

[단보, Short communication]

A tiny egg-eating nudibrach, *Favorinus tsuruganus* Baba & Abe, 1964 (Nudibranchia: Gastropoda) new to Korean water

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ABSTRACT

Favorinus tsuruganus Baba & Abe, 1964 was reported based on a specimen collected from Deunggado, Tongyeong, Gyeongsangnam-do, South Korea in October 2022. This species was initially recorded from Tsuruga Bay, Japan, and widely distributed across the western Pacific region. This species can be distinguished from other congeners by the following characteristics: translucent white body, translucent black rhinophores with three lamellae, orange-colored digestive glands, black apical marking on each ceras, cleioproctus anus and uniseriated radula without denticles. This study includes morphological descriptions, SEM photograph of radula, and DNA barcoding analysis based on mitochondrial COI genes. The uncorrected pairwise genetic distance of *F. tsuruganus* was calculated to range from 0.0% to 1.07%.

Keywords: *Favorinus tsuruganus*, *Favorinus*, Egg-eating nudibranch, Nudibranchia, Korea, COI

INTRODUCTION

The genus *Favorinus* Gray, 1850, is characterized by its cleioproctus anus and its uniseriated radula (Willan, 1983; Gosliner *et al.*, 2018). Thirteen valid species of *Favorinus* have been documented worldwide to date (MolluscanBase eds., 2024). Members of this genus are known for their feeding habits, particularly on the eggs of other sea slugs, with most *Favorinus* species showing a unique coloration of their digestive glands corresponding to the eggs they prey (Rudman, 1999). However, *Favorinus tsuruganus*, which is reported for the first time in Korea through this study, consistently displays orange-colored digestive glands in its cerata

(Rudman, 1999). Particularly, *F. tsuruganus* has been observed feeding on the eggs of several other nudibranchs in previous studies: *Hexabranchnus sanguineus* (Rüppell & Leuckart, 1830), *Hoplodoris nodulosa* (Angas, 1864), *Hypselodoris* spp., *Pelagella felis* (Baba, 1949), and *Tritoniid* spp. (Willan, 1993; Tibirićá *et al.*, 2017; Gosliner *et al.*, 2018).

This study is the first report of both the genus *Favorinus* and the species *F. tsuruganus* in Korea. We provide diagnostic characteristics and diagrams of *F. tsuruganus*, and an SEM image of its radula. Additionally, we calculated uncorrected pairwise genetic distances (*p*-distance) and constructed a neighbor-joining phylogenetic tree using the mitochondrial COI partial gene sequences.

MATERIALS AND METHODS

A single specimen of aeolid nudibranch was collected by scuba diving on October 20, 2022, at Deungga-do Islet, Tongyeong, Gyeongsangnam-do. The collected specimen was photographed in a seawater tank using a TG-4 underwater camera (Nikon, Tokyo, Japan). The specimen was preserved

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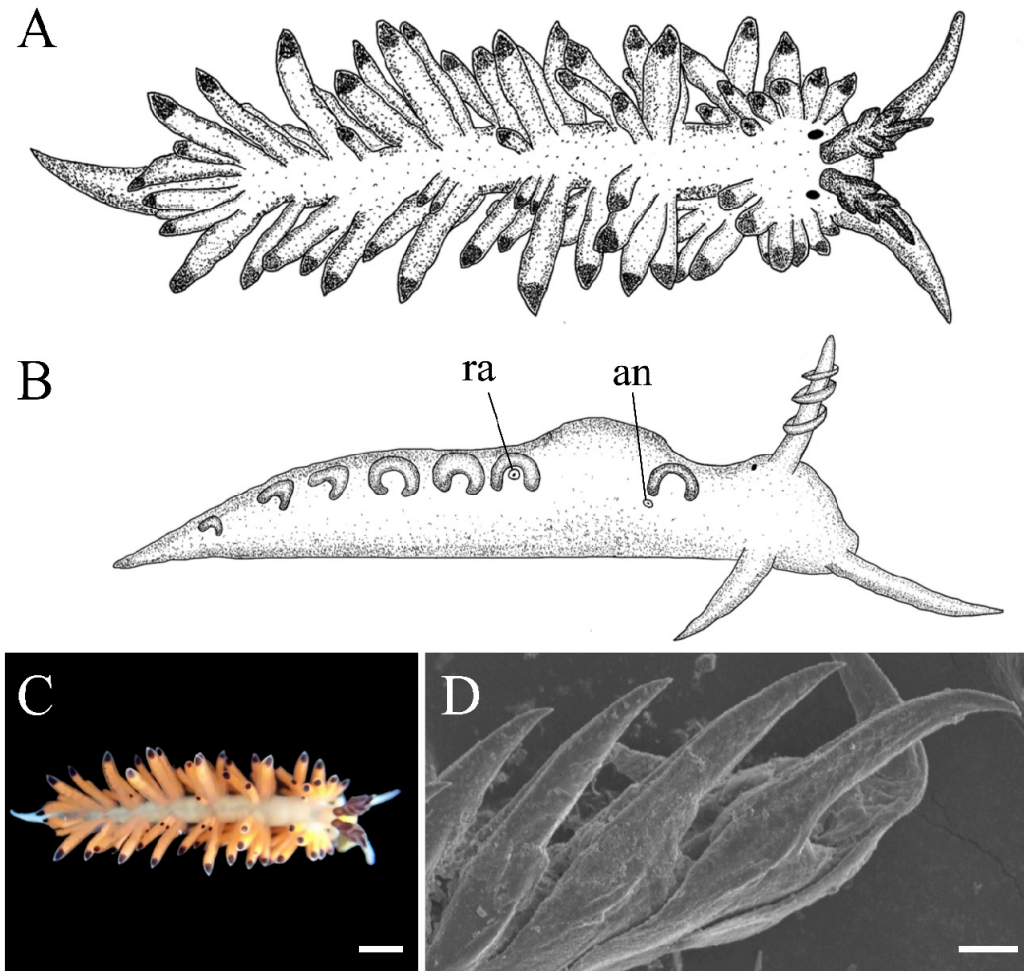


Fig. 1. *Favorinus tsuruganus* Baba & Abe, 1964. **A.** Schematic diagram of the dorsal view; **B.** Schematic diagram of the right lateral view. Abbreviations: an. anus, ra. reproductive apertures; **C.** Dorsal view of living individual. Scale bar = 1 mm; **D.** Dorso-lateral view of central teeth. Scale bar = 50 μ m.

in 95% ethanol, and body length was measured from the base of the oral tentacles to the tip of the metapodium. The buccal mass was removed and dissolved in a 10% NaOH solution for 8 hours. The radula was photographed under a scanning electron microscope (JSM-6390; Jeol, Tokyo, Japan). The specimen was deposited at the National Institute of Biological Resources (FELEIV0000000065).

Total genomic DNA was isolated from the fixed specimen's posterior one-third of the body using the DNeasy Blood & Tissue kit (Qiagen, Hilden, Germany) in accordance with the manufacturer's instruction. Its partial COI gene fragment (658 bp) was amplified

using the LCO1490 and HCO2198 primer set (Folmer *et al.*, 1994), and added to the GenBank database at the NCBI (PP967300). The neighbor-joining phylogenetic tree (Saitou and Nei, 1987) was constructed with 1,000 bootstrap replications using the Kimura-2-parameter distance (Kimura, 1980), and uncorrected pairwise genetic distances were calculated in the MEGA 11 (Tamura *et al.*, 2021).

SYSTEMATIC ACCOUNTS

Phylum Mollusca Linnaeus, 1758 연체동물문
Class Gastropoda Cuvier, 1797 복족강

Table 1. Uncorrected p-distances (%) of the partial mitochondrial COI gene among the eight *Favorinus* species

No.	Species	Locality	1	2	3	4	5	6	7	8	9	10	11	12	13	14	GenBank accession No.	References
1		Korea															PP967300	This study
2		Philippines	0														JX220452	West, 2012
3	<i>F. tsuruganus</i>	"	0.30	0.30													JX220450	"
4		"	0.76	0.76	0.92												JX220454	"
5		"	0.77	0.77	1.07	0.92											JX220451	"
6		"	0.77	0.77	1.07	0.61	0.30										JX220453	"
7	<i>F. elenalexiarum</i>	Costa Rica	15.08	15.08	14.86	14.67	15.08	15.28									HM162755	Pola & Gosliner, 2010
8		Mexico	15.26	15.26	15.04	14.85	15.26	15.46	0.61								JX220471	West, 2012
9	<i>F. brianus</i>	Scotland	18.63	18.63	18.24	18.86	19.47	19.05	18.06	18.67							JX220472	"
10		Philippines	18.99	18.99	18.77	18.56	18.17	18.37	20.10	20.12	21.93						JX220470	"
11	<i>F. japonicus</i>	Maldives	18.85	18.85	18.62	18.83	18.43	18.64	20.81	20.83	21.37	1.09					OQ207001	Cunha <i>et al.</i> , 2023
12		Hawaii, USA	18.99	18.99	18.77	18.56	18.17	18.37	20.52	20.54	21.93	0.92	0.46				JX220469	West, 2012
13		Philippines	18.99	18.99	18.77	18.56	18.17	18.37	20.52	20.54	21.93	0.92	0.46	0.30			JX220468	"
14		Italy	18.95	18.95	18.93	18.93	19.19	19.19	19.57	20.50	17.63	18.86	19.56	19.09	18.86		LT596562	Furfaro <i>et al.</i> , 2016
15	<i>F. branchialis</i>	Scotland	19.07	19.07	19.26	19.05	19.28	19.28	19.60	20.43	16.50	20.55	21.06	20.55	20.55	1.03	AY345042	Grande <i>et al.</i> , 2004
16		Spain	19.28	19.28	19.47	19.26	19.49	19.49	18.98	19.80	16.50	19.92	20.42	19.92	19.92	0.34	HQ616761	Carmona <i>et al.</i> , 2011
17		Bermuda	19.76	19.76	19.96	19.53	19.13	18.92	20.30	21.14	16.86	18.52	18.36	18.52	18.93	19.02	JX220476	West, 2012
18		"	19.98	19.98	20.17	19.74	19.34	19.13	20.94	21.80	17.47	18.72	18.57	18.72	19.14	19.25	JX220473	"
19	<i>F. auritulus</i>	"	20.00	20.00	20.19	19.76	19.36	19.15	20.75	21.60	17.08	18.33	18.17	18.33	18.74	18.81	KX889733	Goodheart <i>et al.</i> , 2017
20		Bermuda	20.63	20.63	20.82	20.39	19.98	19.76	21.16	22.02	17.26	18.93	18.78	18.93	19.34	19.49	JX220475	West, 2012
21		"	20.63	20.63	20.82	20.39	19.98	19.76	21.16	22.02	17.26	19.14	18.99	19.14	19.55	19.49	JX220474	"
22		Marshall Islands	20.67	20.67	20.86	20.86	20.24	20.24	20.82	20.84	21.71	22.66	21.88	22.88	22.44	22.10	JX220464	"
23	<i>F. mirabilis</i>	"	20.88	20.88	21.08	21.08	20.88	20.88	20.39	20.41	21.49	22.66	22.32	23.32	22.88	22.35	JX220465	"
24		Philippines	21.10	21.10	21.29	21.29	20.67	20.67	21.25	21.27	22.14	22.44	21.66	22.66	22.22	22.10	JX220467	"
25		"	21.10	21.10	21.29	21.29	20.67	20.67	20.61	20.63	22.59	22.22	21.44	22.44	22.00	23.09	JX220466	"
26		Italy	22.75	22.75	22.72	22.43	23.33	23.04	22.89	23.48	23.15	26.12	25.81	26.12	26.43	24.48	OP223451	
27	<i>F. ghanensis</i>	"	22.75	22.75	22.72	22.43	23.33	23.04	23.48	24.08	22.86	25.81	25.51	25.81	26.12	24.15	OP223450	Mioni & Furfaro, 2022
28		"	22.75	22.75	22.72	22.43	23.33	23.04	22.89	23.48	23.15	26.12	25.81	26.12	26.43	24.48	OP223449	

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No.	Species	Locality	15	16	17	18	19	20	21	22	23	24	25	26	27	28	GenBank accession No.	References
1		Korea															PP967300	This study
2		Philippines															JX220452	West, 2012
3	<i>F. tsuruganus</i>	"															JX220450	"
4		"															JX220454	"
5		"															JX220451	"
6		"															JX220453	"
7	<i>F. elenalexiarum</i>	Costa Rica															HM162755	Pola & Gosliner, 2010
8		Mexico															JX220471	West, 2012
9	<i>F. blianus</i>	Scotland															JX220472	"
10		Philippines															JX220470	"
11	<i>F. japonicus</i>	Maldives															OQ207001	Cunha <i>et al.</i> , 2023
12		Hawaii, USA															JX220469	West, 2012
13		Philippines															JX220468	"
14		Italy															LT596562	Furfaro <i>et al.</i> , 2016
15	<i>F. branchialis</i>	Scotland															AY345042	Grande <i>et al.</i> , 2004
16		Spain	0.92														HQ616761	Carmona <i>et al.</i> , 2011
17		Bermuda	18.56	17.93													JX220476	West, 2012
18		"	18.77	18.14	0.46												JX220473	"
19	<i>F. auritulus</i>	-	18.37	17.75	0.76	0.61											KX889733	Goodheart <i>et al.</i> , 2017
20		Bermuda	18.98	18.35	0.77	0.61	0.61										JX220475	West, 2012
21		"	18.98	18.35	0.77	0.61	0.61	0.30									JX220474	"
22		Marshall Islands	22.12	21.47	21.77	21.98	22.40	22.42	22.64								JX220464	"
23	<i>F. mirabilis</i>	"	22.34	21.68	21.98	22.20	22.62	22.64	22.86	1.70							JX220465	"
24		Philippines	22.12	21.47	22.20	22.42	22.84	22.86	23.08	0.46	1.86						JX220467	"
25		"	23.01	22.34	22.64	22.86	23.28	23.30	23.52	0.92	1.39	1.08					JX220466	"
26		Italy	24.93	24.63	21.95	22.24	22.27	22.83	22.54	24.05	24.94	24.64	24.94				OP223451	
27	<i>F. ghanensis</i>	"	24.63	24.32	21.38	21.67	21.69	22.24	21.95	23.46	24.34	24.05	24.34	1.23			OP223450	Mioni & Furfaro, 2022
28		"	24.93	24.63	21.95	22.24	22.27	22.83	22.54	24.05	24.94	24.64	24.94	0	1.23		OP223449	

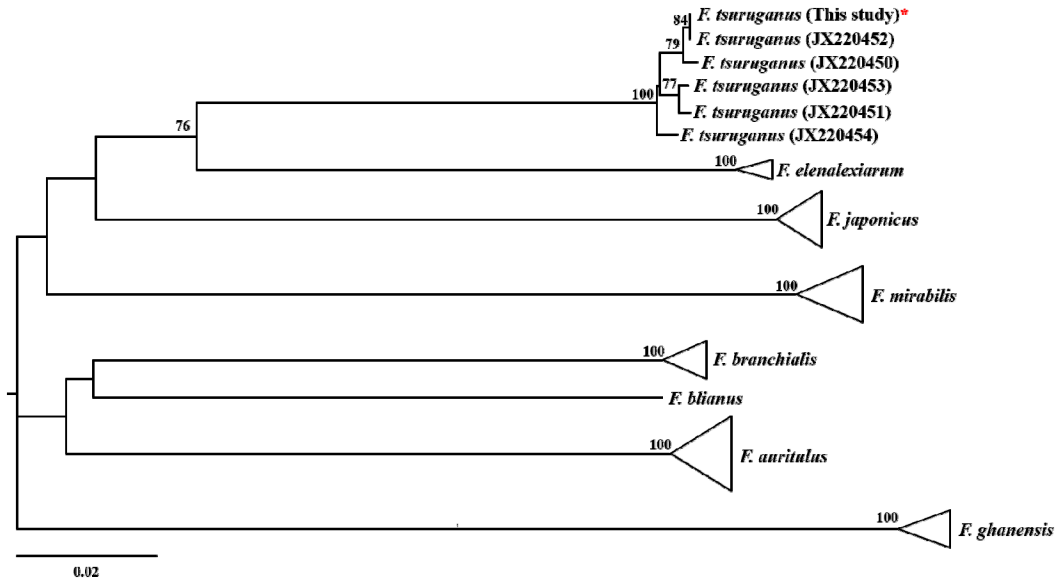


Fig. 2. A reconstructed neighbor-joining phylogenetic tree of the genus *Favorinus* based on mitochondrial COI sequences. Bootstrap values over 75% are indicated above the node. The sequence obtained from this study is marked with a red asterisk.

Order Nudibranchia Cuvier, 1817 나새목

Suborder Cladobranchia Willan and Morton, 1984

갯민숭이아목

Family Facelinidae Bergh, 1889 점하늘소갯민숭이과

Genus *Favorinus* Gray, 1850 고리꼭지갯민숭이속 (신칭)

Favorinus Gray, 1850: 109.

Matharena Bergh, 1871 in Mörch, 1871: 183.

Type species. *Eolis alba* Alder & Hancock, 1844 (= *Favorinus branchialis* Rathke, 1806; type by monotypy).

Diagnosis. Anus cleioproctic. Ceratal cluster grouped with several arches, ceratal cluster decreases in numbers and size toward to metapodium. Radula with a single elongated cusp with either few or no denticles.

***Favorinus tsuruganus* Baba & Abe, 1964** 검은꼭지갯민숭이 (Table 1; Figs. 1, 2)

Favorinus tsuruganus Baba & Abe, 1964: 163-164, fig. 1; 1975: 119, fig. 1; Willan, 1983: 72-75, fig. 1-15; Gosliner *et al.*, 2018: 306.

Type locality. Mizushima, Tsuruga Bay, Japan.

Distribution. Australia (Willan, 1983); Indonesia (Papu *et al.*, 2020); Japan (Baba & Abe, 1964; 1975); Korea

(This study); Mozambique (Tibiriçá *et al.*, 2017); Singapore (Tay, 2018); Taiwan (Su *et al.*, 2009).

Specimen examined. South Korea: 1 specimen, Gyeongsangnam-do, Tongyeong-si, Hansan-myeon, Maejuk-ri, Deungga-do Islet, 20 X 2022, Y Lee (FELEIV0000000065).

Measurement. Body length 8 mm in preserved specimen.

Diagnosis. Body aeolid form with a translucent white ground color (Figs. 1A-C). Rhinophores short and black, each bearing 3 pairs of bulbs on the mid-lower part. Ceratal clusters 7 pairs, each ceras clavate or lanceolate and translucent in color. Digestive gland thin and light orange. Apex of each ceras black. Reproductive apertures located at the base of the first ceratal arch. Anus cleioproctic, opening situated within the second ceratal arch (Fig 1B). Oral tentacles smooth and longer than the rhinophores. Oral tentacles and metapodium with a faint bluish hue against a white background. Propodial tentacles present. Visceral mass exhibits a creamy white coloration and visible through the body. Radula formula is $16 \times 0.1.0$ (Fig. 1D). Each tooth bears a sharply pointed cusp without denticles, with the base of each tooth narrow and highly arched.

GenBank Accession No. PP967300

Remark. The *p*-distances within the genus *Favorinus* were calculated using partial COI gene sequences (462 bp) from 28 individuals across five species (Table 1). The *p*-distances within the genus ranged from 0.0% to 26.43%. The intraspecific *p*-distance of *F. tsuruganus* varied from 0.0% (between the specimen examined here and JX220452) to 1.07% (between JX220450 and JX220451, JX220450 and JX220453). In contrast, the interspecific *p*-distances of *F. tsuruganus* ranged from 14.67% (between *F. tsuruganus* and *F. elenalexiarum*; JX220454 and HM162755) to 23.33% (between *F. tsuruganus* and *F. ghanensis*; JX220451 and OP223449-51). The phylogenetic tree reconstructed from these sequence sets clustered *F. tsuruganus* in a clade with 100% bootstrap support (Fig. 2). Based on these results, DNA barcoding for the genus *Favorinus*, which includes *F. tsuruganus*, is considered effective for species identification.

ACKNOWLEDGMENTS

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