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Ecology and Distribution of Eastern Gulf of Mexico Reef Fishes

GREGORY B. SMITH

Florida Department of Natural Resources
Marine Research Laboratory

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ERRATA

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Page 14, paragraph 1, line 3 should read "factor contributing to reef invertebrate mortalities"

Page 14, paragraph 3, lines 1-5 should read "Major features influencing water clarity were summer plankton blooms of *Oscillatoria* and *Gymnodium* and suspended bottom"

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Edwin A. Joyce, Jr.
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ABSTRACT

Smith, G. B. 1976. Ecology and Distribution of Eastern Gulf of Mexico Reef Fishes. Fla. Mar. Res. Publ. No. 19. 78 pp. One hundred one reef-fish species representing 38 families were collected and/or observed at 12-40 m depths in the eastern Gulf of Mexico between May 1970 and October 1972. Of these species, one represents a first record for the Gulf of Mexico, 15 constitute eastern Gulf records, seven are new additions to the mideastern Gulf checklist, two represent northward range extension records, and seven represent confirmations of dubious or frequently overlooked eastern Gulf records.

A toxic dinoflagellate bloom (*Gymnodinium breve*) and subsequent stress conditions occurring within the study area during summer 1971 resulted in mass mortalities of reef biotas over at least 1536 km of central West Florida Shelf. Preliminary observations on reef-fish succession following the *G. breve* red tide are presented and discussed.

Comparison of the eastern Gulf and other western Atlantic reef ichthyofaunas revealed greater intra-Gulf homogeneity and Caribbean-West Indian affinity than previously suspected. Eastern Gulf reefs harbor a progressively more tropical ichthyofauna with increasing offshore distance and depth. Reef-fish species composition and relative abundance changed most dramatically between 18 and 30 m depths and probably correspond to the transition from inshore, coastal to offshore, Gulf water masses. Preliminary observations at the Florida Middle Ground, a region of high-relief reef structure on the outer West Florida Shelf, indicate a diverse and abundant resident tropical ichthyofauna including numerous insular (West Indian) elements rare or absent at other studied Gulf reefs. In many respects, however, the Middle Ground ichthyofauna resembles those inhabiting offshore banks in the northwestern Gulf of Mexico (e.g., Flower Garden Reefs).

Although a slight increase in numbers and kinds of reef fishes was detected during summer-fall due to juvenile recruitment and occasional appearance of displaced tropical elements, the resident eastern Gulf reef-fish fauna indicated little fluctuation in either species diversity or abundance prior to the 1971 red tide. Minimal species replacement, but drastic fluctuations in species abundance characterized reef-fish succession following the red tide.

Contribution No. 278, Florida Department of Natural Resources Marine Research Laboratory.

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INTRODUCTION

From May 1970 through October 1972, in situ SCUBA observations and collections of fishes inhabiting patch reefs 11-51 km off Sarasota, Florida, were conducted. Ancillary inspection dives and collections were made at the "Mexican Pride" wreck (27°30'N, 83°21'W) in 37 m and Florida Middle Ground (28°14'N, 84°10'W), an anomalous region of irregular submarine terrain in 29-42 m on the outer West Florida Shelf. These investigations constitute the most comprehensive treatment of the eastern Gulf of Mexico reef-fish fauna.

Most ichthyofaunal surveys along the Florida Gulf coast have been largely confined to inshore and nearshore habitats, particularly estuaries, shoreline jetties, Gulf beaches, and coastal marshes (e.g., Reid, 1954; Kilby, 1955; Joseph and Yerger, 1956; Springer and Woodburn, 1960; Tabb and Manning, 1961; Gunter and Hall, 1965; Wang and Raney, 1971; Hastings, 1972). Offshore Gulf fish collections have almost exclusively employed trawls and dredges which capture reef fishes only incidentally or accidentally (Spring and Bullis, 1956; Bullis and Thompson, 1965; Moe and Martin, 1965; Joyce and Williams, 1969). Although primarily interested in nearshore and inshore fishes, Springer and Woodburn (1960) and Hastings (1972) did include supplemental lists of reef fishes observed with SCUBA off respective west-central and northwest Florida coasts. Disclosure of several previously unreported tropical fishes and lack of in situ collections deeper than 18 m prompted Springer and Woodburn's (1960:99) comment that these offshore reefs constitute "one of the least known biocöenoses in the Gulf of Mexico." A few SCUBA collections of reef fishes were made during Project Hourglass on the Central West Florida Shelf (Joyce and Williams, 1969), but results have not been published.

Fuller understanding of eastern Gulf of Mexico reef fishes is desirable from an economic perspective. The broad West Florida Shelf supports a large commercial and sports bottomfishery vitally dependent on continued productivity of these offshore reefs. In 1971, 6,356,360 lb of grouper with a dockside value of $1,272,475 and 5,800,171 lb of snapper worth $2,941,717 were brought into ports along Florida's west coast (Johnson, 1972). Even though this situation exists, amazingly little is known about the life history, ecology, behavior, and distribution of many commercially-exploited reef-fish species. Moe (1969) completed a thorough study of age and growth, movements, and population dynamics of the red grouper *Epinephelus morio* (Valenciennes) in the Gulf of Mexico. The only other commercially important reef fishes to receive partial or rather complete attention are the gray snapper *Lutjanus griseus* (Linné), [Croker 1960, 1962; Starck and Schroeder, 1971], the gag *Mycteroperca microlepis* (Goode and Bean) [McErlean, 1963], the red snapper *Lutjanus campechanus* (Poey) [Camber, 1955; Moseley, 1966b]. Tagging studies (Topp, 1963; Moe, 1967; Beaumariage, 1969; Moe et al., 1970) have elucidated seasonal and ontogenetic migrations of various eastern Gulf reef fishes. Moe (1972) assimilated much of this information in a general synopsis entitled *Movement and Migration of South Florida Fishes.* Almost nothing is known about the basic biology of most non-commercial fishes, integral components of these reef communities.

This paper will provide baseline information for future ecological studies. Nearshore waters of the eastern Gulf are becoming increasingly polluted with detectable levels of mercury, pesticides, cellulose, and sewage (Austin, 1970). Dredge-fill operations along the Florida west coast have destroyed extensive seagrass beds, a habitat important during early development of certain reef fishes (Taylor and Saloman, 1968). Springer and Woodburn (1960: 101) stated that "man's alteration of inshore aquatic habitats will be detrimental to the future abundance of fish speciesin the Tampa Bay area." Offshore areas are increasingly becoming subject to human activities. Recently, several oil-gas tracts have been leased on the outer West Florida Shelf. Smith and Ogren (1974) expressed concern that environmental perturbations affiliated with oil-drilling operations might jeopardize sensitive shelf reef communities. Only through understanding the extant reef ecology can future environmental impacts be assessed.

Knowledge of the eastern Gulf reef ichthyofauna is germane to biogeographic considerations. Varying responses of organisms to bathymetric gradients in physical, chemical, and biological features associated with the broad West Florida Shelf obscure distributional patterns making disposition of biogeographic boundries formidable. The demarcation between tropical (or subtropical) and temperate bioregions has variously been proposed for Cape Sable (Miller, 1969), Cape Romano (Pulley, 1952; Ginsburg, 1952; Briggs, 1974), Sanibel Island (Hedgpeth, 1953), Tampa Bay (Hedgpeth, 1953; Rehder, 1954), and Cedar Key (Warmke and Abbott, 1961; Coomans, 1962) along the Florida west coast. This attests to the confused state of knowledge regarding distributions of eastern Gulf biotas. Ekman (1953), Van Name (1954), Taylor (1955), and Hall (1964) include the entire Gulf of Mexico within a tropical or Caribbean region. Further complicating the situation, attention has been called to a progressive addition of tropical species on outer Gulf Shelves (Pulley, 1952; Rehder, 1954; Bayer, 1961; Dawes and Van Breedveld, 1969; Robins, 1971; Cashman, 1973; Smith and Ogren, 1974; Briggs, 1974). Moreover, biogeographic affinities may often depend on the particular biota under consideration. Cashman (1973:194) observed that while "Texas soft bottom communities are comparable to this temperate-water fauna [Carolinian], the hard bottom communities present on the offshore reefs and banks are more closely allied to the West Indies fauna and these are distinctive from faunas in surrounding soft bottom areas." Realizing the complexity of biotic distributions off Florida west coast, Briggs (1974: 67) stressed that "distributional studies of various marine animal groups that are common along the Florida west coast need to be made" to define the zoogeographic boundary "where the greatest number of range terminations take place."

A Florida red tide (*Gymnodinium breve* Davis) contributing to mass mortalities of benthic reef biotas occurred within the study area during summer 1971 (Steidinger and Ingle, 1972). Accumulation of baseline data at specific reefs allowed the unprecedented opportunity to appraise faunal and floral mortality, and to study patterns of recolonization and succession of communities following the red tide. Although this work is still in progress, preliminary results are reported herein.

AREA DESCRIPTION

Prior to specific descriptions of the study reefs, it is appropriate to first review the general features of the West Florida Shelf and its overlying waters. The West Florida Shelf is arbitrarily defined as extending from Cape Sable to Cape San Blas and seaward to the 183 m isobath (Figure 1).

The West Florida Shelf is broad and of little gradient. The 183 m isobath lies approximately 182 km off Tampa Bay and broadens to more than 242 km off Naples (Moe, 1963). The shelf similarly widens north of Tampa Bay where the 91 m isobath is generally located well over 161 km offshore.

The West Florida Shelf represents a carbonate platform exhibiting a young, drowned karst topography (Brooks, 1973; Pyle, 1974). Geologically similar to the Yucatan Shelf, it is characterized by broad expanses of limestone rock marred with solution basins and sinkholes (Price, 1954). The limestone is typically "marly limestone, sandy limestone, dense fine-grained limestone, or phosphatic conglomeratic limestone" (Gould and Stewart, 1956). The geological history of the West Florida Shelf includes "submergence during the Cretaceous, part of the Oligocene, and upper Miocene" (Lynch, 1954). Gentle post-Miocene uplift has resulted in erosion of the once extensive limestone cover.

Most limestone outcroppings off the Florida west-central coast assume the form of undercut ledges paralleling existing depth contours and probably representing relic shorelines. Ballard and Uchupi (1970) suggested that a gradual rise in Pleistocene sea levels created this "complex mixture of topographic expressions". Inshore of 37 m, most limestone ledges are low relief (<2 m), but offshore, particularly at the Florida Middle Ground, ledges and prominences may rise 10-13 m above surrounding bottoms (Smith and Ogren, 1974). Brooks (1962) attributed the Florida Middle Ground relief to underlying Pleistocene reefs flourishing during the last interglacial period (Sangamon). Presently, live corals contribute little to the configuration of Middle Ground reefs.

Some rocky outcroppings within 14 km of the west coast of Florida consist of Pleistocene beachrock composed of shell fragments in a calcium carbonate matrix and locally containing "phosphatic pebbles, bone fragments, and quartz grains" (Gould and Stewart, 1956). In the vicinity of reefs 13-19 km off Sarasota, Florida, outcroppings are "primarily phosphatic, conglomeratic limestone" identifiable with the Tamiami formation of the late Miocene; interspersed are scattered outcrops of marly limestone affiliated with the Miocene Hawthorne formation (Gould and Stewart, 1956).

Sediments of the West Florida Shelf are of composite origins and generally arranged in bands somewhat parallel to shore (Gould and Stewart, 1956). Inshore of 32 km, sediments are predominately detrital quartz of terrigenous derivation; offshore, sediments grade to "calcareous debris of marine origin" including large areas of coral, algal, and other assorted invertebrate fragments (Gould and Stewart, 1956). The microzonation of sediments in the immediate vicinity of rocky reefs ranges from predominately silt-like and organic debris fractions under the ledge to coarser sand-shell and coral rubble substrates 5-10 m off the ledge. The proportional composition of these sediments is largely determined by the vertical relief, orientation, and degree of undercutting of the ledge.

Offshore rocky outcroppings are generally associated with a diverse assemblage of algae, alcyonarian and scleractinian corals, hydrocorals, sponges, echinoderms, tunicates, and other benthic invertebrates and constitute the so-called "patch

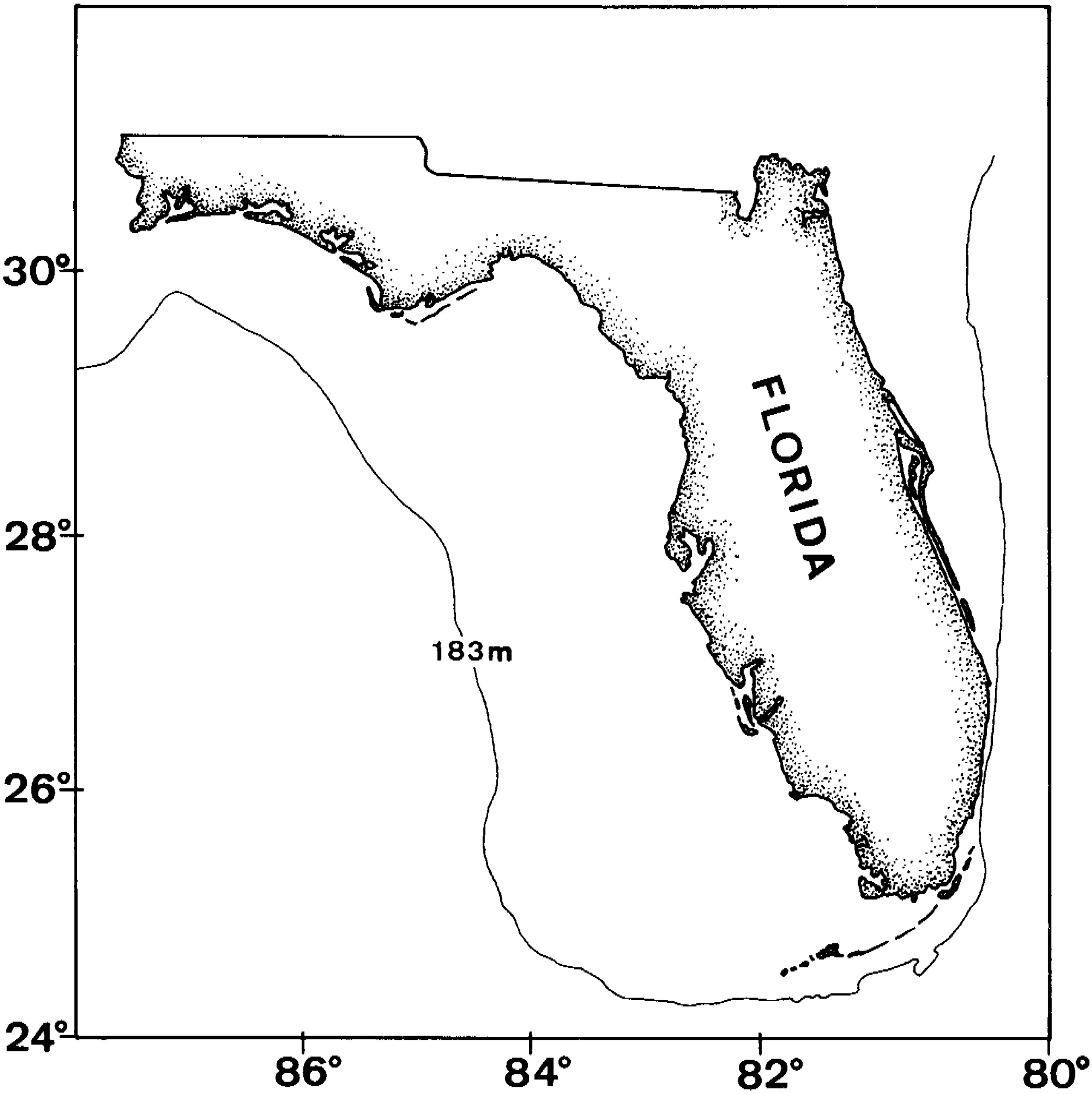

Figure 1. Florida and its continental shelf to a depth of 183 m.

reefs" of the eastern Gulf of Mexico (Springer and Woodburn, 1960; Phillips and Springer, 1960; Moe and Martin, 1965). Benthic reef algae are known from in situ collections of Phillips and Springer (1960) and Project Hourglass trawl-dredge collections reported on by Dawes and Van Breedveld (1969).

Although many hermatypic corals occupy eastern Gulf reefs, their growth form is prostrate and the bottom configuration is primarily due to irregularities in the underlying rock. Dominant hard corals at shallow reefs (12-18 m) include *Cladocora arbuscula* Lesueur, *Porites divaricata* Lesueur, *Stephanocoenia michelini* Edwards & Haime, *Oculina diffusa* Lamarck, *Solenastrea hyades* (Dana), *Blanophyllia floridana* Pourtalès, and the hydrocoral *Millepora alcicornis* Linné; deeper than 18 m, coral assemblages become progressively enriched with *Manicina areolata* (Linné), *Siderastrea sidera* Ellis & Solander, *Isophyllia* *sinuosa* (Ellis & Solander), and *Scolymia lacera* (Pallas) (Walter C. Jaap, Florida Department Natural Resources Marine Laboratory, FDNRMRL, personal communication). Soft (gorgonian) corals well represented at shallow reefs commonly include *Muricea elongata* Lamouroux, *Plexaurella fusifera* Kunze, *Eunicea calyculata* Ellis & Solander, *Pseudopterogorgia acerosa* (Pallas), *P. rigida* (Bielschowsky), *Lophogorgia hebes* (Verrill), and *Pterogorgia guadalupensis* Duchassaing & Michelin (Jennifer L. Smith, FDNRMRL, personal communication). Offshore, gorgonian coral communities become diminished in both species composition and abundance.

Inshore circulation patterns in the eastern Gulf are complex, poorly known, and subject to local conditions of runoff and prevailing wind. Curl (1959) reported that the Apalachicola River runoff

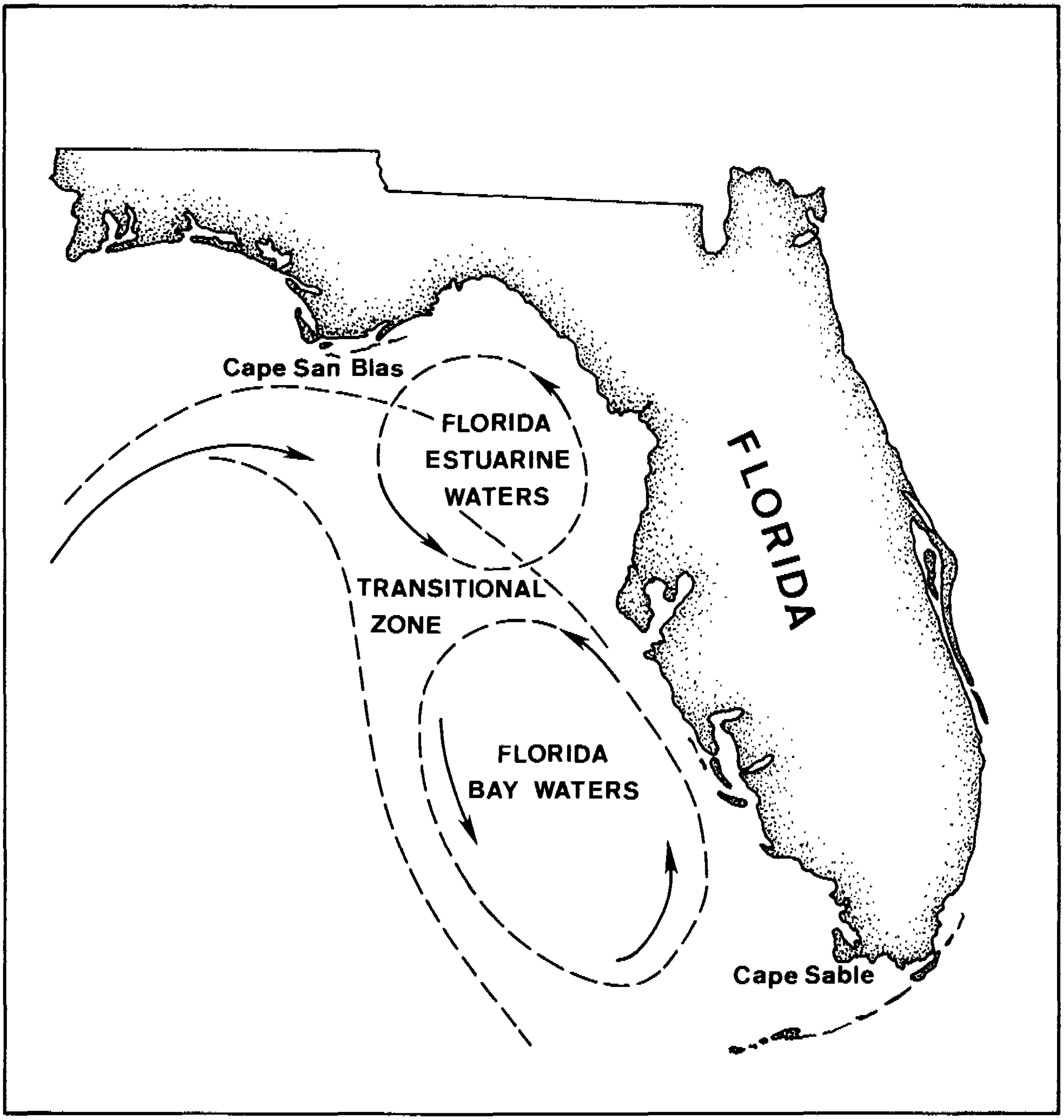

Figure 2. Generalized patterns of offshore surface currents in the eastern Gulf of Mexico during summer.

may depress salinities to 257 km offshore. Nearshore currents may be classified as either permanent or tidal (Storr, 1956). Price (1954) found the direction of longshore drift to be primarily northward from Indian Rocks Beach (27°52'N) to Anclote Key (Tarpon Springs) and predominately southward from Indian Rocks to Cape Romano (Florida Bay).

Offshore water masses of the eastern Gulf may be partitioned into a Loop Current (a northeastward bifurcation of the Yucatan Current), a Florida Estuarine Gyre in the northeastern Gulf, and a Florida Bay Gyre in the southeastern Gulf (Chew, 1955; Austin, 1970) (Figure 2). The boundaries of these water masses are broad, transitional zones subject to the synergistic influences of a multitude of factors. There is ample evidence to suggest seasonal upwelling and concomitant high zooplankton biomass along the seaward edge of the Middle Ground (Austin, 1970). Smith and Ogren (1974) postulated that this situation contributes to the local abundance of planktivorous fishes (e.g., *Chromis, Apogon,* and *Opistognathus*) at the Middle Ground. Surface currents undoubtedly facilitate tropical recruitment into the eastern Gulf of many reef fishes with planktonic larvae. Due to their moderating effects over outer shelf regions, these currents also enhance maintenance of many tropical reef-fish populations once established. The general trend is for higher bottom temperatures, salinities, and transparency with increased depth and distance offshore (Dawes and Van Breedveld, 1969).

Sea surface temperatures in the eastern Gulf vary widely according to season, latitude, water depth, and offshore distance. During summer, surface temperatures are uniformly 26.6° C or higher. The mean March isotherm varies from approximately 17.8° C in northern regions to 22.2° C in the south (Figure 3). Dawes and Van Breedveld

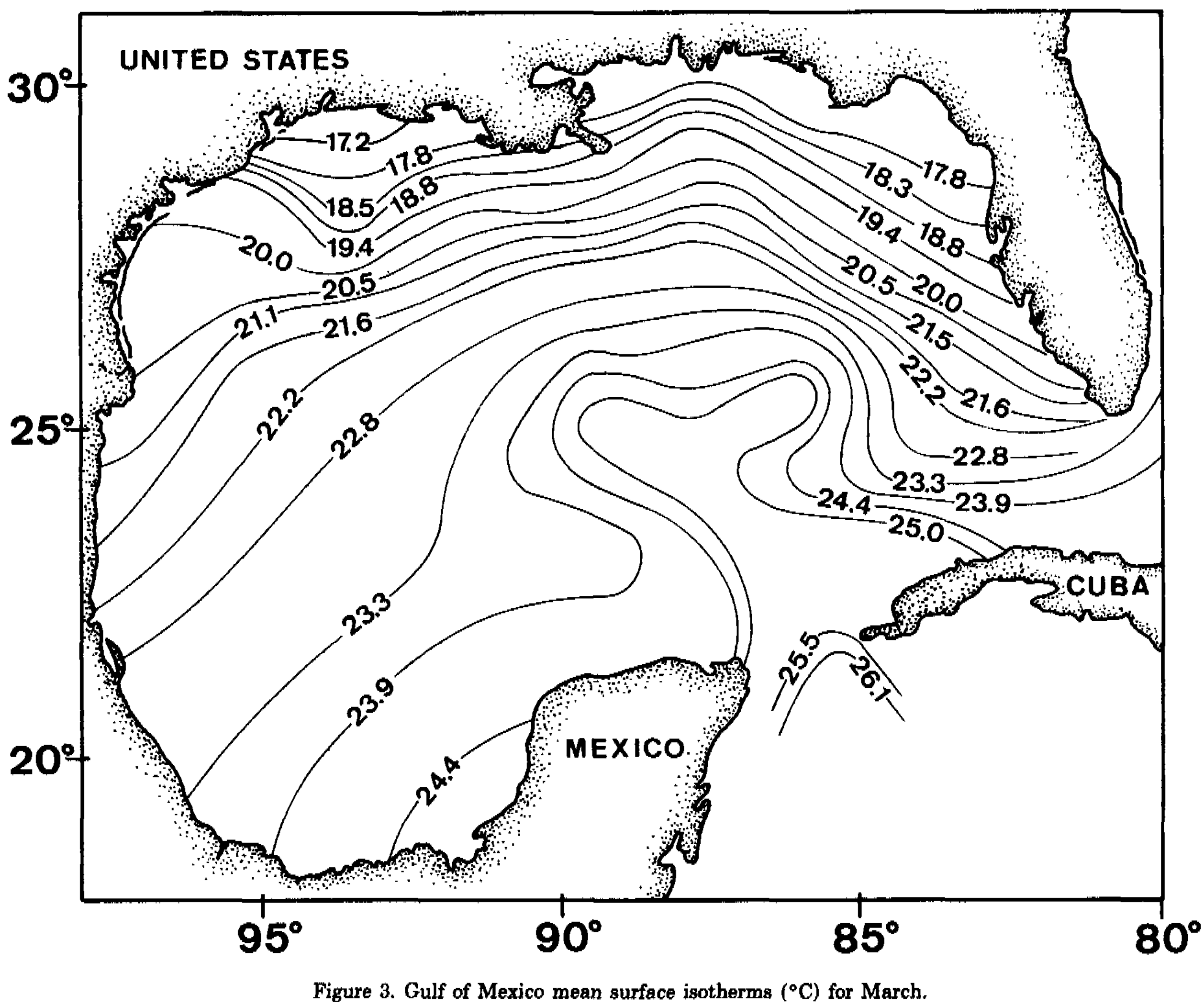

Figure 3. Gulf of Mexico mean surface isotherms (°C) for March.

(1969) reported annual temperature ranges of 11.3-31.5° C at 6 m stations and 17.5-26.0° C at 73 m stations during Project Hourglass on the Central West Florida Shelf. The annual fluctuation of sea surface temperatures is between 15 and 20° C in the northern Gulf, but less than 10° C in the central and southern Gulf (Leipper, 1954). These temperature variations profoundly influence diversity, abundance, and distribution of eastern Gulf reef ichthyofaunas.

There exists not only a horizontal zonation of sea surface temperatures, but also a vertical component. Waters overlying reefs in the eastern Gulf are thermally stratified more often than not. This thermal stratification most frequently occurs as a cool-water layer positioned 1-3 m off the bottom. Inshore, the water column stratifies in mid-fall and the temperature gradient gradually increases until late spring-early summer when vertical mixing and isothermy occur. In offshore areas, thermal stratification of the water column is better developed and persists later into the year. Joyce and Williams (1969) suspected that permanent temperature stratification existed offshore of 55 m. Austin and Jones (1974) detected thermal stratification of waters overlying the Middle Ground during summer, but isothermal conditions throughout winter.

Water transparency generally increases with offshore distance and depth. Transparency is usually greatest, at all depths, during late spring and fall. However, water transparency may sometimes be reduced, particularly inshore, due to spring-fall blooms of the bluegreen alga *Oscillatoria* (=*Trichodesmium*) *erythraea* (Ehrenberg) Küntzing or the dinoflagellate *Gymnodinium breve*. Water clarity is frequently limited during winter when bottom sediments may be suspended following high winds and rough seas accompanying the passage of polar cold fronts. Although primarily a phenomenon of shallow-water areas, waters are occassionally roiled 32-48 km offshore. Water transparency is generally less within cool water strata underlying thermoclines due to entrainment of organic debris and suspended bottom sediments. During spring and fall isothermy, however, the water column may remain uniformly clear surface to bottom.

A dramatic color change (chocolate brown or emerald green to deep blue) of surface waters is frequently encountered, particularly during summer and early fall, between the 22 and 31 m depth contours, 24 to 48 km off the Florida west-central coast. This color transition may correspond to the dynamic interface between coastal and offshore Gulf waters described by Jones et al. (1965). The siphonophore *Physalia physalis* (Linné) and pelagic brown alga *Sargassum* are commonly associated with clear blue offshore waters

STUDY REEF DESCRIPTIONS

Following are physical and biological descriptions of primary (repetitively sampled) study reefs based upon observations prior to the 1971 summer red tide. Due to problems of offshore navigation, only two reefs (STATIONS 1 and 2) were sampled regularly. Other offshore reefs (STATIONS 3-5) represent approximate locations based on compass heading, engine speed, running time, and distinctive bottom features. This appears to be a rather satisfactory method of relocation since precisely the same segment of reef ledge at STATION 3 was encountered on several different occasions. In addition to these primary reef sites, secondary reef sites were sampled once during the study period and are listed in Table 1. Approximate locations of all study reefs are depicted in Figure 4.

STATION 1 (approx. 27°14.8'N,82°43.3'W) is located about 11.5 km, 235° off Sarasota (New Pass), Florida, in 12.8-13.7 m. This reef consists of a low-relief (<1 m) ledge running about 1.4 km along a NW-SE axis, parallel to the shoreline. The shallow, inshore side of the reef lies in 12.8 m and "breaks" to a sand-shell bottom in 13.6-13.7 m (Figure 5). The break along the reef consists of a continuous ledge grading to sand-shell bottoms at either extremity. Immediately offshore of the reef ledge is a predominately sand-shell bottom with only a few scattered rocks. Finer sediments and organic debris accumulated under the reef ledge obscure underlying sand-shell substrates.

STATION 1 exhibits zonation of sessile benthic invertebrates characteristic of shallow (12-18 m) mideastern Gulf reefs. The back reef, 5-20 m shoreward of the reef ledge, is nearly always characterized by an extensive overlay of small stony corals (*Cladocora arbuscula*, *Solenastrea hyades*, and *Oculina diffusa*), scattered soft corals (*Eunicea calyculata*, *Muricea elongata*, *M. laxa*, and *Pseudopterogorgia acerosa*), sponges including the loggerhead *Spheciospongia vesparia* (Lamarck), and the siphonaceous gree algae *Halimeda*, *Udotea*, and *Penicillus*. The fore reef, 5-10 m shoreward of the reef ledge, is typically covered with a luxuriant "forest" of soft corals which, at first glance, seem to exclude nearly everything else. A small ophiuroid echinoderm *Ophiothrix suensoni* Lütken associated with the dominant soft coral, *Muricea elongata*, is rather characteristic of this reef segment. The reef ledge is generally encrusted with the boring sponge *Cliona*, tunicates, serpulid and

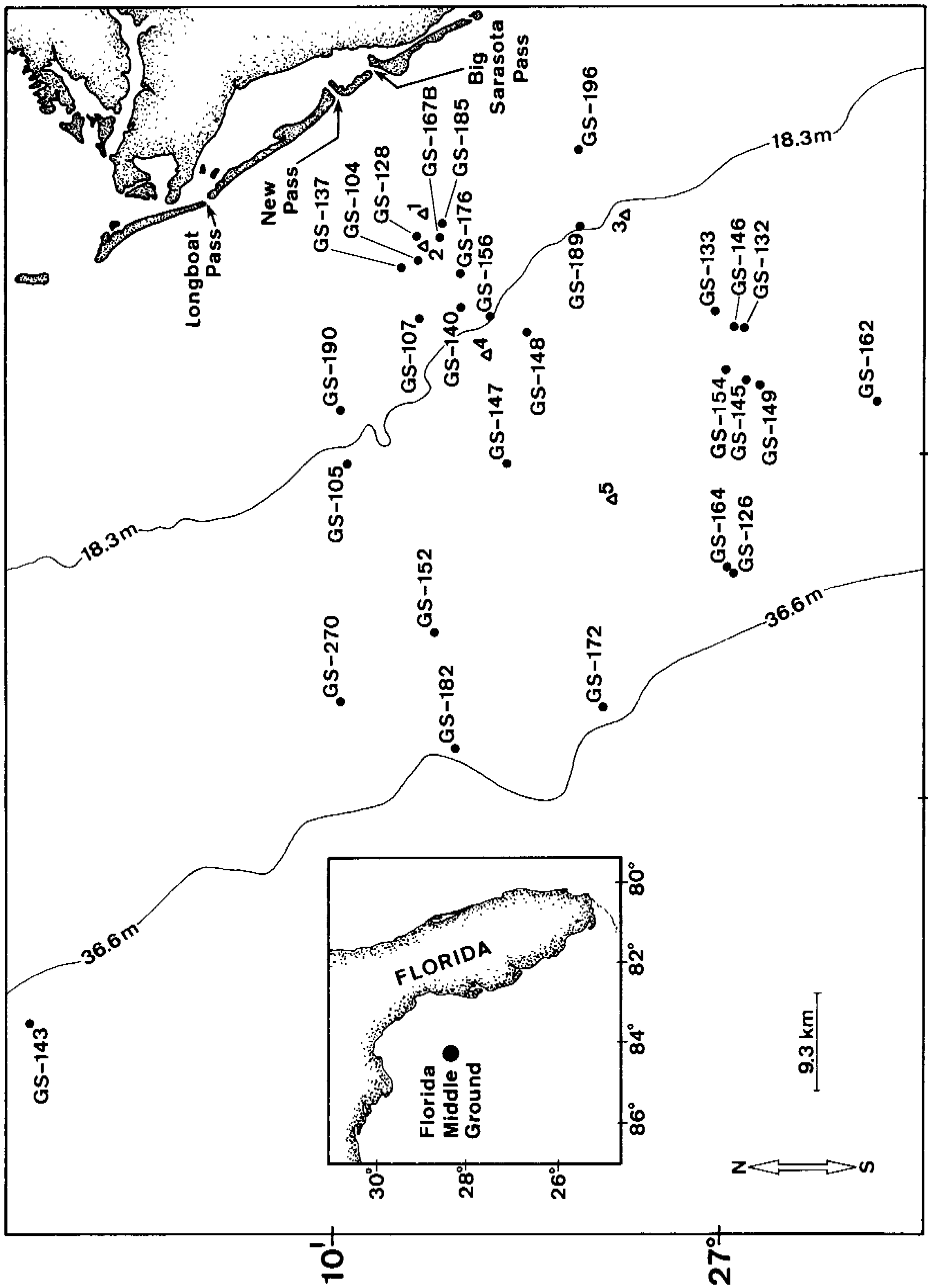

Figure 4. Approximate location of eastern Gulf of Mexico study reefs.

TABLE 1. APPROXIMATE LOCATIONS AND HABITAT DESCRIPTIONS OF SECONDARY STUDY REEF SITES.

Reef No. and sampling date	Approximate location	Habitat description
GS-104 (7-11-70)	14.5-16.0 km off (245°) Sarasota (New Pass), Florida in 14-15 m.	1-2 m-high ledge with numerous crevices and passageways.
GS-105 (7-11-70)	23.9 km off (240°) Cortez (Longboat Pass), Florida in 17 m.	Predominately sand-shell bottom with only scattered low-lying rocky outcroppings.
GS-107 (8-30-70)	19.3 km off (250°) Sarasota (New Pass), Florida in 18-19 m.	Flat, expressionless limestone rock.
GS-126 (2-20-71)	51.5 km off (230°) Sarasota (New Pass), Florida in 40 m.	Mostly flat rock covered with a surficial layer of sand and coral-shell rubble; exposed rocky rims in holes and depressions.
GS-128 (3-3-71)	14.5 km off (240°) Sarasota (New Pass), Florida in 14-16 m.	1-2 m-high ledge; large amount of shelter under reef ledge, rocks, and within rocky holes on upper reef surface.
GS-132 (4-9-71)	38.6 km off (210°) Sarasota (New Pass), Florida in 26-27 m.	1 m-high ledge with numerous holes and shafts.
GS-133 (4-10-71)	35.4 km off (210°) Sarasota (New Pass), Florida in 26-27 m.	1 m-high ledge with numerous holes and shafts.
GS-137 (5-7-71)	14.5 km off (250°) Sarasota (New Pass), Florida in 14-16 m.	1 m-high ledge oriented NW-SE; great amount of shelter.
GS-140 (5-21-71)	19.3 km off (240°) Sarasota (New Pass), Florida in 17 m.	1 m-high ledge bordering an island of rock (approx. 100x15 m) surrounded by sand, calcareous rubble bottom. Entire rocky structure perforated by labyrinthine passageways affording a great deal of shelter.
GS-143 (6-27-71)	59.3 km off (270°) Egmont Key (Tampa Bay), Florida in 37-38 m.	A sunken barge, the "Mexican Pride" rises approximately 6 m above surrounding sand-shell bottoms. Barge dimensions estimated to be 100x20 m.
GS-145 (7-3-71)	38.6 km off (220°) Sarasota (Big Pass), Florida in 29-30 m.	1 m-high ledge aligned NW-SE; upper reef surface marred with numerous holes, crevices, and passageways.
GS-146 (7-10-71)	38.5 km off (210°) Sarasota (New Pass), Florida in 28-29 m.	Gently-rolling limestone bottom with numerous holes and fractures.
GS-147 (7-11-71)	20.9 km off (245°) Sarasota (New Pass), Florida in 19-20 m.	Flat rock with only a few shafts.
GS-148 (7-16-71)	24.1 km (230°) Sarasota (New Pass), Florida in 20-21 m.	Flat, expressionless limestone rock.
GS-149 (7-17-71)	42.7 km off (215°) Sarasota (New Pass), Florida in 29 m.	Flat, expressionless limestone rock.
GS-152 (7-27-71)	45.0 km off (260°) Sarasota (New Pass), Florida in 31-34 m.	Mostly flat, expressionless limestone rock; a few rocky holes.
GS-154 (8-21-71)	40.2 km off (215°) Sarasota (New Pass), Florida in 29-30 m.	Limestone bottom riddled with numerous holes and crevices.
GS-156 (8-23-71)	13.6 km off (235°) Sarasota (New Pass), Florida in 13-14 m.	1 m-high ledge.
GS-162 (9-21-71)	51.5 km off (210°) Sarasota (New Pass), Florida in 27 m.	Shell and mud bottoms with scattered rocky outcrops.
GS-164 (10-23-71)	51.5 km off (230°) Sarasota (New Pass), Florida in 36-37 m.	Shell and coral rubble bottom with scattered low-profile rocky outcroppings. One large (10x20 m) rocky depression surrounded by a 1 m-high ledge.
BARRACUDA HOLE GS-167B (11-14-71)	13.5 km off (235°) Sarasota (New Pass), Florida in 13-15 m.	1-3 m-high ledge undercut 3-4 m in places. Numerous rocky holes, fractures, and passageways throughout the reef structure.

TABLE 1. APPROXIMATE LOCATIONS AND HABITAT DESCRIPTIONS OF SECONDARY STUDY REEF SITES (Continued).

Reef No. and sampling date	Approximate location	Habitat description
GS-172 (12-27-71)	54.7 km off (245°) Sarasota (New Pass), Florida in 36-37 m.	Shell bottom with scattered patches of rock.
FLORIDA MIDDLE GROUND		
GS-174 (1-23-72)	131.9 km off (300°) John's Pass, Florida in 29-41 m.	10-15 m-high rocky hillocks, escarpments, and ledges. Irregular bottom configurations afford tremendous amount of habitat shelter.
GS-176 (2-14-72)	17.7 km off (235°) Sarasota (New Pass), Florida in 16-18 m.	1 m-high ledge.
GS-182 (4-10-72)	56.3 km off (260°) Sarasota (New Pass), Florida in 33-34 m.	Irregular rocky bottom with numerous holes and crevices.
GS-185 (5-30-72)	14.5 km off (230°) Sarasota (New Pass), Florida in 13-14 m.	1 m-high ledge.
GS-189 (7-29-72)	22.5 km off (210°) Sarasota (Big Pass), Florida in 19-20 m.	1-2 m-high ledge, deeply undercut 1-2 m.
GS-270 (8-7-72)	49.9 km off (270°) Sarasota (New Pass), Florida in 31-33 m.	1-2 m-high ledge with unusually heavy invertebrate growth on upper reef surfaces.
GS-190 (8-13-72)	25.7 km off (270°) Sarasota (New Pass), Florida in 15 m.	Small series of ledges (less than 1 m-high). Extremely rough bottom with numerous rocky holes, fissures, and crevices.
GS-192B (8-29-72)	12.8 km off (235°) Sarasota (New Pass), Florida in 13-14 m.	1 m-high ledge.
GS-196 (10-14-72)	17.7 km off (200°) Sarasota (Big Pass), Florida in 15-17 m.	1 m-high ledge; large broken rocks on deeper, offshore side.

sabellid polychaetes, the fire coral *Millepora alcicornis*, and the green alga *Caulerpa racemosa* (Forsskål) J. Agardh. The Western Atlantic deer cowrie *Cypraea cervus* Linńe is rather diagnostic of the ledge microzone where it is usually secreted under the reef overhang or within rocky holes along its margin. Sand-shell substrates peripheral to rocky reefs are relatively barren except for scattered

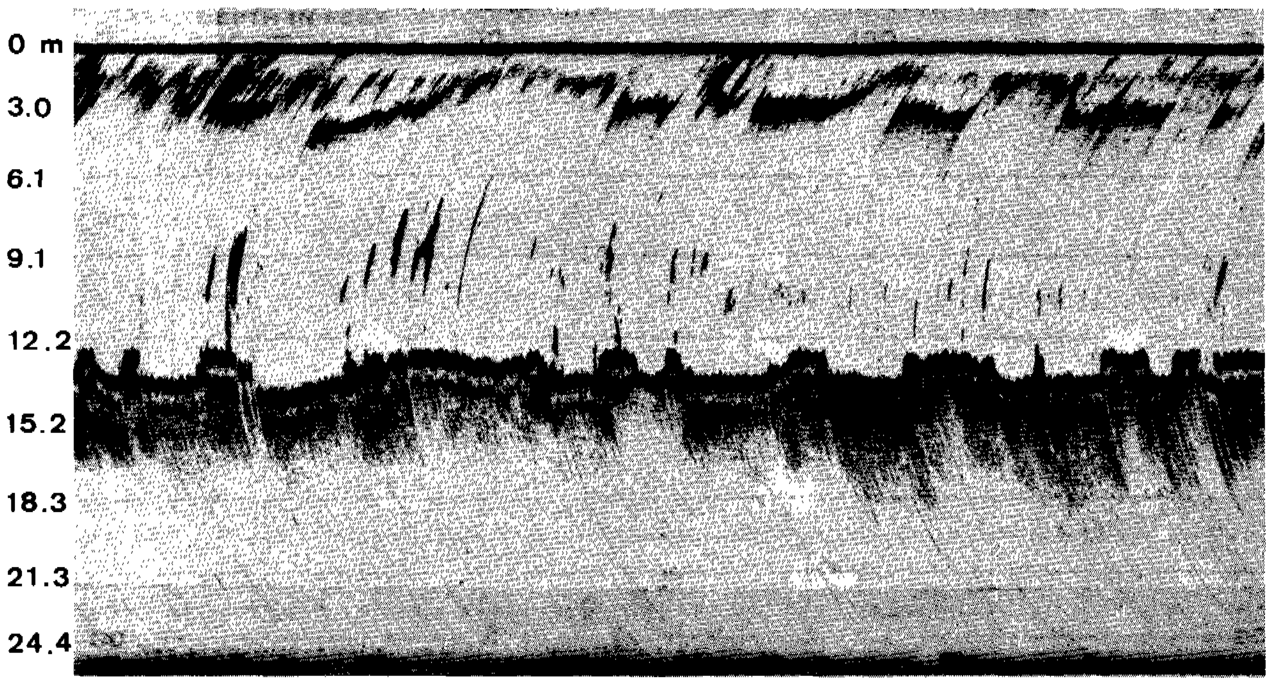

Figure 5. Bathymetry of reef station 1 (12.8-13.7 m).

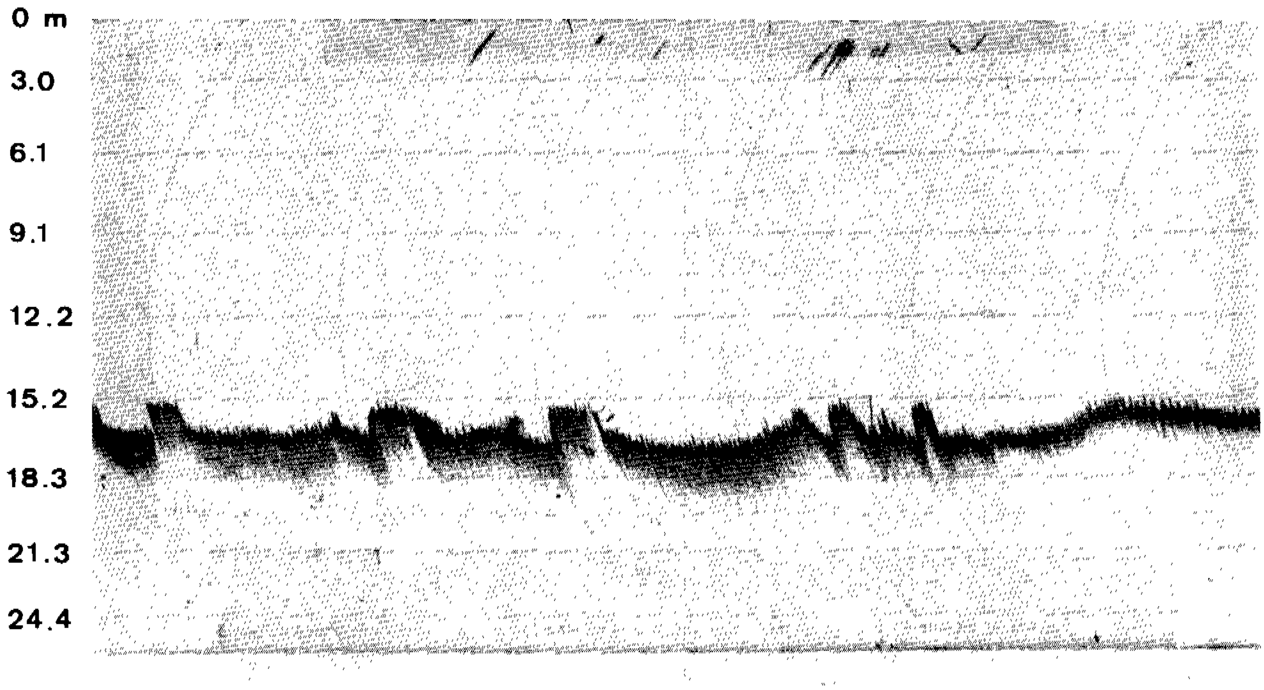

Figure 6. Bathymetry of reef station 2 (14.8-16.6 m).

patches of the green algae *Caulerpa prolifera* (Forsskål) J. Agardh and *C. ashmeadii* Harvey and, at shallow 12-15 m reefs, the seagrass *Thalassia testudinum* König and Sims.

Conspicuous decapod crustaceans at shallow Gulf reefs include the arrow crab *Stenorynchus seticornis* (Herbst), spiny lobster *Panulirus argus* (Latreille) and, seasonally, the stone crab *Menippe mercenaria* (Say). In addition to those echinoderms already mentioned, the echinoids *Arbacia punctulata* (Lamarck), *Lytechinus variegatus* (Lamarck), and *Encope michelini* L. Agassiz, the ophiuroid *Astrophytan muricatum* (Lamarck), and the asteroids *Echinaster spinulosus* Verrill, *Oreaster reticulatus* (Linné), and *Luidia* sp. dwell on or in close proximity to reefs.

STATION 2 (27°12.6'N,82°46.1'W) is located about 15.1 km, 240° off Sarasota (New Pass), Florida in 14.8-16.6 m. The gross configuration of this reef ledge system is similar to that of STATION 1. Ledge relief varies between 1-2 m as it courses approximately 1.8 km along a NW-SE axis (Figure 6). The reef ledge is undercut to 3 m and numerous passageways, crevices, and solution holes interconnect lower and upper reef surfaces. Unlike STATION 1, several large rocks (to 3 m diameter) and limestone chimneys project abruptly from sand-shell bottoms 20-30 m off the reef ledge. The benthic reef biota at STATION 2 may be considered qualitatively identical to that of STATION 1.

STATION 3 (approximately 82°45'N,27°01'W) is located between 19.3-20.6 km, 210° off Sarasota (Big Sarasota Pass), Florida in 18.3-21.0 m. STATION 3 is about 0.7 km^2 of irregular limestone bottom including two series of well-defined ledge systems in 18.3-19.2 m and 20.1-21.0 m. The orientation of the reef ledge systems is approximately NW-SE. Most of these ledges probably represent shoreline features created when gradually rising Pleistocene sea levels temporarily paused at the present 20 m depth contour (Ballard and Uchupi, 1970). Many reefs in the area are impregnated with fossilized bones, presumably of terrestrial origin.

The biota of STATION 3 is qualitatively similar to that of STATIONS 1 and 2 except for the addition of certain tropical and/or deep-water species. Examples include the scleractinian corals *Scolymia lacera* and *Manicina areolata*. Reefs in the vicinity of STATION 3 lack the luxuriant gorgonian coral "forest" so characteristic of shallower reefs. Most of the same alcyonarian coral species are present but in noticeably reduced numbers.

STATION 4 (approximately 27°11'N,82°50'W) lies in 22.0-23.8 m approximately 20.6 km, 240° off Sarasota (New Pass), Florida. The area is characterized by broad expanses of limestone rock marred with crevices, shallow basins, and solution holes. No well-defined ledges were detected. A rich invertebrate fauna is associated with these irregular limestone bottoms. Many species of stony corals rare or absent at shallower reefs are common, but alcyonarian coral assemblages are depauperate by comparison. Both spiny lobster (*Panulirus argus*) and Spanish lobster [*Scyllarides nodifer* (Stimpson)] are common throughout the area, especially in the deeper solution holes. The thorny oyster *Spondylus americanus* Hermann first begins to appear at depths encountered at STATION 4.

STATION 5 (approximately 27°6'N,82°59'W) is located about 38.6 km, 235° off Sarasota (New Pass), Florida, in 29.0-33.0 m. The general vicinity is easily recognizable in fathometer tracings due to an abrupt depth change within an inshore-offshore distance of less than 0.7 km. Although no well-defined ledges exist in the area, the zone of most rapid depth change is characterized by numerous discontinuous, low-relief limestone terraces. A diverse invertebrate and fish fauna is associated with these bottom irregularities. Diagnostic bioindicators of this deep reef community include the decapod crustacean *Stenopus hispidus* (Olivier), the pelycepod mollusk *Lima scabra* (Born), and the echinoid echinoderm *Diadema antillarum* Philippi.

The Florida Middle Ground STATION (28°14'N, 84°10'W) is situated on the outer West Florida Shelf about 141 km, 300° off John's Pass, Florida. Only a single observation and collection (January 1972; GS-174) of reef fishes was conducted at the Middle Ground, but a brief description seems appropriate because of its distinctness from other Gulf patch reefs. Unlike most eastern Gulf reefs, the Middle Ground is typified by 10-15 m high limestone irregularities rising to within 24 m of the surface. Certain physical, chemical, and biotic features have favored development of a diverse and abundant biota, dominated by tropical species, at the Middle Ground (Smith and Ogren, 1974).

METHODS AND MATERIALS

A visual census with SCUBA was the primary method used to study mideastern Gulf reef-fish communities since it appears to be the most satisfactory means of sampling rocky or coral reef areas of irregular terrain. More than 100 inspection dives totaling greater than 125 h of underwater observation, were conducted at several Gulf reefs during May 1970 through October 1972. This in situ reef-fish survey was designed to collect information on 1) species composition and relative abundance, 2) intra-reef species distributional patterns, 3) inter-reef and bathymetric species distribution, 4) relation of physicochemical and biological parameters to species distributions, 5) seasonality, 6) ecology and behavior, and 7) zoogeographical relationships of the mideastern Gulf reef ichthyofauna.

Various types of reef-fish censuses with SCUBA have been employed at Bermuda (Bardach, 1959), Hawaii (Brock, 1954), Virgin Islands (Smith and Tyler, 1972), and northwest Gulf of Mexico (Causey, 1969; Cashman, 1973; Bright and Cashman, 1974). Fishes of eastern Gulf reefs are particularly amenable to direct visual census because of the conspicuous absence of high-relief reef structures. Accordingly, fishes are inherently more visible to underwater observers than in environments of irregular topographic expression typical of Caribbean-West Indian reefs. Eastern Gulf reef communities are notably deficient in schooling pelagic or benthopelagic fishes so diagnostic of many tropical Western Atlantic reefs. Most eastern Gulf reef fishes are sedentary, nongregarious benthic species easily censused through direct observation by divers.

Bardach (1959) reviewed problems of sampling reef-fish populations and concluded that direct counting was the least biased and best census method available. Brock (1954) similarly endorsed visual enumeration techniques if one recognized certain basic assumptions: 1) individual fish or schools must be detected in a quantitative manner, 2) the proportion of fish sampled must reflect the abundance and distribution of the entire population, and 3) accurate species determinations must be ensured. As previously mentioned, certain characteristics of the eastern Gulf reef ichthyofauna ensure that direct observation censuses satisfy the first two assumptions. To satisfy the last criterion, voucher specimens of most reef-fish species observed were collected, identified, and accessioned into the FDNRMRL ichthyological collection (FSBC).

Direct census of reef-fish populations through diver observation certainly underestimates both diversity and abundance, particularly of fishes concealed within or against the reef structure. Periodic rotenone (Chem-Fish Collector) collections made at selected reef localities provided an assessment of cryptic, crepuscular, and nocturnal species which might escape diver observation. Schultz (1948) listed the advantages of collecting small reef fishes with rotenone.

Representative series of reef-fish specimens were taken by spearfishing (speargun and pole spear), hook-and-line, handnets, poisons, and anesthetics. Undiluted Chem-Fish Collector (2.5% rotenone, 5.0% other cubé extracts) was deployed from plastic squeeze bottles over a prescribed section of reef ledge and after 10-20 min, depending upon water temperature, dead and moribund fishes were collected with handnets. An anesthetic concentration of Quinaldine (1 quinaldine: 10 acetone: 20 seawater) was similarly dispersed from squeeze bottles and the immobilized fishes were collected in handnets or plastic bags. Use of Chem-Fish rotenone and Quinaldine yielded many fishes (e.g., apogonids) which were otherwise undetected.

In most instances, reef fishes were observed during a standard 20 min (bottom time) SCUBA dive and ranked according to a scale of relative abundance (abundant, common, frequent, occasional, or rare). Semi-quantitative estimates of reef-fish abundance were periodically determined at reef STATIONS 1 and 2 by swimming an approximately 300 m interval of reef ledge, noting the numbers of individuals of each species observed within an approximate 3 m-wide lane, and recording all data on white plastic slates.

Between 9 May and 21 June 1970, intervals along STATION 1 reef ledge were monitored with SCUBA by ranking the observed fishes according to their relative abundances. During May 1971, a permanent buoy was affixed to the reef approximately 300 m from its southernmost extremity. Between 16 May 1971 and 29 August 1972, censuses of reef fishes were conducted semi-periodically (May, June, July, August, October, November, and December 1971; January, February, March, May, June, July, and August 1972) by swimming this 300 m ledge interval and counting all fishes observed within the 3 m-wide lane.

Relative abundance estimates of fishes were conducted along various segments of STATION 2 ledge during July and September 1970. On 31 October 1970, a permanent buoy was affixed to the ledge approximately 300 m from its southern extension. Thereafter, censuses of all fishes observed within the 3 m-wide lane along this interval were conducted during October, November, and December 1970; January, March (2 dives), April (2), July, August (2), October (2), November, and December 1971; and February, March, April, July, August, and October 1972.

Relative abundance estimates of reef fishes were conducted at STATION 3 during September 1970; April, August, and September 1971; and September (2 dives) and October 1972).

Relative abundances of reef fishes were estimated at STATION 4 during September, October, November, and December 1970 and January and June 1971.

Visual estimates of reef-fish abundance were conducted at STATION 5 during October, November, and December (2 dives) 1970 and February and June 1971.

Air and water temperatures (surface and bottom) were taken with diver-held mercury thermometer and recorded to the nearest 0.1° C. Dissolved oxygen, when taken, was determined according to standard Winkler titrametric techniques and expressed to the nearest 0.1 ml/1. Surface and bottom horizontal visibilities, as indicators of water transparency, were estimated to the nearest meter by underwater observers. Salinities were determined titrametrically according to the Knudsen technique.

All fish collected in the field were fixed in 10% formalin for one or two days depending on the size and kind of fish. Afterwards, specimens were thoroughly rinsed in freshwater and transferred to 40% isopropanol for permanent storage. Measurements were taken with either dividers and millimeter rule or dial calipers and recorded to the nearest millimeter. Standard length (SL) was taken unless specified otherwise.

RESULTS AND DISCUSSION

PHYSICOCHEMICAL DATA

Temperature data were collected during most reef inspection dives (Table 2). Recorded temperatures ranged from a low of 18.5° C (bottom) at STATION 2 during March 1971 to 30.8° C (surface) at the same station during August 1971. Surface and bottom temperatures remained more stable and consistently higher at deep-water reefs throughout winter. However, bottom waters at deeper reef sites remained cooler later into the year than bottom waters over inshore, shallow-water reefs. Seasonal and short-term temperature fluctuations were most pronounced at shallow reef sites. Bottom temperatures, for example, dropped from 29.0 to 22.5° C at STATION 1 during October through December 1971.

Thermal stratification of the water column was seasonally present at all depth locations. Warmer waters were generally contained at the surface whereas cooler waters were typically present within a layer 1-3 m off the bottom. Occasionally, temporary thermal inversions (cooler surface waters) occurred following passage of winter cold fronts. Greatest surface-bottom temperature differentials occurred during late-spring and early-summer at deeper, offshore locations with a maximum value of 6.4° C recorded at STATION GS-143 during June 1971. Vertical mixing and isothermy occurred during late-spring and early-summer over shallow reefs but delayed until

TABLE 2. TEMPERATURE DATA (NEAREST 0.1°C) COLLECTED AT EASTERN GULF OF MEXICO STUDY REEFS DURING MAY 1970 — OCTOBER 1972.

Date	Depth (m)	Station Number	Surface Temperature (°C)	Bottom Temperature (°C)
9 May 1970	12.8	1	25.0	23.0
24 Oct 1970	22.0	4	26.1	26.0
31 Oct 1970	14.8	2	25.2	26.0
19 Nov 1970	14.8	2	21.0	21.2
27 Nov 1970	29.3	5	24.1	24.0
4 Dec 1970	14.8	2	20.5	20.3
4 Dec 1970	18.3	4	22.9	22.8
5 Dec 1970	29.3	5	23.1	23.0
27 Dec 1970	29.3	5	22.5	23.1
9 Jan 1971	14.8	2	22.5	21.5
9 Jan 1971	18.3	4	22.0	22.0
20 Feb 1971	40.2	GS 126	21.9	21.8
21 Feb 1971	29.3	5	24.5	22.0
3 Mar 1971	13.7	GS 128	19.0	19.0
13 Mar 1971	14.8	2	19.0	18.5
9 Apr 1971	29.3	GS 132	19.0	19.0
10 Apr 1971	25.6	GS 133	19.3	19.3
12 Apr 1971	18.3	3	19.0	19.0
14 Apr 1971	14.8	2	21.6	19.0
17 Apr 1971	14.8	2	21.8	19.1
16 May 1971	12.8	1	27.1	27.0
10 Jun 1971	29.3	5	29.9	23.2
27 Jun 1971	36.6	GS 143	30.1	23.7
30 Jun 1971	12.8	1	30.0	29.1
30 Jun 1971	22.0	4	30.0	27.5
3 Jul 1971	28.9	GS 145	31.5	27.1
24 Jul 1971	14.8	2	30.5	30.5
27 Jul 1971	31.1	GS 152	30.6	28.9
22 Aug 1971	14.8	2	30.8	29.1
23 Aug 1971	12.8	1	30.5	30.0
23 Aug 1971	14.8	2	30.5	30.0
24 Aug 1971	18.3	3	30.5	30.5
18 Sep 1971	18.3	3	29.2	28.6
24 Oct 1971	14.8	2	29.0	29.0
24 Oct 1971	22.0	1	28.8	28.8
14 Nov 1971	12.8	1	24.0	23.5
14 Nov 1971	14.8	2	24.0	24.0
15 Nov 1971	12.8	1	23.5	23.5
15 Nov 1971	14.8	2	23.0	22.5
27 Dec 1971	36.6	GS 172	22.2	22.2
23 Jan 1972	29.3	GS 174	21.0	21.0
29 Jan 1972	12.8	1	20.0	19.4
29 Feb 1972	14.8	2	22.0	22.0
29 Feb 1972	12.8	1	23.0	23.0
24 Mar 1972	12.8	1	23.3	22.2
24 Mar 1972	14.8	2	23.3	22.2
20 Apr 1972	14.8	2	25.0	26.8
21 May 1972	12.8	1	26.1	21.6
11 Jul 1972	14.8	2	29.0	27.0
22 Aug 1972	14.8	2	30.1	29.0
29 Aug 1972	12.8	1	30.0	30.0
5 Oct 1972	14.8	2	28.3	26.7

late-summer (July-August) at certain deep reef sites.

Fish behavior appeared to be modified by the presence and degree of thermal stratification of the water column. Benthopelagic plankton-feeding pomacentrids of the genus *Chromis* and schooling predators such as the gray snapper *Lutjanus griseus* remained below thermoclines of more than a few degrees Celsius. When the thermocline was disrupted, however, these species extended their foraging activities higher into the water column.

Salinity was only intermittently monitored during late 1970 and early 1971 (Table 3). Salinities varied between 36.6 ‰ (bottom) at STATION 4 during December 1970 and 34.9 ‰ (surface) at STATION 2 during January 1971.

TABLE 3. SURFACE AND BOTTOM SALINITIES AT EASTERN GULF OF MEXICO STUDY REEFS.

Date	Station	Depth (m)	Surface Salinity (0/00)	Bottom Salinity (0/00)
5 Sept 1970	2	14.8	35.6	35.8
31 October 1970	2	14.8	36.0	36.1
19 Nov 1970	2	14.8	35.8	35.9
4 Dec 1970	2	14.8	36.5	—
4 Dec 1970	4	22.0	36.2	36.6
5 Dec 1970	5	29.3	36.2	36.3
9 Jan 1971	2	14.8	34.9	35.1
9 July 1971	1	12.8	—	35.6

Oxygen levels were only determined during summer 1971 when anoxia was suspected to be a factor contributing to reef invertebrate moralities following a red tide outbreak. Surface oxygen values varied between 3.4 and 6.3 ml/1 at selected reefs in 12.8-27.4 m; bottom oxygen levels at these same sites varied between 0.3 and 2.0 ml/1 (Table 4). Oxygen depletion within cooler bottom waters was probably accelerated by decomposing fishes and phytoplankton-bacterial respiration.

Water transparency (visibility) ranged from less than 1 m at STATIONS 1 and 2 during August 1971 to 45 m at STATION 1 during May 1971 (Table 5). Generally, water transparencies were greater at deeper, offshore reefs. Water transparency was greatest at all depths during spring and fall.

Major features influencing water clarity were summer plankton blooms of *Oscillatoria* and *Gymnodinium* and suspended bott features influencing water clarity were summer plankton blooms of *Oscillatoria* and *Gymnodinium* and suspended bottom sediments stirred up by sustained unidirectional winds accompanying passage of winter cold fronts. Inshore waters were most affected by these phenomena, but during the 1971 summer red tide, horizontal bottom visibilities were reduced to less than 3 m at all depths inspected (13-30 m).

Stratification of water turbidity was generally related to the presence and intensity of thermoclines. Increased turbidity due to suspended organic material usually characterized cool waters underlying thermoclines. During summer plankton blooms, however, bottom waters sometimes remained more transparent than overlying strata. During periods of vertical mixing and isothermy, the water column frequently remained uniformly transparent.

Varying shades of surface water color generally seemed characteristic of particular depth regimes. Inshore waters ranged from a plankton-enriched emerald green (summer) or chocolate brown, roiled conditioned (winter) to turquoise-blue during late-spring, early-summer, and fall. Offshore waters generally remained azure blue year-round except for temporary roiled conditions following the most severe winter cold fronts. The transition between these "inshore" and "offshore" waters occurred between 20 and 30 m depths but was most apparent during summer-fall when a dramatic color change (emerald green to oceanic blue) was frequently encountered in 25 to 30 m, about 40-48 km offshore.

SPECIES CHECKLIST

The following checklist (Table 6) features a species inventory and bathymetric occurrence listing of 101 reef-fish species collected and/or observed during May 1970-October 1972. Unless specified otherwise, phyletic arrangement, scientific and common names follow Bailey et al. (1970).

Identification of reef-fish material collected was accomplished by consulting the most recent and widely accepted taxonomic publications, all of which are included in the Selected References bibliography. Species for which no specimens were collected have been included in the checklist and systematic account only if the field identification is absolutely certain. In these instances, the particular species account generally includes brief notes on coloration or other diagnostic features which aided field identification.

A reef fish, as defined in this paper, includes any resident or semi-resident fish which seems to

TABLE 4. OXYGEN TENSIONS AT SELECTED EASTERN GULF OF MEXICO STUDY REEFS DURING THE 1971 RED TIDE

Date	Station	Depth (m)	Surface Oxygen (ml/l)	Bottom Oxygen (ml/l)
16 July 1971	GS 148	18.3	6.3	1.0
17 July 1971	GS 149	29.3	5.0	2.0
22 Aug 1971	2	14.8	4.0	0.3
23 Aug 1971	1	12.8	3.4	0.7
23 Aug 1971	2	14.8	3.9	0.4
21 Sept 1971	GS 162	27.4	6.0	0.3

TABLE 5. SURFACE AND BOTTOM TRANSPARENCY AT EASTERN GULF OF MEXICO STUDY REEFS

Reef Station	Date	Surface Transparency (m)	Bottom Transparency (m)
1	5-9-70	10	10
	6-6-70	3	2
	6-13-70	10	10
	6-21-70	14	11
	6-30-71	24	7
	7-19-71	3	3
	8-22-71	3	4
	8-23-71	1	5
	10-24-71	7	6
	11-14-71	13	15
	1-29-72	—	5
	2-29-72	9	9
	3-24-72	11	11
	5-21-72	6	12
	6-10-72	9	5
	8-29-72	17	10
2	7-19-70	3	3
	9-5-70	7	3
	10-31-70	30	20
	11-10-70	10	5
	11-19-70	3	2
	12-4-70	21	3
	1-9-71	10	21
	3-13-71	7	4
	4-14-71	22	18
	4-17-71	23	17
	5-16-71	45	40
	7-24-71	6	6
	8-23-71	1	5
	10-2-71	18	29
	11-14-71	13	15
	12-14-71	12	11
	2-27-72	7	6
	2-29-72	9	8
	3-24-72	11	9
	4-20-72	15	10
	7-11-72	8	7
	10-5-72	15	11
3	9-4-70	12	11
	4-12-71	20	15
	9-18-71	27	10
	9-16-72	20	19
4	9-12-70	12	10
	9-23-70	12	11
	10-3-70	13	10
	10-24-70	20	16
	11-19-70	3	2
	12-4-70	21	19
	1-9-71	30	28
	6-30-71	25	23
5	10-10-70	17	13
	11-27-70	14	9
	12-5-70	40	25
	12-27-70	25	20
	2-20-71	21	15
GS-104	7-11-70	3	3
GS-105	7-11-70	6	5
GS-107	8-30-70	12	10
GS-126	2-20-71	10	5

TABLE 5. SURFACE AND BOTTOM TRANSPARENCY AT EASTERN GULF OF MEXICO STUDY REEFS (Continued).

Reef Station	Date	Surface Transparency (m)	Bottom Transparency (m)
GS-128	3-3-71	6	2
GS-132	4-9-71	25	18
GS-133	4-10-71	26	17
GS-137	5-7-71	4	2
GS-143	6-27-71	36	11
GS-145	7-3-71	36	6
GS-146	7-10-71	26	3
GS-147	7-11-71	12	3
Gs-148	7-16-71	20	2
GS-152	7-27-71	34	3
GS-154	8-21-71	30	11
GS-156	8-23-71	5	2
GS-164	10-23-71	35	23
GS-172	12-27-71	30	15
GS-174	1-23-72	34	34
GS-182	4-10-72	35	33
GS-270	8-7-72	33	18

TABLE 6. INVENTORY, BATHYMETRIC OCCURRENCE, AND DISTRIBUTIONAL RECORDS FOR 101 REEF-FISH SPECIES COLLECTED AND/OR OBSERVED AT EASTERN GULF OF MEXICO REEFS, MAY 1970-OCTOBER 1972. SPECIES PRECEDED BY AN ASTERISK (*) REPRESENT FIRST GULF OF MEXICO (CAPE SABLE, FLORIDA TO CABO CATOCHE, MEXICO) RECORDS; DOUBLE ASTERISKS (**) DESIGNATE EASTERN GULF OF MEXICO (CAPE SABLE TO CAPE SAN BLAS, FLORIDA) RECORDS; TRIPLE ASTERISKS (***) SIGNIFY ADDITIONS TO THE MIDEASTERN GULF OF MEXICO (CHARLOTTE HARBOR TO TAMPA BAY, FLORIDA) CHECKLIST: A PLUS SIGN (+) DENOTES NORTHWARD SPECIES RANGE EXTENSIONS; SPECIES FOLLOWED BY (p) MAY BE REGARDED PRIMARY REEF FISHES, THOSE BY (s) SECONDARY REEF FISHES. DEPTH OCCURRENCES ENCLOSED WITHIN PARENTHESES INDICATE THAT THE SPECIES WAS UNRECORDED FROM THAT SHELF INTERVAL PRIOR TO THE RED TIDE.

	Depth of Occurrence (m)				
Species	12-18	18-24	24-30	30-36	Fla. Middle Ground (29-42)
FAMILY ORECTOLOBIDAE					
Ginglymostoma cirratum (s)	X				
FAMILY MURAENIDAE					
****Gymnothorax moringa* (p)		X	X	X	X
FAMILY SYNODONTIDAE					
Synodus intermedius (s)	X	X	X	X	
Trachinocephalus myops (s)	X				
FAMILY BATRACHOIDIDAE					
Opsanus pardus (p)	X	X	X	X	X
FAMILY GOBIESOCIDAE					
Gobiesox strumosus (p)				X	
FAMILY ANTENNARIIDAE					
Antennarius ocellatus (p)	X	X	X	X	
FAMILY OGCOCEPHALIDAE					
Ogcocephalus radiatus (s)	X		X		
FAMILY OPHIDIIDAE					
Ogilbia cayorum (s)	X				

TABLE 6. INVENTORY, BATHYMETRIC OCCURRENCE, AND DISTRIBUTIONAL RECORDS FOR 101 REEF-FISH SPECIES (Continued).

Species	Depth of Occurrence (m) 12-18	18-24	24-30	30-36	Fla. Middle Ground (29-42)
FAMILY HOLOCENTRIDAE					
Holocentrus ascensionis (p)					X
Holocentrus bullisi (p)					X
FAMILY CENTROPOMIDAE					
Centropomus undecimalis (s)	X				
FAMILY SERRANIDAE[1]					
Centropristis melana (p)	X	X			
Centropristis ocyurus (s)	X	X	X	X	X
Diplectrum formosum (s)	X	X	X	X	X
Epinephelus adscensionis (p)				X	X
***Epinephelus cruentatus* (p)	(X)	(X)	X	X	X
Epinephelus drummondhayi (p)				X	
***Epinephelus fulvus* (p)			X	X	X
Epinephelus guttatus (p)				X	X
Epinephelus itajara (p)	X	X	X	X	
Epinephelus morio (p)	X	X	X	X	X
****Epinephelus nigritus* (p)				X	
Hypoplectrus puella (p)	X	X	X	X	X
Mycteroperca bonaci (p)	(X)				X
Mycteroperca microlepis (p)	X	X	X	X	X
Mycteroperca phenax (p)	X	X	X	X	X
Serranus subligarius (p)	X	X	X	X	X
FAMILY GRAMMISTIDAE					
Rypticus maculatus (p)	X	X	X	X	
FAMILY PRIACANTHIDAE					
****Priacanthus arenatus* (p)	X		X		
Pristigenys alta (p)		X	X	X	
FAMILY APOGONIDAE					
Apogon aurolineatus (p)		X			
Apogon pseudomaculatus (p)	(X)	X	X	X	X
Astrapogon alutus (p)	X	X	X	X	
***Phaeoptyx xenus* (p)	X	X	X	X	
FAMILY CARANGIDAE					
Seriola dumerili (s)	X		X	X	X
FAMILY LUTJANIDAE					
Lutjanus campechanus (p)	(X)	(X)		X	X
Lutjanus cyanopterus (p)				X	
Lutjanus griseus (s)	X	X	X	X	X
Lutjanus synagris (s)	X				
Ocyurus chrysurus (p)	(X)				
Rhomboplites aurorubens (p)				X	
FAMILY POMADASYIDAE					
Haemulon aurolineatum (p)	X	X	X	X	
Haemulon plumiere (p)	X	X	X	X	
FAMILY SPARIDAE					
Archosargus probatocephalus (s)	X				
Calamus bajonado (p)					X
Calamus proridens (s)	X	X	X	X	X
Diplodus holbrooki (s)	X				
FAMILY SCIAENIDAE					
Equetus lanceolatus (p)	X	X	X	X	X
Equetus umbrosus (p)	X	X	X	X	
Odontoscion dentex (p)	X				
FAMILY MULLIDAE					
Pseudupeneus maculatus (p)	X				
FAMILY EPHIPPIDAE					
Chaetodipterus faber (s)	X	X			

TABLE 6. INVENTORY, BATHYMETRIC OCCURRENCE, AND DISTRIBUTIONAL RECORDS FOR 101 REEF-FISH SPECIES (Continued).

Species	Depth of Occurrence (m) 12-18	18-24	24-30	30-36	Fla. Middle Ground (29-42)
FAMILY POMACANTHIDAE[2]					
***Centropyge argi* (p)				X	X
Holacanthus bermudensis (p)	X	X	X	X	X
***Holacanthus ciliaris* (p)		X	X	X	X
Pomacanthus arcuatus (p)	X	X	X	X	X
***Pomacanthus paru* (p)				X	
FAMILY CHAETODONTIDAE					
***Chaetodon capistratus* (p)	X	X			
Chaetodon ocellatus (p)	X	X	X	X	X
Chaetodon sedentarius (p)				X	X
***Chaetodon striatus* (p)	(X)	(X)			
FAMILY POMACENTRIDAE					
Abudefduf saxatilis (p)	(X)				
***Chromis cyaneus* (p)					X
Chromis enchrysurus (p)		X	X	X	X
***Chromis scotti* (p)		(X)	X	X	X
***Pomacentrus partitus* (p)	(X)	(X)	X	X	X
Pomacentrus variabilis (p)	X	X	X	X	X
FAMILY LABRIDAE					
Halichoeres bivittatus (p)	X	X	X	X	X
Halichoeres caudalis (p)	X	X	X	X	X
Hempiteronotus novacula (s)				X	
Lachnolaimus maximus (p)	X	X	X	X	X
***Thalassoma bifasciatum* (p)	(X)			X	X
FAMILY SCARIDAE					
Nicholsina usta (s)	X				
Scarus croicensis (p)	(X)	(X)		X	X
FAMILY SPHYRAENIDAE					
Sphyraena barracuda (p)	X	X		X	X
FAMILY OPISTOGNATHIDAE					
**Opistognathus aurifrons* (p)		X		X	X
Opistognathus macrognathus (s)	X	X			
FAMILY CLINIDAE					
Emblemaria pandionis (p)	X	X			
Labrisomus haitiensis (p)					X
FAMILY BLENNIIDAE					
Blennius marmoreus (p)	X	X	X	X	X
Hypleurochilus geminatus (s)	X	X	X	X	X
FAMILY CALLIONYMIDAE					
Callionymus pauciradiatus (s)	X	X			
FAMILY GOBIIDAE					
Coryphopterus punctipectophorus (s)	X	X	X	X	
+,****Gobiosoma horsti* (p)				X	X
Gobiosoma macrodon (s)	X				
+,***Gobiosoma oceanops* (p)			X	X	X
Ioglossus calliurus (s)	X	X	X	X	X
****Microgobius carri* (p)	X				
FAMILY ACANTHURIDAE					
***Acanthurus chirurgus* (p)	(X)	(X)			
Acanthurus coeruleus (p)	(X)				
FAMILY SCORPAENIDAE					
Scorpaena brasiliensis (s)		X	X		
***Scorpaena plumieri* (p)	X				X
FAMILY BALISTIDAE					
Aluterus schoepfi (s)	X	X	X	X	
Balistes capriscus (p)	X	X	X	X	X

TABLE 6. INVENTORY, BATHYMETRIC OCCURRENCE, AND DISTRIBUTIONAL RECORDS FOR 101 REEF-FISH SPECIES (Continued).

Species	Depth of Occurrence (m) 12-18	18-24	24-30	30-36	Fla. Middle Ground (29-42)
****Balistes vetula* (p)	(X)				
Monacanthus ciliatus (s)			X	X	
FAMILY OSTRACIIDAE					
Lactophrys quadricornis (s)	X				
FAMILY TETRAODONTIDAE					
****Canthigaster rostrata* (p)				X	X
Sphoeroides spengleri (s)	X	X	X	X	
FAMILY DIODONTIDAE					
Chilomycterus schoepfi (s)		X			

[1]*Epinephelus cruentatus*, *Epinephelus fulvus* after Smith (1971).
[2]Extraction of Pomacanthidae from Chaetodontidae after Burgess, 1974.

demonstrate an attraction during at least some part of its life history to the reef biotope. I excluded as reef fishes by this rather liberal definition certain pelagic species such as *Scomberomorus* and *Harengula* which may best be regarded as transients to the reef community. Their seasonal, unpredictable, or cosmopolitan occurrence implies no special attraction to reef or reef-like structures. However, certain semi-resident fishes such as *Seriola* and *Sphyraena* seem to be rather characteristic of reef habitats.

Starck (1968) distinguished primary and secondary reef fishes. Primary reef fishes are those species peculiar to reef environments; secondary reef fishes are members which "although normal residents of the reefs, are equally or even more characteristic of areas not associated with reefs" (Starck, 1968:8).

ANNOTATED SYSTEMATIC ACCOUNTS

ORECTOLOBIDAE

1. *Ginglymostoma cirratum* (Bonaterre). Nurse shark.
Sightings. STA. 1: 1 specimen, May 1971. STA. 2: 1 specimen, April 1971a.
Although no specimens were collected, the presence of barbels adjacent to each nostril and long upper caudal fin lobe indicated that the observed specimens were unquestionably *G. cirratum*.

MURAENIDAE

2. *Gymnothorax moringa* (Cuvier). Spotted moray.
Collections. FLORIDA MIDDLE GROUND: 2, FSBC 7540, 640-683 mm TL, January 1972. *Sightings*. STA. 4: rare (1), December 1970. STA. 5: rare (2), December 1970. FLORIDA MIDDLE GROUND: common, January 1972.

Although Randall (1968) reported *G. moringa* as the most common moray in the West Indies, Eldred (1970) believed adults to be rare in the Gulf of Mexico. However, more recent in situ investigations (Cashman, 1973; present study) suggest that the species may be relatively common at offshore, deep-water Gulf reefs. Commercial fisherman (personal communication) report *G. moringa* so common at the Florida Middle Ground that it becomes a "nuisance" when night fishing for groupers and snappers.

A single specimen of *G. moringa* captured in 55 m during Project Hourglass collections (FSBC) and specimens reported herein constitute the first adult records from the mideastern Gulf of Mexico.

SYNODONTIDAE

3. *Synodus intermedius* (Agassiz). Sand diver.
Collections. STA 1: 1, FSBC 7419, 61 mm, June 1970. STA 2: 1, FSBC 7420, 29 mm, July 1970; 1, FSBC 7421, 40 mm, August 1970. *Sightings*. STA. 2: 6, October 1970; occasional, November 1970; 2, January 1971; 2, April 1971b; 5, May 1971. STA. 4: occasional, December 1970a; rare, December 1970b; rare, February 1971.
4. *Trachinocephalus myops* (Forster). Snakefish.
Sightings. GS-104: rare (1), July 1970.
The anterior origin of the anal fin base, long anal fin, and large size (Anderson et al., 1966) identify this species.

BATRACHOIDIDAE

5. *Opsanus pardus* (Goode and Bean). Leopard toadfish.
Collections. STA. 1: 1, FSBC 7505, 184 mm, July 1970. STA. 3: 1, FSBC 7513, 170 mm, June 1970. GS-105: 1, FSBC 7559, 281 mm, September 1970. *Sightings*. STA 1: present,

May 1970; present, June 1970; 3, June 1971; 3, July 1971; 3, August 1971; 1, November 1971; 1, December 1971; 2, March 1972; 2, May 1972; 2, June 1972; 3, July 1972. STA 2: 1, January 1971; 1, March 1971a; 1, March 1971b; 3, April 1971a; 5, April 1971b; 2, July 1971; 2, August 1971b; occasional, February 1972; 3, March 1972; 2, July 1972. STA. 3: rare, April 1971; rare, September 1972a. STA. 4: rare, November 1970. STA. 5: rare, December 1970a; occasional, December 1970b. GS-128: present, March 1971. GS-164: rare, October 1971.

GOBIESOCIDAE

6. *Gobiesox strumosus* Cope. Skilletfish.
Sightings. GS-270: rare (1), August 1972.

Circumstantial evidence suggested that the observed gobiesocid could only be *G. strumosus*. The skilletfish is the only clingfish known from the eastern Gulf of Mexico where it is common inshore and ranges to as deep as 37 m (Briggs, 1958; Springer and Woodburn, 1960; Powell et al., 1972).

ANTENNARIIDAE

7. *Antennarius ocellatus* (Bloch and Schneider). Ocellated frogfish.
Collections. STA 4: 1, FSBC 7531, 118 mm, January 1971; 1, FSBC 7558, 115 mm, June 1971; 1, FSBC 7581, 149 mm, September 1971. STA 5: 1, FSBC 7493, 184 mm, September 1970. *Sightings*: GS-137: rare (1), May 1971.

OGCOCEPHALIDAE

8. *Ogcocephalus radiatus* (Mitchill). Polka-dot batfish.
Collections. STA 2: 2, FSBC 7538, 254-291 mm, June 1971. *Sightings*. STA 1: 1, May 1971. GS-145: 1, July 1971.

OPHIDIIDAE

9. *Ogilbia cayorum* Evermann and Kendall. Key brotula.
Collections. STA 1: 2, FSBC 7275, 40-48 mm, June 1970. STA 2: 1, FSBC 7289, 24 mm, July 1970.

Ogilbia cayorum is a cryptic species only collected with poisons. This species is tentatively identified as *O. cayorum* due to present systematic confusion within the group. Starck (1968) reported *O. cayorum* from the Florida Keys but suspected that more than a single species was involved. The western Atlantic species of *Ogilbia* are currently being reviewed by Dr. Boyd Walker of the University of California at Los Angeles.

HOLOCENTRIDAE

10. *Holocentrus ascensionis* (Osbeck). Squirrelfish.
Collections. FLORIDA MIDDLE GROUND: 2, FSBC 7536 & 7563, 255-278 mm, January 1972. *Sightings*. FLORIDA MIDDLE GROUND: commom, January 1972.

11. *Holocentrus bullisi* Woods. Deepwater squirrelfish.
Collections. FLORIDA MIDDLE GROUND: 1, FSBC 7270, 82 mm, January 1972.

CENTROPOMIDAE

12. *Centropomus undecimalis* (Bloch). Snook.
Sightings. STA. 2: 4, August 1972; 6, October 1972.

The large size (to 10 kg) of snook observed at this reef suggested that they could only be *undecimalis*. These observations apparently constitute the first offshore, reef records of snook. *C. undecimalis* is previously only known from coastal and estuarine habitats (*fide* Böhlke and Chaplin, 1968).

SERRANIDAE

13. *Centropristis melana* Ginsburg. Southern sea bass.
Collections. STA. 2: 2, FSBC 7526, 99-177 mm, January 1971. GS-105: 6, FSBC 7489 & 7509, 177-216 mm, July 1970. *Sightings*. STA. 2: 6, January 1971. STA. 3: rare, September, 1972b.

14. *Centropristis ocyurus* (Jordan and Evermann). Bank sea bass.
Collections. STA. 1: 12, FSBC 7358, 37-40 mm, June 1970; 1, FSBC 7476, 33 mm, June 1971. STA. 3: 1, FSBC 7410, 44 mm, September 1971. STA. 4: 2, FSBC 7366, 41-42 mm, October 1970; 2, FSBC 7473, 64-71 mm, September 1971; 7, FSBC 7530, 32-40 mm, June 1971. STA. 5: 3, FSBC 7381, 36-41 mm, December 1970. GS-107: 5, FSBC 7314, 37-48 mm, August 1970. *Sightings*. STA. 2: present, October 1970; occasional, November 1970; 6, July 1972; 1, August 1972; 2, October 1972. STA. 4: present, October 1970; frequent, December 1970; abundant, January 1971; abundant, June 1971. STA. 5: frequent, December 1970a; frequent, December 1970b; rare, February 1971; abundant, June 1971. GS-107: present, August 1970. GS-126: occasional, February 1971. GS-145: abundant, June 1971. GS-172: common, December 1971. FLORIDA MIDDLE GROUND: occasional, January 1972. GS-182: abundant, April 1972.

15. *Diplectrum formosum* (Linné). Sand perch.

Collections. STA. 1: 3, FSBC 7368, 41-51 mm, June 1970. STA. 2: 1, FSBC 7386, 84 mm, October 1970. STA. 3: 6, FSBC 7408, 48-75 mm, September 1970. GS-105: 2, FSBC 7363 & 7492, 61-178 mm, July 1970. *Sightings*. STA. 1: present, May 1970; present, June 1970; 8, May 1971. STA. 2: present, July 1970; present, September 1970; present, October 1970; present, November 1970; present, December 1970; present, January 1971; present, March 1971a; present, March 1971b; present, April 1971a; present, April 1971b; present, July 1971; present, August 1971a; present, August 1971b; present, October 1972. STA. 3: occasional, September 1970. STA. 4: present, October 1970; present, December 1970. GS-126: common, March 1971. GS-132: common, March 1971. GS-145: rare, July 1971.

With a single exception (STATION 1, May 1971), *D. formosum* was never observed within the transect lane at STATIONS 1 & 2. However, *D. formosum* was regularly observed on sand-shell bottoms adjacent to reef ledges at these stations and is therefore included in the sighting accounts.

16. *Epinephelus adscensionis* (Osbeck). Rock hind.
Collections. FLORIDA MIDDLE GROUND: 1, FSBC 7541, 355 mm, January 1972. *Sightings*. GS-126: rare, February 1971. GS-143: rare, June 1971. FLORIDA MIDDLE GROUND: occasional, January 1972.

17. *Epinephelus cruentatus* (Lacépede). Graysby.
Collections. GS-145: 2, FSBC 7496, 158-168 mm, July 1971. FLORIDA MIDDLE GROUND: 1, FSBC 7577, 240 mm, January 1972. GS-190: 2, FSBC 7544, 86-92 mm, August 1972. *Sightings*. STA. 1: 2, October 1971; 3, November 1971; 4, December 1971; 10, January 1972; 3, February 1972; 8, March 1972; 7, May 1972; 6, June 1972; 11, July 1972; 14, August 1972. STA. 2: 1, November 1971; 8, December 1971; 8, February 1972; 12, March 1972; 8, April 1972; 7, July 1972; 15, August 1972; 13, October 1972. STA. 3: abundant, September 1972a; abundant, September 1972b; common, October 1972. GS-145: frequent, July 1971. GS-164: rare, October 1971. FLORIDA MIDDLE GROUND: common, January 1972. GS-182: present, April 1972.

Epinephelus cruentatus is herein recorded from the eastern Gulf of Mexico for the first time. Previously, *E. cruentatus* was known only from Bermuda, Florida (Atlantic), northwestern and southwestern Gulf of Mexico to Brazil, including the Bahamas and Antilles (Smith, 1971; Cashman, 1973).

Prior to the 1971 summer red tide, *E. cruentatus* was never observed or collected in less than 29 m, but afterwards it became common at shallow reefs during the fall (1971) where it remained throughout the study period.

18. *Epinephelus drummondhayi* Goode and Bean. Speckled hind.
The speckled hind was never observed or collected at study reef sites. However, a single specimen of *E. drummondhayi* was hook-and-lined from 30 m near STATION 5 during August 1970 and several additional specimens were captured in 55 m at the "Elbow" (27°41'N,84°12'W), approximately 119 km west of St. Petersburg, during October 1972. A single 585 mm specimen (FSBC 7097) of *E. drummondhayi* from the Florida Middle Ground resides in the FDNRMRL ichthyological collection.

Smith (1971) lists the range of *E. drummondhayi* as both Florida coasts, Bermuda, and various localities in the Gulf of Mexico. While the speckled hind is not uncommon on the outer West Florida Shelf (Springer and Woodburn, 1960; Moe and Martin, 1965; Smith, 1971), Smith (1971) lists only a single record off Texas and Cashman (1973) failed to detect the species at West Flower Garden Reef off Texas. Struhsaker (1969) listed *E. drummondhayi* from the SE United States continental shelf edge.

19. *Epinephelus fulvus* (Linné). Coney.
Sightings. GS-126: rare (1), February 1971. GS-145: rare (2), July 1971. GS-270: rare (1), August 1972.

All specimens of *E. fulvus* observed during this study resembled the color morph described by Smith (1971) in which the entire fish is "bright chrome yellow."

Specimens of *E. fulvus* captured off Pinellas County and Panama City, Florida contained in the FSBC fish collection (Powell et al., 1972) and the abovementioned in situ sightings considerably extend its range northward into the Gulf of Mexico. Previously, *E. fulvus* was reported from Bermuda, South Carolina, Bahamas, south Florida and Antilles to the southwestern Gulf of Mexico, Panama, Columbia, and Brazil (Smith, 1971).

20. *Epinephelus guttatus* (Linné). Red hind.
Collections. FLORIDA MIDDLE GROUND: 1, FSBC 7520, 400 mm, January 1972. *Sight-*

ings. GS-126: rare (1), February 1971. FLORIDA MIDDLE GROUND: occasional, January 1972.

Springer and Woodburn (1960) mentioned that specimens of *E. guttatus* are occasionally taken by fishermen from deep-water reefs off Tampa Bay. However, Smith (1971) overlooked Springer and Woodburn's mention of *E. guttatus*, recording the species only from Bermuda, Bahamas, Greater Antilles and, along the mainland, from South Carolina, southwestern Gulf of Mexico and Panama to the northern coast of South America. Cashman (1973) recently reported *E. guttatus* at West Flower Garden Reef in the northwestern Gulf of Mexico. Therefore, the collection and sightings of *E. guttatus* made during this study verify Springer and Woodburn's reports of *E. guttatus* on the West Florida Shelf.

21. *Epinephelus itajara* (Lichtenstein). Spotted jewfish.
Sightings. STA. 1: rare, May 1970; rare, June 1970; 1, May 1971; 2, May 1972. STA. 2: rare, July 1970; 1, March 1971b; 1, April 1971a; 1, October 1971b; 1, February 1972. STA. 3: rare (1), September 1970; rare, August 1971. GS-104: rare, July 1970. GS-143: frequent, June 1971. GS-145: rare, July 1971. GS-270: frequent, August 1972.

22. *Epinephelus morio* (Valenciennes). Red grouper.
Collections. STA. 2: 1, FSBC 7311, 114 mm, July 1970; 1, FSBC 7490, 168 mm, September 1970; 1, FSBC 7545, 198 mm, January 1971; 1, FSBC 7574, 134 mm, October 1970. STA. 5: 1, FSBC 7360, 86 mm, December 1970. *Sightings*. STA. 1: present, May 1970; present, June 1970; 7, May 1971; 4, June 1971; 1, March 1972; 6, July 1972; 8, August 1972. STA. 2: present, July 1970; present, September 1970; 7, October 1970; 8, November 1970; 5, December 1970; 3, January 1971; 3, March 1971a; 1, April 1971a; 9, July 1971; 4, August 1972; 4, October 1972. STA. 3: occasional, September 1970; present, April 1971; common, September 1972a; common, September 1972b; occasional, October 1972. STA. 4: present, September 1970; present, October 1970; rare, December 1970; frequent, January 1971; rare (1), June 1971. STA. 5: frequent, November 1970; frequent, December 1970a; frequent, December 1970b; occasional, February 1971; occasional, June 1971. GS-107: present, August 1970. GS-126: rare, February 1971. GS-132: occasional, April 1971. GS-133: occasional, April 1971. GS-143: present, June 1971. GS-172: rare, December 1971. FLORIDA MIDDLE GROUND: common, January 1972. GS-270: frequent, August 1972.

23. *Epinephelus nigritus* (Holbrook). Warsaw grouper.
The Warsaw grouper was never observed at study reef sites, but is occasionally taken by party and commercial fishing boats operating 64-128 km off the Florida west-central coast. I examined one such specimen hook-and-lined from approximately 35 m depths off (240°) Sarasota during August 1970 and it was unquestionably this species. On this basis, *E. nigritus* is included in the checklist appearing in Table 6.

Large individuals of *E. nigritus* may be distinguished from large *E. itajara* by comparison of relative dorsal spine length and body depth (Smith, 1971).

Smith (1971) records the range of *E. nigritus* as Bermuda, Massachusetts and New Jersey south to Florida and Gulf of Mexico. Although the Warsaw grouper is reported from the southwestern, northwestern, and northeastern Gulf (Boschung, 1957; Causey, 1969; Smith, 1971; Hastings, 1972), the sight records mentioned herein verify its suspected but undocumented occurence in the mideastern Gulf.

24. *Hypoplectrus puella* (Cuvier). Barred hamlet.
Collections. GS-113: 1, FSBC 7396, 112 mm, July 1970. GS-145: 2, FSBC 7401, 54-63 mm, October 1970. *Sightings*. STA. 2: rare, September 1970; 6, July 1972; 1, August 1972; 2, October 1972. STA. 3: occasional, September 1972a; occasional, September 1972b. STA. 4: present, September 1970; occasional, November 1970; rare, December 1970. STA. 5: frequent, November 1970; frequent, December 1970a; frequent, December 1970b; occasional, February 1971. GS-133: frequent, April 1971. GS-143: present, June 1971. GS-145: frequent, July 1971. FLORIDA MIDDLE GROUND: occasional, January 1972. GS-270: common, August 1972.

Species relationships within *Hypoplectrus* are unclear. In the past, color morphs were treated as subspecies of *Hypoplectrus unicolor* (Jordan and Evermann, 1896) but more recent evidence (Böhlke and Chaplin, 1968; Randall, 1968) indicates that several species may have been included within this artificial category. Böhlke and Chaplin (1968) recognize six western Atlantic species of *Hypoplectrus*, separated primarily by differences in color patterns. Based upon their descriptions, the form taken off the Florida west coast is tentatively identified as *H. puella*. Several specimens of *H. unicolor* were reportedly collected from 37 m during Project Hourglass (Powell et al., 1972) but, upon more careful examination, these specimens can more accurately be assigned to *H. puella*.

Hypoplectrus puella can be separated from its morphologically similar congener, *H. unicolor*, by the conspicuous absence of a well-defined caudal peduncular black spot and "blue-edged black spot" on the snout (Randall, 1968).

25. *Mycteroperca bonaci* (Poey). Black grouper.
Sightings. FLORIDA MIDDLE GROUND: rare, January 1972. GS-185: rare (2), May 1972.

Large specimens of *M. bonaci* observed at the Florida Middle Ground possessed the characteristic brassy yellow spots, dark blotches arranged in rows, and orange-bordered pectoral fins mentioned in Smith's (1971) diagnosis. Two juvenile black grouper observed in 13 m during May 1972 (GS-185) demonstrated a pattern of dark quadrate blotches separated by vertical and horizontal light bands described by Smith (1971).

The black grouper may be considered a rare, deep-water inhabitant of the West Florida Shelf. Following the 1971 summer red tide, however, juvenile *M. bonaci* were occasionally represented in half-day partyboat catches from shallow-water (<20 m) off Sarasota, Florida (Capt. Kenneth Anderson, personal communication). A 348 mm specimen (FSBC 8017) of *M. bonaci* taken approximately 14 km off Egmont Key (Tampa Bay) resides in the FDNRMRL ichthyological collection.

These sightings and collection of *M. bonaci* confirm its presence in the eastern Gulf of Mexico. Springer and Bullis (1956) reported M. *bonaci* from localities in the Gulf of Mexico, but Smith (1971) suspected that these records were erroneous and outside the verified range of the species. Smith (1971) further suggested positive records of *M. bonaci* existed only for Bermuda, Bahamas, southern Florida, northern South America, Brazil, Antilles, Panama, and the southwestern Gulf of Mexico. Causey (1969) reported *M. bonaci* from a shallow reef off Padre Island, Texas.

26. *Mycteroperca microlepis* (Goode and Bean). Gag.
Collections. STA. 1: 1, unaccessioned, 415 mm, May 1970. STA. 4: 1, unaccessioned, 578 mm, September 1970. *Sightings*. STA. 1: present, May 1970; present, June 1970; 11, May 1971; 5, June 1971; 8, July 1971; 3, August 1971; 2, October 1971; 4, November 1971; 3, December 1971; 5, January 1972; 10, February 1972; 8, March 1972; 4, May 1972; 3, June 1972; 9, July 1972; 9, August 1972. STA. 2: present, July 1970; present, September 1970; 6, October 1970; 16, October 1970; 16, November 1970; 3, December 1970; 19, January 1971; 5, March 1971a; 9, March 1971b; 4, April 1971a; 4, April 1971b; 4, July 1971; 4, August 1971a; 3, October 1971a; 1, October 1971b; 1, November 1971; 7, February 1972; 9, March 1972; 8, April 1972; 4, July 1972; 3, August 1972; 9, October 1972. STA. 3: occasional, September 1970; frequent, April 1971; common, September 1972a; occasional, September 1972b. STA. 4: occasional, September 1970; common, December 1970; frequent, January 1971. STA. 5: frequent, December 1970a; occasional, December 1970b; occasional, February 1971. GS-104: occasional, July 1970. GS-132: rare, April 1971. GS-133: common, April 1971. GS-137: present, May 1971. GS-143: abundant, June 1971. GS-145: occasional, July 1971. GS-164: occasional, October 1971. FLORIDA MIDDLE GROUND: abundant, January 1972. GS-173: frequent, February 1972. GS-176: occasional, February 1972. GS-190: occasional, August 1972. GS-270: common, August 1972.

27. *Mycteroperca phenax* Jordan and Swain. Scamp.
Collections. STA. 4: 2, FSBC 7445 & 7558, 138-175 mm, September 1970. *Sightings*. STA. 1: present, May 1970; present, June 1970; 16, May 1971; 11, June 1971; 14, July 1971; 1, December 1971; 2, January 1972. STA. 2: present, July 1970; present, September 1970; 4, October 1970; 7, November 1970; 3, December 1970; 9, January 1971; 1, March 1971a; 8, April 1971a; 7, April 1971b; 4, February 1972; 8, July 1972; 3, August 1972; 11, October 1972. STA. 3: occasional, September 1972a; rare, September 1972b; occasional, October 1972. STA. 4: present, October 1970; rare, December 1970. STA. 5: rare, November 1970; rare, February 1971. GS-133: occasional, April 1971. GS-137: present, May 1971. GS-143: present, June 1971. GS-145: frequent, July 1971. GS-176: occasional, February 1972. FLORIDA MIDDLE GROUND: common, January 1972. GS-190: common, August 1972. GS-270: common, August 1972.

28. *Serranus subligarius* (Cope). Belted sandfish.
Collections. STA. 1: 26, FSBC 7383, 35-51 mm, June 1970; 25, FSBC 7423, 34-58 mm,

June 1970; 3, FSBC 7466, 41-52 mm, June 1971. STA. 2: 15, FSBC 7327, 28-59 mm, July 1970; 1, FSBC 7409, 45 mm, September 1970; 1, FSBC 7500, 34 mm, April 1971. STA. 3: 3, FSBC 7297, 50-53 mm, September 1970. STA. 4: 1, FSBC 7300, 43 mm, September 1970; 1, FSBC 7462, 34 mm, June 1970; 20, FSBC 7479, 32-54 mm, September 1970. STA. 5: 3, FSBC 7352, 28-41 mm, December 1970. GS-105; 1, FSBC 7274, 80 mm, July 1970. GS-133: 2, FSBC 7459, 41-49 mm, June 1971. GS-147: 1, FSBC 7293, 38 mm, July 1970. GS-146: 1, FSBC 7501, 48 mm, July 1971. *Sightings*. STA. 1: present, May 1970; present, June 1970; 62, May 1971; 47, June 1971; 52, July 1971; 50, August 1971; 9, October 1971; 11, November 1971; 26, December 1971; 25, January 1972; 49, February 1972; 27, March 1972; 17, May 1972; 20, June 1972; 14, July 1972; 16, August 1972. STA. 2: present, July 1970; present, September 1970; 18, October 1970; 14, November 1970; 11, December 1970; 8, January 1971; 39, March 1971a; 43, March 1971b; 48, April 1971a; 50, April 1971b; 57, July 1971; 4, August 1971a; 12, August 1971b; 18, October 1971a; 6, October 1971b; 12, November 1971; 10, December 1971; 70, February 1972; 61, March 1972; 23, April 1972; 69, July 1972; 31, August 1972; 28, October 1972. STA. 3: occasional, September 1970; occasional, April 1971; common, August 1971; common, September 1972a; common, September 1972b; common, October 1972. STA 4: common, September 1970; common, October 1970; frequent, November 1970; common, December 1970; frequent, January 1971; frequent, June 1971. STA. 5: common, October 1970; common, November 1970; common, December 1970a; frequent, December 1970b; rare, February 1971; common, June 1971. GS-104: present, July 1970. GS-105: present, July 1970. GS-107: present, August 1970. GS-126: occasional, February 1971. GS-128: present, March 1971. GS-132: occasional, April 1971. GS-133: frequent, April 1971. GS-137: present, May 1971. GS-140: present, May 1971. GS-143: present, June 1971. GS-145: frequent, July 1971. GS-146: present, July 1971. GS-147: abundant, July 1971. GS-156: occasional, August 1971. GS-164: common, September 1971. FLORIDA MIDDLE GROUND: rare, January 1972. GS-182: present, April 1972. GS-190: frequent, August 1972. GS-270: abundant, August 1972.

GRAMMISTIDAE

29. *Rypticus maculatus* Holbrook. Whitespotted soapfish.

Collections. STA. 1: 3, FSBC 7431, 85-130 mm, June 1970; 6, FSBC 7518, 88-144 mm, June 1970. STA. 2: 5, FSBC 7283 & 7350, 41-133 mm, July 1970; 1, FSBC 7357, 115 mm, October 1970. STA. 3: 5, FSBC 7482, 88-128 mm, September 1970. STA. 4: 1, FSBC 7384, 141 mm, September 1970; 1, FSBC 7477, 67 mm, September 1970. STA. 5: 1, FSBC 7370, 74 mm, October 1970. GS-105: 1, FSBC 7279, 106 mm, July 1970. *Sightings*. STA. 1: present, May 1970; present, June 1970; 8, May 1971; 11, June 1971; 7, July 1971; 6, August 1971; 4, October 1971; 1, November 1971; 8, December 1971; 2, January 1972; 2, February 1972; 1, March 1972; 2, May 1972; 5, June 1972; 3, July 1972; 3, August 1972. STA. 2: present, July 1970; present, September 1970; 3, October 1970; 7, November 1970; 11, December 1970; 9, January 1971; 12, March 1971a; 4, March 1971b; 15, April 1971a; 6, April 1971b; 10, July 1971; 6, August 1971a; 10, August 1971b; 1, October 1971b; 1, November 1971; 2, December 1971; 2, February 1972; 2, March 1972; 2, April 1972; 3, July 1972; 7, August 1972; 9, October 1972. STA. 3: occasional, September 1970; occasional, April 1971; occasional, July 1971; rare, August 1971; rare, September 1972a. STA. 4: rare, September 1970; rare, October 1970; occasional, November 1970; occasional, December 1970; occasional, January 1971. STA. 5: occasional, October 1970; occasional, November 1970; rare, December 1970a; rare, December 1970b. GS-105: present, July 1970. GS-128: present, March 1971. GS-145: frequent, July 1971. GS-156: occasional, August 1971. GS-164: rare, December 1971. GS-172: rare, December 1971. GS-185: present, May 1972. GS-190: occasional, August 1972. GS-270: frequent, August 1972.

Specimens of *R. saponaceous* reported from the eastern Gulf of Mexico by Springer and Woodburn (1960), Moe and Martin (1965) and Powell et al. (1972) were found to be *R. maculatus*. Therefore, *R. saponaceous* remains unreported from the eastern Gulf and is probably allopatric with *R. maculatus* throughout most of its range. The distribution of *R. maculatus* includes Palm Beach (Florida) to Cape Hatteras in the Atlantic and from Tortugas (Florida) to Texas in the Gulf of Mexico. *Rypticus saponaceous* occurs southward of Miami in Florida, the Bahamas, Grand Cayman Island, Jamaica, eastward and southward throughout the Antilles to

Brazil (Courtenay, 1967).

PRIACANTHIDAE

30. *Priacanthus arenatus* Cuvier. Bigeye.
Collections. GS-146: 2, FSBC 7546, 98-103 mm, July 1971. GS-190: 2, FSBC 7532, 183-218 mm, August 1972. *Sightings*. GS-190: 2, August 1972.

Although *P. arenatus* has been reported from widely scattered localities in the western and northwestern Gulf of Mexico (Caldwell, 1962a) it is previously unknown from the mid-eastern Gulf.

31. *Pristigenys alta* (Gill). Short bigeye.
Collections. STA. 4: 2, FSBC 7333, 37 mm, October 1970; 2, FSBC 7582, 112-115 mm, October 1970. GS-149: 2, FSBC 7480, 130-133 mm, May 1971. GS-164: 1, FSBC 7453, 40 mm, October 1971. *Sightings*. STA. 4: rare, October 1970. STA. 5: common, October 1970; frequent, November 1970; frequent, December 1970a; occasional, February 1971; rare, June 1971. GS-164: rare, October 1971. GS-172: rare, December 1971. GS-182: occasional, April 1972.

APOGONIDAE

32. *Apogon aurolineatus* (Mowbray). Bridle cardinalfish.
Collections. STA. 4: 6, FSBC 7322, 31-43 mm, September 1970; 1, FSBC 7341, 31 mm, October 1970.

The bridle cardinalfish was only captured during poison collections. Previous to its occurrence in this study, *A. aurolineatus* was know from the eastern Gulf of Mexico on the basis of nine specimens collected at 12-17 m depths off Tampa Bay (Springer and Woodburn, 1960).

33. *Apogon pseudomaculatus* Longley. Twospot cardinalfish.
Collections. STA. 3: 4, FSBC 7306, 51-69 mm, September 1970. STA. 4: 2, FSBC 7286, 23-50 mm, October 1970; 4, FSBC 7349, 52-68 mm, September 1970; 2, FSBC 7366, 52-53 mm, September 1970. STA. 5: 3, FSBC 7471, 47-58 mm, October 1970. *Sightings*. STA. 2: 1, November 1971. STA. 3: common, September 1970. STA. 4: present, October 1970; occasional, November 1970; occasional, January 1971; rare, June 1971. STA. 5: rare (1), December 1970b. GS-126: frequent, February 1971. GS-145: rare, July 1971. GS-147: pressent, July 1971. GS-172: abundant, December 1971. FLORIDA MIDDLE GROUND: common, January 1972. GS-182: common, April 1972. GS-270: abundant, August 1972.

34. *Astrapogon alutus* (Jordan and Gilbert). Bronze cardinalfish.
Collections. STA. 1: 3, FSBC 7292, 28-31 mm, June 1970; 2, FSBC 7304, 34-41 mm, December 1970. STA. 2: 2, FSBC 7273, 36-38 mm, September 1970; 2, FSBC 7315, 19-32 mm, September 1970; 15, FSBC 7472, 13-44 mm, July 1970. STA. 3: 10, FSBC 7309, 29-45 mm, September 1970. STA. 4: 16, FSBC 7475, 25-43 mm, September 1970; 6, FSBC 7291, 28-36 mm, September 1970; 1, FSBC 7390, 23 mm, June 1971; 3, FSBC 7460, 30-30 mm, October 1970. STA. 5: 1, FSBC 7371, 33 mm, October 1970.

Bronze cardinalfish were captured and observed only following poison collections.

35. *Phaeoptyx xenus* (Böhlke and Randall). Sponge cardinalfish.
Collections. STA. 1: 2, FSBC 7347, 36-37 mm, September 1970. STA. 2: 11, FSBC 7264, 18-51 mm, July 1970. STA. 3: 8, FSBC 7269, 25-39 mm, September 1970. STA. 4: 2, FSBC 7320, 26-35 mm, September 1970. STA. 5: FSBC 7298, 32 mm, December 1970; 3, FSBC 7387, 37-45 mm, October 1970. GS-107: 6, FSBC 7319, 18-26 mm, August 1970. GS-270: 1, FSBC 7463, 45 mm, August 1972. *Sightings*. STA. 1: rare, May 1970. STA. 4: occasional, October 1970. GS-270: rare, August 1972.

Böhlke and Chaplin (1968) suggested that *Apogon* (= *Phaeoptyx*) *xenus* might be a sponge inquiline and collected live specimens from the cylindrical sponges, *Verongia fistularis*, *Callyspongia plicifera* and *C. vaginalis*. Smith and Tyler (1972) realized that *P. xenus* at least vacates the lumens of tubular sponges during its nocturnal foraging activities. That the species is not an obligate sponge dweller was verified during the present study when small aggregations (4-6 individuals) were observed within or adjacent to rocky holes at STATION 4. Also, Hastings (1972) observed a "small group of these cardinalfish just within the hollow end of a log."

With the possible exception of *Apogon pseudomaculatus*, *Phaeoptyx xenus* is probably the most common apogonid in the eastern Gulf. All examined specimens of *A. conklini* and *A. pigmentaria* reported from the West Florida Shelf in earlier studies (Springer and Woodburn, 1960; Moe and Martin, 1966; Powell et al., 1972) were found to be *P. xenus*.

Hastings (1972) intimated that the occurrence of *P. xenus* in the northeastern Gulf is probably seasonal. However, the present study indicates that *P. xenus* is a permanent resident of the mideastern Gulf of Mexico.

The range of *P. xenus* is herein extended from Tortugas, Florida Keys, Bahamas, Curacao and Virgin Islands (Böhlke and Chaplin, 1968; Böhlke and Randall, 1968; Smith and Tyler, 1972) into the eastern and, *fide* Hastings' (1972) observations, northeastern Gulf of Mexico. Specimens from the northeastern Gulf have not been conclusively identified as *P. xenus* since they have some of the characteristics of *P. pigmentaria* (Hastings, 1972).

CARANGIDAE

36. *Seriola dumerili* (Risso). Greater amberjack. *Sightings*. STA. 1: 9, October 1971; 7, November 1971; 6, February 1972; 5, March 1972. STA. 2: 4, October 1971b; 2, December 1971; 1, February 1972; 1, March 1972; 10, April 1972. GS-143: abundant, June 1971. FLORIDA MIDDLE GROUND: occasional, January 1972.

The large size (7-45 kg) of *Seriola* observed during this study eliminated the possibility of it being mistaken for another species.

LUTJANIDAE

37. *Lutjanus campechanus* (Poey). Red snapper. *Collections*. 2, FSBC 7533, 171-187 mm, GS-190, August 1972. *Sightings*. STA. 3: abundant, September 1972a; abundant, September 1972b; abundant, October 1972. FLORIDA MIDDLE GROUND: rare, January 1972. GS-189: abundant, July 1972. GS-190: common, August 1972. GS-192b: common, August 1972. GS-196: abundant, October 1972.

Prior to the 1971 summer red tide, *Lutjanus campechanus* was never observed at the shallow reefs where it became so common during the summer and fall of 1972. Although *L. campechanus* has been reported from shallow-water in parts of its range (Causey, 1969; Hastings, 1972), a shallow-water occurrence and abundance of red snapper along the Florida west-central coast is unprecedented in the regional literature (Springer and Woodburn, 1960; Moe and Martin, 1966).

38. *Lutjanus cyanopterus* (Cuvier). Cubera snapper.
Sightings. GS-270: rare, (1), August 1972.

The cubera snapper closely resembles the gray snapper (*Lutjanus griseus*) but differs in vomerine tooth patch morphology, profile of head and gill raker count (Böhlke and Chaplin, 1968). The specimen observed during this study was judged to be *L. cyanopterus* on the basis of size (estimated to be 40-42 kg) alone. The cubera is the largest member of *Lutjanus* in the western Atlantic and attains weights in excess of 45 kg. The closely related gray snapper, *L. griseus*, probably never grows larger than 9 kg (Böhlke and Chaplin, 1968; Starck and Schroeder, 1971).

39. *Lutjanus griseus* (Linné). Gray snapper. *Collections*. STA. 3: 1, FSBC 7566, 300 mm, April 1970. *Sightings*. STA. 1: present, May 1970; present, June 1970; 28, May 1971; 18, June 1971; 22, July 1971; 1, August 1971; 33, October 1971; 5, November 1971; 13, December 1971; 3, January 1972; 13, February 1972; 9, March 1972; 9, May 1972; 2, June 1972; 3, July 1972; 4, August 1972. STA. 2: present, July 1970; present, September 1970; 10, October 1970; 8, November 1970; 9, December 1970; 1, January 1971; 14, March 1971a; 12, March 1971b; 29, April 1971a; 62, April 1971b; 8, July 1971; 5, August 1971a; 4, October 1971a; 2, October 1971b; 3, November 1971; 11, December 1971; 6, February 1972; 16, March 1972; 11, April 1972; 4, July 1972; 5, August 1972; 9, October 1972. STA. 3: frequent, September 1970; common, April 1971; rare, August 1971; rare, September 1971; occasional, September 1972b; occasional, October 1972. STA. 4: occasional, September 1970; occasional, October 1970; common, November 1970; abundant, December 1970; common, January 1971. STA. 5: occasional, October 1970; occasional, November 1970; abundant, December 1970a; common, December 1970b; frequent, February 1971; occasional, June 1971. GS-104: present, June 1970. GS-128: present, March 1971. GS-133: rare, April 1971. GS-140: present, May 1971. GS-143: frequent, June 1971. GS-145: frequent, July 1970. GS-154: rare (1), August 1971. GS-164: rare, October 1971. GS-190: occasional, August 1972. GS-270: abundant, August 1972.

40. *Lutjanus synagris* (Linné). Lane snapper. *Sightings*. STA. 1: 1, August 1972. STA. 2: 1, March 1972; 1, April 1972; 1, August 1972.

All three sightings at STATION 2 were probably the same individual (180-200 mm).

Lutjanus synagris was readily recognized by its diffuse black spot below the soft dorsal fin and yellow, horizontal body stripes (Randall, 1968).

41. *Ocyurus chrysurus* (Bloch). Yellowtail snapper.
Sightings. STA. 2: 2, July 1972. GS-270: rare (1), August 1972.

Ocyurus chrysurus is easily identified by its prominent mid-lateral stripe, yellow spots dorsally and yellow bands ventrally, and deeply forked caudal fin (Randall, 1968). Although all three specimens observed during the present study were juveniles, I have witnessed large adults (to 4 kg) in commercial bottom fish catches from the Florida Middle Ground.

42. *Rhomboplites aurorubens* (Cuvier). Vermilion snapper.

A single 140 mm specimen of *R. aurorubens* was hook-and-lined from 33 m (GS-182) during April 1972. This species is most abundant offshore of this depth where it commonly forms large "pelagic" schools comprising several hundred individuals.

POMADASYIDAE

43. *Haemulon aurolineatum* Cuvier. Tomtate. *Collections*. STA. 1: 10, FSBC 7584, 175-195 mm, June 1970. STA. 3: 36, FSBC 7503, 51-73 mm, September 1970. STA. 5: 3, FSBC 7478, 60-77 mm, December 1970. GS-105: 1, FSBC 7411, 35 mm, July 1970. GS-107: 4, FSBC 7402, 24-65 mm, August 1970. *Sightings*. STA. 1: abundant (thousands of juveniles), November 1971; 12, December 1971; 50-60, January 1972; 40, February 1972; abundant (thousands of juveniles), March 1972; 22, April 1972; 23, May 1972; 6, June 1972; abundant (thousands of juveniles), August 1972. STA. 2: 26, October 1970; 22, November 1970; 6, December 1970; 32, October 1971a; 40, October 1971b; 2, December 1971; 24, February 1972; 22, March 1972; abundant (thousands of juveniles), July 1972; 33, October 1972. STA. 3: occasional, September 1970; abundant, September 1972a; common, September 1972b; frequent, October 1972. STA. 4: frequent, October 1970. STA. 5: common, June 1971. GS-105: present, July 1970. GS-107: present, August 1970. GS-132: abundant, April 1971. GS-133: abundant, April 1971. GS-143: abundant, June 1971. GS-270: abundant, August 1972.

44. *Haemulon plumieri* (Lacépède). White grunt. *Collections*. STA. 1: 14, FSBC 7510, 7522, 7523, 7524, and 7525, 150-250 mm, June 1970. GS-105: 1, FSBC 7508, 250 mm, July 1970. *Sightings*. STA. 1: present, May 1970; present, June 1970; 40, May 1971; 28, June 1971; 37, July 1971; 46, August 1971; 1, December 1971; 6, March 1972; 2, May 1972; 4, June 1972; 6, July 1972; 7, August 1972. STA. 2: present, July 1970; frequent, September 1970; 22, October 1970; 18, November 1970; 17, December 1970; 38, January 1971; 17, March 1971a; 7, March 1971b; 15, April 1971a; 16, April 1971b; 14, July 1971; 30-40 (juveniles), October 1971b; 1, November 1971; 2, February 1972; 6, March 1972; 15, April 1972; 9, July 1972; 14, August 1972; 4, October 1972. STA. 3: rare, April 1971; rare, August 1971; common, September 1972a; abundant, September 1972b. STA. 5: rare (1), October 1970. GS-105: present, July 1970; common, October 1972. GS-107: present, August 1970. GS-156: common, August 1971.

SPARIDAE

45. *Archosargus probatocephalus* (Walbaum). Sheepshead. *Collections*. STA. 2: 1, FSBC 7578, 212 mm, November 1970. *Sightings*. STA. 1: present, May 1970; present, June 1970; 7, May 1971; 6, June 1971; 9, July 1971; 24, August 1971; 1, October 1971; 2, November 1971; 2, December 1971; 2, January 1972; 4, February 1972; 1, March 1972; 3, June 1972; 1, July 1972; 9, August 1972. STA. 2: present, July 1970; occasional, September 1970; 1, October 1970; 7, November 1970; 16, December 1970; 1, January 1971; 9, March 1971a; 1, March 1971b; 6, April 1971a; 6, April 1971b; 7, July 1971; 4, August 1971a; 3, October 1971b; 5, November 1971; 2, December 1971; 4, February 1972; 1, March 1972; 1, April 1972; 2, July 1972; 1, August 1972; 4, October 1972. GS-104: present, July 1970. GS-105: present, July 1970. GS-128: present, March 1971. GS-137: present, May 1971. GS-156: common, August 1971.

46. *Calamus bajonado* (Bloch and Schneider). Jolthead porgy. *Collections*. FLORIDA MIDDLE GROUND: 2, FSBC 7534 & 7535, 284-305 mm, January 1972. *Sightings*. FLORIDA MIDDLE GROUND: occasional, January 1972.

Although the distribution of *C. bajonado* was suspected to include the eastern Gulf of Mexico (Randall and Caldwell, 1968), specimens reported on by Wang and Raney (1971) and those mentioned herein evidently represent the first documented records of the species from off the Florida west coast.

47. *Calamus proridens* Jordan & Gilbert. Littlehead porgy. *Collections*. STA. 2: 2, FSBC 7585, 206-222 mm, April 1971. STA. 5: 1, FSBC 7556, 235 mm, December 1970. GS-152: 1, FSBC 7560, 152 mm, July 1971. *Sightings*. STA. 1: 7, May 1971; 3, July 1971; 1, December 1971. STA. 2: occasional, September 1970; 2, October 1970; 1, November 1970; 4, December 1970; 23, January 1971; 6, April 1971a; 15, April 1971b; 11, July 1971; 1, October 1971b. STA. 4: occa-

sional, October 1970; rare, November 1970; frequent, December 1970. STA. 5: frequent, November 1970; abundant, December 1970a; abundant 1970b; occasional, February 1971. GS-132: common, April 1971. GS-133: common, April 1971. GS-145: occasional, July 1971. GS-154: rare (2), August 1971. GS-164: rare, October 1971. FLORIDA MIDDLE GROUND: occasional, January 1972. GS-176: occasional, February 1972.

48. *Diplodus holbrooki* (Bean). Spottail pinfish. *Sightings*. STA. 1: present, June 1970; present, July 1970. GS-104: present, July 1970.

Field identification is based upon the presence of a broad black saddle on the caudal peduncle, a character distinguishing it from other porgies (Breder, 1948).

SCIAENIDAE

49. *Equetus lanceolatus* (Linné). Jackknife-fish. October 1970; 1, FSBC 7351, 64 mm, November 1970; 2, FSBC 7553, 104-105 mm, March 1972. STA. 4: 1, FSBC 7355, 36 mm, September 1970; 1, FSBC 7373, 68 mm, October 1970; 5, FSBC 7374, 38-52 mm, October 1970. GS-107: 3, FSBC 7305, 21-57 mm, August 1970. *Sightings*. STA. 1: present, May 1970. STA. 2: present, July 1970; present, September 1970; 2, October 1970; 1, November 1970; 1, February 1972; 1, March 1972; 1, April 1972. STA. 3: occasional, September 1970; occasional, April 1971; occasional, August 1971; common, September 1972a; rare, September 1972b. STA. 4: abundant, November 1970; frequent, December 1970; frequent, January 1971; rare, June 1971. STA. 5: occasional, October 1970; occasional, November 1970; occasional, December 1970a; occasional, December 1970b; abundant, February 1971; frequent, June 1971. GS-126: common, February 1971. GS-132: frequent, April 1971. GS-133: frequent, April 1971. GS-145: rare, June 1971. GS-146: common, July 1971. GS-147: common, July 1971. GS-164: rare, October 1971. FLORIDA MIDDLE GROUND: occasional, January 1972. GS-182: present, April 1972. GS-190: rare, August 1972.

50. *Equetus umbrosus* Jordan and Eigenmann. Cubbyu.
Collections. STA. 1: 6, FSBC 7294, 25-43 mm, June 1970; 8, FSBC 7364, 19-28 mm, December 1970; 8, FSBC 7458, 25-41 mm, June 1970; 9, FSBC 7486 & 7488, 58-137 mm, June 1970; 4, FSBC 7521, 99-139 mm, May 1970. STA. 2: 27, FSBC 7308, 31-56 mm, July 1970. STA. 3: 17, FSBC 7498, 53-128 mm, September 1970. STA. 4: 2, FSBC 7301, 59-70 mm, September 1970; 3, FSBC 7455, 30-31 mm, June 1971; 2, FSBC 7456, 55-60 mm, October 1970. GS-105: 14, FSBC 7281 & 7356, 34-76 mm, July 1970. GS-107: 1, FSBC 7302, 127 mm, August 1970. GS-142: 3, FSBC 7442, 25-41 mm, June 1971. *Sightings*. STA. 1: present, May 1970; present, June 1970; 29, May 1971; 31, June 1971; 56, July 1971; 1, October 1971; 1, December 1971; 8, January 1972; 61, February 1972; 46, March 1972; 31, May 1972; 34, June 1972; 45, July 1972; 45, August 1972. STA. 2: present, July 1970; present, September 1970; 36, October 1970; 40, November 1970; 31, December 1970; 48, January 1971; 49, March 1971a; 36, March 1971b; 44, April 1971a; 69, April 1971b; 17, July 1971; 1, October 1971b; 2, December 1971; 28, February 1972; 24, March 1972; 18, April 1972; 15, July 1972; 54, August 1972; 57, October 1972. STA. 3: frequent, September 1970; occasional, April 1971; common, September 1972a; common, September 1972b; common, October 1972. STA. 4: frequent, October 1970; abundant, November 1970; occasional, December 1970; frequent, January 1971. STA. 5: rare, November 1970; rare, December 1970; frequent, February 1971; frequent, June 1971. GS-104: present, July 1970. GS-105: present, July 1970. GS-107: present, August 1970. GS-126: common, February 1971. GS-128: present, March 1971. GS-132: occasional, April 1971. GS-133: occasional, April 1971. GS-137: present, May 1971. GS-145: occasional, July 1971. GS-146: rare, November 1971. GS-182: present, April 1972. GS-270: abundant, August 1972. GS-190: abundant, August 1972.

Robert V. Miller (personal communication) suggested that *E. acuminatus*, formerly the cubbyu, should be changed to *E. umbrosus*. The name *E. acuminatus* more appropriately applies to the striped drum or high-hat, previously designated *E. pulcher* (Bailey et al., 1970). Both *acuminatus* and *umbrosus* are closely related and R. V. Miller advocates that, based upon the presence of free interneural bones, they be assigned to the genus *Pareques*, previously unknown from the western Atlantic. Bailey et al. (1970) recognized the *umbrosus-acuminatus* change but failed to adopt the generic change implicated by Miller. For this reason, the cubbyu is designated *E. umbrosus* in this paper.

Due to the confusion with regards to application of the names *acuminatus* and *umbrosus*, the distribution of *E. umbrosus* is uncertain. Hastings (1972), through personal communication with George C. Miller reported the range of *E. umbrosus* as "North Carolina south around the Keys and up the west coast of Florida to the Mississippi Delta and Campeche Bank." The high-hat, *Equetus acuminatus*, is primarily insular in its distribution being sympatric with *E. umbrosus* only in zoogeographically transitional regions such as the Florida Keys and lower southeast Florida coast. All specimens of *E. acuminatus* reported from the eastern Gulf of Mexico by Powell et al, (1972) were examined and found to be *E. umbrosus*. Similarly, Hastings (1972) believed all Gulf of Mexico records of *E. acuminatus* to be *E. umbrosus* in light of Miller's recommendations.

Equetus umbrosus may be easily separated from *E. acuminatus* according to the pattern of stripes on the snout and head. In *E. acuminatus* the mid-lateral body stripes are confluent with one another across the snout; in *E. umbrosus*, however, these stripes intersect two vertical, perpendicular stripes between the orbits, thus forming a rectangular pattern along the midline of the snout. In the field, large adult *E. umbrosus* assume an all black body coloration, a phase not noted for *E. acuminatus* by R. V. Miller (personal communication).

51. *Odontoscion dentex* (Cuvier). Reef croaker.
Collections. GS-140: 1, FSBC 7332, 107 mm, May 1971. *Sightings*. GS-140: occasional, May 1971.

With exception of Springer and Woodburn's (1960) account of 11 specimens of *O. dentex* observed at rocky reefs off Tampa Bay, specimens mentioned above are the only other record of the species from the eastern Gulf of Mexico. The seeming rarity of *O. dentex* may only reflect its cryptic habits. By day, the reef croaker resides deep within reef recesses, thereby evading observation by divers.

MULLIDAE

52. *Pseudupeneus maculatus* (Bloch). Spotted goatfish.
Sightings. STA. 2: 2, April 1972. GS-185; rare, (2), May 1972.

Pseudupeneus maculatus was identified in the field by the presence of three blackish blotches on the upper body beneath the dorsal fins (Randall, 1968). The spotted goatfish is known from specimens collected off Tampa Bay (Moe and Martin, 1966; Powell et al., 1972) and Springer and Bullis (1956) reported the species from nearly 37 m in the eastern Gulf of Mexico.

EPHIPPIDAE

53. *Chaetodipterus faber* (Broussonet). Atlantic spadefish.
Sightings. STA. 1: present, June 1970; 4, August 1971; 2, October 1971; 15, November 1971; 2, January 1972; 6, March 1972; 6, June 1972; 2, July 1972; 4, August 1972. STA. 2: present, September 1970; 7, March 1971a; 6, March 1971b; 32, April 1971a; 50, April 1971b; 18, July 1971; 2, August 1971a; 8, October 1971b; 4, December 1971; 5, February 1972; 8, March 1972. STA. 3: common, September 1972a. GS-128: present, March 1971. GS-156: abundant, August 1971. GS-176: occasional, February 1972.

The Atlantic spadefish is readily identified by its deep-profiled body, separate spinous and soft dorsal fins, and dark vertical bars (Böhlke and Chaplin, 1968).

POMACANTHIDAE

Remarks. Although the angelfishes are commonly included with the butterflyfishes within the family Chaetodonidae (Bailey et al., 1970), recent osteological evidence suggests they are distinctive at the familial level and should be separated from the butterflyfishes under the name Pomacanthidae (Burgess, 1974).

54. *Centropyge argi* Woods and Kanazawa. Cherubfish.
Collections. GS-270: 1, FSBC 7262, 48 mm, August 1972. *Sightings*. FLORIDA MIDDLE GROUND: rare (3), January 1972. GS-270: rare (2), August 1972.

The cherubfish is previously known only from Bermuda, the Bahamas, West Indies, southern Florida, southwestern and northwestern Gulf of Mexico (Böhlke and Chaplin, 1968; Randall, 1968; Stark, 1968; Cashman, 1973). Starck (1968) maintained that *C. argi* is characteristic of the West Indies and is found in southeast Florida and the Keys only due to the proximity of clear, oceanic waters derived from the Florida Current. In the Gulf of Mexico, the cherubfish is only known from offshore, deep-water banks where insular-like conditions prevail.

55. *Holacanthus bermudensis* Goode. Blue angelfish.
Collections. STA. 1: 1, FSBC 7564, 230 mm, May 1970; 1, FSBC 7580, 178 mm, June 1970; 1, FSBC 7428, 54 mm, May 1972. STA. 2: 2, FSBC 7449, 25-25 mm, October 1971; 4,

FSBC 7552, 52-61 mm, March 1972. STA 3: 1, FSBC 7495, 141 mm, September 1970. STA 4: 2, FSBC 7343, 20-23 mm, October 1970; 1, FSBC 7567, 220 mm, December 1970. STA 5: 3, FSBC 7344, 46-57 mm, October 1970. GS-107: 2, FSBC 7272, 21-37 mm, August 1970. GS-152: 1, FSBC 7465, 84 mm, July 1971. GS-171: 1, FSBC 7354, 37 mm, December 1971. FLORIDA MIDDLE GROUND: 3, FSBC 7681, 39-66 mm, January 1972. *Sightings*. STA. 1: present, May 1970; present, June 1970; 11, May 1971; 6, June 1971; 5, July 1971; 1, August 1971; 3, October 1971; 2, November 1971; 1, December 1971; 2, January 1972; 2, February 1972; 1, March 1972; 6, May 1972; 6, June 1972; 8, July 1972; 6, August 1972. STA. 2: present, July 1970; present, September 1970; 5, October 1970; 16, November 1970; 12, December 1970; 14, January 1971; 13, March 1971a; 12, March 1971b; 4, April 1971a; 19, April 1971b; 6, July 1971; 2, October 1971a; 1, October 1971b; 4, November 1971; 5, December 1971; 10, February 1972; 10, March 1972; 8, April 1972; 21, July 1972; 16, August 1972; 12, October 1972. STA. 3: occasional, September 1970; occasional, April 1971; rare, September 1971; common, September 1972a; common, September 1972b; common, October 1972. STA. 4: occasional, September 1970; common, November 1970; occasional, December 1970. STA. 5: occasional, October 1970; frequent, November 1970; common, December 1970a; common, December 1970b; occasional, June 1971. GS-104: occasional, July 1970. GS-107: occasional, August 1970. GS-126: occasional, February 1971. GS-128: present, March 1971. GS-132: occasional, April 1971. GS-133: frequent, April 1971. GS-137: present, May 1971. GS-143: present, June 1971. GS-145: frequent, July 1971. GS-156: rare, August 1971. GS-164: common, October 1971. GS-171: present, December 1971. GS-172: common, December 1971. FLORIDA MIDDLE GROUND: common, January 1972. GS-176: abundant, February 1972. GS-182: occasional, April 1972. GS-185: present, May 1972. GS-270: abundant, August 1972. GS-190: common, August 1972.

56. *Holacanthus ciliaris* (Linné). Queen angelfish.
Sightings. STA. 5: rare (1), November 1970. GS-133: occasional, April 1971. GS-143: occasional, June 1971. FLORIDA MIDDLE GROUND: rare (2), January 1972. GS-182: rare (1), April 1972.

Holacanthus ciliaris adults were easily identified in situ by their well-developed nuchal ocelli and distinctive caudal fin coloration (Randall, 1968; Feddern, 1972).

Unlike the blue angelfish, *H. bermudensis*, the queen angelfish is a rare deep-water inhabitant of the West Florida Shelf. The queen angelfish is most abundant in the West Indies where it largely replaces the blue angelfish. Perhaps its preference for clear waters and buffered environmental conditions accounts for its presence at deeper, offshore reefs in the eastern Gulf.

Specimens listed as *Holacanthus ciliaris* in the FDNRMRL fish collection (Powell et al., 1972) were reidentified as *H. bermudensis*. A 115 mm specimen of *H. ciliaris* (FSBC 8775) was collected 13 km off Tampa Bay by Christopher Turk (Dept. Marine Science, University of South Florida). This specimen and those listed above constitute the first adult records of *H. ciliaris* from the eastern Gulf of Mexico.

57. *Pomacanthus arcuatus* (Linné). Gray angelfish.
Collections. STA. 1: 1, FSBC 7452, 40 mm, December 1971; 2, FSBC 7427, 68-69 mm, May 1972. STA. 2: 1, FSBC 7321, 17 mm, October 1970; 5, FSBC 7551, 43-55 mm, March 1972. STA. 4: 1, FSBC 7268, 13 mm, October 1970; 1, FSBC 7337, 30 mm, June 1971; 1, FSBC 7562, 266 mm, December 1970. *Sightings*. STA. 1: present, June 1970; 2, October 1970; 1, November 1971; 2, December 1971; 2, January 1972; 2, February 1972; 1, March 1972; 2, May 1972; 3, June 1972; 2, July 1972; 2, August 1972. STA. 2: 1, October 1970; 1, October 1971a; 4, October 1971b; 6, November 1971; 3, December 1971; 3, February 1972; 5, March 1972; 4, April 1972; 3, July 1972; 2, August 1972; 2, October 1972. STA. 3: rare, September 1971; occasional, October 1972. STA. 4: occasional, October 1970; rare, December 1970; rare, January 1971. STA. 5: rare, December 1970a; rare, December 1970b; rare, February 1971. GS-145: rare, July 1971. GS-146: present, July 1971. GS-156: rare (2), August 1971. GS-164: rare, October 1971. GS-172: rare, December 1971. FLORIDA MIDDLE GROUND: occasional, January 1972. GS-176: common, February 1972. GS-182: rare, April 1972. GS-190: frequent, August 1972.

58. *Pomacanthus paru* (Bloch). French angelfish.
Sightings. GS-143: rare (1), June 1971. FLORIDA MIDDLE GROUND: rare (2),

January 1972.

Adult specimens of *P. paru* were identified in situ by the yellow-bordered body scales not found in *P. arcuatus*. These sight records and the collection of an adult specimen of *P. paru* (FSBC 7997) from off Egmont Key extend the adult range of this species from the Bahamas, southern Florida, West Indies, and southwestern and northwestern Gulf of Mexico (Randall, 1968; Cashman, 1973). Hastings (1972) mentioned collections of juvenile *P. paru* along jetties in the northeastern Gulf but attributed their occurence to the transport of eggs and larvae by currents. However, the presence of large adults reported during this study suggests that *P. paru* may be a rare but resident species in the eastern Gulf.

CHAETODONTIDAE

59. *Chaetodon capistratus* Linné. Foureye butterflyfish.
Collections. STA. 1: 2, FSBC 7429, 34-40 mm, May 1972; 4, FSBC 7485, 48-53 mm, June 1972. STA. 2: 1, FSBC 7316, 49 mm, November 1970; 1, FSBC 7437, 25 mm, October 1971; 3, FSBC 7555, 37-56 mm, May 1972. *Sightings*. STA. 1: 2, October 1971; 1, November 1971; 1, December 1971; 2, January 1972; 2, February 1972; 2, June 1972; 1, July 1972; 2, August 1972. STA. 2: 1, November 1970; 2, October 1971b; 1, December 1971; 3, February 1972; 1, March 1972; 3, April 1972; 3, July 1972; 5, August 1972; 3, October 1972. STA 3: occasional, September 1972a; occasional, September 1972b; occasional, October 1972. GS-176: common, February 1972. GS-185: present, May 1972. GS-190: occasional, August 1972.

With the exception of the sighting of a single individual of *C. capistratus* during November 1970 (STA. 2), this species was never observed at reef sites prior to the 1971 summer red tide. Adult foureye butterflyfish, which reportedly reach 150 mm (Böhlke and Chaplin, 1968), were never observed during this study and it is unlkely that adult populations occur on the West Florida Shelf. Hastings (1972) also reported *C. capistratus* as a straggler in the northeastern Gulf of Mexico where small numbers of juveniles appear at shoreline jetties during late summer and fall. The intrusion of juvenile *C. capistratus* into the eastern Gulf of Mexico may be attributed to its unusually long term pelagic larva (tholichthys) facilitating dispersal by currents.

Although juvenile foureye butterflyfish are occasionally taken along the Florida northwest coast (Hastings 1972), its occurrence off the Florida west coast is previously undocumented.

60. *Chaetodon ocellatus* Bloch. Spotfin Butterflyfish.
Collections. STA. 1: 1, FSBC 7380, 95 mm, December 1970. STA. 2: 2, FSBC 7317, 77-81 mm, November 1970. STA. 4: 2, FSBC 7415, 24-45 mm, September 1970. GS-140: 1, FSBC 7575, 90 mm, May 1971. *Sightings*. STA 1: present, May 1970; present, June 1970; 6, May 1971; 3, June 1971; 3, July 1971; 4, October 1971; 7, November 1971; 5, December 1971; 10, January 1972; 14, February 1972; 19, March 1972; 7, May 1972; 8, June 1972; 4, July 1972; 3, August 1972. STA. 2: present, July 1970; present, September 1970; 2, November 1970; 6, December 1970; 2, January 1971; 5, March 1971a; 4, March 1971b; 4, April 1971a; 2, July 1971; 8, October 1971a; 7, October 1971b; 6, November 1971; 8, December 1971; 14, February 1972; 15, March 1972; 14, April 1972; 3, July 1972; 2, August 1972; 3, October 1972. STA. 3: occasional, August 1970; common, September 1972a; common, September 1972b; common, October 1972. STA 4: rare, December 1970. STA 5: occasional, November 1970; occasional, December 1970b; rare, February 1971. GS-128: present, March 1971. GS-137: present, May 1971. GS-140: present, May 1971. GS-143: occasional, June 1971. GS-147: occasional, July 1971. GS-172: rare, December 1971. FLORIDA MIDDLE GROUND: occasional, January 1972. GS-176: common, February 1972. GS-182: common, July 1972. GS-185: present, May 1972. GS-270: common, August 1972. GS-190: common, August 1972.

61. *Chaetodon sedentarius* Poey. Reef butterflyfish.
Collections. FLORIDA MIDDLE GROUND: 1, FSBC 7318, 77 mm, January 1972. *Sightings*. STA. 5: rare, February 1971. FLORIDA MIDDLE GROUND: rare, January 1972. GS-270: rare, August 1972.

62. *Chaetodon striatus* Linné. Banded butterflyfish.
Collections. STA. 1: 1, FSBC 7438, 35 mm, December 1971. *Sightings*. STA. 1: 1, December 1971. STA. 2: 1, October 1972a. STA. 3: rare (1), September 1971. BARRACUDA HOLE: rare (1), November 1971. GS-176: rare, (1), February 1972.

Böhlke and Chaplin (1968) give the range of *C. striatus* as New Jersey and the

Bahamas south to Brazil, including the Gulf of Mexico. Although juvenile *C. striatus* are occasionally reported from along the northwest Florida coast (Caldwell and Briggs, 1957; Hastings, 1972), there exists no published record of the species from off the Florida west coast.

Although *C. striatus* was never recorded at study reefs before the 1971 summer red tide, juveniles colonized shallow reefs shortly thereafter. No specimens of *C. striatus* have been observed since February 1972, and it is unlikely that the species is a member of a "climax" eastern Gulf of Mexico patch reef community. Its unprecedented occurrence following the red tide may have been due to an initial recolonization advantage gained from successful recruitment of its protracted planktonic larva (tholichthys) from regions far to the south.

POMACENTRIDAE

63. *Abudefduf saxatilis* (Linné). Sergeant major. *Collections*. BARRACUDA HOLE: 1, FSBC 7288, 45 mm, November 1971. *Sightings*. BARRACUDA HOLE: rare (1), November 1971. GS-176: rare (1), February 1972.

Abudefduf saxatilis is a circumtropical species (Briggs, 1958). In the western Atlantic, it is known from New England, Bermuda and the Bahamas to Uruguay and throughout the West Indies and Gulf of Mexico (Böhlke and Chaplin, 1968; Randall, 1968). The sergeant major is known from the northeastern (Caldwell and Briggs, 1957; Haburay et al., 1969; Hastings, 1972), north-central (Dawson, 1962) and northwestern Gulf of Mexico (Causey, 1969), but its occurrence in the eastern Gulf previously was uncertain. Springer and Woodburn (1960) mentioned of "reliable sources" reporting *A. saxatilis* from John's Pass prior to the 1957 cold wave and a single specimen beachcast during the 1957 red tide. However, observations and collection of *A. saxatilis* during the present study represent the first in situ records of its occurrence in the eastern Gulf.

Both specimens of *A. saxatilis* observed during the present study were juveniles and it is unlikely that resident adult populations exist on the West Florida Shelf. Seasonal juvenile populations of *A. saxatilis* are probably maintained by recruitment of eggs and larvae transported via currents from Caribbean-West Indian regions to the south. Pelagic *Sargassum* has been implicated in the dispersal of *A. saxatilis* larvae (Dawson, 1962; Fine, 1970; Dooley, 1972).

64. *Chromis cyaneus* (Poey). Blue chromis. *Sightings*. FLORIDA MIDDLE GROUND: occasional, January 1972.

An aggregaton comprising 15-20 individuals of *C. cyaneus* was observed in 29 m at the Florida Middle Ground.

The low body profile, brilliant blue body coloration and black-bordered dorsal and caudal fins indicate this species.

Based upon this visual sighting, the range of *C. cyaneus* should be extended from Bermuda, the Bahamas, south Florida, Caribbean Sea, southwestern and northwestern Gulf of Mexico (Randall, 1968; Cashman, 1973) into the eastern Gulf of Mexico.

65. *Chromis enchrysurus* Jordan and Gilbert. Yellowtail reeffish. *Collections*. STA. 4: 1, FSBC 7405, 37 mm, September 1970. STA. 5: 5, FSBC 7393, 42-46 mm, October 1970; 1, FSBC 7400, 71 mm, February 1971. GS-132: 1, FSBC 7416, 50 mm, April 1971. GS-152: 1, FSBC 7413, 73 mm, July 1971. *Sightings*. STA. 4: rare, September 1970; rare, November 1970; rare, January 1971; occasional, June 1971. STA. 5: frequent, November 1970; frequent, December 1970a; common, June 1971. GS-126: abundant, February 1971. GS-132: frequent, April 1971. GS-143: rare, June 1971. GS-145: occasional, July 1971. GS-146: present, July 1971. GS-152: present, July 1971.

66. *Chromis scotti* Emery. Purple reeffish. *Collections*. STA. 3: 1, FSBC 7617, 58 mm, July 1971. FLORIDA MIDDLE GROUND: 1, FSBC 7393, 56 mm, January 1972. GS-270: FSBC 7394, 48 mm, August 1972. *Sightings*. STA. 3: rare (1), July 1971. GS-143: occasional, June 1971. GS-145: frequent, July 1971. GS-172: rare, December 1971. FLORIDA MIDDLE GROUND: abundant, January 1972. GS-270: rare, August 1972.

Emery (1968) extracted *Chromis scotti* from *C. insolatus* on the basis of morphological and distributional evidence. *Chromis scotti* is primarily continental in its distribution whereas *C. insolatus* typifies an insular distribution. Both species, however, are found in the Florida Keys, southeast Florida, Bahamas, Belize, Jamaica, and Columbia (Emery, 1968; Starck, 1968; Gilbert, 1972; Palacio, 1972; Colin, 1974). Specimens of *C. insolatus* reported from the eastern Gulf by Powell et al. (1972) were examined and found to be *C. scotti*. Struhsaker's (1969) record of

Chromis insolatus off SE United States probably also refers to *C. scotti.*

These sightings and collections of *C. scotti* establish its presence in the eastern Gulf of Mexico. Previously, it was known only from the Bahamas, Florida Keys and SE Florida, NE-NW-SW Gulf of Mexico, Jamaica, Belize, and Columbia (Emery, 1968; Starck, 1968; Gilber, 1972; Hastings, 1972; Cashman, 1973; Colin, 1974).

Two specimens of *Chromis* (FSBC 7617, 7394) differed from Emery's (1968) description of *C. scotti.* Although similiar in appearance, both of these specimens possessed two iridescent blue lines diverging from the snout, continuing over the nostrils, and terminating at the upper edges of the orbits. The taxonomic status of this "form" awaits collection of additional specimens.

67. *Pomacentrus partitus* Poey. Bicolor damselfish.

the upper edges of the orbits. The taxonomic status of this "form" awaits collection of ad-
Collections. FLORIDA MIDDLE GROUND: 1, FSBC 7328, 50 mm, January 1972. *Sightings.* STA. 1: 3, August 1972. STA. 2: 1, July 1972. STA. 4: rare, September 1970. STA. 5: rare, December 1970a. GS-145: rare, July 1971. FLORIDA MIDDLE GROUND: common, January 1972. GS-182: present, April 1972. GS-270: frequent, August 1972. GS-190: frequent, August 1972.

The bicolor damselfish was never recorded inshore of 22 m (STA. 4) and only rarely ob' served (except at the Florida Middle Ground) inshore of 30 m prior to the 1971 summer red tide. That Springer and Woodburn (1960) failed to observe *P. partitus* is additional evidence to suggest that it typically inhabits deeper reefs of the West Florida Shelf. The shallow-water occurence of juvenile *P. partitus* following the red tide may be only an ephemeral stage in ichthyofaunal succession. Possibly its success was due to relaxed competition from *P. variabilis*, a common shallow reef inhabitant before the red tide.

Böhlke and Chaplin (1968) listed the range of *P. partitus* as Florida, the Bahamas, and throughout the West Indies. Birdsong and Emery (1967) reported the bicolor damselfish from Yucatan (Mexico), Belize, and Nicarauga in the Western Caribbean and Cervigon (1966) reported the species from Venezuela. The bicolor damselfish is also known from the northeastern Gulf of Mexico where Hastings (1972) reported it as a "straggler" represented only by seasonal influxes of juvenile populations. The occurence of *P. partitus* in the present study, therefore, not only represents the first eastern Gulf record, but also documents its permanent residence as adult populations on the outer West Florida Shelf.

Rivas (1960) synonymized *P. partitus* with *P. pictus* from Brazil, but Emery (1973a) questioned this and presented preliminary evidence suggesting specific distinction.

68. *Pomacentrus variabilis* (Castelnau). Cocoa damselfish.

Collections. STA. 1: 1, FSBC 7282, 51 mm, June 1970; 3, FSBC 7362, 49-68 mm, December 1970. STA. 2: 1, FSBC 7278, 81 mm, July 1970; 4, FSBC 7470, 32-78 mm, September 1970; 4, FSBC 7481, 44-53 mm, April 1971. STA. 3: 7, FSBC 7379, 29-69 mm, August 1970. STA. 4: 1, FSBC 7323, 62 mm, September 1970; 4, FSBC 7296, 26-57 mm, September 1970. STA. 5: 3, FSBC 7461, 18-53 mm, October 1970. GS-107: 9, FSBC 7313 & 7379, 29-69 mm, August 1970. GS-149: 1, FSBC, 7483, 56 mm, July 1971. *Sightings.* STA. 1: present, May 1970; present, June 1970; 55, May 1971; 43, June 1971; 46, July 1971; 3, August 1971; 6, October 1971; 4, November 1971; 7, December 1971; 4, January 1972; 9, February 1972; 8, March 1972; 5, May 1972; 8, June 1972; 8, July 1972; 11, August 1972. STA.2: present, July 1970; present, September 1970; 17, October 1970; 18, November 1970; 9, December 1970; 18, March 1971a; 16, March 1971b; 33, April 1971a; 39, April 1971b; 37, July 1971; 4, August 1971a; 2, August 1971b; 1, October 1971a; 6, October 1971b; 12, November 1971; 23, December 1971; 13, February 1972; 29, March 1972; 17, April 1972; 28, July 1972; 23, August 1972; 18, October 1972. STA. 3: common, 1970; occasional, April 1971; rare, August 1971; common, September 1971a; frequent, September 1971b; frequent, October 1972. STA. 4: common, September 1970; occasional, October 1970; abundant, November 1970; frequent, December 1970; frequent, January 1971; occasional, June 1971. STA. 5: occasional, October 1970; occasional, November 1970; frequent, December 1970a; frequent, December 1970b; frequent, February 1971; occasional, June 1971. GS-104: present, July 1970. GS-105: present, July 1970. GS-107: present, August 1970. GS-126: frequent, February

1971. GS-128: present, March 1971. GS-132: frequent, April 1971. GS-133: common, April 1971. GS-137: present, May 1971. GS-143: present, June 1971. GS-145: common, July 1971. GS-147: common, July 1971. GS-156: common, August 1971. GS-164: common, October 1971. GS-172: rare, December 1971. FLORIDA MIDDLE GROUND: occasional, January 1972. GS-176: frequent, February 1972. GS-182: present, April 1972. GS-185: present, May 1972. GS-190: frequent, August 1972. GS-270: common, August 1972.

I examined several eastern Gulf pomacentrids identified as *Pomacentrus leucostictus*; all were *P. variabilis*. It is unlikely that *P. leucostictus* occurs in the eastern Gulf except possibly as an occasional juvenile straggler.

LABRIDAE

69. *Halichoeres bivittatus* (Bloch). Slippery dick. *Collections*. STA. 1: 2, FSBC 7326, 49-52 mm, December 1970; 2, FSBC 7361, 50-54 mm, June 1970. STA. 2: 3, FSBC 7265, 26-83 mm, July 1970. STA. 3: 6, FSBC 7338, 37-84 mm, September 1970. STA. 4: 1, FSBC 7403, 69 mm, October 1970; 2, FSBC 7474, 33-45 mm, September 1970; 6, FSBC 7572, 19-42 mm, June 1971. *Sightings*. STA. 1: present, May 1970; present, June 1970; 57, May 1971; 40, June 1971; 35, July 1971; 7, May 1972; thousands (15-20 mm), June 1972; 14, July 1972; 18, August 1972. STA. 2: present, July 1970; present, September 1970; 35, October 1970; 36, November 1970; 8, December 1970; 42, January 1971; 24, March 1971a; 13, March 1971b; 35, April 1971a; 22, April 1971b; 49, July 1971; 18, July 1972; 19, August 1972; 74, October 1972. STA. 3: occasional, September 1970; frequent, April 1971; common, September 1972a; frequent, September 1972b; frequent, October 1972. STA. 4: frequent, September 1970; common, October 1970; occasional, November 1970; occasional, December 1970; frequent, January 1971; occasional, June 1971. STA 5: common, October 1970; rare, November 1970; frequent, December 1970a; rare, December 1970b; occasional, February 1971; rare, June 1971. GS-104: present, July 1970. GS-105: common, July 1970. GS-107: present, August 1970. GS-132: rare, April 1971. GS-133: rare, April 1971. GS-137: present, May 1971. GS-140: present, May 1971. GS-143: occasional, June 1971. GS-164: common, October 1971. FLORIDA MIDDLE GROUND: common, January 1972. GS-182: present, April 1972. GS-270: occasional, August 1972. GS-190: occasional, August 1972.

70. *Halichoeres caudalis* (Poey). Painted wrasse. *Collections*. STA 2: 1, FSBC 7407, 142 mm, November 1970. STA 3: 2, FSBC 7290, 52-63 mm, September 1970. STA 4: 1, FSBC 7303, 81 mm, September 1970; 1, FSBC 7425, 59 mm, October 1970; 2, FSBC 7528, 51-58 mm, September 1970. STA 5: 10, FSBC 7433, 45-72 mm, October 1970. *Sightings*. STA 2: rare (1), July 1970; 1, November 1970; 3, March 1971a; 2, March 1971b; 1, April 1971a; 3, April 1971b; 2, August 1972; 4, October 1972. STA 3: occasional, September 1970; occasional, April 1971. STA 4: occasional, September 1970; frequent, October 1970; occasional, November 1970; rare, December 1970; frequent, January 1971. STA 5: occasional, October 1970; abundant, November 1970; occasional, December 1970a; occasional, December 1970b; rare, February 1971; frequent, June 1971. GS-126: occasional, February 1971. GS-132: frequent, April 1971. GS-133: occasional, April 1971. GS-143: frequent, June 1971. GS-145: frequent, July 1971. GS-152: present (dead), July 1971. GS-164: abundant, October 1971. GS-172: frequent, December 1971. FMG: common, January 1972. GS-182: present, April 1972. GS-270: frequent, August 1972.

71. *Hemipteronotus novacula* (Linné). Pearly razorfish. *Sightings*. FLORIDA MIDDLE GROUND: rare (2), January 1972.

Although *H. novacula* was only sighted at the Florida Middle Ground during the present study, its presence in the eastern Gulf has been well documented. Springer and Woodburn (1960) mentioned that *Xyrichthys psittacus* (= *H. novacula*) was described by Jordan as *X. jessiae* "from a specimen taken from a grouper off Tampa Bay." Additional specimens have been collected from off Tampa Bay (Powell et al., 1972).

In the field, the pearly razorfish is recognized by characteristic shell or coral fragment mounds surrounding its burrow. Other species of *Hemipteronotus* may hide beneath the sand but do not pile up rubble around the burrow as does *H. novacula* (Böhlke and Chaplin, 1968).

72. *Lachnolaimus maximus* (Walbaum). Hogfish. *Collections*. STA. 1: 1, FSBC 7569, 300 mm, May 1970; 1, FSBC 7579, 164 mm, June 1970.

STA. 2: 1, FSBC 7494, 156 mm, September 1970; 1, FSBC 7583, October 1970. GS-105: 1, FSBC 7570, 355 mm, July 1970. *Sightings*. STA. 1: present, May 1970; present, June 1970; 8, May 1971; 5, June 1971; 4, July 1971; 1, June 1972; 3, August 1972. STA. 2: present, July 1970; 11, September 1970; 8, October 1970; 26, November 1970; 20, December 1970; 33, January 1971; 21, March 1971a; 13, March 1971b; 18, April 1971a; 14, April 1971b; 5, July 1971; 1, February 1972; 2, March 1972; 1, April 1972; 2, July 1972; 1, August 1972; 2, October 1972. STA. 3: occasional, September 1970; rare, April 1971. STA. 4: rare, October 1970; rare, December 1970. STA. 5: rare, June 1971. GS-104: present, July 1970. GS-105: present, July 1970. GS-107: present, August 1970. GS-128: present, March 1971. GS-137: present, May 1971. GS-140: present, May 1971. GS-143: rare, June 1971. GS-145: rare, October 1971. FLORIDA MIDDLE GROUND: occasional, January 1972. GS-185: present, May 1972.

73. *Thalassoma bifasciatum* (Bloch). Bluehead wrasse.
Collections. BARRACUDA HOLE: 1, FSBC 7422, 20 mm, November 1971. *Sightings*. STA. 2: 1, December 1971. BARRACUDA HOLE: rare (1), November 1971. FLORIDA MIDDLE GROUND: occasional, January 1972.

Several juvenile bluehead wrasses (15-25 mm) were observed swimming near the base of the tentacles of a large sea anemone, *Condylactis* sp., at the Florida Middle Ground. These juvenile wrasses appeared to be unaffected by direct contact with the anemone's tentacles, a situation reminiscent and perhaps analogous to the association between Pacific anemones and the clownfishes, particularly of the genus *Amphiprion*. Smith (1973) remarked on an association between the clinid fish *Labrisomus kalisherae* and the sea anemone *Condylactis gigantea* along the Caribbean coast of Panama. With these two exceptions, I know of no other example of fish-anemone symbiosis in the western Atlantic.

Juvenile *T. bifasciatum* were observed cleaning pomacentrids (*Chromis enchrysurus* and *C. scotti*) and a serranid (*Mycteroperca microlepis*) during the Middle Ground observational dive. Juvenile blueheads have previously been acknowledged cleaners of species of acanthurids, kyphosids, pomacentrids, carangids, labrids, scarids, lutjanids and serranids (Longley and Hildebrand, 1941; Eibl-Eiblsfeldt, 1955; Herald, 1961; Feddern, 1965; Collette and Talbot, 1972).

Feddern (1965) suggested that *T. bifasciatum* be considered a conspicuous member of the West Indian reef ichthyofauna, ranging from Bermuda and southern Florida to Honduras and Columbia. The bluehead wrasse is also known from the northeastern and northwestern Gulf of Mexico (Caldwell, 1959; Hastings, 1972; Cashman, 1973). Hastings (1972) reported juvenile and small adult specimens of *T. bifasciatum* along the northwest Florida coast but dismissed them as seasonal stragglers since they were not found at natural reefs offshore. The occurence of *T. bifasciatum* at the Florida Middle Ground constitutes the first record of resident adult populations in the eastern Gulf of Mexico.

SCARIDAE

74. *Nicholsina usta* (Valenciennes). Emerald parrotfish.
Collections. STA. 1: 1, FSBC 7573, 171 mm, June 1972. *Sightings*. STA. 1: rare, June 1970; rare, June 1972. STA. 2: rare, July 1970; 1, November 1970; 2, January 1971; 1, April 1971a.

75. *Scarus croicensis* Bloch. Striped parrotfish.
Collections. STA. 5: 2, FSBC 7409, 46-60 mm, December 1970. *Sightings*. STA. 2: 2, July 1972. STA. 3: frequent, September 1972a; occasional, September 1972b; common, October 1972. GS-145: rare (1), July 1971. GS-152: present (dead), July 1971. FLORIDA MIDDLE GROUND: occasional, January 1972. GS-182: present, April 1972.

Scarus croicensis is easily confused with the princess parrotfish *S. taeniopterus* and the actual ranges of both species are somewhat uncertain. The striped parrotfish probably occurs in Bermuda, south Florida and the Caribbean Sea, perhaps ranging south to Brazil and north to Massachusetts (Randall, 1968). Hastings (1972) reported the seasonal occurrence of juvenile striped parrotfish along the northwest Florida coast but did not believe the species to be a permanent resident of the northern Gulf. However, specimens of *S. croicensis* were observed during all seasons during the present study, suggesting that resident populations occur at deep-water reefs offshore.

Jordan and Evermann (1896) reported *S. evermanni* (= *S. croicensis*) off Tampa but, until the present study, it has not since been recorded from the eastern Gulf of Mexico.

SPHYRAENIDAE

76. *Sphyraena barracuda* (Walbaum). Great barracuda.
Sightings. STA. 1: 1, May 1971; 10 (juveniles), October 1971; 2 (juveniles), November 1971. STA. 2: 80-100 (juveniles), October 1971b; 20 (juveniles), November 1971. STA. 4: rare (1), September 1970. GS-143: abundant, June 1971. BARRACUDA HOLE: frequent, November 1971.

Although Hastings (1972) reported *S. barracuda* in the vicinity of offshore towers in the northeastern Gulf and Springer and Woodburn (1960) noted its conspicuous occurence at offshore wrecks in the eastern Gulf, the present study indicates that great barracuda are also attracted to high-relief ledges on the West Florida Shelf. One such ledge, locally known as the Barracuda Hole, is located approximately 14.5 km off (235°) Sarasota, Florida in 14 to 16 m. Several hundred large (to 22 kg) barracuda take up seasonal residence (spring through early winter) on this particular reef ledge. The barracuda's preference for these high relief ledges may be attributed to large populations of prey fishes attracted to shelter afforded by the reef overhang and recesses.

Prior to the 1971 red tide, juvenile barracuda were never sighted at Sarasota study reefs. For a short time following the red tide, however, large shoals of juveniles (30-75 mm) were common at STATIONS 1 and 2.

OPISTOGNATHIDAE

77. *Opistognathus aurifrons* (Jordan and Thompson). Yellowhead jawfish.
Collections. STA. 4: 1, FSBC 7281, 61 mm, September 1971. *Sightings*. STA. 3: occasional, September 1972. STA. 4: rare, October 1970. STA. 5: frequent, December 1970a; occasional, December 1970b; common, June 1971. GS-145: frequent, July 1971. GS-164: common, October 1971. FLORIDA MIDDLE GROUND: occasional, January 1972.

There are no published accounts of *O. aurifrons* in the Gulf of Mexico north of Tortugas or Florida Keys (Longley and Hildebrand, 1941; Böhlke and Thomas, 1961; Starck, 1968). A single specimen of *O. aurifrons* collected 58 km west of Egmont Key during Project Hourglass (FSBC), visual sightings at natural reefs in the northeastern Gulf of Mexico (Robert Hastings, personal communication), and specimens reported in the present study constitute not only a northward range extension but also first record of the species in the Gulf of Mexico. Previously, the distribution of *O. aurifrons* was considered to be Bermuda, the Bahamas, Florida Keys, Tortugas, and West Indies south to the northern coast of South America (Longley and Hildebrand, 1941; Böhlke and Thomas, 1961; Randall, 1968; Palacio, 1972; Colin, 1973).

78. *Opistognathus macrognathus* Poey. Spotfin jawfish.
Collections. STA. 2: 1, FSBC 7285, 31 mm, July 1970. STA. 3: 1, FSBC 7418, 29 mm, September 1970. STA. 4: 1, FSBC 7299, 32 mm, September 1970; 1, FSBC 7430, 46 mm, September 1970.

The spotfin jawfish was never observed on the rocky reefs and was collected only during poison applications.

CLINIDAE

79. *Emblemaria pandionis* Evermann and Marsh. Sailfin blenny.
Collections. STA. 4: 1, FSBC 7398, 36 mm, January 1971. GS-140: 1, FSBC 7399, 39 mm, May 1971. *Sightings*. STA. 4: rare (1), January 1971. GS-140: rare (1), May 1971.

Stephens (1970) reported *E. pandionis* from widely scattered localities in the Caribbean and West Indies, including Florida, the Bahamas, Puerto Rico, Virgin Islands, and Venezuela. Starck (1968) commented that *E. pandionis* was only occasionally observed at Alligator Reef in the Florida Keys, and Stephens (1970) suspected that Florida was the northern distributional limit for this typically West Indian species. Cashman (1973) subsequently reported *E. pandionis* from West Flower Garden Reef off Texas.

80. *Labrisomus haitiensis* Beebe and Tee-Van. Longfin blenny.
Collections. FLORIDA MIDDLE GROUND: 1, FSBC 7468, 53 mm, January 1972.

This specimen of *L. haitiensis* was retrieved from spewings of a red grouper (*Epinephelus morio*) hook-and-lined from the Florida Middle Ground. Briggs (1958) included the eastern Gulf of Mexico within the range of *L. haitiensis*, but Böhlke and Chaplin (1968) either overlooked or discounted this record, reporting its range as the Bahamas, south Florida, and Greater Antilles.

BLENNIIDAE

81. *Blennius marmoreus* Poey. Seaweed blenny.
Collections. STA. 1: 17, FSBC 7312, 41-61 mm, June 1970; 2, FSBC 7304, 34-42 mm, December 1970; 11, FSBC 7447, 31-57 mm,

June 1970; 1, FSBC 7450, 30 mm, June 1971. STA. 2: 5, FSBC 7340, 36-53 mm, July 1970; 1, FSBC 7266, 61 mm, September 1970; 1, FSBC 7325, 47 mm, September 1970; 1, FSBC 7372, 53 mm, October 1970; 2, FSBC 7304, 34-42 mm, December 1970. STA. 3: 1, FSBC 7365, 48 mm, September 1970. STA. 4: 2, FSBC 7454, 24-39 mm, June 1971. GS-132: 1, FSBC 7576, 30 mm, April 1970. GS-142: 2, FSBC 7454, 24-39 mm, June 1971. GS-152: 1, FSBC 7369, 76 mm, July 1971. GS-164: 1, FSBC 7467, 57 mm, October 1971. *Sightings*. STA. 1: present, May 1970; present, June 1970; 8, May 1971; 3, June 1971; 4, July 1971; 2, October 1971; 3, November 1971; 4, December 1971; 1, January 1972; 2, February 1972; 9, March 1972; 7, May 1972; 7, June 1972; 19, July 1972; 20, August 1972. STA. 2: present, July 1970; present, September 1970; 14, October 1970; 6, November 1970; 5, December 1970; 4, January 1971; 5, March 1971a; 8, March 1971b; 19, April 1971a; 10, April 1971b; 11, July 1971; 8, August 1971a; 6, August 1971b; 3, October 1971; 5, November 1971; 4, December 1971; 4, February 1972; 7, March 1972; 6, April 1972; 16, July 1972; 15, August 1972; 13, October 1972. STA. 3: rare, September 1970; rare, April 1971; common, September 1972a; abundant, September 1972b; common, October 1972. STA. 4: occasional, September 1970; occasional, October 1970; frequent, November 1970; occasional, December 1970; rare, January 1971; abundant, June 1971. STA. 5: occasional, October 1970; occasional, November 1970; occasional, December 1970a; frequent, December 1970b; occasional, February 1971; rare, June 1971. GS-104: present, July 1970. GS-105: present, 1970. GS-107: present, August 1970. GS-126: occasional, February 1971. GS-128: present, March 1971. GS-132: occasional, April 1971. GS-133: occasional, April 1971. GS-137: present, May 1971. GS-140: present, May 1971. GS-143: abundant, June 1971. GS-145: common, June 1971. GS-147: common, July 1971. GS-150: present, July 1971. GS-164: abundant, October 1971. GS-172: common, December 1971. FLORIDA MIDDLE GROUND: common, January 1972. GS-176: rare, February 1972. GS-182: present, April 1972. GS-185: present, May 1972. GS-270: common, August 1972. GS-190: common, August 1972.

The seaweed blenny demonstrates various color phases in which the more characteristic brownish-red mottled body assumes a bright yellow-orange or, less commonly, a solid brown. Yellow-orange individuals comprise an estimated 5-10% of *B. marmoreus* reef populations during the present study and were observed throughout the year at all depth localities. For *B. marmoreus* populations in the northeastern Gulf of Mexico, Hastings (1972) reported three distinct color variations one of which was described as golden-yellow with no other markings. Also, Causey (1969) mentioned some golden-yellow specimens of *B. marmoreus* collected from Seven and One-Half Fathom Reef off Padre Island, Texas. He further noted that all individuals demonstrating the golden-yellow phase possessed a pelvic fin count of I, 2 rather than the more usual I, 3 formula found in mottled brown individuals. A discrepency in pelvic fin formulae between *B. marmoreus* color morphs was not detected for eastern populations of *B. marmoreus*.

82. *Hypleurochilus geminatus* (Wood). Crested blenny.
Collections. STA. 2: 1, FSBC 7469, 34 mm, July 1970. GS-142: 1, FSBC 7443, 41 mm, June 1971. *Sightings*. STA. 1: 6, May 1971; 1, March 1972. STA. 2: 2, February 1972.

CALLIONYMIDAE

83. *Callionymus pauciradiatus* Gill. Spotted dragonet.
Collections. STA. 1: 2, FSBC 7416, 13-14 mm, June 1971. *Sightings*. STA. 3: occasional, August 1971; common, September 1971.
The spotted dragonet is probably far more common on the West Florida Shelf than this study indicates. Its small size and preference for sand-shell substrates off the reef ledges makes it inconspicuous in any type of visual census.
The relative abundance of *C. pauciradiatus* at STA. 3 during August-September 1971 was due to the lack of nearly all other reef fishes which had succumbed to the red tide.

GOBIIDAE

84. *Coryphopterus punctipectophorus* Springer. Spotted goby.
Collections. STA. 1: 1, FSBC 7382, 30 mm, December 1970. STA. 4: 2, FSBC 7412, 27-36 mm, September 1970; 1, FSBC 7424, 14 mm, June 1971. STA. 5: 1, FSBC 7287, 27 mm, October 1970; 1, FSBC 7388, 24 mm, December 1970. GS-142: 1, FSBC 7448, 40 mm, June 1971. *Sightings*. STA. 1: present, May 1970; present, June 1970; 2, May 1971; 6, July 1971. STA. 4: rare, January 1971. STA. 5: frequent, February 1971; frequent, June 1971. GS-126: common, February 1971. GS-143: common,

June 1971. GS-145: abundant, July 1971. GS-164: abundant, October 1971. FLORIDA MIDDLE GROUND: common, January 1972. GS-182: present, May 1972. GS-190: common, August 1972.

Reef population densities of *C. punctipectophorus* are probably greatly underestimated due to its relatively small size, inconspicuous coloration, and preference for holes under ledges at the basis of reef areas.

85. *Gobiosoma horsti* Metzelaar. Yellow goby.
Collections. GS-132: 1, FSBC 7271, 26 mm, April 1971. *Sightings*. STA. 5: rare, December 1970a; rare, December 1970b; occasional, February 1971. GS-126: rare (1), February 1971. GS-145: rare (1), July 1971. GS-164: common, October 1971. GS-172: common, December 1971. FLORIDA MIDDLE GROUND: rare, January 1972. GS-182: rare, May 1972.

The distribution of *C. horsti* on the West Florida Shelf is undoubtedly influenced by the distribution of the sponge *Ircinia* sp.. Without exception, the yellowline goby was always sighted on or near *Ircinia*. Böhlke and Chaplin (1968) also suggested that *G. horsti* occurs in or about large sponges.

The occurence of *G. horsti* off Sarasota and at the Florida Middle Ground represents a northward range extension for the species and verifies its existence in the eastern Gulf. Previously, *G. horsti* was known only from the Bahamas, Grand Cayman Island, Haiti, Curacao, Campeche and, based upon a single specimen in poor condition, southwest of Tampa Bay in the eastern Gulf of Mexico (Hildebrand et al., 1964; Böhlke and Robins, 1968).

86. *Gobiosoma macrodon* Beebe and Tee-Van. Tiger goby.
Collections. STA. 1: 1, FSBC 7389, 25 mm, June 1971. STA. 2: 2, FSBC 7263, 13-13 mm, July 1970. *Sightings*. STA. 1: present, June 1970. STA. 2: present, July 1970.

Due to its small size and preference for sand, shell and coral rubble bottoms off the main reef ledge, populations of *G. macrodon* were inadequately sampled during this study. However, Springer and Woodburn (1960) concluded that *G. macrodon* was "invariably common" in the vicinity of "calcareous rubble found on the surface and around bases of reefs" off Tampa Bay.

87. *Gobiosoma oceanops* (Jordan). Neon goby.
Collections. FLORIDA MIDDLE GROUND: 1, FSBC 7276, 39 mm, January 1972. *Sightings*. STA. 5: rare (1), November 1970; rare (1), December 1970a. FLORIDA MIDDLE GROUND: common, January 1972. GS-182: rare, April 1972.

Böhlke and Robins (1968) suggested that most members of *Gobiosoma* within the subgenus *Elacatinus* are clearly the successful inhabitants of the insular province. However, Robins (1971) recognized that while the neon goby belongs to a group insular in character, it is an indicator of a group of fishes demonstrating a peculiar Florida Keys-Central American distribution. Böhlke and Robins (1968) reported *G. oceanops* from the Florida Keys, southeast Florida coast, and Yucatan and Belize in the southwestern Gulf, but Robins (1971) stated with conviction its absence from the Bahamas and Cayman Islands. Subsequently, Cashman (1973) reported *G. oceanops* from deep-water reef collections off Texas in the northwestern Gulf of Mexico. The occurrence of *G. oceanops* reported herein therefore constitutes first mention of the species in the eastern Gulf of Mexico. Accordingly, the distribution of the neon goby might be described as offshore-continental, suggesting that Robins' (1971) enigmatic Florida Keys-Central American distribution was an artifact based upon insufficient deep-water collections from deep-water Gulf of Mexico reefs. The shallow-water occurence of *G. oceanops* in the Florida Keys and along the Central American coast may be due to clear, insular-like waters nearshore.

88. *Ioglossus calliurus* Bean. Blue goby.
Collections. STA. 3: 1, FSBC 7346, 58 mm, October 1970; 1 FSBC 7391, 52 mm, October 1970. STA. 4: 2, FSBC 7310, 74-88 mm, October 1970. *Sightings*. STA. 1: present, May 1970; present, June 1970; 16, May 1971; 9, June 1971; 11, July 1971. STA. 2: present, July 1970; present, September 1970; 8, July 1971. STA. 3: occasional, September 1970; common, September 1972a; frequent, September 1972b. STA. 4: frequent, November 1971; rare, January 1971. STA. 5: frequent, December 1970a; occasional, December 1970b; common, February 1971; frequent, June 1971. GS-107: present, August 1970. GS-132: frequent, April 1971. GS-133: frequent, April 1971. GS-137: present, May 1971. GS-140: present, May 1971. GS-145: rare, July 1971.

Ioglossus calliurus is not typically a reef inhabitant, but constructs burrows in sand-shell bottoms at the peripheral bases of rocky outcroppings.

Shallow-water populations of *I. calliurus* suffered heavy mortalities during the 1971 red tide and specimens were not observed for nearly 12 months afterwards when juveniles (20-40 mm) were sighted at reef STATION 3.

89. *Microgobius carri* (Fowler). Seminole goby.
Collections. STA. 1: 2, FSBC 7527, 30-38 mm, July 1971.

Although *Microgobius carri* has been recorded from "southwestern Florida" (Briggs, 1958) and the northeastern Gulf (Hastings, 1972), it previously was unreported from the mideastern Gulf of Mexico. Although Briggs (1958) considered *M. carri* a Florida endemic, it is now known from the western Caribbean (Palacio, 1972) and West Indies (Randall, 1968).

ACANTHURIDAE

90. *Acanthurus chirurgus* (Bloch). Doctorfish.
Collections. STA. 1: 1, FSBC 7441, 37 mm, October 1971. GS-171: 1, FSBC 7353, 45 mm, December 1971. GS-185: 1, FSBC 7426, 131 mm, May 1972. *Sightings*. STA. 1: 2, October 1971; 6, November 1971; 10, December 1971; 4, January 1972; 2, February 1972; 10, March 1972; 7, May 1972; 9, June 1972; 9, July 1972; 9, August 1972. STA. 2: 1, November 1970; 2, October 1971a; 3, October 1971b; 6, November 1971; 6, December 1971; 4, February 1972; 9, March 1972; 11, April 1972; 2, July 1972; 9, August 1972; 10, October 1972. STA. 3: occasional, September 1972a; common September 1972b; occasional, October 1972. STA. 5: rare, December 1970. GS-143: occasional, June 1971. GS-145: rare, July 1971. GS-176: occasional, February 1972. FLORIDA MIDDLE GROUND: rare, January 1972. GS-185: present, May 1972. GS-190: common August 1972.

Except for the sightings of a single juvenile at STATION 2 during November 1970, *A. chirurgus* was only rarely observed as juveniles on deep reefs and at the "Mexican Pride" wreck prior to the 1971 red tide. Springer and Woodburn's (1960) failure to detect *A. chirurgas* further suggests that it is not a typical inhabitant of shallow-water eastern Gulf reefs. Following the red tide, however, A. chirurgus rapidly became one of the common fishes at reef STATION 1 and 2. Juvenile doctorfish, 25-50 mm, first appeared at these shallow reefs 4-6 weeks following the red tide and adults up to 250 mm were observed during summer and fall 1972.

Briggs (1958) mentioned that *A. chirurgus* is trans-Atlantic; in the western Atlantic being recorded from New England and Bermuda south to Rio de Janiero (Brazil) and including the northeastern and southwestern Gulf of Mexico. Subsequent reports confirmed its presence in the northwestern Gulf (Briggs et al., 1964). The broad latitudinal distribution of *A. chirurgus*, as well as acanthurids in general, may be explained by its protracted pelagic larva (acronurus) facilitating dispersal by ocean currents. The distribution of resident adult populations of *A. chirurgus* is probably greatly restricted within the general species range listed above.

Although its occurrence was suspected, the observations and collections of *A. chirurgus* mentioned herein represent the first record of the species from the eastern Gulf.

91. *Acanthurus coeruleus* Bloch and Schneider. Blue tang.
Sightings. STA. 2: 1, October 1970; 1, December 1971. BARRACUDA HOLE: rare (1), November 1971.

The distinctive yellow body coloration indicated that observed specimens were young *A. coeruleus*. The specimen (estimated at 100 mm) sighted at the Barracuda Hole was approaching adult coloration and possessed a bluish-cast posteriorly.

Acanthurus coeruleus adults were never observed during the study period and it is presumed that the species does not reside as an adult at eastern Gulf reefs but only as a seasonal (fall-early winter) juvenile straggler. Springer and Woodburn (1960) only noted the "bright yellow young" of *A. coeruleus* at the rocky reefs off Tampa Bay. Similarly, Hastings (1972) believed that *A. coeruleus* was probably not a permanent resident of the northeastern Gulf but probably transported northward of its adult range as pelagic larvae.

SCORPAENIDAE

92. *Scorpaena brasiliensis* Cuvier. Barbfish.
Collections. STA 4: 2, FSBC 7359, 33-59 mm, September 1970. GS-148: 1, FSBC 7446, 61 mm, July 1971.

93. *Scorpaena plumieri* Bloch. Spotted scorpionfish.
Collections. GS-140: 1, FSBC 7497, 168 mm, May 1971. FLORIDA MIDDLE GROUND: 1, FSBC 7539, 266 mm, January 1972. *Sightings*. STA. 2: 1, November 1970; 2, March 1971. STA. 3: occasional, September 1972.

BALISTIDAE

94. *Aluterus schoepfi* (Walbaum). Orange filefish.

Sightings. STA. 1: present, June 1970. GS-143: rare (1), June 1971.

95. *Balistes capriscus* Gmelin. Gray triggerfish. *Collections*. STA. 2: 1, FSBC 7571, 315 mm, July 1970. STA. 4: 1, FSBC 7543, 375 mm, December 1970. *Sightings*. STA. 1: present, May 1970; present, June 1970; 6, May 1971; 4, July 1971; 5, August 1971; 2, October 1971; 3, November 1971; 3, December 1971; 1, January 1972; 2, February 1972; 7, March 1972; 8, May 1972; 13, June 1972; 1, July 1972. STA. 2: present, July 1970; 1, October 1970; 9, November 1970; 12, January 1971; 3, March 1971a; 4, March 1971b; 4, April 1971a; 2, April 1971b; 2, July 1971; 1, December 1971; 2, March 1972; 3, April 1972; 1, July 1972; 4, August 1972; 4, October 1972. STA. 3: rare, April 1971; occasional, August 1971; frequent, September 1971; common, September 1972a; common, September 1972b; common, October 1972. STA. 4: present, September 1970; present, October 1970; occasional, December 1970. STA. 5: frequent, November 1970; frequent, December 1970a; rare, June 1971. GS-104: present, July 1971. GS-105: present, July 1971. GS-107: present, August 1971. GS-140: present, May 1971. GS-143: common, June 1971. GS-145: rare, July 1971. GS-147: rare (1), July 1971. GS-156: abundant, August 1971. GS-164: rare, October 1971. FLORIDA MIDDLE GROUND: rare, January 1972. GS-182: rare, April 1972. GS-270: frequent, August 1972. GS-190: common, August 1972.

96. *Balistes vetula* Linné. Queen triggerfish. *Sightings*. GS-190: rare (1), August 1972.

The individual of *B. vetula* observed at STATION GS-190 was a large adult estimated to be approximately 9 kg. One week later, a dive at the same location revealed what appeared to be the same specimen. *B. vetula* represents a new addition to the mideastern Gulf of Mexico checklist.

97. *Monacanthus ciliatus* (Mitchill). Fringed filefish.
Collections. STA. 5: 1, FSBC 7436, 37 mm, October 1970; 1, FSBC 7434, 39 mm, December 1970. GS-152: 1, FSBC 7435, 36 mm, July 1971. *Sightings*. STA. 5: rare (2), October 1970; rare (1), December 1970b. GS-152: rare (1), July 1971.

OSTRACIIDAE

98. *Lactophrys quadricornis* (Linné). Scrawled cowfish.
Sightings. STA. 1: rare (1), June 1970.

TETRAODONTIDAE

99. *Canthigaster rostrata* (Bloch). Sharpnose puffer.
Sightings. STA. 5: rare (1), February 1971.

In addition to the sightings mentioned above, *C. rostrata* has been collected in 55 and 74 m depths during Project Hourglass (FSBC).

100. *Sphoeroides spengleri* (Bloch). Bandtail puffer. *Collections*. STA. 4: 1, FSBC 7499, 121 mm, September 1970. *Sightings*. STA. 1: 1, May 1971; 1, July 1971. STA. 2: 1, November 1970; 1, January 1971; 1, October 1972. STA. 4: rare (1), September 1970.

DIODONTIDAE

101. *Chilomycterus schoepfi* (Walbaum). Striped burrfish.
Sightings. STA. 3: rare (1), August 1971.

ABUNDANCE, DIVERSITY, AND BATHYMETRIC DISTRIBUTION

One hundred one (101) species of reef fishes within 38 families were observed and/or collected in 13-42 m depths on the central West Florida Shelf during May 1970 through October 1972. Of these, 74 are classified primary reef fishes and 27 secondary reef fishes according to definitions of Starck (1968). One reef-fish species constitutes a Gulf of Mexico record, 15 represent eastern Gulf records, seven are additions to the mideastern Gulf checklist, two represent northward range extension records, and seven confirm dubious or frequently overlooked literature records (Table 7). Moreover, many species are permanent residents of eastern Gulf reef communities rather than stragglers as earlier investigators (Caldwell and Briggs, 1957; Caldwell, 1959, 1963a; Haburary et al., 1969) suspected.

At least 198 reef-fish species (143 primary) are presently known from the West Florida Shelf (northeastern and eastern Gulf) when previous checklists are combined with the present (Table 8). This absolute diversity is rather impressive in view of the fact that the entire Tampa Bay and adjacent Gulf ichthyofauna probably includes fewer than 350 fish species. Moe and Martin (1965) recognized only 312 species of fish from the Tampa Bay region. It should be realized, however, that certain of these reef fishes are only seasonally present as juveniles or stragglers (e.g., *Pomacentrus leucostictus*, *P. fuscus*, *Chaetodon striatus*, and *C. capistratus*).

The most speciose reef-fish families were the Serranidae (16 species), Lutjanidae (6), Pomacentridae (6), and Gobiidae (6). Numerically (biomass and numbers of individuals) important members of eastern Gulf reef communities certainly included

TABLE 7. DISTRIBUTIONAL RECORDS FOR EASTERN GULF OF MEXICO REEF FISHES.

Gulf of Mexico	Eastern Gulf of Mexico	Mideastern Gulf of Mexico	Northward Range Extension	Confirmation of dubious or frequently overlooked records
1. *Opistognathus aurifrons*	1. *Epinephelus cruentatus*	1. *Gymnothorax moringa*	1. *Gobiosoma oceanops*	1. *Epinephelus guttatus*
	2. *Epinephelus fulvus*	2. *Epinephelus nigritus*	2. *Gobiosoma horsti*	2. *Mycteroperca bonaci*
	3. *Phaeoptyx xenus*	3. *Priacanthus arenatus*		3. *Abudefduf saxatilis*
	4. *Centropyge argi*	4. *Gobiosoma horsti*		4. *Gobiosoma horsti*
	5. *Holacanthus ciliaris*	5. *Balistes vetula*		5. *Scarus croicensis*
	6. *Pomacanthus paru*	6. *Canthigaster rostrata*		6. *Labrisomus haitiensis*
	7. *Chaetodon capistratus*	7. *Microgobius carri*		7. *Emblemaria pandionis*
	8. *Chaetodon striatus*			
	9. *Chromis scotti*			
	10. *Gobiosoma oceanops*			
	11. *Pomacentrus partitus*			
	12. *Thalassoma bifasciatum*			
	13. *Acanthurus chirurgus*			
	14. *Scorpaena plumieri*			
	15. *Chromis cyaneus*			

TABLE 8. COMBINED LIST OF WEST FLORIDA SHELF (NE AND E GULF) REEF FISHES. PRIMARY REEF-FISH SPECIES FOLLOWED BY A PLUS (+) SIGN. REFERENCES FOR SPECIES NOT COLLECTED DURING THE PRESENT STUDY: 1 = REID, 1954; 2 = SPRINGER AND BULLIS, 1956; 3 = BRIGGS, 1958; 4 = SPRINGER AND WOODBURN, 1960; 5 = BULLIS AND THOMPSON, 1965; 6 = MOE AND MARTIN, 1965; 7 = HASTINGS, 1972; 8 = POWELL ET AL., 1972; 9 = WALLS, 1975.

1. *Ginglymostoma cirratum*
2. *Gymnothorax funebris* (+) 7
3. *Gymnothorax moringa* (+)
4. *Gymnothorax vicinus* (+) 7
5. *Gymnothorax nigromarginatus* 1, 2, 3, 4, 5, 7, 8
6. *Muraena retifera* (+) 3, 8
7. *Paraconger caudilimbatus* 2, 3
8. *Opsanus pardus* (+)
9. *Gobiesox strumosus*
10. *Antennarius ocellatus* (+)
11. *Antennarius radiosus* 7, 9
12. *Ogcocephalus radiatus*
13. *Lepophidium jeannae* 6
14. *Ophidion holbrooki* 6, 8
15. *Ogilbia cayorum* (+)
16. *Holocentrus ascensionis* (+)
17. *Holocentrus bullisi* (+)
18. *Holocentrus vexillarius* (+) 3, 7, 9
19. *Myripristis jacobus* (+) 3, 5
20. *Aulostomus maculatus* (+) 9
21. *Fistularia tabacaria* (+) 2, 3, 8, 9
22. *Centropomus undecimalis*
23. *Centropristis melana* (+)
24. *Centropristis ocyurus*
25. *Centropristis philadelphica* 2, 3, 5, 9
26. *Diplectrum formosum*
27. *Epinephelus adscensionis* (+)
28. *Epinephelus cruentatus* (+)
29. *Epinephelus drummondhayi* (+)
30. *Epinephelus flavolimbatus* (+) 5, 8, 9
31. *Epinephelus fulvus* (+)
32. *Epinephelus inermis* (+) 7, 9
33. *Epinephelus guttatus* (+)
34. *Epinephelus itajara*

TABLE 8. COMBINED LIST OF WEST FLORIDA SHELF (NE AND E GULF) REEF FISHES (Continued).

35. *Epinephelus morio* (+)
36. *Epinephelus nigritus* (+)
37. *Epinephelus niveatus* (+) 8, 9
38. *Gonioplectrus hispanus* (+) 3
39. *Hemanthias leptus* (+) 3
40. *Hemanthias vivanus* (+) 2, 3, 8, 9
41. *Hypoplectrus puella* (+)
42. *Lipropoma eukrines* (+) 8
43. *Mycteroperca bonaci* (+)
44. *Mycteroperca microlepis* (+)
45. *Mycteroperca phenax* (+)
46. *Mycteroperca venenosa* (+) 4, 9
47. *Ocyanthias martinicensis* 3, 8
48. *Paranthias furcifer* (+) 3, 5, 8, 9
49. *Serranus notospilus* 2, 3, 5, 8
50. *Serraniculus pumilio* 6, 7, 9
51. *Serranus atrobranchus* 9
52. *Serranus phoebe* 3, 5, 6, 8, 9
53. *Serranus subligarius* (+)
54. *Rypticus bistrispinus* (+) 5, 6, 8
55. *Rypticus maculatus* (+)
56. *Priacanthus arenatus* (+)
57. *Pristigenys alta* (+)
58. *Apogon affinis* (+) 8
59. *Apogon aurolineatus* (+)
60. *Apogon pseudomaculatus* (+)
61. *Apogon quadrisquamatus* (+) 8
62. *Apogon maculatus* (+) 7, 9
63. *Astrapogon alutus* (+)
64. *Phaeoptyx conklini* (+) 8, 9 (may refer to *P. xenus*)
65. *Phaeoptyx pigmentarius* (+) 3, 8
66. *Phaeoptyx xenus* (+)
67. *Malacanthus plumieri* 3, 4, 8
68. *Seriola dumerili*
69. *Lutjanus analis* (+) 3, 7, 9
70. *Lutjanus apodus* (+) 3, 7, 9
71. *Lutjanus buccanella* (+) 8, 9
72. *Lutjanus cyanopterus* (+)
73. *Lutjanus griseus* (+)
74. *Lutjanus synagris*
75. *Lutjanus mahogoni* (+) 9
76. *Lutjanus campechanus* (+)
77. *Lutjanus vivanus* (+) 3, 9
78. *Pristipomoides aquilonaris* (+) 9
79. *Ocyurus chrysurus* (+)
80. *Rhomboplites aurorubens* (+)
81. *Anisotremus virginicus* (+) 3, 4
82. *Haemulon sciurus* (+) 8, 9
83. *Haemulon flavolineatum* (+) 9
84. *Haemulon aurolineatum* (+)
85. *Haemulon chrysargyreum* (+) 3
86. *Haemulon macrostomum* (+) 3, 4
87. *Haemulon plumieri* (+)
88. *Archosargus probatocephalus*
89. *Calamus bajonado* (+)
90. *Calamus leucosteus* 3, 7, 8, 9
91. *Calamus nodosus* (+) 7, 8, 9
92. *Calamus penna* 3
93. *Calamus proridens*
94. *Diplodus holbrooki*
95. *Pagrus sedecim* (+) 6, 8, 9
96. *Stenotomus caprinus* 2, 7, 8, 9
97. *Equetus lanceolatus* (+)
98. *Equetus umbrosus* (+)
99. *Odontoscion dentex* (+)
100. *Mulloidichthys martinicus* (+) 7, 9
101. *Upeneus parvus* 9
102. *Pseudupeneus maculatus* (+)
103. *Chaetodipterus faber*
104. *Centropyge argi* (+)
105. *Chaetodon aya* (+) 2, 3, 8, 9
106. *Chaetodon capistratus* (+)
107. *Chaetodon ocellatus* (+)
108. *Chaetodon sedentarius* (+)
109. *Chaetodon striatus* (+)
110. *Holacanthus bermudensis* (+)
111. *Holacanthus ciliaris* (+)
112. *Pomacanthus arcuatus* (+)
113. *Pomacanthus paru* (+)
114. *Abudefduf saxatilis* (+)
115. *Abudefduf taurus* (+) 7, 9
116. *Chromis cyaneus* (+)
117. *Chromis enchrysurus* (+)
118. *Chromis scotti* (+)
119. *Pomacentrus fuscus* (+) 9
120. *Pomacentrus partitus* (+)
121. *Pomacentrus variabilis* (+)
122. *Pomacentrus leucostictus* (+) 9
123. *Bodianus rufus* (+) 3
124. *Decodon puellaris* (+) 2, 3, 5, 8
125. *Doratonotus megalepis* (+) 7
126. *Halichoeres bathyphilus* (+) 5, 8, 9
127. *Halichoeres bivittatus* (+)
128. *Halichoeres caudalis* (+)
129. *Halichoeres pictus* (+) 8
130. *Halichoeres poeyi* (+) 5
131. *Halichoeres radiatus* (+) 3
132. *Hemipteronotus martinicensis* (+) 8
133. *Hemipteronotus novacula* (+)
134. *Hemipteronotus splendens* (+) 8
135. *Lachnolaimus maximus* (+)
136. *Thalassoma bifasciatum* (+)
137. *Nicholsina usta*
138. *Scarus croicensis* (+)
139. *Scarus guacamaia* (+) 7
140. *Scarus coelestinus* (+) 7
141. *Cryptotomus roseus* (+) 5, 7, 8
142. *Sparisoma radians* (+) 9
143. *Sparisoma aurofrenatum* (+) 7
144. *Sparisoma chrysopterum* (+) 7

TABLE 8. COMBINED LIST OF WEST FLORIDA SHELF (NE AND E GULF) REEF FISHES (Continued).

145. *Sparisoma radiatus* (+) 7, 8	172. *Coryphopterus punctipectophorus* (+)
146. *Sparisoma rubripinne* (+) 7	173. *Evermannichthys spongicola* (+) 3, 7, 8, 9
147. *Sparisoma viride* (+) 7, 9	174. *Gobiosoma horsti* (+)
148. *Sphyraena barracuda* (+)	175. *Gobiosoma oceanops* (+)
149. *Sphyraena borealis* 8, 9	176. *Gobiosoma longipala* 9
150. *Lonchopisthus linderi* 8, 9	177. *Gobulus myersi* 3
151. *Opistognathus aurifrons* (+)	178. *Ioglossus calliurus*
152. *Opistognathus lonchurus* 3, 6, 8, 9	179. *Lythrypnus nesiotes* (+) 8
153. *Opistognathus macrognathus*	180. *Microgobius carri* (+)
154. *Opistognathus maxillosus* 1, 9	181. *Risor ruber* (+) 8
155. *Opistognathus whitehursti* 8	182. *Acanthurus chirurgus* (+)
156. *Chaenopsis ocellata* 8	183. *Acanthurus randalli* (+) 3, 7, 9
157. *Chaenopsis limbaughi* (+) 8	184. *Acanthurus coeruleus* (+)
158. *Emblemaria pandionis* (+)	185. *Scorpaena agassizi* 9
159. *Emblemaria atlantica* (+) 3	186. *Scorpaena bergi* (+) 2, 3
160. *Emblemaria piratula* 3	187. *Scorpaena brasiliensis*
161. *Labrisomus haitiensis* (+)	188. *Scorpaena calcarata* 2, 4, 6, 7, 8, 9
162. *Paraclinus fasciatus* 1, 3, 8, 9	189. *Scorpaena dispar* 2, 8, 9
163. *Paraclinus marmoratus* 8	190. *Scorpaena plumieri* (+)
164. *Starksia ocellata* (+) 8, 9	191. *Aluterus schoepfi* (+)
165. *Blennius cristatus* 8, 9	192. *Balistes capriscus* (+)
166. *Blennius marmoreus* (+)	193. *Balistes vetula* (+)
167. *Hypleurochilus geminatus*	194. *Monacanthus ciliatus*
168. *Hypleurochilus bermudensis* (+)	195. *Lactophrys quadricornis*
169. *Blennius nicholsi* (+) 9	196. *Canthigaster rostrata* (+)
170. *Callionymus bairdi* (+) 3, 8, 9	197. *Sphoeroides spengleri*
171. *Callionymus pauciradiatus*	198. *Chilomycterus schoepfi*

the Serranidae, Labridae, Sciaenidae, and Pomadasyidae.

Seventy-one (71) reef-fish species were recorded at shallow reefs (12 to 18 m) but of these, only 58 might be considered representative of that particular shelf interval. The remaining 13 species, detected at shallow reefs only after the red tide (see Table 6), represent either offshore, deep-water forms which invaded shallow reefs as juveniles or preadults, or species previously rare or unknown from the eastern Gulf. All species in this latter category (e.g., *Chaetodon striatus* and *Abudefduf saxatilis*) apparently possess long-term pelagic eggs or larvae and were presumably recruited through the plankton from resident spawning populations to the south.

The most diverse fish families at shallow reefs were the Serranidae (11 species), Lutjanidae (4), Labridae (4), and Gobiidae (4). Of these, however, two serranids (*Epinephelus cruentatus* and *Mycteroperca bonaci*), two lutjanids (*Ocyurus chrysurus* and *Lutjanus campechanus*), and a labrid (*Thalassoma bifasciatum*) were present only following the red tide. The most common members of the shallow reef ichthyocommunity prior to the red tide are listed in Table 9.

As evident from reef poison collections, the most common cryptic reef-fish species at shallow-water reefs were the cardinalfishes (Apogonidae) *Astrapogon alutus* and *Phaeoptyx xenus*. Of these most common shallow-water reef fishes, *Epinephelus morio*, *Equetus umbrosus*, *Holacanthus bermudensis*, *Halichoeres bivittatus*, *Lachnolaimus maximus*, *Astrapogon alutus*, and *Phaeoptyx xenus* were exterminated at 12-30 m reefs during the red tide. Following the red tide, juvenile *Epinephelus cruentatus* (Serranidae), *Chaetodon ocellatus* and *C. capistratus* (Chaetodontidae), *Acanthurus chirurgus* (Acanthuridae), *Holacanthus bermudensis* and *Pomacanthus arcuatus* (Pomacanthidae), and *Haemulon aurolineatum* (Pomadasyidae) rapidly became the most common fishes at shallow reefs.

The deep reef ichthyofauna (> 30 m), including the Florida Middle Ground, was equally diverse with 71 species. However, considering that deep reefs received far less sampling attention (fewer collections and less bottom observational time), a richer deep reef ichthyofauna is anticipated. With more extensive and efficient sampling of these deep reef ichthyofaunas, many of the rarer shallow water reef fishes will undoubtedly be detected in addition to exclusively deep-water spe-

TABLE 9. THE MOST COMMON DEEP-WATER (INCLUDING FLORIDA MIDDLE GROUND) AND SHALLOW-WATER EASTERN GULF OF MEXICO REEF FISHES. ESTIMATES BASED UPON CONDITIONS PRIOR TO THE 1971 SUMMER RED TIDE.

Deep-water (greater than 30 m)	Shallow-water (12-18 m)
SERRANIDAE	
Centropristis ocyurus	
Epinephelus morio	*Epinephelus morio*
Mycteroperca microlepis	*Mycteroperca microlepis*
Mycteroperca phenax	*Mycteroperca phenax*
Serranus subligarius	*Serranus subligarius*
GRAMMISTIDAE	
	Rypticus maculatus
APOGONIDAE	
Apogon pseudomaculatus	
LUTJANIDAE	
Lutjanus griseus	*Lutjanus griseus*
POMADASYIDAE	
Haemulon aurolineatum	
	Haemulon plumieri
SPARIDAE	
Calamus proridens	
	Archosargus probatocephalus
SCIAENIDAE	
Equetus lanceolatus	
Equetus umbrosus	*Equetus umbrosus*
POMACANTHIDAE	
Holacanthus bermudensis	*Holacanthus bermudensis*
POMACENTRIDAE	
Chromis enchrysurus	
Chromis scotti (Middle Ground)	
Pomacentrus variabilis	*Pomacentrus variabilis*
Pomacentrus partitus (Middle Ground)	
LABRIDAE	
Halichoeres bivittatus	*Halichoeres bivittatus*
Halichoeres caudalis	
	Lachnolaimus maximus
BLENNIIDAE	
Blennius marmoreus	*Blennius marmoreus*
GOBIIDAE	
Coryphopterus punctipectophorus	
BALISTIDAE	
	Balistes capriscus

cies, especially those of tropical affinity.

A single inspection dive at the Florida Middle Ground during January 1972 revealed 51 species, approximately two or three times the number as would be observed at Sarasota study reef sites during a single dive of comparable duration. When the Florida Middle Ground ichthyofauna becomes better known, its absolute species diversity and abundance is expected to exceed that of other reef areas on the West Florida Shelf. Smith and Ogren (1974) postulated that buffered environmental conditions associated with offshore distance, reef structural complexity, water column and benthic algal productivity, varying depths, and shallow reef summits are important features contributing to Middle Ground ichthyofaunal variety and abundance.

The most diverse deep reef-fish families were the Serranidae (15 species) and Pomacentridae (6). The most common members of the deep reef ichthyo-community are listed in Table 9. Deep reef poison collections most often yielded the cardinalfishes (Apogonidae) *Phaeoptyx xenus* and *Astrapogon altus*.

Of the total reef-fish species recorded at shallow reefs, only 26 were not also detected at deep reefs. Most of these represented 1) inshore species which may seasonally take up residence on the reefs (e.g., *Diplodus holbrooki, Centropomus undecimalis*); 2) resident populations of secondary reef-fishes equally or more characteristic of nearshore habitats (e.g., *Archosargus probatocephalus, Hypleurochilus geminatus*); 3) expatriate juvenile reef-fish populations which colonized shallow reefs only following the red tide (e.g., *Chaetodon striatus, Abudefduf saxatilis*); 4) warm-temperate fishes (e.g., *Centropristis melana*); and 5) rare forms (e.g., *Priacanthus arenatus, Balistes vetula*) which probably occur at deep-water reefs, their apparent absence in this study probably reflecting less sampling effort.

Of the total deep reef-fish species, 20 were never observed at shallow reefs. The far greater sampling effort expended at shallow reef sites suggests that their absence is real. The vast majority of these represent resident populations of tropical species of either Caribbean (continental) or West Indian (insular) extraction. In addition to these 20 exclusively deep-water reef-fish species, 8 additional species were known from shallow reef areas only after the red tide and probably should not be regarded normal components of a mature shallow reef community. Therefore, 28 reef-fish species are considered typically restricted to deep-water reefs and, if taken inshore at all, known only from shallow reefs as juvenile stragglers or ephemeral populations following periods of ecological instability such as may accompany certain red tides. Many of these fishes which appeared at shallow reefs following the red tide resemble "fugitive species" (MacArthur and Wilson, 1967) or "r-selectionists" (Pianka, 1971) which are well suited for occupation of variable, unpredictable, or fluctuating environments where there exists a selective premium on absolute fecundity, vagility, and rapid development. Many of these same species, however, might be maladapted to the highly competitive situation existing in a more mature community where selection usually favors species possessing greater net efficiency in reproductive, developmental, and interspecific competitive success even at the expense of reduced fecundity, dispersal ability, and growth. As an illustrative example, consider that both chaetodontids and acanthurids were numerically successful during early successional stages following the red tide but are typically among the rarer elements comprising the more mature Gulf reef biocoenoses. Their success as pioneer species following the red tide was probably due to a distinct recolonization advantage gained through broadcast of their protracted planktonic tholichthys (Chaetodontidae) and acronurus (Acanthuridae) larvae.

Reefs of moderate depth (18-30 m) are broadly transitional and characterized by shallow-water species subtraction (e.g., *Centropristis melana, Archosargus probatocephalus* and *Haemulon plumieri*) and deep-water species replacement (e.g., *Chromis enchrysurus, Apogon pseudomaculatus* and *Opistognathus aurifrons);* no reef-fish species seem to be peculiar to this shelf interval (Table 6). This zone of greatest change may correspond to the dynamic interface between offshore Gulf and coastal waters and transition from terrigenous quartz-sand to biogenic carbonate sediments (Cobb et al., 1973; Lyons and Collard, 1974) frequently apparent within this depth regime. Buffered environmental conditions (salinity, turbidity, temperature, etc.) associated with offshore Gulf water masses undoubtedly contribute to the overall tropical facies of deep reef ichthyofaunas.

Forty-three (43) reef fishes demonstrated a eurybathic distribution (12-42 m) but most featured their greatest abundance within a more restricted depth zone. These observed patterns of bathymetric distribution are generally consistent with Moe and Martin's (1965) results indicating a "distinctiveness" in bottomfish assemblages at various depths off Pinellas County in the mideastern Gulf. Bathymetric distributional patterns of Gulf reef fishes may reflect 1) a species' tolerance or preference to inshore-offshore gradients in physicochemical and biological features and 2) spatial displacement through competitive interactions of congeners and/or ecologically equivalent species. In support of the latter, the deep-water reef fishes *Epinephelus cruentatus, Pomacentrus partitus,* and *Lutjanus campechanus* expanded their normal bathymetric ranges shoreward when red tide eliminated or decimated their respective congeneric and/or presumed ecological replacement reef-fish species *Epinephelus morio, Pomacentrus variabilis,* and *Lutjanus griseus* at shallow reefs.

A comparison of the eastern Gulf reef ichthyofauna with those of other Western Atlantic localities is difficult because of a paucity of representative collections. Many reef-fish checklists have been prepared from a single collection or cruise, or consider only a particular segment of the total reef ichthyofauna. However, a few studies which have relied heavily upon in situ collections and observations of specific reef-fish ichthyofaunas have generated representative checklists comparable to that of the present study. Causey (1969) recorded 87 (50 primary) reef fishes at Seven and One-Half Fathom Reef off Padre Island, Texas; Cashman (1973) prepared a list of 128 (90 primary) reef-fish species from West Flower Garden Reef on the outer Texas Shelf; and Starck (1968) compiled a list of 389 (235 primary) reef fishes at Alligator Reef in the Florida Keys. These estimates compare with 101 (74 primary) reef-fish species detected in the mideastern Gulf of Mexico during the present study.

The disparity between Alligator Reef and West Florida Shelf ichthyofaunas may reflect the differential ability of fishes to invade the eastern Gulf rather than an ability to survive once there. For example, both clinids and gobiids lay demersal eggs and possess abbreviated planktonic larval stages whereas chaetodontids feature a protracted planktonic larva (tholichthys) facilitating dispersal by ocean currents. Starck (1968) recorded 23 reef gobiids and 28 reef clinids at Alligator Reef of which only seven species of each have been taken from the West Florida Shelf. On the other hand, of 11 chaetodontids (an insular, tropical family according to Gilbert, 1972) reported from Alligator Reef (Starck, 1968), only two species are unknown from the eastern Gulf.

The rather impoverished tropical reef ichthyofauna of the West Florida Shelf may be partially due to the inability of small fishes with limited vagility to colonize there. However, certain others have undoubtedly been unsuccessful in establishing stable populations due to locally limiting conditions of temperature, sedimentation, and various other factors within the marginally tropical area. Hastings (1972) believes that certain shallow-water tropical reef fishes (e.g., *Abudefduf saxatilis* and *Pomacentrus fuscus*) are excluded from offshore reefs in the northeastern Gulf due to absence of suitable reef biotopes in less than 18 m. Juvenile populations of these same species, however, become seasonally established at artificial jetties constructed along the northwest Florida coast.

Interspecific competition probably accounts for many of the observed patterns of reef-fish diversity and relative abundance in the eastern Gulf. "Species that habitually coexist in a rich, diversified habitat may exclude each other in more homogenous or ecologically marginal habitats" (Mayr, 1970:45). The mutually exclusive bathymetric distributions displayed by reef-fish species pairs, as well as patterns of ichthyofaunal recolonization observed following the red tide suggest that competition, at least, plays an important role. The habitat monotony offered by the sparse, low-profile rocky reefs of the West Florida Shelf implies that competition for substrate must be intense. Consistent with this, increased habitat complexity associated with high-relief ledges seemed to result in enrichment in terms of species composition and abundance.

EFFECTS OF THE 1971 RED TIDE ON EASTERN GULF REEF COMMUNITIES

Patches of discolored water and fish kills attributable to the Florida red tide *Gymnodinium breve* were reported between Naples and St. Petersburg along Florida's west coast between April and August 1971. Fish kills and a short-lived red tide occurred within Sarasota Bay during April (Steidinger and Ingle, 1972). Coastwide and offshore fish kills first detected in southern areas of the region moved progressively northward and, by early June, moderate fish kill and *G. breve* concentrations were reported from Ft. Myers to Sarasota (Steidinger and Ingle, 1972). Subsequently, *G. breve* blooms were transported shoreward resulting in extensive fish mortalities in Tampa Bay and Charlotte Harbor (Steidinger and Ingle, 1972; Steidinger and Joyce, 1973). Red tide conditions persisted in Tampa Bay and nearshore Gulf waters until September (Steidinger and Joyce, 1973).

Two major concentrations of dead fish first appeared in the Gulf of Mexico off Sarasota, Florida. One area of fish kills initially detected 5-6 km offshore in 7-11 m depths during early June secondarily advanced into Sarasota Bay. The second localization of dead fish first encountered 32 to 42 km offshore in 21-26 m depths during early July subsequently spread both offshore to 30-33 m depths inshore where it ultimately merged with the nearshore concentration during late July and August. By mid-August, fish kills and discolored waters prevailed from within Sarasota Bay to 30-33 m depths approximately 45-48 km offshore. Gradual dissipation of discolored waters occurred in late August and by mid-September fish kills were ended.

Offshore reef-fish kills included not only smaller benthic forms, but also large jewfish and grouper (Serranidae), snappers (Lutjanidae), triggerfish and filefish (Balistidae), porgies (Sparidae), and grunts (Pomadasyidae). Although reef fishes featured varying tolerances to progressive red tide conditions, SCUBA observations at widely scattered Gulf sites revealed representatives of nearly every species common on the reefs lying dead on the bottom or floating on the surface.

Reef fishes were not the only organisms to be adversely affected by the red tide. Scleractinian and alcyonarian corals, polychaetous annelids, mollusks, decapod crustaceans, tunicates, poriferans, echinoderms, and algae all sustained heavy mortalities within the red tide sector. Mortalities of most reef invertebrates were probably due to factors secondarily associated with red tide (e.g., oxygen depletion, hydrogen sulphide poisoning, bacterial and fungal infections, etc.) rather than to *G. breve* toxin(s). Decomposing fish certainly accelerated oxygen depression in cooler bottom water and tensions of 0.3-2.0 ml O_2/l were recorded at certain reefs in 13-30 m during July and August. Ogren and Chess (1969) believed that high oxygen demand by live and decomposing phytoplankton contributed to anoxia in bottom waters off New Jersey during fall 1968. Similarly, other investigators (Copenhagen, 1953; Fay, 1965; Steidinger and Joyce, 1973) have postulated that multifarious factors, including anoxia and sulphuretted hydrogen poisoning, may contribute more to faunal mortalities than dinoflagellate toxins.

Reefs located in 18-33 m about 24 to 51 km off Sarasota sustained the greatest faunal mortalities in terms of percentage kill and species affected. Reefs 13-24 km offshore in 13-18 m suffered substantial faunal mortalities, but remnant populations of a few fishes and invertebrates survived at certain localities. Sarasota Diving Club members reported faunas to be even less severely affected at inshore reefs (< 14 m) off Venice, Florida, where observations revealed "no grouper, jewfish, hogfish, beaugregory [*Pomacentrus variabilis*], or other regular [fish] inhabitants", but "relatively unaffected invertebrate populations" (Steidinger and Ingle, 1972:274). Inshore, shallow-water reef biotas may have better survived the red tide because 1) bottom oxygen tensions may have remained higher due to a less well developed thermocline, thereby permitting greater vertical mixing with more oxygenated surface waters, and 2) the shorter duration of red tide blooms at shallower reefs. Fish kills persisted 3-5 weeks offshore between 18-30 m, but only 2-3 weeks inshore between 13-15 m.

Gulf waters cleared following dissipation of the red tide during late August and early September, making it possible to assess its total impact upon reef communities. SCUBA observations were made at twenty reef sites in 13-33 m approximately 13-48 km offshore between a 210° and 270° compass heading off New Pass, Florida. The area encompassed by these boundaries is approximately 1536 km^2.

An estimated 80-90% of the offshore (18-30 m) resident reef-fish species perished during the red tide. At inshore, shallow-water reefs (13-18 m), probably 77% (45 of 58 spp.) of the resident reef-fish species perished. Fishes unquestionably remaining as remnant populations at shallow-water reefs following the red tide included the serranids *Mycteroperca microlepis*, *M. phenax*, *Epinephelus itajara*, and *Serranus subligarius*; the lutjanid *Lutjanus griseus*; the pomadasyid *Haemulon plumieri*; the pomacentrid *Pomacentrus variabilis*; the ephippid *Chaetodipterus faber*; the grammistid *Rypticus maculatus*; the blenniid *Blennius marmoreus*; the sparid *Archosargus probatocephalus*; the batrachoidid *Opsanus pardus*; and the balistid *Balistes capriscus*. Philopatry and thigmotactic behavior exhibited by most reef-fish species certainly contributed to their near complete annihilation during the red tide. Those fishes not ethologically or physiologically restricted to bottom waters (e.g., *Lutjanus griseus*, *Archosargus probatocephalus*, *Balistes capriscus*) survived in greatest numbers, possibly by moving above the thermocline into more oxygenated waters. Reef fishes most susceptible to red tide conditions, as indicated by their early and complete demise, were the benthophilic sciaenids, chaetodontids, pomacanthids, labrids, and the serranid *Epinephelus morio*.

RECOLONIZATION AND SUCCESSION OF REEF ICHTHYOFAUNAS FOLLOWING THE 1971 RED TIDE

Odum (1959:257) defines ecological succession as the "orderly process of community change . . . the sequence of communities which replace one another in a given area." According to this definition, true ecological succession not merely seasonal progression, seems to be occuring at Gulf reefs devastated by the 1971 red tide. However, unlike classical terrestrial succession where most if not "all species in a seral stage are replaced by an entirely new and distinct assemblage of species" (McCloskey, 1970), succession of eastern Gulf reef communities seems to be characterized by progressive species replacement more in terms of relative abundance than substitution. In several instances, even the more dominant pioneer species (e.g., *Chaetodon ocellatus* and *Pomacanthus arcuatus*) were members of a more mature Gulf reef community existing prior to the red tide. Tables 10 and 11 summarize occurrence of fishes at shallow-water reefs (12-18 m) both before and after the 1971 red tide.

Certain fishes colonized shallow-water reefs almost immediately after red tide conditions abated (e.g., *Chaetodon ocellatus*, *Epinephelus cruentatus*, and *Acanthurus chirurgus*); others did not appear for 10-12 months afterwards (e.g., *Halichoeres caudalis*, *H. bivittatus*, *Lutjanus campechanus*, and *Epinephelus morio*) (Table 10). The early arrival of certain groups of fishes, including the chaetodontids and acanthurids, is easily explained by their protracted pelagic larvae which are broadcast by ocean currents. Several fishes previously rare (e.g., *Chaetodon capistratus*, *C. striatus*, and *Acanthurus chirurgus*) or absent (e.g., *Epinephelus cruentatus*, *Scarus croicensis*, *Pomacentrus partitus*, and *Lutjanus campechanus*) at shallow reefs colonized there following the red tide (Table 10). Many fishes within this latter category are deep-water members of species pairs demonstrating bathymetric exclusion prior to the red tide. The

TABLE 10. SIGHTINGS OF FISHES AT SHALLOW-WATER REEFS (12-18 m) BEFORE AND AFTER THE 1971 SUMMER RED TIDE. PARENTHETICAL INSERTION OF OCCURRENCE DESIGNATIONS (X's) INDICATES THAT ONLY JUVENILE INDIVIDUALS WERE SIGHTED.

						Before Red Tide								Red Tide									After Red Tide							
	1970										1971												1972							
	M	J	J	A	S	O	N	D	J	F	M	A	M	J	J	A	S	O	N	D	J	F	M	A	M	J	J	A	S	O
G. cirratum												X	X																	
S. intermedius						X	X		X			X	X																	
T. myops			X																											
O. pardus	X	X							X		X	X		X	X	X			X	X			X	X		X	X	X		X
A. ocellatus													X																	
O. radiatus															X	X														
C. undecimalis																												X		X
C. melana									X																				X	
C. ocyurus				X		X	X			X																	(X)	(X)		(X)
D. formosum	X	X	X		X	X			X		X	X	X		X	X														(X)
E. cruentatus																		(X)	(X)	(X)	(X)	(X)	(X)	(X)	(X)	(X)	(X)	(X)	(X)	(X)
E. itajara	X	X	X		X								X												X					
E. morio	X	X	X	X	X	X	X	X	X			X	X		X												X	X	X	X
H. puella					X																							(X)	(X)	(X)
M. bonaci																									(X)					
M. microlepis	X	X	X		X	X	X		X		X	X	X	X	X	X		X	X	X	X	X	X		X		X	X	X	X
M. phenax	X	X	X		X	X	X	X	X		X	X	X	X	X					X	X	X					X	X	X	X
S. subligarius	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
R. maculatus	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X		X	X	X	X	X	X	X	X	X	X	X	X	X
P. arenatus																												X		
A. pseudomaculatus					X														(X)											
S. dumerili																		X	X	X		X	X	X						
L. campechanus																												(X)	(X)	(X)
L. griseus	X	X	X		X	X	X	X	X		X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
L. synagris																							(X)	(X)				(X)		
O. chrysurus																											(X)			
H. aurolineatum			X	X		X													(X)	(X)	(X)	(X)	(X)			(X)	(X)	(X)	(X)	
H. plumieri	X	X	X		X	X	X	X	X		X	X	X	X	X	X			(X)	X		X	X		X	X	X	X		
A. probatocephalus	X	X	X		X	X	X	X	X		X	X	X	X	X	X		X	X	X	X	X	X	X		X	X	X		X
C. proridens					X	X	X	X	X			X	X		X			X		X		X								
D. holbrooki		X	X																											
E. lanceolatus	X		X		X	X	X					X				X						(X)	(X)	(X)			(X)	(X)		
E. umbrosus	X	X	X		X	X	X	X	X		X	X	X	X	X			(X)		(X)	(X)	(X)	(X)	(X)		(X)	(X)	X	X	X
O. dentex													X																	
P. maculatus																								X	X					
C. faber		X			X						X	X			X	X		X	X		X	X	X			X	X	X	X	
H. bermudensis	X	X	X		X	X	X	X	X		X	X	X	X	X	(X)	(X)	(X)	(X)	(X)	(X)	(X)	(X)	(X)	(X)	X	X	X	X	X
P. arcuatus		X				X	X									(X)	(X)	(X)	(X)	(X)	(X)	(X)	(X)		(X)	(X)	X	X		
C. capistratus							(X)											(X)	(X)	(X)	(X)	(X)	(X)	(X)	(X)	(X)	(X)	(X)	(X)	(X)
C. ocellatus	X	X	X		X		X	X	X		X		X	X	X			(X)	(X)	(X)	(X)	(X)	(X)		(X)	(X)	X	X	X	X
C. striatus																	(X)		(X)	(X)		(X)								(X)
A. saxatilis																			(X)			(X)								
C. scotti															X															
P. partitus																											(X)	(X)		
P. variabilis	X	X	X	X	X	X	X	X		X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X		X
H. bivittatus	X	X	X	X	X	X	X	X			X	X	X	X											(X)	(X)	(X)	(X)	(X)	(X)
H. caudalis			X		X		X				X	X																(X)		(X)
L. maximus	X	X	X	X	X	X	X	X	X				X	X	X							(X)	(X)	(X)	(X)	(X)	(X)	(X)		(X)
T. bifasciatum																			(X)	(X)										
N. usta		X	X				X		X			X													(X)					
S. croicensis																											(X)		(X)	(X)
S. barracuda													X					(X)	(X)											
O. aurifrons																													X	
E. pandionis											X																			
B. marmoreus	X	X	X	X	X	X	X	X	X		X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
H. geminatus													X									(X)	(X)							
C. pauciradiatus																X	X													
C. punctipectophorus													X		X													(X)		
G. macrodon		X	X																											
I. calliurus	X	X	X	X	X								X	X	X														(X)	
A. chirurgus							(X)											(X)	(X)	(X)	(X)	(X)	(X)	(X)	(X)	(X)	X	X	X	X

TABLE 10. SIGHTINGS OF FISHES AT SHALLOW-WATER REEFS (12-18 m) BEFORE AND AFTER THE 1971 SUMMER RED TIDE. PARENTHETICAL INSERTION OF OCCURRENCE DESIGNATIONS (X's) INDICATES THAT ONLY JUVENILE INDIVIDUALS WERE SIGHTED (Continued).

	Before Red Tide												Red Tide										After Red Tide							
	1970								1971												1972									
	M	J	J	A	S	O	N	D	J	F	M	A	M	J	J	A	S	O	N	D	J	F	M	A	M	J	J	A	S	O
A. coeruleus						(X)													(X)	(X)										
S. plumieri							X				X																		X	
A. schoepfi		X																												
B. capriscus	X	X	X			X	X		X		X	X	X	X	X			X	X	X	X	X	X		X	X	X	X		X
B. vetula																												X		
M. ciliatus						X		X																						
L. quadricornis		X																												
S. spengleri							X	X					X		X															X
C. schoepfi																X														

TABLE 11. TRANSECT COUNTS OF THE MOST COMMON REEF FISHES AT STATIONS 1 AND 2 EITHER BEFORE OR AFTER THE 1971 SUMMER RED TIDE. COUNTS ENCLOSED WITHIN PARENTHESES INDICATE THAT ONLY JUVENILES WERE SIGHTED. MULTIPLE MONTHLY COUNTS ARE SEPARATED WITH A SLASH.

		1970			1971								
	STA.	O	N	D	J	F	M	A	M	J	J	A	S
O. pardus	1								0	3	3	3	
	2	0	0	0	1		1/1	3/5			2	0/2	
E. cruentatus	1								0	0	0	0	
	2	0	0	0	0		0/0	0/0			0	0/0	
E. morio	1								7	4	0	0	
	2	7	8	5	3		0/3	0/1			9	0/0	
M. microlepis	1								11	5	8	3	
	2	6	16	3	19		5/9	4/4			4	4/0	
M. phenax	1								16	11	14	0	
	2	4	7	3	9		0/1	8/7			0	0/0	
S. subligarius	1								62	47	52	50	
	2	18	14	11	8		39/43	48/50			57	41/12	
R. maculatus	1								8	11	7	6	
	2	3	7	11	9		12/4	15/6			10	6/10	
L. griseus	1								28	18	22	1	
	2	10	8	9	11		14/12	29/62			8	0/5	
H. aurolineatum	1								0	0	0	0	
	2	26	22	6	0		0/0	0/0			0	0/0	
H. plumieri	1								40	28	37	46	
	2	22	18	17	38		17/7	15/6			14	0/0	
A. probatocephalus	1								7	6	9	24	
	2	1	7	16	1		9/1	6/6			7	4/0	
E. umbrosus	1								29	31	56	0	
	2	36	40	31	48		44/69	49/3			17	0/0	
H. bermudensis	1								11	6	5	1	
	2	5	16	12	14		13/1	24/19			6	0/0	
P. arcuatus	1								0	0	0	0	
	2	1	0	0	0		0/0	0/0			0	0/0	
C. capistratus	1								0	0	0	0	
	2	0	0	0	0		0/0	0/0			0	0/0	
C. ocellatus	1								6	3	3	0	
	2	0	2	6	2		5/4	4/0			2	0/0	
P. variabilis	1								55	43	46	3	
	2	17	18	9			18/16	33/39			37	4/2	
H. bivittatus	1								57	40	35	0	
	2	35	36	8	42		24/13	35/22			49	0/0	
L. maximus	1								8	5	4	0	
	2	8	26	20	33		21/13	8/14			5	0	
B. marmoreus	1								8	3	4	4	
	2	14	6	5	4		5/8	19/10			11	8/6	
A. chirurgus	1								0	0	0	0	
	2	0	(1)	0	0		0/0	0/0			0	0/0	
B. capriscus	1								6	0	4	5	
	2	1	9	0	12		4/3	4/2			2	0/0	

* Too numerous to be counted.

TABLE 11. TRANSECT COUNTS OF THE MOST COMMON REEF FISHES AT STATIONS 1 AND 2 EITHER BEFORE OR AFTER THE 1971 SUMMER RED TIDE. COUNTS ENCLOSED WITHIN PARENTHESES INDICATE THAT ONLY JUVENILES WERE SIGHTED. MULTIPLE MONTHLY COUNTS ARE SEPARATED WITH A SLASH. (Continued).

				1972									
	O	N	D	J	F	M	A	M	J	J	A	S	O
O. pardus	0	1	1	0	0	2		2	2	3	0		
	0/0	0	0		0	3	0			2	0		0
E. cruentatus	(2)	(3)	(4)	(10)	(3)	(8)		(7)	(6)	(11)	(14)		
	0/0	(1)	(8)		(8)	(12)	(8)			(7)	(15)		(13)
E. morio	0/0	0	0	0	0	1		0	0	6	8		
	0/0	0	0		0	0	0			0	4		4
M. microlepis	2	4	3	5	10	8		4	3	9	9		
	3/1	1	0		7	9	8			4	3		9
M. phenax	0	0	1	2	0	0		0	0	0	0		
	0/1	0	0		4	0	0			8	3		11
S. subligarius	9	11	26	25	49	27		17	20	14	16		
	18/6	12	10		70	61	23			69	31		28
R. maculatus	4	1	8	2	2	1		2	5	3	3		
	0/1	1	2		2	2	2			3	7		9
L. griseus	33	5	13	3	13	9		9	2	3	4		
	4/2	3	11		6	16	11			4	5		9
H. aurolineatum	0	(*)	(12)	(60)	(40)	(*)	(22)	(23)	(6)	0	(*)		
	(32/40)	0	(2)		(24)	(22)	0			(*)	0		(33)
H. plumieri	0	0	1	0	0	6		2	4	6	7		
	0/(40)	(1)	0		2	6	15			9	14		4
A. probatocephalus	1	2	2	2	4	1		0	3	1	9		
	0/3	5	2		4	1	1			2	1		4
E. umbrosus	(1)	0	(1)	(8)	(61)	(46)		(31)	(34)	(45)	45		
	0/(1)	0	(2)		(28)	(24)	(18)			(15)	(54)		57
H. bermudensis	(3)	(2)	(1)	(2)	(2)	(1)		(6)	(6)	8	6		
	(2/1)	(4)	(5)		(10)	(10)	(8)			21	16		12
P. arcuatus	0	(1)	(2)	(2)	(2)	(1)		(2)	(3)	(2)	(2)		
	(1/4)	(6)	(3)		(3)	(5)	(4)			3	2		2
C. capistratus	(2)	(1)	(1)	(2)	(2)	0		0	(2)	(1)	(2)		
	(2)	(1)	0		(3)	(1)	(3)			(3)	(5)		(3)
C. ocellatus	(4)	(7)	(5)	(10)	(14)	(19)		(7)	(8)	4	3		
	(8/7)	(6)	(8)		(14)	(15)	(14)			3	2		3
P. variabilis	6	4	7	4	9	8		5	8	8	11		
	1/6	12	23		13	29	17			28	23		
H. bivittatus	0	0	0	0	0	0		(7)	(*)	(14)	(18)		
	0/0	0	0		0	0	0			(18)	(19)		(74)
L. maximus	0	0	0	0	0	0		0	(1)	0	(3)		
	0/0	0	0		(1)	(2)	(1)			(2)	(1)		(2)
B. marmoreus	2	3	4	13	2	9		7	7	19	20		
	3	5	4		4	7	6			16	15		13
A. chirurgus	(2)	(6)	(10)	(4)	(2)	(10)		(7)	(9)	(9)	9		
	(2/3)	(6)	(6)		(4)	(9)	(11)			2	9		10
B. capriscus	2	3	3	1	2	7		8	13	1	0		
			1		0	2	3			1	4		4

* Too numerous to be counted.

shoreward expansion of several deep-water species' ranges possibly reflects relaxed competition from congeneric and/or ecologically similar species exterminated or decimated at shallow-water reefs during the red tide. In support of this, juvenile red snapper *Lutjanus campechanus* only became established at shallow reefs unoccupied by remnant populations of gray snapper *Lutjanus griseus*.

IMPACT OF PREVIOUS RED TIDES ON EASTERN GULF REEF COMMUNITIES

Direct SCUBA observations at mideastern Gulf reefs both before and after the 1971 red tide indicate that, under the appropriate environmental conditions, certain *G. breve* blooms are capable of exterminating reef biotas from large segments of West Florida Shelf. Seasonal progression as well as true ecological succession following reef kills may result in a procession of qualitatively and quantitatively distinct biotas. In strong contrast, earlier predictions assumed that the effects of red tide are "negligible and short-lived" (Springer and Woodburn, 1960), "only temporarily affect inshore and nearshore reef fisheries" (Steidinger and Ingle, 1972), and that the "percentage kill is undoubtedly low" (Rounsefell and Nelson, 1966).

The severity of the 1971 red tide is probably not unprecedented, merely underestimated. The present study as well as Project Hourglass (Joyce and Williams, 1969) indicate that thermoclines may persist late into the year, especially in deep water, and that isothermy may not occur until late summer. Consequently, hydrological conditions presumably favored anoxia in bottom waters during past red tides, particularly those starting or re-initiated during spring-summer (e.g., 1947, 1954, and 1967).

Eyewitness reports and indirect evidence also suggest that events similar to those witnessed during the 1971 red tide have occurred in the past. Springer and Woodburn (1960) related reports that the southern seabass, *Centropristis melana*, was common at nearshore reefs off Tampa Bay prior to the 1957-58 red tide, but rarely caught thereafter. Local fishermen also noted the red grouper *Epinephelus morio* to be more abundant than the gag grouper *Mycteroperca microlepis* prior to the 1957-58 red tide; two years later, however, Springer and Woodburn (1960) found *M. microlepis* to be more abundant at local reefs. This seeming discrepancy is consistent with differential mortalities of *E. morio* and *M. microlepis* following the 1971 red tide. At shallow reefs, *E. morio* populations were completely exterminated but *M. microlepis* survived as remnant populations, thereby gaining a distinct numercial advantage during early stages of ichthyofaunal colonization. Captain Andrew Rassmussen (personal communication) recollected that the hogfish *Lachnolaimus maximus* was not represented in inshore partyboat catches off Cortez, Florida, for 3-4 years following the 1957 red tide. Local fishermen have reported that certain reef areas "have the characteristics of productive (i.e., hard) bottom" in fathometer traces but are "notoriously unproductive", possibly representing "dead bottom" areas resulting from red tide (Moe, 1963). A considerable quantity of dead sponges and alcyonarian corals observed at a reef site (28°18′N, 83°24′W) off Tarpon Springs, Florida, was thought to be linked to red tide conditions and fish mortalities persisting from November 1946 to August 1947 (Anonymous, 1948). An anonymous account deposited in the FDNRMRL archives described fish kills and the presence of a "milky substance which gave the appearance of a thickly matted spider web spread in all directions" in 32 m (105 ft) off Panama City, Florida. The physical appearance of the water, sluggish behavior of bottomfishes, and other associated observational data are reminiscent of conditions which prevailed during the 1971 red tide. That red tides occur off northwest Florida was first documented during July 1964 when *G. breve* blooms, discolored waters, and dead fishes were detected off Apalachee Bay (Steidinger and Joyce, 1973).

Data analyses for two severe red tides (1947 and 1953) revealed landings of commercial and sport fishes to be relatively unaffected (Springer and Woodburn, 1960; Steidinger and Ingle, 1972). However, the relationship of red tide to Gulf reef fisheries requires re-evaluation. Following the 1971 red tide, for example, Sarasota-based partyboats expended greater fishing effort further offshore at unaffected reefs, thereby maintaining catches satisfactory to their patrons. Since these offshore, deep-water reefs yielded more fishes and a greater incidence of large fishes, the local sports fishing catch may have even featured an increase following the red tide. Most commercial fishermen are not directly affected by red tides since most occur inshore of their regular fishing grounds. Some, however, believe their future fishing success to be adversely affected by red tides due to reduced recruitment through extermination of small groupers or depletion of breeding stock at shallower, inshore reefs (Moe, 1963).

GEOGRAPHIC RELATIONSHIPS OF THE EASTERN GULF OF MEXICO REEF ICHTHYOFAUNA

Before 1960, few detailed, long-term studies had been conducted on Western Atlantic reef-fish assemblages. Fragmentary checklists based on a single collection or cruise or from taxonomic literature restricted to a particular group of organisms made it difficult to formulate valid distributional conclusions. Accordingly, many unnatural or artificial faunal regionalizations have been proposed.

Recently, however, numerous in situ SCUBA observations and collections of reef fishes have been completed at widely scattered localities in the Western Atlantic Ocean. As a result, rather complete ichthyofaunal checklists now exist for representative reef environments in the Florida Keys (Longley and Hildebrand, 1941; Starck, 1968), northwestern Gulf of Mexico (Causey, 1969; Cashman, 1973; Bright and Cashman, 1974), Bahamas (Böhlke and Chaplin, 1968), and West Indies (Randall, 1968). Although reef ichthyofaunas are not as well known, additional investigations in the southwestern Gulf of Mexico (Hildebrand et al., 1964; Chavez, 1966; Resendez, 1971; Cashman, 1973) and western Caribbean (Caldwell et al., 1959; Caldwell, 1963b; Birdsong and Emery, 1967;

Cashman, 1973; Colin, 1974) have been of tremendous importance as bases for future work. All these studies have contributed immensely to understanding reef-fish distributions and the mechanisms effecting these distributions. It should be realized, however, that in regions where reef ichthyofaunas are still poorly known (e.g., southwestern Gulf of Mexico and western Caribbean), zoogeographic relationships are tenuous and may be considerably modified as new distributional evidence is accumulated.

I have qualitatively compared the eastern Gulf of Mexico (Cape Sable to Cape San Blas, Florida) ichthyofauna with that of the northeastern Gulf (Cape San Blas, Florida, to the Mississippi Delta), northwestern Gulf (Mississippi Delta to Cabo Rojo, Mexico), southwestern Gulf (Cabo Rojo to Cabo Catoche, Mexico), western Caribbean (Cabo Catoche to Gulf of Venezuela), Florida Keys and southeast Florida Shelf (Dry Tortugas to Cape Kennedy), Atlantic seaboard (Cape Kennedy to Cape Hatteras, North Carolina), Bermuda, and the West Indies (Table 12). Geographic distributions of reef fishes have been compiled from faunistic treatments, unpublished manuscripts including theses and dissertations, museum collection records at FDNRMRL (FSBC) and University of Miami (UMML), and ranges cited in the most recent and widely accepted taxonomic publications available. All publications from which distributional information was extracted are listed in the Selected References section.

TABLE 12. GEOGRAPHIC DISTRIBUTION OF EASTERN GULF OF MEXICO (CAPE SABLE TO CAPE SAN BLAS, FLORIDA) REEF FISHES REPORTED DURING THE PRESENT STUDY. 1 = SE UNITED STATES COAST (CAPE HATTERAS, NORTH CAROLINA TO CAPE KENNEDY, FLORIDA), 2 = SOUTH FLORIDA SHELF (CAPE KENNEDY TO CAPE SABLE, FLORIDA, INCLUDING THE FLORIDA KEYS), 3 = NORTHEASTERN GULF SHELF (CAPE SAN BLAS, FLORIDA TO MISSISSIPPI DELTA), 4 = NORTHWESTERN GULF SHELF (MISSISSIPPI DELTA TO CABO ROJO, MEXICO), 5 = SOUTHWESTERN GULF SHELF (CABO ROJO TO CABO CATOCHE, MEXICO), 6 = WESTERN CARIBBEAN SHELF (CABO CATOCHE, MEXICO TO GULF OF VENEZUELA), 7 = WEST INDIES (INSULAR LOCALITIES WITHIN THE CARIBBEAN SEA, INCLUDING THE BAHAMAS), 8 = BERMUDA

Species	1	2	3	4	5	6	7	8	Remarks
Ginglymostoma cirratum	X	X	X	X	X	X	X	X	
Gymnothorax moringa	X	X	X	X	X	X	X	X	
Synodus intermedius	X	X	X	X	X	X	X	X	
Trachinocephalus myops	X	X	X	X	X	X	X	X	
Opsanus pardus	X		X	X					
Gobiesox strumosus	X	X	X	X	X	X		X	
Antennarius ocellatus	X	X	X	X	X	X	X		
Ogcocephalus radiatus		X		X			X		
Ogilbia cayorum		X	X	X	X	X		X	
Holocentrus ascensionis	X	X	X	X	X	X	X	X	
Holocentrus bullisi	X	X	X		X	X	X	X	
Centropomus undecimalis	X	X	X	X	X	X	X		
Centropristis melana			X		?				Bullis and Thompson (1965) list *C. melana* from a single collection from off Campeche, Mexico. This record is considered doubtful. Gulf of Mexico endemic.
Centropristis ocyurus	X	X	X	X	X				
Diplectrum formosum	X	X	X	X	X	X	X		
Epinephelus adscensionis	X	X	X	X	X	X	X	X	
Epinephelus cruentatus		X	X	X	X	X	X	X	
Epinephelus drummondhayi	X	X	X	X				X	
Epinephelus fulvus	X	X	X		X	X	X	X	
Epinephelus guttatus	X	X	X	X	X	X	X	X	
Epinephelus itajara	X	X	X	X	X	X	X	X	
Epinephelus morio	X	X	X	X	X	X	X	X	
Thalassoma bifasciatum		X	X	X	X	X	X	X	
Nicholsina usta	X	X	X		X	X	X		
Scarus croicensis	X	X	X		X	X	X	X	
Sphyraena barracuda	X	X	X	X	X	X	X	X	
Opistognathus aurifrons		X	X			X	X		
Opistognathus macrognathus		X	X		X	X	X		
Emblemaria pandionis		X		X		X	X		
Labrisomus haitiensis		X				X	X		
Blennius marmoreus	X	X	X	X	X	X			
Hypleurochilus geminatus	X	X	X				X		

TABLE 12. GEOGRAPHIC DISTRIBUTION OF EASTERN GULF OF MEXICO (CAPE SABLE TO CAPE SAN BLAS, FLORIDA) REEF FISHES REPORTED DURING THE PRESENT STUDY. 1 = SE UNITED STATES COAST (CAPE HATTERAS, NORTH CAROLINA TO CAPE KENNEDY, FLORIDA), 2 = SOUTH FLORIDA SHELF (CAPE KENNEDY TO CAPE SABLE, FLORIDA, INCLUDING THE FLORIDA KEYS), 3 = NORTHEASTERN GULF SHELF (CAPE SAN BLAS, FLORIDA TO MISSISSIPPI DELTA), 4 = NORTHWESTERN GULF SHELF (MISSISSIPPI DELTA TO CABO ROJO, MEXICO), 5 = SOUTHWESTERN GULF SHELF (CABO ROJO TO CABO CATOCHE, MEXICO), 6 = WESTERN CARIBBEAN SHELF (CABO CATOCHE, MEXICO TO GULF OF VENEZUELA), 7 = WEST INDIES (INSULAR LOCALITIES WITHIN THE CARIBBEAN SEA, INCLUDING THE BAHAMAS), 8 = BERMUDA (Continued).

Species	1	2	3	4	5	6	7	8	Remarks
Callionymus pauciradiatus		X					X	X	
Coryphopterus punctipectophorus		X	X	X					
Gobiosoma horsti		X			X	X	X		
Gobiosoma macrodon		X	X			X	X		
Gobiosoma oceanops		X		X	X	X			
Ioglossus calliurus	X	X	X	X					
Microbobius carri			X				X		
Acanthurus chirurgus	X	X	X	X	X	X	X	X	*A. chirurgus* probably exists only as juvenile populations in regions 1 and 4.
Acanthurus coeruleus	X	X	X	X	X	X	X	X	*A. coeruleus* probably exists only as juvenile populations in regions 1 and 3.
Scorpaena brasiliensis	X	X	X	X	X	X	X		
Scorpaena plumieri	X	X	X	X	X	X	X	X	
Aluterus schoepfi	X	X	X	X	X	X	X	X	
Balistes capriscus	X	X	X	X	X	X	X	X	
Balistes vetula	X	X	X	X	X	X	X	X	
Monacanthus ciliatus	X	X	X	X	X	X	X	X	
Lactophrys quadricornis	X	X	X	X	X	X	X	X	
Canthigaster rostrata	X	X	X	X	X	X	X	X	
Sphoeroides spengleri	X	X	X	X	X	X	X	X	
Chilomycterus schoepfi	X	X	X	X	X		X	X	
Equetus umbrosus	X	X	X	X					
Odontoscion dentex		X	X	X		X	X		
Pseudupeneus maculatus	X	X	X	X	X	X	X	X	
Chaetodipterus faber	X	X	X	X	X	X	X	X	*C. faber* introduced at Bermuda (Beebe and Tee-Van, 1970).
Centropyge argi		X		X	X	X	X	X	
Holacanthus bermudensis	X	X	X	X	X		X	X	
Holacanthus ciliaris	X	X	X	X	X	X	X		
Pomacanthus arcuatus	X	X	X	X	X	X	X	X	*P. arcuatus* introduced at Bermuda (Beebe and Tee-Van, 1970).
Pomacanthus paru		X	X	X	X	X	X	X	*P. paru* introduced at Bermuda.
Chaetodon capistratus	X	X	X		X	X	X	X	*C. capistratus* probably exists in regions 1 and 3 only as juvenile populations.
Chaetodon ocellatus	X	X	X	X	X	X	X	X	
Chaetodon sedentarius	X	X	X	X	X	X	X	X	
Chaetodon striatus	X	X	X			X	X	X	*C. striatus* probably exists in regions 1 and 3 as juvenile populations.
Adudefduf saxatilis	X	X	X	X	X	X	X	X	*A. saxatilis* probably exists in regions 1 and 3 as juvenile populations only.
Chromis cyaneus		X		X		X	X	X	
Chromis enchrysurus	X	X	X	X					
Chromis scotti	?	X	X	X	X	X	X		Struhsaker (1969) reported *Chromis insolatus* from the S.E. United States. This record probably refers to *C. scotti*.
Pomacentrus partitus		X	X	X	X	X	X		

TABLE 12. GEOGRAPHIC DISTRIBUTION OF EASTERN GULF OF MEXICO (CAPE SABLE TO CAPE SAN BLAS, FLORIDA) REEF FISHES REPORTED DURING THE PRESENT STUDY. 1 = SE UNITED STATES COAST (CAPE HATTERAS, NORTH CAROLINA TO CAPE KENNEDY, FLORIDA), 2 = SOUTH FLORIDA SHELF (CAPE KENNEDY TO CAPE SABLE, FLORIDA, INCLUDING THE FLORIDA KEYS), 3 = NORTHEASTERN GULF SHELF (CAPE SAN BLAS, FLORIDA TO MISSISSIPPI DELTA), 4 = NORTHWESTERN GULF SHELF (MISSISSIPPI DELTA TO CABO ROJO, MEXICO), 5 = SOUTHWESTERN GULF SHELF (CABO ROJO TO CABO CATOCHE, MEXICO), 6 = WESTERN CARIBBEAN SHELF (CABO CATOCHE, MEXICO TO GULF OF VENEZUELA), 7 = WEST INDIES (INSULAR LOCALITIES WITHIN THE CARIBBEAN SEA, INCLUDING THE BAHAMAS), 8 = BERMUDA (Continued).

Species	1	2	3	4	5	6	7	8	Remarks
Pomacentrus variabilis	X	X	X	X	X	X	X	X	
Halichoeres bivittatus	X	X	X	X	X	X	X	X	
Halichoeres caudalis	X	X	X	X	X	X			
Hemipteronotus novacula	X	X	X	X	X	X	X		
Lachnolaimus maximus	X	X	X	X	X	X	X	X	
Epinephelus nigritus	X	X	X	X	X				Smith (1971) rejects the Bermuda record of *E. nigritus*.
Hypoplectrus puella		X	X			X	X	X	
Mycteroperca bonaci		X	X		X	X	X	X	
Mycteroperca microlepis	X	X	X	X	X			X	
Myteroperca phenax	X	X	X		X	X			
Serranus subligarius	X	X	X	X					
Rypticus maculatus	X	X	X	X					
Priacanthus arenatus	X	X	X	X	X	X	X	X	
Pristigenys alta	X	X	X	X	X		X	X	
Apogon aurolineatus		X		X		X	X		Known from the northwestern Gulf only from a single juvenile specimen tenatively identified as *A. aurolineatus* by Hoese (1958).
Apogon pseudomaculatus	X	X	X			X	X	X	
Astrapogon alutus	X	X	X			X	X		
Phaeoptyx xenus		X	X				X		
Seriola dumerili	X	X	X	X	X	X	X	X	
Lutjanus campechanus	X	X	X	X	X				
Lutjanus cyanopterus	X	X	X	X	X	X	X		
Lutjanus griseus	X	X	X	X	X	X	X	X	
Lutjanus synagris	X	X	X	X	X	X	X	X	
Ocyurus chrysurus	X	X	X	X	X	X	X	X	
Rhomboplites aurorubens	X	X	X	X	X	X	X	X	
Haemulon aurolineatum	X	X	X	X	X	X	X	X	
Haemulon plumieri	X	X	X		X	X	X	X	*H. plumieri* introduced at Bermuda (Beebe and Tee-Van, 1970).
Archosargus probatocephalus	X	X	X	X	X				
Calamus bajonado	X	X	X		X	X	X	X	
Calamus proridens	X	X	X			X			
Diplodus holbrooki	X	X	X	X					
Equetus lanceolatus	X	X	X	X	X	X	X	X	

FLORIDA KEYS - SOUTHEAST FLORIDA

Qualitatively, the eastern Gulf of Mexico reef ichthyofauna is most closely allied to that of the Florida Keys and southeast Florida (north to Cape Kennedy) with 98 of its 101 species in common (Table 12). This affinity is not wholly unexpected since the south Florida ichthyofauna is transitional, largely comprised of post-glacial tropical immigrants of both insular and continental derivation (Starck, 1968) and extra-limital warm temperate elements (Herrema, 1974). Five species of eastern Gulf of Mexico reef fishes taken during the present study are Carolinian warm temperate elements which probably do not reach the Florida peninsular tip (*Opsanus pardus*, *Centropristis melana*, *Rypticus maculatus*, *Diplodus holbrooki*, and *Hypleurochilus geminatus*).

Starck (1968) reported 389 species of reef-associated fishes at Alligator Reef (Florida Keys) which compares with 198 species known from the West Florida Shelf (see Table 6). Groups of fishes with demersal eggs and abbreviated planktonic larvae (e.g., clinids, blenniids, gobiids, apogonids, and certain pomacentrids) are poorly represented in the eastern Gulf, possibly due to their inability to utilize current transport mechanisms. The absence of these groups most noticeably contributes to the reduced diversity of the eastern Gulf reef ichthyofauna when compared with that of the Florida Keys. However, other fishes are undoubtedly restricted from the eastern Gulf due to locally limiting conditions of substrate, sedimentation, minimum temperatures, and intense interspecific competition within this marginally tropical area.

Although the southeast Florida reef ichthyofauna contains at least 18 species demonstrating a Carolinian warm-temperate distribution (i.e., discontinuous around the south Florida peninsula) (Herrema, 1974), it is otherwise a diluted Florida Keys ichthyofauna and considerably more diverse than that of comparable latitude in the eastern Gulf of Mexico. Herrema (1974) recorded 206 primary reef-fish species off northern Broward and southern Palm Beach Counties, Florida, and concluded that this fauna is strikingly similar to that reported at Alligator Reef (Florida Keys) by Starck (1968). Christensen (1965) and Grant Gilmore (Harbor Branch Foundation, unpublished manuscript) realized that the tropical reef ichthyofauna persisted even further northward. Gilmore recorded 188 fish species, 159 considered "Caribbean reef fishes", from nearshore reefs (to 7 m depth) off Indian River. The success of this northerly displaced tropical reef ichthyofauna is largely due to the Florida Current nearshore in this region. In fact, Gilbert (1972) and Herrema (1974) suggested that the local influence of the Florida Current accounted for an abundance of certain fishes (e.g., *Centropyge argi, Chaetodon aculeatus, Hypoplectrus gemma, Lutjanus mahogoni*) greater than that in the Florida Keys. Herrema (1974) even reported three typically insular reef-fish species (*Apogon leptocaulus, Lipogramma trilineata*, and *Acanthemblemaria chaplini*) not known from the Florida Keys at reefs off Palm Beach, Florida. The Florida Current departs from the shoreline at Cape Kennedy resulting in a progressive subtraction and offshore displacement of the tropical reef ichthyofauna.

NORTHEASTERN GULF OF MEXICO

The eastern Gulf shares 92 reef-fish species with the northeastern Gulf (Table 12), those unknown from the northeastern Gulf being extra-limital tropical elements most abundant in the Caribbean continental (e.g., *Gobiosoma oceanops, G. macrodon*) or West Indian insular (e.g., *Chromis cyaneus, Centropyge argi, Emblemaria pandionis*) provinces. On the other hand, certain warm-temperate fishes of the northeastern Gulf are absent (e.g., *Stenotomus caprinus, Centropristis philadelphica*[1]) or uncommon (e.g., *Hypleurochilus geminatus, Diplodus holbrooki*) in the mideastern Gulf. There are certain tropical fishes represented as seasonal juvenile populations in the northeastern Gulf which are unrecorded from the eastern Gulf (e.g., *Pomacentrus fuscus, Holocentrus vexillarius, Abudefduf taurus*). Nearly all of these have been reported at shoreline jetties along the northwest Florida coast but are unknown from the natural reefs offshore (Hastings, 1972), suggesting the possibility of their occurence in the eastern Gulf if the appropriate habitats were sampled. A list of northeastern Gulf reef fishes presently unknown from the eastern Gulf is given in Table 13. Regarding resident reef populations, however, the northeastern Gulf ichthyofauna is not noticeably distinct from that of the eastern Gulf, any major difference being quantitative rather than qualitative. Topp and Hoff (1972) also remarked that flatfish assemblages of the northeastern and eastern Gulf were unusually similiar in species composition and relative abundance.

Recent results emphasizing the similarity of eastern and northeastern Gulf ichthyofaunas (Cashman, 1973; Smith and Ogren, 1974; Bright and Cashman, 1974) largely refute earlier speculations (Caldwel and Briggs, 1957; Briggs and Caldwell, 1957; Caldwell, 1959; Briggs, 1973) that a rather anomalous tropical ichthyofauna supplements a more characteristic warm-temperate ichthyofauna in the northeastern Gulf. The seasonal success of these tropical reef fishes has been attributed to suitable benthic habitats and regular recruitment from a tropically-derived ichthyoplankton (Haburay et al., 1969). Similarly, Work (1969) portrayed a more tropical molluscan fauna in the northeastern Gulf (Clearwater to St. Marks) than along southwest Florida. These distributional anomalies reflect sampling artifacts accentuated by prevailing local hydrologic and physiographic features which merely make the fauna more accessible and, therefore, apparent to shoreline collectors. Relatively nearshore deepwater (DeSoto Canyon) and well-developed onshore currents in northeastern Gulf between Panama City and Destin result in a seasonal (summer-fall) shoreward displacement of tropical reef fishes. The local oc-

[1]Although Miller (1959) cites the Gulf of Mexico range of *C. philadelphica* as Brownsville, Texas to Cape Haze, Florida (eastern Gulf), neither his Figure 5 (p. 42) depicting the distribution of *C. philadelphica* nor his "Material Examined" include any eastern Gulf records. This fact and the absence of *C. philadelphica* in any eastern Gulf checklists suggest its absense or adventitious occurence there.

TABLE 13. A LIST OF NORTHEASTERN GULF REEF FISHES UNRECORDED FROM THE EASTERN GULF

Holocentrus vexillarius	*Bodianus pulchellus*
Centropristis philadelphica	*Bodianus rufus*
Lutjanus apodus	*Doratonotus megalepis*
Epinephelus inermis	*Scarus guacamaia*
Stenotomus caprinus	*Pomacentrus fuscus*
Mulloidichthys martinicus	*Sparisoma aurofrenatum*
Abudefduf taurus	*Sparisoma chrysopterum*
Acanthurus randalli	

currence of these tropical fishes at shoreline jetties along northwest Florida should not and does not preclude the occurrence of most of these same species at deeper reefs somewhat further offshore along the Florida west coast. In light of Springer and Woodburn's (1960) report of reef fishes off Tampa Bay, Caldwell (1963a) modified some of his earlier zoogeographic views to include the possibility of spawning populations of deep-water reef-fish populations on the West Florida Shelf (rather than exclusively a Caribbean-West Indian recruitment) to account for the seasonal appearance of juvenile tropical fishes along the northwest Florida coast. Walls (1975:19) recognized that offshore, resident populations within the Gulf of Mexico "serve as the source for the rare, tropical stragglers over the rest of our shores, not the recruitment of fishes from the reefs of the Caribbean." Hastings (1972) documented year-round occurrence of adults of many of these tropical species at offshore reefs in the northeastern Gulf of Mexico. Similarly, Work's (1969) "disjunct *Astraea* zone" between Clearwater and St. Marks merely reflects greater availability of rocky substrates, particularly inshore, in that region. However, I have collected all Work's indicator species of the disjunct tropical zone from scattered patch reefs between Sarasota and Ft. Myers off southwest Florida. On this basis, this disjunct "*Astraea* zone" reportedly harboring tropical species not found in the southeastern Gulf is less real than apparent and more quantitative than qualitative. Admittedly, the greater amount of "reef" substrate in the northeastern Gulf contributes to a more abundant and evident reef biota. However, since rocky outcroppings are a variably common shelf feature from the Florida Keys to Pensacola in the northeastern Gulf (Moe, 1963), there is no reason to suspect qualitative differences among reef biotas in this region. There are no physical barriers tending to localize and restrict populations of reef organisms.

NORTHWESTERN GULF OF MEXICO

There has been much controversy regarding the discreteness of the northwestern and northeastern-eastern Gulf of Mexico biotas. Baughman (1950a, 1950b) attributed the apparent exclusiveness of the northeastern and northwestern Gulf faunas to the "silt laden flood of the Mississippi" or a hypothetical "peninsular barrier, in past geologic epochs, between Cape San Blas and Mobile Bay." Hubbs (1963, 1965) correlated the conspicuous absence of certain fishes in the northwestern Gulf with a deficiency of calcareous coarse sediments. Similarly, Briggs (1958) intimated that much of the difference in ichthyofaunal composition was due to an absence of sponge and coral biotopes in the northwestern Gulf. "In the northern Gulf, there is some indication of speciation within warm-temperate genera" (Briggs, 1974:221) resulting in western and eastern Gulf forms which are largely allopatric. In most instances, slight overlap in the ranges of these species pairs has been noted, but the particular area of overlap does not occur in the same section of northern Gulf (Briggs, 1974). Within the menhaden genus *Brevoortia*, *B. gunteri* is found in the western Gulf and *B. smithi* in eastern Gulf (Dahlberg, 1970). Springer (1959) reported that the blenniid genus *Chasmodes* is represented in the western Gulf by *C. bosquianus* and *C. saburrae* in the eastern Gulf; both species are sympatric in the north-central Gulf. Among the puffers, *Sphoeroides parvus* inhabits the western Gulf and *S. nephelus* the eastern Gulf; both species occur between the Mississippi Delta and Cape San Blas, Florida, in the northern Gulf (Shipp and Yerger, 1969). Dawson (1964) also found the region between the Mississippi Delta and Cape San Blas to be occupied by two species of the flatfish genus *Gymnachirus*; however, *G. texae* extended its distribution westward and *G. melas* its distribution eastward in the northern Gulf.

Hildebrand (1954) suspected little endemism in the ichthyofaunas of either the western or eastern portions of the Gulf of Mexico, believing any noticeable difference to be one of relative abundance rather than absolute species composition. Many species which Baughman (1950a) cited as evidence of the discreteness of these ichthyofaunas have subsequently proved conspecific. Topp and Hoff (1972) noted a certain dissimilarity in flatfish assemblages of the North Florida and Northwest Gulf Shelves "where the distinction between biogenous and terrigenous sediments is clear-cut", but minimized the effect of the Mississippi Delta as a zoogeographic barrier, reporting a 62% coincidence in northeastern and northwestern Gulf of Mexico flatfish species. Of 108 species listed by Briggs (1958) as occurring in the northeastern but not northwestern Gulf, two are based upon erroneous reports and are not known from Florida, and six do not appear in Bailey et al.'s (1970) list of fishes from the United States and Canada (Cashman, 1973). Of the remaining 100 species, 44 have subsequently been taken in the northwestern Gulf of Mexico (Cashman, 1973). Most of these northwestern Gulf records consist of tropical reef fishes inhabiting rocky prominences and snapper "lumps" which occur spottily throughout the northwestern Gulf (Hoese, 1958; Briggs et al., 1964; Moseley, 1966a; Causey, 1969; Cashman, 1973; Bright and Cashman, 1974).

Recent in situ SCUBA observations of reef ichthyofaunas in the eastern (Springer and Woodburn, 1960; present study), northeastern (Hastings, 1972), and northwestern Gulf of Mexico (Causey, 1969; Cashman, 1973; Bright and Cashman, 1974) have emphasized their similarities rather than differences. The eastern and northwestern Gulf of Mexico reef ichthyofaunas feature 77 coincident species (Table 12). Of the primary reef fishes resident at Seven and One-Half Fathom Reef off Texas (Causey, 1969), only three (*Mycteroperca rubra*, *Microspathodon chrysurus*, and *Labrisomus nuchipinnis*) are presently unreported from the West Florida Shelf. Two additional species (*Apogon maculatus* and *Eupomacentrus dorsopunicans* [= *Pomacentrus fuscus*]) are known only from the West Florida Shelf as seasonal stragglers. The yellowtail hamlet *Hypoplectrus chlorurus* (Serranidae) is rare at rocky wharves along the southern Texas coast (Wall, 1975). With these exceptions, comparison of shallow-water ichthyofaunas of eastern and northwestern Gulf patch reefs reveals a striking similarity in both species composition and relative abundance (Causey, 1969; personal communication).

The eastern Gulf reef ichthyofauna may ultimately prove to be more diverse than that of the northwestern Gulf due to enrichment by tropical species. However, recent investigations at West Flower Garden Reef off Texas have revealed numerous tropical reef fishes previously unknown from the northwestern Gulf of Mexico (Cashman, 1973; Bright and Cashman, 1974). Buffered environmental conditions associated with the offshore location of the Flower Garden Reef permit occupation by certain stenoecious fishes of Caribbean-West Indian extraction which may be excluded from most other areas on the Texas Shelf. In this respect, the situation at West Flower Garden Reef is similar to that of the Florida Middle Ground on the West Florida Shelf (Smith and Ogren, 1974). Of 90 primary reef-fish species reported at the Texas West Flower Garden Reef (Cashman, 1973), 30 are not known from the West Florida Shelf (Table 14). It is predicted, however, that additional collecting at deep-water reefs of the West Florida Shelf (particularly the Florida Middle Ground) will uncover many of these species.

Even though qualitative differences between the northwestern and northeastern Gulf of Mexico reef ichthyofaunas are less than previously ascribed, certain distributional patterns indicate at least some ichthyofaunal distinctness. Three species of apogonids (*Phaeoptyx xenus*, *Apogon pseudomaculatus*, and *Astrapogon alutus*) common on the West Florida Shelf are unknown from the Texas Shelf. A fourth eastern Gulf species, *Apogon aurolineatus*, is known from the northwestern Gulf by a single juvenile specimen only tenatively identified as this species (Hoese, 1958). On the other hand, resident populations of *Apogon maculatus* and *Apogon townsendi* are known from the northwestern but not northeastern Gulf. With exception of *A. townsendi*, all these apogonid species are fairly common in their respective Gulf areas. Also, since poison collections were employed at reef sites on the Texas Shelf (Causey, 1969; Cashman, 1973; Bright and Cashman, 1974) and West Florida Shelf (Springer and Woodburn, 1960; present study),

TABLE 14. TEXAS WEST FLOWER GARDEN REEF FISHES (CASHMAN, 1973); BRIGHT AND CASHMAN, 1974) PRESENTLY UNKNOWN FROM THE WEST FLORIDA SHELF.

Moringua edwardsi	*Holocentrus rufus*	*Apogon townsendi*
Kaupichthys nuchalis	*Plectrypops retrospinus*	*Haemulon melanurum*
Enchelychore sp.	*Liopropoma rubre*	*Chaetodon aculeatus*
Holocentrus poco	*Rypticus subbifrenatus*	*Chromis multilineatus*
Pomacentrus planifrons	*Halichoeres garnoti*	*Ophioblennius atlanticus*
Microspathodon chrysurus	*Halichoeres maculipinna*	*Coryphopterus thrix*
Amblycirrhitus pinos	*Scarus taeniopterus*	*Gnatholepis thompsoni*
Clepticus parrai	*Scarus vetula*	*Lythrypnus phorellus*
Acanthurus bahianus	*Quisquilius hipoliti*	*Lythrypnus spilus*
Scorpaenodes caribbaeus	*Melichthys niger*	*Diodon holacanthus*

this disparity in Gulf apogonid ichthyofaunas is undoubtedly real. The distribution of apogonids in the Gulf of Mexico might be related to their limited mobility, both as juveniles and adults. Oral brooding seems more characteristic than exceptional in apogonids (Böhlke and Chaplin, 1968), suggesting that the larvae might be fairly well developed upon hatching and probably have an abbreviated or nonexistent planktonic stage. If this assumption is correct, their localized distribution in the Gulf might be explained by their inability to cross distributional barriers. *Phaeoptyx xenus*, *Astrapogon alutus*, and *Apogon pseudomaculatus* have possibly entered the northeastern Gulf, via the West Florida Shelf, from the Florida Keys but are prevented from occupying the Texas Shelf due to lack of reef biotopes in the north-central Gulf. The clockwise circulation of the Loop Current possibly further retards northwestern Gulf recruitment of northeastern Gulf ichthyoplankton. *Apogon maculatus* and *Apogon townsendi* are known from the southwestern Gulf and western Caribbean and have presumably reached the Texas Shelf via the Mexican Shelf. While this theory adequately explains the absence of three eastern Gulf apogonids from the northwestern Gulf (*P. xenus*, *A. pseudomaculatus*, and *A. alutus* are unknown from the southwestern Gulf), it does not account for the absence of the two northwestern Gulf species (*A. townsendi* and *A. maculatus*) from the northeastern Gulf. Starck (1968) reported both *A. townsendi* and *A. maculatus* from Alligator Reef in the Florida Keys. This piece of evidence together with the fact that *A. maculatus* seasonally occurs as juvenile populations along the Florida northwest coast (Hastings, 1972) suggests that ecological rather than physiographic barriers prevent establishment of resident adult populations of these species on the West Florida Shelf.

As additional evidence that different colonization corridors may contribute to a certain distinctness in northeastern and northwestern Gulf reef ichthyofaunas is the fact that other fish families exhibiting reduced vagility (e.g., clinids, gobiids, certain pomacentrids) demonstrate the greatest sectional differences in species composition. However, certain other fishes which might be expected to be more widespread throughout the northern Gulf occur in only one-half or the other. The pomadasyid *Haemulon plumieri*, for example, is abundant on the West Florida Shelf but unknown from the Texas Shelf whereas *Haemulon melanurum* is known only from the western half of the Gulf even though it is reported common at West Flower Garden Reef off Texas (Cashman, 1973; Bright and Cashman, 1974). Even though such distributions are less easily explained, it still seems likely that the north-central Gulf barrier somehow contributes to their separation. At least the occurrence of nearly all northwestern Gulf reef fishes in the southwestern Gulf suggests operation of the Mexican colonization corridor and north-central Gulf barrier rather than ecological barriers.

That ecological factors operate to some extent in the maintenance of distinctive northwestern and northeastern Gulf reef ichthyofaunas is suggested by those fishes common to both areas but tremendously more abundant in one or the other. Consider, for example, the red grouper *Epinephelus morio* which is one of the dominant serranids on the Yucatan and West Florida Shelves but exceedingly rare off Texas. Familiarity with habitat preferences of the red grouper provides a plausible explanation. Unlike most other groupers, particularly *Mycteroperca*, the red grouper prefers irregular limestone bottoms of low relief rather than reef ledges. Large expanses of this habitat are available on the West Florida and Yucatan Shelves but nearly absent on the Texas Shelf. Reef habitats in the northwestern Gulf consist primarily of discontinuous high-relief structures (e.g., Seven and One-Half Fathom Reef, West Flower Garden Reef, Stetson Bank). Though emphasizing their similarity, Cashman (1973:193) correctly stated that Texas and west Florida reef ichthyofaunas could not be expected to be identical because "temperature, sediments, currents, and reef structure lend a distinctive nature to each reef habitat, thus, though the species complement may be identical, the actual structure of the populations will vary from site to site and most assuredly from extremes of one major section of the Gulf to the next."

In summary, greater compositional similarity exists between the reef ichthyofaunas of the Texas and West Florida Shelves than previously indicated. Quantitative sectional differences that exist can, in many instances, be explained by ecological differences between the two areas. However, for certain groups (especially those less vagile), qualitative differences exist that can be accounted for by different colonization corridors and dearth of reef biotopes in the north-central Gulf of Mexico. For soft substrate-inhabiting fishes, an obvious faunal "break" exists between the Mississippi Delta and Cape San Blas, Florida. This faunal discontinuity may be related to the transition from the muddy waters west of Mobile Bay to clear waters of northwest Florida and gradation from muddy-sand (western Gulf) to quartz-sand eastern Gulf) substrates.

SOUTHWESTERN GULF OF MEXICO

Seventy-five (75) of the 101 eastern Gulf of

Mexico reef fishes reported herein are also known from the southwestern Gulf of Mexico. A greater coincidence of species is expected when the ichthyofauna of the southwestern Gulf becomes better known. The similarity of the biotas of the Yucatan and West Florida Shelves has long been recognized. Agassiz (1878) suggested that the "fauna of the Yucatan Bank is identical with that of the Florida Bank, being characterized by the same species of echinoderms, molluscs, crustaceans, corals, fishes." While this is obviously an overstatement, a close faunal relationship does exist. Hubbs (1963, 1965) attributed the similarity of these faunas to bottom types of comparable geological origin and past history. Hildebrand et al. (1964) listed a 90% ichthyofaunal coincidence for Campeche and Tortugas (Florida), rationalizing the similarity on the basis of prevailing currents (west to east) and transport of ichthyoplankton. Miller (1969) suggested a subtraction of certain stenothermic elements from the Campeche deep-water ichthyofauna (> 30 m) due to seasonal cool-water upwelling. Gunter (1952) believed that from Tampico southward the fauna becomes progressively more tropical, similar to the situation occurring on the West Florida Shelf between Tampa Bay and Ft. Myers in the eastern Gulf of Mexico.

The majority of eastern Gulf reef fishes absent from the southwestern Gulf are of warm-temperate affinity (e.g., *Diplodus holbrooki*, *Hypleurochilus geminatus*, *Rypticus maculatus*, and *Opsanus pardus*) and certain West Indian (insular) tropical elements (e.g., *Ogcocephalus radiatus*, *Hypoplectrus puella*, *Apogon pseudomaculatus*, *Opistognathus aurifrons*, *Emblemaria pandionis*, and *Labrisomus haitiensis*). Many of the latter are species with limited vagility, but others are cryptic in their habits and their presence in the southwestern Gulf may have merely been overlooked.

That the southwestern Gulf reef ichthyofauna is more tropical than that of the eastern Gulf is suggested by the presence of 57 species unreported from the latter region (Table 15). Of these, 28 are contained in the families Clinidae, Blenniidae, and Gobiidae, all of which are composed of small fishes with abbreviated or non-existent planktonic stages and which do not range widely as adults.

WESTERN CARIBBEAN

Of 101 eastern Gulf reef fishes reported in this paper, 78 are recorded from the western Caribbean (Table 12). Certain eastern Gulf tropical reef fishes not known from the northwestern or southwestern Gulf occur in the western Caribbean. At the same time, however, there is continued subtraction of temperate or temperate-like species which persisted in the southwestern Gulf (e.g., *Centropristis ocyurus*, *Serranus subligarius*) and loss of certain continental species (e.g., *Mycteroperca microlepis*, *Mycteroperca phenax*, *Lutjanus campechanus*). The absence of these continental species from the western Caribbean probably reflects the loss of the broad shelf along the Central American coast. Clear inshore waters, well-developed currents, and coral reefs favor occupation by insular fishes, many of which are geographical replacements of their continental counterparts.

Even though the western Caribbean ichthyofauna is poorly known, it is already proved to be far more diverse than that of the eastern Gulf. Miller (1969) included the western Caribbean within a warm-tropical or Antillean region because of greater species diversity than exhibited in cool-tropical regions to the north and south. Robins (1971) attributed this greater diversity to the fact that the western Caribbean is a mixing ground for many continental and insular species. Birdsong and Emery (1967) reported the clinids *Acanthemblemaria*, *Enneanectes*, *Emblemaria*, and *Malacoctenus*, previously known only from the Bahamas, at western Caribbean reef localities. Three collections at Glover's Reef (Belize) yielded 221 species of reef-dwelling fishes (Greenfield, 1973), far more than recorded for the entire West Florida Shelf! A total of 220 reef-associated fishes are known from Birdsong and Emery's (1967) and Cashman's (1973) collections in the northwestern Caribbean. Ichthyofaunal endemism, high species diversity, and records of species previously thought to be restricted to the Bahamas or other distant localities prompted Greenfield's (1973) suspicion that the Central American coast might be a major evolutionary center for the West Indian fish fauna.

WEST INDIES

The eastern Gulf of Mexico shares 79 of its 101 reef fishes with the West Indies (Table 12). Eastern Gulf temperate fishes (e.g., *Opsanus pardus*, *Centropristis melana*, *Rypticus maculatus*, *Diplodus holbrooki*) and tropical continental fishes (e.g., *Gobiosoma oceanops*, *Chromis enchrysurus*, *Equetus umbrosus*, *Mycteroperca phenax*) are subtracted from the West Indian ichthyofauna. In spite of this, regional coincidence remains high due to the eastern Gulf presence of certain West Indian (insular) elements (e.g., *Phaeoptyx xenus*, *Epinephelus fulvus*, *Emblemaria pandionis*, *Holacanthus ciliaris*, *Opistognathus aurifrons*), especially at deeper reefs. Briggs (1958) suspected a close relationship between the Florida and West Indian ichthyo-

TABLE 15. A LIST OF SOUTHWESTERN GULF REEF FISHES NOT KNOWN FROM THE EASTERN GULF (SPRINGER AND BULLIS, 1956; SPRINGER, 1959; CARRANZA, 1959; HILDEBRAND ET AL., 1964; CHAVEZ, 1966; RESENDEZ, 1971; CASHMAN, 1973).

MURAENIDAE	*Enchelycore nigricans*
	Muraena miliaris
ANTENNARIIDAE	*Antennarius multiocellatus*
HOLOCENTRIDAE	*Holocentrus coruscus*
	Holocentrus rufus
	Plectrypops retrospinis
SERRANIDAE	*Epinephelus striatus*
	Mycteroperca tigris
	Mycteroperca rubra
	Serranus tigrinus
GRAMMIDAE	*Gramma loreto*
APOGONIDAE	*Apogon binotatus*
	Astrapogon stellatus
LUTJANIDAE	*Lutjanus jocu*
POMADASYIDAE	*Haemulon bonariense*
	Haemulon carbonarium
	Haemulon flavolineatum
	Haemulon parrai
POMACENTRIDAE	*Chromis multilineatus*
	Microspathodon chrysurus
	Pomacentrus leucostictus
	Pomacentrus pictus
	Pomacentrus planifrons
SCARIDAE	*Scarus coeruleus*
	Scarus vetula
LABRIDAE	*Halichoeres garnoti*
	Halichoeres maculipinna
CLINIDAE	*Acanthemblemaria aspera*
	Emblemaria bahamensis
	Enneanectes boehlkei
	Labrisomus bucciferus
	Labrisomus gobio
	Labrisomus guppyi
	Labrisomus kalisherae
	Labrisomus nuchipinnis
	Malacoctenus aurolineatus
	Malacoctenus macropus
	Malacoctenus triangulatus
	Paraclinus marmoratus
	Paraclinus nigripinnis
	Starksia lepicoelis
	Stathmonotus stahli
BLENNIIDAE	*Blennius cristatus*
	Entomacrodus nigricans
	Ophioblennius atlanticus
GOBIIDAE	*Barbulifer ceuthoceus*
	Bathygobius curacao
	Coryphopterus dicrus
	Coryphopterus glaucofraenum
	Coryphopterus personatus
	Gnatholepis thompsoni
	Nes longus
	Lythrypnus phorellus
	Lythrypnus spilus
	Psilotris alepis
	Quisquilius hipoliti
ACANTHURIDAE	*Acanthurus bahianus*

faunas and computed a 68% ichthyofaunal coincidence value.

Many West Indian fishes are excluded from the Gulf of Mexico because their abbreviated or nonexistent pelagic eggs and larvae reduce the opportunity for planktonic recruitment via the Loop Current. Similarly, Starck (1968) reported that of 82 Bahamian reef fishes not reported at Alligator Reef (Florida Keys), approximately 51% were contained within the families Clinidae, Gobiidae, Apogonidae, and Gobiesocidae, all of which have rather limited abilities for dispersal. However, fishes such as the chaetodontids and acanthurids having protracted pelagic larval stages are well represented on the West Florida Shelf. Starck (1968) ascribed the inability of certain other West Indian fishes to colonize south Florida to ecological competition from continental species which are often geographical replacements. Other forms are excluded from south Florida and eastern Gulf of Mexico due to lack of water quality characteristics usually affiliated with the insular province. However, a greater incidence of insular species occurs on deep-water prominences (e.g., Florida Middle Ground) along the outer West Florida Shelf where waters of an oceanic nature, carbonate sediments, steep topographic profiles, and buffered environmental conditions are locally favorable. Many insular fishes inhabiting the Florida Keys are likely excluded from the Gulf of Mexico due to lowered sea temperatures during winter.

SOUTHEAST NORTH ATLANTIC COAST

Seventy-seven (77) reef fishes from the eastern Gulf of Mexico range northward of Cape Kennedy along the Atlantic coast into or throughout the Carolina warm-temperate region. This distributional pattern, however, does not necessarily reflect a Carolinian heritage for the West Florida Shelf ichthyofauna. Few species typify a Carolinian distribution; most are widely distributed throughout both temperate and tropical waters. Many species within this latter category are represented only as seasonal juvenile populations or stray adults wafted northward by the Gulf Stream Current (Smith, 1902a, 1902b) and probably fewer than 50 eastern Gulf reef fishes are resident north of South Carolina. Robins (1972) acknowledged that many elements of the tropical or subtropical continental ichthyofauna extend their distributions along the United States to the Carolinas or beyond only during summer. Many additional reef fishes restricted to deeper, offshore waters of the Carolina Shelf (Struhsaker, 1969) probably represent submergent tropical species rather than temperate or eurythermic species. Gilbert (1972) attributed the presence of resident populations of tropical reef species (e.g., *Holacanthus tricolor, Bodianus pulchellus, Myripristis jacobus, Holocentrus ascensionis*, and *Chaetodon sedentarius*) in deeper waters of the Carolina Shelf to cold winter temperatures inshore, moderating effects of the Gulf Stream and, less importantly, the paucity of favorable habitats inshore. Pearse and Williams (1951), in a general consideration of the reef biota off the Carolinas, concluded that species at "greater depths showed a slightly greater tendency toward a more southern distribution".

BERMUDA

Eastern Gulf of Mexico reefs share only 57 fishes with Bermuda. Eastern Gulf elements most noticeably lacking in Bermuda are warm-temperate, tropical continental (Caribbean), Gulf of Mexico endemic, and certain tropical insular (West Indian) species. These findings are consistent with Robin's (1971) suspicion that the Bermudan ichthyofauna is a "waif fauna derived from both the United States and from the Bahamas Islands." Despite its geographic isolation, Bermuda has evolved only a meager endemic (4%) ichthyofauna. Briggs (1966) attributes this low endemism to the insufficient time elapses since the Wisconsin glaciation, thereby limiting the recruitment and subsequent evolution of a highly distinctive ichthyofauna.

ZOOGEOGRAPHIC RELATIONSHIPS OF THE EASTERN GULF OF MEXICO REEF ICHTHYOFAUNA

Work (1969) presented an excellent synopsis and critical evaluation of zoogeographical literature of the Gulf of Mexico and Caribbean Sea. Briggs (1974) has since partitioned, on the basis of faunal endemism, the tropical Atlantic region into (1) a Caribbean Province including all shelf areas south of Cape Kennedy (Florida east coast), Cape Romano (Florida west coast) and Cabo Rojo (Mexico) to the Orinoco River Delta (Venezuela), (2) a West Indian Province including all insular localities within the Caribbean Sea, and (3) a Brazilian Province including shelf areas between the Orinoco River Delta and Cape Frio, Brazil. Other investigators (Miller, 1969; Robins, 1971, 1972; Gilbert, 1972) have also realized the distinctness of continental and insular ichthyofaunas. Miller (1969) recognizes three western Atlantic tropical regions: northern cool tropics, warm tropics (Antillean region), and southern cool tropics. His warm tropical or Antillean region, including Briggs' West Indian Province and the Central American shelf, harbors endemic species, causes disjunct Anti-Antillean distributions and isolates cognate species. Other investigators (Robins, 1971; Greenfield, 1973) have realized that the distinction between insular and continental ichthyofaunas may break down in areas where certain local conditions permit mixing (e.g., Florida Keys, Central American coast, and Cuba). The northern and southern cool tropical regions correspond in part to Briggs' Caribbean Province, but

Miller (1969) proposes the subdivision because of greater apparent species diversity in the southern areas. Robins (1971) also proposed a rather enigmatic Florida Keys-Central American distribution exhibited by certain groups insular in nature. However, subsequent disclosure of certain of these Keys-Central American distributional indicator species (e.g., *Gobiosoma oceanops*) in the eastern, northwestern, and southwestern Gulf of Mexico suggest a deep-water Caribbean (i.e., continental) rather than insular-like pattern of distribution. William Lyons (FDNRMRL, personal communication) believes that certain mollusks similarly demonstrate a deep-water continental distribution.

A major feature complicating distributional patterns of eastern Gulf of Mexico reef biotas is the broad West Florida Shelf extending to over 160 km off Tampa. Latitudinal zoogeographic boundaries are often of little significance in these areas because an entirely different faunal complex may be associated with more equable physicochemical and biological characteristics of outer shelf regions. Pulley (1952) suspected bathymetric submergence of tropical species and suggested that the offshore (> 42 m depth) Gulf of Mexico shelf fauna be considered a northerly extension of the West Indian bioregion. Humm and Taylor (1961) also recognized a transition from a seasonal warm-temperate flora to a more stable, perennial tropical flora with increased offshore distance and depth in the eastern Gulf. In spite of this, other investigators have overlooked bathymetric submergence of tropical populations and have proposed tropical-(or subtropical) temperate boundaries at various eastern Gulf shoreline localities including Cape Romano, Ft. Myers, Tampa Bay, Anclote Keys, and Cedar Keys (Work, 1969). While these proposed demarcations may or may not satisfactorily characterize inshore faunal assemblages, they usually have no application to offshore shelf regions. For example, although the shelf fauna off Cape Hatteras is broadly transitional, it can be partitioned into distinctive Virginian, Carolinian, and tropical bioregions with increasing offshore distance and depth (Cerame-Vivas, 1966). Similarly, Work (1969) noted that many West Indian molluscan species occur offshore to North Carolina even though this region is also the inshore limit of the warm-temperate Carolinian fauna. Resident populations of tropical reef fishes are known to exist in deeper waters as far north as Cape Hatteras (Anderson and Gutherz, 1964; Gilbert, 1972). It is therefore suggested that latitudinal zoogeographic boundaries are of limited value in situations where bathymetric gradients in physical, chemical, and biological parameters are associated with broad continental shelves.

Briggs (1958) stressed that the 20°C isocryme generally approximates the boundary between warm-temperate and tropical biotas. In the eastern Gulf of Mexico, however, Deevy (1950) figured the 70°F (21°C) isocryme near Cape Romano inshore but displaced to near the latitude of Tampa offshore. This dramatically illustrates that even though marine climate is one of the prominent features underlying the framework of plant and animal distributions, latitudinal considerations have often overridden an understanding of circulation and water masses, even though the latter may be more important in controlling marine climate than latitude (Cerame-Vivas, 1966).

Another factor adding confusion to zoogeographic relationships of the eastern Gulf biota is that many authors try to interpret distributions of entire biotas when, in fact, various taxa may feature differential responses to factors controlling distributions. Benthic algae of the eastern Gulf include a large and diverse tropical component, particularly in regions deeper than 27 m (Dawes and Van Breedveld, 1967). Likewise, gorgonian corals of the West Florida Shelf represent a "decimated West Indian assemblage" although temperate elements begin to appear near Tampa (Bayer, 1954). Topp and Hoff (1972) surmised that substrate characteristics profoundly affect benthic organism distributions, noting that eastern Gulf flatfishes are most closely allied to the "warm-temperate to subtropical fauna, closely resembling that of the so-called Carolinian sub-province (Cape Hatteras to south Florida), and rather distinctive from that of the Caribbean." In further contrast, the reef ichthyofauna of the eastern Gulf represents an admixture of temperate, tropical and eurythermic species with a progressive subtraction of temperate elements and diversification of tropical taxa in deeper, offshore shelf areas.

Generally, it appears that ecological groups within many taxa exhibit different distributions. Soft substrate faunas demonstrate predominately temperate affinities whereas the hard substrate "reef" fauna is comprised largely of species of Caribbean and West Indian derivation. Gulf of Mexico reef-fish faunas feature a greater incidence of tropical species than does the soft substrate fauna. This pattern may be due to the competitive superiority of a highly diverse coral reef ichthyofauna of the Caribbean and West Indies which would seem well adapted to occupation of rocky substrates on the West Florida Shelf. There would appear to be minimal competition for these "reef" habitats by a warm-temperate ichthyofauna largely dominated by soft substrate forms. Consistent with this speculation, Sekavec and Huntsman (1972) noted that "snappers, groupers, porgies, and grunts, typical of Caribbean and Bahama Banks" inhabit hard substrates on the Carolina Shelf. Pearse and Williams (1951) observed differential responses among various groups to parameters controlling their distributions and reported that hybroids, nemerteans, and fishes of the Carolina Shelf were broadly ranging (both north and south), bryozoans and echinoderms were species common from the Carolinas southward, and sponges and tunicates were largely conspecific with forms in Florida and the West Indies.

Another feature impeding generalizations on relationships of shelf faunas is a basic disagreement as to what constitutes a zoogeographically homogenous area. Briggs (1974) utilizes a qualitative index of faunal distinctness proposing that any areal fauna demonstrating 10% or greater endemism be considered provincially distinctive within a zoogeographic region. Topp and Hoff (1972) have suggested a quantitative approach, placing emphasis on relative abundance of species composition. A distinct disadvantage of utilizing qualitative criteria in a zoogeographic analysis is that it may result in artificial regionalizations, particularly where faunas are poorly known. For example, Starck (1968) reported that of 26 species (or synonyms thereof) of Alligator Reef fishes listed by Briggs (1958) as Florida endemics, only one (*Hypoplectrus gemma*) was still known only from Florida. More recently, Gilbert (1972) listed eight apparently Florida endemic reef or reef-associated fishes: *Hypoplectrus gemma* and *Liopropoma eukrines* (Serranidae), *Lythrypnus phorellus*, *Gobionellus stigmaturus* and *Ioglossus calliurus* (Gobiidae), *Starksia starcki* and *Emblemariopsis diaphana* (Clinidae) and the pomacentrid, *Chromis scotti* even though recently discovered in the Bahamas. Of these eight species, five have since been reported from the northwestern and/or southwestern Gulf of Mexico (Causey, 1969; Cashman, 1973). Briggs (1958) suggested that about 50 species of fish, largely of tropical derivation were relatively common on the Florida east coast but were restricted from the West Florida Shelf due to an absence of suitable substrate. When closer attention was accorded to the scattered patch reefs that do exist in the eastern Gulf, however, most of these species were found. Greenfield (1973) suggested that reef fish distributions in the tropical western Atlantic may be "wider than were [previously] believed, and that levels of endemism cited for a particular locality may simply be a function of intensive collecting." Species coincidence between the ichthyofaunas of the eastern Gulf of Mexico and selected other western Atlantic localities (Table 12) suggests both greater intra-Gulf homogeneity and Caribbean-West Indian affinity than previously recognized. On the other hand, Starck (1968) cautioned against using a quantitative index of faunal similarity because it may not consider variations in geography, hydrography, or biology of the reefs. That is, differences in faunal composition "may be regarded as ecological or quantitative rather than zoogeographic or qualitative" (Starck, 1968).

Evermann and Kendall (1900) partitioned the Gulf of Mexico ichthyofauna into three major constituents based upon known or suspected distributional patterns: (1) a small endemic component, (2) a temperate component, and (3) West Indian component. More recent distributional evidence (Miller, 1969; Robins, 1971; Gilbert, 1972; Briggs, 1974) indicates a distinction between a (3) West Indian or insular province and (4) Caribbean or continental province. An additional distributional pattern (5) exhibited by eastern Gulf fishes may be termed eurythermic to characterize species represented in both temperate and tropical regions. Briggs (1974) further subdivided this eurythermic category into a "eurythermic tropical" component for species extending from the tropics into warm-temperate waters and a "broad eurythermic tropical" component to include species ranging from the tropics into cold-temperate waters. Many Gulf of Mexico fishes conform to these eurythermic distributional patterns and may be the reason many authors have termed the offshore Gulf of Mexico as subtropical (Miller, 1969; Miller and Kent, 1971) rather than depauperate tropical. Definition of a subtropical region based on the predominance of species oftentimes as equally well represented in tropical as in temperate waters is deceptive. One must categorize a zoogeographic region on the basis of faunal distinctness. Robins (1972) realized that all shelf species cannot be categorized as "insular or northern or southern continental", but rather are cosmopolitan shore fishes found throughout the regions, thus providing a common element to both.

Of 101 eastern Gulf of Mexico reef fishes reported herein, the majority may be considered eurythermic in the sense that they range throughout both temperate and tropical waters. Of these, however, many are represented north of Florida only as seasonal juvenile populations displaced by the Gulf Stream (e.g., *Acanthurus coeruleus*, *Chaetodon striatus*, *C. ocellatus*, *C. capistratus*, and *Abudefduf saxatilis*). Numerous others reside as resident populations only at deep, offshore reefs within warm-temperate regions and more properly refer to submergent tropical rather than eurythermic elements (e.g., *Holocentrus ascensionis*, *Chaetodon sedentarius*, and *Epinephelus fulvus*).

Seven (7) eastern Gulf reef fishes typify (*Opsan-*

us pardus, *Centropristis melana*, *Rypticus maculatus*, *Diplodus holbrooki*, *Hypleurochilus geminatus*) or approximate (*Centropristis ocyurus*, *Serranus subligarius*) a Carolinian warm-temperate distribution. With exception of *C. ocyurus*, none of these species apparently range south of 24-26° N latitude. Although reported from Yucatan in the southwestern Gulf, *C. ocyurus* is most abundant in the northern Gulf and along the SE Atlantic coast of the United States (Miller, 1959). Geographically, certain other eastern Gulf reef fishes seem to conform to a temperate-like distribution (e.g., *Epinephelus drummondhayi*) but are deep-water fishes more accurately described as offshore, tropical continental.

Twenty-five (25) eastern Gulf reef fishes may be considered tropical in origin and do not range north of Florida (Table 16). Three (3) eastern Gulf reef fishes reported during this study are known only from the Gulf of Mexico and/or Florida Keys and SE Florida coast (*Centropristis melana*, *Chromis enchrysurus*, and *Coryphopterus punctipectophorus*). Of these, *C. melana* has evolved from its Atlantic cognate *C. striata* since the Florida peninsula separated the once contiguous Gulf-Atlantic warm-temperate ichthyofauna (Miller, 1959). Six of 15 Gulf of Mexico endemic fishes reported at Alligator Harbor were thought to be derived from Atlantic warm-temperate congeners (Joseph and Yerger, 1956). Topp and Hoff (1972) intimated that the present disjunct (i.e., northern Gulf-Atlantic coast) distribution of these geminate species may have been "generated either following periods of Pleistocene submergence of the Florida peninsula or following warmer interglacial periods when southerly displaced faunas retreated northward along either coast." However, more recent evidence does not indicate Pleistocene submergence of Florida (Briggs, 1974). Joseph and Yerger (1956) reported that 15 of 121 (12%) Alligator Harbor fishes are endemic to the Gulf of Mexico. Briggs (1974) suspected an overall 10% endemism for the Gulf of Mexico ichthyofauna. This rather low endemism for the Gulf ichthyofauna may "reflect prevailing environmental extremes, enabling the development of large populations of wide ranging species at the expense of indigenous forms" (Hedgpeth, 1953). Also, the Caribbean-derived Loop Current widely distributes ichthyoplankton throughout the Gulf making the possibility of geographic isolation and subsequent genetic differentiation remote.

A few Gulf of Mexico endemic reef fishes have undoubtedly evolved from widespread West Indian species and are prevented from reoccupying that region by the Florida Current barrier. Emery (1968) suspected that *Chromis scotti* might be a Florida endemic derived from its West Indian cognate *C. insolatus*. *Chromis scotti* is now known from certain West Indian localities (Colin, 1974) but its intrusion there might be secondary since its center of abundance seems to be the Gulf of Mexico. The distribution of *Chromis enchrysurus* and its West Indian counterpart *C. flavicauda* seems to be clearly allopatric and separated by the Florida Current. Smith (1971) believes that the Gulf Stream acts as faunal barrier separating Gulf of Mexico and West Indian centers of differentiation for the American groupers (*Epinephelus*) and allied genera. Lyons (1970) suggested the Florida Current as a possible mechanism preventing establishment of Spanish lobster *Scyllarides nodifer* populations in the West Indies.

Zoogeographic barriers such as the Florida Current may not be the only factors contributing to the distinctness of island vs. continental ichthyofaunas. Many groups of fishes known to range widely due to planktonic transport of their larvae (e.g., serranids) contain species pairs separated by the Florida Current. Robins (1971) maintained that the "ecology of an area and not physiographic barriers have resulted in the separation of the continental from the insular fauna." Robins noted that continental species may predominate at Cuba and

TABLE 16. A LIST OF TROPICAL REEF FISHES (I.E., THOSE NOT RANGING NORTH OF FLORIDA) OCCURRING IN THE EASTERN GULF OF MEXICO DURING THIS STUDY.

Ogcocephalus radiatus	*Chromis scotti*
Ogilbia cayorum	*Pomacentrus partitus*
Epinephelus cruentatus	*Thalassoma bifasciatum*
Hypoplectrus puella	*Opistognathus aurifrons*
Mycteroperca bonaci	*Opistognathus macrognathus*
Apogon aurolineatus	*Emblemaria pandionis*
Phaeoptyx xenus	*Labrisomus haitiensis*
Odontoscion dentex	*Callionymus pauciradiatus*
Centropyge argi	*Gobiosoma horsti*
Pomacanthus arcuatus	*Gobiosoma macrodon*
Pomacanthus paru	*Gobiosoma oceanops*
Chromis cyaneus	*Microgobius carri*
	Canthigaster rostrata

Hispaniola where shelf waters are broad and influenced by runoff, further suggesting that ecological rather than zoogeographic barriers may be operating. The presence of many "insular" reef fishes at offshore, deep-water banks ringing the Gulf of Mexico (Cashman, 1973; Smith and Ogren, 1974) also emphasizes that differences between continental and insular ichthyofaunas are often more quantitative than qualitative. Reef-fish species pairs demonstrating varying degrees of geographical replacement across the Florida Current include the serranids *Mycteroperca phenax* (continental) and *M. interstitialis* (insular), the gobiids *Ioglossus calliurus* (continental) and *I. helenae* (insular), the sciaenids *Equetus umbrosus* (continental) and *E acuminatus* (insular), the pomacanthids *Holacanthus bermudensis* (continental) and *H. ciliaris* (insular).

ZOOGEOGRAPHIC CONCLUSIONS

Although various zoogeographic boundaries have been proposed at various shoreline localities along the Florida west coast (Work, 1969), any major latitudinal discontinuity between warm-temperate and tropical reef ichthyofaunas probably does not exist. The transition between these zoogeographic regions is undoubtedly a broad one as "southern forms begin to appear irregularly and seasonally while the species diversity of northern fishes decreases" along a north to south gradient (Reid, 1954). In addition, there exists strong evidence to suggest that offshore reef habitats in the Gulf of Mexico (e.g., Flower Gardens and Middle Ground) are dominated by fishes of West Indian or Caribbean extraction (Hildebrand et. al., 1964; Austin, 1970; Cashman, 1973; Smith and Ogren, 1974). Work (1969) predicted that "continued collecting from the northeastern Gulf of Mexico, offshore banks in the northwestern Gulf of Mexico, and offshore banks of the Carolinas should eventually extend the ranges of many species of the West Indian fauna." Therefore, a demarcation between the warm-temperate and tropical faunas may be more closely correlated to bathymetric contours than latitudinal gradients. For example, offshore of the Florida west coast a dramatic ichthyofaunal transition occurs at reefs between 18 and 30 m; with increased depth the ichthyofauna becomes progressively enriched with tropical species and simultaneously diminished in diversity and abundance of temperate elements. This bathymetric zoogeographic zonation can probably be attributed to greater stability of physical, chemical and biological parameters in these buffered, offshore environments. Cobb et al. (1973) and Camp (1973) mentioned a transition from green to blue water zones within this depth regime. Deep-water reefs off the Florida west coast receive many elements from the insular fish fauna "requiring clear waters, buffered environmental conditions, and bottom sediments largely of calcium carbonate" (Robins, 1971).

The eastern Gulf reef ichthyofauna certainly cannot be considered subtropical or warm-temperate merely because winter sea temperatures fall somewhat below 18-20°C. However, Miller (1969) and Miller and Kent (1972) have taken this approach, describing the northern Gulf fish fauna as warm-temperate with a subtropical zone containing species with warm-temperate tolerances (< 20°C) deeper than 15 fathoms (27 m). Miller and Kent (1972:238) argue that "tropical fishes (minimum temperature tolerance of 18°C) are not able to survive as adults in the northern Gulf of Mexico and along the South Atlantic coast of the United States, except in the Florida Keys-Tortugas Bank subregion." This artificial distinction between warm-temperate and tropical ichthyofaunas based solely on minimum sea temperatures fails to recognize certain biological phenomena such as the origin and relationship of the fishes or, in the case of tropical fishes, their ability to adapt to slightly lower temperatures if the change is gradual or predictable. For example, typically Caribbean-West Indian fishes such as *Centropyge argi* or *Opistognathus aurifrons* resident on the outer West Florida Shelf could hardly be classified warm-temperate merely by virtue of their occurrence in waters less than 20°C. Also, as repeatedly emphasized in this paper, factors other than temperature (e.g., turbidity, habitat homogeneity, interspecific competition) are responsible for the selective species subtraction of the Caribbean-West Indian ichthyofauna on the West Florida Shelf.

In summary, the eastern Gulf of Mexico reef-fish fauna contains a large number of widely-ranging species and a few warm-temperate species but, on the basis of faunal distinctness, is most closely allied to the tropical Western Atlantic reef-fish fauna. Species diversity of tropical reef fishes increases seaward on the West Florida Shelf. Locally favorable environmental conditions such as occur at the Florida Middle Ground may result in an accentuated tropical ichthyofauna.

SEASONALITY

Although a slight increase in both numbers of species and individuals was noted during warm-water months due to juvenile recruitment and irregular occurence of certain displaced tropical fishes (e.g., *Chaetodon capistratus* and *Acanthurus coeruleus*), the resident adult eastern Gulf reef ichthyofauna displayed little seasonality prior to the red tide. The major exception was the barracuda *Sphyraena barracuda* which vacated the reefs during cold-water months. These observations are consistent with other studies (Bardach, 1958; Moe, 1972) indicating little inter-reef migration in coralophilic fishes. Similarly, Springer and McErlean's (1962) studies of Florida Keys patch reef communities indicated that most populations of fishes are static and feature little, if any, movement from reef to reef. Hastings (1972) noted the seasonal occurrence of certain reef fishes at jetties along the Florida northwest coast, but suggested that populations were more stable at natural reefs offshore.

Springer and Woodburn (1960) reported the seasonal appearance of certain serranids, pomadasyids, and sciaenids on rocky reefs off Tampa Bay, but this pattern may have been due to seasonal recruitment of juvenile fishes rather than large-scale fluctuations in adult stocks. Perhaps this apparent ichthyofaunal seasonality was artifact in that Springer and Woodburn (1960) did not make replicate observations at reef sites. Accordingly, inter-reef variations in species composition and abundance might not have been effectively partitioned from seasonal variation in species composition and abundance. In the present study, significant differences (both qualitative and quantitative) were often observed even between reef ichthyofaunas at the same depth. Cashman (1973) believed that temperatures, sediments, currents, and reef structure all contribute to the distinctive nature of reef habitats so that the actual structure of ichthyofaunal populations will vary from site to site.

Springer and Woodburn (1960) further commented that certain fishes found in abundance during early periods of study were no longer present later; other species disappeared during the course of study. Perhaps these apparent patterns did not reflect seasonal alterations in the ichthyofauna but rather, discrete successional (seral) stages following the red tide of 1967-58. Ichthyofaunal recolonization patterns at reefs devastated by the 1971 red tide suggests that true ecological succession is taking place. Although this succession is characterized by minimal species replacement, wide fluctuations in species abundance is occuring.

Moe (1963) believed that the seasonal movement of commercial fishing boats corresponded to annual migrations of the gag *Mycteroperca microlepis*, between 27 and 54 m. However, it is not necessarily a correct assumption that these boats are following movements of the fish rather than incidence of feeding. Possibly seasonal variation in feeding behavior of *M. microlepis* accounts for the discrepancy between apparent and actual abundance. Although *M. microlepis* is caught in large numbers only during fall through spring at shallow reefs off Sarasota, it is present in similar numbers throughout the year. Hastings (1972) reported that reef populations of *M. microlepis* in the northeastern Gulf do not feature any appreciable variations in seasonal abundance. Any annual inshore-offshore migration of serranids is inconsistent with results from tagging studies (Moe, 1966). Similarly, Topp (1963) and Beaumariage (1969) evidenced that the gray snapper *Lutjanus griseus*, tagged both inshore and offshore, demonstrate no detectable patterns of reciprocal, annual migration.

A seasonal tropical ichthyofauna maintained largely through current transport of pelagic eggs and larvae has been thought to exist in the northeastern Gulf (Caldwell, 1959; Haburay et al., 1969), north-central Gulf (Dawson, 1962), deepwater along the outer edge of Florida and nearshore north of the Florida Keys (Caldwell, 1959, 1963a). However, recent in situ investigations at reef sites in the northeastern and northwestern Gulf indicate that reef fishes are more resident than previously suspected (Hastings, 1972; Cashman, 1973). The present study suggests that a similar situation exists in the eastern Gulf. That planktonic transport accounts for the presence of at least certain Gulf reef fishes and supplements spawning by resident populations is indicated by the presence of juvenile reef fishes in the northeastern Gulf (where currents favor ichthyoplanktonic transport) that are excluded from the eastern Gulf. At least two reef fishes, *Chaetodon striatus* and *Abudefduf saxatilis*, are known to be eastern Gulf stragglers recruited from more southerly populations by current transport. Both of these species were observed at eastern Gulf reefs only after the 1971 red tide.

The presence of gobiids, apogonids, clinids, and other fishes with abbreviated or nonexistent planktotrophic stages also suggest that these populations are well established in the Gulf of Mexico and not maintained solely by current transport from regions to the south. Cashman (1973) indicated that seasonal changes did not noticeably affect reef fish populations at West Flower Garden Reef off Texas. As reported by Cashman (1973), Hinton Hoese suggested that "hard bottom" fishes in the northwestern Gulf are not necessarily seasonal in occurrence, but found as stable, year-round populations on banks of the outer continental shelf.

While any significant seasonal migration in eastern Gulf of Mexico reef fishes is slight, there does not exist ample evidence to suggest an ontogenetic migration to deeper, offshore waters in many of the larger predatory fishes, particularly serranids (Moe, 1963, 1969). Moe and Martin (1965) considered depth to be the most "obvious variable with direct correlation to increasing size." Bardach (1958) also observed that larger reef fishes generally occurred in deeper waters off Bermuda. For certain species such as the gag *Mycteroperca microlepis*, the body size-water depth relationship may be exaggerated by intensive fishing pressure at inshore reefs which selectively removes the larger individuals. At small shallow-water ledges easily overlooked by fisherman, gags up to 10 kg are not uncommon. On ledges assiduously fished, however, gags of this size are exceedingly rare.

Summarizing, ichthyofaunal composition and relative abundance at eastern Gulf reefs more closely resembles the stable conditions of the tropics rather than seasonal oscillations so characteristic of temperate faunas.

SUMMARY

1. One hundred one (101) species of reef fishes representing 38 families were observed and/or collected at 13-42 m depths on the central West Florida Shelf during May 1970-October 1972. Of these, one represents a Gulf of Mexico record, 15 constitute eastern Gulf records, seven are additions to the mideastern Gulf checklist, two represent northward range extensions, and seven confirm doubtful or frequently overlooked records. Contrary to earlier beliefs, most reef-fish species are permanent residents in the eastern Gulf rather than seasonal stragglers from areas to the south.
2. The most speciose eastern Gulf reef-fish families were the Serranidae (16 species), Lutjanidae (6), Pomacentridae (6), and Gobiidae (6). Numerically important (biomass and number of individuals) members of these reef communities included the Serranidae, Labridae, Sciaenidae, Pomacentridae, and Pomadasyidae.
3. Seventy-one (71) reef-fish species were recorded at shallow-water reefs (12-18 m). Of these, only 58 species were considered representative of that particular shelf interval; the remaining 13 species were recorded only following the 1971 red tide.
4. The deep reef (> 30 m) ichthyofauna, including the Florida Middle Ground, numbered 71 species, but an even richer fauna is anticipated when additional collections are made. Deep reefs harbored many tropical reef fishes rare or absent at shallower reefs inshore.
5. A single dive at the Florida Middle Ground, an area of rugged submarine terrain on the outer West Florida Shelf, revealed 51 species, approximately two or three times the number typically observed at other study reefs during a dive of comparable duration. Equable environmental conditions, reef structural complexity, water column and benthic algal productivity, variable depths and shallow reef crests are important characteristics contributing to Middle Ground ichthyofaunal diversity and abundance.
6. Reefs of intermediate depth (18-30 m) possess a transitional ichthyofauna characterized by shallow-water species subtraction and deep-water species addition. No reef-fish species was found to be peculiar to this shelf interval.
7. The 1971 red tide (*Gymnodinium breve* Davis) and subsequent stress conditions occuring within the study area resulted in mass mortalities of reef biotas over at least 1536 km^2 of central West Florida Shelf.
8. An estimated 80-90% of the deep-water (18-30 m) resident reef-fish species perished during the red tide. At inshore, shallow-water (12-18 m) reefs, 77% (45 of 58 species) of the resident reef-fish species were exterminated. Most shallow-water reef fishes surviving the red tide as remnant populations were species which could feasibly swim above the thermocline to avoid oxygen depression.
9. Certain fishes colonized shallow-water reefs shortly after red tide conditions abated, other species did not appear for 10-12 months afterwards. Some typically deep-water fishes recruited to shallow-water reefs following the red tide, possibly in response to relaxed competition from their ecological counterparts eliminated or decimated during the red tide. Minimal species replacement, but wide fluctuations in abundance characterized reef-fish succession following the red tide.
10. The eastern Gulf of Mexico reef-fish fauna, when compared to other western Atlantic regions (Florida Keys-SE Florida, northeastern Gulf, northwestern Gulf, southwestern Gulf, western Caribbean, West Indies, SE North Atlantic coast, Bermuda), demonstrated the greatest affinity (most species in common) with that of the Florida Keys-SE Florida. However, the absence of groups of fishes with limited vagility (clinids, blenniids, gobiids, apogonids) in the eastern Gulf contributes most noticeably to a fauna considerably less diverse

than that of the Florida Keys-SE Florida. However, certain other tropical reef fishes are undoubtedly restricted from the eastern Gulf of Mexico due to locally unfavorable conditions of substrate, sedimentation, minimum temperatures, and interspecific competition in this marginally tropical area.

11. The eastern, northeastern, and northwestern Gulf of Mexico reef-fish faunas demonstrate greater compositional similarity than previously expected. Qualitative differences that exist between the ichthyofaunas of the Texas and Florida Shelves can be largely explained by the isolation that the paucity of reef biotopes in the north-central Gulf imposes on fish groups characterized by limited dispersal ability. The accumulation of species differences in Texas and Florida reef-fish ichthyofaunas may be partially due to the operation of different colonization corridors. Quantitative differences between Texas and Florida reef-fish faunas are best explained by ecological differences in the two areas.
12. Features associated with the broad West Florida Shelf complicate distributional patterns of reef biotas. Tropical reef-fish species diversity increases with offshore distance and water depth.
13. Although a slight increase in both numbers of species and individuals was noted during warm-water months due to juvenile recruitment and occurrence of displaced tropical fishes, the resident reef-fish fauna of the eastern Gulf displayed little seasonality prior to the red tide. Little evidence for a reciprocal inshore-offshore migration was noted, but many fishes (e.g., serranids) demonstrated a body size-water depth relationship suggestive of an undirectional ontogenetic migration.

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