



<http://dx.doi.org/10.11646/zootaxa.3669.4.4>

<http://zoobank.org/urn:lsid:zoobank.org:pub:7B3A771A-6DC5-48C5-867E-03A2B76369B3>

## A redescription of a rare axiid shrimp, *Amakusaxius amakusanus* (Miyake & Sakai, 1967) (Crustacea: Decapoda: Axiidea) from new material collected off Taiwan

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### Abstract

Miyake & Sakai (1967) described a new species of axiid shrimp, *Calocaris (Calastacus) amakusana*, from a single female specimen lacking a major cheliped. Later, Sakai & de Saint Laurent, 1989 transferred this species to their new genus *Acanthaxius*. However, Sakai (2011) recently established a new monotypic genus *Amakusaxius* to accommodate *Acanthaxius amakusana*. Since the original description no additional specimen of this rare species has been reported and consequently an appraisal of *A. amakusanus* (Miyake & Sakai, 1967) has not been possible. Now six specimens including three males and three ovigerous females have been collected from Taiwan. This has enabled the diagnostic characters of the species to be fully evaluated. The presence of a postcervical median carina on the carapace, weak armature on the major cheliped, and the morphology of the uropod are characters that distinguish *Amakusaxius* from *Acanthaxius*. Consequently the monotypic genus *Amakusaxius* Sakai, 2011 is retained.

**Key words:** Crustacea, Decapoda, Axiidea, *Amakusaxius*, *Acanthaxius*, *Calocaris (Calastacus) amakusana*, redescription

### Introduction

Miyake & Sakai (1967) described a new axiid shrimp species, *Calocaris (Calastacus) amakusana*, on the basis of a single female specimen, lacking a major cheliped, from off Tomioka, Amakusa Islands, Kyushu, Japan. They argued that generic assignment of this species was difficult. In their reappraisal of axiid genera, Sakai & de Saint Laurent (1989) transferred this species to their new genus *Acanthaxius* [type species: *Axiopsis (Axiopsis) pilocheira* Sakai, 1987] together with another six species previously assigned to various genera. Recently, Sakai (2011) established a new monotypic genus *Amakusaxius* to accommodate *Acanthaxius*. Since the original description, no additional specimen of this species has been reported, and consequently, no information on the male morphology, which provides important diagnostic characters at genus level, was available.

During the course of a taxonomic study of Axiidae from Taiwan, six specimens (including three males and three ovigerous females, all from Penghu Islands) were obtained that match the original description of *A. amakusaxius*. Comparison with the female holotype confirmed that the specimens from Taiwan belong to the same species. In this study, *A. amakusanus* is fully redescribed and the diagnostic characters of the genus are evaluated.

Material used in this study is deposited in the Kitakyushu Museum of Natural History and Human History (KMNH), Natural History Museum and Institute, Chiba (CBM), National Museum of Marine Biology and Aquarium, Pingtung, Taiwan (NMMBA) and the National Taiwan Ocean University, Keelung (NTOU). The carapace length (cl) is measured dorsally from the level of the orbital margin to the midpoint of the posterodorsal margin of the carapace.

For comparison, the following material was examined:

*Acanthaxius formosa* Kensley & Chan, 1998. Non-type: 1 male (cl 16.3 mm), 1 female (cl 18.4 mm), Donggang fishing port, Pingtung County, southwestern Taiwan, depth unknown, 5 August 1996, commercial trawler, coll. T. Komai, CBM-ZC 2835; 6 males (cl 11.8–13.5 mm), 1 female (cl 13.1 mm), same locality, depth unknown, 10 September 2012, NMMBA.

**Remarks.** Sakai (2011) synonymized *Acanthaxius formosa* under *A. miyazakiensis* (Yokoya, 1933), originally described from Japan, together with *A. polyacantha* (Miyake & Sakai, 1967) also from Japan. However, his arguments are unfortunately not convincing, because he only commented upon similarities among the three taxa. Differentiating characters between *A. formosa* and *A. polyacantha* as proposed by Kensley & Chan (1998), seem to be valid as far as comparing the present specimens with the original description of *A. polyacantha* and the subsequent account based on a single specimen from the Solomon Islands (Ngoc-Ho 2006). *Acanthaxius miyazakiensis* differs from *A. formosa* and *A. polyacantha* in the absence of a covering of granules or spinules on the carapace (see Yokoya 1933; Sakai 2011). Consequently, *A. formosa* and *A. polyacantha* are recognized as valid species and not synonyms of *A. miyazakiensis*.

*Acanthaxius grandis* Kensley & Chan, 1998. Holotype: male (cl 33.5 mm), Donggang fishing port, Pingtung Country, southwestern Taiwan, about 400 m, 5 August 1996, commercial trawler, NTOU-H-1996-8-5. Non-type: 1 female (cl 40.8 mm), Dasi fishing port, Yilan County, northeastern Taiwan, depth unknown, 18 August 2005, commercial trawler, NTOU; 1 male (cl 28.4 mm), Donggang fishing port, depth unknown, 1 February 2012, commercial trawler, NTOU.

**Remarks.** Sakai (2011) synonymized *Acanthaxius grandis* under *A. pilocheira* Sakai, 1987, but again his arguments are not convincing, because he cited only similarities between the two taxa. During this study, the holotype of *A. grandis* and two specimens recently collected from Taiwan were examined. Comparison with the type description of *A. pilocheira* by Sakai (1987) confirmed the existence of the following morphological differences of possible specific significance: the fifth abdominal pleuron is posteriorly rectangular in the Taiwanese specimens (even in female), rather than rounded in the holotype of *A. pilocheira*; dorsal and ventral spines on chelae are distinctly less prominent in the Taiwanese specimens than in the holotype of *A. pilocheira*; fixed fingers of the chelipeds are both furnished with a median carina, bearing fine tubercles or spinules, in the Taiwanese specimens, while such a carina is not seen in the holotype of *A. pilocheira*; the number of dorsal dactylar spines are more numerous in the Taiwanese specimens than in the holotype of *A. pilocheira* (11 or 12 versus eight). Furthermore, although Sakai (1987) indicated that the number of lateral spines on the uropodal exopod is 8 to 10, his figure (Sakai 1987: fig. 1d) clearly shows the presence of 12 lateral marginal spines on the left uropodal exopod. In the present Taiwanese specimens, there are 6 to 9 spines. Considering these morphological differences, *A. grandis* is reinstated as a valid species for the time being. Sakai (2011) also synonymized *A. gathaagudu* Poore & Collins, 2009, described from Western Australia, under *A. pilocheira*, but differentiating characters discussed by Poore & Collins (2009) seem to warrant the recognition of *A. gathaagudu* being distinct from *A. pilocheira*.

## Taxonomic account

### Genus *Amakusaxius* Sakai, 2011

*Acanthaxius* Sakai & de Saint Laurent, 1989: 66 (part).

*Amakusaxius* Sakai, 2011: 44.

**Type species.** *Calocaris (Calastacus) amakusana* Miyake & Sakai, 1967. Original designation.

**Diagnosis.** Rostrum somewhat flattened dorsoventrally, triangular, laterally denticulate, shorter than eyestalks, not depressed below level of carapace, not continuous with lateral carinae. Carapace dorsally granulate; cervical groove deep, visible laterally over half distance to anterolateral margin; supraocular spines prominent; lateral carina divided in two parts, each terminating anteriorly in spine; submedian carina present, spinose; median carina tuberculate or denticulate; low, blunt postcervical carina present. First abdominal pleuron blunt or subacute; second pleuron broad, rounded; third to fifth pleura posteriorly rounded. Telson with lateral fixed spines and posterolateral

movable spinules; posterior margin slightly convex, with small median spine. Eystalk cylindrical, articulating; cornea darkly pigmented. Antennal scaphocerite short, curved; dorsolateral distal spine on second segment of antennal peduncle curved inward. Third maxilliped exopod not clearly bent at base of flagellum. Pleurobranchs absent; podobranchs and arthrobranchs well developed, but former without lamella; epipods present on second maxilliped to fourth pereopod. Chelipeds asymmetrical, with palm somewhat compressed laterally; merus unarmed on ventral margin in major cheliped, armed with row of spines in minor cheliped; dorsal margin of carpus to dactylus of major cheliped only with small spines, that of minor cheliped with prominent spines. Propodi of third and fourth pereopods with transverse rows of corneous spinules; dactyli tapering, with longitudinal row of corneous spinules. First pleopod of male absent. Male second pleopod with appendix masculina; second to fifth pleopods each with appendix interna. Uropodal exopod and endopod narrow, with transverse suture on exopod; exopod with middorsal carina terminating posteriorly in strong marginal spine, terminal flap located lateral to this spine.

**Composition.** Monotypic.

**Remarks.** Sakai & de Saint Laurent (1989) assigned the following eight species to their new genus *Acanthaxius*: *Axius spinulicaudus* Rathbun, 1902; *Axius spinosissimus* Rathbun, 1906; *Axius miyazakiensis*; *Calocaris (Calastacus) amakusana*; *Calocaris (Calastacus) hirsutimana* Boesch & Smalley, 1972; *Axiopsis (Axiopsis) polyacantha*; *Axiopsis (Axiopsis) caespitosa* Squires, 1979; and *Axiopsis (Axiopsis) pilocheira* (type species). Of the eight species, *A. spinulicaudus* was reassigned to *Calocarides* by Kensley (1996a). Since the original description, the following nine species have been added to *Acanthaxius*: *A. polychaetes* Sakai, 1994; *A. kirkmilleri* Kensley, 1996b; *A. formosa*; *A. grandis*; *A. clevai* Ngoc-Ho, 2006; *A. gadaletae* Ngoc-Ho, 2006; *A. garawa* Poore & Collins, 2009; *A. gathaagudu*; *A. ningaloo* Poore & Collins, 2009 (Sakai 1994; Kensley 1996b; Kensley & Chan 1998; Ngoc-Ho 2006; Poore & Collins 2009).

Recently, Sakai (2011) reviewed *Acanthaxius*, and restricted the following seven species to *Acanthaxius*: *A. clevai*, *A. gadaletae*, *A. garawa*; *A. miyazakiensis* (*A. formosa* and *A. polyacanthus* were synonymized with *A. miyazakiensis*), *A. ningaloo*, *A. pilocheirus* (*A. grandis* and *A. gathaagudu* were synonymized with *A. pilocheirus*), and *A. spinosissimus*. *Acanthaxius amakusana* was reassigned to the new genus *Amakusaxius*; *A. kirkmilleri* was transferred to the new genus *Pillsburyaxius* Sakai, 2011; and *A. polychaetes* was transferred to the new genus *Bruceaxius* Sakai, 2011.

Sakai (2011) distinguished *Amakusaxius* from *Acanthaxius* only by the presence of a postcervical median carina on the carapace in the former. The significance of the presence or absence of the postcervical carina alone is questionable, because interspecific variation is known in *Ambiaxius* (see Sakai 1995, Sakai & Ohta 2005, Komai et al. 2010). The present newly collected specimens enable the examination of more characters of possible diagnostic significance. Indeed, *Calocaris (Calastacus) amakusana* is different from other species currently assigned to *Acanthaxius* in the following characters. Ventral spines of the merus and dorsal spines of the palm of the major cheliped are fairly reduced in the size in *C. (C.) amakusana*, whereas they are quite prominent in species of *Acanthaxius*. The uropodal rami are relatively narrower in *C. (C.) amakusana* compared to species of *Acanthaxius*, because of the weakly developed mesial convexity in the former species. Furthermore, the mid-dorsal carina on the uropodal exopod is produced into a strong spine posteriorly in *C. (C.) amakusana*, whereas such a spine is not seen in species of *Acanthaxius*. Moreover, similarities to certain species of *Acanthaxius* are also seen. The triangular, somewhat flattened rostrum links *C. (C.) amakusana* with *A. garawa* (cf. Poore & Collins 2009) and *A. spinosissimus* (cf. Ngoc-Ho 2005). The lateral gastric carina on the carapace is interrupted from the rostral lateral margin in *C. (C.) amakusana*, and similar condition is seen in *A. grandis*, *A. gathaagudu* and *A. pilocheirus* (cf. Sakai 1987; Kensley & Chan 1998; Poore & Collins 2009). In this present study, the validity of *Amakusaxius* is tentatively accepted because of the existence of some unique features that differentiate the type species from *Acanthaxius*, but future phylogenetic studies may eventually reveal that this genus could be a synonym of *Acanthaxius*.

### ***Amakusaxius amakusanus* (Miyake & Sakai, 1967)**

(Figs 1–6)

*Calocaris (Calastacus) amakusana* Miyake & Sakai, 1967: 306, fig. 2, pl. 4B.

*Axiopsis (Axiopsis) amakusana*.—Sakai 1987: 303 (list).

*Acanthaxius amakusana*.—Sakai & de Saint Laurent 1989: 73; Kensley 1996b: 71 (list).

*Amakusaxius amakusanus*.—Sakai 2011: 45.

**Material examined.** Holotype: female (cl 9.4 mm), off Tomioka, Amakusa Island, Kyushu, Japan, 20–40 m, 22–24 August 1956, coll. Sadayoshi Miyake, KMNH (formerly deposited at the Zoological Laboratory, Faculty of Agriculture, Kyushu University, registration number 4580).

Non-type: 1 male (cl 15.5 mm), 1 ovigerous female (cl 13.6 mm), Penghu Islands, Taiwan, commercial trawlers, about 50 m, 31 March 2011, NTOU A01349; same locality, April 2011, 1 male (cl 15.2 mm), 1 ovigerous females (cl 15.6 mm), NTOU A01350; same data, 1 ovigerous female (cl 13.4 mm), CBM-ZC 11570; same locality, January 2013, 1 male (cl 12.0 mm), NTOU AO1351.

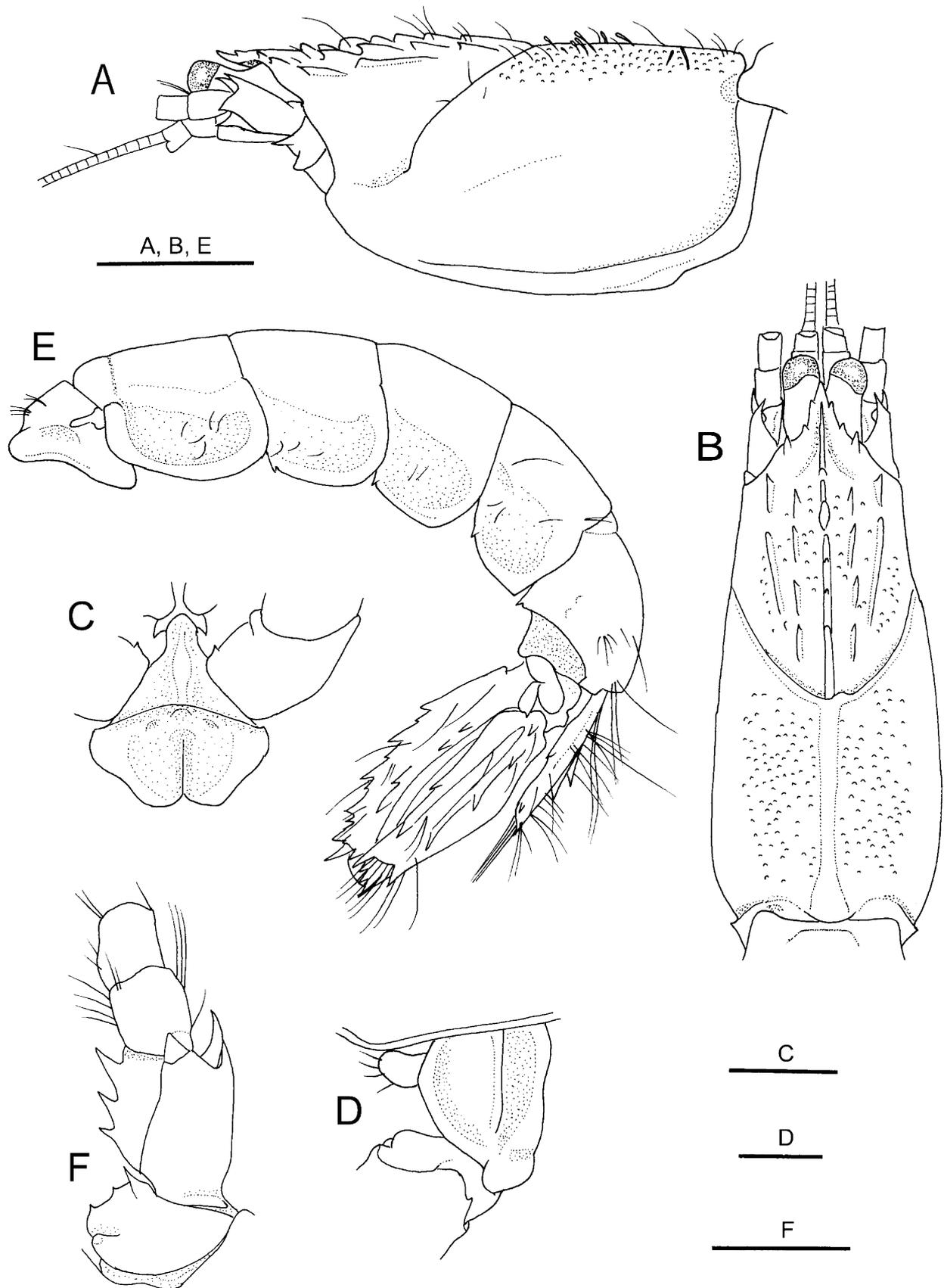
**Redescription.** Body moderately stout. Rostrum (Figs 1A, B; 2A, B) 0.2 times distance between rostral base and cervical groove or 0.1 times as long as carapace, moderately widely triangular with acute tip in dorsal view; lateral margin with 1 or 2 (usually 2) small subacute spines and supraocular spine, not continuous with distinct lateral gastric carina on carapace. Carapace (Figs 1A, B; 2A, B) fairly compressed laterally, sparsely granulate dorsally, nearly smooth or microscopically granulate laterally, with scattered short setae on dorsal surface; dorsal surface nearly straight, gastric region not sloping down to rostrum; gastric median carina distinct, extending beyond rostral base anteriorly and reaching cervical groove, with 6–9 small denticles or tubercles; submedian carinae divided into 4 short divisions, each terminating anteriorly in acute or subacute spine; lateral carinae divided into 2 unequal divisions, each terminating in acute to blunt spine; postcervical carina low, blunt; cervical groove deep, extending to pterygostomial region; suborbital margin broadly convex; pterygostomial margin broadly rounded.

Seventh thoracic sternite with shield (Fig. 1C) divided into two sections by distinct transverse ridge; anterior section triangular, slightly depressed below; posterior section deeply divided by deep median groove, each lateral angle produced in blunt tooth directed ventrally. Precoxal plate on eighth thoracic sternite (Fig. 1D) well calcified, divided into two unequal parts by oblique suture, bearing prominent, basally articulated process at anteroventral angle; posterior division of precoxal plate not expanded into prominent lobe.

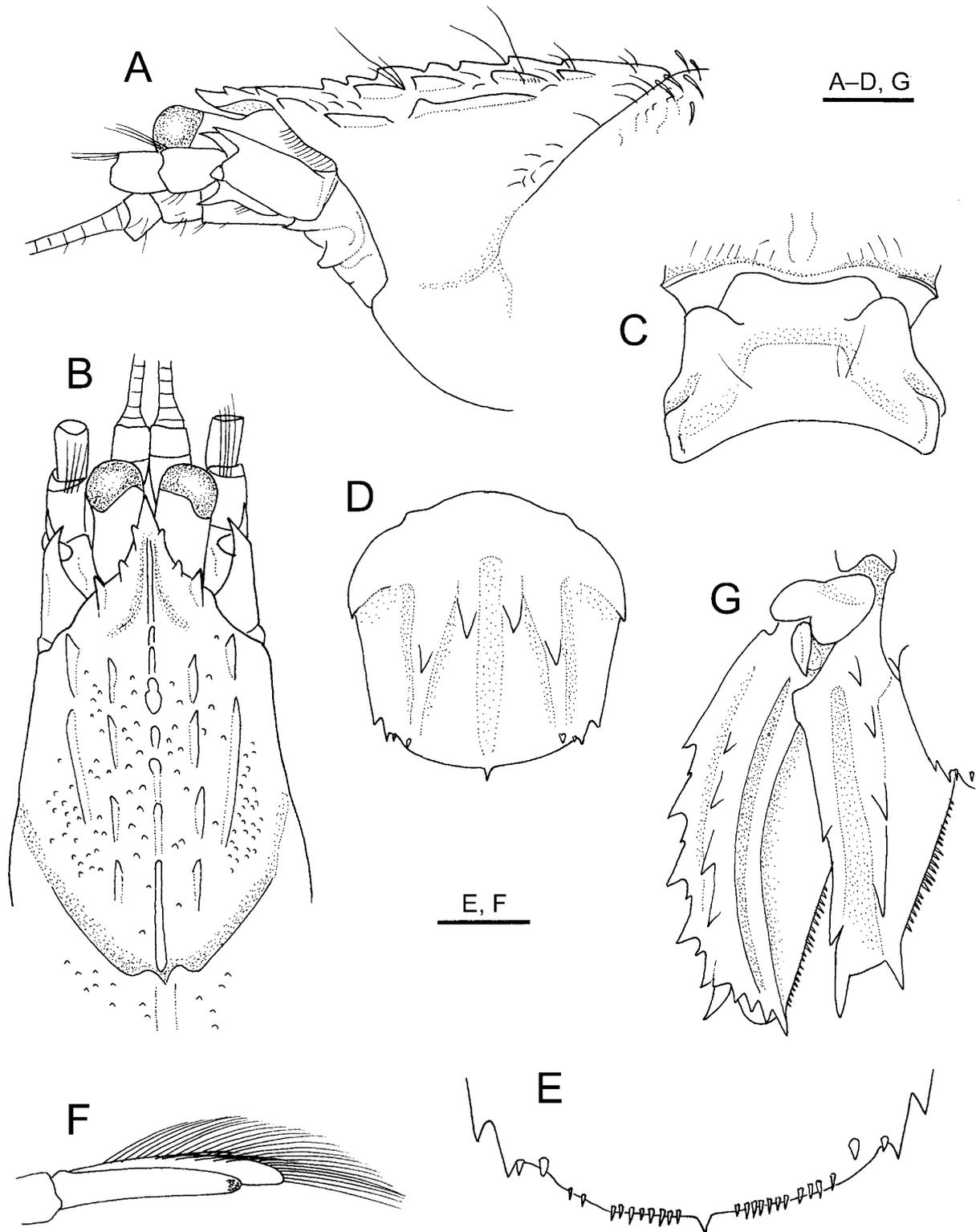
First abdominal somite (Figs 1E; 2C) with tergum bearing subrectangular plateau defined by shallow groove; pleuron triangular with blunt to acute ventral apex, lateral surface with distinct longitudinal carina posteriorly. Second pleuron (Fig. 1E) asymmetrical; lateral surface shallowly depressed; ventral margin unarmed, rounded at either angle. Third to fifth pleura (Fig. 1E) shallowly depressed; third pleuron rounded, unarmed (females) or armed with minute spine at anteroventral angle (male); fourth and fifth pleura (Fig. 1E) each with minute spine at anteroventral angle (male and female holotype) or unarmed (ovigerous female), fourth pleuron bluntly angular, fifth pleuron subacutely (male) or bluntly (female) angular. Sixth pleuron (Fig. 1E) acutely pointed ventrally, with truncate posterolateral projection. Telson (Fig. 2D, E) subrectangular, approximately as long as broad; proximolateral part somewhat thickened, terminating in small marginal spine; lateral margin slightly converging posteriorly, bearing 1 or 2 small spines near posterolateral angle; posterior margin slightly convex, with small posteromedian spine, posterolateral area with 2 subequal, minute movable spines; dorsal face shallowly sulcate medially, submedian ridges each terminating posteriorly in small spine at anterior 0.4, dorsolateral ridges low, obsolete, each with 1 small spine located at about midlength of telson.

Eyestalk (Fig. 2A, B) subcylindrical, exceeding beyond rostral apex by length of cornea; cornea distinctly shorter than eyestalk, slightly inflated, darkly pigmented. Antennular peduncle (Fig. 2A, B) extending as far as antennal peduncle; statocyst lobe on first segment unarmed; flagella more than twice longer than carapace. Antennal peduncle (Figs 1F; 2B) with first segment bearing 1 prominent spine on ventrolateral distal angle and 1 or 2 spinules on ventrodiscal margin; second segment with dorsolateral distal spine curved inward and overreaching distal margin of third segment; scaphocerite acuminate, gently curved, reaching midlength of fourth segment; third segment with 3 spines, increasing in size distally, on ventromesial margin; fourth and fifth segments stout, cylindrical, combined length subequal to second segment; flagellum missing.

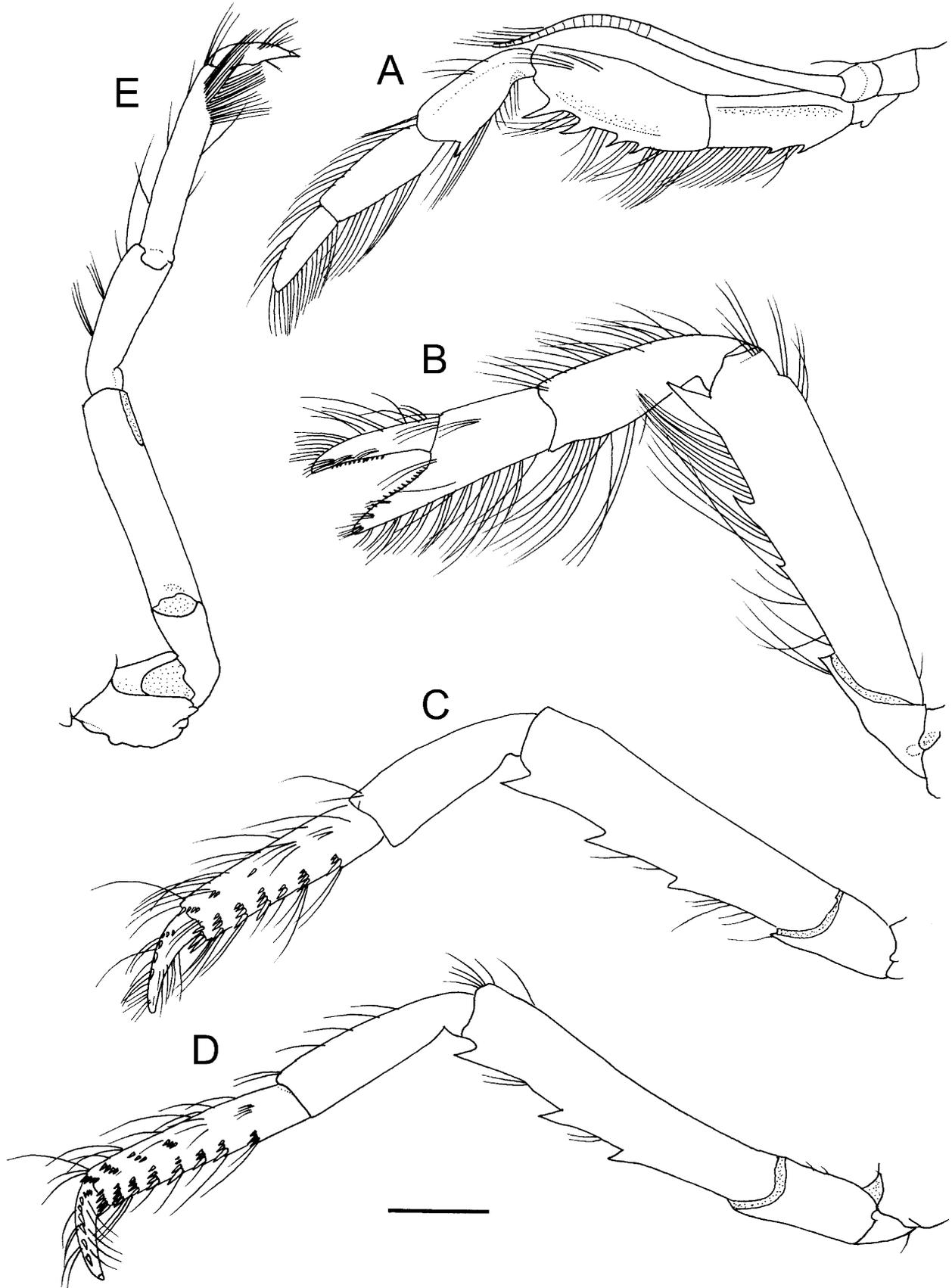
Third maxilliped (Fig. 3A) moderately slender, overreaching antennal peduncle by length of distal two segments. Coxa with ventrodiscal spine. Basis with 1 prominent spine ventrodistally. Ischium with sharp carina on lateral surface dorsally; crista dentata well developed, bearing about 15 slender spines (proximal spines noticeably decreasing in size proximally), distal prolongation curved mesially, reaching proximal 0.2 of merus (Fig. 5A); ventral margin with 2 small spines in proximal half. Merus with 4 ventral spines increasing in size distally. Carpus with 1 small spine at ventrolateral distal angle. Dactylus 0.7 times as long as propodus. Exopod overreaching distal margin of merus.



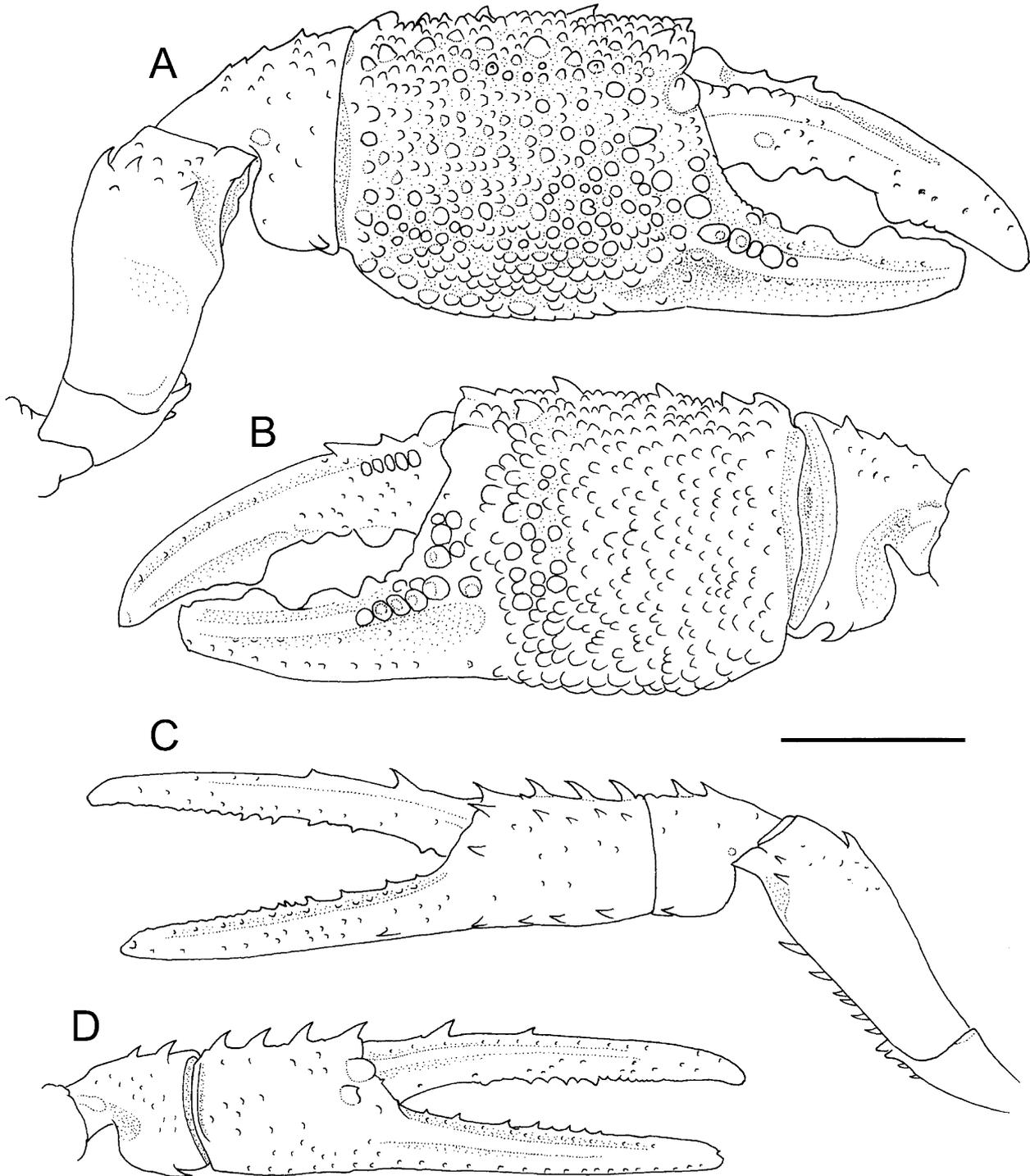
**FIGURE 1.** *Amakusaxius amakusanus* (Miyake & Sakai, 1967), male (cl 15.5 mm), Penghu Islands, NTOU A1349. A, carapace and cephalic appendages, lateral view (setae partially omitted); B, same, dorsal view (setae omitted); C, seventh thoracic sternite, ventral view; D, left precoxal plate on eighth thoracic sternite, lateral view; E, abdomen, telson, and left uropod, lateral view (setae partially omitted); F, left antennal peduncle, ventral view. Scale bars 5 mm for A, B, E; 2 mm for C, F; 1 mm for D.



**FIGURE 2.** *Amakusaxius amakusanus* (Miyake & Sakai, 1967), male (cl 15.5 mm), Penghu Islands, NTOU A1349. A, anterior part of carapace and cephalic appendages, lateral view; B, same, dorsal view (setae omitted); C, first abdominal somite, dorsal view; D, telson, dorsal view (setae omitted); E, detail of posterior margin of telson, dorsal view; F, appendices interna and masculina of left second pleopod, mesial view; G, left uropod, dorsal (perpendicular) view (setae omitted). Scale bars: 2 mm for A–D, G; 1 mm for E; 0.5 mm for F.



**FIGURE 3.** *Amakusaxius amakusana* (Miyake & Sakai, 1967), male (cl 15.5 mm), Penghu Islands, NTOU A1349. A, left third maxilliped, lateral view; B, left second pereopod, lateral view; C, left third pereopod, lateral view; D, left fourth pereopod, lateral view; E, right fifth pereopod, lateral view. Scale bar: 2 mm.



**FIGURE 4.** *Amakusaxius amakusanus* (Miyake & Sakai, 1967), male (cl 15.5 mm), Penghu Islands, NTOU A1349. A, right (major) cheliped, lateral view (setae omitted); B, same, chela and carpus, mesial view (setae omitted); C, left (minor) cheliped, lateral view (setae omitted); D, same, chela and carpus, mesial view (setae omitted). Scale bar: 5 mm.

Chelipeds (Fig. 4A–D) slightly unequal and greatly dissimilar. Major cheliped (Fig. 4A, B) with coxa bearing 2 small spines on mesial margin. Basis with 1 tiny tubercle on ventral margin proximally. Ischium with 3–6 main tubercles on ventral margin becoming stronger and more acute distally. Merus with dorsal margin fairly sinuous, non-carinate, with 1 small subterminal spine; lateral surface with 2 subterminal spines aligned to dorsal spine and some tiny tubercles bearing tuft of stiff setae around subterminal spines, otherwise nearly smooth, with scattered

very short setae, ventrodiscal part forming shallow excavation to receive proximoventral part of carpus, ventrolateral distal angle with spine-like tubercle; mesial face nearly smooth; ventrolateral margin unarmed, ventromesial margin with row of 6 or 7 small spines or tubercles. Carpus much higher than long; dorsal surface with 1 or 2 main spines mesially, followed by some small tubercles; lateral surface with scattered tufts of short stiff setae and some rounded tubercles dorsally, ventrolateral distal angle with small spine; mesial surface with scattered tufts of short setae; ventral surface with 1 small spine mesially. Chela massive, 2.4 times longer than high; ventral margin slightly sinuous; broad hiatus between fingers in proximal half. Palm 1.1–1.2 times longer than high, dorsal surface non-carinate, bearing 4 or 5 small spines or tubercles and scattered small rounded tubercles, these armature partially obscured by tufts of stiff setae arising from distal base of each tubercle; lateral face convex, covered with numerous rounded tubercles of various sizes, each tubercle bearing tuft of stiff setae on distal side (some tubercles adjacent to dorsal margin somewhat enlarged, subconical; 1 subterminal tubercle proximal to base of dactylus larger than others, spine-like); ventral surface forming broad, tuberculate ridge, becoming more clearly delimited distally on fixed finger, tubercles bordering ventral ridge sometimes acute, spine-like; mesial face also with numerous tubercles of various sizes, some tubercles proximal to base of dactylus somewhat enlarged. Fixed finger with tufts of short to long setae on surfaces; blunt but distinct median carina on each lateral and mesial surfaces, extending onto base of dactylus, each carina bearing some prominent tubercles proximally; cutting edge with row of molar-like calcareous teeth. Dactylus slightly curved, 1.1 times longer than palm, tapering distally to blunt calcareous apex, with numerous tufts of short to long stiff setae on lateral and mesial surfaces; dorsal margin with 2 spines in proximal 0.8 and sharply defined keel in distal 0.8; lateral surface with median carina becoming obsolete distally and bearing 4 rounded tubercles proximally; mesial surface also with median carina becoming obsolete distally and bearing 6 rounded tubercles proximally; cutting edge with molar-like calcareous teeth.

Minor cheliped (Fig. 4C, D) much slenderer than major cheliped. Coxa bearing 2 small spines on mesial margin. Basis smooth on ventral margin proximally. Ischium with 5–7 small spines or tubercles on ventral margin increasing in size distally. Merus with dorsal margin gently sinuous, non-carinate, with 2 small spines in distal 0.3; lateral surface with 2 subterminal spines aligned to ultimate spine on dorsal margin, and some setae-bearing tubercles inferior to dorsal subterminal spines, ventrodiscal part forming shallow excavation to receive proximoventral part of carpus, ventrolateral distal angle directed ventrally and terminating in acute spine; mesial face nearly smooth; ventral margin armed with row of 7 small spines increasing in size distally. Carpus higher than long; dorsal surface with 2 prominent spines mesially; lateral surface with scattered tufts of short stiff setae, ventrolateral distal angle with small submarginal spine; mesial surface with scattered tufts of short setae; ventral surface with 1 spine located distal to midlength. Chela elongate, 3.9 times longer than high; ventral margin nearly straight; narrow hiatus between fingers over entire length. Palm slightly becoming higher distally, 1.2 times longer than high, dorsal surface non-carinate, bearing 4 prominent, equidistant spines and short to long setae; lateral face gently convex, with scattered tufts of stiff setae, longitudinal row of 4 spines proximal to base of dactylus and row of 4 prominent, forwardly directed spines adjacent to ventral margin; mesial surface also gently convex, with numerous scattered tufts of short to long setae and 1 small spine proximal to base of dactylus; ventral surface forming broad ridge becoming more distinct on fixed finger. Fixed finger with tufts of short to long setae on surfaces, in particular, those adjacent to cutting edge obscuring armature; cutting edge with row of small teeth becoming obsolescent distally; tip normally acuminate. Dactylus nearly straight, only slightly curved near tip, 2.4–2.5 times longer than palm, with numerous tufts of short to long stiff setae on lateral and mesial surfaces; dorsal margin non-carinate, with 2 or 3 prominent spines in proximal 0.5–0.6; cutting edge with row of small acute teeth in proximal 0.6 and faintly to microscopically denticulate in distal 0.4; tip normally acuminate.

Second pereiopod (Fig. 3B) overreaching antennal peduncle by half length of chela. Coxa unarmed, with shallow concavity on mesial face. Ischium with small ventrodiscal spine. Merus with 3 small spines on ventral margin, increasing in size distally. Carpus 0.9 times as long as chela; ventrodiscal angle somewhat produced. Palm becoming slightly higher distally. Fingers each with row of minute corneous spinules on cutting edge; dactylus about 1.4 times longer than palm.

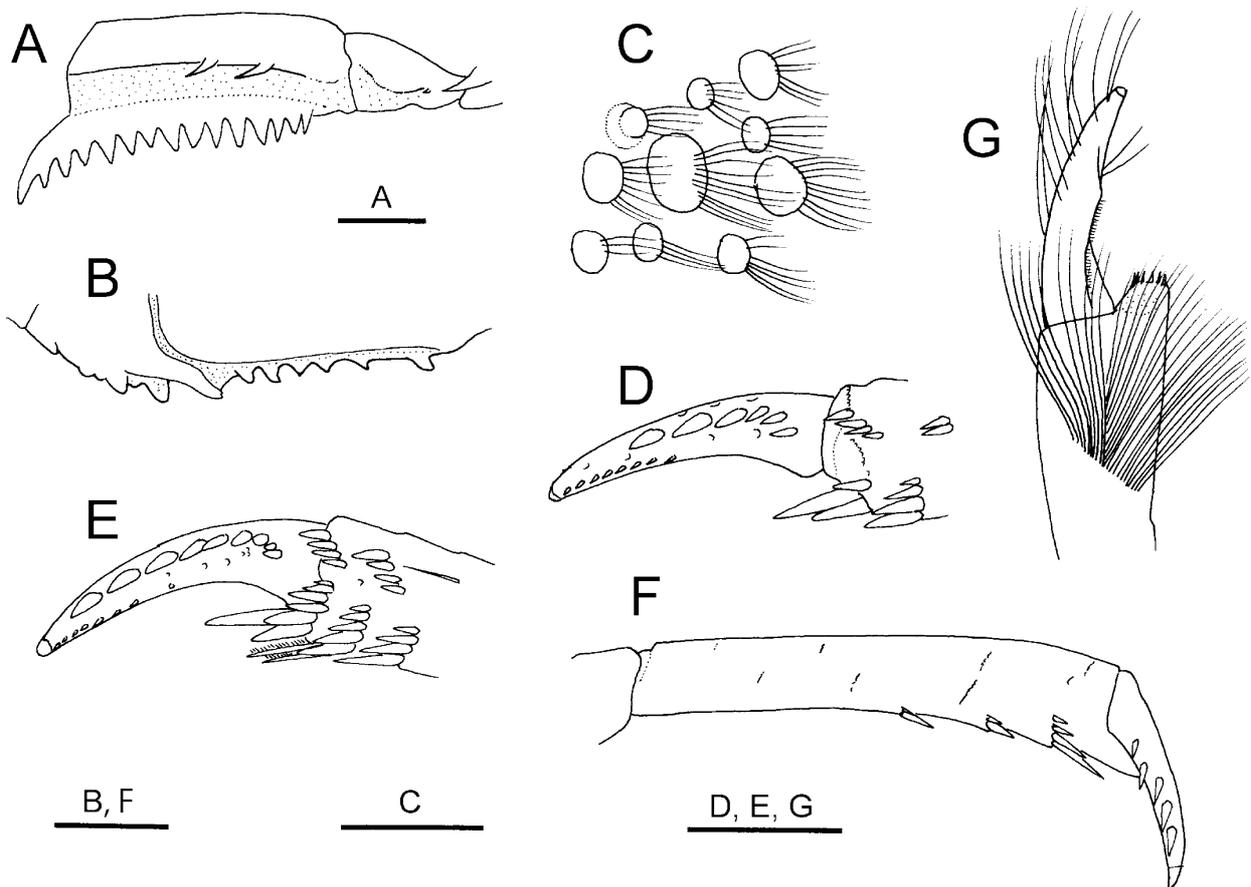
Third pereiopod (Fig. 3C) overreaching antennal peduncle by length of dactylus. Coxa with mesial face slightly concave. Ischium unarmed. Merus with 3 spines on ventral margin, increasing in size distally. Carpus unarmed. Propodus with 6 or 7 transverse sets of corneous spinules on lateral surface ventrally (spines becoming longer ventrally), including one on ventrodiscal margin; lateral surface distally with additional 3 sets of corneous spinules superior to midline. Dactylus (Fig. 5D) half-length of propodus, gently curving, terminating in corneous

claw, with tufts of stiff setae on surfaces; lateral surface with row of 5 or 6 corneous spinules increasing in size distally; mesial surface unarmed; ventral (flexor) margin with row of minute corneous spinules in distal half.

Fourth pereiopod (Fig. 3D) slightly overreaching antennal peduncle by half-length of dactylus. Coxa with minute denticle on mesial surface. Ischium unarmed. Merus with 3 spines on ventral margin, increasing in size distally. Carpus unarmed. Propodus with 7 or 8 transverse sets of corneous spinules on lateral surface ventrally (including that on ventrodistal margin); lateral surface with additional 3 or 4 sets of corneous spinules in distal half; no development of grooming apparatus. Dactylus (Fig. 5E) about 0.4 times as long as propodus, tapering distally to corneous claw, gently curving; lateral surface with row of 7 or 8 corneous spinules increasing in size distally; mesial face unarmed; ventral (flexor) margin with row of minute corneous spinules laterally.

Fifth pereiopod (Figs 3E; 5F) semichelate with distinctly developed ventrodistal process on propodus opposed to dactylus. All segments without conspicuous spines. Propodus with obliquely longitudinal line of grooming setae distally on lateral surface (Fig. 5G); mesial face with 2 or 3 transverse sets of corneous spinules distally, ultimate set located at base of fixed finger; fixed finger rounded, margins bordered by microscopic corneous spinules. Dactylus (Fig. 5G) lanceolate, terminating in corneous claw; outer margin somewhat expanded proximally; flexor surface excavated proximally; inner margin with row of minute corneous spinules. Well developed gonopores present.

Gill formula summarized in Table 1. Podobranchs on third maxilliped to third pereiopod prominent, but devoid of lamellae.



**FIGURE 5.** *Amakusaxius amakusanus* (Miyake & Sakai, 1967), A–E, G, male (cl 15.5 mm), Penghu Islands, NTOU A1349; F, ovigerous female (cl 13.6 mm), same lot. A, ischium of left third maxilliped, ventral view, showing crista dentata; B, ventral margin of ischium and merus of right (major) cheliped (setae omitted), showing armature; C, close up of tubercles on lateral surface of major cheliped, showing setation; D, distal part of propodus and dactylus of left third pereiopod, lateral view (setae omitted); E, distal part of propodus and dactylus of left fourth pereiopod, lateral view (setae omitted); F, propodus and dactylus of left fifth pereiopod, mesial view; G, distal part of propodus and dactylus of right fifth pereiopod, lateral view. Scale bars: 2 mm for B; 1 mm for C–G; 0.5 mm for A.

**TABLE 1.** *Amakusaxius amakusanus* (Miyake & Sakai, 1967). Gill formula.

	Maxillipeds			Pereiopods				
	1	2	3	1	2	3	4	5
Pleurobranchs	0	0	0	0	0	0	0	0
Arthrobranchs	0	2	2	2	2	2	2	0
Podobranchs	0	1	1	1	1	1	0	0
Epipods	1	1	1	1	1	1	1	0
Exopods	1	1	1	0	0	0	0	0

First pleopod absent in males; female first pleopod uniramous, 2-articulated, protopod about 0.3 length of ramus. Second to fifth pleopods moderately narrow, each with well-developed appendix interna. Appendix masculina on second pleopod slightly longer than appendix interna, rod-like, with numerous setae on apex to dorsal margin (Fig. 2F).

Uropod (Fig. 2G) with protopod subtriangular, with deep notch on posterior margin to accommodate proximodorsal knob of exopod. Endopod narrow; lateral margin slightly concave, with distinctly delimited proximal angle; mesial margin gently convex, with peak proximal to midlength, bearing row of minute corneous spinules; lateral carina on dorsal surface distinct, with 2 prominent spines in posterior half and produced posterolaterally in strong spine; middorsal carina also distinctly delimited, with 4 or 5 prominent spines, including posterior marginal one. Exopod exceeding beyond endopod; lateral margin convex, with 5 or 6 prominent spines and sometimes interspersing spinules; mesial margin slightly convex, with row of minute corneous, movable spinules in posterior half; distal suture oblique, bearing 5 spines increasing in size mesially; movable spine just lateral to terminal flap very strong, slightly curved laterally; terminal flap small, subsemicircular; dorsolateral carina with 4 or 5 prominent spines; middorsal carina arcuate, unarmed, terminating posteriorly in spine in series on distal suture; proximodorsal knob terminating in spine.



**FIGURE 6.** *Amakusaxius amakusana* (Miyake & Sakai, 1967), male (cl 12.0 mm), Penghu Islands, NTOU A01351.

**Coloration.** Body generally reddish pink (Fig. 6). Dorsal carapace mostly yellowish. Abdomen with dorsal surface with mosaic of white and reddish pink color, ventral margin of pleura with thick white bands, hinges between somites and spines on tail fan somewhat whitish. Eyes blackish brown. Antennular and antennal flagella pale yellowish. First pereopods with chelae and carpi dorsally orangish and ventrally pale pink to whitish on lateral side and pale yellowish on mesial side, proximal segments reddish pink. Posterior pereopods reddish pink with hinges somewhat pale colored. Eggs orangish.

**Distribution.** Japan and Taiwan; at depths of 20–50 m.

**Remarks.** The holotype female is still in good condition, though the right major cheliped is missing, as Miyake & Sakai (1967) mentioned. Although the six specimens from Taiwan are all larger than the holotype, they agree well with the latter and there is little doubt that they are conspecific.

The gill formula reexamined is different from that of Miyake & Sakai (1967: 307), but the discrepancy is due to the different interpretation of the structure of the epipods and podobranchs on the third maxilliped and pereopods. Miyake & Sakai (1967) counted the numbers of epipods on each third maxilliped to third pereopods as two, but this is an error. The anterior branches on those epipods actually represent podobranchs devoid of gill lamellae (e.g., Poore 1994; Komai 2000).

## Acknowledgements

We sincerely thank Dr. Michitaka Shimomura (Kitakyushu Museum of Natural History and Human History, Kitakyushu, Japan) for sending us on loan the holotype of *Amakusaxius amakusanus*. This work was supported by grants from the National Science Council, Taiwan, R.O.C.

## References

- Boesch, D.F. & Smalley, A.E. (1972) A new axiid (Decapoda, Thalassinidea) from the northern Gulf of Mexico and tropical Atlantic. *Bulletin of Marine Science*, 22, 45–52.
- Kensley, B. (1996a) Systematics and distribution of the genus *Calocarides* (Crustacea: Decapoda: Axiidae). *Proceedings of the Biological Society of Washington*, 109, 53–69.
- Kensley, B. (1996b) New thalassinidean shrimp from the Pacific Ocean (Crustacea: Decapoda: Axiidae and Calocarididae). *Bulletin of Marine Science*, 59, 469–489.
- Kensley, B., & Chan, T.-Y. (1998) Three new species of thalassinidean shrimps (Crustacea, Axiidae and Calocarididae) from Taiwan. *Zoosystema*, 20, 255–264.
- Komai, T. (2000) A new species of the genus *Calaxiopsis* (Decapoda: Thalassinidea: Calocarididae) from Japan. *Journal of Crustacean Biology*, 20 (Special Number 2), 218–229.
- Komai, T., Lin, F.-J. & Chan, T.-Y. (2010) Five new species of Axiidae (Crustacea: Decapoda: Axiidae) from deep-water off Taiwan, with description of a new genus. *Zootaxa*, 2352, 1–28.
- Miyake, S. & Sakai, K. (1967) Two new species of Axiidae (Thalassinidea, Crustacea) from the East China Sea. *Journal of the Faculty of Agriculture, Kyushu University*, 14, 303–309, pl. 4.
- Ngoc-Ho, N. (2005) Thalassinidea (Crustacea, Decapoda) from French Polynesia. *Zoosystema*, 27, 47–83.
- Ngoc-Ho, N. (2006) Three species of *Acanthaxius* Sakai & de Saint Laurent, 1989, including two new to science, from the Solomon Islands and New Caledonia (Crustacea, Thalassinidea, Axiidae). *Zootaxa*, 1240, 57–68.
- Poore G.C.B. (1994) A phylogeny of the families of Thalassinidea (Crustacea: Decapoda) with keys to families and genera. *Memoirs of the Museum of Victoria*, 54, 79–120.
- Poore, G.C.B. & Collins, D.J. (2009) Australian Axiidae. *Memoirs of Museum Victoria*, 66, 221–287.
- Rathbun, M.J. (1902) Descriptions of new decapod crustaceans from the west coast of North America. *Proceedings of the United States National Museum*, 24, 885–905.  
<http://dx.doi.org/10.5479/si.00963801.1272.885>
- Rathbun, M.J. (1906) The Brachyura and Macrura of the Hawaiian islands. *Bulletin of the Bureau of Fisheries*, 23, 827–930, pls 1–24.
- Sakai, K. (1987) Two new Thalassinidea (Crustacea: Decapoda) from Japan, with the biogeographical distribution of the Japanese Thalassinidea. *Bulletin of Marine Science*, 41, 296–308.
- Sakai, K. (1994) Eleven species of Australian Axiidae (Crustacea: Decapoda: Thalassinidea) with descriptions of one new genus and five new species. *The Beagle, Occasional Papers of the Northern Territory Museum of Arts and Sciences*, 11, 175–202.

- Sakai, K. (1995) A new record of the axiid, *Ambiaxius alcocki* (McArdle, 1900) (Crustacea, Anomura, Thalassinidea) from Suruga Bay, Japan. *Bulletin of the National Science Museum, Series A (Zoology)*, 21, 79–86.
- Sakai, K. (2011) Axioidae of the world and a reconsideration of the Callianassoidea (Decapoda, Thalassinidea, Callianassida). *Crustaceana Monographs*, 13, i–x, 1–616.
- Sakai, K. & de Saint Laurent, M. (1989) A check list of Axiidae (Decapoda, Crustacea, Thalassinidea, Anomura), with remarks and in addition descriptions of one new subfamily, eleven new genera and two new species. *Naturalists, Publications of Tokushima Biological Laboratory, Shikoku University*, 3, 1–104.
- Sakai, K. & Ohta, S. (2005) Some thalassinid collections by R/V "Hakuhou-Maru" and R/V "Tansei-Maru", University of Tokyo, in the Sulu Sea, Philippines, and in Sagami Bay and Suruga Bay, Japan, including two new species, one new genus, and one new family (Decapoda, Thalassinidea). *Crustaceana*, 78, 67–93.  
<http://dx.doi.org/10.1163/1568540054024619>
- Squires, H.J. (1979) *Axiopsis caespitosa* (Thalassinidea, Axiidae), a new species from the Pacific coast of Colombia. *Canadian Journal of Zoology*, 57, 1584–1591.  
<http://dx.doi.org/10.1139/z79-207>
- Yokoya, Y. (1933) On the distribution of decapod Crustacea inhabiting the continental shelf around Japan, chiefly based upon the materials collected by S.S. "Soyo Maru" during the years 1923–1930. *Journal of the College of Agriculture, Tokyo Imperial University*, 12, 1–236.