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A new species of *Larimichthys* from Terengganu, east coast of Peninsular Malaysia (Perciformes: Sciaenidae)

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Abstract

A new species of *Larimichthys* from Terengganu, east coast of Peninsular Malaysia is described from specimens collected from the fish landing port at Pulau Kambing, Kuala Terengganu. *Larimichthys terengganui* can be readily distinguished from other species of the genus by having an equally short pair of ventral limbs at the end of the gas bladder appendages, which do not extend lateral-ventrally to the lower half of the body wall, and fewer dorsal soft rays (29–32 vs. 31–36) and vertebrae (24 vs. 25–28). *Larimichthys terengganui* can be distinguished from *L. polyactis* and *L. crocea* by having a gill raker at the angle of first gill arch shorter than the gill filament. Furthermore, the second anal spine in *L. terengganui* is equal or slightly shorter than eye diameter (vs. shorter in *L. polyactis*); *L. terengganui* has 8–9 anal soft rays (vs. only 7 in *L. pamoides*). Snout length of *L. terengganui* is greater than eye diameter, whereas in *L. crocea* the snout is shorter than eye diameter. A key to species of *Larimichthys* is provided. All obtained specimens of the species were recorded from Terengganu waters, east coast of Peninsular Malaysia.

Key words: taxonomy, new species, Sciaenidae, *Larimichthys*, Malaysia, South China Sea

Introduction

Sciaenid fishes, commonly known as croakers or drums, are known as “gelama” in Malaysia. Sciaenids are the main trawl fish species in Malaysia, trawl landings amounting to about 38 024 metric tons in 2012 (Department of Fisheries [DOF], 2012). These are preferably processed into a popular dried salty fish locally known as “ikan masin”. The Sciaenidae is reported as monophyletic family with a cosmopolitan distribution throughout the continental shelf waters of tropical regions (Chao, 1978, 1986; Sasaki, 1989), and are easily distinguished from all other Perciformes by having a long continuous dorsal fin, with a deep notch separating a shorter anterior spinous portion from a longer posterior portion supported by soft rays. All sciaenids have one or two spines in the anal fin (usually three or more in other Percoidei).

Sciaenids are characterized by a well-developed acoustico-lateralis system, comprising pored lateral-line scales extending to the tip of the caudal fin and a thick gas bladder often with elaborated appendages. Sciaenids also have one or two pairs of extremely large and thick otoliths. The sulcus is characteristically tadpole-shaped, with a shallow, oval head portion (ostium) and a J-shaped, deeply grooved tail portion (cauda) (Trewavas, 1977; Chao, 1978, 1995).

Comprehensive diagnosis of synapomorphies and the phylogenetic relationship of worldwide Sciaenidae were first analyzed by Sasaki (1989) and recent genetic analysis was done by Lo *et al.* (2015, in press), and shows a New World origin and Early Miocene diversification of tropical sciaenids.

The new species, *Larimichthys terengganui*, described herein was previously identified as *Larimichthys crocea* by Matsunuma *et al.* (2011: p.140), three specimens kept at Universiti Malaysia Terengganu, UMT. With more specimens collected recently at the fish landing ports near Kuala Terengganu, we made thorough morphological examination and found this species is distinct from the known three species of *Larimichthys*, *L. crocea*, *L. polyactis* and *L. pamoides*. The new species also has a distribution discontinuous from all other species of the genus *Larimichthys* (*sensu* Trewavas, 1977). This paper includes description of new species, and with a key to the species of *Larimichthys*.

Material and methods

Specimens were collected from fish landing ports in Kuala Terengganu, Malaysia between 2008 and 2014. A total of 14 specimens were deposited at the Universiti Malaysia Terengganu, Malaysia (UMT), National Museum of Marine Biology and Aquarium, Taiwan (NMMBA) and Kagoshima University Museum, Japan (KAUM). Methods of counting and measuring generally followed Hubbs & Lagler (1964), and terminology of morphological features and descriptions follow Chao (2001). The procedure of preservation and photograph for specimens are as in Seah *et al.* (2011). Gill raker counts are the total number of rakers at upper and lower limbs, including rudimentary rakers on the first right gill arch. The lateral line scale counts are the number of pored scales excluding those distal to the posterior end of hypural plates.

A long incision was made over the isthmus of the cleithrum to examine the fine appendages on the anterior part of gas bladder. Gas bladders were extracted from the body cavity where possible and photographed both ventrally and dorsally. Drumming muscles were also observed. The right side sagittal otoliths were extracted, its medial surface with a tadpole-shaped sulcus and *in situ* dorsal view with inner surface to the left were photographed as standard presentation for genera verification. Total vertebrae counts were made from radiographs and recorded as pre-caudal and caudal vertebrae.

Other material examined is listed at the end. CAS is the Chinese Academy of Sciences, Institute of Zoology Fish Collection.

Taxonomy

Larimichthys terengganui sp. nov.

(Figs. 1–4, Table 1)

Larimichthys crocea (*non* Richardson, 1846): Matsunuma *et al.*, 2011:140.

Holotype. NMMB-P 21523, 1 (161mm SL), fish landing port at Pulau Kambing, Kuala Terengganu, Malaysia, collected by Norhafiz Hanafi in March 2014.

Paratypes. KAUM-I. 16977, 1 (200 mm SL), Kuala Terengganu, identified as *Larimichthys crocea* (photo on p.140 in Matsunuma *et al.*, (2011). NMMB-P 21723, 1 (166 mm SL), collected with holotype NMMB-P 21523, fish landing port at Pulau Kambing, Kuala Terengganu, Malaysia, collected by Norhafiz Hanafi in March 2014, (gas bladder and right side otolith extracted for illustration). NMMB-P 21542, 2 (151 & 155 mm SL), fish landing port at Pulau Kambing, Kuala Terengganu, Malaysia, collected by Norhafiz Hanafi, March 2014. NMMB-P 21524, 1 (161 mm SL), one of three from UMTF 05798, off Terengganu (Matsunuma *et al.* 2011). UMTF 05949, 05950, 2 (171 & 178 mm SL), two of three from UMTF 05798, off Terengganu (Matsunuma *et al.*, 2011). UMTF 05951-05956, 6 (153–173 mm SL), fish landing port at Pulau Kambing, Kuala Terengganu, Malaysia, collected by Norhafiz Hanafi, March 2014.

Diagnosis. A species of *Larimichthys* with an equally short pair of ventral and dorsal limbs at the lateral ends of gas bladder appendage; gill raker length about $\frac{1}{2}$ the eye diameter, shorter than gill filament at the angle of first gill arch; snout length greater than eye diameter; 2nd anal spine equal or slightly shorter than eye diameter; outer gill rakers of first arch 22–25. Inner gill rakers of first arch 17–19. Vertebrae 11 + 13 = 24. Second dorsal fin soft rays 29–32.

Description. Counts and measurements of the type specimens are shown in Table 1. The following data are provided for the holotype, followed by the size range and mean for the 13 paratypes.

TABLE 1. Morphometric and meristic data of type specimen of *Larimichthys terengganui* sp. nov. in present study. SD = standard deviation.

	Holotype	Paratypes (n = 13)			
	NMMB-P 21523	Min	Max	Mean	SD
Standard Length (mm)	161.0	151.1	197.8	165.8	
Counts					
1 st dorsal fin spine	9	9	9	9.0	0.0
2 nd dorsal fin spine	1	1	1	1.0	0.0
2 nd dorsal fin soft rays	32	29	32	30.9	1.0
Anal fin spine	2	2	2	2.0	0.0
Anal fin soft rays	9	8	9	8.6	0.5
Pectoral fin rays	16	16	17	16.1	0.3
Outer gill rakers of 1 st arch	23	22	25	23.6	1.2
upper limb	7	7	9	7.5	0.7
lower limb	16	15	17	16.1	0.7
Inner gill rakers of 1 st arch	18	17	19	18.4	0.6
upper limb	6	5	6	5.4	0.5
lower limb	12	12	14	12.9	0.6
Lateral line pore scales	51	49	54	51.8	1.3
Scale rows in longitudinal series	58	56	62	57.6	1.9
Scales above lateral line	7	7	8	7.5	0.5
Scales below lateral line	8	7	9	8.1	0.5
Circumpeduncular scales	18	18	20	18.7	0.7
Vertebrae	24	24	24	24.0	0.0
precaudal	11	11	11	11.0	0.0
caudal	13	13	13	13.0	0.0
Measurements					
Snout to anal fin origin	72.0	69.1	72.7	71.2	1.1
Snout to 2 nd dorsal fin origin	51.5	47.6	51.6	50.4	1.0
Snout to 1 st dorsal fin origin	32.5	32.0	34.2	33.0	0.7
Snout to pectoral fin insertion	31.2	30.5	32.2	31.3	0.5
Snout to pelvic fin insertion	35.3	33.0	35.9	34.2	1.0
Head length	32.8	30.6	34.2	32.5	0.8
Snout length	8.0	7.0	8.0	7.6	0.3
Maxillary length	16.9	15.1	17.7	16.6	0.7
Eye diameter	6.7	5.4	7.4	6.5	0.6
Interorbital width	9.4	7.9	9.5	8.9	0.4
Pectoral fin length	28.6	23.3	29.2	26.4	1.7
Pelvic fin length	21.1	18.0	21.3	19.5	1.1
Body depth (D1-P2)	28.9	27.6	30.2	29.3	0.7
Body width (P1-P1)	15.7	13.2	16.5	15.2	0.8

.....continued on the next page

TABLE 1. (Continued)

	Holotype	Paratypes (n = 13)			
	NMMB-P 21523	Min	Max	Mean	SD
1 st dorsal fin base length	17.6	17.1	19.3	18.1	0.7
longest spine length	12.7	9.8	13.4	11.7	1.2
2 nd dorsal fin base length	43.8	42.1	45.9	43.7	1.2
longest ray length	12.3	9.5	12.3	11.0	0.8
Anal fin base length	9.1	7.7	10.6	9.5	0.8
2 nd spine length	6.6	5.1	7.1	6.3	0.7
1 st ray length	16.8	12.1	16.8	14.8	1.5
Caudal peduncle depth	8.4	7.5	8.8	8.3	0.4
Pelvic fin tip to vent	12.0	11.4	16.7	13.7	1.5
Vent to anal fin origin	4.8	3.7	4.9	4.2	0.4
Longest gill raker on 1 st arch	3.4	3.2	3.8	3.5	0.2
Longest gill filament on 1 st arch	3.7	3.5	4.7	4.1	0.4

**FIGURE 1.** *Larimichthys terengganui* sp. nov. (paratype: KAUM-I. 16977, 200 mm SL; identified as *Larimichthys crocea* in Matsunuma *et al.* (2011: 140).

Dorsal fin with IX spines on the anterior (spinous) portion and I spine and 29–32 soft rays on the posterior portion. Anal fin with II spines and 8 or 9 soft rays. Pectoral fin with 16–17 soft rays. Outer gill rakers of 1st arch 7–9 + 15–17 = 22–25. Inner gill rakers of 1st arch 5–6 + 12–14 = 17–19. Preopercular margin weakly indented no sharp spines. Lateral line pore scales 49–54. Circumpeduncular scales 18–20. Vertebrae 11 + 13 = 24.

Gas bladder with 26 pairs of lateral appendages, including a couple of long branched appendages extended to the base of anal fin (Fig. 2). A pair of equally short ventral limbs at the lateral ends of gas bladder appendage, which are not extend lateral-ventrally to lower half of the body wall (Fig. 3).

Sagitta (Fig. 4) kidney-shaped with a shallow tadpole-shaped sulcus mark on its inner surface, ostium (head) rounded, a shallowly grooved, cauda, and a conspicuous marginal groove dorsally; outer surface more elevated at posterior half.

Body fusiform, elongated with a moderately large head, about 3 times in standard length (SL). Head cavernous but moderately firm. Snout 4.1–4.6 in head length, its tip with three upper and five marginal pores; rostral fold slightly indented below the marginal pores. Eye moderately large, oval shaped, horizontal diameter 4.4–5.9 in head length. Interorbital region broad, 3.3–4.0 in head length. Preopercular margin weakly indented without sharp spines or serration.



FIGURE 2. Gas Bladder of *Larimichthys terengganui* (paratype: NMMB-P 21723, 166 mm SL, female), with 26 pairs of lateral appendages and follow by a couple of long branched appendages extended to the base of anal fin. Dorsal view (top) and ventral view (bottom).

Mouth large oblique, terminal, maxillary 1.8–2.1 in head length, the lower jaw slightly projecting, the mouth gape forming an angle of about 45 degrees. Tip of upper lip on horizontal passing near ventral margin of orbit. End of maxillary on vertical line passes near posterior margin of eye. Underside of lower jaw with 6 pores, the median pair set on tip of lower jaw.

Teeth narrow set in ridges, upper jaw with an outer row of clearly enlarged, conical teeth bordered medially by a narrow row of smaller teeth. Lower jaw with a row of enlarged sharp teeth, several larger teeth clustered at the tip of lower jaw.

Gill rakers, moderately long and slender, the longest one at the angle about $\frac{1}{2}$ the eye diameter, shorter than gill filament at the angle of arch.

Anal fin truncate, the second spine short and fairly stout, 4.5–6.1 in head length. Caudal fin rhomboidal, about $\frac{2}{3}$ of head length. Tip of pectoral fin vertically passed beyond the tip of pelvic fin but short of vent. Pelvic tip not filamentous, its distance to vent is greater than that of vent to anal fin origin.

Scales moderately large, thin and ctenoid on posterior half of body behind the tip of pectoral fin tip, ctenii on scales becoming reduced anteriorly, below first portion of dorsal fin and between pectoral and pelvic fins. Transverse scale between dorsal fin origin and lateral line 6–7. Dorsolateral scales above lateral line ctenoid. Head squamation completely cycloid, scales becoming reduced and embedded on the snout and suborbital region. Soft dorsal and anal covered with small cycloid scales from base to distal margin. Pectoral, pelvic and caudal fins, with small cycloid scales at bases, naked distally. Lateral line pored scales smooth anteriorly, but with a small field of ctenii posteriorly. Pored lateral line scales usually with a single dorsal and ventral branch, occasionally more arborescent.

Photophore perforated scales are also found on the belly, which are more prominent above anal fin base and extended to lower portion of caudal peduncle.

Color in alcohol. Ground color brownish darker dorsally and fading to whitish pale ventrally. Snout, top of head, nape, dorsum and sides above level of pectoral fin base profusely dusted with very small brown chromatophores, becoming larger and more widely dispersed ventrally, and disappearing from ventral body surface. Tip of snout with a darkish blotch, upper lip with a dark margin dorsally, lower lip with a dark margin, roof

of mouth pale, becoming dusky posteriorly to dark lining in upper part of inner opercula chamber, appearing as a dark triangle externally. Eye with dark upper and lower margin, suborbital pale with scattered silvery tint. Spinous dorsal with dark tip, distal margin of soft dorsal dusky; pectoral fin axil with a black blotch. Pelvic and anal fin pale to yellowish. Caudal lightly and evenly dusted. Belly with photophores along scale rows, 4–5 prominent rows above anal base to lower part of caudal peduncle. Peritoneum variably sprinkled with large, stellate, chromatophores, especially in anterior portion of the body cavity.

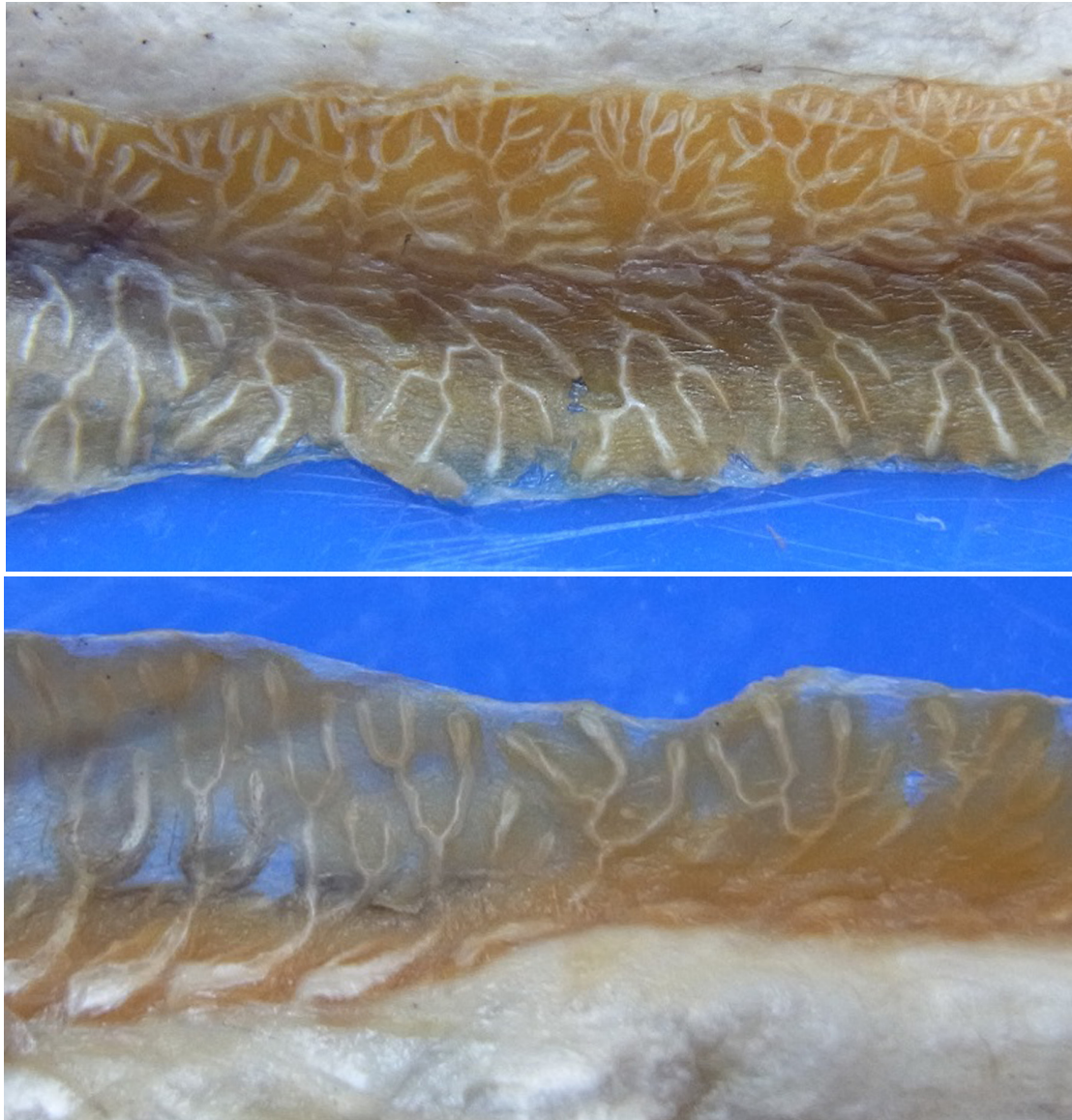


FIGURE 3. Close-up view of gas bladder for *Larimichthys terengganui* (paratype: NMMB-P 21723, 166 mm SL, Female), with an equally short pair of ventral limbs at the lateral end of gas bladder appendages. Dorsal view (top) and ventral view (bottom).

Distribution. All know specimens of the species were collected from South China Sea around Kuala Terengganu, east coast of Peninsular Malaysia. The species may be endemic to the area.

Etymology. Named after the locality of the new species, Terengganu, east coast of Peninsular Malaysia.

Comparisons. *Larimichthys terengganui* can be distinguished from other species of the genus by having gas bladder appendages at ventral limb with a pair of equally short branches; both branches are elongate in *L. crocea* and only one is elongated anteriorly in *L. polyactis*. Although *L. pamoides* (specimens not examined) has a pair of short limbs (Trewavas, 1977, Fig. 60), but other characters are distinct from *L. terengganui* (Trewavas, 1977, p. 542), and as reported from northwestern Australia and southern New Guinea, appears to have a distribution separate from that of *Larimichthys terengganui*. Furthermore, *L. pamoides* is entirely covered in cycloid scales, unlike the other species which are mostly covered with ctenoid scales, with cycloid scales only on head and below pectoral fins. The new

species has the least number of vertebrae (24), compared to the other species, 25 in *L. crocea* and *L. pamoides*, and 28 in *L. polyactis*. *Larimichthys terengganui* has fewer dorsal soft rays (29–32 vs. 31–36 in other *Larimichthys*). Furthermore, the second anal spine in *L. terengganui* is equal or slightly shorter than eye diameter, but shorter in *L. polyactis*, longer in *L. pamoides* and equal or slightly longer in *L. crocea*. *Larimichthys terengganui* can be distinguished from *L. crocea* and *L. polyactis* by having a gill raker shorter than gill filament at the angle of first gill arch, and a relatively elongated anterior part of fish (head length 30.6–34.2% SL; snout to pectoral fin insertion 30.5–32.2% SL; snout to pelvic fin insertion 33.0–35.9% SL). External morphology of *L. terengganui* is most similar to that of *L. crocea*, with a snout length greater than eye diameter, whereas in *L. crocea* the snout is shorter than eye diameter. *Larimichthys terengganui* has fewer gill rakers on the first arch than *Larimichthys crocea* (22–25 vs. 26–28), and has fewer scales above lateral line than *Larimichthys crocea* (7–8 vs. 8–10). Diagnostic characters of the four species of *Larimichthys* are presented in Table 2.

TABLE 2. Comparative counts and measurements of *Larimichthys terengganui* sp. nov. with similar species.

	<i>L. terengganui</i>	<i>L. crocea</i>	<i>L. polyactis</i>	<i>L. pamoides</i> *
SL (mm)	151–198	122–380	105–285	88
Number	14	8	12	1
Counts				
2 nd dorsal fin soft rays	29–32	31–35	32–36	36
Anal fin soft rays	8–9	8	8–10	7
Outer gill rakers of 1 st arch	22–25	26–28	25–31	26
lower limb	15–17	18–20	16–21	18
Inner gill rakers of 1 st arch	17–19	20–22	19–22	-
lower limb	12–14	14–16	13–16	-
Lateral line pore scales	49–54	49–56	54–59	-
Scale rows in longitudinal series	56–62	70–72	64–65	-
Scales above lateral line	7–8	8–10	5–8	-
Circumpeduncular scales	18–20	20–24	20–21	-
Vertebrae	24	25	28	25
precaudal	11	11	12–13	10
caudal	13	14	15–16	15
Measurements				
as % of SL				
Snout to 2 nd dorsal fin origin	47.6–51.6	42.1–43.5	45.2–50.9	-
Snout to 1 st dorsal fin origin	32.0–34.2	28.1–28.6	30.7–36.8	-
Snout to pectoral fin insertion	30.5–32.2	26.8–27.4	27.1–30.2	-
Snout to pelvic fin insertion	33.0–35.9	30.2–32.8	31.0–31.8	-
Head length	30.6–34.2	27.1–30.0	25.1–29.8	31.6
Snout length	7.0–8.0	5.6–6.7	5.3–7.3	8.9
Eye diameter	5.4–7.4	5.2–8.3	5.9–7.5	8.3
Interorbital width	7.9–9.5	7.6–9.1	7.3–8.9	10.6
Pectoral fin length	23.3–29.2	19.6–23.0	21.4–26.6	25.4
Body depth (D1–P2)	27.6–30.2	24.7–28.5	23.3–28.7	30.8
2 nd dorsal fin base length	42.1–45.9	46.0–49.6	41.1–45.5	-
2 nd anal spine length	5.1–7.1	4.8–8.4	4.3–6.7	10.7
Caudal peduncle depth	7.5–8.8	6.8–7.7	7.1–9.0	-
Longest gill raker on 1 st arch	3.2–3.8	3.4–4.5	3.0–4.1	-
Longest gill filament on 1 st arch	3.5–4.7	2.4–4.0	2.4–3.7	-

* Data from Trewavas (1977), for holotype of species.



FIGURE 4. The right sagitta of *Larimichthys terengganui*, medial surface (A), lateral surface (B) and dorsal view (C), NMMB-P 21723, 166 mm SL, Female.



FIGURE 5. *Larimichthys crocea* (A) and gas bladder appendages of ventral limb with two elongated branches, indicate by arrow (B).



FIGURE 6. *Larimichthys polyactis* (A) and gas bladder appendages of ventral limbs with elongated anterior branch and a short posterior branch, indicate by arrow (B).

Remarks. The species was first reported in Matsunuma *et al.* (2011:140) as a new record of *Larimichthys crocea* in east coast of Peninsular Malaysia. Three specimens were kept at the UMT fish collection. In March 2014, Mr Norhafiz Hanafi collected additional specimens and which were subsequently identified as a new species described herein.

Key to species of *Larimichthys*

- 1a Scales all cycloid; 2nd anal spine longer than eye diameter; gas bladder appendage with dorsal and ventral limbs, rather short without long branches; anal fin soft rays 7; vertebrae 25 *Larimichthys pamoides* (northwestern Australia and southern New Guinea)
- 1b Scales mostly ctenoid on body, cycloid below pectoral fin and on head 2
- 2a Snout length greater than eye diameter; gill raker at the angle of first gill arch shorter than gill filament; 2nd anal spine equal or slightly shorter than eye diameter; gas bladder appendage with two equally short limbs without elongated branches; dorsal fin soft rays 29-32; outer gill rakers of first arch 22–25; vertebrae 24. *Larimichthys terengganui* **sp. nov.** (east coast of Peninsular Malaysia)

- 2b Snout length less than eye diameter; gill raker at the angle of first gill arch longer than gill filament, gas bladder appendage with elongated branches on ventral limb. 3
- 3a Caudal peduncle length 3 times or more of its depth; 2nd anal spine equal or slightly longer than eye diameter; scales small 8–10 transverse rows between dorsal origin and lateral line; ventral limb of gas bladder appendage with two equally elongated branches; vertebrae 25. *Larimichthys crocea* (Fig. 5) (Yellow and East China Seas)
- 3b Caudal peduncle length less than 2.5 times of its depth; 2nd anal spine shorter than eye diameter; scales moderately large 5–8 transverse rows between dorsal origin and lateral line; ventral limb of gas bladder appendage with elongated anterior branch and a short posterior branch; vertebrae 28 *Larimichthys polyactis* (Fig. 6) (Yellow and East China Seas)

Other material examined

Larimichthys crocea: NMMB-P, 4760, 1 (227 mm SL), Jingmen, Fujian Province, Taiwan, collected in 1965. NMMB-P, 1185, 1 (259 mm SL), Jingmen, Fujian Province, Taiwan, collected in 2005. CAS 02117, 1 (285 mm SL), East China Sea. CAS 52284, 1 (380 mm SL), South China Sea. Uncatalogued, 4 (122–190 mm SL), Hong Kong fish market.

Larimichthys polyactis: NMMB-P 21561, 2 (176–197 mm SL), fish market, Mazhu, Fujian Province, Taiwan, collected in October 2014. CAS 57914, 4 (105–195 mm SL), Haozifang, Liaoning Province, China. Uncatalogued, 4 (160–200 mm SL), Da Shen Tang, Tian Jing, China. CAS 02118, 1 (285 mm SL), East China Sea. CAS 37547, 1 (245 mm SL), Dalian, Liaoning Province, China.

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