



## A new genus and two new species of alvinocaridid shrimps (Crustacea: Decapoda: Caridea) from a hydrothermal vent field off northeastern Taiwan\*

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### Abstract

Two new species of alvinocaridid shrimps are described from a hydrothermal vent field off northeastern Taiwan at depths of 252–300 m. *Alvinocaris chelys* n. sp. is morphologically very similar to *A. williamsi* Shank & Martin, 2003 from the Mid-Atlantic Ridge, and *A. alexander* Ah Yong, 2009 from the southern Kermadec Ridge. These three species can be differentiated by the shape of the postrostral ridge, telson, the second segment of the antennular peduncle and the armature of the meri and ischia of the third pereopod. The second new species, although rather similar to *Alvinocaris niwa* Webber, 2004 from the Kermadec-Arc, is assigned to a new genus *Alvinocaridinides* gen. nov., which appears to be intermediate between *Shinkaicaris* Komai & Segonzac, 2005 and other derived genera including *Opaepele* Williams & Dobbs, 1995, *Chorocaris* Martin & Hessler, 1990 and *Rimicaris* Williams & Rona, 1986. *Alvinocaridinides formosa* n. sp. differs from *Alvinocaris niwa* by completely lacking any armature on the ischia of the third to fifth pereopods and by bearing two movable spines at the posterolateral angle of the uropodal exopod. These records constitute the first discovery of the family Alvinocarididae in Taiwanese waters and represent the shallowest occurrence for alvinocaridid shrimps.

**Key words:** Crustacea, Decapoda, Caridea, Alvinocarididae, *Alvinocaris*, new species, new genus, *Alvinocaridinides*, Taiwan, hydrothermal vents

### Introduction

The caridean family Alvinocarididae is currently represented by 21 species in seven genera. All of them inhabit reducing environments in deep waters from 534 to 4088 m, i.e. hydrothermal vents or brine and hydrocarbon seeps (Martin & Haney 2005; Komai & Segonzac 2005, 2008; Komai *et al.* 2005, 2006, 2007; Ah Yong 2009). Although this family is widespread across the globe, the geographical range of individual species is generally rather restricted. The genus *Alvinocaris* Williams & Chace, 1982 is most speciose and represented by 11 known species (Komai & Segonzac 2005; Komai *et al.* 2005; Ah Yong 2009); interestingly there has been no record yet of this genus from the Indian Ocean. Komai & Segonzac (2005) suggested the possible monophyly of *Alvinocaris*, as species of the genus have a small spiniform tubercle on the anterior surface of the eyes, an unusual character for Caridea. However, in a note added in the manuscript proof they argued that *Alvinocaris niwa* Webber, 2004 might not be a member of *Alvinocaris* *sensu stricto* because it shares possible synapomorphies with other genera, such as *Shinkaicaris* Komai & Segonzac, 2005; *Opaepele* Williams & Dobbs, 1995; *Chorocaris* Martin & Hessler, 1990 and *Rimicaris* Williams & Rona, 1986. Shank *et al.* (1999) used the mitochondrial Cytochrome Oxidase subunit I gene (COI) to study the phylogenetic relationships among 11 alvinocaridid taxa, but more comprehensive studies will be needed to fully understand the phylogeny within this family.

The hydrothermal vent field off Gueishandao (or Kueishan Island, Turtle Mountain Island) in the Dasi fishing ground off northeastern Taiwan has received considerable attention in recent years. In shallow vents the endemic crab, *Xenograpsus testudinatus* Ng, Huang & Ho, 2000 is the dominant animal (Jeng *et al.* 2004) but it is also found to about 300 m deep. In deeper vents four more endemic animals have been discovered, namely *Paragiopagurus ventilatus* Lemaitre, 2004; *Nihonotrypaea thermophila* Lin, Komai & Chan, 2007; *Bathymodiolus taiwanensis* von Cosel, 2008; *Lucinoma taiwanensis* von Cosel & Bouchet, 2008; as well as the recent fossil, *Meganodontia acetabulum* Bouchet & von Cosel, 2004. In the latest survey (2008) of this hydrothermal vent field, several specimens of alvinocaridids were unexpectedly collected from relatively shallow depths of 252–300 m. These Taiwanese alvinocaridids represent two species new to science. One of them can be assigned to *Alvinocaris*, and the other belongs to a new genus, *Alvinocaridinides* gen. nov. *Alvinocaris chelys* sp. nov. is very similar to *A. williamsi* Shank & Martin, 2003 (known only from hydrothermal vents at Menez Gwen, Mid-Atlantic Ridge) and *A. alexander* Ahyong, 2009 (only known from hydrothermal vents on the southern Kermadec Ridge, northern New Zealand). *Alvinocaridinides formosa* gen. nov., sp. nov., is morphologically most similar to *Alvinocaris niwa*. The presence of a number of presumably apomorphic characters suggests that the new genus is rather close to a group consisting of *Shinkaicaris*, *Opaepele*, *Chorocaris* and *Rimicaris*.

## Material and Methods

Specimens examined in this study are deposited in the Institute of Marine Biology, National Taiwan Ocean University (NTOU) and the Natural History Museum and Institute, Chiba (CBM). The size of the specimens is indicated by postorbital carapace length (cl) measured in mm from the level of the posterior margin of the orbit to the midpoint of the posterodorsal margin of the carapace. The descriptive terminology follows Komai & Segonzac (2005).

For comparative purposes, the following specimens were examined: *Alvinocaris williamsi*. MNHN-Na 15056, 1 female (cl 14.4 mm), SALDANHA, dive 1274, Menez Gwen, 37°51.60'N, 31°31.35'W, 865 m, 15.VII.1998, SMAC tray; MNHN-Na 15057, 1 female (cl 8.0 mm), DIVA 1, dive 14, same site, 37°50.46'N, 31°31.35'E, 845 m, 22.V.1994, slurp gun; MNHN-Na 15061, 1 female (cl 8.8 mm), 1 ov. female (cl 5.8 mm), DIVA 2, dive 16, same site, 37°50.54'N, 31°31.30'W, 866 m, 14.VI.1994, slurp gun.

## Systematics

### Alvinocarididae Christoffersen, 1986

#### *Alvinocaris* Chace and Williams, 1982

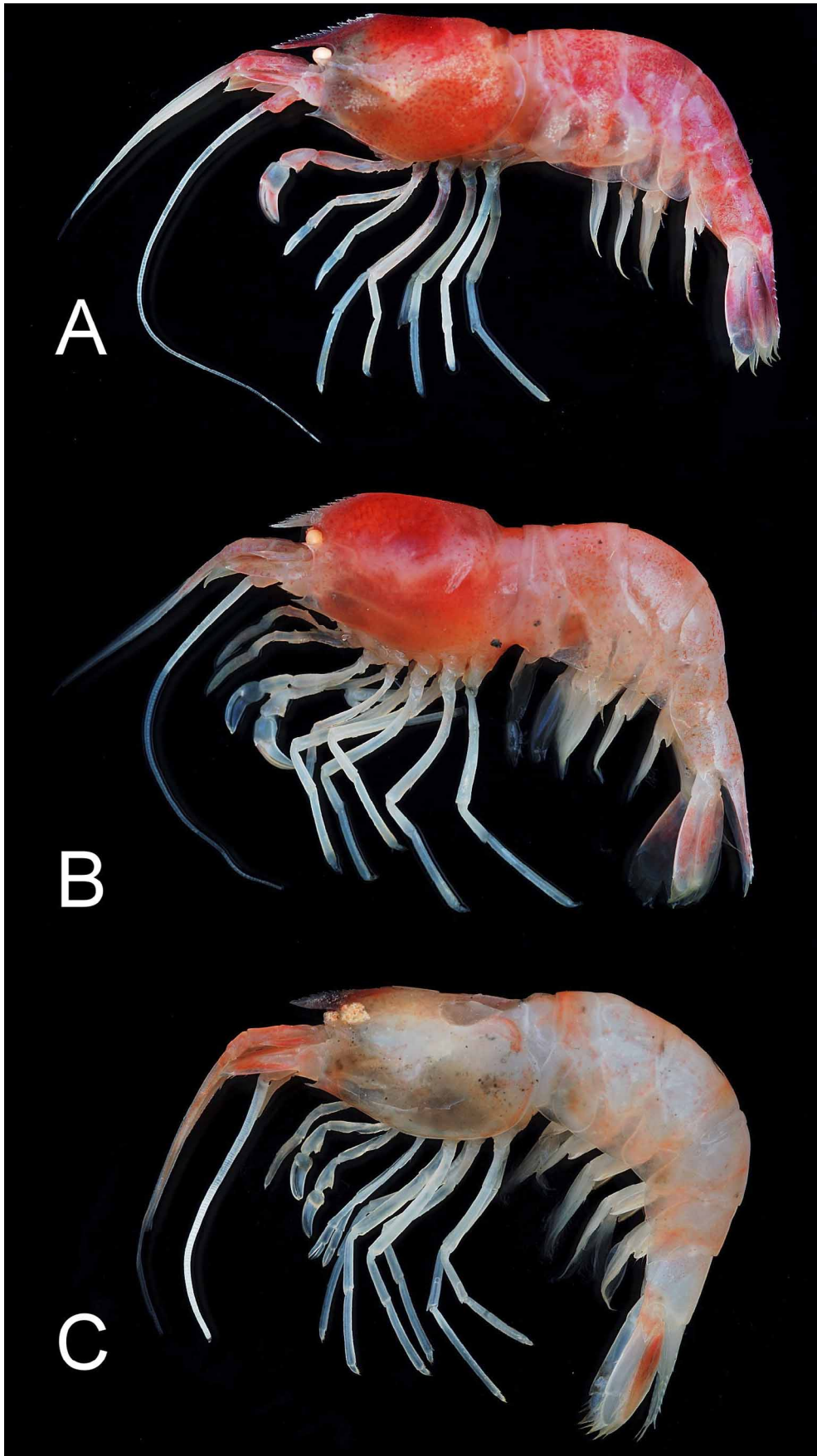
#### *Alvinocaris chelys* sp. nov.

(Figs. 1A–B, 2–6)

**Material examined.** Holotype: female (cl 9.6 mm), Gueishandao, Yilan County, Taiwan, stn KS 12, 24°49.682'N, 122°0.254'E, 300–276 m, 4.IX.2008, 2.5 m beam trawl, NTOUM 00782. Paratypes: same data as holotype, 2 females (cl 6.8–8.5 mm), 1 ovigerous female (cl 9.3 mm), 4 males (cl 5.3–6.5 mm), NTOUM 00783; same data, 1 female (cl 7.4 mm), 1 male (cl 8.5 mm), CBM-ZC 9572; stn KS 13, 24°51.231'N, 121°59.204'E, 252–275 m, 4.IX.2008, 2.5 m beam trawl, 1 male (cl 6.7 mm), NTOUM 00784.

**Description.** Body (Figs. 1A–B, 2) relatively robust; integument thin and soft, but not membranous; surface smooth.

Rostrum (Figs. 3A–B, 6A–B) directed forward or slightly downward, straight, reaching distal margin of first segment of antennular peduncle to midlength of second segment (0.28–0.43 times as long as carapace in females, 0.39–0.45 times in males); dorsal margin sharply carinate, armed with 12–17 moderately small teeth,

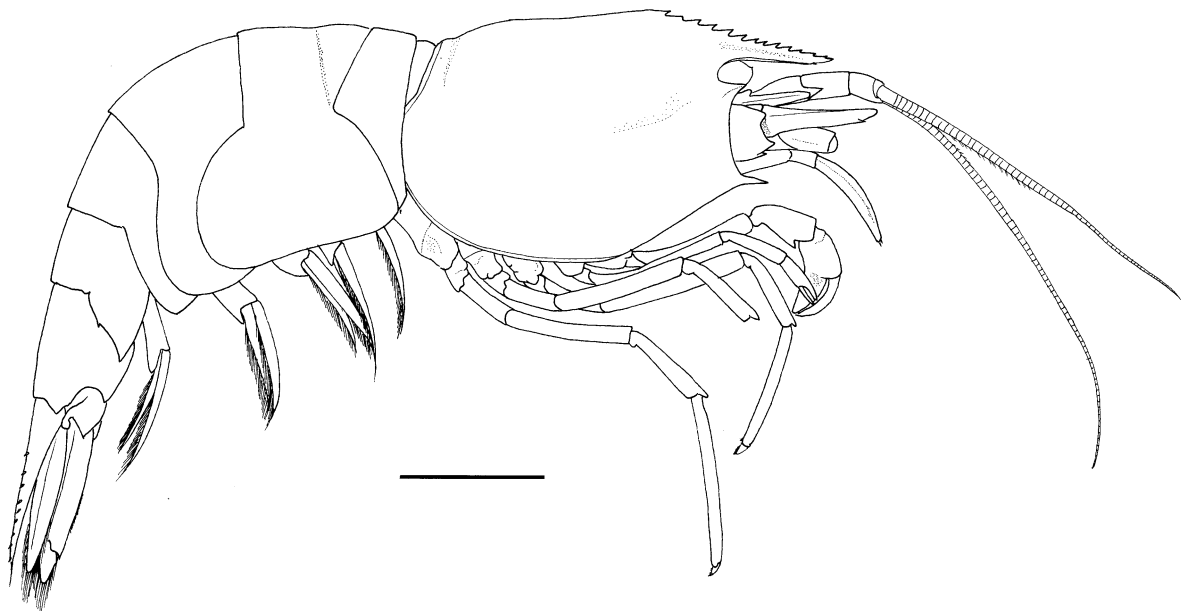


**FIGURE 1.** Entire animals in lateral view, showing fresh coloration. A, *Alvinocaris chelys* sp. nov., holotype, female (cl 9.7 mm), NTOUM 00782; B, *Alvinocaris chelys* sp. nov., paratype, female (cl 7.4 mm), CBM-ZC 9572; C, *Alvinocaridinides formosa* gen. et sp. nov., paratype, female (cl 9.1 mm), NTOUM 00786.

including 7–10 teeth on rostrum proper and 4–7 teeth on carapace posterior to level of orbital margin, posterior-most tooth arising at 0.19–0.24 of carapace length; ventral margin slightly convex to weakly carinate, unarmed or armed with 1 minute subterminal tooth; ventrolateral carina sharp, merging into orbital margin. Carapace (Figs. 2, 3A–B, 6A–B) about 1.40 times longer than wide; postrostral median ridge moderately high to high (higher in females than in males), becoming blunt posterior to posteriormost tooth of dorsal rostral series, extending beyond midlength of carapace, sloping anteriorly to rostrum, dorsal angle up to 155°; antennal tooth moderately large; pterygostomial tooth strong, reaching well beyond antennal tooth; anterolateral margin between antennal and pterygostomial teeth concave; post-antennal groove shallow, diverging to horizontal plane of carapace; branchial region moderately convex.

Eighth thoracic sternite with long median spur directed anteroventrally.

Abdomen (Fig. 2) rounded dorsally; pleura of anterior three somites broadly rounded; fourth pleuron rounded posteroventrally or with subacute to blunt point; fifth pleuron with strong posteroventral tooth and with 1–3 additional denticles on posterolateral margin. Sixth abdominal somite 1.25–1.40 times longer than high. Telson (Figs. 3C–D) not reaching posterior margin of uropodal endopod, length about 2.50 times anterior width and about 4.50 times posterior width; armed with 6–8 dorsolateral spines arranged in a slightly convex row on either side; posterior margin gently convex, armed with 2 pairs of spines at lateral angles (mesial spine about twice length of lateral spine) and 12–14 plumose setae all longer than mesial pair of lateral spines.



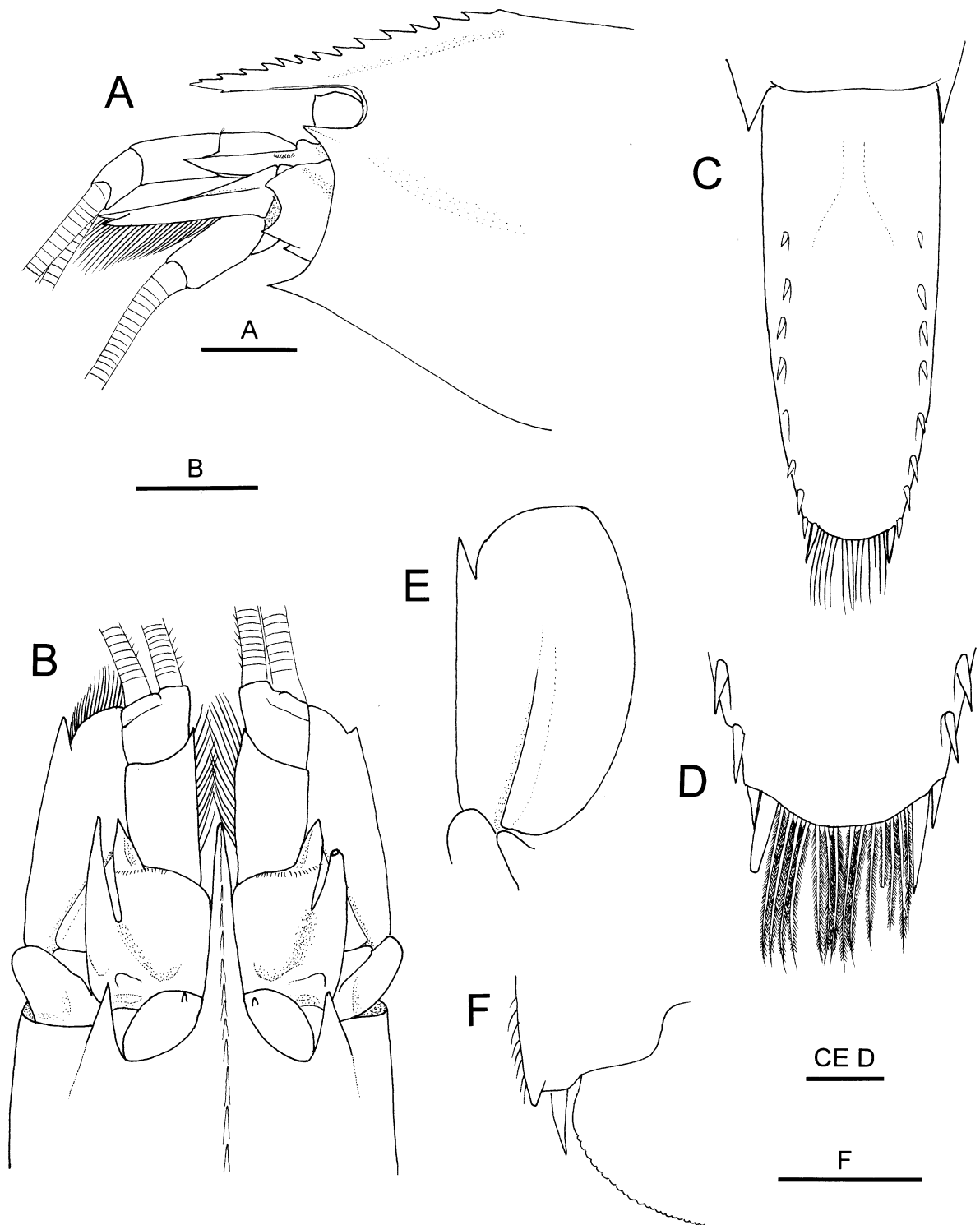
**FIGURE 2.** *Alvinocaris chelys* sp. nov., holotype, female (cl 9.7 mm), NTOUM 00782: entire animal in lateral view. Scale bar = 5 mm.

Eyes (Figs. 3A–B) fused mesially, each with small tubercle on anterodorsal surface; corneal part imperfectly developed, ovate in outline, unfaceted though diffusely pigmented.

Antennular peduncle (Figs. 3A–B, 6A) reaching or slightly overreaching distal margin of antennal scale. First segment with conspicuous proximal tubercle on dorsal surface laterally and strong distolateral tooth; dorsal surface with distinct obliquely longitudinal groove; stylocerite sharp, reaching to mid-length of second segment; distomesial margin with minute, but sharp tooth. Second segment stout, 1.30–1.40 times as long as wide, with small distomesial tooth. Lateral flagellum (Fig. 2) longer than carapace; mesial flagellum somewhat longer than lateral flagellum.

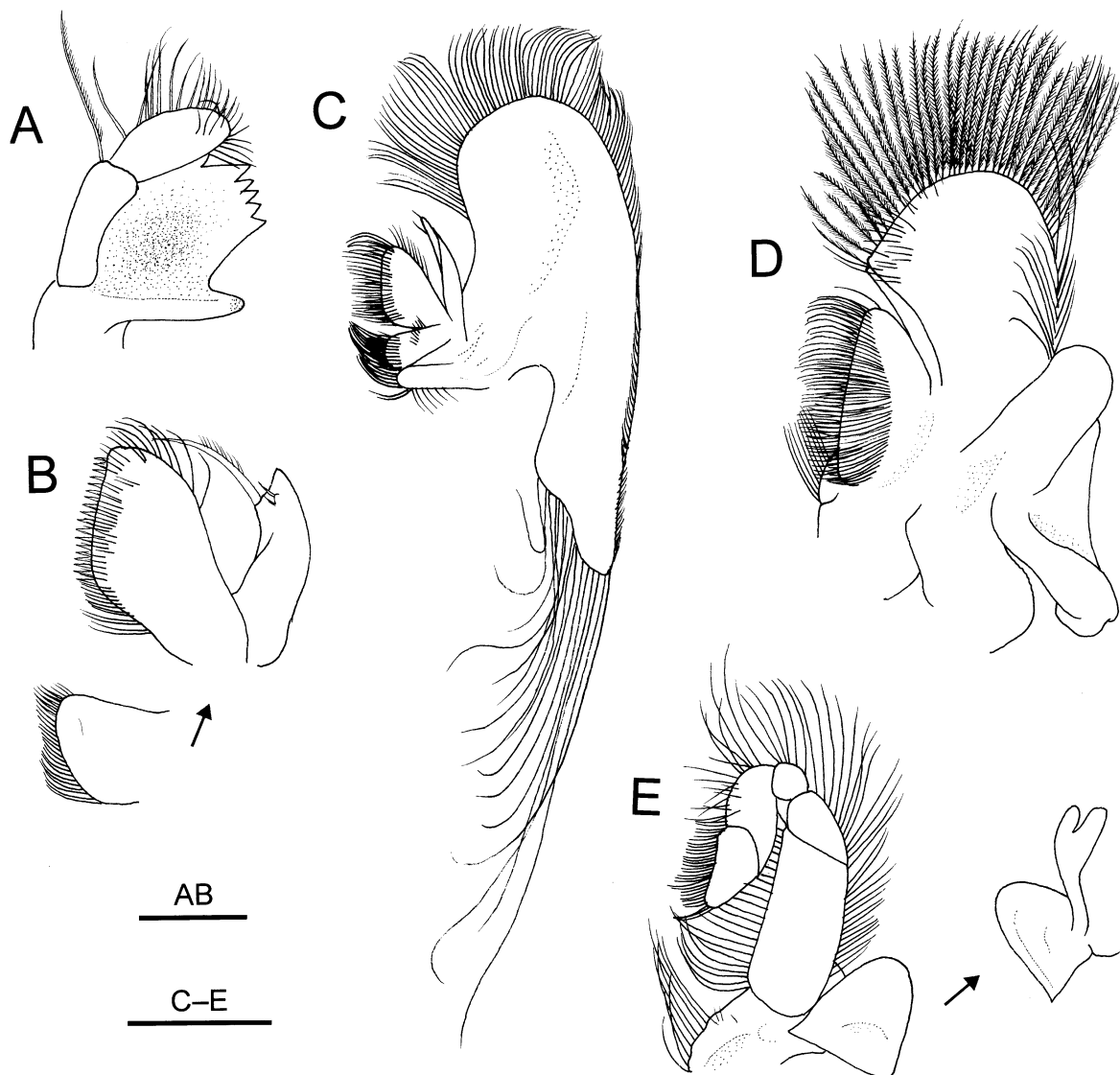
Antenna (Figs. 3A–B, E) with stout basicerite bearing moderately strong ventrolateral and weak ventral teeth. Carpocerite stout, not reaching midlength of antennal scale. Antennal scale 0.38–0.42 times as long as carapace in females, 0.39–0.50 times in males, 1.75–1.80 times longer than wide; lateral margin nearly

straight; middorsal ridge on dorsal surface slightly diverging against lateral margin; distolateral tooth moderately broad, falling short of broadly rounded distal margin of lamella.

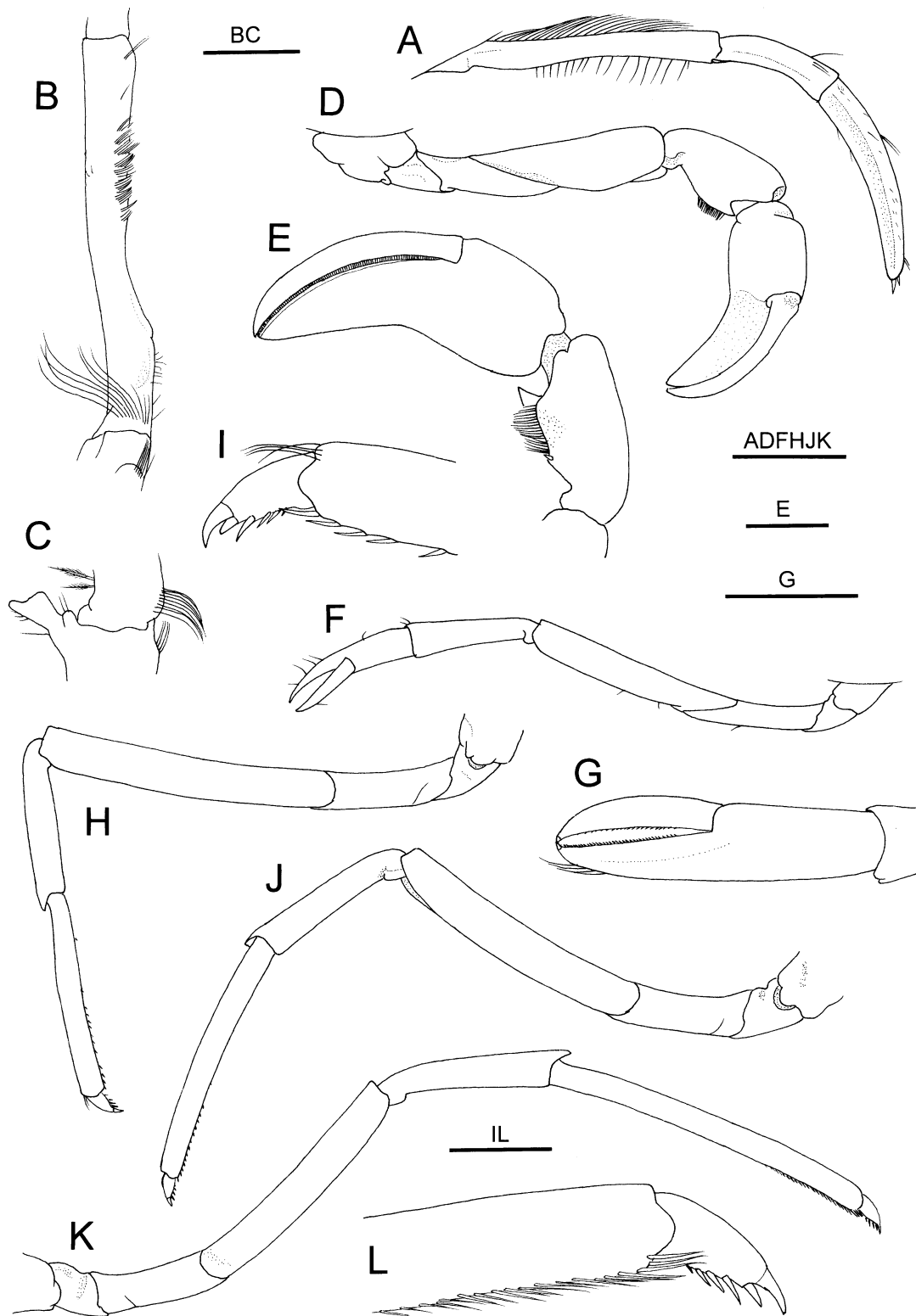


**FIGURE 3.** *Alvinocaris chelys* sp. nov., holotype, female (cl 9.7 mm), NTOUM 00782: A, anterior part of carapace and cephalic appendages, lateral view; B, same, dorsal view; C, telson, dorsal view; D, posterior margin of telson, dorsal view; E, left antennal scale, dorsal view; F, posterolateral part of left uropodal exopod, dorsal view. Scale bars = 2 mm (A–B), 1 mm (C, E, F) 0.5 mm (D).

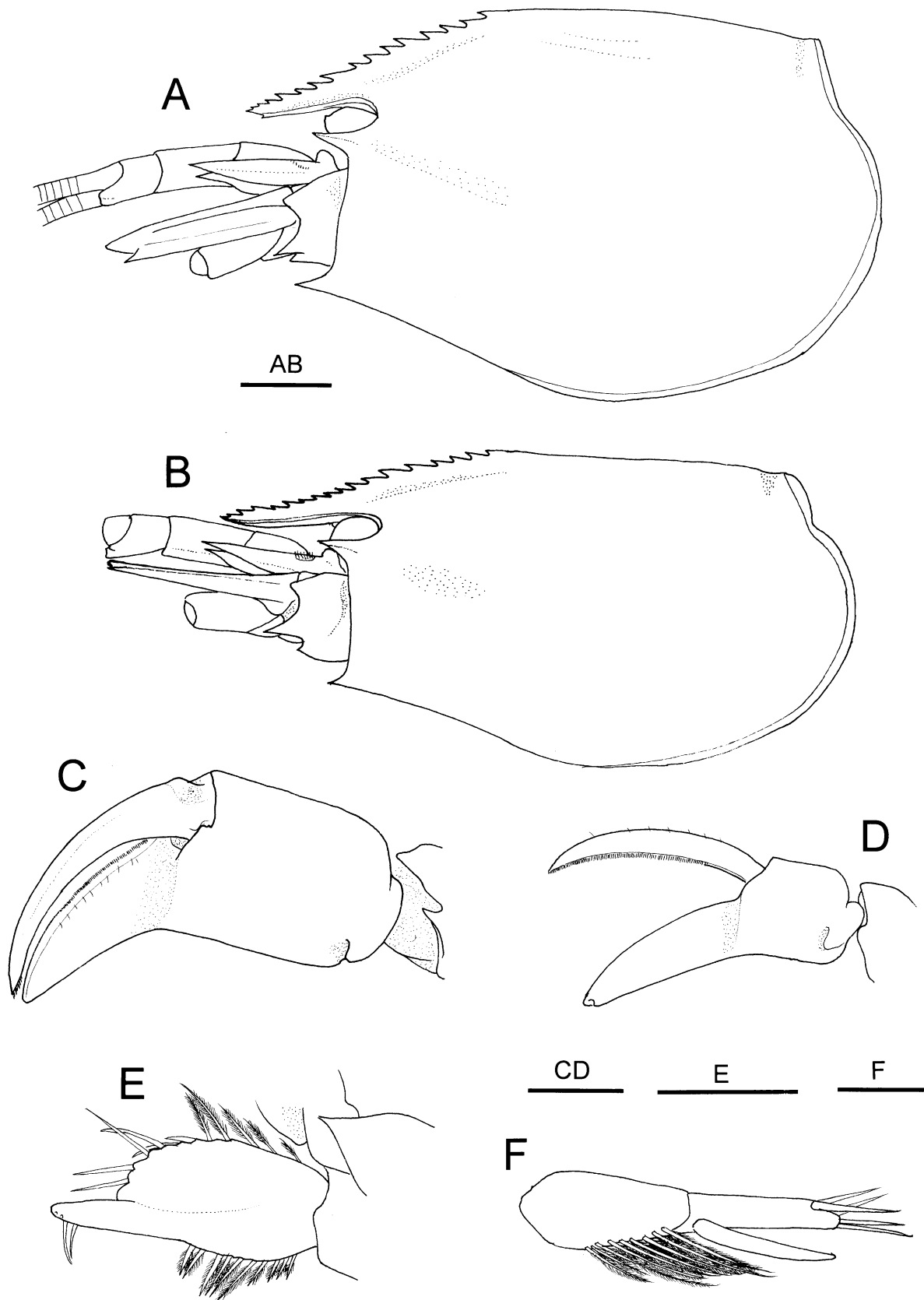
Mouthparts typical of genus (cf. Komai & Segonzac 2005). Mandible (Fig. 4A) with molar process terminating in blunt tip. Endopod of maxillule (Fig. 4B) bearing long, setulose, apical setae on inner lobe. Maxilla (Fig. 4C) with relatively broad scaphognathite. Exopod of first maxilliped (Fig. 4D) broad, with weak mesial projection probably representing reduced flagellum. Second maxilliped (Fig. 4E) relatively stout; epipod with bilobed podobranch. Third maxilliped (Figs. 5A–C) overreaching antennal scale by about 0.50 length of ultimate segment; ultimate and penultimate segments combined arcuate; ultimate segment trigonal in cross section, subtruncate terminal margin with 2 or 3 spines; antepenultimate segment somewhat flattened dorsoventrally, sinuously curved in dorsal view, bearing 1 slender spine at ventrolateral distal angle; dorsal surface of antepenultimate segment with prominent tuft of short to long setae proximomesially, mesial surface with several vertical rows of short stiff setae distal to midlength; coxa stout, with small projection dorsal to base of epipod; epipod small, directed distolaterally, slightly bilobed.



**FIGURE 4.** *Alvinocaris chelys* sp. nov., paratype, male (cl 8.5 mm), CBM-ZC 9572, left mouthparts: A, mandible, inner view; B, maxillule, outer view (inset: coxal endite detached); C, maxilla, outer view; D, first maxilliped, outer view; E, second maxilliped, outer view (inset: epipod and podobranch, inner view). Scale bars = 1 mm (C–E), 0.5 mm (A–B).



**FIGURE 5.** *Alvinocaris chelys* sp. nov. : A, right third maxilliped, lateral view; B, antepenultimate segment of left third maxilliped, dorsomesial view; C, coxa and epipod of left third maxilliped, dorsal view; D, right first pereopod, lateral view; E, chela and carpus of right first pereopod, mesial view; F, left second pereopod, lateral view; G, chela of left second pereopod; H, left third pereopod, lateral view; I, dactylus and distal part of propodus of left third pereopod, lateral view; J, left fourth pereopod, lateral view; K, right fifth pereopod, lateral view; L, dactylus and distal part of propodus of left fifth pereopod. A, D–L, holotype (cl 9.7 mm), NTOUM 00782; B, C, paratype, male (cl 8.5 mm), CBM-ZC 9572. Scale bars = 2 mm (A, D, F, H, J, K), 1 mm (B, C, E, G), 0.5 mm (I, L).



**FIGURE 6.** *Alvinocaris chelys* sp. nov.: A–B, carapace and cephalic appendages, lateral view (antennular and antennal flagella omitted or broken off); C–D, chela of left first pereopods, ventral view; E, endopod of left first pleopod, ventral view; F, appendices interna and masculina of left second pleopod, dorsomesial view. A, C, paratype, ovigerous female (cl 9.3 mm), NTOUM 00783; B, D–F, paratype, male (cl 8.5 mm), CBM-ZC 9572. Scale bars = 2 mm (A–B), 1 mm (C–E); 0.5 mm (F).



First pereopod (Figs. 5D–E, 6C–D) sexually dimorphic, larger in females than in males. Fingers curved downward and inward; outer surface of both fingers convex, inner surface concave, cutting edges uniformly offset, closing without gap, each armed with fine row of closely set teeth, tip of each finger slightly spooned; dactylus 1.4–1.7 times longer than palm in females, about 2.0 times in males, with submarginal row of short, curved setae on inner surface adjacent to cutting edge. Palm much shorter than fingers, with tuft of short setae at middle of ventral surface; short, distinct groove on ventral surface proximally. Carpus cupped distally to receive palm, with acute or subacute ventrodiscal tooth; dorsodiscal mesial margin rounded; ventromesial surface with patch of dense setae and 1 small spine just proximal to setal patch; mesial face shallowly depressed. Merus and ischium strongly obliquely articulated in lateral view; merus slightly inflated ventrally; ischium always unarmed.

Second pereopod (Figs. 5F–G) shorter and more slender than first pereopod, not reaching distal margin of antennal scale. Fingers subequal to palm in length, each terminating in small corneous unguis crossing each other when closed, cutting edges without gap, each pectinated with single row of minute corneous teeth. Carpus slightly longer than chela. Merus and ischium obliquely articulated in lateral view. Ischium unarmed or armed with 1 spine ventrolaterally.

Third to fifth pereopods (Figs. 5H, J–K) moderately slender, generally similar in structure and length although propodus becoming progressively longer, merus progressively shorter from third to fifth, third reaching beyond distal margin of antennal scale by 0.30–0.40 length of propodus. Dactyli (Figs. 5I, L) small (0.15–0.18 of propodal length in third, 0.09–0.18 in fourth, 0.10–0.15 in fifth), 1.90–2.00 times longer than high, each armed with 3–6 accessory spinules arranged in single row on flexor margin. Propodi of third and fourth pereopods (Fig. 5I) with slender spinules arranged in two rows on ventral surface; propodus of fifth pereopod (Fig. 5L) with numerous spiniform setulose setae arranged in three or four rows on distal half of ventral surface. Carpi shorter than propodi. Meri armed usually with 1 spine ventrolaterally or rarely unarmed in third, armed with 1 spine or unarmed in fourth, always unarmed in fifth. Ischia always unarmed.

Male first pleopod (Fig. 6E) with elongate distomesial lobe bearing 4 spiniform setae directed mesially or distomesially on mesial margin; lateral margin gently convex, with 6 spiniform setae in distal half and 5 or 6 setulose setae in proximal half; mesial margin faintly sinuous, with several setulose setae in proximal half. Appendix masculina (Fig. 6F) moderately robust, almost as long as appendix interna, with about 5 spiniform setae terminally or subterminally. Appendices internae on second to fourth pleopods small, slender, tapering distally, without terminal cluster of cincinnuli, but that on fifth pleopod better developed than others, with terminal cluster of cincinnuli.

Protopod of uropod with acute posterolateral angle; endopod subequal in length to exopod; exopod with tiny posterolateral tooth and 1 movable spine just mesial to posterolateral tooth (Fig. 3F).

**Coloration.** Body whitish translucent and patterned with numerous red dots except for flagella, third maxilliped, pereopods and pleopods (Fig. 1A). Basal part of antennular flagella, third maxilliped and first pereopod with some red dots, while distal parts of antennular and antennal flagella, posterior pereopods and pleopods almost entirely lacking red dots. Red dots sometimes less numerous on rostrum, abdomen, antennular and antennal peduncles (Fig. 1B). Eye light yellow with shiny reflection. Eggs reddish.

**Variation.** The postrostral ridge of the carapace is higher in spawning females than in non-spawning females and males. Rostral dentition is variable (Table 1) as in other congeners. The posteroventral margin of the fourth abdominal pleuron varies from rounded to sharply pointed. The fifth abdominal pleuron is always armed with a strong posteroventral tooth and with one to four small additional teeth or denticles on the posterior margin. The antennal scale may be proportionally longer in males than in females. The stoutness of the cheliped of the first pereopod in alvinocaridids is known to vary allometrically but is usually not sexually dimorphic (Komai & Segonzac 2005; but see Ahyong 2009). In the present new species, however, dimorphism appears sex related. All five females have stout chelae (Figs. 5D–E, 6C), whereas the first chelae of all the five males are slender with elongate fingers (about twice length of the palm) (Fig. 6D). Further specimens will be required to evaluate whether the dimorphism observed in the first pereopod is definitely sex related. Variation in the spination of the second to fourth pereopods is summarized in Table 1. It should be noted that the ischia of the third and fourth pereopods are always unarmed; the meri of the third and fourth

pereopods bear at most one spine. The body color varies from red to white (COI sequence comparison between the two color forms, data not presented, shown no difference).

**TABLE 1.** Morphological variation in *Alvinocaris chelys* sp. nov. Abbreviations: cl, carapace length; rl, rostral length; RTF, rostral tooth formula.

Station	Sex	type status	cl (mm)	rl/cl	RTF	P2 ischial spine		P3 meral spines		P3 ischial spine		P4 meral spines		P4 ischial spines	
						left	right	left	right	left	right	left	right	left	right
KS12	female	holotype	9.6	0.41	5+8/1	0	0	0	1	0	0	0	0	0	0
KS12	female	paratype	7.4	0.32	4+8/0	1	1	0	1	0	0	1	1	0	0
KS12	female	paratype	8.5	damaged	5+	0	0	1	1	0	0	–	–	–	–
KS12	female	paratype	6.8	0.35	7+10/0	0	0	1	1	0	0	0	0	0	0
KS12	ovig	paratype	9.3	0.28	7+7/1	1	1	1	1	0	0	0	0	0	0
KS12	male	paratype	8.5	0.39	7+10/0	1	1	1	–	0	0	1	–	0	–
KS12	male	paratype	6.5	0.45	4+8/1	0	0	1	1	0	0	–	0	–	0
KS12	male	paratype	6.1	0.4	4+9/1	1	1	1	1	0	0	1	1	0	0
KS12	male	paratype	5.3	damaged	6+	0	0	1	1	0	0	0	0	0	0
KS13	male	paratype	6.7	damaged	–	0	0	0	0	0	0	0	0	0	0

**Distribution.** Known only from the type locality, Gueishandao, northeastern Taiwan, at depths of 252–300 m.

**Remarks.** The present new species is very similar to *Alvinocaris williamsi* from the Mid-Atlantic Ridge. Shared characters include: the relatively robust body form; rostrum generally with one subterminal tooth or unarmed on the ventral margin; the possession of a row of plumose setae on the posterior margin of the telson; and a tendency for reduction of armature on the meri and ischia of the third to fifth pereopods. There are a few subtle morphological differences between the two species. The postrostral median ridge on the carapace extends beyond the midlength of the carapace in *A. chelys*, rather than not reaching or just reaching the midlength of the carapace in *A. williamsi*. The posteriormost tooth of the dorsal rostral series seems to arise more posteriorly in *A. chelys* than in *A. williamsi* (0.19–0.25 of the carapace length vs. 0.13–0.21). The telson is proportionally narrower in *A. chelys* than in *A. williamsi* (the length is more than 2.50 its width in *A. chelys* sp. n. vs. less than 2.50 in *A. williamsi*). When large specimens (cl > 6.0 mm) are compared, the difference in the shape of telson is clear (Fig. 3C vs. Komai & Segonzac 2005: Fig. 23D). The second segment of the antennular peduncle is proportionally more slender in the new species than in *A. williamsi* (1.30–1.40 times longer than wide versus 1.01–1.11 times).

This new species is also very similar to *A. alexander* from the Kermadec Ridge. Morphological differences between the two are also relatively minor. With regard to females, the postrostral median ridge of the carapace seems to be less strongly elevated in *A. chelys* than in *A. alexander*. This character, however, is expected to be variable (Komai and Segonzac 2005), and should be used with caution, particularly in identifying young specimens. The armature on the ambulatory pereopods seems to be more reduced in the new species than in *A. alexander*. For example, in the new species, the ischia of the third pereopod are always unarmed, but are usually armed with 1 or 2 minute spines in *A. alexander*; the merus of the same pereopod is unarmed or sometimes armed with 1 spine in *A. chelys* n. sp., rather than the usually bearing 2 spines in *A. alexander*. Among the present series of specimens of the new species, none has 2 spines on the merus of the third pereopods. The shape of the chela of the first pereopod is apparently sexually dimorphic in the two species, but the pattern is reversed between them. In *A. chelys*, females have stout chelae, but in *A. alexander* males have stout chelae (Ahyong 2009).

**Etymology.** The name of the new species “*chelys*” (Greek, turtle), is after its type locality Gueishandao, which is the transliteration of “Turtle Mountain Island” in Chinese.

## *Alvinocaridinides* gen. nov.

**Type species.** *Alvinocaridinides formosa* sp. nov., by present designation and monotypy; gender feminine.

**Diagnosis.** Rostrum short, not overreaching distal margin of antennular peduncle, somewhat depressed dorsoventrally, narrow triangular in dorsal view, dorsal midline elevated in blunt ridge, armed with series of teeth not extending to carapace; tip acuminate; ventral surface nearly flat, usually unarmed. Carapace not extremely inflated laterally, with moderately large antennal tooth and large pterygostomial tooth; postrostral ridge absent; suborbital lobe absent; pair of large yellowish white spots present inside cephalothorax posterior to orbits, visible through transparent cuticle, possibly representing posterior extension of eyes. Fourth and fifth abdominal pleura each with posteroventral tooth, latter with 1 or more denticles on posterolateral margin. Telson with dorsolateral spines arranged in sinuous row (second and/or third spines arising distinctly mesial to other spines); posterior margin with row of numerous plumose setae. Eyes broadly fused mesially, each unarmed on anterior surface. First segment of antennular peduncle with small distomesial tooth. Antennal scale oval, not locked with antennular peduncle; distolateral tooth acute. Exopod of first maxilliped with small triangular projection on mesial margin. No prominent setae on surfaces of scaphognathite and exopod of first maxilliped. No strap-like epipods on third maxilliped to fourth pereopods. Ischium of second pereopod unarmed or armed with 1 ventrolateral spine. Dactyli of third to fifth pereopods each with several spines arranged in 2 or 3 rows on flexor surface; meri unarmed or armed with 1 lateral spine in third and fourth pereopods, unarmed in fifth. Appendices internae on second to fourth pleopods small, slender, tapering distally, devoid of cincinnuli, that of fifth pleopod better developed, with cincinnuli. Protopod of uropod with acute posterolateral angle; exopod with 2 movable spines at posterolateral angle.

**Remarks.** There are some intermediate forms between *Alvinocaris* and the *Chorocaris* + *Rimicaris* group (e.g. Komai and Segonzac 2005, 2008; Komai *et al.* 2007). This new genus is superficially similar to *Alvinocaris* in the well-developed, dorsally dentate rostrum, but several presumably apomorphic characters suggest that it is rather close to *Shinkaicaris*, *Opaepele*, *Chorocaris* and *Rimicaris*. These apomorphic characters include: ventral surface of rostrum flattened, unarmed or armed only with one minute subterminal tooth at most; postrostral ridge low, not extending to midlength of carapace; dorsolateral spines on telson arranged in sinuous row, with second and/or third spines arising distinctly mesial to other spines; dactyli of third to fifth pereopods armed with several spines arranged in 2 or more rows on flexor surfaces; spination of meri of third to fifth pereopods showing tendency of reduction; and uropodal exopod bearing 2 movable spines at posterolateral angle (see Komai & Segonzac 2003, 2005, 2008; Komai *et al.* 2007). These apomorphies are not present in *Alvinocaris*, which has: ventral surface of rostrum carinate, with one or more teeth; postrostral ridge high, extending beyond midlength of carapace; dorsolateral spines on telson arranged in straight row; dactyli of third to fifth pereopods each with single row of accessory spinules on flexor margin; meri of third to fifth pereopods each with 1 or 2 lateral spines (though spination tends to be reduced in *A. williamsi* and *A. chelys* sp. nov.). Furthermore, the eyes are unarmed on the anterior facies in these genera, as well as in the new genus, but they possess spiniform denticles on the anterodorsal surface in *Alvinocaris*.

It is interesting that there is a pair of large light yellowish shiny spots visible inside the carapace just posterior to the orbits in *Alvinocaridinides formosa* gen. et sp. nov. These shiny spots may represent an extension of the eyes, which is homologous to the “dorsal eye” found in species of *Rimicaris* (see Van Dover *et al.* 1989; O’Neill *et al.* 1995; Chamberlain 2000; Desbruyères *et al.* 2006). Similar spots are present at least in species of *Chorocaris*, *Opaepele*, *Mirocaris* Vereshchaka, 1997 and *Nautilocaris* Komai & Segonzac, 2004 (Desbruyères *et al.* 2006; Tsuchida *et al.* 2008), whereas such spots are absent in *Alvinocaris* (Komai and Segonzac 2005). The presence of this spot-like organ also suggests a close relationship between the new genus and the derived genera.

*Shinkaicaris* differs from *Alvinocaridinides* gen. nov. in having a better developed, laterally compressed rostrum, which overreaches the distal margin of the first segment of the antennular peduncle, a distinct suborbital lobe and a sharply buttressed antennal tooth. Furthermore, in *Shinkaicaris* the dorsal rostral series and rostral ridge extend slightly onto the carapace beyond the level of the posterior margin of the orbit, rather than being limited to the rostrum proper in the new genus.

*Opaepele* is distinguished from *Alvinocaridinides* by the lack of conspicuous dorsal teeth and middorsal ridge of the rostrum, although these structures are often traceable in young individuals. The second to fifth pereopods completely lack armature on the ischia and meri in *Opaepele*.

*Chorocaris* and *Rimicaris* are easily separated from the new genus by: the rounded or broadly triangular, unarmed rostrum (greatly reduced in adults of *Rimicaris*); blunt antennal tooth on the carapace (also greatly reduced in adults of *Rimicaris*); less acuminate pterygostomial angle of the carapace (broadly rounded in *Chorocaris chacei*, *C. vandoverae* and *Rimicaris* spp.); non-dentate fourth and fifth abdominal pleura; and a complete absence of spines on the meri and ischia of the second to fifth pereopods in adults (see Komai & Segonzac 2008).

The new genus differs from *Mirocaris* and *Nautilocaris*, in lacking strap-like epipods on the third maxilliped to fourth pereopod and the dactyli of the third to fifth pereopod bearing accessory spinules arranged in more than one row.

**Etymology.** From the generic name *Alvinocaris* and the suffix -ides (Greek, son of), in reference to the superficial resemblance of the two genera.

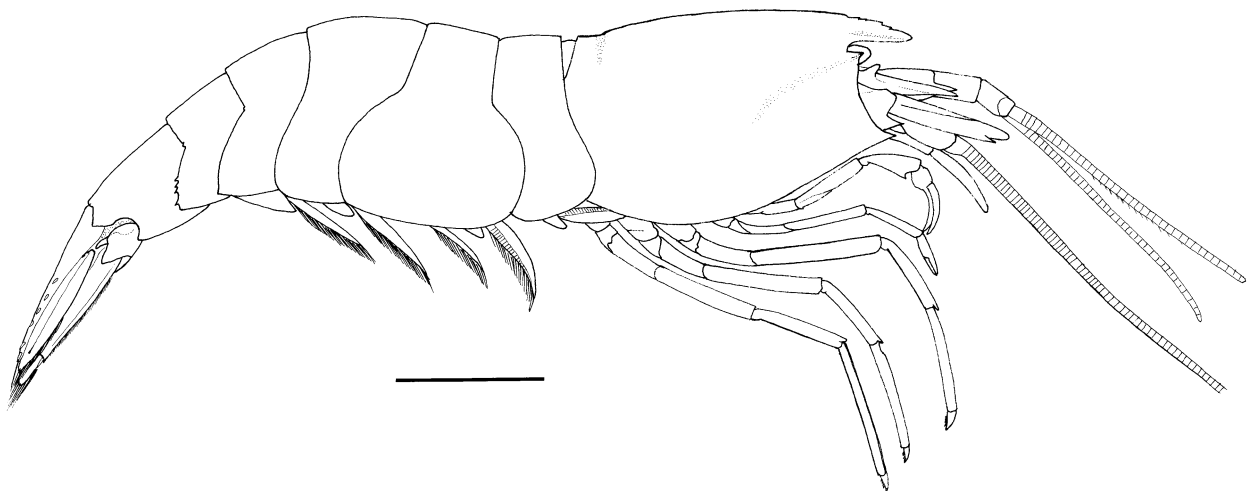
***Alvinocaridinides formosa* sp. nov.**

(Figs. 1C, 7–10)

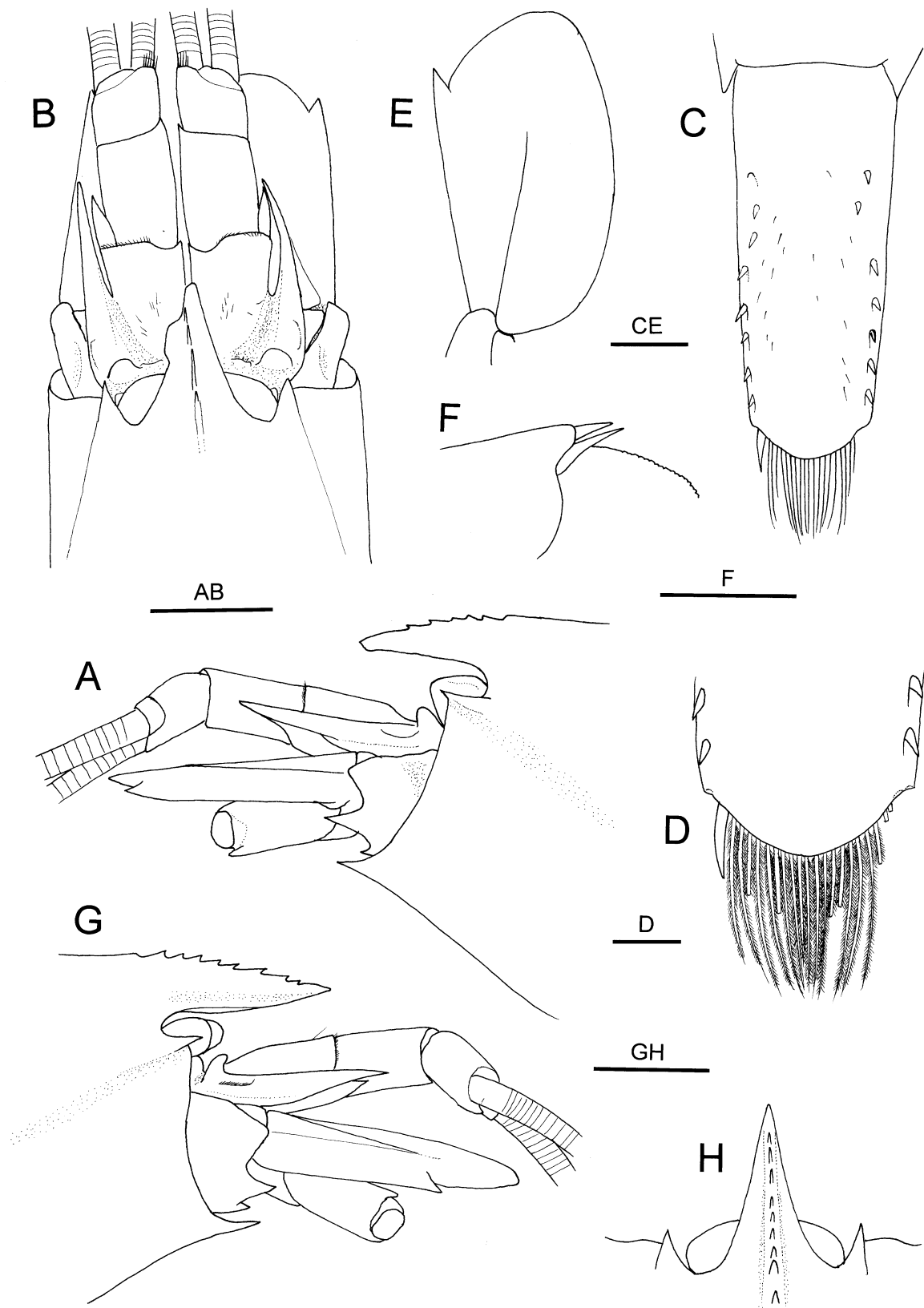
**Material examined.** Holotype: Gueishandao, Yilan County, Taiwan, stn KS 13, 24°51.231'N, 121°59.204'E, 252–275 m, 4.IX.2008, 2.5 m beam trawl, female (cl 8.3 mm), NTOUM 00785. Paratypes: same data as holotype, 1 female (carapace damaged, cl ca. 9.4 mm), NTOUM 00786; same data, 1 female (cl 7.7 mm), CBM-ZC 9573.

**Description.** *Females.* Body (Figs. 1B, 7) moderately robust; integument thin and soft, but not membranous; surface smooth.

Rostrum (Figs. 8A–B, G–H) directed forward, reaching or slightly falling short of distal margin of first segment of antennular peduncle, somewhat depressed dorsoventrally, narrowly triangular in dorsal view; dorsal margin sloping down anteriorly, middorsal line elevated in blunt carina, armed with 6–8 tiny to small teeth, posteriormost tooth arising just above posterior margin of orbit; ventral surface nearly flat, unarmed; ventrolateral carina sharp, merging into orbital margin. Carapace (Figs. 7, 8A–B, G) about 1.40 times longer than wide; postrostral median ridge absent; antennal tooth moderately large, buttressed with weak ridge; pterygostomial tooth slender, strongly produced, reaching well beyond antennal tooth; anterolateral margin between antennal and pterygostomial teeth concave; post-antennal groove shallow, diverging to horizontal plane of carapace; branchial region moderately convex.



**FIGURE 7.** *Alvinocaridinides formosa* gen. n., sp. n., holotype, female (cl 9.7 mm), NTOUM 00785, entire animal in lateral view. Scale bar = 5 mm.



**FIGURE 8.** *Alvinocaridinides formosa* gen. et sp. nov.: A, G, anterior part of carapace and cephalic appendages, lateral view (rostrum damaged in holotype); B, same, dorsal view; C, telson, dorsal view; D, posterior margin of telson, dorsal view; E, left antennal scale, dorsal view; F, posterolateral part of right uropodal exopod, dorsal view (setae omitted); H, rostrum and eyes, dorsal view. A–F, holotype, female (cl 9.7 mm), NTOUM 00785; G–H, paratype, female (cl 7.7 mm), CBM-ZC 9573. Scale bars = 2 mm for A–B, G, H; 1 mm for C, E–F; 0.5 mm for D.

Eighth thoracic sternite with long median spur directed anteroventrally.

Abdomen (Fig. 7) rounded dorsally; pleura of anterior three somites rounded; fourth pleuron with small posteroventral tooth; fifth pleuron also with small posteroventral tooth and 1–4 additional denticles on posterolateral margin. Sixth somite about 1.20 times longer than height. Telson (Figs. 8C–D) not reaching posterior margin of uropodal endopod, length about 2.40 times anterior width and about 3.3 times posterior width; armed with 7 or 8 dorsolateral spines arranged in sinuous row on either side; posterior margin convex, bearing 2 pairs of spines at lateral angles (mesial spine about twice length of lateral spine) and about 20 plumose setae all longer than mesial pair of lateral spines.

Eyes (Figs. 8A–B) broadly fused mesially, each unarmed on anterodorsal surface; corneal part imperfectly developed, subovate in outline, unafaceted.

Antennular peduncle (Figs. 8A–B, G) reaching or slightly overreaching distal margin of antennal scale. First segment with conspicuous proximal tubercle laterally on dorsal surface, strong distolateral tooth reaching nearly midlength of second segment, and small distomesial tooth; dorsal surface with distinct, obliquely longitudinal groove; stylocerite sharp, slender, reaching to mid-length of second segment. Second segment stout, about 1.40 times as long as wide, with small distomesial tooth. Flagella both longer than carapace.

Antenna (Figs. 8A–B, G) with stout basicerite bearing moderately large ventrolateral and small ventral teeth. Carpocerite stout, reaching beyond midlength of antennal scale. Antennal scale (Fig. 8E) 0.38–0.42 times as long as carapace, 1.80–1.90 times longer than wide; lateral margin nearly straight, noticeably diverging against middorsal ridge; middorsal ridge on dorsal surface conspicuous; distolateral tooth moderately broad; distal lamella produced, rounded, far overreaching distolateral tooth.

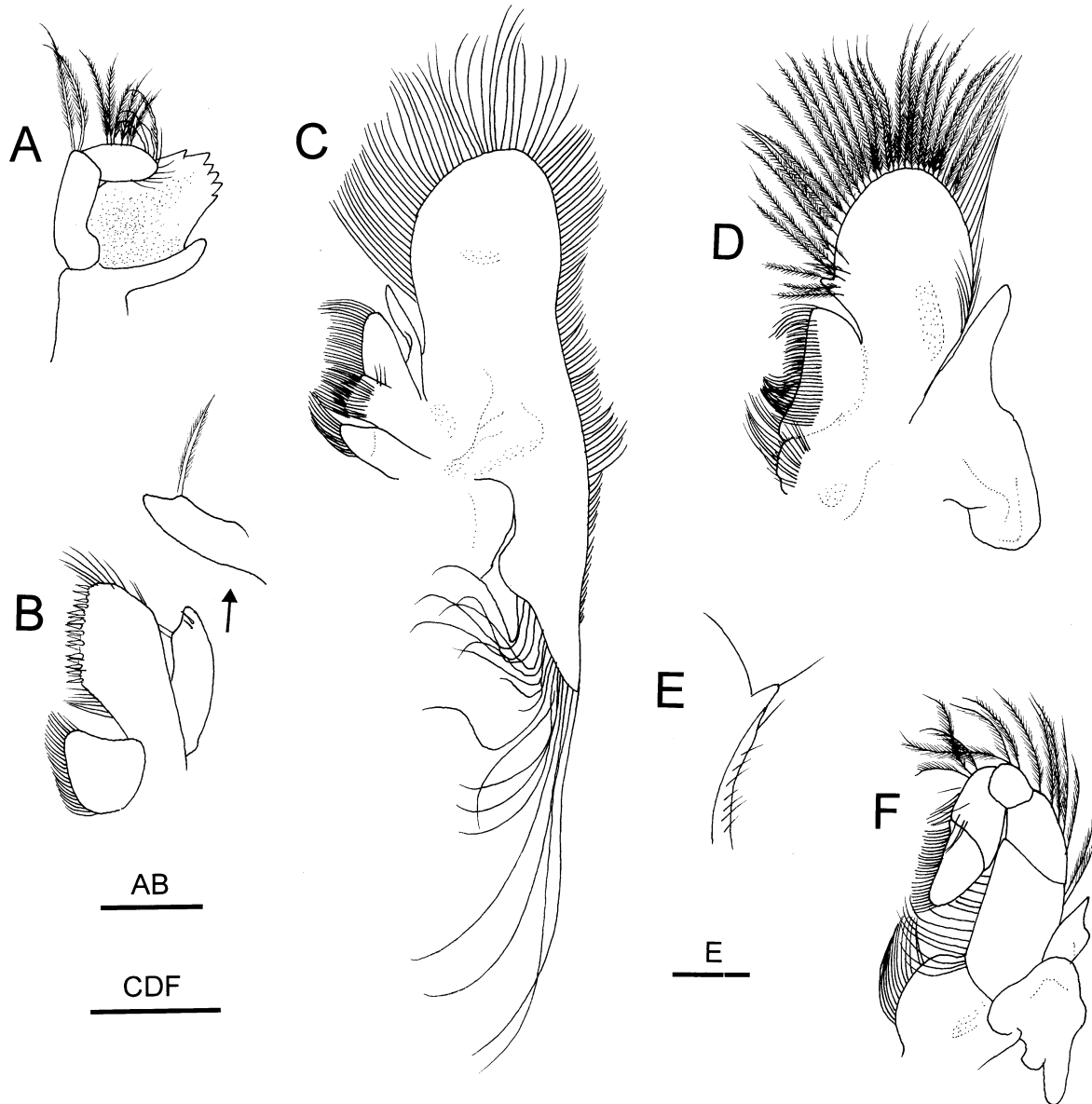
Mouthparts as illustrated. Mandible (Fig. 9A) with molar process terminating in subacute tip. Maxillule (Fig. 9B) with slightly bilobed endopod, inner lobe with 1 long setulose seta apically, outer lobe with 2 submarginal minute setae on outer surface. Maxilla (Fig. 9C) with moderately broad scaphognathite. Exopod of first maxilliped (Figs. 9D–E) broad, with small, distinct triangular lobe on mesial margin, representing reduced flagellum. Second maxilliped (Fig. 9F) with stout endopod; epipod with stout podobranch abruptly tapering distally. Third maxilliped (Figs. 10A–C) overreaching antennal scale by about 0.30 length of ultimate segment; ultimate and penultimate segment combined arcuate; ultimate segment distinctly longer than penultimate segment, trigonal in cross section, subtruncate terminal margin with 2 or 3 spines, lateral margin with longitudinal row of spiniform setae; antepenultimate segment somewhat flattened dorsoventrally, sinuously curved in dorsal view, bearing 1 slender spine at ventrolateral distal angle; dorsal surface of antepenultimate segment with prominent tuft of short to long setae proximomesially, mesial surface with several obliquely vertical tracts of short stiff setae distal to midlength; coxa stout, with small projection dorsal to base of epipod; epipod relatively large, directed distolaterally, subquadrate in dorsal view.

First pereopod (Figs. 10D–F) reaching midlength of antennal scale, relatively slender. Chela small; fingers curved downward and inward, exceeding 4.0 times length of palm; outer surface of both fingers convex, inner concavity with opposed edges uniformly offset, closing without gap, each armed with fine row of closely set teeth, tip of each finger slightly spooned; palm without patch of setae on mesial surface. Carpus cupped distally to receive palm; dorsodistal mesial margin rounded; ventrolateral margin flared into ridge terminating in subacute tooth, ventromesial surface with grooming apparatus consisting of patch of dense setae and 1 small spine just proximal to setal patch; mesial face shallowly concave. Merus and ischium strongly obliquely articulated in lateral view.

Second pereopod (Figs. 10G–H) slightly longer and more slender than first pereopod. Fingers slightly longer than palm, each terminating in small corneous unguis crossing each other when closed, cutting edges without gap, each pectinated with single row of minute corneous teeth. Carpus longer than chela. Merus and ischium obliquely articulated in lateral view. Ischium unarmed.

Third to fifth pereopods (Figs. 10I, L–M) moderately slender, generally similar in structure and length although propodus becoming progressively longer and merus progressively shorter from third to fifth, third extending beyond distal margin of antennal scale by 0.30–0.40 length of propodus. Dactyli (Figs. 10J–K, N) small (0.20–0.22 of propodal length in third and fourth, 0.15–0.18 in fifth), 1.90–2.00 times longer than

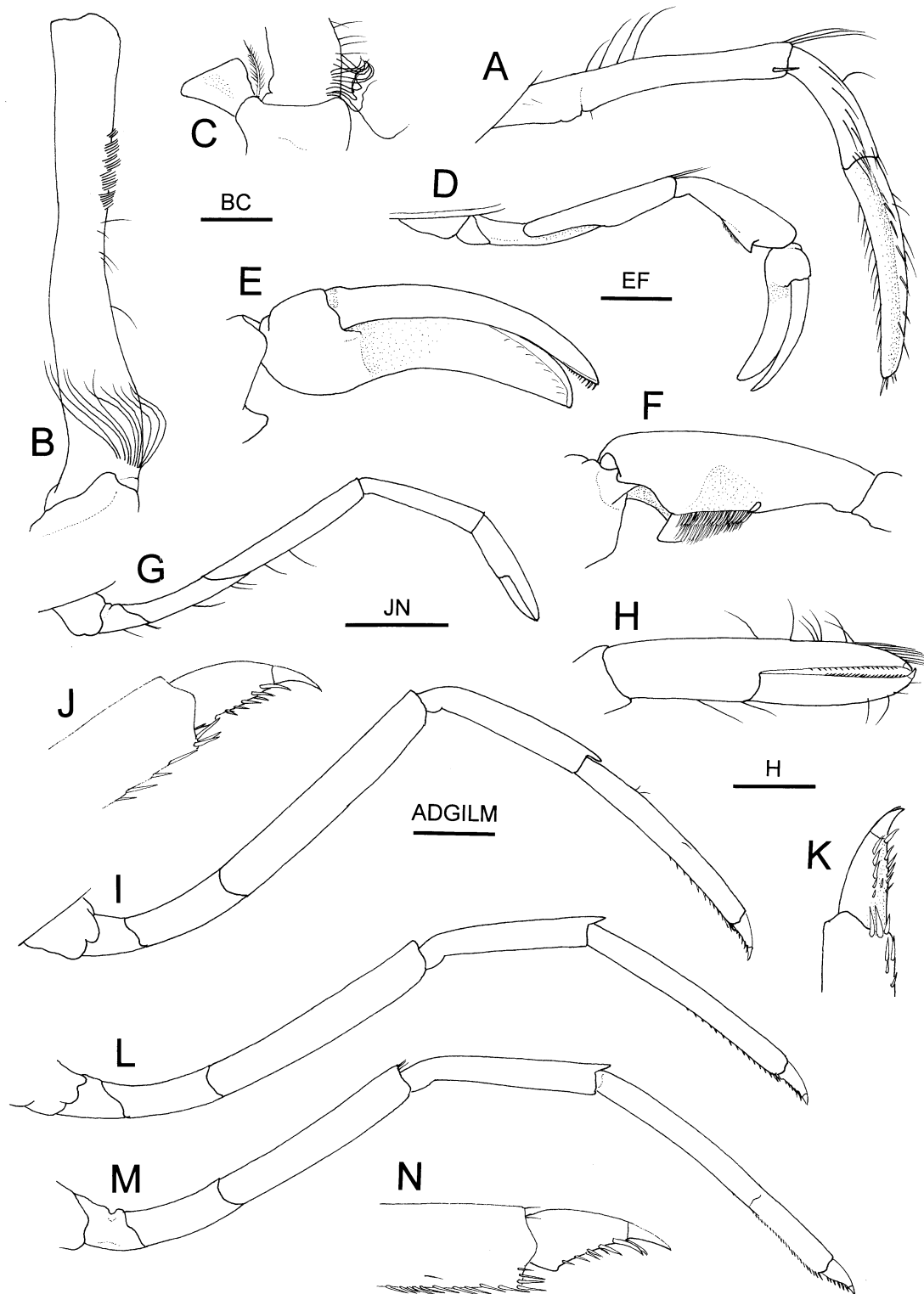
height, each armed with 10 or more corneous spines arranged in 2 or 3 rows on flexor surface. Propodi of third and fourth pereopods (Figs. 10J–K) with slender spinules arranged in 2 rows on ventral surface; propodus of fifth pereopod (Fig. 10N) with numerous spiniform setulose setae arranged in 3 or 4 rows on distal half of ventral surface. Carpi shorter than propodi. Meri and ischia always unarmed.



**FIGURE 9.** *Alvinocaridinides formosa* gen. et sp. nov. Paratype, female (cl 7.7 mm), CBM-ZC 9573, left mouthparts. A, mandible, inner view; B, maxillule, outer view (inset: endopod, inner view); C, maxilla, outer view; D, first maxilliped, outer view; E, mesial margin of exopod of first maxilliped, inner view; F, second maxilliped, outer view. Scale bars: 1 mm (C–D, F); 0.5 mm (A–B, E).

Appendices internae on second to fourth pleopods small, slender, those on second to fourth pleopods tapering distally, without terminal cluster of cincinnuli, but that on fifth pleopod better developed than others, with terminal cluster of cincinnuli.

Protopod of uropod with acute posterolateral angle; endopod slightly shorter than exopod; exopod with 2 movable spines at posterolateral angle (Fig. 8F).



**FIGURE 10.** *Alvinocaridinides formosa* gen. et sp. nov.: A, right third maxilliped, lateral view; B, antepenultimate segment of left maxilliped, dorsomesial view; C, coxa and epipod of left third maxilliped, dorsal view; D, right first pereopod, lateral view; E, chela of right first pereopod, lateral view; F, carpus of right first pereopod, mesial view; G, right second pereopod, lateral view; H, chela of right second pereopod; I, right third pereopod, lateral view; J, dactylus and distal part of propodus of right third pereopod, lateral view; K, same, ventrolateral view; L, right fourth pereopod, lateral view; M, right fifth pereopod, lateral view; N, dactylus and distal part of propodus of right fifth pereopod, lateral view. A, D–N, holotype, female (cl 9.1 mm), NTOUM 00785; B, C, paratype, female (cl 7.7 mm), CBM-ZC 9573. Scale bars = 1 mm (A, D, G, I, L, M), 0.5 mm (B, C, E, F, H, J, N).



**Coloration.** Body whitish translucent. Antennules, antennal peduncles, carapace, abdominal somites and endopod of uropod slightly orangish-reddish. Eye light yellowish and with shiny reflection. Anterodorsal part of carapace behind orbit also with a large light yellowish shiny spot about two times larger than eye in size, visible through cuticle (Fig. 1C).

**Variation.** Dentition of the fourth and fifth abdominal pleura is variable, as in other alvinocaridids. In the holotype, the left fourth pleuron bears a small but sharp posteroventral tooth, but the right is only minutely pointed at the posteroventral angle. In the smaller paratype (cl 7.7 mm, CBM-ZC 9573), each pleuron bears a small posteroventral tooth, but in the larger paratype (cl 9.4 mm, NTOUM), the left pleuron is rounded, while the right pleuron is angular at the posteroventral margin. The fifth pleuron is always armed with a posteroventral tooth, though the size of the tooth is rather variable; there are 1 to 3 additional small teeth or denticles on the posterior margin.

**Distribution.** Known only from the type locality: Gueishandao, northeastern Taiwan, 252–275 m.

**Remarks.** This new species is very similar to *Alvinocaris niwa* from the Kermadec-Arc. In the description of the latter species, Webber (2004) highlighted the high degree of variability in taxonomic characters used in *Alvinocaris*, such as rostral length and spination, spination of the ischia and meri of the third and fourth pereopods, and the armature of the fourth and fifth abdominal pleura. However, Ah Yong (2009) demonstrated that two species were present in the type series of *A. niwa*, describing the other as new *A. alexander* Ah Yong, 2009. Some of the conclusions of Webber (2004) regarding instability of taxonomic characters were probably derived from the composite type series of *A. niwa*. In spite of the close similarity, the present new species can be distinguished from *A. niwa* by completely lacking spines on the ischia of the second to fifth pereopods, and bearing 2 movable spines at the posterolateral angle of the uropodal exopod. In *A. niwa*, the ischium of the second pereopod is armed with 1 spine, and those of the third to fifth pereopods are generally armed with 1 or 2 spines; the uropodal exopod bears only 1 movable spine at the posterolateral angle (Webber, 2004; personal observation). As mentioned in the **Remarks** of the genus, these characters, as exhibited by the new species, are possible synapomorphies uniting *Alvinocaridinides* with *Shinkaicaris*, *Opaepele*, *Chorocaris* and *Rimicaris*. Thus, *A. niwa* is excluded from this group. Furthermore, the posterior margin of the telson is evenly convex in the new species, instead of bilaterally convex with a shallow median notch or indentation in *A. niwa*. The second pereopod is more slender in the new species than in *A. niwa*; the chela is shorter than the carpus in the new species vs. the opposite in *A. niwa*.

**Etymology.** This new species is named after its type locality Taiwan, “Formosa” being an older name for Taiwan.

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