

**New record of the enigmatic moray *Gymnothorax enigmaticus* McCosker and Randall, 1982 (Anguilliformes: Muraenidae) from Taiwan**

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**Abstract**

*Gymnothorax enigmaticus* McCosker and Randall, 1982 is a newly recorded moray eel from Taiwanese water. A single specimen was collected by dip net in < 0.5 m intertidal zone from the eastern coast of Taiwan. Another unpreserved specimen was photographed in 10.7 m deep coral reef from Green Island of Taiwan. In this paper, the brief description and biological characters of this rare moray are reported. The record filled the distribution gap of this moray among islands between southern Japan and Philippines. Comparisons between *G. enigmaticus* and other banded morays sympatric in Taiwan are also provided.

**Key words:** *Gymnothorax enigmaticus*, new record, moray eel, Taiwan

**Introduction**

The family Muraenidae, known as moray eel, is one of the most abundant and diverse families of true eels with 197 species placed in 15 genera of two subfamilies (Smith, 2012). Moray eels widely inhabit the tropical and temperate ocean. Most species occupy the coral reefs

and rocky ledges from intertidal zone to more than 300 m depth (Smith, 2012). Some species even occur in sandy or freshwater habitats occasionally (Tsukamoto et al., 2014). Ho et al. (2015) updated the checklist of Taiwanese moray eel with 71 species in 13 genera, more than one-third of the diversity of

muraenids in the world. Although the comprehensive investigations of indigenous moray eel fauna have been proceeded since 1994 by Chen et al., there are still many new and new record species discovered recently (Chen et al., 2008; Loh et al., 2016). The reclusive habits make moray eels difficult to collect and there may be some undiscovered species even though in inshore habitats. The enigmatic moray *Gymnothorax enigmaticus* McCosker and Randall, 1982 is one of the shallow water muraenids widespread in the Indo-West Pacific region including southern Japan, Hong Kong and the Philippines, but not in Taiwan (McCosker and Randall, 1982; Motomura et al., 2010). The aim of this paper is to document this rare moray to Taiwanese waters.

### Materials and methods

A single specimen was collected by dip net in < 0.5 m intertidal zone at night from the eastern coast of Taiwan (23°06'59.1"N, 121°23'53.5"E) and brought back to the laboratory. The specimen was fixed with 10 % formalin then transferred to 70 % ethanol solution for preservation. The morphometric measurements followed Loh et al. (2016), expressing as proportion in total length (TL) or head length (HL). The vertebral formula was counted from radiographs following the terminologies of Böhlke (1982), showed as predorsal-preanal-total

vertebrae. Teeth counts followed Hatooka (1986) and the sockets of missing teeth were included. The eel specimen was deposited in the Department of Oceanography, National Sun Yat-sen University, Kaohsiung (DOS 03183).

### Results

#### Family Muraenidae

#### Subfamily Muraeninae

#### Genus *Gymnothorax* Bloch, 1795

#### *Gymnothorax enigmaticus* McCosker and Randall, 1982

Figs. 1-3

**Material examined.** DOS 03183, one specimen, 439 mm TL, collected with the dip net in < 0.5 m intertidal zone at night, Jihui, Taitung County, by Wen-Chien Huang, 26 August 2014 (Fig. 1).

**Description of DOS 03183.** A moderate size moray, body elongate, anus anterior to midpoint of body. Dorsal fin moderately high, with origin anterior to gill opening. Anal fin shallow and just behind anal. Eyes close to mid-jaw, anterior to posterior margin of first band. Gill opening below mid-body, anterior to posterior margin of third band. Morphometrics referred to Table 1. Predorsal-preanal-total vertebrae are 4-52-129. Anterior nostril yellowish, elongated and tubular on the tip snout, slightly shorter than eye diameter in length; posterior nostril as a hole above



**Fig. 1.** *Gymnothorax enigmaticus*, DOS 03183, 439 mm TL, fresh coloration.



**Fig. 2.** Underwater photography of *Gymnothorax enigmaticus* at 10.7 m depth, Dabaisha, Green Island, 19 December 2016, specimen not collected.

the anterior margin of eye with raised rims.

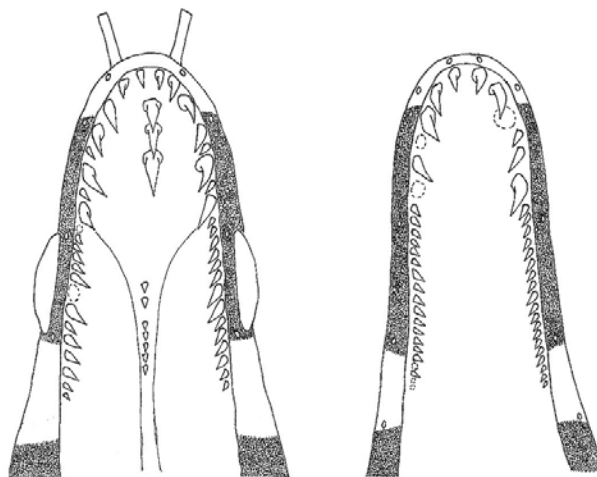
Head pores typical; four infraorbital pores, first behind the anterior nostril, second on the anterior margin of first band, third below the anterior margin of eye, and last pore below posterior margin of eye; three supraorbital pores, first on tip of snout, second just above anterior nostril, third above and between first and second infraorbital pores; six mandibular pores along margin of lower jaw, first on tip of lower jaw, last pore anterior to rictus; two branchial pores on dorsal body before gill opening.

Jaws subequal. Teeth not visible when mouth closed, uniserial, pointed and retrorse in shape, with eight pairs of premaxillary teeth, three large median premaxillary teeth, 14 pairs of maxillary teeth, seven small and stout vomerine teeth, and six large plus 19 small pairs of dentary teeth (Fig. 3).

Pale marbled background covered with 19 black vertical bands encircling head and body, including dorsal and anal fins. Black bands generally thinner than pale areas, equal or slightly wider on head and tail. Eyes within first band on middle of jaw; second band behind rictus, third behind origin of dorsal fin. Three bands on head, five on trunk and 11 on tail. Bands slightly mottled with pale, irregular spots on dorsal side of body. Tail tip and anterior snout pale. Iris of eye yellowish in fresh. Upper inner mouth pale, lower inner mouth dark.

#### Distribution

The species is known from the Indo-West Pacific region, including Keeling Islands, southern India, Thailand, Malaysia, Indonesia, Philippines, Australia, Palau, Tonga, Hong Kong, southern Japan (McCosker and Randall, 1982; Motomura et al., 2010), and now eastern Taiwan.



**Fig. 3.** Dentition of *Gymnothorax enigmaticus*, DOS 03183, 439 mm TL. Dotted lines represent the missing teeth. Left: upper jaw, right: lower jaw.

**Table 1.** Morphometrics and meristics of DOS 03183, compared with the holotype and paratypes in McCosker and Randall (1982).

	DOS 03183		Holotype	Paratypes (n=9)
	Percentage	Proportion	Proportion	Proportion
TL (mm)	439		303.2	–
In TL				
Tail length	56.7	1.8	1.8	1.7–1.8
Trunk length	32.1	3.1	3.3	3.2–3.6
Body depth at gill opening	6.4	15.7	–	–
Body depth at anus	5.2	19.1	–	–
Predorsal length	8.2	12.2	–	–
Head length	11.2	9.0	7.9	7.2–8.2
In HL				
Predorsal length	73.5	1.4	–	–
Length of upper jaw	38.8	2.6	3.0	2.7–3.0
Length of lower jaw	36.7	2.7	–	–
Interorbital width	12.2	8.2	7.8	7.7–9.9
Snout length	16.3	6.1	6.4	5.3–6.4
Eye diameter	10.2	9.8	9.5	8.3–10.4
Teeth				
Premaxillary	8		6	
Median premaxillary	3		3	
Maxillary	14		12	
Vomerine	7		6	
Dentary	25		21	
Vertebrae				
Predorsal	4		4	4
Preanal	52		51	50–52
Total	129		130	128–131

### Remarks

Most morphometrics and meristics of Taiwanese specimen are well fit with the descriptions of holotype and paratypes in McCosker and Randall (1982), except for slightly shorter head length (9.0 vs. 7.2-8.2 in TL), longer trunk length (3.1 vs. 3.2-3.6 in TL), upper jaw (2.6 vs. 2.7-3.0 in HL), and more teeth. The differences in morphometrics and teeth might be attributed to individual variations, and the number of teeth associates with sexual dimorphism, developmental stage or just a counting mistake (Hatooka, 1986).

*Gymnothorax enigmaticus* inhabits tidepools and shallow coral reef flats (McCosker and Randall, 1982). In present study, another individual was recorded and photographed in 10.7 m coral reef with sandy substrate during night diving at Dabaisha, Green Island on 19 December 2016 (22°38'20.2"N, 121°29'32.4"E; Fig. 2). It was a large individual, which nearly reaches the maximum record size of this species (580 mm TL; Myers, 1991). Therefore, it is likely that this moray mainly resides in water shallower than 10 m depth according to our observation and sampling information of holotype and paratypes (McCosker and Randall, 1982). Both of our records were observed roaming with the whole bodies out of the shelter sites at night, implying a nocturnal predator. The body color changes slightly with different conditions. It gets lighter

during daytime, but turns darker and more mottled at night according to our observations. The bands become not solid and sometimes even blurred when getting mottled.

There are several banded morays that inhabit sympatrically and could be misidentified with *G. enigmaticus*, for examples, *Echidna polyzona*, *G. rueppelliae*, *G. chlamydatius* and *G. minor*. *Gymnothorax enigmaticus* can be distinguished from *E. polyzona* by fewer bands (17-21) (vs. more bands, 25-30) and uniserial and pointed teeth (vs. multiserial and conical vomerine and dentary teeth). *Gymnothorax enigmaticus* differs from *G. rueppelliae* by lacking yellow color on top of head when alive (vs. yellow), yellowish anterior nostrils (vs. dark), and bands encircle completely (vs. do not encircle at head and anterior trunk). *Gymnothorax enigmaticus* can be distinguished from *G. chlamydatius* and *G. minor* by a band covering the eyes on head (vs. mottled head without band) (McCosker and Randall, 1982; Chen et al., 1994; Smith and Böhlke, 1997).

*Gymnothorax enigmaticus* is a shallow water moray that rarely observed and is recorded for the first time in Taiwanese waters. The present report contributes to raise the species diversity of Taiwanese eel fauna resources and fills the distribution gap of this moray among islands between southern Japan and the Philippines.

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