# DISTRIBUTION, LENGTH-WEIGHT RELATIONSHIP, AND LENGTH-FREQUENCY DATA OF SOUTHERN KINGFISH, *MENTICIRRHUS AMERICANUS*, IN MISSISSIPPI[1]

Populations of southern kingfish, *Menticirrhus americanus* (Linnaeus), are found in coastal waters from Long Island, N.Y., to Argentina (Stevens 1962; Miller 1965; Richards and Castagna 1970; Irwin 1970; Johnson 1978). Distribution appears to be continuous, but they are of greatest importance to commercial and sport fisheries along the South Atlantic and Gulf states. In 1978, 87,610 kg of southern kingfish valued at $36,085 were landed commercially in Mississippi (U.S. Department of Commerce 1977-78). Southern kingfish are caught incidentally by commercial fishermen using otter trawls in Mississippi coastal areas when fishing for shrimp or finfish such as croakers, red drum, and flounders. Southern kingfish ranked ninth in 1978 in economic value among commercial finfish species in Mississippi (third among trawl caught edible finfish) and is valued along the Gulf coast by sport fishermen who consider it an excellent food fish.

The majority of data available on southern kingfish is from studies conducted on the Atlantic coast (Welsh and Breder 1924; Hildebrand and Schroeder 1928; Irwin 1970). Little research has been conducted on southern kingfish in Mississippi, although information obtained on this species has been part of a large assessment program on finfishes along the Gulf coast (Christmas and Waller 1973; Loman 1978). Loman (1978) presented the only published works on length frequencies and length-weight relationships for southern kingfish in Mississippi.

The present study was conducted to investigate the distribution of southern kingfish in Mississippi coastal waters in relation to geographic range, season, temperature, and salinity. Length-weight relationship and length-frequency data are also presented.

## Study Area

The study area consisted of the Mississippi coastal waters offshore to a depth of 91.4 m and included four estuarine systems: Biloxi Bay, Bay St. Louis, Pascagoula estuaries, and the smaller Pearl River system (Figs. 1, 2). Salinities and

[1]This paper is adapted from the author's unpublished Masters Thesis submitted to the University of Mississippi.

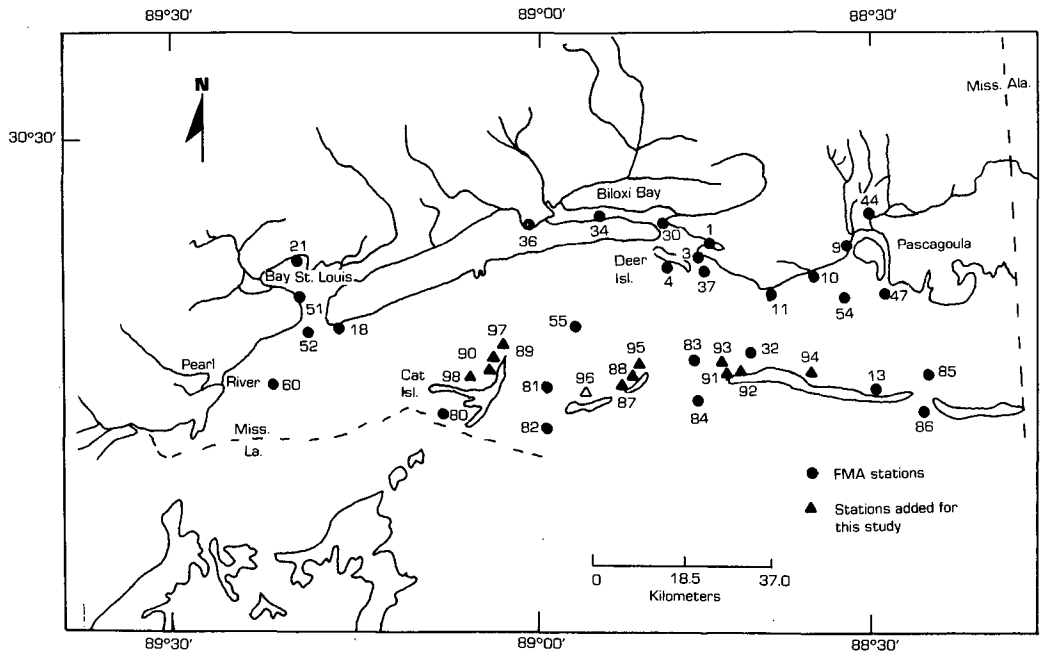


FIGURE 1.—Locations of stations for southern kingfish in estuaries, barrier islands, and offshore areas of the Mississippi Gulf coast sampled monthly.

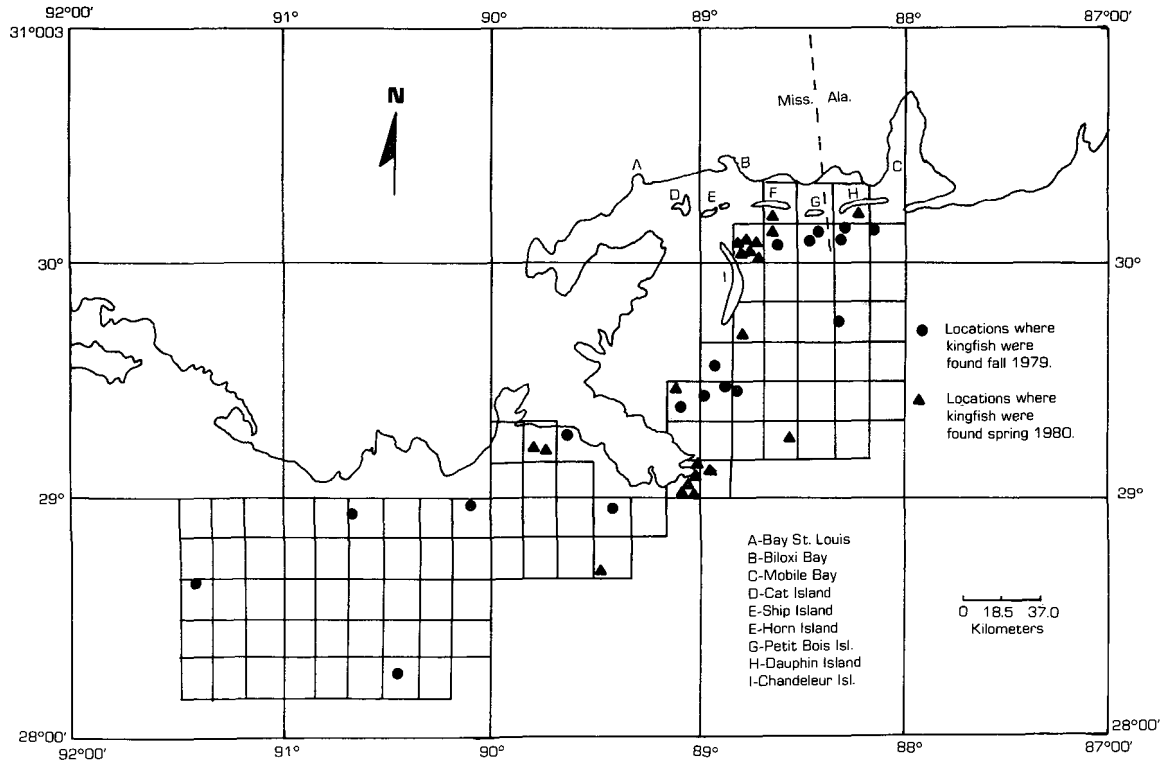


FIGURE 2.—Area of the Gulf of Mexico sampled for southern kingfish during the fall offshore cruise (25 October 1979 through 14 November 1979) and during the spring offshore cruise (10-18 April 1980). Grids represent station sites established by the National Marine Fisheries Service.

temperatures of the waters in these regions are influenced greatly by input from rivers and freshwater runoff. The estuaries drain into the Mississippi Sound which is bordered on the south by barrier islands. A complete description of the Mississippi Sound is given by Eleuterius (1978).

Areas sampled varied geomorphologically with location. Bottom types ranged from mud and silt in the rivers and upper estuaries to sandy tidal zones on the north side of the barrier islands. Overall depths varied from 0.3 m at seine stations to 91.4 m at offshore trawl stations. Sample areas in the estuaries ranged from 0.3 m to 12.2 m with relatively small tidal variations (0.1-0.6 m).

## Materials and Methods

Monthly collections of southern kingfish were made from October 1979 through September 1980 (Fig. 1, Table 1), with the exception of stations 93 through 98 which were sampled monthly from February 1980 through September 1980. Twenty-eight of the stations were sampled in conjunction with the Fisheries Monitoring and Assessment Program at the Gulf Coast Research Laboratory, Ocean Springs, Miss. (Christmas 1978).

The type of gear used was dictated by the bottom topography and geographic location. At five stations along the barrier islands and in the estuaries, a 15.2 m bag seine with 6.4 mm bar mesh was used to collect juveniles. Larval and postlarval fish were collected by towing a Renfro beam plankton net (BPL) with 50 holes/cm$^2$ and a 1.8 m diameter mouth, in a 45.7 m semicircle at five stations. During the 10-min tows, young-of-the-year and adult southern kingfish were sampled with a 4.9 m standard otter trawl with 19.9 mm

TABLE 1.—Bottom salinities at monthly stations where southern kingfish were collected.

| | Number of observations | Maximum salinity (‰) | Minimum salinity (‰) | Average salinity (‰) |
|---|---|---|---|---|
| Rivers | 10 | 34.5 | 9.0 | 26.1 |
| Estuaries | 27 | 27.5 | 2.0 | 17.1 |
| Mississippi Sound | 37 | 33.0 | 14.5 | 24.7 |
| Barrier Islands | 29 | 29.0 | 5.0 | 22.2 |
| Offshore | 35 | 33.5 | 6.0 | 26.7 |

mesh, 6.4 mm tail mesh, and 0.9 m doors at 18 stations in the Mississippi Sound and with a 12.2 m standard otter trawl with 19.1 mm mesh, 6.4 mm tail mesh, and 1.3 m doors at 6 stations in the passes and outside the barrier islands. One sample was taken at each station per month, except at Fort Point (station 30) where two samples were taken: one with the 15.2 m seine and one with the BPL.

In the fall of 1979 and the spring of 1980, collections were made during National Marine Fisheries Service groundfish cruises (U.S. Department of Commerce 1979, 1980). Samples were taken by the RV *Oregon II* in depths of 9.1-91.4 m (5-50 fathom lines) from Mobile Bay, Ala., to Ship Shoal, La., extending to the east and west beyond Mississippi coastal waters (Fig. 2). Three successive 10-min tows were made at each station with a 12.2 m standard otter trawl with 19.1 mm mesh, a 1.22 m vertical opening, and 2.44 m doors, and samples were randomly taken. Specimens were frozen on board the ship, except ripe females which were preserved in 10% Formalin[2] for future use in fecundity estimates.

In the laboratory, each fish was weighed to the nearest 0.1 g and standard length measured to the nearest 1 mm. If the sample exceeded 50, a subsample of 50 was weighed and measured individually. The remainder of the catch exceeding 50 was counted and gross weight taken.

Salinity was determined with a refractometer (accuracy of 1‰) at stations sampled monthly, and on the groundfish cruises by titration at the National Marine Fisheries Service Laboratory (U.S. Department of Commerce 1979, 1980). Temperature was taken with a YSI Model 54 oxygen meter at monthly stations and with a centigrade thermometer on the groundfish cruises. Where a trawl was used, bottom water samples were collected with a Niskin or a Kemmerer bottle depending on the location and vessel used.

The length-weight relationship was calculated for southern kingfish by following the procedure of Rounsefell and Everhart (1953).

## Results

### Geographic Range

The distribution of southern kingfish in Mississippi extends from as far north as Bayou Bernard (station 36) to offshore beyond the barrier islands (Fig. 1). Fish were captured at all monthly sample sites at some time during the year except at seven stations where water depth ranged from 0.3 to 19.5 m.

During the fall groundfish cruise, southern kingfish were captured from 4.8 km south of the barrier islands to below the Mississippi River Delta and from long. 88°10'-91°25'W (Fig. 2). During the spring cruise the geographic range was about the same; however, populations were denser near the Chandeleur Islands and at the southern tip of the Mississippi River Delta. Catches of shrimp, a primary food of southern kingfish, were high in these areas, indicating the fish could have concentrated because of an abundant food supply.

Size of the southern kingfish captured varied with the geographic location. Specimens 50-150 mm SL frequented estuaries and inshore waters, while adults exceeding 150 mm SL were found on the Gulf of Mexico side of the barrier islands and offshore in waters as deep as 69.5 m. Distribution and size of the fish captured were also related to gear selectivity—trawls were used to capture adults in the passes and offshore, whereas smaller mesh gear types were more effective for obtaining juveniles and young-of-the-year in estuaries and inshore waters. Trawls accounted for 42% of the total catch at monthly sample sites.

### Seasonal Distribution

A total of 1,554 southern kingfish was captured from October 1979 through September 1980. The numbers of fish gradually increased from December with a peak in February; from March through September there was no apparent numerical pattern (Fig. 3). On the other hand, the monthly catch by weight peaked in April with a lesser peak in January. Weight gradually declined during the remainder of the year.

Although overall catches for January and February were high, stations in the passes between the barrier islands and offshore accounted for the majority of southern kingfish in these months. Few southern kingfish were found in the estuaries during winter, and no kingfish were landed at any of the offshore stations during May, June, and July.

During the fall offshore groundfish cruise, 121 southern kingfish (100-280 mm SL) were captured. The spring cruise was more productive with 307 fish (70-270 mm SL) taken. No previous data on

[2]Reference to trade names does not imply endorsement by the National Marine Fisheries Service, NOAA.

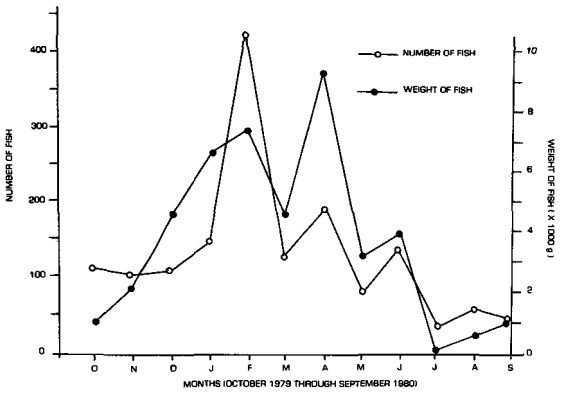


FIGURE 3.—Summary by number and by weight of the catch data for southern kingfish at stations sampled monthly from October 1979 through September 1980.

**the distribution of this species in these offshore areas of Mississippi are available for comparison.**

### Salinity Range

Southern kingfish were captured in waters ranging in salinity from 2.0 to 36.6‰, with the majority found above 20.0‰ (Table 1). The mean salinity for the Mississippi coastal waters where southern kingfish occurred at regularly sampled stations was 23.4‰. During the fall groundfish cruise, bottom salinities where southern kingfish were taken ranged from 31.4‰ west of the Mississippi River Delta to 36.6‰ south of Horn Island, with an average bottom salinity of 34.5‰. No bottom salinities were available during the spring offshore cruise because of equipment problems.

### Temperature Range

Young-of-the-year and adult southern kingfish were captured in waters with bottom temperatures ranging from 8.0°C in December to 37.3°C in August. The largest catches were taken in waters ranging from 20.0° to 30.0°C. Larval and postlarval fish (0.5-20.0 mm SL) were found from May through November in the shallow inshore waters and northern tidal zones of the barrier islands at temperatures ranging from 12.0° to 37.3°C.

The bottom water temperatures where southern kingfish were taken for the fall groundfish cruise ranged from 22.4° to 25.5°C (average of 23.2°C) and for the spring cruise ranged from 22.4° to 25.5°C (average of 22.3°C). In general, bottom temperatures on offshore cruises decreased with increasing depths.

### Length-Weight Relationship

The length-weight relationship was calculated for the 1982 southern kingfish (ranging from 0.5 to 291.0 mm SL) by the following regression equation:

$$\text{Log } W = -4.48683 + 2.92908 \text{ Log } L$$

where $W$ = weight in grams and $L$ = standard length in millimeters (Fig. 4). The coefficient of determination $R^2$ was 0.9779.

### Length-Frequency Data

At stations sampled monthly, southern kingfish juveniles (<50 mm SL) were most common from May through October; fish in the 100-150 mm SL range were fairly constant all year with a peak in March; and fish in the 150-250 mm SL range were rare during all months except April (Fig. 5). August was the only month where fish 10 mm SL or less were captured. The majority of the fish captured during the two offshore cruises were >100 mm SL with an average of 174 mm SL (Fig. 6).

The mean sizes of southern kingfish taken at the monthly stations were generally much smaller than those from the offshore groundfish cruises because young-of-the-year utilize the estuaries and inshore waters as nursery grounds. Gear selectivity must also be taken into account because the larger trawls used offshore are inefficient for capturing juveniles.

## Discussion

Young-of-the-year frequented estuaries and inshore waters, while adult southern kingfish were found to be more abundant offshore in deeper waters. This was also reported by Pearson (1941) for the Chesapeake Bay area and by Geagan (1962) for the coastal waters of Louisiana. Irwin (1970) found the most common habitat for juveniles <50 mm SL to be open surf on sandy beaches, whereas in this study they occurred most often in sandy tidal zones of the barrier islands and estuaries.

High offshore catches and very low inshore catches from December through April support reports by Gunter (1938, 1945) and Christmas and Waller (1973) that adult southern kingfish migrate offshore during winter months and are summer residents of the estuaries. Similar reports were made by McIlwain (1978) for recreational

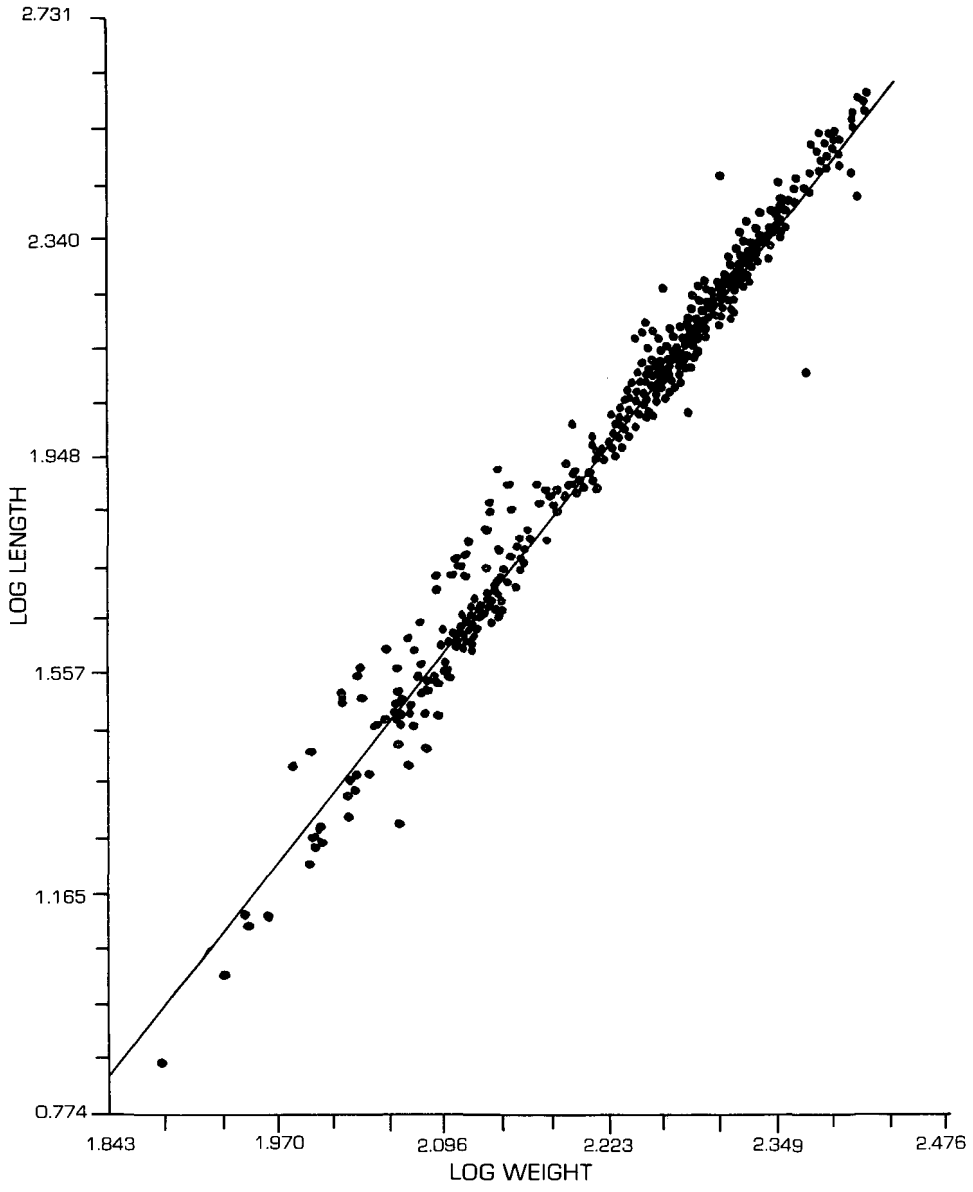


FIGURE 4.—Length-weight regression for all southern kingfish caught from October 1979 through September 1980.

catches from Biloxi Bay, Miss., and by Miller (1965) while trawling off Port Aransas, Tex.

The salinity range of 2.0-36.6‰ is slightly broader than the range of 5.0-35.5‰ reported by Christmas and Waller (1973). Loman (1978) reported that the highest catches of southern kingfish in Mississippi were between 15.0 and 30.0‰ and that mean length increased as salinity increased. The latter was also true in this study since larger fish were captured offshore where salinities were higher, and only postlarval and young-of-the-year fish were found in salinities below 15.0‰.

I concur with most authors that this species is eurythermal (Gunter 1945; Franks 1970; Christmas and Waller 1973; Loman 1978). While Loman (1978) reported southern kingfish in Mississippi coastal waters with temperatures as low as 7.0°C, the highest previously recorded temperature was 31.0°C reported by Springer and Woodburn (1960)

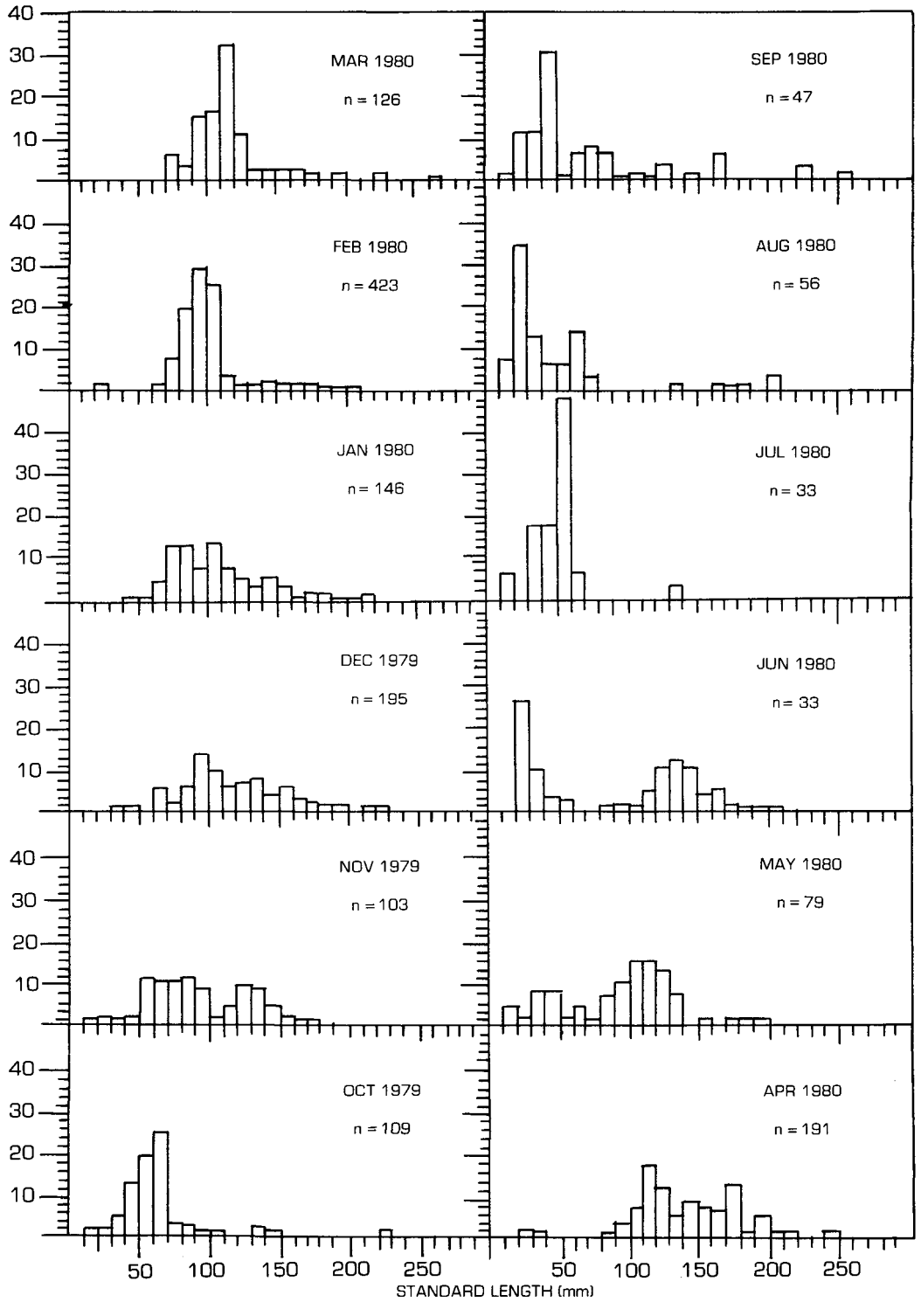


FIGURE 5.—Standard length frequencies of southern kingfish captured at regular monthly stations from October 1979 through September 1980. Total number of fish per month is represented by "n".

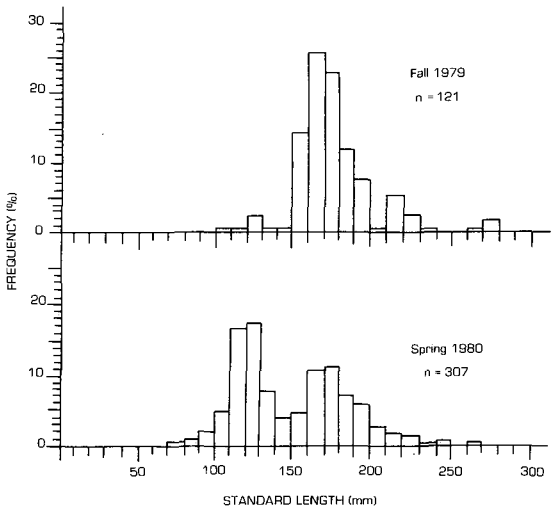


FIGURE 6.—Standard length frequencies of southern kingfish caught during the fall and spring offshore cruises in the Gulf of Mexico. Total number of fish per cruise is represented by "n".

in the Tampa Bay area. Loman (1978) reported a much narrower temperature range of 24.0-30.0°C for larval and postlarval fish (4.0-20.0 mm SL).

The length-frequency distribution recorded during 1979-80 is comparable to the published reports for 1973-76 (Loman 1978). Growth of southern kingfish is fairly consistent among individuals with the most rapid growth during the first year, as also reported by Hildebrand and Cable (1934) and Bearden (1963) for southern kingfish on the Atlantic coast. Young-of-the-year averaged about 100 mm SL by November. Bearden (1963) also reported southern kingfish in South Carolina to reach about 100 mm SL by November of the first year, whereas Hildebrand and Cable (1934) reported a slightly higher average of 135 mm TL by November of the first year in Beaufort, N.C.

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## SCANNING ELECTRON MICROSCOPE EVIDENCE FOR YEARLY GROWTH ZONES IN GIANT BLUEFIN TUNA, *THUNNUS THYNNUS*, OTOLITHS FROM DAILY INCREMENTS

Atlantic bluefin tuna, *Thunnus thynnus*, are found throughout the Atlantic Ocean, the Mediterranean Sea, and the Gulf of Mexico (Gibbs and Collette 1967). Bluefin tuna are both commercially and recreationally important. Thus, it is important that the population dynamics of this species be understood in order that international policies can be developed.

Age determination and subsequent growth estimation are critical for tuna management. However, confusion and controversy surround age estimation in tunas. The earliest record of age and growth of tunas (probably bluefin) was by Greek fishermen nearly 2,000 yr ago as documented in Aristotle's "Historia Anumalium" (Bell 1964). In recent times, the aging of tunas has become much more important and has been critiqued by Hayashi (1958), Bell (1964), and Shomura (1966). These reviews point to the problems and difficulties in aging tuna. These problems and difficulties appear to be more evident in aging bluefin tuna.

Bluefin tuna are usually aged by counting growth increments on their hard parts. Vertebrae have provided acceptable ages (Rodríguez-Roda 1964; Butler 1971; Nichy and Berry 1976; Berry et al. 1976), but the aging of large or "giant" (>250 kg) bluefin tuna is suspect because the outer increments appear very close together. Otoliths have also been used to study age and growth of bluefin tuna (Butler et al. 1977). Berry et al. (1976) compared otolith age estimates with vertebra estimates and discovered a discrepancy. They found corresponding marks on both vertebrae and otoliths for the first 10 yr, but not thereafter, when otoliths had more incremental zones. They hypothesized that more than one incremental zone was deposited yearly in otoliths after the first 10 yr.

Daily increments in yellowfin tuna, *Thunnus albacares*, and skipjack tuna, *Katsuwonus pelamis*, otoliths were studied by Wild and Foreman (1980) and Uchiyama and Struhsaker (1981). Taubert and Tranquilli (1982) used daily increments to verify annuli in the otoliths of large mouth bass, *Micropterus salmoides salmoides*, and it is proposed that an analogous investigation would provide corroborative evidence for the annual nature of outer major increments in giant bluefin tuna otoliths.

### Methods and Materials

Sagittal otoliths were collected in November 1978, from giant bluefin tuna which were reared in the sea ranching program of St. Margaret's Bay, Nova Scotia, Canada. Fish were weighed and measured (TL) and the otoliths were collected as described by Caddy et al. (1976). All otoliths were washed in water and stored dry.

Whole otoliths from four fish were placed in epoxy resin and sectioned on a Buehler Isomet[1] saw. Sections 200 $\mu$m thick were acquired from the region judged to contain the core. A diagrammatic view of a cross section of a bluefin tuna otolith is

[1]Reference to trade names does not imply endorsement by the National Marine Fisheries Service, NOAA.