TULANE STUDIES IN ZOOLOGY

Volume 7, Number 2 July 9, 1959

A REVIEW OF THE SEABASSES OF THE GENUS *CENTROPRISTES* (SERRANIDAE)

RUDOLPH J. MILLER,
Department of Conservation, Cornell University,
Ithaca, New York

CONTENTS

I. Introduction

Prior to 1952, three species were recognized in the serranid genus *Centropristes.* The type species, *Centropristes striatus,* was the largest and best known form, ranging from Cape Cod, Massachusetts, to Pensacola, Florida. The rock sea bass, *Centropristes philadelphicus,* originally was thought to be limited to deep waters off Charleston, South Carolina, but later was found commonly elsewhere, especially off the Texas and Louisiana coasts. The gulf sea bass, *Centropristes ocyurus,* was described from the snapper banks off Pensacola in 1886, but it has been found since from Cape Hatteras, North Carolina, to the Yucatan shelf. Ginsburg (1952) described a new species, *Centropristes melanus,* based on 13 specimens from the west coast of Florida. Before 1952, *melanus* had been considered an extreme western population of *striatus.* He also found differences between Gulf and Atlantic populations of both *ocyurus* and *philadelphicus* but considered them to be "of low degrees, below the subspecies level".

The present study attempts to analyze more fully differences between Gulf and Atlantic populations of *Centropristes.* Descriptions of body and fin proportions, color patterns, and meristic characteristics are presented. Much confusion in the literature on *Centropristes* resulted from a lack of knowledge of variation within species.

II. Methods

Twenty-one measurements and nine counts were made on each specimen examined, except in a few samples obtained at a late date in the study, where only selected counts and measurements were taken. Methods employed in measuring and counting were those outlined by Hubbs and Lagler (1947) except as listed below:

1. *Dorsal-fin origin to caudal base.*—Measured from the dorsal origin to the point where the middle caudal ray disappears into the fleshy caudal base.

2. *Dorsal-fin origin to occiput.*—Measured from the origin of the dorsal fin to the most anterior point of the scaled portion of the dorsal surface. In adults of *ocyurus* there is a noticeable scaleless gap between scales of the head and those of the body (fig. 16). There is also a gap between the scales on either side of the head. The measurement in this case includes the most anterior head scale on the left side.

3. *Pelvic-fin insertion to snout.*—Measured from the insertion of the most anterior pelvic fin ray to the anterior tip of the premaxillary.

4. *Anal-fin origin to caudal base.*—Measured from the origin of the first anal spine to the point where the middle caudal ray meets the fleshy covering of the anterior part of the caudal fin.

5. *Body depth.*—Measured from a point immediately anterior to the origin of the dorsal fin to a point immediately anterior to the pelvic-fin insertion. This measurement of body depth is more reliable than that used by Weed (1937) because the shoulder girdle prevents distortion.

6. *Dorsal-fin origin to lateral line.*—Least distance from the origin of the dorsal fin to the center of the nearest lateral-line scale.

7. *Pelvic-fin insertion to lateral line.*—Least distance between the insertion of the pelvic fin and the center of the nearest lateral-line scale.

8. *Caudal-peduncle length.* — Measured from the point where the last dorsal ray meets the body to the origin of the first upper rudimentary caudal ray. In *philadelphicus* and *ocyurus* a small black spot extends slightly forward from the latter point.

9. *Interorbital width.*—Least fleshy width. Weed measured the width of the bony bridge between the eyes. In larger specimens it is often very difficult to determine the exact limits of this bony bridge due to thickness of the covering flesh. In most specimens the fleshy width is well defined because the shelf of flesh that extends beyond the bony bridge is tough and almost cartilage-like in texture.

10. *Snout length.* — Measured from the anterior tip of the snout to the point where a line extended backward from the tip of the snout along the axis of the body meets a line dropped from the anterior rim of the orbit perpendicular to the axis of the body.

11. *Length of caudal-fin rays.*—Measured from the posterior tip to the point where they disappear into the fleshy caudal base. In forms with a tri-lobed caudal fin four measurements were often taken. The longest ray in each of the three lobes and the

shortest ray in the upper interlobe were measured. In forms with rounded caudals the longest ray was measured.

12. *Predorsal scale rows.* — Head scales are counted as one row in *ocyurus* because only one row approaches the mid-dorsal line (fig. 16).

III. Historical Review of the Species of Centropristes

Linnaeus (1758) described two species of perciform fishes that have since been placed in the genus *Centropristes* (*Labrus striatus* and *Perca philadelphica*). Both descriptions were brief and that of *philadelphica* was inadequate. Linnaeus (1766) used *Perca atraria* for *striatus* and redescribed *Perca philadelphica* as *Perca trifurca*. The new names were used through most of the nineteenth century, and it was not until late in the century that the descriptions in the tenth edition were recognized.

In the sixty years following the original descriptions, the two common species of *Centropristes* were redescribed under various names and by several authors.

Walbaum (1792: 336) listed *striatus* as *Perca furva* from New York (after Schöepff, 1788). Bloch and Schneider (1801: 297) described *striatus* from New York and named it *Coryphaena nigrescens*. Lacépède (1803: vol. 4, 196, 246) described *philadelphicus* and *striatus* as *Lutjanus tridens* and *Lutjanus trilobatus*, respectively. Mitchill (1815: 415, 416) presented a satisfactory color plate of *striatus* and described the form as *Perca varia*.

Centropristes was first proposed by Cuvier and Valenciennes (1829: vol. 3, 27-40). According to Bailey (1951) this section was written by Cuvier who is accorded authorship in the following account. Cuvier (1829b) listed three species from the New World: *nigricans* (=*striatus*) from New York, *trifurcus* (=*philadelphicus*), and *rufus* (probably *striatus*) from Martinique. Some question exists about the spelling of the generic name, which appeared as *Centropristis* in Cuvier's *Le Regne Animal*, apparently published the same year (1829) as the *Histoire*. It is generally accepted that the latter preceded *Le Regne Animal* and that the correct spelling is *Centropristes*. DeKay (1842: 24-25) employed *Centropristes nigricans* for *striatus* and *Centropristes trifurca* for *philadelphicus*, obviously following Cuvier (1829b). Storer (1846: 9, 35) used Cuvier's (1829a: 145) spelling of *Centropristis* and included therein *nigricans* (=*striatus*) and *trifurca* (=*philadelphicus*).

Holbrook (1860: 45-52) accepted *Centropristes* but used *atrarius* for *striatus*. His figures of *Centropristes atrarius* and *Centropristes trifurca* (=*philadelphicus*) are good. Here Holbrook first stated his belief that the northern and southern forms of the black sea bass (*striatus*) were distinct. Supposedly the northern form had the pectoral fin and the pelvic fin conterminus and a non-sacculated air bladder, while the southern form had a sacculated air bladder and the pectoral longer than the pelvic. The line of demarcation between the two was said to be near Cape Hatteras. Various authors accepted Holbrook's ideas and used separate names for populations of *striatus* north and south of Hatteras until late in the nineteenth century when Jordan and Eigenmann (1890) proved him wrong.

Gill (1861) placed Cuvier's *Centropristis* in the family "Percoidae". He recognized two forms of the black sea bass (*striatus*) and called the northern form *nigrescens* and the southern form *atrarius*. He established the genus *Triloburus* to include Storer's *Centropristis trifurca* which he listed as *Triloburus trifurcus* without a description. The name apparently is based on the trilobed caudal fin of adults.

Gill (1873) listed *Centropristis atrarius* (by implication combining northern and southern populations of *striatus*) and *Triloburus trifurcus*.

Jordan and Gilbert (1882a) placed the two known species of *Centropristes* in the larger genus, *Serranus*, and called them *atrarius* and *trifurcus*. They (1882b) also gave a good description of a series of fishes taken from the mouths and stomachs of red snappers at Pensacola, Florida, under the name *Serranus trifurcus*. They noted some differences but could not separate specifically the Pensacola bass from *Serranus trifurcus* from Charleston, South Carolina.

Jordan and Gilbert (1882c) resurrected *philadelphicus*, listed *Serranus atrarius* and *Serranus philadelphicus* as common, and noted that the description of *Perca philadelphica* "could not have been identified with

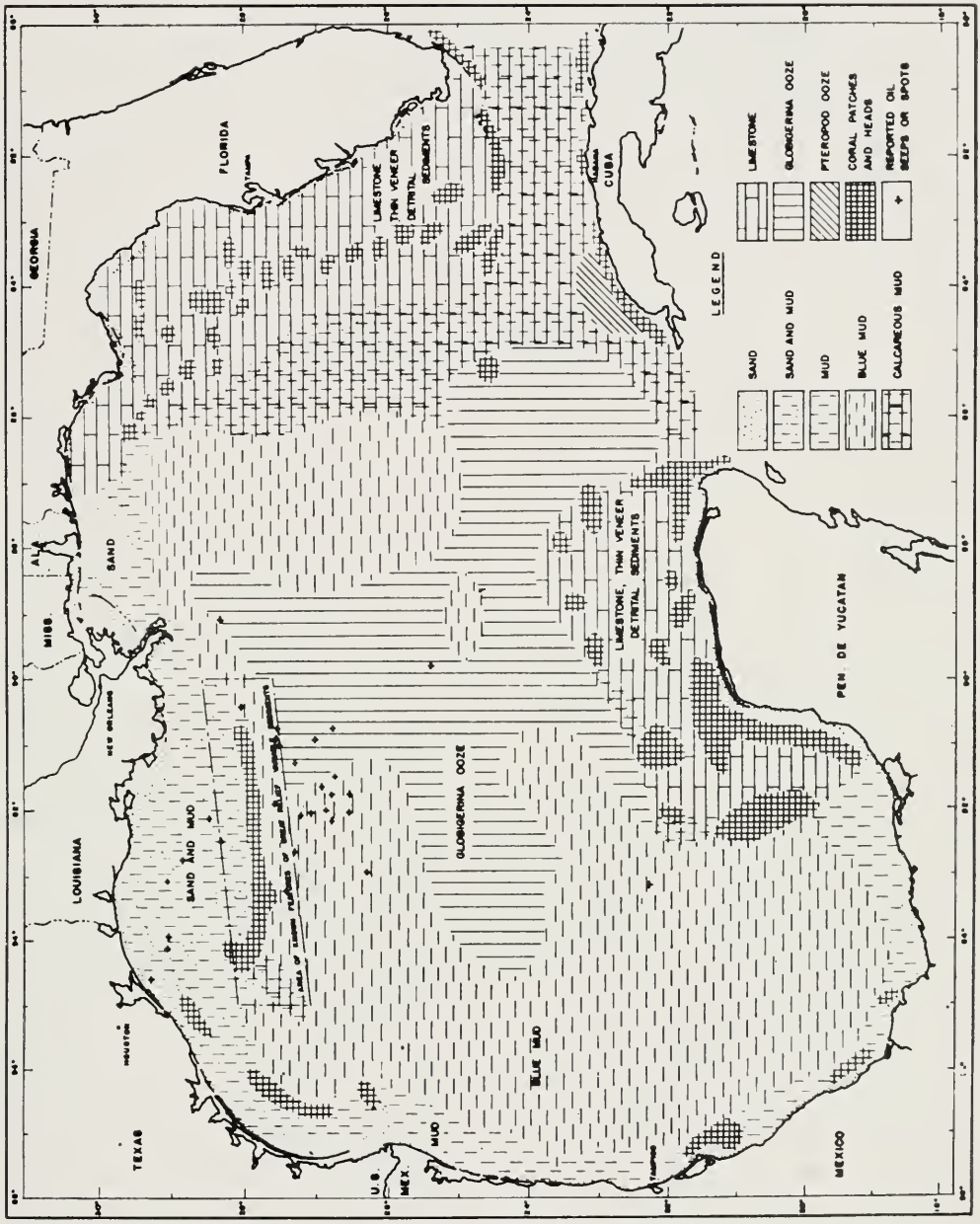

Figure 1. Sedimentary provinces of the Gulf of Mexico (from: U. S. Fish and Wildlife Service, Fishery Bulletin 89.)

this species had not Linnaeus himself in his twelfth edition revised his description..."

Jordan (1885a) listed *Serranus philadelphicus* and gave separate names to northern and southern forms of *striatus,* calling them *Serranus furvus* and *Serranus atrarius,* respectively. In 1886 he examined the two specimens of *Centropristes rufus* Cuvier from Martinique. Though he listed the form as *Serranus rufus,* he expressed some doubt as to its validity.

Jordan and Evermann (1886) described a third form, *Serranus ocyurus.* They identified fishes from Pensacola (1882b) as

TABLE 1.
Frequency distributions of total gill rakers and pectoral rays in populations of Centropristes

Species	Number of gill rakers														
	17	18	19	20	21	22	23	24	25	26	27	28	29	N	$\bar{x}$
s. striatus							5	7	15	46	29	16	4	122	26.2
s. melanus				1	7	15	25	12	4	3				67	22.9
ocyurus															
Gulf		8	32	27	14	1								82	19.6
Atlantic	1	2	20	17	5									45	19.5
philadelphicus															
Gulf	3	11	33	36	20	9								112	19.8
Atlantic	3	7	13	25	14	5								67	19.8

	Number of pectoral rays							
	15	16	17	18	19	20	N	$\bar{x}$
s. striatus				58	188	3	249	18.8
s. melanus		2	79	51			132	17.4
ocyurus								
Gulf		14	137	15			166	17.0
Atlantic		5	78	7			90	17.0
philadelphicus								
Gulf	1	2	18	185	16	1	223	17.9
Atlantic			3	108	23		134	18.1

ocyurus and referred to the previous publication as part of the description. They distinguished *ocyurus* and *atrarius* (=*striatus*) which they regarded as allied forms but ignored *philadelphicus*.

Jordan and Eigenmann (1890) used the spelling *Centropristis* after Cuvier (1829a) and first employed the name *striatus* (Linn. Ed. X) for both northern and southern forms of the black sea bass, stating that they could not distinguish them. They listed *Centropristis rufus* but noted that it could as easily have come from New York as from Martinique. *Centropristis philadelphicus* was described from the south Atlantic coast of the United States, and *Centropristis ocyurus* was listed as a possible deep-water variety of *striatus*. They applied all references from the Gulf to *Centropristis ocyurus*.

Boulenger (1895), apparently ignoring the earlier Linnaean names, listed *Centropristes atrarius*, *ocyurus*, and *trifurca*. Jordan and Evermann (1896) gave keys and descriptions for *Centropristes striatus*, *rufus*, *ocyurus*, and *philadelphicus* and limited *ocyurus* to the Gulf of Mexico and *philadelphicus* to the Atlantic. In Jordan, Evermann, and Clark (1930) the same species were given but *philadelphicus* was placed in *Triloburus* Gill. Since *Triloburus* was never described, few people used the name after the turn of the century, and its appearance in the check-list did little to revive it.

Weed (1937) described *Centropristes springeri* from the Gulf of Mexico. Apparently he was confused by the large amount of color-pattern variation in *Centropristes ocyurus* and was convinced that the type of *ocyurus* was a Gulf specimen of *philadelphicus*. He based the name *springeri* on a specimen with a slightly different color pattern. His *springeri* is a synonym of *ocyurus*.

Ginsburg (1952) described *Centropristes melanus* from the Gulf and compared it with its Atlantic counterpart, *striatus*. His species was based primarily on number of gill rakers and pectoral rays. He believed that the Florida peninsula had isolated the Gulf and Atlantic populations and that speciation had occurred subsequently.

Currently, four species of *Centropristes* are recognized from the coastal waters of the United States. A fifth from Martinique is doubtful.

IV. Generic Description
Centropristes Cuvier

Body robust, somewhat compressed, covered with rather large ctenoid scales. Mouth large, teeth in bands, no canines. Tongue smooth. Preopercle serrate, the lower teeth

TABLE 2.
Frequency distributions of scales in populations of Centropristes.

Species	5	6	7	8	N	$\bar{x}$
Number of scale rows from dorsal-fin origin to lateral line						
s. striatus		36	75	9	120	6.8
s. melanus	4	28	25	1	58	6.4
ocyurus						
Gulf		15	57	7	79	6.9
Atlantic		3	32	7	42	7.1
philadelphicus						
Gulf		84	24		108	6.2
Atlantic		11	52	3	66	6.9

	12	13	14	15	16	17	18	19	20	21	N	$\bar{x}$
Number of scale rows from anal-fin origin to lateral line												
s. striatus		7	26	42	29	8	5				117	15.2
s. melanus	1	28	24	9	4						66	13.8
ocyurus												
Gulf			1	2	19	30	21	3			76	17.0
Atlantic				1	4	17	12	6	1		41	17.5
philadelphicus												
Gulf			1	12	34	38	15	6		1	107	16.5
Atlantic						21	32	18	1	1	73	18.0

	9	10	11	12	13	14	15	16	17	18	N	$\bar{x}$
Number of predorsal scale rows												
s. striatus	1	1	8	20	16	20	26	10	7		109	13.8
s. melanus		9	11	16	7	2	2				47	11.7
ocyurus												
Gulf		2	17	31	20	1					71	12.0
Atlantic		1	7	20	12	1					41	12.1
philadelphicus												
Gulf			2	6	22	35	15	20	8	1	108	14.4
Atlantic				2	12	18	11	13	8		64	14.8

somewhat antrorse. Gill rakers rather long and slender. Supraoccipital and parietals with strong crests extending forward to a point between postfrontal processes; frontals posteriorly with an angular transverse ridge in front of supraoccipital connecting the parietal crests; posterior processes of premaxillaries not reaching frontals. Smooth area on top or cranium short and small. Dorsal fin X, 11, the spines with fleshy filaments at tips; anal fin III, 7; caudal fin typically 17, rounded in young, trilobed or double concave in adults; pelvics I, 5, close together, inserted under or slightly in advance of pectorals. The species of *Centropristes* are closely related.

I agree with Weed (1937) in synonymizing *Triloburus* Gill (based on *philadelphicus*) with *Centropristes*. Further, the evidence refutes the retention of *Triloburus* as a subgenus. *C. philadelphicus* differs from *ocyurus* in about the degree *ocyurus* differs from *striatus* and *ocyurus* is reasonably intermediate in general structure between the two. The data in Tables 1-10 show that *ocyurus* is approximately intermediate in most of the characteristics explored.

The species of *Centropristes* have been found in coastal waters from the Gulf of Maine to the Yucatan banks. Though essentially a temperate and subtropical group, certain forms have apparently been able to acclimatize themselves to the colder waters off Maine and the tropical climes of the southern Gulf of Mexico. In the following discussion *Centropristes rufus*, the doubtful species based on two specimens supposedly from Martinique, will not be dealt with because of the absence of additional records from the West Indies.

V. KEY TO THE SPECIES OF CENTROPRISTES

1. Ground color dark, usually dark brown in alcohol, smoky gray to dusky brown or blue black

Figure 2. Distribution of *C. s. striatus*.

in life. Exposed parts of scales paler than margins, giving appearance of being barred with longitudinal series of pale dots. Seldom with traces of seven vertical bars on sides. Belly only slightly paler than sides, never white. Fins dark, dorsal marked with several series of whitish spots and bands. Dermal flaps extend only slightly past tips of dorsal spines (Black Sea Basses, *C. striatus*) 2

Ground color very pale to white, with seven diffuse to distinct dark vertical bars on sides. Belly considerably paler than sides, usually white, occasionally with traces of dusky pigmentation. Fins pale, sometimes fairly dusky but never black; soft dorsal and caudal with dark to inky spots. 3

2. Total gill rakers and tubercles on first arch usually 22 to 24 (20-26); pectoral rays 17 or 18; jaw usually 18-19 (per cent of standard length); pectoral usually 26-28 (23-29); young with dark stripe from opercular flap to caudal, but with black spot at base of last dorsal spines rather indistinct to almost absent; four dark blotches on upper and lower jaws prominent in young (fig. 23). West coast of Florida from Pensacola to Placida

..... Gulf Black Sea Bass, *C. striatus melanus* Ginsburg

Gill rakers and tubercles usually 25 to 26 (23-29); pectoral rays 18 or 19; jaw usually 16 or 17 (14-18); pectoral usually 28-29 (26-30); young with dark lateral stripe and distinct black spot at base of last dorsal spines; dark blotches on jaws usually absent in young. Atlantic coast, common from Cape Cod south to Cape Canaveral; occasionally found north to Gulf of Maine and south to Florida Keys

..... Atlantic Black Sea Bass, *C. striatus striatus* (Linnaeus)

Figure 3. Distribution of *C. s. melanus*.

3. Dorsal spines with short dermal flaps rarely extending beyond tips of spines. No distinct black spot at base of last three dorsal spines. Distinct black blotch at center of fourth vertical bar just below lateral line (the lateral spot). Lateral bars usually well marked, often broken up by two pale stripes into seven series of three black blotches each. Lowest third of bars often represented by groups of small, inky spots. Pectoral rays usually 17 (16-18); body depth usually 31-34 (28-38); interorbital usually 6-8 (2-9); pelvic fin usually 24-26 (20-29). Atlantic and Gulf of Mexico, from Cape Hatteras to Yucatan, usually over hard bottom ..... Gulf Sea Bass, *C. ocyurus* (Jordan and Evermann)

Dorsal spines with long fleshy filaments, often as long or longer than spines, pale in alcohol, yellow, orange or red life. Distinct black spot at base of last three dorsal spines (the dorsal spot). No distinct black blotch at center of fourth vertical bar. Lateral bars usually poorly marked, diffuse; seldom broken up into three series. Lowest third of bars never as inky spots. Pectoral rays usually 18 (14-19); body depth usually 27-30 (25-33); interorbital usually 4-5 (4-6); pelvic fin usually 20-22 (19-24). Atlantic and Gulf of Mexico, from Cape Hatteras to Texas, straggling north to Chesapeake Bay. Often over hard bottom ..... Rock Sea Bass, *C. philadelphicus* (Linnaeus)

Figure 4. Distribution of *C. ocyurus*.

VI. Species Accounts

Abbreviations used for collections: ANSP, Academy of Natural Sciences of Philadelphia; AMNH, American Museum of Natural History; CHML, Cape Haze Marine Laboratory; CNHM, Chicago Natural History Museum; CU Cornell University; FU, University of Florida; MCZ, Museum of Compartive Zoology, Harvard University; UNC, Institute of Fisheries Research, University of North Carolina; TU, Tulane University; Ore. sta. no., United States Fish and Wildlife Service M. V. *Oregon* stations; and USNM, United States National Museum.

Collections listed were examined and are represented in the data, at least in part. Numbers in parentheses refer to the number of specimens and their ranges in standard length in mm.

Species descriptions are modified after Jordan and Evermann (1896) and Ginsburg (1952). Characters used are presented in identical sequences for the several species. Counts and measurements are based on the samples presented in Tables 1-10 except where otherwise noted by enclosure with brackets. Extreme ranges for the several meristic characters are given in parentheses.

In order to assess clearly differences between Gulf and Atlantic populations of each form, discussions of data will deal primarily with three kinds of measurable characteristics. Meristic data are the easiest and most exact to procure. They are presented in the form of frequency distributions in Tables 1 and 2. The proportional measurements are not so exact because they are influenced by the condition and shape of each specimen examined. All measurements were converted to percentages of standard length, and the resulting data were plotted against standard length on graphs (figs. 25-37) and tabulated (to the nearest whole per cent of standard length) in Tables 3-11. Color pattern cannot be analyzed in the same manner as other characteristics and valid comparisons can be made only after exact descriptions have been made of the existing range of variation. Consequently, pigmentation comparisons are based on virtually the entire available sample of *Centropristes.*

During the course of this study certain information on the biology and natural history of fishes in the genus was revealed. When possible my observations have been correlated with those described in the literature.

A scattergram plotting the per cent of standard length against standard length was made for each measurement of Gulf and Atlantic populations of the three species.

Figure 5. Distribution of *C. philadelphicus.*

Since total scattergrams number over a hundred, only those showing some variation with size will be discussed. Scattergrams for Gulf and Atlantic populations are usually very similar and have, as a rule, been combined. In certain instances, however, both will be presented to illustrate the differences present.

A. *Centropristes striatus* (Linnaeus)
Black Sea Bass
(Figures 8-12)

For pertinent synonymy for this and other species see Jordan, Evermann, and Clark (1930) and previous section on history of the genus.

Figures 6-8. **6.** (upper) Female *C. philadelphicus*, UNC, 157 mm SL. **7.** (middle) Male *C. philadelphicus*, UNC, 192 mm SL. **8.** (lower) Adult *C. s. striatus*, CU 22038, 159 mm SL.

1. Material Examined

Atlantic populations *Centropristes striatus striatus* (124 specimens): CNHM 7109 (1, 210) Buzzards Bay, Mass.; USNM 148150 (1, 146.8) Wood Hole, Mass.; ANSP 13676-77 (2, 50-187.2) Woods Hole, Mass.; USNM 163712 (4, 42.9-203.5) Woods Hole, Mass.; USNM 20618 (5, 33-66.4) Woods Hole, Mass.; TU 18125 (2, 37-59.7) Woods Hole, Mass.; TU 18126 (1, 78.4) Provincetown, Mass.; CU 18607 (1, 215) Sandy Neck, Cape Cod Bay, Mass.; CU 14372 (1, 91.4) Niantic R. at Waterford, Conn.; USNM 118242 (5, 58.3-88.5) Old Bare Shoal, N. J.; ANSP 18569-70 (2, 116.3-102.4) N. J.; ANSP 33062-63 (2, 107.8-114.7) N. J.; USNM 755 (2, 110.8-162) Beesleys Pt., N. J.; USNM 49540 (1, 319) West End, N. J.; CU 22038 (7, 121-158) Sandy Hook, N. J.; USNM 76703 (1, 154) Ocean City, Md.; TU 18127 (2, 116.5-140.7) Ocean City, Md.; USNM 89815 (1, 147) Cobb Id., Potomac, Md.; FU 886 (4, 795-112.6) York R., 1 mi. off Tue. Pt. in Channel, York Co., Va.; CU 31015 (13, 67.7-101.3) Bogue Sd., N. C.; TU 15057 (4, 78-149) 35° 07′ N., 75° 13′ W.; TU 17065 1, 129) 35° 07′ N., 75° 14′ W.; CU 30940 (6, 115-179) Beaufort, N. C.; CU 30747 (1,67.5) White Oak R., N.C.; CU 30872 (3, 62.3-78.7) Bogue Sd., N. C.; CU 31001 (2, 69.6-111) Bogue Sd., N. C.; CNHM 40342 (6, 67-152.8) Beaufort Harbor, N.C.; CNHM 37947 (2, 95.8-123.2) Charleston Harbor, S. C.; TU 14745 (1, 181) 33° 19′ N., 78° 07′ W.; TU 16327 (1, 145.2) 31° 55′ N., 80° 19′ W.; FU 5560 (1, 123.8) 3 mi. off St. Simons Is., Ga.; USNM 127486 (3, 120.8-132.3) Cumberland R. Sd., Ga.; USNM 127490 (5, 75.6-108.9) Cumberland Is., Cumberland Sd., Brunswick, Ga.; CNHM 64295 (1, 176.2) Ga.; USNM 155182 (1, 97.7) Ga.; USNM 18033 (6, 91.1-133) Matanzas Inlet, Fla.; USNM 53339 (1, 97.5) Hillsboro R., New Smyrna, Fla.; FU 678 (1, 129) 1 mi. S. Crescent Beach, St. Johns Co., Fla.; FU 3315 (1, 79.2) Vilano Beach, St. Johns Co., Fla.; TU 14791 (1, 139) 29° 03′ N., 79° 59′ W.; USNM 18033 (1, 114.4) Matanzas Inlet, Fla.; USNM 158084 (1, 145) S. of Miami, Fla.; USNM 155184 (2, 112.1-113.7) Cape Canaveral, Fla.; USNM 155183 (2, 82.8-109.2) Cape Canaveral, Fla.; USNM 155181 (1, 79.1) Cape Canaveral, Fla.; USNM 62627 (5, 72.8-152.9) St. Augustine, Fla.; CNHM 64300 (1, 196) 30° 11′ N., 81° 02′ W.; TU 14722 (1, 113.5) 30° 20′ N., 81° 06′ W.; USNM 42383 (3, 38.2-45.7) Fla. Keys; ANSP 39934 (1, 100) Hawk's Park, Volusia Co., Fla.

Gulf populations *Centropristes striatus melanus* (68 specimens): CNHM 50494 (1, 84.6) Manatee Bay, Englewood, Fla.; FU 1438 (1, 100.4) Clearwater, Fla.; CU 14059 (3, 233-270) Clearwater, Fla.; CU 12882 (1, 161) Clearwater Bay, Fla.; CU 26132 (7, 130.5-197) Gulf of Mex., Clearwater vic.; TU uncat. (5, 54.5-83) mouth of Anclote R., Fla.; Ore. sta. no. 1721 (4, 161-190.6) 28° 33′ N., 83° 08′ W.; CNHM 64278 (2, 178-181) 28° 35′ N., 83° 11′ W.; FU 1452 (2, 135-156.2) Yankeetown (Withlacoochie R.) Levy Co., Fla.; ANSP 21042-44 (3, 177-189) Bayport, Fla.; FU 2154 (1, 139) Cedar Keys (Gulf of Mex.); FU 832 (3, 86.6-103.6) Cedar Keys, Fla.; FU 674 (2, 97.5-97.6) Cedar Keys, Fla.; FU 2738 (4, 141-169.5) Cedar Keys, Fla.; FU 915 (3, 77.8-107.3) Cedar Keys, Fla.; FU 815 (3, 68.2-160.7) Cedar Keys, Fla.; FU 296 (11, 53.7-96.5) Cedar Keys, Fla.; TU 11938 (6, 49.7-69) Cedar Keys Islands, Fla.; FU 2124 (6, 42.5-88.1) Cedar Keys, Fla.

2. Description

Dorsal X, 11; anal III, 7; caudal 17; pelvic I, 5; pectoral usually 16 to 19 (14-20); vertebrae 24 [15], rarely 23; pyloric caecae 6 (4-7) [9]. Scales large, 7 or 8—47 (46-49) — 14 to 17 (13-19); small scales at base of soft-dorsal membranes in two rows, scales at base of anal membranes in single row extending one-third length of membranes; caudal membranes scaled one-third to one-half of length from base; pectorals scaled only near base; predorsal rows 11-15 (8-17). Total gill rakers plus tubercles usually 22-28 (20-29), lower limb usually 14 to 18 (14-19); gill rakers rather long and slender at center of arch grading to small tubercles at both ends of arch. Body robust, the back somewhat elevated anteriorly. Head length usually 39-42 (37-44) per cent of standard length; head large, thick, little compressed. Opercle drawn out to form broad, thin flap; middle opercular spine well developed, lower rather poorly

TABLE 3.
Frequency distribution of proportional characters, expressed as percent of standard length, in populations of Centropristes.

Species	33	34	35	36	37	38	39	40	41	42	N
Dorsal-fin origin to snout											
s. striatus	1	1	11	12	12	8	12	7	1	1	66
s. melanus			1	5	8	6	5	14	4	1	44
ocyurus											
Gulf			10	15	15	19	14	6			79
Atlantic			3	3	15	13	8	2			44
philadelphicus											
Gulf		2	5	20	29	22	8	2	1		89
Atlantic		2	6	14	17	16	4				59

	38	39	40	41	42	43	44	45	46	47	48	N
Anal-fin origin to caudal-fin base												
s. striatus			1	3	6	16	16	17	4	2	1	66
s. melanus	1		3	6	12	13	6	3		1		45
ocyurus												
Gulf	2	2	9	12	20	20	12	3				80
Atlantic		1	3	3	11	15	5	4	2			44
philadelphicus												
Gulf	1	1	2	11	14	22	15	5	1			72
Atlantic			3	11	10	18	12	8	2			64

	8	9	10	11	12	13	14	N
Dorsal-fin origin to lateral line								
s. striatus			6	27	25	5	1	64
s. melanus			1	19	17	7		44
ocyurus								
Gulf		4	35	37	4			80
Atlantic			20	19	3	1		43
philadelphicus								
Gulf	20	48	4					72
Atlantic	1	49	13					63

developed, upper in form of a small, blunt protuberance. Top of head, suborbital, maxillary, lower jaw, and snout naked; cheek scaled in about 11 rows; opercle with large scales in about 8 or 9 rows. Orbit usually 8 to 11 (6-12), about 4 in head. Eye somewhat longer than deep. Upper jaw usually 16 to 19 (14-21); mouth large, terminal; lower jaw subequal to upper in front or slightly projecting. Teeth in jaws in wide bands, outer and inner teeth slightly enlarged; no canines; teeth only slightly depressible; vomerine teeth in crescent shape; patch on palatines long and narrow. Anterior naris with large dermal flap. Posterior border of preopercle finely serrate, the angle and lower border with larger teeth, some antrorse. Branchiostegals 7. Dorsal spines rather strong, first three evenly graduated, first about half as long as second, third almost as long as fourth, the longest; following spines decrease gradually in length to tenth, which is slightly shorter than first dorsal ray; emargination between spinous and soft parts of dorsal slight; soft dorsal short, high; longest ray 18-34, males having noticeably higher fins; pectoral fin long, usually 26 to 29 (23-30), posterior margin nearly truncate, rounded at angles, more so below than above; pelvic long, usually 25-28 (21-30), reaching to anus or just short of it, outer angle in front of lower pectoral angle; anal spines graduated, second spine a little shorter and stouter than third; soft anal short, high; fifth or sixth rays longest, usually 20-23 (17-27); caudal in small specimens asymmetrical, rounded for its greater and lower part, a moderate emargination above, the second branched ray from the top moderately or slightly produced; larger specimens often three lobed, with middle and bottom rays produced; either middle or top lobes longest in tri-lobed specimens, top lobe usually longest in speci-

Figures 9-11. **9.** (upper) Young *C. s. striatus*, USNM 163712, 59.6 mm SL. **10.** (middle) Adult *C. s. melanus*, UF 815, 161.1 mm SL. **11.** (lower) Young *C. s. melanus*, CHML, 59 mm SL.

mens with rounded caudal; longest ray 18-29.

Color pattern in alcohol.—General ground color dark to nearly black; often with faint traces of wide darker cross-areas, separated by narrower, slightly lighter interspaces; scales with a lighter colored area on exposed part anteriorly, surrounded peripherally with dark pigment, presenting in gross appearance effect of bead-like longitudinal lines of light spots along rows of scales; dorsal dark with several series of elongate whitish spots forming oblique light stripes; pectoral light to dusky; pelvic and anal dark to nearly black, sometimes edged with white; caudal almost uniformly dusky or dark, sometimes with faint spots. Young with a black longitudinal band, which later breaks up, sides

variously mottled or with vertical cross shades; belly area paler than adults; large black spot at bases of last three dorsal spines.

Color of adult in life (Hildebrand and Schroeder, 1929).—"Blue black, centers of scales pale to white, forming longitudinal lines; several bluish streaks in front of or below eye present or absent; dorsal blue-black, with pale stripes more numerous on soft part, caudal dusky or dark blue, streaked or mottled with pale markings; anal almost entirely pale or streaked with dark blue; ventrals bluish gray, the rays pale; pectorals grayish. Females are lighter than males, usually gray-blue instead of blue-black." Males develop an adipose hump on the nape which is bright blue in the breeding season. Color is somewhat variable in this species, with individuals that have bronze or reddish brown hues variously placed on the fins and body being taken commonly. In general the basic color of the species varies from dark reddish brown to blue to almost black.

Accounts of color differences in spawning *striatus* are found also in Breder (1932) and Lavenda (1949).

No notes are available on color of live specimens from the Gulf, but presumably it is similar to that of Atlantic forms.

3. Distribution

Centropristes striatus striatus is found commonly from Cape Cod south to Cape Canaveral. There are occasional summer records from the Gulf of Maine and more frequent occurrences south to Miami, Florida. In addition I have examined three small specimens which I identified as *striatus* from the Florida Keys. This form appears to be rare south of Miami, but perhaps small concentrations exist in suitable habitats about the Keys (fig. 2).

Centropristes striatus melanus is found on the west coast of Florida between Pensacola

TABLE 4.

Frequency distribution of proportional characters, expressed as percent of standard length, in populations of Centropristes.

	Caudal-peduncle length									
Species	9	10	11	12	13	14	15	16	17	N
s. striatus	3	9	17	21	12	2	1			65
s. melanus	2	8	17	14	3					44
ocyurus										
Gulf			5	11	25	27	11	1		80
Atlantic		1	3	6	13	15	4	1	1	43
philadelphicus										
Gulf		4	15	18	22	10	2			71
Atlantic		2	7	22	19	10	2			62

	Caudal-peduncle depth						
	11	12	13	14	15	N
s. striatus		5	28	27	5	65
s. melanus			19	22	3	44
ocyurus						
Gulf	8	57	15			80
Atlantic	4	30	10			44
philadelphicus						
Gulf	18	52	1			71
Atlantic		33	30			63

	Head length										
	35	36	37	38	39	40	41	42	43	44	N
s. striatus			2	11	21	36	30	19	4		123
s. melanus					4	13	20	19	7	1	64
ocyurus											
Gulf				5	12	23	28	7	3	1	79
Atlantic			1	1	5	14	15	8		1	45
philadelphicus											
Gulf	1		2	14	39	33	17	4	1		111
Atlantic			8	18	25	14	4				69

and Placida (fig. 3). Accounts of this form from Mississippi, Louisiana, and Texas occur in the literature, but to my knowledge no specimens from west of Pensacola are present in any museum. Occasional migrants or local names of other species are probably responsible for more westerly records.

No records exist of any *Centropristes* from Florida between Placida and the Florida Keys. This is probably due to inadequate sampling. This area is critical for determining to what degree Gulf forms are isolated from the Atlantic. To hypothesize a lack of gene flow between the two populations, one must either try to prove that the ranges do not overlap or find an area where both forms occur and are as distinct as elsewhere. If the two populations are, in fact, separated from each other, it does not necessarily follow that the Gulf form has achieved the species level of differentiation. In order to resolve the problem it will be necessary to collect in this area and determine whether the two forms are truly allopatric as Ginsburg (1952) suggested.

4. Population Analysis

Of the three species of *Centropristes* recognized herein, *striatus* shows the greatest divergence between Gulf and Atlantic populations. Ginsburg (1952), basing his description primarily on gill raker and pectoral-ray counts in 13 specimens, erected a new species, *melanus*, for the Gulf population. I have examined several hundred specimens from both populations and conclude that the degree of divergence is at the subspecies level.

The average divergence in number of gill rakers is 89.9 per cent and the average divergence in pectoral-ray count (Table 1) is 88.4 per cent. All other meristic characters diverge to a lesser degree. Although distinct differentiation exists, it is not deemed worthy of specific recognition.

Certain measurements show variations similar to those of meristic characters. Distance between anal-fin origin and caudal-fin base (Table 3) is somewhat shorter in Gulf than in Atlantic fish, but the greatest differences can be found in upper-jaw length (Table 6 and fig. 24) and pectoral-fin length (Table 6 and fig. 27). The upper jaw is longer and the pectoral fin is shorter in *melanus*, though some overlap exists. These variations, however, do not seem to be large enough or consistent enough to merit full species ranking.

Color pattern in *striatus* has been treated sufficiently in the species description. No color differences were noted between adult specimens of *melanus* and *striatus*. Specimens of approximately the same size are virtually inseparable until several counts are made. Best differences in color between the two are present in young specimens.

Total range of variation in the color pattern of young *melanus* is smaller than that of *striatus*. Most Gulf fishes show a mottled pattern (fig. 11) whereas this mottling is only one of a large number of color patterns found in Atlantic fishes. The dorsal spot in young *melanus* is slightly smaller and fainter but, contrary to Ginsburg (1952), is regularly present.

The most conspicuous difference between preserved young fishes is the presence of four dark smudges on the jaws of *melanus* (fig. 12). These smudges are almost always present, though sometimes they are diffuse, and are rarely found in Atlantic

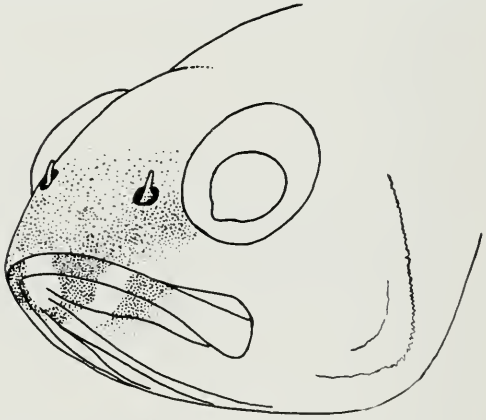

Figure 12. Markings on jaws of young *C. s. melanus*.

specimens. This character is the most consistent one that I investigated and might be considered to warrant specific recognition. Recently, however, I observed a young (83 mm.) specimen of *striatus* alive at Marine Studios, Marineland, Florida, and found that from time to time dark smudges appeared on the jaws of this specimen in the same positions as in preserved specimens of *melanus*. When preserved, almost all markings on the jaws disappeared, leaving the jaws

a uniform dusky color. I cannot explain with any certainty why the Gulf form commonly exhibits this pattern in preservative although its Atlantic counterpart does so only rarely.

Since these differences in color pattern and intensity are known to be highly variable in life, I feel that they should not be emphasized as differentiating features. Rather I believe that the extent of divergence in color pattern noted above is compatible with present ideas about the nature of the subspecies.

It has been shown above that Gulf and Atlantic populations of *C. striatus* are distinctly differentiated. This differentiation is of greater magnitude than that found in other forms of the genus and unquestionably merits nomenclatural status. Ginsburg concluded that the Gulf population has diverged to the point of being a full species. My observations lead me to believe that the species level has not yet been reached by this form.

Hubbs (1943: 109-123) stated that "Incompleteness versus completeness of differentiation is the main test by which subspecies may be distinguihed from species..." In the present situation, completeness of differentiation is extremely difficult to assess. If the two populations are isolated from each other, as is indicated by our present knowledge, reproductive isolation can not be used to aid in the evaluation of the degree of speciation attained by the Gulf form. Therefore, the only data available to aid in such evaluation are those based on morphological characteristics. If, however, future collections locate areas where both forms coexist and maintain individuality, *melanus* may be regarded as a full species.

Considering the totality of divergence, I regard *Centropristes melanus* Ginsburg as a

TABLE 5.
Frequency distribution of proportional characters, expressed as percent of standard length, in populations of Centropristes.

				Interorbital width					
Species			4	5	6	7	8	9	N
s. striatus					20	65	25	2	112
s. melanus				4	13	30	8	3	58
ocyurus									
Gulf				2	27	40	14	1	84
Atlantic					10	25	7	2	44
philadelphicus									
Gulf			27	57	8				92
Atlantic			10	44	13				67
				Snout length					
	7	8	9	10	11	12	13	14	N
s. striatus		3	14	30	14	3			64
s. melanus		1	15	8	16	7	2	1	50
ocyurus									
Gulf		7	23	31	15	2	2		80
Atlantic	1	2	14	17	5	4	1		44
philadelphicus									
Gulf	6	26	33	24	4				93
Atlantic	7	22	24	10	1				64
				Orbit length					
	6	7	8	9	10	11	12	13	N
s. striatus	1	1	8	19	28	9	6		72
s. melanus	1	1	13	11	10	13	2		51
ocyurus									
Gulf			3	18	29	21	9		80
Atlantic			4	2	24	10	4		44
philadelphicus									
Gulf				16	45	29	1	2	93
Atlantic		1		22	29	12			64

subspecies. This subspecies would hereafter be known as *Centropristes striatus melanus* Ginsburg.

5. Biology

Food.—Hildebrand and Schroeder (1927) listed the food of *striatus* in Chesapeake Bay as "... crustaceans, fish, mollusks and plants, named in the order of their apparent importance. Adults had fed chiefly on crabs and fish, and the young on shrimp, isopods, and amphipods." My observations indicate that other species of *Centropristes* subsist on a similar diet. Crabs and fish were present in numerous specimens of each species. Though most fishes were decomposed, two of the genera found in stomachs of *philadelphicus* were *Scorpaena (calcarata)* and *Urophycis* (sp.). Since this aspect of study was incidental, these observations are based on a relatively small number of inspections.

Spawning.—Centropristes striatus striatus: There is much information in the literature dealing with the spawning season of this species. Southern populations spawn at an earlier date than do those in the north. Earll (1885) reported ripe females, with eggs running from 50 per cent of the specimens handled, on March 25, 1880. Smith (1907) reported that the spawning season is "...early spring off the North Carolina coast, probably in May." Hildebrand and Schroeder (1928) believed that spawning occurs in late May near the mouth of the Chesapeake. Various authors (Nichols and Breder, 1927; Smith, 1898; Bean, 1903; and Sumner, Osborn and Cole, 1913) stated that spawning occurs from mid-May to early July along the coast from New England to New Jersey. The spread of spawning dates is probably directly related to water temperatures. Goode (1884) stated that *striatus* is rarely found in waters below 50° F. in temperature. It is reasonable to assume that increasing water temperature is, at least in part, responsible for initiation of spawning behavior. The temperature conducive to spawning would, therefore, be achieved earlier in the spring in southern waters.

Centropristes striatus melanus: Goode (1884) reported that this form spawns in the Gulf of Meixco in early summer, and the young are caught in July and August. Reid (1954) found 22 to 25 mm. specimens at Cedar Keys during May and June, indicating a somewhat earlier spawning date. The discrepancy between the two estimated spawning seasons possibly could be due to latitudinal or climatic variations, since the work reported by Goode was done primarily in the Pensacola region, considerably to the north and west of Cedar Keys.

Growth and body proportions.—Distance between the dorsal origin and occiput increases proportionally with an increase in size (fig. 20). Interorbital width tends to increase with size (fig. 21), as does the snout length (fig. 22). The changes in relationship between snout and orbit length are interesting. As expected, small specimens have relatively large eyes (fig. 23) and small snouts. The dorsal fin is longer in larger fishes (fig. 25) with the males having the longest fins. Anal-fin length (fig. 26) does not increase with size as markedly as the dorsal, but the two populations differ slightly in the relative size of anal fins. The pectoral fin (fig. 27) is slightly shorter in larger fishes, and the pelvic is uniform at all sizes. The caudal fin (fig. 28) is longer in larger fishes and is tri-lobed in the largest. Tri-lobed specimens usually have the top lobe longest, but five individuals with the middle rays extending past the tips of the upper rays were noted.

Upper-jaw length reflects a marked difference between Gulf and Atlantic populations (fig. 24). Although the jaw length in both shows a tendency to increase with increased body length, at any given size Gulf fishes have distinctly larger jaws.

B. *Centropristes ocyurus* (Jordan and Evermann)

Gulf Sea Bass

(Figures 13-16)

1. Material Examined

Atlantic populations (51 specimens): USNM 155169 (2, 85-106) 30° 31′ N., 80° 20′ W.; CNHM 64089 (14, 100-137) 30° 04′ N., 80° 23′ W.; USNM 155172 (1, 206) 28° 59′ N., 80° 04′ W.; TU 14801 (4, 106-156) 28° 52′ N., 80° 05′ W.; CNHM 64200 (1, 82.2) 30° 11′ N., 81° 02′ W.; CNHM 64296 (1, 151.4) 32° 12′ N., 79° 07′ W.; USNM 155165 (1, 96.7) 31° 57′ N., 79° 29′ W.; USNM 155166 (1, 141.4) 31° 28′ N., 79° 46′

TABLE 6.
Frequency distribution of proportional characters, expressed as percent of standard length, in populations of Centropristes.

	Upper jaw length									
Species	14	15	16	17	18	19	20	21	22	N
s. striatus	1	11	47	46	8					113
s. melanus			2	8	27	13	5	1		56
ocyurus										
Gulf				5	31	28	11	3	1	79
Atlantic			1	5	15	16	8			45
philadelphicus										
Gulf				28	37	15	3	1		84
Atlantic			4	16	30	13	4			67

	Pectoral-fin length										
	22	23	24	25	26	27	28	29	30	31	N
s. striatus					5	11	29	19	9		73
s. melanus		1	2	4	10	18	12	3			50
ocyurus											
Gulf				2	16	31	21	8		1	79
Atlantic				3	10	13	12	5	1		44
philadelphicus											
Gulf	1	1	1	12	24	35	15	1			90
Atlantic			2	16	23	21	1	1			64

W.; USNM 155171 (1, 144) 31° 09′ N., 80° 09′ W.; USNM 155167 (1, 97.7) 30° 13′ N., 80° 18′ W.; USNM 155170 (1, 120.7) 31° 33′ N., 79° 36′ W.; CNHM 31766 (1, 179.2) Charleston, S.C.; ANSP 13678 (1, 202) Blackfish, S.C.; TU 17059 (2, 90-97.5) 29° 03′ N., 80° 13′ W.; TU 17049 (1, 104) 32° 32′ N., 79° 55′ W.; USNM 155163 (1, 80.3) Daytona Beach, Fla.; TU 17056 (1, 151) 35° 05′ N., 75° 09′ W.; TU 17089 (1, 136) 32° 34′ N., 78° 46′ W.; USNM 152059 (4, 183.5-188.7) 34° 40′ N., 75° 38′ W.; TU 17061 (4, 90-157.2) 34° 17′ N., 76° 01′ W.; UNC uncat. (1, 166.5) off Cape Hatteras, N.C.; TU 17563 (2, 113.6-118.9) 31° 49′ N., 79° 31′ W.; TU 17550 (3, 137-156.5) 31° 36′ N., 79° 38′ W.; TU 17558 (1, 114) 31° 18′ N., 79° 45′ W.

Gulf populations (83 specimens): USNM 92060 (3, 110-146) south of Tortugas, Fla.; CHML uncat. (1, 155) Tortugas Fla.; CHML uncat. (2, 87.3-117.8) Tortugas, Fla.; USNM 117212 (5, 111-158) Tortugas, Fla.; USNM 117179 (1, 128.5) Tortugas, Fla.; Ore. sta. no. 1022 (1, 117) 24° 59′ N., 83° 35′ W.; USNM 134161 (1, 158) 24° 25′ N., 81° 47′ W.; CNHM 45752 (1, 120.8) 25° 00′ N., 83° 02′ W.; CHML uncat (1, 109.3) 40 mi. S. of Marco Is., Fla.; Ore. sta. no. 892 (3, 92.7-140.5) 28° 55′ N., 85° 07′ W.; CNHM 45761 (2, 131-186) 29° 10′ N., 85° 01′ W.; FU 3613 (2, 116-121.6) 27° 30′ N., 84° 14′ W.; USNM 133820 (1, 143) 28° 45′ N., 85° 02′ W.; USNM 101571 (1, 83.5) 28° 28′ N., 84° 25′ W.; TU 13178 (1, 125) 28° 22′ N., 84° 53′ W.; CU 12869 (1, 134.5) Clearwater, Fla.; FU 3591 (2, 135.8-148.3) 29° 07′ N., 84° 52′ W.; USNM 131664 (1, 62.5) 28° 45′ N., 83° 57′ W.; USNM 133756 (1, 107.3) off Apalachicola, Fla.; TU 12999 (1, 169) 29° 28′ N., 87° 30′ W.; CNHM 45760 (1, 163.4) 29° 37′ N., 86° 03′ W.; TU 13199 (3, 97.5-151) 29° 50′ N., 86° 30′ W.; USNM 163512 (1, 158.3) 29° 50′ N., 86° 30′ W.; USNM 32761 (5, 84.1-156.8) Pensacola, Fla.; USNM 142806 (6, 84.6-104.8) 26 mi. E.S.E. Pensacola light; USNM 30713 (4, 115.5-155.5) Pensacola, Fla.; TU 13206 (1, 123.3) 29° 50′ N., 86° 30′ W.; Ore. sta. no. 26 (3, 107.2-154.3) 29° 56.5′ N., 87° 03′ W.; Ore. sta. no. 1636 (2, 120.1-143.2) 29° 39′ N., 87° 31′ W.; Silver Bay sta. no. 159 (4, 108.4-153) 29° 36′ N., 86° 01′ W.; Ore. sta. no. 328-A (1, 185.8) 30° 04′ N., 86° 48.5′ W.; USNM 131938 (1, 166.5) 29° 24′ N., 88° 01′ W.; TU 16969 (2, 97.5-122) 29° 33′ N., 88° 10′ W.; TU 16253 (1, 150.5) 28° 12′ N., 94° 10′ W.; TU 16231 (1, 143)

Figures 13-14. **13.** (upper) Female *C. ocyurus,* CNHM 64089, 99.5 mm SL. **14.** (lower) Male *C. ocyurus,* CNHM 64089, 157 mm SL.

28° 30′ N., 94° 25′ W.; CNHM 45757 (1, 111.5) 21° 15′ N., 92° 16′ W.; Ore. sta. no. 477 (11, 94-160) 20° 45′ N., 92° 12′ W.; USNM 131459 (1, 127) 22° 18′ N., 87° 04′ W.; USNM 134191 (1, 199.1) 22° 08′ N., 86° 53′ W.; CNHM 45751 (1, 99.5) 22° 16′ N., 89° 03′ W.

The following specimen was examined, but its measurements other than standard length were not taken: MCZ 35131 (1, 154.5) Pensacola, Fla.

2. Description

Dorsal X, 11; anal III, 7; caudal 17; pelvic I, 5; pectoral usually 17 (16-18); vertebrae usually 24 [16]; pyloric caecae 6 [4]. Scales large, 7 or 8 — 47 (46-48) — 17 to 19 (15-21); small scales at base of soft dorsal membranes in single rows, scales at base of anal membranes in single rows extending one-half or less the length of membranes, longer in anterior than posterior part of fin; caudal membranes scaled one-third to one-half of length from base; pectorals scaled only near base; pelvic rays finely scaled on underside for about one-third of length from base; predorsal rows usually 12 or 13 (10-14). Total gill rakers plus tubercles usually 19-21 (17-22), lower limb about 13; gill rakers long and slender at center of arch, grading evenly to small tubercles at ends of arch. Body robust, back elevated less than in *C. striatus,* somewhat more than in *C. philadelphicus.* Head length usually 40 or 41 (37-44). Head large, not as deep as in *C. striatus,* deeper than *C. philadelphicus,* little compressed. Opercle drawn out into thin flap; middle opercular spine well developed, lower rather poorly developed, and upper barely visible, blunt. Top of head, suborbital, maxillary, lower jaw and snout naked; cheek with small scales in 9-10 rows. Orbit usually 9-11 (8-12), about 4 in head. Eye longer than deep. Upper jaw usually 18 or 19 (16-22); mouth large, terminal; lower jaw projecting slightly beyond tip of upper. Teeth in jaws in bands, outer and inner enlarged, those along sides

of lower jaw considerably enlarged, somewhat recurved; some teeth almost large enough to be considered canine; teeth only slightly depressible; patch on vomer V-shaped, patch on palatines long and narrow. Nares very close to eye, anterior naris with large dermal flap. Posterior border of preopercle finely serrate, serrae on ventral border and at angle of preopercle somewhat larger and farther apart. Branchiostegals 7. Dorsal spines moderate, first three evenly graduated, first about half as long as second; third spine slightly shorter than fourth, fourth almost as long as fifth; following spines decrease in length to tenth, which is shorter than first dorsal ray; spines without long filaments, fin membranes extended into short or moderate fleshy flaps

TABLE 7.

Frequency distribution of proportional characters, expressed as percent of standard length, in populations of Centropristes.

	Dorsal-fin origin to caudal-fin base														
Species	64	65	66	67	68	69	70	71	72	73	74	75	76	77	N
s. striatus					3	3	8	10	15	8	10	6	1		64
s. melanus			1	2	1	2	8	11	5	6	6	1			43
ocyurus															
Gulf	1	1	2	3	8	12	18	19	8	3	3	1	1	1	81
Atlantic				3		6	8	11	4	5	4	2		1	44
philadelphicus															
Gulf		1	1	2	7	15	13	19	11	1	1				71
Atlantic					1	7	9	7	15	13	5	4	1		62

	Dorsal-fin origin to occiput													
	11	12	13	14	15	16	17	18	19	20	21	22	23	N
s. striatus			5	4	12	17	10	8	6	3				65
s. melanus		1	1	6	6	6	4	7	6	2		1	1	41
ocyurus														
Gulf	2	7	17	15	19	13	3							76
Atlantic	1	3	7	13	14	4	2	1						45
philadelphicus														
Gulf				4	9	33	24	9	8	2				89
Atlantic				1	6	11	19	22	4					63

TABLE 8.

Frequency distribution of proportional characters, expressed as percent of standard length, in populations of Centropristes.

	Anal-fin length													
Species	15	16	17	18	19	20	21	22	23	24	25	26	27	N
s. striatus					2	12	23	20	11	4	1			73
s. melanus			1	1	5	9	17	13	3	1			1	51
ocyurus														
Gulf		2	2	12	21	18	9	13	5	1				83
Atlantic			2	7	12	9	7	5	1	1				44
philadelphicus														
Gulf	5	31	36	7	1	1		1	2	1	4	3		92
Atlantic		3	20	16	3	1	1	4	3	3	4	2	3	63

	Pelvic-fin length													
	19	20	21	22	23	24	25	26	27	28	29	30	31	N
s. striatus			1		1	4	17	9	18	12	7	2		71
s. melanus					2	6	13	11	13	5			1	51
ocyurus														
Gulf			1	4	8	18	26	14	8	1				80
Atlantic		1		3	7	9	15	7	1		1			44
philadelphicus														
Gulf	5	13	36	26	5	4								89
Atlantic	1	7	17	16	10	10								61

just behind tips of spines; emargination between spinous and soft parts of dorsal moderate; soft dorsal short, high; longest ray 18-28; large males with higher fins; pectoral long, usually 26-28 (25-31), posterior margin nearly truncate, rounded at angles, more so below than above; pelvic long pointed usually 24-26 (20-29), seldom reaching anus, outer angle in front of lower pectoral angle; anal spines graduated, second spine somewhat shorter and little stouter than third; soft anal short, high; fourth to sixth rays longest, usually 18-22 (16-24); caudal in small specimens rounded, sometimes with upper rays slightly produced; middle rays also produced in medium sized specimens, in large specimens distinctly three-lobed, with upper and middle lobes greatly produced; longest ray 22-56, mature males with longer rays.

Color pattern in alcohol.—General ground color pale to white; somewhat darker on sides and back; each side with 3 longitudinal rows of quadrate black blotches, the uppermost series obscure along base of dorsal fin; the second distinct and placed just below lateral line, the lower series often black, not confluent, placed along side of belly on the level of the axil of the pectoral. The blotches in each series correspond in position to those in the other series, so that with dusky shades extending from one to another, they form about 7 dusky vertical bars. Small specimens very often with bars rather distinct. Some dark inky spots on opercle and above base of pectoral; opercle and preopercle with dusky shades. Chin somewhat dusky, premaxillary and maxillary dusky; snout and top of head dark, sometimes with pale stripes and spots. Dorsal spines with 3 or 4 dark to inky spots evenly spaced, membranes between spines dusky, sometimes mottled; soft dorsal with fine oblique bars on a pale ground, some dark blotches above fifth and sixth vertical bars, last rays sometimes with 2 or 3 dark spots. Caudal fin with middle rays dark, the outer pale, all with darker spots that become black on median rays. Anal fin pale, slightly mottled, tips of rays dusky. Ventrals dusky. Pectorals entirely pale.

Color in life.—Modified from field notes of Dr. Royal D. Suttkus. Based on 134.5 mm. specimen, CU 12869 (RDS 542). Head with dull blue and yellow; dorsal faint blue with yellow and dark spots; caudal with blue and yellow to russet on upper portion, lower portion dusky; pectoral clear, slightly dusky; pelvic dusky; anal membrane bright yellow at base, fainter distally, anterior border dark, rest bluish gray. Orange and dusky brown forming vertical bars in upper half of caudal; worm-like marks on head and face dull blue; body color an intermixing of blue gray and pale yellow, overlaid with dark vertical bars and spots; underside with dusky spots, ground color dirty white; tinge of yellow on breast and gular region.

Color-pattern variations. — The following description of the color-pattern variation found within a single series of 14 preserved specimens is presented in order to illustrate the high degree of variation found within the species. Notes on sexual dimorphism are included in the account.

Fourteen specimens of *ocyurus* (CNHM 64089) were collected by the M/V *Bowers* in 25 fathoms off St. Augustine, Florida, May 23, 1956. The specimens range in size from 99.5 to 157 mm. standard length. Two specimens, 130 and 157 mm. S.L. are markedly different from the others in color pattern and general appearance. These proved to be males with what appear to be mature testes. The other specimens, 99.5 to 132 mm. S.L., are females, and the ovaries are full of eggs in every individual.

The variations in color or pigmentation pattern found in this collection are described below. A diagnosis of sexual dimorphism with respect to color pattern is included in the discussion.

Pigmentation pattern in females. — The ground color in alcohol is a faded pink with some specimens having more or less a yellowish caste. In all specimens there are seven dusky vertical bars extending from the mid-dorsal line to somewhat above the mid-ventral line. The width of the whitish belly area varies slightly between specimens. The most anterior bar extends backward from the origin of scalation on the occiput for about five or six scale rows apparently terminating ventrally at the dorsal margin of the opercle, although a dusky spot on the opercle just below the bar suggests a continuation of it. The second dark bar starts three or four scale rows anterior to the dorsal origin and terminates four or five rows posterior to it, extending ventrally to

TABLE 9.
Frequency distribution of proportional characters, expressed as percent of standard length, in populations of Centropristes.

	Body depth														
Species	25	26	27	28	29	30	31	32	33	34	35	36	37	38	N
s. striatus				3	2	5	5	14	30	28	20	8	4	5	124
s. melanus							1	8	12	15	16	7	6	2	67
ocyurus															
Gulf				1	7	3	20	18	16	11	2		1		79
Atlantic						3	10	8	13	3	4	3		1	45
philadelphicus															
Gulf	2	7	16	37	28	15	5	1	1						112
Atlantic		4	9	17	24	7	1	1							63

	Pelvic-fin insertion to lateral line												
	19	20	21	22	23	24	25	26	27	28	29	30	N
s. striatus	1	1	1	5	13	9	17	9	7	3			66
s. melanus				1	7	11	9	10	4	1	1		44
ocyurus													
Gulf		2	7	13	23	16	15		3	1			80
Atlantic			1	7	9	11	8	3	1	1	1	1	43
philadelphicus													
Gulf	3	2	21	24	15	5	1	1					72
Atlantic	2	8	24	21	8								63

TABLE 10.
Frequency distribution of proportional characters, expressed as percent of standard length, in populations of Centropristes.

	Pelvic-fin insertion to snout																		
Species	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48	N
s. striatus		1	1	2	3	8	1	6	9	5	7	4	7	1	2	2	3	2	64
s. melanus					1	2	3	9	2	5	4	7	4	1	3	1	3		45
ocyurus																			
Gulf			1		1	10	10	12	10	9	6	4	7	5	1	1	2		79
Atlantic				2	2	3	5	3	6	4	3	4	5	4	3				44
philadelphicus																			
Gulf	1		2	5	11	9	7	8	5	5	6	1	4	4		1			69
Atlantic		1	4	11	17	15	6	4		2	1	1		1					63

	Dorsal-fin length																			
	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	N
s. striatus		1		7	12	19	13	10	8	1		2								73
s. melanus		2	1	4	10	17	5	3	2	1	1	2	1					1		50
ocyurus																				
Gulf		2	3	3	15	18	14	8	9	5	1	2								80
Atlantic		1	3	2	9	8	8	2	8	1	1	1								44
philadelphicus																				
Gulf	2	10	13	10	16	10	7	5	5	4	1	1	4	2		1	1			92
Atlantic		1	2	7	6	9	7	1	2	2	4	4	5	6	2	2	1	2	1	64

the base of the pectoral fin. The third bar originates at the base of the fifth dorsal spine, extends backward to the seventh spine, and terminates ventrally in a darker series of spots at the white belly area. This pale area extends from under the head backward to about the middle of the caudal peduncle; its depth usually comprises about one-fifth the body depth at a given point. The fourth bar is closer to the third bar than to the fifth, the light area between the two being the narrowest on the body. This bar begins under the eighth dorsal spine and ends just posterior to the first dorsal ray. It extends ventrally to the belly. In all specimens examined, I found a very dark blotch at the center of this bar just below the lateral line. It extends the total width

of the bar and is usually about three scales deep. The dorsal margin of this blotch is invariably the lateral line. The presence of the blotch in all *ocyurus* has led me to assign it a relatively high position with regard to distinguishing specific characters. I shall refer to this spot as the "lateral spot" whenever discussing it. The fifth bar begins under the fourth dorsal ray and ends posterior to the sixth. In most specimens this bar runs diagonally forward and terminates ventrally at the belly, as do all of the last five bars. The sixth bar begins under the ninth dorsal ray, ends under the eleventh, and runs diagonally forward and ventrally to the belly. The angle from the vertical is not large, but the forward slant is noticeable, in most specimens. The last bar covers the posterior half of the caudal peduncle. The anterior margin of the bar has a pronounced forward angle. Below the lateral line it splits into two parts, a narrow three-scale extension forward and a somewhat wider one straight down. There is a conspicuous white area between the two lower branches of the bar. In some specimens the posterior branch encircles the caudal peduncle.

In most specimens the head seems to be relatively devoid of dark spots or markings. The premaxillary integument is dusky in some, though not conspicuously so. Most have a dusky spot at the ventral-posterior angle of the orbit and at the dorsal margin of the preopercle. Some specimens have three or four small dark spots in this general region. The opercular flap in most specimens has two to three small dark spots on it. All specimens have a small dusky to black spot on the dorsal margin of the opercular spine. The preopercle in most has a dusky band along the entire posterior length. One specimen has a small black spot at the angle of the preopercle. The tip of the lower jaw is always dusky.

The pectoral fin is clear with no pigmentation. Each of the dorsal spines has two to four dark to inky black spots, the darkest of which seem to be those nearest the tips. Most specimens have a row of more or less conspicuous spots on the bases of the spines. The membrane between spines is dusky, and in some specimens the melanophores are clustered to form a few gray spots. The soft dorsal has four or five dusky stripes that extend from the first to the last ray and run approximately parallel to the dorsal outline. There are dusky to black spots on the bases of the membranes between the rays that occur above the fifth and sixth body bars. Most individuals have four or five dusky to black spots on the distal regions of the last three rays. The pelvics are dusky with the anterior edge milky. The anal fin is dusky with the color deepening at the extremities of the fin rays. In some the fin has a narrow milky margin. The caudal fin is also dusky, with pigment cells more concentrated near the center of the fin where it is broken up into dark spots on the membranes, usually between the middle five to seven rays. The outer rays and membranes are whitish to gray with some small black spots occasionally occurring on the upper two or three rays. A light colored band extends the width of the caudal peduncle at about the end of the hypural plate. Caudal scales and bases of caudal rays are dusky.

The over-all appearance of these females is varied, especially with reference to the vertical bars. In some the pigmentation is diffuse and the bars appear more or less continuous along the sides; in others the bars are broken into three horizontal rows of dark blotches or spots. Still others have the pigment cells at the ventral margins of the bars concentrated to form clusters of dark or black spots (see figs. 13-15). Occasionally dark spots appear on the lateral line where the bars cross it. Some specimens have a number of small black spots on the body just posterior to the opercular flap. These fish can probably control the appearance of the lateral bars to form either the diffuse bars or the concentrated spots as they are so motivated.

Pigmentation pattern in preserved males. —The most obvious sexual dimorphism in *ocyurus* is the greater length of the caudal lobes in males larger than about 110 mm. There are, however, in this series a number of pigmentary differences that are also of value in determining the sex of this form externally. Generally the basic color pattern is the same for males and females, but the following differences may be noted: In the males the entire upper jaw is much darker; the lower jaw is much darker, and the pigment extends farther back along the midventral membrane of the head; the head is

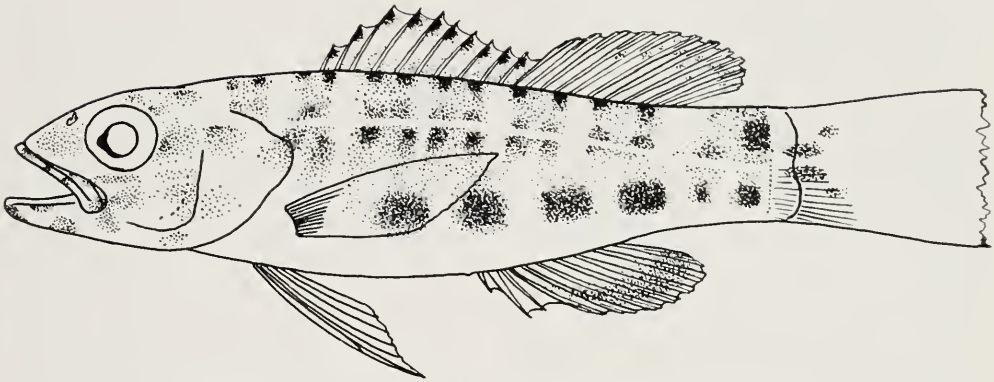

Figure 15. Young *C. ocyurus*, ANSP 73871, 28.2 mm SL.

darker, and the smaller male has wavy patches of darker and lighter areas on the snout and top of the head. This region is uniformly dark in the larger male; the dusky band on the preopercle is much darker, with a dark spot appearing at the angle of the preopercle; lateral bars are more interrupted, with the lower one-third becoming scarcely more than a series of inky spots. The first two bars in the occipital region differ considerably. The center of each scale in the upper four to six scale rows in these bars has an inky black spot in it. Some females have a vague suggestion of these spots, but none are developed to the intensity found in males. Possibly these spots are associated in some way with the courtship and breeding behavior of these fish and may be analogous to the nuchal hump in breeding male *striatus*. In the larger male the lateral bars are almost completely broken up, and the upper part of the body is a slightly mottled dark gray. The lateral spot is very dark and extends forward to the end of the opercle. This gives the appearance of a dark lateral bar on the anterior part of the body. Ventral and anal fins of males are darker and the caudal fin is darker than that of the female, and the spots in the caudal fin membranes are larger and more pronounced. The dorsal fin of the smaller male is similar to the typical female pattern, but the larger male's is not. Here the spots on the spines are lamost absent, whereas the bases of membranes between them are much darker. This darkening of the membrane bases extends back over the entire length of the soft dorsal as well as the spinous dorsal. Dusky rows are absent on the membranes of the soft dorsal, and only a light uniform duskiness prevails. There are more melanophores along the mid-ventral area of the males; the belly thus appears to have a light dusky stripe from the anus to a point anterior to the pelvic fins.

Sexual dimorphism becomes more pronounced with the approach of the spawning season. Though males are larger and have much longer fin rays, they also appear to assume a distinctive color pattern (see above) as they become reproductively motivated. After spawning, color differences diminish and eventually all but disappear.

3. Distribution

Centropristes ocyurus ranges from Cape Lookout, North Carolina, in the north to the Yucatan banks of the southern Gulf of Mexico. These fish appear to be most common in areas where there are coral patches or other types of hard bottom in rather deep water (figs. 1, 4). Although they are taken at times over mud and sand bottoms, this habitat is not typical. This form differs from the others in that it thrives in tropical waters off southern Florida and Yucatan. It is interesting to note that the species is unrecorded from most of the western Gulf, an area with extensive mud or blue-mud bottom. Although I have no records of this form from the east coast of Florida south of Cape Canaveral, the probability seems slight that a fish which thrives in tropical waters around the Tortugas would be excluded by temperature (as Ginsburg suggests) from living in or moving through the waters off the southeast coast of Florida. The Florida peninsula probably does not form a barrier

between Gulf and Atlantic populations of this species. This subject will be discussed more fully later in this paper.

4. Population Analysis

Meristic data for the Gulf and Atlantic populations of *ocyurus* are presented in Tables 1 and 2. These data clearly indicate the uniformity of the two populations, and in no case is there any material differentiation. The highest average divergence occurs in the number of scale rows between the anal-fin origin and the lateral line (Table 2), and that is far less than a racial level of differentiation.

Comparison of proportional measurements (Tables 3-10) shows the two populations to be nearly identical. On the basis of counts and body measurements, there is no reason for separating the Atlantic and Gulf populations at any level.

In comparing Gulf and Atlantic populations of *ocyurus* with respect to color pattern, the total variation present was necessarily investigated. It was found that a selection of nine series included a high percentage of the different patterns found in the complete sample examined. One series (CNHM 64089, described above) was chosen as a standard with which the others were compared. The following series were examined intensively and are representative of the kinds of variations found within the species: Ore. sta. no. 417; Ore. sta. no. 892; TU 12999; TU 17061; TU 17049; CNHM 45761; TU 16969; and CU 12869.

Most differences are due to varying intensities of pigmentation. Small specimens, both male and female, tend to have relatively diffuse lateral bars, and there is usually little spotting on the body. There is, however, considerable variation in this basic pattern, as can be seen in Figs. 13-15. Spotting on the head varies as does the intensity of the color pattern of the fins. Although there is much variation, Gulf and Atlantic populations cannot be separated on the basis of coloration observed in preserved specimens.

In summary, comparison of the two populations shows them to be similar, if not identical, in observable characters. The distribution map shows a hiatus off southeastern Florida, but this gap may be closed with additional collecting in deep water. Fishes capable of enduring summer water temperatures on the Campeche banks or at the Dry Tortugas hardly would find the water temperature off the southeastern tip of Florida a barrier to migration. Bottom types or other ecological conditions perhaps associated with the strong push of the Gulf Stream may have some effect in limiting the distribution of this species off southern Florida, but this seems unlikely.

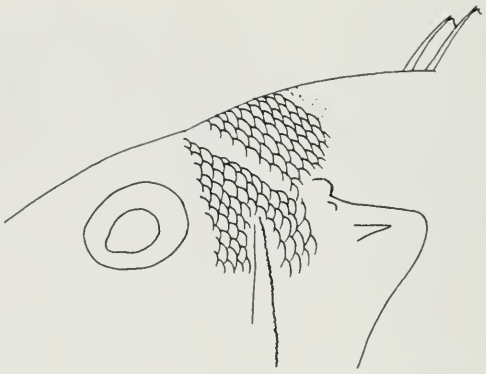

Figure 16. Occipital region of *C. ocyurus*, showing scaleless area on nape.

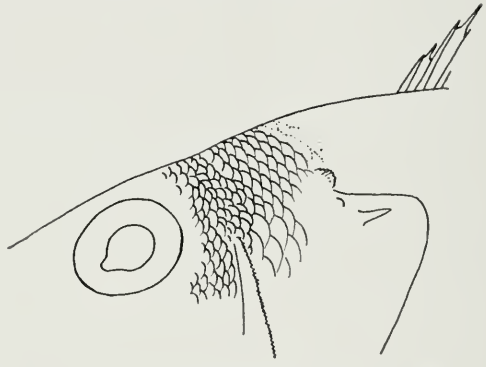

Figure 17. Occipital region of *C. philadelphicus* showing completely scaled nape.

I conclude, therefore, that the two populations are not isolated from each other and that the genetic interchange between them is primarily responsible for their observable similarities.

5. Biology

Spawning.—No information about spawning in this form is available in the literature.

Specimens collected between December and March in the Gulf have well developed ovaries. By July, Gulf specimens are spawned out, and gonads in many cases have become small and shrivelled. There are no records for May or June, but it appears that

spawning occurs sometime between late March and early June.

Atlantic specimens appear to be spawned out by late June, though the males still have rather well developed testes at that time. Young of this species are never found in shallow water, so the entire life of the fish, from egg to spawning adult, probably is spent in deep water, usually where the bottom is rocky or covered with patches of coral.

Growth and Body Proportions.—Measurements discussed under *striatus* are illustrated for *ocyurus* in Figs. 21-29. In many cases the measurements change relative to size in the same manner as they did in *striatus*, though the actual percentages may be different. It is profitable to compare *ocyurus* to *striatus* in regard to some of these characters.

Rate of increase in width of the interorbital is somewhat greater than in *striatus* (fig. 21), as is the rate of increase in the snout length (fig. 22). Orbit length (fig. 23) variation is comparable to that in *striatus*. Upper jaw length (fig. 24) seems to increase more sharply in *ocyurus*, as does dorsal fin length (fig. 25). The anal fin in *ocyurus* is relatively shorter (fig. 26) and does not show a very clear increase in length in larger specimens. The pectoral (fig. 27) and pelvic fins (fig. 28) are shorter in larger fishes, but the caudal-fin length (fig. 29) varies greatly. Few specimens under 90 mm. standard length have very long caudal rays, but those larger have fins that range in size from 21.7 to 56.2 per cent of the standard length. Either the top or the middle lobe can be longest, but the four longest fins recorded were from the middle lobes.

C. *Centropristes philadelphicus* (Linnaeus)
Rock Sea Bass
(Figures 11-12, 17)

1. Material Examined

Atlantic populations (67 specimens): USNM 142814 (2, 183-191) 40-60 mi. E.S.E. Cape Henry, Va.; UNC uncat (10, 110-188) off Cape Lookout, N.C.; USNM 126814 (2, 70.5-79.6) Beaufort, N.C.; USNM 101560 (1, 88.8) 25° 23′ N., 75° 24′ W.; USNM 53404 (1, 83.6) Beaufort, N.C.; TU 17057 (1, 144) 35° 07′ N., 75° 13′ W.; TU 17066 (2, 142-175) 35° 07′ N., 75° 14′ W.; UNC uncat (9, 105.8-195) 7½ mi. E. Knuckle Buoy, Cape Lookout, N.C.; UNC uncat. (3, 172.4-184.4) 18 mi. E.S.E. Cape Lookout, N.C.; UNC uncat. (1, 192.5) 13 mi. S.E. Cape Lookout, N.C.; UNC uncat (4, 113.8-188) 14 mi. E.S.E. Cape Lookout, N.C.; USNM 25959 (1, 168.2) Charleston, S.C.; USNM 25305 (2, 109.5-124.2) Blackfish Banks, 12 mi. off Charleston, S.C.; USNM 33161 (1, 169) Charleston, S.C.; ANSP 13638-40 (3, 132.2-185) S.C.; USNM 127491 (3, 106.1-108.5) St. Simon's Sd., Brunswick, Ga.; USNM 127492 (3, 104.1-115.2) Cumberland R. Sound, Ga.; USNM 92202 (1, 102.7) Savannah, Ga.; FU 5424 (6, 95.3-121) off mouth St. Simon's Sd., Ga.; FU 5561 (3, 101-109.4) 3 mi. off St. Simon's Is., Ga.; USNM 155159 (1, 173.1) 28° 57′ N., 80° 43′ W.; USNM 155139 (1, 108.5) 28° 03′ N., 79° 55′ W.; USNM 155145 (1, 130.7) 28° 12′ N., 81° 31′ W.; USNM 124391 (1, 164) off Cape Canaveral, Fla.; USNM 53349 (1, 118) Hillsboro R., New Smyrna, Fla.; TU 14803 (1, 113.1) 27° 57′ N., 80′ 04′ W.; USNM 155158 (1, 172) Cape Canaveral, Fla.; CNHM 50766 (1, 189.2) Palm Beach, Fla.

Gulf Populations (111 specimens): TU 10641 (1, 152.5) 26° 10′ N., 96° 40′ W.; Ore. sta. no. 1086 (3, 46.9-124.4) 26° 10′ N., 96° 54′ W.; Ore. sta. no. 1083 (1, 41) 26° 13′ N., 96° 45′ W.; TU 12954 (2, 112-113.8) 26° 10′ N., 97° 00′ W.; TU 13225 (2, 93-164) 26° 10′ N., 96° 40′ W.; TU 12916 (3, 125-163.3) 26° 13′ N., 96° 45′ W.; TU 12914 (1, 123.5) 26° 11′ N., 96° 52′ W.; CNHM 45133 (4, 138.8-170.2) 28° 20′ N., 96° 40′ W.; CNHM 40262 (5, 65.5-124.6) less than 50 mi. off Corpus Christi, Tex.; USNM 142813 (9, 76.8-95) Corpus Christi, Tex.; CNHM 45140 (2, 147.9-175.4) 27° 34′ N., 96° 43′ W.; CNHM 45134 (2, 146.2-184) 27° 37′ N., 96° 39′ W.; CNHM 45132 (1, 171) 27° 20′ N., 96° 40′ W.; TU 16227 (2, 130-177.6) 28° 08′ N., 93° 35′ W.; TU 13006 (8, 133.2-154) 28° 41′ N., 89° 32′ W.; TU 12124 (1, 171.6) 28° 46′ N., 89° 58′ W.; TU 8821 (17, 52.2-81.7) Pass-A-Loutre, 140° from old light tower, La.; TU 6093 (1, 56.8) Bayou Taylor to Pass des Isle, Gulf of Mex., La.; TU 5347 (2, 76.5-99.2) mouth Oyster Bayou, La.;

TU 9038 (1, 117.8) Lake Borgne, La.; TU 4075 (1, 134.5) mouth Oyster Bayou, La.; TU 9328 (1, 84.2) Lake Pontchartrain at Rigolets, La.; TU 8398 (1, 59.5) S.W. Pass, outside Vermillion Bay, La.; TU 16295 (1, 137.7) 29° 04′ N., 88° 43′ W.; TU 11658 (4, 102.5-119.2) 29° 17′ N., 88° 51′ W.; TU 5404 (2, 86-147) 29° 15.5′ N., 88° 55.8′ W.; TU 5410 (11, 92-186) 29° 10′ N., 88° 52′ W.; TU 4217 (5, 94.5-138) mouth of Bayou Creole, La.; CNHM 45767 (4, 137-161) 29° 27′ N., 87° 45′ W.; CNHM 31830-31 (2, 100-103.8) Horn Is., Miss.; CNHM 45763 (3, 67.8-128.1) 30° 00′ N., 88° 07′ W.; CNHM 45768 (4, 173-209) 29° 30′ N., 86° 10′ W.; CNHM 33737 (1, 101.6) La.; TU 11768 (1, 187) 29° 50′ N., 86° 30′ W.; TU 13207 (1, 152) 29° 50′ N., 86° 30′ W.; TU 13198 (1, 150) 29° 50′ N., 86° 30′ W.

The following 148 specimens were examined and are included in discussions of species but are not represented in the tabulated data: AMNH 16332 (6, 161-183) Near Chavin, La.; AMNH 16385 (2, 82.3-93) La.; AMNH 16333 (24, 39.8-117.3) near Chavin, La.; AMNH 16478 (1, 101.6) La.; ANSP 55864-69 (5, 93.2-112.3) Breton Is., La.; ANSP 65160-61 (2, 88.2-177) Corpus Christi, Tex.; ANSP 75259 (1, 93) 1 mi. off St. Aug., Fla.; TU 4067 (1, 85.3) mouth of Oyster Bayou, La.; TU 5566 (3, 86.5-98) Gulf Mex. near Oyster Bayou, La.; TU 5390 (45, 66-129.7) 29° 15′ N., 88° 55′ W.; TU 10007 (1, 68.1) Lake Pelto, La.; TU 4182 (10, 87.5-122) 4 mi. W. Atchafalaya R., La.; TU 13745 (4, 49.6-66.5) Bayou Hero, La.; MCZ 2920 (3, 151.5-175) Charleston, S.C.; TU 6046 (3, 49-54) Lake Pelto, La.; TU 9004 (11, 86.8-117.7) off mouth Oyster Bayou, La.; TU 10620 (15, 36.7-138) 26° 10′ N., 96° 54′ W.; MCZ 3067 (6, 156-178.3) Charleston, S.C.; TU 2774 (1, 71.4) 28° 44′ N., 90° 09′ W.; USNM 155162 (1, 32.4) (Poor specimen; may be *ocyurus*), Apalachicola Bay, Fla.; USNM 155138 (1, 72.5) New Smyrna, Fla.; USNM 155142 (1, 123) Cape Canaveral, Fla.; USNM 155147 (1, 128) New Smyrna, Fla.

2. Description

Dorsal X, 11; anal III, 7; caudal 17; pelvic I, 5; pectoral usually 18 (15-20); vertebrae usually 24 [17], rarely 22 or 23; pyloric caecae 6 [4]. Scales large, 7 or 8 — 47 (46-49) — 17 to 20 (15-22); small scales at base of soft dorsal membranes in single rows, scales at base of anal membranes in single rows extending one-half or less the length of membranes; caudal membranes scaled one-third to one-half of length from base; pectorals scaled only near base; pelvic rays finely scaled on underside for one-third length from base; predorsal rows usually 13-16 (11-19). Total gill rakers plus tubercles usually 19-21 (17-22), lower limb about 13; gill rakers long and slender at center of arch, grading evenly to small tubercles at ends of arch. Body robust, back elevated less than in *C. striatus*. Head length usually 38-41 (35-43). Head large, not as deep as in *C. striatus*, little compressed. Opercle drawn out into thin flap; middle opercular spine well developed, lower rather poorly developed, and upper barely visible. Top of head, suborbital, maxillary, lower jaw and snout naked; cheek with small scales in 9-11 rows; opercle with larger scales in 8 or 9 rows. Orbit usually 9-11 (7-13), about 4 in head. Eye longer than deep. Upper jaw usually 17-19 (16-21); mouth large, terminal; lower jaw projecting slightly beyond tip of upper. Teeth in jaws in bands, outer and inner teenth slightly to moderately enlarged, though none can be called canines; teeth only slightly depressible; patch on vomer V-shaped, patch on palatines long and narrow. Nares very close to eye, anterior naris with large dermal flap. Posterior border of preopercle finely serrate, serrae on ventral border and at angle of preopercle somewhat larger and farther apart. Branchiostegals 7. Dorsal spines moderate, first three evenly graduated; first about one-half as long as second; third about as long

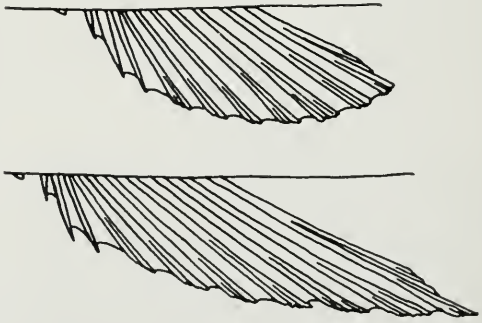

Figure 18. Anal fin of adult female (upper) and male (lower) *C. philadelphicus*.

as fourth, one or the other being longest in fin; following spines decrease in length to tenth, which is shorter than first dorsal ray; spines with fleshy filaments attached to tips, filaments in large specimens often as long as spines; emargination between spinous and soft parts of dorsal moderate; soft dorsal short, high; longest ray 17-37, large males with noticeably higher fins; pectoral long, usually 25-28 (22-29), posterior margin nearly truncate, rounded at angles, more so below than above; pelvic long, pointed, usually 20-22 (19-24), seldom reaching anus; outer angle in front of lower pectoral angle; anal spines graduated, second spine somewhat shorter and stouter than third; soft anal short, high; fourth to seventh rays longest, usually 16-18 (15-29), mature males with obviously longer rays; caudal in small specimens rounded, sometimes with upper rays slightly produced; middle rays also somewhat produced in medium-size (approx. 100 mm.) specimens, large specimens distinctly three lobed, with upper and middle lobes greatly produced; longest ray 21-57, mature males with much longer rays.

Color pattern in alcohol.—General ground color pale to white; seven dark vertical bars along side of body, usually diffuse, never breaking up into series of dark spots, sometimes interrupted by a pale longitudinal streak just above lateral line. Top of head and snout spotted and streaked with dusky color; dusky spot at ventral posterior angle of eye, scattered melanophores present on opercle including flap, and on tip of lower jaw; dorsal fin with several series of elongate dusky spots forming oblique dark stripes; large black spot at base of last three dorsal spines; pectoral pale; pelvic dusky, edged with white; anal clear, dusky color at base of membranes and at ends of fin rays, tips of rays edged with white; caudal spotted. Young (40 mm. or larger) similar to adults in color pattern.

Color in life.—From Jordan and Evermann (1896): Olivaceous above, whitish below; 7 broad brown bars from dorsum obliquely forward to level of middle of pectorals, these almost obsolete along lateral line; the color of the bars is not intense and is formed by shadings along the base and margins of the scales; the anterior bar crosses the nape and is very indistinct; snout and upper part of head with numerous brownish-red spots and lines, three or four of these parallel, stretching from eye to snout, the interspace usually light blue; upper lip reddish brown; tip of lower jaw broadly purplish; a dark blotch on opercle anteriorly and sometimes a small, dark spot behind eye; lining of opercle and throat lemon yellow; a large black blotch behind pseudobranchiae; spinous dorsal translucent, with indistinct whitish and dusky longitudinal streaks; a large dark blotch on membrane of last spines immediately above fourth vertical bar of sides; some dark spots on the spines form two irregular lengthwise series; dorsal filaments bright scarlet, the fin usually with light-bluish shading; soft dorsal with a series of blue-white spots near margin (one between each two rays), one or more incomplete series above and below this; the fin is margined with reddish brown, and has usually several series of reddish-brown spots, these most numerous posteriorly; some irregular olive-brown spots toward base; a small black spot on base of membrane between eighth and ninth and one between tenth and eleventh rays, the former frequently absent; caudal translucent, with irregular series of round brown-red spots, the space between them often with bluish-white spots; the fin margined above with brownish-red; lower lobe whitish, unspotted; anal white, with a median sulphur-yellow streak and a terminal dark bar; ventrals whitish, with dusky areas, often uniform black; pectorals translucent; peritoneum silvery.

3. Distribution

In the Atlantic *philadelphicus* is found from Cape Henry, Virginia, in the north to Palm Beach, Florida, in the south. In the Gulf it is limited to the waters between Brownsville, Texas, and Cape Haze, Florida (fig. 5). Although it occurs frequently in deep water, *philadelphicus* is very common in shallow water at times and has been known to enter harbors, bays, and shallow brackish lakes. That preference for hard bottom is not so obvious in this form is supported by the large numbers found in the Mississippi delta region. In general *philadelphicus* appears to be a more temperate water form than *ocyurus* and seldom, if ever, is able to round the tip of Florida. The paucity of records from the west coast of Florida is perplexing and is probably due

to a combination of environmental conditions rather than water temperature alone.

4. Population Analysis

Comparison of Gulf and Atlantic populations of *philadelphicus* shows divergence in two meristic characters (Table 2). In number of scale rows between the dorsal origin and lateral line, average divergence of populations is 80.6 per cent, a difference considered by some (Ginsburg, 1938) to merit subspecific recognition. In the number of scale rows between anal origin and lateral line, there is an average divergence of 75.4 per cent which, according to standards mentioned above, is on the borderline between subspecies and race.

Body and fin measurements (Tables 3-10) show population differences in a number of cases. Distance between the dorsal-fin origin and the caudal base (Table 7) is slightly greater in Atlantic specimens, as is the distance between the dorsal origin and the occiput (Table 7). Dorsal-fin origin to lateral line (Table 3) shows a fairly marked divergence, with measurements of Atlantic fish averaging higher. The same condition is found with regard to depth of caudal peduncle (Table 4, and fig. 20) which is greater in most Atlantic specimens. The head (Table 4) is slightly longer in Gulf fish; the orbit (Table 5) is also somewhat longer in Gulf fish, but the anal fin (Table 8) tends to be shorter in smaller Gulf specimens.

The color pattern given in the general description is typical of most specimens. Although many differences found are due to fading of the pattern, there are minor variations in the intensity of pigmentation about the head and snout.

In *philadelphicus,* as in *ocyurus,* there are no pigmentary differences in preserved specimens which separate Gulf and Atlantic populations. *C. philadelphicus* has a much smaller range of variation in color pattern and apparently exhibits less sexual dimorphism in color than do the other forms.

Taking all characters into consideration, the two populations appear to be well-defined races that have not diverged to subspecies level.

C. philadelphicus seems to be a more temperate-water form than *ocyurus,* for the southernmost record for it is on the Texas coast, where it is found offshore almost to the Mexican border. In the Atlantic it is apparently absent south of Palm Beach, Florida. Only one specimen (TU 18158) was available from the Florida west coast, although the Oregon Reports (Fish. Rept. No. 196) list the species from three stations in this area. These specimens were not available for examination. Judging by the large number of collections that have been made in the area, it seems improbable that this species is very common there. Why *philadelphicus* should be almost absent here and the other two species present in perplexing, for all three forms are known to prefer hard bottom and coral patches similar to those found along this coastline.

I have been unable to locate specimens or verified records of *philadelphicus* from the Florida Keys, and I believe that the peninsula forms a barrier between Gulf and Atlantic populations. The resulting isolation and subsequent differentiation probably accounts for the minor, though consistent, differences in measurements and counts noted above.

The contrast expressed by the uniformity of *ocyurus* populations and the divergence of *philadelphicus* populations is due to a difference in the relationships between each population pair. In the more heat-tolerant *ocyurus* the gene flow between populations is essentially unhindered, whereas in *philadelphicus* it is almost, if not completely, prevented. The fact that populations of *philadelphicus* are isolated and populations of *ocyurus* are not could be responsible for the situation explained above.

5. Biology

Spawning.—Gulf specimens collected between November and March usually have mature gonads, though there must be some variation in the season at which gonads develop, since I found markedly undeveloped specimens in December, February, and March. I am unable to correlate this with staggering of spawning dates or distribution in the Gulf. Spawning probably occurs from late March to May or possibly June. Atlantic fishes have well developed gonads from February to June and possibly spawn at a later date than their Gulf counterparts. Spawning probably occurs from May to early

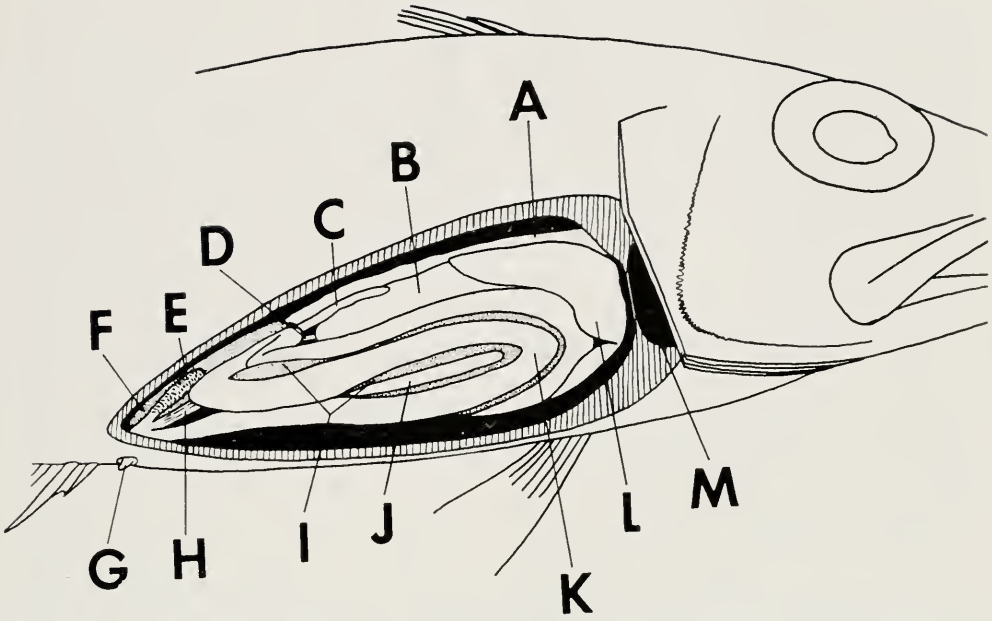

Figure 19. Internal anatomy of *C. philadelphicus*. **A.** Air bladder. **B.** Stomach. **C.** Right lobe of testis. **D.** Left lobe of testis. **E.** Urinary bladder. **F.** Kidney. **G.** U. G. papilla. **H.** Testis. **I.** Fat. **J.** Caecum. **K.** Gut. **L.** Liver. **M.** Pericardial cavity.

June and may be partially influenced by water temperatures.

Young are common in shallow (2-20 fms.) waters of the Gulf during the entire summer. This may indicate that spawning is not entirely restricted to deep waters (50-100 fms.) and could explain the apparent difference in spawning times in the Gulf and Atlantic. If *philadelphicus* spawns in shallower water, the water temperatures there would vary more than in deep water, and an optimum temperature for spawning would probably occur earlier in the Gulf than in the Atlantic.

Growth and Body Proportions.—Scattergrams reveal three characteristics which can be contrasted with those of the other two species: Interorbital width (fig. 21) is smaller in *philadelphicus* than in both of the other species and does not greatly increase with size. Neither the increase in snout length (fig. 22) nor the decrease in orbit length (fig. 23) are as sharp as in other forms.

Other scattergrams show that the caudal peduncle (fig. 20) is definitely deeper in Atlantic than in Gulf populations; the dorsal fin (fig. 25) is much longer in larger fishes, with the longest fins on males; the anal fin (fig. 26) is the shortest of the three forms in smaller fishes, but shows a marked increase in length in mature males; great elongation of one or two of the last anal rays is very conspicuous in spawning males (fig. 18); the pectoral (fig. 27) does not vary with increased size, but the pelvic (fig. 28) tends to be slightly shorter in larger fishes; and the caudal fin increased in length quite sharply in specimens over 90 mm. standard length. As in *ocyurus*, either the top or the middle caudal lobes may be the longest with most of the very longest being middle lobes.

VII. Internal Anatomy

Very few preserved specimens are useful in studying internal anatomy of these fishes because of damage caused by handling and cutting. In 16 specimens examined, however, the internal organs seemed to be similar in all three species. Fig. 19 is a drawing of the body cavity and viscera of a specimen of *philadelphicus*. Except for minor differences in shape and relative placement, internal organs of the three forms conform to the plan presented in the drawing.

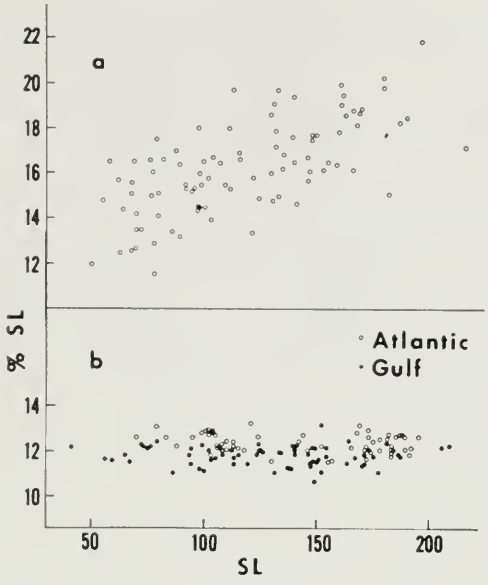

Figure 20. Scatter diagrams for various body measurements. Percent of Standard Length (ordinate) plotted against Standard Length (abscissa). **a.** Dorsal origin to occiput in *striatus*. **b.** Caudal peduncle depth in *philadelphicus*.

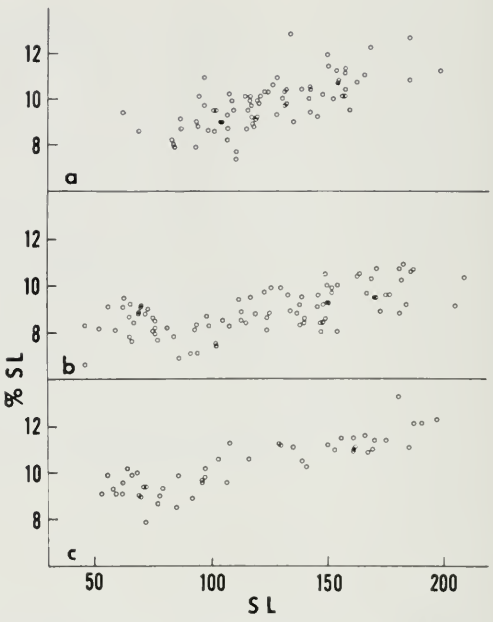

Figure 22. Snout length in: **a.** *ocyurus*, **b.** *philadelphicus*, **c.** *striatus*.

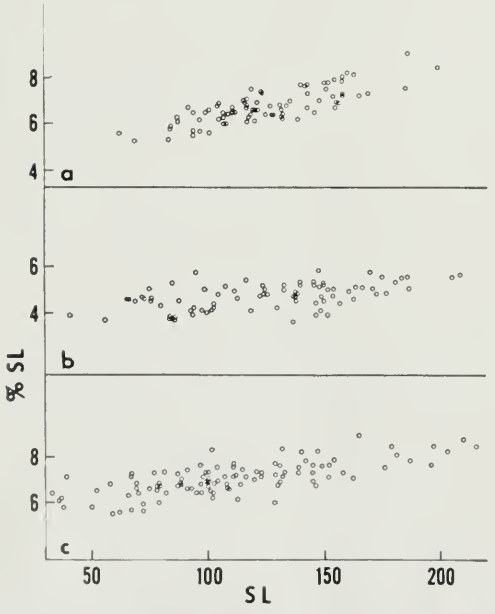

Figure 21. Interorbital width in: **a.** *ocyurus*, **b.** *philadelphicus*, **c.** *striatus*.

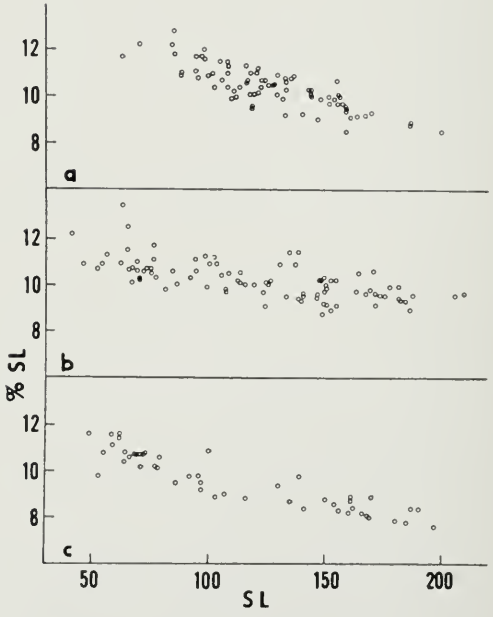

Figure 23. Orbit length in: **a.** *ocyurus*, **b.** *philadelphicus*, **c.** *striatus*.

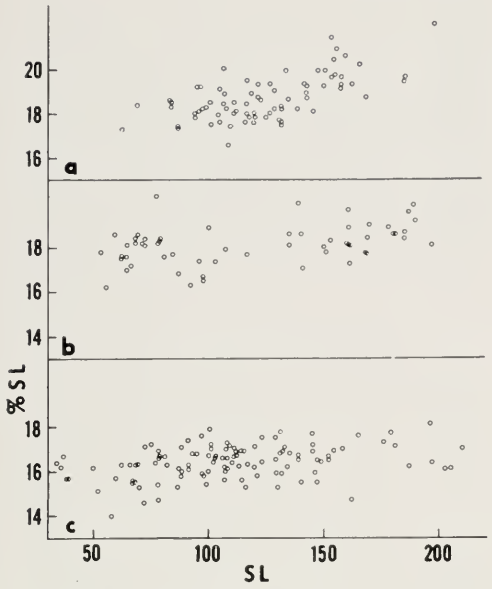

Figure 24. Upper jaw length in: **a.** *ocyurus*, **b.** *s. melanus*, **c.** *striatus*.

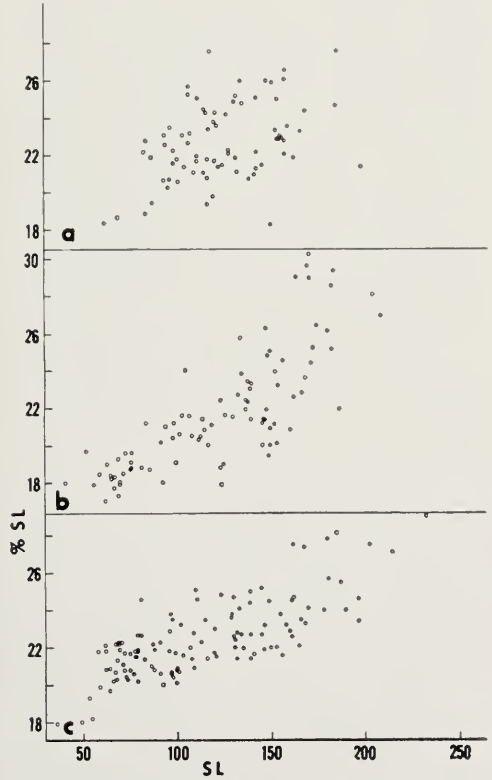

Figure 25. Dorsal fin length in: **a.** *ocyurus*, **b.** *philadelphicus*, **c.** *striatus*.

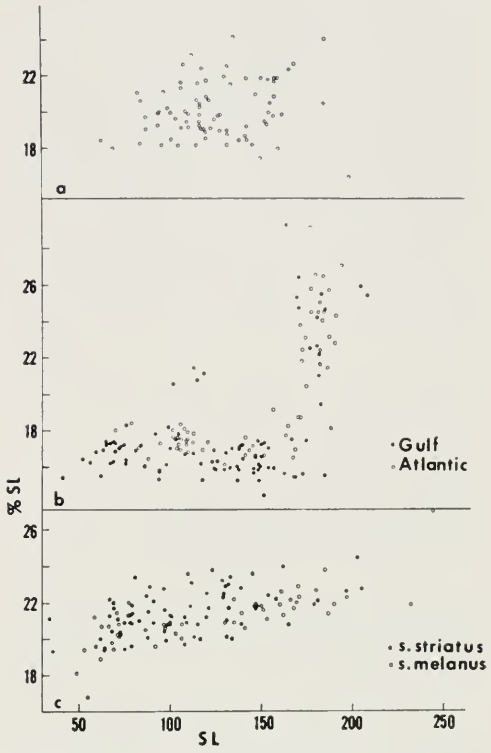

Figure 26. Anal fin length in: **a.** *ocyurus*, **b.** *philadelphicus*, **c.** *striatus*.

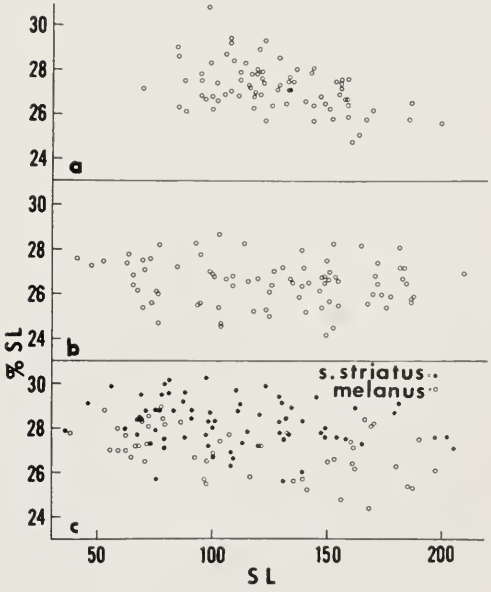

Figure 27. Pectoral fin length in: **a.** *ocyurus*, **b.** *philadelphicus*, **c.** *striatus*.

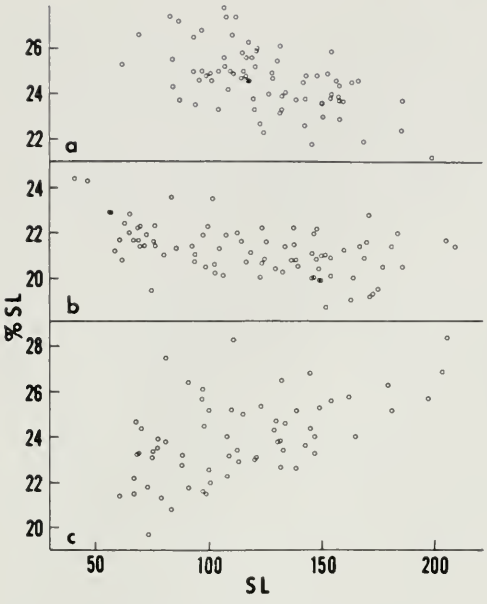

Figure 28. Pelvic fin length in: **a.** *ocyurus*, **b.** *philadelphicus*, and caudal fin length in: **c.** *striatus*.

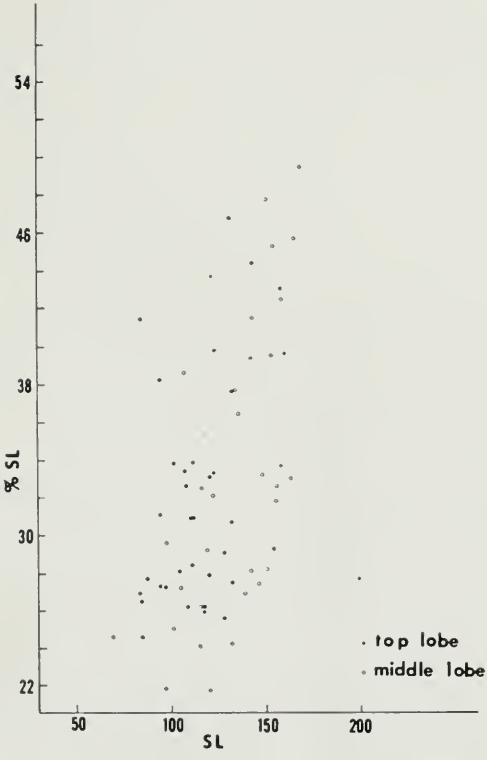

Figure 29. Caudal fin length in *ocyurus*.

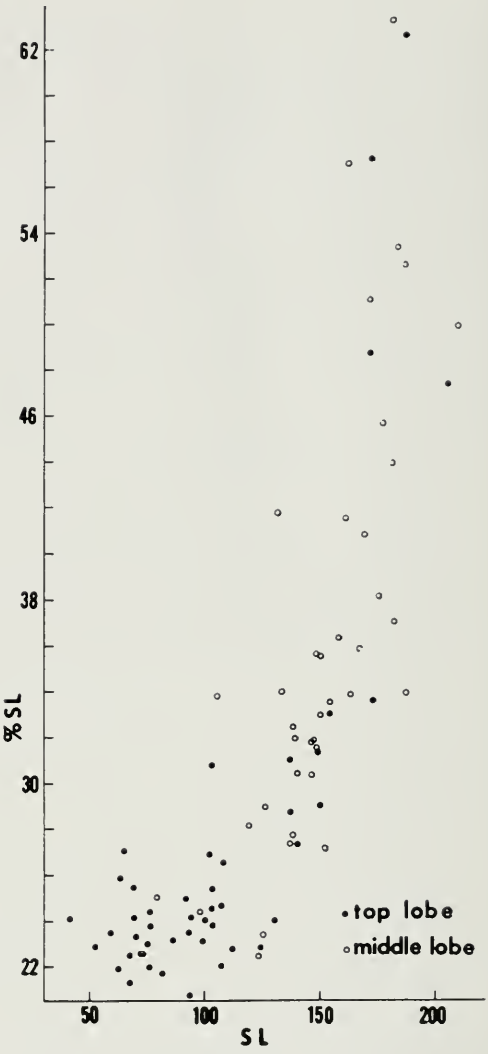

Figure 30. Caudal fin length in *philadelphicus*.

VIII. Summary

Three species of *Centropristes* (*striatus*, *philadelphicus* and *ocyurus*) are recognized.

Gulf and Atlantic populations of these have been compared. The absence of infraspecific differentiation in *ocyurus* is probably due to the lack of isolation. Certain constant, but minor, differences were found in *philadelphicus* which were judged to represent a low degree of divergence, and the populations were designated as races. The amount of overlap in all characters of *melanus* and *striatus* was judged to be more

representative of the subspecies level of differentiation than the species level. They were reduced, therefore, to subspecies, with Gulf forms designated *C. striatus melanus* Ginsburg and Atlantic forms designated *C. striatus striatus* (Linnaeus).

Food habits were found to be similar in all forms with fish and crustaceans forming the major staples in the diet.

Spawning occurs from early to late spring in all species.

IX. Acknowledgements

For the loan of specimens I wish to thank Dr. James Böhlke of the Academy of Natural Sciences of Philadelphia, Drs. Charles M. Breder, Jr. and Vladimir Walters of the American Museum of Natural History, Drs. John C. Briggs and Daniel Cohen of the University of Florida, Dr. Eugenie Clark of the Cape Haze Marine Laboratory, Drs. Earl E. Deubler, Jr. and William E. Fahy of the Institute of Fisheries Research of the University of North Carolina, Drs. Ernest A. Lachner and Leonard P. Schultz of the United States National Museum, Dr. Giles W. Mead and Mr. Harvey R. Bullis of the United States Fish and Wildlife Service, Dr. Edward C. Raney of Cornell University, Mr. Loren P. Woods of the Chicago Natural History Museum, and Dr. Henry B. Bigelow and Mrs. M. Dick of the Museum of Comparative Zoology, Harvard University.

This investigation was conducted at Tulane University as a partial requirement toward the degree of Master of Science. I am indebted to Dr. Royal D. Suttkus of the Department of Zoology, for suggesting this problem and for encouragement and assistance during the study, and to Dr. Edward C. Raney of Cornell University for helpful suggestions on the manuscript. I also thank my wife, Helen C. Miller, for her patient help and encouragement at all times.

X. References Cited

Bailey, Reeve M. 1951. The authorship of names proposed in Cuvier and Valenciennes' "*Histoire Naturelle des Poissons.*" *Copeia*, 1951 (3): 249-251.

Bean, Tarleton H. 1903. Catalogue of the fishes of New York. *Bull. 60, N. Y. State Mus.*, Ann. Rept. N. Y. State Mus., 3: 1-784.

Bloch, Marc Elieser and Johann Gottlob Schneider 1801. *Systema Ichthyologiae iconibus ex illustratum. Post obitum auctoris opus inchoatum absolvit, correxit, interpolavit Jo. Gottlob Schneider*, Saxo. Berolini, lx: 1-584, 110 col. pls.

Boulenger, George Albert 1895. *Catalogue of the Fishes in the British Museum.* Ed 2, London, 394 pp. 15 pls.

Breder, Charles M., Jr. 1932. A record of *Sarda velox* and notes on other Block Island fishes. *Copeia*, 1932 (1): 32.

Cuvier, Georges L.C.F.D. 1829a. *Le Regne Animal.* Ed. 2, 5 vols., Paris, Illust.

Cuvier, Georges (in: Cuvier and Valenciennes) 1829b. *Histoire Naturelle des Poissons.* 22 vols., Paris, 1828?-49; 650 pls.

DeKay, James E. 1842. *New York Fauna.* Part 1, Zoology; part 4, Fishes, Albany, 1-415, 102 pls.

Earll, R. Edward 1885. Blackfish eggs impregnated. *Bull. U. S. Fish. Comm.*, 5: 91.

Gill, Theodore 1861. Catalogue of the fishes of the eastern coast of North America, from Greenland to Georgia. *Proc. Acad. Nat. Sci. Phila.*, (suppl.) 1-63.

———— 1873. Catalogue of the fishes of the east coast of North America. *Rept. U. S. Fish Comm.*, 1871-72, 1: 779-882.

Ginsburg, Isaac 1938. Arithmetic definition of the species, subspecies, and race concept, with a proposal for a modified nomenclature. *Zoologica*, 23: 253-286.

———— 1952. Eight new fishes from the Gulf coast of the United States, with two new genera, and notes on geographic distribution. *Jour. Wash. Acad. Sci.*, 42(3): 84-101, 9 figs.

Goode, G. Brown 1884. *The Fisheries and Fishery Industries of the United States.* Washington, Section 1, part 3: 162-682, 218 pls.

———— 1888. *American Fishes.* New York, 14: 1-496, illust.

Hildebrand, Samuel F. and William C. Schroeder 1928. Fishes of Chesapeake Bay. *Bull. U. S. Bur. of Fish.*, XLIII (Part 1): 1-366, 211 figs.

Holbrook, John Edwards 1860. *Ichthyology of South Carolina.* Ed. 2, Charleston, S. C., 205 pp., pls.

Hubbs, Carl L. 1943. Criteria for subspecies, species, and genera, as determined by researches on fishes. *Annals N. Y. Acad. Sci.*, XLIV (Art. 2): 109-123.

Hubbs, Carl L. and Karl F. Lagler 1947. *Fishes of the Great Lakes Region.* Cranbrook Inst. Sci., Bull. 26: 1-186, 26 pls., 251 figs.

Jordan, David Starr 1885a. A catalogue of the fishes known to inhabit the waters of North America, north of the Tropic of Cancer. *Ann. Rept. Comm. of Fish and Fisheries for 1884*, Washington, 789-973.

1885b. Supplementary notes on North American fishes. *Proc. U. S. Nat. Mus.*, 7: 545-548.

1886. Notes on typical specimens of fishes described by Cuvier and Valenciennes and preserved in the Musee D'Histoire Naturelle in Paris. *Proc. U. S. Nat. Mus.*, 9: 525-546.

Jordan, David Starr and Barton Warren Evermann 1886. Description of six new species of fishes from the Gulf of Mexico, with notes on other species. *Proc. U. S. Nat. Mus.*, 9: 466-476.

1896. Fishes of North and Middle America. *Bull. 47, U. S. Nat. Mus.*, 1896-1900, 4 parts, 3313 pp., 392 pls.

Jordan, David Starr, Barton Warren Evermann, and Howard Walton Clark 1930. Check list of the fishes and fish-like vertebrates of North and Middle America north of the northern boundary of Venezuela and Colombia. *Rept. U. S. Bur. Fish.*, 670 pp.

Jordan, David Starr and Charles Henry Gilbert 1882a. Synopsis of the fishes of North America. *Bull. 16, U. S. Nat. Mus.*, pp. lvii, 1-1018.

1882b. Notes on fishes observed about Pensacola, Florida, and Galveston, Texas, with descriptions on new species. *Proc. U. S. Nat. Mus.*, 5: 241-307.

1882c. Notes on a collection of fishes from Charleston, South Carolina, with descriptions of three new species. *Proc. U. S. Nat. Mus.*, 5: 580-620.

Lacépède, Bernhard Germaine Etienne 1803. *Histoire Naturelle des Poissons.* 14 vols., Paris, (1799-1804).

Lavenda, Nathan 1949. Sexual differences and normal protogynous hermaphroditism in the Atlantic sea bass, *Centropristes striatus*. *Copeia*, 1949 (3): 185-194.

Linnaeus, Carl 1758. *Systema Naturae.* Ed. 10, 2 vols., Holmiae, pp. 285, 291.

1766. *Systema Naturae.* Ed. 12. pp. 485, 489.

Mitchill, Samuel Latham 1815. The fishes of New York, described and arranged. *Trans. Lit. and Phil. Soc. New York*, 1: 355-492, pls. 1-6.

Nichols, J. T. and Charles M. Breder, Jr. 1927. The marine fishes of New York and southern New England. *Zoologica*, 9(I): 1-192.

Reid, George K., Jr. 1954. An ecological study of the Gulf of Mexico fishes, in the vicinity of Cedar Key, Florida. *Bull. Mar. Sci. Gulf and Carib.*, 4(1): 1-94, 13 figs., 8 tables.

Smith, Hugh M. 1898. Fishes found in the vicinity of Woods Hole. *Bull. U. S. Fish Comm.*, 17: 85-111.

1907. *The Fishes of North Carolina. N. Car. Geol. and Econ. Surv.*, Vol. 2, Raleigh, 11: 1-453, 21 pls., 187 figs.

Storer, David Humphreys 1846. *A Synopsis of the Fishes of North America.* Metcalf and Co., Cambridge, Mass., 298 pp.

Sumner, Francis B., Raymond C. Osborn, and L. J. Cole 1913. A catalogue of the marine fauna of Woods Hole and vicinity. *Bull. U. S. Bur. Fish.*, (1911), 31(part 2): 549-794.

Walbaum, Johann Julius 1792. *Petri Artedi renovati*, pars i et ii (and iii-v) *i.e. Bibliotheca et philosophia ichthyologica, cura Iohannis Iulii Wälbaumii* edidit. 5 5 parts in 3 vols., Grypeswaldiaee, 4 pls.

Weed, Alfred C. 1937. Notes on sea basses of the genus *Centropristes*. *Zool. Ser., Field Mus. Nat. Hist., Chicago*, 20: (23): 291-320, 2 figs.

Abstract

Gulf and Atlantic populations of the three species of *Centropristes* are compared. The absence of infraspecific differentiation in *ocyurus* is attributed to lack of isolation between Gulf and Atlantic populations. Certain constant differences, which were judged to represent a low degree of divergence, are found in *philadelphicus*, and the populations are designated as races, denoting distinct but minor differences. Divergence of *melanus* and *striatus* was found to be greater than in the other forms, but overlap in all characters is large enough to dispute their specific distinctness. They are consequently reduced to subspecies. Additional biological data may indicate their exact status.

Food habits are similar in all forms, with fish and crustaceans forming the major staples in the diet.

Spawning probably occurs from early to late spring in all species, with some possible variations between Gulf and Atlantic populations.