



**Research article**

[urn:lsid:zoobank.org:pub:BF7A05CC-65A0-41E6-91E9-2C10FD5EC2DF](https://zoobank.org/pub/BF7A05CC-65A0-41E6-91E9-2C10FD5EC2DF)

**Two new species of *Willowsia* (Collembola: Entomobryidae)  
from Yunnan Province, China**

Rui CHAI<sup>1</sup> & Yitong MA<sup>2,\*</sup>

<sup>1,2</sup>School of Life Science, Nantong University, Nantong 226000, P.R. China.

\*Corresponding author: [mayitong@ntu.edu.cn](mailto:mayitong@ntu.edu.cn)

<sup>1</sup>Email: [chairui2015@126.com](mailto:chairui2015@126.com)

<sup>1</sup>[urn:lsid:zoobank.org:author:0702F470-4C20-4044-A29F-57A35D38FC29](https://zoobank.org/author/0702F470-4C20-4044-A29F-57A35D38FC29)

<sup>2</sup>[urn:lsid:zoobank.org:author:14F92F90-863A-46EB-B056-41EB3FA341A0](https://zoobank.org/author/14F92F90-863A-46EB-B056-41EB3FA341A0)

**Abstract.** We describe two new species of *Willowsia*: *W. baoshanensis* sp. nov. and *W. zhaotongensis* sp. nov. This is the first report of *Willowsia* from Yunnan Province, China. *W. baoshanensis* sp. nov. is mainly characterized by its chaetotaxy, *W. zhaotongensis* sp. nov. by its color pattern and chaetotaxy.

**Keywords.** Entomobryinae, taxonomy, chaetotaxy, scales.

Chai R. & Yitong M. 2017. Two new species of *Willowsia* (Collembola: Entomobryidae) from Yunnan Province, China. *European Journal of Taxonomy* 311: 1–12. <https://doi.org/10.5852/ejt.2017.311>

## Introduction

The genus *Willowsia* was erected by Shoebbotham (1917) to accommodate the species *Seira nigromaculata* Lubbock, 1873 from England, mainly based on its pointed scales. Its main generic characters include mucro bidentation and the presence of a basal spine, eyes 8+8, dental spine absent. Scale morphology and distribution are important in taxonomy. Scales may be absent on the antennae, the legs and the manubrium in some species and are always absent on dens.

Thirty species have been described from all over the world and their habitats are from arctic regions to tropical areas. Thirteen species were described or reported from China. Here, two new species from Yunnan, southwest China, are described and a key to the Chinese species of the genus is given.

## Material and methods

Specimens were mounted under a coverslip in Marc André II solution and were subsequently studied with a Leica DM2500 microscope. Photographs were taken with a mounted Leica DFC300 FX digital camera and enhanced with Photoshop CS2 (Adobe Inc.). The nomenclature of the dorsal chaetotaxy of head and interocular chaetae is described following Jordana & Baquero (2005), Szeptycki (1979) and Mari-Mutt (1986). Labial chaetae are designated following Gisin (1967). Tergal chaetae of the body are designated using the system of Szeptycki (1979). Morphology of scales is described following Zhang, Chen & Deharveng (2011).

### Abbreviations:

Abd. = abdominal segment

Ant. = antennal segment

Mac = macrochaeta(e)

Th. = thoracic segment

### Results

Class Collembola Lubbock, 1873  
Order Entomobryomorpha Börner, 1913  
Family Entomobryidae Tömösvary, 1882  
Subfamily Entomobryinae Schäffer, 1896

Genus *Willowsia* Shoebotam, 1917

### Diagnosis

Moderate size, usually 1–2 mm; eyes 8+8; four segmented antennae; mucro bidentate and with a basal spine; dentes without spine; various scale types in different species and absent on dens.

*Willowsia baoshanensis* sp. nov.

[urn:lsid:zoobank.org:act:A334FCB0-054E-4527-BC0B-F61A322CD9DC](https://zoobank.org/urn:lsid:zoobank.org:act:A334FCB0-054E-4527-BC0B-F61A322CD9DC)

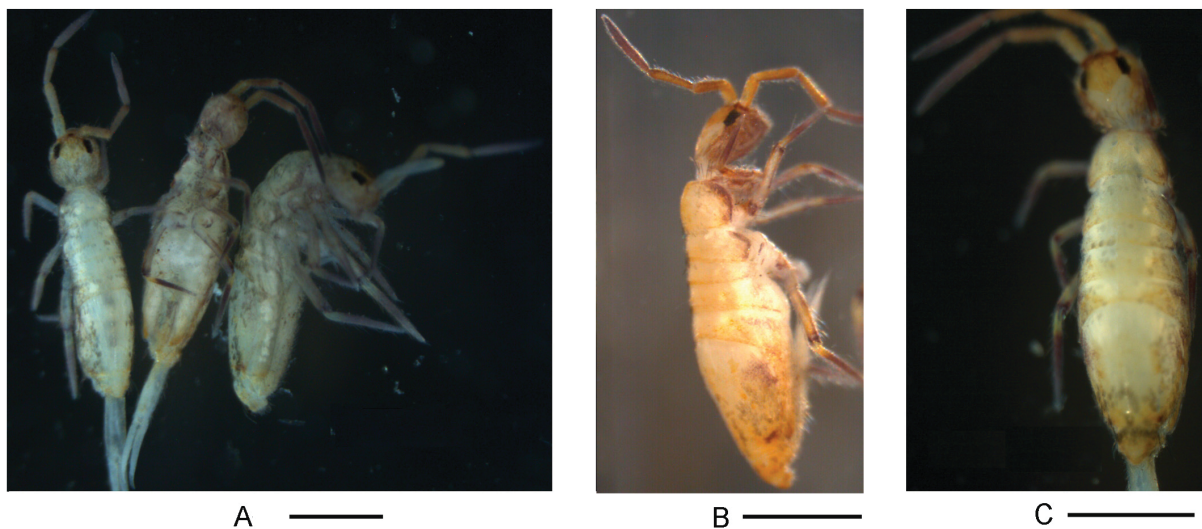
Figs 1–3; Table 1

### Diagnosis

Eyepatches and lateral margin of Th. II and III with a little blue pigment; Abd. I with 4+4 mac; Abd. II usually with 4+4 dorso-central mac; Abd. III with 2+2 dorso-central and 3+3 lateral mac; spinulate type scales present on Ant. I, head, terga, legs, ventral tube and ventral side of manubrium.

### Etymology

The specific epithet refers to the type locality: Baoshan City.



**Fig. 1.** *Willowsia baoshanensis* sp. nov. A–C. Habitus (A, C = paratypes; B = holotype) Scale bars: 500  $\mu$ m.

**Table 1.** Comparison of *W. baoshanensis* sp. nov., *W. guangxiensis* Shi & Chen, 2004 and *W. shi* Pan, Zhang & Chen, 2006.

Characters	<i>W. baoshanensis</i> sp. nov.	<i>W. guangxiensis</i>	<i>W. shi</i>
Labial triangle setae	M <sub>1</sub> M <sub>2</sub> REL <sub>1</sub> L <sub>2</sub>	M <sub>1</sub> M <sub>2</sub> M <sub>3</sub> RRsEL <sub>1</sub> L <sub>2</sub>	MREL <sub>1</sub> L <sub>2</sub>
Scales on legs	present	present	absent
Central macrochaetae on Abd. II	4 (a2, m3, m3e, m3ep, rarely 5, a3 present)	5 (a2, a3, m3ep, m3e, m3)	5 (a2, m3ea, m3ep, m3e, m3)
Central macrochaetae on Abd. III	2 (a2, m3)	2 (a2, m3)	3 (a2, a3, m3)
Lateral macrochaetae on Abd. III	3 (am6, pm6, p6)	4 (am6, pm6, p6, m7)	5 (am6, pm6, p6, m7, p7)
Ungual inner teeth	4	3	4

### Type material

#### Holotype

CHINA: ♀, on slide, collected in Guanjia Village, Xinjie Town, Longyang District, Baoshan City, Yunnan Province, rotten leaves of bamboo, 10 Aug. 2014, Xinnan Jiang leg. (collection number: 1148, Nantong University).

#### Paratypes

CHINA: 5 ♀♀ on slides, 2 ♀♀ in alcohol, same data as holotype.

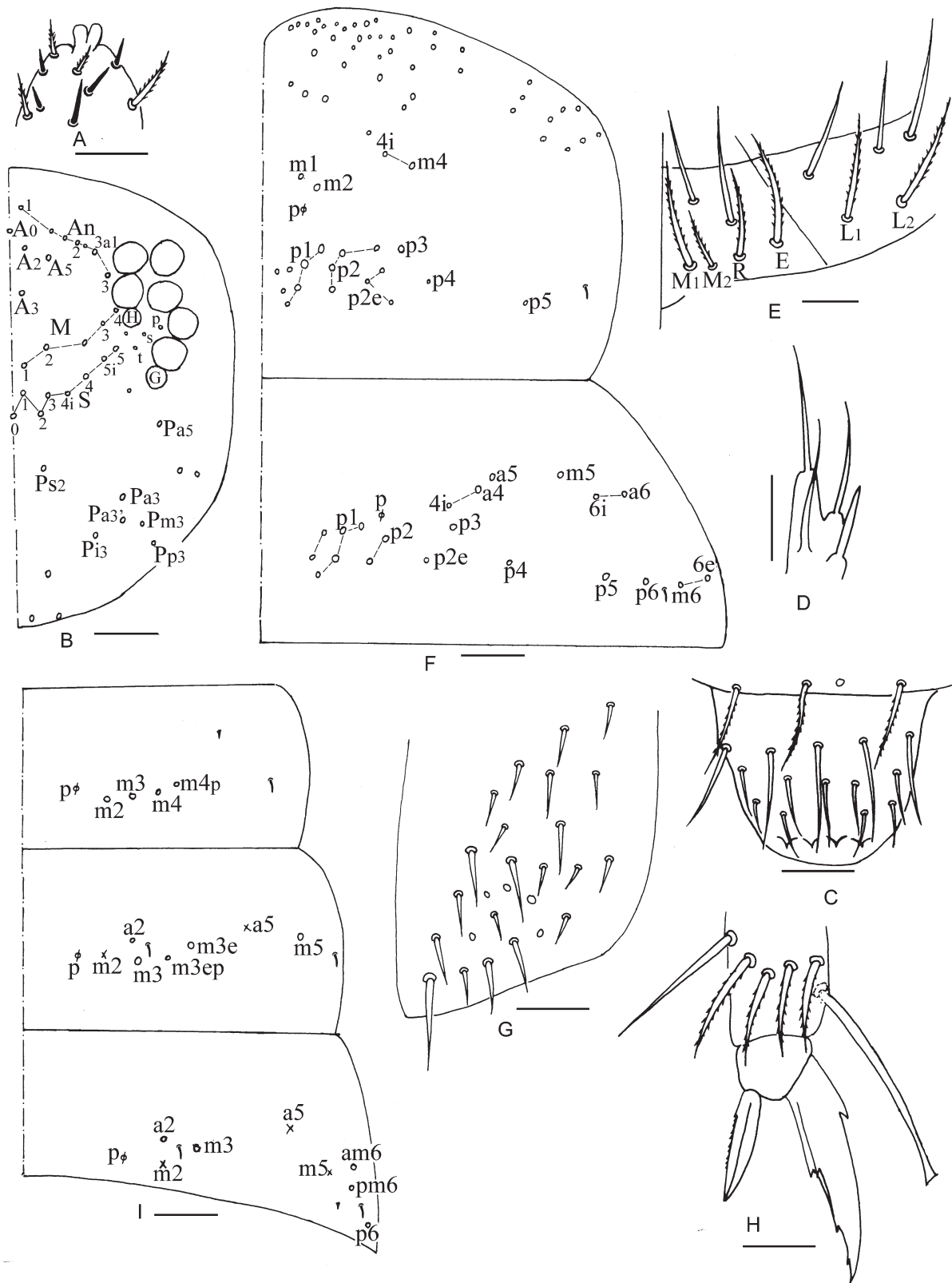
### Description

COLOUR PATTERN. Body length up to 1.9 mm. Ground color pale yellow. Eyepatch dark blue. Ant. IV and tibiotarsus with blue pigment. Lateral margin of Th. II and III also with a little blue pigment (Fig. 1A–C).

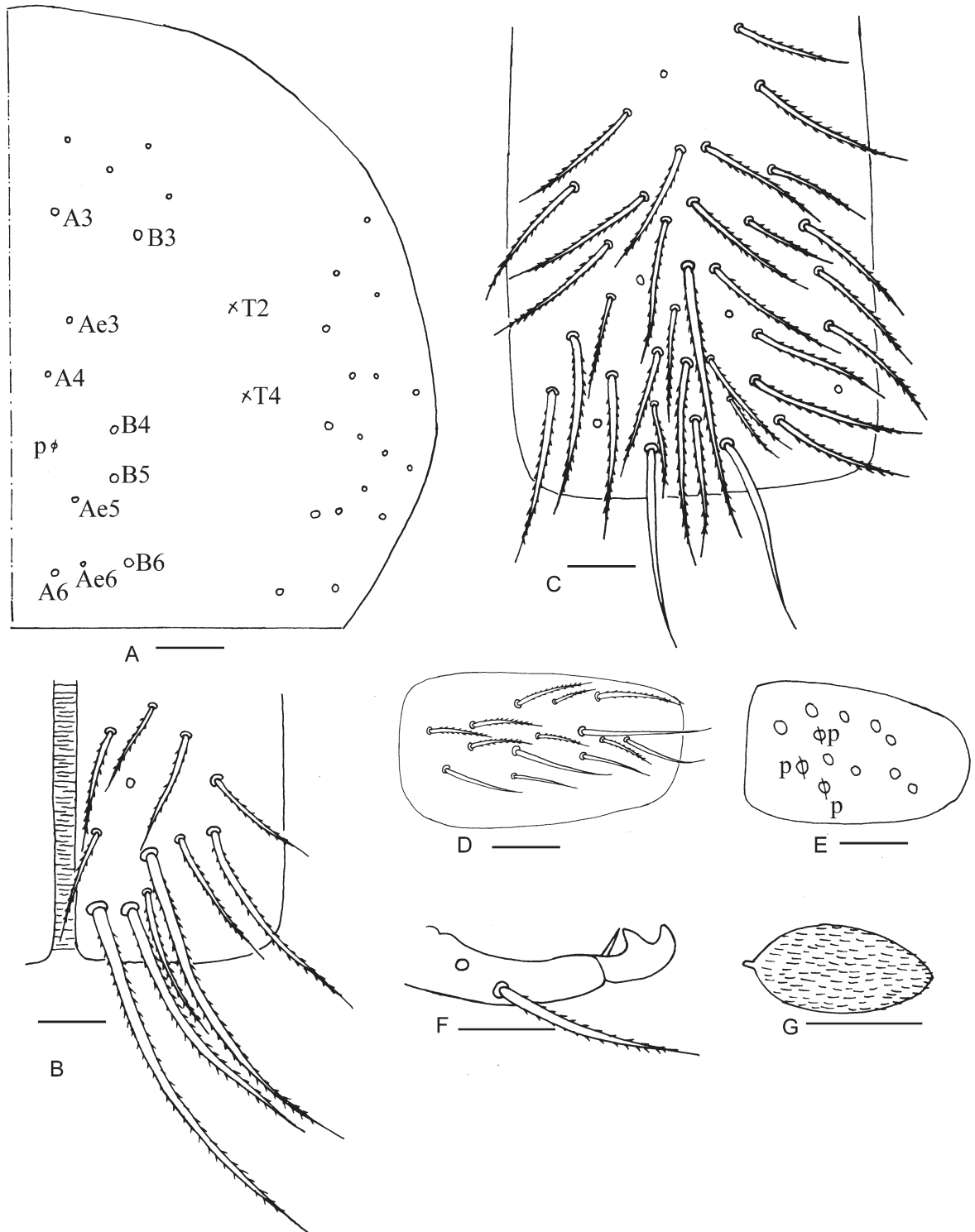
HEAD. Antenna 0.43–0.57 times as long as body. Ratios of length of antennal segments I:II:III:IV = 1:1.6–2.0:1.6–2.4:2.5–4.1. Distal part of Ant. IV with many sensory setae, normal ciliate setae and apical bulb bilobed (Fig. 2A). Dorsal cephalic chaetotaxy with 6–7 antennal (An), 5 (4) median (M<sub>1</sub>–M<sub>4</sub>, an additional seta between M<sub>2</sub> and M<sub>3</sub> rarely absent) and 8 sutural (S<sub>0</sub>–S<sub>5</sub>, S<sub>4i</sub>, S<sub>5i</sub>) mac. Interocular area with p, s, t setae. Eyes 8+8, G and H smaller (Fig. 2B). Labral setae as 4/5, 5, 4, all slender; prelabral setae ciliate, other smooth; distal margin of labrum with 4 papillae, each with 1 denticle (Fig. 2C). Lateral process of labial palp straight, as thick as normal setae, with tip not reaching apex of labial papilla (Fig. 2D). Labial triangle setae as in Fig. 2E, all finely ciliate.

THORAX. Dorsal macrochaetae shown as in Fig. 2F. Th. II with 2 (m1, m2) medio-median, 2 (m4, m4i) medio-lateral and 14–18 posterior mac on each side, 2 specialized setae (S-setae) on antero-lateral margin not clearly seen. Th. III with 13–15 median and 7 (m5, a6, a6i, p5, p6, m6, m6e) lateral mac on each side. Trochanteral organ with 26–30 smooth spiny setae (Fig. 2G). Unguis with 4 inner teeth, one pair located 0.38–0.39 from base of inner edge of unguis, distal unpaired two respectively at 0.68–0.71 and 0.84–0.89 distance from base. Unguiculus acuminate and outer edge serrate. Tenent hair thick with clavate tip, almost equal length to inner side of unguis (Fig. 2H).

ABDOMEN. Abd. IV 4.2–8.0 times as long as Abd. III along dorsal midline. Dorsal mac shown in Figs 2I and 3A. Abd. I with 4 (m2, m3, m4, m4p) mac. Abd. II with 4 (a2, m3, m3e, m3ep) (rarely 5, a3 present), 1 (m5) lateral mac and 2 S-setae. Abd. III with 2 (a2, m3) dorso-central, 3 (am6, pm6, p6)



**Fig. 2.** *Willowsia baoshanensis* sp. nov. **A.** Apex of Ant. IV. **B.** Dorsal chaetotaxy of head. **C.** Labrum. **D.** Lateral process of labial palp. **E.** Labium. **F.** Chaetotaxy of Th. II–III. **G.** Trochanteral organ. **H.** Hind foot complex. **I.** Chaetotaxy of Abd. I–III. Scale bars: A, C–E, G–H = 15  $\mu$ m; B, F, I = 50  $\mu$ m.



**Fig. 3.** *Willowsia baoshanensis* sp. nov. **A.** Chaetotaxy of Abd. IV. **B.** Anterior face of ventral tube. **C.** Posterior face of ventral tube. **D.** Lateral flap of ventral tube. **E.** Plaque of manubrium. **F.** Distal part of dens and mucro. **G.** Scale. Scale bars: A = 50  $\mu$ m; B–G = 15  $\mu$ m.



lateral mac and 3 S-setae (Fig. 2I). Abd. IV with 11–18 central (rarely 7, A3, A4, A6, B3, B4, B5, B6 always present) and 15–17 lateral mac as in Fig. 3A. Ventral tube anteriorly with 3 large and about 9 small ciliate setae (Fig. 3B), posteriorly with 2 apical smooth setae and about 36 ciliate setae of different sizes (Fig. 3C), laterally with 6 smooth and 8 ciliate setae of different sizes (Fig. 3D). Manubrial plaque with 8–9 ciliate setae and 3 pseudopores on each side (Fig. 3E). Dens without spines, uncrenulated dens 1.5–1.7 times as long as mucro. Mucro bidentate, two teeth subequal and tip of basal spine reaching subapical tooth (Fig. 3F).

**SCALES.** All scales spinulate type and present on Ant. I, head, body, legs and ventral tube, ventral side of manubrium (Fig. 3G).

### Remarks

The new species can be distinguished from other species of the genus in its color pattern. It is very similar to Chinese species *W. guangxiensis* Shi & Chen, 2004 and *W. shi* Pan, Zhang & Chen, 2006 in scales and chaetotaxy on Abd. I, but their color pattern, labial triangle setae, chaetotaxy on Abd. II and III and unguis inner teeth are different as shown in Table 1.

*Willowsia zhaotongensis* sp. nov.

[urn:lsid:zoobank.org:act:C1D8D5E5-3BF2-4726-B875-2B729F0DB073](https://doi.org/10.3897/ejt.311.12073)

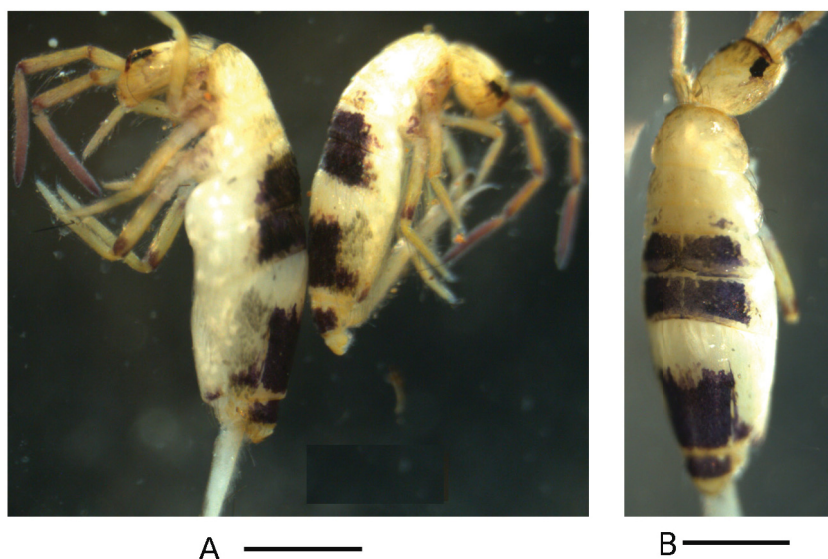
Figs 4–6; Table 2

### Diagnosis

Dorsal part of Abd. II & III and median and posterior parts of Abd. IV central with blue pigments; Abd. I usually with 4+4 mac; Abd. II with 4–5 + 4–5 dorso-central mac; Abd. III with 3+3 dorso-central and 5+5 lateral mac; spinulate type scales present on Ant. I, head, body, legs, ventral tube and ventral side of manubrium.

### Etymology

The specific epithet refers to the type locality: Zhaotong City.



**Fig. 4.** *Willowsia zhaotongensis* sp. nov. A–B. Habitus (A = paratype; B = holotype). Scale bars: 500  $\mu$ m.

**Table 2.** Comparison of *W. zhaotongensis* sp. nov. and *W. bartkei* Stach, 1965.

Characters	<i>W. zhaotongensis</i> sp. nov.	<i>W. bartkei</i>
a1, a2 & a3 on Th. III	absent	present
m3ep on Abd. II	present	absent
a3 on Abd. III	present	absent
Ae2, Ae3 & Ae6 on Abd. IV	present	absent
Scales on antennae and furcula	present	absent
Uncrenulated dens to mucro in length	6–7	4

### Type material

#### Holotype

CHINA: ♀, on slide, collected in Yuanlong Village, Yongfeng Town, Zhaoyang District, Zhaotong City, Yunnan Province, rotten stems of maize, 1 Aug. 2014, Fudong Ding leg. (collection number 1149, Nantong University).

#### Paratypes

CHINA: 7 ♀♀ on slides, 4 ♀♀ in alcohol, same data as holotype.

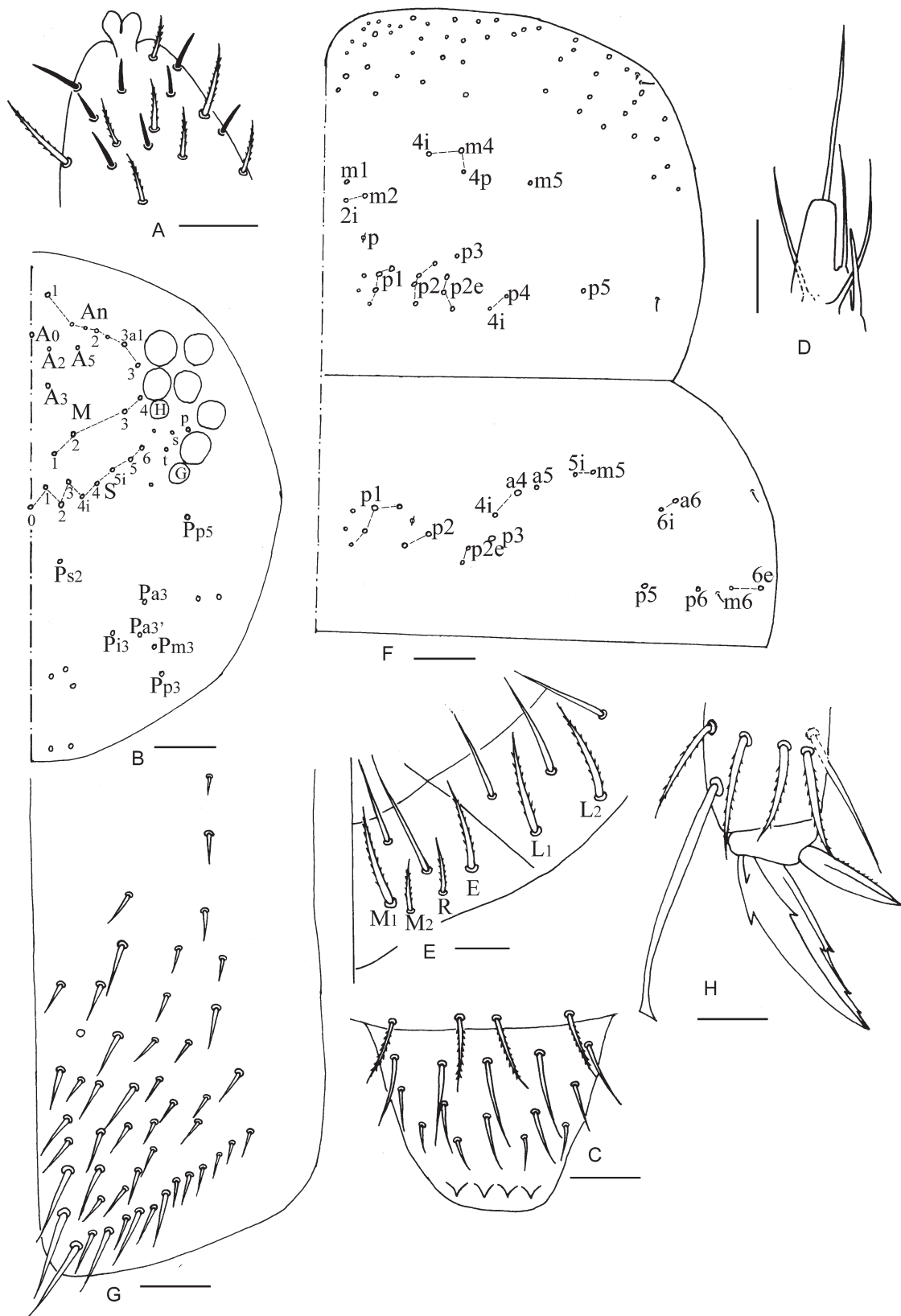
### Description

**COLOUR PATTERN.** Body length up to 2.3 mm. Eyepatch dark blue. Dorsal part of Abd. II & III and median and posterior parts of Abd. IV centrally with blue pigment. Coxa and distal part of Ant. IV weakly pigmented (Fig. 4A–B).

**HEAD.** Antenna 0.45–0.56 times as long as body. Ratios of length of antennal segments I:II:III:IV = 1:1.6–2.0:1.3–1.7:2.3–3.1. Distal part of Ant. IV with many sensory setae, normal ciliate setae and apical bulb bilobed (Fig. 5A). Dorsal cephalic chaetotaxy with 7 antennal (An), 4 median ( $M_1$ – $M_4$ ) and 9 sutural ( $S_0$ – $S_6$ ,  $S_{4i}$ ,  $S_{5i}$ ) mac. Interocular area with p, s, t setae. Eyes 8+8, G and H smaller (Fig. 5B). Labral setae as 4/5, 5, 4, all slender; prelabral setae ciliate, other smooth; distal margin of labrum with 4 papillae, each with 1 denticle (Fig. 5C). Lateral process of labial palp straight, as thick as normal setae, with tip not reaching apex of labial papilla (Fig. 5D). Labial triangle setae as in Fig. 5E, all finely ciliate.

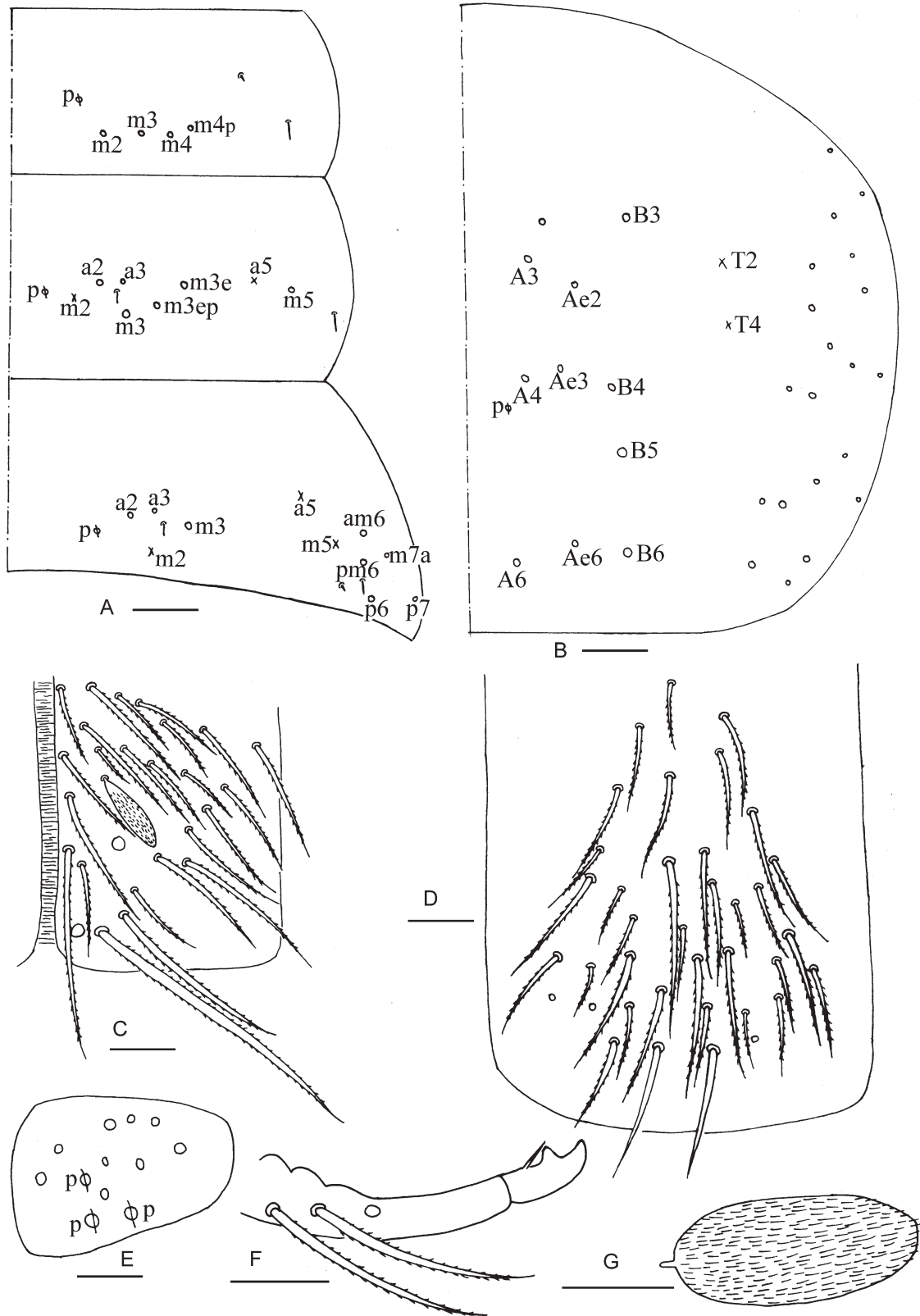
**THORAX.** Dorsal macrochaetae shown as in Fig. 5F. Th. II with 2 (m1, m2) (rarely 3, m2i present) medio-median, 3 (m4, m4i, m4p) medio-lateral and 16–18 posterior mac on each side, 2 S-setae present on medio-lateral margin. Th. III with 16–17 median and 6 (a6, a6i, p5, p6, m6, m6e) lateral mac on each side. Trochanteral organ with 42–49 smooth spiny setae (Fig. 5G). Unguis with 4 inner teeth, one pair located 0.45–0.50 from base of inner edge of unguis, distal unpaired two respectively at 0.70–0.74 and 0.85–0.88 distance from base. Unguiculus acuminate and outer edge serrate. Tenent hair thick with clavate tip, slightly longer than inner side of unguis (Fig. 5H).

**ABDOMEN.** Abd. IV 2.8–5.0 times as long as Abd. III along dorsal midline. Dorsal mac shown in Figs 6A & 6B. Abd. I with 4 (m2, m3, m4, m4p) (rarely 3, m4p absent) mac. Abd. II with 4–5 (a2, a3, m3, m3e, m3ep, a3 sometimes absent), 1(m5) lateral mac and 2 sensory chaetae. Abd. III with 3 (a2, a3, m3) dorso-central, 5 (am6, pm6, p6, m7a, p7) lateral mac and 3 sensory chaetae (Fig. 6A). Abd. IV with 10–12 central (A3, A4, A6, B3, B4, B5, B6 always present) and 17–20 lateral mac as in Fig. 6B. Ventral tube anteriorly with 3 large and 15–23 small ciliate setae (Fig. 6C), posteriorly with 2 apical smooth setae and about 35 ciliate setae of different sizes (Fig. 6D); lateral flap not clearly seen. Manubrial plaque with



**Fig. 5.** *Willowsia zhaotongensis* sp. nov. **A.** Apex of Ant. IV. **B.** Dorsal chaetotaxy of head. **C.** Labrum. **D.** Lateral process of labial palp. **E.** Labium. **F.** Chaetotaxy of Th. II–III. **G.** Trochanteral organ. **H.** Hind foot complex. Scale bars: A, C–E, G–H = 15  $\mu$ m; B, F = 50  $\mu$ m.





**Fig. 6.** *Willowsia zhaotongensis* sp. nov. **A.** Chaetotaxy of Abd. I-III. **B.** Chaetotaxy of Abd. IV. **C.** Anterior face of ventral tube. **D.** Posterior face of ventral tube. **E.** Plaque of manubrium. **F.** Distal part of dens and mucro. **G.** Scale. Scale bars: A-B = 50 μm; C-G = 15 μm.

8–11 ciliate setae and 3(4) pseudopores on each side (Fig. 6E). Dens without spines, uncrenulated dens 1.4–1.7 times as long as mucro. Mucro bidentate, two teeth subequal and tip of basal spine reaching subapical tooth (Fig. 6F).

SCALES. All scales spinulate type and present on Ant. I, head, body, legs and ventral tube, ventral side of manubrium (Fig. 6G).

### Remarks

The new species can easily be distinguished from the other species of the genus by their color pattern, except for the Vietnamese species *Willowsia bartkei* Stach, 1965. Both new species have blue pigment on the dorsal part of Abd. II and III and on the median and posterior parts of Abd. IV centrally, but there is no blue pigment on Abd. I posteriorly and Abd. II and III laterally in the former, whereas pigment is present in the latter. The other differences, such as chaetotaxy and scales, are listed in Table 2.

### Key to the Chinese species of the genus *Willowsia*

1. Abd. II with 2+2 mac .....	2
– Abd. II with at least 3+3 central mac .....	3
2. Abd. III with 1+1 central mac .....	<i>W. formosana</i> Denis, 1929
– Abd. III with 2+2 central mac .....	<i>W. jacobsoni</i> (Börner, 1913)
3. Abd. II with 3+3 mac .....	4
– Abd. II with at least 4+4 mac .....	11
4. Abd. I with 4+4 mac .....	<i>W. qui</i> Zhang, Chen & Deharveng, 2011
– Abd. I at most 3+3 mac .....	5
5. Abd. III with 2+2 central mac .....	6
– Abd. III with 3+3 central mac .....	9
6. Scales present on antennae .....	<i>W. guangdongensis</i> Zhang, Xu & Chen, 2007
– Scales absent on antennae .....	7
7. Body scales of short rib type .....	<i>W. japonica</i> (Folsom, 1897)
– Body scales of long basal rib type .....	8
8. Abd. IV with 5+5 central mac .....	<i>W. pseudobuskii</i> Pan & Zhang, 2016
– Abd. IV with 7+7 central mac .....	<i>W. pseudoplatani</i> Zhang & Pan, 2016
9. Abd. II without blue transverse band .....	<i>W. nigromaculata</i> (Lubbock, 1873)
– Abd. II with a blue transverse band .....	10
10. Metathorax blue pigmented, cephalic S <sub>0</sub> absent .....	<i>W. similis</i> Pan & Zhang, 2016
– Metathorax unpigmented, cephalic S <sub>0</sub> present .....	<i>W. fascia</i> Zhang & Pan, 2016
11. Abd. III with 2+2 central mac .....	12
– Abd. III with 3+3 central mac .....	13
12. Abd. III with 3+3 lateral mac .....	<i>W. baoshanensis</i> sp. nov.
– Abd. III with 4+4 lateral mac .....	<i>W. guangxiensis</i> Shi & Chen, 2004

13. Scales absent on antennae and manubrium ..... *W. yiningensis* Zhang, Chen & Deharveng, 2011  
 – Scales present on antennae and manubrium ..... 14
14. Abd. II–III with blue transverse bands ..... *W. zhaotongensis* sp. nov.  
 – Abd. II–III with scattered blue pigment and irregular patches ..... *W. shi* Pan, Zhang & Chen, 2006

## Discussion

Entomobryidae is the largest family of Collembola in China and about 140 species have been reported. *Willowsia*, a genus of the subfamily Entomobryinae which includes about 120 Chinese species, contains relatively few species with only 13 species reported from China prior to this study. Two new species of the genus were added here: *W. baoshanensis* sp. nov. and *W. zhaotongensis* sp. nov., and it is the first report of the genus from Yunnan Province, southwest China. There are different climate zones in Yunnan, including northern tropical, subtropical, temperate and highland climate zones suggesting a rich biodiversity might be expected. However, due to the lack of research conducted in the area so far, there are only a few records of Collembola from the province.

## Acknowledgements

We thank Xinnan Jiang and Fudong Ding who collected the specimens.

## References

- Gisin H. 1967. Espèces nouvelles et lignées évolutives de *Pseudosinella* endogés. *Memórias e Estudos do Museu Zoológico da Universidade de Coimbra* 301: 5–25.
- Jordana R. & Baquero E. 2005. A proposal of characters for taxonomic identification of *Entomobrya* species (Collembola, Entomobryomorpha), with description of a new species. *Abhandlungen und Berichte des Naturkundemuseums Goerlitz* 76 (2): 117–134.
- Mari-Mutt J.A. 1986. Puerto Rican species of *Lepidocyrtus* and *Pseudosinella* (Collembola: Entomobryidae). *Caribbean Journal of Science* 22 (1–2): 1–48.
- Pan Z.X. & Zhang F. 2016. Contribution to the *Willowsia* species having body scales of long basal rib type: four new species and a redescription of *W. qui* (Collembola: Entomobryidae). *European Journal of Taxonomy* 245: 1–25. <https://doi.org/10.5852/ejt.2016.245>
- Pan J.L., Zhang F. & Chen J.X. 2006. A new Chinese species of the genus *Willowsia* from Tibet (Collembola: Entomobryidae). *Journal of the Kansas Entomological Society* 79 (3): 261–266. <https://doi.org/10.2317/0511.22.1>
- Schäffer C. 1896. Die Collembolen der Umgebung von Hamburg und benachbarten Gebiete. *Mitteilungen aus dem Naturhistorischen Museum* 13: 147–216. Available from <http://biodiversitylibrary.org/page/29521571> [accessed 15 Mar. 2017].
- Shi X. & Chen J.X. 2004. The genus *Willowsia* (Collembola: Entomobryidae) and species from China. *Entomotaxonomia* 26 (4): 241–248.
- Shoebtham J.W. 1917. Notes on the Collembola, part 4. The classification of the Collembola; with a list of genera known to occur in the British Isles. *Annals and Magazine of Natural History* series 8, 19: 425–436. Available from <http://biodiversitylibrary.org/page/22130994> [accessed 15 Mar. 2017].
- Szeptycki A. 1979. *Morpho-Systematic Studies on Collembola. IV. Chaetotaxy of the Entomobryidae and its Phylogenetical Significance*. Polska Akademia Nauk, Kraków.

Zhang F., Chen J.X. & Deharveng L. 2011. New insight into the systematics of the *Willowsia* complex (Collembola: Entomobryidae). *Annales de la Société Entomologique de France* 47 (1–2): 1–20. <https://doi.org/10.1080/00379271.2011.10697692>

*Manuscript received: 9 May 2016*

*Manuscript accepted: 24 August 2016*

*Published on: 20 April 2017*

*Topic editor: Gavin Broad*

*Desk editor: Kristiaan Hoedemakers*

Printed versions of all papers are also deposited in the libraries of the institutes that are members of the *EJT* consortium: Muséum national d'Histoire naturelle, Paris, France; Botanic Garden Meise, Belgium; Royal Museum for Central Africa, Tervuren, Belgium; Natural History Museum, London, United Kingdom; Royal Belgian Institute of Natural Sciences, Brussels, Belgium; Natural History Museum of Denmark, Copenhagen, Denmark; Naturalis Biodiversity Center, Leiden, the Netherlands.