



## Redescription of *Liopropoma aragai* (Teleostei: Serranidae), with two new confirmed records of species of *Liopropoma* from Taiwan

KEITA KOEDA<sup>1,2\*</sup>, HIROSHI SENOU<sup>3</sup>, CHIH-WEI CHANG<sup>4,5</sup> & HSUAN-CHING HO<sup>1,6</sup>

<sup>1</sup>National Museum of Marine Biology & Aquarium, Pingtung 94450, Taiwan

<sup>2</sup>Present address: Kuroshio Biological Research Foundation, 560 Nishidomari, Otsuki, Kochi 788-0333, Japan

<sup>3</sup>Kanagawa Prefectural Museum of Natural History, Odawara 250-0031, Japan

<sup>4</sup>National Academy of Marine Research, Ocean Affairs Council, Kaohsiung 80661, Taiwan

<sup>5</sup>Department of Oceanography, National Sun Yat-sen University, Kaohsiung 80424, Taiwan

<sup>6</sup>Institute of Marine Biology, National Dong Hwa University, Pingtung 94450, Taiwan

\*Corresponding author. E-mail: [hatampo@gmail.com](mailto:hatampo@gmail.com)

### Abstract

*Liopropoma aragai* Randall & Taylor 1988 is redescribed based on the holotype and non-type specimens from Japan and Taiwan. Diagnostic characters of the species and the status of Taiwanese specimens previously referred to *L. aragai* are reassessed. *Liopropoma lemniscatum* Randall & Taylor 1988, previously recorded only from the Pacific coast of Japan and the Ryukyu Archipelago, and *L. lunulatum* (Guichenot 1863), previously known from Okinawa Island (Japan), Guam, Réunion, Rarotonga and Tahiti, are redescribed, both being confirmed for the first time by voucher specimens from Taiwanese waters. A detailed description of each species and a key to Taiwan *Liopropoma* Gill 1861 is provided.

**Keywords:** *Liopropoma lemniscatum*, *Liopropoma lunulatum*, Pisces, new records, distribution, taxonomy

### Introduction

The serranid genus *Liopropoma* Gill 1861, a group of small fishes (up to 22 mm SL) inhabiting shallow to deep waters worldwide (Randall & Taylor 1988), currently comprises 32 species, including 8 in the Atlantic Ocean, 2 in the eastern Pacific and 20 in the Indo-West Pacific and Hawaiian Islands (Fricke *et al.* 2018). Randall & Taylor's (1988) review of Indo-Pacific members of the genus recognized 18 species, 7 of them new, including *Liopropoma aragai* Randall & Taylor 1988, which was originally described based on a single specimen collected from Okinawa Island in the Ryukyu Archipelago. Although several specimens of the latter have been collected subsequently from Japan, there has been no redescription of the species to date. However, examination of the holotype and additional material from Japan and Taiwan resulted in a reassessment of characters for identification of the species. A detailed redescription of *L. aragai* is presented herein.

Although, *L. aragai* has been recorded from Taiwan on several occasions (Lee 1990; Shen *et al.* 1993; Chen 2003; Chen *et al.* 2010; Shen & Wu 2011; Lin & Chang 2012; Chiang *et al.* 2014), most of the photographic records constituted misidentifications. A survey of literature records and museum specimens in Taiwan have revealed the existence of two additional (but similar) species, *Liopropoma lemniscatum* Randall & Taylor 1988 and *L. lunulatum* (Guichenot 1863). Although the latter was reported from Taiwan by Shen & Wu (2011), who included a drawing, it appears to have been based on a misidentification. Accordingly, the above museum specimens represent the first voucher-based records of both species from Taiwan. Detailed descriptions and comparisons of *L. lemniscatum* and *L. lunulatum* are provided for clarification of the three *Liopropoma* species in Taiwanese waters.

## Methods and materials

Methods for counts and measurements follow Randall & Taylor (1988). Fin rays and vertebrae were counted from radiographs. Measurements were made to the nearest 0.1 mm with a needle-point caliper. Standard length and head length are abbreviated as SL and HL, respectively. Morphological descriptions are based on specimens collected from Taiwan and the sex of *L. aragai* specimens was determined from gonad examination, when possible. Collection abbreviations: Biodiversity Research Center, Academia Sinica, Taipei (ASIZP); Kyoto University, Department of Bioresource Science, Faculty of Agriculture (FAKU); Kanagawa Prefectural Museum of Natural History (KPM); National Museum of Marine Biology & Aquarium, Pingtung (NMMB-P); Kyoto University, Seto Marine Biology Laboratory (SMBL).

## Taxonomy

### Family Serranidae

### Genus *Liopropoma* Gill 1861

**Remarks.** A literature survey and examination of museum specimens confirmed a total of 10 species of *Liopropoma* in Taiwanese waters (Table 1).

**TABLE 1.** *Liopropoma* species recorded from Taiwan, with comments on their status.

Species	References/comments
<i>Liopropoma aragai</i> Randall & Taylor 1988	Lee 1990: 65, fig. 84 (misident. <i>L. lemniscatum</i> ); Shao <i>et al.</i> 1992: 86, fig. C (misident. <i>L. lemniscatum</i> ); Shen <i>et al.</i> 1993: 295, pl. 76-1; Chen 2003: 73, fig.; Shao <i>et al.</i> 2008: 248; Chen <i>et al.</i> 2010: 133, fig. I; (misident. <i>L. lemniscatum</i> ); Shen & Wu 2011: 384, fig. (misident. <i>L. lemniscatum</i> ); Senou 2013: 800; Chiang <i>et al.</i> 2014: 94, fig.
<i>Liopropoma dorsoluteum</i> Kon, Yoshino & Sakurai 1999	Chen 2003: 73, fig.; Shen & Wu 2011: 384, fig. (figure from original description); Senou 2013: 799.
<i>Liopropoma erythraeum</i> Randall & Taylor 1988	Randall 1988: 15 (USNM 192964, Penghu); Randall & Tylor 1988: 15; Shen & Wu 2011: 384, fig.; Senou 2013: 799.
<i>Liopropoma japonicum</i> (Döderlein 1883)	Shen 1984: 37, fig. 289-2; Lee 1990: 66, fig. 85; Shao <i>et al.</i> 1992: 86, fig. A; Shen <i>et al.</i> 1993: 295, pl. 76-2; Chen 2003: 74, fig.; Shao <i>et al.</i> 2008: 248; Chen <i>et al.</i> 2010: 133, fig. J; Shen & Wu 2011: 385, fig.; Senou 2013: 800; Chiang <i>et al.</i> 2014: 94, fig.
<i>Liopropoma latifasciatum</i> (Tanaka 1922)	Lee 1990: 67, fig. 86; Shao <i>et al.</i> 1992: 86, fig. C; Shen <i>et al.</i> 1993: 296, pl. 76-3; Chen 2003: 74, fig.; Shao <i>et al.</i> 2008: 248; Chen <i>et al.</i> 2010: 133, fig. K.; Shen & Wu 2011: 385, fig.; Senou 2013: 799; Chiang <i>et al.</i> 2014: 94, fig.
<i>Liopropoma lemniscatum</i> Randall & Taylor 1988	This study, many specimens previously misidentified as <i>L. aragai</i> .
<i>Liopropoma lunulatum</i> (Guichenot 1863)	Shen 1984: 37, fig. 289-1 (misident. <i>Chelidoperca hirundinacea</i> ); Shen & Wu 2011: 385, fig. (drawing only).
<i>Liopropoma maculatum</i> (Döderlein 1883)	Chiang <i>et al.</i> 2014: 94, fig.
<i>Liopropoma pallidum</i> (Fowler 1938)	Shao <i>et al.</i> 2008: 248; Senou 2013: 800.
<i>Liopropoma susumi</i> (Jordan & Seale 1906)	Lee & Lee 1981: 87 (as <i>Ypsigramma lineata</i> ); Randall & Tylor 1988: 27; Lee 1990: 67, fig. 87; Shao <i>et al.</i> 1992: 86, fig. D; Shen <i>et al.</i> 1993: 296, pl. 76-4; Shao <i>et al.</i> 2008: 248; Chen <i>et al.</i> 2010: 133, fig. L; Senou 2013: 798; Shen & Wu 2011: 385, fig.

## Key to the species of genus *Liopropoma* in Taiwan:

1. Dorsal fin divided into two, separated by a clear gape . . . . . 2  
- Dorsal fin continuous (middle portion connected by membranes) . . . . . 3
2. Body with 4–8 dark longitudinal stripes . . . . . *L. susumi*  
- Body without dark longitudinal stripes . . . . . *L. pallidum*
3. Posterior margin of caudal fin blackish; tubular anterior nostril opening midway between snout tip and posterior nostril . . . . . 4  
- Posterior margin of caudal fin not blackish; tubular anterior nostril opening more anteriorly positioned on snout . . . . . 5
4. Pectoral-fin long, 26.9–29.1%; body uniformly bright red when fresh . . . . . *L. erythraeum*  
- Pectoral-fin short, 23.4–23.9%; body red, but dorsally yellow when fresh . . . . . *L. dorsoluteum*
5. Dorsal-fin soft rays 13–14; anal-fin soft rays 10–11; body and fins pink or red; a bright red mid lateral stripe . . . . . *L. japonicum*  
- Dorsal-fin soft rays 12 (except for 13 in *L. latifasciatum*); anal-fin soft rays 8–9; body and fins mainly yellow . . . . . 6
6. Dorsal-fin soft rays 13; anal-fin soft rays 9; a broad dark brown or brownish-yellow stripe along upper body to upper caudal fin base, lower edge of stripe not overlapping straight peduncular portion of lateral line . . . . . *L. latifasciatum*  
- Dorsal-fin soft rays 12; anal-fin soft rays 8; a broad dark brown or brownish-yellow stripe along mid-body to middle of caudal fin base, lower edge of stripe overlapping straight peduncular portion of lateral line or mid-body stripe diffuse . . . . . 7
7. Numerous small spots on upper half of body . . . . . 8  
- Body without spots . . . . . 9
8. Lateral-line scales 61–66; red spots on upper half of body . . . . . *L. maculatum*  
- Lateral-line scales 46–49; black or dark brown spots on upper half of body . . . . . *L. lunulatum*
9. Caudal-fin concavity depth 8.5–9.9% SL; a dark mid-lateral and yellow abdominal stripe when fresh (evident as faint dark pigments when preserved) . . . . . *L. lemniscatum*  
- Caudal-fin concavity depth 10.1–11.0% SL; a yellow stripe anteriorly on body, becoming diffuse centrally and absent on abdomen when fresh (no dark pigments on body when preserved) . . . . . *L. aragai*

### *Liopropoma aragai* Randall & Taylor 1988

Figures 1, 2, 3A, B; Tables 2, 3

*Liopropoma aragai* Randall & Taylor 1988:20, pl. 4, fig. D (type locality: Okinawa Island, Japan); Shen *et al.* 1993:295, pl. 76-fig. 1 (in part, Keelung); Chen 2003:73 (Penghu); Senou 2013:800; Chiang *et al.* 2014:94, top fig. (eastern Taiwan).

**Material examined.** Japan: FAKU 205237 (ex. SMBL 73181), holotype, 132.6 mm SL, off Okinawa Island, ca. 100 m depth, hook and line, August 1973 (purchased at Naha Fish Market, coll. T. Yoshino); KPM-NI 27671, 161.9 mm SL, male, probably from Ryukyu Archipelago (purchased at Naha Fish Market, coll. Y. Sakurai), 13 December 2010; KPM-NI 40886, 151.7 mm SL, KPM-NI 40887, 133.3 mm SL, female, probably from Ryukyu Archipelago (purchased at Naha Fish Market, coll. Y. Sakurai), 21 June 2016; Taiwan: ASIZP 56826, 164.7 mm SL, purchased at Keelung fish market, 1 May 1989, coll. S.-C. Lee; NMMB-P9717, 116.7 mm SL, southern Taiwan (purchased at Houbihu fishing port), 6 Sept. 2008, coll. C.-W. Chang.

**Description.** Counts and measurements given in Tables 2, 3.

Body moderately elongate, compressed; caudal peduncle depth half that of body. Head pointed, dorsal profile nearly straight; snout length 3.6–3.8 in HL; orbit diameter 4.6–5.0 in HL; interorbital space slightly convex, least bony width 5.1–5.7 in HL. Posterior margin of preopercle with slight irregular curve, not obviously serrate. Anterior nostril a thin membranous tube set directly in front of eye on edge of groove separating front of snout from upper lip; posterior nostril with a low fleshy rim, above center of eye. Mouth large, slightly oblique; lower jaw slightly projecting; posterior margin of maxilla not reaching vertical through posterior margin of orbit; upper jaw length 2.3 in HL. Villiform teeth bands on both jaws (up to 16 irregular rows anteriorly on upper jaw), vomer (ca. 6 rows in a broad V-shaped patch) and palatines (long narrow band, 4 or 5 rows wide at broadest point). Tongue slender, end broadly rounded; lips smooth.

Lateral line highly arched over pectoral fin from middle to tip; highest point below base of fifth dorsal-fin spine. Head fully scaled, except around nostrils and large pores on snout; 12 diagonal rows of scales on cheek between orbit and corner of preopercle; small scales on basal one-third of second dorsal, anal and caudal fins.



**FIGURE 1.** Fresh specimens of *Liopropoma aragai* from Japan and Taiwan. A: KPM-NI 27671, 161.9 mm SL, male; B: KPM-NI 40886, 151.7 mm SL; C: KPM-NI 40887, 133.3 mm SL; D: NMMB-P9717, 116.7 mm SL.

Origin of dorsal fin above seventh pored lateral-line scale; first dorsal-fin spine slender, its base close to base of second spine; third spine of dorsal fin longest, its length 3.2–3.6 in HL; seventh spine clearly visible above middle of distinct scaly ridge between first and second dorsal fins; fifth soft ray of dorsal fin longest, its length 1.9 in HL. Origin of anal fin below base of third soft ray of dorsal fin; first spine of anal fin shorter than second and third spines, its length 3.7–3.8 in HL; second soft ray of anal fin longest, its length 1.9–2.3 in HL. Pectoral fins pointed, fifth ray longest, reaching vertical through base of first soft ray in dorsal fin; pectoral fin length 1.4 in HL. Origin of pelvic fin slightly anterior to upper base of pectoral fin; pelvic fin length 1.9–2.0 in HL. Caudal fin emarginate, lobes pointed.

**TABLE 2.** Counts of three *Liopropoma* species from Japan and Taiwan (modes in parentheses).

	<i>L. aragai</i>		Holotype	<i>L. lemniscatum</i>		<i>L. lunulatum</i>	
	n = 3			n = 10		n = 1	
	Taiwan	Japan		Japan	Taiwan	Taiwan	
Standard length (mm)	116.7–164.7	133.3–161.9	132.6	118.2–154.7	114.9		
Dorsal-fin rays	VIII, 12	VIII, 12	VIII, 12	VIII, 12	VIII, 12		
Anal-fin rays	III, 8	III, 8	III, 8	III, 8	III, 8		
Pectoral-fin rays	15	14–15	15	15–16 (15)	15		
Pelvic-fin rays	I, 5	I, 5	I, 5	I, 5	I, 5		
Caudal-fin rays	9 + 8	9 + 8	9 + 8	9 + 8	9 + 8		
Procurent rays	9 + 8	8–9 + 8	N/A	8–9 (9) + 8	9 + 8		
Pored lateral-line scales	48	48	48	46–48 (47)	46		
Scale rows above lateral line	6	5–6	6	6	6		
Scale rows below lateral line	23	24	22	22–24 (23)	23		
Circumpeduncular scales	40–42	41–42	42	40–42 (42)	40		
Gill rakers	6–7 + 12–13	6 + 11–13	7 + 12	6 + 13	6 + 13		
Vertebrae	10 + 14	10 + 14	N/A	10 + 14	10 + 14		

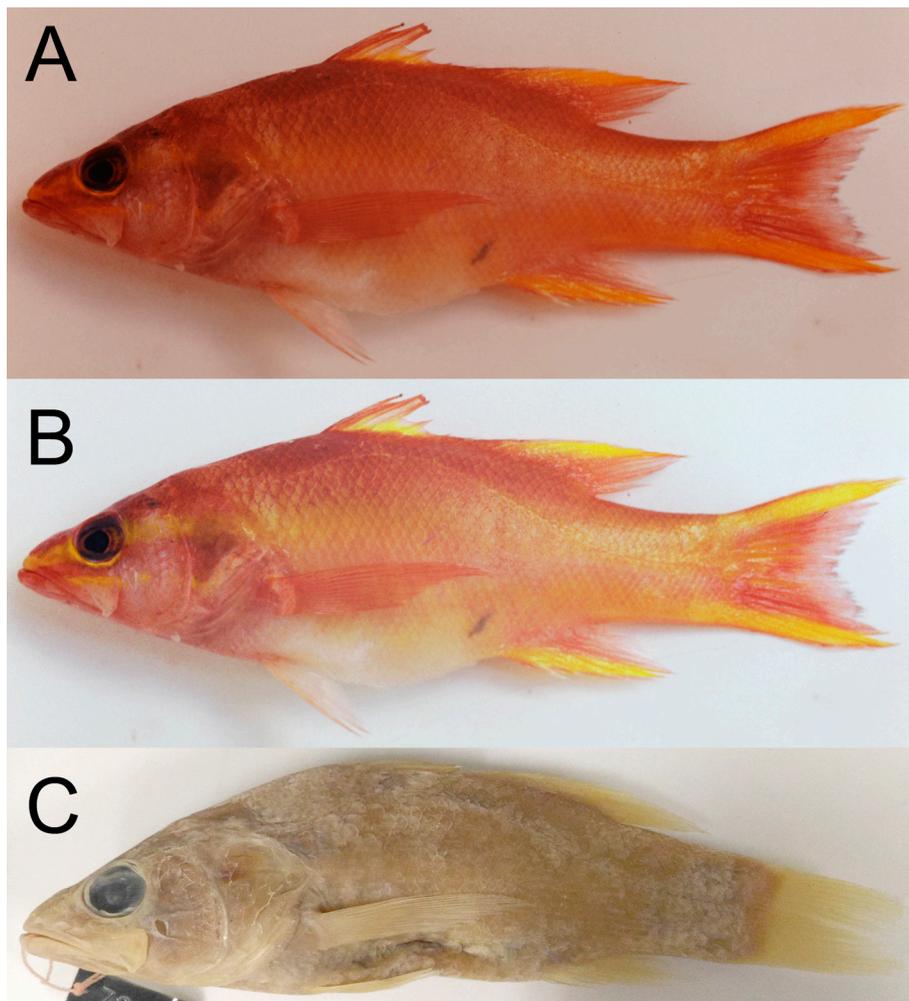
*Color when fresh.* Coloration of male (KPM-NI 27671, Fig. 1A) and female (KPM-NI 40887, Fig. 1B) specimens similar in general appearance. Body bright red dorsally, pink ventrally. A yellow stripe from front of upper lip through eye, across upper operculum, continuing broadly and becoming diffuse on center of body. A broad diffuse yellow area extending anteriorly from lower caudal peduncle to above posterior end of anal-fin base. Faint yellowish freckles on abdomen, not forming a stripe. Posterodorsal edge of maxilla yellow; a patchy yellow stripe narrower than main body stripe running from cheek to anterior of pectoral-fin base. Dorsal fin red, a broad yellow basal band on spinous portion and anteriorly on soft-rayed portion. Anal fin pink, a broad yellow submarginal band anteriorly. Caudal fin light red becoming pink distally on central portion; upper and lower lobes broadly yellow (yellow of lower lobe continuous with yellow zone of lower part of caudal peduncle); pectoral fins light red; pelvic fins pink. Iris purple with yellow band laterally thorough pupil.

*Color when preserved.* Body and fins generally pale without dark stripes (Figs. 2, 3A, B); upper half of body a little darker due to slightly dusky edges of scales.

**Distribution.** *Liopropoma aragai* has been recorded in Japanese waters from Smith Island (Izu Islands) and Okinawa Island (Ryukyu Archipelago) (Randall & Taylor 1988; Senou 2013), its range extending southward to southern Taiwan in the South China Sea (present study).

**Remarks.** Most morphological and color characters of the newly-examined specimens from Japan and Taiwan closely resembled those of the holotype of *L. aragai* (Fig. 2; Tables 2, 3): dorsal fin continuous, all spines and rays connected above their bases by membranes, eighth dorsal-fin spine longer than sixth and seventh, 12 soft rays; anal-

fin soft rays 8; pectoral-fin rays 15; lateral-line scales 48; gill rakers 6–7 (upper) + 12–13 (lower); caudal fin deeply emarginate; head fully scaled, except around nostrils; no dark markings on head, body or fins.



**FIGURE 2.** Fresh and preserved holotype of *Liopropoma aragai*. FAKU 205237 (ex. SMBL 73181), 132.6 mm SL. A: original photograph of fresh holotype (photo taken by T. Yoshino); B: color restored photograph of fresh holotype; C: preserved holotype.

Lee (1990) reported a single specimen collected from Hengchun, Taiwan (ASIZP 56030) as *Liopropoma aragai*. However, that specimen is re-identified here as *L. lemniscatum*. Shen *et al.*'s (1993) subsequent report of *L. aragai* from Keelung, Taiwan and Hengchun, included a fresh specimen photograph, likely taken of ASIZP 56826 (collected at Keelung fish market in 1989), which is herein confirmed as *L. aragai*.

Many subsequent publications followed Lee (1990) and Shen *et al.* (1993), reported only *L. aragai* from various localities in Taiwan (*i.e.*, Chen 2003; Chen *et al.* 2010; Shen & Wu 2011; Chiang *et al.* 2014). However, only the photographs shown in Chen 2003 and Chiang *et al.* (2014) were identified correctly, the remainder being misidentifications of *L. lemniscatum*. In addition, the otolith morphology, purportedly of *L. aragai*, described by Lin & Chang (2012) was based on a voucher specimen (NMMB-P9784) here re-identified as *L. lemniscatum*. First record status discussed in next section.

### ***Liopropoma lemniscatum* Randall & Taylor 1988**

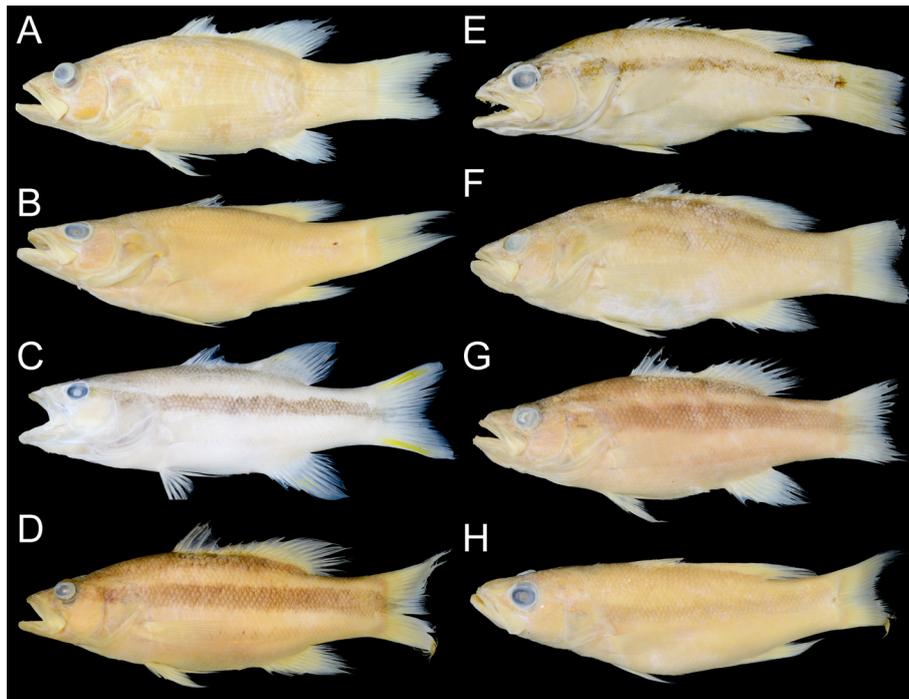
Figures 3C–H, 4; tables 2, 3

*Liopropoma lemniscatum* Randall & Taylor 1988:23, fig. 5 (holotype).

*Liopropoma aragai* (not of Randall & Taylor): Lee 1990:65, fig. 84 (Hengchun); Shao *et al.* 1992:86, fig. C (Kenting); Shen

*et al.* 1993:295 (in part, Hengchun); Shen & Wu 2011:384, unnumbered fig.; Chen *et al.* 2010:133, fig. I; Lin & Chang 2012:104, pl. 28; Chiang *et al.* 2014:94, second top fig. (eastern Taiwan).

**Material examined.** All collected from off Kenting, southern Taiwan: ASIZP 56030, 142.2 mm SL, purchased at Hengchun market, 11 Sep. 1986, coll. K.-T. Shao; ASIZP 58439, 122.3 mm SL, purchased at Hengchun market, 15 August 1993, coll. P.-L. Lin; NMMB-P9624, 118.2 mm SL, purchased at Houbihu fishing port, 4 May 2008, coll. C.-W. Chang; NMMB-P9784, 143.8 mm SL, purchased at Houbihu fishing port, 31 Aug. 2008, coll. C.-W. Chang; NMMB-P16502, 152.3 mm SL, purchased at Hengchun market, 11 Oct. 2010, coll. H.-C. Ho; NMMB-P25930, 154.7 mm SL, purchased at Houbihu fishing port, 2016, coll. H.-C. Ho; NMMB-P26102, 118.2 mm SL, NMMB-P26103, 115.2 mm SL, purchased at Houbihu fishing port, 9 May 2010, coll. C.-W. Chang; NMMB-P26091, 169.3 mm SL, NMMB-P26092, 137.4 mm SL, purchased at Houbihu fishing port, 24 May 2017, coll. H.-C. Ho.



**FIGURE 3.** Preserved specimens of two species of genus *Liopropoma* from Taiwan. *L. aragai*: A: ASIZP 56826, 164.7 mm SL; B: NMMB-P9717, 116.7 mm SL; *L. lemniscatum*: C: ASIZP 56030, 142.2 mm SL; D: ASIZP 58439, 122.3 mm SL; E: NMMB-P9624, 118.2 mm SL; F: NMMB-P9784, 143.8 mm SL; G: NMMB-P16502, 152.3 mm SL; H: NMMB-P25930, 154.7 mm SL.

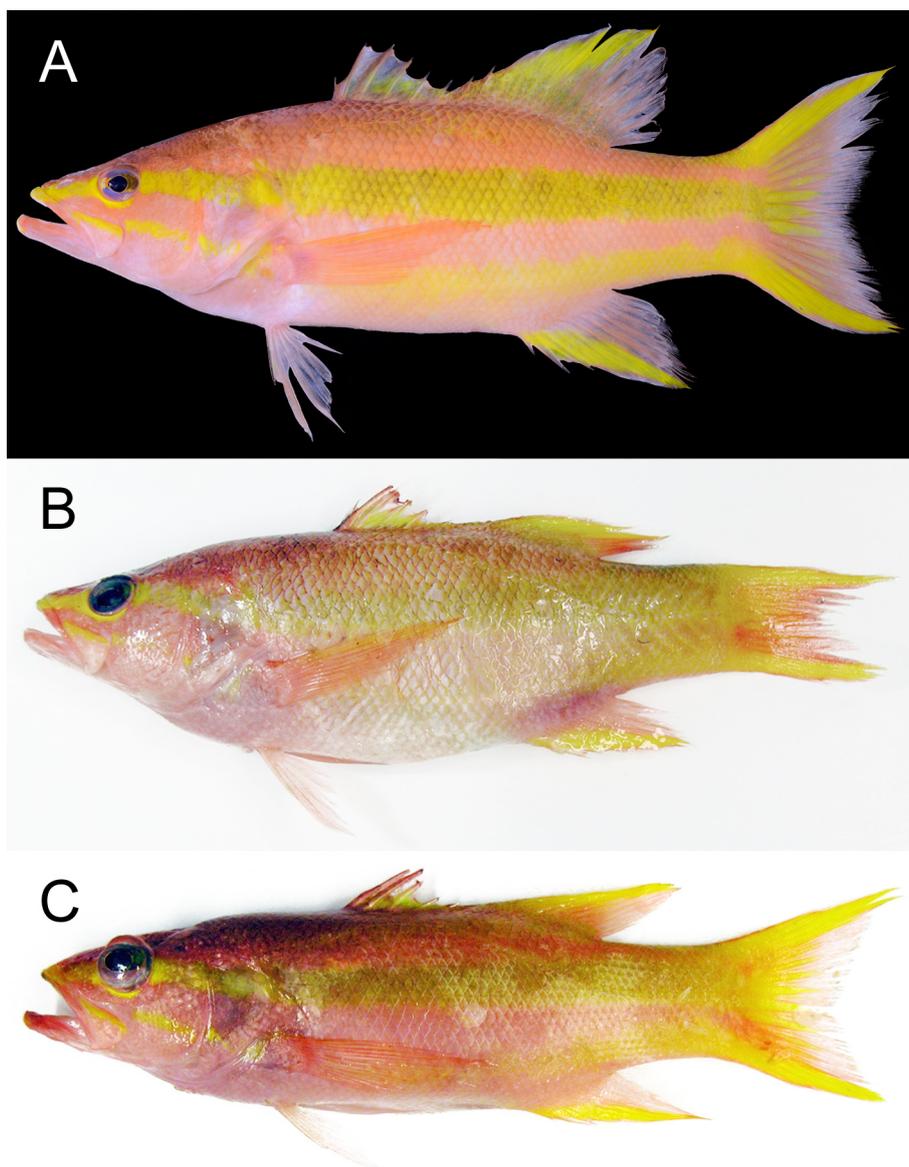
**Description.** Counts and measurements are given in Tables 2, 3.

Body moderately elongate, compressed; depth of caudal peduncle slightly less than half body depth. Head pointed, dorsal profile nearly straight; snout length 3.4–4.2 in HL; orbit diameter 4.5–5.5 in HL; interorbital space slightly convex, least bony width 5.0–5.9 in HL. Posterior margin of preopercle with slight irregular curve, not obviously serrate. Anterior nostril a thin membranous tube set directly in front of eye on edge of groove separating front of snout from upper lip; posterior nostril with a low fleshy rim, above center of eye. Mouth large, slightly oblique; lower jaw projecting; posterior margin of maxilla not reaching vertical through posterior margin of orbit; upper jaw length 2.1–2.3 in HL. Teeth villiform in bands, with up to 16 irregular rows anteriorly on jaws, gradually narrower; with about 6 rows in a broad V-shaped patch on vomer; with a long narrow band on palatine in 4 or 5 rows wide at broadest point. Tongue slender, broadly rounded anteriorly; lips smooth.

Lateral line highly arched over pectoral fin from middle to tip; highest point below base of fifth dorsal-fin spine. Head fully scaled, except around nostrils and large pores on snout; 13 diagonal rows of scales on cheek between orbit and corner of preopercle; small scales on basal one-third of second dorsal, anal and caudal fins.

Origin of dorsal fin above seventh pored lateral-line scale; first dorsal-fin spine slender, its base close to that of second spine; third spine of dorsal fin longest, its length 2.9–3.8 in HL; seventh spine clearly visible above middle of distinct scaly ridge between first and second dorsal fins; fifth soft ray of dorsal fin longest, its length 1.8–2.2 in

HL. Origin of anal fin below base of third soft ray of dorsal fin; first spine of anal fin shorter than second and third spines, its length 3.3–3.7 in HL; second soft ray of anal fin longest, its length 1.8–2.1 in HL. Pectoral fin pointed, length 1.2–1.5 in HL; fifth ray longest, reaching vertical through base of first soft ray in dorsal fin. Origin of pelvic fin slightly anterior to upper base of pectoral fin; pelvic fin length 1.6–1.9 in HL. Caudal fin emarginate, lobes pointed.



**FIGURE 4.** Fresh specimens of *Liopropoma lemniscatum* from Taiwan. A: NMMB-P26091, 169.3 mm SL; B: NMMB-P9624, 118.2 mm SL; C: NMMB-P9784, 143.8 mm SL.

*Color when fresh.* Body bright red to dark red dorsally, red to pink ventrally. A yellow stripe from front of upper lip through eye, across upper operculum, becoming dusky and broadening onto base of caudal fin (lower edge of stripe just including straight peduncular portion of lateral line). Upper edge of broad posterior part of maxilla yellow; a patchy yellow stripe narrower than main yellow stripe, running from cheek to anterior of pectoral-fin base, becoming faintly diffuse on abdomen and continuing to lower part of caudal fin base. A dark yellow dorsal stripe usually present in smaller individuals. Dorsal fin red, a broad yellow basal band on spinous portion and anteriorly on soft-ray portion of fin. Anal fin pink, anteriorly with a broad yellow submarginal band. Caudal fin light red becoming pink distally on central portion; upper and lower lobes broadly yellow (yellow of lower lobe continuous with yellow stripe of lower part of caudal peduncle); pectoral fins light red; pelvic fins pink. Iris purple with yellow band laterally through pupil.

**TABLE 3.** Measurements (expressed as percentages of standard length) of three *Liopropoma* species from Japan and Taiwan (means in parentheses).

	<i>L. aragai</i>			<i>L. lemniscatum</i>	<i>L. lunulatum</i>
	n = 2	n = 3	Holotype	n = 10	n = 1
	Taiwan	Japan	Japan	Taiwan	Taiwan
Standard length	116.7–164.7	133.3–161.9	132.6	115.2–169.3	114.9
Body depth	33.8–33.9 (33.8)	32.9–34.1 (33.3)	31.0	31.2–34.4 (32.8)	30.5
Body width	16.5–17.1 (16.8)	17.0–18.5 (17.7)	14.2	14.3–18.8 (16.6)	15.2
Head length	39.0–41.0 (40.0)	38.1–40.5 (39.5)	39.0	37.5–40.8 (39.3)	39.4
Snout length	10.2–11.3 (10.7)	10.5–11.7 (11.2)	9.9	9.6–11.7 (10.3)	10.6
Orbit diameter	8.2–8.5 (8.3)	7.4–8.6 (8.1)	8.3	7.3–8.8 (8.1)	8.9
Bony interorbital width	6.9–8.1 (7.5)	6.1–6.5 (6.3)	7.3	6.8–7.7 (7.2)	6.1
Upper-jaw length	16.8–18.1 (17.5)	17.5–18.6 (18.1)	18.0	17.3–18.2 (17.5)	17.3
Caudal-peduncle depth	15.3–16.8 (16.1)	16.7–17.6 (17.1)	16.1	16.1–19.4 (16.9)	16.2
Caudal-peduncle length	18.4–20.3 (19.3)	16.9–18.2 (17.5)	18.3	16.4–20.6 (19.0)	20.8
Pre-dorsal-fin length	42.7–45.3 (44.0)	43.5–46.3 (44.7)	46.3	42.6–45.5 (43.9)	43.4
Pre-anal-fin length	68.7–71.9 (70.3)	69.8–72.0 (71.1)	68.6	67.4–71.2 (69.8)	73.5
Pre-pelvic-fin length	38.3–40.5 (39.4)	38.7–39.2 (39.0)	36.0	37.5–42.5 (38.3)	43.8
Length of dorsal-fin base	38.2–38.4 (38.3)	38.7–39.9 (39.4)	39.1	36.1–39.4 (38.3)	36.9
Length of 1st dorsal-fin spine	4.2–4.6 (4.4)	4.2–4.6 (4.4)	3.2	3.2–5.5 (4.1)	4.9
Length of 2nd dorsal-fin spine	9.5–11.8 (10.6)	11.0–11.8 (11.4)	13.7	10.2–12.8 (11.1)	11.9
Length of 3rd dorsal-fin spine	11.4–12.0 (11.7)	12.3–13.2 (12.6)	14.9	11.3–13.5 (12.4)	13.2
Length of 6th dorsal-fin spine	4.5–5.4 (4.9)	5.1–5.7 (5.4)	5.5	4.6–6.3 (5.3)	2.8
Length of 8th dorsal-fin spine	6.0–7.7 (6.9)	6.6–7.4 (7.1)	8.6	5.5–8.0 (7.1)	6.2
Length of longest dorsal-fin ray	20.4–21.0 (20.7)	19.8–22.9 (20.9)	19.2	18.9–21.0 (20.3)	19.4
Length of anal-fin base	13.2–13.5 (13.3)	13.7–15.4 (14.5)	12.1	12.7–14.9 (14.3)	12.1
Length of 1st anal-fin spine	3.2–4.3 (3.8)	4.6–5.0 (4.8)	4.6	3.4–5.7 (4.5)	4.1
Length of 2nd anal-fin spine	9.0–9.7 (9.4)	9.6–10.4 (9.9)	10.2	8.4–10.1 (9.1)	8.9
Length of 3rd anal-fin spine	10.3–11.2 (10.8)	11.3–11.5 (11.3)	11.1	10.4–12.1 (11.0)	10.6
Length of longest anal-fin ray	18.0–20.2 (19.1)	19.1–19.5 (19.3)	19.0	19.3–21.4 (20.3)	20.2
Caudal-fin length	26.4–27.8 (27.1)	25.6–31.4 (29.3)	Damaged	22.5–28.9 (26.3)	26.5
Depth of caudal concavity	10.1–11.0 (10.5)	10.1–11.0 (10.4)	Damaged	8.5–9.9 (9.1)	8.7
Pectoral-fin length	28.3–29.2 (28.7)	29.9–31.5 (30.7)	31.2	27.9–31.1 (29.6)	28.2
Pelvic-fin spine length	9.8–11.4 (10.6)	10.5–10.7 (10.6)	11.5	9.9–12.7 (11.0)	10.1
Pelvic-fin length	20.9–20.1 (20.5)	20.1–20.8 (20.5)	Damaged	20.2–24.5 (21.7)	20.1

*Color when preserved.* Body pale with a blackish stripe about half to three-fourths orbit diameter in width passing from posterior margin of orbit to base of caudal fin (lower edge of stripe just overlapping straight peduncular portion of lateral line) and continuing to center of caudal fin; upper half of body a little darker due to slightly dusky edges of scales; blackish freckles retained from abdomen to lower caudal peduncle. Fins pale, except for extension of lateral stripe onto caudal fin.

**Distribution.** *Liopropoma lemniscatum* has been recorded from Izu-oshima Island, Sagami Bay, Suruga Bay, southern Wakayama Prefecture, Amami-oshima and Okinawa islands in the Ryukyu Archipelago (Japan) (Randall & Taylor 1988; Senou 1997, 2013; Ikeda & Nakabo 2015), and southern Taiwan (present study).

**Remarks.** Most of the morphological characters of the specimens examined here agreed well with the diagnosis of *L. lemniscatum* given by Randall & Taylor (1988): dorsal fin continuous, all spines and rays connected above their bases by membranes; dorsal-fin soft rays 12; eighth dorsal-fin spine longer than sixth and seventh; anal-fin soft rays 8; pectoral-fin rays 15–16 (usually 15); lateral-line scales 46–48; gill rakers 6 (upper) + 13 (lower); caudal fin deeply emarginate; head fully scaled; a dark stripe on body from upper end of gill opening nearly to center of caudal fin, lower end just overlapping lateral line on caudal peduncle.

Although *L. lemniscatum* has a broad dark lateral stripe on the body, similar to *L. latifasciatum* (Tanaka 1922), the former is clearly distinguished from that species in having 12 dorsal-fin soft rays, 8 anal-fin soft rays, and the lower edge of the black stripe overlapping the straight peduncular portion of the lateral line (versus 13 dorsal-fin soft rays, 9 anal-fin soft rays, and the black stripe more elevated on the caudal peduncle, not overlapping the lateral line) (Randall & Taylor 1988).

*Liopropoma lemniscatum* has been recorded only from Japanese waters, the southernmost record being Okinawa Island (26°10'N, 127°35'E) (Randall & Taylor 1988; Senou 2013). Accordingly, the specimens collected from southern Taiwan represent the first record of *L. lemniscatum* in that region, extending the distribution range by ca. 800 km southwest into the South China Sea.

### ***Liopropoma lunulatum* (Guichenot 1863)**

Figure 5; Tables 2, 3

*Grystes lunulatum* Guichenot 1863:C-24 (type locality, Réunion).

*Liopropoma lunulatum* Guichenot 1863:Randall & Taylor 1988:22, pl. 4E (Ryukyu Archipelago, Guam, Rarotonga Island, Tahiti, Kerala and Réunion); Shen & Wu 2011:385, unnumbered figure (drawing only, no voucher specimen indicated). Nair *et al.* 2013:1, fig. 2 (Kerala).

**Material examined.** NMMB-P9718, 114.9 mm SL, southern Taiwan (purchased at Houbihu fishing port), 6 Sept. 2008, coll. C.-W. Chang.

**Description.** Counts and measurements of the specimen are given in Tables 2, 3.

Body moderately elongate, compressed; caudal peduncle depth slightly less than half of body depth. Head pointed, dorsal profile nearly straight; snout length 3.7 in HL; orbit diameter 4.4 in HL; interorbital slightly convex, least bony width 6.4 in HL. Posterior margin of preopercle with slight irregular curve, not obviously serrate. Anterior nostril a thin membranous tube set directly in front of eye on edge of groove separating front of snout from upper lip; posterior nostril with a low fleshy rim, above center of eye. Mouth large, slightly oblique; lower jaw projecting; posterior margin of maxilla not reaching vertical drawn through posterior margin of orbit; upper jaw length 2.3 in HL. Villiform teeth bands on both jaws (up to 15 irregular rows anteriorly on upper jaw), vomer (ca. 6 rows in a broad V-shaped patch) and palatines (long narrow band, 4 or 5 rows wide at broadest point). Tongue slender, end broadly rounded; lips smooth.

Lateral line highly arched over pectoral fin from middle to tip; highest point below base of fifth dorsal-fin spine. Head fully scaled, except around nostrils and large pores on snout; small scales on basal one-third of second dorsal, anal and caudal fins.

Origin of dorsal fin above seventh pored lateral-line scale; first dorsal-fin spine slender, its base close to base of second spine; third spine of dorsal fin longest, its length 3.0 in HL; seventh spine clearly visible above middle of distinct scaly ridge between first and second dorsal fins; fifth soft ray of dorsal fin longest, its length 2.0 in HL. Origin of anal fin below base of third soft ray of dorsal fin; first spine of anal fin shorter than second and third spines, its length 3.7 in HL; second soft ray of anal fin longest, its length 2.0 in HL. Pectoral fins pointed, length 1.4 in HL;

fifth ray longest, reaching vertical through base of first soft ray in dorsal fin. Origin of pelvic fin slightly anterior to upper base of pectoral fin; pelvic fin length 2.0 in HL. Caudal fin emarginate, lobes pointed.

*Color when fresh.* Dorsal one-third of body orange, ventral two-thirds yellow without lateral stripes. A yellow stripe from front of upper lip through eye to upper part of operculum. Posterodorsal edge of maxilla yellow; a patchy yellow stripe running from cheek to anterior of pectoral-fin base. Approximately 20 dark brown spots scattered on dorsal half of body. Dorsal fin red, a broad yellow band basally on spinous portion and anteriorly on soft-ray portion. Anal fin pink, a broad submarginal yellow band anteriorly. Caudal fin light red becoming pink distally on central portion; upper and lower lobes broadly yellow (yellow of lower lobe continuous with yellow stripe on lower part of caudal peduncle); pectoral fins light red; pelvic fins pink. Iris purple with yellow band laterally thorough pupil.

*Color when preserved.* Body and fins pale without dark stripes; dorsal half of body with ca. 20 dark spots, background a little darker due to slight dusky edges on scales.



**FIGURE 5.** Specimen of *Liopropoma lunulatum* (NMMBA-P9718, 114.9 mm SL) from Taiwan. A: fresh specimen; B: preserved specimen.

**Distribution.** *Liopropoma lunulatum* has been recorded from Okinawa Island (Ryukyu Archipelago, Japan), Guam, Rarotonga Island (Cook Islands), Tahiti, Kerala (India), Réunion (Randall & Taylor 1988; Senou 2013; Nair *et al.* 2013). The present specimen is the first record from southern Taiwan and the South China Sea.

**Remarks.** Most morphological characters of NMMB-P9718 agree well with the diagnosis of *L. lunulatum* given by Randall & Taylor (1988): dorsal fin continuous, all spines and rays connected above their bases by membranes; dorsal-fin soft rays 12; eighth dorsal-fin spine longer than sixth and seventh; anal-fin soft rays 8; pectoral-fin rays 15; lateral-line scales 46; gill rakers 6 (upper) + 13 (lower); caudal fin deeply emarginate; head fully scaled; scattered small dark spots on body, especially posteriorly.

*Liopropoma lunulatum* closely resembles *L. aragai* and *L. lemniscatum*, sharing many morphometric characters. However, *L. lunulatum* is easily distinguished by the small dark spots scattered laterally on the body (absent in the other two species). Although *L. randalli* Akhilesh, Bineesh & White 2012 has similar laterally-scattered spots, it also has a broad black stripe from behind the eye to the caudal peduncle (versus absent in *L. lunulatum*) (Akhilesh *et al.* 2012). Although the coloration of *L. lunulatum* is similar to that of *L. aurora*, endemic to the Hawaiian Islands, the latter has 13 dorsal-fin rays and 8 anal-fins rays.

*Liopropoma lunulatum* (as *Chorististium lunulatum*) was first reported from Taiwan by Shen (1984), but the provided photograph was actually of *Chelidoperca hirundinacea* (Valenciennes 1831). This seems to have been fol-

lowed by Shen & Wu (2011), who included a drawing but no voucher specimen. Accordingly, the present specimen from southern Taiwan represents the first confirmed record of *L. lunulatum* in that region.

## Discussion

Although, the third dorsal-fin spine length in HL proportion was a key character separating *L. aragai* from its congeners in the original description (Randall & Taylor 1988), the Japanese and Taiwanese specimens shown above differ from the holotype in this character (3.0–3.6 versus 2.6 in holotype). Since the holotype (135.3 mm SL) was within the size range of the other specimens (116.7–164.7 mm SL), the difference cannot be considered growth-related, the overall range (2.6–3.6) now being seen to overlap those of both *L. lemniscatum* and *L. lunulatum* (2.9–3.8; see below). In addition, the body width in body depth proportion was also used to separate *L. aragai* from congeners by Randall & Taylor (1988). However, ranges of this character also overlap with the latter (2.0–2.2 in *L. aragai* versus 1.75–2.2 in *L. lemniscatum* and *L. lunulatum*: see below). Accordingly, these two characters will not separate these species.

Although *Liopropoma aragai* most closely resembles *L. lemniscatum*, sharing almost all morphometric characters, the two species can be distinguished from each other by their coloration, *L. lemniscatum* having a dark stripe when fresh with a blackish stripe always retained in preservation, whereas the stripe is yellow in *L. aragai* when fresh, but is lost in preserved specimens (Figs. 2, 3). *Liopropoma lemniscatum* also has a yellow stripe on the abdomen (faint blackish pigment remaining in preservation), which is absent in *L. aragai*. In addition, the caudal-fin concavity depth is also different (10.1–11.0% SL in *L. aragai* versus 8.5–9.9% SL in *L. lemniscatum*). These ranges matched those given in the original descriptions and may be useful for distinguishing these species. However, examination of additional material is necessary to establish the full extent of intraspecific variation.

## Acknowledgements

We are especially grateful to Dr. N. Nakayama (Tokai University) for his assistance in examining the holotype of *L. aragai*. We also thank Mr. Michael Lin (fisherman in Houbihu), and Mr. C.-C. Chang and Miss Z.-L. Fang (NMMB-P) for collecting specimens. Miss R.-R. Chen and Mrs. A. Koeda (NMMB-P) provided curatorial assistance and Dr. G.S. Hardy (Ngunguru, New Zealand) checked the English manuscript. The present study was supported in part by a JSPS Overseas Research Fellowship (29-304) to the first author.

## References

- Akhilesh, K.V., Bineesh, K.K. & White, W.T. (2012) *Liopropoma randalli*, a new serranid (Teleostei: Perciformes) fish from the Indian Ocean. *Zootaxa*, 3439, 43–50.
- Chen, J.-P., Shao, K.-T., Jan, R.-Q., Kuo, J.-W. & Chen, J.-Y. (2010) *Marine fishes in Kenting National Park. First Revised Edition*. Kenting National Park Headquarters, Hengchun, 650 pp.
- Chiang, W.-C., Lin, P.-L., Chen, W.-Y. & Liu, D.-C. (2014) *Marine fishes in eastern Taiwan. Fisheries Research Institute Special Publication. Vol. 18*. Fisheries Research Institute, Keelung, x + 337 pp.
- Fricke, R., Eschmeyer, W.N. & van der Laan, R. (Eds.) (2018) Catalog of fishes: genera, species, references. Electronic version. Available from: <http://researcharchive.calacademy.org/research/ichthyology/catalog/fishcatmain.asp>. (accessed 9 Nov. 2018)
- Ikeda, H. & Nakabo, T. (2015) *Fishes of the Pacific coasts of southern Japan*. Tokai University Press, Hadano, xxii + 597 pp. [in Japanese]
- Lee, S.-C. (1990) A revision of the serranid fish (family Serranidae) of Taiwan. *Journal of the Taiwan Museum*, 43 (2), 1–72.
- Lee, S.-C. & Lee, C.-H. (1981) A collection of subtropical fishes from Lanyu (Botel Tobago), Taiwan, with a note on a newly recorded serranid, *Ypsigramma lineata*. *Bulletin of the Institute of Zoology, Academia Sinica*, 20 (2), 87–89.
- Lin, C.-H. & Chang, C.-W. (2012) *Otolith atlas of Taiwan fishes*. National Museum of Marine Biology and Aquarium, Checheng, 415 pp.
- Nair, R.J., Kumar, S.D., Paul, S. & Kuriakose, S. (2013) Occurrence of two serranid fish from Indian waters with a note on their taxonomy. *Marine Biodiversity Records*, 6, e41.
- Randall, J.E. & Taylor, L. (1988) Review of the Indo-Pacific fishes of the serranid genus *Liopropoma*, with descriptions of seven new species. *Indo-Pacific Fishes*, 16, 1–47.

- Senou, H. (1997) *Liopropoma lemniscatum*. In: Okamura, O. & Amaoka, K. (Eds.), *Sea fishes of Japan*. Yamakei, Tokyo, pp. 276. [in Japanese]
- Senou, H. (2013) Serranidae. In: Nakabo, T. (Ed.), *Fishes of Japan with pictorial keys to the species. 3<sup>rd</sup> Edition*. Tokai University Press, Hadano, pp. 757–802 + 1960–1971.
- Shen, S.C. (1984) *Coastal fishes of Taiwan*. Taiwan Museum, Taipei, 191 pp.
- Shen, S.C., Lee, S.C., Shao, K.T., Mok, H.K., Chen, C.H. & Chen, C.T. (1993) *Fishes of Taiwan*. Department of Zoology, National Taiwan University, Taipei, 960 pp.
- Shen, S.C. & Wu, K.Y. (2011) *Fishes of Taiwan*. National Museum of Marine Biology & Aquarium, Checheng, 896 pp.
- Shao, K.T., Chen, J.P. & Shen, S.C. (1992) *Marine fishes of the Ken-Ting National Park*. Ken-Ting National Park Headquarters Construction and Planning Administration Ministry of Interior, Kenting, 427 pp.
- Shao, K.T., Ho, H.C., Lin, P.L., Lee, P.F., Lee, M.Y., Tsai, C.Y., Liao, Y.C. & Lin, Y.C. (2008) A checklist of the fishes of southern Taiwan. *Raffles Bulletin of Zoology*, 2008 (Supplement 19), 233–271.