

A NEW SPECIES OF MORAY EEL, *GYMNOTHORAX TAIWANENSIS*, (ANGUILLIFORMES: MURAENIDAE) FROM EASTERN TAIWAN

Hong-Ming Chen and Kar-Hoe Loh

Department of Aquaculture, National Taiwan Ocean University, Keelung, Taiwan 202, Republic of China

Kwang-Tsao Shao

Biodiversity Research Center, Academia Sinica, Nankang, Taiwan 115, Republic of China

Email: zoskt@gate.sinica.edu.tw (Corresponding author)

ABSTRACT. – A new species of moray eel, *Gymnothorax taiwanensis*, is described from 12 specimens collected from coastal eastern Taiwan. It has short jaws, stout teeth, biserial vomerine dentition, brownish body colour, pale thin reticular pattern, yellowish mucus on skin, darkish tips or rims of nostrils, mean vertebral formula 5-55-119. It is distinct from its closest congener, *Gymnothorax flavocula*, in having shorter tail length (45.8–48.7 vs. 50–52 % of TL), fewer total vertebrae (117–121 vs. 124–127), attain larger total length (523 vs. 407 mm TL), and teeth more numerous on vomerine and dentary.

KEY WORDS. – New species, Muraenidae, Moray eel, *Gymnothorax taiwanensis*, Taiwan.

INTRODUCTION

Chen et al. (1994) reviewed a total of 42 species belonging to nine genera and two subfamilies of the family Muraenidae from Taiwanese waters, including two *Siderea* species: *S. picta* (Ahl, 1789) and *S. thyrsoidea* (Richardson, 1845). Böhlke & Randall (1996) also recognized the genus *Siderea* for the new species *Siderea flavocula* with short jaws, stout teeth and biserial vomerine dentition. But Böhlke & Randall (1999) recommended that all *Siderea* species be retained in the catch-all genus *Gymnothorax* until a thorough generic study could be undertaken, and described a new species *Gymnothorax castlei*. From 2001 to 2007, we were engaged in a series of projects entitled “Investigations and studies of endangered muraenid fishes from the waters around Taiwan” sponsored by Council of Agriculture, R.O.C. and “Diversity, molecular phylogeny and reproductive ecology of the Anguilliformes fishes of Taiwan and the Western Pacific.” We have collected many muraenid specimens from southern and eastern Taiwan and recently described *Gymnothorax shaoi* (Chen & Loh, 2007) as a new moray species. Among these projects, it was noticed that there were several exceptional specimens which had a reticulate pattern similar to but more variable than *Gymnothorax pseudothyrsoides* (Bleeker, 1852). However, their shorter jaws, stouter teeth, two rows of vomerine teeth and smaller mature body size differentiated them from *G. pseudothyrsoides*. Their morphology has been compared with other similar morays and it is here described as a new species.

MATERIALS AND METHODS

The type specimens are deposited in the Museum of the Biodiversity Research Center, Academia Sinica (ASIZP), and in the collections of the Laboratory of Aquatic Ecology, Department of Aquaculture, National Taiwan Ocean University (TOU-AE).

The methods of measurements follow those of Böhlke et al. (1989). Proportional measurements of type specimens of the new moray are expressed as percentage of the total length (TL) or the head length (HL). Preanal length (PAL) is measured from the snout tip to the mid-anus; body depth is measured at the gill openings (DGO) and at the anus (DA) and does not include the fins; snout length is measured from snout tip to the anterior margin of the eye; upper jaw length is from snout tip to mouth angle, lower jaw length from lower jaw tip to mouth angle. Counts for the vertebral formula are obtained from radiographs, as explained in Böhlke (1982); the mean vertebral formula (MVF) gives the mean values for predorsal-preanal-total vertebrae counts. Teeth counts are in with reference to Böhlke & Randall (1996) are approximate and include sockets of missing teeth. Gonadal type was determined by gross and histological examination of the gonads from muraenid specimens.

TAXONOMY

***Gymnothorax taiwanensis*, new species**

(Chinese name: Taiwan Rou-hsun-tsung)

(English name: Taiwanese moray eel)

(Figs. 1–2; Table 1)

Holotype. – ASIZP0069371 (male, 413 mm TL), off-shore from Shihtiping (23°29'N 121°30'E), Hualien, Taiwan, 10 m depth, longline, caught by Captain Jiunn-Shiun Chiou, 3 Jun.2006.

Paratypes. – All the paratypes were also caught by Captain Jiunn-Shiun Chiou, longline. ASIZP0069372 (female, 425 mm TL), off-shore from Changbin (23°18'N 121°26'E), Taitung, Taiwan, 8 m depth, 1 Aug.2005; ASIZP0069373 (male, 448 mm TL), off-shore from Shihtiping (23°29'N 121°30'E), 15 m, 14 Jul.2005; 3 specimens: TOU-AE 1217, 1218, 1223, (male, 452–523 mm TL), off-shore from Shuilien (23°45'N 121°34'E), Hualien, Taiwan, 3 Jul.2005; TOU-AE 1225 (female, 351 mm TL), off-shore from Shuilien, 1 Jul.2005; 3 specimens: TOU-AE 1238 (male, 425 mm TL), TOU-AE 1296, 1297 (female, 392–401 mm TL), off-shore from Changbin, 8 Jul.2005; 2 specimens: TOU-AE 1332 (female, 396 mm TL), TOU-AE 1333 (male, 397 mm TL), off-shore from Shuilien, 2 Jul.2005.

Diagnosis. – A moderate-sized moray, anus behind mid-body; with short jaws, stout teeth, vomerine teeth biserial; brownish body colour with pale thin reticular pattern, yellowish mucus on skin surface when fresh, darkish tips or rims of nostrils, orange irises; mean vertebral formula 5-55-119.

Description. – Table 1 presents the proportions as percentage of total length or head length, vertebral counts, teeth counts and gonadal type of the holotype and 11 paratypes. Some measurements are given in the text as proportions in total length or head length, the value for the holotype is listed first, followed by the range for all types, in parentheses. Tail length 2.1 (2.1–2.2), trunk length 2.5 (2.3–2.5), depth at gill opening 14.9 (13.1–17.2), depth at anus 18.0 (16.5–20.2), head length 8.4 (7.7–10.0), all in TL. Pre-dorsal length 1.4 (1.2–1.5), length of upper jaw 2.6 (2.4–2.8), length of lower jaw 2.7 (2.4–2.9), snout length 6.1 (5.2–6.8), eye diameter 11.7 (10.7–15.0), inter-orbital width 7.9 (7.3–9.0), all in HL. Pre-dorsal vertebrae 5 (5–6), pre-anal vertebrae 55 (55–56) and total vertebrae 119 (117–121).

Anus behind mid-body (Fig. 1a), pre-anal length 1.91 (1.84–1.95) in TL. Dorsal fin moderately high, origin before the gill opening. The depth of anal fin shallow, origin just behind anus. Gill opening at or below mid-body and its length nearly equal to eye diameter (Fig. 1b).

Anterior nostrils on each side of snout tip are tubular (Fig. 1c). Tips of anterior nostrils are lower and with darkish rims. Posterior nostrils are short and tubular above front edge of each eye with darkish, raised flounced rims.

Head pores typical for moray eels (Fig. 1c): supra-orbital canal with three pores, the anterior-most ethmoid pore antero-ventrally at tip of snout, the second pore adjacent to the anterior nostril, the third pore on the midpoint between the anterior and posterior nostrils; infra-orbital canal with four pores, the first just behind the anterior nostril, the last

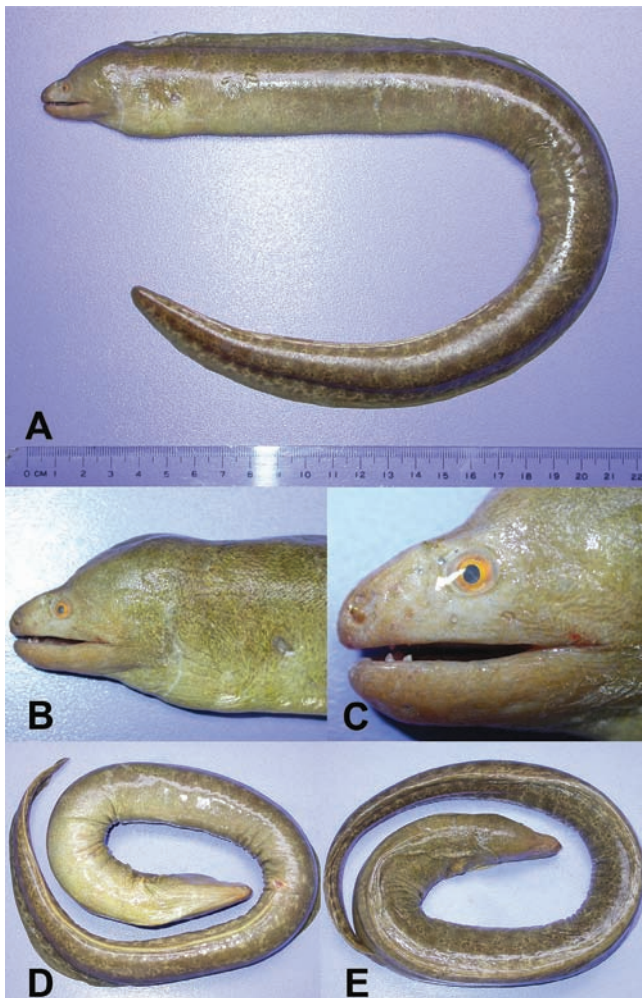


Fig. 1. Holotype of *Gymnothorax taiwanensis*, new species, male, ASIZP0069371, 413 mm TL, Shihtiping, Hualien, Taiwan, longline: A, lateral view of whole body; B, lateral view of head; C, close-up of anterior head; D, ventral view; e, dorsal view.

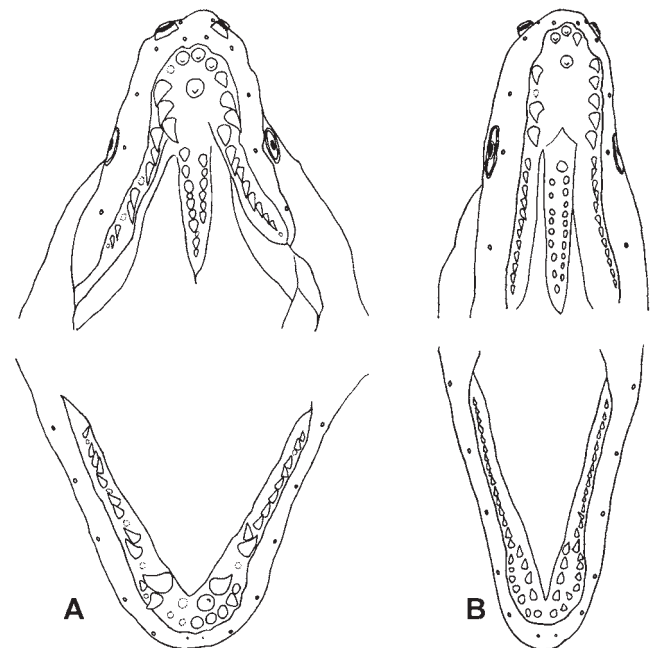


Fig. 2. Diagrams of dentition and placement of jaw pores from the type specimens of *Gymnothorax taiwanensis*, new species: A, holotype, male, ASIZP0069371, 413 mm TL; B, paratype, female, ASIZP0069372, 425 mm TL

Table 1. Proportions as percentage, vertebral counts, teeth counts and gonadal type of the holotype and 11 paratypes of *Gymnothorax taiwanensis*, new species.

	Holotype		Paratypes											Mean	SD	Min	Max
	ASIZP 0069371	ASIZP 0069372	ASIZP 0069373	TOU-AE 1217	TOU-AE 1218	TOU-AE 1223	TOU-AE 1225	TOU-AE 1238	TOU-AE 1296	TOU-AE 1297	TOU-AE 1332	TOU-AE 1333					
Total length (mm)	413	425	448	464	452	523	351	425	401	392	396	397	423.9	44.0	351	523	
% of total length																	
Tail length	47.7	47.5	46.7	46.8	45.8	47.0	48.7	46.8	46.9	48.7	46.0	45.8	47.0	1.0	45.8	48.7	
Trunk length	39.7	41.2	41.1	39.2	42.0	39.4	39.3	40.0	42.9	40.6	41.4	41.1	40.7	1.2	39.2	42.9	
Body depth at gill opening	6.7	6.4	6.9	7.5	7.1	7.6	6.1	7.1	7.0	7.7	5.8	6.8	6.9	0.6	5.8	7.7	
Body depth at anus	5.6	5.6	5.4	5.0	5.8	5.4	5.6	5.4	5.7	5.9	5.6	6.0	5.6	0.3	5.0	6.0	
Head length	11.9	10.6	12.1	12.9	11.5	12.8	10.6	12.2	10.0	10.7	11.1	12.6	11.6	1.0	10.0	12.9	
% of head length																	
Predorsal length	73.1	75.6	66.7	73.8	75.0	71.6	75.1	73.1	80.0	86.9	72.7	72.0	74.6	4.9	66.7	86.9	
Length of upper jaw	38.8	42.2	37.0	39.5	38.5	38.2	37.5	35.6	40.0	40.0	39.5	37.6	38.7	1.7	35.6	42.2	
Length of lower jaw	36.7	42.2	35.2	38.9	36.5	35.8	37.0	34.0	37.5	37.6	38.6	36.0	37.2	2.1	34.0	42.2	
Snout length	16.3	19.3	14.8	16.5	16.3	16.4	16.6	15.8	17.5	18.6	17.0	16.0	16.8	1.2	14.8	19.3	
Eye diameter	8.6	9.3	7.4	6.7	7.7	8.1	9.3	8.2	9.3	8.3	7.3	6.8	8.1	0.9	6.7	9.3	
Interorbital width	12.7	13.3	11.1	12.2	11.5	13.4	13.7	12.1	12.5	11.9	11.4	12.8	12.4	0.8	11.1	13.7	
Vertebrae																	
Predorsal	5	5	5	5	5	5	5	5	5	6	5	5	5.1	0.3	5	6	
Preal	55	55	56	55	55	56	55	55	55	55	56	55	55.3	0.5	55	56	
Total	119	118	120	120	119	121	121	120	119	119	120	117	119.4	1.2	117	121	
Teeth																	
Intermaxillary	5-5	6-6	5-5	6-6	6-7	7-7	6-6	6-6	6-6	6-6	6-6	5-6	5.9	0.6	5	7	
Median	1	1	1	1	2	1	2	1	2	1	2	1	1.3	0.5	1	2	
Maxillary	10-10	12-12	10-11	11-11	11-11	9-10	9-9	9-10	9-10	10-11	9-10	9-10	10.1	0.9	9	12	
Vomerine	16	20	18	21	17	13	21	12	21	21	18	19	18.1	3.1	12	21	
Dentary																	
Inner anterior	2-2	4-4	1-3	2-4	2-3	2-3	2-2	3-3	2-2	2-2	3-4	2-2	2.5	0.8	1	4	
Outer	17-18	23-23	18-19	21-23	19-20	19-20	19-19	19-19	18-19	18-18	19-20	18-18	19.3	1.7	17	23	
Gonadal type	testis	ovary	testis	testis	testis	testis	ovary	testis	ovary	ovary	ovary	testis					

below the posterior margin of the eye; mandibular canal along margin of lower jaw with six pores, the first generally the smallest on tip of lower jaw, the posterior-most just below the rictus; two branchial pores situated just before the mid-point area of the origin of dorsal fin to gill opening.

Mouth slightly inferior and closing completely. Teeth stout, no long fangs (Fig. 2). Five to seven outer inter-maxillary teeth, short and round anteriorly, larger and triangular posteriorly; one or two stout median teeth. Maxillary teeth uniserial, 9–12 triangular retrorse teeth, decreasing in size posteriorly. Vomerine teeth 12–21, small and round, biserial mostly, generally uniserial at the last 1–3. Each side of lower jaw with 1–4 larger stout inner-row teeth anteriorly; 17–23 outer-row teeth, small and short anteriorly, continuing as row of sharp triangular teeth.

Colour. – Body colour in formalin or alcohol grey-brown, body and fins with pale thin reticular pattern. This pale pattern is very variable, mostly reticular. Some patterning is very dense, some patterning obscure on anterior body. Paler chin, jugular and abdomen. No obviously dark spots on jaws, inner mouth or chin. Darkish tips or rims of nostrils. Body colour when fresh similar to colour in preservative, but covered by yellowish mucus on skin surface. Irises of eyes orange.

Biology. – Body length 351–523 mm TL. Male specimens (mean, range) (446, 397–523 mm TL) generally attain a longer body length than do female specimens (393, 351–425 mm TL). All the female specimens had ripe ovaries in which ova measured about 0.8–1.0 mm in diameter. The ripe ovaries reveal spawning season to be near or from July to August. Inhabits shallow reef (3–30 m depth) and rocky shorelines. Benthic. Feeds mainly on crustaceans and small fishes.

Etymology. – The specific name *taiwanensis* is derived from the locality of collection of the type, Taiwan.

Distribution. – From eastern Taiwan. Off-shore habitats from Hualien to Taitung, Taiwan.

Remarks. – The new moray eel is clearly distinct from its closest congener, *Gymnothorax flavocula* (Böhlke & Randall, 1996), in the character combinations of having shorter tail length (45.8–48.7 vs. 50–52 % of TL), fewer total vertebrae (117–121 vs. 124–127), different color of iris (orange vs. yellow), attain larger body length (523 vs. 407 mm TL), more numerous teeth on vomerine and dentary, and different color pattern.

Gymnothorax taiwanensis, new species, is easily distinguished from the other similar species *Gymnothorax pseudothyrsoides* (Bleeker), which also has pale obscure reticular pattern, by having fewer vertebrae (117–121 vs. 128–131), teeth type (stouter vs. longer), row of vomerine teeth (biserial vs. uniserial), longer trunk length, shorter head length, smaller eye diameter, shorter upper and lower jaw length.

We also note differences between the new species and another related species, *Echidna delicatula* (Kaup, 1856). Böhlke & Smith (2002) reviewed the type catalogue of Indo-Pacific Muraenidae, and remarked on the holotype (RMNH 7212) of *Poecilophis delicatulus* Kaup. Their description of holotype RMNH 7212 is as follows: VF 6-47-106; with a darker, fine

reticulated pattern just discernible on head; 10 tall, spaced inner and 18 short, blade-like outer MX teeth. It is quite different to the characters of *Gymnothorax taiwanensis*, new species: vertebral formula (VF 5-55-119), no darkish fine reticulated pattern on anterior head, no inner row of maxillary teeth.

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