



***Lutjanus xanthopinnis*, a new species of snapper (Pisces: Lutjanidae) from the Indo-west Pacific, with a redescription of *Lutjanus madras* (Valenciennes 1831)**

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Abstract

A new species of snapper of the genus *Lutjanus* is described from the Indo-western Pacific region, and the related species with which it frequently has been confused, *Lutjanus madras* (Valenciennes 1831), is redescribed. *Lutjanus xanthopinnis* n. sp. is described from 11 specimens, 56–192 mm SL, from Kagoshima in southern Japan, Taiwan, Indonesia, and Sri Lanka. It differs from *L. madras* in meristics, color, and squamation of the preopercular flange. The new species is distinguished by several embedded scales on the preopercular flange, 4 or 5 scale rows on the cheek, and mostly uniform thin yellow to brownish stripes on the body on adults, missing the well-contrasted and much broader mid-lateral stripe characteristic of *L. madras*. In contrast, *L. madras* lacks scales on the preopercular flange, has 7 or 8 scale rows on the cheek, and has a broad (up to pupil diameter), well-contrasted yellow to brownish stripe along the lateral midline. Comparison of the barcode mitochondrial COI genetic marker reveals a 6.4% minimum interspecific divergence (uncorrected pairwise) between the two species. We also conclude that *L. madras*, formerly considered to be widely distributed in the Indo-western Pacific region, is actually restricted to the Indian Ocean (Zanzibar, Seychelles, Oman, Sri Lanka, and southern India), with the two species apparently sympatric in Sri Lanka. The yellow-lined snapper complex of the Indo-Pacific is clarified, including morphological and marking differences, genetic relationships, and species distributions.

Key words: taxonomy, ichthyology, coral reef fishes, Indian Ocean, phylogenetics, biogeography, DNA barcoding.

Introduction

The 39 species of Indo-Pacific snappers of the genus *Lutjanus* were reviewed by Allen & Talbot (1985) and Allen (1985). More recently four additional species were added, including *L. ophuysenii* (Bleeker 1860) and *L. bouton* (Lacepède 1802), which were resurrected by Iwatsuki *et al.* (1993) and Allen (1995), respectively, and *L. indicus* and *L. papuensis* described as new species by Allen *et al.* (2013).

The present paper describes a new snapper species based on specimens from Japan, Taiwan, Indonesia and Sri Lanka that were previously considered to be *L. madras* (Valenciennes 1831), and also provides a redescription of true *L. madras* as well as genetic comparisons to the other members of the yellow-lined snapper complex. *Lutjanus madras* was formerly believed to be wide ranging across the Indian and western Pacific Oceans and was diagnosed and illustrated in the review of the genus by Allen & Talbot (1985). They included it in the yellow-lined snapper complex along with *L. adetii* (Castelnau 1873), *L. lutjanus* Bloch 1790, *L. mizenkoi* Allen & Talbot 1985, and *L. vitta* (Quoy & Gaimard 1824), all of which exhibit similar color patterns featuring thin yellow to brownish stripes on the body. After their review, an additional member of the complex, *L. ophuysenii*, was recognized as valid by Iwatsuki *et al.* (1993). It occurs in temperate seas of the East Asian Shelf and northwestern Pacific Ocean, but is more common in Japan than in China and Taiwan (Iwatsuki *et al.* 1993; this study). Specimens of the new species *L. xanthopinnis* from Indonesia, Malaysia, southern China, and Taiwan have been frequently misidentified as *L. ophuysenii* in databases.

Illustrations of putative *L. madras* appearing in Allen & Talbot (1985), Allen (1985), and Allen & Erdmann (2012) indicate the presence of two color morphs from the Indo-western Pacific. More recently, *L. madras* was also reported by Manilo & Bogorodsky (2003) and Iwatsuki *et al.* (2013) from the Arabian Sea, including Oman. In addition, Tanaka *et al.* (2010) reported the first record of putative *L. madras* from Japanese seas on the basis of a specimen from the Yaeyama Islands. To clarify the status of the species in the region, we have obtained additional Japanese specimens, as well as new material from Indonesia, Taiwan, and Sri Lanka. Morphological examination of these specimens in conjunction with analysis and comparison of the barcode COI mtDNA marker, from these and other specimens in the Barcode database BOLD, reveals that putative *L. madras* is clearly divisible into two distinct taxa.

In addition, we evaluate the genetic relationships for the broad yellow-lined snapper complex, including *L. bitaeniatus* (Valenciennes 1830) and *L. lemniscatus* (Valenciennes 1828), both of whose juvenile stages show a dark stripe along the lateral midline of the body, similar to that found in other members of this species complex.

Materials and Methods

Institutional codes follow Sabaj Perez (2014), except for the South African Institute for Aquatic Biodiversity (SAIAB; formerly RUSI). Counts and measurements follow the methods of Allen & Talbot (1985) and Iwatsuki *et al.* (1993).

The nomenclature for genetic sequences for type specimens follows Chakrabarty (2010) and Harrison *et al.* (2011). Muscle tissue samples were taken from fresh specimens and stored frozen in 99.9% ethanol. Genomic DNA was extracted from muscle tissue by proteinase K digestion followed by a standard phenol chloroform method (Sambrook & Russell 2001). Primers used for the amplification of the cytochrome-c oxidase subunit 1 (COI) gene were Fish F1–5'-TCAACCAACCACAAAGACATTGGCAC-3' and Fish R1–5'-TAGACTTCTGGGTGGCCAAAGAATCA-3' (Ward *et al.* 2005). The thermal regime consisted of an initial step of 2 min at 95°C followed by 35 cycles of 40 s at 94°C, 40 s at 54°C and 1 min 10 s at 72°C, followed by final extension for 10 min at 72°C. The PCR products were visualized on 1.2 % agarose gels. Sequencing of the samples was performed by the Dragon Genomics Center, Takara Bio Inc. (Otsu, Japan).

The sequences were aligned using CLUSTAL X (Larkin *et al.* 2007), and 612 bp of the COI gene were obtained for the analyses. The average p divergences (%) were calculated using the Kimura two parameter (K2P) distance model (Kimura 1980) from the partial sequences of COI gene (Table 3). A neighbor-joining (NJ) tree of K2P distances was created to provide a graphic representation of the divergence pattern between species (Saitou & Nei 1987), following bootstrapping using “MEGA6” software with 1,000 replications (Tamura *et al.* 2013).



Figure 1. *Lutjanus xanthopinnis*, fresh holotype (reversed), MUFS 33019, 160 mm SL, Kagoshima, Japan (F. Tanaka).

***Lutjanus xanthopinnis*, n. sp.**

Yellowfin Snapper

Japanese name: Imoto-fuedai

Figures 1–5 & 10–11, Tables 1 & 2.

Lutjanus madras (*non Valenciennes*) Allen & Talbot 1985: 21 (in part, Pacific); Allen 1985: 61 (in part, Pacific); Allen 1997: 124 (SE Asia); Allen in Randall & Lim 2000: 618 (South China Sea); Anderson & Allen 2001: 2883 (in part, Western Central Pacific); Allen & Adrim 2003: 39 (Indonesia); Manilo & Bogorodsky 2003: S108 (?in part, Arabian Sea); Iwatsuki & Satapoomin 2009: 140, uppermost color plate (Andaman Sea); Tanaka *et al.* 2010: 16 (Yaeyama Is., Japan); Allen & Erdman 2012: 451 (underwater photograph from Brunei, not Raja Ampat Islands as listed); Fricke *et al.* 2014: 86 (Papua New Guinea).

Holotype. MUFS 33019, 160 mm SL, Kishira, Kimotsuki, Uchinoura Bay, Kagoshima, Japan, 31°11'26" N, 131°00'3" E.

Paratypes. MUFS 46172, 140 mm SL, Negombo fish market, Negombo, Sri Lanka, 7°12'34" N, 79°49'48"

E; MUFS 46204, 46205 & 46216, 3 specimens, 142–164 mm SL, Beruwara, Sri Lanka, 6°29'2" N, 79°59'0" E; MUFS 46558, 46565, 2 specimens, 170–192 mm SL, Keelung, Taiwan, 25°9'17" N, 121°46'9" E; CSIRO H 7360-03, 56 mm SL, Banyuwangi (East Java), Indonesia, 8°9' S, 114°23' E, W. White, Oct. 27, 2008; CSIRO H 7841-01 & H 7842-01, 2 specimens, 161–181 mm SL, Kedonganan fish market, Jimbaran Bay, Bali, Indonesia; 8°45' S, 115°10' E, W. White, July 14, 2008; MZB 22955, 169 mm SL, Kedonganan fish market, Jimbaran Bay, Bali, Indonesia, 8°45' S, 115°10' E, W. White, Nov. 1, 2010.

Diagnosis. A species of *Lutjanus* with the following combination of characters: dorsal-fin rays X,13; anal-fin rays III,8; pectoral-fin rays usually 16 or 17; lateral-line scales 48–50: horizontal scale rows above lateral line 5–6; scale rows on cheek 4 or 5; several embedded scales on preopercular flange; gill rakers on first arch 7–8 (6–7 rudiments) + 14–15 (4–5 rudiments), total gill rakers= 22–23 (including rudiments); pair of small rounded to elliptical nostrils on each side of snout, without conspicuous flap on outer edge of either nostril; predorsal scales extending forward to middle of interorbital; thin yellow to brownish stripes on the body below lateral line, adults with relatively uniform width stripes or, at most, a more prominent slightly wider stripe from behind the eye to the upper caudal peduncle, occupying only a single scale row and well less than half pupil width (juveniles may have a wider lateral stripe); fins mostly yellow.

Description. Dorsal-fin rays X,13; anal-fin rays III,8; pectoral-fin rays usually 16 or 17; lateral-line scales 48–50; horizontal scale rows above lateral line 5–6; scale rows on cheek 4 or 5; several embedded scales on preopercular flange; gill rakers on first arch 7–8 (6–7 rudiments) + 14–15 (4–5 rudiments), total gill rakers= 22–23 (including rudiments).

Body slender and elongate to moderately deep and laterally compressed, greatest depth 2.7–2.9 in SL, head length 2.5–2.7, both in standard length; snout 3.2–3.5, eye 3.1–3.5, interorbital 5.3–6.2, maxilla 2.5–2.7, and preorbital depth 5.7–6.6, all in head length; preopercular notch and interopercular knob poorly developed or indistinct; vomerine teeth in diamond-shaped patch with medial posterior extension; tongue with patch of fine granular teeth; head relatively small with pointed snout; snout-forehead profile almost straight; pair of small rounded to elliptical nostrils on each side of snout, without conspicuous flap on outer edge of either nostril; body, opercle, and preopercle with finely ctenoid scales; predorsal scales extending forward to middle of interorbital; body scales on back rising obliquely above lateral line; preopercular margin finely serrate (serrae increasing in size ventrally); sharp, flattened, leathery projection at middle of opercular margin, with blunt bony spine (mostly



Figure 2. *Lutjanus xanthopinnis*, underwater photograph, about 160 mm SL, Brunei (G.R. Allen).

TABLE 1

Proportional measurements (as percentage of SL with range [mean]) for
Lutjanus xanthopinnis n. sp. and *L. madras*

	<i>L. xanthopinnis</i> holotype	range, paratypes (n=10)	<i>L. madras</i> holotype	range, non-types (n=3)
Body depth	39	34–38 (36)	32	34–37 (36)
Body depth at 1st anal spine	34	29–34 (31)	29	29–30 (30)
Head length	36	37–40 (38)	38	38–40 (39)
Body width	17	15–18 (16)	18	13–15 (14)
Snout length	11	10–12 (11)	13	11–13 (12)
Orbit diameter	11	10–13 (12)	9	10–11 (10)
Dermal eye opening	9	9–11 (10)	8	9 (9)
Interorbital width	7	6–7 (7)	9	8 (8)
Interorbital width + membrane	9	8–9 (8)	10	10 (10)
Upper jaw length	14	11–16 (15)	17	11–16 (14)
Suborbital depth	6	5–7 (6)	5	4–5 (5)
Caudal peduncle depth	12	12 (12)	12	12 (12)
Caudal peduncle length	19	18–21 (20)	17	18–19 (19)
Predorsal length	40	37–44 (41)	39	40–42 (41)
Preanal length	66	63–68 (65)	77	65–67 (66)
Prepelvic length	38	36–42 (40)	44	40–41 (41)
Dorsal-fin base	48	47–54 (51)	48	49–51 (50)
Anal-fin base	15	13–15 (14)	15	15–15 (15)
Caudal-fin length	26	23–29 (26)	24	25–29 (27)
Pelvic-fin spine length	14	12–21 (14)	10	12–14 (13)
Pelvic-fin length	23	19–23 (21)	17	21–22 (21)
Pectoral-fin length	31	28–34 (31)	26	27–31 (30)
First dorsal-fin spine	6	5–6 (6)	4	5–6 (6)
Second dorsal-fin spine	11	11–13 (12)	7	9–11 (10)
Third dorsal-fin spine	13	14–16 (15)	10	13–14 (14)
Fourth dorsal-fin spine	14	14–17 (15)	12	14–16 (15)
Fifth dorsal-fin spine	14	13–16 (14)	12	14 (14)
Sixth dorsal fin spine	13	11–15 (13)	13	9–14 (12)
First soft dorsal-fin ray	12	11–13 (12)	9	10–12 (11)
First anal-fin spine	4	3–7 (5)	4	3–4 (4)
Second anal-fin spine	12	11–14 (12)	9	10 (10)
Third anal-fin spine	13	11–14 (12)	8	9–10 (10)
First soft anal-fin ray	15	13–16 (15)	11	13–15 (14)

TABLE 2

Meristic counts for
Lutjanus xanthopinnis n. sp. and *L. madras*

	<i>L. xanthopinnis</i> holotype	range, paratypes (n=10)	<i>L. madras</i> holotype	range, non-types (n=3)
Dorsal-fin rays	X,13	X,13	X,13	X,13
Anal-fin rays	III,8	III,8	III,9	III,9
Pectoral-fin rays (i+15+i)	17	16–17	17	17
Lateral-line scales	48	48–50	50	49–51
Horizontal scale rows above lateral line	6	5–6	7	6–7
Scale rows on cheek	4	4–5	8	7–8
Scale rows above/ below lateral line	6 ½ / 11 ½	6 ½–7 ½ / 11 ½–14 ½	7 ½ / 17 ½	7 ½ / 16 ½–17 ½
Gill rakers, upper and lower limb totals (rudiments) = total including rudiments	8 (7) + 14 (4)=22	7–8 (6–7) + 14–15 (4–5) =22–23	8 (6) + 17 (7)=25	8–9 (7–8) + 17–18 (7–8) =25–27



Figure 3. *Lutjanus xanthopinnis*, fresh paratype, CSIRO H 7360-03, 56 mm SL, Banyuwangi, Indonesia (W. White).



Figure 4. *Lutjanus xanthopinnis*, fresh paratype, MUFS 46205, 161 mm SL, Sri Lanka (F. Tanaka).

covered by scales) immediately above its base; margins of opercle, interopercle, and subopercle otherwise smooth; upper jaw with pair dagger-like canine teeth anteriorly, with smaller canine teeth between these and symphysis, remaining lateral portion of upper jaw with series of embedded caniniform teeth; lower jaw with about 6–10 small canine teeth on each side, mostly embedded and scarcely visible when mouth closed; dorsal-fin outline moderately incised, fourth or fifth spines longest, remaining spines gradually decreasing in length; profile of soft dorsal-fin relatively low and weakly rounded; pectoral fins pointed, caudal fin emarginate.

Proportional measurements as percentages of standard length (SL) for the holotype and paratypes of *Lutjanus xanthopinnis* in comparison to the holotype and non-type specimens of *L. madras* are presented in Table 1 and comparative meristic counts in Table 2.

Color in life. (Figs. 1–5) Generally reddish to pinkish to silvery-gray background on upper half with whitish abdomen, becoming darker on upper head and back; a series of narrow yellow horizontal stripes (one per scale row) on lower sides of body below the lateral line, the mid-lateral stripe originating at the mid-eye often a little wider and more prominent (but still a single scale row); similar thin yellow to brownish yellow lines above lateral line, but running obliquely upward and along oblique scale rows; dorsal, caudal, anal, and pectoral fins vivid yellow; pelvic fins whitish with yellow tinge; iris reddish to golden yellow. Juvenile similar, but midlateral stripe wider, nearly two scale rows in height and up to about one pupil diameter wide (Fig. 3).

Color in alcohol. Generally yellowish tan on body and fins, with a series of faint brown lines on sides as in live markings; fins tan or yellowish.

Etymology. This species is named “*xanthopinnis*” (Latin: “yellow-finned”) with reference to the prominent yellow fins of this species.

Distribution. The new species occurs widely in the western Pacific Ocean from southern Japan to the East Indies and extends into the Indian Ocean. Previous records of “*L. madras*” from the Pacific Ocean (e.g. Allen & Talbot 1985, Allen 1985, and Allen & Erdmann 2012) are attributable to *L. xanthopinnis*. The distribution includes the Philippines, Brunei, Malaysia, western Indonesia (from the Malay Peninsula to Bali), and northward to China, Taiwan, and Japan. The range extends westward into the eastern Indian Ocean, with records from the Andaman Sea off the coast of western Thailand by Iwatsuki & Satapoomin (2009, p. 140, as “*L. madras*”) and Sri Lanka (this study) where it is apparently sympatric with true *L. madras*. The photograph of this species, as “*L. madras*”, purportedly from the Raja Ampat Islands in West Papua, Indonesia in Allen & Erdmann (2012, p. 451)



Figure 5. *Lutjanus xanthopinnis*, fresh paratype, MUFS 46565, 192 mm SL, Keelung, Taiwan (R. Miki).

was actually taken in Brunei, on the island of Borneo (our Fig. 2).

The new species was only recently reported (as “*L. madras*”) from the northwestern Pacific Ocean at Japan (Tanaka *et al.* 2010), despite numerous previous surveys in this region (Masuda *et al.* 1985, Iwatsuki *et al.* 1992, Shen 1993, Anderson & Allen 2001). Even though it is apparently common at Keelung in northeastern Taiwan (first author’s observations in March 2015), it had not been previously reported from Taiwan despite surveys by the first author in the early 1990s and assessments of snappers from Taiwan by Allen & Talbot (1985) and Shen (1993). One possible explanation is that increased water temperatures due to climate change is responsible for the spread of more tropical marine organisms northward into temperate waters of southwestern Japan (Tanaka *et al.* 2012).

Similar to the situation with *L. xanthopinnis*, several other tropical lutjanids and caesionids have recently been reported from southern Japan, including *Dipterygonotus balteatus*, *Gymnocaesio gymnoptera*, *Lutjanus bengalensis*, *L. dodecacanthoides*, *L. ehrenbergi*, *L. johnii*, *L. timorensis*, and *Pinjalo pinjalo* (see Shimada & Yoshino 1987, Iwatsuki *et al.* 1989, Iwatsuki *et al.* 1999, Yoshino *et al.* 1999, Iwatsuki *et al.* 2004, and Hayashida *et al.* 2012). There has been a dramatic increase in abundance of *L. bengalensis* since it was first reported in Japan in 1999. Both juveniles and adults are now common in southwestern Japan, ranging as far north as the Kii Peninsula (Kimura *et al.* 2008), Tokai District, and Kanto District near Tokyo (based on the first author’s observations). Similar increased sightings are also evident for *Lutjanus xanthopinnis* (as “*L. madras*”) and *L. johnii*, which have been observed annually since their first sightings in Japanese waters.



Figure 6. *Lutjanus madras*, fresh topogenotype, KUT 6818, 270 mm SL, Mahé, Seychelles (A. Bentley).

***Lutjanus madras* (Valenciennes in Cuvier & Valenciennes 1831)**

Indian Snapper

Figures 6–11, Tables 1 & 2.

Mesoprion madras Valenciennes in Cuvier & Valenciennes 1831: 446 (type locality, Mahé, Seychelles); Günther 1859: 200.

Mesoprion machas (as misspelled) Playfair 1868: 849 (type locality, Mahé, Seychelles).

?*Lutjanus lutjanus* [non Bloch] Kyushin *et al.* 1977: 64 (Laccadive Islands, India).

Lutjanus madras Allen & Talbot 1985 (in part): 57 (Zanzibar, Seychelles, & India; Plate VII F); Allen 1985 (in part): 100 (western & central Indian Ocean); Manilo & Bogorodsky 2003: S108 (Arabian Sea).

Holotype. MNHN 0000-8338, 254 mm SL, Mahé, Seychelles.

Non-type specimens examined. MUFS 33568, 224 mm SL, Madrasah, southern Oman, Oman; MUFS 33576, 241 mm SL, Madrasah, southern Oman, Oman; MUFS 46214, 226 mm SL, Beruwara, Sri Lanka, 6°29'2" N, 79°59'0" E.

Diagnosis. A species of *Lutjanus* with the following combination of characters: dorsal-fin rays usually X, 13; anal-fin rays III,9; pectoral-fin rays 17; lateral-line scales 49–51; horizontal scale rows above lateral line 6–7; scale rows on cheek 7–8; scales absent on preopercular flange; gill rakers on first arch 8–9 (6–8 rudiments) + 17–18 (7–8 rudiments); total gill rakers= 25–27 (including rudiments); pair of small rounded nostrils on each side of snout with very low flap on outer edge of anterior nostril; predorsal scales extending forward to vertical at posterior margin of pupil; thin yellow to brownish stripes on the side of body below lateral line with one prominent broad (up to pupil diameter or 1.5–3 scale rows wide), yellow to brownish stripe on the side, from behind eye to upper caudal peduncle; fins mostly yellow.



Figure 7. *Lutjanus madras*, preserved holotype, MNHN 0000-8338, 254 mm SL, Mahé, Seychelles (Y. Fukui).

Description. Dorsal-fin rays usually X,13; anal-fin rays III,8; pectoral-fin rays 17; lateral-line scales 49–51; horizontal scale rows above lateral line 6–7; scale rows on cheek 7–8; scales absent on preopercular flange; gill rakers on first arch 8–9 (6–8 rudiments) + 17–18 (7–8 rudiments); total gill rakers= 25–27 (including rudiments).

Body elongate to moderately deep and laterally compressed, greatest depth 2.7–3.0, head length 2.5–2.6, both in standard length; snout 3.1–3.4, eye 3.6–3.8, interorbital 4.5–4.7, maxilla 2.5–3.5, and preorbital depth 7.1–7.5, all in head length; preopercular notch and interopercular knob poorly developed or indistinct; vomerine teeth in diamond-shaped patch with short posterior extension; tongue with patch of fine granular teeth; head relatively small with pointed snout; snout-forehead profile almost straight; pair of small rounded nostrils on each side of snout with very low flap on outer edge of anterior nostril; body, opercle, and preopercle with finely ctenoid scales; predorsal scales extending forward to vertical at posterior margin of pupil; body scales on back rising obliquely above lateral line; no scales on interorbital but scaled on preopercle; preopercular margin finely serrate (serrae increasing in size ventrally); sharp, flattened, leathery projection at middle of opercular margin, with blunt bony spine (mostly covered by scales) immediately above its base; margins of opercle, interopercle, and subopercle



Figure 8. *Lutjanus madras*, MUFS 33568, 224 mm SL, Madrakah, southern Oman (Y. Iwatsuki).



Figure 9. *Lutjanus madras*, MUFS 46214, 226 mm SL, Beruwara, Sri Lanka (F. Tanaka).

smooth; upper jaw with pair of dagger-like canine teeth anteriorly, with smaller canine teeth between these and symphysis, remaining lateral portion of upper jaw with series of embedded caniniform teeth; lower jaw with about 6–8 small canine teeth on each side, mostly embedded, scarcely visible when mouth closed; dorsal-fin outline slightly incised, fourth or fifth spines longest, remaining spines gradually decreasing in length; profile of soft dorsal-fin relatively low and weakly rounded; pectoral fins pointed, caudal fin emarginate.

Proportional measurements as percentages of standard length (SL) for the holotype and non-type specimens of *L. madras* in comparison to the new species *L. xanthopinnis* are presented in Table 1 and meristic counts in Table 2.

Color in life. Generally reddish to pinkish to silvery-gray background on upper half with whitish abdomen, becoming darker on upper head and back; a series of narrow yellow horizontal stripes (one per scale row) on lower sides of body below the lateral line, the mid-lateral stripe originating at the mid-eye distinctly more prominent and wider, usually up to one pupil diameter or more and from 1.5–3 scale rows wide; similar thin yellow to brownish yellow lines above lateral line, but running obliquely upward and along oblique scale rows; dorsal, caudal, anal, and pectoral fins yellow (caudal fin frequently dusky when fresh); pelvic fins whitish with yellow tinge; iris reddish to golden yellow.

Color in alcohol. Generally yellowish tan on body and fins, with a series of faint brown lines on sides as in live markings; fins tan or yellowish. The very old holotype is mainly brownish (Fig. 7).

Distribution. Probably limited to the western Indian Ocean. The present study confirmed its occurrence on the basis of voucher specimens and matching barcode DNA sequences only from the Seychelles (type locality), Sri Lanka, and Madrasah, southern Oman. It was also illustrated from Tuticorin, India by Allen & Talbot (1985). Specimens reported (as *L. lutjanus*) from the Laccadive Islands, India by Kyushin *et al.* (1977) are also likely *L. madras*. The only record from East Africa is from Zanzibar, reported by Allen & Talbot (1985).

Comparisons between *L. xanthopinnis* and *L. madras*

The new species *L. xanthopinnis* most resembles *L. madras*, with which it was formerly confused. However, it differs mainly in scale characters and, to a degree, in markings in the adults. As can be seen in Fig. 10, *L. madras* has no scales on the preopercular flange, compared to *L. xanthopinnis* having several embedded scales on the preopercular flange. In addition, *L. madras* can be seen to have many more scales on the cheek: 7 or 8 rows vs.

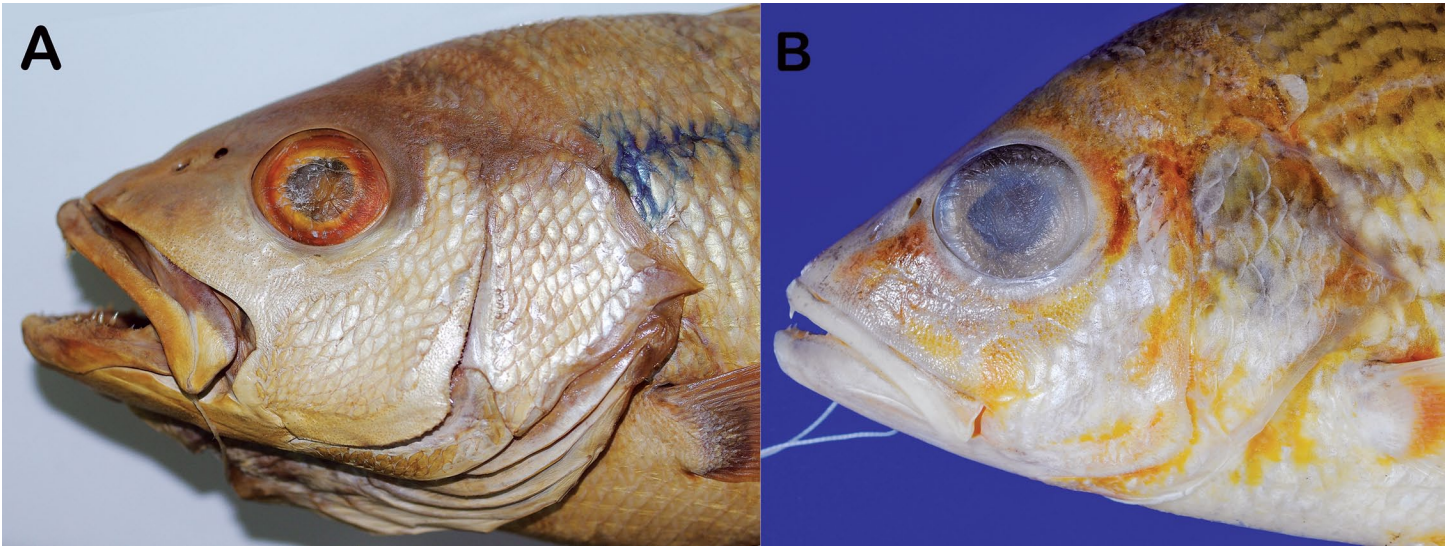


Figure 10. Squamation of the preopercular flange: (A): *Lutjanus madras*, holotype, MNHN 0000-8338, 254 mm SL; and (B): *L. xanthopinnis*, paratype, MUFS 46565, 192 mm (Y. Iwatsuki).

only 4 or 5 scale rows on the cheek of *L. xanthopinnis*. Additional differences on the head can be seen in Fig. 11, where *L. madras* has a rounded posterior nostril and the predorsal scales extending to about the level of the posterior edge of the orbit, vs. an elliptical posterior nostril and the predorsal scales extending forward to about the middle of the interorbital space in *L. xanthopinnis*.

The color and marking differences among the yellow striped snappers can be subtle, but it appears that adults of *L. xanthopinnis* can be distinguished from *L. madras* by the relative uniformity of the lateral yellow stripes below the lateral line. In *L. xanthopinnis*, the stripes are of about equal width, as in the holotype, or with a mid-lateral stripe only slightly more prominent, and only a single scale row in width (Figs. 1–5). In contrast, *L. madras* has a prominent mid-lateral yellow stripe, from 1.5 to 3 scale rows wide (Figs. 6–9). The color pattern difference may not apply to juveniles, since the DNA-confirmed 56-mm SL paratype of *L. xanthopinnis* has a wide mid-lateral stripe (Fig. 3). Juveniles of many of the yellow-striped snapper complex have more prominent lateral stripes.

Finally, the mitochondrial DNA lineages for the two species are reciprocally monophyletic and diverge by 6.4% (minimum interspecific distance; mean divergence of 7.1%; both uncorrected pairwise). They are part of the strict yellow-lined snapper clade in the neighbor-joining phenetic tree, but are not the closest DNA lineages to each other.

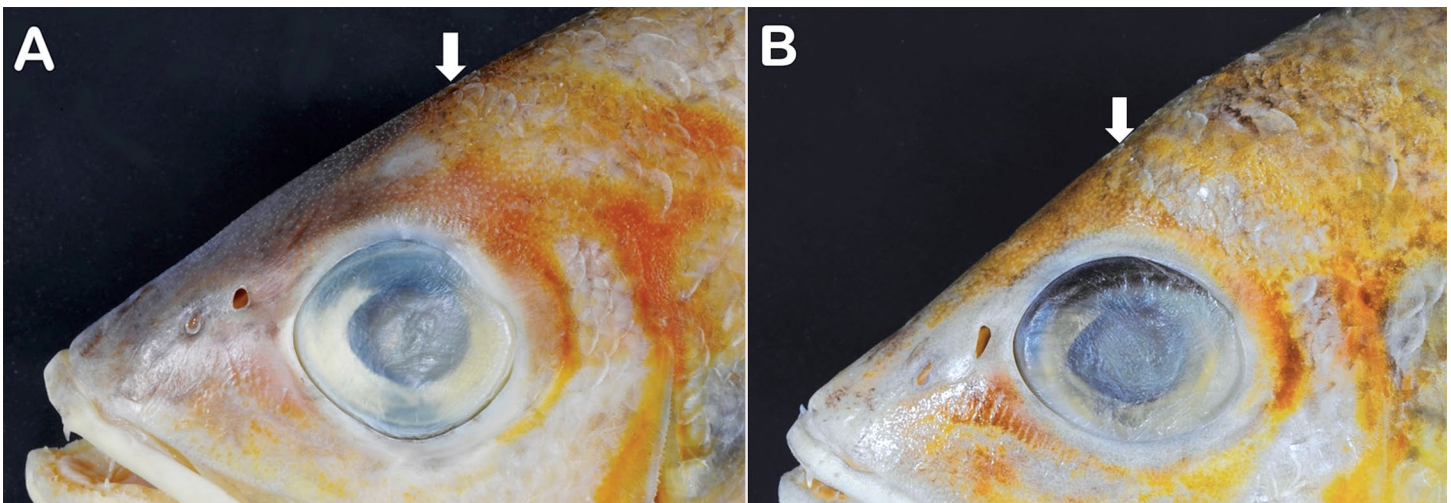


Figure 11. Morphology of paired nostrils on left side of snout and extent of anterior predorsal scales (arrow): (A): *Lutjanus madras*, MUFS 46214, 226 mm SL and (B): *L. xanthopinnis*, paratype, MUFS 46565, 192 mm (Y. Iwatsuki).

The Yellow-lined Snapper Complex

The new species belongs to the yellow-lined snapper complex as delineated by Allen & Talbot (1985, their Table 5). The grouping is largely defined on the basis of their shared color patterns, usually featuring numerous thin yellow to brownish stripes on the body often with a more prominent (usually wider or darker) yellow, brown, or blackish stripe mid-laterally on the side of the head and body. The group as originally defined contained five species: *L. adetii*, *L. lutjanus*, *L. madras*, *L. mizenkoi*, and *L. vitta* (Figs. 12 & 13). An additional species, *L. ophuysenii* (Fig. 14), was subsequently recognized as distinct from *L. vitta*, and therefore is also included in this complex (Iwatsuki *et al.* 1993), as is the presently described *L. xanthopinnis*. The distinguishing meristic, morphological, and marking characters of this group are summarized in Table 3, based on the table in Allen & Talbot (1985), with some modifications.

TABLE 3

Selected characters of the yellow-lined snapper complex
modified after Allen & Talbot (1985)

¹ gill rakers including rudiments

² =horizontal scale rows

	<i>L. adetii</i>	<i>L. lutjanus</i>	<i>L. madras</i>	<i>L. mizenkoi</i>	<i>L. ophuysenii</i>	<i>L. vitta</i>	<i>L. xanthopinnis</i>
Dorsal-fin rays	X–XI,14	(X–)XII,12	X,13	XI,13	X,12–13	X,12–13	X,13
Anal-fin rays	III,8	III,8	III,9	III,8	III,8	III,8	III,8
Pored lateral-line scales	48–51	48–50	49–51	47–50	46–49	49–52	48–50
Gill rakers ¹	27–29	24–26	25–27	15–16	19–23	17–22	22–23
Scale rows on cheek	6–8	5–8	7 or 8	6	5–7	5–7	4 or 5
Scale rows above lateral line ²	6 or 7	4 or 5	7 or 8	6	8 or 9	8–10	6 or 7
Preopercular flange	no scales	scaled	no scales	no scales	no scales	scaled	scaled
Posterior extension of vomerine tooth patch	absent	present	present	present	present	present	present
Stripes on sides	broad midlateral yellow stripe	thin stripes plus broad midlateral yellow stripe	thin stripes plus broad midlateral yellow stripe	thin stripes, central stripes wider	thin stripes plus broad midlateral dark stripe with spot	thin stripes plus broad midlateral dark stripe	thin stripes plus thin midlateral yellow stripe
Approximate range	E Aus-New Caledonia	Indo-W. Pacific	W. Indian Ocean	W. & C. Pacific to NW Aus	NW Pacific	Indo-W. Pacific	W. Pacific-E. Indian



Figure 12. *Lutjanus adetii* (A): about 25 cm SL, Heron Island, Australia (J.E. Randall); and *Lutjanus mizenkoi* (B): about 25 cm SL, Milne Bay, Papua New Guinea (G.R. Allen).



Figure 13. *Lutjanus lutjanus* (A): MUFS 26860, 122 mm SL, Japan (K. Tsuzaki); and *Lutjanus vitta* (B): uncatalogued specimen, about 25 cm TL, Okinawa, Japan (D. Miyagi; <http://zukan.com/fish/leaf48369>; based on zukan.com).

Figure 14 (opposite). *Lutjanus ophuysenii* (A): MUFS 30171 86 mm SL, Kadogawa, Miyazaki, Japan (Y. Iwatsuki); (B): ASIZP 0805692, 152 mm SL, Wujia, Miaoli, Taiwan (K.-T Shao); and (C): MUFS 43780, 174 mm SL, Meitsu, Miyazaki, Japan (Y. Iwatsuki).



Allen *et al.* (2013) presented a genetic matrix of 30 species of Indo-Pacific *Lutjanus* represented in the BOLD database, utilizing the COI marker (www.boldsystems.org). Their analysis included four of the yellow-lined complex, i.e. *L. adetii*, *L. lutjanus*, *L. vitta*, and *L. xanthopinnis* (as “*L. madras*”), with average divergences between these species ranging from 6.4% between *L. xanthopinnis* and *L. vitta* up to 15.6% between *L. adetii* and both *L. vitta* and *L. xanthopinnis*. Indeed, the range of divergences within the broad yellow-lined complex is similar to the range among all *Lutjanus*, which have an overall mean divergence in the barcode sequence between species of 13.2% (Allen *et al.* 2013).

A similar analysis of COI divergences between our set of species in the broad yellow-lined snapper complex (plus *P. bengalensis*) is presented in Table 4. Our results generally match those of Allen *et al.* (2013), but include *L. ophuysenii*. Mean interspecific distances range from 4.1% between *L. bitaeniatus* and *L. lemniscatus* to 15.1% between *L. adetii* and *L. lutjanus*. Among the strictly yellow-lined species of the complex, those with an array of

TABLE 4

Mean Interspecific P-distances (uncorrected pairwise) for mtDNA COI sequences of 9 species of *Lutjanus*

	<i>ade</i>	<i>ben</i>	<i>bit</i>	<i>lem</i>	<i>lut</i>	<i>mad</i>	<i>oph</i>	<i>vitt</i>	<i>xan</i>
<i>L. adetii</i>									
<i>L. bengalensis</i>	14.1								
<i>L. bitaeniatus</i>	12.8	10.5							
<i>L. lemniscatus</i>	14.7	10.5	4.1						
<i>L. lutjanus</i>	15.1	11.6	7.3	8.0					
<i>L. madras</i>	14.5	13.1	6.9	7.5	5.9				
<i>L. ophuysenii</i>	13.9	12.1	6.7	7.2	5.8	4.7			
<i>L. vitta</i>	14.1	11.2	6.5	6.8	6.6	5.3	5.5		
<i>L. xanthopinnis</i>	14.3	12.2	7.8	8.2	7.1	7.1	6.7	6.7	

Minimum Interspecific and Maximum Intraspecific P-distances (uncorrected pairwise) for mtDNA COI sequences of 9 species of *Lutjanus*

	<i>ade</i>	<i>ben</i>	<i>bit</i>	<i>lem</i>	<i>lut</i>	<i>mad</i>	<i>oph</i>	<i>vitt</i>	<i>xan</i>
<i>L. adetii</i>	NA								
<i>L. bengalensis</i>	14.1	NA							
<i>L. bitaeniatus</i>	12.8	10.5	NA						
<i>L. lemniscatus</i>	14.7	10.5	4.1	NA					
<i>L. lutjanus</i>	15.1	11.5	7.2	7.9	0.3				
<i>L. madras</i>	14.4	13.1	6.7	7.4	5.7	0.5			
<i>L. ophuysenii</i>	13.9	12.1	6.7	7.2	5.7	4.6	0.0		
<i>L. vitta</i>	13.7	11.0	6.4	6.7	6.4	5.1	5.4	0.7	
<i>L. xanthopinnis</i>	14.1	11.9	7.4	8.0	6.4	6.4	6.5	5.9	1.3

thin yellow stripes, i.e. *L. lutjanus*, *L. madras*, *L. ophuysenii*, *L. vitta*, and *L. xanthopinnis*, sequence divergences are less, with mean interspecific distances from 4.7% to 7.1%. Minimum interspecific distances were very similar to mean distances in these analyses, indicating relatively low intraspecific variation and relatively deep divergences between species, i.e. a large “barcoding gap”.

A neighbor-joining tree (Fig. 15) was constructed utilizing sequence data for the members of the yellow-lined complex and relatives (except *L. mizenkoi* for which samples were lacking). Both *L. bitaeniatus* and *L. lemniscatus* are included, since they feature a similar striped pattern in the juvenile stage. In addition, *L. bengalensis* is included as an outgroup. The tree provides support for recognition of *L. xanthopinnis* as a distinct member of the yellow-

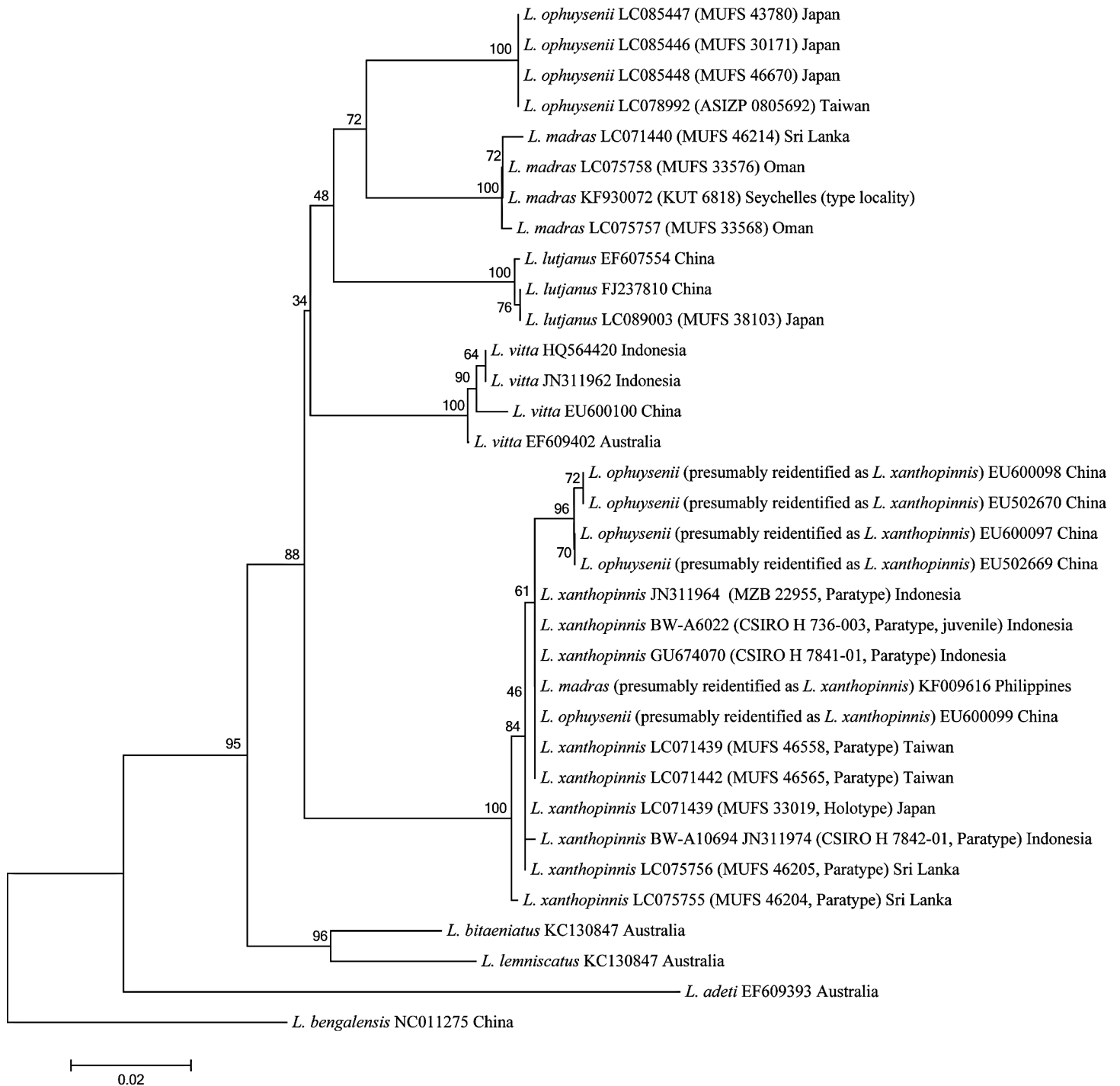


Figure 15. The neighbor-joining phenetic tree of COI sequences for the yellow-lined group of *Lutjanus* snappers following the Kimura two-parameter model (K2P). The scale bar at lower left represents a 2% sequence difference. *Lutjanus bengalensis* is used as the outgroup. GenBank accession numbers and collection locations for the sequences are listed.

lined snapper complex, about the same distance from the other members as any other species in the complex. The tree also reveals that *L. adetii* is well separated from the species with the rows of thin yellow stripes and that *L. bitaeniatus* and *L. lemniscatus* are closely related, and outside the main yellow-lined complex, forming a separate clade, which includes several species allied with the recently described *L. papuensis* by Allen *et al.* (2013).

Comparative material examined. *Lutjanus adetii*: AMS I. 15384-001, 121 mm SL, Queensland, Australia; AMS I.18747-001, 62 mm SL, Sydney Harbour, Sydney, New South Wales, Australia. *L. mizenkoi*: WAM P28314-001 (paratype), 224 mm SL, Western Samoa. *L. ophuysenii*: MUFS 30171, 86 mm SL, Iorigawa, Kadogawa, Miyazaki, Japan; MUFS 43780, 174 mm SL, Meitsu, Miyazaki, Japan.: MUFS 30171, 86 mm SL, Iorigawa, Kadogawa, Miyazaki, Japan; MUFS 43780, 174 mm SL, Meitsu, Miyazaki, Japan; MUFS 46670, 139 mm SL, Iorigawa, Kadogawa, Miyazaki, Japan. *L. lutjanus*: MUFS 33701–33702, 2 specimens, 145–198 mm SL, Oman; MUFS 38108, 109 mm SL, Miyazaki, Japan; MUFS 46176, 126 mm SL, Sri Lanka. *L. vitta*: specimens listed in Iwatsuki *et al.* (1993).

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