A report on species of phyllidiid and polycerid nudibranch including two species new to Korea

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During a systematic study on Korean nudibranchs, two phyllidiid and two polycerid species were collected and identified with examination of their external morphological characters. As a result of the study, two phyllidiid species, Phyllidia ocellata Cuvier, 1804 and Phyllidiella pustulosa (Cuvier, 1804) were re-described since there was no descriptions of these species with Korean specimens. And two polycerid species, Thecacera pennigera (Montagu, 1815) and Triopha catalinae (Cooper, 1863) were described as new to Korean fauna. Diagnostic characters of these species are described with illustrations in this study. DNA barcode data from three species examined were also provided for a supplement to morphological identifications.

Keywords: Korea, Nudibranchia, Phyllidia ocellata, Phyllidiella pustulosa, Phyllidiidae, Polyceridae, Thecacera pennigera, Triopha catalinae

INTRODUCTION

Nudibranchs comprising more than 6,000 species worldwide are distinguished by missing a shell in the adult stage. Species included in the family Phyllidiidae having no primary gill and comprising hard tubercles in dorsal part of body can be easily separated from the species of related families (Gosliner et al., 2008). Within the family, species are distinguished by characteristic color variation of body and spacing of the dorsal tubercles. The family Polyceridae is distinguished by having velar tentacles along anterior part of body, and extrabranchial and lateral appendages (Gosliner et al., 2008).

Until now 8 species in families Phyllidiidae and Polyceridae have been recorded from Korean waters (Choe and Lee, 1997; Lee and Min, 2002; Choi, 2003): Phyllidia ocellata Cuvier, 1804; Phyllidia picta Pruvot-Fol, 1957; Phyllidiella cooraburrama Brunckhorst, 1993; Phyllidiella pustulosa (Cuvier, 1804) in the family Phyllidiidae; Plocamopherus tilesii Bergh, 1877; Tambja amakusana Baba, 1987; Tambja sagamiana (Baba, 1955); Tambja verconis (Basedow and Hedley, 1905) in the family Polyceridae. There was no taxonomic report with descriptions on species included in these families from Korean waters.

In this study, we reported brief re-descriptions with figures of two species in the family Phyllidiidae, Phyllidia ocellata Cuvier, 1804 and Phyllidiella pustulosa (Cuvier, 1804) and two species in the Polyceridae, Thecacera pennigera (Montagu, 1815) and Triopha catalinae (Cooper, 1863) as new to Korea with presentation of diagnoses and illustrations. In addition, mitochondrial COI DNA sequence data of three species examined were presented for an aid of species identification.

MATERIALS AND METHODS

Materials were collected by scuba diving in the subtidal zone of the Korean coast from June 2011 to October 2012. The collected specimens were narcotized with a 10% MgCl₂ solution, and fixed in 10% neutral buffered formalin or 97% ethanol to preserve. The species were examined with a stereoscopic microscope (Olympus SZ-61 with Fuzhou'Tucsen TCA-3). Body lengths of most specimens were measured from the middle points of the rhinophores to the tip of posterior end by using ocular micrometers. Examined specimens were deposited at the National Institute of Biological Resources (NIBR), Incheon, Korea and Sangmyung University, Seoul, Korea. NIBR specimen numbers are recorded for the specimens.
For molecular identification, genomic DNA was extracted from isolated tissues. Mitochondrial COI gene was amplified (500 bp) using a universal primer set (LCO1490, HCO2198; Former et al., 1994). PCR products were purified and analyzed by DNA sequencing. Each of the primers was removed and open reading frame was obtained as sequences translated into protein to avoid numts. GenBank reference sequences have been searched to the resulting sequences using BLAST.

**SYSTEMATIC ACCOUNTS**

Phylum Mollusca Linnaeus, 1758  
Class Gastropoda Cuvier, 1817  
Order Nudibranchia Cuvier, 1817  
Family Phyllidiidae Rafinesque, 1814


**Genus Phyllidia Cuvier, 1797**

**Phyllidia ocellata Cuvier, 1804 (Fig. 1)**

Phyllidia ocellata Cuvier, 1804: 269, pl. a, fig. 7 (cited from Yonow, 1996). Brunckhorst, 1993: 35-37, figs 25D-E, pls. 2D-H, 3A; Yonow, 1996: 485-487, fig. 1, tab. 1; Choe and Lee, 1997: 38, tab. 1; Okutani, 2000: 795, fig. 3; Lee and Min, 2002: 145; Choi, 2003: 47, pl. 5; Debelius and Kuiter, 2007: 265; Gosliner et al., 2008: 287.


Phyllidia multituberculata Boettger, 1918: 129-130, pl. 8, fig. 4a-c (cited from Brunckhorst, 1993); Yonow, 1996: 487-490, figs. 2A-E, 3A-G, 4B, tab. 1.

Phyllidia tuberculata Baba, 1930: 117-118, pl. 4, fig. 1a-d (non Phyllidia tuberculata Risbec, 1928) (cited from Brunckhorst, 1993).

Phyllidia japonica Baba, 1937: 310 (cited from Brunckhorst, 1993); Baba, 1949:72, 157, pl. 29, fig. 108; Lim and Chou, 1970: 134, pl. 16c (cited from Yonow, 1996).


Phyllidia ocellata undula Yonow, 1986: 1411-1413, figs. 5, 12a, b (cited from Brunckhorst, 1993).


**Diagnosis.** Body ovate and elongate (length: 42-63 mm, width: 26-40 mm). Rhinophores lamellate and dark yellow in color (Fig. 1A). Anus open with yellow border. Anus papilla white (Fig. 1B). Back ground color brightly yellow. Dorsum several various sizes of patches of black rings bordered with white, rounded or conical tubercles scattered. Median dorsal tubercles appear to line up longitudinally. Tubercles usually decrease in size from top to edge of mantle (Fig. 1C). Sole of foot gray, divided anteriorly (Fig. 1D). Oral tentacles finger like in shape, rounded ends (Fig. 1E).


**DNA barcode.** COI sequences of the first mentioned specimen in the “Material examined” are as follows: 5′-CGATCATTTTTATAATGTTATTGTAACAGCTCA TGCTTTTGTAATAATTTTCTTTTTGGTAATACCT TTAATAATTGGGTTTCGGGAAATGTGATGGTC CCATTTCAATTGTGTCACCAGACATAAGATTT CCCCCGAATAAATAATATAAGCTTTTTGTTACTA CCACCATTTTATTTATTAAGCTCAACTTT AATAGAAGGTGAGCTGGAAACGGGTGAATCG TTTATCCCAATTATCTGGACCAATAAGGACATG GTGGGACCTCTGTGGATTTAGAATTTTTTTTTT TACACTAGCTGGGACTCTCTCTCTCTCTCTAGGGGC AAATTTATTTATTTACACTACACTCTCTCAATAATAGCT TCACCTGTCTATAAAGAAAGTGAACAGTTAGATTT TTGTGTTGTGTCAGTTTTTTGTTGACAGCTTTTTCTT TACTCTTCCTCTTACCTGTGTTAGCGAGGGCTAT TACTTACTTTATACGAGTTCAAATTTTAAC-3′.

According to BLAST search to GenBank, this sequence matches 88% with Phyllidia elegans (AJ223276). There is no COI sequence information for P. ocellata in the GenBank. Therefore more COI records from different localities of the species are needed for correct molecular identification.

**Remarks.** Phyllidia ocellata is known as variety of color pattern, even from a single locality (Gosliner et al., 2008). In Korea, however, all of specimens examined in this study and previous study (Choi, 2003) are shown same dorsal patterns with bright yellow background and 7-8 black thick rings and several patches.

**Genus Phyllidiella Bergh, 1869**

**Phyllidiella pustulosa** (Cuvier, 1804) (Fig. 2)

Phyllidiella pustulosa Cuvier, 1804: 268, pl. a, fig. 8 (cited from Brunckhorst, 1993); Baba, 1949: 71, 156, pl. 29.
Phyllidia verrucosa Hasselt, 1824: 244 (cited from Brunckhorst, 1993).
Phyllidia albonigra Quoy and Gaimard, 1832: 291-292, pl. 21, figs. 26, 27 (cited from Brunckhorst, 1993).
Phyllidia spectabilis Collingwood, 1881: 136-137, pl. 10, figs. 19-23 (cited from Brunckhorst, 1993).
Fryeria variabilis Collingwood, 1881: 137, pl. 10, figs. 24-28 (cited from Brunckhorst, 1993).


Phyllidia verrucosa Hasselt, 1824: 244 (cited from Brunckhorst, 1993).
Phyllidia albonigra Quoy and Gaimard, 1832: 291-292, pl. 21, figs. 26, 27 (cited from Brunckhorst, 1993).
Phyllidia spectabilis Collingwood, 1881: 136-137, pl. 10, figs. 19-23 (cited from Brunckhorst, 1993).
Fryeria variabilis Collingwood, 1881: 137, pl. 10, figs. 24-28 (cited from Brunckhorst, 1993).
**Phyllidia nobilis**: Risbec, 1928: 58 (cited from Brunckhorst, 1993).


**Phyllidia melanocera** Yonow, 1986: 1406-1407, figs. 2, 10f-i (cited from Brunckhorst, 1993).

**Phyllidiella pustulosa**: Brunckhorst, 1993: 49-54, figs. 3B, 9B-D, 11-13, 27, 28A-C, pl. 5E-F; Choe et al., 1997: 39, figs. 4-5, tab. 3; Okutani, 2000: 795, fig. 2; Valdés, 2001: 339, figs. 1B, 5B-C, 6; Lee and Min, 2002: 145; Choi, 2003: 52, pl. 6; Debelius and Kuiter,

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Material examined. 1 individual (SMD0178), Jeju-do, Seogwipo-si, Seogwi-dong. 19 Feb 2012; 1 individual (KOSPIV0000164403), Jeju-do, Seogwipo-si, Seogwi-dong. 13 Oct 2013.

Diagnosis. Body ovate and elongate (length: 30-53 mm, width: 26-31 mm). Rhinophores lamellate and black in color (Fig. 2A). Anus open with black border (Fig. 2B). Back ground color black. Pinkish gray tubercles clustered 2-3 protuberances with variable in shape and size on dorsum (Fig. 2C, F). Sole of foot gray, divided anteriorly. Oral tentacles finger like in shape (Fig. 2D). Edge of mantle submarginal black line (Fig. 2E).

Distribution. Korea, Japan, Indo-west Pacific to Hawaii, New Caledonia, Fiji.

Family Polyceridae Alder and Hancock, 1845

Diagnosis. Varied body shape. Usually velar tentacles along anterior margin. Dorsal extrabranchial appendages and other lateral appendages (Gosliner et al., 2008).

Genus *Thecacera* Fleming, 1828

*Thecacera pennigera* (Montagu, 1815) (Fig. 3)
*Doris pennigera* Montagu, 1815: 17-18, pl. 4, fig. 5 (cited from Vallés et al., 2000).

*Thecacera pennigera*: Fleming, 1828: 283 (cited from Willan, 1976); Alder and Hancock, 1855, fam. 1, pl. 21a, figs. 1-9 (cited from Baba, 1960); Willan, 1976: 347-352, fig. 1; Vallés et al., 2000: 26, figs. 7C, 9; Debelius and Kuiter, 2007: 40.


*Thecacera lamellate* Barnard, 1933: 294-295, fig. 1 (cited from Vallés et al., 2000).


Diagnosis. Body slender (length: 13-17 mm, width: 9-12 mm) with translucent white. Blunte head. Pointed metapodium (Fig. 3A). Dorsum convex and high (Fig. 3B). Rhinophores lamellate with incomplete sheath. Rhinophores surrounded by bifurcate rhinophoral sheath (Fig. 3C). Gills five bipinnate on center of dorsum. Two very long elongated extrabranchial appendages on both sides of gills (Fig. 3D). Numerous yellow and black spots scattered (Fig. 3E, F).

Distribution. Korea, Japan, Indo-west Pacific to Hawaii, New Caledonia, Fiji.

*Triopha catalinae* (Cooper, 1863) (Fig. 4)

*Triopha catalinae* Cooper, 1863: 59.

*Triopa carpenteri* Stearns, 1873: 78, fig. 2 (cited from McDonald, 1983).


*Triopha modesta* Bergh, 1880: 261-266, pl. 14, figs. 17-20 (cited from McDonald, 1983).

*Triopha modesta*: Fischer, 1887: 527 (cited from McDonald, 1983).

and Kuiter, 2007: 46; Gosliner et al., 2008: 277.
Triopha elioti O’Donoghue, 1921: 165-167 (cited from McDonald, 1983).


Diagnosis. Body elongate (length: 46-100 mm, width: 15-38 mm) and translucent pale white, Anterior rounded, Posterior pointed (Fig. 4A). Head flattened and expand-
ed wider than body (Fig. 4B). Several margin process of frontal veil along anterior of head (Fig. 4C). Rhinophores lamellate and retractable (Fig. 4D). Gills five of simple tripinnate and non-retractable (Fig. 4E). Dorsum slightly arched, Usually several rounded end tubercles on edge of dorsum (Fig. 4E). Same orange color present tip of appendage: Rhionophores, Dorsal-lateral papillae, Dorsal tubercles, Frontal veil margin process, Gill branch, Posterior end.

**Distribution.** Korea, Japan, Alaska, Baja California, Mexico.

**DNA barcode.** COI sequences of the first mentioned specimen in the “Material examined” are as follows: 5′-AGCTGGTGATTTCTAGGGGATGATCATTTTTA

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TAATGTCATTGTAACTGCTCATGCGTTCGTAAT
AATTTTTTTTATAGTTATGCCGTTAATAATCGGA
GGATTTGGTAACTGAATAGTTCCTTTACTAATT
GGAGCACCTGATATAAGTTTTCCTCGAATAAAT
AATATAAGATTTTGACTTCTTCCCCCCTCATTTA
TTTTATTGTTGTGTTCAACATTAATAGAAGGAG
GAGCTGGGACAGGATGAACTGTGTACCCTCCTT
TATCTGGTCCCTGTGGGGCTATGGAGGTACGTCTG
TAGATCTTGCTATTTTTTCTCTCCATTTAGCTGG
CGCATCTTCTTTACTTGGGGCCATTAATTTTATT
ACTACTATTTTTAATATACGGCTTCTCGGCTATAA
CTATAGAACGATTTAAGTTTATCCTGTTAGCTTG
TTGTTGACTGCTTTTACTCTTTGCTTTCTTTA
CCTGTACTAGCCGGAGCTATTACTATACTAT-3’.

According to BLAST search to GenBank, this sequence matches 99% with a COI record of *Triopha catalinae* (GQ292040) available in the GenBank. This may support the morphological identification of the species.

Remarks. *Triopha catalinae* distributed from Alaska to Baja California in the Eastern Pacific. From the Western Pacific Okutani (2000) recorded this species from Sanriku and Hokkaido. The present report of *T. catalinae* from Korea showed a distributional extension of its previously known range.

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