

## Two New Species of *Quadrisegmentum* (Phtisicidae: Amphipoda: Crustacea) from the Central Indo-Pacific, with Notes on the Type Species *Q. triangulum* Hirayama, 1988

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**ABSTRACT.** Two new species of *Quadrisegmentum* (Phtisicidae: Amphipoda: Crustacea) are described from the Central Indo-Pacific. The new species *Quadrisegmentum atauru* sp. nov., is described from the Wetar Basin, Timor-Leste in the Lesser Sunda Region of the Western Coral Triangle. The new species name *Q. yirrgay* sp. nov., is established for material from Ashmore Reef in Queensland and Papua New Guinea originally reported under the name *Q. triangulum* Hirayama, 1998 (Guerra-García 2003, 2006; Guerra-García & Lowry 2009). Study of the type material of *Quadrisegmentum triangulum* described from Ashmore Reef in the Timor Sea, Western Australia confirms the absence of projections on pereonite 2, which prompted reassessment of subsequent identifications. Records of *Q. triangulum* are now limited to the type locality only. An updated key to the four known species of *Quadrisegmentum* is provided.

**KEYWORDS:** *Quadrisegmentum*; new species; Phtisicidae; Amphipoda; Crustacea; taxonomy

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Much work remains to be done on the marine amphipod fauna of the Central Indo-Pacific. In the Western Coral Triangle where the species diversity of coral is the highest in the world (Veron *et al.*, 2009), 28 caprellid species from 21 genera have been reported from shallow-waters in the Indonesian Archipelago (Mayer, 1903; McCain & Steinberg, 1970; Krapp-Schickel & Guerra-García, 2005; Scinto *et al.*, 2008). In the Eastern Coral Triangle and Northeast

Australian Shelf (Spalding *et al.*, 2007), three previous studies documented 19 species and 15 genera from these two regions combine (Guerra-García, 2003, 2006; Lowry & Guerra-García, 2009).

The genus *Quadrisegmentum* was established by Hirayama, 1988 to account for one species, *Q. triangulum*, collected from Ashmore Reef in the Timor Sea. Research by Guerra-García (2006) described a second species of

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*Quadrisegmentum*, *Q. lowryi* Guerra-García, 2006, from Lizard Island on the northern Great Barrier Reef. Guerra-García (2003, 2006) further reported *Q. triangulum* from the Lord Howe Island, Elizabeth and Middleton Reef, the Great Barrier Reef, Ashmore Reef (Coral Sea) and Papua New Guinea.

The present study contributes an additional new species and generic record, *Quadrisegmentum atausro*, from Timor-Leste, which is part of the Lesser Sunda region within the Western Coral Triangle. *Quadrisegmentum atausro* has distinct projections of pereonite 2. Comparative examination of *Q. triangulum* type material confirmed the absence of projections on pereonite 2, yet in material subsequently attributed to *Q. triangulum* (see Guerra-García, 2003, 2006), pereonite 2 projections were observed on male and female species from various locations. Following reassessment of the latter material, a second new species *Q. yirrgay*, is established for previous records of *Q. triangulum* reported throughout the Coral Sea and Bismark Archipelago (Eastern Coral Triangle and Northeast Australian Shelf, respectively).

### Materials and methods

The material examined for this study included type material from the Museum and Art Gallery of the Northern Territory (NTM), Australian Museum (AM) collections of *Quadrisegmentum* and new collections made during the Australian Museum Timor-Leste Expedition in September 2012 (Hughes, 2015). Material was dissected in 80% ethanol. Temporary slides were made using 100% glycerol. Permanent slides were made using either Polyvinyl lactophenol or Aquatex™ (Merck, Darmstadt, Germany) mounting agent. Illustrations were made with a Laborlux K (Leitz Wetzlar, Germany) and Heerbrugg stereomicroscopes (Wilde, Switzerland) fitted with camera lucida. Specimens were prepared for scanning electron microscopy as follows: placed in an ultrasonic cleaning bath for 10 seconds in a 10% solution of Tween 80 surfactant; preserving solution was returned to 80% ethanol then sequentially advanced in 5% increments from 80% to 100% ethanol; critical point dried; mounted individually on pins and gold sputter coated. Images were captured using on a Zeiss EVO LS15 Scanning Electron Microscope with Robinson Backscatter Detector (SEM) (Zeiss, Germany). Abbreviations for parts are as follows: *A*, antenna; *G*, gnathopod; *P*, pereopod and *Ur*, urosome. Family classification follows Takeuchi (1993).

### Systematics section

#### Phtisicidae Vassilenko, 1968

#### *Quadrisegmentum* Hirayama, 1988

**Diagnosis.** Head fused (suture absent) with pereonite 1. Antenna 1 well developed; flagellum with more than 2 articles. Antenna 2 well developed; flagellum with more than 2 articles. Mandible well developed; molar absent; palp 3-articulate; article 3 with 1 distal and 1 (or 2) lateral setae. Maxilliped well developed; inner plate (basal endite) larger than outer plate (ischial endite); outer plate (ischial endite) well developed; palp article 3 with distal projection; palp article 4 well developed. Pereonite 4 clavate appendage

absent. Pereonites 6 and 7 separated. Pereopod 3 well developed, with 7 articles. Pereopod 4 well developed, with 7 articles. Pereopod 5, with 4 articles, and well-developed dactylus. Pereopods 6 and 7 well developed, with 7 articles. Gills on pereonites 2 to 4. Uropods 2 pairs; Uropod 1 biarticulate, uniramous. Uropod 2 biarticulate, uniramous. Telson dorsal lobe present.

**Included species:** *Quadrisegmentum triangulum* Hirayama, 1988, type species; *Q. atausro* sp. nov.; *Q. lowryi* Guerra-García, 2006; *Q. yirrgay* sp. nov.

**Remarks.** Characters which define the family Phtisicidae Vassilenko, 1968 are a fully fused head and pereonite 1, absence of a mandibular molar and 3-articulate palp, gills on pereonites 2–4 (3 pair), pereonites 5 and 6 separated and the urosomites 1 and 2 coalesced (see Takeuchi, 1993, 2015; Lim *et al.*, 2012; Takeuchi and Lowry, 2016). The diagnosis of the genus was based observations of the type material of *Q. triangulum* Hirayama, 1988 by the present study with reference to description and figures of mouth parts in Hirayama (1988) and additionally the two new species described in the current study, *Q. atausro* sp. nov. and *Q. yirrgay* sp. nov. (map Fig. 11) provides the distribution of the four known *Quadrisegmentum* species.

#### *Quadrisegmentum atausro* sp. nov.

Figs 1–4

**Type material.** Holotype ♂, 10.5 mm (illustrated), dissected in part, 1 slide, AM P.98327, Timor-Leste, east of Atauro Island, Outer Reef, dense coral reef slope (8°13'48"S 125°36'57"E), 17 m, green calcareous alga *Halimeda* sp., 20 September 2012, coll. L.E. Hughes (TM 2012-087); paratype ♀, 9 mm (illustrated), AM P.98328, Timor-Leste, east of Atauro Island, Outer Reef, dense coral reef slope (8°13'48"S 125°36'57"E), 17 m, green calcareous alga *Halimeda* sp., 20 September 2012, coll. L.E. Hughes (TM 2012-087). Paratypes: 1 ♂, 5.1 mm [a smaller specimen has been chosen for SEM as it is in better condition], whole animal SEM pin mount, AM P.91095, Timor-Leste, east of Atauro Island, Outer Reef, dense coral reef slope (8°13'48"S 125°36'57"E), 17 m, green calcareous alga *Halimeda* sp., 20 September 2012, coll. L.E. Hughes (TM 2012-087); 1 ♂, 10.5 mm, SEM pin mount, AM P.91091, Timor-Leste, east of Atauro Island, Outer Reef, dense coral reef slope (8°13'48"S 125°36'57"E), 17 m, green calcareous alga *Halimeda* sp., 20 September 2012, coll. L.E. Hughes (TM 2012-087); 3 ♂♂, AM P.91097, Timor-Leste, east of Atauro Island, Outer Reef, dense coral reef slope (8°13'48"S 125°36'57"E), 17 m, green calcareous alga *Halimeda* sp., 20 September 2012, coll. L.E. Hughes (TM 2012-087); 1 ♂, AM P.91092, Timor-Leste, east of Atauro Island, Outer Reef, dense coral reef slope (8°13'48"S 125°36'57"E), 17 m, green calcareous alga *Halimeda* sp., 20 September 2012, coll. L.E. Hughes (TM 2012-087); 1 mature ♀, AM P.91096, Timor-Leste, east of Atauro Island, Outer Reef, dense coral reef slope (8°13'48"S 125°36'57"E), 17 m, green calcareous alga *Halimeda* sp., 20 September 2012, coll. L.E. Hughes (TM 2012-087); many specimens, AM P.91094, Timor-Leste, east of Atauro Island, Outer Reef, dense coral reef slope (8°13'48"S 125°36'57"E), 17 m, green calcareous alga *Halimeda* sp., 20 September 2012, coll. L.E. Hughes (TM 2012-087); 4 mature ♀♀, AM P.91093, Timor-Leste, east of Atauro Island, Outer Reef, dense coral reef slope (8°13'48"S 125°36'57"E), 17 m, green calcareous alga *Halimeda* sp., 20 September 2012, coll. L.E. Hughes (TM 2012-087); 7 specimens (6 ♂♂ and 1 mature ♀), AM P.91090, Timor-Leste, east of Atauro Island, Inner Reef, reef slope (8°14'30"S 125°36'49"E), 14 m, mixed turfing algae, 20 September 2012, coll. L.E. Hughes (TM 2012-034); 1 mature ♀, AM P.91099, Timor-Leste, west of Dili, off Tibar, on outer side of reef, rubble and sandy reef slope (8°33'48"S 125°28'31"E), 10–12 m, coral rubble and mixed algae, 21 September 2012, coll. A. Murray (TM 2012-037); 9 specimens (5 ♂♂ and 4 mature ♀♀), AM P.91098, Timor-Leste, east of Metinaro, Secret Garden Reef (8°29'15"S 125°49'53"E), 20 m, tufts of red algae, 22 September 2012, coll. L.E. Hughes (TM 2012-060).

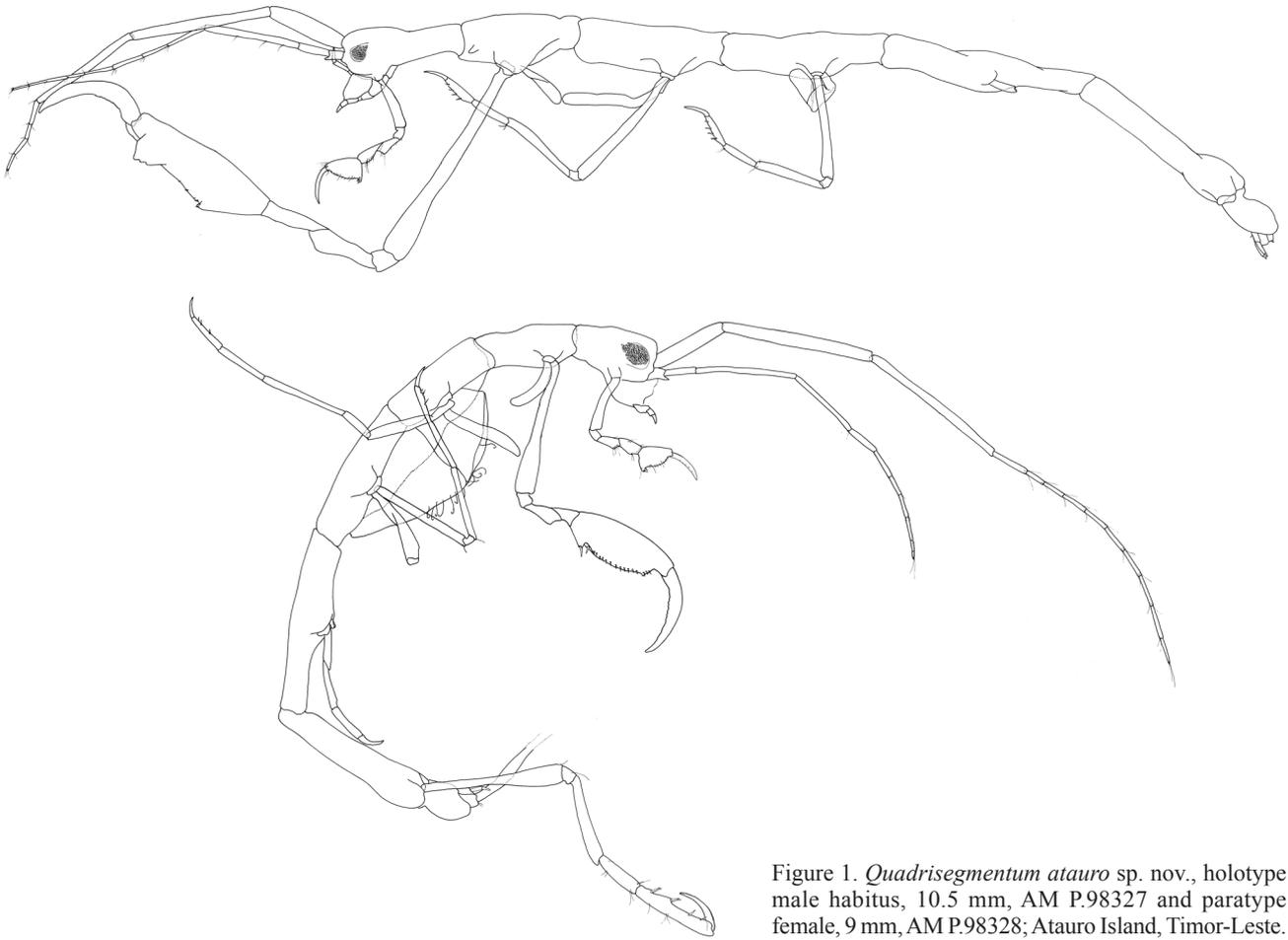


Figure 1. *Quadrisegmentum atauro* sp. nov., holotype male habitus, 10.5 mm, AM P.98327 and paratype female, 9 mm, AM P.98328; Atauro Island, Timor-Leste.

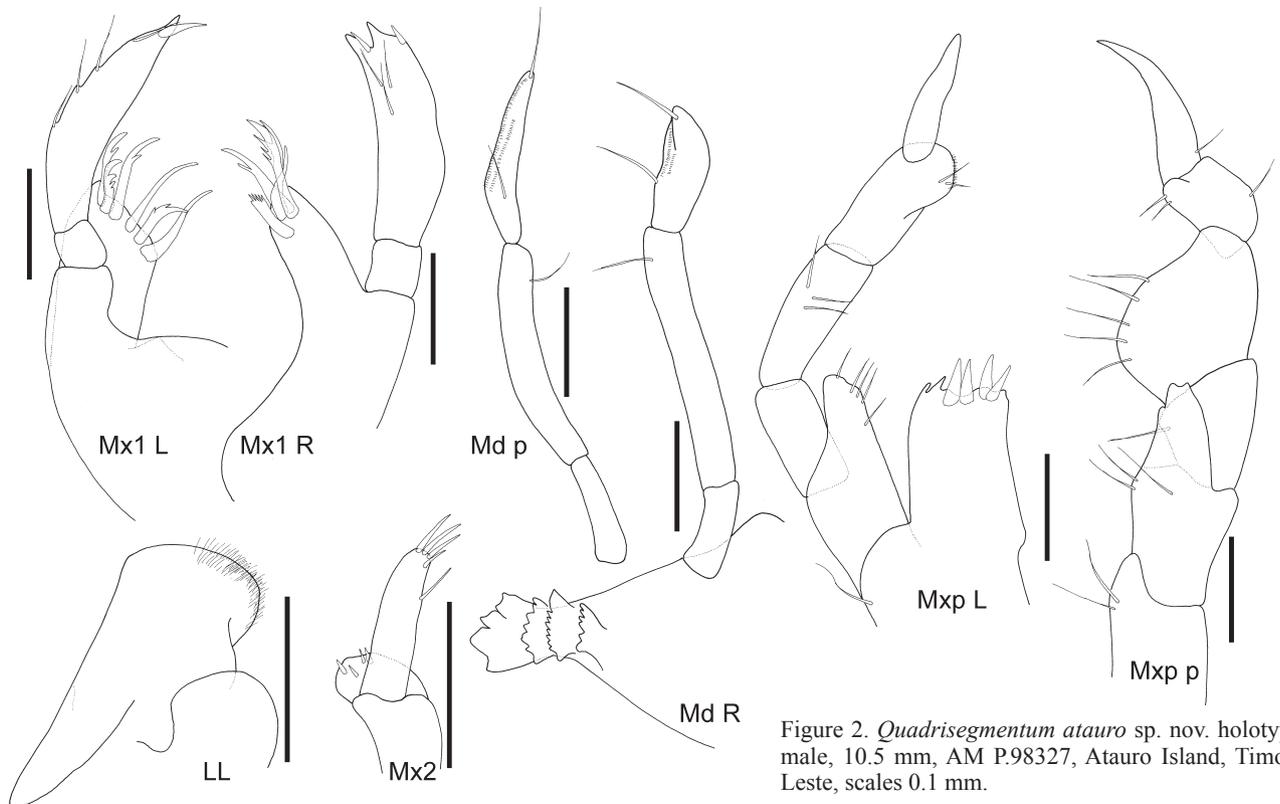


Figure 2. *Quadrisegmentum atauro* sp. nov. holotype male, 10.5 mm, AM P.98327, Atauro Island, Timor-Leste, scales 0.1 mm.

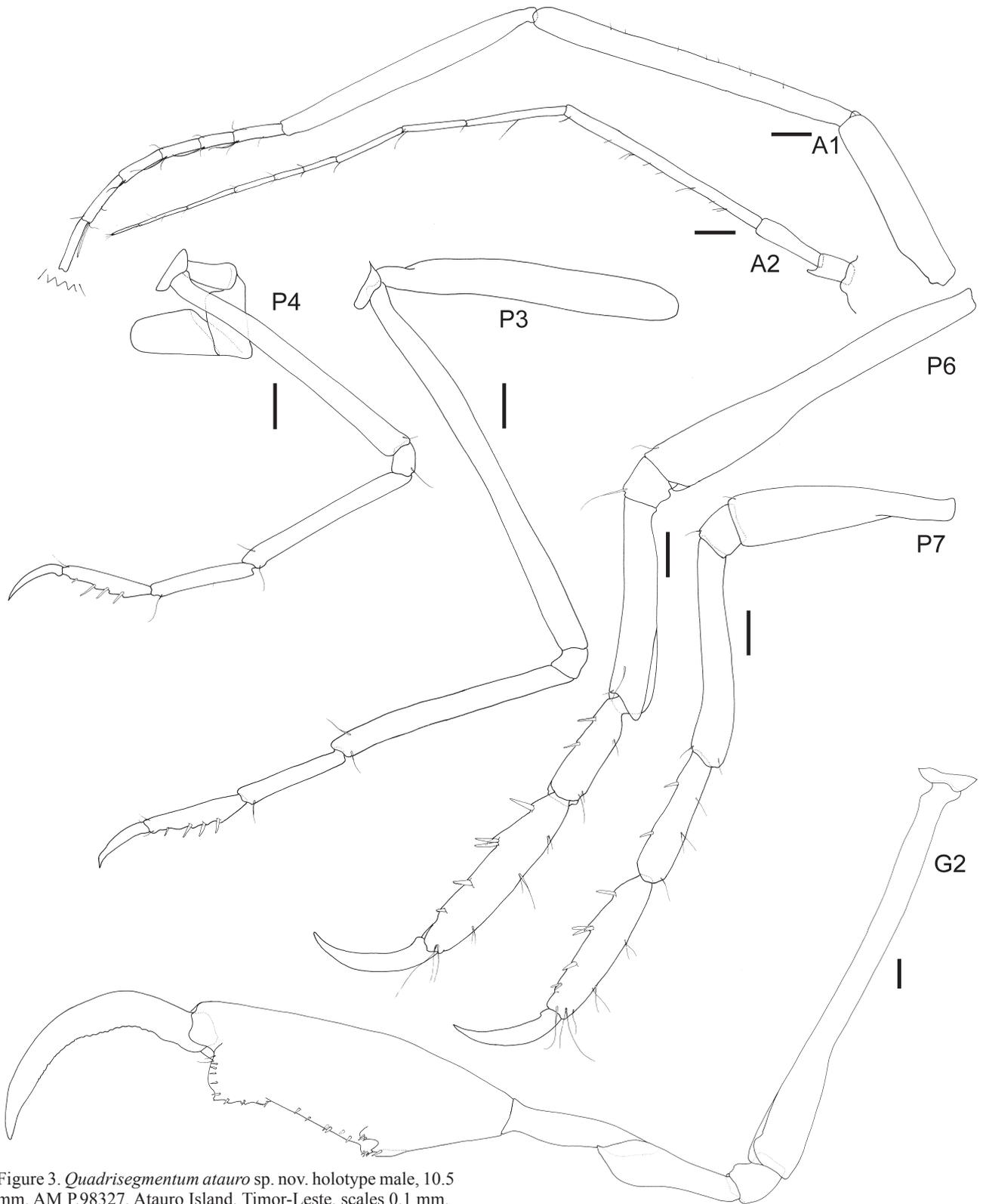


Figure 3. *Quadrisegmentum atauru* sp. nov. holotype male, 10.5 mm, AM P.98327, Atauro Island, Timor-Leste, scales 0.1 mm.

**Type locality.** Timor-Leste, east of Atauro Island, Outer Reef (8°13'48"S 125°36'57"E).

**Etymology.** Named from the type locality, applied as a noun in apposition.

**Description.** (Based on male, body length, 10.5 mm, AM P. 98327, and male, body length, 10.5 mm, AM P.91901 for pereopod 5 and abdomen).

**Body Somites** slender. *Head and pereonite 1* combined, completely fused, suture absent. *Pereonite 2* with small acute anterolateral projection. *Pereonites 3–6* without anterior or mid-lateral projections.

*Antenna 1*  $\frac{1}{3}$  × body length; peduncle article 2 longest, 1.9 × article 1; article 3 length 0.8 × article 2; flagellum length 0.24 × peduncle with 4–6 articles (left and right, respectively). *Antenna 2* 2.0 × *Antenna 1*; flagellum, 0.25 × peduncle length, body with 8–9 articles (left and right, respectively).

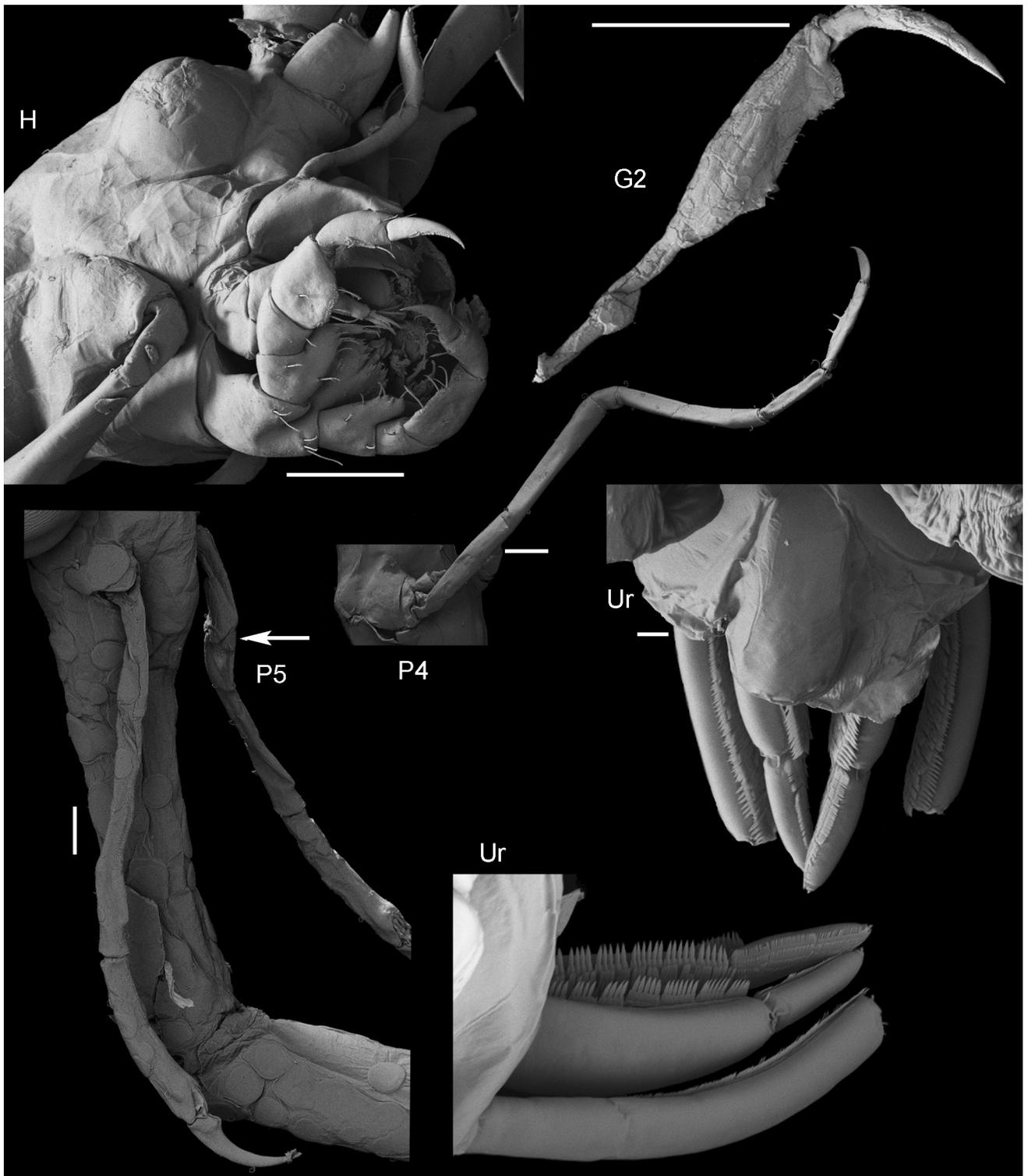


Figure 4. *Quadrisegmentum atauro* sp. nov. SEM image of paratype male, 5.1 mm, head and pereopod 4, AM P.91095; paratype male, 10.5 mm, gnathopod 2, pereopod 5 and urosome paratype male AM P.91091; Atauro Island, Timor-Leste. Scales: H and P4–5 scale 100 µm, Ur dorsal view scale 10 mm and Ur transverse view 20 µm.

*Mandible* right similar to left, incisor with 4 teeth, lacinia mobilis with 7 teeth followed by 2 plates; palp 3-articulate; article 2 longest, with 1 distal slender setae; article 3 with 1 distal and 1 midlateral slender setae, anterodistal margin pubescent. *Mandible* left, palp similar to right palp. *Lower lip* setose on outer lobe. *Maxilla 1* outer plate with 5–6 robust setae; palp 2-articulate, article 2 with 2 triangular projections, each with a robust seta, with 3–4 subapical

slender setae. *Maxilla 2* inner plate short with 4 robust setae; outer plate long, with 4 apical and 1 subapical robust setae. *Maxilliped* basal endite (inner plate) larger than ischial endite (outer plate), rectangular, with 4 apically robust setae near distal margin; ischial endite (outer plate) several slender setae on inner margin; palp 4-articulate; article 2 laterally expanded, with 3–4 slender setae; article 3 with rounded distal projection with 2 setae.

**Pereon.** *Gnathopod 1* basis similar in length to ischium, merus and carpus combined; carpus and merus subequal in length with anterior and posterior slender setae; propodus triangular; palm defined by prominent, curved, bifid process with 2 apical robust setae; dactylus falcate, inner margin lined with setules. *Gill 2* elongate, length  $5\times$  width,  $0.6\times$  pereonite 2 length. *Gnathopod 2* begins  $\frac{1}{3}$  along posterior margin of pereonite 2; basis length  $1.9\times$  pereonite 2 length,  $1.6\times$  ischium, merus and carpus combined; merus subrectangular, distally swollen (length  $2.8\times$  width), subequal to carpus; carpus subrectangular (length  $3.1\times$  width); propodus subovate, longer than wide (length  $2.8\times$  width); palm 60% of posterior margin, 3 proximal projections each with robust seta.

*Gill 3* slender,  $7\times$  width, length  $0.9\times$  pereonite 3 length. *Pereopod 3* length  $0.3\times$  body length; basis longest,  $0.4\times$  pereopod 3 length; ischium  $0.1\times$  basis length; merus  $0.6\times$  basis length; carpus  $0.27\times$  basis length; propodus  $0.9\times$  carpus length with 3 large and 1 small robust setae along palm; dactylus recurved. *Gill 4* subequal to gill 3. *Pereopod 4* shorter than pereopod 3, length  $0.35\times$  body length; basis longest,  $0.4\times$  pereopod length; ischium  $0.06\times$  basis length; merus  $0.65\times$  basis length; carpus  $0.3\times$  basis length; propodus shorter than carpus, length  $0.9\times$  carpus with 3 large and 1 small robust setae along palm; dactylus recurved.

*Pereopod 5* with 4 articles; article 1 length  $0.9\times$  article 2; article 2 longest,  $1.1\times$  article 3; dactylus recurved. *Pereopod 6* slender,  $0.5\times$  body length; basis longest,  $0.37\times$  pereopod 6 length; ischium  $0.08\times$  basis length; merus  $0.7\times$  basis length; carpus  $0.33\times$  basis length, anterior margin with 2 robust setae; propodus  $0.6\times$  basis length, anterior margin with 3 groups of long robust setae (middle group only with paired robust setae) and distal small robust setae; dactylus recurved. *Pereopod 7* slender, smaller than pereopod 6,  $0.4\times$  body length; basis  $0.27\times$  pereopod 7 length; ischium  $0.25\times$  basis length; merus length subequal to basis; carpus  $0.65\times$  basis length, anterior margin with 2 robust setae; propodus  $0.8\times$  basis length, anterior margin with 3 groups of long robust setae (middle group only with paired robust setae) and distal small robust setae; dactylus recurved.

**Pleon.** *Uropod 1* elongate (length  $6\times$  width), with minute a line of lateral setae; ramus damaged. *Uropod 2* peduncle elongate (length  $2.5\times$  width), with a line of lateral setae; ramus  $0.6\times$  peduncle length. *Telson* small, with a pair of setae.

**Female.** (based on female paratype, body length 9 mm, AM P. 98328). Pereonite 4 without rounded anterolateral projection. *Antenna 1* article 2 subequal to article 3 length,  $1.8\times$  article 1 length; flagellum with 10 articles. *Antenna 2* near  $2/3$  length of antenna 1; flagellum  $0.6\times$  peduncle length with 7 articles.

**Remarks.** *Quadrisegmentum atauru* sp. nov. and *Q. yirrgay* sp. nov. have long rectilinear gills which separates them from *Q. triangulum* where the gills are much shorter and subovate. The pereonite 2 in *Q. atauru* sp. nov. has on one pair of acute anterior lateral projections which are not seen for *Q. yirrgay* sp. nov. and *Q. lowryi* Guerra-García, 2006.

**Distribution.** Timor-Leste: Atauro Island, Tibar (current study).

## *Quadrisegmentum triangulum* Hirayama, 1988

Fig. 5

*Quadrisegmentum triangulum* —Hirayama, 1988: 1090–1093, figs. 1–3.

not *Quadrisegmentum triangulum*. —Guerra-García, 2003: 104–105, fig. 9a. —Guerra-García, 2006: 440, fig. 39. —Guerra-García & Lowry, 2009: 323–325 (= *Q. yirrgay* sp. nov.).

**Type material examined.** Paratypes 1 ♂ (no. 1) 8 mm, and 2 ♀♀ (nos. 2–3) 5.2 mm and unmeasured, NTM Cr. 00447, taken from gorgonian host, *Isis hippuris* Linnaeus, 1758 in 18 m on west islet of Ashmore Reef, Northwest Australia ( $12^{\circ}14.28'S$   $122^{\circ}59.14'E.$ ), 24 July 1986, coll. H. K. Larson. (Holotype carcass and slide material not found, presumed lost).

**Type locality.** Ashmore Reef, Timor Sea, north-west Western Australia ( $12^{\circ}14.28'S$   $122^{\circ}59.14'E.$ ).

**Remarks.** Examination of *Q. triangulum* type material recognizes the absence of projections on pereonite 2 in both sexes and also records the presence of anterolateral projections on the male pereonite 3. These anterolateral projections on pereonite 3 were not recorded in the original description by Hirayama (1988). Additional material attributed to *Q. triangulum* by the first and second reviewer from Queensland, Australian and Papua New Guinea (Guerra-García, 2003, 2006), contained specimens where pereonite 2 projections were observed on males and females. This latter material was reassessed as part of this study and determined to be a separate species. These records are transferred to the new species name *Q. yirrgay* described below. The name *Quadrisegmentum triangulum* is once again restricted to the original type material and presently known only from the type locality.

**Distribution.** Ashmore Reef (Hirayama, 1988).

## *Quadrisegmentum yirrgay* sp. nov.

Figs 6–10

*Quadrisegmentum triangulum*. —Guerra-García, 2003: 104–105, fig. 9a. —Guerra-García, 2006: 440, fig. 39. —Guerra-García & Lowry, 2009: 323–325.

**Type material.** Holotype ♂ 9.0 mm, AM P.98563, outer reef slope, Ashmore Reef, Coral Sea, Queensland, Australia ( $10^{\circ}26'16''S$   $144^{\circ}25'47''E$ ), red calcareous cylindrical algae, 19 January 1993, coll. S.J. Keable (QLD 704); paratype ♂ 9.0 mm, AM P.98564, outer reef slope, Ashmore Reef, Coral Sea, Queensland, Australia ( $10^{\circ}26'16''S$   $144^{\circ}25'47''E$ ), red calcareous cylindrical algae, 19 January 1993, coll. S.J. Keable (QLD 704); many specimens, AM P.61630, outer reef slope, Ashmore Reef, Coral Sea, Queensland, Australia ( $10^{\circ}26'16''S$   $144^{\circ}25'47''E$ ), red calcareous cylindrical algae, 19 January 1993, coll. S.J. Keable (QLD 704). Paratypes: ♀, 6 mm, AM P.61624, eastern edge of outer reef slope, Ashmore Reef, Coral Sea, Queensland, Australia ( $10^{\circ}09'10''S$   $144^{\circ}34'43''E$ ) calcareous red tubular algae, 24 January 1993, coll. S.J. Keable (QLD 734); 2 specimens (1 ♂ and 1 ♀), AM P.61627, eastern edge of outer reef slope Ashmore Reef, Coral Sea, Queensland, Australia ( $10^{\circ}09'10''S$   $144^{\circ}34'43''E$ ) mixed sponges, 24 January 1993, coll. S.J. Keable (QLD 736); 4 specimens (2 ♂♂ and 2 ♀♀), AM P.61629, outer reef slope, Ashmore Reef, Coral Sea, Queensland, Australia ( $10^{\circ}13'10''S$   $144^{\circ}24'53''E$ ) sponges, 22 January 1993, coll. S.J. Keable (QLD 722); 1 ♂, AM P.61625, outer reef slope, Ashmore Reef, Coral Sea, Queensland, Australia ( $10^{\circ}26'16''S$   $144^{\circ}25'47''E$ ) sediment, algae and rubble, 19 January 1993, coll. S.J. Keable (QLD 705).

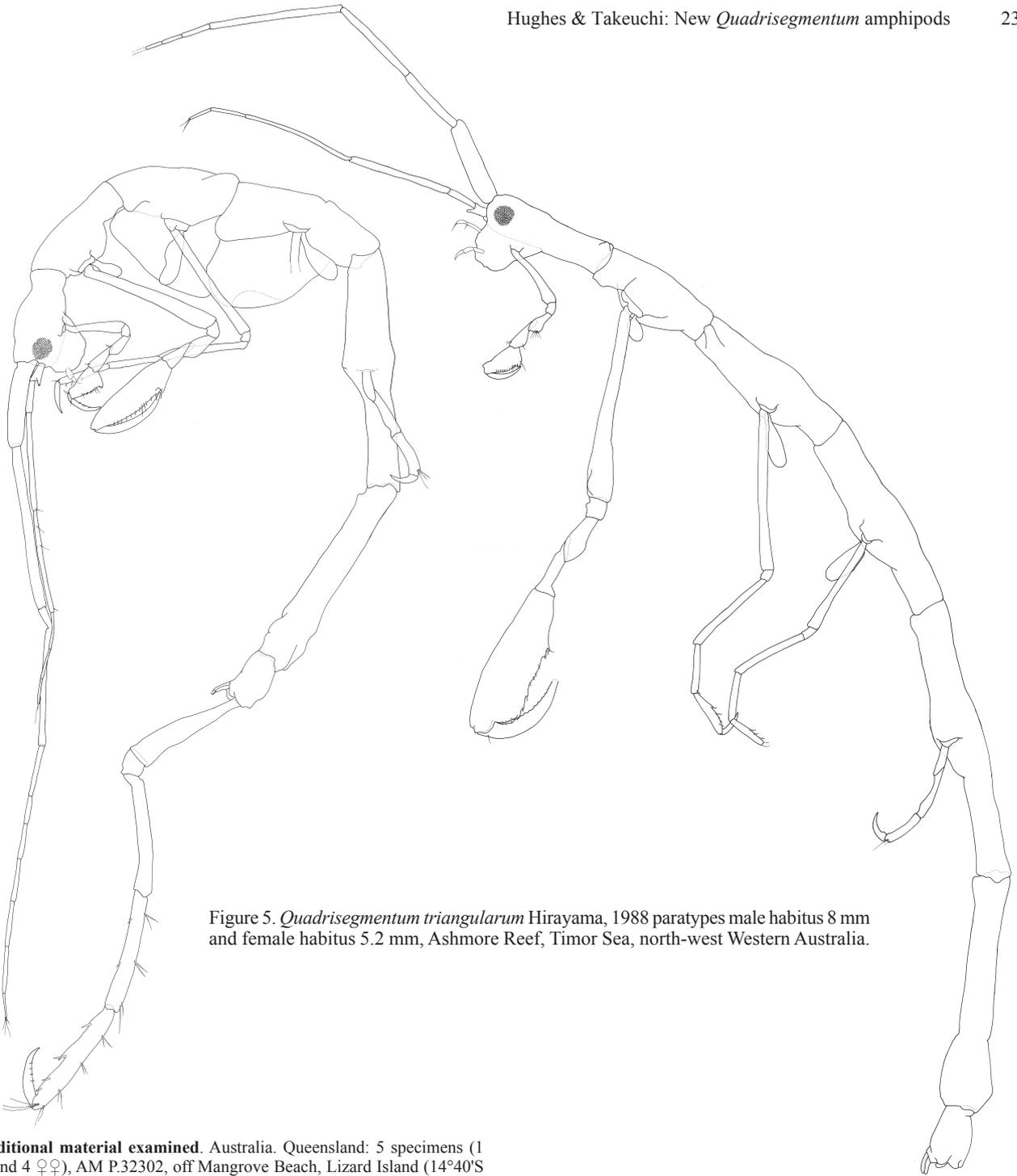


Figure 5. *Quadrisegmentum triangularum* Hirayama, 1988 paratypes male habitus 8 mm and female habitus 5.2 mm, Ashmore Reef, Timor Sea, north-west Western Australia.

**Additional material examined.** Australia. Queensland: 5 specimens (1 ♂ and 4 ♀♀), AM P.32302, off Mangrove Beach, Lizard Island (14°40'S 145°28'E), 2 m, mixed algae from bommie, 28 September 1978, coll. J.K. Lowry (QLD 1); 2 specimens (1 ♂ and 1 ♀), AM P.32314, off southern Point of Mermaid Cove, Lizard Island (14°39'S 145°27'E), 3–6.1 m, filamentous algae with stone washings and scrapings from crevices, 8 October 1978, coll. C. J. Short & P.C. Terrill (QLD-25); 1 ♀, AM P.32318, fringing reef between Bird Islet and South Island, Lizard Island (14°40'S 145°28'E), 25 m, green algae *Halophila* sp. and mixed algae from grass beds off reef base, 9 October 1978, coll. J.K. Lowry (QLD 29); 2 ♂♂, AM P.32320, reefs at western end of Blue Lagoon, Lizard Island (14°40'S 145°28'E), 3 m, sand near artificial reefs, 5 October 1978, coll. P.C. Terrill (QLD 33); 16 specimens (6 ♂♂, 9 ♀♀, 1 juvenile), AM P.32325, Mermaid Cove, Lizard Island (14°40'S 145°28'E), subtidal to 2 m, mixed algae, coral rubble and silt, 14 October 1978, coll. J.K. Lowry (QLD-48); 1 ♀, AM P.32326, off North Point, Lizard Island (14°39'S 145°27'E), 3–6.1 m, red algae (*Galaxaura* sp.) and coral rubble from subtidal caves, 14 October 1978, coll. J.K. Lowry (QLD 49); 9 specimens (7 ♂♂, 1 ♀, 1 juvenile), AM P.32327, off North Point, Lizard Island (14°39'S 145°27'E), 3–6.1 m, mixed algae, 14 October 1978, coll. J.K. Lowry (QLD 50); 7 specimens (4 ♂♂ and 3 ♀♀), AM P.32328, Lizard Island, off North Point, Lizard Island (14°39'S 145°27'E), 6.1 m, green calcareous alga *Halimeda* sp., 14

October 1978, coll. P.C. Terrill (QLD 52); 1 ♂, AM P.61626, Great Barrier Reef, inside outer barrier, Lizard Island (10°34'29"S 143°55'17" E), 15 m, rubble, 16 January 1993, coll. S.J. Keable (QLD 682); 1 ♂, AM P.61712, between Palfrey Island and Lizard Island, western side of Blue Lagoon, Lizard Island (14°41'S 145°27'E), 7 October 2001; 5 specimens (2 ♂♂ and 3 ♀♀), AM P.61713, between Palfrey Island and Lizard Island, western side of Blue Lagoon, Lizard Island (14°41'S 145°27'E), 7 October 2001; 1 ♀, AM P.61714, between Palfrey Island and Lizard Island, western side of Blue Lagoon, Lizard Island (14°41'S 145°27'E), 2–3 m, coral rubble, 7 October 2001, coll. J.M. Guerra-García & S.J. Keable (QLD 1469); 8 specimens (4 ♂♂ and 4 ♀♀), AM P.61715, Coconut Beach, Lizard Island (14°41'S 145°27'E), 6 m, fine live hard coral encrusted with calcareous red algae and filamentous red/green/brown algal turf, 8 October 2001, coll. J.M. Guerra-García & S.J. Keable (QLD 1476); 3 specimens (1 ♀ and 2 juveniles), AM P.61716, Crystal Beach, Lizard Island (14°41'S 145°27'E), 5 m, thick branching coral rubble encrusted with red algal turf and black sponge half buried in sediment, 9 October 2001, coll. J.M. Guerra-García & S.J. Keable (QLD 1483); 1 juvenile, AM P.61717, Crystal Beach, Lizard Island (14°41'S 145°27'E), 4 m, thin branching live coral heavily encrusted

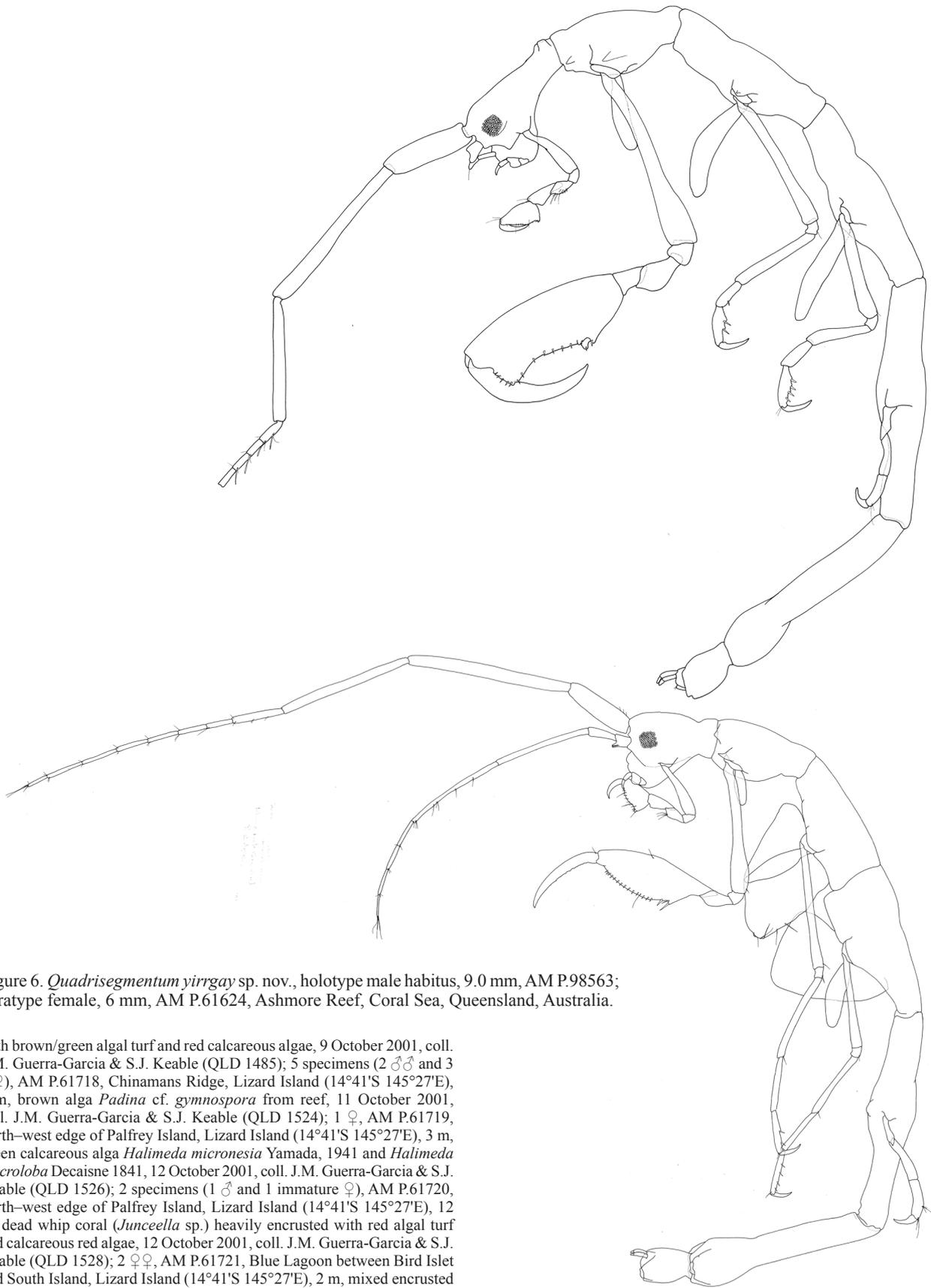


Figure 6. *Quadrisegmentum yirrgay* sp. nov., holotype male habitus, 9.0 mm, AM P.98563; paratype female, 6 mm, AM P.61624, Ashmore Reef, Coral Sea, Queensland, Australia.

with brown/green algal turf and red calcareous algae, 9 October 2001, coll. J.M. Guerra-Garcia & S.J. Keable (QLD 1485); 5 specimens (2 ♂♂ and 3 ♀♀), AM P.61718, Chinamans Ridge, Lizard Island (14°41'S 145°27'E), 2 m, brown alga *Padina* cf. *gymnospora* from reef, 11 October 2001, coll. J.M. Guerra-Garcia & S.J. Keable (QLD 1524); 1 ♀, AM P.61719, north-west edge of Palfrey Island, Lizard Island (14°41'S 145°27'E), 3 m, green calcareous alga *Halimeda micronesia* Yamada, 1941 and *Halimeda macroloba* Decaisne 1841, 12 October 2001, coll. J.M. Guerra-Garcia & S.J. Keable (QLD 1526); 2 specimens (1 ♂ and 1 immature ♀), AM P.61720, north-west edge of Palfrey Island, Lizard Island (14°41'S 145°27'E), 12 m, dead whip coral (*Junceella* sp.) heavily encrusted with red algal turf and calcareous red algae, 12 October 2001, coll. J.M. Guerra-Garcia & S.J. Keable (QLD 1528); 2 ♀♀, AM P.61721, Blue Lagoon between Bird Islet and South Island, Lizard Island (14°41'S 145°27'E), 2 m, mixed encrusted coral rubble, 13 October 2001, coll. J.M. Guerra-Garcia & S.J. Keable (QLD 1536); 1 ♂, AM P.61722, reef slope on south side of South Island, Lizard Island (14°41'S 145°27'E), 20 m, gorgonian (cf. *Paracis* sp.), 14 October 2001, coll. J.M. Guerra-Garcia & S.J. Keable (QLD 1541); many specimens, AM P.61723, reef slope on south side of South Island, Lizard

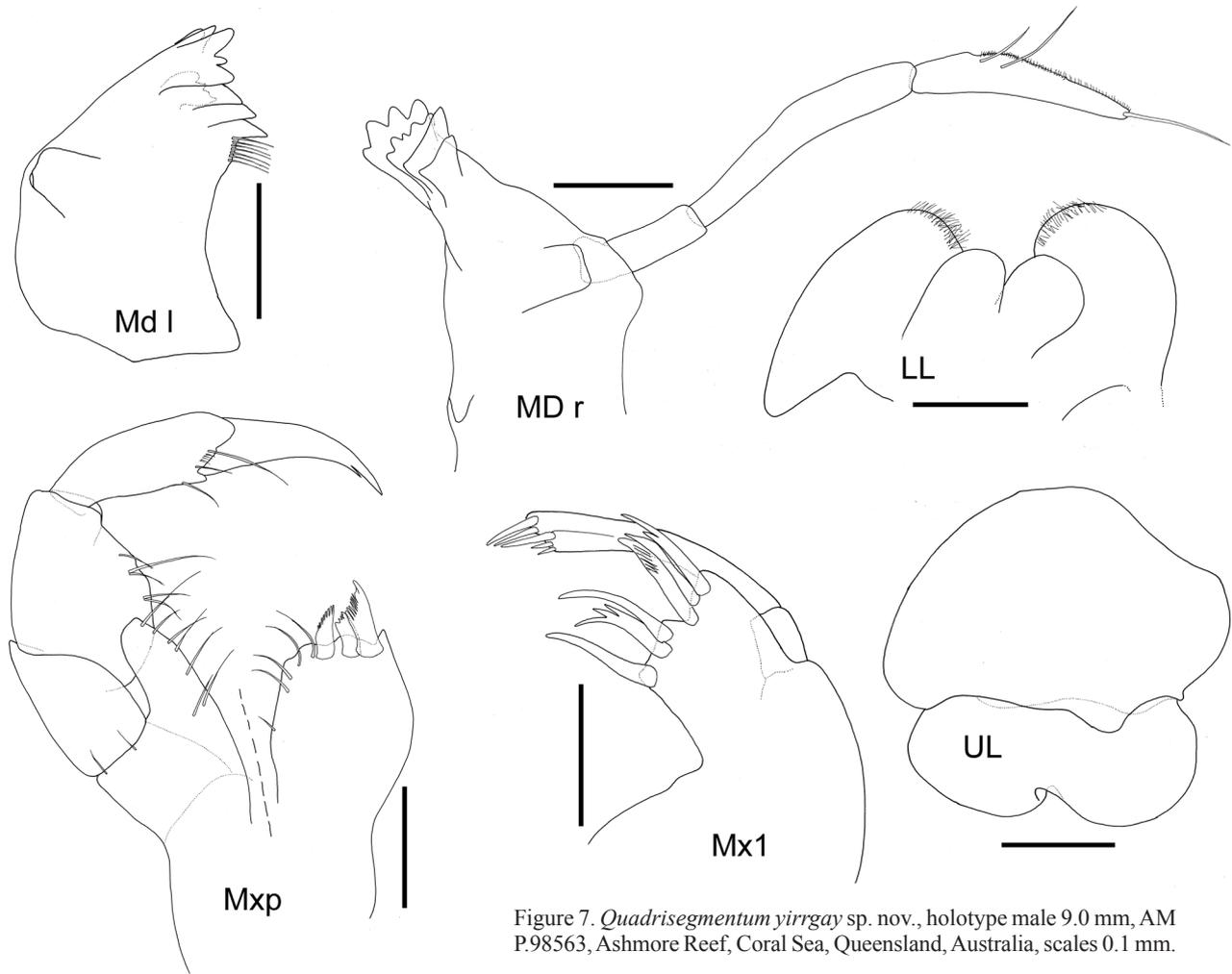


Figure 7. *Quadrisegmentum yirrgay* sp. nov., holotype male 9.0 mm, AM P.98563, Ashmore Reef, Coral Sea, Queensland, Australia, scales 0.1 mm.

Island (14°41'S 145°27'E), 25 m, gorgonian (cf. *Menella* sp.), 14 October 2001, coll. J.M. Guerra-Garcia & S.J. Keable (QLD 1544); 1 ♂, AM P.61724, reef slope on south side of South Island, Lizard Island (14°41'S 145°27'E), 20 m, gorgonian (cf. *Mopsella* sp.), 14 October 2001, coll. J.M. Guerra-Garcia & S.J. Keable (QLD 1545); 2 ♂♂, AM P.61725, north-east side of Lizard Island, reef slope south of "Washing Machine" (14°41'S 145°27'E), 18 m, brown sponge cf. *Clathria reinwardti*, 16 October 2001, coll. J.M. Guerra-Garcia & S.J. Keable (QLD 1565); 1 ♀, AM P.61726, north-east side of Lizard Island, reef slope south of "Washing Machine" (14°41'S 145°27'E), 6 m, green calcareous alga *Halimeda macroloba*, 16 October 2001, coll. J.M. Guerra-Garcia & S.J. Keable (QLD 1568); 1 ♀, AM P.61727, north-east side of Lizard Island, reef slope south of "Washing Machine" (14°41'S 145°27'E), 5 m, sediment with green alga *Halimeda cylindracea* Decaisne 1842, *Udotea* and *Caulerpa* spp., 16 October 2001, coll. J.M. Guerra-Garcia & S.J. Keable (QLD 1569); 2 specimens (1 ♂ and 1 juvenile), AM P.61728, north-east side of Lizard Island, reef slope south of "Washing Machine" (14°41'S 145°27'E), 6 m, mixed silty filamentous red algae and green alga *Caulerpa taxifolia* (M.Vahl) C.Agardh 1817, 16 October 2001, coll. J.M. Guerra-Garcia & S.J. Keable (QLD 1573); 1 ♂, AM P.61729, Pidgin Point, Lizard Island (14°41'S 145°27'E), 20 m, sponge cf. *Clathria reinwardti*, 18 October 2001, coll. J.M. Guerra-Garcia & S.J. Keable (QLD 1581); 1 ♂, AM P.61730, reef just south-west of Osprey Island, Lizard Island (14°41'S 145°27'E), 10–12 m, fine-medium sand with some shell, 18 October 2001, coll. J.M. Guerra-Garcia & S.J. Keable (QLD 1588); 1 mature ♀, AM P.61731, Granite Bluff, Lizard Island (14°40'S 145°28'E), reef rock, 30 August 1976, coll. P.A. Hutchings (25–1); 4 ♂♂, AM P.61732, northern end of Mermaid Beach, Lizard Island (14°41'S 145°27'E), 4 m, brown alga *Padina* sp., 12 October 2001, coll. J.M. Guerra-Garcia & S.J. Keable (QLD 1533).

Tasman Sea: 7 specimens (6 ♂♂ and 1 ♀), AM P.61581, patch reef in lagoon, Middleton Reef, Elizabeth and Middleton Reefs (29°27'36"S 159°06'42"E), prolific coral cover on top of bommie, 6 December 1987

(Site 12); 1 ♂, AM P.61582, The Sound, large alcove near lagoon entrance, Middleton Reef, Elizabeth and Middleton Reefs (29°27'42"S 159°05'24"E), rubble wash, 5 December 1987 (Site 7); 1 ♂, AM P.61475, reef front south of North Passage, straight out from Signal Point, Lord Howe Island (31°31'36"S 159°03'E) coralline algae, coll. G.D. Fenwick, 11 May 1977 (LHA 17).

Papua New Guinea: ♂ 6.1 mm, whole animal SEM pin mount, AM P.97779, The Quarry, near the village of Bunu 2, Madang (4°46'30"S 145°48'E), coral slope with rubble, sand, ascidian *Didemnum molle* (Herdmann, 1886) and sponges, 21 January 1990, coll. J.K. Lowry (PNG 69); ♀ 6.1 mm, AM P.98565, The Quarry, near the village of Bunu 2, Madang (4°46'30"S 145°48'E), coral slope with rubble, sand, ascidian *Didemnum molle* and sponges, 21 January 1990, coll. J.K. Lowry (PNG 69); 3 specimens (2 ♂ and 1 mature ♀), AM P.61534, base of reef slope, outer face, Horseshoe Reef, Bootless Inlet (9°30'30"S 147°15'30"E) green calcareous alga *Halimeda opuntia* (Linnaeus) J.V. Lamouroux 1816, 28 October 1980, coll. S.P. Arnam & J.K. Lowry (PNG-23); 1 mature ♀, AM P.61533, Horseshoe Reef, Bootless Inlet (9°30'30"S 147°15'30"E) coral rubble from reef front slope, 29 October 1980, coll. S.P. Arnam & J.K. Lowry (PNG-32); 1 ♂, AM P.61536, Horseshoe Reef, Port Moresby (9°36'30"S 147°17'54"E) gorgonian, 2 November 1980, coll. A.J. Bruce (AJB 206); 4 specimens (3 ♂♂ and 1 damaged juvenile), AM P.61537, Lion Island, Manunouma Islands (9°32'17"S 147°06'13"E), gorgonian, 5 November 1980, coll. A.J. Bruce (AJB-208); 4 specimens (3 ♂♂ and 1 mature ♀), AM P.61535, outside Horseshoe Reef, Bootless Inlet (9°30'30"S 147°17'30"E), crinoids from outer reef face, 9 November 1980, coll. S.P. Arnam & J.K. Lowry (PNG-63); 74 specimens, AM P.61531, The Quarry, near the village of Bunu 2 (4°46'30"S 145°48'E), coral slope with rubble, sand, ascidian *Didemnum molle* and sponges, 21 January 1990, coll. J.K. Lowry (PNG 69); 1 ♂, AM P.61532, The Quarry, near the village of Bunu 2 (4°46'30"S 145°48'E), coral slope with rubble, sand and black sponge, coll. J.K. Lowry, 21 January 1990 (PNG 68).

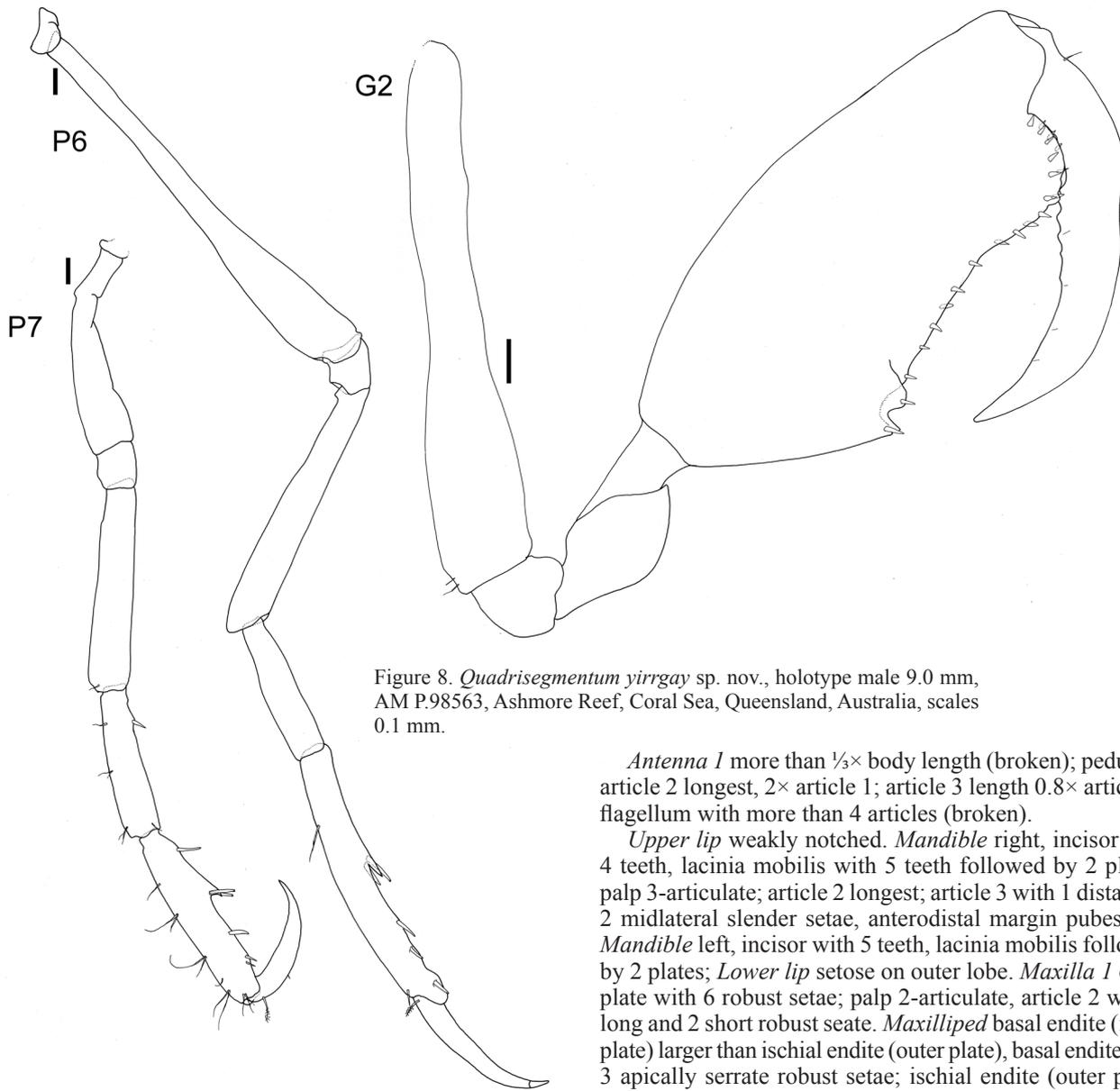


Figure 8. *Quadrisegmentum yirrgay* sp. nov., holotype male 9.0 mm, AM P.98563, Ashmore Reef, Coral Sea, Queensland, Australia, scales 0.1 mm.

*Antenna 1* more than  $\frac{1}{3}$  body length (broken); peduncle article 2 longest,  $2\times$  article 1; article 3 length  $0.8\times$  article 2; flagellum with more than 4 articles (broken).

*Upper lip* weakly notched. *Mandible* right, incisor with 4 teeth, lacinia mobilis with 5 teeth followed by 2 plates; palp 3-articulate; article 2 longest; article 3 with 1 distal and 2 midlateral slender setae, anterodistal margin pubescent. *Mandible* left, incisor with 5 teeth, lacinia mobilis followed by 2 plates; *Lower lip* setose on outer lobe. *Maxilla 1* outer plate with 6 robust setae; palp 2-articulate, article 2 with 3 long and 2 short robust setae. *Maxilliped* basal endite (inner plate) larger than ischial endite (outer plate), basal endite with 3 apically serrate robust setae; ischial endite (outer plate) margin with several slender setae; palp 4-articulate; article 2 lateral expanded, with 5 setae; article 3 with sub-triangular distal projection.

**Type locality.** Ashmore Reef, off Great Barrier Reef, Coral Sea, Queensland, Australia ( $10^{\circ}26'16''\text{S } 144^{\circ}25'47''\text{E}$ ). (The present "Ashmore Reef" is the different "Ashmore Reef", Timor Sea, north-west Western Australia, type locality for *Q. triangulum*)

**Etymology.** "Yirrgay" is the lost spoken language of a coastal indigenous group in Far North Queensland. Applied as a noun in apposition.

**Description.** (Based on holotype ♂, body length 9.0mm, AM P.98563 and male, body length, 6.1 mm, SEM AM P.97779 for abdomen).

**Body Somites** sub-slender. *Head and pereonite 1* combined, completely fused, suture absent, with pair of apically truncate dorsodistal projections. *Pereonite 2*, with small acute anterolateral projection and larger acute mid lateral projection. *Pereonite 3*, with minute mid-lateral projection. *Pereonites 4–6* without anterior or mid-lateral projections

**Pereon.** *Gnathopod 1* basis similar in length to ischium, merus and carpus combined; carpus subequal to merus length, posterior margin with slender setae; propodus triangular; palm defined by prominent, curved, bifid process with 2 apical robust setae; dactylus falcate, inner margin lined with setules. *Gill 2* subovate, length  $0.6\times$  pereonite 2 length. *Gnathopod 2* begins  $\frac{1}{3}$  along posterior margin of pereonite 2; basis length  $1.4\times$  pereonite 2 length,  $2.1\times$  ischium, merus and carpus combined; merus subrectangular, distally swollen (length  $2\times$  width), longer than to carpus; carpus subrectangular (length  $2\times$  width); propodus subovate, longer than wide (length  $2.1\times$  width); palm 60% of posterior margin, 3 proximal projections each with robust seta.

*Gill 3* elongate, length  $0.6\times$  pereonite 3. *Pereopod 3* basis longest,  $0.4\times$  pereopod 3 length; ischium  $0.1\times$  basis length; merus  $0.7\times$  basis length; carpus  $0.25\times$  basis length; propodus  $1.1\times$  carpus length with 2 large robust setae along palm, dactylus recurved. *Gill 4* subequal to gill 3. *Pereopod*

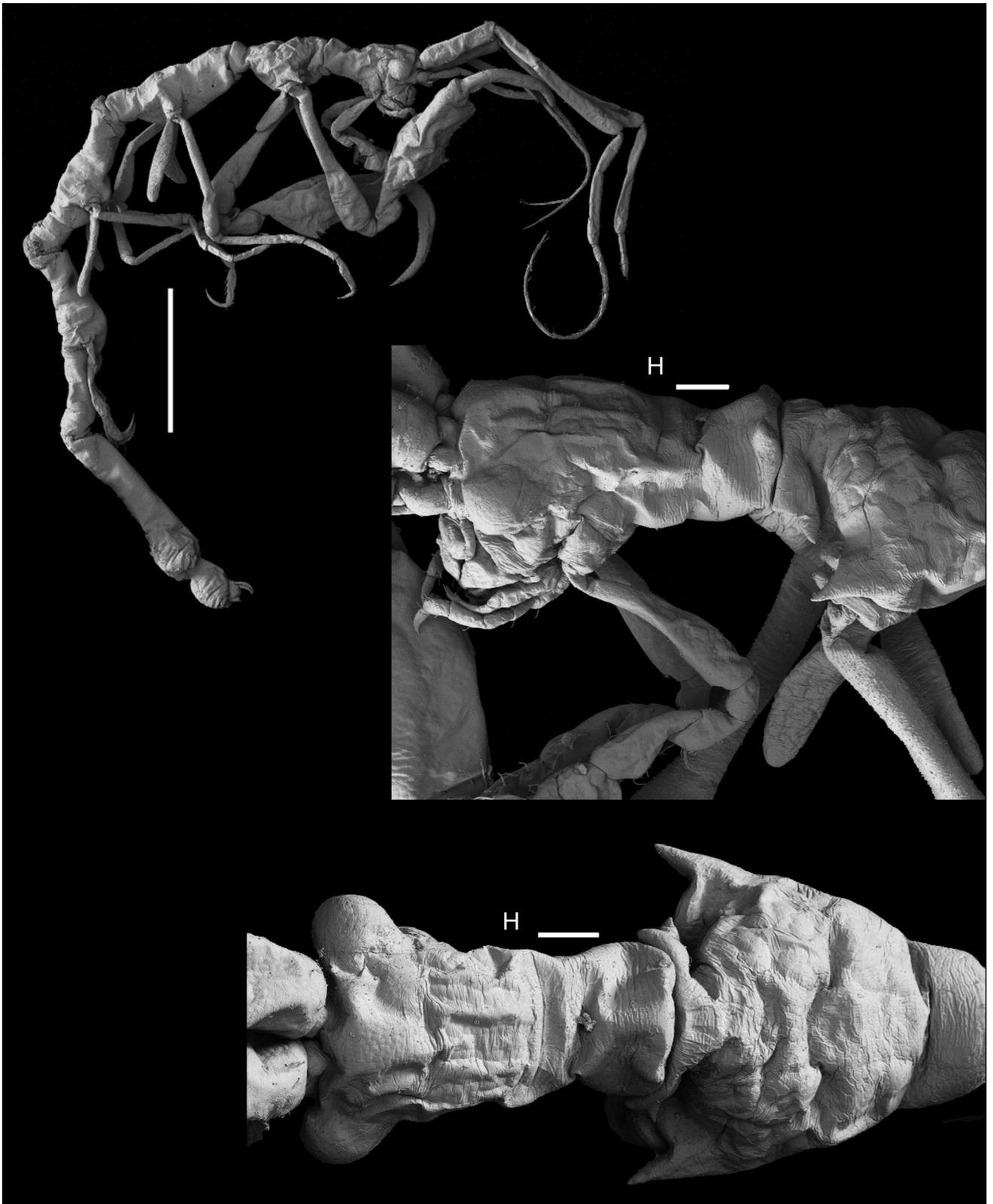


Figure 9. *Quadrisegmentum yirrgay* sp. nov., male, 6.1 mm, AM P.97779, Madang, Papua New Guinea, scales habitus 1 mm, all other scales 100  $\mu$ m.

4 shorter than pereopod 3, length  $0.30 \times$  body; basis longest,  $0.6 \times$  pereopod 3 length; ischium  $0.25 \times$  basis length; merus  $0.6 \times$  basis length; carpus  $0.3 \times$  basis length; propodus longer than carpus, length  $1.1 \times$  carpus with 4 large robust setae along palm; dactylus recurved.

*Pereopod 5* article 1 length  $0.9 \times$  article 2; article 2 longest,  $1.1 \times$  article 3; dactylus recurved. *Pereopod 6* basis longest,  $0.37 \times$  pereopod 6 length; ischium  $0.08 \times$  basis length; merus  $0.6 \times$  basis length; carpus  $0.33 \times$  basis length, anterior margin without robust setae; propodus  $0.6 \times$  basis length, anterior

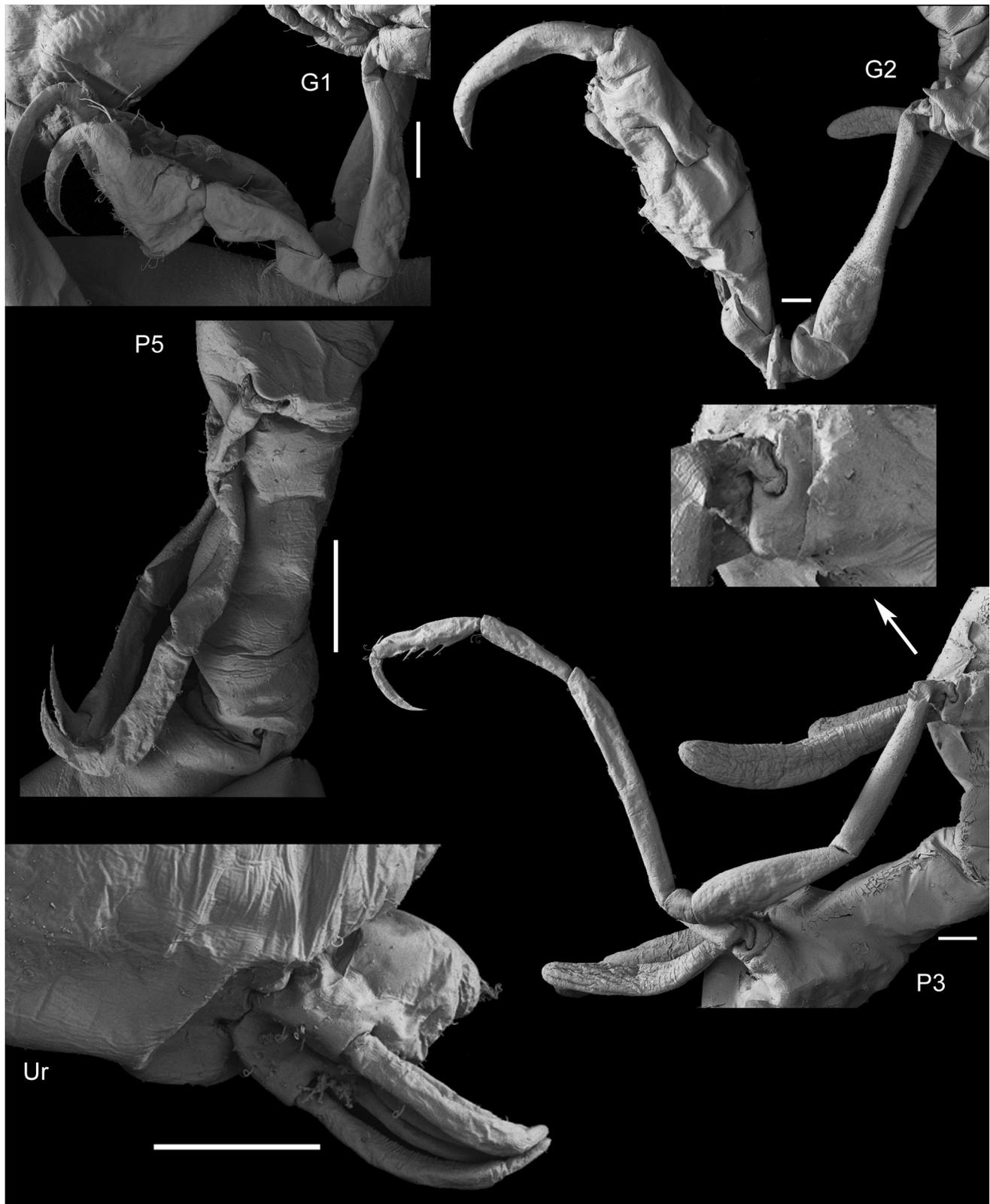


Figure 10. *Quadrisegmentum yirrgay* sp. nov., male, 6.1 mm, AM P.97779, Madang, Papua New Guinea, scales Ur 20 µm, all other scales 100 µm.

margin with 4 groups of long robust setae (proximal group only with paired robust setae); dactylus recurved. *Pereopod* 7 0.8× *pereopod* 6; basis 0.27× *pereopod* 7 length; ischium 0.25× basis length; merus length subequal to basis; carpus 0.65× basis length, anterior margin with 1 robust seta; propodus 0.8× basis length, anterior margin with 3 groups

of long robust setae (middle group only with paired robust setae) and distal small robust setae; dactylus recurved.

**Pleon.** *Uropod* 1 elongate, without setae (broken). *Uropod* 2 (broken). *Telson* small, with a pair of setae (Based on SEM AM P.97779).

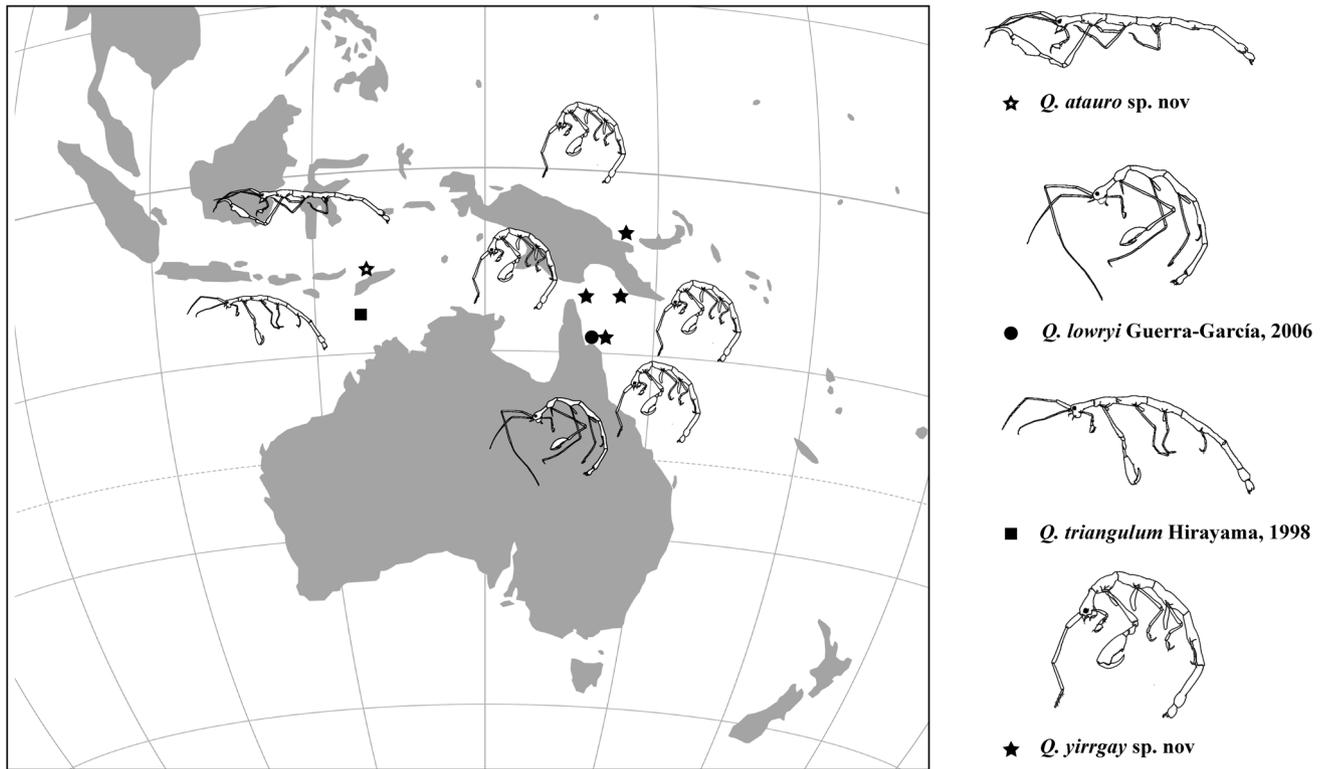


Figure 11. Distribution of world species of *Quadrisegmentum* Hirayama, 1988.

**Female.** (based on paratype AM P.61624). *Pereonite 2* with small anterolateral and small acute mid-lateral projections. *Pereonite 4* with rounded anterolateral projection. *Antenna 1* long  $0.75 \times$  body length; article 2 longest,  $2 \times$  article 1 length; flagellum with 8 articles. *Antenna 2* shorter than antenna 1; flagellum 4-articulated, length  $\frac{1}{2} \times$  antenna 1.

**Remarks.** See remarks for *Q. atauru* sp. nov.

**Distribution.** Australia: Ashmore Reef, Coral Sea, Lizard Island (current study; Guerra-García, 2006; Guerra-García & Lowry, 2009). Lord Howe Island. (Guerra-García, 2006). Elizabeth and Middleton Reef (Guerra-García, 2006). Papua New Guinea: Motupore Island, Manunouma Islands, Port Moresby and Madang (Guerra-García, 2003).

### Key to species of *Quadrisegmentum* Hirayama, 1988

- |   |                                                                                                                        |                            |
|---|------------------------------------------------------------------------------------------------------------------------|----------------------------|
| 1 | Gnathopod 2 merus extremely elongate, more than 5 times carpus length (in males and females) .....                     | <i>Q. lowryi</i>           |
| — | Gnathopod 2 merus not elongate, similar or up to twice carpus length (in males and females) .....                      | 2                          |
| 2 | <i>Pereonite 2</i> without dorsal projections; pereonites 1–3 gills short, subovate .....                              | <i>Q. triangulum</i>       |
| — | <i>Pereonite 2</i> with anterolateral and/or mid-lateral projections; pereonites 1–3 gills elongate, rectilinear ..... | 3                          |
| 3 | Male gnathopod 2 carpus shorter than merus; pereopod 6 carpus without robust setae (in males) .....                    | <i>Q. yirrgay</i> sp. nov. |
| — | Male gnathopod 2 carpus subequal to merus length; pereopod 6 carpus with 2 robust setae (in males) .....               | <i>Q. atauru</i> sp. nov.  |

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