

TWO UNUSUAL SPECIES OF ALPHEIDAE (DECAPODA: CARIDEA)
ASSOCIATED WITH UPOGEBIID MUDSHRIMPS IN THE MUDFLATS OF
TAIWAN AND VIETNAM

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A B S T R A C T

Descriptions are provided for *Athanas denticrostris*, new species, and *Chelomalpheus crangonus*, new species, two alpheid shrimps collected from the burrows of the upogebiids *Upogebia* aff. *takaoensis* Sakai and Türkay, 1995, and *Upogebia edulis* Ngoc-Ho and Chan, 1992, respectively. *Athanas denticrostris*, known only from northern Vietnam, is unique among all Alpheidae in having the superior margin of the rostrum dentate. Adult males of *C. crangonus* are immediately recognizable by the peculiar, subcheliform first pereopods, which show superficial resemblance to the chelipeds of Crangonidae.

In January 2000 the first author studied a small collection of alpheid shrimps, collected in 1997–1999 by Mr. Pham dinh Trong (Institut Océanographique, Haiphong) at different localities in northern Vietnam. In this collection a male specimen of *Athanas*, representing a new species, was found together with a specimen of mudshrimp in the same lot. The latter, lacking both first chelipeds, was tentatively identified as *Upogebia* aff. *takaoensis* Sakai and Türkay, 1995 (Thalassinidea, Upogebiidae). According to field notes, both alpheid and mudshrimp were obtained from the same burrow.

While investigating the biology of the mudshrimp *Upogebia edulis* Ngoc-Ho and Chan, 1992, on the extensive mudflats of western Taiwan, the third author collected two specimens of another alpheid species. These appear to belong to a new species of the recently described, monotypic genus *Chelomalpheus*. The descriptions of both new taxa are presented herein.

MATERIALS AND METHODS

To facilitate observations under the dissection microscope, the very small *Athanas* specimen was stained with a light solution of Chlorazol Black. The material used in this study is deposited in the Muséum National d'Histoire Naturelle, Paris (MNHN), and the National Taiwan Ocean University, Keelung (NTOU).

All measurements are in given in mm. Abbreviations used in text are as follows: CL = carapace length, measured from the tip of the rostrum to the posterior margin

of the carapace; TL = total length, measured from the tip of the rostrum to the posterior margin of the telson; Mxp 3 = third maxilliped; P1–5 = first to fifth pereopods.

SYSTEMATIC ACCOUNT

Family Alpheidae Rafinesque, 1815
Genus *Athanas* Leach, 1814

Athanas denticrostris, new species
Figs. 1–3

Type-material.—Holotype. 1 male, MNHN-Na 13606, Cua Luc, N Vietnam, Pham-dinh-Trong coll., 1.4.1998, fine mud and grit, together with *Upogebia* aff. *takaoensis* Sakai and Türkay, 1995, N. Ngoc-Ho 1999 det.

Description.—Body (Fig. 1) somewhat compressed laterally. Carapace smooth; pterygostomial angle with tiny spine (Fig. 2c); cardiac notch well developed; branchiostegial margin sparsely fringed with elongated setae. Rostrum long, reaching to middle of second antennular article, with distinct lateral ridge; dorsal carina bearing six more or less distinct, small, acute, anteriorly directed teeth (Fig. 2d); inferior margin straight. Extra-corneal and infra-corneal teeth well developed and acute; supra-corneal teeth lacking. Eyes partially visible in lateral and dorsal views, corneas well developed and pigmented.

Antennular peduncles (Fig. 2b) elongated; stylocerite acute, exceeding proximal third of second article; antennular carina well developed and acute; second article shorter than

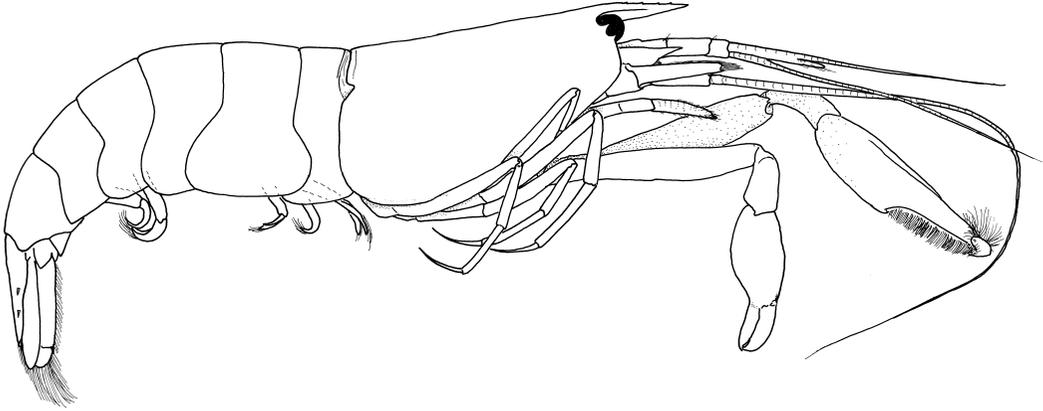


Fig. 1. *Athanas dentirostris*, new species: habitus of male CL 3.8 mm (holotype, MNHN 13606).

first; third article slightly shorter than second. Antenna with basicerite bearing small, acute, ventral tooth (Fig. 2c); scaphocerite overreaching carpuccerite, rectangular, approximately twice as long as wide, reaching to end of antennular peduncle; anterior margin convex; lateral spine small (Fig. 2b).

Mouthparts typical for *Athanas*. Mandibular palp 2-segmented; incisor process bearing 6 acute teeth, one distinctly stronger than the others. Maxillular palp bilobed and setose. Maxilla, first and second maxillipeds, without specific features. Third maxilliped reaching almost to distal margin of scaphocerite; epipodial plate small, acute; epipod present; exopod not reaching penultimate segment; ultimate segment setose, distally unarmed; arthrobranch lacking (Fig. 2g).

First chelipeds asymmetrical, subequal in size, extended; chelae slightly twisted (Fig. 2a). Major cheliped (Fig. 3a–c) with coxa bearing strap-like epipod and setobranch; ischium elongated, with 1 spine on distosuperior margin, and distinct, acute tooth on distoinferior margin; merus elongated, shallowly excavated on mesioventral side, with several smaller rounded teeth (one more developed) on inferior margin; carpus elongated, cup-shaped; chela slender, flattened on inner side; palm smooth, about 1.6 times longer than dactylus; dactylus curved distally; fixed finger and extreme distal portion of palm proximal to fixed finger bearing dense setae inserted on most of ventrolateral side and on cutting edge (Fig. 3c); dactylus also with several rows of dense setae on cutting edge. Minor cheliped (Fig. 3d–e) with ischium and

merus of similar length; carpus more elongated than that of major cheliped; chela somewhat different in shape and proportions from that of major cheliped (Fig. 3d); palm 1.3 times longer than dactylus; dactylus and fixed finger distally with scattered tufts of setae; cutting edges unarmed, fringed with small setae.

Second cheliped (Fig. 3f) slender; coxa with strap-like epipod and setobranch; ischium and merus without specific features; carpus composed of five articles, with approximate ratio (from proximal to distal): 1 : 0.15 : 0.15 : 0.2 : 0.45; chela simple, fixed finger and dactylus longer than palm. Third to fifth pereopods (Fig. 3g–i) similar, slender; coxa of third pereopod with strap-like epipod; setobranchs on third and fourth pereopods; ischium of third and fourth pereopods armed with 2 small spines; merus and carpus unarmed; propodus of third pereopod armed with 2 spinules, that of fourth pereopod with 1 small spinule, propodus of fifth pereopod unarmed; dactylus simple, very slender, curved, about 0.6 times as long as propodus.

Sixth abdominal segment with articulated plate (Fig. 1). Second pleopods with appendix masculina approximately 1.5 times longer than appendix interna. Uropodal exopod (Fig. 2f) with small lateral spine; diaresis straight; endopod without specific features. Telson rectangular (Fig. 2e), tapering distally, with two pairs of dorsal spines situated mesial to lateral margins; posterior margin rounded medially, with one pair of lateral spines (broken ?). Branchial formula: 5 pleurobranchs on P 1–5; 4 strap-like epipods on Mxp 3 and

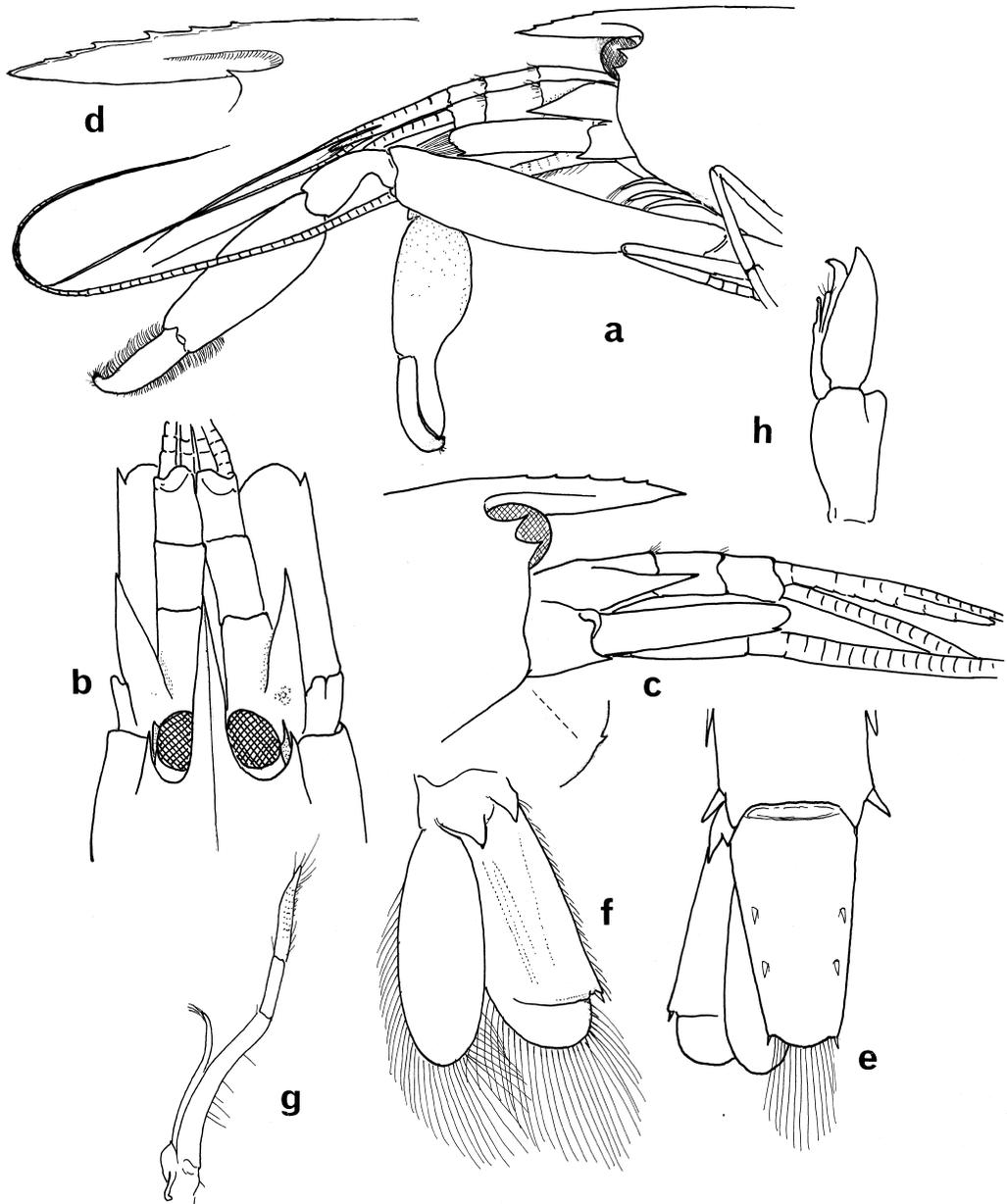


Fig. 2. *Athanas dentirostris*, new species (holotype male CL 3.8 mm): a, anterior region; b, c, frontal region, dorsal and lateral view, respectively; d, rostrum; e, tail fan; f, uropod; g, third maxilliped; h, second pleopod.

P 1–3; 4 sets of setobranchs on P 1–4; 3 exopods on Mxp 1–3; podobranch and arthrobranch absent.

Measurements.—CL 3.8 mm, TL approximately 10 mm.

Color.—No information.

Etymology.—Name derived from the Latin words *dens* (tooth), and *rostrum* (beak), referring to the unique dentate rostrum.

Remarks.—*Athanas dentirostris*, new species, clearly belongs to the *A. dimorphus* group, characterized by the enlarged first chelipeds, which can be flexed against the flattened or

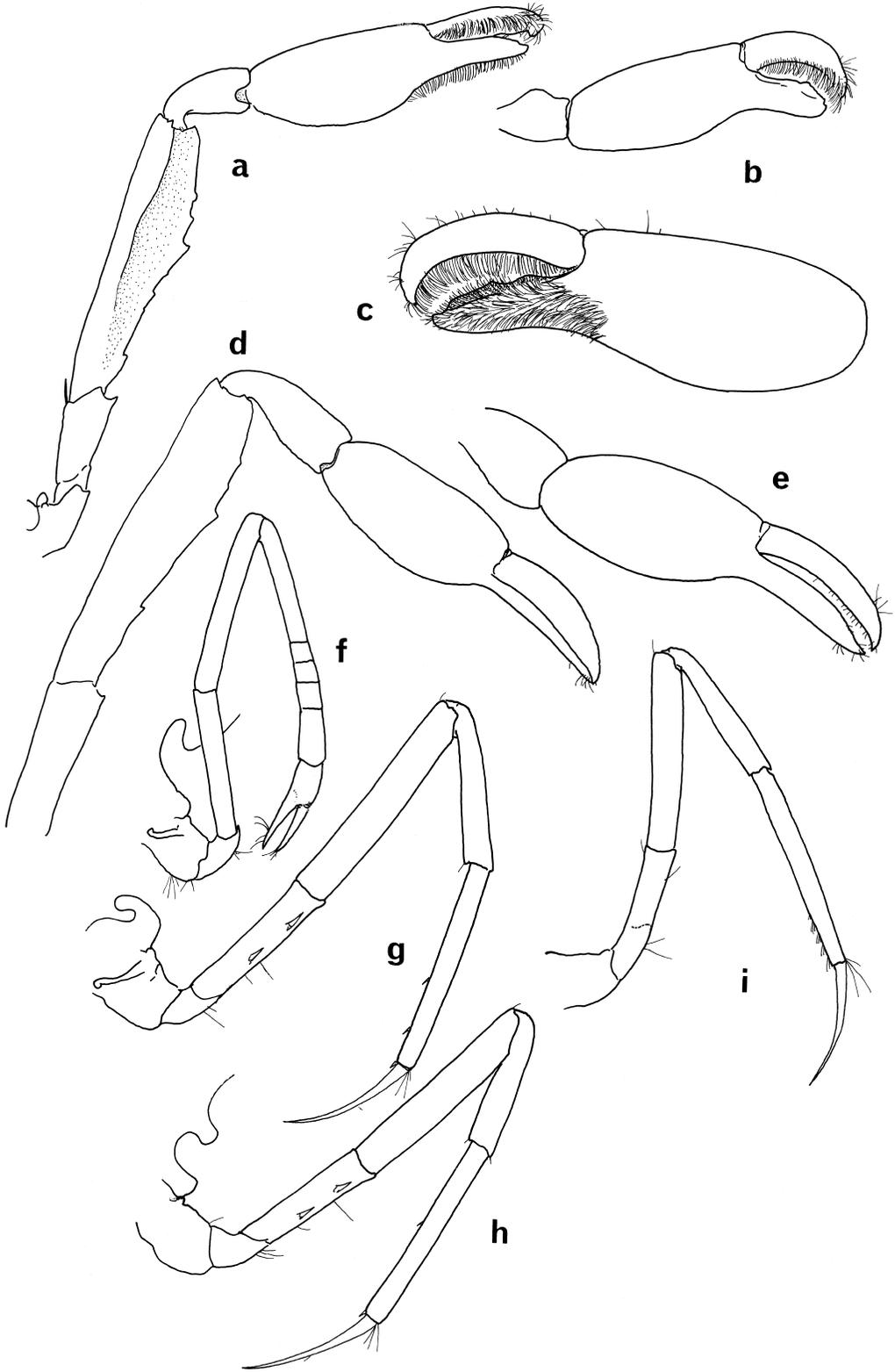


Fig. 3. *Athanas dentiostrius*, new species (holotype male CL 3.8 mm): a, major cheliped, inferior view; b, c, same, chela in outer and inner view, respectively; d, minor cheliped, outer view; e, same, chela; f-i second to fifth pereopod, respectively.

excavated merus (Coutière, 1899). Moreover, the present species relates to a small complex of species within the *A. dimorphus* group having a slender dactylus on the third to fifth pereopods and the meri of the first chelipeds not inflated. This species complex includes four species (Bruce, 1990): *A. polymorphus* Kemp, 1915, (possibly including *A. sp.* near *polymorphus* reported by Banner and Banner, 1966); *A. hongkongensis* Bruce, 1990; *A. gracilipes* Banner and Banner, 1978; and *A. tenuipes* de Man, 1910. All these species, however, lack the small acute teeth on the superior rostral carina.

Athanus hongkongensis is a shallow-water species and was collected on a sandy beach in Hong Kong (Bruce, 1990); *A. gracilipes* and *A. tenuipes* seem to occur only in deeper waters: the first species was collected in about 370 m in the South China Sea, and the second in 72 m in Teluk Tomini (= Kwandang Bay), Sulawesi (de Man, 1911; Banner and Banner, 1978). Unfortunately all three species are known only from females, and moreover, the latter two from incomplete specimens, with the first chelipeds missing. Therefore, comparison of the single male specimen of *A. dentirostris* with these specimens are limited to the frontal margin, the rostrum and the proportions of the second to fifth pereopods.

Of these three species, *A. hongkongensis* appears to be closest to the new species (conf. Bruce, 1990: figs. 7, 8). The rostrum is nearly identical in length and shape, but in *A. hongkongensis* the rostral carina is absent, and as mentioned above, its superior margin is not dentate. The orbital teeth are similar, as well as the antennules (shape of stylocerite, relative length of peduncular articles) and the antennae, although the scaphocerite is somewhat shorter in the new species. The tail fan and the second to fifth pereopods are also much the same (almost identical relative proportions of carpal articles in the second pereopod, and similar shape of dactylus in the third to fifth pereopods). However, the ischium of the third pereopod bears only one small spine, rather than two spines as in *A. dentirostris*.

Athanus gracilipes is distinguishable from the new species by the more slender second pereopods (cf. Banner and Banner, 1978: fig. 3d). *Athanus tenuipes*, the description of which is based on a young specimen, could be a senior synonym to *A. gracilipes* (Banner and

Banner, 1978: 236), and is also different from *A. dentirostris* in the same feature.

Athanus polymorphus inhabits brackish, muddy habitats, such as the huge lagoon-like Chilka Lake in Orissa, India (Kemp, 1915), the mangrove forests of Singapore (Anker, personal observation), or mangal flats of Darwin Harbour, Australia (Bruce and Coombes, 1997). This species has the pterygostomial spine much more produced, and also differs from *A. dentirostris* in the shape of the first chelipeds, which lack a dense setal brush on the fixed finger. The new species shows also some affinities to *A. japonicus* Kubo, 1936, but can be distinguished from it by the much more slender dactylus of the third pereopod and the presence of the dense setal brush on the palm and the dactylus of the first chelipeds.

Genus *Chelomalpheus* Kim, 1998

Chelomalpheus crangonus, new species

Figs. 4–8

Type-material.—Holotype. 1 male, NTOU H-1996-12, Chang-Hua County, W Taiwan, Dec 1996, mudflats, collected together with *Upogebia edulis* Ngoc-Ho and Chan, 1992.—Paratype. 1 female, NTOU P-1991-4, Chang-Hua County, W Taiwan, Apr 1991, mud-flats, collected together with *U. edulis*. Paratype dissected.

Comparative Material.—*Chelomalpheus koreanus* Kim, 1998 = *Cavipelta yamashitai* Hayashi, 1998. 3 specimens (1 male, 1 ovigerous female, 1 female), MNHNN-13607, off Miyazima, Hiroshima Prefecture, Seto Inland Sea, Japan, 13 Feb 1990, tidal flat, from burrows of *Upogebia major* De Haan, coll. K. Yamashita (specimens from *C. yamashitai* paratype series, NFO 530-2-1878, donated to MNHN by K. I. Hayashi).—1 male, MNHN 13608, Rivermouth of Shimanto, Kochi Prefecture, 27 Sep 1999, coll. unknown (specimen donated to MNHN by K. I. Hayashi).

Description.—Body slightly compressed. Carapace smooth, except for two weakly developed longitudinal ridges on the anterior portion of dorsolateral surface (Fig. 6c); pterygostomial angle rounded; cardiac notch well developed; branchiostegial margin with large emargination above first and second pereopods. Frontal margin straight, lacking anteriorly directed rostral process and orbital teeth; adjacent mediodorsal area with triangular, acute crest (Fig. 4c, e). Eyestalks dorsally and laterally exposed, with anterior margin bearing small median rounded projection (Fig. 4c); cornea well pigmented.

Antennular peduncles (Fig. 4c, d) dorsoventrally flattened and elongated; stylocerite acute, not exceeding proximal third of second

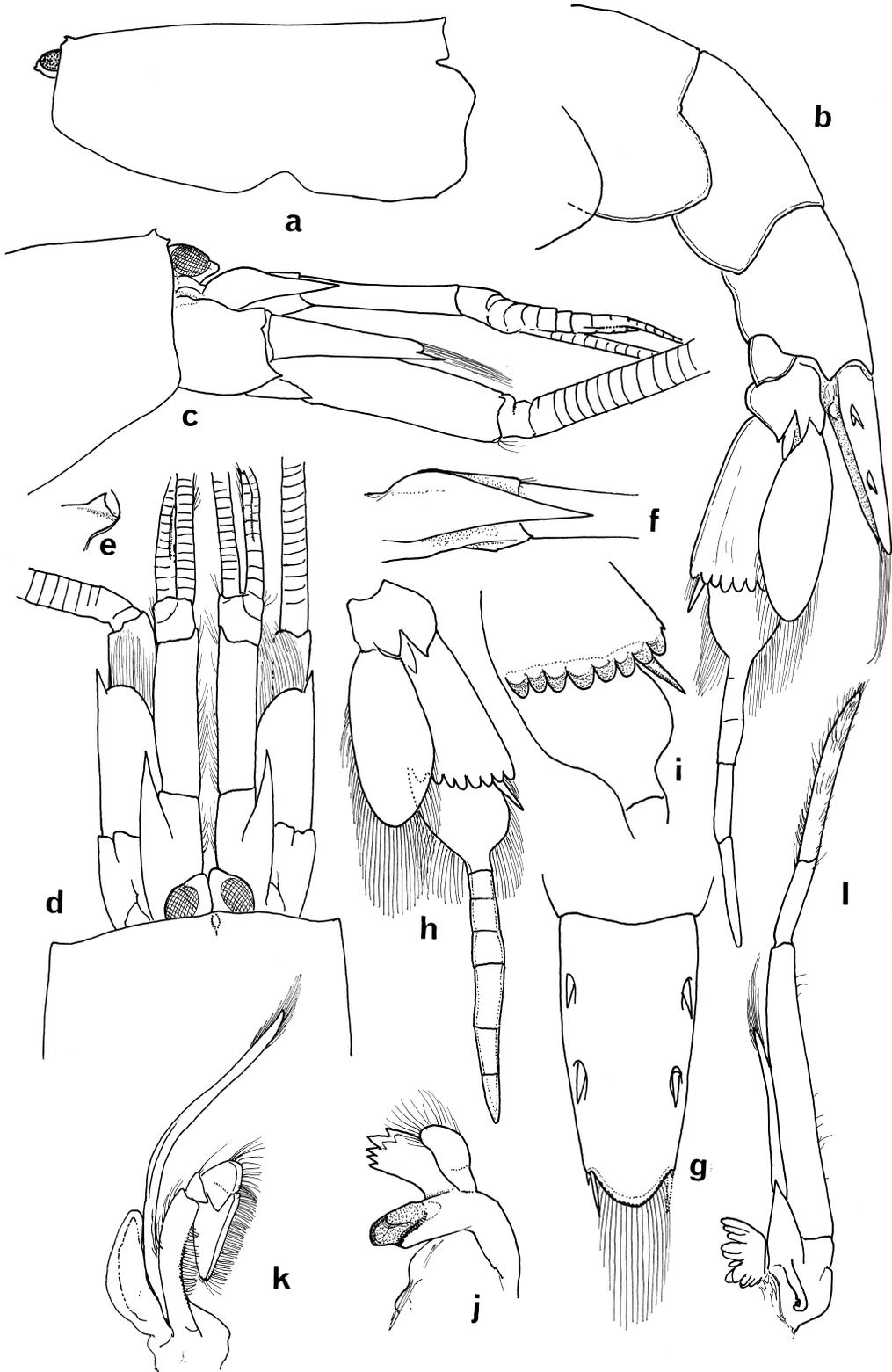


Fig. 4. *Chelomalpheus crangonus*, new species, female 5.9 mm CL (paratype, NTOU P-1991-4): a, carapace; b, posterior abdominal segments and tail fan; c, d frontal region, lateral and dorsal view, respectively; e, detail of rostral crest; f, first antennular segment, stylocerite, and ventral carina; g, telson; h, uropod; i, same, detail of diaresis; j, mandible; k, second maxilliped; l, third maxilliped.

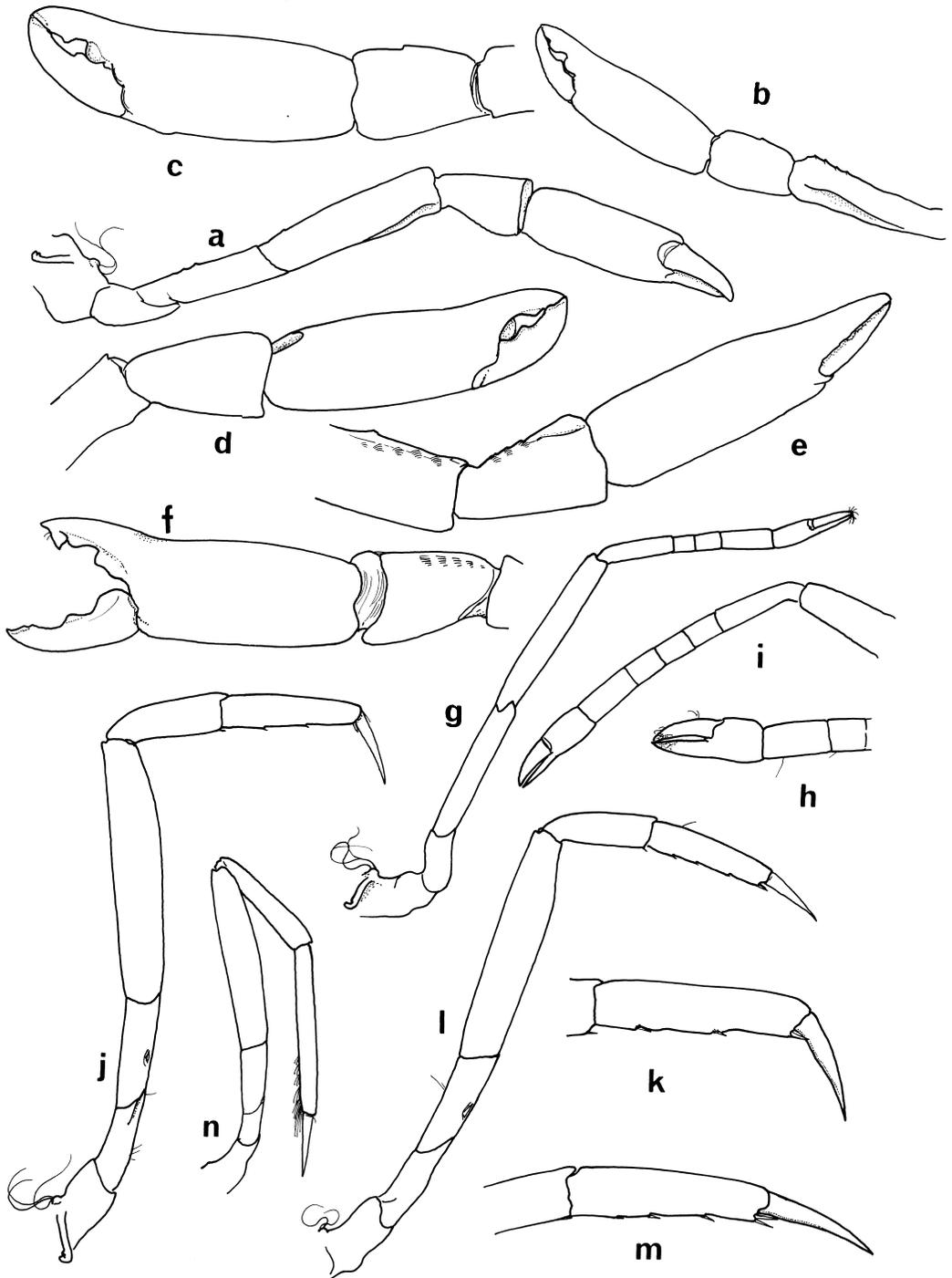


Fig. 5. *Chelomalpheus crangonus*, new species, female 5.9 mm CL (paratype): a, right first cheliped, outer inferior view; b, same, chela in natural position; c, same, in inner view; d, same, in outer view; e, same, in inner superior view; f, same, details of cutting edges of fingers; g, right second pereiopod; h, same, chela; i, left second pereiopod, carpus, and chela; j, third pereiopod; k, same, propodus and dactylus; l, fourth pereiopod; m, same, propodus and dactylus; n, fifth pereiopod.

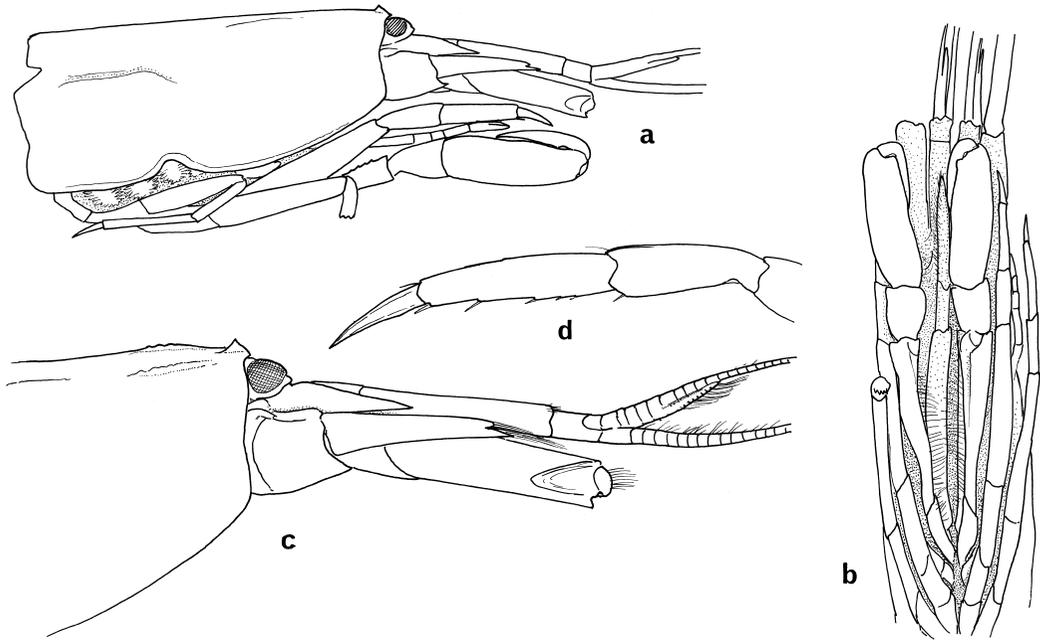


Fig. 6. *Chelomalpheus crangonus*, new species, male CL 6.2 mm (holotype): a, cephalothorax, showing position of first chelipeds in lateral view; b, same, in ventral view; c, frontal region, lateral view; d, fourth pereopod.

article; antennular carina reduced (Fig. 4f); second article about 1.3 times longer than visible portion of first; third article almost 4 times shorter than second; outer flagellum biramous, shorter ramus bearing 4 or 5 segments with tufts of aesthetascs. Antenna with basicerite very stout, bearing acute, ventral tooth (Fig. 4c); scaphocerite shorter than carapocerite, reaching only to distal fourth of second antennular article, about 2.5 times as long as wide; anterior margin not protruding anteriorly; lateral spine strong (Fig. 4d).

Mouthparts typical for genus. Mandibular palp short, articulation between two articles weakly developed; incisor process bearing 5 acute teeth, fourth tooth (starting from inferior margin) strongest (Fig. 4j). Maxillular palp bilobed, setose; superior lacinia short, almost quadrate. Maxilla with superior lacinia undivided. First maxilliped with well-developed caridean lobe, palp elongated. Second maxilliped with epipod and first article of endopod elongated (Fig. 4k). Third maxilliped slender, reaching to distal third of antenna; epipod present; lateral plate elongated, acute; exopod short, not reaching penultimate seg-

ment; ultimate segment setose, distally with small slender spinules; arthrobranch well developed (Fig. 4l).

First chelipeds symmetrical and equal in size, with dactylus in medio-dorsal (adult male) or latero-ventral (female) position (Figs. 5b, 6a). Male cheliped subcheliform (Fig. 7a–d); coxa with strap-like epipod and setobranchs; basis short; inner margins of ischium and merus flattened, extremely setose; outer margin of merus strongly crenulated, with small spines; inner margins of distal portion of merus and carpus with rows of short setae; carpus cup-shaped, without distal teeth; chela cylindrical, smooth except for small tubercles situated between fixed finger and carpus; palm proximally with deep depression (Fig. 7b); fixed finger partially fused with palm and strongly bent backwards, only tip free, cutting edge of fixed finger with series of teeth; dactylus strongly curved and bent backwards. Female cheliped simple, less robust than male cheliped; ischium and merus slender, latter flattened on ventral margin, outer margin crenulated (Fig. 5e); carpus cup-shaped; chela cylindrical, smooth; palm 1.8

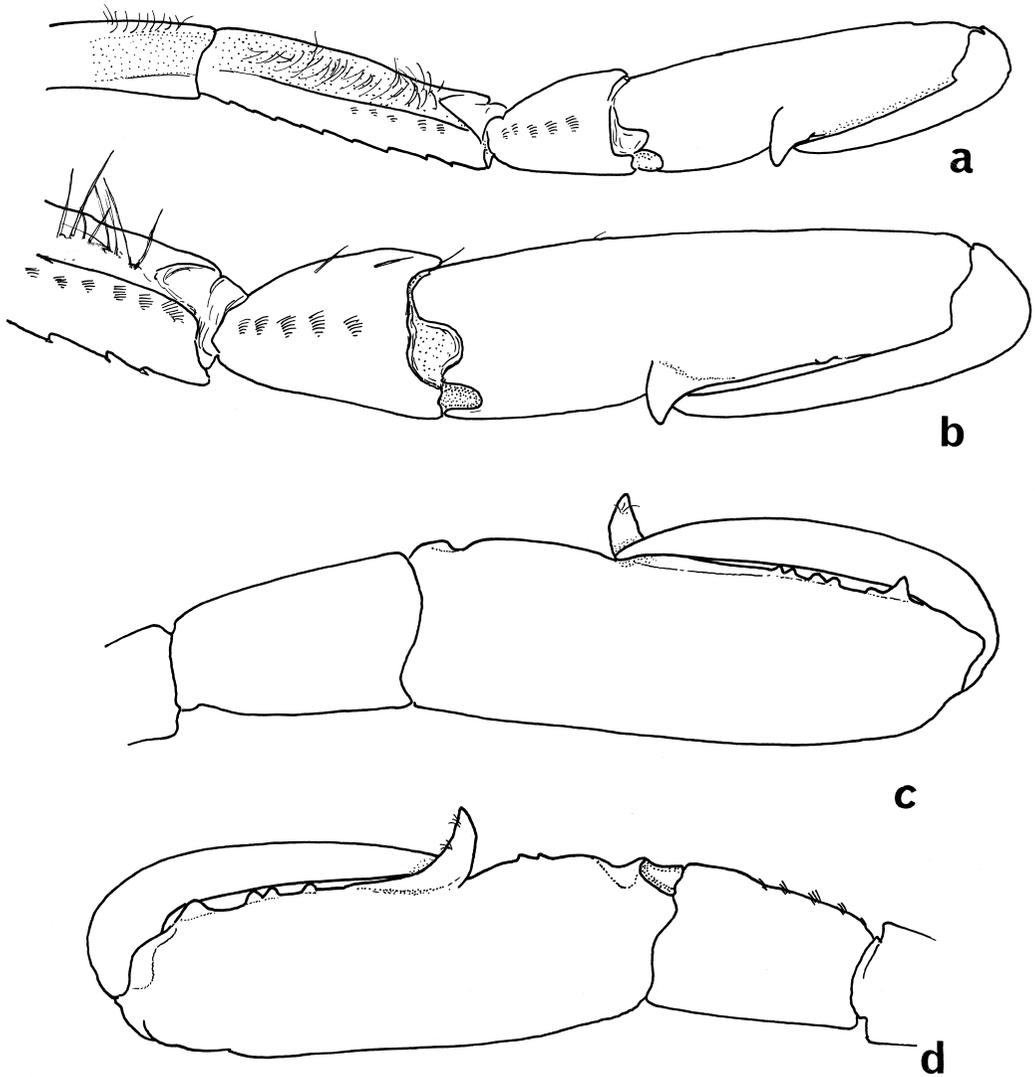


Fig. 7. *Chelomalpheus crangonus*, new species, male CL 6.2 mm (holotype): a, right first cheliped, inner view; b, distal merus, carpus and chela of right first cheliped, inner view; c, same, outer view; d, same, inferior view.

times longer than dactylus; proximal portion of palm with slight depression; fingers gaping when closed; dactylus slightly curved; cutting edges of fixed finger and dactylus armed with strong teeth (Fig. 5f).

Second chelipeds (Fig. 5g–i) slender and unequal in number of carpal articles; right second cheliped slightly more robust than left; coxa with strap-like epipod and setobranchs; ischium and merus equal in length, without specific features; right carpus composed of 4 articles with approximate ratio (from proximal to distal): 1 : 0.3 : 0.4 : 0.8;

left carpus composed of 5 articles with ratio: 1 : 0.3 : 0.35 : 0.3 : 0.8; chela simple, fingers slightly longer than palm.

Third and fourth pereiopods (Fig. 5j–m) similar, laterally flattened; third pereiopod with epipod and setobranchs; fourth pereiopod with setobranchs only; ischium armed with 1 movable spine appressed into small depression; merus unarmed; carpus with small distal spinule; propodus armed with 3 or 4 spinules in female, 4 or 5 in male; dactylus approximately half length of propodus, simple, conical, slightly curved, with incon-



Fig. 8. *Chelomalpheus crangonus*, new species: habitus of male CL 6.2 mm (holotype, NTOU H-1996-12).

spicuous angle on proximal inferior margin. Fifth pereopod (Fig. 5n) shorter, more slender than third and fourth; ischium, merus, carpus and propodus without spines; propodus also with brush of setae on distal portion.

Sixth abdominal segment with triangular articulated plate (Fig. 4b). Second pleopod of male with appendix masculina slender, almost twice length of appendix interna. Uropodal exopod posteriorly continued by long, segmented appendix (Fig. 4h); lateral spine strong; diaresis bearing 7 or 8 large, rounded teeth (Fig. 4h, i); endopod without specific features. Telson slightly tapering (Fig. 4g), with two pairs of strong dorsal spines situated mesial to lateral margins; posterior margin broadly rounded, with two spines at each angle, inner spine much longer than outer spine (broken on right side in paratype). Branchial formula: 5 pleurobranchs on P 1–5; 1 arthrobranch on Mxp 3, 0 podobranchs; 4 strap-like epipods on Mxp 3 and P 1–3; 4 sets of setobranchs on P 1–4; 3 exopods on Mxp 1–3.

Measurements.—CL 6.2 mm (male holotype) and 5.9 mm (female paratype), TL approximately 20 mm for both specimens.

Color.—Almost colorless, with slight greyish green tinge; chelipeds and walking legs whitish; antennular peduncles with bluish tinge; telson and uropods dark greyish blue (Fig. 8).

Etymology.—Name derived from the Latin generic name *Crangon*, referring to the subcheliform condition of the first pereopods, characteristic for Crangonidae.

Remarks.—This is the second species described in the genus *Chelomalpheus* and is easily distinguished from the type-species, *C. koreanus* Kim, 1998 (= *Cavipelta yamashitai* Hayashi, 1998) by the rostral crest, the more elongated caudal appendix on the uropod (6 segments vs. maximum 3 in *C. koreanus*), the 4-segmented right second pereopod, and, especially, by the unusual subcheliform first pereopods. The chela of *C. koreanus* has an elongated, cylindrical carpus, even in adult males, and the main portion of the fixed finger is free, although strongly bent backwards (Hayashi, 1998: fig. 4F). The chela of the adult male of *C. crangonus* has a much shorter, almost cup-shaped carpus, while the



Fig. 9. Mudflats in central-western Taiwan, habitat of *C. crangonus*, showing excavated resin casts of burrows of *Upogebia edulis*.

fixed finger is reduced to its distal portion. This type of chela, which strongly resembles the subchela of the Crangonidae, is obviously evolved from a chela already having both fingers bent backwards, as in *C. koreanus*, by partial fusion with the adjacent portion of the palm. This process was followed by the dactylus becoming more curved to being almost parallel to the palm. The strong sexual dimorphism of the first chelipeds in *C. crangonus* and *C. koreanus* suggests that the modified chela of males might be somehow involved in sexual behaviour or mature males have a different mode of life. Therefore, we assume that the common ancestor of both Recent species of *Chelomalpheus* had a more simple chela, with the fingers straight or only slightly curved, very similar to the chela of females or juvenile males (Hayashi, 1998).

Interestingly, the caudal appendix is present in both males and females of *C. crangonus*, while in *C. koreanus* the appendix was well developed in adult males only and was never found in ovigerous females (Hayashi, 1998, reported as *C. yamashitai*). The func-

tion of this appendix, as pointed out by Hayashi (1998), is not clear, but it is rather unlikely that it is involved in the sexual behaviour, being present in both sexes. Another interesting feature shown by the new species is the asymmetrical development of the second pereiopod. Both female and male have five segments in the left carpus and only four segments in the right carpus. To our knowledge this feature is unique within the Alpheidae.

DISCUSSION

Several alpheid species have been reported as possibly commensal inhabitants of burrows of upogebiid and callianassid mudshrimps. All previously reported species belong to the genera *Betaeus* (Hart, 1964; Branch *et al.*, 1994); *Leptalpheus* (Williams, 1965; Felder *et al.*, 1995; Felder and Manning, 1997; Dworschak and Coelho, 1999); *Fenneralpheus* (Felder and Manning, 1986); *Salmonaeus* (Felder and Manning, 1986); and *Chelomalpheus* (Hayashi, 1998; Kim, 1998).

Until the present study, *Athanas* species were not known to participate in the alpheid-thalassinian associations, although *Athanas amazone* Holthuis, 1951, was reported from the burrows of the stomatopod *Squilla mantis* in the Mediterranean Sea (Frogliia and Atkinson, 1998). The single specimen of *Athanas dentirostris*, n. sp., was collected in the burrow of its potential host *Upogebia takaensis* Sakai and Türkay, 1995, an uncommon species, previously reported only from Takao, southern Taiwan (Sakai and Türkay, 1995; Ngoc-Ho, in press). The biology of this and many other *Upogebia* species remains unstudied. It is assumed that the presence of the unusually dense setae on large cheliped in *A. dentirostris* is somehow related to the commensal life-style in the burrows of the *U. takaensis*, probably functioning as a grooming or filtering brush.

Chelomalpheus crangonus is the second species of *Chelomalpheus* reported to live inside upogebiid burrows. *Upogebia edulis* Ngoc-Ho and Chan, 1992, is the dominant species in the mudflats of western Taiwan (Fig. 9), and it generally requires a mixed mud-sand bottom for digging burrows. The burrow can be as deep as 1 m; it is generally "Y"-shaped, with two openings, and is inhabited by only one individual of *U. edulis*. To date, only one specimen of *C. crangonus* has been found associated with one *U. edulis*

burrow. *Chelomalpheus koreanus* was reported to be associated with *Upogebia major* (De Haan, 1841) in the Seto Inland Sea, Japan (Hayashi, 1998) and in Korea (Kim, 1998). Thus, *Chelomalpheus* is the third alpheid genus containing exclusively Thalassinidea-associated species, along with *Lepttalpheus* and *Fenneralpheus*. *Amphibetaeus jousseau mei* (Coutière, 1896) could also belong to this group, because Coutière (1899: 494) reported this species from Djibouti living "dans les galeries horizontales, plus spacieuses, en compagnie des mêmes Thalassiniens et de Géphyriens, Phascolosomes et Echiures." Interestingly, all these alpheids have very specialized first chelipeds, and the new species of *Chelomalpheus* is no exception. It also appears that most of the alpheid-thalassinian associations are species-specific, and may involve two closely related host species, as in the case of *Chelomalpheus*.

While the alpheid-thalassinidean associations are now intensively studied in the Caribbean Sea and Brazil (Felder and Manning, 1986; Felder and Manning, 1997; Dworschak and Coelho, 1999), the eastern side of the Atlantic Ocean and the vast Indo-Pacific region still remain very poorly explored in this aspect. Several new species from the northern Gulf of Mexico (D. Felder, personal communication), northern Mediterranean and the Cape Verde Islands (P. Dworschak, personal communication), in the process of being described, indicate that the thalassinian burrows often contain a completely unknown, cryptic, very specialized alpheid fauna. This is a huge potential for further research, not only in taxonomy and ecology, but also in evolutionary biology.

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While this paper was in proof, the authors discovered a regional report: Miya, Y., 1997, *Stenalpheops anacanthus*, new genus, new species (Crustacea, Decapoda, Alpheidae) from the Seto Inland Sea and the Sea of Ariake, South Japan. Bulletin of the Faculty of Arts and Sciences, Nagasaki University (1997): 145–161. The species *Stenalpheops anacanthus* is identical with *Cavipelta yamashitai* Hayashi, 1998, and *Chelomalpheus koreanus* Kim, 1998. Therefore, both Miya's generic and specific names have priority, and the new species described herein should have the name *Stenalpheops crangonus* (Anker, Jeng, and Chan).