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Polyconchoecia commixtus gen. et sp. nov. (Ostracoda: Myodocopa: Halocyprididae) from the South China Sea

DU Feiyan[1, 2†], XIANG Peng[3*†], CHEN Ruixiang[3], WANG Lianggen[1, 2], WANG Yu[3], WANG Chunguang[3], LIN Mao[3, 4*]

[1] South China Sea Fisheries Research Institute, Chinese Academy of Fishery Sciences, Guangzhou 510300, China

[2] Guangdong Province Key Laboratory of Fishery Ecology and Environment, Guangzhou 510300, China

[3] Laboratory of Marine Biology and Ecology, Third Institute of Oceanography, State Oceanic Administration, Xiamen 361005, China

[4] Collaborative Innovation Center of Deep Sea Biology, Hangzhou 310012, China

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Abstract

Planktonic ostracods are small crustaceans abundant in marine ecosystem worldwide as appreciable part of marine zooplankton. Family Halocyprididae is a large group of halocyprid ostracods, and the tribe Conchoeciini has contained 21 genera previously. We described a further genus with a species *Polyconchoecia commixtus* gen. et sp. nov. from the middle of South China Sea in this study. The new species can be distinguished from related genera and species in having a unique combination of these characteristics: a lateral gland placed over right asymmetric gland and open near posterior margin; dense edge glands placed along ventral margin of carapace in line; shape of frontal organ; e-seta of first antenna is bare; endopod of second antenna has one small oval hump with central concave on mid-ventral margin, instead of processus mamillaris, exopod 1 has a small disto-dorsal spine, exopod 1 and 2 are fused, exopod 3 and 4 are bare; endopod 1 of mandible has one long ventral seta, endopod 2 has one ventral seta; maxillary endopod 1 has two basal setae; endopod 1 of fifth limb has only one ventral seta; endopod 1 of sixth limb and endopod 2 have no ventral seta. The definite distinctions in locations of major glands are the key characteristics of the new genus.

Key words: taxonomy, Ostracoda, tribe Conchoeciini, *Polyconchoecia commixtus* gen. et sp. nov., South China Sea

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1 Introduction

Marine zooplankton are typically tiny animals that float through virtually everywhere in the ocean, form important links in the process of energy transformation between primary producers and higher trophic levels in the marine ecosystem. Planktonic ostracods sometimes known as seed shrimps, are small crustaceans abundant in marine worldwide, typically about 0.5–2.0 mm in size, but rang covering 0.2–32 mm. As an appreciable part of marine zooplankton, planktonic ostracods feed on the detrital fluxes sinking and play an imperative role in the process of material circulation, marine deposition and biogeochemical cycles in marine ecosystem (Angel et al., 2007), especially in tropical and subtropical oceans (George and Nair, 1980).

In the last two decades, the studies of marine ostracods are well developed, subclass Ostracoda has been emended to class Ostracoda Latreille, 1802, emend. Martin and Davis, 2001, and also revisions of the sub-taxa have been proposed and reported (Harrison-Nelson and Kornicker, 2000; Chavtur, 2003; Lum et al, 2008; Karanovic, 2010; Chavtur and Angel, 2011). Ostracods are big group of living crustaceans with high diversity, classified based on typical features, but might not be monophyletic (Fortey and Richard, 1997), molecular phylogeny of them remains ambiguous (Yamaguchi and Endo, 2003).

Halocyprid ostracods are planktonic living in marine environment from surface to abyss, extremely abundant in zooplankton communities. Family Halocyprididae Dana, 1853 is the largest group in order Halocyprida Dana, 1853, and the second largest group in subclass Myodocopa (Chen and Lin, 1995; Chavtur, 2003; Martin and Davis, 2001; Brandão et al., 2018). Subfamily Conchoeciinae was originally erected by Müller (1912). In 2011, Chavtur and Angel separated the species into two tribes: Conchoeciini Chavtur and Angel, 2011; and Metaconchoeciini Chavtur and Angel, 2011, primarily base on locations of the glands. They erected the tribe Conchoeciini with 20 genera, and then Graves erected another genus *Mamilloecia* Graves, 2012 with two new species from Gulf of Oman in next year. Thus far,

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*Corresponding author, E-mail: xiangpeng@tio.org.cn; linmao@tio.org.cn

†These authors contributed equally to this work.

the tribe Conchoeciini has contained 21 previous genera.

In this study, we described a further genus belonging to tribe Conchoeciini, with a species *Polyconchoecia commixtus* gen. et sp. nov. from the middle of South China Sea, base on our specimens which is herein fully described and illustrated on observations of the detailed structure of the carapace and appendages.

2 Methods

2.1 *Sampling methods*

Collections were made during a cruise in the middle of South China Sea in 2014–2015, during a comprehensive study of the South China Sea sponsored by the State Oceanic Administration (SOA), therefore no specific permissions were required for the sampling activities in the oceanic areas in this study. All zooplankton specimens were collected by a Multinet sampling system (Type Midi, Mesh-size aperture 200 μm, HydroBios Inc., Kiel, Germany) and stratified hauls from bottom to surface. Collections were preserved by immersion in 5% buffered formaldehyde and sorted in the laboratory.

2.2 *Morphological methods*

Specimens were dissected under a zoom-stereomicroscope (Zeiss Discovery V20). Appendages were mounted in permanent slides with CMC-9AF medium (Masters Company Inc., Illinois, USA). Observations, measurements, micrographs and drawings were made following the methodology of Chavtur and Angel (2011). Observations were done by a transmitted-light binocular microscope system, with the AxioVision Image-Pro software (Axio Imager Z2, Carl Zeiss Inc., Oberkochen, Germany). All drawings were made from preserved specimens using a camera Lucida and a drawing apparatus, and further processed with Adobe Photoshop CS6 (Adobe Inc., San Jose, CA, USA).

The type specimens/dissected appendages were deposited in the Marine Biological Sample Museum, Third Institute of Oceanography, SOA (Xiamen, China), under the collection numbers TIO-OHH-PP-01 to TIO-OHH-PP-03 for the new species.

2.3 *Nomenclatural acts*

The electronic edition of this article conforms to the requirements of the amended International Code of Zoological Nomenclature, and hence the new names contained herein are available under that Code from the electronic edition of this article. This published work and the nomenclatural acts it contains have been registered in the ZooBank, the online registration system for the ICZN. The ZooBank LSIDs (Life Science Identifiers) can be resolved and the associated information viewed through any standard web browser by appending the LSID to the prefix "http://zoobank.org/". The LSID for this publication is: urn:lsid:zoobank.org:pub:8C2331C6-8FEE-43C3-9DA4-76F5C7C4AC6F. The electronic edition of this work was published in a journal with an ISSN, and has been archived and is available from the following digital repositories: SpringerLink, PubMed Central, LOCKSS.

3 Results

3.1 *Systematics*

Order Halocyprida Dana, 1853
Suborder Halocypridina Dana, 1853
Family Halocyprididae Dana, 1853
Subfamily Conchoeciinae Müller, 1912
Tribe Conchoeciini Chavtur and Angel, 2011
Genus *Polyconchoecia* Xiang, Chen and Du, gen. nov.

Type species *Polyconchoecia commixtus* Xiang, Chen and Du, sp. nov.

3.2 *Genus Polyconchoecia Xiang, Chen and Du, gen. nov.*

LSID: urn:lsid:zoobank.org:act:F7A328D2-94B4-4CA7-A012-6F4785103DD7

Etymology. The name of genus is referring to this genus has many edge glands.

Generic diagnosis. Carapace broad, pseudo-rectangle to subquadrilateral in lateral view, anterior margin beneath rostal incisure swollen, shoulder vaults unaccentuated, ventral margin with slightly concave, left asymmetric gland slightly moved anteriorly, dense edge glands placed along ventral margin in line; left postero-ventral corner non-glanded.

3.3 *Species Polyconchoecia commixtus Xiang, Chen and Du, sp. nov. (Figs 1–5)*

LSID: urn:lsid:zoobank.org:act:B7B2C8C5-2D29-4954-AF52-F8B10E5DACD1

Etymology. "*Commixtus*" derived from the Latin expression of compound, indicates in this species, the carapace has compound gland.

Holotype. No. TIO-OHH-PP-01, adult female, length 2.09 mm, height 1.19 mm. Collected from Sta. 1403IIB132 (13°30′N, 114°00′E, Sounding 4 320 m) in the middle of South China Sea, at a depth of 500–750 m, March 13, 2014. Dissected appendages were deposited in the Marine Biological Sample Museum, in the Third Institute of Oceanography, SOA (Xiamen, China).

Paratypes. One adult and one underage females, collected from Sta. B4ZI18 (14°31′N, 114°54′E, Sounding 4 306 m) at a depth of 200–500 m, in the middle of South China Sea, January 12, 2015. No. TIO-OHH-PP-02, adult, length 2.15 mm, height 1.25 mm, No. TIO-OHH-PP-03, underage, length 1.85 mm, height 1.04 mm, was dissected and deposited with holotype.

Distribution. Species are only known from the intermediate layers in the South China Sea.

Diagnosis. Carapace without ornamentation or setae, height about 56%–58% of length, pseudo-rectangle in lateral view with rounded corners, anterior margin beneath rostal incisure swollen, shoulder vaults unaccentuated, higher in anterior part, ventral margin with slightly concave, left asymmetric gland slightly moved anteriorly, a compound gland on right postero-ventral corner consisting of asymmetric gland and lateral gland, dense edge glands placed along anterior, ventral and posterior margin in line; left postero-ventral corner non-glanded. Frontal organ spinose with a blunt tip. E-seta of first antenna without spines. Endopod of second antenna with one small oval hump with central concave on mid-ventral margin, instead of processus mamillaris, c-, d-, e-setae absent, exopod 1 and 2 fused, exopod 3 and 4 bare without swimming setae. Mandibular teeth side with four tooth plates, endopod 1 with one long ventral seta, endopod 2 with one ventral seta. Endopod 1 of maxilla with two basal setae. Endopod of fifth limb with one ventral seta. Endopod 2 of sixth limb bare. Furcal lamella without unpaired seta.

3.4 *Description*

Carapace (Figs 1a–c, 2A–C and 5A). Carapace ornamentation: carapace without setae, pits or grooves visible at 40× magnification, pseudo-rectangle in lateral view; anterior margin beneath rostal incisure swollen, rostra anteriorly, wide, developed, equilong, and deeply curved with acutangular tip; shoulder vaults smooth; antero-ventral, postero-ventral margin and postero-ventral corner sharply rounded; anterior part height slightly higher than posterior part; dorsal margin with gentle concave;

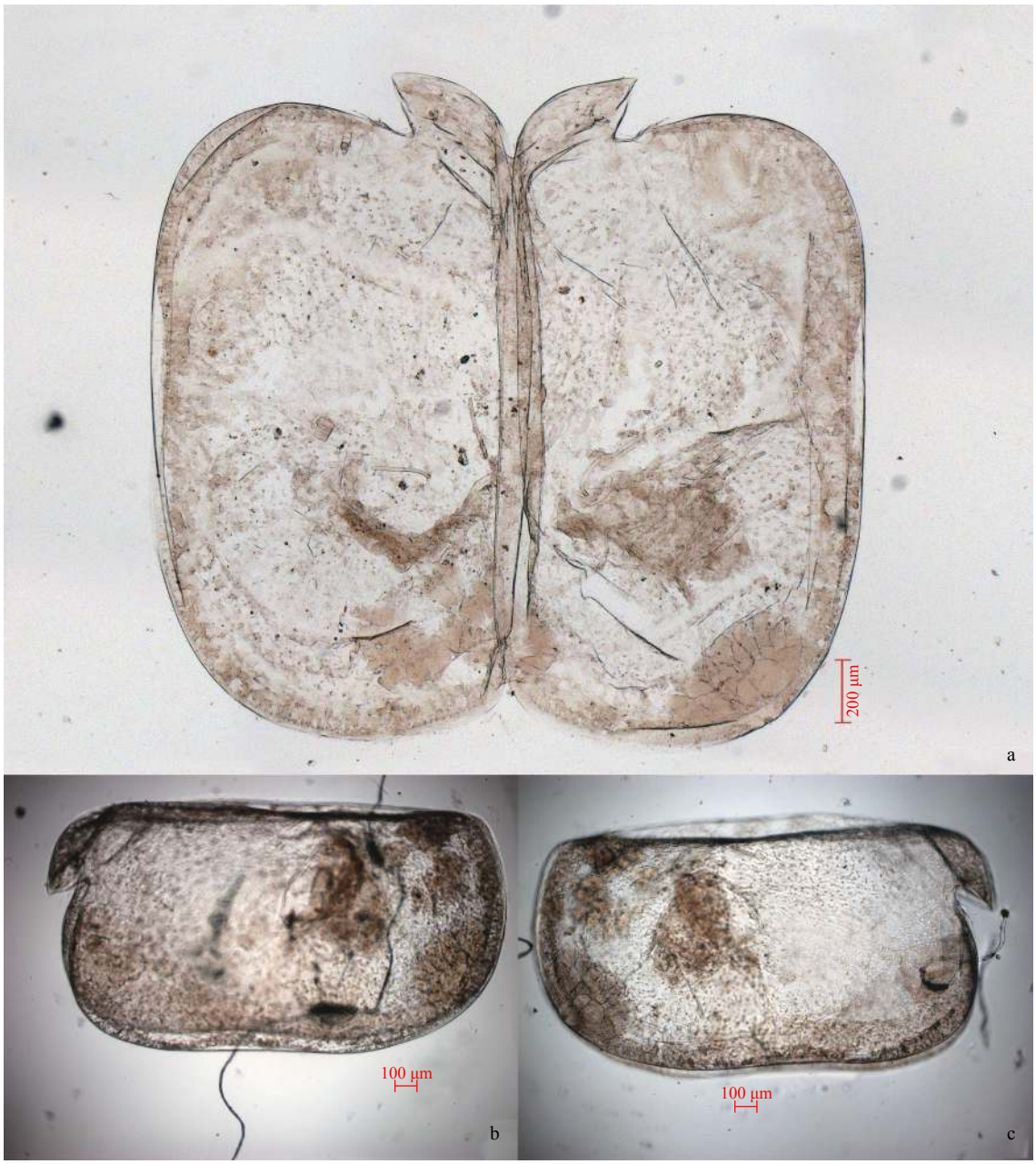

Fig. 1. *Polyconchoecia commixtus* gen. et sp. nov. (♀). a. Carapace, lateral view; b. left valve, lateral view; and c. right valve, lateral view.

ventral margin with slightly central concavity. Carapace symmetrically, with three kinds of glands: one asymmetric gland opening near postero-dorsal margin of left valve, one asymmetric gland opening on right postero-ventral corner; one lateral gland overlapped right asymmetric gland, shared opening on right postero-ventral corner, constituting a compound gland; dense edge glands placed along anterior, ventral and posterior margin in line; left postero-ventral corner without glands. Carapace size: length 1.95–2.15 mm, height 1.10–1.25 mm, height about 56%–58% of length.

Frontal organ (Figs 2D, 3a, 5B and C). Stem and capitulum fused into a single unit, straight and clavate with blunt tip, small disto-ventral and mid-ventral spines, as thick as protopod, capitate base separated from antenna.

First antenna (Figs 2D, 3a, 5B and C). First antenna uniramous. Basale and article 1 bare. Article 2 with one long dorsal seta with plumose central spine on mid-dorsal margin. Articles 3 and 4 very short. Article 4 with two ventral sensory setae (a- and b-setae). Article 5 blunt conical with two ventral sensory setae (c- and d-setae) and one distal sensory setae (e-seta). A- to d-setae analogic long columnar, thin-walled and bare with long end joint, e-seta extremely long (approximately one and a half length of other setae) and bare with short end joint.

Second antenna (Figs 2E and 5D–F). Limb biramous with extremely protopodite with powerful muscles. Endopod on inner side of protopodite disto-ventral side, without c-, d- and e-setae. Endopod 1 large, folded forward, with bend bare a- and b-setae, b-seta approximately two times length of a-seta; one small oval hump with central concave on mid-ventral margin, instead of processus mamillaris. Endopods 2 and 3 integrated into a small

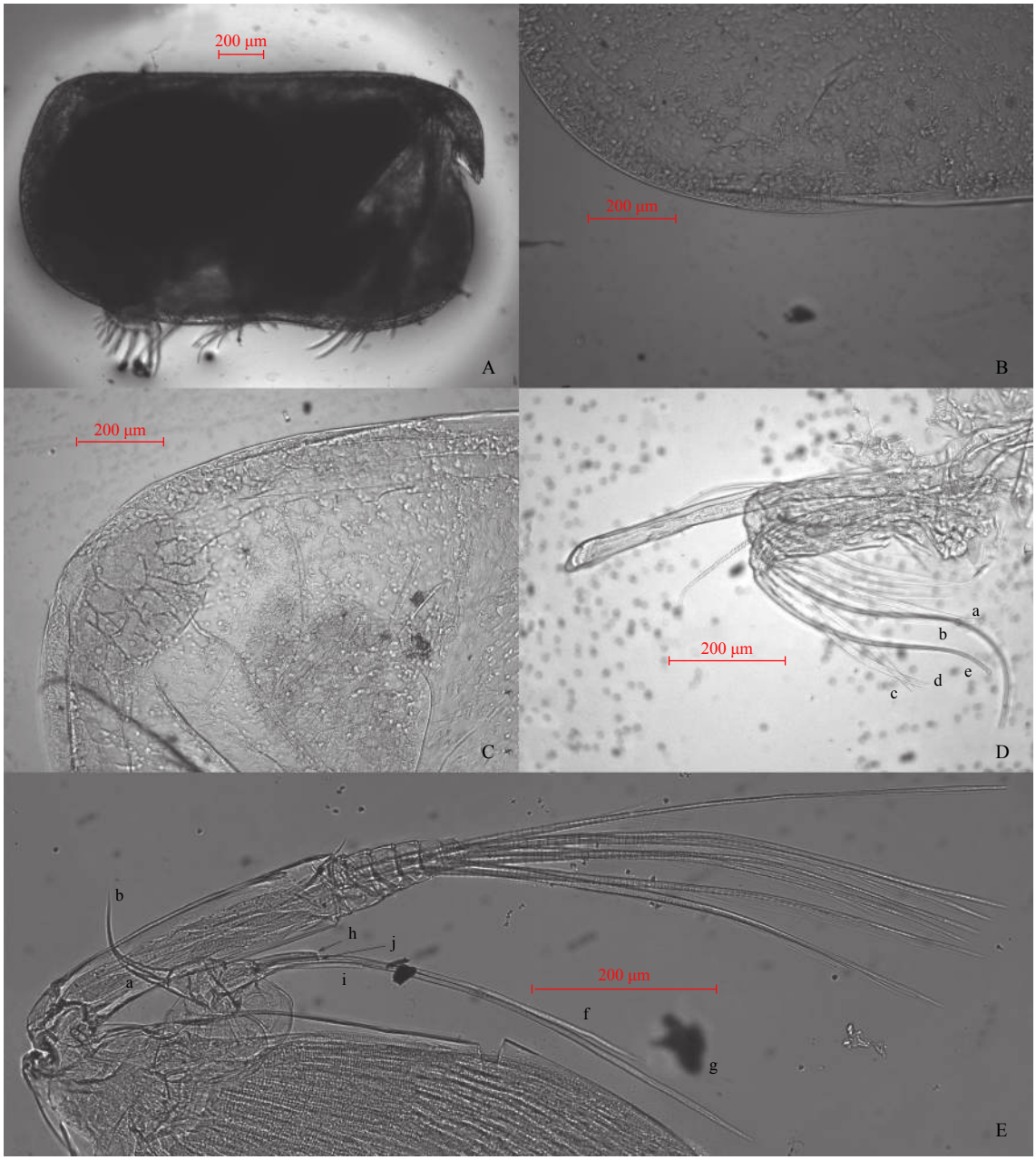

Fig. 2. *Polyconchoecia commixtus* gen. et sp. nov. (♀). A. Right valve (with body), lateral view; B. ventral margin of carapace, lateral view; C. postero-ventral corner of right valve, lateral view; D. first antenna with frontal organ, lateral view; and E. second antenna, medial view.

peg shaped bulge on disto-dorsal margin of article 1, with spinose h-, i-, j-, f- and g-setae, g-seta longest. Exopod with nine articles: article 1 more than thirteen times length of others, with one dorsal acerose spine on disto-medial margin; article 2 healing with article 1; articles 3 to 8 short and equilong; articles 3 and 4 bare; articles 5 to 8 with one analogous long plumose swimming seta on disto-ventral margin respectively; terminal article short blunt conical with three similar long plumose swimming setae and two additional very small distal setae on tip.

Mandible (Figs 3b–e and 5G–J). Exopod tiny peg shaped, with one dorsal seta with long plumose cilia on proximal half part. Basale large with two bare proximo-ventral setae. Endopod 1 with one disto-dorsal acerose seta and one very long ventral seta. Endopod 2 short, with one long seta on disto-ventral margin, one short and two long setae on disto-dorsal edge, longest one with small inner distal spines. Endopod 3 very short, with disto-dorsal cilia, two long spinose claws, and five setae on tip: dorsal claw strong, distal claw bigger; dorsal seta arrayed between claws with dorsal and ventral spines, longest (second ventral) seta bare, other setae with small ventral spines. Coxale teeth side triangular with two bare small long setae on medio-proximal margin, clusters of medial spines, tooth endites with four tooth plates, one proximo-dorsal peg tooth, one medio-dorsal peg tooth, one comb constituted by one big long blunt peg tooth and four small inner blunt peg teeth. Proximal tooth list with one big blunt ventral triangular tooth followed ten to thirteen small dorsal teeth. Penultimate tooth list with twelve to fourteen small teeth. Distal tooth list with three ventral board teeth and four dorsal finger-

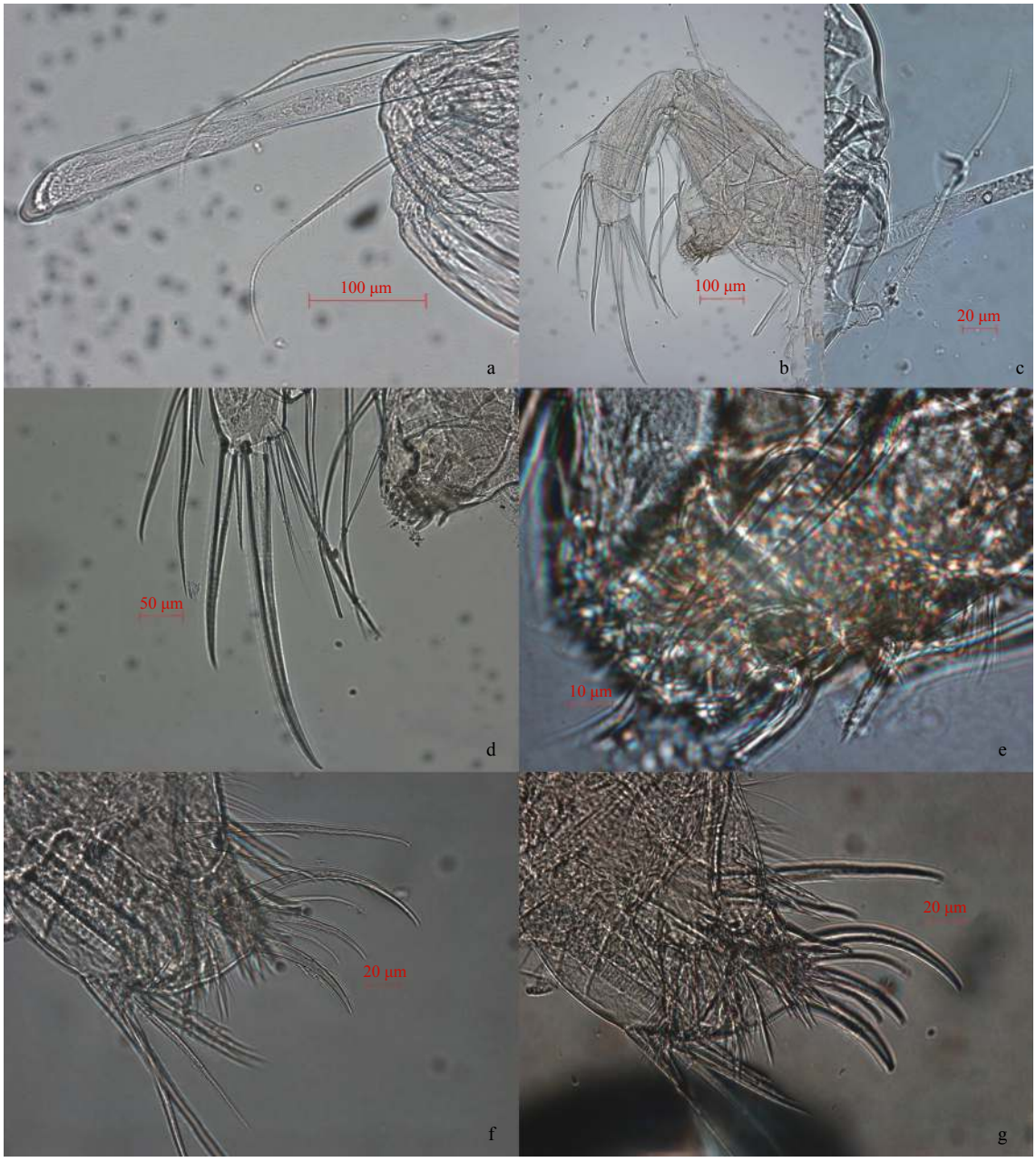

Fig. 3. *Polyconchoecia commixtus* gen. et sp. nov. (♀). a. Frontal organ, lateral view; b. mandible, medial view; c. exopod of mandible, medial view; d. tip of mandible, medial view; e. teeth side of mandibular coxale, medial view; f. maxilla, lateral view; and g. maxilla (show endites), lateral view.

shape teeth. Tooth edge with four small ventral teeth, three mid shape teeth and five large sharp distal teeth.

Maxilla (Figs 3f, g, 4a, 5K and L). Maxilla uniramous with three endites. Basale with one long spinose and one short bare setae. Article 1 rectangular, with six long spinose setae on antero-distal edge, one bare short seta on disto-posterior part, two bare setae on disto-posterior side, and several cilia on posterior side. Terminal article with five strong claws: two bilateral stout spinose claws, and three bare claws. Endite one with eleven plumose setae, endite two with ten plumose setae, endite three with eight plumose setae.

Fifth limb (Figs 4b and 5M). Limb biramous. Basale large and wide with seven setae: dorsal seta long and bare; proximal-ventral group of setae with two spinose central setae and a pair of symmetric ventral setae; disto-ventral group of setae with one spinose central seta and a pair of symmetric ventral setae; basale without dorso-lateral seta. Endopod 1 long and thin with one mid-ventral seta and one mid-dorsal seta; endopod 2 short and small with three bare curved long sword form claws on tip, mid claw longest. Coxale with three endites: endite I big rectangular with one short bare mid-ventral seta; endite II very short with one short and one long plumose setae on ventral margin; ventral group of setae of endite III with one strong basal plumose seta and one cluster of setae (three sharp and two blunt). Epipod with one small bare inner seta and about twenty-one long flexible plumose setae.

Sixth limb (Figs 4c, d, 5N and O). Limb biramous. Basale broad with three small bare setae on disto-ventral part, and one small bare seta on disto-dorsal margin (vesting of exopod). Endo-

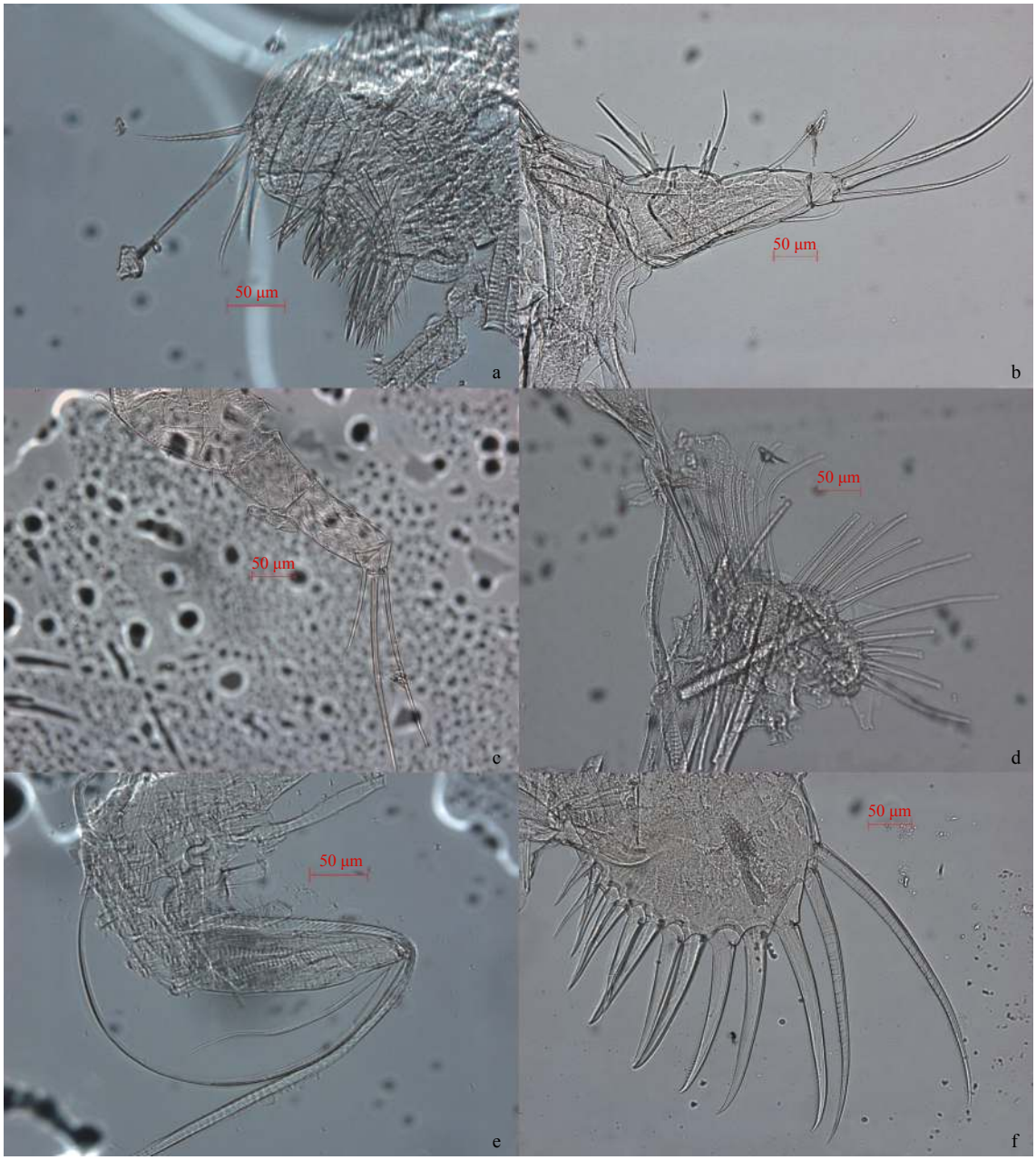

Fig. 4. *Polyconchoecia commixtus* gen. et sp. nov. (♀). a. Endites of maxilla, medial view; b. fifth limb, lateral view; c. sixth limb, lateral view; d. epipod of sixth limb, lateral view; e. seventh limb, lateral view; and f. furca, lateral view.

pod 1 bare. Endopod 2 long and thin, with one small dorsal seta. Terminal article blunt and short conical, with three long slightly curved acerose setae on tip. Epipod with one small bare inner seta and about fifteen long flexible plumose setae.

Seventh limb (Figs 4e and 5P). Article 1 slender and bare. Article 2 very short conical with one bare long seta and one bare lathy lithe seta (two times length of another) on tip. Epipod with one small bare inner seta and about twelve long flexible plumose setae.

Furca (Figs 4f and 5Q): Each furcal lamella subtriangular, with one large dorsal seta, seven claws, from long to short in turn arrangement. Seta with about 1/3 disto-ventral spines, claws long sickle shaped with numerous disto-ventral small spines and about 1/3 proximal bare base. Furca without unpaired seta. Larvae with one small globular bulge instead of last claw.

4 Discussion

According to the diagnosis of tribe Conchoeciini (Chavtur and Angel, 2011), the specimens are easily considered to be one species of this tribe by the shared characteristics: (1) full adult size is in the range of 0.6–6.5 mm; (2) the carapace has no ornamentation; (3) shoulder vaults are smooth; (4) the posterior dorsal corner is rounded; (5) left asymmetric gland is located near the postero-dorsal corner of left valve, and right asymmetric gland is located near the postero-ventral corner; (6) article 2 of the first antenna carries a dorsal seta; (7) the maxillary endopod 1 has six anterior setae; (8) the toothed edge of the mandible is spinose; and (9) the similar structures of the furcal lamella.

But detailed examination of the specimens showed they cannot be suitable for diagnosis of any genus of tribe Conchoeciini. Based on some shared characteristics such as basic shape and or-

Fig. 5. Line drawings of *Polyconchoecia commixtus* gen. et sp. nov. (♀). A. Carapace, lateral view; B. first antenna with frontal organ, lateral view; C. frontal organ, lateral view; D. left second antenna, medial view; E. endopod of right second antenna, medial view; F. endopod of left second antenna, medial view; G. mandible, medial view; H. exopod of mandible, medial view; I. tip of endopod of mandible, medial view; J. teeth side of mandibular coxale, medial view; K. endopod of maxilla, lateral view; L. endites of maxilla, medial view; M. fifth limb, lateral view; N. sixth limb, lateral view; O. epipod of sixth limb, lateral view; P. seventh limb, lateral view; and Q. furca, lateral view.

Table 1. Locations of major glands of *Polyconchoecia commixtus* gen. et sp. nov. and related genera (♀)

Genus	LAG opening location(s)	RAG opening location(s)	LGG opening location(s)	Reference
Conchoecetta Claus, 1890	posterior part, slightly moved anteriorly	PVC	right PM below PDC	Claus (1890)
Conchoecia Dana, 1849	posterior part, near PDC	PVC	below PDC each	Dana (1849)
Discoconchoecia Martens, 1979	PDM, near PDC	PM, above PDC	right PDC	Martens (1979)
Loricoecia Poulsen, 1973	PDM, near PDC	PVC	over or above RAG, not PM	Poulsen (1973)
Orthoconchoecia Granata and Caporiacco, 1949	posterior part, slightly moved dorsally	PM, above PVC slightly	right PM, near PDC	Granata and Caporiacco (1949)
Paraconchoecia Claus, 1891	PDM, near PDC	PVM, before PVC	posterior part, below PDC	Claus (1891)
Platyconchoecia Poulsen, 1973	posterior part, slightly moved anteriorly	PM, near PDC	1 near PVC each	Poulsen (1973)
Porroecia Martens, 1979	PDM, near PDC	VM, before PVC	right PDC	Martens (1979)
Proceroecia Kock, 1992	PDM, near PDC	VM, before PVC	right PM, below PDC	Kock (1992)
Polyconchoecia gen. nov.	DM, before PDC	PM, near PDC	over RAG	this study

Note: LAG left asymmetric gland, LGG lateral gland group, PDC postero-dorsal corner, PM posterior margin, PDM postero-dorsal margin, PVC postero-ventral corner, PVM postero-ventral margin, RAG right asymmetric gland, and VM ventral margin.

namentation of carapace, major glands, structures of limbs, etc., we selected eight related genera of this tribe as congeners, other genus are dissimilar and easy to be distinguished. Comparations showed the significant differences of the locations of the glands between the specimens and congeners (Table 1). Only genus *Loricoecia* has lateral gland over right asymmetric gland, but the location of this gland does not open near posterior margin. Our specimens have dense edge glands and these characteristics can distinguish them easily. Additionally, they also can be distinguished in having a unique combination of characteristics of the carapace and frontal organ (Table 2). Besides, the limbs of our specimens have definite distinctions between them and the related genera (Table 3): (1) the e-seta of the first antenna is bare (Figs 2D and 5B); (2) in the second antenna, endopod has one small oval hump with central concave on mid-ventral margin, instead of processus mamillaris, exopod 1 has a small disto-dorsal spine, exopod 1 and 2 are fused, and exopod 3 and 4 are bare (Figs 2B, 5E and F); (3) in the mandible, endopod 1 has one long ventral seta, endopod 2 has one ventral seta (Figs 3b and 5G); (4) the maxillary endopod 1 has two basal setae (Figs 3f, g and 5K); (5) endopod 1 of the fifth limb has only one ventral seta (Figs 4b and 5M); (6) in the sixth limb, endopod 1 and endopod 2 have no ventral seta (Figs 4c and 5N).

In the tribe Conchoeciini, the locations of glands are just as significant as taxonomic characteristics in genera (Müller, 1894; Angel and Iliffe, 1987; Poulsen, 1973; Chavtur and Angel, 2011). Based on the notable distinctions of the locations of major glands, we erected a new genus with a new species *Polyconchoecia commixtus*, and propose the characteristic of glands as a key to separate them from the previous genus of the tribe Conchoeciini.

Table 2. Comparisons of carapace and frontal organ between *Polyconchoecia commixtus* gen. et sp. nov. and related genera (♀)

Genus	Carapace						Frontal organ			
	Ornamentation	Height/length/%	Highest part	Shoulder accentuated	PDC form	PM form	Fused	To A1 basale	Spinose	Tip
Conchoecetta	none	39–43	posterior	yes	angle	straight	yes	separated	no	sharp
Conchoecia	yes	50–56	anterior	yes	bulge	rounded	yes	fused	yes	sharp
Discoconchoecia	none	37–43	posterior	yes	right, spine	straight	yes	fused	no	blunt
Loricoecia	none	49–52	posterior	no	rounded	rounded	no	separated	yes	blunt
Orthoconchoecia	none	46–51	posterior	yes	rounded	straight	no	fused	yes	blunt
Paraconchoecia	yes	39–44	mid	yes	right spine	rounded	no	fused	yes	sharp
Platyconchoecia	none	45–46	posterior	no	rounded	rounded	yes	fused	yes	sharp
Porroecia	none	44–50	posterior	yes	bulge	rounded	yes	fused	yes	sharp
Proceroecia	none	42–48	posterior	yes	rounded	rounded	yes	fused	yes	sharp
Polyconchoecia	none	56–58	anterior	no	rounded	rounded	yes	separated	yes	blunt

Note: References are given in Table 1.

Table 3. Comparisons of limbs between *Polyconchoecia commixtus* gen. et sp. nov. and related genera (♀)

Genus	A1		A2				Mn			Mx	P5	P6	
	e-seta		En 1	Ex 1				En 1	En 2		En 1	En 1	En 2
	Spinose	End joint	Processus mamillaris	Spine	Ex 1, 2	Ex 3, 4 seta	Tooth plate	Ventral seta	Ventral seta	Basal seta of En 1	Ventral seta	Ventral seta	Ventral seta
Conchoecetta	yes	no	yes	none	separated	yes	2	2–3	2	1	2	1	1
Conchoecia	yes	no	yes	none	separated	yes	3	2–3	2	1	2	1	1
Discoconchoecia	yes	yes	yes	none	separated	yes	2	2–4	2	1	2	1	1
Loricoecia	yes	yes	yes	none	separated	yes	3	3–4	2	1	2	1	1
Orthoconchoecia	yes	yes	yes	none	separated	yes	2	3–4	2	1	2	1	1
Paraconchoecia	yes	yes	yes	none	separated	yes	2	4	2	1	2	1	1
Platyconchoecia	yes	yes	yes	none	separated	yes	3	4	2	1	2	1	1
Porroecia	yes	yes	yes	none	separated	yes	4	2	2	1	2	1	1
Proceroecia	yes	yes	yes	none	separated	yes	4	1–2 (tiny)	1–2	1	2	1	1
Polyconchoecia	no	yes	oval hump 1 (tiny)		fused	none	4	1 (long)	1	2	1	0	0

Note: References are given in Table 1. A1 represents first antenna, A2 second antenna, DM dorsal margin, En endopod; Ex exopod, Mn mandible, Mx maxilla, P5 limb 5, and P6 limb 6.

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