NOAA Technical Report NMFS 44 September 1986

Synopsis of Biological Data on the Porgies, *Calamus arctifrons* and *C. proridens* (Pisces: Sparidae)

George H. Darcy

FAO Fisheries
Synopsis No. 148

NMFS/S 148

SAST-*Calamus arctifrons* 1,70(39)034,02
C. proridens 1,70(39)034,06

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

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NOAA Technical Report NMFS 44
FAO Fisheries Synopsis No. 148

Synopsis of Biological Data on the Porgies, *Calamus arctifrons* and *C. proridens* (Pisces: Sparidae)

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U.S. DEPARTMENT OF COMMERCE
Malcolm Baldrige, Secretary
National Oceanic and Atmospheric Administration
Anthony J. Calio, Administrator
National Marine Fisheries Service
William G. Gordon, Assistant Administrator for Fisheries

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*No information available.

Synopsis of Biological Data on the Porgies, *Calamus arctifrons* and *C. proridens* (Pisces: Sparidae)

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ABSTRACT

Information on the biology and fishery resources of two common species of western Atlantic porgies, *Calamus arctifrons* and *C. proridens*, is compiled, reviewed, and analyzed in the FAO species synopsis style.

INTRODUCTION

Porgies are small to moderately large spiny-rayed fishes of the family Sparidae. They inhabit temperate and tropical marine and estuarine waters from shore to depths of over 100 m. They are ecologically similar to snappers (Lutjanidae) and grunts (Haemulidae). Most are excellent food-fishes and are of considerable commercial importance (Randall and Vergara R. 1978). Many are also important to recreational fishermen.

The genus *Calamus* consists of about 13 species, all of tropical and subtropical American waters. Two species occur in the eastern Pacific, and 11 occur in the western Atlantic (Randall and Caldwell 1966). Eight species are known from coastal waters of the United States (Robins et al. 1980).

The grass porgy, *Calamus arctifrons*, and the littlehead porgy, *C. proridens*, are two common porgies of the western Atlantic Ocean. The grass porgy is essentially restricted to the northeastern Gulf of Mexico and is fairly abundant in shallow water off the northwest coast of Florida. The littlehead porgy occurs on the east coast of Florida, in the northeastern Gulf of Mexico, in the Greater Antilles, and on Campeche Bank where it is one of the most important commercial fishes. This paper summarizes information on these species.

1 IDENTITY

1.1 Nomenclature

1.11 Valid name

Grass porgy, *Calamus arctifrons* Goode and Bean, 1882 (Fig. 1): 425, type locality: Pensacola, Florida. The name comes from the Latin *calamus* (a reed or quill), referring to the quill-like interhaemal bone (Randall and Caldwell 1966), and *arctus* (narrow) and *frons* (forehead), referring to the dorsal profile of the head.

Littlehead porgy, *Calamus proridens* Jordan and Gilbert, 1884 (Fig. 2): 150, type locality: Key West, Florida. The name comes from the Latin *calamus* (see above) and *prora* (prow) and *dens* (tooth), referring to the projecting canine teeth (Jordan and Fesler 1893).

1.12 Objective synonymy

Calamus arctifrons Goode and Bean, 1882

Calamus proridens Jordan and Gilbert, 1884

1.2 Taxonomy

1.21 Affinities

Suprageneric

- Phylum Chordata
  - Class Osteichthyes
    - Superorder Acanthopterygii
      - Order Perciformes
        - Suborder Percoidei
          - Family Sparidae

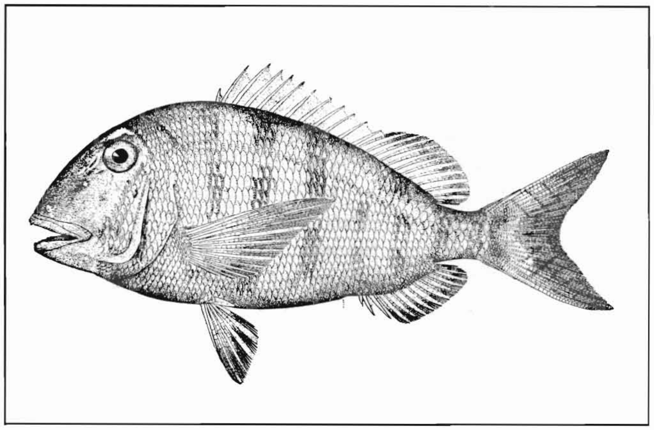

Figure 1.—Adult *Calamus arctifrons*. (From Jordan and Evermann 1896, fig. 550)

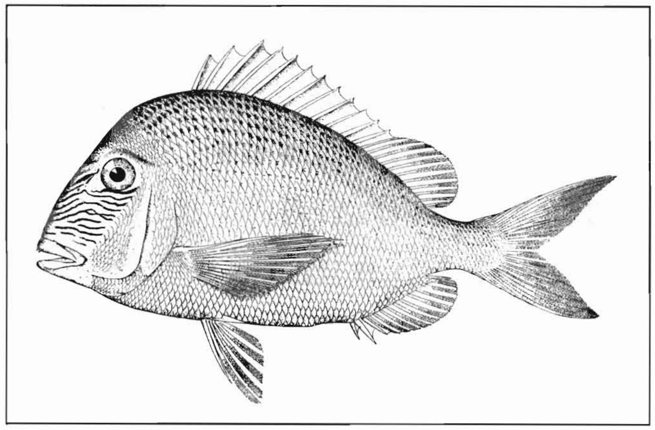

Figure 2.—Adult *Calamus proridens*. (From Jordan and Evermann 1896, fig. 547)

Generic

Systematics of the genus *Calamus* have been badly confused in the past (Randall and Caldwell 1966). Reviews of the genus have appeared in Valenciennes in Cuvier and Valenciennes (1830), Guichenot in de la Sagra (1843), Guichenot (1868), Poey (1874), Jordan and Gilbert (1882), Jordon and Fesler (1893), Jordan and Evermann (1898), Evermann and Marsh (1902), Longley and Hildebrand (1941), and Randall and Caldwell (1966). Species are often difficult to differentiate, and are especially difficult to identify when small. According to Randall and Caldwell (1966), 13 species of *Calamus* exist. All are American, with two species from the eastern Pacific, and 11 from the western Atlantic.

The genus is characterized as follows: Second interhaemal bone enlarged and hollowed anteriorly, receiving posterior portion of swimbladder; dorsal fin preceded by a small antrorse (forward-projecting) spine, often hidden by scales; temporal crests thin and high, joining lateral crests, which form part of the orbit above middle of eye, both crests coalescing with supraoccipital in narrow anterior part of interorbital; body deep, the depth contained 1.8-2.5 times in standard length (SL), and compressed, the width about 6 in SL; head large, its length 2.8-3.6 in SL; dorsal profile of head from moderately to very steep; eye elevated, the suborbital depth 5.4-12.5 in SL (often greater in adults than in juveniles); mouth terminal, not large; anterior teeth in jaws conical, those on sides molariform, in two full rows in lower jaw and three rows in upper jaw (teeth in middle row small); a bony tubercle projecting downward from lower anterior portion of maxillaries; prefrontal with a bony tubercle above posterior nostril, this tubercle much more conspicuous in some species than in others; posterior nostril long and slit-like; preopercle and opercle entire, the margins smooth; dorsal fin rays XII (rarely XI or XIII), 11 or 12 (rarely 13); anal fin rays III, 10 or 11 (rarely 9); pectoral fin rays 14-16 (rarely 13 or 17); pelvic fin rays I, 5; 15 branched caudal fin rays; body completely covered with weakly-ctenoid scales; head with scales on opercle, preopercle, interopercle, and extending anteriorly from nape into interorbital region; no scales on dorsal and anal fins except basally on last two rays; scales extend about two-thirds of way onto caudal fin and occur basally on paired fins, dorsal fin slightly notched between spinous and soft portions; dorsal fin relatively low, the longest spine (third or fourth) contained 5.6-9.6 in SL; pectoral fin length 2.1-3.6 in SL; caudal fin forked; gill rakers short, 9-14 on first gill arch; vertebrae 10+14; three predorsal bones; dorsal fin support count 0-0-0-2 (Randall and Caldwell 1966). The skull was discussed by Jordan and Gilbert (1882), and illustrated by Gregory (1933).

Specific

The most important characters for separating species of *Calamus* are: Number of lateral-line scales; total number of pectoral fin rays; number of dorsal and anal fin rays; dentition; eye diameter; suborbital depth; length of pectoral fins; length of the longest dorsal spine (usually the third spine); body depth; color; and steepness of profile of the head (Randall and Caldwell 1966).

Calamus arctifrons—The following species diagnosis is from Randall and Caldwell (1966): Dorsal fin rays XI to XIII (usually XII), 11 to 13 (usually 12); anal fin rays III, 10 or 11 (usually 10); pectoral fin rays usually 16 (sometimes 15); lateral-line scales 43-49 to base of caudal fin; total gill rakers in first gill arch 10-12 (usually 10); canine teeth in front of jaws about equal in size; no small molariform teeth medial to the three rows at sides of upper jaw; pectoral fins short, their length 3.0-3.6 in SL; eye small; suborbital depth moderately great, 6.6-7.8 in SL; body depth 2.0-2.5 in SL (depth relatively less in adults than juveniles); longest dorsal spine 6.4-8.9 in SL; dorsal profile of head usually smoothly convex, the portion below eye forming an angle of about 50-57° to the horizontal (taken from tip of snout above upper lip to mid-base of caudal fin); maxillary tubercle with a free semicircular margin; prefrontal tubercle not well developed.

Calamus arctifrons is very similar to *C. campechanus*, and probably evolved from a common stock in the not too distant past (Randall and Caldwell 1966). It is distinguished from *C. campechanus* by its smaller suborbital depth, higher number of pectoral fin rays, lower number of gill rakers, and lower dorsal profile of the head below level of the eye (Randall and Caldwell 1966). All specimens of *C. campechanus* examined by Randall and Caldwell had irregular horizontal lines on the unscaled portion of the cheeks, whereas only a few specimens of *C. arctifrons* had these lines. The two species are separated geographically, with *C. campechanus* restricted to Campeche Bank. Environmental conditions such as tubidity, temperature, and salinity apparently exclude both species from the western Gulf of Mexico (Randall and Caldwell 1966).

Calamus proridens—The following species diagnosis is from Randall and Caldwell (1966): Dorsal fin rays XII or XIII (usually XII), 11 or 12 (usually 12); anal fin rays III, 10 or 11 (usually 10); pectoral fin rays 13-15 (usually 14); lateral-line scales 52-57 (usually 54-56); total gill rakers in first gill arch 11-13 (usually 11); fourth canine tooth from symphysis of upper jaw enlarged and strongly outcurved in adults (enlargement begins at about 100 mm SL and is apparent at sizes at least as small as 148 mm SL); a group of small, molariform teeth medial and toward the front of the three rows at sides of upper jaw, forming a partial fourth row at front half of sides of jaw; pectoral fins long, 2.5-3.0 in SL; eye small; suborbital depth relatively great; body depth 1.95-2.20 in SL; longest dorsal fin spine 6.1-8.7 in SL (in specimens >100 mm SL); prefrontal tubercle above posterior nostril not well developed; largest molariform tooth usually smaller than fleshy width of maxillary tubercle; dorsal profile of head steep and relatively straight, portion below eye of adults forming an angle of 58-65° from horizontal and first third above eye an angle of 43-69°.

Calamus proridens is closely related to *C. pennatula*, but differs in having a steeper profile of the upper part of the head, greater average body depth, greater average length of the longest dorsal fin spine (third or fourth) and slightly higher lateral-line scale counts (Randall and Caldwell 1966). Large specimens of *C. proridens* develop a large, bulging forehead not found in *C. pennatula*.

1.22 Taxonomic status

Both *C. arctifrons* and *C. proridens* are considered morphospecies. *Calamus arctifrons* is very closely related to *C. campechanus*, but they are considered separate species (Randall and Caldwell 1966; Randall and Vergara R. 1978).

See 1.21.

1.23 Subspecies

No subspecies of *C. arctifrons* or *C. proridens* are recognized.

1.24 Standard common names, vernacular names

Calamus arctifrons—The accepted common name for *C. arctifrons* in the United States is grass porgy (Robins et al. 1980), and standard FAO common names are: English, grass porgy; French, daubenet cendre; Spanish, pluma negra (Randall and Vergara R. 1978). Other names appearing in the literature are shad porgy (Jordan and Fesler 1893; Evermann and Marsh 1902; Beebe and Tee-Van 1928), pez de pluma (Duarte-Bello 1959) and porgy (Springer and Woodburn 1960). According to Moe (1963), *C. arctifrons*, *C. proridens*, and *C. calamus* are caught on the snapper grounds off the west coast of Florida, and the names bank porgy, Key West porgy, grass porgy, and white snapper are applied to all three species, although Key West porgy usually refers to *C. nodosus*.

Calamus proridens—The accepted common name of *C. proridens* in the United States is littlehead porgy (Robins et al. 1980), and standard FAO common names are: English, littlehead porgy; French, daubenet titête; Spanish, pluma joroba (Randall and Vergara R. 1978). Other names or variations appearing in the literature include little-head porgy (Jordan and Fesler 1893; Beebe and Tee-Van 1928), pez de pluma (Jordan and Fesler 1893; Beebe and Tee-Van 1928; Duarte-Bello 1959), bajonado (Campeche Bank) (Sokolova 1965), crocro and tête-feuilles (Trinidad) (Zaneveld 1983) and bajonado azul (Campeche Bank) (Juárez 1975). The names bank porgy, Key West porgy, grass porgy, and white snapper are sometimes applied indiscriminately to *C. proridens*, *C. arctifrons*, and *C. calamus* from the snapper grounds off the west coast of Florida (Moe 1963).

1.3 Morphology

1.31 External morphology

Calamus arctifrons—The following morphological description is adapted from Evermann and Marsh (1902) and Randall and Vergara R. (1978): Head length 3.3 in SL; body oval, compressed and deep, its depth 2.0-2.5 in SL; eye width 3.4 in SL; snout length 1.9 in SL; maxillary length 2.4 in SL; interorbital distance 3.5 in SL; preorbital distance 2.8 in SL; suborbital space rather deep, 6.6-7.8 in SL; upper head profile usually smoothly convex and moderately steep; jaws anteriorly with about 8-10 canine-like teeth of about equal size; jaws with two rows of molar-like teeth laterally in lower jaw and three rows in upper jaw, without an irregular series inside and toward the front; dorsal fin XII, 12; anal fin III, 10; pectoral fins relatively short, not reaching to anal fin origin when appressed, usually with 16 rays; lateral-line scales 43-49; about five rows of scales on cheek; back not greatly elevated; anterior profile not steep, a slight angle in front of eye.

Additional meristic data are presented in Table 1. The skull of *Calamus* sp. was discussed by Jordan and Gilbert (1882), and illustrated by Gregory (1933).

Table 1.—Meristic data for *Calamus arctifrons*. Numbers in parentheses are percentages of the total number of specimens examined. (From Randall and Caldwell 1966)

Character	Count (%)						
Lateral-line scales	43 (1.2)	44 (8.6)	45 (9.9)	46 (32.1)	47 (29.6)	48 (9.9)	49 (8.6)
Pectoral fin rays			15-15 (11.5)	15-16 (20.5)	16-16 (67.9)		
Dorsal fin spines	XI			XII		XIII	
Dorsal fin rays	12 (1.3)	13 (0)	11 (5.2)	12 (85.7)	13 (1.3)	11 (6.5)	12 (0)
Anal fin spines				III			
Anal fin rays			9 (0)	10 (97.4)	11 (2.6)		
Gill rakers in first arch			10 (63.8)	11 (27.5)	12 (8.7)		

Color of adults in preservative: Light brown; a black spot smaller than the eye, but larger than the pupil near the front of the lateral line; five vertical rows of dark brown blotches on body and two diagonally elongate blotches on caudal peduncle, the last continuing as the upper part of a large V-shaped marking basally on caudal fin; two diffuse dark blotches mid-dorsally on nape anterior to first row of spots on body; occasional specimens have irregular horizontal lines on the unscaled portions of cheeks; dorsal fins with some faint dark blotches in line with rows of blotches on side of body; lobes of caudal fin traversed by about five blackish bands; pelvic fins with two faint transverse dark blotches (Randall and Caldwell 1966).

Color of juveniles in preservative: Darker rows of blotches than in adults, and a dark bar on head running through the eye, its front edge touching opening of the mouth; a few dark streaks on opercle and scattered brown dots on body among the dark blotches forming the dark bars; two dark spots dorsally on caudal peduncle; a row of dark spots on dorsal fin with a second row in spinous portion above and a second row in soft portion below; two rows of dark spots on anal fin; dark bars on caudal lobes very conspicuous; pelvic fins with two broad, dark crossbars (Randall and Caldwell 1966).

Description of colors in life: Silvery, olivaceous or bluish above, the centers of many of the scales pearly and iridescent; paler below; back and sides with 6-8 dark vertical crossbars, narrower than interspaces, with spots between them; conspicuous black blotch on lateral line near upper end of gill opening; row of about six salmon-olive spots along lateral line; snout olive, mottled with bluish and may be streaked with yellow; interorbital area may have a yellow band; broad, dark bar from eye straight downward across cheek; an obscure pearly-blue streak below eye, and two or three similar ones before eye; preorbital usually bluish, with more or less numerous longitudinal streaks and dashes of golden yellow; preorbital sometimes pale salmon-yellow, with a few light bluish streaks; cheeks, preopercle, and opercle pearly, with yellow shades and spots; opercular membrane coppery orange; pectoral fins pale; pelvic fins bluish white, faintly barred; dorsal fin bluish, with blackish spots along base of dorsal; anal fin bluish; caudal fin bluish, with small, dusky salmon spots forming undulating crossbars, posterior margin slightly dusky (Goode and Bean 1882; Jordan and Gilbert 1884; Evermann and Marsh 1902; Randall and Vergara R. 1978).

See 1.21.

Calamus proridens—The following morphological description is adapted from Randall and Caldwell (1966) and Randall and Vergara R. (1978): Body oblong, compressed, very deep anteriorly (1.95-2.20 in SL, relatively less in adults than in juveniles); snout blunt and very steep in adults (less so in juveniles); dorsal profile of head usually smoothly convex; nape strongly convex, developing into a distinct bump in large specimens; suborbital space rather deep, about 6.3-9.9 in SL; mouth small (especially in small specimens), the maxilla not reaching to anterior eye margin; eye small; both jaws anteriorly with canine-like teeth, the fourth from midline on each side enlarged and noticeably outcurved in specimens >18 cm SL; laterally with molar-like teeth in three rows plus an irregular series inside and toward the front in upper jaw; dorsal fin rays XII or XIII (usually XII), 11 or 12 (usually 12); anal fin rays III, 10 or 11 (usually 10); pectoral fin rays 13-15 (usually 14), the pectoral fins extending to or beyond anal fin origin when appressed; lateral-line scales 52-57 (usually 54-56); total gill rakers in first gill arch 11-13 (usually 11).

Additional meristic data are presented in Table 2. The skull of *Calamus* sp. was discussed by Jordan and Gilbert (1882), and illustrated by Gregory (1933).

Color in preservative: Tan to light brown; center of each scale on upper half of body with a dark brown spot; horizontally elongate dark brown blotch, broader posteriorly, running over upper end of gill opening; front end of blotch beginning at or slightly anterior to dorsal end of free margin of preopercle; supra and suborbital dark brown lines; three dark brown lines extending anteriorly from region in front of eye between supra and suborbital lines; unscaled suborbital region with well-defined dark brown horizontal or slightly diagonal lines on a bronze background, usually slightly wavy and sometimes broken into spots or lines; caudal fin about same color as body; other fins paler, dorsal with some faint brownish blotches (Randall and Caldwell 1966).

Table 2.—Meristic data for *Calamus proridens*. Numbers in parentheses are percentages of the total number of specimens examined. (From Randall and Caldwell 1966)

Character	Count (%)					
Lateral-line scales	52 (2.7)	53 (5.4)	54 (29.7)	55 (37.8)	56 (18.9)	57 (5.4)
Pectoral fin rays		13-14 (2.7)	13-15 (0)	14-14 (83.8)	14-15 (13.5)	
Dorsal fin spines		XII		XIII		
Dorsal fin rays		11 (2.8)	12 (94.4)	11 (2.8)	12 (0)	
Anal fin spines			III			
Anal fin rays			10 (91.9)	11 (8.1)		
Gill rakers in first arch			11 (75.9)	12 (20.7)	13 (3.4)	

Color in life: Iridescent silvery, with bright bluish tinges on back and upper sides; diffuse horizontal elongate blue blotch at upper end of gill opening; blue streak running along lower eye margin and alternating blue (narrow) and yellow (wide) horizontal lines across unscaled portion of cheeks; unmarked portion of suborbital and snout brassy; lips yellowish; inside corners of mouth yellow (Randall and Caldwell 1966; Randall and Vergara R. 1978).

See 1.21.

2 DISTRIBUTION

2.1 Total area

Calamus arctifrons—*Calamus arctifrons* occurs in the northeastern Gulf of Mexico, primarily in shallow water along the west coast of Florida, but straying on occasion to Louisiana and Texas (Fig. 3) (Randall and Caldwell 1966; Hoese and Moore 1977; Randall and Vergara R. 1978). The species is apparently absent from the northwestern Gulf of Mexico (Briggs 1958; Randall and Caldwell 1966), and Campeche Bank. Although there are several published reports of *C. arctifrons* from the West Indies (Evermann and Marsh 1902, Puerto Rico; Beebe and Tee-Van 1928, Haiti), Randall and Caldwell (1966) were not able to find any West Indian specimens in museum collections; if the species does occur in the Greater Antilles, it is apparently quite uncommon there. Briggs (1958) placed the southern limit of the range at Ilha Grande, Brazil, which is almost certainly incorrect.

Calamus proridens—*Calamus proridens* occurs along the Atlantic and Gulf of Mexico coasts of Florida to about Louisiana, on Campeche Bank, and through the Greater Antilles (Fig. 4) (Briggs 1958; Randall and Caldwell 1966; Dubovitsky 1977a; Randall and Vergara R. 1978). This species, like *C. arctifrons*, is apparently absent from the northwestern Gulf of Mexico (Briggs 1958; Walls 1975). Struhsaker (1969) reported *C. proridens* as rare, but present, on live bottom in the South Atlantic Bight. Although several authors (Jordan and Gilbert 1884; Jordan and Fesler 1893; Beebe and Tee-Van 1928) reported specimens from the West Indies, Randall and Caldwell (1966) speculated that at least some of these reports may not have been based on natural occurrences, the fish having been caught at some other location. *Calamus proridens* is fished in Cuba (Randall and Vergara R. 1978), and is known to occur in Hispaniola.

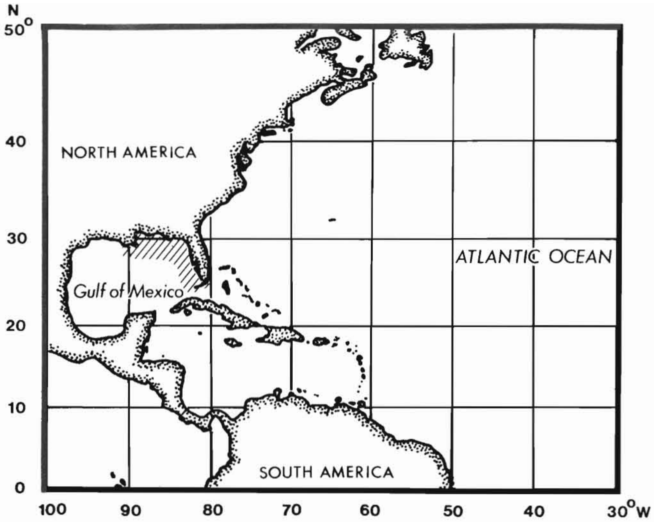

Figure 3.—Distribution of *Calamus arctifrons*. (Based on Randall and Vergara R. 1978)

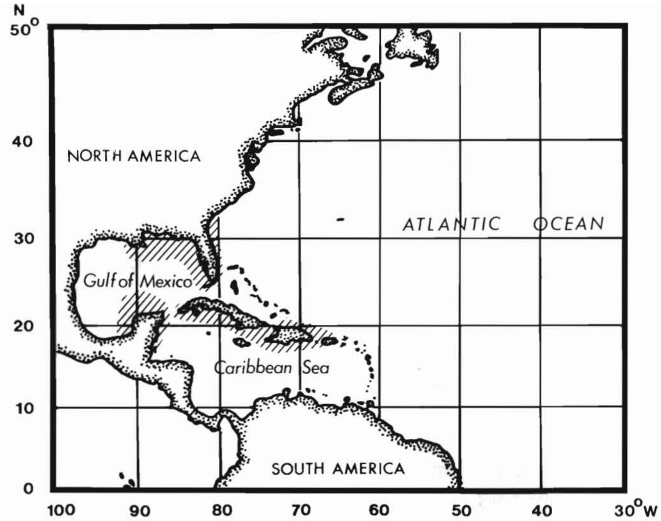

Figure 4.—Distribution of *Calamus proridens*. (Based on Randall and Vergara R. 1978)

2.2 Differential distribution

2.21 Spawn, larvae and juveniles

Calamus arctifrons—Spawning areas of *C. arctifrons* are unknown. Unidentified sparid larvae collected by Houde et al. (1979) in the northeastern Gulf of Mexico probably included *C. arctifrons*. Most (>90%) of the unidentified sparid larvae were collected at stations <50 m deep, and were most common in winter and spring.

Juveniles are often found in shallow seagrass beds. Most of the specimens examined by Tabb and Manning (1961) from Florida Bay *Thalassia* beds were juveniles of 7-10 cm SL.

See 2.3 and 3.16.

Calamus proridens—Spawning areas of *C. proridens* along the coast of the United States are not well known. Unidentified sparid larvae collected by Houde et al. (1979) in the northeastern Gulf of Mexico probably included *C. proridens* (see above).

On Campeche Bank, Dubovitsky (1977a) reported a steady drift of pelagic eggs and larvae westward across the bank, eventually reaching shallow water where the demersal habit is adopted.

Juveniles are found in relatively shallow water. On Campeche Bank, young stay in shallow, productive waters for the first year of life (Dubovitsky 1977a). Between ages I and II, there is a gradual movement offshore toward the northeast and east, where small fish become recruited to the commercial stock.

See 2.3, 3.16, and 3.51.

2.22 Adults

Calamus arctifrons—Adult *C. arctifrons* occur on shallow seagrass beds and other vegetated bottom (Evermann and Marsh 1902; Tabb and Manning 1961; Vick 1964; Randall and Caldwell 1966; Walls 1975; Hoese and Moore 1977; Randall and Vergara R. 1978), and over hard or rock bottoms (Randall and Caldwell 1966; Darcy and Gutherz[3]). They occur from near shore to at least 29.6 m (Darcy and Gutherz[3]), and are demersal.

See 2.1, 2.3, and 3.51.

Calamus proridens—Adult *C. proridens* occur in shallow water, from nearshore to at least 59.3 m on the West Florida Shelf (Darcy and Gutherz unpubl.), and at least 85 m on Campeche Bank (Dubovitsky 1977a). They are found on or near natural and artificial reefs (Smith et al. 1979; Miller and Richards 1980), around offshore platforms (Hastings et al. 1976), and on live bottoms of sponges and corals (Struhsaker 1969; Darcy and Gutherz unpubl.). Smith (1976) termed *C. proridens* a secondary reef fish.

See 2.1, 2.3, and 3.51.

2.3 Determinants of distribution changes

Calamus arctifrons—Distribution of *C. arctifrons* is affected by temperature, salinity, water clarity, water depth, and habitat. In the northern part of its range, *C. arctifrons* appears to be uncommon or absent in shallow water in the coldest months. At Crystal River, Florida, Reid (1954) collected *C. arctifrons* from June through December (except for August); Grimes (1971) collected specimens March through December 1969, with greatest abundance in September and July; and Grimes and Mountain (1971) collected specimens April through December 1970, with greatest abundance in October and December. In the southern part of its range, *C. arctifrons* may remain in shallow water in winter; Tabb and Manning (1961) found them most common October to April in Florida Bay. The species occurs in water of at least 7.8-32.2°C (Crystal River, Reid 1954), and at salinities of at least 9.7-35.7‰ (Crystal River, Reid 1954; Charlotte Harbor, Wang and Raney 1971). *Calamus arctifrons* prefers clear water (Tabb and Manning 1961). Turbidity avoidance may be a reason why this species is absent from the northwestern Gulf of Mexico (Randall and Caldwell 1966).

Calamus arctifrons is stricted to fairly shallow water, perhaps because benthic vegetation is confined to shallow water, and *C. arctifrons* is often associated with vegetation (Evermann and Marsh 1902; Tabb and Manning 1961; Walls 1975; Randall and Vergara R. 1978). The species has been reported from at least as deep as 29.6 m (Darcy and Gutherz unpubl.), but is usually most common in shallower water. At Crystal River, Reid (1954) found *C. arctifrons* on shallow and deep flats and in channels 4.8-5.5 deep. On the West Florida Shelf, Darcy and Gutherz (unpubl.) reported *C. arctifrons* most common in 9-18 m of water, with a mean depth of 15.8 m, in the surveyed area. In addition to vegetated bottom, *C. arctifrons* is common on hard bottom (Randall and Caldwell 1966) and rock bottom (Darcy and Gutherz unpubl.).

See 2.1, 2.21, 2.22, and 3.51.

Calamus proridens—Distribution of *C. proridens* is affected by salinity, temperature, water depth, growth stage of the fish, and habitat. Although there are no specific references in the literature to salinities at which *C. proridens* occurs, it is not found in estuaries or low salinity area, and probably requires a salinity of at least 30‰.

Distributional changes with depth and season are probably attributable to temperature changes. Little is known about the distribution of *C. proridens* on the Atlantic coast of the United States. In the Gulf of Mexico, the species occurs from at least 11 to 59 m (Darcy and Gutherz unpubl.), with greatest abundance in 19-27 m (in January) and a mean depth occurrence of 27.8 m. Abundance was found to vary significantly with depth. Smith (1976) reported *C. proridens* from 29-42 m depths on the Florida Middle Ground.

On Campeche Bank, considerable study has been made of seasonal distribution changes of *C. proridens*. Although Olaechea and Sauskan (1974) did not feel that water temperature influenced abundance of *Calamus* spp. on Campeche Bank, most other authors (Gonzáles 1973; Olaechea 1975; Dubovitsky 1977a) did report relationships between bottom temperature and *C. proridens* abundance. Gonzáles (1973) found good correlation between catch rates of *Calamus* spp. and water temperature on the eastern edge of the bank, with fish moving deeper on the slope when shallow waters warmed. Olaechea and Sauskan (1974) estimated highest abundance of *C. proridens* on the bank in spring and summer. Sauskan and Olaechea (1974) reported this species most common in shallow (15-30 m) water on the central part of the bank, but also common in shallow and deep (50-120 m) water on the eastern bank, and at moderate (30-50 m) depths on the western and central bank (see section 4.2).

Dubovitsky (1977a) presented detailed information on seasonal changes in geographical distribution of *C. proridens* on Campeche Bank. In January (Fig. 5A), the bulk of the population was on the central bank. When bottom temperatures on the bank did not exceed 22°C, *C. proridens* extended its distribution into deep (65-70 m) water and as far south as lat. 20°N. In February and March (Fig. 5B), *C. proridens* was most common in coastal areas of the eastern bank at depths to 25 m, but extended to 40 m where cold water flowed onto the edge of the shelf. In May through June (Fig. 6), *C. proridens* was restricted to shallow water, with commercially exploitable aggregations present. By August (Fig. 7A), fish spread out and moved to somewhat deeper (60-85 m) water; they were most abundant east of long. 89°30′W, and below 30 m depth. Bottom waters from May to August are the coldest of the year on the bank, due to upwelling. In November, bottom temperatures are at their maximum for the year, and fish were found in fairly shallow water (Fig. 7B), with large aggregations only in the eastern and western parts of the bank. In December (Fig. 7B), a similar pattern was seen, with fish well spread out across the bank. In general, aggregations formed in periods of lowest bottom temperatures.

Seasonal changes in size composition of *C. proridens* also occur on Campeche Bank (Dubovitsky 1977a). From December to March, large individuals were always present on the eastern bank where bottom waters were cold, though the numbers of large individuals decreased from December to March. Large fish were present in shallow (<30-35 m) water on the central bank in December, small fish were present in January, and both size groups were present in March. On the offshore part of the bank, at 35-55 m, small (18-20 cm, type of length measurement unspecified) fish dominated from December to March, their numbers increasing with depth. Juveniles of 13-16 cm appeared in offshore waters of the western and central bank in January, and on the eastern bank in February. From May through August, size distributions were similar to those of January. In November, small fish dominated everywhere except on the shallow central bank, where mixed size groups occurred, and on the northwestern bank. There was a notable increase in small, immature fish on the southwestern bank. In general, throughout the year, large fish were associated with low bottom temperatures and were most common on the eastern bank where cold-water upwelling occurred. Large fish penetrated the western bank only when bottom temperatures there declined. Small fish were usually associated with higher bottom temperatures and were most common on the western bank and in shallow water, extending eastward only in times of high bottom temperatures.

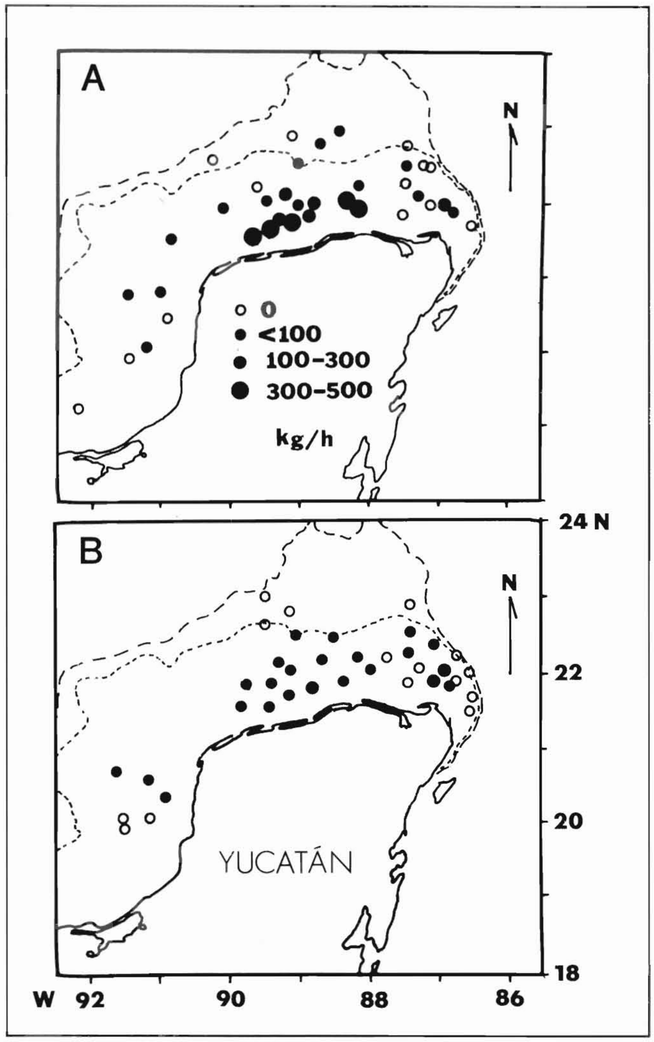

Figure 5.—Distribution of *Calamus proridens* and catch rates on Campeche Bank; A. January 1970; B. February-March 1971. (From Dubovitsky 1977a, fig. 2)

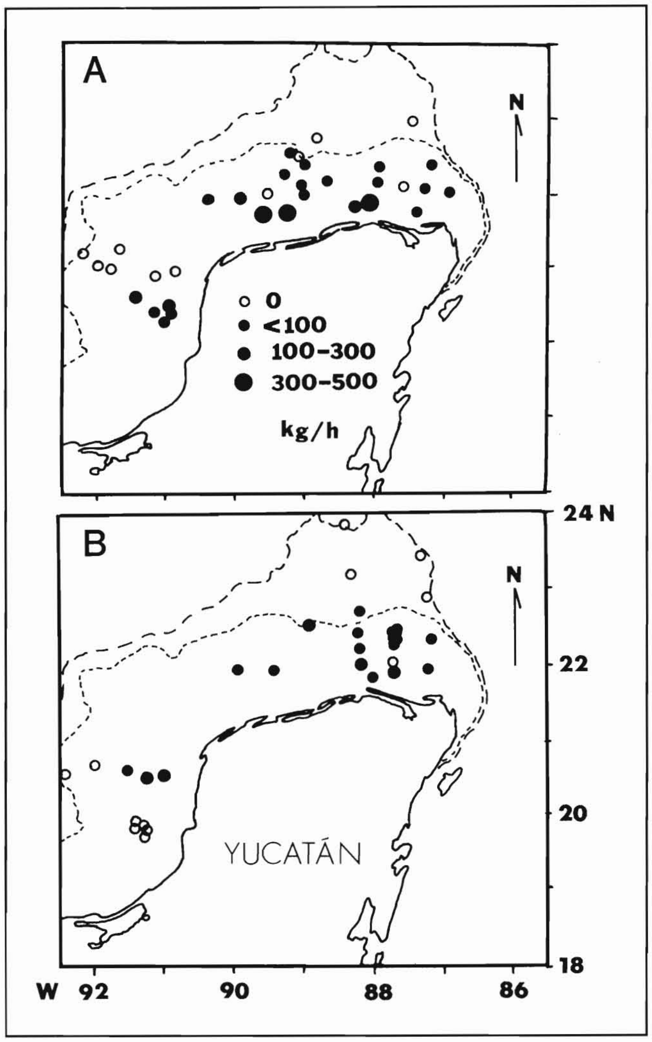

Figure 6.—Distribution of *Calamus proridens* and catch rates on Campeche Bank; A. May 1969; B. June 1969. (From Dubovitsky 1977a, fig. 2)

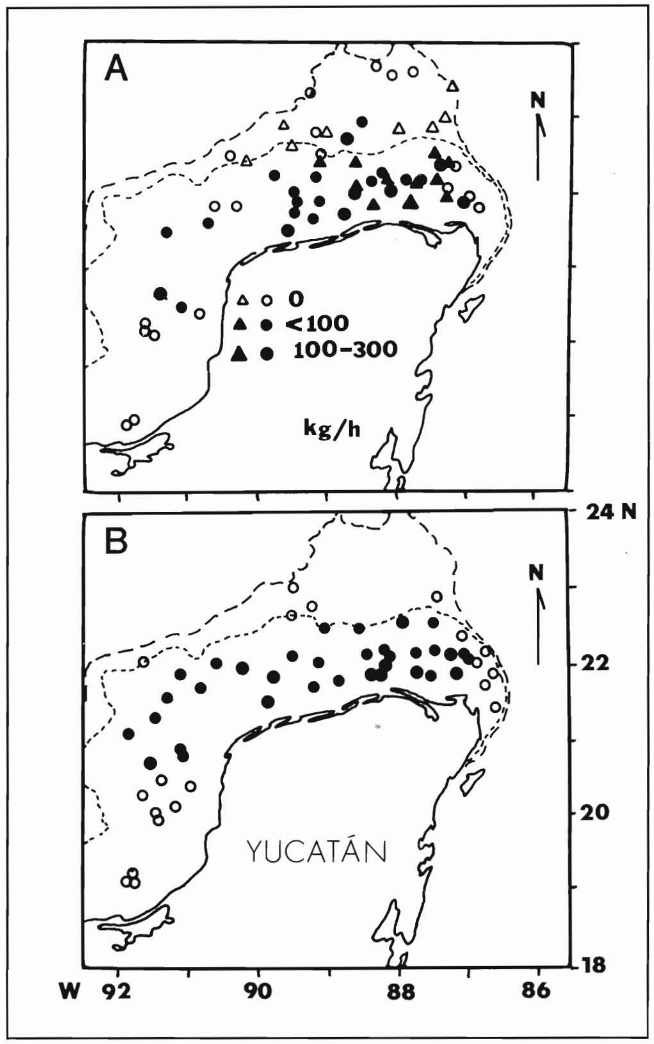

Figure 7.—Distribution of *Calamus proridens* and catch rates on Campeche Bank; A. August 1969 (circles) and August 1971 (triangles); B. November 1970 (circles) and December 1970 (triangles). (From Dubovitsky 1977a, fig. 2)

Calamus proridens is found primarily on sponge and coral bottoms (live bottom) (Struhsaker 1969; Darcy and Gutherz unpubl.). Smith et al. (1979) reported *C. proridens* from natural and artificial reefs off Clearwater, Florida, and Smith (1976) listed it as a secondary reef fish of the northeastern Gulf of Mexico. The species also inhabits offshore platforms in the northern Gulf (Hastings et al. 1976). Hard substrates and sessile invertebrate growths probably provide shelter and harbor food organisms of *C. proridens*.

See 2.1, 2.21, 2.22, 3.51, 3.52, 4.13, and 4.2

2.4 Hybridization

No hybrids of either *C. arctifrons* or *C. proridens* are known.

3 BIONOMICS AND LIFE HISTORY

3.1 Reproduction

3.11 Sexuality

Nothing is known of sexuality of *C. arctifrons*, though it is probably a hermaphroditic species like many other sparids. *Calamus proridens* is known to be a protogynous hermaphrodite, with individuals changing from females to males at about 24 cm (measurement unspecified) (Dubovitsky 1977b). Because of this sex reversal, females are consistently smaller than males (Fig. 8).

See 3.12 and 3.15.

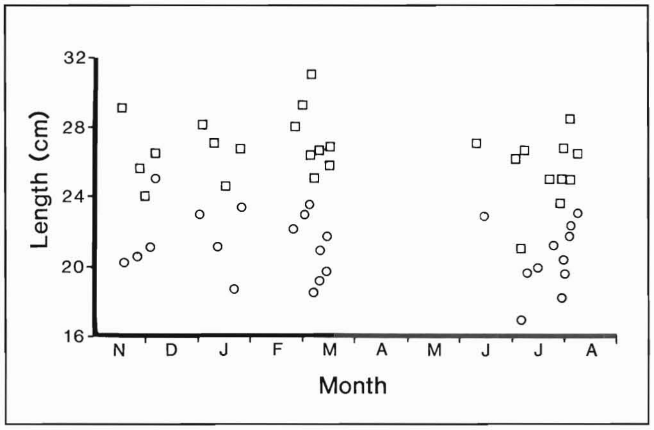

Figure 8.—Mean lengths of males (squares) and females (circles) of *Calamus proridens* from Campeche Bank. Type of length measurement was unspecified. (From Dubovitsky 1977a, fig. 5)

3.12 Maturity

Maturation size and age of *C. arctifrons* are unknown. Although Dubovitsky (1977a, b) did not state a size of maturation for *C. proridens*, he did identify females as small as about 17 cm (measurement unspecified), and males as small as about 23 cm. The great majority of adult females collected by Dubovitsky (1977a) were ripe and in prespawning condition, but never more than half of the ovaries had eggs in ripening condition. Male maturation stages were difficult to assess.

See 3.11 and 3.16.

3.13 Mating

Mating in *C. arctifrons* and *C. proridens* has not been described. Dubovitsky (1977a) stated that *C. proridens* apparently does not form dense spawning aggregations.

3.14 Fertilization

Fertilization is probably external.

3.15 Gonads

Gonads of *C. arctifrons* have not been described. Dubovitsky (1977a, b) histologically examined gonads of *C. proridens*, and found successive sex inversion from female to male. The size at which the ovaries regress and testes develop is very variable, but there is a pronounced sex inversion at about 23-24 cm (measurement unspecified). By the end of the spawning season (middle to late summer), asymmetry of the ovaries is often observed, the left ovary being larger.

See 3.12 and 3.16.

3.16 Spawning

Calamus arctifrons—Spawning season of *C. arctifrons* is not known with certainty. However, unidentified sparid larvae collected in the northeastern Gulf of Mexico by Houde et al. (1979), which probably included *C. arctifrons*, were most abundant in winter and spring. Reid (1954) hypothesized early spring spawning at Crystal River, based on small individuals caught in June and July.

Calamus proridens—Spawning season of *C. proridens* along the coast of the United States is not known, but larval surveys by Houde et al. (1979) in the eastern Gulf of Mexico indicated highest abundance of sparid larvae, probably including *C. proridens*, in winter and spring.

On Campeche Bank, several studies of *C. proridens* have indicated a long spawning period. Juárez (1975) stated that the spawning season lasts from summer into winter, with maximum spawning intensity in winter. Dubovitsky (1977a) reported spawning from December to August, with a peak from January to March. Based on visual inspection and histological examination of ovaries, individuals are apparently partial spawners (Dubovitsky 1977a), and may spawn more than once a year. No dense spawning aggregations have been reported, but localized areas of prespawning (characterized by numerous large, transparent oocytes occupying, visually, about 20% of the total ovary volume) *C. proridens* have been identified (Fig. 9) (Dubovitsky 1977a). Large, ripe individuals occurred from December to June, with greatest abundance in December and February on the shallow eastern bank, and in January on the western bank at depths >35 m. Small prespawning fish were observed from January through August, with peaks in January, March, and July. Ripe, small fish were observed in offshore areas at depths >40-50 m, and only on the central bank. Sequential spawning of size groups was also reported by Dubovitsky (1977a), with different spawning locations for different size groups. Over the spawning season, a gradual diminution of size of spawners occurred. From late May to the beginning of June, average size was 22 cm (measurement unspecified); in early June it was 20 cm; by late July, 18 cm; and by early August, 17 cm.

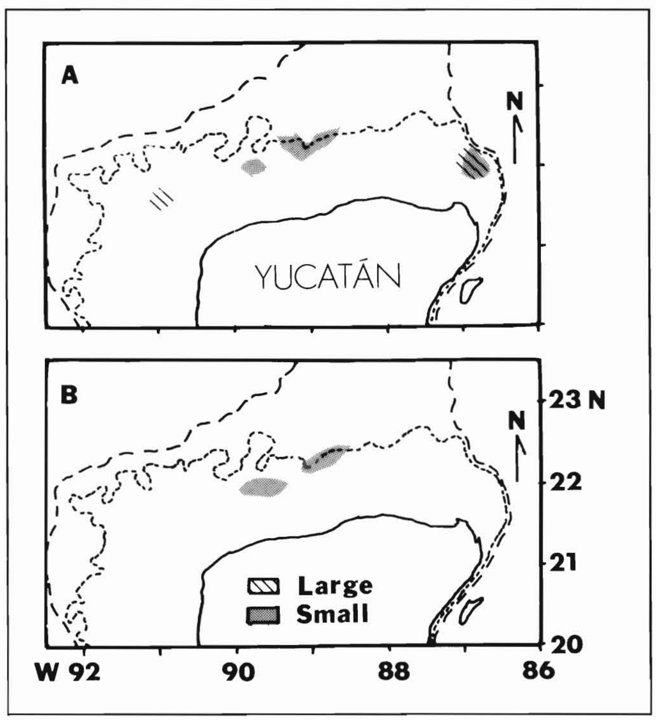

Figure 9.—Locations and months of collection of *Calamus proridens* in pre-spawning condition on Campeche Bank; A. December to March; B. May to August. (From Dubovitsky 1977a, fig. 6)

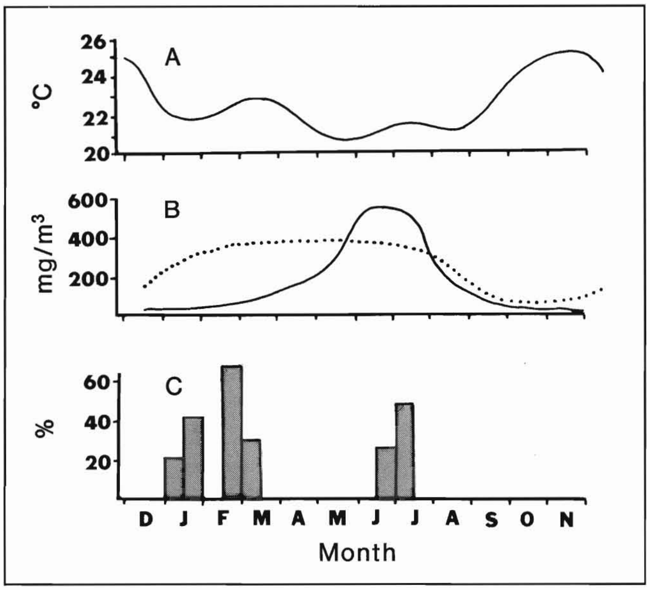

Figure 10.—Seasonal changes in reproductive activity of *Calamus proridens* and related factors on Campeche Bank. A. Bottom temperatures, 1969-1971. B. Total plankton biomass between the 20-m and 200-m isobaths for lat. 91°W (dotted line) and lat. 87°20′W (solid line). C. Percentage of pre-spawning females captured. Plankton productivity figures are from Jrómov (1967). (From Dubovitsky 1977a, fig. 7)

Spawning of *C. proridens* on Campeche Bank is temperature-dependent, beginning with the appearance of cold-water inflows onto the eastern bank in December (Dubovitsky 1977a). Plankton productivity is also temperature-dependent, with maximum productivity in January through August (Jrómov 1967). High plankton productivity at the time of spawning assures that larval stages will have adequate food supply. The relationships between temperature, plankton productivity, and spawning of *C. proridens* on Campeche Bank are shown in Fig. 10.

See 2.21, 2.23, 3.51, and 4.13.

3.17 Spawn

Eggs of *C. arctifrons* are probably pelagic, since most sparids produce pelagic eggs with little or no pigment (Breder 1962). Eggs of *C. proridens* are known to be pelagic (Dubovitsky 1977a).

3.2 Preadult phase

3.21 Embryonic phase

Embryonic development of *C. arctifrons* and *C. proridens* have not been studied. Developing eggs are probably pelagic.

3.22 Larvae and adolescent phase

Larvae of *C. arctifrons* and *C. proridens* have not been described in the literature. Young of *Calamus* spp. are difficult to distinguish. Houde et al. (1979) were unable to separate species of *Calamus* from plankton collections in the eastern Gulf of Mexico. *Calamus proridens* is known to have pelagic larvae (Dubovitsky 1977a); *C. arctifrons* larvae are probably also pelagic.

3.3 Adult phase

3.31 Longevity

Calamus arctifrons reaches a maximum size of about 22 cm (measurement unspecified) and is common to 20 cm (Randall and Vergara R. 1978). *Calamus proridens* reaches 44 cm and is common to 37 cm (Randall and Vergara R. 1978). Life spans of these species are unknown.

3.32 Hardiness

Calamus arctifrons is apparently subject to toxic effects of red tides, because Springer and Woodburn (1960) found several dead individuals on the beach in Pinellas County, Florida, following an outbreak.

See 2.3 and 3.35.

3.33 Competitors

Competitors of *C. arctifrons* and *C. proridens* are not known, but probably include other sparids, haemulids, lutjanids, labrids, and other fishes that feed on benthic invertebrates. Associates of *C. arctifrons* and *C. proridens* on the West Florida Shelf are discussed in section 4.6. Whether these associates are actually competitors is not known.

3.34 Predators

Predators of *C. arctifrons* and *C. proridens* are unknown, but probably include sharks, sphyraenids, and large serranids and lutjanids.

3.35 Parasites, diseases, injuries, and abnormalities

Calamus arctifrons has been reported parasitized by intestinal trematodes, including *Proctoeces lintoni*, *Lepocreadium opsanusi*, *Pseudocreadium anandrum*, and *Pachycreadium crassigulum* (Nahhas and Cable 1964). Red tides apparently prove fatal to some individuals of *C. arctifrons* (Springer and Woodburn 1960).

3.4 Nutrition and growth

3.41 Feeding

Feeding of *C. arctifrons* is unknown, but dentition suggests benthic feeding habits. Sessile and motile invertebrates are probably bitten or picked off hard substrates and seagrass blades, and other prey picked from the surface of softer substrates.

Calamus proridens probably feeds in a manner similar to that described for *C. arctifrons*. On Campeche Bank, feeding intensity varies over the year (Fig. 11), with major feeding concentrated around the spawning and postspawning periods (Dubovitsky 1977a). Primary feeding grounds on Campeche Bank are the inshore parts of the plateau (Dubovitsky 1977a). At the outer edge of the bank, intense feeding, as measured by mean index of stomach fullness, was noted only in the period just prior to spawning.

See 3.42.

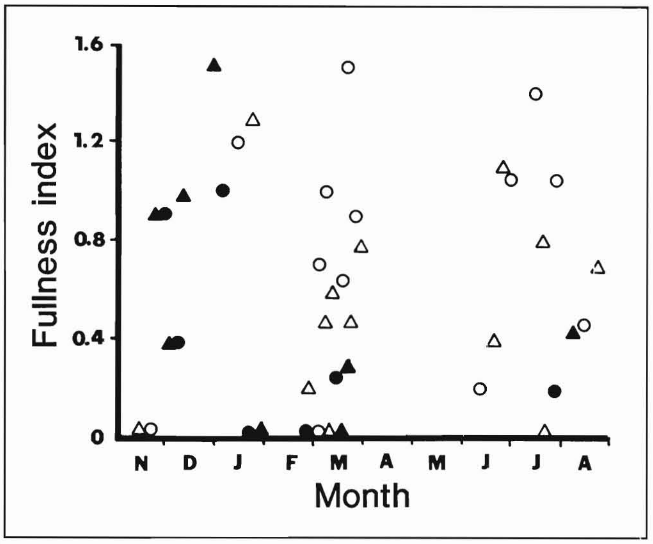

Figure 11.—Feeding intensity of small mature (circles) and large mature (triangles) specimens of *Calamus proridens* by month on Campeche Bank. Solid symbols refer to specimens collected in >30-35 m depths, open symbols refer to specimens collected in depths <30-35 m. (From Dubovitsky 1977a, fig. 9)

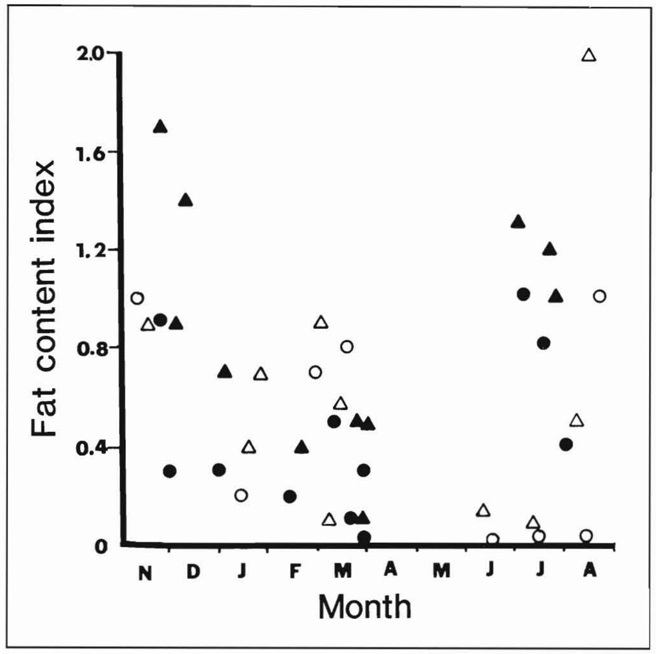

Figure 12.—Seasonal changes in fat content of mature *Calamus proridens* from Campeche Bank. Circles represent small specimens, triangles represent large specimens. Solid symbols refer to specimens caught in depths >30-35 m, open symbols refer to specimens caught at depths <30-35 m. (From Dubovitsky 1977a, fig. 8)

3.42 Food

Both *C. arctifrons* and *C. proridens* probably feed primarily on invertebrates. Beebe and Tee-Van (1928) reported unidentifiable animal and vegetable materials from stomachs of *C. arctifrons*, including *Thalassia* leaves. Whether the leaves were consumed deliberately or incidentally is not known. *Calamus arctifrons* at Crystal River conatined copepods, amphipods, mysids, shrimp, bivalves, and gastropod mollusks (*Mitrella* sp. and *Bittium* sp.) and polychaetes (Reid 1954). *Calamus proridens* examined by Beebe and Tee-Van (1928) contained small crustaceans. Dentition of *C. proridens* suggests feeding on hard-shelled benthic crabs and bivalved mollusks (Dubovitsky 1977a). On the western part of Campeche Bank, south of lat. 20°N, the main food of young *C. proridens* is pink shrimp, *Penaeus duorarum* (Dubovitsky 1977a).

3.43 Growth rate

Growth rate of *C. arctifrons* is unknown. Growth rate of *C. proridens* is reportedly rapid in the first year of life (Dubovitsky 1977a), though Dubovitsky did not publish growth curves. There is apparently substantial variation in timing of growth and spawning within the population, and scale increment formation is variable, possibly due to differences in spawning and feeding among fish of different size groups (Dubovitsky 1977a). Growth rate differs from female to male phase of the fish; egg development reportedly slows growth of individuals functioning as females (Dubovitsky 1977b), after which the growth rate increases again. Dubovitsky based these conclusions on histological examinations of gonads and analysis of length frequencies, but there is little data presented in his publications on which to critically evaluate them.

See 3.44.

3.44 Metabolism

When *C. proridens* individuals are functioning as females, growth rate, as determined from length frequency analysis, slows due to metabolic changes (Dubovitsky 1977b). When fish change from female to male, growth rate increases. Fat content of the body cavity increases in mature fish to a maximum in November and December, just prior to spawning (Fig. 12) (Dubovitsky 1977a). Fat content decreases through the spawning season and is low by the end of spawning. Fat build-up is rapid in July and August in large post-spawning fish. During spawning, fat content is highest in fish living in deep water.

See 3.43.

3.5 Behavior

3.51 Migrations and local movements

No migrations of *C. arctifrons* have been reported.

Migrations of *C. proridens* on Campeche Bank have been reported by Dubovitsky (1977a). Eggs and larvae move primarily from east to west across the bank, and move towards shallow water (Fig. 13). Small fish move gradually from west to east in December through March. The majority of mature fish migrate into coastal waters of the central bank in January, dispersing eastward by March. Migration patterns in mature fish are strongly developed during the spawning period, with spawners generally moving offshore. After spawning, fish move into shallower water again. An extensive migration of 19-21 cm (length unspecified) fish to inshore waters occurs in January. Aggregations of *C. proridens* on Campeche Bank tend to form when bottom temperatures are lowest.

See 2.3 and 3.52.

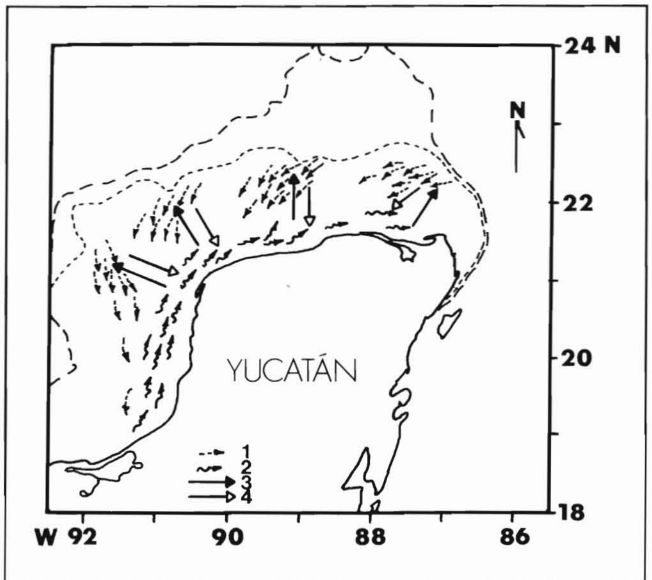

Figure 13.—Schematic representation of migrations and movements of *Calamus proridens* on Campeche Bank. Arrows indicate movements of: 1, eggs and larvae; 2, immature individuals; 3, spawning individuals; 4, post-spawning individuals. (From Dubovitsky 1977a, fig. 10)

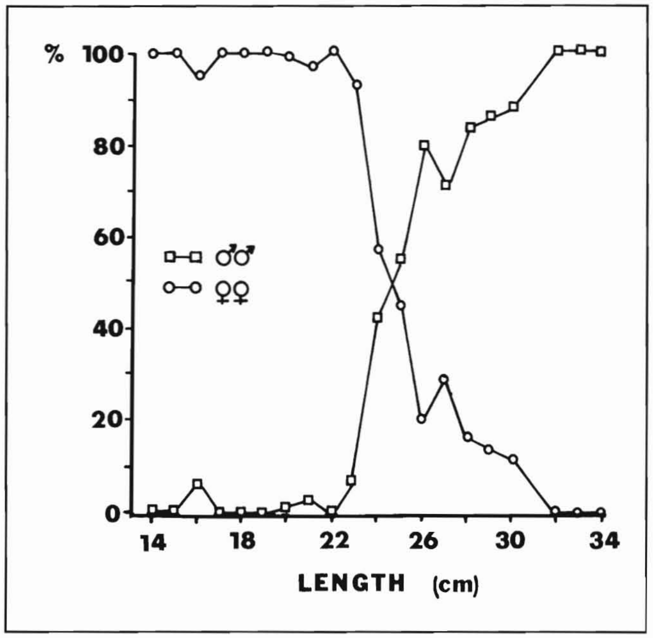

Figure 14.—Overall sex ratio of *Calamus proridens* in the commercially exploited population on Campeche Bank. (From Dubovitsky 1977b, fig. 2)

3.52 Schooling

Although schooling behavior is not well known in *C. arctifrons* and *C. proridens*, most small porgies form aggregations (Randall and Vergara R. 1978). Large individuals are more often solitary or found in small groups. Dubovitsky (1977a) noted concentrations of *C. proridens* on Campeche Bank, but stated that they did not form dense spawning aggregations.

See 3.51.

4 POPULATION

4.1 Structure

4.11 Sex ratio

Sex ratio of *C. arctifrons* is unknown.

On Campeche Bank, Dubovitsky (1977b) found that female *C. proridens* always predominated, regardless of time or location. Sex ratio observed was not constant from year to year, but averaged 1:2.7 males to females. About 73% of the commercially exploited population were females. Sex ratio changed drastically with size of the fish examined (Fig. 14). Only about 1% of specimens <23 cm (measurement unspecified) were males (Table 3). Beyond 24 cm, the percentage of males increased sharply, to about 69% of the total. Only females were found in the smallest specimens, and only males in the largest. Dubovitsky (1977b) derived the following linear relationship between sex ratio and size of fish:

$$S = 2.338 - 0.072\ L$$

where S is the proportion of females, and L is the mean length of the females examined. It is obvious from Fig. 14, however, that the true relationship approaches linearity only over a restricted range of length.

See 4.13.

4.13 Size composition

Size composition of *C. arctifrons* has not been reported.

Size composition of *C. proridens* on Campeche Bank was examined by Dubovitsky (1973, 1977a, b) (Figs. 15-20; Table 4). Size distributions presented by Dubovitsky (1977a) were often bimodal, with the smaller size-class dominating. In stocks of mature fish, females 18-22 cm (measurement unspecified) predominated (Fig. 20). About 59% of all females in the commercially exploited population were between 18 and 21 cm in length, and 65% of the males were between 25 and 28 cm. Size composition of females and their proportions in the commercial population are presented in Fig. 21.

See 2.3.

Table 3.—Percentage of females in three size ranges of *Calamus proridens* in the sexually mature part of the commercial catch on Campeche Bank, 1969-71. (From Dubovitsky 1977b)

Size range[1] (cm)	% females	% examined specimens
14-20	99.3	37.9
21-25	78.5	39.5
26-34	19.7	22.6

[1]Type of length measurement unspecified.

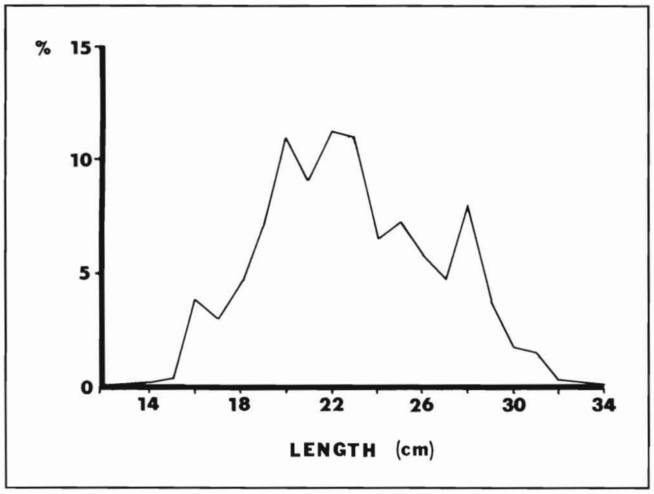

Figure 15.—Size composition of *Calamus proridens* on Campeche Bank (n = 665, $\bar{x}$ = 22.73 cm). Type of length measurement was unspecified. (From Dubovitsky 1973, fig. 3)

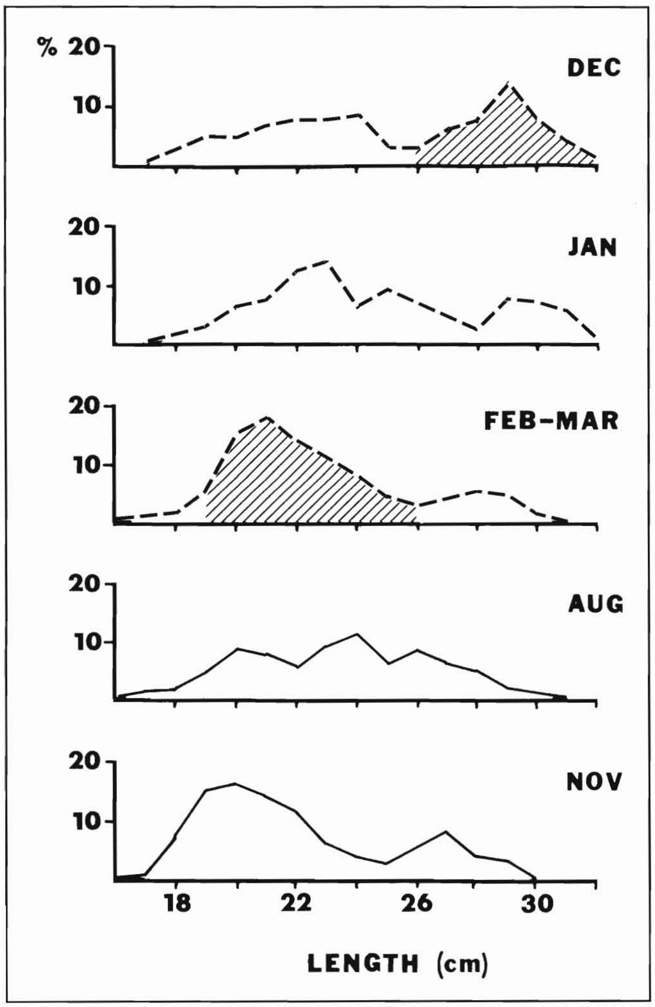

Figure 16.—Size composition of *Calamus proridens* on eastern Campeche Bank, by month. Solid lines represent specimens collected at depths <30-35 m, dashed lines represent specimens collected at >30-35 m. Cross-hatching represents specimens with ovaries in pre-spawning condition. Type of length measurement was unspecified. (From Dubovitsky 1977a, fig. 3)

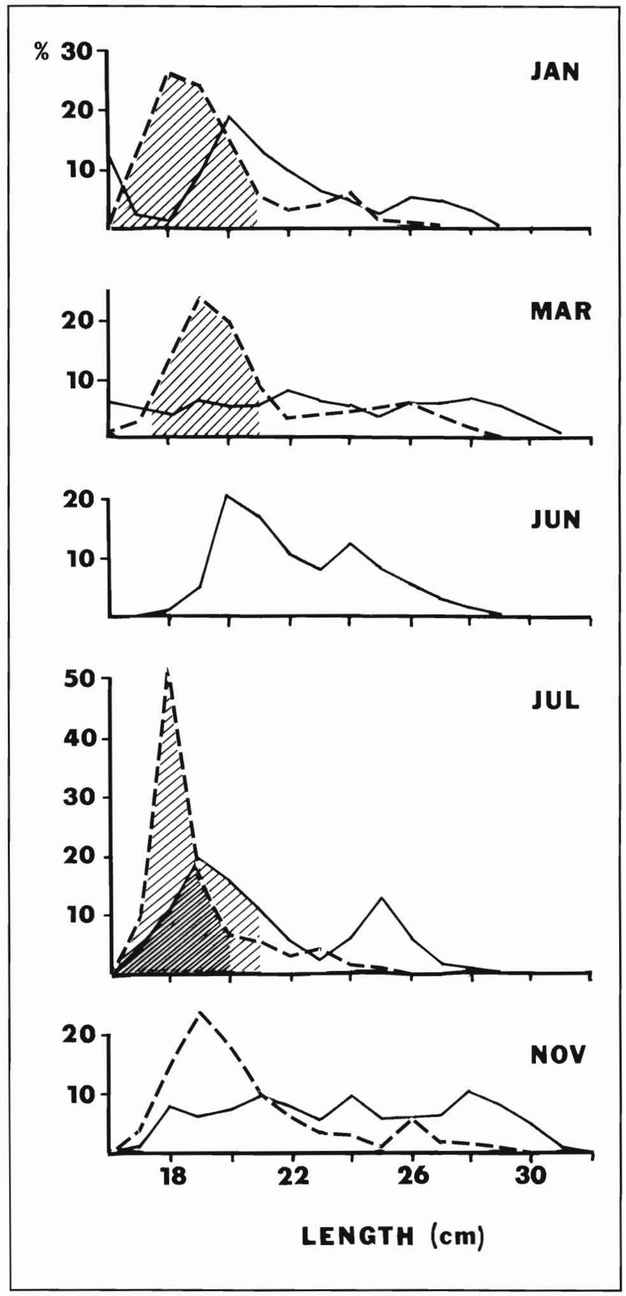

Figure 17.—Size composition of *Calamus proridens* on central Campeche Bank, by month. Solid lines represent specimens collected at depths <30-35 m, dashed lines represent specimens collected at >30-35 m. Cross-hatching represents specimens with ovaries in pre-spawning condition. Type of length measurement was unspecified. (From Dubovitsky 1977a, fig. 3)

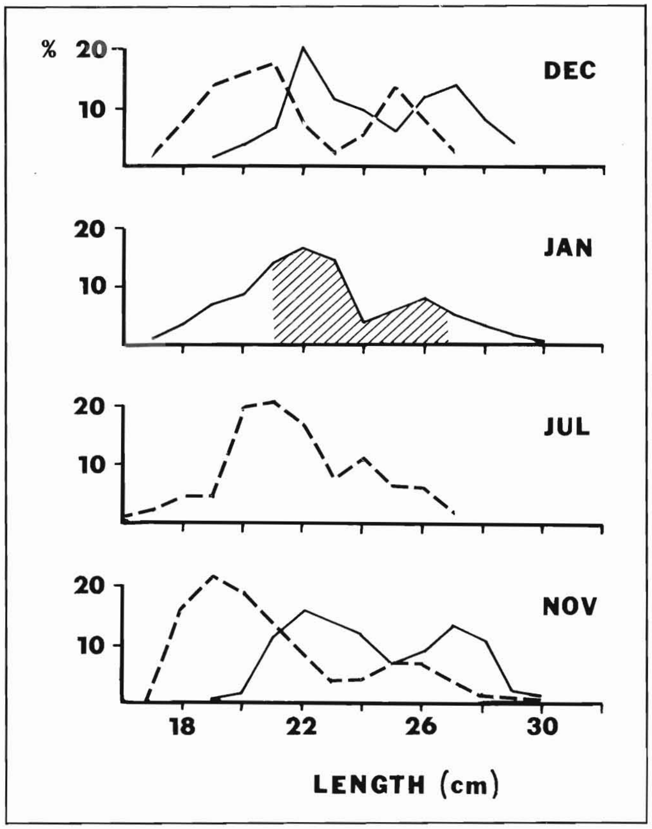

Figure 18.—Size composition of *Calamus proridens* on northwestern Campeche Bank, by month. Solid lines represent specimens collected at depths <30-35 m, dashed lines represent specimens collected at >30-35 m. Cross-hatching represents specimens with ovaries in pre-spawning condition. Type of length measurement was unspecified. (From Dubovitsky 1977a, fig. 4)

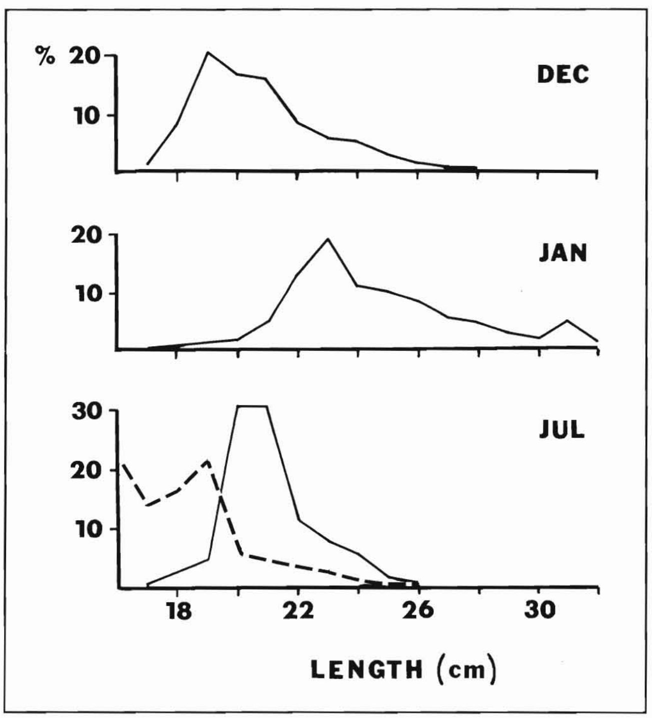

Figure 19.—Size composition of *Calamus proridens* on western Campeche Bank, by month. Solid lines represent specimens collected at depths <30-35 m, dashed lines represent specimens collected at >30-35 m. Cross-hatching represents specimens with ovaries in pre-spawning condition. Type of length measurement was unspecified. (From Dubovitsky 1977a, fig. 3)

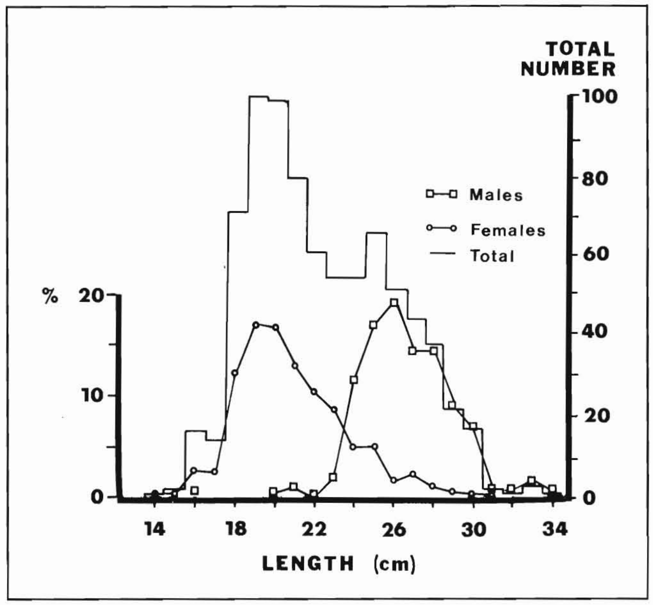

Figure 20.—Size distribution of male and female *Calamus proridens* in the Campeche Bank commercial population with a histogram of lengths. (From Dubovitsky 1977b, fig. 1)

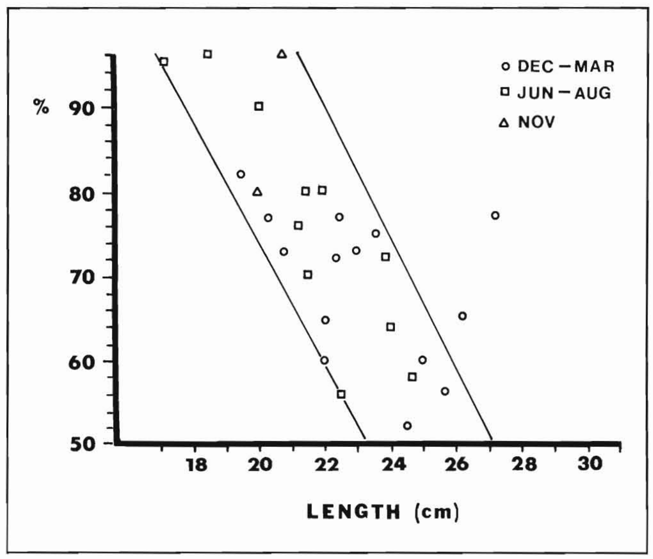

Figure 21.—Size distribution of female *Calamus proridens* and their frequency in the sexually mature part of the Campeche Bank population, 1969-1971. Type of length measurement was unspecified. (From Dubovitsky 1977b, fig. 3)

Table 4.—Size composition of *Calamus proridens* on Campeche Bank. Numbers above horizontal lines refer to specimens caught at depths ≤35 m; figures below lines refer to specimens caught at depths >35 m. (From Dubovitsky 1977a, Table 2)

Months	Size range[1] (cm)	Modal group (cm)	Rel. freq. of modal group (%)	Mean length (cm)	Percent length distribution in sample: <20 cm	20-25 cm	>25 cm
Eastern Area							
Dec.	18-34	21-24 27-31	30 40	25.9	7	39	54
Jan.	18-32	22-23 29-31	24 24	25.0	3	57	40
Feb.-Mar.	13-32	20-23	58	22.9	8	70	22
Aug.	16-31	20-22 24-25	21 22	23.7	11	57	32
Nov.	18-30	19-22	55	22.0	25	54	21
Central Area							
Jan.	15-29	19-22	51	21.2	28	58	14
	16-26	18-19	51	18.6	67	30	3
Mar.	14-34			22.9	27	41	32
	15-29	19-20	43	20.8	42	47	11
June	16-29	20-21 25	14	22.3	9	79	12
July	16-30	18-20 24-26	47 29	21.5	37	53	10
	16-26	18	48	19.0	76	23	1
Nov.	15-33			23.6	18	47	35
	16-30	18-20	58	20.6	47	44	9
Northwest Area							
Dec.	19-29	22-24 26-27	42 26	24.6	1	59	40
	17-27	19-21 24-26	48 27	21.6	26	64	10
Jan.	13-30	21-23	45	22.4	15	65	20
July	15-27	20-22	55	21.6	15	77	8
Nov.	19-30	21-24 26-28	56 32	24.3	1	63	36
	15-30	18-21	56	20.8	40	51	9
Southwest Area							
Dec.	17-29	19-21	56	20.7	34	63	3
Jan.	15-34	22-23	35	24.5	3	66	31
July	17-26	20-21	63	21.0	11	88	1
	14-26	16-19	72	18.2	78	21	1

[1]Type of length measurement unspecified.

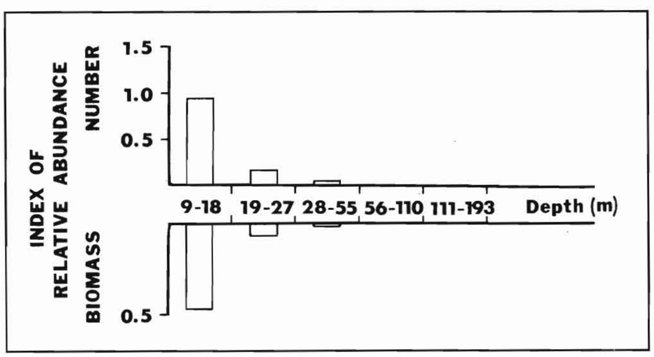

Figure 22.—Index of relative abundance of *Calamus arctifrons* on the West Florida Shelf, January 1978, expressed in terms of biomass and number of individuals. (From Darcy and Gutherz, unpubl., fig. 12.)

4.14 Subpopulations

No subpopulations of *C. arctifrons* or *C. proridens* are known.

4.2 Abundance and density

Calamus arctifrons—*Calamus arctifrons* was reported very abundant around the Florida Keys by Jordan and Fesler (1893). Tabb and Manning (1961) found *C. arctifrons* abundant on *Thalassia* flats in Florida Bay; they were most common from October to April. A trawling survey of the West Florida Shelf (Darcy and Gutherz 1984) collected *C. arctifrons* at 7.7% of the stations sampled; this species ranked tenth in biomass of all demersal fish sampled in 9-93 m in the survey area, and accounted for 3.1% of the total demersal fish biomass collected in that region. North of Tampa Bay, *C. arctifrons* ranked eighth in biomass in 9-35 m, and accounted for 5.6% of the total biomass. Abundance was highest in shallow (9-18 m) water (Fig. 22) and on rock bottom (Darcy and Gutherz unpubl.). A plot of mean abundance by grid zone on the West Florida Shelf (Fig. 23) shows maximum abundance in nearshore waters off the northwest coast of Florida. Estimated standing stock of *C. proridens* on the West Florida Shelf at depths >9 m is about 28,000 mt (Darcy and Gutherz unpubl.). In shallower water in the eastern Gulf of Mexico, *C. arctifrons* was reported common by Reid (1954), Grimes (1971), Moe and Martin (1965), Tabb and Manning (1961), and Grimes and Mountain (1971). The species is not common in the West Indies (Beebe and Tee-Van 1928; Randall and Caldwell 1966).
See 2.1 and 2.3.

Calamus proridens—*Calamus proridens* abundance on the Atlantic coast of the United States is poorly known, but Struhsaker (1969) reported it rather rare in the South Atlantic Bight.

In the Gulf of Mexico, *C. proridens* is not very common in the extreme northern gulf (Walls 1975), but is quite common on the northern central West Florida Shelf (Darcy and Gutherz unpubl.) (Fig. 24). Smith (1976) reported that *C. proridens* is the most common sparid at depths >30 m in the eastern Gulf of Mexico, and Smith et al. (1975) reported it as occasional on the Florida Middle Ground. *Calamus proridens* occurred at 9.2% of the stations sampled on the West Florida Shelf by Darcy and Gutherz (1984), and ranked eighth in biomass (3.7% of total demersal fish biomass) in 9-93 m over the entire survey area. It ranked seventh in biomass (6.5% of total demersal fish biomass) north of Tampa Bay in 9-35 m depths. Abundance was greatest in moderate (19-55 m) depths (Fig. 25) (Darcy and Gutherz unpubl.); estimated standing stock on the West Florida Shelf was about 34,000 mt.

On Campeche Bank, *C. proridens* is the most abundant sparid (Dubovitsky 1973, 1977b); along with *C. nodosus* and *C. bajonado*, *C. proridens* makes up the bulk of the commercial trawl fish catch on Campeche Bank. It has been estimated to comprise 10% of the benthic fish fauna of the bank (Sauskan and Olaechea 1974), and is second only to the tomtate, *Haemulon aurolineatum*, in abundance (Olaechea and Sauskan 1974; Sauskan and Olaechea 1974). According to Dubovitsky (1977a), *C. proridens* is the most important commercial fish on the bank. Catch rates of >500 kg/h trawling have been reported (Dubovitsky 1977a), but rates of <100 kg/h are more usual (Sauskan and Olaechea 1974) (Table 5). Estimated density on Campeche Bank by season, expressed in kilograms per hectare, was:

Winter	*Spring*	*Summer*	*Fall*	$\bar{x}$
1.79	5.50	5.65	1.74	3.74

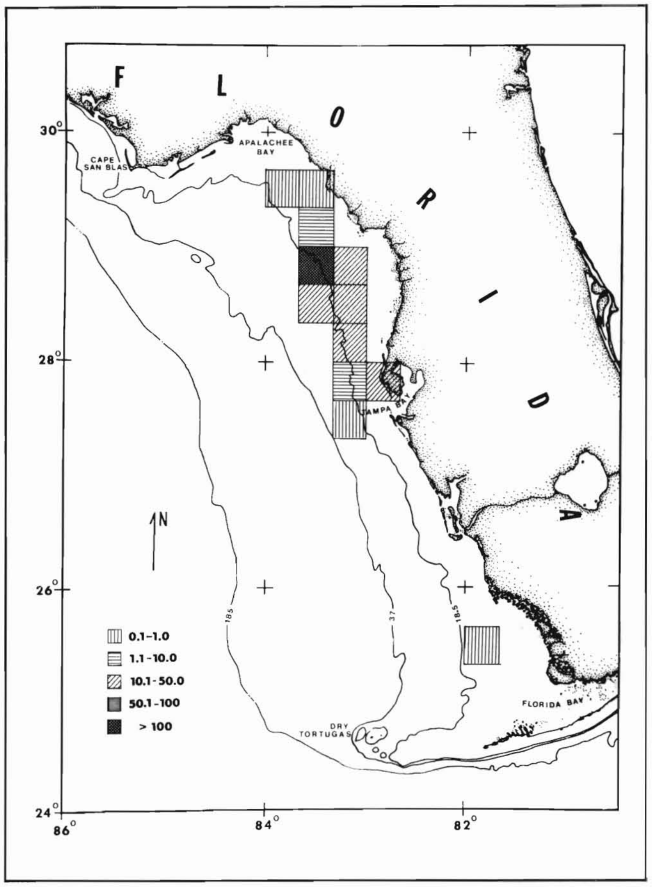

Figure 23.—Mean catch rate of *Calamus arctifrons* by 20′ × 20′ grid zones on the West Florida Shelf, January 1978. Catches are expressed in mean numbers of individuals caught per 10-min tow. (From Darcy and Gutherz, unpubl., fig. 13)

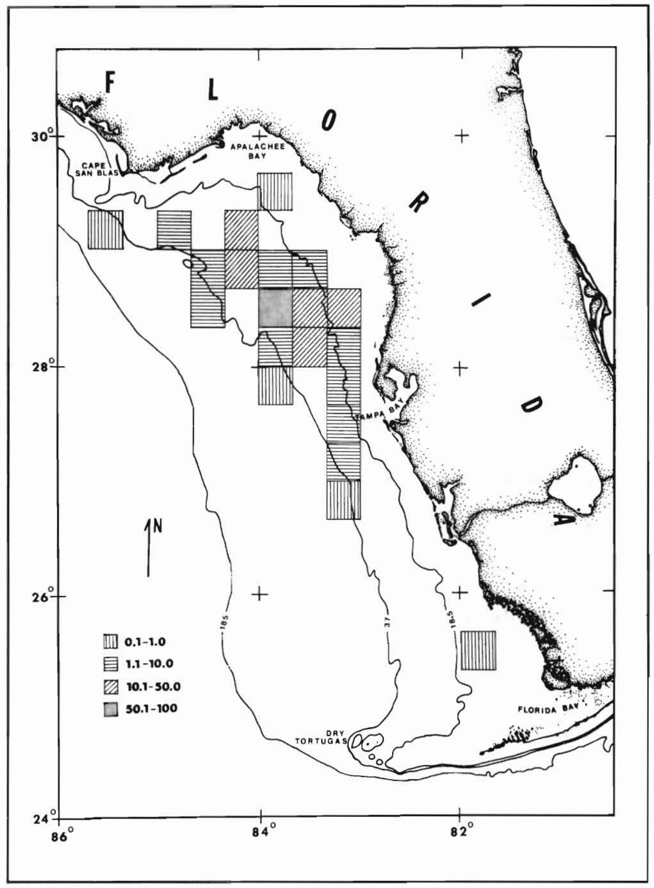

Figure 24.—Mean catch rate of *Calamus proridens* by 20′ × 20′ grid zones on the West Florida Shelf, January 1978. Catches are expressed in mean numbers of individuals caught per 10-min tow. (From Darcy and Gutherz, unpubl., fig. 15)

Table 5.—Mean catch rates of *Calamus proridens* per hour of trawling of SRT-M trawlers on Campeche Bank, and percentage of the total fish catch in each part of the bank accounted for by *C. proridens*. (From Sauskan and Olaechea 1974.)

	Area of Campeche Bank					
	West		Central		East	
Depth (m)	Mean catch (kg/h)	% of total fish	Mean catch (kg/h)	% of total fish	Mean catch (kg/h)	% of total fish
15-30	45.5	12	95.0	14	69.9	6
30-50	53.5	15	54.0	8	27.1	6
50-120	0.0	0	13.9	5	60.9	14

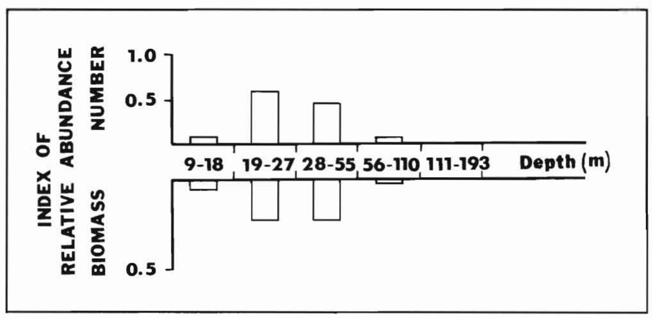

Figure 25.—Index of relative abundance of *Calamus proridens* on the West Florida Shelf, January 1978, expressed in terms of biomass and numbers of individuals. (From Darcy and Gutherz, unpubl., fig. 14)

Table 6.—Estimated standing stock of porgies on Campeche Bank, based on Cuban trawl surveys. Figures for 1974-75 represent two different estimates. (From Klima 1976)

	Dates of surveys			
	1964-72	1974-75	1974-75	Mean
Standing stock (mt)	209,000	182,000	461,000	325,000

(Olaechea and Sauskan 1974). Sauskan and Olaechea (1974) estimated total mean abundance of *C. proridens* on Campeche Bank at 88,000 mt. Estimates of standing stock of all porgies on Campeche Bank are presented in Table 6.

Calamus proridens does not seem to be very common in the West Indies (Randall and Caldwell 1966), though Beebe and Tee-Van (1928) reported them quite common in Haitian fish markets.

See 2.1, 2.21, 2.22, 2.3, 3.16, 3.51, and 4.13.

4.3 Natality and recruitment

4.31 Reproduction rates

Reproduction rates of *C. arctifrons* and *C. proridens* are unknown, but *C. proridens* is a sequential spawner based on ovarian examination and histology (Dubovitsky 1977a) and may spawn more than once each spawning period.

See 3.15 and 3.16.

4.32 Factors affecting reproduction

Although there are no reports of factors affecting reproduction in *C. arctifrons*, temperature probably determines spawning season. Spawning in *C. proridens* is known to be temperature-dependent and to coincide with maximum plankton productivity (Dubovitsky 1977a).

See 3.16.

4.33 Recruitment

Little is known of recruitment in *C. arctifrons*. Wang and Raney (1971) collected a small specimen (26 mm SL) in March in Charlotte Harbor estuary, Florida.

Calamus proridens as small as 18 mm SL were collected on shallow grassflats off Lower Matecumbe Key, Florida, in April, and specimens as small as 21 mm SL were collected in March (Springer and McErlean 1962). On Campeche Bank, *C. proridens* are recruited to the commercial stock between ages I and II, and at lengths of about 14 cm (measurement unspecified) (Dubovitsky 1977a, 1977b).

See 2.21, 2.3, and 3.51

4.6 The population in the community and the ecosystem

Calamus arctifrons is a common member of grassbed communities in shallow water, and live-bottom communities in somewhat deeper water. Associates of *C. arctifrons* in shallow water probably include: pinfish, *Lagodon rhomboides*; spottail pinfish, *Diplodus holbrooki*; sheepshead, *Archosargus probatocephalus*; pigfish, *Orthopristis chrysoptera*; toadfish, *Opsanus* spp., seahorses and pipefishes, Syngnathidae; mojarras, Gerreidae; seatrouts, *Cynoscion* spp.; gobies, Gobiidae; triggerfishes and filefishes, Balistidae; puffers, Tetraodontidae; and porcupinefishes, Diodontidae. In deeper water (>9 m), cluster analysis of demersal fish catches on the West Florida Shelf (Darcy and Gutherz unpubl.) grouped conger eels, *Hildebrandia* sp.; spottail pinfish; crested cusk-eel, *Ophidion welshi*; sand perch, *Diplectrum formosum*; scrawled cowfish, *Lactophrys quadricornis*; black sea bass, *Centropristis striata*; and shortnose batfish, *Ogcocephalus nasutus*, with *C. arctifrons*.

Calamus proridens is a member of live-bottom communities in shallow to moderate depths. On the West Florida Shelf, cluster analysis grouped tomtate; gulf flounder, *Paralichthys albigutta*; Atlantic croaker, *Micropogonias undulatus*; and the cusk-eel, *Lepophidium brevibarbe*, with *C. proridens* in water >9 m deep (Darcy and Gutherz unpubl.). On Campeche Bank, *C. proridens* is often caught with *C. penna*, *C. nodosus*, and *C. bajonado*, especially in summer (Olaechea and Sauskan 1974).

See 3.3.

5 EXPLOITATION

5.1 Fishing equipment

Calamus arctifrons is caught in beach seines (Evermann and Marsh 1902; Randall and Caldwell 1966) and bottom trawls, and on hook-and-line and bottom longlines (Randall and Vergara R. 1978). *Calamus proridens* is caught in fish traps, trawls, and on hook-and-line (Randall and Vergara R. 1978).

5.2 Fishing areas

Calamus arctifrons is fished in coastal waters of the Gulf of Mexico from southern Florida to Louisiana (Randall and Vergara R. 1978), but there is no directed fishery.

Calamus proridens is fished in coastal waters of Florida, Campeche Bay, and Cuba (Randall and Vergara R. 1978). Concentrations of *C. proridens* on Campeche Bank in summer were mapped by Olaechea and Sauskan (1974) (Fig. 26).

See 2.1, 2.22, 2.3, and 3.51.

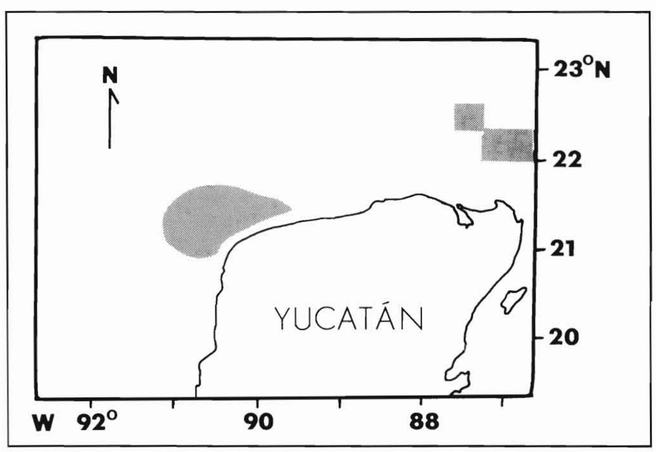

Figure 26.—Principal zones of concentration of *Calamus proridens* on Campeche Bank in summer. *Calamus bajonado*, *C. penna* and *C. nodosus* are also concentrated in the same areas. (From Olaechea and Sauskan 1974, fig. 3)

5.3 Fishing seasons

No specific information regarding fishing seasons is available. Since there is no directed fishery for *C. arctifrons* or *C. proridens* in the United States, catches of these species are probably dependent upon effort expended in pursuit of other species. On Campeche Bank, *C. proridens* are present year-round, but are most concentrated, and therefore most easily fished, when bottom temperatures are low (Dubovitsky 1977a).

See 2.3 and 4.13.

5.4 Fishing operations and results

5.43 Catches

Calamus arctifrons and *C. proridens* are good food fish and are marketed mostly fresh and frozen (Evermann and Marsh 1902; Randall and Vergara R. 1978). Moe (1963) stated that these species are of minor commercial importance, but are sometimes caught by commercial snapper fishermen off the west coast of Florida, and are often used as fresh bait. *Calamus proridens* is one of the most important commercial species on Campeche Bank (Sokolova 1965), and is not uncommon in markets in Haiti (Beebe and Tee-Van 1928).

Catch statistics for *C. arctifrons* and *C. proridens* are not reported separately (Randall and Vergara R. 1978). Total reported catch of *Calamus* spp. from FAO fishing area 31 (western central Atlantic Ocean) in 1975 was about 6,777 mt, but actual landings were undoubtedly much higher, since landings of porgies are usually combined with landings of other percomorph fishes (Randall and Vergara R. 1978). Catches of all species of porgies combined in FAO fishing area 31 were: 1970, 1,400 mt; 1971, 3,600 mt; 1972, 8,900 mt; 1973, 3,600 mt (Klima 1976). Catches of porgies by individual nations fishing in the western central Atlantic area in 1970-73 are shown in Table 7. Most of the reported catch was probably from Campeche Bank. Porgies, of which *C. proridens* is the most common, comprised 30% of trawl survey catches by the Cubans on Campeche Bank in the early 1970's (Klima 1976). Based on these and other surveys, Campeche Bank could yield 33,000-65,000 mt of porgies each year (Klima 1976). Sauskan and Olaechea (1974) estimated the potential catch of *C. proridens* on the bank as 15,000-20,000 mt. Porgies made up 56-58% of Cuban trawl catches on Campeche Bank in 1973-74 (Klima 1976). Commercial catches on the bank have been quite variable, possibly due to changes in environmental conditions (Klima 1976).

Recreational catch figures, like commercial catch figures, are seldom reported for separate species of porgies. The total recreational catch of porgies in the Gulf of Mexico in 1960 was estimated at 8,550,000 fish, of 5,792,000 kg (Clark 1962). Most (72%) were caught from boats, and the rest from shore. Recreational catches of porgies reported in 1970 were 13,234,000 fish, of 9,671,000 kg, in the eastern Gulf of Mexico, and 16,230,000 fish, of 10,913,000 kg, along the Atlantic coast of the United States south of Cape Hatteras (Deuel 1973). Landings are stratified by fishing area and method in Table 8.

See 2.3 and 4.2

Table 7.—Reported catches of porgies from the western central Atlantic fishing area, 1970-73, by fishing nation. (From Klima 1976)

	Catch per year (mt)			
Nation	1970	1971	1972	1973
Cuba	400	2,000	1,900	1,900
U.S.S.R.	0	400	6,000	300
Mexico	500	600	600	800

Table 8.—Recreational catches of porgies in the eastern Gulf of Mexico and along the southern Atlantic coast of the United States, 1970. Figures are in thousands of individuals caught. (Data from Deuel 1973)

	Fishing area		Fishing method			
Geographical area	Ocean	Sounds, rivers, bays	Private, rented boat	Party, charter boat	Bridge, pier, jetty	Beach, bank
South Atlantic	6,266	9,964	4,989	1,068	7,499	2,674
Eastern Gulf of Mexico	905	12,329	6,579	128	4,587	1,940

6 PROTECTION AND MANAGEMENT

6.1 Regulatory measures

Calamus arctifrons is included in the Snapper/Grouper Complex Fishery Management Plan of the South Atlantic Fishery Management Council. Both *C. arctifrons* and *C. proridens* are included in the Reef Fish Fishery Management Plan of the Gulf of Mexico Fishery Management Council.

ACKNOWLEDGMENTS

I thank Donald M. Allen and Albert C. Jones of the National Marine Fisheries Service, Southeast Fisheries Center, for critically reviewing this manuscript.

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