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Morphological description and DNA barcode data of four newly recorded mollusk species from Korean waters

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ABSTRACT

Four molluscan species–*Amicula gurjanovae* Yakovleva, 1952, *Nipponacmea nigrans* (Kira, 1961), *Coralliophila carnosa* Kosuge, 1986, and *Sepia furcata* Ho & Lu, 2005–are reported for the first time from Korean waters. Within the genus *Amicula*, only two valid species are currently recognized worldwide: *A. amiculata* (Pallas, 1788) and *A. gurjanovae* Yakovleva, 1952. *A. gurjanovae* is considered a rare species, previously known only from the southern Kuril Islands and southern Sakhalin. *N. nigrans* is distinguished by its non-protruding apex, dense riblets, and gray pigmentation on the snout and sides of the foot. *C. carnosa* is similar to *C. pulchella* and *C. morishimai*, both known to occur in Korean waters. However, it can be distinguished by its more slender shell, less angular shoulder, and more numerous and pronounced spiral cords. The *S. furcata* specimen identified in this study was slightly larger than in the original description and exhibited an arm formula of 2 > 3 > 4 > 1. For each species, we provide detailed morphological descriptions, high-resolution images, and partial mitochondrial *cox1* sequences as DNA barcode references.

Keywords: Mollusca, *Amicula gurjanovae*, *Nipponacmea nigrans*, *Coralliophila carnosa*, *Sepia furcata*, Korea

INTRODUCTION

The family Mopaliidae Dall, 1889, belongs to the class Polyplacophora and is characterized by a broad girdle that is hairy or bristly, occasionally non-setose, and never covered with scales (Kaas and Van Belle, 1994). This family comprises approximately ten genera and 80 species worldwide (MolluscaBase eds., 2025). In South Korea, only three genera–*Amicula*, *Mopalia*, and *Placiphorella*–and five species have been recorded (Kil *et al.*, 2005; Noseworthy *et al.*, 2007; Lee *et al.*, 2016; Noseworthy and Choi, 2018; Kim *et al.*, 2025; National Marine Biodiversity Institute of Korea, 2025). Among these, only a single species of the genus *Amicula*, *A. amiculata* (Pallas, 1788), has been recorded to date.

The family Lottiidae Gray, 1840, within the subclass Patellogastropoda, is commonly known as the true limpets. The genus *Nipponacmea* Sasaki & Okutani, 1993 is characterized by a simple, conical shell, which typically inhabits rocky intertidal zones and is endemic to the northwestern Pacific region (Nakano and Ozawa, 2007). Due to their simple morphology and high intraspecific variability in shell shape, species identification based solely on external characters is challenging, often requiring molecular approaches for accurate delimitation (Sasaki, 1999; González-Wevar *et al.*, 2011; Teruya *et al.*, 2022). To date, thirteen species of the genus have been described, with six of them recorded in Korean waters (National Marine Biodiversity Institute of

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Korea, 2025).

The family Muricidae Rafinesque, 1815, belonging to the order Neogastropoda, is one of the most diverse marine gastropod families, comprising over 2,500 species worldwide (Choe and Park, 1997; MolluscaBase eds., 2025). Members of this family are predatory marine snails, typically possessing shells sculptured with spiral cords and axial ribs (Kil *et al.*, 2012). In Korean waters, 24 genera and 47 species have been reported, including seven species of the genus *Coralliophila* H. Adams & A. Adams, 1853 (National Marine Biodiversity Institute of Korea, 2025): *C. abnormis* (Dunker, 1857), *C. bulbiformis* (Conrad, 1837), *C. erosa* (Röding, 1798), *C. jeffreysi* (Smith, 1879), *C. morishimai* (Nakayama, 2000), *C. pulchella* A. Adams, 1854, and *C. rubrococcinea* (Kosuge, 1985).

The family Sepiidae Leach, 1817, commonly known as cuttlefish, belongs to the class Cephalopoda. The genus *Sepia* Linnaeus, 1758, has traditionally been considered one of the largest genera of cuttlefish, historically comprising over 110 species. Various researchers have suggested species groups within *Sepia*, often recognized as complex assemblages of species rather than formal subgenera. The classification of this genus has mainly relied on a few morphological characters, especially the cuttlebone and tentacular club. However, these traits may reflect ecological convergence–such as adaptations to habitat depth and prey preference–rather than true evolutionary relationships, making them potentially unreliable for defining natural groups (Ward *et al.*, 2022). Recently, Lupše *et al.* (2023) re-evaluated the genus using molecular data, leading to a major taxonomic revision. As a result, 58 species are recognized within *Sepia* (MolluscaBase eds., 2025), with seven of them reported from Korean waters to date (National Marine Biodiversity Institute of Korea, 2025).

In this study, we report the first records of four molluscan species from Korean waters: *Amicula gurjanovae* Yakovleva, 1952, *Nipponacmea nigrans* (Kira, 1961), *Coralliophila carnosa* Kosuge, 1986, and *Sepia furcata* Ho & Lu, 2005. For each species, we provide detailed morphological descriptions, high-resolution images, and partial mitochondrial *cox1* sequences as DNA barcode references.

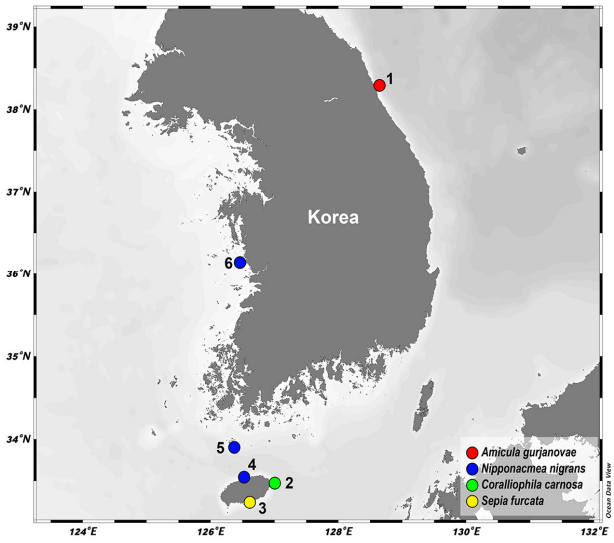

Fig. 1. The map of sampling localities for four mollusk species described in this study. **1**, Goseung; **2**, Udo, Jeju; **3**, Bomok port, Seogwipo-si, Jeju; **4**, Aewol-eup, Jeju-si, Jeju; **5**, Chuja-myeon, Jeju; **6**, Seocheon.

MATERIALS AND METHODS

1. Sample collection and species identification

Specimens were collected from intertidal to subtidal zones at depths of up to approximately 50 meters in South Korea by SCUBA diving (Fig. 1; see examined materials for details). All specimens were preserved in 95% ethyl alcohol. Species identification was conducted through morphological examinations using a stereomicroscope (Leica M205C; Wetzlar, Germany). High-resolution images were obtained using a DSLR camera (Nikon D810). Voucher specimens were deposited in the National Marine Biodiversity Institute of Korea (MABIK).

2. Molecular techniques for mitochondrial *cox1* sequencing

Total genomic DNA was extracted from the foot (Polyplacophora and Gastropoda) and fin tissue (Cephalopoda) using the DNeasy Blood & Tissue Kit (Qiagen, California, USA), following the manufacturer's

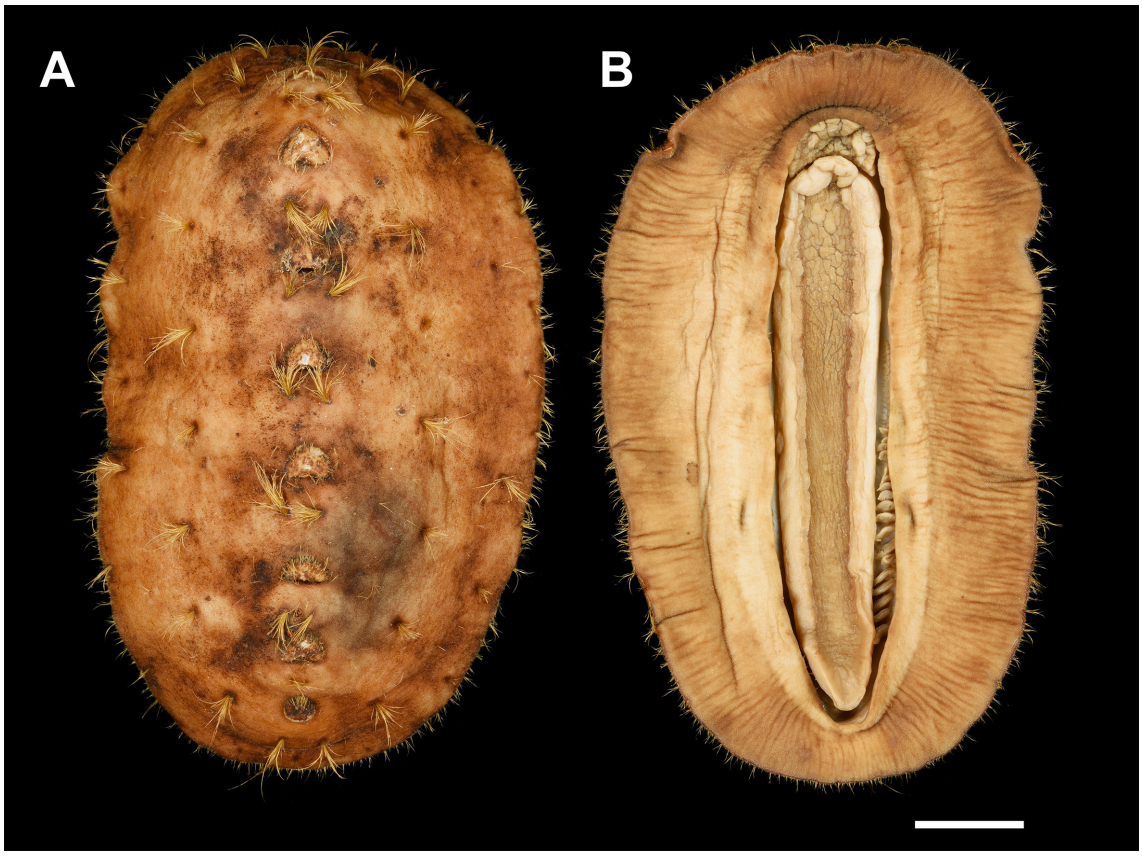

Fig. 2. *Amicula gurjanovae* Yakovleva, 1952 from Goseung, Korea (MO00189197). **A**, dorsal view; **B**, ventral view. Scale bar = 10 mm.

protocols. A partial fragment (658 bp) of the mitochondrial cytochrome *c* oxidase subunit I (*cox1*) gene was amplified using polymerase chain reaction (PCR) with the universal primers LCO1490 and HCO2198 (Folmer *et al.*, 1994) and TaKaRa Ex Taq polymerase (Takara Bio, Shiga, Japan). Each 50 μL PCR reaction mixture contained 33.75 μL of distilled water, 5 μL of 10× Ex Taq buffer, 4 μL of dNTP Mixture (2.5 mM each), 2 μL of each primer, 0.25 μL of TaKaRa Ex Taq, and 3 μL of genomic DNA template. The PCR conditions were as follows: an initial denaturation at 95°C for 1 min; 40 cycles of denaturation at 94°C for 30 s; annealing at 48°C for 30 s, and extension at 72°C for 30 s; followed by a final extension at 72°C for 7 min. Sequencing of the mtDNA *cox1* gene was performed bidirectionally using an ABI PRISM 3700 DNA analyzer (Applied Biosystems, Foster City, CA, USA). The mtDNA *cox1* sequences obtained for the four species in this study were deposited in the GenBank.

SYSTEMATIC ACCOUNTS

Phylum Mollusca Linnaeus, 1758
Class Polyplacophora Gray, 1821
Order Chitonida Thiele, 1909
Family Mopaliidae Dall, 1889
Genus *Amicula* J. E. Gray, 1847

1. *Amicula gurjanovae* Yakovleva, 1952 붉은왕털군부 (Fig. 2)

Amicula gurjanovae Jakovleva, 1952: 85, 86, fig. 40, pl. 7, fig. 1; Okutani and Saito, 1987: 166–172, figs. 1–11, pl. 1; Saito, 2017: 54, 737, pl. 10, fig. 1; Sirenko, 2024: 374–378, figs. 1A, 2A, 6B, 8–10, 12.

Amicula amiculata sensu Kaas and Van Belle, 1994: 344, fig. 139, map 50; Saito, 2000: 16, 17, pl. 8, fig. 10, Min *et al.*, 2004: 72, 73, fig. 11 (non *Chiton amiculatus* Pallas, 1788).

Materials examined. Total 2 individuals; 1 individual (MO00189197); Munamjin-ri, Jukwang-myeon, Goseong-gun, Gangwon-do (38°17'30.7"N, 128°35'20.7"E), collected by Trimix SCUBA diving at depth of 55.2 m, 14 October 2021, collectors: Lee T, Lee D, Choi J-M; 1 individual (MO00189196); Munamjin-ri, Jukwang-myeon, Goseong-gun, Gangwon-do (38°17'58.0"N, 128°34'28.1"E), collected by SCUBA diving at depth of 34.7 m, 12 April 2023, collectors: Lee D, Park J.

Diagnosis. Body elongate-oval; large in size, second only to *Cryptochiton stelleri* (Middendorff, 1847) among known chitons (Fig. 2; in examined specimens, body length [BL] 32.74-66.42 mm, body width [BW] 20.75-40.91 mm). Valves nearly covered by perinotum (Fig. 2A); tegmentum restricted to very small, narrow, inverted heart-shaped, pale yellowish in color; surface sculptured with coarse granules. Head valve small, semicircular, narrower than or as wide as tail valve. Intermediate valves with low, inconspicuous apices; Tail valve subtriangular with posterior mucro. Perinotum light brown to reddish brown, thick, fleshy, dorsally elevated around head and foot; dorsum densely covered with elongate, slender, yellowish spicules. Bristle tufts arranged in two parallel rows along each side of tegmenta, each tuft consisting of long, pale yellow, smooth bristles; additional single row of bristle tufts positioned inward from outer margin of girdle; remaining perinotal surface sparsely covered with shorter bristles. Hyponotum covered with larger, decolorized spicules. Gills arrangement abanal and merobranchial on both sides, from 4th valve to 7th valve (Fig. 2B).

GenBank accession numbers. PV952760 (MO00189197), PV952761 (MO00189196).

Distribution. Low-boreal region of the West Pacific, including the southern part of the Sea of Okhotsk, the East Sea [Sea of Japan], Japan (Hokkaido), and Korea (Goseong-gun).

Remarks. After Sirenko (2024) revised the genus *Amicula* based on comprehensive morphological analysis, only two valid species are currently accepted worldwide: *A. amiculata* (Pallas, 1788) and *A. gurjanovae* Yakovleva, 1952, while *A. vestita* (Broderip et Sowerby, 1829), long regarded valid, was recently synonymized with *A. amiculata*.

This study confirms the presence of *A. gurjanovae* in Korean waters for the first time, indicating that both valid *Amicula* species (*A. amiculata* and *A. gurjanovae*) occur in the region. Considering their known distributions–*A. amiculata* being a widespread and often abundant intertidal species in the North Pacific and Arctic, including the northern Kuril Islands, whereas *A. gurjanovae* is a rare species restricted to deeper waters (≥ 6 m) off the southern Kuril Islands and southern Sakhalin (Sirenko, 2024)–it is possible that some previous Korean records identified as *A. amiculata* may in fact correspond to *A. gurjanovae*. However, due to the lack of reference specimens and the limited quality of earlier Korean records (e.g., low-resolution images, brief descriptions), this assumption remains unverified and requires further re-examination.

Class Gastropoda Cuvier, 1795
Subclass Patellogastropoda Lindberg, 1986
Family Lottiidae Gray, 1840
Genus *Nipponacmea* Sasaki & Okutani, 1993

2. *Nipponacmea nigrans* (Kira, 1961) 검은테배무래기 (Fig. 3)

Notoacmea nigrans Kira, 1961: 293, 295, fig. 2.
Collisella (*Collisella*) *mortoni* Christiaens, 1980: 72, fig. 10, pl. 6B; Sasaki and Okutani, 1994: 130, fig. 2; Teruya *et al.*, 2022: 181.
Nipponacmea concinna nigrans: Higo *et al.*, 1999: 35.
Nipponacmea nigrans: Sasaki and Okutani, 1993: 22, pl. 1, figs. 17–21; Sasaki, 2000: 33. pl. 16, fig. 27; Sasaki, 2017: 743, pl. 16, fig. 1; Teruya *et al.*, 2022: 178, figs. 4F–O, 5G, 6G, 7H–J.

Materials examined. Total 3 individuals; 1 individual (MO00189580); Hagwi 1-ri, Aewol-eup, Jeju-si, Jeju-do (33°29'25.88"N, 126°24'54.33"E), 20 April 2017, collectors: Park J-K, Lee Y-C, Shin Y-H, Park J; 1 individual (MO00189209); Sin-yang-ri, Chuja-myeon, Jeju-si, Jeju-do (33°55'50.74"N, 126°19'46.87"E), 8 September 2021, collectors: Park J-K, Putri ET, Park J; 1 individual (MO00187909); Chunjangdae Beach, Seo-myeon, Seocheon-gun, Chungcheongnam-do

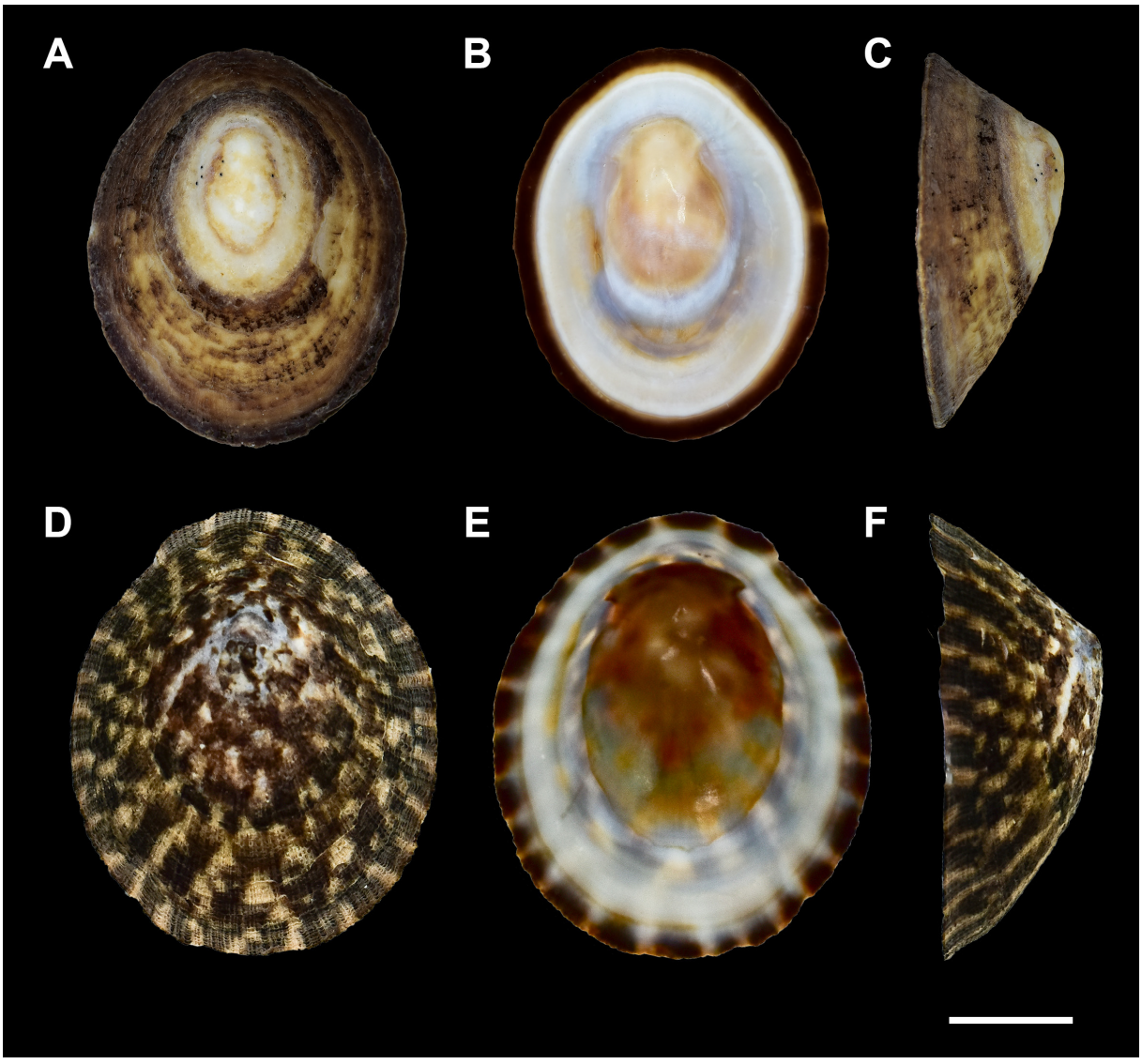

Fig. 3. *Nipponacmea nigrans* (Kira, 1961). **A–C**, small specimen (MO00189209) from Chuja-myeon, Jeju, Korea. **D–F**, large specimen (MO00189580) from Aewol-eup, Jeju-si, Jeju, Korea. **A**, **D**, dorsal view; **B**, **E**, ventral view; **C**, **F**, lateral view. Scale bar = 5 mm.

(36°09'35.53"N, 126°30'58.83"E), 24 March 2024, collectors: Lee S, Kim C-H.

Diagnosis. Shell thick, medium-sized (Fig. 3A, B, D, F; in examined specimens (MO00189209, MO00189580), shell length [SL] 17-21 mm, shell width [SW] 14-17 mm), relatively high (Fig. 3C, F; shell height [SH] 6-9 mm). Apex blunt, often eroded, curved anteriorly, positioned one-fourth from the anterior margin; anterior slope nearly straight; posterior slope straight to slightly convex. Surface sculptured with dense riblets bearing distinct granules. Aperture oval. Exterior color yellowish-brown. Interior margin dark brown; intermediate area milky-white, central area yellow to light brown. Cephalic tentacle black. Snout and lateral side of foot gray.

GenBank accession number. PV952758 (MO00189209).

Distribution. China, Japan, Taiwan, and Korea.

Remarks. This species was originally described by Kira (1961) as *Notoacmea nigrans*, a distinct species. However, subsequent studies treated it as an intraspecific variant of *Nipponacmea concinna*

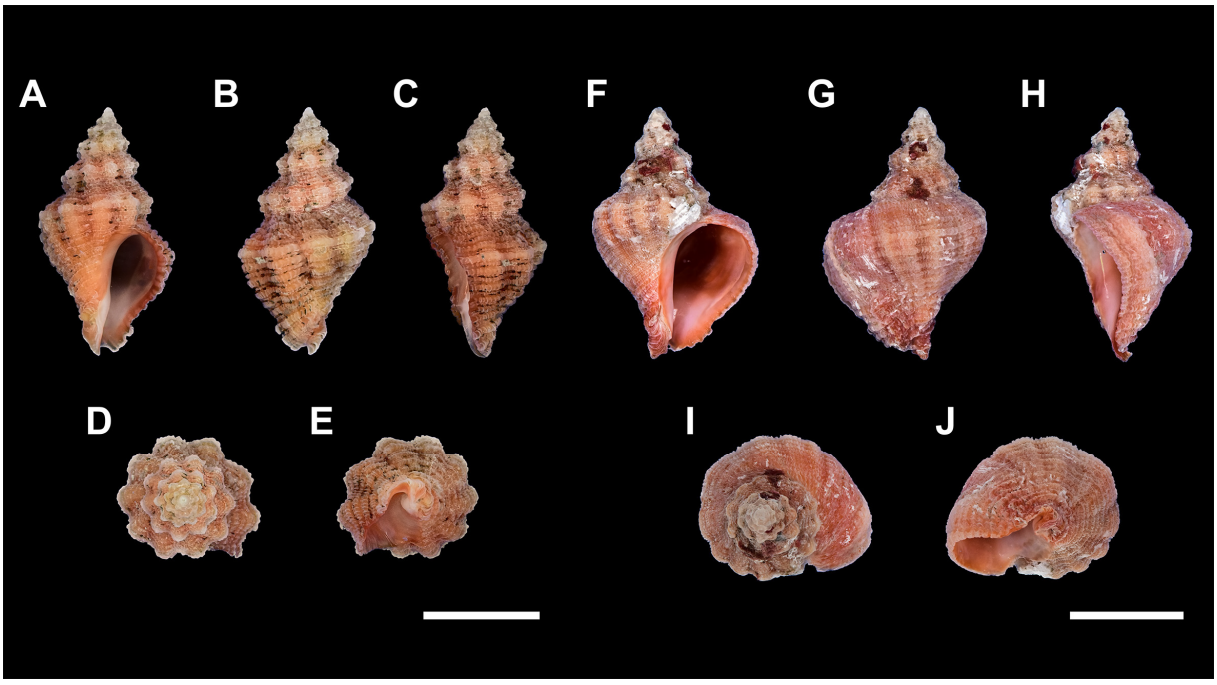

Fig. 4. *Coralliophila carnosa* Kosuge, 1986 from Udo, Jeju, Korea. **A-E**, small specimen (MO00189200); **F-J**, large specimen (MO00189207). **A**, **F**, ventral view; **B**, **G**, dorsal view; **C**, **H**, lateral view; **D**, **I**, apical view; **E**, **J**, basal view. Scale bars: **A-E** = 5 mm; **F-J** = 10 mm.

(Lischke, 1870) (Habe and Kosuge, 1967; Kuroda *et al.*, 1971). In Korea, it has sometimes been referred to as *N. concinna* (Min *et al.*, 2004), leading to taxonomic confusion. Nevertheless, detailed morphological comparison reveals consistent differences between *N. nigrans* and *N. concinna*, particularly in apex position, shell structure, and body coloration. *N. nigrans* has a non-protruding apex, dense riblets, and gray pigmentation on the snout and lateral sides of the foot. In contrast, *N. concinna* exhibits a slightly protruding apex, lacks riblets, and shows no distinct pigmentation on the snout but black pigmentation on the lateral sides of the foot (Teruya *et al.*, 2022). In some specimens (Fig. 3A-C; MO00189209), the granules on the radial ribs are not clearly visible due to environmental factors that have worn the shell. However, these specimens can still be identified as *N. nigrans* by their relatively elevated apex and characteristic gray pigmentation on the snout and lateral foot.

Sasaki and Okutani (1994) suggest that *Collisella mortoni* (Christiaens J, 1980) could be considered a junior synonym of *N. nigrans* after close re-examining the type specimen. This conclusion is supported by the presence of a relatively high apex and granulated shell sculpture.

N. nigrans is also morphologically similar to *Nipponacmea moskalevi* A. V. Chernyshev & Chernova, 2002, which is reported from Peter the Great Bay, Russia, because they share similar in overall shell shapes and the fine radial riblets. *N. nigrans* has distinct body coloration, with gray pigmentation on the snout and lateral sides of the foot, which is absent in *N. moskalevi*.

Subclass Caenogastropoda L. R. Cox, 1960
Order Neogastropoda Wenz, 1938
Family Muricidae Rafinesque, 1815
Subfamily Coralliophilinae Chenu, 1859
Genus *Coralliophila* H. Adams & A. Adams, 1853

3. *Coralliophila carnosa* Kosuge, 1986 비늘산호살이고둥 (Fig. 4)

Coralliophila carnosa Kosuge, 1986: 74, pl. 27, figs. 3, 4, pl. 29, fig. 6; Tsuchiya, 2000: 414, 415, pl. 206, fig. 273; 2017: 969, pl. 264, fig. 2; Nocella *et al.*, 2024.

Materials examined. 10 individuals (MO00189198–

MO00189207); southeastern sea of Udo, Udo-myeon, Jeju-si, Jeju-do (33°29'20.4"N, 126°59'45.6"E), collected by SCUBA diving at depth of 32.4 m, 30 July 2024, collectors: Lee D, Park J, Kim Y, Kil H, Ra S-G, and Song K-Y.

Diagnosis. Shell small in size within genus (Fig. 4A-C, F-H; in examined specimens, SH 11.4-15.73 mm, SW 6.7-11.11 mm), solid, thick, biconical or rhomboidal in shape. Shell color ranging from pale flesh to orange, sometimes pale yellowish gray. Spire short, up to seven whorls, roundly angulated at shoulder with prominent spiral cords. Body whorl large, occupying approximately two-thirds of entire shell length, nearly straight-sided below shoulder. Surface sculptured with thick, distinct axial ribs and scaly spiral cords; axial ribs rounded, densely packed, strongest at shoulder (Fig. 4A-D, F-I), diminishing toward base; spiral cords consist of alternating thicker primary and thinner secondary cords, with approximately 24 cords on the body whorl, each bearing fine, scaly projections, crossed by lamellate axial ribs. Aperture elongate-oval; outer lip thin, denticulate, weakly crenulated inside; inner lip gently curved; columella straight, smooth. Siphonal fasciole short, low, without basal constriction. Umbilicus narrow, with minute perforation (Fig. 4E, J). Operculum thick, reddish brown.

GenBank accession numbers. PV961421–PV961430 (MO00189198–MO00189207)

Distribution. Japan and Korea.

Remarks. This species is newly recorded in the Korean *Coralliophila* fauna, which now comprises eight species: *C. abnormis* (Dunker, 1857), *C. bulbiformis* (Conrad, 1837), *C. erosa* (Röding, 1798), *C. jeffreysi* (Smith, 1879), *C. morishimai* (Nakayama, 2000), *C. pulchella* A. Adams, 1854, and *C. rubrococcinea* (Kosuge, 1985).

C. carnosa is morphologically similar to *C. pulchella* in its small shell size and the presence of intersecting axial and spiral cords, but differs by having a more slender shell form, a less angulated shoulder, and more densely packed axial ribs (Kosuge, 1986). It has also been considered potentially conspecific with *C. morishimai* due to overall morphological similarity (Tsuchiya, 2017); however, *C. carnosa* differs by having a relatively narrower shell width and more numerous and prominent spiral cords. In contrast, *C. morishimai* exhibits a narrower spire, a more inflated body whorl, an open siphonal canal, and axial ribs that are obscure on the body whorl but more distinct from the penultimate whorl upward. Despite these morphological differences, molecular data for *C. morishimai* are currently lacking, and the potential conspecificity between *C. carnosa* and *C. morishimai* requires further investigation through detailed morphometric and molecular analyses.

Class Cephalopoda Cuvier, 1795
Order Sepiida Gray, 1849
Family Sepiidae Leach, 1817
Genus *Sepia* Linnaeus, 1758

4. *Sepia furcata* Ho & Lu, 2005 짧은꼬리갑오징어 (Fig. 5)

Sepia furcata Ho and Lu, 2005: 52–60, figs. 1–4.

Material examined. 1 individual (MO00189208; female); Bomok port, Bomok-dong, Seogwipo-si, Jeju-do (33°14'21.6"N, 126°36'30.8"E), collected by a fisher and submitted by Prof. Kim J-G (Pukyong National University's Marine Fish Resource Bank of Korea [MFRBK]), 24 April 2024.

Diagnosis. Small to moderate-sized cuttlefish (Fig. 5; in examined specimen, mantle length [ML] 65.89 mm, mantle width [MW] 27.36 mm). Mantle oblong with triangular, anteriorly extended dorsal mantle margin. Fins narrow, positioned posteriorly, forming bifurcated tail-like posterior extension. Head slightly slender, narrower than mantle. Eyes moderate in size, approximately half of head length. Arm formula is 2 > 3 > 4 > 1 (18-36.5-36-21 mm); arm suckers proximally tetraserial and distally biserial, without greatly enlarged suckers. Tentacular clubs small, crescent-shaped, with smaller suckers per transverse row; central suckers slightly enlarged. Papillae absent on body, head, arms.

Colour: dorsal mantle pinkish-brown, with denser pigment along the midline; head dark red-brown, with pigment denser around eyes; fins paler than mantle, with pigment denser along boundary

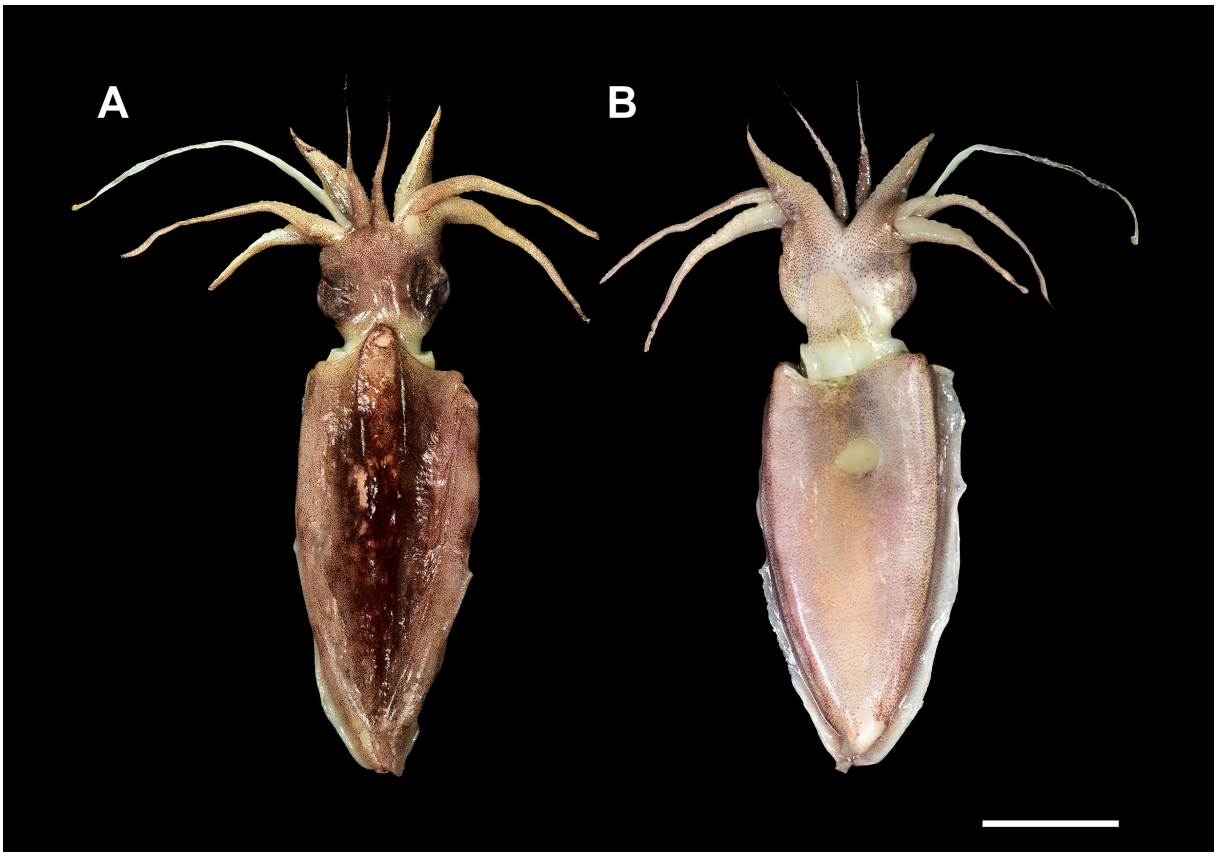

Fig. 5. *Sepia furcata* Ho & Lu, 2005 from Bomok port, Seogwipo-si, Jeju, Korea (MO00189208). **A**, dorsal view; **B**, ventral view. Scale bar = 20 mm.

between mantle and fins. Ventral sides of mantle, head, arms paler than dorsal sides.

GenBank accession number. PV952759 (MO00189208).

Distribution. Taiwan and Korea.

Remarks. This species is recorded for the first time in Korean waters, based on a single female specimen; its type locality is Taiwan. The original description reports a maximum mantle length (ML) of approximately 55 mm and an arm formula of 2 > 3 = 4 > 1. However, some specimens were noted to show variation such as 3 > 4 or even 4 > 3 (Ho and Lu, 2005). The specimen described herein is slightly larger and exhibits an arm formula of 2 > 3 > 4 > 1, consistent with the range of variation noted in the original description. Compared to males, the female specimen exhibits a shorter "tail," the posterior extension of the fin (Ho and Lu, 2005).

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