

Records of the eel-goby, *Taenioides snyderi* (Actinopterygii: Gobiiformes: Gobiidae), from Taiwan

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Abstract

Four gobiid specimens collected from the western coast of Taiwan were identified as *Taenioides snyderi* Jordan et Hubbs, 1925, being characterized by 51–55 (total) dorsal-fin rays, 44–46 (total) anal-fin rays, 17–19 pectoral-fin rays, 10 + 21 = 31 vertebrae, 3 paired barbels on the chin surface, the pelvic-fin base fused by membrane to the abdomen, and the pattern of the dermal folds with sensory papillae on the head and body. *Taenioides snyderi* has been recorded to date only from Japanese waters, although the likelihood of a wider distribution has been suggested by molecular analysis. This study represents the first specimen-based records of the species outside Japan, with data adding to our knowledge of a poorly known fish group.

Keywords

distribution, morphology, range extension, specimen-based records

Introduction

Taenioides Lacepède, 1800, a genus of mud-dwelling eel-gobies inhabiting bays and estuaries, is characterized by dermal folds on the scaleless head and body, barbels on the chin, the first and second dorsal fin connected, the posteriormost rays of the dorsal and anal fins unbranched (rarely branched), and a Y-shaped second anal-fin pterygiophore (Murdy and Shibukawa 2001; Murdy 2011, 2018; Shibukawa and Murdy 2012; Koreeda and Motomura 2021). Although the relations of nominal species of *Taenioides* have not yet been resolved, the validity of *Taenioides anguillaris* (Linnaeus, 1758), *Taenioides gracilis* (Valenciennes, 1837), *Taenioides kentalleni* Murdy et Randall, 2002, *Taenioides purpurascens* (De Vis, 1884), and *Taenioides snyderi* Jordan et Hubbs, 1925 have been recently confirmed (Kurita and Yoshino 2012; Murdy 2018).

Four museum specimens of *Taenioides* previously collected from the western coast of Taiwan were identified as *Taenioides snyderi*, a species originally described from Wakayama Prefecture, Japan (Jordan and Hubbs 1925). Although recorded only from Japan to date (Jordan and Hubbs 1925; Kurita and Yoshino 2012; Koreeda and Motomura 2021), Koreeda and Motomura (2021) suggested that the species may also be distributed off China and Taiwan, following comparisons of molecular studies. The specimens from Taiwan are therefore the first verified records of *T. snyderi* from Taiwan, supported by voucher specimens.

Methods

Counts and measurements followed Murdy (2018), with the following exceptions: distance of posterior end of pelvic-fin base to anterior margin of anus (P–A length) was

measured from posterior margin of membrane between the pelvic fin and the abdomen to anterior margin of the anus. Terminology of sensory-papillae rows followed Koreeda and Motomura (2021). Relations of dorsal-fin pterygiophore and neural spine (P–V) followed Akihito (1984). Dorsal- and anal-fin rays, vertebrae, and pterygiophores were counted from X-ray photographs. Standard length is abbreviated as SL. Institutional codes are as follows: Kagoshima University Museum, Kagoshima (KAUM); National Museum of Marine Biology and Aquarium, Pingtung (NMMB-P).

Results

Family Gobiidae Cuvier, 1816

Taeniooides Lacepède, 1800

Taeniooides snyderi Jordan et Hubbs, 1925

Figs. 1–2; Table 1

Material examined. NMMB-P5491, male, 150.7 mm SL, Chiayi, Taiwan, bottom trawl, 30 Aug. 1965; NMMB-P6090, 137.1 mm SL, Anping Fishing Harbor, Tainan, bottom trawl, 23 Mar. 2003; NMMB-P32256, 2 specimens, 156.8–160.9 mm SL, off mouth of Tseng-Wen River, Tainan, Taiwan, 4 Apr. 1995.

Description. Counts and measurements are shown in Tables 1 and 2 and Fig. 3. Body elongated, subcylindrical, compressed posteriorly. Head slightly depressed. Snout longer than interorbital space. Eye small, embedded in anterodorsal head. Anterior nostril just behind upper lip, with short tube, reaching to or slightly over (NMMB-P32256) upper lip. Posterior nostril in front of eye, forming

oblique crest, size similar to eye diameter. Mouth terminal, forming angle of 60° with body axis, gape relatively wide; maxilla extending posteriorly to slightly in front of eye; upper lip well developed below anterior nostril, extending posteriorly with small flap-like projections; lower lip covering posteroventral margin of lower jaw, smaller than upper lip, smooth. Gill opening narrow, extending from behind posterior margin of preopercle to just below upper part of pectoral-fin base. Anus located at anterior one-third of body.

Sensory canals and pores absent. Three paired slender barbels on chin surface to lower margin of mandible; anteriormost pair on tip of chin; middle pair midway along lower jaw; posteriormost pair slightly before mouth corner. Dermal folds with single row of sensory papillae on head and body (damaged in some areas on specimens, especially NMMB-P 6090); row 14 well developed, extending slightly below row 9 (Fig. 2); row 17 comprising two transverse rows, the anterior row the longer (Fig. 2); anteriormost low lv located on antero-lateral trunk.

First and second dorsal fins connected by membrane; all first dorsal-fin spines flexible; all second dorsal-fin rays segmented; second dorsal fin continuous with caudal fin, with distinct notch between them. All anal-fin rays segmented, height subequal to second dorsal fin, continuous with caudal fin with distinct notch between them. Pectoral fin rounded, just behind gill opening, less than half length of pelvic fin; all rays segmented and branched (except upper and lowermost); free ray absent. Pelvic-fin origin below pectoral-fin base, posterior end reaching midway along trunk; spine covered with skin; all soft rays branched and segmented; fifth soft ray longest, anterior half connected by membrane to adjacent



Figure 1. Preserved specimens of *Taeniooides snyderi* from Taiwan. **A:** NMMB-P5491, male, 150.7 mm SL, Chiayi; **B:** one of NMMB-P32256, male, 156.8 mm SL, Zengwen River; **C:** one of NMMB-P32256, female, 160.9 mm SL, Zengwen River.

Table 1. Counts and measurements of *Taenioides snyderi* from Taiwan.

	NMMB-P			
	5491 Male	32256 Male	32256 Female	6090 Unknown
Standard length [mm]	150.74	156.8	160.9	137.1
Counts				
Total dorsal-fin rays	VI, 49	VI, 47	VI, 45	VI, 45
Total anal-fin rays	46	45	44	44
Pectoral-fin rays	19/17	18/17	18/17	17/19
Pelvic-fin rays	I, 5	I, 5	I, 5	I, 5
Caudal fin rays	10 + 8	9 + 8	11 + 8	—
Barbel arrangement	2-2-2	2-2-2	2-2-2	—
Teeth in upper jaw	14	16	13	10
Teeth in lower jaw	7	12	10	7
Vertebrae	10 + 21	10 + 21	10 + 21	10 + 21
P-V	3-12210/8-9	3-12210/8-9	3-12210/8-9	3-12210/8-9
AP	3	3	3	3
Measurements [%SL]				
Head length	12.9	13.6	12.5	14.1
Head depth	6.1	7.0	6.1	6.5
Head width	6.5	7.7	6.6	6.3
Snout length	3.2	3.4	3.4	4.3
Upper-jaw length	3.5	3.9	3.9	3.5
Body depth at pelvic-fin origin	7.2	6.8	6.7	6.7
Body depth	6.9	7.5	8.3	7.6
Body depth at anal-fin origin	—	7.0	7.2	6.6
Nape width	5.0	5.9	5.6	5.4
Body width at pectoral-fin base	5.4	5.7	5.3	4.7
Body width	5.2	6.3	7.6	5.1
P-A length	12.8	11.1	11.6	11.3
Preanal length	30.5	30.0	31.3	30.8
Predorsal-fin length	19.6	20.3	21.1	19.5
Preanal-fin length	32.0	31.8	34.0	33.6
Pectoral-fin length	3.4	4.5	3.6	3.9
Pelvic-fin length	13.0	12.4	12.9	13.2
Caudal-fin length	11.2	12.6	13.1	12.7
Measurements [%HL]				
Head depth	31.3	32.5	30.3	33.6
Head width	33.1	36.1	33.0	32.4
Snout length	16.4	16.0	16.8	22.3
Upper-jaw length	18.0	18.4	19.3	18.0
P-A length	65.6	51.9	57.9	58.5
Pectoral-fin length	17.4	21.2	17.7	20.0
Pelvic-fin length	66.7	58.1	64.2	68.2
Caudal-fin length	57.3	59.1	65.1	65.6

AP = Number of anal-fin pterygiophores anterior to anteriormost hemal spine.

ray; left and right fins connected by membrane; pelvic frenum present, smooth with slightly concave posterior margin; half length of longest ray fused to abdomen by

membrane; posterior margin of membrane between pelvic fin and abdomen located slightly behind anteriormost sensory papillae row lv. Caudal fin pointed, slightly shorter than pelvic fin.

Scales absent. Teeth in each jaw flat, conical, outer teeth larger than inner teeth; upper jaw with 10–16 slender outer teeth, distributed irregularly almost across entire jaw edge; lower jaw with 7–12 outer teeth (slightly longer than upper jaw teeth), distributed over slightly narrower to two-thirds width of jaw edge; inner teeth of each jaw less than one-third length of outer teeth. First hemal spine vertical. Other hemal spines slenderer than first spine, angled posteriorly. Second anal-fin pterygiophore Y-shaped.

Color in alcohol (Fig. 1). Body grayish-pink to pale pink, tail brownish. Dorsal fin light grayish-brown to grayish-brown with narrow white subtranslucent margin. Anal fin paler than dorsal fin, light grayish-brown to beige. Pectoral and pelvic fins paler than anal fin, pale beige to beige. Caudal fin darker than dorsal fin, dark yellowish-brown.

Distribution. *Taenioides snyderi* has been recorded to date only from southern Japan; Tokyo Bay to Kochi Prefecture (Pacific coast), Fukuoka Prefecture (East China Sea), Seto Inland Sea, Ariake Bay, Yatsushiro Sea, and Kagoshima Bay (Jordan and Hubbs 1925; Kurita and Yoshino 2012; Koreeda and Motomura 2021). The presently reported specimens, from the western coast of Taiwan, represent the first record outside of Japanese waters.

Remarks. Identification of examined specimens was based on the following combination of characters, which closely matched the diagnostic features of *Taenioides snyderi* given by Kurita and Yoshino (2012), Murdy (2018), Kanagawa et al. (2018), and Koreeda and Motomura (2021): total dorsal-fin rays 51–55, total anal-fin rays 44–46, pectoral-fin rays 17–19, vertebrae 10 + 21 = 31, barbel arrangement 2-2-2, sensory papillae row 14 developed and extending just below row 9, row 17 comprising two transverse rows, pelvic-fin base fused to the abdomen by a membrane to anteriormost sensory papillae row lv (half-length of pelvic fin), and brownish second dorsal fin with narrow white subtranslucent margin.

The pelvic-fin posterior end to anus (P-A) length/head length of the Taiwanese specimens of *T. snyderi* was less than 65.6%, being slightly shorter than in

Table 2. Comparison of *Taenioides snyderi* from Japan and Taiwan, and *T. anguillaris*.

Species	Locality	Total dorsal-fin rays										Pectoral-fin rays				
		47	48	49	50	51	52	53	54	55	56	16	17	18	19	20
<i>T. snyderi</i>	SJ					5	6	14	19	13	4		11	29	24	2
<i>T. snyderi</i>	T					2		1		1			1 (3)	2 (0)	1 (1)	
<i>T. anguillaris</i>	J-Ch	1	1	4	3	2						2	9	2		
		Anal-fin rays										Total vertebrae				
		40	41	42	43	44	45	46	47	48	49	29	30	31	32	
<i>T. snyderi</i>	SJ				1	6	13	16	19	5	3			7	51	
<i>T. snyderi</i>	T					2	1	1						4		
<i>T. anguillaris</i>	J-Ch	1	2	2	4	2		1				10	2			

SJ = southern Japan, T = Taiwan, J-Ch = Japan and China; Meristic data (except for Taiwanese specimens) from Kurita and Yoshino (2012), Koreeda and Motomura (2021), and Miyahira and Tachihara (2022); data for paralectotype of *T. snyderi* and holotype of *T. anguillaris* (indicated by **bold font**) also from Murdy (2018). Counts of pectoral fins on the right side of Taiwanese specimens are shown in parentheses.

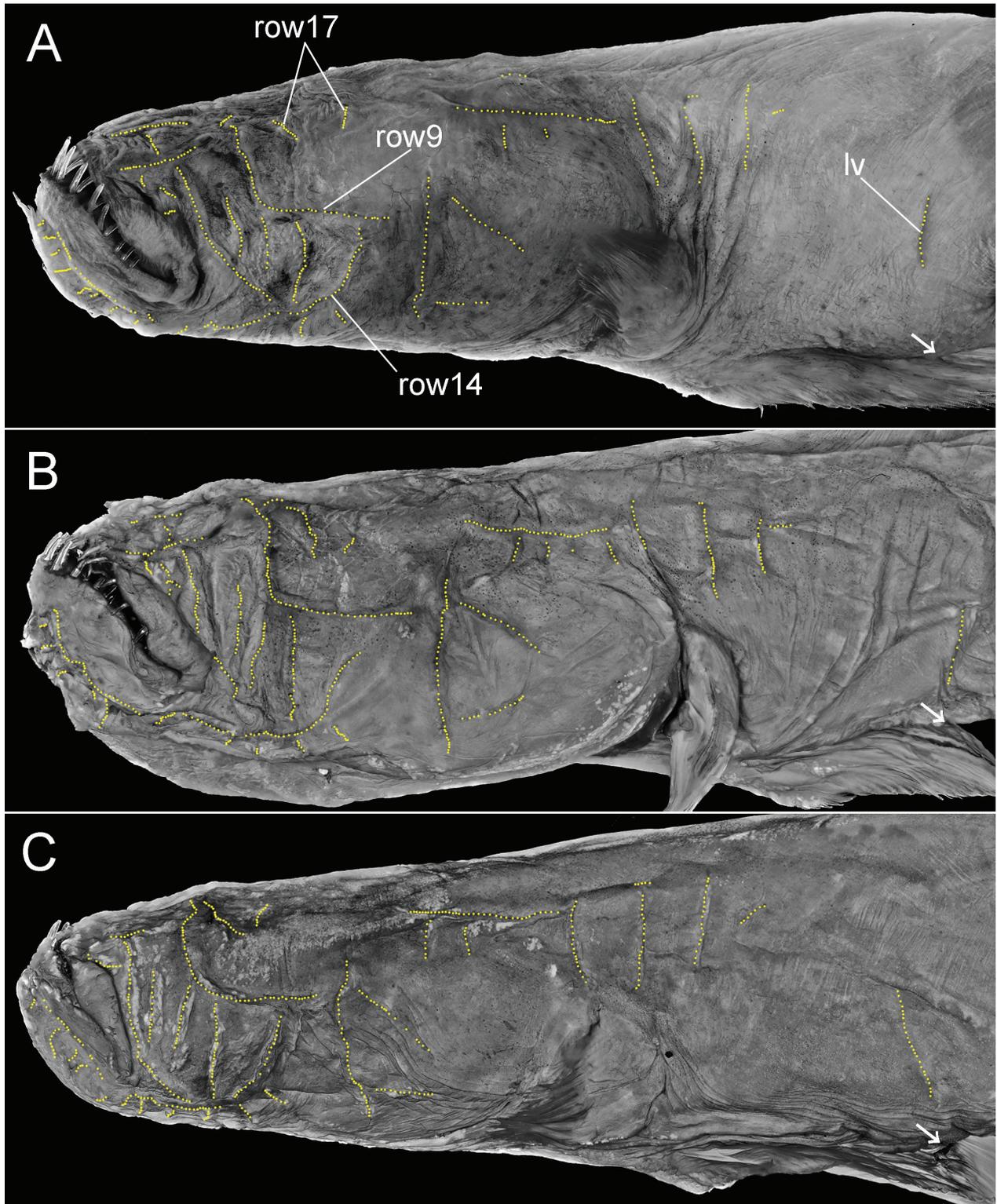


Figure 2. Head view of *Taenioides snyderi* from Taiwan, showing sensory papillae rows on the dermal fold (individual papillae indicated by yellow spots). White arrows indicate posterior end of pelvic-fin base. **A:** NMMB-P5491, 150.7 mm SL, Chiayi; **B:** one of NMMB-P32256, 156.8 mm SL, Zengwen River; **C:** one of NMMB-P32256, 160.9 mm SL, Zengwen River.

Japanese specimens (Fig. 3). The proportion is variable depending on the degree of fusion of the pelvic fin to the abdomen. Koreeda and Motomura (2021) reported that the pelvic-fin base of *T. snyderi* from southern Japan was strongly fused to the abdomen by a membrane,

the posterior end of the base being located below the anteriormost sensory papillae row IV. In the Taiwanese specimens, the pelvic-fin base fusion extended slightly behind the anteriormost row IV. The significance of this difference remains unclear.

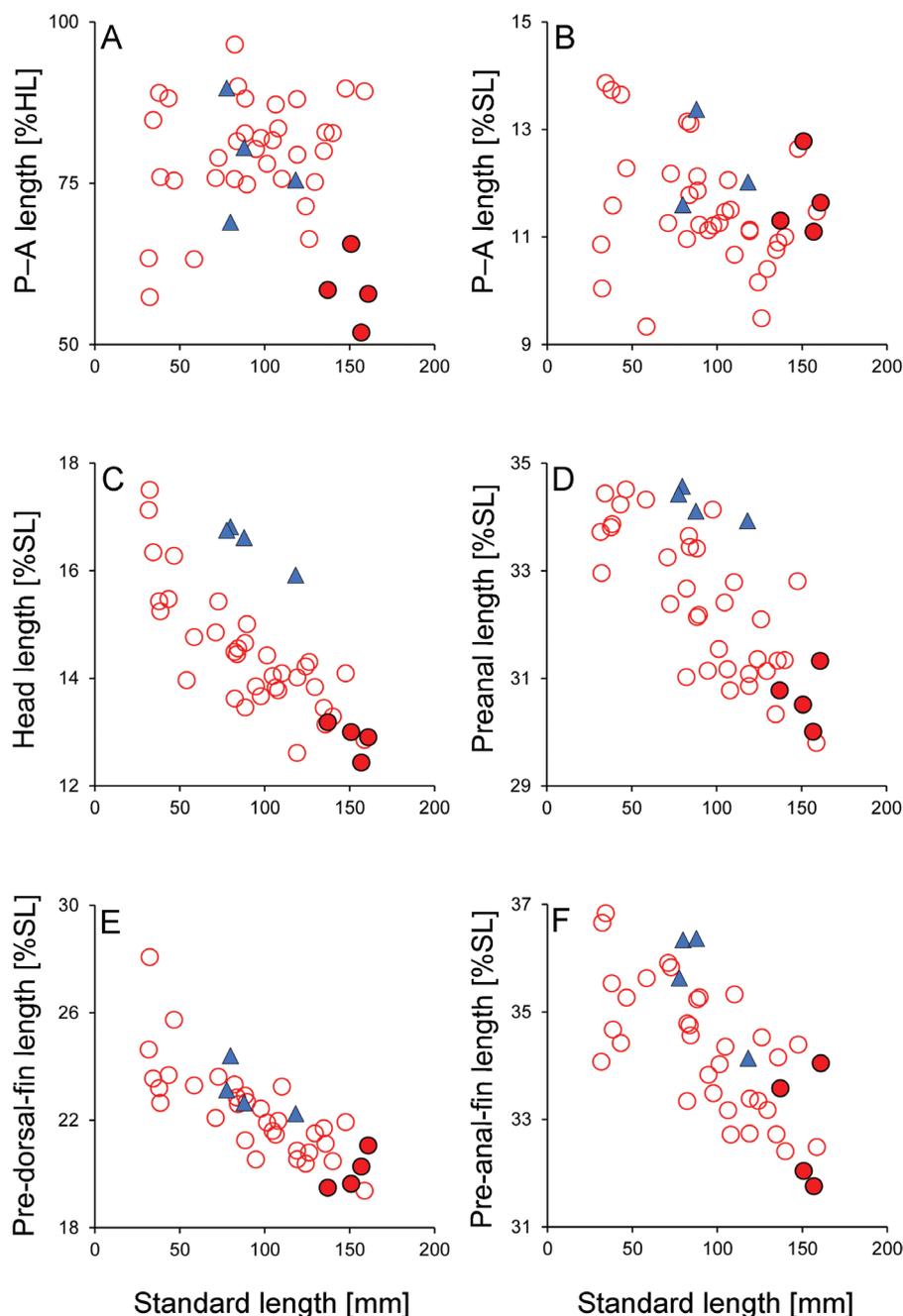


Figure 3. Relations of P–A length (A), as % of head length (mm), and P–A length (B), head length (C), Pre-anal length (D), pre-dorsal-fin length (E), and preanal-fin length (F) as % of standard length [mm] of *Taenioides anguillaris* and *T. snyderi*. Closed red circles: *Taenioides snyderi* (Taiwan); open red circles: *T. snyderi* (Japan); blue triangles: *T. anguillaris* (Japan). Data for *T. anguillaris* and *T. snyderi* from Koreeda and Motomura (2021) and Miyahira and Tachihara (2022).

Discussion

Although Koreeda and Motomura (2021) reported that *Taenioides snyderi* had been recorded only from Japan, they suggested that the species may have a wider distribution. Kurita and Yoshino (2012) reported four species of *Taenioides* from Japanese waters, based on partial sequences of the mitochondrial ND 2 and 16S rRNA genes, their *Taenioides* sp. A, *Taenioides* sp. B, *Taenioides* sp. C, and *Taenioides* sp. D which they deduced as possibly being *T. anguillaris*, *T. snyderi*, *T. gracilis*, and *T. kentalleni*,

respectively. Subsequently, Chen and Wen (2016) reported the complete mitochondrial genome of *Taenioides cirratus* (Blyth, 1860) from Chiku Lagoon, Tainan, Taiwan, and Wei et al. (2015) reported the complete mitochondrial genome of *T. anguillaris* from Xinghua Bay, Fujian Province, China. Koreeda and Motomura (2021) noted that *T. cirratus* of Chen and Wen (2016) and *T. anguillaris* of Wei et al. (2015) were included in the clade of *Taenioides* sp. B proposed by Kurita and Yoshino (2012), following Murdy's (2018) identification of *Taenioides* sp. B sensu Kurita and Yoshino (2012) as *T. snyderi*. This study has

confirmed, on the basis of morphological characters, that *T. snyderi* occurs in Taiwanese waters.

Taenioides anguillaris is known to have head length longer than the pelvic-fin posterior end to anus (P–A) length (e.g., Shen and Wu 2011). However, Koreeda and Motomura (2021) and the presently reported study found that *T. anguillaris* and *T. snyderi* shared that character, and consequently the record of *T. anguillaris* in Taiwan cannot be confirmed, pending examination of additional specimens. Although *T. anguillaris* is very similar to *T. snyderi* in sharing 3 paired barbels on the chin, a well-developed sensory papillae row 14 reaching closely below row 9, row 17 comprising two transverse dermal folds bearing sensory papillae, and a dark purple to reddish-brown body, it differs in the following: total dorsal-fin rays 48–51 (51–56 in *T. snyderi*), total anal-fin rays 41–46 (43–49), pectoral-fin rays 16–18 (17–20), vertebrae 29 or 30 (31 or 32), the posterior end of the fused pelvic fin base well forward of the anteriormost sensory papillae row lv (approximately level with or slightly

behind anteriormost row lv) (Kurita and Yoshino 2012; Murdy 2018; Koreeda and Motomura 2021; this study: Figs. 2–3).

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