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한국산 새우붙이상과의 계통분류학적 연구

**A Systematic Study of the Superfamily
Galattheoidea (Crustacea: Decapoda: Anomura)
from Korea: Taxonomy and DNA Barcoding**

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생명과학부

이 상 휘

ABSTRACT

A Systematic Study of the Superfamily Galatheoidea (Crustacea: Decapoda: Anomura) from Korea: Taxonomy and DNA Barcoding

Sanghui Lee

School of biological sciences

The graduate school

Seoul National University

A systematic study of the superfamily Galatheoidea in Korean waters was conducted. The examined specimens were collected at 51 localities from 1959 to 2012 for present study. 182 individuals of the specimens were collected by author during the period from 2011 to 2012, and 543 individuals of remaining specimens are deposited in the Laboratory of Systematics and Molecular Evolution, Seoul National University from 1959 to 2010. Twenty species of fifteen genera in three families belonging to the superfamily Galatheoidea were identified based on morphological characteristics and literatures. Among them, six species, *Allogalathea elegans* (Adams & White, 1848), *Phylladiorhynchus pusillus* (Henderson, 1885), *Raymunida formosanus* Lin, Chan & Chu, 2004, *Raymunida lineata* Osawa, 2005, *Aliaporcellana pygmaea* (De Man, 1902) and *Lissoporcellana*

nakasonei (Miyake, 1978), were recorded for the first time in Korea. Of all Korean galatheoids, except for two of not obtained species: *Munida japonica* Stimpson, 1858 and *Paramunida scabra* (Henderson, 1885), eighteen species obtained in the study were described with taxonomic remarks, and illustrated with photographs. And the updated checklist and the key to species of Korean galatheoids were provided herein. The mitochondrial cytochrome *c* oxidase subunit I (mtCOI) sequences from 39 individuals of 12 species of the Korean galatheoids were obtained, and examined by DNA barcoding method. As a result, it showed that the interspecific sequence variation rate averaged 15.5%. This means that species identification of the Korean galatheoids using DNA barcoding is valid.

Keywords: Galatheaidea, Korean fauna, Systematic study, DNA barcoding, mtCOI

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INTRODUCTION

The superfamily Galatheoidea Samouelle, 1819 belong to the suborder Anomura is one of the most morphologically and ecologically diverse taxon (De Grave et al., 2009; Baba et al., 2009; Osawa, 2007). For this reason, the monophyletic origin of Galatheoidea had been controversial. By Ahyong et al. (2011), Galatheoidea divided into 2 superfamilies, Chirostyloidea Ortmann, 1892 and Galatheoidea Samouelle, 1819. Galatheoidea contained four families, Galatheidae, Munididae, Munidopsidae, and Porcellanidae. Galatheidae, Munididae and Munidopsidae look like lobster. They have a “crouching or squatting” appearance so they called squat lobster alongside chirostyloids. Porcellanidae is crab-like but are not actually closely related to true crabs. Porcellanids can be easily distinguished from true crabs, brachyurans, in having the fifth pereopod much small, and the antennal peduncle having long flagellum. Galatheoids can be found shallow-water coral reefs to deep-sea hydrothermal vents excluding polar region (De Grave et al., 2009; Baba et al. 2008; Osawa, 2007).

Galatheoids play an important role as recyclers in many sedimentary ecosystems, either by reincorporating organic matter into the food web or by producing highly nutritive faeces. Feeding on primary producers, bacteria or detritus, and being consumed by several top predators, squat lobsters represent a direct trophic shortcut in many marine food webs (Lovrich and Thiel, 2011).

The Galatheoidea includes 63 extant genera and about 930 extant species in the world, and during the last five years, about 80 species were newly reported (Baba et

al., 2009; Osawa and Chan, 2010). Especially in the Indo-West Pacific, which included Korea, the researches of galatheoids are proceeding actively, so 673 species of galatheoids have been recorded.

DNA barcoding is a taxonomic method that uses a short DNA segment to identify it as belonging to a particular species (Hebert et al., 2003). The barcode region for the animal kingdom is a 650 base pair fragment of the mitochondrial cytochrome *c* oxidase subunit I (COI) gene (Carr et al., 2011). This method can be used recognize species with incomplete taxonomy, and morphological, ecological, and behavioural differences are regularly detected upon further examination of divergent taxa (Carr et al., 2011).

Despite a great number of species worldwide, only 14 species belonging to 3 families are reported from Korea (Kim, 1973; Ko, 2003; 2006). A systematic study of Korean galatheoids is nonexistent after Kim (1973).

The aim of this study is to describe the Galatheoids including 14 known species and 6 unrecorded species in Korea. The descriptions, illustrations, photographs of whole body, and taxonomic key of the superfamily Galatheaidea are provided herein. In addition, DNA barcoding was applied to the 12 species. DNA barcoding is one of a DNA based identification system using 658 base-pair of a partial sequence of the mitochondrial genes coding for cytochrome *c* oxidase subunit I (COI) (Hebert et al., 2003).

MATERIALS AND METHODS

Sampling

The examined specimens were collected from 51 localities in Korean coastal regions. More than 700 individuals were examined for this study. During the period March 2011 to October 2012, 182 individuals were collected, and remaining specimens of examined this study are deposited in the Laboratory of Systematics and Molecular Evolution, Seoul National University from May 1959 to October 2010. Materials were collected from intertidal zone and rocky shore, while the species that lived shallow subtidal zone were collected by SCUBA diving. Some deep sea species were collected by trawler. Each material was preserved in 99% ethyl alcohol at the site for morphological study and molecular study.

Table 1. Collection localities list

	Collection locality	Latitude (N)	Longitude (E)
	Incheon Metropolitan City		
1	Yeonpyeong-myeon, Ongjin-gun	37°39'22.37"N	125°42'0.01"E
2	Seonjae-ri, Yeongheung-myeon, Ongjin-gun	37°14'56.52"N	126°31'17.68"E
3	Deokjeok-myeon, Ongjin-gun	37° 5'6.81"N	125°57'19.70"E
	Chungcheongnam-do		
4	Taeon-gun	36°25'17.01"N	126°21'32.91"E
5	Ocheon-myeon, Boryeong-si	36°19'46.81"N	126°21'5.41"E
6	Woljeon-ri, Nampo-myeon, Boryeong-si	36°16'30.31"N	126°32'13.53"E
7	Gwandang-ri, Ungcheon-eup, Boryeong-si	36°14'37.45"N	126°32'2.09"E
	Jeollabuk-do		
8	Okdo-myeon, Gunsan-si	35°44'49.21"N	126°27'59.31"E
9	Gyeokpo-ri, Byeonsan-myeon, Buan-gun	35°36'13.70"N	126°27'53.42"E
10	Buan-gun	35°35'0.97"N	126°36'18.23"E

Table 1. (continued)

	Collection locality	Latitude (N)	Longitude (E)
Jeollabuk-do			
11	Jaryong-ri, Sangha-myeon, Gochang-gun	35°26'18.45"N	126°25'46.39"E
Jeollanam-do			
12	Imja-myeon, Sinan-gun	35° 8'35.16"N	126° 8'28.30"E
13	Hongdo-ri, Heuksan-myeon, Sinan-gun	34°41'53.42"N	125°11'43.56"E
14	Jindo-gun	34°31'4.25"N	126°11'44.40"E
15	Geomun-ri, Samsan-myeon, Yeosu-si	34° 2'49.09"N	127°18'34.25"E
16	Dolsan-eup, Yeosu-si	34°36'22.91"N	127°47'19.43"E
17	Gwangyang-si	34°55'25.03"N	127°41'59.57"E
Gyeongsangnam-do			
18	Sangju-ri, Sangju-myeon, Namhae-gun	34°42'43.61"N	127°59'32.98"E
19	Mijo-ri, Mijo-myeon, Namhae-gun	34°43'4.66"N	128° 3'1.99"E
20	Nodae-ri, Yokji-myeon, Tongyeong-si	34°40'33.56"N	128°13'37.24"E
21	Nambu-myeon, Geoje-si	34°43'54.30"N	128°36'9.77"E
22	Jinhae-gu, Changwon-si	35° 7'21.45"N	128°41'39.75"E
Busan Metropolitan City			
23	Jung-dong, Haeundae-gu	35° 9'27.01"N	129°10'17.54"E
24	Yeongdo-gu	35° 5'35.45"N	129° 4'22.31"E
Gyeongsangbuk-do			
25	Guryongpo-eup, Nam-gu, Pohang-si	35°58'52.33"N	129°33'26.04"E
26	Geumjin-ri, Ganggu-myeon, Yeongdeok-gun	36° 21'15.15"N	129°22'43.07"E
27	Jukbyeon-ri, Jukbyeon-myeon, Uljin-gun	37° 5'48.44"N	129°23'40.40"E
28	Nagok-ri, Buk-myeon, Uljin-gun	37° 7'31.48"N	129°22'31.93"E
29	Sadong-ri, Ulleung-eup, Ulleung-gun	37°27'7.23"N	130°52'31.96"E
30	Seo-myeon, Ulleung-gun	37°28'41.49"N	130°48'20.73"E
31	Jeodong-ri, Ulleung-eup, Ulleung-gun	37°31'35.43"N	130°56'8.18"E
32	Buk-myeon, Ulleung-gun	37°32'36.43"N	130°53'24.53"E
33	Dokdo-ri, Ulleung-eup, Ulleung-gun	37°14'34.95"N	131°51'51.86"E
Gangwon-do			
34	Anin-ri, Gangdong-myeon, Gangneung-si	37°44'16.31"N	129° 0'16.14"E
35	Obong-ri, Jugwang-myeon, Goseong-gun	38°19'32.85"N	128°31'56.57"E
Jeju-do Isl.			
36	Chuja-myeon, Jeju-si	33°57'42.83"N	126°18'42.68"E
37	Gosan-ri, Hangyeong-myeon, Jeju-si	33°18'2.83"N	126° 9'53.79"E

Table 1. (continued)

	Collection locality	Latitude (N)	Longitude (E)
	Jeju-do Isl.		
38	Sinchang-ri, Hangyeong-myeon, Jeju-si	33°20'52.61"N	126°10'34.53"E
39	Geumneung-ri, Hallim-eup, Jeju-si	33°22'16.42"N	126°12'9.67"E
40	Hyeopjae-ri, Hallim-eup, Jeju-si	33°23'40.07"N	126°13'47.52"E
41	Samyang-dong, Jeju-si	33°31'43.92"N	126°35'6.02"E
42	Iho-dong, Jeju-si	33°30'5.76"N	126°27'3.71"E
43	Aewol-eup, Bukjeju-gun	33°28'9.50"N	126°19'26.64"E
44	Cheonji-dong, Seogwipo-si	33°14'12.89"N	126°33'28.18"E
45	Songsan-dong, Seogwipo-si	33°13'56.61"N	126°34'2.92"E
46	Seogwi-dong, Seogwipo-si	33°13'41.43"N	126°33'54.109"E
47	Daecheon-dong, Seogwipo-si	33°13'35.50"N	126°28'35.34"E
48	Beophwan-dong, Seogwipo-si	33°12'59.34"N	126°30'51.19"E
49	Daejeong-eup, Seogwipo-si	33°9'59.29"N	126°16'32.45"E
50	Goseong-ri, Seongsan-eup, Seogwipo-si	33°25'23.83"N	126°55'53.40"E
51	Obong-ri, Udo-myeon, Jeju-si	33°30'57.68"N	126°56'54.74"E

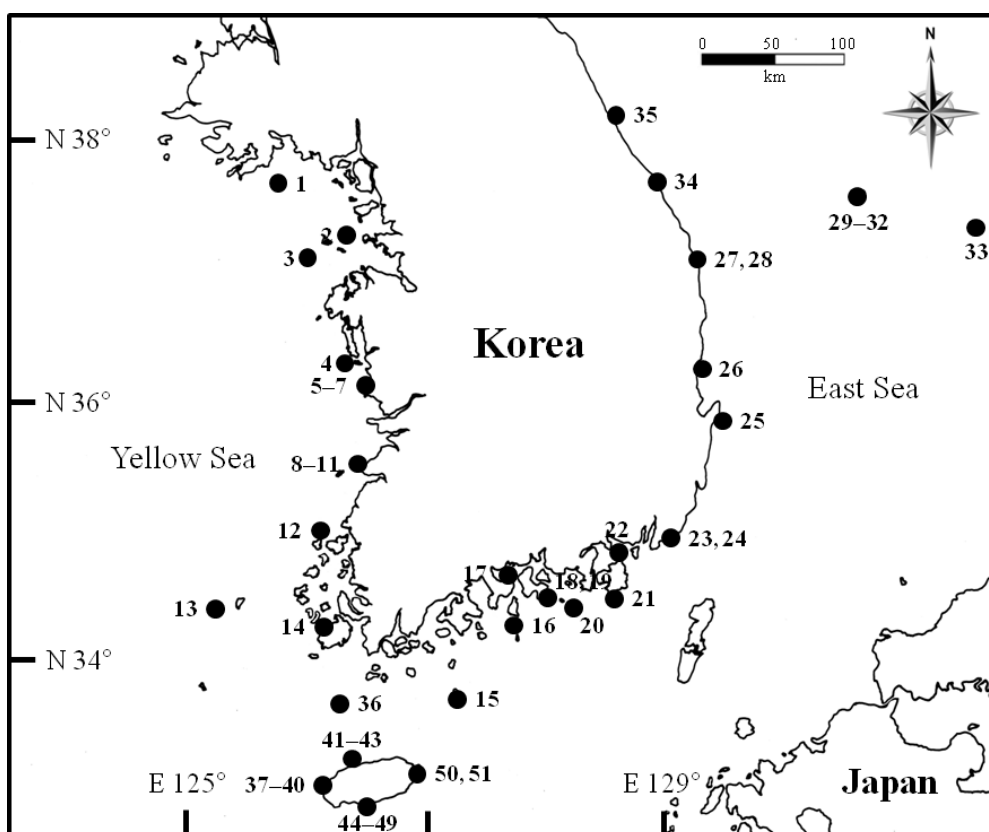


Fig. 1. Collection localities of Korean galatheoids in this study.

Morphological analysis

The samples were sorted out under the naked eyes and cleaned mud and algae off their external skeleton by the soft brush. The specimens were dissected and identified with the dissecting pins made of tungsten wire under a stereomicroscope (Model MZ 8; Leica, Wetzlar, Germany). Each dissected appendages were mounted with small petri dish and stained with methylene blue. All drawings were prepared using camera lucida attached to a stereomicroscope (Model MZ 8; Leica, Wetzlar, Germany). Images were taken using a micro scope digital camera (Model D7000; Nikon, Tokyo, Japan), and produced with Helicon Focus software (Model Helicon Focus; Helicon Soft Ltd., Kharkov, Ukraine). The abbreviation CL refers to the carapace length. In Munididae and Galatheidae, the length of the carapace was measured from the level of the sinus formed by the rostrum and supraocular spines to the posterior spines to the posterior margin along the midline. And in Porcellanidae, the length of the carapace was measured from the anterior median tip or notch of the rostrum to the posteromedian margin of the carapace.

DNA Barcoding

Sequencing

Out of a total of 20 species, 39 individual of 12 species were used for sequencing. Total genomic DNA was extracted from the pereopods of each morphologically identified specimen using a DNeasy Blood & Tissue Kit (QIAGEN, Hilden, Germany). A partial sequence of the mitochondrial genes coding for cytochrome *c*

oxidase subunit I (COI) was amplified by polymerase chain reactions (PCR) using the universal primers, LCO 1490 (5'-GGT CAA CAA ATC ATA AAG ATA TTG G-3') and HCO 2198 (5'-TAA ACT TCA GGG TGA CCA AAA AAT CA-3') (Folmer et al., 1994). PCR were conducted in 25 μ L volumes with 1–3 μ L of genomic DNA, 5 μ L of 5x color Go Taq reaction buffer (Promega, Madison City, WI, USA), 1 μ L of each primer (10 μ M), 1 μ L of dNTP mixture (10mM), 0.3 μ L Go Taq DNA polymerase (Promega, Madison City, WI, USA) and 13.7–15.7 μ L distilled H₂O. Conditions for COI amplification were an initial denaturation at 95°C for 5 min, then 38 cycles of 95°C for 1 min, annealing for 1.5 min at 50°C, extension at 72°C for 2 min and final extension at 72°C 20 min. PCR products were checked by running 5 μ L of the reaction on a 1% agarose gel. PCR products were purified using QIAquick PCR Purification Kit (QIAGEN, Hilden, Germany). Sequencing products were resolved on an ABI 3730 automated DNA sequencer (Applied Biosystems Inc., California, USA).

DNA barcode analysis

The pair-wise nucleotide sequence divergences were quantified using the Kimura 2 parameter (K2P) model of base substitution (Kimura, 1980). The all dataset were used to analyse using neighbor-joining tree (NJ). The bootstrap value with 1,000 replications was applied to examine the NJ tree using MEGA 4 (Tamura et al., 2007).

RESULTS

Systematic accounts

Subphylum Crustacea Brünnich, 1772

Class Malacostraca Latreille, 1802

Subclass Eumalacostraca Grobben, 1892

Superorder Eucarida Calman, 1904

Order Decapoda Latreille, 1802

Infraorder Anomura MacLeay, 1838

Superfamily Galatheoidea Samouelle, 1819

Key to families of Galatheoidea in Korea

1. Third maxilliped operculiform; abdomen folded against thorax; epipod absent
..... Porcellanidae
- Third maxilliped pediform; abdomen bent but not folded against thorax; epipod present 2
2. Rostrum spiniform Munididae
- Rostrum broad, triangular Galatheididae

Family Galatheididae Samouelle, 1819

Key to genera of Galatheididae from Korea

1. Rostrum dagger shaped; having distinct supraocular spine on each side

- *Phylladiorhynchus*
- Rostrum triangular; bearing few lateral teeth; without supraocular spines 2
2. Rostrum extremely elongate; having about 7 lateral teeth *Allogalathea*
- Rostrum moderately elongate; having about 4 lateral teeth *Galathea*

Genus *Allogalathea* Baba, 1969

1. *Allogalathea elegans* (Adams & White, 1848)

Galathea elegans Adams & White, 1848: Pl. 12, fig.7 [type locality: Corregidor, Philippines]; Lewinsohn, 1969: 123, fig. 24.

Allogalathea elegans: Baba, 1969: 6, fig. 1; Haig, 1973: 275; Macpherson, 2008: 289; Baba *et al.*, 2008: 53, fig. 2B; Baba *et al.*, 2009: 88, fig. 73; Cabezas *et al.*, 2011: 256, figs. 2, 3.

Material examined. 1 ♂, 1 ♀, Beophwan-dong, Seogwipo-si, Jeju-do, 14 Aug 2010; 1 ♂, 1 ♀, Beophwan-dong, Seogwipo-si, Jeju-do, 28 Apr 2012.

Distribution. Mozambique, Madagascar, Taiwan, the Philippines, Indonesia, Vanuatu, New Caledonia, South Africa, Sri Lanka, Japan, Australia, Fiji and Korea (in this study).

Description. Carapace (Figs. 2, 3A) exclusive of rostrum, as long as broad; dorsal surface with distinct transverse striae bearing fine setae. Lateral margin with nine spines: having two anterolateral spines, three anterior branchial marginal spines, four branchial marginal spines. Cervical groove distinct. Rostrum triangular,



Fig. 2. *Allogalathea elegans* (Adams & White, 1848), male. Carapace length, 7.2 mm, dorsal view.

pubescent dorsally, slightly shorter than remaining carapace length; bearing about seven lateral teeth.

Pterygostomian flap slightly rugose, bearing setae.

Sternal plastron (Fig. 3B) as long as wide, bearing distinct longitudinal groove medially, lateral limits expand posteriorly. Third sternite with anterior margin having notch.

Second to fourth abdominal somites (Figs. 2, 3A) having three uninterrupted transverse ridges.

Ocular peduncles (Figs. 2, 3A) subcylindrical, slightly expanded distally.

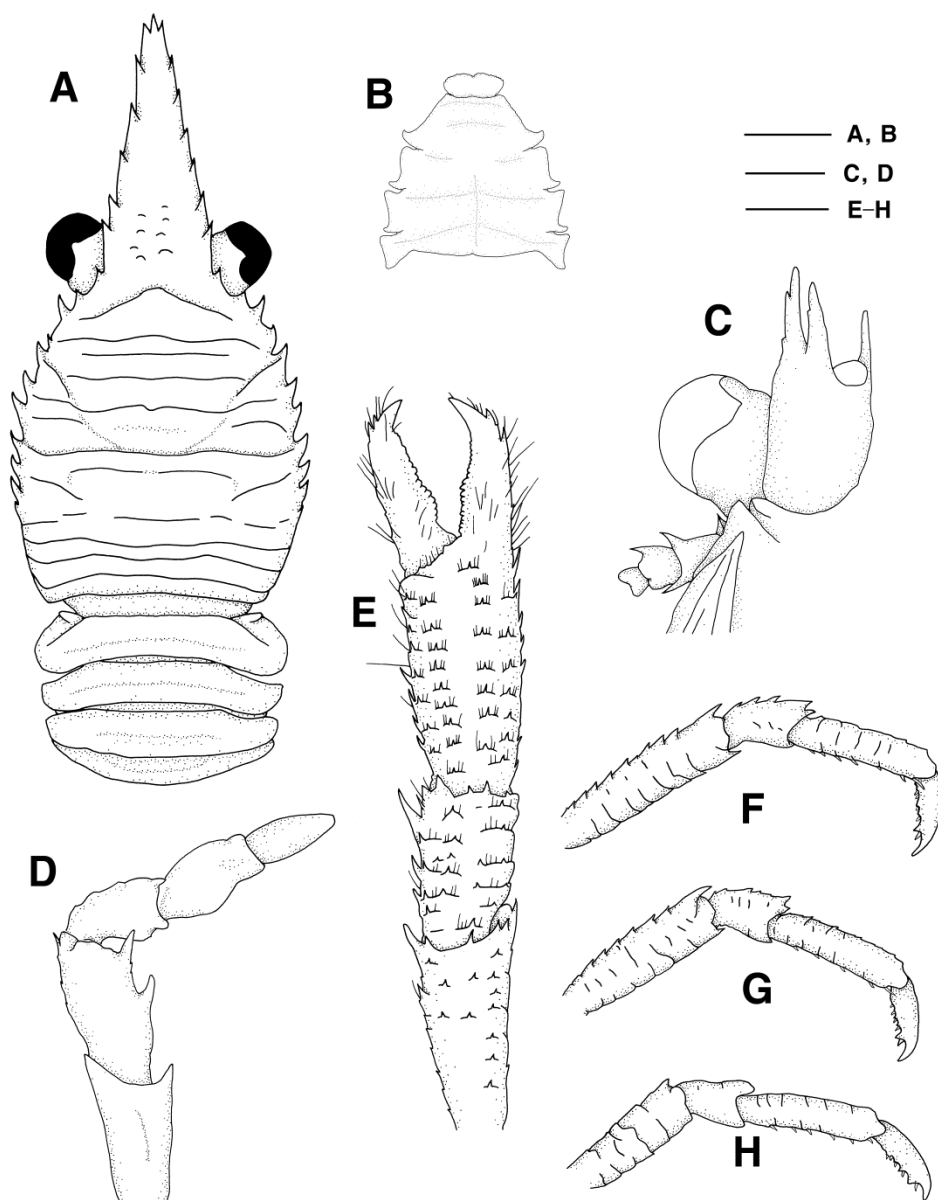


Fig. 3. *Allogalathea elegans* (Adams & White, 1848), male. A, carapace, anterior part of abdomen; B, sternal plastron; C, anterior right part of cephalothorax; D, right third maxilliped; E, right first pereopod; F, right second pereopod; G, right third pereopod; H, right fourth pereopod. Scale bars: A, B=1 mm, C, D=1 mm, E–H= 0.5 mm.

Basal article of antennular peduncle (Fig. 3C) having well developed two distal spines; bearing one lateral spine, longer than distal spines.

Second article of antennal peduncle (Fig. 3C) bearing two distal spines. Third article of antennal peduncle having one small distomesial spine. Fourth article of antennal peduncle unarmed.

Third maxillipeds (Fig. 3D) with ischium bearing one distal spine on flexor margin. Merus with two strong spines on flexor margin. Carpus having one small spine on distal end of extensor margin. Propodus and dactylus unarmed. Exopod reaching distal end of merus.

First pereopod (Fig. 3E) stout, squamous, setose and spinose. Merus with spines on extensor and flexor distal margins. Carpus with row of spines on mesial margin. Palm about 1.2 times as long as movable finger, mesial margin with row of spines. Fingers each bearing two prominent spines distally, the cutting edge having tubercular teeth. Epipod present.

Second to fourth pereopods (Fig. 3F–H) squamous, and slender. Meri of second and third pereopods with row of spines on extensor margin; fourth pereopod with distal extensor margin bearing one spine. Carpi 1.7 times as long as broad; with some extensor marginal spines on second and third pereopods; fourth pereopods unarmed. Propodi 1.8 times longer than carpus; flexor margin bearing eight (second), six (third), seven (fourth) movable spines including distal pair. Dactylus 0.6 times as long as propodus, curving distally; flexor margin bearing five or six movable spines.

Remarks. No *Allogalathea* has been reported from Korea before, but four

specimens belonging to this genus were collected. Baba (1969) separates genus *Allogalathea* from genus *Galathea*. And *Allogalathea elegans* was the only species the genus. Cabezas et al. (2011) found that *A. elegans* sensu lato is divided into four species by morphological and molecular studies.

Cabezas et al. (2011) mentioned that *A. elegans* is morphologically similar to *A. babai*. They share the following features: (1) the length of palm is as long as length of finger, (2) the length of rostrum is relatively longer than other congeners, (3) the most scales on palm have spinules. However, *A. elegans* can be distinguished by the following characteristics: (1) the merus of second pereopod is four times as long as broad, (2) the merus of second and third pereopod have row of spines on dorsal margin.

Cabezas et al. (2011) reported that *A. elegans* has four to five movable spines on dactylus of ambulatory legs. Examined specimens, in male, agree well with his description. However, in female, dactylus of ambulatory legs has six movable spines.

Genus *Galathea* Fabricius, 1793

Key to species of *Galathea* from Korea

1. Basal article of antennular peduncle having well developed distomesial spine;
Pterygostomian having one spine on anterior surface *Galathea orientalis*
Basal article of antennular peduncle without distomesial spine; Pterygostomian
anarmed on anterior surface *Galathea pubescens*

2. *Galathea orientalis* Stimpson, 1858

Galathea orientalis Stimpson, 1858: 252 [type locality: Ly-i-moon Passage near Hong Kong, 46 m]; Ortmann, 1892: 252, Pl. 11: fig. 10, 10a, 10i; Lewinsohn, 1969: 110; Kim, 1973: 175, fig. 19, Pl. 64: fig. 5a, 5b; Haig, 1974: 447; Baba, 2005: 81, 244; Baba *et al.*, 2008: 74; Baba *et al.*, 2009: 120, figs. 100–103.

Galathea acanthomera: Stimpson, 1858: 90; Balss, 1913: 2, fig. 1.

Material examined. 4 ♂♂, Beophwan-dong, Seogwipo-si, Jeju-do, 15 Dec 1969; 2 ♂♂, Jung-dong, Haeundae-gu, Busan, 11 May 1974; 2 ♂♂, 3 ♀♀, Nambu-myeon, Geoje-si, Gyeongsangnam-do, 22 Jul 1978; 1 ♂, 1 ♀, Hamo-ri, Daejeong-eup, Seogwipo-si, Jeju-do, 22 Jul 1982; 1 ♀, Jung-dong, Haeundae-gu, Busan, 26 Apr 1983; 1 ♂, Beophwan-dong, Seogwipo-si, Jeju-do, 19 Jan 1985; 1 ♂, Sinchang-ri,



Fig. 4. *Galathea orientalis* Stimpson, 1858, male. Carapace length, 5.6 mm, dorsal view.

Hangyeong-myeon, Jeju-si, Jeju-do, 3 May 1985; 1 ♀, ,Hamo-ri, Daejeong-eup, Seogwipo-si, Jeju-do, 13 Aug 1985; 1 ♀, Namyang-ri, Seo-myeon, Ulleung-gun, Gyeongsangbuk-do, 12 Jul 1989; 1 ♀, Cheonbu-ri, Buk-myeon, Ulleung-gun, Gyeongsangbuk-do, 16 Jul 1989; 2 ♂♂, 1 ♀, Sadong-ri, Ulleung-eup, Ulleung-gun, Gyeongsangbuk-do, 28 Nov 1991; 1 ♂, Namyang-ri, Seo-myeon, Ulleung-gun, Gyeongsangbuk-do, 13 Aug 1995; 1 ♀, Taeha-ri, Seo-myeon, Ulleung-gun, Gyeongsangbuk-do, 15 Aug 1995; 2 ♂♂, 3 ♀♀, Seogwi-dong, Seogwipo-si, Jeju-do, 19 Sep 1995; 1 ♀, Beophwan-dong, Seogwipo-si, Jeju-do, 1 Oct 1995; 1 ♂, Obong-ri, Udo-myeon, Jeju-si, Jeju-do, 9 Oct 1995; 1 ♂, Samyang-dong, Jeju-si, Jeju-do, 10 Oct 1995; 1 ♀, Beophwan-dong, Seogwipo-si, Jeju-do, 27 Jul 1997; 1 ♀, Ulleung-eup, Ulleung-gun, Gyeongsangbuk-do, 15 Jul 1998; 1 ♀, Sangmo-ri, Daejeong-eup, Seogwipo-si, Jeju-do, 21 Aug 1998; 5 ♂♂, 1 ♀, Daejeong-eup, Seogwipo-si, Jeju-do, 23 Feb 2001; 2 ♂♂, 1 ♀, Hangyeong-myeon, Jeju-si, Jeju-do, 17 Aug 2001; 4 ♂♂, 2 ♀♀, Geomun-ri, Samsan-myeon, Yeosu-si, Jeollanam-do, 15 Oct 2001; 2 ♂♂, Geomun-ri, Samsan-myeon, Yeosu-si, Jeollanam-do, 22 Jun 2002; 2 ♂♂, Seogwi-dong, Seogwipo-si, Jeju-do, 26 Jun 2002; 1 ♂, 1 ♀, Geomun-ri, Samsan-myeon, Yeosu-si, Jeollanam-do, 27 Jun 2002; 1 ♂, Seogwi-dong, Seogwipo-si, Jeju-do, 13 Oct 2002; 1 ♀, Jeodong-ri, Ulleung-eup, Ulleung-gun, Gyeongsangbuk-do, 28 Apr 2005; 3 ♂♂, Namseo-ri, Seo-myeon, Ulleung-gun, Gyeongsangbuk-do, 20 Jun 2006; 3 ♂♂, 2 ♀♀, Ulleung-eup, Ulleung-gun, Gyeongsangbuk-do, 22 Jun 2006; 1 ♂, Uljin-gun, Gyeongsangbuk-do, 21 Oct 2008; 6 ♂♂, 5 ♀♀, Beophwan-dong, Seogwipo-si, Jeju-do, 25 Feb 2009; 2 ♂♂, 2 ♀♀, Seogwi-dong, Seogwipo-si, Jeju-do, 26 Feb 2009; 2 ♂♂, Cheonji-dong, Seogwipo-

si, Jeju-do, 26 Feb 2009; 2 ♂♂, 1 ♀, Chuja-myeon, Jeju-si, Jeju-do, 31 Mar 2009; 2 ♀♀, Mijo-ri, Mijo-myeon, Namhae-gun, Gyeongsangnam-do, 5 Aug 2009; 1 ♀, Songjeong-ri, Mijo-myeon, Namhae-gun, Gyeongsangnam-do, 6 Aug 2009; 1 ♂, Hakdong-ri, Dongbu-myeon, Geoje-si, Gyeongsangnam-do, 29 Aug 2009; 1 ♀, Uljin-gun, Gyeongsangbuk-do, 10 Oct 2009; 1 ♀, 29 Oct 2009; 1 ♂, 2 ♀♀, Seogwi-dong, Seogwipo-si, Jeju-do, 23 Mar 2011; 2 ♂♂, Seogwi-dong, Seogwipo-si, Jeju-do, 15 Jul 2011; 1 ♀, Beophwan-dong, Seogwipo-si, Jeju-do, 16 Jul 2011; 1 ♂, 2 ♀♀, Nodae-ri, Yokji-myeon, Tongyeong-si, Gyeongsangnam-do, 31 Aug 2011; 4 ♂♂, 3 ♀♀, Nodae-ri, Yokji-myeon, Tongyeong-si, Gyeongsangnam-do, 1 Sep 2011; 3 ♂♂, 1 ♀, Nodae-ri, Yokji-myeon, Tongyeong-si, Gyeongsangnam-do, 2 Sep 2011; 1 ♂, 1 ♀, Nodae-ri, Yokji-myeon, Tongyeong-si, Gyeongsangnam-do, 3 Sep 2011; 14 ♂♂, 23 ♀♀, Hyeopjae-ri, Hallim-eup, Jeju-si, Jeju-do, 24 Sep 2011; 6 ♂♂, 7 ♀♀, Hangeong-myeon, Jeju-si, Jeju-do, 24 Sep 2011; 1 ♂, 2 ♀♀, Hyeopjae-ri, Hallim-eup, Jeju-si, Jeju-do, 25 Sep 2011; 1 ♂, Jeju-do, 12 Apr 2012; 7 ♂♂, 3 ♀♀, Seogwi-dong, Seogwipo-si, Jeju-do, 19 Apr 2012.

Distribution. East China Sea, South China Sea, Hong Kong, Japan, western Australia and Korea.

Description. Carapace (Figs. 4, 5A) exclusive of rostrum, as long as broad; dorsal surface with distinct transverse stria having fine and short setae; third stria interrupted by anterior cervical groove; epigastric region bearing two spines. Lateral margin slightly convex, with seven spines: having two anterolateral spines, two anterior branchial marginal spines, three posterior branchial marginal spines. Cervical groove distinct. Rostrum triangular, about 0.5 times as long as remaining

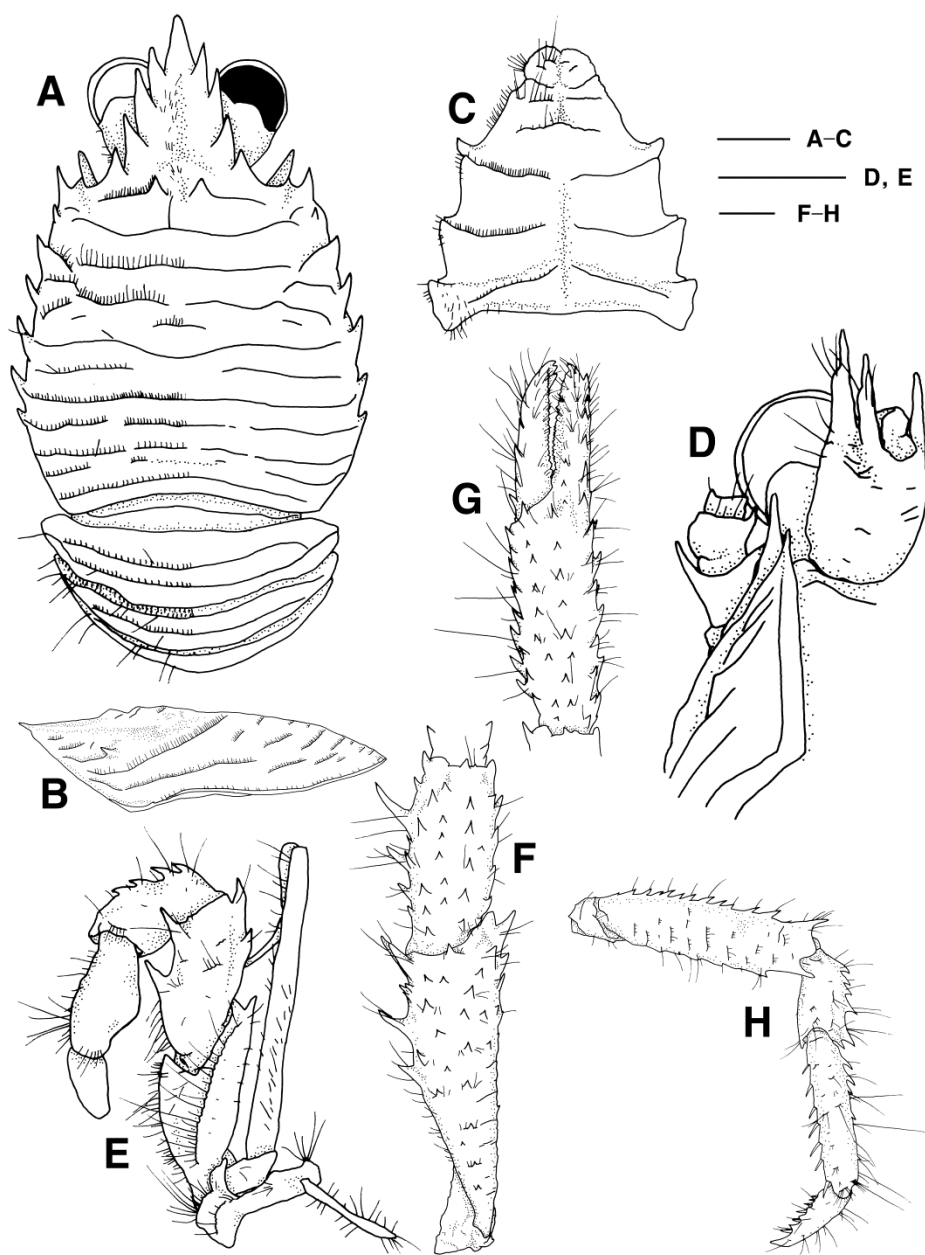


Fig. 5. *Galathea orientalis* Stimpson, 1858, male. A, carapace, anterior part of abdomen; B, left pterygostomian flap; C, Sternal plastron; D, anterior right part of cephalothorax; E, left third maxilliped; F, right first pereopod, ischium, merus, and carpus; G, same, chela; H, right second pereopod. Scale bars: A–C=1 mm, D, E=0.5 mm, F–H= 1 mm.

carapace, as long as broad; bearing about four lateral teeth.

Pterygostomian flap (Fig. 5B) rugose, having one spine on anterior surface; anterior ending with spinule.

Sternal plastron (Fig. 5C) as long as broad having distinct medial groove, lateral limits expand posteriorly.

Second to fourth abdominal somites (Figs. 4, 5A) with two uninterrupted transvers ridges.

Ocular peduncles (Figs. 4, 5A) subcylindrical, expanded distally.

Basal article of antennular peduncle (Fig. 5D) having well developed two distal spines; bearing one lateral spine, longer than distal spines.

Second article of antennal peduncle (Fig. 5D) bearing two distal spines. Third article of antennal peduncle having one small distomesial spine. Fourth article of antennal peduncle unarmed.

Third maxilliped (Fig. 5E) with ischium bearing one distal spine on extensor margin; mesial ridge with crest. Merus bearing two spines on each of flexor and extensor margins. Carpus having two or three (rarely four) spines on extensor margin. Propodus and dactylus unarmed. Exopod overreaching distal end of merus.

First pereopod (Fig. 5F, G) slender, subcylindrical, setose and spinose. Merus 3.1 times as long as broad. Carpus about 0.6 times as long as merus. Palm 2.3 times as long as dactylus; each extensor and flexor margin having row of spines. Fingers spooned distally.

Second to fourth pereopods (Fig. 5H) slender. Meri 4.5 times longer than broad; extensor margin having row of spines. Carpi 0.4 times as long as merus; extensor

margin bearing row of spines. Propodi 1.8 times as long as dactylus; extensor margin with spines, flexor margin bearing eight movable spines including distal pair. Dactylus short, curving distally; flexor margin bearing six movable spines.

Remarks. *Galathea orientalis* is the most common squat lobster in Korean fauna. Stimpson (1858) first reported *G. orientalis* from Hong Kong.

According to Baba (2009), *G. orientalis* is morphologically similar to *G. tanegashimae*. They share the following features: (1) the epigastric region has one pair of spines, (2) the basal segment of antennular peduncle bears well-developed distomesial spine, (3) the merus of third maxilliped has two spines on flexor margin. However, *Galathea orientalis* has the following own characteristics: (1) the gastric region has five striae, (2) the carpus of third maxilliped bears two spines on extensor margin, (3) the anterior part of pterygostomial flap has one spine on surface.

3. *Galathea pubescens* Stimpson, 1858

Galathea pubescens Stimpson, 1858: 90 [type locality: Hakodate and Amami-oshima, Japan, 46–60 m]; Balss, 1913: 11, figs. 11, 12; Kim, 1973: 176, fig. 20, Pl. 65: fig. 6a, 6b; Haig, 1974: 447; Baba, 2005: 83, fig. 30, 246; Baba *et al.*, 2008:76; Baba *et al.*, 2009: 125, figs. 105, 106.

Material examined. 5 ♀♀, Seogwipo-si, Jeju-do, 13 Oct 1963; 1 ♂, 1 ♀, Seogwipo-si, Jeju-do, 16 Aug 1969; 2 ♂♂, Beophwan-dong, Seogwipo-si, Jeju-do, 15 Dec 1969; 1 ♂, 1 ♀, Beophwan-dong, Seogwipo-si, Jeju-do, 16 Aug 1969; 4



Fig. 6. *Galathea pubescens* Stimpson, 1858, male. Carapace length, 9.6 mm, dorsal view.

♀♀, Hamo-ri, Daejeong-eup, Seogwipo-si, Jeju-do, 24 Oct 2005; 1 ♂, 2 ♀♀, Hamo-ri, Daejeong-eup, Seogwipo-si, Jeju-do, 18 Oct 2006.

Distribution. Durban, Zanzibar, Madagascar, Western Australia, Central Queensland, New Caledonia, Arafura Sea, Bali Sea, Kei Islands, Philippines, Taiwan, East China Sea, Japan and Korea.

Description. Carapace (Figs. 6, 7A) exclusive of rostrum, as long as broad; dorsal surface with distinct transverse stria having fine, dense and relatively long setae; anterior part of gastric region having some small spines; epigastric region bearing row of small spines. Lateral margin slightly convex, with seven spines: having two anterolateral spines, two spines on anterior branchial margin, three spines on posterior branchial margin. Cervical groove distinct. Hepatic and anterior branchial

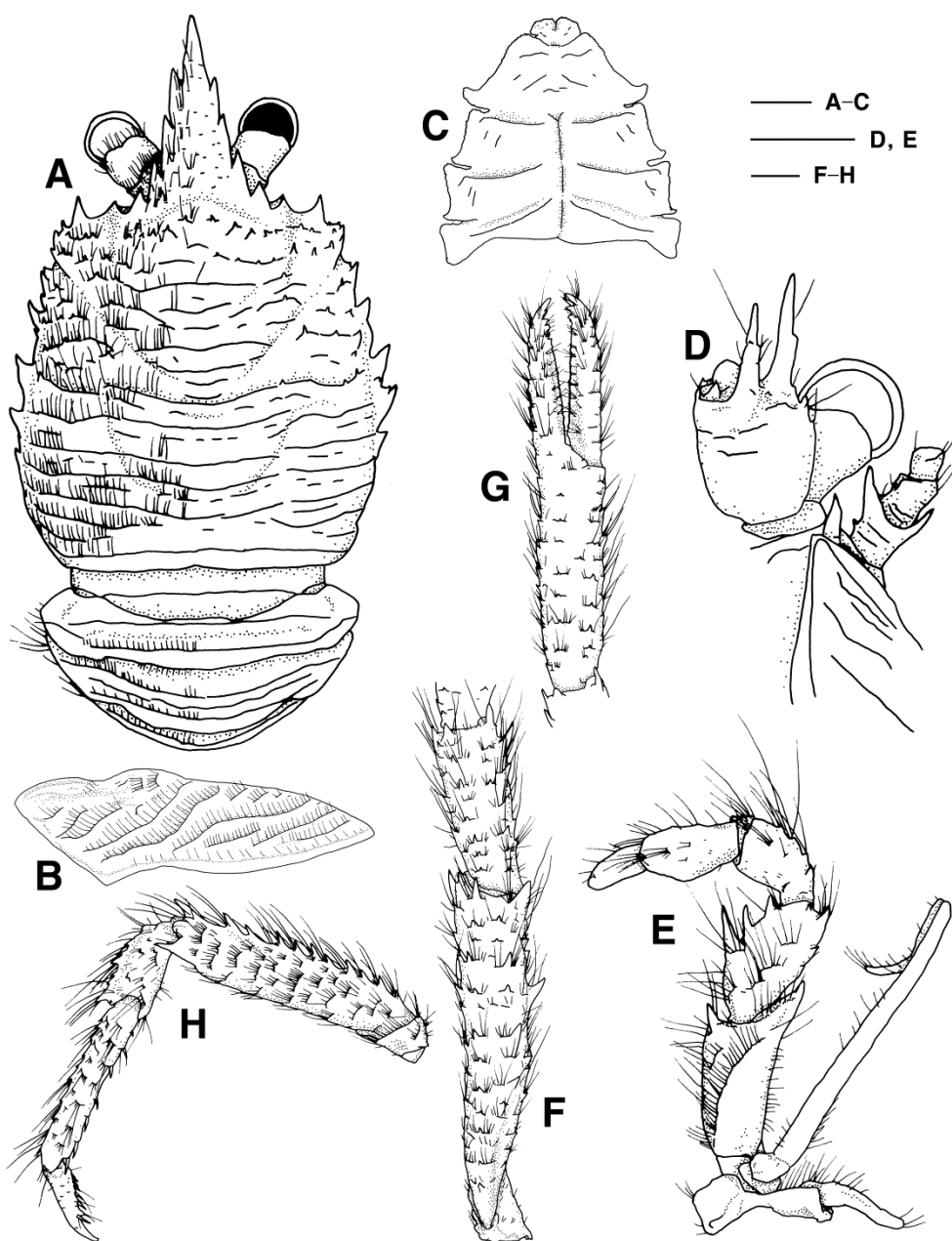


Fig. 7. *Galathea pubescens* Stimpson, 1858, male. A, carapace, anterior part of abdomen; B, left pterygostomian flap; C, Sternal plastron; D, anterior left part of cephalothorax; E, left third maxilliped; F, left first pereopod, ischium, merus, and carpus; G, same, chela; H, right second pereopod. Scale bars: A–C=1 mm, D, E=1 mm, F–H= 1 mm.

regions having some spines. Rostrum triangular, relatively slender, dorsally pubescent, about 0.57 times as long as remaining carapace, 1.4 times as long as broad; bearing about four lateral teeth deeply incised.

Pterygostomian flap (Fig. 7B) with rugae bearing long setae, unarmed; anterior ending blunt.

Sternal plastron (Fig. 7C) 1.1 times as long as broad, having distinct medial groove, lateral limits expand posteriorly.

Second to third abdominal somites (Figs. 6, 7A) with four transverse ridges.

Ocular peduncles (Fig. 7A) subcylindrical, expanded distally, having eyelash.

Basal article of antennular peduncle (Fig. 7D) having well developed one distolateral spine; bearing one lateral spine, longer than distolateral spine.

Second article of antennal peduncle (Fig. 7D) bearing two distal spines, having one small spine on anterior margin. Third and fourth article of antennal peduncle unarmed.

Third maxilliped (Fig. 7E) with ischium bearing one distal spine on extensor margin; crest having setae on mesial ridge. Merus bearing three spines on flexor margins: proximal spine prominent, distal and median spines smaller; extensor margin having two small spines. Carpus having four flat spines on extensor margin. Propodus and dactylus unarmed. Exopod overreaching distal end of merus.

First pereopod (Fig. 7F, G) slender, subcylindrical, spinose, having relatively dense setae. Merus 5.4 times as long as broad. Carpus about 0.5 times as long as merus. Palm 2.3 times as long as dactylus; each extensor and flexor margin having row of small spines. Fingers spooned distally.

Second to fourth pereopods (Fig. 7H) slender, bearing long, dense setae. Merus 5 times longer than broad; extensor margin having row of spines. Carpus 0.3 times as long as merus; extensor margin bearing row of spines. Propodus 2.6 times as long as dactylus; extensor margin with row of spines, flexor margin bearing eight movable spines including distal pair. Dactylus short, curving distally, flexor margin bearing six movable spines.

Remarks. *Galathea pubescens* has been reported only from Jeju-do Isl. in Korean fauna (Kim, 1973). Our specimens are also collected Jeju-do Isl.

G. pubescens resembles *G. albatrossae* Baba, 1988 in the following features: the epigastric region bears row of small spines, and the basal segment of antennule peduncle has obsolescent distomesial spine. However, this species clearly differs from *G. albatrossae* in the following features: the lateral teeth of rostrum are deeply incised, and the merus of third maxilliped has one prominent spine on extensor margin (Baba et al., 2009).

Genus *Phylladiorhynchus* Baba, 1969

4. *Phylladiorhynchus pusillus* (Henderson, 1885)

Galathea pusilla Henderson, 1885: 407 [type locality: Twofold Bay, Australia, 36°59'S, 150°20'E, 275 m]; Lewinsohn, 1969: 116.

Phylladiorhynchus pusillus: Baba, 1969: 4; Haig, 1973: 282; Baba, 1991: 486, fig. 4e–f; Poore, 2004: 238, fig. 66B; Baba, 2005: 201, 305; Baba et al., 2008: 176; Poore et al., 2008: 22; Baba et al., 2009: 287, figs. 262–263.



Fig. 8. *Phylladiorhynchus pusillus* (Henderson, 1885), male. Carapace length, 5.5 mm, dorsal view.

Material examined. 3 ♂♂, 6 ♀♀, Beophwan-dong, Seogwipo-si, Jeju-do, 15 Dec 1969; 1 ♂, 1 ♀, Hamo-ri, Daejeong-eup, Seogwipo-si, Jeju-do, 24 Oct 2005.

Distribution. Australia, Taiwan, Japan, Chile and Korea (in this study).

Description. Carapace (Figs. 8, 9A) exclusive rostrum, as long as broad; dorsal surface with distinct transverse stria; third stria interrupted by anterior cervical groove; with four epigastric spines and one pair of distinct supraocular spine. Lateral border having eight spines: having two anterolateral spines, three anterior branchial marginal spines, three posterior branchial marginal spines. Cervical groove distinct. Rostrum dagger shaped, distally spiniform; length 1.7 times as long as broad.

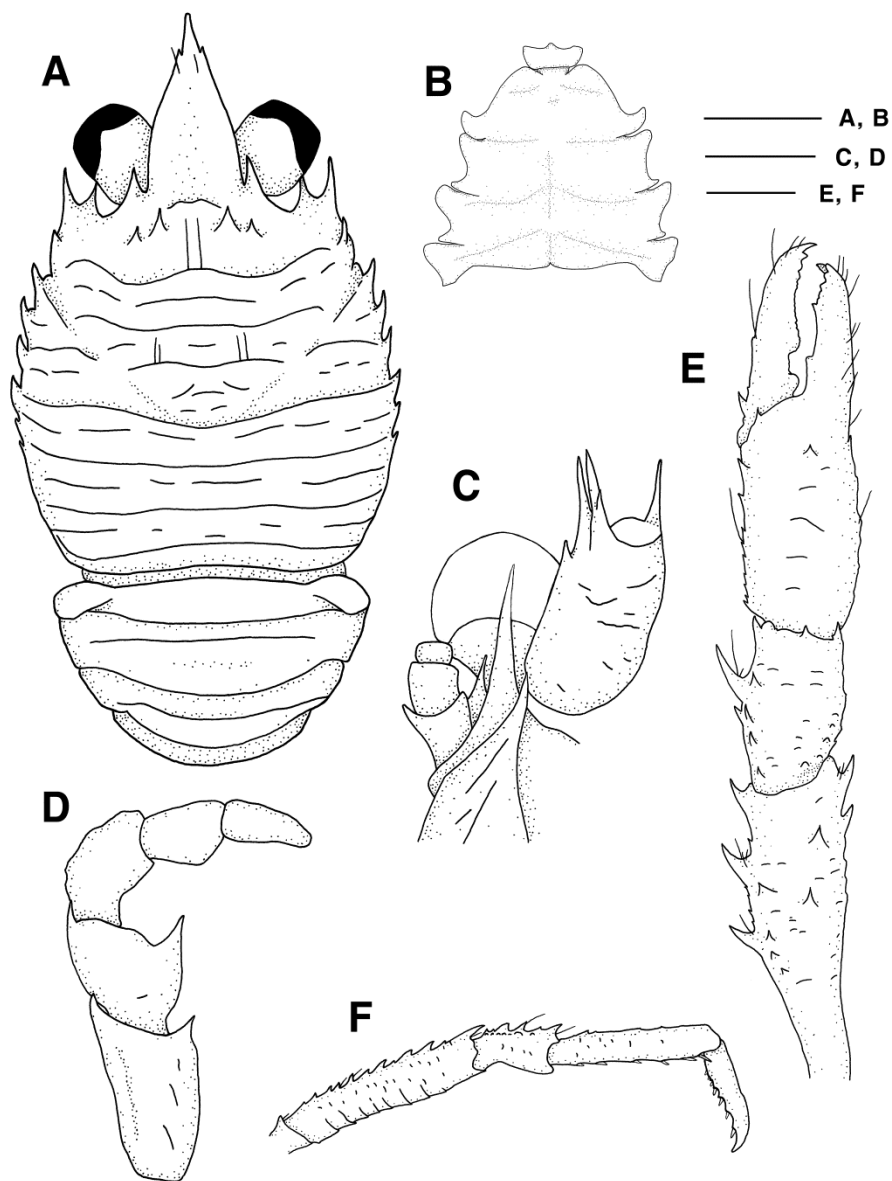


Fig. 9. *Phylladiorhynchus pusillus* (Henderson, 1885), male. A, carapace, anterior part of abdomen; B, sternal plastron; C, anterior right part of cephalothorax; D, right third maxilliped; E, right first pereopod; F, right second pereopod. Scale bars: A, B=1 mm, C, D=0.5 mm, E, F= 1 mm.

Pterygostomian flap rugose; anterior ending with spinule.

Second to third abdominal somites with two uninterrupted transverse ridges.

Sternal plastron (Fig. 9B) as long as broad, smooth, bearing distinct medial groove, having few striae on third sternite; anterior part of fourth sternite as long as third.

Basal article of antennular peduncle (Fig. 9C) having well developed three distal spines: one distomesial spine, two distolateral spines; bearing two lateral spines.

Second article of antennal peduncle (Fig. 9C) bearing two distal spines. Third and fourth article of antennal peduncle unarmed.

Ocular peduncles (Fig. 9A) subcylindrical, slightly expanded distally.

Third maxillipeds (Fig. 9D) with ischium bearing each one distal spine on flexor and extensor margins. Merus having strong spine on flexor margin, one distal spine on extensor margin. Carpus, propodus and dactylus unarmed. Exopod overreaching distal end of merus.

First pereopod (Fig. 9E) stout. Merus 3.3 times as long as broad; armed with three distinct spines on flexor margin, two spines on distal extensor margin. Carpus 0.5 times as long as merus; with one well developed spine on flexor margin. Palm 2 times as long as movable finger. Finger bearing one proximal spine on movable finger.

Second to fourth pereopods (Fig. 9F) slender. Meri about 4 times longer than broad; having row of spines along dorsal border. Carpi 0.4 times as long as merus; with few spines on extensor margin. Propodi 1.7 times as long as dactylus; flexor margin bearing seven movable spines including distal pair. Dactyli curving distally,

bearing seven movable spines on flexor margin. Epipod absent.

Remarks. *Phylladiorhynchus pusillus* (Henderson, 1885) is the first report in the present study from Korean waters.

Baba (1969) separates genus *Phylladiorhynchus* from genus *Galathea*. *Phylladiorhynchus* Baba, 1969 contains five species: *P. bengalensis* Tirmizi & Javed, 1980, *P. ikedai* (Miyake & Baba, 1965), *P. integristrois* (Dana, 1852), *P. nudus* Macpherson, 2008 and *P. pusillus* (Henderson, 1885). Following Baba, 1991 and Macpherson, 2008, *P. pusillus* is easily distinguished from congeners by the following feature. *P. pusillus* has four epigastric spines, whereas there are two epigastric spines in *P. integristrois*, five epigastric spines in *P. bengalensis*, *P. ikedai* and no epigastric spine in *P. nudus*.

Family Munididae Ah Yong, Baba, Macpherson & Poore, 2010

Key to genera of Munididae from Korea

1. Third maxilliped with carpus having one spine on distal end of flexor margin
..... *Raymunida*
Third maxilliped with carpus unarmed on distal end of flexor margin 2
2. Carapace without distinct transverse ridges and striae; rostral spine broad at base
..... *Paramunida*
Carapace with distinct transverse ridges or striae; rostral spine proportionately slender *Munida*

Genus *Raymunida* Macpherson & Machordom, 2000

Key to species of *Raymunida* from Korea

1. Antennal peduncle with second article of mesial margin having small spine; third article of antennal peduncle bearing one small distomesial spine *Raymunida lineata*
- Antennal peduncle with second article of mesial margin unarmed; third article of antennal peduncle unarmed *Raymunida formosanus*

5. *Raymunida formosanus* Lin, Chan & Chu, 2004

Raymunida formosanus Lin, Chan & Chu, 2004: 149, figs. 1–3 [type locality: Dasi



Fig. 10. *Raymunida formosanus* Lin, Chan & Chu, 2004, male. Carapace length, 27.5 mm, dorsal view.

fishing port, Yilan County, Taiwan]; Ah Yong & Poore, 2004: 70, fig. 17; Poore, 2004: 239, fig. 66c, d; Baba, 2005: 307; Baba *et al.*, 2008: 179; Baba *et al.*, 2009: 291, figs. 265, 266.

Material examined. 2 ♂, Seogwipo-si, Jeju-do, 10 Oct 1970.

Distribution. Taiwan, New South Wales and Korea (in this study).

Description. Carapace (Figs. 10, 11A) exclusive of rostrum, 1.07 times as long as broad; dorsal surface with distinct transverse striae; five pairs of epigastric spines exist, having one pair of parahepatic spines and postcervical spines. Anterior branchial region having four to five spines. Frontal margin slightly oblique, having one small spine. Lateral margin somewhat convex, with six spines: having two anterolateral spines, two anterior branchial marginal spines, two posterior branchial marginal spines. Cervical groove distinct. Rostrum spiniform, 0.35 times as long as remaining carapace length. Supraocular spines 0.45 times as long as rostrum length, subparallel.

Pterygostomian flap slightly rugose, unarmed.

Sternal plastron (Fig. 11B) 0.8 times as long as wide, bearing distinct medial groove, lateral limits expand posteriorly.

Second to third abdominal somites (Figs. 10, 11A) each having two uninterrupted transverse ridges.

Ocular peduncles (Fig. 11A) subcylindrical, slightly expanded distally, overreaching supraocular spine.

Basal article of antennular peduncle (Fig. 11C) having well developed two distal spines: one small distomesial spine, one well developed distolateral spine; bearing

two lateral spines, proximal spine short, distal spine prominent, slightly reaching tip of distolateral spine.

First article of antennal peduncle (Fig. 11C) bearing one distomesial spine, slightly overreaching distal margin of third antennal peduncle. Second article of antennal peduncle bearing two distal spines, distomesial spine larger than distolateral spine. Third and fourth article of antennal peduncle unarmed.

Third maxillipeds (Fig. 11D) with ischium bearing one distal spine on flexor margin.

Merus as long as ischium, with two prominent spines on flexor margin, distal spine

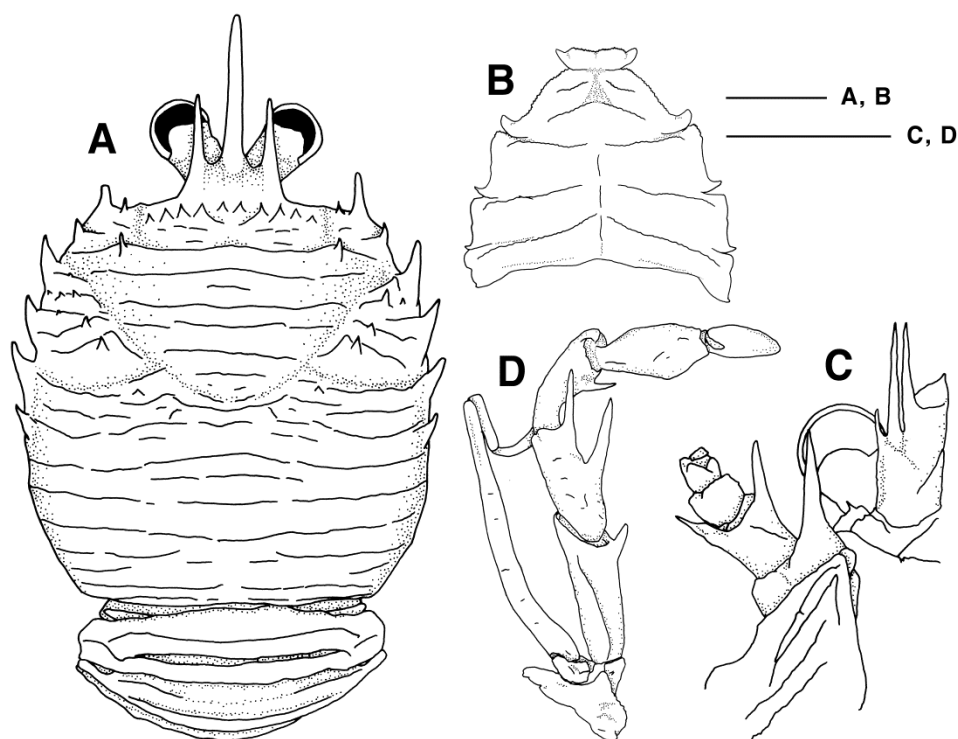


Fig. 11. *Raymunida formosanus* Lin, Chan & Chu, 2004, male. A, carapace, anterior part of abdomen; B, Sternal plastron; C, anterior right part of cephalothorax; D, right third maxilliped. Scale bars: A, B=5 mm, C, D=5 mm.

slightly slender. Carpus having one spine on distal end of flexor margin. Propodus and dactylus unarmed. Exopod overreaching distal end of merus (distal spine excluded).

First pereopod (Fig. 12A, B) stout, squamous and spinose. Merus 3.9 times as long as broad, having irregular spines on extensor and flexor margins. Carpus 2.3 times as long as broad, bearing irregular row of spines on mesial and lateral margins, some spines exist on dorsal surface. Palm 2 times as long as broad, about 1.5 times as long as movable finger, mesial and lateral margin having irregular row of spines. Fingers having one distinct longitudinal ridge on dorsal and ventral side, bearing irregular row of spines; fixed finger curved; movable finger with cutting edge having one large tooth on proximal third.

Second pereopod (Fig. 12C–E) slender. Ischium having one small spine on distoflexor margin. Merus 6.6 times as long as broad, armed with row of spines on extensor margin, flexor margin bearing row of spines on distal third. Carpus 2.2 times as long as broad, four spines on extensor margin. Propodus 3.1 times longer than dactylus, 10.1 times as long as broad, flexor margin armed with five movable spines including distal pair. Dactylus short, curving distally, having seven movable spines on flexor margin. Third pereopod with ischium having one small spine on distoflexor margin; merus 4.5 times as long as broad, having row of spines on extensor margin, flexor margin bearing row of spines on distal third; carpus 2 times as long as broad, bearing four spines on extensor margin; propodus 8.8 times as long as broad, flexor margin bearing five movable spines including distal pair; dactylus short, curving distally, having six movable spines on flexor margin. Fourth

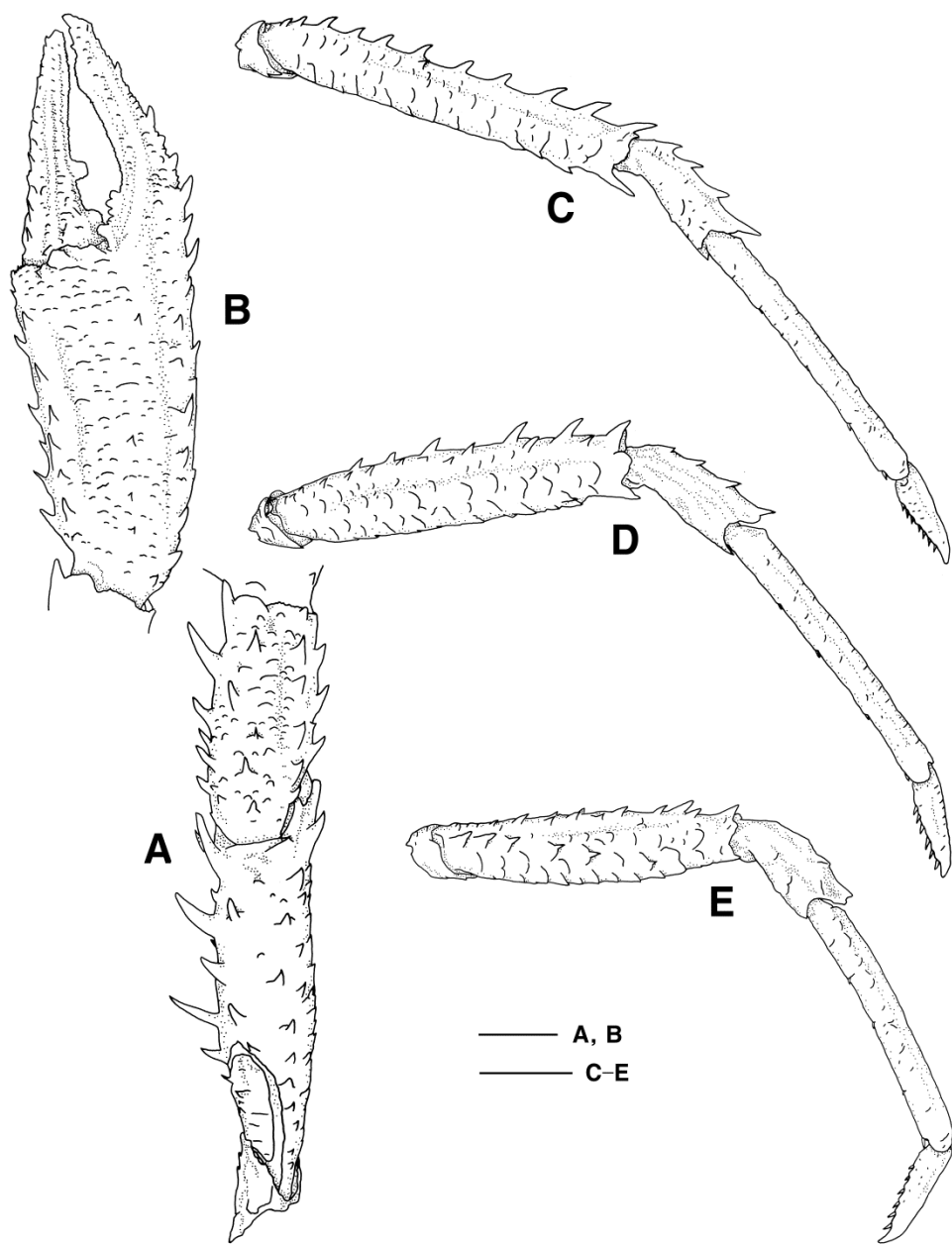


Fig. 12. *Raymunida formosanus* Lin, Chan & Chu, 2004, male. A, right first pereopod, ischium, merus, and carpus; B, same, chela; C, right second pereopod; D, right third pereopod; E, right fourth pereopod. Scale bars: A, B=5 mm, C-E=5 mm.

pereopod with ischium unarmed; merus 4.3 times as long as broad, extensor margin having row of spines; carpus 1.8 times as long as broad, extensor margin bearing four low spines; propodus 7.8 times as long as broad, flexor margin bearing five movable spines including distal pair; dactylus short, curving distally, having six movable spines on flexor margin.

Remarks. No *Raymunida* has been reported from Korea before. *Raymunida formosanus* has been only reported from Taiwan and eastern Australia. Thus, the present study extends the range of geographical distribution of *R. formosanus* northward.

The present specimen agrees well with the original description (Lin et al., 2004) except for one character: the length of distomesial spine on first antennal article. Lin et al. (2004) mentioned that the spine reach basal article of antennular peduncle. In addition, their illustration (Fig. 1b, f) indicate that distomesial spine on first antennal article overreach distal margin of fourth article of antennal peduncle. However, in examined specimens, the spine slightly reach distal margin of third article of antennal peduncle.

The present specimen is morphologically similar to *R. confundens* Macpherson & Machordom, 2001. They share the following features: the second article of antennal peduncle is unarmed on mesial margin, and the frontal margin has one small spine. However, *R. formosanus* can be distinguished by the following own characteristics: (1) the anterior branchial region bears four to five spines, (2) the first pereopod is robust, (3) the second to fourth pereopod bear distinct squamulae (Lin et al., 2004). In Korean fauna, *R. formosanus* resembles *R. lineata*. The features of two species

are discussed under the *R. lineata*.

6. *Raymunida lineata* Osawa, 2005

Raymunida lineata Osawa, 2005: 92, figs. 3–6 [type locality: Izu Peninsula, Shizuoka Prefecture, 20 m]; 2012: 143; Baba *et al.*, 2008: 180.

Material examined. 1 ♂, Songsan-dong, Seogwipo-si, Jeju-do, 8 Mar 2002.

Distribution. Indonesia, Japan and Korea (in this study).

Description. Carapace (Figs. 13, 14A) exclusive of rostrum, 1.2 times as long as broad; dorsal surface with distinct transverse striae; five pairs of epigastric spines



Fig. 13. *Raymunida lineata* Osawa, 2005, male. Carapace length, 10.6 mm, dorsal view.

exist, having one pair of parahepatic spines and postcervical spines. Anterior branchial region having three spines. Frontal margin slightly oblique, having one small spine. Lateral margin slightly convex, with six spines: having two anterolateral spines, two anterior branchial marginal spines, two posterior branchial marginal spines. Cervical groove distinct. Rostrum spiniform, 0.45 times as long as remaining carapace length. Supraocular spines 0.57 times as long as rostrum length, subparallel.

Pterygostomian flap slightly rugose, unarmed.

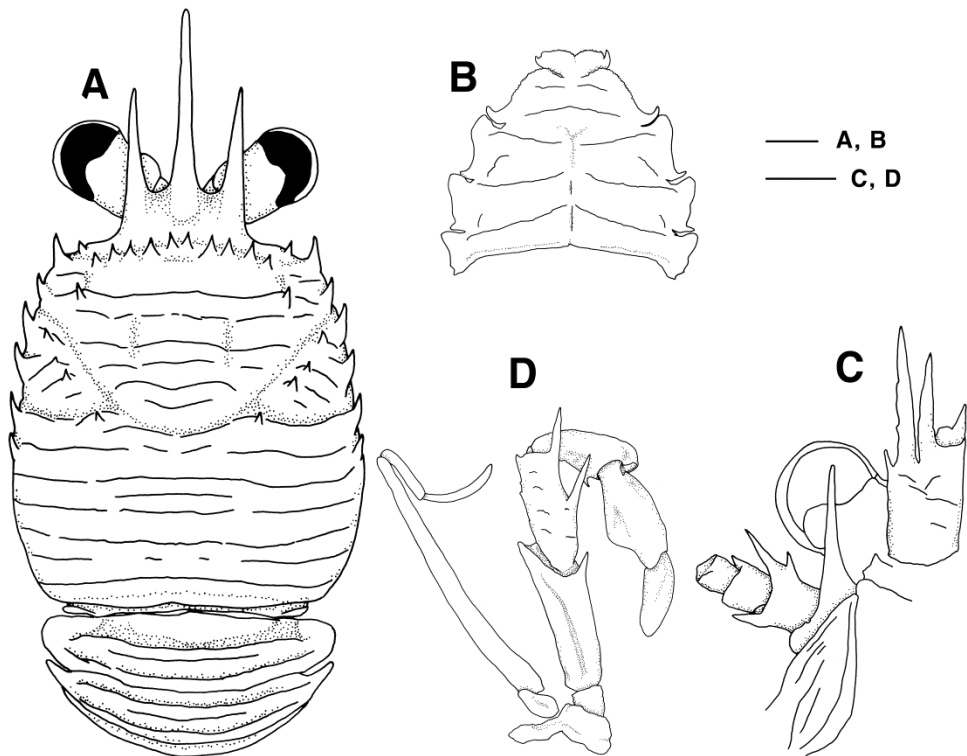


Fig. 14. *Raymunida lineata* Osawa, 2005, male. A, carapace, anterior part of abdomen; B, Sternal plastron; C, anterior right part of cephalothorax; D, right third maxilliped. Scale bars: A, B=1 mm, C, D=1 mm.

Sternal plastron (Fig. 14B) 0.77 times as long as wide, bearing distinct medial groove, lateral limits expand posteriorly; fifth and sixth sternite having distinct oblique ridges on lateral part.

Second to third abdominal somites (Figs. 13, 14A) each having two uninterrupted transverse ridges.

Ocular peduncles (Fig. 14A) subcylindrical, slightly expanded distally, slightly reaching supraocular spine.

Basal article of antennular peduncle (Fig. 14C) having well developed two distal spines: one small distomesial spine, one well developed distolateral spine; bearing two lateral spines, proximal spine short, distal spine prominent, overreaching distolateral spine.

First article of antennal peduncle (Fig. 14C) bearing one distomesial spine, overreaching distal margin of fourth antennal peduncle. Second article of antennal peduncle bearing two distal spines, distomesial spine larger than distolateral spine, mesial margin having small spine. Third article of antennal peduncle bearing one small distomesial spine. Fourth article of antennal peduncle unarmed.

Third maxilliped (Fig. 14D) with ischium bearing one distal spine on flexor margin. Merus as long as ischium, with two prominent spines on flexor margin. Carpus having one spine on distal end of flexor margin. Propodus and dactyls unarmed. Exopod overreaching distal end of merus (distal spine excluded).

First pereopod (Fig. 15A, B) slender, squamous, setose and spinose. Merus 4.8 times as long as broad, having irregular spines on flexor margin, extensor margin having one prominent spine. Carpus 2.3 times as long as broad, bearing row of

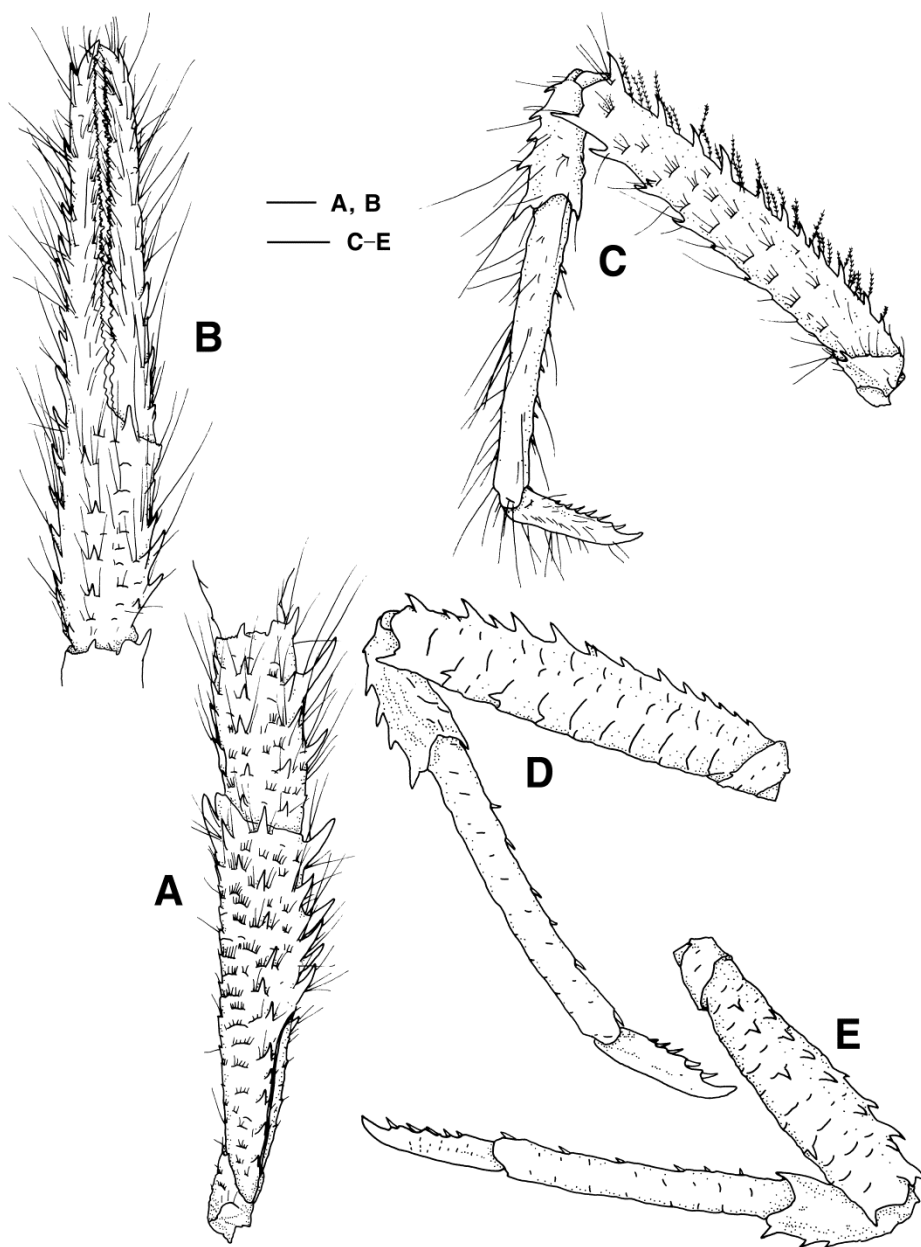


Fig. 15. *Raymunida lineata* Osawa, 2005, male. A, left first pereopod, ischium, merus, and carpus; B, same, chela; C, left second pereopod; D, left third pereopod; E, right fourth pereopod. Scale bars: A, B=1 mm, C-E=1 mm.

irregular spines on mesial and lateral margins, mesial margin spines well developed, dorsal surface with some spines bearing short seta. Palm 1.6 times as long as broad, 0.6 times as long as movable finger, mesial and lateral margin having row of spines. Fingers bearing row of spines; cutting edge having sawlike teeth.

Second pereopod (Fig. 15C) slender. Ischium having one small spine on distoflexor margin. Merus 6.25 times as long as broad, extensor margin armed with row of spines, having plumose seta; flexor margin bearing row of spines on distal half, and spines size increasing distally. Carpus 2.5 times as long as broad, five spines on extensor margin. Propodus 3 times longer than dactylus, 8.7 times as long as broad, flexor margin armed with nine movable spines including distal pair. Dactylus short, curving distally, having six movable spines on flexor margin. Third pereopod (Fig. 15D) with ischium having one small spine on distoflexor margin; merus 4.5 times as long as broad, having row of spines on extensor margin, flexor margin bearing row of spines on distal third; carpus 2.45 times as long as broad, bearing five spines on extensor margin; propodus 8.5 times as long as broad, flexor margin bearing seven movable spines including distal pair; dactylus short, curving distally, having five movable spines on flexor margin. Fourth pereopod (Fig. 15E) with ischium unarmed; merus 3.86 times as long as broad, extensor margin having row of spines; carpus 2.3 times as long as broad, extensor margin bearing four low spines; propodus 8.1 times as long as broad, flexor margin bearing seven movable spines including distal pair; dactylus short, curving distally, having six movable spines on flexor margin.

Remarks. *Raymunida lineata* Osawa, 2005 is the first report in the present study

from Korean waters. The present specimen agrees well with the original description (Osawa, 2005).

According to Osawa (2005), *R. lineata* resembles *R. elegantissima* (De Man, 1902) in second article of antennal peduncle armed with one small spine on mesial margin, and third maxilliped with merus unarmed on extensor margin. This species differs from *R. elegantissima* in fifth and sixth sternal plastron having distinct oblique ridges on lateral part, and first article of antennal peduncle overreaching distal margin of fourth antennal peduncle. In Korean fauna, *R. lineata* is morphologically similar to other congeners, *R. formaosanus*. They can be distinguished by the following features. *R. lineata* has three spines on anterior branchial region, whereas *R. formosanus* has four to five spines on that. *R. lineata* has small spine on second article of antennal peduncle of mesial margin, and one distomesial spine on third article of antennal peduncle. In addition, first pereopod of *R. lineata* is slender than that of *R. formaosanus*.

Genus *Munida* Leach, 1820

7. *Munida japonica* Stimpson, 1858

Munida japonica Stimpson, 1858: 252 [type locality: Makura-zaki, Kagoshima Pref., Japan, 145 m]; Miyake & Baba, 1967: 240, figs. 11, 12; Kim, 1973: 178, Pl. 65: fig. 7; Macpherson & Baba, 1993: 399, fig. 9; Komai, 2000: 356; Baba, 2005: 109, 265; Baba *et al.*, 2008: 102; Baba *et al.*, 2009: 163, figs. 142–148.

Material examined. No specimen.

Distribution. Indonesia, Philippines, Taiwan, East China Sea, Japan and Korea.

Diagnosis. The following is the diagnosis of Baba *et al.*, 2009, with some modification of terms.

Carapace with branchial region having five lateral spines. Intestinal region without scale-like or short stria. Rostrum spiniform. Supraocular spines reaching in half of rostrum. Frontal margin somewhat oblique. Second abdominal somite having two spines on each side of anterior transverse stria. Sternal plastron bearing a few striae on fourth sternite, without granules on seventh sternite; fourth sternite having anterior margin contiguous to median part of posterior margin of third sternite. Eyes large, corneal width distinctly more than distance between sinus formed by supraocular and rostral spines. Distal spines of antennular basal article subequal. First article of antennal peduncle having distomesial spine overreaching third article; second article bearing small mesial marginal spine proximal to prominent distomesial spine overreaching end of peduncle. Mxp3 merus having distinct spine on extensor distal margin. Fingers of pereopod as long as palm, each bearing proximal spines somewhat dorsal between subterminal and basal spines. Second to fourth pereopod dactyli having flexor margin with movable spines, unarmed usually on distal third.

Genus *Paramunida* Baba, 1988

8. *Paramunida scabra* (Henderson, 1885)

Munida scabra Henderson, 1885: 409 [type locality: off the Ki (Kei) Island, 05°49'15"S, 132°14'15"E, 236 m]; Miyake & Baba, 1967: 242, fig. 13; Kim, 1973: 178.

Paramunida scabra: Baba, 1988: 180; Komai, 2000: 360; Baba, 2005: 199, 303; Baba *et al.*, 2009: 281, figs. 257, 258.

Material examined. No specimen.

Distribution. Eastern Africa, Hong Kong, East and South China Sea, Indonesia, Philippines, Taiwan, Japan, Australia and Korea.

Diagnosis. The following is the diagnosis by Baba *et al.*, 2009, with some modification of terms.

Rostrum bearing thin dorsal carina; rostral spine larger than supraocular spines. Carapace with median gastric region having one (rarely two) spine; cardiac region bearing row of three to four spines in midline. Posterior ridge of abdominal fourth somite having distinct single median spine. Sternal plastron bearing numerous striae. Second article of antennal peduncle as long as third and fourth articles combined, having well-developed distomesial spine not reaching end of antennal peduncle and far falling short of end of anterior prolongation of first article. Second pereopod with propodus about 8 times as long as broad, and less than 1.5 times dactylus length.

Family Porcellanidae Haworth, 1825

Key to genera of Porcellanidae from Korea

1. Antennal peduncle with movable freely accessible to orbit 2
- Antennal peduncle with movable articles excluded from orbit by projection of

immovable article adpressed to anterior margin of carapace	3
2. Chelipeds flattened; pterygostomian flap entire	<i>Petrolisthes</i>
Chelipeds robust; pterygostomian flap separated	<i>Pachycheles</i>
3. Carapace broader than long	4
Carapace as long as or longer than broad	6
4. Ambulatory legs with dactyli having single claw; flexor margin unarmed	<i>Raphidopus</i>
Ambulatory legs with dactyli having biunguiculate claw	5
5. Carapace with branchial margin armed with spines	<i>Aliaporcellana</i>
Carapace with branchial margin unarmed	<i>Polyonyx</i>
6. Carapace strongly uneven on dorsal surface	<i>Enosteoides</i>
Carapace nearly smooth on dorsal surface	7
7. Chelae rather flattish, showing pronounced sexual dimorphism in spinulation as well as in degree of distortion of fingers	<i>Pisidia</i>
Chelae subcylindrical, generally similar in both sexes	<i>Lissoporcellana</i>

Genus *Aliaporcellana* Nakasone & Miyake, 1969

9. *Aliaporcellana pygmaea* (De Man, 1902)

Porcellana pygmaea De Man, 1902: 698, Pl. 23: fig. 38, 38a–e [type locality: Ternate, Indonesia].

Polyonyx pygmaeus: Lewinsohn, 1969: 161, fig. 36.

Aliaporcellana pygmaea: Nakasone & Miyake, 1969: 19; Osawa, 2007: 5, fig. 1; Osawa & Chan, 2010: 79, figs. 51–53.



Fig. 16. *Aliaporcellana pygmaea* (De Man, 1902), male. Carapace length, 3.2 mm, dorsal view.

Material examined. 1 ♂, Beophwan-dong, Seogwipo-si, Jeju-do, 2 Jul 1993.

Distribution. Red Sea, Gulf of Aden, Persian Gulf, Seychelles, Madagascar, Cargados Carajos (northeast of Mauritius), Gulf of Thailand, Java Sea, Moluccas, New Caledonia, Loyalty Islands, Taiwan and Korea (in this study).

Description. Carapace (Figs. 16, 17A) slightly broader than long. Dorsal surface moderately convex, with some short transvers ridges bearing stiff setae. Rostrum broad, slightly deflexed, weakly trilobite; median lobe having saw-like teeth; lateral lobes bearing saw-like teeth on anterior margin. Orbits relatively shallow, slightly oblique; supra-ocular margins unarmed; outer orbital angle having one spine. Protogastric ridge moderately produced. Hepatic margin weakly convex, having one

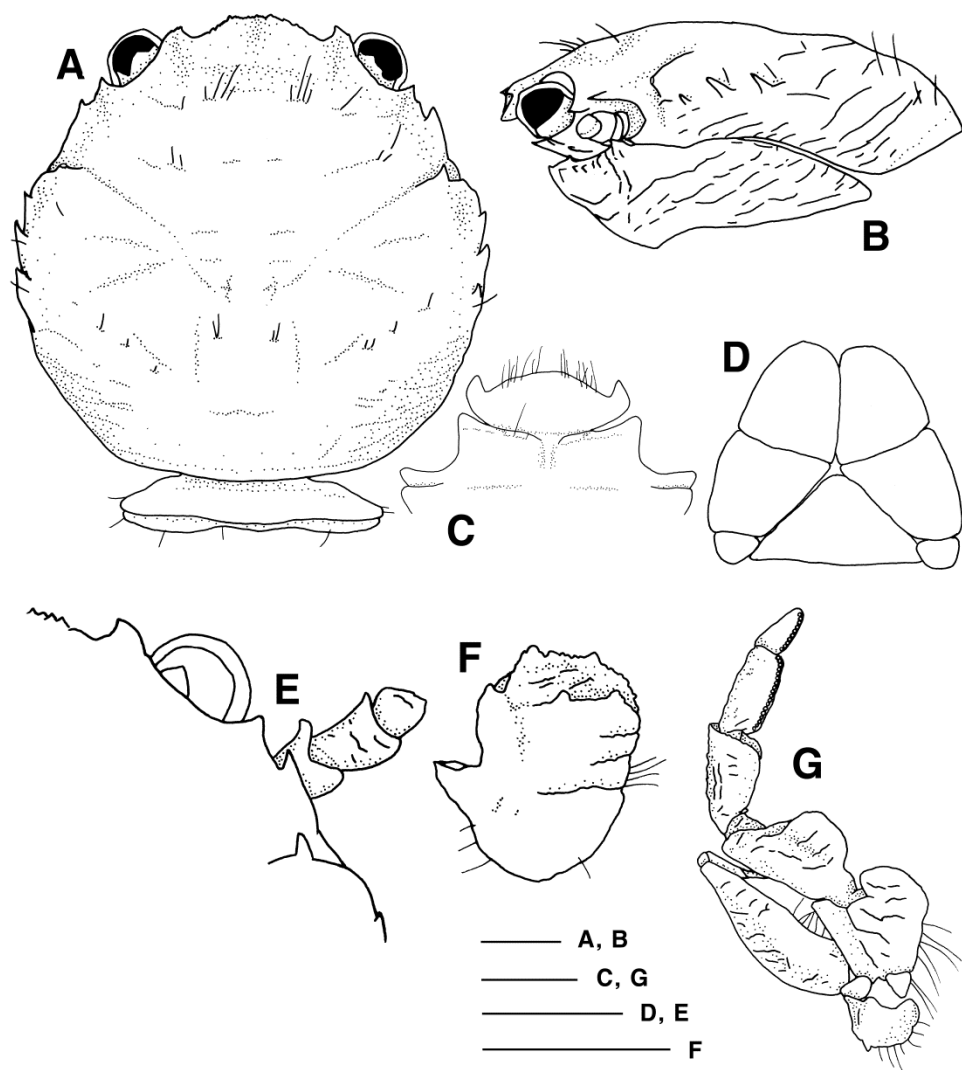


Fig. 17. *Aliaporcellana pygmaea* (De Man, 1902), male. A, carapace, anterior part of abdomen; B, carapace and left pterygostomian flap, lateral; C, third and fourth thoracic sternite; D, telson; E, right anterior part of carapace, ocular peduncle, and antennal peduncle; F, basal segment of left antennular peduncle; G, right third maxilliped. Scale bars: A, B=0.5 mm, C, G=0.5 mm, D, E=0.5 mm, F= 0.5 mm.

distinct spine. Cervical grooves moderately developed. Branchial margin with some striae, bearing one epibranchial spine and three mesobranchial spines.

Pterygostomian flaps (Fig. 17B) entire, rugose, anterior ending with spinule, having two spines on anterodorsal margin.

Third thoracic sternite (Fig. 17C) trilobite on anterior part; median lobe somewhat flat, broad, having setae on anterior margin; lateral lobes narrow. Fourth thoracic sternite with anterior margin slightly broader than third; posterior margin 1.6 times longer than anterior margin; median region concave.

Telson (Fig. 17D) composed of seven plates.

Ocular peduncle (Fig. 17A) subcylindrical, short, slightly expanded distally.

Basal article of antennular peduncle (Fig. 17F) 1.18 times as long as broad; anterior margin denticulate; lateral margin having three dentate striae on ventral surface; mesial and lateral margin bearing some setae.

Antennal peduncle (Fig. 17E) moderately slender; first article immovable; second article having one spine on anterodistal margin; third article bearing some striae on dorsal surface, with one spine on anterodistal margin; fourth article unarmed, shorter than others.

Third maxilliped (Fig. 17G) with ischium as long as broad, transversely rugose on ventral surface, anteromesial margin rounded, extensor margin having longitudinal ridge, flexor margin bearing some setae. Merus 1.8 times as long as broad, transversely rugose on ventral surface; flexor margin rounded. Carpus 2 times as long as broad, longitudinal rugae on extensor margin. Propodus 2.25 times as long as broad, relatively slender, nearly smooth. Dactylus small, subtriangular. Merus to dactylus having long setae on flexor margin. Exopod somewhat robust, reaching distal end of merus, having some rugae on ventral surface.

Chelipeds unequal. Larger cheliped (Fig. 18A, B) with ischium unarmed, short, having some rugae. Merus rugose; dorsal surface unarmed; ventral surface with one spine on flexor margin; flexor margin having sawlike teeth on anterior region, bearing one spine on median part. Carpus 1.6 times as long as broad; dorsal surface bearing some rugae; flexor margin having three broad spines: proximal spine largest, distal spine faint; ventral surface smooth but extensor margin having some rugae. Chela stout, 1.7 times as long as carpus, 2.3 times as long as broad, lying on extensor side; dorsal surface having some rugae, somewhat convex; ventral surface smooth but flexor margin having some rugae; fingers crossed distally. Fixed finger slightly curved distally, extensor margin unarmed, cutting edge crenulate. Dactylus 0.4 times as long as chela, proximal region of flexor margin slightly depressed, slightly curved distally, cutting edge crenulate.

Smaller cheliped (Fig. 18C, D) with ischium unarmed, short, having some rugae. Merus rugose; dorsal surface bearing three spines on distal edge; flexor margin bearing some rugae, having one spine on anterior region; ventral surface with some spines on distal margin. Carpus 1.7 times as long as broad (exclude spine); dorsal surface bearing some stiff setae; flexor margin having three well developed spines: proximal and median spines same size, distal spine smaller than others; ventral surface having some rugae; extensor margin bearing row of spines; distal end armed with one prominent spine. Chela slender, 1.8 times as long as carpus, 2.4 times as long as broad; dorsal surface having some setae; ventral surface smooth but flexor margin having some rugae; extensor margin bearing row of spines; flexor margin having three spines distally: proximal spine faint; fingers crossed distally. Fixed

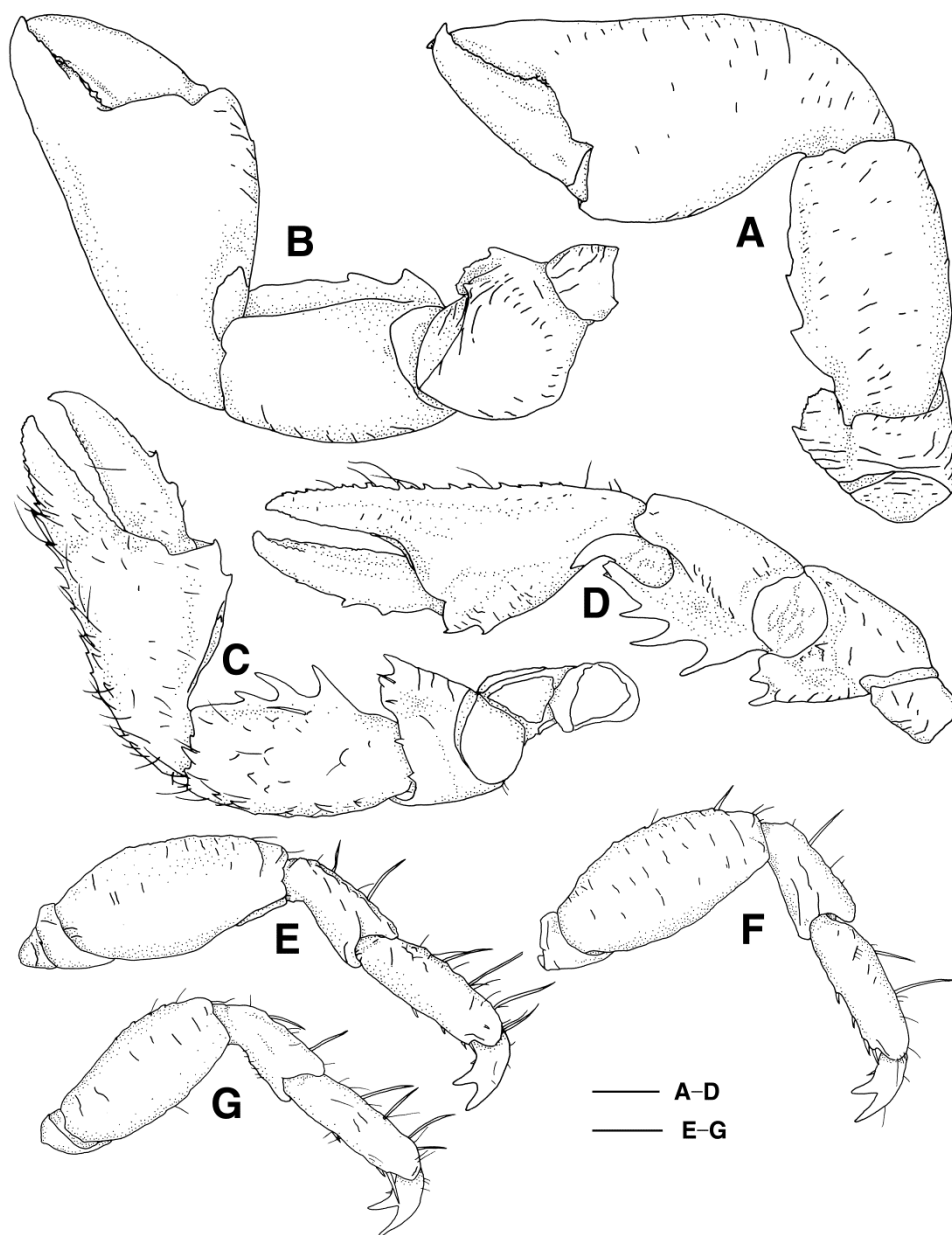


Fig. 18. *Aliaporcellana pygmaea* (De Man, 1902), male. A, larger cheliped, dorsal; B, same, ventral; C, smaller cheliped, dorsal; D, same, ventral; E, right first ambulatory leg; F, right second ambulatory leg; G, right third ambulatory leg. Scale bars: A–D=0.5 mm, E–G= 0.5 mm.

finger slightly curved distally, cutting edge crenulate. Dactylus 0.5 times as long as chela, proximal region slightly depressed, slightly curved distally, extensor margin having row of spines, cutting edge crenulate.

Ambulatory legs (Fig. 18E–G) relatively short, stout, first and second ambulatory legs subequal, third ambulatory leg smaller than others. Meri 1.9–2.1 times as long as broad, stout, bearing few setae on extensor and flexor margins; dorsal surface having some rugae; extensor margin with row of faint spines. Carpi 2.3 times as long as broad, 0.5–0.7 times as long as merus; dorsal surface having short transverse rugae; extensor margin having stiff setae. Propodi 3.3 times as long as broad, 1.6–1.8 times as long as carpus; dorsal surface with short rugae; extensor margin having stiff setae; flexor margin bearing five (first and second) and four (third) movable spines including distal pair. Dactyli short, having biunguiculate claw; extensor margin bearing few setae; flexor margin having one small movable spine.

Remarks. *Aliaporcellana pygmaea* (De Man, 1902) is the first report in the present study from Korean waters.

According to Osawa (2007), *A. pygmaea* morphologically resembles to *A. kikuchii*. They share the following features: (1) the branchial margin bears one epibranchial spine, (2) chelipeds are usually unequal, (3) the dactylus of smaller cheliped has some spines on dorsoflexor margin, (4) the dactyli of ambulatory legs have biunguiculate claw. However, *A. pygmaea* can be distinguished from *A. kikuchii* by some characteristics: the rostrum with lateral lobes bears saw-like teeth on anterior margin, and the dactyli of ambulatory legs have one small movable

spine on flexor margin.

Genus *Enosteoides* Johnson, 1970

10. *Enosteoides ornatus* (Stimpson, 1858)

Porcellana ornatus Stimpson, 1858: 242 [type locality: Hong Kong]; Miyake, 1943: 118, figs. 42, 43; 1978: 173, fig. 70; Kim & Choe, 1968: 1, fig. 1; Kim, 1973: 184, fig. 24.

Porcellana corallicola: Haswell, 1882: 759.

Porcellana (Enosteoides) corallicola: Johnson, 1970: 32, fig. 3q–r.

Enosteoides ornatus: Haig, 1978: 709; 1992: 305, fig. 2; Osawa & Chan, 2010: 84, figs. 56, 57.



Fig. 19. *Enosteoides ornatus* (Stimpson, 1858), male. Carapace length, 6.0 mm, dorsal view.

Material examined. 1 ♀, Seogwi-dong, Seogwipo-si, Jeju-do, 30 Jun 1993; 1 ♀, 19 Jan 1997; 1 ♂, 20 Jan 1997; 1 ♀, Goseong-ri, Seongsan-eup, Seogwipo-si, Jeju-do, 5 Nov 2000; 1 ♂, 1 ♀, Beophwan-dong, Seogwipo-si, Jeju-do, 21 Feb 2001; 1 ♀, Beophwan-dong, Seogwipo-si, Jeju-do, 6 Jun 2001; 3 ♂♂, 4 ♀♀, Hangeong-myeon, Jeju-si, Jeju-do, 8 Jun 2001; 1 ♂, Goseong-ri, Seongsan-eup, Seogwipo-si, Jeju-do, 9 Jun 2001; 2 ♀♀, Songsan-dong, Seogwipo-si, Jeju-do, 8 Mar 2002; 1 ♂, Uljin-gun, Gyeongsangbuk-do, 21 Oct 2008; 1 ♀, Seogwi-dong, Seogwipo-si, Jeju-do, 26 Feb 2009; 1 ♀, Seogwi-dong, Seogwipo-si, Jeju-do, 11 Mar 2009; 1 ♂, Seogwi-dong, Seogwipo-si, Jeju-do, 12 Mar 2009; 1 ♀, Hakdong-ri, Dongbubmyeon, Geoje-si, Gyeongsangnam-do, 29 Aug 2009; 1 ♀, Uljin-gun, Gyeongsangbuk-do, 29 Oct 2009; 2 ♂♂, Seogwi-dong, Seogwipo-si, Jeju-do, 23 Mar 2011; 1 ♂, 2 ♀♀, Seogwi-dong, Seogwipo-si, Jeju-do, 15 Jul 2011; 1 ♂, 2 ♀♀, Hyeopjae-ri, Hallim-eup, Jeju-si, Jeju-do, 24 Sep 2011.

Distribution. North to Honshu in Japan, south to tropical Australia, west to Pakistan, Korea.

Description. Carapace (Figs. 19, 20A) slightly longer than broad. Dorsal surface moderately convex, uneven. Rostrum broad, anterior border having saw-like teeth, median part bearing longitudinal groove, lateral lobes slightly produced. Orbits moderately concave; supra-ocular margins having some small spines; outer orbital angle bearing one spine. Protogastric ridge moderately produced. Each region of carapace well separated by grooves; frontal region and protogastric region divided into two lobes; metagastric region separated from urogastric region; branchial region divided into three lobes: median lobe smaller than others; cardiac region and

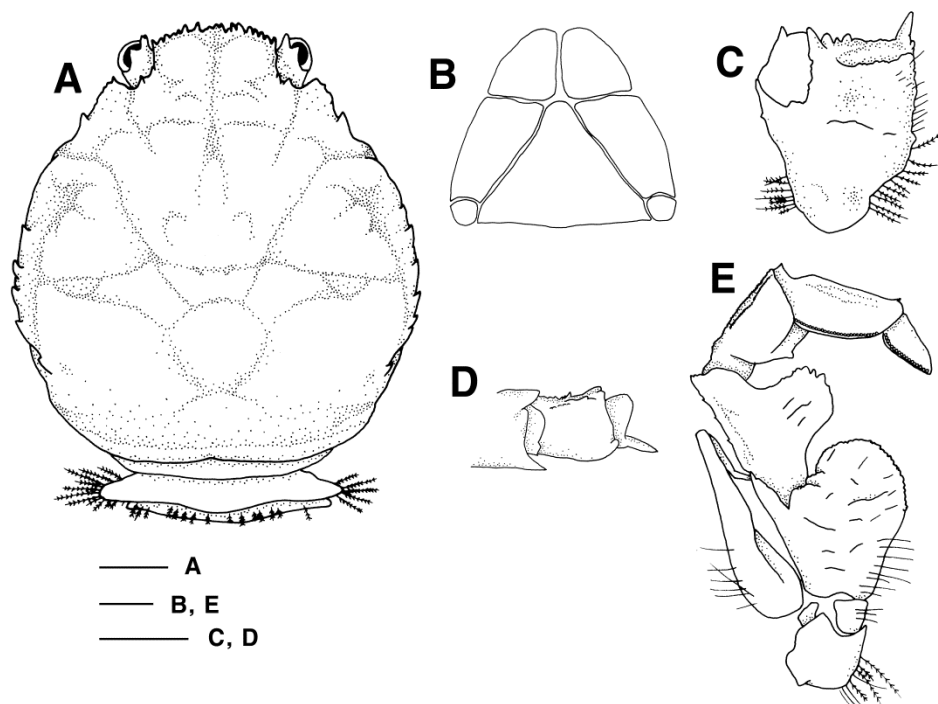


Fig. 20. *Enosteoides ornatus* (Stimpson, 1858), male. A, carapace, anterior part of abdomen; B, telson; C, basal segment of left antennular peduncle; D, antennal peduncle; E, right third maxilliped. Scale bars: A=1 mm, B, E=0.5 mm, C, D=0.5 mm.

intestinal region faint. Hepatic margin having one prominent spine. Cervical grooves moderately developed. Branchial margin bearing five to six spines.

Telson (Fig. 20B) composed of seven plates.

Ocular peduncle (Fig. 20A) subcylindrical, short, eyespine on mesial end of eyestalk.

Basal article of antennular peduncle (Fig. 20C) 1.22 times as long as broad; anterior margin denticulate; anterolateral margin having one prominent spine; lateral margin having one striae on ventral surface; mesial and lateral margin bearing some

plumose setae.

Antennal peduncle (Fig. 20D) moderately slender; first article immovable; second article having one spine on posterodistal margin; third article bearing some small tubercles and spines on anterior margin; fourth article unarmed, shorter than others.

Third maxilliped (Fig. 20E) with ischium as long as broad, transversely rugose on ventral surface, anteromesial margin denticulate and rounded, flexor margin bearing some setae on basal half. Merus 1.45 times as long as broad, transversely rugose on ventral surface; extensor margin bearing three small teeth; flexor margin having saw-like teeth, rounded. Carpus 1.8 times as long as broad, longitudinal ruga on extensor margin. Propodus 2.3 times as long as broad, nearly smooth, having one small tooth on distoextensor margin. Dactylus small, subtriangular. Merus to dactylus having long seatae on flexor margin. Exopod moderately slender, reaching half of merus, having setae on basal third.

Chelipeds (Fig. 21A, B) almost equal. Ischium unarmed, short, smooth. Merus short; having some teeth on distal margin; flexor margin having sawlike teeth on anterior region; extensor margin bearing some plumose setae; ventral surface with very small tubercles; ventroflexor margin having three small spines. Carpus 1.78 times as long as broad; dorsal surface bearing two longitudinal grooves, having some short rugae; extensor margin bearing row of spines; flexor margin having saw-like teeth, with three spines proximally; ventral surface smooth but extensor margin having some rugae. Chela stout, 1.88 times as long as carpus, 2.1 times as long as broad, lying on extensor side; extensor margin bearing row of saw-like teeth and

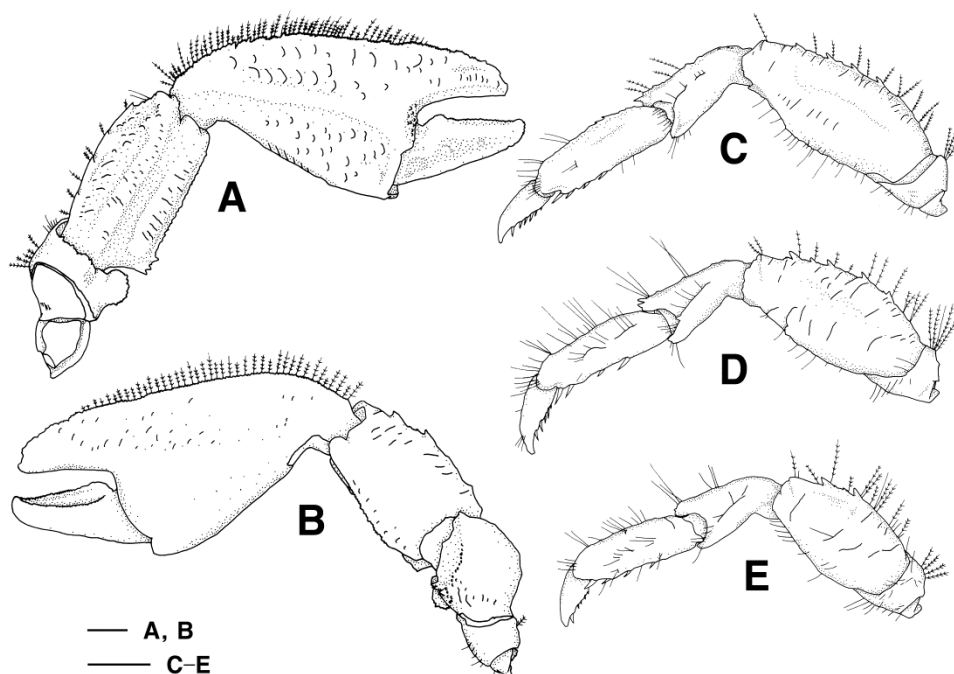


Fig. 21. *Enosteoides ornatus* (Stimpson, 1858), male. A, left cheliped, dorsal; B, same, ventral; C, left first ambulatory leg; D, left second ambulatory leg; E, left third ambulatory leg. Scale bars: A, B=1 mm, C–E= 1 mm.

plumose setae; dorsal surface having large tubercles; ventral surface smooth. Fixed finger extensor margin unarmed, cutting edge almost smooth. Dactylus 0.33 times as long as chela, slightly curved distally, cutting edge crenulate, proximal region concave.

Ambulatory legs (Fig. 20C–E) moderately slender, first and second ambulatory legs subequal, third ambulatory leg smaller than others. Meri 1.64–2.29 times as long as broad, bearing some plumose setae on extensor and flexor margins; dorsal surface having some rugae; extensor margin with row of spines. Carpi 2–2.45 times as long as broad, 0.55–0.7 times as long as merus; dorsal surface having short

transverse rugae; extensor margin having setae; distoextensor margin with one spine. Propodi 3–3.5 times as long as broad, 1.2–1.45 times as long as carpus; dorsal surface with short rugae; extensor margin having setae; flexor margin bearing five movable spines including distal pair. Dactyli short, having single claw; flexor margin having five to six movable spine.

Remarks. *Enosteoides ornatus* was firstly reported as *Porcellana ornatus* by Stimpson, but Haig (1978) subsequently transferred this species to the genus *Enosteoides*. Kim and Choe (1968) were the first to report this species from Korea. Genus *Enosteoides* has four species, and only one species has been reported from Korea.

The present specimens agree with the description of Osawa and Chan (2010). However, slightly difference is present in the dactylus of ambulatory legs. The number of movable spines in the present specimen is five to six compared with four to five in description of Osawa and Chan (2010).

Genus *Lissoporcellana* Haig, 1978

11. *Lissoporcellana nakasonei* (Miyake, 1978)

Porcellana maculata Miyake, 1957: 75, figs. 1–3 [type locality: Tanabe Bay, Wakayama Prefecture, Japan]; Miyake et al., 1962: 125 (list). Not *Porcellana maculata* H. Milne Edwards, 1937 (= *Neopetrolisthes maculatus*).

Porcellana nakasonei: Miyake, 1978a: 28; 1978b: 173 (Key, English part), 149 (Key, Japanese part).

Lissoporcellana maculata: Haig, 1978: 712.



Fig. 22. *Lissoporcellana nakasonei* (Miyake, 1978), female. Carapace length, 3.0 mm, dorsal view.

Lissoporcellana nakasonei: Miyake, 1982: 204, 240; Osawa, 1998: 876, figs. 1–3; Osawa, 2007: 13.

Material examined. 1 ovig. ♀, Hyeopjae-ri, Hallim-eup, Jeju-si, Jeju-do, 24 Sep 2011.

Distribution. Southern Japan, New Caledonia and Korea (in this study).

Description. Carapace (Figs. 22, 23A) 1.27 times as long as broad. Dorsal surface slightly convex, smooth. Rostrum broad, horizontal, trilobite; median lobe broader than lateral lobes, having distinct notch, anterior margin with saw-like teeth, bearing longitudinal groove; lateral lobes sharply end anteriorly. Orbits relatively shallow,

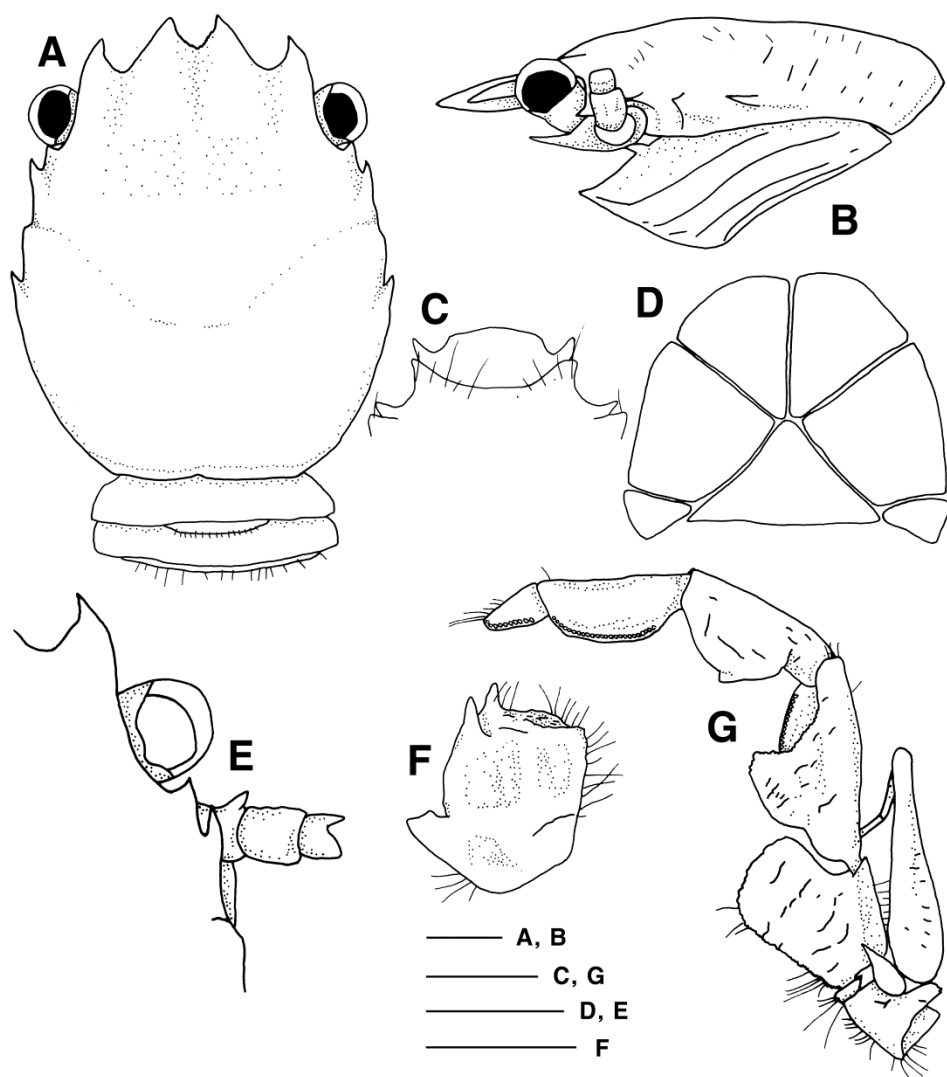


Fig. 23. *Lissoporcellana nakasonei* (Miyake, 1978), female. A, carapace, anterior part of abdomen; B, carapace and left pterygostomian flap, lateral; C, third and fourth thoracic sternite; D, telson; E, right anterior part of carapace, ocular peduncle, and antennal peduncle; F, basal segment of left antennular peduncle; G, left third maxilliped. Scale bars: A, B=0.5 mm, C, G=0.5 mm, D, E=0.5 mm, F=0.5 mm.

strongly oblique; supra-ocular margins unarmed; outer orbital angle having one spine. Protogastric ridge very weakly produced. Hepatic margin having one distinct spine. Cervical grooves very weakly developed. Branchial margin with one mesobranchial spine.

Pterygostomian flaps (Fig. 23B) entire, rugose, anterior ending with spinule, having one spine on anterodorsal margin.

Third thoracic sternite (Fig. 23C) trilobite on anterior part; median lobe somewhat flat, broad; lateral lobes narrow. Fourth thoracic sternite with anterior margin slightly broader than third; posterior margin 1.46 times longer than anterior margin; median region concave.

Telson (Fig. 23D) composed of seven plates.

Ocular peduncle (Fig. 23A, E) subcylindrical, short, slightly expanded distally.

Basal article of antennular peduncle (Fig. 23F) 1.06 times as long as broad; anterior margin denticulate, having some short striae on ventral surface, bearing two well developed spines on mesial corner; mesial and lateral margin bearing some setae.

Antennal peduncle (Fig. 23E) moderately slender; first article immovable; second article having one spine on anterodistal margin; third article unarmed; fourth article unarmed, shorter than others.

Third maxilliped (Fig. 23G) with ischium 1.25 times as long as broad, transversely rugose on ventral surface, anteromesial margin denticulate and rounded, extensor margin having longitudinal ridge, flexor margin bearing some setae. Merus

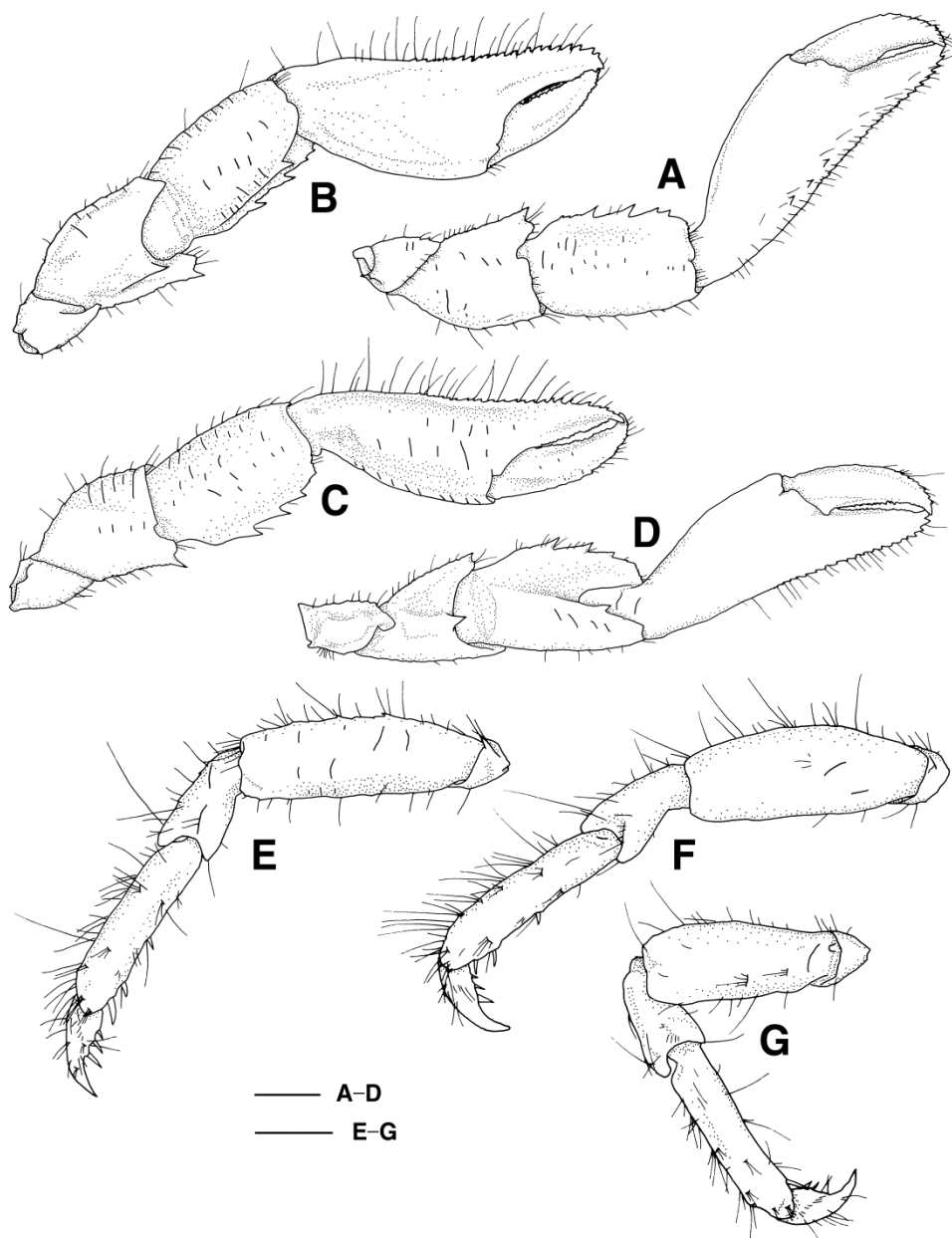


Fig. 24. *Lissoporcellana nakasonei* (Miyake, 1978), female. A, larger cheliped, dorsal; B, same, ventral; C, smaller cheliped, dorsal; D, same, ventral; E, left first ambulatory leg; F, left second ambulatory leg; G, left third ambulatory leg. Scale bars: A-D=0.5 mm, E-G=0.5 mm.

1.8 times as long as broad, having short striae on ventral surface; flexor margin dentate and rounded. Carpus 1.77 times as long as broad, longitudinal rugae on extensor margin. Propodus 2.5 times as long as broad, flexor margin slightly rounded, nearly smooth. Dactylus small, subtriangular. Merus to dactylus having long setae on flexor margin. Exopod relatively robust, reaching half of merus, having some short rugae on ventral surface.

Chelipeds unequal in size, extensor margin having some setae. Larger cheliped (Fig. 24A, B) with ischium unarmed, short, having some rugae. Merus rugose; ventral surface bearing one distinct spine; flexor margin having saw-like teeth, bearing one spine near anterior distal corner. Carpus 1.6 times as long as broad; dorsal surface bearing some short rugae; dorsoextensor margin unarmed; dorsoflexor margin having four spines: proximal two spines distinct, distal two spines faint; ventral surface having some rugae; ventroflexor margin with one prominent spine on distal third. Chela slender, 2.1 times as long as carpus, 3 times as long as broad, lying on extensor side; extensor margin having row of spines on distal half; ventral surface smooth; fingers crossed distally. Fixed finger slightly curved distally, extensor margin having row of spines, cutting edge crenulate. Dactylus 0.44 times as long as chela, slightly curved distally, cutting edge crenulate.

Smaller cheliped (Fig. 24C, D) similar to larger cheliped; chela slender than that of larger cheliped, 3.25 times as long as broad.

Ambulatory legs (Fig. 24E–G) relatively short, slender. First and second ambulatory legs subequal, third ambulatory leg smaller than others. Meri 2.4–3.0 times as long as broad, slender, extensor margin bearing few setae, with row of faint spines. Carpi

2.2–2.0 times as long as broad, 0.5–0.6 times as long as merus; dorsal surface having short transverse rugae; extensor margin having setae. Propodi 4.2–4.4 times as long as broad, 1.6–1.8 times as long as carpus; dorsal surface with short rugae; extensor margin having setae; flexor margin bearing four (first and second) and three (third) movable spines including distal pair. Dactyli short, having single claw; extensor margin bearing few setae; flexor margin having three movable spines.

Remarks. Eleven species are known in the genus *Lissoporcellana* Haig, 1978. Until now, no *Lissoporcellana* has been reported from Korea before. *Lissoporcellana nakasonei* (Miyake, 1978) has only been reported from Southern Japan and New Caledonia.

Examined specimen in this study agrees well with redescription of Osawa (1998) except for the number of movable spine on propodus of third ambulatory legs. Examined specimen has three movable spines on propodus of third ambulatory legs, while description of Osawa (1998) was four spines.

The present specimen is morphologically similar to *L. miyakei* Haig, 1981. They share the following features: the median lobe of rostrum has distinct notch, and the branchial margins of carapace each bear one spine. However, *L. nakasonei* has subparallel branchial margins on carapace, while *L. miyakei* has convex branchial margins on carapace (Osawa, 2007).

Genus *Pachycheles* Stimpson, 1858

Key to species of *Pachycheles* from Korea

1. Propodus and carpus of chelipeds having dense, short plumose setae on dorsal

surface; dactyli of ambulatory legs with flexor margin having three movable spines *Pachycheles hertwigi*

Propodus and carpus of chelipeds without dense, short plumose setae on dorsal surface; dactyli of ambulatory legs with flexor margin having four movable spines *Pachycheles stevensii*

12. *Pachycheles hertwigi* Balss, 1913

Pachycheles hertwigi Balss, 1913: 32, figs. 22–24; Miyake, 1982: 237; Ko, 2006: 7, figs. 1, 2.

Pachycheles balssi: Miyake, 1943: 106, figs. 34–36; 1978: 171, fig. 69; Haig, 1966: 291.



Fig. 25. *Pachycheles hertwigi* Balss, 1913, male. Carapace length, 5.5 mm, dorsal view.

Material examined. 1 ♀, Guryongpo-eup, Nam-gu, Pohang-si, Gyeongsangbuk-do, 17 Jul 1972; 1 ♂, 1 ♀, Ulleung-eup, Ulleung-gun, Gyeongsangbuk-do, 15 Jul 1989; 2 ♀♀, Namyang-ri, Seo-myeon, Ulleung-gun, Gyeongsangbuk-do, 28 Nov 1991; 1 ♂, 1 ♀, Sadong-ri, Ulleung-eup, Ulleung-gun, Gyeongsangbuk-do, 26 Jul 2001; 1 ♀, Hyeonpo-ri, Buk-myeon, Ulleung-gun, Gyeongsangbuk-do, 25 Jun 2007; 1 ♀, Jeodong-ri, Ulleung-eup, Ulleung-gun, Gyeongsangbuk-do, 13 Oct 2012; 1 ♀, Ulleung-gun, Gyeongsangbuk-do, 15 Oct 2012.

Distribution. Japan and Korea.

Description. Carapace (Figs. 25, 26A) 1.1 times as long as broad. Dorsal surface weakly convex, bearing short transverse striae. Rostrum broad, triangular; dorsal surface having dense, short pubescence. Orbits moderately concave, oblique; supra-ocular margins unarmed; outer orbital angle having one blunt spine. Protogastric ridge moderately produced. Hepatic margin weakly convex, unarmed. Cervical grooves weakly developed. Branchial margin with some transverse striae, unarmed.

Telson (Fig. 26B) composed of five plates.

Ocular peduncle (Fig. 26A) subcylindrical, short, slightly expanded proximally.

Basal article of antennular peduncle (Fig. 26C) 1.1 times as long as broad; anterior margin denticulate, bearing two spines on mesial corner and one spine on middle.

Antennal peduncle (Fig. 26D) with first article immovable; second article having one spine on anterodistal margin; third article bearing some short striae on dorsal surface, with tuberculate on anterior margin; fourth article unarmed, shorter than

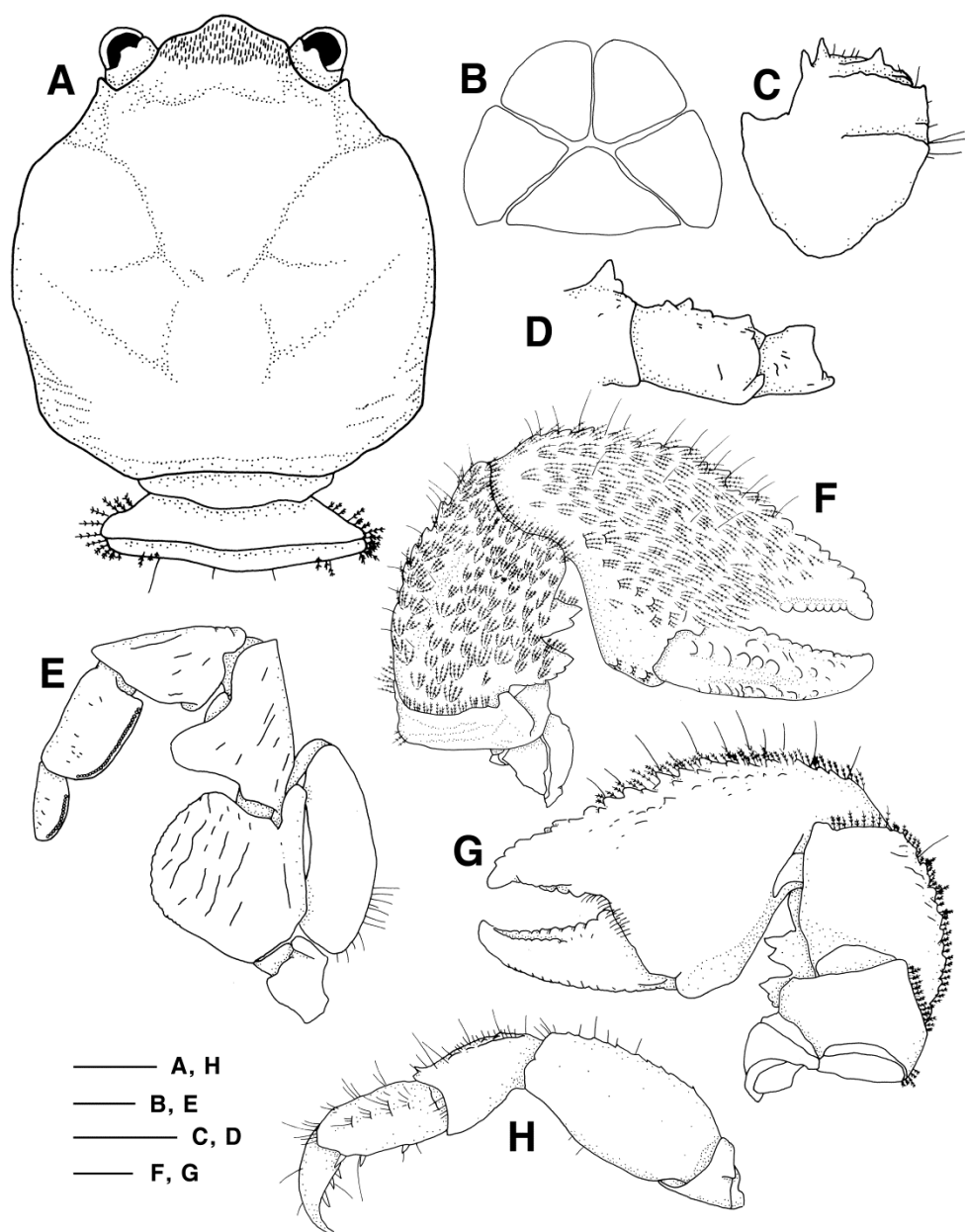


Fig. 26. *Pachycheles hertwigi* Balss, 1913, male. A, carapace, anterior part of abdomen; B, telson; C, basal segment of left antennular peduncle; D, antennal peduncle; E, left third maxilliped; F, larger cheliped, dorsal; G, same, ventral; H, left first ambulatory leg. Scale bars: A, H=1 mm, B, E=0.5 mm, C, D=0.5 mm, F, G=1 mm.

others.

Third maxilliped (Fig. 26E) with ischium slightly longer than broad, transversely rugose on ventral surface, anteromesial margin denticulate and rounded, extensor margin having longitudinal ridge. Merus 1.5 times as long as broad, transversely rugose on ventral surface; flexor margin rounded. Carpus 1.87 times as long as broad, longitudinal rugae on extensor margin. Propodus 1.76 times as long as broad, relatively robust, nearly smooth. Dactylus small. Merus to dactylus having long setae on flexor margin. Exopod robust, overreaching distal end of ischium, having some setae on proximal third.

Chelipeds (Fig. 26F, G) robust, unequal in size. Ischium unarmed, short. Merus rugose. Carpus 1.72 times as long as broad; dorsal surface bearing longitudinal groove, having some tubercles, with dense, short plumose setae; dorsoextensor margin having row of spines; dorsoflexor margin having two well developed, broad teeth. Chela robust, 1.6 times as long as carpus, 1.86 times as long as broad; extensor margin having row of spines; dorsal surface with dense, short plumose setae; ventral surface bearing some tubercles near extensor margin. Fixed finger with extensor margin having row of tubercles, cutting edge crenulate. Dactylus 0.5 times as long as chela, slightly curved distally, dorsal surface having longitudinal groove and row of tubercles, cutting edge crenulate.

Ambulatory legs (Fig. 26H) robust. Meri 2.0 times as long as broad, extensor margins slightly crenulate, bearing setae. Carpi 1.8 times as long as broad, 0.6 times as long as merus; dorsal surface and extensor margin having setae; with row of small tubercles near extensor margin; distoextensor margin bearing one spine.

Propodi 2.36 times as long as broad; dorsal surface and extensor margin having setae; flexor margin bearing four movable spines including distal pair. Dactyli short, having single claw; extensor margin bearing few setae; flexor margin having three movable spines.

Remarks. *Pachycheles hertwigi* Balss, 1913 is closely related with *P. stevensii* Stimpson, 1858. They share the following features: (1) the branchial margin is unarmed, (2) the rostrum has dense, short setae, (3) the pterygostomial flap is not entire, (4) the telson is composed five plates, (5) chelipeds are robust and unequal. However, *P. hertwigi* differs from *P. stevensii* in the following characteristics: chelipeds bear dense, short plumose setae, and the dactylus of ambulatory legs have three movable spines on flexor margin.

Examined specimens agree well with present study of Miyake (1978). However, some specimens have four movable spines on flexor margin of ambulatory legs with dactylus.

This species was first reported by Ko (2006).

13. *Pachycheles stevensii* Stimpson, 1858

Pachycheles stevensii Stimpson, 1858 [type locality: west coast of Hokkaido (=Jesso)]: 242; Ortmann, 1892: 267; Balss, 1913: 32; Miyake, 1943: 103, figs. 32, 33; 1978: 169, fig. 68; Haig, 1966: 290; Kim, 1973: 182, fig. 23, Pl. 66: fig. 10a, 10b.

Material examined. 1 ♂, 1 ♀, Seogwipo-si, Jeju-do, 2 Aug 1970; 1 ♀, Guryongpo-



Fig. 27. *Pachycheles stevensii* Stimpson, 1858, male. Carapace length, 6.8 mm, dorsal view.

eup, Nam-gu, Pohang-si, Gyeongsangbuk-do, 17 Jun 1972; 3 ♂♂, 1 ♀, Hongdo-ri, Heuksan-myeon, Sinan-gun, Jeollanam-do, 20 Jul 1978; 1 ♀, Anin-ri, Gangdong-myeon, Gangneung-si, Gangwon-do; 4 Oct 1981; 1 ♂, Beophwan-dong, Seogwipo-si, Jeju-do, 19 Jan 1985; 2 ♂♂, 2 ♀♀, Woljeon-ri, Nampo-myeon, Boryeong-si, Chungcheongnam-do, 16 Aug 1995; 1 ♂, Sibang-ri, Jangmok-myeon, Geoje-si, Gyeongsangnam-do, 30 Jan 1997; 1 ♀, Geomun-ri, Samsan-myeon, Yeosu-si, Jeollanam-do, 21 Jun 2002; 1 ♂, Goseong-ri, Seongsan-eup, Seogwipo-si, Jeju-do, 10 Oct 2002; 2 ♀♀, Geumjin-ri, Ganggu-myeon, Yeongdeok-gun, Gyeongsangbuk-do, 22 Nov 2002; 3 ♂♂, 4 ♀♀, Maldo-ri, Okdo-myeon, Gunsan-si, Jeollabuk-do, 3 Aug 2003; 1 ♂, Yeongdo-gu, Busan, 30 Aug 2005; 1 ♀, Ulleung-eup, Ulleung-gun, Gyeongsangbuk-do, 22 Jun 2006; 1 ♂, Nagok-ri, Buk-myeon, Uljin-gun,

Gyeongsangbuk-do, 29 Aug 2006; 1 ♂, Yeosu-si, Jeollanam-do, 10 Oct 2006; 1 ♀, Baega-ri, Deokjeok-myeon, Ongjin-gun, Incheon, 3 Jul 2007; 3 ♀♀, Songjeong-ri, Mijo-myeon, Namhae-gun, Gyeongsangnam-do, 6 Aug 2009; 1 ♂, Obong-ri, Jugwang-myeon, Goseong-gun, Gangwon-do, 24 Mar 2010; 1 ♀, Jukbyeon-ri, Jukbyeon-myeon, Uljin-gun, Gyeongsangbuk-do, 25 Aug 2010; 1 ♀, 16 Aug 2011; 2 ♂♂, 2 ♀♀, Jukbyeon-ri, Jukbyeon-myeon, Uljin-gun, Gyeongsangbuk-do, 17 Aug 2011; 1 ♂, Jukbyeon-ri, Jukbyeon-myeon, Uljin-gun, Gyeongsangbuk-do, 25 Aug 2011; 1 ♂, Nodae-ri, Yokji-myeon, Tongyeong-si, Gyeongsangnam-do, 31 Aug 2011; 2 ♂♂, 4 ♀♀, Nodae-ri, Yokji-myeon, Tongyeong-si, Gyeongsangnam-do, 2 Sep 2011.

Distribution. Vladivostok, China, Japan and Korea.

Description. Carapace (Figs. 27, 28A) as long as broad. Dorsal surface weakly convex, bearing short transverse striae. Rostrum broad, triangular; dorsal surface having dense, short pubescence. Orbits moderately concave, oblique; supra-ocular margins unarmed; outer orbital angle having one blunt spine. Protogastric ridge moderately produced. Hepatic margin weakly convex, unarmed. Cervical grooves weakly developed. Branchial margin with some transverse striae, unarmed.

Telson (Fig. 28B) composed of five plates.

Ocular peduncle (Fig. 28A) subcylindrical, short, slightly expanded proximally.

Basal article of antennular peduncle (Fig. 28C) as long as broad; anterior margin denticulate, bearing two spines on mesial corner.

Antennal peduncle (Fig. 28D) with first article immovable; second article having one spine on anterodistal margin; third article bearing some short striae on dorsal

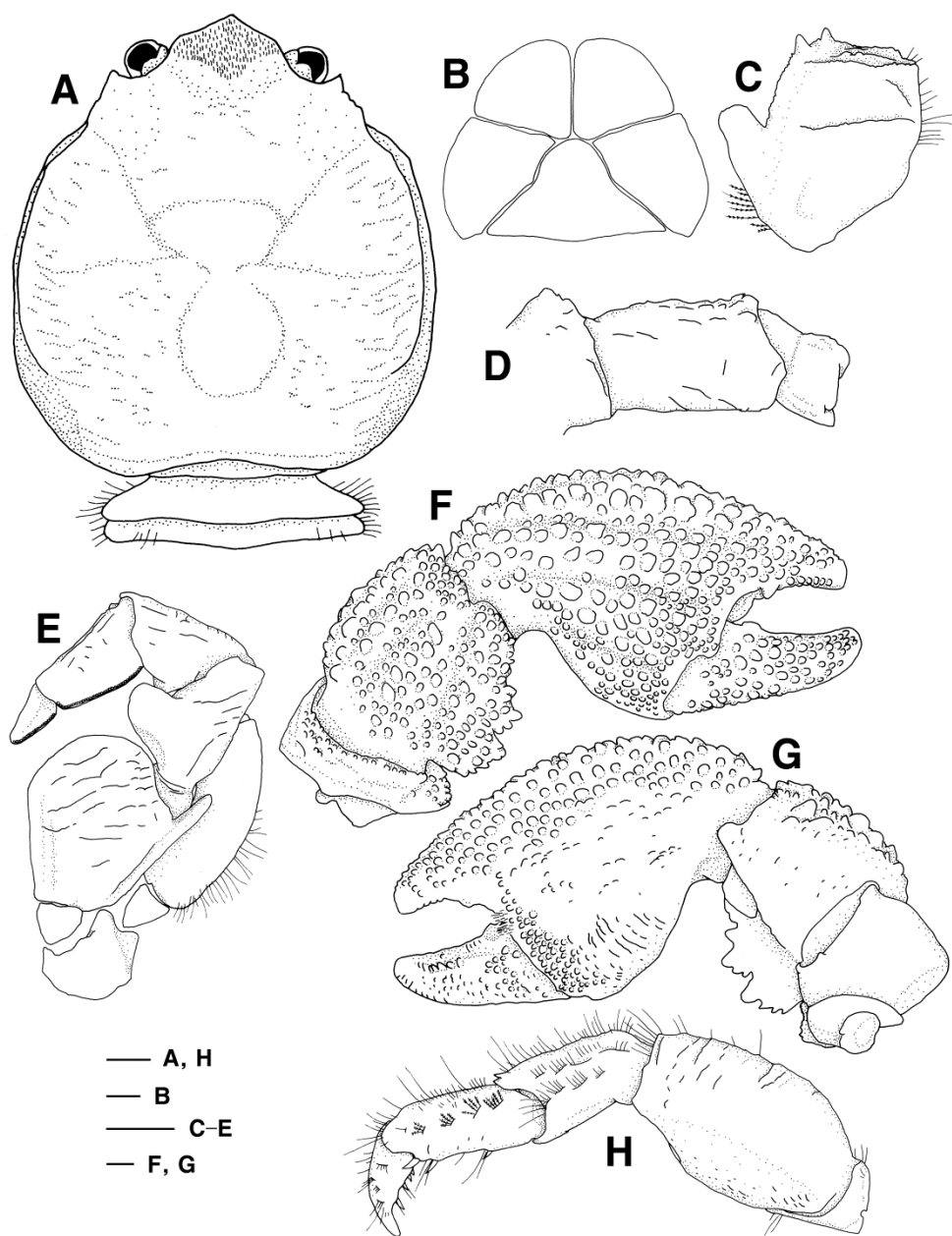


Fig. 28. *Pachycheles stevensii* Stimpson, 1858, male. A, carapace, anterior part of abdomen; B, telson; C, basal segment of left antennular peduncle; D, antennal peduncle; E, left third maxilliped; F, larger cheliped, dorsal; G, same, ventral; H, left first ambulatory leg. Scale bars: A, H=1 mm, B=1 mm, C, D= 0.5 mm, E=1 mm, F, G=1 mm.

surface, with tuberculate on anterior margin; fourth article unarmed, shorter than others.

Third maxilliped (Fig. 28E) with ischium 1.17 times as long as broad, transversely rugose on ventral surface, anteromesial margin rounded, extensor margin having longitudinal ridge. Merus 1.5 times as long as broad, transversely rugose on ventral surface; flexor margin rounded. Carpus 1.76 times as long as broad, longitudinal rugae on extensor margin. Propodus 1.92 times as long as broad, relatively robust, nearly smooth. Dactylus small. Merus to dactylus having long setae on flexor margin. Exopod robust, overreaching distal end of ischium, having some setae on proximal half.

Chelipeds (Fig. 28F, G) robust, unequal in size. Ischium unarmed, short. Merus with dorsal surface bearing row of tubercles on distal margin, flexor margin tuberculate. Carpus 1.21 times as long as broad; dorsal surface bearing three longitudinal grooves, having distinct tubercles; dorsoflexor margin having two well developed, broad teeth. Chela robust, 1.9 times as long as carpus, 1.65 times as long as broad; extensor margin having row of spines; dorsal surface having distinct tubercles, bearing three longitudinal grooves; ventral surface bearing tubercles extensor and distal margin, with transvers striae on flexor margin. Fixed finger with extensor margin having row of tubercles, cutting edge crenulate, with basal region bearing small bundle of plumose setae. Dactylus 0.52 times as long as chela, slightly curved distally, dorsal surface having tubercles, cutting edge crenulate.

Ambulatory legs (Fig. 28H) robust. Meri 1.7 times as long as broad, extensor margins slightly crenulate, bearing setae. Carpi 2.0 times as long as broad, 0.68

times as long as merus; extensor margin having setae; distoextensor margin bearing one spine; dorsal surface bearing short longitudinal rugae and setae. Propodi 2.66 times as long as broad; dorsal surface and extensor margin having setae; flexor margin bearing four movable spines including distal pair. Dactyli short, having single claw; extensor margin bearing few setae; flexor margin having four movable spines.

Remarks. *Pachycheles stevensii* Stimpson, 1858 is common species in Korean fauna. The present specimens agree with description of Miyake (1978) except for some characters. Examined specimens have two broad spines on carpus of chelipeds, while he mentioned that three broad spines exist on those. And examined specimens have four movable spines on ambulatory legs with dactylus, whereas according to Miyake (1978), five or six movable spines exist on those. *P. stevensii* is morphologically similar to *P. hertwigi*. The features of two species are discussed under the *P. hertwigi*.

Genus *Petrolisthes* Stimpson, 1858

Key to species of *Petrolisthes* from Korea

1. Supra-ocular margins without spine; branchial margin without epibranchial spines *Petrolisthes japonicus*
Supra-ocular margins having spine; branchial margin bearing epibranchial spines 2
2. Mesobranchial spine present *Petrolisthes militaris*
Mesobranchial spine absent *Petrolisthes coccineus*

14. *Petrolisthes coccineus* (Owen, 1939)

Porcellana coccinea Owen, 1839: 87, Pl. 26 [type locality: Low (=Tuamotu) Islands].

Porcellana barbata: Heller, 1862: 523 [type locality: Nicobar Islands]

Petrolisthes nipponensis: Miyake, 1937: 213, fig.2, Pl. 12: fig. 1 [type locality: Seto (Shirahama), Wakayama Prefecture, Japan].

Petrolisthes coccineus: Miyake, 1943: 59, figs. 3, 4; Haig, 1992: 313, fig. 9; Ko, 2003: 36, fig. 2, 4; Osawa & Chan, 2010: 125, figs. 92, 93.

Material examined. 1 ♂, Beophwan-dong, Seogwipo-si, Jeju-do, 17 Jan 1985; 1 ♀, Seogwi-dong, Seogwipo-si, Jeju-do, 30 Jun 1993; 1 ♂, Seogwi-dong, Seogwipo-si,



Fig. 29. *Petrolisthes coccineus* (Owen, 1939), male. Carapace length, 9.7 mm, dorsal view.

Jeju-do, 1 Jul 1993; 1 ♂, Daejeong-eup, Seogwipo-si, Jeju-do, 23 Feb 2001; 1 ♂, Geomun-ri, Samsan-myeon, Yeosu-si, Jeollanam-do, 15 Oct 2001; 1 ♀, Seogwi-dong, Seogwipo-si, Jeju-do, 19 Apr 2002; 1 ♀, Seogwi-dong, Seogwipo-si, Jeju-do, 15 Jul 2011; 1 ♀, Beophwan-dong, Seogwipo-si, Jeju-do, 16 Jul 2011.

Distribution. Japan, Indonesia, west to eastern African coast, east to Tuamotu Archipelago and Hawaiian Islands and Korea.

Description. Carapace (Figs. 29, 30A) slightly broader than long. Dorsal surface relatively flat, with some short transverse ridge. Rostrum broad, slightly deflexed, triangular; dorsal surface having short transverse ridges; median region bearing longitudinal groove. Orbits relatively shallow, oblique; supra-ocular margins each

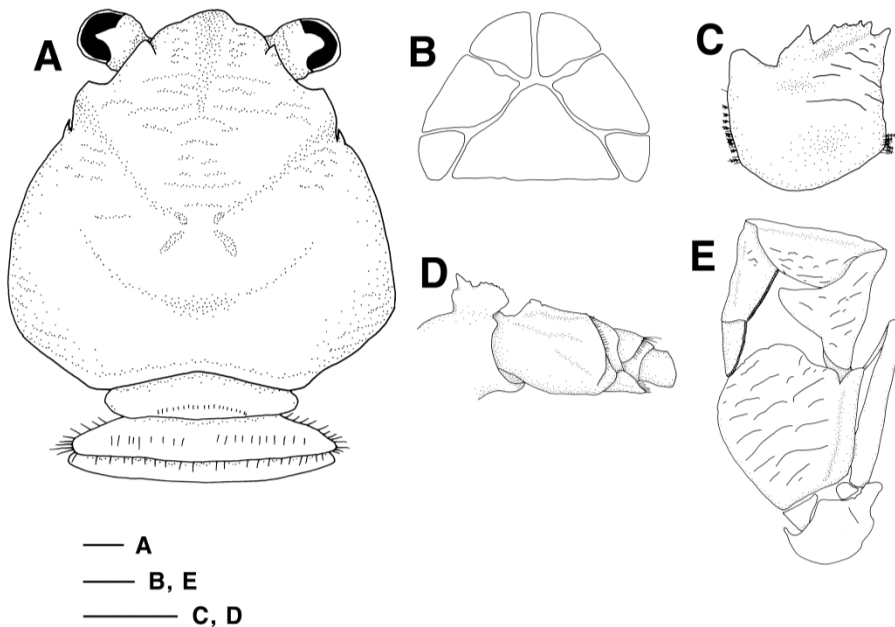


Fig. 30. *Petrolisthes coccineus* (Owen, 1939), male. A, carapace, anterior part of abdomen; B, telson; C, basal segment of left antennular peduncle; D, antennular peduncle; E, left third maxilliped. Scale bars: A=1 mm, B, E=1 mm, C, D=1 mm.

having one spine; outer orbital angle unarmed. Gastric region with some short transverse ridges. Protogastric ridge moderately produced. Hepatic margin weakly convex. Cervical grooves moderately developed. Branchial margin somewhat convex, with some striae, bearing one pair of epibranchial spines.

Telson (Fig. 30B) composed of seven plates.

Ocular peduncle (Fig. 30A) subcylindrical, large, short, slightly expanded distally.

Basal article of antennular peduncle (Fig. 30C) as long as broad; anterior margin denticulate, with distinct spine at each mesial and lateral corner; lateral margin having some striae on ventral surface; mesial and lateral margin bearing some setae.

Antennal peduncle (Fig. 30D) with first article immovable; second article with subrectangular anterior crest having one prominent spine near proximal region; third article bearing some striae on dorsal surface, anterior margin somewhat swollen near proximal region, distal margin having some ridges; fourth article unarmed, shorter than others.

Third maxilliped (Fig. 30E) with ischium as long as broad, having transversely rugose on ventral surface, anteromesial margin rounded, extensor margin having longitudinal ridge. Merus 1.52 times as long as broad, subtriangular, having transversely rugose on ventral surface. Carpus 2.45 times as long as broad, bearing longitudinal rugae on flexor margin. Propodus 2.5 times as long as broad, relatively slender, nearly smooth. Dactylus small, subtriangular. Merus to dactylus having long setae on flexor margin. Exopod slender, reaching half of merus.

Chelipeds (Fig. 31A, B) subequal, with ischium unarmed, short. Merus rugose; dorsal surface bearing rugae, having one small spine at distoextensor margin;

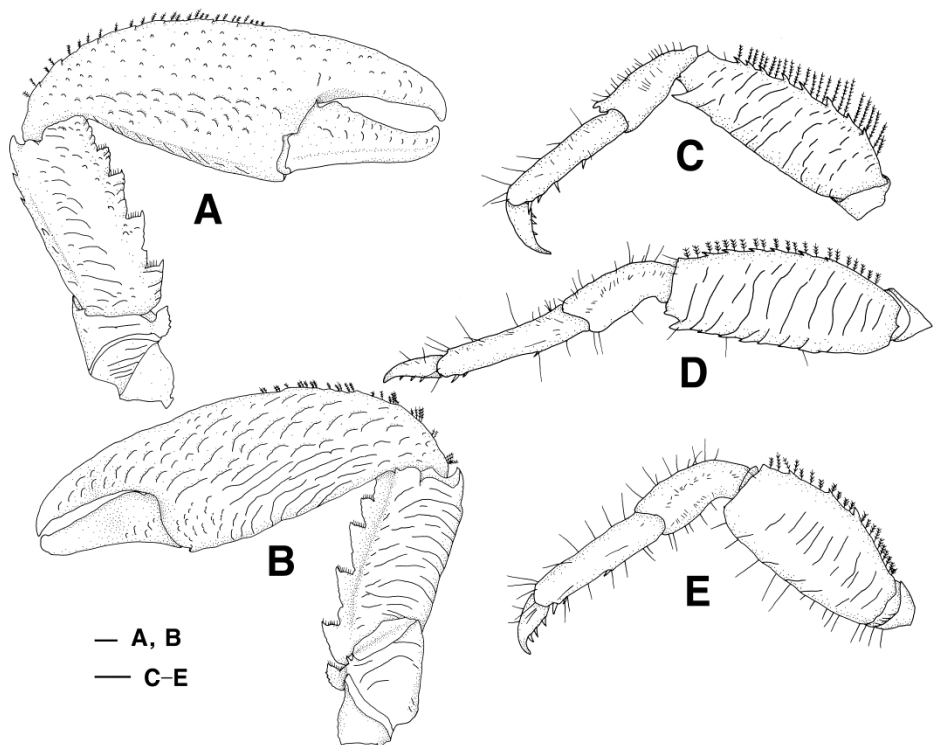


Fig. 31. *Petrolisthes coccineus* (Owen, 1939), male. A, left cheliped, dorsal; B, same, ventral; C, left first ambulatory leg; D, left second ambulatory leg; E, left third ambulatory leg. Scale bars: A, B=1 mm, C-E= 1 mm.

dorsoflexor margin with denticulate lobe; ventral surface with rugae; distoflexor margin having two small spines. Carpus 2.43 times as long as broad; dorsal surface bearing some rugae; dorsoflexor margin having four broad teeth; extensor margin bearing three spines on distal third; ventral surface having some rugae. Chela 2.1 times as long as carpus, 3.0 times as long as broad, lying on extensor side; dorsal surface having longitudinal ridge; extensor margin with plumose setae on proximal half; dorsoextensor region bearing granules; dorsoflexor region with scale like short ridges; ventral surface having rugae. Fixed finger slightly curved distally, extensor

margin and cutting edge unarmed. Dactylus 0.3 times as long as chela, having longitudinal groove on flexor margin, slightly curved distally, cutting edge smooth.

Ambulatory legs (Fig. 31C–E) relatively slender, first and second ambulatory legs subequal, third ambulatory leg smaller than others. Meri 1.9–2.6 times as long as broad; extensor margin bearing plumose setae and row of spines; dorsal surface having some transverse rugae; first and second ambulatory legs with flexor margin having one spine near end. Carpi 2.5–2.8 times as long as broad, 0.5–0.6 times as long as merus; dorsal surface having short setae. Propodi 4.1–5.4 times as long as broad, 1.2–1.3 times as long as carpus; dorsal surface and extensor margin with few setae; flexor margin bearing five (first and second) and four (third) movable spines including distal pair. Dactyli short, having single claw; extensor margin bearing few setae; flexor margin having three small movable spines.

Remarks. In Korean waters, *Petrolisthes coccineus* (Owen, 1939) has been collected from only Jeju-do up to date. The present study has additional occurrence, Geomun-ri, Samsan-myeon, Yeosu-si, Jeollanam-do, in South coast of Korea.

P. coccineus is related to *P. extremus* Kropp and Haig, 1994. However, this species can be distinguished from *P. extremus* by the brachial margins of carapace more convex and third article of antennal peduncle with anterior margin somewhat swollen near proximal region.

15. *Petrolisthes japonicus* (De Haan, 1849)

Porcellana japonica De Haan, 1849: 199, Pl. 50: fig. 5 [type locality: japan].

Petrolisthes japonicus: Miyake, 1937: 210, Pl. 12: fig. 5; 1943: 72, figs. 11–13; Kim,



Fig. 32. *Petrolisthes japonicus* (De Haan, 1849), male. Carapace length, 9.2 mm, dorsal view.

1973: 180, fig. 22, Pl. 2: fig. 9; Haig, 1964: 365; 1992: 314, fig.10; Johnson, 1970: 14; Yang & Sun, 1990: 1, figs. 1, 2; 2005: 7, fig. 4; Osawa & Chan, 2010: 139, figs. 107, 108.

Material examined. 4 ♂♂, 8 ♀♀, Okdo-myeon, Gunsan-si, Jeollabuk-do, 21 Oct 1963; 1 ♂, Jukpo-ri, Dolsan-eup, Yeosu-si, Jeollanam-do, 14 Jun 1969; 2 ♂♂, 4 ♀♀, Iho-dong, Jeju-si, Jeju-do, 11 Aug 1969; 4 ♂♂, 3 ♀♀, Seogwipo-si, Jeju-do, 18 Aug 1969; 1 ♂, 2 ♀♀, Hyeopjae-ri, Hallim-eup, Jeju-si, Jeju-do, 4 Jul 1972; 56 ♂♂, 30 ♀♀, Geumneung-ri, Hallim-eup, Jeju-si, Jeju-do, 6 Jul 1972; 4 ♂♂, 2 ♀♀, Chuja-myeon, Jeju-si, Jeju-do, 16 Jul 1985; 1 ♂, Seogwipo-si, Jeju-do, 22 Apr 1987; 10

♂♂, 5 ♀♀, Goseong-ri, Seongsan-eup, Seogwipo-si, Jeju-do, 24 Oct 1991; 1 ♂, Songsan-dong, Seogwipo-si, Jeju-do, 28 Jun 1993; 1 ♀, Sangju-ri, Sangju-myeon, Namhae-gun, Gyeongsangnam-do, 11 Aug 1997; 1 ♀, Gyeokpo-ri, Byeonsan-myeon, Buan-gun, Jeollabuk-do, 8 May 1998; 1 ♂, 2 ♀♀, Goseong-ri, Seongsan-eup, Seogwipo-si, Jeju-do, 9 Jun 2001; 1 ♀, Seogwi-dong, Seogwipo-si, Jeju-do, 10 Jul 2003; 1 ♀, Jindo-gun, Jeollanam-do, 30 Jun 2004; 3 ♂♂, 1 ♀, Gosan-ri, Hangyeong-myeon, Jeju-si, Jeju-do, 29 Oct 2005; 3 ♂♂, 1 ♀, Aewol-eup, Bukjeju-gun, Jeju-do, 16 Oct 2006; 1 ♂, 2 ♀♀, Goseong-ri, Seongsan-eup, Seogwipo-si, Jeju-do, 17 Oct 2006; 1 ♀, Hamo-ri, Daejeong-eup, Seogwipo-si, Jeju-do, 30 May 2007; 1 ♀, Daechon-dong, Seogwipo-si, Jeju-do, 30 May 2007; 5 ♂♂, 1 ♀, Gapa-ri, Daejeong-eup, Seogwipo-si, Jeju-do, 12 Apr 2011.

Distribution. China, Japan, Taiwan and Korea.

Description. Carapace (Figs. 32, 33A) as long as broad, unarmed. Dorsal surface relatively flat, with some short transverse ridge. Rostrum broad, slightly deflexed, triangular; dorsal surface bearing three longitudinal grooves. Orbits relatively shallow, oblique. Orbital margin slightly concave. Gastric region with some short transverse ridges. Protogastric ridge weakly produced. Cervical grooves moderately developed. Branchial margin convex, with some striae.

Telson (Fig. 33B) composed of seven plates.

Ocular peduncle (Fig. 33A) subcylindrical, large, short, slightly expanded distally.

Basal article of antennular peduncle (Fig. 33C) as long as broad; anterior margin with distinct two spines on mesial corner and one spine lateral corner; ventral surface having some striae.

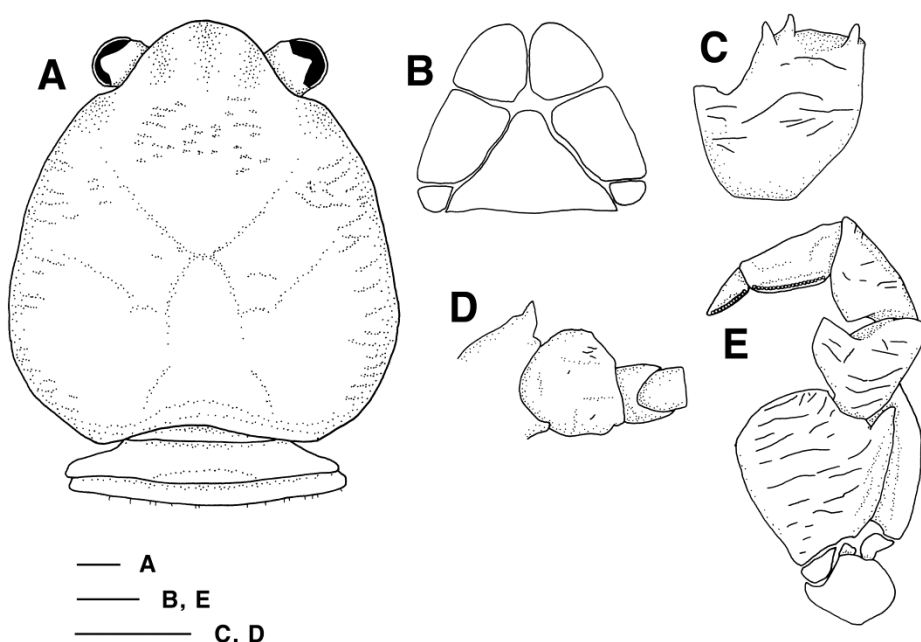


Fig. 33. *Petrolisthes japonicus* (De Haan, 1849), male. A, carapace, anterior part of abdomen; B, telson; C, basal segment of left antennular peduncle; D, antennal peduncle; E, left third maxilliped. Scale bars: A=1 mm, B, E=1 mm, C, D=1 mm.

Antennal peduncle (Fig. 33D) with first article immovable; second article having one prominent spine near anterodistal region; third article relatively short, bearing some striae on dorsal surface, anterior margin somewhat swollen near proximal region; fourth article unarmed, shorter than others.

Third maxilliped (Fig. 33E) with ischium as long as broad, having transverse rugose on ventral surface, anteromesial margin rounded, extensor margin having longitudinal ridge. Merus 1.15 times as long as broad, subtriangular, bearing transversely rugose on ventral surface. Carpus 1.84 times as long as broad, having longitudinal rugae. Propodus 2.5 times as long as broad, relatively slender, nearly

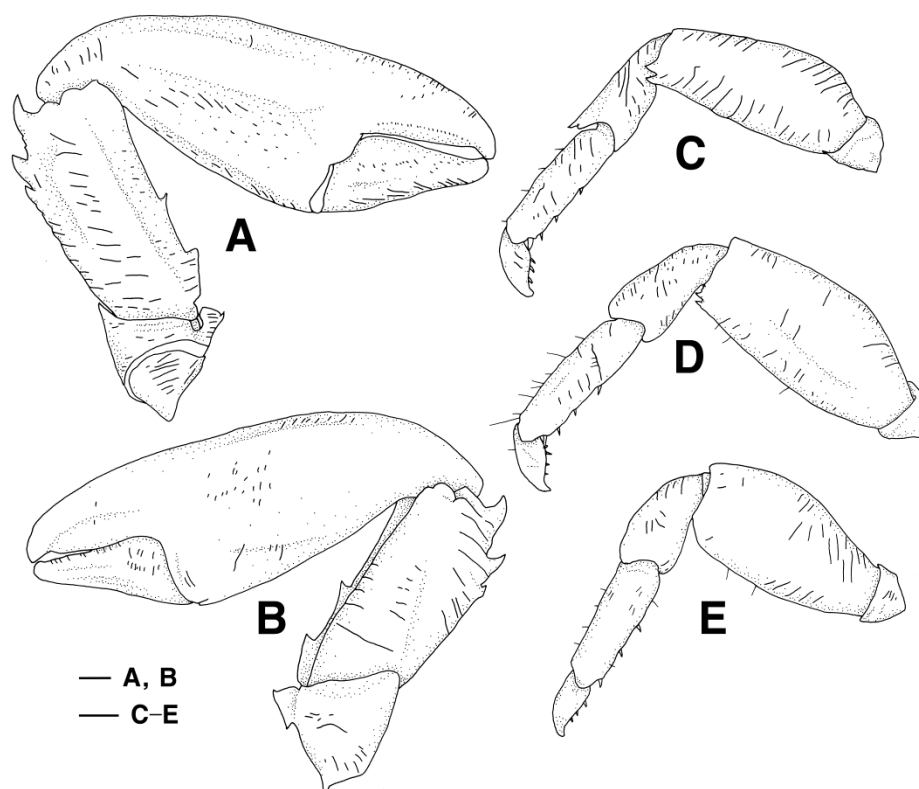


Fig. 34. *Petrolisthes japonicus* (De Haan, 1849), male. A, left cheliped, dorsal; B, same, ventral; C, left first ambulatory leg; D, left second ambulatory leg; E, left third ambulatory leg. Scale bars: A, B=1 mm, C-E= 1 mm.

smooth. Dactylus small, subtriangular. Merus to dactylus having long setae on flexor margin. Exopod slightly robust, reaching half of merus.

Chelipeds (Fig. 34A, B) subequal, with ischium unarmed, short. Merus rugose; dorsal surface bearing rugae; dorsoflexor margin with lobe having one spinule; ventral surface with rugae. Carpus 2.2 times as long as broad; dorsal surface bearing some rugae; dorsoflexor margin having one blunt or acute spine at proximal region,

bearing one spinule on median region or unarmed; extensor margin bearing three spines on distal third; ventral surface having some rugae. Chela smooth, 1.8 times as long as carpus, 2.7 times as long as broad, lying on extensor side; dorsal surface having longitudinal ridge; extensor margin unarmed; ventral surface having few and short rugae. Fixed finger slightly curved distally, extensor margin and cutting edge unarmed. Dactylus 0.3 times as long as chela, slightly curved distally, cutting edge smooth.

Ambulatory legs (Fig. 34C–E) slightly robust, first and second ambulatory legs subequal, third ambulatory leg smaller than others. Meri 1.9–2.3 times as long as broad; extensor margin unarmed; dorsal surface having some transverse rugae; first and second ambulatory legs with flexor margin having two spines on distal corner. Carpi 2.0–2.5 times as long as broad, 0.5–0.6 times as long as merus; dorsal surface having short setae; distoextensor corner with one acute spinule on first ambulatory leg. Propodi 3.2–3.8 times as long as broad, 1.1–1.8 times as long as carpus; dorsal surface and extensor margin with few setae; flexor margin bearing five (first and second) and four (third) movable spines including distal pair. Dactyli short, having single claw; flexor margin having three small movable spines.

Remarks. *Petrolisthes japonicus* (De Haan, 1849) is one of the most common species in the Korean intertidal zone. This species inhabit crevices and under stones on rocky shores. Presented specimens agree well with diagnosis of Osawa and Chan (2010) except for one minor characteristic. Our specimens sometimes have four spines on dactylus of ambulatory legs, while Osawa and Chan mentioned that the species has three spines on those.

16. *Petrolisthes militaris* (Heller, 1862)

Porcellana militaris Heller, 1862: 523 [type locality: Nicobar Islands].

Petrolisthes militaris Miyake, 1943: 56, figs. 1, 2; 1978: 167, fig. 67; Haig, 1964: 357, fig. 1; 1965: 98; 1966: 40; 1992: 316, fig.12; Johnson, 1970: 10, fig. 2; Yang & Xu, 1994: 113, fig. 1A; Ko, 2003: 34, fig. 1, 3; Yang & Sun, 2005: 9, fig. 6; Osawa, 2007: 26, fig. 8A, B; Osawa & Chan, 2010: 147, figs. 114, 115.

Material examined. 12 ♂♂, 14 ♀♀, Seogwipo-si, Jeju-do, 11 Jul 1965; 1 ♂, Seogwi-dong, Seogwipo-si, Jeju-do, 1 Jul 1993; 1 ♂, 1 ♀, Dokdo-ri, Ulleung-eup, Ulleung-gun, Gyeongsangbuk-do, 14 Aug 1995; 1 ♂, 2 ♀♀, Goseong-ri, Seongsan-eup, Seogwipo-si, Jeju-do, 5 Nov 2000; 1 ♂, 1 ♀, Hangeong-myeon, Jeju-si, Jeju-



Fig. 35. *Petrolisthes militaris* (Heller, 1862), male. Carapace length, 12 mm, dorsal view.

do, 6 Nov 2000; 2 ♂♂, Beophwan-dong, Seogwipo-si, Jeju-do, 6 Jun 2001; 1 ♀, Seogwi-dong, Seogwipo-si, Jeju-do, 6 Jun 2001; 1 ♂, 2 ♀♀, Hangyeong-myeon, Jeju-si, Jeju-do, 8 Jun 2001; 1 ♀, Goseong-ri, Seongsan-eup, Seogwipo-si, Jeju-do, 9 Jun 2001; 2 ♂♂, 1 ♀, Daejeong-eup, Seogwipo-si, Jeju-do, 16 Aug 2001; 6 ♂♂, 5 ♀♀, Songsan-dong, Seogwipo-si, Jeju-do, 8 Mar 2002; 1 ♀, Songsan-dong, Seogwipo-si, Jeju-do, 9 Mar 2002; 1 ♀, Jeju-do, 17 Apr 2002; 1 ♂, Seogwi-dong, Seogwipo-si, Jeju-do, 13 Oct 2002; 1 ♀, Seogwi-dong, Seogwipo-si, Jeju-do, 10 Jul 2003; 1 ♀, Beophwan-dong, Seogwipo-si, Jeju-do, 27 Mar 2012.

Distribution. The Indian Ocean including the Red Sea, China, Japan, Taiwan, eastward to New Caledonia, south ward to northern Australia and Korea.

Description. Carapace (Figs. 35, 36A) as long as broad. Dorsal surface relatively flat, with some short transverse ridge. Rostrum broad, slightly deflexed, triangular; dorsal surface having short transverse ridges; anterior margin denticulate; median region bearing longitudinal groove. Orbits relatively shallow, oblique; supra-ocular margins each having one acute spine; outer orbital angle each with one acute spine. Gastric region with some short transverse ridges. Protogastric ridge distinct. Hepatic margin weakly convex. Cervical grooves moderately developed. Branchial margin convex, with some striae, some tubercles present at epibranchial region, bearing two epibranchial spines and four or five small mesobranchial teeth.

Telson (Fig. 36B) composed of seven plates.

Ocular peduncle (Fig. 36A) subcylindrical, large, short, slightly expanded distally.

Basal article of antennular peduncle (Fig. 36C) 1.18 times as long as broad; anterior margin denticulate, with distinct spine at each mesial and lateral corner;

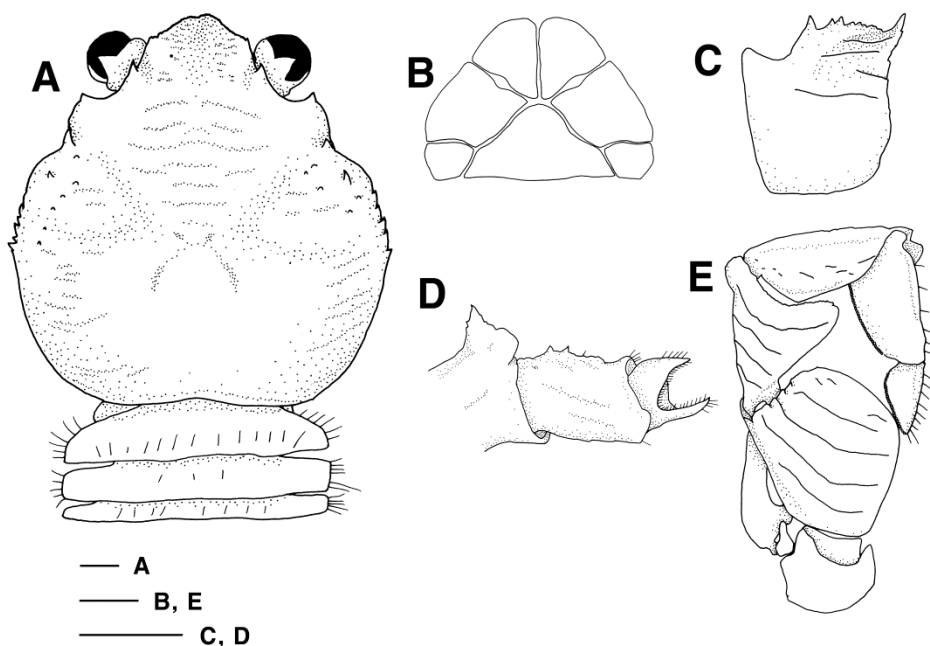


Fig. 36. *Petrolisthes militaris* (Heller, 1862), male. A, carapace, anterior part of abdomen; B, telson; C, basal segment of left antennular peduncle; D, antennal peduncle; E, right third maxilliped. Scale bars: A=1 mm, B, E=1 mm, C, D=1 mm.

anterior region having some striae on ventral surface.

Antennal peduncle (Fig. 36D) with first article immovable; second article with subrectangular anterior crest having one prominent spine on proximal region; third article bearing some striae on dorsal surface, anterior margin having some denticles; fourth article unarmed, shorter than others.

Third maxilliped (Fig. 36E) with ischium slightly longer than broad, having transversely rugose on ventral surface, anteromesial margin rounded, extensor margin having longitudinal ridge. Merus 1.5 times as long as broad, subtriangular, having transversely rugose on ventral surface. Carpus 2.45 times as long as broad,

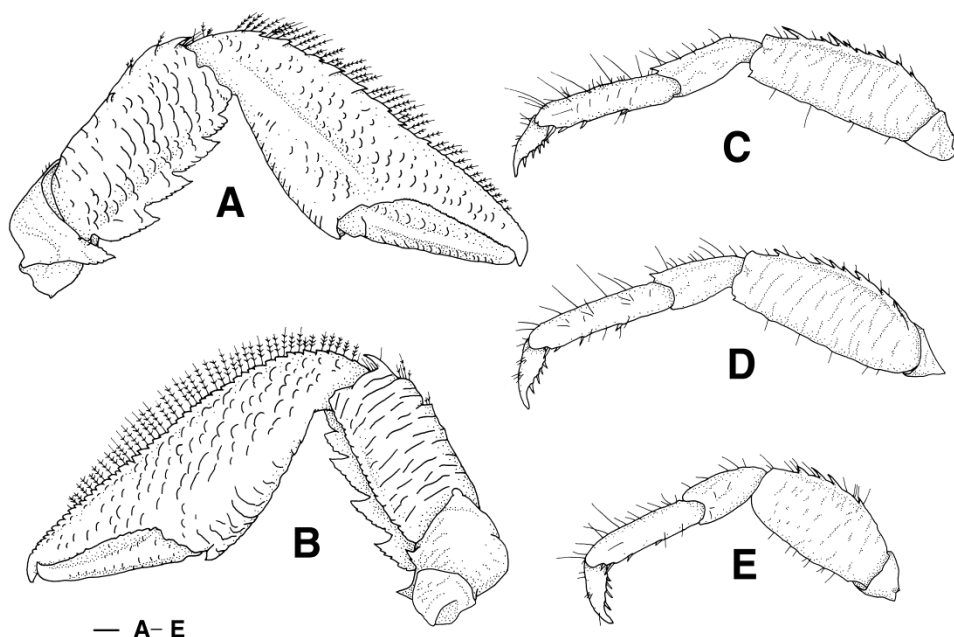


Fig. 37. *Petrolisthes militaris* (Heller, 1862), male. A, left cheliped, dorsal; B, same, ventral; C, left first ambulatory leg; D, left second ambulatory leg; E, left third ambulatory leg. Scale bars: A–E= 1 mm.

bearing longitudinal rugae on flexor margin. Propodus 2.0 times as long as broad, nearly smooth. Dactylus small, subtriangular. Merus to dactylus having long setae on flexor margin. Exopod slender, reaching half of merus.

Chelipeds (Fig. 37A, B) subequal, with ischium unarmed, short. Merus rugose; dorsal surface bearing rugae; dorsoflexor margin with denticulate lobe; ventral surface with rugae; distoflexor margin having one small spine. Carpus 2.22 times as long as broad; dorsal surface bearing scale like ridges; dorsoflexor margin having four broad teeth; extensor margin bearing four row of spines on distal half; ventral surface having some rugae. Chela 1.8 times as long as carpus, 3.0 times as long as

broad, lying on extensor side; dorsal surface having longitudinal ridge; extensor margin with row of plumose setae; dorsoextensor region bearing granules; dorsoflexor region with scale like short ridges; ventral surface having scale like ridges. Fixed finger slightly curved distally, extensor margin having row of teeth, cutting edge crenulate. Dactylus 0.4 times as long as chela, having longitudinal ridge on flexor margin, slightly curved distally, cutting edge crenulate.

Ambulatory legs (Fig. 37C–E) relatively slender, first and second ambulatory legs subequal, third ambulatory leg smaller than others. Meri 1.8–2.6 times as long as broad; extensor margin bearing plumose setae and row of spines; dorsal surface having short transverse rugae; first and second ambulatory legs with flexor margin having one spine near end. Carpi 2.1–3.0 times as long as broad, 0.5–0.6 times as long as merus; dorsal surface having short setae; bearing distoextensor spine on first and second ambulatory legs but unarmed on third ambulatory leg. Propodi 4.5–4.8 times as long as broad, 1.2–1.3 times as long as carpus; dorsal surface and extensor margin with few setae; flexor margin bearing five movable spines including distal pair. Dactyli short, having single claw; extensor margin bearing few setae; flexor margin having four or five small movable spines.

Remarks. Ko (2003) was the first to report this species from Korea. Miyake (1978), Haig (1965) and Yang & Sun (2005) noted that *Petrolisthes militaris* has few mesobranchial spines. However, Miyake (1943), Ko (2003) and Osawa (2007) described that this species has three, four or five and two or three spines on those respectively. The examined specimens bear four or five mesobranchial spines. This characteristic coincides with description of Ko (2003).

In Korean waters, *P. militaris* has been collected from only Jeju-do up to date. The present study has additional occurrence, Dokdo-ri, Ulleung-eup, Ulleung-gun, Gyeongsangbuk-do, in South coast of Korea.

Genus *Pisidia* Leach, 1820

17. *Pisidia serratifrons* (Stimpson, 1858)

Porcellana serratifrons Stimpson, 1858: 242 [type locality: Hong Kong]; Miyake, 1943: 121, figs. 44, 45.

Pisidia serratifrons: Kim, 1973: 187, fig. 26, Pl. 66: fig. 13a, b; Haig, 1981: 277; 1992: 319, fig. 15; Osawa & Chan, 2010: 167, figs. 132, 133.



Fig. 38. *Pisidia serratifrons* (Stimpson, 1858), male. Carapace length, 6.1 mm, dorsal view.

Material examined. 2 ♂♂, Guryongpo-eup, Nam-gu, Pohang-si, Gyeongsangbuk-do, 17 Jul 1972; 2 ♂♂, 2 ♀♀, Gaudio-ri, Geunheung-myeon, Taean-gun, Chungcheongnam-do, 28 Jun 2000; 2 ♂♂, 1 ♀, Oeyeondo-ri, Ocheon-myeon, Boryeong-si, Chungcheongnam-do, 21 Sep 2000; 9 ♂♂, 3 ♀♀, Yeonpyeong-myeon, Ongjin-gun, Incheon, 31 Mar 2001; 2 ♂♂, 4 ♀♀, Sindo-ri, Bukdo-myeon, Ongjin-gun, Incheon, 30 Jun 2007; 2 ♀♀, Seonjae-ri, Yeongheung-myeon, Ongjin-gun, Incheon, 9 May 2008; 1 ♀, Seonjae-ri, Yeongheung-myeon, Ongjin-gun, Incheon, 2 Oct 2008; 1 ♀, Uljin-gun, Gyeongsangbuk-do, 21 Oct 2008; 1 ♀, Uljin-gun, Gyeongsangbuk-do, 26 Mar 2009; 1 ♂, 1 ♀, Chuja-myeon, Jeju-si, Jeju-do, 31 Mar 2009; 4 ♂♂, 4 ♀♀, Mijo-ri, Mijo-myeon, Namhae-gun, Gyeongsangnam-do, 5 Aug 2009; 3 ♂♂, 3 ♀♀, Songjeong-ri, Mijo-myeon, Namhae-gun, Gyeongsangnam-do, 6 Aug 2009; 2 ♂♂, Hakdong-ri, Dongbu-myeon, Geoje-si, Gyeongsangnam-do, 29 Aug 2009; 6 ♀♀, Geomun-ri, Samsan-myeon, Yeosu-si, Jeollanam-do, 23 Oct 2010; 1 ♂, Nodae-ri, Yokji-myeon, Tongyeong-si, Gyeongsangnam-do, 1 Sep 2011; 1 ♂, Jaryong-ri, Sangha-myeon, Gochang-gun, Jeollabuk-do, 28 Sep 2011; 11 ♂♂, 19 ♀♀, Janggok-ri, Gonam-myeon, Taean-gun, Chungcheongnam-do, 26 Nov 2011; 15 ♂♂, 14 ♀♀, Gwandang-ri, Ungcheon-eup, Boryeong-si, Chungcheongnam-do, 9 Apr 2012.

Distribution. Yellow Sea, China, Taiwan, Japan and Korea.

Description. Carapace (Figs. 38, 39A) as long as broad. Dorsal surface slightly convex, with short transvers ridges: sometimes having plumose setae. Rostrum broad, horizontal, trilobite, anterior margin with saw-like teeth, each lobe bearing longitudinal groove; median lobe broader than lateral lobes. Orbits moderately

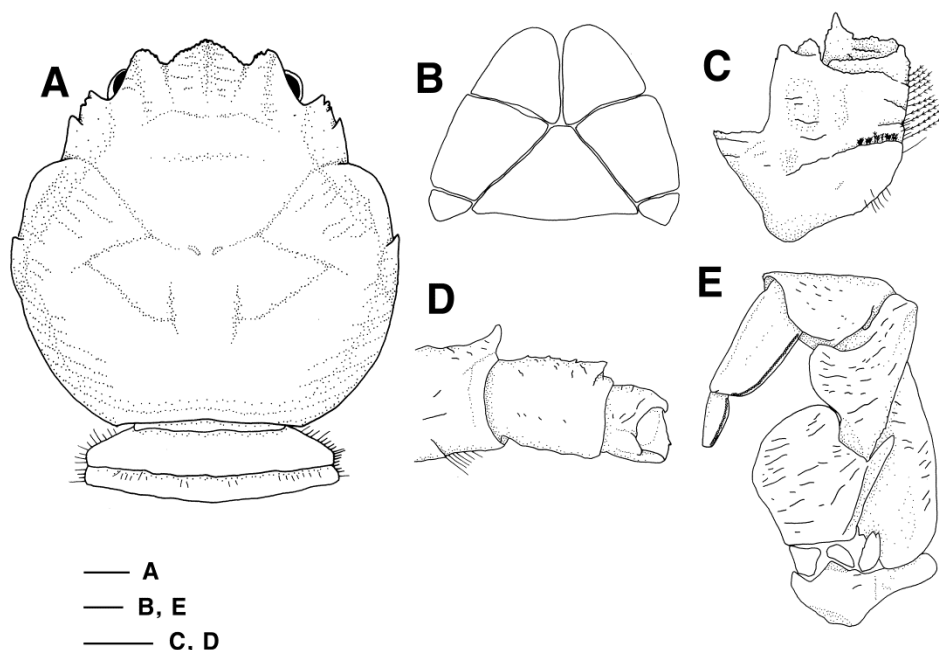


Fig. 39. *Pisidia serratifrons* (Stimpson, 1858), male. A, carapace, anterior part of abdomen; B, telson; C, basal segment of left antennular peduncle; D, antennal peduncle; E, left third maxilliped. Scale bars: A=1 mm, B, E=0.5 mm, C, D=0.5 mm.

shallow, oblique; supra-ocular margins unarmed; outer orbital angle having denticulate teeth posteriorly: posterior tooth largest. Protogastric ridge moderately produced. Cervical grooves moderately developed. Branchial margin with some striae, unarmed on epibranchial margin, bearing one mesobranchial spine.

Telson (Fig. 39B) composed of seven plates.

Ocular peduncle (Fig. 39A) short, slightly expanded distally.

Basal article of antennular peduncle (Fig. 39C) 1.11 times as long as broad; ventral surface bearing some striae; anterior margin denticulate, bearing one blunt spine on mesial corner and one prominent spine on middle; lateral margin bearing

some setae.

Antennal peduncle (Fig. 39D) moderately slender; first article immovable; second article having one spine on anterodistal margin; third article bearing some short striae on dorsal surface, anterior margin denticulate, with one spine near anterodistal margin; fourth article having few short striae, with some tubercles on distal margin, shorter than others.

Third maxilliped (Fig. 39E) with ischium as long as broad, transversely rugose on ventral surface, anteromesial margin rounded, extensor margin having longitudinal ridge. Merus 1.7 times as long as broad, transversely rugose on ventral surface; flexor margin rounded. Carpus 1.7 times as long as broad, longitudinal rugae on ventral surface. Propodus 2.3 times as long as broad, nearly smooth. Dactylus small, subtriangular. Merus to dactylus having long setae on flexor margin. Exopod somewhat robust, having some rugae on ventral surface.

Chelipeds unequal. Larger cheliped (Fig. 40A) with ischium unarmed, short, having some rugae. Merus rugose; dorsal surface unarmed; flexor margin having saw-like teeth on anterior region. Carpus 1.7 times as long as broad; dorsal surface bearing some transverse rugae; flexor margin unarmed or having two spines faintly; extensor margin unarmed or having one spine; distal margin with extensor and flexor corner bearing one spine. Chela slightly stout, 1.8 times as long as carpus, 3.2 times as long as broad, lying on extensor side; dorsal surface having some short rugae; fingers crossed distally, extensor margin unarmed or bearing row of small teeth. Fixed finger slightly curved distally, extensor margin unarmed. Dactylus 0.4 times as long as chela, twisted, slightly curved distally, cutting edge having dense,

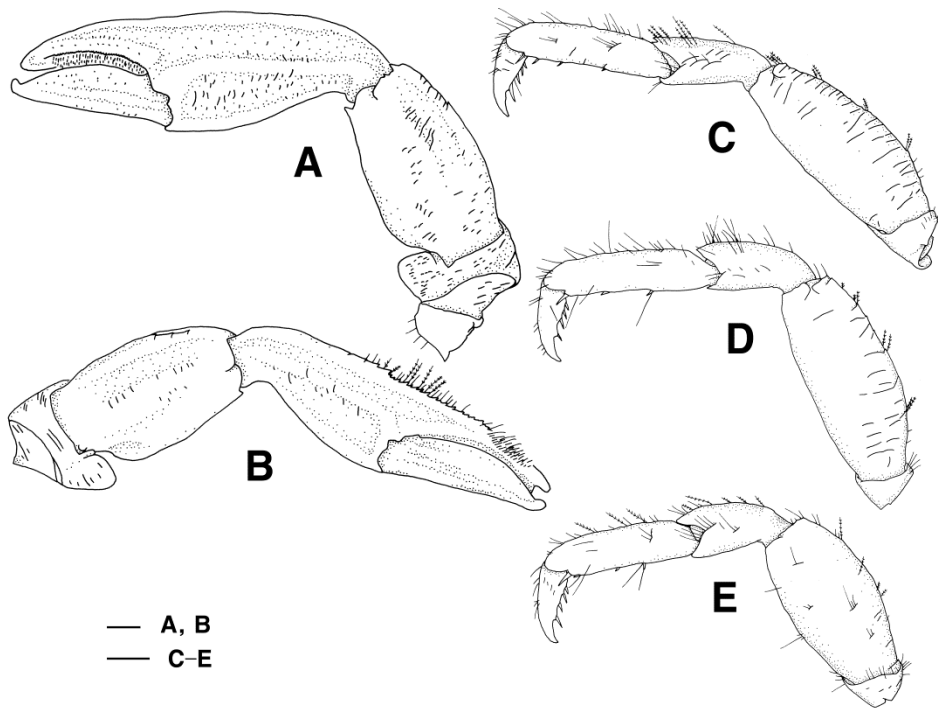


Fig. 40. *Pisidia serratifrons* (Stimpson, 1858), male. A, larger cheliped, dorsal; B, smaller cheliped, dorsal; C, left first ambulatory leg; D, left second ambulatory leg; E, left third ambulatory leg. Scale bars: A, B=1 mm, C-E= 1 mm.

soft setae.

Smaller cheliped (Fig. 40B) with chela slender, 1.8 times as long as carpus, 3.5 times as long as broad; extensor margin unarmed or crenulate, having plumose setae. Fixed finger slightly curved distally, bifurcate distally. Dactylus 0.5 times as long as chela, slightly curved distally.

Ambulatory legs (Fig. 40C-E) relatively short, slender, first and second ambulatory legs subequal, third ambulatory leg smaller than others. Meri 1.9–2.5 times as long as broad, relatively slender, bearing few setae on extensor and flexor

margins; dorsal surface having some transverse rugae. Carpi 2.2–2.5 times as long as broad, 0.4–0.5 times as long as merus; dorsal surface having short rugae; extensor margin having plumose setae. Propodi 3.6–4.5 times as long as broad, 1.3–1.4 times as long as carpus; dorsal surface with short rugae; extensor margin having plumose setae; flexor margin bearing five movable spines including distal pair. Dactyli short, having single claw; extensor margin bearing few setae; flexor margin having four small movable spines.

Remarks. *Pisidia serratifrons* (Stimpson, 1858) is recorded many variations. The material from Japan (Miyake, 1943) is described that the carpi of chelipeds have two or three spines on distal extensor margins, and Osawa and Chan (2010) noted as with the carpi of chelipeds bearing one or two spines on those. Examined specimens are usually like description of Osawa and Chan (2010). Moreover, examined specimens sometimes have plumose setae on protogastric ridge and two small spinules on flexor margin of carpus of cheliped. Larger specimens usually don't have these setae and spines. *Pisidia serratifrons* (Stimpson, 1858) is the most common species in the Korean intertidal zone. This species inhabit crevices and under stones on intertidal zone or near coast line.

Genus *Polyonyx* Stimpson, 1858

18. *Polyonyx sinensis* Stimpson, 1858

Polyonyx sinensis Stimpson, 1858: 244 [type locality: China Sea]; Miyake, 1943: 138, figs. 56, 57; Osawa & Chan, 2010: 173, figs. 136, 137.

Polyonyx asiaticus: Shen, 1936: 279, figs. 1, 2 [type locality: Chefoo, Shantung



Fig. 41. *Polyonyx sinensis* Stimpson, 1858, male. Carapace length, 3.6 mm, dorsal view.

Peninsula, China]; Kim, 1973: 191, figs. 29, 30, Pl. 67: fig. 15a, b.

Polyonyx bella Hsueh & Huang, 1998: 332, fig. 1–3 [type locality: Gaomei, Taichung County, Taiwan].

Material examined. 2 ♂♂, 5 ♀♀, Jukpo-ri, Dolsan-eup, Yeosu-si, Jeollanam-do, 2 Jun 1968; 1 ♂, Seopo-ri, Deokjeok-myeon, Ongjin-gun, Incheon, 6 Jun 1973.

Distribution. China, Taiwan, Japan and Korea.

Description. Carapace (Figs. 41, 42A) subrectangular, 1.4 times as broad as long, smooth. Dorsal surface convex, bearing short transverse striae on posterior branchial margin. Rostrum broad, weakly trilobate; anterior margin curved ventrally.

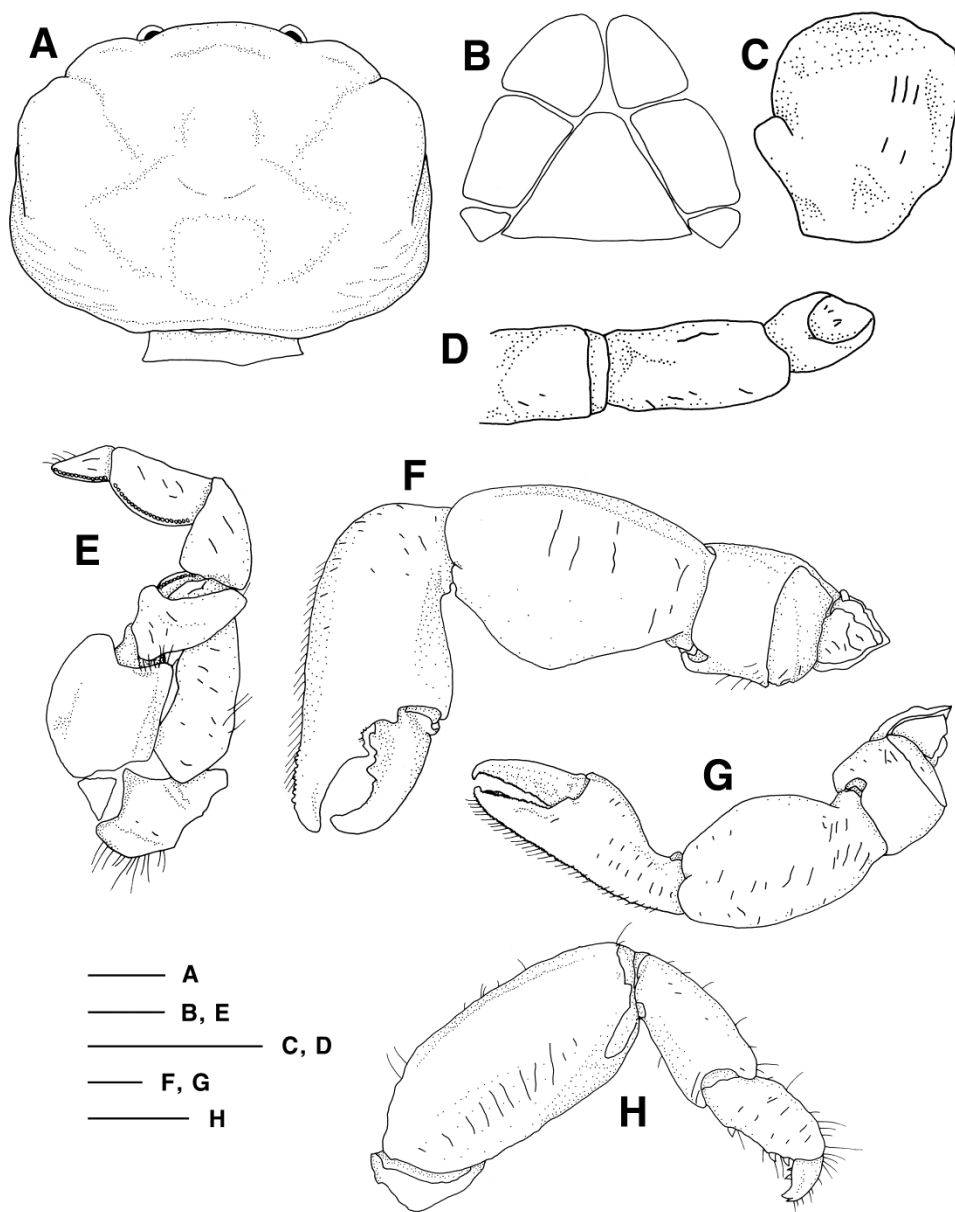


Fig. 42. *Polyonyx sinensis* Stimpson, 1858, male. A, carapace, anterior part of abdomen; B, telson; C, basal segment of left antennular peduncle; D, antennal peduncle; E, left third maxilliped; F, larger cheliped, dorsal; G, smaller cheliped, dorsal; H, right first ambulatory leg. Scale bars: A=1 mm, B, E=0.5 mm, C, D= 0.5 mm, F, G=1 mm, H=1 mm.

Orbits weakly concave; supra-ocular margins and outer orbital angle unarmed. Protogastric ridge weakly produced. Cervical grooves weakly developed. Branchial margin subparallel, unarmed.

Telson (Fig. 42B) composed of seven plates.

Ocular peduncle (Fig. 42A) short, small.

Basal article of antennular peduncle (Fig. 42C) 1.1 times as long as broad, unarmed; anterior margin having smooth grooves.

Antennal peduncle (Fig. 42D) slender, with first article immovable; second article unarmed; third article elongate, bearing some short striae on dorsal surface; fourth article unarmed, shorter than others.

Third maxilliped (Fig. 42E) with ischium 1.3 times as long as broad, smooth on ventral surface, mesial margin rounded, extensor margin having longitudinal ridge. Merus 2.0 times as long as broad, transversely rugose on ventral surface; flexor margin rounded. Carpus 1.5 times as long as broad, longitudinal rugae on ventral surface. Propodus 2.0 times as long as broad, nearly smooth. Dactylus small. Merus to dactylus having long setae on flexor margin. Exopod slightly robust, overreaching merus, having some setae on proximal third.

Chelipeds unequal. Larger cheliped (Fig. 42F) with ischium unarmed, short, having some rugae. Merus with dorsal surface unarmed; flexor margin unarmed. Carpus 1.4 times as long as broad; dorsal surface bearing some transverse rugae, flexor margin produced. Chela stout, 1.3 times as long as carpus, 2.3 times as long as broad; dorsal surface having some rugae, somewhat convex; ventral surface smooth; extensor margin having row of plumose setae; fingers crossed distally,

having distinct gape when closed. Fixed finger slightly curved distally, extensor margin bearing row of teeth, cutting edge having prominent spine proximally. Dactylus 0.4 times as long as chela, proximal region of flexor margin depressed, strongly curved distally, cutting edge bearing two distinct spines on proximal half.

Smaller cheliped (Fig. 42G) with chela slender, 1.5 times as long as carpus, 2.6 times as long as broad; dorsal surface having some short transverse rugae; extensor margin bearing row of spines and setae; fingers crossed distally. Fixed finger slightly curved distally, cutting edge crenulate. Dactylus 0.5 times as long as chela, proximal region slightly depressed, slightly curved distally, cutting edge crenulate.

Ambulatory legs (Fig. 42H) robust. Meri 2.2 times as long as broad, extensor margins unarmed, bearing few setae. Carpi 2.0 times as long as broad, 0.5 times as long as merus; dorsal surface smooth; extensor margin having few setae; distoextensor margin unarmed. Propodi relatively short, 2.1 times as long as broad; dorsal surface bearing short rugae; extensor margin having few setae; flexor margin bearing four movable spines including distal pair. Dactyli short, having bifurcate claws; extensor margin bearing few setae; flexor margin having two movable spines.

Remarks. The genus *Polyonyx* Stimpson, 1858 have been recorded 18 species in the world (Osawa and Chan, 2010). Of these, only one species, *Polyonyx sinensis* Stimpson, 1858, has been reported from Korea. The most members of the genus *Polyonyx* occur in the tube-dwelling polychaetes, sponges and corals (Werdning, 2001; Osawa, 2001). Examined specimens also collected from tubes of polychaetes, *Mesochaetopterus japonicus* Fujiwara, 1934.

Genus *Porcellana* Lamarck, 1801

19. *Porcellana pulchra* Stimpson, 1858

Porcellana pulchra Stimpson, 1858: 243[type locality: Hong Kong]; Ortmann, 1892: 268; Balss, 1913: 31; Miyake, 1943: 124, figs. 46, 47; Kim, 1970: 5, Pl. 1: fig. 1; 1973: 186, fig. 25, Pl. 66: fig. 12a, b; Yang & Sun, 1990: 9, fig. 12; Haig, 1992:322, fig. 18.

Material examined. 1 ♂, Eocheongdo-ri, Okdo-myeon, Gunsan-si, Jeollabuk-do, 31 May 1959; 2 ♂♂, Jukpo-ri, Dolsan-eup, Yeosu-si, Jeollanam-do, 3 Jun 1968; 7 ♂♂, 6 ♀♀, Jukpo-ri, Dolsan-eup, Yeosu-si, Jeollanam-do, 14 Jun 1969; 1 ♂, Durido-ri, Okdo-myeon, Gunsan-si, Jeollabuk-do, 14 Apr 1972; 1 ♀, Gunsan-si,



Fig. 43. *Porcellana pulchra* Stimpson, 1858, male. Carapace length, 7.2 mm, dorsal view.

Jeollabuk-do, 16 Apr 1972; 1 ♂, Yullim-ri, Dolsan-eup, Yeosu-si, Jeollanam-do, 10 May 1997; 1 ♀, Namhae-gun, Gyeongsangnam-do, 7 Feb 2006.

Distribution. China, Japan and Korea.

Description. Carapace (Figs. 43, 44A) 1.1 times as long as broad, unarmed. Dorsal surface relatively flat, smooth. Lateral margin convex. Rostrum broad, distinctly trilobite: median lobe distinctly broader and longer than lateral lobes. Orbits relatively deep, oblique. Orbital margin slightly concave. Protogastric ridge produced faintly. Cervical grooves weakly developed.

Telson (Fig. 44B) composed of seven plates.

Ocular peduncle (Fig. 44A) small, short.

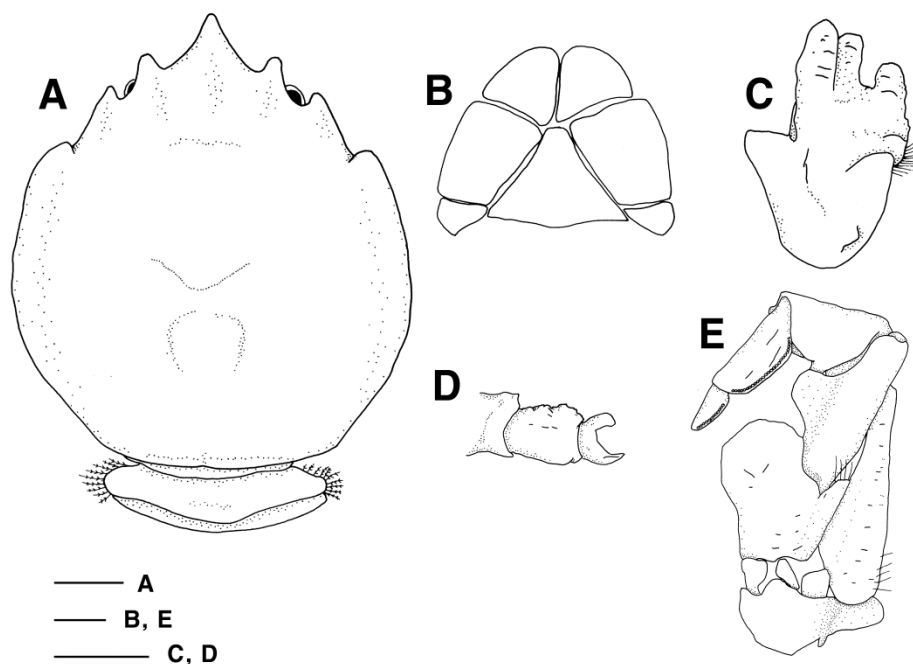


Fig. 44. *Porcellana pulchra* Stimpson, 1858, male. A, carapace, anterior part of abdomen; B, telson; C, basal segment of left antennular peduncle; D, antennal peduncle; E, left third maxilliped. Scale bars: A=1 mm, B, E=0.5 mm, C, D=0.5 mm.

Basal article of antennular peduncle (Fig. 44C) 1.5 times as long as broad; anterior margin with three distinct long blunt tubercles: two tubercles on anteromesial margin almost same size, one tubercle on anterolateral margin shorter than others; ventral surface having some striae.

Antennal peduncle (Fig. 44D) with first article immovable; second article having one small spinule near anterodistal region; third article with anterior margin having denticulate teeth; fourth article unarmed, shorter than others.

Third maxilliped (Fig. 44E) with ischium as long as broad, having some short rugose on ventral surface, anteromesial margin rounded, extensor margin having longitudinal ridge. Merus 2.0 times as long as broad, smooth on ventral surface. Carpus 1.7 times as long as broad, smooth. Propodus 2.4 times as long as broad, nearly smooth. Dactylus small, subtriangular. Merus to dactylus having long setae on flexor margin. Exopod slightly robust, reaching distal third of merus.

Chelipeds (Fig. 45A, B) subequal, with ischium unarmed, short, having some rugae on ventral surface. Merus rugose; dorsal surface bearing rugae; dorsoflexor margin with lobe; ventral surface having some rugae. Carpus 1.6 times as long as broad; dorsal surface bearing some faint rugae, having longitudinal ridge faintly; dorsoflexor margin produced on proximal half; ventral surface having some transverse rugae. Chela 2.4 times as long as carpus, 2.6 times as long as broad, lying on extensor side; dorsal surface having longitudinal ridge, bearing transverse striae; extensor margin having saw-like teeth and plumose setae; ventral surface having few and short rugae. Fixed finger slightly curved distally, extensor margin and cutting edge unarmed; flexor margin with basal region bearing small bundle of

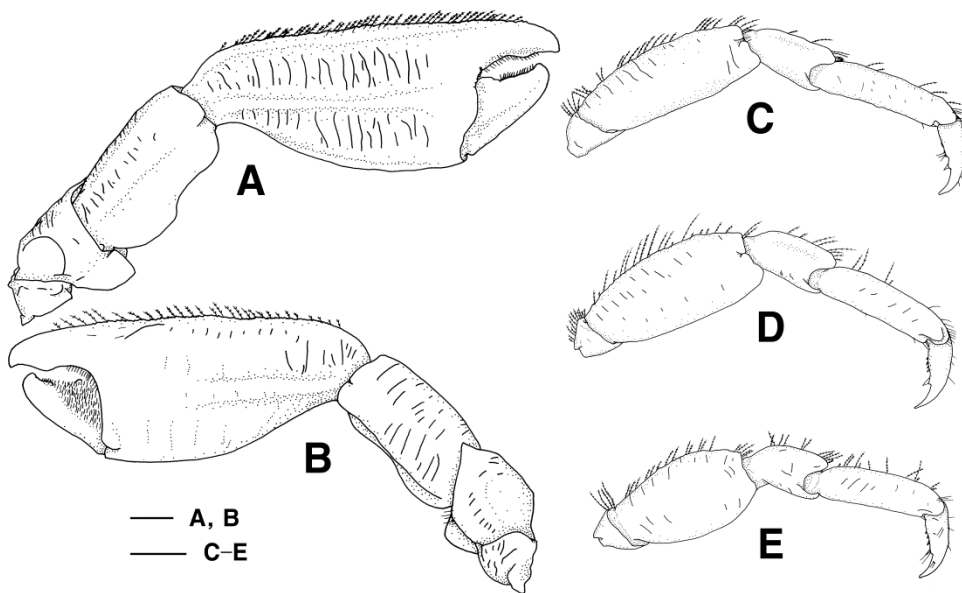


Fig. 45. *Porcellana pulchra* Stimpson, 1858, male. A, left cheliped, dorsal; B, same, ventral; C, right first ambulatory leg; D, right second ambulatory leg; E, right third ambulatory leg. Scale bars: A, B=1 mm, C-E= 1 mm.

plumose setae. Dactylus 0.3 times as long as chela, slightly curved distally, cutting edge smooth.

Ambulatory legs (Fig. 45C–E) slightly slender, first and second ambulatory legs subequal, third ambulatory leg smaller than others. Meri 2.7 (first and second) and 1.8 (third) times as long as broad; extensor margin bearing plumose setae; dorsal surface having some transverse rugae. Carpi 2.1 (first and second) and 1.7 (third) times as long as broad, 0.5 times as long as merus; extensor margin with plumose setae; dorsal surface smooth. Propodi 4.1–4.0 times as long as broad, 1.5–1.7 times as long as carpus; extensor margin with few setae; flexor margin bearing one pair of movable spines distally. Dactyli short, having single claw; flexor margin having five

(first and second) and four (third) small movable spines.

Remarks. In Korean fauna, only one species of genus *Porcellana* Lamarck, 1801 have been reported. *Porcellana pulchra* Stimpson, 1858 is first reported by Kim (1970) in Korea.

According to Miyake (1961), *P. pulchra* resemble *P. habei* Miyake, 1961. *P. pulchra* can be distinguished from *P. habei* by the rostrum without longitudinal groove and the basal article of antennular peduncle having three blunt tubercles on anterior margin.

Genus *Raphidopus* Stimpson, 1858

20. *Raphidopus ciliatus* Stimpson, 1858



Fig. 46. *Raphidopus ciliatus* Stimpson, 1858, male. Carapace length, 6.6 mm, dorsal view.

Raphidopus ciliatus Stimpson, 1858: 241 [type locality: Hong Kong]; Miyake, 1943: 146, figs. 61, 62; Kim, 1963: 292, fig. 7; 1973: 189, fig. 27, Pl. 2: fig. 14; Haig, 1981: 274; 1992: 324, fig. 20; Ng & Nakasone, 1994: 3, figs. 1, 2; Osawa & Chan, 2010: 190, figs. 141, 142.

Material examined. 3 ♂♂, Jinhae-gu, Changwon-si, Gyeongsangnam-do, 1 Aug 1968; 9 ♀♀, Buan-gun, Buan-gun, Jeollabuk-do, 4 Apr 1983; 1 ♂, 2 ♀♀, Sapsido-ri, Ocheon-myeon, Boryeong-si, Chungcheongnam-do, 14 Jul 1998; 1 ♀, Sinsido-ri, Okdo-myeon, Gunsan-si, Jeollabuk-do, 5 Aug 2003; 1 ♂, Gwangyang-si, Jeollanam-do, 12 Feb 2004; 1 ♀, Gunsan-si, Jeollabuk-do, 6 Jul 2006; 1 ♂, 1 ♀, Boryeong-si, Chungcheongnam-do, 14 Nov 2006; 7 ♂♂, 8 ♀♀, Sinan-gun, Jeollanam-do, 13 Nov 2009; 3 ♂♂, 3 ♀♀, Imja-myeon, Sinan-gun, Jeollanam-do, 14 May 2010.

Distribution. Australia, China, Japan, Taiwan, Singapore, Thailand, Malay Peninsula, Arabian Sea and Korea.

Description. Carapace (Figs. 46, 47A) ovate, 1.2 times as broad as long. Dorsal surface relatively flat, with some short transverse striae. Rostrum broad, short, slightly deflexed, trilobate; median region bearing longitudinal groove. Orbits relatively shallow, supra-ocular margins and outer orbital angle unarmed. Gastric region with some short transverse ridges. Protogastric ridge faint. Hepatic region granulate. Cervical grooves developed faintly. Branchial margin convex, bearing one or two mesobranchial spines. Anterolateral border having saw-like teeth. Posterolateral margin bearing long dense plumose setae.

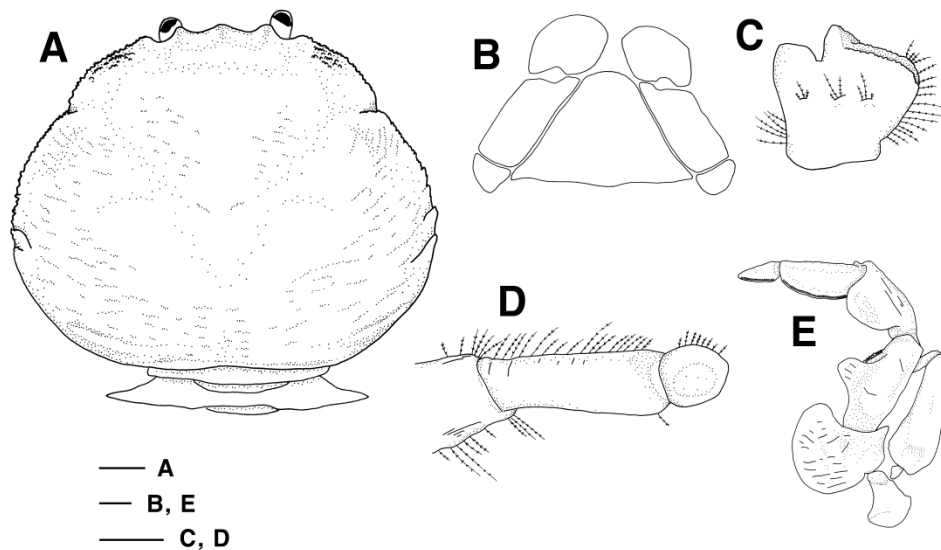


Fig. 47. *Raphidopus ciliatus* Stimpson, 1858, male. A, carapace, anterior part of abdomen; B, telson; C, basal segment of left antennular peduncle; D, antennal peduncle; E, left third maxilliped. Scale bars: A=1 mm, B, E=0.5 mm, C, D=0.5 mm.

Telson (Fig. 47B) composed of seven plates.

Ocular peduncle (Fig. 47A) subcylindrical, small, short.

Basal article of antennular peduncle (Fig. 47C) as long as broad; anterior margin denticulate, with distinct tooth at each mesial corner; lateral and mesial margins having plumose setae.

Antennal peduncle (Fig. 47D) with first article immovable; second article bearing some rugae and plumose setae on anterior and posterior margins; third article relatively long, slender, with plumose setae on anterior margin; fourth article unarmed, shorter than others, having some plumose setae on anterior margin.

Third maxilliped (Fig. 47E) with ischium as long as broad, having transverse and short rugose on ventral surface, mesial margin rounded. Merus 1.6 times as long as

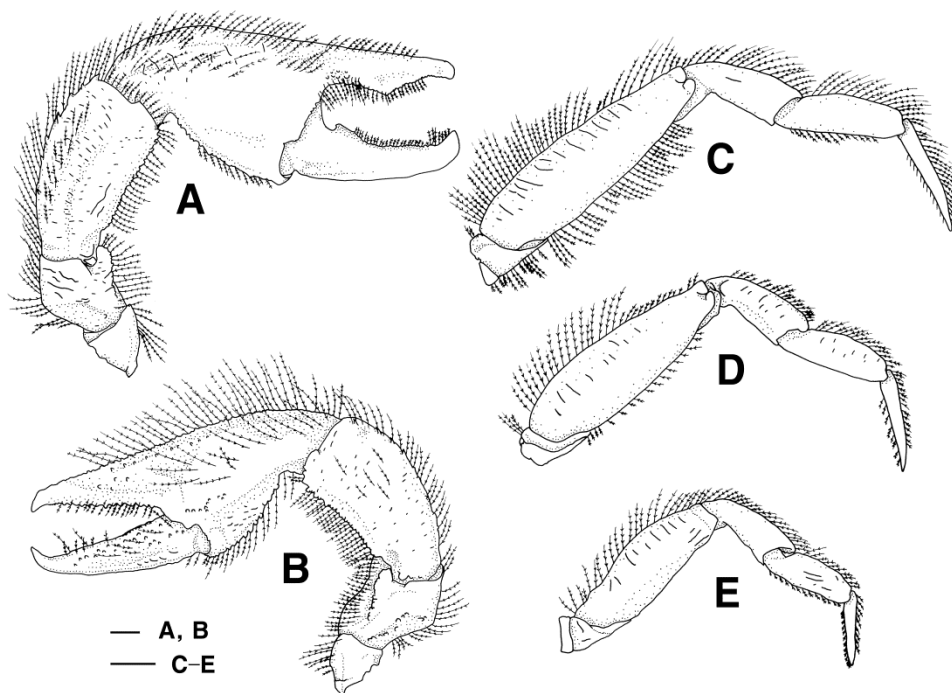


Fig. 48. *Raphidopus ciliatus* Stimpson, 1858, male. A, larger cheliped, dorsal; B, smaller cheliped, dorsal; C, right first ambulatory leg; D, right second ambulatory leg; E, right third ambulatory leg. Scale bars: A, B=1 mm, C-E= 1 mm.

broad, having broad lobe on flexor median region. Carpus 2.0 times as long as broad, bearing longitudinal rugae on extensor margin. Propodus 2.0 times as long as broad, nearly smooth. Dactylus small, subtriangular. Merus to dactylus having long setae on flexor margin. Exopod slender, reaching end of merus.

Chelipeds (Fig. 48A, B) subequal, extensor and flexor margins bearing long and dense plumose setae except for flexor margin of dactylus. Ischium unarmed, short, having plumose setae on flexor margin. Merus rugose; dorsal surface bearing tubercles; dorsoflexor margin with denticulate lobe. Carpus 1.8 times as long as

broad; dorsal surface bearing short, transverse ridges; dorsoflexor margin having saw-like teeth; extensor margin bearing four row of spines on distal half. Chela 1.9 times as long as carpus, 2.4 times as long as broad, lying on extensor side; dorsal surface having longitudinal ridge; dorsoextensor region bearing soft and long plumose setae. Fixed finger slightly curved distally, extensor margin unarmed (large cheliped) and having row of teeth (small cheliped), cutting edge crenulate, bearing plumose setae. Dactylus 0.5 times as long as chela, slightly curved distally, nearly smooth.

Ambulatory legs (Fig. 48C–E) slightly slender, unarmed, having long plumose setae on extensor and flexor margins, first and second ambulatory legs subequal, third ambulatory leg smaller than others. Meri 3.5 (first and second) and 2.9 (third) times as long as broad; dorsal surface having some transverse rugae. Carpi 2.8 times as long as broad, 0.4–0.6 times as long as merus; dorsal surface having short transverse rugae. Propodi 2.8–3.1 times as long as broad, as long as carpus; flexor margin unarmed. Dactyli relatively long, having single claw; flexor margin unarmed.

Remarks. Genus *Raphidopus* Stimpson, 1858 contains four species: *R. ciliatus* Stimpson, 1858, *R. indicus* Henderson, 1893, *R. johnsoni* Ng and Nakasone, 1994 and *R. persicus* Ng, Safaie and Naser, 2012 (Ng, Safaie and Naser, 2012). Only one species, *R. ciliatus* Stimpson, 1858, has been reported in Korean fauna. This species can be distinguished by armature of lateral margins of carapace. *R. ciliatus* has one or two distinct mesobranchial spines. In contrast, other species in congeners unarm mesobranchial margins.

This species is first reported by Kim (1963).

DNA barcoding of Galatheoids in Korea

Total 39 individuals of Galatheoids, belonging to twelve species of eight genera, have been successfully sequenced on the basis of DNA barcoding. At least two individuals per a species were used to the DNA barcoding. However, in the case of *Lissoporcellana nakasonei* (Miyake, 1978) was used only one individual. Each individual was selected by variation of habitat or morphology in same species. A list of the samples tested for DNA barcoding is summarized in Table 2. The sequences were translated to detect nuclear mitochondrial pseudo-genes (NUMTs) which are common in eukaryotes, including indels, frame-shift mutations, and in-frame stop codons (Bensasson et al., 2001; Song et al., 2008).

A total of 639 nucleotides, COI fragment represented 268 variable sites, 371 conservation sites, 11 singleton sites, and 257 parsimony-informative sites. A high level of maximum intraspecific K2P variation was observed in *Pachycheles stevensii* Stimpson, 1858 (4.0%), and low level of minimum interspecific K2P variation was observed between *Pachycheles hertwigi* Balss, 1913 and *Pachycheles stevensii* Stimpson, 1858 (6.6%) (Table 3). The average value of maximum intraspecific distances was 1.0% for all the species except the one species, *Lissoporcellana nakasonei* (Miyake, 1978), which collected only one individual. The average value of minimum interspecific distances was 15.5% for all the species. The presence of a DNA barcode gap was visualized to test the suitability of DNA barcoding (Fig. 49). The barcode gap represents the discontinuity between intraspecific and interspecific divergences (Robinson et al., 2009). To test the

suitability of DNA barcoding, the maximum intraspecific divergence was compared with the minimum interspecific divergence for all test specimens. All species were near the bottom region of the 1:1 line, indicating the presence of a barcode gap. The Neighbor-joining tree showed the good resolution among the Korean Galatheoids species at the species level (Fig. 51).

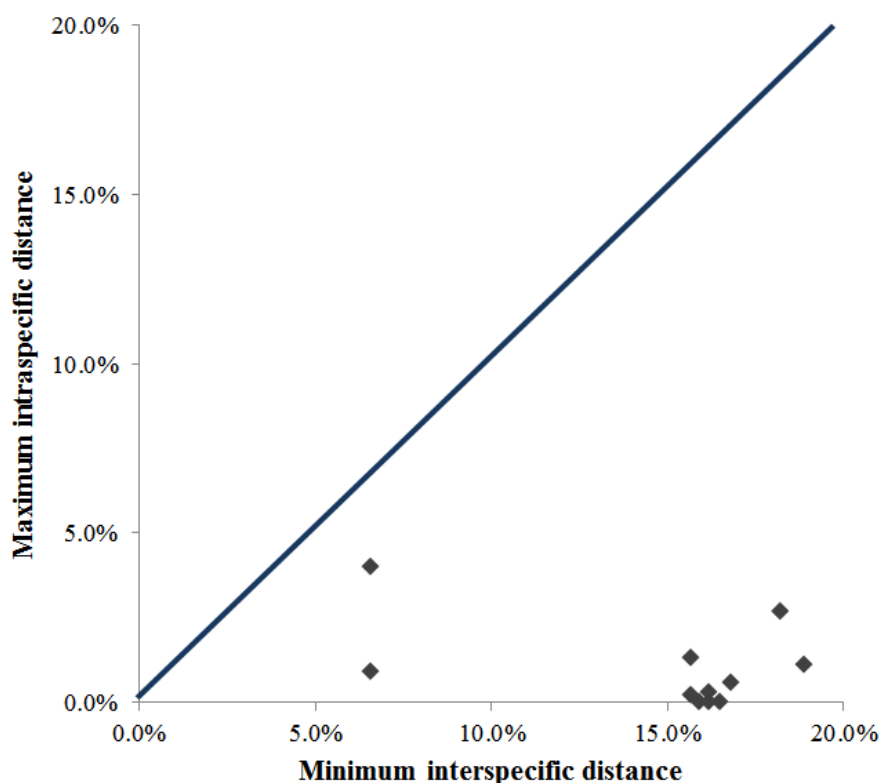


Fig. 49. Minimum interspecific and maximum intraspecific sequence divergence values were calculated to evaluate COI as a DNA barcode for species determination.

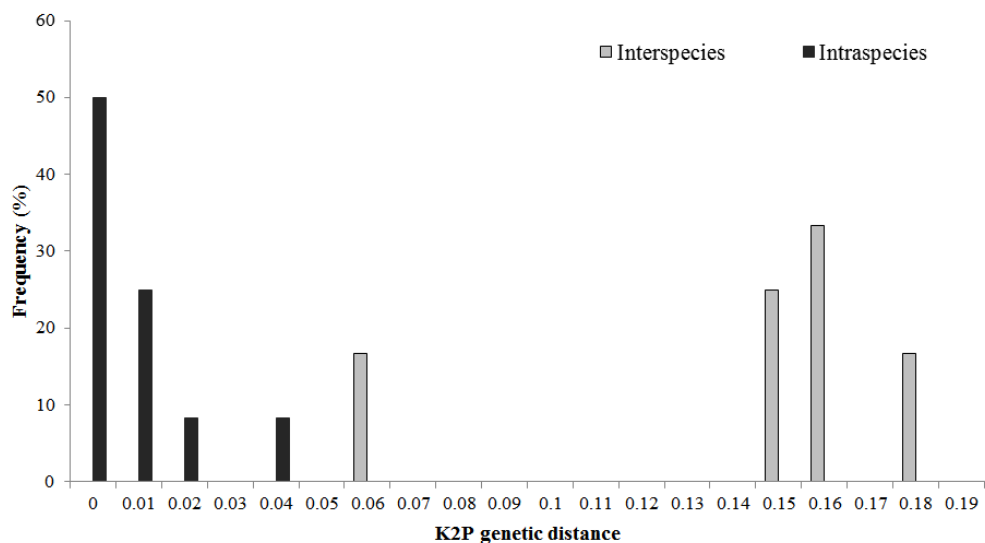


Fig. 50. COI (K2P) distance for the barcode region within interspecies and intraspecies.

Table 2. List of samples examined.

No.	Species	Date	Collection Site
16-1	<i>Allogalathea elegans</i>	20100814	Seogwipo-si, Jeju-do
16-2	<i>Allogalathea elegans</i>	20120428	Seogwipo-si, Jeju-do
13-16	<i>Galathea orientalis</i>	20120412	Jeju-do
13-33	<i>Galathea orientalis</i>	20091029	Uljin-gun, Gyeongsangbuk-do
13-37	<i>Galathea orientalis</i>	20110715	Seogwipo-si, Jeju-do
13-38	<i>Galathea orientalis</i>	19820722	Seogwipo-si, Jeju-do
14-2	<i>Galathea pubescens</i>	20051024	Seogwipo-si, Jeju-do
14-6-1	<i>Galathea pubescens</i>	20061018	Seogwipo-si, Jeju-do
14-6-2	<i>Galathea pubescens</i>	20061018	Seogwipo-si, Jeju-do
4-4	<i>Enosteoides ornatus</i>	20091029	Uljin-gun, Gyeongsangbuk-do
4-5	<i>Enosteoides ornatus</i>	20090829	Geoje-si, Gyeongsangnam-do
4-8	<i>Enosteoides ornatus</i>	20110715	Seogwipo-si, Jeju-do
11-1	<i>Lissoporcellana nakasonei</i>	20110924	Jeju-si, Jeju-do
7-2	<i>Pachycheles hertwigi</i>	20070625	Ulleung-gun, Gyeongsangbuk-do
7-3	<i>Pachycheles hertwigi</i>	19720717	Pohang-si, Gyeongsangbuk-do
7-7	<i>Pachycheles hertwigi</i>	20121015	Ulleung-gun, Gyeongsangbuk-do
6-1	<i>Pachycheles stevensii</i>	20110902	Tongyeong-si, Gyeongsangnam-do
6-5	<i>Pachycheles stevensii</i>	20110816	Uljin-gun, Gyeongsangbuk-do
6-8	<i>Pachycheles stevensii</i>	20100324	Goseong-gun, Gangwon-do
6-10	<i>Pachycheles stevensii</i>	20090806	Namhae-gun, Gyeongsangnam-do
6-12	<i>Pachycheles stevensii</i>	20070703	Ongjin-gun, Incheon
6-21	<i>Pachycheles stevensii</i>	20060622	Ulleung-gun, Gyeongsangbuk-do
1-1	<i>Petrolisthes coccineus</i>	20110716	Seogwipo-si, Jeju-do
1-2	<i>Petrolisthes coccineus</i>	20110715	Seogwipo-si, Jeju-do
1-3	<i>Petrolisthes coccineus</i>	20010223	Seogwipo-si, Jeju-do
2-1	<i>Petrolisthes japonicas</i>	20110412	Seogwipo-si, Jeju-do
2-14	<i>Petrolisthes japonicas</i>	20040630	Jindo-gun, Jeollanam-do
2-17	<i>Petrolisthes japonicas</i>	20061016	Bukjeju-gun, Jeju-do
3-2	<i>Petrolisthes militaris</i>	20021013	Seogwipo-si, Jeju-do
3-19	<i>Petrolisthes militaris</i>	20001106	Jeju-si, Jeju-do
5-1	<i>Pisidia serratifrons</i>	20120409	Boryeong-si, Chungcheongnam-do

Table 2. (continued)

No.	Species	Date	Collection Site
5-2	<i>Pisidia serratifrons</i>	20070630	Ongjin-gun, Incheon
5-3	<i>Pisidia serratifrons</i>	20090805	Namhae-gun, Gyeongsangnam-do
5-29	<i>Pisidia serratifrons</i>	20110901	Tongyeong-si, Gyeongsangnam-do
5-30	<i>Pisidia serratifrons</i>	20090829	Geoje-si, Gyeongsangnam-do
5-31	<i>Pisidia serratifrons</i>	20090829	Geoje-si, Gyeongsangnam-do
8-1	<i>Raphidopus ciliates</i>	20091113	Sinan-gun, Jeollanam-do
8-2	<i>Raphidopus ciliates</i>	20100514	Sinan-gun, Jeollanam-do
8-3	<i>Raphidopus ciliates</i>	20061114	Boryeong-si, Chungcheongnam-do

Table 3. Values of K2P (Kimura 2-parameter) wequence divergence for Korean galatheoids.

Species	Number of specimens	Minimum interspecific distance	Maximum intraspecific distance	Mean interspecific distance	Mean intraspecific distance
<i>Allogalathea elegans</i> (Adams & White, 1848)	2	15.7%	0.2%	22.3%	0.2%
<i>Galathea orientalis</i> Stimpson, 1858	4	15.7%	1.3%	19.7%	1.1%
<i>Galathea pubescens</i> Stimpson, 1858	3	15.9%	0.0%	21.6%	0.0%
<i>Enosteoides ornatus</i> (Stimpson, 1858)	3	18.2%	2.7%	23.1%	2.3%
<i>Lissoporcellana nakasonei</i> (Miyake, 1978)	1	16.2%	N/A	22.5%	N/A
<i>Pachycheles hertwigi</i> Balss, 1913	3	6.6%	0.9%	19.6%	0.6%
<i>Pachycheles stevensii</i> Stimpson, 1858	6	6.6%	4.0%	20.0%	2.2%
<i>Petrolisthes coccineus</i> (Owen, 1939)	3	23.2%	1.1%	26.1%	0.8%
<i>Petrolisthes japonicus</i> (De Haan, 1849)	3	18.9%	1.1%	22.4%	0.7%
<i>Petrolisthes militaris</i> (Heller, 1862)	2	16.8%	0.6%	21.5%	0.6%
<i>Pisidia serratifrons</i> (Stimpson, 1858)	6	16.5%	0.0%	22.4%	0.0%
<i>Raphidopus ciliatus</i> Stimpson, 1858	3	16.2%	0.3%	20.1%	0.2%
Average		15.5%	1.1%	21.8%	0.8%

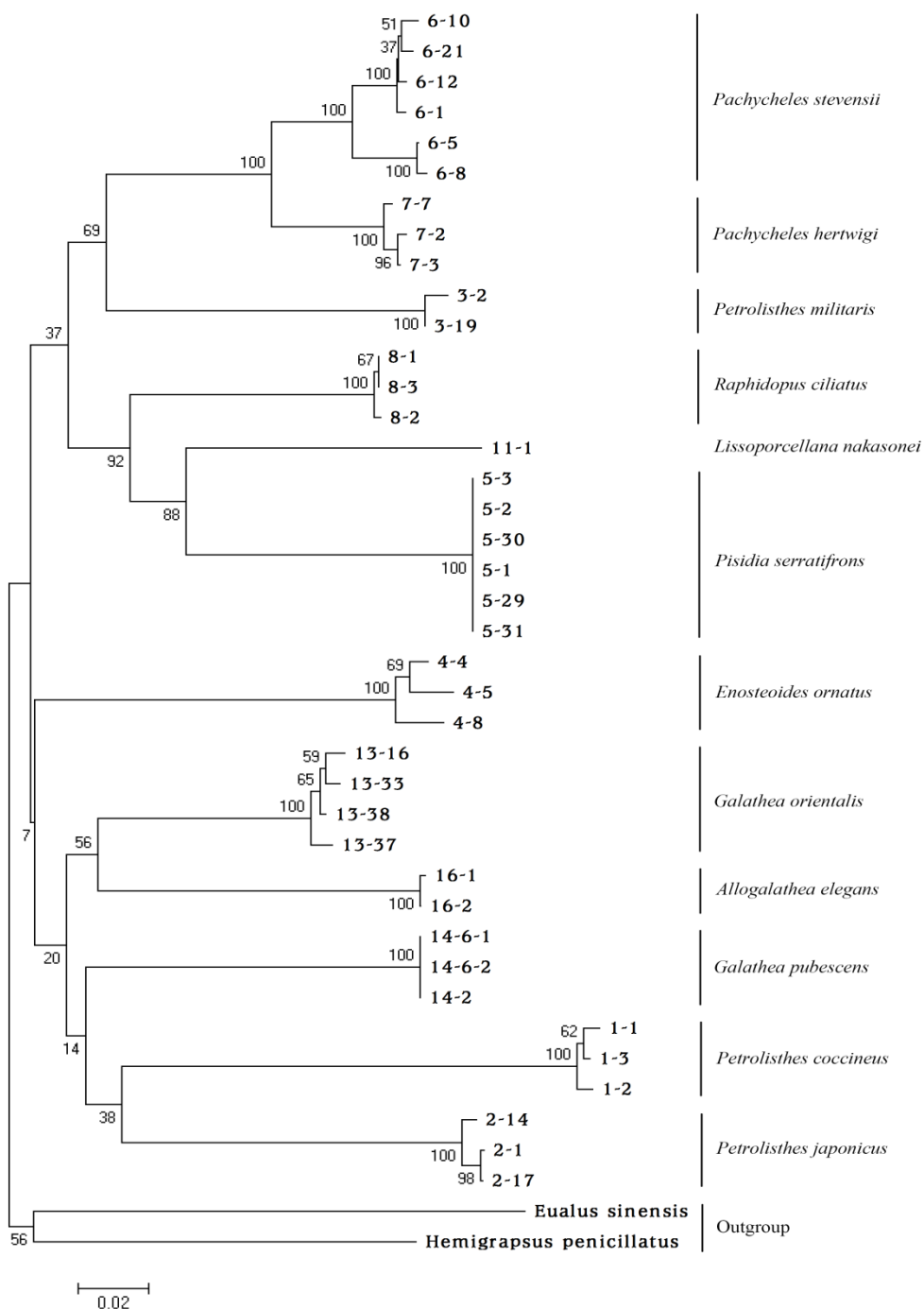


Fig. 51. Neighbor-joining (NJ) tree based on Kimura 2-parameter (K2P) distances. Bootstrap values based on 1,000 replication are included.

CONCLUSION

Korean galatheoids are organized 11 species of 10 genera belonging to 3 families by Dr. H. S. Kim in 1973. Since then, 3 species of porcellanids are additionally reported by Dr. H. S. Ko (Ko, 2003; 2006). Until now, 14 galatheoids have been reported in the Korean fauna, and no revised study of the superfamily has been conducted.

As a result of morphological study, 20 species, 15 genera and 3 families are reported in Korean fauna, of which 6 species and 5 genera are newly reported.

The distribution of Korean galatheoids was also studied. Most galatheoids can be found primarily in tropical regions. And most of Korean galatheoids, 13 species of the total 20 species, are collected in Jeju-do which is warmest locality in Korea. Of these, *Raymunida formosanus* has been recorded from only Taiwan and eastern Australia (Baba et al., 2009). Thus, this study presents the most northern record of this species. Many individuals of *Pachychels stevesii* and *Pisidia serratifrons* are collected in northern region. They would have more ability of resist on cool region than other species. And in case of *Pachycheles hertwigi*, almost all the specimens are collected in Ulleung-do. So, further study on ecology should be followed.

After studying morphology of Korean specimens, molecular work using DNA barcode was also conducted. Total 39 individuals of Galatheoids, belonging to twelve species of eight genera, have been successfully sequenced on the basis of DNA barcoding. As a result, it showed that the interspecific sequence variation rate averagely 15.5%, and intraspecific sequence variation rate averagely 1.1%. In NJ

tree, *Pachycheles hertwigi* and *Pachycheles stevensii* are formed one group. They have only 6.6% of sequence distance. These two species are very similar morphologically, but there are two distinguishable key characters: the number of movable spines on ambulatory legs, and dorsal surface of cheliped with plumose setae. *Pachycheles stevensii* is divided into two clades. They have almost same morphological features, but their intraspecific sequence variation rate is about 4%. It would be a cryptic species. So, additional sampling and ecological study are necessary. On the other hand, in the case of *Pisidia serratifrons*, many morphological variations are observed. But, this species has distinct trilobite rostrum, twisted movable finger, and smaller cheliped with fixed finger bifurcate commonly. And as result of molecular work using mtCOI gene, the author confirmed that these variations of this species are intraspecific variation.

Table 4. The list of the distribution of the Korean galatheoids.

Species	Yellow Sea	Korean Strait	East Sea
<i>Allogalathea elegans</i> (Adams & White, 1848)		+	
<i>Galathea orientalis</i> Stimpson, 1858		+	+
<i>Galathea pubescens</i> Stimpson, 1858		+	
<i>Phylladiorhynchus pusillus</i> (Henderson, 1885)		+	
<i>Raymunida formosanus</i> Lin, Chan & Chu, 2004		+	
<i>Raymunida lineata</i> Osawa, 2005		+	
<i>Munida japonica</i> Stimpson, 1858		+	
<i>Paramunida scabra</i> (Henderson, 1885)		+	
<i>Aliaporcellana pygmaea</i> (De Man, 1902)		+	
<i>Enosteoides ornatus</i> (Stimpson, 1858)		+	+
<i>Lissoporcellana nakasoni</i> (Miyake, 1978)		+	
<i>Pachycheles hertwigi</i> Balss, 1913			+

Table 4. (continued)

Species	Yellow Sea	Korean Strait	East Sea
<i>Pachycheles stevensii</i> Stimpson, 1858	+	+	+
<i>Petrolisthes coccineus</i> (Owen, 1839)		+	
<i>Petrolisthes japonicus</i> (De Haan, 1849)	+	+	
<i>Petrolisthes militaris</i> (Heller, 1862)		+	
<i>Pisidia serratifrons</i> (Stimpson, 1858)	+	+	+
<i>Polyonyx sinensis</i> Stimpson, 1858	+	+	
<i>Porcellana pulchra</i> Stimpson, 1858	+	+	
<i>Raphidopus ciliatus</i> Stimpson, 1858	+	+	

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APPENDIXES

Appendix 1. Checklist of Korean galatheoids.

Superfamily Galatheoidea Samouelle, 1819 새우불이상과

Family Galatheidae Samouelle, 1819 새우불이과

Genus *Allogalatea* Baba, 1969

Allogalatea elegans (Adams & White, 1848)

Genus *Galathea* Fabricius, 1793 새우불이속

Galathea orientalis Stimpson, 1858 새우불이

Galathea pubescens Stimpson, 1858 털보새우불이

Genus *Phylladiorhynchus* Baba, 1969

Phylladiorhynchus pusillus (Henderson, 1885)

Family Munididae Ah Yong, Baba, Macpherson & Poore, 2010

Genus *Raymunida* Macpherson & Machordom, 2000

Raymunida formosanus Lin, Chan & Chu, 2004

Raymunida lineata Osawa, 2005

Genus *Munida* Leach, 1820 바늘이마새우불이속

Munida japonica Stimpson, 1858 바늘이마새우불이

Genus *Paramunida* Baba, 1988 가시새우불이속

Paramunida scabra (Henderson, 1885) 가시새우불이

Family Porcellanidae Haworth, 1825 게불이과

Genus *Aliaporcellana* Nakasone & Miyake, 1969

Aliaporcellana pygmaea (De Man, 1902)

Genus *Enosteoides* Johnson, 1970 가시게불이속

Enosteoides ornatus (Stimpson, 1858) 가시게불이

Genus *Lissoporcellana* Haig, 1978

Lissoporcellana nakasonei (Miyake, 1978)

Genus *Pachycheles* Stimpson, 1858 게불이속

Pachycheles hertwigi Balss, 1913 털손게불이

Pachycheles stevensii Stimpson, 1858 게불이

Genus *Petrolisthes* Stimpson, 1858 갯가게불이속

Petrolisthes coccineus (Owen, 1839) 김붉은게불이

Petrolisthes japonicus (De Haan, 1849) 갯가게불이

Petrolisthes militaris (Heller, 1862) 가시등붉은게불이

Genus *Pisidia* Leach, 1820 알통게불이속

Pisidia serratifrons (Stimpson, 1858) 알통게불이

Genus *Polyonyx* Stimpson, 1858 밀집벌레게불이속

Polyonyx sinensis Stimpson, 1858 밀집벌레게붙이

Genus *Porcellana* Lamarck, 1801 매끈이게붙이속

Porcellana pulchra Stimpson, 1858 매끈이게붙이

Genus *Raphidopus* Stimpson, 1858 털다리게붙이속

Raphidopus ciliatus Stimpson, 1858 털다리게붙이

Appendix 2. Aligned sequences of mtCOI gene of 12 species, 39 individuals.

16-1, *Allogalatea elegans*; 16-2, *Allogalatea elegans*; 13-16, *Galathea orientalis*; 13-33, *Galathea orientalis*; 13-37, *Galathea orientalis*; 13-38, *Galathea orientalis*; 14-2, *Galathea pubescens*; 14-6-1, *Galathea pubescens*; 14-6-2, *Galathea pubescens*; 4-4, *Enosteoides ornatus*; 4-5, *Enosteoides ornatus*; 4-8, *Enosteoides ornatus*; 11-1, *Lissoporcellana nakasonei*; 7-2, *Pachycheles hertwigi*; 7-3, *Pachycheles hertwigi*; 7-7, *Pachycheles hertwigi*; 6-1, *Pachycheles stevensii*; 6-5, *Pachycheles stevensii*; 6-8, *Pachycheles stevensii*; 6-10, *Pachycheles stevensii*; 6-12, *Pachycheles stevensii*; 6-21, *Pachycheles stevensii*; 1-1, *Petrolisthes coccineus*; 1-2, *Petrolisthes coccineus*; 1-3, *Petrolisthes coccineus*; 2-1, *Petrolisthes japonicus*; 2-14, *Petrolisthes japonicus*; 2-17, *Petrolisthes japonicus*; 3-2, *Petrolisthes militharis*; 3-19, *Petrolisthes militharis*; 5-1, *Pisidia serratifrons*; 5-2, *Pisidia serratifrons*; 5-3, *Pisidia serratifrons*; 5-29, *Pisidia serratifrons*; 5-30, *Pisidia serratifrons*; 5-31, *Pisidia serratifrons*; 8-1, *Raphidopus ciliatus*; 8-2, *Raphidopus ciliatus*; 8-3, *Raphidopus ciliates*.

16-1 -----TTTTATTTTTGGTGCATGAGCAGGAATAGTTGGAACCTTCACTAAGACTTAT [60]
16-2 AACACTTTA..... [60]
13-16 -----.....T.....A.....TT...T.... [60]
13-33 -----.....T.....A.....TT...T.... [60]
13-37 -----.....T.....A.....TT...T.... [60]
13-38 -----.....T.....A.....TT...T.... [60]
14-2 TACACTTTA...C.....A..G..G..T.....A.....C..TT....CT.A.. [60]
14-6-1 TACACTTTA...C.....A..G..G..T.....A.....C..TT....CT.A.. [60]
14-6-2 TACACTTTA...C.....A..G..G..T.....A.....C..TT....CT.A.. [60]
4-4 -----C..C.....A..C.....T.....G..G..A..T.....GC. [60]
4-5 -----C..C.....A..C.....TA...G..G..G..G..T.....GC. [60]
4-8 -----C..C.....A..C.....T.....G..G..A..T.....GC. [60]
11-1 -----.....A..T....T..T....A..T.....T..C.. [60]
7-2 -----C.....A.....A..T..AG....T...T.A.. [60]
7-3 -----C.....A.....A..T..AG....T...T.A.. [60]
7-7 AACATTATAC.....A.....A..T..AG....T...T.A.. [60]
6-1 -----C..C.....A.....A..T..GG....T..GT.A.. [60]
6-5 -----C.....A.....A..T..GG....T..GT.A.. [60]
6-8 -----C.....A.....A..T..GG....T..GT.A.. [60]
6-10 -----C..C.....A.....A..T..GG....T..GT.A.. [60]
6-12 -----C..C.....A.....A..T..GG....T..GT.A.. [60]
6-21 -----C..C.....A.....A..T..GG....T..GT.A.. [60]
1-1 -----.....C..C.....T....T..T.....T..CG.C..T..TT.G.. [60]
1-2 -----.....C..C.....T....T..T.....T..CG.C..T..TT.G.. [60]
1-3 -----.....C..C.....T....T..T.....T..CG.C..T..TT.G.. [60]
2-1 AACTTTATA...C.....T....C..T....C....C.....T..C.. [60]
2-14 -----...C.....T....C..T....C....C.....T..C.. [60]
2-17 -----...C.....T....C..T....C....C.....T..C.. [60]
3-2 -----C.....C.....T....T....T....A.....G....C....A.. [60]
3-19 -----C.....C.....T....T....T....A.....G....C....A.. [60]
5-1 -----.....A..T.....T....A..T..A..CT....TT.A.. [60]
5-2 -----.....A..T.....T....A..T..A..CT....TT.A.. [60]
5-3 -----.....A..T.....T....A..T..A..CT....TT.A.. [60]
5-29 -----.....A..T.....T....A..T..A..CT....TT.A.. [60]
5-30 -----.....A..T.....T....A..T..A..CT....TT.A.. [60]
5-31 -----.....A..T.....T....A..T..A..CT....TT.A.. [60]
8-1 -----C....A..C..A.....T.....A.....T.....A.. [60]
8-2 AACATTATAC....A..C..A.....T.....A.....T.....A.. [60]
8-3 -----C....A..C..A.....T.....A.....T.....A.. [60]

16-1 TATCCGTGCTGAACTAGGACAACCAGGAAGTTTAAATTGGGGATGATCAAATTTATAATGT [120]
16-2 [120]
13-16 ...T..A.....T....C.....T.....A..C..... [120]
13-33 ...T..A.....T....C..G..T.....A..C..... [120]
13-37 ...T..A.....T....C.....T.....A..... [120]
13-38 ...T..A.....T....C.....T.....A..C..... [120]
14-2 ...T..G..A..G..T..T....G..G.....AA.....C..... [120]
14-6-1 ...T..G..A..G..T..T....G..G.....AA.....C..... [120]
14-6-2 ...T..G..A..G..T..T....G..G.....AA.....C..... [120]
4-4 ...T....TC.....G..A.....A..C.....C..... [120]
4-5 ...T....TC.....A.....A..C.....C..... [120]
4-8 ...T....TC.....G.....A..C.....C..... [120]
11-1 ...T..A..C...T...T....C...AA.....A..C....G....C.... [120]
7-2 ...T..A..C...T...T.....AC.G....A..... [120]
7-3 ...T..A..C...T...T.....AC.G....A..... [120]
7-7 ...T..A..C...T...T.....AC.G....A..... [120]
6-1 ...T..A..C...T...T.....AC.G....A..C.....C..C.... [120]
6-5 ...T..A..C..GT...T.....AC.G....A..C.....C..... [120]
6-8 ...T..A..C..GT...T.....AC.G....A..C.....C..... [120]
6-10 ...T..A..C...T...T.....AC.G....A..C.....C..C.... [120]
6-12 ...T..A..C...T...T.....AC.G....A..C.....C..C.... [120]
6-21 ...T..A..C...T...T.....AC.G....A..C.....C..C.... [120]
1-1C.....C.....C.....A.....C..G.....C.. [120]
1-2C.....T.....C.....A.....C..G.....C.. [120]
1-3C.....C.....C.....A.....C..G.....C.. [120]
2-1 ...T....A...T...T.....GC.....T.....C..G.....C.. [120]
2-14 ...T....A...T...T.....AC.....T.....C..G.....C.. [120]
2-17 ...T....A...T...T.....GC.....T.....C..G.....C.. [120]
3-2 ...T..A..C.....T.....T..T.....A..C.....C..... [120]
3-19 ...T..A..C.....T.....T..T.....A..C.....C..... [120]
5-1A.....T...T.....A.....T..C..... [120]
5-2A.....T...T.....A.....T..C..... [120]
5-3A.....T...T.....A.....T..C..... [120]
5-29A.....T...T.....A.....T..C..... [120]
5-30A.....T...T.....A.....T..C..... [120]
5-31A.....T...T.....A.....T..C..... [120]
8-1A.....T...T.....A.....A..... [120]
8-2A.....T...T.....A.....A..... [120]
8-3A.....T...T.....A.....A..... [120]

16-1 AATTGTCACCGCCCACGCTTTTGTAAATAATTTTTTTTATAGTTATACCTATTATAATTGG [180]
16-2 [180]
13-16A..T..T.....C.....A..... [180]
13-33A..T..T.....C.....A..... [180]
13-37A..T..T.....C.....A..... [180]
13-38A..T..T.....C.....A..... [180]
14-2 T....A..A..T.....A..... [180]
14-6-1 T....A..A..T.....A..... [180]
14-6-2 T....A..A..T.....A..... [180]
4-4 .G.G..T..A..T.....C....G....G..A..... [180]
4-5 .G.G..T..A..T.....C....G....G..A..... [180]
4-8 .G.G..T..A..T.....C....G....G..A..... [180]
11-1 .G.A..T..T..T....C..C..T.....G..A..CC..... [180]
7-2 TG...T..T..A..T.....T.....A..... [180]
7-3 TG...T..T..A..T.....T.....A..... [180]
7-7 TG...T..T..A..T.....T.....A..... [180]
6-1 TG...T..T.....T.....C.....A..... [180]
6-5 TG...T..T..G.....T.....C.....A..... [180]
6-8 TG...T..T..G.....C..T.....C.....A..... [180]
6-10 TG...T..T.....T.....C.....A..... [180]
6-12 TG...T..T.....T.....C.....A..... [180]
6-21 TG...T..T.....T.....C.....A..... [180]
1-1 TG.C..A....T.....C..G.....C..G..A....A..... [180]
1-2 TG.C..A....T.....C..G.....C..G..A....A..... [180]
1-3 TG.C..A....T.....C..G.....C..G..A....A..... [180]
2-1 GG...A.....T.....C.....A..... [180]
2-1 4GG...A.....T.....C.....A..... [180]
2-17 GG...A.....T.....C.....A..... [180]
3-2 TG...T....T..T....C..T.....C.....G..A..... [180]
3-19 TG...T....T..T....C..T.....C.....G..A..... [180]
5-1 .G.A..T..T.....C..A.T.....A..T..... [180]
5-2 .G.A..T..T.....C..A.T.....A..T..... [180]
5-3 .G.A..T..T.....C..A.T.....A..T..... [180]
5-29 .G.A..T..T.....C..A.T.....A..T..... [180]
5-30 .G.A..T..T.....C..A.T.....A..T..... [180]
5-31 .G.A..T..T.....C..A.T.....A..T..... [180]
8-1 .G.A..T..T..T..T.....T.....C.....A....A..T..... [180]
8-2 .G.A..T..T..T..T.....T.....C.....A....A..T..... [180]
8-3 .G.A..T..T..T..T.....T.....C.....A....A..T..... [180]

16-1 AGGATTTGGTAACTGATTAGTACCTTTTAATATTAGGAGCCCCTGATATAGCTTTTCCTCG [240]
 16-2 [240]
 13-16 T..C..C..A..T.....C.....T..... [240]
 13-33 T..C..C..A..T.....C.....T..... [240]
 13-37 T..C..C..A..T.....C.....T..... [240]
 13-38 T..C.....A..T.....C.....T.....C..... [240]
 14-2 ...T.....T.....G.....C.....G.....C..A.. [240]
 14-6-1 ...T.....T.....G.....C.....G.....C..A.. [240]
 14-6-2 ...T.....T.....G.....C.....G.....C..A.. [240]
 4-4 C..C.....A..T...C...C..AC.....A...A..A.....A..C..G.. [240]
 4-5 C..C.....A..T...C...C..AC.....A...A..A.....A..C..G.. [240]
 4-8 C..C.....A..T...C...C..AC.....A...A..A.....A..C..G.. [240]
 11-1C.....T...C...T.....T.....A.. [240]
 7-2 G.....A.....T.....G.....A..A.....G.. [240]
 7-3 G.....A.....T.....G.....A..A.....G.. [240]
 7-7 G.....A.....T.....G.....A..A.....G.. [240]
 6-1A.....C...T.....A..A.....C..G.. [240]
 6-5A.....C...T...C.....A..A.....C..A.. [240]
 6-8A.....C...T...C.....A..A.....C..A.. [240]
 6-10A.....C..A..T.....A..A.....G.. [240]
 6-12A.....C...T.....A..G.....C..G.. [240]
 6-21A.....C...T.....A..A.....C..G.. [240]
 1-1 ...C.....A..T...C..T..C.....C...T.....G..A..C..... [240]
 1-2 ...C.....A..T...C..T..C.....C...T.....G..C..... [240]
 1-3 ...C.....A..T...C..T..C.....C...T.....G..G..C..... [240]
 2-1 ...T.....T...C..T..T.....C..C...T.....C..C.. [240]
 2-14 ...T.....T...C..T..T.....C..C...T.....C..... [240]
 2-17 ...T.....T...C..T..T.....C..C...T.....C..C.. [240]
 3-2 ...G.....A..T.....T.....GC..T..G..T.....A.. [240]
 3-19 ...G.....A..T.....T.....GC..T..G..T.....A.. [240]
 5-1C..A..T..G..G..T...C.....A.....C..... [240]
 5-2C..A..T..G..G..T...C.....A.....C..... [240]
 5-3C..A..T..G..G..T...C.....A.....C..... [240]
 5-29C..A..T..G..G..T...C.....A.....C..... [240]
 5-30C..A..T..G..G..T...C.....A.....C..... [240]
 5-31C..A..T..G..G..T...C.....A.....C..... [240]
 8-1 G..G.....A.....C..A.....G.....C..A.. [240]
 8-2 G..G.....A.....C..A.....G.....C..A.. [240]
 8-3 G..G.....A.....C..A.....G.....C..A.. [240]

16-1 AATAAATAATATAAGATTTTGACTTCTTCCGCCCTTCTTTAACATTATTACTTATAAGAGG [300]
 16-2 [300]
 13-16G.....A.....GC.C.....G..G.. [300]
 13-33G.....A.....GC.C.....G..G.. [300]
 13-37G.....G.....A.....GC.C.....G..G.. [300]
 13-38G.....A.....GC.C.....G..G.. [300]
 14-2T.AT.A..T.....C.C..CC.TC.T..C..... [300]
 14-6-1T.AT.A..T.....C.C..CC.TC.T..C..... [300]
 14-6-2T.AT.A..T.....C.C..CC.TC.T..C..... [300]
 4-4 T.....C.....T..A.....TC.T...T.A.....A. [300]
 4-5 T.....C.....C..G.....TC.T...A.....A. [300]
 4-8 T.....C.....C..A.....TC.T...A.....A. [300]
 11-1C.....A....A..CG..C....GC.TC...A..... [300]
 7-2C...T.G....A....AC.T...C.CC.TT.A..... [300]
 7-3C...T.G....A....AC.T...C.CC.TT.A..... [300]
 7-7C...T.A....A....AC.T...C.CC.TT.A..... [300]
 6-1T.A....A....GC.T...C.CC.TT.A..... [300]
 6-5GT.A....A....AC.T...C.TC.TT.A..... [300]
 6-8GT.A....A....AC.T...C.TC.TT.A..... [300]
 6-10T.A....A....GC.T...C.CC.TT.A..... [300]
 6-12T.A....A....GC.T...C.CC.TT.A..... [300]
 6-21T.A....A....GC.T...C.CC.TT.A..... [300]
 1-1 T..G....C....G.....T.A..T.....C.T..CC.TC..... [300]
 1-2 T..G....C....G.....T.A..T.....C.T..CC.TC..... [300]
 1-3 T..G....C....G.....T.A..T.....C.T..CC.TC..... [300]
 2-1 C.....C.....T.A..T.....C.....C.TC.T..... [300]
 2-14 T.....C.....T.A..T.....C.....C.TC.T..... [300]
 2-17 T.....C.....T.A..T.....C.....C.TC.T..... [300]
 3-2 T....C..C.....T..A..GC.T..TC.T...T.A..... [300]
 3-19 T....C..C.....T..A..GC.T..TC.T...T.A..... [300]
 5-1C....C..AG.A.....C.TC.TT.G..... [300]
 5-2C....C..AG.A.....C.TC.TT.G..... [300]
 5-3C....C..AG.A.....C.TC.TT.G..... [300]
 5-29C....C..AG.A.....C.TC.TT.G..... [300]
 5-30C....C..AG.A.....C.TC.TT.G..... [300]
 5-31C....C..AG.A.....C.TC.TT.G..... [300]
 8-1C.....C..A..CG.A....TC.T...A..... [300]
 8-2C.....C..A..CG.A....TC.T...A..... [300]
 8-3C.....C..A..CG.A....TC.T...A..... [300]

16-1 AATGGTAGAAAGAGGTGTAGGAACAGGGTGAAGTGTCTACCCTCCCTTGCCGCAGGAAT [360]
 16-2A..... [360]
 13-16 ...A..T.....A.....T.....T.....T.....A..... [360]
 13-33 ...A..T.....A.....T.....T.....T.....A..... [360]
 13-37 ...A..T.....A.....T.....T.....T.....T.....A..... [360]
 13-38 ...A..T.....A.....T.....T.....T.....T.....A..... [360]
 14-2 ...A.....A..G..T....T.....T.....C..TT.G..A.G..... [360]
 14-6-1 ...A.....A..G..T....T.....T.....C..TT.G..A.G..... [360]
 14-6-2 ...A.....A..G..T....T.....T.....C..TT.G..A.G..... [360]
 4-4 ...A..G...AG..A.....A....C..G..T..A...T.GT...T.... [360]
 4-5 ...A..G...AG..A.....A....C..G..T..A..A..GT...T.... [360]
 4-8 ...A..G...A...A.....G..A....C..A..T..G..A..GT...T.... [360]
 11-1 ...A..T.....A.....A.....T..A..AT..AAT.C [360]
 7-2 G..A..T.....A.....C..A.....T..T.....TT..AT..A..TA.... [360]
 7-3 G..A..T.....A.....C..A.....T..T.....TT..AT..A..TA.... [360]
 7-7 G..A..T.....A.....C..A.....T..T.....TT..AT..A..TA.... [360]
 6-1 ...A..T.....A..T....C..A.....T..T..C..TT.GT..A..TA.... [360]
 6-5T.....A..T....C.....T..T.....TT.GT..A..TA.... [360]
 6-8T.....A..T....C.....T..T.....TT.GT..A..TA.... [360]
 6-10 ...A..T.....A..T....C..A.....T..T..C..TT.GT..A..TA.... [360]
 6-12 ...A..T.....A..T....C..A.....T..T..C..TT.GT..A..TA.... [360]
 6-21 ...A..T.....A..T....T..A.....T..T..C..TT.GT..A..TA.... [360]
 1-1 T....T..G.....T..T..C..C.....T..T.....T..T..CA.... [360]
 1-2 T....T..G.....T..T..C..C.....T..T.....T..T..CA.... [360]
 1-3 T....T..G.....T..T..C..C.....T..T.....T..T..CA.... [360]
 2-1 .T.A.....A.....T..T..C..T.....T..T.....T..AT..A..TA.... [360]
 2-14 .T.A.....A.....T..T..C..T.....T..T.....T..AT..A..TA.... [360]
 2-17 .T.A.....A.....T..T..C..T.....T..T.....T..AT..A..TA.... [360]
 3-2 G..A..T.....T..C..A.....A..T..C..GT..AT..G..TA.... [360]
 3-19 G..A..T.....T..C..A.....A..T..C..GT..AT..G..TA.... [360]
 5-1 ...A..T.....A.....C..A....C..T..T..A..TT..A..GT..AAT.. [360]
 5-2 ...A..T.....A.....C..A....C..T..T..A..TT..A..GT..AAT.. [360]
 5-3 ...A..T.....A.....C..A....C..T..T..A..TT..A..GT..AAT.. [360]
 5-29 ...A..T.....A.....C..A....C..T..T..A..TT..A..GT..AAT.. [360]
 5-30 ...A..T.....A.....C..A....C..T..T..A..TT..A..GT..AAT.. [360]
 5-31 ...A..T.....A.....C..A....C..T..T..A..TT..A..GT..AAT.. [360]
 8-1 .T.A..T.....A..G..G....A.....T.....T..A..A...AAC.. [360]
 8-2 .T.A..T.....A..G..G....A.....T.....T..A..A...AAC.. [360]
 8-3 .T.A..T.....A..G..G....A.....T.....T..A..A...AAC.. [360]

16-1 TGCCCATGCCGGAGCATCTGTTGACATAGGAATTTTTTCACTTCACCTAGCTGGAGTATC [420]
16-2 [420]
13-16 ...T....G....G..C....T.....C..T....TT...G....T.. [420]
13-33 ...T....G....G..C....T.....C..T....TT...G....T.. [420]
13-37 ...T....G....G..C....T.....C..T....TT...A....T.. [420]
13-38 ...T....G....G..C....T.....C..T....TT...G....T.. [420]
14-2T....T....C..T..G.....T....TT...G....T.. [420]
14-6-1T....T....C..T..G.....T....TT...G....T.. [420]
14-6-2T....T....C..T..G.....T....TT...G....T.. [420]
4-4 ...T.....T..A..A..T...C.....T....TT...A....C.. [420]
4-5 ...T.....T..A..A..T...C.....T....TT...A....C.. [420]
4-8 ...T.....T..A..A..T...C.....T....TT...A....C.. [420]
11-1 C..T...T.A..G..T..A..A.....C..A..T..T..C....T.. [420]
7-2A.....A..T.....TT.G....T..T.. [420]
7-3A.....A..T.....TT.G....T..T.. [420]
7-7A.....A..T.....TT...C..T..T.. [420]
6-1A.....A..T.....C..C..TT...C..T..C.. [420]
6-5C..A.....A.....G..C..TT...C..T..C.. [420]
6-8C..A.....A.....G..C..TT...C..T..C.. [420]
6-10A.....G..T.....C..C..TT...C..T..C.. [420]
6-12A.....A..T.....C..C..TT...C..T..C.. [420]
6-21A.....G..T.....C..C..TT...C..T..C.. [420]
1-1 ...T.....C..T..A..A....G.....C..G..T..T.....C.. [420]
1-2 ...T.....C..T..A..A....G.....C..G..T..T.....C.. [420]
1-3 ...T.....C..T..A..A....G.....C..G..T..T.....C.. [420]
2-1C..T....T..A....T.....TT.A..TT...A....T.. [420]
2-14C.....T..A....T.....TT.A..TT...A....T.. [420]
2-17C..T....T..A....T.....TT.A..TT...A....T.. [420]
3-2 ...T..C.....C..T.....T....TT...A..T.... [420]
3-19 ...T..C.....C..T.....T....TT...A..T.... [420]
5-1 ...T....T....T..A..A..T.....T..C..TT...A..G..G.. [420]
5-2 ...T....T....T..A..A..T.....T..C..TT...A..G..G.. [420]
5-3 ...T....T....T..A..A..T.....T..C..TT...A..G..G.. [420]
5-29 ...T....T....T..A..A..T.....T..C..TT...A..G..G.. [420]
5-30 ...T....T....T..A..A..T.....T..C..TT...A..G..G.. [420]
5-31 ...T....T....T..A..A..T.....T..C..TT...A..G..G.. [420]
8-1A.....C..A..T.....T..A..T..T..A....T.. [420]
8-2A.....C..A..T.....TT.A..T..T..A....T.. [420]
8-3A.....C..A..T.....T..A..T..T..A....T.. [420]

16-1 TTCAATCCTAGGTGCTATTAACTTTTATAACAACCTGTTATTAAACATGCGACCTAAAGGTAT [480]
 16-2 [480]
 13-16 A..T..TT....A..A.....T.....A.....T..A..... [480]
 13-33 A..T..TT....A..A.....T.....A.....T..A..... [480]
 13-37 A..T..TT....A..A.....T.....A.....T..A..... [480]
 13-38 A..T..TT....A..A.....T.....A.....T..A..... [480]
 14-2 C.....TT....A..C.....T.....C.....T.....T..... [480]
 14-6-1 C.....TT....A..C.....T.....C.....T.....T..... [480]
 14-6-2 C.....TT....A..C.....T.....C.....T.....T..... [480]
 4-4 A..T..TT....A...G....T..C..TT....A..A.....T..A.....A.. [480]
 4-5 A..T..TT....A...G....T..C..TT....A..A.....T.....A.. [480]
 4-8 A..T..TT....A...G....T..C..TT....A..A.....T.....C....A.. [480]
 11-1TT....A...G.A.....TT.T.....T..A...T.AGTT..A.. [480]
 7-2 G..T..T.....A..AG.A.....T.....G.....A..C...TC..... [480]
 7-3 G..T..T.....A..AG.A.....T.....G.....A..C...TC..... [480]
 7-7 G..T..T.....A..AG.A.....T.....G.....A..C...TC..... [480]
 6-1 A..T..TT....C..AG.A.....T....A.....T..A..T..CTC...A.. [480]
 6-5 A..T..TT....C..AG.A..T.....T....G....T..A..T..TC...A.. [480]
 6-8 A..T..TT....C..AG.A..T.....T....G....T..A..T..TC...A.. [480]
 6-10 A..T..TT....C..AG.A.....T....G....T..A..T..CTC...A.. [480]
 6-12 A..T..TT....C..AG.A.....T....G....T..A..T..CTC...A.. [480]
 6-21 A..T..TT....C..AG.A.....T....C.....T..A..T..CTC...A.. [480]
 1-1 ...T..T.....G..AG....T....G..T..C..C..C..T..A....CTC...A.. [480]
 1-2 ...T..T.....G..GG....T....G..T..C..C..C..T..A....CTC...A.. [480]
 1-3 ...T..T.....G..GG....T....G..T..C..C..C..T..A....CTC...A.. [480]
 2-1 C..T..T.....A.....T.....C..A.....T..... [480]
 2-14 C..T..T.....A.....T..C.....C..A.....T..... [480]
 2-17 C..T..T.....A.....T.....C..A.....T..... [480]
 3-2 A.....TT....A..AG....T...T....T....A.....A....AGT..... [480]
 3-19 A.....TT....A..AG....T.....T....A.....A....AGT..... [480]
 5-1 A.....TT....A...G.A..T....TT.T..AA.....A...T..GCT..... [480]
 5-2 A.....TT....A...G.A..T....TT.T..AA.....A...T..GCT..... [480]
 5-3 A.....TT....A...G.A..T....TT.T..AA.....A...T..GCT..... [480]
 5-29 A.....TT....A...G.A..T....TT.T..AA.....A...T..GCT..... [480]
 5-30 A.....TT....A...G.A..T....TT.T..AA.....A...T..GCT..... [480]
 5-31 A.....TT....A...G.A..T....TT.T..AA.....A...T..GCT..... [480]
 8-1 A.....TT....A..CG.A..T....TT.T.....A...T..TC...A.. [480]
 8-2 A.....TT....A..CG.A..T....TT.T.....A...T..TC...A.. [480]
 8-3 A.....TT....A..CG.A..T....TT.T.....A...T..TC...A.. [480]

16-1 AACTTTAGATCGTATACCACTTTTCGTCTGATCTGTTTTCATCACTGCTATCCTTCTCCT [540]
16-2 [540]
13-16 ...A.....A.....TT.A..T..A.....T..T..C.....TT.AT.A.. [540]
13-33 ...CA.....A.....TT.A..T..A.....T..T..C.....TT.AT.AT. [540]
13-37 ...A.....A.....TT.A..T..A.....T..T..C.....TT.AT.A.. [540]
13-38 ...CA.....A.....TT.A..T..A.....T..T..C.....TT.AT.A.. [540]
14-2 ...AA....C..A.....T.....T..T.....A..T..T.....TT.A..TT. [540]
14-6-1 ...AA....C..A.....T.....T..T.....A..T..T.....TT.A..TT. [540]
14-6-2 ...AA....C..A.....T.....T..T.....A..T..T.....TT.A..TT. [540]
4-4 ...AA....C.....T.A..T..G.....T..T..C..C..T..A..T.. [540]
4-5 ...AA....C.....T.A..T..G.....T..T..C..C..T..A..T.. [540]
4-8 ...AA....C.....T.A..T..G.....T..T..C..C..T..A..T.. [540]
11-1 ...A..T..C.....G..TT.A..T..T....A..G..T..T....C..T.A.... [540]
7-2 ...AA.....A.....T..T..G.....T..T..C..C..TT.A..TT. [540]
7-3 ...AA.....A.....T..T..G.....T..T..C..C..TT.A..TT. [540]
7-7 ...AA.....A.....T..T..G.....T..T..C..C..TT.A..TT. [540]
6-1 ...AA.....A.....T..T..G.....T..T....C..TT.A..TT. [540]
6-5 ...A.....A.....T..T..G.....T..T....C..TT.A..TT. [540]
6-8 ...A.....A.....T..T..G.....T..T....C..TT.A..TT. [540]
6-10 ...AA.....A.....T..T..G.....T..T....C..TT.A..TT. [540]
6-12 ...AA.....A.....T..T..G.....T..T....C..TT.A..TT. [540]
6-21 ...AA.....A.....T..T..G.....T..T....C..TT.A..TT. [540]
1-1 G...A....C..A..G..T.....T..A..GG.....T..T..C..A..T...T.AT. [540]
1-2 G...A....C..A..G..T.....T..A..GG.....T..T..C..A..T...T.AT. [540]
1-3 G...A....C..A..G..T.....T..A..GG.....T..T..C..A..T...T.AT. [540]
2-1 ...AA.....A.....T..G.....T..T..A..G..T..C..TT. [540]
2-14 ...AA.....A.....T..G.....T..T..A..G..T..C..TT. [540]
2-17 ...AA.....A.....T..G.....T..T..A..G..T..C..TT. [540]
3-2 .T..A.G....A.....T.....T..T.....A..T..T.....T.AT.A.. [540]
3-19 .T..A.....A.....T.....T..T.....A..T..T.....T.AT.A.. [540]
5-1 .T.A..T...T..T....TT.A..T..A.....A..T..T..A.....TT.AT.G.. [540]
5-2 .T.A..T...T..T....TT.A..T..A.....A..T..T..A.....TT.AT.G.. [540]
5-3 .T.A..T...T..T....TT.A..T..A.....A..T..T..A.....TT.AT.G.. [540]
5-29 .T.A..T...T..T....TT.A..T..A.....A..T..T..A.....TT.AT.G.. [540]
5-30 .T.A..T...T..T....TT.A..T..A.....A..T..T..A.....TT.AT.G.. [540]
5-31 .T.A..T...T..T....TT.A..T..A.....A..T..T..A.....TT.AT.G.. [540]
8-1 ...A..T..CT.....T.....T..G.....T..T..A.....T.A..T.. [540]
8-2 ...A..T..CT.....T.....T..G.....T..T..A.....T.A..T.. [540]
8-3 ...A..T..CT.....T.....T..G.....T..T..A.....T.A..T.. [540]

16-1 ACTTTCACTTCCAGTCCTAGCAGGAGCAATTACAATATTATTAACAGATCGTAATCTTAA [600]
16-2 [600]
13-16 .T.A..TT.A..T..TT.....T..G.....C.....C.. [600]
13-33 .T.A..TT.A..T..TT.....T.....C.. [600]
13-37 .T.A..TT.A..T..TT.....T.....C.. [600]
13-38 .T.A..TT.A..T..TT.....T.....C.. [600]
14-2TT.A.....TT....G..G.....C..... [600]
14-6-1TT.A.....TT....G..G.....C..... [600]
14-6-2TT.A.....TT....G..G.....C..... [600]
4-4 ...A..C..A..T..TT.....C.....A...T.A.. [600]
4-5 ...A..C..A..T..TT.....G.....C.....A...T.A.. [600]
4-8 T..G..C..A..T..TT.....C.....A....A.. [600]
11-1 CT.A..T..A.....AT.....C.TC.C.....A..CT.A.. [600]
7-2 .T.A...T.A.....TT....G..T.....T...C.....T....G...T.A.. [600]
7-3 .T.A...T.A.....TT....C..T.....T...C.....T....A...T.A.. [600]
7-7 .T.A..GT.A.....TT....C..T.....T...C.....T....A...T.A.. [600]
6-1 .T.A..CT.A.....T....C..C..T....T...C.T....T....A...T.A.. [600]
6-5 .T.A..CT.A.....T....C..C..T....T...C.T....T....A...T.A.. [600]
6-8 .T.A..CT.A.....T....C..C..T....T...C.T....T....A...T.A.. [600]
6-10 .T.A..CT.A.....T....C..C..T....T...C.T....T....A...T.A.. [600]
6-12 .T.A..CT.A.....T....C..C..T....T...C.T....T....A...T.A.. [600]
6-21 .T.A..CT.A.....T....T..C..T....T...C.T....T....A...T.A.. [600]
1-1 GT.G..TT.A..T..TT.G..T....T....T..G.....T...C.....T.A.. [600]
1-2 GT.A..TT.A..T..TT.G..T....T....T..G.....T...C.....T.A.. [600]
1-3 GT.A..TT.A..T..TT....T....T....T..G.....T...C.....T.A.. [600]
2-1 ...C..C..A..C..T....C..C..T.....C.T.....C.....C..A.. [600]
2-14 ...C..C..A..T..T....C..C..T.....C.T.....C.....C..A.. [600]
2-17 ...C..C..A..C..T....C..C..T.....C.T.....C.....C..A.. [600]
3-2 TT.A..CT.A..T...T...T.....C..GC.T.....C.....CT.A.. [600]
3-19 TT.A..CT.A..T..TT...T.....C..GC.T.....C.....CT.A.. [600]
5-1 CT.A..C.....AT.....T....T...C.TC.T.....A...T.A.. [600]
5-2 CT.A..C.....AT.....T....T...C.TC.T.....A...T.A.. [600]
5-3 CT.A..C.....AT.....T....T...C.TC.T.....A...T.A.. [600]
5-29 CT.A..C.....AT.....T....T...C.TC.T.....A...T.A.. [600]
5-30 CT.A..C.....AT.....T....T...C.TC.T.....A...T.A.. [600]
5-31 CT.A..C.....AT.....T....T...C.TC.T.....A...T.A.. [600]
8-1 TT.A..TT.A.....TT.....T...C.T.....C..A..CT.A.. [600]
8-2 TT.A..TT.A.....TT.....T...C.T.....C..A..CT.A.. [600]
8-3 TT.A..TT.A.....TT.....T...C.T.....C..A..CT.A.. [600]

16-1 TACATCATT TTTTGGACCCCGCCGGAGGAGAGATCCTGTTTATATCAACACCTATT- [658]
16-2----- [658]
13-16T.....T..A..T.....AA.....C.....T..G..- [658]
13-33T.....T..A..T.....AA.....T..G..- [658]
13-37T.....T....T.....AA.....T..G..- [658]
13-38T.....T..A..T.....AA.....T..G..- [658]
14-2T..C.....T..G..A....G.....A..C.....----- [658]
14-6-1T..C.....T..G..A....G.....A..C.....----- [658]
14-6-2T..C.....T..G..A....G.....A..C.....----- [658]
4-4 C.....A.T..G..T....T..T.....A.C.....C..G.....- [658]
4-5 C.....A.T..G..T....T..T.....A.C.....C..G.....- [658]
4-8 C.....A.T..A..T....T..T.....A.....C..G.....- [658]
11-1T.....T..AT.A....T....C..A..C.....T.....- [658]
7-2 ...T..T..C.....T.....A..T.....C..A..C.C.....T.....- [658]
7-3 ...T..T..C.....T.....A..T.....C..A..C.C.....TT.....- [658]
7-7 ...T..T..C.....T.....A..T.....C..A..C.C.....T.....T [658]
6-1 ...T..C.....T.....A....G....C..A..C.T.....TT.....- [658]
6-5 ...T..C..C.....T..A..A....G....C..A..C.T.....TT.....- [658]
6-8 ...T..C..C.....T..A..A....G....C..A..C.T.....T.....- [658]
6-10 ...T..C..C.....T.....A....G....C..A..C.T.....TT.....- [658]
6-12 ...T..C..C.....T.....A....G....C..A..C.T.....TT.....- [658]
6-21 ...T..C..C.....T.....A....G....C..A..C.T.....TT.....- [658]
1-1 ...C..T..C..C.....A....C.....C.....CC.T.....T.G..- [658]
1-2 ...C..T..C..C.....A....T.....C.....CC.T.....T.G..- [658]
1-3 ...C..T..C..C.....A....C.....C.....CC.T.....T.G..- [658]
2-1T..C.....G....T..T..T.....----- [658]
2-14T..C.....G..A..T..T..T.....T..T..- [658]
2-17T..C.....G....T..T..T.....T..T..- [658]
3-2 ...T..T..C.....T..A..A.....C..A..CC.T..C.....T..T..- [658]
3-19 ...T..T..C.....T..A..A.....C..A..C.T..C.....T..T..- [658]
5-1 C.....C.....T..TT.T.....A..C.T.....T..C..- [658]
5-2 C.....C.....T..TT.T.....A..C.T.....T..C..- [658]
5-3 C.....C.....T..TT.T.....A..C.T.....T..C..- [658]
5-29 C.....C.....T..TT.T.....A..C.T.....T..C..- [658]
5-30 C.....C.....T..TT.T.....A..C.T.....T..C..- [658]
5-31 C.....C.....T..TT.T.....A..C.T.....T..C..- [658]
8-1T.....G..A.....C..AA.....C.....TT.....- [658]
8-2T..C.....G..A.....C..AA.....C.....TT....T [658]
8-3T.....G..A.....C..AA.....C.....TT.....- [658]

국문초록

한국산 새우붙이상과에 대한 계통분류학적 연구를 수행하였다. 이번 연구를 수행하는데 사용된 표본은 1959년부터 2012년 까지 총 51개의 지점에서 채집되었다. 2011년 이후의 표본들은 직접 채집하였고 나머지 표본들은 서울대학교 계통분류 및 분자진화학 실험실에 보관되어 있는 표본을 사용하였다. 이렇게 얻게 된 725개체의 표본들의 형태적 특징과 문헌들을 검토한 결과 한국에 3과 15속 20종의 새우붙이상과가 분포하고 있는 것이 확인되었다. 이 중 6종은 한국에서 최초로 보고되는 종이다: *Allogalathea elegans* (Adams & White, 1848), *Phylladiorhynchus pusillus* (Henderson, 1885), *Raymunida formosanus* Lin, Chan & Chu, 2004, *Raymunida lineata* Osawa, 2005, *Aliaporcellana pygmaea* (De Man, 1902), *Lissoporcellana nakasonei* (Miyake, 1978). 표본을 확보하지 못한 2종: *Munida japonica* Stimpson, 1858, *Paramunida scabra* (Henderson, 1885)을 제외한 18종에 대한 기재, 사진 및 도판을 작성하였다. 또한 한국산 새우붙이상과의 종 목록과 검색표를 작성하였다. 한국해역에 서식하는 새우붙이상과의 12종에 대한 mtCOI 염기서열을 획득하여 DNA barcoding을 실시하였다. 그 결과 종간 변이율은 15.5%로 나타나 새우붙이상과에서의 DNA barcoding을 통한 종동정이 성공적으로 이루어졌다.

주요어 : 새우붙이상과, 한국의 동물상, 계통분류학, DNA 바코딩, mtCOI

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