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GROWTH AND RESIDENCY OF JUVENILE FISHES WITHIN A SURF ZONE HABITAT IN THE GULF OF MEXICO

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ABSTRACT Over a 32-month study period, 154,469 fish representing 76 species were collected from the Gulf shore of Horn Island, Mississippi. Fishes collected were identified as either resident or migrant species according to length frequency data. The migrant component, dominated numerically by *Anchoa lyolepis*, represented the greatest number of species and individuals collected. Resident fishes constituted only six species but comprised 42.0% of all fish captured. The more abundant species residing within the Horn Island surf zone, *Trachinotus carolinus*, *Menticirrhus littoralis*, and *Harengula jaguana*, appeared to utilize this habitat as a nursery for approximately 3 months throughout the spring and summer period. Of these three residents, the two former species exhibited intermittent recruitment into the exposed beach habitat during the spring and early summer, whereas larval *H. jaguana* exhibited two distinct periods of immigration, occurring first in the late spring and again in midsummer.

INTRODUCTION

The importance of estuaries as nursery and feeding areas for fishes is well documented in the literature (e.g., Gunter 1938, 1945; Joseph and Yerger 1956). In contrast, relatively few studies have investigated the role of high-energy beaches in the early life history of fishes. Greeley (1939), investigating an exposed beach habitat in New York, recognized three groups of fishes occupying the surf zone: permanent residents, immature summer residents, and migrants. Warfel and Merriman (1944), examining the ichthyofauna of a protected Connecticut beach, further divided the migrant category into immature offspring of breeding migrants and immature migrants produced elsewhere that moved into the shallow inshore habitat. Both beach studies observed that the greatest numerical component of fishes collected were immature individuals.

Although the surf zone of an exposed beach was characterized by Springer and Woodburn (1960) as an extreme habitat offering little environmental diversity, this habitat may provide several benefits to immature fishes. Suggested advantages of the surf zone include the abundance of food (McFarland 1963a), increased metabolic efficiency via heat acquisition (Reynolds and Thomson 1974), and protection from predators (Daly 1970). The present study was designed to evaluate the temporal association of juvenile fishes to a barrier island surf zone habitat within the northern Gulf of Mexico.

METHODS AND MATERIALS

The study area is located along the windward shore of Horn Island, Jackson County, Mississippi. Horn Island is one of a chain of barrier islands lying parallel to the Mississippi-Alabama Gulf coast (Figure 1). The island, approximately

14 km offshore, has a length of 19 km and never exceeds 1.2 km in width. The center of the island lies at latitude 30°14' and longitude 88°40' (Franks 1970). The windward beach is partially protected from oceanic wind-driven waves by a series of sand bars which extend the length of the island. The exposed beach is characterized by a sand substrate, moderate wave activity, and the absence of any rooted vegetation. The study area has a diurnal tidal pattern with maximum spring amplitude of approximately 1 m. The windward shore of the northern Gulf coast barrier island system has been categorized by Odum and Copeland (1969) as a high-energy beach system.

The barrier island system functions as an effective barrier to the mixing of brackish water from Mississippi Sound and the higher salinity Gulf waters, although water is

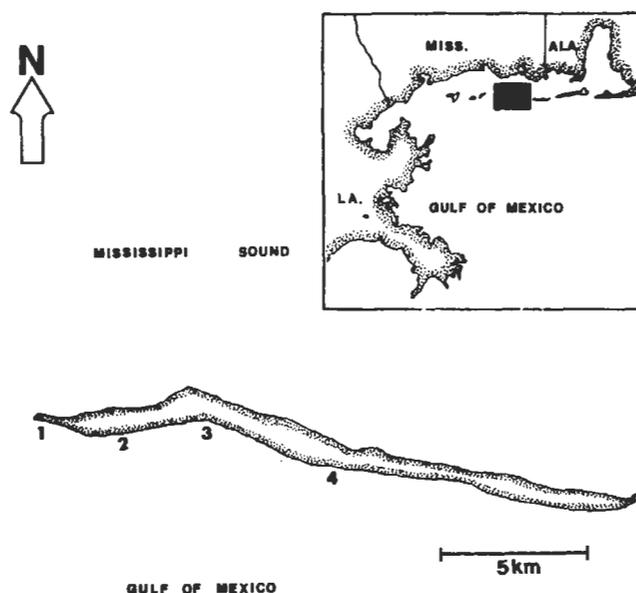


Figure 1. Chart of Horn Island and vicinity, Jackson County, Mississippi. Four collection stations are indicated.

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rapidly exchanged through the passes. Because of its proximity to the coast, however, the salinity of the outer beaches is affected by seasonal discharges from mainland rivers. During the study period, outer beach salinities on Horn Island ranged from 18.0 ppt in March to 33.0 ppt in July and August.

Four primary collecting stations were established along the windward shore of Horn Island between the western tip and its midpoint (Figure 1). Collections were taken from each station at approximately 5-week intervals between May 1976 and November 1977 (Table 1). In addition, monthly collections were taken between March and September 1976, excluding August, at approximately 4-hour intervals from a single station. On occasion, collections also were taken from locations adjacent to stations 3 and 4. In addition, fishes collected between April and November 1975, at approximately 7-week intervals from undesignated locations along the western half of Horn Island, also were included in the analysis.

Fishes were collected with a 9.1 m seine with 3.2 mm mesh. Seine hauls were made perpendicular to the beach, and within 16 to 18 m from shore. Individual collections at each station consisted of a successive number of seine hauls until no new species were collected (generally ranging between 5 and 9 hauls). A total of 613 seine hauls were made in 112 collections. Fishes collected were identified to species, and their standard length (SL) recorded at 5-mm intervals. Data were grouped by collection for determination of percent occurrence.

RESULTS

The ichthyofauna collected from the surf zone of Horn Island during the present study were primarily postlarval and juvenile fishes, with only 1.1% of the numbers exceeding 50 mm standard length. Based upon their temporal utilization

TABLE 1

Collection dates for fish taken from the surf zone habitat on the windward shore of Horn Island, Mississippi, between April 1975 and November 1977. Each collection represents a set of seine hauls taken from a specific location.

| 1975 | | 1976 | | 1977 | |
|-------|-----------------------|-------|-----------------------|-------|-----------------------|
| Date | Number of Collections | Date | Number of Collections | Date | Number of Collections |
| 4/12 | 3 | 3/13 | 6 | 1/22 | 4 |
| 6/21 | 2 | 4/23 | 4 | 3/17 | 5 |
| 8/12 | 3 | 5/28 | 7 | 4/28 | 5 |
| 10/18 | 4 | 6/25 | 11 | 5/27 | 8 |
| | | 7/23 | 8 | 6/27 | 5 |
| | | 8/24 | 5 | 7/23 | 5 |
| | | 9/ 2 | 8 | 9/17 | 4 |
| | | 10/ 1 | 6 | 11/23 | 4 |
| | | 12/ 4 | 5 | | |

of the shallow, inshore habitat, the more abundant juvenile fishes collected could be divided into either resident or migrant categories. According to subjective analysis of length frequency patterns, and to a lesser extent frequency of occurrence, only 6 of 76 species, representing 42.0% of the fishes numerically, were categorized as residents. The greatest number of individuals and species collected were considered migrant fishes; however, the dominant numerical component of this category was represented by only a few species (Table 2).

TABLE 2.
Numbers and percent occurrence of the resident and most abundant migrant fishes collected from the surf zone of Horn Island between April 1975 and November 1977.

| Species | Number | % Occurrence |
|--------------------------------|--------|--------------|
| Resident | | |
| <i>Harengula jaguana</i> | 59,732 | 64.3 |
| <i>Trachinotus carolinus</i> | 3,268 | 56.3 |
| <i>Menticirrhus littoralis</i> | 1,394 | 67.0 |
| <i>Menticirrhus americanus</i> | 272 | 25.9 |
| <i>Menticirrhus saxatilis</i> | 116 | 34.8 |
| <i>Astroscopus y-graecum</i> | 19 | 9.8 |
| Total | 64,801 | |
| Migrant | | |
| <i>Anchoa lyolepis</i> | 64,031 | 47.3 |
| <i>Brevoortia patronus</i> | 8,848 | 17.9 |
| <i>Anchoa hepsetus</i> | 3,751 | 44.6 |
| <i>Anchoa mitchilli</i> | 2,953 | 29.5 |
| <i>Leiostomus xanthurus</i> | 2,216 | 18.8 |
| <i>Anchoviella perfasciata</i> | 1,255 | 21.4 |
| Other species | 6,634 | |
| Total | 89,668 | |

Resident fishes were considered those species which indicated adolescent utilization of the surf zone by a relatively uniform increase in length throughout a given season, and usually exhibited a high frequency of occurrence. Numerically, the dominant resident species collected from Horn Island between 1975 and 1977 was *Harengula jaguana*. A small number of scaled sardine, between 16 and 25 mm, first appeared in the beach area in April 1976 and 1977 (Figure 2). Although recruitment was continual, particularly in 1976, most immigration occurred during two periods within each season. The modal length interval of fish collected in June 1975 was 31 to 35 mm; however, the modal length interval in August 1975 was 21 to 25 mm, indicating a second wave of recruitment. Incidence of two waves in recruitment was more clearly indicated by length frequency data from 1976 and 1977. Fish first appeared in the beach area in early spring, increased in length, and were not well

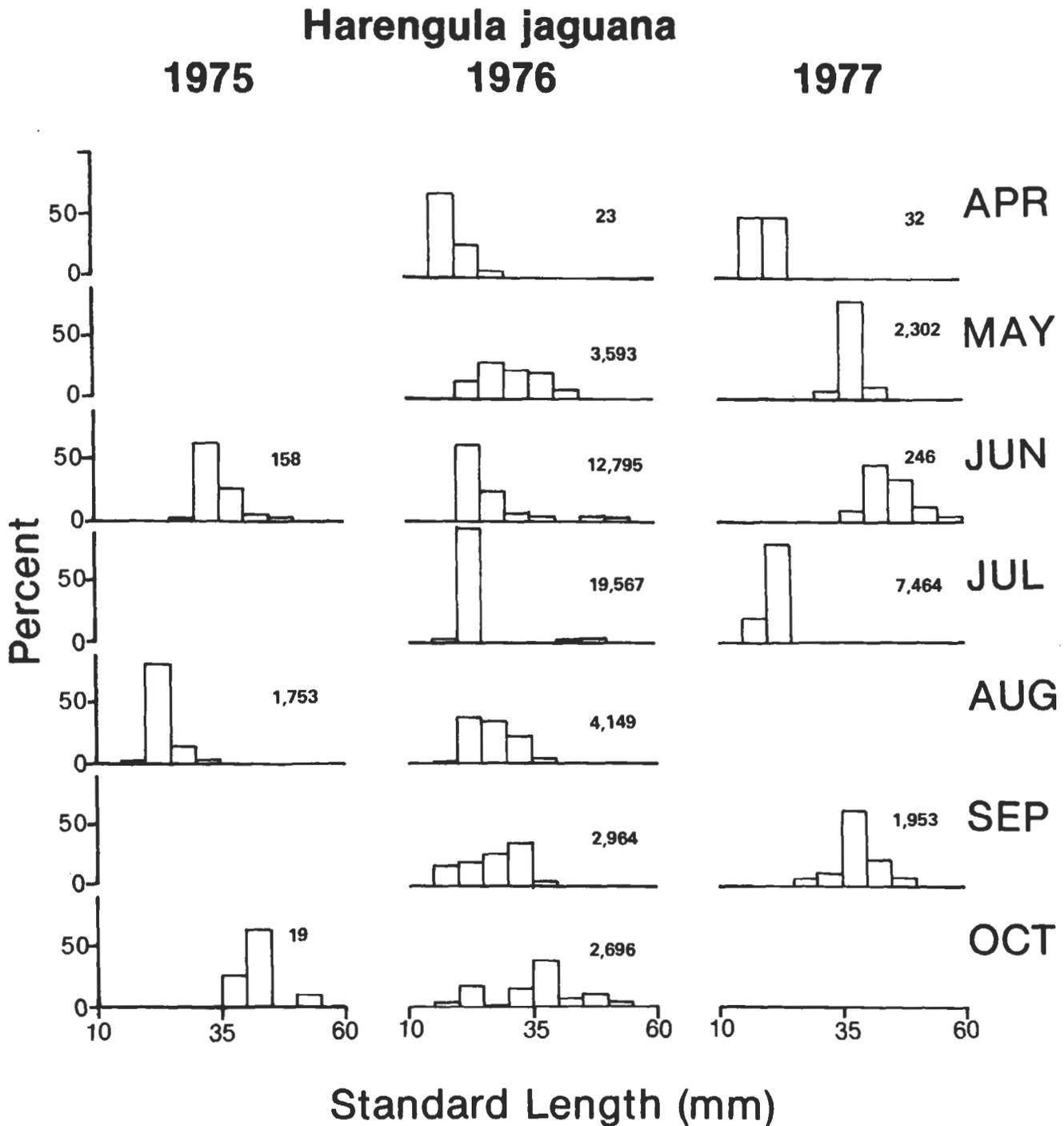


Figure 2. Seasonal length frequency changes and monthly numbers of *Harengula jaguana* collected from the surf zone of Horn Island between April 1975 and September 1977.

represented in beach collections after June. Fish representing the second wave of recruitment appeared in late June and July, and increased in length through early October. Individuals exceeding 50 mm were not well represented in seine collections, which may be attributed to both reduced susceptibility to capture and movement outward from the beach.

Trachinotus carolinus, the second most abundant resident, was also first captured from the surf zone in April with most

individuals ranging between 16 and 20 mm long (Figure 3). Greatest recruitment of juvenile pompano occurred through the spring of 1975 and 1976, and during both spring and summer of 1977. Length frequencies suggested that growth rates were rapid, with fish spawned in early spring reaching standard length of 80 mm by late June. Fish greater than 80 mm were rarely collected from the surf zone. Although *Menticirrhus littoralis* was only third in abundance among

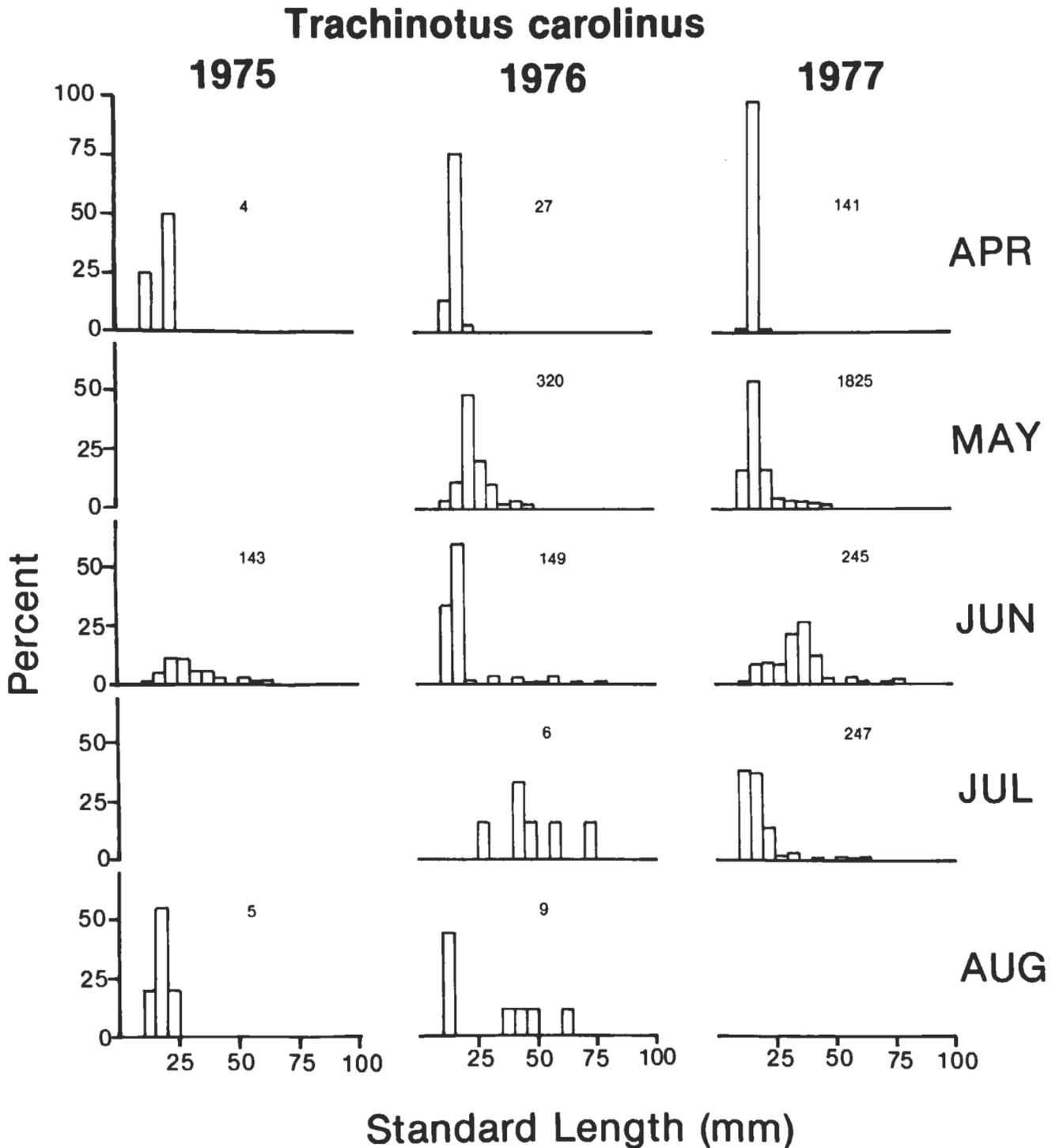


Figure 3. Seasonal length frequency changes and monthly numbers of *Trachinotus carolinus* collected from the surf zone of Horn Island between April 1975 and July 1977.

resident fishes, the Gulf kingfish exhibited the highest frequency of occurrence (Table 2). These fish first appeared within the surf zone as larvae, some as small as 8 mm SL. Recruitment of juvenile fishes appeared greatest during the summer months but was observed as early as April and as late as October (Figure 4). In mid-April of 1977, these

fish first appeared with a 16- to 20-mm modal length. However, in both 1975 and 1976, larval *M. littoralis* did not appear in the surf zone until after April. Recruitment of juveniles onto the beach continued through July, and also was observed during October in both 1975 and 1976. Immature fish approaching 80 mm were collected by

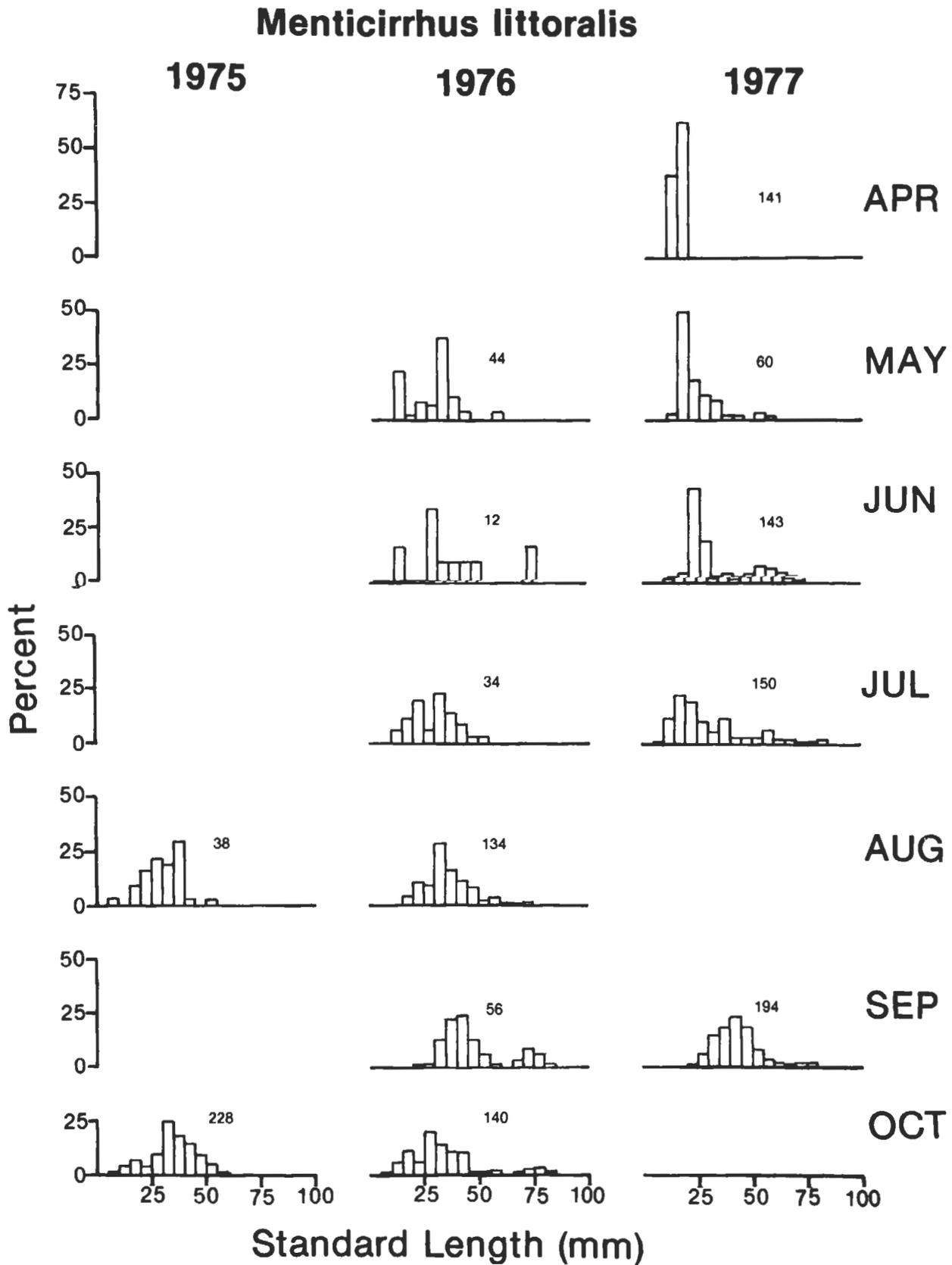


Figure 4. Seasonal length frequency changes and monthly numbers of *Menticirrhus littoralis* collected from the surf zone of Horn Island between April 1975 and September 1977.

the end of August 1976 and June 1977.

Relatively few *Menticirrhus saxatilis* or *M. americanus* were collected during this study. Small *M. saxatilis*, 6 to 10 mm SL, first appeared in April with fewer individuals of increasing length collected through October. Increases in lengths of fish during a season were similar to *M. littoralis* with a few individuals between 96 and 100 mm collected in June 1977. *Menticirrhus americanus* was first collected in May. Few postlarval fish were captured with only three specimens collected under 16 mm SL. As were its congeners, *M. americanus* also was collected through October with fish reaching 91 to 95 mm as early as June.

The least abundant resident collected was *Astroscopus y-graecum*. The relatively few number of fish captured can be attributed to both low density and their mode of concealment within the sand. Juveniles, 11 to 20 mm SL, were collected most often in the surf zone during the months of November and December. Isolated subadults and adults were collected between May and July 1976, and April and July 1977.

Migrant juvenile fishes were considered those species which utilize or pass into the surf zone habitat for only a brief time. They did not exhibit uniform increases in length during the periods in which they were collected from the exposed inshore habitat. This category constituted 58.0% of the individuals, and by far, the greatest number of species (70) collected from Horn Island. Migrants could be further subdivided into either estuarine or marine categories. Estuarine migrants represented denatant (*sensu* Cushing 1975) immigrants, which were spawned offshore and moved through the barrier island passes into Mississippi Sound, and fishes straying from estuaries. The former group was represented primarily by immature *Brevoortia patronus*, *Leiostomus xanthurus*, *Lagodon rhomboides*, *Mugil cephalus*, and *Eucinostomus* sp. The first four species were collected primarily during the winter months and composed 97.9% of the fishes collected between January and March in 1976 and 1977. Estuarine strays were most common during warmer months (Modde and Ross 1980), and were primarily represented by *Anchoa hepsetus* and *A. mitchilli*.

Marine migrants were represented primarily by immature fishes migrating or straying through marine waters adjacent to Horn Island. Although most species were observed irregularly in low numbers, several species occurred consistently throughout the study. Most marine migrants appeared during the summer months; however, *Sphyraena borealis* and *Pomatomus saltatrix* were collected only between March and May.

The marine migrant category was dominated numerically by *Anchoa lyolepis* and included species such as *Anchoviella perfasciata* and *Sardinella anchovia*. The dusky anchovy was collected consistently in large numbers within the surf zone between May and September 1976. In 1975, large numbers of *A. lyolepis* were collected only in August, while in 1977, fish were abundant in May and July although no

collection was taken in August. Length frequency data indicate that no increase in length intervals occurred during the study, suggesting a continual influx and rapid departure of juvenile fish (Figure 5). The greatest number of individuals was represented by late larvae and newly transformed juveniles. Transformation occurred between 28 and 30 mm SL.

DISCUSSION

Immature fishes constituted the dominant numerical component of the ichthyofauna collected from the surf zone of Horn Island, Mississippi. The relative abundance of juvenile fishes within the exposed inshore habitat of the Gulf of Mexico has also been reported by Gunter (1958), Springer and Woodburn (1960), and Naughton and Saloman (1978). Among the fishes collected from Horn Island only 7.9% of the species, yet nearly half of the numbers, resided seasonally within the surf habitat. In the previously cited studies, the dominant numerical component of the surf zone ichthyofauna consisted of residents, primarily *Harengula jaguana*. Surprisingly, *Anchoa lyolepis*, the most abundant species collected from Horn Island, was collected only occasionally by Gunter (1958) and Naughton and Saloman (1978), and was not mentioned by McFarland (1963b) or by Springer and Woodburn (1960). Christmas and Waller (1973) reported capturing large *A. lyolepis* (nasuta) within Mississippi Sound but stated that over several years of observation, the dusky anchovy occurred only in the summer and fall months and never was abundant in Gulf inshore waters. Because *A. lyolepis* were collected primarily as small postlarvae in the present study and were most common within the surf zone habitat in the early light hours (Modde and Ross 1980), this species may not have been accessible to previous investigations in the northern Gulf in which larger mesh seines were used during the diurnal hours.

Residency within the exposed inshore habitat for both mature (McFarland 1963b) and immature (Gunter 1958) fishes has been observed to be limited primarily to the spring and summer months. In this respect, the nursery function of the surf zone varies from the estuarine areas. While utilization of estuaries by immature residents occurs through the cold-temperature months (Gunter 1945, Livingston 1976), only *Astroscopus y-graecum*, in relatively low numbers, resided within the exposed beach habitat of Horn Island during the winter period. Recruitment of most species residing within the Horn Island surf zone was observed first in April. Although changes in length frequency varied among species, larger individuals of the three more abundant species, *H. jaguana*, *T. carolinus*, and *M. littoralis*, were no longer collected after approximately 3 months following this initial appearance within the inshore habitat. Bellinger and Avault (1970), reporting growth rates of *T. carolinus* collected from the Louisiana coast, indicated that pompano utilized the surf zone for only 2 1/2 to 3 months before moving off the beach into deeper water. Individuals of the three more abundant species in the present study, representing the

Anchoa lyolepis

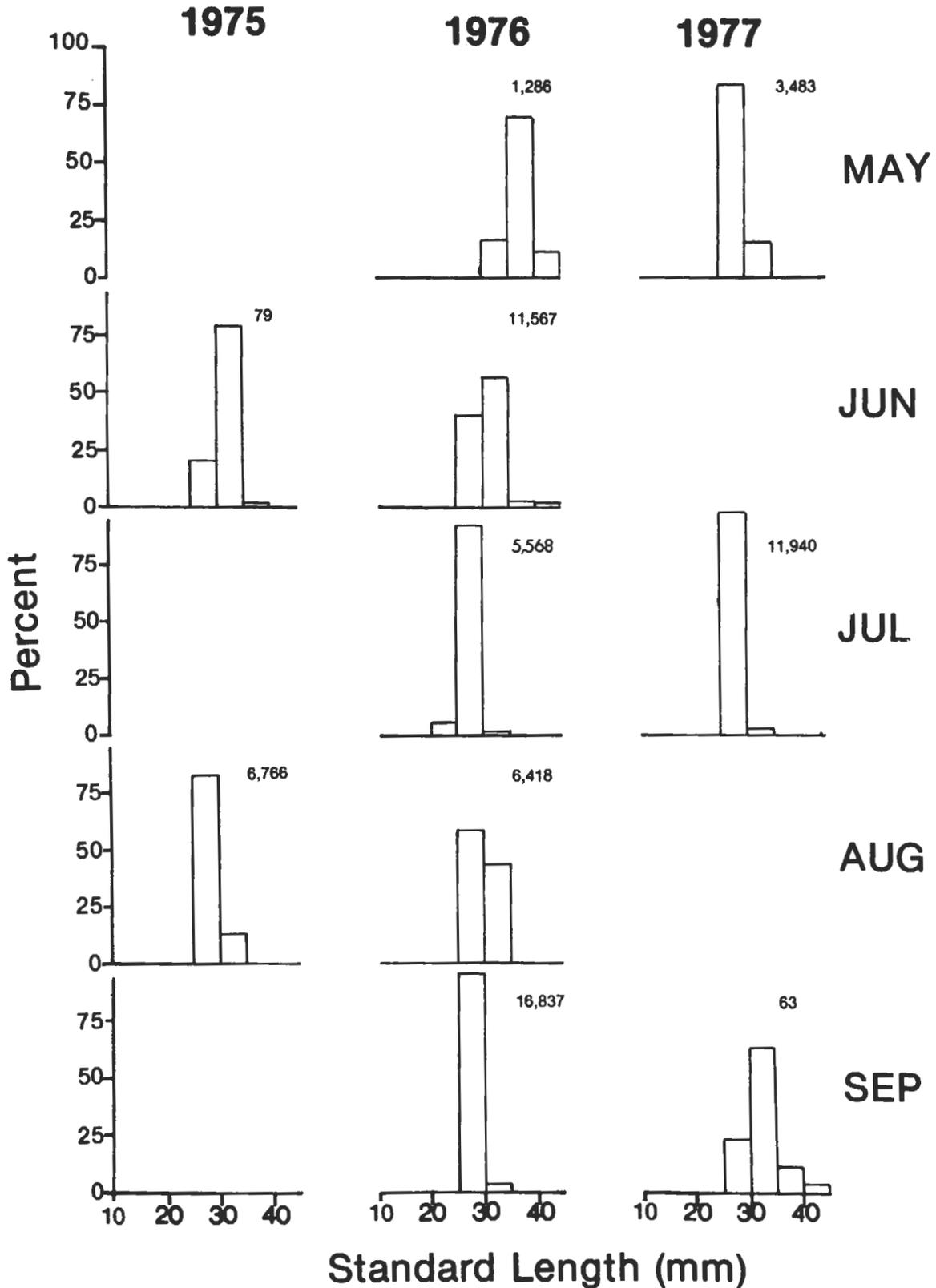


Figure 5. Seasonal length frequency changes and monthly numbers of *Anchoa lyolepis* collected from the surf zone of Horn Island between April 1975 and September 1977.

greatest portion of immature resident fishes occupying the surf zone of Horn Island, also appeared to utilize this habitat as a nursery for approximately 3 months.

Although recruitment of *T. carolinus* and *M. littoralis* into the beach area appeared intermittent, *H. jaguana* exhibited two distinct waves of recruitment. Christmas and Waller (1973) also have observed a bimodal length frequency of *H. jaguana* collected during a single season from Mississippi Sound. Gunter (1945, 1958) reported two peaks in recruitment of juvenile *H. jaguana* onto Mustang Island, TX, beaches, and suggested that this species exhibited two spawning periods: one in spring and one in late summer. However, length frequency data of *H. jaguana* collected from Florida suggested only a single peak in recruitment into the beach habitat (Springer and Woodburn 1960, Roessler 1970), as did larval abundance data reported from the Texas coast (Hoese 1965). Houde (1977) reported that spawning did not occur in great concentrations in the eastern Gulf of Mexico and suggested that it may occur twice, intermittently, within individuals during the season.

Although many estuarine fishes either strayed or actively moved into the adjacent higher-salinity beach habitat, the greatest number of estuarine migrants was represented by winter denatant postlarvae. The presence of these migrating larvae represented a temporary concentration along the seaward side of the island associated with the movement of fishes through the island passes into Mississippi Sound. Conversely, most marine migrants, while representing the greatest number of species, were the most common during the summer. Marine and estuarine categories roughly corresponded with the two migrant categories suggested by Warfel and Merriman (1944), regularly occurring and stray species.

Most marine migrant fishes did not appear within the

surf zone on a regular basis; however, the dominant numerical component of this category, *Anchoa lyolepis* and *Anchoviella perfasciata*, occurred consistently throughout the study. Length frequency patterns of *A. lyolepis* indicated that a continual influx and departure of individuals from the surf zone occurred. In addition, Modde and Ross (1980) reported that *A. lyolepis* exhibited a distinct daily activity pattern. The consistently high number of fishes collected which exhibited a distinct daily activity pattern suggested that this fish utilized the exposed inshore habitat as some form of refuge or orientation site.

The present study indicates that the surf zone habitat of an exposed sand beach represents a significant spatial resource to the early life stages of certain fishes within the northern Gulf of Mexico. Nearly half of the fishes collected from the surf zone of Horn Island used this area as a residence. In addition, this habitat appeared to attract a large number of immature migrant fish which may briefly utilize this environment either as a refuge or an orientation site.

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