이학박사학위논문

Systematic Study of the Superfamily Paguroidea (Crustacea: Decapoda: Anomura) from Korea

한국산 집게상과(갑각아문: 십각목: 이미하목)의 계통분류학적 연구

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Abstract

Systematic Study of the Superfamily Paguroidea (Crustacea: Decapoda: Anomura) from Korea

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In this study, the author present a systematic discussion of Korean hermit crabs by analysis of morphologic and DNA barcoding characteristics. The author performed a taxonomic examination of 61 species, 18 genera, and 3 families of Korean paguroid. Based on the findings of this study, the exclusive presence of 3 species in Korea could be called into question, 2 species were found to be synonymized, the Korean names of 5 species could be confirmed and the author could expand the geographical distributions for 6 species. A checklist, distribution maps, and identification keys were also designed for this study. In the DNA barcoding study, 159 individuals of 9 species of Paguroidea specimens in Korea were analyzed using the *cytochrome c oxidase subunit I* (COI) and *16S rRNA* sequences. The results show that the 5 species do not fit into the existing taxonomic scheme i.e., *Pagurus minutus* group, *P. brachiomastus* and *P. simulans* group, and *P. quinquelineatus* and *P. rectidactylus* group.

Keywords: Paguroidea, Hermit crab, Korea, Systematic, Morphological taxonomy, DNA barcode

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SYSTEMATICS OF KOREAN PAGUROIDEA BY USING MORPHOLOGICAL EXAMINATION AND DNA BARCODE

INTRODUCTION

The infraorder, Anomura, is divided into superfamilies containing a variety of decapod crustaceans, including the superfamily. Six families of Paguroidea (hermit crabs), 120 genera, and 1,106 species, are known to be widespread across the globe i.e., these decapods occur as part of marine life in areas as far apart as polar and tropical regions (McLaughlin, 1980; 1983; Appeltans et al., 2012). Hermit crabs (Anomura: Paguroidea) for a relatively small proportion of all decapods (Appeltans et al., 2012), but can be viewed as being part very diverse taxa based on morphology (McLaughlin, 2003).

Paguroid species are an important group in terms of biodiversity. Members of this group are important predators and scavengers in intertidal environments (Whitman et al., 2001) and primary consumers of marine life in its zoea stage (Kim & Son, 2006). Paguroidea is an important taxon in the marine ecosystem due to its interactions because many organisms will attach to the shells of members of this group (Williams and McDermott, 2004). Paguroid heavily influences global marine biodiversity through its abundance and extensive geographical distribution (Williams and McDermott, 2004).

The history of modern systematics of Paguroidea has started by a Swedish biologist Carl von Linne, the founder of modern taxonomic scheme (McLaughlin et al., 2010). He reported *Cancer bernhardus* Linnaeus, 1758 in the 10th edition of Systema Naturae. In 1802, a French researcher Pierre André Latreille founded family Paguridae.

After than, Coenobitidae Dana, 1851, Parapaguridae Smith, 1882, Pylochelidae Spence Bate, 1888, Diogenidae Ortmann, 1892, and Pylojacquesidae McLaughlin & Lemaitre, 2001 (McLaughlin, 2003; McLaughlin et al., 2010) have been reported, respectively.

Taxonomy research of Paguroidea has proceeded actively in Europe and USA since the 18th century (Linnaeus, 1758; Latreille, 1802; Dana, 1851; Stimpson, 1858; Smith, 1882; Spence Bate, 1888; Ortmann, 1892; McLaughlin & Lemaitre, 2001). From early 20th century, outstanding taxonomic research of Paguroidea has been performed in Japan by researchers from national history museum or universities (Terao, 1913; Yokoya, 1933; Kamita, 1954; 1955; Komai, 1995; 2003). From late 20th century, taxonomic researches of Paguroidea started to be performed in Brazil, Taiwan, and Indonesia (Rahayu, 1996; Rahayu & Komai, 2013; McLaughlin et al., 2007a; Malay et al., 2012; Negri et al., 2014).

Before western modern taxonomy was introduced to Korea, Korean scholar Yakjeon Jeong described hermit crab in his book, 'Jasaneobo', which was written in 1814. However, he misidentified hermit crab as gastropod in his book. At the end of the 19th century, Edward John Miers reported *Pomatocheles jeffreysii* Miers, 1879 as a new species by the specimen caught near Korea Straits.

In the early-middle of the 20th century, Korean paguroid was studied by Japanese researchers. Yokoya (1933) reported *Eupagurus dubius* Ortmann, 1892 (not *Pagurus minutus* Hess, 1865) and *Paguristes kagoshimensis* Ortmann, 1892 (=*Paguristes digitalis* Stimpson, 1858) from the western waters of Tsushima Island. Japanese taxonomist such as Kamita took specimens of decapod caught in Korea to Japan during the Japanese colonial era. Kamita wrote papers about Korean hermit crabs (1954, 1955). In 1954, he reported *Pagurus arrosor* (Herbst, 1796) (=*Dardanus arrosor*), *Pagurus impressus* De Haan, 1849 (=*Dardanus impressus* (De Haan, 1849)), *Diogenes edwardsii* (De Haan, 1849), *Eupagurus ochotensis* (Brandt, 1851) (=*Pagurus ochotensis* Brandt, 1851), *Eupagurus middendorffii* Brandt, 1851 (=*Pagurus middendorffii* Brandt, 1851), and *Eupagurus pubescens* (Kröyer, 1838) (=*Pagurus trigonocheirus* (Stimpson, 1858)). Kamita (1955) reported *Paguristes digitalis* Stimpson, 1858, *Eupagurus constans* Stimpson, 1858 (=*Pagurus constans* (Stimpson, 1858)), *Eupagurus japonicus* Stimpson, 1858 (=*Pagurus japonicus* (Stimpson, 1858)), *Eupagurus dubius* Ortmann, 1892 (=*Pagurus minutus* Hess, 1865), and *Eupagurus* sp. (=*Pagurus rubrior* Komai, 2003). He reported a total of 10 species, 3 genera, and 2 families of Paguroidea from Korean waters.

After the independence of Korea, Korean Paguroidea was actively studied by Korean researchers. Kim (1973) published an illustrated encyclopedia and compiled Korean hermit crabs as 24 species, 7 genera, and 2 families. Oh (2000) revised a checklist of Korean hermit crabs with 38 species, 9 genera and, 3 families, including Pylochelidae. Kim and Son (2006) added 8 species and 3 genera to the Korean hermit crab fauna in ‘Hermit crabs in Korean waters’. In 'Invertebrate Fauna of Korea: Hermit crabs' (Kim & Kim, 2014), 57 species, 18 genera, and 3 families were reported. This checklist is a result of ongoing morphology taxonomical studies on the Korean Paguroidea until the present (Kim et al., 2004; 2011; 2013; Hong et al., 2006a; 2006b; Kim & Son, 2006; Ko & McLaughlin, 2008; Jung and Kim, 2014).

However, some problems were found in the taxonomic study of the Korean Paguroidea i.e., inexact geographical distribution, questionable existence, misidentification, and confusion about the Korean names. For example, *Orthopagurus minimus* (Holmes, 1900) was first reported in Korean waters, but its was not an exact match to that of the original *O. minimus*. Meanwhile, recently reported Korean Paguroidea species were mostly based on studies of new species found in Japanese waters by Komai (1994; 1995; 1996; 1997; 2000; 2001; 2003a; 2003b; 2003c; 2009). Identification of many species reported by Komai relied on minor morphological differences from previously reported species. For example, *Pagurus simulans* was differentiated from P. brachiomastus based on minor characteristics such as the ratio of shield length/ocular peduncle and armature of right chela (Komai, 2000). In this case, it would have been difficult to identify Korean paguroidea without a detailed examination of the morphologies. Therefore, systematic revisions of Korean hermit crabs are needed due to detailed analysis of morphologic and molecular characteristics such as DNA barcodes.

DNA barcodes are useful to identify species based on short DNA sequences such as the cytochrome oxidase subunit I (Hebert et al., 2003). Recently, an active DNA barcoding survey was conducted of Paguroidea (Hirose et al., 2010; Komai et al., 2011; Malay et al., 2012; Negri et al., 2014).

In this study, the author evaluated the morphologic and DNA barcoding characteristics of Korean paguroidea and provided a systematic overview of results.

MATERIALS AND METHODS

MATERIALS

Characteristic analysis of Korean paguroid was performed by specimens deposited at Laboratory of Systematic and Molecular Evolution (EVOSYS) and Marine Arthropods Deposited Bank of Korea (MADBK) of Seoul National University (1,257 specimens, 8,382 individuals), National Fisheries Research and Development Institute (NFRDI), National Institute of Biological Resources (NIBR) and Ewha Womans University Natural History Museum (EWUNHM) from 40 collection sites (administrative district, Si(city) or Gun(country), Figure 1). All specimens from the present study were preserved in 70−99% ethanol.

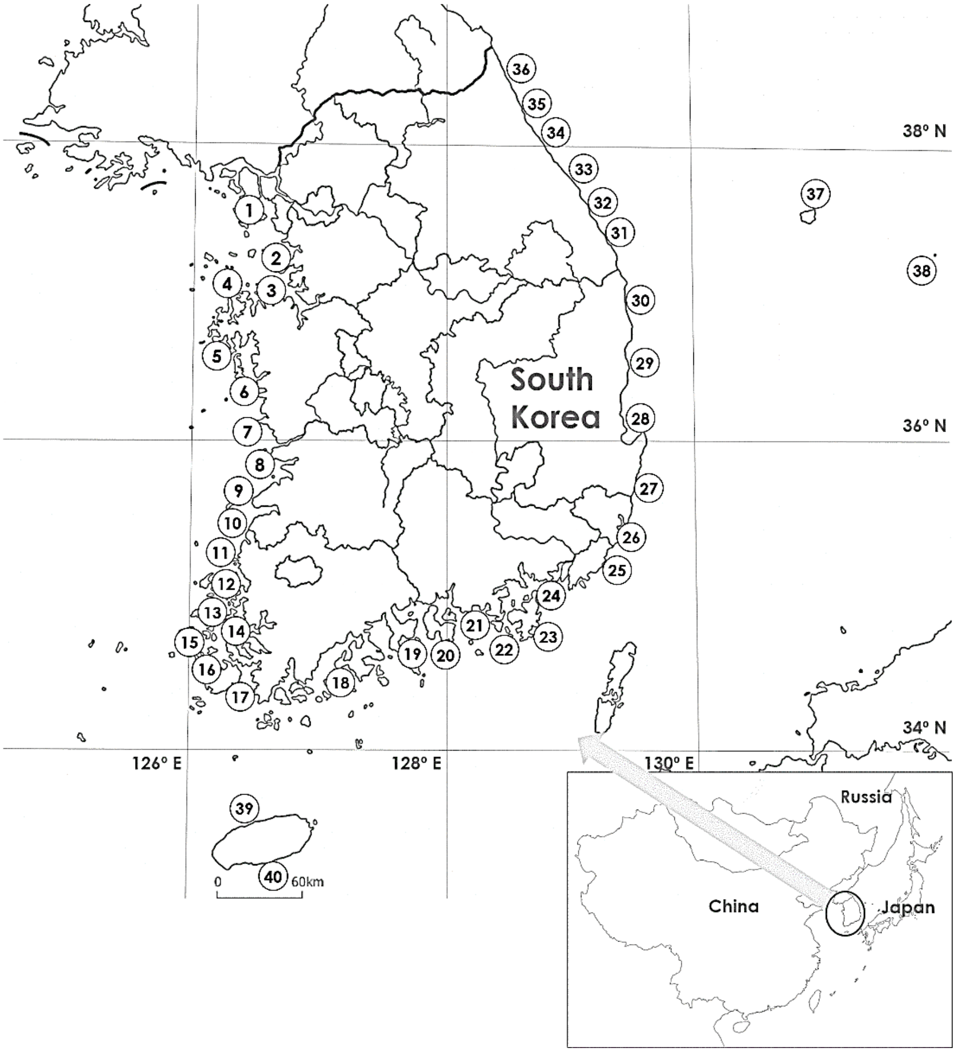

Figure 1. Map of Korea with collecting sites in this study. 1: Incheon; 2: Hwaseong; 3: Dangjin; 4: Seosan; 5: Taean; 6: Boryeong; 7: Seocheon; 8: Gunsan; 9: Buan; 10: Gochang; 11: Yeonggwang; 12: Hampyeong; 13: Muan; 14: Mokpo; 15: Shinan; 16: Jindo; 17: Wando; 18: Goheung; 19: Yeosu; 20: Namhae; 21: Goseong; 22: Tongyeong; 23: Geoje; 24: Changwon; 25: Busan; 26: Ulsan; 27: Gyeongju; 28: Pohang; 29: Yeongdeok; 30: Uljin; 31: Samcheok; 32: Donghae; 33: Gangneung; 34: Yangyang; 35: Sokcho; 36: Goseong; 37: Ulleung; 38: Dokdo; 39: Jeju; 40: Seogwipo.

CHARACTERISTIC ANALYSIS

Morphological characteristic analyses were processed by examining the specimen and reviewing related literature. Checklist verifying was performed by comparative study with WoRMS (2017). The diagnosis of Paguroidea species are provided except those already described in Kim & Kim (2014; in press). All drawings were made with a dissecting microscope MZ8 (Leica, Wetzlar, Germany) equipped with a camera lucida. Photographs were taken with a Nikon D200 digital camera and processed with the focus stacking program Helicon Focus (Helicon Soft Ltd., Kharkov, Ukraine). Shield length (sl) was given to indicate size of the specimen, measured from the tip of the rostrum to the midpoint of the posterior margin of the shield, and was taken using a digital caliper CD6CSX (Mitutoyo, Kawasaki, Japan) to the nearest 0.1 mm. The works by McLaughlin, 2003 and McLaughlin et al. (2007) were followed for terminology.

DNA barcoding characteristic analysis of Korean paguroid was focused on the 9 species divided as 3 groups by morphological similarity (Komai, 2000; 2003; Komai et al., 2015): *Pagurus minutus* and *P. filholi* (*P. minutus* group); *P. brachiomastus*, *P. proximus* and *P. simulans* (*P. brachiomastus* group); *P. nigrivittatus*, *P. quinquelineatus*, *P. rectidactylus* and *Boninpagurus pilosipes* (*B. pilosipes* group). Tissues were excised from one of the pereopods of each individual in order to extract total DNA using a QIAamp DNA Micro Kit (QIAGEN, Hilden, Germany). The universal primers, LCO1490, HCO2198 and jgLCO, jgHCO were used to amplify a 658-

659 bp fragment of the mitochondrial COI gene (Folmer et al., 1994; Geller et al., 2013). For amplifying a 545 bp fragment of the mitochondrial 16S rRNA gene, 16SH2 and 16SL2 primers were used (Schubart et al., 2000). A polymerase chain reaction (PCR) solution included 1 μL of DNA template, 1 μL of each primer (10 μM), 0.3 ųL Go Taq DNA polymerase (Promega, Madison City, WI, USA), 5 μL of 5x color Go Taq reaction buffer, 1 μL of dNTP mixture (10 mM) and 15.7 μL distilled H_2O (total 25 μL). The amplification protocol generally involved 5–10 min denaturation at 94℃ followed by a 38–42 cycle of 1 min at 94℃, 1.5 min at 45–48℃ and 2 min at 72℃ and a final extension of 10 min at 72℃. The size of PCR products were observed in 1% agarose gels. PCR products were analyzed on an ABI 3730 automated sequencer (Applied Biosystems, Foster City, CA, USA). The examined Korean specimens, gDNA and sequence files in this study were deposited in the National Center for Biotechnology Information (NCBI), MADBK or EVOSYS.

The mitochondrial DNA sequences were edited with SeqMan 5.0 (DNASTAR, Madison City, WI, USA) and aligned using ClustalW (Thompson et al., 1994) with an interface to the MEGA7 program (MEGA, PA, USA) (Kumar et al., 2016) with default parameters. The Korean Paguroidea COI sequences were used to analyze using Maximum Likelihood (ML) analysis based on the Jukes–Cantor model (Jukes and Cantor 1969) which is the lowest Bayesian information criterion score substitution models in the DNA/Protein Model Selection Analysis of MEGA7. The consistency of topologies was assessed using bootstrap values with 1,000 replications and values larger than 50%. Other options were following the default value. Interspecific and intraspecific sequence divergences were obtained based on the Jukes−Cantor model of MEGA7.

A total of 106 individuals of *P. minutus* from 14 collection sites in Korea were morphologically examined and used for COI and 16S rRNA sequence analysis of them (Table 1, Figure 2). The author identified haplotypes of *P. minutus* by multiple sequence alignment and analysis using DNA Sequence Polymorphism (DnaSP) Version 5 software (Librado and Rozas 2009). The COI haplotypes sequences (GenBank accession numbers: KY321934−KY321976), the three COI sequences of *P. minutus* retrieved from GenBank (GenBank accession numbers: JX502977−JX502979) and the four COI sequences of *P. filholi* (De Man, 1887) (GenBank accession numbers: KY321977−KY321980) were used to construct COI phylogenetic tree. The all Korean haplotypes 16S rRNA sequences (77 individuals, 14 haplotypes, GenBank accession numbers: KY327281–KY327294) were used to construct 16S rRNA phylogenetic tree.

In the DNA barcoding analysis of *P. brachiomastus* group, 46 COI [*P. brachiomastus* (13, 2 from NCBI), *P. proximus* (15, 2 from NCBI) and *P. simulans* (18)] and 20 of 16S rRNA [*P. brachiomastus* (7), *P. proximus* (6) and *P. simulans* (7)] sequences of three *Pagurus* species were used (Table 2).

In the DNA barcoding analysis of *B. pilosipes* group, 7 COI sequences [*B. pilosipes* (3, 1 from NCBI), *P. nigrivittatus* (2), *P. quinquelineatus* (1), and *P. rectidactylus* (1)] of four *Pagurus* species were used (Table 3).

Table 1. Geographical locations and sample information of *Pagurus minutus* in this study. The sites are ordered in Major Group only– abbreviations order–Minor Group included– abbreviations order.

Collection Location (Abbreviations)	Coordination	Major Group (MAG)			Minor Group (MIG)		
		Number of individual	Number of haplotype	Nucleotide diversity (average over loci)	Number of individual	Number of haplotype	Nucleotide diversity (average over loci)
Seocheon (C)	36° 07'52"N 126° 35'18"E	9	7	0.003968 ± 0.002652			
Jindo (D)	34° 31'37"N 126° 12'56"E	10	8	0.005100 ± 0.003227			
Seonjaedo (E)	37° 17'13"N 126° 30'39"E	3	2	0.002026 ± 0.002082			
Goseong (G)	35° 00'46"N 128° 29'52"E	4	2	0.002026 ± 0.001860			
Hampyeong (H)	35° 09'36"N 126° 22'23"E	10	6	0.003647 ± 0.002443			
Jeju (J)	33° 33'00"N 126° 41'25"E	5	4	0.003647 ± 0.002766			
Silmido (M)	37° 24'09"N 126° 23'32"E	13	8	0.004325 ± 0.002736			
Pohang (P)	36° 09'52"N 129° 16'29"E	7	4	0.004053 ± 0.002804			
Seosan (S)	36° 52'27"N 126° 21'59"E	3	2	0.005066 ± 0.004403			
Seogwipo (W)	33° 19'10"N 126° 50'38"E	13	6	0.002455 ± 0.001743			
Boryeong (B)	36° 14'44"N 126° 32'12"E	7	7	0.006079 ± 0.003955	3	3	0.002026 ± 0.002082
Ochungdo (O)	36° 07'12"N 125° 58'49"E	2	2	0.006079 ± 0.006797	2	2	0.004559 ± 0.005265
Taean (T)	36° 24'58"N 126° 21'43"E	7	3	0.003474 ± 0.002472	2	2	0.001520 ± 0.002149
Sokcho (H)	38° 12'51"N 128° 36'03"E				2	2	0.001520 ± 0.002149
Gangneung (N)	37° 54'25"N 128° 49'32"E				2	1	
Kujin (K)	38° 26'52"N 128° 27'55"E				3	2	0.001013 ± 0.001264
Total		92	35		14	8	

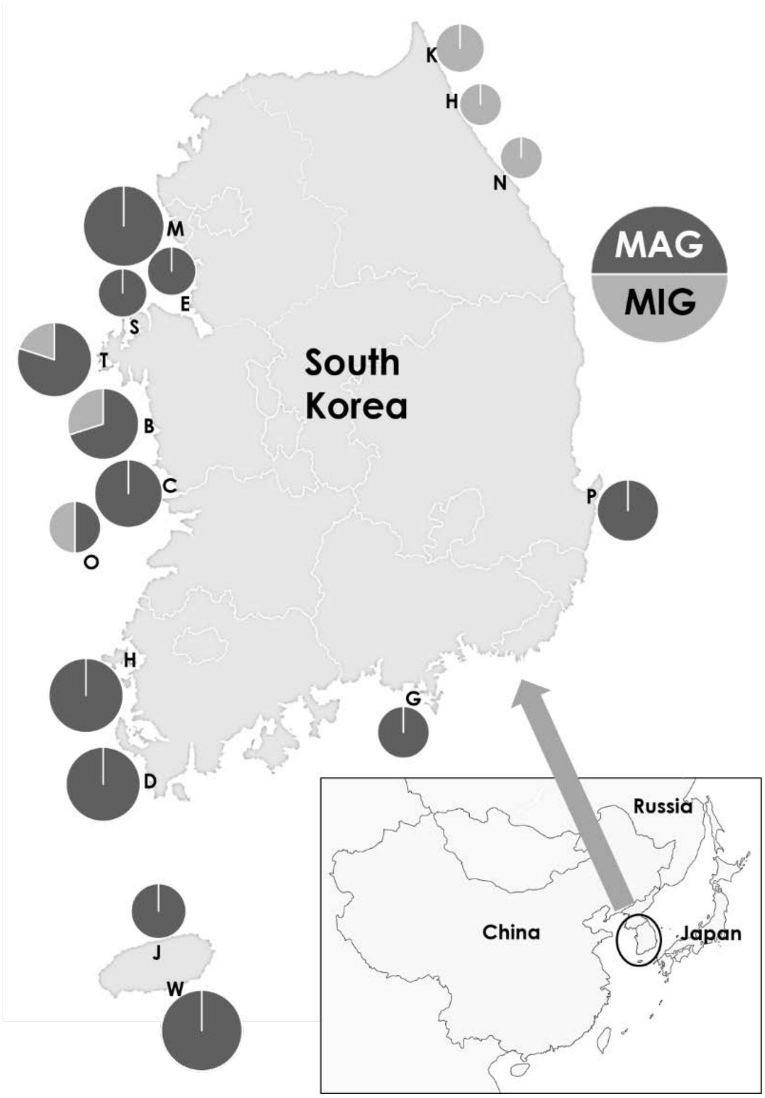

Figure 2. Sampling sites of *Pagurus minutus* Hess, 1865 in Korea (abbreviation is location refer to Table 1). The pie-graphs represent the size and proportions of individuals belonging to the Major Group (MAG, dark gray) and Minor Group (MIG, gray).

Table 2. The species and locality of MADBK specimens used in DNA barcoding analysis of *Pagurus brachiomastus* group in Korea. *: NCBI sequence.

Species name	Accession number	Number of individual	Coordination (or collection locality)	Collection date
Pagurus brachiomastus	160704_019	1	37° 0'43.67"N 129° 25'41.47"E	2009.10.28
	160704_024	1	38° 21'33.15"N 128° 33'57.73"E	2010.06.22
	160704_026	1	38° 20'42.80"N 128° 32'44.95"E	2010.06.22
	160704_031	1	38° 21'11.57"N 128° 32'44.77"E	2010.06.24
	160704_033	1	38° 19'24.35"N 128° 33'6.61"E	2010.06.25
	160704_034	1	36° 58'54.99"N 129° 25'9.68"E	2010.10.20
	160704_045	1	37° 58'9.26"N 128° 45'34.02"E	2014.06.25
	160704_048	1	37° 58'9.26"N 128° 45'34.02"E	2014.06.24
	160704_049	2	37° 58'9.26"N 128° 45'34.02"E	2014.06.25
	160704_050	1	37° 55'49.00"N 128° 47'25.00"E	2014.06.25
	JN590063*	1	(eastern Russia)	
	KC347556*	1	(eastern Russia)	
Pagurus proximus	160718_017	1	37° 0'18.03"N 129° 25'40.81"E	2010.10.20
	160718_026	2	38° 21'11.57"N 128° 32'44.79"E	2010.06.22
	160718_033	1	34° 35'49.24"N 125° 45'58.02"E	2008.10.16
	160718_037	1	34° 35'49.24"N 125° 45'58.02"E	2008.10.16
	160718_038	1	34° 35'49.24"N 125° 45'58.02"E	2008.10.16
	160718_042	1	34° 35'49.24"N 125° 45'58.02"E	2008.10.16
	160718_047	2	34° 40' 6.47"N 128° 15'31.69"E	2011.09.02
	160718_048	2	37° 9'35.93"N 125° 46'18.92"E	2011.11.03
	160718_049	1	36° 24'55.97"N 126° 22'2.69"E	2011.11.26
	160718_051	1	37° 56'52.96"N 128° 48'39.14"E	2014.04.10
	KC347562*	1	(eastern Russia)	
	KC347563*	1	(eastern Russia)	
Pagurus simulans	160719_012	10	35° 8'16.83"N 129° 9'37.01"E	2012.11.18
	160719_017	4	35° 8'16.83"N 129° 9'37.01"E	2010.11.12
	160719_019	4	35° 8'16.83"N 129° 9'37.01"E	2010.09.04

Table 3. The species and locality of Korean specimens used in molecular phylogeny analysis of Paguroidea. *: NCBI sequence (JF495166).

Species name	Number of individual	Collection locality	Collection date
Boninpagurus pilosipes	2	Yeosu	2002.06.26
	1*	Sagami Bay	2009.09.23
Pagurus nigrivittatus	2	Ulleung	2013.11.13
Pagurus quinquelineatus	1	Ulleung	1991.11.26
Pagurus rectidactylus	1	Dokdo	2015.06.03

RESULTS

SYSTEMATICS ACCOUNTS

Checklist of Korean Paguroidea

Phylum Arthropoda von Siebold, 1848 절지동물문

Class Malacostraca Latreille, 1802 연갑강

Order Decapoda Latreille, 1802 십각목

Family Pylochelidae Spence Bate, 1888 뿔조개집게과

Genus *Pomatocheles* Miers, 1879 뿔조개집게속

1. *Pomatocheles jeffreysii* Miers, 1879 뿔조개집게

Family Diogenidae Ortmann, 1892 넓적왼손집게과

Genus *Areopaguristes* Rahayu and McLaughlin, 2010 꼬마긴눈집게속

2. *Areopaguristes nigroapiculus* (Komai, 2009) 꼬마긴눈집게

3. *Areopaguristes japonicus* (Miyake, 1961) 작은꼬마긴눈집게

Genus *Paguristes* Dana, 1851 긴눈집게속

4. *Paguristes seminudus* Stimpson, 1858 발가숭이긴눈집게

5. *Paguristes acanthomerus* Ortmann, 1892 가시긴마디긴눈집게

6. *Paguristes versus* Komai, 2001 민무늬긴눈집게

7. *Paguristes digitalis* Stimpson, 1858 갈색털보긴눈집게

8. *Paguristes ortmanni* Miyake, 1978 털보긴눈집게

Genus *Ciliopagurus* Forest, 1995 고리무늬집게속

9. *Ciliopagurus strigatus* (Herbst, 1804) 분홍고리무늬집게

10. *Ciliopagurus krempfi* (Forest, 1952) 흰발가락고리무늬집게

Genus *Clibanarius* Dana, 1852 가로가위집게속

11. *Clibanarius virescens* (Krauss, 1843) 청색가위집게

Genus *Diogenes* Dana, 1851 넓적왼손집게속

12. *Diogenes penicillatus* Stimpson, 1858 털손왼손집게

13. *Diogenes edwardsii* (De Haan, 1849) 넓적왼손집게

14. *Diogenes nitidimanus* Terao, 1913 긴왼손집게

15. *Diogenes deflectomanus* Wang and Tung, 1980 긴넓적왼손집게*[1]

Genus *Dardanus* Paul'son, 1875 왼손집게속

16. *Dardanus lagopodes* (Forskål, 1775) 흰털왼손집게*

17. *Dardanus arrosor* (Herbst, 1796) 털줄왼손집게

18. *Dardanus crassimanus* (H. Milne Edwards, 1836) 벽돌길왼손집게

19. *Dardanus aspersus* (Berthold, 1846) 붉은점왼손집게

20. *Dardanus impressus* (De Haan, 1849) 두드러기왼손집게

21. *Dardanus pedunculatus* (Herbst, 1804) 굵은눈왼손집게

Family Paguridae Latreille, 1802 집게과

Genus *Porcellanopagurus* Filhol, 1885 조개집게속

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[1] *: Unrecorded species previously reported by the author

22. *Porcellanopagurus nihonkaiensis* Takeda, 1985 조개치레참집게

Genus *Lophopagurus* McLaughlin, 1981 꼬마참집게속

23. *Lophopagurus* (*Australeremus*) *triserratus* (Ortmann, 1892) 꼬마참집게

Genus *Discorsopagurus* McLaughlin, 1974 관참집게속

24. *Discorsopagurus maclaughlinae* Komai, 1995 대롱집게*

25. *Discorsopagurus tubicola* Komai, 2003 관참집게*

Genus *Nematopagurus* A. Milne-Edwards and Bouvier, 1892 가로마루참집게속

26. *Nematopagurus lepidochirus* (Doflein, 1902) 가로마루참집게

Genus *Boninpagurus* Asakura and Tachikawa, 2004 줄무늬참집게속

27. *Boninpagurus pilosipes* (Stimpson, 1858) 줄무늬참집게

Genus *Labidochirus* Benedict, 1892 작은배참집게속

28. *Labidochirus anomalus* (Balss, 1913) 작은배참집게

Genus *Elassochirus* Benedict, 1892 오목손참집게속

29. *Elassochirus cavimanus* (Miers, 1879) 오목손참집게

Genus *Diacanthurus* McLaughlin and Forest, 1997 가시꼬리참집게속

30. *Diacanthurus ophthalmicus* (Ortmann, 1892) 가시꼬리참집게

Genus *Catapaguroides* A. Milne-Edwards and Bouvier, 1892 얼룩꼬마참집게속

31. *Catapaguroides fragilis* (Melin, 1939) 얼룩꼬마참집게

Genus *Pagurixus* Melin, 1939 작은참집게속

32. *Pagurixus fasciatus* Komai and Myorin, 2005 얼룩작은참집게

Genus *Pagurus* Fabricius, 1775 참집게속

33. *Pagurus decimbranchiae* Komai and Osawa, 2001 얼룩다리참집게

34. *Pagurus nigrivittatus* Komai, 2003 검은줄무늬참집게

35. *Pagurus quinquelineatus* Komai, 2003 다섯줄참집게*

36. *Pagurus rectidactylus* Komai, Saito and Myorin, 2015 제집줄참집게*

37. *Pagurus maculosus* Komai and Imafuku, 1996 가는몸참집게

38. *Pagurus lanuginosus* De Haan, 1849 털다리참집게

39. *Pagurus proximus* Komai, 2000 검은털손참집게

40. *Pagurus simulans* Komai, 2000 갈색털손참집게

41. *Pagurus brachiomastus* (Thallwitz, 1892) 털손참집게

42. *Pagurus minutus* Hess, 1865 긴발가락참집게

43. *Pagurus nigrofascia* Komai, 1996 검은참집게

44. *Pagurus filholi* (De Man, 1887) 참집게

45. *Pagurus japonicus* (Stimpson, 1858) 붉은눈자루참집게

46. *Pagurus rubrior* Komai, 2003 얼룩참집게

47. *Pagurus similis* (Ortmann, 1892) 주황얼룩참집게

48. *Pagurus parvispina* Komai, 1997 긴가시참집게*

49. *Pagurus pectinatus* (Stimpson, 1858) 빗참집게

50. *Pagurus conformis* De Haan, 1849 큰발참집게

51. *Pagurus exiguus* (Melin, 1939) 동도참집게

52. *Pagurus spina* Komai, 1994 가시다리참집게

53. *Pagurus imaii* (Yokoya, 1939) 서도참집게

54. *Pagurus constans* (Stimpson, 1858) 제집참집게

55. *Pagurus trigonocheirus* (Stimpson, 1858) 세모손참집게

56. *Pagurus ochotensis* Brandt, 1851 북방참집게

57. *Pagurus rathbuni* (Benedict, 1892) 털발목참집게

58. *Pagurus gracilipes* (Stimpson, 1858) 납작손참집게

59. *Pagurus nipponensis* (Yokoya, 1933) 일본참집게

60. *Pagurus undosus* (Benedict, 1892) 혹손참집게*

61. *Pagurus middendorffii* Brandt, 1851 긴다리참집게

Glossary of terms

Body of Paguroidea consists of three parts: head (5 segments), thorax (8 segments), and pleon (7 segments). Paguroidea has cephalothorax consisting of head and thorax with 5 pairs of pereopods in thorax segments (Figure 2). Anterior surface of cephalothorax is covered with calcific shield. Shield length (sl) is the size indicator of Paguroidea. The middle of distal margin of shield bears with rostrum and each side of rostrum bears with lateral projection. Eye consists of ocular peduncle and cornea. On inner margin of base of ocular peduncle, there is an ocular acicle which is small and calcific appendage. Antennule is located under the eye. It consists of ultimate segment, basal segment, and flagellum. Antenna is located outside of the shield, consisting of antennal segment and flagellum. Mouth consists of 6 parts: mandible, maxillule, maxilla, first maxilliped, second maxilliped, and third maxilliped. Pereopods consist of 1 pair of chelipeds (or 1st pereopod), 2 fairs of ambulatory legs (1st–2nd ambulatory legs or 2nd–3rd pereopods), and 2 fairs of pereopods (4th–5th pereopods). Chelipeds are used for eating, attacking, and defending. Size and shape of each cheliped are different by taxa. Size difference of each cheliped is one major character to distinguish each taxon of Paguroidea. Other important characteristics are: number of gill, length of coxa gap of cheliped, calcification late of pleon, shape of antennula flagellum, sternite IX, and so on. Each pereopod consists of dactylus, propodus, capus, merus, ischium or basis, and coxa. Pleon is mostly membranous among taxa of Paguroidea except calcific abdominal plates, endopod, and telson. Endopod and telson are located at the end of pleon. Carcinoecia and body of Paguroidea are combined each other by endopod and telson. The number of pleopod is variable depending on abdominal plate, sex, and taxa. Most female individuals have pleopods in 2−5 abdominal plates to carry and protect their eggs (thousands in number). Sex of paguroid species are recognized by position of gonopore (Figure 3). The gonopore is positioned on the base of 5th pereopods in male individual, whereas base of 3th pereopods in female individual. The shape and number of gonopore is differed by the taxa (McLaughlin, 2003).

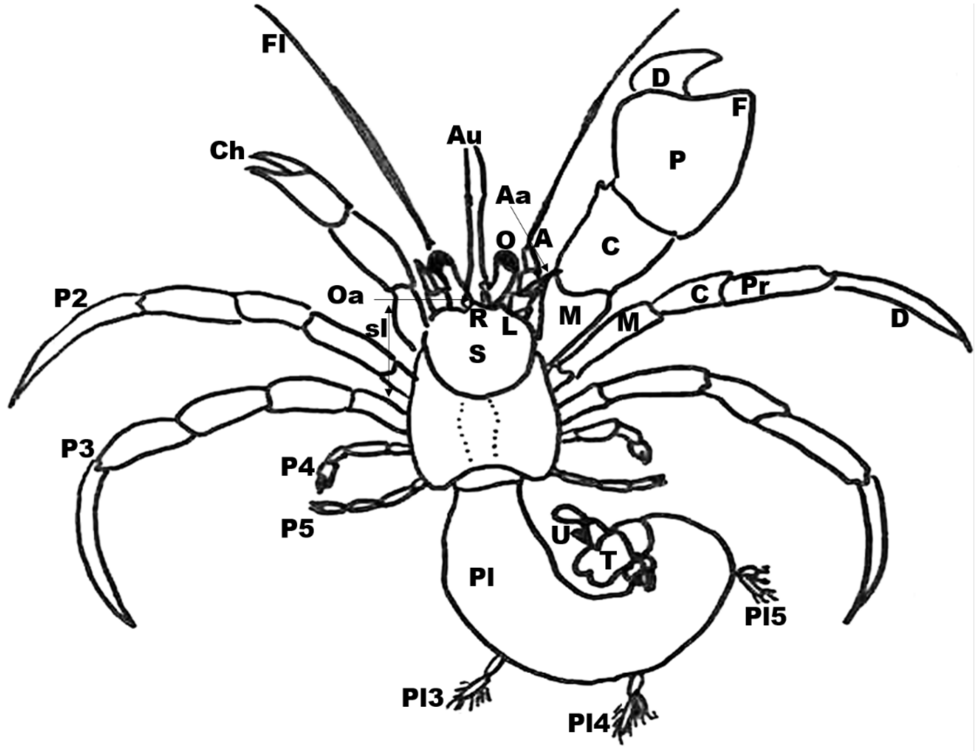

Figure 3. Dorsal margin of generalized Paguridae. Abbreviations: Aa = antennal acicle; A = antenna; Au = antennule; C = carpus; Ch = cheliped; D =dactyl; F = fixed finger; Fl = antennal flagellum; L = lateral projection; M = merus; Oa = ocular acicle; O = ocular peduncle; P2−5 = pereopods 2−5; Pl3−5 = pleopods 3−5; P = palm; Ple = Pleon; Pr = propodus; R = rostrum; S = shield; sl = shield length; T = telson; U = uropod. [modified from McLaughlin, 2007].

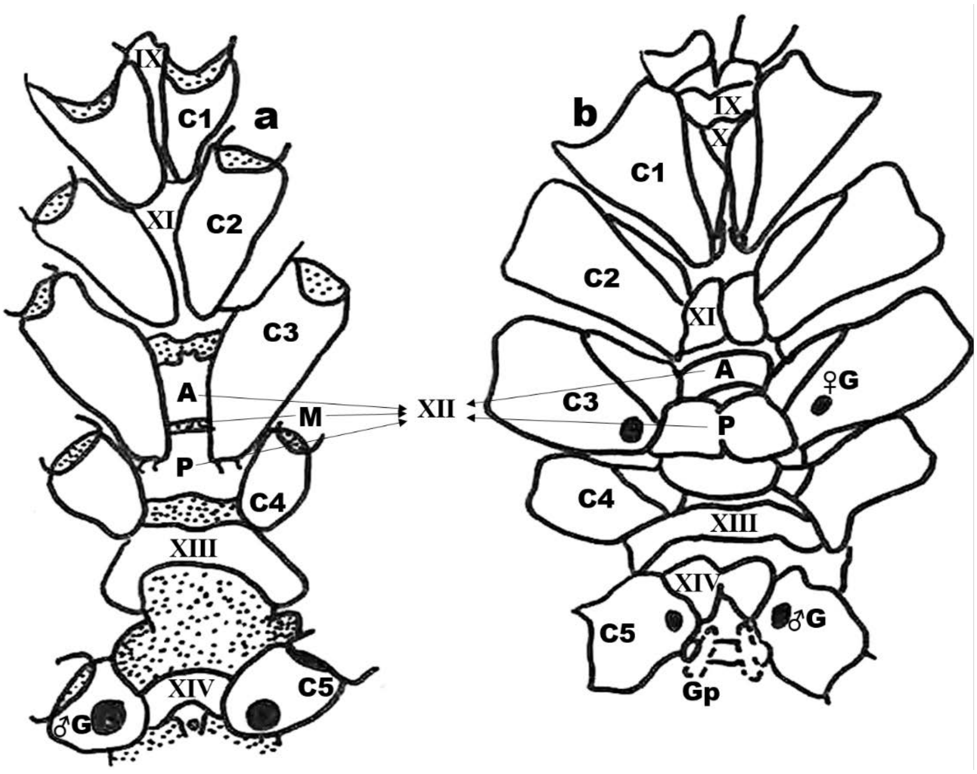

Figure 4. Thoracic sternites and coxae of pereopods: a, *Pylojacquesia colemani* McLaughlin & Lemaitre; b, generalized Paguridae. Abbreviations: Ap = anterior portion; C1–5 = coxae of pereopods 1–5; **Ⅸ–ⅩⅣ** = sternites **Ⅸ–ⅩⅣ**. G = gonopore; Gp = paird first gonopods; M = membranous hinge; P = posterior portion [modified from McLaughlin, 2003].

Keys to the Korean Paguroidea family (modified to McLaughlin, 2003)

1. Paired pleopods on abdominal somites 2–5; abdominal tergites 1–5 well calcified · Pylochelidae
– No paired pleopods on abdominal somites 4 and 5; abdominal tergites not well calcified · 2
2. Maxilliped 3 generally approximate basally; chelipeds subequal or left one largest · Diogenidae
– Maxilliped 3 generally widely separated basally; right chelipeds largest · Paguridae

Family Pylochelidae Spence Bate, 1888 뿔조개집게과

Species belonging to this family have symmetrical chelipeds and pleon appendages. The pleon is almost straight with well calcified plates. These features are regarded as ancestral characters among Paguroidea. Therefore, Pylochelidae is regarded as a primeval taxon (Bracken−Grissom et al., 2013). The typical house of pylochelids is straight shape such as tusk shells, pieces of wood, soft rocks, sponges, or corals. Pylochelidae is mostly found in deep water of Indo−West Pacific (Forest, 1987b). In Korea, there is only one species of Pylochelidae: *Pomatocheles jeffreysii* Miers, 1879.

Genus *Pomatocheles* Miers, 1879 뿔조개집게속

1. *Pomatocheles jeffreysii* Miers, 1879 뿔조개집게 (Plate 1)

Pomatocheles jeffreysii Miers, 1879: 49, pl. 3, fig. 2; Kim & Choe, 1976: 45, text-fig. 2; Forest, 1987a: 119, figs. 4a, 5c, d, 7c; Kim & Kim, 1997: 216; Hong et al., 2006b: 352; Kim & Son, 2006: 50; McLaughlin et al., 2007a: 33; 2010: 41.

Mixtopagums jeffreysii: Balss, 1913: 35-36, text-fig. 25, pl. 2, fig. 1; Yokoya, 1933: 71.

Matarial examined. 1 ♂, 1 ♀, Seogwipo, Korea, 7 Feb. 1971, Coll. Kim, H. S., EVOSYS 260801#001: 1 ♂, SEEZ st. R2, 1 Oct. 2007, Coll. Song, S. J., MADBK 160801_001: 1 ♀, Jeju, Korea, 8 Apr. 2014, Coll. Kim, M. H., NIBRIV0000423050.

Distribution. Japan, Taiwan, Jeju Island of Korea, 23-300 m.

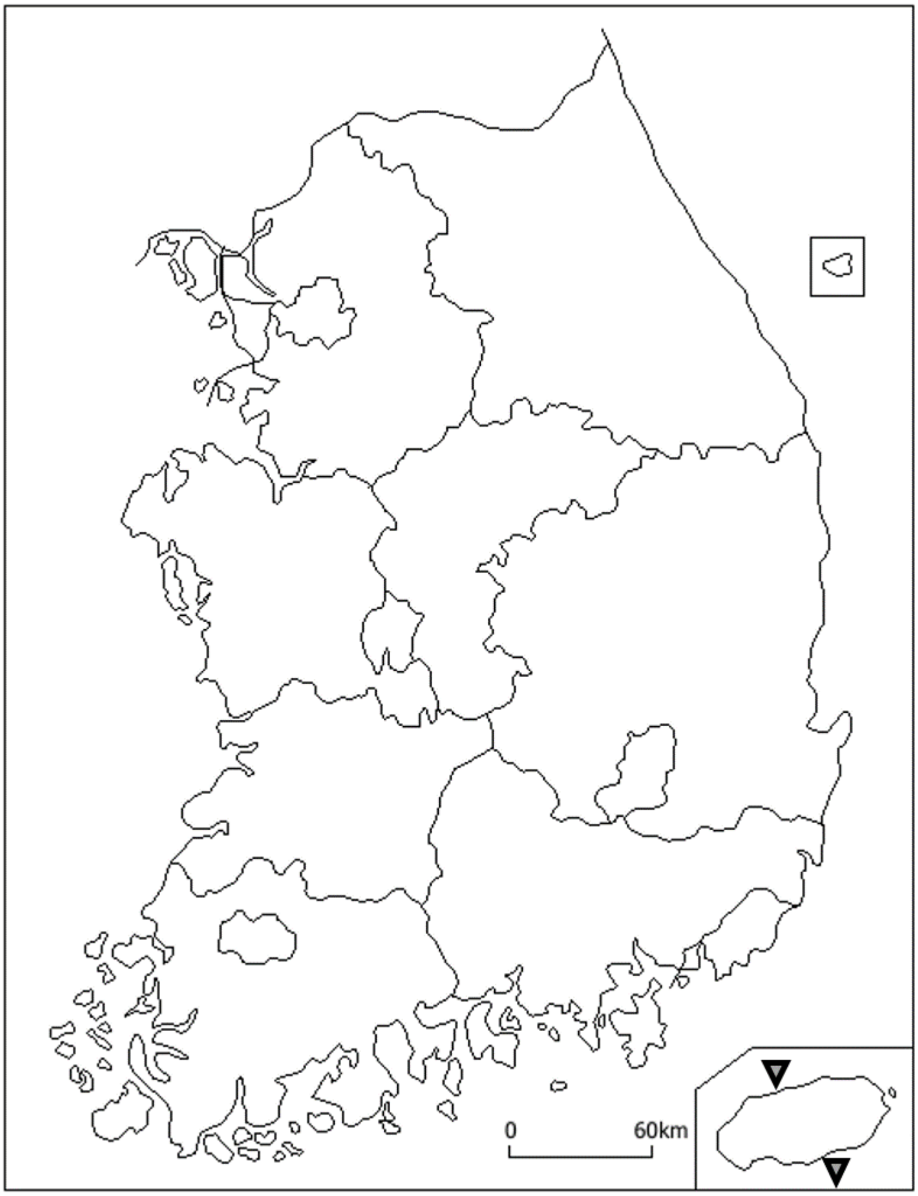

Figure 5. Distribution map of *Pomatocheles jeffreysii* Miers, 1879 in Korea.

Family Diogenidae Ortmann, 1892 넓적왼손집게과

The species belonging to this family generally have chelipeds that are subequal or left one larger, and asymmetrical pleon appendages. Diogenids are mostly found in the tropical area of Indo−Pacific (McLaughlin et al., 2010). All species of Diogenidae in Korea live in the gastropod shell. In Korean waters, 20 species and six genera are reported from 21 genera of Diogenidae.

Key to the Korean Diogenidae genera

1. With first pleopods · 2
− No first pleopods · 3
2. 12 pairs of gills · · · · · · · · · · · · · · · · · *Areopaguristes*
− 13 pairs of gills · *Paguristes*
3. Chelipeds subequal · 4
− Left chelipeds larger · 5
4. Pereopods with numerous striae with setae · · · · *Ciliopagurus*
− Pereopods lack striae · · · · · · · · · · · · · · · · · *Clibanarius*
5. 13 pairs of gills · *Diogenes*
− 14 pairs of gills · *Dardanus*

Genus *Areopaguristes* Rahayu and McLaughlin, 2010 꼬마긴눈집게과

Key to the Korean *Areopaguristes* species

Mesial margin of dactyl of chelae with numerous scattered blunt spinules · *A. nigroapiculus*

– Mesial margin of dactyl of chelae with row of spines *A. japonicus*

2. *Areopaguristes nigroapiculus* (Komai, 2009) 꼬마긴눈집게

(Plate 2)

Paguristes japonicus: Kim, 1964: 4, 8; 1970: 12; 1973: 212, 597, fig. 43, pl. 68, fig. 24; 1985: 28; Miyake, 1978: 44 (part); Kim & Kim, 1997: 215; Hong et al., 2006b: 356; Kim & Son, 2006: 60.

Paguristes puniceus: Miyake, 1978: 38 (part), text-fig. 13.

Paguristes ortmanni: Petryashov & Kornienko, 2006: 120, fig. 2.

Stratiotes nigroapiculus Komai, 2009: 68, figs. 5-8.

Areopaguristes nigroapiculus: McLaughlin et al., 2010: 18, fig. 11F; Arima, 2014: 102.

Matarial examined. 3 inds., Uljin, Korea, 37° 3'6.20"N 129° 27'14.40"E, Scuba 15m, 17 Aug. 2011, Coll. Lee, S. K., MADBK 160510_002: 2 inds., Yangyang, Korea, 37° 58'9.26"N

128° 45'34.02"E, Scuba, 25 June 2014, Coll. Jung, J., MADBK 160529_004: 1 ind., same as MADBK 160529_004, 160529_006, NIBRIV0000320801: 2 inds., Busan, Korea, 35° 8'16.83"N 129° 9'37.01"E, fishing trap, 24 Mar. 2015, Coll. Jung, J., MADBK 160529_005: 1 ind., Busan, Korea, fishing trap, 35° 8'16.83"N 129° 9'37.01"E, 12 Nov. 2010, MADBK 160529_007: 14 inds., Busan, Korea, fishing trap, 35° 8'16.83"N 129° 9'37.01"E, 30 Jan. 2016, Coll. Jung, J., MADBK 160529_008: 2 inds., Busan, Korea, 35° 8'16.83"N 129° 9'37.01"E, fishing trap, 31 Jan. 2016, Coll. Jung, J., MADBK 160529_009: 3 inds., same as MADBK 160529_009, MADBK 160529_010: 8 inds., same as MADBK 160529_009, MADBK 160529_011: 2 inds., same as MADBK 160529_009, MADBK 160529_012: 3 inds., Seogwipo, Korea, 13 Oct. 1963, Coll. Kim, H. S., EVOSYS 260510#001: 1 ♀, Pohang, Korea, fishing net, 7 Sep. 2001, EVOSYS 260510#008.

Diagnosis. Shield slightly longer than broad; rostrum triangular, overreaching lateral projections; lateral projections roundly triangular; dorsolateral surface with scattered spinules and tufts of setae.

Ocular peduncles slender, slightly inflated basally; corneas not dilated; ocular acicles multifid, slightly elongate, with long setae. Antennular peduncles overreaching distal corneal margins. Antennal flagellum stout, longer than shield, with long setae.

Pereopods generally with numerous sharp, black tips spines and tuft of setae.

Chelipeds subequal. Chelae 2 times longer than broad. Dactyl 2 times longer than palm; mesial surface with row of spines. Palms shorter than carpi, ventral surfaces convex; cutting edges each with row of blunt calcareous teeth, terminating in strong corneous teeth. Carpi slightly shorter than meri.

Second and third pereopods stout. Dactyl slightly longer than propodi, somewhat curved. Propodi longer than carpi. Carpi slightly shorter than meri. Meri with short transverse ridges on dorsal margins; lateral surfaces smooth. Armature of third pereopods weaker than second pereopod.

Abdomen twisted, uropod asymmetry.

Telson with posterior lobes asymmetrical, left lobe larger, separated by narrow median cleft; each terminal margins with curved spines, extending lateral margin on either side.

Color. Carapace light brown in general. Ocular peduncle and antennule purplish brown. Antenna yellowish brown. Pereopods reddish brown in general. Tips of spines on pereopods black.

Distribution. Northwestern to eastern mainland Japan, southeastern Russia, eastern to southern Korea, low intertidal to 140 m.

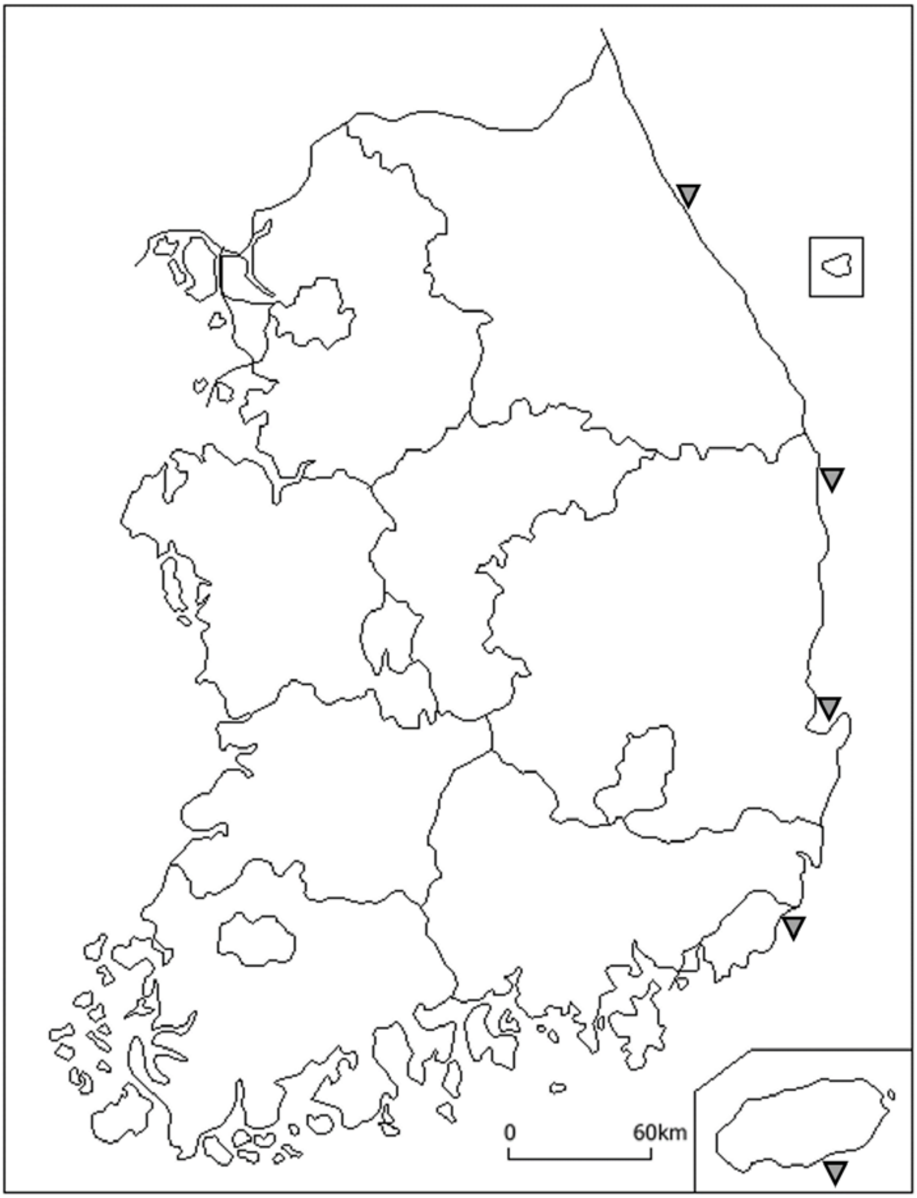

Figure 6. Distribution map of *Areopaguristes nigroapiculus* (Komai, 2009) in Korea.

Remark. Komai (2009) has suggested that *Stratiotes japonicus* (genus is moved to *Areopaguristes* Rahayu and McLaughlin, 2010) previously reported in Korea by Kim (1964; 1970; 1973) is regarded as *S. nigroapiculus* (*Areopaguristes nigroapiculus*). The reference specimen of Kim (1964) (EVOSYS 260510#001) agreed with original description of *A. nigroapiculus*. Therefore, the Korean name of *A. japonicus*, 꼬마긴눈집게, should be moved to *A. nigroapiculus* according to principle of priority.

On the abdomen of Korean specimen of *A. nigroapiculus* (EVOSYS 260510#008), a specimen of parasitic barnacle was found. Its approximate morphological characteristics are similar to those of peltogastrid species. However, further study of this specimen is needed because of its unusual host (R. Yoshida, pers. observation).

3. *Areopaguristes japonicus* (Miyake, 1961) 작은꼬마긴눈집게

(Plate 3)

Paguristes sp.: Miyake, 1961a: 169.

Paguristes japonicus Miyake, 1961b: 243 (part), figs. 5, 6; 1978: 44 (part), text-fig. 16, pl. 3, fig. 6.

Stratiotes japonicus: Komai, 2009: 61, figs. 1-4.

Areopaguristes japonicus: McLaughlin et al., 2010: 18, fig. 11E; Arima, 2014: 101; Kim & Kim, 2014: 9, fig. 2.

Matarial examined. 3 inds., Tongyeong, Korea, 1 Sep. 2007, MADBK 160510_004: 1 ind., Ulleung, Korea, 37° 27'24.23"N 130° 51'33.25"E, Scuba, 14 Nov. 2013, Coll. Jung, J., MADBK 160510_011: 1 ind., Gyeongju, Korea, 35° 48'17.25"N 129° 30'13.41"E, 25 Jan. 2015, Coll. Jung, J., MADBK 160510_019: 2 inds., Wando, Korea, 34° 11'35.67"N 126° 54'53.48"E, 7 July 2014, Coll. Park, J. H., MADBK 160510_023: 1 ind., Busan, Korea, 35° 12'5.10"N 129° 13'52.59"E, 23 Mar. 2015, Coll. Jung, J., MADBK 160510_020: 2 inds., Busan, Korea, 35° 12'5.10"N 129° 13'52.59"E, 8 Oct. 2015, Coll. Jung, J., MADBK 160510_024: 1 ind., Tongyeong, Korea, 3 Aug. 2011, Coll. Jung, J., NIBRIV0000540416, NIBRIV0000540417: 1 ind., Yeosu, Korea, 23 Apr. 2013, NIBRIV0000297867–NIBRIV0000297868: 1 ind., Uljin, Korea, 4 June 2013, Coll. Kim, M. H., NIBRIV0000307541.

Distribution. Northwestern to eastern mainland Japan, eastern to southern Korea, low intertidal to 25 m.

Remark. A couple of parasitic isopod is found in the Korean specimen of *Areopaguristes japonicus* (MADBK 160510_011). Its approximate morphological characteristics are similar to those of *Athelges takanoshimensis* Ishii, 1914. However, this relationship has not been reported yet.

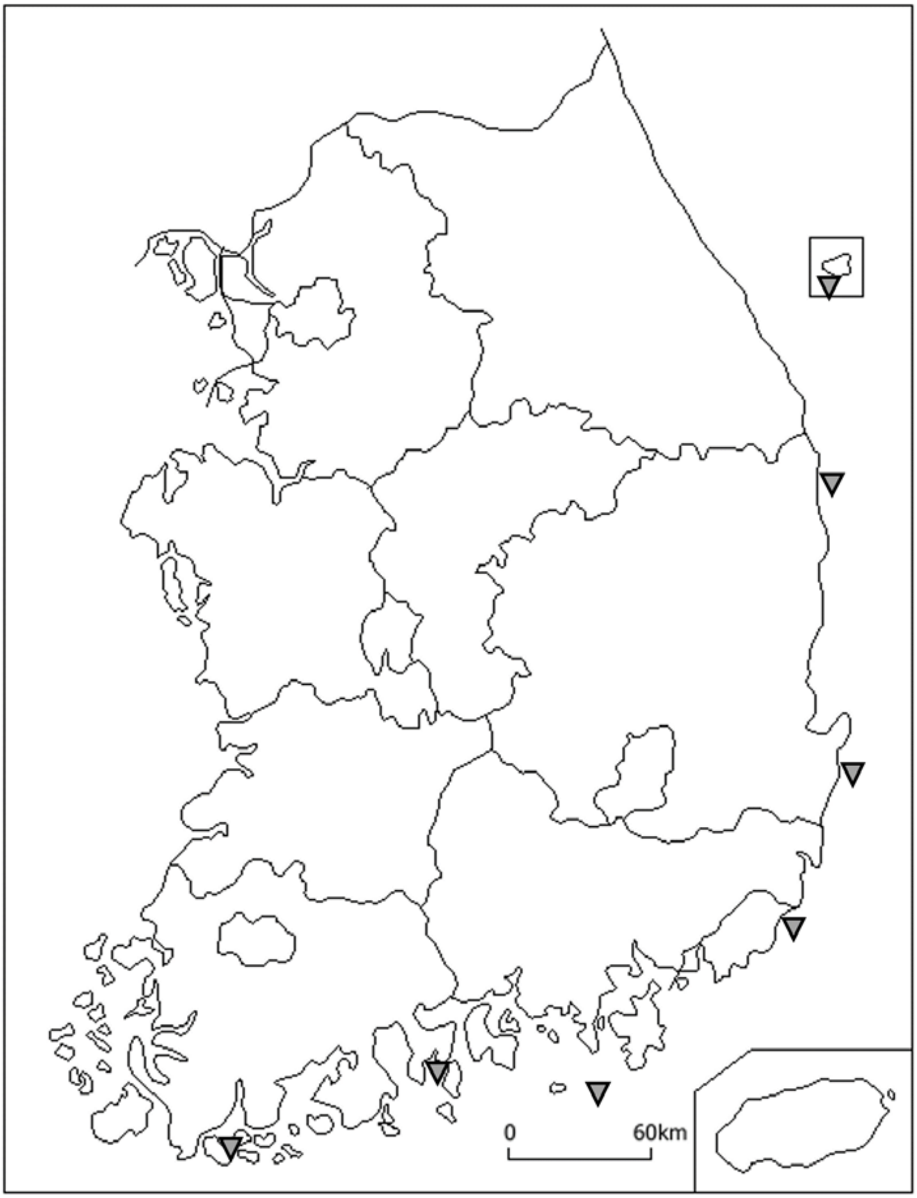

Figure 7. Distribution map of *Areopaguristes japonicus* (Miyake, 1961) in Korea.

Genus *Paguristes* Dana, 1851 긴눈집게속

Key to the Korean *Paguristes* species

1. Telson unarmed · 2
– Telson with spines · 4
2. Chelipeds with small spines · · · · · · · · · · · · *P. seminudus*
– Chelipeds with strong spines · · · · · · · · · · · · · · · · · · 3
3. Ventromesial margin of merus of chelae with a large spine · · · *P. acanthomerus*
– Ventromesial margin of merus of chelae with small spines · · · · *P. versus*
4. Mesial surface of fixed finger of chelae with 5–7 rows of spines *P. digitalis*
– Mesial surface of fixed finger of chelae with scattered tubercles · *P. ortmanni*

4. *Paguristes seminudus* Stimpson, 1858 발가숭이긴눈집게 (Plate 4)

Paguristes seminudus Stimpson, 1858: 85; 1907: 213; Kim & Choe, 1976: 46, text-fig. 3; Miyake, 1978: 25; Kim & Kim, 1997: 215; McLaughlin et al., 2007a: 47.; 2010: 23; Huang & Lin, 2012: 84

Matarial examined. 1 ♂, Seogwipo, Korea, 12 Dec. 1969, Coll. Kim, H. S., EVOSYS 260512#001.

Diagnosis. Shield longer than broad; rostrum elongate triangular, overreaching lateral projections. Lateral projections roundly triangular.

Ocular peduncles long and slender; corneas not dilated; ocular acicles subtriangular, with elongate sharp spine. Antennular peduncles slightly shorter than ocular peduncles. Antennal peduncles shorter than ocular peduncles.

Chelipeds genenally with numerous small spines and short setae, left one larger.

Second and third pereopods long and slender. Dactyl of second pereopods longer than propodi, weakly curved; dorsal margins with row of spinules; mesial faces with longitudinal sulcus and small spines proximally; ventral margins with 34–45 spinules. Propodi longer than carpi; dorsal margins with row of spines; ventral margins with row of spinules; lateral surfaces with rows of small spines; mesial faces with 2 rows of small spines. Dorsal margins of carpi with irregular rows of spines. Ventral margins of meri with row of spinules.

Third pereopods generally similar to second pereopods. Mesial faces of propodi with row of small spines, dorsal, ventral margins and lateral surfaces unarmed in left, dorsal margin with row of small spines in right. Carpi with row of small spines on dorsal surface. Vertral margins of meri almost unarmed.

Abdomen twisted, uropod asymmetry.

Telson with posterior lobes asymmetrical, left lobe larger, separated by median cleft; each terminal margins with numerous long setae.

Distribution. Pacific coast of mainland Japan, East China Sea, northeast of Taiwan, Jeju Island of Korea, 50−280m.

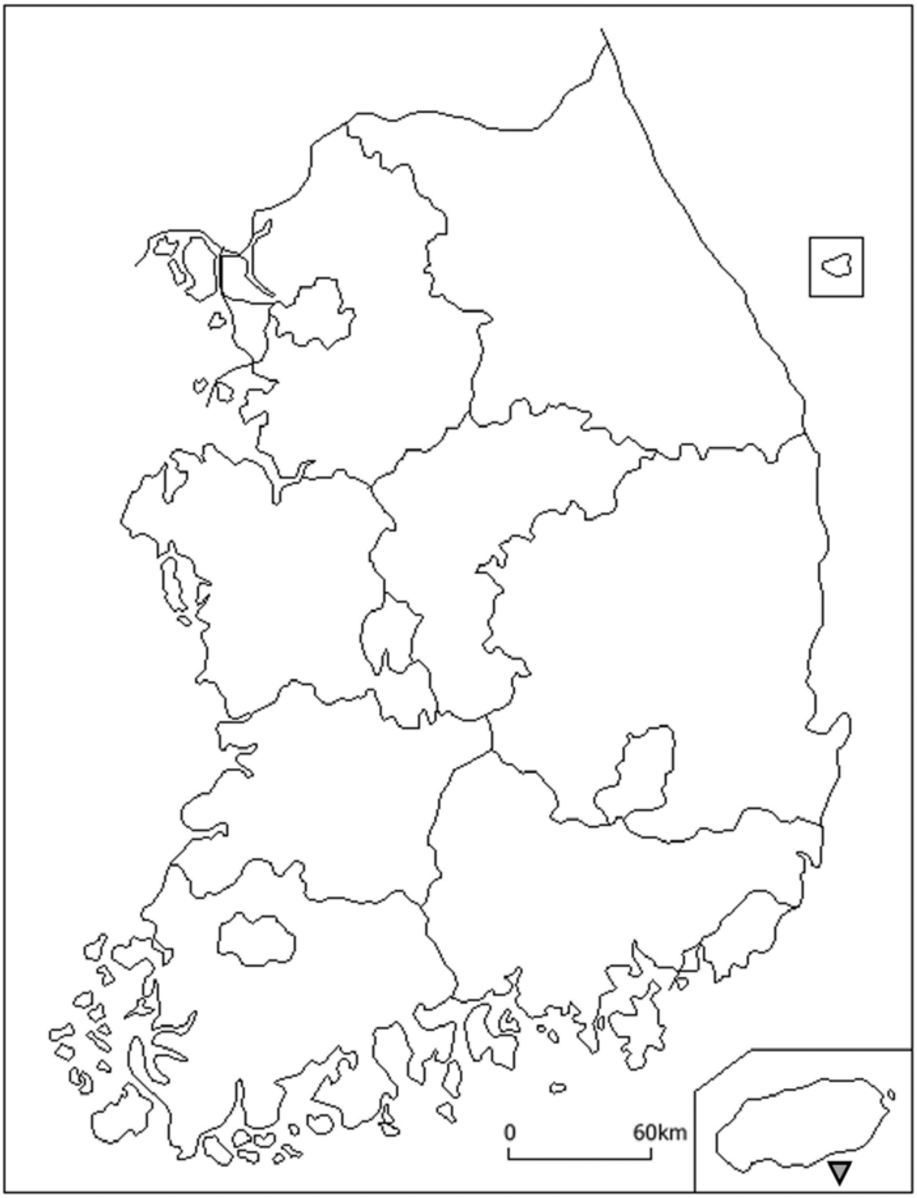

Figure 8. Distribution map of *Paguristes seminudus* Stimpson, 1858 in Korea.

5. *Paguristes acanthomerus* Ortmann, 1892 가시긴마디긴눈집게

(Plate 5)

Paguristes acanthomerus Ortmann, 1892: 279, pl. 12, fig. 6; Doflein, 1902: 645; Alcock, 1905: 155; Balss, 1913: 39; Terao, 1913: 373; Yokoya, 1933: 74; Miyake, 1978: 32, fig. 11; Kim, 1985: 71, fig. 2B; Kim & Kim, 1997: 215; Kim & Son, 2006: 62; McLaughlin et al., 2007a: 40; 2010: 22; Huang & Lin, 2012: 84; Arima, 2014: 94.

Paguristes kagoshimensis: Miyake, 1978: 32 (part).

Matarial examined. 2 ♀♀, Seogwipo, Korea, fishing net, 6 Feb. 1971, MADBK 160509_001: 1 ind., Seogwipo, Korea, EWUNHM DP 20151202038.

Diagnosis. Shield longer than broad; dorsolateral surface with spinules and tufts of setae, posterior margin with protuberances. Rostrum elongate triangular, overreaching lateral projections. Lateral projections triangular.

Ocular peduncles long and slender, inflated basally, corneas not dilated. Ocular acicles subtriangular, with elongate sharp spine. Antennular and antennal peduncles shorter than ocular peduncles.

Chelipeds short, subequal, genenally with numerous spines and tuft of setae. Chelae 1.7 times longer than broad. Dactyl 1.6 times longer than palm. Palm shorter than carpi. Carpi shorter than meri. Ventromesial margin of meri with large spine.

Second and third pereopods long and slender, with tuft of setae. Dactyl of second pereopods longer than propodi, weakly curved; dorsal margins with 1−2 spines; ventral margins with 22−26 spinules. Propodi longer than carpi; dorsal margins with row of spines; ventral margins with row of small spines. Dorsal margins of carpi with single or double rows of spines. Dorsal margins of meri with 3−4 small spine, ventral margins with double row of spinules.

Third pereopods generally similar to second pereopods. Dorsal and ventral margins of propodi with protuberant. Carpi with row of small spines on dorsal surface. Dorsal and vertral margins of meri almost unarmed.

Abdomen twisted, uropod asymmetry.

Telson with posterior lobes asymmetrical, left lobe larger, separated by median cleft; each terminal margins with numerous long setae.

Distribution. Pacific coast of mainland Japan, East China Sea, northeast of Taiwan, Jeju Island of Korea, 50−250m.

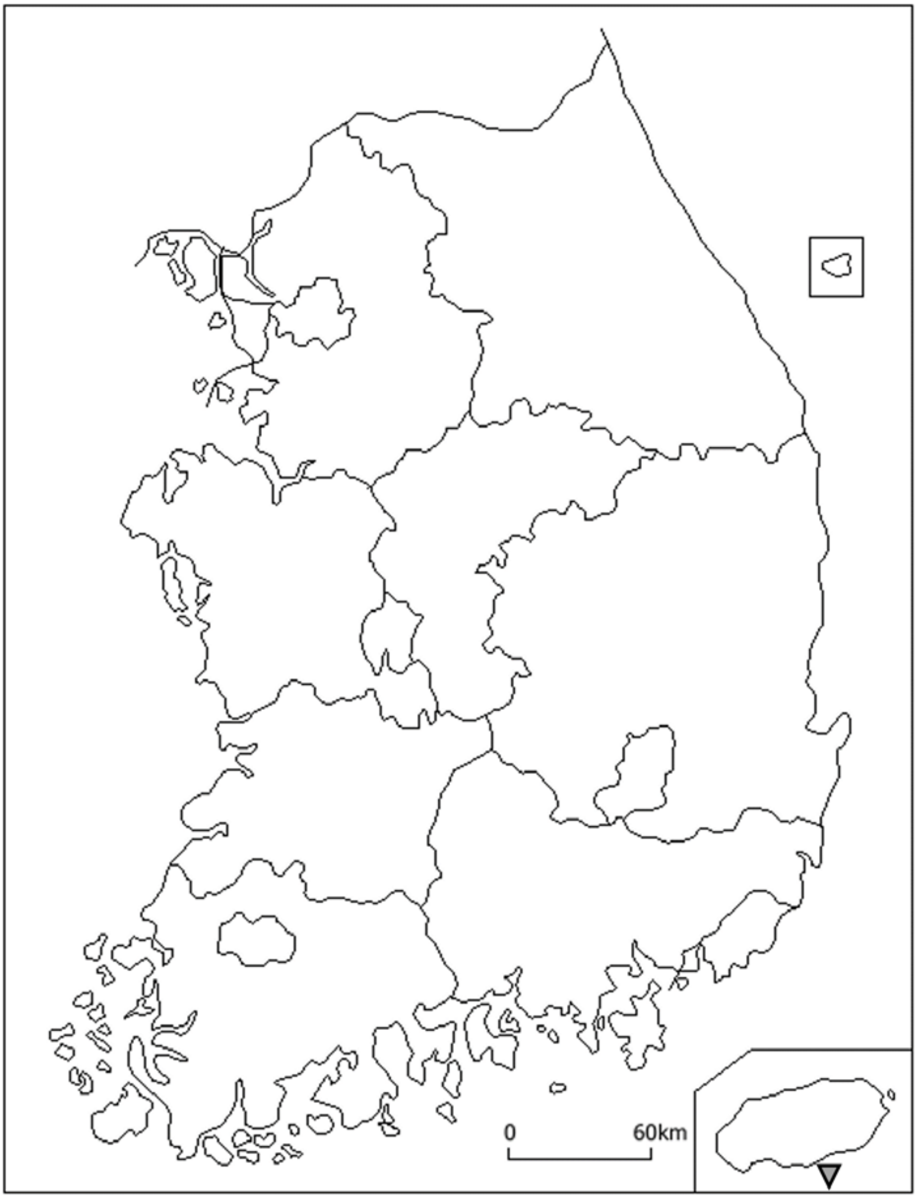

Figure 9. Distribution map of *Paguristes acanthomerus* Ortmann, 1892 in Korea.

6. *Paguristes versus* Komai, 2001 민무늬긴눈집게 (Plate 6)

Paguristes kagoshimensis: Kim, 1963: 308; 1964: 8; 1970: 12; 1973: 214, 597, fig. 44, pl. 69, fig. 25; Miyake, 1978: 35, fig. 12; Kim & Kim, 1997: 215.

Paguristes versus Komai, 2001: 406, figs. 23–27; Kim & Son, 2006: 63; McLaughlin et al., 2007a: 54; 2010: 23, fig. 10H; Huang & Lin, 2012: 85; Kim & Kim, 2014: 24, fig. 9, pl. 7.

Matarial examined. 4 inds., Kochi; Japan, 33° 26'19.69"N 133° 27'34.03"E, MADBK 160511_001: 2 ♂♂, eastern Jeju Island of Korea, 28 Mar. 2013, Coll. Kim, M. H., NFRDI H 234.

Distribution. Eastern mainland Japan, Jeju Island of Korea, Taiwan, 110m.

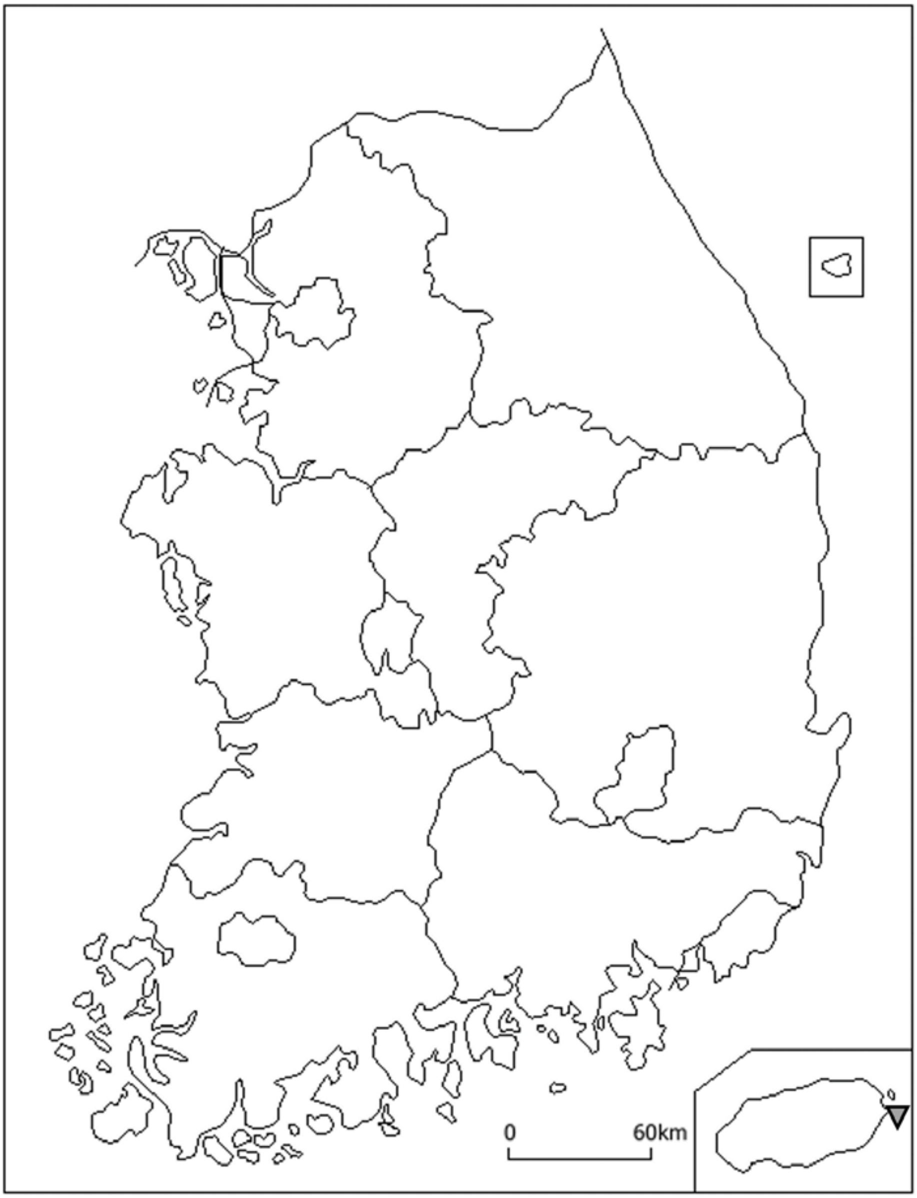

Figure 10. Distribution map of *Paguristes versus* Komai, 2001 in Korea.

7. *Paguristes digitalis* Stimpson, 1858 갈색털보긴눈집게 (Plate 7)

Paguristes digitalis Stimpson, 1858: 247; Alcock, 1905: 155; Balss, 1913: 37, figs. 26, 27; Terao, 1913: 374; Yokoya, 1933: 73; Makarov, 1962: 156, fig. 66; Yokoya, 1939: 280; Kamita, 1955: 30, fig. 10; Miyake, 1978: 29, fig. 9; Komai, 2001: 396, figs. 19–22; Hong et al., 2006b: 355; Kim & Son, 2006: 59; McLaughlin et al., 2010: 22, fig. 9H; Arima, 2014: 94; Kim & Kim, 2014: 20, fig. 7, pl. 5.

Paguristes kagoshimensis Ortmann, 1892: 281, pl. 12, fig. 8; Alcock, 1905: 155.

Paguristes barbatus: Doflein, 1902: 645 (part).

Matarial examined. 3 inds., Busan, Korea, 35° 12'5.10"N 129° 13'52.59"E, fishing trap, 23 Apr. 2011, Coll. Jung, J., MADBK 160514_001: 2 inds., Yeosu, Korea, 34° 06'09.38"N 127° 28'82.55"E, Scuba, 3 July 2014, Coll. Park. J. H., MADBK 160514_002: 2 inds., Busan, Korea, 35° 12'5.10"N 129° 13'52.59"E, fishing trap, 8 Oct. 2015, Coll. Jung, J., MADBK 160514_003.

Distribution. Southern Hokkaido to Kyushu of Japan, southern Korea, subtidal to 220m.

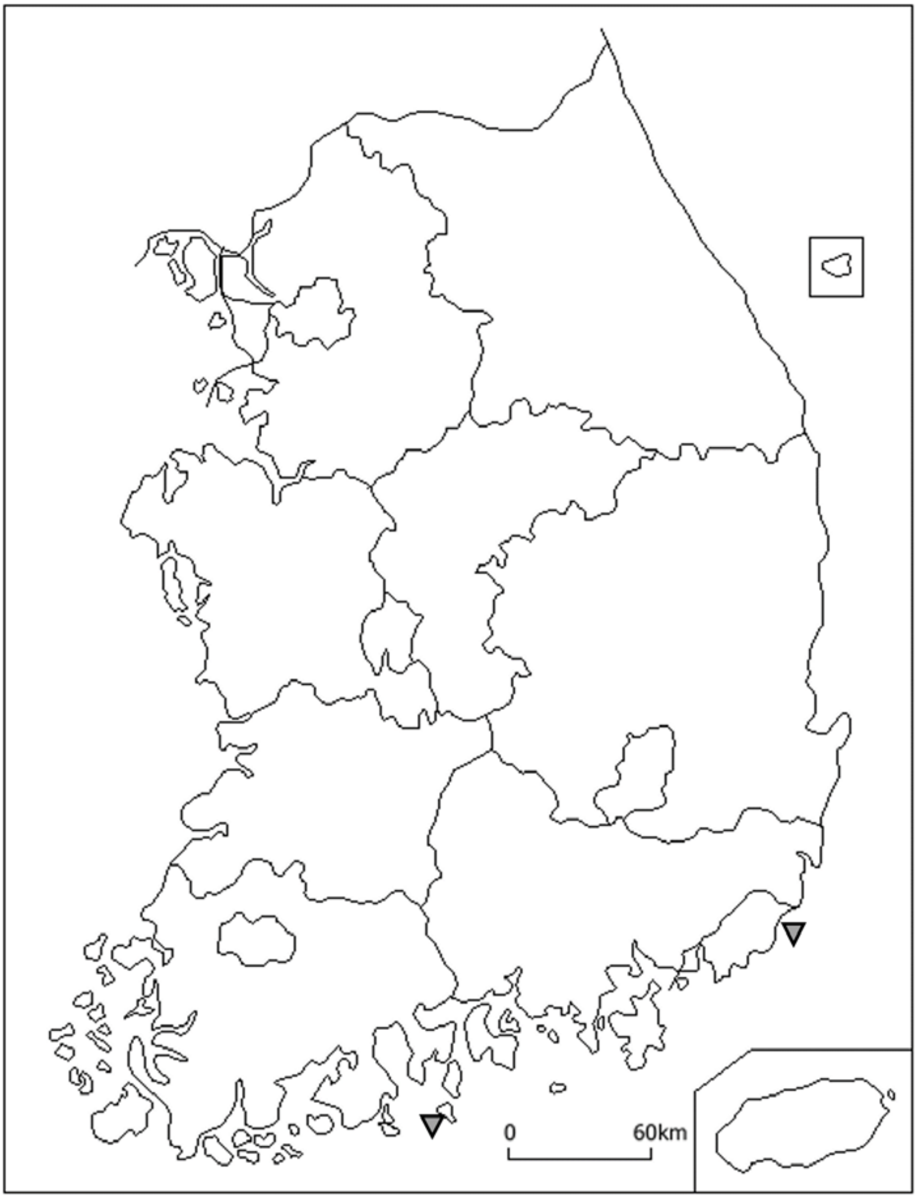

Figure 11. Distribution map of *Paguristes digitalis* Stimpson, 1858 in Korea.

Remark. Two individuals of *Paguristes digitalis* (MADBK 160514_002) were found living in the straight tusk shell. There is no report of this species living in this kind of carcinoecia. However, their pleon is coiled. And each side of uropod and telson has asymmetry. These two morphological characters are not typical characters of hermit crab living in straight shell but those that live in spiral shell.

8. *Paguristes ortmanni* Miyake, 1978 털보긴눈집게 (Plate 8)

Paguristes barbatus: Ortmann, 1892: 279, pl. 12, fig. 7, 7p; Doflein, 1902: 645 (part); Balss, 1913: 39; Yokoya, 1939: 278, figs. 10A, B; Kim, 1963: 297, fig. 14; 1964: 8; 1970: 12; 1973: 210, 597, fig. 42, pl. 5, fig. 23; Huang & Lin, 2012: 86.

Paguristes digitalis: Igarashi, 1970: pl. 2, fig. 4.

Paguristes japonicus: Miyake, 1978: 44 (part); Oh, 1983: 101; Kim & Son, 2006: 60, unnumbered figure.

Paguristes ortmanni Miyake, 1978: 46, fig. 17, pl. 2, fig. 1; Asakura, 1995: 355, pl. 94, fig. 4; Kim & Kim, 1997: 215; Hong et al., 2006b: 356; Kim & Son, 2006: 61; McLaughlin et al., 2010: 22; Arima, 2014: 93; Kim & Kim, 2014: 22, fig. 8, pl. 6.

Matarial examined. 27 inds., Ulsan, Korea, 35° 34'53.76"N 129° 35'3.59"E, 10 Apr. 2009, Coll. Shin, M. K., MADBK 160513_001: 8 ♀♀, Jeju, Korea, 33° 20'52.59"N 126° 10'36.37"E, Scuba, 10 Mar. 2010, Coll. Lee, S. K., MADBK 160513_005: 1 ♀, 8 ♂♂, Uljin, Korea, 37° 0'18.03"N 129° 25'40.81"E, 2 July 2009, Coll. Hong, J., MADBK 160513_010: 6 inds., Goseong, Korea, 38° 21'33.15"N 128° 33'57.72"E, Scuba, 22 June 2010, Coll. Lee, S. K., MADBK 160513_023: 4 ind., Yeonggwang, Korea, 35° 13'49.69"N 126° 8'31.32"E, Scuba, 22 June 2010, Coll. Kang, S., MADBK 160513_027: 6 ind., Pohang, Korea, 36° 0'40.98"N 129° 37'29.55"E, hand, 17 Sep. 2011, Coll. Jung, J., MADBK 160513_050: 117 inds., Busan, Korea, 35° 12'5.10"N 129° 13'52.59"E, fishing trap, 18 Nov. 2012, Coll. Kim, H., MADBK 160513_051: 3 ♂♂, Seogwipo, Korea, 33° 13'31.07"N 126° 33'57.39"E, Scuba, 15 July 2011, Coll. Park, J. H., MADBK 160513_052: 2 inds., Tongyeong, Korea, 34° 40'8.99"N 128° 15'25.80"E, Scuba, 1 Sep. 2011, Coll. Lue, W., MADBK 160513_053: 8 inds., Yangyang, Korea, 37° 55'49.00"N 128° 47'25.00"E, Scuba, 15 Aug. 2013, Coll., Park, J. H., MADBK 160513_058: 8 inds., Ulleung, Korea, 37° 27'34.59"N 130° 51'22.89"E, Scuba, 16 Nov. 2013, Coll. Park, J. H., MADBK 160513_065: 2 inds., Gyeongju, Korea, 35° 48'17.25"N 129° 30'13.41"E, hand, 25 Jan. 2015, Coll. Jung, J., MADBK 160513_070: 5 inds., Sokcho, Korea, 38° 12'51.11"N 128° 36'3.13"E, hand, 8 May 2015, Coll. Jung, J., MADBK 160513_074: 8 inds., Changwon, Korea, 12 July 2012, Coll. Jung, J., MADBK 160513_077: 1 ind., Taean, Korea, 8 June 2010, Coll. Ko, H. S., NIBRIV0000234168, NIBRIV0000234169, NIBRIV0000234219.

Distribution. Mainland Japan, China, Korea, intertidal to 210m.

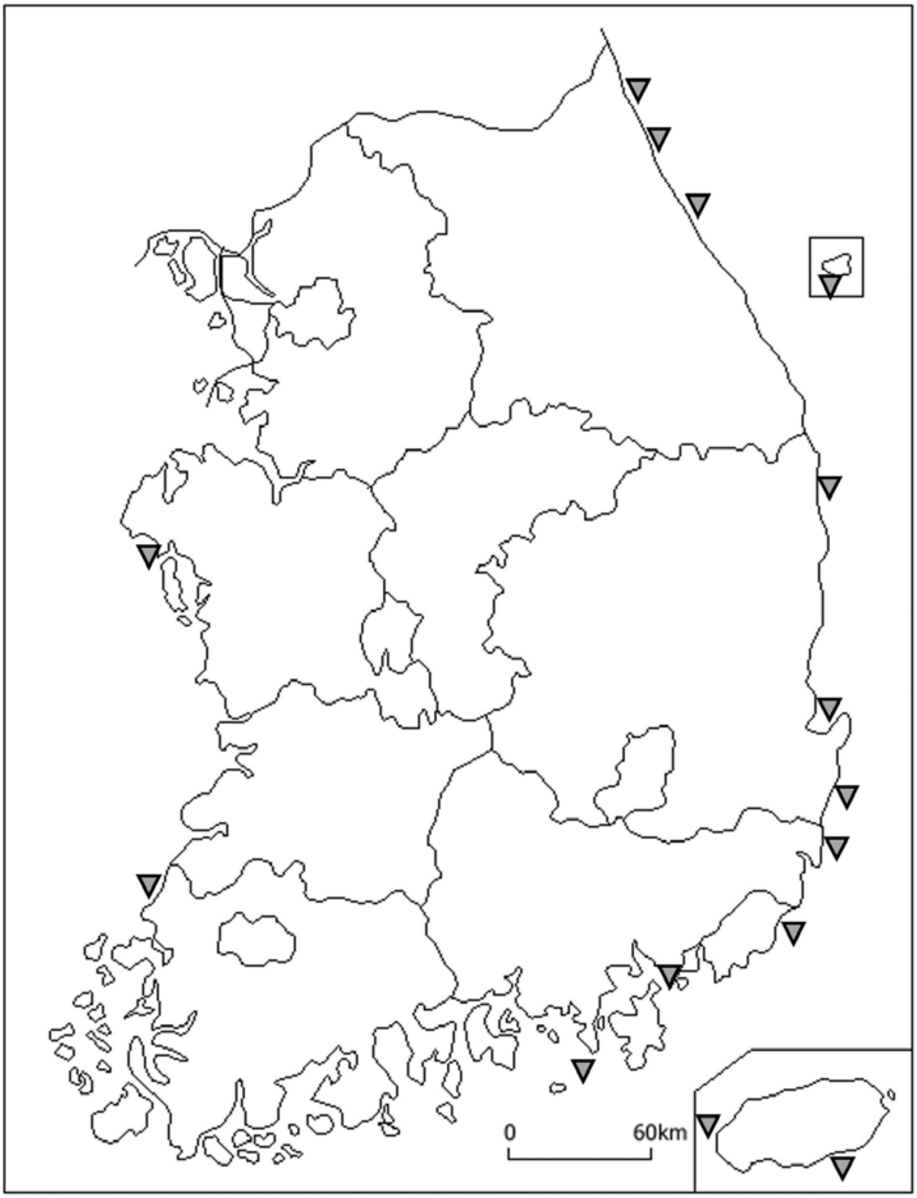

Figure 12. Distribution map of *Paguristes ortmanni* Miyake, 1978 in Korea.

Remark. On the abdomen of an individual of *Paguristes ortmanni* (MADBK 160513_050), parasitic barnacle was found. Its approximate morphological characteristics and COI sequence are similar to those of *Peltogaster* sp. recently reported by Yoshida et al. (2014).

Genus *Ciliopagurus* Forest, 1995 고리무늬집게속

Key to the Korean *Ciliopagurus* species

Dorsal surfaces of palms of chelipeds with 3 continuous transverse striae · *C. strigatus*
− Dorsal surfaces of palms of chelipeds with 4 continuous transverse striae · *C. krempfi*

9. *Ciliopagurus strigatus* (Herbst, 1804) 분홍고리무늬집게 (Plate 9)

Cancer strigatus Herbst, 1804: 25, pl. 61, fig. 3.

Pagurus strigatus: Olivier, 1811: 647.

Pagurus annulipes: H. Milne Edwards, 1848: 63.

Pagurus (s.s.) *strigatus*: Hilgendorf, 1879: 820 (part).

Aniculus strigatu: Alcock, 1905: 96 (part).

Trizopagurus strigatus: Forest, 1952: 256; Miyake, 1978: 18 (part); Asakura, 1995: 352: pl. 93, fig. 3.

Ciliopagurus strigatus: Forest, 1995: 49, figs. 8a, 9, 10a, 12a, 31a–b, 37c; McLaughlin et al., 2007a: 70; 2010: 19; Poupin & Malay, 2009: 213, figs. 1A, 2, 3A, 4A; Huang & Lin, 2012: 86; Arima, 2014: 51.

? *Trizopagurus strigatus*: Kim, 1985: 70, fig. 2A.

Not *Ciliopagurus strigatus*: Forest, 1995: 50 (part, specimens from the Marquesas) = *C. vakovako* Poupin, 2001.

Matarial examined. 2 inds., Okinawa; Japan, 21 Sep. 2015, Coll. Jung, J., MADBK 160515.

Diagnosis. Shield as long as broad. Rostrum rounded. Lateral projections obsolete.

Ocular peduncles almost as long as half length of shield; corneas slightly dilated; ocular acicles multifid. Antennular peduncles shorter than ocular peduncles. Antennal peduncles 0.6–0.7 times as long as ocular peduncles.

Pereopods with numerous striae with setae. Chelipeds slightly subequal; palms with 3 continuous striae. Ambulatory legs with dactyl almost as long as propodi; ventral margins of dactyl and propodi with tufts of setae.

Abdomen twisted and slightly squashed, uropod asymmetry.

Telson with posterior lobes round, asymmetrical, left lobe slightly larger, separated by narrow median cleft; each terminal margins with small spinules.

Color. Shield white. Ocular peduncles, ocular acicles, antennular and antennal peduncles red-orange. Pereopods red base with yellow striae.

Habitat. Living in the gastropod shells with narrow shell mouth.

Distribution. Indo-West Pacific from Red Sea to northern and eastern Australia, Japan, French Polynesia to Hawaii, ? Jeju Island of Korea, subtidal to 25m.

Remark. *Ciliopagurus strigatus* was first reported in the Korea by Kim (1985). However, his description and figure were not enough to identify it accurately. It is doubtful that the specimen of Kim (1985) really represents *C. krempfi*. And the reference specimen is also lost. However, *C. krempfi* has been found in Okinawa Island (Japan) and Taiwan, which is close to Jeju Island. In addition, *Ciliopagurus krempfi*, a sister species of *C. strigatus*, has been found in Jeju Island. Therefore, there is possibility that *C. strigatus* is present in Korean waters.

10. *Ciliopagurus krempfi* (Forest, 1952) 흰발가락고리무늬집게 (Plate 10)

Aniculus strigatus: Alcock, 1905: 97, pl. 7, fig. 4.

Trizopagurus strigatus: Miyake, 1978: 18, pl. 3, fig. 5.

Trizopagurus krempfi Forest, 1952: 256; Oh, 1993: 88, fig. 1.

Ciliopagurus krempfi: Forest, 1995: 59, figs. 10c, 12c, 31d, 37g, h; McLaughlin et al., 2007a: 72; 2010: 19, fig. 6B; Huang & Lin, 2012: 86.

Matarial examined. 1 ♂, Seogwipo, Korea, Scuba, 1 July 1993, EVOSYS 121: 1 ind., Seogwipo, Korea, 6 Feb. 1971, EWUNHM DP 20151210003, 20151210004.

Diagnosis. Shield longer than broad. Rostrum rounded. Lateral projections obsolete.

Ocular peduncles almost as long as half length of shield; corneas slightly dilated, ocular acicles bifid. Antennular peduncles almost as long as ocular peduncles. Antennal peduncles as long as half of ocular peduncles.

Pereopods with numerous striae with setae. Chelipeds subequal; palms with 4 continuous striae. Ambulatory legs with dactyl almost as long as propodi; ventral margins of dactyl and propodi with tufts of setae.

Abdomen twisted and slightly squashed, uropod asymmetry.

Telson with posterior lobes round and short, subequal, separated by narrow median cleft.

Color. Shield whitish orange. Ocular peduncles, ocular acicles, antennular and antennal peduncles orange. Pereopods generally red base with white striae; dactyls of ambulatory legs orange.

Habitat. Living in the gastropod shells with narrow shell mouth.

Distribution. East Indian Ocean from Kenya to Arabian Sea, Australia, Jeju Island of Korea Japan, New Caledonia, French Polynesia, 10–300 m.

Remark. One individual of *Ciliopagurus krempfi* (EWUNHM DP 20151210003) was found living in straight gastropod of worm shell. There is no report of this species living in this kind of carcinoecia. However, their pleon is slightly coiled. And each side of uropod and telson has asymmetry. These morphological characters are not the typical characters of hermit crab that lives in straight shell but those that live in spiral shell.

Species belonging to genus *Ciliopagurus* are well-known for their squashed body because they mostly live in the gastropod shell with narrow shell mouth. However, this specimen has normal body because worm shell has round shell mouth.

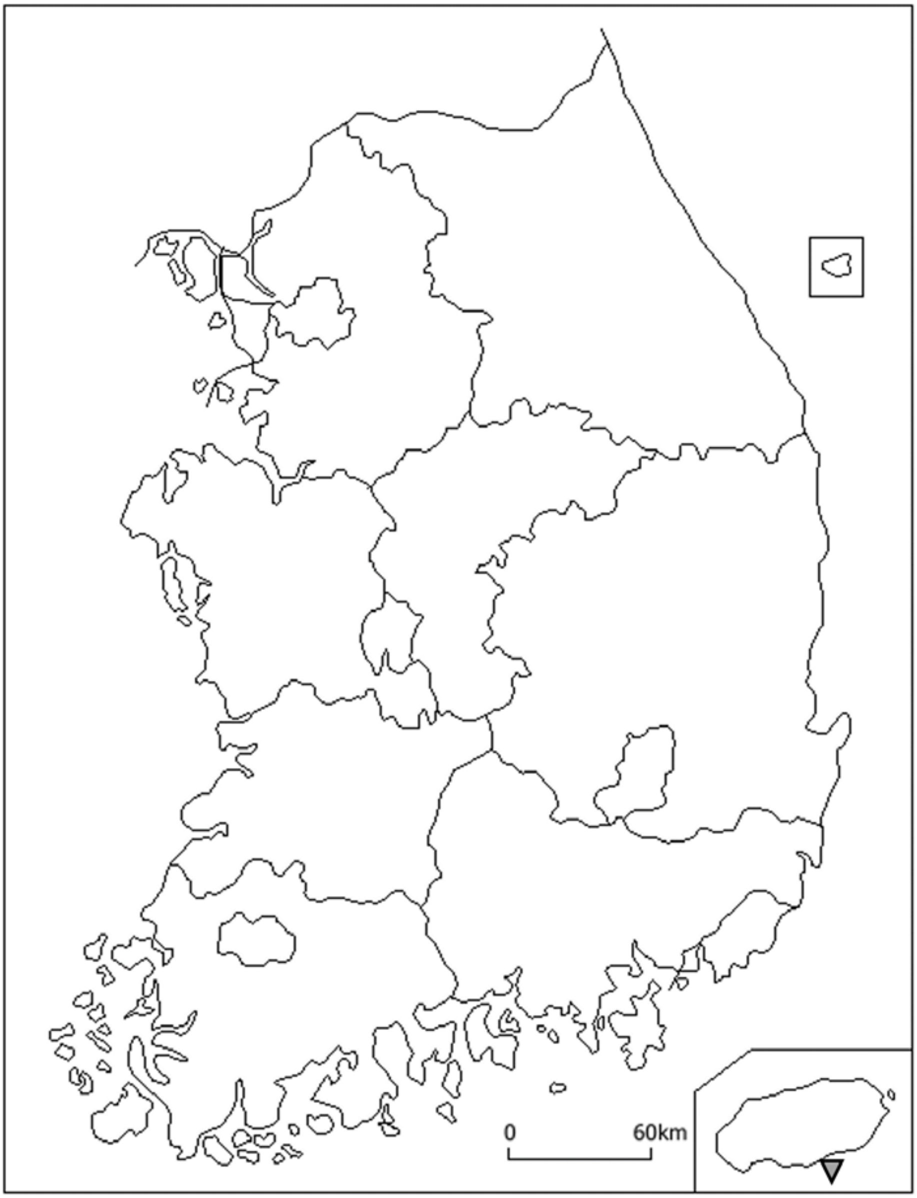

Figure 13. Distribution map of *Ciliopagurus krempfi* (Forest, 1952) in Korea.

Clibanarius Dana, 1852 가로가위집게속

11. *Clibanarius virescens* (Krauss, 1843) 청색가위집게
(Plate 11)

Pagurus virescens Krauss, 1843: 56, pl. 4, fig. 3.

Pagurus (*Clibanarius*) *virescens*: Hilgendorf, 1879: 821, pl. 3, fig. 11.

Clibanarius virescens: Dana, 1852b: 466; Oh, 1983: 106, pl. 1, figs. 3, 4, pl. 3. figs. 1–5; Kim & Kim, 1997: 215; McLaughlin et al., 2007a: 126; 2010: 20, fig. 7C; Huang & Lin, 2012: 91; Arima, 2014: 54.

Clibanarius bimaculatus: Ortmann, 1892: 291; Balss, 1913: 41, fig. 28.

Clibanarius aequabilis: Stebbing, 1920: 258.

Clibanarius pacificus: Maki & Tsuchiya, 1923: 103, pl. 9, fig. 3.

Matarial examined. 1 ind., Seogwipo, Korea, hand, 1 Nov. 2010, Coll. Kang, S, Park, J. H., Hwang, H. S., Jung, J., MADBK 160501_002: 1 ind., Busan, Korea, 34° 4'33"N 128° 1'36"E, hand, 24 Sep. 2011, Coll. Jung, J., and Lee, S. H., MADBK 160501_003: 3 inds., Busan, Korea, 35° 12'5.10"N 129° 13'52.59"E, hand, 8 Oct. 2015, Coll. Jung J., MADBK 160501_005.

Distribution. East coast of Africa to Indonesia, southern Korea, Japan, Fiji Islands, intertidal to shallow subtidal.

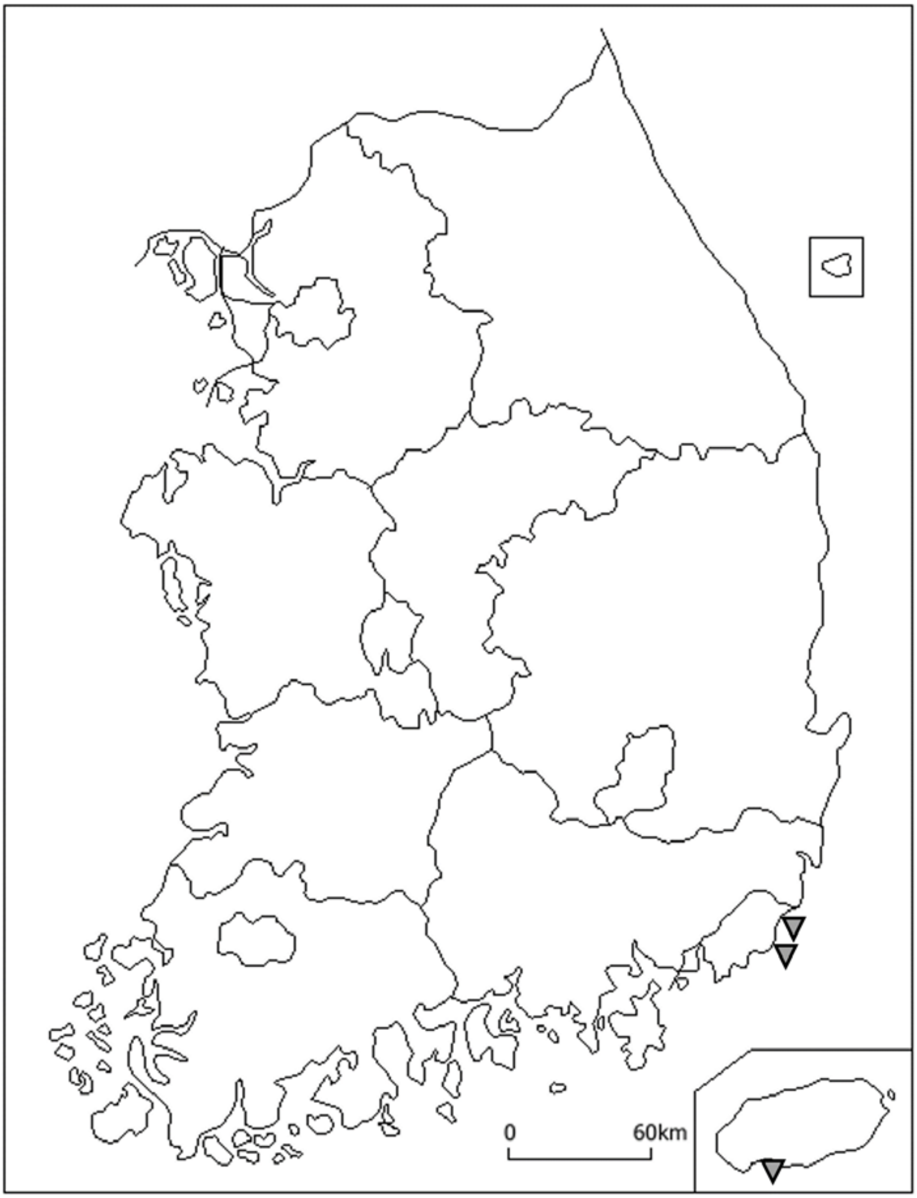

Figure 14. Distribution map of *Clibanarius virescens* (Krauss, 1843) in Korea.

Genus *Diogenes* Dana, 1851 넓적왼손집게속

Key to the Korean *Diogenes* species

1. Propodus of 3rd pereopods with rows of spines · · · · · · · · · 2

– Propodus of 3rd pereopods unarmed or a row of small spines · 3

2. Left cheliped with numerous setae · · · · · · · · *D. penicillatus*

– Left cheliped without setae · · · · · · · · · · · · · · *D. edwardsii*

3. Cutting edge of dactylus of right chela with calcareous teeth · · *D. nitidimanus*

– Cutting edge of dactylus of right chela almost unarmed · · · · · *D. deflectomanus*

12. *Diogenes penicillatus* Stimpson, 1858 털손왼손집게 (Plate 12)

Diogenes penicillatus Stimpson, 1858: 256; Makarov, 1962: 150; Hong et al., 2006b: 355; Kim & Son, 2006: 58; McLaughlin et al., 2007a: 140; 2010: 21; Arima, 2014: 83.

Diogener penicillatus: Huang & Lin, 2012: 92.

Matarial examined. 1 ind., Busan, Korea, 35° 12'5.10"N 129° 13'52.59"E, fishing trap, 12 Nov. 2010, Coll. Kim, S. H., MADBK 160508_001: 1 ind., Busan, Korea, 35° 12'5.10"N 129° 13'52.59"E, fishing trap, 24 Mar. 2015, Coll. Jung, J., MADBK 160508: 1 ind., Pohang, Korea, 35° 52'32.03"N 129° 31'7.43"E, fishing net, 11 Aug. 1982, EVOSYS 260508#001: 1 ind., Yeosu, Korea, 15 June 1969, EWUNHM DP 20151202066.

Distribution. Russia, Japan, southeastern Korea, Taiwan, 30−90 m.

Remark. Huang and Lin (2012) reported genus *Diogener* in Chinese water. However, this species name is regarded as a typing error of *Diogenes* because photos and figures of this genus represent *Diogenes* exactly.

One individual of *Dardanus penicillatus* (MADBK 160508) was found living in the gastropod shell covered with associated hydrozoan, *Hydrissa sodalis*. There is no report that *D. penicillatus* is associated with this hydrozoan.

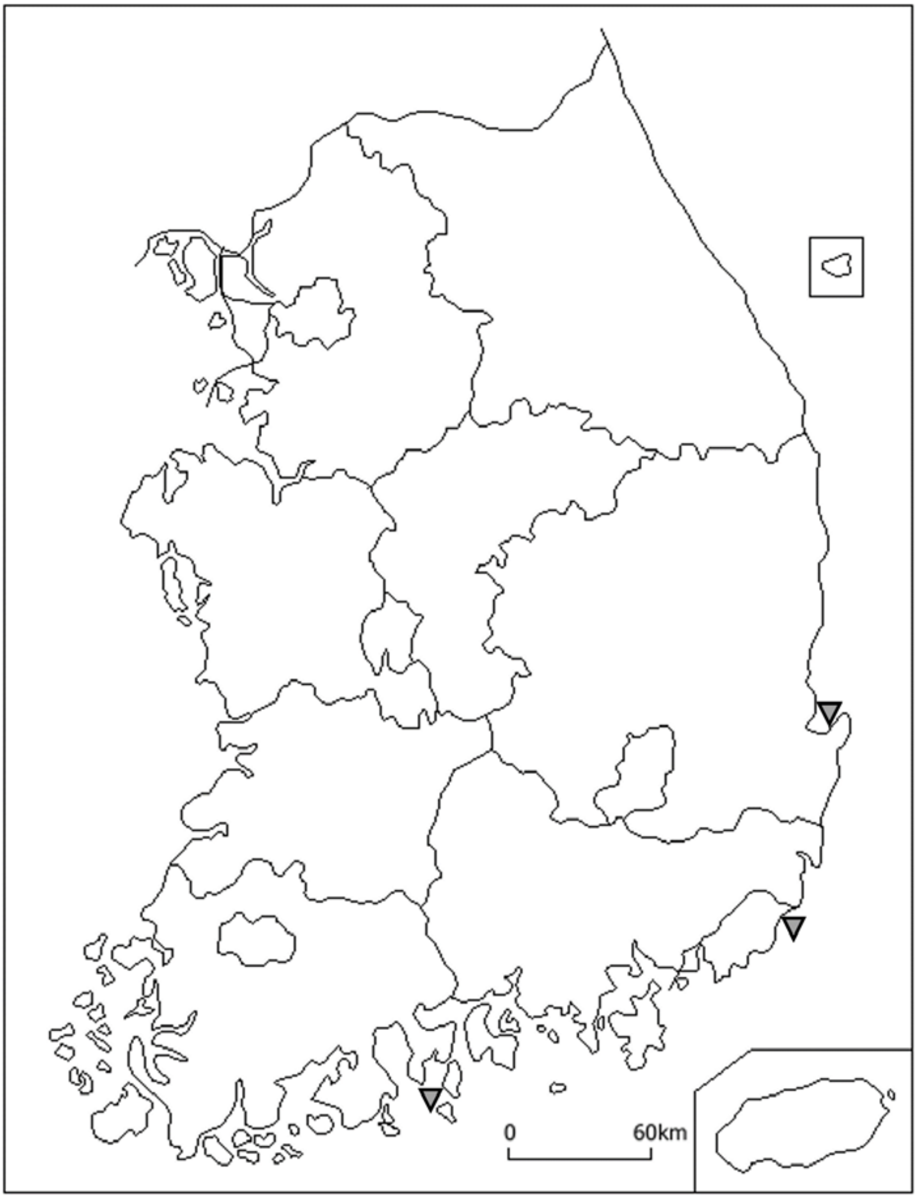

Figure 15. Distribution map of *Diogenes penicillatus* Stimpson, 1858 in Korea.

13. *Diogenes edwardsii* (De Haan, 1849) 넓적왼손집게 (Plate 13)

Pagurus edwardsii De Haan, 1849: 211, pl. 50, fig. 1.

Diogenes edwardsii: Stimpson, 1907: 202, pl. 24, fig. 1; Kamita, 1954: 68, figs. 8, 9; Makarov, 1962: 150, pl. 1; Kim, 1963: 297, fig. 13; 1964: 8; 1970: 12; 1973: 206, 596, fig. 39, pl. 67, fig. 21, Asakura, 1995: 357, fig. 21−272C, pl. 93, fig. 5; Kim & Kim, 1997: 215; Hong et al., 2006b: 354; Kim & Son, 2006: 55; McLaughlin et al., 2007a: 145; 2010: 21; Arima, 2014: 79; Kim & Kim, 2014: 16, fig. 5, pl. 3.

Diogener edwardsii: Huang & Lin, 2012: 92.

Matarial examined. 3 ♀♀, 10 ♂♂, Ulsan, Korea, 35° 38'32.50"N 129° 30'36.44"E, 30 Apr. 2009, Coll. Shin, M. K., MADBK 160507_002: 1 ind., Boryeong, Korea, 36° 14'51.90"N 126° 31'49.81"E, 1 Sep. 2010, Coll., Lue, W., MADBK 160507_004: 16 inds., Yeongdeok, Korea, 36° 21'38.08"N 129° 24'7.15"E, 13 Nov. 2010, Coll. Kim, S. H., MADBK 160507_005: 1 ♂, Goseong, Korea, 38° 28'1.05"N 128° 33'33.66"E, 27 July 2011, Coll., Lee, S. K., MADBK 160507_007: 1 ♂, Busan, Korea, 35° 8'16.83"N 129° 9'37.01"E, fishing trap, 23 Apr. 2011, Coll., Jung, J., MADBK 160507_008: 4 inds., Uljin, Korea, 37° 2'43.86"N 129° 25'30.30"E, 23 May 2013, Coll. Kim, S. H., MADBK 160507_011: 4 inds., Mokpo, Korea, 34° 50'15.40"N 126° 23'47.57"E, 21 Apr. 1986, MADBK 160507_013: 2 inds., Ulleung, Korea, 37° 32'33.10"N 130° 53'31.50"E, 24 July 1989, MADBK 160507_014: 1 ♂, Yeosu, Korea, 13 June 1969, Coll., Kim, H. S., EVOSYS 260507#004: 7 ♀♀, 10 ♂♂, Incheon, Korea, 13 June 1969, Coll., Kim, H. S., EVOSYS 260507#007: 1 inds., Gunsan, Korea, 24 Oct. 2003, EVOSYS 260507#021. 2 inds., Incheon, Korea, 4 July 2007, EVOSYS 260507#030.

Distribution. Japan, Korea, East China Sea, Taiwan, Hong Kong, 16–97 m.

,

Remark. Polynoid polychaet were found in two specimens of *Diogenes edwardsii* (EVOSYS 260507#021, EVOSYS 260507#030). There is no report that *D. edwardsii* lives with polynoid. Approximate morphological characteristics of this species are similar to those of *Eunoe depressa* Moore, 1905 and *E. nodosa* (M. Sars, 1861). However, this specimen does not have tubercles on the posterior surface of dorsal plates, whereas have in *E. depressa* and *E. nodosa*.

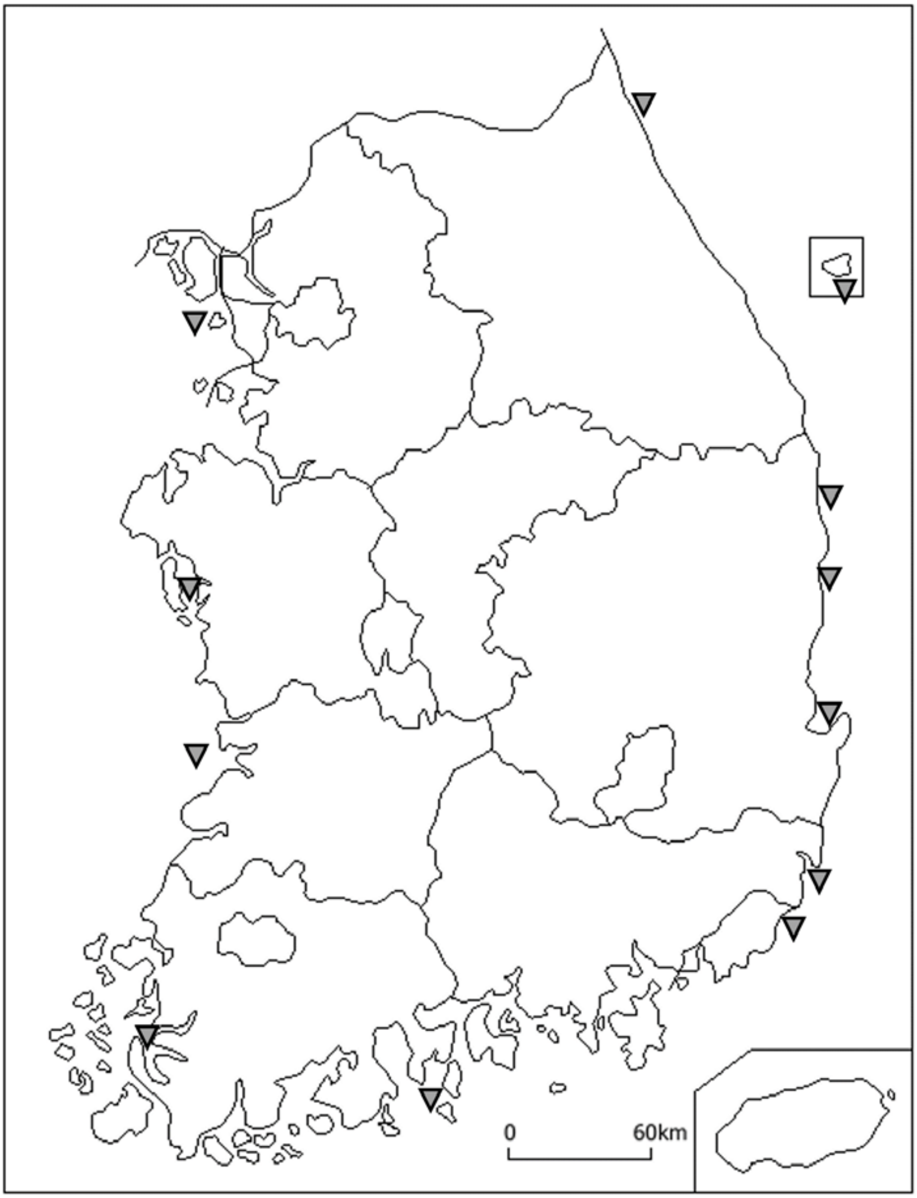

Figure 16. Distribution map of *Diogenes edwardsii* (De Haan, 1849) in Korea.

14. *Diogenes nitidimanus* Terao, 1913 긴윈손집게 (Plate 14)

Diogenes edwardsii: Ortmann, 1892: 295.

Diogenes nitidimanus Terao, 1913: 363, fig. 1; Kim, 1970: 12; 1973: 208, 596, fig. 40, pl. 68, fig. 22; Asakura, 1995: 352, fig. 21; Kim & Kim, 1997: 215; Hong et al., 2006b: 354; Kim & Son, 2006: 56; Korn et al., 2008: 3, figs. 1–3; McLaughlin et al., 2010: 21, fig. 9B; Arima, 2014: 80; Kim & Kim, 2014: 18, fig. 6, pl. 4.

Diogenes spinifrons: Komai et al., 1992: 196.

Diogenes aff. *nitidimanus*: McLaughlin et al., 2007a: 149.

Diogener aff. *nitidimanus*: Huang & Lin, 2012: 93.

Matarial examined. 1 ind., Incheon, Korea, 37° 9'35.93"N 125° 46'18.92"E, hand, 4 Nov. 2011, Coll. Jung, J., MADBK 160506_001: 1 ind., Boryeong, Korea, 36° 14'50.48"N 126° 32'14.37"E, hand, 27 Oct. 2014, Coll. Chungbuk National University, MADBK 160506_002: 7 inds., Taean, Korea, 36° 47'13.75"N 126° 8'27.15"E, hand, 5 Oct. 2013, Coll., Jung, J., MADBK 160506_003: 1 ind., Jindo, Korea, 34° 26'17.92""N 126° 7'37.27""E, hand, 17 Aug. 2016, Coll., Kim, H. K., MADBK 160506_007: 1 ind., Geoje, Korea, 24 May 2008, NIBRIV0000540410– NIBRIV0000540413: 1 ind., Shinan, Korea, 2 June 2011, Coll., Kang, D. W., EWUNHM DP 20151228025.

Distribution. Japan, western and southern Korea, Taiwan, low intertidal and shallow subtidal.

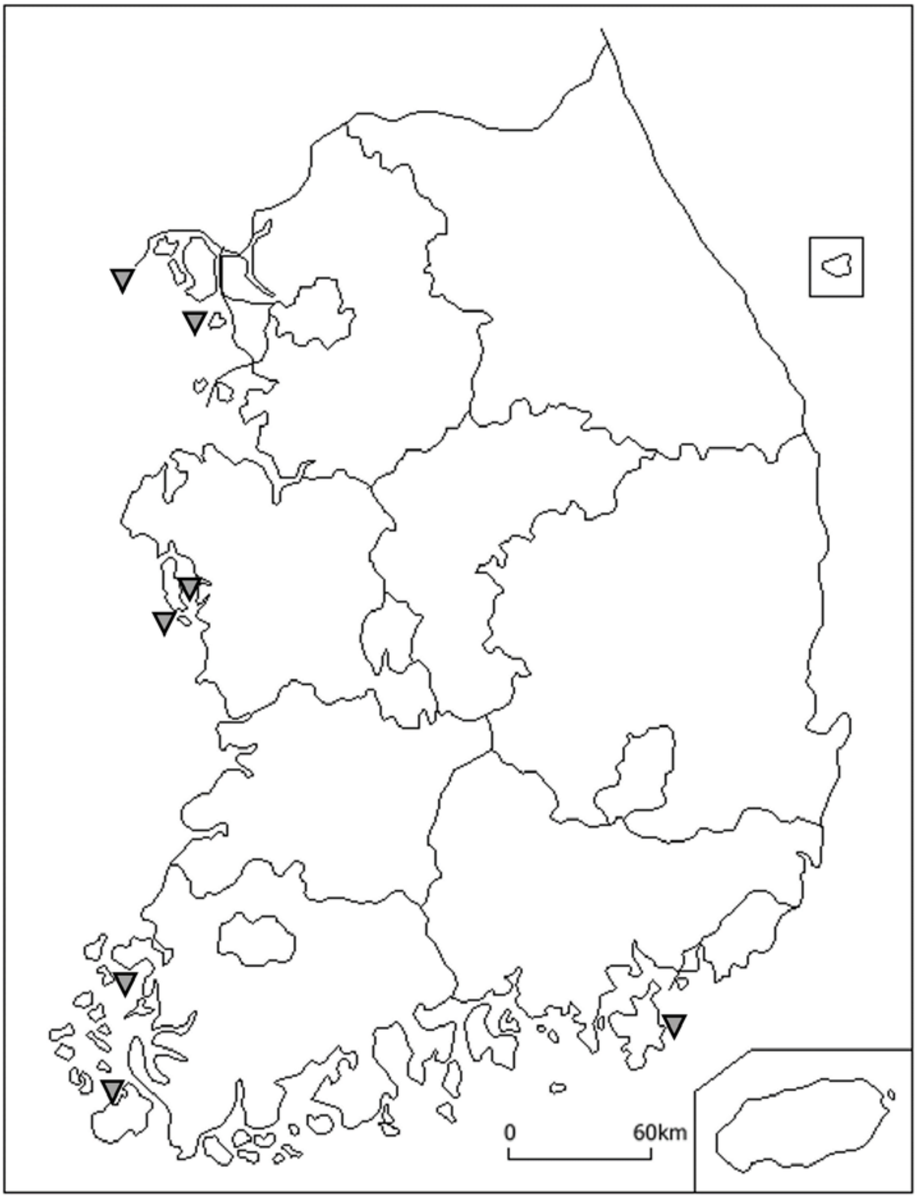

Figure 17. Distribution map of *Diogenes nitidimanus* Terao, 1913 in Korea.

15. *Diogenes deflectomanus* Wang and Tung, 1980 긴넓적왼손집게

(Plate 15)

Diogenes deflectomanus Wang & Tung, 1980: 35, figure 1; McLaughlin et al., 2010, 21; Huang & Lin, 2012: 94; Komai et al., 2012: 1228, figs. 6–9; Jung & Kim, 2015: 110, figs. 3, 4.

Diogenes defrectomanus (sic): Rahayu, 1996: 389.

Diogenes nitidimanus: Kim & Son, 2006: 56, unnumbered fig.

Material examined. 1 ♂ (sl 4.8 mm), Goseong, Korea, 38° 19'53.63"N 128° 34'47.33"E, Scuba, 27 July 2011, Coll. Lee, S. K., MADBK 160540_001: 2 ♂♂, Jindo, Korea, 7 July 2016, Coll. Kim, H. K., MADBK 160540_002.

Distribution. Eastern to southeastern China, Jindo and Goseong of Korea, intertidal to 30 m.

Remark. Kim and Son (2006) described *D. nitidimanus* including living condition picture. However, picture located in the upper-left side regarded as *D. deflectomanus* according to shape of the left cheliped and color pattern.

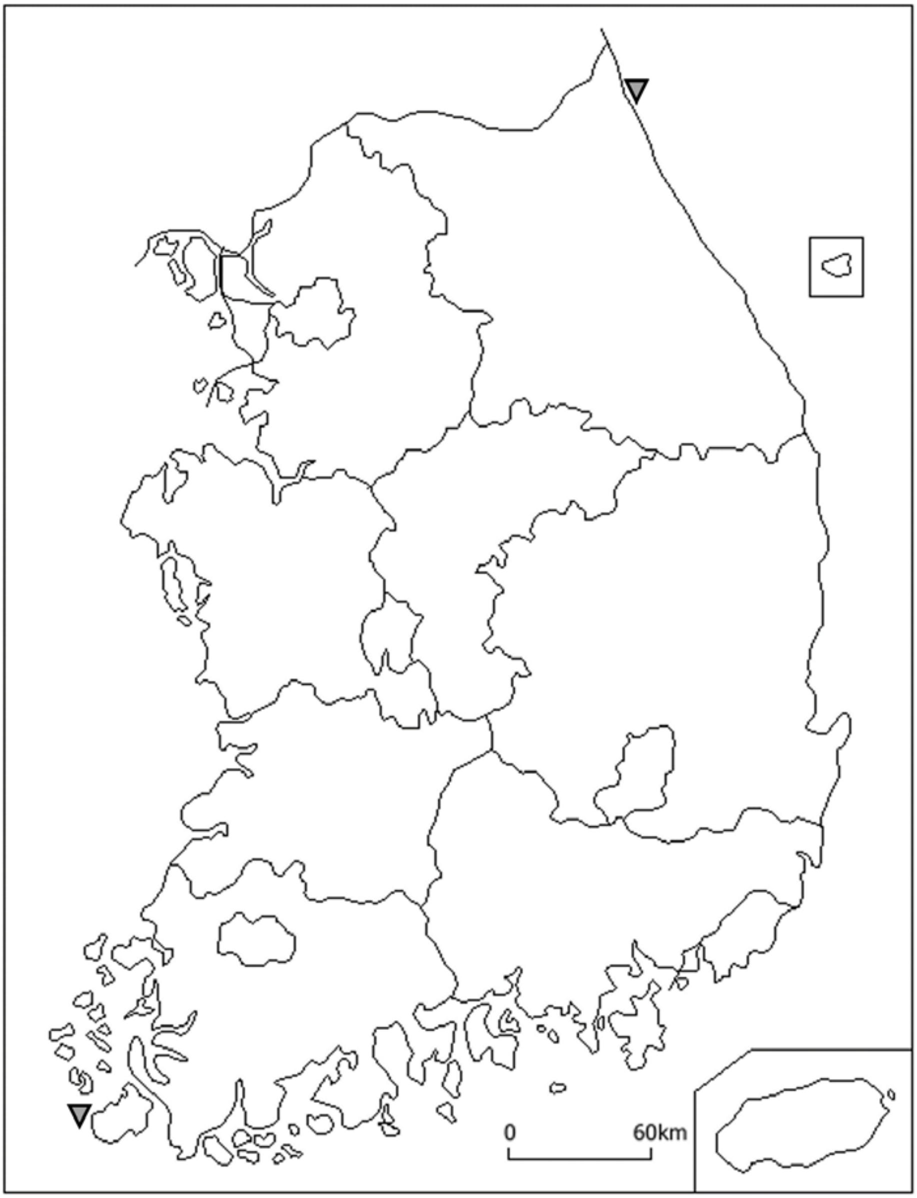

Figure 18. Distribution map of *Diogenes deflectomanus* Wang and Tung, 1980 in Korea.

Genus *Dardanus* Paul'son, 1875 왼손집게속

Key to the Korean *Dardanus* species

1. Mesial surface of palm of left cheliped with sharp spines · · · 2
– Mesial surface of palm of left cheliped without sharp spines · 5
2. Chelipeds subequal · · · · · · · · · · · · · · · · · *D. lagopodes*
– Left cheliped larger than right · · · · · · · · · · · · · · · · · 3
3 Pereopods with scutes · · · · · · · · · · · · · · · · · · *D. arrosor*
– Pereopods without scutes · 4
4. Dorsolateral and ventrolateral surface of dactyl and propodus of left third pereopod with numerous scales · · · · · *D. crassimanus*
– Dorsolateral and ventrolateral surface of dactyl and propodus of left third pereopod without scales · · · · · · · · · · *D. aspersus*
5. Lateral surface of left chela with several rows of blunt tubercle · *D. impressus*
– Lateral surface of left chela unarmed · · · · · · *D. pedunculatus*

16. *Dardanus lagopodes* (Forskål, 1775) 흰털왼손집게

(Plate 16)

Cancer lagopodes Forskål, 1775: 93.

Pagurus sanguinolentus Quoy & Gaimard, 1824: 532, pl. 79, fig. 2.

Pagurus affinis H. Milne Edwards, 1836: 274.

Pagurus euopsis Dana, 1852b: 452; Alcock, 1905: 86, pl. 9, fig. 2.

Pagurus depressus Heller, 1861: 248.

Dardanus hellerii Paul'son, 1875: 90, pl. 12, fig. 4, 4a–c.

Dardanus euopsis: Maki & Tsuchiya, 1923: 98, pl. 8, fig. 4.

Dardanus sanguinolentus: Forest, 1956: 49.

Dardanus lagopodes: Miyake, 1978: 55, fig. 19; Asakura, 1995: 357, pl. 95, fig. 6; McLaughlin et al., 2007a: 91; 2010: 20, fig. 8A; Huang & Lin, 2012: 88; Arima, 2014: 71; Jung & Kim, 2015: 108, figs. 1, 2.

Material examined. 1 ♂ (sl 2.2 mm), Ulleung, Korea, 37° 27'32.54"N 130° 51'23.42"E, Scuba, 15 July 2013, Coll. Jung, J., Park, J. H., MADBK 160528_013.

Distribution. East Africa, Red Sea, Indian Ocean, Southeast Asia, Australia, Polynesia, Taiwan, Japan, Ulleung of Korea, intertidal to 30m.

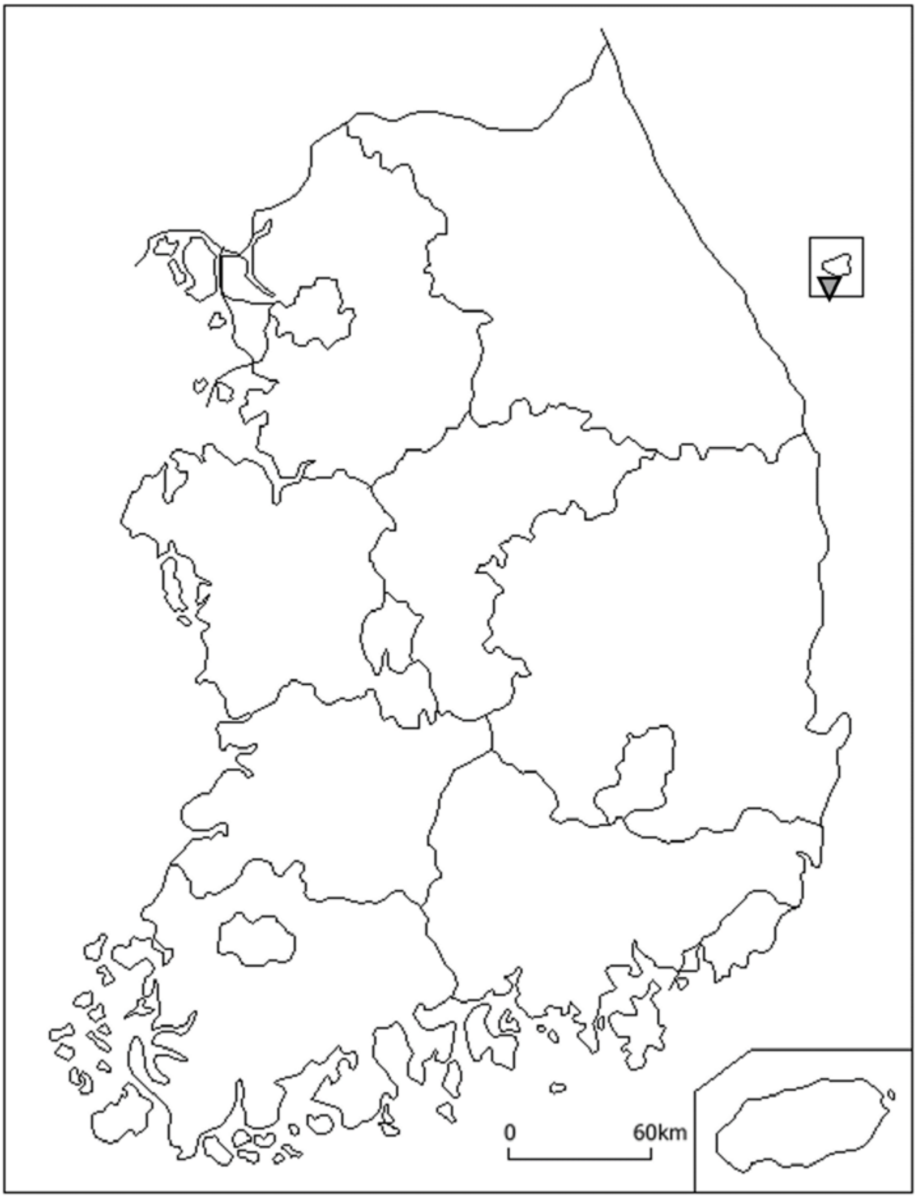

Figure 19. Distribution map of *Dardanus lagopodes* (Forskål, 1775) in Korea.

17. *Dardanus arrosor* (Herbst, 1796) 털줄왼손집게 (Plate 17)

Cancer arrosor Herbst, 1796: 170, pl. 43, fig. 1.

Pagurus strigosus Bosc, 1802: 77, pl. 11, fig. 3.

Pagurus striatus Latreille, 1802: 163; De Haan 1849: 204, pl. 49, fig. 1.

Pagurus incisus Olivier, 1811: 641; pl. 9, fig. 1.

Pagurus striatus: Risso, 1816: 54.

Pagurus strigosus: Hope, 1851: 12.

Eupagurus striatus Cuénot, 1892.

Petrochirus arrosor: Rathbun, 1900: 302.

Pagurus arrosor: Balss, 1913: 46; Yokoya, 1933: 78; Kamita, 1954: 66, fig. 7.

Dardanus arrosor: Makarov, 1962: 159, pl. 1, fig. 1; Kim, 1963; 295; fig. 12; 1964: 9; 1970: 12; 1973: 200, 595, fig. 35, pl. 4, fig. 18; Miyake, 1978: 58, fig. 20, pl. 1, fig. 5; Asakura, 1995: 357, pl. 95, fig. 1; Kim & Kim, 1997: 215; Hong et al., 2006b: 353; Kim & Son, 2006: 51; McLaughlin et al., 2007a: 76; 2010: 20; Huang & Lin, 2012: 87; Arima, 2014: 76; Kim & Kim, 2014: 12, fig. 3, pl. 1.

Aniculus typicus: Heller, 1865: 90.

Aniculus aniculus: Chilton, 1911: 300.

Aniculus chiltoni Thompson, 1930: 265, pl. 41, fig. a-e.

Material examined. 1 ind., Tongyeong, Korea, 34° 38'5.22"N 128° 15'56.87"E, 7 Dec. 2010, Coll. Lue, W., MADBK 160502_003: 2 ♂♂, Busan, Korea, 35° 6'6.54"N 129° 12'26.51"E, 23 Apr. 2011, Coll. Jung, J., MADBK 160502_005: 24 inds., Busan, Korea, 35° 6'6.54"N 129° 12'26.51"E, 1 Nov. 2011, Coll. Kim, S. H., MADBK 160502_007: 1 ♀, Jeju, Korea, fishing net, 13 Aug. 1969, EVOSYS 260502#004: 2 ♀♀, 2 ♂♂, Seogwipo, Korea, fishing net, Oct. 1970, EVOSYS 260502#010: 1 ♂, Tongyeong, Korea, fishing net, 14 Nov. 2006, EVOSYS 260502#011: 3 ♂♂, Wando, Korea, 7 Aug. 1996, EVOSYS 260502#016: 1 ind., Wando, Korea, 25 July 1981, Coll., Shin, EWUNHM DP 20151126024: 1 ind., Ulsan, Korea, 30 Dec. 1999, Coll. Jang, C. Y., NIBRIV0000021812: 1 ind., Goheung, Korea, 31 Aug. 2005, Coll. Ko, H. S., NIBRIV0000190620.

Distribution. Mediterranean and Red Seas, West and South Africa, the Philippines, Taiwan, Japan, East China Sea and Korea Strait, Australia, New Zealand, 30–290 m.

Remark. One individual of *Dardanus arrosor* (EVOSYS 260502#011) was found living in the carcinoecia formed by *Hydrissa sodalis*. There is no report of this species living in this kind of carcinoecia.

One individuals of *D. arrosor* (MADBK 160701_005) found in the intertidal. This unusual habitat is regarded as influence of discard by fisher because small port and fisher market is located nearby the collection site.

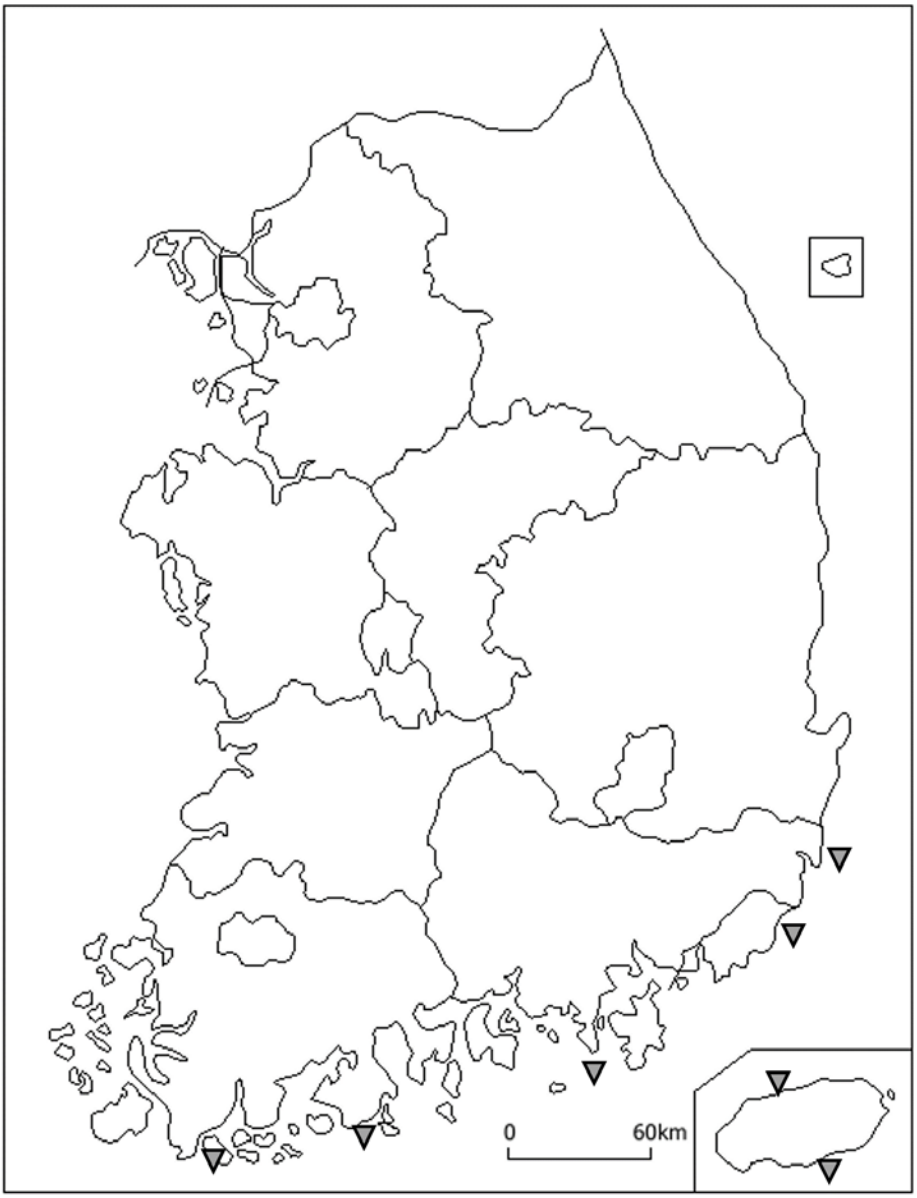

Figure 20. Distribution map of *Dardanus arrosor* (Herbst, 1796) in Korea.

18. *Dardanus crassimanus* (H. Milne Edwards, 1836) 벽돌길윈손집게

(Plate 18)

Pagurus crassimanus H. Milne Edwards, 1836: 277.

Pagurus setifer: De Haan, 1849: 209; Terao, 1913: 379.

Pagurus sculptipes Stimpson, 1858: 287; Ortmann, 1892: 287; Doflein, 1902: 646; Alcock, 1905: 83, pl. 8, fig. 3; Balss, 1913: 48.

Pagurus pavimentatus Hilgendorf, 1879: 816, pl. 3, figs. 1–5.

Clibanarius crassimanus: Alcock, 1905: 162.

Dardanus sculptipes: Rathbun, 1903: 34.

Dardanus crassimanus: Kim, 1970: 12; 1973: 204, 596, fig. 37, pl. 4, fig. 20; Miyake, 1978: 61, fig. 22, pl. 1, fig. 1; Asakura, 1995: 357, pl. 95, fig. 2; Kim & Kim, 1997: 215; Kim & Son, 2006: 52; McLaughlin et al., 2007a: 98; 2010: 20; Huang & Lin, 2012: 89; Arima, 2014: 75; Kim & Kim, 2014: 14, fig. 4, pl. 2.

Material examined. 1 ♀ (ovi.), Seogwipo, Korea, 33° 13'27.59"N 126° 33'57.76"E, 25 Aug. 2001, MADBK 160503_001: 1 ♂, Seogwipo, Korea, 11 July 1965, EVOSYS 260503#001: 1 ♂, Seogwipo, Korea, 3 Aug. 1970, EVOSYS 260503#002: 1 ♂, Seogwipo, Korea, Apr. 2006, EVOSYS 260503#003: 1 ind., Jeju, Korea, 17 Jan. 2007, Coll. Kim, J. N., NIBRIV0000307549.

Distribution. East Africa, Australia, the Philippines, South China Sea, Japan, Jeju Island of Korea, 10–180 m.

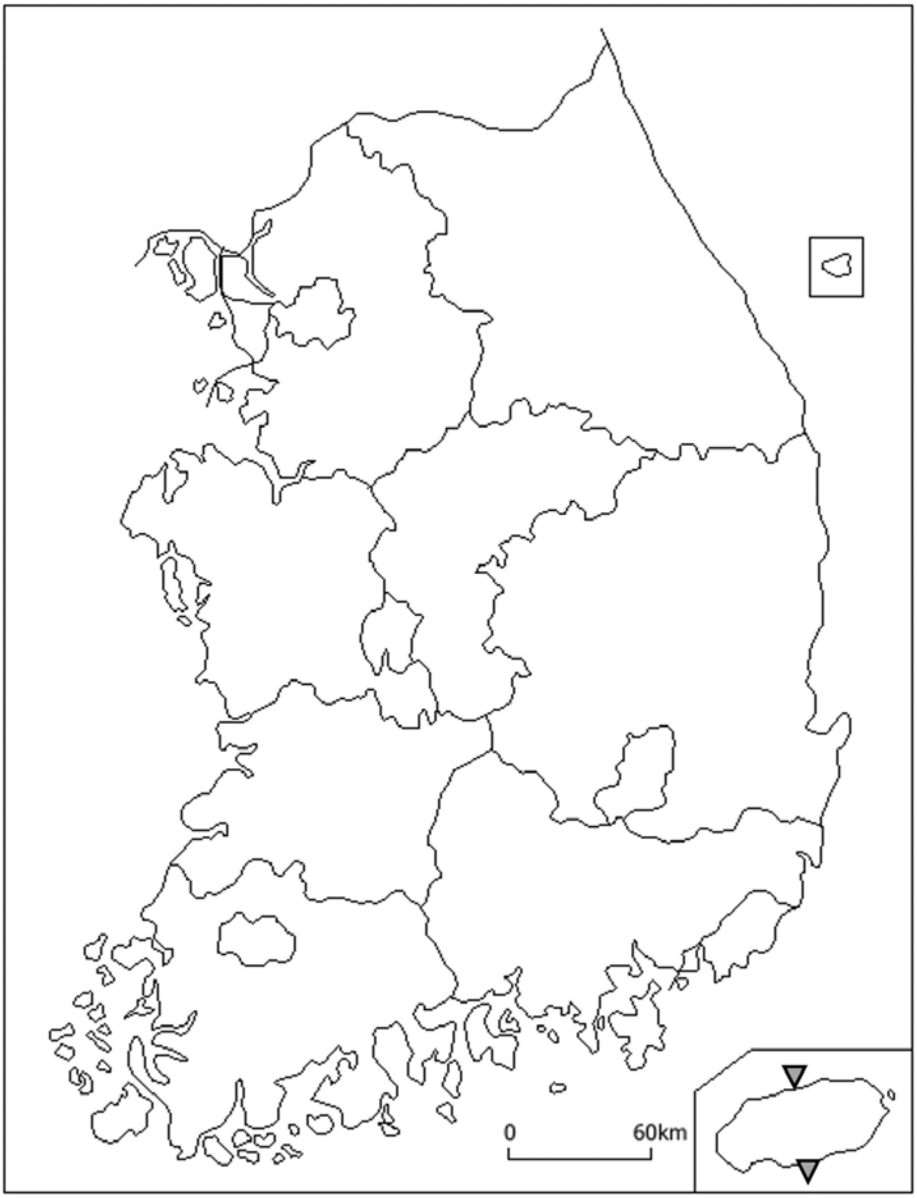

Figure 21. Distribution map of *Dardanus crassimanus* (H. Milne Edwards, 1836) in Korea.

19. *Dardanus aspersus* (Berthold, 1846) 붉은점윈손집게

Pagurus aspersus Berthold, 1846: 21, pl. 2, fig. 1; Alcock, 1905: 168.

Pagurus diogenes: De Haan, 1849: 208; Ortmann, 1892: 285; Terao, 1913: 377.

Dardanus diogenes: Gee, 1925: 159.

Dardanus aspersus: Miyake, 1978: 64, fig. 23, pl. 1, fig. 2; Oh, 1990: 73, figs. 1, 2; McLaughlin et al., 2007a: 96; 2010: 20; Huang & Lin, 2012: 89; Arima, 2014: 75.

Distribution. Japan, Taiwan, East and South China Seas, Jeju Island of Korea, 20−60 m.

20. *Dardanus impressus* (De Haan, 1849) 두드러기윈손집게

(Plate 19)

Pagurus impressus De Haan, 1849: 204, 207, pl. 3; Balss, 1913: 46, figs. 30, 31; Kamita, 1954: 67, fig. 7.

Dardanus impressus: Rathbun, 1903: 34; Kim, 1973: 202, 595, fig. 36, pl. 4, fig. 19; Miyake, 1978: 65, fig. 24; Kim & Kim, 1997: 215; Hong et al., 2006b: 353; Kim & Son, 2006: 53; McLaughlin et al., 2007a: 85; 2010: 20; Huang & Lin, 2012: 87; Arima, 2014: 74.

Material examined. 1 ind., Jeju, Korea, 33° 24'58.56"N 126° 15'0.70"E, 7 July 1972, MADBK 160504_001: 2 ♀♀, 1 ♂, Seogwipo, Korea, 16 Aug. 1969, Coll., Kim, H. S., EVOSYS 260504#003: 2 ♀♀, Seogwipo, Korea, 8 Aug. 1970, Coll., Kim, H. S., EVOSYS 260504#004: 1 ind., same as EVOSYS 260504#004, EVOSYS 260504#005: 4 inds., Jeju, Korea, 7 July 1972, EVOSYS 260504#007: 2 inds., Seogwipo, Korea, 21 May 1982, Coll. Song, J., EWUNHM DP 20151125018: 1 ind., Seogwipo, Korea, 12 Dec. 1969, Coll. Rho. B. J., EWUNHM DP 20151202013: 2 inds., Seogwipo, Korea, 6 Feb. 1971, EWUNHM DP 20151202040.

Distribution. East Africa, Australia, the Philippines, South China Sea, Japan, Jeju Island of Korea, 10–100 m.

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Remark. Specimens of *Dardanus impressus* in Korea are associated with *Hydrissa sodalis*. Of 13 specimens of *P. simulans* caught in subtidal area of Korea from 1969 to 1972, 8 (61.5 %) specimens are associated with *H. sodalis*. It is noteworthy that 7 out of the 8 specimens have *H. sodalis* associated with moderately large gastropod shell. This feature is different from the pattern of *H. sodalis* associated with *P. constans.* that its gastropod shell is small and fully covered by *H. sodalis.*

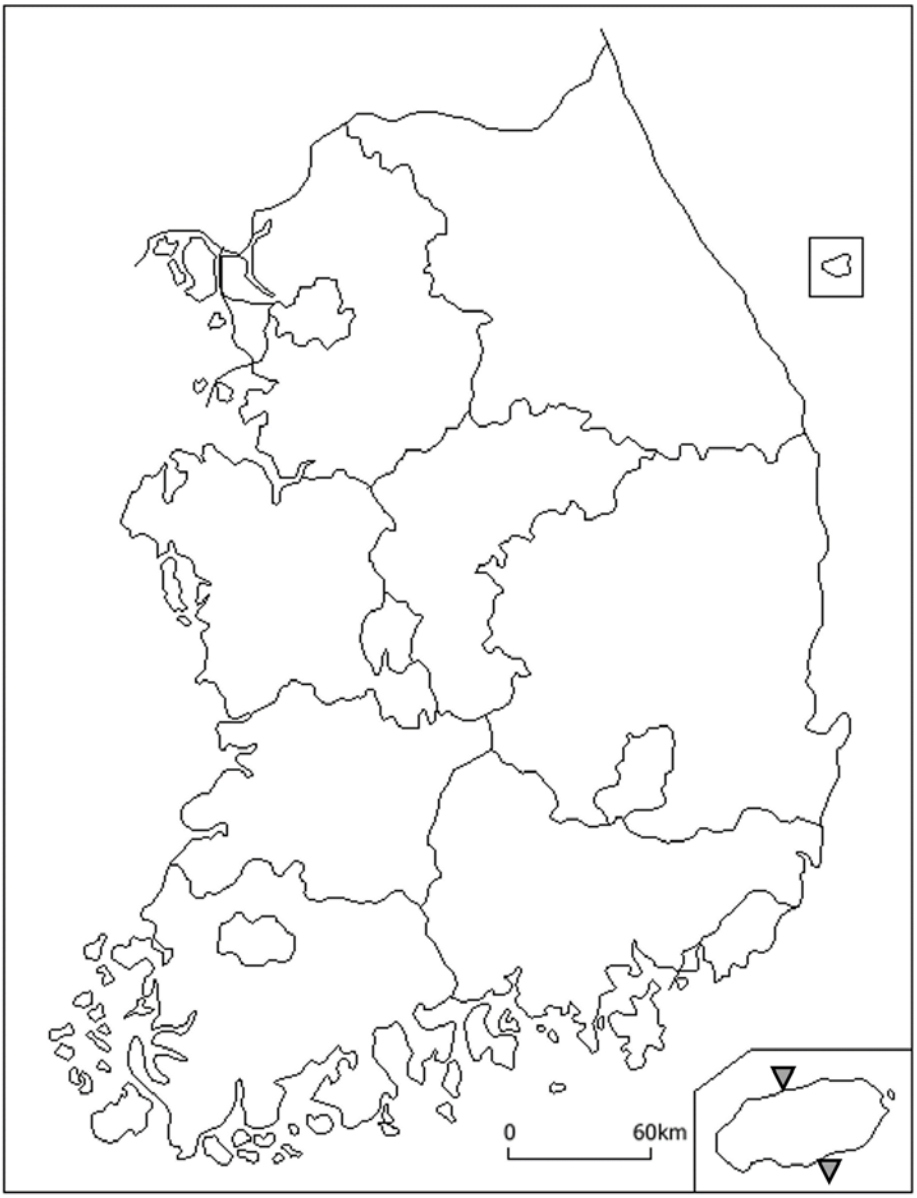

Figure 22. Distribution map of *Dardanus impressus* (De Haan, 1849) in Korea.

21. *Dardanus pedunculatus* (Herbst, 1804) 굵은눈왼손집게

(Plate 20)

Cancer pedunculatus Herbst, 1804: 25, pl. 61, fig. 3.

Pagurus pedunculatus: Olivier, 1811: 647.

Pagurus pedunculatus var. *varipes*: Hilgendorf, 1879: 815.

Pagurus asper De Haan, 1849: 208, pl. 49, fig. 4; Alcock, 1905: 90, pl. 9, fig. 5.

Pagurus sigmoidalis Zehntner, 1894: 192, pl. 8, fig. 191, 191b.

Dardanus haani Rathbun, 1903: 34.

Neopagurus horai Kamalaveni, 1950: 83, figs. 2a–c, 3.

Pagurus haani: Laurie, 1926: 158.

Pagurus varipes: Alcock, 1905: 90, pl. 9, fig. 7.

Dardanus pedunculatus: Miyake, 1978: 60, fig. 21; Asakura, 1995: 358; Kim & Kim, 1997: 215; Kim & Son, 2006: 54; McLaughlin et al., 2007a: 83; 2010: 20; Huang & Lin, 2012: 87; Arima, 2014: 66.

Material examined. 1 ♀, Seogwipo, Korea, 33° 13'27.59"N 126° 33'57.76"E, Scuba, 3 Nov. 2009, Coll. Kim, S. H., MADBK 160505_001: 2 ♀♀ 1 ♂, Seogwipo, Korea, 33° 13'27.59"N 126° 33'57.76"E, Scuba, 8 May 2010, Coll. Kim, S. H., MADBK 160505_002: 1 ind., Seogwipo, Korea, 33° 14'10.13"N 126° 31'2.71"E, 15 Nov. 2008, Coll. Kim, S. H., MADBK 160505_003: 1 ♂, Seogwipo, Korea, 33° 14'16.61"N 126° 33'37.92"E, Scuba, 13

Apr. 2013, Coll. Park, J. H., MADBK 160505_004: 1 ♀, Seogwipo, Korea, Scuba, 29 Sep. 1995, EVOSYS 260505#004: 1 ♂, Seogwipo, Korea, Scuba, 26 Aug. 2002, EVOSYS 260505#006.

Distribution. From Southern Japan to Australia, Hawaii, Jeju Island of Korea, 10−300 m.

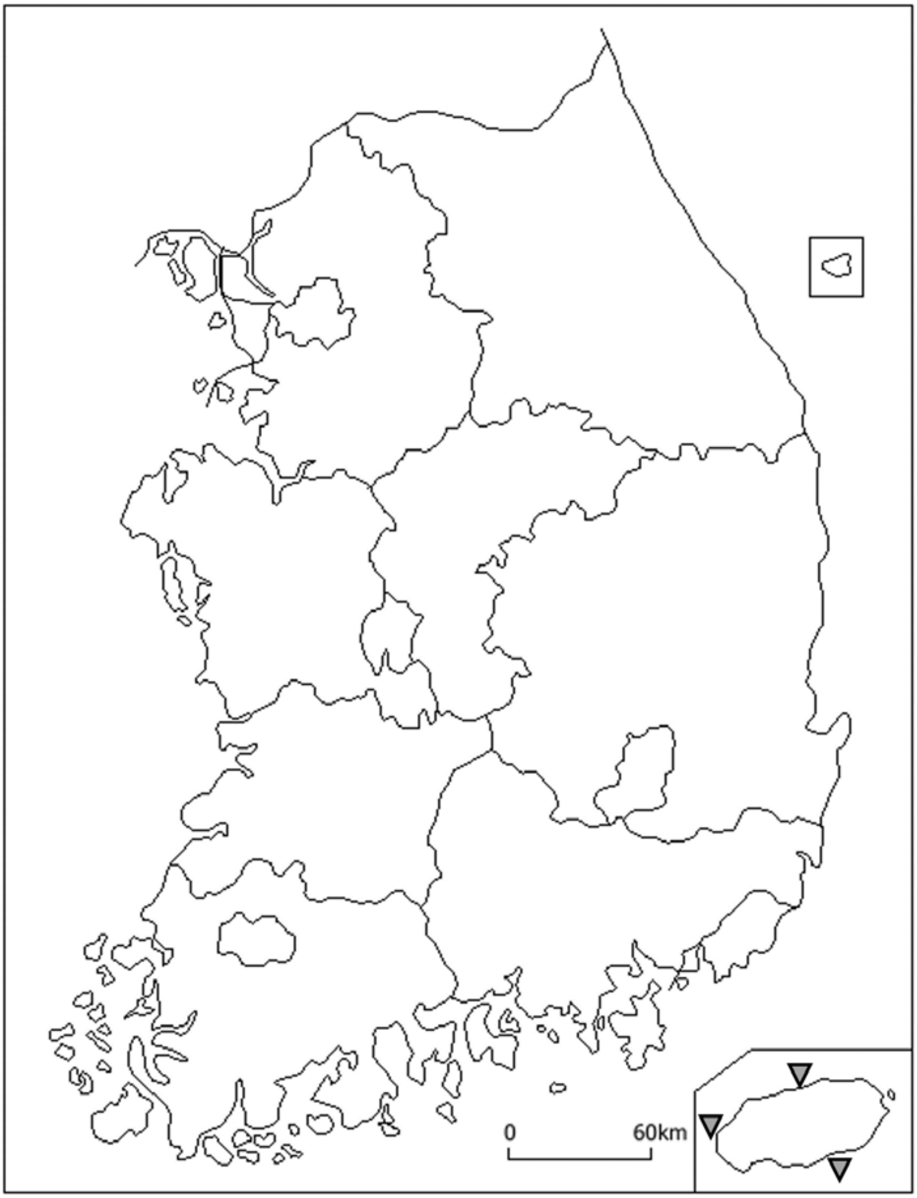

Figure 23. Distribution map of *Dardanus pedunculatus* (Herbst, 1804) in Korea.

Family Paguridae Latreille, 1802 집게과

Korean species belonging to this family have larger right cheliped than the left one, and asymmetrical pleon appendages. A lot of species of Paguridae are found in subtropical, temperate, and cold areas of northern hemisphere, from intertidal to 2000 m although some is found in the tropical area (McLaughlin et al., 2010). A lot of species of Paguridae in Korea are housed in the gastropod shell. However, some species inhabit uncommon houses such as serpulid worm tubes, sponge, and carcinoecia formed by associated hydrozoan (Jung and Kim, 2014; 2016; 2017). In Korean waters, 42 species from 11 genera of Paguridae have been reported.

Key to the Korean Paguroidea genera

1. Uropod symmetric · 2
– Uropod asymmetric · 4
2. Lateral margin of shield with teeth · · · · · *Porcellanopagurus*
Lateral margin of shield without teeth · · · · · · · · · · · · · · · 3
3. Telson with lateral indentations *Lophopagurus* (*Australeremus*)
– Telson without lateral indentations · · · · · *Discorsopagurus*
4. Male with sexual tube · 5
Male without sexual tube · 6
5. Sexual tube well developed · · · · · · · · · · · *Nematopagurus*
– Only coxa of right fifth pereopods with sexual tube *Boninpagurus*

6. Pleon well developed · 7
– Pleon strongly reduced · · · · · · · · · · · · · · · *Labidochirus*
7. Carpus of right cheliped with wing–like expansions *Elassochirus*
– Carpus of right cheliped simple · · · · · · · · · · · · · · · · · 8
8. Median cleft of telson armed, separating deep posterior lobes · *Diacanthurus*
– Telson without median spine and deep posterior lobes · · · · 9
9. Crista dentata with accessory tooth · · · · · · · · · · · · · · 10
– Crista dentata without accessory tooth · · · · · *Catapaguroides*
10. Male gonopore on right fifth coxa covered by tuft of stiff setae · *Pagurixus*
– Male gonopore on right fifth coxa naked · · · · · · · · *Pagurus*

Genus *Porcellanopagurus* Filhol, 1885 조개집게속

22. *Porcellanopagurus nihonkaiensis* Takeda, 1985 조개치레참집게

(Plate 21)

Porcellanopagurus japonicus: Miyake, 1978: 118 (part); 조성환 외., 2006: 72, 73, unnumbered fig..

Porcellanopagurus nihonkaiensis Takeda, 1985: 141, figs. 1B, 2; Ko & McLaughlin, 2008: 129, figs. 1, 2; McLaughlin et al., 2010: 35, 17C; Arima, 2014:145.

Material examined. 1 ind., Seogwipo, Korea, 33° 14'20.69"N 126° 32'40.53"E, Scuba, 26 Feb. 2009, Coll. Park, T. S., MADBK

160730_001: 2 ind., Jeju, Korea, 33° 25'17.44"N 126° 9'38.96"E, Scuba, 24 Sep. 2011, Coll. Lee, S. K., MADBK 160730_002: 2 ♀♀, 2 ♂♂: 1 ovig, Seogwipo, Korea, 33° 13'42.90"N 126° 39'19.23"E, Scuba, 13 Apr. 2014, Coll. Jung, J., MADBK 160730_003: 1 ind., Seogwipo, Korea, 16 June 2011, Coll. Ko, H. S., NIBRIV0000286807: 1 ind., same as 160 MADBK 160730_003, NIBRIV0000320898: 1 ind., Seogwipo, Korea, 8 Mar. 2014, Coll. Kim, M. H., NIBRIV0000423049.

Distribution. Southeastern mainland Japan, Jeju Island of Korea, 15–60 m.

Remark. Jo et al. (2006) first reported *Porcellanopagurus japonicus* in Jeju Island, Korea. However, its figure was more similar to *P. nihonkaiensis* in terms of shape of shield. According to literature review and examination results of three specimens in Natural History Museum and Institute, Chiba, Japan (CBM–ZC 4597; 7868; 10382) of *P. japonicus*, this species is usually found at depth close to 100 m. However, *P. nihonkaiensis* and Korean *P. japonicus* were collected at depth close to 30 m. In addition, *P. japonicus* has two morphological characters different from *P. nihonkaiensis* and Korean *P. japonicus*: First, the posterolateral projection is acute or subacute in *P. japonicus* but blunt in *P. nihonkaiensis* and Korean *P. japonicus*. Second, lateral teeth are thick and entirely spinous in *P. japonicus* but sharp and smooth in *P. nihonkaiensis* and Korean *P. japonicus*.

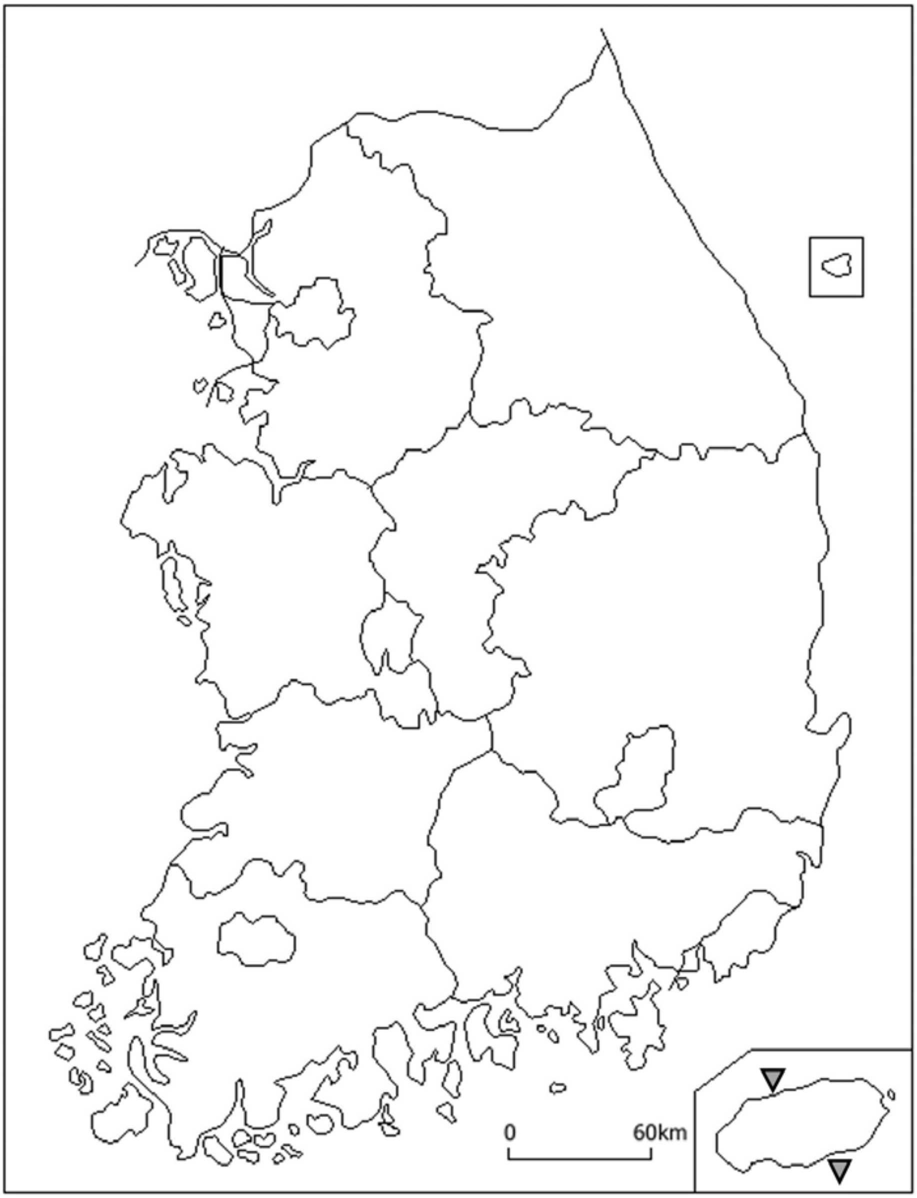

Figure 24. Distribution map of *Porcellanopagurus nihonkaiensis* Takeda, 1985 in Korea.

In Jo et al. (2006), the Korean name of *P. japonicus* is 조개치레참집게. Later, Ko (2008) assigned Korean name of *P. nihonkaiensis* to 조개집게. However, the Korean *P. japonicus* is regarded as *P. nihonkaiensis* according to the above reasons. Therefore, the Korean name of *P. nihonkaiensis* should be called as 조개치레참집게 according to principle of priority.

On the abdomen of a specimen of *P. nihonkaiensis* (MADBK 160730_002), parasitic barnacle was found. Its approximate morphological characteristics are similar to those of *Peltogasterella gracilis* (Boschma, 1927) (R. Yoshida, pers. observation). However, this relationship has not been reported yet.

Lophopagurus McLaughlin, 1981 꼬마참집게속

23. *Lophopagurus* (*Australeremus*) *triserratus* (Ortmann, 1892) 꼬마참집게 (Plate 22)

Eupagurus triserratus Ortmann, 1892: 308, pl. 12, fig. 15.

Pagurus triserratus: Kim, 1963: 5; 1970: 14; 1973: 225, 599, fig. 50, pl. 65, fig. 30; Kim & Kim, 1997: 216.

Lophopagurus (*Australeremus*) *triserratus*: McLaughlin et al., 2010: 30, 13E; Arima, 2014:146.

Pylopagurus serpulophilus Miyake, 1978: 120, pl. 4, fig. 4; Kim & Son, 2006: 88.

Material examined. 1 ind., Seogwipo, Korea, 15 Dec. 1969, Coll. Rho, B. J., EVOSYS 260721: 1 ind., Jeju, Korea, 5 Apr. 2003, Coll. Kim, M. H., NIBRIV0000423044: 1 ind., EEZ#110, 33° 14'20.69"N 126° 32'40.53"E, 5 Apr. 2003, Coll. Kim, M. H., NFRDI H 3.

Distribution. Japan, East China Sea, Jeju Island of Korea, 10–400 m.

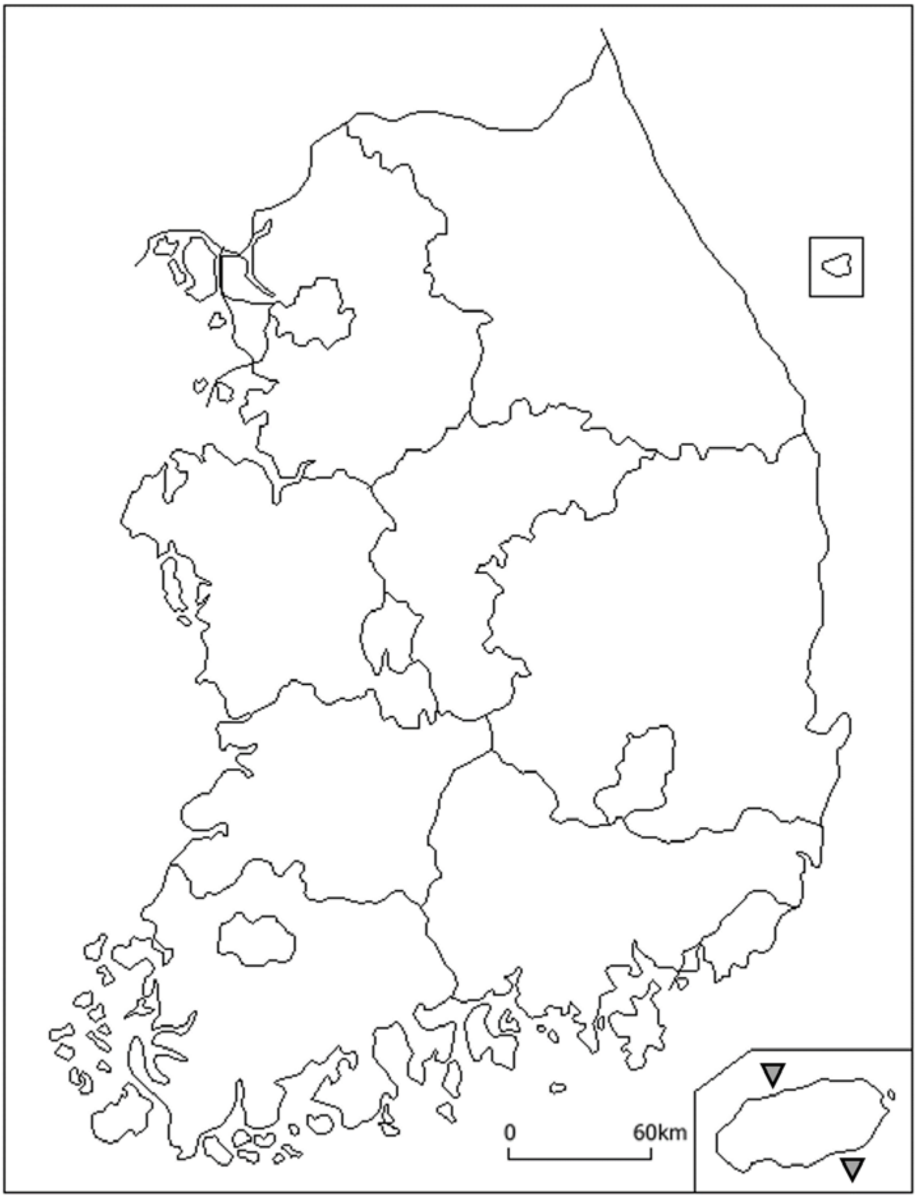

Figure 25. Distribution map of *Lophopagurus* (*Australeremus*) *triserratus* (Ortmann, 1892) in Korea.

Genus *Discorsopagurus* McLaughlin, 1974 관참집게속

Key to the Korean *Discorsopagurus* species

Antennal flagellum with very short setae · · · · *D. maclaughlinae*

− Antennal flagellum with long setae · · · · · · · · · *D. tubicola*

24. *Discorsopagurus maclaughlinae* Komai, 1995 대롱집게

(Plate 23)

Orthopagurus schmitti: Makarov, 1962: 217, pl. 2, fig. 1.

Discorsopagurus schmitti: McLaughlin, 1974: 354.

Discorsopagurus maclaughlinae Komai, 1995: 617-627, figs. 1-4; Petryashev, 2005: 13; McLaughlin et al., 2010, 29; Marin et al., 2012: 277, figs. e, f; Arima, 2014: 195; Jung & Kim, 2016: 142, figs. 1, 2.

Orthopagurus minimus: Kim, 1985: 75, fig. 2D.

Material examined. 1 ♀ (ovi.) (sl 2.1 mm), Samcheok, Korea, bottom trawl, 28 Jan. 2002, EVOSYS 260746: 2 ♂♂ (sl 2.8-4.1 mm), 1 ♀ (sl 2.8 mm), Gangneung, Korea, netting, 21 May 2002 MADBK 260746: 7 ♂♂ (sl 2.9-5.0 mm), Gangneung, Korea, fishing ship, 22 May 2002, MADBK 160746_001: 1 ♂ (sl 2.5 mm), Yangyang, Korea, bottom trawl, 25 Feb. 2003: 1 ♀ (ovi.) (sl 3.9 mm), Samcheok, Korea, 26 Feb. 2003, MADBK 160746_002.

Distribution. Northern Japan, southeastern Russia, eastern Korea.

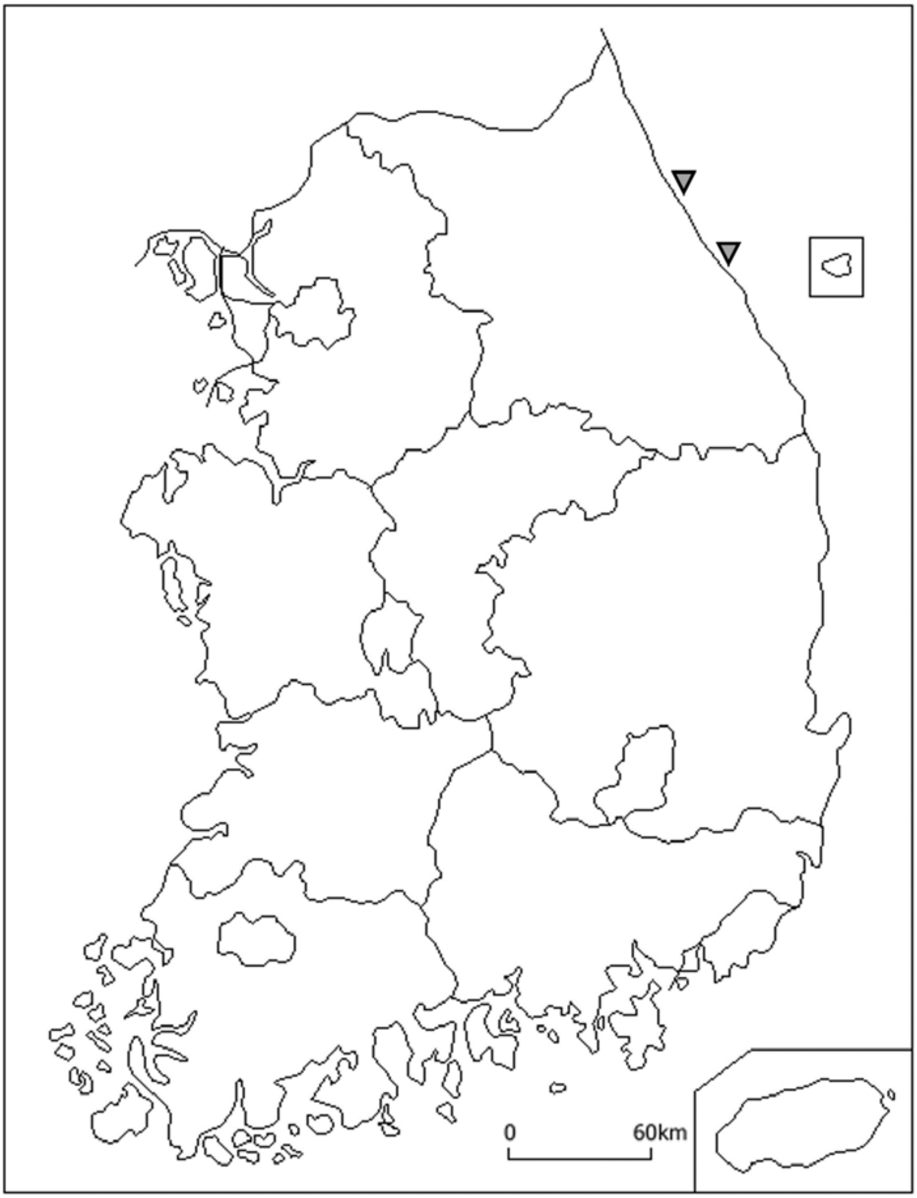

Figure 26. Distribution map of *Discorsopagurus maclaughlinae* Komai, 1995 in Korea.

Habitat. The tube of a Polychaeta tubeworm.

Remark. Kim (1985) first reported *Orthopagurus minimus* from Korean waters. However, his descriptions and figure are regarded as representing *D. maclaughlinae*. According to literature review and examination results of three specimens in Smithsonian Institution (USNM 50078, 50592, 103772, 170404) of *O. minimus*, they are usually found in water near California (USNM 1111021 was found in the Philippines; it needs more exact examinations). *Orthopagurus minimus* has five morphological characters different from *D. maclaughlinae* and Korean *O. minimus*: First, palm of right cheliped is covered with short setae in *O. minimus*, while *D. maclaughlinae* and Korean *O. minimus* have regular spines. Second, dactylus of right cheliped is covered with 3−4 rows of spines in *O. minimus*, while it is covered by 2 rows of spines in *D. maclaughlinae* and Korean *O. minimus*. Third, dorsodistal margin of merus of left cheliped bearing with 4−8 spines and distinct row of spines in *O. minimus*, while there are 4 spines and indistinct row of spine in *D. maclaughlinae* and Korean *O. minimus*. Fourth, dactyli of ambulatory legs are shorter than propodus in *O. minimus*, but they are longer than propodus in *D. maclaughlinae* and Korean *O. minimus*. Fifth, telson has transverse indentations in *O. minimus*, but it has no such indentation in *D. maclaughlinae* or Korean *O. minimus*.

In the paper of Kim (1985), the Korean name of *O. minimus* is 대롱집게. Later, Jung and Kim (2016) assigned Korean name of *D. maclaughlinae* as 긴관참집게. However, the Korean name of *O. minimus* is regarded as *D. maclaughlinae* according to above reasons.

Therefore, the Korean name of *D. maclaughlinae* should be called 대롱집게 according to principle of priority.

25. *Discorsopagurus tubicola* Komai, 2003 관참집게

(Plate 24)

Discorsopagurus tubicola Komai, 2003a: 182, figs. 1−4; McLaughlin et al., 2010, 29, fig. 13B; Jung & Kim, 2016: 144, figs. 3−6.

Material examined. 1 ♂ (sl 4.6 mm), Geoje, Korea, 34˚52’4"N 128˚44’6"E, Scuba, 27 Sep. 1981, EVOSYS 260747: 1 ♀ (sl 3.5 mm), Goseong, Korea, 38° 20'1.96"N 128° 30'58.02"E, Scuba, 24 June 2010, Coll. Park, T. S., MADBK 160747_001: 1 ♂ (sl 2.1 mm), Namhae, Korea, Scuba, 8 Aug. 2009, Coll. Park, T. S., MADBK 160747.

Habitat. The tube of a Polychaeta tubeworm.

Distribution. Southeastern mainland Japan, eastern and southern Korea.

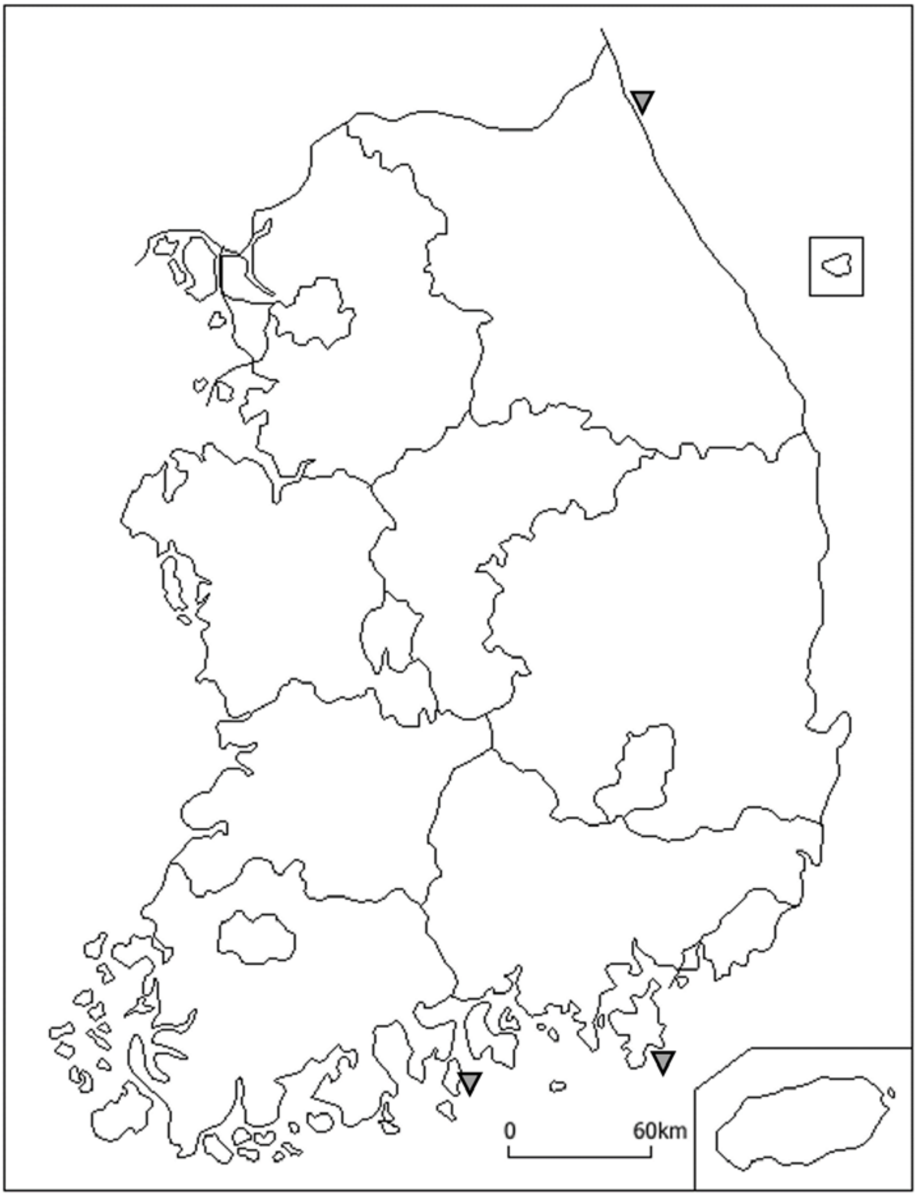

Figure 27. Distribution map of *Discorsopagurus tubicola* Komai, 2003 in Korea.

Genus *Nematopagurus* A. Milne-Edwards & Bouvier, 1892

가로마루참집게속

26. *Nematopagurus lepidochirus* (Doflein, 1902) 가로마루참집게

(Plate 25)

Eupagurus lepidochirus Doflein, 1902: 623.

Pagurus lepidochirus: Miyake, 1978: 110.

Nematopagurus squamichelis: Miyake, 1978: 129.

Nematopagurus lepidochirus: McLaughlin et al., 2007a: 224; 2010, 31; Huang & Lin, 2012: 98; Kim et al., 2014: 1670, figs. 2, 3; Kim & Kim, 2014: 34, figs. 13, 14, pl. 10.

Material examined. 1 ♂, eastern water of Jeju Island of Korea, 129 m, 28 Mar. 2013, Coll. Kim, M. H., NFRDI H 6.

Distribution. Vanuatu and New Caledonia, Indonesia, The Philippines, China, Japan, Jeju Island of Korea, 70-570 m.

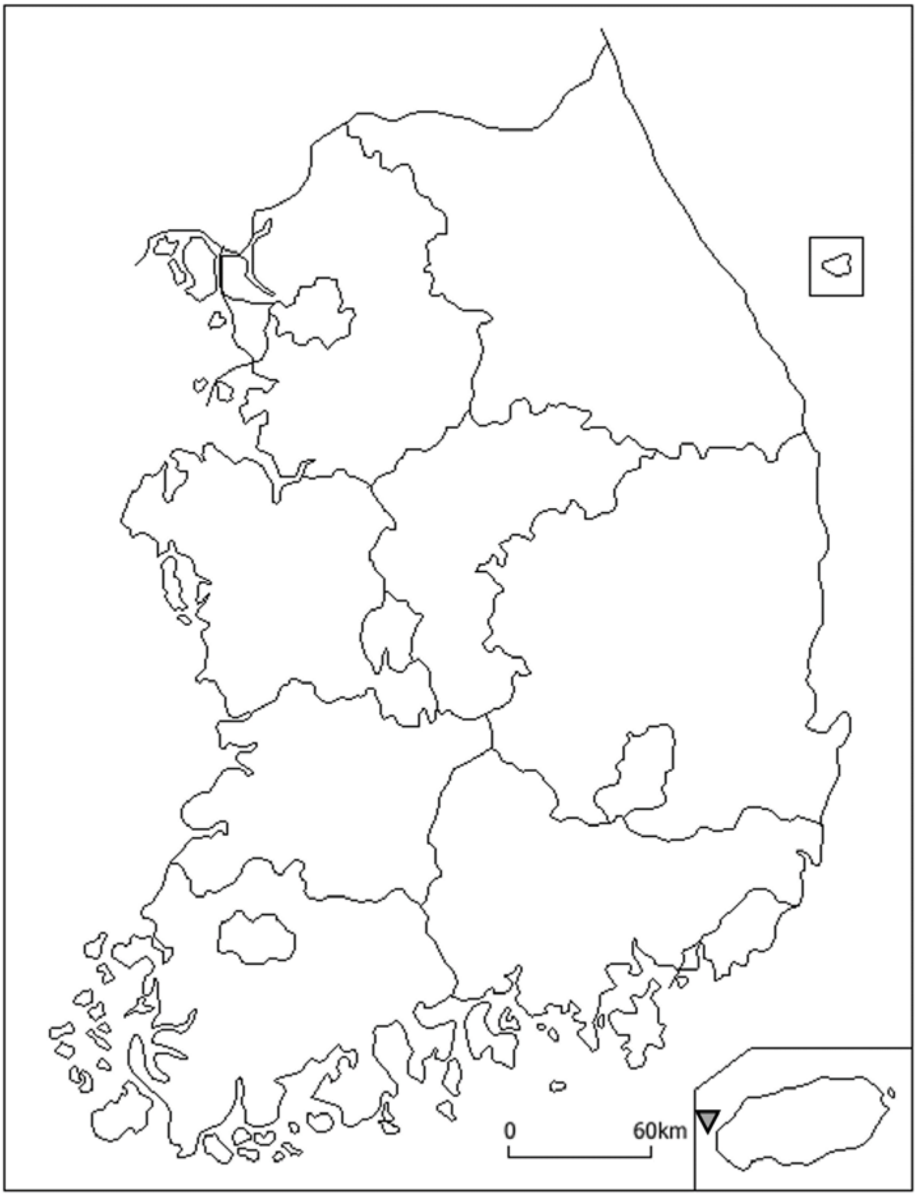

Figure 28. Distribution map of *Nematopagurus lepidochirus* (Doflein, 1902) in Korea.

Genus *Boninpagurus* Asakura and Tachikawa, 2004 줄무늬참집게속

27. *Boninpagurus pilosipes* (Stimpson, 1858) 줄무늬참집게

(Plate 26)

Eupagurus pilosipes Stimpson, 1858: 249; Alcock, 1905: 177; Stimpson, 1907: 223; Terao, 1913: 371.

Not *Pagurus pilosipes*: Miyake, 1978: 91, fig. 34.

Pagurus pilosipes: Oh, 1983: 106, pl. 1, figs 3, 4, pl. 2, figs 1–5; Kim & Kim, 1997: 216; Komai, 2003c: 117, figs. 1–5, 24A; Jo et al., 2006: 71; McLaughlin et al., 2010, 34.

Boninpagurus pilosipes: Komai et al., 2011: 43, figs. 1–4; Arima, 2014: 201; Kim & Kim, 2014: 27, fig. 10, pl. 8.

Boninpagurus acanthocheles Asakura & Tachikawa, 2004: 158, figs 1–7; McLaughlin et al., 2010: 27.

Boninpagurus sp.: McLaughlin et al. 2010: fig. 12C.

Material examined. 1 ♂, Busan, Korea, 34° 58'13.72"N 129° 21'22.24"E, fishing trap, 18 Nov. 2012, Coll. Kim, H., MADBK 160716_002: 3 inds., Seogwipo, Korea, 33° 13'42.90"N 126° 39'19.23"E, Scuba, 13 Apr. 2014, MADBK 160716_003, MADBK 160716_004: 2 inds., Yeosu, Korea, 34° 40'6.47"N 128° 15'31.69"E, Scuba, 3 Sep. 2011, Coll. Park, J. H., MADBK 160716_006.

Distribution. Okinawa, Ogasawara, Izu Islands, and Southern mainland of Japan, Jeju Island and Busan of Korea, intertidal to 25 m.

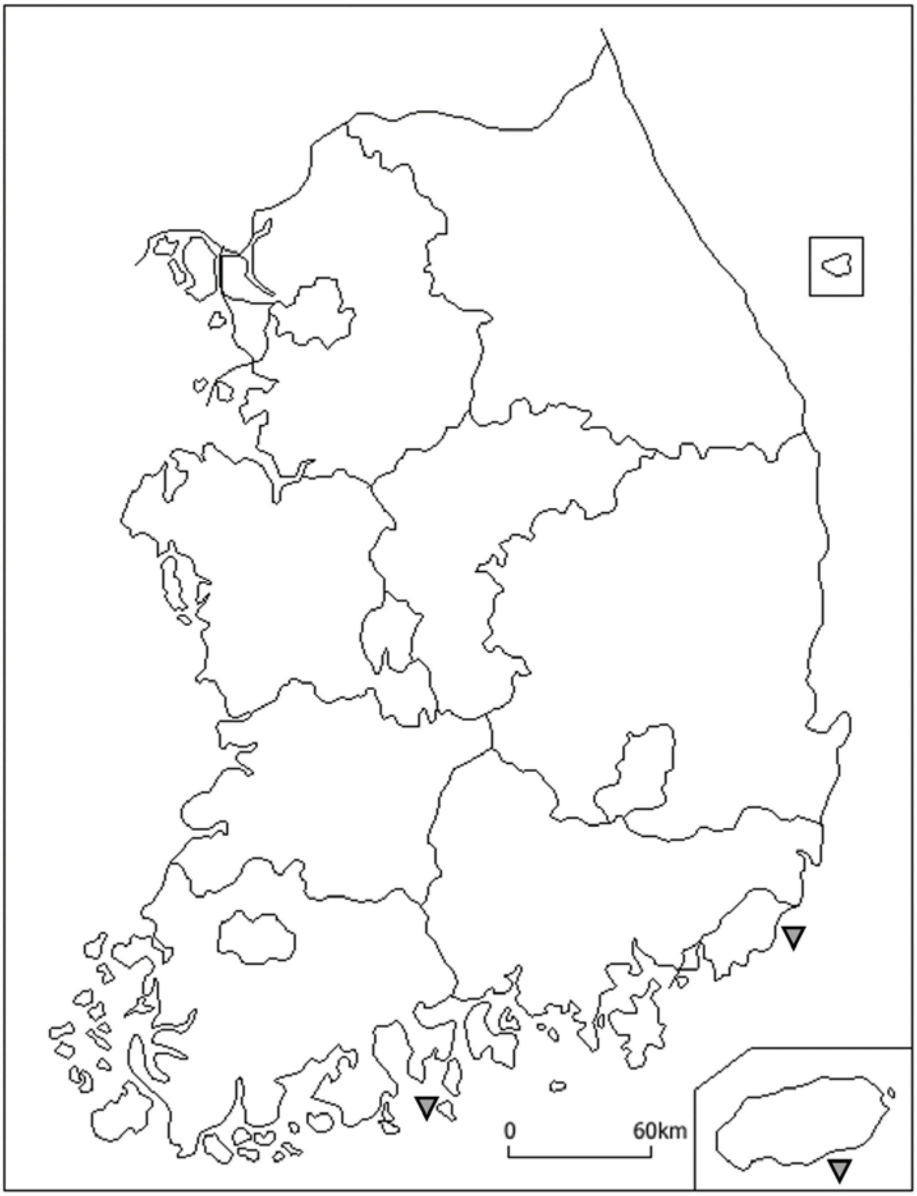

Figure 29. Distribution map of *Boninpagurus pilosipes* (Stimpson, 1858) in Korea.

Genus *Labidochirus* Benedict, 1892 작은배참집게속

28. *Labidochirus anomalus* (Balss, 1913) 작은배참집게 (Plate 27)

Eupagurus anomalus Balss, 1913: 53, fig. 32; Yokoya, 1933: 80.

Pagurus anomalus: Makarov, 1962: 185−187, pl. 4, fig. 5; Kim, 1973: 230, 600, fig. 53, pl. 6, fig. 33; Arima, 2014: 148.

Labidochirus anomalus: Kim & Kim, 1997: 216; McLaughlin et al. 2010: 30: Arima, 2014: 148.

Material examined. 9 inds., Goseong, Korea, 38° 19'53.63"N 128° 34'47.29"E, 24 Mar. 2010, Coll. Lee, S. K., MADBK 160702_002: 11 inds., Uljin, Korea, 37° 2'43.86"N 129° 25'30.33"E, 26 July 2011, Coll. Kim, S. H., MADBK 160702_003: 1 ind., Gangneung, Korea, 37° 54'48.57"N 129° 1'52.00"E, 16 Jan. 2009, Coll. Shin, M. H., MADBK 160702_008: 1 ind., Samcheok, Korea, 37° 17'19.46"N 129° 19'3.55"E, fishing trap, 16 Aug. 1982, Coll. Kim, S. H., MADBK 160702_009: 9 inds., Sokcho, Korea, 22 Aug. 1970, Coll. Kim, H. S., EVOSYS 260702#001: 1 ♀, Pohang, Korea, 7 July 1972, EVOSYS 260702#002: 4 inds., Donghae, Korea, 24 Apr. 2000, EVOSYS 260702#005: 2 inds., Yeongdeok, Korea, 9 Aug. 1971, Coll. Rho, B. J., EWUNHM DP 20151202021.

Diagnosis. Carapace well calcified, with moderately large granules and tuft of short setae. Lateral margin with a row of spines anteriorly.

Shield as long as broad. Rostrum triangular. Lateral projections acute, with additional spine. Dorsal surface with spines anteriorly. Ocular peduncles short and stout; corneas dilated, ocular acicles small and acute. Ultimate segment of antennular peduncles overreaching distal margin of corneas. Antennal peduncles overreaching distal margin of corneas by half of of fifth segment.

Pereopods with numerous setae. Chelipeds slender, subequal, right slightly larger than left; with short transverse wrinkle except unarmed dactyl and immobile fingers. Cutting edges of right cheliped with row of fused corneous teeth and 3−4 calcareous teeth, left with only row of corneous teeth. Right palm longer than dactylus, left shorter than dactylus. Dorsal surfaces and dorsomesial margins of palms and carpi with a row of strong spine. Dorsolateral margins of palm with 2 rows of small spines. Dorsodistal margins of merus with strong spine.

Ambulatory legs with numerous scalelike wrinkle except dactyl. Dactyl slightly twisted; dorsal margins and mesial surfaces with a row of spinules. Propodi. Dorsal margins of carpi with a row of spines. Ventral margins of meri with a row of spine, dorsolateral surface of second ambulatory legs with a row of strong spines.

Abdomen reduced in large specimen; dorsal surface with slightly calcified plates; ventral surface with numerous granules. Uropod asymmetry. Telson without spine.

Telson separated by very narrow median cleft, left lobe slightly larger than right one. Posterior margins of each lobe with several small spinules.

Distribution. Northeastern mainland Japan, southeastern Russia, eastern Korea, 15–270 m.

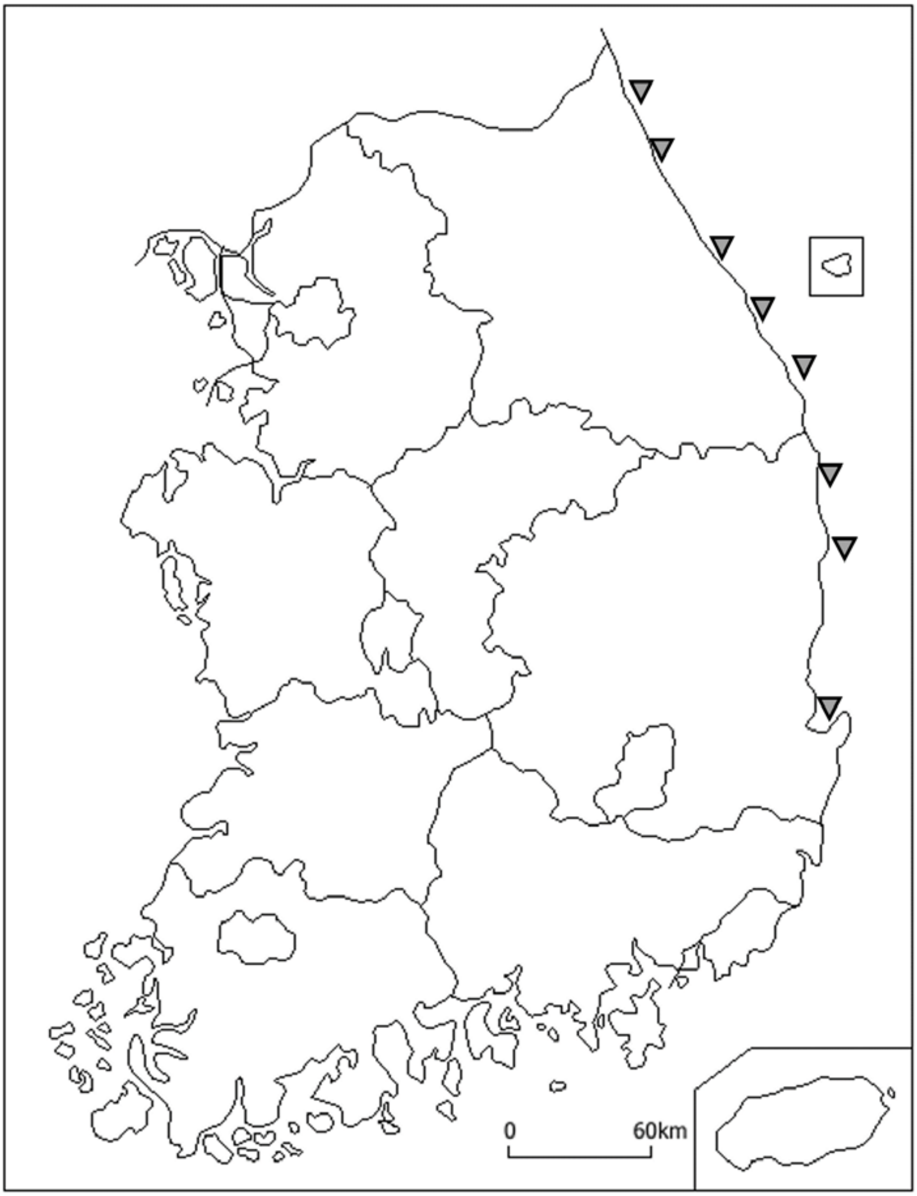

Figure 30. Distribution map of *Labidochirus anomalus* (Balss, 1913) in Korea.

Remark. A small individual of *Labidochirus anomalus* (sl 7.3 mm, MADBK 160702_003) was found having a well-developed abdomen. It is conflict with the fact that species of genus *Labidochirus* has reduced abdomen which is reported in the previous report (McLaughlin, 1974; 2003).

Genus *Elassochirus* Benedict, 1892 오목손참집게속

29. *Elassochirus cavimanus* (Miers, 1879) 오목손참집게 (Plate 28)

Eupagurus cavimanus Miers, 1879: 21, 48, pl. 3, fig. 1; Alcock, 1905: 178; Balss, 1913: 58, fig. 34; Terao, 1913: 365; Yokoya, 1933: 81.

Eupagurus (*Elassochirus*) *munitus* Benedict, 1892: 19.

Pagurus (*Elassocheirus*) *munitus*: Holmes, 1900: 150

Eupagurus munitus: Alcock, 1905: 179.

Pagurus cavimanus: Makarov, 1962:169, fig. 68b; Kim, 1973: 220, 598, fig. 47, pl. 5, fig. 27.

Pagurus cavimanus?: Makarov, 1962: 146.

Pagurus cavimanus munitus: Makarov, 1962: 147.

Pagurus gilli cavimanus: Makarov, 1962: 168.

Elassochirus cavimanus: Miyake, 1978: 124; Kim & Kim, 1997: 216; Hong et al., 2006b: 357; Kim & Son, 2006: 64; McLaughlin et al. 2010: 29, fig. 13C; Arima, 2014: 147; Kim & Kim, 2014: 32, fig. 12, pl. 9.

Eupagurus gotoi Terao, 1913: 366, fig. 2.

not *Eupagurus cavimanus*: Balss, 1913: 58, fig. 34.

not *Eupagurus munitus*: Balss, 1913: 58.

not *Pagurus cavimanus*: Makarov, 1962: 147.

Material examined. 10 inds., Uljin, Korea, 37° 2'43.86"N 129° 25'30.30"E, 21 Mar. 2009, Coll. Kim, S. H., MADBK 160701_001: 4 inds., Uljin, Korea, 37° 2'43.86"N 129° 25'30.30"E, fishing net, 25 Jan. 2010, Coll. Kim, S. H., MADBK 160701_002: 1 ind., Yangyang, Korea, 38° 5'1.05"N 128° 52'26.52"E, 22 Mar. 2010, Coll. Lee, S. K., MADBK 160701_005: 28 inds., Uljin, Korea, 37° 2'43.86"N 129° 25'30.32"E, 14 Nov. 2010, Coll. Kim, S. H., MADBK 160701_006: 1 ♂, Goseong, Korea, 38° 19'53.63"N 128° 34'47.22"E, fishing trap, 12 June 2011, Coll. Park, J. H., MADBK 160701_007: 2 ♂♂, Samcheok, Korea, 37° 4'51.20"N 129° 26'11.87"E, 18 Sep. 2011, Coll. Jung, J., MADBK 160701_009: 1 ind., Ulleung, Korea, 37° 29'3.87"N 130° 54'20.81"E, fishing trap, 15 Nov. 2013, Coll. Park, J. H., MADBK 160701_010: 2 inds., Pohang, Korea, 35° 52'32.03"N 129° 31'7.43"E, fishing trap, 25 Jan. 2015, Coll. Jung, J., MADBK 160701_011: 1 ind., Sokcho, Korea, 38° 12'51.11"N 128° 36'3.13"E, 8 May 2015, Coll. Jung, J., MADBK 160701_012: 7 inds., Donghae, Korea, 25 Aug. 1970, Coll. Kim, H. S., EVOSYS 260701_001: 1 ind., Yeongdeok, Korea, 23 Dec. 2011, Coll. Ko, H. S., NIBRIV0000256819, NIBRIV0000256820, NIBRIV0000256925: 1 ind., Ulsan, Korea, 17 Oct. 2011, Coll., Jang, C. Y., NIBRIV0000257270.

Distribution. Western America and Canada, eastern Russia, northern Japan, eastern water of Korea, 36–400 m.

Remark. Two individuals of *Elassochirus cavimanus* (MADBK 160701_002, MADBK 160701_007) were found living in the gastropod shell covered by colony of associated hydrozoan, *Hydrissa sodalis*. There is no report that *E. cavimanus* is associated with this hydrozoan.

One individuals of *E. cavimanus* (MADBK 160701_012) found in the intertidal. This unusual habitat is regarded as influence of discard by fisher because small port and fisher market is located nearby the collection site.

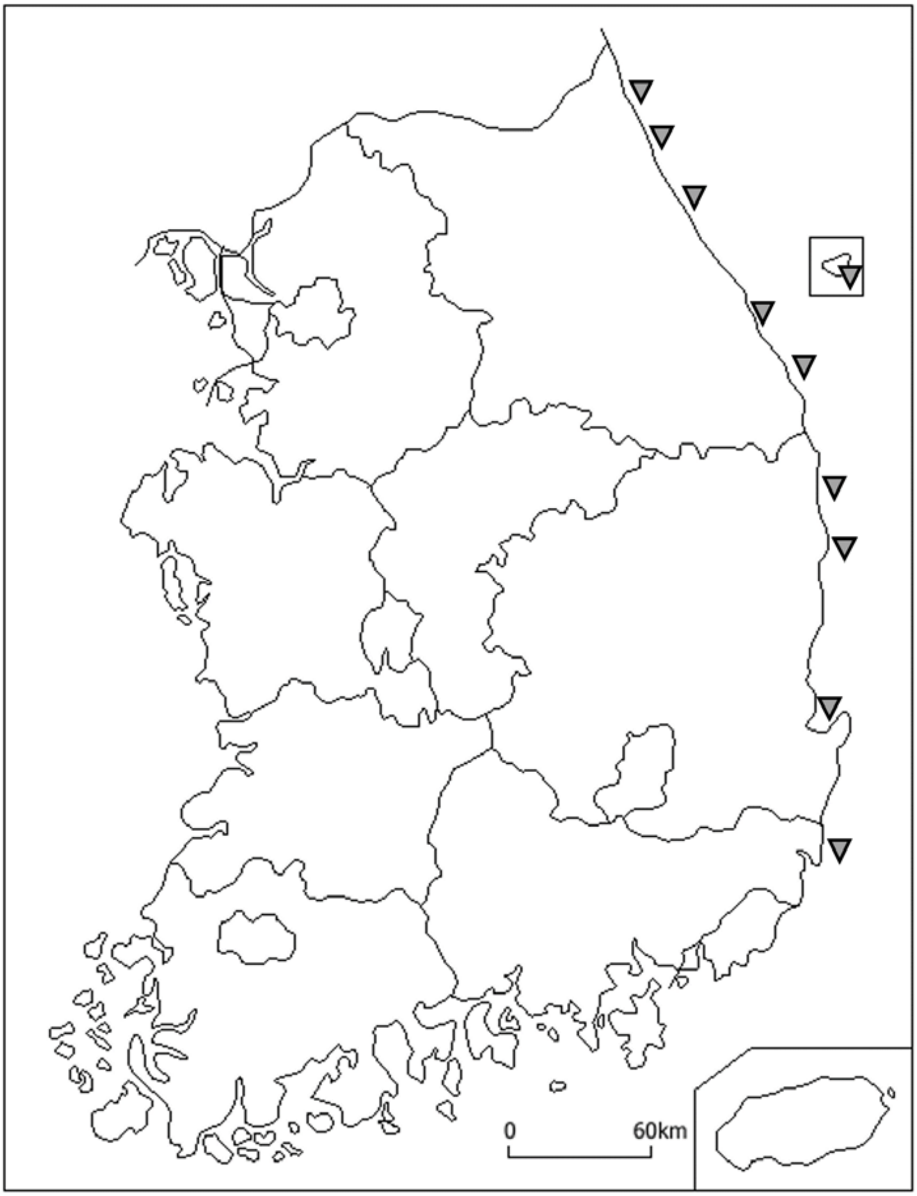

Figure 31. Distribution map of *Elassochirus cavimanus* (Miers, 1879) in Korea.

Genus *Diacanthurus* McLaughlin and Forest, 1997 가시꼬리참집게속

30. *Diacanthurus ophthalmicus* (Ortmann, 1892) 가시꼬리참집게

(Plate 29)

Eupagurus ophthalmicus Ortmann, 1892: 314, pl. 12, fig. 19.

Pagurus ophthalmicus: Miyake, 1978: 107, fig. 42.

Diacanthurus ophthalmicus: McLaughlin & Forest, 1997: 244, figs. 1, 2b, 4; McLaughlin et al., 2007a: 247; 2010: 29; Huang & Lin, 2012: 100; Kim et al., 2014: 1669, fig. 1; Kim & Kim, 2014: 30, fig. 11.

Material examined. 1 ♂ (sl 5.0 mm), eastern water of Jeju Island of Korea, 129m, 28 Mar. 2013, Coll. Kim, M. H., NFRDI H 5.

Distribution. Japan, Taiwan, Jeju Island of Korea, 65−400 m.

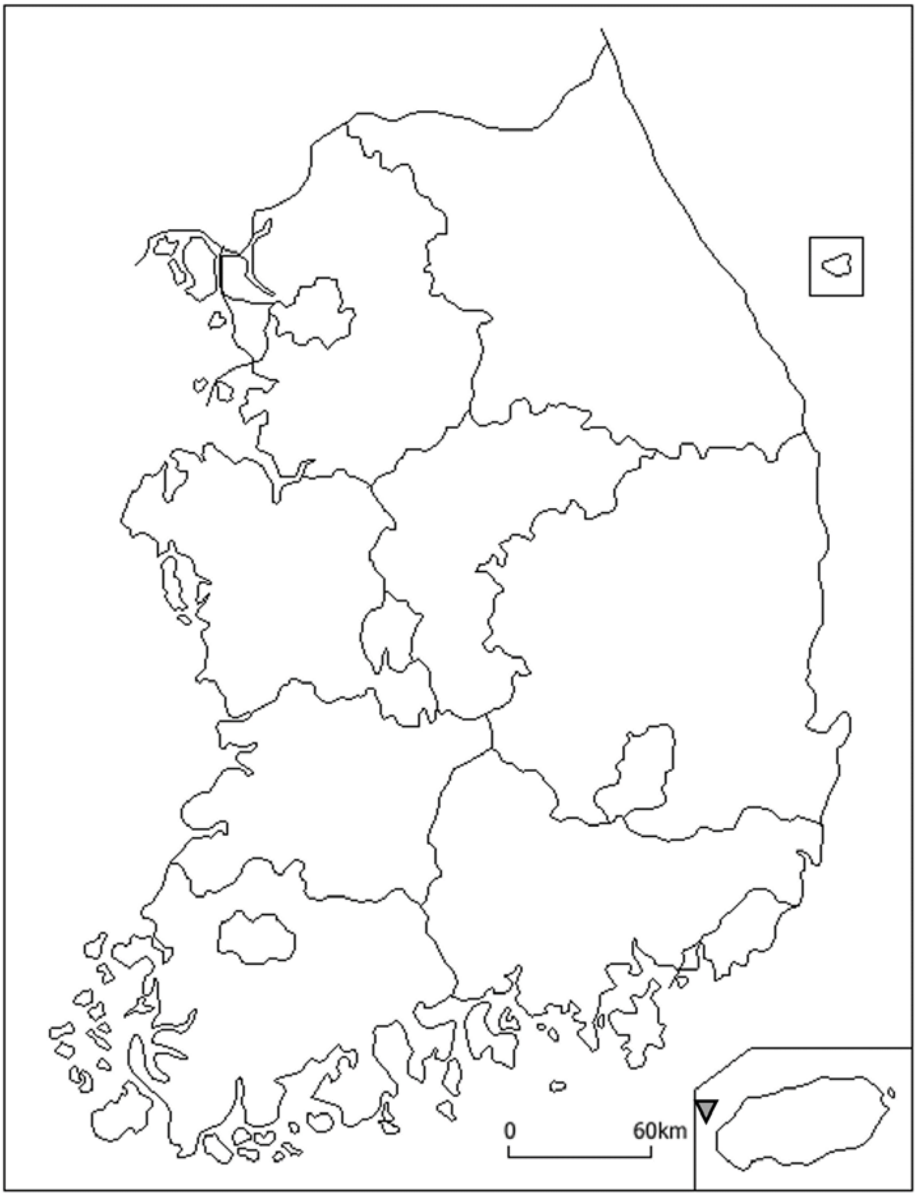

Figure 32. Distribution map of *Diacanthurus ophthalmicus* (Ortmann, 1892) in Korea.

Genus *Catapaguroides* A. Milne-Edwards and Bouvier, 1892

얼룩꼬마참집게속

31. *Catapaguroides fragilis* (Melin, 1939) 얼룩꼬마참집게

Eupagurus (*Catapagurus*) *fragilis* Melin, 1939: 45, figs. 23-26

? Catapagurus setosus Edmondson, 1951: 200, fig. 9.

Catapaguroides fragilis: Miyake, 1978: 134 (part); McLaughlin et al., 2010: 28; Arima, 2014: 155; Hwang et al., 2014: 487, figs. 1-2.

Material examined. 1 ind., Seogwipo, Korea, fishing trap, 8 Mar. 2014, Coll. Kim, M. H., NFRDI H 2.

Distribution. Southern Japan, Mururoa, Jeju Island of Korea, 10-75 m.

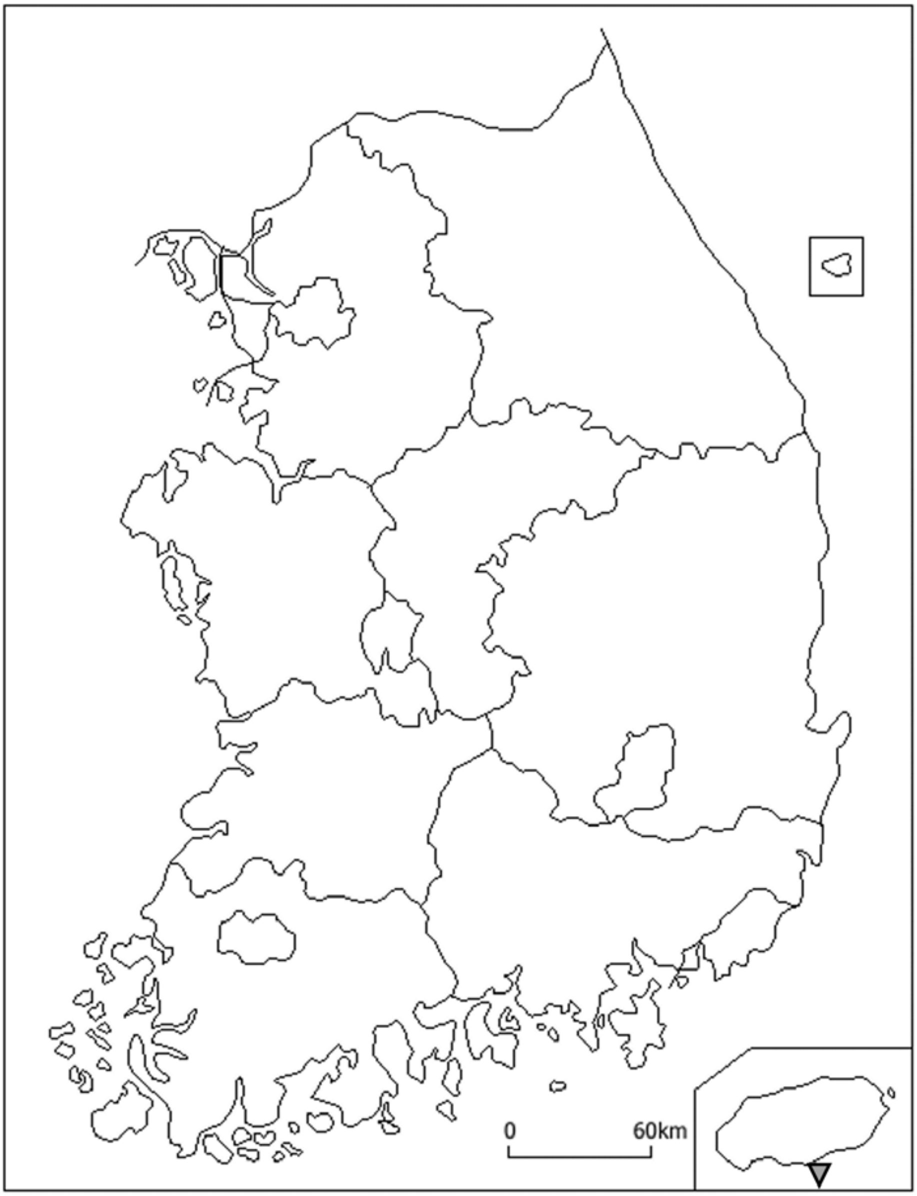

Figure 33. Distribution map of *Catapaguroides fragilis* (Melin, 1939) in Korea.

Genus *Pagurixus* Melin, 1939 작은참집게속

32. *Pagurixus fasciatus* Komai and Myorin, 2005 얼룩작은참집게

Pagurixus fasciatus Komai and Myorin, 2005: 1, figs. 1–4; McLaughlin et al., 2010: 31; Arima, 2014: 183.

? *Pagurixus patiae*: Kim et al., 2011: 176, figs. 1, 2.

? *Pagurixus fasciatus*: Kim & Kim, 2014: 37, figs. 15, 16.

Distribution. Shikoku and Izu Islands of Japan, ? Busan of Korea, intertidal? to 45 m.

Remark. *Pagurixus patiae* was first reported in Korea by Kim et al. (2011). Later, this specimen was synonymized as *Pagurixus fasciatus* by Kim & Kim (2014). However, in the figure of Kim et al. (2011) and Kim & Kim (2014), there is no ridge dorsomesial margin of palm of right cheliped which is the identification key of this species. And other morphological characters on these papers such as asymmetry of fourth pereopods and shape of telson are different from the original paper (Komai & Myorin, 2005). In addition, the living color of this species does not match the original color of *P. patiae*. At this moment, it is difficult to identify this Korean *Pagurixus* sp.. More specimens and exact examination are needed for Korean *Pagurixus* sp..

Genus *Pagurus* Fabricius, 1775 참집게속

Key to the Korean *Pagurus* species

1. Propodus and carpus of ambulatory legs with 3 or more stripes 2

– Propodus and carpus of ambulatory legs without 3 stripes · · 5

2. Chelipeds subequal · · · · · · · · · · · · · *P. decimbranchiae*

– Right cheliped larger than left one · · · · · · · · · · · · · · · 3

3. Ventral margin of dactylus of with 5–7 short spines · · · · · · *P. nigrivittatus*

– Ventral margin of dactylus of with 8–16 long spines · · · · · 4

4. Dorsal surface of right chela with 6–8 row of spines · · · · · *P. quinquelineatus*

– Dorsal surface of right chela with 4–5 row of spines · · · · · · *P. rectidactylus*

5. Ventromesial margin of right chela with a prominent humplike projection · 6

– Ventromesial margin of right chela without prominent humplike projection · 7

6. Ventromesial margin of merus of right cheliped with a prominent tubercle · *P. maculosus*

– Ventromesial margin of merus of right cheliped without a prominent tubercle · *P. lanuginosus*

7. Ventral surface of merus of chelipeds with 2 prominent tubercles proximally · 8

– Ventral surface of merus of chelipeds without 2 prominent tubercles proximally · 10

8. Propodus of second pereopods with dorsal spine · · · · · · 9

– Propodus of second pereopod almost without dorsal spine · · · *P. proximus*

9. Dorsal surface of chelae with 5 rows of spine · · · · · · · · · *P. simulans*

– Dorsal surface of chelae with 6–7 rows of spine · · · · · · · · *P. brachiomastus*

10. Ventral surface of merus of chelipeds with a prominent tubercle proximally · 11

– Ventral surface of merus of chelipeds without prominent tubercle proximally · 14

11. Dactylus of left 3rd ambulatory leg distinguished longer than propodus · 12

Dactylus of left 3rd ambulatory leg similar or shorter than propodus · 13

12. Carpus of ambulatory legs with single stripe · · · *P. minutus*

– Carpus of ambulatory legs with two stripes · · · · · · · · *P.* sp.

13. Propodus and carpus of 2nd pereopod with row of spines · · · *P. nigrofascia*

– Propodus and carpus of 2nd pereopod without row of spines · *P. filholi*

14. Dorsal surface of right palm with long setae · · · · · · · 15

– Dorsal surface of right palm without long setae · · · · · · 23

15. Dorsal surface and lateral margin of chelae with capsulelike spines · 16

– Dorsal and lateral margins of chelae without capsulelike spines 18

16. Length of ocular peduncles below half of shield · *P. japonicus*

– Length of ocular peduncles half or more than shield · · · · 17

17. Dactylus of left 3^{rd} ambulatory leg distinguished longer than propodus · *P. rubrior*

– Dactylus of left 3^{rd} ambulatory leg similar to propodus *P. similis*

18. Dorsal surface of right chela with large and strong spines 19

– Dorsal surface of right chela with small spines · · · · · · · 20

19. Dactylus of left 3^{rd} ambulatory legs distinguished longer than propodus · *P. parvispina*

– Dactylus of left 3^{rd} ambulatory legs as long as propodus · · · · *P. pectinatus*

20. Ventral surface of carpus of chelipeds with pinhole *P. conformis*

– Ventral surface of carpus of chelipeds without pinhole · · · 21

21. Right chela with spinules · · · · · · · · · · · · · · · · · 22

– Right chela without spinules · · · · · · · · · · · · · *P. exiguus*

22. Ventrolateral margin of ischium of cheliped with a strong spine · *P. spina*

– Ventrolateral margin of ischium of cheliped without spine *P. imaii*

23. Dorsal surface of right chela with strong spines · · · · · 24

– Dorsal surface of right chela without strong spines · · · · · 26

24. Dorsal surface of right chela with 3–4 rows of strong granules · *P. constans*

– Dorsal surface of right chela with more than 6 irregular rows of strong granules · 25

25. Dorsal surface of right chela with numerous tuft of short setae · *P. trigonocheirus*

– Dorsal surface of right chela with few setae · · · *P. ochotensis*

26. Dactylus of left cheliped elongated and curved inwardly · · · *P. rathbuni*

– Dactylus of left cheliped not curved inwardly · · · · · · · 27

27. Dorsal surface of left cheliped flattened or slightly convex; dorsomesial and dorsolateral margin slightly elevated · · · · 28

– Dorsal surface of left cheliped elevated; dorsomesial and dorsolateral margin not elevated · · · · · · · · · · · · · · 29

28. Posterior lobe of telson slightly concave; terminal margins horizontal · *P. gracilipes*

– Posterior lobe of telson concave; terminal margins oblique · · · *P. nipponensis*

29. Median margin of dorsal surface of right chela with elevated ridge · *P. undosus*

– Dorsal surface of right chela almost unarmed; median margin without elevated ridge · · · · · · · · · · · · · · *P. middendorffii*

33. *Pagurus decimbranchiae* Komai and Osawa, 2001 얼룩다리참집게

(Plate 30)

Pagurus pilosipes: Miyake, 1978: 91 (part).

Pagurus decimbranchiae Komai & Osawa, 2001: 1291, figs. 1–6; 조성환 외., 2006: 72; Kim & Son, 2006: 67; McLaughlin et al., 2010: 32; Arima, 2014: 124.

Material examined. 1 ind., Jeju, Korea, 8 Mar. 2014, Coll. Kim, M. H., NFRDI H 4, NIBRIV0000423045: 1 ⚦, Seogwipo, Korea, 26 Aug. 2014, Scuba 12m, Coll. Ko, H. S., SUZ DH 1.

Distribution. Eastern mainland Japan, Jeju Island of Korea, intertidal to 15 m.

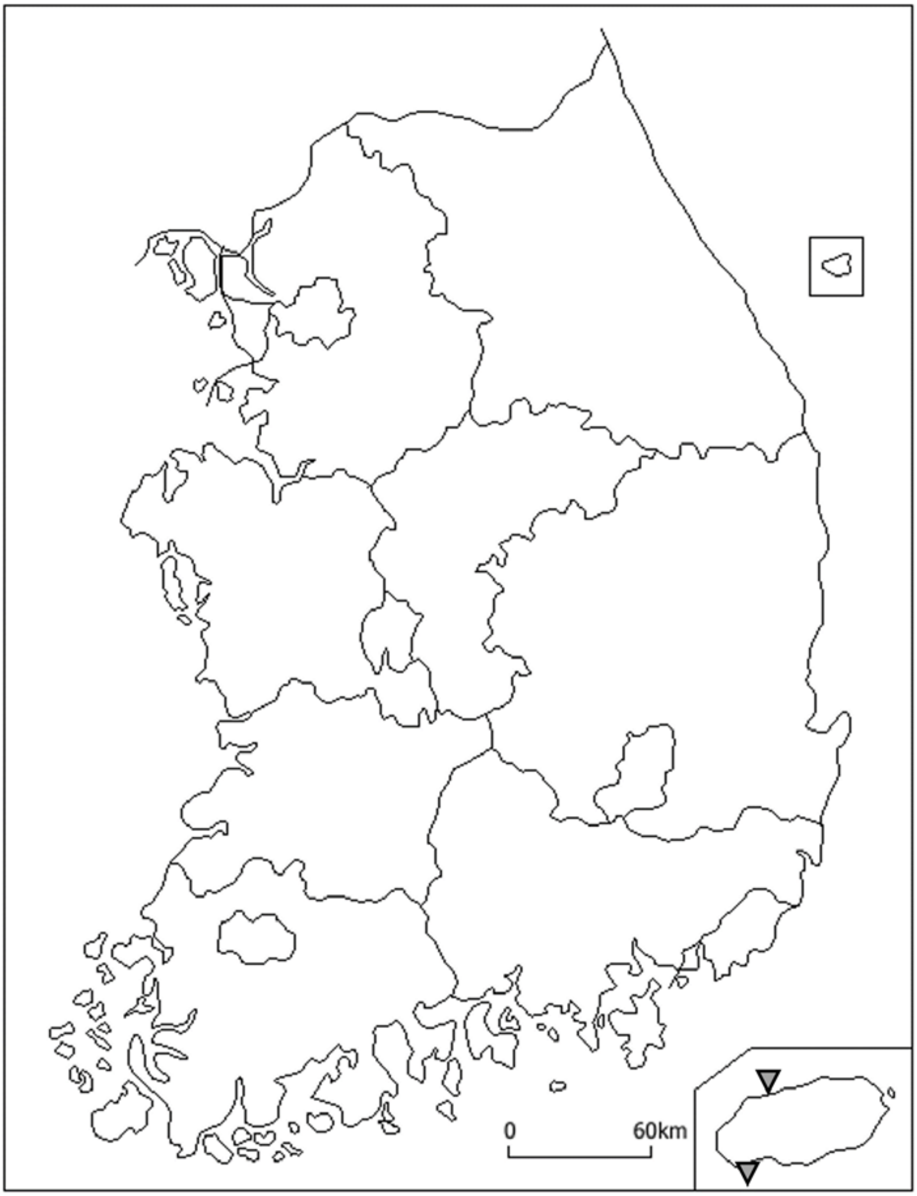

Figure 34. Distribution map of *Pagurus decimbranchiae* Komai and Osawa, 2001 in Korea.

34. *Pagurus nigrivittatus* Komai, 2003 검은줄무늬참집게 (Plate 31)

Pagurus pilosipes: Asakura, 1995: 363, pl. 97, fig. 9.

Pagurus dubius: Matsukubo, 1999: 170.

Pagurus nigrivittatus Komai, 2003c: 141, figs. 16–19, 24D, 25B; Hong et al., 2006a: 253, fig. 3C; Hong et al., 2006b: 360; Kim & Son, 2006: 75; McLaughlin et al., 2007a: 275; 2010: 33; Huang & Lin, 2012: 102; Arima, 2014: 116.

Material examined. 1 ind., Jeju, Korea, 33° 25'17.44"N 126° 9'38.96"E, 29 Sep. 2014, Scuba, Coll. Lee, S. K., MADBK 160725_001: 5 inds., Ulleung, Korea, 37° 27'45.19"N 130° 50'18.64"E, Scuba, 13 Nov. 2013, Coll. Park, J. H., MADBK 160725_002: 2 inds., Dokdo, Ulleung, Korea, 37° 14'23.90"N 131° 51'46.80"E, Scuba, 27 May 2015, Coll. Park, J. H., MADBK 160725_003: 1 ind., same as MADBK 160725_002, NIBRIV0000458781–NIBRIV0000458783.

Distribution. Southern and Fukui Prefecture of mainland Japan, Taiwan, Jeju, Dokdo Island and Ulleung of Korea, intertidal to 15 m.

Remark. Some specimens of *Pagurus nigrivittatus* (MADBK 160725_001, 160725_002, NIBRIV0000458781–83) were found in Ulleung and Jeju. These locations seem to be the northern and eastern limiting line of this species, respectively.

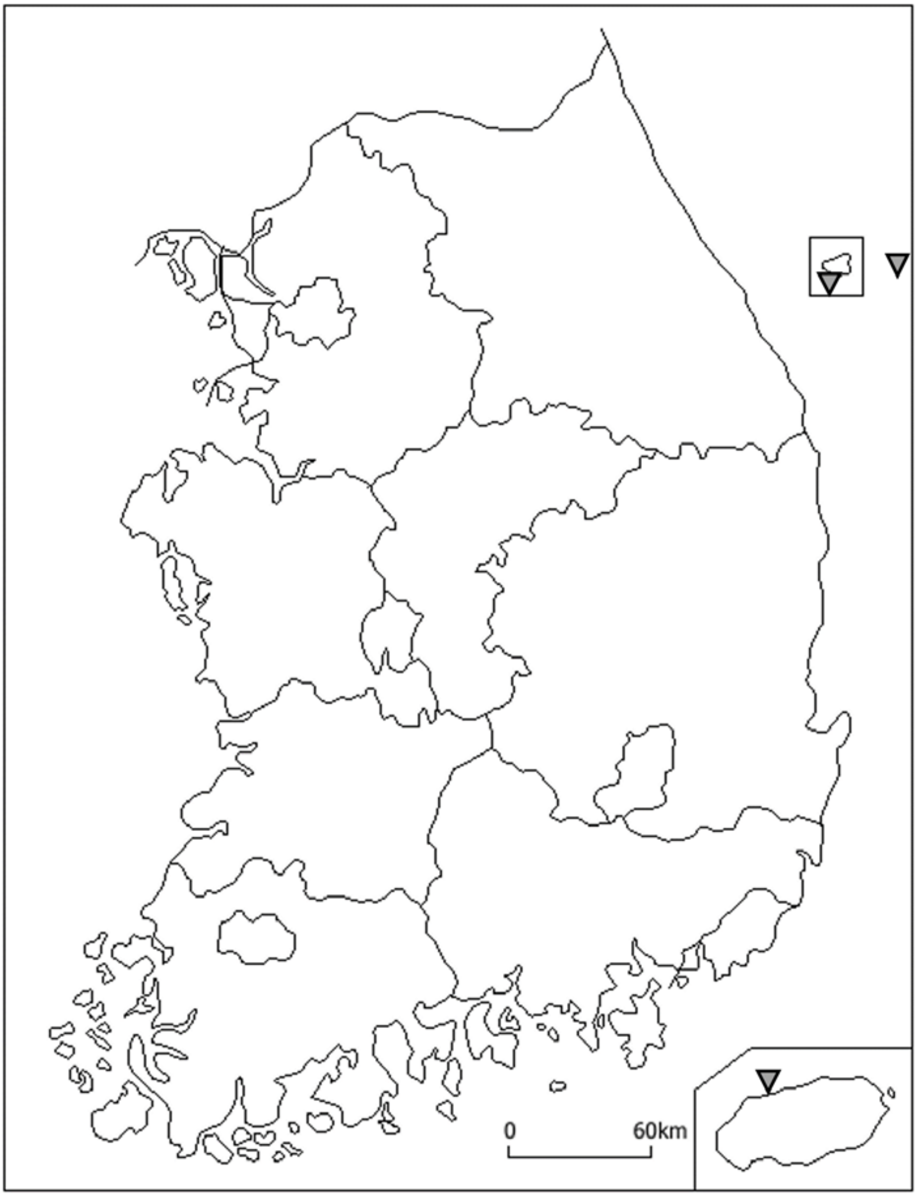

Figure 35. Distribution map of *Pagurus nigrivittatus* Komai, 2003 in Korea.

35. *Pagurus quinquelineatus* Komai, 2003 다섯줄참집게

(Figure 36, Plate 32)

Pagurus pilosipes: Miyake, 1978: 91 (part), fig. 34d

Pagurus quinquelineatus Komai, 2003c: 149, figs. 20–23, 24E, 25C; Komai & Takeda, 2006: 116; McLaughlin et al., 2010: 34, 16D; Arima, 2014: 118; Jung & Kim, 2017: 661, fig. 1.

Material examined. 1 ♀ (sl 2.2 mm), Uljin, Korea, Scuba, 30 Oct. 2009, MADBK 160742_001: 1 ⚥, Ulleung, Korea, Scuba, 20 June 2013, Coll. Jung, J., EVOSYS 260742: 1 ♀ (sl 2.7 mm), Ulleung, Korea, Scuba, 13 Nov. 2013, Coll. Jung, J., NIBRIV0000325763.

Diagnosis. Shield (Figure 36A) as long as broad, with tuft of setae. Rostrum roundly triangular, exceeding base of ocular acicle. Lateral projection obsolete. Posterior carapace almost membranous, with tuft of setae.

Ocular peduncle shorter than shield; dorsomesial margin with row of tuft of setae. Ocular acicle subcircular, terminating in small submarginal spine, separated basally by about half width of acicle. Antennular peduncle slightly exceeding cornea. Antennal peduncle reaching cornea. Antennal flagellum exceeding distal end of right cheliped.

Pereopods with numerous long tufts of setae. Right cheliped (Figure 36B) longer than left one. Chela of right cheliped two times as long as broad. Dactylus slightly shorter than palm; dorsal surface with row of spines; dorsomesial margin with small tubercles; cutting edge with row of calcareous teeth, terminating in corneous claw. Palm shorter than carpus, dorsal surface slightly convex with 7 rows of small tubercles; dorsomesial and dorsolateral margin with row of spines. Carpus shorter than merus; dorsal surface with scattered spines. Ventromesial and ventrolateral margin of merus with row of spines.

Chela of left cheliped (Figure 36C) 3 times as long as broad. Dactylus unarmed, longer than palm; cutting edge with row of corneous teeth, terminating in corneous claw. Palm half times as long as carpus; dorsal surface slightly convex with 2 rows of spines nearby midline, mesial part with 3–4 small spines; dorsolateral margin with row of spines. Carpus as long as merus, depressed laterally; dorsomesial and dorsolateral margins with rows of spines; ventrolateral margin with row of spines distally. Ventromesial and ventrolateral margin of merus with row of spines.

Ambulatory legs (Figure 36D–F) slightly slender and long. Dactylus subequal to propodus, with distal corneous claw; dorsomesial surface with row of spines; ventral margin with 8–12 long spines. Ventral margin of propodus with row of 3–6 spines distally. Carpus with dorsodistal spine.

Abdomen coiled rightward, with 4 unpaired pleopods in female and asymmetric uropods.

Terminal margin of telson (Figure 36G) slightly concave, terminal lobe divided by shallow and wide median cleft, each lobe armed with 6–7 spines.

Color. In ethanol, each ambulatory leg with 3 stripes on lateral surface of dactylus, 5 stripes on propodus, and 4 stripes on carpus.

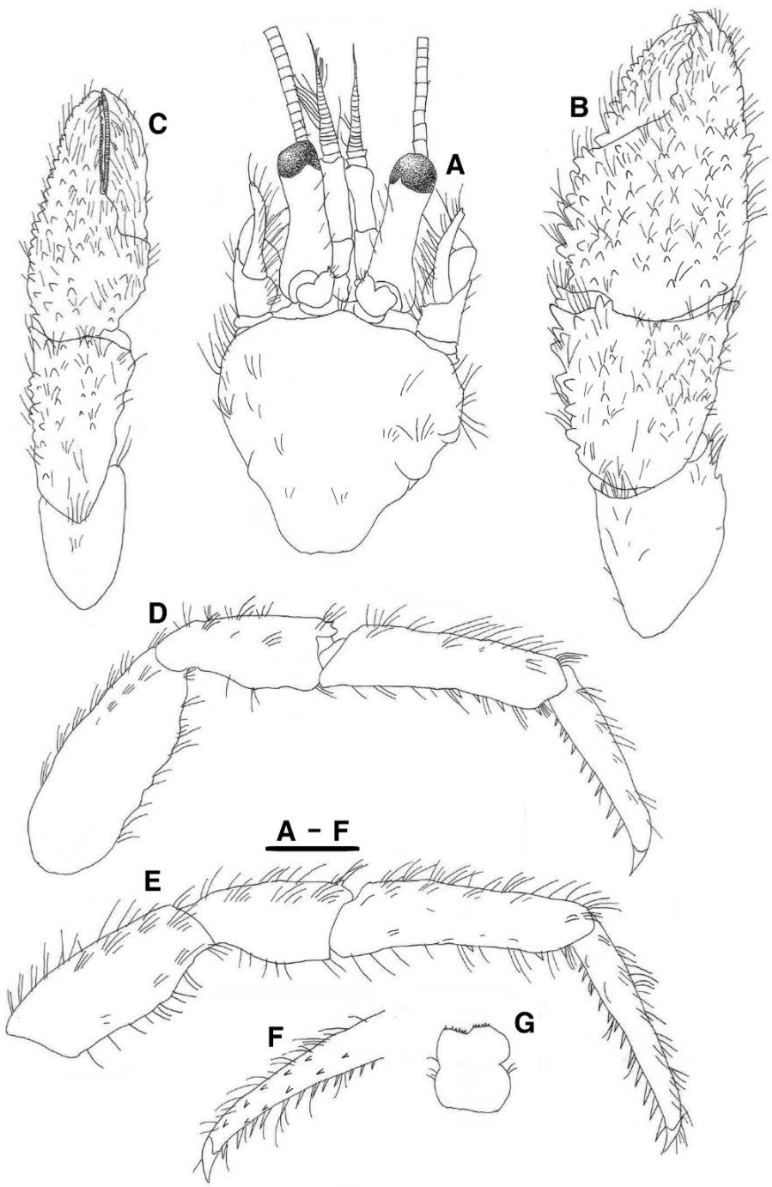

Figure 36. *Pagurus quinquelineatus* Komai, 2003, female, sl 2.7 mm, NIBRIV0000325763. A, Shield and cephalic appendages, dorsal view; B, Right cheliped, dorsal view; C, Left cheliped, dorsal view; D, Left pereopod 2, lateral view; E, Left pereopod 3, lateral view; F, Dactylus of left pereopod 3, mesial view; G, Telson, dorsal view. Scale bar = 1.0 mm.

Distribution. Southeastern and northwestern mainland Japan, Ulleung and Uljin of Korea, intertidal to 20 m.

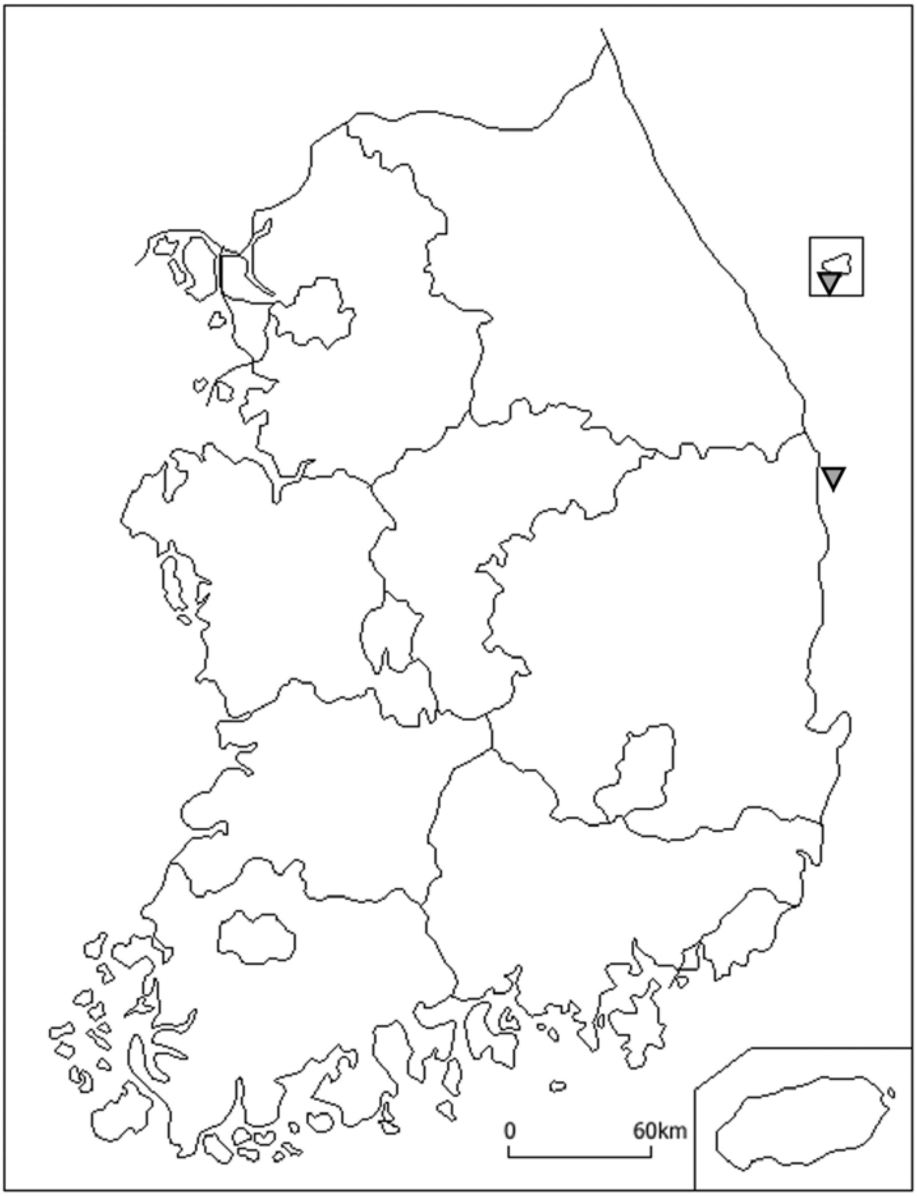

Figure 37. Distribution map of *Pagurus quinquelineatus* Komai, 2003 in Korea.

Habitat. Inhabited gastropod shell.

Remark. *Pagurus quinquelineatus* is similar to *P. nigrivittatus*, previously reported from Korea. This species, however, can be distinguished from the latter species by the following characteristics. First, mesial face of dactylus of second pereopod bears a row of spines, whereas no spines in *P. nigrivittatus*. Second, mesial face of dactylus of third pereopod is covered with two rows of spines, whereas one row of spines in *P. nigrivittatus*. Third, ventral margin of dactylus of pereopod bears 8−16 long spines, whereas 5−7 short spines in *P. nigrivittatus*. Fourth, ventral margin of propodus of left third pereopod bears 3−8 corneous spines, whereas numerous tiny spinules in *P. nigrivittatus*. Fifth, Lateral surface of propodus of each ambulatory leg bears 5 stripes, whereas 3 stripes in *P. nigrivittatus*.

Pagurus quinquelineatus and *P. rectidactylus* are very similar to each other. They are differing from each other in five minor morphological characteristics. First, antennular peduncle of *P. quinquelineatus* is shorter than that of *P. rectidactylus*. Second, dorsal surface of dactylus of right cheliped is armed with a row of spines in *P. quinquelineatus*, whereas unarmed or armed with a row of tiny spines in *P. rectidactylus*. Third, dorsal surface of palm of right cheliped is armed with 7 rows of spines in *P. quinquelineatus*, whereas 4−5 rows of spines in *P. rectidactylus*. Fourth, each ambulatory leg of *P. quinquelineatus* is shorter than that of *P. rectidactylus*. Fifth, ventral margin of dactylus of each ambulatory leg is armed with 8−12 spines in *P. quinquelineatus*, whereas 12−16 spines in *P. rectidactylus*. Komai et al. (2015) mentioned that *P.*

quinquelineatus and *P. rectidactylus* differ in the number of spines on ventral margins of dactylus and propodus of each ambulatory leg, but also stated that the number slightly overlaps between the two species. In the present study, overlapping of spines between the two species was also noted (*P. quinquelineatus*: 3–6 spines, *P. rectidactylus*: 4–8 spines).

Using COI, *P. quinquelineatus* and *P. rectidactylus* are mixed as one clade in the DNA barcoding results (Figures 38). This result and morphological similarities suggest that they are the same species. This result is discussed detailed in the 'Discussion' section.

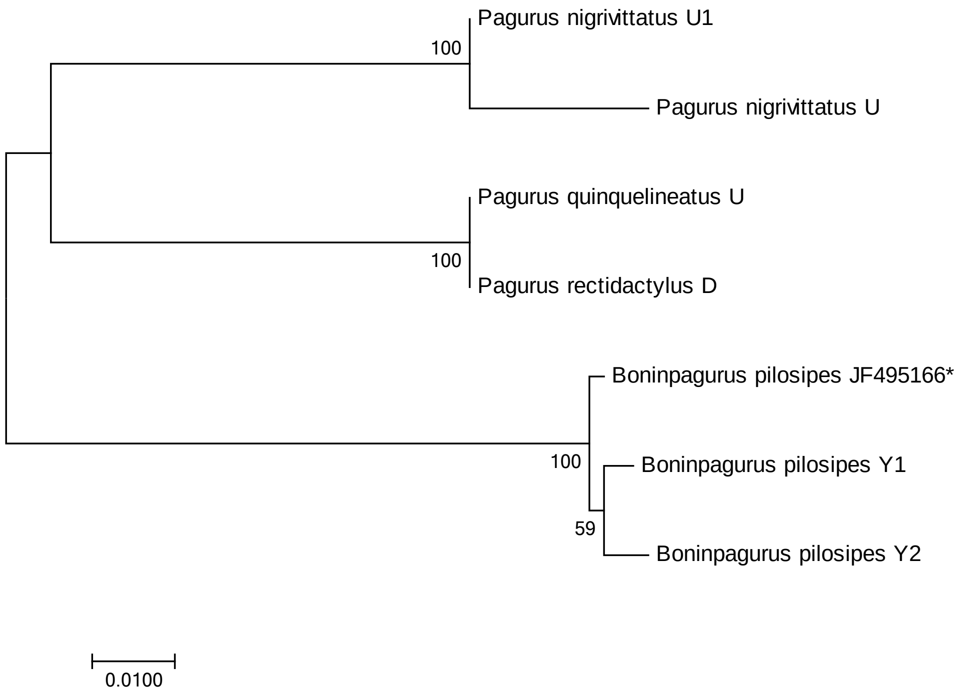

Figure 38. A Maximum likelihood tree of COI of Korean *Boninpagurus pilosipes* group. Abbreviations after species name is first letter of location in the Table 3. * means NCBI sequence. Bootstrap values are calculated from 1,000 replicates; the nodes are shown values above 50%.

36. *Pagurus rectidactylus* Komai, Saito and Myorin, 2015[2]

제집줄참집게 (Figure 39, Plate 33)

Pagurus rectidactylus Komai, Saito and Myorin, 2015: 225, figs. 1–5; Jung & Kim, 2017: 661, figs. 2, 3.

Material examined. 1 ♂ (sl 5.4 mm), Dokdo, Ulleung, Korea, Scuba, 21 Sep. 2015, Coll. Park, J. H., MADBK 160748_001: 1 ♂ (sl 3.5 mm), Dokdo, Ulleung, Korea, Scuba, 3 June 2015, Coll. Park, J. H., NIBRIV0000325762.

Diagnosis. Shield (Figure 39A) as long as broad, with tuft of setae. Rostrum broadly triangular, exceeding base of ocular acicles. Lateral projection obsolete. Posterior carapace almost membranous, with tuft of setae.

Ocular peduncle shorter than shield; dorsomesial margin with a row of tuft of setae. Ocular acicles subcircular, terminating in small submarginal spine, separated basally by about basal width of acicle. Antennular peduncle exceeding corneas by half of ultimate segment. Antennal peduncle exceeding corneas. Antennal flagellum reaching distal end of right cheliped.

Pereopods with numerous long tufts of setae. Right cheliped (Figure 39B) longer than left one. Chela of right cheliped two times as long as broad. Dactylus slightly shorter than palm; dorsal surface unarmed

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[2] The explanation of this species in this thesis came from the paper of the author (Jung & Kim, 2017).

or row of tiny spines; dorsomesial margin with small tubercles; cutting edge with row of calcareous teeth, terminating in corneous claw. Palm as long as carpus and merus, dorsal surface slightly convex with 4–5 rows of small spines or tubercles; dorsomesial and dorsolateral margin with row of spines. Dorsal surface of carpus with 4 irregular rows of spines. Ventromesial and ventrolateral margin of merus with row of spines.

Chela of left cheliped (Figure 39C) 3 times as long as broad. Dactylus unarmed, longer than palm; cutting edge with row of corneous teeth, terminating in corneous claw. Palm half time as long as carpus; dorsal surface slightly convex with 2 rows of spines nearby midline, mesial part with 3–4 small spines or tubercles; dorsolateral margin with row of spines. Carpus as long as merus, depressed laterally; dorsomesial and dorsolateral margins with rows of spines sparsely; lateral surface with few tubercles; ventrolateral margin with row of spines distally. Ventromesial and ventrolateral margin of merus with row of spines.

Ambulatory legs (Figure 39D–F) slender and long. Dactylus subequal to propodus, with distal corneous claw; dorsomesial surface with row of spines; ventral margin with 12–16 long spines. Ventral margin of propodus with row of 4–8 spines distally. Carpus with dorsodistal spine.

Abdomen coiled rightward, with 3 unpaired pleopods in male and asymmetric uropods.

Terminal margin of telson (Figure 39G) slightly concave, terminal lobe divided by shallow and wide median cleft, each lobe armed with 6 spines.

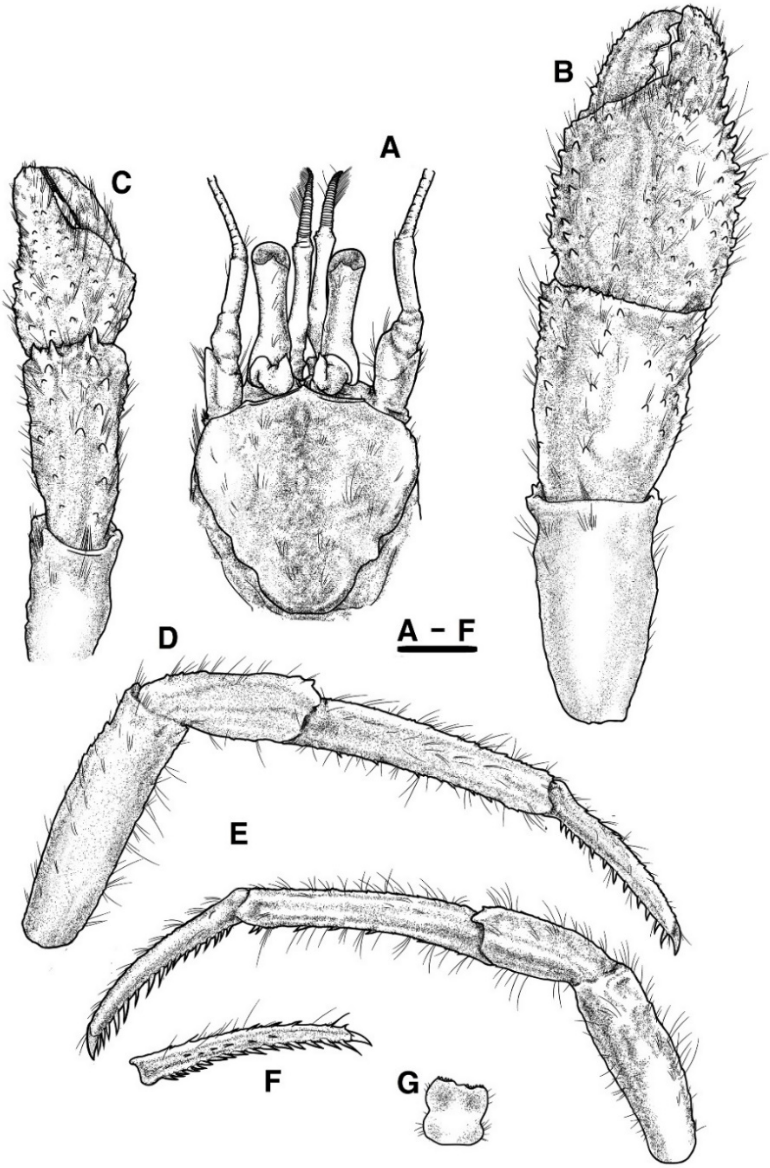


Figure 39. *Pagurus rectidactylus* Komai, Saito & Myorin, 2015, male, sl 5.4 mm. A, Shield and cephalic appendages, dorsal view; B, Right cheliped, dorsal view; C, Left cheliped, dorsal view; D, Left pereopod 2, lateral view; E, Left pereopod 3, lateral view; F, Dactylus of left pereopod 3, mesial view; G, Telson, dorsal view. Scale bar = 2.0 mm (Jung & Kim, 2017).

Color. In ethanol, each ambulatory leg with 3 stripes on lateral surface of dactylus, 5 stripes on propodus, and 4 stripes on carpus.

Distribution. Hiroshima and Fukui of Japan, Dokdo Island and Ulleung of Korea, intertidal to 15 m.

Habitat. Carcinoecia formed by an associated hydrozoan, *Hydrissa sodalis*.

Remark. The present specimens of South Korean *P. rectidactylus* showed some differences from the original description (Komai et al., 2015). First, there are 12 spines on the ventral margin of dactylus of right second pereopods in the present specimens, whereas 15–20 spines in the original description. Second, left chela in the present specimens has more spines and tubercles than original description. Third, antennal acicles were missing in one specimen of South Korean *P. rectidactylus* (MADBK 160748_001), and it might be due to injury or abnormality. The last and distinct feature is that associated hydrozoan forming carcinoecia of *P. rectidactylus* is *H. sodalis* in the present specimens, whereas *Bouillonactinia misakiensis* (Iwasa, 1934) in the original description.

As mentioned in the remark of *P. quinquelineatus*, *P. rectidactylus* and *P. quinquelineatus* are mixed as one clade in the COI tree (Figures 38). This result and morphological similarities suggest that they are the same species. This result is discussed detailed in the 'Discussion' section.

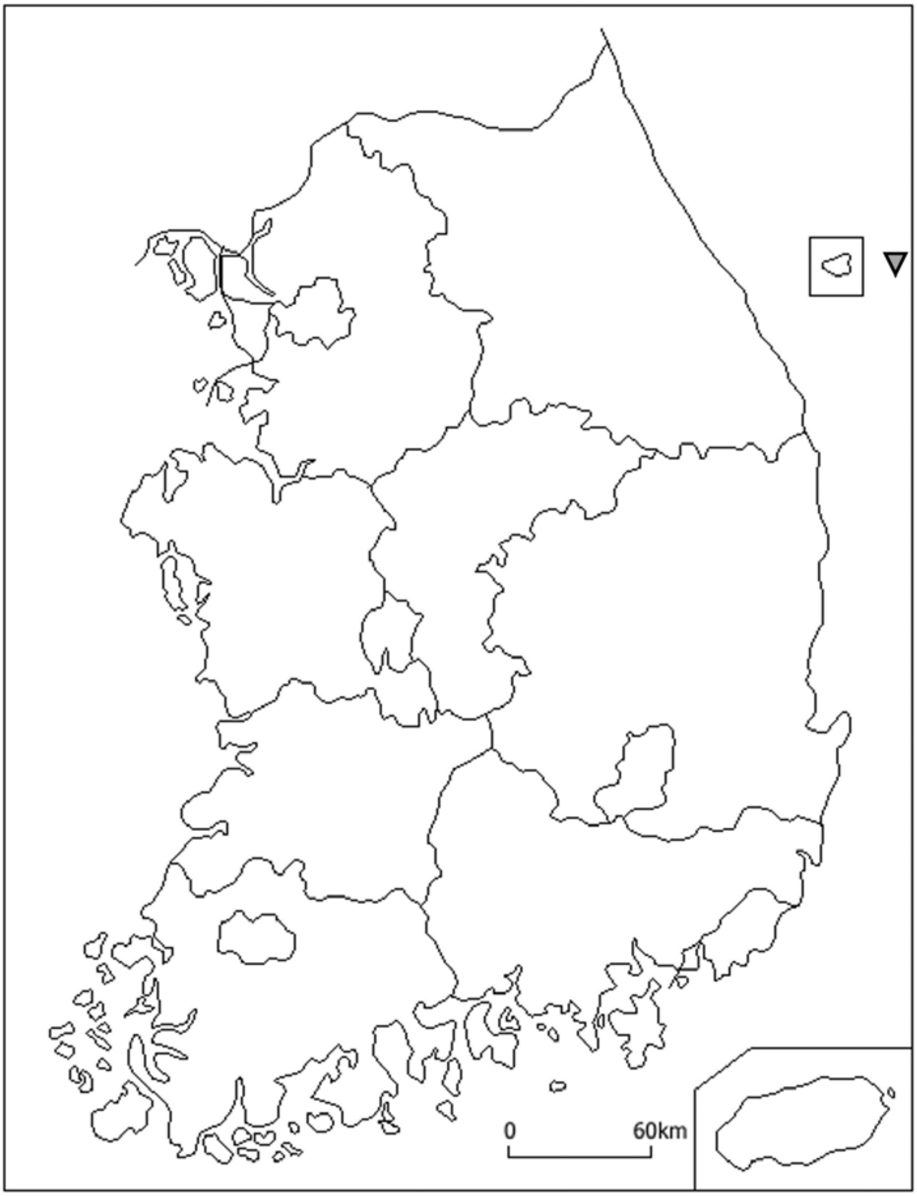


Figure 40. Distribution map of *Pagurus rectidactylus* Komai, Saito and Myorin, 2015 in Korea.

37. *Pagurus maculosus* Komai and Imafuku, 1996 가는몸참집게

(Plate 34)

Eupagurus lanuginosus: Ortmann, 1892: 312 (part); Doflein, 1902: 647 (part); Balss, 1913: 56 (part).

Pagurus lanuginosus: Miyake, 1978: 81 (part); Asakura, 1995: 363, pl. 97, fig. 11.

Pagurus maculosus Komai & Imafuku, 1996: 791, figs. lB, C bottom, 6; Kim & Son, 2006: 71; McLaughlin et al., 2010: 33; Arima, 2014: 118; Kim & Kim, 2014: 53, fig. 22, pl. 15.

Pagurus angustus: Oh, 1983: 108, pl. 1, figs. 5, 6, pl. 4, figs. 1–5; Hong et al., 2006a: 253, fig. 3B, Hong et al., 2006b: 359; Kim & Son, 2006: 70.

Material examined. 3 inds., Gangneung, Korea, 37° 54'37.03"N 128° 51'11.41"E, 21 Oct. 2010, Coll. Lee, S. K., MADBK 160722_004: 4 ♀♀, 6 ♂♂, Jeju, Korea, 33° 16'20.45"N 125° 59'15.61"E, hand, 2 Nov. 2010, Coll. Kang, S., MADBK 160722_005: 1 ♀, 2 ♂♂, Uljin, Korea, 37° 0'18.03"N 129° 25'40.81"E, 3 July 2009, Coll. Yeom, D., MADBK 160722_009: 10 inds., Pohang, Korea, 36° 0'40.98"N 129° 37'29.58"E, hand, 17 Sep. 2011, Coll. Jung, J., MADBK 160722_013: 1 ind., Busan, Korea, 34° 58'13.72"N 129° 21'22.24"E, fishing trap, 18 Nov. 2012, Coll. Kim, H., MADBK 160722_014: 43 inds., Ulleoung, Korea, 37° 27'32.54"N 130° 51'23.42"E, Scuba, 16 Nov. 2013, Coll. Park, J. H., MADBK 160722_024: 1 ind., Sokcho, Korea, 38° 10'44.74"N

128° 36'36.64"E, hand, 23 Jan. 2015, Coll. Jung, J., MADBK 160722_025: 3 inds., Gyeongju, Korea, 35° 48'17.25"N 129° 30'13.41"E, hand, 25 Jan. 2015, Coll. Jung, J., MADBK 160722_026: 5 inds., Dokdo, Ulleung, Korea, 37° 14'17.77"N 131° 52'06.29"E, Scuba, 21 Sep. 2014, Coll. Park, J. H., MADBK 160722_028: 1 ind., Ulsan, Korea, 9 Oct. 1998, EVOSYS 260722.

Distribution. Southeastern mainland Japan, eastern and southern Korea, intertidal to subtidal.

Remark. Some specimens of *Pagurus maculosus* (MADBK 160722_025, EVOSYS 260712#065) were found in Sokcho and Jeju. These locations seem to be the northern and eastern limiting line of this species, respectively.

Oh (1983) first reported *Pagurus angustus* from Korean waters. However, the description, figures, and reference specimens (NIBRIV0000167393, NIBRIV0000167394) represent *P. maculosus*. According to literature review and examination results of specimen (MADBK 160703, colletion sites: Japan, Taiwan) of *P. angustus*, this species has five morphological characters different from *P. maculosus* and Korean *P. angustus*. First, palm of right cheliped is covered with few short setae and numerous granules in *P. angustus*, while it is covered with numerous long setae and spines in *P. maculosus* and Korean *P. angustus*. Second, ventromesial margin of right chela without prominent humplike projection in *P. angustus*, but it has prominent humplike projection in *P. maculosus* and Korean *P.*

angustus. Third, middle of ventral surface of merus of right cheliped and left cheliped bearing with a prominent tubercle in *P. angustus*, while ventromesial margin of merus of right cheliped bearing with a prominent tubercle in *P. maculosus* and Korean *P. angustus*. Fourth, telson bearing with tiny spinules in *P. angustus*, while large spines and tiny spinules are present in *P. maculosus* and Korean *P. angustus*. Fifth, pereopods without pale blue or pale purple spots in *P. angustus*, but they are covered with pale blue or pale purple spots in *P. maculosus* and Korean *P. angustus*.

Oh (1983) reported the Korean name of *P. angustus* as 가는몸참집게. Later, Kim and Son (2006) assigned Korean name of *P. maculosus* as 흰점털다리참집게. However, the Korean *P. angustus* is regarded as *P. maculosus* according to above reasons. Therefore, the Korean name of *P. maculosus* should be called 가는몸참집게 according to principle of priority.

On the abdomen of two specimens of *P. maculosus* (MADBK 160712_013, MADBK 160712_024), parasitic barnacles were found. Its approximate morphological characteristics are similar to those of *Peltogasterella gracilis* (Boschma, 1927). This relationship has already been reported by Yanagimachi (1961).

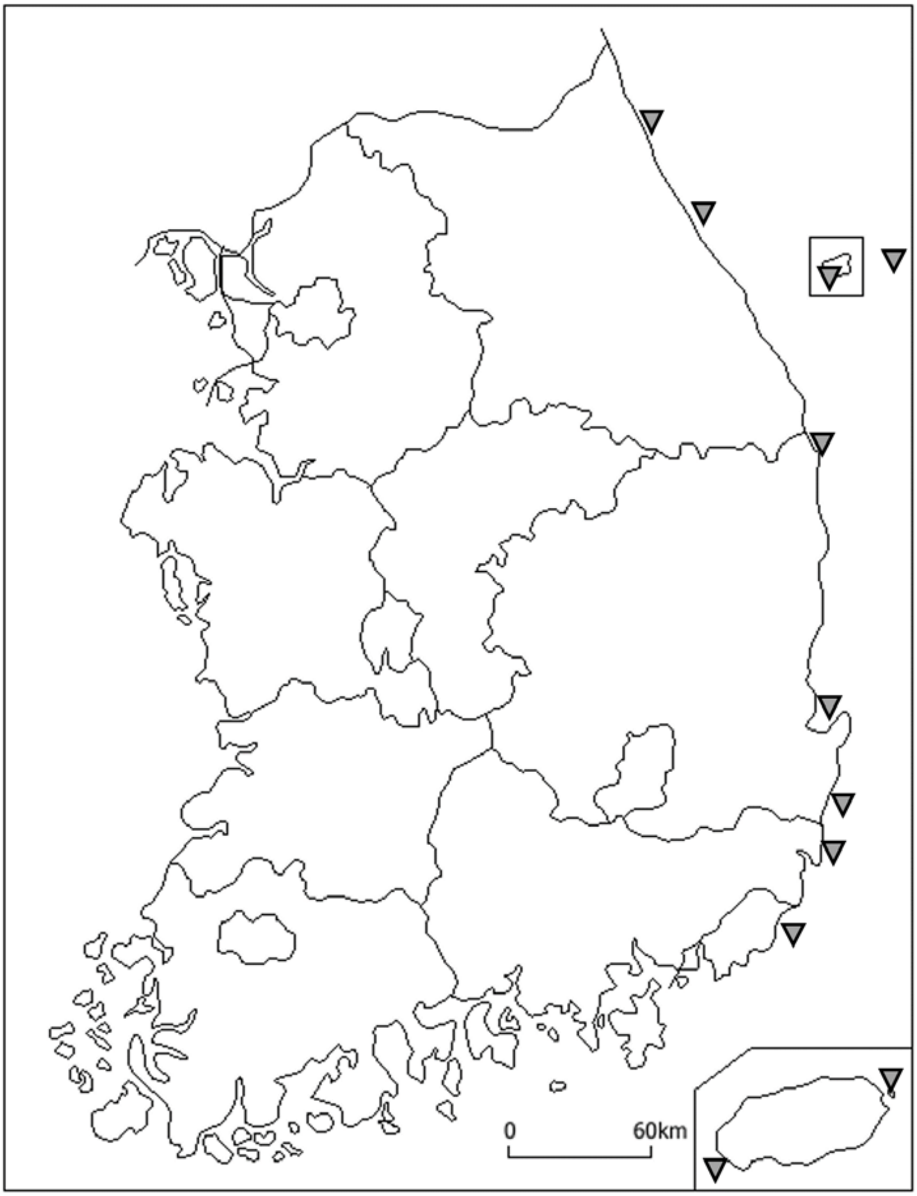


Figure 41. Distribution map of *Pagurus maculosus* Komai and Imafuku, 1996 in Korea.

38. *Pagurus lanuginosus* De Haan, 1849 털다리참집게 (Plate 35)

Pagurus lanuginosus De Haan, 1849: 204; 1850: pl. 49, fig. 2; Miyake, 1961a: 169; Makarov, 1962: 201 (part), pl. 5, fig. 2; Kim, 1963: 298, fig. 15; Kim, 1964: 9; Igarashi, 1970: 7, pl. 5, fig. 15; Kim, 1970: 7; Kim, 1973: 237, 602, pl. 71, fig. 37a, b; Miyake, 1978: 81 (part), text figs. 29, 30; Oh, 1983: 105; Komai & Imafuku, 1996: 783, figs. 1A, C top, 2–5; Kim & Kim, 1997: 216; Hong et al., 2006b: 359; Kim & Son, 2006: 70; McLaughlin et al., 2010: 33; Arima, 2014: 119; Kim & Kim, 2014: 53, fig. 22, pl. 15.

Eupagurus lanuginosus: Ortmann, 1892: 312 (?part); Doflein, 1902: 647 (?part); Alcock, 1905: 17; Balss, 1913: 56 (?part), fig. 33; Terao, 1913: 370

Not *Eupagurus lanuginosus*: Yokoya, 1933: 87.

Material examined. 9 inds., Pohang, Korea, 36° 9'21.87"N 129° 25'43.90"E, 14 Nov. 2008, Coll. Shin, M. K., MADBK 160712_001: 1 ♀, Changwon, Korea, 35° 5'41.16"N 128° 27'4.25"E, 10 Apr. 2009, Coll. Shin, M. K., MADBK 160712_004: 2 ♀♀, 5 ♂♂, Ulsan, Korea, 35° 38'32.50"N 129° 30'36.44"E, 30 Apr. 2009, Coll. Shin, M. K., MADBK 160712_005: 7 inds., Uljin, Korea, 37° 0'18.03"N 129° 25'40.81"E, 27 Oct. 2009, Coll. Lee, S. K., MADBK 160712_011: 5 ♀♀, 2 ♂♂, Gangneung, Korea, 37° 54'18.17"N 128° 51'41.41"E, 24 Mar. 2010, Coll. Lee, S. K., MADBK 160712_012: 1 ♂, Wando, Korea, 34° 17'26.81"N 126° 40'54.97"E, 20 June 2010, Coll. Shin, M. H., MADBK 160712_013: 32 inds., Tongyeong, Korea, 34° 38'51.73"N 128° 15'34.73"E, 8 Dec. 2010, Coll. Lue, W., MADBK 160712_017: 5 ♀♀, 3 ♂♂, Goseong, Korea, 38° 30'43.71"N 128° 27'5.67"E, 4 Apr. 2011, Coll. Lue, W., MADBK 160712_023: 1 ♂, Geoje, Korea, 34° 48'3.50"N 128° 40'54.75"E, 16 Apr. 2011, Coll. Kim, S., MADBK 160712_024: 5 inds., Incheon, Korea, 37° 9'35.93"N 125° 46'18.92"E, hand, 3 Nov. 2011, Coll. Jung, J., MADBK 160712_026: 11 inds., Busan, Korea, 35° 8'16.83"N 129° 9'37.01"E, fishing net, 18 Nov. 2012, Coll. Kim, H., MADBK 160712_029: 1 ind., Ulleung, Korea, 37° 28'11.55"N 130° 49'7.04"E, Scuba, 16 Nov. 2013, Coll. Park, J. H., MADBK 160712_032: 19 inds., Yeosu, Korea, 34° 47'45.30"N 127° 45'28.01"E, hand, 25 Oct. 2014, Coll. Jung, J., MADBK 160712_034: 10 inds., Yeongdeok, Korea, 36° 33'26.33"N 129° 26'3.91"E, hand, 24 Jan. 2015, Coll. Jung, J., MADBK 160712_035: 1 ind., Gyeongju, Korea, 35° 48'17.25"N 129° 30'13.41"E, 25 Jan. 2015, Coll. Jung, J., MADBK 160712_037: 16 inds., Sokcho, Korea, 38° 12'51.11"N 128° 36'3.13"E, hand, 8 May 2015, Coll. Jung, J., MADBK 160712_041: 4 inds., Busan, Korea, 35°12'5.10"N 129°13'52.59"E, hand, 30 June 2016, Coll. Jung, J, MADBK 160712_042: 29 inds, Taean, Korea, 18 May 2000, EVOSYS 260712#023: 1 ind., Gunsan, Korea, 4 May 2002, Coll. Kim, S. H., NIBRIV0000025460.

Distribution. Southeastern Russia, mainland Japan, mainland Korea, intertidal to subtidal.

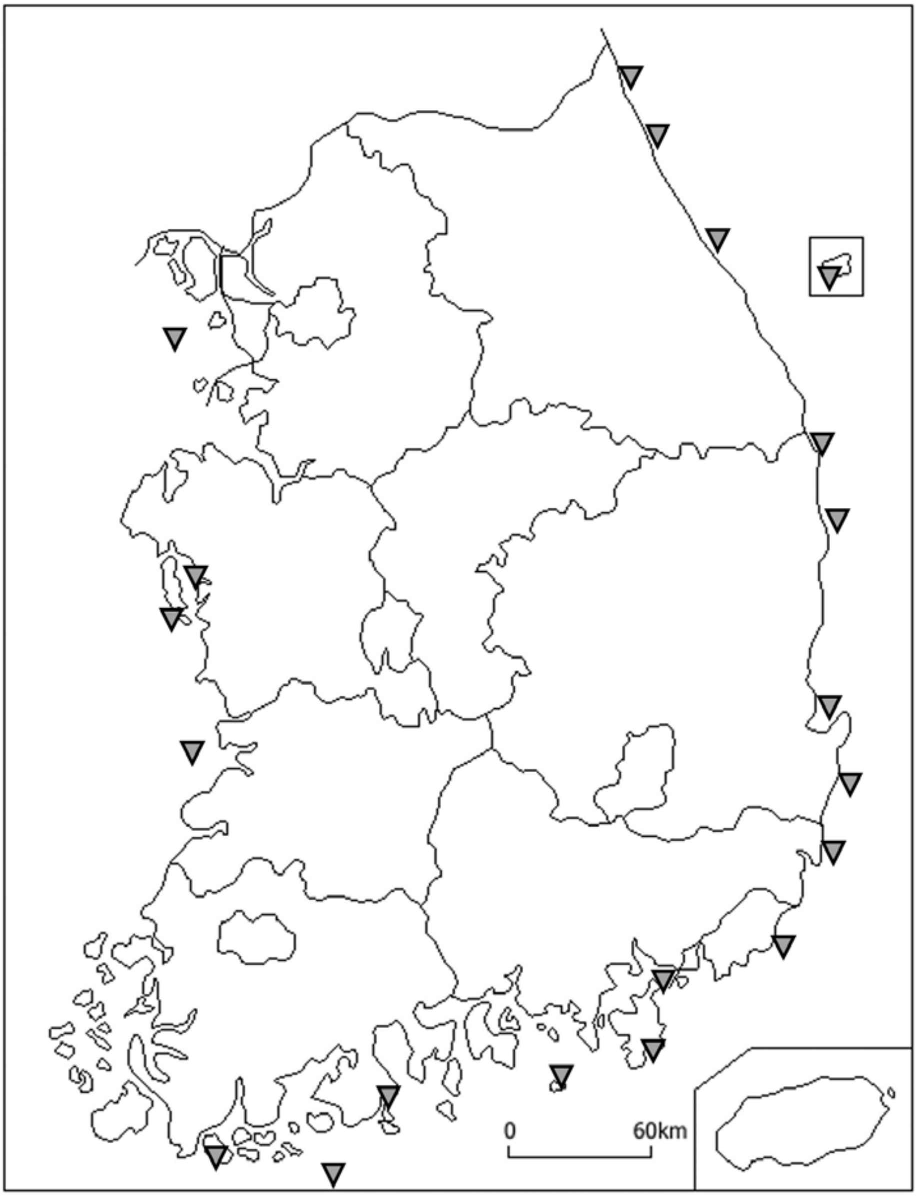


Figure 42. Distribution map of *Pagurus lanuginosus* De Haan, 1849 in Korea.

Remark. On the abdomen of a specimen of *Pagurus lanuginosus* (EVOSYS 260712#023), parasitic barnacle was found. Its approximate morphological characteristics are similar to those of *Peltogasterella socialis* (Müller, 1863) or *P. gracilis* (Boschma, 1927). This relationship has already been reported by Ichikawa and Yanagimachi (1957) and Yanagimachi (1961).

39. *Pagurus proximus* Komai, 2000 검은털손참집게 (Plate 36)

Eupagurus pectinatus: Balss, 1913: 60 (part).

Eupagurus brachiomastus: Yokoya, 1939: 282 (part).

Pagurus brachiomastus: Kim, 1973: 236 (part), pl.70, fig. 36.

Pagurus proximus Komai, 2000: 241, figs. 1C, 7–10; Kim et al., 2004: 88, figs. 1, 2; Hong et al., 2006b: 361; Kim & Son, 2006: 78; McLaughlin et al., 2010: 34; Arima, 2014: 121; Kim & Kim, 2014: 70, fig. 31, 32, pl. 20.

? *Pagurus brachiomastus*: Huang & Lin, 2012: 104.

Material examined. 1 ♀, 1 ♂, Shinan, Korea, 34° 35'49.24"N 125° 45'58.02"E, 16 Oct. 2008, Coll. Lee, S. K., MADBK 160718_001: 5 inds., Uljin, Korea, 36° 59'43.60"N 129° 25'43.23"E, Scuba, 29 Oct. 2009, Coll. Lee, S. K., MADBK 160718_009: 5 inds., Goseong, Korea, 38° 20'42.80"N 128° 32'44.101"E, Scuba, 22 June 2010, Coll. Lee, S. K., MADBK 160718_016: 37 inds., Wando, Korea, 34° 23'0.92"N 126° 56'3.51"E, 12 Mar. 2010, Coll. Kim, S. H., MADBK 160718_028: 7 ♀♀, 12 ♂♂, Changwon, Korea, 35° 5'41.16"N 128° 27'4.25"E, 25 Apr. 2009, Coll. Shin, M. K., MADBK 160718_029: 20 inds., Ulsan, Korea, 35° 38'32.50"N 129° 30'36.44"E, 30 Apr. 2009, Coll. Shin, M. K., MADBK 160718_030: 1 ind., Tongyeong, Korea, 34° 40'6.47"N 128° 15'31.69"E, Scuba, 2 Sep. 2011, Coll. Park, J. H., MADBK 160718_047: 13 inds., Incheon, Korea, 37° 9'35.93"N 125° 46'18.92"E, hand, 3 Nov. 2011, Coll. Jung, J., MADBK 160718_048: 2 inds., Taean, Korea, 36° 24'55.97"N 126° 22'2.69"E, hand, 26 Nov. 2011, Coll. Shin, M. H., MADBK 160718_049: 1 ♂ Yangyang, Korea, 37° 56'52.96"N 128° 48'39.14"E, Scuba, 17 July 2013, Coll. Park, J. H., MADBK 160718_050: 5 inds., Yeosu, Korea, 34° 47'45.30"N 127° 45'28.01"E, hand, 25 Oct. 2014, Coll. Jung, J., MADBK 160718_052: 1 ind., Yangyang, Korea, 37° 56'20.58"N 128° 47'22.96"E, Scuba, 25 June 2015, Coll. Jung, J., MADBK 160718_054.

Distribution. Eastern and western mainland Japan, southeastern Russia, ? China, mainland Korea, intertidal to 25 m.

Remark. A specimen of *Pagurus proximus* (MADBK 160718_048) was found in Incheon. This location seems to be the northwestern limiting line of this species.

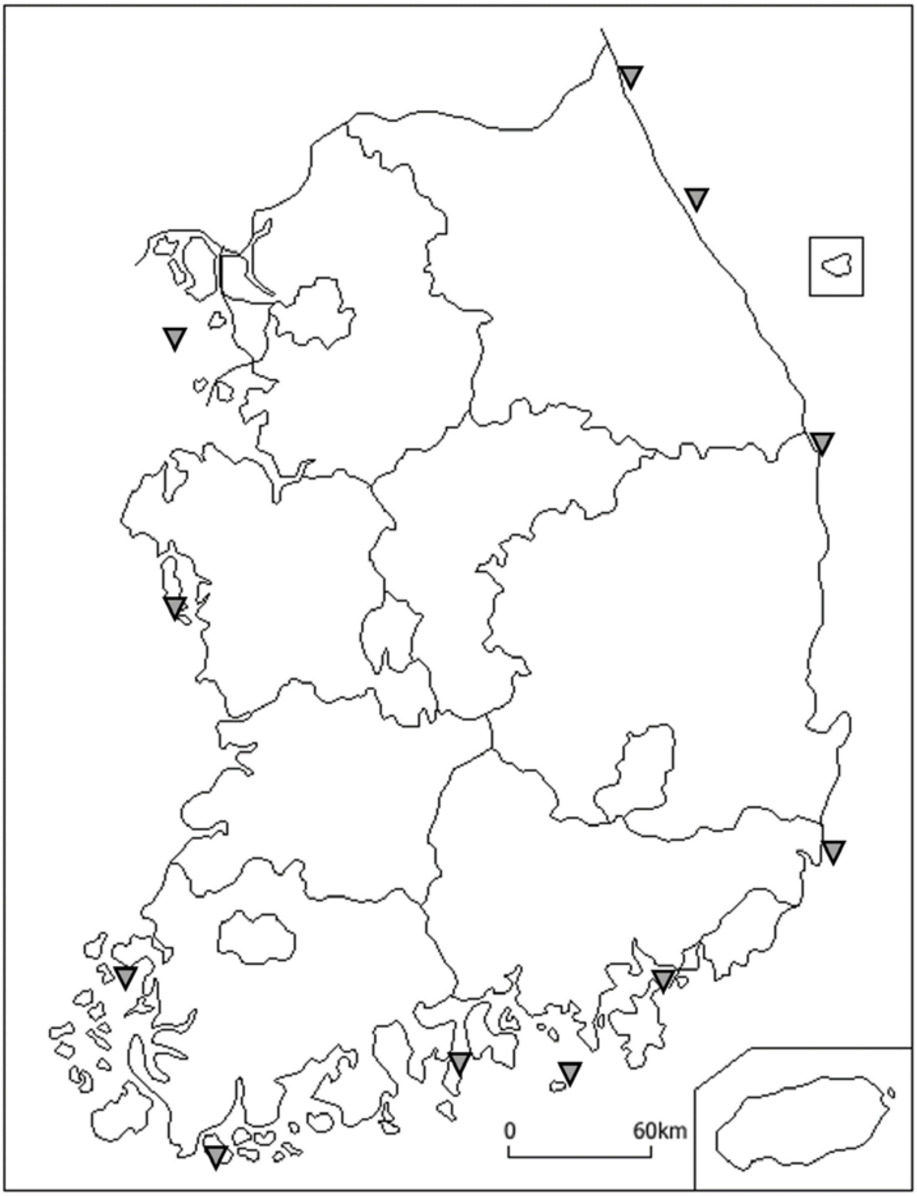


Figure 43. Distribution map of *Pagurus proximus* Komai, 2000 in Korea.

Komai (2000) has argued that *Pagurus brachiomastus* previously reported in Korea by Kim (1970; 1973) should be referred to as *P.*

proximus by photograph. The reference specimens and descriptions of Kim (1973) mostly agreed with Komai (2000). However, the tip of cheliped was sometimes described as red in the description of *P. brachiomastus* by Kim (1973). In addition, the author found additional reference specimens which was exactly identified as *P. brachiomastus* by Kim. Therefore, Kim' s references are regarded as a mixture of these two species.

Figure of Huang and Lin (2012) of *P. brachiomastus* should be regarded as *P. proximus* because of its geographical similarity of *P. proximus* and relatively long and slender ambulatory legs. However, reference specimen and additional examinations are needed to clearly identify them because description is absent in this book and corneas seem to be slightly dilated in the figure.

40. *Pagurus simulans* Komai, 2000 갈색털손참집게 (Plate 37)

Eupagurus brachiomastus: Yokoya, 1939: 282 (part).

Pagurus brachiomastus: Miyake, 1978: 97, text-figs. 36, 37.

Pagurus sagamiensis Miyake, 1978: 116 (part).

Pagurus pilosipes: Miyake, 1978: 91 (part).

Pagurus simulans Komai, 2000: 249, figs. 1D, 11-14; Kim et al., 2004: 91, figs. 3, 4; Hong et al., 2006b: 363; Kim & Son, 2006: 81; McLaughlin et al., 2010: 34, fig. 16F; Arima, 2014: 124 (part); Kim & Kim, 2014: 78, fig. 36, 37, pl. 22.

Parapagurus constans: Kim & Son, 2006: 83 (part).

Material examined. 1 ind., Ulsan, Korea, 35° 17'48.70"N 129° 24'29.22"E, 17 Sep. 2011, Coll. Jung, J., MADBK 160719_001: 12 inds., Busan, Korea, 35° 8'16.83"N 129° 9'37.01"E, fishing trap, 24 Mar. 2015, Coll. Jung, J., MADBK 160719_002: 49 inds., Busan, Korea, 35° 8'16.83"N 129° 9'37.01"E, fishing trap, 31 Jan. 2016, Coll. Jung, J., MADBK 160719_005: 2 inds., Yeosu, Korea, 19 Apr. 2012, MADBK 160719_015: 1 ind., Geoje, Korea, 9 July 1996, EVOSYS 260705#003: 2 inds., Tongyeong, Korea, 3 June 1978, Coll. Rho, B. J., EWUNHM DP 20151202022: 1 ind., Pohang, Korea, 26 Dec. 1974, Coll. Rho, B. J., EWUNHM DP 20151202052.

Distribution. Southern mainland Japan, southeastern Korea, 30−260 m.

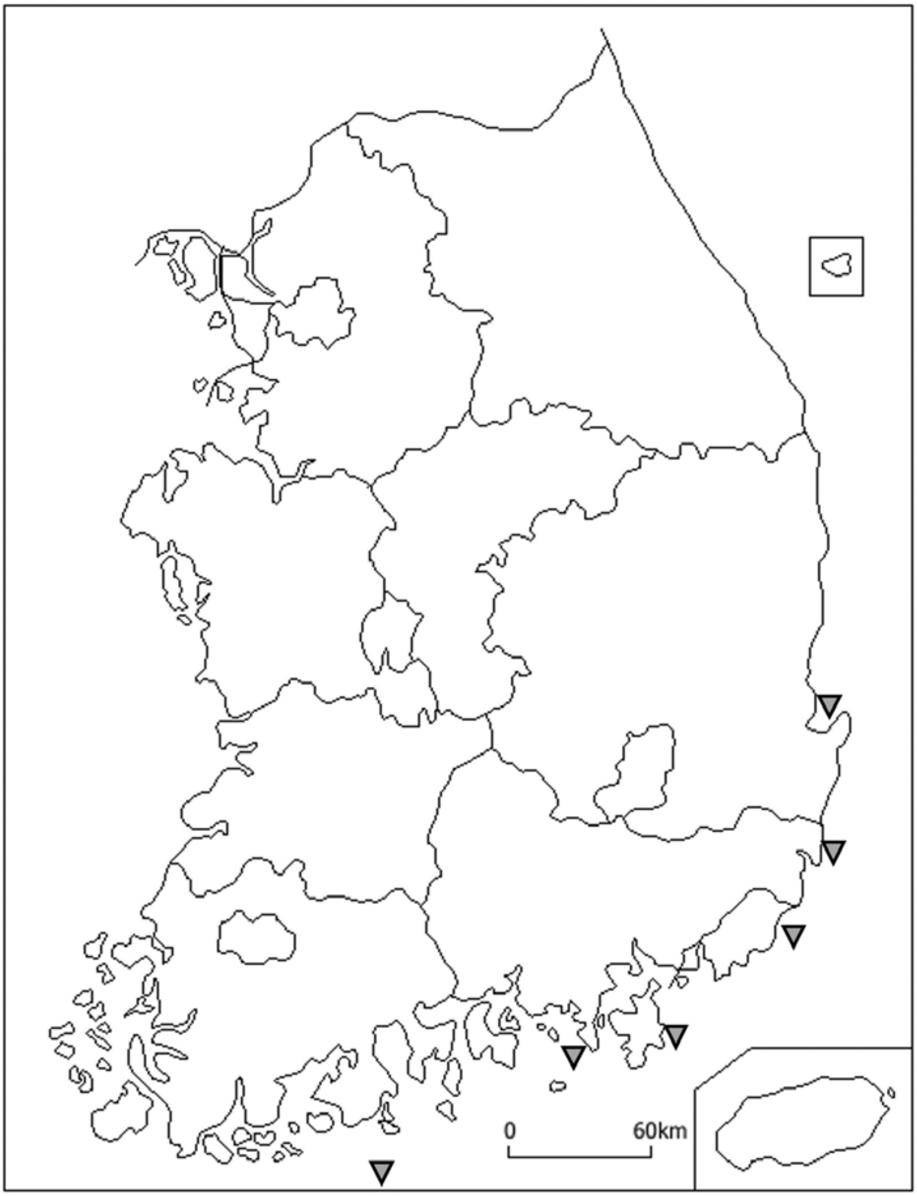


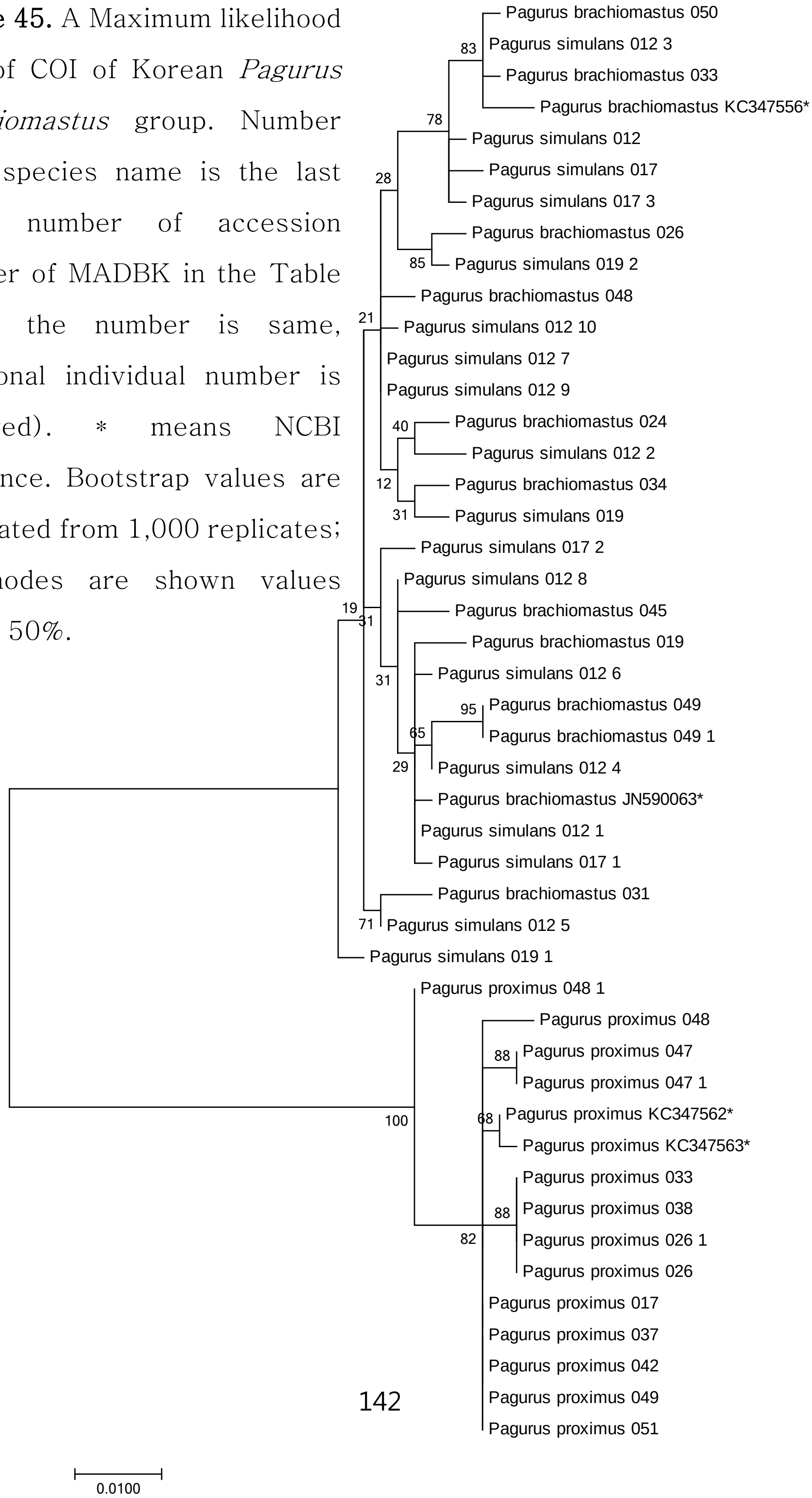
Figure 44. Distribution map of *Pagurus simulans* Komai, 2000 in Korea.

Remark. Kim and Son (2006) described *Parapagurus constans* (= *Pagurus constans*), including its living condition picture. However, living condition picture should be regarded as *Pagurus simulans* according to band color pattern of pereopods, two rows of strong spines on the dorsal surface of left palm, and the fact that not only *P. constans*, but also *P. simulans*, are associated with *Hydrissa sodalis*. Of 139 specimens of *P. simulans* caught in the subtidal area of Korea from 2010 to 2016, 80 (57.6 %) specimens are associated with *H. sodalis*. It is noteworthy that 51 out of these 80 specimens have *H. sodalis* associated with moderately large gastropod shell. This feature differs from the pattern of *H. sodalis* associated with *P. constans.*

Using COI and 16S rRNA*, P. simulans* and *P. brachiomastus* are mixed as one clade in the DNA barcoding results (Figures 45, 46). It suggests that they are the same species. Morphological similarities to the results of Komai (2000) support this hypothesis. This result is discussed detailed in the 'Discussion' section.

This species seems to abandon its carcinoecia more easily than other species of Paguroidea when caught by fishing trap boat. 46 % of *P. simulans* abandoned its carcinoecia while other species are mostly found existing in the house.

Figure 45. A Maximum likelihood tree of COI of Korean *Pagurus brachiomastus* group. Number after species name is the last three number of accession number of MADBK in the Table 2 (if the number is same, additional individual number is followed). * means NCBI sequence. Bootstrap values are calculated from 1,000 replicates; the nodes are shown values above 50%.



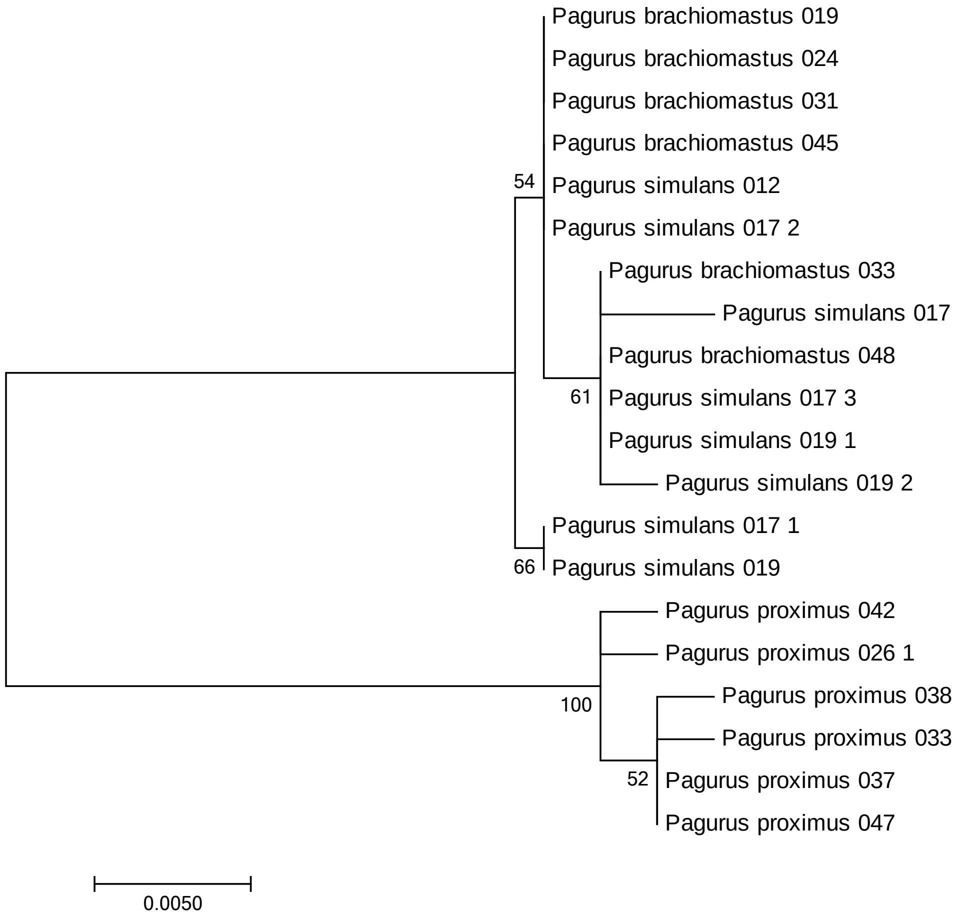


Figure 46. A Maximum likelihood tree of 16S rRNA of Korean *Pagurus brachiomastus* group. Number after species name is the last three number of accession number of MADBK in the Table 2 (if the number is same, additional individual number is followed). Bootstrap values are calculated from 1,000 replicates; the nodes are shown values above 50%.

41. *Pagurus brachiomastus* (Thallwitz, 1892) 털손참집게

(Plate 38)

Eupagurus brachiomastus Thallwitz, 1892: 35, Ortmann, 1892: 312, Alcock, 1905: 177, Terao, 1913: 365.

Pagurus brachiomastus: Makarov, 1962: 200, pl. 2, fig. 6; Kim, 1973: 236 (part); Miyake, 1978: pl. 1, figs. 7, 8; Komai, 2000: 230, figs. 1A, 1B, 2-6; Kim & Son, 2006: 66; McLaughlin et al., 2010: 32; Arima, 2014: 132; Kim & Kim, 2014: 42, fig. 17, pl. 11.

Material examined. 2 inds., Uljin, Korea, 36° 59'43.60"N 129° 25'43.23"E, Scuba, 29 Oct. 2009, Coll. Lee, S. K., MADBK 160704_022: 22 inds., Goseong, Korea, 38° 20'42.80"N 128° 32'44.95"E, Scuba, 22 July 2010, Coll. Lee, S. K., MADBK 160704_026: 1 ind., Goseong, Korea, 38° 19'24.35"N 128° 33'6.61"E, Scuba, 25 June 2010, Coll. Lee, S. K., MADBK 160704_033: 2 inds., Gangneung, Korea, 37° 50'25.40"N 128° 53'15.69"E, 27 Mar. 2004, MADBK 160704_037: 8 inds., Yangyang, Korea, 37° 55'49.00"N 128° 47'25.00"E, Scuba, 15 Aug. 2013, Coll. Park, J. H., MADBK 160704_044: 1 ind., Yangyang, Korea, 37°55'49.00"N 128°47'25.00"E, Scuba, 10 Apr. 2014, Coll. Park, J. H., MADBK 160704_047; 1 ind., Ulleung, Korea, fishing net, 7 Aug. 1985, EVOSYS 260706#069; 1 ind., Samcheok, Korea, 12 Aug. 1987, Coll. Rho, B. J., EWUNHM DP 20151202023: 6 inds., Gangneung, Korea, 31 Oct. 1999, Coll. Yun, S. J., EWUNHM DP 20151202029.

Distribution. Northern and eastern mainland Japan, southeastern Russia, northeastern Korea, intertidal to 25 m.

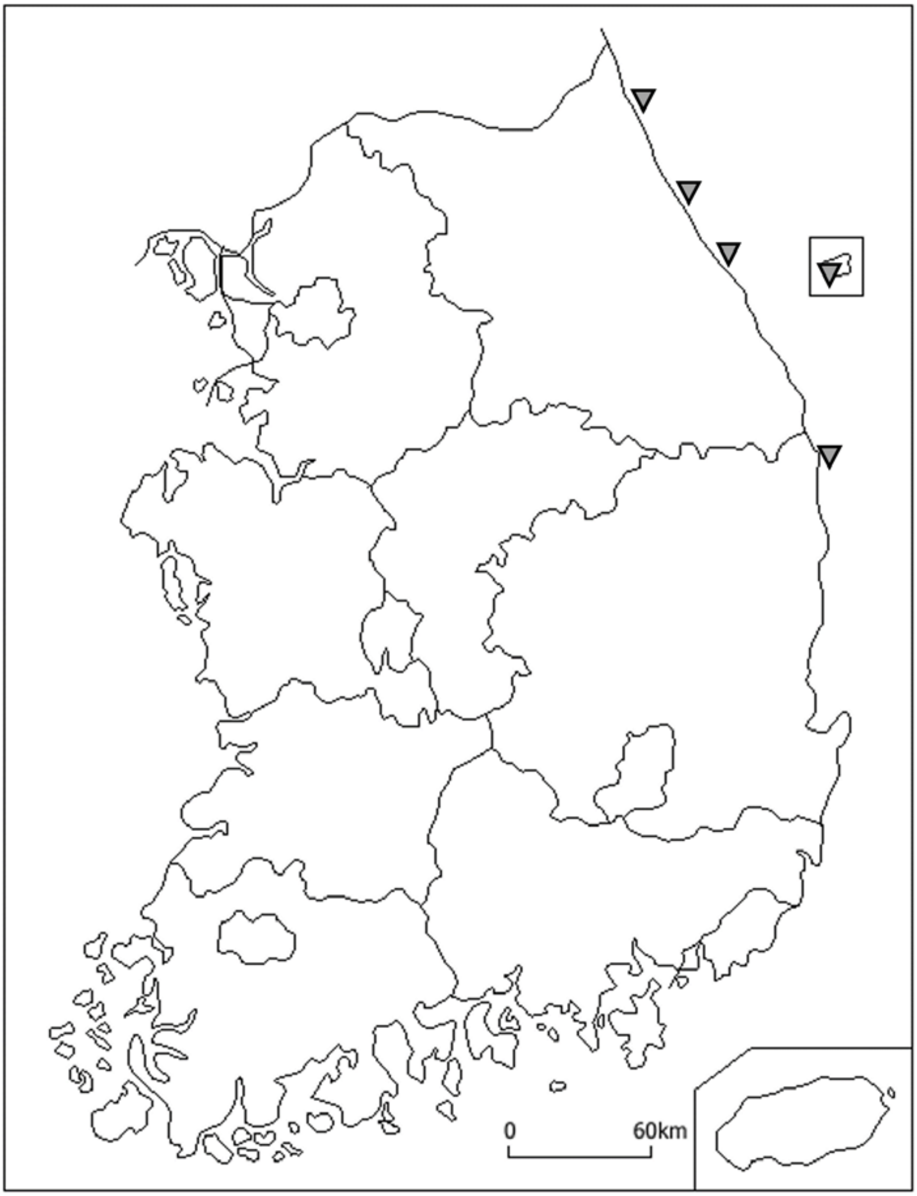


Figure 47. Distribution map of *Pagurus brachiomastus* (Thallwitz, 1892) in Korea.

Remark. One individual of *Pagurus brachiomastus* (EVOSYS 260706#069) was found living in the carcinoecia formed by Hydrissa sodalis. There is no report of this species living in this kind of carcinoecia.

A polychaet was found in the shell of an individual of *P. brachiomastus* (MADBK 160704_033). Its approximate morphological characteristics are similar to those of *Cheilonereis cyclurus* (Harrington, 1897). This relationship has already been reported in the paper of Thallwitz (1891).

As mentioned in the remark of *P. simulans*, *P. brachiomastus* and *P. simulans* are mixed as one clade in the COI and 16S rRNA trees (Figures 45, 46). It suggests that they are the same species. Morphological similarities to the results of Komai (2000) support this hypothesis. This result is discussed detailed in the 'Discussion' section.

On the abdomen of two specimens of *P. brachiomastus* (MADBK 160704_047), parasitic barnacles were found. Their approximate morphological characteristics and COI sequence are similar to those of *Peltogaster lineata* Shiino, 1943.

42. *Pagurus minutus* Hess, 1865 긴발가락참집게 (Plate 39)

Pagurus minutus Hess, 1865: 180 (part); Sandberg & McLaughlin, 1993: 219, figs. 2, 4; Komai & Mishima, 2003: 16, figs. 1–6; 조성환 외., 2006: 71; Hong et al., 2006b: 359; Kim & Son, 2006: 73; McLaughlin et al., 2007a: 269; 2010: 33; Huang & Lin, 2012: 102; Arima, 2014: 115; Kim & Kim, 2014: 56, fig. 23, pl. 16.

Eupagurus minutus: De Man, 1887: 705, fig. 2.

Eupagurus dubius Ortmann, 1892: 309 (part), pl. 12, figs. 12, 14k; Balss, 1913: 55; Yokoya, 1933: 284; Kamita, 1955: 39.

Eupagurus similis: Doflein, 1902: 646.

Pagurus dubius: Kim, 1963: 300, fig. 17; Kim, 1973: 227, fig. 51, pl. 70, fig. 1a, b; Miyake, 1978: 99, fig. 38, pl. 1, fig. 6; Asakura, 1995: 363, pl. 97, fig. 10.

Material examined. 5 ♂♂, Goseong, Korea, 34° 59'50.00"N 128° 33'16.91"E, 25 Apr. 2009, Coll. Shin, M. K., MADBK 160706_003: 1 ♀, 4 ♂♂, Ulsan, Korea, 35° 22'28.00"N 129° 20'49.73"E, 11 Apr. 2009, Coll. Shin, M. K., MADBK 160706_004: 5 ♂♂, Changwon, Korea, 35° 5'41.16"N 128° 27'4.25"E, 25 Apr. 2009, Coll. Shin, M. K., MADBK 160706_005: 1 ind., Hwaseong, Korea, 37° 8'43.66"N 126° 39'32.64"E, 28 Nov. 2008, Coll. Hong, J., MADBK 160706_009: 137 inds., Seogwipo, Korea, 32° 52'21.58"N 126° 5'49.85"E, 13 Mar. 2009, Coll. Lee, S. K., MADBK 160706_011: 190 inds., Incheon, Korea, 37° 17'13.60"N 126° 30'39.02"E, 5 Aug. 2008, Coll. Lee, S. K., MADBK 160706_019: 12 inds., Hampyeong, Korea, 35° 1'33.57"N 126° 19'6.51"E, 19 May 2010, Coll. Kim, S., MADBK 160706_021: 62 inds., Taean, Korea, 36° 36'32.66"N 126° 16'42.87"E, hand, 30 Sep. 2010, Coll. Park, J. H., MADBK 160706_033: 5 inds., Jeju, Korea, 33° 33'51.84"N 126° 41'3.30"E, hand, 4 Nov. 2010, Coll. Kang, S., MADBK 160706_042: 2 inds., Tongyeong, Korea, 34° 38'5.22"N 128° 15'56.87"E, hand, 8 Dec. 2010, Coll. Lue, W., MADBK 160706_044: 69 inds., Seocheon, Korea, 36° 7'47.44"N 126° 33'45.75"E, 14 May 2009, Coll. Lee, S. K., 160706_045: 9 inds., Pohang, Korea, 36° 9'20.44"N 129° 36'29.49"E, 20 June 2010, Coll. Shin, M. H., MADBK 160706_046: 1 ♀, Wando, Korea, 34° 13'3.89"N 126° 48'33.59"E, 21 June 2010, Coll. Shin, M. H., MADBK 160706_047: 7 ♂♂, Geoje, Korea, 34° 59'50.66"N 128° 36'23.58"E, 16 Apr. 2011, Coll. Kim, S., MADBK 160706_050: 6 inds., Gunsan, Korea, 36° 6'16.99"N 125° 59'2.40"E, hand, 8 Apr. 2012, Coll. Jung, J., MADBK 160706_059: 4 inds., Namhae, Korea, 34° 52'40.83"N 127° 56'43.61"E, hand, 14 Nov. 2012, Coll. Jung, J., MADBK 160706_065: 7 inds., Seosan, Korea, 36° 52'20.79"N 126° 21'57.24"E, hand, 6 Oct. 2013, Coll. Jung, J., MADBK 160706_069: 11 inds., Jindo, Korea, 34° 25'4.26"N 126° 18'58.58"E, hand, 15 Aug. 2011, Coll. Kim, S., MADBK 160706_074: 15 inds., Haenam, Korea, 34° 36'40.23"N 126° 46'40.46"E, hand, 18 July 2013, Coll. Jung, J., MADBK 160706_080: 1 ind., Uljin, Korea, 37° 4'361"N 129° 25'428"E, 5 Apr. 2014, Coll. Rho, H. S., MADBK 160706_082: 37 inds., Boryeong, Korea, 36° 14'41.26"N

126° 32'7.33"E, hand, 9 May 2014, Coll. Lue, W., MADBK 160706_085: 19 inds., Dangjin, Korea, 37° 1'51.69"N 126° 36'43.74"E, hand, 8 Oct. 2014, Coll. Jung, J., MADBK 160706_093: 23 inds., Shinan, Korea, 37° 1'51.69"N 126° 36'43.74"E, hand, 8 Oct. 2014, Coll. Jung, J., MADBK 160706_094: 12 inds., Yeosu, Korea, 34° 44'30.55"N 127° 34'43.98"E, hand, 24 Oct. 2014, Coll. Jung, J., MADBK 160706_100: 2 inds., Yeongdeok, Korea, 36° 33'26.33"N 129° 26'3.91"E, hand, 24 Jan. 2015, Coll. Jung, J., MADBK 160706_101: 5 inds., Busan, Korea, 35° 12'5.10"N 129° 13'52.59"E, hand, 24 Mar. 2015, Coll. Jung, J., MADBK 160706_108: 17 inds., Gochang, Korea, 35° 31'48.10"N 126° 32'33.19"E, hand, 28 Oct. 2015, Coll. Jung, J., MADBK 160706_109: 2 inds., Gangneung, Korea, 37°54'25"N 128°49'32"E, 21 Oct. 2010, Coll. Lee, S. K., MADBK 160706_037: 3 inds., Goseong, Korea, 38°30'43.71"N 128°27'5.66"E, 25 July 2011, Coll. Lee, S. K., MADBK 160706_049: 2 inds., Sokcho, Korea, 38°12'51"N 128°36'03"E, 8 May 2015, Coll. Jung, J., MADBK 160706: 2 inds., Taean, Korea, 36°24'58"N 126°21'43"E, 26 Nov. 2011, Coll. Shin, M. H., MADBK 160706_055: 2 inds., Gunsan, Korea, 36°07'12"N 125°58'49"E, 8 Apr. 2012, Coll. Jung, J., MADBK 160706_059: 4 inds., Goseong, Korea, 38°30'43.71"N 128°27'5.66"E, 4 Apr. 2011, Coll. Lue, W., MADBK 160706_060: 3 inds., Boryeong, Korea, 36°14'44"N 126°32'12"E, 27 Oct. 2014, Coll. Chunbuk Univ., MADBK 160706_106.

Distribution. Japan, southeastern Russia, northeastern China, western Taiwan, Korea, intertidal to 5 m.

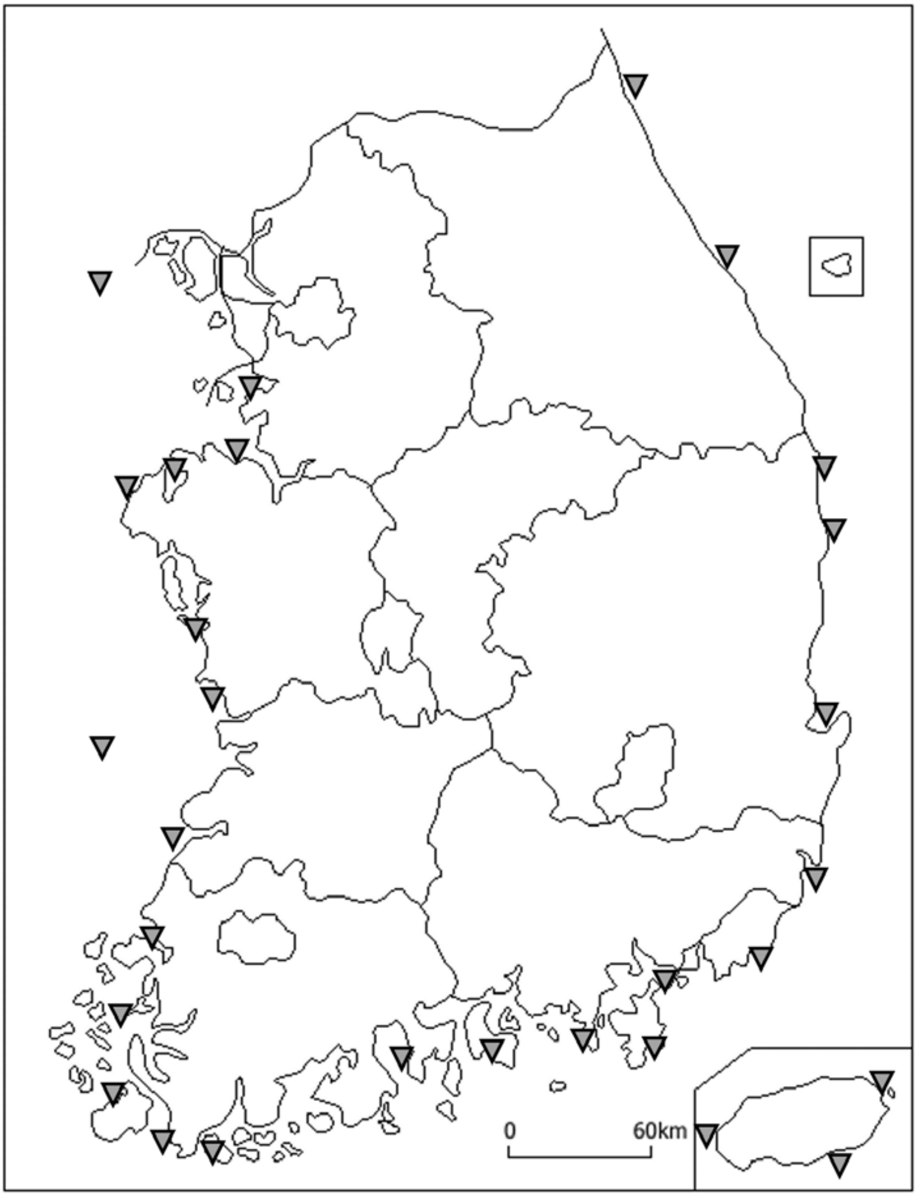


Figure 48. Distribution map of *Pagurus minutus* Hess, 1865 in Korea.

Remark.[3] Using COI and 16S rRNA, *P. minutus* can be divided into two genetic groups (MAG: major group, MIG: minor group) with clear genetic gaps (Figure 49). The COI sequence of MAG and MIG shows a significant genetic divergence between them (8.7–10.0%) and *P. filholi* (COI: 6.2–9.1%). The genetic divergence of the 16S rRNA sequence between the two groups of *P. minutus* is 1.9–2.2%. It suggests that *P. minutus* is not the monophyletic group and maybe including cryptic species. MAG and MIG also differ in population size, distribution area, and color pattern. This result is discussed detailed in the 'Discussion' section.

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[3] The remark and discussion of this species in this thesis is the further study of the thesis of the coworker with agreement (Park, 2016).

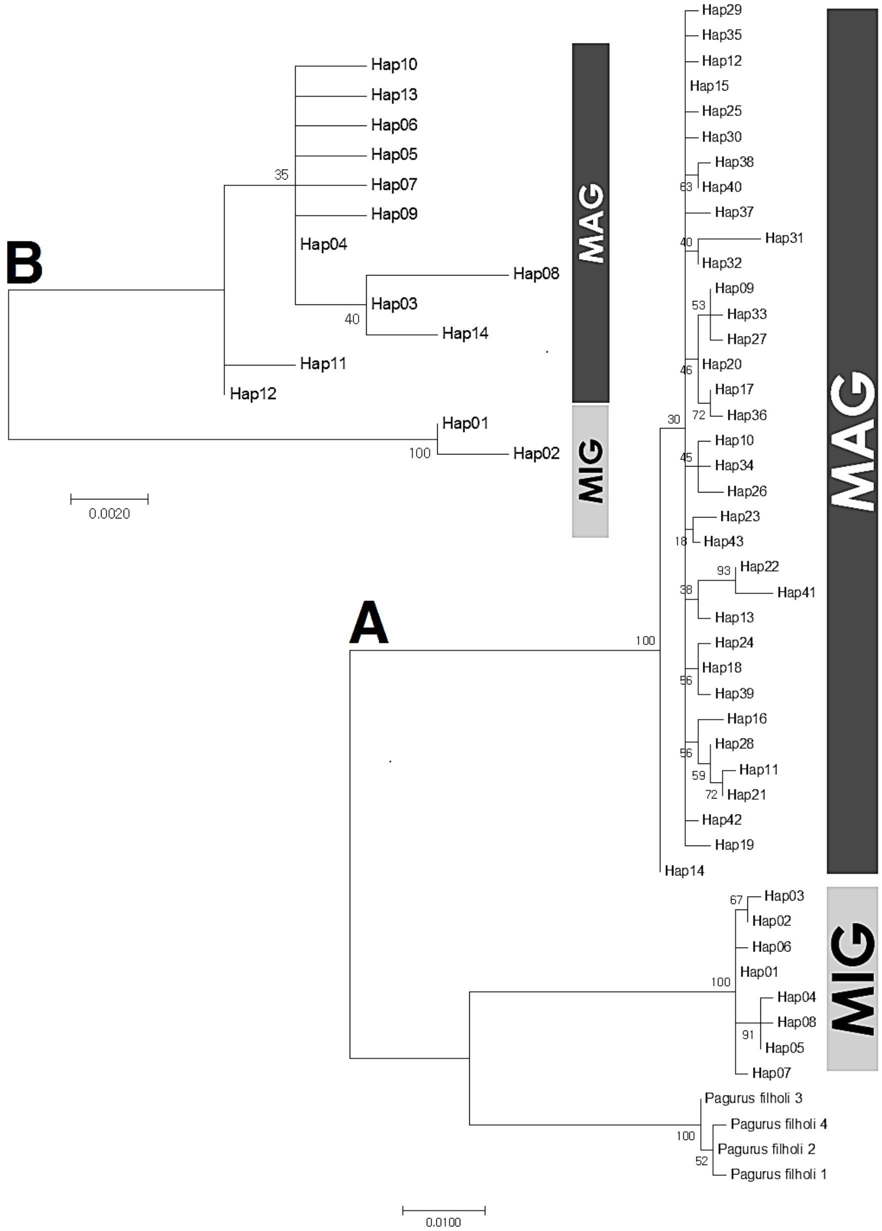

Figure 49. Maximum likelihood rooted trees of COI (A) and 16S rRNA (B) haplotypes of the groups of Korean *Pagurus minutus* Hess, 1865, major group (MAG) and minor group (MIG). Bootstrap values are calculated from 1,000 replicates; only the nodes with values above 50% are shown.

43. *Pagurus nigrofascia* Komai, 1996 검은참집게 (Plate 40)

? *Eupagurus hirsutiusculus*: Stimpson, 1858: 250 (part); 1907: 233 (part); Terao, 1913: 369 (part).

? *Eupagurus hirsutiusculus*: Miyake, 1978: 80.

Pagurus nigrofascia Komai, 1996: 60, figs. 1–6; Kim & Son, 2006: 74; McLaughlin et al., 2010: 33, fig 16C; Arima, 2014: 120; Kim & Kim, 2014: 58, fig. 24, pl. 17.

? *Pagurus geminus*: Huang & Lin, 2012: 103.

Material examined. 3 inds., Tongyeong, Korea, 34° 38'34.33"N 128° 16'31.40"E hand, 8 Dec. 2010, Coll. Lue, W., MADBK 160723_001: 2 ♂♂, Geoje, Korea, 34° 59'50.66"N 128° 36'23.58"E, 16 Apr. 2011, Coll. Kim, S., MADBK 160723_002: 1 ind., Busan, Korea, 35° 1'34.88"N 129° 7'1.64"E, hand, 23 Apr. 2011, Coll. Jung, J., MADBK 160723_003: 13 inds., Gunsan, Korea, 36° 6'16.99"N 125° 59'2.40"E, hand, 8 Apr. 2012, Coll. Jung, J., MADBK 160723_004, NIBRIV0000320628, NIBRIV0000320632, NIBRIV0000320633: 1 ind., Incheon, Korea, 37° 49'41.84"N 124° 43'22.71"E, 29 Mar. 1958, MADBK 160723_007: 17 inds., Yeosu, Korea, 34° 47'46.00"N 127° 45'23.52"E, hand, 2 Jan. 2017, Coll. Kim, H., MADBK 160723_009: 1 ind., Boryeong, Korea, 9 May 2014, Coll. Jung, J., NIBRIV0000320331–NIBRIV0000320333.

Distribution. Southern Hokkaido and mainland Japan, ? China, western to southreastern mainland Korea, intertidal to subtidal.

Remark. Two specimens of *Pagurus nigrofascia* (MADBK 160723_004, MADBK 160723_007) were found in Gunsan and Incheon. These locations seem to be the western and northwestern limiting line of this species, respectively.

Figure of *Pagurus geminus* by Huang and Lin (2012) is regarded as *P. nigrofascia* because of its geographical similarity to *P. nigrofascia* and the presence of moderately long setae on the right chela. The figure is unarmed on the dorsal margin of propodi and carpi of ambulatory legs so there is some doubt that the figure represents *P. nigrofascia*. However, dorsal spines of pereopods of *Pagurus pectinatus* are also missing in this book. Such absent status of dorsal spines is regarded as omitted because of long setae. However, reference specimen and additional examinations are needed to clearly identify it due to the absence of description.

In the figure of Huang and Lin (2012), unusual structure was found, looking like a parasitic barnacle on the abdomen. However, this relationship has not been reported yet.

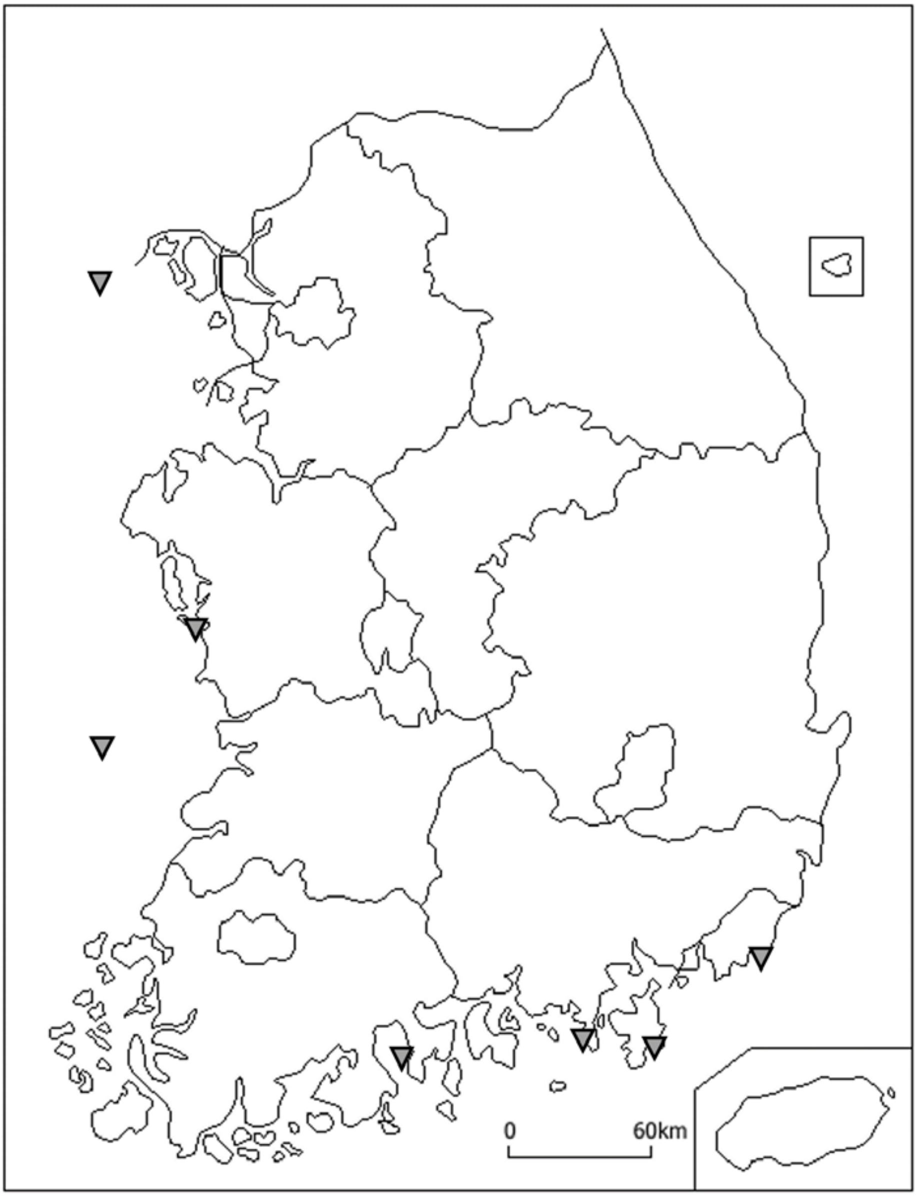

Figure 50. Distribution map of *Pagurus nigrofascia* Komai, 1996 in Korea.

44. *Pagurus filholi* (De Man, 1887) 참집게 (Plate 41)

Eupagurus filholi De Man, 1887: 707, fig. 3.

Pagurus filholi: Sandberg & McLaughlin, 1993: 198, figs. 1, 3; Hong et al., 2006b: 362; Kim & Son, 2006: 68; McLaughlin et al., 2010: 33; Arima, 2014: 115; Kim & Kim, 2014: 47, fig. 19, pl. 13.

Eupagurus samuelis: Stimpson, 1858: 250; Ortmann, 1892: 301, pl. 12, fig. 12.

Pagurus samuelis: Makarov, 1962:179 (part, not pl. 3, fig. 6); Kim, 1964: 4; 1970: 12; 1973; 228, fig. 51, pl. 70, fig 32; Miyake, 1978: figs. 46, 47, pl. 1, fig. 3.

Pagurus minutus Hess, 1865: 34, 160 (part).

Pagurus geminus McLaughlin, 1976: 16, figs. 1–3; Kim & Kim, 1997: 216.

Material examined. 1 ind., Uljin, Korea, 37° 3'6.20"N 129° 27'14.40"E, hand, 19 Oct. 2010, Coll. Lee, S. K., MADBK 160707_008: 10 inds., Tongyeong, Korea, 34° 38'5.22"N 128° 15'56.87"E, hand, 8 Dec. 2010, Coll. Lue, W., MADBK 160707_018: 76 inds., Seogwipo, Korea, 33° 15'38.47"N 126° 29'39.61"E, 27 Mar. 2011, Coll. Kim, S. H., MADBK 160707_019: 27 inds., Geoje, Korea, 34° 48'3.50"N 128° 40'54.74"E, 16 Apr. 2011, Coll. Kim, S., MADBK 160707_020: 16 inds., Busan, Korea, 35° 1'34.88"N 129° 7'1.64"E, hand, 23 Apr. 2011, Coll. Jung, J., MADBK 160707_021: 9 inds., Pohang, Korea, 36°

0'40.98"N 129° 37'29.56"E, hand, 17 Sep. 2011, Coll. Jung, J., MADBK 160707_027: 40 inds., Jeju, Korea, 33° 30'54.50"N 126° 57'29.08"E, 14 Oct. 2006, MADBK 160707_030: 11 inds., Yeosu, Korea, 34° 1'10.11"N 127° 18'19.22"E, 25 Apr. 2013, Coll. Park, J. H., MADBK 160707_032: 6 inds., Yeongdeok, Korea, 36° 33'26.33"N 129° 26'3.91"E, hand, 24 Jan. 2015, Coll. Jung, J., 160707_038: 6 inds., Gyeongju, Korea, 35° 48'17.25"N 129° 30'13.41"E, hand, 24 Jan. 2015, Coll. Jung, J., 160707_039: 1 ind., Ulsan, Korea, 35° 34'53.76"N 129° 35'3.59"E, 10 Apr. 2009, Coll. Shin, M. K., MADBK 160707_041: 4 inds., Busan, Korea, 35° 12'5.10"N 129° 13'52.59"E, 30 June 2016, Coll. Jung, J., MADBK 160707_048.

Distribution. Japan, southeastern Russia, northeastern China, Jeju Island and southeastern mainland Korea, intertidal to shallow subtidal.

Remark. On the abdomen of two specimens of *Pagurus filholi* (MADBK 160707_032, MADBK160707_052), parasitic barnacles were found. Their approximate morphological characteristics and COI sequence are similar to those of *Peltogasterella gracilis* (Boschma, 1927) and *Peltogaster postica* Yoshida & Osawa, 2011.

The population of *P. minutus* was clearly divided into two monophyletic groups, and each of one of these groups was arranged close to the independent clade in the ML phylogram from a clade of *P. filholi* (Figure 49). This result suggested that *P. filholi* was a sister taxon of these two populations. Their morphologies (Komai &

Mishima, 2003) supported this hypothesis.

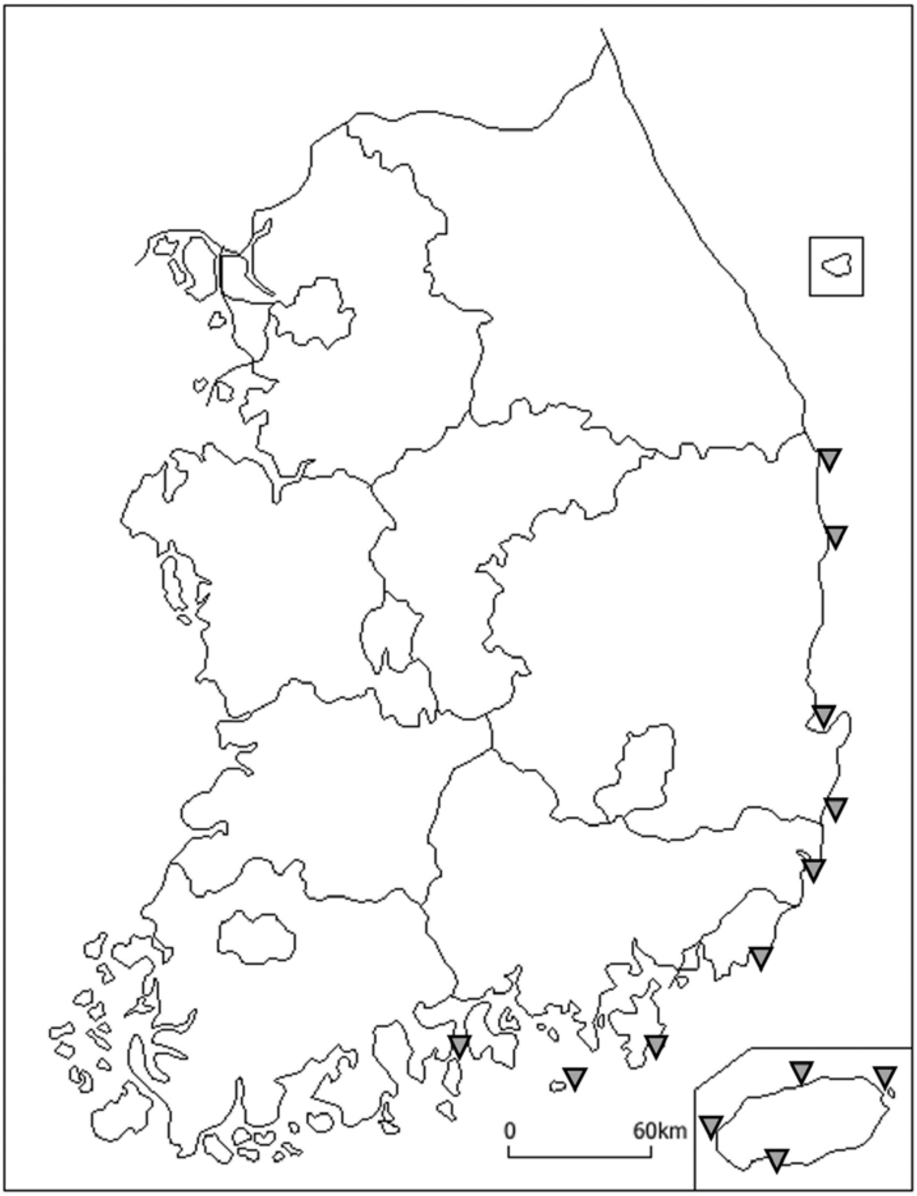

Figure 51. Distribution map of *Pagurus filholi* (De Man, 1887) in Korea.

45. *Pagurus japonicus* (Stimpson, 1858) 붉은눈자루참집게

(Plate 42)

Eupagurus japonicus Stimpson, 1858: 250; 1907: 226, pl. 25, fig. 2; Alcock, 1905: 177; Terao, 1913: 369 (part); Kamita, 1955: 34, fig. 13.

? *Eupagurus japonicus*: Balss, 1913: 56; Yokoya, 1933: 85.

Pagurus japonicus: Kim, 1963: 300, fig. 18; 1964: 9; 1970: 13; 1973: 239, 602, fig. 58, pl. 71, fig. 38; 1985: 74; Miyake, 1978: 94 (part), fig. 35, pl. 2, fig. 2; Oh, 1983: 111; Asakura, 1995: 362, pl. 97, fig. 3; Komai, 2003b: 379, figs. 1−5; Hong et al., 2006a: 253, fig. 3C; Hong et al., 2006b: 358; Kim & Son, 2006: 69; McLaughlin et al., 2007a: 264; 2010: 33, fig. 16A; Huang & Lin, 2012: 101; Arima, 2014: 122; Kim & Kim, 2014: 51, fig. 21, pl. 14.

Eupagurus barbatus Ortmann, 1892: 311; Alcock, 1905: 177; Terao, 1913: 365; Yokoya, 1933: 85.

Pagurus barbatus: Miyake 1978: 105, fig. 41.

Material examined. 5 inds., Seogwipo, Korea, 33° 13'27.59"N 126° 33'57.76"E, Scuba, 15 Nov. 2008, Coll. Kim, S. H., MADBK 160710_001: 4 ♀♀, 5 ♂♂, Tongyeong, Korea, 34° 40'6.47"N 128° 15'31.67"E, Scuba, 31 Aug. 2011, Coll. Park, J. H., MADBK 160710_004: 8 inds., Ulleung, Korea, 37° 27'34.40"N 130° 51'16.03"E, Scuba, 16 Nov. 2013, Coll. Park, J. H., MADBK 160710_009, NIBRIV0000320054, NIBRIV0000320055: 2 inds., Jeju, Korea, 33° 56'36.57"N 126° 19'40.81"E, Scuba, 16 Dec. 2013, Coll.

Park, J. H., MADBK 160710_010: 1 male, Jeju, Korea, 33° 13'42.90"N 126° 39'19.23"E, Scuba, 13 Apr. 2014, MADBK 160710_012: 1 ind., Ulleung, Korea, 37° 27'34.40"N 130° 51'16.03"E, Scuba, 16 Nov. 2013, Coll. Park, J. H., MADBK 160710_013: 4 inds., Seogwipo, Korea, Scuba, 25 Aug. 2007, EVOSYS 260710#021: 1 ind., Yeosu, Korea, 2 Aug. 2007, Coll. Ko, H. S., NIBRIV0000114033: 1 ind., Busan, Korea, 3 Aug. 1980, Coll. Song, J., EWUNHM DP 20151203048.

Distribution. Western to southeastern of mainland Japan, northern China, northeast Taiwan, Korea, intertidal to 300 m.

Remark. On the abdomen of a specimen of *Pagurus japonicus* (EVOSYS 260710#021), parasitic barnacle was found. Its approximate morphological characteristics are similar to those of species belonging to genus *Peltogaster*. However, the specimen of parasitic barnacle is seriously damaged. This relationship has not been reported yet. Therefore, additional specimen and examinations are needed for its identification.

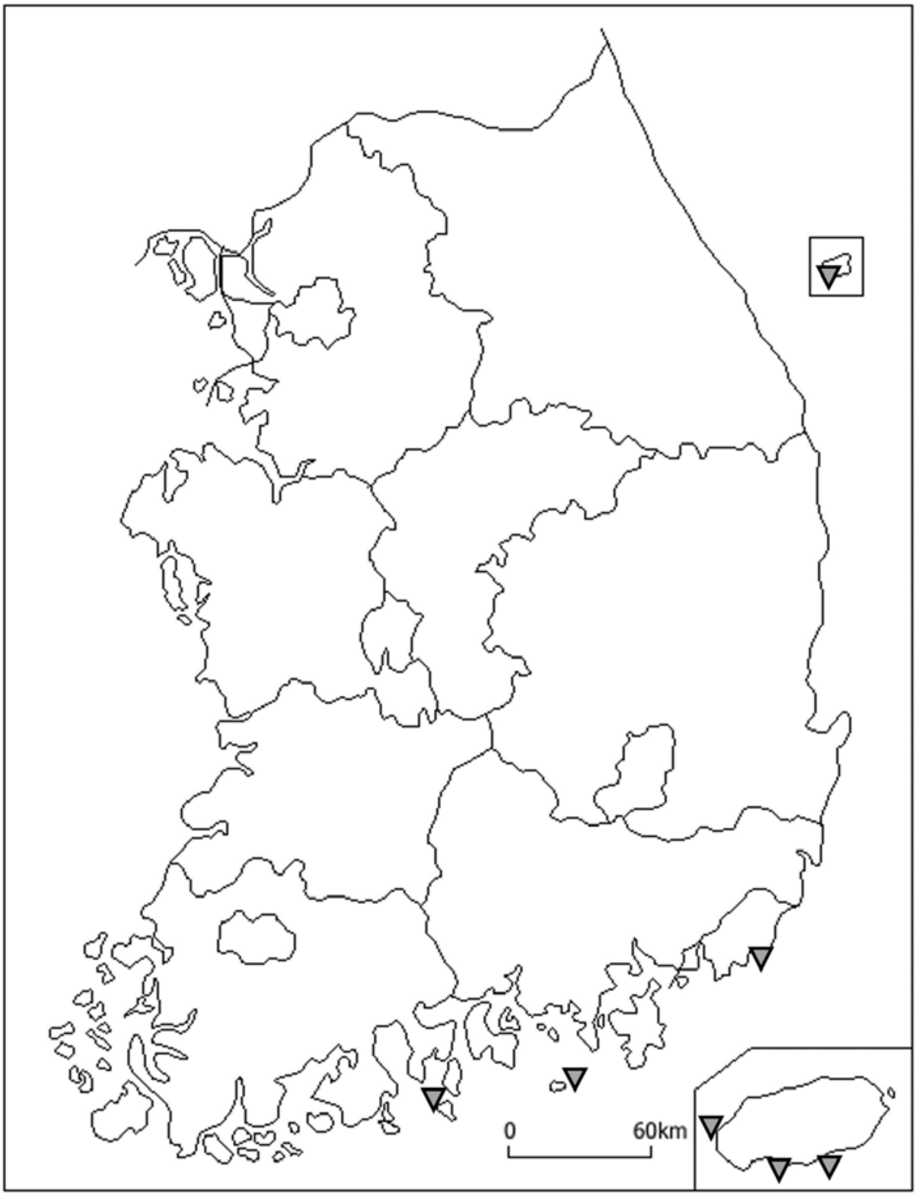

Figure 52. Distribution map of *Pagurus japonicus* (Stimpson, 1858) in Korea.

46. *Pagurus rubrior* Komai, 2003 얼룩참집게 (Plate 43)

Eupagurus japonicus: Ortmann 1892: 309, pl. 12, fig. 16.

Pagurus similis: Kim 1964: 9; 1970: 13; 1973: 240, 603, fig. 59, pl. 7, fig. 39; Miyake, 1978: 103 (part), fig. 40, pl. 2, fig. 3; Asakura, 1995: 362, pl. 97, fig. 4.

Pagurus rubrior Komai, 2003b: 401, figs. 6B, 12, 13; 조성환 외., 2006: 72; Hong et al., 2006a: 254, fig. 3E; Hong et al., 2006b: 362; Kim & Son, 2006: 79; McLaughlin et al., 2010: 34; Arima, 2014: 123; Kim & Kim, 2014: 76, fig. 35, pl. 21.

Eupagurus sp.: Kamita, 1955: 36, fig. 14. (= ? *Pagurus rubrior*)

Material examined. 9 inds., Seogwipo, Korea, 33° 14'10.13"N 126° 31'2.71"E, Scuba, 14 Nov. 2008, Coll. Kim, S. H., MADBK 160717_007: 2 inds., Dokdo, Ulleung, Korea, 37° 14'33.60"N 131° 51'40.26"E, Scuba, 8 Oct. 2008, Coll. Lee, S. K., MADBK 160717_010: 3 ♀♀, 2 ♂♂, Tongyeong, Korea, 34° 40'6.47"N 128° 15'31.67"E, Scuba, 31 Aug. 2011, Coll. Park, J. H., MADBK 160717_013: 3 inds., Ulsan, Korea, 35° 17'48.70"N 129° 24'29.22"E, 17 Sep. 2011, Coll. Jung, J., MADBK 160717_015: 1 ♀, 1 ♂, Jeju, Korea, 33° 25'17.44"N 126° 9'38.96"E, Scuba, 24 Sep. 2011, Coll. Lee, S. K., MADBK 160717_017: 2 inds., Yeosu, Korea, 34° 3'1.97"N 127° 18'37.33"E, Scuba, 23 Apr. 2013, Coll. Park, J. H., MADBK 160717_021: 4 inds., Ulleung, Korea, 37° 27'32.54"N 130° 51'23.42"E, Scuba, 15 Nov. 2013, Coll. Jung, J., MADBK 160717_025: 1 ind., Wando, Korea, 34° 11'5.85"N 126° 50'43.99"E, 2 Oct. 2014, MADBK 160717_028: 3 inds., Busan, Korea, 35° 8'16.83"N 129° 9'37.01"E, fishing trap, 17 Feb. 2016, Coll. Jung, J., MADBK 160717_032: 26 inds., Busan, Korea, 35° 8'16.83"N 129° 9'37.01"E, fishing trap, 18 Nov. 2012, Coll. Jung, J., MADBK 160717_034: 2 inds., Pohang, Korea, 9 Oct. 1963, Coll. Kim, H. S., EVOSYS 260717#001: 6 inds., Busan, Korea, 12 July 1969, Coll. Kim, H. S., EVOSYS 260717#003: 6 inds., Jeju, Korea, fishing net, 13 Aug. 1969, Coll. Kim, H. S., EVOSYS 260717#004: 1 ind., Busan, Korea, 15 July 1972, fishing trap, EVOSYS 260717#012: 1 ind., Yeosu, Korea, 21 June 2002, St. 1, EVOSYS 260717#033: 2 inds., Seogwipo, Korea, 13 July 1972, fishing net, Coll. Lee, K. S., EVOSYS 260717#038: 3 inds., Busan, Korea, 9 Feb. 1971, EWUNHM DP 20151125023: 1 ind., Geoje, Korea, 3 Oct. 2011, Coll. Ko, H. S., NIBRIV0000256816-NIBRIV0000256818.

Distribution. Southwestern to southeastern mainland Japan, Jeju and Ulleung Island and south to southeasten Korea, 10-100 m.

Remark. Komai (2003) has suggested that *Pagurus similis* previously reported in Korea by Kim (1964; 1970; 1973) is questionable but regarded as *Pagurus rubrior* by photograph. Results of literature review and examination of reference specimen of Kim (1973) (EVOSYS 260717#001, EVOSYS 260717#003, EVOSYS 260717#004) agreed with the original description of *P. rubrior*. Therefore, the Korean name of *P. similis*, 얼룩참집게, should be used for *P. rubrior* according to principle of priority. The author suggest the Korean name of *P. similis* as 주황얼룩참집게.

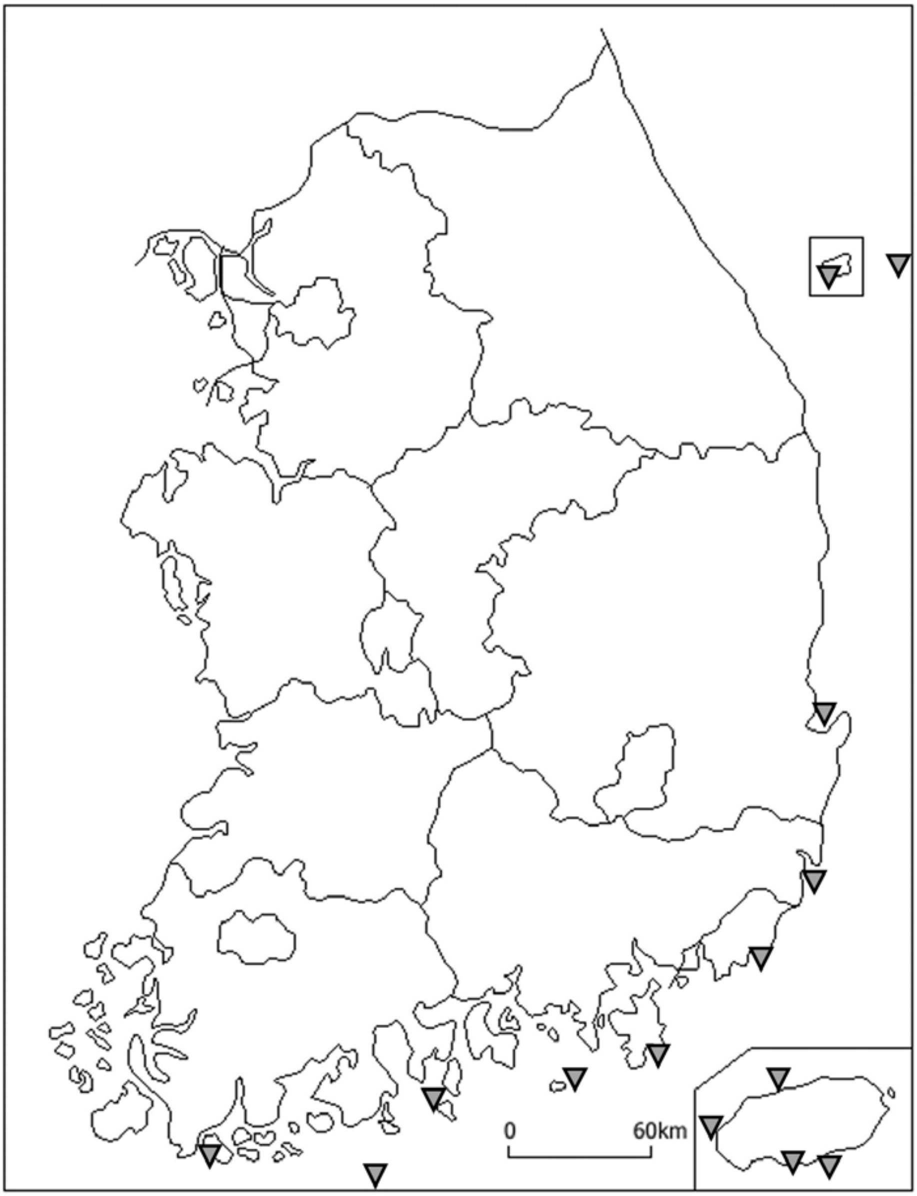

Figure 53. Distribution map of *Pagurus rubrior* Komai, 2003 in Korea.

Kamita (1955) has reported *Eupagurus* sp. in Korean waters such as Jeju, Yeosu, and Ulleung. Its description and figure are similar to those of *P. rubrior*. The distribution similarity of this specimens and *P. rubrior* supports that *Eupagurus* sp. is a representative of *P. rubrior*. However, *P. similis* and *P. rubrior* are very closely related species by morphological characters. Therefore, it is difficult to prejudged them by these facts. Additional examination for the reference specimen is needed.

Parasitic barnacles were found on the abdomen of 4 specimens of *Pagurus rubrior* (EVOSYS 260717#012, EVOSYS 260717#033, EVOSYS 260717#038, EWUNHM DP 20151125023). Their approximate morphological characteristics are similar to those of species belonging to genus *Peltogaster*. However, this relationship has not been reported yet.

One individual of *P. rubrior* (EVOSYS 260717#056) was found living in the carcinoecia formed by *Hydrissa sodalis*. There is no report of this species living in this kind of carcinoecia. However, the specimen of hermit crab is seriously damaged so additional specimen is needed.

47. *Pagurus similis* (Ortmann, 1892) 주황얼룩참집게 (Plate 44)

Eupagurus similis Ortmann, 1892: 310; Alcock, 1905: 177; Yokoya, 1933: 86.

Eupagurus barbatus: Balss, 1913: 55.

Pagurus similis: Miyake, 1978: 103 (part); Komai, 2003b: 391, figs. 6A, 7–11; Hong et al., 2006b: 362; Kim & Son, 2006: 80; McLaughlin et al., 2007a: 267; 2010: 34; Arima, 2014: 131; Kim & Kim, 2014: 51, fig. 21, pl. 14.

Pagurus similes: Huang & Lin, 2012: 101.

Material examined. 1 ♂, Busan, Korea, 35° 8'16.83"N 129° 9'37.01"E, fishing trap, 23 Apr. 2011, Coll. Jung, J., MADBK 160724_001: 4 inds., Busan, Korea, 35° 8'16.83"N 129° 9'37.01"E, 17 Feb. 2011, Coll. Kim, S. H., MADBK 160724_002: 10 inds., Busan, Korea, 35° 8'16.83"N 129° 9'37.01"E, 12 Nov. 2010, Coll. Kim, S. H., MADBK 160724_005: 2 inds., Busan, Korea, 35° 8'16.83"N 129° 9'37.01"E, fishing trap, 24 Mar. 2015, Coll. Jung, J., MADBK 160724_006: 1 ♂, Busan, Korea, 35° 8'16.83"N 129° 9'37.01"E, fishing trap, 31 Jan. 2016, Coll. Jung, J., MADBK 160717_031: 1 ind., Jeju, Korea, 7 July 1972, Coll. Choe, B. L., EVOSYS 260717#009: 1 ind., Busan, Korea, 9 Oct. 1982, Coll. Kim, H. S., EVOSYS 260717: 1 ind., Seogwipo, Korea, 6 Feb. 1971, EWUNHM DP 20151202036: 1 ind., Ulleung, Korea, 14 Aug. 2014, Coll. Kim, M. H., NIBRIV0000423046.

Distribution. Southern and southwestern mainland Japan, Jeju and Ulleung Island and Busan, Korea, Taiwan, 30–200 m.

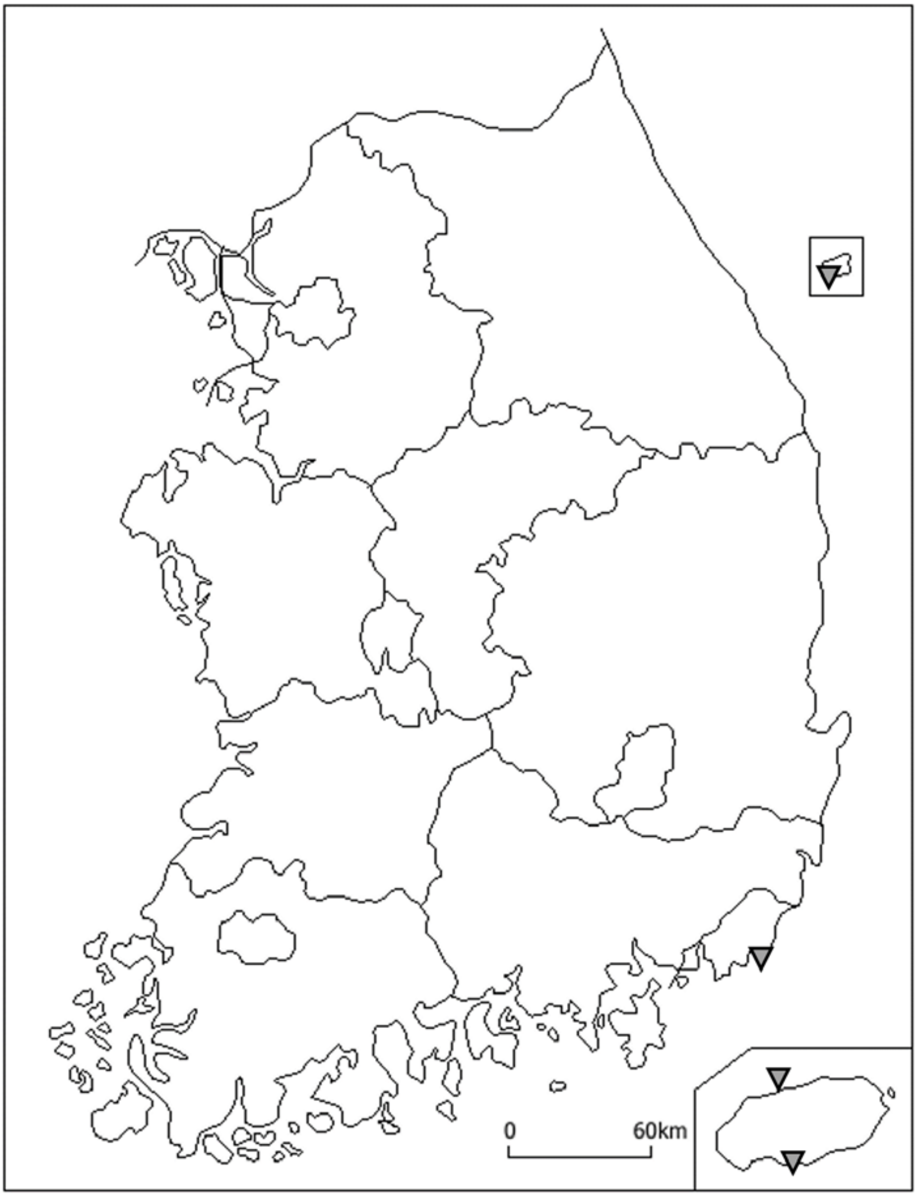

Figure 54. Distribution map of *Pagurus similis* (Ortmann, 1892) in Korea.

Remark. Huang and Lin (2012) have reported *Pagurus similes* in Chinese water. However, the name of this species is regarded as *Pagurus similis* due to a typing error because photo and figure represent *P. similis* exactly.

48. *Pagurus parvispina* Komai, 1997 긴가시참집게 (Plate 45)

Pagurus rathbuni: Igarashi, 1970: 6, pl. 4, fig. 13.

Pagurus parvispina Komai, 1997: 113–122, figs. 1–4; McLaughlin et al., 2010: 33; Marin et al., 2012: 275–276, figs. a–d; Jung & Kim, 2014; 10, figs. 3, 4; Kim & Kim, 2014; 64, figs. 27, 28.

Material examined. 1 ♂ (sl 12.7 mm), Pohang, Korea, 35° 51'27.30"N 129° 41'56.66"E, fishing trap, 22 Apr. 2011, Coll. Jung, J., MADBK 160744_001: 1 ind., Pohang, Korea, 35° 52'32.03"N 129° 31'7.43"E, 25 Jan. 2015, Coll. Jung, J., MADBK 160720_015: 1 ind., Yeongdeok, Korea, fishing ship, 24 Dec. 1977, Coll. Rho, B. J., EWUNHM DP 20151125011: 1 ind., Ulleung, Korea, 19 June 1988, Coll. Song, J., EWUNHM DP 20151202006: 2 inds., Goseong, Korea, 22 Nov. 1980, Coll. Rho, B. J., EWUNHM DP 20151217063: 1 ind., Yeongdeok, Korea, 23 Dec. 2011, Coll. Ko, H. S., NIBRIV0000261140.

Distribution. Vostok Bay of Russia, northern and northeastern Japan, eastern Korea.

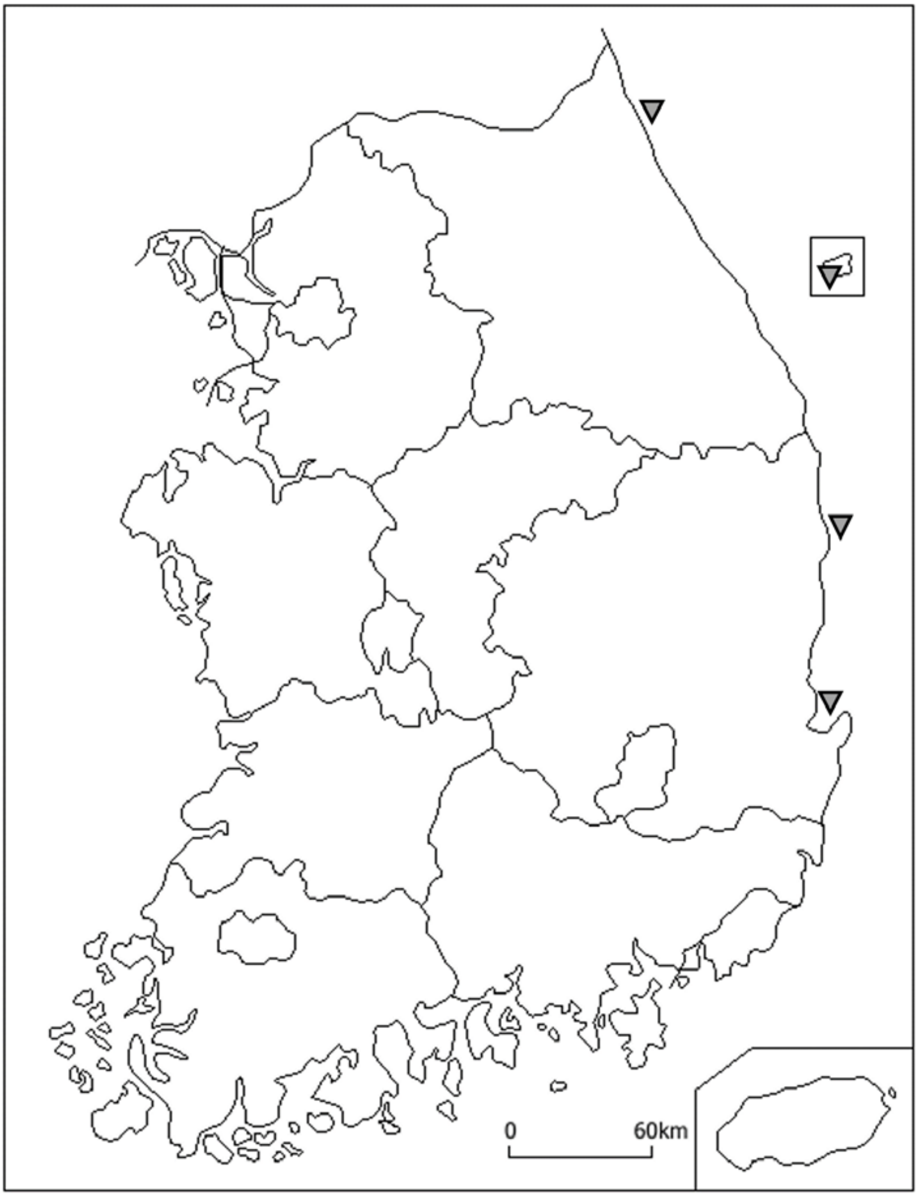

Figure 55. Distribution map of *Pagurus parvispina* Komai, 1997 in Korea.

Remark. Two individuals of *P. parvispina* (MADBK 160744_001, EWUNHM DP 20151202006) were found living in the gastropod shell covered by colony of associated hydrozoan, *Hydrissa sodalis*. There is no report that *P. parvispina* is associated with this hydrozoan.

On the abdomen of specimens of *P. parvispina* (EWUNHM DP 20151217063), parasitic barnacles were found. Their approximate morphological characteristics are similar to those of *Peltogaster paguri* Rathke, 1842. However, this relationship has not been reported yet.

49. *Pagurus pectinatus* (Stimpson, 1858) 빗참집게 (Plate 46)

Eupagurus pectinatus Stimpson, 1858: 249; 1907: 220; Alcock, 1905: 177; Balss, 1913: 60 (part), text-fig. 35, pl.1, fig. 8; Terao, 1913: 371; Yokoya, 1933: 83 (part); 1939: 280; Kamita, 1955: 39, fig. 16.

Eupagurus seriespinosus Thallwitz, 1891:34; Terao, 1913: 372.

Clibanarius japonicus Rathbun, 1902: 35, figs. 2-5; Terao, 1913: 361; Makarov, 1962: 154, fig. 65; Miyake, 1978: 49.

Pagurus pectinatus: Makarov, 1962: 203, pl. 4, fig. 3; Igarashi, 1970: 7, pl.5, fig.17; Kim, 1963: 309; 1964: 8; 1970: 13; 1973: 242, 603, figs. 60, 61, pl. 7, fig. 40; Komai, 2000: 323, figs. 1-5; Hong et al., 2006b: 361; Kim & Son, 2006: 77; McLaughlin et al., 2010: 34; Huang & Lin, 2012: 104; Arima, 2014: 124 (part), 136; Kim & Kim, 2014: 67, fig. 29, 30.

Material examined. 1 ♀, 1 ♂, Goseong, Korea, 38° 19'46.46"N 128° 33'16.56"E, 24 Mar. 2010, Coll. Lee, S. K., MADBK 160715_001: 2 ♀♀, 1 ♂, Uljin, Korea, 37° 0'28.53"N 129° 24'59.38"E, Scuba, 29 Oct. 2009, Coll. Lee, S. K., MADBK 160715_009: 1 ind., Yeonggwang, Korea, 35° 13'49.69"N 126° 8'31.32"E, 24 June 2010, Coll. Lee, S. K., MADBK 160715_014: 44 inds., Busan, Korea, 35° 8'16.83"N 129° 9'37.01"E, 12 Nov. 2010, Coll. Kim, S. H, MADBK 160715_016, MADBK 160715: 1 ♂, Goseong, Korea, 38° 19'53.63"N 128° 34'47.33"E, fishing trap, 27 July 2011, 24 Mar. 2010, Coll. Lee, S. K., MADBK 160715_020: 1 ♂, Pohang, Korea, 35° 57'22.60"N 129° 40'27.41"E, fishing trap, 17 Sep. 2011, Coll. Jung, J., MADBK 160715_023: 4 inds., Gangneung, Korea, 37° 48'28.86"N 128° 58'53.19"E, 27 Mar. 2004, MADBK 160715_024: 7 inds., Yangyang, Korea, 37° 56'27.62"N 128° 47'23.56"E, 22 Apr. 2000, MADBK 160715_026: 1 ind., Gunsan, Korea, 25 May 1965, Coll. Choe, B. L., EVOSYS 260715#001: 1 ind., Geoje, Korea, 9 July 1996, EVOSYS 260715#012: 6 inds., Samcheok, Korea, fishing trap, 28 Jan. 2002, EVOSYS 260715#021: 1 ind., Tongyeong, Korea, Scuba, 29 July 2003, EVOSYS 260715: 5 inds., Sokcho, Korea, 3 Oct. 1990, Coll. Song, J., EWUNHM DP 20151125013: 1 ind., Yeongdeok, Korea, 10 Aug. 1971, Coll. Rho, B. J., EWUNHM DP 20151202019: 1 ind., Wando, Korea, 25 Mar. 1991, Coll. Shin, S., EWUNHM DP 20151203018: 1 ind., Taean, Korea, 23 Apr. 2009, Coll. Ko, H. S., NIBRIV0000538764–NIBRIV0000538793.

Distribution. Mainland Japan, eastern Russian, China, mainland Korea, 4–220 m.

Remark. Arima (2014) has reported that some *Pagurus simulans* are living in the sponge. However, the largest photo is regarded as *Pagurus pectinatus* according to color of band on pereopods and color of corneas.

On the abdomen of specimens of *P. pectinatus* (MADBK 160715_016, EWUNHM DP 20151125034, EWUNHM DP 20151202019), parasitic barnacles were found. Their approximate morphological characteristics and COI sequence are similar to those of *Peltogasterella gracilis* (Boschma, 1927).

One individual of *P. pectinatus* (MADBK 160715) was found living in the carcinoecia formed by *Hydrissa sodalis*. There is no report of this species living in this kind of carcinoecia.

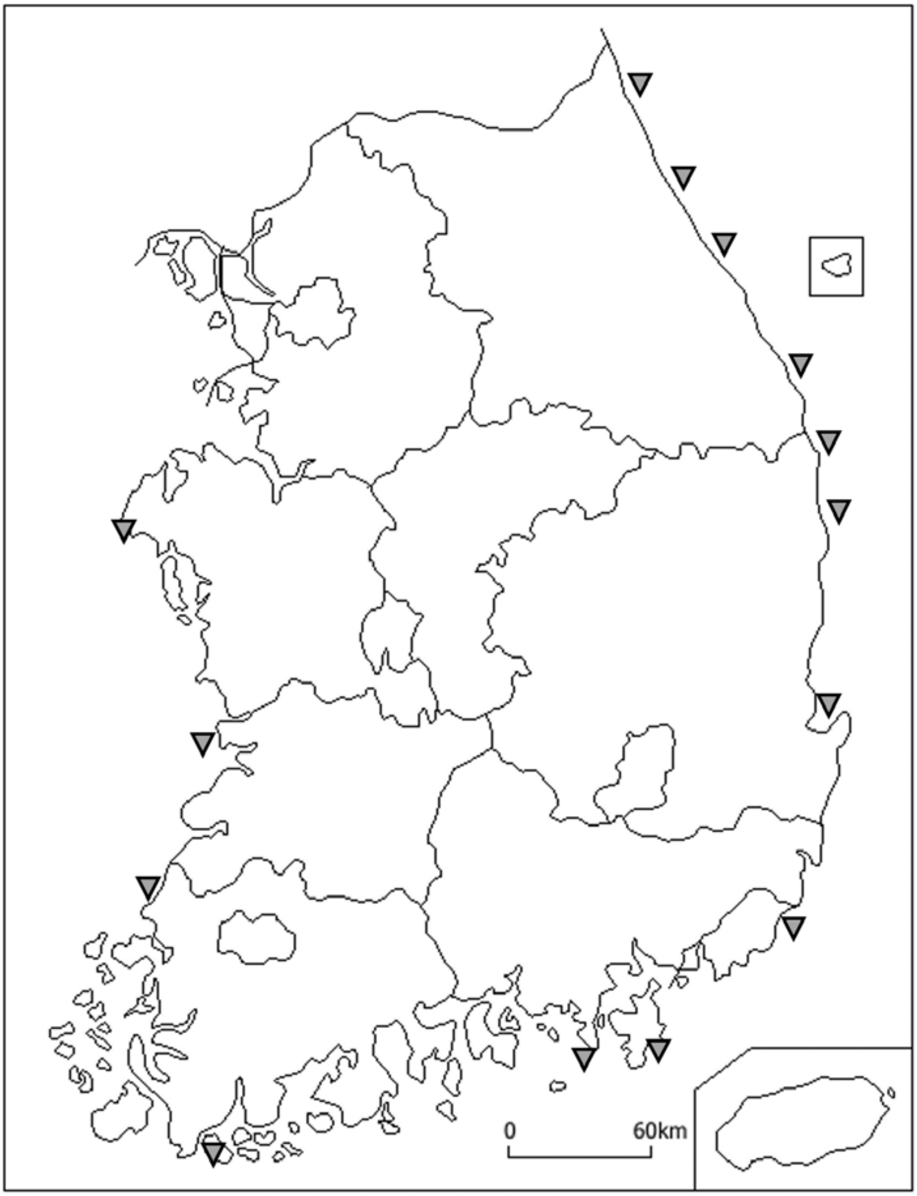

Figure 56. Distribution map of *Pagurus pectinatus* (Stimpson, 1858) in Korea.

50. *Pagurus conformis* De Haan, 1849 큰발참집게

Pagurus conformis De Haan, 1849: 204; Alcock, 1905: 177; McLaughlin et al., 2007a: 224; 2010: 31; Huang & Lin, 2012: 100; Arima, 2014: 125.

Eupagurus megalops Stimpson, 1858: 248; 1907: 216; Alcock, 1905: 176; Terao, 1913: 370.

Eupagurus conformis: Ortmann, 1892: 298, 305; Doflein, 1902: 647; Balss, 1913: 52; Terao, 1913: 366.

Eupagurus carpoforaminatus var. *nephromma*: Terao, 1913: 370.

Pagurus megalops: Kim, 1973: 223, 599, figs. 60, 61, pl. 69, figs. 29a, 29b; Miyake, 1978: 84, fig. 31; Kim & Kim, 1997: 216.

Distribution. Southern to southeastern of mainland Japan, East China Sea, Taiwan, Jeju Island of Korea; 5–190 m.

51. *Pagurus exiguus* (Melin, 1939) 동도참집게

Eupagurus (*Pagurillus*) *exiguus* Melin, 1939: 3, 34, figs. 11–13.

Pagurus exiguus: Miyake, 1978: 81l; McLaughlin, 1995: 570, fig. 1; McLaughlin et al., 2010: 33.

? *Pagurus exiguus*: Oh, 2001: 218, pl. 2, figs. 3, 4.

Distribution. Bonin Islands of Japan, ? Dokdo Island of Korea.

Remark. *Pagurus exiguus* was first reported in the Korea by Oh (2001). However, it is doubtful that the specimen of Oh (2001) really represents *P. exiguus* due to three reasons. First, his figures are not enough to identify it. Second, there is no description about his specimen. Third, Dokdo Island is located at a slightly long distance from Bonin Islands, the type locality of *P. exiguus*. Additional examination of the reference specimen is needed.

52. *Pagurus spina* Komai, 1994 가시다리참집게 (Plate 49)

Pagurus spina Komai, 1994a: 23, figs. 1−3; Hong et al., 2006a: 254, fig. 2; McLaughlin et al., 2010: 34; Arima, 2014: 128.

Material examined. 10 inds., Ulleung, Korea, 37° 27'32.54"N 130° 51'23.42"E, Scuba, 16 Nov. 2013, Coll. Park, J. H., MADBK 160726_003: 9 inds., same as MADBK 160726_003, MADBK 160726_005: 2 inds., same as MADBK 160726_003, MADBK 160726_006: 1 ind., same as MADBK 160726_003, NIBRIV0000320056, NIBRIV0000320057, NIBRIV0000458753, NIBRIV0000458754.

Diagnosis. Shield as long as width; rostrum elongated triangular; lateral projections reduced. Ocular peduncles about 0.6 length of shield, corneas slightly dilated; ocular acicles subovate. Antennular peduncles exceeding distal margins of corneal by half of ultimate segments. Antennal peduncles exceeding distal margins of corneal by half of fifth segments.

Chelipeds with long setae, right larger; ventrolateral margin of ischium of cheliped with a strong spine. Dactyl of right cheliped with row of spines on dorsal surface; dorsomesial margin with row of spines. Palm with irregular rows of strong spines on dorsal surface, dorsomesial and dorsolateral margins with row of spines. Dorsal surface of carpus with scattered spines, dorsomesial margin with row of strong spines.

Dactyl of left cheliped with scattered spines on dorsal surface. Palm with scattered spines on dorsal surface; dorsolateral margin with row of small spines. Carpus with dorsolateral and dorsomesial row of strong spines.

Second and third pereopods with long setae. Dactyls slightly twisted, almost as long as propodi; dorsomesial, ventromesial and ventral margins with row of spines. Carpi with dorsodistal spine.

Abdomen twisted, uropods asymmetry.

Telson with asymmetrical posterior lobes, lobes separated by shallow median cleft, each lobe with row of spinules.

Distribution. Miyako of Japan, Dokdo Island and Ulleung of Korea, intertidal to 15 m.

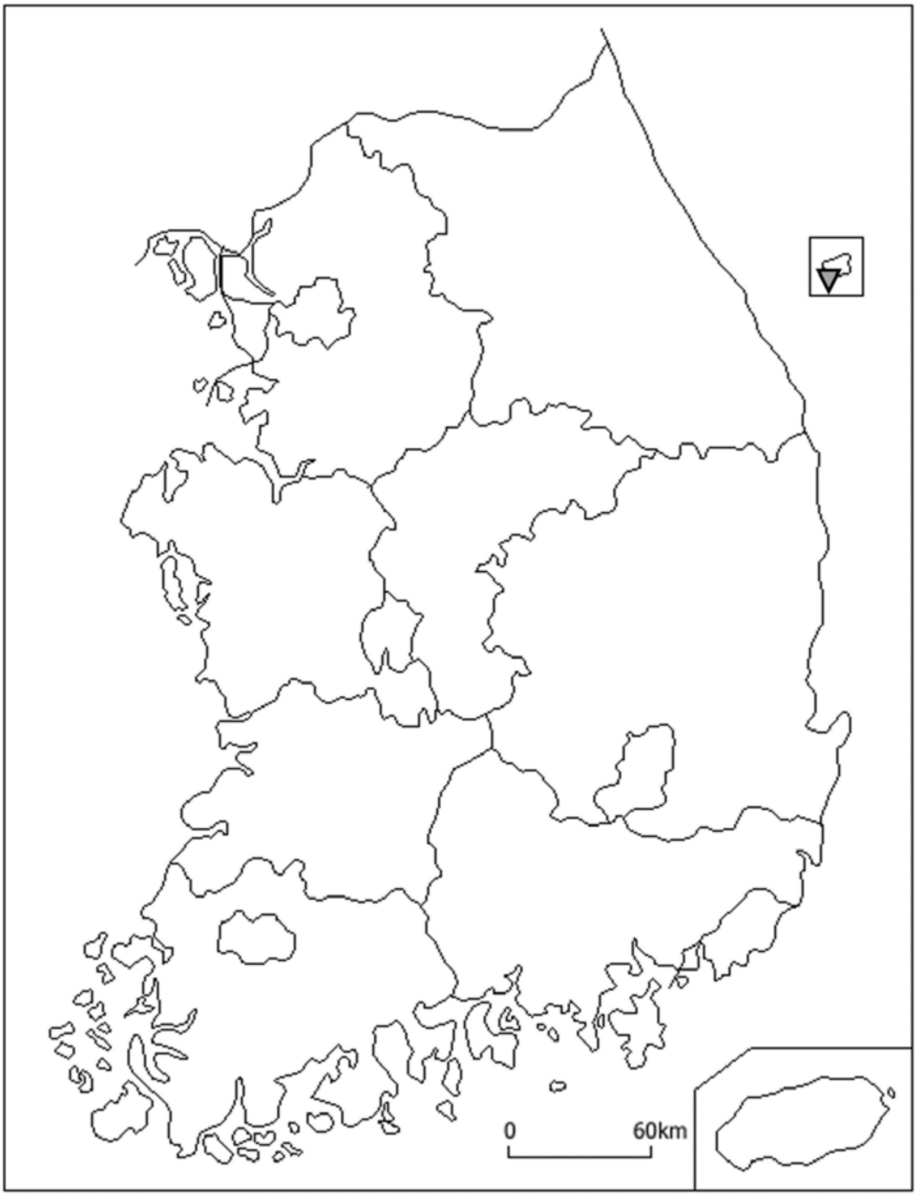

Figure 57. Distribution map of *Pagurus spina* Komai, 1994 in Korea.

Remark. Many specimens of *Pagurus spina* (MADBK 160726_003, MADBK 160726_005, MADBK 160726_006, NIBRIV0000320056, NIBRIV0000320057, NIBRIV0000458753, NIBRIV0000458754) were found in Ulleung Island. This location seems to be the eastern limiting line of this species.

On the abdomen of a specimen of *P. spina* (MADBK 160726_003), parasitic barnacle was found. Its approximate morphological characteristics and COI sequence are similar to those of *Peltogasterella gracilis* (Boschma, 1927).

53. *Pagurus imaii* (Yokoya, 1939) 서도참집게

Eupagurus imaii Yokoya, 1939: 285, fig. 13

Pagurus imaii: Miyake, 1978: 81; Komai, 1994c: 33, figs. 1-3; McLaughlin et al., 2010: 33: Arima, 2014: 129.

Parapagurus imaii: Komai, 1999b: 88, fig. 5; Hong et al., 2006a: 256, fig. 3F; Kim & Son, 2006: 86.

? *Pagurus imaii*: Oh, 2001: 218, pl. 4, figs. 6, 7.

Distribution. Miyagi and southern Hokkaido of Japan, Dokdo Island of Korea, 20-35 m.

Remark. *Pagurus imaii* was first reported in Korea by Oh (2001). However, his figures are not enough to identify it. There is no description about his specimen. Therefore, it is doubtful that the specimen of Oh (2001) really represents *P. imaii*, although Kim and

Son (2006) have reported *Parapagurus imaii* (= *Pagurus imaii*) in Korean waters.

54. *Pagurus constans* (Stimpson, 1858) 제집참집게 (Plate 48)

Eupagurus constans Stimpson, 1858: 248(86); 1907: 218, pl. 24, fig. 3; Henderson, 1888: 67, pl. 6, fig. 8; Ortmann, 1892: 310; Doflein, 1902: 647; Alcock, 1905: 177; Balss, 1913: 55; Terao, 1913: 366; Yokoya, 1933: 81; 1939: 285; Kamita, 1955: 33, fig. 12.

Pagurus constans: Makarov, 1962: 210, fig. 73; Miyake, 1978: 87, fig. 32; Kim, 1970: 7; 1973: 244, 604, fig. 62, pl. 72, fig. 41a, b; Asakura, 1995: pl. 97, fig. 6, 362; McLaughlin et al., 2010: 33; Arima, 2014: 135.

Parapagurus constans: Komai, 1999b: 88, fig. 5; Hong et al., 2006b: 364; Kim & Son, 2006: 83 (part).

Pagurus sagamiensis Miyake, 1978: 116 (part).

Material examined. 13 inds., Busan, Korea, 35° 8'16.83"N 129° 9'37.01"E, 12 Nov. 2010, Coll. Kim, S. H., MADBK 160705_002: 2 inds., Geoje, Korea, 34° 42'39.91"N 128° 37'39.97"E, 9 July 1996, MADBK 160705_006: 1 ind., Busan, Korea, 35° 8'16.83"N 129° 9'37.01"E, 30 Jan. 2016, Coll. Jung, J., MADBK 160705_008: 4 inds., Pohang, Korea, 24 July 1968, EVOSYS 260705#001: 3 inds., Tongyeong, Korea, 14 Nov. 2006, EVOSYS 260715#019: 1 ind., Seogwipo, Korea, 15 Dec. 1969, Coll. Rho, B. J., EVOSYS 260715: 1

ind., Tongyeong, Korea, 26 May 1982, Coll. Yun, S. J., EWUNHM DP 20151203027.

Distribution. Eastern and western mainland Japan, Jeju Island and southeastern Korea, 5−150 m.

Remark. In the specimen of *Pagurus constans* in Korea (MADBK 160705_008), the left cheliped is stouter and distinctly longer than the right cheliped. This condition may be due to regeneration as under normal condition, the right cheliped is larger than the left one in this species (Stimpson, 1858).

Most gastropod shell inhabited by *P. constans* is small and fully covered by *Hydrissa sodalis* as indicated in previous studies (Goto, 1910; Makarov, 1962). However, a specimen of *P. constans* in Korea (EVOSYS 260715#019) lived in a sponge, as reported previously by Komai (1999a).

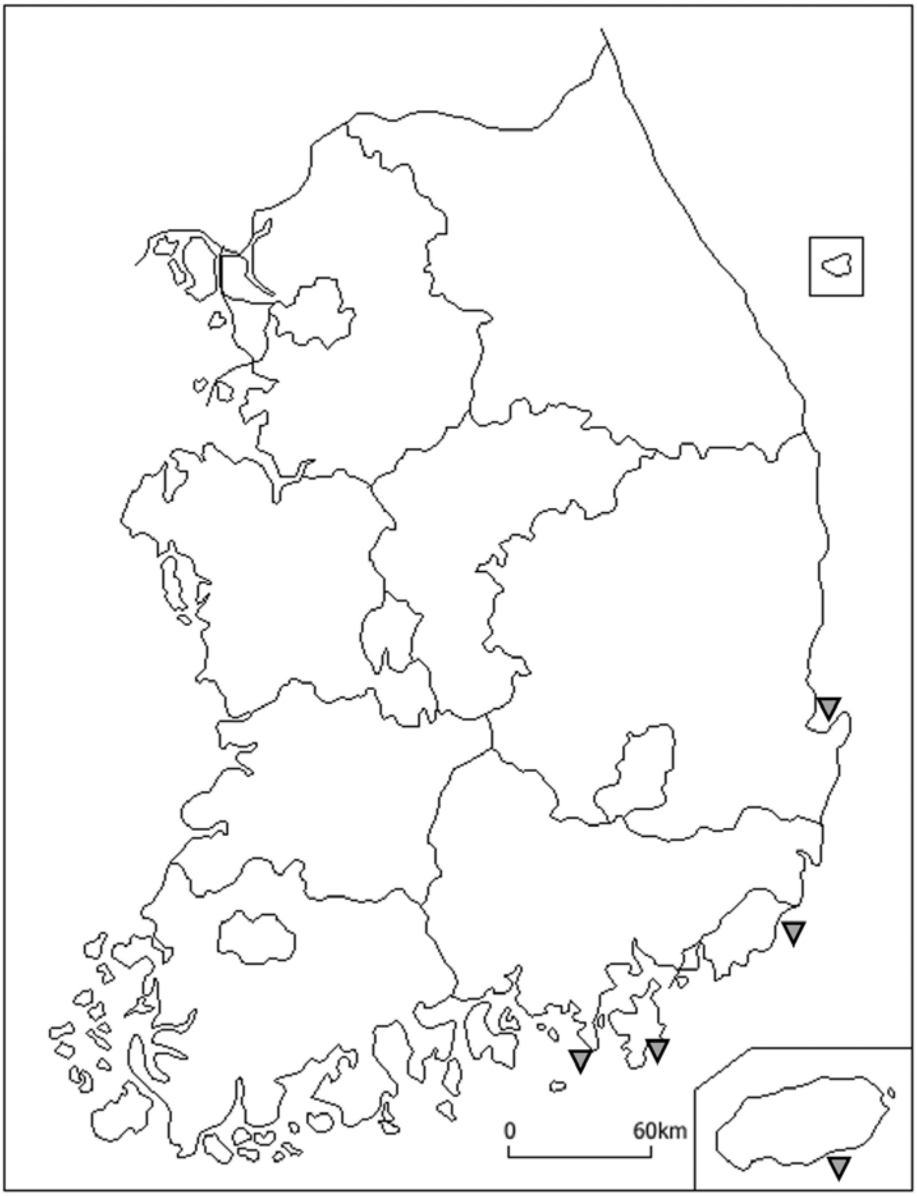

Figure 58. Distribution map of *Pagurus constans* (Stimpson, 1858) in Korea.

55. *Pagurus trigonocheirus* (Stimpson, 1858) 세모손참집게

(Plate 49)

Eupagurus trigonocheirus Stimpson, 1858: 249; 1907: 211, pl. 26 fig. 2; Terao, 1913: 373; Yokoya, 1933: 83

Pagurus trigonocheirus: Makarov, 1962: 199: Kim, 1973: 234, 601, fig. 55, pl. 6, fig. 35; McLaughlin, 1974: 233, figs. 59, 60; Hong et al., 2006b: 363; Kim & Son, 2006: 82; McLaughlin et al., 2010: 34, fig. 16H; Kim & Kim, 2014: 80, fig. 38, pl. 23.

Pagurus pubescens: Makarov, 1962: 199 (part), pl. 4 fig. 1; Kim, 1963: 302, fig. 21.

Eupagurus (*Trigonochirus*) *trigonocheirus*: Benedict, 1892: 1.

Eupagurus (*Trigonochirus*) *brandti* Benedict, 1892: 9 (in part); Kim, 1964: 8. Kim, 1970: 7.

Eupagurus pubescens: Alcock, 1905: 183 (part): Kamita, 1954: 60 (part); 1955: 44, fig. 20 (part).

Pagurus (*Trigonocheirus*) *trigonocheirus*: Holmes, 1900: 138.

Pagurus (*Trigonocheirus*) *Brandti*: Holmes, 1900: 139 (part).

Eupagurus trigonochirus: Alcock, 1905: 17.

Eupagurus brandti: Alcock, 1905: 178 (part).

? not *Pagurus trigonocheirus*: Huang & Lin, 2012: 103.

Material examined. 4 ♀♀, 13 ♂♂, Goseong, Korea, 38° 19'53.63"N 128° 34'47.35"E, 23 Aug. 2011, Coll. Park, J. H., MADBK 160720_001: 12 inds., Uljin, Korea, 37° 2'43.86"N 129° 25'30.37"E, 18 Apr. 2011, Coll. Kim. S. H., MADBK 160720_003: 2 ♂♂, Pohang, Korea, 35° 52'11.38"N 129° 38'46.39"E, 22 Apr. 2011, Coll. Jung, J., MADBK 160720_005:

2 inds., Samcheok, Korea, 37° 4'51.20"N 129° 26'11.87"E, 18 Sep. 2011, Coll. Jung, J., MADBK 160720_007: 10 inds., Yangyang, Korea, 37° 56'52.96"N 128° 48'39.11"E, 5 Apr. 2012, Coll. Kim, S. H., MADBK 160720_009: 4 inds., Ulleung, Korea, 37° 29'3.87"N 130° 54'20.81"E, fishing trap 200 m, 15 Nov. 2013, Coll. Park, J. H., MADBK 160720_015: 7 inds., Sokcho, Korea, 23 May 2011, MADBK 160720_016: 5 inds., Donghae, Korea, 24 Apr. 2000, EVOSYS 260720#005: 4 inds., Yeongdeok, Korea, 24 Dec. 1977, Coll. Rho, B. J., EWUNHM DP 20151125008.

Distribution Arctic Ocean to Point Barrow, Chukchi Sea, Bering Sea, Sea of Okhotsk, northeastern mainland Japan, eastern Korea, 9–590 m.

Remark. Figure of Huang and Lin (2012) of *Pagurus trigonocheirus* is not regarded as *P. trigonocheirus*, but other *Pagurus* sp. because of its geographical dissimilarity with other *P. trigonocheirus*, shape and ratio of shield compare to ocular peduncles, and the presence of long setae on the dorsal surfaces of chelae and lateral surfaces of ambulatory legs. However, reference specimen and additional examination are needed for clear identification of this due to the absence of description.

One specimen of *P. trigonocheirus* (MADBK 160720_007) was found living in the gastropod shell covered by colony of associated hydrozoan, *Hydrissa sodalis*. There is no report that *P. trigonocheirus* is associated with this hydrozoan.

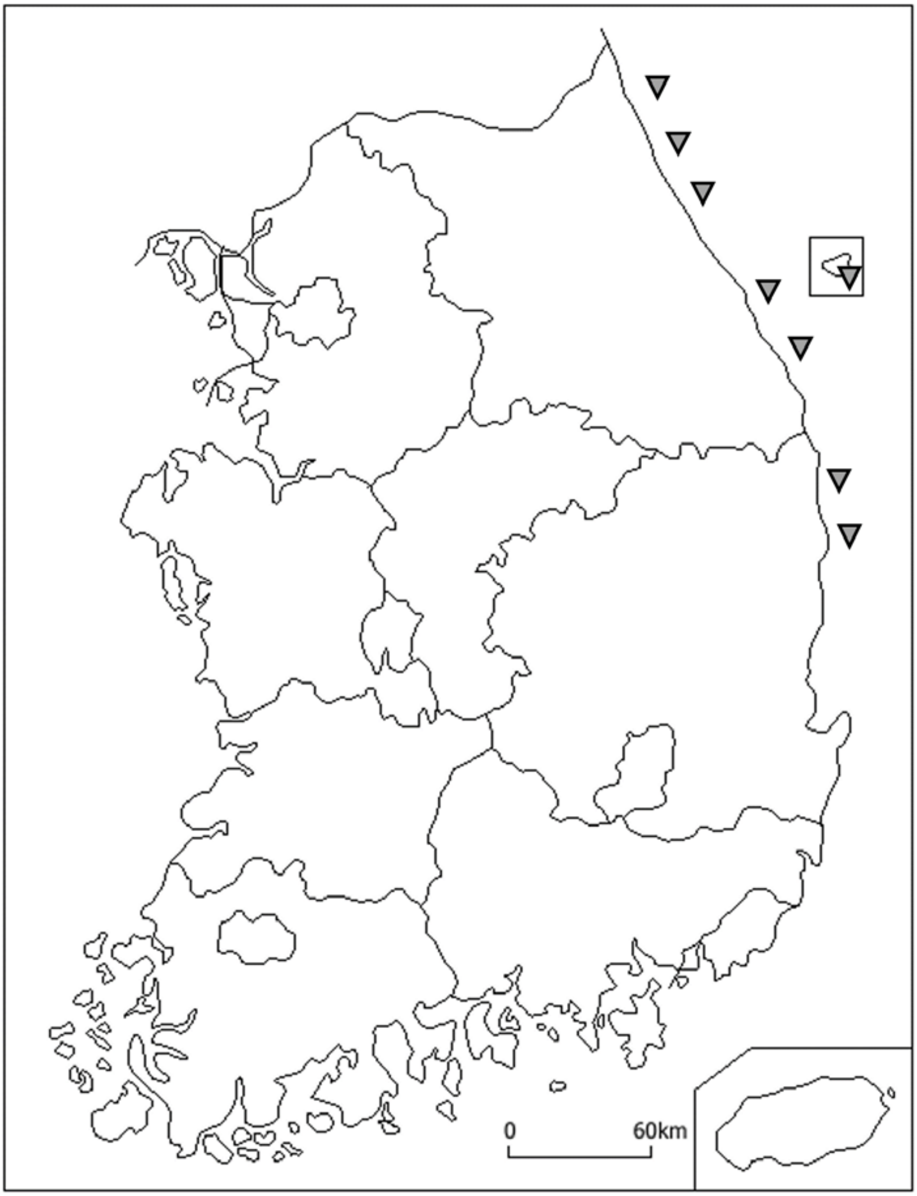

Figure 59. Distribution map of *Pagurus trigonocheirus* (Stimpson, 1858) in Korea.

56. *Pagurus ochotensis* Brandt, 1851 북방참집게 (Plate 50)

? *Cancer bernhardus*: Herbst, 1791: 15, pl. 22 fig. 6.

Pagurus (*Eupagurus*) *bernhardus* var. *B. granulato-denticulata* Brandt, 1851: 107.

Pagurus (*Eupagurus*) *bernhardus* var. C. *spinimana* or sp. *ochotensis* Brandt, 1851: 108.

Eupagurus bernhardus: Stimpson, 1857: 483.

Eupagurus ochotensis: Stimpson, 1858: 248 (part); 1907, 218; Alcock, 1905: 178 (part); Balss, 1913: 60; Yokoya, 1933: 82; 1939: 284; Kamita, 1954: 60; 1955: 42, fig. 18; Kamita, 1956: 69.

Eupagurus (*Eupagurus*) *alaskensis* Benedict, 1892: 2.

Eupagurus alaskensis: Alcock, 1905: 178.

Pagurus (*Eupagurus*) *alaskensis*: Holmes, 1900: 135.

Pagurus ochotensis: Makarov, 1962: 188, figs. 44, 69B, pl. 2 fig. 2; Kim, 1963: 302; 1964: 8; 1970: 7; 1973: 232, 600, fig. 54, pl. 6, fig. 34; McLaughlin, 1974: 57, figs. 15, 16; Hong et al., 2006b: 360; Kim & Son, 2006: 76; McLaughlin et al., 2010: 33; Huang & Lin, 2012: 103;

Arima, 2014: 138; Kim & Kim, 2014: 62, fig. 26, pl. 19.

Eupagurus ortmanni Balss, 1911: 7.

Pagurus alascensis: Balss, 1911: 7; 1913: 60.

Eupagurus spinimanus: Terao, 1913: 372.

Material examined. 1 ind., Yangyang, Korea, 37° 56'52.96"N 128° 48'39.12"E, 22 Mar. 2010, Coll. Lee, S. K., MADBK 160714_002: 30 inds., Uljin, Korea, 37° 2'43.86"N 129° 25'30.36"E, 14 Nov. 2010, Coll. Kim, S. H., MADBK 160714_004: 1 ♂, Ulsan, Korea, 35° 35'29.62"N 129° 35'28.41"E, fishing net, 22 Jan. 2011, Coll. Shin, M. K., MADBK 160714_005: 4 inds., Goseong, Korea, 38° 19'53.63"N 128° 34'47.31"E, 24 Mar. 2010, Coll. Lee, S. K., MADBK 160714_006: 1 ♂, Pohang, Korea, 35° 57'22.60"N 129° 40'27.41"E, 17 Sep. 2011, Coll. Jung, J., MADBK 160714_007: 1 ind., Gangneung, Korea, 37° 48'28.86"N 128° 58'53.19"E, 27 Mar. 2004, MADBK 160714_009: 1 ind., Boryeong, Korea, 36° 14'41.26"N 126° 32'7.33"E, 1 Mar. 1996, MADBK 160714_010: 1 ♀, Busan, Korea, 35° 8'16.83"N 129° 9'37.01"E, fishing trap, 31 Jan. 2016, Coll. Jung, J., MADBK 160714_013: 2 ♂♂, Gunsan, Korea, 31 May 1969, Coll. Choe, B. L., EVOSYS 260714#001: 2 ♂♂, Incheon, Korea, 17 July 1973, Coll. Kim, H. S., EVOSYS 260714#003: 1 ♂, Jeju, Korea, fishing net, 22 Nov. 2006, EVOSYS 260714: 1 ind., Gyeongju, Korea, 31 July 1971, EWUNHM DP 20151202008: 1 ind., Samcheok, Korea, 12 Aug. 1987, Coll. Rho, B. J., EWUNHM DP 20151202024: 27 inds., Goseong, Korea, 22 Jan. 2011, Coll. Choe, S., EWUNHM DP 20151202050: 2 inds., Yeosu, Korea, 15 July 1977, Coll. Song, J., EWUNHM DP 20151203015.

Distribution. Northern to southeastern Russia; northwestern to western North America; western mainland Japan, China, Korea, subtidal to 250 m.

Remark. One specimen of *Pagurus ochotensis* (MADBK 260714) was found in the port of Jeju Island. This location seems to be the southern limiting line of this species. However, the location of the exact collecting site (collected by fishing vessel) is not specified. Therefore, collection of additional specimen nearby Jeju Island is needed to determine the southern limiting line of this species.

One specimen of *P. ochotensis* (EWUNHM DP 20151202050) was found living in the gastropod shell covered by colony of associated hydrozoan, *Hydrissa sodalis*. There is no report that *P. ochotensis* is associated with this hydrozoan.

One specimen of *P. ochotensis* (EVOSYS 260714#001) was found living in the gastropod shell covered by small colony of sponge. There is no report of this species living with sponge.

On the abdomen of a specimen of *P. ochotensis* (MADBK 160714_013), parasitic barnacle was found. Its approximate morphological characteristics are similar to those of species belonging to genus *Peltogaster*. However, this relationship has not been reported yet.

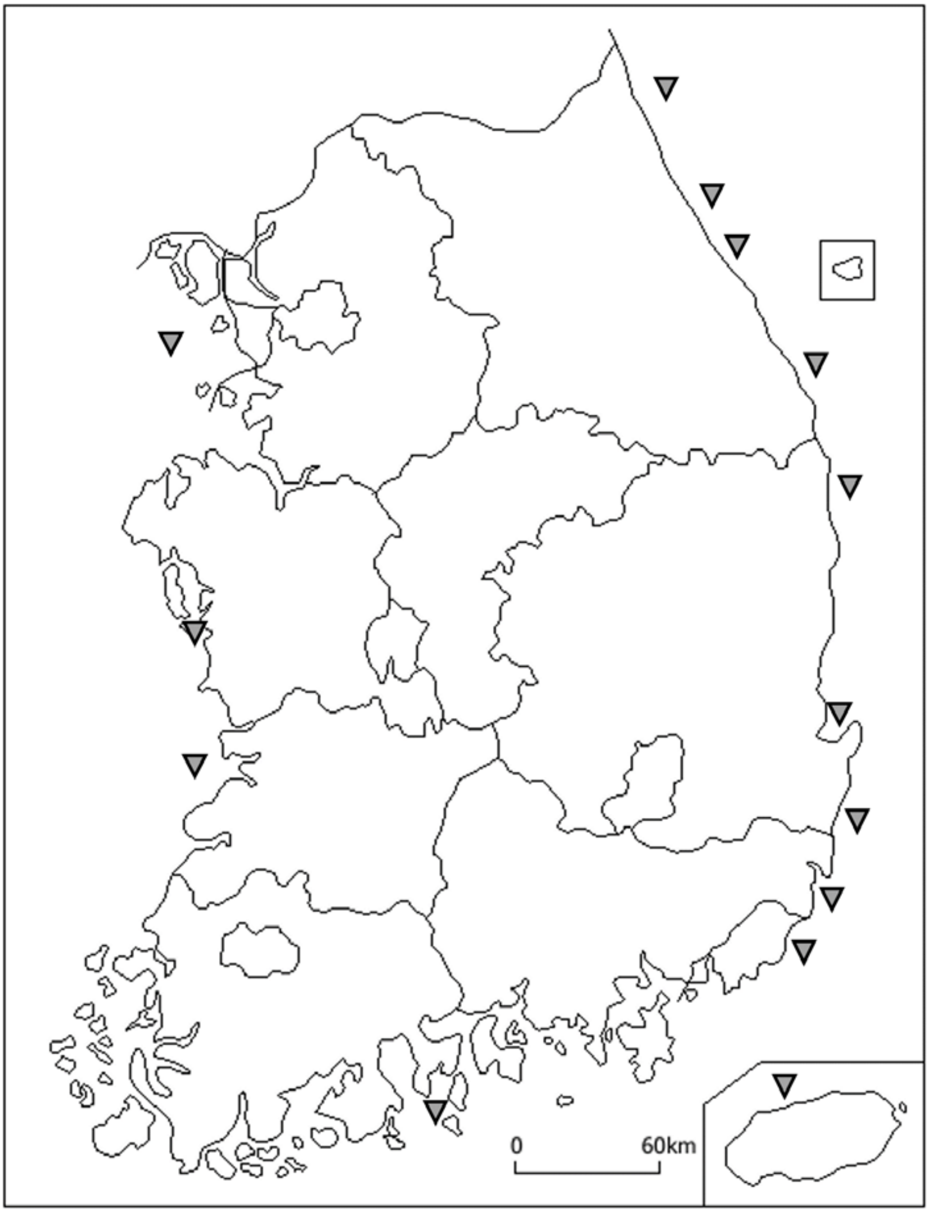

Figure 60. Distribution map of *Pagurus ochotensis* Brandt, 1851 in Korea.

57. ***Pagurus rathbuni*** **(Benedict, 1892)** 털발목참집게 (Plate 51)

Eupagurus (*Trigonochirus*) *rathbuni* Benedict, 1892: 14.

Eupagurus rathbuni: Alcock, 1905: 179.

Pagurus rathbuni: Makarov, 1962: 193, pl. 3 fig. 3; MaLaughlin, 1974: 298, figs. 78−80; Komatsu and Komai, 2009: 592; McLaughlin et al., 2010: 34, fig. 16E; Kim et al., 2013: 53, figs. 1−2; Arima, 2014: 139; Kim & Kim, 2014: 73, figs. 33−34.

Material examined. 1 ♂, Goseong, Korea, 38° 19'46.46"N 128° 33'16.57"E, 24 Aug. 2011, Coll. Park, J. H., MADBK 160731_001: 1 ind., Goseong, Korea, 38° 19'46.46"N 128° 33'16.57"E, 23 Aug. 2011, Coll. Park, J. H., MADBK 160731_002: 9 inds., Yangyang, Korea, 21 May 2002, EVOSYS 260720#013: 1 ind., Donghae, Korea, 7 Aug. 1971, Coll. Rho, B. J., EWUNHM DP 20151202032, 1 ind., Samcheok, Korea, 1 Dec. 2012, Coll. Kim, J. N., NIBRIV0000307790, NIBRIV0000307813.

Distribution Arctic Ocean to Point Barrow, Chukchi Sea, Bering Sea, Sea of Okhotsk, northeastern mainland Japan, eastern Korea, 9−500 m.

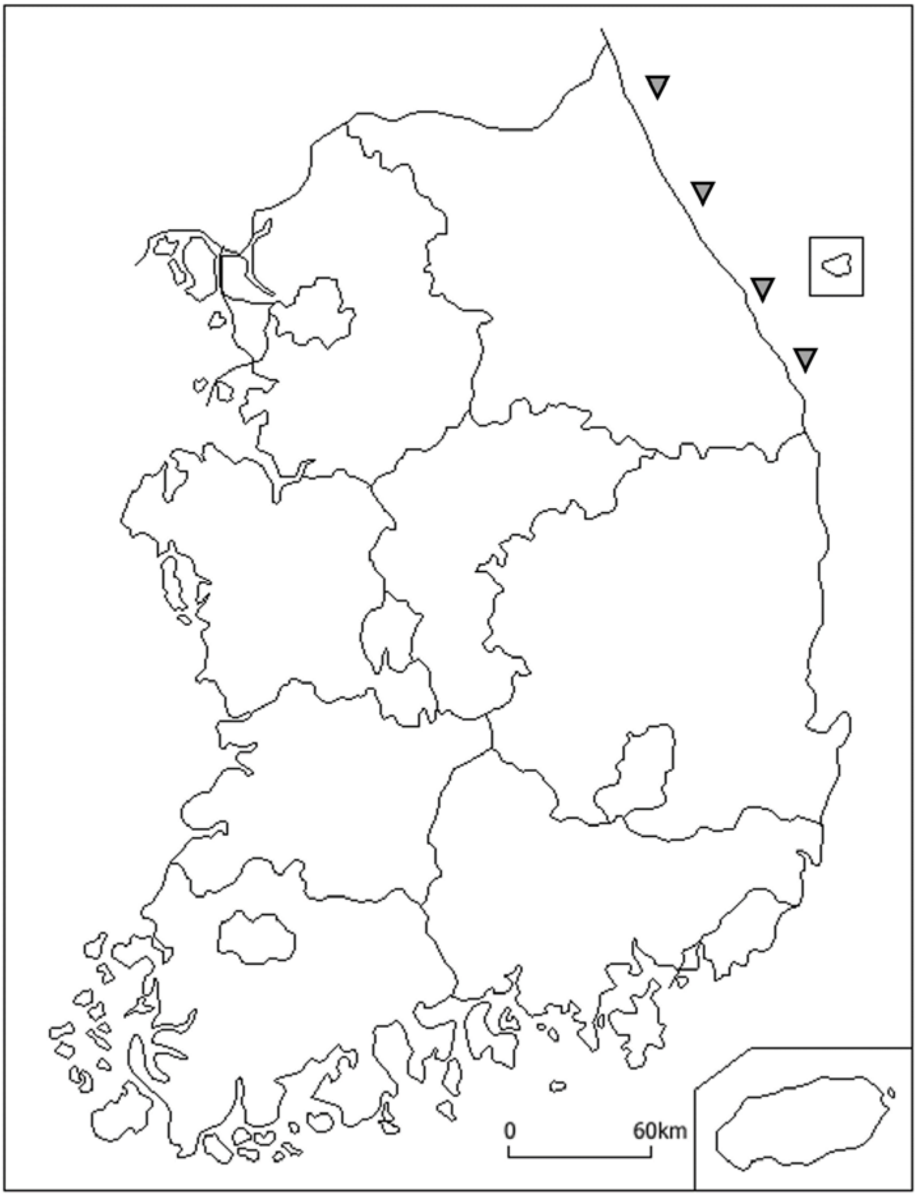

Figure 61. Distribution map of *Pagurus rathbuni* (Benedict, 1892) in Korea.

Remark. One individual of *Pagurus rathbuni* (EWUNHM DP 20151202032) was found living in the gastropod shell covered by colony of associated hydrozoan, *Hydrissa sodalis*. There is no report that *P. rathbuni* is associated with this hydrozoan.
On the abdomen of a specimen of *P. rathbuni* (EVOSYS 260720#013), a parasitic barnacle was found. Its approximate morphological characteristics are similar to those of *Peltogaster paguri* Rathke, 1842. However, this relationship has not been reported yet.

58. *Pagurus gracilipes* (Stimpson, 1858) 납작손참집게 (Plate 52)

Eupagurus gracilipes Stimpson, 1858: 248; 1907: 217; Alcock, 1905: 177 (part); Yokoya, 1939: 281.

Pagurus gracilipes: Makarov, 1962: 175 (part), pl. 4, fig. 4; Kim, 1973: 222, 598, fig. 48, pl. 5, fig. 28; Miyake, 1982: 126 (part); McLaughlin et al., 2010: 33; Arima, 2014: 134; Kim & Kim, 2014: 49, figs. 20.

Parapagurodes nipponensis: Komai, 1998: Hong et al., 2006b: 364; Kim & Son, 2006: 85.

Material examined. 1 ind., Goseong, Korea, 38° 20'42.80"N 128° 32'44.96"E, 22 June 2010, Coll. Lee, S. K., MADBK 160709_002, 003: 6 inds., Yangyang, Korea, 37° 55'49.00"N 128° 47'25.00"E, Scuba, 16 m depth, 15 Aug. 2013, Coll. Park, J. H., MADBK 160709_005: 17 inds., same as MADBK 160709_005, MADBK 160709_006: 3 inds., same as MADBK 160709_005, MADBK 160709_007: 1 ♂, Gunsan, Korea, 20 May 1969, EVOSYS 260709_001: 1 ind., same as MADBK 160709_005, NIBRIV0000297876–NIBRIV0000297878: 1 ind., Samcheok, Korea, 9 Oct. 2013, Coll. Kim, M. H., NIBRIV0000307558: 1 ind., Ulleung, Korea, Scuba, 13 Nov. 2013, Coll. Jung, J., NIBRIV0000458757–NIBRIV0000458759.

Distribution. Northern to eastern mainland Japan, southeastern Russia, northeastern and ? Gunsan of Korea, subtidal to 60 m.

Remark. One specimen of *Pagurus gracilipes* (EVOSYS 260709_001) was found in Gunsan. This location seems to be the western limiting line of this species. However, the location is slightly far from its main distribution. Therefore, collecting additional specimen nearby Gunsan is needed to determine the western limiting line of this species.

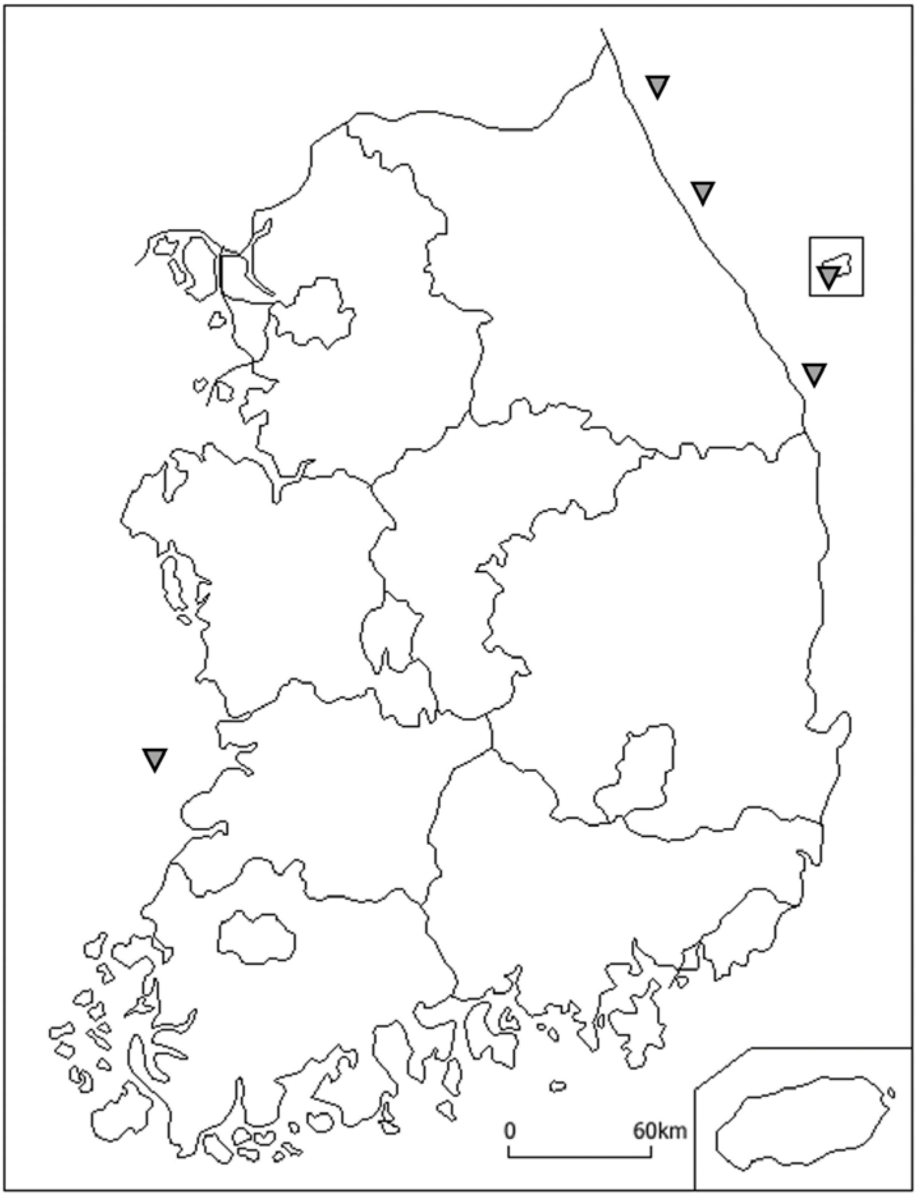

Figure 62. Distribution map of *Pagurus gracilipes* (Stimpson, 1858) in Korea.

59. *Pagurus nipponensis* (Yokoya, 1933) 일본참집게

Eupagurus gracilipes: Doflein, 1902: 647, pl. 6, figs. 6−8.

Eupagurus tricarinatu: Balss, 1913: 58.

Eupagurus nipponensis Yokoya, 1933: 87 (part), fig. 32.

Pagurus gracilipes: Makarov, 1962: 175 (part).

Pagurus gracilipes: Miyake, 1978: 85, fig. 33.

Parapagurodes nipponensis: Komai, 1998: Kim & Son, 2006: 87.

Pagurus nipponensis: McLaughlin et al., 2007a: 224; 2010, 31; Huang & Lin, 2012: 101; Arima, 2014: 130; Kim & Kim, 2014: 60, figs. 25, pl. 18.

Parapagurodes nipponensis: Komai, 1998: 275, figs. 1, 6; Kim & Son, 2006: 87.

Distribution. Southern mainland Japan, Taiwan, eastern Korea, 30−335 m.

60. *Pagurus undosus* (Benedict, 1892) 혹손참집게 (Plate 53)

Eupagurus (*Trigonochirus*) *undosus* Benedict, 1892: 18.

Pagurus undosus: Rathbun, 1904: 159, fig. 6; Makarov, 1962: 182; McLaughlin, 1974: 252, figs. 64−66; Komai, 1994b: 24−27, fig. 1; McLaughlin et al., 2010: 34; Arima, 2014: 130; Jung & Kim, 2014; 14, figs. 1, 2.

Eupagurus undosus: Alcock, 1905: 179.

Eupagurus trigonochirus var. *paulensis* Balss, 1913: 64, figs. 38, 39.

Material examined. 3 ♂♂ (sl 3.3–6.9 mm), 1 ♀ (sl 3.0 mm), 1 ♀ (ovi.) (sl 4.9 mm), Samcheok, Korea, bottom trawl, 28 Jan. 2002, MADBK 160745: 1 ♂ (sl 6.8 mm), Samcheok, Korea, 37° 13'33.33"N 129° 20'29.57"E, 6 Sep. 2011, MADBK 160745_001: 1 ♂ (sl 7.2 mm), 2 ♀♀ (ovi.) (sl 4.5 mm), Samcheok, Korea, 26 Feb. 2003, EVOSYS 260745#001: 1 ♂ (sl 6.7 mm), 2 ♀♀ (sl 5.7, 5.8 mm), Goseong, Korea, shrimp trap, 17 June 2012, Coll. Park, J. H., EVOSYS 260745#002.

Color. Whole body orange generally. Spines on capi and meri of chelipeds reddish brown. Second and third pereopods with reddish brown bands unclearly delimited on white or orange background.

Habitat. Most specimens were found in the gastropod shell, but the specimen used in the description was living in the sponge.

Distribution. Bering Sea, Chukchi Sea, Sea of Okhotsk, northern Japan, eastern Korea; 20–70 m.

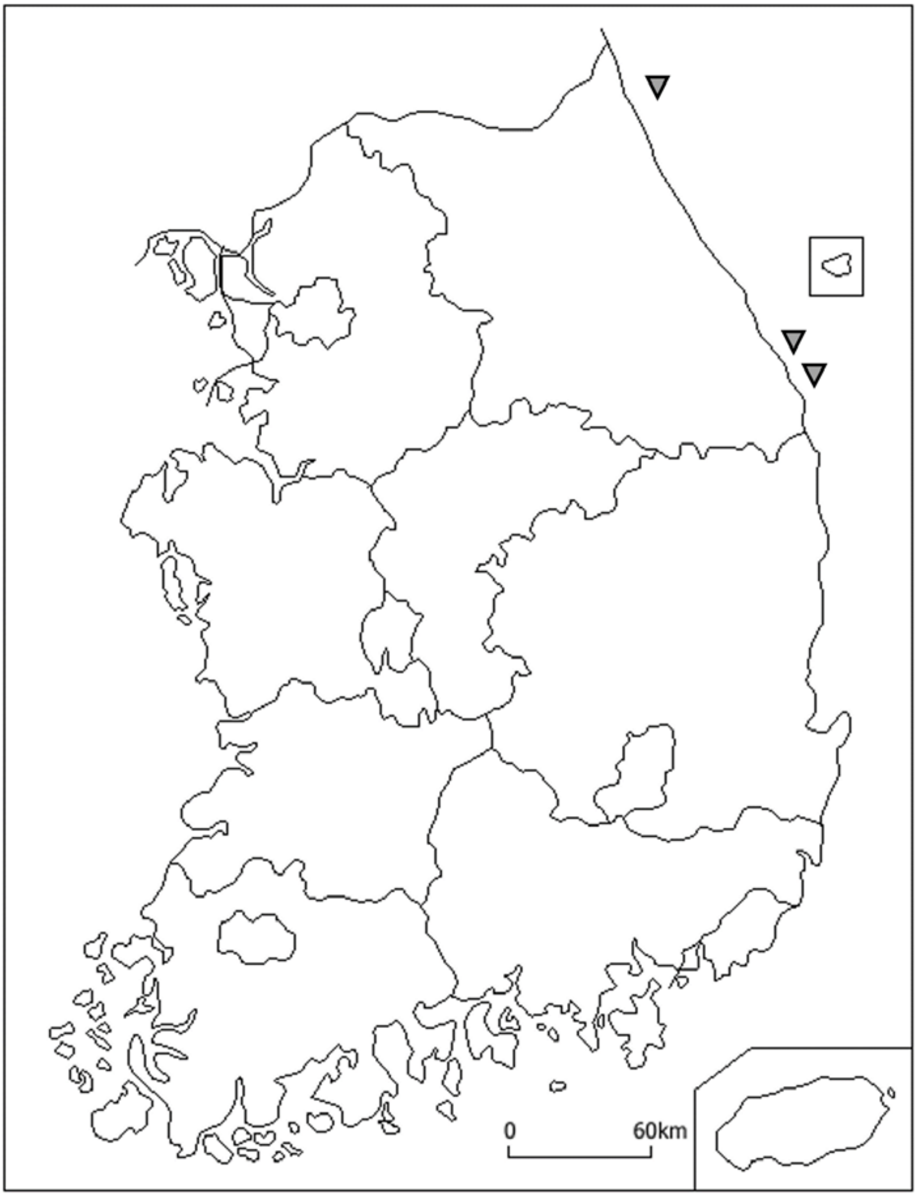

Figure 63. Distribution map of *Pagurus undosus* (Benedict, 1892) in Korea.

61. *Pagurus middendorffii* Brandt, 1851 긴다리참집게 (Plate 54)

Pagurus (*Eupagurus*) *Middendorffii* Brandt, 1851: 108, pl. 5 figs. 1–6.

Eupagurus middendorffii: Stimpson, 1857: 482; 1858: 250; 1907: 226; Alcock, 1905: 178; Balss, 1913: 58; Yokoya, 1939: 281, fig. 11; Kamita, 1954: 60; 1955: 38, fig. 15.

Eupagurus middendorffi: Ortmann, 1892: 301; Doflein, 1902: 646; Terao, 1913: 371.

Pagurus Middendorffii: Holmes, 1900: 234.

Pagurus middendorffii: Rathbun, 1903: 35; Makarov, 1962: 165 (not pl. 5 fig. 6); Kim, 1963: 203, fig. 19; 1964: 8; 1970: 7; 1973: 218, 598, fig. 46, pl. 5, fig. 26; McLaughlin, 1974: 185, figs. 45–47; Kim & Son, 2006: 72; McLaughlin et al., 2010: 33; Arima, 2014: 137.

Material examined. 1 ♀, Gangneung, Korea, 37° 54'18.17"N 128° 51'41.42"E, 24 Mar. 2010, Coll. Lee, S. K., MADBK 160713_001: 1 ♀, Uljin, Korea, 37° 0'18.03"N 129° 25'40.81"E, Scuba, 3 July 2009, Coll. Yeom, D., MADBK 160713_005: 4 ♂♂, Goseong, Korea, 38° 30'43.71"N 128° 27'5.69"E, 4 Apr. 2011, Coll. Lue, W., MADBK 160713_006: 1 ♂, Goseong, Korea, 38° 28'1.05"N 128° 33'33.66"E, 25 July 2011, Coll. Lee, S. K., MADBK 160713_007: 1 ind., Jeju, Korea, 33° 55'13.42"N 126° 38'17.74"E, 11 July 1985, MADBK 160713_008: 16 inds., Sokcho, Korea, 38° 12'51.11"N 128° 36'3.13"E, hand, 8 May 2015, Coll. Jung, J., MADBK 160713_009: 4 inds., Yeosu, Korea, 22 July 1958, Coll. Kim,

H. S., EVOSYS 260713#001: 2 inds., Seogwipo, Korea, 25 Mar. 1988, EVOSYS 260713#002: 1 ♂, Samcheok, Korea, 9 Sep. 2001, EVOSYS 260701#005: 1 ♂, Yangyang, Korea, 4 June 1972, Coll. Kim, H. S., EVOSYS 260701: 1 ind., Sokcho, Korea, 9 May 2015, hand, Coll. Jung, J., NIBRIV0000462365– NIBRIV0000462367.

Diagnosis. Shield varying; rostrum acutely triangular; lateral projections reduced. Ocular peduncles about 0.4–0.6 length of shield, corneas dilated; ocular acicles subovate. Antennular peduncles exceeding distal margins of corneal by 0.3 times of ultimate segments. Fifth segments of antennal exceeding distal margins of corneal by 0.3 times of fifth segments.

Pereopods with small granules. Right cheliped larger than left.

Ventral margins of dactyls of ambulatory legs with row of several spines.

Abdomen twisted, uropods asymmetry.

Telson with almost symmetrical posterior lobes, lobes separated by shallow median cleft, each lobe with row of spinules.

Distribution. Eastern to southeastern Russia, Alaska, Hokkaido of Japan, eastern to Jeju Island of Korea, intertidal.

Remark. On the abdomen of a specimen of *Pagurus middendorffii* (MADBK 160713_007), parasitic barnacle was found. Its approximate morphological characteristics are similar to those of *Peltogasterella gracilis* (Boschma, 1927). This relationship has already been reported in the paper of Nagasawa et al. (1996).

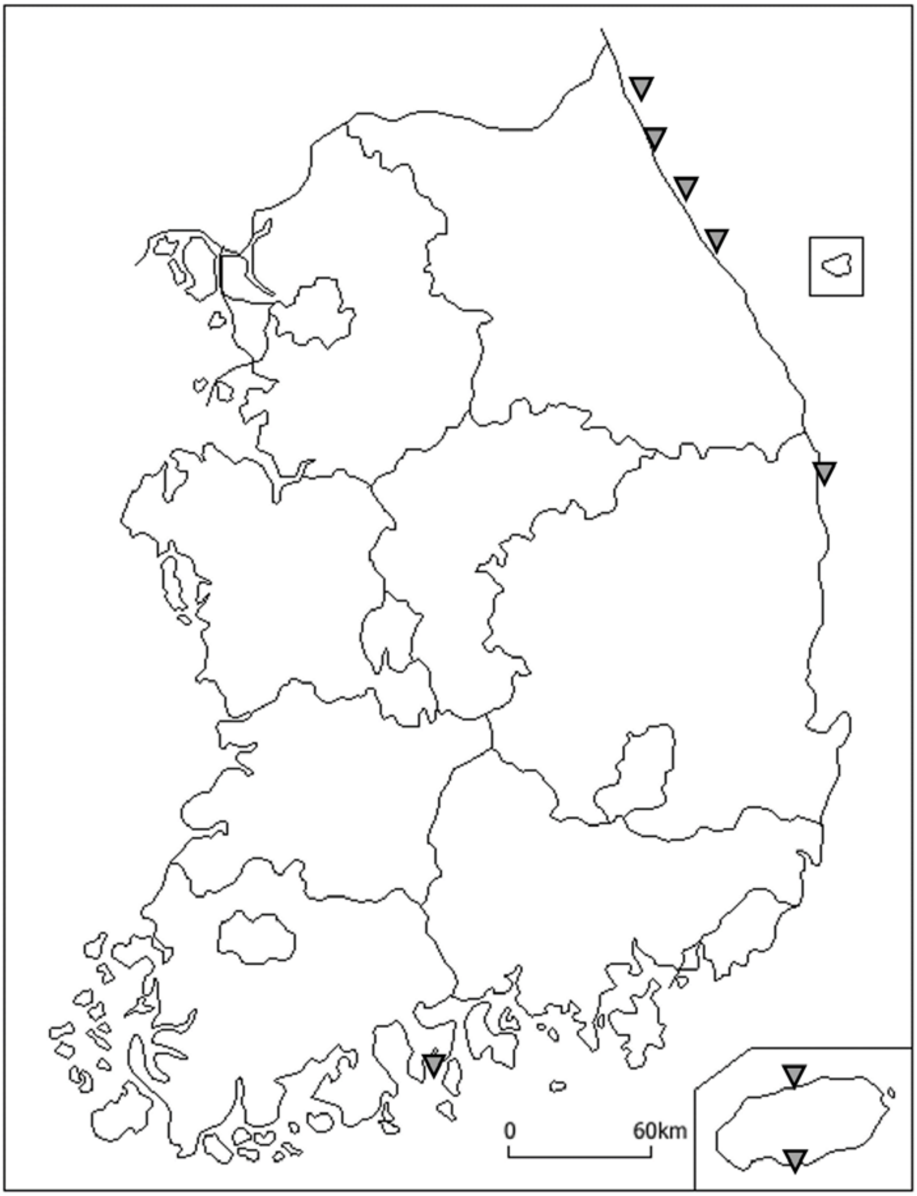

Figure 64. Distribution map of *Pagurus middendorffii* Brandt, 1851 in Korea.

DISCUSSION

The author have updated the biogeographical grouping of Korean Paguroidea (Kim, 1973) through our systematic study of its distribution (Table 4). A total of 24 species of Korean Paguroidea could be divided into four groups based on distribution (Kim, 1973) i.e., 2 tropical species, 5 polar species, 16 temperate species, and 1 cosmopolitan species. The author updated the list according to the reported species and newly discovered biogeographical areas after 1973. As a result, a total of 9 tropical species, 8 polar species, and 45 temperate species were found to be present in Korea (cosmopolitan species was removed because it was found to be synonymous). In comparison with a previous study of Kim (1973), 7 tropical species, 3 polar species, and 29 temperate species were discovered. After 1973, the highest growth rate was seen in tropical species (450%), while the highest new records were in temperate species. These results could be related to recent climate change (Ackerly et al., 2010).

The number of species per group in tropical, polar, and temperate waters, respectively, are shown below: 1, 8, 29 in the eastern water; 2, 2, 20 in Korean Strait; 0, 2, 8 in Yellow Sea; 8, 2, 22 in Jeju Island. The results showed that the temperate species were most common in the Korean waters. In the eastern water, the polar species was common than other waters. In Jeju Island, the tropical species was common than other waters. The Yellow Sea had the lowest

Paguroidea biodiversity in Korea. The unique species in each water could be grouped based on tropical, polar, and temperate regions, as shown below, respectively: 1, 6, 13 in the eastern water; 0, 0, 2 in Korean Strait; 0, 0, 0 in Yellow Sea; 6, 0, 11 in Jeju Island. These results were supported by the current flow near Korea (Kim, 1973) and supported the division of Korean waters into 4 areas (Kim & Kim, 1982).

The array result of Korean paguroid database by collection locality modified from Kim (1973) show that subtidal area of Korean Strait and the eastern water of Korea (clear water) provided high biodiversity of Paguroidea (8 species in Busan). Intertidal area of Korean Strait, the eastern water of Korea and Jeju Island (clear water) provided moderate biodiversity of Paguroidea (5 species in Gyeongju). Intertidal area of Yellow sea (muddy water) provided low biodiversity of Paguroidea (4 species in Incheon and Boryeong but other areas are around 1−2) although the number of individuals is numerous (the individual number of *P. minutus* in Incheon: 193).

Table 4. The biogeographical grouping of Korean Paguroidea. (Updated from Kim, 1973) Jeju Island is added according to Kim & Kim (1982). ?: questionable species in presence, *: recorded species from Korea after 1973.

Species \ Area	Eastern water	Korean Strait	Yellow Sea	Jeju Island	Japan	China	Taiwan	Eastern Russia	Etc.	Group
1. *Pomatocheles jeffreysii**				O	O		O			Temperate
2. *Areopaguristes nigroapiculus*	O			O	O					Temperate
3. *Areopaguristes japonicus**	O	O			O					Temperate
4. *Paguristes seminudus**				O	O	O	O			Temperate
5. *Paguristes acanthomerus**				O	O	O	O			Temperate
6. *Paguristes versus*				O	O		O			Temperate
7. *Paguristes digitalis**		O			O					Temperate
8. *Paguristes ortmanni*	O	O	O	O	O	O				Temperate
9. *Ciliopagurus strigatus**				O?	O		O		Indian Ocean Western Pacific	Tropical
10. *Ciliopagurus krempfi**				O	O		O		Indian Ocean Western Pacific	Tropical

11. *Clibanarius virescens**		O		O	O		O		Indian Ocean Western Pacific	Tropical
12. *Diogenes penicillatus**	O	O			O		O	O		Temperate
13. *Diogenes edwardsii*	O	O	O		O	O	O			Temperate
14. *Diogenes nitidimanus*	O	O			O		O			Temperate
15. *Diogenes deflectomanus**	O		O			O				Temperate
16. *Dardanus lagopodes**	O				O		O		Indian Ocean Western Pacific	Tropical
17. *Dardanus arrosor*		O		O	O				Mediterranean Sea Indian Ocean Western Pacific	Tropical
18. *Dardanus crassimanus*				O	O	O	O		Indian Ocean Western Pacific	Tropical
19. *Dardanus aspersus**				O	O	O	O			Temperate
20. *Dardanus impressus*				O	O	O	O		Indian Ocean Western Pacific	Tropical
21. *Dardanus pedunculatus**				O	O		O		Western Pacific	Tropical

22. *Porcellanopagurus nihonkaiensis**				O	O					Temperate
23. *Lophopagurus* (*Australeremus*) *triserratus*				O	O	O				Temperate
24. *Discorsopagurus maclaughlinae**	O				O			O		Temperate
25. *Discorsopagurus tubicola**	O	O			O					Temperate
26. *Nematopagurus lepidochirus**				O	O	O			Western Pacific	Tropical
27. *Boninpagurus pilosipes**		O		O	O					Temperate
28. *Labidochirus anomalus*	O				O			O		Temperate
29. *Elassochirus cavimanus*	O				O			O	Northern Pacific	Polar
30. *Diacanthurus ophthalmicus**				O	O		O			Temperate
31. *Catapaguroides fragilis**				O	O					Temperate
32. *Pagurixus fasciatus**		O?			O					Temperate
33. *Pagurus decimbranchiae**				O	O					Temperate
34. *Pagurus nigrivittatus**	O			O	O		O			Temperate

35. *Pagurus quinquelineatus**	O				O				Temperate
36. *Pagurus rectidactylus**	O				O				Temperate
37. *Pagurus maculosus**	O	O		O	O				Temperate
38. *Pagurus lanuginosus*	O	O	O		O				Temperate
39. *Pagurus proximus**	O	O	O		O				Temperate
40. *Pagurus simulans**	O	O			O				Temperate
41. *Pagurus brachiomastus*	O				O				Temperate
42. *Pagurus minutus*	O	O	O	O	O	O	O	O	Temperate
43. *Pagurus nigrofascia**		O	O		O	?			Temperate
44. *Pagurus filholi*	O	O		O	O		O	O	Temperate
45. *Pagurus japonicus*	O	O		O	O	O	O		Temperate
46. *Pagurus rubrior*	O	O		O	O				Temperate
47. *Pagurus similis**	O	O		O	O		O		Temperate
48. *Pagurus parvispina**	O				O			O	Polar

49. *Pagurus pectinatus*	O	O	O		O	O		O		Polar
50. *Pagurus conformis*				O	O	O	O			Temperate
51. *Pagurus exiguus**	O?				O					Temperate
52. *Pagurus spina**	O				O					Temperate
53. *Pagurus imaii**	O				O					Temperate
54. *Pagurus constans*		O		O	O					Temperate
55. *Pagurus trigonocheirus*	O				O	O?		O	Northern Pacific	Polar
56. *Pagurus ochotensis*	O	O	O	O?	O	O		O	Northern Russia Northern Pacific	Polar
57. *Pagurus rathbuni**	O				O			O	Northern Pacific	Polar
58. *Pagurus gracilipes*	O		O?		O			O		Temperate
59. *Pagurus nipponensis**	O				O		O			Temperate
60. *Pagurus undosus**	O				O			O	Northern Pacific	Polar
61. *Pagurus middendorffii*	O			O	O			O	Northern Pacific	Polar

Among 61 species of paguroid in this study, *Pagurus minutus* is one of the most dominant hermit crab species in the temperate coast of Far East. This species is distributed from the Primorye of East Russia, Japan (from the southern coast of Hokkaido to Okinawa Island), Korea, northeast coast of China to west coast of Taiwan (Kim. 1973; Komai and Mishima, 2003; McLaughlin et al., 2007a). *P. minutus* mainly inhabits the sandy or muddy coast, although some live along the rocky coast. The intertidal region between Korea and Japan supports a high density of this species (Kim. 1973; Komai and Mishima, 2003).

The color of *P. minutus* was briefly reported as dirty gray in its original description (Hess, 1865). Makarov (1962) described the color distribution of alcohol-preserved specimens of *P. dubius* (Ortmann, 1892), the senior synonym of *P. minutus*, as having a pale-pinkish yellow base with red longitudinal stripes on the lateral face of its ambulatory legs. Komai and Mishima (2003) mentioned the detailed color distribution of living *P. minutus* as a brown or olive base, with a single median longitudinal stripe on the lateral face of ambulatory legs.

However, the color patterns of MIG (minor group of *P. minutus*, Figure 49) are different from the general patterns of *P. minutus*. The latter patterns describe as: 1) Basic color is cream in these specimens, 2) Lateral surface of carpus of the ambulatory legs with 2 dark olive stripes in these specimens. In addition, MIG is rarely found in the western and northeastern coasts of Korea, whereas MAG (major group of *P. minutus*, Figure 49) is commonly found throughout Korean waters, with the exception of the northeastern coast.

Using COI and 16S rRNA*, P. minutus* can be divided into two groups, MAG and MIG (Figure 49). The results indicate that MAG and MIG have a large genetic gap between them compared to the interspecies genetic variation of other Paguroidea and Anomura (6.7% difference of COI in Young et al. 2002, 0.6–1.8% difference of 16s rRNA in Mantelatto et al. 2009). It suggests that *P. minutus* is not the monophyletic group and maybe including cryptic species.

There is some research that biogeographical and color differences between the populations of decapod species are positively related to differences of genome and population characteristics (Malay et al., 2012; Negri et al., 2014; Tsoi et al., 2014). According to the results of this study, the two groups of *P. minutus* in this study also follow the results of these studies. MAG and MIG are not only different in terms of DNA sequence, but also characteristics such as different colors, biogeographies, and populations. Therefore, the author considered MAG to be *P. minutus* and that MIG was a cryptic species due to population size, distribution area, color pattern, and molecular differences among the living creatures.

Among 30 species of *Pagurus* in this study, *P. brachiomastus* is a hermit crab with numerous tuft of setae and red tip colored chelae. It lives in the northern part of the East Sea and Japan mainland, from intertidal to subtidal (Komai, 2000). Komai (2000) has reexamined many specimens of *P. brachiomastus* and split them to three species based on their differences in morphology and coloration: *P. brachiomastus, P. proximus,* and *P. simulans*.

However, DNA barcoding results of *P. brachiomastus*, *P. proximus*, and *P. simulans* showed that there was a problem in existing taxonomy scheme (Figures 45, 46). Therefore, the taxonomic status of these three species was reexamined based on morphological and ecological characters.

Morphologically, *P. brachiomastus* and *P. simulans* share more important taxonomical feature than each of these species to *P. proximus*. *P. brachiomastus* and *P. proximus* were similar in terms of dilated rate of corneal region of eye, recurved rate of external lobe of endopod of maxillule and pattern of dorsal spines on right palm. *P. brachiomastus* and *P. simulans* were similar in terms of strength of spines on propodus of right second pereopod, color pattern of ambulatory legs, and shape of terminal margins of telson. *P. proximus* and *P. simulans* were only similar in terms of delimited rate of ventrolateral margin of left palm (Komai, 2000). Among these morphological characters, the shape of telson is regarded as the more important feature than the others in the Paguroidea morphology (McLaughlin & Lemaitre, 1997; McLaughlin et al., 2007b).

Ecologically, *P. brachiomastus* and *P. proximus* were more similar to each other than to *P. simulans*. Geographical distribution of *P. brachiomastus* was not overlapping with that of *P. simulans*. However, geographical distribution of *P. proximus* was slightly overlapping with that of *P. brachiomastus*. *P. brachiomastus* and *P. proximus* were living from the intertidal to shallow subtidal while *P. simulans* was only living in subtidal. Specimens of *P. simulans* had carcinoecia associated with *Hydrissa sodalis* (Stimpson, 1858). However, this is very rare in specimens of *P. brachiomastus* or *P. proximus*.

According to these results, *P. simulans* is regarded as a southern variation of *P. brachiomastus*. Molecular data and shared important morphological features suggest that these two species are almost the same species. In this case, the minor morphological differences and no overlap in geographical distribution may indicate geographical variations.

If *P. brachiomastus* and *P. simulans* are same species, it is difficult to explain difference in carcinoecia, which is caused by associated hydrozoan, by these data. There are many reports that preference of paguroid host of associated organism is different by location (Williams & McDermott, 2004; Yoshida et al., 2011; 2012). According to these reports, the carcinoecia difference caused by associated hydrozoan is regarded as a geographical variation. This is an acceptable explanation based on results of this study because geographical distributions of the two species are clearly divided. *H. sodalis* is only associated with *P. simulans* as a southern living group.

The author suggest that the minor morphological differences between *P. brachiomastus* and *P. simulans* might have originated from carcinoecia difference. Morphological characters of hydrozoan associated with Paguroidea can change according to its host Paguroidea (Namikawa, 2012). Therefore, the morphological feature change might occur in host Paguroidea, too.

Molecular phylogenetic results of *P. quinquelineatus* and *P. rectidactylus* support the above hypothesis. *P. rectidactylus* which is morphologically similar to *P. quinquelineatus* has been reported as a new species based on different characteristics concerning armature of dactylus of right cheliped, length and armature of ambulatory legs, and the kind of carcinoecia (Komai et al., 2015). However, molecular phylogenetic results of Korean Paguroidea showed that these two species were mixed as single clade. These two species are closely located to each other in Korean waters. Therefore, geographical effect is insignificant. The only distinguished difference between them is carcinoecia. *P. rectidactylus* is associated with hydrozoan *H. sodalis* while *P. quinquelineatus* is not. Therefore, morphological differences between *P. quinquelineatus* and *P. rectidactylus* might have originated from carcinoecia difference. The morphological differences between *P. brachiomastus* and *P. simulans* could be explain as similar way.

Therefore, the author suggest *P. simulans* as subspecies of *P. brachiomastus* and *P. rectidactylus* as subspecies of *P. quinquelineatus* according to their similarities of morphology and molecular phylogeny.

To identify these two groups of *P. minutus* as different species, more morphological difference should be examined besides living color. And it is necessary to examine the genetic introgression between the populations of *P. minutus* using a nuclear marker such as microsatellite. A further study about taxonomic status of *P. brachiomastus*, *P. simulans*, *P. quinquelineatus* and *P. rectidactylus* such as karyotyping, microsatellite analysis and hybridization test is also needed.

CONCLUSION

The systematic status of Korean Paguroide was revised as 61 species, 18 genera, and 3 families in this thesis. This checklist included 8 newly recorded species which were previously reported by the author: *Diogenes deflectomanus*, *Dardanus lagopodes*, *Discorsopagurus maclaughlinae*, *D. tubicola*, *Pagurus quinquelineatus*, *P. rectidactylus*, *P. parvispina* and *P. undosus* (Jung & Kim, 2014; 2015; 2016; 2017).

This study identifed three questionable species among Korean fauna. The range of geographical distribution of six Paguroidea species was slightly expanded. The expanded range of the geographical distribution by the species are listed below: *P. maculosus* as northern and eastern expanding, *P. proximus* as northwestern expanding, *P. nigrofascia* as western and northwestern expanding, *P. spina* as western expanding, *P. ochotensis* as southern expanding, and *P. gracilipes* as western expanding. In addition, 30 Paguroidea species, both living in Korea and China, were revised.

The scientific names of two species in the report of Paguroidea in Korea werre synonymized in the present study. Two paguroid species could be synonymized, as listed below: *Orthopagurus minimus* –> *Discorsopagurus maclaughlinae*, *Pagurus angustus* –> *P. maculosus*.

Korean names of five Paguroidea species were corrected. The Paguroidea species with problematic Korean names were fixed in this thesis, as shown below: *Porcellanopagurus nihonkaiensis* (조개집게

–> 조개치레참집게), *Discorsopagurus maclaughlinae* (긴관참집게 –> 대롱집게), *Pagurus maculosus* (흰점털다리참집게 –> 가는몸참집게), *P. rubrior* (붉은얼룩참집게 –> 얼룩참집게), and *P. similis* (얼룩참집게 –> 주황얼룩참집게).

In this thesis, intertidal collection of *Dardanus arrosor* and *Elassochirus cavimanus* which are subtidal species were recorded. The author expressed doubt about the genus characteristics of *Labidochirus* i.e., reduced pleon, compared to a small specimen of *L. anomalus*, which has normal pleon.

Also, 9 species of Korean Paguroidea were analyzed by DNA barcodes using COIs and 16S rRNAs. The results showed that the *Pagurus minutus* group, *P. brachiomastus*, *P. simulans*, *P. quinquelineatus* and *P. rectidactylus* were shown to be in conflict with the morphological taxonomic scheme. Korean population of *P. minutus* was certainly divided into two clades. *P. brachiomastus* and *P. simulans*, *P. quinquelineatus* and *P. rectidactylus* were mixed with each other as one clade.

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국문초록

본 연구에서 필자는 형태학적 형질과 DNA 바코드 형질 분석을 통해 한국산 집게상과의 계통분류학적 고찰 결과를 제시한다. 형태학적 관찰을 통해 3 과 18 속 61 종의 한국산 집게상과를 확인하였다. 이번 연구로 인해 6 종의 지리학적 분포가 확장되었고, 국내 서식이 불분명한 3 종을 확인하였으며, 2 종이 동종이명 처리되었고, 5 종의 국명이 수정되었다. 본 연구로 인해 한국산 집게상과의 종목록, 분포도 및 검색표가 제작되었다. DNA 바코드 연구에서는 9 종 159 개체의 한국산 집게상과를 대상으로 COI 과 16S rRNA 의 염기 서열을 분석하였다. 그 결과 긴발가락참집게, 털손참집게와 갈색털손참집게, 그리고 다섯줄참집게와 제집줄참집게 총 다섯 종에서 기존 분류체계와 상반된 결과를 보였다.

핵심 용어: 집게상과, 집게, 대한민국, 계통분류학, 형태분류학, DNA 바코드

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Plate 22. *Lophopagurus* (*Australeremus*) *triserratus* (Ortmann, 1892) (꼬마참집게, male, sl 4.7 mm, NFRDI H 3). A, Dorsal surface; B, Ventral surface.

Plate 23. *Discorsopagurus maclaughlinae* Komai, 1995 (대롱집게, ovig female, sl 3.9 mm, MADBK 160746_002). A, Dorsal surface; B, Ventral surface.

Plate 24. *Discorsopagurus tubicola* Komai, 2003 (관참집게, female, sl 3.5 mm, MADBK 160747_001). A, Dorsal surface; B, Ventral surface.

Plate 25. *Nematopagurus lepidochirus* (Doflein, 1902) (가로마루참집게, male, sl 4.7 mm, NFRDI H 6). A, Dorsal surface; B, Ventral surface.

Plate 26. *Boninpagurus pilosipes* (Stimpson, 1858) (줄무늬참집게, male, sl 3.3 mm, MADBK 160716_003). A, Dorsal surface; B, Ventral surface.

Plate 27. *Labidochirus anomalus* (Balss, 1913) (작은배참집게, MADBK 160702_003). A, Dorsal surface (male, sl 15.8 mm); B, Ventral surface (male, sl 15.8 mm); C, Small individual (female, sl 7.3 mm).

Plate 28. *Elassochirus cavimanus* (Miers, 1879) (오목손참집게, female, sl 20.4 mm, MADBK 160701_001). A, Dorsal surface; B, Ventral surface.

Plate 29. *Diacanthurus ophthalmicus* (Ortmann, 1892) (가시꼬리참집게, male, 5.0 mm, NFRDI H 5). A, Dorsal surface; B, Ventral surface.

Plate 30. *Pagurus decimbranchiae* Komai and Osawa, 2001 (얼룩다리참집게, male, sl 2.7 mm, SUZ DH 1). A, Dorsal surface; B, Ventral surface.

Plate 31. *Pagurus nigrivittatus* Komai, 2003 (검은줄무늬참집게, male, sl 2.6 mm, MADBK 160725_002). A, Dorsal surface; B, Ventral surface.

Plate 32. *Pagurus quinquelineatus* Komai, 2003 (다섯줄참집게, female, sl 2.7 mm, NIBRIV0000325763). A, Dorsal surface; B, Ventral surface.

Plate 33. *Pagurus rectidactylus* Komai Komai, Saito and Myorin, 2015 (제집줄참집게, male, sl 5.4 mm, MADBK 160748_001). A, Dorsal surface; B, Ventral surface.

Plate 34. *Pagurus maculosus* Komai and Imafuku, 1996 (가는몸참집게; male, sl 7.4 mm, MADBK 160712_024). A, Dorsal surface; B, Ventral surface; C, Parasitic barnacle on the pleon.

Plate 35. *Pagurus lanuginosus* De Haan, 1849 (털다리참집게, MADBK 160712_042). A, Dorsal surface (ovig female, sl 6.5 mm); B, Ventral surface (ovig female, sl 6.5 mm); C, Parasitic barnacle on the pleon (male, sl 6.5 mm).

Plate 36. *Pagurus proximus* Komai, 2000 (검은털손참집게, male, sl 4.9 mm, MADBK 160718_050). A, Dorsal surface; B, Ventral surface.

Plate 37. *Pagurus simulans* Komai, 2000 (갈색털손참집게, male, sl 6.4 mm, MADBK 160719_002). A, Dorsal surface; B, Ventral surface.

Plate 38. *Pagurus brachiomastus* (Thallwitz, 1892) (털손참집게). A, Dorsal surface (ovig female, sl 5.8 mm, MADBK 160704_044); B, Ventral surface (MADBK 160704_044); C, Parasitic barnacle on the pleon (MADBK 160704_047); D, Polycheata with *P. brachiomastus* (MADBK 160704_033).

Plate 39. *Pagurus minutus* Hess, 1865 (긴발가락참집게) A, Dorsal surface (male, sl 5.5 mm, MADBK 160706_094); B, Ventral surface (male, sl 5.5 mm, MADBK 160706_094); C, Dorsal surface (male, sl 2.2 mm, MADBK 160528_013).

Plate 40. *Pagurus nigrofascia* Komai, 1996 (검은참집게, ovig female, sl 2.8 mm, MADBK 160723_009). A, Dorsal surface; B, Ventral surface.

Plate 41. *Pagurus filholi* (De Man, 1887) (참집게). A, Dorsal surface (male, sl 4.5 mm, MADBK 160707_048); B, Ventral surface (MADBK 160707_048); C, Parasitic barnacle on the pleon (MADBK 160707_052); D, Polycheata and parasitic barnacle with *P. filholi* (MADBK 160707_032).

Plate 42. *Pagurus japonicus* (Stimpson, 1858) (붉은눈자루참집게, male, sl 8.9 mm, MADBK 160710_012) with parasitic barnacle. A, Dorsal surface; B, Ventral surface

Plate 43. *Pagurus rubrior* Komai, 2003 (붉은얼룩참집게). A, Dorsal surface (female, sl 5.6 mm, MADBK 160717_032); B, Ventral surface (MADBK 160717_032); C, Specimen associated with *Hydrissa sodalis* (EVOSYS 260717#056); D, Parasitic barnacle on the pleon (EVOSYS 260717#038).

Plate 44. *Pagurus similis* (Ortmann, 1892) (얼룩참집게, male, sl 11.7 mm, MADBK 160717_031). A, Dorsal surface; B, Ventral surface.

Plate 45. *Pagurus parvispina* Komai, 1997 (긴가시참집게, male, sl 12.7 mm, MADBK 160744_001). A, Dorsal surface; B, Ventral surface.

Plate 46. *Pagurus pectinatus* (Stimpson, 1858) (빗참집게). A, Dorsal surface (male, sl 11.5 mm, MADBK 160715_014); B, Ventral surface (MADBK 160715_014); C, Parasitic barnacle on the pleon (MADBK 160715_016).

Plate 47. *Pagurus spina* Komai, 1994 (가시다리참집게). A, Dorsal surface (male, sl 5.4 mm, MADBK 160726_005); B, Ventral surface (MADBK 160726_005); C, Parasitic barnacle on the pleon (MADBK 160726_003).

Plate 48. *Pagurus constans* (Stimpson, 1858) (제집참집게). A, Dorsal surface (female, sl 8.6 mm, MADBK 160715_003); B, Ventral surface (MADBK 160715_003); C, Specimen living in the sponge (EVOSYS 260715#019).

Plate 49. *Pagurus trigonocheirus* (Stimpson, 1858) (세모손참집게, male, sl 19.1 mm, MADBK 160720_011). A, Dorsal surface; B, Ventral surface.

Plate 50. *Pagurus ochotensis* Brandt, 1851 (북방참집게, female, sl 8.5 mm, MADBK 160714_013). A, Dorsal surface with parasitic barnacle; B, Ventral surface with parasitic barnacle.

Plate 51. *Pagurus rathbuni* (Benedict, 1892) (털발목참집게, EVOSYS 260720#013). A, Dorsal surface (male, sl 13.0 mm); B, Ventral surface (male, sl 13.0 mm); C, Parasitic barnacle on the pleon (male, sl 12.5 mm).

Plate 52. *Pagurus gracilipes* (Stimpson, 1858) (납작손참집게, male, sl 5.5 mm, MADBK 160709_002). A, Dorsal surface; B, Ventral surface.

Plate 53. *Pagurus undosus* (Benedict, 1892) (혹손참집게, male, sl 6.8 mm, MADBK 160745_001). A, Dorsal surface; B, Ventral surface.

Plate 54. *Pagurus middendorffii* Brandt, 1851 (긴다리참집게). A, Dorsal surface (male, sl 6.3 mm, MADBK 160713_009); B, Ventral surface (MADBK 160713_009); C, Parasitic barnacle on the pleon (MADBK 160713_007).

PLATE

Plate 1. *Pomatocheles jeffreysii* Miers, 1879

A, Dorsal surface.

B, Ventral surface.

Plate 2. *Areopaguristes nigroapiculus* (Komai, 2009)

A, Dorsal surface.

B, Ventral surface. C, Parasitic barnacle on the pleon.

Plate 3. *Areopaguristes japonicus* Miyake, 1961

A, Dorsal surface.

B, Ventral surface.

C, With parasitic isopod.

Plate 4. *Paguristes seminudus* Stimpson, 1858

A, Dorsal surface.

B, Ventral surface.

Plate 5. *Paguristes acanthomerus* Ortmann, 1892

A, Dorsal surface.

B, Ventral surface.

Plate 6. *Paguristes versus* Komai, 2001

A, Dorsal surface.

B, Ventral surface.

Plate 7. *Paguristes digitalis* Stimpson, 1858

A, Dorsal surface.

B, Ventral surface.

Plate 8. *Paguristes ortmanni* Miyake, 1978

A, Dorsal surface.

B, Ventral surface.

C, Parasitic barnacle on the pleon.

Plate 9. *Ciliopagurus strigatus* (Herbst, 1804)

A, Dorsal surface.

B, Ventral surface.

Plate 10. *Ciliopagurus krempfi* (Forest, 1952)

A, Dorsal surface.

B, Ventral surface.

Plate 11. *Clibanarius virescens* (Krauss, 1843)

A, Dorsal surface.

B, Ventral surface.

Plate 12. *Diogenes penicillatus* Stimpson, 1858

A, Dorsal surface.

B, Ventral surface.

Plate 13. *Diogenes edwardsii* (De Haan, 1849)

A, Dorsal surface.

B, Ventral surface.

C, Specimen associated with *Hydrissa sodalis*.

D, Polynoid polycheata with *D. edwardsii*.

Plate 14. *Diogenes nitidimanus* Terao, 1913

A, Dorsal surface.

B, Ventral surface.

Plate 15. *Diogenes deflectomanus* Wang & Tung, 1980

A, Dorsal surface.

B, Ventral surface.

Plate 16. *Dardanus lagopodes* (Forskål, 1775)

Plate 17. *Dardanus arrosor* (Herbst, 1796)

A, Dorsal surface.

B, Ventral surface.

Plate 18. *Dardanus crassimanus* (H. Milne Edwards, 1836)

A, Dorsal surface.

B, Ventral surface.

Plate 19. *Dardanus impressus* (De Haan, 1849)

A, Dorsal surface.

B, Ventral surface.

Plate 20. *Dardanus pedunculatus* (Herbst, 1804)

A, Dorsal surface.

B, Ventral surface.

Plate 21. *Porcellanopagurus nihonkaiensis* Takeda, 1985

A, Dorsal surface.

B, Ventral surface.

C, Parasitic barnacles on the pleon.

Plate 22. *Lophopagurus* (*Australeremus*) *triserratus* (Ortmann, 1892)

A, Dorsal surface.

B, Ventral surface.

Plate 23. *Discorsopagurus maclaughlinae* Komai, 1995

A, Dorsal surface.

B, Ventral surface.

Plate 24. *Discorsopagurus tubicola* Komai, 2003

A, Dorsal surface.

B, Ventral surface.

Plate 25. *Nematopagurus lepidochirus* (Doflein, 1902)

A, Dorsal surface.

B, Ventral surface.

Plate 26. *Boninpagurus pilosipes* (Stimpson, 1858)

A, Dorsal surface.

B, Ventral surface.

Plate 27. *Labidochirus anomalus* (Balss, 1913)

A, Dorsal surface.

B, Ventral surface.

C, Small individual.

Plate 28. *Elassochirus cavimanus* (Miers, 1879)

A, Dorsal surface.

B, Ventral surface.

Plate 29. *Diacanthurus ophthalmicus* (Ortmann, 1892)

A, Dorsal surface.

B, Ventral surface.

Plate 30. *Pagurus decimbranchiae* Komai & Osawa, 2001

A, Dorsal surface.

B, Ventral surface.

Plate 31. *Pagurus nigrivittatus* Komai, 2003

A, Dorsal surface.

B, Ventral surface.

Plate 32. *Pagurus quinquelineatus* Komai, 2003

A, Dorsal surface.

B, Ventral surface.

Plate 33. *Pagurus rectidactylus* Komai, Saito & Myorin, 2015

A, Dorsal surface.

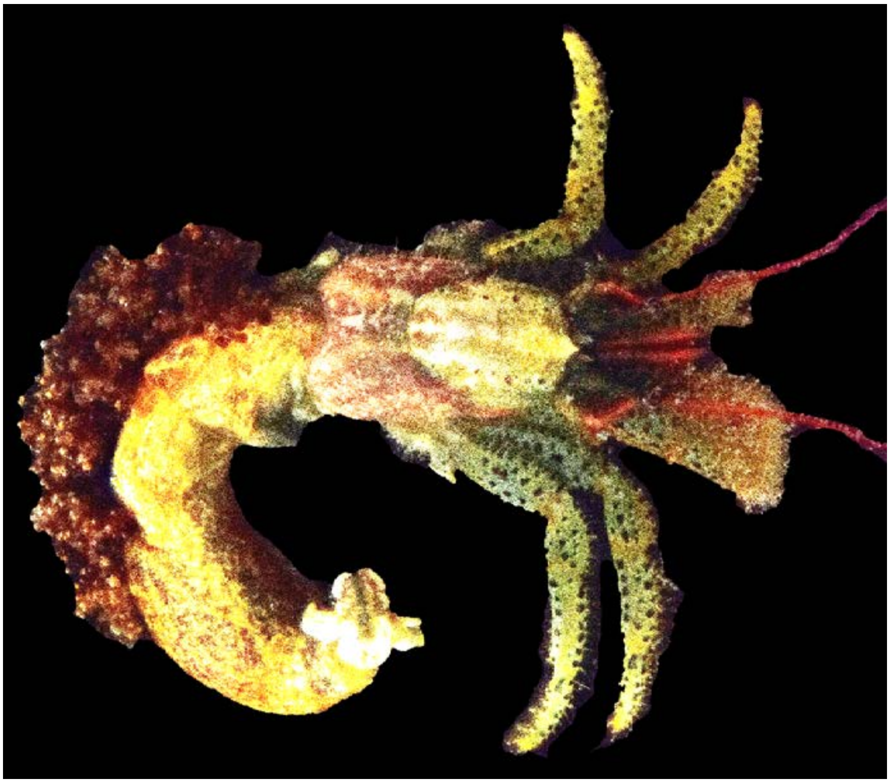
B, Ventral surface.

Plate 34. *Pagurus maculosus* Komai & Imafuku, 1996

A, Dorsal surface.

B, Ventral surface.

Plate 35. *Pagurus lanuginosus* De Haan, 1849



A, Dorsal surface.

B, Ventral surface.   C, Parasitic barnacle on the pleon.

Plate 36. *Pagurus proximus* Komai, 2000

A, Dorsal surface.

B, Ventral surface.

Plate 37. *Pagurus simulans* Komai, 2000

A, Dorsal surface.

B, Ventral surface.

Plate 38. *Pagurus brachiomastus* (Thallwitz, 1892)

A, Dorsal surface.

B, Ventral surface. C, Parasitic barnacle on the pleon.

D, Polycheata with *P. brachiomastus*

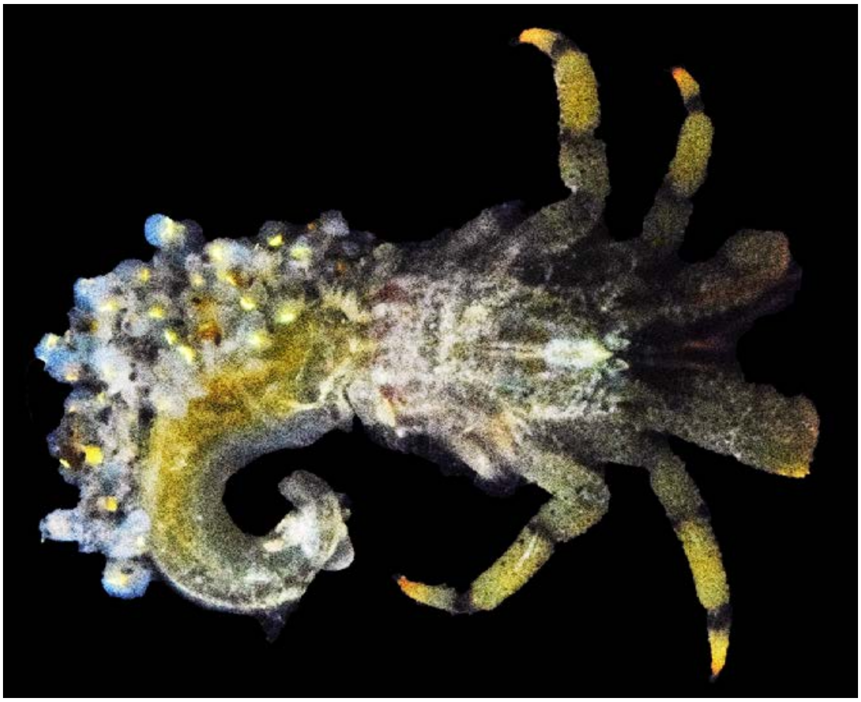
Plate 39. *Pagurus minutus* Hess, 1865

A, Dorsal surface.

B, Ventral surface.

C, Dorsal surface.

Plate 40. *Pagurus nigrofascia* Komai, 1996



A, Dorsal surface.

B, Ventral surface.

Plate 41. *Pagurus filholi* (de Man, 1887)

A, Dorsal surface.

B, Ventral surface.

C, Parasitic barnacle on the pleon.

D, Polycheata and parasitic barnacle with *P. filholi*.

Plate 42. *Pagurus japonicus* (Stimpson, 1858)

A, Dorsal surface.

B, Ventral surface.

Plate 43. *Pagurus rubrior* Komai, 2003

A, Dorsal surface.

B, Ventral surface.

C, Specimen associated with *Hydrissa sodalis*

D, Parasitic barnacle on the pleon.

Plate 44. *Pagurus similis* (Ortmann, 1892)

A, Dorsal surface.

B, Ventral surface.

Plate 45. *Pagurus parvispina* Komai, 1997

A, Dorsal surface.

B, Ventral surface.

Plate 46. *Pagurus pectinatus* (Stimpson, 1858)

A, Dorsal surface.

B, Ventral surface.

C, Parasitic barnacle on the pleon.

Plate 47. *Pagurus spina* Komai, 1994

A, Dorsal surface.

B, Ventral surface.

C, Parasitic barnacle on the pleon.

Plate 48. *Pagurus constans* (Stimpson, 1858)

A, Dorsal surface.

B, Ventral surface.

C, Specimen living in the sponge.

Plate 49. *Pagurus trigonocheirus* (Stimpson, 1858)

A, Dorsal surface.

B, Ventral surface.

Plate 50. *Pagurus ochotensis* Brandt, 1851

A, Dorsal surface.

B, Ventral surface.

Plate 51. *Pagurus rathbuni* (Benedict, 1892)

A, Dorsal surface.

B, Ventral surface. C, Parasitic barnacle on the pleon.

Plate 52. *Pagurus gracilipes* (Stimpson, 1858)

A, Dorsal surface.

B, Ventral surface.

Plate 53. *Pagurus undosus* (Benedict, 1892)

A, Dorsal surface.

B, Ventral surface.

Plate 54. *Pagurus middendorffii* Brandt, 1851

A, Dorsal surface.

B, Ventral surface. C, Parasitic barnacle on the pleon.