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NOAA Technical Report NMFS 26

# Synopsis of Biological Data on the Sand Perch, *Diplectrum formosum* (Pisces: Serranidae)

March 1985

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Synopsis No. 143

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U.S. DEPARTMENT OF COMMERCE
National Oceanic and Atmospheric Administration
National Marine Fisheries Service

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Malcolm Baldrige, Secretary
National Oceanic and Atmospheric Administration
John V. Byrne, Administrator
National Marine Fisheries Service
William G. Gordon, Assistant Administrator for Fisheries

## CONTENTS

*No information available.

# Synopsis of Biological Data on the Sand Perch, *Diplectrum formosum* (Pisces: Serranidae)

GEORGE H. DARCY[1]

**ABSTRACT**

**Information on the biology and fishery resources of a common western Atlantic serranid, *Diplectrum formosum*, is compiled, reviewed, and analyzed in the FAO species synopsis style.**

## INTRODUCTION

The sand perch, *Diplectrum formosum*, is a small serranid occurring along the southeastern Atlantic coast of the United States, throughout the Gulf of Mexico and much of the Caribbean Sea, and along the coast of Central and South America south to about Uruguay. Sand perch occur from shore to depths of over 130 m. They are sometimes abundant and widely distributed over sand or shell bottoms, particularly in the South Atlantic Bight, on the West Florida Shelf, and on Campeche Bank. Because of their abundance, they may be important as forage for larger predators, such as snappers, groupers, porgies, and sharks. Sand perch enter commercial landings primarily as by-catch of the shrimp and bottomfish fisheries; many are discarded. Despite their small size, sand perch are desirable recreational species due to their excellent food quality. They are commonly caught by recreational and subsistence fishermen, especially on the west coast of Florida. This paper summarizes information on the sand perch in the FAO species synopsis format.

1 IDENTITY

1.1 Nomenclature

1.11 Valid name

*Diplectrum formosum* (Linnaeus 1766) (Fig. 1).

Sand perch, *Diplectrum formosum* Linnaeus 1766:488-489, type locality: Carolina. The name is derived from the Greek *di-* (two) and *plektron* (cock's spur), referring to the preopercle, which bears two clusters of spines, and the Greek *formosus*, meaning beautiful.

1.12 Objective synonymy

The following synonymy is based on Bortone (1977):

*Perca formosa* Linnaeus 1766
*Serranus radians* Quoy and Gaimard 1824
*Serranus fascicularis* Valenciennes *in* Cuvier and Valenciennes 1828
*Serranus irradians* Valenciennes *in* Cuvier and Valenciennes 1828 (in part)
*Diplectrum fasciculare* Holbrook 1855
*Centropristis fascicularis* Günther 1859
*Centropristis radians* Günther 1859
*Diplectrum radians* Poey 1876
*Serranus formosus* Jordan 1885
*Diplectrum formosum* Goode and Bean 1886
*Centropristis formosus* Berg 1895
*Haliperca formosa* Miranda-Ribeiro 1904
*Diplectrum formosus* Jordan, Evermann, and Clark 1930
*Diplectrum fascicularis* Poey 1955
*Diplectrum radiale* Ringuelet and Aramburu 1960 (misidentification)

1.2 Taxonomy

1.21 Affinities

Suprageneric

Phylum: Chordata
Class: Osteichthyes
Superorder: Acanthopterygii
Order: Perciformes
Suborder: Percoidei
Family: Serranidae

Systematics of the family Serranidae have been discussed by several authors. Jordan and Eigenmann (1890) reviewed the American serranids and included six subfamilies. Three of these (Grammistinae, Latinae, and Percichthyinae) are usually excluded from Serranidae in recent literature. Kendall (1979) considered the taxa Serraninae, Anthiinae, Epinephelinae, and Liopropominae subfamilies, but Smith (1978) treated Anthiinae as a separate family. Gosline (1966) considered only Serraninae, Anthiinae, and Epinephelinae to be subfamilies of Serranidae. *Diplectrum* belongs to the subfamily Serraninae.

Generic

The genus *Diplectrum* is composed of nine eastern Pacific and three western Atlantic species (Rosenblatt and Johnson 1974; Bortone 1977), and is endemic to tropical and subtropical shelf waters of the Western Hemisphere. All species of *Diplectrum* are hermaphroditic.

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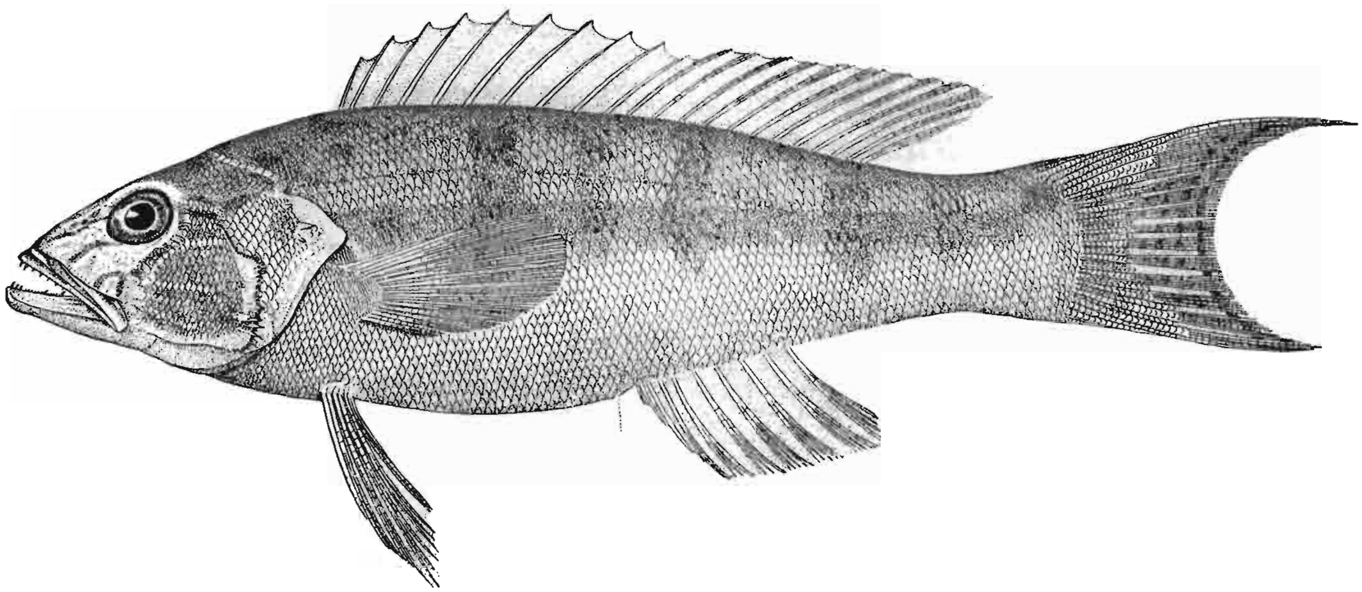

**Figure 1.—Adult *Diplectrum formosum*. (From Jordan and Eigenmann 1890.)**

The genus was characterized as follows by Bortone (1977). Small percoid fishes, moderately compressed; body depth moderate to slender; jaws terminal; dorsal and ventral body profiles nearly equal. Caudal fin truncate or slightly forked; upper caudal lobe usually somewhat longer than lower, sometimes extended as elongated filament. Dorsal fin continuous, only slightly indented between spinous and soft dorsals. Villiform teeth present in upper and lower jaws; both jaws with 5-10 small caniform teeth; vomer with villiform teeth in wedge or V-shape; palatines with thin, elongate band of villiform teeth. Preopercle forms almost right angle between vertical and horizontal limbs, both limbs serrated along their entire lengths; posterior preopercular angle expanded as a spur of various shapes, composed of numerous enlarged spines; opercle with 3 spines or projections posteriorly, the middle spine the longest; posttemporal serrate; top of cranium smooth. Pelvic fin origin under or in advance of pectoral fin. Branchiostegals 7; vertebrae 10+14. Predorsal fin supports weakly developed. Dorsal fin X, 12; anal fin III, 7 or 8; pectoral rays 14-19. Scales ctenoid; snout naked and top of head naked posteriorly to vertical line with preopercular arm; dorsal fin unscaled; pored lateral line scales with distal portion of pore projecting parallel to body midline.

*Diplectrum* was erected by Holbrook (1855:32) with the type species *Serranus fasicularis* Valenciennes = *Perca formosa* by subsequent designation of Goode and Bean (1886:203). Synonyms include *Diplectron* Troschel 1858 (improper emendation) and *Haliperca* Gill 1863 (type species *Serranus bivittatus* Valenciennes, by monotypy) (Bortone 1977). No subgenera were recognized by Bortone (1977).

Specific

The following species diagnosis is from Bortone (1977): Preopercle with 2 clusters of radiating spines from upper and lower posterior corners; scales small; cheek scale rows A (from the posteroventral angle of the eye downward and posteriorly toward the lower preopercular angle) 9-16 (mode 11); cheek scale rows B (from the posterior serrated upper arm of the preopercle downward and anteriorly to the distal corner of the maxillary) 12-18 (mode 16); 8-12 scales above lateral line; pectoral rays 16 modally; spinous-dorsal profile nearly parallel to dorsum.

Two other species of *Diplectrum*, *D. radiale* and *D. bivittatum*, occur in the western Atlantic. *Diplectrum formosum* is distinguished from these species by having 2 spiny lobes on the preopercle, its larger size as an adult, 16 (modally) pectoral rays (*D. bivittatum* has 15, *D. radiale* 17), smallest scales and highest mean scale counts, broadest lachrimals, and narrowest maxillaries (Bortone 1977; Smith 1978). As juveniles, *D. formosum* may be separated from the other species by smaller eye diameter and by scale counts (Bortone 1977).

Osteology of *D. formosum* was described in detail by Bortone (1977); the bones of the skull are illustrated in Figure 2. According to Bortone, *D. formosum* is an apomorphic species with respect to high scale counts, the enlarged preopercular spurs, and other characters, and may represent a phylogenetic line long separated from other members of the genus.

1.22 Taxonomic status

*Diplectrum formosum* is generally considered a morphospecies in recent literature.

1.23 Subspecies

Two morphological populations of *D. formosum* were identified by Bortone (1977); these he recommended be recognized as subspecies. The northern subspecies, *D. formosum formosum* (Linnaeus 1766), occurs along the Atlantic and Gulf of Mexico coasts of North America, and the southern subspecies, *D. formosum radians* (Quoy and Gaimard 1824), occurs in the Caribbean Sea and along the coast of South America. The subspecies differ little in meristic characters, except for gill raker counts, but differ in morphometry (Table 1). The number of gill rakers increases from north to south, with a mean of 18.83 (range 17-22) in *D. formosum formosum* and 22.01 (19-24) in *D. formosum radians*.

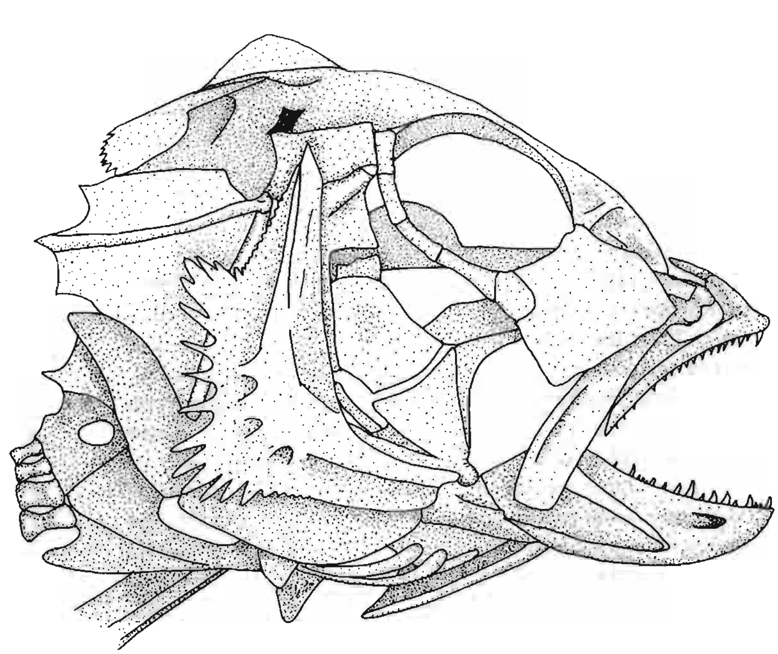

**Figure 2.—Right lateral view of skull of *Diplectrum formosum*. (From Bortone 1977.)**

**Table 1.—Mean proportional data in thousandths of standard length (SL) for two *Diplectrum formosum* subspecies. (From Bortone 1977, table 9.)**

| Character | Subspecies | |
|---|---|---|
| | *D. formosum formosum* | *D. formosum radians* |
| SL (mm) | 140 | 119 |
| TL | 1,340 | 1,269 |
| FL | 1,191 | 1,183 |
| Body depth | 275 | 270 |
| Head length | 359 | 362 |
| Postorbital length | 191 | 192 |
| Snout length | 113 | 101 |
| Lacrimal width | 59 | 52 |
| Maxillary width | 26 | 27 |
| Orbit length | 74 | 83 |
| Orbit width | 59 | 63 |
| Interorbital width | 74 | 73 |
| Upper jaw length | 160 | 160 |
| Lower jaw length | 179 | 181 |
| Cheek height | 125 | 119 |
| Cheek length | 128 | 129 |
| Caudal peduncle depth | 134 | 125 |
| Pectoral fin length | 235 | 238 |
| Pelvic fin length | 216 | 210 |
| Predorsal length | 349 | 350 |
| Pelvic origin to lower jaw | 341 | 342 |
| Pelvic origin to anus | 306 | 314 |
| Postanal length | 402 | 401 |
| Dorsal spine height | | |
| first | 51 | 53 |
| second | 78 | 79 |
| third | 95 | 100 |
| fourth | 105 | 110 |
| fifth | 110 | 113 |
| Anal spine height | | |
| first | 25 | 29 |
| second | 47 | 53 |
| third | 70 | 74 |

### 1.24 Standard common names, vernacular names

The accepted common name of *D. formosum* in the United States is sand perch (Robins et al. 1980), and standard FAO common names are: English, sand seabass; French, serran de sable; Spanish, serrano arenero (Smith 1978). Other common names and spelling variations that have appeared in the literature include: squirrel-fish (Jordan and Eigenmann 1890), squirrel fish (Baughman 1944), squirrelfish (Springer and Woodburn 1960), sand fish (Breder 1948), sandfish (Hoese 1958), and sandperch (Briggs 1958). In Brazil it is known as mixole or margarida (Brandão 1964).

## 1.3 Morphology

### 1.31 External morphology

The following morphological description is based on Miller and Jorgensen (1973), Roux (1973), Bortone (1977), and Smith (1978).

Body moderately small, slender, elongate. Body depth about 3.8 in SL; head about 2.5 in SL. Head and snout moderately long, the snout flat and unscaled. Maxilla broad, completely exposed at posterior end. Eye 5.3 times in head. Preopercle with 2 bony lobes, one at the angle and one above it, each with radiating spines connected together by a membrane for most of their length. Number of spines in preopercular spurs variable, 6-15, but usually 9-12. Southern subspecies (*D. f. radians*) has slightly longer spines, tending to diverge earlier in ontogeny (75 mm SL) than those of the northern subspecies (*D. f. formosum*), which diverge at about 90 mm SL. Horizontal and vertical preopercular arms serrate. Opercle with 3 flat spines, the middle spine the longest. Gill rakers of moderate length, 11-12, with 2-3 rudimentary rakers at base of the first arch. Anterior nostril bears a short flap.

Dorsal and anal fins high. Dorsal fin single, unnotched, X, 12. Anal fin III, 7, occasionally 6 or 8. Bases of dorsal and anal fins with a few scales on the membranes, but not covered by thick, scaly skin. Pectoral fins blunt, longer than pelvics, with 15-17 rays (mean 15.95). Caudal fin truncate in southern subspecies, slightly forked in northern subspecies. Northern subspecies often has elongated filament on upper lobe of caudal.

Scales ctenoid. About 80 rows of scales along length of body above lateral line. Pored lateral line scales 49.76 mean (range 46-55). Scale rows in lateral line 76.78 mean (66-88); scale rows above lateral line 9.38 mean (8-12); scale rows below lateral line 21.36 mean (18-26); predorsal scale rows 17.20 mean (14-22). Anterior chest scales embedded and slightly smaller than lateral body scales. Scale development was examined by DeLamater and Courtenay (1974).

Skeletal descriptions were provided by Bortone (1977). A drawing of the skull appears in Figure 2.

Color pattern complex. Dorsum light brown, lateral surfaces tan, ventral surface white. Lateral body surfaces with 2 dark brown stripes in juveniles; in adults the stripes are interrupted to form 5-7 vertical bars, sometimes more. Caudal spot distinct, equal to eye diameter, present on upper half of caudal peduncle. Anal fin with pale yellow spots, pectorals and pelvics pale bluish white. Midlateral ventral area pink orange in adults. Upper pharyngeal region yellow with blue flecks. Posterior branchial cavity pale. Upper medial preopercular surface with small patch of dark gray; lower medial surface pale white. Snout with 2 bright blue lines from anterior edge of lachrimal to orbit, with bright blue irregular lines below joining to form a single line running irregularly across upper cheek. Additional blue lines on cheek, opercle, and preopercle. Blue spots on maxillary. Lower jaw bluish purple. Throat white, a bluish-purple blotch ventral and posterior to lower jaw symphysis. Top of head brown, with 4-5 bluish-green lines. Seven to 9 longitudinal blue lines trimmed with yellow along sides of body, bright blue above and paler ventrally. Anterior dorsal fin with 2 longitudinal blue lines on an orange field. Tips of dorsal spines bright red orange. Spinous dorsal more deeply forked than soft dorsal. Caudal fin with numerous orange spots or rows of fused spots or vertical lines on a pale blue field. Extended caudal filament orange. With preservation, colors fade, orange and yellow becoming pale and blue becoming dusky.

Coloration may undergo ontogenetic and behavioral changes. Small individuals have 2 longitudinal stripes as the dominant lateral pattern, whereas in larger individuals these become broken into what appears to be vertical bars (Bortone 1971a, b). Böhlke and Chaplin (1968) reported that sand perch at rest show the barred pattern and active individuals show the longitudinally striped pattern.

See 1.21.

## 2 DISTRIBUTION

### 2.1 Total area

Sand perch are distributed in waters of the continental shelf from Virginia to southern Brazil or Uruguay (Fig. 3), including the Gulf of Mexico, Bahamas, Cuba, Virgin Islands, and the southern West Indies (Böhlke and Chaplin 1968; Randall 1968; Smith 1978). The most northerly record is from Chincoteague, VA, though the species seldom occurs north of Cape Lookout, NC; the Virginia record was taken during an unusually favorable period of weather (Bortone 1977). Sand perch are not present in Bermuda (Smith 1976). The southern end of the range is approximately São Paulo, Brazil, with unconfirmed records as far south as Uruguay (Bortone 1977).

Along the southern Atlantic coast of the United States, sand perch are associated with open shelf habitat, particularly sand bottom (Struhsaker 1969). They are widely distributed over such bottom in 10-132 m of water from off Cape Fear, NC, to south of Cape Canaveral, FL (Barans and Burrell 1976; Avent and Stanton 1979; Wenner et al. 1979a, c, d). They also occur inshore in

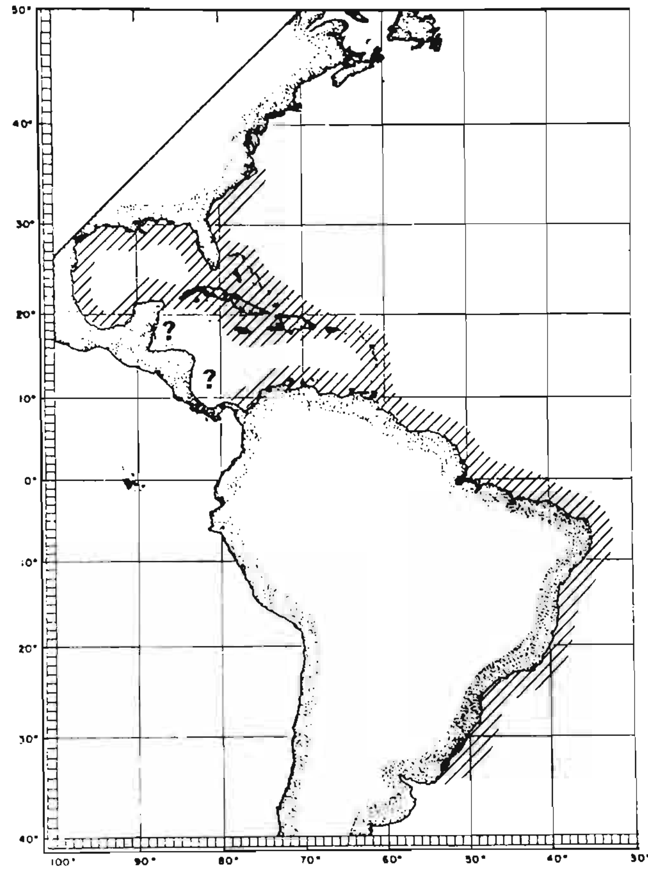


**Figure 3.—Distribution of *Diplectrum formosum*. (Based on Bortone 1977; Smith 1978.)**

shallow embayments. Sand perch are considered characteristic of the subtropical fish fauna in this region (Hoese 1973).

In the Gulf of Mexico, sand perch occur from the West Florida Shelf to Campeche Bank (Sauskan and Olaechea 1974), but are more common in the northeastern Gulf than in the northwestern Gulf (Hoese and Moore 1977). In the northeastern Gulf, sand perch occur from shore to reefs, ledges, man-made platforms (Hastings et al. 1976), and live bottom offshore. They occur on the Florida Middle Grounds, but are apparently not common there (Smith et al. 1975). In the northwestern Gulf, they appear to inhabit deeper water farther offshore (Chittenden and Moore 1977). Sand perch are found on offshore snapper and grouper banks off both Florida (Bortone 1971a) and Texas (Baughman 1944).

Sand perch are not common in the Bahamas and West Indies. Böhlke and Chaplin (1968) found them only near Eleuthera I. at the northeastern end of the Great Bahama Bank. The species appears to prefer continental margins to insular environments.

See 2.21, 2.22, 2.23, and 4.2.

### 2.2 Differential distribution

#### 2.21 Spawn, larvae, and juveniles

Eggs are presumably planktonic. Larvae are abundant in the eastern Gulf of Mexico and are widely distributed in surface waters overlying the West Florida Shelf (Houde 1982; Houde et al.[2]) (Fig. 4). In their survey of ichthyoplankton of the eastern Gulf of Mexico, Houde et al. (footnote 2) found sand perch larvae (1.1-16.0 mm SL) most common from spring to fall, though larvae were present throughout the year; peak abundance was in spring and summer, particularly in May. In winter, most larvae were taken in the southern part of the survey area. Larvae were collected in water 9-155 m deep; 50% of the occurrences from stations < 30 m deep, and 90% from stations < 60 m deep. Specimens were collected at surface water temperatures of 17.0° to ≥ 32.0°C, but were most common at 23.0°-29.0°C. Most were collected in water of ≥ 35.0‰ salinity, though some were taken at salinities as low as 31.0‰.

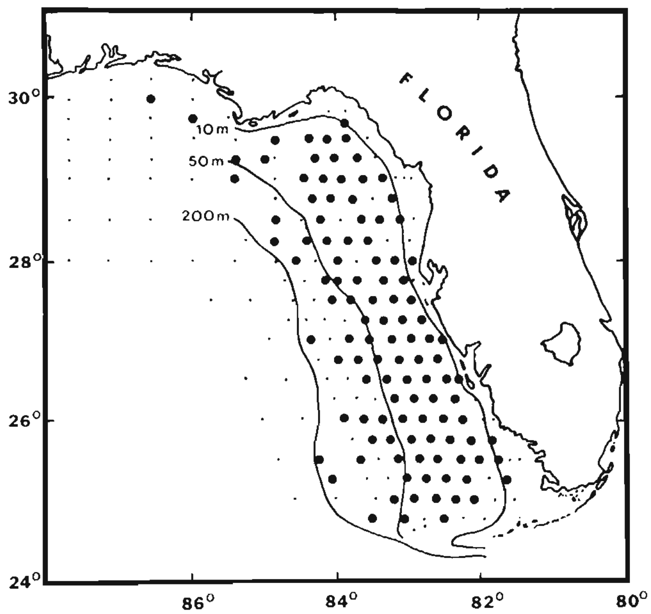


**Figure 4.—Stations at which *Diplectrum formosum* larvae were collected at least once during 17 cruises to the eastern Gulf of Mexico, 1971-74. Small points indicate stations at which no *D. formosum* larvae were collected. (From Houde et al. see text footnote 2, fig. 86.)**

Juvenile sand perch are most common in shallow water. In the South Atlantic Bight, Wenner et al. (1979a, b, c) found smallest individuals (< 10-15 cm FL) in shallow water, usually in 9-27 m. In the northern Gulf of Mexico, sand perch smaller than about 15.0 cm SL are usually found in water < 15 m deep (Bortone 1971a). Hastings (1972) observed juveniles near jetties in the northern Gulf of Mexico, usually in summer and fall, though a few individuals remained in shallow water year-round. Most juveniles leave shallow water when the temperature drops below about 20°C (Hastings 1972).

See 2.3.

2.22 Adults

Adult sand perch occupy a variety of habitats from nearshore to at least 130 m depth. Sand or sand-shell bottom is preferred, especially near some form of cover, such as reefs, rocks, or manmade structures.

Nearshore, adults are found near jetties (Hastings 1972), reefs (Starck 1968), mangrove lagoons (Cervigon 1966), and *Thalassia* beds (La Monte 1952; Starck and Davis 1966; Bortone 1971a). Near rocks or jetties, sand perch usually lie on the bottom or hover a few centimeters above it (Hastings 1972). Individuals often live in holes in the bottom or under rocks.

Adults are somewhat more common offshore then in very shallow water, with largest individuals inhabiting the deepest water (Smith 1978; Wenner et al. 1979c). Hastings (1972) rarely found large adults inshore in St. Andrew Bay, FL, especially when water temperature dropped below 20°C. Sand perch > 15.0 cm SL are usually found in water > 15 m deep (Bortone 1971a).

Offshore, sand perch occur over sand, mud, or shell bottoms, especially near the bases of reefs, rocks, or near upper edges of depressions in the bottom (Moe and Martin 1965; Bortone 1971a; Hastings 1972; Smith 1976; Smith 1978). Baughman (1944) reported sand perch from smooth sandy or muddy bottom off Texas. Miller and Richards (1980) listed the sand perch as a reef species of the South Atlantic Bight. Smith (1976) reported the species from offshore reefs in 12-42 m in the eastern Gulf of Mexico and termed it a "secondary reef" species. Sand perch are found near artificial reefs and around offshore platforms, as well as near natural limestone reefs (Bortone 1971a; Hastings 1972; Hastings et al. 1976; Smith et al. 1979). They have been reported from water at least as deep as 132 m (Avent and Stanton 1979), but are not common in depths > 50 m (Bortone 1977; Wenner et al. 1979a, c, d; Darcy and Gutherz[3]).

See 2.3 and 4.2.

2.3 Determinants of distribution changes

Distribution of sand perch is influenced by water temperature, season, salinity, depth, growth stage of the fish, and availability of suitable habitat.

The sand perch is a subtropical species requiring warm water. Northern and southern limits of the range are probably determined by low water temperature. Roessler (1970) reported the temperature range of the sand perch as 18°-34°C, but individuals have since been found at considerably lower temperatures. MARMAP trawling in the South Atlantic Bight produced sand perch from 15.7°-20.1°C water in winter-early spring 1975 (Wenner et al. 1979d) and 17.1°-22.0°C water in spring 1974 (Wenner et al. 1979b). Hastings (1972) found a few individuals in shallow water as cold as 14°C in St. Andrew Bay; none were found in water below 13°C. Few sand perch were found in shallow water when the temperature fell below about 20°C (Hastings 1972). Adults are particularly scarce at low temperatures.

Seasonal changes in water temperature affect local distribution. In general, sand perch leave shallow water in winter to avoid low temperatures. Although Wang and Raney (1971) observed no seasonality in sand perch abundance in the Charlotte Harbor estuary, FL, most other authors have indicated a decrease in abundance of sand perch inshore in the colder months. Near Cedar Key, FL, Reid (1954) found sand perch from June to November, but not during the cooler months of the year. Tabb et al. (1962) reported that sand perch reach peak abundance in northern

[2]Houde, E. D., J. C. Leak, C. E. Dowd, S. A. Berkeley, and W. J. Richards. 1979. Ichthyoplankton abundance and diversity in the eastern Gulf of Mexico. Report to Bureau of Land Management under Contract No. AA550-CT7-28, 546 p.

[3]Darcy, G. H., and E. J. Gutherz. Abundance and distribution of commonly trawled species of fish and invertebrates, West Florida Shelf, January 1978. Manuscr. in prep. Southeast Fisheries Center, National Marine Fisheries Service, NOAA, 75 Virginia Beach Drive, Miami, FL 33149-1099.

Florida Bay, FL, in fall and early winter. Roessler (1970) reported that 100% of the sand perch caught in his study of Buttonwood Canal, FL, were caught from September through November. Hastings (1972) found juvenile and adult sand perch near St. Andrew Bay jetties in summer and fall, but they were rare or absent in winter. Adults are not usually found inshore in water cooler than 20°C; most juveniles and adults leave shallow water as the temperature falls in late fall or early winter (November in St. Andrew Bay) (Hastings 1972). Ogren and Brusher (1977) found sand perch to be most abundant in St. Andrew Bay in fall, and least abundant late winter through early summer (February-June). Sand perch are able to tolerate temperatures well below 20°C and are commonly found on offshore reefs in the northern Gulf of Mexico at 15°C (Hastings 1972). Movement to deeper water may protect the sand perch against rapid or extreme drops in temperature.

Although seasonal changes in distribution of sand perch on offshore grounds are not dramatic, some seasonal shift of distribution with depth may occur. In the South Atlantic Bight, sand perch are apparently more common in summer than in winter (Hoese 1973; Barans and Burrell 1976). Although Barans and Burrell (1976) stated that no seasonal change in depth distribution of sand perch was discernible in their study, their data (Fig. 5) indicate a slight shift in abundance towards shallower water (9-18 m) in summer, and some preference for deeper water (27-55 m) in spring; peak abundance was in 18-27 m throughout the year. Barans and Burrell speculated that territoriality may explain the relatively uniform distribution of sand perch in shelf waters of the South Atlantic Bight.

Sand perch are usually found in waters of relatively high salinity. Most records are from full salinity seawater (35-36‰) (Bortone 1971a), though sand perch have been reported from salinities at least as low as 18‰ (Gunter and Hall 1965, St. Lucie estuary, FL). Tabb and Manning (1961) collected sand perch in 39‰ water in Whitewater Bay, FL. In St. Andrew Bay, sand perch are most common in high salinity areas (Ogren and Brusher 1977).

Growth stage of sand perch also affects their distribution. Larvae are present year-round in surface waters of the eastern Gulf of Mexico, but are most abundant in spring and summer (Houde 1982; Houde et al. footnote 2). In winter, larvae are much more common over the southern West Florida Shelf than farther to the north (Houde et al. footnote 2), possibly indicating that spawning is more continuous in the south, or that larval survival is reduced in the north due to cold. Over the entire survey period, however, there was no statistical difference in larval abundance between the north and south (Houde 1982). Juveniles and adults occur both inshore and offshore, but adults occur over a wider depth range. There is a tendency for size of fish to increase with depth (Moe and Martin 1965; Bortone 1971a, 1977; Smith 1978; Wenner et al. 1979a, c). Wenner et al. (1979a) calculated mean sand perch size for catches in three depth zones in the South Atlantic Bight: 9-18 m, 12±2 cm FL; 19-27 m, 15±1 cm FL; 28-55 m, 19±1 cm FL. Results of other MARMAP surveys were similar (Fig. 6).

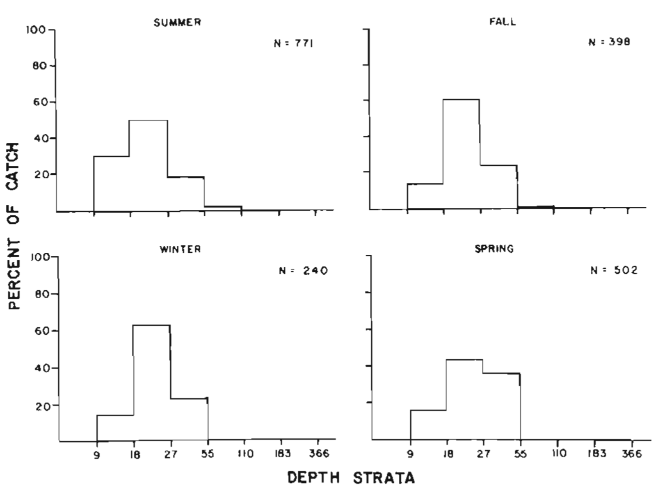


**Figure 5.—Seasonal depth distribution of *Diplectrum formosum* in the South Atlantic Bight. (From Barans and Burrell 1976, fig. 9.)**

Sand perch are usually most abundant at moderate depths. Barans and Burrell (1976) and Wenner et al. (1979a, b, c, d) found them to be most common at 19-27 m in the South Atlantic Bight. Off Tampa Bay, Moe and Martin (1965) found sand perch most common at 8-14 m. A trawling survey of the West Florida Shelf (Darcy and Gutherz footnote 3) indicated that sand perch were most abundant in 19-27 m in January 1978. Durand (1960) reported sand perch from 20-70 m depth off the Guianas, with peak abundance in 45-50 m.

When other physical parameters are suitable, presence or absence of sand perch depends on availability of suitable habitat (Bortone 1971a). Sand or sand-shell substrate is preferred (Bortone 1971a; Barans and Burrell 1976). Although often seen over open bottom, sand perch also associate with bottom irregularities (Hastings 1972) and may be common near reefs, rock outcrops, jetties, ledges, or over live bottom (Darcy and Gutherz footnote 3). Sand perch are dominant members of the pink shrimp community in the Gulf of Mexico, including Campeche Bank, but are rare or absent on brown shrimp or white shrimp grounds (Hildebrand 1955; Chittenden and McEachran 1976). Pink shrimp grounds typically have the sand and calcareous sediments that sand perch prefer, whereas brown shrimp and white shrimp grounds usually have soft, muddy sediments.

See 2.21, 2.22, and 4.2.

### 2.4 Hybridization

No hybrids of the sand perch are known.

## 3 BIONOMICS AND LIFE HISTORY

### 3.1 Reproduction

#### 3.11 Sexuality

The sand perch, like all members of the genus *Diplectrum*, is a synchronous hermaphrodite. Separate sexes do not exist.

#### 3.12 Maturity

The testis begins to develop at approximately 90 mm SL (age 2) and is normally fully mature in specimens of 125 mm SL (age 2 or 3) (Bortone 1971a). Ovarian tissue is not distinguishable in individuals smaller than about 90 mm SL, and is not usually recognizable macroscopically in specimens < 125 mm SL (Bortone 1971a). Mature eggs and sperm occur simultaneously in sand perch > 150 mm SL, but whether an individual can function as both male and female at the same time is unknown (Bortone 1971a).

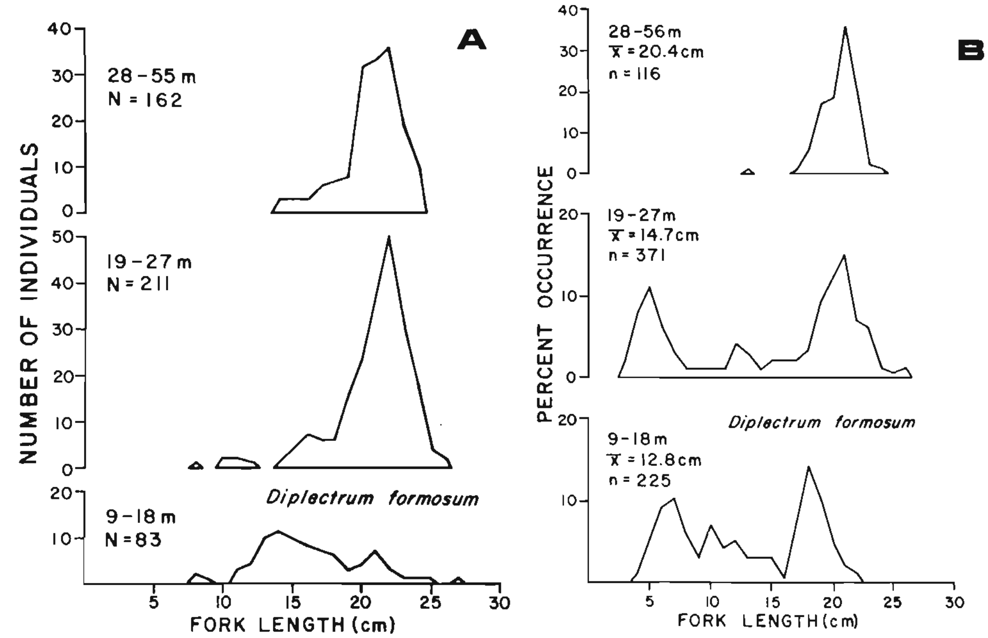


**Figure 6.—Length-frequency distribution of *Diplectrum formosum* by depth zone for A) spring 1974, and B) summer 1974, based on MARMAP groundfish cruises in the South Atlantic Bight. (From Wenner et al. 1979b, fig. 10D; 1979c, fig. 7D.)**

3.13 Mating

Mating patterns of sand perch are not well-known, but mating pairs probably form and result in cross-fertilization (Bortone 1971a).

3.14 Fertilization

Fertilization is external. Cross-fertilization probably occurs between mated pairs, though external self-fertilization could possibly take place (Bortone 1971a). There is no evidence of internal self-fertilization.

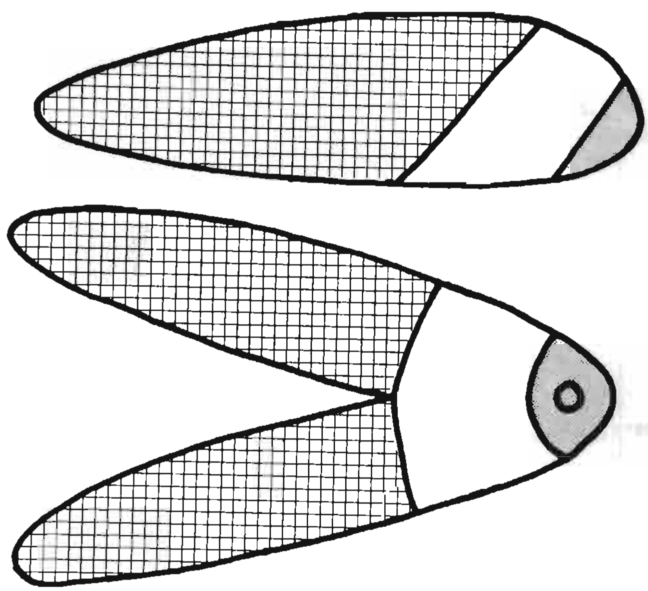

**Figure 7.—Schematic gonad diagram of *Diplectrum formosum*. Cross-hatched area, ovarian tissue; white area, testicular tissue; shaded area, posterior ovarian-sinus region. Top figure is left lateral view, bottom figure is ventral view, with gonopore represented as a circle. Posterior portion of the gonads is to the right. (From Bortone 1977, fig. 8A.)**

3.15 Gonads

Gonads of sand perch consist of an ovotestis. According to Bortone (1977), the ovarian portion of the ovotestis appears yellow and granular, and the testicular portion appears white and fine-grained. The ovotestis is U-shaped with the ovarian portion lying anterior to the testicular portion (Fig. 7). The lamellar ovarian tissues surround the central lumen. Testicular tissue lies in a wide diagonal band posterior to the ovarian region. The extreme posteroventral portion forms an "ovarian sinus" (Bortone 1977).

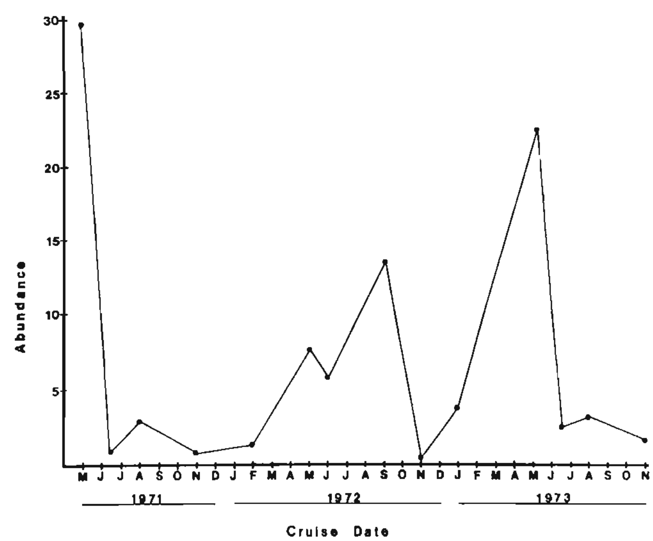


**Figure 8.—Estimated mean abundance (number per 10 m² of sea surface) of *Diplectrum formosum* larvae in the eastern Gulf of Mexico, 1971-73. (From Houde et al. see text footnote 2, fig. 85.)**

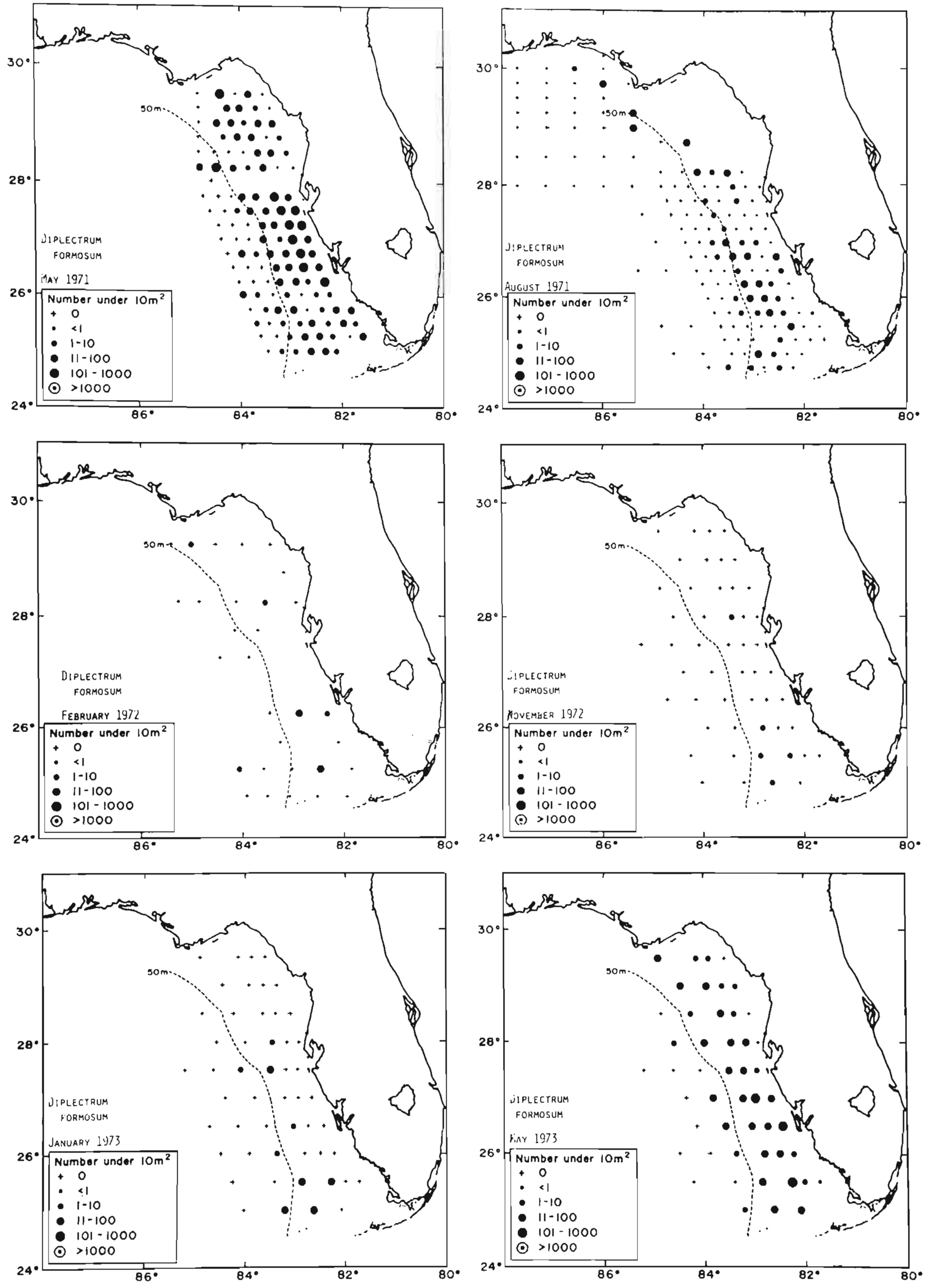


**Figure 9.—Distribution and abundance of *Diplectrum formosum* larvae in the eastern Gulf of Mexico, 1971-73. (From Houde et al. see text footnote 2, fig. 87.)**

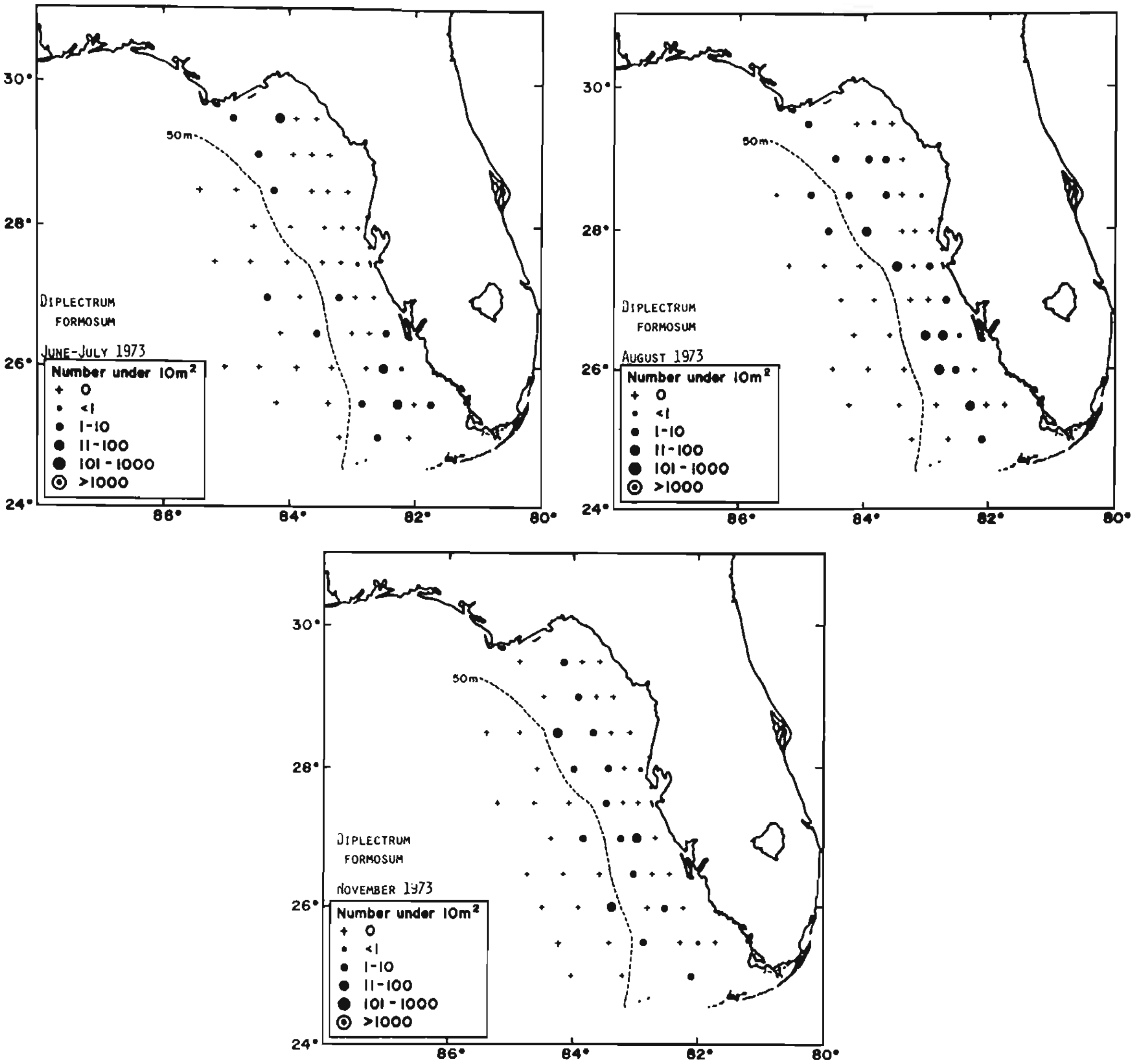


**Figure 9.**—*Continued.*

3.16 Spawning

Spawning of sand perch may occur at any time during the year, but is at a peak in spring and early summer. Bortone (1971a) observed gonad maturation in sand perch from the northern Gulf of Mexico beginning in March and April and reaching a maximum in May, though some ovotestes examined contained eggs as late as September. Specimens examined by Bortone in November and December had regressed ovotestes. The smallest sand perch collected by Reid (1954) near Cedar Key (17-39 mm SL) were from May and June. Smallest specimens collected by Bortone (1971a) (11-22 mm SL) were caught in late May and June. Houde et al. (footnote 2) found sand perch larvae year-round in surface waters of the eastern Gulf of Mexico, but they were most abundant in spring and summer (Figs. 8, 9), particularly in April through June (Houde 1982). According to Houde et al. (footnote 2), some spawning occurs in deep shelf waters (100-200 m), though most larvae were collected at stations in 50 m of water or less.

3.17 Spawn

Little is known concerning spawn of sand perch. Largest ovarian eggs examined by Bortone (1971a) were about 0.87 mm in diameter. Eggs are presumably planktonic.

3.2 Preadult phase

3.21 Embryonic phase

Embryonic development of sand perch has not been described in the literature.

3.22 Larvae and adolescent phase

Sand perch larvae are planktonic (Houde et al. footnote 2). Two types of *Diplectrum* larvae were described by Kendall (1979), Type 1 and Type 2. Neither type has been associated with a particular species, however, since *Diplectrum* species have overlapping ranges and meristic features. Generalized *Diplectrum* larvae are characterized by the following: Dorsal fin IX-X, 11-13; anal fin III, 6-9; pectoral fin 15-18; vertebrae 10+14; predorsal pattern 0/0/0,2; body slender; dorsal and pelvic fin spine development precocious; pigment located on jaw, cleithrum, anus, anal fin base, caudal peduncle, and on the dorsal and pelvic fin membranes.

According to Kendall (1979), Type 1 larvae are more common and more characteristic of the genus than Type 2; *D. formosum* probably has Type 1 larvae. Type 1 larvae exhibit most features of other serranine larvae. Body shape of the larva approaches that of the adult, and after fin ray formation they are among the most slender serranine larvae. First dorsal fin spines and pelvic fin elements form early; none of the early forming dorsal spines are very elongate. Individual melanophores are more uniform in size than those of *Centropristis* larvae. A series of about five spots occurs ventrally on the caudal peduncle, with at least one spot on the base of the caudal fin. Type 1 larvae are illustrated in Figure 10, and characteristic spine-bearing bones of the larvae are shown in Figure 11.

3.3 Adult phase

3.31 Longevity

Sand perch reach a total length of about 30 cm (Jordan and Evermann 1896; Cervigon 1966; Randall 1968; Smith 1978), though they are usually considerably smaller. The largest specimen examined by Bortone (1977) was 22.3 cm SL (28.5 cm TL) and 6 yr old. Maximum age is probably 6 to 7 yr (Bortone 1977).

3.32 Hardiness

Sand perch can tolerate temperatures at least as low as 14°C (Hastings 1972, St. Andrew Bay) and as high as 34°C (Tabb and Manning 1961, Whitewater Bay). Gilmore et al. (1978) reported that sand perch remained relatively active during cold waves in the Tampa Bay, FL, area in 1976 and 1977 when temperatures as low as 11.6°C were recorded in bottom waters on offshore reefs; no sand perch were reported killed. Galloway (1941) found dead sand perch near Key West, FL, following a cold wave in 1940; water temperature was measured at 13.9°C.

Juveniles and adults usually leave inshore waters in winter and return in spring (Bortone 1971a). Larvae have been collected from 17.0° to ≥ 32.0°C (Houde et al. footnote 2).

Salinity tolerance of sand perch is at least 18‰ (Gunter and Hall 1965, Caloosahatchee estuary, FL) to 39‰ (Tabb and Manning 1961, Whitewater Bay). Larvae are usually found at salinities ≥ 35‰ (Houde et al. footnote 2). Reid (1954) reported mass mortality of fish, including sand perch, following a hurricane near Cedar Key in 1950 that lowered salinity from 23.5 to 9.7‰ over a 4-d period. Whether mortality was caused by the salinity drop, increased turbidity, or both, is not known.

Sand perch were apparently killed or driven away from shallow (12-18 m) reefs on the west coast of Florida by a red tide in 1971 (Smith 1976). Sightings of sand perch on the reefs dropped dras-

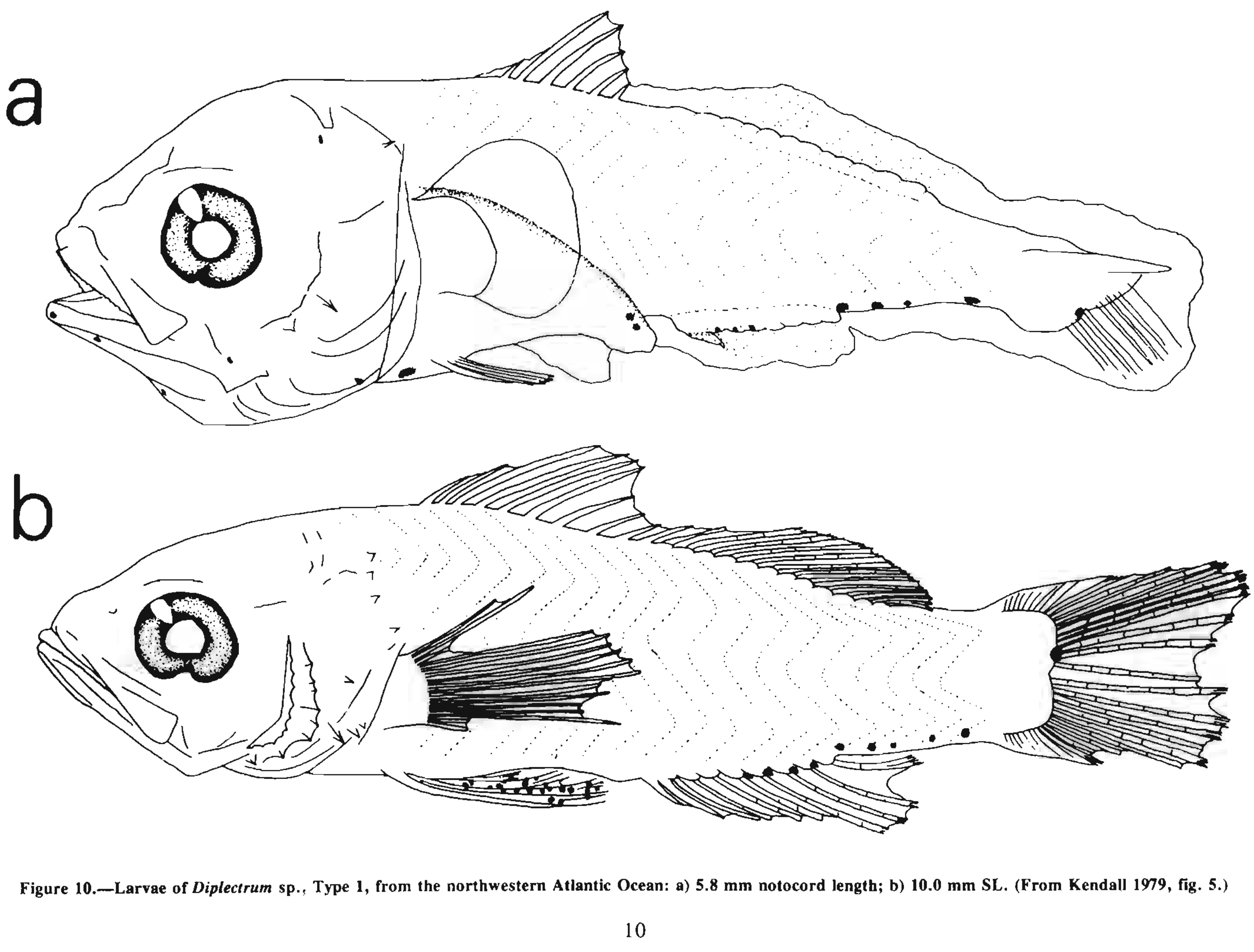


**Figure 10.—Larvae of *Diplectrum* sp., Type 1, from the northwestern Atlantic Ocean: a) 5.8 mm notocord length; b) 10.0 mm SL. (From Kendall 1979, fig. 5.)**

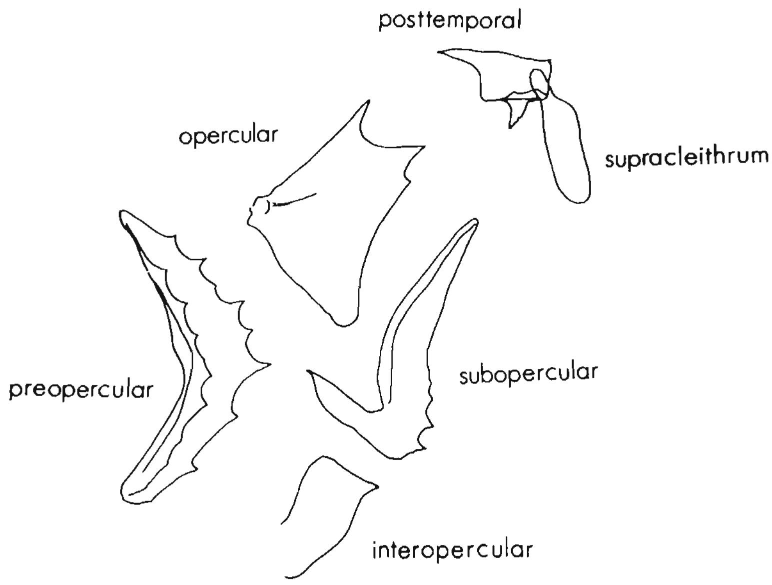


**Figure 11.—Spine-bearing bones of the opercular and posttemporal regions of a 10.3 mm SL *Diplectrum* sp. Type 1 larva. (From Kendall 1979, fig. 7.)**

tically following the red tide and none were sighted for almost a year.

3.33 Competitors

Associates of sand perch in open-shelf habitat of the South Atlantic Bight include longspine porgy, *Stenotomus caprinus*; orange filefish, *Aluterus schoepfi*; searobins (*Prionotus* spp.); and inshore lizardfish, *Synodus foetens* (Struhsaker 1969). Hoese (1973) found sand perch closely associated with pearly razorfish, *Hemipteronotus novacula*, off the Georgia coast. Extensive MARMAP trawling in the South Atlantic Bight produced data appropriate for species cluster analysis (Table 2) (Wenner et al. 1979a, b, c, d, 1980). Species most closely associated with sand perch in the South Atlantic Bight, based on MARMAP surveys, include inshore lizardfish; planehead filefish, *Monacanthus hispidus*; and orange filefish. Most of these species are widely distributed over sand bottom in depths of < 55 m (Wenner et al. 1979a).

**Table 2.—Closest associated species of *Diplectrum formosum* on sand bottom in the South Atlantic Bight based on MARMAP trawling, 1973-75. Approximate similarity indices are based on species cluster inverse analysis, Canberra-Metric correlation on log-transformed data. (Data from Wenner et al. 1979a, b, c, d, 1980.)**

| Species | Fall 1973 | Spring 1974 | Summer 1974 | Winter-early Spring 1975 | Summer 1975 |
|---|---|---|---|---|---|
| *Synodus foetens* | 0.52 | 0.52 | 0.45 | 0.25 | 0.53 |
| *Stephanolepis hispidus* | | | | | |
| (= *Monacanthus hispidus*) | 0.41 | —[1] | 0.55 | — | 0.42 |
| *Aluterus schoepfi* | 0.15 | 0.39 | 0.30 | 0.17 | — |
| *Balistes capriscus* | 0.15 | — | — | — | 0.00 |
| *Prionotus carolinus* | 0.15 | — | −0.05 | — | 0.00 |
| *Chaetodipterus faber* | 0.00 | — | — | — | — |
| *Lactophrys quadricornis* | 0.00 | — | — | — | 0.00 |
| *Raja eglanteria* | — | 0.20 | — | 0.17 | — |
| *Stenotomus aculeatus* | | | | | |
| (= *S. caprinus*) | — | 0.15 | −0.05 | 0.34 | 0.22 |
| *Ophidion grayi* | — | −0.10 | — | — | — |
| *Mustelus canis* | — | −0.10 | — | — | — |
| *Ancylopsetta quadrocellata* | — | −0.10 | — | — | 0.00 |
| *Syacium papillosum* | — | — | −0.05 | −0.05 | — |
| *Centropristis ocyurus* | — | — | −0.05 | −0.05 | — |
| *Prionotus salmonicolor* | — | — | — | −0.05 | 0.00 |
| *Ophidion holbrooki* | — | — | — | −0.05 | — |
| *Trachinocephalus myops* | — | — | — | −0.05 | — |
| *Scorpaena calcarata* | — | — | — | −0.05 | — |
| *Hemipteronotus novacula* | — | — | — | — | 0.00 |

[1]No data.

On the West Florida Shelf, a trawling survey in 9-193 m from off Cape San Blas, FL, to the Dry Tortugas, FL, produced numerous specimens of sand perch (Darcy and Gutherz footnote 3). Cluster analysis indicated that closest associates of sand perch on the West Florida Shelf are scrawled cowfish, *Lactophrys quadricornis*; black sea bass, *Centropristis striata*; grass porgy, *Calamus arctifrons*; shortnose batfish, *Ogcocephalus nasutus*; conger (*Hildebrandia* sp.); spottail pinfish, *Diplodus holbrooki*; and crested cusk-eel, *Ophidion welshi*.

In the northern Gulf of Mexico, in 1-7 m of water, Bortone (1971a) observed sand perch associated with belted sandfish, *Serranus subligarius*; pygmy sea bass, *Serraniculus pumilio*; pigfish, *Orthopristis chrysoptera*; spot, *Leiostomus xanthurus*; pinfish, *Lagodon rhomboides*; cocoa damselfish, *Pomacentrus variabilis*; slippery dick, *Halichoeres bivittatus*; crested blenny, *Hypleurocheilus geminatus*; and doctorfish, *Acanthurus chirurgus*. In deeper water (7-36 m), associates of sand perch reported by Bortone included bank sea bass, *Centropristis ocyurus*; southern sea bass, *Centropristis striata melana*; gag, *Mycteroperca microlepis*; red snapper, *Lutjanus campechanus*; vermilion snapper, *Rhomboplites aurorubens*; greater amberjack, *Seriola dumerili*; white grunt, *Haemulon plumieri*; red porgy, *Pagrus pagrus*; and gulf flounder, *Paralichthys albigutta*.

To what extent these associated species actually compete with sand perch is not known. Most of the species listed above are carnivores, as are sand perch, and some probably compete with sand perch for food. Since sand perch are smaller than many of the associated species, juveniles of some of the larger species of serranids, lutjanids, and carangids may compete with sand perch more than the adults of those species do.

A study by Bortone et al. (1981) comparing morphology, abundance, food, and feeding habits of *D. formosum* and *D. bivittatum*, in the vicinity of the Dry Tortugas, did not reveal a mechanism for reducing or eliminating competition between these often sympatric species. Jaw structures, gill raker structures, body size, mouth size, and time of feeding were remarkably similar, and there were few differences in the food habits observed. Some competitive exclusion may occur due to competition that results in segregation based on substrate preference (Bortone et al. 1981).

3.34 Predators

Predators of sand perch include snappers and groupers (Jordan and Gilbert 1883; Jordan 1885); red porgy, *Pagrus pagrus* (Manooch 1977); red drum, *Sciaenops ocellatus* (Overstreet and Heard 1978); and bull shark (Branstetter 1981). Other large piscivores, such as jacks, barracudas, and flatfishes, probably also prey on sand perch. According to Böhlke and Chaplin (1968), sand perch dart into holes to escape predators.

3.35 Parasites, diseases, injuries, and abnormalities

Parasites of sand perch include nematodes and digenetic trematodes. Nahhas and Powell (1971) found the trematode *Lecithochirium parvum* in the stomach of a sand perch from Pensacola Bay, FL. The nematode *Hysterothylacium reliquens* has also been reported from sand perch (Deardorff and Overstreet 1981).

Sand perch are apparently killed or driven off by red tides. Smith (1976) noted a dramatic reduction in sand perch sightings on shallow reefs off the west coast of Florida following a red tide outbreak.

See 3.32.

3.4 Nutrition and growth

3.41 Feeding

Sand perch feed primarily on or near the bottom near low reefs or rocks (Bortone 1971a). These feeding habits are reflected in the foods reported from sand perch stomachs. Bortone (1971a) described sand perch as aggressive and voracious feeders. No seasonality of feeding was detected in Bortone's (1971a) study in the northern Gulf of Mexico. Feeding activity appears to be greatest in mid-morning and mid-afternoon (Bortone et al. 1981) (Fig. 12).

See 3.42.

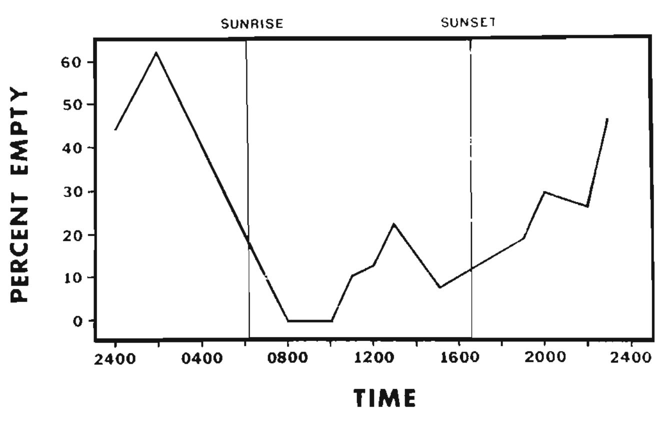


**Figure 12.—Feeding activity of *Diplectrum formosum* from off the Dry Tortugas, FL. (From Bortone et al. 1981, fig. 2.)**

3.42 Food

Sand perch feed primarily on benthic crustaceans and fishes. Longley and Hildebrand (1941) reported that sand perch fed mainly on crabs and shrimp at Dry Tortugas. Lowe-McConnell (1962) and Böhlke and Chaplin (1968) came to the same conclusion based on specimens from the coast of Guyana and the Bahamas, respectively. At Cedar Key, Reid (1954) found that 70-110 mm SL specimens taken in fall contained caridean and palaemonid shrimps, and mysids; samples from October contained primarily penaeid shrimps. Copepods and fish also occurred in specimens examined by Reid (1954). In Venezuela, Cervigon (1966) reported shrimp and other decapod crustaceans, engraulid fishes, amphipods, larval shrimp, and planktonic decapod crustacean larvae among foods eaten by sand perch.

A more thorough study of food habits of sand perch was conducted by Bortone (1971a) in the northern Gulf of Mexico (Table 3). Crabs and shrimp made up the major part of the diet. Amphipods were particularly important in the diets of young fish. Fishes made up a moderate portion of the diet and included small sea bass (*Centropristis* sp.), sea robins (*Prionotus* sp.), blennies, gobies, flatfishes (*Symphurus* sp.), and filefish (*Monacanthus* sp.). Other food items included hermit crabs, isopods, stomatopods, crab zoeae, polychaetes, bivalve mollusks, and ophiuroids.

Another study of food habits of sand perch was conducted by Bortone et al. (1981) near the Dry Tortugas; food habits of the sand perch were compared with a sympatric congener, the dwarf sand perch, *D. bivittatum*. Sand perch examined contained primarily amphipods, natantian shrimp, and brachyuran crabs, by number; and fish, shrimp, and crabs, by volume (Table 4). Among crustaceans identified from the guts were *Alpheus floridanus*, *Thor* sp., *Sicyonia brevirostris*, *Periclimenes* sp., *Solenocera* sp., *Portunus* sp., *Speocarcinus lobatus*, *Caprella* sp., *Eurysquilla plumata*, *Squilla chydaea*, and *Squilla heptacantha*. Sand perch consumed

**Table 3.—Stomach analysis of 154 specimens of *Diplectrum formosum* from the northern Gulf of Mexico in percentage frequency of occurrence and average number of organisms per stomach. (From Bortone 1971a, table 2.)**

| Food item | Frequency (%) | Average number |
|---|---|---|
| Annelid worms | | |
| Polychaetes | 4.5 | < 0.1 |
| Mollusks | | |
| Bivalves | 2.6 | < 0.1 |
| Crustaceans | | |
| Isopods | 1.3 | < 0.1 |
| Amphipods | 11.1 | 0.4 |
| Stomatopods | 0.7 | < 0.1 |
| Decapods | 67.0 | 7.1 |
| Shrimp | 56.5 | 6.0 |
| Crabs | 37.7 | 1.1 |
| Echinoderms | | |
| Ophiuroids | 1.9 | < 0.1 |
| Fishes | | |
| Perciforms | 3.9 | < 0.1 |
| Scorpaeniforms | 3.9 | < 0.1 |
| Pleuronectiforms | 2.6 | < 0.1 |
| Tetraodontiforms | 0.7 | < 0.1 |
| Unidentified | 15.6 | 0.2 |
| Plants | 3.9 | 0.0 |
| Unidentified material | 12.3 | 0.0 |
| Empty | 17.5 | 0.0 |

Table 4.—Stomach content analysis of 326 *Diplectrum formosum* (100 empty). (From Bortone et al. 1981, table 1.)

| Food item | % No. | No./fish | % Vol. | Vol./fish (μl/g) | Vol./item (μl/g) | Vol. (μl)/item per g fish |
|---|---|---|---|---|---|---|
| Nematoda | 1.3 | 0.05 | —[1] | — | — | — |
| Polychaeta | 2.2 | 0.08 | 4.8 | 20 | 232 | 5.80 |
| Unident. worms | 0.7 | 0.03 | — | — | — | — |
| Natantia | 21.5 | 0.83 | 20.7 | 84 | 102 | 2.54 |
| Brachyura | 8.5 | 0.33 | 13.0 | 53 | 161 | 4.03 |
| Stomatopoda | 0.9 | 0.04 | 4.9 | 20 | 563 | 14.09 |
| Mysidacea | 0.7 | 0.03 | 0.1 | 1 | 17 | 0.42 |
| Cumacea | 0.3 | 0.01 | — | — | — | — |
| Amphipoda | 29.5 | 1.14 | 0.3 | 1 | 1 | 0.03 |
| Unident. crustaceans | 16.1 | 0.62 | 12.5 | 51 | 82 | 2.06 |
| Mollusca | 3.5 | 0.13 | 1.2 | 5 | 37 | 0.92 |
| Ophiuroidea | 6.4 | 0.23 | 5.8 | 24 | 95 | 2.37 |
| Pisces | 6.1 | 0.23 | 31.2 | 127 | 542 | 13.56 |
| Unidentifiable | 2.3 | 0.09 | 5.6 | 23 | 255 | 6.39 |

[1]Measured volume displaced < 0.1 ml.

nearly the same frequency of food items as the dwarf sand perch, though the sand perch contained a more even distribution of the items.

3.43 Growth rate

Otoliths can be used to age sand perch, annuli being formed in March-April in the northern Gulf of Mexico (Bortone 1971a). Fish length and otolith radius are related as follows:

$$Y = 0.12002 + 0.02753X \quad (r^2 = 0.988)$$

where $Y$ is otolith radius in millimeters and $X$ is standard length in millimeters (Bortone 1971a). Growth rate is fastest in the first 3 yr of life, slowing after annulus 3 is laid down (Table 5, Fig. 13).

Length and weight of sand perch are related as follows:

$$\log W = -4.67194 + 3.04051 \log L$$

where $W$ is body weight in grams and $L$ is standard length in millimeters ($n$ = 194; range = 21-223 mm SL, 0.3-331.0 g).

Table 5.—Mean annual increase in standard length (SL) of *Diplectrum formosum* in the northern Gulf of Mexico based on otolith readings. (Data from Bortone 1971a, table 1.)

| | Year | | | | | |
|---|---|---|---|---|---|---|
| | 1 | 2 | 3 | 4 | 5 | 6 |
| SL increase (mm) | 34.7 | 43.2 | 59.5 | 37.8 | 21.0 | 11.2 |
| SL (mm) | 34.7 | 77.9 | 137.4 | 175.2 | 196.2 | 207.4 |

3.5 Behavior

3.51 Migrations and local movements

Sand perch are not known to undergo large-scale migrations, but evidence indicates that there is seasonal inshore-offshore movement. Both Bortone (1971a) and Hastings (1972) observed a decrease in sand perch abundance in shallow water as the temperature dropped in late autumn. A few juveniles remain in shallow water all winter, but most juveniles and virtually all adults are absent from shallow water in winter (Hastings 1972). Juveniles and adults return to shallow water in spring when waters warm. Since sand perch are common on offshore reefs in winter, Hastings (1972) theorized that the fish leaving shallow water winter offshore.

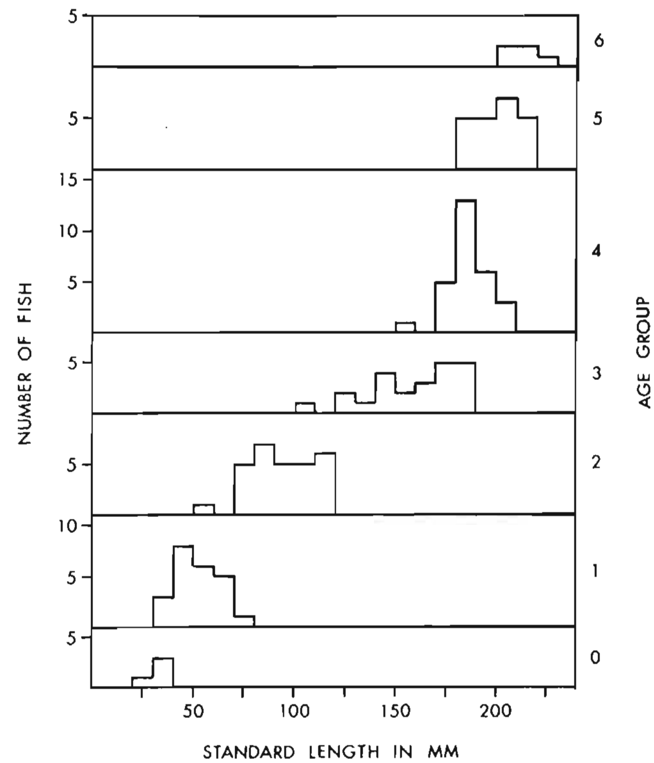


Figure 13.—Length-frequency histograms of *Diplectrum formosum* aged by otoliths for age-groups 0 through 6. (From Bortone 1971a, fig. 5.)

Local movements are probably slight. Sand perch are territorial, living in holes in the bottom or under rocks; some holes they dig themselves by vibrating their bodies rapidly to throw up loose sand, others they find ready-made (Longley and Hildebrand 1941; Böhlke and Chaplin 1968). When approached by divers or large fish, sand perch dive into cover (Longley and Hildebrand 1941). Young have been seen darting into depressions occupied by stone crabs (Bortone 1971a). Bortone (1971a) observed a sand perch in an aquarium bury itself in the sand with only its eyes protruding, indicating a possible escape reaction. One fish may occupy the same hole for a long period of time (Böhlke and Chaplin 1968).

Each sand perch maintains a home territory which it defends against intruders. Barans and Burrell (1976) theorized that this territoriality could explain the fairly uniform distribution of sand perch on the continental shelf of the South Atlantic Bight. Individuals have been shown to return to their home territories if displaced (Bortone 1971a).

See 3.52.

### 3.52 Schooling

Sand perch do not appear to school; territoriality tends to space the individuals apart. Size of home territories increases with increasing size of the fish (Bortone 1971a). Individuals < 40 mm TL occur as close together as 1 m apart, whereas 100 mm individuals are found about 3 m apart (Bortone 1971a).

### 3.53 Responses to stimuli

Sand perch respond to falling water temperatures by moving to deeper water. Strong currents may force them to leave their home territories temporarily (Bortone 1971a). Light also affects activity patterns, with greatest activity occurring during daylight and general inactivity at night (Starck and Davis 1966; Bortone 1971a; Hastings et al. 1976) (Fig. 14). Roessler (1965) caught more sand perch at night than during the day in Biscayne Bay, FL, possibly because their reduced activity at night slowed their escape response to the trawl.

See 2.3.

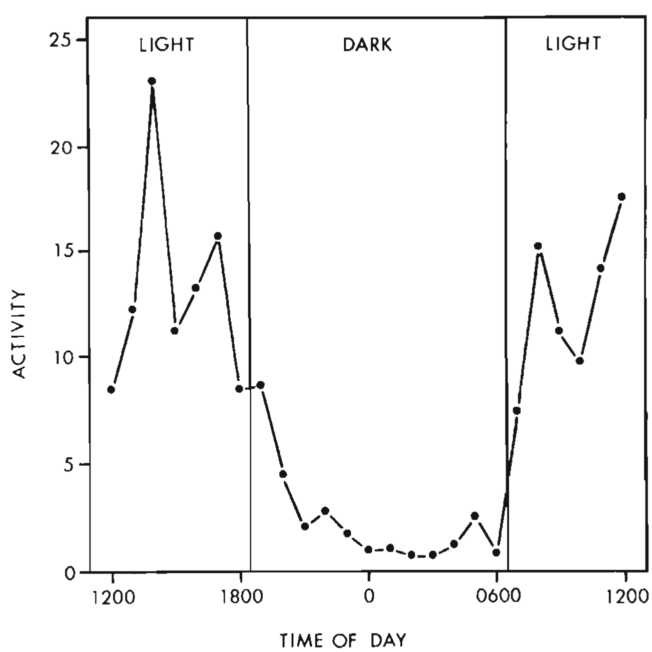


**Figure 14.—Activity pattern of *Diplectrum formosum* based on three trials on one fish in an aquarium. Activity is the number of 10 cm squares the fish traversed per minute. (From Bortone 1971a, fig. 7.)**

## 4 POPULATION

### 4.1 Structure

#### 4.11 Sex ratio

Sand perch are synchronous hermaphrodites. There are no separate sexes.

#### 4.13 Size composition

Larval sand perch collected by Houde (1982) had a standard length mode of 2.1-3.0 mm during seasons when larvae were abundant and spawning was at a peak (primarily spring and early summer). During the rest of the year, the modal length increased to 3.1-4.0 mm.

Length-frequency histograms based on MARMAP surveys of the South Atlantic Bight over a 2-yr period indicate that the modal size of sand perch in that area is about 20-22 cm FL and is quite constant over time (Wenner et al. 1979a, b, c, d, 1980) (Fig. 15). Summer and fall MARMAP surveys showed a small size class of sand perch (mode about 5 cm FL) entering the population at that time. Few individuals > 25 cm FL were collected.

See 2.3, 4.33, Figure 6.

#### 4.14 Subpopulations

There is no direct evidence that subpopulations of sand perch exist, though the two subspecies named by Bortone (1977) based on morphometric differences may indicate subpopulations. To what extent the subspecies are reproductively isolated is not known.

### 4.2 Abundance and density

Sand perch are often quite abundant and may occur over large areas of bottom. Because they are not schooling fish, extremely large catches of sand perch are seldom reported. Abundance of sand perch may not be accurately reflected by trawl catches due to their ability to dart into holes or under other cover.

In the South Atlantic Bight, sand perch are very common and are among the most ubiquitous fishes of the open shelf. Struhsaker (1969) collected sand perch at more than 50% of the stations he sampled. Barans and Burrell (1976) reported sand perch catch rates of 0.29 kg/30-min tow in winter to 0.69 kg/30-min tow in summer, with greatest catch rates in 19-27 m. Sand perch composed about 2% of the total fish catch weight in Barans and Burrell's survey. Observations from research submersibles off the central east coast of Florida (Avent and Stanton 1979) indicate that sand perch are dominant members of the sand-bottom communities of the inner and outer continental shelf between lat. 27°30′ and 28°30′N.

MARMAP groundfish surveys in the South Atlantic Bight have provided much information on distribution and abundance of sand perch in that area. Sand perch were most abundant in 19-27 m in all seasons surveyed (Fig. 16), but occurred in a high percentage of samples in 9-55 m. They contributed the highest proportion of the total fish catch by number and by weight in 28-55 m (Table 6). The sand perch was the most abundant serranid in the MARMAP survey area (Wenner et al. 1979b). Minimum standing stock estimates of sand perch in the South Atlantic Bight for fall 1973 and spring 1974 appear in Table 7. Density estimates for spring 1974 were 3.1 individuals/ha and 0.361 kg/ha for log-transformed data

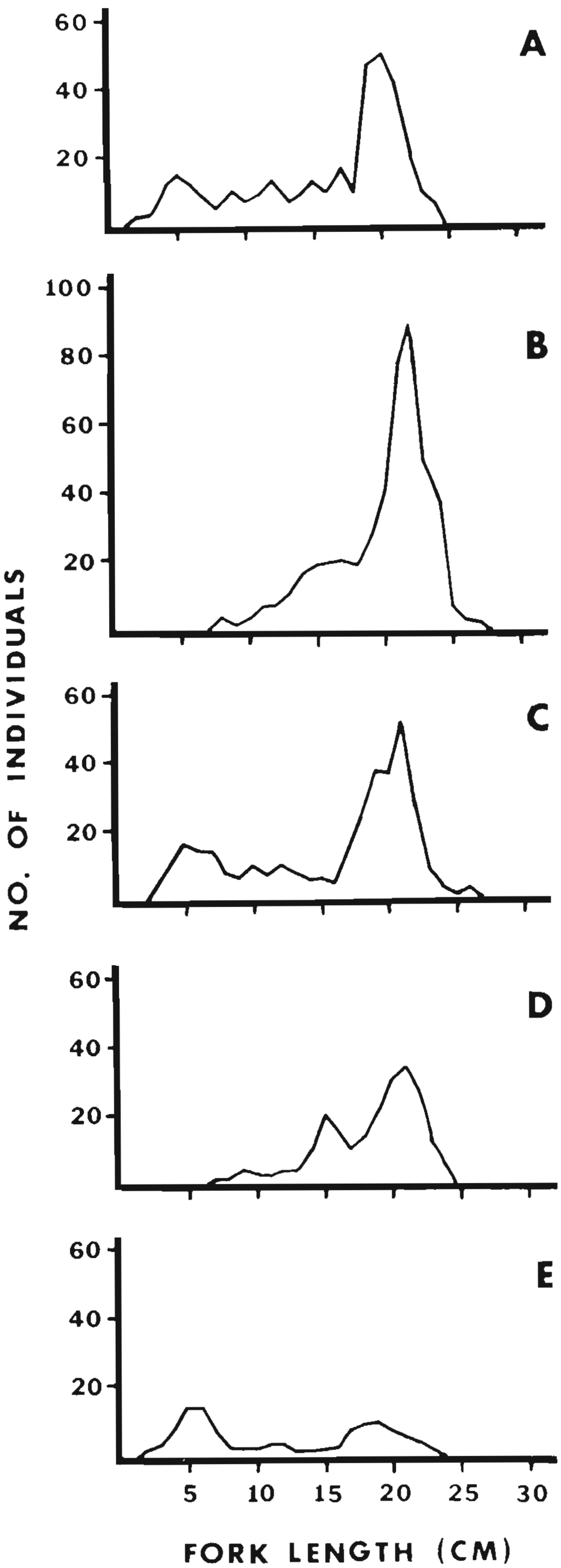


Figure 15.—Length-frequencies of *Diplectrum formosum* in the South Atlantic Bight: A. Fall 1973; B. spring 1974; C. summer 1974; D. winter-early spring 1975; E. summer 1975, based on MARMAP groundfish cruises. (Based on Wenner et al. 1979a, fig. 14B; 1979b, fig. 10D; 1979c, fig. 7D; 1979d, fig. 8D; 1980, fig. 4F.)

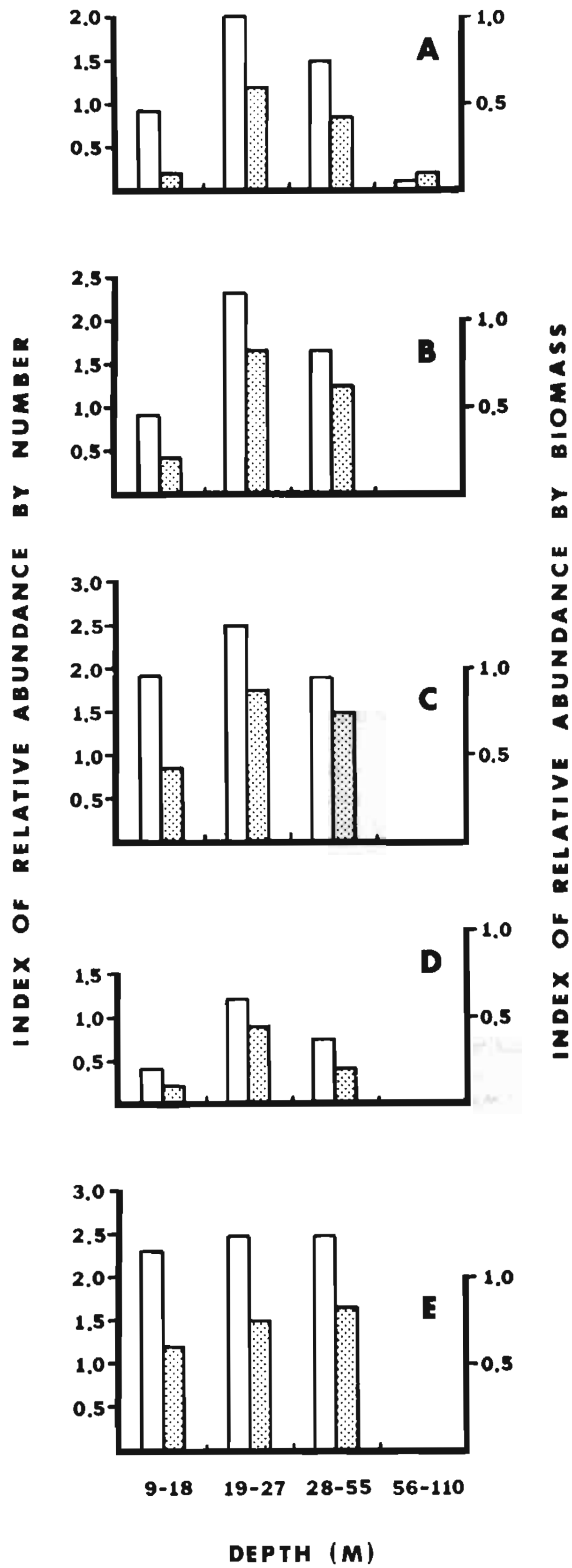


Figure 16.—Indices of relative abundance of *Diplectrum formosum* from the South Atlantic Bight, 1973-75. A. Fall 1973; B. spring 1974; C. summer 1974; D. winter-early spring 1975; E. summer 1975, based on MARMAP groundfish cruises. Shaded columns represent indices based on biomass, open columns represent indices based on numbers. (From Wenner et al. 1979a, fig. 14A; 1979b, fig. 10C; 1979c, fig. 7C; 1979d, fig. 8C; 1980, fig. 4E.)

Table 6.—Percentage of total catch by number and weight of *Diplectrum formosum* in the South Atlantic Bight based on MARMAP groundfish surveys. (Data from Wenner et al. 1979a, b, c, d, 1980.)

| Date of survey | Depth range (m) 9-18 %No. | 9-18 %Wt. | 19-27 %No. | 19-27 %Wt. | 28-55 %No. | 28-55 %Wt. | 56-110 %No. | 56-110 %Wt. |
|---|---|---|---|---|---|---|---|---|
| Fall 1973 | 1.1 | —[1] | 2.8 | 2.7 | 10.5 | 11.1 | — | — |
| Spring 1974 | 0.5 | 2.5 | 4.2 | 6.8 | 4.6 | 6.7 | 0 | 0 |
| Summer 1974 | 7.9 | 6.3 | 10.8 | 11.4 | 23.4 | 21.6 | 0 | 0 |
| Winter-early spring 1975 | 1.7 | 3.5 | 0.7 | 7.8 | — | 2.0 | 0 | 0 |
| Summer 1975 | 2.8 | 7.6 | 6.3 | 10.1 | 22.8 | 11.6 | 0 | 0 |

[1]Not given.

(Wenner et al. 1979b). Estimated density of sand perch in summer 1975 was 6.6 individuals/ha and 0.38 kg/ha, for an estimated standing stock of $3.71\times10^7$ individuals or $2.14\times10^3$ t (metric tons) in the South Atlantic Bight at 9-55 m (Wenner et al. 1980).

In the eastern Gulf of Mexico, sand perch have been reported locally common in shallow water, as well as on offshore reefs and on live bottom on the West Florida Shelf. Large individuals are frequently caught from bridges and bulkheads in Tampa Bay and on reefs offshore (Springer and Woodburn 1960). Hastings (1972) reported sand perch common near jetties and on offshore reefs in the northeastern Gulf. In St. Andrew Bay, sand perch comprised 2.6% of trawl catches in a survey by Pristas and Trent (1978). Sand perch are among the dominant fish on natural and artificial reefs off Clearwater, FL (Smith et al. 1979). A groundfish survey of the West Florida Shelf (Darcy and Gutherz 1984) indicated that sand perch are most common in 9-35 m of water in the area between Tampa Bay and Dry Tortugas, (Fig. 17) where they made up 9.9% of total fish biomass in the survey tows. Sand perch were present at 35.5% of the stations sampled between Cape San Blas, FL, and the Dry Tortugas. Over the entire survey area, sand perch ranked fifth in biomass of all fish species; 5.1% of total fish biomass was contributed by sand perch. Abundance of sand perch was greatest in 19-27 m, both in number of individuals caught and biomass (Darcy and Gutherz footnote 3) (Fig. 18). Hourglass investigations of the West Florida Shelf indicated that sand perch may be abundant enough to be of some commercial importance (Joyce 1968).

Sand perch larvae are among the most abundant and most frequently caught fish larvae in the eastern Gulf of Mexico (Houde et al. footnote 2); 55.5% of all serranid larvae collected were sand perch (Houde 1982). Houde et al. (footnote 2) collected sand perch larvae on all 17 cruises to the eastern Gulf, though they were most abundant from spring to fall. Mean larval abundance ranged from 0.3 to 29.8 larvae under each 10 m² of surface area, with maximum abundance in May. Although larval abundance indicates large sand perch biomass in the eastern Gulf, relatively high fecundity may mean that the actual biomass is not as large as the larval abundance indicates (Houde et al. footnote 2). Because of their abundance, sand perch larvae may be useful indicators to monitor effects of environmental changes in the Gulf of Mexico ecosystem (Houde 1982).

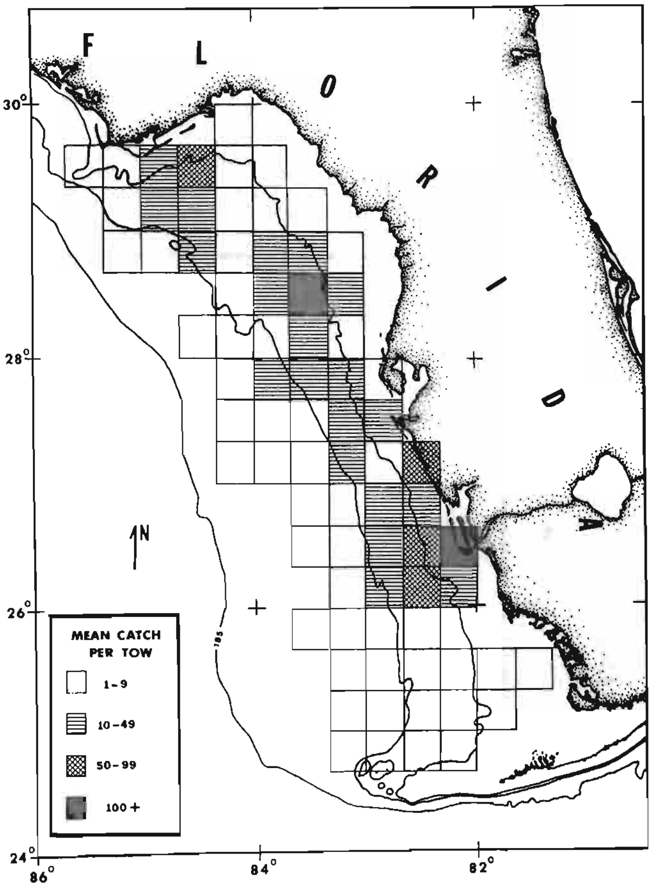


Figure 17.—Mean catches of *Diplectrum formosum* by 20′ latitude × 20′ longitude grid zones on the West Florida Shelf based on bottom trawling by the *Oregon II*, Cruise 85, January 1978. Catches are per 10-min tow of a 12.2 m semi-balloon shrimp trawl. Isobaths are 18.5, 37, and 185 m.

Table 7.—Minimum standing stock estimates of *Diplectrum formosum* in the South Atlantic Bight, 9-55 m in fall 1973 and spring 1974. The Bliss approximation has been used for the estimate on natural log transformed data. Data have not been adjusted for vulnerability of this species to the 3/4 Yankee trawl and should be regarded as minimum estimates. LCL and UCL are lower and upper 90% confidence limits, respectively. Biomass is expressed in metric tons. (Data from Wenner et al. 1979a, table 17; 1979b, table 14.)

| | Fall 1973 Standing stock | Fall 1973 LCL | Fall 1973 UCL | Spring 1974 Standing stock | Spring 1974 LCL | Spring 1974 UCL |
|---|---|---|---|---|---|---|
| Number | | | | | | |
| untransformed | $1.47\times10^7$ | $0.91\times10^7$ | $2.03\times10^7$ | $1.56\times10^7$ | $1.19\times10^7$ | $1.94\times10^7$ |
| transformed | $1.51\times10^7$ | $1.09\times10^7$ | $2.05\times10^7$ | $1.75\times10^7$ | $1.33\times10^7$ | $2.28\times10^7$ |
| Biomass | | | | | | |
| untransformed | $1.17\times10^3$ | $0.72\times10^3$ | $1.63\times10^3$ | $2.11\times10^3$ | $1.50\times10^3$ | $2.71\times10^3$ |
| transformed | $1.12\times10^3$ | $0.83\times10^3$ | $1.45\times10^3$ | $2.03\times10^3$ | $1.59\times10^3$ | $2.54\times10^3$ |

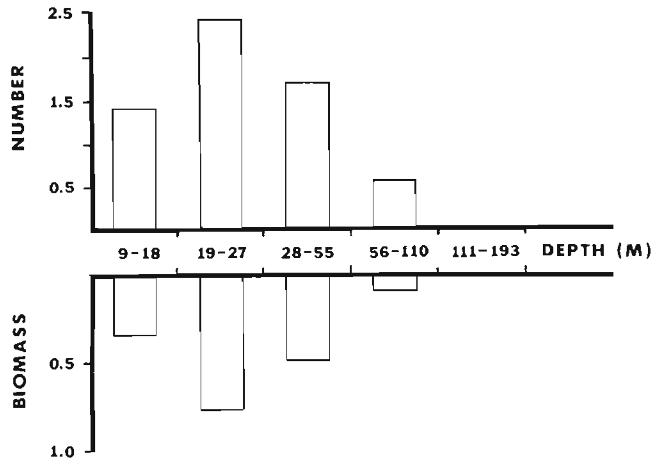


**Figure 18.—Index of relative abundance of *Diplectrum formosum* on the West Florida Shelf, January 1978. (Darcy and Gutherz see text footnote 3.)**

Sand perch are not very common in the northwestern Gulf of Mexico (Hoese and Moore 1977). They rarely occur on brown shrimp grounds in the western Gulf (Hildebrand 1954).

On Campeche Bank, sand perch are very common in 11-19 m, and are among the most abundant fishes of the pink shrimp grounds (Hildebrand 1954, 1955). During MEXUS-GOLFO[4] trawling investigations of Campeche Bank, sand perch were the third largest component (4.9%) of the fish catch during the day, and the eighth largest component (1.9%) at night. The average total biomass of sand perch on Campeche Bank was estimated at 16,000 t by Sauskan and Olaechea (1974).

Off northern South America, sand perch are common in 45-50 m of water on shell and sand bottoms (Durand 1960).

See 2.1, 2.2, and 2.3.

### 4.3 Natality and recruitment

#### 4.31 Reproduction rates

The reproduction rate of sand perch is not known. Houde et al. (footnote 2) stated that sand perch may have high relative fecundity (ova produced per gram of somatic tissue).

#### 4.32 Factors affecting reproduction

Reproduction is apparently influenced by season (water temperature). Highest larval densities in the eastern Gulf of Mexico were reported in spring through fall, particularly in May (Houde et al. footnote 2), indicating a spawning peak as waters warm (Figs. 8, 9). Some spawning occurs year-round, particularly in the southeastern Gulf (Houde 1982; Houde et al. footnote 2).

See 2.3 and 3.16.

#### 4.33 Recruitment

Small sand perch (< 10 cm FL) appear in summer and fall trawl catches in the South Atlantic Bight (Wenner et al. 1979a, c, 1980), indicating that small individuals are recruited to the demersal fish community during that period (see Figs. 6, 15).

See 2.1, 3.16, and 4.13.

### 4.4 Mortality and morbidity

Sand perch are known to be killed by low temperatures (Galloway 1941), and are suspected of being killed by red tides (Smith 1976). Mortality data for larval sand perch from the eastern Gulf of Mexico were presented by Houde et al. (footnote 2) (Fig. 19). Approximately 98% mortality occurs between 2.8 and 7.8 mm SL.

See 3.32.

### 4.6 The population in the community and the ecosystem

Sand perch are important members of open-shelf and live-bottom communities of the southeastern United States because of their abundance and their widespread distribution on the shelf. Associated fishes include sharks, rays, lizardfishes, cusk-eels, sea basses, porgies, spadefishes, razorfish, scorpionfishes, searobins, flatfishes, cowfish, filefishes, and trunkfishes (Table 2). A generalized diagram of the trophic position of sand perch appears in Figure 20.

Seasonal inshore-offshore migrations of some sand perch may effect transfer of energy to inshore fish communities in spring and to offshore communities in fall.

See 3.33, 3.34, and 3.51.

## 5 EXPLOITATION

### 5.1 Fishing equipment

Sand perch are caught on handlines, in fish traps, and in bottom trawls (Smith 1978). They are a common catch of recreational fishermen using hook and line from shore, bridges, small private boats, and party boats. Hastings (1972) reported that they are fished by charter boats off the Florida Panhandle. Shrimp trawlers sometimes catch sand perch (Siebenaler 1952; Anderson and Gehringer 1965; Anderson 1968; Keiser 1977).

### 5.2 Fishing areas

Sand perch are caught throughout their range (Smith 1978), though there appears to be no directed fishery. Shrimp trawlers fishing off North Carolina sometimes land small quantities of sand perch (Keiser 1977). Sand perch also enter shrimp catches off northeastern Florida and off Key West (Siebenaler 1952) and industrial bottomfish catches in the northern Gulf of Mexico (Roithmayr 1965).

Recreational catches of sand perch are greatest in Florida, though they are occasionally caught by headboat fishermen off the Carolinas in 28-93 m (Huntsman 1976). They are commonly taken on offshore reefs and on snapper-grouper banks off the west coast of Florida (Moe and Martin 1965; Bortone 1971a), as well as inshore in bays, tidal creeks, and from bridges (Sutherland 1977; Smith 1978). All reported recreational landings of sand perch in 1979 were from Florida (U.S. Department of Commerce 1980); 10.4% of the catch was from the Atlantic coast and 89.6% from the Gulf coast. Throughout Florida, 66.2% of reported sand perch were caught > 4.8 km (3 mi) from shore, 5.5% were caught in open water < 4.8 km from shore, 2.9% were caught in enclosed

[4]MEXUS-GOLFO. 1979. Report on MEXUS-GOLFO research activities. Mimeogr., 11 p. Southeast Fisheries Center, National Marine Fisheries Service, NOAA, 75 Virginia Beach Drive, Miami, FL 33149-1099.

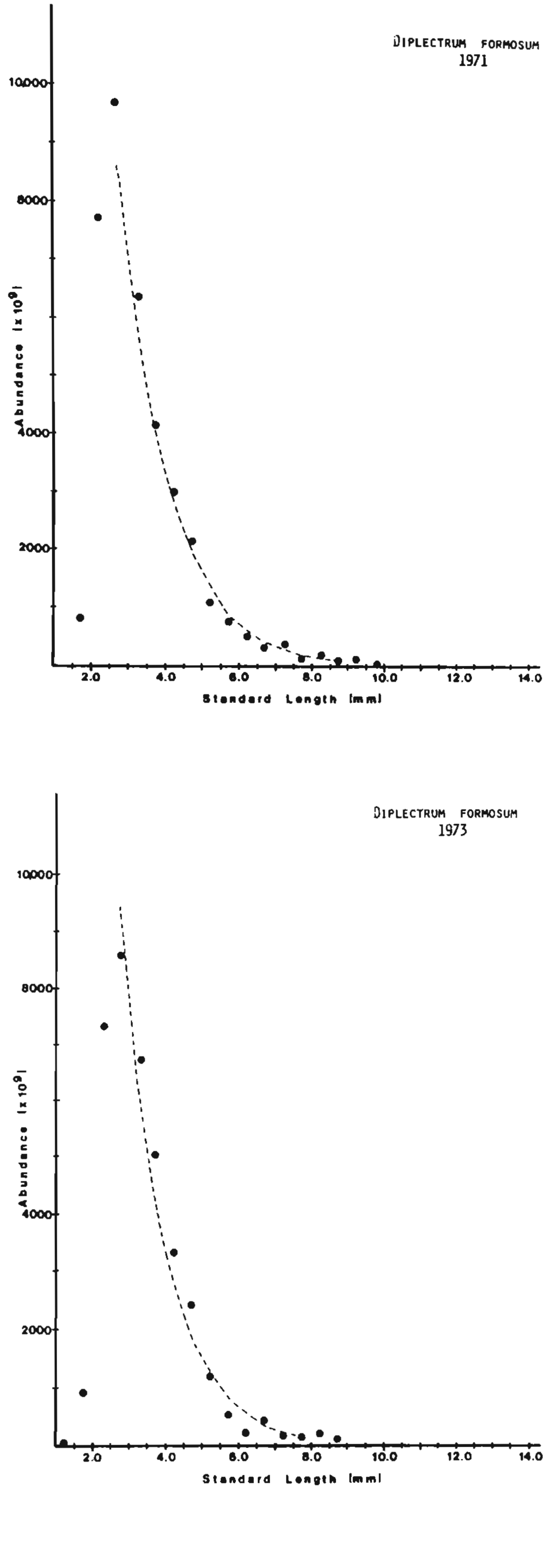


Figure 19.—Apparent mortality rates of *Diplectrum formosum* larvae determined by ichthyoplankton survey cruises to the eastern Gulf of Mexico, 1971-73. (From Houde et al. see text footnote 2, fig. 162.)

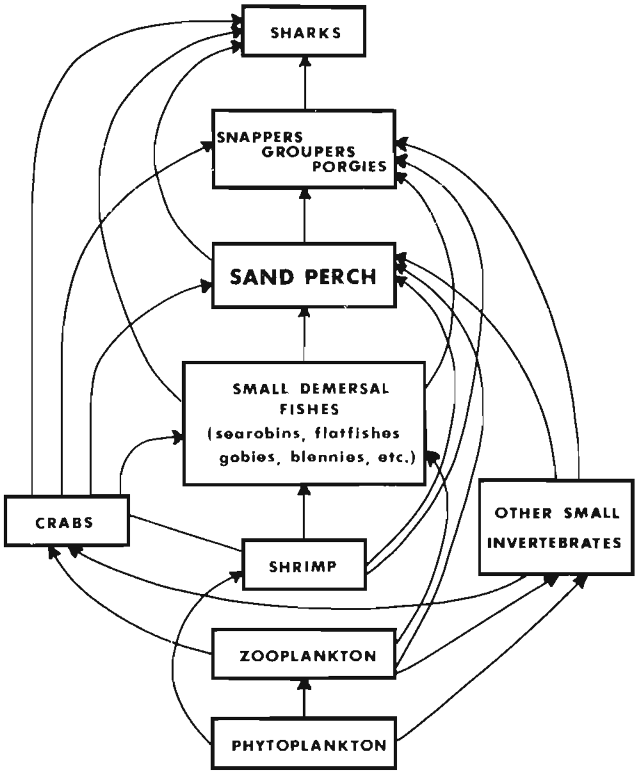


**Figure 20.—Schematic diagram of the major trophic relationships of *Diplectrum formosum* in the southeastern United States. Direction of arrows is from prey or food item to consumer.**

coastal waters, and 25.2% were from unknown areas. On the Atlantic coast of Florida most were caught < 4.8 km from shore, whereas on the Gulf coast most were caught beyond 4.8 km.

See 2.1 and 5.43.

5.3 Fishing seasons

No well-defined fishing seasons for sand perch exist. Hastings (1972) reported that charter boats off Destin and Panama City, FL, sometimes target sand perch in winter when larger species are not available. Sand perch are available offshore year-round, but are not common inshore in winter; inshore catches are probably low in winter. In St. Andrew Bay, most reported sand perch catches from bridges are in October and November (Sutherland 1977).

5.4 Fishing operations and results

5.41 Effort and intensity

There is little effort information available for sand perch. MARMAP groundfish cruises have provided some catch/effort data from the South Atlantic Bight. In fall 1973, mean catch/30-min tow was 7.56 individuals, with a mean weight of 0.563 kg/tow (based on log-transformed catch data) (Wenner et al. 1979a). Spring 1974 catch rates were 8.8 individuals/30-min tow, and 1.022 kg/tow based on transformed catch data (Wenner et al. 1979b).

See 5.43.

5.43 Catches

Separate catch statistics are not reported for sand perch (Smith 1978), though recreational fishing surveys have collected some data on noncommercial catches. Sand perch enter commercial catches primarily as by-catch of fisheries directed at sciaenid bottomfishes (Roithmayr 1965) and shrimp (Siebenaler 1952; Anderson and Gehringer 1965; Anderson 1968; Keiser 1977). Only small numbers are actually landed. Some are retained for use as bait for larger fish species, such as groupers (Bortone 1971a).

Sand perch are of considerable importance as recreational fish, though they are seldom targeted. They are caught from shore, bridges, jetties, and small boats inshore, and from larger private, charter, and party boats offshore (Moe and Martin 1965; Bortone 1971a; Hastings 1972; Huntsman 1976; Sutherland 1977; Smith 1978). Because of their small size, sand perch are not often the preferred catch, but they are excellent food fish and fight gamely on light tackle (Jordan and Evermann 1904; La Monte 1952; Hastings 1972). They are sometimes sought when other larger species are not available (Hastings 1972).

Recreational catches of sand perch reported in 1979 were entirely from Florida waters (U.S. Department of Commerce 1980). On the east coast of Florida, 190,000 sand perch were reported caught by recreational fishermen in 1979; 1,643,000 were reported from the west coast of Florida. Most were caught from private or rental boats, some from man-made structures, and a few from party boats. Most sand perch caught on the east coast of Florida were caught nearshore, whereas on the west coast most were farther offshore. The average sand perch kept by recreational fishermen and recorded in the survey was about 0.22 kg.

See 5.2.

6 PROTECTION AND MANAGEMENT

6.1 Regulatory measures

Sand perch are not regulated under the Fishery Management Plans of the South Atlantic, Gulf of Mexico, or Caribbean Fishery Management Councils at this time.

## ACKNOWLEDGMENTS

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