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Stephen A. Bortone  
*University of West Florida*

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## OSTEOLOGICAL NOTES ON THE GENUS *Centropristis* (PISCES: SERRANIDAE)

Stephen A. Bortone  
Faculty of Biology  
The University of West Florida  
Pensacola, Florida 32504

**ABSTRACT:** Osteological examination of *Centropristis striata*, *C. ocyurus* and *C. philadelphica* reveals characters which may be useful in defining the genus. The medially elongate subocular shelf appears unique for the genus among other Serraninae examined. Species may be distinguished on the basis of otoliths, supraoccipital-parietal ridges, shape of vomerine toothpatch and other characters. *C. striata* shows increased frontal bone ossification (hyperostosis) which is apparently correlated with sex reversal and is a male secondary sex characteristic. *C. striata* is the most specialized species while *C. philadelphica* is the least specialized. *C. fuscus* is retained in the genus until a skeleton is available.

Currently *Centropristis* Cuvier is composed of five western North Atlantic species. Among these the black sea bass, *Centropristis striata* (Linnaeus) is composed of two subspecific forms: *C. s. striata* (Linnaeus) which occurs along the Atlantic coast of the United States; and *C. s. melana* Ginsburg found along northern and eastern coastal areas of the Gulf of Mexico. The species is of considerable economic importance to the state of Florida as it is abundant along Florida's Atlantic and Gulf coasts (Godcharles, 1970). Ecologically, sea basses of the genus *Centropristis* tend to be inhabitants of low reef areas (i.e., coral and limestone outcroppings, and artificial reefs) which typify much of Florida's continental shelf. The role which sea basses play in this area is apparently that of a euryphagic carnivore (Reid, 1954; Hildebrand and Schroeder, 1928). Indications are that the genus is protogynously hermaphroditic, that is, all individuals develop as functional females and later transform into functional males. Hoff (1970) has initiated studies on artificial spawning and rearing of *C. s. melana* as the species has a potential to lend itself to mariculture.

Because of the economic and ecological importance of the sea basses, a study was undertaken to examine and understand more fully relationships within the genus *Centropristis*.

*Centropristis* has been placed in the subfamily Serraninae by Jordan and Eigenmann (1890). Except for a study on *Paralabrax* Girard and its comparison with *Centropristis* by Smith and Young (1966), no further significant comments, based on data, have been made on its generic affinity with other Serraninae. All currently recognized Serraninae genera are poorly defined. Comparative intrageneric studies have been conducted on a few groups such as *Serranus* Cuvier (Robins and Starck, 1961) and *Diplectrum* Holbrook (Bortone, 1973). These studies have brought some order to the Serraninae but much work remains to be done. It is felt that osteological studies on other Serraninae genera will eventually permit a more comprehensive evaluation and definition of this subfamily.

Considered in the present study are those species also studied by Miller (1959): *C. striata striata* (Linnaeus), *C. striata melana* Ginsburg, *C. ocyurus* (Jordan and Evermann) and *C. philadelphica* (Linnaeus). *C. rufus* Cuvier is not

considered here as no skeletal material is currently available for examination. *C. fuscus* Poey was studied from a radiograph and is referred to briefly.

This study presents an osteological characterization and comparison of three species of *Centropristis*. A tentative phyletic lineage is proposed based on osteological information, and possible relationships with other Serraninae (i.e., *Diplectrum*, *Serranus*, and *Paralabrax*) are considered.

## MATERIALS AND METHODS

Osteological examination was conducted on specimens prepared by several methods. Clearing and staining using trypsin was performed according to Taylor (1967) but was modified in that staining preceded clearing (C. L. Smith, pers. comm.). Dermestid beetles were utilized for preparing dry, articulated ("bugged") skeletons. Skeletons were also prepared by maceration. Bone terminology follows that of Smith (1971), McAllister (1968), Monod (1968), and Woolcott (1957). Abbreviations used are as follows: B, branchiostegals; BB 1-3, basibranchials; BO, basioccipital; BS, basisphenoid; CB 1-5, ceratobranchials; CH, ceratohyal; CL, cleithrum; COR, coracoid; ECT, ectopterygoid; EH, epihyal; EPO, epiotic; EXO, exoccipital; FR, frontal; GH, glossohyal; HB, hypobranchials; IC, intercalar; IH, interhyal; LAC, lacrimal; LE, lateral ethmoid; LH, lower hypohyal; PA, parietal; PAS, parasphenoid; PRO, prootic, PTO, pterotic; PTS, pterosphenoid; R, radial; SC, scapular; SE, supraethmoid; SL, standard length; SO, supraoccipital; SS, subocular shelf; UH, upper hypohyal; V, vomer. Vertebrae were counted and separated as to precaudal and caudal by a plus sign, the last vertebrae counted being the urocentrum. Dorsal fin supports were enumerated according to the

method of Smith and Bailey (1961).

Institutional abbreviations used are: LACM, Los Angeles County Museum; USNM, United States National Museum; ANSP, Academy of Natural Sciences of Philadelphia. Specimens lacking museum designations are in the personal collection of the author. Uncataloged representatives of all species will deposited at LACM. The following specimens were examined: *Centropristis striata striata*, North Carolina: 2 specimens (140-149 mm standard length, macerated; 3(202-250), bugged; 4(53-79), cleared and stained. *Centropristis striata melana*, Northwest Florida: 4 adult skulls, bugged; LACM 33312-1 (234), bugged; LACM 31848-5 (201), bugged; LACM 33311-1 (157), bugged. *Centropristis ocyurus*, Northwest Florida: LACM 3306-4 (211), bugged; LACM 3306-5 (224), bugged; LACM 3306-6 (216), bugged; LACM 3309-1 (1 adult), bugged; LACM 33310-1 (170), bugged. North Carolina: 2(56-70), cleared and stained. *Centropristis philadelphica*, North Carolina: (149), bugged; 2 (88-97), macerated; 4(72-88), cleared and stained. *Centropristis fuscus*, Havana, Cuba: ANSP 94422 (134), radiographed.

Comparative generic material is as listed in Bortone (1973). This material includes 12 species of *Diplectrum* from the eastern Pacific and western Atlantic, four species of *Serranus* from the western Atlantic, and three species of *Paralabrax* from the eastern Pacific.

## OBSERVATIONS

Osteological characters examined which differ interspecifically (Table 1): Vomer (Fig. 1, A-C) Vomerine teeth are present as villiform or small caniniform teeth. In *C. striata* the tooth patch is wedge shaped; in *C. ocyurus* the tooth patch is broad and triangular; while *C. philadelphica* bears its vomerine tooth patch in a narrow chevron-shaped wedge.

Table 1. Osteological comparison of three species of *Centropristis*.

Character	<i>C. striata</i>	<i>C. ocyurus</i>	<i>C. philadelphica</i>
1. Vomer: Toothpatch	wedge shaped	broadly triangular	narrow chevron-shaped
2. Hyperossification	intense	none	none
3. Frontal: Dorsal foramen	large, broadly ovulate, becoming occluded with age	large, broadly ovulate	small, as narrow slits
4. Anterior foramen	large, ovulate	large, ovulate	small, narrowly ovulate
5. Posterior-lateral cranial ridges	low, present laterally, disappearing medially	well-developed, extending nearly to mid-line	absent
6. Parietal: Anterior cranial ridge	narrowly U shaped, obliterated in adults due to hyperossification	broadly U shaped	absent or present as slight medial projection from anterior portion of longitudinal parietal ridge
7. Supraoccipital: Anterior base	thickened in small adults hyperossified in large adults	thickened, combines with anterior parietal ridges	not thickened
8. Supportive stay	absent	present	present
9. Parietal-Supra-occipital junction	depressed	flat	flat
10. Epiotic: Post-temporal facet	flattened, narrow, V shaped, medial point longest	broadly triangular, posterior projection short	enlarged, narrow elongate, V shaped medial point longest
11. Preopercle: Serrae	large	small	small
12. Vertebra: tenth	shortened parapophysis, more horizontally directed	elongate parapophysis, directed more ventrally	as in <i>C. ocyurus</i>
13. Vertebra: eleventh	haemal spine thin dorsoventrally flattened, slightly spatulate	haemal spine thick deep trough on antero-ventral surface	as in <i>C. striata</i>
14. Otolith: anterior portion of medial groove	terminates abruptly	anteriorly, groove terminates gradually	as in <i>C. ocyurus</i>
15. Ridge dorsal to median groove	low	high	high
16. Postpelvic process	narrow	broad	broad

**Frontals** (Fig. 2-4) Morphology of the dorsal, frontal surface in *C. striata* is dominated by an ontogenetic increase in ossification (a condition referred to as hyperostosis, Fig. 4). Small specimens (generally less than 150 mm SL) show little hyperossification, but noticeable hyperostosis is observed in larger specimens (greater than 200 mm SL). *C. ocyurus* and *C. philadelphia* show no evidence of hyperostosis.

All species examined have a dorsal foramen in each frontal bone, however in *C. striata* each frontal bone bears a large dorsal foramen which becomes occluded owing to hyperostosis (Fig. 2 & 4). As small adults (less than 150 mm SL), the dorsal frontal foramina are ovulate in *C. striata* and *C. ocyurus* but are elongate, narrow slits in *C. philadelphia*. The frontals of all species have a deep furrow anteriorly which leads to a large, ovulate, anterior foramen in *C. striata* and *C. ocyurus* but to a smaller foramen in *C. philadelphia* (Fig. 2 & 3). The posterior-lateral portion of the frontals bears a low transverse ridge in *C. striata*. This ridge is thicker and higher in *C. ocyurus* but is virtually absent in *C. philadelphia*. In large adults of *C. striata* hyperostosis obliterates these ridges.

**Parietals** (Fig. 2-4) All species bear well-developed, elevated and elongate longitudinal parietal ridges. In *C. striata* these ridges meet in a narrow U-shape at the frontal-supraoccipital suture. Hyperossification in the posterior frontal area of large adults destroys these ridges. In *C. ocyurus* the parietal ridges extend onto the anterior supraoccipital edge and are more broadly U-shaped. In *C. philadelphia* the parietal ridges do not extend to meet at the dorsal midline but curve medially and terminate before reaching the posterior frontal border.

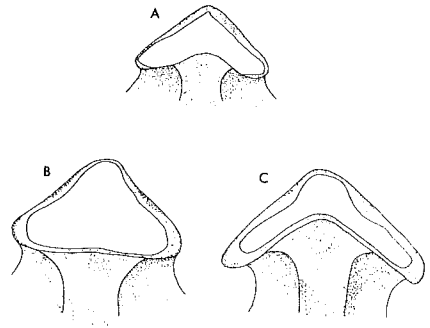


Fig. 1. Anterior portion of vomer, ventral view.  
A. *C. striata* (202 mm SL) N. C.;  
B. *C. ocyurus* (216 mm SL) N. W. Fla.;  
C. *C. philadelphia* (149 mm SL) N. C.

**Supraoccipital** (Fig. 2-4) The anterior edge shows some ridge formation in *C. ocyurus* and to a lesser extent in small adult *C. striata* (again becoming hyperossified in large adults). *C. philadelphia* shows no anterior thickening. In all three species the supraoccipital crest originates posterior to the orbit, remains low and terminates on the posterior portion of the exoccipitals. A longitudinal bony ridge on the mid-lateral supraoccipital crest surface, here termed a supportive stay, is well developed in *C. ocyurus* and *C. philadelphia* but is nearly lacking in *C. striata*.

**Parietal-Supraoccipital junction** (Fig. 4) This area is nearly flat in *C. philadelphia* and *C. ocyurus*, but is depressed slightly in *C. striata*.

**Epiotic** In *C. striata* the posttemporal facet is narrow and bears two posterior projections, the medial point being the longest. *C. philadelphia* has a more elongate and slightly enlarged posttemporal facet in which the pair of posterior projections are more elongate than in *C. striata*, again with the medial projection longest. *C. ocyurus* has a broad posttemporal facet, nearly triangular in shape.

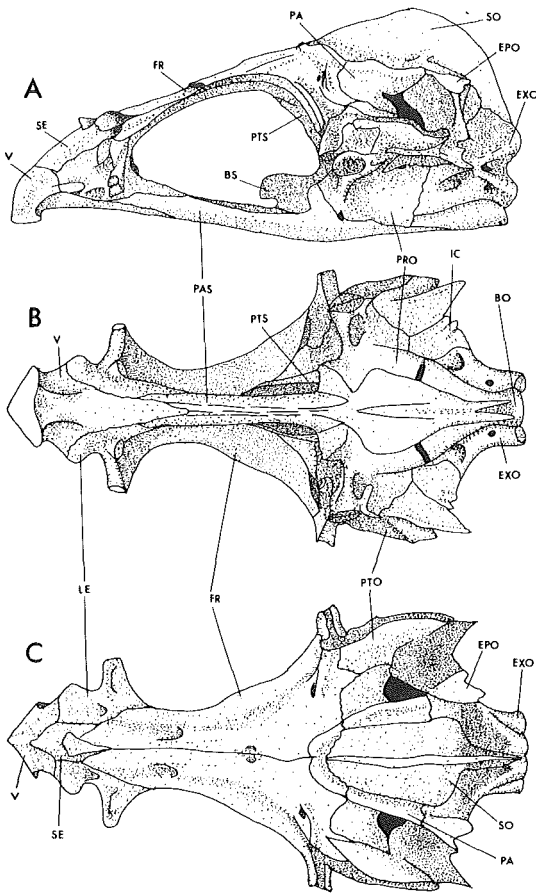


Fig. 2. Cranial skeleton of *C. striata* (140 mm SL) N. C.

- A. left lateral view;
- B. ventral view;
- C. dorsal view.

**Preopercle** (Fig. 5C) The horizontal and vertical arms form a slightly obtuse angle in all species. The bone is serrated on its posterior and ventral edges. These serrae are largest in *C. striata* and slightly finer serrations are present in *C. ocyurus* and *C. philadelphia*.

**Tenth vertebra** (Fig. 5A-B) The parapophysis is slightly more elongate and is directed more ventrally in *C. ocyurus* and *C. philadelphia* than in *C. striata*.

**Eleventh vertebra** (Fig. 5A-B) The first haemal spine appears as a thin dorso-ventrally flattened spine which is only slightly spatulate distally in *C. striata* and *C. philadelphia*. In *C. ocyurus* the first haemal spine is thick, broadest at midlength, and has a deep trough formed on its anteroventral surface.

**Otoliths** (Fig. 6A-C) Anteriorly the medial groove ends abruptly or nearly so in *C. striata* specimens examined. In *C. ocyurus* the groove gradually enters the otolith surface but its ventral edge does bear an abrupt lateroventral angle. *C. philadelphia* has a groove which gradually reaches the surface and bears no abrupt angles. A distinct, high ridge is present along the dorsal edge of the medial groove in *C. ocyurus* and *C. philadelphia*. *C. striata* bears a much lower, less distinct ridge. Otolith shapes are variable and features along the perimeters are generally unreliable as differentiating characters.

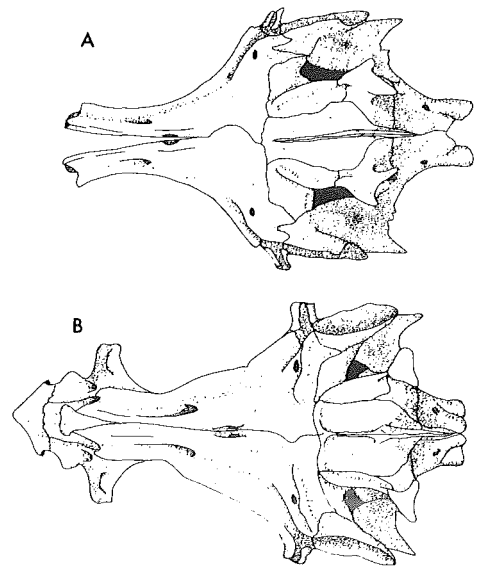


Fig. 3. Cranial skeleton, dorsal view.

- A. *C. philadelphia* (89 mm SL) N.C. (ethmoid region not shown);
- B. *C. ocyurus* (170 mm SL) N. W. Fla.

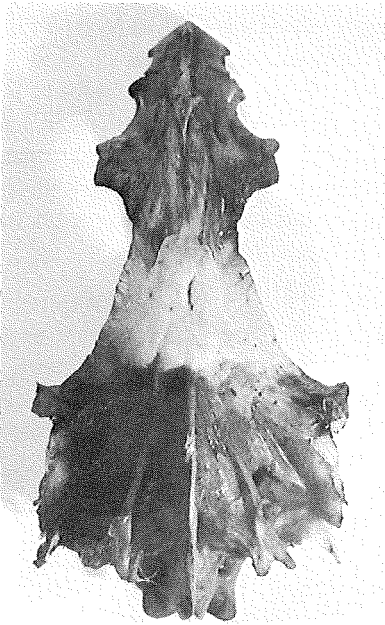


Fig. 4. *C. striata*, dorsal view of an adult cranial skeleton depicting intense ossification in frontal regions.

**Postpelvic process** A broadened process (as in Fig. 7B of Gosline, 1966) is present in *C. philadelphica* and *C. ocyurus*. *C. striata* shows a narrow and elongate postpelvic process, similar to that in Fig. 7A of Gosline (1966).

**Osteological characters common to species observed.**

In the suborbital series (Fig. 7A-B), the third suborbital bone is extended medially to form an elongate, rectangular-shaped shelf under the orbit. The intercalary process for articulation with the lower posttemporal arm is greatly produced posteriorly and can be seen from above. The posttemporal is serrated in all species. The scapula bears  $3\frac{1}{2}$  radials while the coracoid bears  $\frac{1}{2}$  radial (Fig. 7C). Branchiostegals are consistently seven in all species: the ceratohyal bearing  $5\frac{1}{2}$  branchiostegals and the epihyal bearing  $1\frac{1}{2}$  (Fig. 8B). Anteriorly the first branchiostegal has a lateral attachment to the distal portion of the cera-

tohyal; the second and third are ventral in attachment; the posteriormost four branchiostegals have lateral attachments on the cerato- and epihyals. The hypobranchials bear rudimentary tooth patches and no true gill rakers (Fig. 8A). A glossohyal is present, as are three basilbranchials, three hypobranchials, and five ceratobranchials (Fig. 8A). The caudal fin structure (Fig. 5D) is of type V-B of Monod (1968). The predorsal fin support formulae are all 0-0-0-2- and the interneurals are well developed. Vertebral counts are consistently 10 + 14.

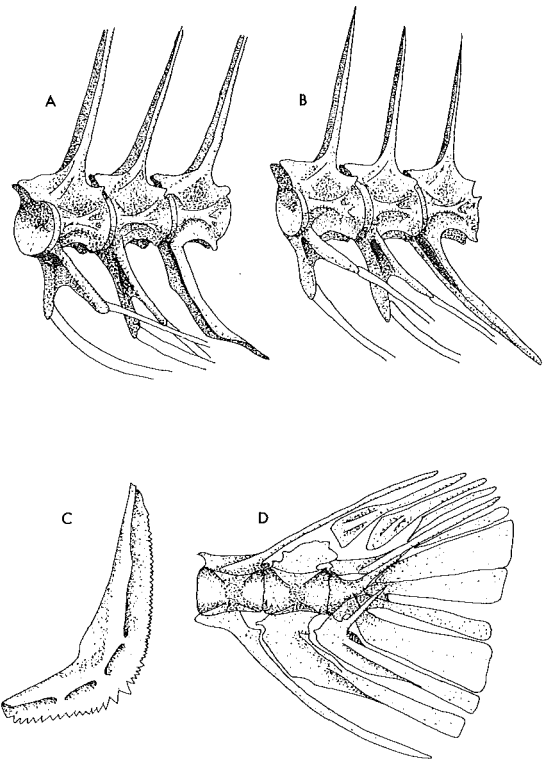


Fig. 5. A. 9th, 10th and 11th vertebrae of *C. ocyurus*, lateral view; B. 9th, 10th, and 11th vertebrae of *C. striata*; C. left preopercle of *C. striata* (140 mm SL) N. C.; D. caudal skeleton, left lateral view of *C. striata* (61 mm SL) N. C.

The lacrimal (first suborbital bone) is quite broad in adults of all species (Fig. 7A). The anterodorsal edge is gently curved, the lateral surface of the bone being slightly broader anteriorly. Juveniles tend to have a narrow lacrimal bone which is generally narrower than the maxillary width. In adults the lacrimal is much broader than the maxilla.

The maxillary is broad and spatulate distally. The premaxilla and dentary bones each bear an outer row of caniniform or strong villiform teeth and an inner row of smaller villiform teeth. Posteriorly, on the dentary, however, the inner villiform band decreased in width so that posteriorly only the outer row of caniniform teeth remain.

### Generic relationships

It is not the purpose of this study to compare in detail all Serraninae genera. Comparisons can hardly be made with

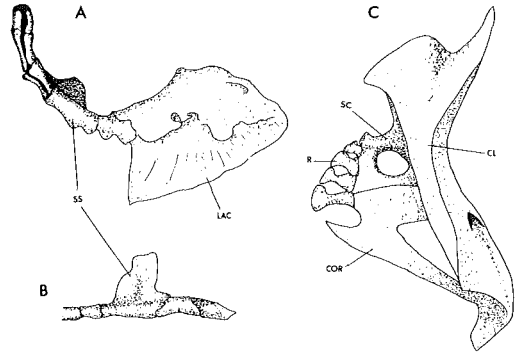


Fig. 7. A. *C. striata* (234 mm SL) N. W. Fla., right lateral view of suborbital bones; B. *C. ocyurus* (223 mm SL) N. W. Fla., right dorsal view of suborbital bones; C. *C. ocyurus* (170 mm SL) N. W. Fla., right lateral view of pectoral girdle.

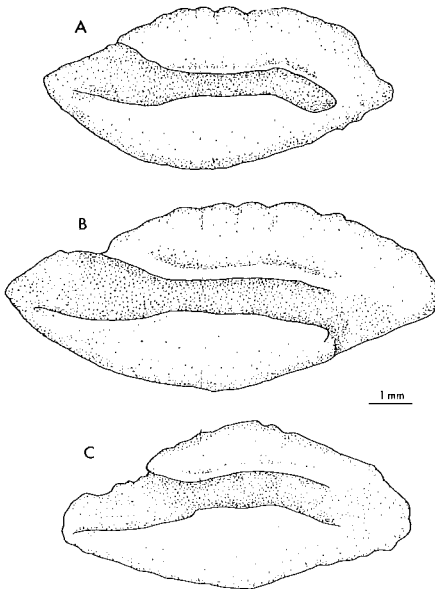


Fig. 6. Left otoliths, medial view from:  
A. *C. striata* (157 mm SL) N. W. Fla.;  
B. *C. ocyurus* (170 mm SL) N. W. Fla.;  
C. *C. philadelphica* (149 mm SL) N. C.

these genera at this time owing to the lack of comparative material and an incomplete understanding of the morphologically similar genus *Paralabrax*. Examination of *Paralabrax clathratus* (Girard), *P. nebulifer* (Girard), and *P. maculato-fasciatus* (Steindachner) reveals the presence of parietal ridges similar to those in *Centropristis*, but in *Paralabrax* these ridges are shorter, thinner, and lower than those observed in *Centropristis*. Also, the ridges do not extend as far anteriorly (i. e., to the posterior frontal border) as they do in *Centropristis*. Smith and Young (1966) indicated that the lateral crests (= parietal ridges) are similar in *Paralabrax* and *Centropristis*. In this study I have compared juvenile *Paralabrax* with juvenile *Centropristis* of equal size and have noted subtle but necessarily important difference in the parietal ridges between these genera.

In nearly all *Diplectrum* the parietal ridges are short, low and do not extend



to the posterior area of the frontal bone. However, in *Diplectrum maximum* Hildebrand, *D. pacificum* Meek and Hildebrand, and *Diplectrum eumelum* Rosenblatt and Johnson, these ridges are slightly higher and tend to curve anteriorly and medially (Bortone, 1973) as they do in *C. philadelphia*. Examination of *Serranus notospilus* Longley, *S. tabacarius* (Cuvier), *S. phoebe* Poey and *S. tigrinus* (Bloch) reveals short, low, thin ridges as depicted by Smith and Young (1966:Fig. 5A). A narrow, elongate subocular shelf is apparently unique in *Centropristis*. *Paralabrax*, *Diplectrum*, and *Serranus* all have broad subocular shelves which do not project medially to any great extent. Norman (1966) implied that the posterior angle of the supraoccipital crest is of value in distinguishing *Centropristis* from other Serraninae. This may have to be reconsidered as a generic character as *Serranus* and *Diplectrum*, while having a much lower crest (i. e., lower cranial profile) posteriorly, appear the same as *Centropristis*.

It would appear that *Centropristis* represents a phyletic line with an intermediate degree of specialization among Serraninae having: scales on the interoperculum, enlarged cranial ridges, and a rather modified subocular shelf.

### Species Relationships

The present study is concerned only with osteology, but similarities and differences in bone morphology may be interpreted phyletically. In Table 1 the 16 osteologically differentiated characters presented reveal eight characters in common among *C. philadelphia* and *C. ocyurus*, five characters in common among *C. striata* and *C. ocyurus*, and only three characters in common among *C. striata* and *C. philadelphia*. The above comparison reveals an implied phyletic lineage (Fig. 9) in which *C.*

*ocyurus* is more similar to *C. philadelphia* than *C. striata*; and *C. striata* is more similar to *C. ocyurus* than it is to *C. philadelphia*.

*C. striata* is viewed as an apomorphic member of the genus. The apomorphic presence of hyperostosis, larger body size (Miller, 1959), narrow postpelvic process, depressed parietal-supraoccipital junction and the absence of a supportive supraoccipital crest stay all indicate a specialized situation among other Serraninae. Observations by the author indicate that serraninae generally lack hyperostosis, are small (usually less than

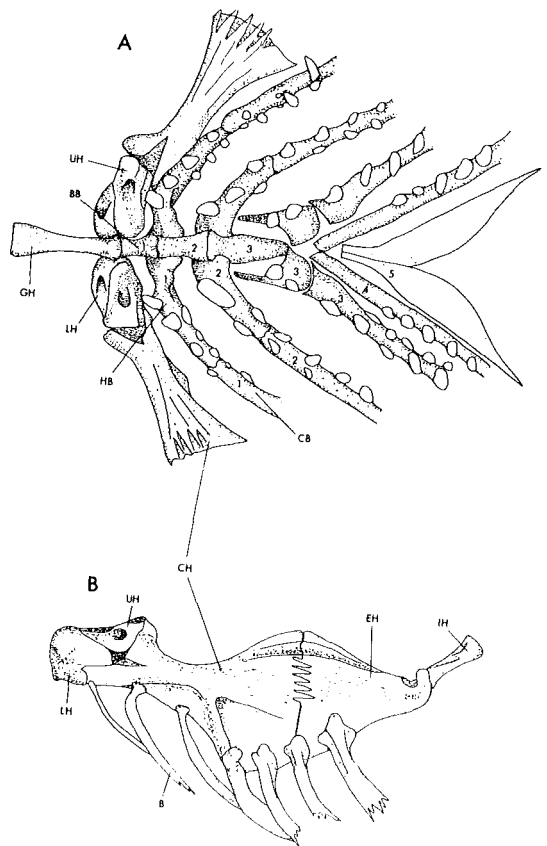


Fig. 8. *C. striata*

A. dorsal view of lower pharyngeal skeleton;

B. left lateral view of hyoid and branchiostegal bones.

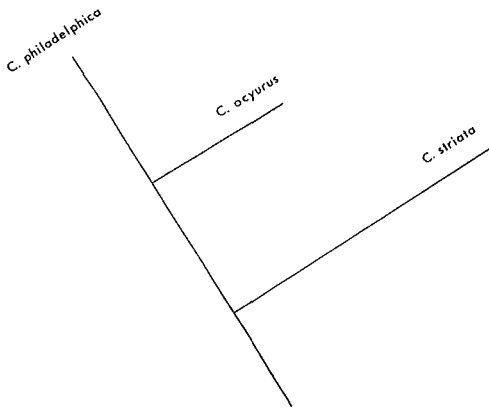


Fig. 9. A possible phyletic relationship of three *Centropristis* species.

200 mm SL), have a short, broad post-pelvic process and are flattened at the parietal-supraoccipital junction. *C. striata* may be considered somewhat specialized in that the species has eight out of sixteen characters which it does not share with either of the other two species. *C. ocyurus* is unique within the genus in only three characters while *C. philadelphica* is unique in five characters.

The *C. ocyurus* - *C. philadelphica* sister group is more plesiomorphic with regard to osteological characters in that these species lack the derived characters of *C. striata*. *C. philadelphica* represents a plesiomorphic sister group of this lineage as it lacks the derived character of well developed parietal and frontal ridges; a feature which *C. philadelphica* shares with other non-*Centropristis* Serraninae.

## DISCUSSION

*Centropristis* is a member of the sub-family Serraninae (*sensus* Jordan and Eigenmann, 1890; Katayama, 1960) as defined by the composite of the following characters: no supplementary bone

present on the unscaled maxillary; teeth not depressable; dorsal fin continuous, bearing ten spines; preopercle finely serrate; suborbital shelf present on either the second, third, or fourth suborbital bones; urohyal shorter than the ceratohyal; vertebrae 10 + 14.

## Generic definition

The generic characters of *Centropristis* taken from Robins and Starck, 1961; Miller, 1959; Norman, 1966; and Jordan and Eigenmann, 1890 can be summarized as follows: interopercle scaled, head scaled forward to occiput, gonad type is protogynous hermaphroditism, dentition strong, supraoccipital-parietal ridges prominent and extending forward to meet with a ridge present on the posterior frontals, top of skull smooth and small, pelvic fin origin anterior to pectoral fin origin, supraoccipital crest long and encroaching on posterior cranial border (the profile is not vertical along the occipital region).

As a result of the present study the genus *Centropristis* may additionally be defined according to a new character. The subocular shelf is elongate (i. e., more medially projecting) and narrow, strictly confined to the third suborbital bone. When other Serraninae have been studied osteologically, more generic characters will certainly become apparent.

Hyperostosis in *C. striata* is probably correlated with ontogeny. Fish greater than 200 mm SL tend to have a noticeable hyperostosis and this ossification increases with standard length. Lavenda (1949:189) indicated that males larger than 250 mm SL have an "adipose occipital hump" as an obvious secondary sex characteristic. The general dorsal configuration of the occipital hump is due not only to the presence of adipose tissue but also is probably the result of an

underlying foundation of increased frontal bone ossification (Smith and Young, 1966). The initial change from female to male in this protogynous hermaphrodite occurs at about four years of age (i. e., 190-265 mm SL: Lavenda, 1949: Table 1). This information suggests that the hyperostosis is related to sex reversal.

No osteological differences were noted between *C. striata striata* and *C. striata melana*. There is close similarity in external morphology between these forms (Miller, 1959). Recognition at the specific level is not warranted based on osteological morphology.

Radiograph examination of *C. fuscus* (ANSP 94422) did not allow clear observation of the supraoccipital-parietal ridges or the subocular shelf. Examination of the specimen and data presented by Robins and Starck (1961) lead me to agree with their statement that *C. fuscus* should be retained in the genus *Centropristis*.

Additional studies on all biological aspects of *Centropristis* are still needed. Comparative life history data on all species and geographical forms will delineate ecological differences and similarities. Morphological studies such as those by Miller (1959) and the present study cannot decisively determine the relationships between Gulf and Atlantic populations within species or subspecies. Also, in order to ascertain the fishery potential and full environmental importance, comparative ecological and life history data need to be determined for each species population of sea basses.

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