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RESEARCH PAPER

A new luminous roughy fish from northeastern Taiwan, with comments on congeners in Taiwan (Trachichthyidae: *Aulotrachichthys*)

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Abstract. A new species of the luminous roughy fish genus *Aulotrachichthys* is described based on a single specimen collected from northeastern Taiwan. It differs from congeners in having the combination of characters: striated area on the caudal peduncle extending posteriorly, slightly beyond the middle point on the caudal peduncle, its length 66.7% caudal-peduncle length; a black vertical line on caudal-fin base; an overall dark-brown colouration, with isthmus, chest, abdominal scutes black; dorsal-fin elements V, 13; anal-fin spines III; lateral-scale rows 58; rakers on first gill arch 6 + 1 + 14 = 21; a rather slender body; a proportionally shorter trunk, distance between dorsal- and anal-fin origins, dorsal fin, pectoral fin, forehead, snout, and both upper and lower jaws; a proportionally longer preanal length, postdorsal length, and striated area. DNA-barcoding analysis revealed that the new species is clustered within *Aulotrachichthys prosthemius* and *A. latus*. The identity of *A. sajademalensis* from Taiwan is also discussed after a thorough examination of the fish collections of Taiwan. Moreover, we suggested that *A. sajademalensis* is restricted to the western Indian Ocean and, therefore, should be excluded from the ichthyofauna of Taiwan due to the misidentification of literature records and the absence of voucher specimens.

Key words: Actinopterygii, Trachichthyiformes, ichthyology, DNA barcoding, taxonomy

Introduction

The luminous roughy fish genus *Aulotrachichthys* Fowler, 1938 belongs to the family Trachichthyidae. *Aulotrachichthys* is characterized by having a rather slender body, body height at dorsal-fin origin < 40% standard length; its anus situated between pelvic-fin bases, and with a perianal bacterial bioluminescent organ; its body with a pair of silvery striated areas (tissue) along ventral-lateral side (Fig. 1); cycloid scales present between lateral line and pectoral-fin base; three to eight dorsal-fin spines; and six pelvic-

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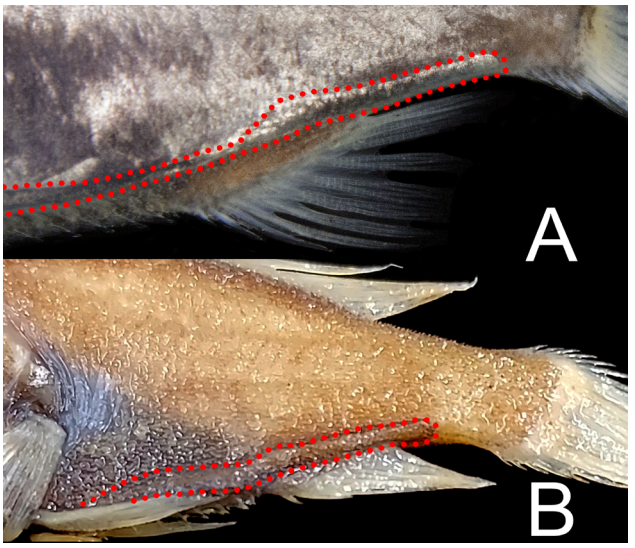

Fig. 1. Striated area (outlined by red dots) of *Aulotrachichthys* spp. A) *A. prosthemius* (Jordan & Fowler, 1902), NMMB-P37171, 1 of 19, 72.3 mm SL, preserved. B) *A. latus* (Fowler, 1938), ASIZP068110, 44.0 mm SL, preserved.

fin soft rays (Gomon & Kuiter 1987, Kotlyar 1996, Ghedotti et al. 2021, Matsunuma et al. 2023).

Although *Aulotrachichthys* was initially established as a subgenus of *Paratrachichthys* by Fowler (1938), Gomon & Kuiter (1987) elevated it to a valid genus due to the presence of striated areas, a character shared with *Sorosicthys* but not *Paratrachichthys*. A recent phylogenetic and anatomic study conducted by Ghedotti et al. (2021) showed that although not well-supported, *Aulotrachichthys* formed a monophyletic clade and is a sister clade with *Sorosichthys* and together formed a sister clade of *Paratrachichthys*. Moreover, they found that the structure of the light organ is different between *Aulotrachichthys* and *Paratrachichthys*. Together with the diagnostic characters provided by Kotlyar (1996), ten species are placed under *Aulotrachichthys*, including *A. argyrophanus* (Woods, 1961), *A. atlanticus* (Menezes, 1971), *A. heptalepis* (Gon, 1984), *A. latus* (Fowler, 1938), *A. novazelandicus* (Kotlyar, 1980), *A. prosthemius* (Jordan & Fowler, 1902), *A. pulsator* (Gomon & Kuiter, 1987), *A. sajademalensis* (Kotlyar, 1979), *A. spiralis* Matsunuma et al., 2023, and *A. titan* Matsunuma et al., 2023. Among them, only *A. prosthemius* and *A. sajademalensis* have been documented in the ichthyofauna of Taiwan (Shen & Wu 2011).

During a taxonomic review of Trachichthyidae around Taiwanese waters, we found a distinct specimen of *Aulotrachichthys* collected from northeastern Taiwan. It can be separated from all other congeners by having different colouration, meristic and morphometric characters. In addition, a DNA barcoding analysis supports the genetic difference of the new species from its three congeners. Moreover, the record of *A. sajademalensis* in Taiwan is also discussed after a thorough examination of specimens deposited in the fish collections of Taiwan.

Material and Methods

Morphological analysis

Specimens were photographed, fixed in 4% formaldehyde, and transferred to 70% ethanol or 50% isopropanol for permanent preservation. Specimens were deposited at Academia Sinica, Biodiversity Research Center, Taipei, Taiwan (ASIZP), and the Pisces collection of the National Museum of Marine Biology and Aquarium, Taiwan (NMMB-P).

Table 1. COI sequences of Trachichthyidae used for genetic analysis in this study. Sequences marked with asterisks * were those generated for this study, and others were retrieved from Genbank (Benson et al. 2012) or BOLD system (Ratnasingham & Hebert 2007).

Species	Accession numbers
Aulotrachichthys nyx sp. nov.	*TFDOT001-23
Aulotrachichthys latus	*OQ213904-OQ213905
Aulotrachichthys novazelandicus	AMSF163-09, FOAK279-10, FOAO184-14
Aulotrachichthys prosthemius	DQ648438.1, FTW176-09, FTW643-09, KU943263.1, KU943264.1, KU943265.1, *OQ213906-OQ213926
Paratrachichthys trailli	EF609430.1, FMVIC412-08, FNZ102-06, FNZ521-06, FNZ522-06, FNZ523-06, FOA320-04, FOA321-04, FOA322-04, FOA323-04, FOA324-04, FOAO2266-20, FOAP306-17, FOAQ387-21
Sorosichthys ananassa	FOAK674-10, FOAO276-14, SAFS057-18
Trachichthys australis	AMS364-08, FMVIC413-08

Terminology and methodology follow Su et al. (2022), except for the following: the second urostyle was included in the count of caudal vertebrae; lateral-scale rows were counted horizontally from the posterior end of opercle to the caudal-fin base; the caudal-peduncle length was measured between the vertical of anal-fin base and caudal-fin base; the length between the end of the anal-fin base to the end of the striated area (A-SA), and the length between the end of the striated area to caudal-fin base (SA-C) were measured additionally. Terminology and definitions of head bones follow Matsunuma et al. (2023).

The number of vertebrae was determined from radiographs taken by a digital radiograph machine set up in the National Museum of Marine Biology and Aquarium. All measurements were taken from point to point using 150 mm digital callipers to the nearest 0.1 mm. Morphometric data were expressed as percentages or ratios of standard length (SL) and/or head length (HL), except where otherwise indicated. Comparison data with congeners are adopted from Gon (1984), Gomon & Kuiter (1987), Kotlyar (1996), and Matsunuma et al. (2023), except for those taken by us.

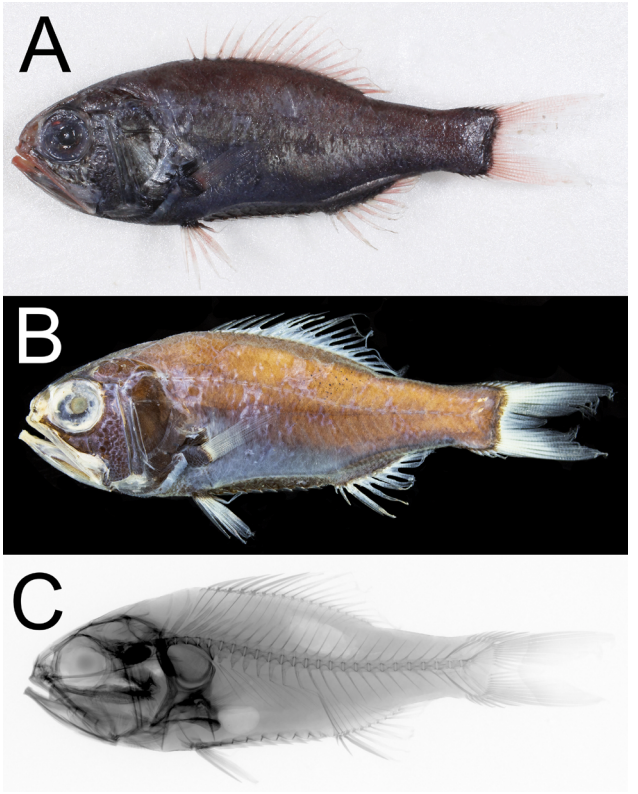

Fig. 2. *Aulotrachichthys nyx* sp. nov., ASIZP080537, holotype, 82.5 mm SL. A) Fresh condition. Photo P.-L. Lin. B) Preserved condition in 70% ethanol. C) X-radiograph.

Genetic analysis

Prior to fixation in 4% formaldehyde, a piece of tissue was removed from the right side of the specimen and fixed in 95% ethanol at room temperature. DNA extraction method followed the protocol of the Tissue & Cell Genomic DNA Purification Kit (Biokit). Fragments of mitochondrial cytochrome c oxidase subunit I gene (COI) were then amplified and sequenced using the primer pair FishF1

Table 2. Selected meristic characters of *Aulotrachichthys nyx* sp. nov., *A. prosthemius* (Jordan & Fowler, 1902), and *A. sajademalensis* (Kotlyar, 1979). Paired-fin characters were presented as left/right whenever available. Data were retrieved from Kotlyar (1996) for comparison. Abbreviations: HT – holotype; NT – non-type.

	A. nyx sp. nov.	*A. prosthemius*		*A. sajademalensis*
Data source	This study	This study	Kotlyar (1996)	Kotlyar (1996)
	HT	NT (n = 46)	NT	HT; NT (n = 20)
Dorsal-fin elements	V, 13	V-VI, 12-13	V-VI, 13-14	V, 13-14
Pectoral-fin elements	12/12	12-13	12-13	11-13
Anal-fin elements	III, 8	III, 8	III, 8-9	III, 8-10
Gill rakers	6 + 1 + 14 = 21	5-6 + 1 + 11-14 = 18-21	6 + 1 + 13-14 = 20-21	5-7 + 1 + 11-14 = 18-21
Pseudobranchial filaments	22	15-21	N/A	N/A
Lateral-line scales	28	28-31	26	26-30
Lateral-scale rows	58	51-59	49-54	58-74 (usually > 60)
Abdominal scutes	9	8-11	9-10	8-11
Vertebrae	13 + 14 = 27	12-14 + 13-14 = 25-27 (modally 13 + 14 = 27; n = 61)	13 + 14 = 27	13 + 13-14 = 26-27

(5′-TCAACCAACCACAAAGACATTGGCAC-3′) and FishR1 (5′-TAGACTTCTGGGTGGCCAAAGAATCA-3′), published by Ward et al. (2005).

The COI sequence of the holotype of *Aulotrachichthys nyx* sp. nov. was provided by The Fish Database of Taiwan (Shao 2022) and submitted to the Barcode of Life Data System (BOLD) (Ratnasingham & Hebert 2007) under permission, with accession number: TFDOT001-23 (Table 1). Sequences of congeners generated in this study were submitted to Genbank with accession numbers: OQ213904-OQ213926 (Table 1). Other sequences of *Aulotrachichthys*, *Paratrachichthys*, and *Sorosichthys* that are available on Genbank (Benson et al. 2012) and the BOLD System were downloaded, with additional sequences of *Trachichthys australis* selected as the outgroup. All sequences were aligned by ClustalW (Thompson et al. 1994) using the default settings in Geneious v.8.1.9 (Kearse et al. 2012), and trimmed to 655 base pairs before analysis.

Model test implemented in the software MEGAX (Kumar et al. 2018) was conducted to find the best nucleotide substitution model with the lowest BIC (Bayesian Information Criterion) score. The selected model was then applied to reconstruct the maximum-likelihood (ML) tree with 1,000 bootstrap pseudoreplicates in MEGAX. Inter-specific genetic distances were calculated with the Kimura-2-Parameter (K2P) model (Kimura 1980).

Results

Family Trachichthyidae

Aulotrachichthys Fowler, 1938

Aulotrachichthys Fowler, 1938: 40 (originally described as a subgenus of *Paratrachichthys*. Type species: *Paratrachichthys latus* Fowler, 1938).

Aulotrachichthys nyx sp. nov.
New English name: dark-night luminous roughy
New Chinese name: 暗夜管燧鯛
Figs. 2-5, Tables 1-5

Holotype: ASIZP080537, 82.5 mm SL, off Yilan, Northeast Taiwan, 24°21′0.05′′ N, 122°09′0.02′′ E, 195-200 m, 31 March 2016, deep-line fishing, collected by S.-J. Pai; tissue number: ASIZP0917465; Bold System number: TFDOT001-23.

Etymology: This species is named after Nyx, the Greek goddess of night, in reference to its overall darker appearance than its congeners. The name is treated as a noun in apposition.

Diagnosis: A species of *Aulotrachichthys* that differs from congeners in having the following combination of characters: striated area extending posteriorly, slightly beyond the middle point on the caudal peduncle, its length 66.7% caudal-peduncle length; dorsal-fin elements V, 13; anal-fin spines III; gill rakers on first gill arch 6 + 1 + 14 = 21; abdominal scutes 9; lateral-scale rows 58; body height 34.1% SL; pelvic-fin-anal-fin length 30.3% SL; forehead height 2 4.1% SL; pectoral-fin length 18.1% SL; dorsal-fin-anal-fin length 42.6% SL; dorsal-fin length 35.3% SL; postdorsal length 29.6% SL; A-SA length 12.4% SL; an overall dark-brown body colouration, with chest, isthmus, and abdominal scutes uniformly black; and a distinct black vertical line along caudal-fin base.

Description: Meristic and morphometric data are provided in Tables 2-3 and 5. Dorsal-fin elements V, 13; pectoral-fin elements 12 (left)/12 (right), upper and lowermost two rays unbranched, others branched; pelvic-fin elements I, 6; anal-fin elements III, 8; principal caudal-fin rays 10 + 9, uppermost and lowermost rays unbranched; procurrent caudal-fin rays 7 and 6 on upper and lower lobe, respectively; rakers on outer face of first gill arch 6 + 1 + 14 = 21; pseudobranchial filaments 22; lateral-line scales 28; scale rows above lateral line 10; scale rows below lateral line 18; lateral-scale rows 58; abdominal scutes 9; vertebrae 13 + 14 = 27; branchiostegal rays 8; supraneural and pterygiophore insertion formula 0/0/1 + 1/1/1/1 (spinous dorsal fin only).

Body oval, slender, depth at dorsal-fin origin 2.9 in SL. Head small, length 2.9 in SL, its height distinctly smaller than its length, 1.3 in HL; upper profile of head straight, gently curved to dorsal-fin origin; forehead convex and narrow, forehead height 1 (HF1) 21.3 and forehead height 2 (HF2) 8.6 in HL; eyes moderate, width 2.9 in HL; snout convex and short, not extending before premaxilla, length 7.5 in HL; interorbital space broad, width 3.8 in HL; postorbital length 1.8 in HL.

Mouth large, upper-jaw length 1.7 in HL; posterior end of maxilla reaching to vertical through posterior margin of eye; lower-jaw length larger than upper-jaw length, 1.5 in HL. Two nostrils, situated right before anterior margin of eye, are above horizontal through centre of eye; posterior nostril is much larger than anterior nostril. Symphysis of premaxillae notched and naked, without any teeth. Symphysis

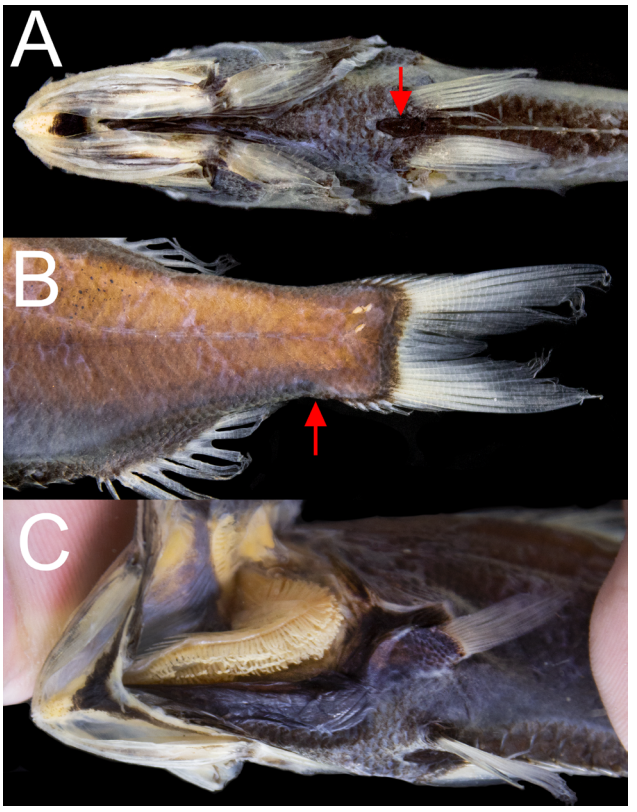

Fig. 3. Close-up images of *Aulotrachichthys nyx* sp. nov., ASIZP080537, holotype, 82.5 mm SL, preserved, showing A) The position of light organ (arrowed) and colouration of ventral side. B) The end of striated area (arrowed) and colouration of caudal-fin base. C) Colouration of branchial chamber and adjacent region.

of dentaries with small blunt knob and naked. Supramaxilla single, with long needle-like process extending anteriorly and rectangular posteriorly; posterior portion covering about half of posterior portion of maxilla. Premaxilla and dentary covered with villiform teeth on lateral and medial surfaces. Palatine with narrow band of teeth; vomer with nine teeth, forming oval patch. Preopercular spine very short, its tip very near posterior margin of interopercle.

Crests on head bones well developed. Interorbital ridge with 20 and 32 serrae on anterior portion and posterior portion, respectively. Posterior interorbital ridge separated posteriorly and becomes gradually wider posteriorly. Posttemporal crest bearing one distinct central spine; posterior margin of crest pointed. Ventral face of dentary and angular with three and two ridges, respectively; all ridges serrated.

Gill rakers rod-shaped, somewhat laterally compressed, covered with small conical teeth on tips and inner surfaces; rakers on outer row of first arch longer than rest, longest gill raker 1.8 in eye diameter; on outer row of second arch slightly shorter than those on outer row of first arch; on inner row of first and second arch short; and on inner and outer rows of third arch and outer row of fourth arch forming bumps. Large, somewhat triangular villiform tooth patch present on fifth ceratobranchial. Large, oval villiform tooth patch on second pharyngeal arch and third hypobranchial. Large, tear-shaped villiform tooth patch on third pharyngeal arch. Gill filaments at angle of first arch short, longest length 5.2 in eye diameter, or 1.5 in length of longest pseudobranchial filament.

Body scales firmly attached, scales on body covered with short ctenii, except for those on pectoral-fin region cycloid; gular region and isthmus naked, without any scales; lateral-line scales same size as adjacent body scales; centre of each lateral-line scale without distinct spine but forming small ridge; enlarged, serrated scales forming scutes on abdomen between pelvic-fin base and anal-fin origin, their bases covered with one or two rows of small scales, all scutes with single tip.

Dorsal fin with short base, length of dorsal-fin base 2.8 in SL; fin spines progressively longer posteriorly; all rays branched except for anteriormost one; outer margin of dorsal-fin soft rays nearly straight. Pectoral fin short, its length 1.9 in HL, tip slightly pointed, reaching about midline of pelvic-fin and anal-fin origins. Pelvic fin short, its length 2.0 in HL, tip reaching fifth abdominal scute. Outer margin of anal-fin soft rays nearly straight. Caudal fin moderate, deeply forked, its length 1.3 in HL. All fin spines smooth, unserrated.

Lateral line single, originating slightly below postemporal spine; its anterior portion slightly curved, with nearly straight posterior portion ending at caudal-fin base. Anus situated anteriorly, located between pelvic-fin bases. Light organ present, oval, surrounding anus, its length about three times its width (Fig. 3A). Striated area (tissue) present, starting from origin of abdominal scutes, running along lateral-ventral side of the body, above base of abdominal scutes, to caudal peduncle; its end exceeds beyond middle of caudal peduncle (Fig. 3B), length on caudal peduncle 66.7% caudal-peduncle length. Caudal peduncle moderately stout, its height 2.9 of HL; its length rather long, length 1.9 in HL, postdorsal length 1.2 in HL and postanal length 1.7 in HL.

Colouration: When fresh (Fig. 2A), body dark brown, slightly reddish, and abdominal region darker. All fins, snout, premaxilla, and anterior portion of dentary

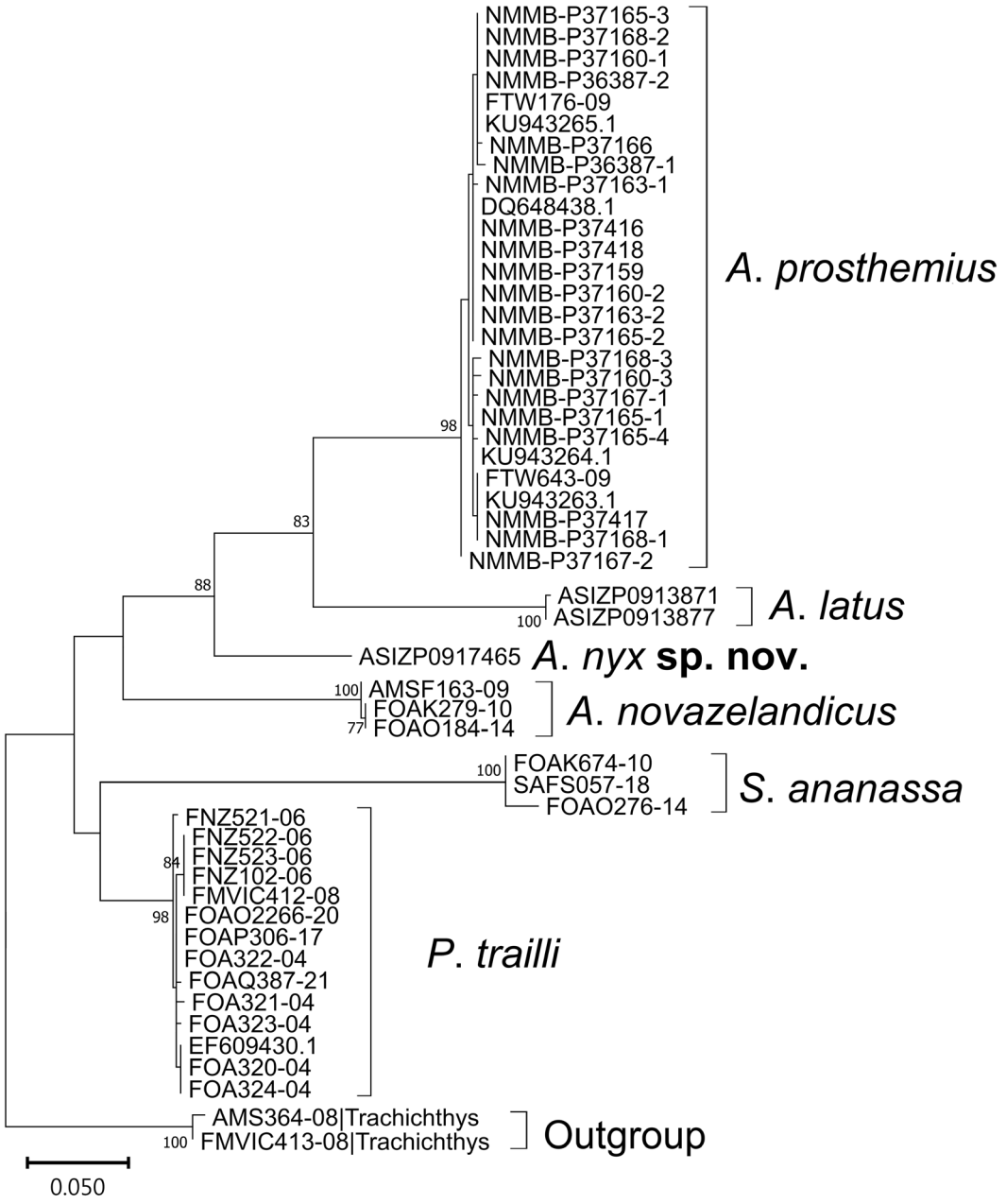

Fig. 4. Maximum-likelihood tree based on COI sequences of *Aulotrachichthys*, *Paratrachichthys*, and *Sorosicthys* generated by HKY model (Hasegawa et al. 1985) with 1,000 bootstrap pseudoreplicates, and *Trachichthys australis* selected as the outgroup. Numbers beside each node denote bootstrap values, with values < 75% neglected. Scale bar at bottom-left corner represents the number of substitutions per unit length on the tree.

reddish. Caudal-fin base, including the procurrent rays, covered with dark pigments forming a broad black vertical line. Striated area on abdomen silvery white. When preserved in 70% ethanol (Fig. 2B), body brownish, somewhat paler than fresh. Dorsal-, anal-, and pectoral-fin bases somewhat darker and caudal fin-base, including the procurrent rays, with a distinct black vertical line (Fig. 3B). All fins pale. Oral cavity, including underside of tongue whitish with scattered black pigmentation. Branchial chamber, isthmus, abdominal scutes, exposed portion of cleithrum, branchiostegal rays and chest uniformly black (Figs. 3A, C); gill arches uniformly white; inner surface of preopercle dusky, whereas inner side of opercle black. Anterior portion of striated area slightly darker than body colour, becoming darker along anal-fin base posteriorly.

Distribution: Only known from the holotype collected from northeastern Taiwan, at depth 195-200 m.

Genetic analysis: Hasegawa-Kishino-Yano (HKY) model (Hasegawa et al. 1985) with gamma distribution was selected as the best model. The ML tree reconstructed based on COI sequences (Fig. 3) strongly supports the monophyly of species with more than one sequence sampled. However, species- and higher-level interrelationships are only partially

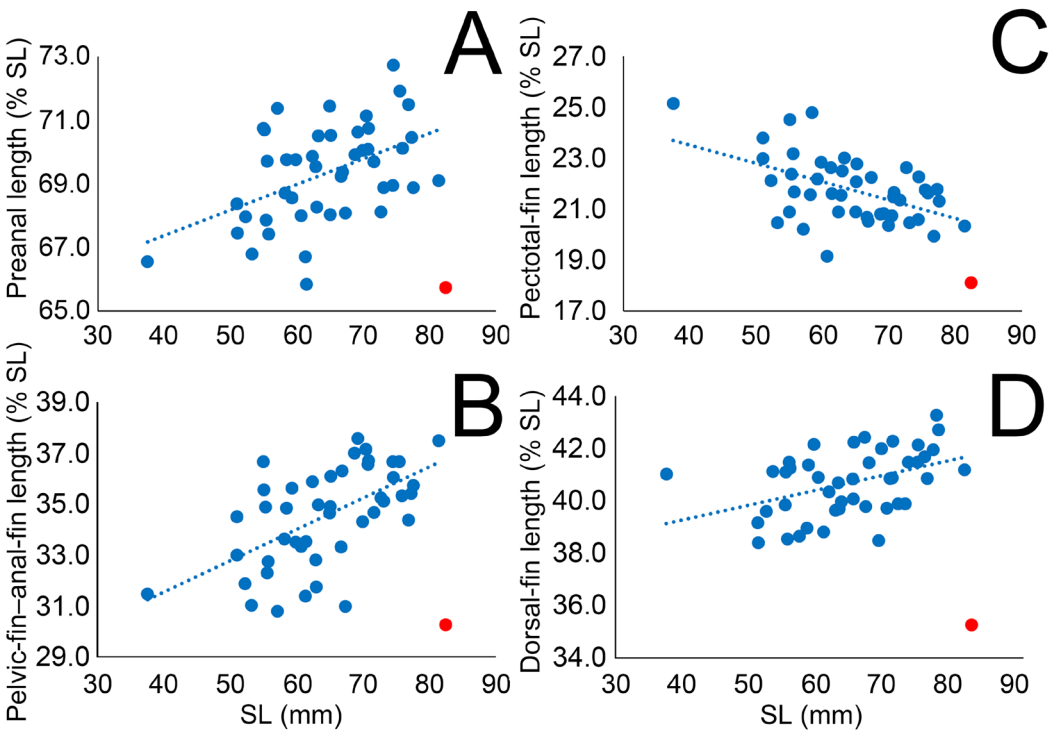

Fig. 5. Allometric growth observed in *Aulotrachichthys prosthemius* (Jordan & Fowler, 1902; blue), with a comparison of *A. nyx* sp. nov. (red). A) Preanal length (% SL *vs.* SL). B) Pelvic-fin-anal-fin (% SL *vs.* SL). C) Pectoral-fin length (% SL *vs.* SL). D) Dorsal-fin base length (% SL *vs.* SL).

Table 3. Morphometric characters of three *Aulotrachichthys* species. Abbreviations: A – anal-fin; C – caudal-fin; D – dorsal-fin; GR – gill raker; HF – forehead height; HT – holotype; NT – non-type; P – pectoral-fin; SA – striated area. Data of *A. sajademalensis* were retrieved from Kotlyar (1996).

	A. nyx sp. nov.	*A. prosthemius*		*A. sajademalensis*	
Locality	HT	NT (n = 45)		HT; NT (n = 18)	NT (n = 2)
	Taiwan	Taiwan		West Indian Ocean	Kyushu-Palau Ridge
SL (mm)	82.5	37.5-81.4		60-96	92-99
% SL		Mean (range)	SD	Range	Range
HL	34.9	36.5 (34.4-40.2)	1.2	30.8-39.5	35.9-36.4
Head depth	26.7	29.2 (26.3-33.2)	1.6	29.9-33.4	29.9-31.3
Predorsal length	41.6	41.6 (39.0-46.6)	1.4	40.6-45.0	39.4-41.3
Prepectoral length	37.4	36.7 (34.4-41.5)	1.3	37.2-42.6	35.9-37.4
Prepelvic length	37.7	38.0 (33.2-41.0)	1.4	37.0-44.8	37.5-40.4
Preanal length	65.7	69.3 (65.8-72.7)	1.5	63.2-73.0	67.6-70.7
Snout length	4.7	5.2 (4.4-5.9)	0.4	6.2-10.0	7.1-7.6
Eye diameter	12.0	13.0 (11.4-16.4)	0.8	10.0-12.5	9.5-11.1
Interorbital length	9.3	10.6 (9.2-12.2)	0.6	8.3-10.6	9.1-9.8
Upper-jaw length	20.8	22.2 (17.7-26.8)	1.4	22.8-25.8	21.7-22.2
Lower-jaw length	22.9	23.5 (22.0-26.0)	1.0	23.9-27.9	24.2-25.0
HF1	1.6	2.3 (1.6-3.7)	0.5	0.7-3.3	1.0-1.6
HF2	4.1	4.9 (4.2-5.7)	0.4	-	-
Postorbital length	19.2	19.1 (16.7-21.2)	0.9	13.6-18.7	19.0-20.2

Table 3. continued

Locality	*A. nyx* sp. nov.	*A. prosthemius*		*A. sajademalensis*	
	HT	NT (n = 45)		HT; NT (n = 18)	NT (n = 2)
	Taiwan	Taiwan		West Indian Ocean	Kyushu-Palau Ridge
P length	18.1	21.8 (19.1-25.2)	1.3	19.8-23.9	22.7-22.8
D-P length	26.1	26.9 (23.7-30.0)	1.3	-	-
D-V length	34.8	37.1 (34.2-40.2)	1.2	-	-
Body height	34.1	37.5 (35.3-40.5)	1.1	33.8-38.1	33.2-36.4
V length	17.5	20.8 (17.3-23.9)	1.5	16.3-24.3	18.2-18.5
V spine length	13.0	14.7 (11.6-17.3)	1.3	-	-
P-V length	8.5	8.5 (6.9-10.0)	0.7	4.7-8.5	8.1-8.7
D-A length	42.6	46.8 (43.0-50.7)	1.8	-	-
V-A length	30.3	34.6 (30.8-37.6)	1.9	29.6-37.7	34.8-37.4
D length	35.3	40.7 (38.4-43.3)	1.2	31.3-40.6	39.4-41.3
D height	19.3	20.5 (16.5-20.7)	1.6	-	-
1st D spine length	7.6	7.1 (5.2-9.1)	0.9	-	-
2nd D spine length	8.9	9.3 (7.3-11.8)	0.9	-	-
Last D spine length	12.0	12.5 (9.5-15.4)	1.4	-	-
A length	16.6	15.2 (13.5-17.5)	0.9	11.4-16.9	15.8-16.2
A height	N/A	16.1 (13.1-18.7)	1.4	-	-
3rd A spine length	12.3	10.8 (6.2-13.4)	1.5	-	-
Postanal length	21.1	19.8 (16.7-21.4)	1.1	-	-
Postdorsal length	29.6	25.5 (22.9-27.6)	0.9	-	-
Caudal-peduncle length	18.6	-	-	17.1-22.9	16.7-17.9
Caudal-peduncle height	11.9	12.9 (11.6-14.5)	0.7	10.0-12.3	12.5-13.1
C length	27.6	30.0 (26.2-32.9)	1.7	-	-
End of A-end of SA	12.4	10.6 (7.8-12.2)	0.8	-	-
End of SA-C base	8.8	9.0 (7.0-11.0)	0.7	-	-
Longest GR	6.6	7.5(5.5-13.6)	1.2	-	-
% HL		Mean (range)	SD	Range	Range
Head depth	76.5	80.1 (74.0-88.5)	3.8	82.8-100.0	83.3-86.1
Snout length	13.4	14.2 (12.0-16.8)	1.0	18.0-29.3	19.7-20.8
Eye diameter	34.3	35.5 (32.3-40.8)	1.7	28.0-37.5	28.8-30.6
Interorbital length	26.6	29.0 (26.4-33.1)	1.4	25.0-33.4	25.0-27.3
Upper-jaw length	59.7	60.8 (49.5-66.8)	3.1	62.6-78.9	60.6-61.1
Lower-jaw length	65.8	64.4 (60.7-68.4)	2.0	65.5-84.2	66.7-69.7
HF1	4.7	6.3 (4.3-9.9)	1.2	2.0-10.5	2.8-4.5
HF2	11.7	13.4 (11.3-15.7)	1.1	-	-
Postorbital length	55.0	52.4 (48.7-59.0)	2.1	-	-

Table 4. Average pairwise COI genetic distances calculated with Kimura-2-parameter model (Kimura 1980). Number in the first row corresponds to the number in the first column. Values are in percentage (%).

	n	1	2	3	4	5	6
1. *A. nyx* sp. nov.	1	0	14.0	11.5	12.5	11.0	16.9
2. *A. latus*	2	-	0.2	12.1	15.1	11.5	18.3
3. *A. prosthemius*	27	-	-	0.4	15.6	14.4	18.0
4. *A. novazelandicus*	3	-	-	-	0.2	11.8	15.2
5. *P. trailli*	14	-	-	-	-	0.4	13.9
6. *S. ananassa*	3	-	-	-	-	-	1.0

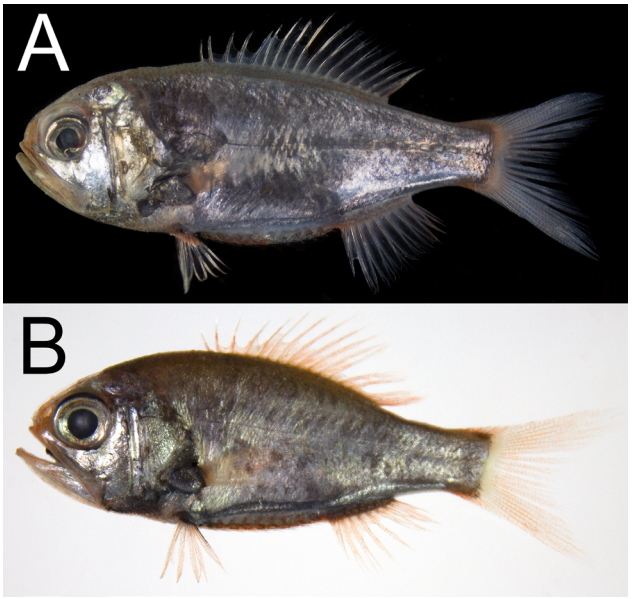

Fig. 6. Fresh specimens of *Aulotrachichthys prosthemius* (Jordan & Fowler, 1902). A) NMMB P37176, 59.3 mm SL. B) Uncatalogued specimen, 44.8 mm SL, collected from Ke-Tzu-Liao fishing port.

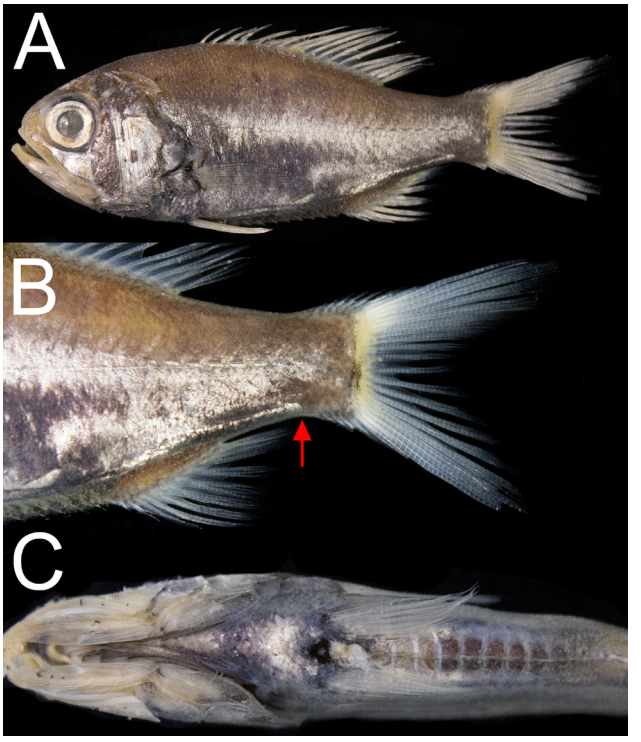

Fig. 7. *Aulotrachichthys prosthemius* (Jordan & Fowler, 1902), NMMB-P37171, 1 of 19, 72.3 mm SL, preserved. A) Overall colouration. B) Close-up image of tail region and the end of striated area (arrowed). C) Ventral view, showing the colouration of chest and abdominal scutes. Anterior to left. Figure not to scale.

resolved. The single sequence of *A. nyx* sp. nov. is clustered with *A. latus* and *A. prosthemius* with a high supporting value (88%).

The pairwise genetic distance calculated with the K2P model shows an average distance of 11.0-16.9% between *A. nyx* sp. nov. and other purported species (Table 4).

Discussion

The holotype is recognized as a member of the genus *Aulotrachichthys* by the presence of a pair of striated area on the ventral-lateral margin of the body and cycloid scales between the lateral line and pectoral fin. The result of phylogenetic analysis supports the generic placement of the new species in *Aulotrachichthys* rather than *Paratrachichthys*. The single sequence of *A. nyx* sp. nov. is clustered with *A. latus* (type species of *Aulotrachichthys*) and *A. prosthemius* with high bootstrap-supporting value.

Based on the characters provided by Kotlyar (1996) and Matsunuma et al. (2023), *A. nyx* sp. nov. is most similar to *A. pulsator* and *A. prosthemius* in having a long striated area which extends over half of the caudal peduncle, to near caudal-fin base (Fig. 1A). In contrast, other species, namely *A. atlanticus*, *A. argyrophanus*, *A. heptalepis*, *A. latus*, *A. novazelandicus*, *A. sajademalensis*, *A. spiralis*, and *A. titan*, have a short striation, which reaches to or before the middle of the caudal peduncle (Fig. 1B, Table 5).

Aulotrachichthys nyx sp. nov. differs from *A. pulsator* in having anal-fin spines III (*vs.* II in *A. pulsator*; Table 5), and a dark-brown body colouration (*vs.* golden, with dorsum slightly brownish and ventral side

Table 5. Comparison of selected characters of *Aulotrachichthys* spp. Data sources: 1. This study, 2. Matsunuma et al. (2023), 3. Gomon & Kuiter (1987), 4. Kotlyar (1996), 5. Gon (1984), 6. Fowler (1938). Abbreviations: A – anal-fin; CPL – caudal-peduncle length; D – dorsal-fin; SA – striated area.

	A. nyx sp. nov.	*A. prosthemius*	*A. pulsator*	*A. atlanticus*	*A. argyrophanus*	*A. heptalepis*
D elements	V, 13	V-VI, 12-13	V, 13	IV-V, 13-14	V, 12-14	V, 12-14
A elements	III, 8	III, 8	II, 9	II-III, 8-12	II, 9-10	II-III, 8-9
Gill rakers	6 + 1 + 14 = 21	5-6 + 1 + 11-14 = 18-21	5-7 + 1 + 11-13 = 17-21	6-7 + 1 + 12-13 = 20-21	5-6 + 1 + 10-12 = 16-18	6-8 + 1 + 12-14
Lateral-scale rows	58	51-59	-	50-60	48-58	40-59
Abdominal scutes	9	8-11	8-9	8-10	7-9	7-8
End of SA on caudal peduncle	Near caudal-fin base	Near caudal-fin base	Near caudal-fin base	Before middle	Before middle	Before middle
A-SA length (% CPL)	66.7	58.9-78.5	-	-	-	24.5-35.9
Fresh body colouration	Dark brown, slightly reddish, with ventral side darker than dorsum	Silvery, with dorsum brownish	Golden, with dorsum slightly brownish and ventral side slightly silvery	Dorsum silvery blue and ventral side dark	*Reddish-brown, with ventral side dark gray to black	*Reddish-brown
Type locality	Taiwan	Japan	S Australia	Brazil	Brazil	Hawaii
Distribution	NW Pacific	W Pacific	S Australia	W Atlantic	W Atlantic	Hawaiian Islands
Data source	1	1, 2	2, 3	2, 4	2, 4	2, 5

	A. latus	*A. novazelandicus*	*A. sajademalensis*	*A. spiralis*	*A. titan*
D elements	III-V, 15-16	V, 13	V, 13-14	IV-V, 12-14	V, 13
A elements	I-II, 9	III, 8	III, 8-10	II-III,	III, 8
Gill rakers	5-6 + 1 + 9-11 = 16-17	7 + 1 + 11 = 19	5-7 + 1 + 11-14 = 18-21	5-6 + 1 + 12-14 = 19-21	6 + 1 + 13 = 20
Lateral-scale rows	28-74	44-49[4] or ca. 60[2]	58-74	27-62	72
Abdominal scutes	7-10	8-9	8-11	7-10	10
End of SA on caudal peduncle	Before middle	Before middle	Near middle	Before middle	Near middle
A-SA length (% CPL)	24.9-33.9	31.8-35.4	52.6	25.2-39.7	43.2
Fresh body colouration	Brownish-silvery	*Brownish black, with head blackish	Silvery, slightly greenish, with dorsum brownish and ventral side blackish	Silvery, with dorsum and ventral side red brown.	Silvery, with dorsum pinkish and ventral side black.
Type locality	The Philippines	New Zealand	W Indian Ocean	Japan	Japan
Distribution	W Pacific	SW Pacific	Indian Ocean	NW Pacific	NW Pacific
Data source	1, 2, 6	2, 4	2, 4	2	2

* Based on preserved specimens.

silvery). Moreover, it differs from *A. prosthemius* co-occurring in Taiwan in having: preanal length 65.7% SL (*vs.* 65.8-72.7, mean 69.3% SL, in *A. prosthemius*; Table 3); pelvic-fin-anal-fin length 30.3% SL (*vs.* 30.8-37.6, mean 34.6% SL); HF2 4.1% SL (*vs.* 4.2-5.7, mean 4.9% SL); pectoral-fin length 18.1% SL (*vs.* 19.1-25.2, mean 21.8% SL); body rather slender, depth at dorsal-fin origin 34.1% SL (*vs.* 35.3-40.5, mean 37.5% SL); distance between dorsal- and anal-fin origins 42.6% SL (*vs.* 43.0-50.7, mean 46.8% SL); dorsal-fin length 35.3% SL (*vs.* 38.4-43.3, mean 40.3% SL); postdorsal length 29.6% SL (*vs.* 22.9-27.6, mean 25.5% SL); length of striated area (A-SA) 12.4% SL (*vs.* 7.8-12.2, mean 10.6% SL); a dark-brown overall appearance (*vs.* body colour paler, with region below lateral line silvery; Figs. 6 and 7A); a distinct, broad black line along caudal-fin base (*vs.* black line absent on caudal-fin base; Fig. 7B); chest uniformly black (*vs.* silvery white with scattered black pigments; Fig. 7C); and abdominal scutes uniformly blackish (*vs.* blackish at the middle portions of scutes only; Fig. 7C).

Aulotrachichthys nyx differs from *A. sajademalensis* in having: head depth 26.7% SL (*vs.* 29.9-33.4% SL, in *A. sajademalensis*; Tables 3 and 5); snout length 4.7% SL (*vs.* 6.2-10.0% SL); upper-jaw length 20.8% (*vs.* 21.7-25.8% SL) and lower-jaw length 22.9% SL (*vs.* 23.9-27.9% SL); pectoral-fin length 18.1% SL (*vs.* 19.8-23.9% SL); and the striated area ending at near caudal-fin base, length 66.7% caudal-peduncle length (*vs.* extends to near the middle of caudal peduncle, length 52.6%).

Despite the length of the striated area on the caudal peduncle, *A. nyx* is also similar to *A. atlanticus* in having overlapped fin-ray and scale counts (Table 5). However, *A. nyx* can be separated from *A. atlanticus* in having 14 lower gill rakers (*vs.* 12-13 in *A. atlanticus*), 14 caudal vertebrae (*vs.* 13), body height at dorsal-fin origin 2.9 in SL (*vs.* 2.3-2.7 in SL), head length 2.9 in SL (*vs.* 2.6-2.7), and eye diameter 8.4 in SL (*vs.* 7.1-8.1) (Kotlyar 1996).

Aulotrachichthys nyx differs from the two species recently described by Matsunuma et al. (2023) from the western Pacific Ocean, namely *A. spiralis* and *A. titan* in having posttemporal crest with a spine (*vs.* no distinct spine in both species); a distinct black vertical line on caudal-fin base (*vs.* caudal-fin base pale in *A. spiralis* and discontinuous in *A. titan*); striated area 66.7% caudal-peduncle length (*vs.* 25.2-39.7% and 43.2% in *A. spiralis* and *A. titan*, respectively); lateral-scale rows 58 (*vs.* 72 in *A. titan*).

In summary, *Aulotrachichthys nyx* is unique in having a distinct black vertical line on the caudal-fin base, a character not seen in congeners according to available data and photos (Jordan & Fowler 1902, Fowler 1938, Woods 1961, Menezes 1971, Kotlyar 1980, 1996, Gon 1984, Gomon & Kuiter 1987, Matsunuma et al. 2023), which we suggest a possible autapomorphy for this species. In order to search for additional specimens, efforts have been made to examine most specimens deposited in fish collections and collect new specimens. However, only a single specimen representing the new species described herein has been found. Although only based on a single specimen, the unique character of the holotype readily distinguishes it from congeners, which is also supported by the genetic analysis.

Comments on the record of *A. sajademalensis* in Taiwan and adjacent waters

Aulotrachichthys sajademalensis (Kotlyar, 1979), originally described as *Paratrachichthys sajademalensis*, was described from a single specimen collected from the Saya de Malha Bank, Southwest Indian Ocean, at depth 156-159 meters (Kotlyar 1979). Later, it was reported from the Kyushu-Palau Ridge, West Pacific by Yamakawa (1982), in which he provided a detailed description and a colour photo of the voucher specimen (catalogue number not provided). Subsequently, it was recorded several times in Japan; some provided the same photo of Yamakawa (1982) (e.g. Yamakawa 1984, Okamura & Amaoka 1997), and others provided line drawings (e.g. Hayashi 2013).

In his review of the beryciform fishes of the world, Kotlyar (1996) stated that *A. sajademalensis* differs from the other species of *Aulotrachichthys* in having lateral-scale rows 58-74, usually > 60; the end of the striated area extends to the middle of the last anal-fin ray. He also reported two specimens of *A. sajademalensis* collected from the Kyushu-Palau Ridge and compared the morphometric data between the two specimens and those collected from the western Indian Ocean.

In Taiwan, *A. sajademalensis* was formally documented by Shen & Wu (2011), which was likely based on some unpublished theses (i.e. Ou 2004, Chu 2009). We examined the voucher specimens identified as *P. sajademalensis* (= *A. sajademalensis*) in these theses (ASIZP066685 and NMMB-P10417) and found that all of their striated areas extending to the tip of the last anal-fin ray and near the caudal-fin base. Moreover, we examined more than 270 specimens

collected around Taiwan and found that the striated area of all specimens extends to near caudal-fin base (or nearly so in smaller specimens), which is contrary to the definition of *A. sajademalensis* (i.e. striated area extends to the middle of the adpressed last anal-fin ray). As a consequence, all of these specimens are identified as *A. prosthemius* by us.

Recently, Matsunuma et al. (2023) revised the Japanese record of *A. sajademalensis*, and recognized the previous Japanese record (e.g. Yamakawa 1982, Kotlyar 1996) as a new species, *A. titan*, and described *A. spiralis*, which also has a short striated area. Since no specimens in Taiwan were identified as *A. sajademalensis* by us and the specimens used in previous works from Taiwan are all misidentifications of *A. prosthemius*, we suggest that *A. sajademalensis* should be excluded from the ichthyofauna of Taiwan. Moreover, the Japanese record of *A. sajademalensis* was described as a new species (*A. titan*), which demonstrates that the records of *A. sajademalensis* from the western Pacific Ocean are erroneous, and this species should be restricted to the western Indian Ocean (Matsunuma et al. 2023).

Conclusion

In the present study, a new species of the luminous roughy genus *Aulotrachichthys* is described based on morphological and molecular evidence. *Aulotrachichthys nyx* sp. nov. differs from congeners in having its striated area extending to near the caudal-fin base; a distinct black vertical line on the caudal-fin base; an overall dark-brown body colouration; different meristic values; a proportionally shorter trunk, dorsal-fin-anal-fin length, dorsal fin, pectoral fin, forehead, snout, and both upper and lower jaws; and a proportionally longer preanal length, postdorsal length, and striated area. The identity of the records of *A. sajademalensis* is discussed after a thorough study, and this species should be removed from the ichthyofauna of Taiwan.

Comparative materials

Aulotrachichthys latus (Fowler, 1938): ASIZP068110 (1 specimen, 44.0 mm SL), The Philippines, 14°32′18.01′′ N, 121°42′06.58′′ E, 233-249 m, 29 May 2007, bottom trawl, collected by Y.-C. Liao & K.-T. Shao. COI: OQ213904. Tissue ID: ASIZP0913871. ASIZP068116, (1, 30.5), The Philippines, 16°31′11.99′′ N, 122°00′46.18′′ E, 335-356 m, 29 May 2007, bottom trawl, collected by Y.-C. Liao & K.-T. Shao. COI: OQ213905. Tissue ID: ASIZP0913877.

Aulotrachichthys prosthemius (Jordan & Fowler, 1902): Two hundred and seventy-four specimens, 37.5-81.4 mm SL, all collected around Taiwan. ASIZP057470 (1 specimen, 51.2 mm SL), off Nanfang-ao fishing port (ca. 24°34′53.16′′ N, 121°52′12.21′′ E), Yilan, northeastern Taiwan, 16 September 1993, collected by B.-H. Kao. ASIZP058257 (2, 60.8-66.6), off Daxi fishing port (ca. 24°56′28.16′′ N, 121°52′12.21′′ E), Yilan, northeastern Taiwan, 16 November 1996, collected by B.-H. Kao. ASIZP058616 (1, 78.2), off Daxi fishing port, 21 August 1997, collected by J.-H. Kuo. ASIZP058906 (1, 68.7), off Dong-gang fishing port (ca. 22°22′22′′ N, 120°27′34′′ E), Pingtung, southwestern Taiwan, 5 December 1995, collected by B.-H. Kao. ASIZP060081 (2, 69.4-76.4), off Daxi fishing port, 100-300 m, 27 January 1999, bottom trawl, collected by P.-L. Lin. ASIZP060235 (2, 51.6-61.1), off Dong-gang fishing port, 23 November 1997, collected by M.-L. Chiu. ASIZP061011 (1, 47.9), offshore of Jinshan District, Taipei, northern Taiwan, 23 October 2000, collected by Z.-H. Wu. ASIZP061054 (2, 68.3-70.2), offshore of Daxi fishing port, 24°46′48.00′′ N, 122°01′48.00′′ E, 200 m, 1 December 2000, bottom trawl, collected by Z.-H. Wu. ASIZP061139 (1, 68.1), offshore of Aodi District, New Taipei, northeastern Taiwan, 25°02′23.99′′ N, 122°02′59.99′′ E, 100 m, 15 November 2000, bottom trawl, collected by Z.-H. Wu. ASIZP061180 (2, 54.3-61.8), offshore of Aodi District, 25°04′47.99′′ N, 122°01′11.99′′ E, 200 m, 15 November 2000, bottom trawl, collected by Z.-H. Wu. ASIZP061495 (1, 61.3), offshore of Daxi fishing port, 24°54′36.00′′ N, 121°55′12.00′′ E, 100 m, 1 December 2000, bottom trawl, collected by Z.-H. Wu. ASIZP062371 (1, 67.6) offshore of Kaohsiung Harbor, Kaohsiung, southwestern Taiwan, 22°24′36.00′′ N, 120°15′00.00′′ E, 200 m, 10 November 2001, bottom trawl, collected by J.-H. Wu. ASIZP064299 (1, 74.9), offshore of Daxi fishing port, 24°53′50.18′′ N, 121°57′42.17′′ E, 100 m, 6 July 2004, bottom trawl, collected by J.-Y. Tsai. ASIZP066013 (1, 70.8), ASIZP066014 (1, 68.0), ASIZP066017 (1, 59.1), off Nanfang-ao fishing port, 20-400 m, 8 March 2005, collected by P.-F. Lee. ASIZP066686 (1, 81.4), off Daxi fishing port, 31 December 2005, collected by W.-H. Ou. ASIZP066687 (1, 55.9), off Daxi fishing port, 28 May 2005, collected by W.-H. Ou. NMMB-P00894 (3, 62.3-74.9), off Dong-gang fishing port, 12 January 1985. NMMB-P00895 (4, 63.2-74.2), off Dong-gang fishing port, 1 December 1983. NMMB-P00908 (3, 69.1-71.8), off Dong-gang fishing port, 30 November 1984, bottom trawl. NMMB-P01016 (9, 59.1-75.2), off Dong-gang fishing port, 7 December 1984. NMMB-P01146 (2, 49.8-70.8), off Dong-gang fishing

port, 6 November 1985, bottom trawl. NMMB-P02697 (4, 51.0-67.4), off Dong-gang fishing port, 4 January 1985, bottom trawl. NMMB-P02708 (1, 57.1), off Dong-gang fishing port, 11 April 1994, bottom trawl, collected by H.-K. Mok. NMMB-P02715 (1, 59.6), off Dong-gang fishing port, 23 November 1994, bottom trawl. NMMB-P02809 (1, 66.9), offshore of Kaohsiung, northwestern Taiwan, 200 m, 10 November 2001, bottom trawl, collected by J.-H. Wu. NMMB-P02810 (1, 66.1), same collection data with NMMB-P02809. NMMB-P02888 (1, 65.6), offshore of Fong-gang, Pingtung, southwestern Taiwan, 200 m, 8 November 2001, bottom trawl, collected by J.-H. Wu. NMMB-P04043 (3, 61.8-72.3), off Daxi fishing port, 12 August 1997, bottom trawl. NMMB-P04079 (2, 73.1-75.9), off Dong-gang fishing port, 6 December 1986, bottom trawl, collected by K.-S. Lee. NMMB-P05561 (3, 57.3-72.9), off Kaohsiung, 23 January 1971, bottom trawl, collected by M.-J. Yu. NMMB-P06121 (2, 59.5-66.7), off Daxi fishing port, 264 m, 8 May 2003, bottom trawl, collected by Y.-M. Ju. NMMB-P06201 (3, 60.6-65.2), off Daxi fishing port, 460 m, 8 May 2003, bottom trawl, collected by Y.-M. Ju. NMMB-P08344 (1, 67.4), offshore of Dong-gang fishing port, 22°05′24.17′′ N, 120°04′58.67′′ E, 200 m, 17 March 2005, bottom trawl, collected by Y.-M. Ju. NMMB-P10417 (1, 71.5), off Dong-gang fishing port, 13 November 2008, collected by C.-W. Chang. NMMB-P11275 (1, 57.0), off Dong-gang fishing port, 27 May 2008, collected by H.-C. Ho. NMMB-P11276 (1, 70.7), off Dong-gang fishing port, 12 January 2011, collected by H.-C. Ho. NMMB-P11277 (4, 62.5-72.6), off Dong-gang fishing port, 15 December 2009, collected by H.-C. Ho. NMMB-P12191 (1, 70.9), collected with NMMB-P11276. NMMB-P14008 (1, 53.9), off Dong-gang fishing port, 6 September 2011, collected by H.-C. Ho. NMMB-P14780 (2, 55.0-55.7), collected with NMMB-P06201. NMMB-P17874 (21, 67.1-74.6), off Dong-gang fishing port, 25 January 2012, collected by H.-C. Ho. NMMB-P20870 (1, 68.6), off Dong-gang fishing port, 12 March 2014, collected by H.-C. Ho. NMMB-P21176 (1, 73.4), off Dong-gang fishing port, 2 April 2014, collected by H.-C. Ho. NMMB-P21965 (1, 65.9), off Dong-gang fishing port, collected by H.-C. Ho. NMMB-P21970 (1, 74.6), off Dong-gang fishing port, collected by H.-C. Ho. NMMB-P22397 (1, 73.3), off Dong-gang fishing port, 12 March 2015, collected by H.-C. Ho. NMMB-P22789 (2, 56.1-62.6), off Ke-Tzu-Liao fishing port (ca. 22°42′53′′ N, 120°13′12′′ E), Kaohsiung, southwestern Taiwan, 11 February 2015, collected by H.-C. Ho. NMMB-P22829 (3, 61.4-62.9), off Ke-Tzu-Liao fishing port, 21 January 2015, collected by H.-C. Ho. NMMB-P22861 (4, 64.3-72.1), collected with NMMB-P22789. NMMB-P24066 (1, 61.5), off Ke-Tzu-Liao fishing port, 12 March 2015, collected by H.-C. Ho. NMMB-P24945 (2, 74.5-76.8), off Ke-Tzu-Liao fishing port, 2 April 2015, collected by H.-C. Ho. NMMB-P25397 (2, 59.1-69.8), off Dong-gang fishing port, 6 November 2015, collected by H.-C. Ho. NMMB-P25620 (1, 51.0), off Dong-gang fishing port, 20 January 2017. NMMB-P26820 (1, 67.4), off Dong-gang fishing port, 11 March 2017, collected by H.-C. Ho. NMMB-P27340 (1, 66.7), off Dong-gang fishing port, 20 October 2017, collected by K. Koeda and J.-F. Huang. NMMB-P28343 (2, 50.0-64.0), off Nanfang-ao fishing port, 6 September 2010, collected by C.-W. Chang. NMMB-P28423 (2, 72.2-72.9), 12 September 2009, collected by C.-W. Chang, no other data. NMMB-P29813 (1, 64.6), off Ke-Tzu-Liao fishing port, 29 June 2017, collected by H.-C. Ho. NMMB-P31146 (2, 60.7-64.4), off Dong-gang fishing port, 6 January 2018, collected by H.-C. Ho. NMMB-P31166 (7, 56.1-67.0), collected with NMMB-P31146. NMMB-P32759 (2, 68.7-72.5), off Dong-gang fishing port, 30 December 2010, collected by C.-W. Chang. NMMB-P34945 (40, 65.0-77.8), 23 May 1983, collected by Y.-P. Hsu, no other data. NMMB-P34967 (1, 62.5), off Dong-gang fishing port, 6 October 2019, collected by H.-C. Ho. NMMB-P35054 (4, 65.2-72.2), off Dong-gang fishing port, 22 January 2020, collected by H.-C. Ho. NMMB-P36387 (2, 69.9-70.5), off Dong-gang fishing port, 27 July 2021, collected by Y. Su and H.-C. Ho, COI: OQ213919-213920. NMMB-P37158 (7, 61.7-65.2), off Ke-Tzu-Liao fishing port, 28 February 2021, collected by Y. Su. NMMB-P37159 (1, 58.2), off Dong-gang fishing port, 17 March 2021, collected by Y. Su, COI: OQ213909. NMMB-P37160 (4, 63.9-73.5), off Ke-Tzu-Liao fishing port, 28 March 2021, collected by Y. Su, COI: OQ213910-213912. NMMB-P37161 (4, 64.8-68.8), off Ke-Tzu-Liao fishing port, 5 April 2021, collected by Y. Su. NMMB-P37162 (10, 62.2-74.3), off Ke-Tzu-Liao fishing port, 11 April 2021, collected by Y. Su. NMMB-P37163 (2, 62.9-65.1), off Dong-gang fishing port, 26 April 2021, collected by Y. Su & R.-Y. Hung, COI: OQ213913-213914. NMMB-P37164 (5, 56.7-75.5), off Ke-Tzu-Liao fishing port, 1 May 2021, collected by Y. Su. NMMB-P37165 (4, 57.4-64.7), off Daxi fishing port, 8 May 2021, collected by J.-F. Huang, COI: OQ213915-213918. NMMB-P37166 (1, 64.3), off Daxi fishing port, 13 August 2021, collected by Y. Su & J.-F. Huang, COI: OQ213921. NMMB-P37167 (2, 61.7-73.8), off Daxi fishing port, 20 August 2021, collected by S.-L. Ng, COI: OQ213922-213923. NMMB-P37168 (3, 55.6-77.6), off Daxi fishing port, 21 August 2021, collected by S.-L. Ng, COI: OQ213924-213926. NMMB-P37169 (1, 63.0), off Dong-gang fishing port, 25 November 2021, collected by Y. Su. NMMB-P37170

(5, 57.3-75.5), off Ke-Tzu-Liao fishing port, 5 December 2021, collected by Y. Su. NMMB-P37171 (19, 52.3-72.7), off Dong-gang fishing port, 21, January 2022, collected by Y. Su, J.-F. Huang, T.-K. Chou, N.-S. Leung & W.-C. Huang. NMMB-P37172 (1, 37.1), off Daxi fishing port, 1 March 2022, collected by C.-H. Lin. NMMB-P37173 (3, 61.5-72.2), off Dong-gang fishing port, 7 March 2022, collected by Y. Su, S.-C. Chung, Y.-H. Yu & M. Fikáček. NMMB-P37174 (1, 64.7), off Ke-Tzu-Liao fishing port, 2 April 2022, collected by Y. Su. NMMB-P37175 (1, 77.3), off Ke-Tzu-Liao fishing port, 4 April 2022, collected by Y. Su. NMMB-P37176 (1, 59.3), off Daxi fishing port, 9 June 2022, collected by Y. Su. NMMB-P37416, COI: OQ213906. NMMB-P37417 (1, 60.4), COI: OQ213907. NMMB-P37418 (1, 64.1), COI: OQ213908. All collected with NMMB-P37158.

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Author Contributions

Y. Su collected specimens, conducted the molecular experience and composed the manuscript; H.-C. Ho and H.-C. Lin revised the manuscript, gave critical comments and provided funding. All authors read and approved the final version of the manuscript.

Data Availability Statement

The DNA sequences generated in this study are available in the Bold System and Genbank. Other data sets generated in this study are available from the corresponding author upon request.

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