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REVISION OF EASTERN PACIFIC CATALUFAS (PISCES: PRIACANTHIDAE) WITH DESCRIPTION OF A NEW GENUS AND DISCUSSION OF THE FOSSIL RECORD

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ABSTRACT: Four species of catalufas inhabit eastern Pacific waters: *Cookeolus boops* (Schneider, 1801), *Heteropriacanthus cruentatus* (Lacépède, 1801), *Pseudopriacanthus serrula* (Gilbert, 1891), and *Priacanthus alalaua* Jordan and Evermann, 1904. Each of these species is illustrated, and diagnostic characters, meristic data, morphometric measurements, maximum size, geographic range, depth distribution and other information also are presented. *Heteropriacanthus* is a new generic name for *Priacanthus cruentatus*, a cosmopolitan species that differs in numerous salient features from the species assignable to *Priacanthus* (i.e., *alalaua, arenatus, hamrur, macracanthus, meeki* and *tayenus*). An identification key is presented. Otoliths (sagittae) and scales of the four eastern Pacific species also are illustrated. The only reported priacanthid fossils are from the Eocene of Europe. Of the six species, *Pristigenys substriata* is known from skeletal remains and is unquestionably a priacanthid. Only two of the five species described from otoliths, *Pristigenys bella* and *P. dentifer*, appear to be priacanthids, but there is no assurance they can be assigned to *Pristigenys*, since none of the skeletal "imprints" of *P. substriata* contained otoliths, nor do all of the otoliths assigned to these two species appear to be correctly identified.

INTRODUCTION

For years, fishermen aboard long-range sportfishing boats that operated out of San Diego sought only such large game species as yellowfin and bigeye tuna (*Thunnus albacares* and *T. obesus*), wahoo (*Acanthocybium solanderi*), yellowtail (*Seriola lalandi*), giant sea bass (*Stereolepis gigas*) and several kinds of large serranids (*Epinephelus* spp. and *Mycteroperca* spp.). During 1978, however, at the urging of California Department of Fish and Game (DFG) biologists, skippers and crew members of these vessels commenced fishing for and saving miscellaneous small fishes caught at the Revillagigedo Islands, Alijos Rocks, and other fishing spots off southern Baja California.

Among the first of these incidentally caught species turned over to DFG personnel were a half-dozen catalufas that appeared to represent three species of *Priacanthus*. A literature search

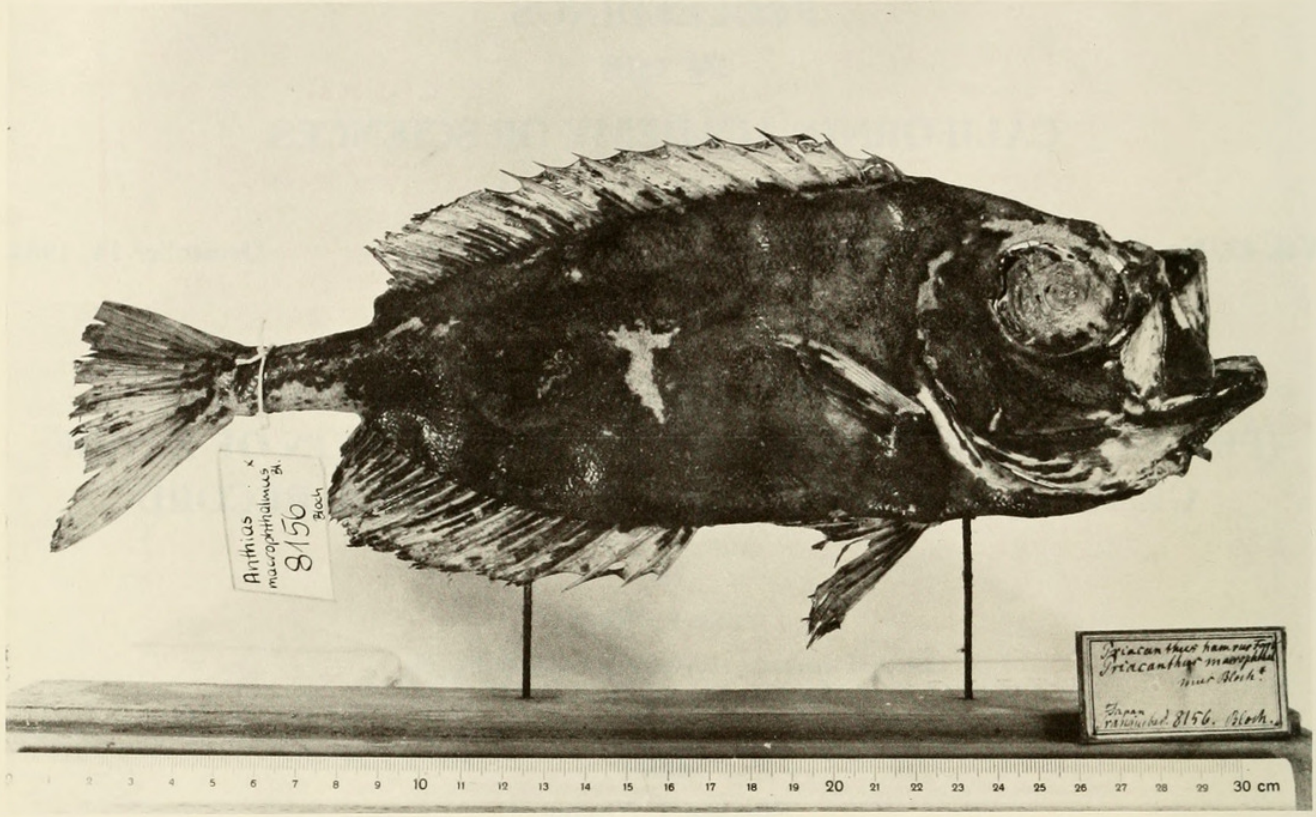

FIGURE 1. Type specimen of *Anthias macrophthalmus* Bloch, 1792 (ZMB 8156). Photo courtesy of Hans-J. Paepke, Museum für Naturkunde der Humboldt–Universität zu Berlin.

and examination of all the priacanthids in the fish collections at Scripps Institution of Oceanography (SIO), Natural History Museum of Los Angeles County (LACM), University of California, Los Angeles (UCLA) and California Academy of Sciences (CAS) revealed that, until then (Dec. 1978), any priacanthid collected in the eastern Pacific that was not judged to be either *Pseudopriacanthus* or *Cookeolus,* automatically had been relegated to *Priacanthus cruentatus* (see also Fitch and Schultz 1978).

Once it became obvious that we were dealing with several species, the differences in scale counts, pelvic fin pigmentation, eye diameter, otoliths, and gas bladder morphology became equally obvious. During the succeeding four years, in an effort to determine exactly what species we were observing, we examined several hundred priacanthids from throughout the world. As a result, we arrived at the conclusion that there were four species of catalufas in the eastern Pacific: *Cookeolus boops, Priacanthus alalaua, Priacanthus cruentatus* and *Pseudopriacanthus serrula.*

In the course of our investigation, we found that otoliths (sagittae) and gas bladders of *Priacanthus alalaua* were so radically different from otoliths and gas bladders of *P. cruentatus* that a new generic name was needed for one of the two. This necessitated determining the condition of the otoliths and gas bladder of Bloch's (1792) *Anthias macrophthalmus,* since it was the type-species for *Priacanthus* Oken, 1817. Fortunately, Bloch's type specimen, a skin from the right side of the fish, still exists in the Museum für Naturkunde der Humboldt-Universität zu Berlin (ZMB8156), and Hans-J. Paepke, Curator of Fishes, sent us an excellent photograph of this specimen (Fig. 1). Wayne Starnes (pers. comm.), to whom we sent a copy of the photograph, has confirmed that Bloch's *Anthias macrophthalmus* is conspecific with *Sciaena hamrur* Forsskål, 1775.

KEY TO EASTERN PACIFIC PRIACANTHIDAE

1a. Pored scales in lateral line 35 to 40; dorsal soft rays 11 (rarely 10 or 12); anal rays 10; dorsal profile turns abruptly downward under base of soft portion of second dorsal fin; ventral profile turns abruptly upward

FIGURE 2. *Pseudopriacanthus serrula*. Photo by Jack W. Schott.

under anal fin base; ctenii on scales in parallel species, presenting a corrugated or waffled appearance ..... *Pseudopriacanthus serrula*

1b. More than 50 pored scales in lateral line; 12 (rarely) or more dorsal soft rays; 12 or more anal rays; dorsal and ventral profiles tapering gradually to caudal peduncle; ctenii on scales not as above 2

2a. Eighteen to 20 scale rows between 8th dorsal spine and lateral line; more than 20 rows on dorsum of caudal peduncle; anal rays 13; peduncle depth about equal to horizontal eye diameter; dorsal, anal and caudal fins yellow, edged with black; ctenii thick and bristlelike, in rows ..... *Cookeolus boops*

2b. Eight to 10 scale rows between 8th dorsal spine and lateral line; fewer than 15 scale rows on dorsum of caudal peduncle; anal rays 14; peduncle depth fits about 1¼ times into horizontal eye diameter; dorsal, anal and caudal fins never with yellow or tipped with black; ctenii thin and filamentous 3

3a. Second dorsal, anal and caudal fin membranes red, without spotting; pelvic fin membranes jet black; gas bladder with anteriorly projecting "ears" that extend to the otic bullae, and posteriorly projecting horns that reach to above end of anal fin; otoliths (sagittae) with a ventral keellike blade and centrally positioned pronglike rostrum; ctenii filamentous, in rows; preopercle completely scaled ..... *Priacanthus alalaua*

3b. Second dorsal, anal and caudal fin membranes with rust-colored spotting (dusky in formalin-preserved specimens); pelvic fin membranes lightly pigmented to clear; gas bladder contained entirely within body cavity, without ears and no anterior or posterior projections; otoliths (sagittae) lack keellike blades, oval in outline, with normal, anteroventral rostrum; ctenii fil-

amentous, only on scale margin, sparse; posterior margin of preopercle without scales ..... *Heteropriacanthus cruentatus* new genus

Species Accounts

Pseudopriacanthus serrula (Gilbert, 1891)
(Figure 2)

Diagnostic Characters.—35 to 40 pored scales in lateral line; 10 to 12 (typically 11) dorsal soft rays; 10 anal rays; ctenii on scales in a parallel series (Fig. 3d) presenting a corrugated or waffled appearance; dorsal profile turns abruptly downward, becoming nearly vertical, under second dorsal fin base; ventral profile becomes nearly vertical under anal fin base.

Meristic Data.—D. X,10–12; A. III,10; P. 17; GR 6–7 + 15–18 = 21–25; pored lateral line scales 35–40; vertebrae 10 + 13 = 23. Twenty-three of the 25 specimens we examined for meristic data had 11 dorsal soft rays, one had 10, and one had 12.

Maximum Size.—The largest individual we observed was a female 274 mm SL (353 mm TL) that weighed 1300 g. This was one of 24 individuals caught in gill nets in "30–40 fm" (55–73 m) off Magadalena Bay, Baja California, during March 1976.

Range.—Monterey Bay, California, to Talara, Peru (Fitch and Lavenberg 1975) and at most offshore islands from the Coronados to the Galapagos in 3.6 to more than 100 m (DFG, unpublished data).

Remarks.—Morphometric data were taken on only 13 of the more than 60 individuals we examined (Table 1). The smallest of these (34 mm SL, LACM 22796) had a relatively short pelvic fin (41% of SL) as compared with the Eocene fossil *Pristigenys substriata* (Fig. 11) and pelagic stages of the extant *Cookeolus boops* (Fig. 5, Table 1). Fritzsche and Johnson (1981) considered *Pseudopriacanthus* a junior synonym of *Pristigenys,* but for reasons given later, we believe both genera are distinct and valid.

Of perhaps 20 individuals that have been caught or observed in Californian waters, one each was from Monterey Bay and off San Luis Obispo, the rest have been from south of Pt. Dume. Scuba divers report that *P. serrula* is unafraid and can be picked up by hand when encountered in its natural surroundings.

Cookeolus boops (Schneider, 1801)
(Figure 4)

Diagnostic Characters.—18 to 20 scale rows between eighth dorsal spine and lateral line; more than 20 rows of scales on dorsum of caudal peduncle; ctenii on scales thick and bristlelike (Fig. 3a), in rows; anal rays 12–13; dorsal, anal and caudal fins yellow, edged with black; peduncle depth about equal to horizontal eye diameter; pelvic fins of pelagic juveniles comprise 50–70% of SL or more.

Meristic Data.—D. X,13; A. III,12–13; P. 18–19; GR 6–8 + 17–18 = 23–26; pored lateral line scales 53–61; vertebrae 10 + 13 = 23. One of the 35 specimens we examined for meristic data had 12 anal rays, the rest had 13.

Maximum Size.—The largest individual we observed was a female 397 mm SL (507 mm TL) that weighed 2725 g. It was caught by a sportfisherman at Alijos Rocks, Baja California, Mexico, in 1974 in "18 fm" (33 m) of water. This fish (LACM 34253) was erroneously identified by Fitch and Schultz (1978) as *Priacanthus cruentatus.* In the western North Atlantic, a *C. boops* has been reported that was 507 mm SL and weighed 5.2 kg (Anderson et al. 1972).

Range.—Worldwide in tropical and subtropical seas; in the eastern Pacific from Alijos Rocks, Mexico (24°57′N, 115°45′W) to 10°N 98′W (LACM 30506-1). Although adults have been caught in water as shallow as 30 m in the eastern Pacific, they are most commonly hooked at depths "exceeding 40 fm" (73 m) and have been taken as deep as "75 fm" (137 m). Pelagic juveniles have been captured at the surface at scattered offshore localities between the Tres Marias Islands and the Gulf of Tehuantepec. In the western North Atlantic, *C. boops* has been taken at depths exceeding 365 m (Anderson et al. 1972).

Remarks.—Although *Cookeolus* was not recognized from the eastern Pacific until Fritzsche (1978) reported upon six pelagic juveniles ranging from 148 to 226 mm SL, adults had been taken at Alijos Rocks as early as 1970, but were erroneously identified as *Priacanthus cruentatus* (Fitch and Schultz 1978). Not until 1978, when long-range sportfishing boats started bringing in fair numbers of adult *C. boops* from Alijos Rocks, the Revillagigedo Islands and Hurricane Bank (16°52′N, 117°28′W) were they recognized for what they were. Most of the confusion in identification had resulted from the relatively shorter

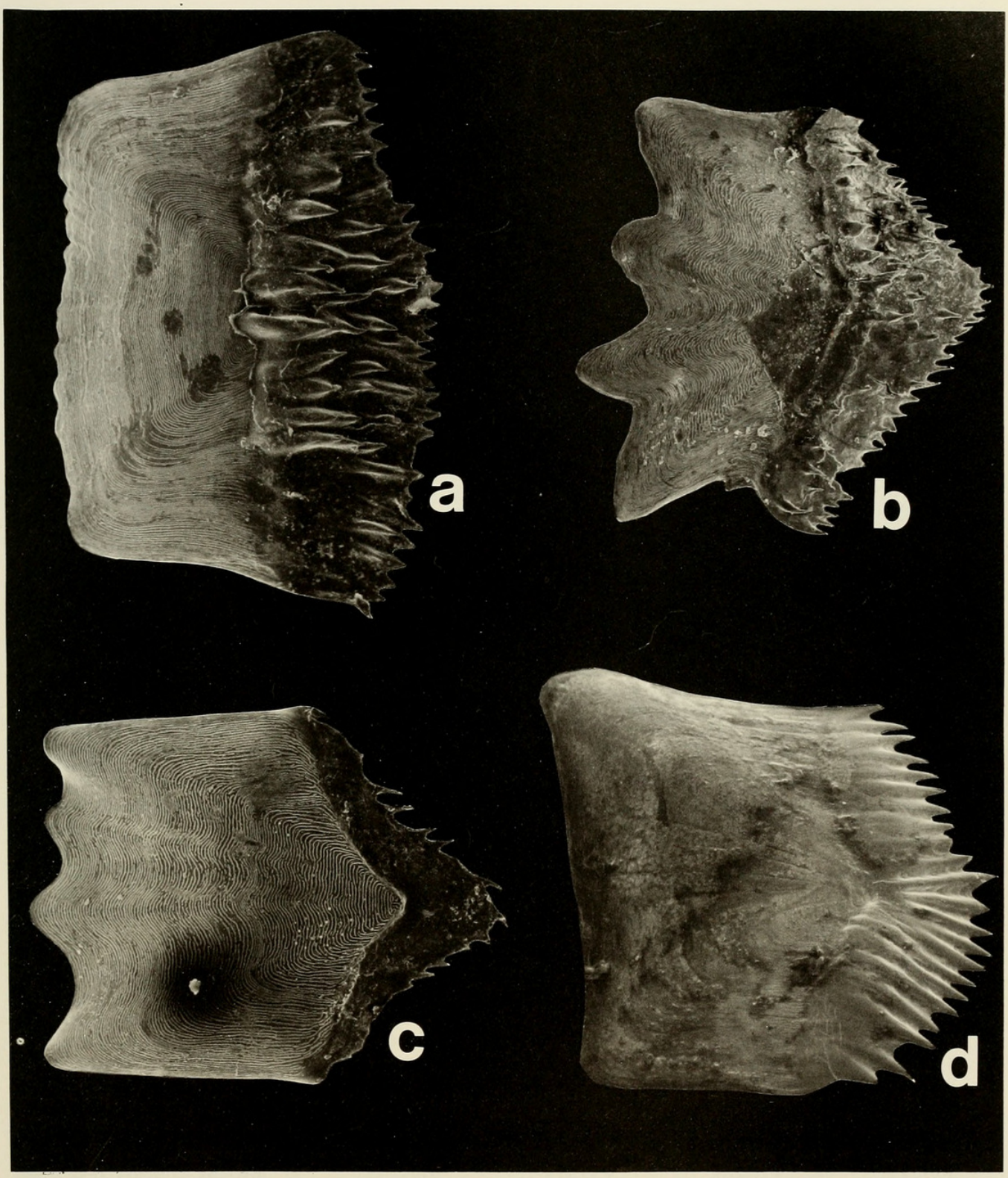

FIGURE 3. Scales of eastern Pacific Priacanthidae (scale height and length, in mm, in parens): a) *Cookeolus boops* (4.6 by 3.5); b) *Priacanthus alalaua* (3.1 by 3.1); c) *Heteropriacanthus cruentatus* (1.9 by 2.4); d) *Pseudopriacanthus serrula* (3.6 by 4.0). SEM photos by Richard Huddleston.

pelvic fins of the bottom-dwelling adults and the lack of spots and blotches which are so typical of the pelagic juveniles (Fritzsche 1978).

Although pelvic fin length commences to shorten when *Cookeolus* takes up a bottom-dwelling existence, six of the specimens we used in obtaining morphometric data (Table 1) still had pelvic fins that exceeded 40% of SL. All six of these fish, ranging from 197 to 267 mm SL (Fig. 5), had been hooked on the bottom. On the other hand, two bottom-dwelling specimens (222 and 257 mm SL) had pelvic fins that had short-

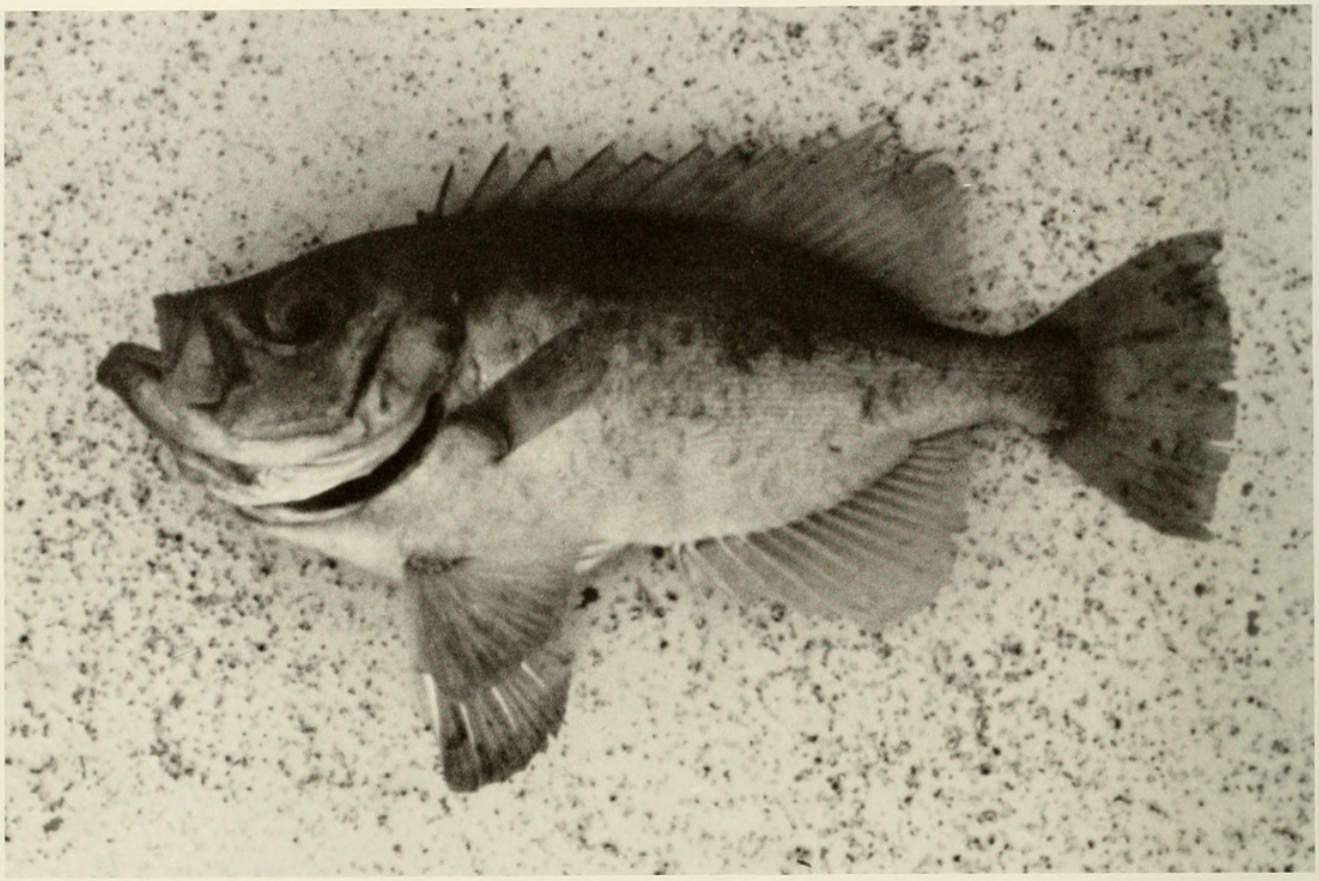

FIGURE 4. *Cookeolus boops.* Photo by Lee Stockland.

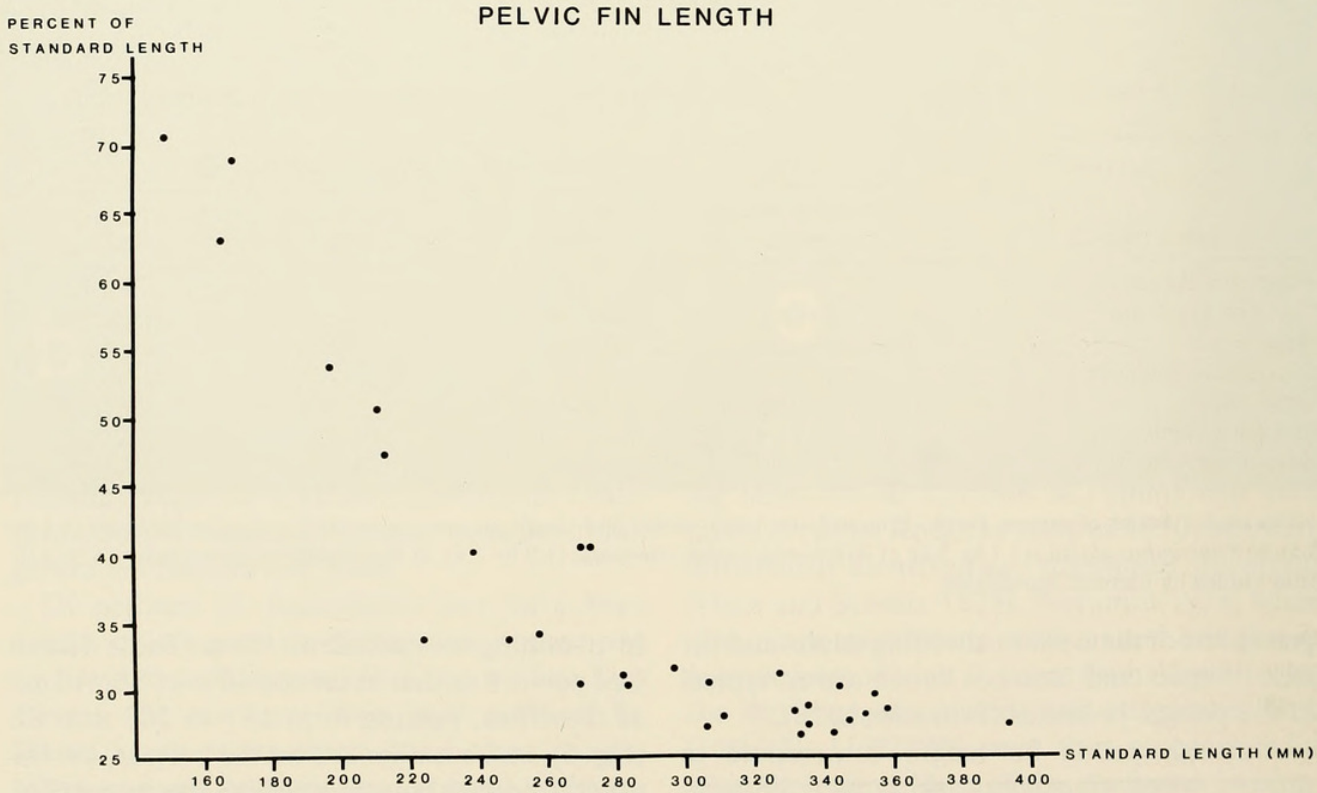

FIGURE 5. Pelvic fin length (as percent of SL) plotted against SL for 32 specimens of *Cookeolus boops.*

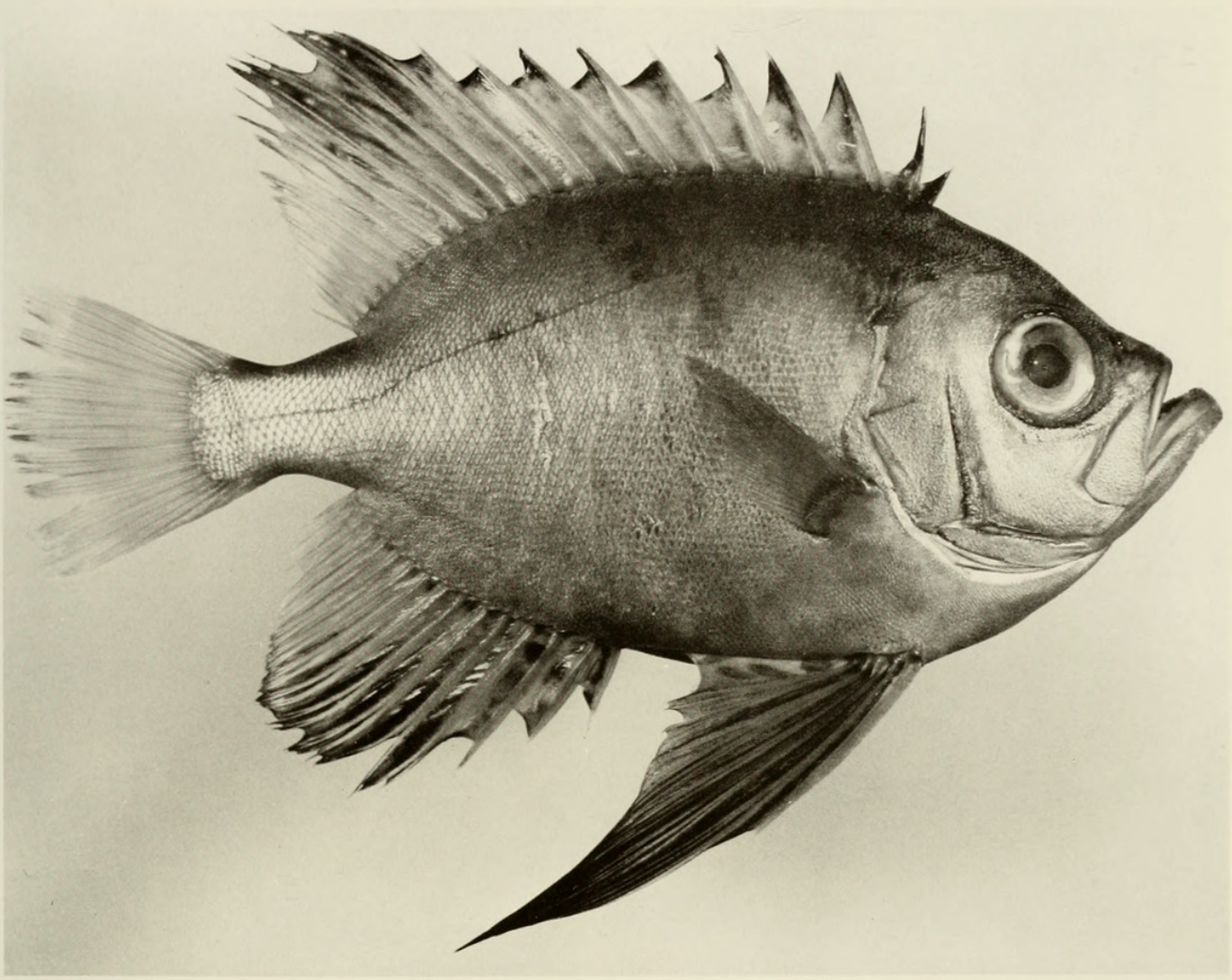

FIGURE 6. Juvenile *Cookeolus boops*, 211 mm SL, taken on hook and line in "15 fms" at Alijos Rocks. Photo by Paul Gregory.

TABLE 1. COMPARATIVE MEASUREMENTS FOR THE FOUR EASTERN PACIFIC PRIACANTHIDS (in percent standard length).

Measurement	Species and number of specimens measured			
	Pseudopriacanthus serrula	*Cookeolus boops*	*Priacanthus alalaua*	*Heteropriacanthus cruentatus*
Number of specimens	13	32	14	50
Standard length (mm)	34–261	151–392	215–261	81.5–245
Head length	36.1–41.2	31.2–37.4	29.4–33.3	28.6–36.4
Horizontal eye diameter	14.3–18.0	9.6–13.9	12.5–14.1	10.2–15.2
Snout length	9.0–11.4	9.8–11.7	9.5–10.5	9.0–10.1
Maxillary length	20.0–21.6	16.6–19.2	14.7–16.1	15.5–17.1
Bony interorbital width	7.9–10.2	8.2–10.5	8.0–9.1	8.4–10.1
Snout to 1st dorsal fin insertion	33.7–36.4	28.0–33.3	30.0–32.3	29.7–32.3
Snout to pectoral fin insertion	37.6–40.8	31.7–37.9	30.9–34.8	30.1–32.9
Snout to pelvic fin insertion	44.8–46.8	34.0–44.0	33.3–38.8	35.4–38.3
Snout to anal fin insertion	70.9–75.6	58.1–67.9	55.3–60.9	51.3–59.0
Dorsal fin insertion to pelvic insert	48.4–53.6	37.7–48.8	36.4–39.1	35.0–40.3
Depth perpendicular to AS_1	48.8–54.2	37.1–49.2	35.6–38.6	34.3–39.8
Caudal peduncle depth	12.8–14.0	9.6–12.3	7.7–8.2	8.3–10.5
Pectoral fin length	19.3–23.2	18.9–24.8	20.8–23.2	17.0–21.0
Pelvic fin length	25.6–35.4[1]	27.0–70.2[2]	25.3–31.4	19.7–26.7
Longest gill raker	5.9–8.8	5.0–7.2	4.1–5.4	4.4–5.2

[1] Pelvic fin length of 34 mm specimen (41.2%) not included, remaining specimens 172 to 261 mm SL.
[2] See Figure 5.

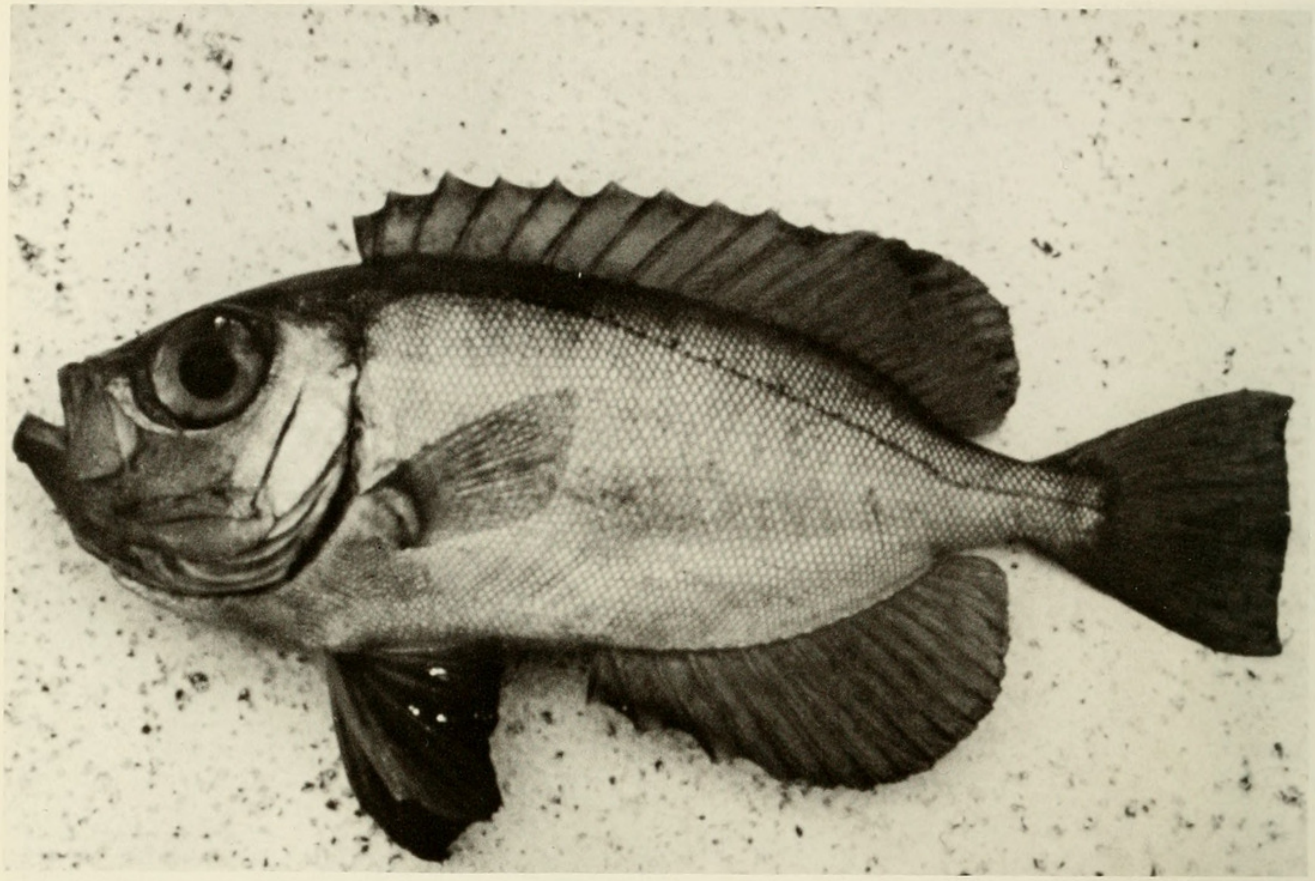

FIGURE 7. *Priacanthus alalaua.* Photo by Lee Stockland.

ened to 34% of SL (Figs. 5 and 6). The largest pelagic juvenile reported by Fritzsche (1978) was 226 mm SL. Based upon these lengths, in the eastern Pacific, *Cookeolus* remains in the pelagic environment until it reaches a size of approximately 200–250 mm SL.

Interestingly, the otoliths (sagittae) of *Cookeolus* also change with adulthood (Fig. 8c, d). Those of pelagic juveniles are almost perfectly oval in outline with a ratio of height into length of about 1:1.25. In adults, the otolith becomes more elongate (height into length ratio 1:1.6) and the posteroventral border becomes slightly concave as the marginal ornamentation (lobules) spreads and the notches deepen. We do not know of any other perciform in which such differences in otolith morphology occur with age.

Priacanthus alalaua Jordan and Evermann, 1904
(Figure 7)

DIAGNOSTIC CHARACTERS.—Second dorsal, anal and caudal fin membranes red; pelvic fin membranes jet black; gas bladder with anteriorly projecting "ears" that extend beyond the body cavity to the otic bullae, and posteriorly projecting horns that reach to above the end of the anal fin (Fig. 9); otoliths (sagittae) with a ventral keellike blade and centrally positioned pronglike rostrum (Fig. 8e); preopercle completely scaled; ctenii filamentous, in rows (Fig. 3b).

MERISTIC DATA.—D. X,13; A. III,14; P. 18–19; GR 4–6 + 14–17 = 19–23; pored lateral line scales 61–66; vertebrae 10 + 13 = 23. Only one of the 20 specimens we examined for meristic data had 19 elements in the pectoral fin; the rest had 18.

MAXIMUM SIZE.—The longest individual we observed was a female 261 mm SL (335 mm TL) from San Benedicto Island, Revillagigedos. The heaviest individual was a 257 mm SL female from Socorro Island, Revillagigedos, which weighed 574 g. Gosline and Brock (1960) report that in Hawaiian waters *P. alalaua* "reaches 14 inches in length" (357 mm), but they apparently did not examine any specimens of this species.

RANGE.—Hawaiian Islands and eastern north Pacific. In the eastern North Pacific, *P. alalaua* has been taken at Alijos Rocks and all of the Revillagigedo Islands (San Benedicto, Socorro, Roca Partida and Clarion). In the Revillagigedos, where sportfishermen catch fair numbers on oc-

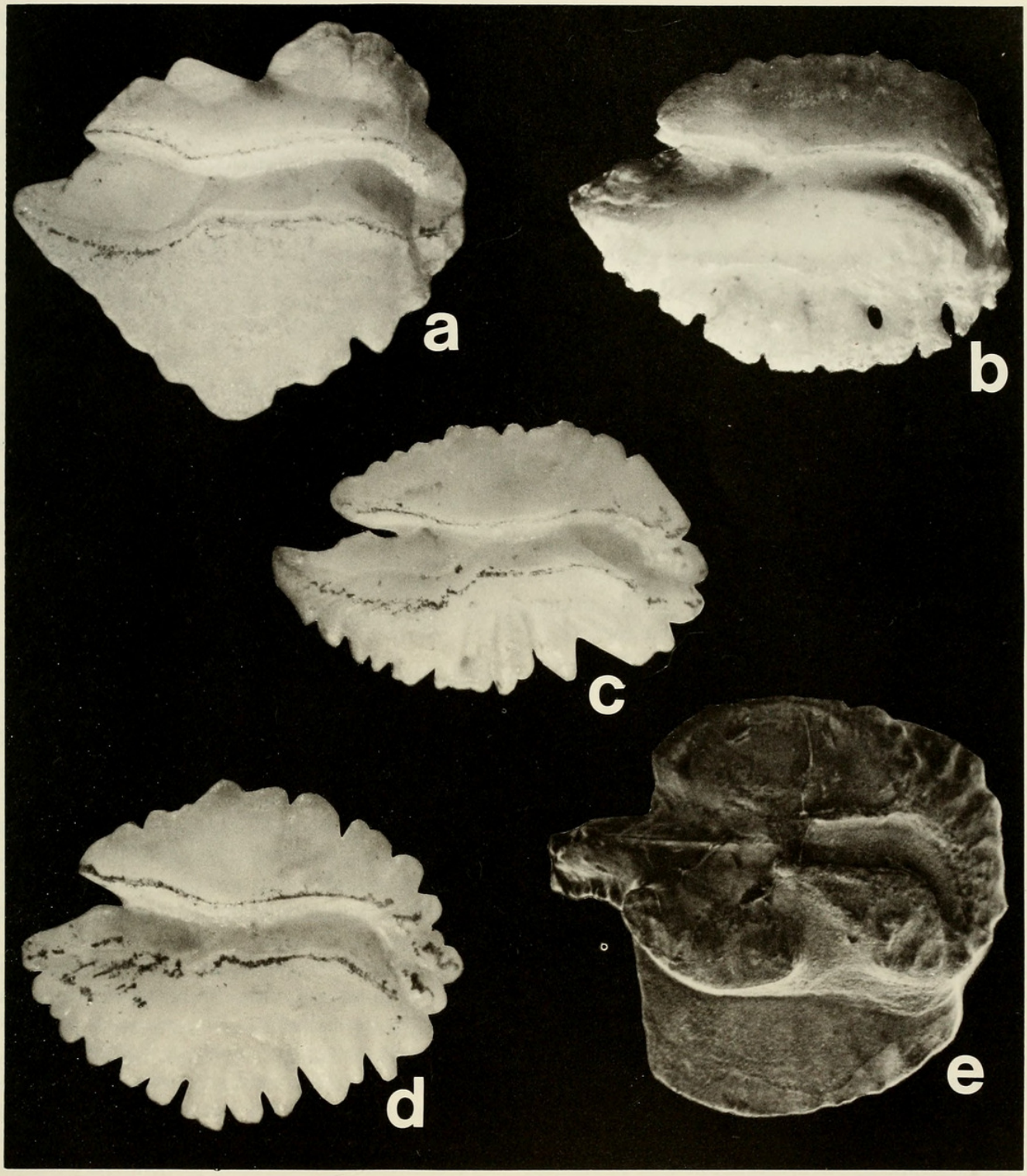

FIGURE 8. Otoliths (sagittae) of eastern Pacific Priacanthidae (otolith length and fish SL, in mm, in parens): a) *Pseudopriacanthus serrula* (7.2 and 2.9); b) *Heteropriacanthus cruentatus* (5.3 and 195); c and d) *Cookeolus boops* (7.6 and 257; 5.5 and 180); e) *Priacanthus alalaua* (3.6 and 221). Photos a through d by Jack W. Schott; SEM photo e by Brian White.

casion, it has been taken mostly at night in depths of "5 to 25 fm or more" (9–46 m).

REMARKS.—Although three individuals of *P. alalaua* were taken in gill nets set overnight just upcoast from Braithwaite Bay, Socorro Island, in April 1955, they were misidentified as *P. cruentatus,* and meristic data from them (e.g., "A. III,13") were reported by Fitch and Schultz (1978) along with data from seven *cruentatus* taken at the same time and place. Fortunately, their unique otoliths had been removed and saved, and counts and measurements were made before they were skeletonized, so subsequent identification as *P. alalaua* was easily verified.

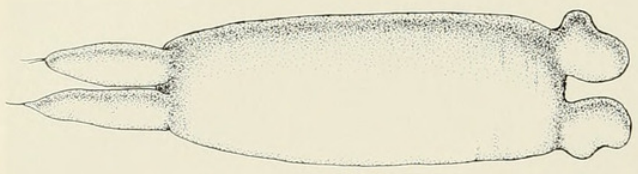

FIGURE 9. Gas bladder (124 mm total length) from *Priacanthus alalaua* 220 mm SL. Drawing by Mary Butler.

We examined the entire collection (worldwide) of priacanthids at Los Angeles County Museum of Natural History and found that *arenatus, hamrur, macracanthus, meeki,* and *tayenus* possessed similar peculiar gas bladders and otoliths. Therefore, we believe these species should be assigned to *Priacanthus.*

Heteropriacanthus new genus

TYPE-SPECIES.—*Priacanthus cruentatus* (Lacépède, 1801).

DIAGNOSIS.—Second dorsal, anal and caudal fins with rust-colored spotting (dusky in formalin-preserved specimens); pelvic fin membranes lightly pigmented to clear; gas bladder thin-walled, contained entirely within the body cavity; otoliths (sagittae) oval in outline with normal anteroventral rostrum (Fig. 8b); ctenii filamentous, sparse, and only on scale margin (Fig. 3c); posterior margin of preopercle scaleless.

ETYMOLOGY.—From Greek *heteros* (different), alluding to its being different from other *Priacanthus.*

Heteropriacanthus cruentatus (Lacépède, 1801)
(Figure 10)

DIAGNOSTIC CHARACTERS.—As for the genus.

MERISTIC DATA.—D. X,12–13; A. III,14–15; P. 17–19; GR 5–6 + 17–20 = 22–25; pored lateral line scales 57–65; vertebrae 10 + 13 = 23. Only two of the 61 specimens we examined for meristic data had 12 dorsal soft rays; the rest had 13. One specimen had an anal count of V,13 (LACM 32283), obviously a freak, so it was not included. Of the remaining 60 specimens, two had counts of III,15 and the rest III,14. All but eight specimens had 18 total elements in their pectoral fins; three had 17 and five had 19.

MAXIMUM SIZE.—The largest individual we observed (sex undetermined) from the eastern Pacific was 247 mm SL (315 mm TL). This fish (SIO 70-136) was from the Gulf of Chiriqui, Panama. We did not obtain a weight for it or for any other large *H. cruentatus.*

RANGE.—Worldwide in tropical and subtropical seas. In the eastern Pacific, *H. cruentatus* ranges from Guadalupe Island, Baja California (SIO 60-18) to the Galapagos Islands, Ecuador (numerous West Coast collections) in depths of "2 to 15 fm" (3.6–27 m) at least. Within this range, it has been collected at all of the Revillagigedo Islands, Hurricane Bank, the Tres Marias Islands (Mexico), Cocos Island (Costa Rica), and many islands off Panama. Its mainland distribution is not so extensive, ranging from Cape San Lucas, Baja California (UCLA-W52-259) to Panama (SIO 70-140).

REMARKS.—Typically an overall reddish or crimson when alive, *H. cruentatus* often will develop silvery marbling or blotching on the sides and back. Thomson et al. (1979) suggest that this color pattern results from stress.

Although we examined specimens of *H. cruentatus* from several localities far removed from the eastern Pacific, we were unable to find any differences that could be considered of specific, or even subspecific, magnitude.

FOSSIL RECORD

Fossil priacanthids have been reported only from Europe and only from Eocene deposits. These fossil remains have consisted of skeletal bones and impressions from Italy (*Pristigenys substriata*: see Fritzsche and Johnson 1981), otoliths from Belgium and France (*Pristigenys rutoti* and *P. caduca*: Stinton and Nolf 1970; Nolf 1973), and otoliths and dorsal fin spines from England (*P. bella, P. spectabilis,* and *P. dentifer*: Stinton 1980).

In identifying fossil fishes, an ideal situation would be to have a three-dimensional specimen with all bony elements and conventional characters present (e.g., viscera, gas bladder, scales, otoliths, etc.). Unfortunately, this does not happen. Soft parts can only be inferred. Rarely are three-dimensional fossil fishes found, and even two-dimensional skeletal impressions are not all that common compared with isolated teeth, scales, otoliths, and bones (Schafer 1972). Obviously, the more complete the fossil specimen or specimens, the greater the likelihood of making a correct identification.

The skeletal impressions of *P. substriata* from Italy generally have been in excellent condition and have permitted direct comparison of many salient features with the same features on extant priacanthids. None of these two-dimensional skeletal impressions has contained otoliths, how-

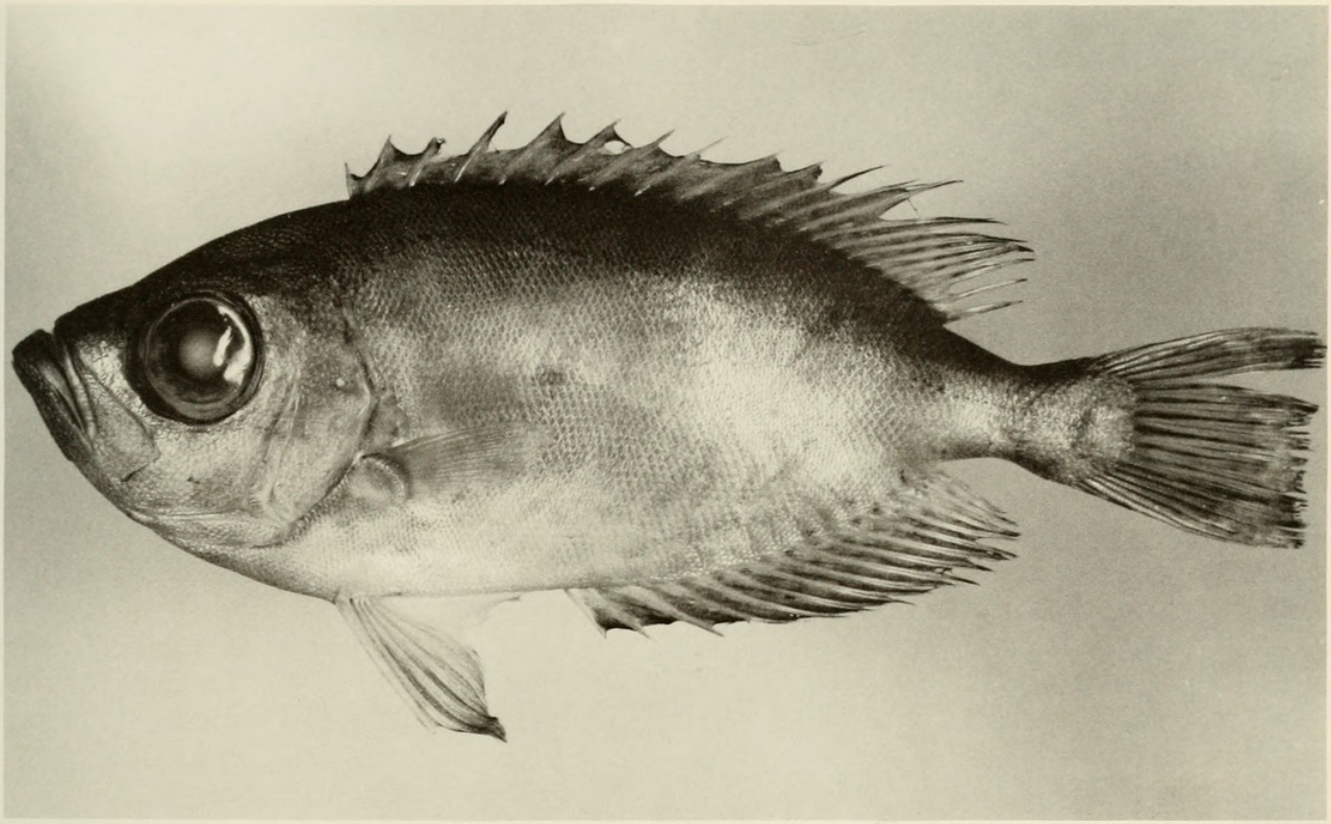

FIGURE 10. *Heteropriacanthus cruentatus.* Photo by Paul Gregory.

ever; to associate isolated otoliths with the genus *Pristigenys* is pure speculation.

In using otoliths (sagittae) as a taxonomic character, the most important feature for determining family and/or generic relationships (including ancestry) is the sulcus or groove on the inner face: its position, configuration, proportions, angle of curvature, and other features. If features of the sulcus do not match exactly, the otolith cannot belong to the same genus as the one to which it is being compared. Overall otolith shape, ratio of height into length, marginal ornamentation and similar surface features are important primarily at species level.

FOSSIL ACCOUNTS

Pristigenys substriata (Blainville, 1818)

(Figure 11)

White (1936) presents an excellent account of the taxonomy of this species as follows:

> Among the numerous fossil fishes described by Volta (1796 . . .) from the lower Lutetian of 'Monte Bolca' was a small imperfect specimen which he identified with the living species *Chaetodon striatus,* . . . illustrating his description with a figure that is unusually obscure; this specimen was later referred by de Blainville (1818 . . .) to a new species *C. substriatus.* Agassiz (1835 . . .) recognizing that the fossil was not a *Chaetodon,* renamed it completely, *Pristigenys macrophthalmus,* and sketched a few of its more obvious characters, which led him to suppose that this was 'un genre voisin de *Beryx*'; and under Agassiz' name it was listed among the Berycidae by A. S. Woodward (1901 . . .); finally, Eastman (1905 . . .) added details omitted by previous authors, and re-figured the unique original specimen. Eastman rightly named the species *Pristigenys substriatus* (for while Agassiz' genus is good, so is de Blainville's species), and retained it in the Berycidae.

White went on to report that the fossil was not a berycoid but a priacanthid, which, in his opinion, was identical with the extant *Pseudopriacanthus* Bleeker, 1869, and that this generic name, by reason of its later publication date, must be replaced by *Pristigenys.*

White's report appears to have been overlooked by subsequent authors until Myers (1958) called it to the attention of contemporary ichthyologists. Subsequently, as discussed by Fritzsche and Johnson (1981), there has been considerable controversy as to the validity of placing *Pseudopriacanthus* in the synonymy of *Pristigenys.* In concurring with such synonymy, Fritzsche and Johnson point out that a "predorsal bone" is a character shared only by *Pristigenys* and *Pseudopriacanthus* among all priacanthid genera. Interestingly, they support their contention of close relationship by presenting four

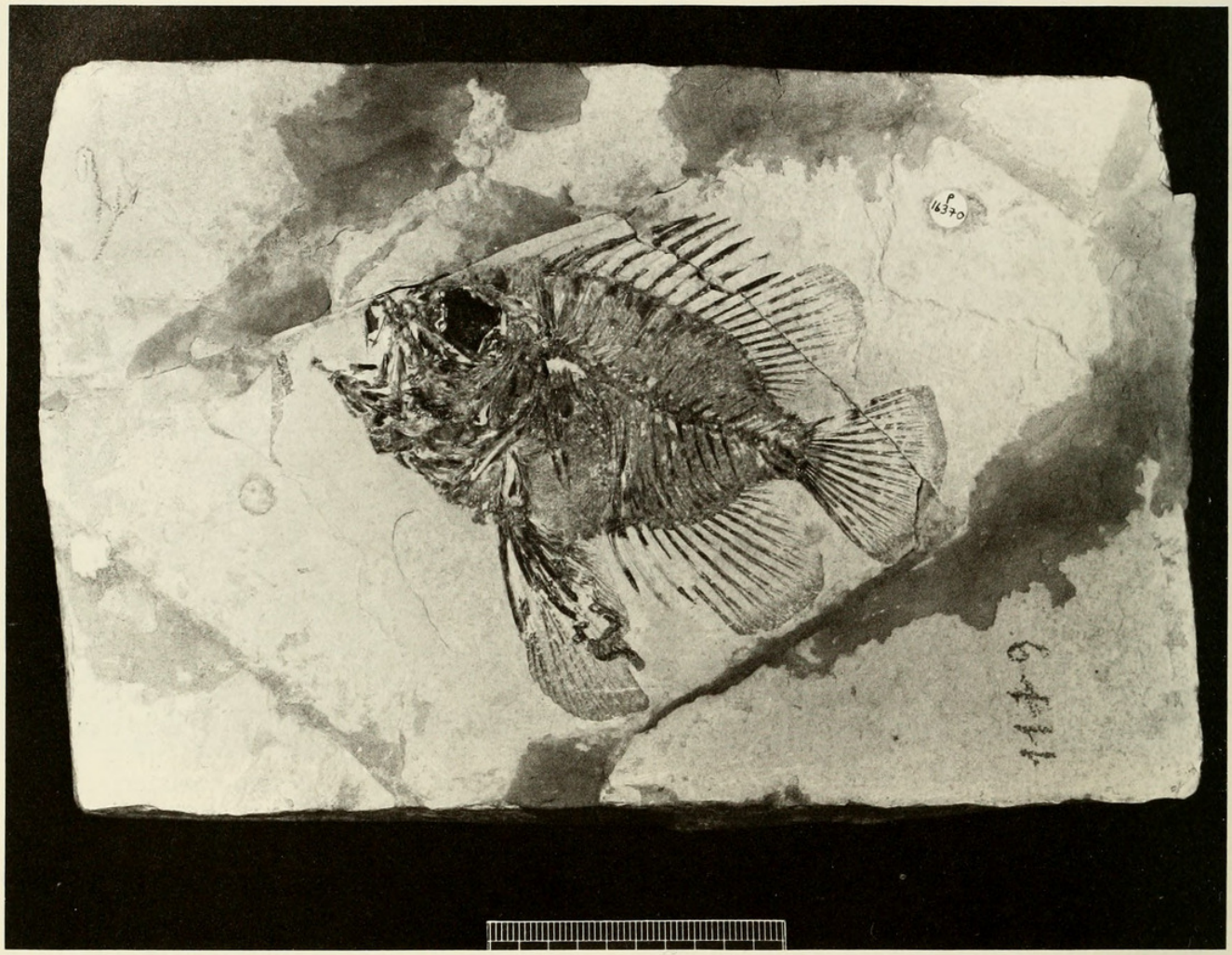

FIGURE 11. *Pristigenys substriata* (BMNH P.16370) 155 mm SL. Photo courtesy of Colin Patterson, British Museum (Natural History).

sets of morphometric data and two sets of meristic characters (from *Pristigenys substriata* and *Pseudopriacanthus altus*), while one paragraph later they state that "morphometric characters are not generally considered to be valid indicators of relationship" within the perciforms.

After carefully examining all available characters for the fossil *Pristigenys substriata* and for three species of the extant *Pseudopriacanthus* (i.e., *altus, niphonius,* and *serrula*), it is our contention that both *Pristigenys* and *Pseudopriacanthus* are valid genera. While we agree that these two genera share at least one character that appears to be of generic magnitude (i.e., the "predorsal bone" of Fritzsche and Johnson), there are other salient characters of equal magnitude that are shared with other priacanthid genera or are distinctive within their own genus.

Based upon the associated Monte Bolca fish fauna, *Pristigenys substriata* was living in a pelagic environment. The pelagic environment and extremely long pelvic fins (Fig. 5) are shared with juvenile *Cookeolus,* and apparently all known specimens of *P. substriata* represent juveniles as none exceeds 155 mm SL. The scales of *Pseudopriacanthus* (Fig. 3d) are unique among priacanthids for the shape and arrangement of ctenii; scales of *Pristigenys* appear to resemble those of *Priacanthus* or *Heteropriacanthus* (Colin Patterson, pers. comm.). Other features of *Pristigenys* (e.g., scale size, body shape, dorsal fin spine, and ray lengths) are intermediate to the same features as found on *Cookeolus* and *Pseudopriacanthus.* There is other less salient evidence to support retention of both *Pristigenys* and *Pseudopriacanthus* as valid genera.

Pristigenys rutoti (Leriche, 1905)
(Figure 12b)

Otoliths of this species were described and figured from Belgium by Leriche as "*Sparidarum rutoti.*" Subsequently, Schubert (1916) reported

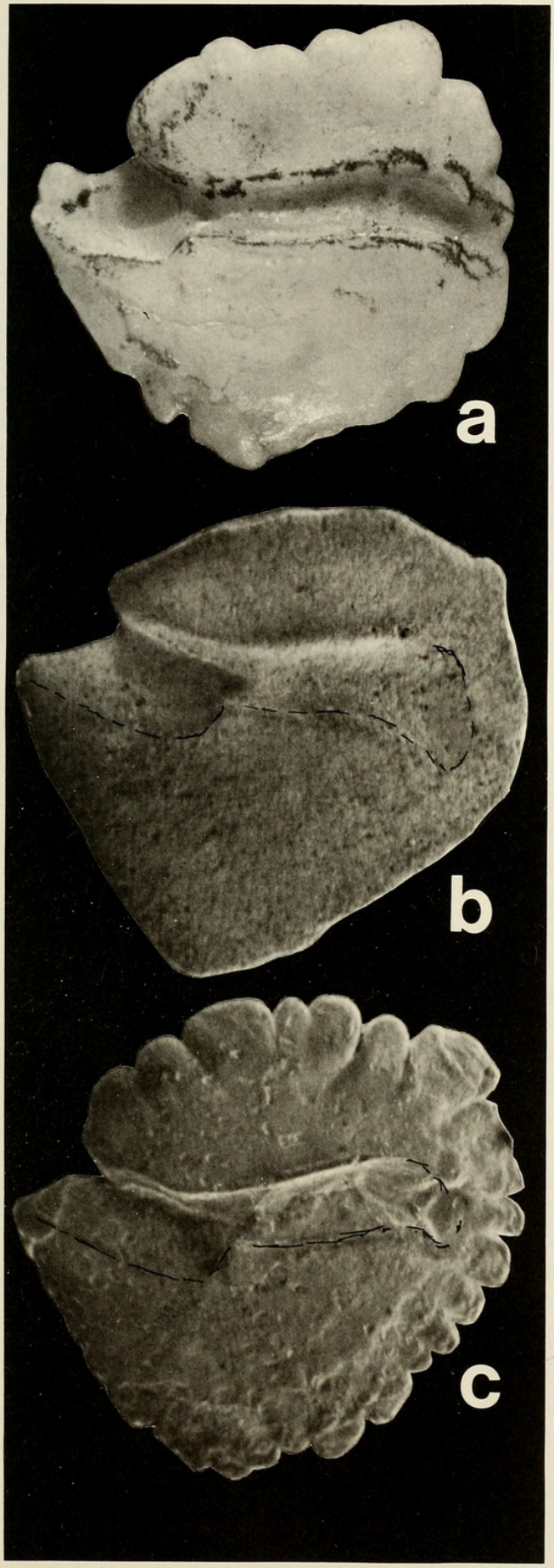

FIGURE 12. Otoliths (sagittae) of: a) *Pseudopriacanthus niphonius* (type species of *Pseudopriacanthus*) 6.5 mm long; b) *Pristigenys rutoti* 2.7 mm long; and c) *Pristigenys caduca* 2.7 mm long. Photo of *Pseudopriancanthus* by Jack W. Schott; SEM photos of *Pristigenys* by Brian White. Sulcus of fossils highlighted with broken inked line to show configuration.

their occurrence in England (refuted by Stinton 1980) and mentioned their similarity to "*Otolithus* (*Sparidarum*) *rutoti Leriche* [sic]," but then erroneously referred them to Koken's (1891) *Otolithus* (*Sparidarum*) *gregarius* using the combination "*Otolithus* (*Pagellus*?) *gregarius*." Additional errors in their taxonomy appeared in later years by other authors, climaxed by their being placed in "family Pseudopriacanthidae" (genus *Pseudopriacanthus*) by Stinton and Nolf (1970). Because Leriche used the genitive plural in giving these a generic name, he cannot be considered the authority for the species, nor can the 1905 publication date be considered valid. Schubert might possibly qualify as the author, but depending upon interpretation of the International Rules of Zoological Nomenclature, this also is questionable. It is entirely possible that Stinton and Nolf are the authorities for "*Pristigenys rutoti*," with a publication date of 1970, but the matter is irrelevant to priacanthid taxonomy because features of the sulcus of this fossil otolith do not permit its placement in family Priacanthidae. In sagittae of extant priacanthids (except *Priacanthus*) the upper and lower rims of the ostium (anterior part of the sulcus) converge posteriorly to appear slightly ovoid and funnel-shaped (Fig. 7a–d).

In the fossil otolith, the dorsal rim of the sulcus sweeps posteriorly in a continuous, gentle sigmoid curve, making it difficult to distinguish ostium from cauda without reference to the ventral rim, which sweeps abruptly dorsad at its juncture with the cauda. The ostium comprises less than 37% of total otolith length in three species of *Pseudopriacanthus*, whereas in *Pristigenys rutoti*, ostium length exceeds 41% of otolith length. Finally, when priacanthid otoliths (except *Priacanthus*) are placed with the outer face down on a flat surface, the sulcal side is highly arched (convex). Sagittae of *P. rutoti* lie almost flat when placed in this position.

Pristigenys caduca Nolf, 1973
(Figure 12c)

Features of the sulcus of this otolith do not permit a placement in the family Priacanthidae.

Again, the dorsal rim of the sulcus forms a continuous, gentle sigmoid curve, while the lower rim of the ostium sweeps abruptly upward at its posterior terminus—a beryciformlike ostial character, but also found in such unrelated fishes as *Lactarius, Epigonus, Ambassis, Glaucosoma,* some pempherids, and others.

Pristigenys bella Stinton, 1980

We have not handled otoliths from this species, but from Stinton's excellent photographs, it appears that the holotype and paratype shown in his text figure 34 are valid priacanthid sagittae. We cannot vouch for their generic placement, however, as otoliths do not accompany the skeletal impressions of *Pristigenys substriata,* the type of the genus. Again, because of ostial configuration, we question the assignment of the otoliths (presumably *P. bella*) shown in Stinton's Plate 13 (figs. 27 and 28) to family Priacanthidae. Stinton states that these otoliths "are from immature fish and demonstrate the ontogenetic changes [found in otoliths of these fishes]." Except for *Cookeolus,* which goes from a pelagic existence as juveniles to a benthic existence as adults, we have not observed ontogenetic changes in priacanthid sagittae, and the changes in *Cookeolus* otoliths are not the same as those attributed by Stinton to his fossil *P. bella.*

Pristigenys spectabilis Stinton, 1980

We have examined a dozen otoliths from this species, and judged by sulcal characters, it should not be assigned to family Priacanthidae. Stinton's excellent photographs of type material also show the non-priacanthid ostial configuration that precludes their being priacanthids.

Pristigenys dentifer Stinton, 1980

Based upon Stinton's photographs of the otoliths of *P. dentifer,* we believe that more than one species is involved. Some of his illustrated sagittae are very similar to priacanthid otoliths in sulcal characters, while others do not appear to be. One of his paratypes was found associated with "a few bones and spines" inside the cavity of a gastropod, *Clavilithes macrospira.* According to Stinton "some [of the] peculiarly prickly fin spines . . . were independently identified as a species of *Pristigenys.*"

We were loaned one of these fin spines by Colin Patterson (BMNH), who informed us (pers. comm.) that these prickly spines "are certainly different from those of *Pristigenys substriata,* which are smooth apart from longitudinal ribs." We compared the fossil spine with fin spines of all extant genera of priacanthids and could find no agreement with any of them. Camm Swift (LACM) examined the spine and suggested it bore resemblance to some beryciform fin spines, but was unable to suggest a family or generic affiliation.

Otoliths (especially sagittae) generally are excellent taxonomic tools, but when working with fossils, factors other than those observed on the otoliths themselves must be considered. Zoogeography, environment and habitat preferences are especially important. If zoogeography had been considered, it is doubtful that embiotocid perch (presently restricted entirely to the North Pacific Ocean) and *Leuresthes, Atherinops,* and other New World atherinids would have been reported from the tropical and subtropical Eocene of Europe.

Except for the early pelagic stage of *Cookeolus boops,* all extant priacanthids inhabit areas of high relief. Fishes living in these kinds of habitats frequently fossilize, but their remains rarely contain otoliths. Fossil deposits that contain otoliths almost invariably represent faunas that inhabit flat relief, or pelagic and mesopelagic realism. The occasional otolith from an inhabitant of rocky, high-relief habitat found in a fossil deposit generally represents a prey item or a straggler into the flat-relief area, a not uncommon phenomenon today. Such otoliths are rare, however, so the abundance of Eocene sagittae assigned to family Priacanthidae (*Pristigenys* spp.) by European paleontologists indicates that habitat preference was not a consideration. As already pointed out, features of the sulcus also were overlooked when making such assignments. Regardless, otoliths are excellent taxonomic tools, extremely abundant in the fossil record, and if properly used, can furnish an insight into the past that can not be gained any other way.

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