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Two new species of *Typhlodromus* Scheuten (Acari: Phytoseiidae) from Hainan Islands, China

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Abstract

Typhlodromus contains the most species in the subfamily Typhlodrominae and 85 species have been recorded in China. Two new species *T. (Anthoseius) bawanglingensis* **sp. nov.** and *T. (Anthoseius) informibus* **sp. nov.** were found by examining the specimens collected from Hainan Bawangling National Nature Reserve and Hainan Jianfengling National Nature Reserve in Hainan Islands. Herein, they are described and illustrated based on female specimens.

Key words: Phytoseioidea, taxonomy, description

Introduction

Phytoseiid mites (Acari: Phytoseiidae) are diverse and widespread arthropods, and play an important ecological role (McMurtry *et al.* 2013; Lofego *et al.* 2017; Fang *et al.* 2017). Typhlodrominae Chant & McMurtry is the most primitive group in Phytoseiidae, with the most idiosomal setae as many as 38 pairs, including 22 genera (Chant & McMurtry 1994, 2007; Wu *et al.* 2009; Demite *et al.* 2017). *Typhlodromus* Scheuten is the most diverse, with about 460 nominal species in the world (Demitte *et al.* 2017). There are 85 species have been recorded in China, among which 83 species belong to the subgenus *Anthoseius* De Leon and two species belong to the subgenus *Typhlodromus* (Wu *et al.* 2009; Ma *et al.* 2016; Liao *et al.* 2017).

This group widely distributes all over the world and most species are found in the subtropical and tropical areas. Hainan Islands, the most southern province in China, isolated from the mainland by Qiongzhou Straits, belongs to tropical monsoon climate. There are abundant species of phytoseiid mites, with 63 species recorded so far, including 11 *Typhlodromus* species (Wu *et al.* 2009, 2010). This study presents two new species *T. bawanglingensis* **sp. nov.** and *T. informibus* **sp. nov.** from Hainan Islands.

Materials and Methods

Mite specimens examined in this study were collected from Hainan Islands in 2017, with a particular focus on Hainan Bawangling National Nature Reserve and Hainan Jianfengling National Nature Reserve. Mites were mounted in Hoyer's medium and examined, measured, illustrated, and

photographed under an optical microscope (Leitz®512836) and picture pick-up system (Ming-Mei®MC-15). Measurements are presented in micrometers (µm). Holotype measurements are shown in bold type for the new species, followed by their mean and range in parentheses. Morphological features of adult mites were measured as follows: dorsal shield length and width were taken from anterior to posterior margins of the shield along midline and from lateral margins at *s4* level, respectively; for all ventral shields, lengths were measured along their midlines; sternal shield width between bases of *st2*; epigynial shield width between setae *st5-st5*; ventrianal shield width between setae *ZV2-ZV2*; cheliceral fixed digit length was measured from dorsal poroid to the anterior tip and its movable digit length was measured from basal articulation to the tip. The general terminology used for morphological descriptions in this study follows that of Chant & McMurtry (2007), idiosomal seta terminology follows those by Rowell *et al.* (1978) and Chant & Yoshida-Shaul (1991, 1992), adenotaxy and poroidotaxy terminology followed that of Beard (2001), and chaetotaxy of legs follows that of Evans (1963).

Taxonomy

Typhlodromus (Anthoseius) bawanglingensis Fang, Hao & Wu sp. nov.

(Figures 1–6, Plates 1–7)

Diagnosis

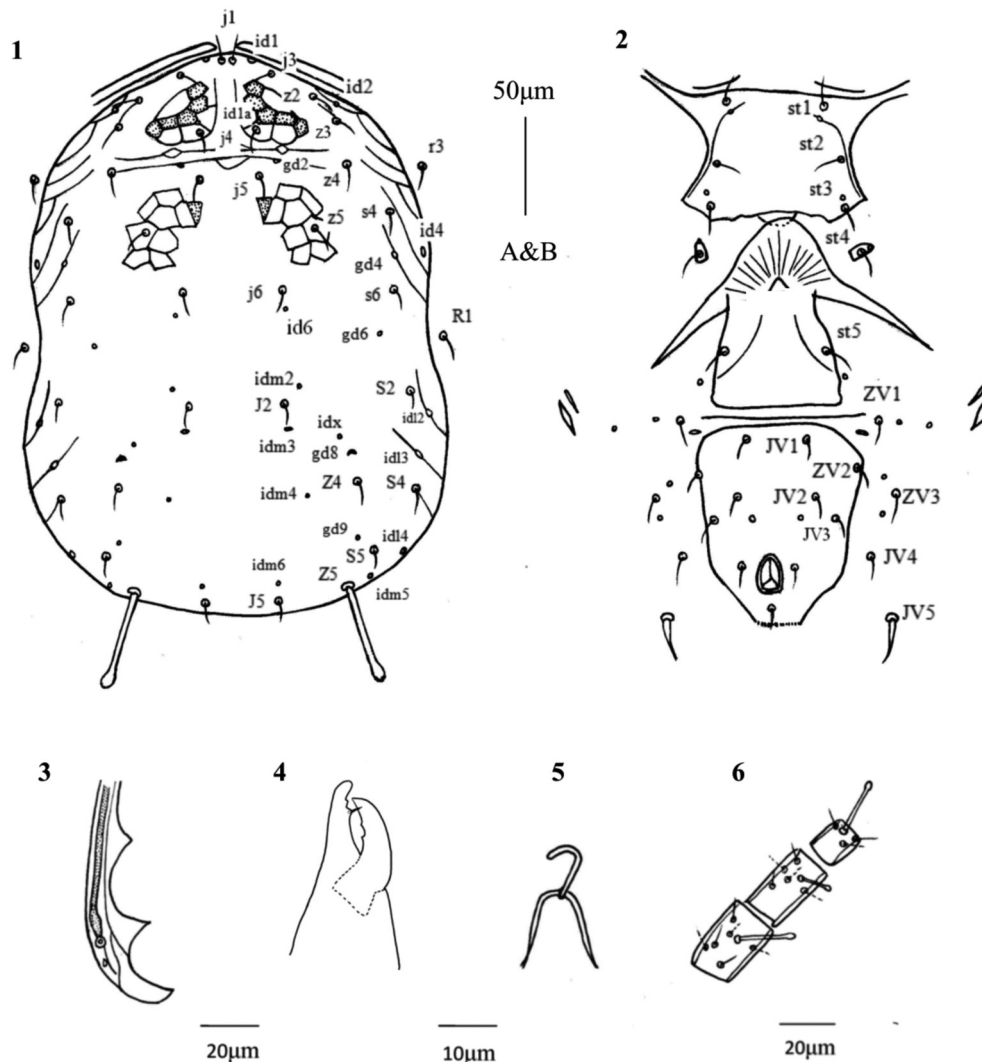
Dorsal shield surface smooth, with patchy and lateral reticulation. All dorsal shield setae smooth and setiform, except *Z5* knobbed apically. With five pairs of solenostomes on dorsal shield (*gd2*, *gd4*, *gd6*, *gd8–9*). Sternal shield length and width similar, with three pairs of setae. One pair of solenostomes posteromedian to *JV2*, almost at level of setae *JV3*. Peritreme extending to *j1* level. Fixed digit of chelicera with three teeth and movable digit with two teeth. Genu, tibia and basitarsus of leg IV each with an apically knobbed macrosetae.

Female (n=5)

Dorsal idiosoma (Figure 1, Plate 1). Dorsal setal pattern 12A:8A. Dorsal shield **275** 286 (275–299) long and **196** 193 (189–196) wide, distances between setae *j1-J5* **263** 275 (261–287) and *s4-s4* **146** 150 (146–153), shield nearly oval, slightly constricted at level of *R1*; shield surface smooth, with patchy and lateral reticulation, *r3* and *R1* on soft membranous cuticle laterad of dorsal shield, *r3* at level of *z4*, *R1* at level of shield incisions. Dorsal setae *j1*, *j3*, *Z4* and *Z5* relatively longer (> 15), other setae shorter. All dorsal shield setae smooth and setiform, except *Z5* knobbed apically. With five pairs of solenostomes on dorsal shield (*gd2*, *gd4*, *gd6*, *gd8–9*), 14 pairs of lyrifissures (*idl1*, *idl1a*, *idl2*, *id4*, *id6*, *idx*, *idl2–4*, *idm2–6*). Length of setae: *j1* **15** 16 (13–19), *j3* **17** 17 (15–19), *j4* **10** 10 (8–12), *j5* **10** 10 (8–12), *j6* **10** 10 (9–10), *J2* **12** 10 (10–14), *J5* **7** 7 (7–9), *z2* **10** 8 (7–10), *z3* **14** 10 (7–11), *z4* **11** 10 (9–12), *z5* **9** 9 (7–10), *Z4* **19** 17 (17–21), *Z5* **52** 52 (48–55), *s4* **14** 14 (12–15), *s6* **15** 14 (12–15), *S2* **14** 13 (11–15), *S4* **11** 10 (9–12), *S5* **9** 9 (7–10), *r3* **10** 10 (10–12), *R1* **10** 10 (8–11).

Ventral idiosoma (Figure 2, Plate 2). Ventral setal pattern JV: ZV. All ventral setae smooth. Sternal shield smooth, anterior margin convex, posterior margin of shield with rounded median lobe, **58** 58 (56–61) long, **57** 58 (57–60) wide, length and width similar, with three pairs of setae *st1* **18** 17 (15–20), *st2* **14** 15 (14–17), *st3* **17** 17 (14–17), and two pairs of lyrifissures (*pst1–2*). Metasternal platelets drop-shaped, with one pair of metasternal setae, *st4* **15** 14 (12–16) and one pair of lyrifissures (*pst3*). Genital shield smooth, with one pair of thin genital setae *st5* **17** 16 (14–17), **53** 57 (53–57) wide, trailing edge flat; one pair of associated poroids on soft cuticle near posterior corners of shield. Ventrianal shield smooth, pentagonal, **96** 96 (94–97) long, **79** 79 (76–80) wide at level of

ZV2, with four pairs of thin pre-anal setae JV1 9 10 (7–10), JV2 10 10 (9–10), JV3 10 11 (10–12), ZV2 10 9 (7–10); Pa 12 11 (10–13), Pst 9 8 (7–10) long. Pre-anal pores round-shaped, posteromesad JV2, almost at level of setae JV3, distance between pores 22 24 (22–24). On soft cuticle laterad of dorsal shield: four pairs of setae, ZV1 9 9 (7–10), ZV3 9 9 (7–10), JV4 10 10 (7–11), JV5 36 34 (33–37) long. All ventral setae thin, except JV5, thick. Two pairs of metapodal plates, primary plate 17 17 (17–17) long, 6 6 (5–7) wide, secondary plate 9 8 (7–10) long, 1 1 (1–1) wide.



FIGURES 1–6. *Typhlodromus bawanglingensis* sp. nov., female. 1. Dorsal shield; 2. Ventral idiosoma; 3. Posterior region of peritrematal shield; 4. Chelicera; 5. Spermatheca; 6. Leg IV, genu-basitarsus. Scale bars: 50 µm for 1, 2; 20 µm for 3, 6; 10 µm for 4, 5.

Peritreme. Peritreme extending to *j1* level. Peritrematal shields (Figure 3, Plate 3) with one pair of solenostomes (*gd3*) and one pair of lyrifissures (*id3*).

Chelicera (Figure 4, Plate 4). Fixed digit 22 21 (19–22) long, with three teeth and pilus dentilis; movable digit 24 23 (21–24) long, with two teeth.

Spermatheca (Figure 5, Plates 5–6). Calyx of spermathecal apparatus **9** 10 (9–11) long, **8** 7 (6–8) wide at opening, bell-shaped; atrium **3** 3 (3–3) wide, small, knot-like, incorporated with calyx; major duct narrow, without neck, and minor duct not visible.

Legs. Genu formula leg I 2–2/1, 2/1–2, leg II 2–2/0, 2/0–1, leg III 1–2/1, 2/0–1, leg IV 1–2/1, 2/0–1. Legs I–II without macrosetae. Leg III with one macrosetae on genu **19** 18 (17–20) long. Leg IV with three apically knobbed macrosetae on genu, tibia and basitarsus (Figure 6, Plate 7), *Sge* IV **26** 26 (25–27), *Sti* IV **16** 14 (13–16) and *St* IV **26** 26 (24–28), *St* IV \approx *Sge* IV > *Sti* IV.

Male. Unknown.

Material examined. Holotype: ♀, Hainan Bawangling National Nature Reserve (accession no. HN-0393), on *Adinandra hainanensis* Hayata, 17–VII-2017, Du X. coll. Paratypes: 2♀ (accession no. HN-0391, HN-0392), same locality, host, date and collector as holotype; Paratypes: 2♀ (accession no. HN-0771, HN-0891), 20–VII-2017, Fang X. D. coll., same locality as holotype.

Etymology. The name *bawanglingensis* refers to the type locality bawangling, from where the type specimens were collected.

Remarks. By having noticeably longer *Z5* relative to setae *Z4* on dorsal shield, shove-shaped setae *Z5*, and a distinctly shove-shaped macrosetae on genu, tibia and basitarsus of leg IV, respectively, this new species is similar to *T. admirabilis* Wainstein, 1978, *T. tridentiger* Tseng, 1975 and *T. qianshanensis* Wu, 1988. By having similar shaped of spermatheca, dorsal plate, ventrianal shield and pre-anal pore, and three apically knobbed macrosetae on leg IV, this new species is similar to *T. miyarai* Ehara, 1967. Differences between *T. bawanglingensis* and related species are given in Table 1.

TABLE 1. Differences in diagnostic characters between *Typhlodromus bawanglingensis* Fang, Hao & Wu sp. nov. and similar species.

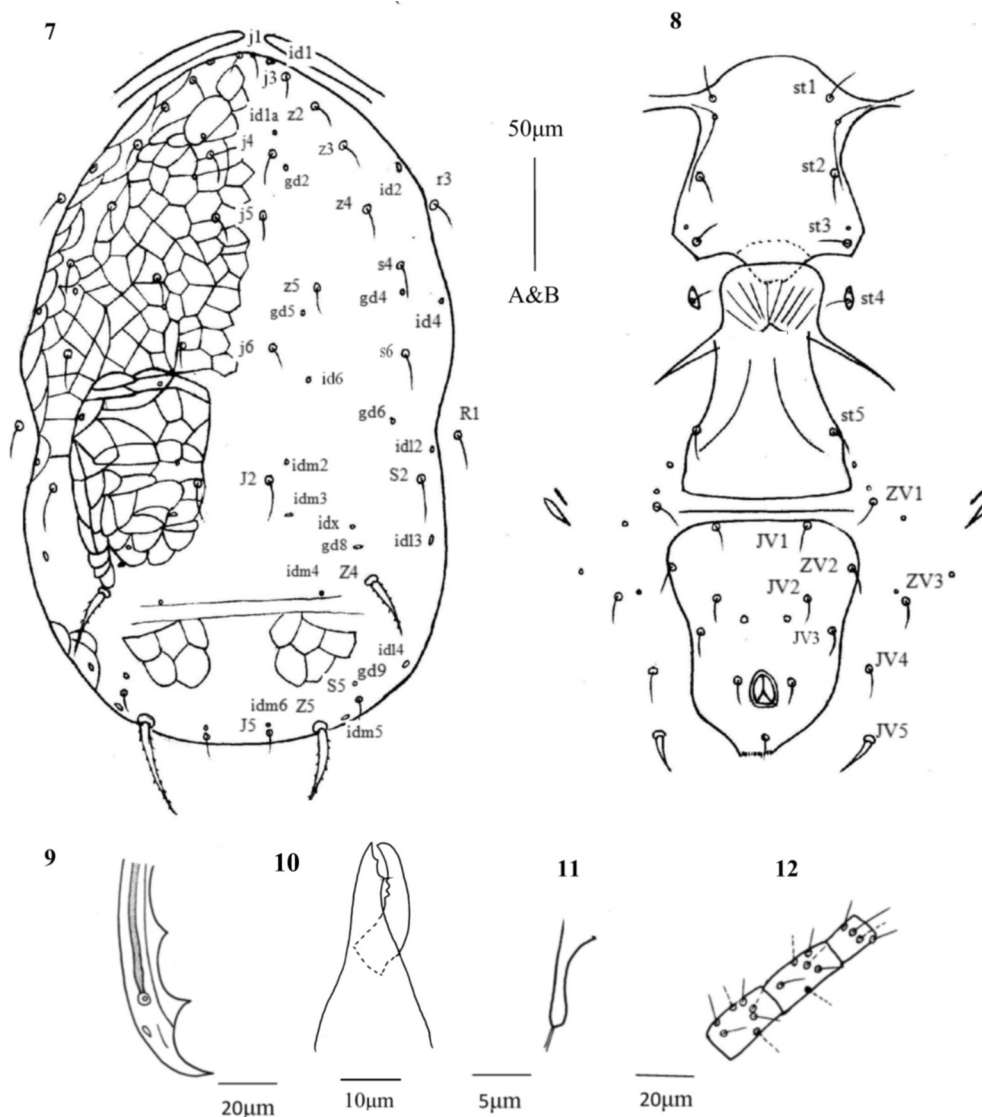
	<i>bawanglingensis</i> ^a	<i>miyarai</i> ^b	<i>admirabilis</i> ^c	<i>tridentiger</i> ^d	<i>qianshanensis</i> ^d
Body size	275–299 long, 189–196 wide	330 long, 230 wide	370 long, 205 wide	375 long, 196 wide	300–310 long, 181 wide
Dorsal shield	reticulate laterally	reticulate throughout	reticulate laterally	smooth	reticulate throughout
Relative length of <i>Z4</i> , <i>Z5</i>	$Z5 \approx 3Z4$	$Z5 \approx Z4$	$Z5 \approx 2Z4$	$Z5 \approx 1.5Z4$	$Z5 \approx 1.5Z4$
Posterior margin of sternal Shield	with rounded median lobe	Sclerotization weak	flat	Sclerotization weak	flat and concave on both ends
Calyx of spermatheca	bell-shaped	bell-shaped	saccular	sublyriform	triangle
Pre-anal pore	round-shaped	round-shaped	crescent-shaped	crescent-shaped	crescent-shaped
Macrosetae	<i>St</i> IV \approx <i>Sge</i> IV > <i>Sti</i> IV	<i>St</i> IV > <i>Sge</i> IV \approx <i>Sti</i> IV	<i>St</i> IV > <i>Sge</i> IV > <i>Sti</i> IV	<i>St</i> IV > <i>Sge</i> IV > <i>Sti</i> IV	<i>St</i> IV \approx <i>Sge</i> IV > <i>Sti</i> IV

^a from five specimens, ^b from Ehara, 1967, ^c from Wainstein, 1978, ^d from Wu *et al.*, 2009

***Typhlodromus (Anthoseius) informibus* Fang, Hao & Wu sp. nov.**
(Figures 7–12, Plates 8–15)

Diagnosis

Dorsal shield reticulate to colliculate throughout. All setae smooth, except *Z4–5* thick, serrate. With six pairs of solenostomes on dorsal shield (*gd2*, *gd4–6*, *gd8–9*). Sternal shield length and width similar, with three pairs of setae. One pair of solenostomes between and behind *JV2*, slightly anterior to level of *JV3*. Peritreme extending to *j1* level. Fixed digit of chelicera with two teeth and movable digit with three teeth. Leg IV with one macrosetae on basitarsus.



FIGURES 7–12. *Typhlodromus informibus* sp. nov., female. 7. Dorsal shield; 8. Ventral idiosoma; 9. Posterior region of peritrematal shield; 10. Chelicera; 11. Spermatheca; 12. Leg IV, genu-basitarsus. Scale bars: 50 µm for 7, 8; 20 µm for 9, 12; 10 µm for 10; 5 µm for 11.

Female (n=7)

Dorsal idiosoma (Figure 7, Plate 8). Dorsal setal pattern 12A:7B. Dorsal shield reticulate to colliculate throughout, relatively weaker caudally and middle posterior. Dorsal shield **282** 279 (275–286) long and **162** 155 (150–162) wide, distances between setae *j1*–*J5* **275** 272(265–278) and *s4*–*s4* **133** 129(122–133), shield nearly oval, slightly constricted at level of *R1*. Setae *r3* and *R1* on soft membranous cuticle laterad of dorsal shield, *r3* at level of *z4*, *R1* at level of shield incisions. All setae smooth, except *Z4*, *Z5* thick, serrate. With six pairs of solenostomes on dorsal shield (*gd2*, *gd4*–*6*, *gd8*–*9*), 14 pairs of lyrifissures (*id1*, *id1a*, *id2*, *id4*, *id6*, *idx*, *idm2*–*6*, *idl2*–*4*). Length of setae: *j1* **19** 16 (15–19), *j3* **17** 15 (13–17), *j4* **12** 14 (12–15), *j5* **14** 14 (12–15), *j6* **14** 14 (13–16), *J2* **14** 15 (14–

17), *J5* 9 9 (7–10), *z2* 10 8 (8–10), *z3* 13 10 (9–13), *z4* 11 10 (9–12), *z5* 9 9 (8–10), *Z4* 19 17 (17–21), *Z5* 52 52 (49–54), *s4* 14 14 (12–15), *s6* 15 14 (12–15), *S2* 16 16 (15–18), *S5* 9 9 (7–10), *r3* 10 10 (9–12), *R1* 10 10 (8–11).

Ventral idiosoma (Figure 8, Plate 9). Ventral setal pattern JV: ZV. All ventral setae smooth. Sternal shield smooth, anterior margin convex, posterior margin with a faint median projection, **58** 58 (56–60) long, **57** 58 (57–60) wide, length and width similar, with three pairs of setae *st1* 18 17 (16–19), *st2* 14 15 (13–16), *st3* 17 17 (14–18), and two pairs of lyrifissures (*pst1*–2). Metasternal platelets drop-shaped, with one pair of metasternal setae, *st4* 15 14 (13–15) and one pair of lyrifissures (*pst3*). Genital shield smooth, with one pair of thin genital setae *st5* 17 16 (13–17), **53** 57 (53–58) wide, trailing edge flat; one pair of associated poroids on soft cuticle near posterior corners of shield. Ventrianal shield smooth, pentagon, **96** 96 (93–98) long, **79** 79 (76–81) wide at level of ZV2, with four pairs of thin pre-anal setae *JV1* 9 10 (7–10), *JV2* 10 10 (9–10), *JV3* 10 11 (10–14), *ZV2* 10 9 (7–10); *Pa* 12 11 (10–14), *Pst* 9 8 (7–10) long. Pre-anal pores round-shaped, between and behind *JV2*, slightly anterior to level of *JV3*, distance between pores **22** 24 (22–24). On soft cuticle laterad of dorsal shield: four pairs of setae, *ZV1* 9 9 (7–10), *ZV3* 9 9 (7–10), *JV4* 10 10 (9–12), *JV5* 36 34 (31–36) long. All ventral setae thin, except *JV5*, thick. Two pairs of metapodal plates, primary plate **17** 17 (17–17) long, **6** 6 (5–7) wide, secondary plate **9** 8 (7–10) long, **1** 1 (1–1) wide.

Peritreme. Peritreme extending to *j1* level. Peritrematal shields (Figure 9, Plate 10) lightly sclerotised, with one pair of solenostomes (*gd3*) and one pair of lyrifissures (*id3*).

Chelicera (Figure 10, Plates 11–12). Fixed digit **19** 19 (18–22) long, with two teeth and pilus dentilis, movable digit **19** 21 (18–22) long, with three teeth.

Spermatheca (Figure 11, Plates 13–14). Calyx of spermathecal apparatus **10** 10 (10–10) long, shallowly funnel-shaped; atrium **2** 2 (1–2) wide, small, knot-like; major duct narrow, very short, without neck, and minor duct invisible.

Legs. Genu formula leg I 2–1/1, 2/1–1, leg II 2–2/0, 2/0–1, leg III 1–2/1, 2/0–1, leg IV 1–2/0, 2/1–1. Legs I–III without macrosetae. Leg IV with one macrosetae (Figure 12, Plate 15) on basitarsus, *Sti* IV **17** 17 (16–20).

Male. Unknown.

Material examined. Holotype: ♀, Hainan, Bawangling National Nature Reserve (accession no. HN-0733), *Rourea minor* (Gaerm.) Leenh. 21-VII-2017, Fang X. D. coll. Paratypes: 3 ♀ (accession no. HN-0701, HN-0731, HN-0732), same locality, host, date and collector as holotype; Paratypes: 3 ♀, Hainan, Main top, Jianfengling National Nature Reserve (accession no. HN-0031, HN-0081, HN-0082), Fang X. D., *Mussaenda hirsutula* Miq. same collector and date as holotype.

Etymology. The species name *informibus*, latin for “funnel”, refers to the distinctive shape of the spermathecal apparatus in this species.

Remarks. By having reticulation throughout on dorsal shield, absence of *S4* dorsal seta, round-shaped pre-anal pore between and behind *JV2*, *T. informibus* **sp. nov.** is similar to *T. arizonicus* (Tuttle & Muma, 1973) and *T. demoraesi* Lofego & Feres, 2007. But there are obvious differences in the shape of ventrianal shield among the three species: pentagonal (*T. informibus*), triangular (*T. arizonicus*) and rectangular (*T. demoraesi*). Additionally, the new species has setae *JV4* and also one macroseta on basitarsus IV, but the other two species do not have them.

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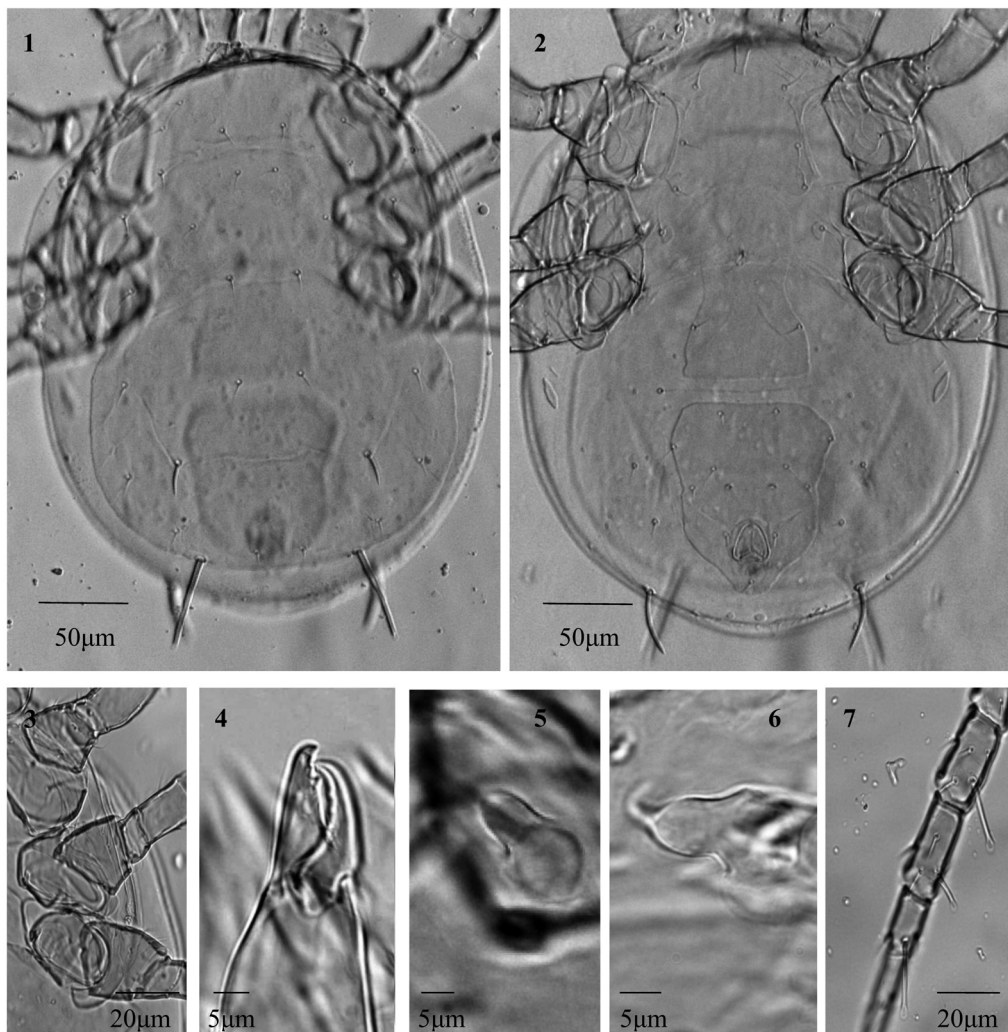
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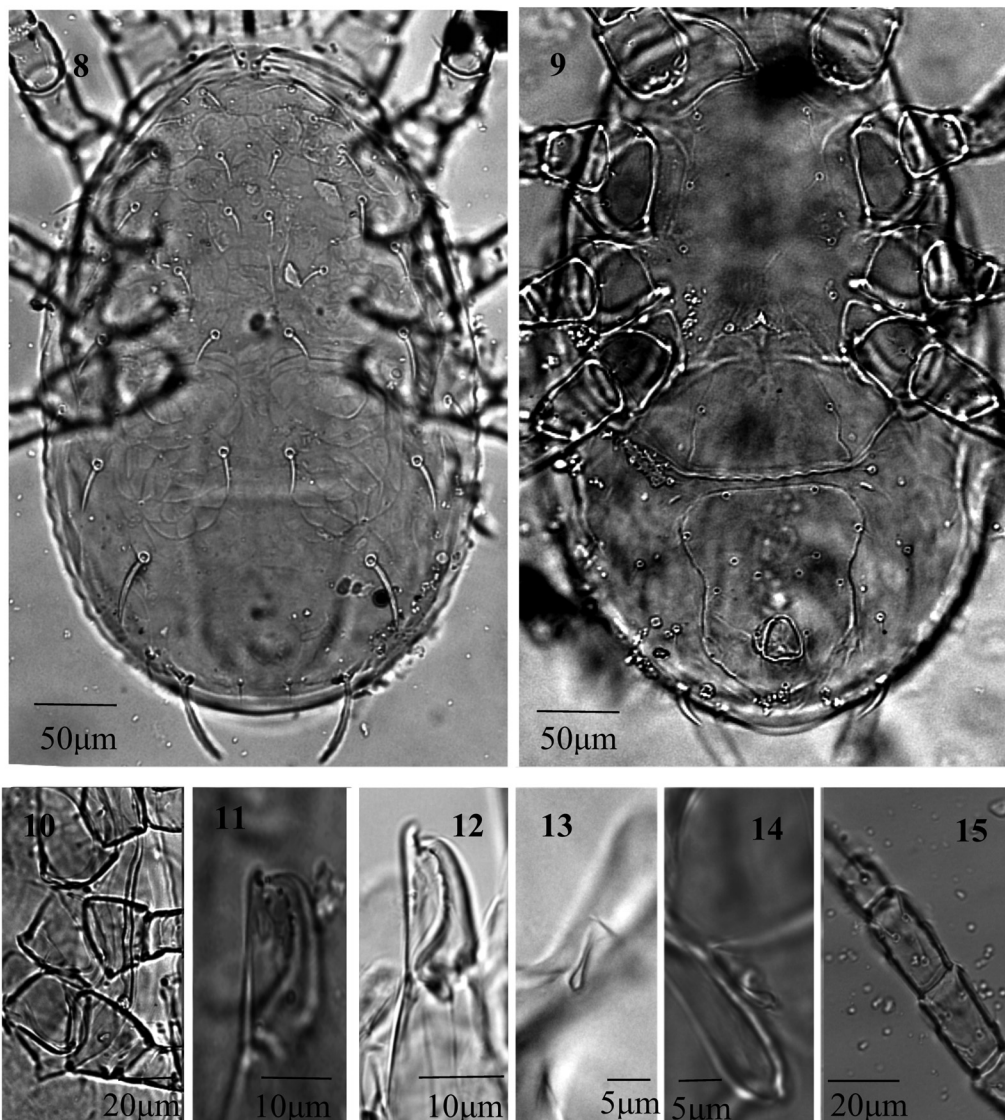
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Appendix



PLATES 1–7. *Typhlodromus bawanglingensis* **sp. nov.**, female. 1. Dorsal idiosoma; 2. Ventral idiosoma; 3. Peritrematal shield; 4. Chelicera; 5, 6. Spermatheca; 7. Leg IV, genu-basitarsus. Scale bars: 50 µm for 1, 2; 20 µm for 3, 7; 5 µm for 4, 5, 6.



PLATES 8–15. *Typhlodromus informibus* sp. nov., female. 8. Dorsal idiosoma; 9. Ventral idiosoma; 10. Peritrematal shield; 11. Chelicera (Fixed digit); 12 Chelicera (Movable digit); 13, 14. Spermatheca; 15. Leg IV, genu-basitarsus. Scale bars: 50 µm for 8, 9; 20 µm for 10, 15; 10 µm for 11, 12; 5 µm for 13, 14.