



Review of the shrimp-associated goby genus *Lotilia* (Actinopterygii: Perciformes: Gobiidae), with description of a new species from the West Pacific

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Abstract

The Indo-West Pacific gobiid fish genus *Lotilia*, symbiotically associated with alpheid shrimps, is reviewed. The genus comprises two species, viz. *L. graciliosa* Klausewitz, 1960 and *L. klausewitzi* sp. nov., the latter of which is described herein based on 11 specimens (including seven type specimens) from Japan, Australia and the Bismark Archipelago. *Lotilia klausewitzi*, previously misidentified as *L. graciliosa* in the West Pacific, is readily distinguished from *L. graciliosa* by having the following features, in addition to some minor differences in the sensory-papillae configuration on the cheek: cephalic sensory canals and associated pores present (vs. absent in *L. graciliosa*); 7+6=13 branched caudal-fin rays (vs. 7+7=14); pale area on dorsum from snout to dorsoanterior part of body relatively long, extending posteriorly to, or beyond, base of fifth spine of first dorsal fin (vs. extending posteriorly to around base of third or fourth spine); a faint, relatively small dark grayish brown spot at center of first dorsal fin behind third or fourth spine, and its paler margin usually absent or obscure (vs. conspicuous ocellated black spot with vivid pale margin at center of first dorsal fin, extending anteriorly beyond third spine); and a submarginal row of black spots on caudal fin (vs. absent). Geographic records based on the specimens examined and underwater photographs indicate that *L. graciliosa* appears to be restricted to the Red Sea and its adjacent areas, whereas *L. klausewitzi* is widely found in the West Pacific. *Lotilia* is re-diagnosed, and *L. graciliosa* is re-described based on five specimens including the holotype.

Key words: Perciformes, Gobiidae, *Lotilia*, new species, shrimp-associated goby, Indo-West Pacific

Introduction

Lotilia is an Indo-West Pacific fish genus of the gobiid subfamily Gobiinae (*sensu* Pezold 1993), symbiotically associated with alpheid shrimps. The genus was originally described by Klausewitz (1960) for his new species, *L. graciliosa* Klausewitz, 1960, from the Red Sea. Since then, *Lotilia* has been considered monotypic.

Hayashi *et al.* (1981) recorded *Lotilia graciliosa* from the Ishigaki-jima Island, Yaeyama Group of Ryukyu Islands, Japan. This represented the first record of the species outside the Red Sea, although subsequent authors revealed a widespread distribution in the West Pacific (Randall *et al.* 1990, 1997; Akihito *et al.* 1993, 2002; Myers 1999; Kuitert & Tono-zuka 2001; Senou *et al.* 2004; Allen *et al.* 2003; Randall 2005). Kuitert & Tono-zuka (2001) and Senou *et al.* (2004) pointed out that some color variants were recognized in this species, but they did not provide any details.

Recently the first author (KS) examined the holotype of *Lotilia graciliosa*, housed in the Natur-Museum und Forschungs-Institut Senckenberg, Germany. Although the holotype was indeed similar to the West Pacific specimens in general physiognomy, the former evidently differed from the latter in, e.g., cephalic sensory systems and coloration. Based on subsequent examination of several additional specimens, we conclude that the West Pacific population is a distinct species, described herein as new.

Materials and methods

Institutional abbreviations for materials examined follow Leviton *et al.* (1985), exclusive of the Kanagawa Prefectural Museum of Natural History, Odawara (KPM). All fish lengths given are standard lengths (SL). Measurements were made point-to-point with calipers under a dissecting microscope to the nearest 0.01 mm. The methods for measurements followed those of Hubbs & Lagler (1958), with exceptions given below (the snout tip refers to the mid-anteriormost point of the upper lip): interorbital width was the least width between the innermost rims of the right and left eyeballs; jaw length was measured between the snout tip and the posteriormost point of the lip; head width and depth were measured at the posterior margin of the preopercle; body depth was measured at the anal-fin origin; nape width was measured between the dorsalmost margins of the right and left gill openings; preanal and prepelvic lengths were measured from the snout tip to the origin of each fin; pectoral-fin length was measured from the base to the tip of the longest ray; pelvic-fin length was measured between the base of the pelvic-fin spine and the distal tip of the longest segmented ray; caudal-fin length was measured from the base to the tip of the middle caudal-fin ray. The methods of counting followed Akihito (1984), except for the following: longitudinal scale count was the number of oblique (anterodorsal to posteroventral) scale rows and was taken from just dorsal to the upper attachment of the opercular membrane posteriorly to the midbase of the caudal fin; three methods of transverse scale counts were taken (see descriptive accounts); circumpeduncular scale count was the number of scales along zigzag vertical line, counted from the second middorsal scale prior to the anteriormost upper procurrent caudal-fin ray; gill rakers including all rudiments were counted on the outer side of the first arch; the count of pseudo-branchial filaments included all rudiments. Scales (except for predorsal and circumpeduncular scales) and paired-fin rays were counted on both sides, but gill rakers and pseudobranchial filaments were counted on the right side only. Osteological features were observed from radiographs. The methods of Akihito (1984) were used in describing the pattern of the interdigitation of the dorsal-fin pterygiophores between the neural spines ("P-V"). Cephalic sensory canals and papillae were observed on specimens stained with cyanine blue, and notations on them followed Akihito (1984) and Miller (1986), respectively. In the description of meristic counts of each species, the counts of the holotype are marked with an asterisk, and the frequency of each count is given in the parentheses following the relevant count.

Lotilia Klausewitz, 1960

Japanese name: Odori-haze zoku

Lotilia Klausewitz, 1960: 158. Type species: *Lotilia graciliosa* Klausewitz 1960, by original designation and monotypy.

Included species. *Lotilia* comprises two allopatric species, *L. graciliosa* (known from the Red Sea and adjacent areas) and *L. klausewitzi* sp. nov. (known from the West Pacific).

Diagnosis. *Lotilia* is distinguished from the other gobiine genera in having the following combination of characters: VI-I, 9–10 dorsal-fin rays; I, 9 anal-fin rays; 47–52 longitudinal scales; no scales on head and predorsal midline; scales on body cycloid anteriorly, ctenoid posteriorly; 10+16=26 vertebrae; P-V 3/II II I I 0/9; body stubby, its depth at anal-fin origin 18.2–23.6 % of SL; mouth moderate in size, not extending posteriorly to a vertical through posterior margin of eye; gill opening relatively narrow, extending anteriorly to a vertical through mid-operculum; gill membranes broadly attached to isthmus, interspace between posteriormost points of right and left sides of gill-membrane attachments to isthmus (= narrowest interspace between right and left sides of gill opening) broader than pupil; distinct transverse pattern of sensory-papillae rows on cheek (Fig. 1), including five transverse rows, viz. rows 1–5; rows 3 and 4 divided at midway by longitudinal row *b*; row *b* continuous and long, extending from a vertical through anterior half of eye to posterior part of cheek; a pair of short longitudinal rows of sensory papillae just behind chin (= row *f*); pectoral fin with distinct black spotted pattern. The vivid bicolor pattern, viz. blackish brown body with a broad pale area on dorsum from tip of snout to mid-base of first dorsal fin, followed by 2–3 small white saddles (Fig. 2–3), is highly characteristic, and a similar pattern is found only in a few other gobiines (see "Comparison" below). Fishes of *Lotilia* are small, bottom-oriented coral-reef gobies, symbiotically associated with alpheid shrimps of the genus *Alpheus*.

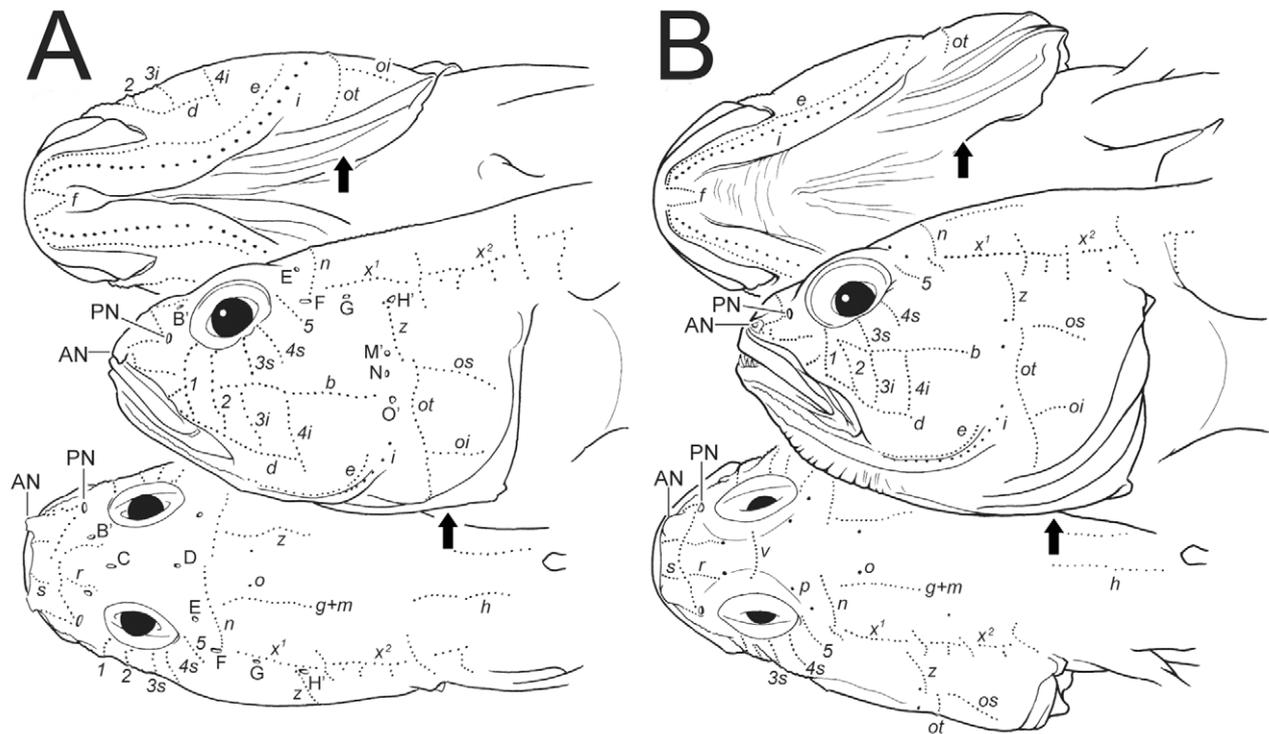


FIGURE 1. Ventral (top), lateral (middle) and dorsal (bottom) views of heads of two species of *Lotilia*, showing cephalic sensory-canals pores (indicated by uppercase letters, except for AN and PN, which are defined below) and sensory papillae (indicated by lowercase letters). A) *L. klausewitzii* sp. nov., one of URM-P 3296, 21.5 mm SL, female; B) *L. graciliosa*, one of SMF 9581, 30.5 mm SL, male. AN and PN, anterior and posterior nares, respectively. Arrows show the position where the gill membrane is attached to isthmus. Drawn by K. Shibukawa.

Description. Dorsal-fin rays VI-I, 9–10; anal-fin rays I, 9; pectoral-fin rays 14–17; pelvic-fin rays I, 5; segmented caudal-fin rays 9+8, including 7+6–7 branched rays; dorsal unsegmented caudal-fin rays 5–7; ventral unsegmented caudal-fin rays 5–6; longitudinal scales 48–53; transverse scales from anal-fin origin dorsoanteriorly to first dorsal-fin base 19–22; transverse scales from anal-fin origin dorsoposteriorly to second dorsal-fin base 16–19; transverse scales from second dorsal-fin origin ventroposteriorly to anal-fin base 16–18; predorsal scales 0; circumpeduncular scales 20–22; gill rakers 3–4+11–13=14–17; pseudobranchial filaments 5–8; vertebrae 10+16=26; P-V 3/II II I I 0/9; epural 1; anal-fin pterygiophores anterior to first haemal spine 2.

Body relatively short and deep (body depth at anal-fin origin 18.2–23.6 % of SL), compressed posteriorly. Head slightly compressed, width of head 78.6–92.8 % of its depth. Snout short, its length subequal or slightly longer than eye diameter (snout length 20.3–23.8 % of head length); snout does not protrude beyond upper lip; dorsal profile from tip of snout to nape gently curved (viz. not steeply descending before eye). Eye dorsolateral, moderately large, its diameter 19.4–22.5 % of head length; interorbital space moderately wide, its width narrower than pupil diameter and 8.1–12.1 % of head length. No cutaneous ridge along dorsal midline of nape. Gape oblique, forming an angle of about 30–50 degrees with body axis. Mouth terminal; jaws subequal; posterior end of jaws extending to posterior half of eye (but not extending beyond posterior margin of eye). Anterior nasal opening at tip of short tube; no fleshy flap at tip of anterior naris; posterior nasal opening a pore, closer to eye than to anterior naris. Tongue free from floor of mouth; anterior margin of tongue nearly truncate or very weakly emerginate. Posteroventral margin of lower lip interrupted at lower-jaw symphysis. Mental frenum undeveloped. Gill opening moderately wide, but not extending anteriorly to a vertical line through posterior margin of preopercle; gill membranes broadly attached to isthmus, width of posteriormost part of gill-membrane attachment to isthmus (= interspace between right and left sides of anteroventral edge of gill opening) broader than pupil. No fleshy projections on lateral wing of shoulder girdle. No bony projections along posterior margin of preopercle. Gill rakers on outer surface of ventral arm of first arch well developed, long and thin, finger- or blade-like; gill rakers on outer surface of dorsal arm of first arch distinctly shorter than dorsalmost raker on outer surface of ventral arm of first arch; ossified gill rakers developed on both outer and inner surface of all gill arches; first gill slit usually large, ventral ca.

one-seventh or one-eighth of ventral arm closed by membrane. Caudal peduncle moderately slender, its depth 52.0–64.1 % of caudal-peduncle length. First dorsal fin subequal to second dorsal fin in height; first dorsal fin close to second dorsal fin, but not connected by membrane; all dorsal-fin spines slender and flexible; all segmented rays of second dorsal fin branched. Origin of anal fin on a vertical line between bases of first and second segmented rays of second dorsal fin; height of anal fin slightly lower than second dorsal fin; anal-fin spine slender and flexible; all segmented anal-fin rays branched. Caudal fin oblong, symmetrical dorsoventrally; caudal-fin length 88.9–94.8 % of head length. Pectoral fin oblong, extending posteriorly beyond a vertical through anus; all pectoral-fin rays branched, excluding 1–2 lowermost and/or uppermost simple ray(s). Origin of pelvic fin slightly anterior to a vertical line through origin of first dorsal fin; pelvic fins united medially by well-developed frenum (between spines) and connecting membrane (between innermost rays); pelvic frenum moderately thin, with smooth posterior margin; all segmented pelvic-fin rays branched.

Body covered with cycloid scales anteriorly, ctenoid scales with peripheral cteni posteriorly; ctenoid-scale area wedge-shaped anteriorly, with the midside scales extending anteriorly to a vertical line through posterior end of first dorsal-fin base or anus; scales on pectoral-fin base, basal area of caudal fin, belly and prepelvic region cycloid; head, nape and narrow area on dorsum around first dorsal-fin base naked.

Teeth in both jaws conical, slender, more or less inwardly curved; upper jaw with 4–5 rows of teeth anteriorly, narrowing to 1–2 rows posteriorly; teeth on middle row(s) of upper jaw smaller than teeth in outermost and/or innermost rows; lower jaw with 3–4 rows of teeth anteriorly, narrowing to single row posteriorly; some posterior teeth on innermost row of lower jaw (located around midpoint of lower jaw) enlarged, sometimes canine-like; other teeth on lower jaw subequal in size; no teeth on vomer or palatine. Anterior part of vomer not projecting downward behind symphysis of upper jaw.

Cephalic sensory systems of two species of *Lotilia* are illustrated in Fig. 1. Cephalic sensory canals present in *Lotilia klausewitzi*, whereas absent in *L. graciliosa*; in *L. klausewitzi*, anterior oculoscapular canal with pores B', C (single), D (single), E, F, G and H' and preopercular canal with pores M', N and O'; right and left sides of anterior oculoscapular canals fused medially in interorbital space; posterior oculoscapular canal not developed. All cephalic sensory-papillae rows uniserial or comprising a single papilla, not forming multiple lines nor aggregations; distinct transverse pattern of sensory-papillae rows, comprising five transverse rows (rows 1–5), on cheek; rows 3 and 4 divided by longitudinal row *b*; row *b* continuous, long, extending anteriorly to a vertical line through anterior half of pupil; a pair of short longitudinal rows just behind chin (= row *f*); row *n* transverse, long; row *s*^l longitudinal. Sensory papillae on midlateral body form uniserial vertical rows, each row short and restricted, found on a single or, in some parts, two scales; three radiating rows of sensory papillae on caudal fin, each along the fourth, seventh and tenth branched caudal-fin rays; all three sensory papillae rows on caudal fin extend from posterior margin of scaled area to near distal end of each ray.

Comparison. *Lotilia* resembles the shrimp-associated goby genera *Cryptocentrus*, *Myersina* and *Stonogobius* in having the following combination of features: five (5–7 in the other three genera) well-developed transverse sensory-papillae rows on cheek, two (2–3) rows of them divided at midway by long longitudinal row *b*; row *f* comprising a pair of short longitudinal rows of sensory papillae; the “Priolepis Group” (*sensu* Birdsong *et al.* 1988) pattern of axial skeletal features, viz. 10+16=26 vertebrae, P-V 3/II II I I 0/9, two anal-fin pterygiophores anterior to first haemal spine, and single epural; scales on body small, 48–53 (44 or more) in longitudinal series. *Lotilia* is readily distinguished from these three genera by having: narrow gill opening, not extending anteriorly to a vertical through posterior margin of preopercle (vs. gill opening broad, extending beyond a vertical through posterior margin of preopercle in the latter three genera); ossified gill rakers present on both inner and outer surface of all gill arches (vs. absent on inner and outer sides of first and second gill arches, respectively); and its characteristic vivid bicolor pattern of body (see also below). *Mahidolia*, another Indo-Pacific shrimp-goby genus, is also similar in sharing most of these features, but has slightly larger scales, viz. usually less than 40 in longitudinal scales (Akihito *et al.* 2002); furthermore, *Mahidolia* differs from *Lotilia* in having: broader gill opening, extending anteriorly to well beyond a vertical through posterior margin of preopercle (vs. not extending anteriorly to a vertical through posterior margin of preopercle in *Lotilia*); larger jaws, extending posteriorly to well beyond a vertical through posterior margin of eye at least in male (vs. not reaching posteriorly to a vertical through posterior margin of eye in both sexes); tall first dorsal fin, taller than second dorsal fin (vs. subequal to second dorsal fin in height); and dark oblique barred pattern on body (vs. barred pattern not found on body).

As well as several black spots on caudal and/or pectoral fins, its vivid bicolor pattern of head and body is

highly characteristic for *Lotilia*. Similar bicolor pattern, viz. blackish body with broad pale area and/or small pale saddle-like blotches on dorsum of head and body, is found in some species of *Cryptocentrus*, including *C. albidorsalis*, *C. nigrocellatus*, *C. leucostictus* and *C. maudae*. However, these gobies are bottom dwellers, not showing hovering habits, and easily distinguished from *Lotilia* species by their different coloration of fins, more elongate body and steep snout.

***Lotilia klausewitzi*, new species**

Japanese name: Odori-haze

(Figures 1A, 2A–B & 3, Table 1)

Lotilia graciliosa (non Klausewitz, 1960). Hayashi *et al.* 1981:10, pl. 6; Hayashi 1984; Masuda & Allen 1987:416; Akihito *et al.* 1993:1059, 1108, fig. 7; Kobayashi 1994:123, fig. 13; Randall *et al.* 1990:404, 1997:404; Myers 1999:163, pl. 153, fig. 5; Kuitert & Tonozuka 2001:634; Akihito *et al.* 2002:1223, 1297; Allen *et al.* 2003:308; Randall 2005:541; Senou *et al.* 2007:68.

Holotype. YCM-SSP 9169, 27.1 mm SL, Yonehara, Ishigaki-jima Island, Yaeyama Group of Ryukyu Islands, Japan, 7 July 1980, hook & line (collected by T. Suzuki & H. Senou).

Paratypes. Total six specimens, 18.8–27.1 mm SL: AMS I. 19456-084, 1 specimen, 18.8 mm SL, Lizard Island area, Great Barrier Reef, Queensland, Australia, Nov. 1975 (collected by the AMS party); BMNH 2011.1.11.1, 1 specimen, 27.1 mm SL, New Britain, Bismark Archipelago, Papua New Guinea (collected by Roger Lubbock); URM-P 3296, 2 specimens, 21.5–24.9 mm SL, Hoshizuna Beach, Iriomote-jima Island, Yaeyama Group of Ryukyu Islands, Japan, 8 June 1982, spear (collected by H. Senou); URM-P 34034, 1 specimen, 27.1 mm SL, collecting locality same with URM-P 3296, 16 July 1995 (collected by T. Yoshino, H. Yoshigou & Mutoh); URM-P 35997, 1 specimen, 23.1 mm SL, collecting locality same with URM-P 3296, 23 July 1996 (collected by H. Yoshigou).

Non-type materials. AMS I. 18039-023, 1 specimen, 10.2 mm SL, Abaiang Atoll, Gilbert and Ellice Islands, 5 Nov. 1973 (collected by D. Hoese and B. G. Goldman); URM-P 3387, 3 specimens, 6.6–18.1 mm SL, Yonehara, Ishigaki-jima Island, Yaeyama Group of Ryukyu Islands, Japan, 30 July 1980.

Images examined (all registered in the Image Database of Fishes of KPM). KPM-NR 7101, Maeda Point, Okinawa Island, Okinawa Group of Ryukyu Islands, Japan, 5 m depth, Nov. 1994; KPM-NR 7102, same locality and date as KPM-NR 7101, 8 m depth; KPM-NR 10325, Ie-jima Island, Okinawa Group of Ryukyu Islands, Japan, 35 m depth, 10 Sept. 1994; KPM-NR 11185, Okinawa-jima Island, Okinawa Group of Ryukyu Islands, Japan, July 1996; KPM-NR 11188, same locality and date as KPM-NR 11185; KPM-NR 11236, Okinawa-jima Island, Okinawa Group of Ryukyu Islands, Japan, 26 July 1996; KPM-NR 11320, Zamami, Okinawa Group of Ryukyu Islands, Japan, 8 May 1995; KPM-NR 11321, same locality and date as KPM-NR 11320; KPM-NR 13709, Minna-jima Island, Okinawa Group of Ryukyu Islands, Japan, 10 m depth, 10 Aug. 1997; KPM-NR 23374, Iriomote-jima, Yaeyama Group of Ryukyu Islands, Japan, Sept. or Oct. 1996; KPM-NR 24258, Sipadan Island, Sabah, Malaysia, 14 m depth, 30 May 1996; KPM-NR 26098, Kushimoto, Wakayama Prefecture, Japan, 13 m depth, 28 Dec. 1996; KPM-NR 26270, Kerama, Okinawa Group of Ryukyu Islands, Japan; KPM-NR 30606, Ie-jima Island, Okinawa Group of Ryukyu Islands, Japan, 23 June 1996; KPM-NR 31515, Mabul Island, Sagah, Malaysia, 23 Sept. 1992, 3 m depth; KPM-NR 32282, Ie-jima Island, Okinawa Group of Ryukyu Islands, Japan, 13 June 1997; KPM-NR 32283, same locality as KPM-NR 32282, Japan, 6 May 1995; KPM-NR 32374, Ie-jima Island, Okinawa Group of Ryukyu Islands, Japan, 21 June 1998; KPM-NR 32877, Tokashiki-jima Island, Okinawa Group of Ryukyu Islands, Japan, 24 May 1998, 6 m depth; KPM-NR 33263, Shionomisaki Point, Kushimoto, Wakayama Prefecture, Japan, 20 Jan. 1998, 16 m depth; KPM-NR 33353, Kume-jima Island, Okinawa Group of Ryukyu Islands, Japan, 1 July 1999, 9 m depth; KPM-NR 33842, Panglao Island, Bohol, Philippines, 7 m depth, Nov. 1997; KPM-NR 41939, Kushimoto, Wakayama Prefecture, Japan; KPM-NR 61729, 26 June 2001; KPM-NR 68001, Miyako-jima Island, Miyako Group of Ryukyu Islands, Japan, 3 m depth, 31 July 2000; KPM-NR 68002, Shimoji-jima Island, Miyako Group of Ryukyu Islands, Japan, 26 July 1997; KPM-NR 68003, Irabu-jima Island, Miyako Group of Ryukyu Islands, Japan, 6 Aug. 2001, 12 m depth; KPM-NR 81633, Ishigaki-jima Island, Yaeyama Group of Ryukyu Islands, Japan; KPM-NR 82012, Irabu-jima Island, Miyako Group of Ryukyu Islands, Japan, 11 Aug. 2003, 24 m depth; KPM-NR 82270, Taveuni Island, Fiji, 10 m depth, 6 Aug. 1996.



FIGURE 2. Lateral (A and C) and dorsal (B and D) views of alcohol-preserved specimens of two species of *Lotilia*. A–B) *L. klausewitzi* sp. nov., paratype, one of URM-P 3296, 24.9 mm SL, female; C–D) *L. graciliosa*, one of SMF 9581, 30.5 mm SL, male.

Diagnosis. *Lotilia klausewitzi* is distinguished from its only known congener, *L. graciliosa*, in having: cephalic sensory canals and associated pores B', C (unpaired), D (unpaired), E, F, G, H', M', N and O' (vs. cephalic sensory canals and pores absent in *L. graciliosa*); sensory-papillae row 4i usually extending ventrally beyond a horizontal line through posterior end of row d (vs. not extending ventrally beyond a horizontal line through posterior end of row d); right and left sides of row n very close or joined to one another medially, with short interspace

between them (vs. not close to one another, with broad interspace between them); 7+6=13 branched caudal-fin rays (vs. 7+7=14); pale area on dorsum from snout to dorsoanterior part of body relatively long, extending posteriorly to, or beyond, base of fifth spine of first dorsal fin (vs. extending posteriorly to around base of third or fourth spine); a faint, relatively small, dark grayish-brown spot at center of first dorsal fin behind third or fourth spine, and its paler margin absent or, if present, usually obscure (vs. conspicuous ocellated black spot with vivid pale margin at center of first dorsal fin, extending anteriorly beyond third spine); a submarginal row of black spots on caudal fin present (vs. absent).

Description. Dorsal-fin rays VI-I, 9* (7); anal-fin rays I, 9* (7); pectoral-fin rays 14 (1), 15* (7) or 16 (6); pelvic-fin rays I, 5* (14); segmented caudal-fin rays 9+8* (7), including 7+6* (7) branched rays; upper unsegmented caudal-fin rays 5 (1), 6* (2) or 7 (3); lower unsegmented caudal-fin rays 5* (3) or 6 (3); longitudinal scales 46 (2), 47* (2), 48 (2), 49* (2), 52 (1) or 53 (1); transverse scales from origin of anal fin upward and forward to base of first dorsal fin 19 (2), 20* (5) or 21* (5); transverse scales from origin of anal fin upward and backward to base of second dorsal fin 16* (1), 17* (4) or 18 (5); transverse scales from origin of second dorsal fin downward and backward to base of anal fin 16 (1), 17* (7) or 18 (2); predorsal scales 0* (6); scales in preventral midline 2 (1), 4 (2) or 5 (2); circumpeduncular scales 20 (3) or 22* (4); gill rakers 3+12=15 (2), 3+13=16 (2) or 4+13=17 (1); pseudobranchial filaments 5 (1), 6 (1) or 8 (3); vertebrae 10+16=26* (5); P-V 3/II II I I 0/9* (5); anal-fin pterygiophores anterior to first haemal spine 2* (5); epural 1* (5).

Coloration. Following descriptions of coloration when alive are based on underwater photographs (e.g. Fig. 3 and Senou *et al.* 2004). Ground color of head and body blackish or dark grayish-brown; broad mid-dorsal pale or pale beige stripe, extending from snout tip to, or beyond, base of fifth spine of first dorsal fin through dorsal part of eye; two small pale beige saddles at posterior end of base of second dorsal fin and caudal peduncle; sometimes an additional small pale beige saddle, continuous with whitish anteroventral corner of second dorsal fin, present at second dorsal-fin origin; anterior narial tube whitish; anteroventral part of first dorsal fin whitish; remaining part of first dorsal fin dark yellowish-brown, gradually changing to white at distal one-half or one third of fin; a dark gray brown spot, subequal to or slightly smaller than eye, at center of first dorsal fin behind fourth spine; second dorsal fin dark grayish-brown or dark yellowish-brown, gradually becoming subtranslucent distally, with or without whitish anteroventral corner (whitish area often expanded a little onto body); anal fin dark grayish brown, with slightly paler distal margin and a small white blotch at anterodorsal part; caudal fin translucent (exclusive of narrow basal dark grayish-brown area), with 5–8 pupil-sized (or slightly larger) dark grayish brown submarginal spots; pectoral fin translucent, exclusive of narrow blackish basal area with two white spots dorsoventrally; several pupil-sized black spots at middle and submarginal parts of petoral fin; pelvic fin dark grayish brown, with a white spot around spine.

No obvious differences are apparent in coloration between live and freshly-collected specimens, except for ground color being slightly paler. Color of alcohol-preserved specimens is also similar, but the white spots on the pectoral fin are completely faded.

There are some minor variations in coloration. For example, the pale saddle on posterior end of second dorsal-fin base is absent in URM-P 34034; in addition, the specimen has a fairly distinct black spot with a faint narrow subtranslucent margin on the first dorsal fin, as found in the photographed specimens in Allen *et al.* (2003) and KPM-NR 24258 (taken from Sabah, Malaysia) and 81633 (taken from Ryukyu Islands, Japan).

Distribution and habitat. The specimens of *Lotilia klausewitzii* examined here were collected from Japan (Ryukyu Islands), Papua New Guinea (Bismark Archipelago) and Australia. As far as we are aware, all underwater photographs, previously identified as “*Lotilia graciliosa*” from the West Pacific [including southern Japan (Wakayama Prefecture of Honshu to Ryukyu Islands), the Philippines, Indonesia, Micronesia, Malaysia (Sabah of Borneo) Fiji and the Great Barrier Reef] can be re-identified as *L. klausewitzii*, based on specific coloration. Contrariwise, all the Red Sea specimens and photographs we have examined are identified as the true *L. graciliosa*. It suggests that these two species are probably distributed allopatrically. In the West Pacific, fishes of *Lotilia*, presumed to be *L. klausewitzii*, have been also recorded from Phoenix Islands (Randall 2005).

Lotilia klausewitzii lives around reef patches on sandy bottoms with rubble, at depths of 1–50 m in coral-reef moats and lagoons, outer-reef slopes, or under drop offs (Senou *et al.* 2004). It is symbiotically associated with a snapping shrimp, *Alpheus rubromaculatus*, and usually hovers just above the burrow entrance (Randall *et al.* 1990; Myers 1999; Allen *et al.* 2003; Senou *et al.* 2004; Randall 2005). As noted by Myers (1999), this species “constantly waves its fan-like pectoral fins in an ungoby-like manner.” In Japan, *L. klausewitzii* is called “Odori-haze”

(meaning “dancing goby”) as its vernacular name in reference to its characteristic “dancing” behavior. Also in English, this goby is called “Dancer shrimp goby” (Kuiiter & Tonozuka 2001), as well as “Whitecap goby,” “Whitecap shrimpgoby” or “Graceful shrimpgoby” (Randall *et al.* 1990, 1997; Myers 1999; Allen *et al.* 2003; Randall 2005; Yearsley *et al.* 2006).

Etymology. The new species is named *klausewitzii* in honor of W. Klausewitz, who described many Indo-Pacific fishes, including the genus *Lotilia*.

Remarks. A 10.2 mm SL juvenile (AMS I. 18039-023) has uncompleted sensory canals on its head with pores C' (unpaired), D (unpaired), E and F'.

***Lotilia graciliosa* Klausewitz, 1960**

(Figures 1B & 2C–D, Table 1)

Lotilia graciliosa Klausewitz 1960: 158, figs. 8–10 (type locality: Sarad-Sarso Island, Farasan Islands, Red Sea); Goren 1979:44–45.

Materials examined. Total 5 specimens, 15.2–31.3 mm SL: SMF 4794, 1 specimen (female, holotype of *Lotilia graciliosa*), 29.3 mm SL, Sarad-Sarso Island, Farasan Islands, Red Sea; SMF 9581, 3 specimens (male, female and juvenile), 15.2–31.3 mm SL, Suakin, west coast of Red Sea; SMF 13299, 1 specimen (male), 29.9 mm SL, Elat, northern Red Sea, 1974.

Images examined (registered in the Image Database of Fishes of KPM). KPM-NR 61513, off southernmost part of Sinai Peninsula, Egypt, 30 Dec. 1991.

Diagnosis. See diagnosis of only congener, *Lotilia klausewitzii*.

Description. Dorsal-fin rays VI–I, 10* (5); anal-fin rays I, 9* (5); pectoral-fin rays 15 (1), 16* (6) or 17 (2); pelvic-fin rays I, 5* (10); segmented caudal-fin rays 9+8 (3), including 7+7 (3) branched rays; upper unsegmented caudal-fin rays 6 (2); lower unsegmented caudal-fin rays 5 (1) or 6 (1); longitudinal scales 50 (1), 51 (3) or 52 (2); transverse scales from origin of anal fin upward and forward to base of first dorsal fin 20 (2), 21 (2) or 22 (2); transverse scales from origin of anal fin upward and backward to base of second dorsal fin 17 (2), 18 (2) or 19 (2); transverse scales from origin of second dorsal fin downward and backward to base of anal fin 17 (2) or 18 (4); predorsal scales 0; scales in preventral midline 2 (1), 3 (1) or 5 (1); circumpeduncular scales 20 (2) or 22 (1); gill rakers 3+11 (1); pseudobranchial filaments 6 (1); vertebrae 10+16=26 (4); P–V 3/II II I I 0/9 (4); anal-fin pterygiophores anterior to first haemal spine 2 (4); epural 1 (4).

Coloration. According to Klausewitz (1960), coloration of the holotype when alive was as follows: ground color of head and body blackish-brown; snout and narrow area of maxilla pale gray; nape whitish; white spots on back and caudal peduncle; first dorsal fin with orange-colored ocellated spot; pectoral fin whitish, with black cross-bars; caudal fin whitish basally, remaining part colorless and hyaline; other fins blackish-brown, likewise body; iris orange. Coloration of preserved specimens in alcohol is as follows: ground color of head and body dark grayish-brown; broad mid-dorsal pale beige stripe, extending from snout tip to bases of third or fourth spine of first dorsal fin through dorsal part of eye; two small pale beige saddles at anterior part of second dorsal-fin base and caudal peduncle; anterior nare tube pale; anteroventral part of first dorsal fin whitish; remaining part of first dorsal fin dark grayish-brown, gradually becoming paler distally; a conspicuous black spot with narrow pale margin (= ocellus), larger than eye, at center of first dorsal fin behind third spine; second dorsal fin dark grayish brown, gradually becoming paler distally, with a whitish anteroventral corner; anal fin dark grayish brown, with a small whitish blotch anteriorly; caudal fin subtranslucent, exclusive of basal scaled area dark grayish brown; pectoral fin subtranslucent, exclusive of triangular basal blackish area; several pupil- or eye-sized black spots at middle and submarginal parts of pectoral fin (those at middle of fin always larger); pelvic fin largely dark grayish-brown; pelvic frenum pale with a triangular or rounded blackish blotch basally.

Distribution and habitat. All examined specimens and underwater photographs of *Lotilia graciliosa* were taken from the Red Sea (see also “Distribution and habitat” of *L. klausewitzii*). We could not detect any certain records of this species from other areas. There are records of “*Lotilia graciliosa*” from the Gulf of Aden (Manilo & Bogorodsky 2003) and the Glorieuses Islands of western Indian Ocean (Durville *et al.* 2003); unfortunately these records were not accompanied by any morphological information about the voucher specimen(s), and, thus, it was uncertain whether their identification was reliable.

According to Klausowitz (1960), this species is found only on sandy areas, and symbiotically associates with a snapping shrimp, probably *Alpheus djiboutensis*. It swims freely at ca. 10–15 cm above the nest hole as it moves its pectoral fins alternately. Karplus *et al.* (1974) reported that, in the northern Red Sea, *L. graciliosa* associated with an unidentified species of *Alpheus* (as *Alpheus* sp. A), not corresponding with *A. djiboutensis*.



FIGURE 3. Underwater photograph of *Lotilia klausowitzi* sp. nov., Iriomote-jima Island, Yaeyama Group of Ryukyu Islands, Japan (photographed by K. Yano).

Discussion

Lotilia belongs to the gobiid subfamily Gobiinae *sensu* Pezold (1993) in having the following combination of characters: oculoscapular canals fused medially at interorbital space, with unpaired pore C; P-V 3/II II I I 0/9; 10+16=26 vertebrae; single epural. However, the interrelationships between *Lotilia* and the other gobiine genera have never been explored; any sister groups for *Lotilia* have not yet been proposed. *Lotilia* is one of the shrimp-associated goby genera, but the relationships of these genera are hitherto poorly understood.

Akihito & Meguro (1983) indicated that six shrimp-associated gobies they examined, including *Myersina nigrivirgata*, *M. macrostoma*, *M. filifer* (as *Cryptocentrus filifer*), *Cryptocentrus singaporensis*, *C. caeruleomaculatus* (as *Mars caeruleomaculatus*) and *Stonogobiops xanthorhinica* (as *Stonogobiops* sp.), shared the following features: inner and outer surfaces of lower arms of first and second gill arches, respectively, with unossified gill rakers, while the other sides of these gill arches with ossified gill rakers; unossified scapula. As pointed out by Akihito & Meguro (1983), this pattern of gill-raker ossification is uncommon within the Gobiidae, and hitherto confirmed in only seven Indo-Pacific gobiine genera (KS pers. obs.), viz. *Cryptocentroides*, *Cryptocentrus*, *Mahidolia*, *Myersina*, *Psilogobius*, *Stonogobiops* and *Tomiyamichthys* (and related nominal genera *Eilatia* and *Flabelligobius*). All of these except *Cryptocentroides*, are known as typical shrimp-associated goby genera in the Indo-Pacific. Reduction of gill-raker ossification is also common in the other gobiid subfamilies (Amblyopinae, Gobionellinae, Oxudercinae and Sicydiinae), but typical condition in these subfamilies, i.e., ossified gill rakers developed only on outer surface of first gill arch (Shibukawa & Iwata 1998, fig 7A; KS pers. obs.), is heterogeneous from that of *Cryptocentrus* and its relatives. *Cryptocentrus* and the other six genera listed above also share a characteristic prolongation of the frontal (Hoese & Randall 1987; Hoese & Larson 2004; KS pers. obs.); namely, in these genera, the frontal is “greatly prolonged behind eyes, resulting in displacement of sphenotic and sphenotic flange away from

orbit posteriorly” (Hoese & Randall 1987: 4). Such prolongation of the frontal is uncommon within the Gobiidae, but also found in the subfamily Amblyopinae (Murdy, 1989) as a result of convergence. On the other hand, as far as we know, the remaining Indo-Pacific shrimp-associated goby genera, including *Amblyeleotris*, *Ctenogobiops*, *Lotilia* and *Vanderhorstia*, have ossified gill rakers on both sides of first and second gill arches (Akihito & Meguro 1983; present study; KS pers. obs.) and the frontal lacks modification as in *Cryptocentrus* and its relatives (KS pers. obs.). However, these conditions are common and shown to be plesiomorphic within the subfamily and do not therefore indicate a close relationship between these four genera. Moreover, regarding the considerable differences in the configuration of sensory-papilla rows on the head, *Lotilia* appears to be not closely related to *Amblyeleotris*, *Ctenogobiops* and/or *Vanderhorstia*. Further analysis is needed to verify the phylogenetic position of *Lotilia*.

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