fig. 6, mode I). A few smaller fish stayed in the estuary over winter. Yearling spot usually entered the study area from March to May and left the area in September (Fig. 6, mode II). The intermediate mode (between mode I and II) on Figure 6, April and May 1972 was not found in 1973 and 1974 samples. This may indicate a late spawning in the previous year (1971). The length frequencies of young spot from May to July during 1972 to 1974 were pooled and grouped by river strata (Fig. 7). Young-of-the-year spot move up to the confluence of the Pamunkey and Mattaponi rivers (Fig. 1). Most yearling spot stayed in the lower parts of the York River. During the same periods, no differences were found between the length frequency distributions in both shoal and channel stations (Fig. 8) of either young-of-the-year or yearling spot.

Spot caught by beach seine (Fig. 8) were obviously smaller than those taken by trawls. Spot was the most abundant sciaenid in the beach seine zone (depth less than 1.5 m) for collections with the 15.25 m and 30.5 m seine. The length frequency distribution of spot caught by beach seine was typically unimodal; mostly young-of-the-year (Fig. 9). Some smaller yearlings were taken occasionally (Fig. 9, 1974, mode II) and individuals larger than 135 mm TL were captured only with the 30.5 m seine (Fig. 9, August and September, 1972).

In summary, young-of-the-year spot entered the York River in April and used the estuary as a nursery ground. In December, most spot left though some smaller fish stayed in the estuary through the winter, joining the yearlings as they returned to the river in the next spring. The yearlings left the estuary after an extended feeding period from March to October.

2. Other studies:

Selected length frequency data for spot along the Atlantic and Gulf of Mexico coasts of the U.S. are summarized (Table 1) for comparison with the present study. Hildebrand and Schroeder (1928) and Pacheco (1957 and 1962a) reported length frequency of spot from the present study area (York River and Chesapeake Bay). Across all areas (Table 1), young-of-the-year spot (Group 0 on Table 1) enter the estuarine nursery grounds during the first half of the year. Spot may enter estuaries as early as January (Table 1; Hildebrand & Cable, 1930; Springer and Woodburn 1960 and Sundararaj, 1960). Spot first enter the estuary in February on the Atlantic coast (Georgia, Music, 1974) and

Gulf of Mexico coast (Florida, Townsend, 1956; Louisiana, Dunham, 1972; Texas, Parker, 1971). In South Carolina (Dawson 1958), North Carolina (Shealy, et. al., 1974) and the lower Chesapeake Bay (Hildebrand and Schroeder, 1928 and present study) young-of-the-year spot first entered the estuary in April (Table 1). In upper Chesapeake Bay (Young, 1953) and Delaware River (Thomas, 1971), young-of-the-year spot probably do not appear until May (Table 1). The smallest young-of-the-year spot from trawl catches are about 15 to 20 mm TL in all areas. Which indicates that the young-of-the-year spot in northern areas enter the estuary later than southern ones. When spot first enter estuaries, gear selectivity (Table 1) affects the size ranges of spot captured; beach seines usually catch only the small specimens (Young, 1954 and Fig. 9), but pound nets (Pacheco, 1957) and large otter trawls (Music, 1974) usually catch larger fishes. Offshore movements of spot during the winter season are evident in all areas studied, because spot completely absent or in low abundance in inshore catches (Table 1). Yearling or older spot (Group I of Table 1) usually leave the estuary after September and do not return until spring of the next year (Table 1). Some young-of-the-year spot over-winter in the estuary (Fig. 6 and Table 1). Tagged spot (Pacheco, 1962b) have moved from the Chesapeake Bay to an area west of Diamond Shoals, North Carolina. Similarly, a spot tagged and released from Delaware Bay in October 1930 was recovered from Ocracoke Inlet, North Carolina in December, 1930 (Pearson, 1932). Thus, spot from these areas may have a common coastal feeding or spawning ground during the winter, although Struhsaker (1969) reported a winter offshore movement of spot into deeper water (lower-shelf habitat off South Carolina). These offshore spots may be a mixture of northern and southern populations or just southern residents. The late fall or early winter spawning time of spot appears to be the same in both Atlantic and Gulf waters (Welsh and Breder, 1923). Later spawning by a northern component is evidence in the length ranges of postlarvae and juvenile spot (Table 1). Young-of-the-year spot begin to enter the estuarine nursery grounds of Delaware, Maryland, Virginia, North and South Carolina during April (Table 1).

Cynoscion regalis (Bloch and Schneider)

1. Early life history in the York River:

Weakfish, *C. regalis*, showed distinct seasonal fluctuations. Young-of-the-year weakfish first entered trawl catches in July or August and virtually all left the estuary in the winter (Fig. 10, mode I). Yearling weakfish returned to the river in April or May and left in September or October (Fig. 10, mode II). Larger weakfish (two years or older) were caught only sporadically during this study because of gear avoidance. The length mode of small weakfish in August showed a rapid increase (Fig. 10). This increase may be due to the recruitment of yearlings or an earlier spawned group of young-of-the-year. Length frequencies for weakfish (under 250 mm TL) caught from August to October, 1972-1974, were pooled to compare distribution by size in the York River and its tributaries (Fig. 11). Smaller fishes were more abundant in the Pamunkey and Mattaponi rivers, than in the York River proper. Yearling weakfish also showed a movement up river (Fig. 11). This suggests that young weakfish entered the low salinity nursery ground (upper portion of the York River) and then moved down river as they grew. Pooled length frequency distributions revealed an apparent difference between shoal and channel areas of the York River (Fig. 12). Yearling weakfish (or larger ones) are proportionally more abundant in the channel. The 15.25 m beach seine catches contained no weakfish, but occasionally the 30.5 m seine caught some young-of-the-year weakfish in the summer.

2. Other studies:

Major populations of weakfish are confined to the Atlantic coast of the U.S. from the Gulf of Maine to Florida. Existing data indicate young-of-the-year weakfish enter estuarine or coastal catches from May to July (Table 2). The smallest sizes of the weakfish in the catches differ with area and may be due to gear and/or time of sampling. Small fishes with less size variation (about 5 mm) were taken over a longer period of time in southern areas than northern areas (Table 2). Young-of-the-year weakfish do not occur in catches during winter months in northern coastal areas or estuaries (Perlmutter, 1956; Massman et. al., 1958; Thomas, 1971; Markle, 1976). Year round catches of weakfishes from Beaufort, North Carolina (Hildebrand & Cable, 1934) and Georgia (Mahood, 1974) were from sounds and short coastal rivers. Most of the studies suggest the age Group 0 on Table 2 were a combination of young-of-the-year and yearlings. No distinct mode could be identified for young-of-the-year from these studies. This may be due to the multiple spawning of the females (Merriner, 1973) and/or the recruitment of the young-of-the-year from different spawning populations.

The reproductive biology weakfish is better known than other sciaenid fishes studied here. Welsh and Breder (1923) described the eggs and devělopment of weakfish and they also indicated the Delaware Bay as a spawning ground of weakfish. Merriner (1973) indicated that weakfish have an extended spawning season in North Carolina (March to August) and are characterized by high fecundity and possible multiple spawning by some females. Pearson (1941) took plankton tows of lower Chesapeake Bay from May to August in 1929 and 1930 and reported greater densities of weakfish (1.5 to 17 mm TL) in subsurface tows (average 67 per tow) than in surface tows (average 13 per tow). The density of planktonic weakfish decreased at those stations within Chesapeake Bay, compared with sites near the bay mouth. Harmic (1958) reported that newly hatched larval weakfishes averaged 1.8 mm TL. Soon after hatching, the larvae became demersal and were dispersed into the nursery areas of Delaware Bay by means of the "salt wedge". The smallest weakfishes taken in the bottom trawl were 6-10 mm TL (Hildebrand and Cable, 1934). The young-of-the-year weakfish in York River are probably progeny from adults spawning near the mouth of Chesapeake Bay. Weakfish tagged and released in lower Chesapeake Bay (Nesbitt, 1954) were later recovered to the north in New York and New Jersey, and southward in North Carolina. Nesbitt (1954), Perlmutter, et. al. (1956) and Harmic (1958) cited the presence of a northern spawning population in New York and northern New Jersey waters and a southern spawning population from New Jersey to North Carolina. Seguin (1960) found that morphometric and meristic variation of weakfish exists along the middle Atlantic coast and suggested that three possible population segments may exist; a New

York group, a Delaware and lower Chesapeake group and a North Carolina group. Joseph (1972) questioned the division of weakfish into northern and southern stocks and did not consider the decline of weakfish in Chesapeake Bay to be a result of the trawl fisheries in the shallow coastal waters and bays of North Carolina. Joseph (1972) also cited Chesapeake Bay as a major spawning area and nursery ground, but also cited failure to obtain one weakfish larva per tow in extensive VIMS ichthyoplankton studies during 1959-1963. As a result of the present study, I am not convinced that Chesapeake Bay is a major spawning area of weakfish even though weakfish eggs and larvae were reported by Hildebrand and Schroeder (1928), and Pearson (1941). I agree with Massmann's (1963) implication, that Chesapeake Bay weakfish are from southern spawning populations or stocks. No ripe female weakfish were caught from the lower Chesapeake Bay in present study. Pearson (1932) described the winter trawl fishery off North Carolina and cited higher total catches of weakfish from area B (southwest of Cape Hatteras) than from area A (northeast of Cape Hatteras) in deeper waters. I assume that most young-of-the-year and larger weakfish left the York River and moved southward to their wintering ground, off Cape Hatteras. In spring, weakfishes disperse from the wintering fround; some fish move north and spawning may occur from late spring to summer along the coast from North Carolina to New York.

Bairdiella chrysoura (Lacépède)

1. Early life history in the York River:

Silver perch, *B. chrysoura*, were present from April to December and were most abundant from August to October (Fig. 13). Total catches were reduced in 1973 and 1974. Young-of-the-year silver perch first entered the catches in July and most silver perch left the river in November. Yearlings may enter the river as early as April (Fig. 13, 1974) and most leave the river in October. There were no silver perch taken from January to March during the present study (1972-1974). Pooled length frequencies from August to October, 1972 to 1974, indicated that silver perch were most concentrated in the lower part of the York River (Fig. 14) and larger specimens tended to stay in the channel (Fig. 15). The 30.5 m beach seine caught young-of-the-year occasionally but the 15.25 m seine rarely caught any silver perch.

2. Other studies:

Silver perch occur along the U.S. coast from New York to Texas. The seasonal distribution pattern is similar in all Atlantic coastal states (Table 3). Young-of-the-year silver perch were first caught in bottom trawls during June or July. Size of the smallest young-of-the-year silver perch during a given month decreases as latitude of the nursery ground increases on the Atlantic coast and west coast of Florida (Table 3). Silver perch are present almost all year round south of Chesapeake Bay (Table 3), which may be due to the higher salinity or temperature of these study areas. The embryonic development of silver perch from Beaufort, North Carolina was described by Kuntz (1913). Welsh and Breder (1923) made further observations from material obtained at Atlantic City, New Jersey. Jannke (1971) described larval silver perch from the Everglades National Park, Florida and showed that the larvae of 2 to 3 mm "notochord" length were present all year round. Hildebrand and Schroeder (1928) reported ripe fish of both sexes in Chesapeake Bay (24 m deep, off Crisfield, Maryland). This indicated that silver perch spawn in the deeper waters of lower Chesapeake Bay in late spring and early summer but, because of its relatively small size, commercial catches of silver perch were relatively small. Silver perch might move oceanward or to the deeper part of the Chesapeake Bay in winter (Hildebrand and Schroeder, 1928).

Micropogonias undulatus (Linnaeus)

1. Early life history in the York River:

Young-of-the-year croaker, *M. undulatus*, first entered the trawl and beach seine catches in August and stayed in the York River throughout the winter (Fig. 16). They left the estuary between August and September of the following year as yearlings (Fig. 16, mode III). Large croaker (more than 1.5 years old) were caught only sporadically in this study due to gear avoidance, but they were present from February to September. There were apparently two to three length groups (modes) of young-of-the-year croaker in September (1972 to 1974). The mode II was different from mode I and mode III of 1972 and 1974 (Fig. 16). The former group did not stay in the York River over winter, they entered the estuary as early as May (Fig. 16, mode II) and most left in November.

Size may be a determining factor for migration of young croaker from the York River. From 1972 to 1974, the length frequencies (Fig. 16) indicate that very few young-of-the-year croakers larger than 130 mm TL stayed in the York River during the winter months. Young-of-the-year croakers were present in the York River in large numbers all year round except during the summer months (June to August). Young croakers showed slower growth rate over winter (Fig. 16). Those entering the estuary between September and November were the main strength of the year class (modes I of Fig. 16). Whether they represent progeny from a different spawning population compared to the earlier group (mode II of Fig. 16) is unknown at present.

Length frequencies of croakers taken between September and November, 1972-1974, were pooled to compare distribution by size in the York River (Fig. 17). The size composition indicated that smaller fish were caught in the upper part of the York River and saline portions of the Mattaponi and Pamunkey rivers. Larger fish were proportionally more abundant in the lower part of the river. Larger fish also constituted a larger portion of the croaker catch in the channel than in the shoal area (Fig. 18). Beach seines (Fig. 19) caught exclusively yearlings in the 30.5 m beach seine. The 15.25 m seine caught almost no croakers.

In summary, young-of-the-year croaker enter the estuary in May and from August on. The earlier group entered in May and left the estuary in November, as do older year classes. The later group (August-November) stay in the estuary until the summer months of the following year. Young croaker moved to the upper part of the York River and the saline portions of major tributaries after first entry, then move down the York River into more saline waters as they grew. Smaller fishes (less than 130 mm TL) stayed in the river throughout the winter.

2. Other studies:

Croaker occur from the Gulf of Maine to Argentina, along the coasts of the Atlantic and Gulf of Mexico. Length frequency distributions exsit for different areas of the U.S., including Wallace (1940) and Haven (1957) for the lower Chesapeake Bay and York River (Table 4). Studies usually show that small croakers (10-20 mm TL) were present in the estuary during all except the summer months (June to August). Croakers seemingly have a long spawning season since small individuals (<20 mm TL) were present from October to May in different estuarine areas (Table 4). Some croaker were very small (< 20 mm TL) in spring because of slow growth of fish spawned late in winter, or because they were spawned in spring. Such groups found in this study (mode II, Fig. 16) were not found in previous Chesapeake Bay studies. Tagging of adult croakers from Maryland and Virginia by Haven (1959) showed spring time movement of croaker up the estuaries and up the Chesapeake Bay, as well as an oceanward and southerly migration in fall (some recoveries were from off the North Carolina coast). Pearson (1932) reported a high percentage of croaker in the catches of the commercial trawl fishery during November (88%) and December (76%) from the fishing grounds off the North Carolina coast. Croaker may migrate out from the estuary to a southern coastal or offshore wintering and spawning ground. Hildebrand and Cable (1930) believed croaker spawning probably began in August in Chesapeake Bay and northward, in September at Beaufort (North Carolina), and in October in Texas. Croaker from all areas may have the same spawning period, probably from July to January (Table 4). A later group apparently spawning from March to May (mode II, Fig. 16) was found in the present study. White and Chittenden (1976) indicated that some croaker in the Gulf of Mexico may lack the first (overwinter) ring on the scales. This suggests that some croaker may spawn in the spring in the Gulf of Mexico.

Massmann and Pacheco (1960) reported the disappearance of young croakers from the York River but their conclusion may have been in error because of selectivity of their fishing gear. Haven's (1957) length frequencies for croaker during 1952 and 1953 differs from those presented by Massmann and Pacheco (1960) for the same years. No fish less than 100 mm TL were reported by Massmann and Pacheco (1960) and their gear was a net with three quarter inch mesh, whereas Haven (1957) used quarter inch mesh. Joseph (1972) attributed the decline of croaker in the commercial catches of the middle Atlantic coast to climatic trends. The apparent increase of juvenile croakers in 1973 and 1974 was probably due to the warmer winter months in those years. The main year class strength of croaker in the York River was dependent on the success of the late young-of-the-year group (Fig. 16, mode I). Because they stayed in the estuary through the winter. Milder winters probably were the most important factor determining the success of a given year class. VIMS York River trawl data showed mass mortalities of young-of-the-year croaker during cold winters (VIMS, Ichthyology Department, unpublished).

IV. Feeding Mechanisms.

Sciaenidae have the widest spectrum of feeding niches of any fish family in the Chesapeake Bay. The four most abundant species of sciaenids are *Cynoscion regalis, Bairdiella chrysoura, Micropogonias undulatus* and *Leiostomus xanthurus*. These species are most abundant in the estuary from late spring to fall, especially young-of-the-year and yearlings (Figs. 6 to 19). Under these conditions possible food resources may be limiting and division of feeding niches may have evolved in order to reduce competitive exclusion among the dominant species. Fishes that are closely related and show feeding niche segregation also often show morphological differentiation in the feeding apparatus in *Larimus fasciatus, Cynoscion regalis, Bairdiella chrysoura, Micropogonias undulatus, Menticirrhus saxatilis* and *Leiostomus xanthurus* to test the hypothesis that feeding niche division has evolved among those six species.

The feeding structures examined were mouth position and size, dentition, number of gill rakers and intestine length, which directly effect the size and kind of food ingested and digested. Other accessary structures examined, such as the pore and barbel system on the snout and/or lower jaw, the nares and body shape were more important in locating food. Morphological differentiation and adaptation of these structures was found to be correlated with feeding partitioning of these species.

Mouth Position:

Mouth position and size of the opening limit the size of prey and habitats in which the predator can effectively capture the prey. *Larimus fasciatus* have the most oblique mouth (Fig. 20,A) with the lower jaw projecting strongly in front of the nonprotrusible upper jaw. The maxilla (Fig. 21,A) is under the lateral margin of the rostral fold and its anterior end is firmly attached to the premaxilla and skull (dermethmoid). As the mouth opens, the distal ends of the premaxilla and maxillae push forward as the lower jaw is lowered (Fig. 20,A'). *Cynoscion regalis* have a large oblique mouth with the tip of the lower jaw projecting in front of the nonprotrusible upper jaw (Fig. 20,B). The anterior end of the maxilla is firmly attached to the premaxilla and articulates with the dermethmoid (Fig. 21,B). As the mouth opened, the posterior end of the premaxilla and the lower jaw move forward (Figs. 20,B'). *Bairdiella chrysoura* has a similar mechanism of jaw movement (Fig. 20,C'), but the mouth is only slightly oblique with the lower jaw about equal in length to the upper jaw (Figs. 20,C and 21,C). *Micropogonias undulatus* has an inferior mouth with the tip of the lower jaw enclosed by the protrusible upper jaw (Fig. 20,D). The anterior end of the maxilla is loosely attached to the premaxilla (Fig. 21,D). As the mouth is opened, the entire premaxilla and the lower jaw move anterio-ventrally (Fig. 20,D'). *Menticirrhus saxatilis* and *Leiostomus xanthurus* have a similar mechanism of jaw movement but their upper jaws seem more protrusible (Figs. 20,E' & F' and 21,E & F). In *M. saxatilis*, the mouth is inferior and the lower jaw is enclosed by the upper jaw (Fig. 20,E). *L. xanthurus* also has a small inferior mouth (Fig. 20,F).

The mouth position indicates that *L. fasciatus, C. regalis* and *B. chrysoura* are the pelagic feeders (Fig. 20,A, B & C) and that *M. undulatus, M. saxatilis* and *L. xanthurus* feed on the bottom (Fig. 20,D, E & F). The relative length of the premaxilliary and dentary bones decreases and the height of the anterior dorsal process of the premaxilla increased from fishes adapted to feed in mid-water to those adapted to feed on the bottom (Fig. 2). This trend is also evident in the relative mouth size (Fig. 21,a, b, c, d, e & f, Table 5). The index number, the length of the upper jaw multiplied by the length of the lower jaw then divided by head length, decreases as the species trends toward a bottom feeding habit.

In bottom feeders, *Micropogonias undulatus, Leiostomus xanthurus* and *Menticirrhus saxatilis*, have protrusible premaxillae (Figs. 20,D', E' & F' and 21,D, E & F). This can be advantageous in getting the mouth opening close to food that is to be sucked in from the bottom (Alexander, 1967). The mid-water feeders, *Larimus fasciatus, Cynoscion regalis* and *Bairdiella chrysoura*, have lost the protrusibility of premaxillae (Figs. 20,A', B' & C' and 21,A, B & C). *C. regalis* and *B. chrysoura* may compensate for this with faster swimming speed. Gero (1952) and Nyberg (1971) have discussed this aspect in detail. *Larimus fasciatus* differs from other sciaenids studied here. It may swim around with its mouth open and using its gill rakers as a filter similar to that of *Engraulis* (Gunther, 1962).

Dentition:

Teeth on the premaxila and dentary are important in capturing prey whereas the pharyngeal teeth are used for grinding and/or transporting food to the esophagus. In sciaenids, members of the genus *Cynoscion* usually have a pair of enlarged canine teeth at the tip of the upper jaw (Fig. 21,B). Other teeth are conical and present on narrow ridges of the premaxilla and dentary. The tips of the upper and lower jaws are broad and have several rows of teeth which decrease in number to a single prominent row in the narrower posterior portion of the jaws. Small teeth also develop inside the larger functional row of upper jaw teeth and outside the lower jaw teeth. *L. fasciatus* and *B. chrysoura* have a band of teeth similar to *C. regalis* but lack large canine teeth at the tip of the upper jaw (Fig. 21,A & C). *L. fasciatus* teeth are finer than those of *B. chrysoura*. *M. undulatus, L. xanthurus* and *M. saxatilis* have broad villiform bands of teeth on the premaxillae and dentaries and also lack canine teeth.

Pharyngeal teeth are generally conical in sciaenids (Fig. 22). The lower pharyngeal teeth form a pair of separate narrow tooth patches and are situated on the most medial pairs of ceratobranchial bones. The upper pharyngeal teeth are mainly formed by two pairs of patches on the two most medial pairs of epibranchial bones. The pharyngeal plates are relatively small and narrow in *Larimus fasciatus* and *Cynoscion regalis* compared to the other sciaenids examined (Fig. 22,A & B). The pharyngeal teeth of *L. fasciatus* and *C. regalis* are sharp, conical and directed backward but in *Bairdiella chrysoura* the pharyngeal teeth are blunt and the median ones are enlarged (Fig. 22,C). *Micropogonias undulatus* has much stronger and more enlarged pharyngeal teeth along the median rows (Fig. 22,D). *Leiostomus xanthurus* develops molariform teeth medially on the pharyngeal plates (Fig. 22,F). *Menticirrhus saxatilis* has fine and sharp pharyngeal teeth (Fig. 22,E).

The sequential morphological changes in pharyngeal teeth reflect the feeding niches differentation from mid-water to benthic.

Gill rakers:

Gill rakers on the branchial arches of fishes are important in protecting the delicate gill filaments from abrasion by ingested materials and may also be adapted to particular food and feeding habits (Nikolsky, 1963). In sciaenids, the gill rakers reflect feeding niches by their numbers, size and shape. They are found on the dorsolateral surface of the branchial arch (Fig. 22) and along the inner surface of the branchial arch. In sciaenids, the lateral gill rakers are well-developed only on the first gill arch and the inner (or medial) gill rakers occur only as tubercles on all five gill arches. Only the rakers on the first gill arch are discussed here.

Menticirrhus saxatilis and *Cynoscion regalis* have the fewest gill rakers (Table 6). *B. chrysoura* and *Micropogonias undulatus* have an intermediate number and *Leiostomus xanthurus* and *Larimus fasciatus* have the most gill rakers. Numbers of inner gill rakers (Table 6) follow a similar sequence. The relative size of the gill rakers and their morphology differ among species (Fig. 23). *L. fasciatus* has the longest and the most closely spaced gill rakers (Fig. 23,A). Each raker has many minute spicules scattered on it (Fig. 23,a). *C. regalis* and *B. chrysoura* have long gill rakers compared with the length of the gill filaments (Fig. 23,B & C). Numerous minute spicules are also present on each raker, especially on the basal portion of the raker (Fig. 23,b & c). *M. undulatus* has relative shorter gill rakers (Fig. 23,D) with seemingly strong serrations limited to the basal half of the raker (Fig. 23,d). The relative lengths of the lateral gill rakers in *M. saxatilis* and *L. xanthurus* are the shortest (Fig. 23, E & F) and lack strong spicules (Fig. 23,e & f). *L. xanthurus* has only slightly denticulated gill rakers and *M. saxatilis* has smooth gill rakers.

The inner gill rakers are knob-like, sometimes with spicules or teeth on their distal ends (Fig. 23,a', b', c', d', e' & f'). *C. regalis, M. undulatus* and *M. saxatilis* have broad, short inner gill rakers, with the height not longer than the width of the base. *C. regalis* and *M. undulatus* have prominent spicules at the distal ends of their inner gill rakers (Fig. 23,b' & d'). *M. saxatilis* lacks spicules on its inner gill rakers (Fig. 23,e'). *L. fasciatus, B. chrysoura,* and *L. xanthurus* have long inner gill rakers, with the height longer than the width of the base. *L. fasciatus* and *B. chrysoura* have prominent spicules at the distal ends of their inner gill rakers (Fig. 23,b' & c'). *L. xanthurus* has minute spicules on its inner gill rakers (Fig. 23,f'). Furthermore, in *L. fasciatus* a small inner gill raker is often present inbetween the larger inner gill rakers (Fig. 23,a'). This is rather common among western Atlantic sciaenids.

The lateral and inner gill rakers on the second to fifth gill arches are similar in size and structure to the inner gill rakers on the first gill arch. The gill arches of these six species also differ in the relative lengths of the epibranchial (upper) arm and ceratobranchial (lower) arm (Fig. 23). *L. xanthurus* has the shortest upper arm and *M. saxatilis* has the shortest lower arm. The numbers and size of the gill rakers indicate that mid-water feeders have lateral rakers longer than those of bottom feeders. The relative lengths of inner rakers are longer in fishes with higher numbers of lateral rakers, e.g. *L. fasciatus* and *L. xanthurus* (Fig. 23,a' & f' and Table 6). Although *M. undulatus* has the strongest spicules on the lateral gill rakers (Fig. 23,d), the mid-water feeders usually have better developed spicules on the lateral rakers than the bottom feeders (Fig. 23). The morphological differentiation of gill rakers seems to relate to the filter feeding habits in the water column. Higher numbers of rakers (both inner and lateral) suggest that the filtering mechanism is more important in these fishes.

Digestive tract:

The digestive tract of sciaenids includes four parts: esophagus, stomach, phloric caeca and intestine. The intestine usually has two loops (Fig. 24) except that of *Cynoscion regalis,* which is a straight tube from stomach to anus (Fig. 24,B). The relative position and size of the stomach and intestine vary with the amount of food present. The numbers of pyloric caeca and the relative length of the intestine may be correlated with the feeding habits (Suyehiro, 1942). The relative length of the intestine of these six species of sciaenid fishes (Table 7), may be grouped into three general categories. *C. regalis* has the shortest intestine. *Bairdiella chrysoura* has an intermediate intestine length. *Micropogonias undulatus, Leiostomus xanthurus, Larimus fasciatus,* and *Menticirrhus saxatilis* have a long intestine. The numbers of pyloric caeca (Table 8) in these six sciaenid fishes also show a similar trend. *C. regalis* has the least number of pyloric caeca, four to five. *B. chrysoura* and *M. saxatilis* have six to eight pyloric caeca, *M. undulatus* and *L. xanthurus* have seven to 10 pyloric caeca. *L. fasciatus* has 10 to 11 pyloric caeca. *L. fasciatus* and *L. xanthurus* have both a longer intestine and more pyloric caeca, but *L. fasciatus* is a mid-water feeder and *L. xanthurus* is a bottom feeder. They both have large amounts of small crustaceans in their diet. *C. regalis* has the shortest intestine and the fewest pyloric caeca, its diet is mainly composed of large crustaceans and fishes (see section "Food specialization"). Thus, the relative lengths of the intestine and the numbers of pyloric caeca in these sciaenids may be correlated with the size of the food rather than the feeding position in the water column, or their phylogenetic position (see part I of the whole study).

Pores and Barbels:

The mucus pores on the snout and the tip of the lower jaw, and mental barbels in fishes are sense organs probably involved in touch, taste, or both. The number and arrangement of the pores and barbels in sciaenid fishes are closely related to their feeding habitats (see Part I of the whole study). These six species of sciaenid fishes show a gradual increase in the number of pores from upper water column feeders to lower water column and bottom feeders (Fig. 25). *Larimus fasciatus* has five marginal pores on the snout and four pores at the tip of the lower jaw (Fig. 25,A & a). *Cynoscion regalis* has only two marginal pores on the snout and no pores or barbels on the lower jaw (Fig. 25,B & b). *Bairdiella chrysoura* has five marginal and five upper pores on the snout, and six mental pores at the tip of lower jaw (Fig. 25,C & c). *Leiostomus xanthurus* has five marginal and five upper pores on the snout, and five mental pores at the tip of the lower jaw (Fig. 25,F & f).

Micropogonias undulatus also has five marginal and five upper pores on the snout, and five mental and six minute barbels at the tip of the lower jaw (Fig. 25,D & d). *Menticirrhus saxatilis* has five marginal pores and three upper pores on the snout, and four mental pores and a short, rigid barbel at the tip of lower jaw (Fig. 25,E & e). An apical pore is also present on the barbel of *M. saxatilis*. The anterior margin of the snout (rostral fold) in *L. fasciatus* and *C. regalis* are complete without notches (Fig. 25,A & B). *B. chrysoura* and *L. xanthurus* have a similar indented rostral fold, although the former has a terminal mouth and the latter has an inferior mouth (Fig. 25,C & F). Both *M. undulatus* and *M. saxatilis* have deeply notched rostral folds (Fig. 25,D & E), correlated to their inferior mouth positions. The mental pores of *L. fasciatus* (Fig. 25,a) are the smallest of these sciaenids. The barbels of *M. undulatus* and *M. saxatilis* may differ in function as well as to number, because the single barbel of *M. saxatilis* has a pore at the tip, whereas barbels of *M. undulatus* do not (Fig. 25,d & e). The numbers of pores increase as the feeding niche of the fish tends toward the bottom and barbels are present only in the bottom feeders.

Nares:

Sciaenid fishes have two pairs of closely set nostrils. The anterior one is usually round; the posterior one is oval and elongate (Fig. 26). A flap of skin is sometimes also present along the posterior margin of the anterior nostil in bottom feeding species. The nasal cavity is generally oval shaped with a cluster of olfactory laminae forming a nasal rosette anteriorly (Fig. 26). *Larimus fasciatus* has the shortest nasal cavity (Fig. 26,A) and *Leiostomus xanthurus* has the longest (Fig. 26,F). The shape of the nasal rosettes and olfactory laminae are similar in these six species of sciaenid fishes. The mean number of laminae (averaging both sides per specimen and rounding upward) differs among these species (Table 9) and is variable within a species. The numbers of laminae are 13 to 14 in *L. fasciatus*; 14 to 22 in *Cynoscion regalis*; 16 to 31 in *L. xanthurus* and 18 to 19 in *Menticirrhus saxatilis*. *L. fasciatus, C. regalis,* and *B. chrysoura* average fewer laminae than *M. undulatus, L. xanthurus* and *M. saxatilis* (Table 9). Within a species, the number of nasal laminae seems higher in larger specimens. The number of nasal laminae is greater in bottom feeding fishes.

Other Morphological Characters:

Differences in body shape, mouth structure, food specialization and habitat preferences of fishes may act to restrict interspecific competition within a fauna (Keast and Webb, 1966). The six species of sciaenid fishes discussed here show a correlation between body shape and feeding habitat (Fig. 27). Young *Larimus fasciatus* are oblong, and relatively deep and have a compressed body and a pointed tail (Fig. 27,A). These features, in combination with a strong oblique mouth and large eyes (Fig. 20,A & A' and Table 5) indicate that *L. fasciatus* is a moderate swimmer that feeds in the upper water column by sight. Young *Cynoscion regalis* have a fusiform and compressed body, and a long pointed tail, (Fig. 27,B). These features, in combination with a large oblique mouth and relatively large eyes (Fig. 20,B & B' and Table 5) indicate that *C. regalis* is a fast swimmer that feeds in the upper water column by sight. Young *Bairdiella chrysoura* have an oblong and compressed body, and a broad and slightly rounded to truncate tail (Fig. 27,C). These features, together with its terminal mouth and relatively large eyes (Fig. 20,C & C' and Table 5) indicate that *B. chrysoura* is a moderate swimmer that feeds in the middle water column. Young *Micropogonias undulatus* have an elongate and less compressed body and a long pointed tail (Fig. 27,D). These features, combined with an inferior mouth with barbels and relatively smaller eyes (Fig. 20,D & D' and Table 5), indicate that *M. undulatus* is a moderate swimmer that feeds in the lower water column by sight, olfaction and touch. The young of *Leiostomus xanthurus* have a rather short and deep body, and a broad and truncate tail (Fig. 27,F). These features, combined with an inferior mouth and large eyes (Fig. 20,F & F' and Table 5), indicate that *L. xanthurus* is a slow swimmer that feeds in the lower water column by sight and olfaction. Young *Menticirrhus saxatilis* have an elongate, round and narrow body, and a relatively pointed tail (Fig. 27,E). These features, combined with an inferior mouth with a pored-barbel (Fig. 25,e) and relative smaller eyes (Table 5) indicate that *M. saxatilis* is a slow swimmer that feeds in the lower water column by sight, olfaction, and touch.

The cross sections of these young sciaenid fishes (Fig. 27) also indicate their habitat. *L. fasciatus, C. regalis,* and *B. chrysoura* are compressed and have relatively narrow ventral surfaces (Fig. 27,A, B & C) in comparison to *M. undulatus, L. xanthurus* and *M. saxatilis* (Fig. 27,D, E & F). Some of these morphological characters such as the shape of the tails and the size of the eyes vary ontogenetically. Generally, most juvenile sciaenids have pointed tails and relatively larger eyes than adults.

V. Food Specialization:

The food habits of young sciaenids have been studied by numerous authors and the information reported by them is scattered and presented in different ways. Some of this work has been summarized for comparison with the present study (Tables 10 to 14). Only those studies having some sort of quantitative analysis were chosen for the comparison. Different authors have used different taxonomic catagories to analyze their information. The classification of the food items in the present study has been modified from Darnell (1961) and Qasim (1972). Six major food groups were employed more or less according to their vertical occurrence in the water column, from the upper water column to the bottom. They were fishes, macrozooplankton, microzooplankton, epibenthos, infauna and other organic matters. Within each food group, several items were listed and the trivial and generic names of the primary prey species in the study area were indicated. The boundaries for these six food groups are not definite, because some prey taxa move vertically in the water column and some taxa may also include both pelagic and benthic species in parts of the water columns. Generalized terms used by many authors such as shrimps, annelids, mollusks, crabs, et. al. were placed under respective food groups for the convenience of comparison. The food habits of each species were compared with previous studies from different geographic areas and seasons. Food items were listed in different catagories for each species. Under each listed item, there were cases where more than a single food taxon was listed by the original authors. Then the one that had the highest frequency (by occurrence, volume, or weight) was chosen to represent that item.

All fish specimens used for stomach analyses in this study were randomly selected from specimens collected in June to November (1972 to 1974). During this period, these sciaenids reach their maximum abundance and degree of sympatry. All specimens were young-of-the-year or yearlings.

Larimus fasciatus:

In this study, stomachs of 12 specimens of *L. fasciatus* (14 to 125 mm TL) were examined. All stomachs contained crustaceans, exclusively: *Neomysis americana* in seven stomachs, Cumacea in five, Amphipoda (mostly *Gammarus*) in four and calanoid copepoda (mostly *Acartia tonsa*) in two. Most of these prey species were of small size.

Published information on food habits of *L. fasciatus* was scarce. Welsh and Breder (1923) reported on food of four *L. fasciatus* (50-110 mm SL) from Mississippi and Texas. Only two stomachs had food, one with a post-larval clupeoid and the other with "schizopodous forms" (crustacean remains).

Cynoscion regalis:

In this study, stomachs of 36 specimens (67-183 mm TL) of *C. regalis* were examined (Table 10). They fed only on *Anchoa mitchilli* and *Neomysis americana*. *A. mitchilli* was very abundant in the same area as *C. regalis* in the same months (Colvocoresses, 1975; Markle, 1976). Fishes and planktonic crustaceans were the major food items of *C. regalis* (Table 10). A shift of food habits with growth was noted by Thomas (1971), Merriner

(1975), and Stickney et. al. (1975). The smaller weakfish fed more on mysid shrimp and the larger weakfish fed more on fishes.

Bairdiella chrysoura:

In this study, stomachs of 68 specimens (57-190 mm TL) of *B. chrysoura* were examined (Table 11). They fed mainly on *Neomysis americanus* and *Anchoa mitchilli*. Juvenile *B. chrysoura* fed mainly on crustaceans and fishes (Table 11). Smaller specimens (less than 40 mm SL) fed mostly on copepods but as they grew they fed more on *Neomysis americanus*, amphipods and other larger crustaceans. Fishes became more important food items for specimens over 70 mm SL (Thomas, 1971; Carr and Adams, 1973; Stickney, et. al., 1975).

Micropogonias undulatus:

In this study, stomachs of 69 specimens (65-199 mm TL) of *M. undulatus* were examined (Table 12). They showed as wide a variety of prey items as have previous studies from other geographic areas (Table 12). Polychaetes and crustaceans were the main food items of the juvenile *M. undulatus* in the study area. Juvenile *M. undulatus* fed on a large variety of invertebrates and sometimes fishes (Table 12). Stickney, et. al. (1975) indicated that smaller specimens (less than 100 mm SL) depend extensively on hapacticoid copepods, which were mainly bottom dwellers. As the fish grew, they became more generalized feeders (Parker, 1971). Geographic variation in food habits of juvenile *M. undulatus* (Table 12) probably is attributable to availability of food species in the area.

Menticirrhus saxatilis:

In this study, stomachs of 20 specimens (36.5-118 mm TL) of *M. saxatilis* were examined. They all had crustaceans in the stomach and polychaetes were also important in their diet. The occurrence of organic detritus was also frequent. This suggests that *M. saxatilis* is a bottom feeder. Juvenile *M. saxatilis* also feed mainly on crustaceans and polychaetes (Table 13). Welsh & Breder (1923) indicated that *M. saxatilis* fed mainly on relatively large crustaceans.

Leiostomus xanthurus:

In this study, stomachs of 77 specimens (73-205 mm TL) of *L. xanthurus* were examined. Although they showed a wide variety of food species, the major part of the food was benthic. *Pectinaria gouldii*, a burrowing polychaete, was a major food item in the diet of *L. xanthurus* in the study area. This indicated that *L. xanthurus* not only feeds on the bottom but also on infauna. Juvenile *L. xanthurus* fed mostly on benthic invertebrates (Table 14). Stickney, et. al. (1975) chosed that harpacticoid copepods were the main food for juvenile *L. xanthurus* and that seasonal variations in diet were slight. Organic detritus and unidentified remains were also common in stomachs (Table 14).

To summarize the feeding habits of the juveniles of the six sciaenid species, a chart (Fig. 28) had been prepared for six food groups defined previously. The main food group of *Larimus fasciatus* was mostly planktonic (Fig. 28) and the primary food species was *Neomysis americana*. *Cynoscion regalis* and *Bairdiella chrysoura* fed mainly on fishes and macrozooplankton (Fig. 28), the primary food species were *Anchoa mitchilli* and *N. americana,* respectively. *Micropogonias undulatus* fed on a wide variety of food including all six food groups (Fig. 28), with the dominant food organisms *N. americana* and *Nereis succinea*. *Menticirrhus saxatilis* fed mainly on macrozooplankton and epibenthos (Fig. 28), with the primary food organisms being *N. americana* and polychaetes. *Leiostomus xanthurus* also fed on a wide variety of food including five food groups (Fig. 28). The dominant food organisms were *N. americana* and *Pectinaria gouldii*. Food specialization or selectivity of the fishes *per se* does not seem sufficient to indicate food partitioning among them.

Neomysis americana was a very abundant and available food item to all species of sciaenids in the study area. This shrimp migrates vertically in response to change in ambient light (Herman, 1963). *N. americana* is negatively phototactic. In shallow turbid water (as in the study area) during daylight it might concentrate near the bottom in the darkest sector of the vertical light gradient (Stickney, et. al. 1975). Because of the abundance and availability of *N. americana*, the other prey items should provide a better indication of feeding specialization. As has been repeatedly shown (Tables 10 to 14), most fishes were sufficiently opportunistic in their food habits to take advantage of extremely abundant prey species. All the fishes in the present study were sampled by bottom trawl during the daytime. Therefore, both the prey and predators might have been dwelling close to the bottom.

Polychaetes were also the major food resources for the bottom feeders (Tables 12 to 14); *Micropogonias undulatus, Leiostomus* *xanthurus* and *Menticirrhus saxatilis*. But, *M. undulatus* fed more on the "crawling" species of worms (Table 12) such as *Nereis* and *Nephthys* (Barnes, 1969) and *L. xanthurus* fed more on "tubiculous" or "burrowing" species of worms (Table 14) such as *Pectinaria* and *Amphitrite*. This is contradictory to the findings of Roelofs (1954) and Stickney et. al. (1975). Observations of the feeding behavior of these two species in the aquarium agreed with Roelofs (1954). But, *L. xanthurus* seemed to "dive" into the bottom sand much more often than *M. undulatus,* and the depth of the "dives" by *L. xanthurus* was not shallower than *M. undulatus* as stated by Roelofs (1954).

VI. Correlation of Feeding Structures and Food Habits.

Larimus fasciatus and *Cynoscion regalis* have oblique mouths (Fig. 20,A & B) and their upper jaws are slightly or not protrusible (Fig. 21,A & B). These features allow them to feed anteriorly and dorsally to the longitudinal axis of their bodies along their swimming course. Their mouth opens as the lower jaw drops anterio-ventrally and the distal ends of the premaxillae move forward (Fig. 20,A' & B'). The mouth openings of *L. fasciatus* and *C. regalis* are relatively larger than in the other species studied (Table 5). The anterior views of their mouth openings (Fig. 21,a, a', b & b') show that the upper jaws (premaxillae) are larger or equal to the lower jaws (dentaries). Although both of them feed "anterio-dorsally and pelagically" they did show differences in diet (Fig. 28). The following morphological characters are correlated with the dietary differences. The premaxillary and dentary teeth of both species are sharp and ridge-like. *C. regalis* has much larger teeth than *L. fasciatus* (Fig. 21,A & B) especially a pair of large canines at the tip of upper jaw in *C. regalis*. These large sharp teeth are adaptations for grasping larger swimming prey. Both species have small sharp pharynegeal teeth (Fig. 23,A & B). The arrangement and size of the gill rakers (Fig. 23,A & B) in *L. fasciatus* are much denser and longer than those of *C. regalis*. These differences reflect the food contents in the stomachs of *L. fasciatus*, which consisted of small crustaceans collected by the filtering function of the gill rakers. The stomach contents of *C. regalis* consisted of large crustaceans and fishes (Table 10). *L. fasciatus* has a much longer two-looped intestine than the straight intestine of *C. regalis* (4 to 5).

These morphological differences are probably correlated with the size of food ingested. The pore systems of *C. regalis* and *L. fasciatus* are not well-developed. *C. regalis* has only two marginal pores on the snout (Fig. 25,B) whereas *L. fasciatus* has five marginal pores on the snout and four pores on the tip of the lower jaw (Fig. 25,A). In addition, the fusiform *C. regalis*(Fig. 27,B) is adapted for fast swimming and active predation. The robust, and presumably slower joving *L. fasciatus* (Fig. 27,A) is probably better adapted for a plankton picking type of feeding (Davis & Birdsong, 1973).

Bairdiella chrysoura has a slightly oblique terminal mouth (Fig. 20,C) and a slightly protrusible upper jaw (Fig. 20,C'). These features allow the fish to feed directly in front of its body axis along its swimming course. Its mouth opens as the lower jaw drops anterio-ventrally and the premaxillae move forward (Fig. 20,C'). The relative size of the mouth opening in *B. chrysoura* (Table 5) is similar to *L. fasciatus* and *C. regalis*. The anterior view of its mouth opening shows equal upper and lower jaws (Fig. 20,c'). Although *B. chrysoura* feeds "anteriorly", a "median" pelagic feeder, its stomach contents are similar to those of *C. regalis* (Fig. 28) except for a smaller proportion of fishes. The difference in the morphology of feeding structures may also give a clue to food partitioning between *B. chrysoura* and *C. regalis*. The jaw teeth of *B. chrysoura* are strong, conical and arranged in narrow ridges, but lacks a pair of canines at the tip of the premaxilla (Fig. 21,C). Its pharyngeal teeth are relatively stronger and blunter than in *C. regalis* (Fig. 22,C), especially along the median rows. Gill rakers of *B. chrysoura* are intermediate between *L. fasciatus* and *C. regalis* in number (Table 6) and length (Fig. 23,C). The intestine of *B. chrysoura* has two loops and its relative length and number of pyloric caeca (6 to 8) are also intermediate between *L. fasciatus* and *C. regalis* (Fig. 24,C and Tables 7 & 8). These intermediate features reflect the intermediate feeding habits of *B. chrysoura* (Fig. 28). In addition, the body shape of *B. chrysoura* is oblong (Fig. 27,C) and not fusiform as in *C. regalis,* thus resulting in slower swimming and less efficiency in capturing fishes, as reflected in the diet. The relatively well-developed pore systems of *B. chrysoura* (Fig. 25,C), three upper and five marginal pores on the snout and six mental pores on the tip of the lower jaw, also may indicate that *B. chrysoura* depends more on "taste" and "touch" than "sight" feeding lower in the water column than *L. fasciatus* and *C. regalis*.

Micropogonias undulatus, Leiostomus xanthurus and *Menticirrhus saxatilis* have inferior mouths (Fig. 20,D, E & F) and rather protrusible premaxillae (Fig. 20,D', E' & F'). These features enable them to feed "anteriorly and ventrally" to their body axis along their swimming courses. Their mouths open as the lower jaw drops ventrally backward and premaxillae protrudes antero-ventrally (Fig. 20,D', E' & F'). Their mouth openings are relatively smaller than the pelagic feeders described previously (Table 5). The anterior views of their mouth openings (Fig. 20,d, e & f) show that the upper jaws (premaxillae) are smaller than the lower jaws (dentaries). Although they all feed antero-ventrally, and benthically, there are differences in their feeding habits (Fig. 28). These differences are reflected in the structural differences in the feeding apparatus and feeding behavior among them. The jaw teeth of *M. undulatus, L. xanthurus* and *M. saxatilis* are all in bands and the outer row of teeth in the upper jaw and the inner row of teeth in the lower jaws are slightly enlarged. The pharyngeal teeth of *M. undulatus* and *M. saxatilis* are conical (Fig. 22,D & E) and the median rows are larger and blunt. *L. xanthurus* has smaller pharyngeal teeth and the median ones are molariform (Fig. 22,F). The gill rakers of these three bottom feeding sciaenids differ in number (Table 6) and size (Fig. 23,D, E & F). *M. saxatilis* has the fewest and shortest gill rakers among them. *M. undulatus* has fewer but longer gill rakers than *L. xanthurus*. The inner gill rakers of *L. xanthurus* (Fig. 23,f') are best developed, and most numerous (Table 6). This is reflected in the larger amounts of small crustaceans (e.g. copepods), ingested by *L. xanthurus* (Table 14). The relative length of intestines (Table 7) and *in situ* position (Fig. 24,D, E & F) are similar among benthic feeders. The average relative intestinal length of *M. undulatus* and *M. saxatilis* is slightly shorter than in *L. xanthurus* (Table 7). The intestine of *L. xanthurus* is much thinner than in *M. undulatus* and *M. saxatilis*, and the food is visible through the intestinal wall. *L. xanthurus* is the only sciaenid fish in the study area with a completely black peritoneal lining. The numbers of pyloric caeca of these bottom feeders are similar (Table 8). The pore and barbel system differ among *M. undulatus, L. xanthurus* and *M. saxatilis*. They all have five upper and five marginal pores on the tip of snout (Fig. 25,D, E & F). *M. undulatus* and *M. saxatilis* also have a deeply notched rostral fold. Ventrally, *M. undulatus* has five pores and six miniature barbels (Fig. 25,d); *M. saxatilis* has four pores and a short rigid barbel with an apical pore (Fig. 25,e); *L. xanthurus* has five pores and no barbel (Fig. 25,f). *M. saxatilis* also has the most pronounced snout and most elongate and rounded body form (Fig. 27,E). *L. xanthurus* has the least pronounced snout and shortest and deepest body form (Fig. 27,F). *M. undulatus* is intermediate in snout and body form between *M. saxatilis* and *L. xanthurus*.

The length of snout and body form reflect the feeding habits of these three species. Food habits (Fig. 28) indicate that *M. saxatilis* and *M. undulatus* feed on the substrate, on the epifauna, more than they feed "into" the substrate on the infauna. *L. xanthurus* feeds more on the infauna. The long projecting snout seems to be an obstacle for fishes with an inferior mouth to forage into the bottom for food. Roelofs' (1945) observations on feeding behavior of *M. undulatus* and *L. xanthurus* in aquaria with sandy bottoms were repeated during the present study. Juveniles of both species foraged into the bottom sand often, especially when the substrate was freshly dug from the beach. Foraging tapered off gradually, especially in *M. undulatus*, apparently as the food in the substrate decreased. Brine shrimp (*Artemia*) were fed to these two species in the aquarium. Both *M. undulatus* and *L. xanthurus* were able to feed on brine shrimp just below the water surface. *M. undulatus* fed on the surface shrimp in an oblique to vertical position. To feed on brine shrimp close to the surface, *L. xanthurus* occasionally maneuvered in an oblique upside down position, with the dorsal fin pointing toward the bottom to overcome its inferior mouth position.

Other accessory organs of feeding, such as the nares and eyes also reflect the feeding habits of young sciaenid fishes. The numbers of nasal laminae of the six species (Table 9) overlap due to ontogenetic changes. The absolute number of the nasal laminae increase as the fishes grow larger. The upper ends of ranges in number (Table 9) are most important, as they indicate the highest number of nasal laminae each species may develop. Generally, the bottom feeders, *M. undulatus* and *L. xanthurus*, have more nasal laminae than *L. fasciatus, C. regalis* and *B. chrysoura* (Table 9). *M. saxatilis* has relatively fewer nasal laminae than other benthic feeders, but it has a pored mental barbel on the lower jaw. This may suggest that *M. saxatilis* depends more on "touch" sense for foraging than other benthic feeders. The relative eye size of *M. saxatilis* is smaller than in other sciaenid fishes studied here (Table 5). Larger eye sizes are found among the pelagic feeders, *L. fasciatus, C. regalis* and *B. chrysoura* (Table 5). Allometrically, the relative eye size of all these sciaenid fishes is larger in young specimens and smaller in adults. For benthic feeders, decrease in relative eye size with growth is faster than for the pelagic feeders. The relative roles of olfaction, touch and vision in feeding in young sciaenids studied may be hypothesized as follows. The benthic feeders, *M. undulatus, L. xanthurus* and *M. saxatilis* depend more on their senses of "smell" or "touch" or both to locate their prey. The pelagic feeders, *L. fasciatus, C. regalis* and *B. chrysoura* depend more on their senses of "sight" to catch their prey, especially in *C. regalis* and *B. chrysoura* which prey on *Anchoa mitchilli*, an active small anchovy.

Morphological differences in the feeding apparatus, especially the mouth position, size and protrusibility, the form of teeth and the gill raker structure are limiting factors for the habitat and the size of the prey species which can be eaten by the fish. Evidently, the off-bottom feeders, *L. fasciatus, C. regalis* and *B. chrysoura* almost completely lack any sedentary benthos in their diets (Fig. 28). Even among the bottom feeders, *M. undulatus* feeds more on epibenthic polychaete species (Table 13) and *L. xanthurus* feeds more on the burrowing polychaete species (Table 14).

Morphological differences of the digestive tract, the number of pyloric caeca and the length of intestine may be an adaptation to more efficient use of food already ingested. As is evident in *L. fasciatus* and *L. xanthurus*, size of the food items is important, *L. fasciatus* fed exclusively on small crustaceans (small Mysidacea and Amphipoda); *L. xanthurus* fed mainly on copepods (Table 14). *L. fasciatus* is mainly a pelagic feeder and *L. xanthurus* is mainly a benthic feeder. Both species have longer intestines (Table 7) and more pyloric caeca (Table 8) than other species in their respective groups (pelagic and benthic).

The so-called "selective feeding habits" of these young sciaenids reported by many previous authors (see citation of Tables 10-14) are not evident in the present study. Partitioning of food among these young sciaenids depends more on the habitats of the prey species than on the "selective preferences" of the fishes. These juvenile sciaenids feed opportunistically in a limited depth range in the water column, probably within or close to two meters above the bottom. Within this layer of the water column, *Larimus fasciatus, Cynoscion regalis,* and *Bairdiella chrysoura* feed in the upper portion of the water column and *Micropogonias undulatus, Leiostomus xanthurus* and *Menticirrhus saxatilis* feed in the lower portion of the water column to the bottom. The difference in habitat preference of juvenile sciaenids from York River was also demostrated by Cooke (1974).

Feeding niche division and resulting dietary differences among these species of sciaenids in the Chesapeake estuary area are attributable to differences in feeding behavior imposed upon these species by adaptive morphological limitations rather than to selective feeding *per se*.

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Table 1. Growth of Spot, *Leiostomus xanthurus*, from different estuarine areas along U.S. Atlantic and Gulf of Mexico coasts.

Author	Thomas, 1971		Young, 1953		Hildebrand & Schroeder, 1928	
Locality	Delaware River, Delaware		Chesapeake Bay, Maryland		Chesapeake Bay	
Period	1969 (June 1968 to Sept. 1970)		May to October 1951		Prior to 1928	
Gear*	16 ft T & S		75 x 4 ft Haul S.		?	
Source	Table 68		Tables 4 & 5		Table on p. 273	
Length (mm)	Total length		Total length		Total length	
Age groups*	O	I	O	I	O	I
January						75-149
February						
March					15-19	
April					20-24	
May			16-60		15-74	155-174
June	19.2		26-80		20-99	115-174
July	30-80	90-140	(26-130)		40-124	135-209
August	45-100	110-165	86-90		65-149	
September		120-170	86-106		94-170	190-209
October		125-175	(71-155)		100-184	190-299
November					75-184	
December					75-119	

* Gear: G, gill net; P, pound net; Pl, plankton net; Pu, push net; R, rotenone; S, seine; T, trawl; Tr. trammel net.

Age groups: O represents smallest group of young-of-the-year first taken from January on, other fishes (including overwintering young-of-the-year) are included in age group I. Parentheses indicate that the boundary of age 0 and I groups is indistinguishable.

Table 1. (continued, growth of *Leiostomus xanthurus*)

Author	Pacheco, 1957		Chao, 1976		Hildebrand & Cable, 1930	
Locality	Lower Chesapeake Bay & York River, Virginia		York River, Virginia		Beaufort, North Carolina	
Period	May 1955 to Feb. 1956		Jan. 1972 to Dec. 1974		Prior to 1930	
Gear*	P & 30 ft T		16 ft T & S		Pl & T	
Source	Table 3		Fig. 6 (present study)		Tables 7 & 8	
Length (mm)	Total length		Total length		Total length	
Age groups*	0	I	0	I	0	I
January		155-255		95-175	4-21	82-195
February		150-275		70-140	3-27	91-200
March				90-160	10-39	93-200
April			15-65	95-185	7.5-54	84-214
May	80-105	130-225	20-95	95-225	11-94	97-215
June	115-(140)	(145)-210	25-105	140-235	29-119	122-198
July	115-(150)	(155)-230	35-155	155-235	43-127	130-228
August	125-(180)	(200)-245	55-(175)	(160)-250	67-139	140-219
September	135-(185)	(190)-260	70-185	230	81-153	155-234
October	135-(235)		80-(195)	(170)-240	92-170	175-269
November	165-(205)		80-185	(160)-240	90-188	190-264
December	155-185	220-240	75-190		1.5-9.2	84-188

Table 1. (continued, growth of _Leiostomus xanthurus_)

Author	Shealy, et. al., 1974		Music, 1974		Townsend, 1956	
Locality	South Carolina		Georgia		Alligator Harbor, Florida	
Period	Feb. 1973 to Jan. 1974		Oct. 1970 to Sept. 1973		March 1955 to May 1956	
Gear*	20 ft T		40 ft T , 12 ft S , 300 ft G		150 & 600 ft S	
Source	Table 27		Fig. 10		Table I	
Length (mm)	Total length		Total length		Total length	
Age groups*	O	I	O	I	O	I
January		88-207		80-250		
February		83-142	10-35	85-225	10-34	95-159
March		113-182	10-40	95-225	15-54	105-175
April	18-52	107-162	15-75	95-280	20-74	105-184
May	23-82	88-147	30-100	120-260	20-89	125-189
June	33-(132)		40-130	135-270	60-89	145-164
July	23-(152)		45-(170)	(170)-280	60-99	145-159
August	48-117	153-157	45-(175)	(175)-280	75-99	165-169
September	73-132	148-152	65-150	150-265	100-109	
October	78-127		80-150	150-250	70-124	145-169
November	78-127		75-115	120-250	85-129	
December	83-147	168-192	65-95	100-260		

Table 1. (continued, growth of *Leiostomus xanthurus*)

Author	Springer & Woodburn, 1960		Sundararaj, 1960		Dunham, 1972	
Locality	Tampa Bay, Florida		Lake Ponchartrain, Louisiana		Coast, Louisiana	
Period	Jan. to Dec. 1958		July 1953 to May 1955		July 1969 to June 1972	
Gear*	T, 80 ft S & Pu		T , Tr & S,R		16 ft T	
Source	Table 13		Fig. 17		Fig. 21	
Length (mm)	Standard length		Total length		Total length	
Age groups*	O	I	O	I	O	I
January	13-31		15-25	90-165		100-170
February	13-49		15-40	115-165	10-80	110-170
March	10-73		10-75	140-230	20-100	110-170
April	19-79		30-100	140-255	40-110	
May	25-85		45-120	(120)-240	50-125	
June	31-103		55-145	150-255	50-155	
July	48-118		40-160	165-250	20-155	
August	49-103		85-(180)	(180)-215	70-160	
September	52-82		95-(150)	(150)-210	90-170	210
October	52-97		90-150	170-190	120-160	
November	67-91		110-(170)	(170)-205	100-180	
December	76-109		135-165		70-180	

Table 1. (continued, growth of Leiostomus xanthurus)

Author	Nelson, 1969		Parker, 1971		Pearse, 1928	
Locality	Mobile Bay, Alabama		Galveston Bay, Texas		Subine River to Rio Grande, Texas	
Period	May 1963 to April 1964		Jan. 1963 to Dec. 1965		March 1926 to May 1927	
Gear*	16 ft T		4.0 m. T		Tr , T , S & G	
Source	Table 9		Table 2		Table 31	
Length (mm)	Total length		Total length		Total length	
Age groups*	O	I	O	I	O	I
January		75-160		60-170		
February		90-125	30	70-180		
March		90-180	10-30	60-190		
April	45-70	90-165	10-70	90-160	10-90	120-250
May	45-(125)	(130)-171	30-100	110-190	40-120	130-250
June	50-140	170-180	30-110	140-190	70-(150)	(150)-230
July	55-145	200	30-140	170	80-140	150-230
August	80-135		30-150	170-180	110-(220)	230-270
September			30-160		110-(240)	250-260
October	95-(190)		50-160		110-(170)	(170)-260
November	95-165		60-150		130-190	200-250
December	90-175	200	70-180		130-190	200-250

Table 2. Growth of Weakfish, *Cynoscion regalis* from different estuarine areas along U. S. Atlantic coast.

Author	Thomas, 1971		Pearson, 1941		Chao, 1976	
Locality	Delaware River, Delaware		Lower Chesapeake Bay		York River, Virginia	
Period	1969		1929-1930		Jan. 1972 to Dec. 1974	
Gear*	T & S		Pl & P		16 ft T	
Source	Table 4		Fig. 23		Figs. 10 to 12 (present study)	
Length (mm)	Total length		Total length		Total length	
Age groups*	O	I	O	I	O	I
January						60-200
February						315
March						
April				130-250		65-175
May						155-330
June	5-70					140-385
July	15-125		20-(150)		20-55	105-305
August	15-(185)		30-(160)		10-(95)	100-370
September	70-(185)			(130)-180	70-(110)	115-300
October	40-(175)				35-(135)	140-325
November					65-(140)	140-205
December					95-(170)	

*Gear: P, pound net; Pl, plankton net; S, seine; T, trawl.

Age group: 0 represents smallest groups of young-of-the-year taken from January on, other fishes (including overwintering young-of-the-year) are included in age group I. Parentheses indicate that the boundary of age 0 and I groups is indistinguishable.

Table 2. (continued, growth of *Cynoscion regalis*)

Author	Hildebrand & Cable, 1934		Shealy et. al., 1974		Mahood, 1974	
Locality	Beaufort, North Carolina		South Carolina coast		Georgia coast	
Period	?		Feb. 1973 to Jan. 1974		Oct. 1970 to Sept. 1973	
Gear*	Pl , P & T		20 ft T		40 ft T.	
Source	Table 4		Table 32		Table 7	
Length (mm)	Total length		Total length		Total length	
Age groups*	O	I	O	I	O	I
January		75-204		138-327		68-438
February		105-274				68-388
March		90-230		155		83-358
April		80-284		118-188		78-408
May	4-9	125-224				48-358
June	4-44	95-279	23-47	72	13-(128)	(133)-328
July	4-(39)	40-379	23-(52)	(53)-187	18-(173)	(178)-363
August	4-(64)	65-369	23-(72)	(73)-182	23-(203)	(208)-323
September	10-(79)	80-314	23-(67)	(68)-208	18-(213)	(218)-388
October	45-(94)	100-329	28-(72)	(73)-228	28-(223)	(228)-313
November	45-(99)	(100)-329	68-72	78-702	48-(233)	(238)-348
December	85-(94)	(95)-299	88-92	108-197	53-(233)	(238)-348

Table 3. Growth of silver perch, *Bairdiella chrysoura*, from different estuarine areas along U.S. Atlantic and Gulf of Mexico coasts.

Author	Thomas, 1971		Chao, 1976		Hildebrand & Cable, 1930	
Locality	Delaware River, Delaware		York River, Virginia		Beaufort, North Carolina	
Period	1969		Jan. 1972 to Dec. 1974		Spring 1926 to Summer 1927	
Gear*	16 ft T		16 ft T		Pl & T	
Source	Table 28		Figs. 13 to 15 (present study)		Tables 5 & 6	
Length (mm)	Total length		Total length		Total length	
Age groups*	0	I	0	I	0	I
January						74-204
February						90-209
March						98-204
April						93-195
May				85-200	1-6	85-204
June	5-20			145-185	1-38	110-210
July	5-65		20-60	120-190	9-76	105-224
August	45-100		15-85	100-205	20-92	130-204
September	70-120		65-135	160-210	45-122	135-189
October	65-130		60-135	160-220	73-115	145-224
November			70-155	210	68-143	150-229
December			73-110		78-124	

*Gear: Pl, plankton net; Pu, puchnet; S, seine; T, trawl.

Age groups: 0 represents smallest group of young-of-the-year first taken from January on, other fishes (including overwintering young-of-the-year) are included in age group I. Parentheses indicate that the boundary of age 0 and I groups is indistinguishable.

Table 3. (continued, growth of *Bairdiella chrysoura*)

Author	Shealy et al. 1974		Springer & Woodburn, 1960		Reid, 1954	
Locality	South Carolina coast		Tampa Bay, Florida		Cedar Key, Florida	
Period	Feb. 1973 to Jan. 1974		Oct. 1957 to Dec. 1958		June 1950 to May 1951	
Gear*	20 ft T		T, S & Pu		15 ft T , S & Pu	
Source	Table 42		Fig. 12		Fig. 10	
Length (mm)	Total length		Standard length		Standard length	
Age groups*	O	I	O	I	O	I
January	18-(72)	93-182		67		55-60
February		88-137		52-76		
March		98-172		67-73		65-95
April		73-182				
May		113-152	13-25		5-40	84-110
June		123-132	16-52		15-50	
July	33-87	128-192	16-70		20-70	
August	58-107	143-172	16-82		5-80	
September	73-132	138-177	25-85		10-82	
October	78-(187)		28-91		40-95	
November	98-(172)		19-97		50-70	
December	98-(182)		46-106			

Table 4. Growth of Croaker, Micropogonias undulatus, from different estuarine areas along U.S. Atlantic and Gulf of Mexico coasts.

Author	Thomas, 1971		Haven, 1957		Chao (1976)	
Locality	Delaware River, Delaware		York River, Virginia		York River, Virginia	
Period	June 1968 to Dec. 1970		Oct. 1952 to July 1953		Jan. 1972 to Dec. 1974	
Gear*	16 ft T		30 ft T		16 ft T & S	
Source	Table 70		Fig. 7		Figs. 16 to 19 (present study)	
Length (mm)	Total length		Total length		Total length	
Age groups*	0	I	0	I	0	I
January			15-(85)	(95)-105		20-120
February			10-60	(45)-100		20-155
March			10-(70)	(70)-120		20-175
April			10-(65)	70-100		25-120
May			25-(90)	70-140	20-30	(20)-240
June			40-(120)	(120)-155	20-70	(60)-245
July			75-145	(135)-175	30-(110)	(80)-250
August			N.S.	N.S.	30-(90)	(70)-240
September			N.S.	N.S.	10-(100)	(70)-195
October	20	135-140	10-(40)	(40)-85	10-(110)	(100)-250
November	25		15-(60)	(60)-115	15-100	(60)-250
December	20-50		10-(60)	(60)-120	20-110	165-175

*Gear: Pl, plankton net; S. seine; T. trawl.

Age group: 0 represents smallest group of young-of-the-year first taken from January on, other fishes (including overwintering young-of-the-year) are included in age group I. Parentheses indicate that the boundary of age 0 and age I groups is indistinguishable. N.S.; no sample.

Table 4. (continued, growth of *Micropogonias undulatus*)

Author	Hildebrand & Cable, 1930		Shealy, et. al., 1974		Hoese, 1973	
Locality	Beaufort, N. C.		Coast South Carolina		Georgia, coast	
Period	Spring 1926 to Summer 1927		Feb. 1973 to Jan. 1974		Aug. 1956 to Aug. 1966	
Gear*	T & Pl		20 ft T		30 & 40 ft T	
Source	Tables 9 & 10		Table 22		Fig. 12	
Length (mm)	Total length		Total length		Total length	
Age groups*	O	I	O	I	O	I
January	3-24	25-269	18-97	108-297	10-80	120-130
February	3-29	40-294	28-82	113-187	20-80	
March	2-24	40-294	13-102	123-173	20-80	110-120
April	25-19	100-259	18-(132)	138-192	40-100	
May	8-25	195-239	28-112		20-110	
June		31-284	33-142		50-140	200-210
July		43-234	28-(182)		60-140	
August		66-289	53-177		90-160	190-200
September	2-9	80-279	78-182		60-150	
October	2-50	98-294	68-182		100-180	
November	1.5-66	85-284	43-153			
December	2.5-69	85-259	48-163	183-197		

Table 4. (continued, growth of *Micropogonias undulatus*)

Author	Hansen, 1969		Suttkus, 1955		Parker, 1971	
Locality	Pensacola, Florida		Lake Pontchatrain, & Louisiana Coast		Galveston Bay, Texas	
Period	Aug. 1963 to Dec. 1965		July 1953 to Oct. 1954		Jan. 1963 to Dec. 1965	
Gear*	5 m T		T & S		4.9 m T	
Source	Fig. 2		Table 1		Fig. 21	
Length (mm)	Total length		Total length		Total length	
Age groups*	O	I	O	I	O	I
January	15-20	45-95	10-79	120-189	10-(80)	90-200
February	20-25	40-95	10-89	130-179	10-(90)	(90)-250
March	15-35	75-85	20-119	120-259	10-(90)	(100)-250
April	N.S.	N.S.	20-129	130-339	10-(120)	(130)-250
May	20-(75)	(60)-135	30-139	140-319	10-(130)	(130)-240
June	30-(95)	(90)-150	30-139	140-329	40-(140)	(156)-250
July	35-(90)	(90)-145	50-159	160-380	30-(150)	(160)-230
August	35-(110)	(100)-150	80-169	170-319	60-160	170-250
September	40-(90)	(90)-150	80-169	170-319	60-(170)	(170)-190
October	45-(110)	(110)-150	90-189	(170)-349	10-40	60-220
November	50-105		20-59	130-309	10-(60)	60-210
December	10-95		10-79	120-299	10-(70)	70-230

Table 5. Relative size of mouth and eye diameter in six species of juvenile sciaenids from York River.

Species	SL (mm)	Index of mouth size				SL (mm)	Eye diameter in % of SL			
		Range	$\bar{x}$	S.D.	N.		Range	$\bar{x}$	S.D.	N.
Larimus fasciatus	55.3-107	3.17 -5.90	4.634	0.957	20	55.3-107	7.38- 9.84	8.602	0.672	21
Cynoscion regalis	35.2- 75.3	1.929-3.54	2.827	0.518	22	35.2- 82.4	8.20-11.45	9.55	0.782	26
Bairdiella chrysoura	38.4- 76.2	1.76 -3.08	2.494	0.431	17	30.0- 75.3	8.27-10.82	9.407	0.677	20
Micropogonias undulatus	35.5-116	1.20 -2.41	1.686	0.325	30	35.5-116	6.45- 9.46	7.850	0.837	30
Menticirrhus saxatilis	29.2- 99.6	0.50 -1.37	0.957	0.264	30	29.2- 99.6	6.03- 8.56	7.043	0.644	30
Leiostomus xanthurus	47.4-146	0.77 -2.64	1.472	0.477	30	47.4-163	7.05-11.11	9.139	0.889	46

* Index of mouth size = (upper jaw length x lower jaw length) / head length.

Table 6. Total number of lateral and medial gill rakers in six species of juvenile sciaenids from York River.

Species	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	N	$\bar{x}$
<u>Menticirrhus</u> <u>saxatilis</u>						6	11	9	3	1											30	12.04
(29.2-99.6 mm SL)	[5	20	4		1]																[30	6.73]
<u>Cynoscion</u> <u>regalis</u>										1	8	13	13	2							37	17.19
(35.2-75.3 mm SL)			[1		4	10	8	2	2]												[27	11.40]
<u>Micropogonias</u> <u>undulatus</u>														1		3	16	15	7		42	22.55
(35.5-116 mm SL)									[2	8	16	4]									[30	15.73]
<u>Bairdiella</u> <u>chrysoura</u>																2	3	13	14	1	33	24.27
(38.4-75.3 mm SL)								[1	2	5	6	6]									[20	15.70]

Species	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	N	$\bar{x}$
<u>Leiostomus</u> <u>xanthurus</u>												4	7	6	12	9	13	3	1				55	32.29
(47.4-148 mm SL)						[1	1	4	9	7	14	6	2]										[44	27.18]
<u>Larimus</u> <u>fasciatus</u>																		5	9	5	2	1	22	38.00
(55.3-107 mm SL)	[1	1	5	7	4	2	1]																[21	21.04]

[ ] medial gill rakers

Table 7. Relative length of intestine in six species of juvenile sciaenids from York River.

Species	SL (mm)	Intestine length in % of SL			
		Range	$\bar{x}$	S.D.	N.
Cynoscion regalis	35.2-152	35.5-49.6	40.24	3.07	36
Bairdiella chrysoura	30.0-151	46.1-64.1	55.34	5.92	30
Micropogonias undulatus	35.5-145	52.3-88.6	65.57	6.56	39
Menticirrhus saxatilis	29.2- 91.2	56.6-88.2	76.06	6.67	26
Larimus fasciatus	35.3- 99.8	73.1-97.7	83.87	9.08	14
Leiostomus xanthurus	47.4-166	73.6-97.8	84.69	6.95	30

Table 8. Number of pyloric caeca in six species of juvenile sciaenids from York River.

Species	4	5	6	7	8	9	10	11	N	$\bar{x}$
Cynoscion regalis	20	14							34	4.41
(35.2-82.4 mm SL)										
Bairdiella chrysoura			8	20	1				29	6.76
(30.0-75.3 mm SL)										
Menticirrhus saxatilis			11	19					30	6.63
(29.2-99.6 mm SL)										
Micropogonias undulatus				1	25	11			37	8.27
(35.5-116 mm SL)										
Leiostomus xanthurus				6	13	8	1		28	8.14
(47.4-148 mm SL)										
Larimus fasciatus							9	6	15	10.4
(55.3-107 mm SL)										

Table 9. Number of laminae in olfactory rossettes in six species of juvenile sciaenids from York River.

Species	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	N	$\bar{x}$
<u>Larimus fasciatus</u> (55.3-107 mm SL)		3	5	2	5																		15	12.6
<u>Cynoscion regalis</u> (35.2-86.4 mm SL)			1	6	6	4	7	5	1	2	1	1	2										36	15.89
<u>Bairdiella chrysoura</u> (30.0-75.3 mm SL)			2	2	2	8	4	6	2	6	3			1		1							37	16.81
<u>Micropogonias undulatus</u> (35.5-116 mm SL)	1	1			3	3	4	3	3		2	1	2	3	2		2	1	1	1		1	34	19.53
<u>Menticirrhus saxatilis</u> (29.2-99.6 mm SL)		1			1	6	6	3	3	6	3	2	1										32	17.3]
<u>Leiostomus xanthurus</u> (47.4-148 mm SL)							1	2	4	4	3	2	7	6		1	5	1			1		37	21.70

Table 10. Stomach contents of weakfish, *Cynoscion regalis* from different estuarine areas along U.S. Atlantic coast.

Author	Chao, present study	Welsh & Breder, 1923			
Locality	York River, Virginia	Acushnet River, Massachusetts	Cape Charles, Virginia	Winyah Bay, South Carolina	Fernandina, Florida
Period	June to Aug. 1973	Sept. 1882	Sept. 1916	July 1915	March 1920
Source	Original	p. 159	p. 160	p. 161	p. 161
Number of specimens	36	28	45	34	105
Empty stomachs	2	5	0	5	74
Length of specimens	70-183 mm TL	7-11 cm SL	43-11.5 cm SL	2.8-6.2 cm SL	5-17 cm SL
Quantitative Method	% of Occurrence	% of volume	% of volume	% of volume	% of volume
Fishes					
Anchoa mitchilli	72.2				
Others & remains	8.3	48.0	2.0	9	18
Macrozooplankton					
Mysid sp.	2.8				
Neomysis americana	63.9				
Isopoda		0.5		6	
Decapoda (shrimps)		47.0	0.5		46
Others & remains			91.0	83	18
Microzooplankton					
Copepoda			3.5	2	
Calanoid sp.					
Others & remains					
Epibenthos					
Polychaeta		0.5			
Neris succinea					
Amphipoda			3.0		
Gammarus sp.					
Others & remains					
Unidentified remains	5.6	4.0			18

Table 10. (continued, stomach contents of *Cynoscion regalis*)

Author	Thomas, 1971				
Locality	Delaware River, Delaware				
Period	June 1969	July 1969	Aug. 1969	Sept. 1969	Oct. 1969
Source	Table 20	Table 20	Table 20	Table 20	Table 20
Number of specimens	71	94	94	120	66
Empty stomachs	10	11	10	18	12
Length of specimens	11-76 mm TL	5-123 mm TL	15-180 mm TL	20-180 mm TL	61-180 mm TL
Quantitative method	% of occurrence	% of occurrence	% of occurrence	% of occurrence	% of occurrence
Fishes	7.0*	14.9*	16.0*	33.3*	34.8*
Anchoa mitchilli	1.4	2.1	1.1	3.3	4.5
Others & remains	2.8	7.4	13.8	12.5	30.3
Macrozooplankton					
Mysid sp.	74.6	59.6	65.8	66.7	
Neomysis americana					
Isopoda		4.3	2.1	1.7	
Decapoda (shrimps)		2.1	3.2	6.7	10.6
Others & remains					
Microzooplankton					
Copepoda	19.7	4.3	2.1	3.3	
Calanoid sp.					
Others & remains	9.9	4.3	1.1	0.8	1.5
Epibenthos					
Polychaeta					
Neris succinea					
Amphipoda					
Gammarus sp.	9.9	58.5	58.5	28.3	28.8
Others & remains					
Unidentified remains					

* All fishes combined

Table 10. (continued, stomach contents of <u>Cynoscion regalis</u>)

Author	Merriner, 1975		Stickney, et. al., 1975	
Locality	Pamlico sound & Morehead City, North Carolina		Savannah River & Ossabow sound, Georgia	
Period	June 1967 to Jan. 1970		May 1972 to July 1973	
Source	Table 1		Table 1	
Number of specimens	2159		120	
Empty stomachs	1342		35	
Length of specimens	135-481 mm SL		30-169 mm SL	
Quantitative method	% of occurrence	% of volume	% of occurrence	
Fishes				
Anchoa mitchilli	58.1	15.6	2.5	
Others & remains	15.7	74.0	31.7	
Macrozooplankton				
Mysid sp.			0.8	
Neomysis americana	31.0	0.9	55.0	
Isopoda			2.5	
Decapoda (shrimps)	0.1		2.5	
Others & remains	1.5	1.2		
Microzooplankton				
Copepoda			5.0	
Calanoid sp.			2.5	
Others & remains				
Epibenthos				
Polychaeta	0.5			
Neris succinea			15.0	15
Amphipoda			2.5	2.5
Gammarus sp.			1.7	1.7
Others & remains	1.5	0.1	9.2	9.2
Unidentified remains	96.8	8.2	2.5	2.5

Table 11. Stomach contents of silver perch, *Bairdiella chrysoura* from different estuarine areas along U.S. Atlantic and Gulf of Mexico coasts.

Author	Chao, present study	Thomas, 1971	Welsh & Breder, 1923
Locality	York River, Virginia	Delaware River, Delaware	Cape Charles, Virginia
Period	June to Aug. 1973	Aug. to Oct. 1969	Sept. 1916
Source	Original	Table 46	P. 174-175
Number of specimens	68	99	21
Empty stomachs	10	9	0
Length of specimens	57-153 mm TL	5-130 mm TL	6-8.2 cm TL
Quantitative method	% of occurrence	% of occurrence	% of occurrence
Fishes		12.1*	
Anchoa mitchilli	5.1	3.0	
Others & remains	20.7	8.1	1
Macrozooplankton			
Mysid sp.	1.7	89.9	
Neomysis americana	74.1		
Isopoda	1.7	1.0	
Decapoda (shrimp)	10.3	17.2	5
Others & remains	1.7		87
Microzooplankton			
Copepoda			
Others & remains			
Epibenthos			
Annelida (polychaete)	3.5		2
Neris succinea	3.5		
Cumacea	1.7		
Amphipoda	1.7	15.2	5
Gammarus sp.	3.5	62.6	
Crabs		3.0	
Others & remains	1.7		
Infauna (bivalve & nemaloda)	3.5		
Unidentified Remains	6.9	2.0	

* All fishes combined

Table 11. (continued, contents of *Bairdiella chrysoura*)

Author	Stickney, et. al., 1975	Reid, 1954		Carr & Adams, 1973
Locality	Savannah River & Ossabow sound, Georgia	Cedar key, Florida		Crystal River, Florida
Period	May 1972 to July 1973	June 1950 to May 1951		Oct. 1970 to Aug. 1971
Source	Table 1	Table 5		Estimate from Fig. 9
Number of specimens	161	45	6	195
Empty stomachs	48	0	0	43
Length of specimens	30-149 mm TL	25-99 mm SL	100-130 mm SL	5-130 mm TL
Quantitative method	% of occurrence	% of occurrence		% of occurrence
Fishes				
Anchoa mitchilli	2.7			
Others & remains	6.6	4.4	16.6	31.2
Macrozooplankton				
Mysid sp.	0.6			
Neomysis americana	25.1			
Isopoda	1.1			
Decapoda (shrimp)	5.5	73.3	33.3	51.6
Others & remains	8.2	4.4	66.6	
Microzooplankton				
Copepoda	3.9	4.0		
Others & remains	2.2			
Epibenthos				
Annelida (polychaete)	0.6	2.2		7.3
Neris succinea	8.2			
Cumacea				
Amphipoda	2.2	33.3	16.6	9.2
Gammarus sp.	6.0			
Crabs	8.2		16.6	
Others & remains	0.6	6.6		
Infauna (bivalve & nemaloda)				
Unidentified Remains				8

Table 12. Stomach contents of croaker, Micropogonias undulatus from different estuarine areas along U.S. Atlantic and Gulf of Mexico coasts.

Author	Chao	Thomas, 1971	Roelofs, 1954	Welsh & Breder, 1923	
Locality	York River, Virginia	Delaware River, Delaware	Coast, North Carolina	Winyah Bay South Carolina	Cape Canaveral Florida
Period	June to Aug. 1973	Nov. to Dec. 1970	All seasons 1950	July 1915	Dec. 1919
Source	Original	Table 71	Table 1	P. 184	P. 183
Number of specimens	69	25	159	37	24
Empty stomachs	5	3	?	0	6
Length of specimens	56-199 mm TL	23-50 mm TL	60-140 mm TL	4.2-6.2 cm SL	
Quantitative method	% of occurrence	% of occurrence	% of occurrence	% of volume	
Fish & Remains	20.3		3.1	0.7	
Macrozooplankton					
Mysidace	3.1	64.0	5.7		
Neomysis americana	35.9				
Isopoda	1.6	4.0			
Decapoda (or shrimp)	9.4		3.1	7.0	24.0
Insecta	1.6				
Others & Remains	3.1			7.0	
Microzooplankton					
Copepoda	3.1	76.0	25.2		
Calanoid	10.9				
Harpacticoid					
Ostracoda					
Others & Remains	6.3		4.4	2.0	

Table 12. (continued, stomach contents of Micropogonias undulatus)

Author	Chao	Thomas, 1971	Roelofs, 1954	Welsh & Breder, 1923 Winyah Bay	Welsh & Breder, 1923 Cape Canaveral
Epibenthos					
Annelids (or polychaets)	67.2		89.9	29.0	3.0
Neris succinea	18.8				
Glycinde solitaria	9.4				
Phyllodocid	1.6				
Spionid	6.3				
Cumacea	4.7			2.0	
Amphipoda	21.9		5.7		
Gamanarus sp.	7.9				
Crabs	3.1			1.8	
Others & Remains	6.3			1.0	2.5
Infauna					
Pectinaria gouldii	15.6				
Ampharetid	1.6				
Gastropoda	1.6				
Pelecypoda			11.3		
Nematoda			0.6		
Others & Remains					
Unidentified Remains & Organic Matters	23.5		4.4	22.0	48.0

Table 12. (continued, stomach contents of <u>Micropogonias undulatus</u>)

Author	Stickney, et. al., 1975	Hansen, 1969	Parker, 1971 Lake Pontchartrain, Louisiana		Parker, 1971 Clear Lake, Texas	
Epibenthos						
Annelids (or polychaets)	12.4	61.5	17.0	6.5	6.0	7.0
Neris succinea	3.0					
Glycinde solitaria						
Phyllodocid						
Spionid	1.0					
Cumacea	6.0					
Amphipoda	8.0		4.0	4.5	5.0	16.0
Gamanarus sp.	9.5					
Crabs	4.5		17.0	10.0	16.0	10.5
Others & Remains	7.0		17.0	18.5	22.0	18.0
Infauna						
Pectinaria gouldii						
Ampharetid						
Gastropoda						
Pelecypoda	2.5	3.5#	9.0#	3.0#	18.0#	18.0#
Nematoda		0.3				
Others & Remains	1.5					
Unidentified Remains & Organic Matters	35.6	2.5	17.0	14.0	12.0	9.0

* Arthropods
# Mollusks

Table 12. (continued, stomach contents of *Micropogonias undulatus*)

Author	Stickney, et. al., 1975	Hansen, 1969	Parker, 1971			
Locality	Savannah River & Ossabow Sound, Georgia	Pensacola, Florida	Lake Pontchartrain, Louisiana		Clear Lake, Texas	
Period	May, 1972 to July, 1973	Aug. 1963 to Dec. 1965	Jan. 1963 to Dec. 1965			
Source	Table 1	Table 5	Table 28			
Number of specimens	196	2520	63	44	1866	475
Empty stomachs	15	?	2	6	194	15
Length of specimens	39-180 mm SL	76-173 mm TL	10-74 mm TL	75-124 mm TL	10-96 mm TL	70-110 mm TL
Quantitative Method	% of occurrence	% of volume	% of occurrence			
Fish & Remains	7.5	15.9	11	9	4	5
Macrozooplankton		14.3*				
Mysidace	1.0		5	4.5	2	2
Neomysis americana	16.9					
Isopoda	1.0		6.5	8.0	10.5	18.0
Decapoda (shrimp)	3.0		17.0	18.5	19.5	14.5
Insecta	0.5		3	18.5	13.0	20.0
Others						
Microzooplankton						
Copepoda	7.0		2.0	6.5	1.0	3.0
Calanoid	1.0					
Harpacticoid	10.0					
Ostracoda	0.5		8.0	12.0	9.0	8.0
Others & Remains						

Table 13. Stomach contents of northern kingfish, *Menticirrhus saxatilis*, from different estuarine areas along U.S. Atlantic coast.

Author	Chao	Welsh & Breder, 1945	
Locality	York River, Virginia	Cape May, New Jersey	Falmouth, Massachusetts
Period	March 1972 to Dec. 1974	August, 1916	August, 1892
Source	Original	p. 194	p. 194
Number of specimens	20	21	17
Empty Stomachs	0	0	4
Length of Specimens	37-118 mm TL	1.9-7.2 cm SL	2.4-7.4 cm SL
Quantitative Methods	% of Occurrence	% of Volume	% of Volume
Macrozooplankton			
Neomysis americana	35.0		
Isopoda		5.0	
Decapoda (shrimp)		9.0	42.0
Crangon septemspinosa	5.0		
Palaemonetes	10.0		
Insecta	5.0		
Others & remains	70.0	9.0	42.0
Microzooplankton			
Copepoda	5.0		
Calanoid	5.0		
Others & remains			
Epibenthos			
Polychoete	70.0	19.0	
Glycindae solitaria	10.0		
Spionids sp.	15.0		
Amphipoda	35.0	30.0	
Gammarus sp.	15.0		
Others & remains	40.0		
Unidentified Remains & Organic Matters	50.0	26.0	16.0

Table 14. Stomach contents of spot, Leiostomus xanthurus from different estuarine areas along U.S. Atlantic and Gulf of Mexico coasts.

Author	Chao	Roelofs, 1954	Stickney, et. al. 1975
Locality	York River, Virginia	North Carolina	Savannah River & Ossabow Sound, Georgia
Period	June to Aug. 1973	All Season, 1950?	May 1972 to July 1973
Source	Original	Table 1	Table 1
Number of specimens	77	73	126
Empty stomachs	4	0	7
Length of specimens	73-202 mm TL	60 to 140 mm TL	50 to 149 mm SL
Quantitative method	% of occurrence	% of occurrence	% of occurrence
Fish & Remains	8.2	6.8	5.0
Macrozooplankton			
Mysidace	8.2	4.1	
Neomysis americana	27.4	7.4	
Isopoda	2.7		
Decapoda (or shrimp)	1.4	5.5	0.8
Insecta	2.7	1.4	1.7
Others & Remains	1.4		0.8
Microzooplankton			
Copepoda	21.9	100	
Cyclopoid	19.2		
Calanoid	13.7		33.1
Harpacticoid	20.5		88.4
Ostracoda		2.7	5.8
Others & Remains	1.4	6.8	7.4

Table 14. (continued, stomach contents of *Leiostomus xanthurus*)

Author	Chao	Roelofs, 1954	Stickney, et. al. 1975
Epibenthos			
Annelids (or polychaete)	56.6	32.9	11.6
Neris succinea	27.4		9.1
Glycinde solitaria	37.0		
Nephthys sp.	11.0		
Phyllcdocid	6.8		
Spionid	6.8		
Oligochaete	4.1		1.7
Cumacea	21.9		13.2
Amphipoda	24.7		
Gammarus sp.	12.3		11.6
Crabs	1.4		
Cnidaria	9.6		
Others & Remains	5.5	13.7	2.5
Infauna			
Pectinaria gouldii	53.4		
Ampharetid	19.2		
Gastropoda	20.5		0.8
Pelecypoda	27.4	11.0	
Nematoda	34.2	71.2	
Others & Remains	5.5		5.0
Unidentified Remains & Organic Matters	42.5	23.3	35.6

Table 14. (continued, stomach contents of Leiostomus xanthurus)

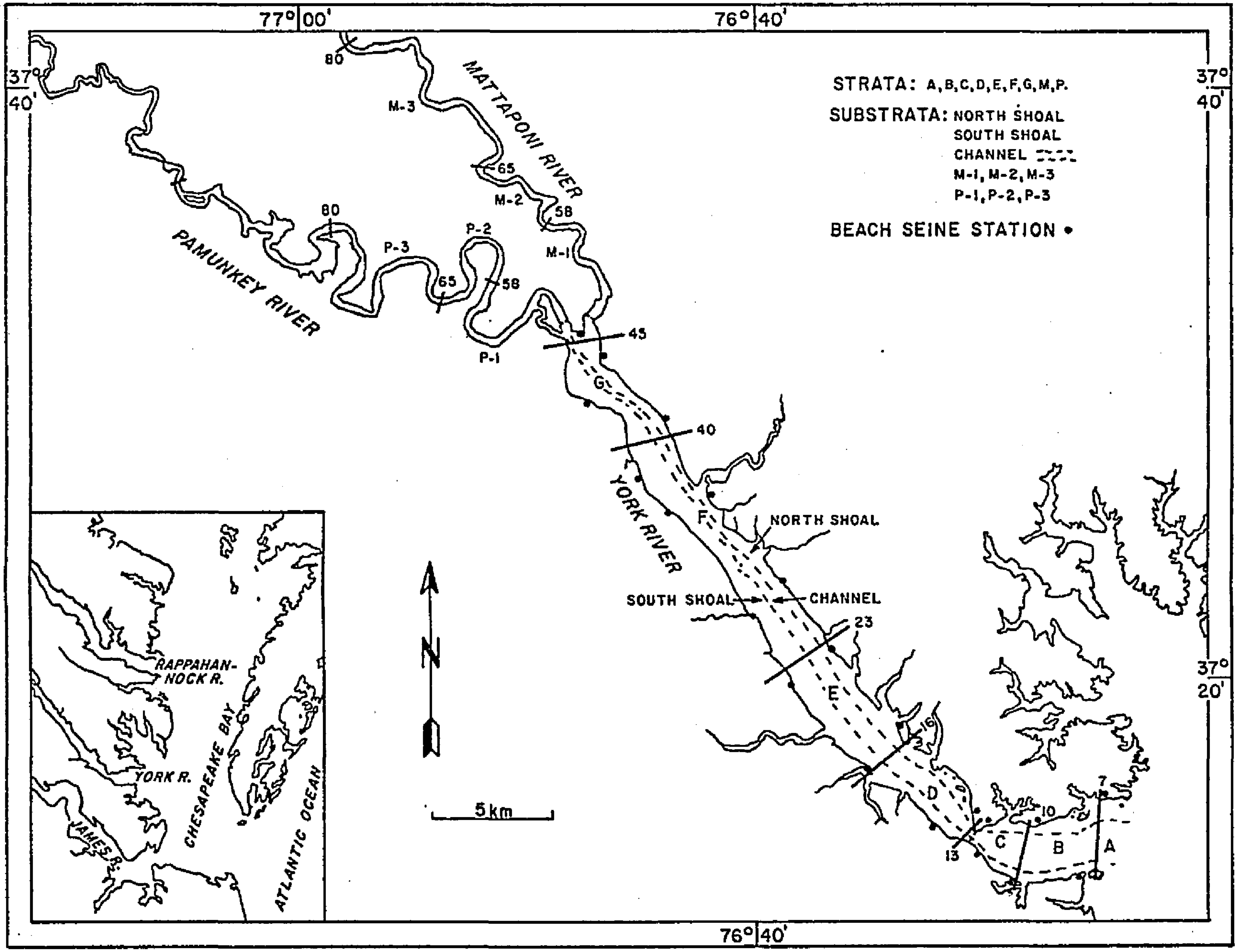
Author	Welsh & Breder, 1945	Townsend, 1956	Parker, 1971	
Locality	St. Vincent Sound, Florida	Alligator Harbor, Florida	Lake Pontcha Train, Louisiana	Clear Lake, Texas
Period	April 1915	June 1955 to May 1956	July 1959 to March 1961	
Source	P. 179	Table 3	Table 13	
Number of specimens	50	45	22	457
Empty stomachs	0	9	4	60
Length of specimens	2.1-3.5 cm SL	16-163 mm SL	40-99 mm TL	18-99 mm TL
Quantitative method	% of volume	% of occurrence	% of occurrence	
Fish & Remains		11.1	19	14
Macrozooplankton				
Mysidace			14.5	8.5
Neomysis americana				
Isopoda			7.0	16.0
Decapoda (or shrimp)		5.5	19.0	15.0
Insecta			14.0	19.0
Others & Remains				
Microzooplankton				
Copepoda	8.0	66.7	3.0	1.0
Cyclopoid				
Calanoid				
Harpacticoid				
Ostracoda	72.0	2.8	5.0	3.0
Others & Remains	1.0		14.5	13.0

Table 14. (continued, stomach contents of *Leiostomus xanthurus*)

Author	Welsh & Breder, 1945	Townsend, 1956	Parker, 1971 Louisiana	Parker, 1971 Texas
Epibenthos				
Annelids (or polychaete)	1.0		14.5	13.0
Neris succinea				
Glycinde solitaria				
Nephthys sp.				
Phyllodocid				
Spionid				
Oligochaete				
Cumacea				
Amphipoda	2.0		7.0	8.5
Gammarus sp.		16.7		
Crabs				
Cnidaria				
Others & Remains	0.5	16.6	19.0	12.0
Infauna				
Pectinaria gouldii				
Ampharetid				
Gastropoda			4.0	17.0
Pelecypoda			1.5	10.0
Nematoda		30.6		
Others & Remains				
Unidentified Remains & Organic Matters	14.0	36.1	14.5	7.0

Fig. 1

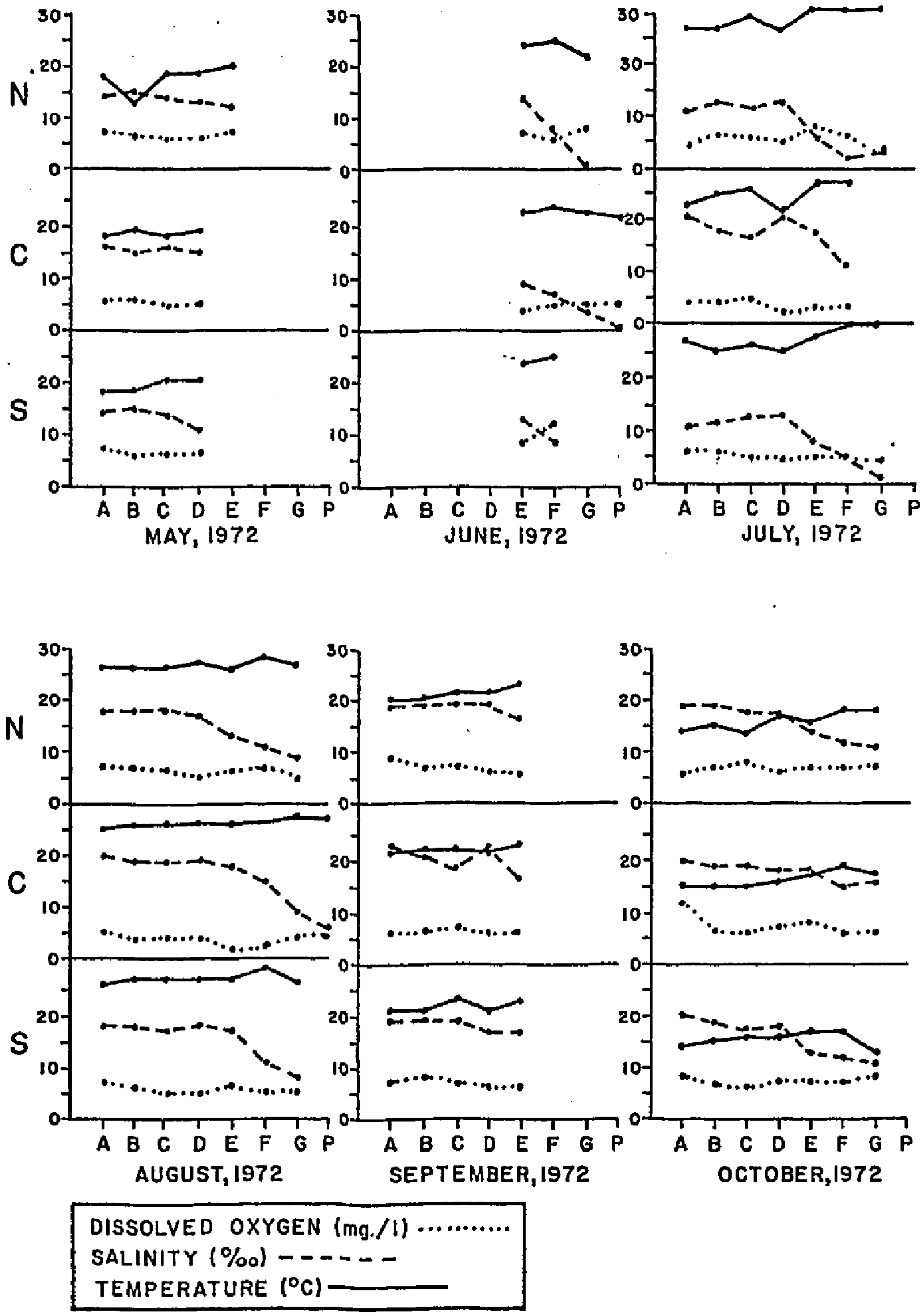
The trawl strata, substrata, and beach seine stations (•) in the York River estuary, Virginia. Strata: A, B, C, D, E, F, G, M and P. Substrata: N. north shoal; C. channel; and S. south shoal. Substrata in Mattaponi River expressed as M-1, M-2 and M-3, in Pamunkey River as P-1, P-2 and P-3. River distances from the mouth of York River (0 km) are indicated in kilometers.



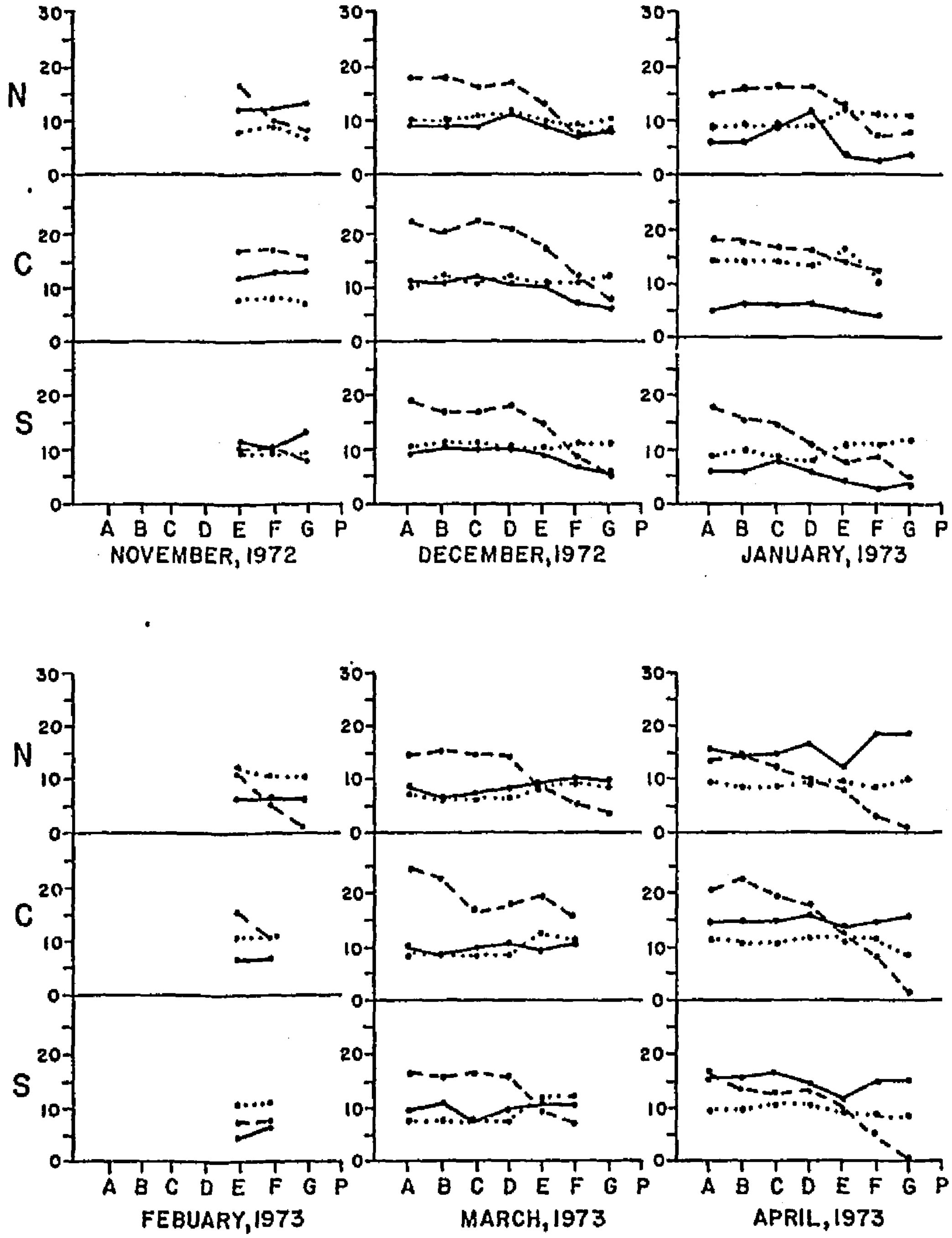
77° 00'
76° 40'
37° 40'
37° 20'
STRATA: A, B, C, D, E, F, G, M, P.
SUBSTRATA: NORTH SHOAL
SOUTH SHOAL
CHANNEL
M-1, M-2, M-3
P-1, P-2, P-3
BEACH SEINE STATION •
MATTAPONI RIVER
PAMUNKEY RIVER
YORK RIVER
NORTH SHOAL
SOUTH SHOAL
CHANNEL
5 km
N
RAPPAHAN-NOCK R.
YORK R.
JAMES R.
CHESAPEAKE BAY
ATLANTIC OCEAN

Fig. 2

Monthly means of the bottom temperature, salinity and dissolved oxygen in the York River estuary from May, 1972 to August, 1973. Strata: A to G in York River and P in Pamunkey River. Substrata: N. north shoal, C. channel and S. south shoal.



N
C
S
A B C D E F G P
MAY, 1972
JUNE, 1972
JULY, 1972
AUGUST, 1972
SEPTEMBER, 1972
OCTOBER, 1972
DISSOLVED OXYGEN (mg./l)
SALINITY (‰)
TEMPERATURE (°C)



N
C
S
30
20
10
0
A B C D E F G P
NOVEMBER, 1972
DECEMBER, 1972
JANUARY, 1973
FEBUARY, 1973
MARCH, 1973
APRIL, 1973

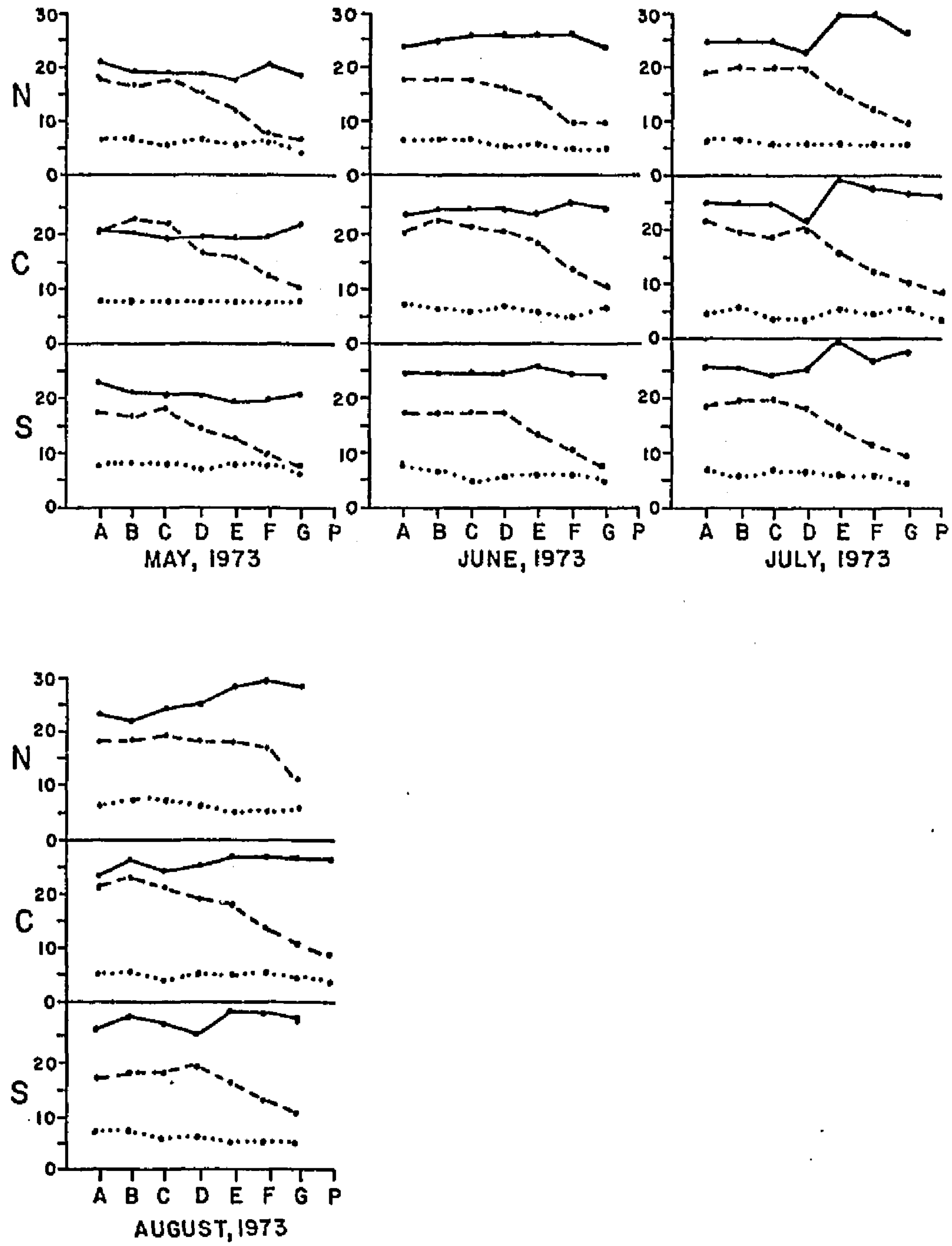
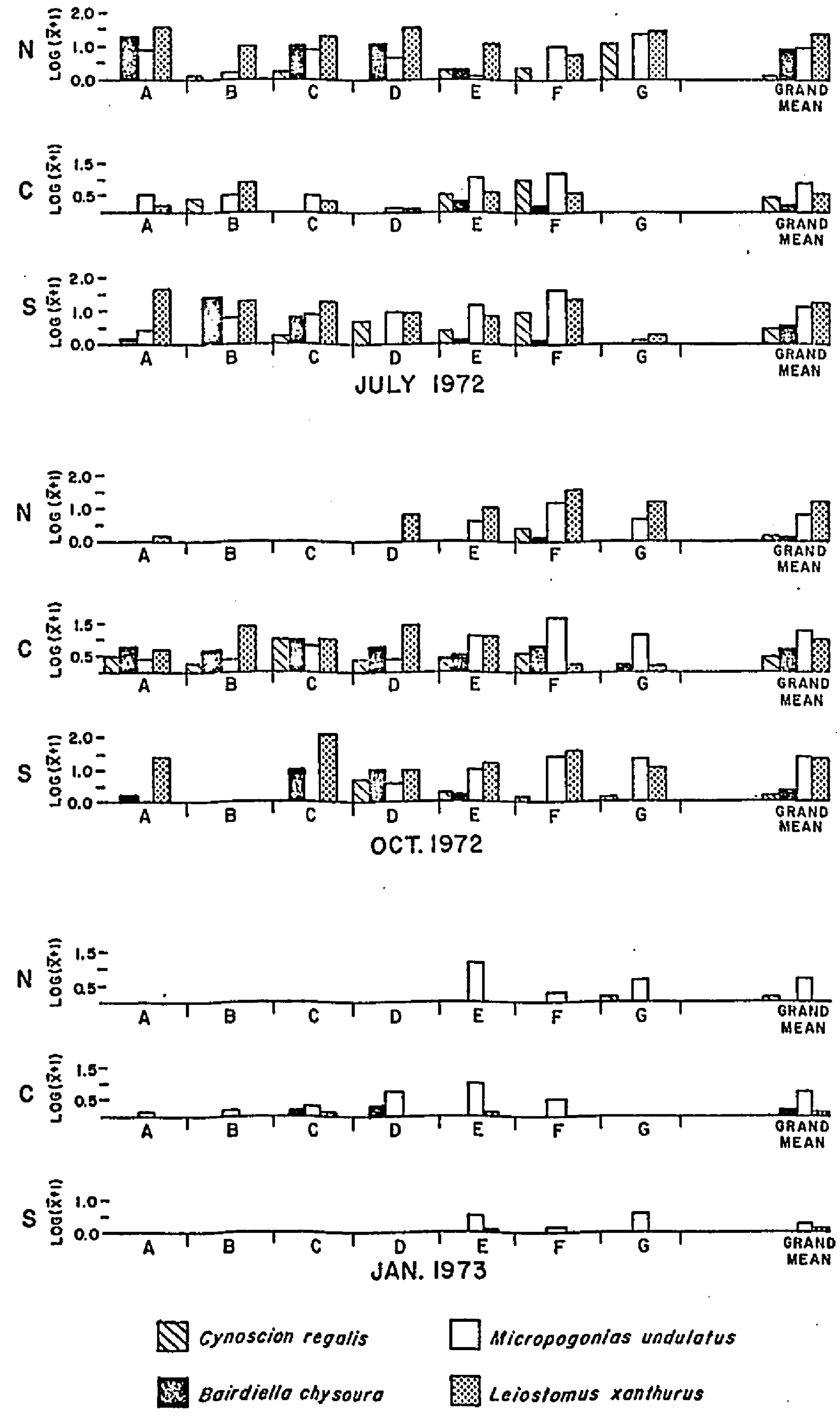

N
C
S
30
20
10
0
A B C D E F G P
MAY, 1973
JUNE, 1973
JULY, 1973
AUGUST, 1973

Fig. 3

Seasonal abundance of four juvenile sciaenids with depth and distance upstream in the York River. Mean numerical catch per tow expressed as log $(\bar{x}+1)$. Strata: A to G; substrata: N. north shoal, C. channel and S. south shoal.


N
LOG ($\bar{X}$+1)
2.0
1.0
0.0
A
B
C
D
E
F
G
GRAND MEAN
C
1.5
0.5
S
JULY 1972
OCT. 1972
JAN. 1973
Cynoscion regalis
Micropogonias undulatus
Bairdiella chysoura
Leiostomus xanthurus

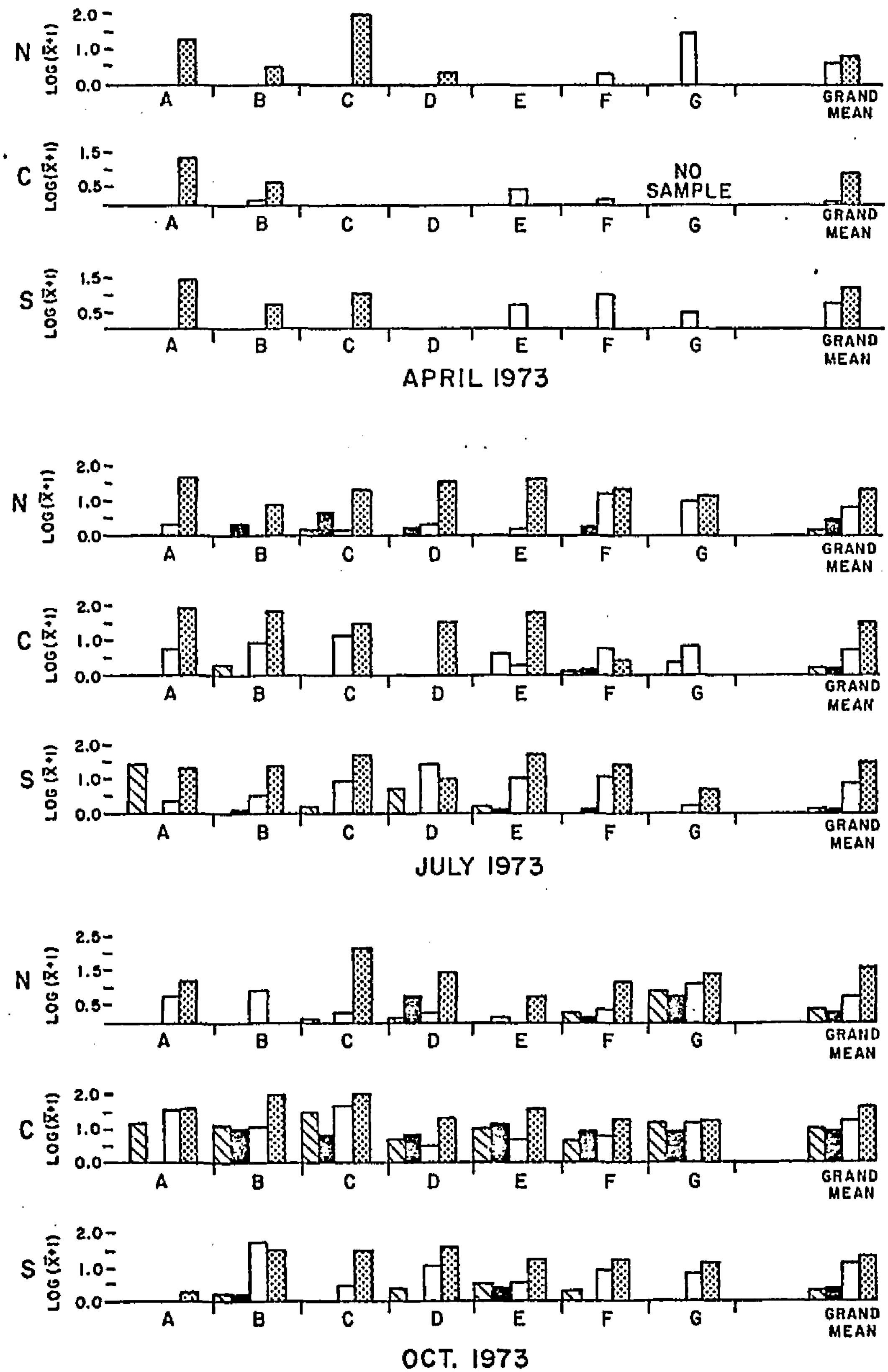
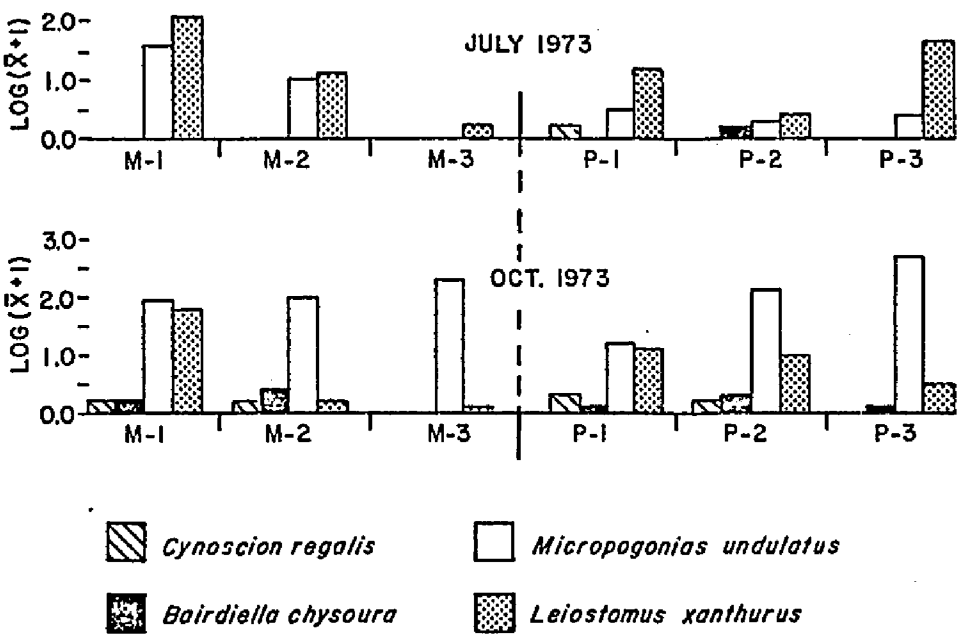

N
LOG ($\bar{X}$+1)
2.0
1.0
0.0
A
B
C
D
E
F
G
GRAND MEAN
C
1.5
0.5
NO SAMPLE
S
APRIL 1973
JULY 1973
2.5
OCT. 1973

Fig. 4

Seasonal abundance of four juvenile sciaenids in Mattaponi and Pamunkey rivers. Mean numerical catch per tow expressed as log $(\bar{x}+1)$. Strata: M. Mattaponi River, P. Pamunkey River. Substrata: 1, 2 and 3 designated by river distance upstream.



LOG($\bar{X}$+1)
2.0
1.0
0.0
JULY 1973
M-1
M-2
M-3
P-1
P-2
P-3
LOG($\bar{X}$+1)
3.0
2.0
1.0
0.0
OCT. 1973
M-1
M-2
M-3
P-1
P-2
P-3
Cynoscion regalis
Micropogonias undulatus
Bairdiella chysoura
Leiostomus xanthurus

Fig. 5

Seasonal mean abundance of four juvenile sciaenids along the salinity gradient (strata) in the York River estuary. Grand mean numerical catch of channel and shoals per tow expressed as log $(\bar{x}+1)$. Strata: A to G in York River, M. Mattaponi River, P. Pamunkey River.

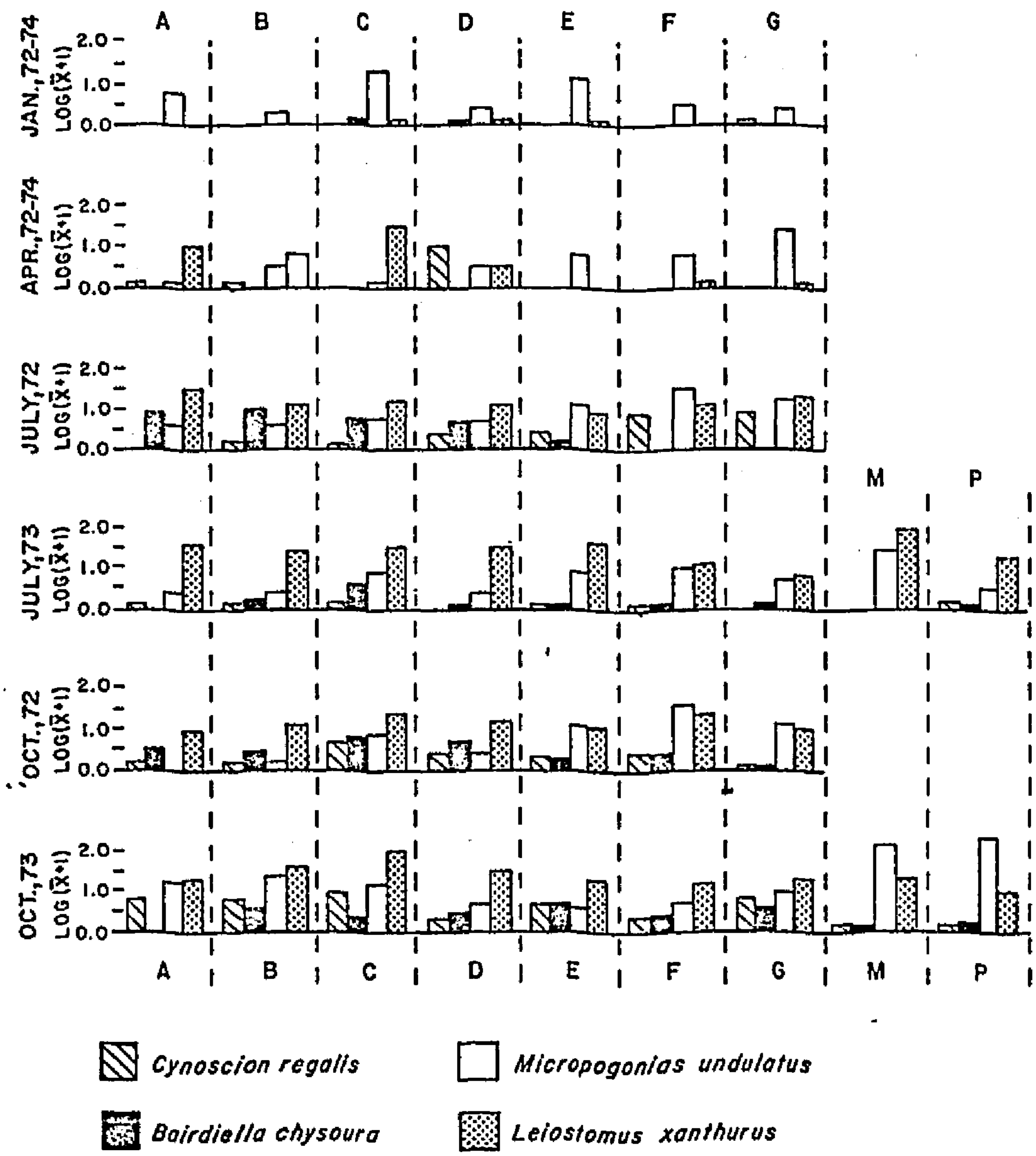
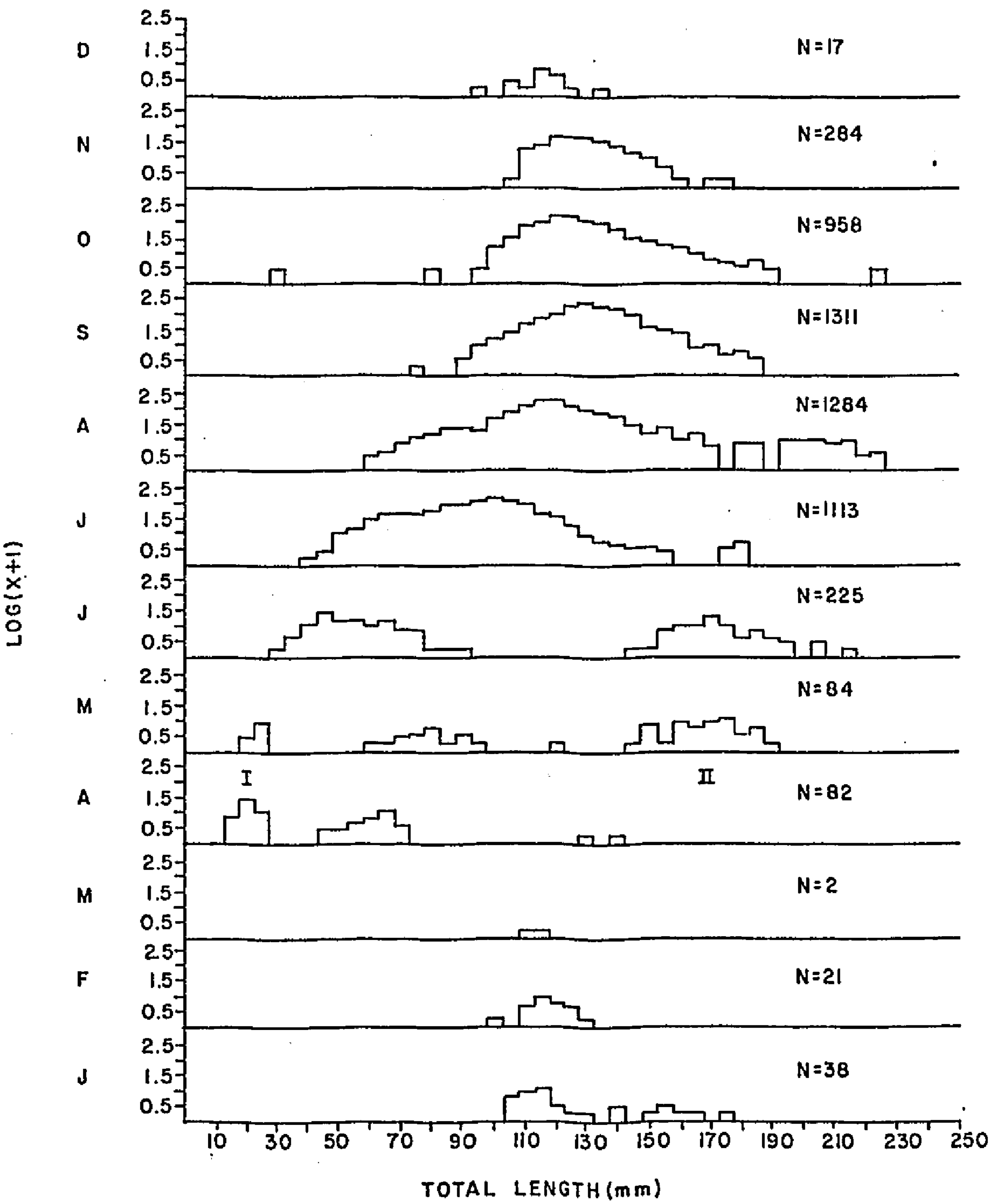
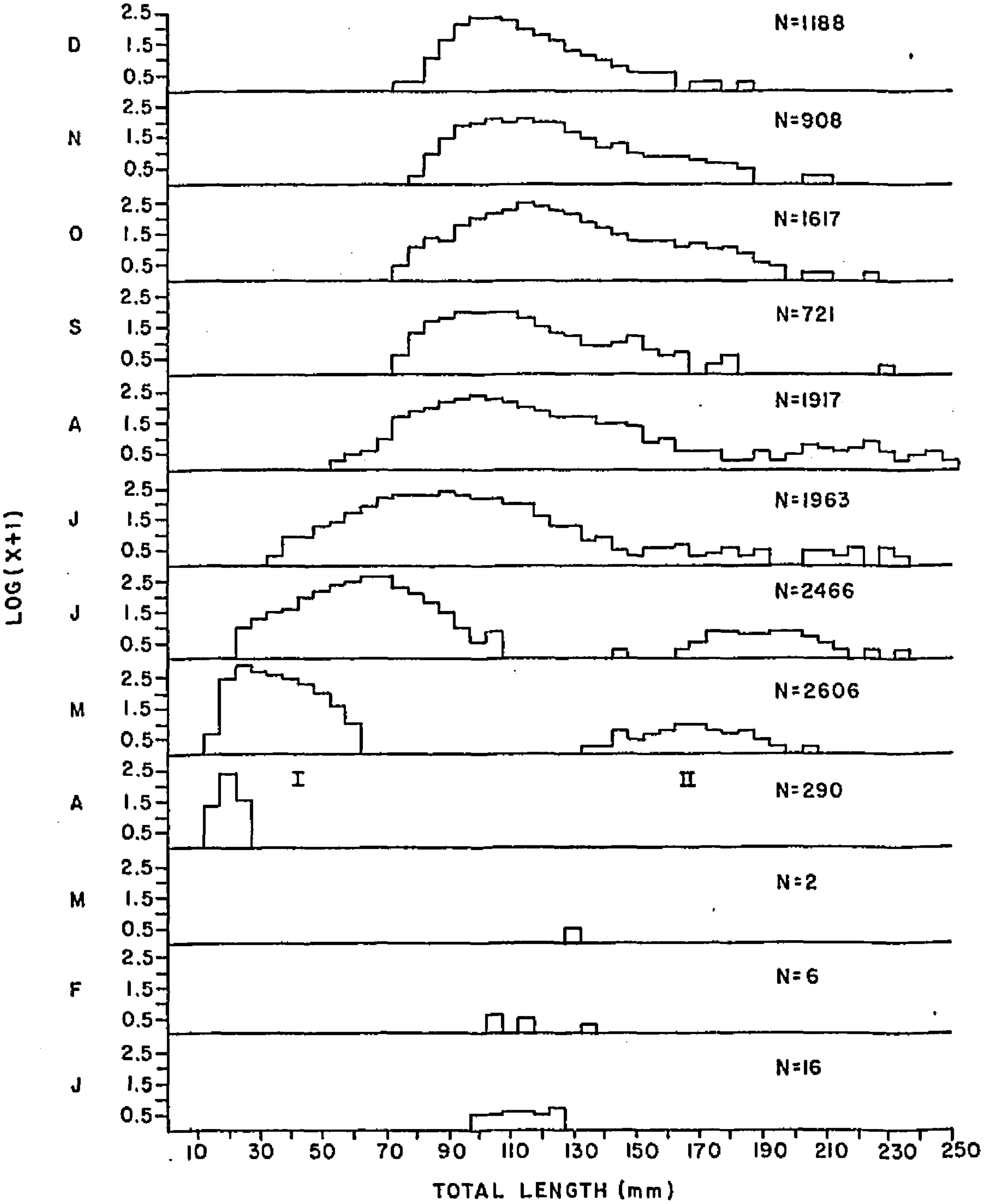

A
B
C
D
E
F
G
M
P
JAN.,72-74
APR.,72-74
JULY,72
JULY,73
OCT.,72
OCT.,73
LOG(X̄+1)
2.0
1.0
0.0
Cynoscion regalis
Micropogonias undulatus
Bairdiella chysoura
Leiostomus xanthurus

Fig. 6

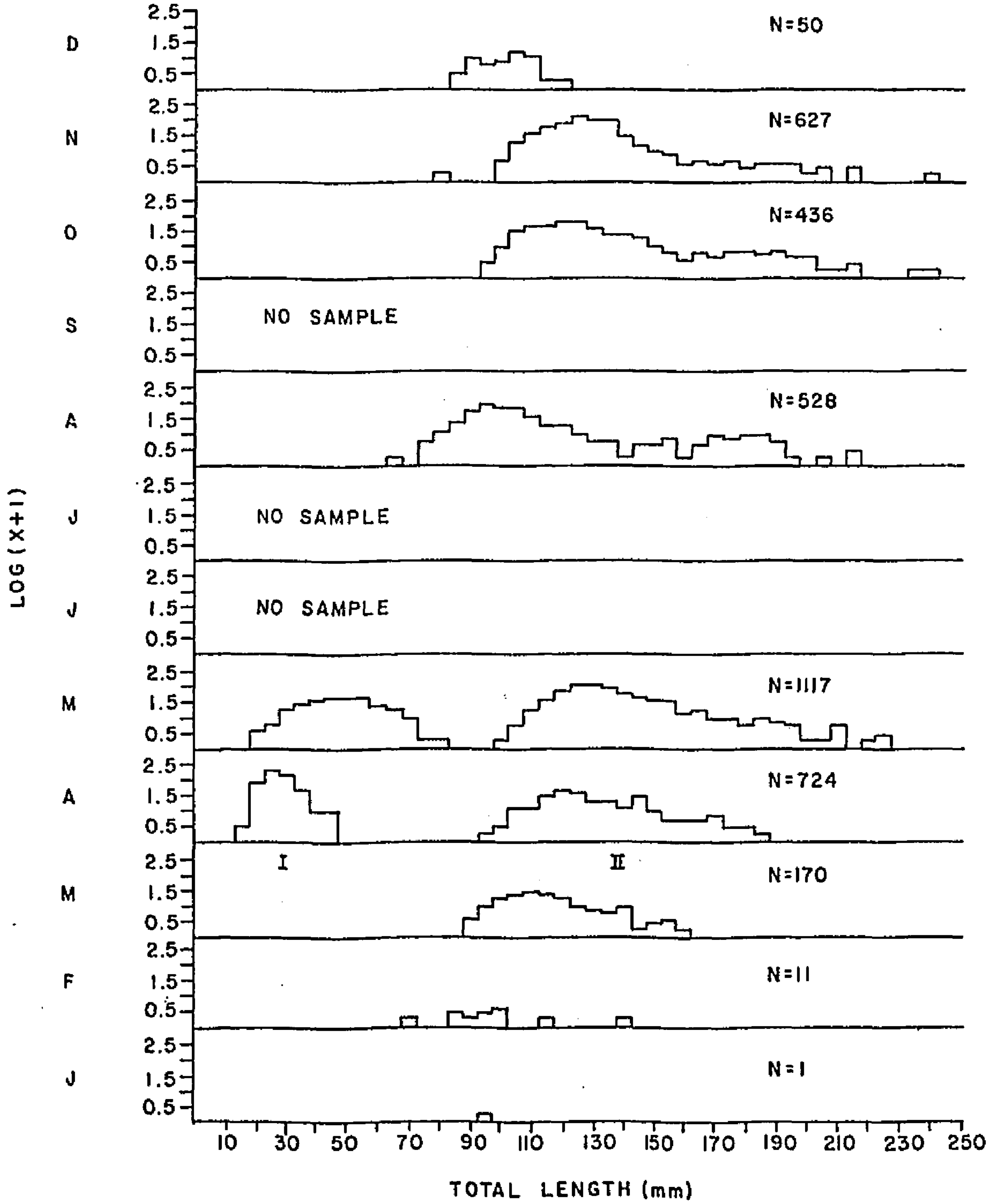
Monthly length frequency distributions of juvenile spot, *Leiostomus xanthurus*, from York River, 1972-74. Mode I, young-of-the-year; mode II, yearlings. Frequencies expressed as log (x+1) at 5 mm increments. Only the lower portion of river (strata A to D) represented in 1974.



Leiostomus xanthurus, 1972 Total



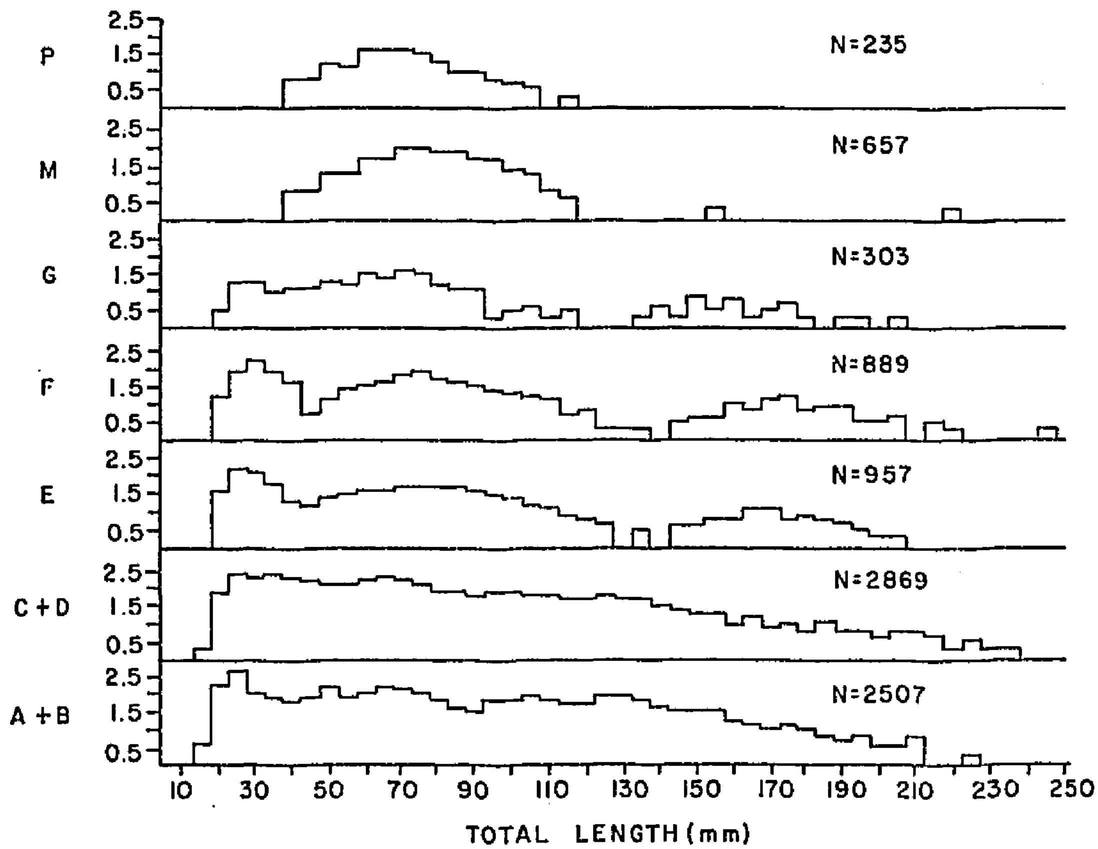
Leiostomus xanthurus, 1973 Total



Leiostomus xanthurus, 1974 Total

Fig. 7

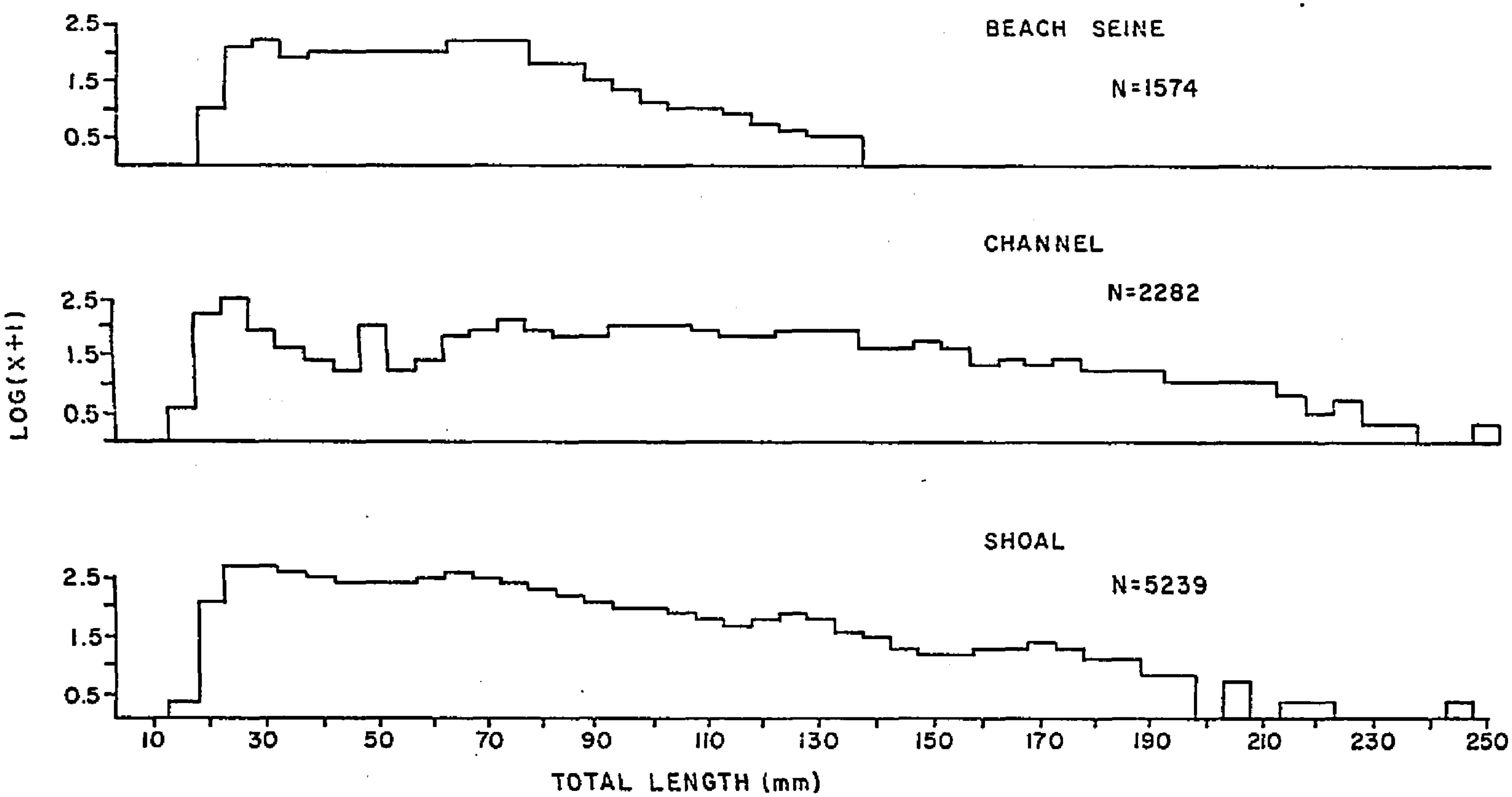
Length frequency distributions of spot, *Leiostomus xanthurus*, by river distance (strata) upstream in the York River estuary. Pooled total, May to July 1972-74. Strata: A to G in York River, M. Mattaponi River, P. Pamunkey River. Frequencies expressed as log (x+1) at 5 mm increments.



Leiostomus xanthurus May to July, 1972-1974

Fig. 8

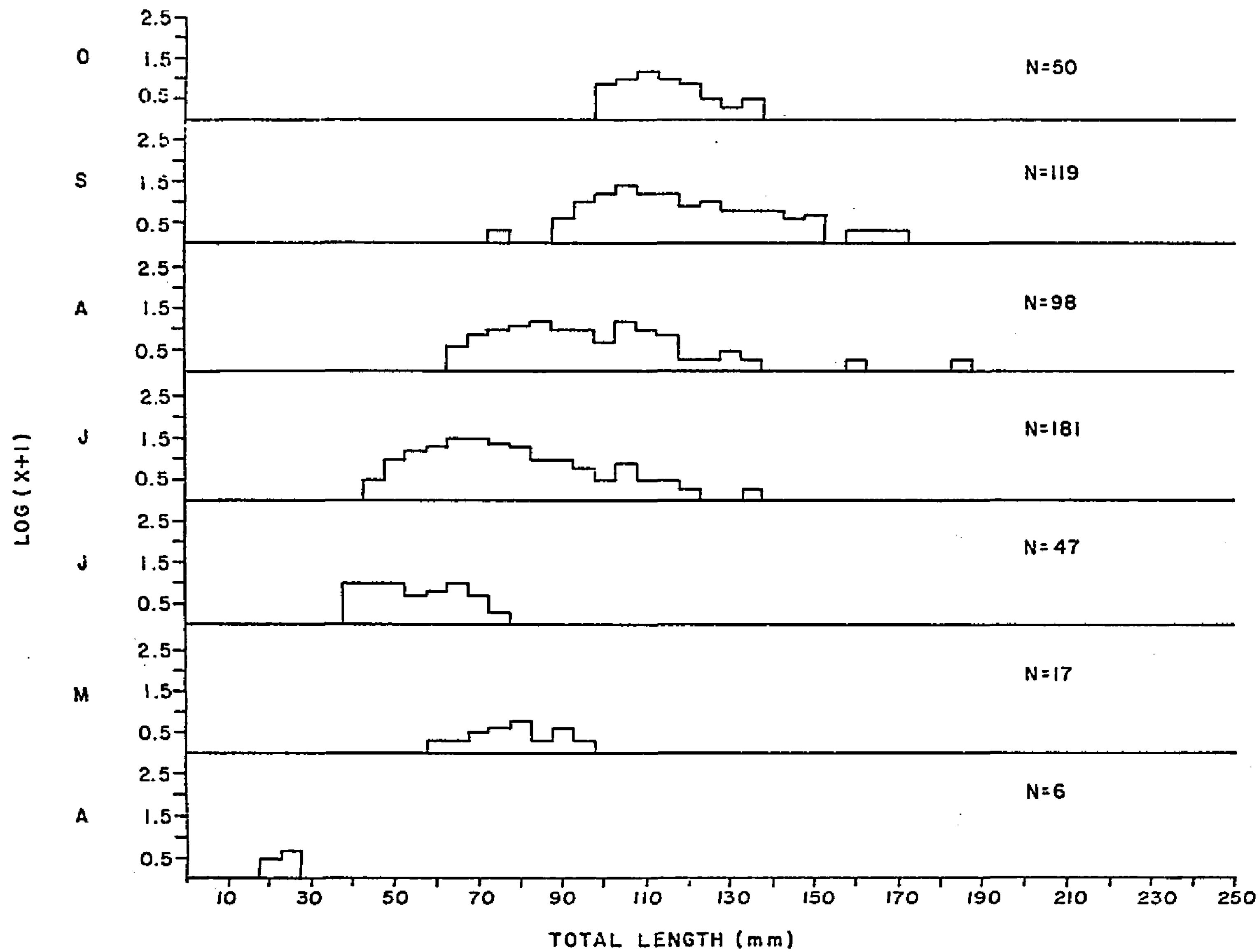
Length frequency distributions of spot, *Leiostomus xanthurus*, by depth of York River. Pooled total, May to July 1972-74. Frequencies expressed as log (x+1) at 5 mm increments.



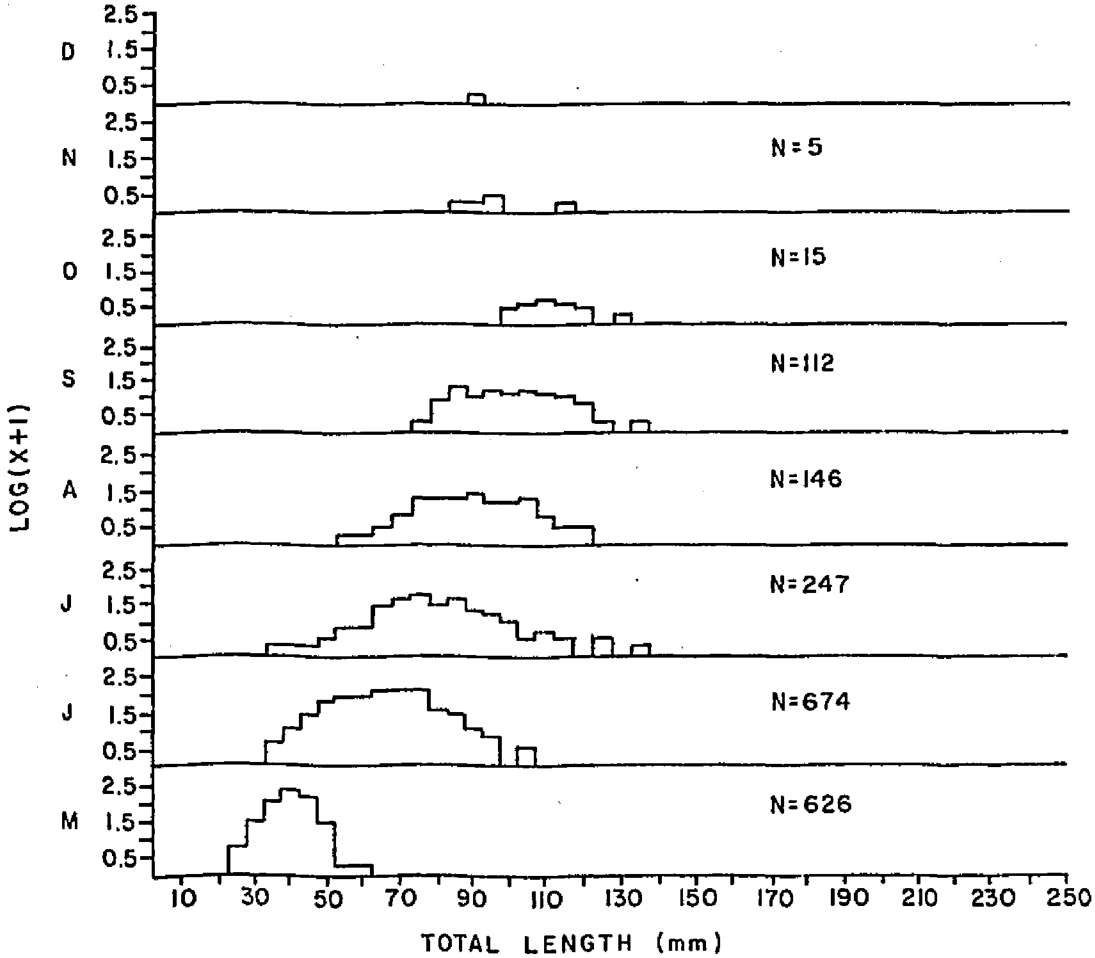
Leiostomus xanthurus May to July, 1972-1974

Fig. 9

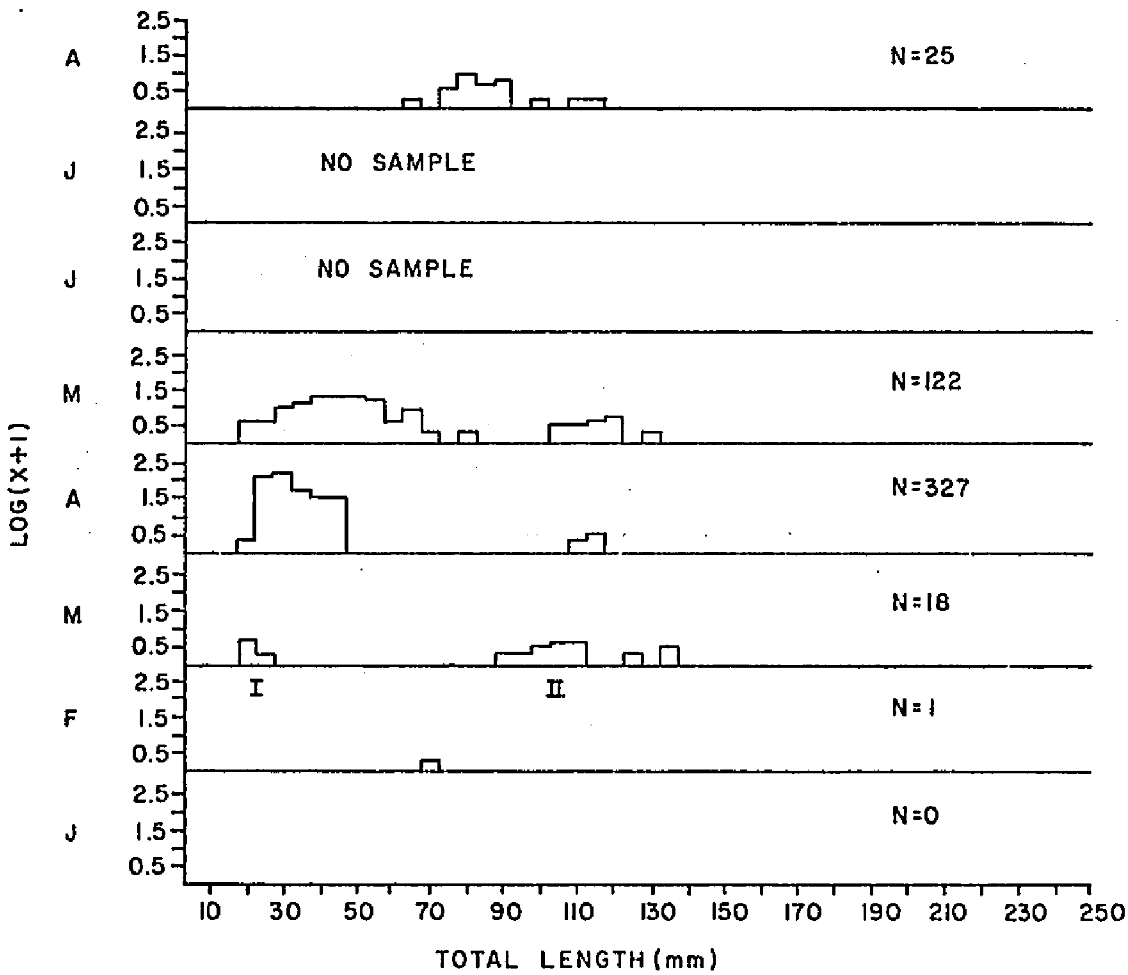
Monthly length frequency distributions of spot, *Leiostomus xanthurus*, from the beach seine catches of York River, 1972-74. Frequencies expressed as log (x+1) at 5 mm increments.



Leiostomus xanthurus 1972 Beach Seine



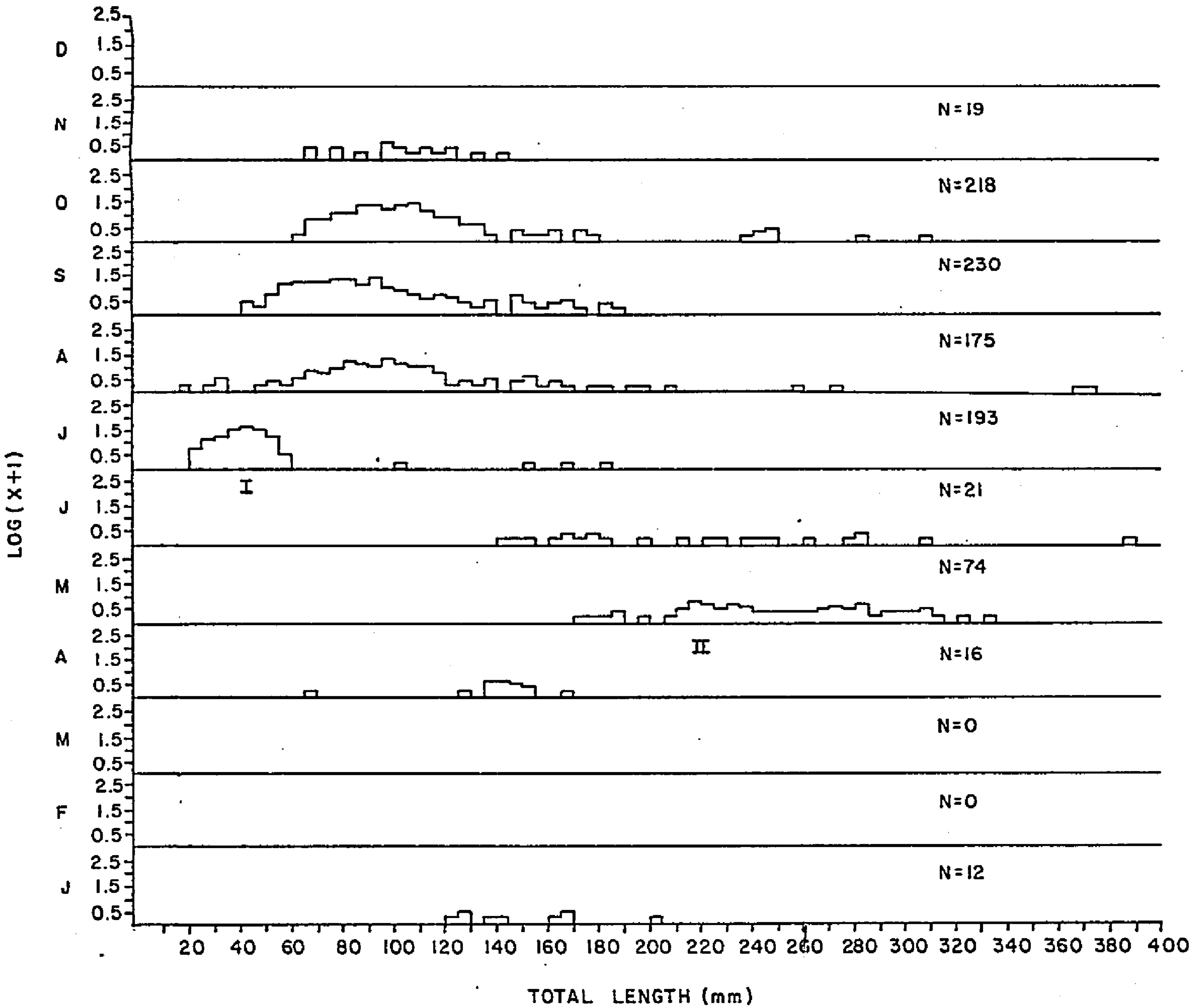
Leiostomus xanthurus 1973 Beach Seine



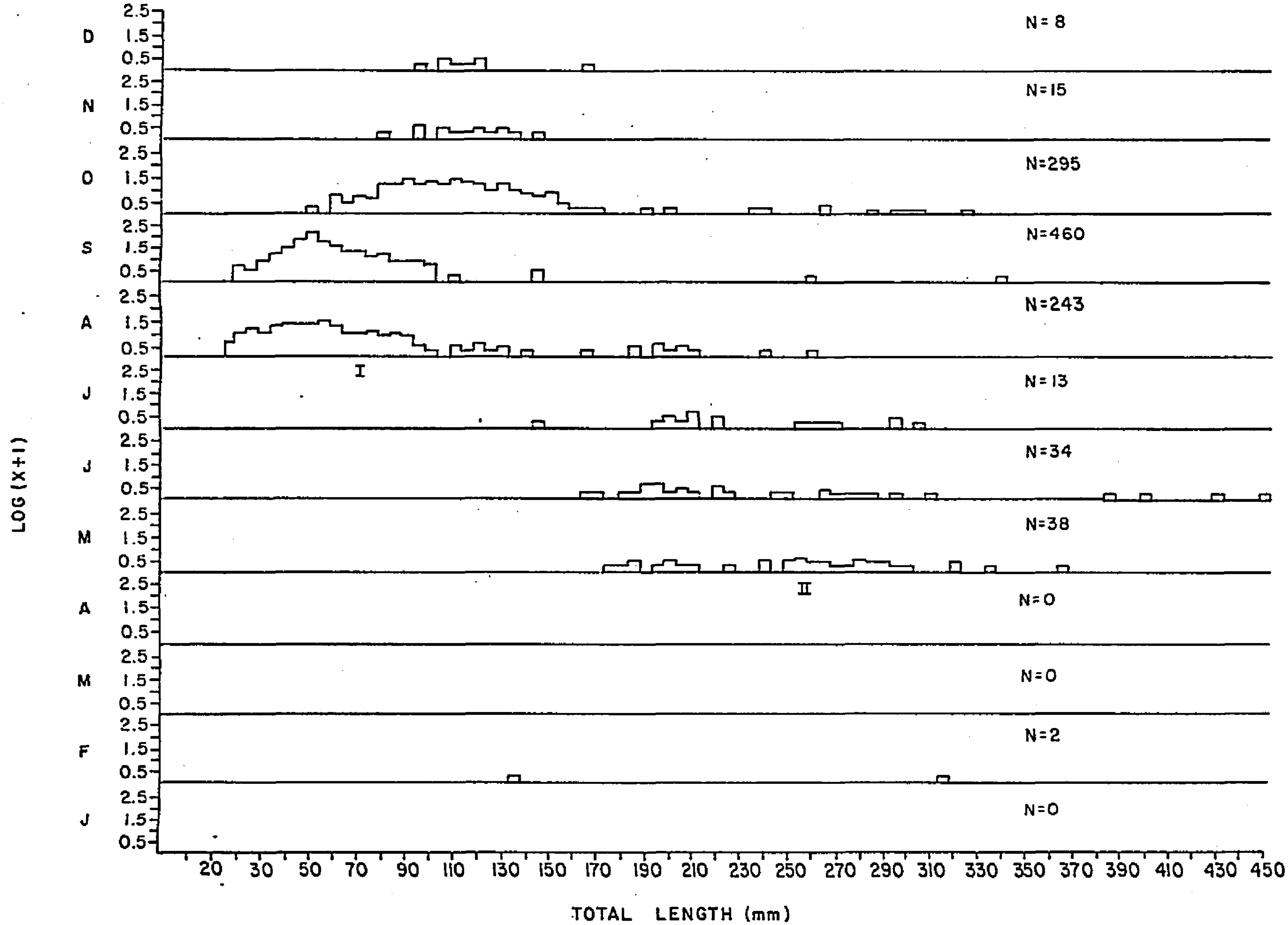
Leiostomus xanthurus 1974 Beach Seine

Fig. 10

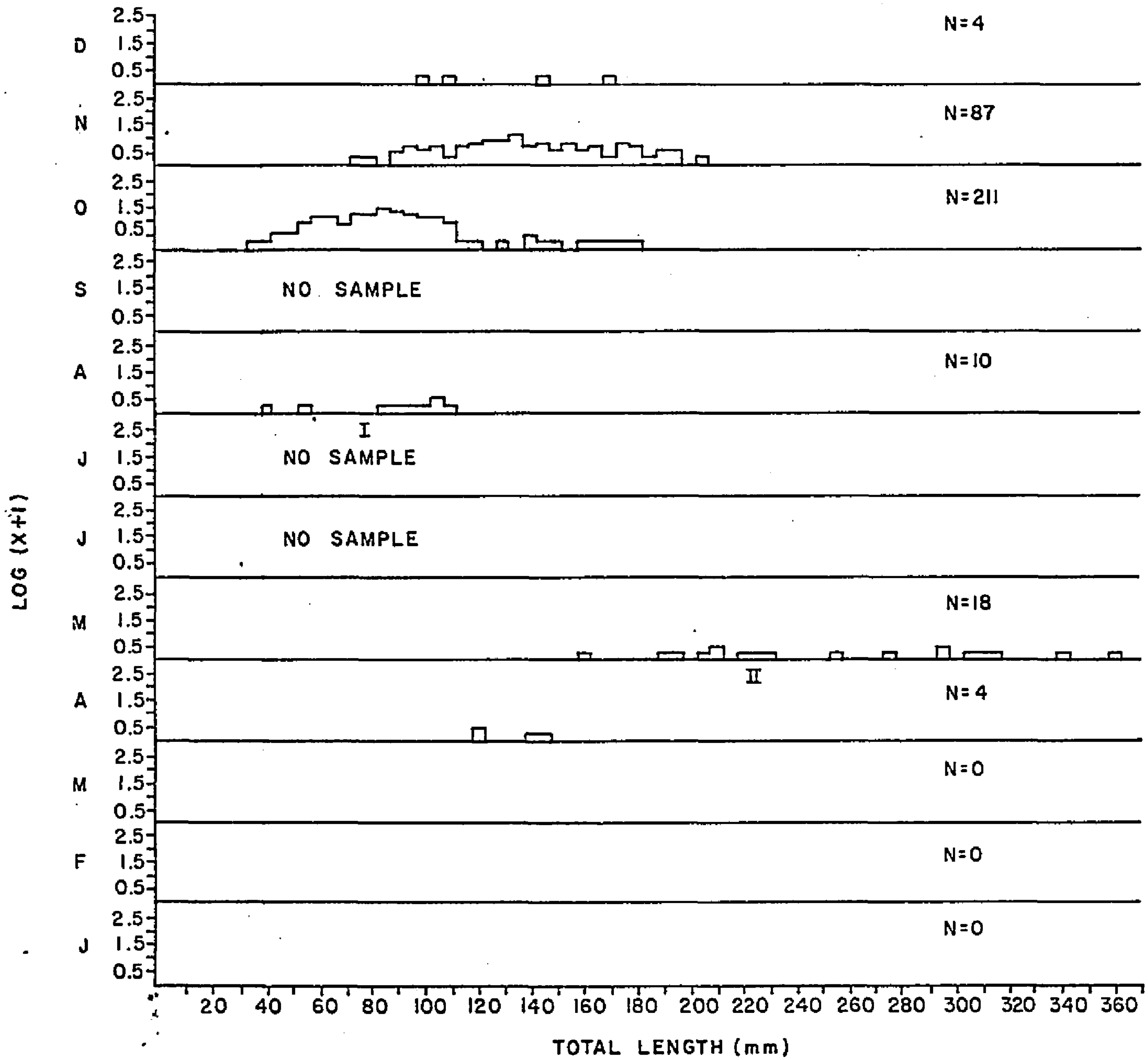
Monthly length frequency distributions of weakfish, *Cynoscion regalis*, from York River, 1972–74. Mode I, young-of-the-year; mode II, yearlings. Frequencies expressed as log (x+1) at 5 mm increments. Only the lower portion of river (strata A to D) represented in 1974.



Cynoscion regalis 1972 Total



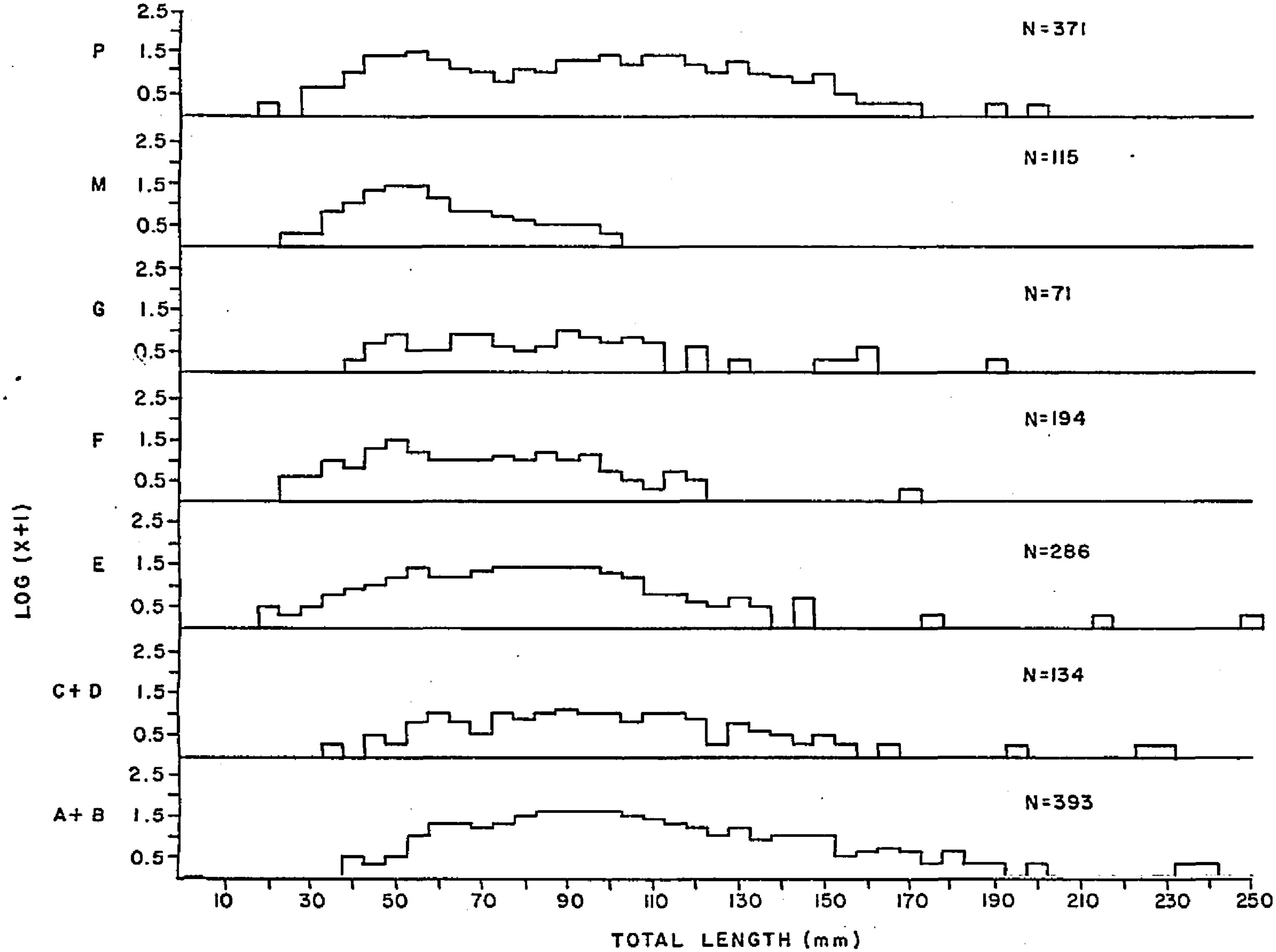
Cynoscion regalis 1973 Total



Cynoscion regalis 1974 Total

Fig. 11

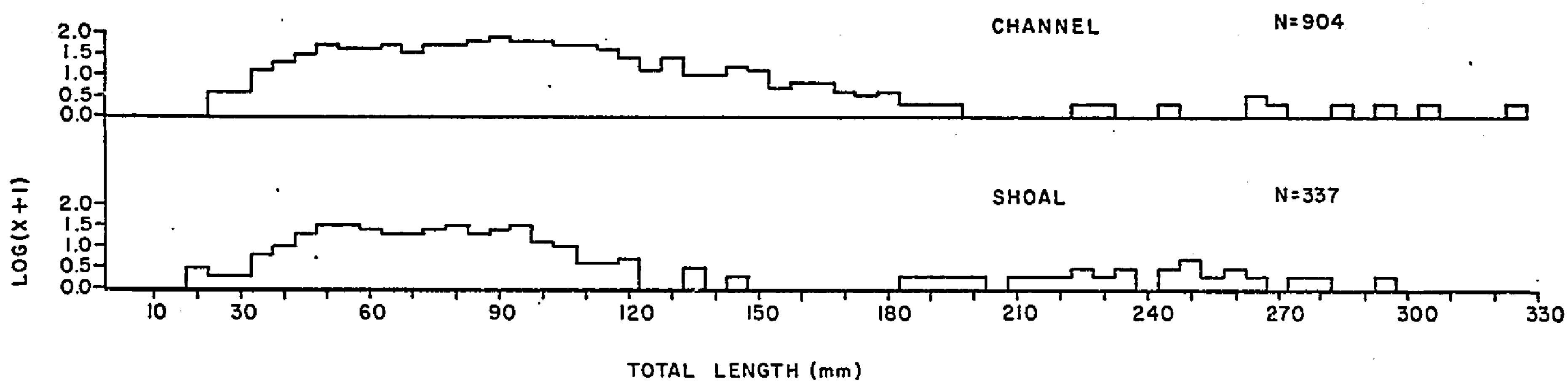
Length frequency distributions of weakfish, *Cynoscion regalis*, by river distance (strata) upstream of the York River estuary. Pooled total, August to October 1972-74. Strata: A to G in York River, M. Mattaponi River, P. Pamunkey River. Frequencies expressed as log (x+1) at 5 mm increments.



Cynoscion regalis August to October, 1972-1974

Fig. 12

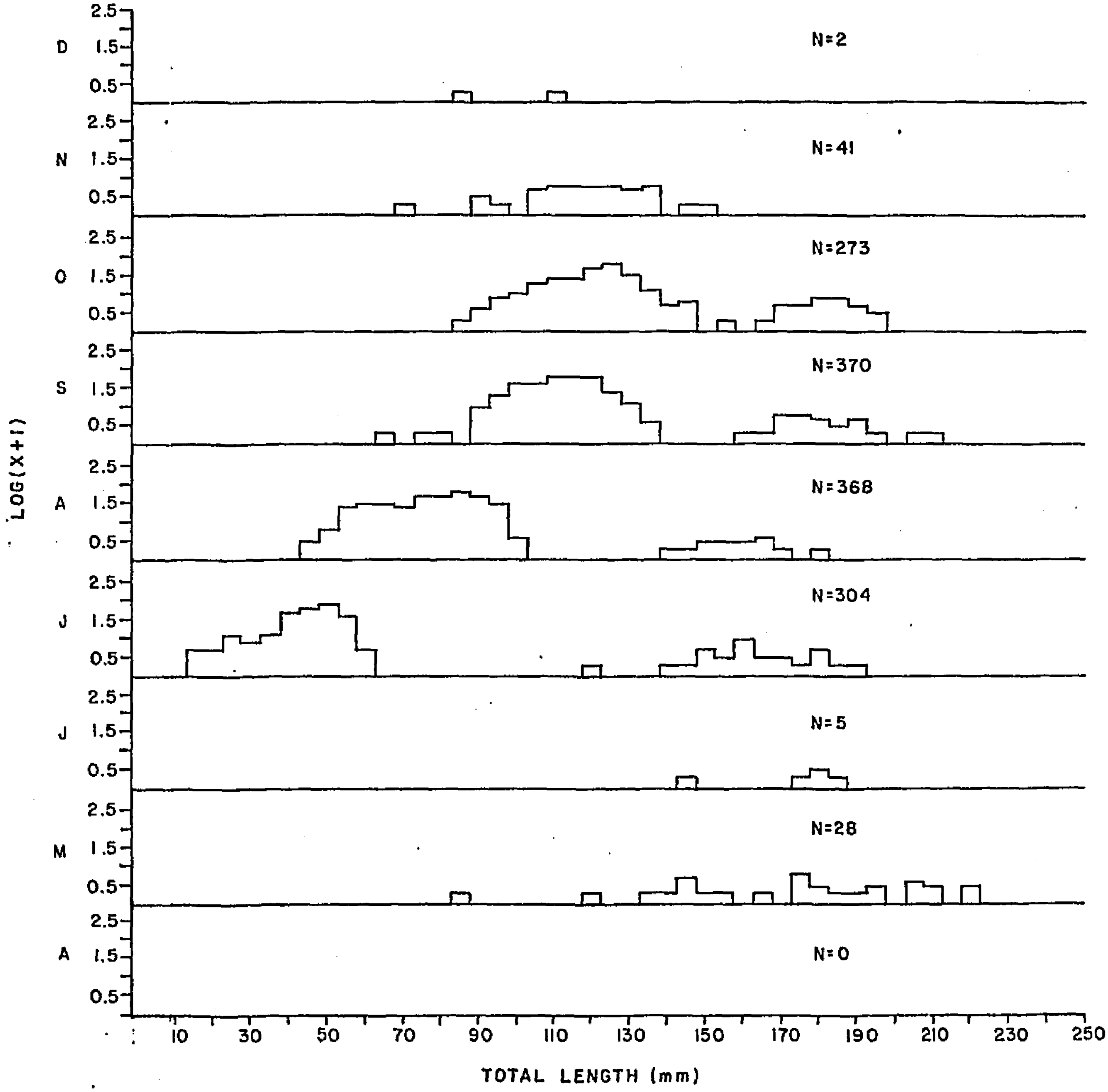
Length frequency distributions of weakfish, *Cynoscion regalis*, by depth of York River. Pooled total, August to October, 1972-74. Frequencies expressed as log (x+1) at 5 mm increments.



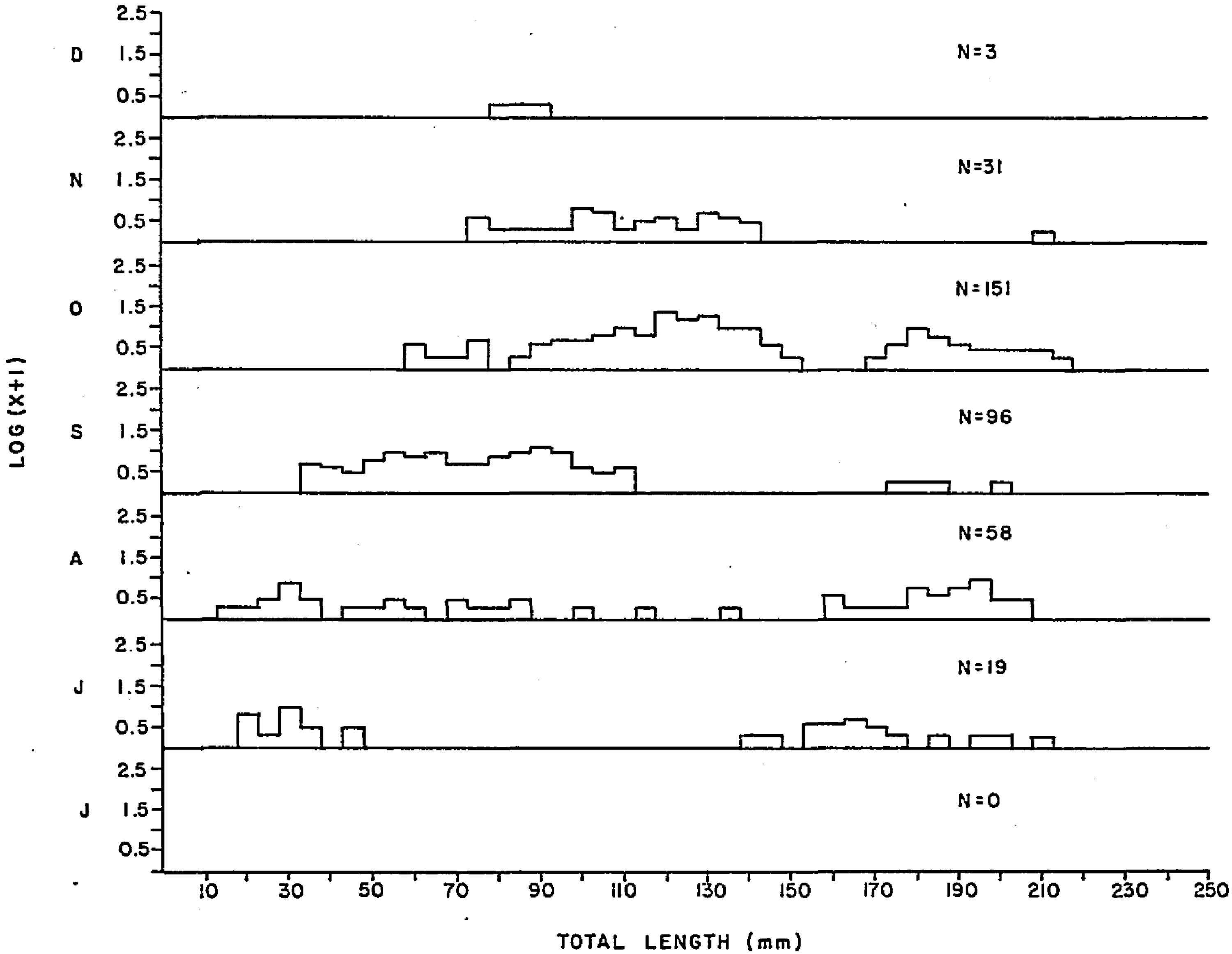
Cynoscion regalis August to October, 1972-1974

Fig. 13

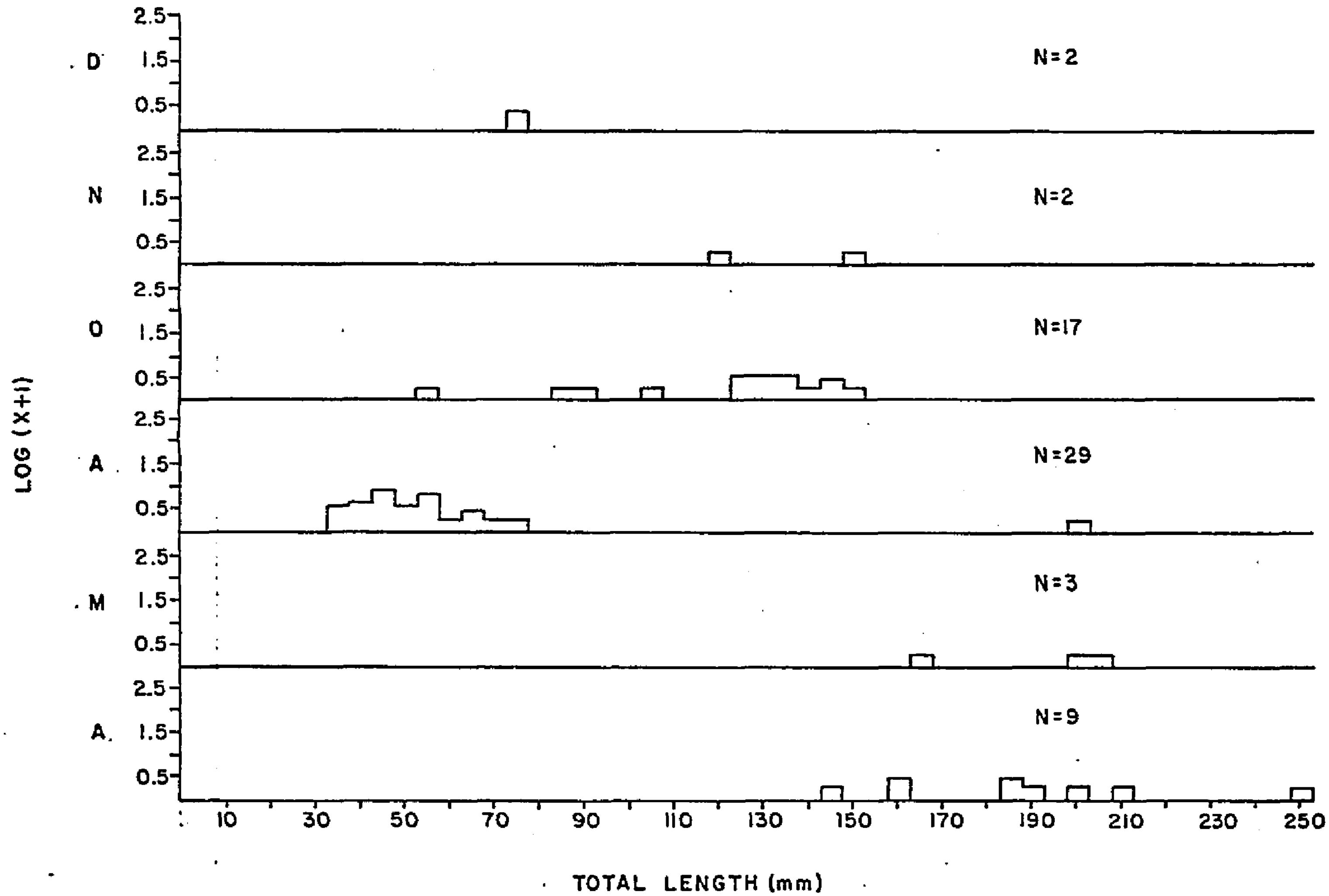
Monthly length frequency distributions of silver perch, *Bairdiella chrysoura* from York River, 1972-74. Frequencies expressed as log (x+1) at 5 mm increments. Only the lower portion of river (strata A to D) represented in 1974.



Bairdiella chrysoura 1972 Total



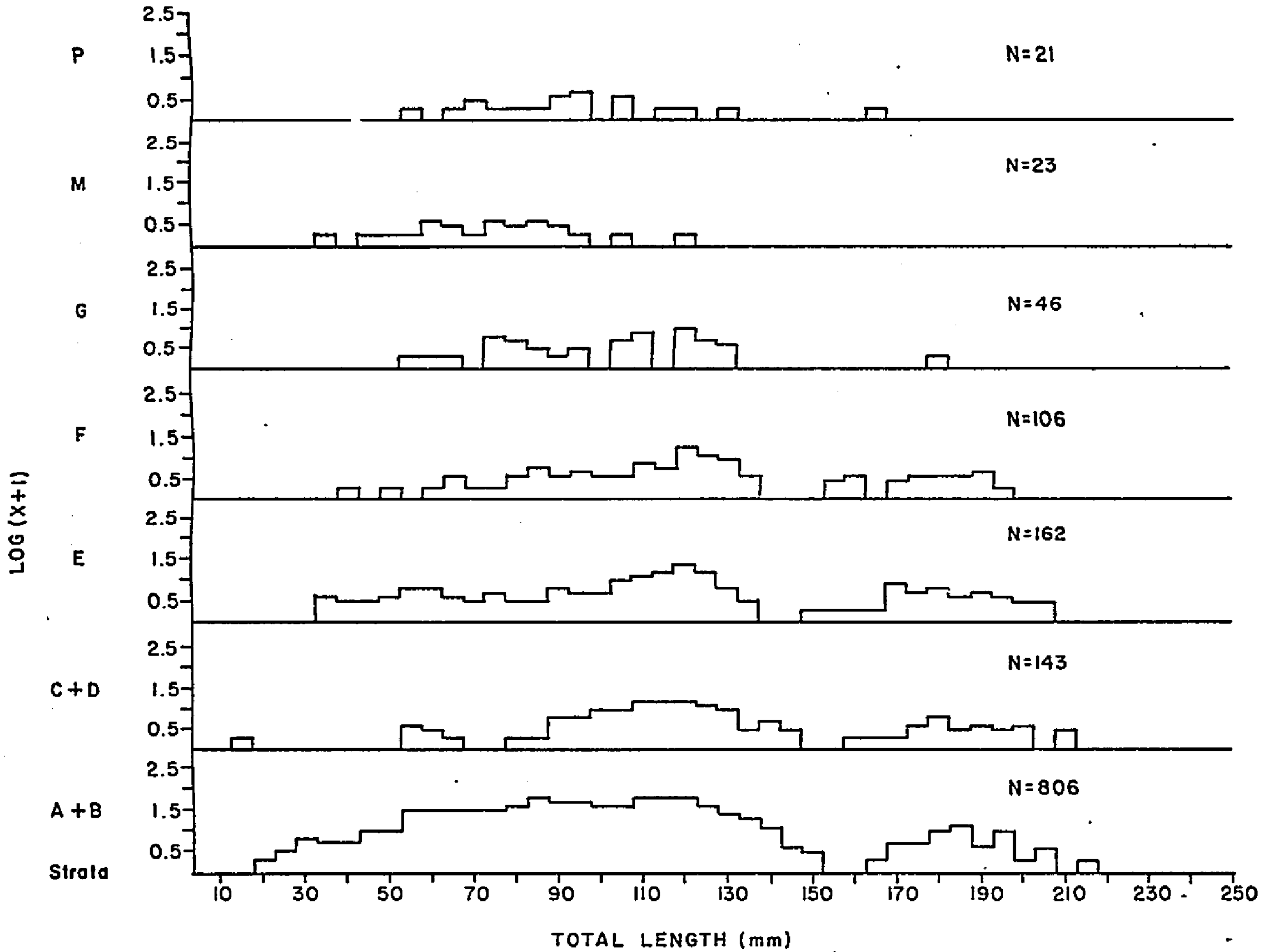
Bairdiella chrysoura 1973 Total



Bairdiella chrysoura 1974 Total

Fig. 14

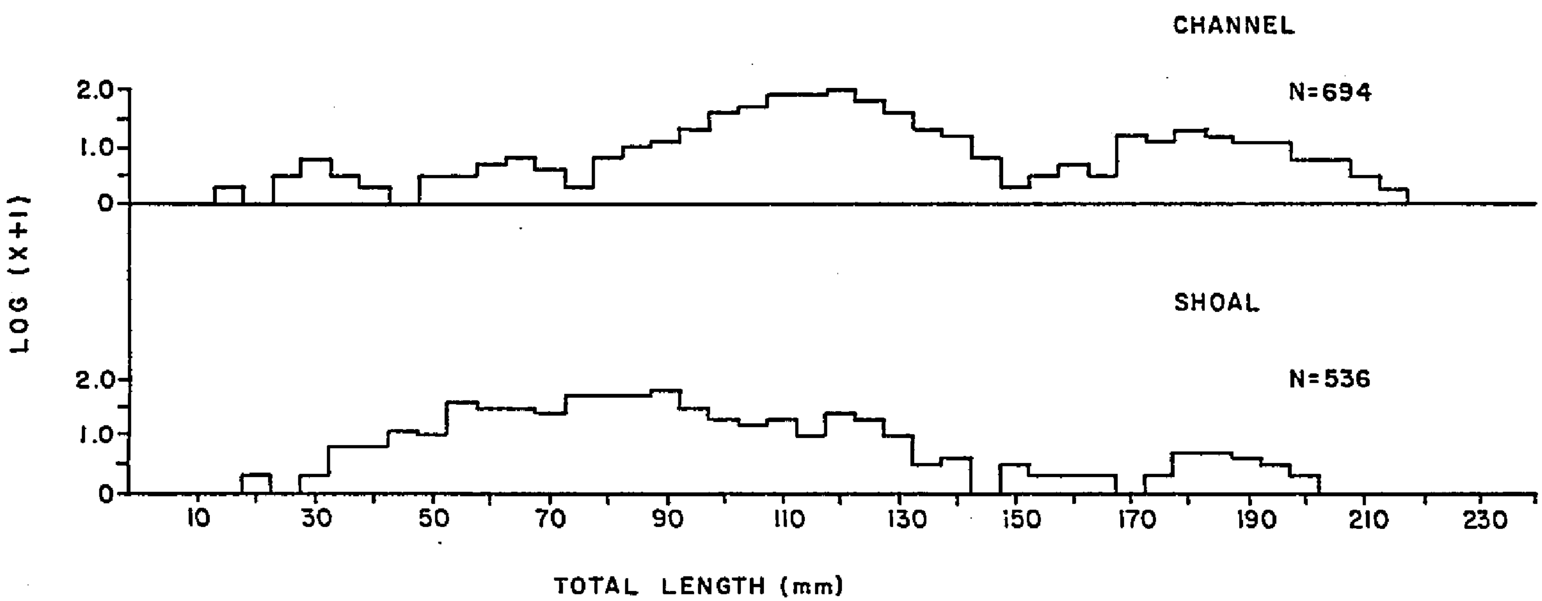
Length frequency distributions of silver perch, *Bairdiella chrysoura* by river distance (strata) upstream of the York River estuary. Pooled total, August to October, 1972-74. Strata: A to G in York River, M. Mattaponi River, P. Pamunkey River. Frequencies expressed as log (x+1) at 5 mm increments.



Bairdiella chrysoura August to October, 1972–1974

Fig. 15

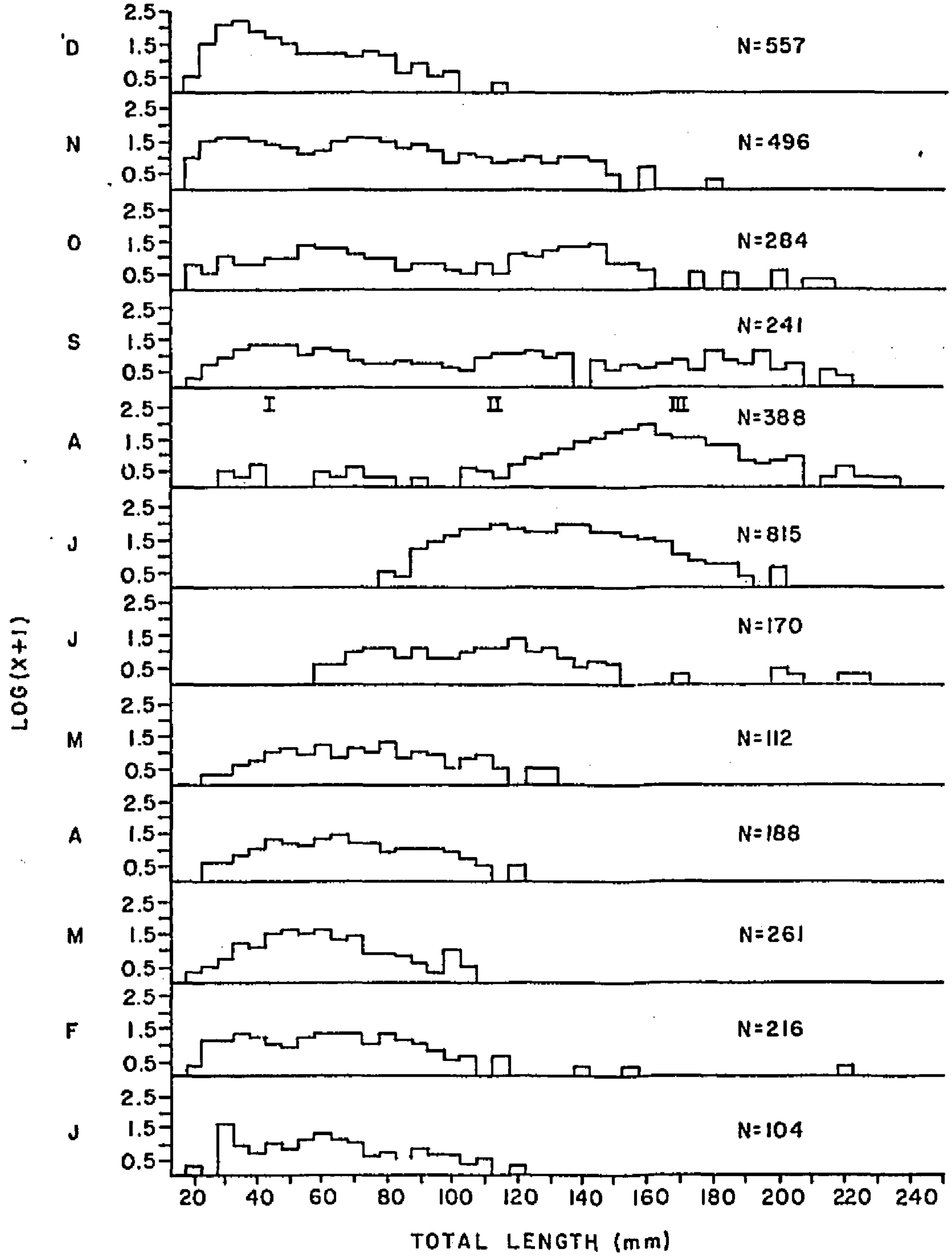
Length frequency distributions of silver perch, *Bairdiella chrysoura* by depth of York River. Pooled total, August to October, 1972-74. Frequencies expressed as log (x+1) at 5 mm increments.



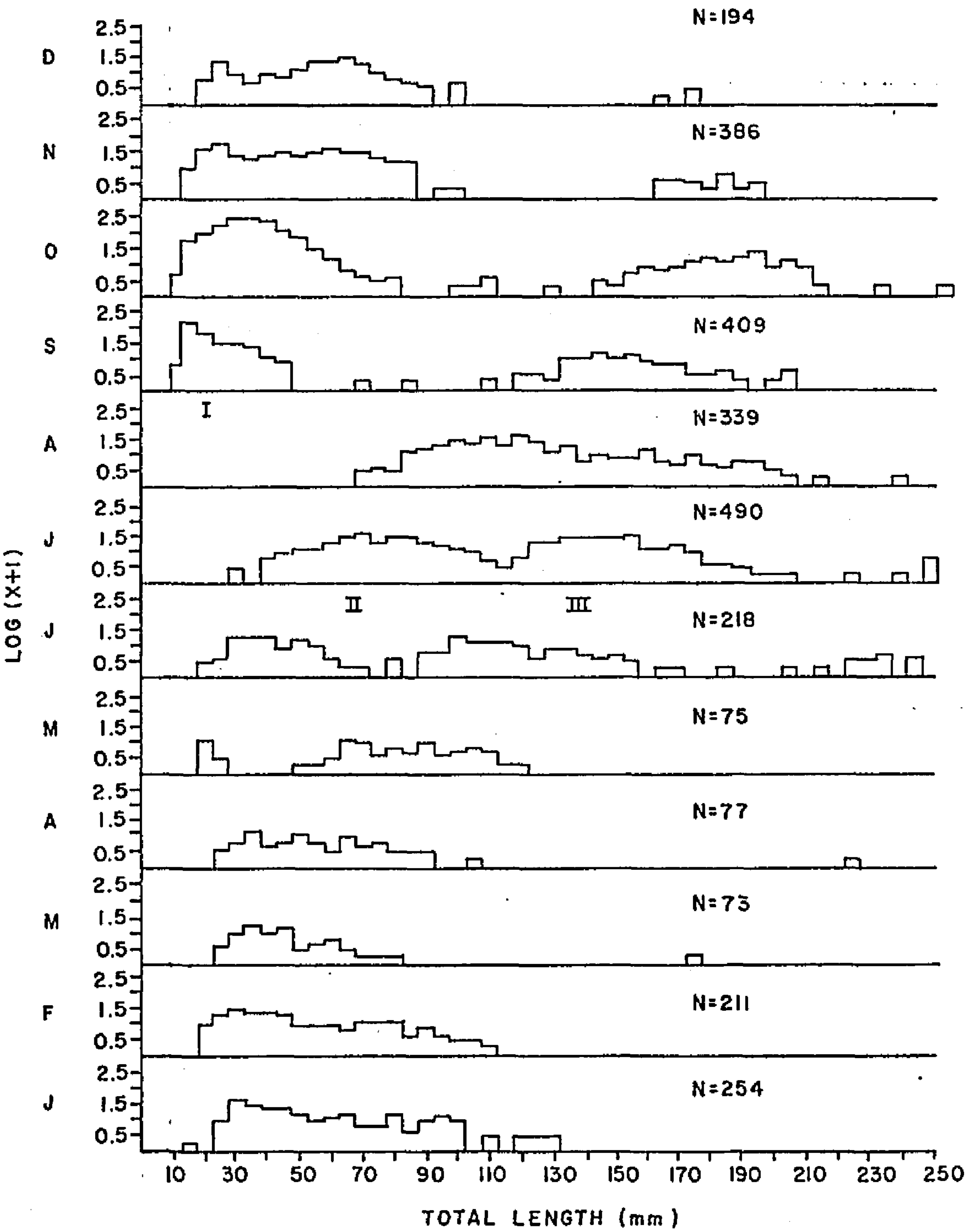
Bairdiella chrysoura August to October, 1972-1974

Fig. 16

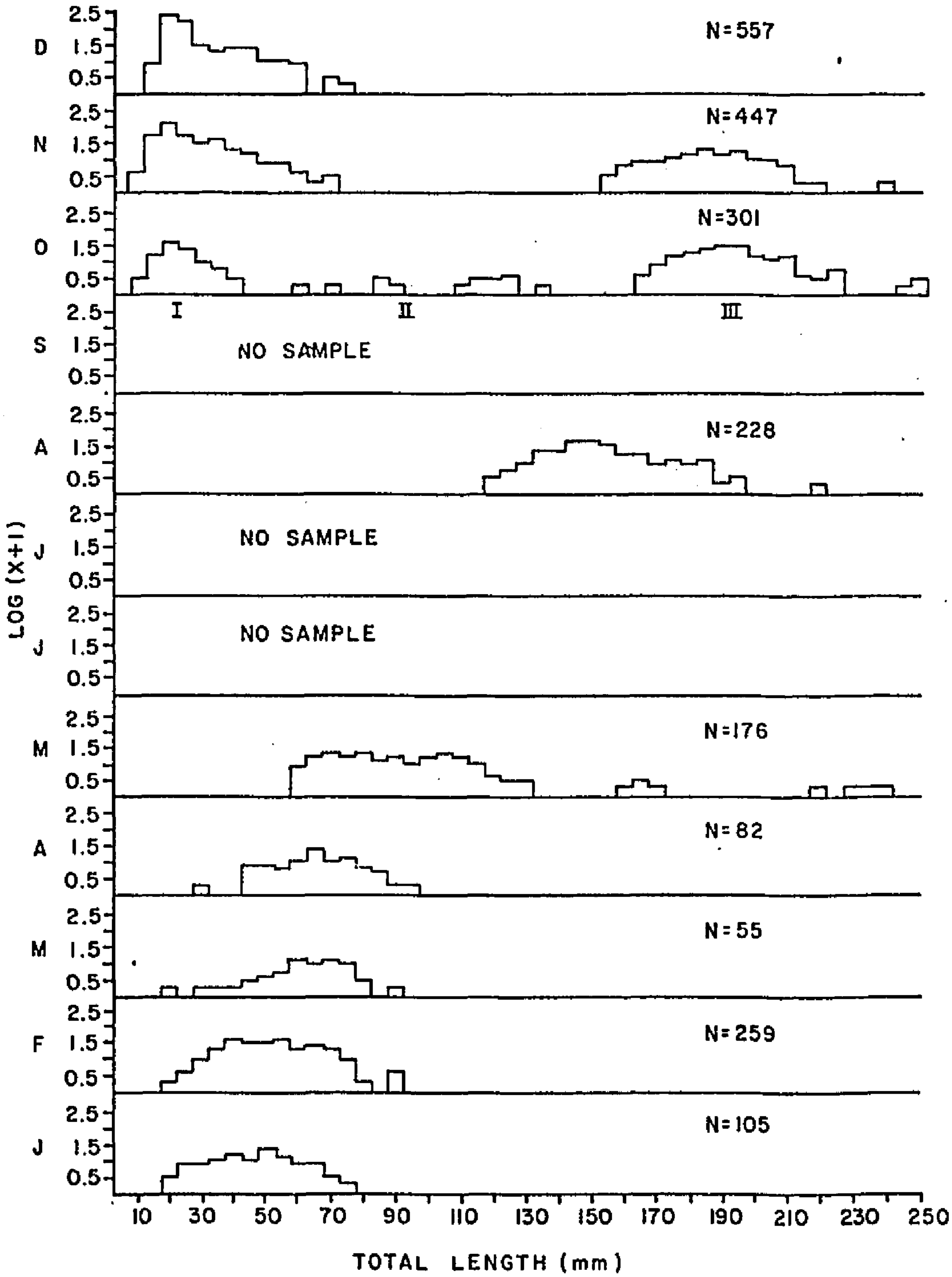
Monthly length frequency distributions of croaker, *Micropogonias undulatus* from York River, 1972-74. Modes I & II, young-of-the-year; mode III, yearling. Frequencies expressed as log (x+1) at 5 mm increments. Only the lower portion of river (strata A to D) represented in 1974.



Micropogonias undulatus 1972 Total



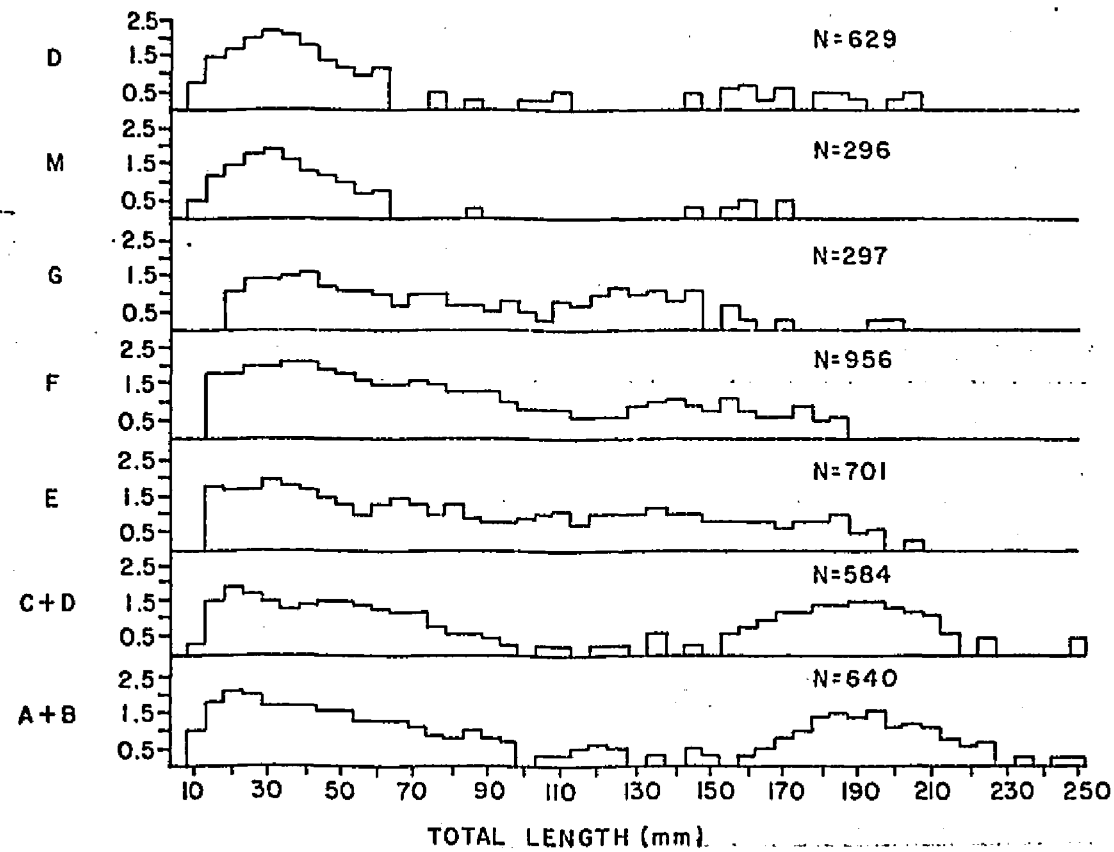
Micropogonias undulatus 1973 Total



Micropogonias undulatus 1974 Total

Fig. 17

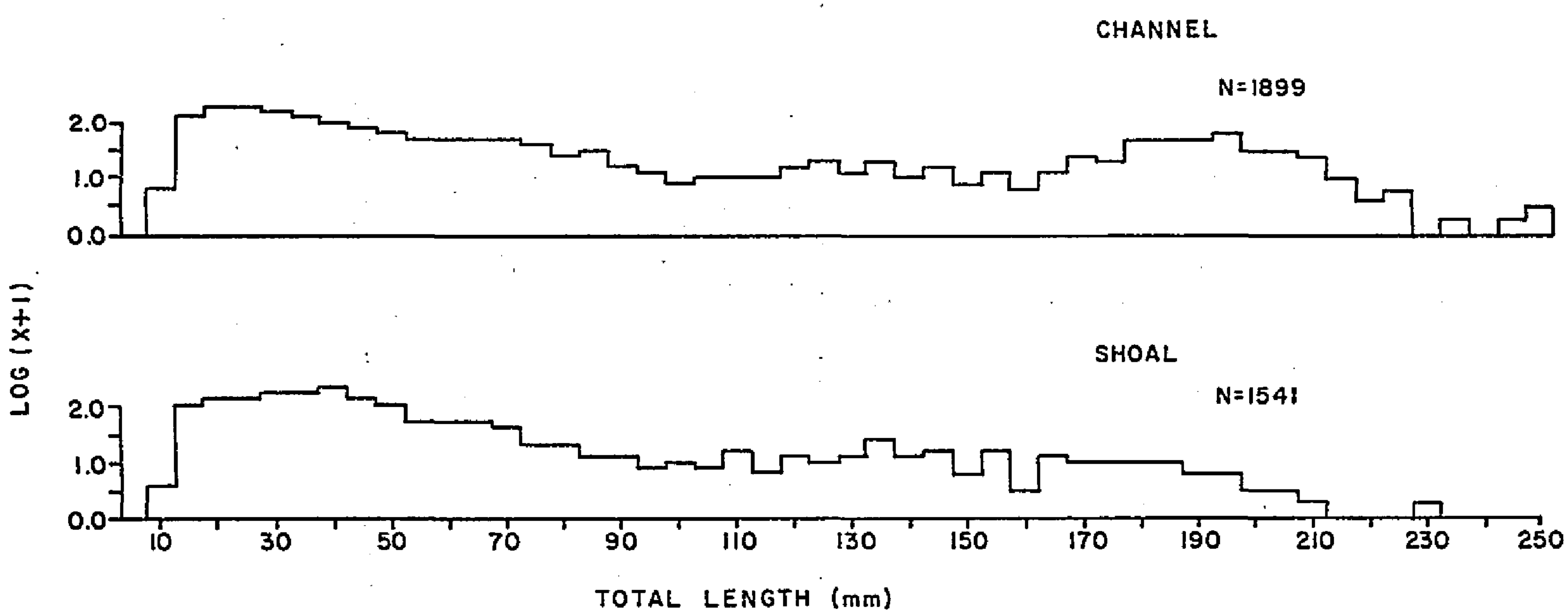
Length frequency distributions of croaker, *Micropogonias undulatus* by river distance (strata) upstream of the York River estuary. Pooled total, September to November, 1972-74. Strata: A to G in York River, M. Mattaponi River, P. Pamunkey River. Frequencies expressed as log (x+1) at 5 mm increments.



Micropogonias undulatus September to November, 1972-1974

Fig. 18

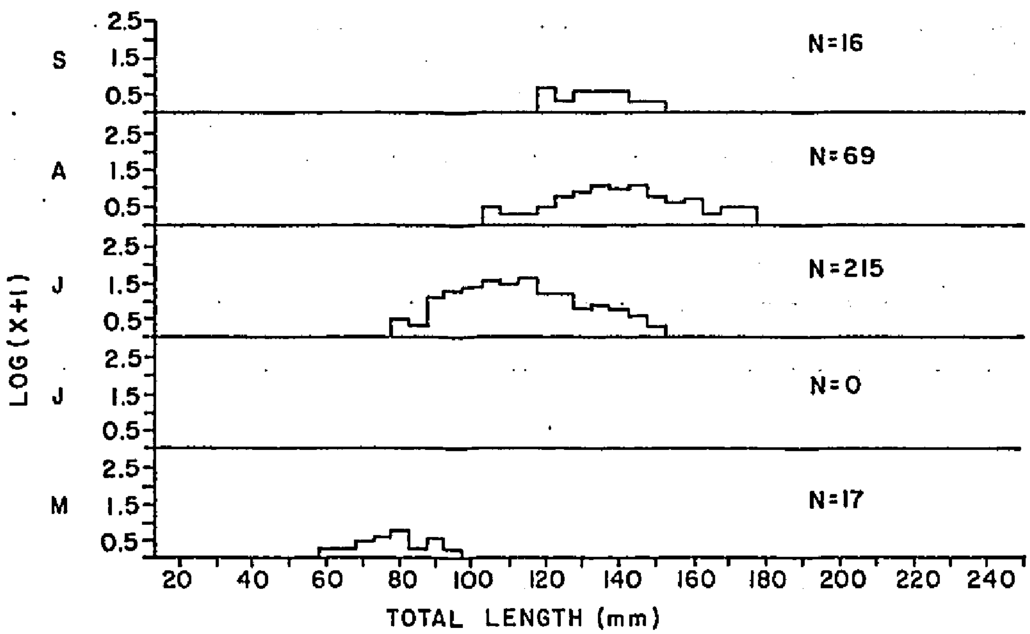
Length frequency distributions of croaker, *Micropogonias undulatus*, by depth of York River. Pooled total, September to November, 1972-74. Frequencies expressed as log (x+1) at 5 mm increments.



Micropogonias undulatus September to November, 1972-1974

Fig. 19

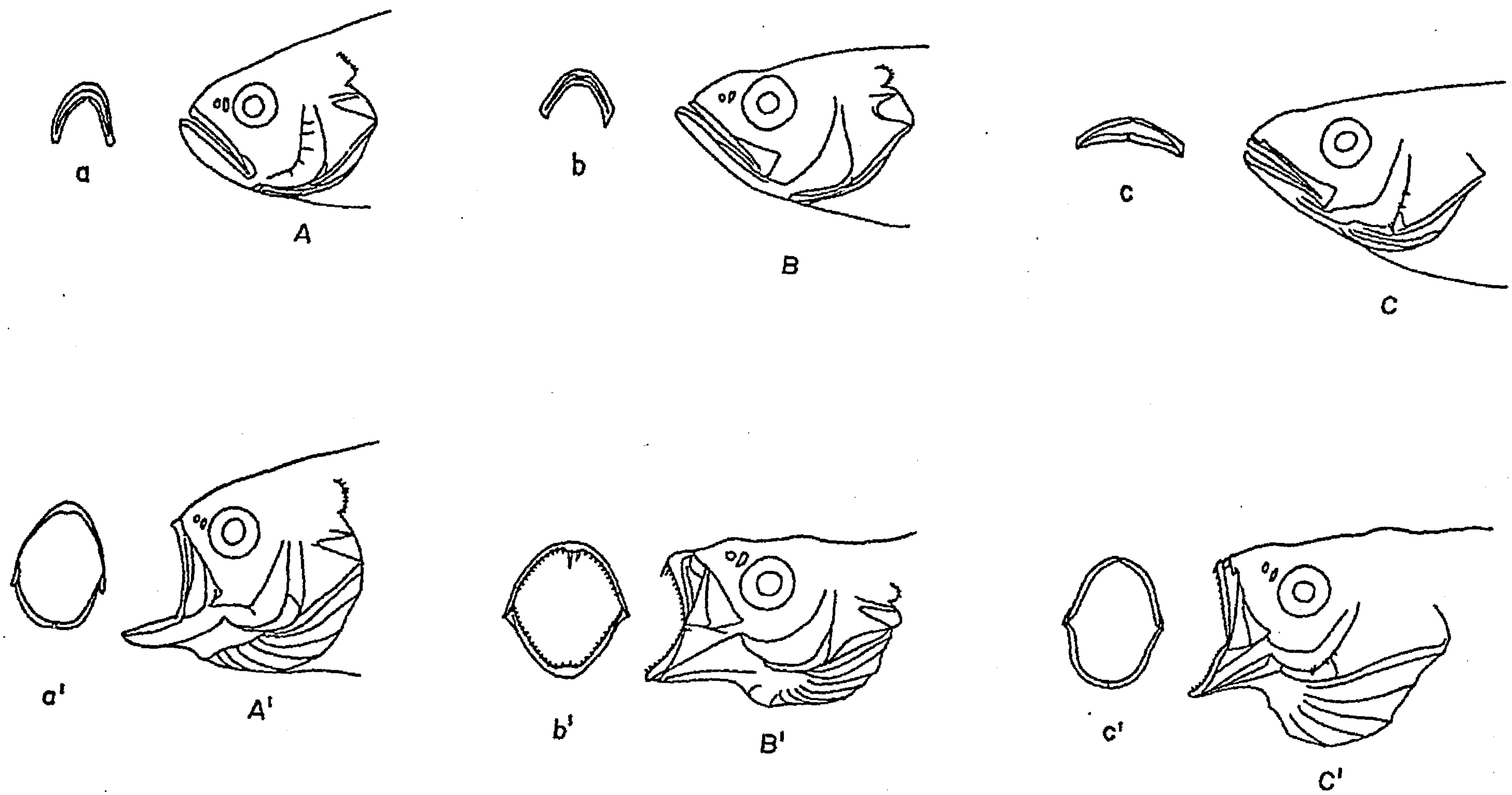
Length frequency distributions of croaker, *Micropogonias undulatus*, from beach seine catches of York River, May to September, 1972. Frequencies expressed as log (x+1) at 5 mm increments.



Micropogonias undulatus May to September 1972, Beach Seine

Fig. 20

Mouth position and opening in six species of juvenile sciaenids from York River. A, A', a & a', *Larimus fasciatus*; B, B', b & b', *Cynoscion regalis*; C, C', c & c', *Bairdiella chrysoura*; D, D', d & d', *Micropogonias undulatus*; E, E', e & e', *Menticirrhus saxatilis*; F, F', f & f', *Leiostomus xanthurus*. A, B, C, D, E & F, mouth closed. A', B', C', D', E' & F' mouth wide open. Front view of mouth openings (lower case letters) in corresponding positions.


a
A
b
B
c
C
a'
A'
b'
B'
c'
C'

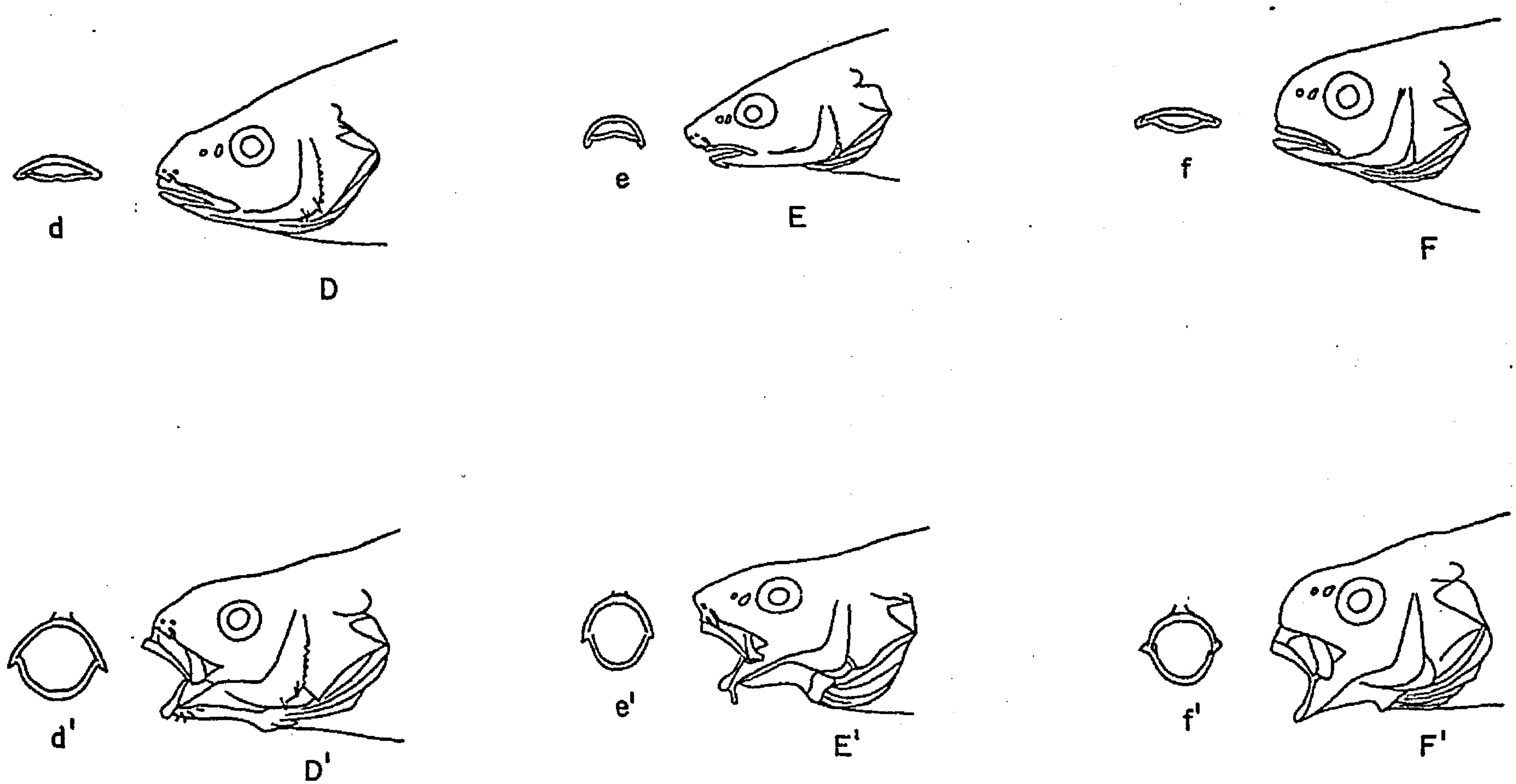

d
D
e
E
f
F
d'
D'
e'
E'
f'
F'

Fig. 21

Osteology of mouth opening in six species of juvenile sciaenids from York River. A. *Larimus fasciatus*; B. *Cynoscion regalis*; C. *Bairdiella chrysoura*; D. *Micropogonias undulatus*; E. *Menticirrhus saxatilis*; F. *Leiostomus xanthurus*.

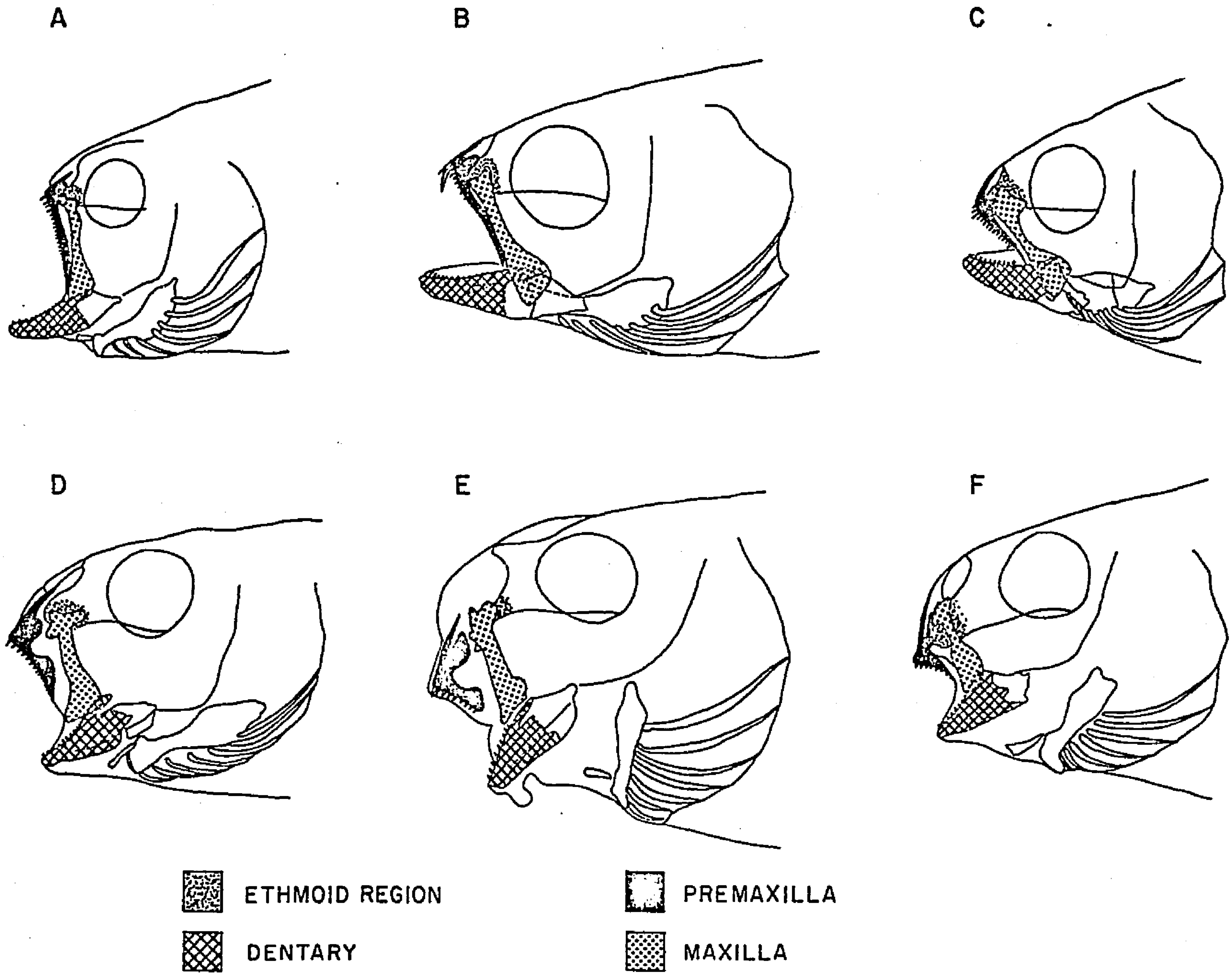
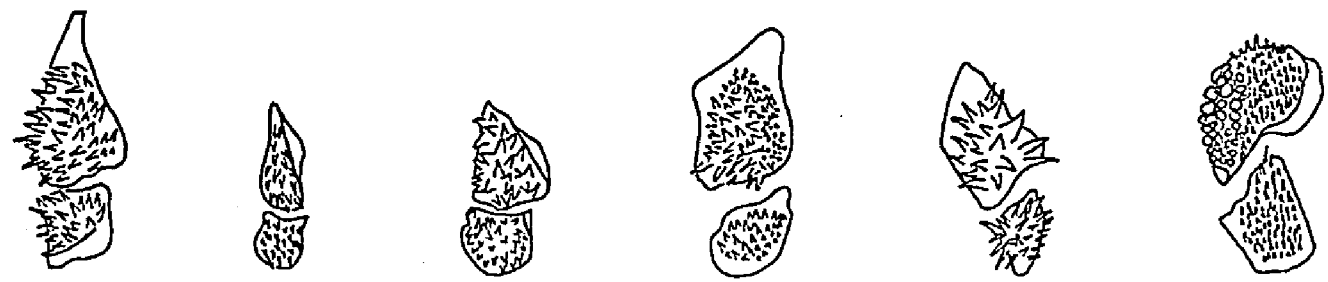
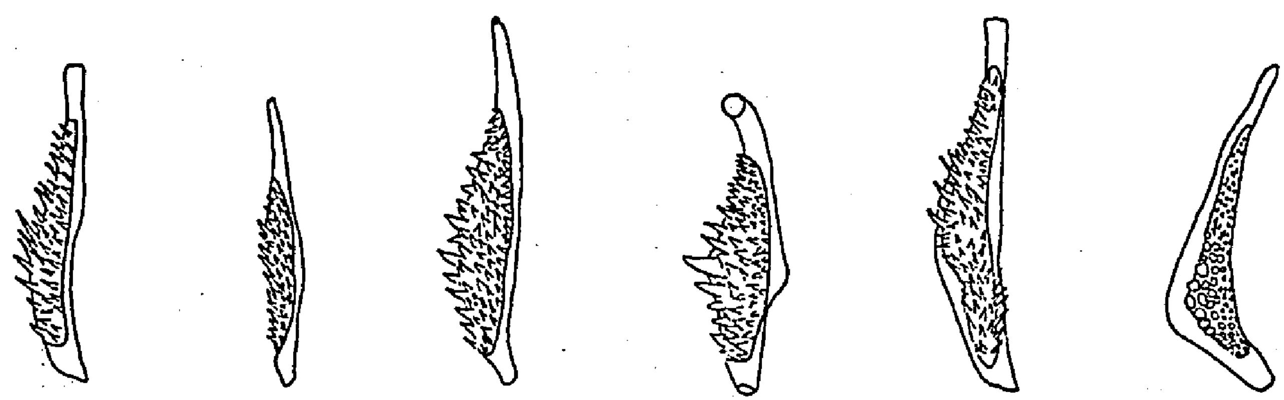

A
B
C
D
E
F
ETHMOID REGION
DENTARY
PREMAXILLA
MAXILLA

Fig. 22

Portions of right pharyngeal teeth in six species of juvenile sciaenids from York River. A. *Larimus fasciatus*; B. *Cynoscion regalis*; C. *Bairdiella chrysoura*; D. *Micropogonias undulatus*; E. *Menticirrhus saxatilis*; F. *Leiostomus xanthurus*. Anterior end toward the middle of the page.



UPPER PHARYNGEAL TEETH

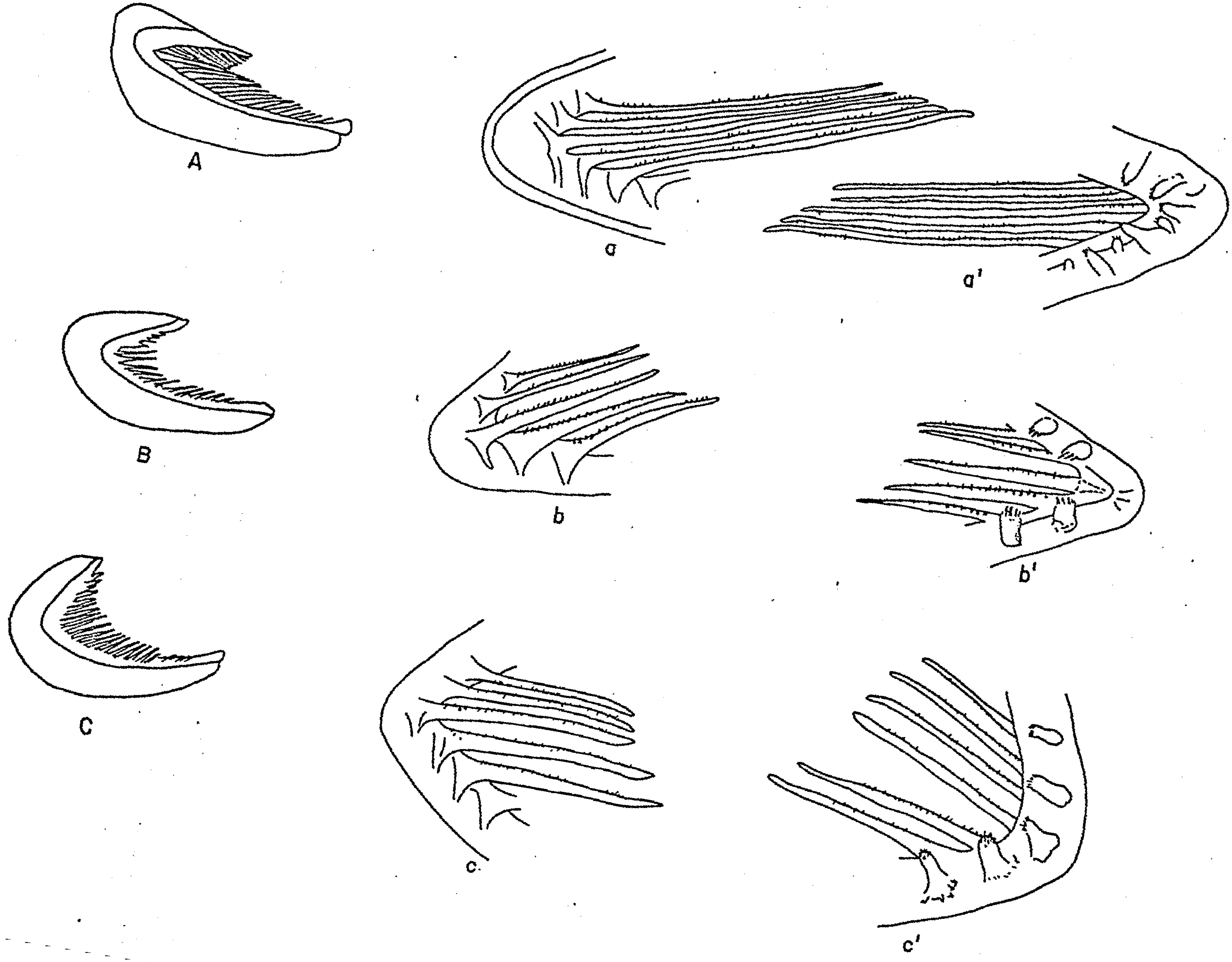


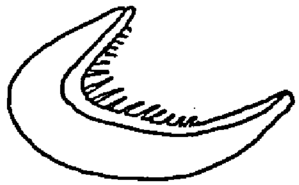
A B C D E F

LOWER PHARYNGEAL TEETH

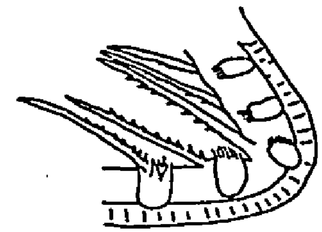
Fig. 23

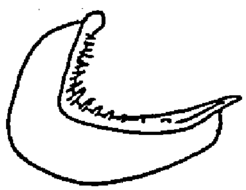
First right gill arch in six species of juvenile sciaenids from York River. A, a & a', *Larimus fasciatus*; B, b & b', *Cynoscion regalis*; C, c & c', *Bairdiella chrysoura*; D, d & d', *Micropogonias undulatus*; E, e & e', *Menticirrhus saxatilis*; F, f & f', *Leiostomus xanthurus*. a, b, c, d, e & f, lateral view at the corner; a', b', c', d', e', & f', medial view at the corner.


A
a
a'
B
b
b'
C
c
c'

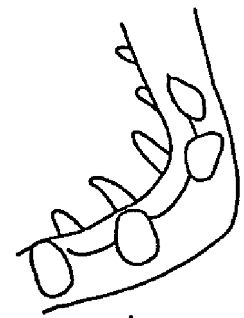

D

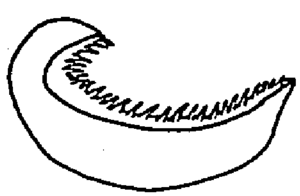

d

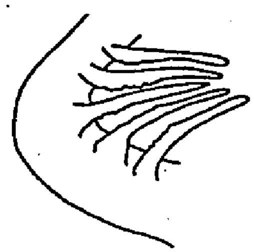

d'


E


e


e'


F


f

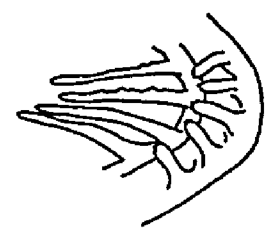

f'

Fig. 24

Ventral view of the digestive tract of six species of juvenile sciaenids from York River. A. *Larimus fasciatus*; B. *Cynoscion regalis*; C. *Bairdiella chrysoura*; D. *Micropogonias undulatus*; E. *Menticirrhus saxatilis*; F. *Leiostomus xanthurus*.

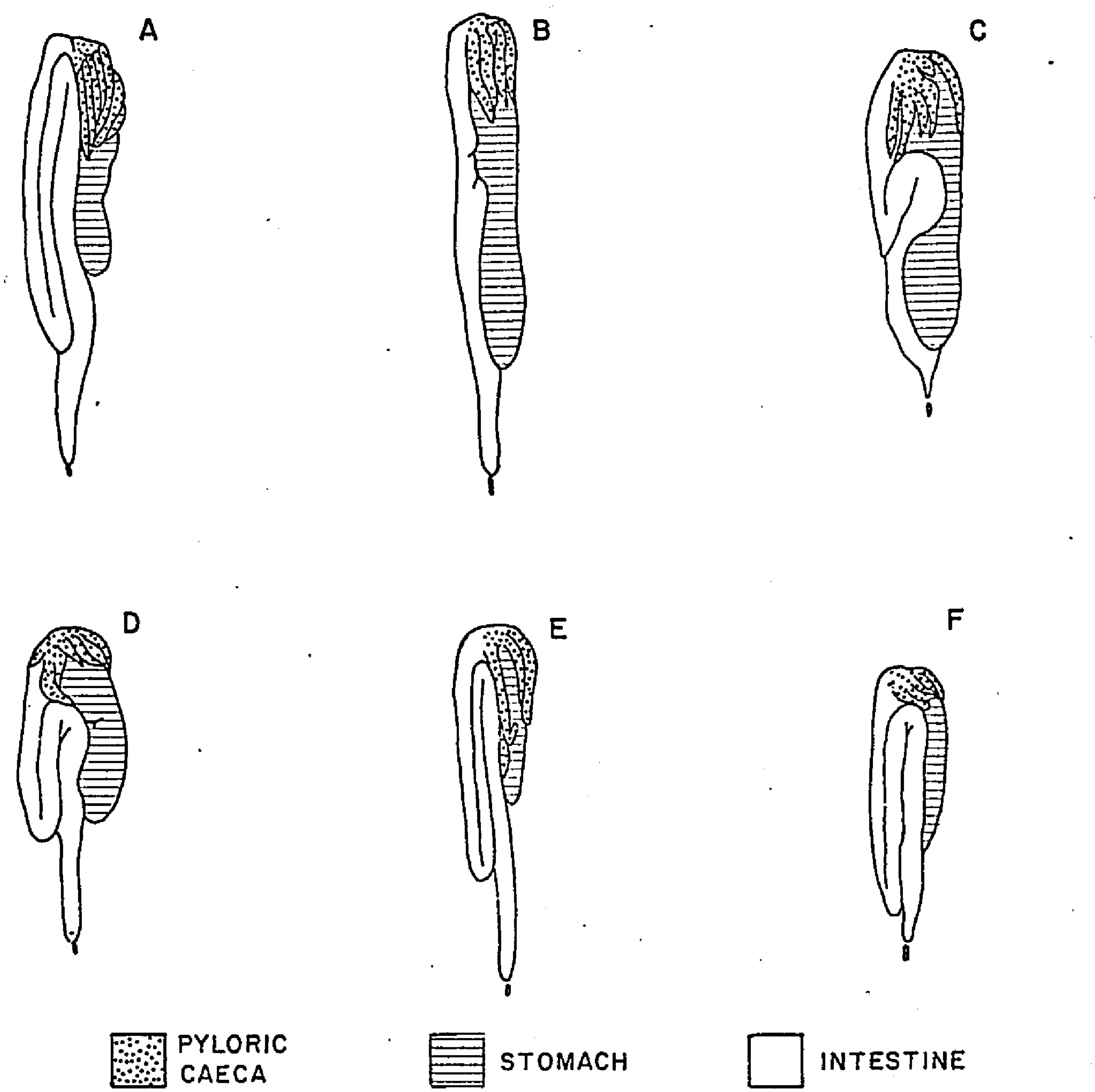

A
B
C
D
E
F
PYLORIC CAECA
STOMACH
INTESTINE

Fig. 25

Snout pores (capital letters) and mental pores and barbels (lower case letters) in six species of juvenile sciaenids from York River. A & a, *Larimus fasciatus*; B & b, *Cynoscion regalis*; C & c, *Bairdiella chrysoura*; D & d, *Micropogonias undulatus*; E & e, *Menticirrhus saxatilis*; F & f, *Leiostomus xanthurus*.

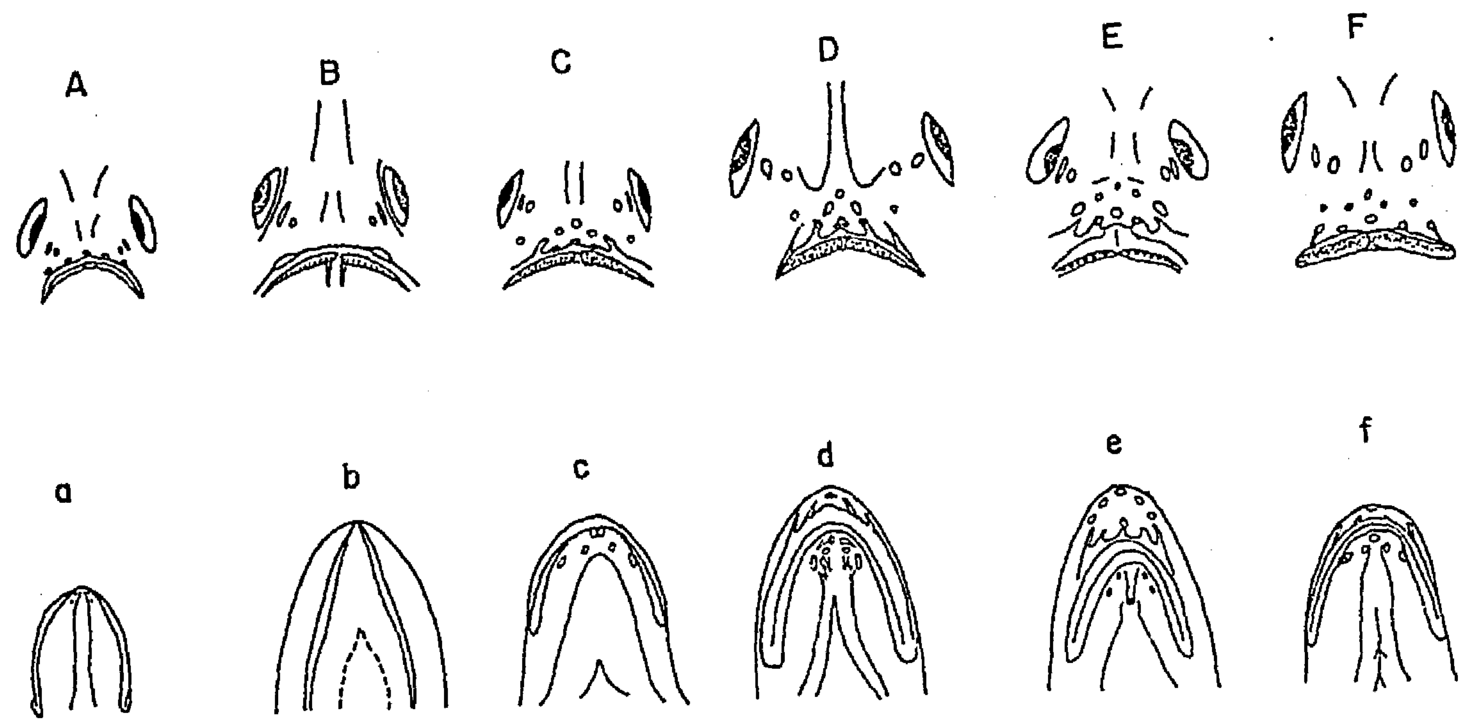

A
B
C
D
E
F
a
b
c
d
e
f

Fig. 26

Right olfactory rosette and nasal cavity in six species of juvenile sciaenids from York River. A. *Larimus fasciatus*; B. *Cynoscion regalis*; C. *Bairdiella chrysoura*; D. *Micropogonias undulatus*; E. *Menticirrhus saxatilis*; F. *Leiostomus xanthurus*. Dotted circles represent nostrils, the anterior nostril to the right.

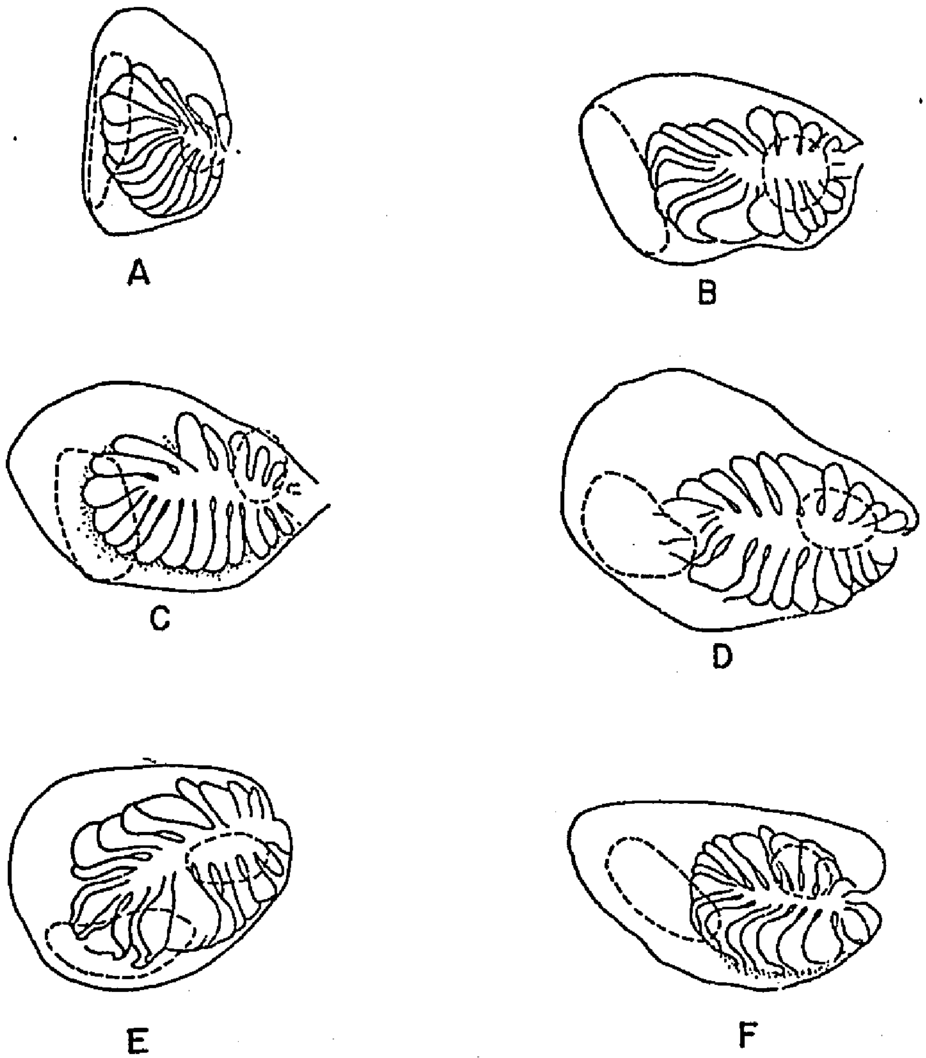
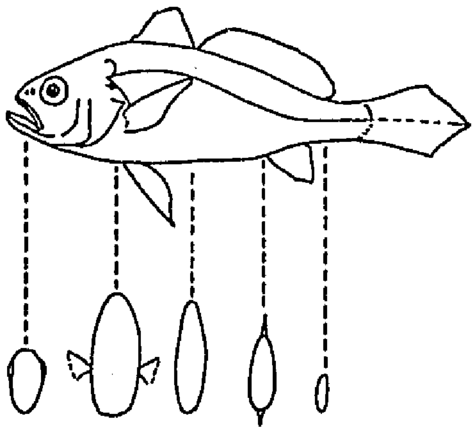
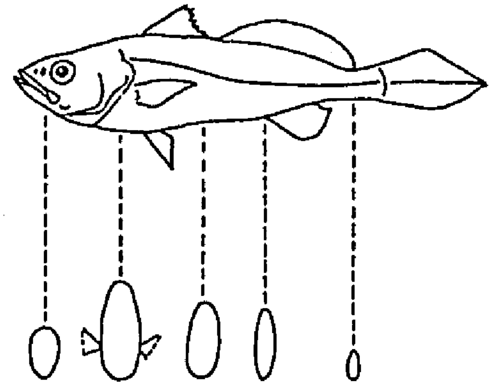

A
B
C
D
E
F

Fig. 27

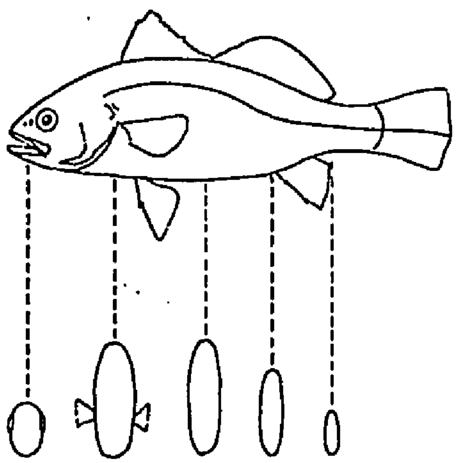
Body shape and cross sections of six species of juvenile sciaenids from York River. A. *Larimus fasciatus*; B. *Cynoscion regalis*; C. *Bairdiella chrysoura*; D. *Micropogonias undulatus*; E. *Menticirrhus saxatilis*; F. *Leiostomus xanthurus*.



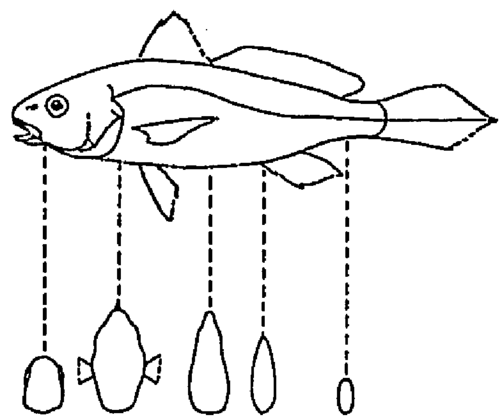
A



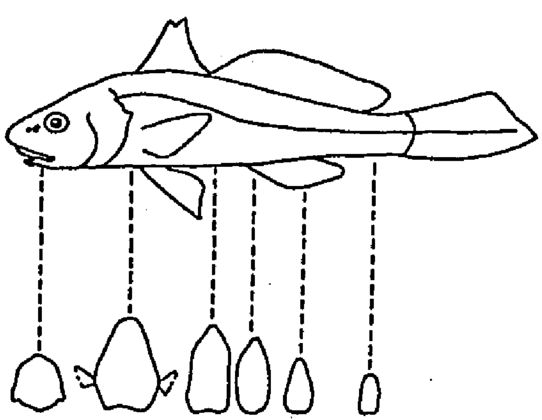
B



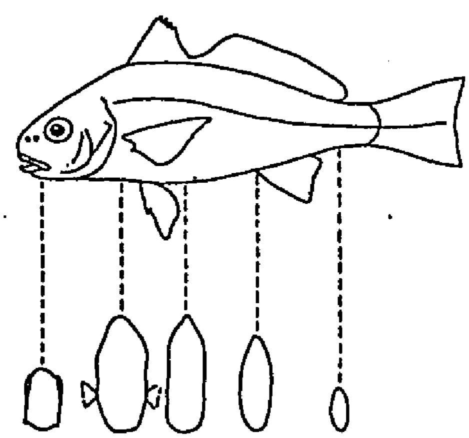
C



D



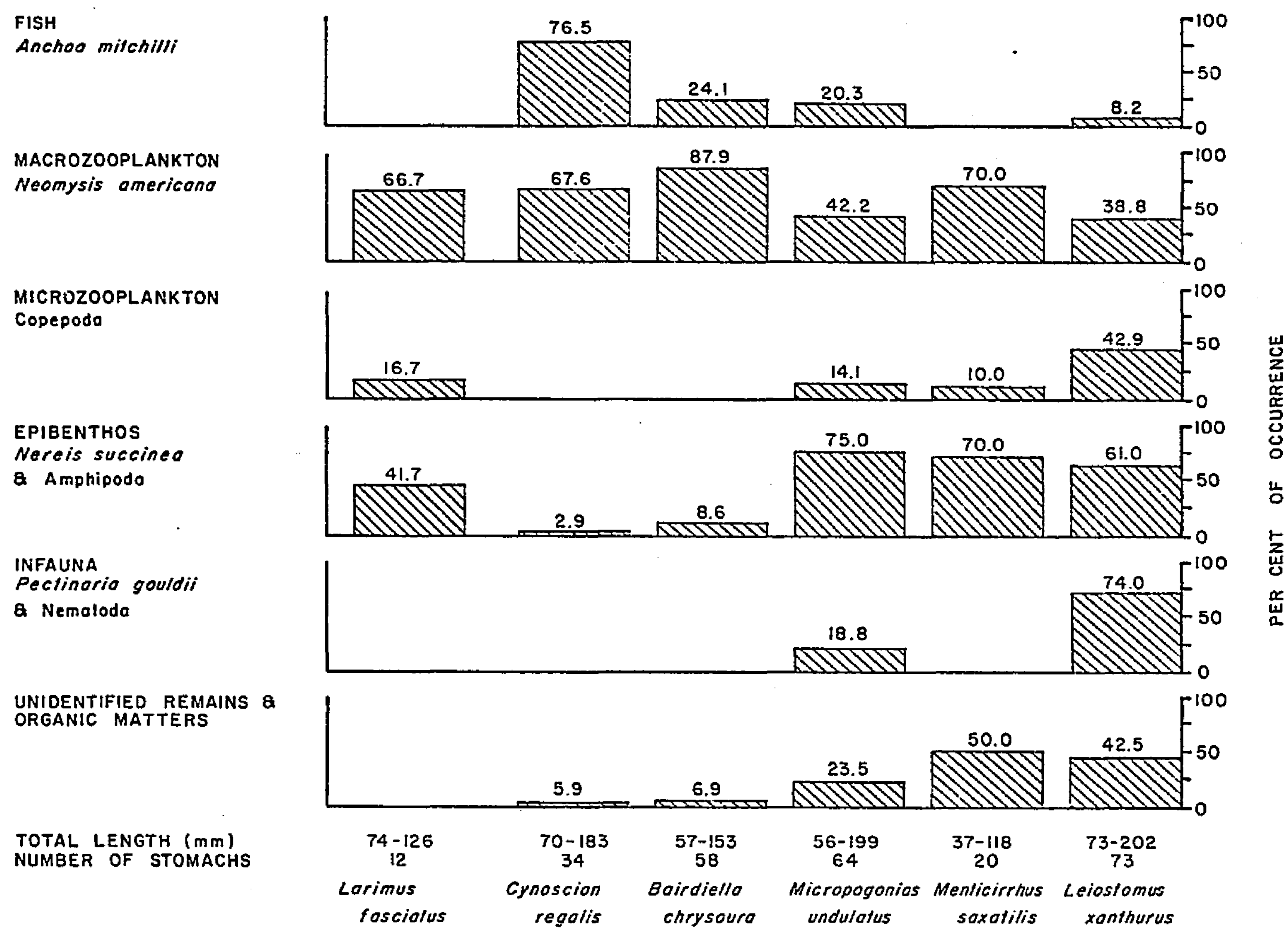
E



F

Fig. 28

Frequencies of occurrence of various categories of food groups in stomachs of six species of juvenile sciaenids from York River.


FISH
Anchoa mitchilli
MACROZOOPLANKTON
Neomysis americana
MICROZOOPLANKTON
Copepoda
EPIBENTHOS
Nereis succinea
& Amphipoda
INFAUNA
Pectinaria gouldii
& Nematoda
UNIDENTIFIED REMAINS & ORGANIC MATTERS
TOTAL LENGTH (mm)
NUMBER OF STOMACHS
76.5
24.1
20.3
8.2
66.7
67.6
87.9
42.2
70.0
38.8
16.7
14.1
10.0
42.9
41.7
2.9
8.6
75.0
70.0
61.0
18.8
74.0
5.9
6.9
23.5
50.0
42.5
0
50
100
PER CENT OF OCCURRENCE
74-126
12
70-183
34
57-153
58
56-199
64
37-118
20
73-202
73
Larimus fasciatus
Cynoscion regalis
Bairdiella chrysoura
Micropogonias undulatus
Menticirrhus saxatilis
Leiostomus xanthurus

APPENDIX

Mean surface and bottom water temperature (TEMP), salinity (SALN) and dissolved oxygen (D.O.) of the York River estuary from March 1972 to March 1974. Strata are expressed as A, B, C, D, E, F & G for the York River and M for the Mattaponi and P for Pamunkey rivers. Substrata are expressed as N (north choal), C (channel) and S (south shoal) for each stratum of the York River.

Quantitative units:

Depth; in meters.

TEMP; in ^{o}C.

SALN; in parts per ten thousand for strata A to D, others in .

D.O.; in one tenth of mg/l for strata A to D, others in mg/l.

YEAR = 72 MONTH = 03

SURFACE

	TEMP					SALN					D.O.				
	MEAN	MAX	MIN	S D	NO	MEAN	MAX	MIN	S D	NO	MEAN	MAX	MIN	S D	NO
A-N	10.4	11.5	10.0	0.67	11	169	173	163	3.96	11	100	108	84	9.97	11
A-C	10.0	10.0	10.0	0.00	8	163	172	117	7.52	8	94	107	10	1.67	8
A-S	10.0	10.0	10.0	0.00	6	155	172	122	3.57	6	104	106	103	1.41	6
B-N	9.7	11.0	9.0	0.86	11	164	170	159	3.75	11	100	107	63	1.88	11
B-C	9.3	10.0	9.0	0.47	6	163	170	159	4.78	6	104	106	103	1.41	6
B-S	9.1	9.5	9.0	0.19	11	152	161	146	6.04	11	103	105	100	1.76	11
C-N	9.3	10.0	9.0	0.39	11	163	168	160	3.42	11	103	105	100	1.76	11
C-C	9.0	9.0	9.0	0.00	8	153	166	144	8.47	8	103	103	102	0.50	8
C-S	10.3	14.5	9.0	2.23	14	156	164	145	8.62	14	96	107	76	0.14	14
D-N	9.5	10.0	9.0	0.40	14	138	161	123	5.58	14	96	107	76	0.14	14
D-C	9.1	9.5	9.0	0.20	10	134	140	129	3.53	10	128	410	67	4.18	10
D-S	9.6	10.0	9.0	0.43	11	134	155	119	3.43	11	103	112	93	5.04	11

BOTTOM

	DEPTH				TEMP					SALN					D.O.				
	MEAN	MAX	MIN	NO	MEAN	MAX	MIN	S D	NO	MEAN	MAX	MIN	S D	NO	MEAN	MAX	MIN	S D	NO
A-N	3	5	1	8	9.8	10.0	9.0	0.43	8	172	173	171	1.00	8	96	107	85	0.20	8
A-C	13	16	8	8	9.1	9.5	9.0	0.22	8	193	220	170	5.31	8	136	410	87	3.85	6
A-S	5	6	4	6	9.7	10.0	9.5	0.24	6	172	172	171	0.47	6	104	105	104	0.47	6
B-N	3	5	1	11	8.6	9.5	8.0	0.54	8	165	169	162	2.59	8	104	105	104	0.48	8
B-C	15	23	5	6	8.3	9.0	8.0	0.47	6	190	204	178	0.60	6	102	104	100	1.63	6
B-S	2	5	1	11	8.6	9.5	8.0	0.65	8	151	160	140	5.26	8	103	104	102	0.83	8
C-N	2	3	1	11	8.4	9.5	8.0	0.65	8	163	166	158	3.64	8	103	104	102	0.83	8
C-C	10	14	6	8	8.4	9.0	8.0	0.41	8	163	177	145	1.61	8	102	105	98	3.16	8
C-S	2	4	1	14	9.0	9.0	9.0	0.00	8	150	154	147	2.69	8	98	107	79	0.90	6
D-N	2	2	1	14	9.5	10.0	9.0	0.35	8	132	143	127	0.30	8	98	107	79	0.90	8
D-C	14	17	9	10	9.0	9.0	9.0	0.00	10	171	199	135	4.47	10	89	102	64	5.90	10
D-S	3	5	1	8	9.4	10.0	9.0	0.41	8	138	148	130	6.12	8	85	114	51	2.84	6

YEAR = 72 MONTH = 04

SURFACE

	TEMP					SALN					D.O.				
	MEAN	MAX	MIN	S D	NO	MEAN	MAX	MIN	S D	NO	MEAN	MAX	MIN	S D	NO
A-N	15.4	16.5	14.5	0.77	15	160	167	155	4.38	15	88	99	49	5.51	15
A-C	15.1	16.0	14.5	0.58	10	162	164	160	1.79	10	76	81	73	2.79	10
A-S	15.5	16.0	14.0	0.77	10	162	165	159	1.96	10	84	92	69	8.38	10
B-N	15.7	17.0	15.0	0.94	9	164	171	158	5.11	9	84	92	69	8.80	9
B-C	14.8	15.0	14.0	0.43	8	160	165	156	3.34	8	83	90	71	7.70	8
B-S	17.0	21.0	14.5	2.25	14	164	173	154	8.07	14	108	129	84	6.47	14
C-N	15.3	16.0	15.0	0.45	11	160	167	157	4.56	11	103	129	84	6.95	11
C-C	14.8	15.0	14.5	0.25	4	155	158	151	3.50	4	81	82	80	1.00	4
C-S	17.2	20.5	14.5	2.50	17	160	171	142	9.71	17	86	99	58	4.82	17
D-N	16.4	18.0	15.0	1.20	17	159	165	146	7.20	17	86	99	58	4.82	17
D-C	15.2	15.5	15.0	0.24	6	138	141	134	3.09	6	61	82	47	3.23	6
D-S	15.9	17.0	14.5	1.04	11	144	160	130	4.30	11	80	89	64	9.55	11

BOTTOM

	DEPTH				TEMP					SALN					D.O.				
	MEAN	MAX	MIN	NO	MEAN	MAX	MIN	S D	NO	MEAN	MAX	MIN	S D	NO	MEAN	MAX	MIN	S D	NO
A-N	2	5	1	15	15.1	16.0	14.0	0.71	12	159	162	156	2.61	12	87	99	58	1.70	12
A-C	12	15	7	10	12.8	13.0	12.0	0.40	10	215	233	160	7.98	10	63	82	47	2.31	10
A-S	4	5	2	10	15.1	16.0	13.0	1.11	10	162	164	160	1.36	10	80	89	64	0.01	10
B-N	3	5	1	9	14.7	15.0	14.5	0.24	6	162	163	162	0.47	6	79	89	64	9.59	6
B-C	14	18	9	8	13.1	14.0	12.0	0.74	8	167	229	160	8.28	8	68	76	54	8.62	8
B-S	1	3	1	14	14.5	16.5	13.5	1.22	8	157	160	154	3.00	8	83	87	79	3.54	8
C-N	3	5	1	11	14.5	15.0	14.0	0.35	8	160	163	157	2.38	8	83	87	79	3.54	8
C-C	11	12	10	4	13.8	14.0	13.5	0.25	4	155	162	147	7.50	4	72	74	69	2.50	4
C-S	1	3	1	17	14.3	15.0	14.0	0.47	6	150	154	144	4.32	6	64	76	50	1.43	6
D-N	2	3	1	17	14.3	14.5	14.0	0.24	6	155	160	146	5.25	6	64	78	50	1.43	6
D-C	12	14	9	6	13.8	14.0	13.5	0.24	6	147	167	136	4.38	6	52	60	47	5.56	6
D-S	3	5	2	6	14.5	14.5	14.5	0.00	6	137	139	133	2.62	6	65	88	46	6.76	6

YEAR = 72 MONTH = 05

SURFACE

	TEMP					SALN					D.O.				
	MEAN	MAX	MIN	S D	NO	MEAN	MAX	MIN	S D	NO	MEAN	MAX	MIN	S D	NO
A-N	21.1	24.0	18.0	2.92	12	150	159	134	0.15	12	73	81	62	6.14	12
A-C	18.5	18.8	18.3	0.21	6	144	149	137	5.25	6	60	65	55	4.08	6
A-S	18.2	18.4	18.1	0.12	6	138	142	131	5.19	6	68	70	66	1.70	6
B-N	20.9	24.0	18.5	2.69	14	132	161	61	7.27	14	70	90	57	0.94	14
B-C	18.8	19.0	18.5	0.24	6	147	151	143	3.30	6	65	67	63	1.70	6
B-S	19.4	20.5	18.0	1.11	12	156	163	148	6.29	12	61	65	57	2.54	12
C-N	19.1	19.5	18.5	0.30	14	146	156	136	9.02	14	64	80	57	7.11	14
C-C	19.1	19.2	19.0	0.09	6	131	141	123	7.48	6	65	65	64	0.47	6
C-S	21.1	24.0	19.0	1.96	21	146	155	132	6.87	21	71	88	49	0.81	21
D-N	20.4	23.5	19.0	2.03	20	142	148	129	7.18	20	71	86	49	0.99	20
D-C	19.8	20.5	19.0	0.62	6	115	133	102	4.38	6	64	76	56	7.95	6
D-S	20.9	22.0	19.5	1.13	12	122	138	105	6.13	12	69	83	56	8.75	12

BOTTOM

	DEPTH				TEMP					SALN					D.O.				
	MEAN	MAX	MIN	NO	MEAN	MAX	MIN	S D	NO	MEAN	MAX	MIN	S D	NO	MEAN	MAX	MIN	S D	NO
A-N	3	5	1	6	18.2	18.5	18.0	0.24	6	141	150	134	6.80	6	69	80	60	6.24	6
A-C	16	18	13	6	18.0	18.0	18.0	0.00	6	172	190	150	6.66	6	64	76	56	7.95	6
A-S	3	5	2	6	18.2	18.3	18.0	0.12	6	139	142	134	3.56	6	66	67	64	1.41	5
B-N	2	3	2	8	13.5	18.5	0.1	8.19	11	147	148	147	0.43	8	65	67	55	3.50	8
B-C	10	12	9	6	18.7	19.0	18.5	0.24	6	151	155	145	3.68	6	61	63	59	1.70	6
B-S	2	2	1	6	18.3	18.5	18.0	0.24	6	149	151	148	1.29	6	59	63	56	2.94	6
C-N	2	5	1	14	18.9	19.5	18.5	0.41	8	141	144	138	2.29	8	59	68	53	4.58	8
C-C	12	24	6	6	18.5	19.0	17.5	0.68	6	164	212	151	4.87	6	52	62	44	7.48	6
C-S	2	4	1	15	19.8	21.5	19.0	1.18	6	139	140	139	0.47	6	60	76	46	7.55	8
D-N	1	2	1	14	19.0	19.0	19.0	0.00	8	135	140	129	4.63	8	60	76	46	7.55	8
D-C	12	14	10	6	19.3	19.5	19.0	0.21	6	153	171	132	3.66	6	57	75	42	3.72	6
D-S	2	4	1	12	19.8	20.5	19.3	0.52	6	112	120	105	6.13	6	61	66	56	3.40	6

YEAR = 72 MONTH = 06

SURFACE

	TEMP					SALN					D.O.				
	MEAN	MAX	MIN	S D	NO	MEAN	MAX	MIN	S D	NO	MEAN	MAX	MIN	S D	NO
A-N	23.5	23.5	23.5	0.00	6	156	156	156	0.00	6	80	80	80	0.00	6
B-N	27.0	27.0	27.0	0.00	6	150	150	150	0.00	6	92	92	92	0.00	6
B-S	25.0	25.0	25.0	0.00	6	159	159	159	0.00	6	81	85	77	4.00	6
C-N	24.0	24.0	24.0	0.00	6	156	156	156	0.00	6	81	85	77	4.00	6
C-S	23.2	31.0	24.0	3.43	10	155	159	148	5.39	10	74	83	62	7.94	10
D-N	24.0	24.0	24.0	0.00	5	142	142	142	0.00	5	80	80	80	0.00	5
D-S	27.0	27.0	27.0	0.00	6	151	151	151	0.00	6	106	106	106	0.00	6

BOTTOM

	DEPTH				TEMP					SALN					D.O.				
	MEAN	MAX	MIN	NO	MEAN	MAX	MIN	S D	NO	MEAN	MAX	MIN	S D	NO	MEAN	MAX	MIN	S D	NO
B-N	1	1	1	6															
B-S	1	1	1	6															
C-N	1	1	1	6															
C-S	1	1	1	10															
D-S	1	1	1	6															

YEAR = 72 MONTH = 06

SURFACE

	TEMP					SAL					D.O.				
	MEAN	MAX	MIN	S D	NO	MEAN	MAX	MIN	S D	NO	MEAN	MAX	MIN	S D	NO
E-N	24.0				1	13.97				1	6.80				1
E-C	24.30	24.6	24.0	0.300	2	5.77	9.33	2.21	3.460	2	6.60	7.90	5.30	1.300	2
E-S	24.0				1	12.71				1	8.70				1
F-N	25.25	25.5	25.0	0.250	2	7.46	8.16	6.76	0.700	2	6.60	6.60	6.60	0.000	2
F-C	24.25	25.5	24.0	0.559	6	3.46	7.63	0.27	2.743	6	6.33	8.20	4.90	1.176	6
F-S	25.50	26.0	25.0	0.408	3	8.46	10.61	6.16	1.820	3	7.43	7.50	7.30	0.094	3
G-N															
G-S															
P	22.85	23.2	22.5	0.494	2	0.28	0.48	0.11	0.240	2	5.00	4.00	6.00	1.410	2

BOTTOM

	DEPTH				TEMP					SALN					D.O.				
	MEAN	MAX	MIN	NO	MEAN	MAX	MIN	S D	NO	MEAN	MAX	MIN	S D	NO	MEAN	MAX	MIN	S D	NO
E-N	2.0			1	24.00				1	13.60				1	6.60				1
E-C	7.50	6.0	9.0	2	22.75	22.00	23.50	0.750	2	9.19	14.85	3.53	5.660	2	4.45	4.60	4.30	0.150	2
E-S	3.0			1	24.00				1	12.86				1	8.60				1
F-N	2.50	3.0	2.0	2	25.00	25.0	25.0	0.000	2	7.16	7.82	6.50	0.660	2	6.20	6.30	6.10	0.100	2
F-C	8.17	10.0	6.0	6	23.52	24.0	23.0	0.389	6	6.64	12.31	0.49	3.550	6	5.03	7.40	3.10	1.279	6
F-S	2.67	3.0	2.0	3	25.33	25.5	25.0	0.236	3	8.73	11.28	6.12	2.107	3	7.60	8.10	6.70	0.638	3
G-N	6.0			1	22.00				1	6.18				1	8.20				1
G-C																			
G-S																			
P	6.66	9.0	5.0	3	22.40	22.6	22.0	0.346	3	0.18	0.43	0.05	0.216	3	4.80	8.20	2.20	3.070	3

YEAR = 72 MONTH = 07

SURFACE

	TEMP					SALN					D.O.				
	MEAN	MAX	MIN	S D	NO	MEAN	MAX	MIN	S D	NO	MEAN	MAX	MIN	S D	NO
A-N	27.4	28.0	27.0	0.49	14	111	117	100	7.68	14	65	73	57	7.33	14
A-C	27.1	27.5	27.0	0.20	10	105	109	100	3.74	10	70	76	67	4.12	10
A-S	27.0	27.0	27.0	0.00	8	105	107	100	2.77	8	66	70	59	4.49	8
B-N	27.4	28.0	27.0	0.49	14	117	120	110	3.15	14	68	83	53	9.47	14
B-C	28.0	28.0	28.0	0.00	6	109	113	105	3.30	6	73	83	66	5.61	6
B-S	28.0	31.0	12.9	4.36	15	114	129	103	8.72	15	69	99	49	0.02	15
C-N	28.1	30.0	27.0	1.07	13	117	120	112	3.29	11	70	99	49	0.57	13
C-C	28.0	29.0	27.0	0.82	6	116	120	112	3.30	6	53	66	34	3.74	6
C-S	30.5	33.0	27.0	2.03	17	111	131	79	1.24	17	42	50	37	4.66	17
D-N	27.1	27.5	27.0	0.19	12	103	131	77	6.19	12	42	50	37	5.23	12
D-C	27.5	28.5	27.0	0.71	6	121	126	117	3.05	6	50	68	14	0.79	6
D-S	30.0	33.0	27.0	3.00	12	103	129	78	5.34	12	74	110	59	8.38	10

BOTTOM

	DEPTH				TEMP					SALN					D.O.				
	MEAN	MAX	MIN	NO	MEAN	MAX	MIN	S D	NO	MEAN	MAX	MIN	S D	NO	MEAN	MAX	MIN	S D	NO
A-N	2	5	1	14	27.1	28.0	26.5	0.54	8	108	120	102	7.07	8	44	50	37	5.32	8
A-C	11	12	9	10	22.8	27.0	20.0	2.71	10	210	266	106	2.38	10	40	68	12	3.60	10
A-S	3	4	2	8	26.9	27.0	26.5	0.22	8	107	112	101	4.15	8	65	70	59	4.40	8
B-N	2	4	1	14	27.0	27.0	27.0	0.00	8	126	141	111	1.08	8	65	70	59	4.40	8
B-C	10	11	9	6	24.8	26.5	22.0	2.01	6	178	250	132	1.73	6	40	61	23	3.85	6
B-S	2	3	1	9	25.6	27.5	13.0	4.46	9	115	130	109	9.60	9	58	72	50	7.45	9
C-N	3	5	1	13	27.9	29.0	27.0	0.89	8	118	116	117	0.50	4	60	72	50	6.58	6
C-C	13	23	7	6	25.5	29.0	21.5	3.08	6	160	243	114	8.60	6	45	61	16	0.34	6
C-S	2	3	1	11	26.7	27.0	26.5	0.24	6	130	131	128	1.41	6	49	52	48	1.89	6
D-N	2	3	1	12	26.5	26.5	26.5	0.00	6	130	131	129	0.94	6	49	52	48	1.89	6
D-C	15	20	10	6	22.2	23.5	21.0	1.03	6	214	237	201	6.31	6	21	30	13	6.98	6
D-S	3	4	2	6	26.0	26.5	25.0	0.71	6	134	145	126	8.16	6	46	52	39	5.31	6

YEAR = 72 MONTH = 07

SURFACE

	TEMP					SAL					D.O.				
	MEAN	MAX	MIN	S D	NO	MEAN	MAX	MIN	S D	NO	MEAN	MAX	MIN	S D	NO
E-N	30.07	30.5	29.5	0.419	3	5.33	5.77	5.08	0.312	3	9.13	9.50	8.50	0.450	3
E-C	29.78	30.5	29.0	0.501	6	5.61	9.69	3.64	1.967	6	8.63	11.10	6.20	1.595	6
E-S	29.79	31.0	29.0	0.619	8	4.82	5.53	3.67	0.680	8	8.31	11.50	5.60	1.577	8
F-N	30.88	32.0	30.0	0.740	4	1.92	3.31	0.65	0.971	4	6.45	7.20	5.80	0.610	4
F-C	30.13	30.5	29.5	0.415	4	1.76	2.32	1.23	0.535	4	4.17	6.50	3.00	1.429	4
F-S	30.30	31.0	30.0	0.400	5	3.34	4.28	2.23	0.783	5	5.40	6.30	3.30	1.092	5
G-N	30.93	31.5	30.3	0.492	3	2.59	6.88	0.37	3.034	3	4.60	5.50	3.80	0.698	3
G-C															
G-S	29.97	30.9	29.5	0.660	3	1.14	1.16	1.13	0.014	3	4.90	6.10	4.30	0.849	3

BOTTOM

	DEPTH				TEMP					SALN					D.O.				
	MEAN	MAX	MIN	NO	MEAN	MAX	MIN	S D	NO	MEAN	MAX	MIN	S D	NO	MEAN	MAX	MIN	S D	NO
E-N	2.00	2.0	2.0	3	29.67	30.5	28.5	0.850	3	6.25	8.01	5.26	1.250	3	8.23	10.10	5.70	1.857	3
E-C	9.33	11.0	7.0	6	26.50	30.0	25.0	1.893	6	12.60	13.67	9.97	1.244	6	2.63	3.50	2.00	0.531	6
E-S	2.50	3.0	2.0	8	27.94	31.5	25.5	1.828	8	7.81	12.84	5.01	3.077	8	5.05	8.80	2.50	2.045	8
F-N	2.00	2.0	2.0	4	30.20	30.5	30.0	0.212	4	2.19	3.31	1.34	0.711	4	5.95	7.10	4.00	1.167	4
F-C	6.75	9.0	5.0	4	27.13	27.5	26.5	0.415	4	10.34	10.98	9.91	0.457	4	2.57	3.40	2.10	0.492	4
F-S	2.20	3.0	1.0	5	29.5	31.0	27.0	1.304	5	5.01	9.30	2.91	2.336	5	4.54	6.10	2.50	1.237	5
G-N	1.67	2.0	1.0	3	29.57	30.5	28.7	0.736	3	2.55	4.12	0.71	1.405	3	3.20	3.40	3.10	0.141	3
G-C																			
G-S	2.00	2.0	2.0	3	29.67	30.0	29.0	0.471	3	1.44	2.21	1.06	0.542	3	4.13	4.20	4.00	0.094	3

YEAR = 72 MONTH = 08

SURFACE

	TEMP					SALN					D.O.				
	MEAN	MAX	MIN	S D	NO	MEAN	MAX	MIN	S D	NO	MEAN	MAX	MIN	S D	NO
A-N	27.9	31.0	25.8	2.21	18	164	181	149	2.71	18	90	120	48	3.60	18
A-C	26.9	27.0	26.6	0.16	8	161	185	176	2.59	8	81	93	71	9.50	8
A-S	26.0	27.0	20.1	2.00	10	130	181	178	1.20	10	86	97	60	6.94	8
B-N	27.3	30.5	25.4	2.38	14	166	180	150	3.78	14	100	120	60	7.74	14
B-C	26.0	26.1	25.8	0.12	6	176	177	173	1.89	6	55	56	52	1.89	6
B-S	26.3	27.7	25.5	0.90	13	165	177	152	0.93	13	72	97	53	4.79	13
C-N	27.1	28.0	25.7	0.93	14	160	176	140	7.43	14	74	57	53	5.63	14
C-C	26.1	26.5	25.7	0.33	6	180	183	177	2.49	6	60	64	52	5.44	6
C-S	26.9	28.0	26.0	0.85	16	156	171	146	0.06	16	73	67	38	4.79	16
D-N	27.9	29.0	26.8	0.95	14	153	163	135	5.41	14	72	87	38	5.30	14
D-C	26.7	26.8	26.5	0.14	6	169	172	164	3.40	6	54	64	30	1.55	6
D-S	27.4	27.8	26.9	0.28	12	147	169	127	0.06	12	74	87	48	4.55	12

BOTTOM

	DEPTH				TEMP					SALN					D.O.				
	MEAN	MAX	MIN	NO	MEAN	MAX	MIN	S D	NO	MEAN	MAX	MIN	S D	NO	MEAN	MAX	MIN	S D	NO
A-N	4	6	2	12	26.1	25.8	25.3	0.49	12	178	192	162	1.09	12	70	87	38	5.65	12
A-C	12	13	12	8	25.4	25.5	25.3	0.07	8	198	199	197	0.67	8	51	64	30	2.52	8
A-S	4	6	3	10	26.1	26.6	25.7	0.33	10	185	197	179	6.47	10	71	87	48	4.56	10
B-N	3	5	1	14	25.8	26.4	25.2	0.43	8	178	179	176	1.30	8	67	87	48	3.63	8
B-C	14	21	10	6	25.5	25.9	25.0	0.37	6	186	200	176	0.08	6	40	56	28	1.67	6
B-S	2	5	1	13	26.6	27.6	25.6	0.72	8	176	176	175	0.43	8	64	69	57	4.27	8
C-N	2	4	1	14	26.2	27.0	25.4	0.73	8	178	182	173	3.19	8	64	69	57	4.27	8
C-C	7	8	7	6	25.5	25.9	25.0	0.37	6	186	190	183	2.94	6	39	58	29	3.44	6
C-S	2	3	1	16	26.7	26.9	26.3	0.21	6	170	171	169	0.82	6	54	58	52	2.62	6
D-N	2	2	1	14	27.0	27.3	26.5	0.31	8	169	177	163	5.12	8	53	58	41	5.15	8
D-C	12	13	11	6	25.8	25.8	25.7	0.05	6	185	188	181	2.67	6	34	38	28	4.19	6
D-S	3	5	2	6	26.5	27.2	26.0	0.50	6	176	186	167	7.79	6	47	61	31	2.28	6

YEAR = 72 MONTH = 08

SURFACE

	TEMP					SAL					D.O.				
	MEAN	MAX	MIN	S D	NO	MEAN	MAX	MIN	S D	NO	MEAN	MAX	MIN	S D	NO
E-N	26.26	26.50	26.2	0.120	5	12.15	12.56	10.94	0.701	5	7.62	7.90	7.10	0.271	5
E-C	26.96	27.10	26.4	0.232	7	11.69	12.45	10.79	0.889	7	8.16	9.30	7.20	0.880	7
E-S	27.19	27.90	26.3	0.428	8	11.01	12.10	10.19	0.645	8	7.51	9.00	5.80	1.171	8
F-N	27.12	27.20	26.90	0.130	4	10.79	11.61	9.80	0.713	4	7.25	7.80	6.50	0.532	4
F-C	26.93	28.1	26.0	0.696	7	10.95	11.8	9.59	0.732	7	7.43	10.3	6.30	1.322	7
F-S	27.08	29.0	26.4	0.709	11	10.68	11.59	9.89	0.653	11	6.67	9.00	5.50	0.985	11
G-N	27.20	28.0	26.7	0.572	3	7.78	9.19	5.75	1.470	3	7.33	7.70	7.00	0.287	3
G-C	26.70	27.2	26.2	0.500	2	7.21	7.53	6.90	0.315	2	6.65	7.80	5.50	1.150	2
G-S	25.90	25.9	25.9	0.000	2	7.02	8.05	5.99	1.030	2	5.75	6.10	5.40	0.350	2
P	28.3				1	4.82				1	8.8				1

BOTTOM

	DEPTH				TEMP					SALN					D.O.				
	MEAN	MAX	MIN	NO	MEAN	MAX	MIN	S D	NO	MEAN	MAX	MIN	S D	NO	MEAN	MAX	MIN	S D	NO
E-N	2.00	2.0	2.0	5	26.16	26.2	26.0	0.080	5	13.46	16.03	11.88	1.373	5	5.68	6.10	4.60	0.588	5
E-C	8.71	11.0	6.0	7	25.84	26.8	24.8	0.597	7	17.83	20.21	16.61	1.304	7	1.59	2.40	0.80	0.528	7
E-S	2.38	4.0	1.0	8	27.07	28.0	26.7	0.397	8	11.92	15.65	10.74	1.574	8	5.56	6.70	3.40	1.226	8
F-N	1.50	2.0	1.0	4	28.02	28.30	27.90	0.164	4	10.73	11.44	9.79	0.632	4	6.67	7.70	5.50	0.944	4
F-C	8.57	11.0	5.0	7	26.51	28.00	24.90	1.100	7	14.70	17.24	12.20	1.593	7	2.47	4.00	1.50	0.770	7
F-S	2.09	4.0	1.0	11	27.68	28.90	26.70	0.709	11	11.18	12.94	9.83	1.675	11	5.43	7.20	3.50	0.991	11
G-N	3.00	4.0	2.0	3	27.40	27.60	27.20	0.141	3	8.52	9.87	6.32	1.569	3	5.03	5.80	4.30	0.613	3
G-C	4.50	5.0	4.0	2	27.25	27.50	27.00	0.250	2	8.46	8.72	8.20	0.260	2	4.25	4.50	4.00	0.250	2
G-S	2.00	2.0	2.0	2	26.05	26.10	26.00	0.05	2	7.66	8.60	6.72	0.940	2	4.85	5.60	4.10	0.750	2
P	3.5	2.0	5.0	2	27.20	27.40	27.00	0.200	2	6.55	7.10	6.01	0.540	2	5.30	6.00	4.60	0.700	2

YEAR = 72   MONTH = 09

SURFACE

	TEMP					SALN					D.O.				
	MEAN	MAX	MIN	S D	NO	MEAN	MAX	MIN	S D	NO	MEAN	MAX	MIN	S D	NO
A-N	20.7	21.5	19.0	0.97	16	183	189	176	4.95	16	78	89	65	0.37	16
A-C	21.2	21.5	21.0	0.24	10	188	190	184	2.40	10	84	96	79	5.99	10
A-S	20.8	21.5	20.0	0.56	8	190	192	186	1.79	8	74	87	58	0.36	8
B-N	21.1	22.0	20.0	0.83	14	183	188	177	5.35	14	75	87	58	6.07	14
B-C	21.0	21.0	21.0	0.00	6	191	192	191	0.47	6	64	75	56	8.18	6
B-S	21.1	22.0	20.0	0.78	13	183	191	175	6.43	13	72	89	49	2.09	13
C-N	21.5	22.6	20.0	0.82	14	182	195	173	8.36	14	71	89	49	1.75	14
C-C	21.7	22.5	21.0	0.62	6	193	205	183	9.09	6	75	82	71	4.78	6
C-S	22.9	26.0	21.0	1.63	17	178	187	173	6.33	17	79	92	57	1.71	17
D-N	21.2	22.0	19.5	0.84	14	172	185	163	8.50	14	80	92	57	1.53	14
D-C	21.3	21.5	21.0	0.24	6	177	184	170	5.73	6	62	70	49	7.34	6
D-S	21.3	22.0	20.5	0.69	12	163	174	156	7.27	12	68	89	47	6.46	12

BOTTOM

	DEPTH				TEMP					SALN					D.O.				
	MEAN	MAX	MIN	NO	MEAN	MAX	MIN	S D	NO	MEAN	MAX	MIN	S D	NO	MEAN	MAX	MIN	S D	NO
A-N	4	6	2	10	20.0	21.0	19.0	0.71	10	187	197	176	6.93	10	86	92	74	6.83	10
A-C	12	14	11	10	21.7	22.0	21.0	0.40	10	230	238	222	6.58	10	56	70	41	9.65	10
A-S	4	6	2	8	20.8	21.0	20.0	0.43	8	191	198	188	3.96	8	73	89	47	6.87	8
B-N	2	5	1	14	20.0	20.5	19.5	0.35	8	188	188	187	0.50	8	73	89	47	6.67	8
B-C	12	15	8	6	21.7	22.0	21.5	0.24	6	206	210	198	5.44	6	62	106	40	0.88	6
B-S	2	5	1	13	20.6	21.0	20.0	0.41	8	188	191	184	2.49	8	72	86	58	0.40	8
C-N	2	5	1	14	20.8	22.0	19.5	0.90	8	188	190	186	1.58	8	72	86	56	0.40	8
C-C	9	12	7	6	21.8	22.0	21.5	0.24	6	192	200	185	5.44	6	65	71	59	4.92	6
C-S	2	5	1	17	22.5	24.0	21.5	1.06	6	187	187	187	0.00	6	65	86	52	1.51	6
D-N	2	4	1	14	20.8	21.0	20.0	0.43	8	186	191	181	3.57	8	64	86	52	9.98	8
D-C	11	12	11	6	22.2	22.5	22.0	0.24	6	225	230	218	5.10	6	54	57	52	2.16	6
D-S	6	62	1	12	20.5	20.5	20.5	0.00	6	171	174	168	2.45	6	61	76	46	2.26	6

YEAR = 72 MONTH = 09

SURFACE

	TEMP					SAL					D.O.				
	MEAN	MAX	MIN	S D	NO	MEAN	MAX	MIN	S D	NO	MEAN	MAX	MIN	S D	NO
E-N	23.45	23.6	23.3	0.150	4	16.85	17.55	16.28	0.548	4	5.62	5.90	4.90	0.421	4
E-C	23.33	23.4	23.3	0.045	7	16.81	16.99	16.45	0.162	7	5.77	6.50	5.40	0.353	7
E-S	22.70	23.4	22.20	0.576	4	16.52	16.83	16.22	0.262	4	6.37	6.90	5.90	0.476	4
F-N															
F-C															
F-S															
G-N															
G-C															
G-S															

BOTTOM

	DEPTH				TEMP					SALN					D.O.				
	MEAN	MAX	MIN	NO	MEAN	MAX	MIN	S D	NO	MEAN	MAX	MIN	S D	NO	MEAN	MAX	MIN	S D	NO
E-N	1.50	2.0	1.0	4	23.07	23.3	23.0	0.130	4	17.07	17.58	16.47	0.462	4	5.60	6.00	5.20	0.316	4
E-C	7.71	10.0	5.0	7	23.14	23.2	23.1	0.049	7	17.22	17.30	17.03	0.088	7	5.84	6.40	5.10	0.545	7
E-S	3.00	4.0	2.0	4	22.87	23.1	22.8	0.130	4	16.71	17.13	16.32	0.379	4	6.23	6.70	5.60	0.464	4
F-N																			
F-C																			
F-S																			
G-N																			
G-C																			
G-S																			

YEAR = 72 MONTH = 10

SURFACE

	TEMP					SALT					D.O.				
	MEAN	MAX	MIN	S D	NO	MEAN	MAX	MIN	S D	NO	MEAN	MAX	MIN	S D	NO
A-N	15.5	17.0	13.9	1.45	12	182	188	178	4.42	12	69	102	82	7.99	12
A-C	14.7	15.1	14.0	0.48	6	187	189	185	1.70	6	84	97	77	9.20	6
A-S	14.7	14.9	14.6	0.15	4	188	188	187	0.50	4	91	108	74	7.00	4
B-N	16.0	17.0	14.6	1.65	12	184	190	179	4.82	12	87	108	75	0.86	12
B-C	15.1	15.2	15.0	0.08	8	188	194	182	5.31	8	65	68	63	1.79	8
B-S	18.0	18.0	18.0	0.00	6	170	170	170	0.00	6	67	67	67	0.00	6
C-N	16.6	18.0	14.5	1.69	10	181	182	180	0.80	10	85	87	81	2.94	10
C-C	15.9	16.4	14.9	0.68	6	179	180	177	1.25	6	77	91	67	6.20	6
C-S	20.3	23.0	15.8	2.60	14	169	177	166	3.80	14	64	84	44	8.33	14
D-N	17.4	18.0	16.1	0.82	18	157	175	146	1.90	18	67	90	44	6.64	18
D-C	16.0	16.4	15.3	0.26	8	177	179	174	2.12	8	68	90	53	2.08	8
D-S	22.2	75.4	16.2	6.37	12	158	177	159	8.53	12	60	68	60	0.60	12

BOTTOM

	DEPTH				TEMP					SALA					D.O.				
	MEAN	MAX	MIN	NO	MEAN	MAX	MIN	S D	NO	MEAN	MAX	MIN	S D	NO	MEAN	MAX	MIN	S D	NO
A-N	3	4	2	6	14.4	14.6	14.3	0.12	6	195	200	189	4.97	6	57	84	49	2.44	6
A-C	10	12	6	6	14.7	14.9	14.5	0.17	6	200	204	195	3.86	6	72	90	58	1.86	6
A-S	3	3	2	4	14.4	14.9	14.0	0.45	4	202	204	199	2.50	4	76	86	66	0.00	4
B-N	2	4	1	12	14.7	14.9	14.4	0.22	6	186	187	185	0.94	6	72	86	60	0.09	6
B-C	11	14	8	8	14.8	15.0	14.6	0.14	8	186	198	182	6.80	8	64	79	56	8.92	8
B-S	1	1	1	6															
C-N	1	2	1	10	13.6	14.4	12.8	0.80	4	181	181	181	0.00	4	83	86	79	3.50	4
C-C	15	23	11	6	15.4	15.8	14.7	0.48	6	191	193	189	1.70	6	64	70	61	4.03	6
C-S	2	7	1	14	15.8	15.8	15.8	0.00	2	170	170	170	0.00	2	58	58	58	0.00	2
D-N	1	2	1	18	16.6	16.8	16.3	0.21	6	174	175	172	1.25	6	59	63	53	3.21	6
D-C	13	18	9	8	16.1	16.3	15.9	0.18	8	180	181	178	1.50	8	65	69	59	3.77	8
D-S	3	5	1	12	16.1	16.2	16.0	0.09	6	179	179	179	0.00	6	67	71	65	2.83	6

YEAR = 72 MONTH = 10

SURFACE

	TEMP					SAL					D.O.				
	MEAN	MAX	MIN	S D	NO	MEAN	MAX	MIN	S D	NO	MEAN	MAX	MIN	S D	NO
E-N	16.00	16.8	15.6	0.566	3	13.50	16.53	9.22	3.111	3	7.80	8.50	7.30	0.510	3
E-C	16.02	16.8	15.0	0.805	6	12.04	15.30	9.27	2.787	6	7.58	7.70	7.30	0.167	6
E-S	17.29	20.0	15.1	1.201	12	11.74	15.45	8.99	2.223	12	7.69	8.30	7.00	0.375	12
F-N	18.11	21.1	15.5	2.249	9	11.99	14.56	9.63	1.458	9	7.23	7.50	6.80	0.279	9
F-C	18.11	21.1	15.5	2.352	7	11.57	14.76	9.06	2.031	7	6.89	7.60	5.70	0.685	7
F-S	17.04	20.6	15.0	1.895	15	11.56	14.25	8.98	1.836	19	7.18	7.60	5.90	0.451	19
G-N	18.04	21.1	16.8	1.778	8	9.88	11.45	8.34	1.166	8	6.85	8.00	5.90	0.725	8
G-C	18.37	21.7	16.6	2.358	3	8.18	8.78	7.69	0.451	3	7.20	8.30	5.80	1.042	3
G-S	17.70	18.9	16.5	1.200	2	9.35	10.99	7.71	1.640	2	7.90	8.20	7.60	0.300	2

BOTTOM

	DEPTH				TEMP					SALN					D.O.				
	MEAN	MAX	MIN	NO	MEAN	MAX	MIN	S D	NO	MEAN	MAX	MIN	S D	NO	MEAN	MAX	MIN	S D	NO
E-N	2.00	2.0	2.0	3	15.90	16.5	15.6	0.424	3	13.85	16.38	8.86	3.531	3	7.40	7.60	7.20	0.163	3
E-C	9.17	10.0	9.0	6	17.05	18.5	15.6	1.354	6	18.26	19.24	17.72	0.674	6	7.58	7.90	7.10	0.329	6
E-S	2.54	4.0	2.0	12	17.18	20.0	14.2	1.443	12	12.69	15.46	9.68	2.063	12	7.36	8.50	5.20	1.013	12
F-N	1.89	5.0	1.0	9	17.82	21.1	14.8	2.502	9	12.20	14.66	9.50	1.700	9	6.83	7.40	5.60	0.624	9
F-C	1.86	10.0	5.0	7	18.47	21.1	16.2	2.039	7	15.80	17.33	13.60	1.389	7	6.43	7.50	4.60	1.008	7
F-S	2.11	4.0	1.0	19	17.22	21.1	14.7	1.972	15	11.68	15.48	8.40	2.373	19	7.25	8.10	6.00	0.479	19
G-N	2.88	5.0	2.0	8	18.26	21.1	16.4	1.687	8	11.37	12.37	9.33	1.144	8	6.92	8.10	5.50	0.729	8
G-C	4.33	5.0	4.0	3	18.40	21.1	17.0	1.910	3	11.01	12.55	9.12	1.422	3	6.60	8.40	4.60	1.558	3
G-S	2.00	2.0	2.0	2	18.10	19.4	16.8	1.300	2	11.40	11.84	10.96	0.440	2	7.90	7.90	7.90	0.000	2

YEAR = 72 MONTH = 11

SURFACE

	TEMP					SALN					D.O.				
	MEAN	MAX	MIN	S D	NO	MEAN	MAX	MIN	S D	NO	MEAN	MAX	MIN	S D	NO
B-S	8.2	8.2	8.2	0.00	6	155	155	155	0.00	6	106	106	106	0.00	6
C-S	11.1	14.2	8.1	3.05	12	132	137	126	5.50	12	105	109	92	7.36	12
D-N	12.5	12.5	12.5	0.00	6	124	124	124	0.00	6	109	109	109	0.00	6
D-S	7.2	7.2	7.2	0.00	6	104	104	104	0.00	6	110	110	110	0.00	6

BOTTOM

DEPTH				TEMP					SALN					D.O.				
MEAN	MAX	MIN	NO	MEAN	MAX	MIN	S D	NO	MEAN	MAX	MIN	S D	NO	MEAN	MAX	MIN	S D	NO

YEAR = 72 MONTH = 11

SURFACE

	TEMP					SAL					D.O.				
	MEAN	MAX	MIN	S D	NO	MEAN	MAX	MIN	S D	NO	MEAN	MAX	MIN	S D	NO
E-N	11.53	12.1	11.0	0.419	3	15.98	17.16	13.72	1.596	3	8.27	8.60	8.00	0.249	3
E-C	11.20	11.4	11.0	0.158	4	14.65	15.38	14.15	0.473	4	8.75	9.70	8.20	0.594	4
E-S	10.98	11.4	10.5	0.248	9	13.97	15.33	12.80	0.322	9	8.89	9.50	8.30	0.351	9
F-N	12.70	13.4	12.2	0.396	6	9.07	10.28	8.13	0.742	6	8.65	9.20	7.90	0.431	6
F-C	12.05	13.2	11.4	0.692	6	9.89	12.57	8.39	1.463	5	8.48	9.00	8.00	0.319	5
F-S	10.51	11.3	9.7	0.550	11	9.40	12.60	8.37	1.133	11	8.55	9.80	6.80	0.866	11
G-N	12.60	12.9	12.3	0.300	2	7.93	8.93	6.93	1.000	2	7.95	8.00	7.90	0.050	2
G-C	11.55	12.60	10.50	1.050	2	9.38	9.52	9.24	0.140	2	7.80	8.3	7.3	0.500	2
G-S	12.9				1	7.53				1	9.90				1

BOTTOM

	DEPTH				TEMP					SALN					D.O.				
	MEAN	MAX	MIN	NO	MEAN	MAX	MIN	S D	NO	MEAN	MAX	MIN	S D	NO	MEAN	MAX	MIN	S D	NO
E-N	2.00	2.0	2.0	3	11.67	11.9	11.5	0.170	3	16.54	16.99	15.64	0.634	3	8.47	8.70	8.30	0.170	3
E-C	9.0	11.0	6.0	4	12.20	12.8	11.5	0.524	4	17.21	19.67	15.23	1.799	4	8.07	10.40	6.60	1.561	4
E-S	2.67	4.0	1.0	9	11.27	12.2	10.8	0.490	9	15.00	18.90	13.17	2.061	9	8.67	9.90	7.30	0.830	9
F-N	2.00	2.0	2.0	6	12.23	13.5	11.7	0.593	6	10.01	14.60	8.12	2.271	6	9.07	12.0	7.80	1.376	6
F-C	7.17	10.0	6.0	6	13.17	13.4	12.8	0.189	6	17.03	19.41	15.64	1.322	6	7.78	8.90	6.60	0.901	6
F-S	1.91	2.0	1.0	11	10.64	11.70	9.10	0.826	11	10.07	12.96	8.79	1.061	11	8.57	10.00	6150	0.878	10
G-N	2.5	2.0	3.0	2	12.50	12.5	12.5	0.000	2	7.70	7.77	7.64	0.650	2	7.40	7.50	7.30	0.100	2
G-C	6.5	7.0	6.0	2	13.0	13.0	13.0	0.000	2	16.15	16.21	16.09	0.060	2	6.85	7.10	6.60	0.250	2
G-S	2.0			1	12.60				1	8.01				1	8.60				1

YEAR = 72 MONTH = 12

SURFACE

	TEMP					SALN					D.O.				
	MEAN	MAX	MIN	S D	NO	MEAN	MAX	MIN	S D	NO	MEAN	MAX	MIN	S D	NO
A-N	7.0	10.0	2.0	3.56	18	162	174	155	5.78	18	104	114	95	6.16	18
A-C	9.1	9.2	9.0	0.08	8	157	166	153	5.12	8	109	113	104	3.27	8
A-S	9.2	9.7	8.9	0.36	6	161	166	152	6.18	6	107	111	104	2.87	6
B-N	8.6	12.5	4.0	3.51	18	148	170	120	9.85	18	107	111	104	1.89	18
B-C	9.2	9.8	8.8	0.38	10	165	204	150	9.69	10	107	110	102	3.07	10
B-S	8.4	10.0	7.0	1.40	12	156	160	149	3.55	12	90	114	64	9.08	12
C-N	8.3	9.0	7.0	0.94	18	152	165	136	1.61	18	94	114	64	6.63	18
C-C	9.5	9.8	9.2	0.28	8	166	171	157	5.39	8	96	101	90	5.02	8
C-S	9.2	11.0	7.0	1.67	18	160	170	157	3.94	18	91	108	69	1.82	18
D-N	7.9	11.0	3.3	3.09	24	134	152	107	6.94	24	94	111	69	1.76	24
D-C	10.0	10.0	9.8	0.08	10	159	172	148	0.46	10	100	106	95	5.79	10
D-S	6.5	10.0	3.0	3.47	12	151	170	142	1.70	10	99	109	86	9.23	12

BOTTOM

	DEPTH				TEMP					SALN					D.O.				
	MEAN	MAX	MIN	NO	MEAN	MAX	MIN	S D	NO	MEAN	MAX	MIN	S D	NO	MEAN	MAX	MIN	S D	NO
A-N	4	6	2	6	9.4	10.0	9.0	0.43	6	181	189	170	8.18	6	104	108	101	3.09	6
A-C	14	20	10	8	9.5	9.9	9.2	0.25	8	211	224	205	7.58	8	100	106	95	3.98	8
A-S	4	5	2	6	9.4	9.5	9.2	0.14	6	185	192	174	7.72	6	104	106	100	2.05	6
B-N	3	3	2	6	9.4	9.5	9.2	0.17	6	175	185	169	7.12	6	104	106	100	2.05	6
B-C	13	19	9	10	9.7	10.2	9.3	0.36	10	193	204	162	5.51	10	107	110	104	2.48	10
B-S	2	4	1	12	10.1	10.8	9.2	0.66	6	166	180	151	2.36	6	108	111	105	2.49	6
C-N	2	3	1	12	9.4	9.5	9.3	0.09	6	164	165	163	0.82	6	108	111	105	2.49	6
C-C	16	23	11	8	10.7	12.0	10.1	0.75	8	205	215	197	6.54	8	98	108	92	6.34	8
C-S	2	5	1	12	10.3	10.5	10.2	0.12	5	166	168	163	2.50	4	110	112	108	1.70	6
D-N	2	3	1	12	10.8	11.0	10.3	0.33	6	165	179	153	9.67	6	110	112	108	1.70	6
D-C	13	17	8	10	10.4	11.0	9.8	0.39	10	200	204	198	1.87	10	105	112	97	5.65	10
D-S	3	3	3	6	10.3	10.5	10.2	0.12	6	181	189	170	8.18	6	98	100	95	2.50	4

YEAR = 72 MONTH = 12

SURFACE

	TEMP					SAL					D.O.				
	MEAN	MAX	MIN	S D	NO	MEAN	MAX	MIN	S D	NO	MEAN	MAX	MIN	S D	NO
E-N	9.2				1	13.29				1	10.20				1
E-C	8.95	9.1	8.8	0.096	6	12.80	13.20	12.47	0.284	6	10.20	10.40	10.00	0.129	6
E-S	8.95	9.1	8.8	0.112	8	12.55	14.28	11.37	0.888	8	10.22	10.90	9.70	0.323	8
F-N	7.47	8.8	4.9	1.587	6	8.07	13.61	4.80	2.783	6	9.23	12.00	7.50	1.922	6
F-C	6.67	8.7	5.5	1.443	3	7.60	8.72	5.90	1.175	3	9.75	10.60	8.90	0.850	2
F-S	7.11	8.9	4.8	1.727	9	8.07	11.01	4.65	2.012	9	10.53	11.8	9.50	0.868	9
G-N	8.37	8.6	8.2	0.148	4	4.46	6.43	2.82	1.566	4	9.55	9.90	9.00	0.335	4
G-C	5.20	5.2	5.2	0.000	2	4.65	4.89	4.41	0.240	2	11.25	11.40	11.10	0.150	2
G-S	5.27	5.4	5.1	0.125	3	4.28	4.99	3.40	0.659	3	11.50	11.70	11.20	0.216	3

BOTTOM

	DEPTH				TEMP					SALN					D.O.				
	MEAN	MAX	MIN	NO	MEAN	MAX	MIN	S D	NO	MEAN	MAX	MIN	S D	NO	MEAN	MAX	MIN	S D	NO
E-N	2.0			1	9.1				1	13.34				1	10.0				1
E-C	8.67	11.0	5.0	6	9.03	9.2	8.8	0.137	6	17.70	18.65	16.20	0.899	6	10.12	10.30	9.90	0.146	6
E-S	2.75	4.0	2.0	8	8.97	9.2	8.6	0.192	8	15.01	18.59	11.90	2.025	8	10.39	11.00	9.00	0.285	8
F-N	2.0	2.0	2.0	6	7.42	8.5	5.5	1.322	6	7.46	18.48	6.77	0.532	6	9.22	12.50	7.80	1.960	6
F-C	6.67	9.0	5.0	3	6.63	8.4	5.3	1.302	3	11.88	14.94	10.20	2.165	3	10.23	11.30	8.50	1.236	3
F-S	2.22	4.0	1.0	9	7.34	8.8	4.4	1.572	9	7.50	7.81	6.23	0.625	9	10.50	12.00	9.00	1.160	9
G-N	2.00	2.0	2.0	4	8.17	8.3	8.1	0.083	4	6.96	8.22	5.70	1.260	4	9.75	10.40	9.30	0.415	4
G-C	5.50	7.0	4.0	2	5.50	5.1	5.0	0.050	2	4.78	5.17	4.43	0.303	2	11.40	11.40	11.40	0.000	2
G-S	2.0	2.0	2.0	3	5.10	5.3	5.0	0.141	3					3	11.47	11.90	11.90	0.419	3

YEAR = 73 MONTH = 01

SURFACE

	TEMP					SALN					D.O.				
	MEAN	MAX	MIN	S D	NO	MEAN	MAX	MIN	S D	NO	MEAN	MAX	MIN	S D	NO
A-N	5.4	6.5	4.0	1.07	11	161	171	145	1.42	11	104	111	87	6.98	11
A-C	4.9	6.0	4.0	0.85	16	161	166	155	4.30	16	69	100	69	9.15	16
A-S	4.4	5.0	4.1	0.42	6	180	198	165	5.57	6	64	100	38	5.52	6
B-N	7.1	8.5	5.2	1.44	12	155	169	149	5.79	12	85	107	58	7.31	12
B-C	5.9	6.5	5.0	0.56	10	156	167	142	6.13	10	92	101	77	6.78	10
B-S	4.8	6.5	4.3	0.79	12	136	168	113	4.27	12	100	106	88	7.48	12
C-N	8.1	26.3	6.1	5.26	13	146	193	136	4.92	13	100	106	86	7.37	13
C-C	6.4	6.3	6.0	0.28	10	142	150	139	4.05	10	94	104	86	5.48	10
C-S	5.5	11.0	3.8	2.38	18	137	150	125	9.50	12	100	106	67	8.79	18
D-N	5.5	6.5	3.9	1.19	18	136	162	122	6.74	18	100	106	67	8.79	18
D-C	5.5	6.2	5.1	0.41	10	157	170	147	6.45	10	83	96	69	9.88	10
D-S	3.3	5.5	2.0	1.62	10	126	162	103	8.06	10	93	104	69	4.65	10

BOTTOM

	DEPTH				TEMP					SALN					D.O.				
	MEAN	MAX	MIN	NO	MEAN	MAX	MIN	S D	NO	MEAN	MAX	MIN	S D	NO	MEAN	MAX	MIN	S D	NO
A-N	2	3	2	6	5.5	5.8	5.2	0.24	6	154	162	146	6.55	6	93	100	67	1.72	6
A-C	12	15	10	16	5.4	6.8	4.8	0.64	16	164	211	169	4.76	16	85	97	69	0.44	16
A-S	3	5	2	6	5.5	5.9	5.0	0.37	6	178	198	165	4.52	6	86	104	69	4.86	6
B-N	4	7	2	6	6.3	7.0	6.0	0.47	6	159	161	158	1.41	6	86	104	69	4.86	6
B-C	14	21	8	10	5.9	7.0	5.2	0.59	10	184	205	162	7.81	10	85	90	81	3.50	10
B-S	2	3	2	6	6.0	7.2	5.2	0.83	6	160	170	145	0.60	6	95	98	92	2.49	6
C-N	3	4	2	7	9.2	26.0	6.3	6.85	7	165	197	157	3.89	7	94	98	90	2.83	7
C-C	10	12	6	10	6.1	6.5	6.0	0.20	10	168	191	147	7.91	8	93	99	87	3.93	10
C-S	2	3	2	6	7.8	9.0	7.2	0.85	6	143	154	144	4.32	6	93	100	80	6.78	6
D-N	2	3	2	6	7.2	8.0	6.3	0.70	6	160	162	157	2.05	6	93	100	80	6.76	6
D-C	12	15	8	10	6.3	6.5	6.0	0.20	10	163	166	153	4.86	10	76	83	71	4.03	10
D-S	3	3	3	4	5.8	5.9	5.8	0.05	4	163	163	162	0.50	4	75	78	71	3.50	4

YEAR = 73 MONTH = 01

SURFACE

	TEMP					SAL					D.O.				
	MEAN	MAX	MIN	S D	NO	MEAN	MAX	MIN	S D	NO	MEAN	MAX	MIN	S D	NO
E-N	3.70	4.6	2.5	0.754	7	11.41	14.00	7.35	2.470	7	11.06	11.70	10.60	0.444	7
E-C	3.91	4.9	3.3	0.567	9	10.67	14.08	8.34	1.737	9	11.32	11.50	10.80	0.210	9
E-S	3.80	4.2	2.9	0.361	10	10.99	13.32	9.05	1.035	10	11.38	11.70	10.80	0.244	10
F-N	3.55	3.6	3.5	0.050	2	10.66	14.12	7.21	3.455	2	11.45	11.5	11.4	0.050	2
F-C	3.70	3.7	3.7	0.000	3	6.90	9.04	5.59	1.485	3	11.47	11.50	11.40	0.047	3
F-S	3.24	3.8	2.2	0.576	8	7.56	9.13	5.95	1.288	9	11.36	11.50	11.00	0.171	9
G-N	4.15	4.3	4.0	0.150	2	5.58	5.75	5.42	0.165	2	11.35	11.50	11.20	0.150	2
G-C															
G-S	3.80	3.8	3.8	0.000	2	4.04	4.04	4.04	0.000	2	11.40	11.40	11.40	0.000	2

BOTTOM

	DEPTH				TEMP					SALN					D.O.				
	MEAN	MAX	MIN	NO	MEAN	MAX	MIN	S D	NO	MEAN	MAX	MIN	S D	NO	MEAN	MAX	MIN	S D	NO
E-N	1.29	2.0	1.0	7	3.56	3.90	2.60	0.417	7	12.82	15.44	8.65	2.037	7	11.06	11.70	10.70	0.374	7
E-C	8.00	11.0	5.0	9	4.56	5.00	4.20	0.260	9	13.78	16.14	11.97	1.370	9	10.63	11.70	5.10	1.966	9
E-S	2.40	4.0	10.	10	3.80	4.90	3.40	0.415	10	12.67	16.55	9.80	1.714	10	11.40	11.70	10.80	0.224	10
F-N	1.00	1.0	1.0	2	2.75	2.80	2.70	0.050	2	7.25	7.35	7.16	0.095	2	11.30	11.40	11.20	0.100	2
F-C	7.33	10.0	5.0	3	4.33	4.70	3.90	0.330	3	12.47	14.22	10.98	1.335	3	11.40	11.50	11.30	0.082	3
F-S	1.89	4.0	1.0	9	3.14	4.40	2.10	0.803	8	9.41	13.11	6.80	2.231	9	11.40	11.60	11.20	0.149	9
G-N	2.00	3.0	1.0	2	4.0				1	7.85	9.41	6.30	1.555	2	11.20	11.30	11.10	0.100	2
G-C																			
G-S	1.00	1.0	1.0	2	4.0	4.0	4.0	0.00	2	4.81	4.81	4.81	0.00	2	11.60	11.60	11.60	0.000	2

YEAR = 73 MONTH = 02

SURFACE

	TEMP					SALN					D.O.				
	MEAN	MAX	MIN	S D	NO	MEAN	MAX	MIN	S D	NO	MEAN	MAX	MIN	S D	NO
A-N	5.6	5.6	5.6	0.00	6	155	155	155	0.00	6	116	116	116	0.00	6
B-N	6.5	6.5	6.5	0.00	6	156	156	156	0.00	6	115	115	115	0.00	6
B-S	7.2	7.2	7.2	0.00	6	147	147	147	0.00	6	114	116	113	1.12	6
C-N	6.9	6.9	6.9	0.00	6	147	147	147	0.00	6	114	116	113	1.12	6
C-S	9.1	12.8	5.5	3.65	12	144	148	139	4.50	12	116	117	114	1.50	12
D-N	4.7	5.2	4.2	0.50	12	123	135	123	6.00	12	116	117	114	1.50	12
D-S	6.2	6.2	6.2	0.00	6	123	123	123	0.00	6	118	118	118	0.00	6

[illegible]

	DEPTH				TEMP					SALN					D.O.				
	MEAN	MAX	MIN	NO	MEAN	MAX	MIN	S D	NO	MEAN	MAX	MIN	S D	NO	MEAN	MAX	MIN	S D	NO
C-S	1	1	1	6															

YEAR = 73 MONTH = 02

SURFACE

	TEMP					SAL					D.O.				
	MEAN	MAX	MIN	S D	NO	MEAN	MAX	MIN	S D	NO	MEAN	MAX	MIN	S D	NO
E-N	6.90	7.0	6.7	0.122	4	8.88	13.89	6.27	3.009	4	11.47	12.70	10.90	0.715	4
E-C	6.80	7.0	6.6	0.120	7	11.43	13.83	7.33	2.170	7	11.03	12.00	10.70	0.423	8
E-S	5.65	7.0	5.0	0.775	11	6.99	10.62	4.85	1.977	11	10.97	11.30	10.50	0.287	11
F-N	6.62	6.8	6.5	0.117	5	4.55	6.58	2.87	1.297	5	10.98	11.10	10.70	0.147	5
F-C	6.70	6.9	6.6	0.122	4	4.68	6.28	2.90	1.260	4	10.77	10.90	10.70	0.083	4
F-S	6.77	7.0	6.5	0.139	8	5.35	7.20	3.69	1.004	8	11.31	12.50	10.60	0.518	8
G-N	6.6				1	1.52				1	11.20				1
G-C															
G-S															

BOTTOM

	DEPTH				TEMP					SALN					D.O.				
	MEAN	MAX	MIN	NO	MEAN	MAX	MIN	S D	NO	MEAN	MAX	MIN	S D	NO	MEAN	MAX	MIN	S D	NO
E-N	2.00	4.0	1.0	4	6.80	7.10	6.50	0.224	4	11.58	15.36	7.01	3.001	4	11.07	11.50	10.60	0.383	4
E-C	7.43	10.0	5.0	7	6.54	6.70	6.40	0.090	7	15.65	16.76	14.24	0.777	7	10.96	11.10	10.80	0.090	7
E-S	1.82	4.0	1.0	11	5.22	6.90	4.10	0.982	11	7.76	13.45	4.67	3.167	11	10.90	11.30	10.70	0.226	11
F-N	1.00	1.0	1.0	5	6.54	6.70	6.10	0.224	5	6.11	12.02	3.28	3.192	5	10.92	11.50	10.60	0.306	5
F-C	6.50	8.0	5.0	4	6.55	6.60	6.50	0.050	4	10.87	12.27	9.91	0.887	4	10.77	11.00	10.00	0.179	4
F-S	1.63	4.0	1.0	8	6.75	6.80	6.60	0.070	8	7.88	12.55	4.33	2.958	8	11.30	11.90	10.80	0.384	8
G-N	1.0			1	6.60				1	1.46				1	10.90				1
G-C																			
G-S																			

YEAR = 73 MONTH = 03

SURFACE

	TEMP					SALN					D.O.				
	MEAN	MAX	MIN	S D	NO	MEAN	MAX	MIN	S D	NO	MEAN	MAX	MIN	S D	NO
A-N	12.3	15.5	9.0	3.17	12	155	164	154	4.42	12	91	94	84	4.11	12
A-C	9.2	9.5	9.0	0.23	14	162	164	160	1.51	14	87	89	85	1.29	14
A-S	9.3	9.8	9.0	0.38	6	167	168	166	0.94	6	86	89	86	1.25	6
B-N	10.3	13.2	7.8	2.51	14	160	171	151	6.95	14	85	89	81	2.71	14
B-C	9.2	10.0	8.5	0.49	10	219	766	155	2.36	10	86	88	85	1.36	10
B-S	11.6	13.6	9.9	1.22	12	164	169	157	4.82	12	89	94	84	3.94	12
C-N	10.0	10.8	8.2	0.95	12	158	166	153	5.65	12	89	94	84	3.94	12
C-C	8.9	9.5	8.5	0.34	10	165	170	162	3.25	10	84	86	83	1.17	10
C-S	10.5	11.5	8.3	1.42	18	157	165	149	6.53	18	88	95	80	5.11	18
D-N	12.1	14.3	9.3	1.94	18	144	155	141	5.10	18	88	95	80	5.11	18
D-C	9.7	10.0	9.5	0.21	8	153	155	149	2.60	8	83	83	81	0.87	8
D-S	11.1	12.0	9.8	1.02	11	149	155	145	2.50	11	83	86	78	2.61	11

BOTTOM

	DEPTH				TEMP					SALN					D.O.				
	MEAN	MAX	MIN	NO	MEAN	MAX	MIN	S D	NO	MEAN	MAX	MIN	S D	NO	MEAN	MAX	MIN	S D	NO
A-N	3	4	2	6	10.2	11.0	9.5	0.62	6	163	165	161	1.63	6	86	89	82	2.56	6
A-C	12	18	5	14	8.8	9.5	7.8	0.63	14	243	273	166	6.81	14	83	86	81	1.52	14
A-S	3	5	1	6	10.2	11.2	9.5	0.71	6	166	166	165	0.37	6	83	86	78	3.40	6
B-N	3	4	2	8	8.4	10.1	7.5	1.01	8	167	173	156	6.65	8	83	86	78	3.00	8
B-C	10	15	8	10	8.2	9.5	7.5	0.68	10	225	269	170	7.60	10	83	84	82	0.89	10
B-S	4	5	1	6	11.0	11.0	11.0	0.00	6	160	162	158	1.70	6	84	85	83	0.69	6
C-N	2	2	1	6	8.6	10.0	7.8	0.97	6	164	166	161	2.16	6	84	85	83	0.69	6
C-C	10	15	6	10	8.5	9.5	7.9	0.55	10	164	168	163	1.85	10	83	86	80	2.33	10
C-S	4	5	4	6	8.2	8.3	8.1	0.08	6	165	167	162	2.16	6	81	84	78	2.75	6
D-N	2	3	2	6	9.6	10.0	9.3	0.29	6	157	161	153	3.30	6	81	84	78	2.75	6
D-C	11	15	7	8	9.7	10.0	9.0	0.41	8	171	173	169	1.48	8	80	81	78	1.30	8
D-S	3	5	2	5	10.4	11.0	10.0	0.49	5	161	168	155	5.50	5	82	84	80	1.79	5

YEAR = 73 MONTH = 03

SURFACE

	TEMP					SAL					D.O.				
	MEAN	MAX	MIN	S D	NO	MEAN	MAX	MIN	SD	NO	MEAN	MAX	MIN	S D	NO
E-N	12.20				1	10.11				1	13.10				1
E-C	11.50				1	10.53				1	12.40				1
E-S	11.15	11.2	11.1	0.050	2	8.92	9.25	8.60	0.325	2	13.20	13.60	12.80	0.400	2
F-N	11.50				1	4.24				1	11.00				1
F-C	11.90	12.5	11.3	0.600	2	5.77	7.26	4.28	1.490	2	11.10	11.50	10.70	0.400	2
F-S	11.05	11.2	10.9	0.150	2	7.04	7.49	6.60	0.445	2	11.60	12.00	11.20	0.400	2
G-N	11.2				1	4.84				1	10.50				1
G-C															
G-S															

BOTTOM

	DEPTH				TEMP					SALN					D.O.				
	MEAN	MAX	MIN	NO	MEAN	MAX	MIN	S D	NO	MEAN	MAX	MIN	S D	NO	MEAN	MAX	MIN	S D	NO
E-N	2.00			1	10.70				1	10.34				1	11.40				1
E-C	8.00			1	8.9				1	18.73				1	11.80				1
E-S	1.00	2.0	1.0	2	11.15	11.4	10.9	0.250	2	10.43	10.94	9.92	0.510	2	12.45	12.60	12.30	0.150	2
F-N	1.00			1	11.60				1	6.57				1	10.50				1
F-C	10.0	10.0	10.0	2	9.70	10.00	9.40	0.300	2	14.71	16.40	13.03	1.685	2	10.75	11.00	10.50	0.250	2
F-S	1.00	1.0	1.0	2	11.25	11.50	11.00	0.250	2	8.10	8.43	7.78	0.325	2	11.50	11.70	11.30	0.200	2
G-N	1.0			1	11.00				1	5.24				1	10.30				1
G-C																			
G-S																			

YEAR = 73 MONTH = 04

SURFACE

	TEMP MEAN	TEMP MAX	TEMP MIN	TEMP S D	TEMP NO	SALN MEAN	SALN MAX	SALN MIN	SALN S D	SALN NO	D.O. MEAN	D.O. MAX	D.O. MIN	D.O. S D	D.O. NO
A-N	15.9	17.1	15.0	0.93	12	149	155	140	5.04	12	94	112	79	5.08	12
A-C	16.8	17.5	16.0	0.38	16	155	214	137	3.28	16	107	112	105	1.04	16
A-S	16.3	16.5	16.0	0.24	6	153	155	151	1.70	6	107	112	103	3.80	6
B-N	16.1	17.8	15.2	1.03	12	142	149	137	5.24	12	98	112	89	9.25	12
B-C	16.4	17.2	16.0	0.49	10	142	148	135	4.54	10	110	113	104	3.19	10
B-S	16.4	16.8	15.9	0.31	12	145	164	128	1.59	12	109	112	105	2.69	12
C-N	15.5	16.8	14.5	1.05	12	138	144	135	4.63	12	109	112	105	2.69	12
C-C	16.6	17.5	15.5	0.72	10	131	149	115	3.60	10	107	109	105	1.36	10
C-S	16.7	20.0	15.5	1.30	18	135	140	120	4.79	18	98	112	89	7.87	18
D-N	16.4	19.0	15.0	1.53	19	120	131	100	1.24	19	99	112	89	8.27	19
D-C	18.0	18.0	17.9	0.04	8	110	113	104	3.50	8	110	111	109	0.87	8
D-S	17.4	19.0	16.5	0.96	12	115	123	93	0.65	12	99	110	89	9.57	12

BOTTOM

	DEPTH MEAN	DEPTH MAX	DEPTH MIN	DEPTH NO	TEMP MEAN	TEMP MAX	TEMP MIN	TEMP S D	TEMP NO	SALN MEAN	SALN MAX	SALN MIN	SALN S D	SALN NO	D.O. MEAN	D.O. MAX	D.O. MIN	D.O. S D	D.O. NO
A-N	4	4	3	6	16.7	17.0	16.1	0.42	6	154	156	152	1.63	6	108	112	106	1.91	6
A-C	11	18	6	16	14.4	17.1	13.0	1.41	16	202	251	155	5.78	16	106	111	99	3.97	16
A-S	3	4	2	6	15.9	16.5	14.9	0.69	6	156	170	151	8.34	6	99	110	89	9.57	6
B-N	3	4	2	6	16.4	17.3	15.6	0.66	6	156	171	146	0.96	6	99	110	89	9.57	6
B-C	13	18	9	10	13.7	15.1	13.0	0.79	10	219	233	187	7.26	10	103	107	98	3.88	10
B-S	4	6	2	6	15.5	16.5	14.5	0.82	6	144	154	132	9.18	6	103	107	100	2.87	6
C-N	3	4	2	6	15.8	16.0	15.5	0.24	6	142	143	140	1.25	6	103	107	100	2.67	6
C-C	10	17	5	10	14.2	15.0	13.0	0.81	10	189	211	164	8.18	10	101	104	100	1.50	10
C-S	3	6	2	6	16.9	18.5	16.0	1.11	6	131	135	129	2.62	6	106	108	104	1.46	6
D-N	2	2	2	7	17.7	18.0	17.0	0.45	7	113	115	109	2.49	7	106	108	104	1.50	7
D-C	13	14	12	8	14.7	15.8	14.1	0.67	8	172	183	164	7.08	8	107	110	102	6.30	8
D-S	2	2	2	6	15.2	15.2	15.1	0.05	6	138	157	114	7.91	6	105	106	104	0.94	6

YEAR = 73 MONTH = 04

SURFACE

	TEMP					SAL					D.O.				
	MEAN	MAX	MIN	S D	NO	MEAN	MAX	MIN	S D	NO	MEAN	MAX	MIN	S D	NO
E-N	13.70	14.5	12.9	0.566	5	9.87	12.23	7.08	2.013	5	10.42	11.20	9.90	0.534	5
E-C	13.65	14.4	12.9	0.750	6	9.04	12.17	6.55	2.196	6	11.08	12.60	10.00	0.857	6
E-S	12.42	17.2	11.5	1.612	12	10.23	12.79	5.87	1.871	12	9.82	11.50	8.50	0.755	12
F-N	15.03	16.2	14.0	0.903	3	5.43	6.19	4.91	0.548	3	10.07	10.80	8.80	0.899	3
F-C	14.77	15.9	14.2	0.676	4	5.59	6.36	4.92	0.608	4	10.35	10.90	9.00	0.789	4
F-S	15.35	17.1	12.1	1.601	10	5.36	8.18	3.31	1.615	10	9.40	10.60	8.60	0.711	10
G-N	14.80	14.9	14.7	0.100	2	1.73	2.08	1.38	0.350	2	10.70	10.70	10.70	0.000	2
G-C	15.00	15.2	14.8	0.200	2	0.61	1.01	0.21	0.400	2	8.75	8.80	8.70	0.050	2
G-S	15.60				1	1.32				1	9.00				1

BOTTOM

	DEPTH				TEMP					SALN					D.O.				
	MEAN	MAX	MIN	NO	MEAN	MAX	MIN	S D	NO	MEAN	MAX	MIN	S D	NO	MEAN	MAX	MIN	S D	NO
E-N	1.80	4.0	1.0	5	14.20	15.30	13.30	0.718	5	9.90	12.14	7.08	1.929	5	10.54	11.30	10.00	0.492	5
E-C	6.50	10.0	7.0	6	12.55	12.90	12.20	0.350	6	11.77	13.58	10.36	1.278	6	10.62	11.60	9.40	0.699	6
E-S	2.33	4.0	1.0	12	12.11	17.90	10.70	2.099	12	10.62	13.32	6.48	1.963	12	9.96	12.60	8.60	0.919	12
F-N	1.33	2.0	1.0	3	15.20	16.00	14.50	0.616	3	5.37	5.83	4.78	0.439	3	9.73	10.40	8.50	0.873	3
F-C	8.00	10.0	5.0	4	13.80	14.20	13.30	0.324	4	7.98	10.99	5.90	2.045	4	10.12	10.80	8.80	0.798	4
F-S	2.30	4.0	1.0	10	14.55	16.50	11.50	1.512	10	6.06	9.10	3.87	1.652	10	9.22	10.40	8.40	0.741	10
G-N	1.00	1.0	1.0	2	15.30	15.60	15.00	0.300	2	1.73	2.07	1.39	0.340	2	10.65	10.80	10.50	0.150	2
G-C	5.50	7.0	4.0	2	14.80	14.90	14.70	0.100	2	1.49	2.12	0.87	0.625	2	8.35	8.46	8.30	0.050	2
G-S	1.0			1	15.40				1	1.12				1	8.80				1

YEAR = 73   MONTH = 05

SURFACE

	TEMP					SALN					D.O.				
	MEAN	MAX	MIN	S D	NO	MEAN	MAX	MIN	S D	NO	MEAN	MAX	MIN	S D	NO
A-N	20.1	21.0	18.5	0.97	12	165	175	159	6.32	12	80	96	56	6.49	12
A-C	19.2	20.2	14.2	1.34	16	170	198	161	1.00	16	65	68	63	1.43	16
A-S	19.8	20.0	19.5	0.21	6	164	171	158	5.35	6	66	68	63	1.67	6
B-N	20.2	21.5	18.5	1.34	12	156	165	154	5.40	12	73	97	63	3.76	12
B-C	19.6	20.0	19.0	0.36	10	160	162	158	1.63	10	67	72	59	4.71	10
B-S	18.7	20.2	18.0	0.93	10	153	159	151	3.12	10	85	99	68	3.31	10
C-N	19.8	20.5	19.0	0.69	12	159	163	140	4.98	12	81	99	62	4.77	12
C-C	19.3	20.3	18.7	0.54	10	155	162	147	5.13	10	66	73	62	3.97	10
C-S	19.1	19.3	18.0	0.75	18	155	199	140	7.71	18	83	95	63	3.65	18
D-N	19.2	19.8	18.2	0.72	18	137	147	133	5.27	18	85	99	63	3.65	13
D-C	19.6	19.8	19.2	0.24	3	127	135	121	6.73	[illegible]	58	70	66	1.48	8
D-S	18.5	19.3	17.5	1.05	12	136	146	119	8.32	12	73	94	61	2.25	12

BOTTOM

	DEPTH				TEMP					SALN					D.O.				
	MEAN	MAX	MIN	NO	MEAN	MAX	MIN	S D	NO	MEAN	MAX	MIN	S D	NO	MEAN	MAX	MIN	S D	NO
A-N	2	2	1	6	20.7	21.5	19.3	0.77	6	175	175	174	0.47	6	69	74	63	3.54	6
A-C	11	13	6	16	19.3	20.0	18.6	0.45	16	188	216	159	6.11	16	64	70	52	5.36	16
A-S	2	2	2	6	21.5	21.6	21.3	0.12	6	165	172	160	5.25	6	66	68	61	2.63	6
B-N	3	4	2	6	19.1	19.5	18.8	0.29	6	174	182	170	5.44	6	66	68	61	2.63	6
B-C	12	15	3	10	18.6	19.3	18.0	0.50	10	206	215	201	5.46	10	61	66	56	3.46	10
B-S	1	2	1	10	19.9	20.5	19.3	0.60	4	161	162	159	1.50	4	67	68	66	1.00	4
C-N	4	7	2	6	18.5	19.2	18.0	0.50	6	180	198	162	4.70	6	64	68	56	4.34	6
C-C	11	15	6	10	18.4	19.3	17.5	0.57	10	200	208	195	4.43	10	61	66	56	3.56	10
C-S	2	2	1	12	19.5	20.0	18.9	0.45	6	166	189	152	6.39	6	66	68	63	2.05	6
D-N	2	2	2	6	19.4	19.6	19.2	0.17	6	145	150	138	5.10	6	66	68	63	2.05	6
D-C	10	12	6	8	18.3	18.5	18.0	0.20	8	153	194	115	7.34	8	56	59	52	2.95	8
D-S	2	2	1	6	19.5	19.6	19.3	0.22	6	136	145	129	6.80	6	63	64	61	1.25	6

YEAR = 73 MONTH = 05

SURFACE

	TEMP					SAL					D.O.				
	MEAN	MAX	MIN	S D	NO	MEAN	MAX	MIN	S D	NO	MEAN	MAX	MIN	S D	NO
E-N	18.58	18.7	18.5	0.098	5	12.41	13.51	10.38	1.061	5	6.86	7.10	6.10	0.388	5
E-C	13.17	18.8	2.0	7.896	3	11.27	13.11	10.12	1.316	3	6.73	7.30	6.20	0.450	3
E-S	19.02	19.7	18.7	0.349	8	11.11	12.44	10.01	0.830	8	6.80	7.30	5.90	0.406	8
F-N	19.72	20.50	19.00	0.598	6	7.60	8.76	5.87	0.890	6	7.58	8.10	7.20	0.339	6
F-C	20.10	21.2	19.1	0.644	12	8.12	10.04	3.97	1.768	12	7.16	8.10	6.70	0.444	12
F-S	19.51	20.2	19.2	0.324	10	8.41	10.49	6.01	1.532	10	7.38	8.00	6.70	0.389	10
G-N	20.5				1	5.47				1	6.00				1
G-C	22.0				1	3.72				1	6.60				1
G-S	21.9				1	4.30				1	8.20				1

BOTTOM

	DEPTH				TEMP					SALN					D.O.				
	MEAN	MAX	MIN	NO	MEAN	MAX	MIN	S D	NO	MEAN	MAX	MIN	S D	NO	MEAN	MAX	MIN	S D	NO
E-N	1.40	2.0	1.0	5	18.3	18.5	17.9	0.210	5	13.03	13.79	10.23	1.400	5	6.10	6.70	5.80	0.352	5
E-C	7.33	9.0	5.0	3	17.97	18.5	17.4	0.450	3	14.46	14.76	14.22	0.224	3	6.20	6.60	5.00	0.283	3
E-S	2.88	4.0	1.0	8	18.51	19.8	17.5	0.780	8	12.48	13.79	10.71	1.010	8	6.69	7.80	6.10	0.509	8
F-N	1.17	2.0	1.0	6	19.57	20.6	19.0	0.537	6	7.65	9.02	5.86	0.971	6	7.30	7.80	6.90	0.332	6
F-C	7.75	10.0	5.0	12	17.61	20.0	1.90	4.765	12	10.73	13.84	6.40	2.153	12	6.42	7.30	5.90	0.406	12
F-S	1.70	4.0	1.0	10	19.23	19.8	18.7	0.355	10	8.81	10.80	6.65	1.530	10	7.01	7.70	6.10	0.532	10
G-N	1.0			1	19.2				1	6.81				1	5.20				1
G-C	5.0			1	20.1				1	8.79				1	6.20				1
G-S	4.0			1	19.8				1	6.74				1	6.10				1

YEAR = 73 MONTH = 06

SURFACE

	TEMP					SALN					D.O.				
	MEAN	MAX	MIN	S D	NO	MEAN	MAX	MIN	S D	NO	MEAN	MAX	MIN	S D	NO
A-N	25.5	27.5	24.0	1.61	16	175	181	170	4.36	16	80	86	71	4.97	16
A-C	24.9	25.6	24.0	0.65	10	176	181	171	3.65	10	75	77	72	1.72	10
A-S	25.3	26.8	24.2	0.95	10	178	183	171	5.19	10	79	102	74	8.05	10
B-N	26.3	28.0	24.7	1.48	14	179	183	176	2.65	14	78	102	74	6.91	14
B-C	25.1	25.2	25.0	0.09	6	181	185	180	1.25	6	75	76	74	0.94	6
B-S	26.5	28.5	24.3	1.78	14	182	184	181	1.29	14	74	77	70	3.04	14
C-N	23.7	26.4	20.5	2.74	14	174	184	165	6.38	14	74	77	70	3.04	14
C-C	25.0	25.3	24.7	0.25	6	183	184	181	1.25	6	72	77	68	3.66	6
C-S	28.2	32.1	25.0	2.86	18	179	181	177	1.70	18	69	90	55	8.94	18
D-N	26.3	27.5	25.2	0.92	20	170	175	163	4.27	20	69	90	55	6.65	20
D-C	25.6	26.0	25.1	0.37	6	167	174	162	4.99	6	68	70	64	2.19	6
D-S	27.0	28.8	24.9	1.82	12	175	176	167	3.55	12	118	670	36	6.72	12

BOTTOM

	DEPTH				TEMP					SALN					D.O.				
	MEAN	MAX	MIN	NO	MEAN	MAX	MIN	S D	NO	MEAN	MAX	MIN	S D	NO	MEAN	MAX	MIN	S D	NO
A-N	4	10	1	10	24.3	24.7	23.9	0.31	10	183	190	173	5.91	10	71	90	55	9.10	10
A-C	10	12	6	10	23.3	23.4	23.3	0.04	10	202	222	183	2.54	10	68	70	61	2.93	10
A-S	3	4	2	10	24.7	25.0	24.3	0.25	10	182	187	175	4.26	10	132	670	66	9.44	10
B-N	3	4	2	8	24.6	24.8	24.2	0.24	8	184	185	183	0.83	8	147	670	68	7.66	8
B-C	13	17	10	6	23.6	24.4	23.0	0.59	6	217	242	203	7.72	6	58	68	45	9.53	6
B-S	3	4	2	8	25.1	25.8	24.5	0.47	8	184	186	183	1.09	8	72	76	64	3.48	8
C-N	3	3	2	8	25.6	27.0	24.6	0.87	8	184	187	182	1.79	8	72	76	64	3.46	8
C-C	10	14	8	6	23.5	24.0	22.4	0.75	6	207	229	190	6.31	6	50	67	39	2.19	6
C-S	2	4	1	12	25.0	25.2	24.6	0.28	6	184	190	181	4.03	6	54	64	41	9.63	6
D-N	1	2	1	8	25.6	26.0	25.5	0.21	8	166	169	163	2.60	8	56	64	41	8.75	8
D-C	13	14	12	6	24.4	24.8	24.0	0.31	6	196	202	190	4.92	6	56	57	54	1.25	6
D-S	3	4	2	6	24.7	25.2	24.5	0.33	6	176	183	167	6.50	6	60	61	59	0.82	6

YEAR = 73 MONTH = 06

SURFACE

	TEMP					SAL					D.O.				
	MEAN	MAX	MIN	S D	NO	MEAN	MAX	MIN	S D	NO	MEAN	MAX	MIN	S D	NO
E-N	25.70	25.8	25.6	0.100	4	14.04	15.12	12.71	0.897	4	6.65	6.90	6.40	0.180	4
E-C	25.85	26.1	25.6	0.250	4	13.59	14.53	11.11	1.129	4	6.40	6.80	5.70	0.342	4
E-S	26.37	27.3	25.4	0.596	9	13.24	14.72	11.22	1.223	9	6.63	7.10	6.30	0.221	9
F-N	26.47	27.6	24.5	0.979	6	8.90	9.81	6.83	1.002	6	6.03	6.30	5.80	0.170	6
F-C	26.80	26.8	26.8	0.000	2	9.21	9.21	9.21	0.000	2	6.10	6.10	6.10	0.000	2
F-S	25.50	26.0	25.0	0.500	2	10.57	11.79	8.91	0.910	8	6.00	6.20	5.70	0.166	8
G-N	25.0				1	7.03				1	5.80				1
G-C	25.33	25.5	25.0	0.230	3	7.57	9.22	6.20	1.249	3	6.33	6.40	6.30	0.047	3
G-S	25.63	26.0	25.0	0.415	4	6.32	7.26	5.98	0.543	4	6.42	6.60	6.30	0.109	4

BOTTON

	DEPTH				TEMP					SALN					D.O.				
	MEAN	MAX	MIN	NO	MEAN	MAX	MIN	S D	NO	MEAN	MAX	MIN	S D	NO	MEAN	MAX	MIN	S D	NO
E-N	1.25	2.0	1.0	4	25.60	25.8	25.4	0.200	4	14.95	16.53	12.69	1.592	4	6.00	6.20	5.80	0.141	4
E-C	8.00	11.0	6.0	4	23.40	23.7	23.1	0.300	4	18.12	18.70	16.67	0.775	4	4.75	5.30	4.20	0.345	4
E-S	1.78	4.0	1.0	9	25.80	26.6	24.7	0.636	9	14.03	15.57	12.08	0.887	9	5.93	6.30	5.60	0.250	9
F-N	2.00	4.0	1.0	6	26.12	26.9	24.5	0.843	6	9.67	12.31	6.98	1.746	6	5.30	5.70	4.60	0.351	6
F-C	9.0			1	25.3				1	13.11				1	4.30				1
F-S	1.63	4.0	1.0	8	25.20	25.4	25.0	0.200	2	11.48	14.03	8.73	1.633	8	5.55	5.800	4.90	0.332	8
G-N	2.0			1	24.0				1	10.16				1	4.70				1
G-C	5.00	7.0	3.0	3	23.67	24.0	23.0	0.471	3	10.18	11.97	8.56	1.387	3	6.17	8.40	5.00	1.580	3
G-S	2.25	4.0	1.0	4	24.75	25.5	24.0	0.559	4	7.65	9.09	5.89	1.229	4	5.30	5.90	4.80	0.480	4

YEAR = 73 MONTH = 07

SURFACE

	TEMP					SALN					D.O.				
	MEAN	MAX	MIN	S D	NO	MEAN	MAX	MIN	S D	NO	MEAN	MAX	MIN	S D	NO
A-N	26.6	27.6	26.0	0.74	16	190	200	180	6.21	16	74	85	60	0.93	16
A-C	26.1	26.2	26.0	0.06	10	189	199	180	5.04	10	81	97	55	4.09	10
A-S	26.1	26.4	26.0	0.15	10	191	195	187	3.16	10	76	90	52	1.66	10
B-N	26.4	27.2	25.4	0.72	14	198	200	195	2.19	14	74	90	52	0.84	14
B-C	25.7	25.8	25.7	0.05	4	199	199	199	0.00	4	70	73	67	3.00	4
B-S	26.2	31.2	25.7	2.60	14	201	203	197	2.31	14	65	81	54	9.36	14
C-N	26.2	25.5	25.5	0.43	10	200	201	200	0.40	10	63	81	54	9.51	10
C-C	25.8	25.9	25.8	0.05	4	197	197	197	0.00	4	75	77	73	2.00	4
C-S	29.5	33.0	25.6	2.96	18	199	203	193	3.94	18	69	106	52	7.82	18
D-N	27.5	32.3	23.0	3.45	20	196	200	191	3.16	20	87	106	47	7.70	20
D-C	22.8	25.0	21.3	1.60	6	191	205	180	0.53	6	71	74	67	2.94	6
D-S	26.7	29.3	21.5	2.91	12	194	196	190	2.61	12	73	92	64	9.98	12

BOTTOM

	DEPTH				TEMP					SALN					D.O.				
	MEAN	MAX	MIN	NO	MEAN	MAX	MIN	S D	NO	MEAN	MAX	MIN	S D	NO	MEAN	MAX	MIN	S D	NO
A-N	3	4	2	10	25.4	25.7	25.2	0.19	10	169	200	184	6.05	10	68	106	52	5.92	10
A-C	15	18	9	10	24.5	25.0	23.5	0.52	10	220	232	200	1.57	10	54	74	15	3.25	10
A-S	4	6	2	10	26.0	26.8	25.4	0.46	10	194	198	190	2.61	10	74	92	64	0.52	10
B-N	3	3	2	8	25.4	25.8	25.0	0.30	8	199	201	195	2.45	8	74	92	64	0.60	8
B-C	10	10	10	4	25.1	25.4	24.8	0.30	4	202	205	201	1.00	4	59	65	53	6.00	4
B-S	4	6	1	8	25.6	26.0	25.1	0.32	8	200	202	199	1.30	8	64	68	61	2.64	8
C-N	2	5	1	10	24.8	25.2	24.5	0.35	4	202	202	201	0.50	4	65	66	61	2.05	4
C-C	11	11	10	4	24.5	24.9	24.2	0.35	4	194	207	180	3.50	4	37	43	30	6.50	4
C-S	4	5	2	6	25.2	25.5	24.6	0.31	6	202	209	198	4.97	6	65	70	59	3.96	6
D-N	2	3	1	14	23.3	25.2	22.5	1.12	8	198	201	194	2.74	8	63	70	47	6.87	8
D-C	12	14	8	6	21.6	25.0	19.7	2.43	6	211	222	191	4.36	6	35	68	18	3.11	6
D-S	3	5	2	6	25.8	26.0	25.5	0.24	6	192	197	188	3.86	6	68	72	64	3.30	6

YEAR = 73 MONTH = 07

SURFACE

	TEMP					SAL					D.O.				
	MEAN	MAX	MIN	S D	NO	MEAN	MAX	MIN	S D	NO	MEAN	MAX	MIN	S D	NO
E-N	30.05	31.5	28.3	1.161	4	15.81	16.19	14.97	0.489	4	5.62	6.30	4.10	0.893	4
E-C	29.60				1	13.24				1	6.40				1
E-S	29.73	31.2	29.3	0.520	10	14.09	15.00	13.70	0.435	10	5.46	6.70	1.40	1.937	10
F-N	28.93	30.10	27.0	1.245	6	12.15	13.20	10.86	0.900	6	5.93	6.60	5.50	0.427	6
F-C	29.23	30.3	27.5	1.189	9	11.95	13.23	9.79	1.301	9	5.61	6.80	3.30	1.135	9
F-S	26.99	27.4	26.3	0.382	8	12.64	16.66	11.18	1.669	8	6.42	7.00	6.00	0.295	8
G-N	27.2				1	9.46				1	5.10				1
G-C	27.5				1	10.66				1	6.00				1
G-S	28.60	30.2	27.0	1.600	2	9.28	9.93	8.64	0.645	2	5.10	5.90	4.30	0.800	2
P	28.05	28.4	27.8	0.251	4	7.46	7.84	6.97	0.424	4	3.53	3.9	3.0	0.450	4

BOTTOM

	DEPTH				TEMP					SALN					D.O.				
	MEAN	MAX	MIN	NO	MEAN	MAX	MIN	S D	NO	MEAN	MAX	MIN	S D	NO	MEAN	MAX	MIN	S D	NO
E-N	1.25	2.0	1.0	4	29.1	29.9	28.0	0.791	4	15.79	16.29	14.68	0.649	4	6.05	6.50	5.50	0.364	4
E-C	9.00			1	29.70				1	15.97				1	6.00				1
E-S	1.80	4.0	1.0	10	20.62	31.2	28.7	0.685	10	14.50	14.90	13.99	0.288	10	5.86	6.40	3.70	0.739	10
F-N	1.50	4.0	1.0	6	28.82	30.4	27.0	1.268	6	12.53	13.31	10.91	0.802	6	6.27	7.10	5.70	0.556	6
F-C	7.33	10.0	4.0	9	28.52	30.0	26.9	0.998	9	12.68	14.00	10.67	1.228	9	5.30	6.40	3.50	0.970	9
F-S	1.13	2.0	1.0	8	26.76	27.6	26.1	0.534	8	12.25	13.20	11.33	0.661	8	6.27	6.80	5.50	0.380	8
G-N	1.0			1	26.50				1	9.80				1	5.90				1
G-C	4.0			1	26.90				1	10.91				1	5.80				1
G-S	1.00	1.0	1.0	2	28.35	29.9	26.8	1.550	2	9.84	10.52	9.17	0.675	2	4.95	5.50	4.40	0.550	2
P	4.75	6.0	3.0	4	26.9	27.3	26.3	0.489	4	8.57	9.57	7.87	0.769	4	3.8	4.00	3.60	0.230	4

YEAR = 73 MONTH = 08

SURFACE

	TEMP					SALN					D.O.				
	MEAN	MAX	MIN	S D	NO	MEAN	MAX	MIN	S D	NO	MEAN	MAX	MIN	S D	NO
A-N	27.1	32.0	23.5	3.80	16	185	187	181	2.06	16	77	97	64	5.22	16
A-C	25.5	26.8	24.8	0.77	10	183	188	179	3.52	10	69	77	62	6.50	10
A-S	26.8	27.3	26.0	0.47	10	180	182	179	1.10	10	74	79	66	3.42	10
B-N	28.2	31.8	22.4	3.28	14	184	189	179	3.06	14	74	79	66	3.79	14
B-C	27.6	28.0	27.3	0.29	6	186	190	181	3.74	6	84	90	75	6.65	6
B-S	27.6	28.2	27.0	0.50	14	186	189	181	3.46	14	73	82	62	7.82	14
C-N	26.7	28.3	24.8	1.31	17	192	201	182	6.06	17	71	82	58	7.90	17
C-C	25.3	26.0	24.8	0.52	6	189	190	189	0.47	6	65	73	56	6.94	6
C-S	28.1	28.4	27.0	0.49	12	190	191	189	0.74	18	79	105	55	6.42	18
D-N	29.7	33.5	26.4	2.69	20	190	194	186	2.84	20	82	125	55	6.51	20
D-C	26.5	27.0	26.2	0.34	6	196	199	193	2.49	6	74	92	41	5.16	6
D-S	26.5	26.9	25.5	0.52	12	190	195	186	4.22	12	76	97	68	8.85	12

BOTTOM

	DEPTH				TEMP					SALN					D.O.				
	MEAN	MAX	MIN	NO	MEAN	MAX	MIN	S D	NO	MEAN	MAX	MIN	S D	NO	MEAN	MAX	MIN	S D	NO
A-N	2	4	2	10	24.1	24.5	23.2	0.46	10	185	187	182	2.32	10	69	92	55	3.52	10
A-C	12	18	6	10	23.6	26.0	20.8	1.76	10	222	268	187	4.53	10	64	92	32	3.14	10
A-S	3	5	2	10	27.3	28.0	26.3	0.60	10	182	188	179	3.26	10	78	97	68	9.27	10
B-N	3	5	2	8	23.2	26.0	21.2	2.11	8	186	188	183	1.79	8	78	90	68	7.43	8
B-C	11	12	9	6	26.6	27.0	26.1	0.39	6	192	193	192	0.47	6	59	60	58	0.94	6
B-S	2	4	1	14	27.5	27.8	27.1	0.27	8	185	189	182	3.06	8	78	80	76	2.00	8
C-N	2	6	1	17	24.7	26.1	21.8	1.46	11	196	201	182	6.72	11	76	80	66	4.89	11
C-C	11	15	6	6	24.7	25.5	23.7	0.74	6	216	236	195	7.68	6	52	69	36	3.52	6
C-S	2	3	1	12	27.3	27.8	27.0	0.33	6	191	191	190	0.47	6	69	76	66	4.71	6
D-N	2	5	1	14	26.3	26.6	26.0	0.23	8	193	197	191	2.28	8	69	76	66	4.35	8
D-C	12	15	9	6	26.4	26.7	26.3	0.19	6	204	206	202	1.70	6	63	71	54	6.97	6
D-S	4	5	2	6	26.0	26.2	25.9	0.12	6	199	202	194	3.56	6	66	72	65	4.03	6

YEAR = 73 MONTH = 08

SURFACE

	TEMP					SAL					D.O.				
	MEAN	MAX	MIN	S D	NO	MEAN	MAX	MIN	S D	NO	MEAN	MAX	MIN	S D	NO
E-N	28.50	28.8	28.2	0.300	4	18.12	18.14	18.12	0.009	4	6.27	6.60	6.00	0.277	4
E-C	28.68	29.2	28.2	0.387	5	15.86	17.19	15.08	0.932	5	6.62	6.80	6.40	0.133	5
E-S	29.79	30.4	28.5	0.489	11	16.18	17.43	15.38	0.647	11	6.31	6.80	5.90	0.284	11
F-N	29.50	29.8	28.9	0.367	4	12.65	13.27	12.20	0.396	4	6.45	7.00	5.50	0.568	4
F-C	28.87	29.3	28.5	0.310	7	13.33	14.27	11.58	0.820	7	6.51	6.90	5.60	0.419	7
F-S	29.20	29.6	28.9	0.240	9	14.46	15.86	12.65	1.137	9	6.32	6.60	5.80	0.286	9
G-N	29.03	30.1	28.4	0.759	3	11.36	11.85	10.71	0.478	3	6.00	6.50	5.40	0.455	3
G-C															
G-S	28.8				1	10.3				1	6.10				1
P	28.96	29.0	28.9	0.577	3	9.37	10.97	8.57	1.385	3	5.27	5.30	5.20	0.057	3

BOTTOM

	DEPTH				TEMP					SALN					D.O.				
	MEAN	MAX	MIN	NO	MEAN	MAX	MIN	S D	NO	MEAN	MAX	MIN	S D	NO	MEAN	MAX	MIN	S D	NO
E-N	1.25	2.0	1.0	4	27.82	28.0	27.3	0.303	4	18.69	19.14	18.40	0.311	4	5.62	5.90	4.80	0.476	4
E-C	9.20	10.0	8.0	5	28.00	28.3	27.7	0.253	5	18.65	19.51	18.08	0.614	5	5.60	6.00	5.10	0.341	5
E-S	2.55	4.0	1.0	11	28.86	30.5	27.7	0.840	11	16.77	18.78	16.15	0.760	11	6.44	7.40	5.60	0.477	11
F-N	2.00	5.0	1.0	4	29.30	29.8	28.9	0.367	4	12.63	13.19	12.09	0.389	4	6.45	7.00	6.10	0.335	4
F-C	6.43	8.0	6.0	7	28.10	28.6	27.8	0.293	7	14.92	17.22	11.27	2.362	7	5.64	5.90	5.50	0.168	9
F-S	1.11	2.0	1.0	9	29.13	29.5	28.8	0.170	9	14.49	16.21	12.95	1.112	9	6.33	6.80	5.60	0.422	7
G-N	2.33	4.0	1.0	3	28.47	29.0	27.9	0.450	3	12.34	13.13	11.56	0.641	3	5.67	6.30	4.80	0.634	3
G-C																			
G-S	1.0			1	28.4				1	11.95				1	5.70				1
P	4.50	5.0	4.0	3	28.40	28.6	28.0	0.346	3	10.21	11.55	9.57	1.114	3	4.766	4.80	4.70	0.057	3

YEAR = 73 MONTH = 09

SURFACE

	TEMP					SALN					D.O.				
	MEAN	MAX	MIN	S D	NO	MEAN	MAX	MIN	S D	NO	MEAN	MAX	MIN	S D	NO
A-N	25.0	23.0	23.0	2.36	15	195	197	194	1.32	16	90	112	76	7.24	16
A-C	24.1	24.5	23.5	0.38	8	193	199	194	2.06	8	73	79	64	5.41	8
A-S	24.0	24.5	23.5	0.33	10	199	199	199	0.00	10	73	78	64	5.55	10
B-N	25.7	27.8	23.3	1.86	14	196	197	194	1.48	14	73	78	64	4.75	14
B-C	23.7	23.8	23.6	0.09	6	197	197	197	0.00	6	71	72	69	1.25	6
B-S	26.8	27.5	25.2	0.75	14	193	196	190	2.53	14	77	89	65	9.18	14
C-N	23.5	24.0	23.0	0.47	14	194	198	191	2.65	14	77	89	65	9.16	14
C-C	24.1	25.5	23.2	1.02	6	194	194	193	0.47	6	71	72	70	0.82	6
C-S	27.3	31.0	24.9	2.39	18	190	193	184	4.03	18	73	103	60	2.12	18
D-N	24.9	27.8	23.0	1.90	20	186	196	179	6.52	20	77	103	60	2.56	20
D-C	23.4	23.9	23.0	0.39	6	192	194	189	2.05	6	69	73	67	2.19	6
D-S	25.1	25.9	23.0	2.79	12	147	192	106	1.40	12	68	72	49	6.04	12

BOTTOM

	DEPTH				TEMP					SALN					D.O.				
	MEAN	MAX	MIN	NO	MEAN	MAX	MIN	S D	NO	MEAN	MAX	MIN	S D	NO	MEAN	MAX	MIN	S D	NO
A-N	2	3	2	10	23.6	24.0	23.0	0.37	10	196	197	195	0.63	10	72	79	60	5.96	10
A-C	10	15	6	8	24.5	25.0	23.2	0.75	8	198	199	196	1.22	8	69	73	64	2.68	8
A-S	3	4	2	10	24.4	25.0	24.0	0.42	10	199	200	199	0.40	10	67	72	49	6.48	10
B-N	3	3	2	8	24.0	24.5	23.8	0.29	8	197	197	197	0.00	8	68	72	49	7.14	8
B-C	15	18	13	6	24.0	24.0	24.0	0.00	6	198	198	197	0.47	6	69	70	68	0.94	6
B-S	3	6	2	8	25.1	26.0	24.5	0.65	8	197	198	195	1.30	8	68	71	66	2.12	8
C-N	2	3	1	14	23.2	23.8	23.0	0.33	8	196	197	194	1.12	8	68	71	65	2.12	8
C-C	11	13	7	6	23.5	24.5	23.0	0.71	6	196	197	195	0.94	6	69	70	68	0.82	6
C-S	4	4	4	6	25.2	25.5	25.0	0.24	6	195	195	194	0.47	6	66	69	60	3.11	6
D-N	2	2	2	8	23.2	23.4	23.0	0.14	8	195	197	192	1.87	8	65	69	60	3.35	8
D-C	11	12	10	6	23.5	23.8	23.0	0.36	6	193	195	192	1.25	6	67	67	66	0.47	6
D-S	2	3	2	6	23.1	23.2	23.0	0.09	6	192	193	191	0.94	6	70	73	69	1.89	6

YEAR = 73 MONTH = 10

SURFACE

	TEMP					SALN					D.O.				
	MEAN	MAX	MIN	S D	NO	MEAN	MAX	MIN	S D	NO	MEAN	MAX	MIN	S D	NO
A-N	15.6	18.0	11.5	3.15	16	199	200	197	1.00	16	79	85	75	4.59	16
A-C	18.2	18.5	18.0	0.24	10	199	205	194	3.76	10	74	77	70	2.50	10
A-S	18.7	19.0	18.0	0.40	10	199	201	195	2.33	10	78	87	73	3.99	10
B-N	15.5	18.0	13.0	2.19	14	197	199	195	1.50	14	78	87	75	3.60	14
B-C	17.9	18.0	17.8	0.09	6	197	198	196	0.94	6	77	78	76	0.94	6
B-S	17.0	19.0	15.0	1.75	14	197	200	194	2.80	14	75	77	73	1.67	14
C-N	16.6	18.2	15.5	0.99	14	196	199	189	3.33	14	75	77	73	1.67	14
C-C	18.2	18.7	18.0	0.33	6	186	193	180	5.91	6	73	75	71	1.63	6
C-S	18.1	19.5	16.5	1.26	18	197	201	190	4.08	18	77	82	69	3.20	18
D-N	15.1	18.5	12.5	2.04	20	191	198	176	6.32	20	77	82	65	4.07	20
D-C	16.0	16.0	16.0	0.00	6	189	194	182	5.10	6	74	77	72	2.05	6
D-S	15.4	16.8	14.5	0.92	12	191	194	189	1.83	12	75	79	70	2.14	12

BOTTOM

	DEPTH				TEMP					SALN					D.O.				
	MEAN	MAX	MIN	NO	MEAN	MAX	MIN	S D	NO	MEAN	MAX	MIN	S D	NO	MEAN	MAX	MIN	S D	NO
A-N	3	5	1	10	17.9	18.0	17.5	0.20	10	202	206	197	3.14	10	76	82	69	3.11	10
A-C	10	14	8	10	18.2	19.0	17.8	0.42	10	205	208	202	2.84	10	74	77	71	2.00	10
A-S	2	3	1	10	18.7	19.0	18.0	0.38	10	200	205	195	3.16	10	75	79	70	2.29	10
B-N	2	3	1	8	17.0	17.7	16.0	0.66	8	196	198	195	1.09	8	75	79	70	2.45	8
B-C	14	15	12	6	17.5	17.5	17.5	0.00	6	205	206	204	0.82	6	70	71	69	0.82	6
B-S	2	5	1	14	18.1	19.0	17.5	0.65	8	195	197	193	1.58	8	74	77	72	1.92	8
C-N	2	2	1	14	17.4	18.5	17.0	0.62	8	196	198	192	2.29	8	74	77	72	1.92	8
C-C	7	9	4	6	18.5	19.0	18.0	0.41	6	196	200	192	3.27	6	72	73	71	0.82	6
C-S	2	5	1	18	18.5	19.0	18.0	0.41	6	192	193	190	1.25	6	77	78	75	1.12	6
D-N	2	3	1	8	16.6	18.0	15.0	1.19	8	188	195	178	7.46	8	76	78	72	1.80	8
D-C	11	14	8	6	16.8	17.0	16.5	0.24	6	233	247	218	1.90	6	68	70	67	1.25	6
D-S	2	5	1	12	16.2	16.5	16.0	0.24	6	193	197	187	4.50	6	72	75	70	2.16	6

YEAR = 73 MONTH = 11

SURFACE

	TEMP					SALN					D.O.				
	MEAN	MAX	MIN	S D	NO	MEAN	MAX	MIN	S D	NO	MEAN	MAX	MIN	S D	NO
A-N	13.9	13.9	13.8	0.05	12	216	218	214	1.70	12	80	82	76	1.70	12
A-C	13.7	14.5	13.3	0.34	16	217	220	215	1.58	16	85	85	75	3.16	16
A-S	14.4	15.0	14.1	0.40	6	220	221	219	0.94	6	81	82	78	1.69	6
B-N	14.1	14.4	13.9	0.25	12	214	215	213	1.00	12	84	93	76	4.71	12
B-C	13.7	14.1	13.5	0.27	10	222	246	215	2.12	10	89	96	86	3.50	10
B-S	13.9	15.0	12.8	1.07	12	213	215	213	0.75	12	87	88	82	1.66	12
C-N	13.3	13.9	13.0	0.38	12	213	215	212	1.15	12	87	88	82	1.66	12
C-C	13.1	13.6	12.9	0.25	10	215	220	211	3.01	10	86	95	80	5.69	10
C-S	14.6	16.7	12.9	1.53	18	212	214	210	1.75	18	89	99	78	7.63	18
D-N	12.2	14.4	9.4	2.05	18	206	220	191	8.68	18	89	99	78	7.63	18
D-C	12.9	13.8	12.0	0.81	8	195	213	175	7.81	8	82	87	75	4.32	8
D-S	13.3	14.1	12.2	0.59	12	204	214	182	0.17	12	83	93	77	4.26	12

BOTTOM

	DEPTH				TEMP					SALN					D.O.				
	MEAN	MAX	MIN	NO	MEAN	MAX	MIN	S D	NO	MEAN	MAX	MIN	S D	NO	MEAN	MAX	MIN	S D	NO
A-N	3	5	2	6	14.6	14.9	14.4	0.24	6	217	217	216	0.47	6	90	99	80	9.17	6
A-C	11	17	7	16	14.2	14.5	13.8	0.27	16	233	242	224	7.72	16	80	87	63	5.56	16
A-S	4	5	3	6	15.0	15.6	14.2	0.51	6	217	222	210	5.10	6	83	93	77	5.80	6
B-N	2	3	2	6	15.1	15.3	14.9	0.17	6	215	216	214	0.94	6	83	93	77	5.80	6
B-C	10	15	3	10	14.0	14.6	13.4	0.47	10	229	240	218	7.63	10	84	93	77	6.11	10
B-S	2	3	2	6	13.4	15.0	12.5	1.16	6	213	214	213	0.47	6	85	88	80	2.69	6
C-N	2	3	2	6	14.3	14.6	13.9	0.29	6	214	215	214	0.47	6	85	88	80	2.69	6
C-C	8	10	7	10	13.5	13.8	12.6	0.47	10	218	227	214	4.71	10	82	84	80	1.50	10
C-S	2	3	1	6	13.5	15.4	12.2	1.39	6	213	214	212	0.94	6	85	94	77	6.03	6
D-N	2	3	1	6	14.0	15.4	11.7	1.64	6	203	209	192	7.59	6	85	94	77	6.03	6
D-C	12	16	9	8	13.0	13.9	11.9	0.93	8	222	223	219	1.64	8	83	88	79	3.27	8
D-S	3	5	2	6	13.9	15.3	11.4	1.75	6	201	214	180	4.62	6	85	87	83	1.63	6

YEAR = 73 MONTH = 12

SURFACE

	TEMP MEAN	TEMP MAX	TEMP MIN	TEMP S D	TEMP NO	SALN MEAN	SALN MAX	SALN MIN	SALN S D	SALN NO	D.O. MEAN	D.O. MAX	D.O. MIN	D.O. S D	D.O. NO
A-N	5.3	7.8	3.0	2.35	12	217	219	215	1.21	12	104	108	96	4.62	12
A-C	8.6	9.0	8.2	0.35	14	219	220	217	1.12	14	96	106	93	4.23	14
A-S	8.2	8.3	8.2	0.05	6	216	220	210	4.50	6	101	105	97	2.54	6
B-N	5.7	5.7	5.7	0.00	6	217	217	217	0.00	6	101	105	97	2.54	6
B-S	7.9	7.9	7.9	0.00	6	212	212	212	0.00	6	100	100	99	0.50	6
C-N	9.6	9.6	9.6	0.00	3	211	211	211	0.00	3	99	99	99	0.00	3
D-N	4.1	4.1	4.1	0.00	6	197	197	197	0.00	6	102	106	97	2.69	6
D-S	5.5	5.5	5.5	0.00	6	193	193	193	0.00	6	99	100	96	1.60	6

BOTTOM

	DEPTH MEAN	DEPTH MAX	DEPTH MIN	DEPTH NO	TEMP MEAN	TEMP MAX	TEMP MIN	TEMP S D	TEMP NO	SALN MEAN	SALN MAX	SALN MIN	SALN S D	SALN NO	D.O. MEAN	D.O. MAX	D.O. MIN	D.O. S D	D.O. NO
A-N	2	3	1	6	7.8	8.0	7.4	0.26	6	218	218	218	0.00	6	102	106	97	2.69	6
A-C	13	16	11	14	8.3	8.7	7.8	0.26	14	220	222	219	1.05	14	96	100	93	2.40	14
A-S	3	3	2	6	8.0	8.2	7.8	0.16	6	217	220	210	4.71	6	99	100	96	1.60	6
C-N	1	1	1	3															

YEAR = 74 MONTH = 01

SURFACE

	TEMP					SALN					D.O.				
	MEAN	MAX	MIN	S D	NO	MEAN	MAX	MIN	S D	NO	MEAN	MAX	MIN	S D	NO
A-N	8.2	9.8	7.2	1.05	12	133	157	111	2.02	12	131	155	105	4.18	12
A-C	9.2	10.0	8.7	0.38	14	157	160	154	1.77	14	107	113	103	3.50	14
A-S	9.0	10.0	4.9	1.71	7	161	176	156	6.48	7	193	707	105	9.96	7
B-N	9.1	10.4	8.7	0.60	12	154	159	111	3.03	12	162	707	94	5.49	12
B-C	9.4	10.2	9.0	0.43	10	159	160	157	1.10	10	102	108	91	5.95	10
B-S	9.5	12.0	7.9	1.80	12	158	161	117	0.67	12	126	149	96	2.33	12
C-N	8.9	10.0	8.0	0.88	12	140	160	120	9.51	12	126	149	98	2.33	12
C-C	9.4	10.0	9.0	0.42	10	158	167	151	5.60	10	100	114	89	8.00	10
C-S	10.2	12.8	7.4	2.23	18	124	161	98	4.75	18	120	146	81	2.06	18
D-N	8.7	10.0	7.9	0.85	18	121	144	107	5.50	18	120	146	81	2.06	18
D-C	10.1	10.2	10.0	0.09	8	139	145	120	7.76	8	99	102	90	4.97	8
D-S	8.9	10.2	7.8	1.12	12	126	144	114	2.70	12	108	139	97	4.59	12

BOTTOM

	DEPTH				TEMP					SALN					D.O.				
	MEAN	MAX	MIN	NO	MEAN	MAX	MIN	S D	NO	MEAN	MAX	MIN	S D	NO	MEAN	MAX	MIN	S D	NO
A-N	4	5	3	6	8.8	9.0	8.6	0.17	6	158	159	157	0.54	6	102	113	81	9.93	6
A-C	12	25	6	14	8.4	10.3	7.3	0.90	14	166	218	158	1.91	14	97	104	65	6.00	14
A-S	4	6	2	7	8.7	9.5	5.0	1.55	7	165	176	156	7.20	7	102	108	97	3.38	7
B-N	3	4	1	6	9.8	10.0	9.4	0.26	6	158	159	157	0.62	6	101	105	97	2.52	6
B-C	12	14	11	10	8.4	9.5	8.0	0.56	10	169	214	159	0.45	10	85	95	78	6.28	10
B-S	2	3	1	12	10.8	11.5	9.9	0.67	6	161	161	160	0.47	6	98	105	83	7.37	6
C-N	3	6	1	6	9.8	10.3	8.8	0.68	6	164	177	158	8.96	6	98	105	63	7.37	6
C-C	12	23	7	10	9.0	9.5	8.5	0.35	10	181	214	153	2.79	10	88	95	61	5.46	10
C-S	2	4	1	12	10.5	11.1	9.5	0.71	6	160	161	158	1.41	6	87	99	72	1.22	6
D-N	2	4	1	12	10.1	10.2	10.0	0.06	6	146	149	144	2.36	6	87	99	72	1.22	6
D-C	13	14	10	8	9.2	9.9	8.8	0.45	8	171	183	149	3.97	8	91	99	87	4.92	8
D-S	3	5	2	6	10.1	10.2	10.0	0.06	6	146	155	130	1.15	6	99	100	97	1.25	6

YEAR = 74 MONTH = 02

SURFACE

	TEMP					SALN					D.O.				
	MEAN	MAX	MIN	S D	NO	MEAN	MAX	MIN	S D	NO	MEAN	MAX	MIN	S D	NO
A-N	7.7	9.7	5.4	1.99	12	167	171	158	4.73	12	104	112	100	4.69	12
A-C	5.4	6.0	5.0	0.37	16	164	166	161	1.80	16	112	115	105	2.96	16
A-S	4.7	5.1	4.3	0.37	5	175	176	169	3.12	5	112	116	107	3.56	5
B-N	7.3	6.7	5.6	1.42	12	162	154	153	2.45	12	106	118	96	7.52	12
B-C	5.7	6.1	5.2	0.32	10	162	164	160	1.33	10	108	113	90	8.93	10
B-S	8.0	10.2	5.0	2.24	12	169	176	159	7.76	12	103	116	87	3.49	12
C-N	6.1	6.4	5.8	0.19	12	158	162	153	2.73	12	103	118	87	3.49	12
C-C	5.8	6.8	5.0	0.61	12	152	166	146	4.22	12	113	123	115	2.75	12
C-S	8.0	12.8	5.2	3.40	18	161	173	150	9.04	18	105	117	89	9.16	18
D-N	7.8	9.2	6.2	1.18	18	160	178	154	9.24	18	105	117	89	9.16	18
D-C	6.4	6.5	6.3	0.08	6	167	171	162	3.68	6	112	114	110	1.53	6
D-S	8.0	9.6	6.2	1.60	12	159	163	143	7.21	12	104	113	91	5.67	12

BOTTOM

	DEPTH				TEMP					SALN					D.O.				
	MEAN	MAX	MIN	NO	MEAN	MAX	MIN	S D	NO	MEAN	MAX	MIN	S D	NO	MEAN	MAX	MIN	S D	NO
A-N	4	5	3	6	5.9	6.3	5.7	0.26	6	162	165	157	3.56	6	107	111	103	3.27	6
A-C	12	18	3	16	5.4	5.9	4.8	0.36	16	186	224	166	7.12	16	106	114	92	8.01	16
A-S	3	4	2	5	4.8	5.0	4.7	0.11	5	172	176	168	3.61	5	106	112	99	5.67	5
B-N	3	4	2	6	6.3	6.8	5.6	0.41	6	174	207	158	3.10	6	104	112	91	7.67	6
B-C	12	13	10	10	5.6	6.3	4.7	0.54	10	193	212	174	5.53	10	106	117	92	8.01	10
B-S	1	2	1	12	5.8	6.2	5.0	0.57	6	161	164	159	2.36	6	113	118	108	4.11	6
C-N	3	3	2	6	6.3	6.6	6.1	0.22	6	166	173	157	6.60	6	113	118	108	4.11	6
C-C	13	24	6	12	5.6	6.2	2.6	0.92	12	182	205	161	7.90	12	103	117	87	1.38	12
C-S	3	5	1	12	5.1	5.4	5.0	0.19	6	153	154	151	1.25	6	114	120	106	4.43	6
D-N	2	3	2	6	5.9	6.0	5.7	0.14	6	170	179	165	5.38	6	114	120	106	4.43	6
D-C	12	16	7	6	6.1	6.2	6.0	0.09	6	177	178	176	0.94	6	106	111	103	3.40	6
D-S	2	3	1	12	6.2	6.3	6.2	0.05	6	158	168	143	6.80	6	107	113	96	6.01	6

YEAR = 74 MONTH = 03

SURFACE

	TEMP					SALN					D.O.				
	MEAN	MAX	MIN	S D	NO	MEAN	MAX	MIN	S D	NO	MEAN	MAX	MIN	S D	NO
A-N	11.0	14.5	7.3	3.54	12	179	181	177	1.86	12	100	102	96	1.70	12
A-C	8.9	9.5	8.3	0.44	16	184	185	182	0.93	16	95	104	81	6.65	16
A-S	8.7	8.9	8.5	0.16	6	185	187	183	1.65	6	96	99	90	4.07	6
B-N	11.9	14.8	8.9	2.85	12	183	184	182	0.90	12	99	108	90	6.03	12
B-C	9.3	10.0	9.2	0.30	10	181	182	179	1.26	10	91	96	81	6.49	10
B-S	11.2	12.6	9.2	1.46	12	178	179	176	1.41	12	100	111	83	9.28	12
C-N	11.2	13.6	8.0	2.46	12	179	182	177	2.15	12	100	111	83	9.28	12
C-C	9.2	9.5	9.0	0.13	10	178	181	177	1.50	10	94	99	90	2.94	10
C-S	13.0	17.2	9.4	3.34	18	174	178	169	3.54	18	103	110	84	7.14	18
D-N	12.0	14.5	9.5	1.97	18	171	175	167	2.27	18	103	110	84	7.14	18
D-C	9.3	9.5	9.2	0.11	8	160	162	159	1.30	8	97	103	90	6.50	8
D-S	10.5	11.5	9.2	1.05	12	161	166	154	5.37	12	103	109	99	3.72	12

BOTTOM

	DEPTH				TEMP					SALN					D.O.				
	MEAN	MAX	MIN	NO	MEAN	MAX	MIN	S D	NO	MEAN	MAX	MIN	S D	NO	MEAN	MAX	MIN	S D	NO
A-N	3	5	1	12	7.4	7.8	7.2	0.28	6	181	184	180	1.69	6	99	107	84	7.14	6
A-C	13	15	11	16	8.9	9.8	8.7	0.34	16	202	209	183	7.94	16	85	103	62	4.15	16
A-S	3	3	3	6	8.9	9.0	8.8	0.09	6	185	185	184	0.47	6	101	102	99	1.26	6
B-N	3	3	2	6	8.6	9.5	7.6	0.78	6	184	184	183	0.47	6	101	102	99	1.26	6
B-C	18	24	11	10	8.8	9.2	8.1	0.43	10	205	217	192	0.97	10	77	79	75	1.83	10
B-S	2	3	2	6	9.1	9.4	9.0	0.19	6	177	180	176	1.59	6	85	90	75	5.60	6
C-N	2	3	2	6	8.3	8.9	7.8	0.45	6	183	184	182	0.94	6	85	90	75	5.60	6
C-C	11	20	3	10	9.0	9.2	8.8	0.16	10	187	192	181	4.22	10	72	86	62	8.98	10
C-S	2	5	1	12	10.0	12.2	8.8	1.56	6	175	177	175	0.82	6	93	102	80	9.42	6
D-N	2	2	1	6	9.3	9.5	9.5	0.14	6	170	175	166	3.68	6	93	102	80	9.42	6
D-C	11	12	9	8	9.1	9.2	9.0	0.08	8	189	194	183	4.87	8	85	88	78	4.09	8
D-S	2	3	1	6	9.5	9.8	9.0	0.38	6	156	162	153	4.24	6	76	94	41	4.96	6

VITA

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