Acta Oceanol. Sin., 2018, Vol. 37, No. 10, P. 195–201
DOI: 10.1007/s13131-018-1306-1
http://www.hyxb.org.cn
E-mail: hyxbe@263.net

The first report of the genus *Willenstenhelia* (Copepoda: Harpacticoida: Miraciidae) from the China seas, with description of a new species

MA Lin[1, 2], LI Xinzheng[1, 2, 3, 4*]

[1] Department of Marine Organism Taxonomy and Phylogeny, Institute of Oceanology, Chinese Academy of Sciences, Qingdao 266071, China

[2] Center for Ocean Mega-Science, Chinese Academy of Sciences, Qingdao, 266071, China

[3] Graduate University, University of Chinese Academy of Sciences, Beijing 100049, China

[4] Laboratory for Marine Biology and Biotechnology, Pilot National Laboratory for Marine Science and Technology (Qingdao), Qingdao 266237, China

Received 30 June 2017; accepted 23 December 2017

Abstract

A new species *Willenstenhelia mirabilipes* sp. nov. (Copepoda: Harpacticoida: Miraciiidae) is described based on specimens collected from the South China Sea. This is also the first report of the genus *Willenstenhelia* from the China seas. The new species differs from congeners by the combined characters: all somites without spinules on surface except anal somite; third segment of female P4 exopod with two inner setae; female P5 baseoendopodal lobe with four elements and P5 exopod with sharp apical spine; caudal ramus about six times as long as broad.

Key words: Crustacea, new species, taxonomy

Citation: Ma Lin, Li Xinzheng. 2018. The first report of the genus *Willenstenhelia* (Copepoda: Harpacticoida: Miraciidae) from the China seas, with description of a new species. Acta Oceanologica Sinica, 37(10): 195–201, doi: 10.1007/s13131-018-1306-1

1 Introduction

Miraciidae Dana, 1846 is the second largest family in the order Harpacticoida Sars, 1903, which can inhabit a wide range of sediment types from flocculent mud to coralline debris, primarily in intertidal and subtidal areas of continental shelves (Chullasorn, 2009). Ten benthic miraciid species identified into species level were reported from China seas until now (Mu and Gee, 2000; Mu and Huys, 2002; Huys and Mu, 2008; Ma and Li, 2011, 2017), but no *Willenstenhelia* species had been previously reported from China seas before the new species described in this paper.

The miraciid genus *Willenstenhelia* Karanovic and Kim, 2014 is a small genus, just including three species (Walter, 2018) before the new species been found. Karanovic and Kim (2014) established the genus based on morphology characters and molecular data, meanwhile they discussed the different morphology of the genus with other similar genera.

Several specimens of harpacticoid copepods were sorted from benthic samples collected off the Hainan Island, the South China Sea in 2007. These specimens are proved to belong to an unknown species of *Willenstenhelia*, which we here describe as new to science.

2 Materials and methods

The type specimens were collected from the South China Sea (Fig. 1), fixed in 10% formalin. The specimens were extracted from benthic samples using a 38 μm sieve and the colloidal silica Ludox TM-50 suspension centrifugation flotation method. Specimens were preserved in 75% alcohol. For their identification, the specimens were cleared in lactic acid and observed with light microscopy. Before dissection, the habitus was drawn and the whole body length was measured while being temporarily mounted

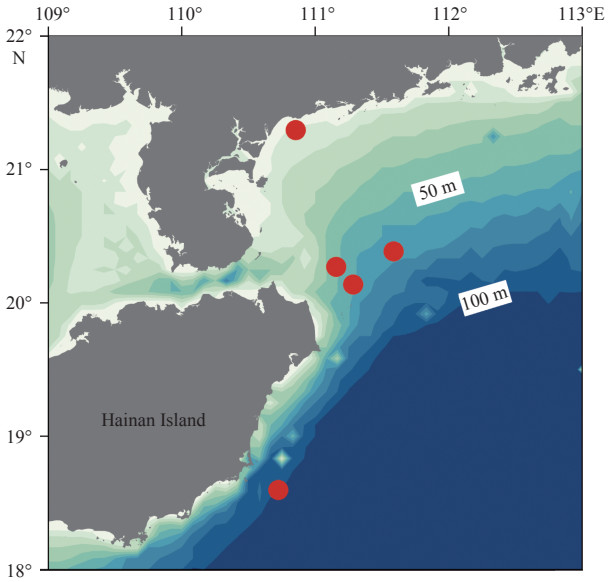

Fig. 1. Sampling stations.

Foundation item: The National Natural Science Foundation of China under contract No. 31772415; the IOCAS Funding under contract No. 2012IO060104; the Scientific and Technological Innovation Project financially supported by the Pilot National Laboratory for Marine Science and Technology (Qingdao) under contract No. 2015ASKJ01.
*Corresponding author, E-mail: lixzh@qdio.ac.cn

in lactic acid. Specimens were dissected in lactic acid and mounted on slides in lactophenol, subsequently sealed with nail polish. Observing, dissecting and drawing were made with an Olympus BH-2 phase contrast microscope with a drawing tube. The habitus was drawn at 400× magnification, appendages were drawn at 1 000× magnification, with an oil immersion lens.

The terminology follows Huys et al. (1996). Abbreviations used in the text and figures are: aes, aesthetics; P1–P5, swimming legs 1–5. Body length was measured from the anterior margin of the rostrum to the posterior margin of the caudal rami. Type material is deposited in the Marine Biological Museum, Chinese Academy of Sciences, Qingdao, China (MBMCAS).

3 Results

Systematic part

Order Harpacticoida Sars, 1903

Family Miraciidae Dana, 1846

Genus *Willenstenhelia* Karanovic and Kim, 2014

***Willenstenhelia mirabilipes* sp. nov.**

(Figs 2–5)

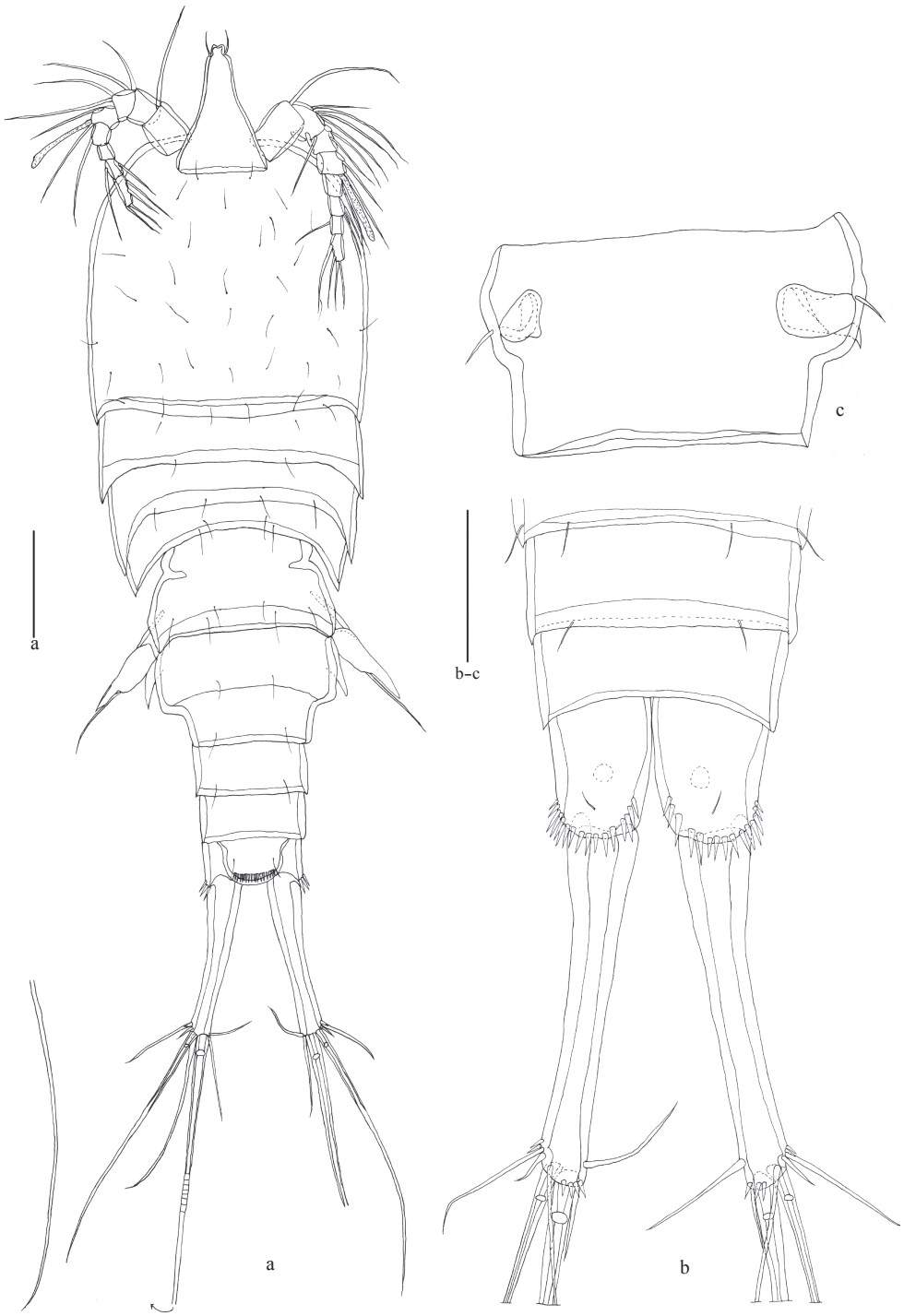

Fig. 2. *Willenstenhelia mirabilipes* sp. nov. Holotype (female, MBM189111). a. Habitus, dorsal; b. urosome (removing genital double-somite), ventral; paratype (female, MBM189114); and c. genital double-somite, ventral. Scale bars: 100 μm.

Fig. 3. *Willenstenhelia mirabilipes* sp. nov. Holotype. a. Rostrum, b. antennule, c. antenna, and d. P5. Scale bar: 50 μm

Material examined. Holotype: female, dissected on four slides (MBM189111), South China Sea, 18°35.807 1′N, 110°43.436 6′E, soft mud, 30.1 m depth, on 19 October 2007. Paratypes: one female, dissected on three slides (MBM189114), South China Sea, 20°16.169 3′N, 111°09.379 5′E, soft mud, 47.5 m depth, on 12 October 2007; one female, preserved in alcohol (MBM189112), South China Sea, 20°23.143 1′N, 111°35.286 9′E, soft mud, 67.3 m depth, on 10 October 2007; one female, preserved in alcohol (MBM189115), South China Sea, 20°08.246 6′N, 111°17.047 9′E, soft mud, 58.5 m depth, on 12 October 2007. Others (MBM189113): one female, preserved in alcohol, same collection data as holotype; one female, preserved in alcohol, South China Sea, 21°17.742 6′N, 110°51.189 1′E, soft mud, 15.5 m depth, on 9 October 2007. Collectors: Wang Jinbao, Shuai Lianmei, Zhou Jin, Han Qingxi and Ma Lin.

Etymology. The species is named "*mirabilipes*" for its very special P5 exopod, which having strong spine basely fused to exopod.

Diagnosis. Habitus robust but not spindle shaped in dorsal view, widest at posterior end of cephalothorax but with very wide first two urosomites; podoplean boundary between prosome and urosome very conspicuous. Genital double-somite in female completely fused along ventral surface. Caudal rami more or less cylindrical, with slightly wider base, six times as long as wide, completely smooth, and with seven setae (three lateral, one dorsal and three apical). Antennule eight-segmented in female, with one aesthetasc on fourth segment, distal posterior corner of first segment with spiniform process, and eighth segment with three lateral and two apical setae; no apical aesthetasc on ultimate segment. Antennary basis with one seta, endopod one-segmented, exopod three-segmented. Mandibular gnathobase with row of teeth and two inner setae, exopod one-segmented, with six setae, endopod elongated and curved, with two lateral setae and five apical setae. Maxillulary arthrite of praecoxa with seven spines and one seta at distal margin, two setae on surface, endopod and exopod fused basally, endopod with four setae, exopod with two setae. Maxillary syncoxa bearing three endites with two, three, three setae, respectively, endopod one-segmented, with six setae. Maxilliped not prehensile, three-segmented (two endopodal segments fused). Exopods of all swimming legs three-segmented, endopod of first leg two-segmented, endopods of second to fourth legs three-segmented, armature formula of exopods/endopods in female as follows: first leg, 0.1.022/1.211; second leg, 0.1.123/1.2.121; third leg, 0.1.223/1.1.121; fourth leg, 0.1. 223/1.0.121.

Description. Female (based on holotype and one paratype).

Habitus (Figs 2a–c).Body length from 820 to 917 μm (body plus caudal rami, excluding caudal setae). Body with clear distinction between broad prosome and narrow urosome, with prosome a little longer than urosome. Cephalothorax length/width ratio about 1.1, cephalic shield with sensilla; thoracic and urosomal somites both tapering posteriorly. All somites except for penultimate furnished with sensilla, prosome and urosome without spinules except anal somite. Genital double-somite (free somites 5 and 6) not completely fused dorsally but fused ventrally, laterally expanded into posteriorly directed, large spiniform processes; paired copulatory pores reniform in anterior part, situated ventro-laterally; only more sclerotized part of genital apparatus visible inside. Anal somite medially clefted in pos-

Fig. 4. *Willenstenhelia mirabilipes* sp. nov. Holotype. a. Mandible, b. maxillule, c. maxilla, and d. maxilliped. Scale bar: 50 μm.

terior half, with one pair of large dorsal sensilla, one pair of ventral pores, few spinules along medial cleft and distal margin, two curved ventral rows of spinules between median cleft and ventral pores, anal operculum well developed, broad and smooth, reaching beyond distal margin of anal somite. Caudal rami about six times as long as broad, nearly cylindrical; armature consisting of seven setae (three lateral, one dorsal and three apical); two short spinules at lateral margin, very close to distal margin, three short spinules at base of innermost apical seta; lateral setae all smooth, seta I about three times as long as seta II, seta II short and slender, seta III longest and most slender, displaced to subdistal ventral margin, setae IV and V well developed, slightly pinnate, seta VI very slender, located at inner apical edge, seta VII slender, dorsally located at inner edge.

Rostrum (Fig. 3a) large, demarcated from cephalothorax at base, broadly triangular with bifid tip, about 1.4 times as long as wide; with a pair of sensilla subapically; base of rostrum about seven times as wide as its anterior margin.

Antennule (Fig. 3b) eight-segmented; first segment large, with single row of spinules. Distal posterior corner of first segment produced into sharp process. Armature formula: I(1), II(9), III(7), IV(4+aes), V(2), VI(4), VII(3), VIII(5).

Antenna (Fig. 3c) relatively short, composed of coxa, allobasis, one-segmented endopod and three-segmented exopod. Coxa

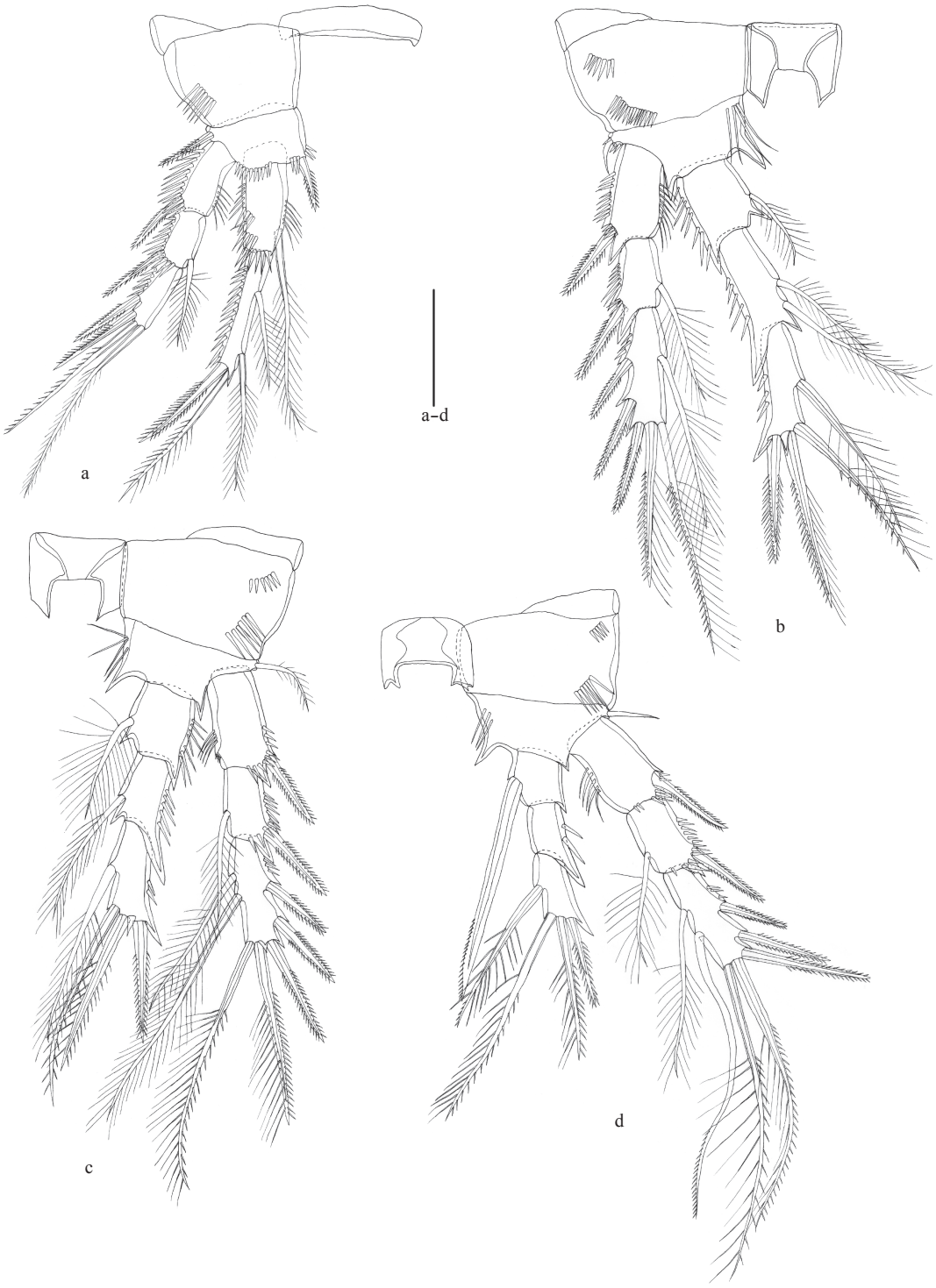

Fig. 5. *Willenstenhelia mirabilipes* sp. nov. Holotype. a. P1, anterior; b. P2, anterior; c. P3, anterior; and d. P4, anterior. Scale bar: 100 μm.

small, with row of setules. Allobasis with plumose seta in proximal half of abexopodal margin, with row of setules on abexopodal margin. Exopod three-segmented, with 1–1–(1+3) setae and length ratio of segments 1:0.1:1; first segment long, with long spinules on inner margin; second segment clearly shorter than first segment; third segment with single row of strong inner spinules. Endopod almost cylindrical, about four times as long as wide, with two surface frills subdistally and two lateral spines; lateral armature consisting of one slender seta and two stout pinnate spines; apical armature consisting of seven elements: two pinnate spines, three geniculate pinnate setae and two slender setae, one fused basally to outermost geniculate seta.

Mandible (Fig. 4a) with gnathobase compacted with fine and pointed teeth, inner edge bearing two setae, one pinnate and one smooth. Palp biramous, comprising basis, one-segmented exopod, and one-segmented endopod. Basis large, with three rows of

spinules and three smooth setae subdistally. Exopod well developed, with six naked setae altogether. Endopod enlarged, recurved and twisted over exopod, with two marginal and five terminal setae, one elongated and fringed with hyaline membrane.

Maxillule (Fig. 4b) composed of praecoxa, coxa, basis, one-segmented endopod, and one-segmented exopod; endopod and exopod fused basally. Praecoxa large; demarcated with coxa; arthrite with seven apical spines and one seta, two juxtaposed setae on surface. Coxal endite with two pinnate setae. Basis with two endites, bearing 3+4 setae, respectively. Endopod broader and longer than exopod, with four slender and smooth apical setae. Exopod with two slender and smooth setae.

Maxilla (Fig. 4c) with syncoxa bearing three endites; proximal endite with two apical pinnate setae; middle and distal endite with three pinnate setae, respectively. Basal endite with two claw-like setae. Endopod one-segmented, about two times as long as wide, bearing six setae, almost all equal in length.

Maxilliped (Fig. 4d) not prehensile. Syncoxa with row of spinules, with three well developed pinnate setae located at distal margin. Basis short, bearing two slender setae on distal margin. Endopod one-segmented, with two equal and slender setae.

P1 (Fig. 5a) with smooth and short intercoxal sclerite, smaller than other swimming legs. Praecoxa somewhat triangular, shorter than coxa, unornamented. Coxa with row of long spinules on anterior surface. Basis with pinnate outer seta and strong inner pinnate spine, terminal margin with spinules, inner margin with setules. Exopod three-segmented, outer margins of all segments with spinules, inner margin of first segment with row of setules, distal margin of second segment with four short spinules; first two segments each with outer pinnate spines; distal segment with two outer pinnate spines, two terminal pinnate setae. Endopod two-segmented; first segment broader and shorter than distal segment, with spinules along outer and distal margins, with long brushy seta and row of setules along inner margin; distal segment with two brushy inner setae, apical seta and pinnate outer spine.

P2–P4 (Figs 5b–d) with exopods and endopods three-segmented. Intercoxal sclerites smooth, with two lateral projections. Praecoxa somewhat triangular, shorter than coxa, unornamented. Coxae of almost rectangular shape, all with two rows of spinules each. Basis with small and slender outer seta; inner margin with setules and distal corner produced into spinose process; distal margin between rami forming blunt or spinous process. Outer distal corner of first segment in second swimming leg produced into spinous process; endopods and exopods of equal length in second and third swimming legs, shorter in fourth swimming leg; inner seta of first segment in second and third swimming legs slender, stout in fourth swimming leg.

Setal formulae of female P1–P4 are shown in Table 1.

P5 (Fig. 3d) baseoendopodal lobes completely fused, each with four elements (elements I–IV), with enormous gap between elements II and III; element I strongest, unpinnate along outer margin, twice as long as element II; element II minute, pinnate, and slender; element III stout, twice as long as element IV; element IV slender. Exopod almost ovoid, 1.2 times as long as wide; with five elements, innermost one shorter than others, second outermost one fused to exopod at base, formed sharp spine.

Male. Unknown.

Table 1. Setal formulae of swimming legs 1–4 in female

	Exopod	Endopod
P1	0.1.022	1.211
P2	0.1.123	1.2.121
P3	0.1.223	1.1.121
P4	0.1.223	1.0.121

4 Discussion

Karanovic and Kim (2014) established the genus *Willenstenhelia* and gave diagnosis of the genus. The new species *Willenstenhelia mirabilipes* sp. nov. were placed into genus *Willenstenhelia* according to the features: (1) armature formula of exopods/endopods in female as follows: first leg, 0.1.022/1.211; second leg, 0.1.123/1.2.121; third leg, 0.1.223/1.1.121; fourth leg, 0.1.223/1.0.121; (2) female fifth legs fused medially, without posterior spinules or spiniform process on baseoendopod; baseoendopodal lobe with large gap between inner setae and outer ones; exopod with five setae. Now, the genus *Willenstenhelia* includes species *W. terpsichore* Karanovic and Kim, 2014, *W. thalia* Karanovic and Kim, 2014, *W. urania* Karanovic and Kim, 2014 and *Willenstenhelia mirabilipes* sp. nov..

Willenstenhelia mirabilipes sp. nov. shows distinctive characters of the genus by having P5 baseoendopodal lobe with four elements (two strong, two slender) and P5 exopod with sharp spine, which may considered as autapomorphic characters. Karanovic and Kim (2014) considered the minute inner seta on the female fifth leg exopod as an autapomorphic character of *W. thalia*. This character can also be found in *W. mirabilipes* sp. nov., which is not the special feature in *W. thalia* now.

Within the genus, *W. mirabilipes* sp. nov. differs from *W. thalia* by the following characteristics (female): caudal ramus about six times as long as broad (about 4.6 times as long as broad in *W. thalia*); third segment of P4 exopod with two setae (with one seta in *W. thalia*); P5 baseoendopodal lobe with four elements, outermost one strong, near outermost one slender (P5 baseoendopodal lobe with three elements, outermost one slender, near outermost one strong in *W. thalia*); P5 exopod with sharp spine (no sharp spine in *W. thalia*). For species *W. urania* and *W. terpsichore*, the original description were unthorough that just a very limited set of morphological characters were given (Por, 1964; Marinov and Apotolov, 1981). *Willenstenhelia mirabilipes* sp. nov. can be distinguished from *W. terpsichore* and *W. urania* by the following characteristics: caudal ramus about six times as long as broad (about five times as long as broad in *W. urania*, four times in *W. terpsichore*); P5 baseoendopodal lobe with four elements (with three setae and innermost one reduced in *W. urania* and *W. terpsichore*); inner seta in P5 exopod far shorter than innermost apical seta (inner seta as long as innermost apical seta in *W. urania* and *W. terpsichore*); P5 exopod with sharp spine (no sharp spine in *W. urania* and *W. terpsichore*).

Acknowlegements

Thanks to the fellows in our team for their assistance in collecting samples.

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