

Two new species of *Thalassaphorura* from China (Collembola: Onychiuridae)

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Abstract. Two new *Thalassaphorura* species, *T. sichuanensis* and *T. whitteni*, are reported from China. *Thalassaphorura sichuanensis* can be separated easily from the similar species *T. macrospinata* and *T. petiti* by body size (1.0–1.4 mm), S-chaetae indistinct from ordinary chaetae, absence of male genital organ and presence of psx on Abd. VI sternum. *Thalassaphorura whitteni* is most similar to the species *T. cryptopyga*, *T. franzi*, *T. hoguei*, and *T. tovtrensis* as having no anal spines; it can be easily distinguished by the dorsal or ventral pso formula, the number of pso on subcoxae, of papillae on the sensory organ of Ant. III, of vesicles on postantennal organ, and of chaetae on the ventral tube.

Key words. taxonomy, *Thalassaphorura sichuanensis*, *Thalassaphorura whitteni*, Guangxi, Sichuan

INTRODUCTION

The genus *Thalassaphorura* Bagnall, 1949 is characterised by having simple vesicles on postantennal organ, 4/1,4,2 chaetae on labrum, chaeta d0 present on head (rarely absent), reduced number (six, seven, or nine) of chaetae in the distal whorl of tibiotarsi, four (rarely two) small dental chaetae in two rows posterior to a finely granulated area on furcal rudiment, and one manubrial row of chaetae posteriorly to dental chaetae (Sun et al., 2010; Sun et al., 2013, Sun et al., 2017). Until now, 28 species have been reported from China, mostly distributed in the south part of the country (Sun et al., 2017).

In the present paper, two new species of *Thalassaphorura*, *T. sichuanensis* and *T. whitteni*, are described from Guangxi (South China) and Sichuan provinces (Southwest China).

MATERIAL AND METHODS

Specimens were collected by Berlese extraction, preserved in ethanol, cleared in lactic acid, and then mounted in Hoyer's medium to permanent slides.

Chaetotaxy of the labium, anal valves, and the furcal remnant is applied according to Fjellberg (1999), Yoshii (1996) and

Weiner (1996), respectively. Chaetotaxy of the ventral tube (in Table 1) is presented as the number of anterior/distal/proximal chaetae. Unguiculus/unguis ratio is given according to the length of the medial line of unguiculus and the length of the inner edge of the unguis. The formulae of pseudocelli, parapseudocelli, pseudopores and S-chaetae are presented as the number per half-tergum/sternum from head to Abd. V (Abd. VI for S-chaetae and parapseudocelli). The tibiotarsus chaetotaxy formula follows Deharveng (1983) and is expressed as the total number of chaetae, with the number of chaetae in the whorls C, B, and A+T, for example, 18 (1, 8, 9).

Abbreviations. Ant., antennal segments; AIIO, sensory organ of Ant. III; PAO, postantennal organ; d0, unpaired axial chaeta on area frontalis on head; Th., thoracic segments; Abd., abdominal segments; AS, anal spine; p-chaeta, chaetae in posterior row; pso, pseudocellus; psx, parapseudocellus; ms, microchaeta s (microsensillum); ^m, unpaired pseudopore or parapseudocellus; VT, ventral tube; IGA-CAS, Northeast Institute of Geography and Agroecology, Chinese Academy of Sciences, Changchun (China); MNHN, Muséum National d'Histoire Naturelle, Paris (France).

SYSTEMATICS

Family Onychiuridae Börner, 1913

Thalassaphorura Bagnall, 1949

Thalassaphorura sichuanensis, new species (Figs. 1, 2; Table 1)

Material examined. Holotype female, 5 female, 2 male and 6 juvenile paratypes on slides (17JZG21), China: Sichuan:

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A Ba: Jiuzhaigou natural reserve (alt. about 2,369 m), rotten wood and moss, Berlese extraction, Yu Daoyuan and Yan Qibao leg., 1 August 2017; 2 female and 2 juvenile paratypes on slides (17WL11), China: Sichuan: Pingwu: Wanglang natural reserve (alt. about 3,000 m), moss, Berlese extraction, coll. Yu Daoyuan and Yan Qibao, 30 July 2017. Holotype and 10 paratypes are deposited in IGA-CAS, 7 paratypes in MNHN.

Description. Body length: 1.1–1.4 mm in female, 1.0 mm in male; holotype 1.25 mm. Shape of body cylindrical, Abd. III–IV more or less broadened, and anal spines present (Fig. 1A, H). Colour white in alcohol.

Pso formula: 32/233/33343 dorsally and 11/000/01120 ventrally (Fig. 1A, H). Subcoxae 1 of legs I–III with 2 pso each. Parapseudocellar formula: 0/000/100001^m ventrally, dorsal psx absent (Fig. 1A, H). Pseudopore formula as 0/011/11110 dorsally and 0/111/0001^m00 ventrally (Fig. 1A, H).

Head. Antennae short, as long as head. Length ratio of antennal segments I: II: III: IV = 1: 1.8: 1.8: 2.5. Subapical organite of Ant. IV with globular apex (Fig. 1D); invaginated apical bulb absent; basolateral ms above the second proximal row of chaetae (Fig. 1D). Ant. III sensory organ composed of 5 papillae, 5 guard chaetae, 2 small rods, and 2 smooth sensory clubs (Fig. 1C); lateral ms just behind sensory organ (Fig. 1C). Ant. II with 13 chaetae. Ant. I with 9 chaetae. Antennal base well marked. PAO with 26–32 simple vesicles arranged in two rows along the axis of the organ (Fig. 1B). Dorsal cephalic chaeta d0 present (Fig. 1A). 3+3 p-chaetae between 2 inner posterior pso on the head, p1 in line with others (Fig. 1A). Mandible with a strong molar plate and 4 apical teeth. Maxilla bearing 3 teeth and 6 lamellae. Maxillary palp simple with 1 basal chaeta and 2 sublobal hairs (Fig. 1F). Labral chaetae formula as 4/1,4,2. Labium with 6 proximal, 4 basomedian (E, F, G, and f) and 6 basolateral (a, b, c, d, e, e') chaetae (Fig. 2A). Labial palp of AC type, labial papillae A–E with 1, 4, 0, 3, and 2 guard chaetae respectively (Fig. 1E). Head ventrally with 4+4 postlabial chaetae along the ventral groove (Fig. 2A).

Body chaetotaxy. S-chaetae not distinguishable from ordinary chaetae. Tiny and blunt ms, present dorso-laterally on Th. II–III (Fig. 1A). Dorsal ordinary chaetae of various lengths, the largest as well-differentiated macrochaetae. Th. tergum I with 6+6(7) chaetae. Each tergum of Th. II–Abd. III with 3–4+3–4 chaetae along the axial line (Fig. 1A). Abd. tergum IV with axial chaeta m0; Abd. tergum V often with asymmetric chaetae; Abd. tergum VI with axial chaeta m0 (Figs. 1A, 2F). Each sternum of Th. I–III with 1+1 chaetae between legs.

Appendages. Subcoxae 1 of legs I–III with 4, 4, and 4 chaetae, subcoxae 2 with 1, 4, and 4 chaetae respectively. Coxae of legs I, II, and III with 3, 10, and 13 chaetae respectively, trochanters with 9 chaetae each and femora with 15–16 chaetae. Tibiotarsi of legs I, II and III with 19 (2, 8, 9), 19 (2, 8, 9), and 18 (1, 8, 9) chaetae, M-chaeta present

(Fig. 2B, D). Unguis without teeth. Unguiculus slender, long and pointed, 1.1 times as long as the inner edge of unguis, without inner basal lamella (Fig. 2B, D). Ventral tube with 1+1 anterior, 6+6 distal, and 2+2 basal chaetae (Fig. 1G). Furca reduced to a finely granulated area with 4 small dental chaetae in two rows posteriorly; one manubrial row of chaetae (mp) present (Fig. 2C).

Genital plate with 12–22 chaetae in females, about 40 in males. Each lateral anal valve with chaetae a0 and 2a1; upper unpaired valve with chaetae a0, 2a1, 2b1, c0, 2c1 and 2c2 (Fig. 2E). Anal spines without distinct papillae, 0.8 times as long as inner edge of hind unguis (Fig. 2F).

Etymology. *Thalassaphorura sichuanensis* is named for the province where the type material was collected.

Discussion. *Thalassaphorura sichuanensis*, new species, belongs to the group with pso formula as 32/233/33343 dorsally and 11/000/01120 ventrally (Table 1). The new species is most similar to the species *T. macrospinata* Sun & Wu, 2012 and *T. petiti* Sun & Wu, 2013 from the northeast and northwest parts of China respectively. However, it can be separated easily from them by having indistinct S-chaetae on the body, a larger ratio of unguiculus/unguis and absence of the male ventral organ. A comparison with other species of the group is shown in Table 1.

Thalassaphorura whitteni, new species (Figs. 3, 4)

Material examined. Holotype female, 1 female paratype on slides (CHIGx09–080), China: Guangxi: Huanjiang: near the cave Dong Qiao Dong, litter, sifting and Berlese extraction, coll. Tian Mingyi, 5 November 2009; 2 female paratypes on slides (CHIGx05–109), China: Guangxi: Huanjiang: Min Li forest (107.96647°E 25.09935°N), litter, Berlese extraction, coll. Deharveng Louis & Bedos Anne, 14 March 2005. Both collecting sites are located in the karst of the Mulun National Nature Reserve. Holotype and 1 paratype are deposited in IGA-CAS; 2 paratypes in MNHN.

Description. Body length: 0.93–0.98 mm; holotype 0.94 mm. Shape of body cylindrical, Abd. III–IV more or less broadened and anal spines absent (Fig. 3A, F). Colour white in alcohol.

Pso formula: 32/233/33343 dorsally and 11/000/01110 ventrally (Fig. 3A, F). Subcoxae 1 of legs I–III with 2 pso each. Parapseudocellar formula: 0/000/100000 ventrally, psx absent dorsally (Fig. 3A, F). Pseudopore formula as 0/011/11110 dorsally and 0/111/0001^m00 ventrally (Fig. 3A, F).

Head. Antennae short, as long as head. Length ratio of antennal segments I: II: III: IV = 1: 1.8: 1.8: 2.8. Subapical organite of Ant. IV with globular apex; invaginated apical bulb absent; basolateral ms above the second proximal row of chaetae (Fig. 3B). Ant. III sensory organ composed of 5 papillae, 5 guard chaetae, 2 small rods, and 2 smooth sensory

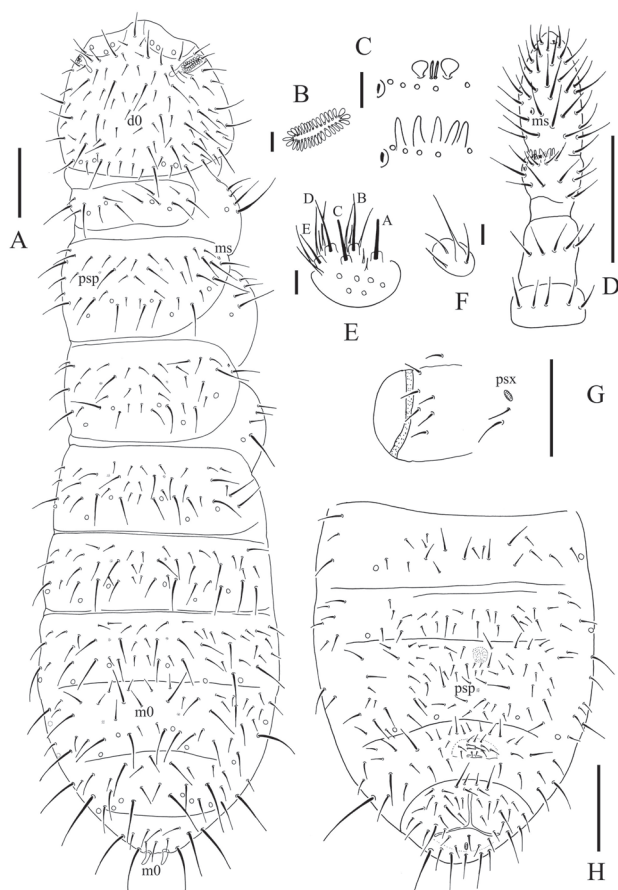


Fig. 1. *Thalassaphorura sichuanensis*, new species. A, dorsal side of body; B, PAO; C, clubs, rods, and papillae of AIIIO; D, antenna; E, labium; F, maxillary palp; G, ventral tube; H, ventral side of Abd. II–VI. Scales: 0.1 mm (A, D, G–H), 0.01 mm (B, C, E, F).

clubs (Fig. 3B); lateral ms just behind sensory organ (Fig. 3B). Ant. II with 13 chaetae. Ant. I with 9 chaetae. Antennal base well marked. PAO with 16–20 simple vesicles arranged in two rows along the axis of the organ (Fig. 3D). Dorsal cephalic chaeta d0 present (Fig. 3A). 4+4 p-chaetae between two inner posterior pso on head, p1 in line with others (Fig. 3A). Mandible with a strong molar plate and 4 apical teeth. Maxilla bearing 3 teeth and 6 lamellae. Maxillary palp simple with 1 basal chaeta and 2 sublobal hairs. Labral chaetae formula as 4/1,4,2. Labium with 6 proximal, 4 basomedian (E, F, G, and f) and 5 basolateral (b, c, d, e, e') chaetae (Fig. 3E). Labial palp of AC type, labial papillae A–E with 1, 4, 0, 3 and 2 guard chaetae respectively (Fig. 3C). Head ventrally with 4+4 postlabial chaetae along the ventral groove (Fig. 3E).

Body chaetotaxy. S-chaetae weakly thickened but distinguishable from ordinary chaetae, S-chaetae formula: 11/011/222121 dorsally and 11/000/000100 ventrally. Tiny and blunt ms, present dorso-laterally on Th. II–III (Fig. 3A, F). Dorsal ordinary chaetae relatively short with macrochaetae weakly differentiated. Th. tergum I with 5+5 chaetae. Each tergum of Th. II–Abd. III with 3+3 chaetae along the axial line. Abd. tergum IV with axial chaeta m0; Abd. tergum V with asymmetric chaetae; Abd. tergum VI



Fig. 2. *Thalassaphorura sichuanensis*, new species. A, ventral side of head; B, tibiotarsus and claw complex of leg I; C, central part of abdominal sternum IV; D, tibiotarsus and claw complex of leg III; E, anal valves; F, dorsal side of Abd. IV–VI. Scales: 0.1 mm (A, F), 0.05 mm (B–E).

with axial chaeta a0 (Fig. 3A). Each sternum of Th. I–III with 1+1 chaetae between legs.

Appendages. Subcoxae 1 of legs I–III with 4, 4, and 4 chaetae, subcoxae 2 with 1, 4, and 4 chaetae respectively. Coxae of legs I, II, and III with 3, 10, and 13 chaetae respectively, trochanters with 9 chaetae each and femora with 14 chaetae. Tibiotarsi of legs I, II, and III with 18 (1, 8, 9) chaetae each, M-chaeta present (Fig. 4B, D). Unguis without teeth. Unguiculus rather slender, pointed, 0.5 times as long as inner edge of unguis, with inner basal lamella (Fig. 4B, D). Ventral tube with 6+6 distal, 2+2 basal, and anterior chaetae absent. Furca reduced to a finely granulated area with 4 small dental chaetae in two rows posteriorly; one manubrial row of chaetae (mp) present (Fig. 4A).

Female genital plate with 18–21 chaetae, no male observed. Each lateral valve with chaetae a0 and 2a1; upper unpaired valve with chaetae a0, 2a1, 2b1, c0, 2c1 and 2c2 (Fig. 4C).

Etymology. *Thalassaphorura whitteni* is named in honour of Tony Whitten in appreciation for his strong support to biological surveys in Guangxi and conservation studies of the karsts of Asia.

Table 1. Differential characters of *Thalassaphorura* species with pso formula as 32/233/33343 dorsally and 11/000/01120 ventrally. A, number of chaetae in distal whorl of tibiotarsi; B, number of chaetae between posterior inner pso on head; C, ratio of AS/unguis; D, inner basal lamella on unguiculus; E, number of papillae on AIIIO; F, number of proximal chaetae on labium; G, number of vesicles in PAO; H, dorsal S-chaetae formula; I, labial type; J, number of chaetae on Th. I tergum; K, uneven axial chaetae on tergum Abd. V; L, uneven axial chaetae on Abd. tergum VI; M, number of chaetae on the ventral tube; N, male ventral organ; O, distribution.

	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O
<i>T. sichuanensis</i> , new species	9	3+3	0.8	absent	5	6	26–32	indistinct	AC	6+6(7)	absent	m0	1+1/6+6/ 2+2	absent	China
<i>T. bisetosa</i> Sun & Wu, 2013	9	3+3	0.9	absent	5	6	22–27	10/011/221120	AC	7(8)+7(8)	absent	a0 and m0	1+1/7+7/ 2+2	modified chaetae on ventral tube	China
<i>T. encarpata</i> (Denis, 1931) sensu Pomorski 1998	9	3+3	0.8	absent	5	6	22–25	indistinct	A	7+7	a0	a0 and m0	0+0/ 6-7+6-7/ 2+2(1+1)	absent	cosmopolita n
<i>T. franzi</i> (Stach, 1946)	?	?	AS absent	absent	4	?	21–23	?	?	?	?	?	?/6+6/?	absent (?)	Austria
<i>T. hainanica</i> Sun, Gao & Potapov, 2014	9	3+3	0.3	present	5	6	16–17	11/011/222121	AC	5+5	a0	a0	1+1/6+6/ 2+2	absent	China
<i>T. lifouensis</i> (Thibaud & Weiner, 1997)	9	4+4	0.5	present	5	6	17–23	10/011/11?10	AC	5+5	a0	a0 and m0	1+1/6+ 6(7)/2+2	absent	New Cledonia, China
<i>T. linzhiensis</i> Sun & Li, 2015	9	3+3	0.6	absent	5	6	21–23	indistinct	AC	5+5	absent	a0 and m0	1+1/6+6/ 2+2	absent	China
<i>T. macrospinata</i> Sun & Wu, 2012	9	3+3	1.1	absent	5	6	28–32	11/011/222120	AC	7+7	a0	m0	1+1/6+6/2 +2	5+5 modified chaetae on ventral tube	China
<i>T. qinlingensis</i> Sun & Wu, 2013	9	4+4	0.9– 1.0	absent	5	6	20–22	10/011/221120	AC	7(8)+7(8)	absent	a0 and m0	1+1/7+7/ 2+2	modified chaetae on ventral tube	China

<i>T. petaloides</i> (Rusek, 1981)	7	3+3	1.0	present	5	6	18–21	10/011/221121	AC	?	absent	a0 and m0	0+0/6+6/2+2	absent	Irak, New Caledonia, Hawaii, China
<i>T. petiti</i> Sun & Wu, 2013	9	3+3	0.9	present	5	6	18–22	10/011/221120	AC	6+6	absent	a0 and m0	1+1/7+7/2+2	2+2 modified chaetae on ventral tube	China
<i>T. qixiaensis</i> Yan, Shi & Chen, 2006	9	3+3	0.8	absent	5	7	21–30	indistinct	AC	6+6	a0	a0 and m0	0+0/6–7+6–7/0+0	absent	China
<i>T. tenuis</i> Babenko, 2007	9	3+3	0.4	absent	5	5–6	11–13	11/011/111010	ABC	6+6(7)	a0	a0	1+1/5+5/2+2	absent	Russia
<i>T. thaibinhensis</i> Nguyen, 2001	?	3+3	0.9	absent	5	?	20	10/???/???/??	?	5+5	a0	a0 and m0	1+1/6+6/2+2	absent	Vietnam
<i>T. tiani</i> Sun, Chen & Deharveng, 2010	9	3+3	1.0	present	5	6	24–26	11/011/222120	AC	5+5	a0	a0 and m0	1+1/6+6/2+2	absent	China
<i>T. tibiotarsalis</i> Sun, Chen & Deharveng, 2010	7	3+3	0.7	present	5	6	17–18	11/011/222120	ABC	5+5	absent	a0	0+0/6+6(7)/2+2	absent	China
<i>T. tovtrensis</i> (Kaprut' & Weiner, 1994)	9	3+3	AS absent	absent	4	?	10–13	indistinct	?	5+5	absent	a0	1+1/6+6(5+5)/2+2	absent	Ukraine
<i>T. xihuensis</i> Sun & Li, 2015	9	3+3	0.7	absent	4	6	20–24	11/011/222120	AC	6+6	a0	a0 and m0	1+1/6+6/2+2	absent	China
<i>T. zschokkei</i> (Handschin, 1919) sensu Pomorski 1998	9	3+3	0.7	present	5	?	24–28	indistinct	AC	5+5	m0	a0	0+0/6+6/2+2	absent	Europe

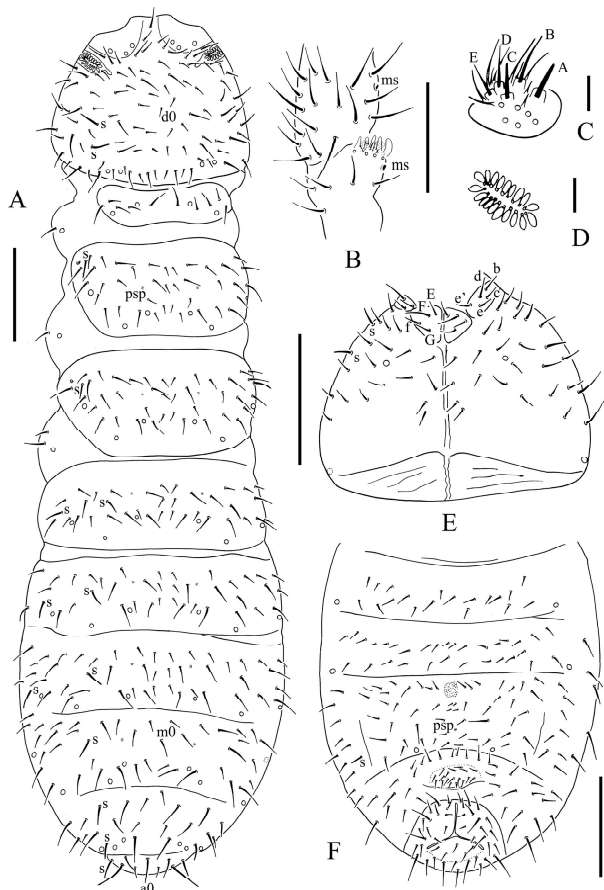


Fig. 3. *Thalassaphorura whitteni*, new species. A, dorsal side of body; B, antenna III and IV; C, labium; D, PAO; E, ventral side of head; F, ventral side of Abd. II–VI. Scales: 0.1 mm (A–B, E–F), 0.05 mm (D), 0.01 mm (C).

Discussion. *Thalassaphorura whitteni*, new species, belongs to the species-group devoid of anal spines defined by Kaprus' & Pašnik (2017). It is most similar to *T. stebaevae* Kaprus' & Pašnik, 2017 as having pso formula as 32/233/33343 dorsally and 11/000/01110 ventrally. However, it can be easily distinguished from *T. stebaevae* by the number of pchaetae between two inner posterior pso on the head (4+4 in *T. whitteni* and 3+3 in *T. stebaevae*), dorsal S-chaetae formula (11/011/222121 in *T. whitteni* and 11/011/111011 in *T. stebaevae*), presence of chaetae on Th. sternum I (present in *T. whitteni* and absent in *T. stebaevae*), presence of inner basal lamella on unguiculus (present in *T. whitteni* and absent in *T. stebaevae*), and presence of male ventral organ (absent in *T. whitteni* and present in *T. stebaevae*). Among the 10 species of *Thalassaphorura* known from Guangxi (Sun et al., 2010; Sun et al., 2017), the new species is the only one devoid of anal spines.

ACKNOWLEDGEMENTS

We are grateful to Liu Jin and the late Tony Whitten who facilitated the biological surveys in Guangxi covered by the project “Guangxi integrated forestry development and conservation” of World Bank GEF. Thanks should also be given to Tian Mingyi, Yan Qibao, and Daoyuan Yu for pro-

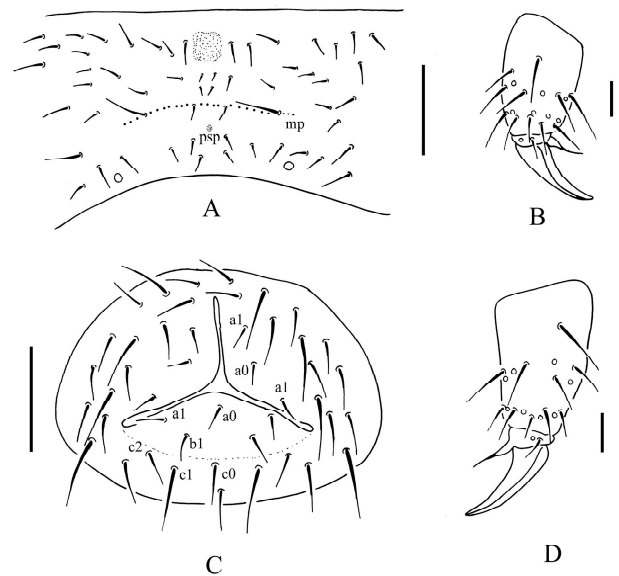


Fig. 4. *Thalassaphorura whitteni*, new species. A, central part of abdominal sternum IV; B, tibiotarsus and claw complex of leg I; C, anal valves; D, tibiotarsus and claw complex of leg III. Scales: 0.05 mm (A, C), 0.01 mm (B, D).

viding the studied material. The study was supported by funds of National Natural Science Foundation of China [41571052, 41811530086, 31861133006], and National Science and Technology Fundamental Resources Investigation Program of China [2018FY100300].

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