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A new species of *Polyipnus* (Teleostei: Stomiiformes) from the western Pacific, with comments on the *P. triphanos* species complex

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Abstract

A new species of the teleostean family Sternoptychidae, *Polyipnus notatus* **n. sp.**, is described based on material collected mainly off Taiwan in the South China Sea. The new species is most similar to *P. triphanos*, based on the presence of a single posttemporal spine, lack of scale spination, and the second and third ACA (=supra-anal) photophores elevated relative to the first and connected to each other in a common organ. These characters typify other members of the *P. asteroides* species group that occur in various tropical to temperate ocean basins. Based on a limited sample of 27 specimens, *P. notatus* (maximum observed size 30.7 mm SL) appears to be smaller than most other congeners. It is also characterized by an unusual lateral pigment bar, which is narrow and distinctly triangular. Based on the material examined, the geographical distribution of the species appears to be restricted to the South China Sea and adjacent minor ocean basins.

Key words: Sternoptychidae, *Polyipnus notatus* **n. sp.**, hatchetfish, South China Sea

Introduction

Polyipnus is one of the three genera of luminescent, deep-bodied marine hatchetfishes, and is the most diverse genus of the Sternoptychidae with 32 valid species (Eschmeyer 2014; Harold *et al.* 1998). The species are planktivorous and thought to be benthopelagic commonly to a depth of about 500 meters, with some species (e.g., *P. unispinus* Schultz, 1938) above 100 meters at night (Harold, 1994). The genus has been reviewed most recently by Harold (1994), Baird (1971), and Schultz (1938, 1961, 1964). Species of this genus occur in tropical to temperate latitudes and, like many groups of marine organisms (Ekman, 1953), exhibit high diversity in the western Pacific, especially in the region from around Japan and the Philippines southward to the Coral and Tasman seas (Harold *et al.* 2015). Several endemic species of *Polyipnus* have been described from the area from the South China Sea northwards to Japan (e.g., Aizawa 1990; Harold 1990a; Schultz 1961).

We have been studying morphological variation in *Polyipnus triphanos* Schultz 1938 and similar forms in an attempt to document more completely the diversity within the monophyletic *P. asteroides* Schultz, 1938 species group (*sensu* Harold 1994). *Polyipnus triphanos* has been recorded from several localities ranging from the Japanese Archipelago southward through the South China Sea area, Indonesia, and off the east coast of Australia (Fujii 1984; Harold 1994; Liao *et al.* 2008; Schultz 1961). *Polyipnus triphanos* was designated a species complex on the basis of intraspecific variation in several critical characters that was broader than that observed in other species. These characters include a dorsal pigmentation bar and saddle pattern, photophore arrangement, and meristic features like gill rakers and anal-fin rays. A shortage of material from most areas of the geographical range has continued to cause difficulty in determining exactly how many species are contained in the complex.

The current project focuses on the clarification of one part of the *P. triphanos* species complex by describing a new species from the South China Sea off Taiwan. Some of the specimens of the new species (CAS 56034) were

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assigned provisionally to the *Polyipnus triphanos* species complex by Harold (1994: 495), pending further study and comparison with other material. With more material now available, we move forward with a description of the specimens from off Taiwan as a new species, but set aside the remaining complex for further analysis.

Materials and methods

Body size is standard length (SL) in all cases. Morphometric, meristic, photophore and other characters were determined following the methods and terminology of Hubbs & Lagler (1958), with modifications based mainly on Harold (1994). Values for paired features reported for the left side, unless stated otherwise. Terminology of the photophores follows Badcock (1984) and Weitzman (1986), which was adopted by Harold (1994), with modifications relating to opercular photophores (Harold & Lancaster 2002), for the deep-bodied sternoptychids *Argyropelecus*, *Polyipnus* and *Sternoptyx*, so that the same set of photophore terms are used for all stomiiforms. These terms are repeated and illustrated here (Fig. 1) for convenience, and because the terms now in use replace those of Schultz (1961) that occur in much of the earlier sternoptychid literature. The abbreviation for each photophore series/cluster and their synonyms, as used by Schultz (1961, 1964) and Baird (1971) are provided in Fig. 1 to facilitate comparisons mainly with earlier literature. Pigmentation features referred to and which typify *P. triphanos* are illustrated in Fig. 1: scope of variation in dorsal pigmentation pattern among species of *Polyipnus* shown in Harold (1994: fig.2). Meristic data include counts of total dorsal-, anal-, pectoral- and pelvic-fin rays, upper and lower gill rakers, total vertebrae, and ACB photophores.

Morphometric data were obtained with a digital caliper interfaced with spreadsheet software, with statistical analysis performed in Microsoft Excel. The following additional characters were designed for the current study to quantify variation in topographical positions of OVB and ACA photophores. Elevation on the body flank of each of the OVB photophores (OVB 1 height, OVB 2 height, and OVB 3 height) are the distances between the dorsal border (of the circular body of white tissue present in each photophore) of OVB 1 and PV 7 (PV photophore located immediately below and in the same segment), OVB2 and PV 8, and OVB 3 and PV 9, respectively. The two measurements for the relative elevations of the first two ACA photophores (ACA 1-AFPS distance, and ACA 2-AFPS distance) are the distances from distal tip of anal fin pterygiophore lateral process (location homologous with base of anal-fin pterygiophore spine, AFPS, in species bearing such a spine; Fig. 1) to the dorsal borders of ACA 1 and ACA 2 photophores, respectively. The size of the gap between the ACB and ACC photophore clusters (ACB-ACC D) was determined by measuring the distance between the posterior ACB photophore and the anterior ACC. The dorsal spinous process (dorsal blade, Schultz, 1961) is an external bony structure immediately anterior to the dorsal fin, formed from the fusion of a proximal and middle pterygiophore (radial) and the posterior - supraneural bone (Weitzman 1974).

Material examined, specimen, and collection data are reported in the following sequence: institutional abbreviation and catalog number, in parentheses the number of specimens examined and their size range in mm SL, latitude and longitude, locality general description, trawl depth, water depth, time of day, vessel, station number, collector, field number, and date. The term “mwo is an abbreviation of “meters of wire out, sometimes present in collection data for midwater tows in place of depth of capture. Meristic character ranges are accompanied by the value for the holotype in parentheses and total number of specimens examined in brackets. Numbers of specimens examined contributing to morphometric and meristic data vary because physical damage to external structures often did not permit accurate observation. Clearing and counterstaining for bone and cartilage follow Potthoff (1984) and Taylor & Van Dyke (1985). Observations on osteology and dentition are based on two cleared and stained specimens of *Polyipnus notatus* **n. sp.** (CAS 56034, 29.5 mm and ZMUC 206963, 30.4 mm). Institutional abbreviations are as listed in Sabaj-Pérez (2013).

***Polyipnus notatus* new species**

Fig. 2, Table 1

Polyipnus triphanos (non Schultz): Harold, 1994:495 (in part, CAS 56034 only, and map, fig. 30).
Polyipnus triphanos Schultz 1938. In part (USNM 103028, one specimen, 21.2 mm SL, Celebes Sea, *P. triphanos* paratype).

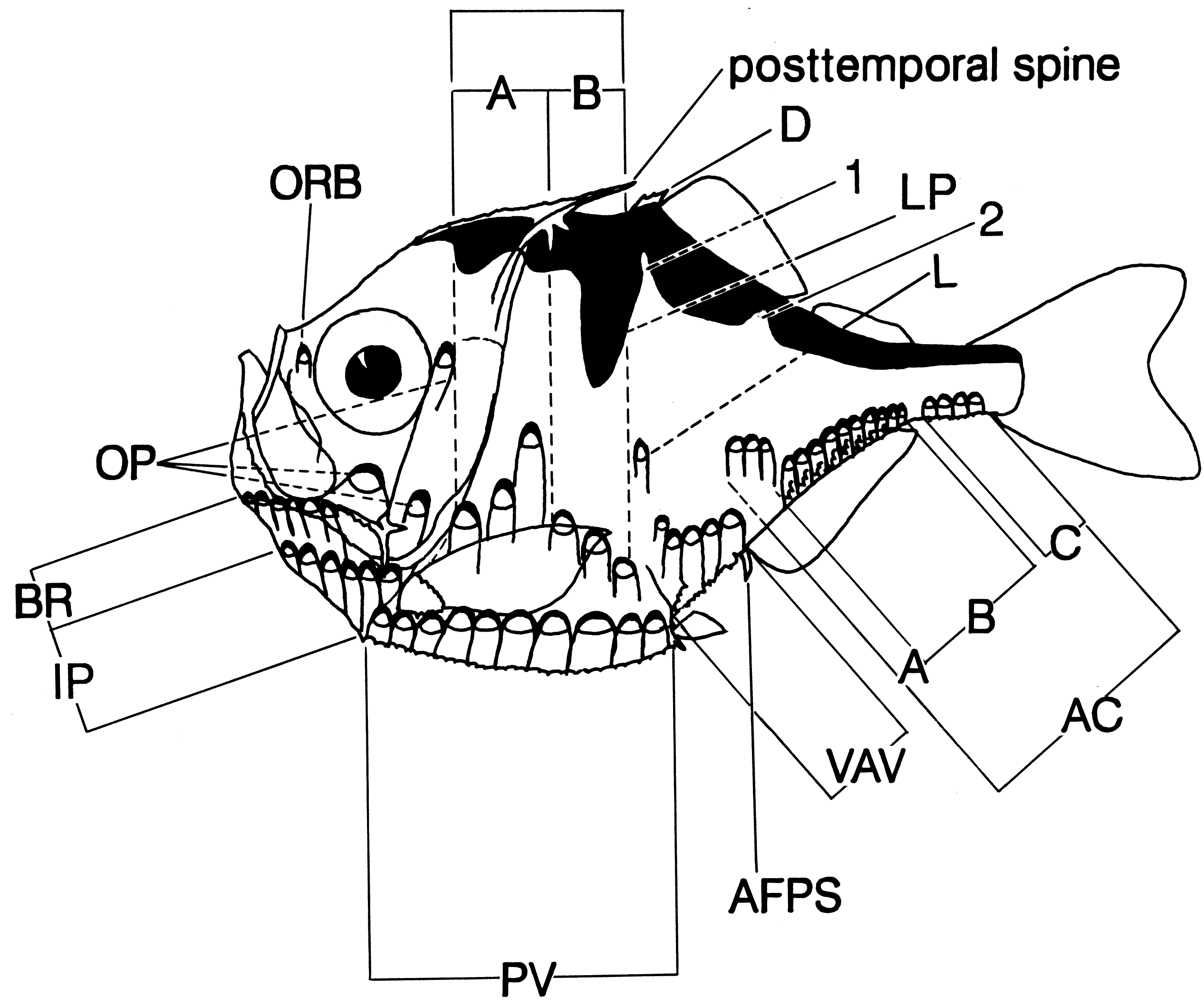

FIGURE 1. Photophores and other external features of species of *Polyipnus*. AFPS, anal fin pterygiophore spine; D, dorsal spinous process; LP, lateral pigment bar; 1, predorsal pigment inflection; 2, postdorsal pigment inflection. Photophore terminology, with replaced abbreviations of Baird (1971) and equivalent descriptive terms of Schultz (1961) in parentheses, except as noted for OP photophores: AC, subdivided into ACA (SAN, supra-anal), ACB (AN, anal), ACC (SC, subcaudal), BR (BR, branchiostegal), IP (I, isthmus), L (L, lateral; equivalent to a posterior OV photophore in other stomiiforms), OP (PRO, preopercular + PTO, postorbital + SO, subopercular; following Badcock, 1984), ORB (PO, preorbital), OVA (SP, suprapectoral), OVB (SAB, supra-abdominal), PV (AB, abdominal), and VAV (PAN, preanal). Reproduced, with permission, from Harold (1994: fig.1).

Holotype: USNM 361926 (27.7 mm), 22°17'N, 120°21'E, South China Sea, SW of Taiwan, (0–) 200 m, 1000–1200 h, R/V Jen-Ming-Fa, coll. by J. Ta-Ming Wang, 05 Feb 1995.

Paratypes. (22, 17.6–30.7 mm). ASIZP 62376 (10, 21.8–30.7 mm), 22°44'N, 120°55'E, South China Sea, off Tungkang, Taiwan. CAS 56034 (10, 17.6–30.0 mm; one specimen, 29.5 mm, cleared and counter-stained), 22°23'N 120°25'E, South China Sea, off Tungkang, Taiwan, coll. by Weise Chang, field number WC 18-XI-83, 18 Nov 1983. USNM 427221 (2, 18.3–26.2 mm), collected with holotype.

Non-types. USNM 103028 (1 of 2, 21.2 mm), 08°37'45"N 124°36'45"E, Celebes Sea, (0–) 488 m, R/V Albatross Sta. 5500, 04 Aug 1909, *Polyipnus triphanos* paratype (17.6 mm specimen in this lot cannot be reliably identified to species). ZMUC P206962 (1, 28.9 mm), off Batangas, Philippines, 13°32'N, 121°21'E, 600 mwo, depth 450 m, R/V *Dana*, Sta. 3733-2, 15 Oct 1929. ZMUC P206963 (2, 26.5–30.4 mm; 30.4 mm specimen cleared and counter-stained), north of Mindanao, Philippines, 09°17'N, 123°58'E, 600 mwo, depth 1770 m, R/V *Dana*, Sta. 3736-6, 28 Jun 1929.

TABLE 1. Morphometric character values expressed as percentages of head length (2 to 4) or standard length (all others) for *Polyipnus notatus* holotype (USNM 361926) and range for 22 paratypes, ASIZP 62376 (10), CAS 56034 (10), and USNM 427221 (2), with overall mean and N for each character.

		Holotype	Paratypes (range)		mean	N
1.	Standard length	27.7	17.6	30.7	26.0	23
2.	Posttemporal spine length	5.9	4.8	13.1	9.4	23
3.	Orbit length	49.1	42.1	57.1	51.9	22
4.	Snout length	24.6	18.1	29.4	24.4	23
5.	Head length	34.3	31.8	38.8	35.4	23
6.	Body depth	59.0	57.2	68.8	61.5	23
7.	Caudal peduncle length	13.3	9.6	16.0	13.5	22
8.	Caudal peduncle depth	11.3	8.7	13.2	10.8	23
9.	Dorsal fin base length	18.9	16.1	21.7	18.7	23
10.	Anal fin base length	27.2	25.5	30.5	28.0	22
11.	Preanal length	67.7	64.8	74.7	70.0	23
12.	Predorsal length	54.5	54.5	60.3	56.7	23
13.	Prepelvic length	60.2	60.0	69.6	64.2	23
14.	Postdorsal length	55.5	46.5	55.2	52.3	21
15.	Postanal length	41.5	38.9	46.0	42.0	23
16.	Dorsal-pelvic length	54.4	51.5	61.5	55.7	23
17.	ACC length	5.9	6.7	9.9	8.3	23
18.	ACB-ACC length	2.4	0.9	5.0	1.9	23
19.	OVB 1 height	10.2	10.1	15.3	12.2	22
20.	OVB 2 height	5.1	3.5	7.4	5.8	22
21.	OVB 3 height	8.1	7.6	10.7	9.1	22
22.	ACA 1-AFPS distance	13.8	11.4	14.9	13.2	22
23.	ACA 2-AFPS distance	18.1	15.4	19.6	17.4	22

Diagnosis. Unique pattern of dark dorsal pigmentation, with narrow, distinctly triangular vertical lateral bar extending ventrally of predorsal blade to near midline (Fig. 2), compared with a typically broad lateral pigment bar in the other members of the *P. asteroides* species group, *P. asteroides* Schultz, 1938, *P. bruuni* Harold, 1994, *P. clarus* Harold, 1994, *P. laternatus* Garman, 1899, *P. polli* Schultz, 1961, and *P. triphanos* Schultz, 1938 (Harold, 1994: figs. 27, 29, 31, 32, 33, 34, respectively). Ventral margin of dorsal pigment anterior of lateral pigment bar nearly straight and horizontal (Fig. 2), not arched as in other members of the species group. Very small gap between ACB and ACC photophore clusters in most specimens (mean 1.9 left side, 1.8 right side, range 0.9–3.2 % SL, in specimens greater than 20 mm SL), compared with mean 5.6 left side, 5.5 right side, range 2.4–7.8 % SL in *P. triphanos* (*sensu stricto*) and 2.2–5.8 combined range for other members of the *P. asteroides* species group. Other characters in combination: ACB photophores 9–10 (7 and 8 observed in 17.6 mm specimen); 7–9 in *P. triphanos* species complex (Table 2), values of 10 or higher present only in Atlantic species *P. asteroides*, *P. clarus* and *P. laternatus*, and gill rakers 14–15 (16–24 total range for remaining members of group) (Table 3).

Description. 23 specimens: (27.7 mm) 17.6–30.7 mm. Maximum observed body size 30.7 mm SL. D (11) 10–12 [23]. A (18) 17–18 [22]. Posteriormost ray of both dorsal and anal fins divided completely to its base. P (14) 12–14 [22]. V (7) 6–7 [6]. C 10 dorsal and 9 ventral segmented rays. Dorsal adipose fin present. GR (4) 4–5 + (10) 9–11 = (14) 14–15 [16]. Branchiostegal rays 10 (7 anterior ceratohyal + 3 posterior ceratohyal). Total vertebrae (33) 33–34 [22]. Scales deciduous. Remaining scales thickened and modified in association with photophores. Body profile anterior of dorsal fin and pelvic fin broadly elliptical, although dorsal profile of head from premaxilla to occiput nearly straight, from that point to dorsal-fin origin nearly straight, with a broadly obtuse angle, its apex located at occiput. Profile from dorsal-fin origin to caudal peduncle nearly straight, but with slight convexity posteriorly; ventral margin of abdomen (PV photophore outline) slightly convex, profile from pelvic-fin base to anal-fin origin (ventral margin of VAV photophore scales) slightly convex, profile of anal-fin base gently sinusoidal with slight concavity anteriorly; caudal peduncle slightly elongate and tapered posteriorly.

TABLE 2. Frequency distribution of counts of ACB photophores, dorsal-, anal-, and pectoral-fin rays, and total vertebrae. *juvenile specimen (17.6 mm) with 8 left and 7 right ACB photophores. Values reported for *P. notatus* based on the type series and four non-types. Indo-Philippine refers to oceanic areas through Indonesia, northward to and including the Philippines (North Pacific).

	ACB photophores			
	7	8	9	10
P. notatus		1*	12	14
P. triphanos Indo-Philippine	12	8	1	
P. triphanos Coral Sea	4	21	1	

	Dorsal-fin Rays			
	10	11	12	13
P. notatus	2	22	3	
P. triphanos Indo-Philippine	4	16	1	1
P. triphanos Coral Sea	3	19	4	

	Anal-fin Rays			
	15	16	17	18
P. notatus			15	15
P. triphanos Indo-Philippine		8	11	3
P. triphanos Coral Sea	2	2	14	2

	Pectoral-fin Rays			
	12	13	14	15
P. notatus	5	15	6	
P. triphanos Indo-Philippine	2	8	12	
P. triphanos Coral Sea		6	18	1

	Vertebrae			
	31	32	33	34
P. notatus			16	9
P. triphanos Indo-Philippine		4	16	
P. triphanos Coral Sea		2	19	5

Orbit slightly ovate, with elongation in anterodorsal to posteroventral direction. Dentition characters based on one cleared and counter-stained specimen (CAS 56034, 29.5 mm): premaxillary teeth uniserial, 39 left and 36 right, conical to slightly recurved; maxillary teeth minute and conical, biserial with 19 left to 22 right teeth in lateral series on margin of bone and about 6 in medial series scattered along length of bone. Ventral margin of dentary gently convex, with lower jaw terminating posteriorly in acute ventrally directed angle. Dentary teeth slightly larger than maxillary teeth, conical to slightly recurved, 14 in main series along length of bone, two additional series of 5 or 6 recurved teeth near symphysis. Palatine teeth 2, anteriormost tooth conical and about half the length of medial premaxillary teeth, posterior tooth about a quarter the length of other tooth (both sides of cleared and stained specimen). Endopterygoid teeth absent. Vomerine teeth about equal in size to medial premaxillary teeth, recurved, 3 on left lateral process, 2 medially, and 2 on right lateral process, no teeth present on elongate posteromedian process. Gill rakers moderately elongate, with 3–5 longitudinal series of minute conical teeth confined to medial and lateral surfaces. Pseudobranch present, with 10 filaments. Parietal crest discontinuous; anterior portion a laterally compressed, sheet-like ridge, posterior region with two conical spines in the median plane, directed anteriorly and posteriorly; gap between anterior and posterior portions of crest variously occluded by ossification. Parietal with small conical spine posteriorly. Posttemporal spine relatively short, (5.9) 4.8–13.1 % HL), acutely triangular, non-serrate, posterodorsally directed. Exserted anteroventral margin of cleithrum (pectoral shield) with three or four posteroventrally-directed small conical spines. Preopercular rami smooth, lacking serration; one short preopercular spine, (3.8) 5.0–9.8 % HL, in posteroventral angle. Dorsal spinous process with smooth exterior surfaces, terminating posterodorsally in bilateral conical posterodorsally-directed spines. Pelvic (iliac) spine single, acutely triangular but with slight concavity on anterior surface, directed posteroventrally. Anal-fin pterygiophore spine absent, with rounded body of cartilage present only.

TABLE 3. Frequency distribution of counts of gill rakers for *Polyipnus notatus* and *P. triphanos*.

	Gill Rakers							
	14	15	16	17	18	19	20	21
P. notatus	6	14						
P. triphanos Indo-Philippine			4	4	5	3	3	
P. triphanos Coral Sea					1	5	4	3

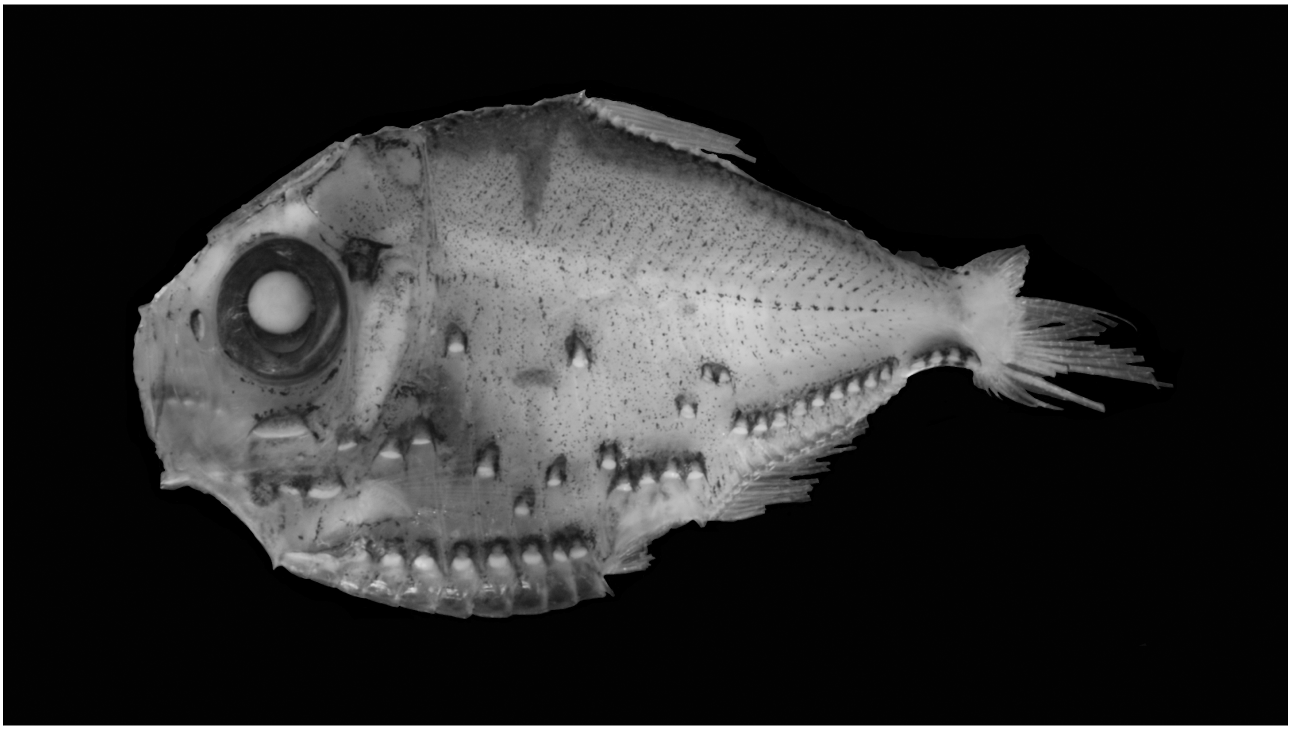

FIGURE 2. *Polyipnus notatus*, holotype, 27.7 mm SL, USNM 361926, South China Sea.

Ventral margins of photophore scales lacking spines or denticles. ACA 1+2 with #2 and #3 highly elevated with respect to #1. ACB (10) 7–10 [23], 9 or 10 in all but smallest specimen (17.6 mm SL), with dorsal step between #3 and #4, very small gap between ACB and ACC, mean 1.9 left side, 1.8 right side, (2.4) 0.9–3.2 % SL in specimens greater than 20 mm SL (Fig. 3), appearing in some specimens as a nearly continuous series from ACB to

ACC. OVB 1+1+1, in a V configuration but with anteriormost photophore (#1) elevated with respect to #3. Counts of remaining photophore series/clusters consistent with other species of *Polyipnus*: BR 6, IP 6, L 1, OP 1+1+1, ORB 1, OVA 3. PV 10, VAV 5.

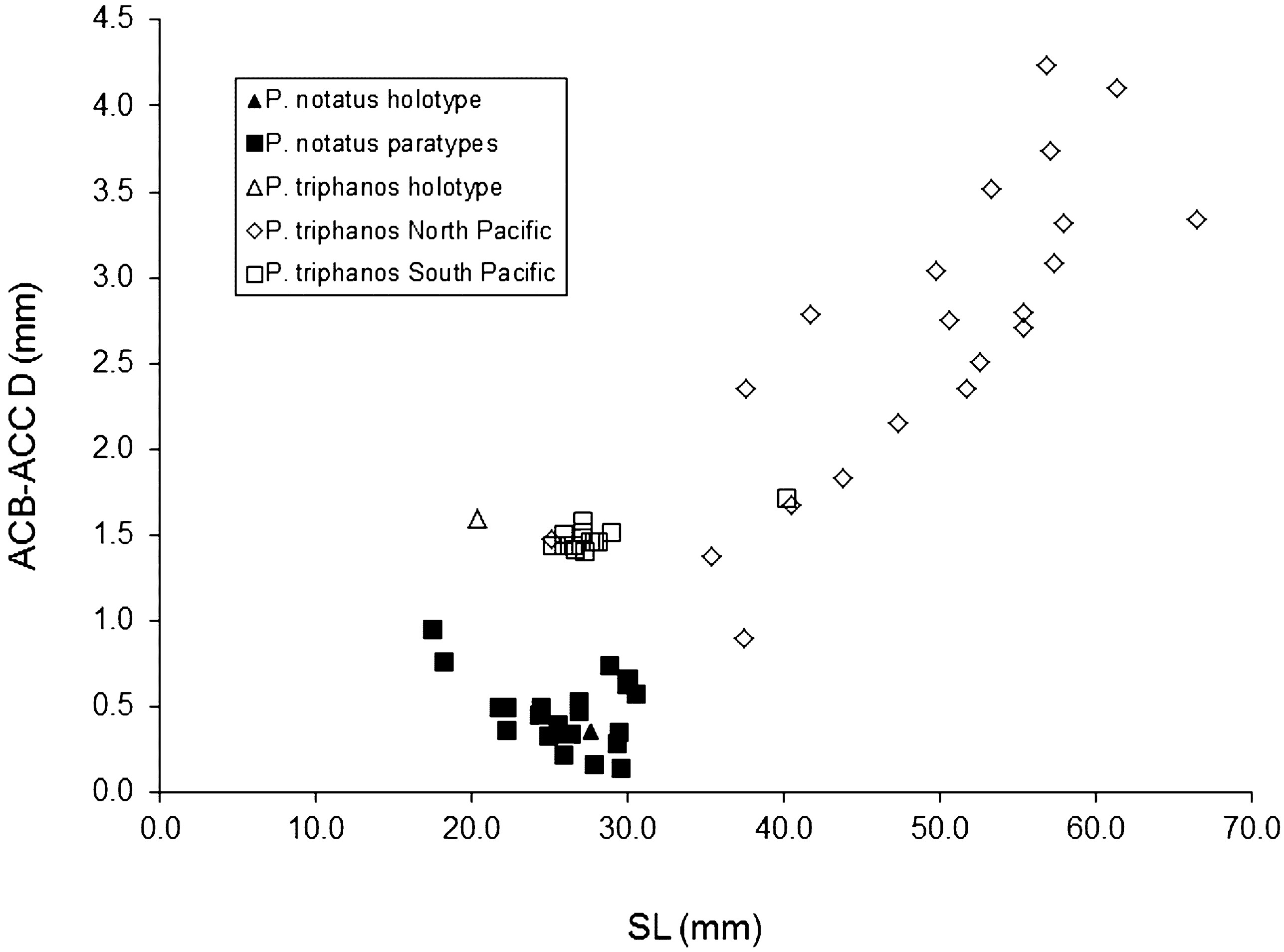

FIGURE 3. Scatterplot of ACB-ACC D (right side) versus standard length for *Polyipnus notatus* and *P. triphanos* from the western North and South Pacific Ocean. Solid triangle, *P. notatus* holotype; solid squares, *P. notatus* paratypes; open triangle, *P. triphanos* holotype; open diamonds, *P. triphanos*, North Pacific; open squares, *P. triphanos*, South Pacific. Linear regression statistics: *P. notatus*, y = -0.0211x + 1.0031, R^2 = 0.1517; *P. triphanos*, y = 0.0559x - 0.0666, R^2 = 0.7650.

Pigmentation in preservative. Ventral margin of dark brown dorsal pigment below dorsal fin nearly parallel to fin base, not extended ventrally in the form of a saddle (Fig. 2). Dorsal pigment with a distinct predorsal inflection or notch extending dorsally towards but not reaching anterior base of dorsal fin; ventral margin of dorsal pigment below dorsal fin nearly parallel to base of fin, not forming a ventrally extended saddle-like pattern. Moderately long, typically acutely triangular (occasionally rounded termination), lateral pigment bar extending ventrally from near anterior portion of predorsal blade, not reaching lateral midline. Ventral margin of dark dorsal pigment anterior of lateral pigment bar nearly straight and horizontal (Fig. 2). Dorsal pigment also with areas of concentrated dark chromatophores in series along base of dorsal fin, continuing posteriorly to dorsal surface of caudal peduncle where pigment is most concentrated as a blotch. Dark brown to black chromatophores delineating pattern of body segments, including pleural ribs and posterior myosepta, and passing through lateral midline where pigment is most concentrated, creating effect of midlateral row of pigment spots, most visible in posterior half of body. Other dark pigment associated with glandular portion of photophores and photophore reflectors (modified scales), dorsal margin of orbit, frontal and parietal crests, cheek and opercular region, lateral surface of head immediately posterodorsally to orbit and immediately anterior to external rami of posttemporal, posteriormost ventral margin of lower jaw, and exterior surfaces of eye. Dorsal surface of caudal peduncle with a concentration of dark pigment in the form of a blotch; bases of caudal-fin rays, unpigmented or with only one or two dark chromatophores.

Etymology. The specific epithet *notatus* is a Latin adjective meaning marked, or having been marked, in reference to the distinctive shape of the lateral pigment bar.

Distribution. *Polyipnus notatus* is known almost entirely from collections from off Taiwan in the South China Sea. Other occurrences are restricted to the Celebes Sea (USNM 103028) and two localities off the Philippines (ZMUC P206962 and ZMUC P206963). Precise depth of capture is unknown because the specimens were all collected by open tow. Available collection data show the maximum depth of capture to be 200 m for the holotype (USNM 361926), and 450, 488 and 1770 m for the three non-type lots, indicating a position in the upper water column at the transition between the meso- and epipelagic zones.

Discussion

Polyipnus notatus is a member of the *P. asteroides* species group based on the presence of the five synapomorphies proposed by Harold (1994:447–448, fig. 14). These characters, according to the character-numbering system used in that work, are photophores ACA 2 and 3 united in a common organ (character 27); dense pitting of the surfaces of portions of the maxillary (character 28), and premaxillary bones (character 29); a distinct maxillary palatinad facet (character 30), and an arched dorsal profile of the anterior ceratohyal (character 31, state 1). The new species is most similar to *P. triphanos* on the basis of elevation of OVB 1 photophore well above the level of OVB 3 (unique to the *P. triphanos* species complex), and absence of an anal-fin pterygiophore spine (AFPS), also absent in the west Pacific species *P. surugaensis* Aizawa, 1990 of this species group. *Polyipnus notatus* is distinguished from the remaining forms within the *P. triphanos* species complex (including *Polyipnus* sp., Aizawa 2002), based on the differences in dorsal pigmentation (very narrow, acutely terminating lateral pigment bar and a ventral margin of dorsal pigment anterior of lateral pigment bar nearly straight and horizontal, not arched as in other members of the *P. asteroides* species group, as illustrated in Aizawa, 2002:7), number of ACB photophores (7–10, usually 9 or 10, compared with 7–9, usually 7 or 8) (Table 2), the size of the gap between the ACB and ACC photophore clusters (narrow compared with relatively broad) (Fig. 3), and number of gill rakers (14 or 15 versus 16–21) (Table 3).

Within the studied size range of *P. notatus* the number of ACB photophores has a somewhat broad range of values (7–10), although only the smallest specimen (17.6 mm) had the lower values (8 left, 7 right). It has been well documented that in sternoptychids the number of photophores in a given cluster increases during development by a budding process (Ahlstrom *et al*. 1984; Harold 1990b; Harold *et al*. 1998). Since the smallest specimen of *P. notatus* has the uniquely low ACB number then it is probably the result of capture before attaining the adult complement. Among the South Pacific specimens of the related *P. triphanos* there were four specimens with 7 ACB photophores and three of those were less than 20 mm in standard length, although the fourth was much larger at 27.8 mm.

Related to the slightly higher number of ACB photophores in *P. notatus,* compared with *P. triphanos*, is the smaller distance between the ACB and ACC clusters (ACB-ACC length). As the ACB photophore cluster develops through posterior budding it encroaches on the space between the two clusters between the anal fin and the caudal peduncle. Based on that spatial relationship, these are not independent characters but they do provide different ways of distinguishing between *P. notatus* and *P. triphanos*. Plotting the ACB-ACC length against SL (Fig. 3) shows that the two species have different ontogenetic trajectories for the feature, a conclusion not possible to reach by simply documenting variation in the number of ACB photophores. According to the linear regression statistics (Fig. 3) the slope is positive for *P. triphanos* and negative for *P. notatus*, although R^2 for the latter is much lower than for *P. triphanos*. The slope for *P. notatus* is heavily influenced by the two points to the left that represent the two smallest specimens, 17.6 and 18.3 mm SL, with low ACB counts because of their relatively early stage of photophore development. Nevertheless, the general relative growth trend for the two species is clearly shown by the plot. The graph also shows that *P. notatus* specimens are markedly smaller overall than most of the *P. triphanos* specimens available from the region adjacent to the known range of *P. notatus*, and smaller at a given ACB-ACC length. This seems to indicate that the development of the ACB photophore series and concomitant closing of the gap between them and the ACC series is accelerated in *P. notatus* relative to the other species.

Observations on the lateral pigment bar in relation to body size indicate that the shape of the marking is essentially fixed by a body size of 17.6 mm SL in *P. notatus* and 17.4 mm in *P. triphanos* making it a qualitative character of great utility as a diagnostic feature in addition to which it could be used in combination with other basic features to provisionally identify specimens in photographic images or to sort visually in the field.

Even with the designation of *P. notatus* as a new species, there remains significant variation within the *P. triphanos* complex, as demonstrated by both a broad dispersion of points as well as clustering in Fig. 3. We suspect that there are other undescribed species contained in the southern half of the complex's range, particularly in the Java Trench and Coral Sea areas. Our efforts in the future will be focused on obtaining more material and covering as wide a geographical and body size range as possible, as we attempt to solve the problem.

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References

Ahlstrom, E.H., Richards, W.J. & Weitzman, S.H. (1984) Families Gonostomatidae, Sternoptychidae, and associated stomiiform groups: development and relationships. *In*: Moser, H.G., Richards, W.J., Cohen, D.M., Fahay, M.P., Kendall, A.W. Jr. & Richardson, S.L. (Eds.), *Ontogeny and Systematics of Fishes*. American Society of Ichthyologists and Herpetologists, Special Publication Number 1, pp. 184–198.

Aizawa, M. (1990) A new species of the genus *Polyipnus* (Stomiiformes, Sternoptychidae) from Suruga Bay, Japan. *Japanese Journal of Ichthyology*, 37 (2), 95–97.

Aizawa, M. (2002) Sternoptychidae. Marine Hatchetfishes. *In*: Nakobo, T. (Ed.), *Fishes of Japan with pictorial keys to the species. 2 Vols.* Tokai University Press, Tokyo, pp. 311–317, 1475–1476. [English Edition]

Badcock, J. 1984. Sternoptychidae. *In*: Whitehead, P.J.P., Bauchot, M.-L., Hureau, J.-C., Nielsen, J., & Tortonese, E. (Eds.), *Fishes of the north-eastern Atlantic and the Mediterranean. 3 Vols*. UNESCO, Paris, Vol. 1, pp. 302–317.

Baird, R.C. (1971) The systematics, distribution, and zoogeography of the marine hatchetfishes (Family Sternoptychidae). *Bulletin of the Museum of Comparative Zoology, Harvard University*, 142 (1), 1–128.

Ekman, S. (1953) *Zoogeography of the Sea*. Sidgwick and Jackson, London, 417 pp.

Eschmeyer, W.N. (Ed.) (2014) Catalog of Fishes: Genera, Species, References. Available from: http:/research.calacademy.org/research/ichthyology/catalog/fishcatmain.asp (accessed 29 May 2014)

Fujii, E. (1984) Family Sternoptychidae. *In*: Masuda, H., Amaoka, K., Araga, C., Uyeno, T. & Yoshino, T. (Eds.), *Fishes of the Japanese Archipelago*. Tokai University Press, Tokyo, pp. 47–48, pl. 49.

Harold, A.S. (1990a) *Polyipnus danae* **n. sp.** (Stomiiformes: Sternoptychidae): a new hatchetfish species from the South China Sea. *Canadian Journal of Zoology*, 68, 1112–1114. http://dx.doi.org/10.1139/z90-164

Harold, A.S. (1990b) Redescription of *Polyipnus fraseri* Fowler, 1934 (Teleostei: Stomiiformes: Sternoptychidae), with remarks on paedomorphosis. *Proceedings of the Biological Society of Washington*, 103 (3), 509–515.

Harold, A.S. (1994) A taxonomic revision of the sternoptychid genus *Polyipnus* (Teleostei: Stomiiformes) with an analysis of phylogenetic relationships. *Bulletin of Marine Science*, 54 (2), 428–524.

Harold, A.S. & Lancaster, K. (2003) A new species of the hatchetfish genus *Argyripnus* (Stomiiformes: Sternoptychidae) from the Indo-Pacific. *Proceedings of the Biological Society of Washington*, 116 (4), 883–891.

Harold, A.S., Stewart, A.L. & Roberts, C.D. (2015) Family Sternoptychidae. *In*: Roberts, C.D., Stewart, A.L. & Struthers, C.D. (Eds.), *Fishes of New Zealand. 4 Vols*. Museum of New Zealand, Te Papa Press, Wellington, New Zealand, pp. 446–468.

Harold, A.S., Wessel, J.H. & Johnson, R.K. (1998) A new species of *Polyipnus* (Teleostei: Stomiiformes) from the western Indian Ocean, with comments on sternoptychid ecology. *Proceedings of the Biological Society of Washington*, 111 (4), 942–953.

Hubbs, C.L. & Lagler, K.F. (1958) *Fishes of the Great Lakes Region*. The University of Michigan Press, Ann Arbor, 186 pp.

Liao, Y.-C., Chang, C.-H. & Shao, K.-T. (2008) Twenty new records of Stomiiformes Fishes (Pisces: Stomiiformes) from Taiwanese waters. *Journal of the Fisheries Society of Taiwan*, 35 (4), 369–397.

Potthoff, T. (1984) Clearing and staining techniques. *In*: Moser, H.G., Richards, W.J., Cohen, D.M., Fahay, M.P., Kendall Jr., A.W. & Richardson, S.L. (Eds.), *Ontogeny and Systematics of Fishes*. American Society of Ichthyologists and Herpetologists, Special Publication Number 1, pp. 35–37.

Sabaj-Pérez, M.H. (Ed.) (2013) *Standard symbolic codes for institutional resource collections in herpetology and ichthyology: an Online Reference, Version 4.0* (http://www.asih.org/, American Society of Ichthyologists and Herpetologists, Washington, DC)

Schultz, L.P. (1938) Review of the fishes of the genera *Polyipnus* and *Argyropelecus* (Family Sternoptychidae), with descriptions of three new species. *Proceedings of the United States National Museum*, 86, 135–155. http://dx.doi.org/10.5479/si.00963801.86-3047.135

Schultz, L.P. (1961) Revision of the marine silver hatchetfishes (Family Sternoptychidae). *Proceedings of the United States National Museum*, 112, 587–649. http://dx.doi.org/10.5479/si.00963801.112-3449.587

Schultz, L.P. (1964) Family Sternoptychidae. *In*: Bigelow, H.B., Breder, C.M., Cohen, D.M., Mead, G.W., Merriman, D., Olsen, Y.H., Schroeder, W.C., Schultz, L.P. & Tee-Van, J. (Eds.), *Fishes of the Western North Atlantic, Part 4, Isospondyli*. Sears Foundation for Marine Research, Memoir Number 1, pp. 241–273.

Taylor, W. R. & Van Dyke, G.C. (1985) Revised procedures for staining and clearing small fishes and other vertebrates for bone and cartilage study. *Cybium*, 9, 107–119.

Weitzman, S.H. (1974) Osteology and evolutionary relationships of the Sternoptychidae, with a new classification of stomiatoid families. *Bulletin of the American Museum of Natural History*, 53 (3), 327–478.

Weitzman, S.H. (1986) Order Stomiiformes. Introduction. *In*: Smith, M.M. & Heemstra, P.C. (Eds.), *Smith's Sea Fishes*. MacMillan South Africa, Johannesburg, pp. 227–229.

Comparative material examined

Polyipnus triphanos: AMS I.24316-004 (1, 43.8 mm), 00°04'S to 10°04'S, 97°55'E to 122°43'E, (0-) 300 m. AMS I.24338-001 (1, 47.3 mm), 08°30'S, 117°46'E. AMS I.25816-008 (1, 40.3 SL), 17°59'S to 17°55'S, 147°07'E to 147°05'E, Coral Sea. AMS I.36455-007 (3, 37.6–56.9 mm), 12°54'49"N to 12°57'50"N, 124°23'77"E to 124°21'45"E, San Bernadino Straight, Philippines, 382.0–376.0 m, 23 Sep 1995. AMS I.36455-008 (2, 81.2-82.7 mm), 12°54'49"N to 12°57'50"N, 124°23'77"E to 124°21'45"E. AMS I.36454-016 (1, 50.0 mm), 13°08'98"N to 13°09'84"N, 124°04'72"E to 124°00'01"E. CAS 34889 (1, 40.4 mm), Batangas Bay, Luzon Island, Philippines, 219–245 m, 0905-1000 h, 09 Aug 1966. CAS 88725 (7, 50.6–66.5 mm), San Bernadino Straight, Philippines, 382–376 m, 1623–1819 h, R/V *Fishery Researcher I*, 23 Sep 1995. SIO 77-167 (1, 37.5 mm), 17°40'N, 19°55'E. SIO 77-167 (1, 37.5 mm), 17°40'N, 119°55'E, South China Sea, west of Luzon Island, Philippines, 3000 mwo, 2743 m. SIO 77-184 (1, 26.8 mm), 05°21.2'S, 133°34.7'E, Aru Basin, Indonesia, (0–) 3456 m. NMV A 26583-001 (25, 17.4–29.0 mm), 19°42'25"S to 19°43'52"S, 159°00'41"E to 158°57'44"E, East of Chesterfield Islands, New Caledonia, 234 m, R/V *Alis*, NEC 1HS1 M009, 08 Aug 2011. USNM 103027 (1, 20.4 mm), 13°35'30"N 121°48'E, (0–) 333 m, R/V *Albatross*, Sta. 5368, Sulu Sea, 23 Feb 1909, *Polyipnus triphanos* holotype. USNM 103028 (2, 17.6–21.2), 08°37'45"N 124°36'45"E, Celebes Sea, (0–) 903 m, R/V Albatross Sta. 5500, 04 Aug 1909, *Polyipnus triphanos* paratypes. YPM 10045 (1, 35.3 mm), 12°55'59.5"N, 124°22'36.5"E, San Bernadino Strait, Philippines, 23 Sep 1995. YPM 10046 (5, 41.8–61.3 mm), 13°09'24.5"N, 124°02'22.0"E, Albay Gulf, Philippines, R/V *Fishery Researcher I*, 23 Sep 1995. ZMUC 209076 (1, 25.1 mm), off west coast of Sumatra, 01°19'S, 100°12'E, 500 mwo, depth 540 m.