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Two new goatfishes of the genus *Upeneus* (Mullidae) from Australia and Indonesia

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Abstract

Two new goatfishes of the genus *Upeneus* (Mullidae) belonging to the putative *japonicus* species group are described and compared with congeneric species using a large set of meristic, morphometric and colour characters. *Upeneus farnis* **n. sp.** Uiblein & Peristiwady is described based on 14 adult specimens (≥ 65 mm SL) collected at the local fish market of Bitung, NE Sulawesi, Indonesia. *Upeneus spottocaudalis* **n. sp.** Uiblein & Gledhill is described based on 16 adult and seven subadult specimens (< 65 mm SL) specimens collected by trawling surveys off NE Australia and one non-type adult specimen collected off southern Indonesia. The new species differ from all other congenerics in the combination of dorsal-fin spine, pectoral-fin ray and gill raker numbers, body and head depth, length of head, snout, barbels and paired fins, height of anal and dorsal fins, eye size, and body, barbel and caudal-fin colour patterns. When compared in detail with the 12 other species of the *japonicus* group, *Upeneus farnis* **n. sp.** can be distinguished by smaller eyes, shallower anal and second dorsal fins, more pectoral-fin rays and gill rakers, and the lower caudal-fin lobe almost completely dark pigmented. *Upeneus spottocaudalis* **n. sp.** differs from the other *japonicus*-group species in larger eyes, higher second dorsal fin, pectoral fin shorter than pelvic fin, and presence of rounded, dark spots on the lower caudal-fin lobe. Subadults differ from adult *U. spottocaudalis* **n. sp.** mainly in longer pelvic fins. The high diversity of *Upeneus* species in relation to divergence in colour patterns and the need of further taxonomic exploration of the genus *Upeneus* is discussed.

Key words: Indonesia, Australia, fish markets, demersal trawling cruises, meristic characters, body shape, colour patterns

Introduction

The goatfish genus *Upeneus* (Mullidae) consists of 37 small- to medium-sized species (maximum-size range 74–300 mm SL) which are characterized by a dorsal fin with 7 or 8 spines, villiform jaw teeth in jaws, small scales on basal portion of the 2nd dorsal and anal fin, the snout shorter than or subequal to postorbital length, and oblique bars on the caudal fin and/or one or several lateral body stripes (Uiblein & Gouws 2014; Uiblein & White 2015; Uiblein *et al.* 2016). To facilitate taxonomic studies of this highly diverse genus, all currently known species with seven dorsal-fin spines have been subsumed in the putative *japonicus*-species group (Uiblein & Heemstra 2010; Uiblein & Gledhill 2015; Uiblein *et al.* 2016). This species group still requires attention regarding the possible occurrence of yet undiscovered species.

The 11 valid species of the *japonicus* group are as follows: *Upeneus asymmetricus* Lachner 1954 (southern Indonesia, Philippines), *U. australiae* Kim & Nakaya 2002 (Australia, New Caledonia), *U. francisi* Randall & Guézé 1992 (New Zealand, Norfolk Island), *U. guttatus* (Day 1868) (Indo-West Pacific), *U. itoui* Yamashita, Golani & Motomura 2011 (Japan), *U. lombok* Uiblein & White, 2015 (Lombok, Indonesia), *U. japonicus* (Houttuyn 1782) (West Pacific), *U. pori* Ben-Tuvia & Golani 1989 (Western Indian Ocean, Eastern Mediterranean), *U. saiab* Uiblein & Lisher 2013 (northern Mozambique), *U. seychellensis* Uiblein & Heemstra

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2011 (Seychelles Bank), and *U. torres* Uiblein & Gledhill 2015 (northern Australia, Vanuatu). Eight of these species (= 72 %) were described in the past 30 years and five (= 45 %) since 2011. In addition, several new species records have been recently reported, such as e.g. *U. pori*, from South Africa (Uiblein & Lisher 2013).

Three of the most recent examples of new species descriptions or new species records feature *japonicus*-group species occurring in the area extending from NE Australia (including the Great Barrier Reef) to Indonesia. Apart from the new *Upeneus lombok* and *U. torres*, a new record of *U. asymmetricus*, originally described from the Philippines, was reported from southern Indonesia in 2015 (Uiblein & White 2015). Between 2015 and 2017, the senior author conducted several research visits to fish collections in Australia (Australian Museum Sydney, CSIRO National Fish Collection Hobart, Queensland Museum Brisbane) and the Indonesian Institute of Sciences (LIPI) in Bitung, NE Sulawesi (LBRC), and Jakarta (NCIP), where he examined large numbers of preserved *Upeneus* specimens. Preliminary inspection of specimens with seven dorsal-fin spines and associated voucher photographs of fresh fish indicated the presence of two distinct forms that differ from each other as well as from all the other species of the *japonicus* group.

The hypotheses that each of these two forms of goatfishes encountered represents a yet undescribed species were examined by adopting a comprehensive alpha-taxonomic approach (Uiblein *et al.* 2016). Based on a large comparative set of morphometric, meristic and colour characters, we describe here *Upeneus farnis* **n. sp.** from NE Sulawesi and *U. spottocaudalis* from NE Australia and southern Indonesia. We compare the new species with all *japonicus*-group species using data available from earlier studies, as well as newly generated data. Additional comparisons with published data from the other 26 *Upeneus* species are also made. In both the descriptions and the comparisons, size-related allometric changes in body form are considered (e.g., Uiblein & Gledhill 2015). The results are discussed, emphasizing the high diversity of the genus *Upeneus*, the need to further screen museum collections and to obtain more samples from fish markets and from the field for taxonomic and genetic studies.

Material and methods

Standard length (SL) and a total of 40 morphometric and 10 meristic characters, as well as body- and fin-colour patterns in both fresh and preserved fish were obtained from 14 specimens of *Upeneus farnis* **n. sp.** and 24 specimens of *U. spottocaudalis* **n. sp.** These data were compared with data taken from 273 specimens of the other 11 species of the *japonicus* group, split into two subgroups of adult specimens ($\geq$ 65 mm SL) with lower and higher gill-raker counts (five species with 15–19 vs. six species with 18–23 gill rakers on lower limb, respectively), and a separate subgroup of subadult specimens (< 65 mm). The methods for size grouping, measuring and counting, as well as the description of colour of fresh and preserved fishes follow Uiblein & Gledhill (2015). Ranges of morphometric characters given as percentage or as a ratio of SL were rounded to one decimal place below values of 10. The means of all measurements and counts were rounded to one decimal.

In all comparisons, attention was paid to the most diagnostic characters, taking sample size and intraspecific variation into consideration. As in Uiblein & Gledhill (2015), only morphometric characters were compared separately for adults ($\geq$ 65 mm SL) and subadults (< 65 mm SL), as meristic characters did not show any size dependency. In the comparisons with two species, *U. itoui* and *U. pori*, pectoral-fin ray and gill-raker counts provided by Yamashita *et al.* (2011) are referred to in addition, as those counts are based on larger sample sizes.

The relevant literature sources for the comparative data obtained from the other 11 *japonicus*-group species and additional data generated for the present study are listed at the end of this article. Furthermore, comparative data available from the remaining 26 *Upeneus* species (material and data referred to by Uiblein *et al.* 2016) were used for more general intrageneric comparisons of the two new species.

Institutional acronyms follow Fricke & Eschmeyer (2017). Other acronyms or abbreviations are: HIFIRE = Fish collection of the Institute of Marine Research, Bergen, Norway; HT = holotype; LL = lateral-line scales; PT = paratype(s); VNMN = Vietnam National Museum of Nature, Hanoi, Vietnam.

Taxonomy

Genus *Upeneus* Cuvier 1829

Upeneus farnis n. sp. Uiblein & Peristiwady

Farnis' goatfish
(Figs 1, 2; Tables 1, 2)

Holotype. LBRC-F 001450, 97 mm SL, Indonesia, NE Sulawesi, Bitung fish market.

Paratypes. (13: 70–141 mm SL). LBRC-F 001449, 123 mm SL; LBRC-F 001451, 141 mm SL; LBRC-F 001452, 108 mm SL; LBRC-F 001453, 117 mm SL; LBRC-F 001454, 129 mm SL, LBRC-F 001455, 121 mm SL; LBRC-F 001488, 134 mm SL; LBRC-F 001489, 123 mm SL; LBRC-F 001491, 118 mm SL; LBRC-F 001492, 76 mm SL; LBRC-F 001493, 92 mm SL; LBRC-F 001495, 70 mm SL; LBRC-F 001496, 88 mm; all same locality as holotype.

Diagnosis. Dorsal fins VII + 9; pectoral fins 15 or 16; gill rakers 7–9 + 20–22 = 28–31; measurements in % SL (only adults): body depth at first dorsal-fin origin 23–25; body depth at anus 20–22; caudal-peduncle depth 8.8–9.9; maximum head depth 19–21; head depth through eye 15–17; interorbital length 7.2–8.6; head length 28–31; snout length 9.9–12; postorbital length 11–14; orbit length 5.6–7.2; upper jaw length 9.6–12; barbel length 18–23; caudal-peduncle length 21–25; caudal-fin length 27–29; anal-fin height 12–15; pelvic-fin length 19–21; pectoral-fin length 18–20; first dorsal-fin height 16–20; second dorsal-fin height 12–15; upper lobe of caudal fin with 4 to 7 dark brown-grey narrow bars, interrupted by pale interspaces of similar width as bars, lower caudal-fin lobe almost entirely brown-grey pigmented, except for the distal-most ray forming a pale ventral margin; barbels pale grey; body and head dorsally dark brown grey, a weak mid-lateral body stripe of same colour; preserved fish dorsal dark, upper caudal-lobe bars and lower-caudal lobe pigmentation retained.

Description. Morphometric data as ratios of SL for holotype, followed by data for paratypes in square brackets: body moderately deep, depth at first dorsal-fin origin 4.1 [3.9–4.4], body depth at anal-fin origin 4.7 [4.5–4.9]; head depth through eye 6.4 [5.8–6.7]; head length 3.5 [3.2–3.6], larger than maximum depth of body and subequal to caudal-fin length (3.6 [3.4–3.8]); snout length 9.1 [8.1–10], slightly larger than caudal-peduncle depth (11 [10–11]; eyes small (orbit length 18 [14–18]), half of postorbital distance (8.3 [7.3–9.0]); barbel length 5.6 [4.3–5.6]; anal-fin height 7.1 [6.9–8.1]; dorsal fins rather shallow, first dorsal fin height 5.1 [5.1–6.3], second dorsal-fin height 7.1 [6.5–8.0]; pectoral-fin length 5.5 [5.1–5.5], subequal to pelvic-fin length (5.2 [4.7–5.4]).

Fresh colour: body above lateral line and head dorsally from mid-eye level dark brown-grey, a pale dark brown-grey mid-lateral body stripe running from behind operculum to anterior caudal-peduncle region where it merges with the dorsal body pigmentation; body below stripe and head below eyes light brown-grey, covered with a red-mottled pigmentation in some specimens; belly pale; barbels pale-grey; caudal-fin upper lobe with 4–7 dark brown-grey, narrow oblique bars, 1 small bar at or close to fin tip, the most-proximal two to three bars slightly bent; hyaline bar interspaces equal in width to bars; lower caudal-fin lobe almost completely brown-grey pigmented, except for the distal-most ray forming a pale ventral margin, in some cases with tiny dark-brown patches or bars; pectoral, pelvic and unpaired fins hyaline, dorsal and pectoral fins show traces of two to three pale brown stripes.

Preserved colour. All types dark grey on head and dorsal half or two-thirds of body, pale brown on ventral side of head and on ventral part of body, 4–7 oblique brown bars on upper caudal-fin lobe, lower lobe almost entirely brown pigmented, with ventral-most one or two rays pale, sometimes with weak traces of narrow short brown bars; barbels uniformly pale brown.

Distribution. Currently only known from Bitung, NE Sulawesi, Indonesia, Western Pacific.

Etymology. The name "*farnis*" is used as a noun in apposition and honours Professor Farnis Boneka, Department of Fisheries and Marine Science, Sam Ratulangi University (UNSRAT), Manado, Sulawesi, Indonesia, for his efforts to support fish taxonomy and the research here presented.

Comparisons. *Upeneus farnis* **n. sp.** differs from all congeneric species in the following combination of characteristics: 7 dorsal-fin spines, 15–16 pectoral-fin rays, 28–31 total gill rakers (20–22 rakers on lower limb), orbit length 5.6–7.2% SL, anal-fin height 12–15% SL, first dorsal-fin height 16–20% SL, second-dorsal fin height 12–15% SL, interspaces between the oblique bars on the upper caudal lobe narrow, and head and body dorsally dark brown grey.

Upeneus farnis **n. sp.** differs from the other species of the *japonicus* group with similarly high gill-raker counts as follows (comparative data in Table 1): from *U. asymmetricus* it differs in longer head and barbels, shallower anal and second dorsal fins, more pectoral-fin rays, fewer gill rakers, lack of prominent lower-caudal lobe bars, and

head and body darker dorsally; it differs from *U. francisi* in smaller eyes, shallower anal fin, shorter pelvic and pectoral fins, more pectoral-fin rays and lower-limb gill rakers, and a dorsally darker head and body with the presence of a mid-lateral body stripe; it differs from *U. japonicus* in shallower anal and dorsal fins, more pectoral-fin rays, more gill rakers, narrower interspaces between the oblique bars on the upper caudal lobe, head and body dorsally darker with the presence of a mid-lateral body stripe, and the barbels pale grey (not yellow); it differs from *U. lombok* in a deeper body at anal-fin origin, longer snout, smaller eyes, more oblique upper caudal-fin lobe bars, narrower interspaces between those bars, a more entirely pigmented lower caudal-fin lobe, and the presence of a pale mid-lateral body stripe; it differs from *U. pori* in longer head and barbels, shorter anal and pectoral fins, shallower dorsal fins, slightly fewer pectoral-fin rays and gill rakers, and no prominent oblique bars on the lower caudal-fin lobe; it differs from *U. saiab* in the deeper body, smaller eyes, a slightly shallower first dorsal fin, narrower interspaces between the oblique bars on the upper caudal-fin lobe, and head and body dorsally darker with the presence of a mid-lateral body stripe.

Further, *Upeneus farnis* **n. sp.** differs from the species of the *japonicus* group with lower gill-raker counts as follows (comparative data in Table 2): from *U. australia* in shallower anal fin, narrower interspaces between bars on upper caudal-fin lobe, lack of prominent oblique bars on lower caudal-fin lobe, and a dorsally darker head and body; it differs from *U. guttatus* in shallower anal fin, darker body pigmentation with the presence of a mid-lateral body stripe, barbels pale grey (not yellow), and no or less prominent oblique bars on lower caudal-fin lobe in fresh fish; it differs from *U. itoui* in the deeper body at dorsal-fin origin and deeper head, shallower anal fin, fewer pectoral-fin rays, and no or less prominent oblique bars on the lower-caudal-fin lobe; it differs from *U. seychellensis* in the deeper body, shorter anal-fin base, shallower second dorsal fin, wider interspaces between oblique bars on upper caudal-fin lobe, and dorsally darker body and head pigmentation with a weak mid-lateral body stripe; it differs from *U. spottocaudalis* **n. sp.** in the shallower anal and second dorsal fins, shorter pectoral fins, and more pectoral-fin rays; and it differs from *U. torres* in smaller eyes, shorter barbel, shallower anal and dorsal fins, shorter pectoral fins, narrower interspaces between the oblique bars on the upper caudal lobe, head and body dorsally darker with a mid-lateral body stripe, and barbels pale grey (not yellow).

Remarks. All available type specimens for this study were collected at the local fish market of Bitung, NE Sulawesi, and no natural habitat information is available. Only larger specimens and no subadults were available for study.

Distinction of *Upeneus farnis* **n. sp.** from species that are rather similar or slightly overlap in body shape and meristic characters like *U. asymmetricus*, *U. japonicus* and *U. lombok* is best achieved by comparing the colour patterns of fresh fish. In particular, the width of the oblique bars and their interspaces on the upper caudal-fin lobe, as well as the pigmentation pattern on the lower lobe are important for diagnosis (Figure 1). In preserved fish, species distinction is best achieved when morphometric and meristic characters are compared in combination (Figure 2).

Upeneus farnis **n. sp.** attains at least 141 mm SL.

Upeneus spottocaudalis n. sp. Uiblein & Gledhill

Tailspot goatfish
(Figs 1, 3; Tables 1–3)

Holotype. CSIRO H 3436-05, 97 mm SL, Australia, Queensland, Torres Strait, E of Cape York Peninsula, Blackwood Channel, 11°43.8’ S, 143°43.8’ E, FV *Clipper Bird*, prawn trawl, 24 m depth, 26 March 1993.

Paratypes (16 adults, 7 subadults: 36–103 mm SL). Australia, Queensland, Torres Strait: AMS I 46540-001, 68 mm SL, E of Cape York Peninsula, NE of Shelburne Bay, 11°10.19’ S 143°58.09’ E, FRV *Gwendoline May*, demersal trawl, 32 m depth; CSIRO H 3436-06, 90 mm SL, same collecting data as holotype; CSIRO H 6722-04, 3, 48–55 mm SL, NE of Cape York Peninsula, S of Seven Reefs, 10°32.37’ S 143°51.52’ E, FRV *Gwendoline May*, demersal trawl, 27 m depth; CSIRO H 6722-05, 2, 36–55 mm SL, same collecting data as preceding; CSIRO H 6905-09, 2: 67–68 mm SL, same collecting data as AMS I 46540-001; CSIRO H 7205-01, 80 mm SL, E of Cape York Peninsula, NE of Shelburne Bay, 11°11.60’ S 143°47.88’ E, FRV *Gwendoline May*, demersal trawl, 35 m depth; CSIRO H 7205-02, 79 mm SL, same collection data; CSIRO H 7658-01, 2, 63–72 mm SL, E of Cape York Peninsula, NE of Cape Weymouth, 12°19.64’ S 143°43.48’ E, FRV *Gwendoline May*, demersal trawl, 24 m depth; CSIRO H 7659-01, 60 mm SL, NE of Cape York Peninsula, 10°27.52’ S 143°48.79’ E; FRV *Gwendoline May*, demersal trawl, 30 m depth; CSIRO H 7462-02, 2: 69–83mm SL, E of Cape York Peninsula, 10°55.08’ S 143°54.63’ E, FRV *Gwendoline May*, demersal trawl, 32 m depth; CSIRO H 6799-02, 5: 72–76 mm SL, E of Cape York Peninsula, 11°48.93’ S 143°40.53’ E, FRV *Gwendoline May*, demersal trawl, 23 m depth; QM I 39293, 103 mm SL, same collecting data as CSIRO H 6722-04.

Non-type material. BMNH 1986.10.1.16, 78 mm SL, southern Indonesia, Eastern Indian Ocean, Bali Strait to Timor Sea.

Diagnosis. Dorsal fins VII + 9; pectoral fins 12 or 13; gill rakers 5 or 6 + 15–18 = 20–23; measurements in % SL for adults (for subadults in round brackets): body depth at first dorsal-fin origin 22–25 (22–24); body depth at anus 19–22 (18–20); caudal-peduncle depth 8.6–10 (8.6–10); maximum head depth 19–22 (19–21); head depth through eye 15–18 (16–18); interorbital length 7.3–8.9 (7.7–8.1); head length 30–32 (30–32); snout length 9.7–12 (10–11); postorbital length 11–13 (12–14); orbit length 6.9–8.2 (7.2–8.9); upper jaw length 10–13 (11–13); barbel length 19–22 (21–23); caudal-peduncle length 21–24 (23–25); caudal-fin length 28–32 (30–33); anal-fin height 16–19 (18–19); pelvic-fin length 22–24 (24–26); pectoral-fin length 19–22 (20–23); first dorsal-fin height 19–22 (21–23); second dorsal-fin height 18–21 (18–21); fresh specimens with three to five red or pale brown bars on each caudal-fin lobe, the bars on the lower lobe interrupted or replaced by three or four dark-brown rounded or triangular spots at mid-lobe; dorsal, anal and pelvic fins with red pigment forming patches or stripes, barbels yellow, body and head red, with dark dots along lateral line and a saddle behind second dorsal fin; preserved fish with pale-brown head and body, sometimes with remains of pigmentation dorsally and on dorsal fins, bars on upper-caudal fin lobe mostly retained, spots on lower caudal-fin lobe always retained in both adults and subadults.

Description. Morphometric data as ratios of SL for holotype, followed by data for adult paratypes in round brackets and subadult paratypes in square brackets: body moderately deep, its depth at first dorsal-fin origin 4.2 (3.9–4.6) [4.2–4.6], body depth at anal-fin origin 4.8 (4.5—5.4) [4.9–5.5]; head depth through eye 5.9 (5.8–6.5) [5.4–6.3]; head length 3.3 (3.1–3.4) [3.1–3.4], larger than maximum depth of body and subequal to caudal-fin length (3.6 (3.1–3.6) [3.0-3.3]); snout length 8.9 (8.3–10.3) [8.8–9.6], shorter than postorbital length in subadults (8.1 (7.9–9.4) [7.3–8.6]); orbit length 15 (12–15) [11–14], smaller than caudal-peduncle depth in adults (10 (10–12) [9.7–12]); barbel length 5.2 (4.5–5.4) [4.3–4.7]; anal-fin height 5.9 (5.2–6.3) [5.2–5.6], second dorsal-fin height 5.6 (4.7–5.7) [4.7–5.5]; pectoral-fin length 4.9 (4.6–5.2) [4.4–5.0], shorter than pelvic-fin length (4.5 (4.1–4.6) [3.9–4.2]).

Fresh colour (holotype and paratype H 7205-01). Body and head dorsolaterally reddish except for mostly pale mouth region, and ventrally white; preopercle and body to posterior anal-fin base ventrolaterally bordered by red blotches of variable size; four large blotches of about orbit size behind anal fin reaching down to ventral body margin; two to four tiny brown blotches of less than pupil size along lateral line and below dorsal fins and two darker blotches right behind second dorsal fin, connecting to a faint brown saddle dorsally; barbels yellow; caudal-fin upper lobe with four or five pale-brown or pale-red oblique bars, the distal-most bar covering the fin tip; white or hyaline interspaces between bars becoming distally wider than bars; lower caudal-fin lobe with three or four weakly indicated pale-brown or pale-red dashed bars and three to four rounded or triangular dark-brown blotches or spots along mid-lobe that either interrupt or replace the bars; at least two of these spots are of pupil size or slightly larger, the distal-most covering the fin tip; rays and central part of first dorsal fin pale red pigmented, second dorsal fin with two pale red stripes, one just below fin tip and the other stripe at fin base covering the anteriormost third of fin, with two tiny isolated patches at posterior fin margin; pectoral fins hyaline, pelvic and anal fins hyaline or whitish with weakly indicated pale-red stripes, five or six on pelvic fins and three on anterior part of anal fin.

Preserved colour. Holotype and adult as well as subadult paratypes uniformly pale brown with hyaline dorsal, pectoral, pelvic and anal fins; remains of darker pigmentation on body dorsally and dorsal fins with grey pigmentation close to fin tips in a few paratypes; caudal fin hyaline, with bars on upper fin lobe retained in some of the paratypes and the dark spots on lower lobe retained in all examined specimens, including subadults and the specimen from southern Indonesia; the latter shows remains of dots below the second dorsal fin and formation of a dark saddle just behind (Figure 1G).

Distribution. NE Australia, Western Pacific, Torres Strait, E to NE of Cape York Peninsula, 23–35 m depth; a single record from the Eastern Indian Ocean, southern Indonesia, area between the Bali Strait and Timor Sea.

Etymology. The name "*spottocaudalis*" refers to the conspicuous rounded or triangular dark spots or blotches on the lower caudal-fin lobe in both fresh and preserved specimens, an important diagnostic colour character of this species.

TABLE 1. Morphometric and meristic characters in adults of *Upeneus farnis* n. sp. and six other species of the *japonicus* group with high gill-raker counts. Differences from comparisons with *U. farnis* n. sp. are indicated by italics, differences from *U. spottocaudalis* n. sp. (Table 2) are emphasized by underlining

	Upeneus farnis n.sp.					*U. asymmetricus*				*U. francisi*	*U. japonicus*				*U. lombok*			*U. pori* *			*U. saiab*			
	HT	Min	Mean	Max	*n*	Min	Mean	Max	*n*	PT	Min	Mean	Max	*n*	HT	PT	Min	Mean	Max	*n*	Min	Mean	Max	*n*
SL	113	70	111.0	141	14	74	89.1	100	8	74	66	99.4	123	37	94	86	66	96.1	110	7	70	83.6	102	6
in % SL																								
Body depth at first dorsal-fin origin	24	23	24.1	25	14	22	23.1	24	8	24	21	23.5	25	37	21	23	21	23.0	24	7	21	22.0	24	6
Body depth at anal-fin origin	21	20	21.4	22	14	20	20.4	22	8	22	18	19.7	22	37	***19***	***19***	20	20.5	22	7	*17*	*18.4*	*19*	6
Half body depth at first dorsal fin origin	21	19	20.4	22	14	19	19.3	20	8	20	18	19.7	21	27	18	20	18	19.3	21	7	*16*	*17.6*	*19*	5
Half body depth at anal fin origin	17	15	16.4	17	14	14	15.6	17	8	17	14	16.0	18	26	*14*	*14*	14	15.4	16	7	***13***	***14.2***	***15***	6
Caudal-peduncle depth	9.3	8.8	9.2	9.9	14	8.5	9.2	9.9	8	10	8.0	9.6	11	37	9.2	9.3	9.1	9.5	9.8	7	8.7	8.9	9.2	6
Caudal-peduncle width	3.4	3.4	3.9	4.4	14	3.7	4.3	5.0	8	***3.3***	3.1	3.9	4.8	37	3.8	4.2	3.5	3.8	4.2	7	3.0	3.6	3.9	6
Maximum head depth	20	19	20.0	21	14	19	19.7	20	8	21	18	19.8	21	37	19	20	18	19.3	20	7	18	19.5	20	6
Head depth through eye	16	15	16.1	17	14	15	15.5	16	8	16	15	15.9	17	37	14	15	15	15.5	16	7	15	16.0	17	6
Suborbital depth	10	8.7	9.4	10	14	8.8	9.4	10	8	9.6	8.2	9.4	10	37	8.5	9.7	8.9	9.4	9.9	7	8.4	9.5	11	6
Interorbital length	8.4	7.2	8.1	8.6	14	8.0	8.6	9.0	8	7.4	6.9	7.7	8.7	37	7.2	8.3	7.4	7.9	8.4	7	7.0	7.6	8.2	6
Head length	29	28	29.2	31	14	*26*	*27.1*	*29*	8	30	27	28.6	31	37	28	30	*26*	*27.4*	*29*	7	29	29.6	30	6
Snout length	11	9.9	10.8	12	14	9.9	10.2	11	8	10	10	11.0	12	37	*9.2*	*9.6*	11	11.2	12	7	10	10.4	11	6
Postorbital length	12	11	12.2	14	14	11	11.4	13	8	12	9.8	11.1	13	37	12	12	11	11.6	12	7	12	12.7	13	6
Orbit length	5.6	5.6	6.5	7.2	14	5.7	6.7	7.7	8	***7.8***	6.1	7.4	8.2	37	***7.5***	***7.9***	5.9	6.8	7.8	7	6.8	7.1	7.5	6
Orbit depth	5.1	5.0	5.6	6.1	14	4.8	5.5	6.5	8	***7.1***	5.2	6.4	7.2	37	***6.5***	***6.9***	5.1	6.1	7.7	7	***6.2***	***6.6***	***7.0***	6
Upper-jaw length	10	9.6	10.4	12	14	8.7	9.6	11	8	11	9.7	10.6	12	37	9.4	9.7	10	10.7	12	7	9.5	10.5	12	6
Lower-jaw length	9.4	9.1	9.8	11	14	8.4	9.1	10	8	10	9.2	10.1	11	37	8.6	9.3	9.7	10.2	11	7	8.9	9.7	11	6
Snout width	7.8	7.5	8.4	9.8	14	7.6	8.2	9.3	8	8.2	7.1	8.4	9.8	37	8.0	7.8	8.0	8.5	10	7	7.5	8.0	8.5	6
Barbel length	18	18	20.0	23	14	*17*	*17.9*	*19*	8	19	18	21.1	23	36	19	20	*16*	*17.3*	*19*	7	19	19.9	22	6
Maximum barbel width	0.7	0.7	0.9	1.1	14	0.7	0.8	1.0	8	1.0	0.6	0.8	1.0	36	0.7	0.8	0.6	0.7	0.9	7	0.9	0.9	1.0	6
First pre-dorsal length	36	35	37.1	40	14	35	36.5	38	8	40	34	36.1	39	37	37	38	34	36.0	37	7	37	37.4	38	6
Second pre-dorsal length	64	64	65.5	67	14	62	64.3	66	8	66	61	63.7	67	37	64	66	63	64.6	67	7	64	65.4	68	6
Interdorsal distance	15	15	15.9	17	14	14	15.5	16	8	14	14	15.6	18	37	15	16	13	14.6	16	6	14	14.9	16	6
Caudal-peduncle length	21	21	22.7	25	14	22	23.2	24	8	23	21	23.2	25	37	23	21	22	22.9	24	7	22	23.0	24	6
Pre-anal length	66	64	66.1	69	14	62	64.2	68	8	65	61	65.1	69	37	65	67	60	63.9	67	7	65	66.1	67	6
Pre-pelvic length	32	30	32.9	35	14	31	32.3	34	8	34	30	32.5	35	37	30	32	28	30.6	32	7	32	33.3	35	6
Pre-pectoral length	29	29	30.7	33	14	29	29.7	31	8	32	29	31.0	33	37	29	31	28	29.3	30	7	31	31.7	33	6
Second dorsal-fin depth	22	21	21.9	23	14	19	20.7	22	8	23	18	20.4	22	37	***20***	***20***	20	21.0	22	7	*17*	*18.4*	*19*	6

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TABLE 1. (Continued)

	Upeneus farnis n.sp.					*U. asymmetricus*				*U. francisi*	*U. japonicus*				*U. lombok*			*U. pori* *			*U. saiab*			
	HT	Min	Mean	Max	*n*	Min	Mean	Max	*n*	PT	Min	Mean	Max	*n*	HT	PT	Min	Mean	Max	*n*	Min	Mean	Max	*n*
Pelvic-fin depth	24	23	24.3	26	14	22	23.0	24	8	25	21	23.4	25	37	23	24	22	23.3	25	7	***20***	***21.4***	***23***	6
Pectoral-fin depth	17	16	16.8	18	14	14	15.5	17	8	17	14	16.2	18	37	16	16	16	16.4	17	7	***14***	***14.7***	***16***	6
Length of first dorsal-fin base	15	13	14.6	15	14	13	14.4	15	8	17	14	14.7	17	37	14	15	14	15.1	16	6	14	15.2	16	6
Length of second dorsal-fin base	14	12	13.6	15	14	12	12.8	14	8	***16***	12	13.4	15	37	13	14	13	13.6	15	7	13	13.9	15	6
Caudal-fin length	28	27	27.9	29	14	27	28.3	30	8	***30***	25	26.9	29	34	28	29	27	27.9	29	6	27	27.9	29	6
Length of anal-fin base	11	11	11.9	13	14	9.9	10.9	12	8	12	9.9	11.5	13	37	11	10	10	11.9	13	7	11	11.7	13	6
Anal-fin height	14	12	13.8	15	14	***15***	***15.9***	***16***	6	***17***	***15***	***17.3***	***19***	34	12	13	***16***	***16.2***	***17***	7	14	15.2	16	6
Pelvic-fin length	19	19	19.8	21	14	19	20.3	22	8	***22***	19	20.7	23	36	21	22	20	21.1	23	7	20	20.9	21	6
Pectoral-fin length	18	18	19.1	20	14	18	19.5	21	7	***22***	***21***	***22.9***	***25***	36	20	21	***20***	***20.8***	***22***	7	20	20.7	21	6
Pectoral-fin width	4.4	3.9	4.5	5.2	14	4.0	4.5	5.1	8	4.3	3.7	4.3	5.0	37	4.1	4.3	4.4	4.7	5.7	7	4.4	4.6	5.0	6
First dorsal-fin height	20	16	18.4	20	14	19	20.4	21	7	-	***20***	***22.0***	***24***	36	-	19	***20***	***21.0***	***22***	6	***19***	***20.6***	***22***	6
Second dorsal-fin height	14	12	13.9	15	14	*15*	*15.8*	*17*	6	*17*	*15*	*17.4*	*19*	34	14	14	*15*	*15.8*	*16*	6	14	15.5	16	6
Meristic characters																								
Pectoral-fin rays	15	15	15.2	16	12	***12***	***13.0***	***14***	8	*14*	***13***	***13.9***	***15***	37	14	15	*14*	*14.0*	*14*	7	14	14.8	15	6
Rudimentary gill rakers on upper limb	1	1	2.9	5	10	1	2.6	4	8	0	2	3.2	5	37	3	3	0	1.1	2	7	1	2.2	3	6
Developed gill rakers on upper limb	6	4	5.0	6	10	3	4.6	7	8	*8*	2	3.6	5	37	4	5	5	6.3	7	7	5	6.0	7	6
Developed gill rakers on lower limb	16	14	15.6	17	10	15	16.3	17	8	*19*	11	13.7	17	37	15	15	14	15.9	18	7	15	16.5	17	6
Rudimentary gill rakers on lower limb	5	4	5.1	7	10	2	3.6	5	8	4	3	5.3	7	37	5	6	2	3.0	5	7	3	4.3	6	6
Total gill rakers on upper limb	7	7	7.9	9	10	7	7.3	8	8	8	6	6.8	8	37	7	8	7	7.4	8	7	8	8.2	9	6
Total gill rakers on lower limb	21	20	20.7	22	10	19	19.9	21	8	*23*	18	19.1	21	37	20	21	*18*	*18.9*	*20*	7	20	20.8	21	6
Total gill rakers	28	28	28.6	31	10	26	27.1	28	8	31	*24*	*25.9*	*28*	37	27	29	*26*	*26.3*	*27*	7*	29	29.0	29	6
Scales along lateral line	30	29	29.2	30	9	28	29.1	31	8	-	29	29.3	30	17	31	30	29	29.1	30	7	29	29.3	30	4

* counts from Yamashita *et al*. (2011): pectoral-fin rays 14–15, total gill rakers on lower limb 18–21, total gill rakers 25–28

TABLE 2. Morphometric and meristic characters in adults of *Upeneus spottocaudalis* n. sp. and five other species of the *japonicus* group with low gill-raker counts. Differences from comparisons with *U. spottocaudalis* n. sp. are emphasized by underlining, differences from *U. farnis* n. sp. (Table 1) are indicated by italics.

	Upeneus spottocaudalis n. sp.						*U. australiae*				*U. guttatus*				*U. itoui* **				*U. seychellensis*				*U. torres*			
	HT	Min	Mean	Max	*n*	*n*=1	Min	Mean	Max	*n*	Min	Mean	Max	*n*	Min	Mean	Max	*n*	Min	Mean	Max	*n*	Min	Mean	Max	*n*
Morphometric characters																										.
SL	97	67	77.9	103	16	78	72	103.2	128	45	69	102,9	159	112	87	106.4	118	3	96	104.2	115	3	65	81.7	101	11
in % SL																										.
Body depth at first dorsal-fin origin	24	22	24.1	25	16	25	23	23.8	27	38	21	23,5	26	100	***22***	***21.8***	***22***	3	*20*	*21.2*	*22*	3	23	25.1	27	11
Body depth at anal-fin origin	21	19	20.5	22	16	21	20	21.1	23	38	17	20,3	22	100	20	20.6	21	3	*18*	*18.2*	*19*	3	19	20.1	22	11
Half body depth at first dorsal fin origin	19	19	20.6	22	5	22	18	19.6	22	35	16	19,4	21	88	*18*	*18.0*	*18*	3	17	18.1	19	3	20	20.8	22	6
Half body depth at anal fin origin	16	15	15.8	16	8	16	15	16.3	18	33	14	15,9	18	83	16	15.7	16	3	14	14.2	15	3	15	16.0	17	6
Caudal-peduncle depth	9.7	8.6	9.4	10	16	9.6	9.9	10.6	12	45	9,1	10,0	11	100	9.4	9.6	9.9	3	9.2	9.4	9.6	3	8.9	9.8	11	11
Caudal-peduncle width	3.4	2.9	3.7	4.1	16	4.3	3.2	4.0	5.1	38	3,2	4,0	5,1	100	4.0	4.3	4.5	3	3.6	3.8	4.1	3	3.5	3.8	4.2	11
Maximum head depth	21	19	20.7	22	16	21	20	20.8	22	38	18	20,1	22	100	*18*	*18.3*	*18*	3	18	19.1	20	3	19	21.4	23	11
Head depth through eye	17	15	16.5	17	16	18	15	16.4	18	38	15	16,2	18	100	*13*	*13.9*	*14*	3	15	15.7	17	3	15	17.5	19	11
Suborbital depth	9.5	8.3	9.4	11	16	9.8	9.0	10.2	12	38	8,6	9,7	12	100	8.9	9.0	9.2	3	9.2	9.8	10	3	9.3	10.4	11	11
Interorbital length	7.8	7.3	7.8	8.5	16	8.9	7.1	8.0	9.6	38	6,9	7,8	8,9	100	6.7	7.5	8.1	3	6.7	7.1	7.7	3	7.2	7.9	8.2	11
Head length	30	30	30.4	32	16	31	27	28.9	30	38	26	27.8	30	100	27	27.7	28	3	27	28.3	30	3	28	29.9	31	11
Snout length	11	9.7	11.1	12	16	12	9.9	11.6	13	38	9,4	10,8	13	100	11	11.3	12	3	11	11.7	12	3	9.8	11.1	12	11
Postorbital length	12	11	11.8	13	16	11	11	11.5	13	38	9,7	11,1	13	100	11	11.4	12	3	12	11.8	12	3	10	12.1	13	11
Orbit length	6.9	6.9	7.6	8.2	16	8.1	6.0	6.9	8.0	38	5,9	7,1	8,8	100	5.7	6.1	6.4	3	6.0	6.3	6.5	3	***7.4***	***7.9***	***8.9***	11
Orbit depth	6.1	5.9	6.7	7.4	16	7.7	5.0	6.0	6.8	38	5,0	6,2	7,6	100	5.0	5.4	5.8	3	5.5	5.7	6.2	3	***6.1***	***6.7***	***7.3***	11
Upper-jaw length	11	10	11.5	13	16	12	9.3	10.9	12	38	9,5	10,9	12	100	10	10.4	11	3	11	11.0	11	3	10	11.4	12	11
Lower-jaw length	10	9.4	10.9	12	16	10	9.0	10.3	11	37	8,7	10,3	12	100	9.8	9.9	10	3	10	10.5	11	3	9.3	10.7	12	11
Snout width	8.7	7.1	8.3	10	15	9.1	7.9	8.7	10	35	7,6	8,6	11	96	7.6	7.9	8.4	3	7.3	8.2	9.2	3	7.9	9.1	10	8
Barbel length	19	19	20.3	22	16	20	16	18.4	20	45	16	18,1	21	98	*17*	*17.4*	*18*	3	17	18.7	22	3	*24*	*24.3*	*26*	11
Maximum barbel width	0.9	0.8	0.9	1.0	16	0.9	0.8	0.9	1.1	38	0,7	0,8	1,1	100	0.8	0.8	0.9	3	0.7	0.8	0.8	3	0.7	0.8	1.0	11
First pre-dorsal length	36	35	36.2	39	16	38	33	36.3	39	38	33	35,9	38	100	35	35.2	36	3	37	38.0	39	3	35	37.1	39	11
Second pre-dorsal length	65	61	63.9	66	16	65	61	63.6	66	38	60	63,6	67	100	61	62.0	63	3	63	64.0	65	3	63	65.1	67	11
Interdorsal distance	16	15	16.0	17	16	14	13	14.5	16	38	13	15,9	19	100	14	15.1	16	3	12	14.1	16	3	15	16.4	18	11
Caudal-peduncle length	22	21	23.1	24	16	22	22	24.1	26	38	22	23,7	26	100	24	24.7	25	3	24	23.9	24	3	21	23.1	25	11
Pre-anal length	67	63	65.5	68	16	65	60	63.4	67	38	61	64,7	69	100	63	63.2	63	3	65	66.6	68	3	60	64.0	66	11
Pre-pelvic length	34	33	34.3	37	16	34	30	32.4	35	38	28	31,4	34	100	31	31.1	32	3	30	31.7	33	3	32	34.1	37	11

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TABLE 2. (Continued)

	Upeneus spottocaudalis n. sp.						*U. australiae*				*U. guttatus*				*U. itoui* **				*U. seychellensis*				*U. torres*			
	HT	Min	Mean	Max	*n*	*n*=1	Min	Mean	Max	*n*	Min	Mean	Max	*n*	Min	Mean	Max	*n*	Min	Mean	Max	*n*	Min	Mean	Max	*n*
Pre-pectoral length	31	30	31.8	34	16	32	29	30.2	32	38	27	29,5	32	100	29	29.4	30	3	28	29.9	32	3	30	32.1	34	11
Second dorsal-fin depth	22	19	20.7	22	16	21	20	21.5	24	38	19	20,9	24	100	20	21.0	22	3	18	18.7	19	3	20	21.0	22	11
Pelvic-fin depth	24	22	23.6	25	16	25	22	23.8	27	38	21	23,4	26	100	***21***	***21.7***	***22***	3	21	21.7	23	3	23	25.1	27	11
Pectoral-fin depth	17	14	15.5	17	16	17	15	16.7	19	38	14	16,2	19	100	***15***	***14.9***	***15***	3	16	16.6	17	3	16	16.8	18	11
Length of first dorsal-fin base	15	14	14.9	16	16	15	13	15.2	17	38	13	14,8	17	100	14	14.5	15	3	14	13.8	14	3	13	14.1	15	11
Length of second dorsal-fin base	14	12	13.5	15	16	13	12	13.6	15	38	11	13,6	15	99	14	14.3	15	3	12	12.5	13	3	12	13.2	14	11
Caudal-fin length	28	28	29.9	32	16	-	27	29.7	32	35	27	28,9	31	88	28	28.2	28	3	28	29.1	30	3	28	28.5	30	10
Length of anal-fin base	11	11	11.6	13	16	11	10	11.7	13	38	9,5	11,4	14	100	11	11.0	11	3	*9.6*	*10.0*	*10*	3	9.8	10.9	12	11
Anal-fin height	***17***	***16***	***17.6***	***19***	16	-	***15***	***16.3***	***18***	35	***15***	***16,4***	***19***	99	***16***	***16.3***	***17***	3	14	14.8	15	3	***16***	***17.9***	***20***	11
Pelvic-fin length	***22***	***22***	***23.1***	***24***	16	***24***	20	21.1	23	38	19	20,7	22	100	18	18.7	19	3	20	20.6	21	3	20	21.6	23	11
Pectoral-fin length	20	19	20.6	22	16	20	19	20.7	22	44	19	20,3	22	99	19	19.9	20	3	***21***	***21.1***	***21***	3	*24*	*25.1*	*26*	11
Pectoral-fin width	4.0	3.5	3.9	4.3	16	4.0	4.3	4.6	5.5	45	3,5	4,1	5,0	100	3.8	4.0	4.1	3	3.9	4.0	4.2	3	3.7	4.2	4.7	11
First dorsal-fin height	-	19	20.8	22	14	20	18	20.8	23	36	19	21,7	24	86	19	19.7	20	2	19	19.8	20	3	***21***	***22.5***	***24***	9
Second dorsal-fin height	***18***	***18***	***19.1***	***21***	16	**18**	14	15.9	18	36	14	16,1	18	94	16	16.8	17	2	*16*	*16.0*	*17*	3	***16***	***17.1***	***19***	10
Meristic characters																										.
Pectoral-fin rays	***13***	***12***	***12.9***	***13***	16	**13**	13	14.2	15	45	12	13,3	15	112	***13***	***13.3***	***14***	3	14	14.7	15	3	13	14.0	15	11
Rudimentary gill rakers on upper limb	2	1	2.7	4	16	3	1	2.8	4	45	0	3,5	5	111	1	2.0	3	3	4	4.3	5	3	3	3.3	4	11
Developed gill rakers on upper limb	3	2	2.9	4	16	2	2	3.5	6	45	2	2,9	6	111	4	4.3	5	3	***2***	***2.7***	***3***	3	***2***	***2.7***	***3***	11
Developed gill rakers on lower limb	***12***	***11***	***12.5***	***14***	16	**10**	11	12.6	14	45	11	12,5	14	111	***13***	***13.0***	***13***	3	***13***	***13.0***	***13***	3	***11***	***12.5***	***13***	11
Rudimentary gill rakers on lower limb	6	3	4.5	6	16	6	3	4.2	6	45	3	4,7	7	111	3	3.3	4	3	5	5.3	6	3	4	4.8	6	11
Total gill rakers on upper limb	***5***	***5***	***5.6***	***6***	16	5	5	6.2	7	45	5	6,5	8	111	6	6.3	7	3	7	7.0	7	3	5	6.0	7	11
Total gill rakers on lower limb	***18***	***16***	***17.0***	***18***	16	***16***	***16***	***16.8***	***18***	45	***15***	***17,3***	***19***	111	***16***	***16.3***	***17***	3	***18***	***18.3***	***19***	3	***16***	***17.3***	***18***	11
Total gill rakers	***23***	***22***	***22.6***	***23***	16	***21***	***22***	***23.1***	***24***	45	***21***	***23,7***	***26***	111	***22***	***22.7***	***24***	3	*25*	*25.3*	*26*	3	***22***	***23.3***	***25***	11
Scales along lateral line	29	29	29.0	29	2	31	27	28.9	30	26	28	29,4	31	71	29	29.5	30	2	29	29.7	31	3	30	30.0	30	4

** counts from Yamashita *et al.* (2011): pectoral-fin rays 13–15, total gill rakers on lower limb 16–18, total gill rakers 22–25.

Comparisons. *Upeneus spottocaudalis* **n. sp.** differs from all congeneric species in the following combination of characteristics: 7 dorsal-fin spines, 12 or 13 pectoral-fin rays, 20–23 total gill rakers, head length 30–32% SL, and pectoral fins shorter than pelvic fins, the length of the latter 22–24% SL in adults and 24–26% SL in subadults; it differs from all other goatfishes in the presence of 3 or 4 conspicuous dark spots on lower-caudal fin lobe in fresh and preserved adult and subadult specimens.

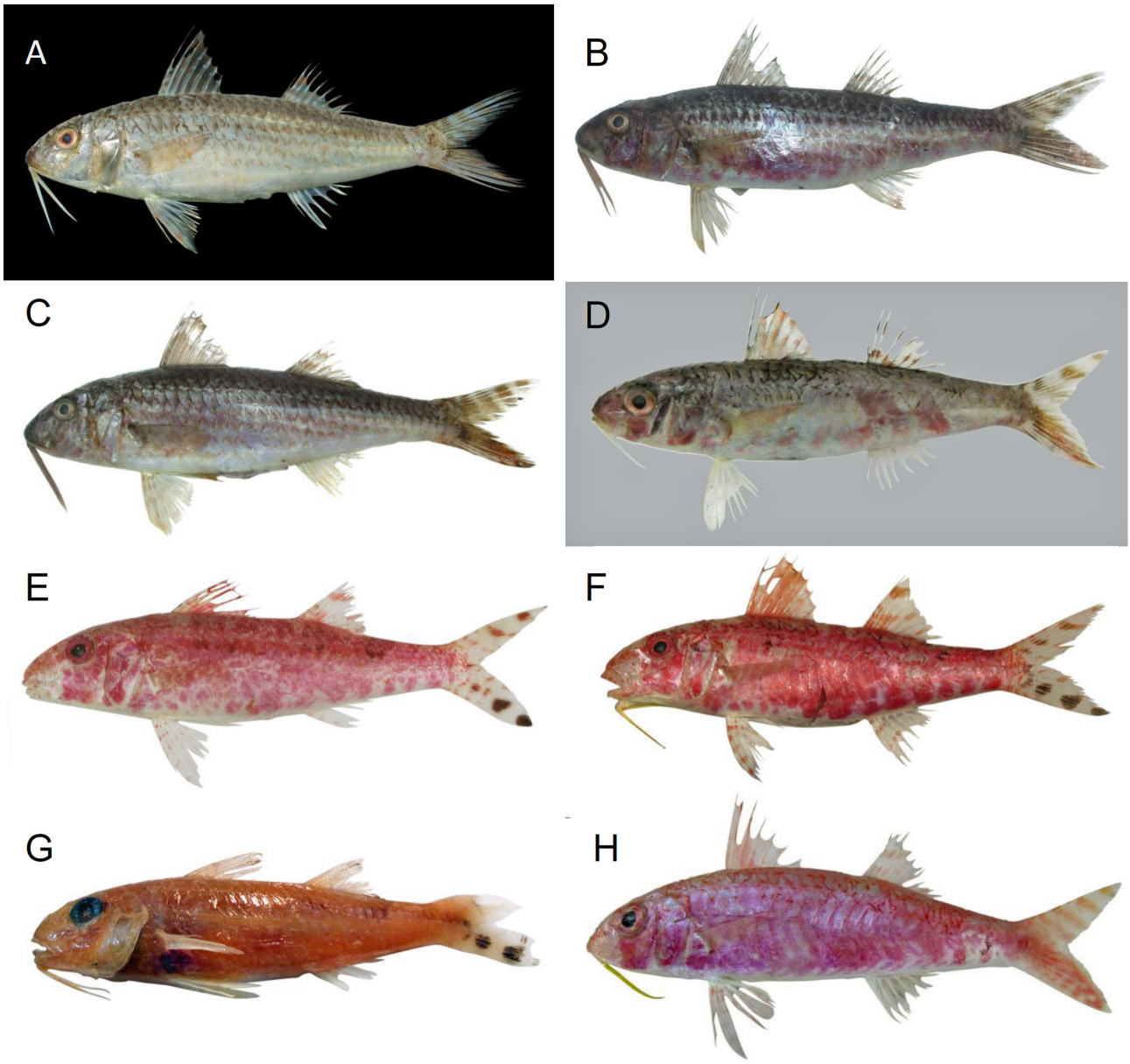

FIGURE 1. (A) *Upeneus farnis* **n. sp.**, holotype (LBRC-F 001450), 97 mm SL, Bitung fish market, NE Sulawesi, Indonesia (T. Peristiwady); (**B**) *Upeneus farnis* **n. sp.**, paratype (LBRC-F 001489), 123 mm SL, same locality and photographer; (**C**) *Upeneus farnis* **n. sp.**, paratype (LBRC-F 001493), 92 mm SL, same locality and photographer; (**D**) *U. lombok,* paratype (MZB 22710), 51 mm SL (subadult), Lombok, Indonesia (W.T. White); (**E**) *U. spottocaudalis* **n. sp.**, holotype (CSIRO H 3436-05), 97 mm SL, E of Cape York Peninsula, Blackwood Channel, Queensland, Australia (T. Carter); (F) *U. spottocaudalis,* **n. sp.**, paratype (CSIRO H 7205-01), 80 mm SL, E of Cape York Peninsula, NE of Shelburne Bay (D.C. Gledhill); (G) *U. spottocaudalis,* **n. sp.** (BMNH 1986.10.1.16), 78 mm, Bali Strait to Timor Sea, Indonesia (F. Uiblein); (H) *U. guttatus* (CSIRO H 7212-02), 121 mm, SE of Cairns, Queensland, Australia (D.C. Gledhill)

Adult *Upeneus spottocaudalis* **n. sp.** differs from the other species of the *japonicus* group with low gill-raker counts as follows (comparative data in Table 2): from *U. australiae* in shallower caudal-peduncle depth, longer head, narrower pectoral fin, higher second-dorsal fin, slightly fewer pectoral-fin rays, and absence of mid-lateral body stripe in fresh specimens; it differs from *U. guttatus* in longer head and pelvic fins, higher second dorsal fin,

fewer gill rakers, shallower body and head, shorter snout and jaws, lower anal and second dorsal fins, and shorter pectoral fins; it differs from *U. itoui* in narrower caudal peduncle, deeper and longer head, larger eyes, longer barbels and pelvic fins, and higher second dorsal fin; it differs from *U. seychellensis* in deeper body, larger eyes, longer and higher anal fin, longer pelvic fins, higher second-dorsal fin, fewer pectoral-fin rays, and fewer gill rakers; and it differs from *U. torres* in shorter barbels and pectoral fins, and slightly fewer pectoral-fin rays.

From adults of the species of the *japonicus* group with higher gill-raker counts *Upeneus spottocaudalis* **n. sp.** differs furthermore as follows (comparative data in Table 1): from *U. asymmetricus* in longer head and barbels, longer pelvic fins, and higher second-dorsal fin; it differs from *U. farnis* in higher anal and second dorsal fins, longer pectoral fins, and fewer pectoral-fin rays; it differs from *U. francisi* in slightly shallower body at anal-fin origin and higher second dorsal fin; it differs from *U. japonicus* in slightly longer pelvic fins and slightly higher second dorsal fins; it differs from *U. pori* in longer head and barbels, higher second dorsal fin, and fewer pectoral rays; and it differs from *U. saiab* in deeper body, longer pelvic fins, higher second-dorsal fin, and fewer pectoral-fin rays.

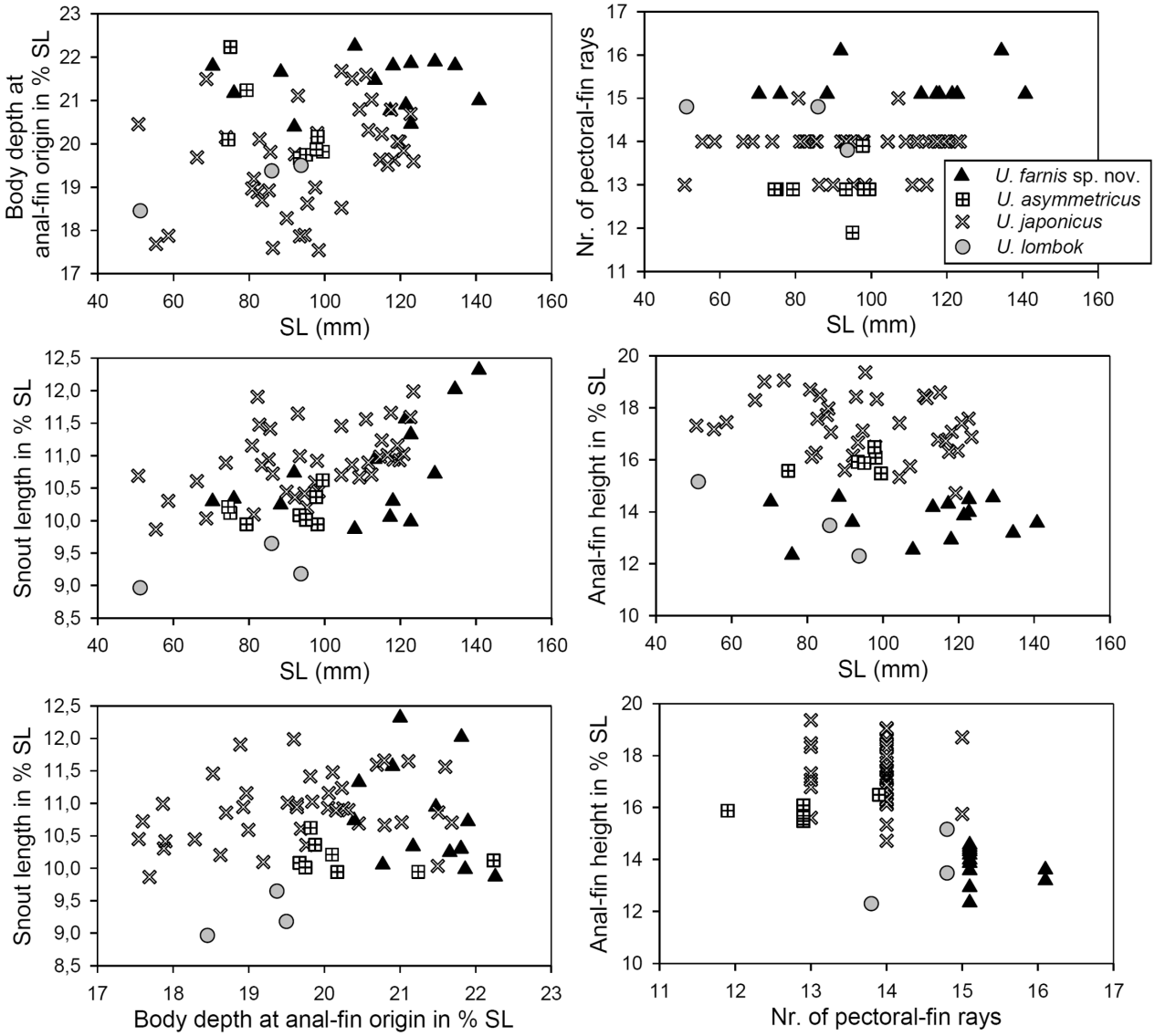

FIGURE 2. Relationships between SL, three body-form characters, and number of pectoral-fin rays in *Upeneus farnis* **n. sp.** and three other similar and/or co-occurring species, *U. asymmetricus*, *U. japonicus,* and *U. lombok*.

Subadult *U. spottocaudalis* **n. sp.** (see also Figure 3, Table 3) differs from conspecific adults in longer pelvic fins; it differs from *U. australiae* subadults in shallower head, narrower interorbital, smaller eyes, longer barbels, longer pelvic fins, higher second-dorsal fin, and fewer pectoral-fin rays; it differs from *U. francisi* subadults in wider caudal peduncle, longer barbels, longer pelvic fins, and fewer gill rakers; it differs from *U. guttatus* subadults in longer barbels and pelvic fins; it differs from *U. japonicus* subadults in higher anal fin, longer pelvic fins, and fewer gill rakers; it differs from the single *U. lombok* subadult in longer head, snout and jaws, longer barbels, longer first dorsal-fin base, higher anal fin, longer pelvic fins, narrower pectoral fins, shallower second dorsal fin, fewer pectoral-fin rays, and fewer gill rakers; and it differs from *U. torres* subadults in shorter barbels, longer pelvic fins, and shorter pectoral fins.

Remarks. The entire type material of *Upeneus spottocaudalis* **n. sp.** originates from a relatively small area in the eastern range of the Torres Strait, NE to E of the Cape York Peninsula, close to the shelf edge. All specimens, apart from the holotype and one adult paratype, derive from collections made during the Torres Strait Ecosystem survey (Pitcher *et al.* 2007). The single specimen from off southern Indonesia (Bali Strait to Timor Sea) was collected during one of the cruises of the Jetindofish project (Lohmeyer 1982) and no detailed collection data are available.

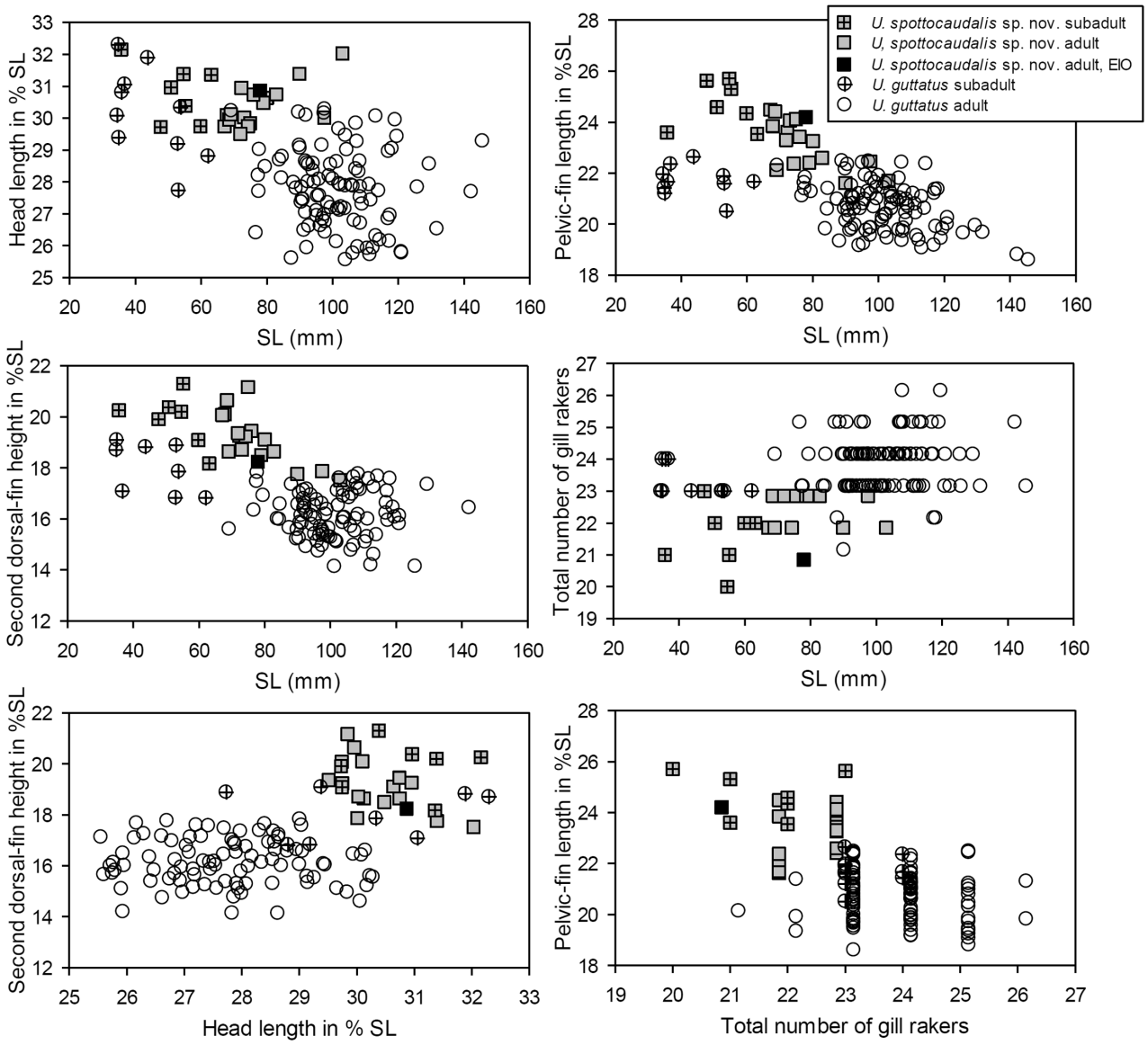

FIGURE 3. Relationships between SL, three body-form characters, and total number of gill rakers in *Upeneus spottocaudalis* **n. sp.** and the most similar and co-occurring species, *U. guttatus*. *Upeneus spottocaudalis* **n. sp.** has been separated by different symbols into three groups consisting of adult and subadult types from NE Australia and the non-type from southern Indonesia.

Distinction of *Upeneus spottocaudalis* **n. sp.** from other species, including the rather similar and co-occurring *U. guttatus*, is best achived by comparing the colour patterns on the caudal fin in both fresh and preserved fish. The large, rounded or triangular spots on the lower caudal-fin lobe of *U. spottocaudalis* n. sp are retained in preserved specimens (Figure 1). These spots represent a unique feature among all goatfishes (see also discussion). Also, the length difference between the pelvic and pectoral fins with the pelvic fin being clearly longer in most specimens (when the fin is not broken) in contrast to being similar in size or shorter in other *Upeneus* species should assist in identification. Furthermore, differences from *U. guttatus* become apparent when examing head length, pelvic fin length, second-dorsal fin height, and the number of total gill rakers in combination, and for adults and subadults separately (Figure 3). Accordingly, adults of the two species are best distiguished by the combination of head length and second dorsal-fin height, while subadults differ clearly when pelvic-fin length is plotted against total number of gill rakers (Figure 3).

The single specimen of *Upeneus spottocaudalis* **n. sp.** from southern Indonesia has slightly wider interobital and slightly narrower interdorsal distances than the conspecifics from NE Australia, suggesting intraspecific geographic variation.

Upeneus spottocaudalis **n. sp.** attains at least 103 mm SL.

Discussion

The number of valid *Upeneus* species is now 39 with the number of species in the *japonicus* group increasing from 11 to 13 with the current study. The morphology-based placement of species in the *japonicus* group has greatly facilitated the process towards new species discovery and the elaboration of species descriptions and comparisons. To find out if this grouping and the here applied additional subgrouping based on gill-raker counts do reflect phylogenetic relationships, genetic studies will be required (Uiblein & Gouws 2015). No genetic tissue samples are currently available for several species of the *japonicus* group including *U. farnis* **n. sp.**, *U. francisi*, *U. saiab* and *U. seychellensis*,

The large number of species in the genus *Upeneus* goes hand in hand with marked divergence in body form and colour patterns, as revealed by the interspecific comparisons. The new species co-occur with several other *japonicus* group species, such as *U. guttatus* (Indonesia, Torres Strait and Bali Strait to Timor Sea), *U. lombok* and *U. asymmentricus* (southern Indonesia), and *U. australiae* and *U. torres* (Torres Strait). All these species differ from each other in number, size, colour and/or form of the oblique bars on the caudal fin, as well as in a combination of body-form and meristic characters.

The divergence in caudal-fin colour patterns revealed in this and several earlier taxonomic studies on *Upeneus* species may deserve particular attention from a classificatory, and an evolutionary ecology perspective. All *Upeneus* species, except for *U. doriae* (Günther 1869) and *U. sulphureus* Cuvier 1829, have oblique bars on the caudal fin. These bars form conspicuous colour patterns that may assist visual species recognition and communication in both single- and multispecies contexts. The large, rounded or triangular, dark spots on the lower caudal-fin lobe in *U. spottocaudalis* **n. sp.** represent a new and rather unique colour pattern. These spots occur in the same places as the oblique bars, and are often still associated with rather rudimentary remains of the latter. Large prominent spots on the body or fins of fishes have been reported from several other families and several possible functions have been suggested, including antipredator and social communication functions (e.g. Uiblein & Nielsen 2005).

While the diversity of *Upeneus* species and their morphology motivates advanced systematic studies, there is still pressing need for basic taxonomic research. In total, six new *Upeneus* species described since 2010 occur within the area between northern Australia and Indonesia: *U. farnis* **n. sp.**, *U. lombok*, *U. margarethae* Uiblein & Heemstra 2010 (Western Indian Ocean to Arafura Sea), *U. spottocaudalis* **n. sp.**, and *U. stenopsis* Uiblein & McGrouther 2012 (northern Australia and Philippines). Additional undescribed or unreported *Upeneus* species are expected to be discovered as relevant fish collection holdings are further examined. Also, field sampling during dedicated research cruises has insufficiently covered all available habitats and many fish markets remain to be explored. Given the economic relevance of goatfishes (e.g., Uiblein 2007; White *et al.* 2013), high priority should be given to (1) completing the species inventory by enhanced taxonomic research and (2) providing suitable tools and local assistance with species identification, so that adequate fisheries-related monitoring and management can be supported and adopted.

TABLE 3. Morphometric and meristic characters for subadults of *Upeneus spottocaudalis* n. sp. and six other species of the *japonicus* group. Differences from comparisons with *U. spottocaudalis* n. sp. are emphasized by underlining, indicating also the intraspecific differences with adults for the new species.

	Upeneus.spottocaudalis n. sp.				*U. australiae*				*U. francisi*				*U. guttatus*				*U. japonicus*				*U. lombok*	*U. torres*			
	Min	Mean	Max	*n*	Min	Mean	Max	*n*	Min	Mean	Max	*n*	Min	Mean	Max	*n*	Min	Mean	Max	*n*	*n*=1	Min	Mean	Max	*n*
SL	36	52.4	63	7	24	27.9	33	4	49	55.7	62	5	34	44.3	62	10	51	54.9	59	3	51	33	49.3	61	16
in % SL																									
Body depth at first dorsal-fin origin	22	22.8	24	7	23	24.0	25	4	23	23.3	24	5	22	24.6	26	10	21	22.3	23	3	23	21	22.5	24	16
Body depth at anal-fin origin	18	19.3	20	7	19	20.4	22	4	19	19.1	20	5	18	19.6	21	10	18	18.7	20	3	18	17	17.7	20	16
Half body depth at first dorsal fin origin	19	19.4	19	1	19	19.7	20	3	18	19.2	20	5	18	19.0	20	2	-	-	-	0	-	17	17.7	19	10
Half body depth at anal fin origin	-	-	-	0	16	15.9	16	2	15	14.9	16	5	-	-	-	0	-	-	-	0	-	12	13.5	15	8
Caudal-peduncle depth	8.6	9.6	10	7	10	10.7	11	4	9.2	9.7	10	5	8.4	9.2	10	10	9.3	9.4	9.6	3	9.5	8.2	8.7	9.1	16
Caudal-peduncle width	3.3	3.7	4.3	7	3.2	3.5	3.7	3	2.3	2.8	3.3	5	3.1	3.6	4	9	3.6	3.8	4.1	3	3.5	2.8	3.1	3.9	16
Maximum head depth	19	20.5	21	7	22	22.2	23	4	20	20.3	21	5	20	21.6	23	10	18	18.7	20	3	19	18	20.2	22	16
Head depth through eye	16	17.2	18	7	19	19.3	20	3	17	17.7	18	5	18	18.4	19	10	16	16.2	16	3	16	16	17.3	19	16
Suborbital depth	8.2	8.8	9.3	7	11	11.1	12	3	8.4	9.0	9.3	5	7.4	9.0	10	10	8.6	8.8	9.1	3	8.9	8	9.2	9.9	16
Interorbital length	7.7	7.9	8.1	7	8.3	8.6	9.0	4	7.6	8.1	8.4	5	7.5	7.9	8.3	10	7.2	7.4	7.8	3	7.8	6.8	7.6	8.2	16
Head length	30	30.8	32	7	31	31.7	32	4	31	31.3	32	5	28	30.2	32	10	29	30.0	31	3	29	28	30.6	34	16
Snout length	10	10.8	11	7	9	9.5	10	4	9.7	10.3	11	5	9.1	10.2	11	10	9.9	10.3	11	3	9.0	9.8	10.5	12	16
Postorbital length	12	12.4	14	7	13	13.9	14	4	11	12.2	13	5	11	12.2	13	10	11	11.7	12	3	12	11	11.9	14	16
Orbit length	7.2	8.2	8.9	7	9.4	9.5	9.8	4	8.5	9.2	9.5	5	7.8	8.5	9.3	10	8.2	8.6	9.3	3	8.4	8.3	9.0	9.7	16
Orbit depth	6.4	7.2	8.0	7	8.2	8.6	8.9	4	7.6	8.1	8.4	5	7.2	7.6	8.5	10	7.5	7.8	8.3	3	7.6	7.4	8.0	8.7	16
Upper-jaw length	11	12.3	13	7	11	11.3	12	3	9.9	10.7	12	5	11	12.2	13	10	11	11.2	12	3	9.8	10	11.3	13	16
Lower-jaw length	10	11.6	12	7	11	10.7	11	3	9.1	9.9	11	5	11	11.3	12	10	10	10.8	11	3	8.8	9.3	10.3	12	16
Snout width	6.6	7.5	8.5	7	8.4	9.0	9.5	3	7	7.7	8.3	3	7	7.9	8.9	10	7.6	8.1	8.3	3	6.6	6.8	8.2	8.8	7
Barbel length	21	21.8	23	7	16	17.3	19	4	17	17.2	18	5	19	20.2	21	10	20	21.1	22	3	17	24	26.2	28	16
Maximum barbel width	0.7	0.9	1	7	0.8	0.9	0.9	3	0.7	0.7	0.8	5	0.7	0.7	0.9	10	0.7	0.8	0.8	3	0.8	0.7	0.8	0.9	16
First pre-dorsal length	35	37.6	39	7	38	38.2	38	3	38	38.7	40	5	34	36.7	39	10	35	36.4	38	3	37	35	36.8	40	16
Second pre-dorsal length	62	64.3	66	7	65	64.6	65	3	64	65.4	66	5	62	64.1	66	10	63	64.4	66	3	62	61	63.6	65	16
Interdorsal distance	15	15.6	17	7	14	14.4	15	3	14	15.0	16	5	14	15.4	16	10	16	16.4	17	3	15	13	14.4	17	16
Caudal-peduncle length	23	23.9	25	7	25	24.7	25	3	23	23.7	25	5	20	22.5	25	10	21	22.2	23	3	24	20	23.4	26	16
Pre-anal length	65	65.5	67	7	63	65.0	66	3	65	66.4	68	5	60	63.5	66	10	63	63.8	65	3	66	60	64.9	69	16
Pre-pelvic length	33	34.2	36	7	35	35.3	36	3	33	35.5	37	5	31	33.4	35	10	32	32.9	34	3	32	33	35.6	38	16
Pre-pectoral length	32	32.4	33	7	32	33.2	34	3	32	33.5	34	5	30	32.1	34	10	32	32.7	33	3	30	31	33.1	35	16
Second dorsal-fin depth	18	20.1	21	7	20	20.9	21	3	19	19.9	20	5	18	19.4	21	10	18	19.0	20	3	19	16	17.6	20	16

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TABLE 3. (Continued)

	Upeneus.spottocaudalis n. sp.				*U. australiae*				*U. francisi*				*U. guttatus*				*U. japonicus*				*U. lombok*	*U. torres*			
	Min	Mean	Max	*n*	Min	Mean	Max	*n*	Min	Mean	Max	*n*	Min	Mean	Max	*n*	Min	Mean	Max	*n*	*n*=1	Min	Mean	Max	*n*
Pelvic-fin depth	22	22.8	24	7	23	23.9	25	3	22	23	24	5	23	24.5	27	10	20	21.2	22	3	23	20	21.9	25	16
Pectoral-fin depth	14	15.2	17	7	15	15.6	16	3	14	14.8	16	5	14	15.8	17	10	14	14.6	15	3	14	13	14.1	17	16
Length of first dorsal-fin base	14	15.0	16	7	14	14.4	15	3	14	14.6	15	5	14	15.4	16	10	14	14.4	14	3	13	13	14.2	15	16
Length of second dorsal-fin base	12	14.4	15	7	14	13.8	14	3	13	13.4	14	5	14	14.1	15	10	13	13.7	15	3	13	12	13.3	15	16
Caudal-fin length	30	31.8	33	7	29	30.0	31	3	28	29.4	30	5	31	32.3	33	10	29	29.5	30	3	29	29	31.0	34	11
Length of anal-fin base	11	11.6	12	7	11	11.6	12	3	11	12	13	5	12	12.6	13	10	11	11.5	12	3	11	11	12.3	13	16
Anal-fin height	18	18.7	19	7	16	16.9	18	3	16	17.6	19	5	17	18.1	20	10	17	17.3	17	3	15	17	18.6	20	16
Pelvic-fin length	24	24.7	26	7	20	20.8	21	3	22	23.6	24	5	21	21.7	23	10	21	21.9	22	3	20	21	22.0	24	16
Pectoral-fin length	20	21.9	23	7	21	22.2	23	4	23	23.5	25	5	22	22.3	23	10	23	23.2	23	3	21	24	24.8	26	16
Pectoral-fin width	3.3	3.9	4.5	7	4	4.1	4.2	3	3.7	3.9	4.2	5	3.6	3.9	4.2	10	4.2	4.4	4.7	3	4.6	3.7	4.1	4.6	16
First dorsal-fin height	21	22.0	23	6	21	21.8	22	3	21	22.6	24	5	19	21.8	24	9	23	23.1	24	3	20	20	22.3	24	15
Second dorsal-fin height	18	19.9	21	7	17	17.0	17	3	16	17.6	18	5	17	18.0	19	8	18	18.3	19	3	16	16	17.7	20	12
Meristic characters																									
Pectoral-fin rays	12	12.7	13	7	14	14.3	15	4	13	13.6	14	5	13	13.0	13	10	13	13.7	14	3	15	13	13.7	14	16
Rudimentary gill rakers on upper limb	1	2.1	3	7	0	1.5	4	4	1	1.0	1	5	2	3.4	4	10	3	3.3	4	3	1	1	2.4	4	16
Developed gill rakers on upper limb	3	3.1	4	7	3	5.3	6	4	8	8.2	9	5	2	2.6	4	10	3	3.3	4	3	7	2	3.6	5	16
Developed gill rakers on lower limb	12	12.4	13	7	14	14.5	15	4	21	21.8	23	5	11	12.4	13	10	13	13.7	14	3	18	12	14.1	15	16
Rudimentary gill rakers on lower limb	3	3.9	5	7	2	2.8	3	4	0	0.6	1	5	4	4.9	6	10	4	4.7	5	3	2	2	3.8	6	16
Total gill rakers on upper limb	5	5.3	6	7	6	6.8	7	4	9	9.2	10	5	5	6.0	7	10	6	6.7	7	3	8	5	6.1	7	16
Total gill rakers on lower limb	15	16.3	17	7	17	17.3	18	4	22	22.4	23	5	16	17.3	18	10	18	18.3	19	3	20	17	17.8	19	16
Total gill rakers	20	21.6	23	7	23	24.0	25	4	31	31.6	32	5	23	23.3	24	10	25	25	25	3	28	22	23.9	25	16
Scales along lateral line	-	-	-	0	28	28.0	28	4	28	29.0	30	5	-	-	-	0	-	-	-	0	-	29	29.2	30	5

Comparative material examined

For nine of the 11 *japonicus*-group species, previously published data were used in the comparisons exclusively. These are (species name with number of specimens examined, size range, and literature source in round brackets): *Upeneus asymmetricus* (8: 74–100 mm SL; Uiblein & White 2015); *U. australiae* (49: 24–128 mm SL; Uiblein & Gledhill 2015); *U. francisi* (6: 49–74 mm SL; Uiblein & White 2015); *U. japonicus* (40: 51–123 mm SL; Uiblein & Gledhill 2015); *U. lombok* (3: 51–94 mm SL; Uiblein & White 2015); *U. pori* (7: 66–110 mm SL; Uiblein & Lisher 2013); *U. saiab* (6: 70–102 mm SL; Uiblein & Lisher 2013); *U. seychellensis* (3: 96–115 mm SL; Uiblein & Heemstra 2011); *U. torres* (27: 33–101 mm SL; Uiblein & Gledhill 2015).

For *U. guttatus*, the data of 92 adult and subadult specimens (34–146 mm SL) listed in Uiblein & Gledhill (2015) were used, plus newly generated data for the following 30 additional specimens (28 adults and 2 subadults, 53–159 mm SL): Saudi Arabia, Red Sea: SMF 35012, 78 mm SL, 16°54.869' N 42°26.044' E, 21 m depth; Mozambique: SAM MB-F034156, 4: 94–104mm SL, off Beira, 19°49’ S 36°05’ E; VIMS 7487, 93 mm SL, 20°30' S 35°49' E, 32 m depth; Myanmar: SAIAB 203668, 109 mm SL, 18°37.61’ N 93°39.53’ E, 36–38 m depth; SAIAB 203673, 104 mm SL, 13°02.43’ N 96°45.03’ E, 104 m depth; SAIAB 203675, 104 mm SL, 19°40.84’ N 92°54,13’ E, 45 m depth; SAIAB 203676, 99 mm SL, 19°06.31’ N 93°07.89’ E, 78 m depth; VIMS 7521, 96 mm SL, 09°54' N, 97°42' E, 73 m depth; VIMS 7584, 102 mm SL, same locality as before; Indonesia, Lombok: CSIRO H 7217-07, 90 mm SL, Tanjung Luar; MZB 23014, 92 mm SL, same locality as before; NTM S-11339-002, 69 mm SL, West Alas Strait, 8°44' S 116°36' E; Philippines: CAS 232885, 118 mm SL, Negros, north of Cadiz town, 11°5'0"N 123°20'0"E, 18-36 m depth; Australia, Queensland: CSIRO H 7662-01, 53 mm SL, E of Cairns, 16°53.77’ S 146°26.81’ E, 65 m depth; CSIRO H 7663-01, 62mm SL, Townsville, NE of Bowling Green Bay, 19°10.38’ S 147°46.56’ E, 42 m depth; QM I.20325, 2; 89-104mm SL, Flora Passage, 17°03' S 146°14' E, 37–42 m depth; QM I.3410, 117mm SL, South Queensland coast; CSIRO CA 3858, 104 mm SL, Western Australia, off Port Hedland, 19°17.8’ S 117°55.2’ E, 84 m depth; New Caledonia, Chesterfield Islands: BPBM 39472, 3: 90–102mm; Vietnam: HIFIRE 58183, 129mm, Nha Trang, central fish market; HIFIRE 58184, 118mm, Nha Trang, central fish market; HIFIRE 58334, 120mm, Nha Trang; MNHN 1965-0273, 159 mm SL, 12°3’ N 112°3’ E; VNMN I-20, 88 mm SL, Danang.

Three *Upeneus itoui* (87–118 mm SL) were studied: KAUM 10384 (wrongly referred to as KAUM 10984 in Uiblein & Lisher 2013), 87 mm SL, Japan, Kagoshima, off east of Sakinoyama, 31°25.74' N, 130°11.82' E, 27 m; KAUM 13595, 118 mm SL, same locality as before; MNHN 2010-1050, 114 mm SL, paratype, same locality as before.

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