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## New oribatid mites of the genera *Plasmobates* and *Arcoppia* from Ethiopia (Acari: Oribatida)

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ABSTRACT. Two new species of oribatid mites, *Plasmobates foveolatus* sp. n. and *Arcoppia arborea* sp. n., are described from Ethiopia. First species was obtained from soil in Harena Forest (Bale Mountains National Park); second species was obtained from mosses on trees in Cholomu Forest (10 km to the south from Ginchi city). *Plasmobates foveolatus* sp. n. belongs to the species group of *Plasmobates* with foveolate notogaster and sensilli slightly dilated distally, shorter than or equal to the distance between interlamellar setae. New species is most similar to *Plasmobates pagoda*, but the latter has smaller body length and sensillus with large swelling. *Arcoppia arborea* sp. n. belongs to the *Arcoppia* species group with sensilli having a single branch. The new species is distinguishable from the other species in this group by the presence of following combination of character states: large body size; rostral seta strongly curved in media-distal part; lamellar seta well developed, equidistant from rostral and interlamellar setae; interlamellar seta long (hardly shorter than sensillus); sensillar branch shorter than sensillar stalk; notogastral setae long, little differing in length, except c short and  $p_1-p_3$  slightly shorter than the other; adanal setae  $ad_1$  in paraanal position.

**Key words:** acarology, taxonomy, oribatid mites, new species, *Plasmobates*, *Arcoppia*, Ethiopia.

### INTRODUCTION

In the course of taxonomic studies of oribatid mite fauna of Ethiopia we have found new species in the genera *Plasmobates* GRANDJEAN, 1929 (Plasmobatidae) and *Arcoppia* HAMMER, 1977 (Oppiidae), which are described below.

*Plasmobates* is a rather small genus that was proposed by GRANDJEAN (1929) with *Plasmobates pagoda* GRANDJEAN, 1929 as type species. Currently, the genus comprises ten species that are distributed in the Pantropical region and southern Palearctic; only three of these species are known from African region (all «sp. inq.», described from Congo): *Plasmobates africanus* BALOGH, 1958, *Plasmobates machadoi* BALOGH, 1958, and *Plasmobates minor* BALOGH, 1958 (SUBÍAS 2004).

*Arcoppia* is a genus that was proposed by HAMMER (1977) with *Arcoppia brachyramosa* HAMMER, 1977 as type species. Currently, the genus comprises 57 species and nine subspecies that distributed in the Pantropical and subtropical regions; 12 species are known from African region (SUBÍAS 2004), of which only *Arcoppia rugosa* (MAHUNKA, 1974) has been found in Ethiopia (MAHUNKA 1982). Distinctive morphological characters of most African species of *Arcoppia* were summarized by BALOGH and BALOGH (2002).

#### MATERIAL AND METHODS

Locality and habitat of the new species are characterized in the “Material examined” sections.

Specimens were studied and illustrated in lactic acid, mounted on temporary cavity slides for the duration of the study. All body measurements are presented in micrometers. Body length was measured in lateral view, from the tip of the rostrum to the posterior edge of the ventral plate, to avoid discrepancies caused by different degrees of notogastral distension. Notogastral width refers to the maximum width in dorsal aspect. Length of body setae was measured in lateral aspect. Some specimens of each species were dissected for detailed studies (gnathosoma, ovipositor, legs).

Formulas for leg setation are given according to the sequence trochanter–femur–genu–tibia–tarsus (famulus included). Formulas for leg solenidia are given according to the sequence genu–tibia–tarsus.

#### DESCRIPTIONS OF NEW SPECIES

##### **Family Plasmobatidae GRANDJEAN, 1961 Genus *Plasmobates* GRANDJEAN, 1929**

##### ***Plasmobates foveolatus* ERMILOV, SIDORCHUK and RYBALOV sp. n. (Figs. 1-22)**

#### DIAGNOSIS

With character states of *Plasmobates* that were proposed by GRANDJEAN (1929), and expanded by AOKI (1973). New species is recognized by the size of body, 498-547 × 332-348; surface of notogaster foveolate; rostral setae (*ro*) 61-69, slightly thickened and curved mediad distally, smooth, set on oblong apophyses; lamellar setae (*le*) short, 16-20, smooth, set on small apophyses; interlamellar setae (*in*) 20-28, strong, smooth, tips blunt-ended or with one pointed thorn; sensilli (*ss*) are the largest setae on

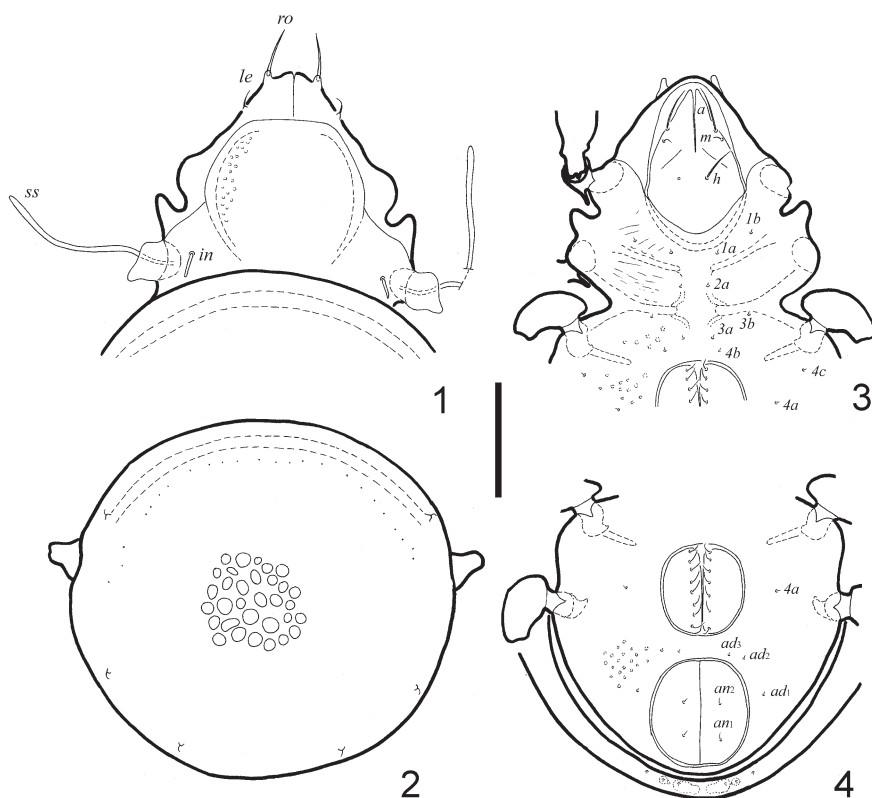
prodorsum, 114-135, slightly dilated distally, with serrated margins; distance between interlamellar setae (135-139) larger than or equal to the length of sensillus; notogaster circular in dorsal view, hardly longer than wide; six pairs of notogastral setae present; genital plates with six to eight setae, sometimes asymmetrically positioned (six and seven, seven and eight setae); adanal setae  $ad_2$  and  $ad_3$  located close to each other; epimeral setal formula: 2-1-2-3.

## DESCRIPTION

**Measurements.** Body length 498-547 (holotype 547), mean 518; body width 332-348 (holotype 348), mean 340.

**Integument.** Body color brown. Surface of notogaster foveolate; foveolae oval or round (up to 20  $\mu\text{m}$  in length or diameter), distance between foveolae shorter than diameters or lengths of foveolae. Surface of anogenital region, part of prodorsum and epimeral region with indistinct small foveolae.

**Prodorsum** (Figs. 1, 5-9). Typical for Plasmobatidae. Rostral setae 61-69, slightly thickened and curved mediad distally, smooth, set on oblong apophyses. Lamellar



1-4. *Plasmobates foveolatus* sp. n.: 1 – prodorsum, dorsal view, legs removed, 2 – notogaster, dorso-anterior view, legs removed, 3 – epimeral region, legs partly removed, 4 – anogenital region, legs partly removed.

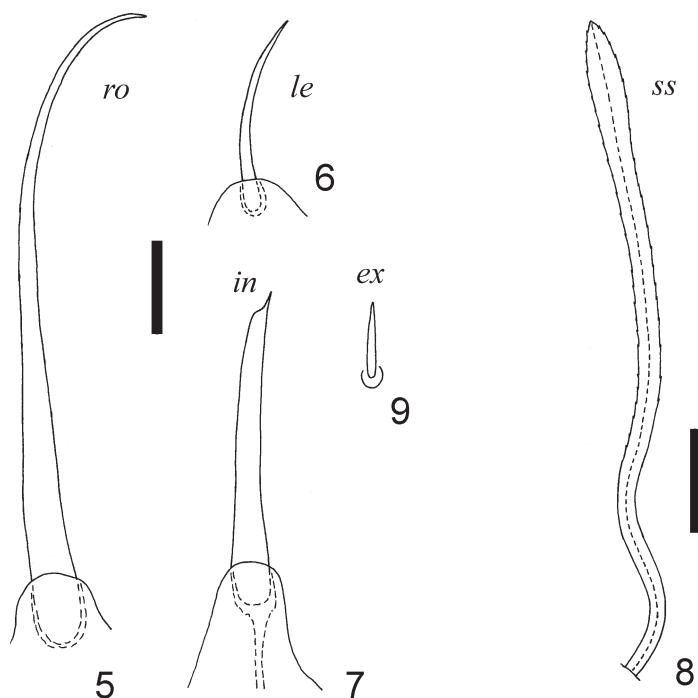
Scale bars 100  $\mu\text{m}$

setae short, 16-20, smooth, set on small apophyses. Interlamellar setae 20-28, strong, smooth, tips blunt-ended or with one pointed thorn. Sensilli are the largest setae on prodorsum, 114-135, slightly dilated distally, with serrated margins (serration is visible only under high magnification). Distance between interlamellar setae (135-139) is more than or equal to the length of sensillus. Exobothridial setae (*ex*) 8-10, shortest on prodorsum, smooth.

**Notogaster** (Figs. 2, 10-12). Almost circular in dorsal view; always hardly longer than wide. Only six pairs of notogastral setae present. Dorsal three pairs of setae short (4), smooth, set on apophyses. Caudal three pairs of setae poorly visible. Scalps with morphology typical for Plasmobatidae.

**Anogenital region** (Figs. 4, 13, 14). Two pairs of anal (*an*<sub>1</sub>, *an*<sub>2</sub>, 4-8) and three pairs of adanal setae (*ad*<sub>1</sub>-*ad*<sub>3</sub>, 4-8) short, smooth; *ad*<sub>2</sub> and *ad*<sub>3</sub> situated near to each other. Aggenital setae (*ag*) absent. Genital plates with six to eight setae: seven pairs in two specimens, six pairs in one specimen, and an asymmetric localization in two specimens (six and seven and seven and eight setae on two genital valves of each). Genital setae 16-28, setiform, smooth.

**Epimeral region** (Fig. 2). Epimeral setal formula: 2-1-2-3; setae *1c*, *3c* or their alveoli not observed. Epimeral setae short (4), smooth.



5-9. *Plasmobates foveolatus* sp. n.: 5 – rostral seta, 6 – lamellar seta, 7 – interlamellar seta, 8 – sensillus, 9 – exobothridial seta. Scale bars (5-7, 9) 10  $\mu$ m, scale bar (8) 20  $\mu$ m

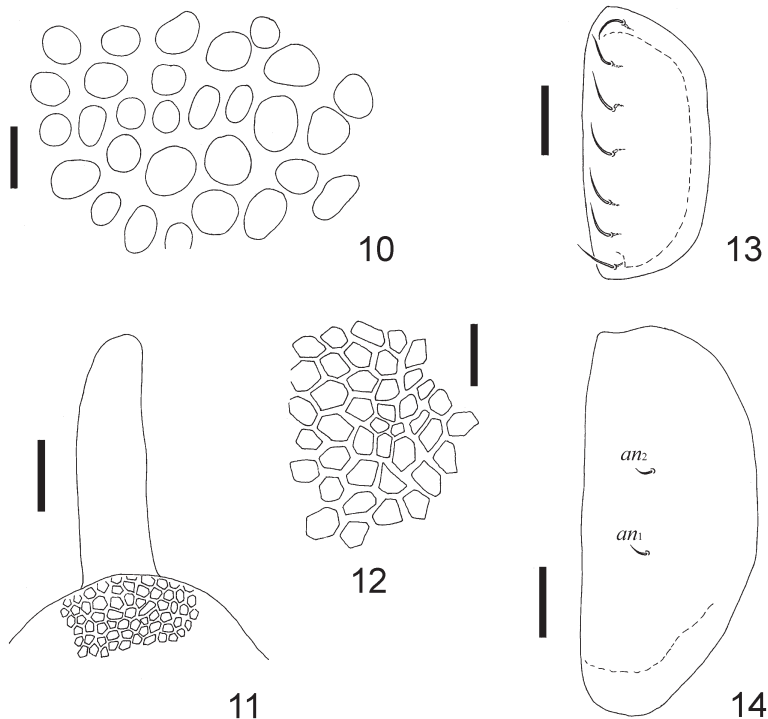


**Gnathosoma** (Figs. 15-17). Subcapitulum longer than wide: 131-139 × 86-90. Hypostomal setae long, setiform, smooth; *a* 41-45 longer than *h* 32-36 and *m* 20-28. Adoral setae absent. Palp (82-86) with setation 0-2-1-3-8(+1 $\omega$ ). Solenidion ( $\omega$ ) long, rod-like, straight. Chelicera 155, slightly curved in media-distal part, with two or three very small pointed teeth on movable digit. Cheliceral setae not observed.

**Legs** (Figs. 18-22). Claw with one small thorn on ventral side. Formulas of leg setation and solenidia: I (1-6-5-5-20) [1-2-2], II (1-6-5-5-12) [1-1-2], III (2-3-3-4-11) [1-1-0], IV (1-3-3-4-11) [0-1-0]; homology of setae and solenidia indicated in Table 1. Setae *p* on tarsi II-IV and *it* on tarsi II-III absent. Solenidia  $\omega_1$  and  $\omega_2$  on tarsi I thickened, curved; solenidia  $\omega_1$  and  $\omega_2$  on tarsi II rod-like, straight; solenidia  $\phi_1$  on tibiae I long, setiform; solenidia  $\phi_2$  on tibiae I short, setiform; other solenidia short, slightly dilated distally.

#### MATERIAL EXAMINED

Holotype and four paratypes were obtained from: African region, Ethiopia, 6°38'N, 39°43'E, 1883 m above sea level, Bale Mountains National Park, Harena Forest, in soil, collected by L.B. Rybalov, 23.11.2009.

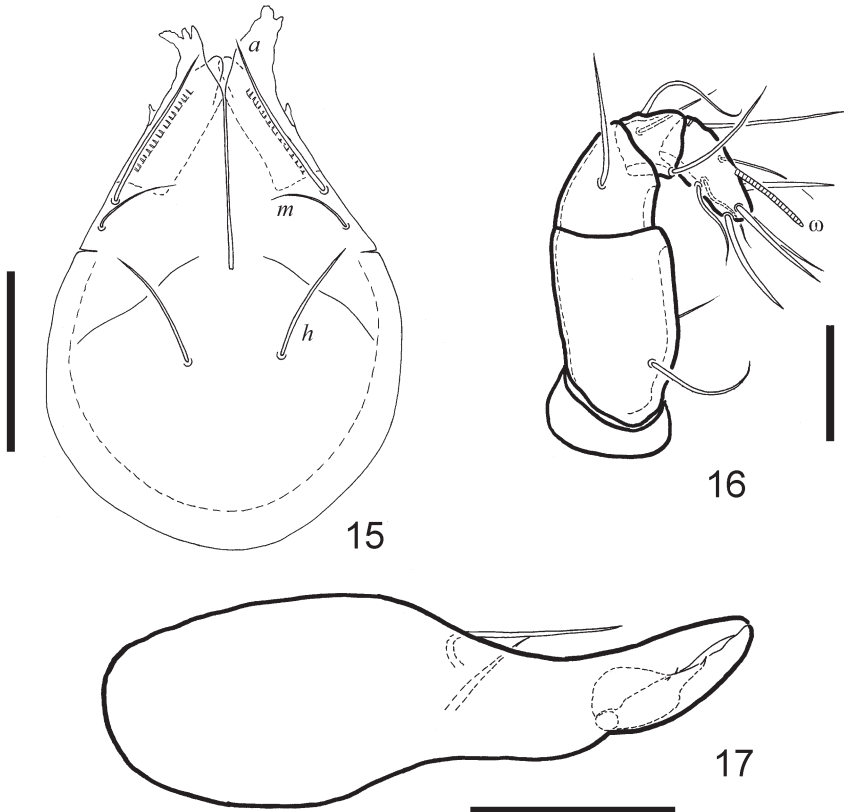


10-14. *Plasmobates foveolatus* sp. n.: 10 – notogastral foveolae in median part, 11 – anterior part of tritonymphal scalp, 12 – ornament in median part of tritonymphal scalp, 13 – genital plate, left, 14 – anal plate, left. Scale bar (11) 50  $\mu$ m, scale bars (10, 12-14) 20  $\mu$ m

**Table 1.** Leg setation and solenidia of *Plasmobates foveolatus* sp. n.\*

Leg	Trochanter	Femur	Genu	Tibia	Tarsus
I	v'	d, (l), (v), bv''	d, (l), (v), $\sigma$	d, (l), (v), $\phi_1, \phi_2$	(ft), (tc), (p), (u), (a), s, (pv), (v), (pl), (l), e, $\omega_1, \omega_2$
II	v'	d, (l), (v), bv''	d, (l), (v), $\sigma$	d, (l), (v), $\phi$	(ft), (tc), (u), (a), s, (pv), l', $\omega_1, \omega_2$
III	l', v'	d, l', v'	d, l', v', $\sigma$	d, l', (v), $\phi$	ft'', (tc), (u), (a), s, (pv), v'
IV	v'	d, l', v'	d, l', v'	d, l', (v), $\phi$	ft'', (tc), (u), (a), s, (pv), v'

\*Roman letters refer to normal setae, Greek letters refer to solenidia; e – famulus. One apostrophe (') marks setae on anterior and double apostrophe (") setae on posterior side of the given leg segment. Parentheses refer to a pair of setae.

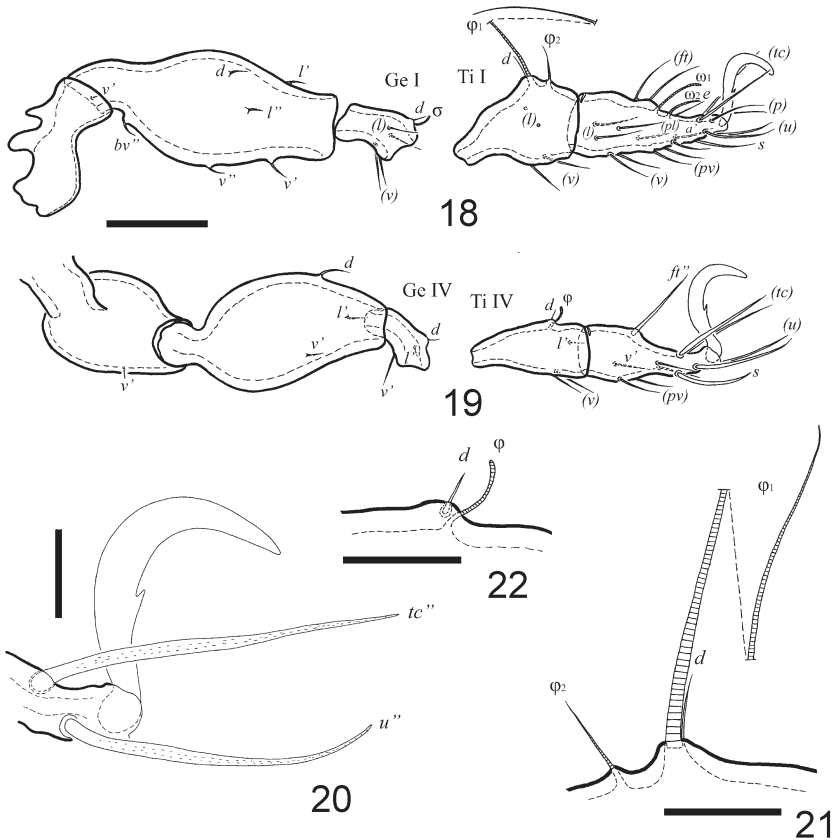


15-17. *Plasmobates foveolatus* sp. n.: 15 – subcapitulum, 16 – palp, 17 – chelicera. Scale bars (15, 17) 50  $\mu\text{m}$ , scale bar (16) 20  $\mu\text{m}$

The holotype is deposited in the collection of Zoological Institute of Russian Academy of Sciences, St. Petersburg, Russia; two paratypes are deposited in the collection of Siberian Zoological Museum, Novosibirsk, Russia; two paratypes are in the personal collection of the first author.

## REMARKS

*Plasmobates foveolatus* sp. n. belongs to the species group of *Plasmobates* with foveolate notogaster and sensilli slightly dilated distally, shorter than or equal to the distance between interlamellar setae. *Plasmobates foveolatus* sp. n. is most similar to *Plasmobates pagoda*, but the latter has smaller body length (350-420) and sensillus with large swelling. Also *Plasmobates foveolatus* sp. n. is similar to *Solenozetes carinatus* (HAMMER, 1961) (distribution: Neotropical region), but the latter has very short interlamellar setae, sensillus longer than distance between interlamellar setae, claw II



18-22. *Plasmobates foveolatus* sp. n.: 18 – leg I, right, antiaxial view, 19 – leg IV, right, paraxial view, 20 – leg IV, claw and setae (*tc''*, *u''*), right, paraxial view, 21 – solenidia and seta *d* of tibia I, 22 – solenidium and seta *d* of tibia IV; Ti, Ge – tibia, genu, accordingly. Scale bars (18, 19) 50  $\mu$ m, scale bars (20-22) 20  $\mu$ m

with very long thorn on ventral side. Among African species *Plasmobates foveolatus* sp. n. is most similar to *Plasmobates africanus*, but the latter has much smaller body (360 × 220), and notogaster with two weakly developed humps.

#### ETYMOLOGY

The name "*foveolatus*" refers to the morphology of notogaster.

#### DISTRIBUTION

At present, this species is known only from the type locality in Ethiopia.

### Family Oppiidae SELLNICK, 1937

#### Genus *Arcoppia* HAMMER, 1977

#### *Arcoppia arborea* ERMILOV, SIDORCHUK and RYBALOV sp. n.

(Figs. 23–41)

#### DIAGNOSIS

With character states of *Arcoppia* that were proposed by HAMMER (1977), and summarized by BALOGH and BALOGH (1992). New species is recognized by the large size of body, 680-747 × 348-415; surface of body smooth (only lateral and basal part of prodorsum with granules); rostrum tridentate in dorsal aspect; rostral setae 90–98, setiform, curved, well barbed; lamellar (53–57), interlamellar (127-143) and exobothridial (28-32) setae setiform, slightly barbed; sensilli (150-158) elongate spindle-shaped, with noticeable swelling and single branch (sensillar swelling smooth or with one small corniculus); ten pairs of notogastral setae setiform, slightly barbed, long, little differing in length, 164-188 (only setae *c* short, 41-61, and setae  $p_1$ - $p_3$  slightly shorter than the other).

#### DESCRIPTION

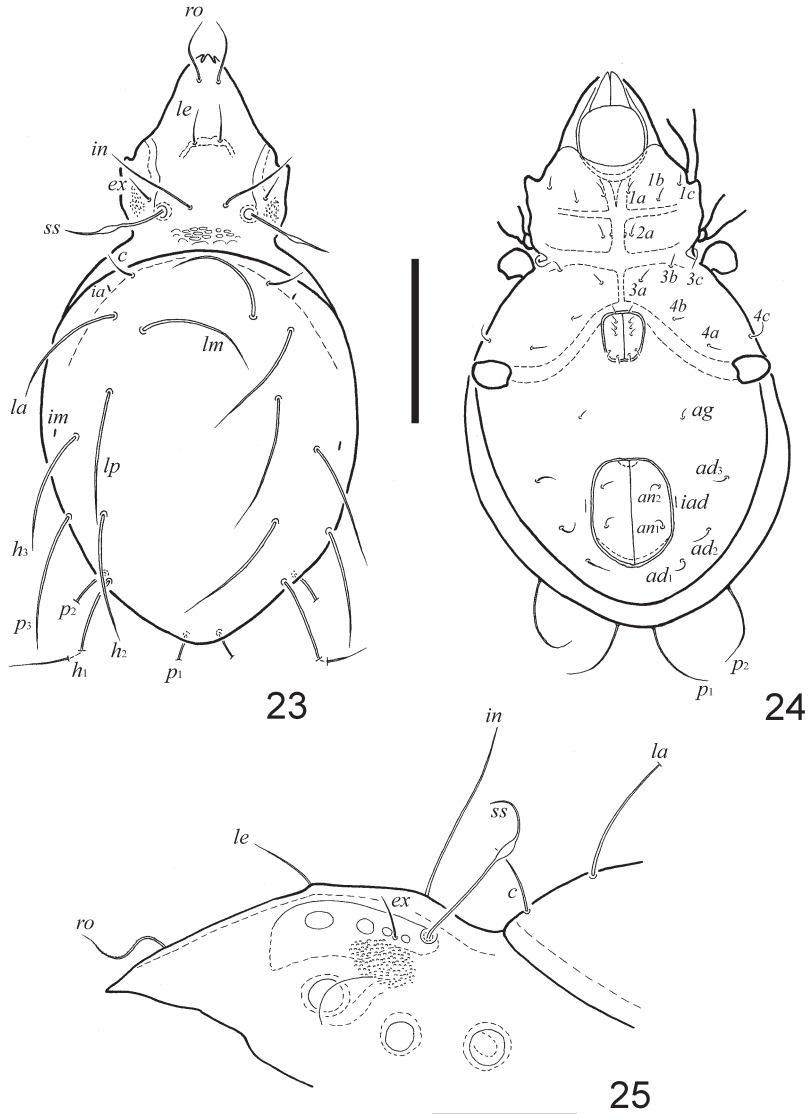
**Measurements.** Body length 680-747 (holotype 747), mean 723; body width 348-415 (holotype 415), mean 391.

**Integument.** Body color light brown to brown. Surface of body smooth. Only lateral and basal parts of prodorsum with granules; lateral granules hemispherical (up to 4 μm in diameter), basal granules oval or rectangular (up to 16 μm in length).

**Prodorsum** (Figs. 1, 3, 26-31). Rostrum conical, tridentate in dorsal aspect; median dent being the largest. Lateral costulae and few lateral muscle sigillae present. Rostral setae 90-98, setiform, strongly curved in media-distal parts, well barbed, located dorsally. Lamellar (53-57), interlamellar (127-143) and exobothridial (28-32) setae setiform, slightly barbed. Weakly formed transverse line present between lamellar setae. Sensilli are the largest setae on prodorsum, 150-158, elongate spindle-shaped, with noticeable swelling and single branch. Sensillar swelling smooth (in four specimens) or with one small corniculus (in two specimens). Sensillar stalk (69-73) longer than branch (53-65) and swelling (20-32).

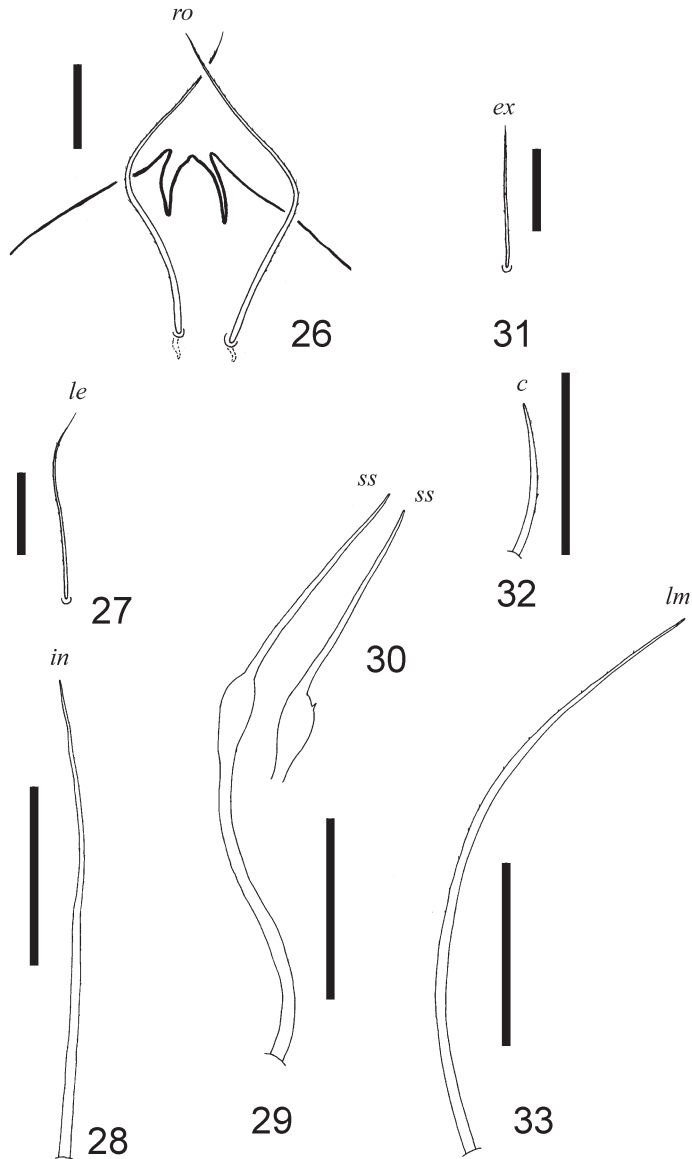
**Notogaster** (Figs. 23, 32, 33). Egg-shaped in dorsal view. Ten pairs of notogastral setae long, little differing in length in a given specimen, 164-188 (except setae *c* 41-61, and slightly shorter  $p_1$ - $p_3$ ), slightly barbed.

**Anogenital region** (Figs. 24, 34-36). Two pairs of anal setae (36-41), three pairs of adanal setae (61-69), one pair of aggenital setae (24-32), and six pairs of genital



23-25. *Arcoppia arborea* sp. n.: 23 – dorsal view, legs removed, 24 – ventral view, legs partly removed, 25 – prodorsum and part of the notogaster, lateral view, legs removed. Scale bars (23, 24) 200  $\mu$ m, scale bar (25) 100  $\mu$ m

setae (14-18) setiform, slightly barbed (barbs are visible only under high magnification). Ovipositor typical for Oppiidae (ERMILOV 2010): elongate, narrow ( $171 \times 36$ ), length of lobes 57, length of cylindrical distal part 114. Setae setiform, smooth;  $\psi_1 \approx \tau_1$  (36-41) longer than  $\psi_2 \approx \tau_a \approx \tau_b \approx \tau_c$  (24). Setae *k* not observed.

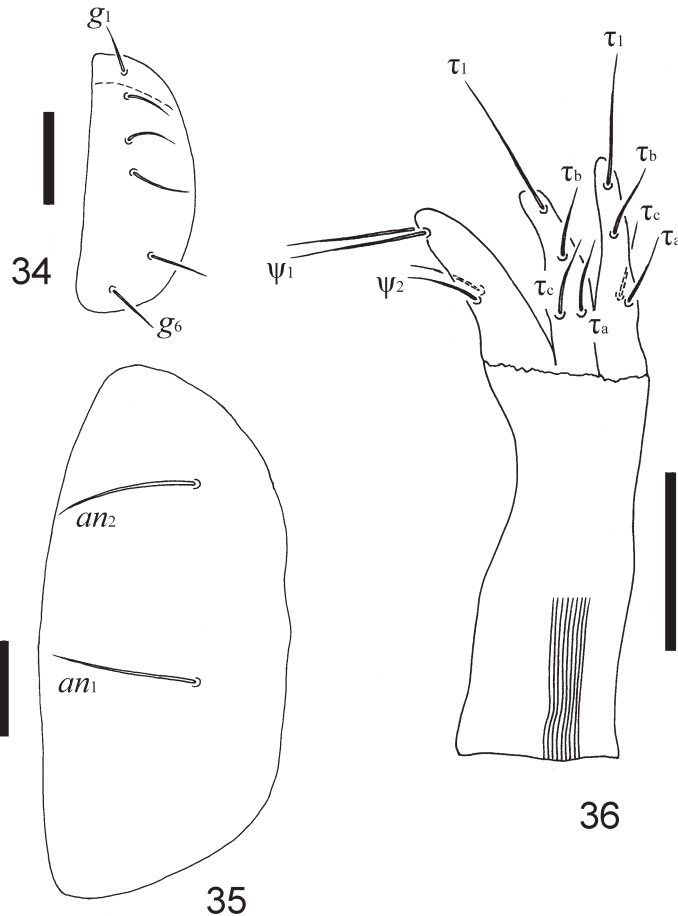


26-33. *Arcoppia arborea* sp. n.: 26 – rostrum and rostral seta, 27 – lamellar seta, 28 – interlamellar seta, 29 – sensillus, 30 – distal part of sensillus with corniculus, 31 – exobothridial seta, 32 – notogastral seta *c*, 33 – notogastral seta *lm*. Scale bars (26, 27, 31) 20  $\mu$ m, scale bars (28-30, 32, 33) 50  $\mu$ m

**Epimeral region** (Fig. 24). Epimeral setal formula: 3-1-3-3. Epimeral setae 28-32 (*3c* and *4c* longer, 49-61), setiform, slightly barbed (barbs are visible only under high magnification).

**Gnathosoma** (Figs. 37-39). Subcapitulum longer than wide:  $139 \times 98$ . Hypostomal setae long, setiform, slightly barbed (barbs are visible only under high magnification); *h* (41) a little longer than *m* (32) and *a* (36). Adoral setae absent. Palp (82-90) with setation 0-2-1-3-9(+1 $\omega$ ). Solenidion ( $\omega$ ) long, rod-like, pressed to palptarsus. Chelicera (length 123-127) with weakly developed few blunt teeth on fixed and movable digits. Cheliceral setae setiform, barbed; *cha* (36) longer and thinner than *chb* (28).

**Legs** (Figs. 40, 41). Claws simple. Formulas of leg setation and solenidia: I (1-5-2-4-20) [1-2-2], II (1-5-2-4-14) [1-1-2], III (2-3-1-3-13) [1-1-0], IV (1-2-2-3-10) [0-1-0]; homology of setae and solenidia indicated in Table 2. Setae *p* on tarsi II-IV



34-36. *Arcoppia arborea* sp. n.: 34 - genital plate, left, 35 - anal plate, left, 36 - ovipositor. Scale bars (34, 35) 20  $\mu$ m, scale bar (36) 50  $\mu$ m

absent. Setae setiform, barbed. Solenidia  $\omega_1$  on tarsi I,  $\omega_1$  and  $\omega_2$  on tarsi II,  $\sigma$  on genua III rod-like, other solenidia setiform.

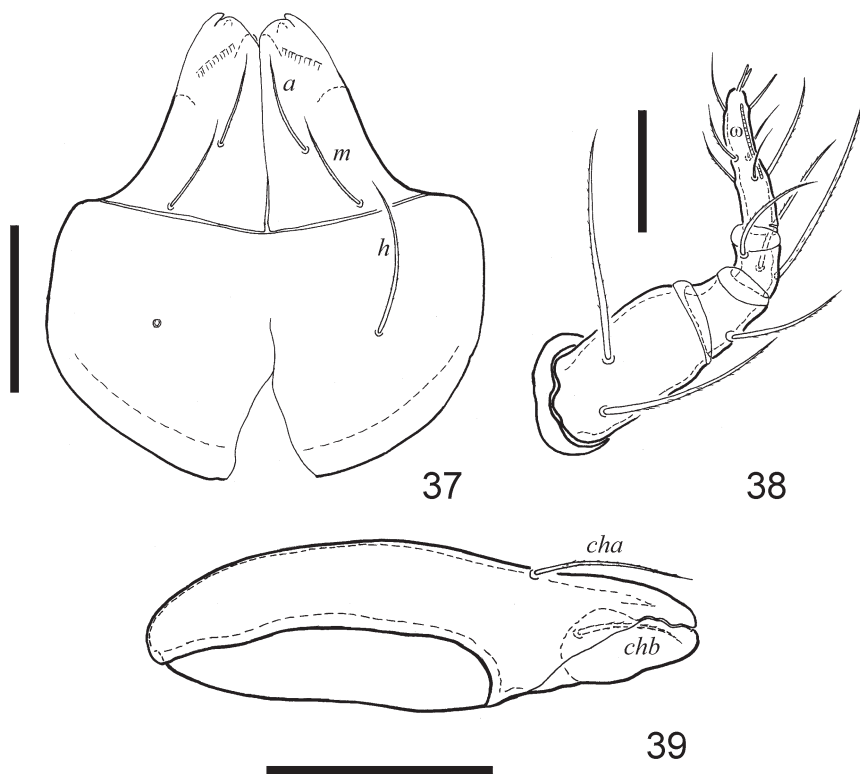
MATERIAL EXAMINED

Holotype and five paratypes were obtained from: African region, Ethiopia, 8°53'N, 38°09'E, 10 km to the south from Ginchi city, 2900 m above sea level, Cholomu Forest (wood species, in particular, *Hagenia abissinica* and *Podocarpus* forming the canopy; undergrowth of ferns), in mosses on trees, 15.11.2009, collected by L.B. Rybalov.

The holotype is deposited in the collection of Zoological Institute of Russian Academy of Sciences, St. Petersburg, Russia; three paratypes are deposited in the collection of Siberian Zoological Museum, Novosibirsk, Russia; two paratypes (dissected) are in the personal collection of the first author.

REMARKS

*Arcoppia arborea* sp. n. belongs to the *Arcoppia* species group with sensilli having a single branch (sensillar swelling smooth or with one small corniculus). The new spe-



37-39. *Arcoppia arborea* sp. n.: 37 – subcapitulum, 38 – palp, 39 – chelicera. Scale bars (37, 39) 50  $\mu$ m, scale bar (38) 20  $\mu$ m



**Table 2.** Leg setation and solenidia of *Arcoppia arborea* sp. n.\*

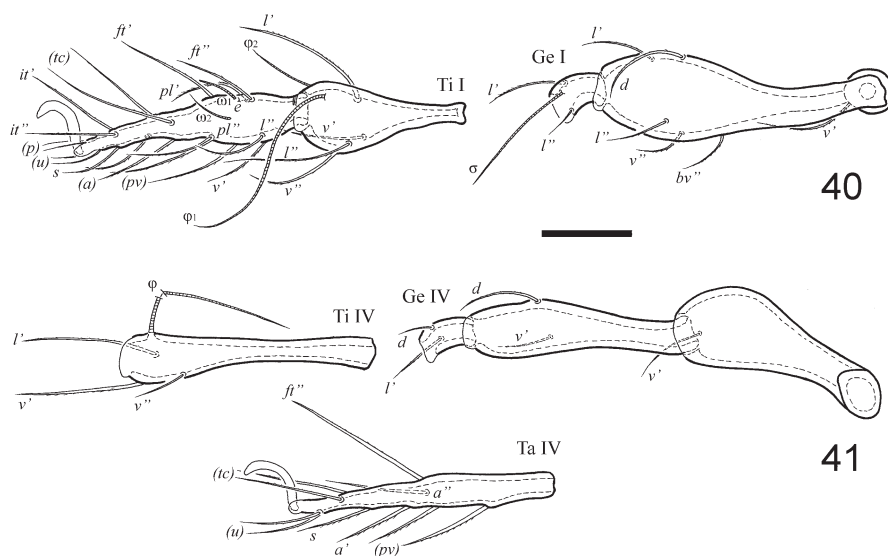
Leg	Trochanter	Femur	Genu	Tibia	Tarsus
I	v'	d, (l), v'', bv''	(l), $\sigma$	(l), (v), $\varphi_1$ , $\varphi_2$	(ft), (tc), (it), (p), (u), (a), s, (pv), v', (pl), l'', e, $\omega_1$ , $\omega_2$
II	v'	d, (l), v'', bv''	(l), $\sigma$	(l), (v), $\varphi$	(ft), (tc), (it), (u), (a), s, (pv), v', $\omega_1$ , $\omega_2$
III	l', v'	d, l', v'	l', $\sigma$	(v), l', $\varphi$	(ft), (tc), (it), (u), (a), s, (pv)
IV	v'	d, v'	d, l'	(v), l', $\varphi$	ft'', (tc), (u), (a), s, (pv)

\*See Table 1 for explanation.

cies is distinguishable from the other species of the group by the presence of following character states in combination: 1) large body size (680-747 × 348-415); 2) rostral setae strongly curved in media-distal parts; 3) lamellar setae well developed, equally far removed from rostral and interlamellar setae; 4) interlamellar setae long (slightly shorter than sensilli); 5) sensillar branch shorter than sensillar stalk; 6) notogastral setae long, little differing in length (except short *c* and slightly shorter *p*<sub>1-3</sub>); 7) adanal setae *ad*<sub>1</sub> in paraanal position.

#### ETYMOLOGY

The name “*arborea*” refers to the trees, on which the species is collected.



40-41. *Arcoppia arborea* sp. n.: 40 – leg I, left, antiaxial view, 41 – leg IV, left, paraxial view; Ta, Ti, Ge – tarsus, tibia, genu, accordingly. Scale bar 50  $\mu$ m

## DISTRIBUTION

At present, this species is known only from the type locality in Ethiopia.

## ACKNOWLEDGEMENTS

The authors are very grateful to Dr. Umukusum SHTANCHAEVA (Caspian Institute of Biological Resources, Makhachkala, Russia) and Prof. Dr. Luis SUBÍAS (Universidad Complutense de Madrid, Madrid, Spain) for their consultations. The authors also are very grateful to Prof. Dr. Roy A. NORTON (State University of New York, College of Environmental Science and Forestry, Syracuse, USA), Edit HORVÁTH (Hungarian National History Museum, Hungary) and Kerstin FRANKE (Senckenberg Museum für Naturkunde Görlitz, Germany) for their help with collecting literature. The work was performed within the framework of the Joint Russian-Ethiopian Biological Expedition financially supporting by the Russian Academy of Sciences. We are grateful to our Project Coordinators Dr. Andrey Darkov and Ato Girma Yosef for management of the Expedition. We thank Dr. Kemal Ali, director of the Ambo Plant Protection Research Centre, EIAR for supporting field studies and organizing laboratory operations.

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