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First record of *Monstrillopsis* G.O. Sars, 1921 (Copepoda: Monstrilloida) from the South China Sea, with description of a new species

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Abstract. A new species of the monstrilloid copepod genus *Monstrillopsis* G.O. Sars, 1921 is here described and illustrated based on specimens collected from Sanya Bay, South China Sea. The new species displays the generic characters of *Monstrillopsis*, including well-developed eyes and an anteriorly positioned oral papilla. The diagnostic feature is the modified fifth antennular segment, with a slight inner expansion and a short, attenuated, sabre-like spine on the tip. The new species has a type II genital complex but can be distinguished from other congeneric species by its body size (1.46 mm long), two postgenital somites, and a modified fifth antennular segment with slight inner expansion, and short sabre-like spine on the tip. This is the first record of this genus in the China Seas.

Key words. Monstrillidae, semi-parasitic copepods, zooplankton first record, taxonomy

INTRODUCTION

The order Monstrilloida G.O. Sars, 1901, represents one of the most intriguing taxa among copepods (Suárez-Morales 2011). Monstrilloida species are distinguished from other copepods by their unique life cycle. During the preadult stages, they parasitise various marine benthic invertebrates, such as polychaetes and molluscs. Adults are planktonic and are usually found in coastal zooplankton samples but are rarely found in great abundance. They appear to be most abundant and diverse in reef-related areas (Sale et al., 1976; Suárez-Morales, 2001, 2011). The planktonic adults are nonfeeding, reproductive forms that lack second antennae and mouthparts. Because of their relative rarity in zooplankton samples, there are large areas in which the monstrilloid copepod fauna remains practically unknown (Suárez-Morales, 2011). The order is currently represented by nearly 250 nominal species contained in seven valid genera: *Monstrilla* Dana, 1849; *Cymbasoma* Thompson, 1888; *Monstrillopsis* G.O. Sars, 1921; *Maemonstrilla* Grygier & Ohtsuka, 2008; *Australomonstrillopsis* Suárez-Morales & McKinnon, 2014; *Caromiobenella* Jeon, Lee & Soh, 2018 and *Spinomonstrilla* Suárez-Morales, 2019 (also Huys & Boxshall, 1991; Grygier, 1993; Walter & Boxshall, 2024). Recent research on monstrilloids has focused mostly on taxonomy and the morphological description of adults in different regions of the world. In lesser-studied waters, the search for monstrilloid diversity has been promoted (Suárez-Morales, 2014; Suárez-Morales, 2019; Jeon, 2020; Suárez-Morales, 2021). The studies on life stages and host-parasite interactions are also increasing (Grygier & Ohtsuka, 1995; Suárez-Morales et al., 2010; Suárez-Morales, 2014). These investigations imply the possible occurrence of large numbers of undescribed taxa in less-studied areas and environments (Suárez-Morales & Mercado-Salas, 2023). Studies on the taxonomy of monstrilloid copepods are rare in China. There are only three genera and 19 nominal species in the China Seas (Suárez-Morales, 2000; Chen & Li, 2008; Chen & Huang, 2012; Lian et al., 2018; Zhang et al., 2019; Walter & Boxshall, 2024).

With more than 21 species, *Monstrillopsis* is one of the smaller genera in the Monstrilloida. It has a wide geographical distribution, including in the tropical, temperate, and polar zones (Razouls, 1996). Most of these species have been reported from the eastern tropical Pacific, North America, Australia, South Korea, Japan, and South Africa (Suárez-Morales, 2006; Suárez-Morales, 2014; Lee, 2016; Delaforge, 2017; Jeon et al., 2020). The absence of female *Monstrillopsis* in collections is characteristic of the genus. Of all known species in *Monstrillopsis*, only five species have been described based on both sexes; five species are based only on females, while eleven are based on males (Suárez-Morales, 2011, 2014; Lee et al., 2016; Jeon et al., 2020). There have been no previous studies on *Monstrillopsis* in China. Recently, we re-examined samples of zooplankton deposited at the South China Sea Marine Biodiversity Collection, Chinese Academy of Sciences, Guangzhou, China. In one of these samples, two adult male specimens of a previously undescribed *Monstrillopsis* species were found; and these are herein formally described. This is the first species of *Monstrillopsis* to be recorded in the coastal waters of China.

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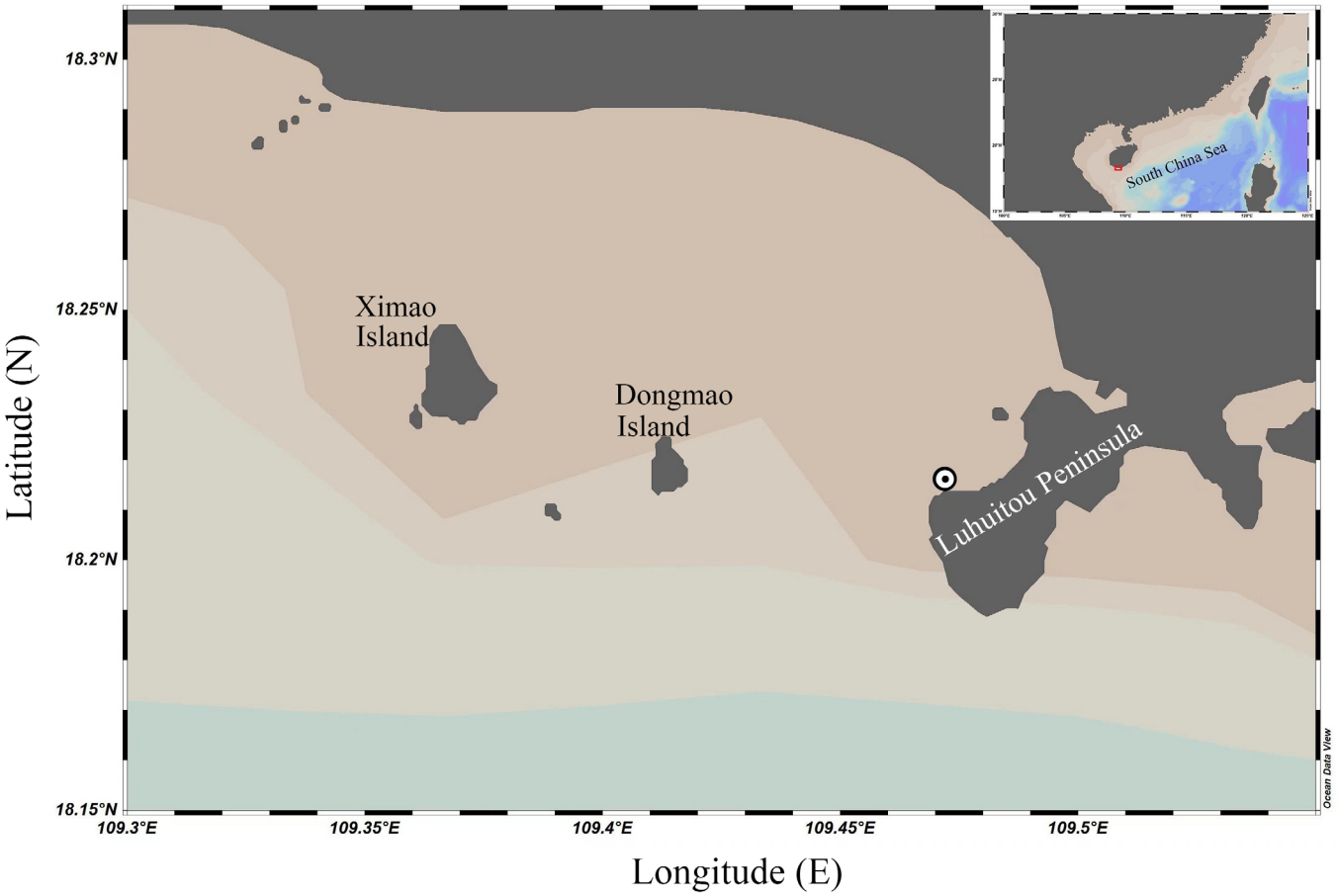

Fig. 1. Map of the sampling sites of *Monstrillopsis plumosa*, new species, in Sanya Bay, Hainan, China.

MATERIAL AND METHODS

Zooplankton were collected in Sanya Bay (18.21°N, 109.47°E), Hainan, South China Sea, on 10 December 2016 by a vertical tow net (0.505 mm mesh, 0.8 m diameter at a pulling speed of 0.5 ms^{-1}) (Fig. 1). The sample was preserved immediately in 5% formalin which was diluted with seawater. Two monstrilloid copepods were sorted from a sample for further taxonomic examination. Observation and measurements were carried out under a stereomicroscope (Leica M205C), and images were drawn with the aid of a microscope digital camera (Leica MC 190HD). The standard terminology for copepod morphology follows that of Huys & Boxshall (1991). Composition of new scientific names followed the recommendations of Brown (1956). The monstrilloid antennulary armature terminology, as described by Grygier & Ohtsuka (1995, 2008) and Huys (2007), is followed here. The material examined is deposited in the South China Sea Marine Biodiversity Collection (SCSMBC), Chinese Academy of Sciences, Guangzhou, China.

TAXONOMY

Family Monstrillidae Dana, 1849

Genus *Monstrillopsis* G.O. Sars, 1921

Monstrillopsis plumosa, new species

(Figs. 2–5)

Material examined. Holotype, adult male (SCSMBC-031012), 1.46 mm total length (TL), Sanya Bay, Hainan Province, China (18.21°N, 109.47°E), vertical haul, 5–0 m, 0.505 mm-mesh plankton net, coll. X. Lian, 10 December 2016. Paratype, adult male (SCSMBC-031013), 1.43 mm total length (TL), same data as holotype.

Diagnosis. Medium-sized male *Monstrillopsis* (1.46 mm total body length), with body divided in relatively short prosome representing about half of total body length, pedigerous somites 2–4 tapering posteriorly, and slender, cylindrical urosome. Cephalothorax with low, rounded medial frontal projection, Antennule 5-segmented, geniculate. Geniculation between segments 4, 5. Last segment relatively short, lacking inner expansion, with apical claw less than half length of segment. Fifth pedigerous somite separate from preceding somite, 5th legs absent. Legs 1–4 with outer seta on basis; exopods, endopods 3-segmented, basipodal setae absent. Genital somite with no obvious transverse striations in dorsal field. Urosome with two postgenital somites; anal somite

Fig. 2. Photomicrograph of *Monstrillopsis plumosa*, new species, holotype, adult male (SCSMBC-031012), Sanya Bay, Hainan, China. Scale bar = 500 μm.

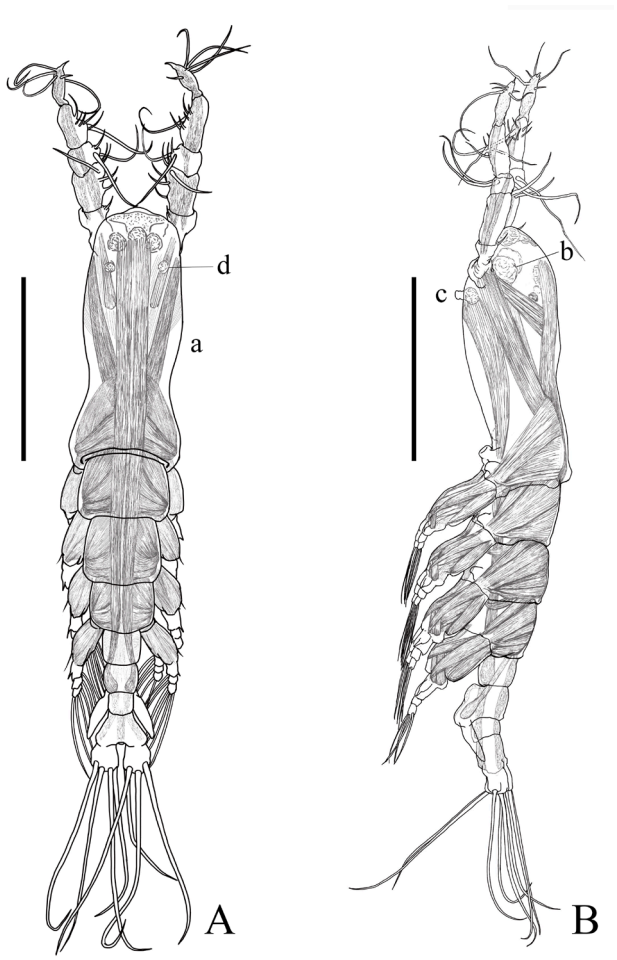

Fig. 3. *Monstrillopsis plumosa*, new species, holotype, adult male (SCSMBC-031012), Sanya Bay, Hainan, China. A, habitus, dorsal view; B, habitus, lateral view. a, cephalothorax, dorsal view; b, forehead, dorsal view; c, oral papilla, lateral view; d, rounded protuberances. Scale bars: A, B = 500 μm.

as long as genital double-somite. Ventral genital complex represented by pair of slender distally diverging lappets; lappets medial surface smooth. Caudal rami subquadrate, with four subequally long caudal setae.

Description. Adult male. Total body length of holotype 1.46 mm, as measured from anterior end of cephalic somite to posterior margin of anal somite (Fig. 3A, B). Cephalothorax length about 0.4 times whole body length (Fig. 3a). Forehead medially flat in dorsal view, lacking integumental ornamentation. Eyes represented by one ventral, two lateral cups; pigment cups moderately developed, weakly pigmented; ventral cup slightly smaller than lateral cups (Fig. 3b). Oral papilla small, located on about anterior one-third of ventral surface of cephalothorax (Fig. 3c). One pair of rounded protuberances on dorsal surface below ocelli (Fig. 3d).

Antennule relatively long, measuring 0.49 mm, about 0.34 times total body length. Antennule 5-segmented with geniculation between 4th, 5th segments (Fig. 4A, B). Length ratio of segments 10.85%: 23.25%: 8.52%:28.68%: 29.45%. First segment with element 1 arising dorsally on inner corner. Second segment armed with spinous elements $2d_1$,

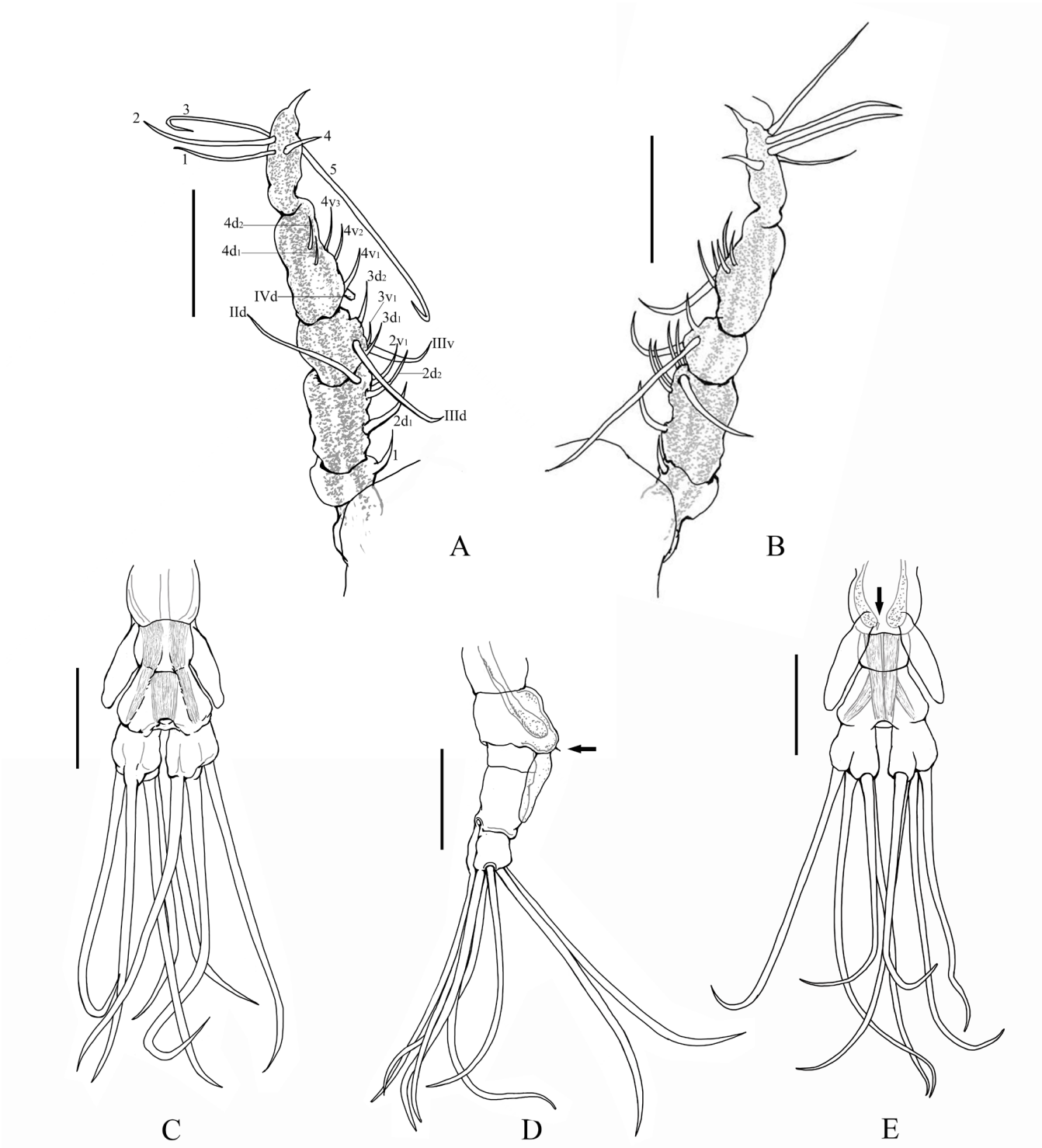

Fig. 4. *Monstrillopsis plumosa*, new species, holotype, adult male (SCSMBC-031012), Sanya Bay, Hainan, China. A, left antennule, dorsal view. B, right antenuule, dorsal view. C, urosome and caudal rami, dorsal view. D, urosome, lateral view, showing fifth leg and features of genital complex. E, urosome and caudal rami, ventral view. Scale bars: A, B = 150 μm; C, D = 200 μm.

$2d_2$, $2v_1$, long strap-like, outward seta IId; Dorsal spinous elements ($2v_1$) slightly longer than ventral ones ($2d_1$, $2d_2$). Third segment with elements $3d_1$, $3d_2$, $3v_1$, IIId, IIIv. Long IIIv, IIId setae located on inner side, extended downward to second segment. Fourth segment with 6 elements ($4d_1$, $4d_2$, $4v_{1\text{-}3}$, IVd), all arising at inner side. Terminal antennular segment modified: with slight inner proximal expansion, rest of distal part relatively thin, elongate, short and sabre-like. Terminal segment armed with unbranched elements 1–5. Among these, elements 1–3 located on outer distal margin, and element 5 located on inner side and longer than elements 1–4 (Fig. 4A).

First thoracic pedigerous somite incorporated into cephalothorax; this and 3 free succeeding pedigerous somites each bearing pair of well-developed legs, with endopodites, exopodites 3-segmented (Fig. 5 A). Pedigerous somites 2–4 accounting for 34.93% of total body length in dorsal view

Table 1. Setal armature patterns of legs 1–4 of *Monstrollopsis plumosa*, new species.

	Coxa	Basis	Exopod	Endopod
Leg 1	0-0	0-0	I-I; 0-1;I,2,2	0-1;0-1;1,2,2
Leg 2	0-0	0-0	I-0; 0-1;I,2,3	0-1;0-1;1,2,2
Leg 3	0-0	0-0	I-0; 0-1;I,2,3	0-1;0-1;1,2,2
Leg 4	0-0	0-0	I-0; 0-1;I,2,3	0-1;0-1;1,2,2

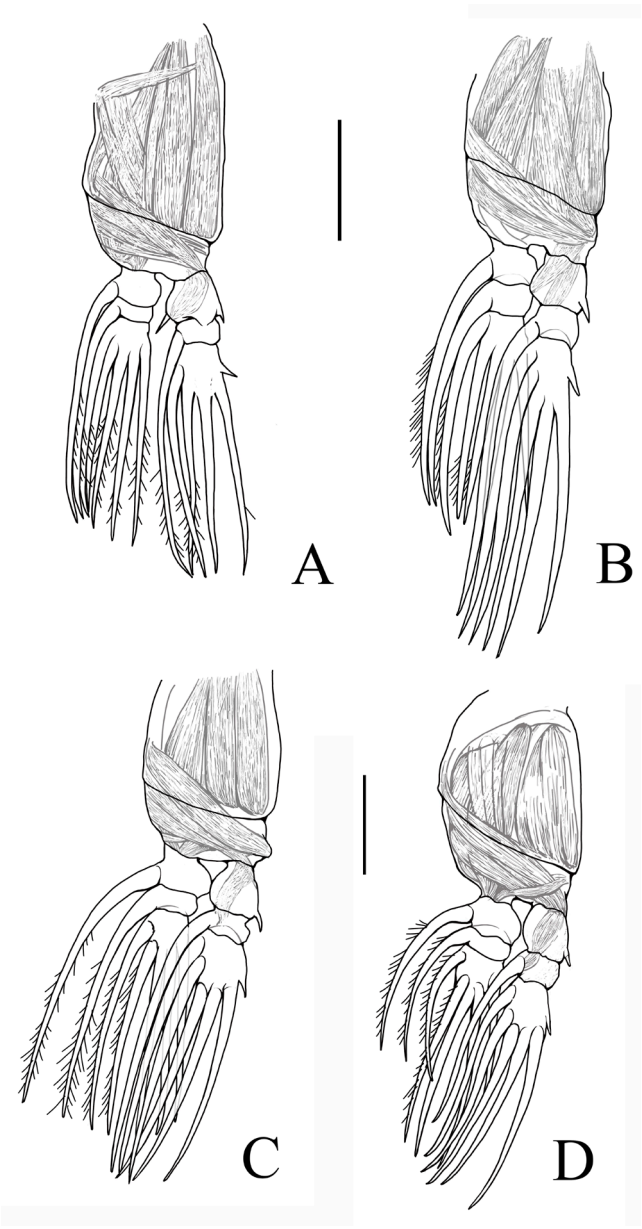

Fig. 5. *Monstrillopsis plumosa*, new species, holotype, adult male (SCSMBC-031012), Sanya Bay, Hainan, China. A, first swimming leg; B, second swimming leg; C, third swimming leg; D, fourth swimming leg. Scale bars: A–D = 100 μm.

(Fig. 3 A, B). Protopods consisting of large coxal portion, relatively small basis (Fig. 5A, B). Articulation between coxa, basis clearly expressed. Basis of legs 1–4 lacking setae. Ramus setae all long except for spiniform outer setae on exopodal segments 1, 3, inner seta of first exopodal segment on leg 1 also spiniform (Fig. 5A). Setal patterns of legs 1–4 shown in Figure 5 and Table 1 (Roman numerals indicate numbers of spines, and Arabic numerals indicate numbers of setae).

Urosome consisting of 4 somites: 5th pedigerous somite (5th legs absent), genital somite with genital apparatus, 1 free postgenital somite, long anal somite (Fig. 4C). Genital somite rounded in lateral view, no obvious transverse striations, with enlarged base of cylindrical shaft. Cylindrical shaft smooth, with short bud at insertion of lappets, visible in lateral, ventral views (Fig. 4D, E). Distal part armed with two genital lappets. Lappets reaching beyond midlength of anal somite. Lappets smooth, flake-like, without protrusion or ornamentation, transparent, slightly tapering distally in ventral view (Fig. 4).

Anal somite trapezoidal; lateral margin smooth. Caudal rami subquadrate, smooth both on dorsal, ventral surfaces. Each ramus armed with 4 subequally long, non-plumose setae: 3 dorsal apical, 1 inner ventral.

Female. Unknown.

Etymology. The species epithet is derived from the Latin adjective 'plumosa' which means feathery or feathered, in allusion to the plumose (feather-like) setae of the swimming legs on the endopodite and exopodite of the new species; used as an adjective (feminine).

Distribution. Known only from the type locality at Sanya Bay, Hainan, China.

Remarks. The male type specimens of the present new species are easily assignable to the genus *Monstrillopsis* by virtue of several characters including the sabre-like spine on the tip of antennule, the expansion in the last segment of the attennule, the oral papilla located far anteriorly on the cephalothorax, and the fully developed eyes (Huys & Boxshall, 1991; Suárez-Morales et al., 2006). The most obvious distinguishing feature of *Monstrillopsis plumosa*, new species, is the modified fifth antennular segment, with a slight inner expansion and an attenuated, short sabre-like spine on the tip. Suárez-Morales & McKinnon (2014) recognised two main types of male genital complexes in *Monstrillopsis*. Type I has a long, well-developed cylindrical shaft and relatively short, rounded lappets, and type II has a short shaft and relatively long, basally separated lappets, as in *M. plumosa*, new species. The type II genital complex

Table 2. Comparison of the main characteristics of 9 similar species (type II genital complex, with a short shaft and relatively long, basally separated lappets) of *Monstrillopsis*, females only. Species as follows: (A), *M. chilensis* Suárez-Morales, Bello-Smith & Palma, 2006; (B), *M. chathamensis* Suárez-Morales & Morales-Ramírez, 2009; (C), *M. coreensis* Lee, Kim & Chang, 2016; (D), *M. hastata* Surarez-Morales & McKinnon, 2014; (E), *M. boonwurrungorum* Surarez-Morales & McKinnon, 2014; (F), *M. longilobata* Lee, Kim & Chang, 2016; (G), *M. pontoeuxinensis* Suárez-Morales & Ustun, 2018; (H), *M. paradoxus* Jeon, Lee, Soh & Eyun, 2019; (I), *M. plumosa*, new species.

Species	**A**	**B**	**C**	**D**	**E**	**F**	**G**	**H**	**I**
Total body length	1.76 (f) 0.78 (m)	0.93	2.01	0.81	0.91	1.74	0.561	0.78	1.46
Number of postgenitial somites (contain anal somite)	3 (f, m)	3	3	2	3	3	3	1	2
Number of caudal setae	4 (f, m)	4	4	4	4	4	4	4	4
Eyes well developed	Yes (f, m)	yes	yes	yes	yes	yes	yes	yes	yes
Inner process on first segment of antennule	Yes (f, m)	yes	yes	yes	yes	yes	yes	yes	yes
Known sexes	f, m	m	m	m	m	m	m	m	m

m = male; f = female.

was previously reported in eight other congeneric species, including *M. chilensis* Suárez-Morales, Bello-Smith & Palma, 2006, *M. chathamensis* Suárez-Morales & Morales-Ramírez, 2009, *M. coreensis* Lee, Kim & Chang, 2016, *M. hastata* Surarez-Morales & McKinnon, 2014, *M. boonwurrungorum* Surarez-Morales & McKinnon, 2014, *M. longilobata* Lee, Kim & Chang, 2016, *M. pontoeuxinensis* Suárez-Morales & Ustun, 2018, and *M. paradoxus* Jeon, Lee, Soh & Eyun, 2019 (Suárez-Morales et al., 2014). However, six species of the type II group, i.e., *M. chilensis*, *M. chathamensis*, *M. hastata*, *M. boonwurrungorum*, *M. pontoeuxinensis*, and *M. paradoxa,* can be immediately excluded from further morphological consideration because of significant differences in body size compared to the new species. The body length of these species is less than 1.0 mm (i.e., 0.93 mm in *M. chathamensis*, 0.81 mm in *M. hastata*, 0.91 mm in *M. boonwurrungorum*, 0.561 in *M. pontoeuxinensis*, 0.78 mm in *M. paradoxa*, and 0.78 mm in *M. chilensis*) (Suárez-Morales & Morales-Ramírez, 2008, 2009; Suárez-Morales et al., 2014; Suárez-Morales & Üstün, 2018; Jeon et al., 2020). In addition, among the known type-II *Monstrillopsis* species, *M. paradoxus* is unique in having the minimum number of postgenital somites, specifically just one segment, while *M. plumosa* and *M. hastata* have two postgenital somites, and the rest have three postgenital somites (Suárez-Morales et al., 2006; Lee et al., 2016) (Table 2).

Monstrillopsis plumosa, new species, also differs from its abovementioned congeners in other characters, such as the slight inner expansion and the short, sabre-like apical element in the distal antennulary segment (Fig. 3d). The quantity of plumose setae on swimming legs 1–4 of the new species is another remarkable feature. In the genus *Monstrillopsis*, other species either have only one plumose seta on the outer apical exopodites or have entirely glabrous legs. Both *M. plumosa* and *M. coreensis*, on the other hand, are exceptional for having several plumose setae on their swimming legs 1–4 (Lee et al., 2016). Nonetheless, the plumose setae of *M. coreensis and M. plumosa* also differ from one another. Every ramus seta on the swimming legs of *M. coreensis* is plumose and heterogeneously ornamented with setules, whereas only specific ramus setae of *M. plumosa* exhibit plumose characters (Fig. 5) (Lee et al., 2016). In *M. plumosa*, Leg 1 has 11 plumose setae on the endopodites and exopodite, Leg 2 has 5, and Leg 3 and 4 have 4 plumose setae each on their endopodites (Fig. 5).

The new species can be distinguished from all the other species of *Monstrillopsis* on the basis of this suite of characters: 1) a type II genital complex; 2) total body length greater than 1.0 mm (1.46 mm & 1.43 mm for holotype & paratype, respectively); 3) two postgenital somites (containing anal somite); 4) a slight inner expansion and a short, sabre-like apical element in the distal antennulary segment; 5) the fifth genital somite with a short bud at the insertion of the lappets; and 6) the distinct pattern of plumose setae on the swimming legs.

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