

A new palaemonid shrimp of the “*Philarius gerlachei* (Nobili, 1905) species complex” (Crustacea: Decapoda: Palaemonidae) from Hainan Island, South China Sea

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Abstract. A new species of the coral-associated palaemonid shrimp, *Philarius venustus*, is described and illustrated based on a single male specimen collected from Sanya, Hainan Island, China. The new species could be distinguished from the congeneric species by a series of morphological features and the unique colour pattern. The COI barcode was obtained from the material and submitted to GenBank.

Key words. Palaemonidae, *Philarius*, new species, coral-associated, Hainan Island

INTRODUCTION

A palaemonid shrimp, living as a commensal on a scleractinian coral of the genus *Acropora*, was collected during the recent survey of coral-associated organisms from Sanya, Hainan Island. After careful examination, the specimen was confirmed to belong to the genus *Philarius* Holthuis, 1952, which is characterised by the possession of a broad triangular median process on the fourth thoracic sternite, the absence of a mandibular palp, a hepatic spine, and an arthrobranch on the third maxilliped, and the simple, strongly curved dactylus of the last three pereopods. Furthermore, in the absence of a supraorbital spine and a tooth on the carpus of the second pereopods, the specimen falls into the “*Philarius gerlachei* (Nobili, 1905) species complex”, which was successively revised by Marin & Anker (2011), Marin (2012) and Mitsunashi (2012). However, the specimen can be distinguished from the other seven species of this complex by its unique colour pattern and several morphological characters mainly in the rostrum and pereopods. Therefore, the specimen was identified as a new species of the genus and described and illustrated herein.

MATERIAL AND METHODS

The specimen was collected from colonies of the slender-branched species of the genus *Acropora* Oken, 1815 (Scleractinia, Acroporidae), by scuba diving on the coral reefs of Sanya, Hainan Island. The specimen was examined, measured, and illustrated under a Zeiss SteREO Discovery

V8 stereomicroscope. The type specimen is preserved in 75% ethanol and deposited in the Marine Biological Museum, Chinese Academy of Sciences (MBMCAS), Qingdao, China. The DNA extraction and COI gene amplification followed the protocol provided by Franssen & Reijnen (2012). Then the sequence was submitted to GenBank.

Abbreviations used in the article: CL = carapace length, measured from the level of the posterior margin of the orbit to the midpoint of the posterior margin of the carapace; BL = body length, measured from the level of the posterior margin of the orbit to the end of the telson; P = pereopod; coll. = collector.

TAXONOMY

Family Palaemonidae Rafinesque, 1815

Genus *Philarius* Holthuis, 1952

Philarius venustus, new species (Figs. 1–6)

Material examined. Holotype: 1 male, MBM 283036 (CL 2.8 mm, BL 9.2 mm), Houhai, Sanya, Hainan Island, China, 18°16'33"N, 109°43'40"E, 2–8 m depth, from *Acropora* sp., coll. X. Z. Li, 27 November 2014.

Description. Small-sized palaemonid shrimp with subcylindrical body form (Figs. 1A, 6A, B). Carapace (Figs. 1A–C, 2A) smooth, glabrous; supraorbital rim rounded; epigastric, hepatic, supraorbital spines absent; inferior orbital angle produced, rounded, reaching middle of antennal spine; antennal spine acute, marginal; pterygostomial angle bluntly produced anteriorly. Rostrum (Figs. 1A–C, 2A) well developed, compressed, slightly upcurved distally, not reaching distal margin of scaphocerite; dorsal carina with

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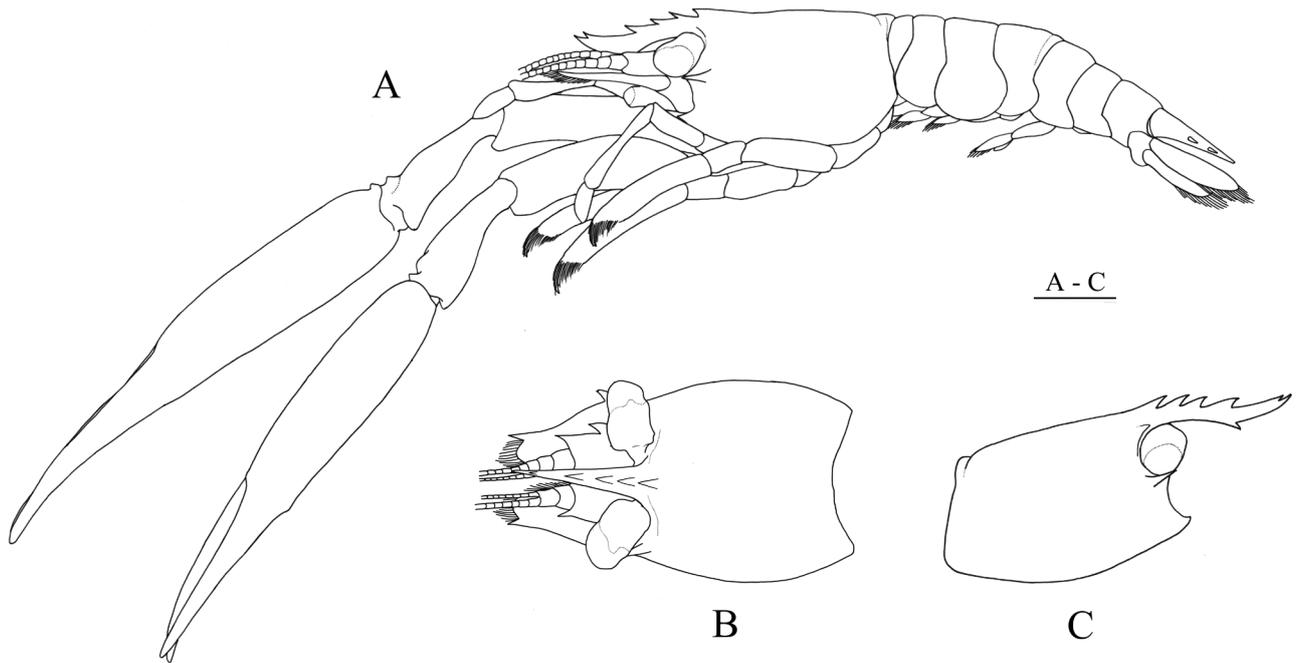


Fig. 1. *Philarius venustus*, new species. Holotype, male (CL 2.8 mm). A, body, lateral; B, carapace and cephalic appendages, dorsal; C, carapace, lateral. Scale bar = 1 mm.

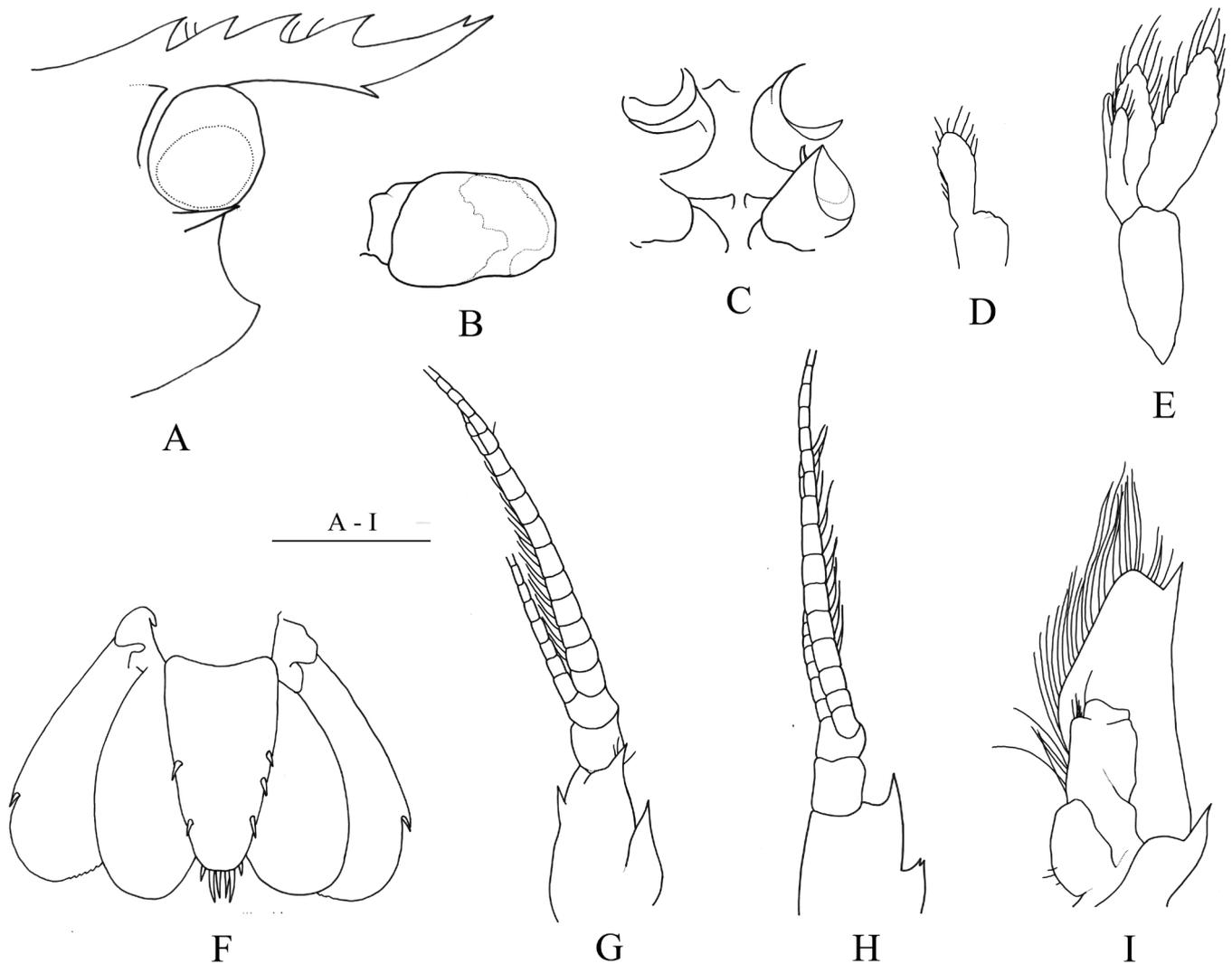


Fig. 2. *Philarius venustus*, new species. Holotype, male (CL 2.8 mm). A, anterior part of carapace, lateral; B, eye, lateral; C, fourth and fifth thoracic sternites and bases of first and second pereiopods; D, endopod of first pleopod, ventral; E, second pleopod, ventral; F, telson and uropods (setae omitted), dorsal; G, left antennule, lateral; H, right antennule, dorsal; I, left antenna, ventral. Scale bar = 1 mm.

five teeth, posterior four teeth almost equidistant, acute, distalmost tooth separated from second tooth, posteriormost tooth inconspicuous, situated right above orbital margin; ventral carina with single acute tooth situated right beneath second anterior dorsal tooth; proximolateral carina without supraocular lobe.

Fourth thoracic sternite (Fig. 2C) with broad triangular median process; fifth thoracic sternite (Fig. 2C) with transverse ridge with median notch.

Abdominal somites (Fig. 1A) smooth, glabrous; pleura of first to third somites broadly rounded; fifth somite posteriorly produced, angled; sixth somite about 1.5 times of fifth somite.

Telson (Fig. 2F) about 1.8 times as long as sixth abdominal somite, tapering posteriorly, 2.1 times as long as greatest width; two dorsolateral spines situated at 0.53 and 0.83 of telson length on left side, three dorsolateral spines situated at 0.47, 0.63 and 0.80 of telson length on right side, dorsolateral spines slender, anteriormost spine on right side smallest.

Eyes (Fig. 2B) well developed, cornea globular, without accessory pigment spot; eyestalk about as long as wide, slightly wider than cornea.

Antennular peduncle (Figs. 1B, 2G, H) reaching to about level of fifth dorsal rostral tooth; stylocerite acute, with (right) or without (left) a subdistal tooth, reaching to middle of basal segment; distolateral spine of basal segment not overreaching to intermediate segment; submarginal ventral tooth distinct, small; intermediate segment about as long as wide; distal segment slightly wider than long; upper flagellum biramous, proximal 10 (left) or 9 (right) segments fused.

Antenna (Figs. 1B, 2I) with stout basicerite armed with sharp, triangular, distoventral tooth, overreaching distal margin of the segment; carpocerite extending to middle of scaphocerite; scaphocerite reaching to tip of rostrum, about 2.5 times as long as maximal width, lateral margin concave, distolateral tooth acute, overreaching distal margin of lamina, about 0.15 of scaphocerite length.

Epistome unarmed.

Mouthparts typical for genus. Mandible (Fig. 3A) without palp; molar process with four strong blunt teeth and several tiny teeth; incisor process robust, with three acute teeth. Maxillula (Fig. 3B) with single curved palp; upper lacinia slender, straight, distal margin armed with stout setae and about 10 articulate spines in two rows; lower lacinia tapering, with long simple setae. Maxilla (Fig. 3C) with simple palp, slender, tapering, with several plumose setae on lateral margin; basal endite simple, about 1.4 times longer than palp, with simple setae on distal margin; scaphognathite broad, with numerous marginal plumose setae. First maxilliped (Fig. 3D) with short palp, slender, medial margin with four short plumose setae; basal endite broad, with dense marginal setae, coxal endite without setae; exopod with well-developed flagellum, bearing long plumose setae along its distal borders;

caridean lobe small; epipod large, triangular, feebly bilobed. Second maxilliped (Fig. 3E) with normal endopod; dactylar segment narrow, about 4.5 times longer than wide, medial margin slightly concave, with dense rows of simple spines medially; propodal segment with anteromedial margin bluntly produced, bearing long setae and several simple spines; carpus short, anteromedially angulate; merus distal slender; ischium and basis completely fused; exopod with well-developed flagellum; coxa inflated medially; epipod large, subrectangular, without podobranch. Third maxilliped (Fig. 3F) with slender endopod reaching to mid-length of scaphocerite; ischio-merus and basis almost fused, only separated by a notch in median margin; antepenultimate segment about three times as long as central width, medial margin with numerous long simple setae; penultimate segment about 0.6 of length of antepenultimate segment, tapering slightly distally, with three simple spines and groups of short stout setae medially; terminal segment tapering distally, about 0.9 of length of penultimate segment with transverse rows of stout setae; exopod with well-developed flagellum, distally with long plumose setae; coxal plate sub-oval, with several setae; arthrobranch absent.

First pereiopod (Figs. 4A, B) moderately slender, chela and distal half of carpus over-reaching distal margin of scaphocerite; palm (Fig. 4B) subcylindrical, slightly longer than dactylus, ventral and dorsal margin with sparse transverse rows of setae; dactylus and fixed finger tapering, fixed finger with dense setae and more scattered setae on outer surface, dactylus bearing sparse transverse rows of setae; cutting edges entire; carpus widening distally, about 2.4 times of chela length, about five times as long as distal width, with row of setae at subdistal margin; merus about twice length of chela, five times longer than width; ischium about 0.8 of chela length; basis and coxa without special features.

Second pereiopod (Figs. 1A, 4C–E, 5A–C) large, similar, subequal in size, about 1.6 times of BL, overreaching distal margin of scaphocerite by chela, carpus and half length of merus when extended anteriorly; left chela (Fig. 4C) about 2.5 times CL, right chela (Fig. 4D, E) about 2.6 times CL; palm smooth, glabrous, subcylindrical, not swollen proximally, about 1.1 times as long as dactylus, three times longer than deep; fingers slender, tapering, with robust hooked tip, outer aspect bearing several short setae; dactylus about five times longer than proximal depth, tapering distally, with well-developed hooked tip, proximal 2/3 of cutting edge of dactylus with six low, blunt teeth and long setae along cutting edge; fixed finger similar; carpus (Figs. 4C, D, 5A–C) slender proximally and expanded distally, cup-shaped, about 0.5 times as long as palm, distal margin not strongly flaring, without distal tooth or blunt projections but notched dorsally and with rounded lobe ventrally; merus about 1.2 times as long as carpus, 3.2 times as long as width, distoventral margin feebly angulate; ischium about 0.6 times as long as merus, twice as long as distal width.

Third pereiopod (Figs. 1A, 4F) robust, tip overreaching distal margin of scaphocerite when extended anteriorly; merus

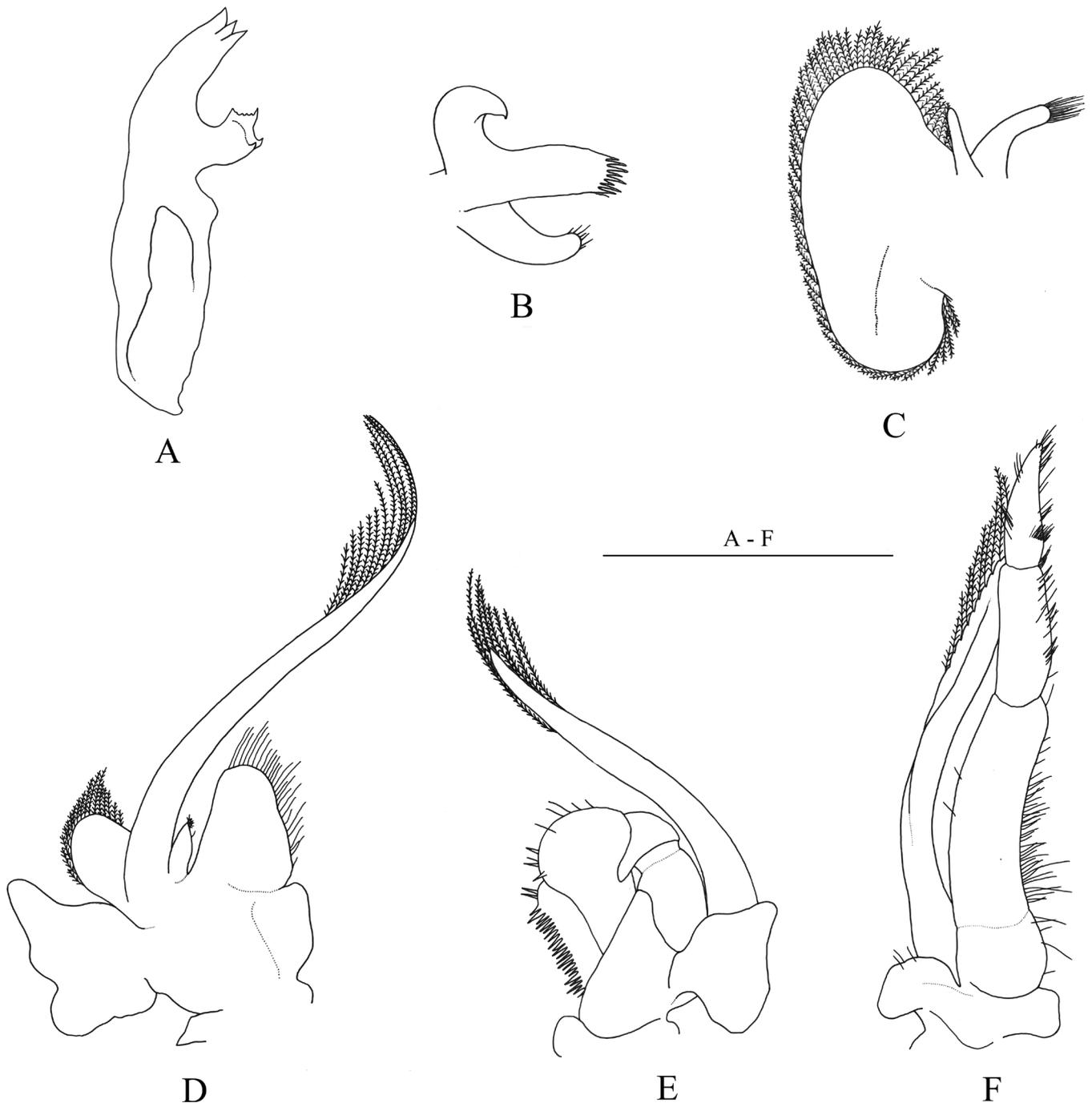


Fig. 3. *Philarius venustus*, new species. Holotype, male (CL 2.8 mm). A, mandible, dorsal; B, maxillula, ventral; C, maxilla, ventral; D, first maxilliped, ventral; E, second maxilliped, dorsal; F, third maxilliped, ventral. Scale bar = 1 mm.

unarmed, about twice as long as carpus, 3.2 times as long as width; carpus unarmed, about 1.8 times as long as distal width; propodus smooth, about twice as long as carpus, five times as long as width, distal margin with groups of long setae, longest setae overreaching entire dactylus, distal 1/3 of ventral surface of propodus with tufts of long simple setae; dactylus about 0.35 of propodal length, simple, strongly curved, unguis distinctly demarcated. Fourth and fifth (Fig. 4G, H) pereopods similar.

Pleopods well developed, first pleopod without appendix intema on endopod (Fig.2D), endopod about four times

as long as width, half length of exopod; second pleopod (Fig.2E) with appendix masculina moderately stout, about 3.2 times as long as wide, about 0.8 length of appendix interna and bearing seven long setae, second to fifth pleopods with appendix interna about 0.4 times of endopod length, endopod 0.9 times as long as exopod.

Uropods (Fig. 2F) normal; protopodite unarmed laterally; exopod broad, overreaching distal margin of telson, about 1.8 times longer than wide, lateral margin straight, terminating in short distolateral tooth and small mobile spine; endopod about 0.9 times as long as exopod, 2.2 times as long as width.

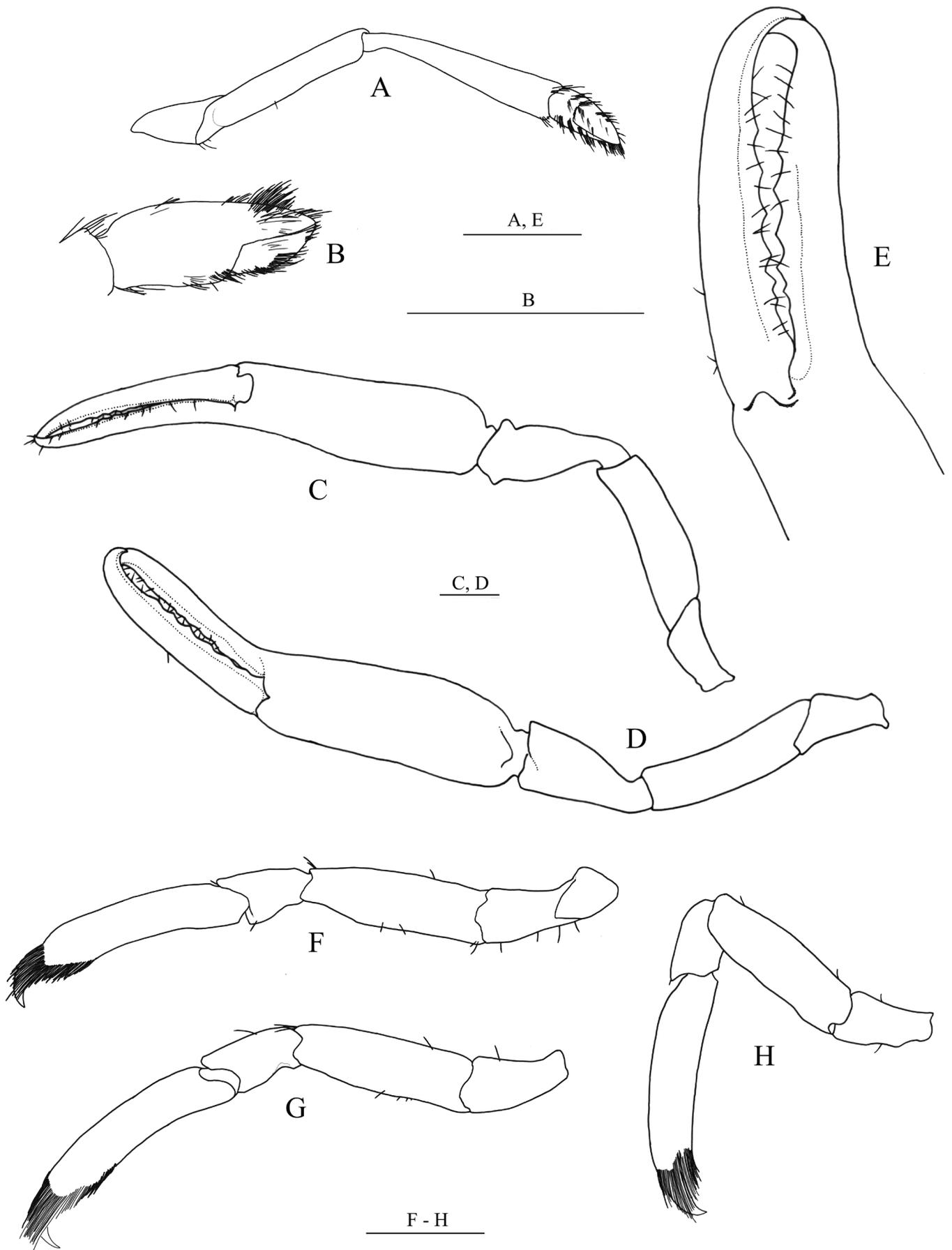


Fig. 4. *Philarius venustus*, new species. Holotype, male (CL 2.8 mm). A, right first pereiopod, ventral; B, same, chela, lateral; C, left second pereiopod, ventral; D, right second pereiopod, lateral; E, same, fingers, lateral; F, right third pereiopod, medial; G, left fourth pereiopod, lateral; H, left fifth pereiopod, lateral. Scale bars = 1 mm.

DISCUSSION

Colouration. Body generally semitransparent, whitish (Fig. 6A, B). Carapace sparsely covered with minute bronze spots. Abdomen and telson colourless, without stripes or patches. Eyes with cornea black. Dorsal margin of eyestalk with a yellowish longitudinal stripe. Antennular and antennal flagella semitransparent, colourless, without colour stripes. Second pereiopods mainly whitish, without lateral longitudinal colour stripes, finely speckled with bronze and black adjacent to joints, fingers with semitransparent, yellowish cutting edges. First and third to fifth pereiopods without longitudinal colour stripes, only with several minute unnoticeable blackish spots.

Host. The new species was found in association with slender-branched scleractinian corals, *Acropora* sp. (Fig. 6C). Specimens of *Philarius imperialis* (Kubo, 1940) were collected from the same spot during the sampling.

Etymology. From Latin *venustus*, meaning elegant, indicating the whitish and glabrous body and the palms of the second pereiopods of the species.

Distribution. Currently only known from the type locality, Hainan Island at a depth of 2–8 m.

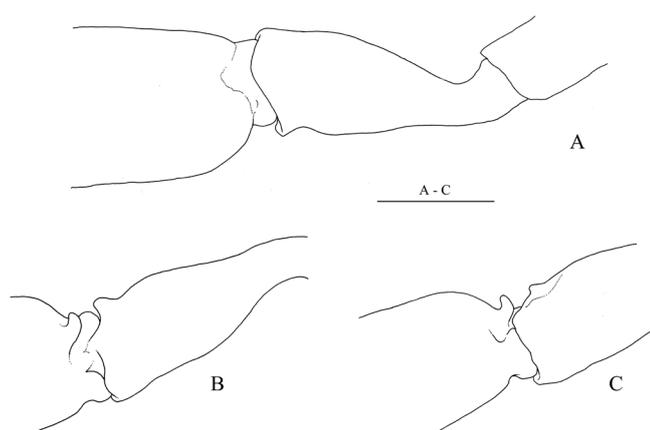


Fig. 5. *Philarius venustus*, new species. Holotype, male (CL 2.8 mm). A, right second pereiopod, carpus, ventral; B, same, dorsal; C, same, lateral. Scale bar = 1 mm.

Presently, the genus *Philarius* includes nine valid species (Marin & Anker, 2011; Marin, 2012; Mitsuhashi, 2012). *Philarius venustus*, new species, can be distinguished from *P. lifuensis* (Borradaile, 1898) by the absence of a supraorbital spine. It differs from *P. imperialis* (Kubo, 1940) by the absence of a strong tooth on the carpus of the second pereiopods. The remaining seven species, also lack these two morphological features and, as such, are considered to belong to the “*P. gerlachei* (Nobili, 1905) species complex” together with *P. venustus*.

Within this species complex, *P. venustus*, new species, most resembles *P. polynesianus* Marin & Anker, 2011, in the following morphological characters: rostrum with five dorsal teeth (four or five in *P. polynesianus*), tip not reaching distal margin of scaphocerite blade and the supraocular lobes absent. The two species also inhabit similar hosts (slender-branched species of the genus *Acropora*) and occur at similar depths. However, *P. venustus*, new species, is different from *P. polynesianus* in having fewer segments of the antennular flagellum fused, relatively longer fingers of the second pereiopods, no dense cover of setae on the palms of the second pereiopods, and no yellow-greenish longitudinal stripes along the appendages (Marin & Anker, 2011: fig. 9A–E).

Philarius venustus, new species, is also closely similar to *P. condi* Marin, 2012 with the rostrum not reaching the distal margin of the scaphocerite blade, having a similar number of fused segments of the antennular flagellum and considerably long fingers of the second pereiopods. However, *P. venustus*, new species, can be distinguished from *P. condi* by the additional rostrum dorsal teeth, the slender palm of the chela, which is not swollen proximally, the absence of dark purple longitudinal stripes along appendages and dorsal aspect of the eyestalk (Marin, 2012: fig. 4A–F), and the dissimilar hosts and habitats (see Marin, 2012).

Apart from *P. polynesianus* and *P. condi*, *P. venustus*, new species, is also similar to *P. gerlachei* (Nobili, 1905) and *P. minor* Marin & Anker, 2011, to some extent. Except for

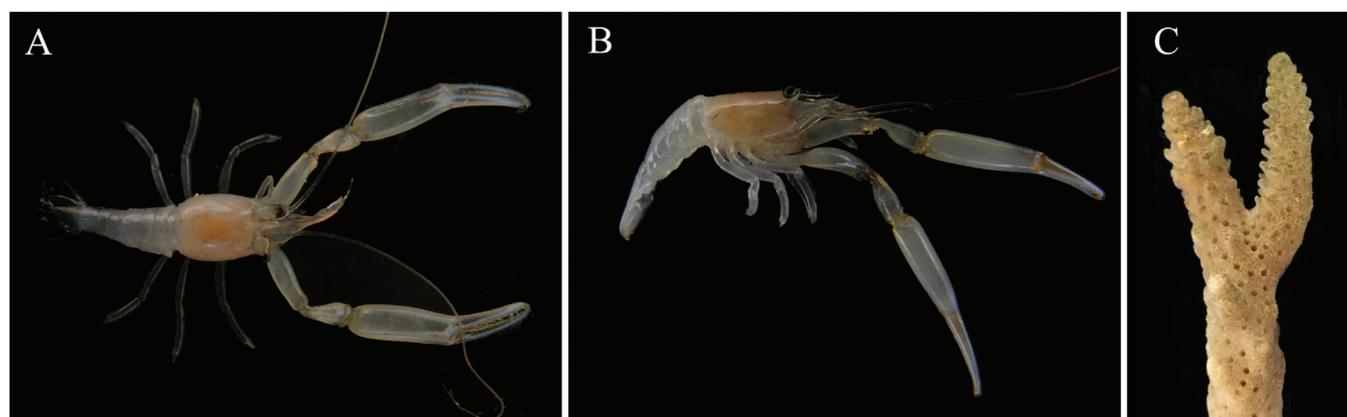


Fig. 6. Fresh colouration of the holotype male of *Philarius venustus*, new species [A, B] and the partial enlargement of its host coral [C]. A, dorsal view; B, lateral view; C, a branch of slender-branched coral *Acropora* sp. (Photographs by: Dong Dong, Yueyun Wang and Jixing Sui).

Table 1. Comparison of morphological characters among the species of the “*Philarius gertachei* complex”, according to the description, figures or photographs from Bruce (1982), Marin & Anker (2011), Marin (2012) and Mitsuhashi (2012).

Species	<i>P. gertachei</i> (Nobili)	<i>P. polynesianus</i> Marin & Anker	<i>P. rufus</i> Marin & Anker	<i>P. minor</i> Marin & Anker	<i>P. albimaculatus</i> Marin & Anker	<i>P. condi</i> Marin	<i>P. rufulus</i> Mitsuhashi	<i>P. venustus</i> sp. nov.
Rostral dentition*	0+4/1	0+4-5/1	1+4/1	0+4/1	1+6/1	0+4/1	0+5/2	0+5/1
Rostrum tip	Not reaching distal margin of scaphocerite blade	Not reaching distal margin of scaphocerite blade	Overreaching distal margin of scaphocerite blade	Overreaching distal margin of scaphocerite blade	Overreaching distal margin of scaphocerite blade	Not reaching distal margin of scaphocerite blade	Not reaching distal margin of scaphocerite blade	Not reaching distal margin of scaphocerite blade
Supraocular lobe	Absent	Absent	Absent	Present	Absent	Absent	Absent	Absent
Number of fused segments of antennular flagellum	~25	~16	~11	~8	5	10-12	11, 12	9, 10
Shape of scaphocerite: length / greatest width	Slender, ~2.9	Broad, ~2.4	Slender, ~3.0	Broad, ~2.1	Broad, ~2.4	Moderate, ~2.7	Broad, ~2.3	Broad, ~2.3
Length ratio between big chela and carapace	~2.2	~1.9	~2.1	~2.1	~2.4	~1.9	~1.8	~2.6
Distodorsal margin of palm of P2	Straight	Straight	Straight	Straight	With blunt crest	Straight	Straight	Straight
Setae on palm of P2	Dense	Dense	Dense	Dense	Dense	Sparse	Sparse	Bare
Length ratio between finger and palm of P2	0.7-0.8	0.5-0.6	~0.8	~0.7	0.7-0.8	~1.0	~0.8	~0.9
Distal margin of carpus of P2	With two blunt teeth	With two blunt teeth	With two blunt teeth	With two blunt projections	With two blunt projections	With two blunt projections	Without distal teeth	Without distal teeth or projections
Shape of telson: length / proximal width**	Slender, ~2.8	Stout, ~2.2	Slender, ~2.8	Moderate, ~2.5	Slender, ~2.8	Moderate, ~2.5 (1.7)	Stout, ~1.8	Stout, ~2.0
Colour pattern: background	“Bottle-green”	Semitransparent, pale greenish/yellowish	Semitransparent, reddish	Semitransparent, greenish	Semitransparent, whitish	Semitransparent, greenish	Semitransparent, whitish	Semitransparent, whitish

Species	<i>P. gerlachei</i> (Nobili)	<i>P. polynesicus</i> Marin & Anker	<i>P. rufus</i> Marin & Anker	<i>P. minor</i> Marin & Anker	<i>P. albimaculatus</i> Marin & Anker	<i>P. condi</i> Marin	<i>P. rufulus</i> Mitsubashi	<i>P. venustus</i> sp. nov.
Colour pattern: spots or patches	Large dark dorsolateral spots on abdomen	Small dark spots on P2, carapace, abdomen and telson	Small red spots on P2, abdomen and telson	No conspicuous spots	Large white spots on body, appendages and antennular peduncles	No conspicuous spots	Bright olive and reddish brown patches on carapace and abdomen	No conspicuous spots
Colour pattern: appendages	P2 with a narrow black line along carpus, palm and fingers	P1 and P3-5 with a brownish longitudinal line	P1 and P3-5 with an orange-red longitudinal line; P2 with some orange lines on merus and carpus	No conspicuous stripes	No conspicuous stripes	P1-5 with a violet-blue longitudinal line	P1 and P3-5 with a longitudinal reddish orange line; P2 with a dark blue line along carpus, palm and fingers	No conspicuous stripes
Colour pattern: dorsal margin of eyestalk	With a conspicuous dark stripe	No conspicuous stripes	With an orange-red stripe	With a golden- brownish stripe	With a whitish spot	With a violet-blue stripe	With a reddish stripe	With a yellowish stripes
Colour pattern: cornea	No data	Blackish	Reddish	Pale golden- brownish	Whitish	Blackish	Reddish	Black
Colour pattern: antennular/ antennal flagellum	Blackish	Pale orange-yellow	Pale orange-yellow	Purplish blue	Colourless	Violet-blue	Dark purple	Colourless

* Rostral dentition given as: number of post-orbital teeth + number of rostral dorsal teeth / number of rostral ventral teeth.

** Estimated ratio from the figure in Marin (2012) is in parenthesis.

the rostral dentition, *P. venustus*, new species, differs from *P. gerlachei* in the conspicuously fewer fused segments of the antennular flagellum, relatively broader scaphocerite and telson. The new species differs from *P. minor* in lacking the supraocular lobes, the tip of the rostrum not overreaching the distal margin of the scaphocerite blade, and the relatively slender scaphocerite. In addition, *P. venustus*, new species, can be easily distinguished from these two species by the plain coloration, while *P. gerlachei* has dark spots on abdomen and black longitudinal stripes along the second pereopods and dorsal aspect of the eyestalk (see Bruce, 1982) and *P. minor* has the flagella of the antennules and antennae are violet-blue (Marin & Anker, 2011: fig. 19C, D).

There are several subtle morphological differences between *P. venustus*, new species, and the other species of the “*P. gerlachei* species complex”. Firstly, in *P. venustus*, new species, the posteriormost dorsal tooth is situated right above the orbital margin (Figs. 1A–C, 2A), while it is situated in a more posterior position in *P. rufus* Marin & Anker, 2011 and *P. albimaculatus* Marin & Anker, 2011 or rather anterior in the other species. Secondly, although the second pereopods are commonly enlarged in *Philarius* species, especially in adult males, those of *P. venustus*, new species, are more greatly enlarged compared with those of the other species. Additionally, the carpus of the second pereopod of *P. venustus*, new species, is somewhat short, and its distal margin is not strongly flaring, relatively smooth (Fig. 5A–C), while the distal margin of carpus of the second pereopod usually has two subtriangular blunt teeth or projections in other species. As for the additional dorsolateral spine on the right side of the telson, judging by the size and position, it should be regarded as an abnormality of the specimen rather than a stable diagnostic feature. Some other morphological character details and a comparison among the species of the “*Philarius gerlachei* complex” are provided in Table 1.

Finally, the COI barcode of *P. venustus*, new species, was obtained and submitted to GenBank (accession number KT025843).

ACKNOWLEDGEMENTS

This work was supported by the National Natural Science Foundation of China (No. 41406147). We are extremely grateful to Dong Dong, Yueyun Wang and Jixing Sui for their kind help with photographing the specimen. Thanks are also due to two anonymous reviewers for their valuable comments.

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