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RELATIONSHIPS OF THE PERCOID FISH *PENTACEROS RICHARDSONI* SMITH, WITH DESCRIPTION OF A SPECIMEN FROM THE COAST OF CALIFORNIA

by

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A specimen of the percoid fish *Pentaceros richardsoni* Smith[1] was collected March 10, 1960, off Pigeon Point, San Mateo County, California. This capture extends the recorded range of this species more than 400 miles southward on the Pacific coast of North America and adds to the known fauna of California the western Pacific family Pentacerotidae.

The specimen (fig. 1), California Academy of Sciences no. 26759, measures 252 mm. in standard length and 305 mm. in total length. It was collected by the drag boat *Henrietta Paladini* in California Department of Fish and Game Block 481 (37° 15′ N., 122° 55′ W.) in one of three tows made at depths of 265, 255, and 220 fathoms.

Other fishes taken in these tows were the pleuronectids *Eopsetta jordani* (Lockington), *Parophrys vetulus* Girard, *Microstomus pacificus* (Lockington), and *Glyptocephalus zachirus* Lockington; the scorpaenids *Sebastodes*

1. See Generic Position, p. 324, and Nomenclature, p. 328.

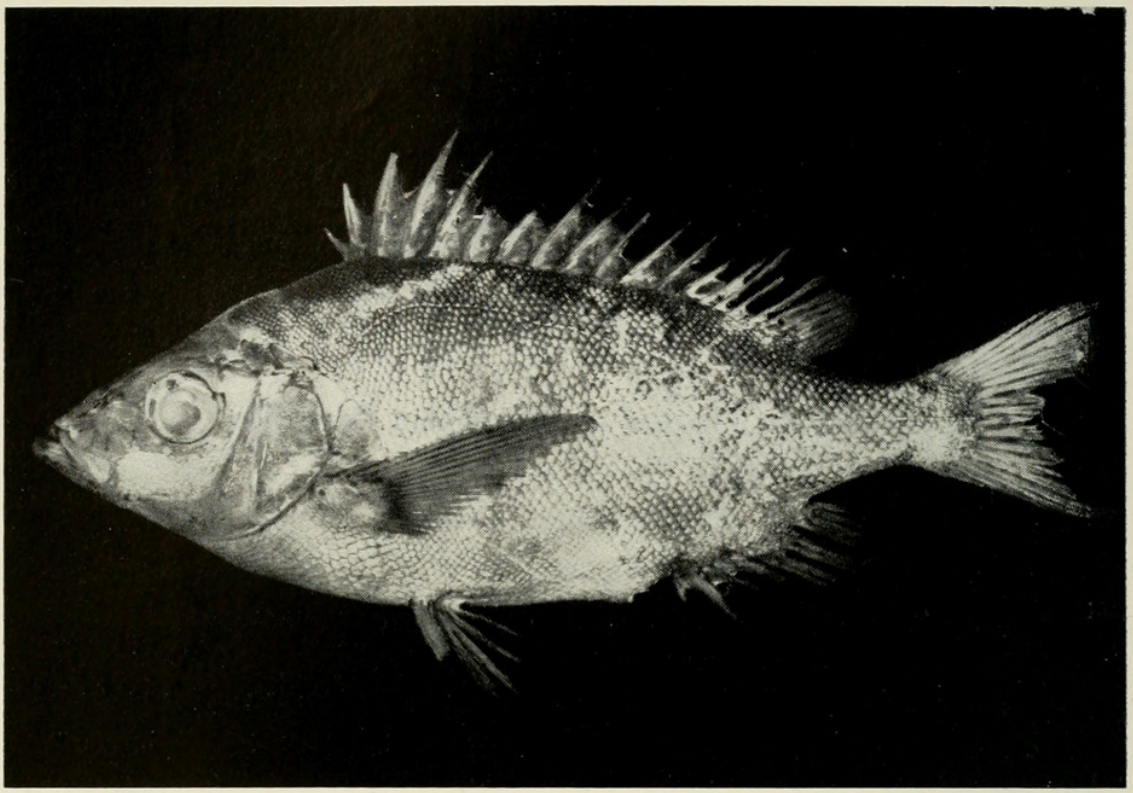

Figure 1. Pelagic armorhead, *Pentaceros richardsoni* Smith, CAS 26759, standard length 252 mm., collected March 10, 1960, off Pigeon Point, San Mateo County, California. Photograph by W. I. Follett.

paucispinis (Ayres), *S. goodei* Eigenmann and Eigenmann, and *Sebastolobus alascanus* Bean; and the anoplopomatid *Anoplopoma fimbria* (Pallas).

DISTRIBUTION

Pentaceros richardsoni has been recorded but once from South Africa, its type-locality (Smith, 1849), and twice from New Zealand (Hutton, 1890; McCulloch and Phillipps, 1923). Certain evidence suggests that its center of abundance is in the vicinity of southern Japan: a number of specimens have been taken south of Tokyo (Abe, 1957; Tomiyama and Abe, 1958), and a fishery for this species is conducted about 50 nautical miles northeast of Hachijō Island, off central Honshu (Tokiharu Abe, personal communication, November 21, 1961). Probably, the specimens recorded from the North Pacific Ocean (Welander, Johnson, and Hajny, 1957) and off British Columbia (Neave, 1959; Clemens and Wilby, 1961) and Oregon (Wagner and Bond, 1962), and our specimen from central California, were transported far to the east of the center of abundance of this species by the North Pacific current system (Kuroshio, Kuroshio Extension, North Pacific Current, and California Current; see Sverdrup, Johnson, and Fleming, 1946, pp. 719–724; chart 7).

SYNONYMY

Pentaceros richardsonii SMITH, 1849, p. [3] (listed in index to plates). GÜNTHER, 1859, p. 212 (reference; diagnosis; distribution; holotype in British Museum). BLEEKER, 1876, p. 270 (type-species, by original designation, of *Pseudopentaceros,* new genus). HUTTON, 1890, p. 277 (specimens, from New Zealand, in Canterbury Museum). GILL, 1893a, p. 116 (synonym of *Pseudopentaceros richardsonii;* reference). GILCHRIST, 1902, p. 108 (references). WAITE, 1907, p. 19 (reference). THOMPSON, 1916, p. 134 (synonymy).

Pentaceros richardsoni SMITH, 1849, pp. [51]–[52] (original description; type-locality, "near to Cape Point," South Africa, "in very deep water"); pl. 21. BLEEKER, 1860, p. 52 (listed, Cape of Good Hope). HUTTON, 1904, p. 41 (reference). JORDAN, 1907, p. 236 (specific name only; type of *Gilchristia,* new genus; record). MCCULLOCH, 1915, p. 144 (type of *Pseudopentaceros* Gill [*sic*], which = *Gilchristia* Jordan and, possibly, *Quinquarius* Jordan; references). JORDAN, 1919, p. 382 (orthotype of *Pseudopentaceros* Bleeker, which "replaces" *Gilchristia* Jordan).

Pseudopentaceros richardsonii. GILL, 1893a, p. 116 (*Pentaceros richardsonii* a synonym; listed, New Zealand). WAITE, 1907, p. 19 (listed, New Zealand; reference). PHILLIPPS, 1927, p. 13 (listed, New Zealand).

Histiopterus richardsoni. JORDAN, 1920, p. 524 (orthotype [*sic*] of *Gilchristia* Jordan[2], a synonym of *Pseudopentaceros* Bleeker).

Pseudopentaceros richardsoni. HUTTON, 1904, p. 41 (listed, New Zealand). MCCULLOCH and PHILLIPPS, 1923, p. 18 (references; description of 70-mm. specimen from Nelson, New Zealand); pl. 4, fig. 1. BARNARD, 1927, pp. 621–622 (references; description; distribution); 1937, pp. 56, 57 (comparisons; counts; reference). SMITH, 1951, pp. 873–875 (distribution; references; comparisons); 1961, p. 242 (references; diagnosis; distribution); pl. 35, fig. 622. WELANDER, JOHNSON, and HAJNY, 1957, p. 244 ("boar fish"); p. 245 (reference; counts; measurements; description; comparisons; taxonomic notes; specimens from North Pacific, 45° 49′ N., 160° 03′ W., to 51° 00′ N., 150° 00′ W.) ABE, 1957, pp. 35–39, 71–73 ("kusakari-tsubodai"; references; description; counts; measurements; comparisons; specimens from southern part of Bōsō Peninsula (probably), from Hachijō Island, and off Amatsu, Japan); fig. 1. TOMIYAMA and ABE, 1958, p. 165 ("kusakari-tsubodai"; diagnosis; "fairly palatable"; distribution; specimens from Hachijō Island and off Amatsu; col. fig.). NEAVE, 1959, p. 384 ("boar fish"; reference; specimen from 50° N., 145° W., off British Columbia). CLEMENS and WILBY, 1961, p. 42

2. Jordan (1920, p. 524) wrote "orthotype *Histiopterus richardsoni* Gilchrist"—surely a *lapsus calami* for *Pentaceros richardsoni* Smith (see Jordan, 1919, p. 382).

(characters in key); p. 219 ("boarfish"; description; records; distribution); fig. 126. WAGNER and BOND, 1962, pp. 71–72 (references; counts; measurements; distinguishing characters; age; specimens from Oregon coast, between Umpqua and Alsea rivers, in 80–90 to 110 fathoms); fig. 1; fig. 2 (head).

Griffinetta nelsonensis WHITLEY and PHILLIPPS, 1939, p. 233 (new genus and species, based on young specimen (total length 70 mm.) from Nelson, New Zealand, described as *Pseudopentaceros richardsoni* by McCulloch and Phillipps, 1923, p. 18).

In view of the extensive changes that occur with age in this family (McCulloch, 1915, pp. 145–146, pl. 26; Waite, 1923, p. 143; Smith, 1951, pp. 874–875), we follow McCulloch and Phillipps (1923, p. 18) in referring their young specimen from Nelson, New Zealand, to *Pentaceros richardsoni*. Whitley and Phillipps (1939, p. 233) referred this specimen to a distinct genus and species, *Griffinetta nelsonensis*, but expressed no basis for such distinction.

DESCRIPTION

We confine our discussion to those respects in which our observations differ from, or supplement, the excellent description of this species by Abe (1957).

Counts and measurements are expressed as by Hubbs and Lagler (1958). Principal caudal rays consist of all branched rays plus the upper and the lower adjacent unbranched ray; all other unbranched caudal rays are regarded as procurrent rays. Predorsal bones (called auxiliary interneurals by Starks, 1904, p. 613) are the median bones (rayless pterygiophores) that are anterior to the dorsal pterygiophores (see Smith and Bailey, 1961, p. 345). Counts of the caudal rays, predorsal bones, and vertebrae were determined from a radiograph.

COUNTS. Dorsal rays XIV,9. Anal rays IV,8. Caudal rays: principal 17 (9 upper, 8 lower); procurrent 11 (6 upper, 5 lower). Pectoral rays 19 on each side (first two and last two unbranched). Pelvic rays I,5 on each side. Scales (left side): 68 lateral-line pores, 14 rows above lateral line, 42 rows below lateral line. Scales (right side): 69 lateral-line pores, 14 rows above lateral line, 41 rows below lateral line. Cheek scales: horizontal rows 7 on each side; vertical rows 13 on each side. Predorsal bones 2. Branchiostegal rays 4 + 3 on each side. Vertebrae 25 (precaudal 12; caudal 13, including urostylar vertebra).

Gill rakers (counts include all rudiments; count of lower limb includes raker in angle of arch):

	Anterior		Posterior	
	Left	Right	Left	Right
1st arch	7 + 17	7 + 17	3 + 15	4 + 15
2nd arch	3 + 15	3 + 15	2 + 12	2 + 12
3rd arch	2 + 12	2 + 13	1 + 11	1 + 11
4th arch	1 + 11	1 + 11	0 + 7	0 + 7

MEASUREMENTS. These are given in hundredths of standard length (252 mm.). Body depth: fifth dorsal spine to pelvic spine 40; fourteenth dorsal spine to first anal spine 30; posterior end of dorsal base to posterior end of anal base 15. Least depth of caudal peduncle 9. Body thickness: greatest 16; between outer margins of pelvic origins 10.

Snout to dorsal origin 39. Dorsal base 53; spinous-dorsal base 40; soft-dorsal base 13. Posterior end of soft-dorsal base to base of middle caudal ray 15. Snout to pectoral origin 33. Snout to pelvic origin 45. Pelvic origin to anal origin 29. Snout to anal origin 72. Anal base 17; spinous-anal base 7; soft-anal base 10. Length of caudal peduncle (posterior end of anal base to base of middle caudal ray) 16.

Head: length 33; depth 30; width 16; postorbital length 13. Snout length 12. Suborbital width 1. Cheek: height 9; length 15. Orbit to angle of preopercle 12. Interorbital width (least bony) 11. Orbit: horizontal diameter 9; vertical diameter 8. Upper-jaw length 10. Mandible length 13. Gape width 7.

DORSAL-FIN SUPPORTS. The two predorsal bones and the first proximal pterygiophore are shaped somewhat like the number "7." The first and second proximal pterygiophores are ankylosed, but they are distinguishable from each other by their lateral keels (as we have confirmed by dissection). Thus distinguished, the first and second pterygiophores support each one dorsal spine. The first predorsal bone extends downward in front of the first neural spine; the second predorsal bone, between the first and second neural spines. The first and second pterygiophores extend downward between the second and third neural spines; the third and fourth pterygiophores, between the third and fourth neural spines. The fifth pterygiophore extends downward between the fourth and fifth neural spines. (Radiographs reveal the same arrangement in the three other specimens of *Pentaceros richardsoni* that we have examined (see table 1) and in a specimen of *Quinquarius* (=*Pentaceros) japonicus* (Stanford University no. 18191) 184 mm. in standard length.)

DORSAL SPINES. The dorsal spines are heteracanth. Because of their bilateral asymmetry, they fit closely together when depressed into the

Figure 2. Locking mechanism of dorsal spines of *Pentaceros richardsoni*, CAS 26759. Spines erect. Radiograph by W. I. Follett.

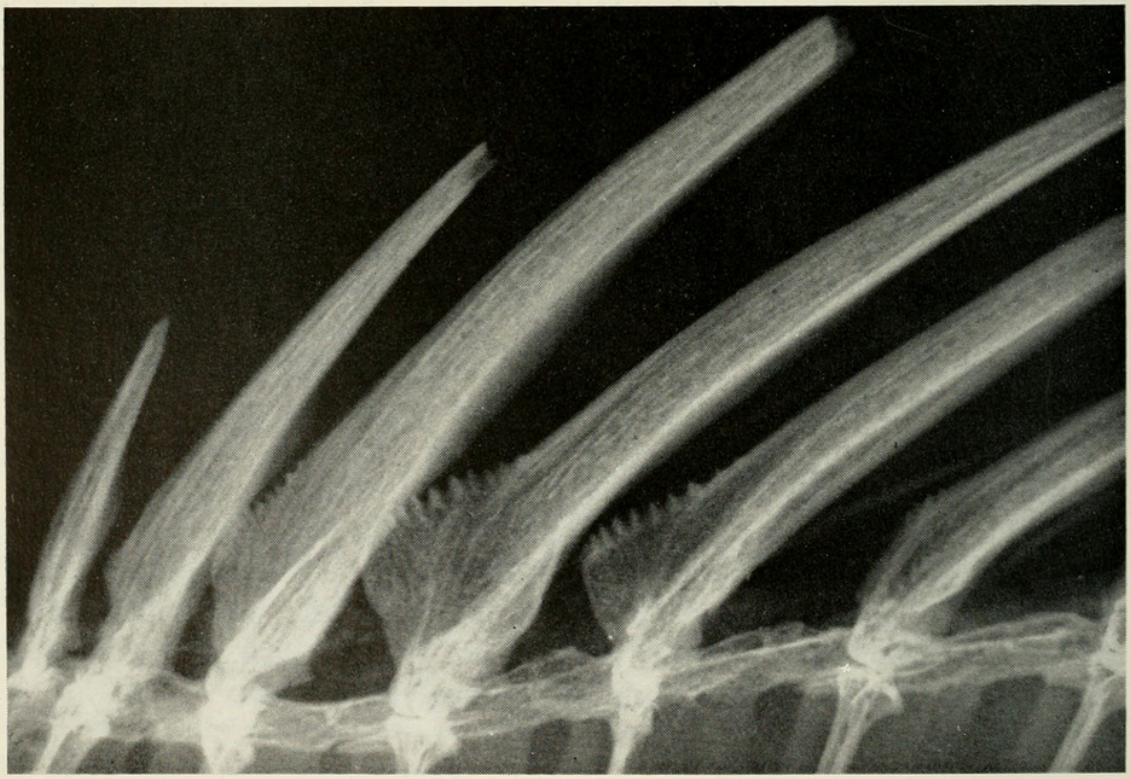

Figure 3. Locking mechanism of dorsal spines of *Pentaceros richardsoni*, CAS 26759. Spines partly depressed, indicating the manner in which the serrate lobe engages the face of the preceding spine. Radiograph by W. I. Follett.

dorsal groove. (Jordan, 1907, p. 235, perhaps inadvertently, noted as a familial character "dorsal . . . spines . . . not depressible in a groove.") As in one of the specimens recorded by Abe (1957, p. 72), the first, third, fifth, and successive odd-numbered spines incline to the right and the second, fourth, sixth, and successive even-numbered spines incline to the left. (In two other specimens recorded by Abe (1957, pp. 36, 71) the odd-numbered spines inclined to the left and the even-numbered spines inclined to the right.) The spines are longitudinally ridged. The ridges are more conspicuous on the left side of the odd-numbered spines and on the right side of the even-numbered spines.

The third to sixth spines, immediately distal to the articulation, are each expanded into a vertical, laterally compressed anterior lobe (see figs. 2–4). (A lobe is faintly indicated on the second and the seventh spines, but is not discernible on any of the others.) The front edge of the lobe is bluntly serrate. The serrae are marginal protrusions of smooth ridges that extend obliquely around the front edge of the lobe (see fig. 4). The lobe of the third and fifth spines is at the left of the interradial membrane; that of the fourth and sixth spines is at the right.

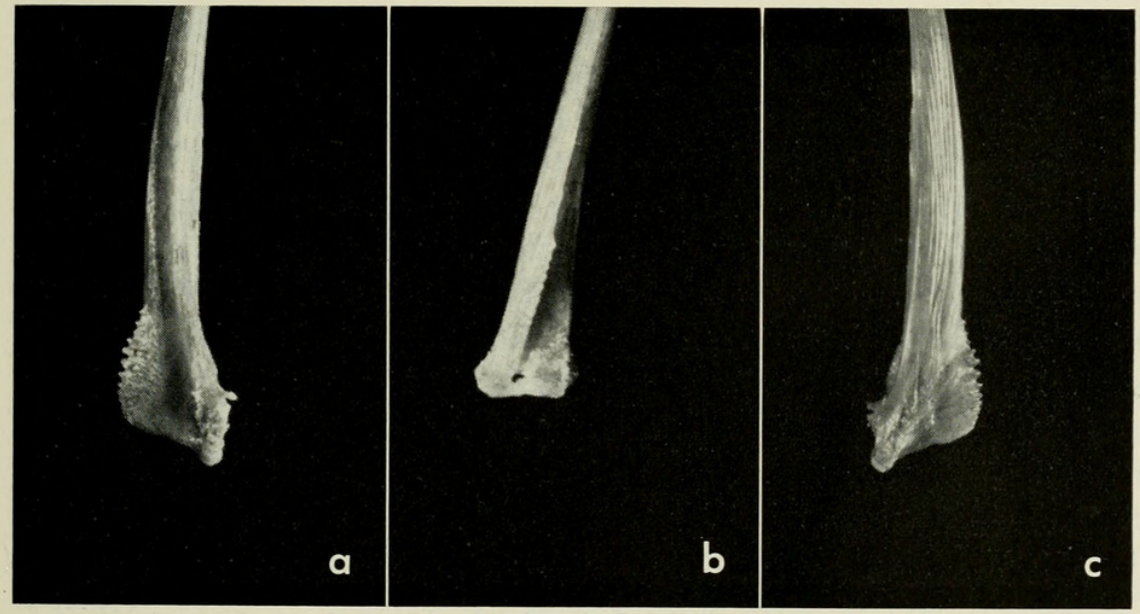

Figure 4. Fourth dorsal spine of *Pentaceros richardsoni*, CAS 26759. a. Lateral view, left side. b. Anterior view. c. Lateral view, right side. Photographs by W. I. Follett.

These lobate spines, which resemble those in *Pentaceros capensis* Cuvier *in* Cuvier and Valenciennes, 1829, and those in *Pentaceros japonicus* Döderlein *in* Steindachner and Döderlein, 1884, function as a locking

mechanism. This mechanism is similar to that in *P. capensis* as described by Smith (1951, p. 878).

ANAL SPINES. The anal spines are heteracanth. The first and third spines incline to the left; the second and fourth, to the right. (In two specimens recorded by Abe, 1957, p. 72, the second spine inclined to the right.) The spines are longitudinally ridged. The ridges are more conspicuous on the right side of the first and third spines and on the left side of the second and fourth spines.

The third spine, immediately distal to its articulation, is expanded into a vertical, laterally compressed anterior lobe, the edge of which bears five blunt serrae. There is a slight anterior lobe on the second spine, but none is discernible on the first or fourth. These lobes are elements of a locking mechanism.

PELVIC SPINES. Longitudinal ridges similar to those on the dorsal and anal spines extend along both sides of the pelvic spines (and along the basal portion of the lower side of the pelvic soft-rays).

BRANCHIOSTEGAL MEMBRANES. The inner fold of the right branchiostegal membrane overlaps that of the left. This asymmetry is contrary to the rule that, in fishes with overlapping branchiostegal membranes, the left membrane generally overlaps the right (see Hubbs and Hubbs, 1945, p. 279; Crossman, 1960, p. 368).

Variability in the asymmetry of the branchiostegal membranes may be common in this species. Three specimens with the right branchiostegal membrane overlapping the left, and four with the left overlapping the right, were recorded by Abe (1957, pp. 38, 71, 72, 73). In the 254-mm. specimen preserved by Welander, Johnson, and Hajny (1957, p. 245), the right branchiostegal membrane overlaps the left; in their 240-mm. specimen, the left overlaps the right. In a 257–mm. specimen collected by Richard C. Johnson, August 15, 1958, in the North Pacific Ocean, 49° 43′ N., 146° 10′ W., the left branchiostegal membrane overlaps the right.

ASSOCIATION OF BILATERAL ASYMMETRIES IN SEVEN SPECIMENS

The bilateral asymmetries of the dorsal spines, anal spines, and branchiostegal membranes in *Pentaceros richardsoni* are variously associated with one another. The combinations of these characters in the four specimens examined by us and in three specimens recorded by Abe (1957) are shown in table 1.

Table 1. *Bilateral asymmetries in seven specimens of* Pentaceros richardsoni.

Specimen	Side of spine expanded into an anterior lobe				Overlapping branchiostegal membrane
	Odd–numbered spines		Even–numbered spines		
	Dorsal	Anal	Dorsal	Anal	
CAS 26759	Left	Right	Right	Left	Right
Abe '57–125	Right	Right	Left	Left	Left
Abe (Masuda) ..	Right	Right	Left	Left	Left
Abe 10552	Left	Right	Right	Left	Right
UW 11468[1]	Right	Right	Left	Right	Left
UW 11469[2]	Left	Left	Right	Left	Right
UW 15515[3]	Left	Right	Right	Left	Left

1. Welander, Johnson, and Hajny (1957, p. 245), 240-mm. specimen.
2. Welander, Johnson, and Hajny (1957, p. 245), 254-mm. specimen.
3. Specimen collected in a surface gill net by Richard C. Johnson, August 25, 1958, in the North Pacific Ocean, 49° 43′ N., 146° 10′ W., water temperature 11.8° C.

DENTITION. The teeth on the premaxillaries and dentaries are in a band. They are small, conical, and slightly curved—those of the outer row irregularly enlarged. There are 24 small, scarcely curved teeth on the head of the vomer. No teeth are present on the shaft of the vomer or on the palatines or tongue. The teeth of the upper and lower pharyngeals are similar in shape to the enlarged teeth of the premaxillaries and dentaries, but are somewhat larger. (The lower pharyngeals are not coalesced.)

CAUDAL SKELETON. Characters revealed by a radiograph of our specimen indicate that the caudal skeleton of *Pentaceros richardsoni* resembles the most primitive perciform type as defined by Gosline (1961). In the following discussion, the terminology follows that of Gosline (1961), except as noted.

Epurals. There are three epurals, similar in shape and size. Their rounded anterior (lower) ends lie above uroneural 1, the anterior end of epural 1 extending slightly ahead of uroneural 1, to a point above the neural process of the penultimate (12th) vertebra.

Uroneurals. There appear to be two uroneurals. Uroneural 1 is similar in shape to that figured by Gosline (1961, fig. 1). The presence of uroneural 2 is suggested by a projection above the dorsal margin of hypural 6 (the uppermost hypural) and by a faint line extending obliquely downward and forward from that projection.

Urostyle. There is a single urostylar ossification.

Hypurals. The sutures separating all six hypurals are distinct. The hypural spine (defined by Merriman, 1940, p. 63) is well developed.

Hemal arches. The hemal arch of the antepenultimate vertebra, as well as that of the penultimate vertebra, is autogenous (separate from the centrum).

Caudal rays. There are 17 principal caudal rays (9 upper, 8 lower) and 11 procurrent rays (6 upper, 5 lower), their articulation with the epurals, hypurals, and hemal spines, respectively, appearing to be as follows:

Epurals 1 and 2 support each one procurrent ray; epural 3 supports four procurrent rays.

Hypural 6 supports one unbranched ray (the uppermost principal ray); hypural 5, six branched rays; hypurals 5 and 4 together, one branched ray; hypural 4, one branched ray (the lowermost ray of the upper lobe); hypural 3, one branched ray (the uppermost ray of the lower lobe); hypural 2, four branched rays; and hypural 1, two branched rays (including the lowermost branched ray of the lower lobe).

The hemal spine of the penultimate vertebra supports the lowermost (unbranched) principal ray and three procurrent rays. The hemal spine of the antepenultimate vertebra supports two procurrent rays.

GENERIC POSITION

We find no characters that justify the distinction of *Pseudopentaceros* Bleeker, 1876, from *Pentaceros* Cuvier *in* Cuvier and Valenciennes, 1829.

When Bleeker (1876, p. 270) erected the genus *Pseudopentaceros* (type-species, *Pentaceros richardsoni),* he diagnosed it as having small teeth on maxillaries and vomer, 14 dorsal spines, 4 anal spines, and no crests or prominent osseous tubercles on the upper surface of the head. He diagnosed the genus *Pentaceros* Cuvier and Valenciennes (type-species, *Pentaceros capensis)* as having small teeth on maxillaries and vomer, 12 dorsal spines, 5 anal spines, and crests or prominent osseous tubercles on the upper surface of the head (Bleeker, 1876, p. 269).

The supposed distinction based on 14 dorsal spines and 4 anal spines in *Pseudopentaceros* in contrast with 12 dorsal spines and 5 anal spines in *Pentaceros* is dispelled by the following material:

1) A specimen of *Pentaceros capensis* with 4 anal spines (Fowler, 1935, pp. 393–394 and fig. 26, as *Quinquarius capensis).* (Fowler's scale counts negate the possibility considered by Barnard, 1937, p. 57, that this specimen might represent *Pentaceros richardsoni.)*

2) A specimen of *Pentaceros capensis* with 13 dorsal spines (Barnard, 1937, p. 56, as *Quinquarius capensis).*

3) A specimen of *Pentaceros richardsoni* with 13 dorsal spines (Clemens and Wilby, 1961, p. 219, and fig. 126, as *Pseudopentaceros richardsoni).*

The presence or absence of cephalic crests or osseous tubercles appears of doubtful significance. This distinction was proposed by Bleeker on the basis of a juvenile of one form and an adult of the other, and apparently without knowledge that these structures are known only in juveniles. (See McCulloch, 1915, pp. 145–146, pl. 26; Waite, 1923, p. 143; Smith, 1951, pp. 874–875.)

In the following summary of noteworthy similarities of the two forms, the characters of *Pentaceros richardsoni* are based on our specimen, 305 mm. in total length, and those of *P. capensis* are based on the description by Smith (1951, as *Quinquarius capensis)* of a specimen 320 mm. in total length.

Bones of the head exposed, bearing rugulose ridges. Lips and chin villous. Dorsal spines heteracanth, longitudinally ridged on alternate sides; on the ridged side, a serrate anterior lobe near the base of the third, fourth, and fifth spines, functioning as an element of a locking mechanism. Anal spines heteracanth, longitudinally ridged on alternate sides; on the ridged side, a serrate anterior lobe near the base of the third spine, functioning as an element of a locking mechanism. Teeth on head of vomer[3], none on palatines or tongue. Lower pharyngeals not coalesced. Preorbital, circumorbitals, preopercle, and ventral surface of mandible, with large sensory pores roofed by membrane. Six large pores across the chin. Lateral line arching toward base of fourth dorsal spine, thence roughly parallel to dorsal base, curving down to caudal peduncle, and thence extending horizontally to caudal base. Scales of throat, breast, cheeks, belly, and nape scutelike, slightly or not at all imbricate. Vertebrae $12 + 13 = 25$. (The vertebral count of $12 + 12$ noted by Welander, Johnson, and Hajny (1957, p. 245) in two specimens of *Pentaceros richardsoni* must have excluded the urostylar vertebra. We have X-rayed these two specimens and we find that each has a vertebral count of $12 + 13$, including the urostylar vertebra. Smith (1951, p. 877) noted the number of vertebrae in his specimen of *Pentaceros capensis* as $13 + 12$. His demarcation between precaudal and caudal vertebrae may be different from ours, since his radiograph *(ibid.,* pl. 18) shows 13 vertebrae that we regard as caudal, and seems to show 12 vertebrae that we regard as precaudal. We therefore believe that both forms have the vertebrae, according to our method of counting, $12 + 13 = 25$.)

Smith (1951, p. 874) stated that if only the adult stadia of *Pseudopentaceros* and *Quinquarius* (= *Pentaceros)* were compared, "one might al-

3. In the original diagnosis of the genus *Quinquarius,* Jordan (1907, p. 238) stated that there are "no teeth on vomer . . . ," but in his key to the genera of the Quinquariinae *(ibid.,* p. 236), he stated that there are "teeth on vomer" in *Quinquarius.* In a 154-mm. specimen of *Quinquarius* (= *Pentaceros) japonicus* (Stanford University no. 18191), which we have examined, teeth are present on the head of the vomer, but not on its shaft.

most be justified in uniting them." But he distinguished them on the following basis *(ibid.,* p. 876) :

Pseudopentaceros	*Quinquarius* (= *Pentaceros)*
Scales in more than 70 series	Scales in fewer than 60 series
Exposed bones of head without marked sensory pores	Exposed bones of head with large sensory pores
In juveniles:	In juveniles:
No horns above eye	Horns above eye
Pelvics not very widely separated	Pelvics widely separated
Depth of body less than half length	Depth of body more than half length

The difference in scale counts does not impress us as of generic significance.

In our specimen of *Pentaceros richardsoni,* the exposed bones of the head have large sensory pores. The presence of such pores in this species has been noted also by Welander, Johnson, and Hajny (1957, p. 245) and Abe (1957, p. 37).

The presence or absence of horns above the eye in juveniles may not be a reliable character in this family. In another species of this family, these structures, which had been considered characteristic of the young of that species, were absent in one young specimen (Barnard, 1927, p. 621).

The distance between pelvics has not been determined for juveniles of *Pentaceros richardsoni.* (In the four adults that we have examined (see table 1), this distance ranges from 2.5 to 3.3 in length of head.)

The difference between a body depth of 2.3 in a juvenile of *Pentaceros richardsoni* (McCulloch and Phillipps, 1923, p. 18) and a body depth of 1.8 in juveniles of *P. capensis* of comparable size (Smith, 1951, p. 881) does not impress us as of generic significance.

We therefore concur with Welander, Johnson, and Hajny (1957, p. 245) in regarding *Pseudopentaceros* Bleeker, 1876, as a subjective synonym of *Pentaceros* Cuvier *in* Cuvier and Valenciennes, 1829.

Specific Distinction

A lower number of dorsal soft-rays and a higher number of scales distinguish *Pentaceros richardsoni* from *P. capensis,* as well as from P. *japonicus* Döderlein *in* Steindacher and Döderlein, 1884, and from *P. hendecacanthus* McCulloch, 1915; a lower number of dorsal soft-rays distinguishes *P. richardsoni* from *P. decacanthus* Günther, 1859 (based on a dried specimen less than two inches long). See table 2.

(The data in table 2 suggest that *P. japonicus* and *P. hendecacanthus,* and possibly even *P. decacanthus,* may not be specifically distinct from *P. capensis.)*

Table 2. *Counts of five species of* Pentaceros.

	richardsoni[1] (15 specimens)	*capensis*[2] (5 specimens)	*decacanthus*[3] (1 specimen)	*japonicus*[4] (4 specimens)	*hendecacanthus*[5] (8 specimens)
Dorsal	XIII or XIV,8 to 10	XII or XIII,12	X,13	XI or XII,13 or 14	XI,13 to 15
Anal	IV,7 to 9	IV to VI,7 or 8	IV,8	IV or V,9 or 10	IV,10 or 11
Pectorals	17 to 19	16	.....	16 or 17	17
Pelvics	I,5	I,5	I,5	I,5	I,5
Caudal	9 + 8	9 + 8	.....	9 + 8	9 + 8
Gill rakers	6 to 8 + 17 or 18	5 or 6 + 16 or 17	.....	7 + 17	.....
Lateral-line pores	64 to 78	50	.....	46 to 49	45 to 47
Scale rows:					
Above lateral line	12 to 14	7	.....	9	10
Below lateral line	41 to 46	27 or 28	.....	31 or 32	33
Predorsal	14 or 15	10	.....	10	9
Cheek:					
Horizontal	7 to 9	5	.....	5 or 6	5
Vertical	12 to 14	10	.....	9 or 10	9
Branchiostegals	4 + 3	7	7	4 + 3	.....
Vertebrae	12 + 13 = 25	12 + 13 = 25	.....	11 + 14 = 25	.....

1. Data from four specimens examined by us (see table 1) and from Smith (1849), McCulloch and Phillipps (1923), Abe (1957), and Clemens and Wilby (1961).

2. Data from Cuvier and Valenciennes (1829) and Smith (1951).

3. Data from Günther (1859).

4. Data from a specimen examined by us (Stanford University no. 18191, 154 mm. in standard length, collected March 17, 1952, by A. Ishizuka at Kozu, Sagami Bay, Japan) and from Steindachner and Döderlein (1884) and Abe (1957).

5. Data from McCulloch (1915).

Nomenclature

Generic name. The generic name *Pentaceros* Cuvier *in* Cuvier and Valenciennes (1829, p. 30) is valid. For some time it has been thought to be preoccupied either by *Pentaceros* Schulze (1760, p. 50) or by *Pentaceros* Schröter (1782, p. 58), but it is evident that under the present rules neither of those earlier names is nomenclaturally available.

For a name to be available, the International Code of Zoological Nomenclature requires that its author must have consistently applied the principles of binominal nomenclature in the work in which the name is published (International Commission on Zoological Nomenclature, 1961, Art. 11c). Binominal nomenclature is the system under which each species receives a name consisting of two words, of which the first is the generic name and the second is the specific name *(ibid.,* Glossary, p. 148).

Schulze (1760) did not consistently, if at all, apply the principles of binominal nomenclature (see Clark, 1908, p. 517; Springer, 1909, p. 183; Bather, 1909, p. 40; and Jordan and Richardson, 1909, p. 192). It cannot be demonstrated that the names used by Schulze are even names of genera or species. *Pentaceros* Schulze (1760, p. 50) is a descriptive term applied to a group of starfishes of indeterminate rank. It includes two subgroups, also of indeterminate rank, the *planae* (plural) and the *gibbae* (plural). Jordan and Evermann (1917, p. 126) remarked that "obviously this is not scientific nomenclature," and Fisher (1908, p. 91) stated that "there is no evidence that Schulze knew anything about binomial nomenclature, for he does not conform to the Linnaean system . . ."

Any doubt regarding the nomenclatural status of *Pentaceros* Schulze, 1760, has now been eliminated by Opinion 636, which placed Schulze, 1760 (misspelled "Schultze"), on the Official Index of Rejected and Invalid Works in Zoological Nomenclature, on the ground that the author did not apply the principles of binominal nomenclature (International Commission on Zoological Nomenclature, 1962, p. 263).

Schröter (1782), the next author to use the name *Pentaceros,* did not consistently apply the principles of binominal nomenclature. In his only mention of *Pentaceros (ibid.,* p. 58), he merely cited the polynominal term that had been applied to the "five-horned star" by the pre-Linnaean author Linck:

"Fig. III. ist auf der Seite des Rückens vorgestellt, und kommt vor im Link [*sic*] de stellis mar. tab. III. fig. 3. auf der Rückenseite, und Tab. II. fig. 3. auf der Seite der Mündung. S. 21. 22. stehet er unter dem Geschlecht *Pentaceros,* der fünfhörnige Stern, und heisst *Pentaceros gibbus turritus pluribus velut turriculis munitus.* Die Seepastete Rumph holländ. p. 39. Beym Linné ist er ed. XII. p. 1100. Gen. 298, sp. 7. *Asterias nodosa* oder *Asterias stellata, radiis convexis longitudinaliter elevatis muricatis. . . .*"

We concur with Fisher (1908, p. 93), who stated, "Schröter, in 1782 (Musei Gottwaldiani Testaceorum, Stellarum marinum, etc., Nürnberg, 58), used *Pentaceros,* but he is not a consistent binomialist, and his 'generic' names are not tenable."

Since *Pentaceros* Cuvier *in* Cuvier and Valenciennes is not preoccupied, the name *Quinquarius* Jordan, 1907, which was proposed "to replace *Pentaceros* Cuv. & Val., regarded as preoccupied" (Jordan, 1920, p. 524), is relegated to synonymy.

The name *Pentaceros* Cuvier *in* Cuvier and Valenciennes has been used in the primary zoological literature within the past fifty years (Thompson, 1916, p. 134), and is therefore not to be considered a forgotten name *(nomen oblitum);* see International Commission on Zoological Nomenclature (1961, Art. 23b).

FAMILY NAME. The oldest available family-group name based on the nominal genus *Pentaceros* is Pentacerotinae (correction by Gill, 1893b, p. 134, of Pentaceratina Günther, 1859, p. 212). The name Pentacerotinae fulfils the requirements of availability of family-group names (International Commission on Zoological Nomenclature, 1961, Art. 11e): it was based on the name then valid for a contained genus *(Pentaceros)* and it was a noun in the nominative plural; it was clearly used to denote a suprageneric taxon (it was designated "group" but was used in the sense of subfamily), and was not merely employed as a plural noun or adjective referring to the members of a genus. The subfamily name Pentacerotinae, so used, makes available the family name Pentacerotidae Günther, 1859 (see International Commission on Zoological Nomenclature, 1961, Arts. 29, 36). The name Pentacerotidae, which has priority over the name Histiopteridae Jordan (1905, p. 398, and footnote to p. 585), is the valid name of this family. (Under the present rules, the valid name of a family is the oldest available name applied to it. See International Commission on Zoological Nomenclature, 1961, Art. 23.)

The correct form of the family name based on *Pentaceros* is Pentacerotidae, not Pentaceridae or Pentaceratidae. The genitive singular of *Pentaceros,* an adjectival form (used as a noun) based on *-ceras,* is *Pentacerotos,* from which is derived the family name Pentacerotidae (L. W. Grensted, classical adviser to the International Commission on Zoological Nomenclature, *in litt.,* February 9, 1962).

Family-group names based on *Pentaceros* have been used by a number of authors: the family name Pentacerotidae, by Bleeker (1860, p. 52, correction by Gill, 1885, p. 210, of Pentacerotoidei), by Gill (1893a, pp. 105, 116; 1893b, p. 134), by Jordan and Evermann (1902, p. 351), by Hutton (1904, p. 41), by Jordan (1905, p. 333), by Smith and Pope (1906, p. 479), and by Jordan and Richardson (1909, p. 192); the subfamily name Penta-

cerotinae, by Günther (1859, p. 212, correction by Gill, 1893b, p. 134, of Pentaceratina), by Bleeker (1876, pp. 269, 287, correction by Gill, 1893b, of Pentacerotiformes), by Boulenger (1910, p. 660), and by Thompson (1916, p. 134, correction of Pentaceratinae).

SPECIFIC NAME. The specific name of this fish was spelled in two ways in the original publication (Smith, 1849): *richardsonii* in the index to the plates, and *richardsoni* in the text and on plate 21.

If a name is spelled in more than one way in the original publication, the spelling adopted by the first reviser is to be accepted as the correct original spelling (International Commission on Zoological Nomenclature, 1961, Art. 32b). An author, to be a first reviser, must cite the names in question, make it clear that he believes them to represent the same taxon, and choose one as the name of that taxon *(ibid.*, Art. 24a(i)).

Since we have found no publication, other than the original description, in which both original spellings of this specific name were cited, we conclude that neither spelling has been adopted by a "first reviser."

The Code recommends that a specific name based on a modern personal name that is neither Latin nor latinized nor of Greek origin should end in *-i* rather than *-ii (ibid.*, Appendix D, Recommendation 16). As first revisers, we therefore choose the spelling *richardsoni* in preference to the spelling *richardsonii* for the specific name of this fish.

COMMON NAME

We propose the common name "pelagic armorhead" for *Pentaceros richardsoni.*

Although the name "boarfish" has been applied to this and other species of the Pentacerotidae by a number of ichthyologists (see, for example, Günther (1880, p. 388), Tenison-Woods (1883, p. 183), Waite (1898, p. 33; 1911, p. 216; 1921, p. 117), Roughley (1916, pp. 9, 127), Phillipps (1927, p. 13), McCann (1953, p. 12), Welander, Johnson, and Hajny (1957, p. 244), Smith (1961, p. 242), and Clemens and Wilby (1961, p. 219)), we believe that "boarfish" should be restricted to the species of the Caproidae. Such a restriction appears justified on the following grounds:

1) *Capros* (the name of the type-genus of the family Caproidae) itself means "boar." The vernacular "aper," meaning "wild boar," was applied to the fish currently known as *Capros aper* (Linnaeus, 1758) more than 400 years ago (Boussuet, 1558, p. 28)—and more than 300 years before "boarfish" was applied to any species of the Pentacerotidae.

2) Use of the name "boarfish" for *Capros aper* and other species of the Caproidae is deeply ingrained in the literature of the past century (see Yarrell, 1859, p. 258; Couch, 1869, p. 142; Buckland, 1880, p. 77; Günther, 1880, p. 449; Tenison-Woods, 1883, p. 183; Gill, 1885, p. 209;

Jordan and Evermann, 1898, p. 1663; Jordan and Fowler, 1902, p. 521; Aflalo, 1904, pp. 129, 137; Jordan, 1905, p. 398; Boulenger, 1910, p. 666; Meek, 1916, p. 305; Barnard, 1925, p. 380; Norman, 1931, p. 378; Gregory, 1933, p. 272; Munro, 1938, p. 77, and 1955, p. 89; Jenkins, 1950, p. 81; Berry, 1959; Food and Agriculture Organization, 1960, p. 99; Myers, 1960, pp. 89, 96; Herald, 1961, p. 160).

3) The name "boarfish" has been adopted for species of the Caproidae by the American Fisheries Society Committee on Names of Fishes (1960, p. 24).

No English name other than "boarfish" has been widely used for species of the Pentacerotidae[4]. It seems desirable therefore to apply a new common name to those species. Our choice of such a name, "armorhead," is based on the rough, bony plates of the head—a conspicuous and unique character.

The attributive "pelagic" in the proposed name, "pelagic armorhead," refers to the occurrence of *Pentaceros richardsoni* far offshore.

Summary

1) A specimen of *Pentaceros richardsoni* Smith from the coast of California is described, with meristic and morphometric data and notes on the dorsal-fin supports, the locking mechanism of the dorsal and anal spines, and the osteology of the caudal region. The bilateral asymmetries of the dorsal spines, anal spines, and branchiostegal membranes of seven specimens of this species are shown to be variously associated.

2) Distributional notes and an annotated synonymy of *Pentaceros richardsoni* are provided.

3) *Pseudopentaceros* Bleeker, 1876 (type species, *Pentaceros richardsoni)* is shown to be a subjective synonym of *Pentaceros* Cuvier *in* Cuvier and Valenciennes, 1829 (type species, *Pentaceros capensis).*

4) The specific distinction of *Pentaceros richardsoni* from *P. capensis* Cuvier *in* Cuvier and Valenciennes, *P. decacanthus* Günther, *P. japonicus* Döderlein *in* Steindachner and Döderlein, and *P. hendecacanthus* McCulloch is confirmed. *Pentaceros japonicus* and *P. hendecacanthus,* and possibly even *P. decacanthus,* are regarded as questionably distinct from *P. capensis.*

5) The generic name *Pentaceros* Cuvier *in* Cuvier and Valenciennes, 1829, thought to be preoccupied either by *Pentaceros* Schulze, 1760, or by *Pentaceros* Schröter, 1782, is shown to be valid. *Quinquarius* Jordan, 1907, proposed to replace *Pentaceros* Cuvier *in* Cuvier and Valenciennes, is relegated to synonymy. The family name Pentacerotidae Günther, 1859, which has priority over Histiopteridae Jordan, 1905, is shown to be valid.

6) Of the two original spellings, *richardsoni* is adopted as the correct

4. The vernacular "porgy," used for species of this family by Jordan (1907), has been adopted for certain species of the Sparidae by the American Fisheries Society Committee on Names of Fishes (1960, p. 32).

original spelling in preference to *richardsonii* for the name of this species.

7) The common name "pelagic armorhead" is proposed for *Pentaceros richardsoni.*

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