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이학박사학위논문

Systematic Studies on the Sea Spiders (Arthropoda: Pycnogonida) from Korean waters

한국산 바다거미류의 분류학적 연구

2020년 8월

서울대학교 대학원

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Systematic Studies on the Sea Spiders (Arthropoda: Pycnogonida) from Korean waters

A dissertation submitted in partial fulfillment
of the requirement for the degree of

DOCTOR OF PHILOSOPHY
TO THE FACULTY OF THE
SCHOOL OF BIOLOGICAL SCIENCE
at
SEOUL NATIONAL UNIVERSITY
by

Damin Lee

Date Approved:
24 Jun 2020

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ABSTRACT

Systematic Studies on the Sea Spiders (Arthropoda: Pycnogonida) from the Korean waters

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Systematic studies on the Sea Spiders (Arthropoda: Chelicerata: Pycnogonida) from the Korean waters were conducted. Various sampling methods were used, including, SCUBA, grab, and light trap. A total of 43 species (1,321 individuals) were obtained. A systematic review of Korean pycnogonids was completed based on observed morphological and molecular characteristics.

The following conclusions were obtained by reviewing the Korean pycnogonid, based on newly obtained specimens in Korean waters, type specimens, and each species' original description. 1. Five species [*Cilunculus armatus* (Böhm, 1879), *Decachela discata* Hilton, 1939, *Hedgpethia chitinosa* (Hilton, 1943), *Pallenopsis temperans* Stock, 1953, *Pycnogonum* (*Pycnogonum*) *tenue* Slater, 1879] collected in the Korean Strait were included as Korean

pycnogonids. Four species, except *C. armatus*, were excluded from the Korean pycnogonids since the collection coordinates of these four species are confirmed to be outside the Korean water boundaries according to the Korea-Japan continental shelf boundary treaty. 2. *Achelia latifrons* (Cole, 1904) was newly reported in Korean waters in 1954. Since it was a juvenile specimen, its identification was uncertain. Moreover, *Achelia orpax* Nakamura & Child, 1983, the most similar species to *A. latifrons*, was reported as a new species. Research was needed to distinguish *A. latifrons* from its congener, *A. orpax* and it was necessary to ensure identification from the juvenile specimen. Based on morphological and molecular analysis, the author confirms that its identification is correct. 3. There were errors in the morphology descriptions and classifications of 8 species [*Ammothea hedgpethi* (Utinomi, 1959), *A. hilgendorfi* (Böhm, 1879), *Paranymphon magnidigitum* Hong & Kim, 1987, *Callipallene amaxana*, (Ohshima, 1933), *C. sagamiensis* Nakamura & Child, 1983, *Endeis nodosa* Hilton, 1942, *Anoplodactylus crassus* Nakamura & Child, 1988, *A. erectus* Cole, 1904, *A. velamellus* Nakamura & Child, 1991] in Korean pycnogonids. Based on the examined material and the original descriptions, the morphological characteristics were reviewed to correct any error in the previous literature. In addition, newly discovered classification methods were applied to these species. 4. Additional variations of 13 species species [*Achelia alaskensis* (Cole, 1904), *A. orpax* Nakamura & Child, 1983, *Ammothella indica* Stock, 1954, *Paranymphon spinosum* Caullery, 1896, *Tanystylum scrutator* Stock, 1954, *T. ulreungum* Kim, 1983, *Ascorhynchus glaberrimus* Schimkewitsch, 1913, *A. ramipes* (Böhm, 1879), *Nymphonella tapetis* Ohshima, 1927, *Nymphon japonicum* Ortmann, 1891, *N. kodanii* Hedgpeth, 1949, *N. longitarse* Krøyer, 1844, *N. striatum* Losina-Losinsky, 1929] were recorded. 5. *Achelia ohshimai* Utinomi, 1951 was reported as a new species in Japan that was synonymized with *A. bituberculata* Hedgpeth, 1949. Based on comparison of mtCOI DNA barcode, *A. ohshimai* has been returned to species level instead of

a synonym of *A. bituberculata*.

Six previously unrecorded in Korean pycnogonids were found during field surveys, and described in detail. 1. A candidate of new species was found in Jejudo Island and identified to *Pycnogonum* (*Nulloviger*) sp. nov. 2. Five species [*Achelia spatula* Nakamura & Child, 1983, *Pallenopsis sibogae* Loman, 1911, *Anoplodactylus stellatus* Nakamura & Child, 1983, *A. tubiferus* (Haswell, 1884), *Pycnogonum* (*Pycnogonum*) *tenue* Slater, 1879] are newly discovered in Korean waters. Among them, *A. spatula* and *A. stellatus* are only the second specimens to be collected since the holotype was first reported, and a female specimen of *A. stellatus* was newly discovered in the present study. In addition, *Cilunculus armatus* was collected in Korean waters. It is the first time that actual specimens have been observed, so its morphology is described in detail.

Previous studies on Korean pycnogonids have been conducted based on morphology. In this study, a total of 36 mtCOI DNA barcodes from 36 species were analyzed. The morphological characteristics of each specimen were also analyzed, and intra- and interspecific variations were presented for the first time.

Key words: Systematics, Korean pycgnonid, Korean waters, Morphological variations, mtCOI DNA barcode, interspecific variation

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INTRODUCTION

1. Background

The Pycnogonida are marine arthropods that have thin bodies and long legs. They are called a “sea spider” because their appearance resembles terrestrial spiders. They form an independent taxonomic group (Arthropoda: Cheilcerata: Pycnogonida) and has equivalent position to Class Arachinda, which terrestrial spiders belong to. The name “Pycnogonida” comes from the Greek words (pyknos = thick, and gony = knee). A total of 1,355 species of the Pycnogonida have been discovered worldwide (Bamber *et al*., 2020).

Sea spiders are marine-living animals found down to a depth of 7,000 m (Wolff, 1958; 1970). They usually have four pairs of legs, but some species have five or six pairs of legs. The smallest sea spider leg is 2 mm in length. Leg length increases to 70 cm as their distritution gets closer to the polar region (Crooker, 2008). They do not have a specific respiratory system, but exchange gases through leg cuticles. Since the digestive system and reproductive system expand from the trunk to the legs, we can see the color of what pycnogonids eat through their semi-transparent cuticles and can locate eggs in their trunk and legs. The pycnogonids show paternal care, which means that the female lays the eggs, and the male takes care of and raises the eggs. They are parasitic on many hosts, like sponges, cnidarians, bryozoans, mollusks, echinoderms, polychaetes and algae, and consume the body fluids (Arnaud & Bamber, 1988).

Latreille (1810) established the class Pycnogonia and Gerstaecker (1863) established the order Pantopoda. Since then, many following researchers published Pycnogonida monograph (Hoek, 1881; Dohrn, 1881; Sars, 1891; Loman, 1908). Hedgpeth (1947) unified and organized the various classification systems based on sea spider morphology. Nakamura & Child (1983, 1991) conducted taxonomic research on pycnogonids inhabiting Japan. Since 2000, many new species of pycnogonids have been continuously

discovered, as the systematics of Japanese sea spiders have been thoroughly studied by researches (Takahashi, 2007; 2012, Nakamura, 2015; Hosoda, 2018). Arango (2002) described pycnogondis inhabiting the tropical seas of Australia, and conducted additional follow-up research (Arango, 2007; 2015). In China, Lou (1936) first published information regarding Chinese pycnogonids, but any further research was not completed before a foreign researcher, Bamber, appeared (Bamber, 1992). Although Wang, a Chinese researcher, hass been studying the systematics of pycnogonids since 2013, there is no monograph regarding Chinese pycnogonids, and only nine papers have been published so far (Wang, 2013; 2015; 2018). In Southeast Asian countries, pycnogonids have only been studied by foreign researchers. There is no literature regarding Vietnamese pycnogonids. Most of the prestigious sea spider researchers have retired, but successors such as Arango (Australia), Lucena (Brarzil), Cano-Sanchez (Spain), Sabroux (France), Miyazaki (Japan), and Wang (China) are studying pycnogonids now (Arango, 2015; Lucena, 2019; Cano-Sanchez, 2019; Miyazaki, 2015; Sabroux, 2017; Wang, 2018). Thanks to their efforts, 1,355 species of pycnogonids in 16 families and 89 genera have been reported (Bamber *et al*., 2020).

In Korea, Hedgpeth (1949) reported a specimen of *Nymphon uniunguiculatum* Losina-Losinsky, 1933 collected in Guryongpo, Pohang, which was the first record of a Korean pycnogonid. Stock (1954) mentioned that a juvenile specimen of *Achelia latifrons* (Cole, 1904) was collected at a depth of 60–100 ftm along the Korean coast. In addition, Stock (1955) recorded a female specimen of *Nymphon longitarse* Krøyer, 1844 collected at a depth of 45 ftm along the Korean coast. Both records noted the collection site only in relation to the Korean coast, and did not provide accurate location information. *Tanystylum ulreungum* Kim, 1983 was the first record of a new species discovered by a Korean researcher. Kim & Stock (1984) reported *Pycnogonum*

koreanum collected at Ulleungdo Island as a new species, but it was synonymized with *Pycnogonum uedai* Nakamura & Child, 1983. Since then, Hoonsoo Kim, Ilhoi Kim, and Jaesang Hong conducted taxonomic studies of Korean pycnogonids (Kim & Kim, 1985; Kim, 1986; Kim & Hong, 1986; 1987; Hong & Kim, 1987). Kim (1988) compiled the Pycnogonida in the "Illustrated Encyclopedia of Fauna & Flora of Korea" and organized the 14 genera, 38 species of pycngonids in the Korean waters. Kim (2013) published "Invertebrate Fauna of Korea, Sea Spider" adding seven more species. Since Kim gathered Korean pycnogonids, eight new species have been discovered in Korean waters (Kim, 1983; Kim & Kim, 1985; Kim & Hong, 1986; 1987; Hong & Kim, 1987).

2. General morphology of Class Pycnogonida

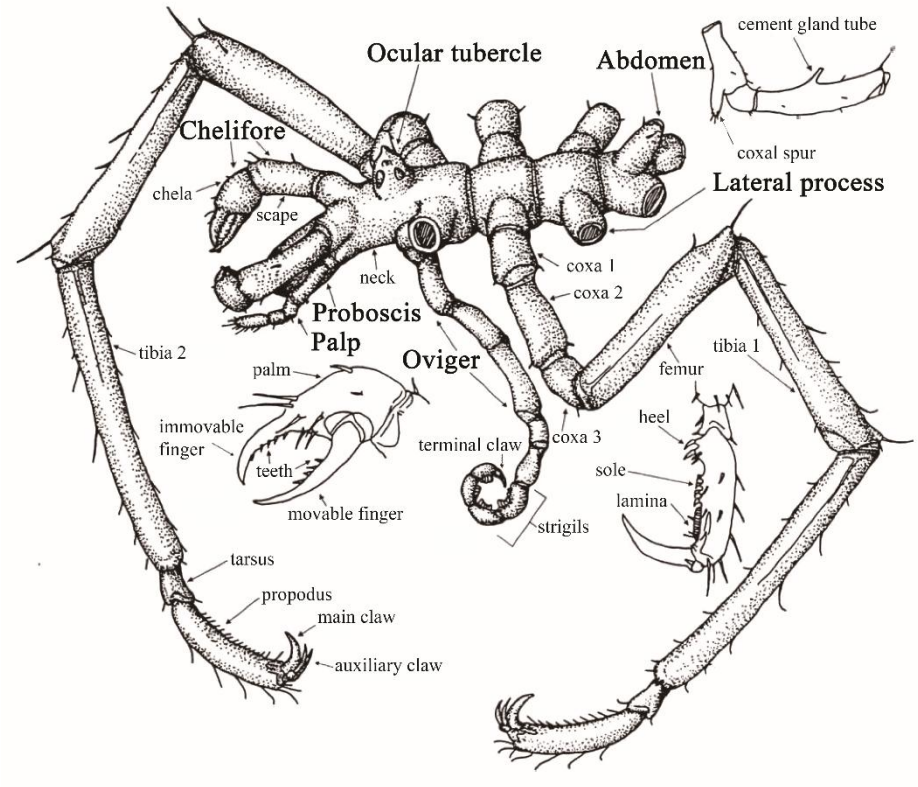


Fig. 1. Anatomy of the Pycnogonida. Modified from Child (1998).

Trunk

Pycnogonids are composed of a centralized with multiple appendages. The trunk is mainly composed of four segments, and in some species, segments 3–4 are combined, or all segments are combined. In some species, like the genus *Pycnogonum*, the posterior margin of each segment has a large tubercle, or is raised, forming transverse ridge. The first trunk segment is also called the cephalic segment and is connected to lateral process 1, the ocular tubercle,

proboscis, chelifore, and oviger. The anterior surface of the cephalic segment protrudes anteriorly in some species, forming a neck structure. In the genus *Callipallene*, the anterior part over the neck is also called the crop (Stock, 1952). In the case of the genus *Cilunculus*, the dorsal surface of the anterior part of the cephalic segment is covered by a hood structure.

Lateral process

Lateral processes protrude from the trunk laterally, and legs are attached here to connect to the trunk. Their surfaces are adorned with multiple ornaments, such as tubercles, spines, and setae, or glabrous. Their size and the intervals between their lateral processes are important characters that can be used to distinguish species.

Ocular tubercle

An ocular tubercle is a tubercle with eyes. It presents on the dorsal surface of the cephalic segment and its precise position (e.g., anterior, middle, or posterior surface of the cephalic segment) is species-dependent. Some species have tubercles, papillae, spines, or setae on the ocular tubercle, which has various tips (e.g., conical, nodulous). Sea spiders usually have four pigmented eyes, but the genus *Stylopallene* has eight (Staples, 1997). Eyes are sometimes completely lacking, which is presumed to be the result of environmental adaptations to a lack of sunlight (e.g., mud or deep seas). In some cases, there is a tubercle behind the ocular tubercle, which is called the post ocular tubercle.

Proboscis

The proboscis is related to food uptake, and is present on the cephalic segment. It has a mouth on its tip, which it uses to sucks debris and fluids (e.g., mucus and body fluids). It has a wide variety of shapes, from straw-like in the family Austrodecidae, to thick and ovoid. Proboscis are usually composed of one segment, but in the genus *Eurycyde*, it has two segments. Some species have ornaments on the proboscis such as setae, tubercles, swellings, or bumps (Arnaud & Bamber, 1988).

Abdomen

The abdomen is attached to segment 4 of the trunk (also called the caudal segment) and has an anus on the tip. It can have a variety of shapes (e.g., spindle shape, club shape, or cylindrical shape), and directions (e.g., vertical, horizontal, or posterodorsal). Some species also have tubercles, setae, or swellings. In some species, the abdomen has an articulation at its base. The length of the abdomen is often expressed compared to coxa.

Chelifore

The chelifore function as forceps to pick or tear objects. It consists of a scape and a chela. The scape has one or two segments, and is sometimes ornamented with tubercles or setae. The chela are composed of a palm and fingers. The palm is at the base of the fingers and usually has setae on its surface. Teeth are present at the inner surface of the fingers, but are sometimes lacking. Since the degree of degeneration varies depending on the taxa, some species have a scape and atrophied chela, or the chelifore is atrophied entirely.

Palp

The palp consists of various numbers of 1–10 segments. The palp usually has many setae on distal segments. Although its function is not exactly known, it is assumed that it is used for moving, cleaning, sensing, and handling food. In the genera *Propallene* and *Oropallene*, only males have the palp and it is absent in the females (Staples, 1997).

Oviger

The oviger is related to mating, breeding, and grooming (Davenport *et al.*, 1987; Staples, 1997). It usually has 10 segments, but the number of segments vary in many species. There is a sexual dimorphism depending on the taxa, so their appearances are gender specific, or the oviger is absent on one side. The last four segments are called the strigilis and they usually have compound spines on their inner surfaces. In some species, such as *Nymphon*, there is a terminal claw after the strigilis.

Leg

The legs consist of eight segments with main or auxiliary claws, and have a role in locomotion. Coxa consists of three segments. Coxa 1 often has dorsal ornaments, such as tubercles, setae, and spines. Coxa 2 has a gonopore and its position is usually on the ventral surface, but the exact position depends on the taxa. In the male, the ventrodistal margin of the coxa 2 protrudes to form a coxal spur.

The male's femur has a cement gland tube on its dorsal surface. Cement gland usually bears a cement gland tube that secretes sticky mucus and collects

eggs in a bracelet structure (Bain & Govedich, 2004). The tibia consists of two segments and often has a tubercle on the dorsodistal marign. The length ratio of femur and tibia is also used to distinguish species. The tarsus is small and often has spines or setae on its ventral surface.

The propodus is straight or curved. It has ornaments on both its dorsal and ventral surfaces, and those of the ventral surface are considered to be important characters. On the ventral surface of the propodus, there are heel spines on proximal part, sole spines or sole setae from the middle to distal end. Lamina is fan-shaped and present at the distal part of the ventral surface of the propodus in some species such as *Anoplodactylus*.

The main claw and auxiliary claws are curved and connected to the propodus. The main claw is usually larger than the auxiliary claws, but there are some exceptions, such as *Ammothella biunguiculata* (Dohrn, 1881).

MATERIAL & METHODS

1. Sampling

In the intertidal zone, sampling was performed at low tide or when the water level was low. Whole bodies of sea weeds were collected and rinsed by water to detach the pycnogonids from their hosts. Pycnogonids were also collected by turning ovger stones and rocks, and collecting them attached to their bottom surfaces (Fig. 2A).

Among the various methods used to find specimens in the subtidal zone, SCUBA (self-contained underwater breathing apparatus) diving (Fig. 2B) was used particularly for collecting pycnogonids living in shallow waters (near 0–35 m depth). The author scraped rock surfaces and walls to collect algae, sponges, bryozoan and hydra where pycnogonids were expected to live, or shoveled sand and rubbles. After diving, the collections were rinsed with fresh water to find specimens. Trimix SCUBA diving (Fig. 2C) was performed using helium, oxygen, and nitrogen gas to discover creatures living in deeper waters (near 35–75 m depth). Since species that made up the environment changed according to depth changes, different types of creatures were collected in each depth zone.

Grab (Fig. 2D) was used as a method of finding specimens that lived on the surface or in shallow depths with soft floors, such as mud flats or sand flats. The Van Veen grab and Smith McIntyre grab were usually performed at 0–100 m depth.

Harbor investigation was a method of investigating fishery products and its by-products collected by fish net or fish trap. This method found organisms that lives that lived in deep waters or areas which were difficult for humans to approach directly. Pycnogonids were collected directly with other creatures such as shrimps and crabs, or with their hosts, like starfish (Fig. 2E).

Light trap was a method of collecting marine animals using the positive phototaxix, which is the nature of being attracted to light. The trap was set at a port or a seashore at night for 2–3 hours in the short version or overnight in the long version. Among the Korean pycnogonids, *Callipallene amaxana* (Ohshima, 1933) and *Propallene longiceps* Böhm were usually collected using this method (Fig. 2F). Kim (2013) noted that *Nymphonella tapetis* Ohshima, 1927 was also collected by the light trap.

When specimens were not obtained using the above methods, they were borrowed from other institutions (Table 1): National Institute of Biological Resources (NIBR), Ewha Womans University Natural History Museum (EWUNHM), Natural History Museum of Denmark (NHMD), Museum Victoria (MV), and Smithsonian National Museum of Natural History (NMNH). These specimens were useful for checking the variation range between the domestic and the abroad, and for comparing some species with their congeners.

Fig. 2. Various methods of sampling. A, Bottom surface of rock in intertidal zone, circles indicating pycnogonids; B, SCUBA diving sampling; C, Trimix SCUBA diving sampling; D, Grab sampling; E, Sampling from local fisherman's net net; F, Light trap sampling.

Table 1. Specimens loan from various institutions

Institution	Species	Type Series	Voucher No.	Specimen Locality
NIBR	*Achelia alaskensis*	Non-type	NIBRIV0000124430	Korea
	Achelia orpax	Non-type	NIBRIV0000227042	Korea
	Paranymphon magnidigitum	Non-type	NIBRIV0000124468	Korea
	Paranymphon spinosum	Non-type	NIBRIV0000124448	Korea
	Ascorhynchus glaberrimus	Non-type	NIBRIV0000124469	Korea
	Ascorhynchus glaberrimus	Non-type	NIBRIV0000859908	Korea
	Ascorhynchus glaberrimus	Non-type	NIBRIV0000859909	Korea
	Ascorhynchus glaberrimus	Non-type	NIBRIV0000124472	Korea
	Ascorhynchus ramipes	Non-type	NIBRIV0000125483	Korea
	Ascorhynchus ramipes	Non-type	NIBRIV0000124682	Korea
	Ascorhynchus ramipes	Non-type	NIBRIV0000124466	Korea
	Ascorhynchus ramipes	Non-type	NIBRIV0000130419	Korea
	Ascorhynchus ramipes	Non-type	NIBRIV0000620005	Korea
	Ascorhynchus ramipes	Non-type	NIBRIV0000124464	Korea
	Pycnogonum (*Nulloviger*) sp.	Holotype	NIBRIV0000837749	Korea
EWUNHM	*Pycnogonum* (*Pycnogonum*) *tenue*	Non-type	-	Korea
NHMD	*Nymphon longitarse*	Syntype	NHMD 110685	Greenland
	Nymphon longitarse	Syntype	NHMD110686	Greenland
	Nymphon longitarse	Syntype	NHMD 110687	Greenland
	Nymphon longitarse	Non-type	NHMD 652671	Korea
	Achelia latifrons	Non-type	NHMD 652670	Korea
MV	*Pycnogonum* (*Nulloviger*) *carinatum*	Holotype	NMV J48800	Australia
	Pycnogonum (*Nulloviger*) *carinatum*	Paratype	NMV J48806	Australia
NMNH	*Achelia latifrons*	Non-type	USNM 80898	US
	Achelia latifrons	Non-type	USNM 173719	US
	Achelia alaskensis	Non-type	USNM 80910	US
	Anoplodactylus erectus	Paratype	USNM 81299	US
	Anoplodactylus viridintestinalis	Non-type	USNM 122432	US
	Ascorhynchus glaberrimus	Non-type	USNM 183907	Japan
	Ascorhynchus glaberrimus	Non-type	USNM 183913	Japan
	Nymphon elongatum	Non-type	USNM 80605	Russia
	Nymphon longitarse	Non-type	USNM 128264	Canada
	Nymphon longitarse	Non-type	USNM 181997	US
	Paranymphon spinosum	Non-type	USNM 181063	US
	Paranymphon spinosum	Non-type	USNM 183953	Japan

2. Material treatments

The examined specimens were collected by the above methods from 1974 to 2020. These specimens were fixed in 70 % ethanol, and stained with Methylene Blue or Lignin Pink, if necessary. Appendages were detached from the trunk and observed under a stereomicroscope (Leica M165C, Germany) and a light microscope (Olympus BX51, Japan). Photographs were taken using a digital camera (Nikon D850, Japan) and a microscope digital camera (Leica MC170, Germany). To improve the depth of the field, Helicon Focus software (Helicon Focus, Ukraine) was used after taking the photographs. Digital drawings were produced following Coleman (2009).

3. Measurements

Specimens were measured following the methods of Fry & Hedgpeth (1969) and Lee & Kim (2020). The trunk length was measured between the anterior margin of the cephalic segment and the posterior margin of the lateral process 4 in the dorsal view (Fig. 3A). The trunk width was measured between the middle points of the distal ends of the lateral process 2 in the dorsal view (Fig. 3A). The proboscis and abdomen were measured between the middle point of the basal height and the distal margin in the lateral view (Fig. 3B). Legs were measured between the middle points of the distal ends in the lateral view. Curved segments were measured according to the chord length of the central arc (Fig. 3C). In the case of distal segments (pointed at distal margin), the length was measured between the middle point of the proximal end and the distal point (Fig. 3D).

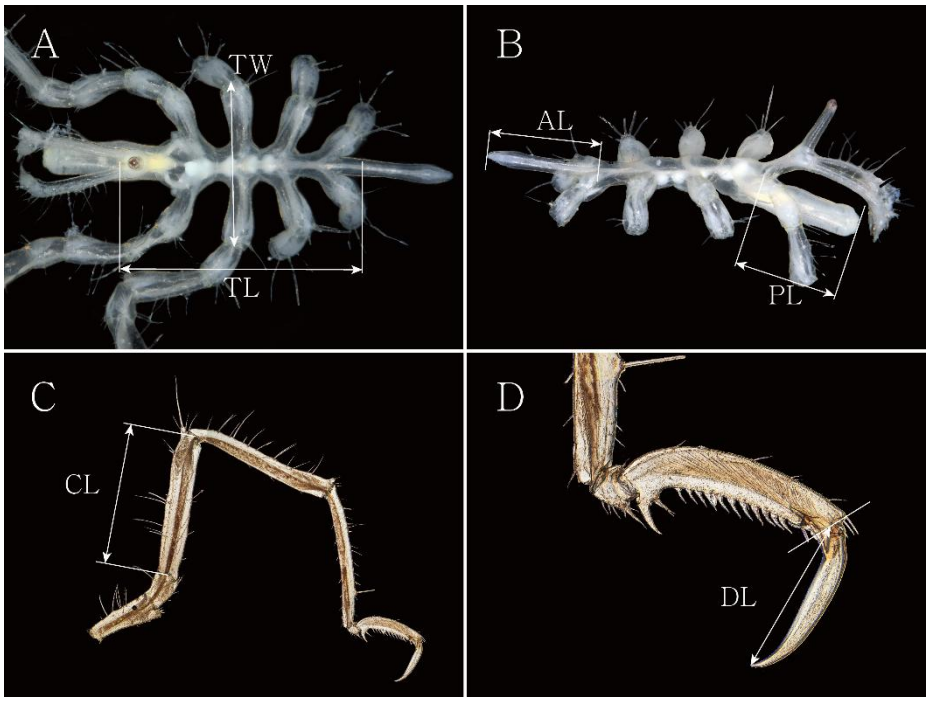


Fig. 3. Measurements of Pycnogonida. A, Trunk, dorsal view; B, Trunk, lateral view; C, Leg, lateral view; D, Leg, distal segments. TL = trunk length, TW = trunk width, PL = proboscis length, AL = abdomen length, CL = length of curved segment, DL = length of distal segment.

4. Molecular experiments

To extract DNA, part of the legs or entire legs were prepared and lysed at 56 ℃ overnight. Subsequent experiments were conducted with one of two kits: DNeasy Blood & Tissue Kit (QIAGEN, Germany) for large tissue samples, and QIAamp DNA Micro Kit (QIAGEN, Germany) for small tissue samples. For use in species identification and phylogenetic tree construction, DNA barcodes (COI regions) were amplified by PCR experiments (Table 2). The universal primers were used first, and if that did not work, then modified primers were

applied (Sabroux *et al*., 2017).

Table 2. PCR primers for target regions

Target Region	Primer	Direction	Base sequence (5' → 3')	Reference
COI	LCO1490	Forward	GGT CAA CAA ATC ATA AAG ATA TTG G	Folmer *et al.*, 1994
	HCO2198	Reverse	TAA ACT TCA GGG TGA CCA AA AAA TCA	Folmer *et al.*, 1994
	Py-COI-U	Forward	TCA ACW AAT CAT AAA GAY ATT GG	Sabroux *et al*., 2017
	Py-COI-L3	Reverse	GGR TCH CCH CCH GMD GGR TC	Sabroux *et al*., 2017

PCR mixtures were created in a 20 µl volume reaction adding 2 µl of each 10 µM primers, 13 µl DW, and 3 µl of gDNA to the AccuPower® Taq PCR PreMix. The PCR condition consisted of an initial denaturaing step at 94 ℃ for 3 min, 40 amplification cycles (94 ℃ for 1 min, 45 ℃ for 1 min 15 sec, and 72 ℃ for 1 min) and a final extentsion step at 72 ℃ for 5 min for getting COI regions. If it is difficult to obtain COI regions in this way, PCR experiments were conducted per Sabroux *et al*. (2017). The PCR program consisted of an initial denaturaing step at 94 ℃ for 4 min, 40 amplification cycles (94 ℃ for 30 sec, 50 ℃ for 30 sec, and 72 ℃ for 1 min) and a final extentsion step at 72 ℃ for 10 min.

Obtained sequences were aligned using Seqman. The Pairwise Distances were computed using the Kimura 2-parameter method, and were in the units of the number of base substitutions per site (Kimura, 1980). The phylogenetic tree was inferred using the Neighbor-Joining method (Saitou & Nei, 1987). The percentage of replicate trees in which the associated taxa clustered together in the bootstrap test (1000 replicates) were shown next to the branches (Felsenstein, 1985). The analyses were conducted on MEGA7 (Kumar *et al*., 2016).

RESULTS

1. Morphological analysis

1.1. Species found in Korean Strait

Kim (2013) included five species into the Korean pycnogonids referring the previous records (Table 3). Reviewing these records, the Korean Strait was the collection site of these species.

Table 3. Previous records of pycnogonids collected in Korean Strait

Species	Collection Coordinate	Reference
Cilunculus armatus	33°53.6'N 128°33.4'E	Nakamura & Child, 1991
Decachela discata	34°25.3'N 129°5.4'E	Nakamura & Child, 1991
Hedgpethia chitinosa	34°24'N 130°10'E	Stock, 1954
Pallenopsis temperans	34°11'N 130°02'E	Stock, 1954
Pycnogonum (*Pycnogonum*) *tenue*	32°49'N 128°14'E	Stock, 1954

This strait is encompassed by both Korean and Japanese waters. When defining the boundary of the Korean waters in the Korea Strait, the EEZ cannot be considered because an agreement between Korea and Japan has not been reached and the scope of the EEZ has not been established in there. Therefore, the boundary of the Korean waters in the Korea Strait has not been confirmed and is estimated in the Treaty of Continental Shelf between Korea and Japan (U.N.T.S. Vol. 1225, No. 19777; Vol. 1225, No. 19778).

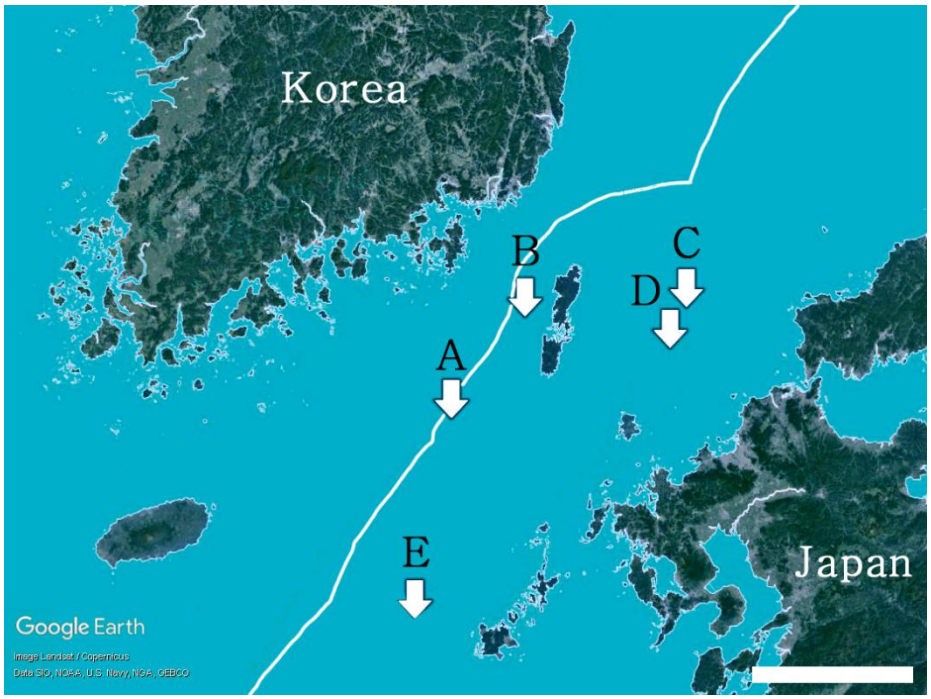


Fig. 4. Coordinates of the five pycnogonids quoted from Kim (2013). A, *Cilunculus armatus*; B, *Decachela discata*; C, *Hedgpethia chitinosa*; D, *Pallenopsis temperans*; E, *Pycnogonum* (*Pycnogonum*) *tenue*. Scale bar = 100 km. Modified from Claus *et al*. (2014).

Applying the collection coordinates to a map (Claus *et al*., 2014), the coordinate of *Cilunclus armatus* is close to the boundary (Fig. 4). Since the boundary may be changed at a later date, this species was not excluded in this study. The remaining four species were collected very close to the territory of Japan, and they are likely to be part of the Japanese waters in the future. Therefore, the records for these four species were excluded from this study, and since *P*. (*P*.) *tenue* was obtained in Korea, the record and descriptions were provided.

1.2. List of Pycnogonida species in Korean waters

In the present study, Korean pycnogonids were classified into 48 species, 18 genera, and nine families through field and literature surveys. A species marked with an asterisk (*) was presented as a candidate for a new species. A species with double asterisks (**) was resurrected as a species once it had been synonymized with other species. Five species marked with three asterisks (***) were newly discovered from the Korean waters and one species marked with four asterisks (****) was first described in detail with Korean specimens. Two species marked with five asterisks (*****) were re-examined once they had been mentioned without descriptions.

Phylum Arthropoda Latreille, 1829 절지동물문

Class Pycnogonida Latreille, 1810 바다거미강

Order Pantopoda Gerstäcker, 1863 바다거미목

Family Ammotheidae Dohrn, 1881 접시바다거미과

Genus *Achelia* Hodge, 1864 애기손바다거미속

1. *Achelia alaskensis* (Cole, 1904) 북방애기손바다거미

2. *Achelia bituberculata* Hedgpeth, 1949 등뾰족애기손바다거미

3. *Achelia crurispinifera* Kim & Kim, 1985 뿔애기손바다거미

4. *Achelia echinata* Hodge, 1864 가시애기손바다거미

5. *Achelia latifrons* (Cole, 1904) 털보애기손바다거미*****

6. *Achelia ohshimai* Utinomi, 1951**

7. *Achelia orpax* Nakamura & Child, 1983 남방털보애기손바다거미

8. *Achelia spatula* Nakamura & Child, 1983***

Genus *Ammothea* Leach, 1814 술병부리바다거미속

9. *Ammothea hedgpethi* (Utinomi, 1959) 작은술병부리바다거미

10. *Ammothea hilgendorfi* (Böhm, 1879) 술병부리바다거미

Genus *Ammothella* Verrill, 1900 긴손접시바다거미속

11. *Ammothella biunguiculata* (Dohrn, 1881) 꼬마긴손접시바다거미

12. *Ammothella indica* Stock, 1954 남방긴손접시바다거미

13. *Ammothella monotuberculata* Hong & Kim, 1987

외돌기긴손접시바다거미

Genus *Cilunculus* Loman, 1908 어깨홈바다거미속

14. *Cilunculus armatus* (Böhm, 1879) 어깨홈바다거미****

Genus *Paranymphon* Caullery, 1896 너도접시바다거미속

15. *Paranymphon magnidigitum* Hong & Kim, 1987 큰손너도접시바다거미

16. *Paranymphon spinosum* Caullery, 1896 너도접시바다거미

Genus *Tanystylum* Miers, 1879 꼬마바다거미속

17. *Tanystylum scrutator* Stock, 1954 꼬마바다거미

18. *Tanystylum ulreungum* Kim, 1983 울릉꼬마바다거미

Family Ascorhynchidae Hoek, 1881 코바다거미과

Genus *Ascorhynchus* Sars, 1878 코바다거미속

19. *Ascorhynchus glaberrimus* Schimkewitsch, 1913 매끈코바다거미

20. *Ascorhynchus ramipes* (Böhm, 1879) 돌기코바다거미

21. *Ascorhynchus stocki* Hong & Kim, 1987 조개코바다거미

Genus *Nymphonella* Ohshima, 1927 더듬바다거미속

22. *Nymphonella tapetis* Ohshima, 1927 더듬바다거미

Family Ascorhynchoidea incertae sedis

Genus *Decachela* Hilton, 1939 불가사리바다거미속

23. *Decachela dogieli* Loshina-Losinsky, 1961 불가사리바다거미

Family Callipallenidae Hilton, 1942 각시바다거미과

Genus *Bradypallene* Kim, 1987 느림보바다거미속

24. *Bradypallene espina* Kim & Hong, 1987 느림보바다거미

Genus *Callipallene* Flynn, 1929 각시바다거미속

25. *Callipallene amaxana* (Ohshima, 1933) 긴목각시바다거미

26. *Callipallene dubiosa* Hedgpeth, 1949 뚱보각시바다거미

27. *Callipallene sagamiensis* Nakamura & Child, 1983 사가미각시바다거미

Genus *Cheilopallene* Stock, 1955 입술바다거미속

28. *Cheilopallene nodulosa* Hong & Kim, 1987 입술바다거미

Genus *Propallene* Schimkewitsch, 1909 두마디손각시바다거미속

29. *Propallene longiceps* (Böhm, 1879) 두마디손각시바다거미

Family Endeidae Norman, 1908 민바다거미과

Genus *Endeis* Philippi, 1843 민바다거미속

30. *Endeis nodosa* Hilton, 1942 남양민바다거미

Family Nymphonidae Wilson, 1878 기생바다거미과

Genus *Nymphon* Fabricius, 1794 기생바다거미속

31. *Nymphon akanei* Nakamura & Child, 1983 꼬마기생바다거미

32. *Nymphon elongatum* Hilton, 1942 긴팔기생바다거미

33. *Nymphon japonicum* Ortmann, 1891 매끈기생바다거미

34. *Nymphon kodanii* Hedgpeth, 1949 고다니기생바다거미

35. *Nymphon longitarse* Krøyer, 1844 긴발목기생바다거미*****

36. *Nymphon striatum* Losina-Losinsky, 1929 혹기생바다거미

37. *Nymphon uniunguiculataum* Losina-Losinsky, 1933

외발톱기생바다거미

Family Pallenopsidae Fry, 1978 무촉지바다거미과

Genus *Pallenopsis* Wilson, 1881 무촉지바다거미속

38. *Pallenopsis sibogae* Loman, 1911***

Family Phoxichilidiidae Sars, 1891 낫바다거미과

Genus *Anoplodactylus* Wilson, 1878 낫바다거미속

39. *Anoplodactylus crassus* Nakamura & Child, 1988 접시낫바다거미

40. *Anoplodactylus erectus* Cole, 1904 돌기낫바다거미

41. *Anoplodactylus hwanghaensis* Kim & Hong, 1986 황해낫바다거미

42. *Anoplodactylus pycnosoma* (Helfer, 1938) 뚱보낫바다거미

43. *Anoplodactylus stellatus* Nakamura & Child, 1983***

44. *Anoplodactylus tubiferus* (Haswell, 1884)***

45. *Anoplodactylus velamellus* Nakamura & Child, 1991 가는낫바다거미

Family Pycnogonidae Wilson, 1878 송장바다거미과

Genus *Pycnogonum* Brünnich, 1764 송장바다거미속

46. *Pycnogonum* (*Nullovgier*) sp. nov.*

47. *Pycnogonum* (*Pycnogonum*) *tenue* Slater, 1879 작은송장거미***

48. *Pycnogonum* (*Pycnogonum*) *uedai* Nakamura & Child, 1983

송장바다거미

1.3. Systematic accounts

Key to the pycnogonid families in Korean waters.

1. Chelifore and palp present 2

- Chelifore or palp absent 6

2. Chielifore or chela atrophied except genus *Paranymphon* 3

- Chelifore and chela well developed 4

3. Auxiliary claws present except genus *Paranymphon* ..... Ammotheidae

- Auxiliary claws absent ..... Ascorhynchidae

4. Proboscis attached to trunk ventrally ..... Pallenopsidae

- Proboscis attached to trunk anteriorly 5

5. Palp 5-segmented, not shorter than proboscis ..... Nymphonidae

- Palp absent or less than 5-segmented, shorter than proboscis ... Callipallenidae

6. Chelifore present ..... Phoxichilidiidae

- Chelifore absent 7

7. Oviger only present in male with terminal claw or absent in both gender ..... Pycnogonidae

- Oviger only present in male without terminal claw ..... Endeidae

Family Ammotheidae Dohrn, 1881 접시바다거미과

Diagnosis

Trunk compact or elongated. Palp 4 to 10-segmented, usually longer than proboscis. Chelifore usually shorter than proboscis; scape or chla or both atrophied, sometimes lacking. Oviger 9 to 10-segmented in both gender; strigilis having simple or compound spines.

Key to the Ammotheidae genera in the Korean waters.

1. Chelifore well developed ..... *Paranymphon*

- Chelifore atrophied 2

2. Lateral processes touching each other 3

- Lateral processes separated 4

3. Palp 8-segmented. Chela atrophied but present ..... *Achelia*

- Palp 4 to 7-segmented. Chela absent ..... *Tanystylum*

4. Cephalic segment having hood structure ..... *Cilunculus*

- Cephalic segment not having hood structre 5

5. Chelifore 2-segmented or reduced to bud ..... *Ammothea*

- Chelifore 3-segmented ..... *Ammothella*

Genus *Achelia* Hodge, 1864 애기손바다거미속

Diagnosis

Trunk usually small, unsegmented or partially segmented; anterior part of cephalic segment shorter than width. Lateral processes touching or almost touching. Ocular tubercle present at base of anterior part of cephalic segment. Proboscis in various shape. Abdomen not articulated. Palp usually 8-segmented, last 4 segments short and hairy. Oviger 10-segmented, without terminal claw; strigilis having compount spines. Propodus having large heel spine and smalll spines at sole. Main claw large. Auxiliary claw present. Male having coxal spur on leg 3–4; oviger usually having reverse spine at segment 6, longer than female. Female having gonopores on coxa 2 of all legs.

Type species

Achelia echinata Hodge, 1864

Key to the *Achelia* species in Korean waters.

1. Ocular tubercle as long as basal width 2

- Ocular tubercle longer than basal width 4

2. Abdomen without dorsal tubercle ..... *A. alaskensis*

Abdomen with dorsal tubercles 3

3. One dorsal tubercle on base of abdomen ..... *A. ohshimai*

- Two dorsal tubercles on base of abdomen ..... *A. bituberculata*

4. Proboscis tapering distally ..... *A. echinata*

- Proboscis not tapering 5

5. Proboscis cylindrical ..... *A. crurispinifera*

- Proboscis barrel-shaped 6

6. Legs having spatulated spines ..... *A. spatula*

- Legs having normal spines 7

7. Coxa 1 having 1 dorsodistal tubercle ..... *A. orpax*

- Coxa 1 having 3 dorsodistal tubercles ..... *A. latifrons*

1. *Achelia alaskensis* (Cole, 1904) 북방애기손바다거미 (Fig. 5)

Ammothea alaskensis Cole, 1904:266, pl. 12: fig. 4, pl. 17: figs. 4–12.—Losina-Losinsky, 1933:59, fig. 10.—Exline, 1936:421.—Okuda, 1940:73, figs. 1–10.

Ammothea nudiuscula Hall, 1913:135, pl. 3: figs. 1–8.—Hilton, 1939:32; 1943:93.—Hedgpeth, 1941:256 [key].

Achelia alaskensis.—Utinomi, 1954:14, figs. 6–7.—Losina-Losinsky, 1961:91.—Utinomi, 1971:329.—Kim & Hong, 1986:44, fig. 7.—Child, 1987:552; 1995:2.—Bamber, 1997:157 [key].—Turpaeva, 2007a:1039, pl. 1: figs. 1–9; 2007b:110, pl. 10: figs. 8–12.—Kim, 2013:13, fig. 2.

Achelia gurjanovii Losina-Losinsky, 1961:93, fig. 18.

Achelia kamtschatica Losina-Losinsky, 1961:92, fig. 17.—Turpaeva,

2007a:114, pl. 13: figs. 8–13.

Material examined

1 ind. (1♂), NIBRIV0000124430, Yeongheungdo Island, Incheon, Korea, coll. J.S. Hong, 29 Aug 2001; 20 inds, USNM80910, Key Route Pier, San Francisco Bay, California, United States, United States Fish Commission, 02 Aug 1912.

Diagnosis

Trunk without segmentation line. Lateral processes touching each other, having small dorsal tubercle on posterodistal margin. Ocular tubercle as long as basal width. Proboscis spindle-shaped. Abdomen not reaching distal margin of coxa 1. Palp 8-segmented. Chelifore scape having dorsodistal tubercle; chela atrophied. Oviger 10-segmented. Leg coxa 1 having dorsal tubercle; coxa 2 having coxal spur on leg 3–4 in male; propodus having three heel spines; auxiliary claw present.

Fig. 5. *Achelia alaskensis*, NIBRIV0000124430. Trunk, dorsal view. Scale bar = 1 mm.

Distribution

Korea (Incheon and Chungcheong-do), Japan (Hokkaido), Russia, Alaska, and California.

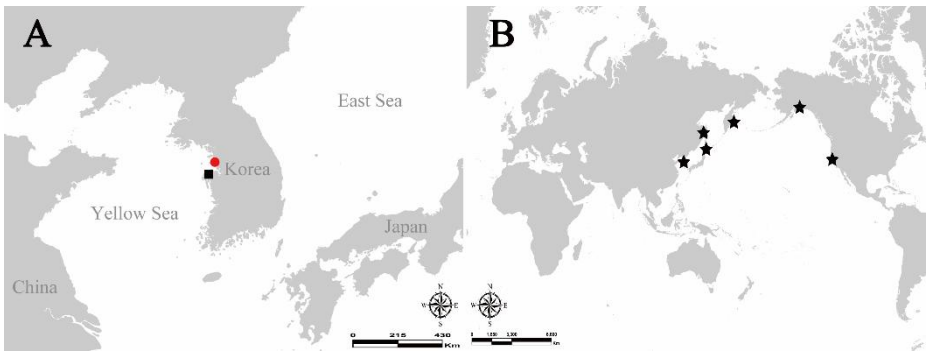


Fig. 6. Distribution of *Achelia alaskensis*. A, Distribution in Korea, ● indicating present study, ■ indicating previous record in Korea (Kim, 2013); B, Distribution in the world, ★ indicating worldwide distribution.

Remarks

The present species is morphologically similar to *Achelia gracilipes* (Cole, 1904) and *Achelia laevis* Hodge, 1864 by the presence of ovoid proboscis, low ocular tubercle, and the absence of trunk segmentation. Comparing with the original description of *A. gracilipes* (Cole 1904), the present species is distinguished from the *A. gracilipes* by followings: (1) There is no tubercle on the anterolateral margin of the cephalic segment (having round tubercle in *A. gracilipes*). (2) The femur is longer than the tibia (femur as long as tibia). Referring the description and figures of Hodge (1864) and Bamber (2010), the present species is different from the *A. laevis* by followings: (1) The lateral processes are touching each other (slightly separated in *A. laevis*). (2) The prominent dorsal tubercle is present on the scape (without tubercle). (3) The auxiliary claws are developed, reaching half of the main claw (having short auxiliary claws).

Observing the examined material, the lateral processes have a low dorsal tubercle on the posterodistal surface with a small seta. A dorsal tubercle is present on the coxa 1 of all legs, and a dorsodistal tubercle is present on the scape (Fig. 5). These characteristics were noted in the original description, not in Kim (2013). The trunk length of the examined material is larger than that of material in Kim (2013): NIBRIV0000124430, 0.8 mm; USNM 80910, 1.04mm; Kim's (2013) specimen, 0.69 mm. Comparing the male and female specimens, the male specimens have a prominent coxal spur on the coxa 2 of leg 3–4 and the oviger segment 3–5 are longer than those of the female.

The present species is distributed between Chungcheong-do, Korea and Alaska, US in latitude and 0–180 m at depth range (Müller, 1993).

2. *Achelia bituberculata* Hedgpeth, 1949 등뾰족애기손바다거미 (Figs. 7, 8)

Achelia bituberculata Hedgpeth, 1949:287, fig. 41a–g.—Stock, 1954:94, fig. 44.—Utinomi, 1962:97, fig. 4.—Nakamura & Child, 1983:6; 1991:3.—Kim & Hong, 1986:46.—Hirohito & Nakamura, 1987:18, pl. 16: figs. 1–12.—Turpaeva, 2007a: 108, pl. 11: figs. 1–6; 2007b:1045.—Nakamura, 2009:615.—Kim, 2013:15, figs. 3–4.

Material examined

1 ind. (1 juvenile), DM211, Guryongpo, Pohang, Gyeongsangbuk-do, Korea, 36°01'04.4"N 129°35'08.4"E, 20 m, SCUBA, coll. D. Lee, 18 Nov 2016; 1 ind. (1 juvenile), Jumunjin breakwater, Gangneung, Gangwon-do, Korea, 37°53'24.5"N 128°49'59.4"E, 14 Oct 2003; 1 ind. (1 ♀), DM231, Jumunjin breakwater, Gangneung, Gangwon-do, Korea, 37°53'24.5"N 128°49'59.4"E, 20 Oct 2005; 1 ind. (1 ♀), DM297, Munam dive resort, Goseong, Gangwon-do, Korea, 38°17'48.3"N 128°33'00.1"E, 5 m, SCUBA, coll. D. Lee, 22 Mar 2017; 8 inds. (8 juveniles), Munam dive resort, Goseong, Gangwon-do, Korea, 38°17'48.3"N 128°33'00.1"E, 5 m, SCUBA, coll. D. Lee, 22 Mar 2017; 3 inds. (3 juveniles), Gisamun Barbor, Yangyang, Gangwon-do, Korea, 38°00'28.2"N 128°43'50.5"E, coll. D. Lee, 8 Feb 2018; 1 ind. (1 ♀), DMJJ1810, East of Moonseom Island, Jejudo Island, Korea, 33°13'34.3"N 126°34'09.1"E, 58 m, Trimix SCUBA, coll. D. Lee, 18 Jan 2018.

Diagnosis

Trunk not segmented. Cephalic segment having anterolateral spine. Lateral processes touching each other, having 2–3 dorsodistal tubercles. Ocular tubercle as long as basal width. Proboscis barrel-shaped. Abdomen reaching over distal margin of coxa 1, having 2 strong dorsal tubercles at base. Palp 8-segmented. Chelifore scape having 2 strong dorsal tubercles; chela atrophied. Oviger 10-segmented; reverse spine present at segment 6 in male. Legs stout; propodus having 3 heel spines; auxiliary claws present.

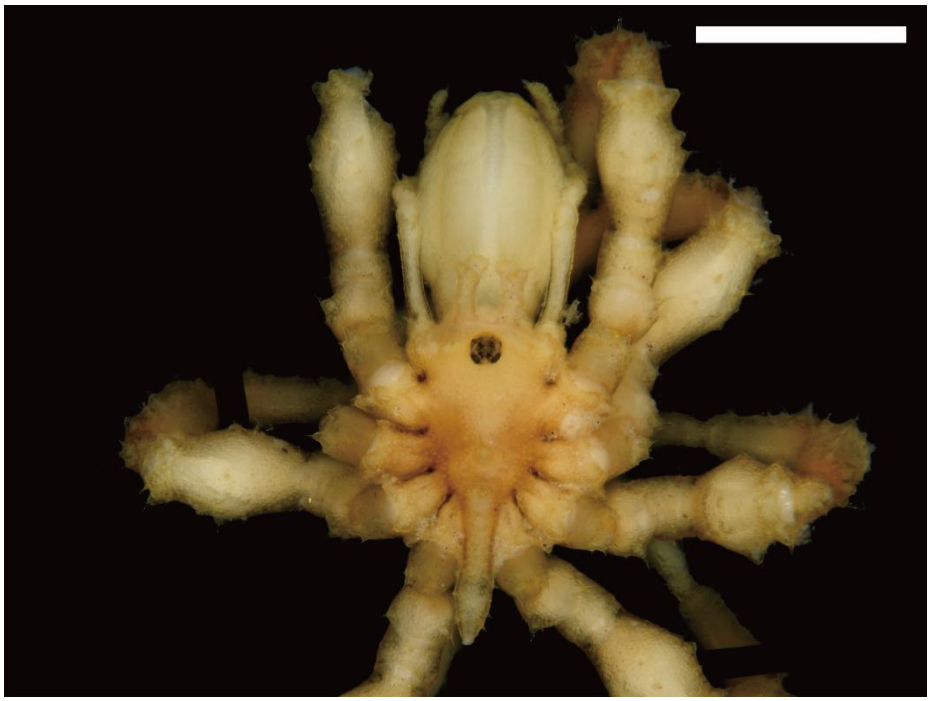


Fig. 7. *Achelia bituberculata*, DM297. Trunk, dorsal view. Scale bar = 1 mm.

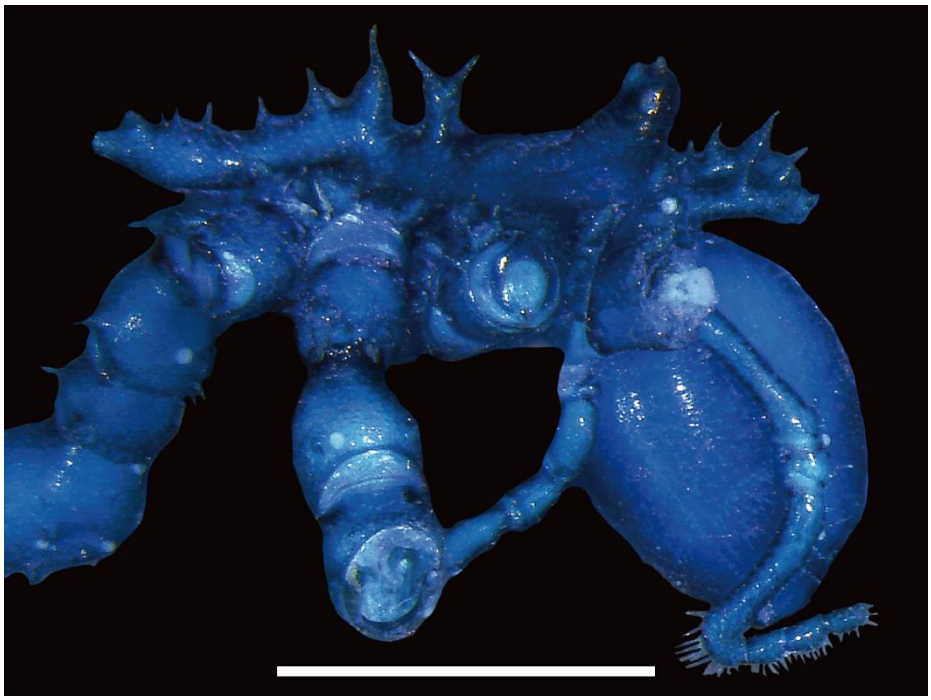


Fig. 8. *Achelia bituberculata*, DMJJ1810. Trunk, lateral view. Scale bar = 1 mm.

Distribution

Korea (Gangwon-do, Gyeongsang-do, Jeolla-do, and Jejudo Island) and Japan (from Honshu to Amakusa Island).

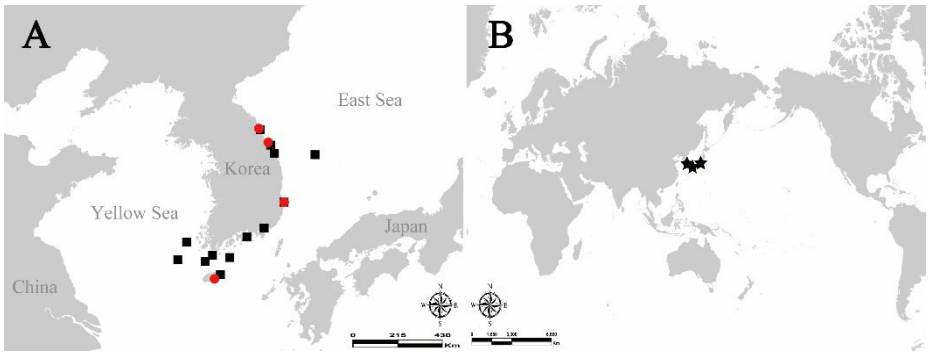


Fig. 9. Distribution of *Achelia bituberculata*. A, Distribution in Korea, ● indicating present study, ■ indicating previous records in Korea (Kim, 2013); B, Distribution in the world, ★ indicating worldwide distribution.

Remarks

The present species is close to *Achelia curticauda* Nakamura, Miyazaki & Child, 1996 and *Achelia kiiensis* Utinomi, 1951. *Achelia curticauda* is distinguished from the present species by having short trunk length (0.65 mm), distinct trunk segmental lines, not ovoid proboscis, abdomen reaching slightly over the lateral process 4, slim tubercles on the lateral processes and the coxa 1, and having scape with round tubercles. *Achelia kiiensis* is different from the present species in the absence of a dorsal tubercle on trunk and scape, and the presence of two heel spines on the propodus.

Achelia ohshimai was synonymized with the present species by Nakamura & Child (1983), but the present study divided the two species as independent taxa. *Achelia bituberculata* is morphologically distinguished from *A. ohshimai* by different number of dorsal tubercles at the abdomen base (Figs. 8, 17B, 17F).

The present species is distributed between Amakusa Island and Gangwon-do in latitude and 0–75 m at depth range (Nakamura & Child, 1991).

3. *Achelia crurispinifera* Kim & Kim, 1985 뿔애기손바다거미 (Fig. 10)

Achelia crurispinifera Kim & Kim, 1985:120, figs. 1–2.—Nakamura & Child, 1991:5.—Kim, 2013:18, figs. 5–6.

Diagnosis

Trunk large, unsegmented. Cephalic segment having 4–6 tubercles on anterior part. Lateral processes touching each other, having 3 tubercles on

dorsodistal margin. Ocular tubercle longer than basal width. Proboscis cylindrical. Abdomen reaching beyond distal margin of coxa 1. Palp 8-segmented. Chelifore scape having dorsal tubercles; chela atrophied. Oviger 10-segmented. Legs having many tubercles; propodus having 6–7 heel spines; auxiliary claw present.

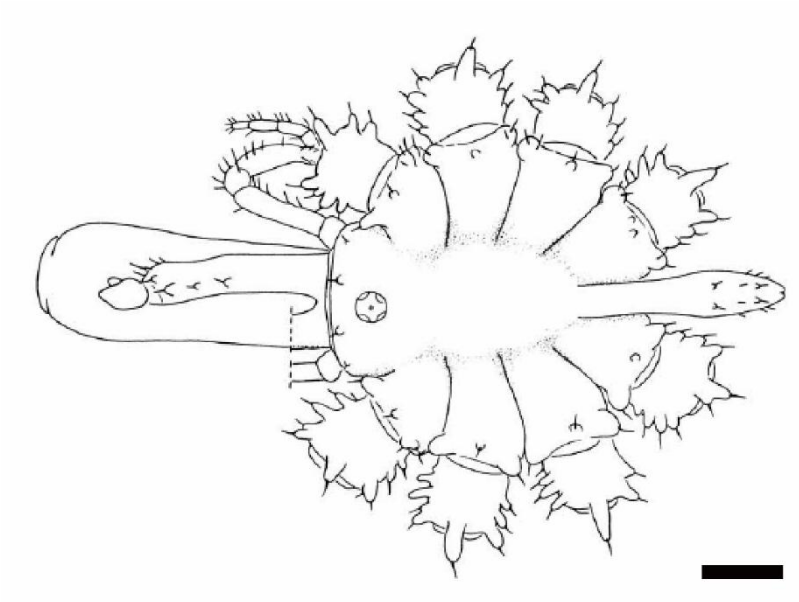


Fig. 10. *Achelia crurispinifera*. Trunk, dorsal view. Scale bar = 1 mm. Modified from Kim (2013).

Distribution

Korea (Gyeongsang-do), Japan (Tsushima Island), and China (Zhoushan Island, Shandong Peninsula)

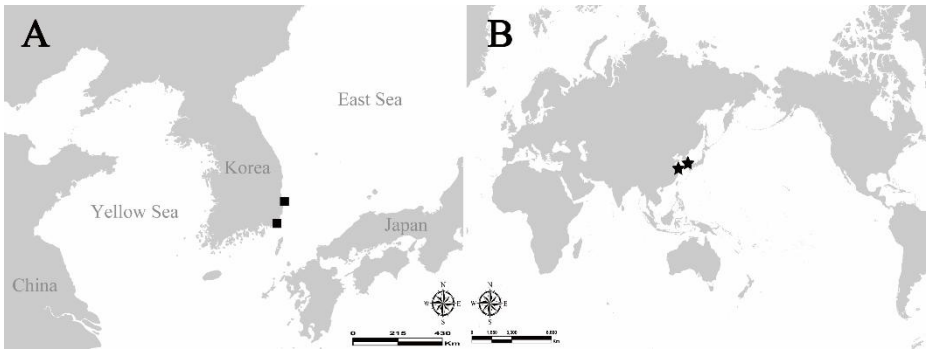


Fig. 11. Distribution of *Achelia crurispinifera*. A, Distribution in Korea, ■ indicating previous records in Korea (Kim, 2013); B, Distribution in world, ★ indicating worldwide distribution.

Remarks

The author has not obtained any specimen of this species. According to Kim & Kim (1985), this species is easily identified by its large body and cylindrical proboscis. Nakamura & Child (1991) extended the distribution of this species to Japan and China, and mentioned the depth range from 59 to 150 m. Despite the very large size (trunk length, 9.6 mm; leg, 38.0–39.0 mm), this species has been rarely reported.

This species is distributed between Zhoushan Island and Shandong Peninsula, China in latitude and 59–150 m at depth range (Nakamura & Child, 1991).

4. *Achelia echinata* Hodge, 1864 가시애기손바다거미 (Fig. 12)

Achelia echinata Hodge, 1864:115, pl. 12: figs. 7–10.

Ammothea fibulifera Dohrn, 1881:141, pl. 4: figs. 1–22.

Ammothea echinata.—Sars, 1891:120, pl. 13: fig. 1a–m.—Calman, 1938:160.

Ammothea (*Achelia*) *echinata*.—Bouvier, 1923:55.

Ammothea (*Achelia*) *echinata* var. *sinensis* Lou, 1936:19, figs. 7–9, pls. 2–4.

Achelia echinata orintalis.—Hedgpeth, 1949:318.—Turpaeva, 2007:113, pl. 13: figs. 1–7.

Achelia echinata.—Stock, 1955:245; 1987:506; 1990:217.—Utionomi, 1935:97.—King, 1974:28, figs. 11–12, 14C.—Bamber, 1997:144.—Kim, 2013:21, figs. 7–8.—Bamber, 2010:74, fig. 119.—Munilla & Soler-Membrives, 2014: 86, figs. 43–44.

Achelia echinata sinensis.—Utinomi, 1971:328.—Kim & Hong, 1986:46.—Hirohito & Nakamura, 1987:19, pl. 17: figs. 1–17.—Hong & Kim, 1987:141.—Nakamura & Child, 1983:7.

Material examined

4 inds. (4 juveniles), Namhyeongjae Island, Busan, Korea, 34°55'54.7"N 128°58'26.4"E, 31 m, SCUBA, coll. D. Lee, 5 Dec 2019; 17 inds. (6 ♂♂, 5 ♀♀, 6 juveniles), Geomundo Island, Yeosu, Jeollanam-do, Korea, 34°01'02.3"N 127°17'36.3"E, 25 m, SCUBA, coll. T. Lee, 9 Jul 2019; 2 juveniles, Chaguido Island, Jejudo Island, Korea, 33°18'39.7"N 126°09'04.0"E, 25 m, SCUBA,

Taekjun Lee, 6 Nov 2000; 8 inds. (2 ♂♂, 6 juveniles), South of Moonseom Island, Jejudo Island, Korea, 33°13'29.7"N 126°33'56.8"E, 30 m, SCUBA, coll. D. Lee, 27 Nov 2018; 9 inds. (2 ♀♀, 7 juveniles), near Baeksangeo Resort, Goseong, Gangwon-do, Korea, 38°21'45.3"N 128°31'27.0"E, 31 m, SCUBA, coll. D. Lee, 22 Nov 2018; 5 inds. (2 ♂♂, 3 ♀♀), Hongdo Island, Sinan, Jeollanam-do, Korea, 20 m, SCUBA, coll. S.k. Lee, 20 Jun 2018; 1 inds. (1 ♂), DM180723, Gajicho Point, Dokdo Island, Korea, 37°15'02.0"N 131°51'57.1"E, 25 m, SCUBA, coll. D. Lee, 16 Jul 2018; 6 inds. (6 ♀♀), Gajicho Point, Dokdo Island, Korea, 37°15'02.0"N 131°51'57.1"E, 25 m, SCUBA, coll. D. Lee, 16 Jul 2018; 9 inds. (1 ♂, 8 juveniles), Reef of Navarone point, Chujado Island, Jejudo Island, Korea, 33°57'21.1"N 126°17'26.8"E, 15 m, SCUBA, coll. D. Lee, 13 Sep 2017.

Diagnosis

Trunk segmented; segment 3–4 fused. Cephalic segment protruding anteriorly, having anterolateral tubercle. Lateral processes touching each other, having two tubercles on dorsodistal margin. Ocular tubercle present at anterior margin of cephalic segment, about 2 times as long as basal width. proboscis thick in two fifth from base, tapering distally like pipette-shape. Abdomen cylindrical, reaching distal margin of coxa 1. Palp 8-segmented; segment 5–8 having many setae on ventral surface. Chelifore present; scape having three dorsal tubercles; chela atrophied. Oviger 10-segmented, without terminal claw; segment 6 having reverse spine in male. Legs long, setose; coxa 1 having four distinct tubercles on dorsal surface; coxa 2 having coxal spur at leg 3–4 in male; femur having cement gland tube on dorsodistal margin in male; propodus having 3–4 heel spines; auxiliary claws present.

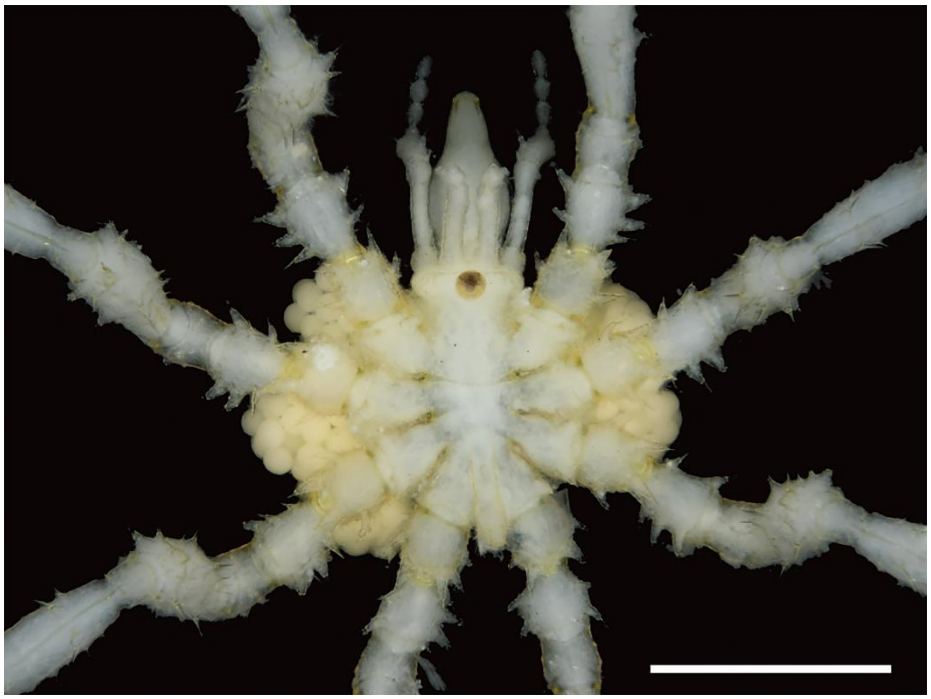


Fig. 12. *Achelia echinata*, DM180723. Trunk, dorsal view. Scale bar = 1 mm.

Distribution

Korea (Gangwon-do, Gyeongsang-do, Jeolla-do, Chungcheong-do, and Jejudo Island) and boreal waters (North Atlantic, Mediterranean and Northwest Pacific).

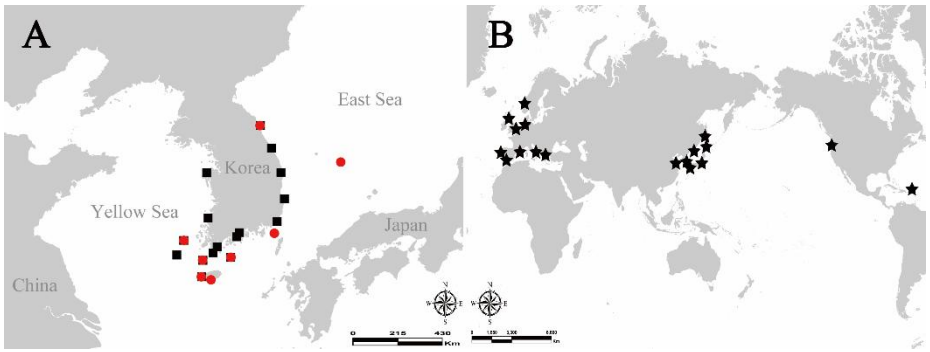


Fig. 13. Distribution of *Achelia echinata*. A, Distribution in Korea, ● indicating present study, ■ indicating previous records in Korea (Kim, 2013); B, Distribution in world, ★ indicating worldwide distribution.

Remarks

The present species is close to *Achelia langi* (Dohrn, 1881) and *Achelia vulgaris* (Costa, 1861) having similar shape of proboscis and distinct dorsal tubercles on the coxa 1. *Achelia langi* has ovoid proboscis and a dorsal tubercle on the posterodistal margin of the lateral processes, while the present species has pipette-shaped proboscis and two dorsal tubercles on the dorsodistal margin of the lateral processes. The present species is distinguished from *A. vulgaris* by the followings: (1) The palp segment 8 is slightly longer than segment 7 (much longer in *A. vulgaris*). (2) The coxa 2 has two tubercles on the lateral surface (three tubercles). (3) The tibia 2 is about 4 times as long as broad (about 7 times as long as broad).

The present species is distributed in boreal waters (North Atlantic, Mediterranean and Northwest Pacific) and between 0–336 m at depth range (Müller, 1993).

5. *Achelia latifrons* (Cole, 1904) 털보애기손바다거미 (Figs. 14, 15)

Ammothea latifrons Cole, 1904:263, pl. 11: fig. 3, pl. 16: figs. 1–9, pl. 17: figs. 1–3.—Schmitt, 1934:68.—Hilton, 1942b:295, pl. 41.—Hilton, 1943:93.

Achelia latifrons.—Stock, 1954:96.—Kim, 2013:24.

Material examined

1 ind. (1 juvenile), NHMD 652670, Korean coast, Washed from Sertularella, 60–100 fathoms, coll. Suenson, 1882; 2 inds. (1 ♀, 1 juvenile), USNM 173719, Aleutian Island, Alaska, US, 51°55'12.0"N 176°34'12.0"W, Hand-pick, coll. J. Rosewater, 8 Jun 1979; 8 inds. (1 ♂, 7 inds.), USNM 80898, Aleutian Islands, Alaska, US, 51°57'00.0"N 17°27'00.0"E, 16–27 m, coll. W.H. Dall, Jul 1873.

Description

Juvenile. Trunk disk-shaped, unsegmented, without dorsal tubercle. Anterior part of cephalic segment in in rectangular shaped, having tubercle on anterolateral margin (Fig. 14A).

Lateral processes about 1.7 times as long as basal width, widening distally, touching each other, having three tubercles with spine at tip on dorsodistal margin (Fig. 14A, 14B).

Ocular tubercle present at anterior margin of cephalic segment, about 1.3 times as long as basal width, having slightly conical tip; four eyes pigmented, present at top of ocular tubercle (Fig. 14B).

Proboscis ovoid, broad at middle, tapering distally, subequal to trunk length (Fig. 14A, 14B).

Abdomen not articulated, slightly widening distally, broad at two third from base, tapering distally, not reaching beyond distal margin of coxa 2, having four dorsal spines at base, dorsal spine on middle, and two dorsal spines at two third from base (Fig. 14A, 14B).

Palp 5-segmented, having many setae. Segment 2 longest. Distal four segments missing (Fig. 14D).

Chelifore 2-segmented, as long as proboscis in dorsal view. Scape about 3.3 times as long as basal width, having tubercles with spine at top on dorsal surface. Chela in juvenile stage, having fingers. (Fig. 14A, 14B)

Oviger 5-segmented, incompletely developed. Segment tapering distally, growing (Fig. 14E).

Leg 3 having many long spines (Fig. 14F). Coxa 1 about 1.5 times as long as basal width, having three dorsal tubercles with spine at tip; median tubercle longer than other tubercles (Fig. 14C). Coxa 2 elongated, about 2.5 times as long as basal width. Coxa 3 about 1.3 times as long as basal width. Femur about 3.5 times as long as basal width, having long tubercle with spines at dorsodistal margin. Tibia 1 about 5 times as long as basal width, longer than femur, having many long spines on dorsal surface. Tibia 2 about 5 times as long as basal width, longer than tibia 1 and femur, having many long spines on dorsal surface. Tarsus short, having spine on dorsal surface and 6–8 spines on ventral surface. Propodus curved, with spines on dorsal surface, having two heel spines and 8–10 sole spines. Main claw curved, about 0.45 times as long as propodus. Auxiliary claws about 0.67 times as long as main claw.

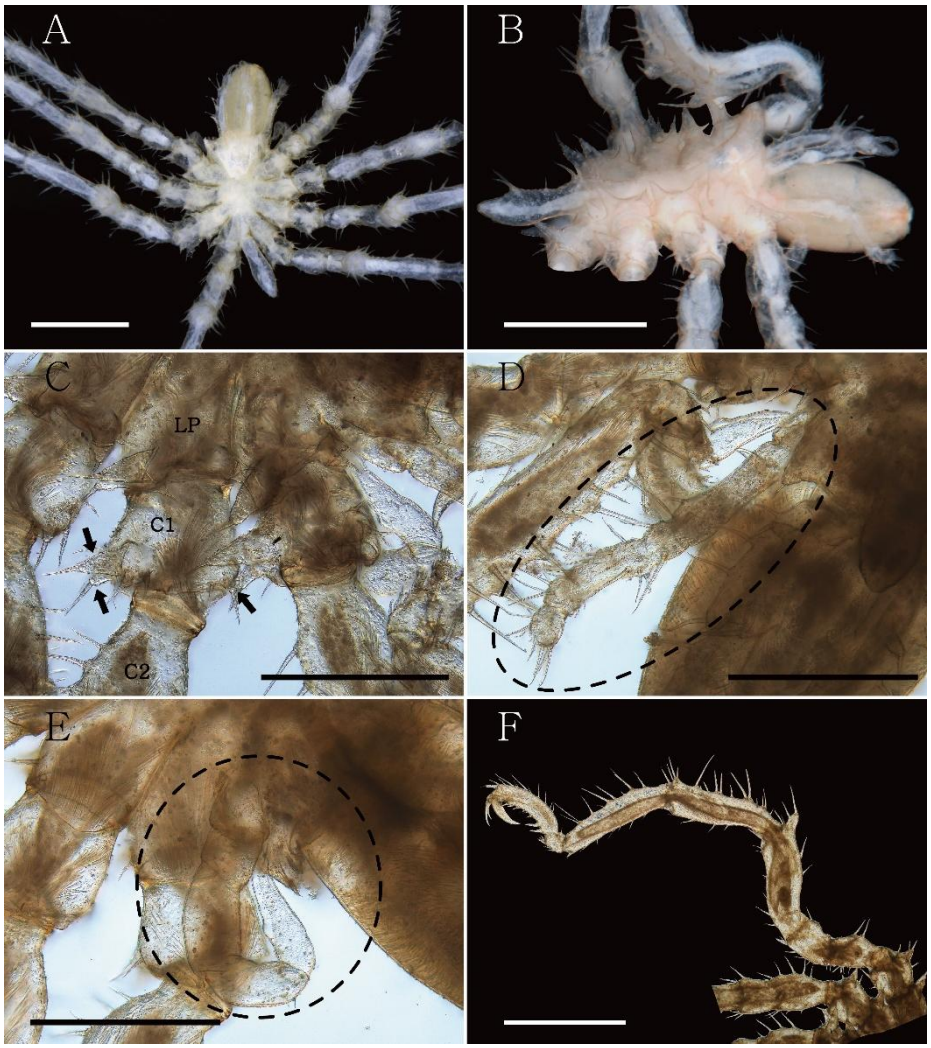


Fig. 14. *Achelia latifrons*, NHMD 652670 (juvenile). A, Trunk, dorsal view; B, Trunk, lateral view; C, Coxa 1, arrows indicating tubercles; D, Palp; E, Oviger; F, Leg 3. LP = Lateral process, C1 = Coxa 1, C2 = Coxa 2. Scale bars = 1 mm (A, B, F), 0.5 mm (C–E).

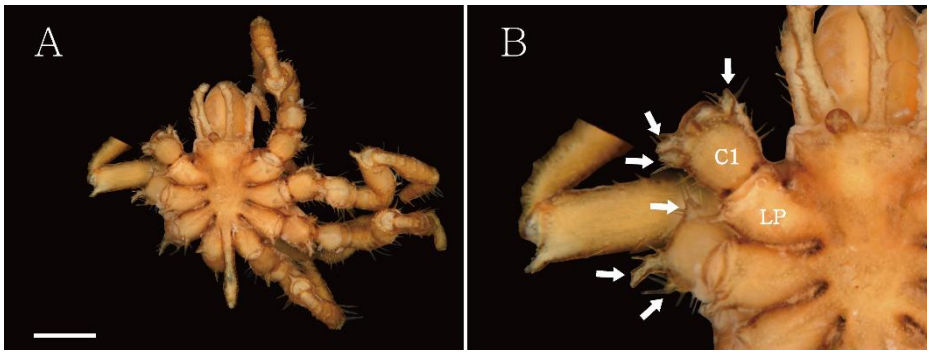


Fig. 15. *Achelia latifrons*, USNM 80898 (male). A, Trunk, dorsal view; B, Coxa 1, arrows indicating tubercles. LP = Lateral process, C1 = Coxa 1. Scale bar = 1 mm.

Measurements (mm)

NHMD 652670, trunk length, 1.17; width, 1.09; proboscis, 1.08; abdomen, 0.93. Leg 3; coxa 1, 0.30; coxa 2, 0.46; coxa 3, 0.30; femur, 0.85; tibia 1, 0.91; tibia 2, 0.95; tarsus, 0.16; propodus, 0.58; main claw, 0.27; auxiliary claw, 0.18.

Distribution

Korea, Bering Sea, Alaska, and California.

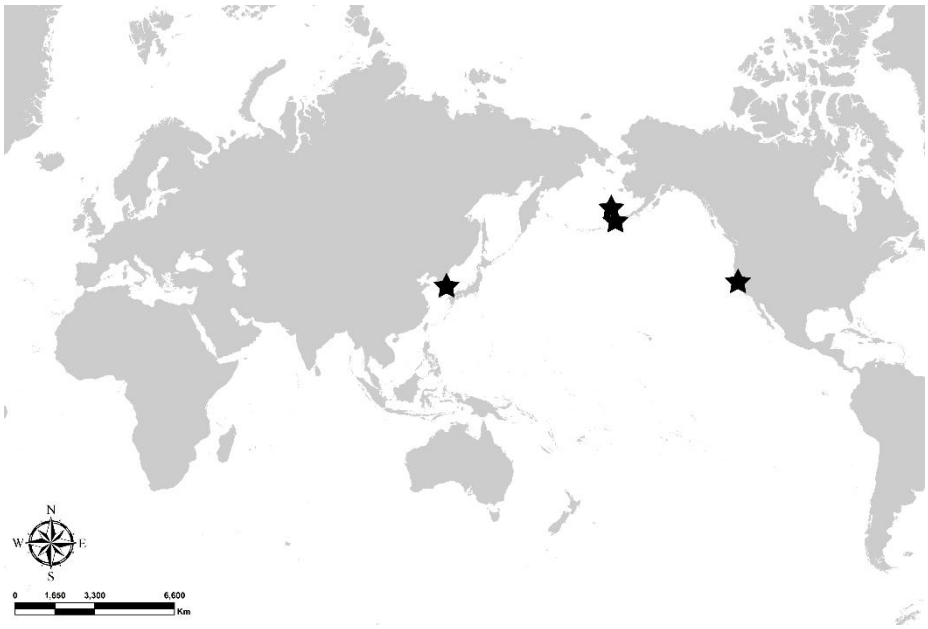


Fig. 16. Distribution of *Achelia latifrons* in the world. ★ indicating worldwide distribution. Korean distritubion recorded by Stock (1954).

Remarks

In 1954, Stock reported a juvenile of *A. latifrons* collected in Korean coast. He noted that this juvenile specimen was fit to the original description and noted that the difference was only to have more spiny lateral processes. Because close species, *A. orpax*, was the first discovered in 1983, it was necessary to confirm that there may be errors in the identification by Stock (1954). To confirm the identification, NHMD 652670 was borrowed from the National History Museum of Denmark and was re-examined. *Achelia latifrons* has three tubercles on the dorsodistal surface of the coxa 1 and simple spines on appendages (Fig. 15A, 15B), while *A. orpax* has a dorsal tubercle on the posterodistal margin of the coxa 1 and compound spins on appendags. Although

NHMD 652670 is in the juvenile stage, it fits in the descriptions of *A. latifrons*. Therefore, Stock's (1954) identification is correct. Since there are no distal four segments of the palp and the ovigers are not fully developed, it is difficult to provide detailed descriptions of these appendages.

The record of collection site of NHMD 652670 indicated only "Korean coast" and the author have not obtained the exact information of collection site.

6. *Achelia ohshimai* Utinomi, 1951 (Fig. 17)

Achelia ohshimai Utinomi, 1951:163, fig. 2; 1954:18, fig. 8; 1971:330.

Achelia bituberculata.—Kim, 2013: 15, fig. 3A–B.

Material examined

1 ind. (1 ♀), DM191017, Intertidal zone of Bijindo Island, Tongyeong, Gyeongsangnam-do, Korea, 34°43'01.1"N 128°27'37.4"E, hand-pick, coll. D. Lee, 29 Oct 2019; 1 ind. (1 ♀), DM227, Jumunjin breakwater, Gangneung, Gangwon-do, Korea, 37°53'24.5"N 128°49'59.4"E, 14 Oct 2013.

Description

Trunk disk-shaped, unsegmented, without dorsal tubercle, widening anteriorly in lateral view. Anterior part of cephalic segment in rectangular shape, having tubercle next to ocular tubercle and on anterolateral margin (Fig. 17A, 17B).

Lateral processes about 2 times as long as basal width, widening distally, touching each other, having three tubercles at dorsodistal and posterodistal margin; posterodorsal tubercle larger than anterodorsal tubercle, having spine on tip (Fig. 17A).

Ocular tubercle present at anterior margin of cephalic segment, as long as basal width, having small tubercle on anterodorsal margin; four eyes big, pigmented (Fig. 17B).

Proboscis barrel-shaped, broad at middle, about 0.8 times as long as trunk length (Fig. 17A, 17C).

Abdomen not articulated, cylindrical, tapering distally, reaching distal margin of coxa 2, having strong tubercle at base with spine on tip and many spines on dorsal surface (Fig. 17A, 17B, 17F).

Palp 8-segmented (Fig. 17C). Segment 2 as long as segment 4. Segment 5 about 1.2 times as long as basal width, having many setae on ventral surface. Segment 6–7 short, swollen ventrally, having many setae on ventral surface. Terminal segment elongated, about 3 times as long as basal width, having many setae.

Chelifroe 2-segmented, about 0.45 times as long as proboscis in dorsal view (Fig. 17A, 17C). Scape broad at base, tapering distally, about 2.4 time as long as basal width, having low dorsal tubercle with spine on tip at middle and distinct process with spines on dorsodistal margin. Chela atrophied to globular shape, having spine on anterior margin.

Oviger 10-segmented, short (Fig. 17D). Segment 2–3 subequal. Segment 4 longest in oviger segments. Terminal segment short, globular. Strigilis having compound spines with 6–7 teeth, arranged in 3:2:1:2.

Leg 3 setose (Fig. 17E). Coxa 1 as long as basal width, having three tubercles on dorsodistal margin. Coxa 2 about 1.8 times as long as basal width, swollen at dorsal and ventral surface, having three setae on ventrodistal surface. Coxa 3 as long as basal width, having setae on ventral surface. Femur subequal

to tibia 1, about 3.4 times as long as basal width, bearing dorsodistal tubercle with seta on tip, having low dorsal projection and distinct ventral swelling with setae. Tibia 1 shorter than femur and tibia 2, about 3 times as long as basal width, with two short setae on ventrodistal margin, having two proximal tubercles and low distal tubercle with setae on dorsal surface. Tibia 2 about 4 times as long as basal width, with many short setae on ventral surface, having 4–5 tubercles and setae on dorsal surface. Tarsus short, convex ventrally with many setae. Propodus curved, with many setae on dorsal surface, having three heel spines and 10–11 sole spines. Main claw curved, about half times as long as propodus. Auxiliary claws about 0.58 times as long as main claw.

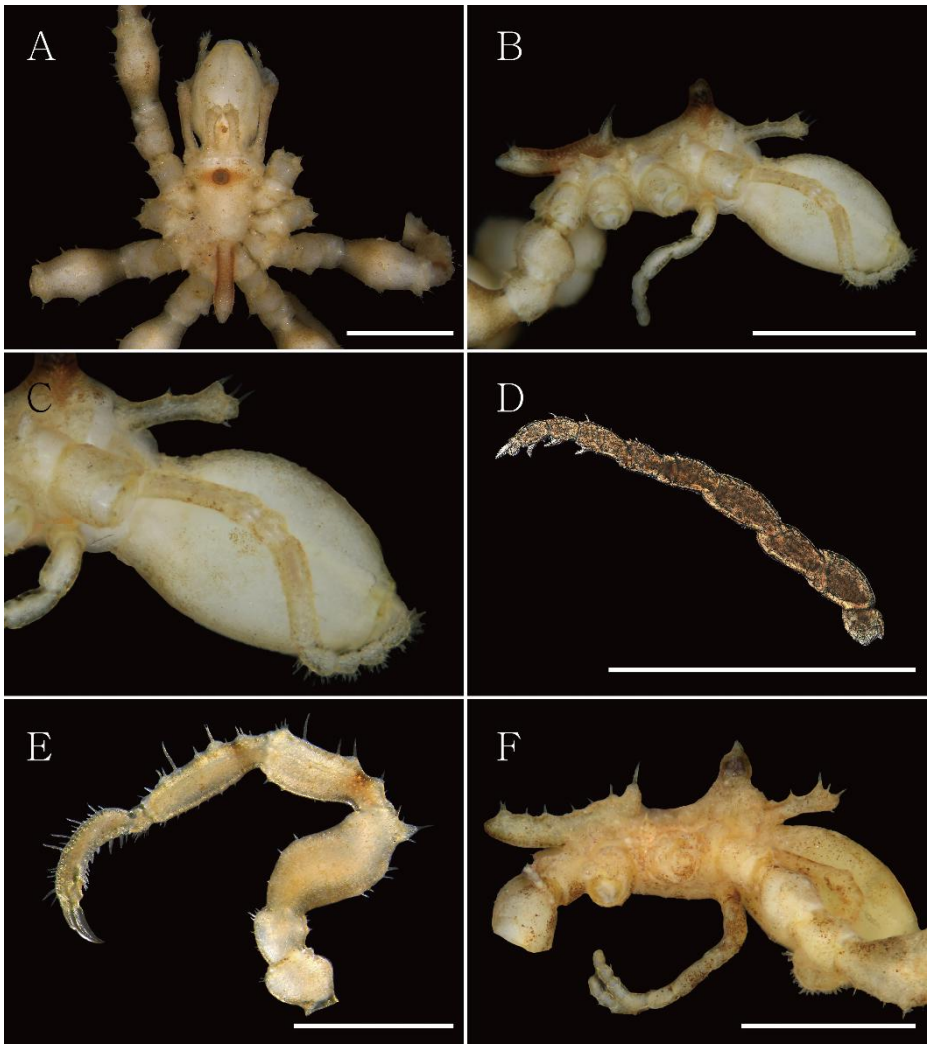


Fig. 17. *Achelia ohshimai*, DM191017 (female, A–E), DM227 (female, F). A, Trunk, dorsal view; B, Trunk, lateral view; C, Palp and chelifore, lateral view; D, Oviger; E, Leg 3; F: Trunk, lateral view. Scale bars = 1 mm (A, B, D–F).

Measurements (mm)

DM191017, trunk length, 1.18; width, 1.09; proboscis, 0.95; abdomen, 0.72. Leg 3; coxa 1, 0.27; coxa 2, 0.35; coxa 3, 0.32; femur, 0.84; tibia 1, 0.75; tibia 2, 0.82; tarsus, 0.16; propodus, 0.63; main claw, 0.31; auxiliary claw, 0.18.

Distribution

Korea (Gangwon-do and Gyeongsang-do) and Japan (Tanabe Bay and Hokkaido).

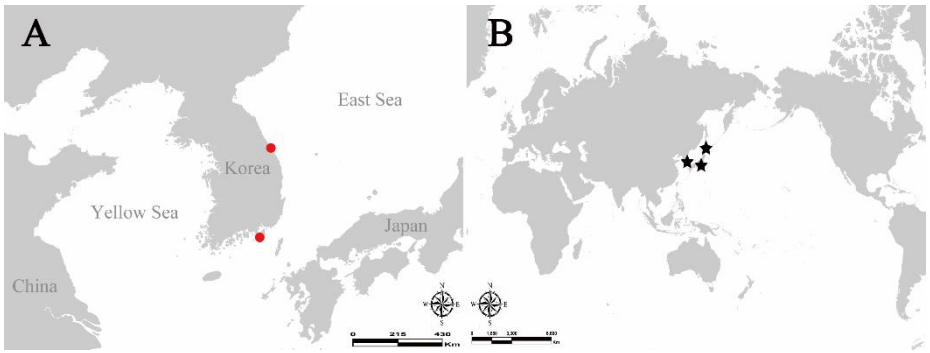


Fig. 18. Distribution of *Achelia ohshimai*. A, Distribution in Korea, ● indicating present study; B, Distribution in the world, ★ indicating worldwide distribution.

Remarks

Achelia ohshimai was synonymized with *A. bituberculata* by Nakamura & Child (1983) considering the different number of dorsal tubercles at the abdomen base as a variation.

Through field surveys, two specimens were collected from Bijindo Island and Jumunjin breakwater. Their dorsal tubercle was only one at the abdomen

base (Fig. 17B, 17F). By comparing mtCOI DNA barcodes, the two specimens were separated from other specimens of *A. bituberculata* and the two clades were differed by 14.1 % (Fig. 19). When checked with NCBI data, the 14.0 % of difference was sufficient to separate the two taxa into independent groups (Table 4, 5). Therefore, *Achelia ohshimai* should return to the species and dorsal tubercles at the abdomen base are considered a characteristic not a variation.

The examined specimens have three tubercles on distal margin of the lateral processes and the strigilis has compound spines arranged in 3:2:1:2, while in original description, there were two tubercles on the lateral processes and compound spines on the strigilis were arranged in 2:1:1:2. The number of spines on the abdomen is various and the compound spines on the strigilis have 6–7 teeth.

The present species is distributed between the Tanabe Bay and the Hokkaido in latitude and collected only at the intertidal zone (Utinomi, 1971).

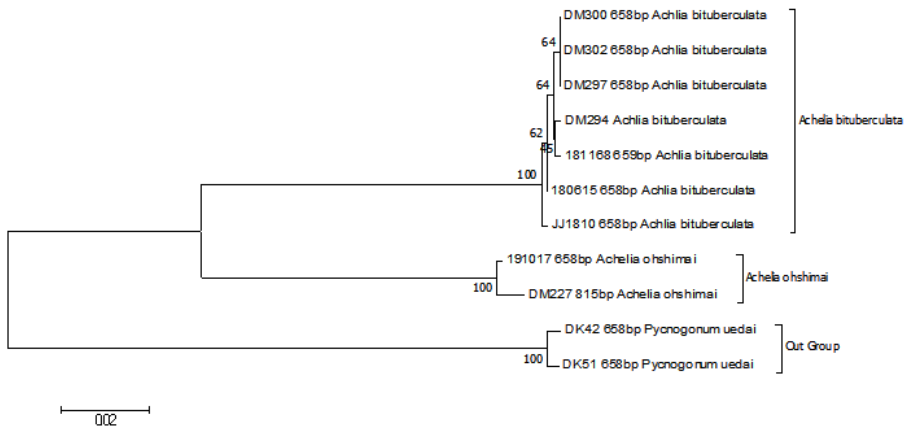


Fig. 19. Phylogenetic tree of *Achelia ohshimai* and *Achelia bituberculata* resolved by Neighbor-Joining method based on mtCOI DNA barcodes.

Table 4. List of species used in comparing genus *Achelia*

No.	Species	Voucher	Accession No.	Database	No.	Species	Voucher	Accession No.	Database
1	*Achelia bituberculata*	DM294	-	Present study	2	*Achelia bituberculata*	DM297	-	Present study
3	*Achelia bituberculata*	DM300	-	Present study	4	*Achelia bituberculata*	DM302	-	Present study
5	*Achelia bituberculata*	DMJJ1810	-	Present study	6	*Achelia bituberculata*	DM180615	-	Present study
7	*Achelia bituberculata*	DM181168	-	Present study	8	*Achelia ohshimai*	DM191017	-	Present study
9	*Achelia ohshimai*	DM227	-	Present study	10	*Achelia echinata*	DM30	-	Present study
11	*Achelia echinata*	DM82	-	Present study	12	*Achelia echinata*	DM180723	-	Present study
13	*Achelia orpax*	NIBRIV0000227042	-	Present study	14	*Achelia orpax*	DM295	-	Present study
15	*Achelia orpax*	DM180407	-	Present study	16	*Achelia spatula*	DM200201	-	Present study
17	*Achelia gracilis*	-	MK411053.1	GenBank	18	*Achelia gracilis*	-	MK411197.1	GenBank
19	*Achelia sawayai*	-	MK411051.1	GenBank	20	*Achelia sawayai*	-	MK411195.1	GenBank
21	*Achelia hispida*	-	FJ862875.1	GenBank	22	*Achelia hoekii*	-	DQ390046.1	GenBank
23	*Achelia nana*	-	KX535354.1	GenBank	24	*Achelia boschi*	-	KX535401.1	GenBank
25	*Achelia boschi*	-	KX535415.1	GenBank	26	*Achelia boschi*	-	KX535438.1	GenBank
27	*Achelia mixta*	-	KX535421.1	GenBank	28	*Achelia assimilis*	-	KF603908.1	GenBank
29	*Achelia assimilis*	-	KF603909.1	GenBank	30	*Achelia assimilis*	-	KF603910.1	GenBank

Table 5. Comparison of Pairwise Distances (%) between *Achelia* species

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29
1																													
2	0.4																												
3	0.4	0.0																											
4	0.4	0.0	0.0																										
5	0.7	0.7	0.7	0.7																									
6	0.4	0.4	0.4	0.4	0.4																								
7	0.4	0.4	0.4	0.4	0.7	0.4																							
8	14.5	14.3	14.3	14.3	14.0	14.0	14.3																						
9	15.2	14.9	14.9	14.9	14.7	14.7	14.9	0.9																					
10	23.7	23.4	23.4	23.4	22.6	23.1	23.7	21.1	21.1																				
11	23.7	23.4	23.4	23.4	22.6	23.1	23.7	21.1	21.1	0.0																			
12	23.7	23.4	23.4	23.4	22.6	23.1	23.7	20.9	20.9	0.2	0.2																		
13	24.3	24.5	24.5	24.5	24.8	24.8	24.5	24.8	25.0	27.5	27.5	27.3																	
14	24.5	24.8	24.8	24.8	25.0	25.0	24.8	25.3	25.5	27.6	27.6	27.3	0.4																
15	24.5	24.8	24.8	24.8	25.1	25.1	24.8	25.0	25.3	27.8	27.8	27.5	0.2	0.5															
16	20.4	20.4	20.4	20.4	19.9	19.9	20.4	20.2	20.2	21.9	21.9	21.9	16.5	16.1	16.8														
17	30.3	29.7	29.7	29.7	29.4	29.7	30.3	27.1	27.3	27.1	27.1	27.1	27.3	27.5	27.5	25.1													
18	30.3	29.7	29.7	29.7	29.4	29.7	30.3	27.1	27.3	27.1	27.1	27.1	27.3	27.5	27.5	25.1	0.0												
19	28.0	27.7	27.7	27.7	27.2	27.5	27.8	27.4	27.4	23.6	23.6	23.8	28.0	27.8	28.3	24.8	16.5	16.5											

20	27.5	26.9	26.9	26.9	26.7	26.9	27.2	27.7	27.7	23.3	23.3	23.6	28.0	27.8	28.3	25.1	16.1	16.1	0.9										
21	19.0	19.0	19.0	19.0	18.8	18.5	18.8	19.5	19.3	21.8	21.8	22.0	23.4	23.6	23.7	20.9	31.2	31.2	28.6	29.1									
22	19.9	20.4	20.4	20.4	20.2	20.2	20.2	18.3	18.1	21.4	21.4	21.4	22.4	22.4	22.6	18.8	29.0	29.0	24.9	24.6	17.2								
23	19.7	19.5	19.5	19.5	19.5	19.5	19.5	15.8	15.6	15.0	15.0	15.0	23.8	23.6	24.1	18.8	25.8	25.8	23.3	23.0	18.9	15.1							
24	23.7	23.4	23.4	23.4	23.2	23.4	23.4	23.2	23.7	21.5	21.5	21.5	25.9	25.8	25.6	22.0	27.2	27.2	25.4	25.4	25.3	21.7	18.9						
25	23.5	23.2	23.2	23.2	23.0	23.2	23.2	23.2	23.2	20.7	20.7	20.7	25.6	25.6	25.3	21.7	25.9	25.9	24.3	24.3	25.3	20.9	18.4	2.2					
26	23.7	23.4	23.4	23.4	23.2	23.5	23.5	23.4	23.4	20.7	20.7	20.7	25.6	25.6	25.4	21.7	25.9	25.9	24.1	24.1	25.3	20.9	18.4	1.8	0.4				
27	20.2	19.9	19.9	19.9	19.7	19.7	20.2	18.1	18.4	20.9	20.9	21.2	20.0	19.8	20.3	15.6	26.4	26.4	25.4	25.9	20.2	18.1	19.7	21.0	20.8	21.3			
28	16.9	16.9	16.9	16.9	16.2	16.5	16.7	14.5	14.5	20.2	20.2	20.2	21.4	21.6	21.6	18.5	26.4	26.4	26.9	26.6	20.0	17.8	15.1	22.2	21.5	22.0	17.6		
29	16.9	16.9	16.9	16.9	16.2	16.5	16.7	14.5	14.5	20.2	20.2	20.2	21.4	21.6	21.6	18.5	26.4	26.4	26.9	26.6	20.0	17.8	15.1	22.2	21.5	22.0	17.6	0.0	
30	16.9	16.9	16.9	16.9	16.2	16.5	16.7	14.5	14.5	20.2	20.2	20.2	21.4	21.6	21.6	18.5	26.4	26.4	26.9	26.6	20.0	17.8	15.1	22.2	21.5	22.0	17.6	0.0	0.0

7. *Achelia orpax* Nakamura & Child, 1983 남방털보애기손바다거미 (Fig. 20)

Achelia orpax Nakamura & Child, 1983:8, fig. 2; 1991:5, fig. 1g–h.—Kim, 2013:24, figs. 9–10.

Achelia latifrons.—Kim & Hong, 1986:46, fig. 8.—Turpaeva, 2007a:109, pl. 10: figs. 13–15.

Material examined

1 ind. (1 ♂), DM295, Munam dive resort, Goseong, Gangwon-do, Korea, 38°17'48.3"N 128°33'00.1"E, rinsing sea grass, 5m, SCUBA, coll. D. Lee, 22 Mar 2017; 1 ind. (1 juvenile), DM180407, Molar point, In to the sea resort, Yangyang, Gangwon-do, Korea, 37°52'04.8"N 128°50'59.4"E, 17 m, SCUBA, coll. D. Lee, 18 Apr 2018; 1 ind. (1 ♂), NIBRIV0000227042, Songjiho Beach, Goseong, Gangwon-do, Korea, rinsing algae, 15 m, SCUBA, coll. Y. Eun, T. Park, & C. Lee, 16 Sep 2010

Diagnosis

Trunk unsegmented. Cephalic segment having anterolateral tubercle. Lateral processes touching each other, having two tubercles on dorsodistal margin. Ocular tubercle longer than basal width. Proboscis barrel-shaped. Abdomen reaching beyond distal margin of coxa 2. Palp 8-segmented, having feather-shaped spines. Chelifore having feather-shaped spines; chela atrophied. Oviger 10-segmented, having feather-shaped spines. Legs having feather-shaped spines; coxa 1 having dorsal tubercle on posterodistal margin; propodus

having three heel spines; auxiliary claws present.

Fig. 20. *Achelia orpax*, NIBRIV0000227042. Trunk, dorsal view. Scale bar = 1 mm.

Distribution

Korea (Gangwon-do, Chungcheong-do, Jeolla-do) and Japan (near Sagami Bay)

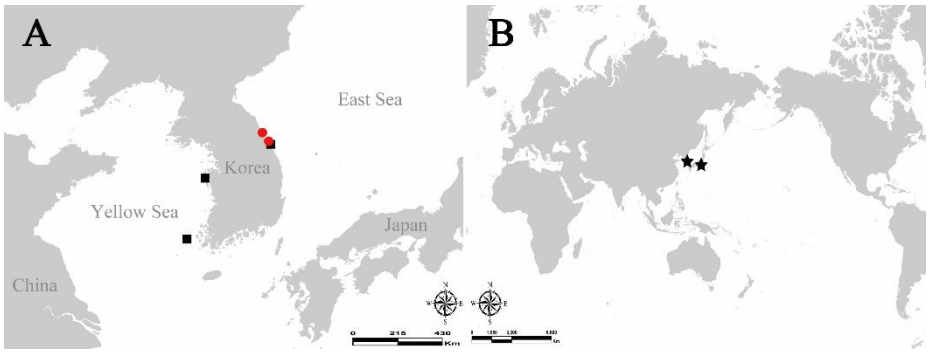


Fig. 21. Distribution of *Achelia orpax*. A, Distribution in Korea, ● indicating present study, ■ indicating previous records in Korea (Kim, 2013); B, Distribution in the world, ★ indicating worldwide distribution.

Remarks

The present species is close to *Achelia kurilensis* Losina-Losinsky, 1961 and *A. latifrons* by having ovoid proboscis, hairy body, lateral processes touching each other, and long abdomen. *Achelia kurilensis*, however, differs from the present species in having short ratio of chelifore to proboscis, long palp segments, less hairy palp and chelifore, and more curved propodus. *Achelia latifrons* is very similar, but distinguished by the followings: (1) All spines on appendages are feather-shaped form (simple spines in *A. latifrons*). (2) Only one tubercle is present on the dorsodistal surface of the coxa 1 (three tubercles). (3) The propodus is less curved (more curved).

Nakamura & Child (1983) reported *A. orpax* as a new species and they compared this species with *A. latifrons* (Nakamura & Child, 1991). Kim & Hong was previously identifying 1 male specimen collected in Hongdo Island as *A. latifrons*, but accepted Nakamura & Child's opinions and revised it to *A. orpax*.

The juvenile specimen has some different appearances from the adult specimens. The chela is present in the juvenile stage. Incomplete oviger consists of 2-segments. The ocular tubercle has a conical ornament on tip. The coxa 1 has little spines and a strong tubercle on the coxa 1. Although there are some differences between the adult and juvenile stage, the juvenile specimen was easily identified to *A. orpax* having ovoid proboscis, long abdomen and a tubercle on the dorsodistal margin of the coxa 1. It is also supported by Pairwise Distance comparison of DNA barcodes (COI region) having little difference between the adult and juvenile specimens (Table 6).

The present species is distributed between Gangwon-do and Jeolla-do in latitude (Kim, 2013) and the present study extends depth range at 5–30 m.

Table 6. *Achelia orpax*. Pairwise Distance comparison (%)

		1	2
1	DM295 (♂)		
2	DM180407 (juvenile)	0.3	
3	NIBRIV0000227042 (♂)	0.3	0

8. *Achelia spatula* Nakamura & Child, 1983 (Figs. 22, 23)

Achelia spatula Nakamura & Child, 1983:10, fig. 3.

Material examined

1 ind. (1 ♂), DM200201, South of Jukdo Island, Goseong, Gangwon-do, Korea, 38°20'01.6"N 128°32'07.2"E, rinsing sea grass, 12m, SCUBA, Ye Eun, Taeseo Park, 17 May 2012.

Description

Trunk unsegmented, having spines, without dorsal tubercle (Figs. 22A, 23A). Anterior part of cephalic segment in rectangular shape, having laterodistal tubercle with spine on tip (Fig. 22C).

Lateral processes 3 times as long as basal width, widening distally, touching each other (Figs. 22A, 23A). Two tubercles present on dorsodistal margin, having spine on tip and lateral surface; posterior tubercle larger than anterior tubercle (Figs. 22B, 23C).

Ocular tubercle present at anterior part of cephalic segment, 0.7 times as high as basal width, having conical tip leaning slightly forward; four eyes pigmented, present at middle of ocular tubercle (Figs. 22B, 23C).

Proboscis in barrel shape, heading downward, about 0.8 times as long as trunk length (Figs. 22B, 23C).

Abdomen not articulated, reaching over distal margin of coxa 1, having round tip in dorsal view and rectangular tip with setae in lateral view (Fig. 22A, 23B).

Palp 8-segmented (Fig. 22B, 22C). Segment 2 and 4 subequal in length. Segment 5 slightly expanded ventrally, having 5 small spatulated spines on ventrodistal margin. Segment 6 about 2.6 times as long as basal width, having small spatulated spines ventrodistally. Segment 7 about 3.4 times as long as basal width, having small spatulated spines on dorsal and ventral surface. Terminal segment 3.7 times as long as basal width, having many small spatulated spines at distal margin.

Chelifore 2-segmented (Fig. 23C). Scape 4.5 times as long as basal width, 3 times as long as chela, having distinct tubercle on dorsodistal margin and small spatulated spines on distal margin. Chela atrophied, connected to scape through joint (Fig. 22A, 22B); palm having two small spines on lateroventral surface; movable finger faintly distinguished.

Oviger 10-segmented, having spatulated spines on all segments (Figs. 22D,

23B). Segment 2 having two small spines on inner distal margin, wider than segment 3–10. Segment 3 longest, having 10 small spines on outer surface. Segment 4 slightly longer than segment 2, having small spines on inner and outer surface. Segment 5 subequal to segment 2, swollen on posterodistal margin, having many spines at inner proximal margin and eight small spines on outer surface. Terminal segment having two spines distally.

Leg 3 having many spatulated spines (Fig. 22E). Coxa 1 having three spines on anterior and posterior surface; three tubercles present on dorsodistal margin of which anterior tubercle having two spines and middle tubercle largest with spine on tip. Coxa 2 about 2.5 times as long as basal width, having four spines on dorsal surface, 5–7 spines on lateral surface, and coxal spur on ventrodistal margin which as long as coxa 2 diameter. Coxa 3 as long as coxa 1, having spines on ventral and ventrodistal surface, two spines on dorsodistal margin. Femur 4.5 times as long as basal width, longer than tibia, having dorsodistal tubercle with spine on tip, bearing small cement gland on posterior surface of tubercle (Figs. 22E, 23D). Tibia 1 about 4.5 times as long as basal width, having spine on dorsal surface and dorsodistal tubercle with many spines. Tibia 2 about 5.8 times as long as basal width, as long as tibia 1, having spines on dorsal surface and ventrodistal margin, without dorsal tubercle. Tarsus short, convex ventrally, having spines on ventrodistal margin and spine on dorsal margin. Propodus curved, having eight dorsal spines, three heel spines, and 19 sole spines, bearing distinct distal tubercle with spines. Main claw curved, about half length of propodus. Auxiliary claws 0.6 times as long as main claw.

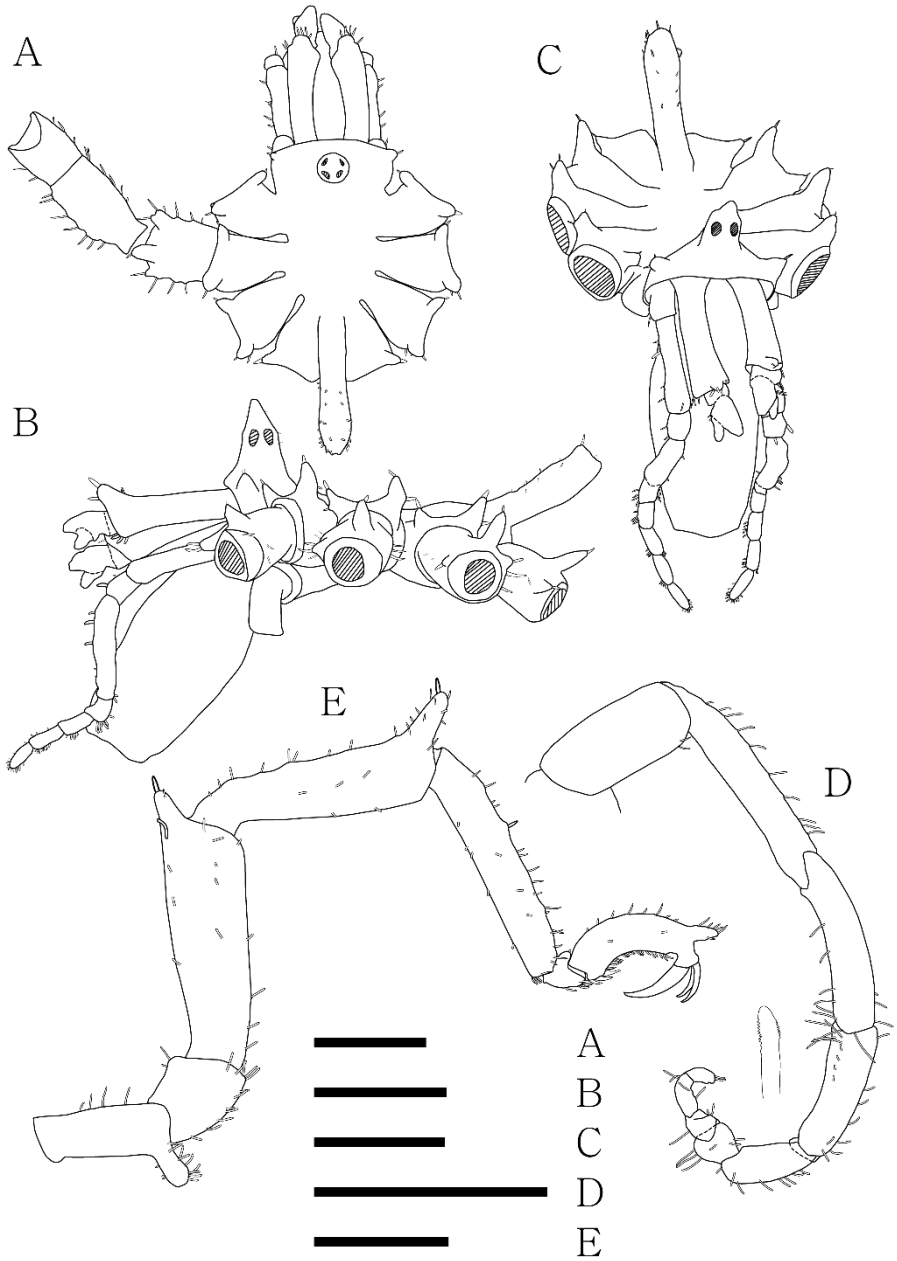


Fig. 22. *Achelia spatula*. A, trunk, dorsal view; B, trunk, lateral view; C, trunk, anterodorsal view; D, oviger with spatulated spine; E, leg 3, lateral view. Scale bars = 1 mm (A–E).

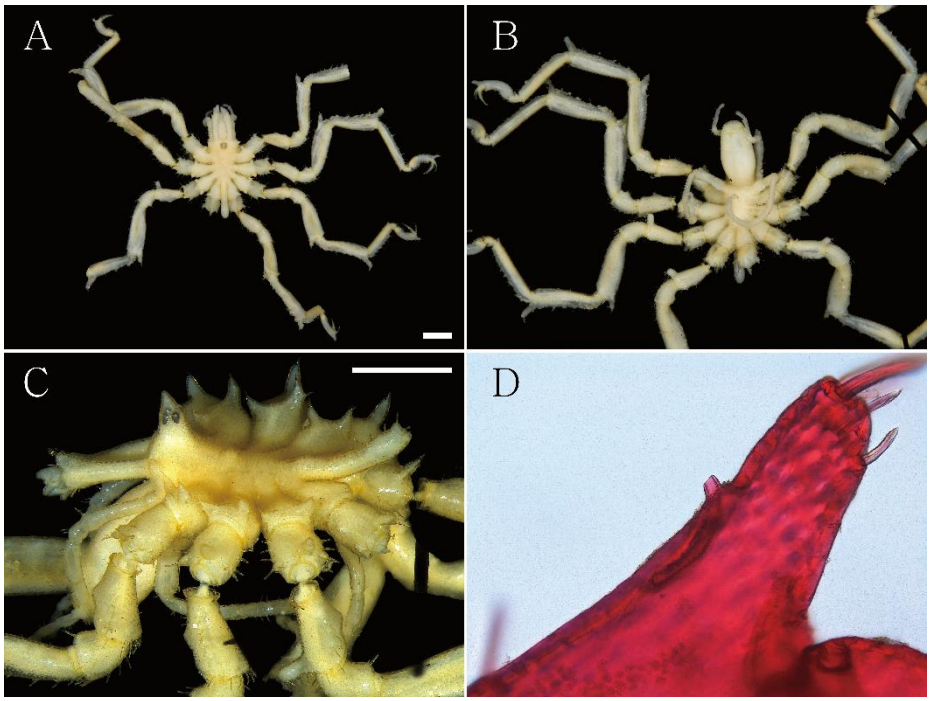


Fig. 23. *Achelia spatula*. A, trunk, dorsal view; B, trunk, ventral view; C, trunk, lateral view; D, cement gland in leg 4. Scale bars = 1 mm (A, C).

Measurements (mm)

Trunk length, 2.16; width, 2.10; proboscis, 1.82; abdomen, 0.88. Leg 3; coxa 1, 0.60; coxa 2, 1.00; coxa 3, 0.64; femur, 1.82; tibia 1, 1.73; tibia 2, 1.74; tarsus, 0.31; propodus, 1.05; main claw, 0.47; auxiliary claw, 0.29.

Distribution

Korea (Gangwon-do) and Japan (Type locality: Sagami Bay).

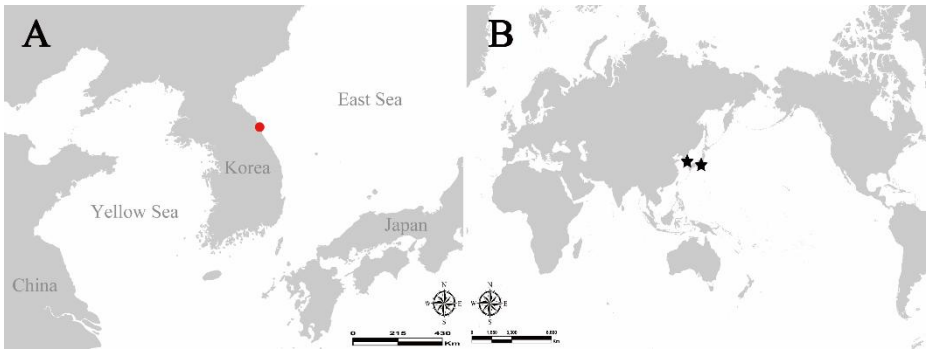


Fig. 24. Distribution of *Achelia spatula*. A, Distribution in Korea, ● indicating present study; B, Distribution in the world, ★ indicating worldwide distribution.

Remarks

The present species is similar to *Achelia harrietae* Marcus, 1940 and *Achelia spinoseta* (Hilton, 1939), but easily distinguished by having a distinct distal tubercle on propodus.

The examined material is the second specimen of the present species after the holotype was found, and the first specimen having entire body, since the holotype lost the distal part of the abdomen. Comparing with the original description, the examined material has distinct conical tip on the ocular tubercle (Figs. 22B, 23C) and larger dorsal tubercles on the lateral processes (Fig. 22B). The chela is atrophied, but fingers are clearly distinguished (Fig. 22B). The palp has more spines than the original description (Fig. 22B). The trunk is longer than the holotype (1.86 mm).

The present species is distributed in Gangwon-do and Sagami Bay, Japan and between 7–15 m at depth range (Nakamura & Child, 1983).

Genus *Ammothea* Leach, 1814 술병부리바다거미속

Diagnosis

Trunk fully segmented, with or without dorsomedian tubercle. Lateral processes separated clearly. Ocualr tubercle distinct with pigmented eyes. Palp 6–9 segmented. Chelifore lacking or 1 to 2-segmented; chela lacking or atrophied bumps, rarely functional. Oviger 10-segmented; strigilis having simple or complex spines. Cement gland present on dorsodistal surface of femur. Auxiliary claw distinct. Predominantly found in Antarctic and Subantarctic regions.

Type species

Ammothea carolinensis Leach, 1814

Key to the *Ammothea* species in Korean waters.

1. Scape distinct. Tibia 2 longer than tibia 1. Propodus with distinct apophysis on dorsodistal part ..... *A. hedgpethi*

- Chelifore reduced to bump. Tibia 2 as long as tibia 1. Propodus without apophysis on dorsodistal part ..... *A. hilgendorfi*

9. *Ammothea hedgpethi* (Utinomi, 1959) 작은술병부리바다거미 (Figs. 25, 26)

Lecythorhynchus sp. Hedgpeth, 1949:296, fig. 44e–f.

Lecythorhynchus hedgpethi Utinomi, 1959:212, figs. 7–9; 1962:103; 1971:336.

Ammothea hedgpethi.—Clark, 1977:173.—Hong & Kim, 1987:142, fig. 2.—Hirohito & Nakamura, 1987:23, pl. 19: figs. 1–12, pl. 20: figs. 1–7.—Nakamura & Child, 1991:6.—Kim, 2013:27, figs. 11–12.

Material examined

1 inds. (1 ♀), DM180989, Guryongpo, Pohang, Gyeongsangbuk-do, Korea, 36°00'48.0"N 129°35'19.4"E, 30 m, SCUBA, coll. D. Lee, 20 Sep 2018; 2 inds. (2 juveniles), Guryongpo, Pohang, Gyeongsangbuk-do, Korea, 36°00'48.0"N 129°35'19.4"E, 30 m, SCUBA, coll. D. Lee, 20 Sep 2018; 1 ind. (1 juvenile), Somaemuldo Island, Tongyeong, Gyeongsangnam-do, Korea, 20 m, SCUBA, coll. S.K. Lee, 9 Jul 2017; 1 ind. (1 juvenile), DM180616, East of Moonseom Island, Jejudo Island, Korea, 33°13'35.4"N 126°34'09.2"E, 55 m, Trimix SCUBA, coll. J.H. Park, 20 Jun 2018.

Diagnosis

Trunk fully segmented. Lateral processes glabrous, separated by less than diameter. Ocular tubercle as long as basal width. Proboscis cylindrical. Abdomen cylindrical. Palp 9-segmented. Chelifore present; chela atrophied. Oviger 10-segmented. Legs long, having short setae; tibia 1 shorter than tibia 2; propodus having four heel spines, distal apophysis; auxiliary claws present.

Fig. 25. *Ammothea hedgpethi*, DM180989. Trunk, dorsal view. Scale bar = 2 mm.

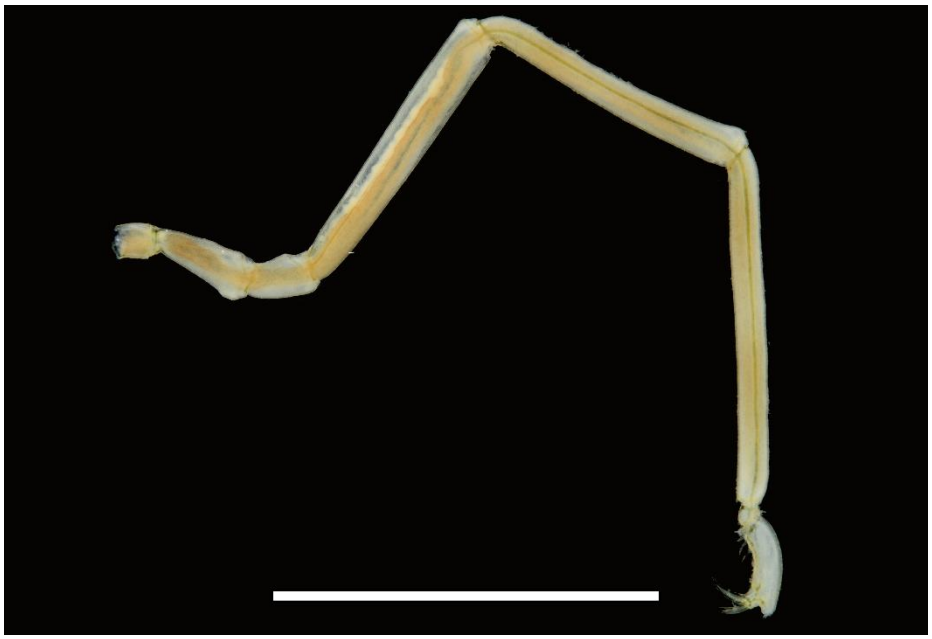


Fig. 26. *Ammothea hedgpethi*, DM180989. Leg 3, lateral view. Scale bar = 5 mm.

Distribution

Korea (Gangwon-do, Gyeongsang-do, Jeolla-do, and Jejudo Island) and Japan (Sagami Bay).

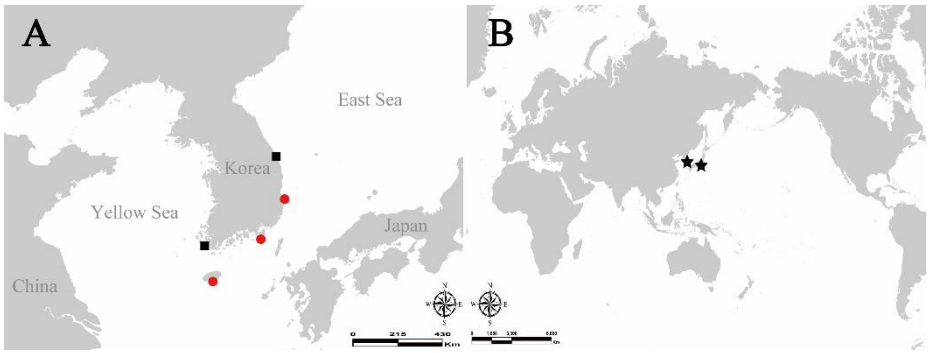


Fig. 27. Distribution of *Ammothea hedgpethi*. A, Distribution in Korea, ● indicating present study, ■ indicating previous records in Korea (Kim, 2013); B, Distribution in the world, ★ indicating worldwide distribution.

Remarks

Ammothea hedgpethi and A. hilgendorfi are morphologically close. Comparing *A. hedgpethi* with *A. hilgendorfi*, the present species has larger body, longer legs, and distinct chelifores. In addition, the tibia 2 is longer than the tibia 1 (Fig. 26) and the propodus has an apophysis on dorsodistal part. Both species in the juvenile stage are morphologically very close, making it difficult to distinguish them with size and existence of an apophysis at the propodus, but the ratio of the tibiae is still useful. Unlike *A. hilgendorfi*, the present species is not commonly found.

Unlike the original description, examined material have abdomen with blunt tip in lateral view and little long setae on the femur and tibia, which is

noted by Hong & Kim (1987). Nakamura & Child (1991) mentioned a pair of prominent lateral setae on the femur, but Utinomi (1959) and Hong & Kim (1987) didn't noted them. The author also can't observe these features on the examined material.

The present species is distributed between Gangwon-do and Jejudo Island in latitude and 8–95 m at depth range (Müller, 1993).

10. *Ammothea hilgendorfi* (Böhm, 1879) 술병부리바다거미 (Fig. 28)

Corniger Hilgendorfi Böhm, 1879a:187, taf. 2: fig. 3a–d.

Lecythorhynchus Hilgendorfi.—Böhm, 1879b:140.—Loman, 1911:8, taf. 2: figs. 28–29.

Lecythorhynchus hilgendorfi.—Ohshima, 1927:610, figs. 1–3.—Hedgpeth, 1949:296, fig. 44a–b.—Utinomi, 1951:166.

Lecythorhynchus marginatus Cole, 1904:260, pl. 11: figs. 1–2, pl. 15: figs. 1–8.—Losina-Losinsky, 1933:61.—Hedgpeth, 1949:296, fig. 44c–d.—Turpaeva, 2007a:114, pl. 15: figs. 1–7.

Lecythorhynchus marginatum.—Stock, 1954:139, fig. 69.

Lecythorhynchus ovatus Hilton, 1942c:54, fig. 10a–b.

Ammothea hilgendorfi.—Child, 1979:8.—Krapp & Sconfietti, 1983:124, figs. 3–4.—Nakamura & Child, 1983:13; 1991:6.—Bamber, 1985: 269, fig. 1; 2010:82, fig. 123.—Kim & Hong, 1986:48.—Hong & Kim, 1987:143.—Kim, 2013:30, fig. 13.

Material examined

3 inds. (1 ♂, 2 juveniles), Gamji Beach, Busan, Korea, 35°03'33.4"N 129°04'39.0"E, 8 m, SCUBA, coll. D. Lee, 4 Dec 2019; 9 inds. (2 ♂♂, 1 ♀, 6 juveniles), Intertidal zone of Bijindo Island, Tongyeong, Gyeongsangnam-do, Korea, 34°43'01.1"N 128°27'37.4"E, beneath rocks, coll. D. Lee, 29 Oct 2019; 1 ind. (1 juvenile), DM190806, North of Moonseom Island, Jejudo Island, Korea, 33°13'40.3"N 126°34'04.0"E, 52 m, Trimix SCUBA, coll. D. Lee, 16 Aug 2019; 1 ind. (1 ♂), DMJS34, Daeyu breakwater, Geumodo Island, Yeosu, Jeollanam-do, Korea, light trap, coll. D. S.H. Kim, 28 Jun 2017; 1 ind. (1 juvenile), DM190716, Geomundo Island, Yeosu, Jeollanam-do, Korea, 25 m, SCUBA, coll. T. Lee, 9 Jul 2019; 2 inds. (1 ♂, 1♀), Gaeyado Island, Gunsan, Jeollabuk-do, Korea, SCUBA, coll. S.H. Lee, 6 Aug 2015; 1 inds. (1 ♂), DM108, Gamji Beach, Busan, Korea, 35°03'33.4"N 129°04'39.0"E, 7 m, SCUBA, coll. D. Lee, 22 Sep 2016; 5 inds. (1 ♂, 4 ♀♀), Gamji Beach, Busan, Korea, 35°03'33.4"N 129°04'39.0"E, 11 m, SCUBA, coll. D. Lee, 23 Sep 2016; 1 ind. (1 juvenile), five element point, White Shark resort, Goseong, Gangwon-do, Korea, 38°22'16.3"N 128°31'21.3"E, 28 m, SCUBA, coll. D. Lee, 20 Nov 2018; 3 inds., Jukdo Island, Ulleungdo Island, Korea, 37°31'37.9"N 130°56'23.7"E, 29 m, SCUBA, coll. D. Lee, 28 Jul 2016; 4 inds. (1 ♀, 3 inds.), Chujado Island, Jejudo Island, Korea, 33°59'16.8"N 126°14'47.9"E, 18 m, SCUBA, coll. D. Lee, 12 Sep 2017; 2 inds. (1 ♂, 1 juvenile), dock at East Island of Dokdo, Korea, 37°14'22.6"N 131°52'00.6"E, 10 m, night SCUBA, coll. D. Lee, 17 Jul 2018; 3 inds. (2 ♂♂, 1 juvenile), Lahyeon-ri, Geoje, Gyeongsangnam-do, Korea, 34°48'40.0"N 128°42'17.0"E, coll. S.H. Kim, 4 Jul 2017; 14 inds. (5 ♂♂, 4♀♀, 5 juveniles), Nambumin breakwater, Busan, Korea, 35°05'09.7"N 129°01'36.4"E, coll. S.H. Lee, 10 Apr 2019; 2 inds. (2 juveniles), Ieodo Island, Jejudo Island, Korea, 32°07'22.6"N 125°10'56.8"E, fish trap, coll. S.H. Lee, 8 Jun 2016.

Diagnosis

Trunk fully segmented. Lateral processes glabrous, separated by less than diameter. Ocular tubercle conical, as long as basal width. Proboscis cylindrical. Abdomen cylindrical. Palp 9-segmented. Chelifore reduced to bud. Oviger 10-segmented. Legs having short setae; tibia 1 as long as tibia 2; propodus having five heel spines without apophysis; auxiliary claws present.

Fig. 28. *Ammothea hilgendorfi*, DM108. Trunk, dorsal view. Scale bar = 1 mm.

Distribution

Korea (Gangwon-do, Gyeongsang-do, Jeolla-do, Chungcheong-do, Gyeonggi-do, and Jejudo island), the Pacific Ocean (from China to Mexico), South Africa, UK, and Mediterraneans.

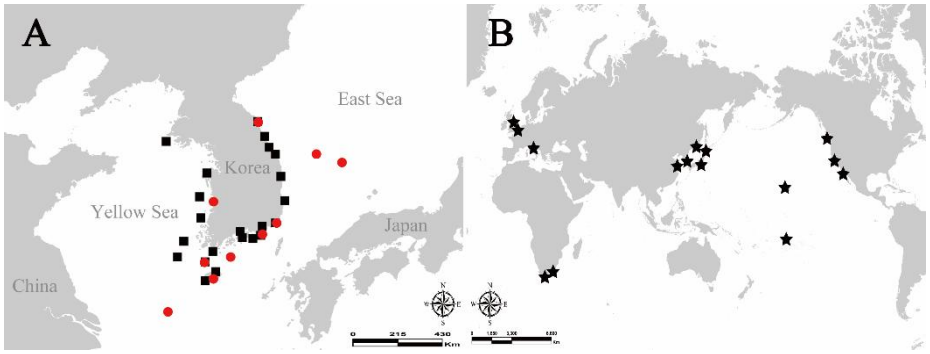


Fig. 29. Distribution of *Ammothea hilgendorfi*. A, Distribution in Korea, ● indicating present study, ■ indicating previous records in Korea (Kim, 2013); B, Distribution in the world, ★ indicating worldwide distribution.

Remarks

As mentioned before, the present species is morphologically similar to *A. hedgpethi*, but distinguished by having smaller trunk, shorter legs, and bud chelifores. The tibia 2 is as long as the tibia 1 and an apophysis on propodus is less distinct.

Comparing male and female specimens, the trunk length of male is 2.42–2.73 mm (mean: 2.47 mm), which is slightly longer than that of female of 1.82–2.52 mm (mean: 2.24 mm). In male specimens, the oviger segment 7 is swollen. The cement gland is present on the dorsodistal surface of the femur and the gonopores exist on the only ventral surface of the coxa 2 of leg 4. Unlike male

specimens, female specimens are distinguished by the presence of the gonopores on the ventral surface of the coxa 2 of all legs and the absence of cement gland and swollen oviger segment 7. Regardless of the gender, the chelifore ratio of length to width varies from 1:1 to 2:1. Connection angle and shape between the palp segment 5 and 6 segment are various among the examined species. This variation was used to distinguish *Lecythorhynchus hilgendorfi* and *L. marginatus*, which were synonymized with *A. hilgendorfi*.

The present species living in the Pacific Ocean has been transferred to the Mediterranean (Krapp & Sconfietti, 1983) and UK waters (King, 1974, Bamber, 1985) through ship-hull fouling on international trade.

Genus *Ammothella* Verrill, 1900 긴손접시바다거미속

Diagnosis

Trunk segmented or partially segmented, thin with many setae and spines. Abdomen long. Palp 9-segmented. Chelifore 3-segmented; chela atrophied. Oviger 10-segmented; strigilis with compound spines. Legs long and slender.

Type species

Ammothella rugulosa Verrill, 1900

Key to the *Ammothella* species in Korean waters.

1. Main claw vestigial, much shorter than auxiliary claw ..... *A. biunguiculata*

- Main claw distinct, larger than auxiliary claw 2

2. Lateral processes with two dorsolateral setae, without tubercle ..... *A. indica*

- Lateral processes with many, feather-shaped setae, having dorsal tubercle ..... *A. monotuberculata*

11. *Ammothella biunguiculata* (Dohrn, 1881) 꼬마긴손접시바다거미 (Fig. 30)

Ammothea bi-unguiculata Dohrn, 1881:158, pl. 80: figs. 1–3.—Ohshima, 1927:611, fig. 4.

Ammothea (*Ammothella*) *bi-unguiculata*.—Bouvier, 1923:52, figs. 49–49a.

Ammothella bi-unguiculata var. *californica* Hall 1912:93, fig. 50; 1913:130.

Ammothella bi-unguiculata var. *fusca* Hilton, 1942c:50, fig. 7; 1943:97.

Ammothella bi-unguiculata var. *australiensis* Williams, 1940:197, figs. 1–3.

Ammothella bi-unguiculata.—Hedgpeth, 1941:259, pl. 10.—Hilton, 1942b:297, pl. 42.

Ammothella biunguiculata biunguiculata.—Clark, 1963:63, fig. 31A–D.

Ammothella biunguiculata australiensis Clark, 1963:63, fig. 31E–H.

Ammothella biunguiculata.—Stock, 1968b:14, fig. 6; 1974:12, fig. 1.—Utinomi, 1971:330.—Nakamura & Child, 1983:17; 1991:6.—Kim & Hong, 1986:48.—Hong & Kim, 1987:143, fig. 3.—Kim, 2013:33, fig. 14.—Munilla & Soler-Membrives, 2014:97, figs. 50–51.

Material examined

1 ind. (1 ♂), Hongdo Island, Sinan, Jeollanam-do, Korea, 10 m, SCUBA, coll. S.K. Lee, 19 Jun 2018; 4 inds. (4 ♂♂), DM191031–34, Intertidal zone of Bijindo Island, Tongyeong, Gyeongsangnam-do, Korea, 34°43'01.1"N 128°27'37.4"E, hand-pick, coll. D. Lee, 29 Oct 2019; 21 inds. (1 ♀, 20 inds.), dock at East Island of Dokdo Island, Korea, 37°14'22.6"N 131°52'00.6"E, 10 m, night SCUBA, coll. D. Lee, 17 Jul 2018; 10 inds. (3 ♂♂, 7 inds.), Ttongnyeo point, Dokdo Island, Korea, 37°14'44.2"N 131°52'07.8"E, 17 m, SCUBA, coll. D. Lee, 18 Jul 2018; 3 inds. (3 juveniles), dock at East Island of Dokdo Island, Korea, 37°14'22.8"N 131°51'57.0"E, 10 m, night SCUBA, coll. D. Lee, 10 Jun 2016; 2 inds., Heukdomgul cave point, West Island of Dokdo Island, Korea, 37°14'22.1"N 131°51'54.4"E, 17 m, SCUBA, coll. D. Lee, 17 Jul 2018.

Diagnosis

Trunk fully segmented. Lateral processes glabrous, separated by less than diameter. Ocular tubercle low. Proboscis spindle-shaped. Abdomen directing horizontally, reaching beyond distal margin of coxa 1. Palp 9-segmented. Chelifore 3-segmented; scape 1 short; chela atrophied. Oviger 10-segmented. Legs having short setae; propodus without heel spines; main claw tiny; auxiliary claws present.

Fig. 30. *Ammothella biunguiculata*, DM191031. Trunk, dorsal view. Scale bar = 1 mm.

Distribution

Korea (Gyeongsang-do and Jeolla-do), tropical and temporate regions.

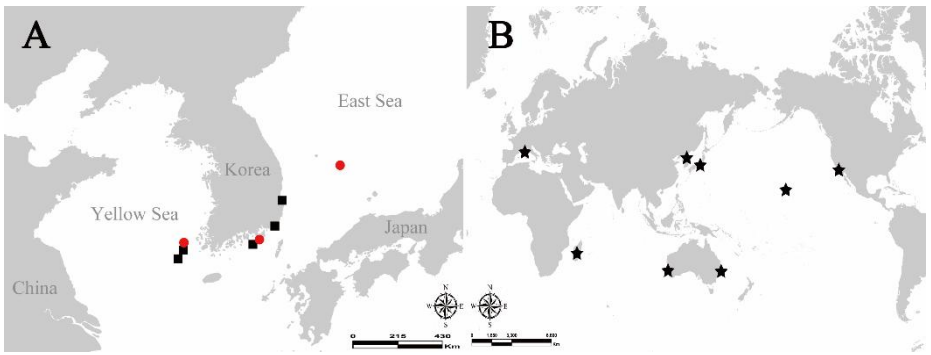


Fig. 31. Distribution of *Ammothella biunguiculata*. A, Distribution in Korea, ● indicating present study, ■ indicating previous records in Korea (Kim, 2013); B, Distribution in the world, ★ indicating worldwide distribution.

Remarks

In the past, the present species was divided into four subspecies based on various shapes of palps, chelifores, and ovigers. Stock (1974) examined material found in California, Hawaii, and Madagascar and synonymized all subspecies with *A. biunguiculata* treating the differences as variations.

The present species has vestigial main claw, which is a conspicuous characteristic among *Ammothella* species.

The present study extends distribution of the Nouthern Limit Line of the present species to Dokdo Island. The present species is distributed between 0–135 m at depth range (Clark, 1963).

12. *Ammothella indica* Stock, 1954 남방긴손접시바다거미 (Fig. 32)

Ammothella indica Stock, 1954:113, figs. 54–55, 56c, 57a–c; 1994:27; 1974:13.—Utinomi, 1959:203, figs. 2–3; 1971:331.—Child, 1970:292; 1988a:51; 1988b:5; 2002:1806.—Nakamura & Child, 1983:18.—Kim & Hong, 1986:48.—Hirohito & Nakamura, 1987:26, pl. 22: figs. 1–8, pl. 23: figs. 1–6.—Müller, 1992a:156.—Kim, 2013:35, fig. 15.

Material examined

3 inds. (1 ♂, 1 ♀, 1 juvenile), dock at East Island of Dokdo, Korea, 37°14'22.8"N 131°51'57.0"E, 10 m, night SCUBA, coll. D. Lee, 10 Jun 2016; 1 ind., Moonseom Island, Jejudo Island, Korea, SCUBA, coll. D. Lee, Aug 2016; 17 inds. (17 juveniles), Gamji Beach, Busan, Korea, 35°03'35.3"N

129°04'28.2"E, 7 m, SCUBA, coll. D. Lee, 22 Sep 2016; 16 inds. (16 juveniles), near Gamji Beach, Busan, Korea, 35°03'33.1"N 129°04'11.5"E, 11 m, SCUBA, coll. D. Lee, 23 Sep 2016; 6 inds. (6 juveniles), Anemone point, Seopsum Island, Jejudo Island, Korea, 33°13'46.1"N 126°35'46.6"E, 15 m, SCUBA, coll. D. Lee, 13 Oct 2016; 1 inds. (1 juvenile), Jumunjin, Gangneung, Gangwon-do, Korea, 23 Nov 2004; 2 inds. (2 juveniles), Dolsando Island, Yeosu, Jeollanam-do, Korea, 19 Nov 2003; 2 inds. (2 juveniles), Kal Hotel point, Seoguipo, Jejudo Island, 33°14'36.9"N 126°34'55.1"E, 3 m, SCUBA, coll. D. Lee, 8 Jan 2017; 1 ind. (1 juvenile), Anemone point, Seopsum Island, Jejudo Island, Korea, 33°13'46.1"N 126°35'46.6"E, 15 m, SCUBA, coll. D. Lee, 12 Apr 2017; 4 inds. (4 juveniles), Jikgudo island, Jejudo Island, Korea, 33°59'16.8"N 126°14'47.9"E, 18 m, SCUBA, coll. D. Lee, 12 Sep 2017; 1 ind. (1 juvenile), Intertidal zone of Sacheonjin Harbor, Yangyang, Gangwon-do, Korea, 37°50'08.8"N 128°52'38.5"E, hand-pick, coll. D. Lee, 9 Feb 2018; 1 ind. (1 juvenile), North of Moonseom Island, Jejudo Island, Korea, 33°13'41.0"N 126°34'04.0"E, 37 m, SCUBA, coll. D. Lee, 27 Nov 2018; 1 ind. (1 ♂), Hangaechang point, Moonseom Island, Korea, 33°13'42.1"N 126°33'49.9"E, 36 m, SCUBA, coll. D. Lee, 28 Nov 2018; 1 ind. (1 juvenile), Wolpo C Leisure Resort, Pohang, Gyeongsangbuk-do, Korea, 36°11'53.6"N 129°22'48.4"E, 12 m, SCUBA, coll. G.S. Kim, T. Lee & D. Lee, 28 Mar 2019; 1 ind. (1 ♂), DMDK33, Moonseom Island, Jejudo Island, Korea, 12 m, SCUBA, coll. Y.H. Kim, 24 May 2018; 2 inds. (1 ♀, 1 ind.), Intertidal zone of Udo Island, Jejudo Island, Korea, 33°29'36.6"N 126°56'44.9"E, hand-pick, coll. S.H. Kim, 17 Jun 2019; 1 ind. (1 ♂), Hayu breakwater, Geojae, Gyeongsangnam-do, Korea, 35°01'18.0"N 128°43'11.0"E, coll. S.H. Kim, 25 Aug 2017; 1 ind. (1 juvenile), Hwataedo Island, Yeosu, Jeollanam-do, Korea, 34°35'36.0"N 127°43'07.0"E, coll. S.H. Kim, 10 Apr 2017; 3 inds. (3 juveniles), Intertidal zone of Bijindo Island, Tongyeong, Gyeongsangnam-do, Korea, 34°43'01.1"N 128°27'37.4"E, hand-pick, coll. D. Lee, 29 Oct 2019; 15 inds. (15 juveniles), Gamji Beach,

Busan, Korea, 35°03'33.4"N 129°04'39.0"E, rinsing algae, 8 m, SCUBA, coll. D. Lee, 4 Dec 2019.

Diagnosis

Trunk fully segmented. Cephalic segment having anterolateral tubercle. Lateral processes having tubular setae on distal margin, separated by less than diameter. Ocular tubercle long, about 3 times as long as basal width. Proboscis spindle-shaped. Abdomen long, having long setae. Palp 9-segmented, longer than proboscis. Chelifore 3-segmented; scape 2 about 2 times as long as scape 1; chela atrophied. Oviger 10-segmented. Legs long, having many setae; propodus having four heel spines; auxiliary claw present.

Fig. 32. *Ammothella indica*, DMDK33. Trunk, dorsal view. Scale bar = 1 mm.

Distribution

Korea (Gangwon-do, Gyeongsang-do, Jeolla-do, and Jejudo Island) and Indo-West Pacific Oceans.

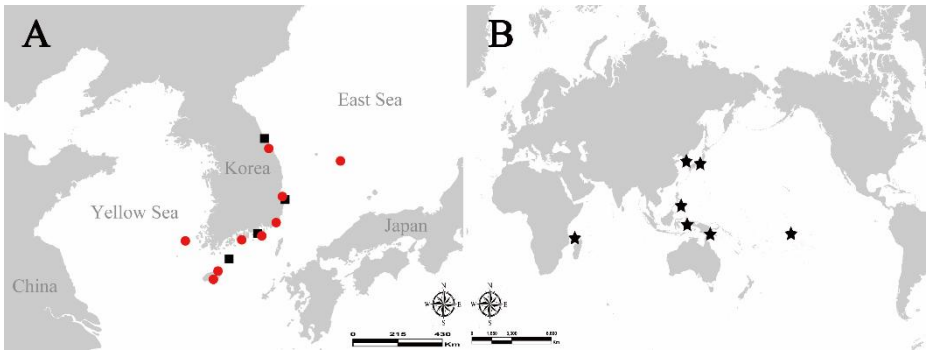


Fig. 33. Distribution of *Ammothella indica*. A, Distribution in Korea, ● indicating present study, ■ indicating previous records in Korea (Kim, 2013); B, Distribution in the world, ★ indicating worldwide distribution.

Remarks

The present species is close to *Ammothella fistella* Lee & Arango, 2003, *Ammothella pacifica* Hilton, 1942c, and *Ammothella tippula* Child, 1983 having tubular setae, long ocular tubercle, and long chelifores. The length ratio of the scape 1 to scape 2 is an important characteristic to distinguish the present species from the congeners. In *A. tippula* and *A. fistella*, the scape 1 is almost as long as the scape 2. In addition, *Ammothella fistella* has many spinules on dorsal surface of the trunk. In *A. pacifica*, the scape 2 is about 1.5 times as long as the scape 1 and there is no spines or tubercles at the anterolateral margin of the cephalic segment.

The anterolateral tubercle on the cephalic segment were not mentioned in Kim (2013). However, observing the material, there is a tubercle on the anterolateral margin of the cephalic segment.

The Nouthern Limit Line of the present species is Gangwon-do (Kim, 2013). The present study extends depth range at 0–37 m.

13. *Ammothella monotuberculata* Hong & Kim, 1987

외돌기긴손접시바다거미 (Fig. 34)

Ammothella monotuberculata Hong & Kim, 1987:144, figs. 4–5.—Kim, 2013:37, figs. 16–17.

Diagnosis

Trunk partially segmented; segment 3–4 fused. Cephalic segment having tubercle on anterolateral margin. Lateral processes having many setae on lateral surface, separated by more than diameter. Ocular tubercle long. Proboscis spindle-shaped. Abdomen long, with little setae. Palp 9-segmented. Chelifore present; scape 2 about 2 times as long as scape 1; chela atrophied. Oviger 10-segmented. Legs thin, having setae; propodus having 4–5 heel spines; auxiliary claws present.

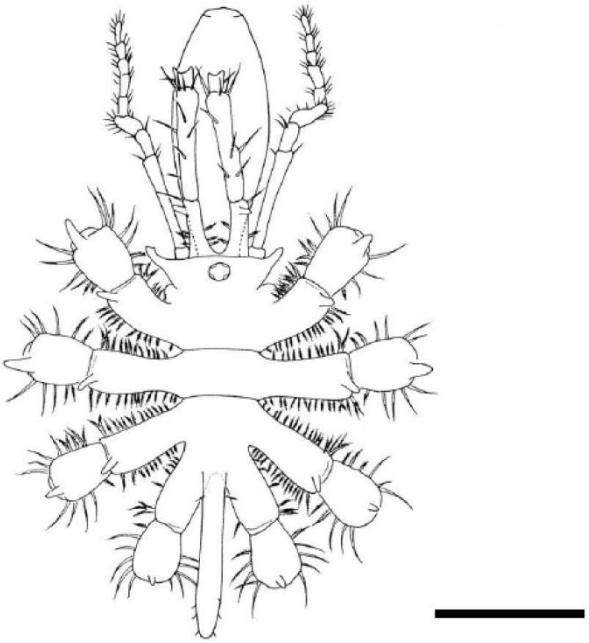


Fig. 34. *Ammothella monotuberculata*. Trunk, dorsal view. Scale bar = 1 mm. Modified from Kim (2013).

Distribution

Korea (Gyeongsang-do)

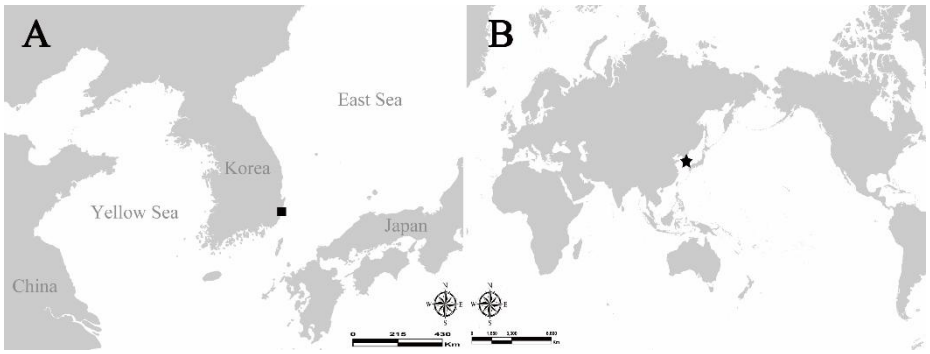


Fig. 35. Distribution of *Ammothella monotuberculata*. A, Distribution in Korea, ■ indicating previous record in Korea (Kim, 2013); B, Distribution in the world, ★ indicating worldwide distribution.

Remarks

The author has not obtained any specimen of this species and the original description is the only record. According to Hong & Kim (1987), this species is similar to *Ammothella cymose* Nakamura & Child, 1983 and *Ammothella rostrata* Losina-Losinsky, 1961, but distinguished by the presence of trunk segmentation and a tubercle on the lateral processes, coxa 1, and scape.

Genus *Cilunculus* Loman, 1908 어깨홈바다거미속

Diagnosis

Trunk segmented; cephalic segment with hood. Lateral processes well separated, with dorsodistal tubercle or spine. Ocular tubercle tall; eyes sometimes lacking. Abdomen articulated. Palp 9-segmented. Chelifore scape 1-segmented, sometimes 2-segmented; chela atrophied. Oviger 10-segmented; strigilis with compound spines, without terminal claw. Leg with many setae or spines.

Type species

Cilunculus frontosus Loman, 1908

14. *Cilunculus armatus* (Böhm, 1879) 어깨홈바다거미 (Figs. 36, 37)

Lecythorhynchus armatus Böhm, 1879b:141.

Parazetes pubescens Ortmann, 1891:163, pl. 24: fig. 5a–d.

Cilunculus armatus.—Loman, 1911: 9, Taf. 1: figs. 1–8.—Hedgpeth, 1949:294, fig. 43.—Utinomi, 1955:27, fig. 16.—Nakamura & Child, 1983: 33; 1991:16.—Hirohito & Nakamura, 1987:33, pl. 30: figs. 1–12.—Miyazaki & Makioka, 1993:127, figs. 1–5.—Turpaeva, 2007a:117, pl. 15: figs. 8–13.

Material examined

1 ind. (1 ♀), DMJS01, Chujado Island (CJ4), Jejudo Island, Korea, 33°56'34.0"N 126°17'06.6"E, grab, 30 m, coll. S.H. Kim, 16 Jan 2019; 1 ind. (1 ♂), DMJS02, Chujado Island (CJ2), Jejudo Island, Korea, 33°59'06.9"N 126°17'18.0"E, grab, 30 m, coll. S.H. Kim, 16 Jan 2019; 1 ind. (1 juvenile), DMJS03, Chujado Island (CJ4), Jejudo Island, Korea, 33°56'34.0"N 126°17'06.6"E, grab, 30 m, coll. S.H. Kim, 16 Jan 2019; 1 ind. (1 juvenile), North of Baekdo Island, Geomundo Island, Yeosu, Jeollanam-do, Korea, 34°03'04.0"N 127°36'13.0"E, grab, coll. S.H. Kim, 28 Jun 2017.

Description

Trunk fully segmented (Figs. 36A, 37A). Each segment connected like ball & socket joint, with transverse ridge on posterior margin having 3–4 spines and dorsomedian tubercle ornamented with spines on transverse ridge (Fig. 36A, 36B). Cephalic segment connected to main body through neck, forming hood structure, broad at base, slightly tapering distally, with hook-like process on anterolateral margin and many spines on anterior and lateral margin (Fig. 36A, 36B).

Lateral processes about 2 times as long as basal width, separated by less than diameter, having several tubercles with spines on dorsodistal margin; median tubercle on dorsodistal margin tallest and largest (Figs. 36A, 36B, 37A).

Ocular tubercle present at anterior part of cephalic segment, about half height of dorsomedian tubercle on trunk, having two spines on dorsolateral

margin; eye absent (Fig. 36A, 36B).

Proboscis pyriform, directing ventrally, about 0.8 times as long as trunk length, having 6–7 spinules on anterolateral proximal surface; spinules arranged in row along anteroposterior axis (Figs. 36B, 37B).

Abdomen club-shaped, articulated at base, not reaching distal margin of coxa 2, having many tubercles with spines on dorsal surface, bearing dorsal swelling on two third from base (Figs. 36A, 36B, 37A).

Palp 9-segmented, attached under hood; segment 2 longest, about 9 times as long as basal width, having dorsal setae; segment 4 second longest, about 6.7 times as long as basal width, having dorsal setae; segment 5–8 short, slightly expanded ventrally, having many setae on ventral surface; terminal segment about 3.7 times as long as basal width, having many setae on ventral and anterior surface (Fig. 36B).

Chelifore attached under hood, consisting of 2-segmented scape and chela (Fig. 36A, 36B). Scape segment 1 short, wider than scape 2, having long setae on distal margin; segment 2 about 3 times as long as basal width, having long setae on distal margin. Chela spindle-shaped, without teeth; immovable finger thick, longer than palm, having small tubercle on distal margin; movable finger small and sharp like spine, attached on ventral groove (Fig. 37C).

Oviger 10-segmented, ornamented with setae; segment 2 longest, about 5 times as long as basal width; segment 4 about 1.2 times as long as segment 5; segment 6 swollen in male, having many long setae; segment 7 having many long setae; segment 8 having long setae and 2 compound spines at inner surface; segment 9 having compound spine at inner distal margin; terminal segment small, having 2 compound spines (Figs. 36C, 37B).

Leg 3 ornamented with many setae (Fig. 36D). Coxa 1 about 0.8 times as long as basal width, sometimes having distinct dorsomedian tubercle with spine at distal margin. Coxa 2 about 4 times as long as basal width, having coxal spur on ventrodistal margin of leg 3–4 and gonopore on tip in male. Coxa 3 about

1.6 times as long as basal width, longer than coxa 1. Femur longer than other segments in leg, about 6 times as long as basal width, having cement gland tube on dorsal surface; cement gland stalk and ball-shaped, longer than basal width of femur (Figs. 36D, 37D). Tibia 1 about 5 times as long as basal width. Tibia 2 longer than tibia 1, about 6 times as long as basal width. Tarsus small, convex ventrally, having dorsal setat and 5 ventral setae. Propodus moderately curved, having many dorsal setae, 5 heel spines, 6 sole spines, and 3 sole setae. Main claw curved, about 0.5 times as long as propodus. Auxiliary claw curved, about 0.5 times as long as main claw.

In female, oviger less hairy than male; segment 6 not swollen; strigils having compound spines arranged 3:2:0:2. Gonopore present at ventral surface of coxa 2 of all legs. Coxal spur and cement gland absent.

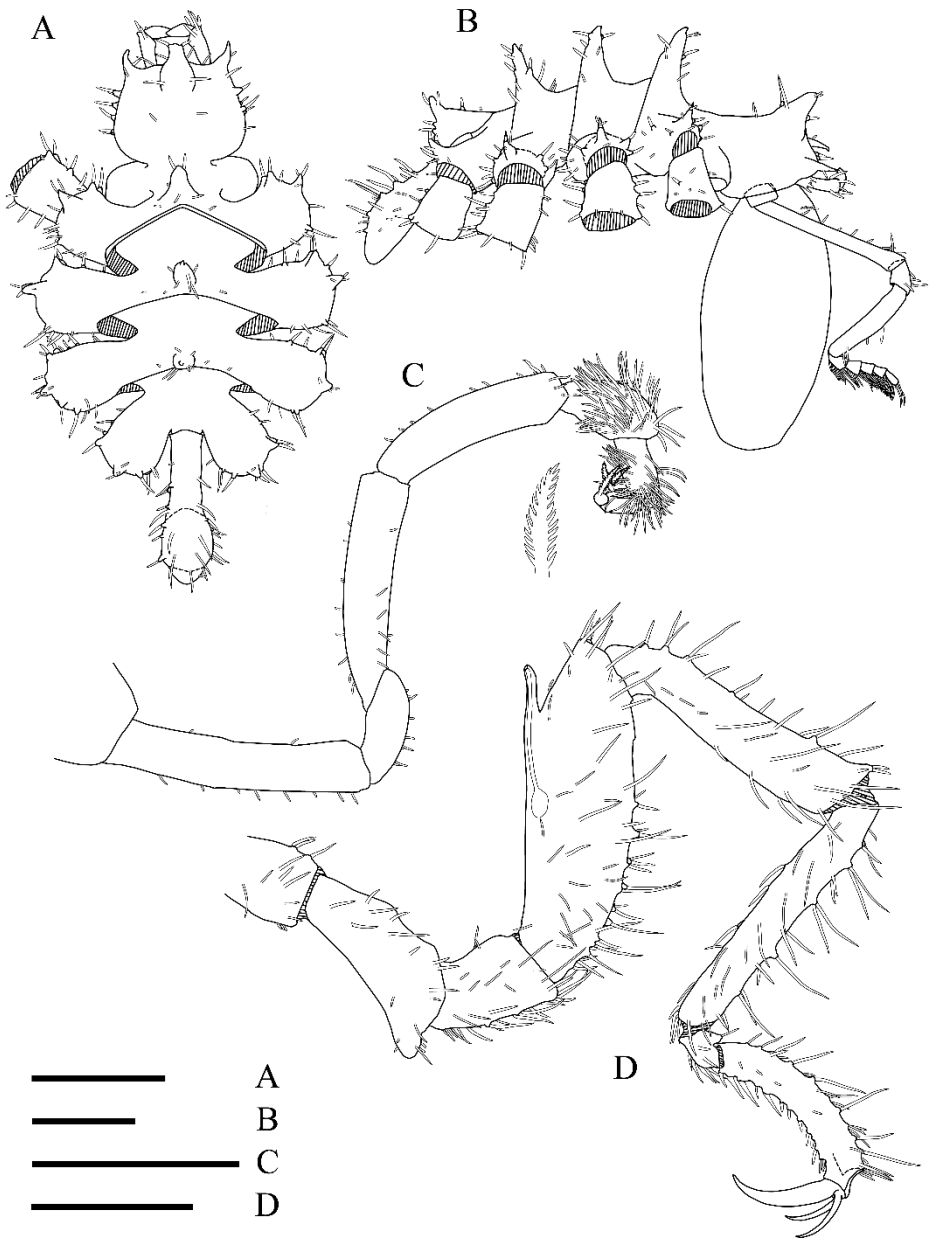


Fig. 36. *Cilunculus armatus*, DMJS02 (male). A, Trunk, dorsal view; B, Trunk, lateral view; C, Left oviger with compound spine; D, Right leg 3. Scale bars = 1 mm (A–D).

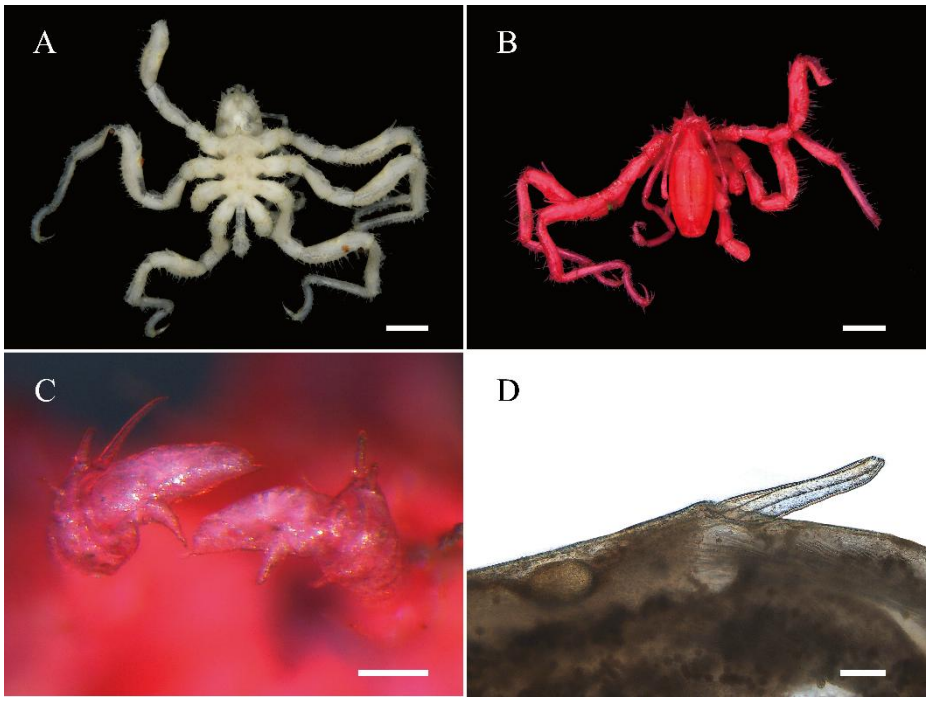


Fig. 37. *Cilunculus armatus*, DMJS02 (male). A, Trunk, dorsal view; B, Trunk, anterior view; C, Chela, anterior view; D, Cement gland on leg 4. Scale bars = 1 mm (A, B), 0.1 mm (C, D).

Measurements (mm)

DMJS02, trunk length, 3.09; width, 2.25; proboscis, 2.59; abdomen, 1.60. Third leg; coxa 1, 0.49; coxa 2, 1.03; coxa 3, 0.67; femur, 1.89; tibia 1, 1.61; tibia 2, 1.73; tarsus, 0.26; propodus, 1.18; main claw, 0.63; auxiliary claw, 0.37.

Distribution

Korea (Jeolla-do, and Chujado Island), Russia (Sea of Okhotsk), and Japan.

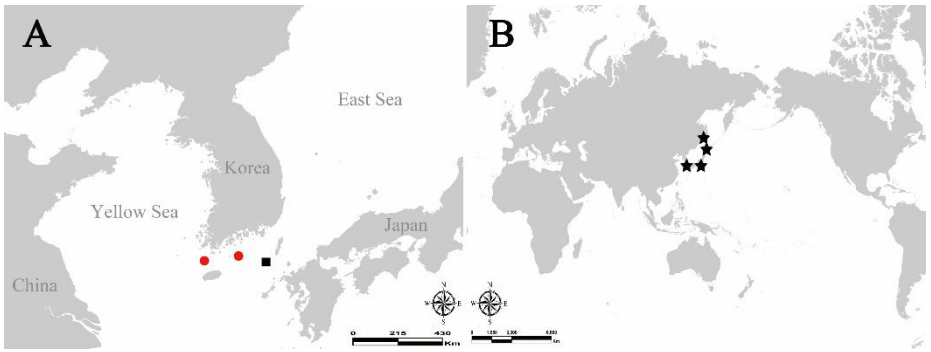


Fig. 38. Distribution of *Cilunculus armatus*. A, Distribution in Korea, ● indicating present study, ■ indicating previous record in Korea (Kim, 2013); B, Distribution in the world, ★ indicating worldwide distribution.

Remarks

The present species is close to *Cilunculus australiensis* Clark, 1963 having transverse ridge with dorsomedian tubercle and setose legs. However, the present species is distinguished from the congener by having larger trunk, low ocular tubercle without eyes, and five heel spines at the propodus, while *C. australiensis* has a short trunk length (1.32 mm), long ocular tubercle with distinct eyes, and two heel spines at the propodus.

In comparison with the description given by Hirohito & Nakamura (1987), variations are observed in the present specimens. Hirohito & Nakamura (1987) described that the chela was globular, small (0.2–0.3 times as long as scape 2), and without fingers. However, in the present study, the chela is spindle-shaped like Loman's figure (Loman, 1911, Taf 1: fig. 7) and about 0.7 times as long as scape 2 (Figs. 36A, 37C). Furthermore, the prominent fingers are present in both genders. This feature is presumed that the examined material is in the subadult stage or overlooked in previous research. In the present specimens, the arrangement of the compound spines on the strigilis is 0:2:1:2 in the male and 3:2:0:2 in the female, while it differs from the original description (3:3:1:2 in

the female) and that of Hirohito & Nakamura (0:1:1:2 in the male and 3:1:1:2 in the female). Five heel spines at the propodus are observed in the present specimens, whereas three heel spines were recorded in the Japanese specimens. In addition, we found that the male specimen is larger than the female specimen and this phenomenon is uncommon in the genus *Cilunculus*. Because few specimens have ever been observed, it is difficult to generalize about this finding.

The present species is distributed between the Sea of Okhotsk, Russia and Amakusa Island, Japan in latitude and 0–700 m at depth range (Turpaeva, 2007a).

Genus *Paranymphon* Callery, 1896 너도접시바다거미속

Diagnosis

Trunk unsegmented, without dorsal tubercle. Lateral processes separated more than their width, having dorsodistal tubercle. Ocular tubercle and abdomen long, erect. Proboscis cylindrical. Palp 7-segmented. Chelifore having distinct teeth. Oviger 10-segmented with terminal claw. Auxiliary claw only present in *P. bifilarium*.

Type species

Paranymphon spinosum Caullery, 1896

Key to the *Paranymphon* species in Korean waters.

1. Movable finger curved in semicircular shape. Tarsal ratio larger than 1.5 ..... *P. magnidigitum*

- Movable finger curved in an acute angle. Tarsal ratio smaller than 1.5 ..... *P. spinosum*

15. *Paranymphon magnidigitum* Hong & Kim, 1987

큰손너도접시바다거미 (Fig. 39)

Paranymphon magnidigitum Hong & Kim, 1987:150, figs. 10–11, Tab. 1.—Nakamura & Child, 1991:24.—Kim, 2013:41, figs. 18–19.

Material examined

1 ind. (1 ♀), DMJS09, near Hakampo Harbor (M1 GX1), Taean, Chungcheongnam-do, Korea, 36°54'14.8"N 126°12'39.6"E, grab, coll. S.H. Kim, 10 Sep 2018; 3 inds. (2 ♂♂, 1 ♀), NIBRIV0000124468, Songdo, Incheon, Korea, coll. J.S. Hong, 10 Feb 1999; 1 ind. (1 ♂), Yongheungdo Island, Incheon, Korea, coll. J.S. Hong, 4 Nov 1997.

Diagnosis

Trunk not segmented. Lateral processes long, separated by more than diameter, having tubercle on dorsodistal margin. Ocular tubercle longer than basal width. Proboscis cylindrical. Abdomen short. Palp 7-segmented.

Chelifore 2-segmented; chela having teeth, very curved finger. Oviger 10-segmented, having terminal claw. Legs having short setae; tarsal ratio larger than 1.5; propodus without heel spines; auxiliary claw absent.

Fig. 39. *Paranymphon magnidigitum*, NIBRIV0000124468 (male). Trunk, dorsal view. Scale bar = 1 mm.

Distribution

Korea (Gyeonggi-do, Chungcheong-do, and Jeolla-do) and Japan (Sagami Bay).

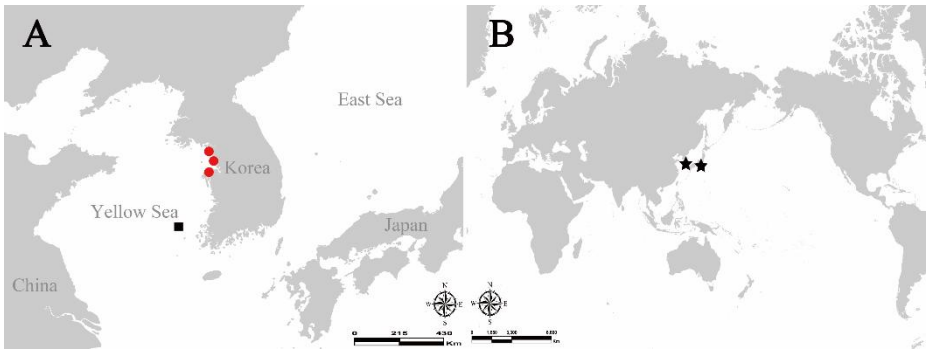


Fig. 40. Distribution of *Paranymphon magnidigitum*. A, Distribution in Korea, ● indicating present study, ■ indicating previous record in Korea (Kim, 2013); B, Distribution in the world, ★ indicating worldwide distribution.

Remarks

The family Ammotheidae consists of six genera (*Achelia* Hodge, 1864, *Ammothea* Leach, 1814, *Ammothella* Verrill, 1900, *Cilunculus* Loman, 1908, *Paranymphon* Caullery, 1896, and *Tanystylum* Miers, 1879) of Korean pycnoginds. Among the six genera, the genus *Paranymphon* is distinguished from the other genera by the presence of distinct chelae, a terminal claw at the distal end of the ovigers, and the absence of auxiliary claws. Hedgpeth (1948) changed this genus and *Ainigma* Helfer, 1938 to the family Ammotheidae, however, the current state of *Ainigma* has changed to the genus *Ascorhynchus*, which belongs to the family Ascorhynchidae. Hegpeth's (1948) research has been used thus far, since no further research has been conducted on the phylogenetic position of the genus *Paranymphon*. Characteristics of *Paranymphon*, such as having elongated lateral processes, a terminal claw at ovigers, and no auxiliary claws at the legs, are similar to *Ascorhynchus* species. Therefore, additional morphological and molecular studies are needed to accurately determine the phylogenetic position of the genus *Paranymphon*.

The movable finger of the chela is much curved in semicircular shape, and the teeth on the fingers are arranged evenly. Comparing the present species with *P. spinosum*, *Paranymphon bifilarium* Arango, 2009, and *Paranmyphon filarium* Stock, 1986, the tarsal ratio ($\frac{\text{Tarsus+Propodus+Main claw}}{\text{Tibia 2}}$), used by Stock (1958) in the genus *Rhopalorhynchus,* is 1.65, having a larger value than other *Paranymphon* species: *P. spinosum*, 1.31; *P. bifilarium*, 0.49; *P. filarium*, 0.86. Dorsolateral tubercles on the coxa 1 are one of main differences apart the present species from the other species.

The examined specimens have unpigmented eyes on top of the ocular tubercle as Nakamura & Child (1991), which is unknown whether the lack of eye pigment is due to alcohol or not. Although there is no trace of the eye in the original drawings, “Eye not visible” might be used to mean unpigmented eyes.

The male specimens have gonopores at the ventral surface of the coxa 2 of only leg 4, but the female specimens have them on same part of all legs.

The present species is distributed between Incheon and Sagami Bay in latitude and 49–80 m at depth range (Nakamura & Child, 1991).

16. *Paranymphon spinosum* Caullery, 1896 너도접시바다거미 (Fig. 41)

Paranymphon spinosum Caullery, 1896:361, pl. 12: figs. 1–6.—Bouvier, 1917:16, figs. 3–6.—Hedgpeth, 1948:253, fig. 41.—Stock & Soyer, 1965:415.—Stock, 1966:408, fig. 1; 1978:204, fig. 5d–g; 1987:506.—Child, 1982:18; 1992b:31, fig. 14.—Bamber, 1983:69.—Nakamura & Child, 1983:38; 1991:24.—Arnaud, 1987:43.—Hong & Kim, 1987:149, figs. 8–

9.—Bamber, 2010:98, fig. 131.—Kim, 2013:44, figs. 20–21.—Munilla & Soler-Membrives, 2014:118, figs. 63–64.

Material examined

1 ind. (1 ♀), NIBRIV0000124448, Uido Island Sinan, Jeollanam-do, Korea, coll. J.S. Hong, Mar 2000.

Diagnosis

Trunk unsegmented. Lateral processes long, separated by more than diameter, having long tubercle on dorsodistal margin. Ocular tubercle very long, longer than proboscis; eye absent. Proboscis cylindrical and tapering distally. Abdomen long. Palp 7-segmented. Chelifore longer than proboscis; chela having curved finger. Oviger 10-segmented, having terminal claw. Legs having short setae; tarsal ratio smaller than 1.5; propodus without heel spine; auxiliary claw absent.

Fig. 41. *Paranymphon spinosum*. Trunk, dorsal view. Scale bar = 1 mm.

Distribution

Korea (Jeolla-do), Japan, the North Atlantic, the Mediterranean and Guyana.

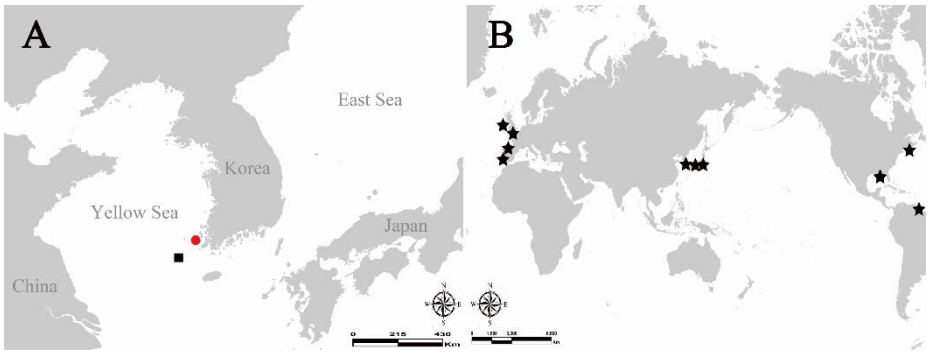


Fig. 42. Distribution of *Paranymphon spinosm*. A, Distribution in Korea, ● indicating present study, ■ indicating previous record in Korea (Kim, 2013); B, Distribution in the world, ★ indicating worldwide distribution.

Remarks

The present species is morphologically similar to *P. filarium* having curved movable finger, long dorsal tubercles on the lateral processes, and absence of tubercles on the coxa 1. These two species are distinguished by the following differences: (1) A dorsal tubercle on the lateral processes is long and conical in the present species (thread-like and recurved). (2) The tarsal ratio is larger having 1.31 (0.86). (3) The proboscis is more tapered at distal (less tapered). (4) Less number of spinules are present on the ventral surface of the femur (dense).

Although small spines on the anterior and posterior surface of the lateral processes are conspicuous feature of the present species, they were not observed in the examined specimen. This feature results from the gender (Child, 1992b). The female specimen has gonopores on the ventral surface of the coxa 2 of all legs.

The present species is distributed between UK and Guyana in latitude and 7–2300 m at depth range (Munilla & Soler-Membrives, 2014).

Genus *Tanystylum* Miers, 1879 꼬마바다거미속

Diagnosis

Trunk tiny, compact, circular shape, unsegmented. Lateral processes touching each other or separated slightly. Ocular tubercle low, with eyes. Proboscis having various shape. Palp 4 to 7-segmented. Chelifore atrophied or lacking. Oviger 10-segmented. Legs short and robust.

Type species

Nymphon styligerum Miers, 1875

Key to the *Tanystylum* species in Korean waters.

1. Proboscis tapered, hopper-shaped ..... *T. scrutator*

- Proboscis tapered, cylindrical ..... *T. ulreungum*

17. *Tanystylum scrutator* Stock, 1954 꼬마바다거미 (Fig. 43)

Tanystylum scrutator Stock, 1954:142, fig. 70.—Nakamura & Child, 1983: 41; 1991:24.—Kim & Hong, 1986:50.—Kim, 2013:46, fig. 22.

Material examined

2 inds. (2 ♂♂), Hangaechang point, Moonseom Island, Jejudo Island, 33°13'38.4"N 126°33'47.9"E, SCUBA, coll. Y.H. Kim, 25 Oct 2017; 8 inds. (1 ♂, 4 ♀♀, 3 juveniles), Dongnimmun gate point, Sungsan Resort, Seguipo, Jejudo Island, Korea, 33°27'14.5"N 126°56'54.3"E, rinsing algae, 25 m, SCUBA, coll. D. Lee, 14 Mar 2019; 4 inds. (3 ♂♂, 1 ♀), South of Moonseom Island, Jejudo Island, Korea, 33°13'29.7"N 126°33'56.8"E, 30 m, SCUBA, coll. D. Lee, 27 Nov 2018; 3 inds. (1 ♂, 1 ♀, 1 juvenile), Hongdo Island, Sinan, Jeollanam-do, Korea, 10 m, SCUBA, coll. S.K. Lee, 20 Jun 2018; 10 inds. (4 ♂♂, 1 ♀, 5 juveniles), Gajicho point, Dokdo Island, Korea, 37°14'56.7"N 131°52'02.5"E, 30 m, SCUBA, coll. D. Lee, 17 Jul 2018; 1 ind. (1 ♀), near old

dock, Dokdo, Korea, 16 m, SCUBA, coll. D. Lee, 16 Jul 2018; 2 inds. (1 ♀, 1 juvenile), Oedolgae point, Seguipo, Jejudo Island, Korea, 23 m, SCUBA, coll. D. Lee, 19 Jun 2018: 3 inds. (3 juveniles), Artificial reef point near Sacheonjin Harbor, Yangyang, Gangwon-do, Korea, 18 m, SCUBA, coll. D. Lee, 9 Feb 2018; 5 inds. (1 ♂, 4 juveniles), Reef of Navarone point, Chujado Island, Jejudo Island, Korea, 33°57'21.1"N 126°17'26.8"E, 15 m, SCUBA, coll. D. Lee, 13 Sep 2017; 4 inds. (4 ♀♀), East of Moonseom Island, Jejudo Island, Korea, 33°13'36.4"N 126°34'07.7"E, 13 m, SCUBA, coll. D. Lee, 13 Apr 2017; 1 ind. (1 ♀), Anemone point, Seopsum island, Jejudo Island, Korea, 33°13'46.1"N 126°35'46.6"E, 15 m, SCUBA, coll. D. Lee, 12 Apr 2017; 1 ind. (1 ♂), Oedolgae point, Seguipo, Jejudo Island, Korea, 33°14'22.1"N 126°32'56.0"E, 8 m, SCUBA, coll. D. Lee, 9 Jan 2017; 2 inds. (2 ♂♂), Little Hangaechang point, Beomsum Island, Jejudo Island, Korea, 33°13'06.3"N 126°30'51.1"E, 10 m, SCUBA, coll. D. Lee, 14 Oct 2016; 3 inds. (2 ♂♂, 1 juvenile), Anemone point, Seopsum island, Jejudo Island, Korea, 33°13'46.1"N 126°35'46.6"E, 15 m, SCUBA, coll. D. Lee, 13 Oct 2016; 7 inds. (3 ♂♂, 4 juveniles), Moonseom Island, Jejudo Island, Korea, SCUBA, coll. D. Lee, Aug 2016; 1 ind. (1 ♂), DM29, Seopsum island, Jejudo Island, Korea, 33°13'46.1"N 126°35'46.6"E, SCUBA, coll. D. Lee, 27 Jun 2016; 2 inds. (2 juveniles), Moonseom Island, Jejudo Island, Korea, 33°13'36.7"N 126°34'06.5"E, 25 m, SCUBA, coll. D. Lee, 28 Apr 2016; 1 ind. (1 juvenile), Anemone point, Seopsum island, Jejudo Island, Korea, 33°13'46.1"N 126°35'46.6"E, 19 m, SCUBA, coll. D. Lee, 28 Apr 2016.

Diagnosis

Trunk tiny, unsegmented. Cephalic segment having tubercle on anterolateral margin. Lateral processes touching each other, having two tubercles on dorsodistal margin. Ocular tubercle having conical tip. Proboscis

tapered, hopper-shaped. Abdomen cylindrical, reaching distal margin of coxa 1. Palp 5-segmented. Chelifore reduced to bud or seta. Oviger 10-segmented. Legs stout; coxa 1 having three dorsodistal tubercles; propodus having three heel spines; auxiliary claws present.

Fig. 43. *Tanystylum scrutator*, DM29. Trunk, dorsal view. Scale bar = 0.5 mm.

Distribution

Korea (Gangwon-do, Gyeongsang-do, Jeolla-do, and Jejudo Island) and Japan (from Sagami Bay to Kii Strait).

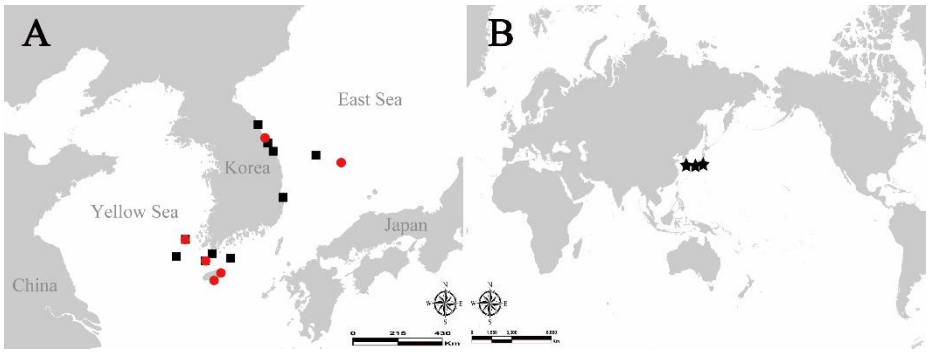


Fig. 44. Distribution of *Tanystylum scrutator*. A, Distribution in Korea, ● indicating present study, ■ indicating previous records in Korea (Kim, 2013); B, Distribution in the world, ★ indicating worldwide distribution.

Remarks

The tapered proboscis is a distinct characteristic to distinguish the present species from other Korean pycnogonids. This characteristic is also found in the following species: *Tanystylum californicum* Hilton, 1939, *Tanystylum intermedium* Cole, 1904, *Tanystylum isabellae* Marcus, 1940, and *Tanystylum acuminatum* Stock, 1954. Abdomen of *T. californicum* is shorter than the lateral processes. In *T. intermedium*, the chelifore consists of 2 segments and the palp is 7 segmented. *Tanystylum isabellae* and *T. acuminatum* is very close to the present species. The former species has a more pointed ocular tubercle and a proboscis without parallel part. The proboscis of the latter species is tapering at distal one fifth instead of half of the proboscis.

The original description of the present species mentioned that the each chelifore was reduced to a bud with spine. The chelifores of some specimens are corresponded to the original description, but the other specimens have each chelifore reduced to a spine without tubercle.

The present species is distributed between Gangwon-do and Jejudo Island in latitude and 0–40 m at depth range (Müller, 1993).

18. *Tanystylum ulreungum* Kim, 1983 울릉꼬마바다거미 (Fig. 45)

Tanystylum ureungum: Kim & Hong, 1986:50.—Nakamura, 1990:25, pl. 3: figs. 6–9.—Nakamura *et al*., 1996:120.—Turpaeva, 2007a:115, pl. 14: figs. 5–8.—Kim, 2013:48, fig. 23.

Tanystylum nabetensis Nakamura & Child, 1983:39, fig. 13.

Material examined

1 ind. (1 juvenile), DM205, Nagoksujung Resort, Uljin, Gyeongsangbuk-do, Korea, 37°07'12.4"N 129°23'03.7"E, rinsing hydra, 20 m, SCUBA, coll. D. Lee, 17 Nov 2016; 1 ind. (1 ♂), DMMB13, Oryu 1-ri, Gyeongju, Gyeongsangbuk-do, Korea, SCUBA, coll. S.H. Lee, 11 Jul 2018; 3 inds. (1 ♂, 2 juveniles), Oryu-ri, Gyeongju, Gyeongsangbuk-do, Korea, 35°50'11.0"N 129°31'02.0"E, coll. S.H. Kim, 30 Sep 2017.

Diagnosis

Trunk tiny, unsegmented. Lateral processes touching each other, having spine on dorsodistal surface. Ocular tubercle having distinct eyes. Proboscis cylindrical and tapering distally. Abdomen cylindrical, not reaching distal margin of coxa 1. Palp 5-segmented. Chelifore reduced to bud. Oviger 10-segmented. Legs stout; coxa 1 having dorsal tubercle on anterodistal margin;

propodus having three heel spines; auxiliary claws present.

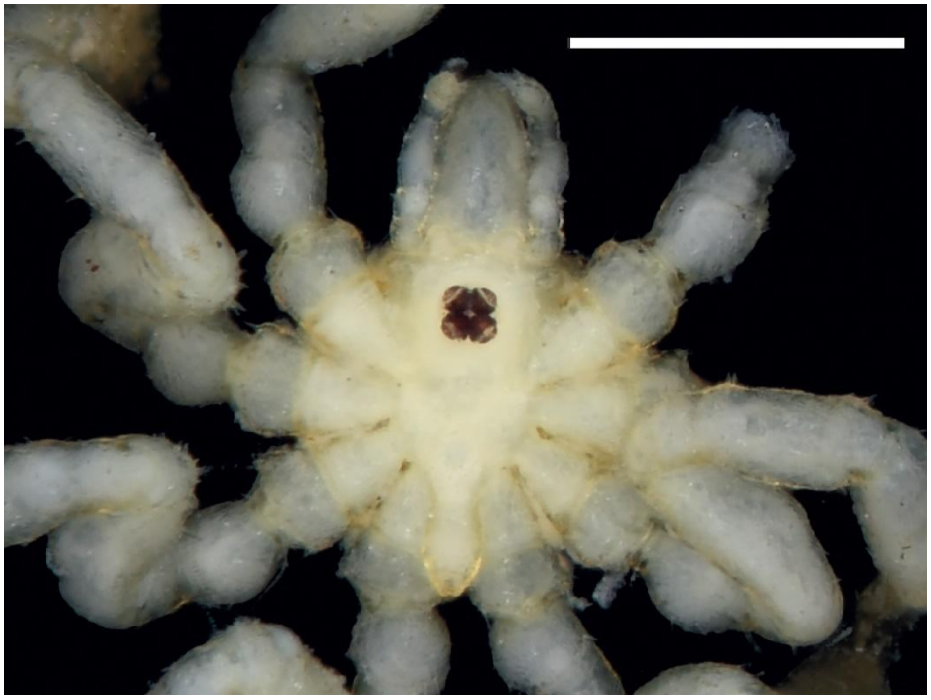


Fig. 45. *Tanystylum ulreungum*, DMMB13. Trunk, dorsal view. Scale bar = 0.5 mm.

Distribution

Korea (Gangwon-do, Gyeongsang-do, and Jeolla-do), Japan (Sagami Bay, Ogasawara Island).

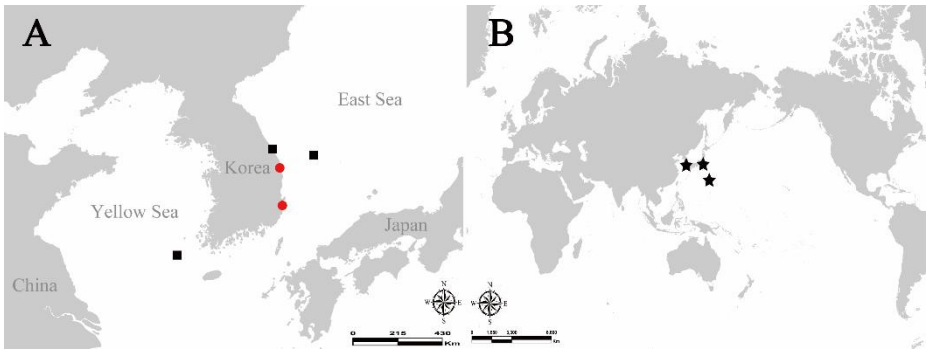


Fig. 46. Distribution of *Tanystylum ulreungum*. A, Distribution in Korea, ● indicating present study, ■ indicating previous records in Korea (Kim, 2013); B, Distribution in the world, ★ indicating worldwide distribution.

Remarks

Tanystylum bredini Child, 1970 is the most similar congener to the present species among 48 species of the genus *Tanystylum*, sharing cylindrical and tapered proboscis. The congener is different to the present species in following characteristics: (1) Chelifore is one fourth length of proboscis. (2) Palps are 4-segmented. (3) Cement gland is present on more distal part of the femur.

The trunk length of examined material ranges from 0.46 to 0.62 mm. A tubercle with 2–3 spines is present on the anterodistal surface of the coxa 1, which is not mentioned by previous literature.

The present species is distributed between Gangwon-do and Ogasawara Island in latitude (Nakamura & Child, 1983) and the present study extends the depth range at 7–20 m.

Family Ascorhynchidae Hoek, 1881 코바다거미과

Diagnosis

Trunk segmented. Proboscis bulbous or styliform. Palp longer than proboscis. Chelifore present. Oviger 10-segmented. Auxiliary claw absent.

Key to the Ascorhynchidae genera in Korean waters.

1. Ocular tubercle present at middle of cephalic segment. Distal part of palp and leg 1 plain ..... *Ascorhynchus*

- Ocular tubercle present at anterior margin of cephalic segment. Distal part of palp and leg 1 distinct, with numerous segments ..... *Nymphonella*

Genus *Ascorhynchus* Sars, 1878 코바다거미속

Diagnosis

Trunk fully segmented; having transverse ridges or dorsal tubercles on posterior part. Eyes of ocular tubercle sometimes lacking. Proboscis large with 2–3 lateral constrictions. Chelifore scape 1 to 2-segmented; chela tiny or atrophied. Oviger 10-segmented; strigilis with compound spines, having terminal claw. Auxiliary claw absent.

Type species

Ascorhynchus abyssi Sars, 1877

Key to the *Ascorhynchus* species in Korean waters.

1. Trunk with tubercles. Coxa 1 with 2 laterodistal tubercles ..... *A. ramipes*

- Trunk without tubercle. Coxa 1 glabrous 2

2. Neck as long as proboscis. Lateral processes separated more than width ..... *A. glaberrimus*

- Neck shorter than proboscis. Lateral processes separated less than width ..... *A. stocki*

19. *Ascorhynchus glaberrimus* Schimkewitsch, 1913 매끈코바다거미 (Fig. 47)

Ascorhynchus glaberrimus Schimkewitsch, 1913: 242, Tab. 3, figs. 8–14.—Hedgpeth, 1949: 293.—Kim, 2013: 51, fig. 24.

Ascorhynchus glaberrimum.—Utinomi, 1955: 26, fig. 15; 1959: 208; 1971: 334.—Nakamura & Child, 1983: 24, fig. 7; 1991:7.—Kim & Hong, 1986: 48, fig. 9.—Hirohito & Nakamura, 1987: 29, pl. 25, figs. 1–7.—Turpaeva, 2007a: 119, pl. 17, figs. 1–5.

Material examined

1 ind. (1 ♂), NIBRIV0000124469, Hoijin Harbor, Jangheung, Jeollanam-do, Korea, coll. J.S. Hong, Jun 1999; 1 ind. (1 ♂), NIBRIV0000859908, Jangheung, Jeollanam-do, Korea, 24 Jul 2009; 1 ind. (1 ♀), NIBRIV0000859909, Jangheung, Jeollanam-do, Korea, 24 Jul 2009; 1 ind. (1

♀), NIBRIV0000124472, Gwangyang Bay, Gwangyang, Jeollanam-do, Korea, coll. J.S. Hong, 14 Mar 1992.

Diagnosis

Trunk elongated, fully segmented. Cephalic segment protruding anteriorly forming neck. Lateral processes long, glabrous, separated by diameter. Ocular tubercle present at middle of neck. Proboscis swollen at middle, tapering distally. Abdomen not reaching distal margin of coxa 1. Palp 10-segmented. Chelifore 2-segmented. Oviger 10-segmented, having terminal claw. Legs polymorphous; femur having 10 cement glands; tarsus being short from leg 1 to leg 4; main claw being longer from leg 1 to leg 4; auxiliary claw absent.

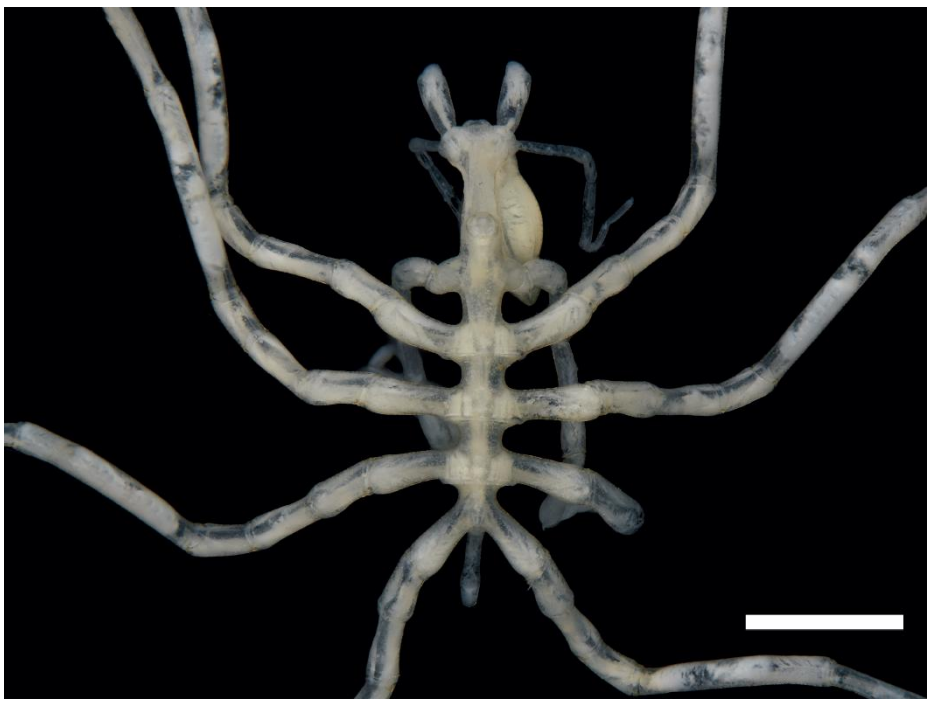


Fig. 47. *Ascorhynchus glaberrimus*, NIBRIV0000859908. Trunk, dorsal view. Scale bar = 2 mm.

Distribution

Korea (Jeolla-do and Gyeongsang-do) and Japan (from Hokkaido to Amakusa Island).

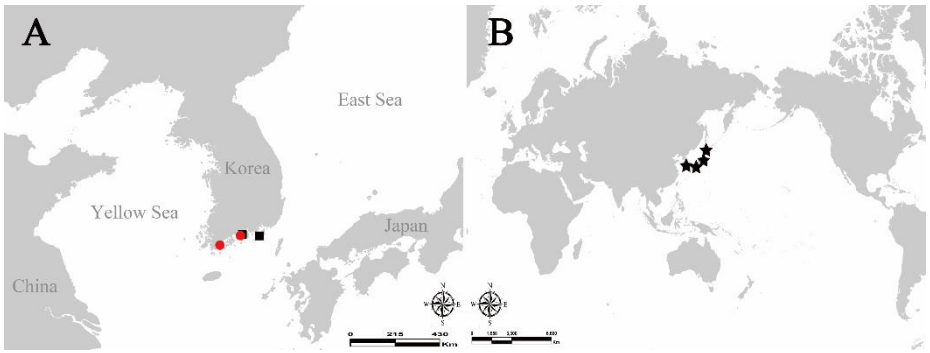


Fig. 48. Distribution of *Ascorhynchus glaberrimus*. A, Distribution in Korea, ● indicating present study, ■ indicating previous records in Korea (Kim, 2013); B, Distribution in the world, ★ indicating worldwide distribution.

Remarks

The present species is closely related to *Ascorhynchus dietheus* Child, 2002 having non or low tuberculate armature. The congener is distinguished by having slightly lower tubercles on the lateral processes, longer scape, and three cement glands on the femur and 3–5 cement glands on the tibia 1.

The male and female specimens have the trunk length between 5.84–5.86 mm, but that of NIBRIV0000124469 is shorter than that range (3.82 mm). This may result from the subadult stage or growth difference. The abdomen of NIBRIV0000859909 has swollen end, which is slightly different shape from the previous literature. The male specimens have 10 cement glands on the dorsal surface of the femur on all legs.

The present species is distributed between Hokkaido and Amakusa Island in latitude and 0–300 m at depth range (Hirohito & Nakamura, 1987).

20. *Ascorhynchus ramipes* (Böhm, 1879) 돌기코바다거미 (Figs. 49, 50)

Gnaptorhynchus ramipes Böhm, 1879c: 56, fig. 1.

Ascorhynchus ramipes.—Hoek, 1881: 25.—Ortman, 1891: 161, pl. 24, fig. 4.—Hedgpeth, 1949: 292.—Utinomi, 1959: 207, fig. 4; 1971, 332.—Nakamura & Child, 1983: 29; 1991:8.—Kim & Hong, 1986: 50.—Hirohito & Nakamura, 1987: 31, pl. 28, figs. 1–12.—Turpaeva, 2007a: 118, pl. 17, figs. 6–11.—Kim, 2013: 53, fig. 25.

Ascorhynchus latus Calman, 1923: 270, figs. 2–3.—Stock, 1954: 128.

Ascorhynchus ramipes var. *tsingtaocnsis* Lou, 1936: 2, figs. 2–6.

Material examined

1 ind. (1 ♂), DMJS08, near Sohyeoldo Island (B1), Tongyoung, Gyeongsangnam-do, Korea, 34°46'09.5"N 128°26'40.9"E, grab, coll. S.H. Kim, 22 Nov 2018; 1 ind. (1 ♂), DMJS10, near Hodo Island (Z32 GX1), Boryeong, Chungcheongnam-do, Korea, 36°19'37.1"N 126°15'03.1"E, grab, coll. S.H. Kim, 10 Sep 2018; 4 inds. (3 ♀♀, 1 juvenile), NIBRIV0000125483, Yeongjongdo Island, Incheon, Korea, coll. J.S. Hong, 17 Jan 2000; 1 ind. (1 ♂), NIBRIV0000124682, Yeongheungdo Island, Incheon, Korea, coll. J.S. Hong, 29 Nov 2001; 1 ind. (1 juvenile), NIBRIV0000124466, Songdo, Incheon, Korea, coll. J.S. Hog, 26 Aug 1998; 1 ind. (1 juvenile), NIBRIV0000130419,

Yeongheungdo Island, Incheon, Korea, coll. J.S. Hong, 29 Aug 2001; 1 ind. (1 ♀), NIBRIV0000062005, Yeongheungdo Island, Incheon, Korea, coll. J.S. Hong, 21 Feb 2002; 1 ind. (1 ♀), NIBRIV124464, Taean, Chungcheongnam-do, Korea, coll. J.S. Hong, May 2001.

Diagnosis

Trunk fully segmented, having low dorsal tubercle on posterior margin of segment 1–3. Cephalic segment protruding anteriorly, having tubercle under chelifore. Lateral processes long, having low dorsal tubercle on distal margin; intervals being wider from anterior to posterior. Ocular tubercle present at middle of cephalic segment. Proboscis swelling at middle, tapering distally. Abdomen long, reaching distal margin of coxa 2. Palp 10-segmented. Chelifore present; chela atrophied. Oviger 10-segmented, having terminal claw. Legs long, dimorphic in leg 1; coxa 1 having two laterodistal tubercles; coxa 2 having dorsal tubercle; femur having 6–8 cement glands; propodus glabrous; main claw absent in leg 1, present in other legs; auxiliary claw absent.

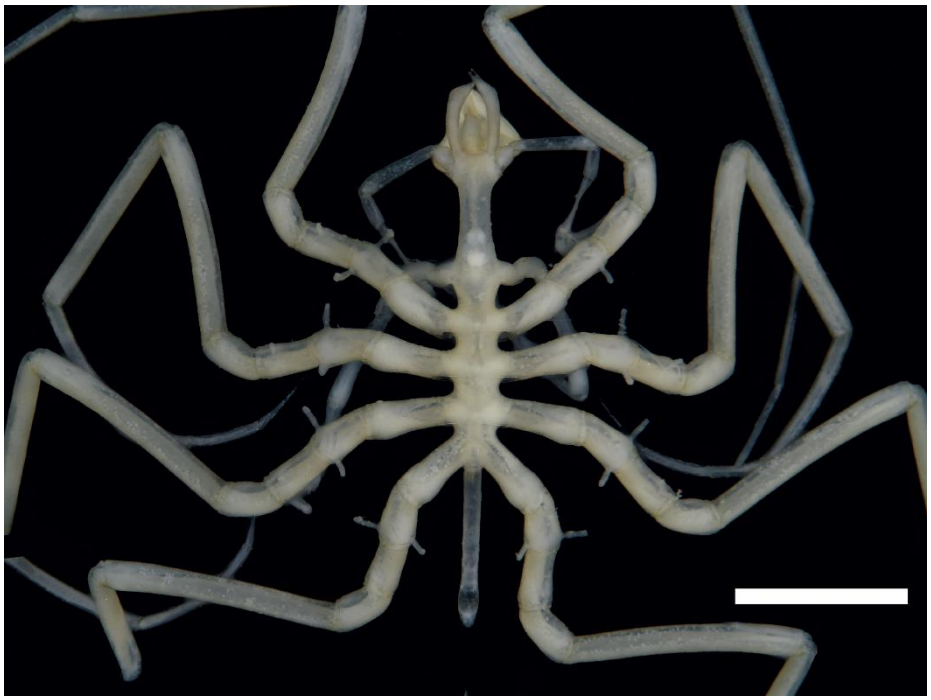


Fig. 49. *Ascorhynchus ramipes*, DMJS10. Trunk, dorsal view. Scale bar = 2 mm.

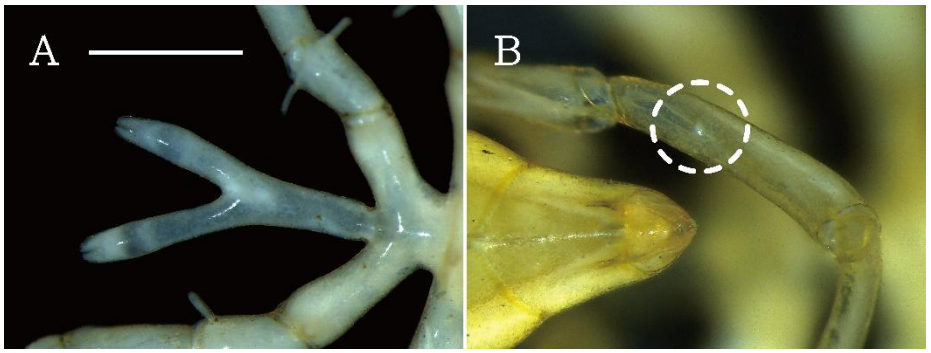


Fig. 50. *Ascorhynchus ramipes*, NIBRIV0000062005 (A, female), NIBRIV0000124464 (B, female). A, Abdomen bifurcated; B, Oviger segment 4, circle indicating pore-like structure. Scale bar = 1 mm.

Distribution

Korea (Gyeongi-do, Chungcheong-do, Jeolla-do, and Gyeongsang-do), Japan to the Gulf of Thailand and the Gulf of Manaar.

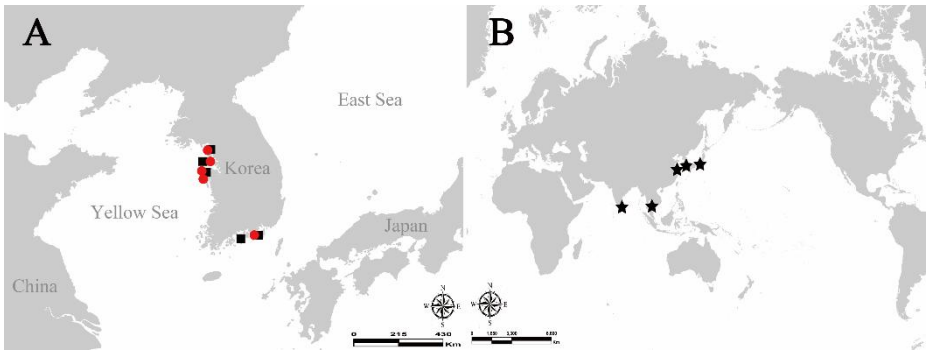


Fig. 51. Distribution of *Ascorhynchus ramipes*. A, Distribution in Korea, ● indicating present study, ■ indicating previous records in Korea (Kim, 2013); B, Distribution in the world, ★ indicating worldwide distribution.

Remarks

The present species is characterized by having atrophied chela, a low dorsal tubercle on the lateral processes, two laterodistal tubercles on the coxa 1, a dorsal tubercle on the coxa 2, and dimorphic legs. With these features, the present species is easily identified from other *Ascorhynchus* species.

The chela is atrophied in the adult stage, but there are fingers in the juvenile stage. A specimen (NIBRIV0000062005) shows abnormal shape of the abdomen, which is bifurcated in the middle like Y-shape (Fig. 50A). The oviger segment 4 has a pore-like structure in one third from the proximal part (Fig. 50B). This structure is present on both gender and has not been mentioned before. Further study is needed to understand the function of this structure. The

trunk length of the male (4.15–4.48 mm) is slightly smaller than that of the female (4.55–4.98 mm) and female specimens have gonopores on the ventral surface of the coxa 2 of all legs. In the male, gonopores are present on the ventral surface of the coxa 2 of only leg 4.

The present species is distributed between Incheon and the Gulf of Manaar in latitude and 10–200 m at depth range (Müller, 1993).

21. *Ascorhynchus stocki* Hong & Kim, 1987 조개코바다거미 (Fig. 52)

Ascorhynchus stocki Hong & Kim, 1987: 146, figs. 6–7.—Kim, 2013: 55, fig. 26.

Ascorhynchus spec. A Stock, 1953a: 305, fig. 16.

Diagnosis

Trunk fully segmented. Cephalic segment having neck. Lateral processes slightly separated, glabrous. Ocular tubercle shorter than basal width. Proboscis spindle-shaped. Abdomen curved. Palp 9-segmented. Chelifore present. Oviger 10-segmented, having terminal claw. Legs having short setae; femur having cement gland tube on dorsodistal margin; propodus glabrous; auxiliary claw absent.

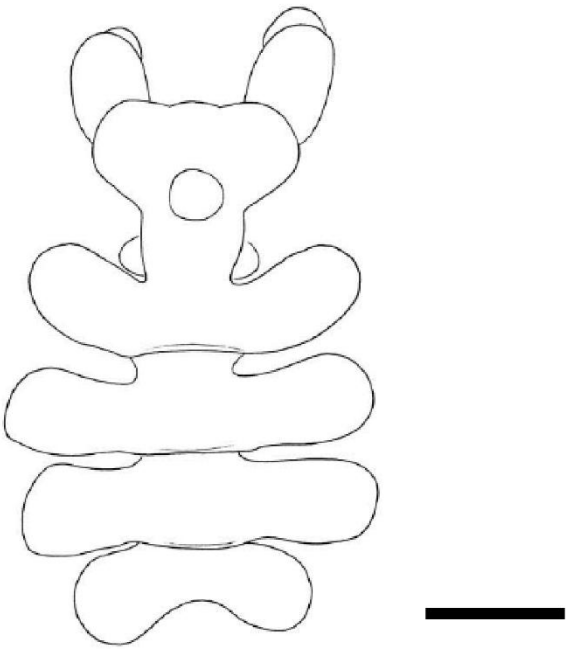


Fig. 52. *Ascorhynchus stocki*. Trunk, dorsal view. Scale bar = 1 mm. Modified from Kim (2013).

Distribution

Korea (Jeolla-do and Gyeongsang-do) and Indonesia (Timor Island).

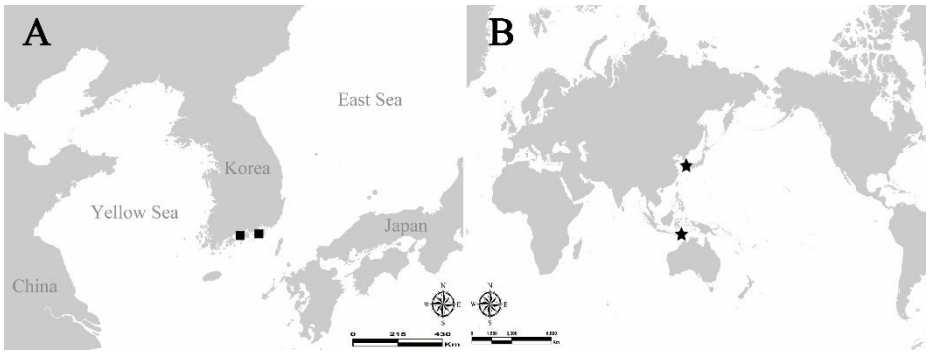


Fig. 53. Distribution of *Ascorhynchus stocki*. A, Distribution in Korea, ■ indicating previous records in Korea (Kim, 2013); B, Distribution in the world, ★ indicating worldwide distribution.

Remarks

The author has not obtained any specimen of this species. According to Hong & Kim (1987), this species was collected at mud flats in South Sea where many pen shells (*Atrina pectinata* (Linnaeus, 1767)) were also found.

This species is distributed between 5–8 m at depth range (Kim, 2013).

Genus *Nymphonella* Ohshima, 1927 더듬바다거미속

Diagnosis

Trunk segmented, elongated. Lateral processes having dorsodistal or dorsolateral tubercles. Ocular tubercle low. Abdomen long, reaching over coxa 1. Palp consisting of many segments. Chelifore shorter than proboscis; chela reduced. Oviger 10-segmented. Leg 1 consisting of many segments at distal; auxiliary claw absent.

Type species

Nymphonella tapetis Ohshima, 1927

22. *Nymphonella tapetis* Ohshima, 1927 더듬바다거미 (Fig. 54)

Nymphonella tapetis Ohshima, 1927: 257, figs. 1–4.—Utinomi, 1971: 331.—Arnaud, 1987: 42.—Turpaeva, 2007a: 116, pl. 16, figs. 1–2.—Kim, 2013: 57, figs. 27–28.—Munilla & Soler-Membrives, 2014: 141, fig. 75.

Nymphonella lecalvezi Guille & Soyer, 1968: 345, figs. 1–2, pls. 1–2.—Munilla, 1988: 194.

Material examined

1 ind. (1 ♂), Anemone point, Seopsum Island, Jejudo Island, Korea, 33°13'46.1"N 126°35'46.6"E, hand-pick, 15 m, night SCUBA, coll. D. Lee, 1 Mar 2016.

Diagnosis

Trunk elongated, fully segmented. Cephalic segment protruding anteriorly. Lateral processes long, separated by about twice of diameter, having tubercle on anterolateral and posterolateral margin. Ocular tubercle having distinct eyes. Proboscis spindle-shaped, having constriction at middle. Abdomen long, almost reaching distal margin of coxa 2. Palp consisting of many segments. Chelifore present; chela inserted in scape. Oviger 10-segmented. legs long, dimorphic; distal segments of leg 1 consisting of many segments; auxiliary claw absent.

Fig. 54. *Nymphonella tapetis*. Trunk, dorsal view. Scale bar = 5 mm.

Distribution

Korea (Gangwon-do and Jejudo Island), Japan, Namibia, and the Mediterranean Sea.

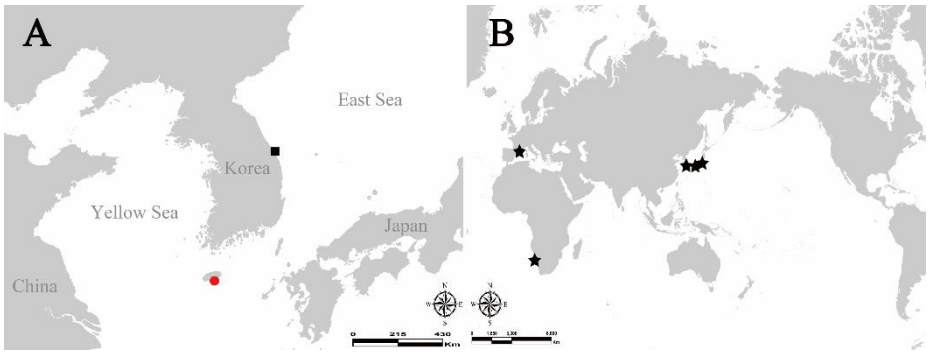


Fig. 55. Distribution of *Nymphonella tapetis*. A, Distribution in Korea, ● indicating present study, ■ indicating previous record in Korea (Kim, 2013); B, Distribution in the world, ★ indicating worldwide distribution.

Remarks

The genus *Nymphonella* consists of two species, *N. tapetis* and *Nymphonella lambertensis* Stock, 1959. The present species is different from *N. lambertensis* by the absence of a projection on the lateral processes and a small tubercle at the base of the scape. In addition, the proboscis is longer than the length of the cephalic segment.

The trunk length of the examined material (4.23 mm) is slightly longer than Kim's (2013) specimen (4.05 mm). There is a small tubercle on the anteroproximal dorsal surface of the coxa 1. It is described in Munilla & Soler-Membrives (2014), not Kim (2013). The male specimen has a gonopore at the ventral surface of the coxa 2 of only leg 4.

The present species is distributed between Namibia and the Mediterranean Sea in latitude and 0–15 m at depth range (Müller, 1993).

Family Ascorhynchoidea incertae sedis

Genus *Decachela* Hilton, 1939

Diagnosis

Trunk unsegmented, circular shape. Lateral processes touching each other. Proboscis cylindrical. Palp lacking. Chelifore 2-segmented; chela atrophided. Oviger 10-segmented. Propodus spine large, having subchelate function with main claw.

Type species

Decachela discata Hilton, 1939

23. *Decachela dogieli* Losina-Losinsky, 1961 불가사리바다거미 (Figs. 56, 57)

Decachela dogieli Losina-Losinsky, 1961: 88, fig. 16.—Hong & Kim, 1987: 155, figs. 13–14.—Turpaeva, 2007a: 120, pl. 18, figs. 3–6.—Kim, 2013: 61, figs. 29–30.

Material examined

1 ind. (1 ♂), DMECH03, Daejin Harbor, Goseong, Gangwon-do, Korea, 38°29'57.1"N 128°25'34.6"E, parasitic on *Solaster paxillatus* Djakonov, 1938 (MERS-A-0474), 100 m, coll. S. Shin, 29 Aug 2013; 29 inds. (3 ♂♂, 3 ♀♀, 23 inds.), DMECH04–32, Dadaepo Harbor, Busan, Korea, 35°02'54.9"N

128°59'11.3"E, parasitic on an individual of *Solaster uchidai* Hiyashi, 1939 (MERS-AK01491), 50 m, coll. S. Shin, 30 Jun 2014; 1 ind. (1 ♀), DMECH33, Jookbyeon Harbor, Uljin, Gyeongsangbuk-do, Korea, 37°02'20.2"N 129°25'49.6"E, parasitic on *S. paxillatus* (MERS-AE00577), 80 m, coll. S. Shin, 8 Jul 2002.

Diagnosis

Trunk unsegmented, having many setae. Lateral processes touching each other, having three tubercles on dorsodistal margin. Ocular tubercle present. Proboscis cylindrical. Abdomen cylindrical, reaching beyond coxa 1. Palp reduced to bud. Chelifore having many tubercles; chela atrophied. Oviger 10-segmented. Legs having many tubercles and setae; propodus having two large spines at sole which having subchelate function with main claw; auxiliary claw absent.

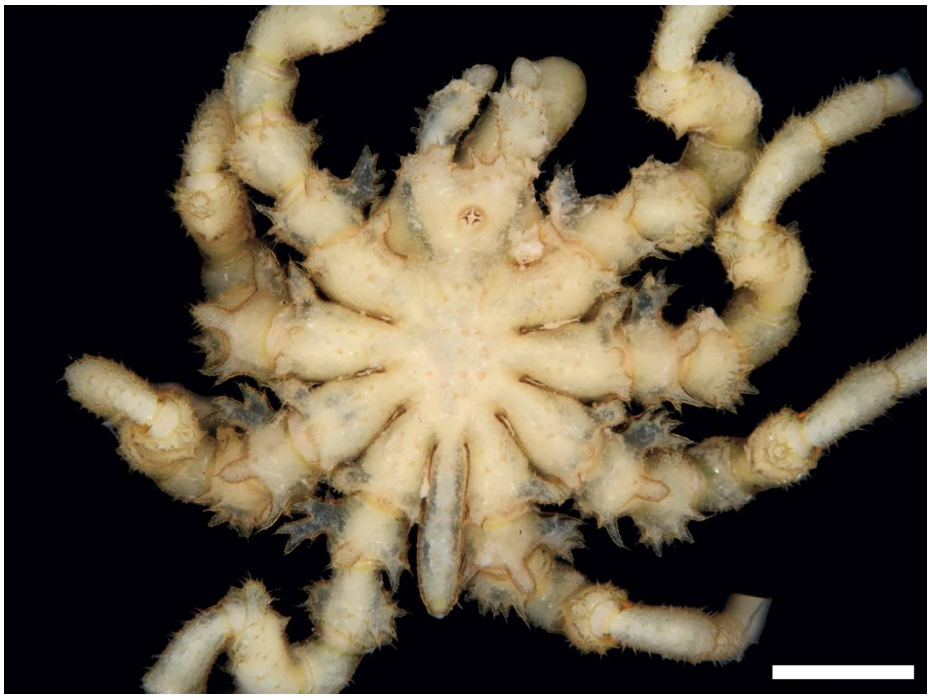


Fig. 56. *Decachela dogieli*, DMECH03. Trunk, dorsal view. Scale bar = 1 mm.

Fig. 57. *Decachela dogieli* with host (*S. uchidai*), circles indicating pycnogonids near ambulacral groove.

Distribution

Korea (Gangwon-do and Gyeongsang-do) and Russia (the Sea of Okhotsk).

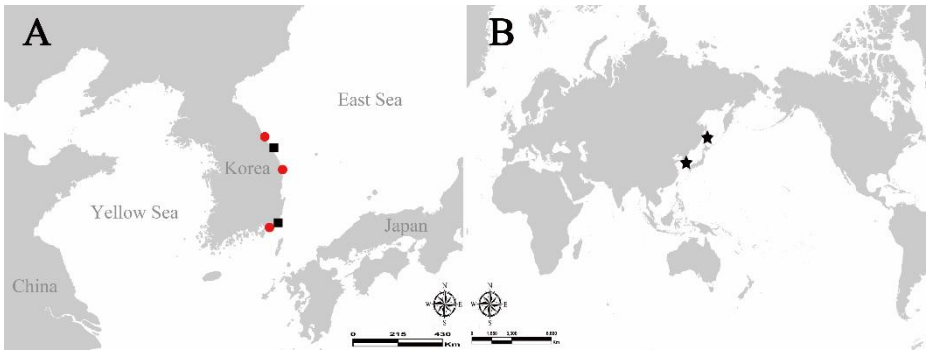


Fig. 58. Distribution of *Decachela dogieli*. A, Distribution in Korea, ● indicating present study, ■ indicating previous records in Korea (Kim, 2013); B, Distribution in the world, ★ indicating worldwide distribution.

Remarks

The present species is distinguished from the only other species, *Decachela discata* Hilton, 1939, by having larger trunk length, tuberculated trunk and appendages, coxal spur on the the coxa 2, and a dorsodistal tubercle on the femur. And the present species has been reported to have a parasitic relationship with the starfish (*Pteraster* sp. and *Solaster* sp., Fig. 57), while *D. discata* has not been reported to have such a relationship with the echinoderms.

In the male specimens, an anterolateral tubercle on the coxa 1 has various shapes, and the cephalic segment is ornamented with many small tubercles. In the female specimens, there are two short tubercles on the lateral processes and only one dorsal tubercle at the middle of the coxa 1. Gonopores are present on

the ventral surface of the coxa 2 of all legs, but coxal spur is absent.

The present species is distributed from the Sea of Okhotsk to Busan in latitude (Turpaeva, 2007a) and the present study extends the depth range at 50–100 m.

Family Callipallenidae Hilton, 1942 각시바다거미과

Diagnosis

Trunk segmented. Palp segmented variably, sometimes lacking. Chlifore scape 1 to 2-segmented; chela functional. Oviger 9 to 10-segmented, without terminal claw

Key to the Callipallenidae genera in Korean waters.

1. Palp present 2

- Palp absent 3

2. Palp 3-segmented. Auxiliary claw present ..... *Bradypallene*

- Palp 2-segmented in male. Auxiliary claw absent ..... *Propallene*

3. Oviger with terminal claw. Proboscis having jaws ..... *Cheilopallene*

- Oviger without terminal claw. Proboscis without jaws ..... *Callipallene*

Genus *Bradypallene* Kim & Hong, 1987 느림보바다거미속

Diagnosis

Trunk compact, segmented. Lateral processes separated less than diameter. Ocular tubercle low, present on anterior part of cephalic segment. Proboscis cylindrical. Palp 3 to 6-segmented. Chelifore chela without teeth. Oviger 10-segmented, without terminal claw. Propodus without heel spines. Main claw atrophied. Auxiliary claw well developed.

Type species

Bradypallene espina Kim & Hong, 1987

24. *Bradypallene espina* Kim & Hong, 1987 느림보바다거미 (Fig. 59)

Bradypallene espina Kim & Hong, 1987:272, figs. 1–2.—Kim, 2013:66, fig. 31.

Material examined

1 ind. (1 ♂), DM60, Bukjeo Rock point, Ulleungdo Island, Korea, 37°30'04.2"N 130°55'14.5"E, 29 m, SCUBA, coll. D. Lee, 27 Jul 2016.

Diagnosis

Trunk fully segmented. Lateral processes slightly separated. Ocular tubercle low. Proboscis cylindrical. Abdomen reaching beyond coxa 1. Palp 3 to 6-segmented, having indistinct segmentation line. Chelifore present. Oviger 10-segmented. legs with short setae; femur having cement gland at dorsodistal margin; propodus without heel spine; main claw shorter than auxiliary claws.

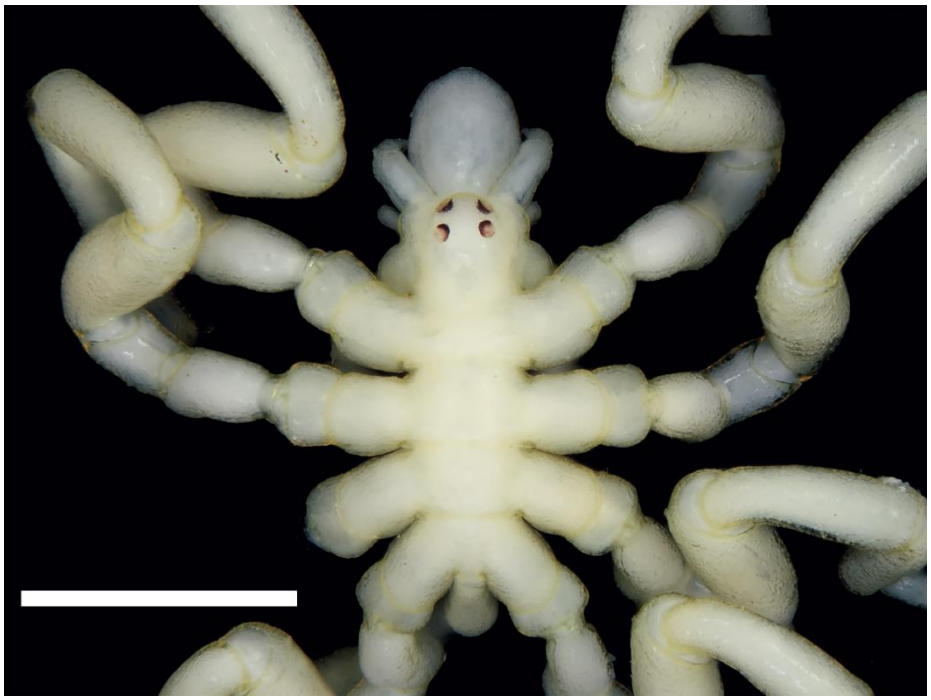


Fig. 59. *Bradypallene espina*, DM60. Trunk, dorsal view. Scale bar = 1 mm.

Distribution

Korea (Ulleungdo Island).

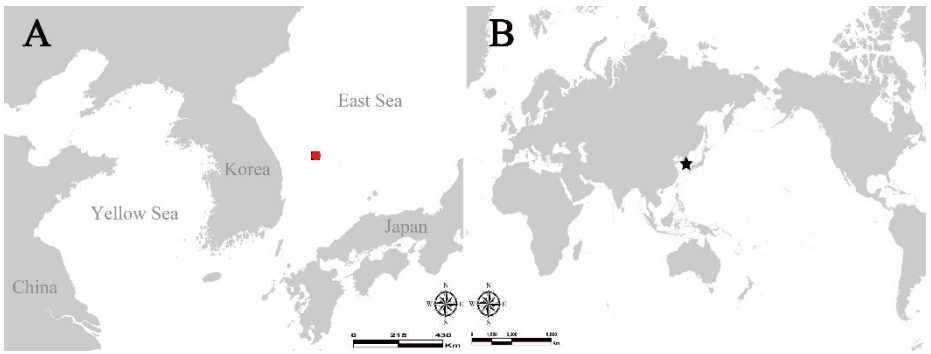


Fig. 60. Distribution of *Bradypallene espina*. A, Distribution in Korea, ● indicating present study, ■ indicating previous record in Korea (Kim, 2013); B, Distribution in the world, ★ indicating worldwide distribution.

Remarks

Since Kim & Hong (1987) reported the genus *Bradypallene* as a new genus, the present species is the only species consisting the genus. The present species has low ocular tubercle, no tubercles on trunk and lateral processes, long tube shape of cement glands, and atrophied main claw, which is also found in *Ammothella biunguiculata*. The trunk length of the examined material is 1.35 mm and the cement glands are found at the dorsal surface of the femora. Oviger segment 1 is as long as basal width and leg 3–4 have a low coxal spur at the coxa 2.

The present species is found at the only type locality and distributed between 7–29 m at depth range.

Genus *Callipallene* Flynn, 1929 각시바다거미속

Diagnosis

Trunk small, slender. Ocular tubercle present on posterior part of cephalic segment. Palp absent. Chelifore scape 1-segmented; chela functional. Oviger without terminal claw. Propodus sometimes having lamina. Auxiliary claw present.

Type species

Pallene brevirostris Jonston 1837

Key to the *Callipallene* species in Korean waters.

1. Neck as long as proboscis in dorsal view. Tibia 1 as long as tibia 2 ..... *C. amaxana*

- Neck shorter than proboscis in dorsal view. Tibia 2 is longer than tibia 1 2

2. Neck present. Coxa 2 about 6 times as long as basal width ..... *C. sagamiensis*

- Neck absent. Coxa 2 about 4 times as long as basal width ..... *C. dubiosa*

25. *Callipallene amaxana* (Ohshima, 1933) 긴목각시바다거미 (Figs. 61, 62)

Pallene amaxana Ohshima, 1933:216, figs. 8–12.

Callipallene phantoma amaxana Stock, 1968a:37, fig. 14a–d.—Utinomi, 1971:322.—Turpaeva, 2007a:122, pl. 19, figs. 10–12.

Callipallene amaxana.—Kim & Hong, 1986:38.—Nakamura & Child, 1991:35.—Kim, 2013:68, figs. 32–33.

Material examined

1 ind. (1 ♀), Jukdo Island, Ullreungdo Island, Korea, 37°31'37.2"N 130°56'12.2"E, SCUBA, coll. D. Lee, 15 Jun 2016; 3 inds. (1 ♂, 2 ♀♀), Gwaneumdo Island, Ullreungdo Island, Korea, 37°32'42.5"N 130°55'19.2"E, 22 m, SCUBA, coll. D. Lee, 28 Jul 2016; 1 ind. (1 ♂), Intertidal zone of Guryongpo Scuba Resort, Guryongpo, Pohang, Gyeongsangnam-do, Korea, 36°00'05.0"N 129°34'13.9"E, hand-pick, coll. D. Lee, 24 Sep 2016; 3 inds. (1 ♂, 2 ♀♀), Jikgudo Island, Chujado Island, Jejudo Island, Korea, 33°59'16.8"N 126°14'47.9"E, 18 m, SCUBA, coll. D. Lee, 12 Sep 2017; 2 inds. (1 ♂, 1 ♀), South of Moonseom Island, Jejudo Island, Korea, 33°13'29.7"N 126°33'56.8"E, 30 m, SCUBA, coll. D. Lee, 27 Nov 2018; 3 inds. (1 ♂, 2 ♀♀), North of

Moonseom Island, Jejudo Island, Korea, 33°13'40.7"N 126°34'03.8"E, 37 m, SCUBA, coll. D. Lee, 27 Nov 2018; 1 ind. (1 ♂), DM190722, Geomundo Island, Yeosu, Korea, 34°01'37.6"N 127°18'37.5"E, 9 m, light trap, coll. D. Lee, 10 Jul 2019; 1 ind. (1 ♀), Nohwado Island, Wando, Jeollanam-do, Korea, 34°13'28.0"N 126°33'47.0"E, coll. S.H. Kim, 25 May 2017; 7 inds. (4 ♂♂, 1 ♀, 2 juveniles), Jukrim Beach, Geojae, Gyeongsangnam-do, Korea, 34°50'17.0"N 128°35'10.0"E, coll. S.H. Kim, 3 Jul 2017; 1 ind. (1 ♀), Breakwater at Dongho Harbor, Tongyeong, Gyeongsangnam-do, Korea, 34°50'33.1"N 128°26'27.7"E, 7 m, light trap, coll. D. Lee, 3 Oct 2019; 1 ind. (1 ♀), Gangguan Harbor, Tongyeong, Gyeongsangnam-do, Korea, 34°50'34.9"N 128°25'26.1"E, 4 m, light trap, coll. D. Lee, 3 Oct 2019; 1 ind. (1 ♀), Daejangdudo Island, Tongyeong, Gyeongsangnam-do, Korea, 34°46'07.4"N 128°22'56.7"E, rinsing algae, coll. S.J. Song, 23 Dec 2014; 1 ind. (1 ♂), Hongd Island, Tongyeong, Gyeongsangnam-do, Korea, 34°32'12.8"N 128°43'52.2"E, rinsing algae, coll. S.J. Song, 18 May 2012.

Diagnosis

Trunk segment 1–3 having segmentation line. Cephalic segment protruding anteriorly, forming neck. Lateral processes glabrous, separated by more than diameter. Ocular tubercle present at base of neck. Proboscis cylindrical, tapering distally, as long as neck. Abdomen short. Palp absent. Chelifore present. Oviger 10-segmented. Legs long, having setae; coxa 2 about 8 times as long as basal width; tibia 1 as long as tibia 2; auxiliary claw present.

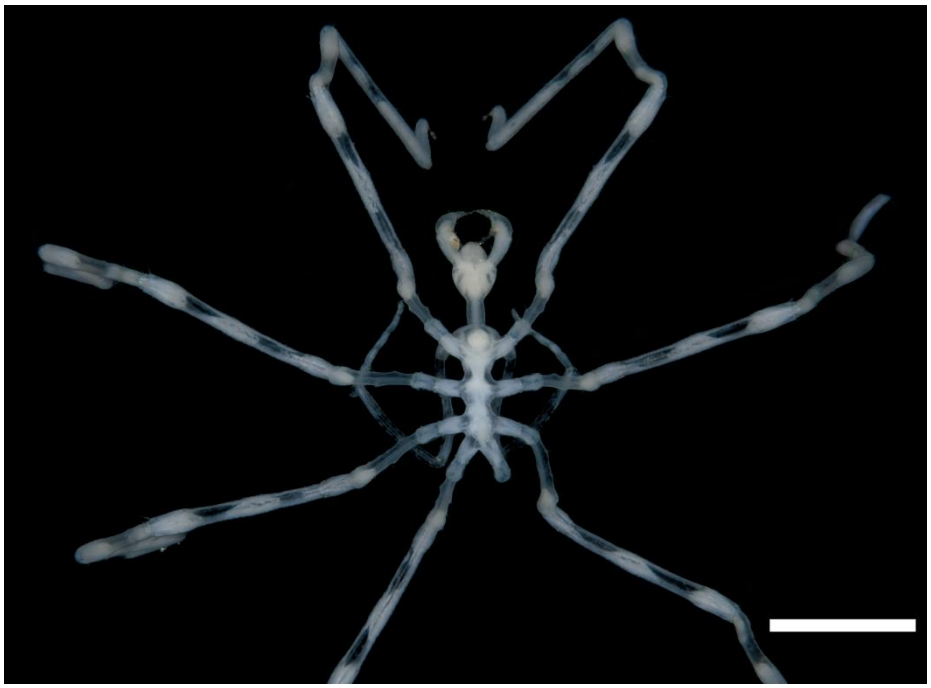


Fig. 61. *Callipallene amaxana*, DM190722. Trunk, dorsal view. Scale bar = 1 mm.

Fig. 62. *Callipallene amaxana,* DM190722. Leg 3, lateral view. Scale bar = 1 mm.

Distribution

Korea (Gangwon-do, Gyeongsang-do, Jeolla-do, and Jejudo Island), Japan, and the Straits of Malacca.

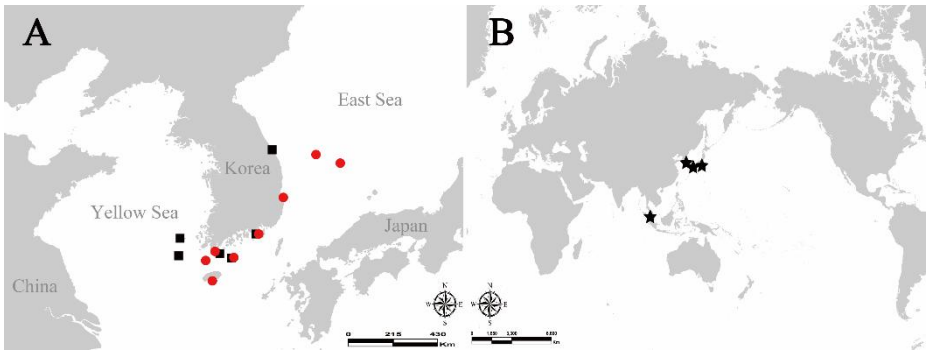


Fig. 63. Distribution of *Callipallene amaxana*. A, Distribution in Korea, ● indicating present study, ■ indicating previous records in Korea (Kim, 2013); B, Distribution in the world, ★ indicating worldwide distribution.

Remarks

The present species is similar to *Callipallene phantoma* (Dohrn, 1881) and *Callipallene producta* (Sars, 1888) having long neck and legs. *Callipallene phantoma* has short auxiliary claws. *Callipallene producta* has conical tip on the ocular tubercle, the tibia 2 much longer than the tibia 1, and the curved propodus.

In the examined material, the trunk length ranges between 1.27–1.41 mm and the coxa 2 is about 7.5 times as long as basal width. The proboscis is as long as neck length in dorsal view and the tibia1 is as long as the tibia 2 (Fig. 62).

The present species is distributed between the Straits of Malacca and

Gangwon-do in latitude and 4–160 m at depth range (Müller, 1993).

26. *Callipallene dubiosa* Hedgpeth, 1949 뚱보각시바다거미 (Fig. 64)

Callipallene dubiosa Hedgpeth, 1949:275, fig. 35.—Stock, 1954:41, fig. 17.—Utinomi, 1971:322.—Kim & Hong, 1986:38.—Müller, 1990b:71; 1992a:159.—Nakamura & Child, 1991:38.—Kim, 2013:73, fig. 35.

Callipallene aff. *dubiosa* Bartolino & Krapp, 2007:223, fig. 1.

Material examined

2 inds. (2 ♀♀), Intertidal zone of Daemaemuldo Island, Tongyeong, Gyeongsangnam-do, Korea, 34°38'47.8"N 128°34'39.6"E, coll. S.H. Kim, 2 Aug 2019; 1 ind. (1 ♀), Baechi Rock point, Geomundo Island, Yeosu, Jeollanam-do, Korea, 34°00'18.9"N 127°19'34.2"E, 23 m, SCUBA, coll. D. Lee, 11 Jul 2019; 4 inds. (3 ♂♂, 1 ♀), Oryu-ri, Gyeongju, Gyeongsangbuk-do, Korea, coll. S.H. Lee, 11 Jul 2018; 1 juvenile, East of Namhyeongjae Island, Busan, Korea, 34°53'05.1"N 128°57'09.2"E, SCUBA, coll. Y.H. Kim, 4 Jun 2018; 1 ind. (1 ♀), West of Hangaechang point, Moonseum Island, Jejudo Island, Korea, 33°13'38.4"N 126°33'47.9"E, SCUBA, coll. Y.H. Kim, 25 Oct 2017; 1 ind. (1 ♂), South of Moonseum Island, Jejudo Island, Korea, 33°13'29.7"N 126°33'56.8"E, 30 m, SCUBA, coll. D. Lee, 27 Nov 2018; 1 ind., Hongdo Island, Sinan, Jeollanam-do, Korea, 20 m, SCUBA, coll. S.K. Lee, 20 Jun 2018; 1 ind., Old dock of Dokdo Island, Korea, 37°14'26.2"N 131°52'16.7"E, 16 m, SCUBA, coll. D. Lee, 16 Jul 2018; 2 inds. (1 ♂, 1 ♀), Reef of Navarone point, Chujado Island, Jejudo Island, Korea, 33°57'21.1"N

126°17'26.8"E, 15 m, SCUBA, coll. D. Lee, 13 Sep 2017; 1 ind. (1 juvenile), Jukdo Island, Ulleungdo Island, Korea, 37°31'32.1"N 130°56'16.0"E, SCUBA, coll. D. Lee, 17 Jun 2016; 1 ind. (1 ♂), DM87, Moonseum Island, Jejudo Island, Korea, SCUBA, coll. D. Lee, Aug 2016.

Diagnosis

Trunk fully segmented. Cephalic segment without neck. Lateral processes having setae, separated by less than diameter. Ocular tubercle present posterior part of cephalic segment. Proboscis cylindrical, tapering distally. Abdomen short. Palp absent. Chelifore present. Oviger 10-segmented. Legs having setae; coxa 2 about 4 times as long as basal width; tibia 2 longer than tibia 1; auxiliary claws present.

Fig. 64. *Callipallene dubiosa*, DM87. Trunk, dorsal view. Scale bar = 1 mm.

Distribution

Korea (Gangwon-do, Gyeongsang-do, Jeolla-do, Chungcheong-do, and Jejudo Island), Japan (from Hokkaido to Honshu) to East Africa.

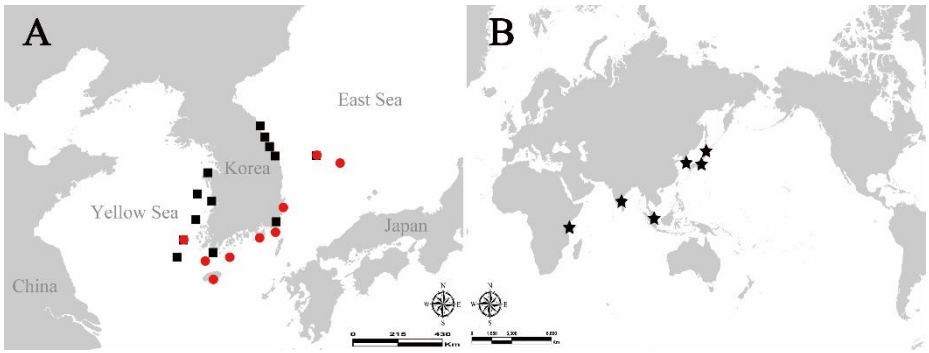


Fig. 65. Distribution of *Callipallene dubiosa*. A, Distribution in Korea, ● indicating present study, ■ indicating previous records in Korea (Kim, 2013); B, Distribution in the world, ★ indicating worldwide distribution.

Remarks

Calliapllene pectinata (Calman, 1923) and *Calliapllene novaezealandiae* (Thomson, 1884) are morphologically similar to the present species, but the following characteristics are not found in the present species. Pectinate structure is present on the auxiliary claws of *C. pectinata*. In *C. novaezealandiae*, the chela is narrow and slightly curved. The number of heel spines on the propodus is seven and that of sole spines is 15. In addition, the crenulated heel spines are distinct characteristic of *C. novaezealandiae* (Nakamura & Child, 1983).

The male specimens have a gonopore at the ventral surface of the coxa 2 of the only leg 4 and the oviger segment 5 has an apophysis at the distal margin.

Opposed to the male, the female specimens have no apophysis at ovigers and the gonopores are present at the ventral surface of the coxa 2 of all legs.

The present species is distributed between the Hokkaido and Kenya in latitude and 0–46 m at depth range (Müller, 1993).

27. *Callipallene sagamiensis* Nakamura & Child, 1983

사가미각시바다거미 (Figs. 66, 67)

Callipallene sagamiensis Nakamura & Child, 1983:59, fig. 20; 1991:38.—Kim & Hong, 1986:38, fig. 3.—Hirohito & Nakamura, 1987:9, pl. 7, figs. 1–9.—Kim, 2013:73, fig. 35.

Material examined

1 ind. (1 ♀), Jukdo Island, Ulleungdo Island, Korea, 37°31'37.2"N 130°56'12.2"E, SCUBA, coll. D. Lee, 15 Jun 2016; 1 ind. (1 juvenile), Jukdo Island, Ulleungdo Island, Korea, 37°31'32.1"N 130°56'16.0"E, SCUBA, coll. D. Lee, 17 Jun 2016; 1 ind. (1 ♀), Geumgangsan point, LF Moonam Dive Resort, Goseong, Gangwon-do, Korea, 38°17'36.9"N 128°33'24.5"E, 23 m, SCUBA, coll. D. Lee, 22 Mar 2017; 1 ind. (1 ♂), DM354, Jikgudo Island, Chujado Island, Jejudo Island, Korea, 33°59'16.8"N 126°14'47.9"E, 18 m, SCUBA, coll. D. Lee, 12 Sep 2017; 3 inds. (1 ♂, 2 inds.), Jikgudo Island, Chujado Island, Jejudo Island, Korea, 33°59'16.8"N 126°14'47.9"E, 18 m, SCUBA, coll. D. Lee, 12 Sep 2017; 2 inds. (1 ♂, 1 ♀), Reef of Navarone point, Chujado Island, Jejudo Island, Korea, 33°57'21.1"N 126°17'26.8"E, 15 m, SCUBA, coll. D. Lee, 13 Sep 2017; 2 inds. (1 ♀, 1 juvenile), East of Moonseom

Island, Jejudo Island, Korea, 33°13'35.3"N 126°34'11.0"E, 55 m, Trimix SCUBA, coll. D. Lee, 20 Jun 2018; 1 ind. (1 ♀), Daepunggam point, Ulleungdo Island, Korea, 37°31'23.9"N 130°47'48.7"E, 29 m, SCUBA, coll. D. Lee, 29 Aug 2018; 1 ind. (1 ♀), Guryongpo Resort, Guryongpo, Pohang, Gyeongsangbuk-do, Korea, 36°00'48.0"N 129°35'19.4"E, 32 m, SCUBA, coll. D. Lee, 20 Sep 2018; 1 ind. (1 ♀), Five elements point, Baeksangeo Resort, Goseong, Gangwon-do, Korea, 38°22'16.3"N 128°31'21.3"E, 28 m, SCUBA, coll. D. Lee, 20 Nov 2018; 1 ind. (1 ♀), Jariyeo point, Seongsan Scuba Resort, Jejudo Island, Korea, 33°27'14.5"N 126°56'47.8"E, 22 m, SCUBA, coll. D. Lee, 14 Mar 2019; 1 ind. (1 ♀), East of Namgyeongjae Island, Busan, Korea, 34°53'05.1"N 128°57'09.2"E, SCUBA, coll. Y.H. Kim, 4 Jun 2018; 1 ind. (1 ♀), Baechi Rock point, Geomundo Island, Yeosu, Jeollanam-do, Korea, 34°00'18.9"N 127°19'34.2"E, 23 m, SCUBA, coll. D. Lee, 11 Jul 2019.

Diagnosis

Trunk fully segmented. Cephalic segment having neck. Lateral processes glabrous, separated by diameter. Ocular tubercle present at posterior part of cephalic segment. Proboscis cylindrical, tapering distally, longer than neck. Abdomen short. Palp absent. Chelifore present; immovable finger longer than movable finger. Oviger 10-segmented. Legs having setae; coxa 2 about 6 times as long as basal width; tibia 2 longer than tibia 1; auxiliary claws present.

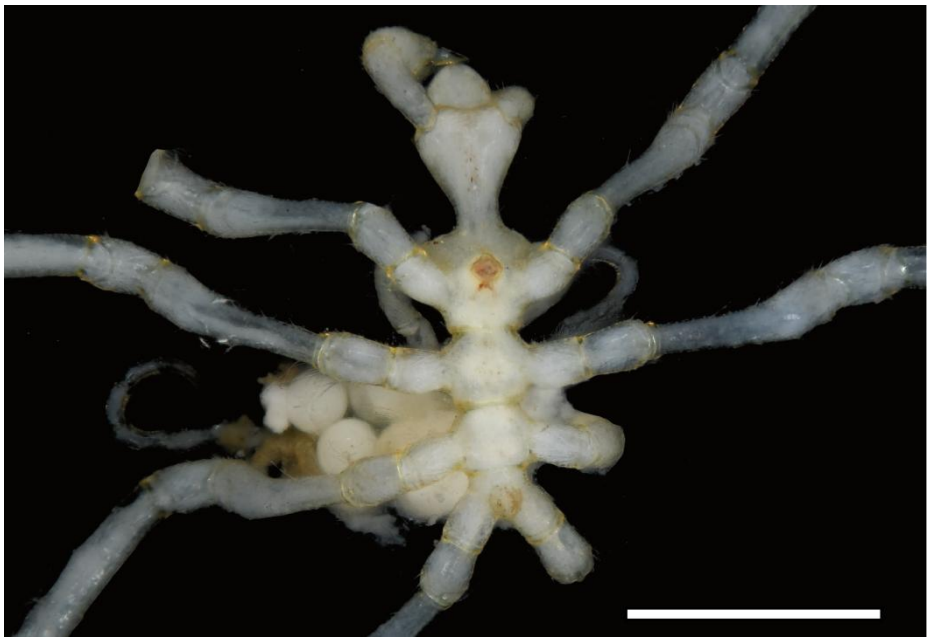


Fig. 66. *Callipallene sagamiensis*, DM354. Trunk, dorsal view. Scale bar = 1 mm.

Fig. 67. *Callipallene sagamiensis*, DM354. Leg 3, lateral view. Scale bar = 1 mm.

Distribution

Korea (Gangwon-do, Gyeongsang-do, Jeolla-do, Chungcheong-do, and Jejudo Island) and Japan (from the Kii Strait to Sagami Bay).

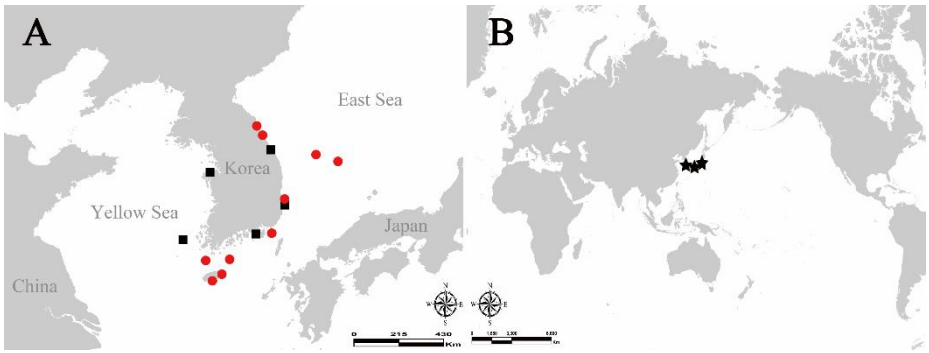


Fig. 68. Distribution of *Callipallene sagamiensis*. A, Distribution in Korea, ● indicating present study, ■ indicating previous records in Korea (Kim, 2013); B, Distribution in the world, ★ indicating worldwide distribution.

Remarks

The present species and *Callipallene cuspidata* Stock, 1954 are morphologically close species and the both species share the type locality, Sagami Bay. *Callipallene cuspidata* is distinguished by following characteristics: (1) There is a spiniform tip on the ocular tubercle. (2) In the chela, the finger is longer than palm. (3) The movable finger is as long as the immovable finger.

Comparing the *Callipallene* species in the Korean fauna, *Callipallene amaxana* has similar features with the present species. In the present species, the neck is shorter than the proboscis in dorsal view and is about 0.7 times of the basal width. The coxa 2 is about 6 times as long as basal width. The tibia 2

is much longer than that of *C. amaxana* and longer than the tibia 1 (Fig. 67).

The present study extends distribution of Southern Limit Line of the present species to Moonseum Island, Jejudo Island and depth range at 15–416 m (Nakamura & Child, 1991).

Genus *Cheilopallene* Stock, 1955 입술바다거미속

Diagnosis

Trunk smooth, segmented. Neck present. Lateral processes 1–3 separated by half or less of diameter at base; 3–4 touching or slightly separated. Proboscis cylindrical; jaws triradiate. Palp absent. Oviger 6-segmented in male or 10-segmented in both genders. Auxiliary claw absent.

Type species

Cheilopallene clavigera Stock, 1955

28. *Cheilopallene nodulosa* Hong & Kim, 1987 입술바다거미 (Fig. 69)

Cheilopallene nodulosa Hong & Kim, 1987:153, fig. 12.—Nakamura & Child, 1991:39, fig. 13G.—Kim, 2013:75, fig. 36.—Staples, 2015:51.

Material examined

1 ind. (1 juvenile), Anemone point, Seopseom Island, Jejudo Island, Korea,

33°13'46.1"N 126°35'46.6"E, 15 m, SCUBA, coll. D. Lee, 13 Oct 2016; 1 ind. (1 juvenile), Anemone point, Seopseom Island, Jejudo Island, Korea, 33°13'46.1"N 126°35'46.6"E, 15 m, SCUBA, coll. D. Lee, 12 Apr 2017; 1 ind. (1 ♀), DM398, Hoopo point, Chujado Island, Jejudo Island, Korea, 33°57'37.7"N 126°16'59.8"E, 22 m, SCUBA, coll. D. Lee, 13 Sep 2017; 1 ind. (1 juvenile), Saekkiseom point, Moonseom Island, Jejudo Island, Korea, 33°13'38.5"N 126°34'08.1"E, rising sponges, 58 m, Trimix SCUBA, coll. D. Lee, 29 Mar 2018; 2 inds. (2 juveniles), East of Moonseum Island, Jejudo Island, Korea, 33°13'35.5"N 126°34'10.2"E, 54 m, Trimix SCUBA, coll. D. Lee, 21 Jun 2018; 2 inds. (2 juveniles), Southwest of Moonseum Island, Jejudo Island, Korea, 33°13'31.5"N 126°33'46.5"E, 47 m, Trimix SCUBA, coll. D. Lee, 12 Sep 2018; 3 inds. (2 ♀♀, 1 juvenile), West of Hangaechang point, Moonseum Island, Jejudo Island, Korea, 33°13'38.4"N 126°33'47.9"E, SCUBA, coll. Y.H. Kim, 25 Oct 2017; 1 ind. (1 ♀), Baechi Rock point, Geomundo Island, Yeosu, Jeollanam-do, Korea, 34°00'18.9"N 127°19'34.2"E, 23 m, SCUBA, coll. D. Lee, 11 Jul 2019; 1 ind. (1 juvenile), North of Saekkiseum point, Moonseum Island, Jejudo Island, Korea, 33°13'40.3"N 126°34'04.0"E, 52 m, Trimix SCUBA, coll. D. Lee, 16 Aug 2019; 1 ind. (1 juvenile), South of Seopseom Island, Jejudo Island, Korea, 33°13'42.1"N 126°35'48.9"E, 46 m, Trimix SCUBA, coll. D. Lee, 23 Oct 2019.

Diagnosis

Trunk glabrous, segmented. Cephalic segment protruding anteriorly. Lateral processes separated by less than diameter; 3–4 touching each other. Ocular tubercle having papillae on dorsolateral margin. Proboscis tapering distally, having sharp tip. Abdomen short. Palp absent. Chelifore present; scape having node at base in female; fingers short. Oviger 10-segmented, having

terminal claw in female; 6-segmented, without terminal claw in male. Legs having setae; propodus straight; auxiliary claw absent.

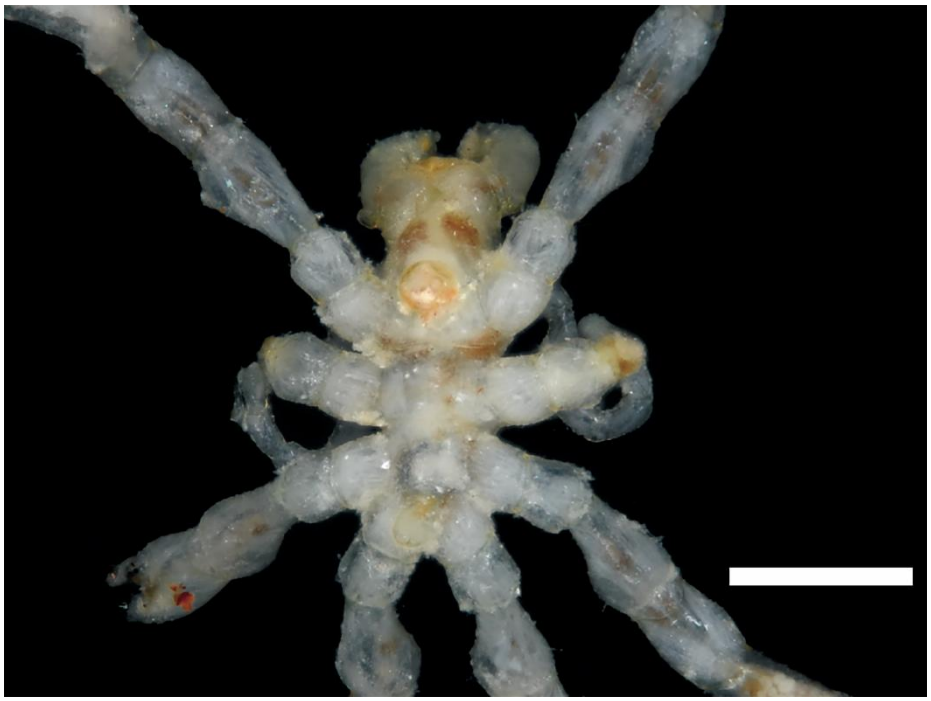


Fig. 69. *Cheilopallene nodulosa*, DM398. Trunk, dorsal view. Scale bar = 1 mm.

Distribution

Korea (Jeolla-do and Jejudo Island) and Japan (Wakayama Prefecture and Sagami Bay).

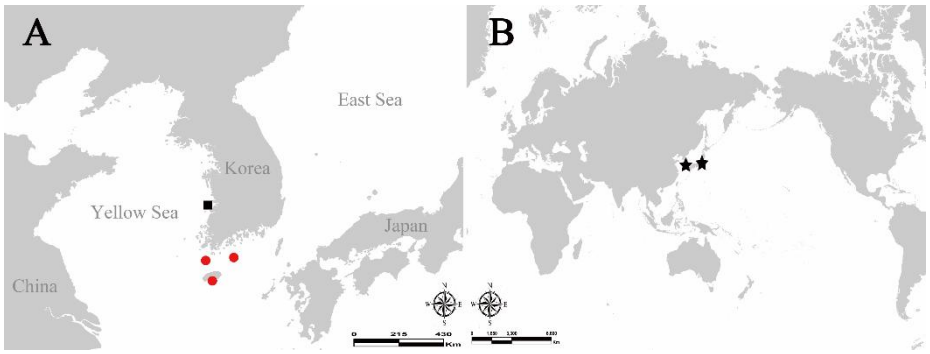


Fig. 70. Distribution of *Cheilopallene dubiosa*. A, Distribution in Korea, ● indicating present study, ■ indicating previous record in Korea (Kim, 2013); B, Distribution in the world, ★ indicating worldwide distribution.

Remarks

The present species is close to *Cheilopallene clavigera* Stock, 1955 and *Cheilopallene brevichela* Clark 1961, but a balloon-like node on the base of the scape is a conspicuous characteristic of the present species. In addition, *Cheilopallene clavigera* has cylindrical proboscis which is not narrowing distally, and conical tip on the ocular tubercle. *Cheilopallene brevichela* shares sole spines of the propodus and position of the ocular tubercle with the present species, but there is a spine-tipped tubercle under the scape and compound spines are present on the strigilis.

The examined material and Kim (2013) are treating the female and juvenile specimens except the male. The female is easily identified by having a

balloon-like node on the base of the scape and gonopores on the ventral surface of the coxa 2 of all legs. Nakamura & Child (1991) reported that the male had 6-segmented ovigers and no node on the scape. Child identified pycnogonids collected at Lizard Island, Australia as *C. nodulosa* in 1990, but Staples (2015) re-examined the pycnogonids and corrected them to *C. brevichela*.

The present study extends distribution of the Southern Limit Line to Jejudo Island and depth range at 5–58 m.

Genus *Propallene* Schimkewitsch, 1909 두마디손각시바다거미속

Diagnosis

Trunk segmented, elongated. Neck present. Lateral processes well separated. Proboscis cylindrical. Palp 2-segmented, only present in male. Chelifore with teeth. Oviger segment 5 having apophysis in male, without terminal claw. Auxiliary claw absence.

Type species

Pallene longiceps Böhm, 1879

29. *Propallene longiceps* Böhm, 1879 두마디손각시바다거미 (Fig. 71)

Pallene longiceps Böhm, 1879c:59.—Ortman, 1891:165, pl. 24, fig. 7.—Ohshima, 1933:12, figs. 1–7.

Propallene longiceps.—Stock, 1954:31, fig. 12a–b; 1975b:90, figs. 1–20.—

Utinomi, 1959:199; 1971:321.—Nakamura & Sekiguchi, 1980:163, figs. 1–5.—Nakamura & Child, 1983:61; 1991:41.—Kim & Hong, 1986:41, fig. 4.—Hirohito & Nakamura 1987:13, pl. 11, figs. 1–10.—Turpaeva 2007a:121, pl. 19, figs. 5–9.—Kim, 2013: 77, figs. 37–38.

Material examined

3 inds. (1 ♂, 2 ♀♀), Nohwado Island, Wando, Jeollnam-do, Korea, coll. S.H. Kim, 26 May 2017; 5 inds. (1 ♂, 4 ♀♀), Daeyu Breakwater, Yeosu, Jeollanam-do, Korea, 34°32'12.0"N 127°45'46.0"E, light trap, coll. S.H. Kim, 28 Jun 2017; 1 ind. (1 ♂), DM191011, near Gabaerideokwon Village Hall, Gabae-ri, Geojae, Gyeongsangnam-do, Korea, 34°46'35.5"N 128°34'28.1"E, light trap, coll. D. Lee, 28 Oct 2019; 1 ind. (1 ♀), Jeogu Harbor, Geojae, Gyeongsangnam-do, Korea, 34°43'51.1"N 128°36'22.6"E, light trap, coll. D. Lee, 29 Oct 2019; 4 inds. (3 ♀♀, 1 juvenile), Sinjindo Island, Taean, Chungcheongnam-do, Korea, 36°40'42.1"N 126°08'06.6"E, light trap, coll. S.J. Song, 21 Aug 2006; 1 ind. (1 ♂), NIBRIV0000124469, Hoejin Harbor, Jangheung, Jeollanam-do, Korea, coll. J.S. Hong, Jun 1999.

Diagnosis

Trunk fully segmented. Cephalic segment having neck. Lateral processes having short setae, separated by diameter. Ocular tubercle low, present at posterior part of cephalic segment. Proboscis cylindrical, tapering distally. Abdomen short, reaching beyond distal margin of lateral process 4. Palp 2-segmented in male, absent in female. Chelifore present; chela distinct, curved, having 4–6 teeth. Oviger 10-segmented, without terminal claw. Legs having setae; propodus straight, having 2–3 heel spines; auxiliary claw absent.

Fig. 71. *Propallene longiceps*, DM191011. Trunk, dorsal view. Scale bar = 1 mm.

Distribution

Korea (Chungcheong-do, Jeolla-do, and Gyeongsang-do) and Japan.

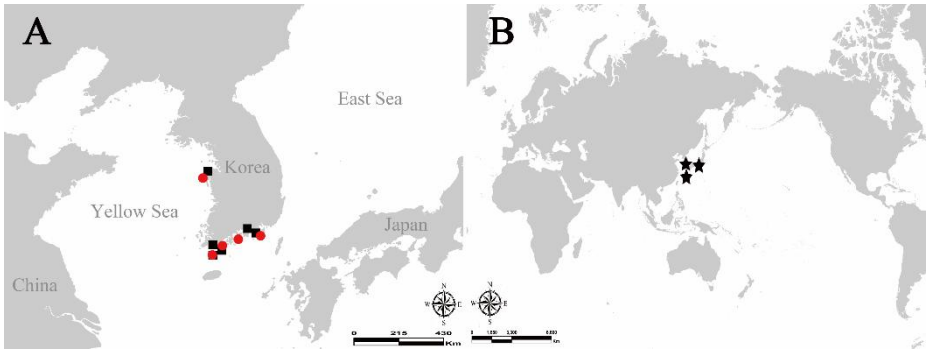


Fig. 72. Distribution of *Propallene longiceps*. A, Distribution in Korea, ● indicating present study, ■ indicating previous records in Korea (Kim, 2013); B, Distribution in the world, ★ indicating worldwide distribution.

Remarks

The present species is similar to *Propallene similis* Barnard, 1955 in many characters, but can be distinguished by the following characteristics: intervals between the lateral processes are narrower than their diameter, the neck is short, the ocular tubercle is in conical shape, the propodus is curved, and the heel spine of the propodus is crenulated at the inner distal margin, while in the present species intervals between the lateral processes are as long as their diameter, the neck is long, the ocular tubercle is round at tip, the propodus is straight, and the heel spine of the propodus is simple.

This species has distinct sexual dimorphism especially in the palp. The palp is only present on the male and segment 2 is about 6 times as long as basal width. An apophysis is present on the oviger segment 5 of the male and a gonopore is only present on the ventral surface of the coxa 2 of leg 4. Unlike the male, the female has no palp and apophysis on the oviger. The gonopores are present on the ventral surface of the coxa 2 of all legs.

The present species is distributed between Chungcheong-do and Ryukyu Island, Japan in latitude and 6–103 m at depth range (Müller, 1993).

Family Endeidae Norman, 1908 민바다거미과

Genus *Endeis* Philippi, 1843 민바다거미속

Diagnosis

Trunk slender. Lateral processes short, well separated. Proboscis long, cylindrical. Palp and chelifore absent. Oviger 7-segmented in only male. Auxiliary claws well developed.

Type species

Endeis spinosa (Montagu, 1808)

30. *Endeis nodosa* Hilton, 1942 남양민바다거미 **(Fig. 73)**

Endeis (*Phoxichilus*) *nodosa* Hilton, 1942c:47.

Endeis nodosa.—Child, 1982b:275, fig. 2g–i.—Nakamura & Child, 1988a:663; 1991:35.—Müller, 1992b:50, figs. 20–22.—Kim, 2013:94, fig. 45.

Material examined

4 inds. (2 ♂♂, 2 ♀♀), DM04–07, South of Green Island, Taiwan, 22°38'04.2"N 121°28'56.1"E, collected with *Lepas* (*Anatifa*) *anatifera* Linnaeus, 1758 on buoy rope, coll. Benny K.K. Chan, G. Xu & H.K. Kim, 20 May 2016.

Diagnosis

Trunk slender, fully segmented. Lateral processes having small setae, separated by less than diameter. Ocular tubercle conical. Proboscis long, cylindrical. Palp and chelifore absent. Oviger 7-segmented, present only in male. Legs having diverticula or caecae; femur having triangular projection at ventromedian surface; auxiliary claws present.

Fig. 73. *Endeis nodosa* (DM06, male) collected in Taiwan. Trunk, dorsal view. Scale bar = 1 mm.

Fig. 74. *Lepas* (*Anatifa*) *anatifera*, host of *Endeis nodosa* in Taiwan.

Distribution

Korea (Jejudo Island), Japan (Ryukyu Island, Sagami Bay), Taiwan (Green land), Hawaii, Marshall Islands and Caribbean Sea

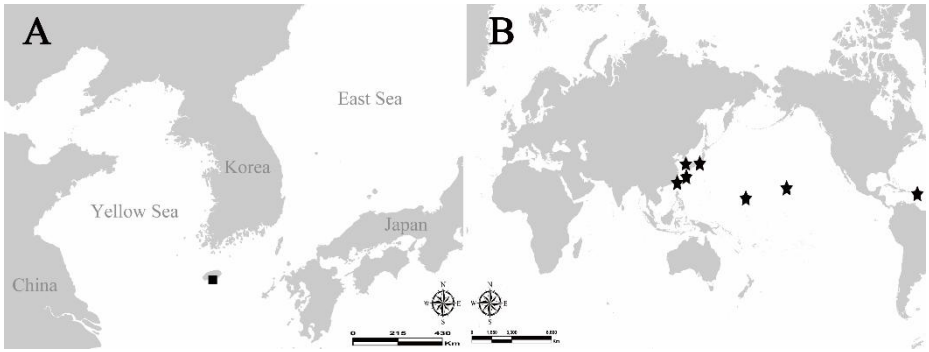


Fig. 75. Distribution of *Endeis nodosa*. A, Distribution in Korea, ■ indicating previous record in Korea (Kim, 2013); B, Distribution in the world, ★ indicating worldwide distribution.

Remarks

The author collected the present species not in Korean waters, but in Green Island, Taiwan with *L.* (*A.*) *anatifera* attached on buoy rope (Fig. 74). The *Endeis* species appear to have similar appearance, among which *Endeis flaccida* Calman, 1923 is very close to the present species. To distinguish the congener, the ventral projection at the middle of the femur is a main characteristic, which is absent in *E. flaccida*.

The male and female are easily distinguished by the presence of the oviger. In the male, the oviger is conspicuous and gonopores are present on the ventral surface of the coxa 2 of leg 3–4. The trunk length is measured to 1.58 and 1.66 mm. The female specimens lack the oviger entirely and gonopores are present on same position of all legs. The trunk length is measured to 1.90 and 1.92 mm, slightly longer than that of male.

Different to Kim's (2013) description, the lateral processes are separated by their diameter and three spines are present on the dorsodistal margin of the lateral processes, of which dorsolateral spines are sometimes small and inconspicuous. A spine is present on the dorsodistal margin of the coxa 1, which is bigger than spines on the lateral processes.

The present species is distributed between Sagami Bay, Japan and Marshall Islands in latitude and 0–45 m at depth range (Müller, 1993).

Family Nymphonidae Wilson, 1878 기생바다거미과

Genus *Nymphon* Fabricius, 1794 기생바다거미속

Diagnosis

Trunk segmented, elongated. Lateral processes well separated. Ocular tubercle present on posterior part of cephalic segment. Proboscis cylindrical. Palp 5-segmented, longer than proboscis. Chelifore scape 1-segmented; chela functional. Oviger 10-segmented, with terminal claw.

Type species

Nymphon grossipes (Fabricius, 1780)

Key to the *Nymphon* species in Korean waters.

1. Auxiliary claw absent ..... *N. uniunguiculatum*

- Auxiliary claw present 2

2. Tarsus longer than propodus 3

- Tarsus not longer than propodus 5

3. Tubercle present under scape ..... *N. striatum*

- Tubercle absent under scape 4

4. Auxiliary claw half length of main claw. Tarsus about 2 times as long as propodus ..... *N. elongatum*

- Auxiliary claw one third length of main claw. Tarsus less than 2 times as long as propodus ..... *N. longitarse*

5. Propodus having spines at sole 6

- Propodus having small setae at sole ..... *N. akanei*

6. Chela with more than 30 teeth ..... *N. japonicum*

- Chela with less than 30 teeth ..... *N. kodanii*

31. *Nymphon akanei* Nakamura & Child, 1983 꼬마기생바다거미 (Fig. 76)

Nymphon akane Nakamura & Child, 1983:54, fig. 19.—Kim & Hong, 1986:37, fig. 2.

Nymphon akanei Nakamura & Child, 1991:42.—Kim, 2013:81, fig. 39.

Material examined

1 ind. (1 ♀), Reef of Navarone point, Chujado Island, Jejudo Island, Korea, 33°57'21.1"N 126°17'26.8"E, 15 m, SCUBA, coll. D. Lee, 13 Sep 2017; 1 ind. (1 ♀), Dolsando Island (St. 7-2), Yeosu, Jeollanam-do, Korea, 19 Nov 2003; 1 ind. (1 juvenile), Dolsando Island (St. 7), Yeosu, Jeollanam-do, Korea, 10 Sep 2004; 1 ind. (1 ♂), DM237, Dolsando Island (St. 8-2), Yeosu, Jeollanam-do, Korea, 19 Nov 2003; 1 ind. (1 ♂), Dolsando Island (St. 8-3), Yeosu, Jeollanam-do, Korea, 19 Nov 2003; 1 ind. (1 ♀), Dolsando Island (St. 7-1), Yeosu, Jeollanam-do, Korea, 19 Nov 2003.

Diagnosis

Trunk fully segmented. Cephalic segment protruding anteriorly, having short neck. Lateral processes glabrous, separated by about 1.5 times of diameter. Ocular tubercle present at posterior part of cephalic segment, as long as basal width, having papillae on dorsolateral margin. Proboscis cylindrical, longer than neck. Abdomen short, cylindrical, slightly reaching beyond distal margin of lateral process 4. Palp 5-segmented; segment 1 very short; segment 2 longest. Chelifore present; chela having 11–12 teeth. Oviger 10-segmented; segment 5 longest in male; terminal claw having 4–5 teeth. Leg thin, long, having short setae; tarsus not longer than propodus; propodus having small setae at sole; auxiliary claws present.

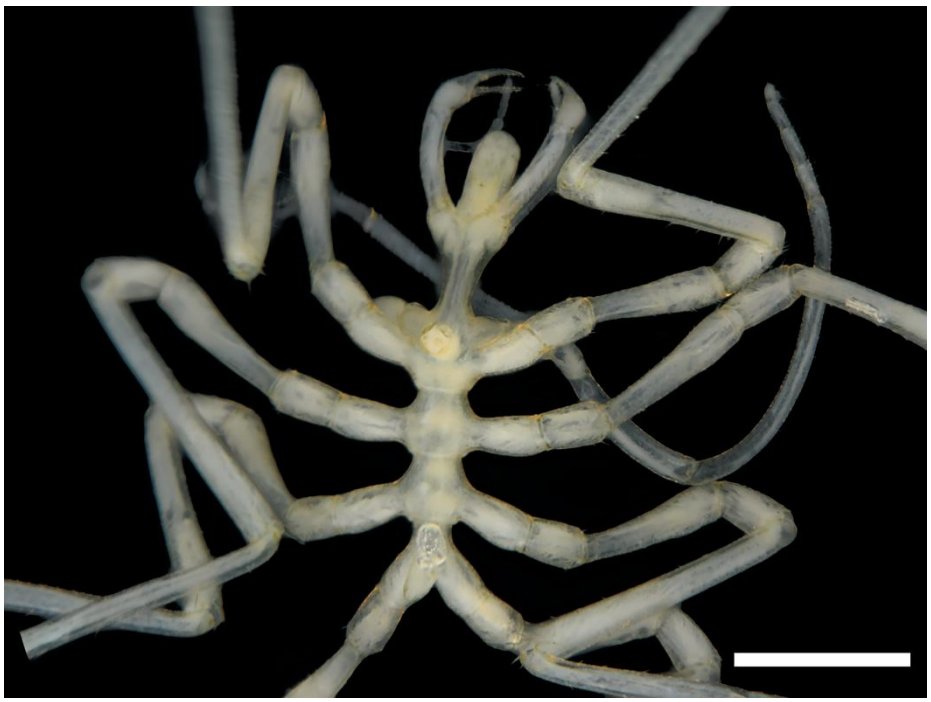


Fig. 76. *Nymphon akanei*, DM237. Trunk, dorsal view. Scale bar = 1 mm.

Distribution

Korea (Chungcheong-do, Jeolla-do, and Jejudo Island) and Japan (Sagami Bay and Amakusa Island).

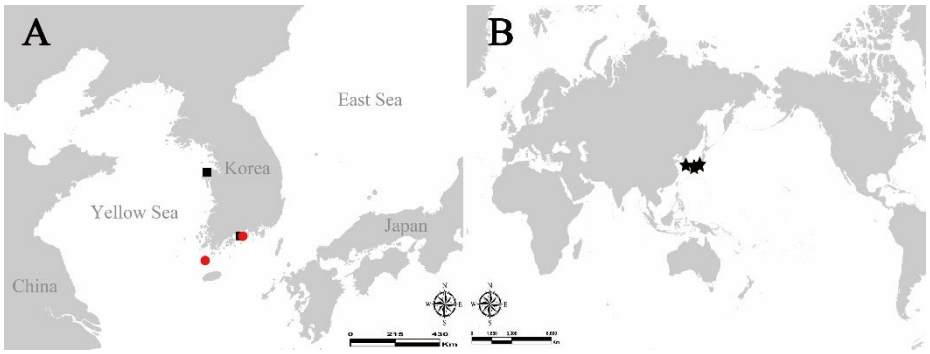


Fig. 77. Distribution of *Nymphon akanei*. A, Distribution in Korea, ● indicating present study, ■ indicating previous records in Korea (Kim, 2013); B, Distribution in the world, ★ indicating worldwide distribution.

Remarks

Nakamura & Child originally named the present species *Nymphon akane* in 1983, but changed to *N. akanei* in 1991 following the International Code of Zoological Nomenclature.

The present species is closed to *Nymphon benthos* Hedgpeth, 1949 and *Nymphon macronyx* Sars, 1877, but the long auxiliary claws are a distinct characteristic of the present species. *Nymphon benthos* has longer palm than that of the present species and *N. macronyx* has more teeth at the fingers.

The trunk length is 2.18–2.27 mm and the palp segment 5 is about 0.7 times as long as segment 3. Comparing the male and female, the segment 5 of the male oviger is very long and curved and gonopores are present on the

ventral surface of the coxa 2 of leg 3–4. The segment 5 of the female is as long as segment 4 and gonopores are present on the same position of all legs.

The present species is distributed between Seosan, Korea and Amakusa Island, Japan in latitude and 7–30 m at depth range (Nakamura & Child, 1983).

32. *Nymphon elongatum* Hilton, 1942 긴팔기생바다거미 (Fig. 78)

Nymphon elongatum Hilton 1942a:5.—Hedgpth, 1949:251, figs. 22, 34f.—Stock, 1954:17, fig. 5.—Hong & Kim, 1987:158, fig. 15.—Turpaeva, 2007a:99, pl. 4, figs. 12–15.—Kim, 2013:83, fig. 40.

Diagnosis

Trunk fully segmented, glabrous. Cephalic segment protruding anteriorly, having long neck. Lateral processes long, separated by more than 2 times of diameter. Ocular tubercle present at posterior part of cephalic segment, as long as basal width, having papillae on dorsolateral margin. Proboscis cylindrical, as long as neck. Abdomen short, not reaching beyond distal margin of lateral process 4. Palp 5-segmented; segment 2 longest. Chelifore present; chela having 20 or more teeth. Oviger 10-segmented; terminal claw having 20 teeth. Legs thin, long; tarsus about 2 times as long as propodus; auxiliary claws 0.5 times as long as main claw.

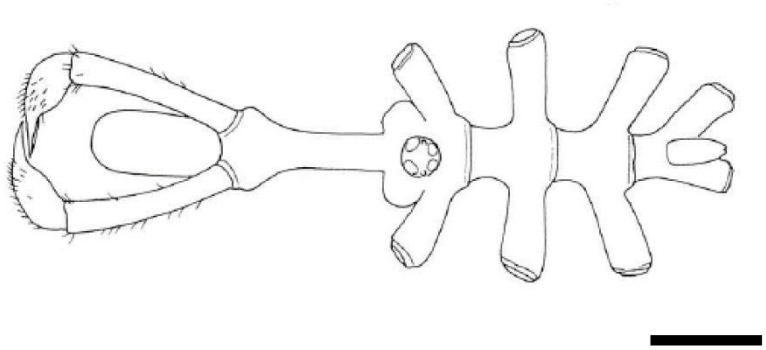


Fig. 78. *Nymphon elongatum*. Trunk, dorsal view. Scale bar = 1 mm. Modified from Kim (2013).

Distribution

Korea (Gangwon-do), Japan (Nagasaki), and Russia (Bering Island and Sakhalin Island).

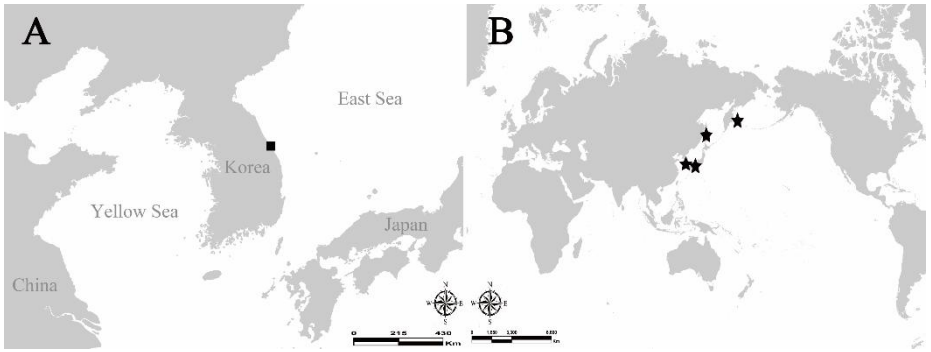


Fig. 79. Distribution of *Nymphon elongatum*. A, Distribution in Korea, ■ indicating previous record in Korea (Kim, 2013); B, Distribution in the world, ★ indicating worldwide distribution.

Remarks

The author didn't obtain this species in the Korean waters. To observe this species, USNM 80605 lodged in the Smithsonian Natural Museum of Natural History was borrowed and examined. Re-examining this specimen, it was not *N. elongatum*, but *N. longitarse* because the auxiliary claws were one third length of the main claw, and the tarsus was about 1.6 times as long as the propodus. Therefore, the specimen (USNM 80605) was re-identified to be *N. longitarse* collected near Sakhalin Island, Russia.

This species is morphologically closed to *Nymphon gunteri* Hedgpeth, 1949, *Nymphon heterospinum* Hedgpeth, 1949, and *Nymphon grossipes* (Fabricius, 1780). *Nymphon gunteri* has a smaller number of teeth at the fingers and two heel spines on the propodus. The auxiliary claws are one third length of the main claw. In *N. heterospinum*, there are three heel spines on the propodus and the auxiliary claws are one third length of the main claw. *Nymphon grossipes* has conical tip on the ocular tubercle. The palp segment 3 is the longest segment in the palp, while the palp segment 2 is the longest segment in this species. In addition, a long tarsus is conspicuous in this species.

This species is distributed between Bering Island, Russia and Nagasaki, Japan in latitude and 10–1600 m at depth range (Turpaeva, 2007a).

33. *Nymphon japonicum* Ortmann, 1891 매끈기생바다거미 (Fig. 80)

Nymphon japonicum Ortmann, 1891:158, Taf. 24, fig. 1a–c.—Loman, 1911:8.—Hedgpeth, 1949:249, fig. 20.—Utinomi, 1951:159.—Nakamura & Child, 1983:56.—Hirohito & Nakamura, 1987:5, pl. 3, figs. 1–11.—Hong &

Kim, 1987:158, fig. 16.—Turpaeva, 2007a:101, pl. 6, figs. 1–8.—Takahashi *et al*., 2012:1344, fig. 4.—Kim, 2013:85, fig. 41.

Material examined

4 inds. (1 ♂, 3 ♀♀), DM191103–04, DM191109–10, DMJagalchi Fish Market, Busan, Korea, 35°05'45.7"N 129°01'50.7"E, gill net, collected with shrimps, coll. M.S. Ryu & G.S. Lee, 9 Nov 2019.

Diagnosis

Trunk elongated, fully segmented. Cephalic segment protruding anteriorly, having neck. Lateral processes glabrous, separated by diameter. Ocular tubercle present at posterior part of cephalic segment, as long as basal width. Proboscis cylindrical, longer than neck. Abdomen short. Palp 5-segmented; segment 2 longest. Chelifore present; chela curved, having more than 30 teeth. Oviger 10-segmented; terminal claw having 5–9 teeth. Legs long, thin; tarsus as long as propodus in leg 1, shorter than propodus in leg 2–4; propodus having spines at sole; auxiliary claws 0.5 times as long as main claw.

Fig. 80. *Nymphon japonicum*, DM191104. Trunk, dorsal view. Scale bar = 5 mm.

Distribution

Korea (Gyeongsang-do and Jejudo Island) and Japan.

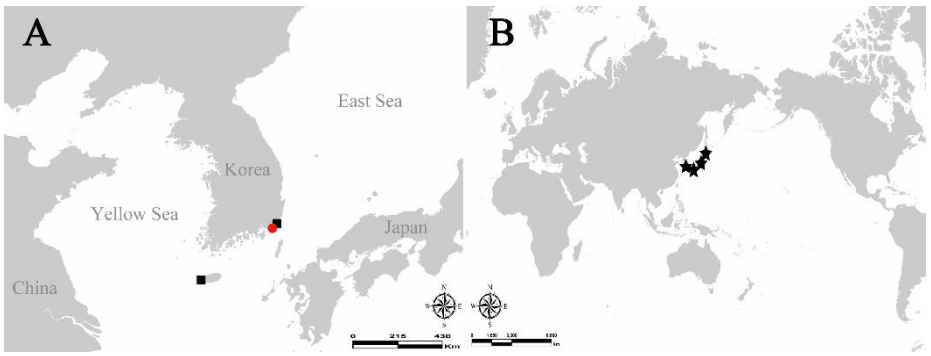


Fig. 81. Distribution of *Nymphon japonicum*. A, Distribution in Korea, ● indicating present study, ■ indicating previous records in Korea (Kim, 2013); B, Distribution in the world, ★ indicating worldwide distribution.

Remarks

The present species is close to *Nymphon ortmanni* Hedgpeth 1983 and *Nymphon micropedes* Hedgpeth 1983 having similar appearance in the dorsal view, but distinguished by details. The former is different from the present species in having short auxiliary claws, and palm as long as fingers. The latter has short tarsus and six sole spines at the propodus.

Observing the material, the trunk length of the male (10.07 mm) is longer than that of the female (8.64 mm) and the number of sole spines at the propodus is 15 not 10 in Kim (2013). The length ratio of the tarsus-propodus becomes shorter from the the leg 1 to leg 4 like Hong & Kim's (1987) descriptions. Takahashi *et al*. (2012) described that the immovable finger was shorter than the movable finger, however it was not observed in the present study. The oviger segment 5 of the male is long, curved, and swollen at the distal end. The gonopores are present on the ventral surface of the coxa 2 of the leg 3–4. The female specimens have the gonopores on the ventral surface of the coxa 2 of all legs.

The present species is distributed between Hokkaido and Kagoshima in latitude and 20–5488 m at depth range (Müller, 1993).

34. *Nymphon kodanii* Hedgpeth, 1949 고다니기생바다거미 (Fig. 82)

Nymphon kodanii Hedgpeth, 1949:252, fig. 23.—Stock, 1954:21.—Utinomi, 1955:7, fig. 3.—Nakamura & Child, 1991:53.—Turpaeva, 2007a:101, pl. 7, figs. 6–10.—Kim, 2013: 86, fig. 42.

Material examined

5 inds. (4 ♂♂, 1 ♀), DM191101–02, DM191105–07, Jagalchi Fish Market, Busan, Korea, 35°05'45.7"N 129°01'50.7"E, gill net, collected with shrimps, coll. M.S. Ryu & G.S. Lee, 9 Nov 2019.

Diagnosis

Trunk fully segmented. Cephalic segment protruding anteriorly, having long neck. Lateral processes having setae, separated by diameter. Ocular tubercle present at posterior part of cephalic segment, as long as basal width, having big eyes. Proboscis cylindrical. Abdomen cylindrical, reaching beyond distal margin of lateral process. Palp 5-segmented, setose; segment 2 longest. Chelifore distinct; chela having 15–20 teeth. Oviger 10-segmented; terminal claw having 11 teeth. Legs long, thin, setose; tarsus as long as propodus; propodus having spines at sole; auxiliary claws about 0.7 times as long as main claw.

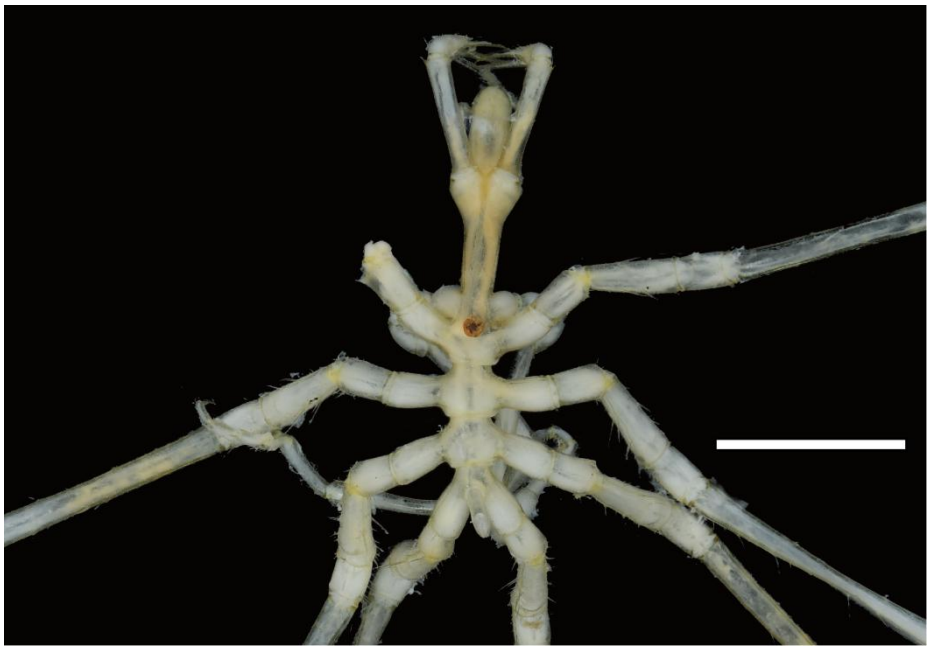


Fig. 82. *Nymphon kodanii*, DM191102. Trunk, dorsal view. Scale bar = 5 mm.

Distribution

Korea (Gyeongsang-do), Japan, and Russia (Kuril Islands).

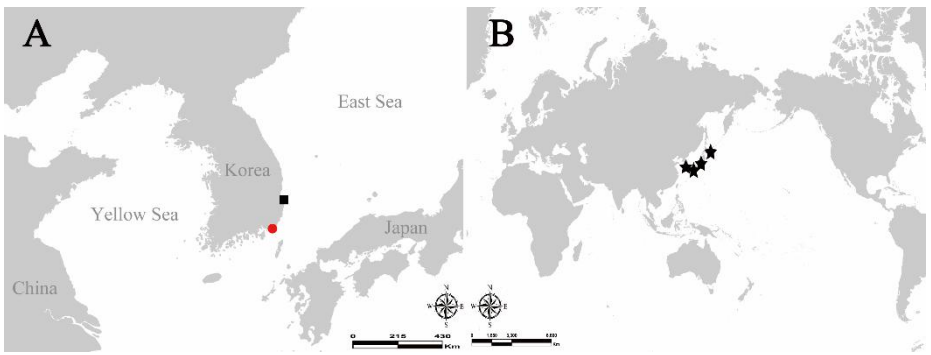


Fig. 83. Distribution of *Nymphon kodanii*. A, Distribution in Korea, ● indicating present study, ■ indicating previous record in Korea (Kim, 2013); B, Distribution in the world, ★ indicating worldwide distribution.

Remarks

The present species is similar to *Nymphon leptocheles* Sars, 1888, but the congener is distinguished by the followings: (1) The palp segment 4 is short (long in *N. leptocheles*). (2) Compound spines on the strigilis have 2–3 pairs of teeth (more serrated). (3) The tarsus is as long as the propodus (longer than propodus). (4) The auxiliary claws are long, more than 0.5 times of the main claw (short and tiny).

The present species has been reported having in a wide range of variations. Hedgpeth (1949) referred that the structure of the palp, tarsus, and setose legs was variable and Stock (1954) noted that features of setose legs, the tarsus, and the auxiliary claws were various. In addition, Nakamura & Child (1991) found more various features of the palp, the tarsus, and the auxiliary claws. Hedgpeth (1949) and Stock (1954) noted that some specimens had setose legs, but others had glabrous legs. The author found that the male legs were setose, but only the female legs were glabrous. This is thought to be a sexual dimorphism, but more specimens should be observed to confirm that it is not a coincidence. The oviger segment 5 in the male is long, curved, and swollen distally. The male gonopore is present on the ventral surface of the coxa 2 of the leg 3–4, while gonopores in the female present on the same position of all legs.

The present species is distributed between Kuril Islands, Russia and Kii Strait, Japan in latitude and 75–1970 m at depth range (Müller, 1993).

35. *Nymphon longitarse* Krøyer, 1844 긴발목기생바다거미 (Figs. 84, 85)

Nymphon longitarse Krøyer, 1844:112.—Wilson, 1878:19, pl. 7, fig. 2a–h; 1880:489, pl. 6, fig. 30.—Sars, 1891:75, pl. 7, fig. 3a–h.—Losina-Losinsk, 1933:67; 1961:65.—Needler, 1943:9, fig. 9.—Hedgpeth, 1943:86; 1948:190, fig. 13b; 1949:247.—Stock, 1955:217.—Utinomi, 1971:318.—Child, 1982a:43; 1995:23.—Turpaeva, 2004:1091.—Kim, 2013:88.

Nymphon longitarse longitarse.—Turpaeva, 2007a:99, pl. 4, figs. 1–5.

Material examined

1 ind. (1 ♀), NHMD 652671, Korean Sea, 45 ftm, coll. Suenson, 22 Jan 1882; Syntype, 1 ind. (1 ♂), NHMD 110685, Greenland; Syntype, 4 inds. (2 ♂♂, 2 ♀♀), NHMD 110686, Greenland; Syntype, eggs, NHMD 110687, Greenland; 2 inds. (1 ♂, 1 ♀), USNM 80605 (*N. elongatum*), East of Cape Terpeniya, Sakhalin Island, Russia, 48°43'30.0"N 145°03'00.0"E, 137 m, Trawl, 27 Sep 1906; 1 ind. (1 ♂), UNSM 128264, Lake Melville, Labrador, Canada, 53°56'30.1"N 58°58'12.0"W, 64 m, coll. D. Nutt, 23 Jul 1950.

Description

Trunk elongated, fully segmented, without ornamentation. Cephalic segment having neck, expanding anteriorly; neck articulated at middle (Fig. 84A).

Lateral processes about 2 times as long as basal width, widening distally, glabrous, separated by about 2 times of diameter (Fig. 84A).

Ocular tubercle present at posterior part of cephalic segment, as long as basal width, having round tip and papillae on dorsolateral margin; four eyes pigmented (Fig. 84A, 84B).

Proboscis cylindrical, about one third times as long as trunk length (Fig. 84A, 84B).

Abdomen articulated at base, cylindrical, tapering distally, erected upward, having small setae on dorsal surface (Fig. 84B).

Palp 5-segmented. Segment 2 slightly longer than segment 1, having setae on distal margin. Terminal segment about 1.2 times as long as segment 4. Segment 3–5 having many setae on ventral surface (Fig. 84D).

Chelifore 2-segmented, longer than proboscis in dorsal view (Fig. 84B, 84C). Scape cylindrical, about 5.6 times as long as basal width, having small setae. Chela curved, about 0.7 times as long as scape, having about 25 teeth; palm as long as immovable finger, slightly widening distally, having small setae on distal margin; movable finger longer and more curved than movable finger.

Oviger 10-segmented. segment 4 about 0.86 times as long as segment 5. Strigilis having compound spines arranged in 17:14:14:14; Terminal claw present, having 22 small teeth (Fig. 84D).

Leg 3 thin and long, covered in small setae (Fig. 84E). Coxa 1 glabrous, about 1.8 times as long as basal width. coxa 2 long, about 7 times as long as basal width. Coxa 3 about 2.6 times as long as basal width. Femur elongated, about 12 times as long as basal width, with rather long seta on dorsodistal margin. Tibia 1 elongated, longer than femur, about 21 times as long as basal width. Tibia 2 elongated, longer than tibia 1, about 29 times as long as basal width, having rather long seta on distal margin. Tarsus elongated, about 14 times as long as basal width, about 1.6 times as long as propodus (Fig. 84F).

Propodus elongated, about 9.7 times as long as basal width, having short setae at sole; sole setae shorter than basal width. Main claw long, about 0.6 times as long as propodus. Auxiliary claws tiny, about 0.2 times as long as main claw.

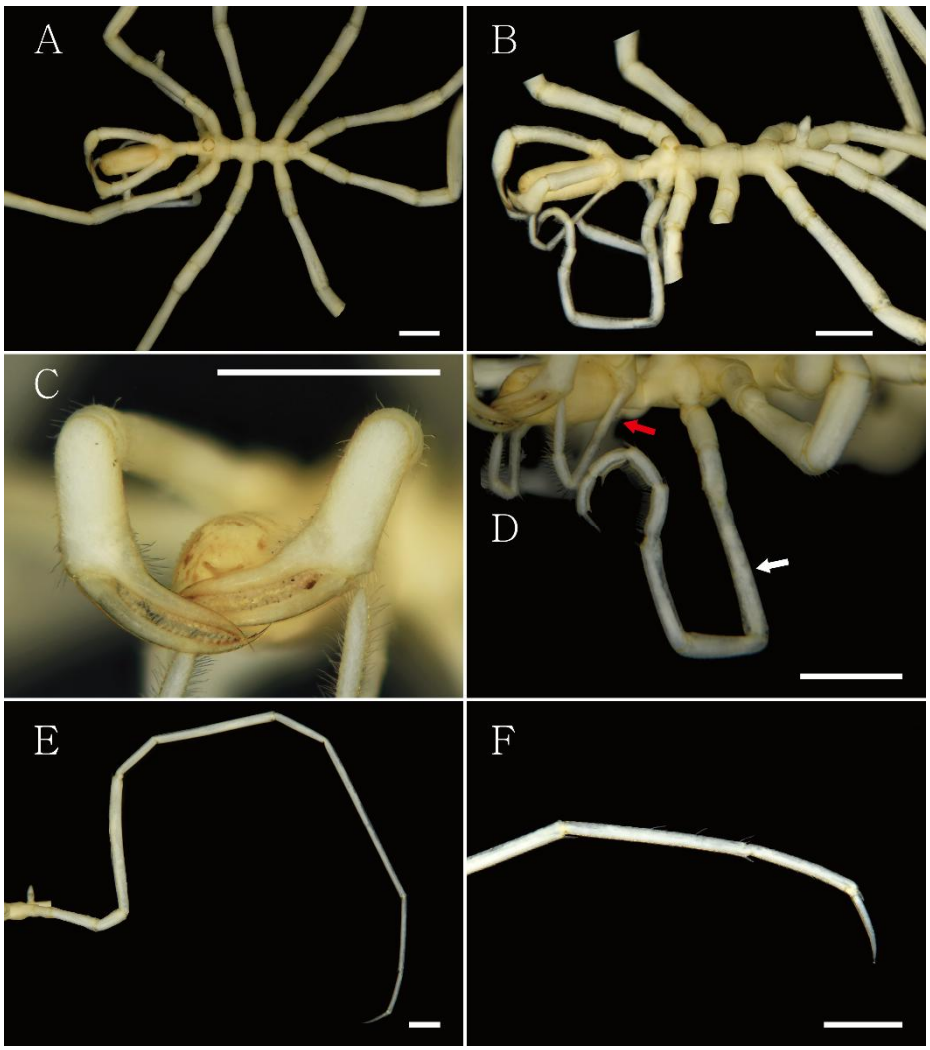


Fig. 84. *Nymphon longitarse*, NHMD 652671. A, Trunk, dorsal view; B, Trunk, lateral view; C, Chela, anterior view; D, Palp and oviger, red arrow indicating palp and white arrow indicating oviger; E, Leg 3; F, Distal segments of leg 3. Scale bars = 1 mm (A–F).

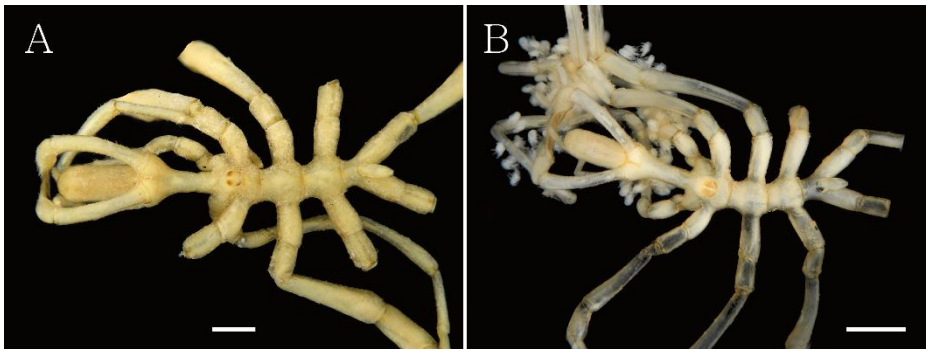


Fig. 85. *Nymphon longitarse*, NHMD 110686 (Syntype, female, A), USNM 128264 (male, B). A, Trunk, dorsal view; B, Trunk, dorsal view. Scale bars = 1 mm (A, B).

Measurements (mm)

NHMD 652671, trunk length, 4.17; width, 1.78; proboscis, 1.45; abdomen, 0.56. Leg 3; coxa 1, 0.64; coxa 2, 1.98; coxa 3, 0.74; femur, 4.33; tibia 1, 5.61; tibia 2, 7.50; tarsus, 2.35; propodus, 1.42; main claw, 0.93; auxiliary claw, 0.20.

Distribution

Korea and the Circumpolar regions in boreal-arctic waters.

Fig. 86. Distribution of *Nymphon longitarse*. ★ indicating worldwide distribution. Korean distritubion recorded by Stock (1955).

Remarks

The present species is similar to *Nymphon pixellae* Scott, 1912 in having tarsus longer than the propodus and no tubercle under the scape, but distinguished by the ratio of the auxiliary claws. The auxiliary claws of the present species are about 0.3 times as long as the main claw, while in *N. pixellae*, they are about half times as long as the main claw.

The author didn't collect the present species living in Korean waters. To observe the present species, the museum specimens lodged in the Natural

History Museum of Denmark and the Smithsonian Natural Museum of Natural History were borrowed including the specimen collected in Korea coast (NHMD 652671), and examined. From the observation, USNM 80605 is not *N. elongatum*, but *N. longitarse* having auxiliary claws about 0.3 times as long as the main claw and the tarsus about 1.6 times as long as the propodus. Any heel spine is not found. Therefore, the specimen (USNM 80605) is re-identified to *N. longitarse* collected near Sakhalin Island, Russia.

Segmentation line of the neck was clearly observed at middle of the neck including the Syntype specimens, which was not mentioned even in the original description (Fig. 85A). The segmentation line of UNSM 128264 is faint, but clearly present (Fig. 85B). This line is also found in *Nymphon micronesicum* Child, 1982 and *Nymphon giraffa* Loman, 1908. Child (1982) raised the possibility that it could be an artifact, but further study has not been conducted. Stock (1955) mentioned length variations of the finger and the palp segment 4, but these variations are not found in the examined material. On a female Syntype specimen, only right leg 4 has different morphological features from the other legs in having the ratio of tarsus-propodus to 1:1 and the auxiliary claws are half times as long as the main claw. The trunk length ranges in 3.69–6.01 mm.

The male has gonopores on the ventral surface of the coxa 2 of the leg 3–4 and oviger segment 5 is long, curved, and swollen distally. The female has gonopores on the same position of all legs.

The present species is distributed at the Circumpolar regions in boreal-arctic waters. The Korean record should extend the Southern Limit Line of the present species, but the exact location is unknown.

36. *Nymphon striatum* Losina-Losinsky, 1929 흑기생바다거미 (Fig. 87)

Nymphon striatum Losina-Losinsky, 1929:538, fig. 1; 1933:64, fig. 13.—Utinomi, 1954:2, fig. 1.—Hong & Kim, 1987:160.—Nakamura & Child, 1991:61.—Turpaeva, 2007a:98, pl. 3, figs. 7–12.—Kim 2013:89, fig. 43.

Material examined

1 ind. (1 ♂), DM191108, Jagalchi Fish Market, Busan, Korea, 35°05'45.7"N 129°01'50.7"E, gill net, collected with shrimps, coll. M.S. Ryu & G.S. Lee, 9 Nov 2019; 3 inds. (1 ♂, 2 juveniles), DM180412–14, Molar Rock point, IntotheSea Resort, Yangyang, Gangwon-do, Korea, 16 m, SCUBA, coll. D. Lee, 18 Apr 2018.

Diagnosis

Trunk elongated, fully segmented. Cephalic segment protruding anteriorly, having neck, bearing tubercle under chelifore. Lateral processes long, separated by about twice of diameter. Ocular tubercle low, present at base of neck. Proboscis cylindrical, as long as neck. Abdomen short, not reaching distal margin of lateral process. Palp 5-segmented. chelifore present; chela having around 25 teeth. Oviger 10-segmented; terminal claw having 15 teeth. Legs long, thin, setose; tarsus longer than propodus; auxiliary claws 0.5 times as long as main claw.

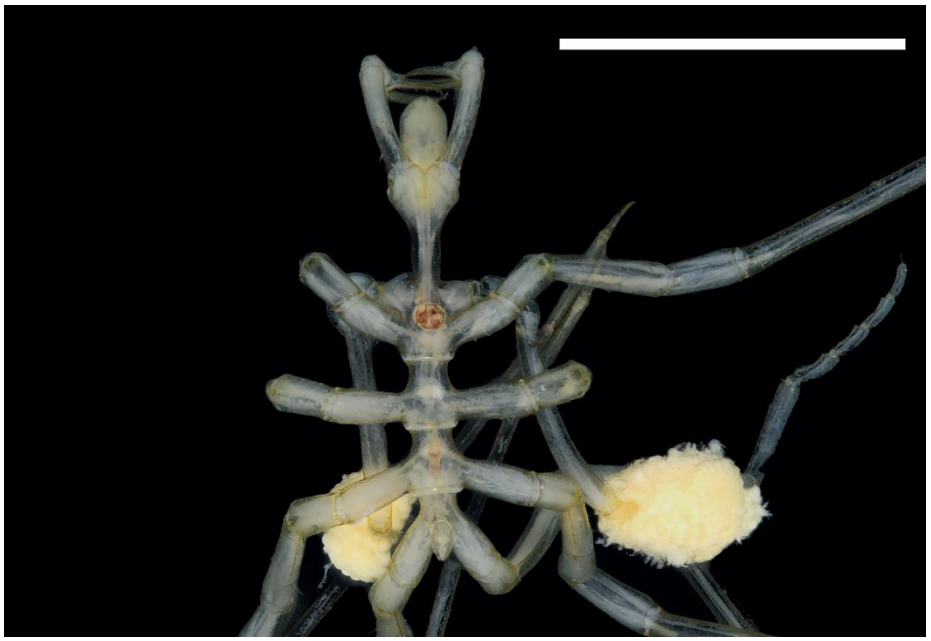


Fig. 87. *Nymphon striatum*, DM191108. Trunk, dorsal view. Scale bar = 5 mm.

Distribution

Korea (Gyeongsang-do and Gangwon-do), Japan (from Toyama bay to Hokkaido), and Russia (Sakhalin Island).

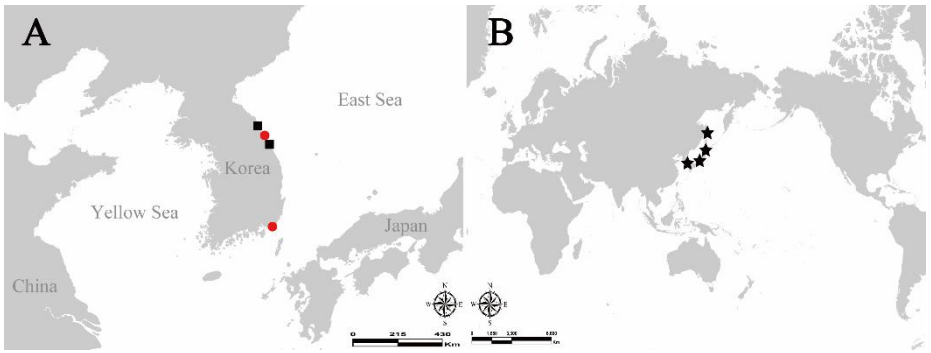


Fig. 88. Distribution of *Nymphon striatum*. A, Distribution in Korea, ● indicating present study, ■ indicating previous records in Korea (Kim, 2013); B, Distribution in the world, ★ indicating worldwide distribution.

Remarks

The present species is close to *Nymphon basispinosum* Hedgpeth, 1949 having tubercles under the scape, but the congener is distinguished by the followings: (1) There is not large heel spine on the propodus (having large heel spines in *N. basispinosum*). (2) The tarsus is longer than the propodus (subequal to propodus).

The trunk length of the examined material varies from 2.51 to 6.04 mm showing a wide range of variations even in the adult stage. Although the length of the tarsus and the propodus varies from the juvenile to the adult stage, they are identified to the same species. It is also supported by Pairwise Distance comparison of DNA barcodes (COI region) having little difference between the adult and juvenile specimens (Table 7). Therefore, this ratio seems to be applied only in the adult stage.

The present study extends distritubion of the Southern Limit Line of the present species to Gyeongsang-do. The present species is distributed between 0–212 m at depth range (Müller, 1993).

Table 7. *Nymphon striatum*. Pairwise Distance comparison (%)

		1	2
1	180412 (juvenile)		
2	180413 (♂)	0.6	
3	191108 (♂)	0.9	0.6

37. *Nymphon uniunguiculatum* Losina-Losinsky, 1933

외발톱기생바다거미 (Fig. 89)

Nymphon uniunguiculatum Losina-Losinsky, 1933:62, fig. 12; 1961:72.—Hedgpeth, 1949:263, fig. 29.—Hong & Kim, 1987:161.—Turpaeva, 2004:1096; 2007a:104, pl. 6, figs. 9–16.—Kim, 2013:91, fig. 44.

Material examined

1 ind. (1 ♀), Ayajin Harbor, Goseong, Gangwon-do, Korea, 38°16'17.9"N 128°33'22.1"E, coll. J.H. Won, 27 Mar 2019.

Diagnosis

Trunk elongated, fully segmented. Cephalic segment protruding anteriorly, having neck. Lateral processes glabrous, long, separated by more than diameter. Ocular tubercle present at posterior part of cephalic segment. Proboscis cylindrical, longer than neck. Abdomen cylindrical, not reaching distal margin of lateral process. Palp 5-segmented, long; segment 2 as long as segment 3; segment 4 as long as terminal segment. Chelifore long; scape longer than proboscis; chela having tiny teeth. Oviger 10-segmented; terminal claw having 25 tiny teeth. Legs long, thin; tarsus longer than propodus; main claw about 0.7 times as long as propodus; auxiliary claw absent.

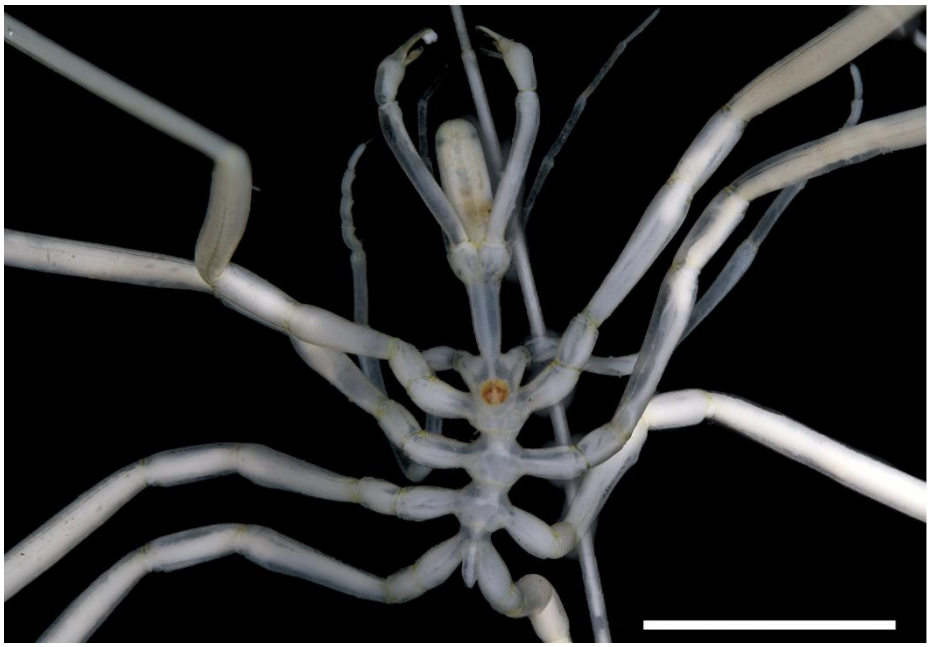


Fig. 89. *Nymphon uniunguiculatum*. Trunk, dorsal view. Scale bar = 5 mm.

Distribution

Korea (Gangwon-do), Japan (Benkei Misaki, Hokkaido), and Russia (Peter the Great Bay).

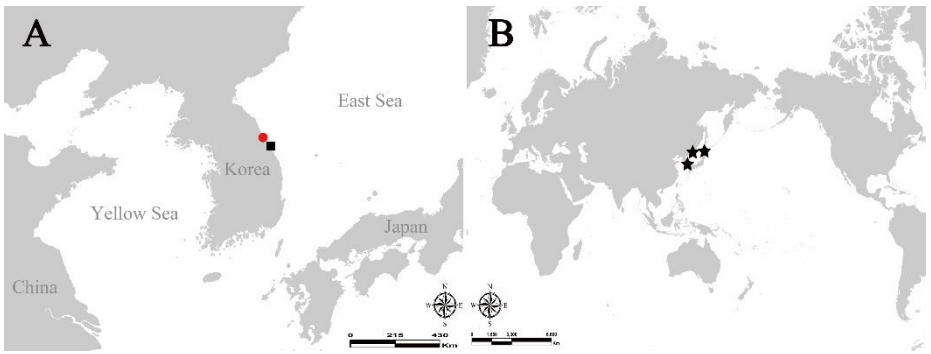


Fig. 90. Distribution of *Nymphon uniunguiculatum*. A, Distribution in Korea, ● indicating present study, ■ indicating previous record in Korea (Kim, 2013); B, Distribution in the world, ★ indicating worldwide distribution.

Remarks

The absence of the auxiliary claws is a distinct characteristic of the present species among the *Nymphon* species. *Nymphon albatrossi* Hedgpeth, 1949, is close to the present species in terms of morphology, but distinguished by the followings: (1) The palp segment 5 is as long as the segment 4 (segment 5 longer than segment 4 in *N. albatrossi*). (2) The chela has many tiny teeth (large teeth). (3) The main claw is about 0.7 times as long as the propodus (main claw longer than propodus).

The trunk length of the examined material (7.16 mm) is longer than the type specimens (Holotype, male, 5.3 mm; Paratype, female, 6.15 mm) and shorter than Kim's (2013) specimen (8.04 mm). The female specimen has a gonopore on the ventral surface of the coxa 2 of all legs. The oviger segment 4 is as long as segment 5.

The present species is distributed between Peter the Great Bay, Russia and Gangwon-do, and 150–770 m at depth range (Turpaeva, 2007a).

Family Pallenopsidae Fry, 1978 무촉지바다거미과

Genus *Pallenopsis* Wilson, 1881 무촉치바다거미속

Diagnosis

Trunk segmented, without dorsal tubercle. Cephalic segment protruding over proboscis. Palp atrophied to node. Chelifore 2 to 3-segmented; finger oriented at distinct angle on palm. Oviger 10-segmented, without terminal claw. Auxiliary claw present.

Type species

Pallenopsis fluminensis (Krøyer, 1844)

38. *Pallenopsis sibogae* Loman, 1911 (Figs. 91, 92)

Pallenopsis plumipes Loman, 1908:66, Taf. 12, figs. 160–164.

Pallenopsis sibogae Loman, 1911:13.—Stock, 1954:63, fig. 30h–i.—Utinomi, 1955:19, fig. 11; 1959:199.—Hirohito & Nakamura, 1987:10, pl. 8, figs. 1–7.

Pallenopsis (*Pallenopsis*) *sibogae*.—Nakamura & Child, 1991:41.

Material examined

1 ind. (1 ♀), NIBRIV0000862977, Hangaechang point, Moonseom Island, Jejudo Island, Korea, 33°13'39.5"N 126°33'49.1"E, 40 m, Trimix SCUBA, coll.

S.H. Lee, 13 Sep 2018; 1 ind. (1 juvenile), East of Moonseum Island, Jejudo Island, Korea, 33°13'36.0"N 126°34'11.9"E, collected on Bryozoa, 57.7 m, Trimix SCUBA, coll. D. Lee, 26 Jul 2019; 1 ind. (1 juvenile), North of Saekkiseum Island, Moonseom Island, Jejudo Island, Korea, 33°13'40.3"N 126°34'04.0"E, collected on Bryozoa, 52 m, Trimix SCUBA, coll. D. Lee, 16 Aug 2019.

Description

Trunk elongated, fully segmented, without ornamentation. Cephalic segment protruding anteriorly (Fig. 91A).

Lateral processes cylindrical, about 1.3 times as long as basal width, separated by about 2 times of diameter, having three setae on dorsodistal margin; setae feather-shaped, about half times as long as diameter of lateral process (Fig. 91A).

Ocular tubercle present at anterior margin of cephalic segment, about 0.7 times as long as basal width, rising steeply on posterior surface, sloping down gently on anterior surface; four eyes pigmented (Fig. 91B, 91C).

Proboscis cylindrical, attached to ventral surface of cephalic segment, about 0.16 times as long as trunk length (Fig. 91C).

Abdomen not articulated, glabrous, erected upward, cylindrical, slightly widening at three fourth from base, tapering distally, having cleft tip (Fig. 91B).

Palp 1-segmented, bud-shaped, heading downward (Fig. 91C).

Chelifore 2-segmented. Scape cylindrical, widening at distal margin, about 3.7 times as long as basal width, having many short setae on distal margin.

Chela having short setae; palm cylindrical, about 3 times as long as fingers; fingers wedge-shaped, oriented at distinct angle to palm (Fig. 91C, 91D).

Oviger 9-segmented, having short setae. Segment 4 longest in oviger segments, about 0.9 times as long as segment 2. Segment 6 not curved, having three short setae on outer surface. Segment 7 having two setae on inner surface and seta on outer distal margin. Segment 8 without seta. Terminal segment about 2.5 times as long as basal width, subequal to segment 8, having five setae (Fig. 91E).

Leg 3 having many feather-shaped setae (Fig. 91F). Coxa 1 as long as basal width, having two dorsal setae on laterodistal margin; setae as long as or longer than basal width of coxa 1. Coxa 2 elongated, about 4 times as long as basal width, slightly swollen at ventrodistal margin, having two dorsolateral setae at two third from base. Coxa 3 about 1.3 times as long as basal width, slightly swollen at ventrodistal margin. Femur elongated, longer than tibia 1, about 11 times as long as basal width, having long and short setae. Tibia 1 elongated, about 16 times as long as basal width, having many dorsal setae. Tibia 2 elongated, longer than femur, about 26 times as long as basal width, having many dorsal setae. Tarsus short, with dorsal seta, having strong spine and setae at surface. Propodus curved, with setae on dorsal surface, having three heel spines, two small heel spines, six sole spines, two small setae at sole. Main claw curved, about half times as long as propodus. Auxiliary claws about 0.6 times as long as main claw.

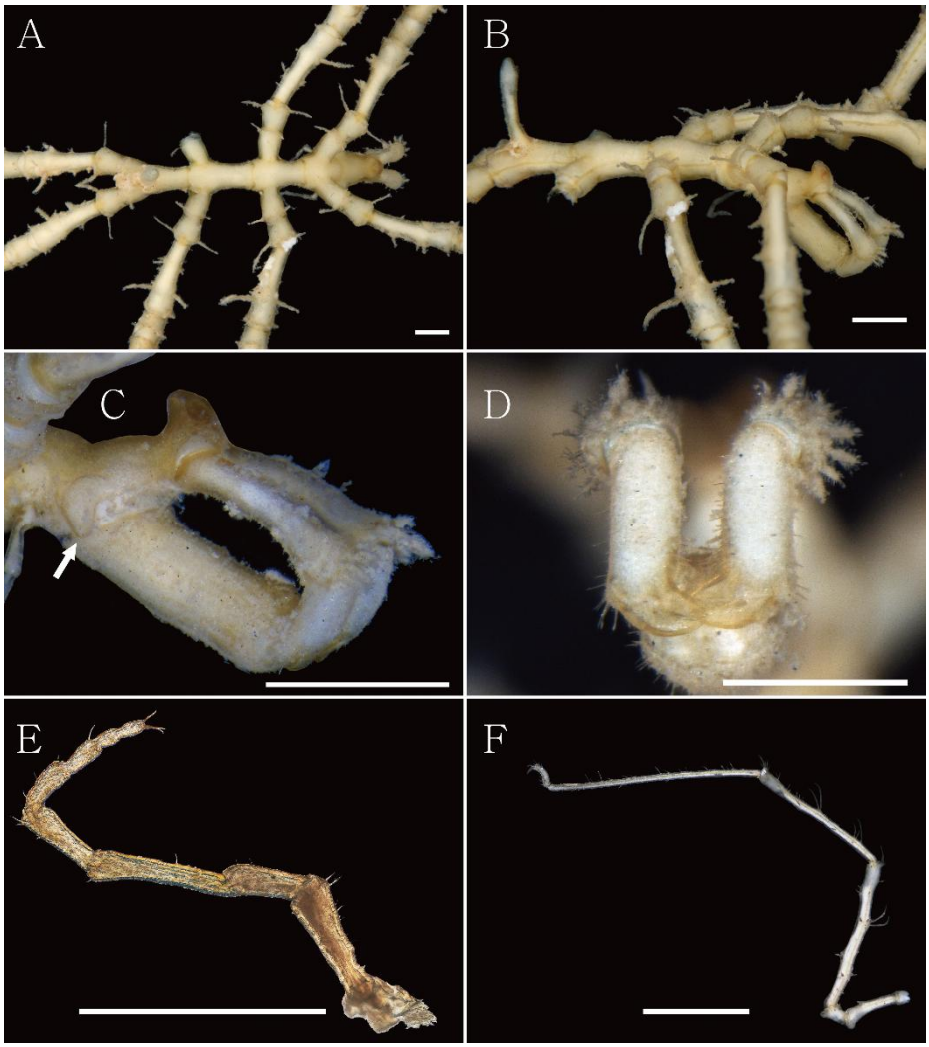


Fig. 91. *Pallenopsis sibogae*, NIBRIV0000862977 (female). A, Trunk, dorsal view; B, Trunk, lateral view; C, Anterior part of trunk, arrow indicating palp; D, Chela, anterior view; E, Oviger; F, Leg 3. Scale bars = 1 mm (A–E), 5 mm (F).

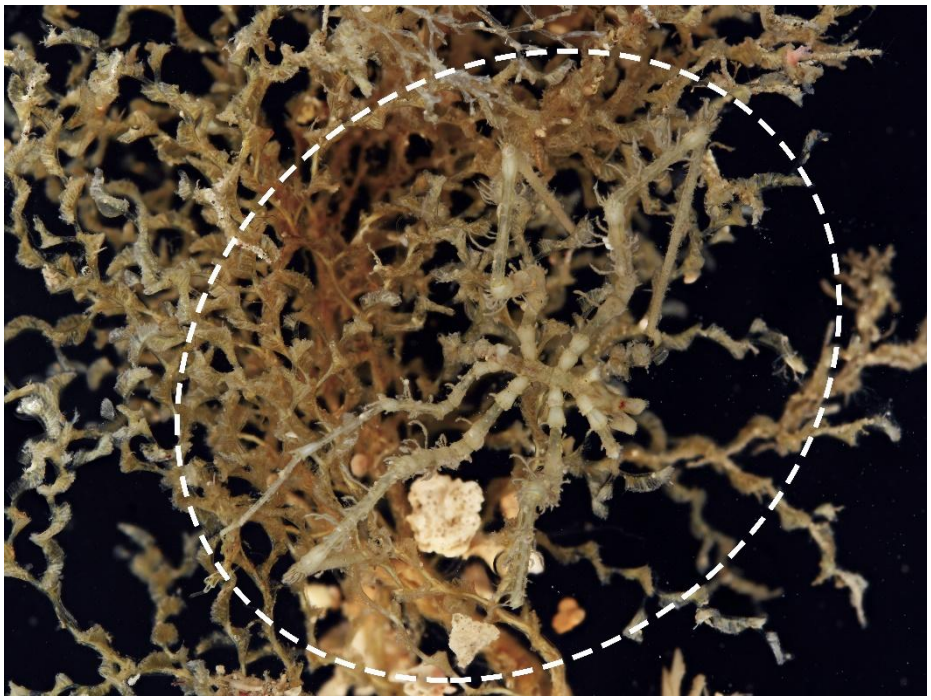


Fig. 92. *Pallenopsis sibogae*, juvenile. Circle indicating pycnogonid collected on bryozoan.

Measurement.

NIBRIV0000862977, trunk length, 7.67; width, 2.51; proboscis, 1.20; abdomen, 1.61. Leg 3; coxa 1, 0.64; coxa 2, 2.67; coxa 3, 0.85; femur, 7.16; tibia 1, 6.89; tibia 2, 10.06; tarsus, 0.28; propodus, 0.98; main claw, 0.53; auxiliary claw, 0.33.

Distribution

Korea (Jejudo Island) and from Japan (Sagami Bay and Suruga Bay) to Indonesia.

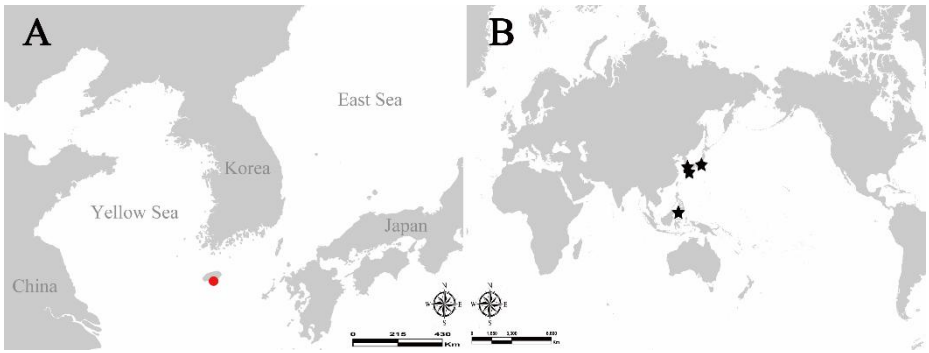


Fig. 93. Distribution of *Pallenopsis sibogae*. A, Distribution in Korea, ● indicating present study; B, Distribution in the world, ★ indicating worldwide distribution.

Remarks

The present species is close to *Pallenopsis schmitti* Hedgpeth, 1943a, *Pallenopsis kempfi* Stock, 1975, and *Pallenopsis childi* Stock, 1986 in having elongated trunk, slenderness of the lateral processes, and hairy legs. The present species is easily distinguished from the congeners by having feather-shaped setae and very long tibia 2.

In previous literature, the present species has 10-segmented ovigers in both genders, however, the examined material (NIBRIV0000862977) has 9-segmented ovigers. It is presumed that two segments were fused together or a distal segment was lacking innately. The terminal segment of the ovigers has five setae, while Stock (1954) recorded four setae on the terminal segment. The

female specimen is longer than the holotype (female, 6.5 mm) and a Japanese specimen (Utinomi, 1955, male, 6.0 mm).

The present species is distributed between Sagami Bay, Japan and Indonesia in latitude and 37–160 m at depth range (Müller, 1993).

Family Phoxichilidiidae Sars, 1981 낫바다거미과

Genus *Anoplodactylus* Wilson, 1878 낫바다거미속

Diagnosis

Trunk usually elongated and segmented. Cephalic segment protruding over proboscis. Proboscis inserted ventrally. Palp absent. Chelifore functional. Oviger 6-segmented in only male, without terminal claw. Propodus usually having lamina at sole. Auxiliary claw tiny or lacking.

Type species

Anoplodactylus lentus Wilson, 1878

Key to the *Anoplodactylus* species in Korean waters.

1. Lateral processes touching each other ..... *A. crassus*

- Lateral processes separated 2

2. Femur having more than two cement gland cups in male 3

- Femur having cement gland tube in male 5

3. Trunk elongated. Ocular tubercle having conical tip 4

- Trunk not elongated. Ocular tubercle low, having blunt tip ..... *A. pycnosoma*

4. Proboscis ornamented with three triangular tubercles at distal margin ..... *A. stellatus*

- proboscis without ornamentation. ..... *A. velamellus*

5. Tubercle present on dorsodistal margin of lateral process ..... *A. erectus*

- Tubercle absent on lateral process 6

6. Ocular tubercle about 4 times as long as basal width ..... *A. tubiferus*

- Ocular tubercle low ..... *A. hwanghaensis*

39. *Anoplodactylus crassus* Nakamura & Child, 1988 접시낫바다거미 (Fig. 94)

Anoplodactylus crassus Nakamura & Child, 1988b:810, fig. 1; 1991:25.—Kim, 2013:103, fig. 49.

Anoplodactylus viridintestinalis.—Kim & Hong, 1986:44.—Hong & Kim, 1987:225.

Material examined

Anoplodactylus crassus

1 ind. (1 ♂), DM103, Gamji beach, Busan, Korea, 35°03'35.3"N 129°04'28.2"E, 7 m, SCUBA, coll. D. Lee, 22 Sep 2016; 1 ind. (1 ♀), Jumunjin Breakwater, Gangneung, Gangwon-do, Korea, 14 Oct 2003; 1 ind. (1 ♂), Oedolgae point, Seoguipo, Jejudo Island, Korea, 33°14'22.1"N 126°32'56.0"E, 8 m, SCUBA, coll. D. Lee, 9 Jan 2017; 2 inds. (1 ♂, 1 ♀), East of Moonseum Island, Jejudo Island, Korea, 33°13'36.4"N 126°34'07.7"E, 13 m, SCUBA, coll. D. Lee, 13 Apr 2017; 1 ind. (1 ♀), Ttongnyeo point, Dokdo, Korea, 37°14'36.9"N 131°51'41.1"E, 17 m, SCUBA, coll. D. Lee, 18 Jul 2018; 1 ind.

(1 ♀), near Guryongpo Dive Resort, Pohang, Gyeongsangbuk-do, Korea, 36°00'48.0"N 129°35'19.4"E, 32 m, SCUBA, coll. D. Lee, 20 Sep 2018; 1 ind. (1 ♀), North of Moonseum Island, Jejudo Island, Korea, 33°13'41.0"N 126°34'04.5"E, 37 m, SCUBA, coll. D. Lee, 27 Nov 2018; 1 ind. (1 ♂), near Wolpo C Reisure Resort, Pohang, Gyeongsangbuk-do, Korea, 36°11'53.6"N 129°22'48.4"E, 12 m, SCUBA, coll. G.S. Kim, T. Lee & D. Lee, 28 Mar 2019; 1 ind. (1 ♂), Intertidal zone of Yeonhwa-ri, Tongyeong, Gyeongsangnam-do, Korea, 34°46'13.2"N 128°23'49.4"E, rocky shore, coll. S.H. Kim, 30 Jul 2019; 1 ind. (1 juvenile), Intertidal zone of Bijindo Island, Tongyeong, Gyeongsangnam-do, Korea, 34°43'01.1"N 128°27'37.4"E, rinsing algae, coll. D. Lee, 29 Oct 2019; 2 inds. (1 ♀, 1 juvenile), South of Bukheongjae Island, Busan, Korea, 34°55'54.7"N 128°58'26.4"E, 31 m, SCUBA, coll. D. Lee, 5 Dec 2019.

Anoplodactylus viridintestinalis

10 inds. (4 ♂♂, 6 ♀♀), USNM 122432, Dillon Beach, Tomales Bay, California, United States, collected on bryozoan, coll. O. Hartman, 20 Dec 1934.

Diagnosis

Trunk unsegmented; segment 3–4 segmented in female. Lateral processes touching each other, having tubercle at dorsodistal margin. Ocular tubercle having round tip with posterior tubercle. Proboscis cylindrical. Abdomen borad at base, tapering distally in lateral view. Palp absent. Chelifore present; scape having three dorsal tubercles; movable finger having five teeth; immovable finger having three teeth. Oviger present only in male, 6-segmented. legs having setae; coxa 2 having low coxal spur in male; femur having cement gland

at dorsomedian surface; propodus having long lamina; auxiliary claw absent.

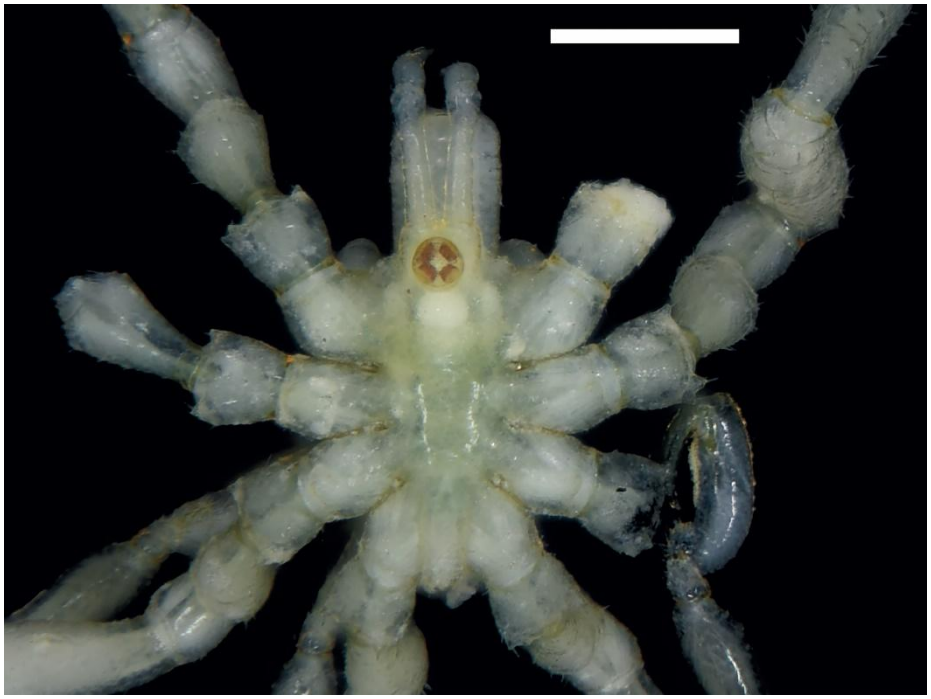


Fig. 94. *Anoplodactylus crassus*, DM103. Trunk, dorsal view. Scale bar = 0.5 mm.

Distribution

Korea (Gangwon-do, Gyeongsang-do, Jeolla-do, Chungcheong-do, and Jejudo Island), Japan (Honshu), and Samoa.

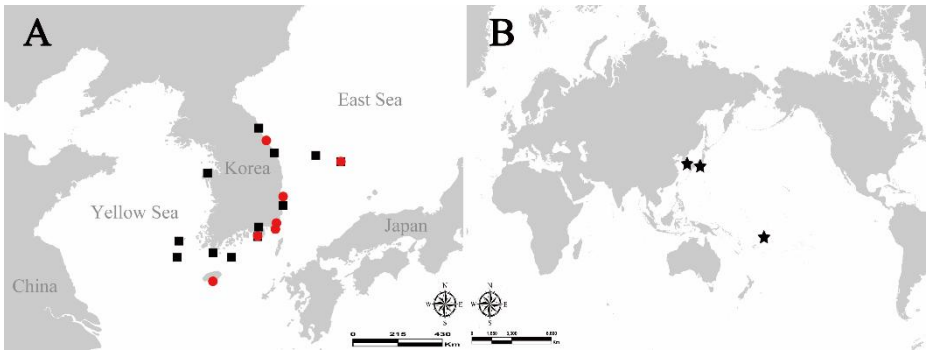


Fig. 95. Distribution of *Anoplodactylus crassus*. A, Distribution in Korea, ● indicating present study, ■ indicating previous records in Korea (Kim, 2013); B, Distribution in the world, ★ indicating worldwide distribution.

Remarks

The present species is morphologically close to *Anoplodactylus viridintestinalis* (Cole, 1904). Although Kim & Hong (1986) and Hong & Kim (1987) had identified the present species as *A. viridintestinalis*, Kim (2013) accepted Nakamura & Child's notes (1998) and revised it to *A. crassus*. The present species is distinguished from the congener by the followings: (1) Three tubercles are present on the dorsal surface of the scape (0–1 tubercle in *A. viridintestinalis*). (2) The abdomen is broad at the base, tapering to tip in the lateral view (cylindrical). (3) There are three dorsodistal tubercles on the coxa 1 (0–1 tubercle). (4) The coxal spur is not prominent (long and distinct). Nakamura & Child (1988b) also mentioned that *A. crassus* had a round tip on the ocular tubercle and a seta at the tip of the lateral process tubercle, while *A.*

viridintestinalis had a conical tip on the ocular tubercle and a seta near the tubercle. However, the shape of the ocular tubercle and the position of a seta are mixed in both species. Based on the observation, these two features are thought to be variations and not useful to distinguish the both species.

The trunk segment 3–4 of the female are well separated as Kim's (2013) descriptions, which was not mentioned at the original description. Although Kim (2013) noted that a tubercle was absent on the dorsal surface of the lateral process 2 in the female, the examined material has a dorsal tubercle on same position as the original description. Trunk length ranges in 0.69–1.04 mm regardless of the gender. The lateral processes of the male are touching each other, but the lateral process 3–4 of the female are well separated. The male is easily distinguished by having complete ovigers and a gonopore on the ventral surface of the coxa 2 of the leg 3–4. In the female, the oviger is absent and a gonopores is present on same position of all legs.

The present species is distributed between Gangwon-do and Samoa in latitude (Müller, 1993) and the present study extends depth range at 0–37 m.

40. *Anoplodactylus erectus* Cole, 1904 돌기낫바다거미 (Fig. 96)

Anoplodactylus erectus Cole, 1904:289, pl. 26: figs. 1–10.—Hilton, 1939:28; 1942b:283, pl. 37.—Stock, 1955:239, figs. 13–14.—Child, 1970:288; 1979:52; 1992a:37.—Kim & Hong, 1986:41, fig. 5.—Hong & Kim, 1987:161.—Nakamura & Child, 1988b:813; 1991:25.—Müller, 1989:126.—Bamber, 1997:147, fig. 3.—Kim, 2013:96, fig. 46.

Material examined

Paratype, 4 inds. (4 ♂♂), USNM 81299, San Diego, California, US, coll. Kelsey, Sep 1896; 1 ind. (1 ♀), Moonseum Island, Jejudo Island, Korea, 33°13'36.7"N 126°34'06.5"E, 25 m, collected with feather star, SCUBA, coll. D. Lee, 28 Apr 2016; 1 ind. (1 ♀), Eastof Moonseum Island, Jejudo Island, Korea, 33°13'35.3"N 126°34'07.4"E, 20 m, SCUBA, coll. D. Lee, 11 Apr 2017; 1 ind. (1 juvenile), Hupo, Chujado Island, Jejudo Island, Korea, 33°57'37.7"N 126°16'59.8"E, 22 m, SCUBA, coll. D. Lee, 13 Sep 2017; 1 ind. (1 ♂), DM180938, near Guryongpo Scuba Resort, Guryongpo, Pohang, Gyeongsangbuk-do, Korea, 36°00'48.0"N 129°35'19.4"E, 16 m, SCUBA, coll. S.H. Lee, 19 Sep 2018; 11 inds. (4 ♂♂, 7 ♀♀), near Guryongpo Scuba Resort, Guryongpo, Pohang, Gyeongsangbuk-do, Korea, 36°00'48.0"N 129°35'19.4"E, 16 m, SCUBA, coll. S.H. Lee, 19 Sep 2018; 1 ind. (1 ♀), near Guryongpo Scuba Resort, Guryongpo, Pohang, Gyeongsangbuk-do, Korea, 36°00'48.0"N 129°35'19.4"E, 32 m, SCUBA, coll. D. Lee, 20 Sep 2018; 1 ind. (1 juvenile), Southwest of Moonseum Island, Jejudo Island, Korea, 33°13'27.2"N 126°33'51.8"E, 55 m, Trimix SCUBA, coll. D. Lee, 12 Sep 2018; 2 inds. (2 ♀♀), West of Moonseum Island, Jejudo Island, Korea, 33°13'38.4"N 126°33'47.9"E, SCUBA, coll. Y.H. Kim, 25 Oct 2017; 1 ind. (1 ♂), Moonseum Island, Jejudo Island, Korea, SCUBA, coll. Y.H. Kim, 24 May 2018; 1 ind. (1 ♂), Baechi Rock point, Geomundo Island, Yeosu, Jeollanam-do, Korea, 34°00'18.9"N 127°19'34.2"E, 23 m, SCUBA, coll. D. Lee, 11 Jul 2019.

Diagnosis

Trunk fully segmented. Cephalic segment protruding anteriorly. Lateral processes long, separated by less than diameter, having tubercle on dorsodistal margin. Ocular tubercle slightly longer than basal width. proboscis cylindrical.

Abdomen cylindrical, long, reaching beyond distal margin of lateral process. Palp absent. Chelifore present; scape without dorsal tubercle; fingers without teeth. Oviger present only in male, 6-segmented. legs long, setose; coxa 2 having coxal spur at leg 3–4 in male; femur having cement gland at dorsomedian surface; propodus having short lamina at inner distal margin; auxiliary claws tiny.

Fig. 96. *Anoplodactylus erectus*, DM180938. Trunk, dorsal view. Scale bar = 0.5 mm.

Distribution

Korea (Jeolla-do, Gyengsang-do, and Jejudo Island), Japan, Samoa, Hawaii, Canada, US, Mexico, Colombia, Ecuador, and Chile.

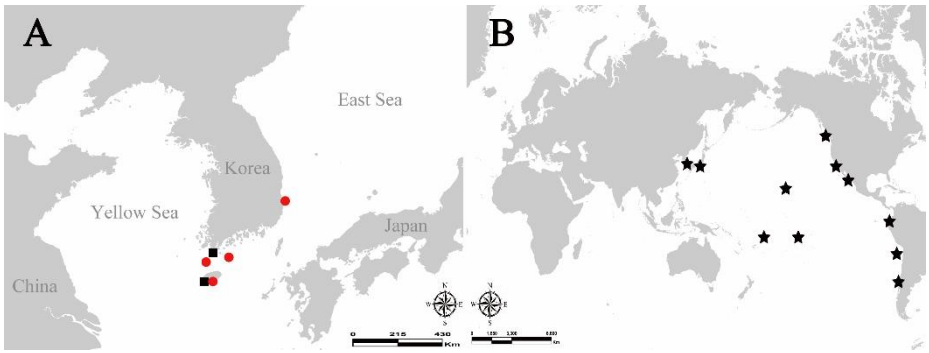


Fig. 97. Distribution of *Anoplodactylus erectus*. A, Distribution in Korea, ● indicating present study, ■ indicating previous records in Korea (Kim, 2013); B, Distribution in the world, ★ indicating worldwide distribution.

Remarks

The present species is close to *Anoplodactylus petiolatus* (Krøyer, 1844) and *Anoplodactylus pacificus* Hilton, 1942 belonging to "*erectus*-group". Stock (1955) left a question that *A. erectus* and *A. petiolatus* might be twin-species, but the present species is different from *A. petiolatus* in having short subcutaneous extension of the cement gland of which characteristic is reliable in this genus. The present species has a dorsal tubercle on the lateral processes and simple spines at the sole of the propodus. The oviger segment 2 is about 6 times as long as basal width and as long as segment 4. However, *Anoplodactylus pacificus* has compound spines at the sole of the propodus and no dorsal tubercle on the lateral processes. The oviger segment 2 is about 12 times as long as basal width and 2 times as long as segment 4.

Comparing the Korean specimens with the Paratype, the trunk length of the Paratype (1.71–2.35 mm) is much longer than that of the Korean specimens (0.83–1.15 mm). The lateral processes are separated by more than diameter, while in the Korean specimens, they are separated by less than diameter. The author thinks that these differences result from different types: the Paratype is belonged to a slender-form and the Korean specimens are belonged to a compact-form.

The Korean specimens has distinct trunk segmentations and lamina at the sole of the propodus, which is not described by Kim (2013), but Kim & Hong (1986). The male has 6-segmented ovigers and a coxal spur on the ventrodistal margin of the coxa 2 of the leg 3–4. The female has no oviger and a gonopore on the ventral surface of the coxa 2 of all legs.

The present species is distributed between Canada and Chile in latitude (Müller, 1993) and the present study extens depth range at 0–55 m.

41. *Anoplodactylus hwanghaensis* Kim & Hong, 1986 황해낫바다거미 (Fig. 98)

Anoplodactylus hwanghaensis Kim & Hong, 1986:41, fig. 6.—Nakamura & Child, 1991:27.—Kim, 2013:98, fig. 47.

Diagnosis

Trunk partially segmented; segment 3–4 fused. Lateral processes separated by less than diameter, having seta on dorsodistal margin. Ocular tubercle lower than basal width. Proboscis thick, barrel-shaped, convex

ventrally. Abdomen short, reaching distal margin of lateral process. Palp absent. Chelifore present; scape curved dorsally, without dorsal tubercle; movable finger having five teeth; immovable finger having two teeth. Oviger present only in male, 6-segmented. Legs long; femur having cement gland at dorsoproximal surface; propodus having long lamina at sole; auxiliary claws tiny.

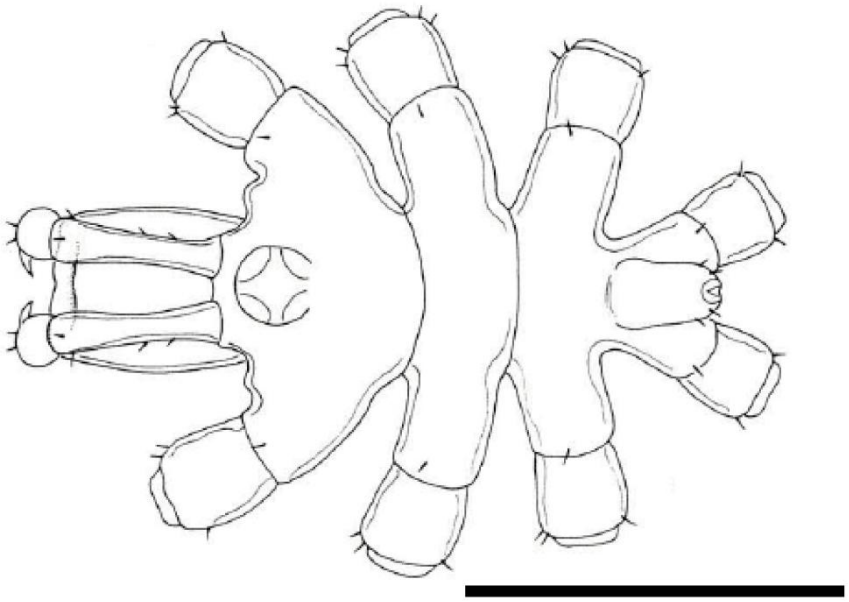


Fig. 98. *Anoplodactylus hwanghaensis*. Trunk, dorsal view. Scale bar = 1 mm. Modified from Kim (2013).

Distribution

Korea (Chungcheong-do and Jeolla-do) and Japan (Shirahama and Omaezaki).

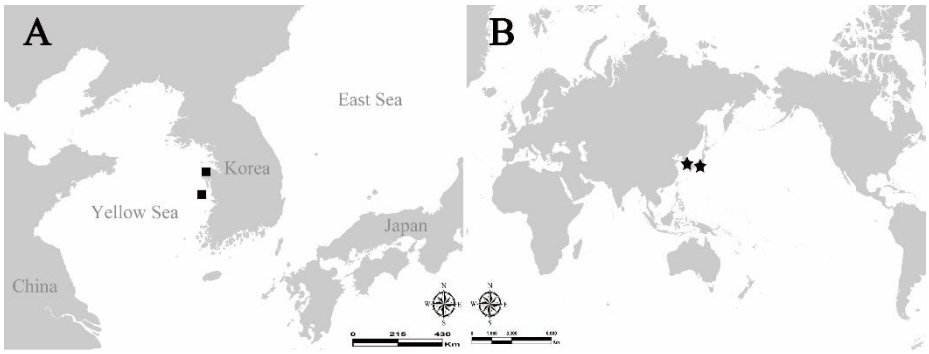


Fig. 99. Distribution of *Anoplodactylus hwanghaensis*. A, Distribution in Korea, ■ indicating previous records in Korea (Kim, 2013); B, Distribution in the world, ★ indicating worldwide distribution.

Remarks

The author didn't obtain this species. Referring the original description, this species is morphologically close to *Anoplodactylus* sp.1 Child, 1979 and *Anoplodactylus stri* Child, 1979. Unlike this species, the former has dorsal tubercles on the lateral processes and short lamina at the sole of the propodus. The latter has longer proboscis and only one heel spines on the propodus.

This species is distributed between Chungcheong-do and Shirahama, Japan in latitude and found at intertidal zone (Nakamura & Child, 1991).

42. *Anoplodactylus pycnosoma* (Helfer, 1938) 뚱보낫바다거미 (Fig. 100)

Peritrachia pycnosoma Helfer 1938:176, fig. 7.

Anoplodactylus pycnosoma.—Stock, 1953b:41, fig. 5; 1954:75, fig. 33; 1974:16; 1975a: 132.—Child, 1975:20; 1983:708; 1988a:59; 1988b:20; 1991:144; 1998:32.—Nakamura & Child, 1983:50; 1991:30.—Kim & Hong, 1986:44.—Müller, 1990a:100, figs. 7–13; 1992:173, figs. 43–48.—Bamber, 2000:613.—Turpaeva, 2007a:126, pl. 10: figs. 9–12.—Kim, 2013:100, fig. 48.

Material examined

1 ind. (1 ♀), Intertidal zone of Yeonhwa-ri, Tongyeong, Gyeongsangnam-do, Korea, 34°46'13.2"N 128°23'49.4"E, rocky shore, coll. S.H. Kim, 30 Jul 2019; 2 inds. (2 ♂♂), Intertidal zone of Bijindo Island, Tongyeong, Gyeongsangnam-do, Korea, 34°43'01.1"N 128°27'37.4"E, rinsing algae, coll. D. Lee, 29 Oct 2019; 1 ind. (1 ♂), DM191016, Intertidal zone of Bijindo Island, Tongyeong, Gyeongsangnam-do, Korea, 34°43'01.1"N 128°27'37.4"E, rinsing algae, coll. D. Lee, 29 Oct 2019.

Diagnosis

Trunk fully segmented; segment 3–4 sometimes fused. Lateral processes separated by less than diameter. Ocular tubercle low, present at anterior margin of cephalic segment. Proboscis thick, barrel-shaped, convex ventrally. Abdomen cylindrical, thick, slightly reaching beyond distal margin of lateral process. Palp absent. Chelifore present; scape long, thin; finger having 8 teeth.

Oviger present only in male, 6-segmented. Legs short, having short setae; femur having 5–8 cement gland cups; propodus having 15 sole spines without lamina; auxiliary claws tiny.

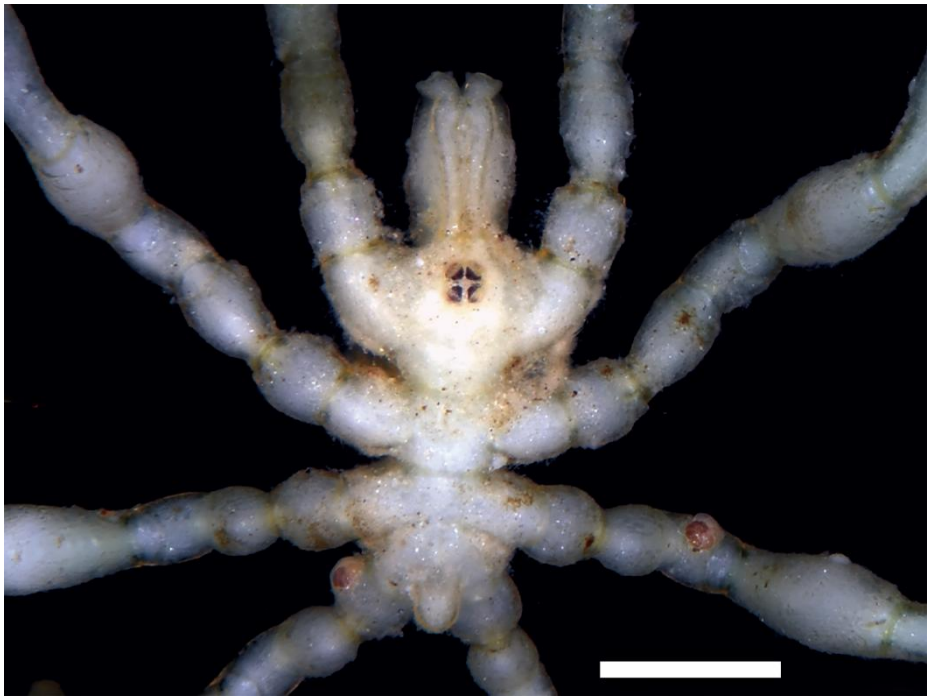


Fig. 100. *Anoplodactylus pycnosoma*, DM191016. Trunk, dorsal view. Scale bar = 0.5 mm.

Distribution

Korea (Gangwon-do, Gyeongsang-do, Jeolla-do, and Chungcheong-do) and from Japan to Australia and Tanzania.

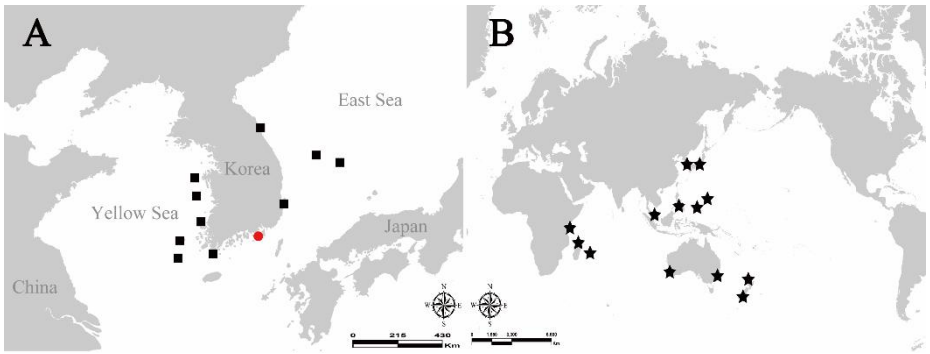


Fig. 101. Distribution of *Anoplodactylus pycnosoma*. A, Distribution in Korea, ● indicating present study, ■ indicating previous records in Korea (Kim, 2013); B, Distribution in the world, ★ indicating worldwide distribution.

Remarks

The present species is close to *Anoplodactylus robustus* (Dohrn, 1881), but distinguished by the followings: (1) The lateral processes are separated (touching each other in *A. robustus*). (2) The oviger segment 6 is present (absent).

In the examined material, Spinules are sparsely present on the dorsal surface of the lateral processes. The trunk length ranges in 0.99–1.11 mm. The male has 6-segmented ovigers and a gonopore on the ventral surface of the coxa 2 of the leg 2–4. The female has no oviger and a gonopore on the same position of all legs, which is bigger than that of the male.

The present species is distributed between Gangwo-do and New zealand and 0–122 m at depth range (Müller, 1993).

43. *Anoplodactylus stellatus* Nakamura & Child, 1983 (Figs. 102, 103)

Anoplodactylus stellatus Nakamura & Child, 1983:50, fig. 17.

Material examined

2 inds. (1 ♂, 1 ♀), DM191231–32, South of Namhyeongjae Island, Busan, Korea, 34°53'03.4"N 128°57'03.2"E, collected on fan coral, 32 m, SCUBA, coll. D. Lee, 5 Dec 2019; 1 ind. (1 ♂), East of Namhyeongjae Island, Busan, Korea, 34°53'05.1"N 128°57'09.2"E, SCUBA, coll. Y.H. Kim, 4 Jun 2018.

Description

Trunk elongated, fully segmented; segmentation line between segment 3–4 faint but observed. Cephalic segment protruding anterodorsally (Fig. 102A).

Lateral processes 1.6 times as long as basal width, separated by 1.2 times of diameter, having 1–2 setae on dorsodistal margin. Lateral process 2–3 having small tubercle like papilla with seta on dorsomedian distal margin (Fig. 102A).

Ocular tubercle present at anterior margin of cephalic segment, 2.5 times as long as basal width, with papilla on lateral side, having long and conical tip heading anterodorsally; four eyes present near base, pigmented (Fig. 103A, 103B).

Proboscis cylindrical, attached to base of protruding part of cephalic segment, heading downward, about 1/4 times as long as trunk length, ornamented with three triangular tubercles at distal margin (Fig. 102B, 102C).

Abdomen cylindrical, glabrous, not articulated, about 2 times as long as basal width, rising upward (Fig. 102B).

Palps absent.

Chelifore 2-segmented (Fig. 102A, 102B, 102D). Scape 6.7 times as long as basal width, having four setae on dorsal surface and large tubercle with spines on dorsodistal margin. Chela functional; palm as long as fingers; immovable finger having six teeth; movable finger having seven teeth and two setae on outer median surface.

Oviger present only in male, 6-segmented, having setae except segment 1; segment 3 longest, having three setae on each inner and outer surface; terminal segment smaller than other segments, triangular-shaped, having two setae (Fig. 102E).

Leg 3 slender, setose (Fig. 102F). Coxa 1 about 2 times as long as basal width, having setae on distal margin. Coxa 2 about 3 times as long as basal width, subequal to sum of coxa 1 and coxa 3, swollen ventrodistally, having four setae on ventral surface and three setae on ventrodistal margin. Coxa 3 about 1.8 times as long as basal width, swollen ventrodistally, having setae on ventrodistal margin. Femur about 6.8 times as long as basal width, having long dorsodistal tubercle; dorsodistsal tubercle ornamented with many setae, having long seta at tip; two cement gland cups present on dorsomedian surface, in truncated cone shape; anterolateral tubercle large, triangular, present on distal surface, having long seta on tip; posterolateral tubercle large, triangular, present on proximal surface, having long seta on tip. Tibia 1 about 7.6 times as long as

basal width, having long seta without tubercle at dorsodistal margin. Tibia 2 about 6.7 times as long as basal width, having long seta without tubercle at dorsodistal part. Femur and tibia subequal in length. Tarsus small, having two dorsal setae, with stout spine and setae at ventrodistal margin. Propodus slightly curved, without lamina, bearing low dorsodistal tubercle with several setae, having two large heel spines, two small heel spines, six sole spines, and three sole setae. Main claw curved, about 0.5 times as long as propodus. Auxiliary claws tiny, about 0.14 times as long as main claw.

In female, trunk slightly longer and thinner than those of male (trunk length, 2.33 mm; width, 0.83 mm, Fig. 103A). Lateral processes about 1.3 time as long as basal width, separated by 2 times of diameter. Oviger and cement gland absent. Gonopore present at ventral surface of coxa 2 of all legs (Fig. 103B). Coxa 2 less swollen at ventrodistal margin.

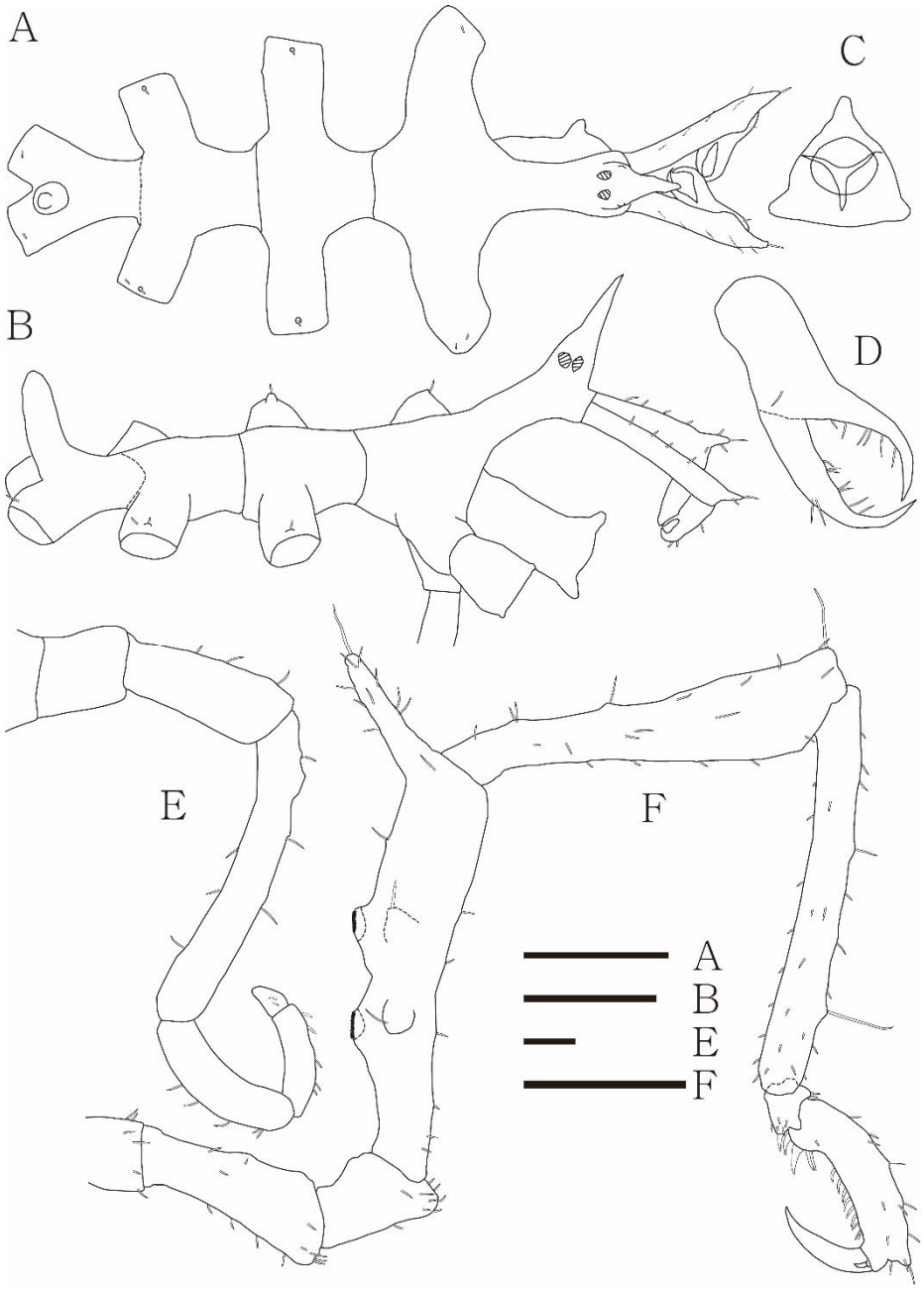


Fig. 102. *Anoplodactylus stellatus*, DM191231 (male). A, Trunk dorsal view; B, Trunk, lateral view; C, Tip of proboscis, anterior view; D, Chela, anterior view; E, Oviger; F, Right leg 3, lateral view. Scale bars = 0.5 mm (A, B, F), 0.1 mm (E).

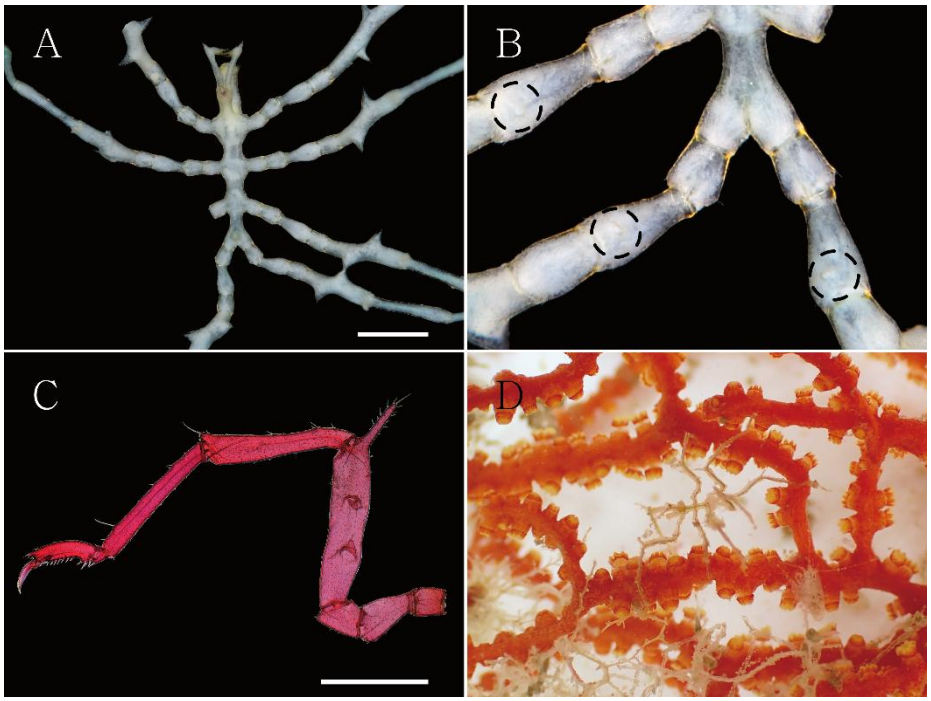


Fig. 103. *Anoplodactylus stellatus,* DM191232 (female). A, Trunk, dorsal view; B, Trunk, ventral view, circles indicating gonopores; C, Left leg 3, lateral view; D, Pycnogonid collected on fan coral. Scale bars = 1 mm (A, C).

Measurement (mm).

DM191231, trunk length, 2.15; width, 1.02; proboscis, 0.50; abdomen, 0.40. Leg 3; coxa 1, 0.28; coxa 2, 0.61; coxa 3, 0.32; femur, 1.25; tibia 1, 1.22; tibia 2, 1.23; tarsus, 0.17; propodus, 0.60; main claw, 0.30; auxiliary claw, 0.04.

Distribution

Korea (Busan) and Japan (Sagami Bay).

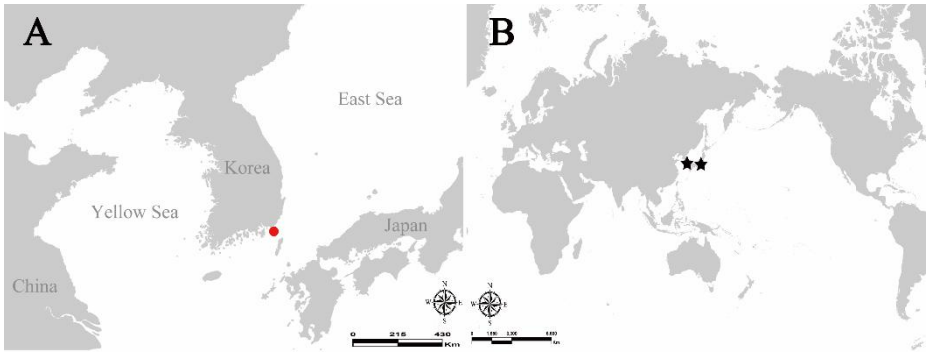


Fig. 104. Distribution of *Anoplodactylus stellatus*. A, Distribution in Korea, ● indicating present study; B, Distribution in the world, ★ indicating worldwide distribution.

Remarks

The present species is close to *Anoplodactylus velamellus* Nakamura & Child, 1991, but distinguished by having three triangular tubercles on the proboscis, lateral tubercles at the femur, and more teeth at the chela.

Nakamura & Child (1983) only examined the holotype and there was no report of Paratype and Allotype. Since the original description, the present study is the second note of the present species and the first desription of the female.

Comparing with the original description, the examined material has faint but discernable segmentation line between the trunk segment 3–4. The number of cement gland cups are two, while only right leg 1 has three cement gland cups although the holotype was described having three cement gland cups. The

examined material has six sole spines at the propodus, while 10–11 sole spines were described in the Holotype.

The present species is distributed in Busan and Sagami Bay, Japan (Nakamura & Child, 1983) and found at 32 m depth.

44. *Anoplodactylus tubiferus* (Haswell, 1884) (Fig. 105)

Phoxichilidium tubiferum Haswell, 1884:1032, pl. 57: figs. 1–5.

Anoplodactylus tubiferus.—Cole, 1904: 288.

Anoplodactylus stylops.—Loman, 1908:71, pl. 11: figs. 20–24.

Anoplodactylus tubiferus.—Loman, 1908:72; Flynn, 1919:79, pl. 20: figs. 12–14, pl. 21: fig. 15.—Staples,1982:457, fig. 2C–F.—Child, 1988a:61.

Anoplodactylus pulcher.—Carpenter, 1907:97, pl. 12: figs. 13–19.—Stock, 1965:29, fig. 45.—Nakamura & Child, 1983:49.—Nakamura & Child, 1991:32.

Material examined

1 ind. (1 ♀), MR-4 point, Marado Island, Jejudo Island, Korean, 33°06'54.9"N 126°16'42.8"E, 71 m, grab, coll. S.H. Kim, 31 Jan 2018.

Description

Female. Trunk elongated, fully segmented; segmentation line 2–4 faint but observed. Cephalic segment protruding anterodorsally, having neck, widening distally (Fig. 105A).

Lateral processes about 2.4 times as long as basal width, separated by about 1.5 times of diameter, having five long setae on dorsodistal margin (Fig. 105A).

Ocular tubercle present at anterior margin of cephalic segment, about 3.8 times as long as basal width, having round tip; four eyes pigmented, present at top of ocular tubercle (Fig. 105A, 105B).

Proboscis cylindrical, broad at one third from base, about half times as long as trunk length, attached at base of protruding part of cephalic segment, heading anteroventrally (Fig. 105A, 105B).

Abdomen articulated at base, cylindrical, tapering distally, long, reaching middle of coxa 2, having dorsal seta on two third from base (Fig. 105B, 105C).

Palp absent.

Chelifore 2-segmented (Fig. 105A, 105B). Scape elongated, curved at distal part, about 6.6 times as long as basal width, having many long setae on dorsal surface. Chela about half times as long as scape, having three teeth on each finger; palm slightly shorter than movable finger, having two setae under movable finger; movable finger longer than movable finger, having seven setae; immovable finger having two setae (Fig. 105D).

Oviger absent in female.

Leg 4 having many long setae (Fig. 105E). Coxa 1 about 1.3 times as long as basal width, having 4–6 long setae on dorsodistal margin; long setae about

1.5 times as long as basal width of coxa 1. Coxa 2 about 4.1 times as long as basal width, swollen at ventrodistal margin, having long setae on dorsal surface and short setae on ventral surface. Coxa 3 about 1.5 times as long as basal width, having three setae on ventrodistal margin. Femur long, about 6.7 times as long as basal width, having dorsodistal tubercle with long seta. Tibia 1 elongated, about 8.3 times as long as basal width, longer than femur and tibia 2, having dorsodistal tubercle with long seta. Tibia 2 elongated, about 8.8 times as long as basal width, as long as femur. Tarsus short, with two setae on dorsal surface, having six setae on ventral surface, bearing spine on ventrodistsal margin. Propodus slightly curved, with short setae on dorsal surface, having heel spine, two small heel spines, 11 spines, short lamina, and two distal setae at sole (Fig. 103F). Main claw slightly curved, about 0.7 times as long as propodus. Auxiliary claws tiny, about 0.1 times as long as main claw.

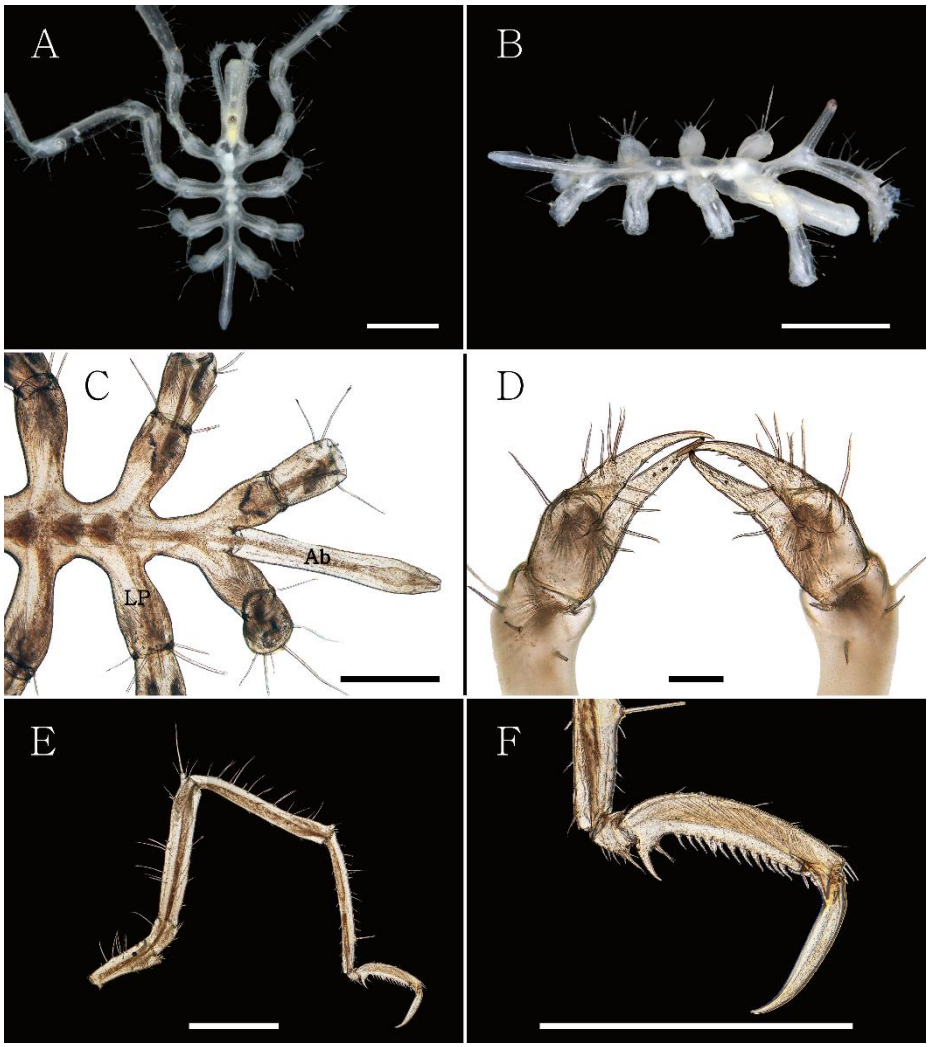


Fig. 105. *Anoplodactylus tubiferus*. A, Trunk, dorsal view; B, Trunk, lateral view; C, Abodmen, dorsal view; D, Chela, ventral view; E, Leg 4, lateral view; F, Propodus in Leg 4. Ab = Abdomen, LP = Lateral process. Scale bars = 1 mm (A, B, E, F), 0.5 mm (C), 0.1 mm (D).

Measurement (mm).

Trunk length, 1.88; width, 1.47; proboscis, 0.98; abdomen, 1.02. Leg 4; coxa 1, 0.37; coxa 2, 0.71; coxa 3, 0.35; femur, 1.56; tibia 1, 1.61; tibia 2, 1.50; tarsus, 0.14; propodus, 0.72; main claw, 0.51; auxiliary claw, 0.04.

Distribution

Korea (Jejudo Island), from Madagascar to Japan.

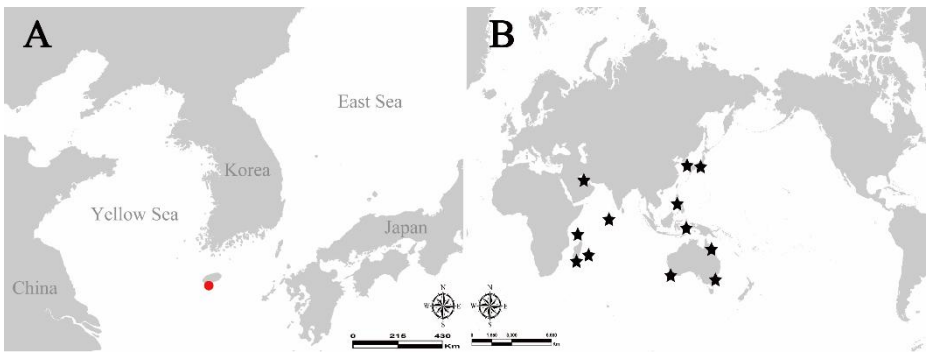


Fig. 106. Distribution of *Anoplodactylus tubiferus*. A, Distribution in Korea, ● indicating present study; B, Distribution in the world, ★ indicating worldwide distribution.

Remarks

The present species is similar to *Anoplodactylus petiolatus* (Krøyer, 1844) and *Anoplodactylus amoybius* Bamber, 2004 having elongated trunk, cylindrical proboscis, and long ocular tubercle. The present species is distinguished from *A. petiolatus* by the followings: (1) There is no tubercle on the lateral processes (small tubercle present on the lateral processes in *A.*

petiolatus). (2) The ocular tubercle is almost 4 times as long as basal width, having a round tip (about 2 times as long as basal width and having a conical tip). (3) The propodus has short lamina (long lamina). The latter congener has tubercles on the lateral processes and long ocular tubercle (about 3 times as long as basal width). The trunk has a segmentation line only between segment 1–2. The chela is glabrous without teeth and long lamina is present at the sole of the propodus. The present species has a fully segmented trunk, fingers with three teeth and many setae, and short lamina at the propodus.

In 1965, Stock re-examined the Syntype of *Anoplodactylus stylops* and synonymized this species with *Anoplodactylus pulcher.* Staples (1982) examined *A. tubiferus* and the Syntype of *A. stylops* and concluded that *A. pulcher* was a synonym of the present species. Therefore, *Anoplodactylus stylops* and *A. pulcher* are synonyms of the present species.

The examined specimen is 1.88 m in the trunk length and it is similar to that of the Holotype (1.9 mm). Because the specimen has few legs and leg 3 is absent, the description of the leg is based on the leg 4. Female gonopores are present on the ventral surface of the coxa 2 of all legs. This specimen has an articulated abdomen and this feature has not been described in previous literature. Only Flynn (1919) illustrated this feature in his figure (pl.21: fig. 15) without words. Further study is needed to determine whether this feature is a variation.

The present species is distributed between Sagami Bay, Japan and Australia in latitude and 0–135 m at depth range (Müller, 1993).

45. *Anoplodactylus velamellus* Nakamura & Child, 1991 가는낫바다거미 (Fig. 107)

Anoplodactylus velamellus Nakamura & Child, 1991:32, fig. 12.—Kim, 2013: 105, fig. 50.

Anoplodacylus spec. a Stock, 1954:88, fig. 40c–d.—Hong & Kim, 1987:161, fig. 17.

Material examined

2 inds. (2 ♀♀), DMDK43, DMDK54, East of Namhyeongjae Island, Busan, Korea, 34°53'05.1"N 128°57'09.2"E, coll. Y.H. Kim, SCUBA, 4 Jun 2018.

Diagnosis

Trunk fully segmented. Cephalic segment protruding anteriorly. Lateral processes glabrous, separated by diameter. Ocular tubercle conical-shaped, about 1.5 times as long as basal width, present on anterior margin of cephalic segment. Proboscis cylindrical. Abdomen cylindrical, reaching beyond distal margin of lateral process, erected almost upright. Palp absent. Chelifore present; scape having dorsodistal low tubercle; movable finger having two teeth; immovable finger having tooth. Oviger present only in male, 6-segmented. legs setose; femur having dorsodistal tubercle and two cement gland cups; propodus without lamina; auxiliary claws tiny.

Fig. 107. *Anoplodactylus velamellus*, DMDK43. Trunk, dorsal view. Scale bar = 1 mm.

Distribution

Korea (Dokdo Island and Gyeongsang-do) and Japan (Sagami Bay).

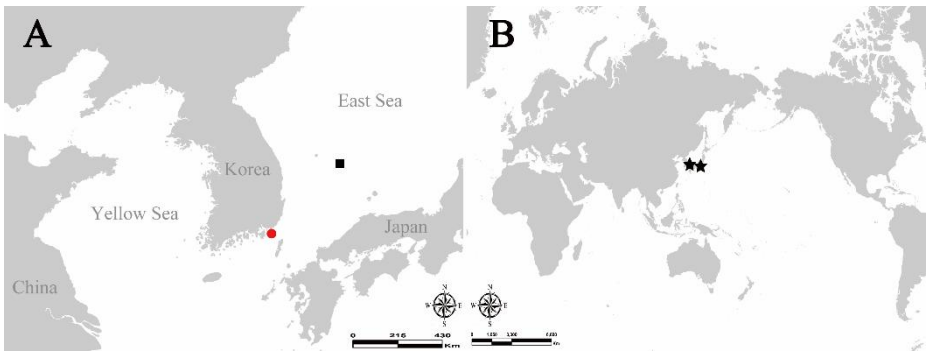


Fig. 108. Distribution of *Anoplodactylus velamellus*. A, Distribution in Korea, ● indicating present study, ■ indicating previous record in Korea (Kim, 2013); B, Distribution in the world, ★ indicating worldwide distribution.

Remarks

The present species is similar to *Anoplodactylus longiceps* Stock, 1951, *Anoplodactylus longiformis* Child, 1977, and *A. stellatus* having elongated trunk, conical ocular tubercle, and a dorsodistal tubercle on the femur. *Anoplodactylus longiceps* is different from the present species in having wider intervals between the lateral processes, a dorsodistal tubercle on the tibia 1. In addition, the lamina and a heel spine are present on the propodus. *Anoplodactylus longiformis* is distinguished by having wider intervals between the lateral processes, no tubercle on the scape, 8–10 cement gland cups on the dorsal surface of the femur, and lamina on the propodus. *Anoplodactylus stellatus* is separated from the present species by having three triangular tubercles at the distal margin of the proboscis, and lateral tubercles on the femur.

In the examined material, the trunk length (1.41 and 1.76 mm) is longer than the Holotype (1.18 mm). Kim (2013) described that two dorsal tubercles were present on the distal margin of the scape, however, only one tubercle is observed as in the original description There is a gonopore on the ventral surface of the coxa 2 of all legs in the female.

The present species is distributed between Dokdo Island and Sagami Bay, Japan in latitude and 2–60 m at depth range (Kim, 2013).

Family Pycnogonidae Wilson, 1878 송장바다거미과

Genus *Pycnogonum* Brunnich, 17644 송장바다거미속

Diagnosis

Trunk segmented, stout, sometimes having dorsal ornamentation. Lateral processes short, separated. Palp and chelifore absent. Oviger present in only male, having terminal claw; segmentation depending on subgenus: subgenus *Pycnogonum* 8 to 9-segmented; subgenus *Retroviger* 4 to 7-segmented; subgenus *Nulloviger* absent. Leg short, stout. Auxiliary claw small or lacking.

Type species

Pycnogonum littorale (Stroem, 1762)

Key to the *Pycnogonum* species in Korean waters.

1. Oviger absent ..... *Pycnogonum* (*Nulloviger*) sp. nov.

- Oviger present 2

2. Auxiliary claws present ..... *P.* (*Pycnogonum*) *uedai*

- Auxiliary claw absent ..... *P.* (*Pycnogonum*) *tenue*

46. *Pycnogonum* (*Nulloviger*) sp. nov. (Figs. 109, 110)

Material examined

Pycnogonum (*Nulloviger*) sp. nov.

1 ind. (1 ♂), NIBRIV0000837749, East of Moonseom Island, Jejudo Island, Korea, 33°13'35.4"N 126°34'10.6"E, 58 m, Trimix SCUBA, coll. D. Lee, 18 Jan 2018.

Pycnogonum (*Nulloviger*) *carinatum*

Holotype, 1 ind. (1 ♂), NMV J48800, near Cape Conran, Beware Reef, Victoria, Australia, 37°49'21.0"S 148°47'24.0"E, 5–6 m, SCUBA, Dr. Tim D O'Hara, 15 Apr 1998; Paratype, 2 inds. (2 ♀♀), NMV J48806, Point Nepean, Cheviot Beach, Victoria, Australia, 38°18'00.0"S 144°40'12.0"E, 3.5–5 m, SCUBA, Dr. Tim D O'Hara, 31 Mar 1998.

Description

Trunk fully segmented, with intermittent spines, covered in tiny granules surrounded by spinules; transverse ridge raised on posterior margin of segment 1–3, having dorsomedian tubercle; dorsomedian tubercle granular, about 1/3 times as long as trunk height. Cephalic segment protruding anteriorly, having rectangular shape at anterior part (Figs. 109A, 109C, 110A).

Lateral processes very short, touching each other, having granular ridge on dorsodistal margin with median tubercle; median tubercle larger and more distinct from lateral process 1 to 4. Lateral process 1 about 0.6 times as long as

basal width, having posteroventral distal process. Lateral process 4 having distinct dorsal tubercle; dorsal tubercle as long as dorsomedian tubercle on trunk segment 1 (Fig. 109A, 109B).

Ocular tubercle present on anterior margin of cephalic segment, 0.6 times as long as basal width, having flat tip and posterodorsal papilla; four eyes pigmented. Post ocular tubercle half times as long as basal width, 0.7 times as long as ocular tubercle, having anterodorsal and posterodorsal granular tubercles (Fig. 109A, 109B).

Proboscis covered in many granules, truncated cone shaped, tapering distally; basal width about 2 times as wide as distal width (Fig. 109A, 109B, 109C).

Abdomen articulated at base, spindle-shaped, directing horizontally, reaching beyond posterior margin of coxa 2, having spines on tip, bearing two spines on dorsodistal nodulous process; upper surface tapering toward end in lateral view; lower surface flat in lateral view (Fig. 109A, 109B).

Palp, chelifore, and oviger absent.

Leg 3 short, stout, having intermittent spines, covered in tiny granules (Figs. 109D, 110C). Coxa 1 as long as basal width, as wide as lateral processes, having granular ridge on distal margin except ventral surface. Coxa 2 as long as basal width, half times as wide as distal width of coxa 1, longest segment among coxae. Coxa 3 about 0.8 times as long as basal width, having granular low process on ventrodistal margin. Femur half times as long as basal width, longest segment in leg, having dorsodistal granular process, with long and short spines on dorsodistal process. Tibia 1 half times as long as basal width, having long spine on dorsodistal margin and short spine on ventrodistal margin, bearing granular dorsal surface. Tibia 2 half times as long as basal width, as

long as coxa 2, having long spine on dorsodistal margin and four spines on ventrodistal margin, bearing granular dorsal surface. Tarsus short, convex ventrally, 1/4 times as long as propodus, having several spines on ventral surface. Propodus almost straight, without heel spine, having 11 sole spines and seven dorsal spines. Spines on ventral surface of tibia and propodus having bifurcated tips. Main claw curved, 0.4 times as long as propodus. Auxiliary claws tiny, about 0.17 times as long as main claw.

Male gonopore present on ventroinner surface of coxa 2 of leg 4 (Fig. 110D).

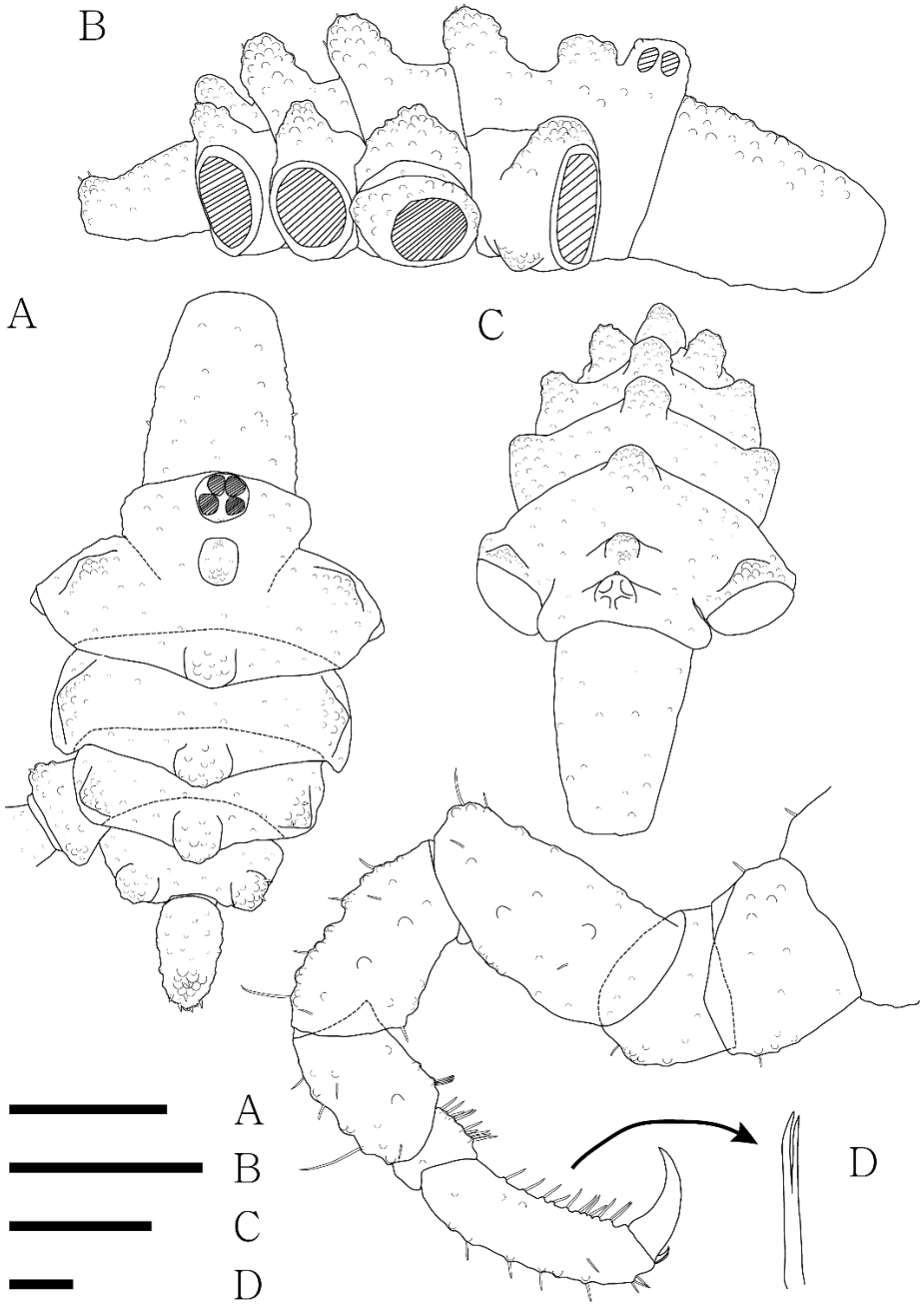


Fig. 109. *Pycnogonum* (*Nulloviger*) sp. nov., male. A, Trunk, dorsal view; B, Trunk, lateral view; C, Trunk, anterolateral view; D, Leg 3, arrow indicating bifurcated tip. Scale bars = 0.5 mm (A–C), 0.1 mm (D).

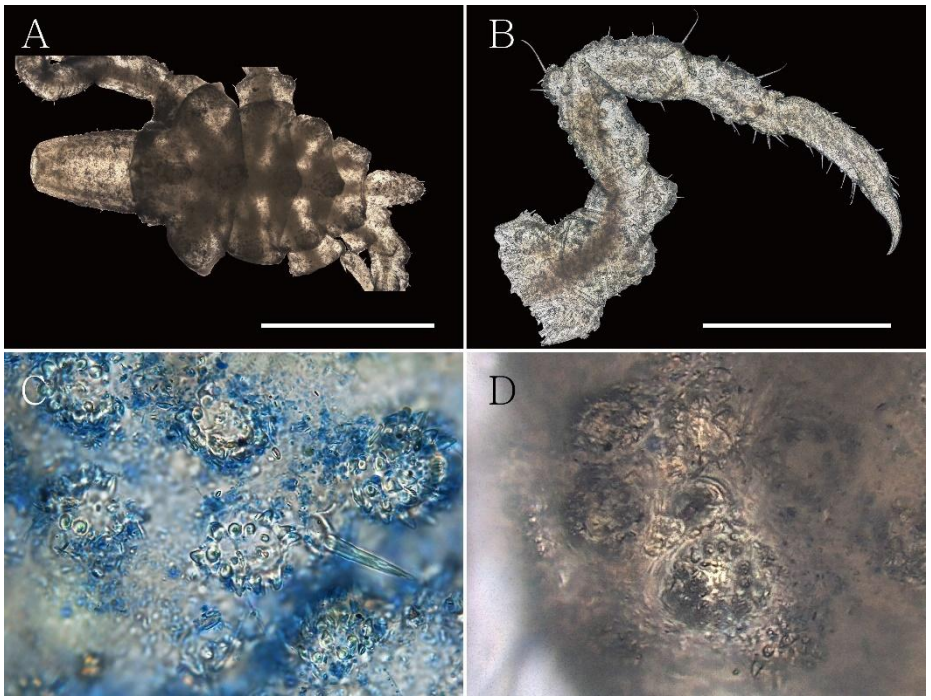


Fig. 110. *Pycnogonum* (*Nulloviger*) sp. nov., male. A, Trunk, dorsal view; B, Leg 4, lateral view; C, Granules; D, Gonopore. Scale bars = 1 mm (A), 0.5 mm (B).

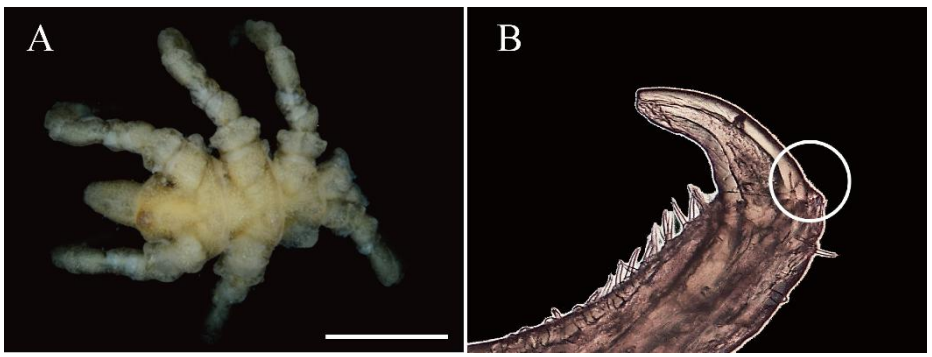


Fig. 111. *Pycnogonum* (*Nulloviger*) *carinatum*, NMV J48800 (Holotype, male). A, Trunk, dorsal view; B, Distal parts of leg 3, circle indicating absence of auxiliary claws. Scale bars = 1 mm.

Measurement (mm).

Trunk length, 1.38; width, 0.95; proboscis, 0.61; abdomen, 0.34. Third leg; coxa 1, 0.16; coxa 2, 0.24; coxa 3, 0.20; femur, 0.43; tibia 1, 0.28; tibia 2, 0.24; tarsus, 0.10; propodus, 0.39; main claw, 0.16; auxiliary claw, 0.03.

Distribution

Korea (Jejudo Island).

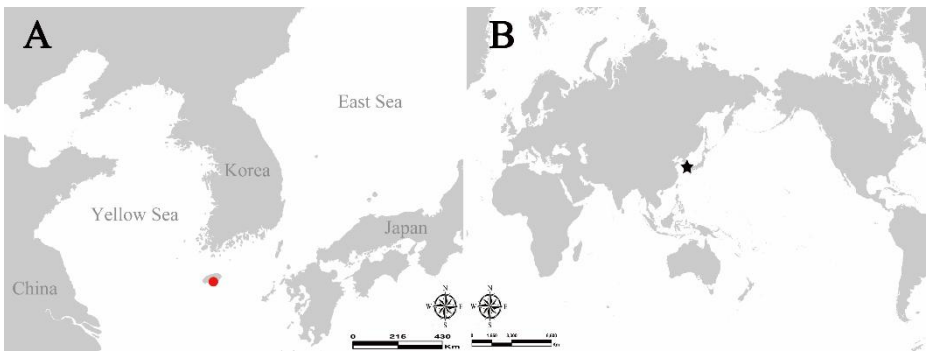


Fig. 112. Distribution of *Pycnogonum* (*Nulloviger*) sp. nov. A, Distribution in Korea, ● indicating present study; B, Distribution in the world, ★ indicating worldwide distribution.

Remarks

The present species is similar to *Pycnogonum* (*Retroviger*) *pustulatum* Stock, 1994, *Pycnogonum* (*Retroviger*) *pusillum* Dohrn, 1881, *Pycnogonum (Pycnogonum) asiaticum* Muller, 1992, and *Pycnogonum* (*Nulloviger*) *carinatum* Staples, 2002 having trunk and appendages covered in granules surrounded by spinules.

The congeners except *P.* (*N.*) *carinatum* are easily distinguished from the present species by the presence of the oviger. Furthermore, *Pycnogonum* (*Retroviger*) *pustulatum* is distinguished from the present species by followings: (1) The lateral processes are touching each other (separated in *P.* (*R.*) *pustulatum*). (2) A posterodistal swelling is present at the only lateral process 1 (present at all lateral processes). (3) The femur has no ventral swelling (having a large proximoventral swelling). (4) The auxiliary claws are tiny (long).

The present species has lateral processes touching each other and the prominent post ocular tubercle, while in *P.* (*R.*) *pusillum*, the lateral processes are separated and there is no post ocular tubercle.

Pycnogonum (Pycnogonum) asiaticum is different from the present species in having separated lateral processes, not articulated abdomen, and large auxiliary claws.

Among the subgenus *Nulloviger*, the present species is very close to *P.* (*N.*) *carinatum* having granular trunk, post ocular tubercle, similar shape of the abdomen (Fig. 111A). These two species are distinguished by the existence of the auxiliary claws (Fig. 110B, 111B).

Comparing leg 3 and 4, the leg 4 has a more prominent ventrodistal process at the coxa 3 and a more distinct dorsodistal process at the femur (Fig. 110B).

The present species has gonopores on the ventroinner surface of the coxa 2 of the leg 4 and no ovigers. Therefore, it belongs to the subgenus *Nulloviger* (Stock, 1968b) and is added to key of subgenus *Nulloviger* (Lee & Kim, 2020).

Revised Key to the subgenus *Nulloviger* of *Pycnogonum*.

1. Auxiliary claw present 2

- Auxiliary claw absent 3

2. Lateral processes touching each other. Post ocular tuber present ..... ***Pycnogonum* (*N.*) sp. nov.**

- Lateral processes slightly separated. Post ocular tubercle absent. ..... *P.* (*N.*) *planum*

3. Dorsal tubercle of proboscis present 4

- Dorsal tubercle of proboscis absent 9

4. Abdomen with dorsodistal tubercle. Dorsal tubercles of fourth lateral processes touching at base ..... *P. grumus* *

- Abdomen without dorsodistal tubercle. Dorsal tubercles of fourth lateral processes not touching 5

5. Trunk segment 3 and 4 articulated ..... *P. nodulosum* *

- Trunk segment 3 and 4 fusion or partial fusion 6

6. Trunk length around 5 mm. Abdomen reaching half of coxa 3. Leg as long as trunk ..... *P.* (*N.*) *tuberculatum*

- Trunk length around 2 mm. Abdomen reaching distal margin of coxa 2. Leg longer than trunk 7

7. Transverse ridge inconspicuous. Proboscis around half of trunk length. Long spine of femur on the dorsal tubercle ..... *P. moolenbeeki* *

- Transverse ridge distinct. Proboscis less half of trunk length. Long spine of femur not on the dorsal tubercle 8

8. Trunk integument pitted. Round tips on ventral surface of tibia, tarsus, and propodus ..... *P. spatium* *

- Trunk integument granulated. Cleft tips on ventral surface of tibia, tarsus, and propodus ..... *P.* (*N.*) *granulatum*

9. Post ocular tubercle present ..... *P.* (*N.*) *carinatum*

- Post ocular tubercle absent 10

10. Proboscis styliform 11
- Proboscis cylindrical 12
11. Ocular tubercle on anterior margin of cephalon. Proboscis much longer than trunk. Tibia 2 longer than propodus, less than twice as long as broad ..... *P.* (*N.*) *elephas*
- Ocular tubercle on middle of cephalon. Proboscis shorter than trunk. Tibia 2 shorter than propodus, more than twice as long as broad ..... *P.* (*N.*) *africanum*
12. Transverse ridge distinct. Abdomen truncated at distal. Tarsus trapezoid shape. Propodus width even along distal ..... *P.* (*N.*) *lobipes*
- Transverse ridge inconspicuous. Abdomen conical or round at distal. Tarsus triangular shape. Propodus width narrower along distal ..... *P.* (*N.*) *anovigerum*

* These species are not belonging to the subgenus *Nulloviger* because there's no report of the female. Nevertheless, since they are morphologically similar to the subgenus, the author includes them in this key.

47. *Pycnogonum* (*Pycnogonum*) *tenue* Slater, 1879 작은송장바다거미 (Figs. 113, 114)

Pycnogonum littorale var. *tenue* Slater 1879:283.—Ortmann, 1891:167.

Pycnogonum tenue.—Hedgpeth, 1949:303, figs. 48b, 50c–d.—Stock, 1954:162, fig. 80.—Utinomi, 1955:36, figs. 22–23; 1971:338.—Nakamura & Child, 1983:64; 1991:63.—Hirohito & Nakamura, 1987:37, pl. 34: figs. 1–6.—Takahashi *et al*., 2007:75, fig. 6.

Pycnogonum (*Pycnogonum*) *tenue*.—Turpaeva, 2007a:130, pl. 23: figs. 7–9.

Material examined

1 ind. (1 ♀), Mipo Harbor, Busan, Korea, coll. B.J. Rho, 15 Jul 1974.

Description

Trunk granulated and reticulated, fully segmented, having nodulous dorsal tubercles on posterodorsal margin of each segment; cephalic segment having enlarged anterior part, touching lateral process 1 (Figs.113A, 113C, 114A).

Lateral processes shorter than width, slightly separated, bearing nodulous ridge on dorsodistal margin. Lateral process 1 having low nodulous tubercle only on posterior margin of ridge. Lateral process 2 and 3 having three low nodulous tubercles on dorsodistal margin. Lateral process 4 having two low nodulous tubercles on dorsolateral margin (Figs. 113A, 114A).

Ocular tubercle present on anterior part of cephalic segment, as long as basal width, as long as dorsal tubercle 3 on trunk, having small papillae on tip; four eyes pigmented, half times as long as ocular tubercle. Post ocular tubercle present, having flat tip, about 0.3 times as long as ocular tubercle (Fig. 113A, 114B).

Proboscis curved downward, wide at base, narrowing to half like hopper, slightly swollen at distal part (Fig. 113A, 113B, 113C).

Abdomen not articulated, having round tip, reaching at middle of coxa 2, having low nodulous elevation at dorsodistal margin (Fig. 113A, 113B).

Palp and chelifore absent.

Oviger absent in female.

Legs stout, granulated dorsally, having scarce small spines (Fig. 113D). Coxa 1 having two dorsal tubercles on laterodistal margin. Coxa 2 longer than coxa 1 and coxa 2, without dorsal tubercle, having female gonopore on dorsolateral surface (Fig. 114B). Coxa 3 longer than coxa 1, without distinct ornamentation. Femur about 2.3 times as long as basal width, slightly longer than tibia 1, having low ventroproximal swelling and low mid-dorsal projection. Tibia 1 about 2.8 times as long as basal width, having few small spines on ventral surface. Tibia 2 about 2.6 times as long as basal width, about 0.7 times as long as tibia 1, having small spines on ventral surface. Tarsus about 0.4 times as long as propodus, shorter than other segments in leg, convex ventrally, having small spines on ventral surface. Propodus slightly curved, narrowing distally, having about 30 sole spines without heel spine. Spines on ventral surface of tibia and propodus having bifurcated tips. Main claw curved, half times as long as propodus. Auxiliary claw absent.

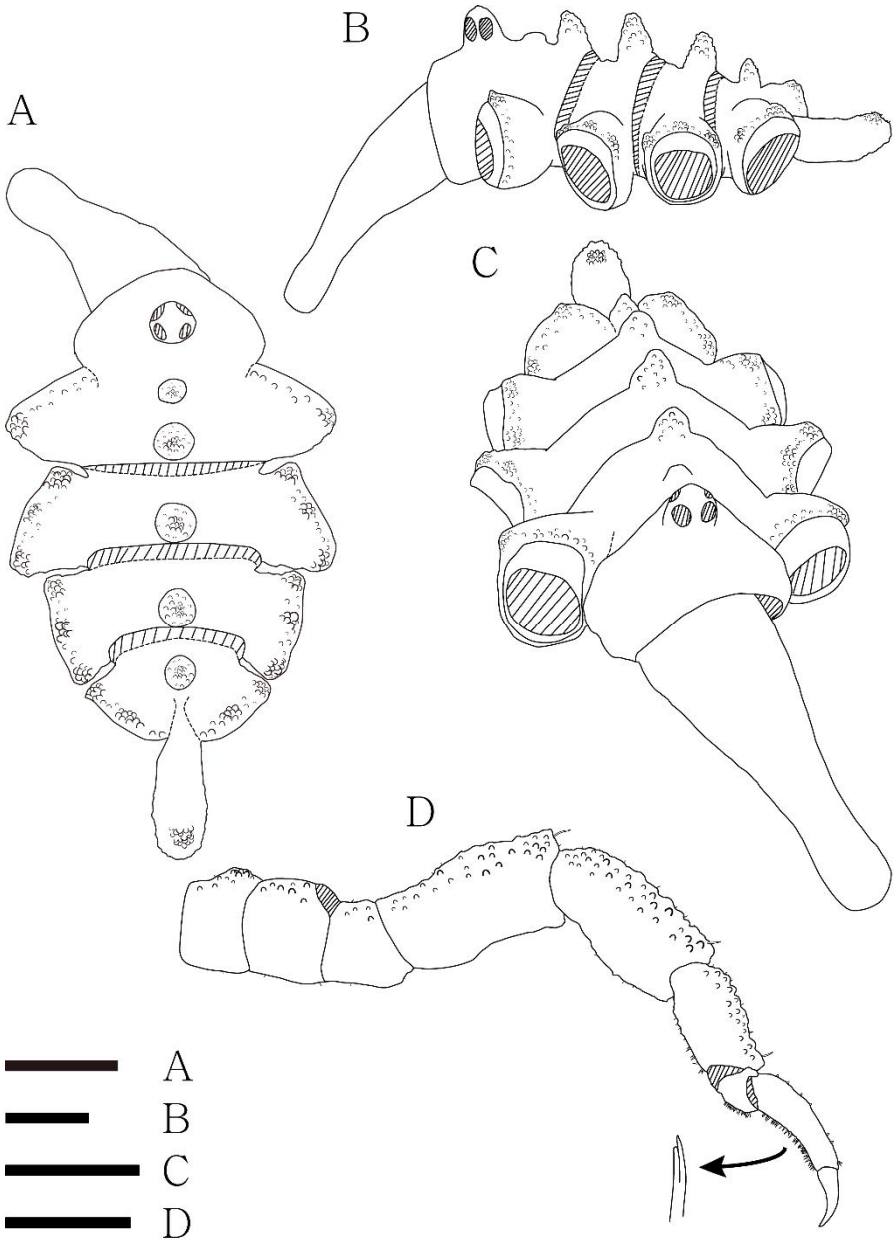


Fig. 113. *Pycnogonum* (*Pycnogonum*) *tenue,* female. A, Trunk, dorsal view; B, Trunk, lateral view; C, Trunk, anterolateral view; D, Leg 3, arrow indicating bifurcated tip. Scale bars = 1 mm (A–D).

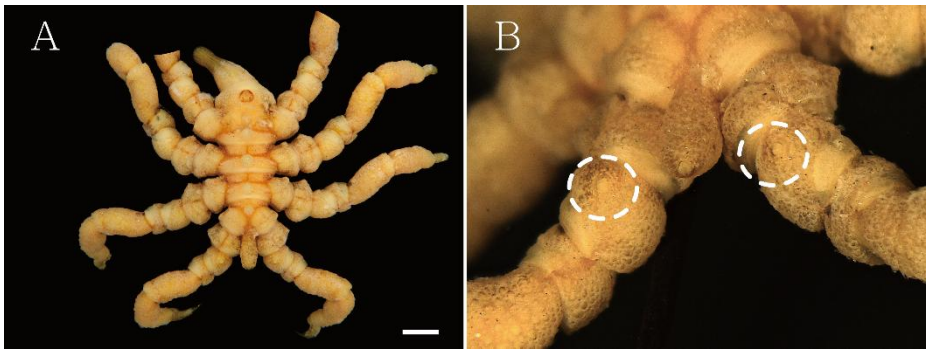


Fig. 114. *Pycnogonum* (*Pycnogonum*) *tenue*, female. A, Trunk, dorsal view; B, Gonopores. Scale bar = 1 mm.

Measurements (mm)

Trunk length, 4.23; width, 2.64; proboscis, 2.63; abdomen, 1.08. Third leg; coxa 1, 0.49; coxa 2, 0.68; coxa 3, 0.53; femur, 1.44; tibia 1, 1.41; tibia 2, 0.99; tarsus, 0.34; propodus, 0.86; main claw, 0.48.

Distribution

Korea (Gyeongsang-do) and Japan (from Sagami Bay to Okinawa).

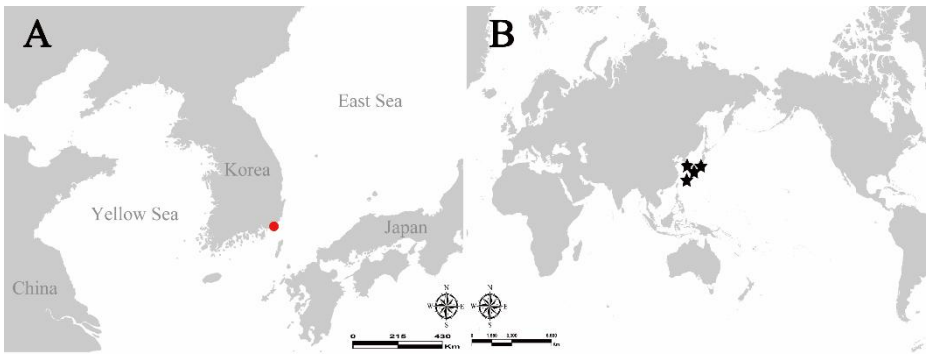


Fig. 115. Distribution of *Pycnogonum* (*Pycnogonum*) *tenue*. A, Distribution in Korea, ● indicating present study; B, Distribution in the world, ★ indicating worldwide distribution.

Remarks

The present species resembles *Pycnogonum* (*Pycnogonum*) *litorale* (Strøm, 1762), but differs from the congener in the followings: (1) Legs are slenderer (stout in *P*. (*P*.) *litorale*). (2) The proboscis is tapering distally (truncated cone shape). (3) The abdomen has round tip (truncated tip). *Pycnogonum* (*Nulloviger*) *africanum* Calman, 1938 is similar to the present species, but easily distinguished by the different subgenera. Furthermore, the congener has a regularly tapering proboscis, three longer and slenderer dorsal tubercles on the trunk, and no post ocular tubercle.

Stock (1954) described the present species observing one male and two female specimens collected at Korean Strait (32°49'N 128°14'E) and Kim (2013) noted this record was included in Korean waters. The author re-examined this coordinate. It was located near Fukue island, Japan and over the boundary of the Korean continental shelf. Therefore, this record seems to be excluded from the Koreane records.

The observed specimen is large like the Holotype, the Albatross specimens (Hedgpeth, 1949), and Takahashi's specimens (Takahashi *et al*., 2007), while Stock's (1954) specimens were smaller than the examined material. The examined material has a distally swollen shape of the proboscis and this is thought to be a variation.

The present species is distributed between Sagami Bay and Okinawa, Japan in latitude and 7–416 m at depth range (Takahashi *et al*., 2007).

48. *Pycnogonum* (*Pycnogonum*) *uedai* Nakamura & Child, 1983

송장바다거미 (Fig. 116)

Pycnogonum uedai Nakamura & Child, 1983:64, fig. 21; 1991:63.—Kim, 2013:108, fig. 51.

Pycnogonum (*Retroivger*) *koreanum* Kim & Stock, 1984:685, figs. 1–6.

Pycnogonum (*Pycnogonum*) *koreanum*.—Turpaeva, 2007a:130, pl. 23: figs. 10–12.

Material examined

2 inds. (2 ♂♂), Oedolgae point, Seoguipo, Jejudo Island, Korea, 33°14'22.1"N 126°32'56.0"E, 8 m, SCUBA, coll. D. Lee, 9 Jan 2017; 1 ind. (1 ♂), near Sacheonjin Harbor, Yangyang, Gangwon-do, Korea, artificial reef, 18 m, SCUBA, coll. D. Lee, 9 Feb 2018; 1 ind. (1 ♀), Gajicho point, Dokdo Island, Korea, 37°15'02.0"N 131°51'57.1"E, 25 m, SCUBA, coll. D. Lee, 16 Jul 2018; 1 ind. (1 ♂), DMDK41, Keongaje point, Dokdo Island, Korea, SCUBA, coll. Y.H. Kim, 13 Jun 2018; 2 inds. (1 ♂, 1 ♀), Gongam Rock point, Ulleungdo Island, Korea, 37°32'23.3"N 130°50'49.2"E, SCUBA, coll. Y.H. Kim, 17 Jun 2018; 1 ind. (1 ♀), Oryu-ri, Gyeongju, Gyeongsangbuk-do, Korea, 35°50'11.0"N 129°31'02.0"E, coll. S.H. Kim, 30 Sep 2017; 1 ind. (1 ♀), Interdital zone of Daemaemuldo Island, Tongyeong, Gyengsangnam-do, Korea, 34°38'47.8"N 128°34'39.6"E, coll. S.H. Kim, 2 Aug 2019; 1 ind. (1 ♀), South of Seopseom Island, Jejudo Island, Korea, 33°13'42.1"N 126°35'48.9"E, 37 m, Trimix SCUBA, coll. D. Lee, 16 Aug 2019.

Diagnosis

Trunk granulated, fully segmented, having low dorsal tubercle on posterior margin of each segment. Lateral processes short, slightly separated. Ocular tubercle low, having blunt tip, present at anterior part of cephalic segment. Proboscis stout, spindle-shaped. Abdomen cylindrical, not articulated, directing horizontally, reaching beyond coxa 1. Palp and chelifore absent. Oviger 8-segmented, having terminal claw. Legs short, stout, granulated; femur having ventral swelling; propodus slightly curved; spines on ventral surface of tibia and propodus having bifurcated tips; auxiliary claws tiny.

Fig. 116. *Pycnogonum (Pycnogonum) uedai*, DMDK41. Trunk, dorsal view. Scale bar = 1 mm.

Distribution

Korea (Gangwon-do, Gyeongsang-do, Jeolla-do, Chungcheong-do and Jejudo Island) and Japan (Wa kayama and Sagami Bay).

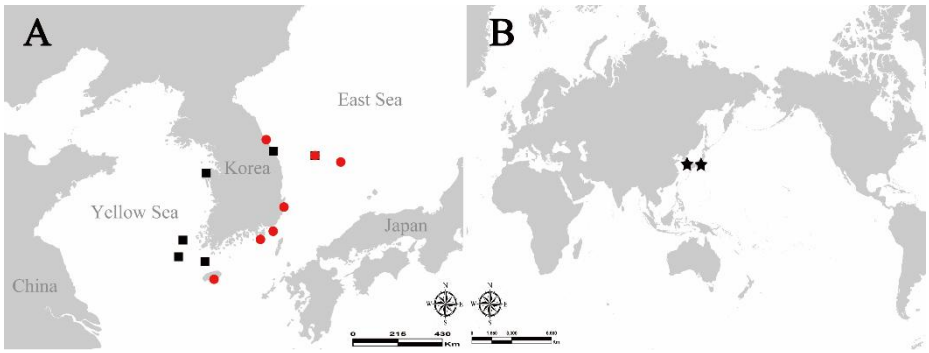


Fig. 117. Distribution of *Pycnogonum (Pycnogonum) uedai*. A, Distribution in Korea, ● indicating present study, ■ indicating previous records in Korea (Kim, 2013); B, Distribution in the world, ★ indicating worldwide distribution.

Remarks

The present species is similar to *Pycnogonum* (*Pycnogonum*) *ungellatum* Loman, 1911 and *Pycnogonum* (*Pycnogonum*) *benokianum* Ohshima, 1935 having cylindrical proboscis and dorsal tubercles on the trunk without post ocular tubercle. Comparing the congeners with the present species, the present species has a smaller trunk from 1.74 mm to 2.18 mm (6 mm, larger in *P.* (*P.*) *ungellatum*) and 8-segmented ovigers (9-segmented in *P.* (*P.*) *ungellatum*). In the present species, the tibia 2 is two third length of the femur and the auxiliary claws are tiny, while in *P.* (*P.*) *benokianum,* the tibia 2 is as long as the femur and the auxiliary claws are half length of the main claw.

Kim & Stock (1984) reported *Pycnogonum* (*Retroviger*) *koreanum* as a new species. Nakamura & Child (1991) examined three specimens of *P.* (*R.*) *koreanum* and synonymized *P.* (*R.*) *koreanum* with the present species confirming that there was no difference between them.

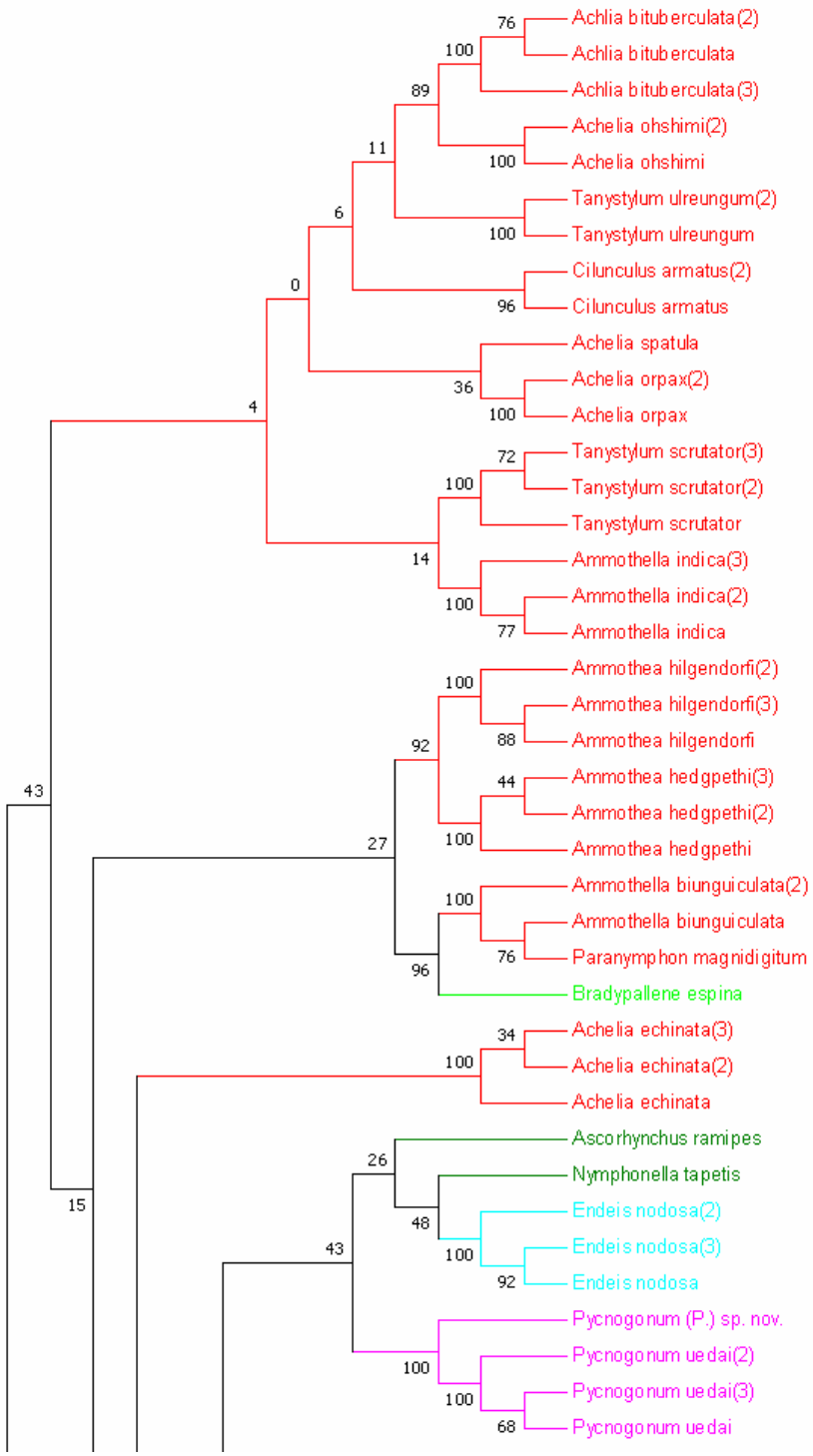
The examined specimens fit well in the original description, but having much smaller trunk (1.74–2.18 mm) than Kim's (2013) description (3.44 mm).

The present study extends distribution of Southern Limit Line of the present species to Jejudo Island and the present species is distributed between 0–90 m at depth range (Nakamura & Child, 1991).

2. Molecular analysis

In the present study, 48 species in 18 genera and nine families (Ammotheidae, Ascorhynchidae, Callipalllenidae, Endeidae, Nymphonidae, Pallenopsidae, Phoxichilidiidae, Pycnogonidae, and Ascorhynchoidae incertae sedis) were presented. Among 48 species, 36 species of DNA barcode (COI region) in 17 genera and eight families were acquired.

The phylogenetic tree was inferred using the Neighbor-Joining method (Fig. 118). The optimal tree with the sum of branch length = 4.09249477 is shown. The distances were computed using the Kimura 2-parameter method and are in the units of the number of base substitutions per site. Codon positions included were 1st+2nd+3rd+Noncoding. All positions containing gaps and missing data were eliminated. There was a total of 514 positions in the final dataset. The analyses were conducted in MEGA7. Each family was marked with a different color (Ammotheidae: red, Ascorhynchidae: dark green, Endeidae: light blue, Pycnogonidae: purple, Nymphonidae: blue, Callipalllenidae: light green, Phoxichilidiidae: navy blue, and Family incertae sedis: brown).


Achlia bituberculata(2)
Achlia bituberculata
Achlia bituberculata(3)
Achelia ohshimi(2)
Achelia ohshimi
Tanystylum ulreungum(2)
Tanystylum ulreungum
Cilunculus armatus(2)
Cilunculus armatus
Achelia spatula
Achelia orpax(2)
Achelia orpax
Tanystylum scrutator(3)
Tanystylum scrutator(2)
Tanystylum scrutator
Ammothella indica(3)
Ammothella indica(2)
Ammothella indica
Ammothea hilgendorfi(2)
Ammothea hilgendorfi(3)
Ammothea hilgendorfi
Ammothea hedgpethi(3)
Ammothea hedgpethi(2)
Ammothea hedgpethi
Ammothella biunguiculata(2)
Ammothella biunguiculata
Paranymphon magnidigitum
Bradypallene espina
Achelia echinata(3)
Achelia echinata(2)
Achelia echinata
Ascorhynchus ramipes
Nymphonella tapetis
Endeis nodosa(2)
Endeis nodosa(3)
Endeis nodosa
Pycnogonum (P.) sp. nov.
Pycnogonum uedai(2)
Pycnogonum uedai(3)
Pycnogonum uedai
76
100
89
11
100
6
100
0
96
4
36
100
72
100
14
100
77
100
92
88
44
27
100
100
76
96
34
100
26
48
43
100
92
100
100
68
43
15

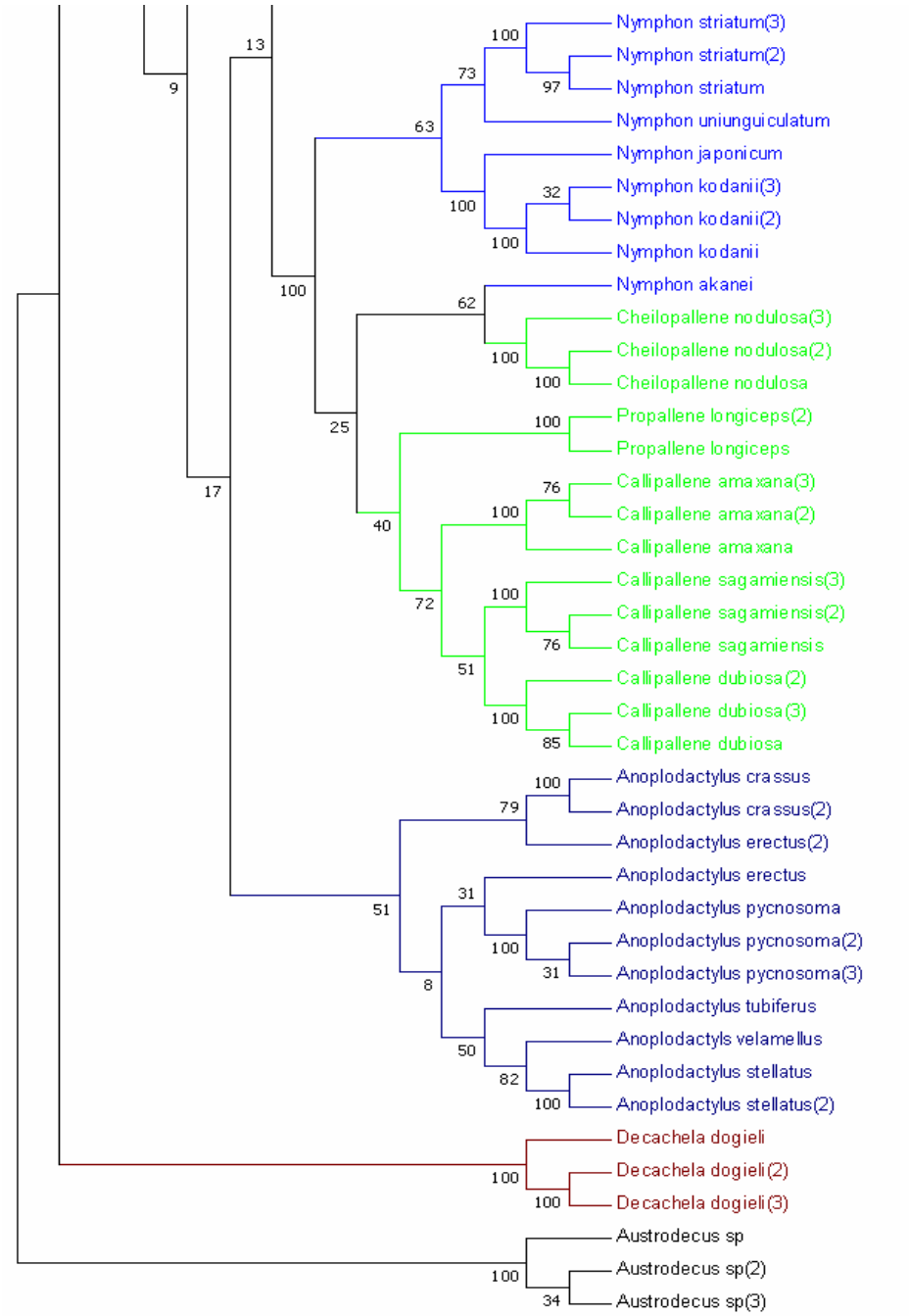


Fig. 118. Phylogenetic tree of collected pycnogonid taxa resolved by Neighbor-Joining method based on COI region.

In the phylogenetic tree, Endeidae, Pycnogonidae, and Phoxichilidiidae corresponds well with the morphological analyses consisting of monophyletic tree. However, in the family Ammotheidae, many genera and species are mixed unlike morphological analyses, and there are many low bootstrap values. More diverse DNA barcode analyses are needed to produce meaningful results and compare with morphological analysis. Callipallenidae and Nymphonidae are rather consinsting of monophyletic tree except the *B. espina*, *C. nodulosa* and N. *akanei*. To confirm the exact phylogenetic positions of these data, additional DNA barcode analyses are needed. It is difficult to infer any results due to the lack of data from Endeidae and Ascorhynchidae.

Comparing Pairwise Distance between groups were analyzed in 17 genera (Table 8). The number of base substitutions per site from estimation of net average between groups of sequences are shown. Analyses were conducted using the Kimura 2-parameter model. Codon positions included were 1st+2nd+3rd+Noncoding. All positions containing gaps and missing data were eliminated. There was a total of 514 positions in the final dataset. The analyses were conducted in MEGA7. Through the comparison, the difference between genera was 5.2–35.2%.

Comparing Pairwise Distance between groups were analyzed in 36 species (Table 9). The number of base substitutions per site from between sequences are shown. Analyses were conducted using the Kimura 2-parameter model. Codon positions included were 1st+2nd+3rd+Noncoding. All positions containing gaps and missing data were eliminated. There was a total of 557 positions in the final dataset. The analyses were conducted in MEGA7. Through the comparison, the difference between species was 6.4–41.9%. The minimum difference wass between *P. magnidigitum* and *A. biunguiculata*. The following ranges were obtained through comparison between different species in the same genus (*Achelia*: 13.6–25.1%, *Ammothea*: 14.5%, *Ammothella*: 15.3%,

Tanystylum: 16.6%, *Callipallene*: 15.3%, *Nymphon*: 11.9–27.9%, *Anoplodactylus*: 20.7–34.5%, *Pycnogonum*: 14.0%). The average value of these data was 15.2%.

Table 8. Comparing Pairwise Distance (%) between Genera

		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
1	*Achelia*	0															
2	*Ammothea*	8.5															
3	*Ammothella*	5.2	8.3														
4	*Cilunculus*	5.8	12.0	7.6													
5	*Paranymphon*	14.7	18.0	10.3	17.5												
6	*Tanystylum*	5.4	11.1	6.4	8.0	16.6											
7	*Ascorhynchus*	15.9	16.5	17.4	18.6	25.5	18.8										
8	*Nymphonella*	20.1	20.3	21.7	23.0	32.5	23.0	22.9									
9	*Decachela*	10.1	13.9	10.4	12.9	20.2	10.7	24.9	28.6								
10	*Bradypallene*	10.8	13.0	9.7	13.1	16.5	13.8	22.0	25.9	16.2							
11	*Callipallene*	15.0	17.3	15.8	17.2	25.4	18.6	23.4	27.0	22.2	20.2						
12	*Cheilopallene*	17.6	22.2	16.8	20.9	25.2	18.4	27.6	31.2	24.2	22.7	11.7					
13	*Propallene*	23.5	26.7	26.2	26.8	34.1	30.4	29.4	32.1	35.2	29.6	15.9	20.3				
14	*Endeis*	16.2	18.7	18.6	16.3	27.2	21.9	25.8	24.1	27.0	23.6	27.9	30.0	32.9			
15	*Nymphon*	13.2	16.7	14.6	17.1	22.3	16.2	21.2	24.0	19.2	19.6	8.9	9.5	15.7	24.7		
16	*Anoplodactylus*	6.8	9.8	7.2	9.0	16.4	9.9	16.0	18.3	13.0	12.7	14.2	16.5	21.7	17.0	12.1	
17	*Pycnogonum*	14.1	17.6	15.7	17.8	23.5	16.7	20.6	24.8	21.8	19.5	21.9	22.8	30.6	22.5	21.0	14.5

Table 9. Comparing Pairwise Distance (%) between pycnogonid species

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35
1																																			
2	21.8																																		
3	13.6	19.2																																	
4	22.0	25.1	22.5																																
5	18.4	19.6	16.6	14.9																															
6	21.8	20.8	19.8	21.8	17.8																														
7	25.2	23.3	21.2	21.8	18.0	14.5																													
8	19.6	19.6	16.4	17.8	14.8	16.2	17.8																												
9	20.1	23.0	16.9	17.8	13.8	18.0	19.6	15.3																											
10	22.8	23.7	20.8	21.1	18.1	22.1	22.4	18.8	19.5																										
11	24.7	25.0	20.3	23.7	20.5	21.3	21.8	6.4	21.3	22.8																									
12	20.3	19.4	13.6	19.9	12.1	18.4	20.6	15.9	14.4	21.3	20.3																								
13	18.4	21.7	16.9	19.7	15.3	20.9	21.3	17.1	18.0	23.9	22.8	16.6																							
14	21.3	26.2	20.3	24.0	21.7	18.9	24.5	19.4	21.3	23.7	23.7	23.4	22.2																						
15	29.2	28.1	27.0	27.7	24.3	23.2	27.5	25.6	24.7	26.7	30.8	27.3	26.2	22.5																					
16	23.7	22.5	18.7	18.2	15.8	19.8	23.0	16.4	17.6	22.8	22.5	14.9	21.5	25.9	29.0																				
17	20.1	21.0	18.0	17.8	15.3	15.3	18.7	10.4	15.1	20.2	15.6	16.6	18.0	20.5	25.4	17.8																			
18	32.1	26.9	31.2	29.7	27.4	25.4	28.2	23.4	26.2	28.1	27.5	28.5	28.8	28.0	32.4	32.0	23.7																		
19	28.8	27.2	26.2	30.5	25.9	27.4	26.7	25.2	26.7	27.3	28.3	28.0	30.4	27.7	32.6	29.6	25.9	17.1																	
20	28.5	25.5	28.5	29.6	26.9	26.2	26.7	26.5	26.2	29.1	31.7	29.5	29.0	26.4	30.8	29.4	25.7	15.5	15.3																
21	28.5	26.9	26.4	27.2	27.2	27.2	25.9	22.7	23.4	29.7	28.0	25.2	25.6	29.3	30.4	29.3	24.1	17.1	20.6	20.8															
22	32.6	29.1	31.7	30.5	31.0	32.0	27.0	27.5	30.7	30.4	32.7	34.6	33.7	27.0	31.0	36.1	28.0	21.1	24.0	21.5	21.3														
23	27.7	24.6	26.0	24.5	23.0	22.0	22.4	20.2	23.6	19.1	24.3	26.4	26.8	26.0	25.2	28.0	23.0	31.0	34.5	31.0	30.2	33.6													

24	35.1	33.3	31.8	32.5	30.3	30.1	32.4	29.7	29.9	32.0	34.2	29.4	32.4	33.1	35.8	35.0	29.7	22.0	25.7	26.2	20.1	27.6	34.5												
25	36.9	32.1	32.0	34.7	34.3	30.2	31.6	27.0	34.9	33.9	28.3	34.1	34.3	30.6	36.1	35.0	31.8	26.8	26.5	26.6	24.0	25.8	34.4	27.9											
26	33.7	28.3	28.0	29.9	28.8	27.0	28.3	22.7	28.8	30.8	27.2	28.5	30.6	27.7	31.3	28.6	26.4	20.9	24.2	22.3	19.1	21.8	33.0	27.0	11.9										
27	28.2	26.4	26.2	27.0	24.7	25.7	27.5	23.9	23.4	28.6	29.1	24.6	25.4	28.5	30.2	27.4	23.9	19.2	22.7	20.8	16.2	24.8	30.2	22.4	22.9	18.8									
28	33.2	29.1	30.7	30.3	29.1	31.0	30.5	30.2	31.0	32.1	33.8	28.1	29.7	32.2	32.4	32.7	31.0	24.1	26.0	23.8	22.0	23.8	35.6	26.6	22.2	18.8	15.7								
29	27.0	23.7	24.9	24.8	21.3	23.7	26.3	24.4	22.4	25.2	27.7	23.7	23.9	27.7	30.8	23.9	23.4	28.2	31.2	28.5	28.2	32.3	27.5	35.2	34.0	30.1	26.4	32.0							
30	30.4	29.7	26.8	28.0	25.4	27.3	30.9	23.9	25.9	29.6	27.2	25.7	24.2	33.7	33.2	26.8	27.2	36.5	36.0	38.1	32.6	39.7	33.3	41.3	41.9	35.4	31.5	37.6	21.7						
31	30.6	28.3	27.7	28.0	24.7	25.4	28.1	23.2	23.2	28.3	27.5	27.7	29.3	24.2	29.7	27.0	23.4	29.5	31.7	32.0	28.7	28.0	31.0	37.7	37.2	29.3	31.5	33.1	24.4	31.1					
32	31.8	28.2	28.7	31.4	29.5	26.5	26.6	25.0	26.8	32.0	28.6	27.9	29.8	32.3	30.6	28.1	26.0	34.0	35.5	34.1	32.6	35.0	29.8	35.7	36.2	31.0	35.2	34.9	26.7	34.5	27.1				
33	26.7	22.7	22.2	24.8	20.8	22.2	20.3	21.5	19.1	26.5	26.7	21.7	23.7	26.2	27.1	22.5	21.7	28.2	27.2	26.7	26.4	28.1	28.1	32.1	34.5	29.3	28.8	30.1	22.2	24.7	22.5	20.7			
34	30.2	28.8	27.3	27.9	26.8	27.0	28.7	26.0	24.5	26.3	31.3	26.8	26.8	27.2	29.5	31.6	26.7	30.9	32.0	32.3	29.9	34.0	28.5	31.4	38.5	32.9	29.0	3.0	24.2	32.5	25.8	22.7	22.8		
35	30.4	31.3	30.9	25.9	25.7	28.8	27.2	24.4	26.2	31.3	27.2	26.4	26.2	29.0	33.5	30.1	26.2	31.7	34.2	33.6	33.1	35.7	30.5	37.5	38.8	33.4	34.5	37.0	32.0	38.1	34.8	36.3	29.3	36.1	
36	27.2	25.5	24.2	23.0	21.3	24.4	22.5	20.5	23.7	25.7	24.7	22.7	22.8	22.2	28.8	26.5	20.1	30.1	30.3	31.7	26.4	31.2	26.0	32.7	35.1	30.4	28.0	31.9	27.4	34.0	29.0	36.1	25.7	29.7	14.0

1 *Achelia bituberculata* 2 *Achelia echinata* 3 *Achelia ohshimai* 4 *Achelia orpax* 5 *Achelia spatula* 6 *Ammothea hedgpethi*
7 *Ammothea hilgendorfi* 8 *Ammothella biunguiculata* 9 *Ammothella indica* 10 *Cilunculus armatus* 11 *Paranymphon magnidigitum* 12 *Tanystylum scrutator*
13 *Tanystylum ulreungum* 14 *Ascorhynchus ramipes* 15 *Nymphonella tapeties* 16 *Decachela dogieli* 17 *Bradypallene espina* 18 *Callipallene amaxana*
19 *Callipallene dubiosa* 20 *Callipallene sagamiensis* 21 *Cheilopallene nodulosa* 22 *Propallene longiceps* 23 *Endeis nodosa* 24 *Nymphon akanei*
25 *Nymphon japonicum* 26 *Nymphon kodanii* 27 *Nymphon striatum* 28 *Nymphon uniunguiculatum* 29 *Anoplodactylus crassus* 30 *Anoplodactylus erectus*
31 *Anoplodactylus pycnosoma* 32 *Anoplodactylus stellatus* 33 *Anoplodactylus tubiferus* 34 *Anoplodactylus velamellus* 35 *Pycnogonum* (*Nulloviger*) sp. nov. 36 *Pycnogonum* (*Pycnogonum*) *uedai*

CONCLUSION

1. Morphological analysis

As a result of the research on Korean pycnogonids, 48 species belonging to 18 genera and nine families (Ammotheidae, Ascorhynchidae, Callipallenidae, Endeidae, Nymphonidae, Pallenopsidae, Phoxichilidiidae, Pycnogonidae, and Ascorhynchoidae incertae sedis) have been discovered in Korean waters. Among the families, Ammotheidae consists of 18 species making up 37.5 % of all species. Nymphonidae and Phoxichilidiidae have the second highest ratio with seven species, and Endeidae, Pallenopsidae, and Ascorhynchoidae incertae sedis (genus *Decachela*) have the lowest ratio with one species each (Fig. 119).

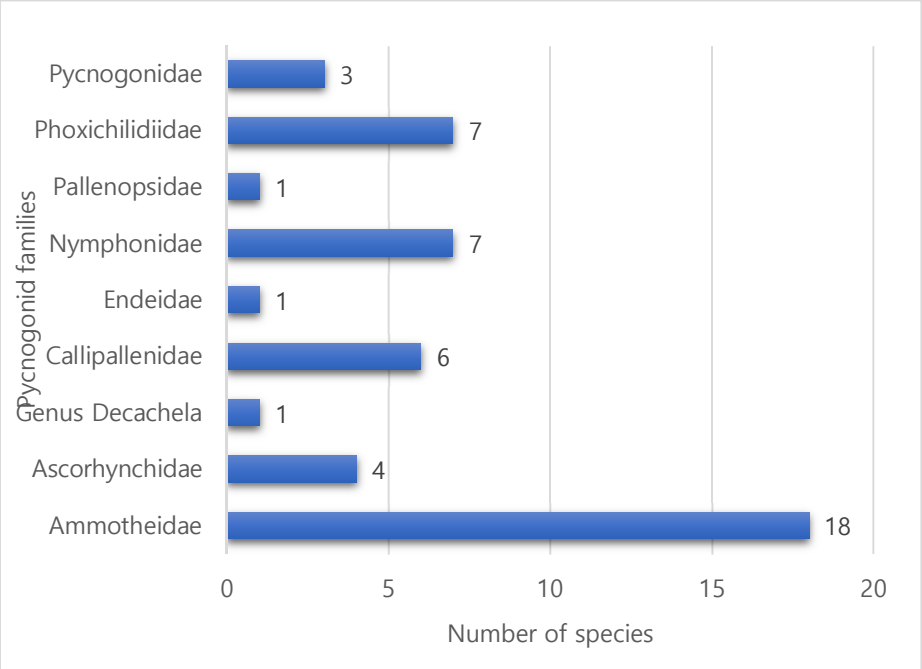


Fig. 119. Composition of Korean pycnogonid families.

SCUBA diving was the main method used, and seeweed, hydra, sponge, bryozoan, and wall surfaces were mainly targeted for sampling. A total of 41 species (1,281 individuals) were directly collected by the author. By collecting targets, it is possible to directly and indirectly know the ecological environment and their habits of each species (Table 10). When collecting, most species showed negative phototaxis, however, two species [Callipallene amaxana (Ohshima, 1933), and *Propallene longiceps* (Böhm, 1879)] were collected using light trap. It is not clear whether these species are attracted to the light (positive phototaxis), or if they had gathered to eat other creatures caught in the trap. As a singularity, when collecting specimens by light trap, only one individual was collected per trap. This may be due to the fact that pycnogonids have a small biomass in their environment, or it may be that only one individual occupied a trap at a time due to competition. To solve this problem, further studies are needed. The majority of species were collected from algae and hydra, and some species were found only in certain environments, such as steel structures, fan coral, and starfish (*Solaster* spp.). Given this sampling data, it can be inferred that pycnogonids live mainly near algae and hydra, whoese mucus is their main food source.

Table 10. Sampling targets and method of each species

Target Species	Sampling Target	Method
Achelia spp.	Algae, hydra, sponge	SCUBA, Intertidal zone survey
Ammothea hilgendorfi	Algae, Mussel patch, rock surface	SCUBA, Intertidal zone survey
Ammothella biunguiculata	Rock surface	SCUBA, Intertidal zone survey
Ammothella indica	Algae, dead body of Cnidaria	SCUBA
Anoplodactylus stellatus	Fan coral	SCUBA
Anoplodactylus tubiferus	Soft bottom on the surface or shallow depth	Grab

Anoplodactylus spp.	Algae, hydra	SCUBA
Ascorhynchus ramipes	Soft bottom on the surface or shallow depth	Grab
Callipallene amaxana	Sponge, algae (mainly red algae), light?	SCUBA, Intertidal zone survey, Light trap
Callipallene spp.	Sponge, algae (mainly red algae) Sargassum (shallow depth)	SCUBA, Intertidal zone survey
Cheilopallene nodulosa	Hydra, sponge, bryozoan (deep depth)	SCUBA
Cilunculus armatus	Soft bottom on the surface or shallow depth	Grab
Decachela dogieli	Starfish (*Solaste*r spp.)	Fish net, Fish trap
Nymphon striatum	Steel structure	SCUBA
Nymphon spp.	-	Fish net, Fish trap
Nymphonella tapetis	Free swimming	Night SCUBA
Pallenopsis sibogae	Bryozoan	SCUBA
Propallene longiceps	Light?	Light trap
Pycnogonum (*Pycnogonum*) *uedai*	Algae (mainly near holdfast of *Ecklonia cava*)	SCUBA
Tanystylum scrutator	Algae, hydra	SCUBA

In Korea, Ilhoi Kim had conducted systematic studies of Pycnogonida collected in Korean fauna. In 2013, he published “Invertebrate Fauna of Korea, Sea Spider” and reported that 45 pycnogonid species were found in Korean waters. Kim (2013) included five species [*Cilunculus armatus* (Böhm, 1879), *Decachela discata* Hilton, 1939, *Hedgpethia chitinosa* (Hilton, 1943), *Pallenopsis temperans* Stock, 1953, and *Pycnogonum* (*Pycnogonum*) *tenue* Slater, 1879], that had not been reported in previous Korean research. Their collection coordinates have since been confirmed to be outside the boundaries of the continental shelf of Korea, making it difficult to decide if the collection records are indeed within Korean waters. In the case of *C. armatus*, the coordinate is confirmed to be near the boundary and there is a possibility that

the coordinate will be included in Korean waters according to the EEZ agreement in the future. Therefore, it is reasonable to retain the record of *C. armatus* as it is, and to exclude the other records of the four species

Stock (1954) mentioned that the identification of *Achelia latifrons* (Cole, 1904) collected from the Korean coast was uncertain, since it was in the juvenile stage. Moreover, *Achelia orpax* Nakamura & Child, 1983, the most similar species to *A. latifrons*, was reported as a new species in 1983, so a distinction was needed between the two species. In *A. latifrons*, there are three tubercles on the dorsodistal margin of coxa 1, while in *A. orpax*, only one tubercle is present on the dorsodistal margin of coxa 1. Both adult and juvenile specimens of *A. orpax* were collected and compared with mtCOI DNA barcodes, which identified that there are small differences between both stages (Table 5). The both stages of specimens had a tubercle on the coxa 1 and through this study, it can be deduced that this characteristic can also be applied to the juvenile stages of other species in the genus *Achelia*. The loaned Korean specimen (NHMD 652670) has three tubercles on coxa 1, even though the juvenile specimen is identified to *A. latifrons*. Stock's (1954) identification is thus confirmed to be correct.

Of the 48 species of Korean pycnogonids, 43 species were collected by various methods. Examination of 43 species found that there are errors in the morphology descriptions and classifications of eight species [*Ammothea hedgpethi* (Utinomi, 1959), *A. hilgendorfi* (Böhm, 1879), *Paranymphon magnidigitum* Hong & Kim, 1987, *Callipallene amaxana*, (Ohshima, 1933), *C. sagamiensis* Nakamura & Child, 1983, *Endeis nodosa* Hilton, 1942, *Anoplodactylus crassus* Nakamura & Child, 1988, *A. erectus* Cole, 1904, and *A. velamellus* Nakamura & Child, 1991]. Based on the examined material and the original descriptions, the morphological characteristics were reviewed to

correct errors in previous literature. Newly discovered classification methods were also applied to these species.

The author also recorded additional variations in 13 species [*Achelia alaskensis* (Cole, 1904), *A. orpax* Nakamura & Child, 1983, *Ammothella indica* Stock, 1954, *Paranymphon spinosum* Caullery, 1896, *Tanystylum scrutator* Stock, 1954, *T. ulreungum* Kim, 1983, *Ascorhynchus glaberrimus* Schimkewitsch, 1913, *A. ramipes* (Böhm, 1879), *Nymphonella tapetis* Ohshima, 1927, *Nymphon japonicum* Ortmann, 1891, *N. kodanii* Hedgpeth, 1949, *N. longitarse* Krøyer, 1844, and *N. striatum* Losina-Losinsky, 1929]. In addition, the location of gonopores was indicated according to the gender of each species.

Achelia ohshimai Utinomi, 1951 was reported as a new species in Japan, but synonymized with *A. bituberculata* Hedgpeth, 1949. Based on mtCOI DNA barcode comparisons, *A. ohshimai* was returned to species level and found not to be a synonym of *A. bituberculata*. The morphology of *A. ohshimai* was described in detail, and variations examined were compared with the original description.

During field surveys, six unrecorded Korean pycnogonids were found. A new species candidate was found in Jejudo Island, and it should belong to the genus *Pycnognum*. Due to the absence of ovigers and the male specimen, it was determined to belong to the subgenus *Nulloviger*. Through the presence of auxiliary claws and the lateral processes that touch each other, *Pycnogonum* (*Nulloviger*) sp. nov. was easily distinguished from the other species.

Five species [*Achelia spatula* Nakamura & Child, 1983, *Pallenopsis sibogae* Loman, 1911, *Anoplodactylus stellatus* Nakamura & Child, 1983, *A. tubiferus* (Haswell, 1884), and *Pycnogonum* (*Pycnogonum*) *tenue* Slater, 1879] were newly discovered in Korean waters. Among them, *A. spatula* and *A.*

stellatus were the second specimens recorded since the holotype was first reported, and a female specimen of *A. stellatus* was newly discovered. The morphology of these five species were described in detail. *Cilunculus armatus* was also collected in Korean waters, which was the first time that actual specimens have been observed. Its morphology was also described in detail.

Through the present study, the location of *Ammothella biunguiculata* (Dohrn, 1881) was expanded to the north. Locations of four species [*Callipallene sagamiensis* Nakamura & Child, 1983, *Cheilopallene nodulosa* Hong & Kim, 1987, *Nymphon striatum* Losina-Losinsky, 1929, and *Pycnogonum* (*Pycnogonum*) *uedai* Nakamura & Child, 1983] were expanded to the south.

2. Molecular analysis

Phylogenetic tree was created using the Neighbor-Joining method, based on mtCOI DNA barcodes from 36 species. Although it is difficult to determine upper phylogenetic relationships using only mtCOI DNA barcodes, some peculiarities have been confirmed. The first peculiarity is the phylogenetic position of genus *Bradypallene* Kim & Hong, 1987 (Fig. 118). This genus consists of only one species, *Bradypallene espina* Kim & Hong, 1987. Kim & Hong (1987) reported the genus *Bradypallene* as a new genus, and included this genus in the family Callipallenidae given its morphology (3-segmented palps, complete chela, and 10-segmented oviger in both gender) was similar to that of other Callipallenidae genera. However, in the phylogenetic tree created using the mtCOI DNA barcodes, this genus was found to be closely related to *Ammothella biunguiculata* (Dohrn, 1881) of the family Ammotheidae, without any relation to the other genera of Callipallenidae. These two species share the

following characteristics: 1) The ocular tubercle is low and present at the anterior end of the cephalic segment. 2) The trunk is fully segmented. 3) The lateral processes are as long as their diameter, are separated by less than half of the diameter, and do not have distinct ornamentation. 4) The main claw at the legs is vestigial. Further studies are needed to determine the relationship between the two species and the phylogenetic position of the genus *Bradypallene*.

The genus *Decachela* Hilton, 1939 consists of two species, but only *Decachela dogieli* Losina-Losinsky, 1961 is found in Korean waters. This species is found in deep water, and since the other collection site of this species is found only in Russia, it is presumed to live in cold waters. It is thought to be parasitic on echinoderms, as they were attached to Starfish (*Solaster paxillatus* Sladen, 1889, *S. uchidai* Hayashi, 1939) when collected. The current phylogenetic position of this genus is unknown. In this study, it can be seen that this genus forms an independent clade apart from the other families. This genus may belong to a family that has not yet been discovered in Korean waters, or may belong to a new independent family. Though the genus *Decachela* is similar to the genus *Tanystylum* Miers, 1879 in having a disk-shaped trunk, lateral processes touching each other, reduced chela and palp, and no terminal claw at oviger, these two genera are quite different with 10.7 % difference when mtCOI DNA barcodes are compared. To determine the exact phylogenetic positon of this genus, additional methods are needed, such as using 18S, 28S DNA barcodes.

Differences between 17 genera ranged from 5.2–35.2 %. The minimum differences were found between *Ammothea* Leach, 1814 and *Ammothella* Verrill, 1900. In Ammothea genera, the difference between *Paranymphon* and other genera was obvious, which was predicted by morphological analysis. The

following minimum difference were obtained by comparing different species in the same genus (*Achelia*: 13.6 %, *Ammothea*: 14.5 %, *Ammothella*: 15.3 %, *Tanystylum*: 16.6 %, *Callipallene*: 15.3 %, *Nymphon*: 11.9 %, *Anoplodactylus*: 20.7 %, and *Pycnogonum*: 14.0 %). Through this study, around 11.9 % was estimated to be the criteria needed to identify species when using mtCOI DNA barcodes.

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요 약

한국 해역에 서식하는 협각아문 바다거미강에 대한 분류학적 연구를 수행하였다. 스쿠버다이빙, 그랩, 라이트 트랩 등 다양한 채집 방법으로 국내·외에 서식하는 43종 1,321개체의 바다거미류 표본을 확보하였고, 형태학적 형질과 분자생물학적 형질을 바탕으로 한국산 바다거미류에 대해 분류학적 재검토를 시행하였다.

한국 해역에서 새롭게 채집된 표본과 재검토 대상 분류군의 모식표본, 원기재 문헌을 중심으로 한국산 바다거미류를 재검토하여 다음과 같은 결론을 얻었다. 1. 대한해협에서 발견된 5종[*Cilunculus armatus* (Böhm, 1879), *Decachela discata* Hilton, 1939, *Hedgpethia chitinosa* (Hilton, 1943), *Pallenopsis temperans* Stock, 1953, *Pycnogonum* (*Pycnogonum*) *tenue* Slater, 1879]이 한국산 바다거미류로 보고되었으나, *C. armatus*를 제외한 나머지 4종의 채집기록은 한·일 대륙붕 경계선 조약에 근거한 한국 해역의 경계선 밖에서 확인되기 때문에 한국산 바다거미류에서 제외함. 2. *Achelia latifrons* (Cole, 1904)는 1954년에 한국산 바다거미류로 확인되었지만 유생 단계 표본만 확보되었고, 형태가 유사한 *Achelia orpax* Nakamura & Child, 1983이 뒤에 신종으로 보고되었기 때문에 동정이 모호했음. 해당 표본을 대여하여 관찰하고 성체와 유생 단계 표본의 형태적 형질과 분자생물학적 형질을 함께 비교하여 기존의 동정을 확증하였음. 3. 기존 한국산 바다거미류의 형태 기재 및 분류 방법에 오류가 있었던 8종[*Ammothea hedgpethi* (Utinomi, 1959), *A. hilgendorfi* (Böhm, 1879), *Paranymphon magnidigitum* Hong & Kim, 1987, *Callipallene amaxana*,

(Ohshima, 1933), *C. sagamiensis* Nakamura & Child, 1983, *Endeis nodosa* Hilton, 1942, *Anoplodactylus crassus* Nakamura & Child, 1988, *A. erectus* Cole, 1904, *A. velamellus* Nakamura & Child, 1991]의 형태적 형질을, 확보된 표본 및 원기재 문헌을 중심으로 재검토하여 기재 오류를 수정하고 새롭게 발견된 분류 방법을 적용함. 4. 13종[*Achelia alaskensis* (Cole, 1904), *A. orpax* Nakamura & Child, 1983, *Ammothella indica* Stock, 1954, *Paranymphon spinosum* Caullery, 1896, *Tanystylum scrutator* Stock, 1954, *T. ulreungum* Kim, 1983, *Ascorhynchus glaberrimus* Schimkewitsch, 1913, *A. ramipes* (Böhm, 1879), *Nymphonella tapetis* Ohshima, 1927, *Nymphon japonicum* Ortmann, 1891, *N. kodanii* Hedgpeth, 1949, *N. longitarse* Krøyer, 1844, *N. striatum* Losina-Losinsky, 1929]에 대해 새롭게 발견된 형태변이를 추가 기록함. 5. 일본에서 신종으로 보고되었된 *Achelia ohshimai* Utinomi, 1951은 *Achelia bituberculata* Hedgpeth, 1949의 synonym으로 여겨졌으나 한국 해역에서 채집된 표본의 DNA 바코드 분석을 통해 *A. bituberculata* 와는 별개의 종임을 확인하고 *A. ohshimai*를 적합명칭으로 되돌림.

본 연구를 위한 표본확보 중 6종의 미발굴 바다거미류 표본을 확보하여 다음과 같이 동정하고 기재하였다. 1. 제주해역에서 한 종의 송장바다거미류 신종후보종 표본이 채집되어 *Pycnogonum* (*Nulloviger*) sp. nov. 로 기재하였음. 2. 제주와 남해, 동해해역에서 미기록종 5종[*Achelia spatula* Nakamura & Child, 1983, *Pallenopsis sibogae* Loman, 1911, *Anoplodactylus stellatus* Nakamura & Child, 1983, *A. tubiferus* (Haswell, 1884), *Pycnogonum* (*Pycnogonum*) *tenue* Slater, 1879]이 발견되어 기재하였으며, 이중 *A. spatula*와 *A. stellatus*는 원기재 이후 두 번째로 발견된 표본이며 *A. stellatus* 암컷 표본이 최초로 발견되어 암수 형태

차이를 기재함. 또한 한국산 기록으로 인정되었으나 국내에 표본이 존재하지 않아 형태관찰이 불가능했던 *C. armatus* 표본이 남해해역에서 확보되어 형태를 자세히 관찰하고 형태변이 포함하여 재기재하였다.

기존의 한국산 바다거미류의 분류학적 연구는 형태 분석에 기반한 연구가 수행되었으나 본 연구에서는 형태 분석을 통한 연구와 함께 총 36종의 한국산 바다거미류의 mtCOI DNA 염기서열을 분석하였으며 한국산 바다거미류의 종내변이율과 종간변이율을 비교하여 처음으로 제시하였다.

주요어 : 계통분류학, 한국산 바다거미류, 한국 해역, 형태변이, mtCOI DNA 염기서열, 종간변이율

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