

## Axioid shrimps from Guam (Crustacea, Decapoda, Thalassinidea)

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**Abstract**—Eleven species of axioid shrimps are recorded from the shallow waters of Guam. Of these, only *Marianaxius kroppi*, *Neaxius acanthus*, and *Paraxiopsis bisquamosa* were previously known from the Marianas Islands. Four species are described as new: *Axiopsis pica* (apparently closely related to the widely distributed *A. serratifrons*), and *Paraxiopsis paulayi* and *P. plumosimanus*. *Paraxiopsis majuro* from the Marshall Islands is also described. The second record for *Bowvieraxius springeri*, originally described from the Philippines, and the second record of *Marianaxius kroppi*, described from Guam, are noted. A new genus, *Manaxius*, is diagnosed for *Axiopsis pitatucensis* De Man, 1925, as this species does not agree with the diagnoses of either *Axiopsis* or *Songiarius*, nor with any other axiid genus.

### Introduction

Axioid shrimps are, almost by definition, cryptic animals and difficult to collect. As a result, many species have been described on a single, or on very few specimens. In spite of the risk inherent in this taxonomic practice, however, it is important to reveal the diversity and widespread distribution of this group of shrimps, as a characteristic component of coral reefs and associated areas. These shrimps are one of the groups that would be impacted by a widespread demise of coral reefs. As for many such groups, it is unclear how dependant they are on live coral colonies, and whether it is merely the structural complexity of reefs that affords habitat for them.

The axioid fauna of Guam is poorly known, with few published records. Kensley (1996b) described *Marianaxius kroppi* from Guam. Two species have been recorded from nearby Saipan: *Neaxius acanthus* and *Paraxiopsis bisquamosa*. With material of eleven species now available, this paper aims to document the known axioid fauna of the region.

### Materials and Methods

A collection of axioid shrimps has been deposited in the collections of the National Museum of Natural History, Smithsonian Institution (USNM). A few duplicates have been deposited in the Florida Museum of Natural History,

University of Florida (UF), Gainesville, Florida, and in the collection of the University of Guam Invertebrate Collection (UGI). This material was collected during a program of the University of Guam, especially by Dr. Gustav Paulay, documenting the marine biodiversity of the region, and sent to the Smithsonian for identification and deposition. During the mid-1980's, collections made in the course of other crustacean studies by Dr. Roy Kropp, now of Batelle Memorial Institute, were also deposited at the Smithsonian. Color photographs were taken during the course of this collecting, which have provided valuable clues in the separation of closely-related species. This paper summarises the axioids now known from Guam, and describes four new species (including a species of *Paraxiopsis* from the Marshall Islands).

## Results

With 11 axiid and strahlaxiid species in eight genera known from Guam, it is clear that this area of the tropical Pacific is well endowed with these cryptic animals, as are most areas that have been well investigated, and that intensive collecting will no doubt reveal more species. While several widespread genera predictably are present (e.g. *Axiopsis*, *Paraxiopsis*, *Neaxius*), the occurrence of the endemic genus *Marianaxius*) suggests that the endemism typical of isolated islands is also a factor in the overall crustacean diversity of Guam.

Axioid shrimps recorded from Guam:

*Allaxius clypeatus* (De Man, 1887)

*Allaxius picteti* (Zehntner, 1894)

*Axiopsis pica* sp. nov.

*Axiopsis serratifrons* (A. Milne Edwards, 1873)

*Bouvieraxius springeri* Kensley, 1996a

*Manaxius pitatucensis* (De Man, 1925a)

*Marianaxius kroppi* Kensley, 1996a

*Neaxius acanthus* (A. Milne Edwards, 1879)

*Parascytoleptus tridens* (Rathbun, 1906)

*Paraxiopsis paulayi* sp. nov.

*Paraxiopsis plumosimanus* sp. nov.

## Systematic Account

Family Axiidae Huxley, 1879

*Allaxius clypeatus* (De Man, 1887)

*Axius clypeatus* De Man, 1887: 470, pl. 20 fig. 2.

*Allaxius clypeatus*: Sakai & de Saint Laurent, 1989: 75.

**Material examined:** USNM 243494, 1 ♀ cl 3.0 mm, Agana Bay, Guam, on reef front, 12 m, coll. R. K. Kropp, 30 May 1986.

**Previous records:** Ambon, Indonesia; Fiji.

*Allaxius picteti* (Zehntner, 1894)

Plate 5, 6

*Paraxius picteti* Zehntner, 1894: 196, pl. 9 fig. 25a-e.*Allaxius picteti*: Sakai & de Saint Laurent, 1989: 75.

**Material examined:** USNM 243502, 2 ♂ cl 3.0 mm, 4.4 mm, 1 ovigerous ♀ cl 4.2 mm, Shark's Hole, Guam, hole in reef flat, 2 m, coll. R. K. Kropp, 19 Feb 1984. USNM 243503, 1 ♂ cl 5.2 mm, Alupat Island, Agana Bay, Guam, in dead coral, 8 m, coll. R. K. Kropp, 11 Sep 1984. USNM 243504, 1 ♂ cl 5.0 mm, 2 ovigerous ♀ cl 5.1 mm, 5.2 mm, Anae Island, Guam, 1 m, coll. R. K. Kropp, 4 Sep 1984. UGI, 2 ovigerous ♀ cl 3.8 mm, 4.3 mm, south Orote, Guam, in *Montipora* coral, 5 m, coll. G. Paulay, 16 Feb 2000.

**Previous records:** Malaysia; Kabaena Island, Amboina, Indonesia; Bikini Atoll; Marshall Islands; Fiji; Papua New Guinea.

**Remarks:** Dr. G. Paulay (pers. comm., 15 Dec 2000) notes that this species is abundant in *Montipora* coral colonies in depths of 2-20 m. There are typically several shrimps per coral colony, each at an irregular burrow or tunnel opening. The whitish antennae (plate 5) are conspicuous in the burrows, aiding in capture of the animals.

*Axiopsis pica* sp. nov.

Fig. 1, 2, Plate 1

**Material examined:** Holotype, USNM 296400, ♂ cl 13.5 mm, Anae Island, Guam, under rock, shore side reef flat, 1 m, coll. J. Starmer, 13 Mar 1999. Paratype, USNM 243376, ♀ cl 12.0 mm, ovig. ♀ cl 15.9 mm, Luminao, outer reef flat, Guam, 1 m, coll. R. Kropp, 8 Jun 1986. Paratype, USNM 243377, ovig. ♀ cl 13.0 mm, Pugua Patch Reef (Double Reef), between shore and patch reef, Guam, 15 m, coll. V. Tyndzik, 24 Feb 1984. Paratypes, USNM 243369, ♂ cl 11.7 mm, ovig. ♀ cl 13.0 mm, Piti Bay, outer reef flat near mouth of Tepungan Channel, in sand under rock, Guam, 2.5 m, coll. RF. Kropp, 25 May 1986. USNM 296401, ovig. ♀ cl 8.0 mm, Apra Harbor, rubble at glass breakwater entrance, Guam, 12 m, coll. J. Starmer, 6 Aug 1998. USNM 291365, ♀ 13.0 mm, Amo Atoll, Marshall Islands, coll. R. W. Hiatt, 1950. UGI, ♂ cl 9.6 mm, Tepungan Channel, Guam, 2 m, coll. L. Kirkendale, 4 Nov 1998. UF, 1 ovigerous ♀ cl 12.6 mm, Agat, north of Alutom Is. fore reef, Guam, among rocks, 3-5 m, coll. H. T. Conley, 17 Aug 2000. UF, 2 ovigerous ♀ cl 10.7 mm, 13.8 mm, Agat Bay, north of Alutom Island, 2.5-6 m, among silty rocks, coll. H. T. Conley, 20 Nov 2000. UF, 2 ♂ cl 9.4 mm, 10.0 mm, 5 ovigerous ♀ cl 11.5 mm, 13.2 mm, 13.3 mm, 14.0 mm, 14.0 mm, 1 ♀ cl 12.9 mm, Agat Bay, north of Alutom Island, 2.5 - 6 m, among rocks, coll. H. T. Conley, 29 Nov - 17 Dec 2000.



Figure 1. *Axiopsis pica* sp. nov., holotype in lateral view. Scale = 5 mm.

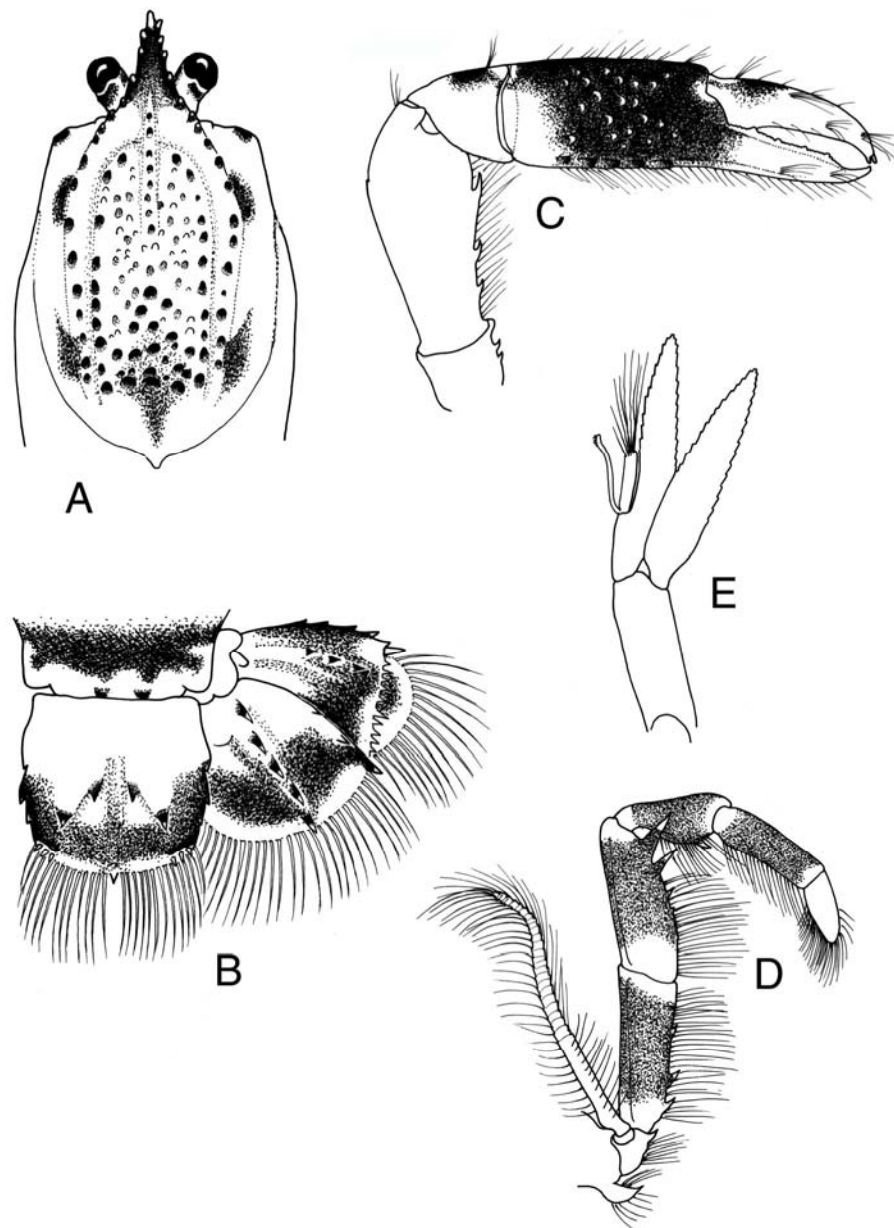


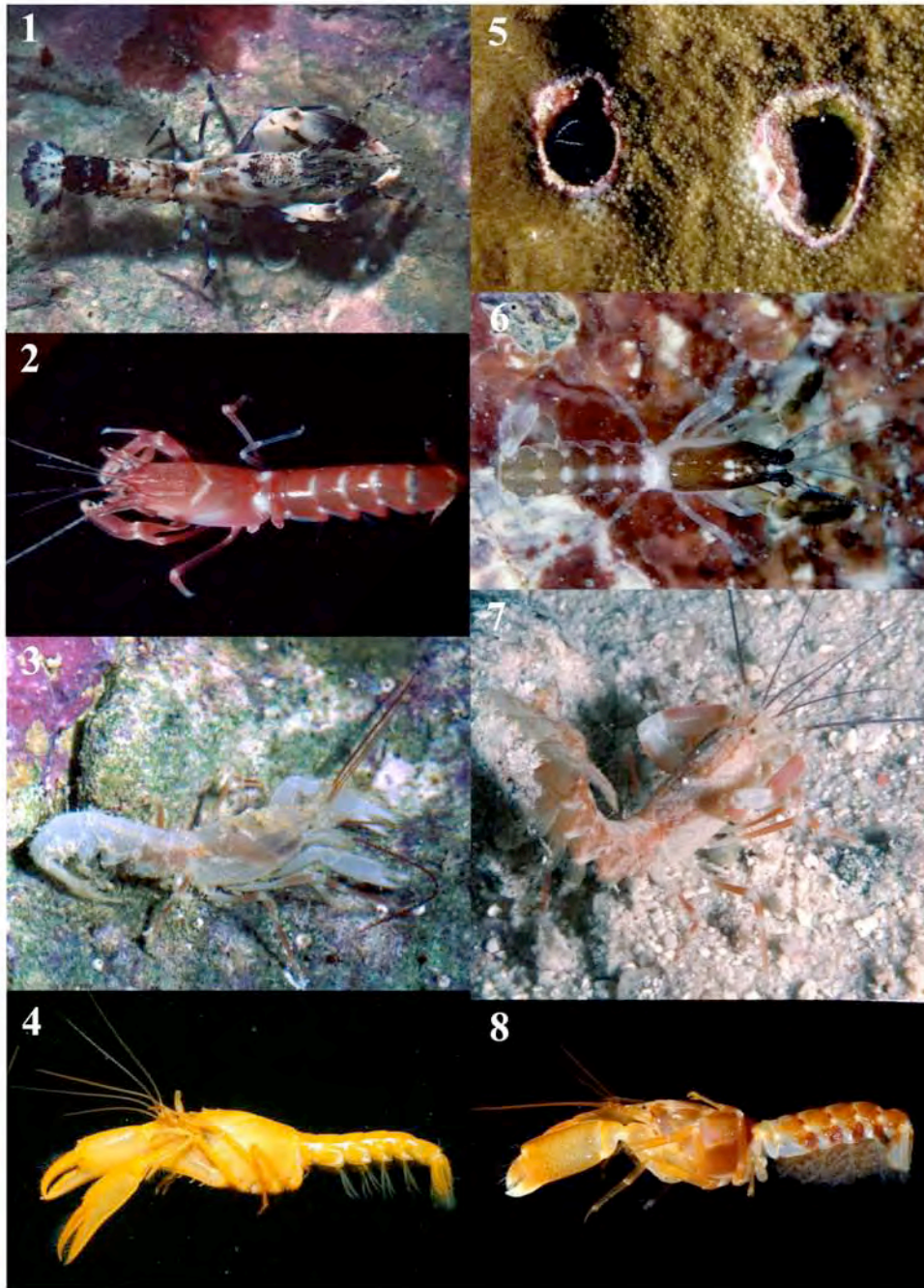
Figure 2. *Axiopsis pica* sp. nov.: A, anterior carapace in dorsal view; B, telson and right uropod in dorsal view; C, pereopod 1 smaller cheliped; D, maxilliped 3; E, male pleopod 2.

**Diagnosis:** Male: Carapace with rostrum reaching anteriorly to second antennular peduncle article, bearing 4 or 5 pairs of small marginal teeth,

produced posteriorly into poorly-defined lateral carina bearing about 12 rounded tubercles; submedian carina poorly defined, bearing about 11 rounded tubercles; median carina bearing 8 small tubercles anteriorly; numerous rounded tubercles between submedian and median carinae. Cervical groove strong and clearly defined dorsally; branchiostegal groove shallow, poorly defined. Surface of carapace especially posterodorsally and branchiostegite faintly pitted, with very short stiff scattered setules. Pleuron of pleonite 1 ventrally narrowed, rounded; pleuron 2 broad, anteriorly and posteriorly rounded; pleura 3-5 each having small tooth on anterior margin; pleuron 6 with small ventral tooth. Telson basal width slightly greater than midlength, having 3 lateral margin teeth, 3 small mobile spines at posterolateral angle, small median tooth on posterior margin, 2 pairs teeth on dorsal surface.

Antennular peduncle with 2 distal articles together shorter than basal article. Antennal acicle strong, reaching to distal margin of peduncle article 4. Maxilliped 3 with strong mesial spinose process; basis with mesiodistal spinose process; ischium with 3 teeth on mesial margin, dentate process with 19 teeth increasing in length distally; merus with 5 teeth on mesial margin, 2 proximal ones small; carpus with small distomesial tooth; dactylus slightly more than half length of propodus; all articles bearing dense mesial setae. Pereopod 1, larger cheliped, ischium with 3 small teeth on ventral margin; merus with 3 teeth on mesioventral margin, lateroventral margin having a row of about 10 small rounded tubercles, dorsal margin usually lacking tooth, occasionally with single tooth; carpus unarmed; propodus with palm 1.5 times longer than wide, with 6 flattened tubercles along ventral margin, lateral and mesial surface bearing numerous flattened tubercles, dorsal margin unarmed; fixed finger with 2 cusps on cutting edge; dactylus with single triangular cusp basally on cutting edge. Pereopod 1, smaller cheliped, merus, ischium and carpus as in larger cheliped, merus with small denticle on dorsal margin; propodal palm about twice longer than wide, with 5 rounded tubercles on ventral margin, with flattened tubercles on lateral and mesial surfaces, upper margin unarmed; fixed finger with 4 cusps plus several tiny rounded denticles on cutting edge; dactylus with low triangular cusp basally. Pereopod 2, merus with 3 teeth on ventral margin. Pereopods 3 and 4 similar, propodus with several rows of short corneous setae on lateral surface; dactylus with row of small corneous setae on lateral surface. Pereopod 5 shorter than preceding legs, twisted anteriorly, with rows of corneous setae on lateral surface of propodus and dactylus. Pleopod 1 lacking; pleopod 2 appendix masculina shorter than slender appendix interna, with numerous terminal slender setae. Uropodal lateral ramus with 5 lateral teeth on margin, slender mobile seta at suture, about 10 teeth along suture, 3 teeth on dorsal surface; mesial ramus with 3 teeth on lateral margin, dorsal ridge bearing 5 strong teeth.

Color pattern: Dense blue-black patches of pigment on rostrum, eyestalks, antennal peduncle and acicle, with lighter patches on posterior branchiostegite. Pleonite 1 dorsally solid black; pleonites 2-4 with middorsal and posterolateral black patches; pleuron of pleonite 2 with anterior and posterior marginal black



Plates 1-8. 1. *Axiopsis pica*, Guam, holotype, USNM 296400; 2. *Axiopsis serratifrons*, Guam, USNM; 3. *Paraxiopsis paulayi*, Guam, paratype, USNM 296397; 4. *Bouvieraxius springeri*, Guam, USNM 296399; 5. *Allaxius picteti* burrows in *Montipora*, note antennae visible in left burrow, Guam; 6. *Allaxius picteti*, Guam; 7. *Paraxiopsis majuro*, Majuro, holotype, USNM 243603; 8. *Axiopsis serratifrons*, Guam. (Photos: G. Paulay)

patch, pleura 3 and 4 each with posterior marginal black patch; pleonites 5 and 6 almost completely black; telson with black band across posterior half. Antennal and antennular flagella having distinctive bands of pigment separated by equal-spaced white segments. Maxilliped 3 with propodus, carpus, merus, and ischium with broad blue-black band of pigment. Pereopod 1, larger cheliped with white fingers, most of palm, except for posteroventral part, densely blue-black; small black patch on dorsal margin of carpus; smaller cheliped similar to larger. Pereopods 2-5 having broad blue-black bands on propodus carpus, and merus, with small dorsal patch on ischium. Uropods with both rami having band of blue-black pigment across distal half of rami.

**Remarks:** Kensley (1981) examined the morphological variation of *Axiopsis serratifrons* from a range of localities in the Atlantic, Indian, and Pacific oceans, and summarised the distribution of the species. He concluded that there was no basis for suggesting that more than one species was involved in this circum-tropical distribution, even though there were disparities in size of ovigerous females, and in color patterns.

With 27 specimens of *Axiopsis* now available from Guam, along with color photographs of some of these, a striking difference in the color pattern between two forms was noticed. Seven specimens were typical of *A. serratifrons*, with slender first pereopod chelipeds, and a solid red-brown pigmentation on carapace, abdomen, and pereopods, with only the tips of the chelae of pereopod 1 being white. These specimens agree well with a specimen (USNM 280222) from Hawaii (the type locality), which shows the remnants of a similar color pattern, and possesses slender pereopod 1 chelipeds. They also agree with the color pattern of Atlantic Ocean specimens, although some specimens from Belize have an almost brown-black pigmentation.

Twenty specimens, including one with a well preserved color pattern confirmed by a color photograph, differed in having a broader and more robust larger cheliped of pereopod 1 bearing flattened scale-like tubercles, and a different color pattern (Table 1). Thirteen of the 20 specimens lacked a tooth on the upper margin of the merus of pereopod 1, four had a single dorsal tooth. These 20 specimens also seemed to have more short setules scattered on the carapace and abdomen, than in typical *A. serratifrons*. A specimen from the Marshall Islands, which agrees with this form, had an even more noticeably setulose carapace. Kensley (1981) showed that *A. serratifrons* is a somewhat variable species with respect to pereopodal armature and proportions; nevertheless it is felt that with 20 specimens showing a consistently similar broad major chela of pereopod 1, along with the distinctive flattened tubercles and a strikingly different color pattern, there is sufficient evidence to suggest that a second species is involved here. Knowlton (1986), in a discussion of color patterns in decapod crustaceans, noted that in several groups, while shade and intensity of color may vary, the actual pattern of pigmentation is consistent and can be used to separate morphologically very similar species. A new species of *Axiopsis* is thus described to accommodate these 20 specimens.



**Etymology:** The specific name is the Latin for a magpie, and refers to the black and white color pattern of the shrimp.

Table 1. Comparison of pereopod 1 major cheliped in *Axiopsis pica* and *Axiopsis serratifrons*.

Species	Tooth on upper margin of merus	Flattened scales on lower margin of palm	Ratio of length/width of propodal palm
<i>A. pica</i>	Absent (N=15)/present (N=2)*	Scales present to base of fixed finger	1.53 (1.49-1.57; N=2)
<i>A. serratifrons</i>	Present (N=9)	Scales absent	1.59 (1.39-1.72; N=13) 2.00 (1.75-2.42; N=8) 1.60 (N=1)

\* Two specimens having the *A. pica* pigment pattern had subsimilar chelipeds of pereopod 1, a condition resulting from the loss and regrowth of the major cheliped.

*Axiopsis serratifrons* (A. Milne Edwards, 1873)

Plate 2, 8

*Axia serratifrons* A. Milne Edwards, 1873: 11, pl. 2 fig. 6.

*Axiopsis serratifrons*: Kensley, 1981: 1253, fig. 1-5.

**Material examined:** USNM 243362, 1 ♂ cl 8.1 mm, Gab-Gab Beach, Apra Harbor, Guam, 6.1 m, coll. R. F. Bolland, 10 Dec 1983. USNM 243370, 1 ♂ cl 12.2 mm, Piti Bay, Guam, edge of channel, 1 m, coll. R. K. Kropp & B. D. Smith, 18 May 1986. USNM 243371, 1 ♂ cl 18.1 mm, Piti Bay, Guam, under rock, inner bay near Tepungan Channel, coll. 29 Dec 1969. USNM 243372, 1 ♂ cl 11.2 mm, Piti Bay, Guam, Cabras Island reef flat, 1 m, coll. R. K. Kropp, 14 Aug 1984. USNM, 1 ♂ cl 17.0 mm, Piti reef flat, Guam, under rock on sand, 1.5 m, coll. G. Paulay, Nov 1994. USNM, 1 juvenile cl 8.3 mm, inshore of Double Reef, Guam, fore-reef rubble field, under rock, 3-5 m, coll. J. Starmer, 4 Mar 1997. UF, 1 ♂ cl 10.5 mm, South Orote, under rocks on reef flat in bay west of Neye Island, 0 - 2 m, coll. L. Kirkendale & G. Paulay, 13 Mar 2000.

**Previous records:** *Pacific Ocean*: Pacific Mexico; Hawaii; Palmyra Island; Fanning Island; Gilbert Islands; Caroline Islands; Bikini Atoll; Samoa; Palau; Noordwachter Island; Ambon Island; Obi Island; Damar Island; Lucipara Island; Kur Island; Roti Island; Papua New Guinea. *Indian Ocean*: Maldive Islands; Aldabra Atoll; Chagos Archipelago; Obock, Red Sea; Zululand, South Africa. *Atlantic Ocean*: Belize; Colombia; Florida, USA; Bermuda; Ascension Island.

*Bouvieraxius springeri* Kensley, 1996

Plate 4

*Bouvieraxius springeri* Kensley, 1996a: 472, figs. 2, 3.

**Material examined:** USNM 296398, 1 hermaphrodite cl 14.9 mm, Apra Harbor Glass breakwater, Guam, 5-9 m, coll. H. T. Conley, 21 Jun 1998. USNM

296399, 1 hermaphrodite cl 13.8 mm, Piti Reef margin, Guam, in rubble pile, 1.5-2.5 m, coll. H. T. Conley, Sep 1998.– USNM 252832, 1 hermaphrodite cl 6.0 mm, Agat Bay, north of Aluton Island, among forereef rocks, 3-5 m, coll. H. T. Conley, 14-17 Aug 2000. UF, 1 hermaphrodite 13.8 mm, Agat Bay, north of Aluton Island, 2.5-6 m, among rocks, coll. H. T. Conley, 29 Nov - 17 Dec 2000.

**Previous record:** Sulu Sea, 0-14 m.

**Remarks:** *Bouvieraxius springeri* was described on the basis of a single specimen displaying both male and female genital orifices, and having a very strong appendix masculina on pleopod 2. Of the present material, (the second record of the species), the Apra Harbor specimen also has both sets of orifices and a strong appendix masculina. The Piti Reef specimen, by contrast, although having both sets of orifices, lacks both appendix masculina and appendix interna, while pleopod 1 is weaker and less sclerotized than in the 'male' specimens. The foregoing suggests that *B. springeri* is indeed a functionally hermaphroditic species, but whether protandrous or protogynous, it is not yet possible to establish.

*Manaxius* gen. nov.

**Diagnosis:** Rostrum level with carapace, reaching well beyond eye; median carina ending anterior to cervical groove, armed with about 6 teeth starting at level of orbital margin; submedian carina bearing about 8 small teeth; area between median and submedian carinae bearing tiny tubercles; lateral carina extending onto rostrum, with 3 rostral and 1 or 2 carapace teeth; more dorsal areas of carapace with scattered short setae. Abdominal pleuron 1 ventrally narrowed, apically acute; pleura 2-5 ventrally angular, with small denticle on anterior margin.

Telson longer than wide, lacking medial spine on posterior margin; with 2 pairs of spines on dorsal surface, 3 spines on lateral margin, with submarginal articulated spine adjacent to anteriormost lateral spine, 2 articulated spines at posterolateral angle. Eyes fully pigmented, rounded; eyestalk slightly more than half length of rostrum.

Antennal acicle short, not reaching distal margin of peduncle article 4, curved distally. Maxilliped 3 exopod not clearly bent. Pereopod 1, chelae unequal, fixed finger shorter than palm in length; both fixed finger and dactylus with strong rounded basal tubercle on cutting edge; upper surfaces of dactylus, propodal palm, carpus, and distal merus strongly setose; strong spine at upper distal end of palm and at base of dactylus on lateral face of palm; merus with 3 spines on upper margin, 4 on lower margin. Pereopodal epipods present; pleurobranchs present above pereopods 2-4. Pleopod 1 in male absent; appendix interna present on remaining pleopods. Uropodal lateral ramus with distinct distal transverse suture bearing about 6 or 7 teeth.

**Type species:** By present designation, *Axiopsis (Axiopsis) pitatucensis* De Man, 1925b.

**Remarks:** Although Sakai & De Saint Laurent (1989) placed *A. pitatucensis* in the genus *Spongiaxius*, even a cursory examination shows that it differs from the type species, *Spongiaxius brucei* (Sakai, 1986) primarily in lacking the characteristic spathulate pleopod 1 in the male; neither does the species live in sponges. Other differences include the somewhat reduced and poorly pigmented eye in *S. brucei*, the presence of pleurobranchs above pereopods 2-4 (absent in *S. brucei*), the well developed uropodal suture (reduced in *S. brucei*), the short poorly-dentate rostrum (prominent and multidentate in *S. brucei*). It is difficult to arrive at a genus for this species using Poore's (1994) key, especially given the ambiguity of some of the couplets relating to *Spongiaxius*.

The strong setation on the upper surfaces of the chelae of pereopod 1, the strong spine on the lateral palmar surface at the base of the dactylus, and the articulated submarginal spine at the first lateral spine of the telson are the features that distinguish this genus from all other axiid genera described.

**Etymology:** The genus is named for Johannes Govertus de Man (1850-1930), Dutch carcinologist *non pareil*.

*Manaxius pitatucensis* (De Man, 1925)

Fig. 3, 4

*Axiopsis* (*Axiopsis*) *pitatucensis* De Man, 1925a: 133, fig. 5a-f; 1925b: 6, 67, 69.

*Spongiaxius pitatucensis*: Sakai & de Saint Laurent, 1989: 44.

**Material examined:** USNM 243378, 1 ♂ cl 3.0 mm, 1 ♀ cl 2.9 mm, Agana Bay, Guam, in rubble on reef flat, 10 m, coll. J. H. Dominguez, 23 Oct 1984. USNM 243380, 1 juvenile cl 2.4 mm, Agana Bay, Guam, in dead coral on reef flat, 14 m, coll. R. K. Kropp, 25 Apr 1984. USNM 243381, 1 ♂ 2.9 mm, Cabras Island, Guam, dead coral in Piti Channel, 12 m, coll. J. H. Dominguez & R. K. Kropp, 31 May 1984. USNM 243379, 1 ♂ cl 5.5 mm, Okinawa Island, Japan, 70.1 m, coll. R. Bolland, 11 Jun 1981.

**Previous records:** Buka Island, Indonesia.

*Marianaxius kroppi* Kensley, 1996

*Marianaxius kroppi* Kensley, 1996a:484, fig. 9-10.

**Material examined:** Holotype, USNM 243530, 1 ♂ cl 5.1 mm, Piti Bay, Guam, outer reef flat rubble, 1.5 m, coll. R. K. Kropp, 11 Jun 1986. Paratype, USNM 243531, 1 ♀ cl 4.7 mm, Piti Bay, Guam, outer reef flat, 1 m, coll. R. K. Kropp, 18 May 1986. USNM 252856, 1 ♀ cl 4.6 mm, Agat Bay, north of Alutom Island, Guam, among rocks, 2.5 - 6 m, coll. H.T.Conley, 29 Nov - 12 Dec 2000.

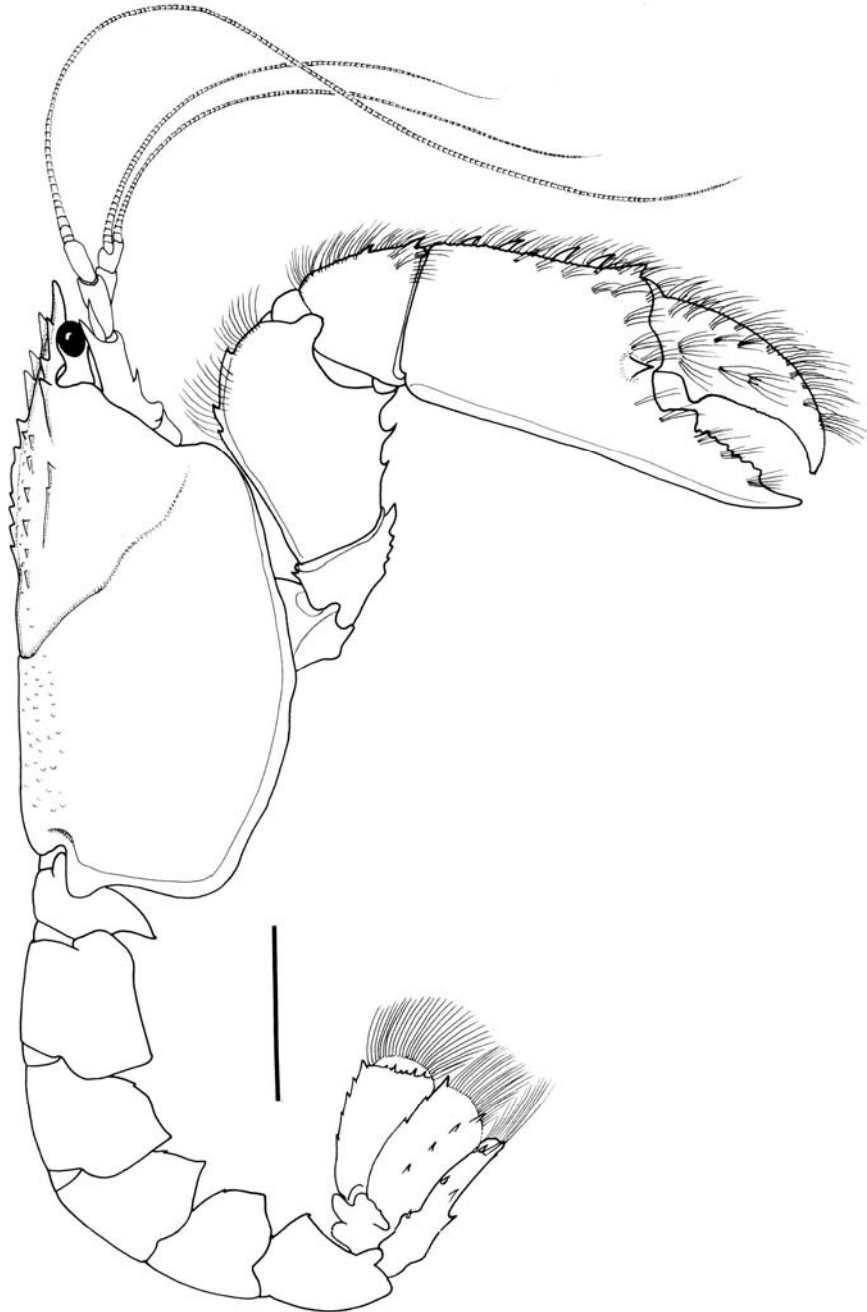


Figure 3. *Manaxius pitatucensis* (De Man, 1905), USNM 243379, male, Okinawa, Japan. Scale = 2 mm.

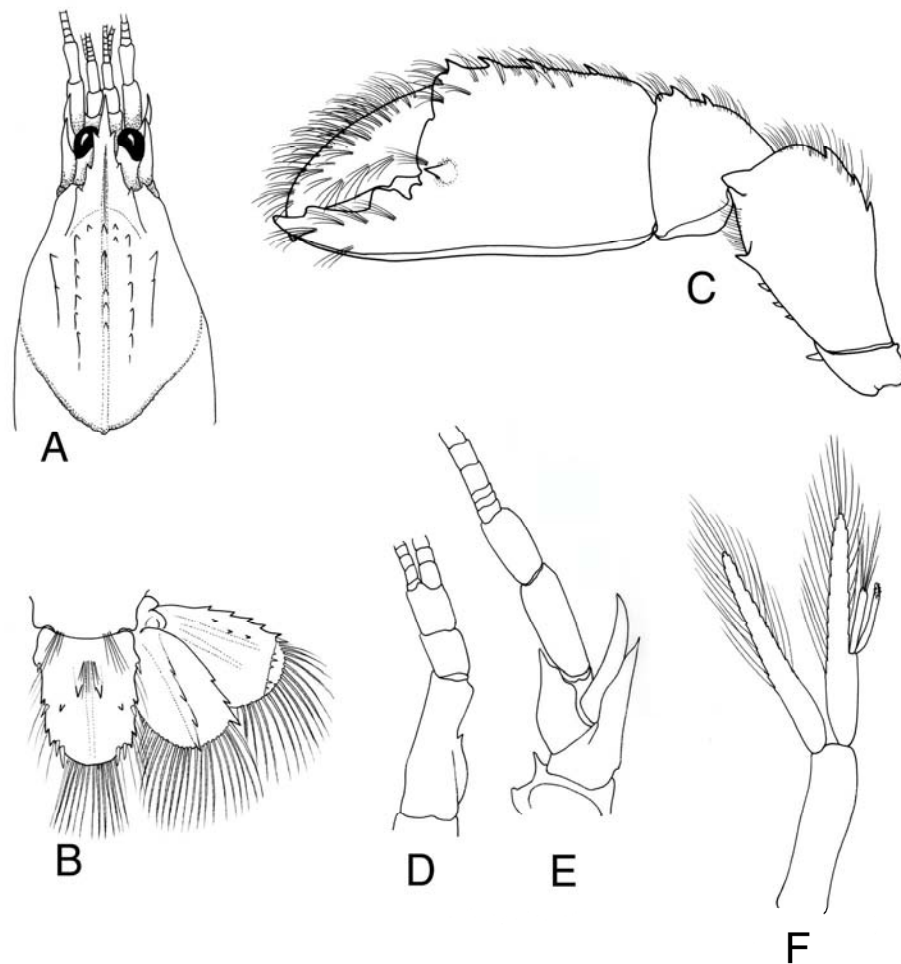


Figure 4. *Manaxius pitatucensis* (De Man, 1905), USNM 243379, male, Okinawa, Japan: A, anterior carapace in dorsal view; B, telson and right uropod in dorsal view; C, pereopod 1 smaller cheliped; D, antennular peduncle; E, antennal peduncle; F, pleopod 2.

**Remarks:** The recently-collected specimen from Agat lacks an appendix masculina on pleopod 2, and is regarded as a female, even though both male and female genital orifices are present, as was noted for the earlier type material. In the holotypic male, a strong appendix masculina is present on pleopod 2.

*Parascytoleptus tridens* (Rathbun, 1906)

*Paraxius tridens* Rathbun, 1906: 895, fig. 53.

*Parascytoleptus tridens*: Sakai, 1992: 212, fig. 2.

**Material examined:** USNM 239352, 1 ♂ cl 3.1 mm, 2 ovigerous ♀ cl 3.5 mm, 4.2 mm, 3 juv., Piti Bay, Guam, rubble on reef flat, 1 m, coll. J. H. Dominguez, 24 Jan 1984. USNM 239353, 1 ♂ cl 3.3 mm, 1 ♀ cl 4.0 mm, 1 juv., Agana Bay, Guam, rubble on reef flat, 1 - 1.5 m, coll. J. H. Dominguez, 26 Jan 1984. USNM 239354, 1 ♂ cl 4.2 mm, 1 ♀ cl 5.8 mm, Agana Bay, Guam, Alupat Island reef flat, 8-10 m, coll. R. K. Kropp & J. H. Dominguez, 3 Feb 1984. USNM 239355, 10 ♂ cl 2.6 - 4.5 mm, 4 ovigerous ♀ cl 3.0 - 7.0 mm, 1 ♀ cl 4.2 mm, Agana Bay, Guam, reef front, 10 m, coll. J. H. Dominguez, 3 Feb 1984. USNM 239356, 1 ♂ cl 2.5 mm, Tanguisson Point, Guam, rubble on reef front, 20 m, coll. J. H. Dominguez, 7 Feb 1984. USNM 239357, 1 ♂ cl 2.5 mm, Shark's Hole, Guam, reef flat, 1.5 m, coll. R. K. Kropp, 19 Feb 1984. USNM 239358, 2 ♂ cl 2.8 mm, 3.0 mm, Agana Bay, Guam, dead branching coral on reef front, coll. R. K. Kropp, 20 Feb 1984. USNM 239359, 1 ♂ cl 2.4 mm, Gun Beach, Guam, dead coral on reef front, 15 m, coll. J. H. Dominguez, 12 Apr 1984. USNM 239360, 1 ♂ cl 3.3 mm, 1 ovigerous ♀ cl 3.8 mm, Agana Bay, Guam, rubble on reef front, 12 m, coll. J. H. Dominguez, 25 Apr 1984. USNM 239361, 1 ovigerous ♀ cl 4.8 mm, Tanguisson Point, Guam, reef front, coll. 25 May 1984. USNM 239362, 1 ovigerous ♀ cl 3.2 mm, 1 juv., Cabras Island, Guam, dead branching coral on reef front, 18 m, coll. J. H. Dominguez & R. K. Kropp, 31 May 1984. USNM 239363, 1 ♂ cl 4.0 mm, 1 ovigerous ♀ cl 4.8 mm, Piti Bay, Guam, under rocks on inner reef flat, 0.5 m, coll. J. H. Dominguez, 7 Aug 1984. USNM 239364, 1 ♀ cl 2.5 mm, Pagua patch reef, Guam, on dead coral, 13 m, coll. R. K. Kropp & J. H. Dominguez, 24 Aug 1984. USNM 239365, 2 ♂ cl 2.9 mm, 3.6 mm, 1 ♀ cl 4.3 mm, 1 juv., Agana Bay, Guam, Alupat Island reef front, 6 m, coll. R. K. Kropp, 11 Sep 1984. USNM 239366, 1 ♂ cl 3.5 mm, 1 ovigerous ♀ cl 4.2 mm, 1 ♀ cl 3.9 mm, 1 juv., Cocos Lagoon, Guam, rubble on reef, 1.5 m, coll. J. H. Dominguez, 3 Oct 1984. USNM 239367, 1 ♂ cl 3.5 mm, 1 juv., Luminao, Guam, rubble on reef flat, coll. J. H. Dominguez, 8 Oct 1984. USNM 239368, 2 ♂ cl 3.2 mm, 3.9 mm, 1 ovigerous ♀ cl 3.8 mm, 1 ♀ cl 4.5 mm, Luminao, Guam, reef flat near Magundas, 1.5 m, coll. J. H. Dominguez, 13 Oct 1984. USNM 239369, 1 ovigerous ♀ cl 5.3 mm, Facpi Point, Guam, reef front, 6-8 m, coll. R. K. Kropp & J. H. Dominguez, 8 Mar 1984. USNM 243452, 1 ♀ cl 6.8 mm, Alupat Island, Agana Bay, Guam, in rubble, 8.5 m, coll. P. Gates, 5 Jun 1984.

**Previous records:** *Pacific Ocean:* French Frigate Shoals; Society Islands; Moorea; Bora Bora; Hawaii; Tahiti. *Indian Ocean:* Aldabra Atoll.

**Remarks:** With 55 specimens in the present collection, *P. tridens* would seem to be the commonest axiid in reef habitats around Guam. Ovigerous females were collected in January, February, March, April, May, August, and October, making it seem likely that the species breeds throughout year.

*Parascytoleptus tridens* is one of a suite of small axiid shrimps, including *Allaxius clypeatus*, *A. picteti*, species of *Coralaxius*, *Marianaxius kroppi*, and some species of *Paraxiopsis*, that inhabit coral rubble habitats in the Indo-Pacific and are probably widespread throughout this region.

*Paraxiopsis* De Man, 1905

*Paraxiopsis* De Man, 1905:597; 1925b: 6, 71.–Kensley, 1996b: 709.

*Eutrichocheles* (part): Sakai & De Saint Laurent, 1989: 51. Ngoc-Ho, 1998: 363.

**Discussion:** Ten species of *Paraxiopsis*, including the type species *P. brocki* (De Man, 1887) have now been recorded from the Pacific Ocean, seven from the Atlantic (see Kensley 1996b).

The most useful morphological features for separating species of *Paraxiopsis* are the carapace setation and ornamentation, the teeth on the lateral, submedian, and median carinae, the shape of the abdominal pleura, the spination of the telson and uropods, and the spination, setation, and ornamentation of the articles of the pereopod 1 chelipeds. On the basis of these characters, Table 2 distinguishes the seven previously described Indo-Pacific species and the three species described here.

*Paraxiopsis bisquamosa* (De Man, 1905)

*Axiopsis* (*Paraxiopsis*) *bisquamosa* De Man, 1905: 597; 1925b: 109, pls. 8, 9.–Holthuis, 1953: 51.

*Eutrichocheles bisquamosa*: Sakai & De Saint Laurent, 1989: 53, fig. 15. Kensley, 1994: 822.

**Material examined:** USNM 95558, ovigerous ♀ cl.5.0 mm, ♀ 4.3 mm, lagoon west of Saipan, 12 Apr 1949.

**Previous records:** Salibabu Is., Indonesia; Palau, Caroline Islands; Aldabra Atoll, Seychelles.

**Remarks:** This species is included here, as it has been recorded from nearby Saipan Island.

*Paraxiopsis paulayi* sp. nov.

Fig. 5, 6, Plate 3

**Material examined:** Holotype, USNM 296395, ♀ cl 10.2 mm, Paratype USNM 296396, ♀ cl 7.5 mm, Luminao Reef flat, Guam, 10 m, coll. L. Kirkendale, 21 May 1999. Paratype, USNM 296397, 1 ♀ cl 6.9 mm, Double Reef, Guam, 3-6 m, under rock, coll. G. Paulay, 10 Dec 1998.–Paratype, USNM 252856, 1 ♀ cl 9.4 mm, south-west of Orote peninsula, under rock, 20-25 m, coll. G. Paulay, 6 Feb 1998.

**Diagnosis:** Carapace surface smooth; rostrum reaching third antennular peduncle article, bearing pair of strong teeth anterior to orbit, extending posteriorly into lateral carina bearing 2 pairs of teeth, anterior pair supraocular in position; submedian carina with small anterior tooth, carina reaching posteriorly as far as lateral carina; median carina lacking teeth. Anterior carapace margin bearing antennal spine. Abdominal pleuron 1 ventrally narrowed, with apical

Table 2. Comparison of 10 species of *Paraxiopsis* from the Pacific Ocean, with type localities.

Taxon	Carapace carinae teeth (l : s : m)	Carapace ornamentation	Abdominal pleura	Pereopod chela	Dorsal telson spines
<i>P. austrinus</i> (Sakai, 1994) Darwin, Australia	5 : 5 : 0	short setules	posteriorly truncate/concave	unornamented, setose	3 pairs
<i>P. bisquamosa</i> (De Man, 1905) Saibabu Is., Indonesia	5 : 0 : 0 2 flattened squamae	smooth	rounded	unornamented	3 pairs
<i>P. brocki</i> (De Man, 1887) Amboine, Indonesia	2 : 1-2 : 0	smooth	rounded	unornamented	4 pairs
<i>P. johnstoni</i> (Edmondson, 1925) Johnston Atoll	3 : ?	smooth	rounded	unornamented	0
<i>P. crosnieri</i> Ngoc-Ho, 1998 Vietnam	6 : 6 : 0	finely tuberculate	posteriorly truncate / concave	dorsally dentate; small rounded tubercles	3 pairs
<i>P. tuamotu</i> Ngoc-Ho, 1998 Tuamotu Archipelago	3 : 8-10 : 0	smooth	2 posteriorly rounded, 3 & 4 posteriorly truncate	dorsal rounded tubercles	3 pairs
<i>P. majuro</i> sp. nov. Marshall Islands	5 : 1 : 0	finely pitted	posteriorly truncate	slender, unornamented	3 pairs
<i>P. paulayi</i> sp. nov. Guam	3 : 1 : 0	smooth	posteriorly truncate	small rounded tubercles	3 pairs
<i>P. plumosimanus</i> sp. nov. Guam	3 : 1 : 0	short setules	rounded	small rounded tubercles, dense plumose setae	4 pairs
<i>P. pumilus</i> (Sakai, 1994) Cobourg Peninsula, Australia	2 : 0 : 0	smooth	rounded	unornamented	3 pairs



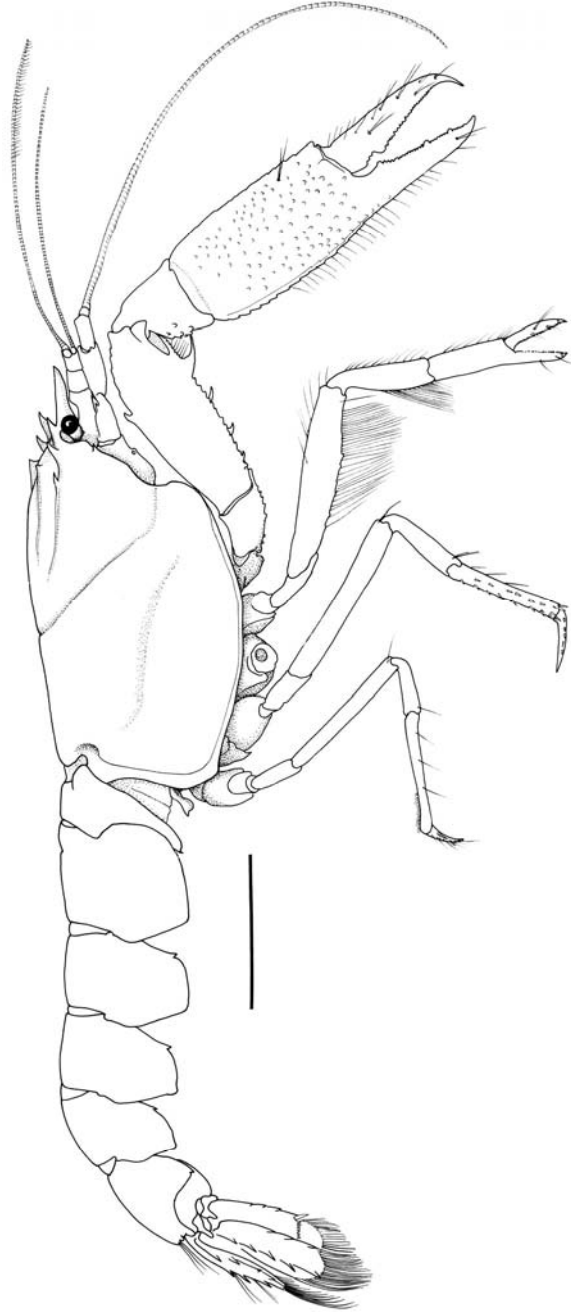


Figure 5. *Paraxiopsis paulayi* sp. nov., holotype in lateral view. Scale = 5 mm.

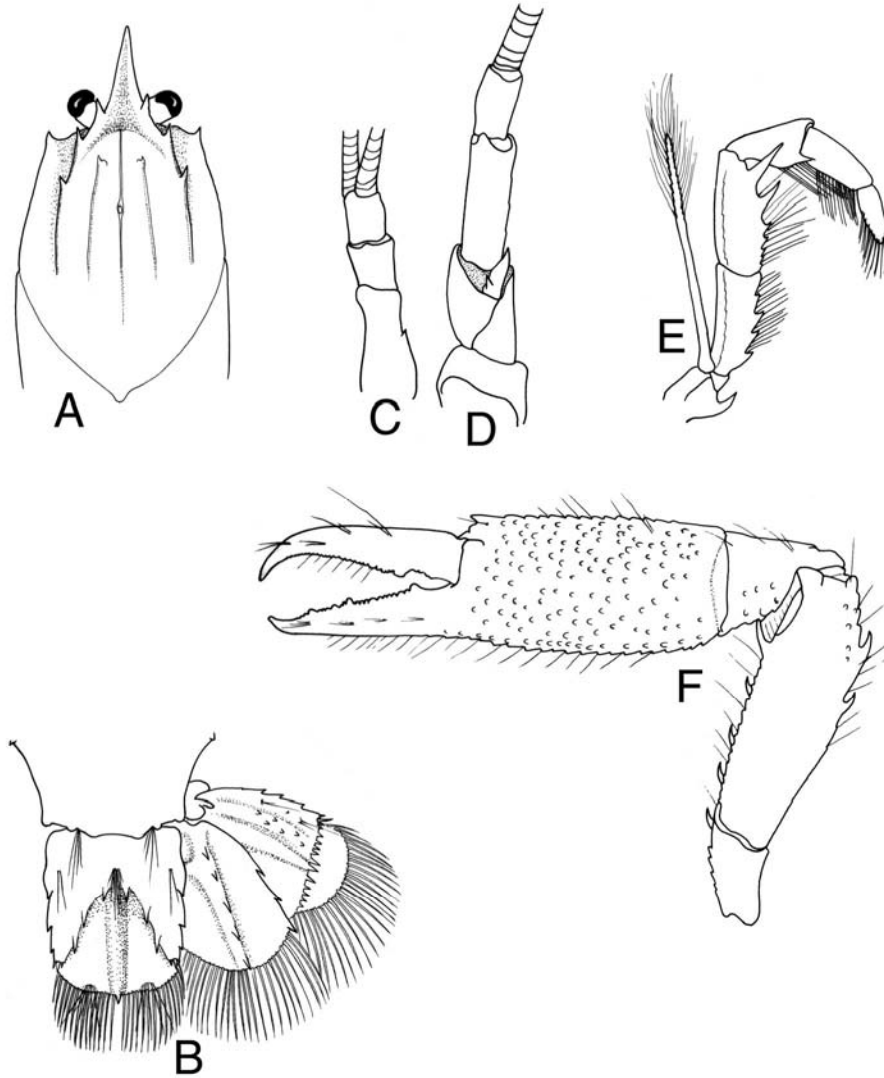


Figure 6. *Paraxiopsis paulayi* sp. nov.: A, anterior carapace in dorsal view; B, telson and right uropod in dorsal view; C, antennular peduncle; D, antennal peduncle; E, maxilliped 3; F, pereopod 1 smaller cheliped.

tooth; broad second pleuron anterior rounded, posteriorly truncate; pleura 3-5 each with small tooth on anteroventral margin, posterior margins truncate; pleuron 6 with small posteroventral tooth. Telson with 3 pairs lateral marginal teeth, 3 small mobile spines posterolaterally, 3 pairs of strong teeth on dorsal surface, shallow medial longitudinal groove, and small medial spine on posterior margin.

Antennular peduncle basal article with small stylocerite tooth, slightly longer than articles 2 and 3 together; superior flagellum subequal in length to carapace, inferior flagellum slightly shorter. Antennal peduncle acicle fairly slender, with small basal tooth, apically acute. Mouthparts typical of genus.

Maxilliped 3, basis with strong curved tooth; ischium with 4 teeth on mesial margin, toothed crest on mesial surface bearing about 13 teeth, 9 distal ones large; merus with 7 teeth on mesial margin, 2 distalmost longest; carpus with mesiodistal tooth. Pereopod 1 chelipeds subsimilar, subequal; ischium with 1 strong posterodistal tooth, plus several small marginal serrations; merus with 1 or 2 strong teeth on upper margin, 4 strong teeth on lower margin, distalmost strongest; carpus with few rounded granules on lower lateral surface; propodus with numerous rounded granules on lateral surface of palm, latter 1.3 times length of dactylus, upper and lower margins serrate, upper ending in blunt tooth; fixed finger cutting edge with numerous small rounded denticles plus 3 slightly larger rounded denticles; dactylus with basal emargination on cutting edge, followed by row of small denticles evenly decreasing in size distally. Pereopod 2, lower margin of ischium and merus serrate, merus with ventral row of elongate setae; carpus slightly longer than propodal palm, with dense band of setae ventrally; chela with fingers about four-fifths length of palm; cutting edges bearing short fine spine-like setae. Pereopods 3 and 4 similar, 3 longer; propodus with series of short corneous mobile spines; dactylus with small corneous spines on lateral surface. Pereopod 5, propodus with numerous distal short setae; dactylus turned anteriorly. Pleopod 1 represented by short tapered article inserted on sternum. Uropod with lateral ramus having 4 or 5 teeth on lateral margin, slender movable spine at suture, latter with about 13 fixed spines, 7 or 8 granules on distodorsal surface; mesial ramus having 3 strong teeth on lateral margin, dorsal longitudinal rounded ridge bearing 5 strong teeth.

**Color:** Body translucent milky white with scattering of pink-red chromatophores; antennular and antennal flagella red-brown; pereopods with distal merus, carpus, propodus and dactylus with scattering of small pink-red chromatophores; pereopod 1 propodal palm a clearly-defined pink-red rectangle.

**Etymology:** The species is named for Dr. Gustav Paulay, late of the University of Guam, now of the Florida Museum of Natural History, who has collected valuable crustacean material from the shallow waters of Guam.

*Paraxiopsis plumosimanus* sp. nov.

Fig. 7, 8

**Material examined:** Holotype, USNM 296394, 1 hermaphrodite cl. 11.5 mm, left pereopod 1 missing, Apra Harbor, Sasa Bay, Guam, sand bottom, 3-5 m, Coll. L. Kirkendale, 14 Jan 1998.

**Diagnosis:** Carapace surface bearing tiny scattered short setae, especially dorsolaterally; branchiostegites faintly pitted; rostrum reaching third antennular peduncle article, bearing pair of strong teeth anterior to orbit, extending

posteriorly into lateral carina bearing 2 pairs of teeth, anterior pair supraocular in position; submedian carina with small anterior tooth, rest of carina unarmed, reaching posteriorly to about level of lateral carina; median carina lacking teeth. Anterior carapace margin bearing antennal spine. Abdominal pleuron 1 ventrally acute; pleuron 2 broadly ovate, anteriorly and posteriorly rounded; pleura 2-6 bearing fringe of setae on ventral margins; pleuron 3 posteroventrally rounded; pleura 4 and 5 with small tooth on anterior margin and faint posteroventral angle; pleuron 6 with small posteroventral tooth. Telson with 4 pairs lateral teeth, 4 pairs of strong teeth on dorsal surface, shallow median longitudinal groove, and small medial spine on posterior margin.

Antennular peduncle basal article with small stylocerite tooth, longer than articles 2 and 3 together; superior flagellum subequal in length to carapace plus rostrum, inferior flagellum slightly longer. Antennal peduncle acicle fairly slender, with small basal tooth, apically acute. Mouthparts typical of genus.

Maxilliped 3, coxa and basis each with strong distal tooth; ischium with 6 teeth on mesial margin, toothed crest on mesial surface bearing about 13 teeth, 5 proximal ones tiny, 8 distal teeth large; merus bearing 6 teeth on mesial margin, increasing in length distally; carpus with small mesiodistal tooth. Pereopod 1, left cheliped lost, right cheliped ischium with 4 teeth on ventromesial margin, several serrations on lateroventral margin; merus with 4 strong teeth on ventromesial surface, increasing in length distally, upper margin bearing 2 strong teeth; carpus with few rounded tubercles on ventrolateral surface; propodus with numerous rounded granules on lateral surface of palm, latter almost twice length of fixed finger; latter with strong triangular cusp proximally on cutting edge; dactylus with triangular cusp at about midlength of cutting edge; carpus, propodus, and dactylus bearing numerous dense clumps of soft, finely setulose setae, especially on upper surface of propodus. Pereopod 2, merus with 2 small teeth on lower margin; carpus slightly longer than propodal palm; latter 1.3 times length of fingers; cutting edges bearing short fine spine-like setae. Pereopods 3 and 4 similar, 3 slightly longer, propodus bearing rows of short corneous mobile spines; dactylus with small corneous spines on lateral surface. Pereopod 5, both legs lost. Pleopod 1 uniramous, slender, elongate, setose in distal half. Pleopod 2 lacking appendix masculina. Uropod with lateral ramus having 4 teeth on lateral margin, slender mobile spine at suture, latter having 9 fixed spines, 7 spinose granules on distodorsal surface; mesial ramus having 4 teeth on lateral margin; dorsal longitudinal rounded ridge bearing 5 strong teeth.

**Remarks:** The present specimen has both male and female genital orifices, but pleopod 1 is present, while pleopod 2 lacks an appendix masculina. The specimen is thus regarded as a female.

**Etymology:** The specific name refers to the plumose setae found on the first pereopod cheliped.

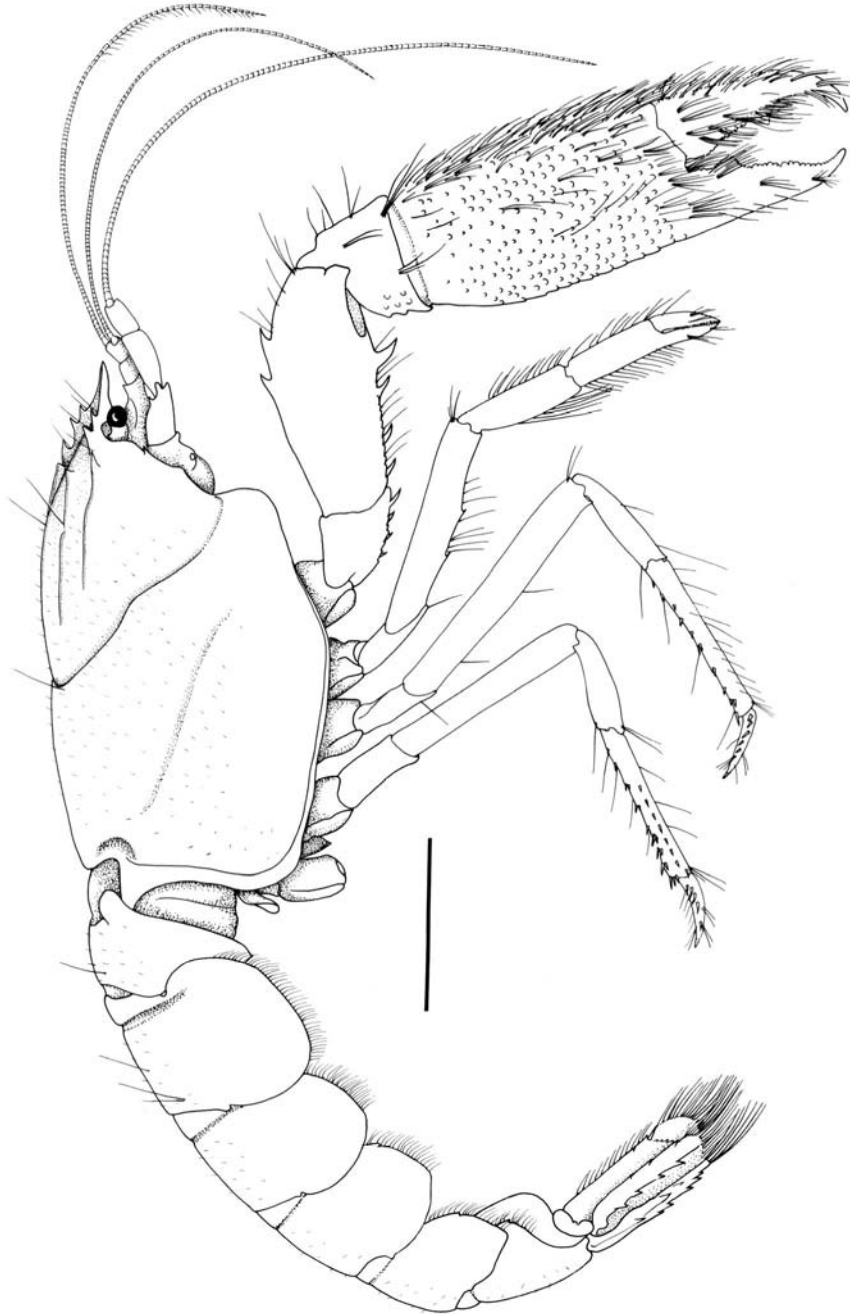


Figure 7. *Paraxiopsis plumosimanus* sp. nov., holotype in lateral view. Scale = 5 mm.

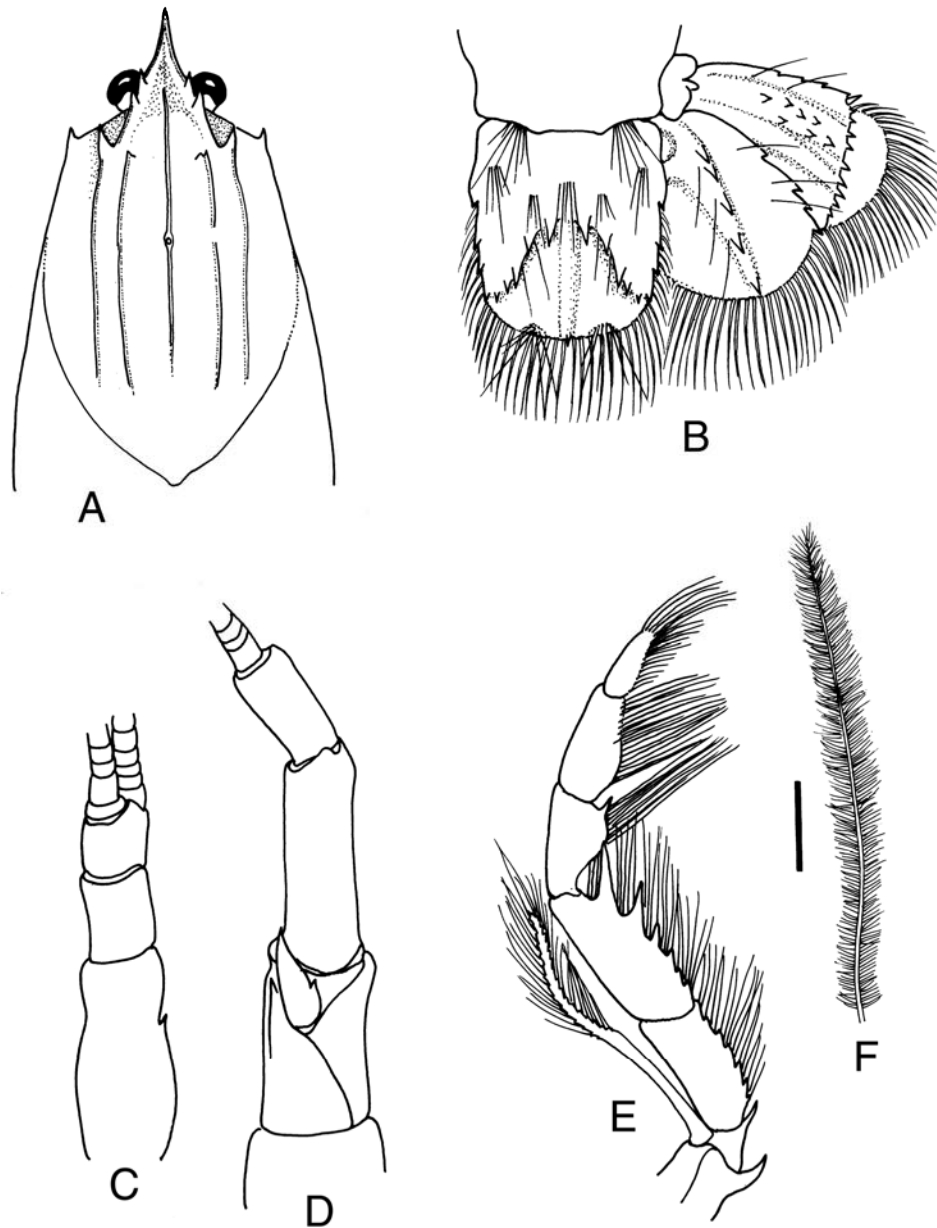


Figure 8. *Paraxiopsis plumosimanus* sp. nov.: A, anterior carapace in dorsal view; B, telson and right uropod in dorsal view; C, antennular peduncle; D, antennal peduncle; E, maxilliped 3; F, single plumose seta from pereopod 1, scale = 0.5 mm.

*Paraxiopsis majuro* sp. nov.

Fig. 9, 10, Plate 7

**Material examined:** Holotype, USNM 243603, hermaphrodite cl 9.0 mm, sta BMAJ-8, patch reef in north-north-east lagoon, under rock, Majuro Island, Marshall Islands, 10 m.

**Diagnosis:** Carapace surface faintly and shallowly pitted, faintly rugose on branchiostegite; rostrum reaching distal margin of antennular peduncle article 3, bearing 2 teeth anterior to orbit, one supra-orbital tooth, plus 2 teeth on lateral carina; submedian carina with single anterior tooth; median carina lacking teeth. Anterior carapace margin bearing small antennal spine. Abdominal pleuron 1 ventrally narrowly rounded with small tooth apically; pleuron 2 broad, anterior margin rounded, posterior margin truncate; pleura 3-5 with small tooth on anterior margin, posterior margins straight/truncate. Telson with 4 pairs lateral marginal teeth, small mobile spine posterolaterally, 3 pairs strong spines on dorsal surface, shallow median longitudinal groove, small medial spine on posterior margin.

Antennular peduncle basal article with small stylocerite tooth, article subequal to two distal articles together; superior flagellum subequal to carapace in length, inferior flagellum somewhat longer. Antennal peduncle acicle fairly slender, apically acute, with small basal tooth. Mouthparts typical of genus. Maxilliped 3, basis with strong curved tooth distally; ischium with 4 or 5 irregular teeth on mesial margin, toothed crest on mesial surface bearing 15 teeth, 4 proximal ones tiny; merus with 7 teeth on mesial margin increasing in length distally; carpus with single mediobasal tooth. Pereopod 1 chelipeds subsimilar, subequal; ischium with 3 strong teeth on ventral surface; merus with 4 strong teeth on ventral surface, increasing in length distally, 3 or 4 strong teeth on upper margin; carpus with few rounded tubercles ventrally; chela fairly slender, propodus with upper margin of palm carinate, ending distally in small tooth, ventral margin serrate, palm about 2.2 times longer than wide, about 1.6 times length of fingers, lateral surface unornamented; cutting edge of fixed finger and dactylus with numerous small rounded cusps few of which slightly larger. Pereopod 2, lower margin of merus barely serrate; merus, carpus and propodal palm bearing row of setae; carpus about one-third longer than propodal palm; chela about half length of palm; cutting edges bearing short fine spine-like setae. pereopods 3 and 4 similar, 3 longer; propodus with series of short corneous mobile spines; dactylus with small corneous spine on lateral surface. Pereopod 5 twisted anteriorly, propodus with numerous short mobile spines; dactylus flexed anteriorly. Genital openings on coxae of pereopods 3 and pereopods 5. Pleopod 1 short uniramous conical structure; pleopod 2 lacking appendix masculina. Uropod with lateral ramus having 4 teeth on lateral margin, slender mobile spine at suture, 12 teeth along suture, 5 spinose tubercles distally on dorsal surface; mesial ramus with 3 teeth on lateral margin, dorsal longitudinal rounded ridge bearing 5 strong teeth.

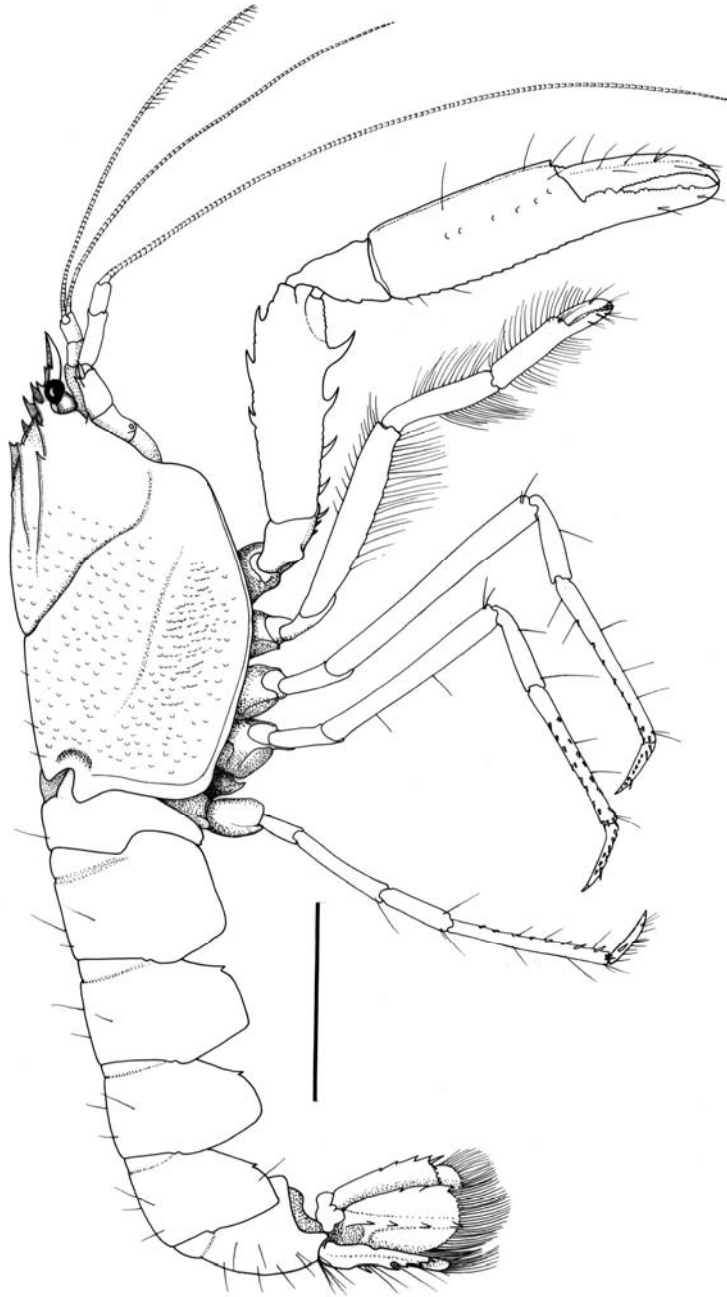


Figure 9. *Paraxiopsis majuro* sp. nov., holotype in lateral view. Scale = 5 mm.



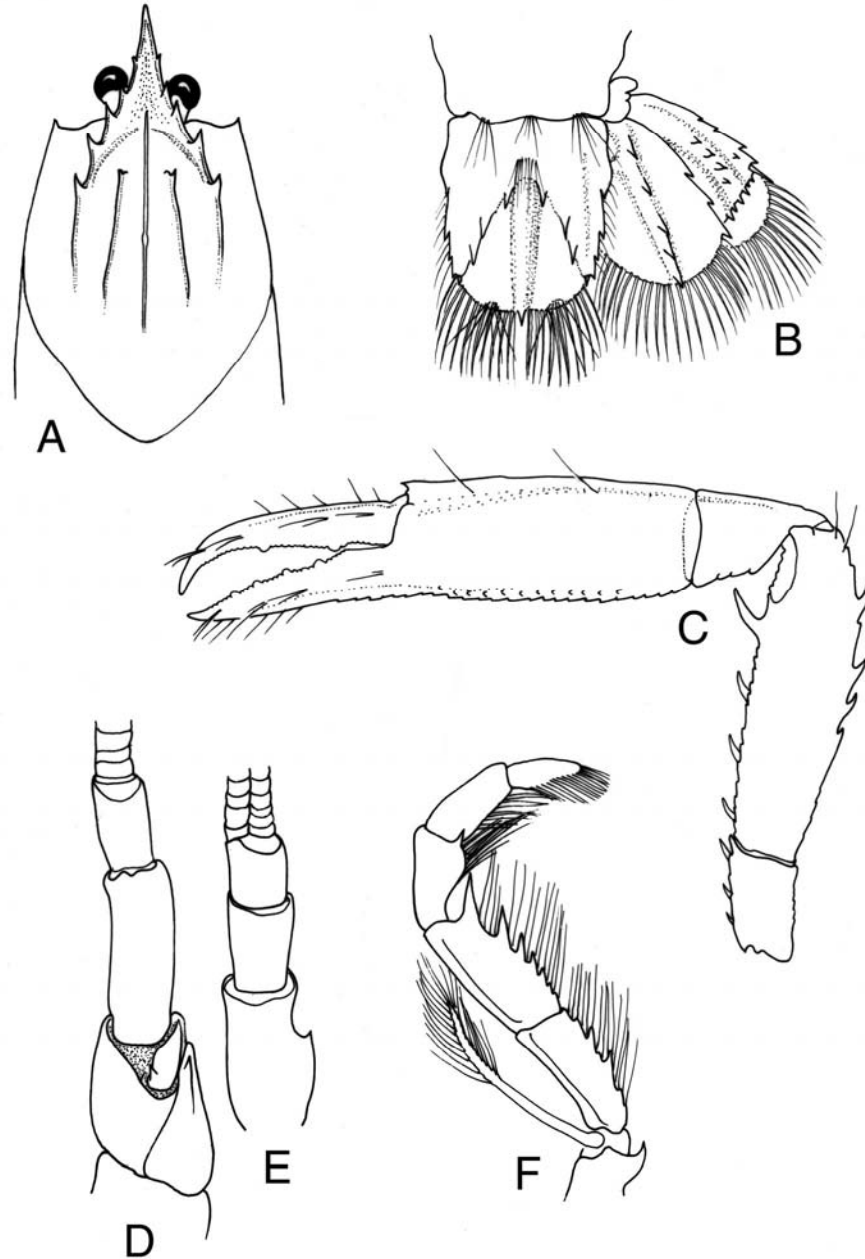


Figure 10. *Paraxiopsis majuro* sp. nov.: A, anterior carapace in dorsal view; B, telson and right uropod in dorsal view; C, pereopod 1 smaller cheliped; D, antennal peduncle; E, antennular peduncle; F, maxilliped 3.

**Etymology:** The specific name is from the type locality, Majuro Island in the Marshall Islands.

Family Strahlaxiidae Poore, 1994

*Neaxius acanthus* (A. Milne Edwards, 1879)

*Axia acantha* A. Milne Edwards, 1879: 110.

*Axius* (Neaxius) *acanthus*: Borradaile, 1903: 537.

**Material examined:** USNM 243604, 1 ♀ cl 18.0 mm, Piti Bay, Guam, in rubble, 0.5 - 1 m, coll. J. Starmer, 24 Nov 1995. UGI, 2 ♂ cl 24.5 mm, 25.0 mm, Pago Bay Guam, reef flat, coll. B. D. Smith, Apr 1999.

**Previous records:** *Pacific Ocean*: New Caledonia; Lizard Island, Australia; Philippines; Saipan; Japan; New Britain; Torres Strait; Murray Island. *Indian Ocean*: Kenya; Madagascar; Mauritius: Glorieuses Island.

### Acknowledgements

I am grateful to Dr. Gustav Paulay for making available for study some of the material described here, and to Dr. Roy Kropp who deposited crustacean collections in the Smithsonian collections in the mid-1980's. Both of these also generously made color photographs available, which proved invaluable in species-separation. I thank all the collectors who assisted in making the abovementioned collections.

### References

- Borradaile, L. A. 1903. On the classification of the Thalassinidea. *Annals and Magazine of Natural History* (7)12:534-551.
- De Man, J. G. 1887. Bericht über die im indischen Archipel von Dr. J. Brock gesammelten Decapoden und Stomatopoden. *Archiv für Naturgeschichte* 53(1): 215-600.
- De Man, J. G. 1905. Diagnoses of new species of macrurous decapod Crustacea from the "Siboga Expedition". *Tijdschrift der Nederlandsche Dierkundige Vereeniging, Leiden* 9(2) 587-614.
- De Man, J. G. 1925a. Ueber neue oder wenig bekannte Axiidae. *Mitteilungen aus dem Zoologische Museum in Berlin* 12(1):119-140.
- De Man, J. G. 1925b. The Decapoda of the Siboga-Expedition. Part 6. The Axiidae collected by the Siboga-Expedition. *Siboga-Expeditie monographie* 39a5:1-127.
- Holthuis, L. B. 1953. Enumeration of the decapod and stomatopod Crustacea from Pacific coral islands. *Atoll Research Bulletin* 24:1-66.
- Huxley, T. H. 1879. On the classification and the distribution of the crayfishes. *Proceedings of the Zoological Society of London* 1878: 752-788.

- Kensley, B. 1981. Notes on *Axiopsis* (*Axiopsis*) *serratifrons* (A. Milne Edwards) (Crustacea: Decapoda: Thalassinidea). Proceedings of the Biological Society of Washington 93(4):1253-1263.
- Kensley, B. 1994. The genus *Coralaxius* redefined, with the description of two new species (Crustacea: Decapoda: Axiidae). Journal of Natural History 28:813-828.
- Kensley, B. 1996a. New thalassinidean shrimp from the Pacific Ocean (Crustacea: Decapoda: Axiidae and Calocarididae). Bulletin of Marine Science 59(3): 469-489.
- Kensley, B. 1996b. The genus *Paraxiopsis* De Man, with descriptions of new species from the western Atlantic (Crustacea: Decapoda: Axiidae). Bulletin of Marine Science 58(3): 709-729.
- Knowlton, N. 1986. Cryptic and sibling species among the decapod Crustacea. Journal of Crustacean Biology 6(3):356-363.
- Milne Edwards, A. 1873. Description de quelques Crustacés nouveaux ou peu connus provenant du Musée de M. C. Godeffroy. Journal de Muséum Godeffroy 4:77-88.
- Milne Edwards, A. 1879. Additions à la famille des thalassiniens. Bulletin de la Société Philomathique de Paris (7)3: 110-113.
- Ngoc-Ho, N. 1998. Le genre *Eutrichocheles* Wood Mason, 1876 (Crustacea, Decapoda Thalassinidea) en Polynésie française et au Vietnam avec description de deux espèces nouvelles. Zoosystema 20(2):363-378.
- 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.
- Rathbun, M. J. 1906. The Brachyura and Macrura of the Hawaiian Islands. U. S. Fish Commission Bulletin for 1903, Part 3:827-930.
- Sakai, K. 1986. *Axiopsis brucei* sp. nov., a new sponge-inhabiting axiid (Crustacea: Decapoda: Thalassinidea), from north-west Australia. The Beagle 3(1):11-20.
- Sakai, K. 1992. Notes on some species of Thalassinidea from French Polynesia. Senckenbergiana Maritima 22 (3/6): 211-216.
- Sakai, K. & M. de Saint Laurent. 1989. A checklist of Axiidae (Decapoda, Crustacea, Thalassinidea, Anomura), with remarks and in addition descriptions of one new subfamily, eleven new genera and two new species. Naturalists 3: 1-104.
- Zehntner, L. 1894. Crustacés de l'Archipel Malais. Revue Suisse de Zoologie et Annales du Musée d'Histoire Naturelle de Genève 2: 135-214.