Bull. Natl. Mus. Nat. Sci., Ser. A, **35**(1), pp. 73–81, March 22, 2009

A New Species of the Genus *Abyssotheres* (Crustacea, Decapoda, Brachyura, Pinnotheridae) from the Ryukyu Islands, Southwestern Japan, with Taxonomic Notes on the Genus

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Abstract A new species of the genus *Abyssotheres* is described and illustrated based on two ovigerous females and a single male taken in the mantle cavity of the bivalve mollusk, *Acesta philippinensis* (Bartsch, 1913) from the depths of 722–738 m off the Ryukyu Islands, southwestern Japan. *Abyssotheres acesticola* sp. nov. can be distinguished from the unique member of the genus, *A. abyssicola* (Alcock and Anderson, 1899), in the absence of a projection on the dactylus of the walking legs and the relative length of the dactylus of the cheliped and the walking legs. The diagnosis of the genus is revised and its taxonomic position is discussed.
Key words : Crustacea, Brachyura, Pinnotheridae, *Abyssotheres*, new species, Japan.

Introduction

Since 1988, research cruises of TRV *Toyoshio-maru* of the Hiroshima University investigating benthic and planktonic faunae in the Ryukyu Islands, southwestern Japan, have been intensively carried out by the second author. Parts of its results have already published as a monograph (Hasegawa *et al*., 2005). During the recent cruises of 2007 and 2008, both sexes of an unusual pinnotherid crab were found from the mantle cavity of the deep-sea large bivalve mollusk, *Acesta philippinensis* (Bartsch, 1913). These are identified as an undescribed species of the monotypic genus *Abyssotheres* Manning and Galil, 2000 and herein described and illustrated as a new species. The only, previously known species, *A. abyssicola* (Alcock and Anderson, 1899), was found from the mantle cavity of the deep-sea bivalve, *Acesta indica* (Smith, 1899), collected at a depth of 787 m off Travancore, India. The male of the genus is for the first time described herein.

Through the morphological study of the new species, the diagnosis of the genus is emended. Then the taxonomic position of the genus is discussed.

Material and Methods

The material was collected with a sledge net towed along the muddy bottoms north off Nagannu Island, Kerama Group, the Ryukyu Islands. The crab specimens removed from the host shells were fixed with 80% ethanol and then preserved in 70% ethanol. A pleopod and eggs of a paratypic ovigerous female were separately preserved in 99% ethanol for future DNA analysis. Unfortunately, the host shells are not extant. In the laboratory, crab body parts and appendages were examined under a stereomicroscope (Leica MZ8). For detailed observation of the surface structure, body parts and appendages were stained by a methylene blue solution. Drawings were made with the aid of a camera lucida. Measurements, given in millimeters (mm), are of the greatest carapace length and breadth, respective-

ly. Pereiopods are measured along the outer margin from ischium to dactylus. The specimens examined are deposited in the National Museum of Nature and Science, Tokyo (NSMT). Abbreviations used are: cb, carapace breadth; cl, carapace length; G1, first male gonopod; G2, second male gonopod; stn, station; WL, walking leg(s); WT, water temperature.

Taxonomy

Family Pinnotheridae de Haan, 1833

Subfamily Pinnotherinae de Haan, 1833 *sensu* Campos, 2009

Abyssotheres Manning and Galil, 2000

Diagnosis (*emend*.). Carapace length and width subequal, front prominent, transverse, projecting anteriorly beyond eyes. Eyes visible in dorsal view. Third maxilliped with ischium and merus indistinguishably fused, arched, inner margin projecting at about distal third. Palp 3-segmented, relative length carpus>propodus> dactylus; dactylus styliform, articulated at end of propodus. WL slender, symmetrical; dactyli hooked at tips. All abdominal segments free in both sexes.

Remarks. The following diagnostic features proposed by Manning and Galil (2000) are not suitable for the new species, and therefore should be considered as the specific features of *A. abyssicola*: (1) size is medium (8 mm in female); (2) the dactylus of the chela is slightly less than half of the propodus; (3) the dactyli of the WL 1–2 is longer than that of the WL 3–4. Hence these should be eliminated from the generic diagnosis.

Since male of the genus has been first discovered in the present study, features of the sex are preliminarily diagnosed: (1) size is small (cl<3 mm); (2) the WL 2–3 bear swimming setae; (3) all abdominal segments are free. And the following feature may be unique for the genus, but we do not know whether *A. abyssicola* shares it or not: the basal protuberance of the antenna is partially covered by the medially projecting buccal frame (=labrum).

Manning and Galil (2000) described the third maxilliped of *A. abyssicola* as bearing 2-segmented palp through the examination of the holotype, however, that of *A. acesticola* contradictorily bears 3-segmented palp. The original description of *Pinnotheres abyssicola* by Alcock and Anderson (1899) mentioned that "the dactylus of the external maxillipeds (=third maxillipeds) is styliform and is inserted at the end of the preceding joint (segment)" and furthermore the subsequent description by Alcock (1900) mentioned that "the palp of the external maxillipeds is minute and is much concealed by hairs that fringe the prominent internal angle of the merus: the dactylus is borne at the tip of the propodite (=propodus)." These descriptions well agree with that of *A. acesticola*. In conclusion, the palp of the third maxilliped of *A. abyssicola* is actually 3-segmented, and the dactylus was possibly hidden beneath the setae or had already been detached when Manning and Galil (2000) examined. Thus, the diagnosis of the genus *Abyssotheres* should be revised as follows: (1) the palp of the third maxilliped is 3-segmented; (2) the dactylus of the third maxilliped is styliform and is articulated at the end of the propodus.

Affinity. In the family Pinnotheridae, the taxonomic position of *Abyssotheres* had been uncertain (Campos, 2009). But the present morphological study shows that *Abyssotheres* shares the diagnosis of the subfamily Pinnotherinae *sensu* Campos, 2009, except that the carapace is not soft. Regarding other diagnostic features, particularly the protuberance in the basal antennal article, however, *Abyssotheres* should be placed in the subfamily Pinnotherinae.

In the subfamily Pinnotherinae, the simply 3-segmented palp of the third maxilliped with the dactylus articulated at the end of the propodus like *Abyssotheres* is unusual and is hitherto observed only in the members of *Otrhotheres* Sakai, 1969, *Limotheres* Holthuis, 1975, *Austinotheres* Campos, 2002, and the Bürger's

(1895) three species of the genus *Pinnotheres*, viz., *Pinnotheres glaber* Bürger, 1895, *P. laevis* Bürger, 1895, and *P. longipes* Bürger, 1895. *Orthotheres* was originally monotypic, *O. turboe* Sakai, 1969, and then Schmit *et al*. (1973) added 5 more species to the genus. Subsequently, Campos (1989) revised *Orthotheres* with removing the three species added by Schmit *et al*. (1973), viz., *P. rathbunae* Schmit, 1973, *P. laevis*, and *P. longipes*, due to the difference in the shape of the carapace, the palp of the third maxilliped, and the dactyli of the WL. Campos (1989) additionally placed two other species in *Orthotheres*. Geiger and Martin (1999) described a new species, *O. haliotidis*, with modification on the diagnosis of the genus. On the other hand, Ahyong and Ng (2007) placed *P. glaber*, *P. laevis*, and *P. longipes* in *Orthotheres* as a new combination due to "the subdistal insertion of the dactylus on the propodus of the third maxilliped" only. But these three species are not suitable for the diagnosis given by Geiger and Martin (1999) in: (1) the carapace is broader than long; (2) the carpus of the third maxilliped is longer than the propodus; (3) the WL dactyli are uniformly short. In this paper, we tentatively remove these three species from *Orthotheres* and follow the diagnosis given by Geiger and Martin (1999).

The genus *Abyssotheres* is similar to the genus *Orthotheres* in the complete fusion between ischium and merus and the terminally articulated dactylus to the propodus of the third maxilliped, but can be distinguished from *Orthotheres* by: (1) the carapace is subequal in length and breadth (vs. broader than long in *Orthotheres*); (2) the eyes are visible in dorsal view (vs. hardly visible in *Orthotheres*); (3) the relatively long (about 4 times as long as broad) dactyli of the WL (vs. short (less than 3 times as long as broad) in Otrhotheres) (Sakai, 1969; Geiger and Martin, 1999).

The genus *Abyssotheres* is also similar to *Limotheres* in the shape of the third maxilliped, the moderately long and hooked dactyli of the WL, and the same host bivalve family, Limidae, but can be distinguished from *Limotheres* by: (1) the carapace is rounded (vs. pentagonal in *Limotheres*); (2) the frontal region is prominent and transverse (vs. distinctly triangular in *Limotheres*); (3) the upper surface of the carapace is smooth (vs. with distinct median, longitudinal ridges in *Limotheres*) (Holthuis, 1975).

The genus *Abyssotheres* is also similar to *Austinotheres* in the subcircular carapace and the shape of the third maxilliped, but can be distinguished from *Austinotheres* by: (1) the carapace is firm (vs. thin and easily wrinkled in *Austinotheres*); (2) the WL 2 is symmetrical in length (vs. asymmetrical in *Austinotheres*) (Campos, 2002). Comparison of the genera is provided in Table 1.

The Bürger's (1895) three species of *Pinnotheres*, viz., *P. glaber*, *P. laevis*, and *P. longipes*, are similar to *Abyssotheres* in the rounded carapace and the shape of the third maxilliped, but they are different from *Abyssotheres*

Table 1. Comparison of the morphological characters and the ecologiccal features between *Abyssotheres* and its allied genera.

	Abyssotheres	*Orthotheres*	*Limotheres*	*Austinotheres*
Carapace				
general contour	rounded	transversely elliptical	hexagonal	rounded
upper surface	smooth	smooth	with longitudinal ridges	smooth
Eyes	visible in dorsal view	invisible in dorsal view	visible in dorsal view	invisible in dorsal view
Dactyli of walking legs	about 4 times as long as broad	less than 3 times as long as broad	about 3 times as long as broad	4.6-7.6 times as long as broad
Habitat	deep water	shallow water	shallow water	shallow water
Host	limid bivalve mollusk, *Acesta*	gastropod mollusks	limid bivalve mollusk, *Lima*	oysters, genera *Ostrea* and *Mayrakeena*

in: (1) the eyes are not visible in dorsal view (vs. visible in *Abyssotheres*); (2) the propodus of the third maxilliped is longer than carpus (vs. shorter in *Abyssotheres*); and the dactyli of the WL1, 3, 4 are short (about twice as long as broad) (vs. long (about 4 times as long as broad) in *Abyssotheres*) (Bürger, 1895; Ahyong and Ng, 2007). Thus, we remain these three species to the genus *Pinnotheres*.

Abyssotheres acesticola sp. nov.

[New Japanese name: Shinkai-pinno]

(Figs. 1–4)

Material examined. Holotype, ovig. female (cl 11.2×cb 11.1 mm), NSMT-Cr 19860, north of Nagannu I., Kerama Group, Ryukyu Is., Japan, 26°23.15′N, 127°30.09′E–26°23.56′N, 127°30.39′E, TRV *Toyoshio-maru*, stn TY-07-9, sledge net, 738–722 m deep, bottom of soft grey mud, coll. H. Komatsu, 26 May 2007. Paratype, male (cl 3.0×cb 2.6 mm), NSMT-Cr 19861, same data as holotype. Paratype, ovig. female (cl 10.1×cb 10.8 mm), NSMT-Cr 19862, north of Nagannu I., Kerama Group, Ryukyu Is., Japan, 26°21.93′N, 127°29.54′E–26°21.49′N, 127°29.34′E, TRV *Toyoshio-maru*, stn TY-08-7, sledge net, 736–738 m deep, WT 6.4°C, coll. H. Komatsu, 24 May 2008.

Description. Female: Size large (cl>10 mm). Carapace (Fig. 1A) rounded, firm but not hard, nearly as long as broad, convex dorsally, naked on dorsal surface, covered with short setae on anterolateral surface, regions ill-defined. Front prominent, projecting beyond eyes, slightly de-

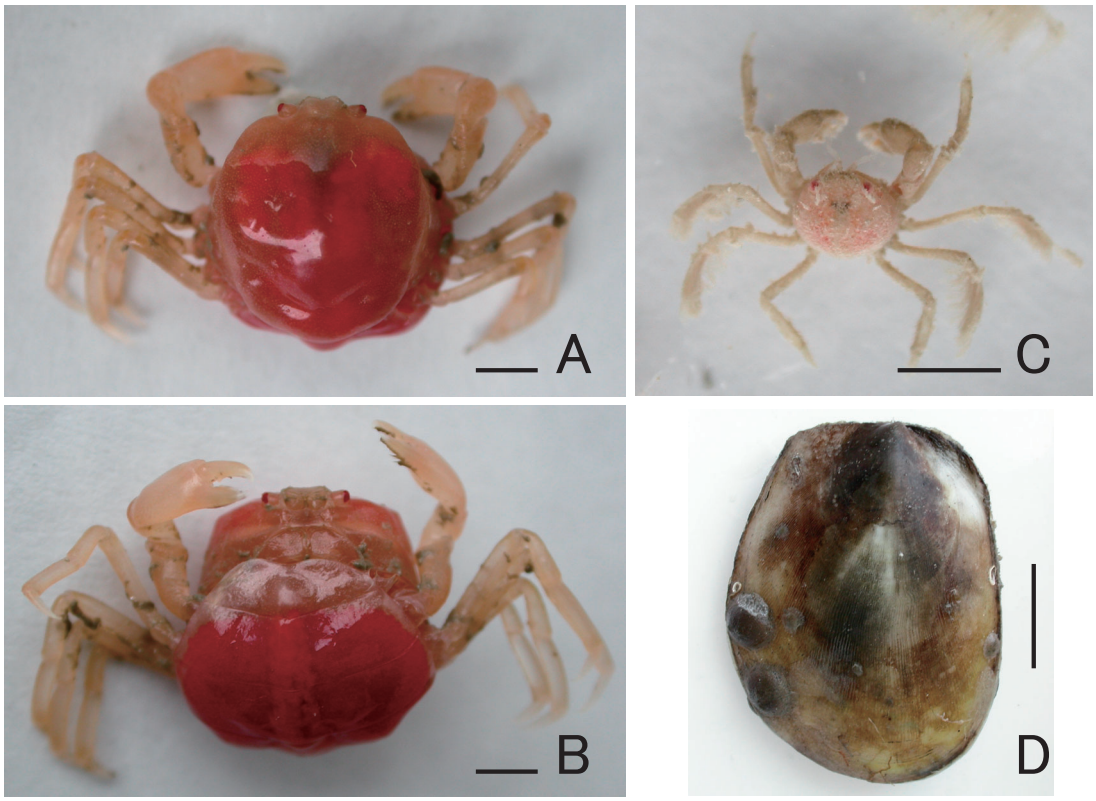

Fig. 1. A–C, *Abyssotheres acesticola* sp. nov. A–B, holotype, ovigerous female (NSMT-Cr 19860; cl 11.2×cb 11.1 mm), dorsal and ventral views, respectively; C, paratype, male (NSMT-Cr 19861; cl 3.0×cb 2.6 mm), dorsal view. D, *Acesta philippinensis* (shell height ca 170 mm; id by K. Hasegawa), host of paratype, ovig. female (NSMT-Cr 19862). Scales: 3 mm (A–C), 50 mm (D).

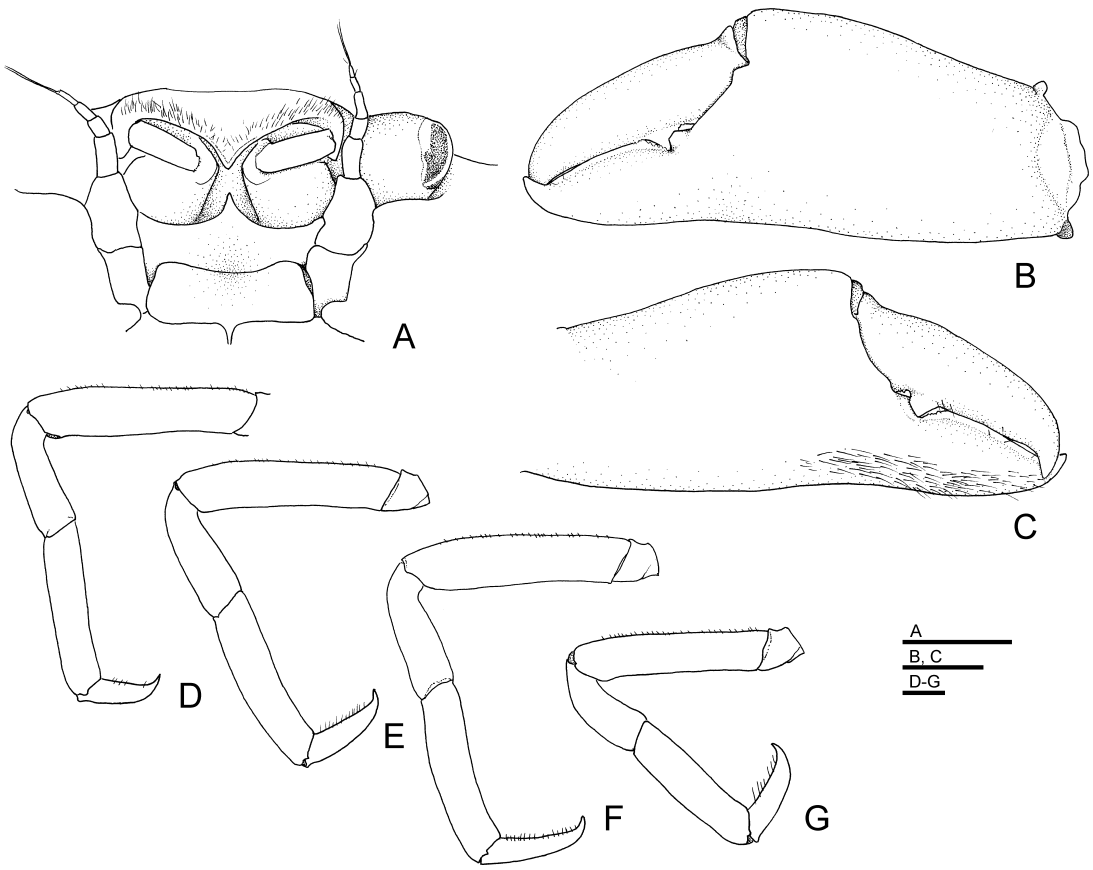

Fig. 2. *Abyssotheres acesticola* sp. nov., holotype, ovigerous female (NSMT-Cr 19860; cl 11.2×cb 11.1 mm). A, carapace, frontal view; B–C, left chela, outer and inner views, respectively; D–G, left first to fourth walking legs, posterior view. Scales: 1 mm.

pressed medially; margin scarcely concave medially, fringed with short setae. Cardiac region convex.

Eye stalk (Fig. 2A) short, immovable, visible in dorsal view; cornea pigmented; orbital hiatus partially filled with distal half of second segment of antenna.

Antennule (Fig. 2A) slightly obliquely folded in antennular fossa; basal segment occupying ventral 0.6 of fossa. Antenna (Fig. 2A) basal segment longitudinally rectangular, with disto-lateral extension; basal protuberance present, partially covered by the medially projecting buccal frame (=labrum); second segment longitudinally rectangular.

Mandible (Fig. 3A) not well calcified; molar process triangular; incisor process (lacking on distal corner in figure) with some fine teeth; palp 3-segmented, straight. Maxillule (Fig. 3B) with coxal endite tongue-shaped; basal endite triangular; endopod 2-segmented, with some setae on tip of distal segment. Maxilla (Fig. 3C) with coxal endite divided into 2 lobes; basal endite faintly divided into 2 lobes; endopod thin, tongue-shaped; scaphognathite (exopod) longitudinally ovoid. First maxilliped (Fig. 3D) with coxal endite subcircular; basal endite tongue-shaped; endopod longitudinally rectangular; exopod with flagellum. Second maxilliped (Fig. 3E) with dactylus articulated at proximal part of propodus; exopod with flagellum. Third maxilliped (Fig. 3F) with ischium and merus indistinguishably fused, arched; mesial margin straight (lacking on proximal angle in figure); palp 3-segmented, rela-

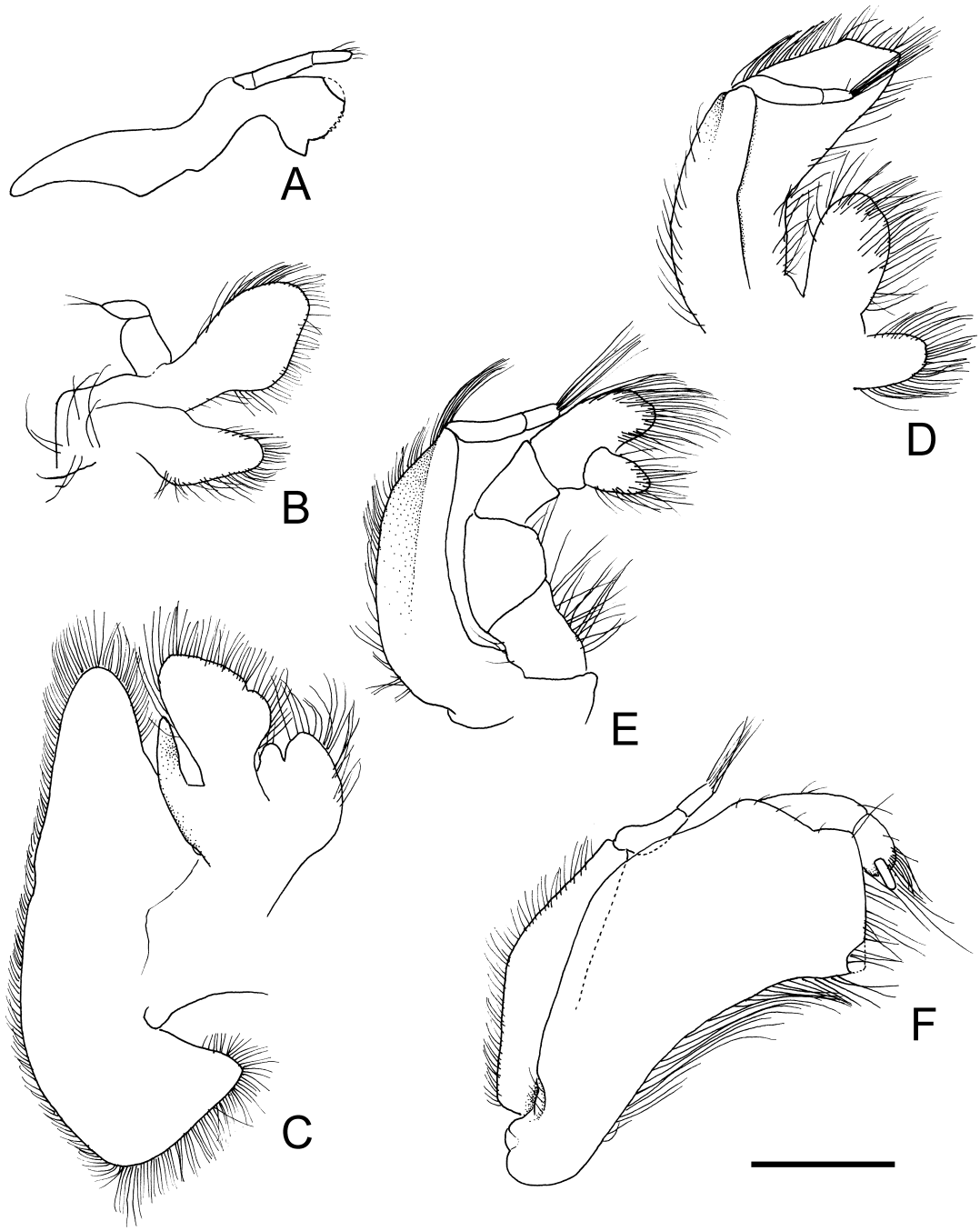

Fig. 3. *Abyssotheres acesticola* sp. nov., holotype, ovigerous female (NSMT-Cr 19860; cl 11.2×cb 11.1 mm). A, mandible (lacking on mesio-distal corner of incisor process); B, maxillule; C, maxilla; D, first maxilliped; E, second maxilliped; F, third maxilliped (lacking on mesio-proximal angle of merus). Scale 1 mm.

tive length carpus>propodus>dactylus; dactylus styliform, articulated at distal end of propodus; exopod present, with flagellum.

Cheliped (Figs. 1A–B, 2B–C) 1.1 times as long as carapace; merus and carpus subcylindrical; palm weakly convex; fingers subconical, without gap between cutting edges when closed, crossing at tip; cutting edge of movable finger with triangular, subproximal tooth, with thin blade except on proximal tooth and tip; immovable finger with dense short setae on ventral 0.3 of inner surface, with triangular tooth on proximal end of cutting edge.

Walking legs (Fig. 2D–G) similar in shape,

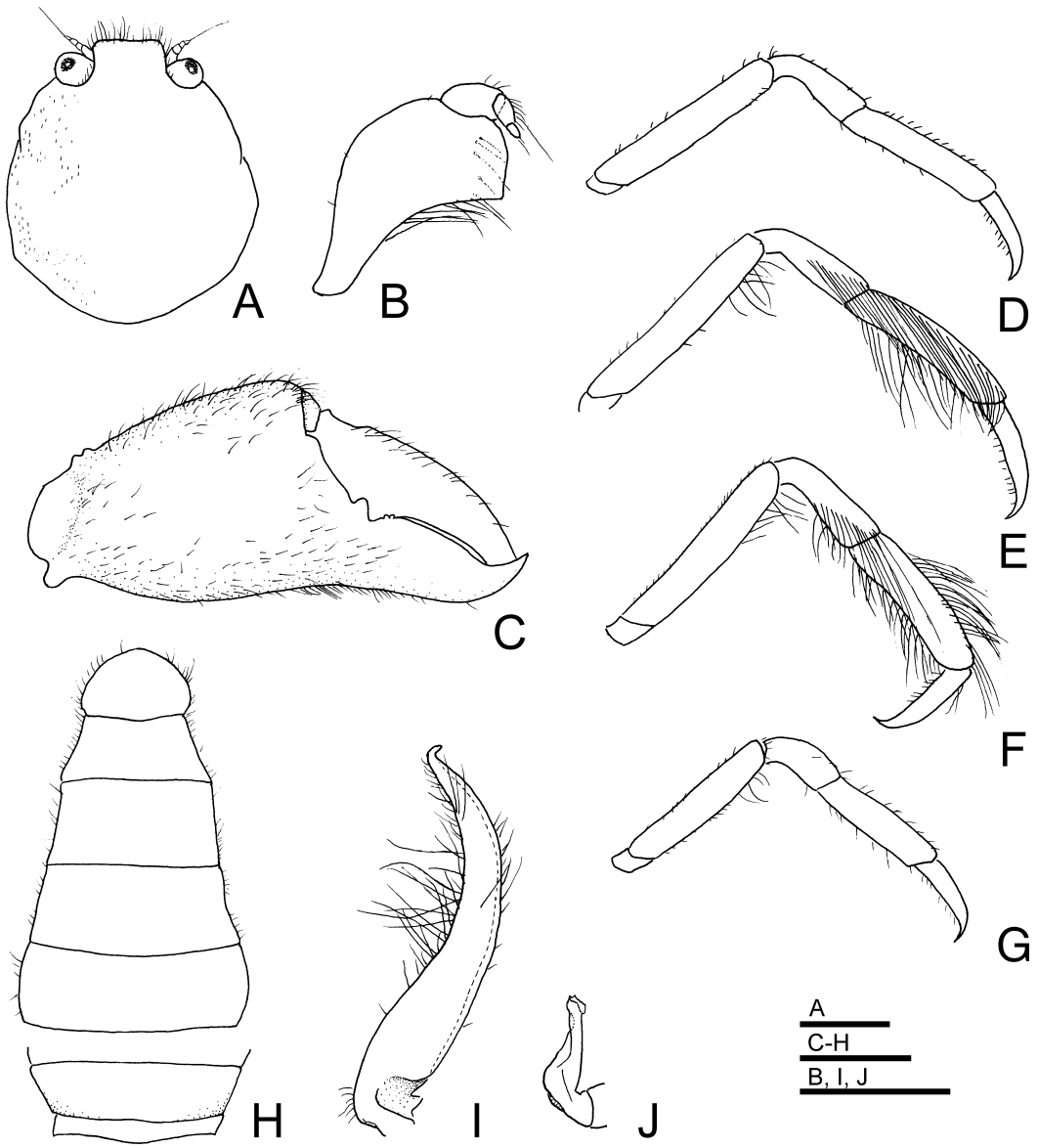

Fig. 4. *Abyssotheres acesticola* sp. nov., paratype, male (NSMT-Cr 19861; cl 3.0×cb 2.6 mm). A, carapace, dorsal view; B, third maxilliped, ventral view; C, right chela, outer view; D–G, right walking legs, posterior view; H, abdomen, ventral view; I, right first gonopod, ventral view; J, right second gonopod, ventral view. Scales: 1 mm (A, D–G), 0.5 mm (B–C, H–J).

relative length WL2>WL3>WL1>WL4; meri subcylindrical, with very short setae on outer margins; carpi and propodi subcylindrical; dactyli long, about 4 times longer than broad, weakly compressed, hooked on tips, with short setae on inner margins, relative length WL2>WL3>WL4>WL1.

Thoracic sternites with medially interrupted, transverse sutures, without longitudinal median suture. Genital pores opening at sixth sternite, directed medially.

Abdomen (Fig. 1B) transversely ovate, strongly convex ventrally, entirely fringed with short setae; all segments free, transversely rectangular, weakly convex along midline; fifth segment broadest, 1.2 time as broad as carapace; distal margin of telson divided into two lobes by shallow medial notch in holotype, almost straight in paratype.

Male: Size small (cl<3 mm). Carapace (Figs. 1C, 4A) longitudinally ovoid in outline, convex dorsally, entirely covered with very short setae; front projecting, fringed with short plumose setae, shallowly concave medially. Eye stalk very short, immovable, visible in dorsal view; cornea pigmented. Antennule and antenna as in female. Third maxilliped (Fig. 4B) ischium and merus arched; palpal segments articulated end to end; exopod present (missing in figure), with flagellum. Cheliped (Figs. 1C, 4C) moderate, 1.2 times as long as carapace; chela covered with very short setae; each finger with triangular tooth on proximal end. Walking legs (Fig. 4D–G) similar in shape except setation, slender, compressed; WL2–3 with swimming setae on carpi and propodi; dactyli hooked on tips. Thoracic sternites scattered with small pores; transverse sutures medially interrupted; median suture extending from fifth to eighth sternite; fifth sternite with small button on each side of abdominal groove; genital pores opening on eighth sternite. Abdomen (Fig. 4H) subtriangular, entirely fringed with short setae; all segments free; sixth segment with socket on each side of inner surface; telson semicircular. G1 (Fig. 4I) compressed, curving laterally, tapering distally, with long setae on lateral margin and short setae on medial margin, acute tip directed medially. G2 (Fig. 4J) short, 0.3 times as long as G1.

Color. Whole body translucent, amber; cornea red; eggs and oocytes orange-red.

Etymology. The specific name derives in reference to the association with a large bivalve mollusk, *Acesta*.

Host. A large bivalve mollusk in the family Limidae, *Acesta philippinensis* (Bartsch, 1913) (identified by Dr. K. Hasegawa, NSMT). We have hitherto collected two specimens of *A. philippinensis* and found *Abyssotheres acesticola* living in the mantle cavity of both. The paratypic male was found from the same host individual together with the holotypic female, which is an evidence that these belong to the same species in spite of remarkable sexual dimorphic features.

Remarks. *Abyssotheres acesticola* sp. nov. can be distinguished from the unique congener, *A. abyssicola* (Alcock and Anderson, 1899) (type locality: off Travancore, India, 787 m), by: (1) the dactylus of the cheliped is longer than half of the propodus (vs. slightly less than half of propodus in *A. abyssicola*); (2) the dactylus of the WL is without any projection (vs. with a obtuse subdistal projection on the dorsal surface in *A. abyssicola*); (3) the relative length of the WL dactyli is WL2>WL3>WL4>WL1 (WL 1–2>WL 3–4 in *A. abyssicola*).

Acknowledgements

We wish to express our cordial thanks to Dr. Ernesto Campos for reviewing the manuscript and offering valuable comments for improvements. Our thanks are also due to all the staff of TRV *Toyoshio-maru* and all the member who joined the cruises for their support on board. We obliged to Dr. K. Hasegawa of NSMT for identification of the host bivalve mollusks. This study was partially supported by a grant-in-aid from the Japan Society for the Promotion of Science awarded to SO (No. 20380110).

References

Ahyong, S. T. and P. K. L. Ng, 2007. The pinnotherid type material of Semper (1880), Nauck (1880) and Bürger (1895) (Crustacea: Decapoda: Brachyura). *Raffles Bulletin of Zoology*, Supplement, (16): 191–226.

Alcock, A., 1900. Materials for a carcinological fauna of India. No. 6. The Brachyura Catometopa, or Grapsoidea. *Journal of Asiatic Society of Bengal*, **69**: 279–456.

Alcock, A. and A. R. S. Anderson, 1899. Natural history notes from H.M. Royal Indian Marine Survey Ship 'Investigator,' Commander T.H. Heming, R.N., commanding. Series III, No. 2. An account of the deep-sea Crustacea dredged during the surveying-season of 1897–98. *Annals and Magazine of Natural History*, Series 7, **3**: 1–27.

Bürger, O., 1895. Ein Beitrag zur kenntniss der Pinnotherinen. *Zoologische Jahrbücher, Abtheilung für Systematik, Geographie und Biologie der Thiere*, **8**: 361–390, pls. 9–10.

Campos, E., 1989. Comments on taxonomy of the genus *Orthotheres* Sakai, 1969. *Bulletin of Marine Science*, **44**: 1123–1128.

Campos, E., 2002. Two new genera of pinnotherid crabs from the tropical eastern Pacific (Decapoda: Brachyura: Pinnotheridae). *Journal of Crustacean Biology*, **22**: 328–336.

Campos, E., 2009 (in press). A new species and two new genera of pinnotherid crabs from the northeastern Pacific Ocean, with a reappraisal of the subfamily Pinnotherinae de Haan, 1833 (Crustacea: Brachyura: Pinnotheridae). *Zootaxa*.

Geiger, D. L. and J. W. Martin, 1999. The pea crab *Orthotheres haliotidis* new species (Decapoda: Brachyura: Pinnotheridae) in the Australian abalone *Haliotis asinina* Linnaeus, 1758 and *Haliotis squamata* Reeve, 1846 (Gastropoda: Vetigastropoda: Haliotidae). *Bulletin of Marine Science*, **64**: 269–280.

Hasegawa, K., G. Shinohara and M. Takeda (eds.), 2005. Deep-Sea Fauna and Pollutants in Nansei Islands. *National Science Museum Monographs*, (29): 1–476.

Holthuis, L. B., 1975. *Limotheres*, a new genus of pinnotherid crab, commensal of the bivalve *Lima*, from the Caribbean Sea. *Zoologische Mededelingen*, **48**: 291–295.

Manning, R. B. and B. S. Galil, 2000. A new genus of pinnotherid crab from the Indian Ocean (Crustacea: Decapoda: Brachyura). *Proceedings of the Biological Society of Washington*, **113**: 66–69.

Sakai, T., 1969. Two new genera and twenty-two new species of crabs from Japan. *Proceedings of the Biological Society of Washington*, **82**: 243–280.

Schmitt, W. L., J. C. McCain and E. S. Davidson, 1973. Decapoda I: Brachyura I: Fam. Pinnotheridae. *Crustaceorum Catalogus*, **3**: 1–160.