



***Siphamia arnaza*, a new species of cardinalfish (Teleostei: Apogonidae) from Papua New Guinea**

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Abstract

A new species of cardinalfish, *Siphamia arnaza*, is described from 18 specimens, 15.6–21.4 mm SL, collected in 8–12 m depth at Milne Bay Province, Papua New Guinea. The new species belongs to the *Siphamia tubulata* species group, characterized by light-organ pigmentation consisting of dark dots. It is most similar to *S. cyanophthalma* of the Philippines, eastern Indonesia, Palau, and offshore reefs of northwestern Australia, but differs from all congeners by having a distinctive “cat’s eye” black bar through the eye, covering more than the pupil at center, and flanked by white crescents covering the remaining iris. In life, the new species is translucent pale pink to reddish orange with a dense covering of variable-sized orange spots on the head and anterior body.

Key words: taxonomy, systematics, ichthyology, coral-reef fishes, bioluminescence, Indo-Pacific Ocean, cat’s eye

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Introduction

The Indo-Pacific apogonid genus *Siphamia* is unique within the family Apogonidae in having a bacterial bioluminescent system and spinoid scales. The genus comprises 24 species and was recently reviewed by Gon & Allen (2012) and Gon et al. (2014). There are two main species-groups, based on the pattern of dark pigmentation on the prominent light organ situated on the ventral body. The light organ of the *Siphamia tubifer* group (with 14 species) has dark vertical or slanted striations, in contrast to the *Siphamia tubulata* group (with 10 species), which has scattered dark dots. These fishes occur mainly on coral reefs and are frequently associated with invertebrates such as sea urchins, crown-of-thorns starfish, and coral.

We describe here a new coral-dwelling species of *Siphamia* belonging to the *S. tubulata* group from Milne Bay Province, Papua New Guinea. The new species was discovered by Arnaz Mehta (the second author's wife), while scuba diving in December 2016 and was collected by the authors on a subsequent expedition in May 2018. This latest discovery provides further evidence that Milne Bay Province, which occupies the extreme eastern end of the island of New Guinea in the western Pacific Ocean, is one of the world's richest areas for reef-fish diversity. Allen & Erdmann (2012) reported 1,109 species from this area and ongoing field studies by the authors have since raised this total to 1,284.

Materials and Methods

Type specimens are deposited at the Smithsonian National Museum of Natural History, Washington, DC, USA (USNM) and the Western Australian Museum, Perth, Australia (WAM).

Lengths are given as standard length (SL), measured from the median anterior point of the upper lip to the base of the caudal fin (posterior end of the hypural plate); body depth is measured at the pelvic-fin insertion; body width is the widest point anterior to the pectoral-fin bases; head length is the distance from the tip of the upper jaw to the most posterior edge of opercular membrane; snout length is taken from the tip of the upper jaw to the front edge of the eye; eye diameter is the fleshy orbit diameter measured horizontally; interorbital width is the least bony width; lengths of the upper and lower jaws are measured from the tip of the jaws to the posterior edge of the maxilla and the angular bone, respectively; depth of the maxilla is measured vertically at the posterior edge of the bone; lengths of median fin spines and rays are taken from the front of the base to the tip of these elements; caudal-peduncle depth is the least depth; caudal-peduncle length is measured between verticals at the posterior end of the anal-fin base and the end of the hypural plate; pectoral-fin and pelvic-fin lengths are taken from the uppermost and anteriormost points of the fin bases, respectively, to the tip of the longest fin rays; pelvic-fin spine length is measured along its anterior edge; the distance between the pelvic and anal fins is measured from the anteriormost point of the pelvic-fin base to the anal-fin origin; predorsal, preanal, and prepelvic distances are the distances from tip of upper jaw to the origin of the dorsal, anal, and pelvic fins, respectively. Pectoral-fin ray counts include the uppermost rudimentary ray; the lateral-line scale count includes the tubed scales just behind the head; the gill raker at the angle of the first gill arch is included in the lower-limb; a developed gill raker is higher than the width of its base; a gill-raker found on the ceratobranchial-hypobranchial joint is included in the ceratobranchial gill-raker count.

Cyanine Blue 5R (Acid Blue 113) stain was used to facilitate scale counts (Saruwatari et al. 1997). The range of counts and proportional measurements for paratypes are indicated in parentheses when different from the value for the holotype (for proportions followed by the mean value for all type specimens).

Proportional measurements of type specimens of the new species are presented in Table 1 as percentages of the standard length. The frequency distribution of counts for the soft dorsal-fin and anal-fin rays, the pectoral-fin rays, the total tubed lateral-line scales, and the number of developed gill rakers on the first branchial arch are presented in Table 2.

Siphamia arnazae, n. sp.

Cat's Eye Cardinalfish

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Figures 1–3; Tables 1 & 2

Holotype. WAM P.34854-031, 21.4 mm SL female, Papua New Guinea, Milne Bay Province, Nuakata Island, Duduwali Bay, -10.2891°, 151.0055°, 8–12 m, clove oil & hand net, M.V. Erdmann, 5 May 2018.

Paratypes. USNM 443803, 5 specimens, 15.6–20.6 mm SL, collected with holotype; WAM P.34854-032, 12 specimens, 15.9–20.4 mm SL, collected with holotype.

Diagnosis. A species of *Siphamia* with a dark-dotted light organ (*S. tubulata* group); 7 first dorsal-fin spines, usually 12 pectoral-fin rays; 1–4 (usually 1–2) tubed lateral-line scales; a single developed gill raker on upper limb and 8–9 developed rakers on lower limb of first gill arch; 8–15 small serrae around angle of preopercle edge; light organ barely extending onto caudal peduncle, the extent 5.2–23.1 in caudal peduncle length; color in life generally translucent pale pinkish to reddish orange with a dense covering of variable-sized orange spots on head and anterior two-thirds of body; and eye with a prominent “cat’s eye” black bar through eye, covering more than pupil at center, and flanked by white crescents covering remaining iris.

Description. Dorsal-fin elements VII+I,9 (VI+I,8 in 4 paratypes); anal-fin elements II,8; last soft ray of dorsal and anal fins split to base; pectoral-fin rays 12 (except one paratype with 10 and 11), two upper and lowermost rays unbranched; pelvic-fin rays I,5, all soft rays branched; principal caudal-fin rays 17, upper and lowermost rays unbranched; upper and lower procurrent rays 6 (5–6); tubed lateral-line scales 2 (1–4); vertical scale rows 21 (21–23); horizontal scale rows at level of second-dorsal-fin origin 7 (6–7); median predorsal scales 4 (4–6); circumpeduncular scales 12; developed gill rakers 1+8 (1 + 8–9); gill rakers on ceratobranchial 7 (6–7); branchiostegal rays 7; supraneurals 2; vertebrae 24 (6 specimens).

Body deep and compressed, its depth 2.3 (1.9–2.4; 2.2) in SL and its width 2.4 (2.1–2.7; 2.3) in depth; head length 2.3 (2.0–2.3; 2.1) in SL; snout length 5.8 (4.0–6.0; 5.1), eye diameter 2.5 (2.4–2.8; 2.6), and interorbital width, 5.1 (4.5–5.2; 4.7), all in HL.



Figure 1. *Siphamia arnazae*, freshly collected female holotype, 21.4 mm SL, Nuakata Island, Milne Bay Province, Papua New Guinea (M.V. Erdmann).



Figure 2. *Siphamia arnazaе*, approx. 20 mm SL, Sideia Island, Milne Bay Province, Papua New Guinea (M.V. Erdmann).

Mouth terminal, oblique and large; maxilla reaching posteriorly to vertical at rear edge of eye; upper jaw length 1.8 (1.7–2.1; 1.9) and lower jaw 1.6 (1.5–1.8; 1.7) in HL; both jaws with band of small conical teeth; upper-jaw band with two series at symphysis, increasing to about 5 series at middle of jaw; lower-jaw band with 4 series at symphysis tapering to single series posteriorly; inner series teeth of lower jaw enlarged; vomer and palatines with single irregular series. Posterior naris oval, close in front of eye, vertical diameter about 2.6–3.0 in pupil diameter; anterior naris round with slightly raised posterior rim, diameter about one-half of longer axis of posterior naris, and closer to posterior naris than to tip of snout (excluding upper lip). Preopercular edge with 15 (8–15) very small serrae around angle and adjacent part of ventral edge; preopercular ridge smooth; exposed edge of posttemporal with 3 (2–5) tiny serrae.

Body scales large, thin, and easily shed; scales spinoid; tubed scales usually followed by notched scales; caudal fin with low scaly sheath of 1 or 2 scale series across base; other fins without scales or scaly sheath.

Dorsal-fin origin over third lateral-line scale and slightly behind vertical through upper pectoral-fin base; first dorsal-fin spine very small, damaged in holotype (3.2–5.0; 4.0) in second spine; second dorsal-fin spine 3.6 (3.9–5.8; 4.5) and third or fourth dorsal-fin spine longest 2.6 (2.8–3.8; 3.2) in HL; spine of second dorsal fin 3.6 (3.2–4.7; 3.7) and longest dorsal-fin soft ray 1.8 (1.7–2.3; 2.0) in HL; first anal-fin spine 2.4 (2.2–3.3; 2.7) in second spine; second anal-fin spine 3.9 (3.5–5.6; 4.5) and longest anal-fin ray 2.4 (2.2–2.8; 2.4) in HL; pectoral fin 4.4 (3.7–4.4; 4.1) in SL, reaching to about anal-fin origin; pelvic fin 4.3 (4.0–4.8; 4.4) in SL, origin slightly anterior to vertical though upper pectoral-fin base, end reaching slightly beyond anus, pelvic-fin spine 1.7 (1.4–1.7; 1.6) in fin length; caudal fin forked, 3.7 (3.4–3.9; 3.7) in SL; length of light organ extent onto caudal peduncle 7.1 (5.2–23.1; 10.0) in caudal-peduncle length.

Dorsal profile of head straight (slightly convex in some paratypes), predorsal distance 2.2 (2.0–2.2; 2.1), preanal distance 1.5 (1.4–1.5; 1.5), and prepelvic distance 2.5 (2.1–2.5; 2.3) in SL; caudal-peduncle depth 1.4 (1.3–1.6; 1.4) in length, and the length 1.4 (1.0–1.6; 1.2) into distance between pelvic-fin base and anal-fin origin, measuring 3.6 (2.9–4.5; 3.6) in SL.

Color in life. (Fig. 2) Translucent pale pinkish to reddish orange (on interorbital, snout, and chin), with dense covering of variable-sized orange spots on head and anterior two-thirds of body; eye with a prominent “cat’s eye” black bar through eye, covering more than pupil at center, and flanked by white crescents covering remaining iris;

TABLE 1

Proportional measurements of selected type specimens of *Siphamia arnazaе*, n. sp.
as percentages of the standard length

	holo- type		paratypes							
	WAM P.34854	WAM P.34854	WAM P.34854	WAM P.34854	USNM 443803	WAM P.34854	WAM P.34854	WAM P.34854	USNM 443803	USNM 443803
Standard length (mm)	21.4	20.4	20.0	19.8	19.4	19.2	18.3	17.2	16.0	15.6
Body depth	42.7	44.3	44.4	45.1	46.6	43.2	43.2	46.3	46.0	46.6
Body width	17.6	20.4	18.8	19.8	20.0	20.8	20.8	21.5	21.3	21.2
Head length	44.2	46.5	45.2	46.8	47.5	44.9	44.9	48.8	47.9	46.2
Snout length	7.7	9.8	8.5	8.5	9.0	8.9	8.9	8.2	10.5	11.6
Eye diameter	17.7	16.8	18.5	18.7	18.6	16.5	16.5	17.8	17.5	18.5
Interorbital width	8.6	10.0	10.0	9.6	9.9	8.8	8.8	10.6	11.7	10.7
Upper-jaw length	24.5	25.1	25.2	27.0	24.3	22.7	22.7	23.4	24.4	24.9
Lower-jaw length	26.9	27.4	27.4	29.4	28.0	26.8	26.8	30.1	27.9	29.8
Maxillary width	7.2	7.1	7.8	7.6	7.4	7.3	7.3	6.6	7.1	7.4
Length first dorsal spine	damage	2.7	3.1	2.7	2.1	3.3	3.3	1.7	2.5	2.9
Length second dorsal spine	12.2	10.7	9.3	10.6	9.7	10.6	10.6	8.4	10.8	12.0
Length fourth dorsal spine	16.7	14.8	14.9	16.5	15.2	14.7	14.7	12.7	13.7	13.8
Spine of second dorsal fin	12.2	14.5	13.9	14.2	11.6	13.4	13.4	10.5	12.2	13.6
Length longest dorsal ray	24.9	23.7	23.9	25.0	21.1	23.2	23.2	21.3	24.0	22.1
Length first anal spine	4.7	4.5	4.2	4.6	4.9	3.5	3.5	2.7	3.3	3.5
Length second anal spine	11.4	9.9	10.4	13.3	13.1	11.1	11.1	8.7	9.0	10.3
Length longest anal ray	18.8	19.8	19.3	20.4	20.6	20.7	20.7	18.8	18.9	21.0
Length pectoral fin	22.7	25.1	23.9	25.8	24.9	23.8	23.8	24.7	24.1	24.5
Length pelvic fin	23.1	24.4	22.9	23.6	25.3	22.3	22.3	22.2	20.9	24.2
Length pelvic-fin spine	13.9	15.5	15.5	15.8	15.8	15.5	15.5	13.5	14.7	14.0
Length caudal fin	26.8	26.5	28.7	29.2	27.5	27.2	27.2	25.7	25.7	28.2
Caudal-peduncle length	19.9	22.7	22.2	21.9	21.0	21.3	21.3	22.3	22.9	23.3
Caudal-peduncle depth	14.2	16.0	15.1	15.5	15.9	16.0	16.0	14.3	15.5	16.5
Anus to anal-fin origin	7.5	7.8	8.1	8.0	8.2	6.5	6.5	7.0	6.3	6.4
Pelvic fin to anal-fin origin	27.4	33.0	29.3	31.7	34.6	26.1	26.1	22.5	23.6	26.2
Predorsal length	45.5	47.6	45.1	48.1	48.8	49.0	49.0	49.6	46.7	46.6
Preanal length	66.1	73.3	68.5	68.3	70.9	69.6	69.6	69.1	66.5	66.2
Prepelvic length	39.9	44.3	41.3	42.2	42.3	44.0	44.0	46.9	47.3	44.2



Figure 3. *Siphamia arnazaе*, preserved female holotype, 21.4 mm SL, Nuakata Island, Milne Bay Province, Papua New Guinea (M.V. Erdmann).

light organ dark silvery-grey ventrally and broadly orange dorsally, extending from just below pectoral-fin base to slightly beyond level of last anal ray; fins translucent.

Color when fresh. (Fig. 1) Similar to live color but body more opaque and bright orange on nape and interorbital; eye bar brown.

Color in alcohol. (Fig. 3) Head and anteroventral portion of body below line extending from upper rear edge of operculum to anal-fin origin grayish to silver, with strong silvery reflections on cheek, operculum, and abdomen; remainder of body, including nape region, pale yellowish white; “cat’s eye” black bar through the eye; large, roughly triangular, dark-brown mark above middle of eye, and smaller oblique brown band below rear corner of eye; dense covering of fine melanophores on anterior body below spinous dorsal fin and concentrations of larger, darker melanophores along upper jaw, along edges of lowermost branchiostegal rays, on ventral abdomen, and overlying silvery light organ; fins translucent whitish.

TABLE 2

Meristic values for *Siphamia arnazaе*, n. sp.

Dorsal-fin rays		Pectoral-fin rays			Lateral-line scales				Vertical scale rows			Predorsal scales			Gill rakers	
8	9	10	11	12	1	2	3	4	21	22	23	4	5	6	9	10
4	14	1	1	34	6	9	1	2	9	16	1	12	5	1	6	12

Etymology. The new species is named for the second author’s wife, Arnaz Mehta, who discovered the fish while diving at Sideia Island, Milne Bay Province, in December 2016.

Distribution and habitat. *Siphamia arnaza* is currently known only from two locations in Milne Bay Province of eastern Papua New Guinea. In addition to the type locality at Nuakata Island we have also recorded it from Sideia Island, which lies approximately 43 km southwest of Nuakata. It occurs on sheltered reef slopes at depths of 8–20 m. The habitat consists of predominately *Seriotopora hystrix* coral colonies, but also small *Acropora* coral heads with close-set branches, affording shelter for groups of about 10–30 fish.

Remarks. The new species belongs to the *S. tubulata* group with a dark-dotted light organ as defined by Gon & Allen (2012). It is clearly distinct from all members of this group and all other congeners on the basis of the unusual “cat’s eye” marking on the eye. Aside from the distinctive eye pattern, it is similar in general appearance to *S. cyanophthalma* Gon & Allen, 2012 (Fig. 4), which shares most meristic and morphometric features. Both species are translucent pinkish with numerous orange spots, however *S. cyanophthalma* has a pair of narrow blue stripes across the eye and notably differs in having a much longer posterior extension of the light organ, which reaches to about the level of the middle of the caudal peduncle vs. barely extending beyond the anal-fin base. The count of tubed lateral-line scales differs: 1–4 (usually 1–2) in *S. arnaza* and 4–8 in *S. cyanophthalma*. *Siphamia arnaza* is superficially similar to *S. jebbi* Allen, 1993 (Fig. 5), which is also orange-spotted, however, *S. jebbi* has a striated light organ (*S. tubifer* group) and has two instead of a single developed raker on the upper limb of the first gill arch, usually 13 pectoral-fin rays (vs. 12), and a broad, horizontal dark band through the middle of the eye (vs. “cat’s eye”). Both *S. jebbi* and *S. cyanophthalma* are widely distributed in the western Pacific Ocean and although we did not observe or collect either species at Milne Bay Province, they may well occur in the area.



Figure 4. *Siphamia cyanophthalma*, approx. 20 mm SL, Raja Ampat Islands, West Papua Province, Indonesia (G.R. Allen).



Figure 5. *Siphamia jebbi*, approx. 20 mm SL, Cenderawasih Bay, West Papua Province, Indonesia (G.R. Allen).

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