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Revision of the family Dolichocybidae (Acari: Heterostigmata) from the collection of V.D. Sevastianov

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ABSTRACT

The dolichocybid mites in the collection of V.D. Sevastianov, namely *Pavania riparia* Sevastianov, 1980, *P. tadjikistanica* Sevastianov, 1980, *P. protracta* Sevastianov, 1980, *P. tahanae* Sevastianov and Abo-Korah, 1985 and *Dolichocybe firjusae* Sevastianov and Chydyrov, 1994, are revised and redescribed based on both the type and additional materials. An updated key to species of the genus *Pavania* is provided. The taxonomic position of *Pavania protracta* and *P. tahanae* is discussed.

Keywords systematics; redescription; *Pavania*; *Dolichocybe*; dung beetles; soil

Zoobank <http://zoobank.org/3C207D47-8CE2-41A8-89E4-AFEAF392C621>

Introduction

The family Dolichocybidae is a small group of early-derivative heterostigmatic mites that currently includes 2 subfamilies, 6 genera and 45 species (Hajiqanbar and Khaustov 2010; Rahiminejad *et al.* 2011; Zhang *et al.* 2011; Loghmani *et al.* 2013; Katlav *et al.* 2014; Bahramian *et al.* 2015; Mortazavi *et al.* 2015; Sobhi *et al.* 2017; Khaustov and Frolov 2017, 2018a, b; Khaustov and Trach 2017; Khaustov 2017). Little is known about the way of life of dolichocybid mites, but all of them are probably fungivorous (Rack 1967; Magowski 1988; Kaliszewski *et al.* 1995). Some species are important pests of edible mushrooms (Lan *et al.* 2017).

The identification of many dolichocybid mites is difficult or even impossible due to their incomplete and inadequate descriptions. All species described by V.D. Sevastianov and his co-authors belong to this “problematic” group. The list of dolichocybids described by V.D. Sevastianov and his co-authors includes 6 species, namely *Formicomotes octipes* Sevastianov, 1980, *Pavania riparia* Sevastianov, 1980, *P. tadjikistanica* Sevastianov, 1980, *P. protracta* Sevastianov, 1980, *P. tahanae* Sevastianov and Abo-Korah, 1985, and *Dolichocybe firjusae* Sevastianov and Chydyrov, 1994 (Sevastianov 1980; Sevastianov & Abo-Korah 1985; Sevastianov *et al.* 1994). Only *Formicomotes octipes* was recently redescribed (Khaustov and Frolov 2018a), while other species remain unstudied since the times of their original descriptions.

The main aim of this article is to provide redescriptions of dolichocybid mites described by V.D. Sevastianov and co-authors based on type and additional material.

Materials and methods

The type materials of dolichocybid mites were loaned from the collection of the Odessa I. I. Mechnikov National University Museum of Zoology, Odessa, Ukraine. Additional material of

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Figure 1 *Pavana riparia* Sevastianov, 1980, female: A – dorsum of the body, B – venter of the body. Legs omitted.

Pavana riparia was collected by junior author on the dung beetle *Copris lunaris* and mounted in Hoyer's medium. One non type material slide of *P. riparia* from the collection of the junior author was remounted and several specimens were removed, dusted with gold and scanned with aid of a JEOL-JSM-6510LV SEM microscope.

Mite morphology was studied using a Carl Zeiss AxioImager A2 compound microscope

with phase contrast and DIC objectives. Photomicrographs were taken with an AxioCam ICc5 digital camera.

The terminology of the idiosoma and legs follows Lindquist (1986); the nomenclature of subcapitular setae follows Grandjean (1944). All measurements are given in micrometers (μm). For leg chaetotaxy the number of solenidia is given in parentheses.

Taxonomy

Family Dolichocybidae Mahunka, 1970a

Genus *Pavania* Lombardini, 1949

Type species: *Pavania fusiformis* Lombardini, 1949, by original designation.

***Pavania riparia* Sevastianov, 1980**

***Pavania riparia* Sevastianov, 1980, p.1457, Figs 1–3.
(Figs 1–4)**

Redescription

Female (Figs 1–4)

Body oval, weakly sclerotized. Length of idiosoma 125–130, width 74–86.

Gnathosoma (Figs 4A–C) — Gnathosomal capsule, excluding palps, almost round, its length 22, width 22–24. Dorsally with two pairs of weakly barbed and blunt-ended cheliceral setae (*cha*, *chb*). Setae *cha* 13–14 distinctly longer than *chb* 9–10. Dorsal median apodeme well developed. Postpalpal setae (*pp*) short, divided distally (Fig. 4C). Venter of gnathosoma with one pair of smooth, pointed subcapitular setae *m* 12. Palps with smooth setae *dFe* and *dGe* dorsolaterally, setae *dGe* 10–11 pointed, more than two times longer than blunt-ended

Figure 2 *Pavania riparia* Sevastianov, 1980, female: A – right leg I in dorsal view, B – right leg II in dorsal view, C – right leg III in dorsal view, D – right leg IV in dorsal view.

dFe 4. Palps ventrally with two solenidia (*sol*). Inner solenidium slightly shorter than outer one. Palp tibiotarsus with short, blunt-ended ventrolateral seta (probably tibial *l'*) and distal eupathidium-like tiny seta (*eup*) (Fig. 4B). Palps terminate with well-developed tibial claw (*cl*) (Fig. 4A, B). Cheliceral stylets strong, curved. Pharynx thin-walled, elongate, with weak lateral projections.

Idiosomal dorsum (Figs 1A, 3A) — All dorsal shields with small sparsely distributed dimples (Fig. 3A). Prodorsal shield with three pairs of setae (v_1 , v_2 , sc_2) and a pair of clavate, barbed trichobothria sc_1 with rounded apex. All dorsal setae blunt-ended. Most of dorsal setae smooth or with very small barbs and only setae h_1 with distinct barbs. Tips of setae h_2 thickened into tiny clubs. Cupules *ia* on tergite D and *ip* on tergite EF small, round; other cupules not evident. Posterior margins of tergites C, D, and EF with several weak projections. Lengths of dorsal setae: v_1 16, v_2 6, sc_2 30–32, c_1 23–27, c_2 18, d 17, e 10–12, f 17–18, h_1 13–14, h_2 54–63. Distances between setae: v_1 – v_1 16–17, v_2 – v_2 24–26, sc_2 – sc_2 28, c_1 – c_1 24–28, d – d 48–49, e – e 40–41, f – f 28–29, h_1 – h_1 10, h_1 – h_2 7–8.

Idiosomal venter (Figs 1B, 3B, 4D) — All ventral plates smooth. All ventral setae smooth; setae $2c$ pointed, other setae blunt-ended. Apodemes 1 (*ap1*) and apodemes 2 (*ap2*) well developed; prosternal apodeme not evident; apodemes 3 (*ap3*) and 4 (*ap4*) well developed. Coxal fields I–IV each with three pairs of setae. Lengths of ventral setae: $1a$ 6, $1b$ 7, $1c$ 6, $2a$ 10, $2b$ 6, $2c$ 19, $3a$ 9, $3b$ 8–9, $3c$ 10–11, $4a$ 8, $4b$ 8–9, $4c$ 9, ag 9–10, g_1 4–5, g_2 4, ps 9.

Figure 3 DIC photomicrographs of *Pavania riparia* Sevastianov, 1980, female: A – dorsal view, B – ventral view.

Legs (Fig. 2) — Leg I (Fig. 2A). Setal formula: 0–4–2–6(2)–11(2). Tarsus with two small claws and semioval empodium. All leg setae smooth. Setae l' of femur, l' , v' of genu, k and v' of tibia blunt-ended; other leg setae (except eupathidia) pointed. Trochanter dorsally with four spine-like projections. Tarsus I with ventrodistal membranous flange. Lengths of solenidia ω_1 5, ω_2 3, ϕ_1 6, ϕ_2 4; Solenidia ϕ_2 and ω_2 weakly clavate, solenidium ϕ_1 distinctly clavate, solenidium ω_1 finger-shaped. Leg II (Fig. 2B). Setal formula: 0–2–1–4(1)–6(1). Tarsal claws simple, hooked; empodium large. Solenidium ω 4 finger-shaped, solenidium ϕ 2–3 clavate. Trochanter dorsally with two spine-like projections. Setae tc'' and u' of tarsus with flattened and weakly sclerotized blunt-ended tips. Other leg setae pointed. Setae v'' of femur, l' , v'' of tibia and tc' , pl'' of tarsus weakly barbed, other setae smooth. Leg III (Fig. 2C). Setal formula: 0–1–1–4–5. Claws and empodium of same shape as on tarsus II. Setae (tc) of tarsus with flattened and weakly sclerotized blunt-ended tips, other leg setae pointed. Seta pl'' of tarsus weakly barbed; other leg setae smooth. Leg IV (Fig. 2D). Setal formula: 0–1–1–4–5. Claws and empodium of same shape as on tarsus III. Seta d of femur blunt-ended, seta tc' of tarsus weakly blunt-ended, other leg setae pointed. Seta tc' of tarsus smooth; other leg setae weakly barbed.

Male unknown.

Figure 4 SEM images of *Pavana riparia* Sevastianov, 1980, female: A – gnathosoma in ventral view, B – left palp in ventral view, C – postpalpal seta, D – opisthosoma in ventral view.

Figure 5 *Pavana tadjikistanica* Sevastianov, 1980, female (holotype): A – dorsum of the body, B – venter of the body. Legs omitted.

Material examined

Female holotype, and 10 female paratypes, slide No. D-T-2, Ukraine, vicinity of Odessa, coast of Kuyalnik Liman, on *Copris lunaris* (Coleoptera, Scarabaeidae), 22 May 1960, Sevastianov V.D. leg.; 10 females, Ukraine, Odessa Prov., Razdelnaya District, vicinity of settlement Kolontaeveka (46°43' N, 30°18' E), on *C. lunaris*, 20 Sept. 2009, Trach V.A. leg.; 8 females,

Ukraine, Kherson Prov., Kalanchak District., vicinity of settlement Preobrazhenka (46°11' N, 33°36' E), on *C. lunaris*, 2-4 May 2011, Trach V.A. leg.

Remarks

The holotype and paratypes available for study are in poor condition and redescription is based on additional material collected by the junior author.

Pavania tadjikistanica Sevastianov, 1980

Pavania tadjikistanica Sevastianov, 1980, p.1457, Figs 4–7.

(Figs 5–7)

Redescription

Female (Figs 5–7)

The holotype and two paratypes available for this study are in rather bad condition (Fig. 7) and some tiny structures like cupules, dimples of dorsal plates and weak barbs on setae are not discernible. Length of idiosoma 120, width 80.

Gnathosoma — Gnathosomal capsule, excluding palps, almost round, its length 27, width 31. Dorsally with two pairs of blunt-ended cheliceral setae (*cha*, *chb*). Setae *cha* 15 distinctly longer than *chb* 10. Dorsal median apodeme well developed. Postpalpal setae (*pp*) short, peg-like. Venter of gnathosoma with one pair of pointed subcapitular setae *m* 9. Palps with smooth and pointed setae *dFe* and *dGe* dorsolaterally, setae *dGe* 11 almost twice longer than *dFe* 6. Palps ventrally with two solenidia. Inner solenidion much shorter than outer one. Palp tibiotarsus with short, blunt-ended ventrolateral seta (probably tibial *l*"). Palps terminated with well-developed tibial claw. Cheliceral stylets strong, falcate. Pharynx not discernible.

Idiosomal dorsum (Figs 5A, 7A) — Prodorsal shield with three pairs of setae (*v*₁, *v*₂, *sc*₂) and a pair of broken trichobothria *sc*₁. Setae *sc*₂ pointed, other dorsal setae blunt-ended. Tips of setae *h*₂ thickened into tiny clubs. Posterior margins of tergites without projections. Lengths of

Figure 6 *Pavania tadjikistanica* Sevastianov, 1980, female (holotype): A – right leg I in dorsal view, B – right leg II in dorsal view, C – left leg III in dorsal view, D – left leg IV in dorsal view.

dorsal setae: v_1 14, v_2 6, sc_2 36, c_1 20, c_2 20, d 22, e 16, f 17, h_1 13, h_2 53. Distances between setae: v_1-v_1 22, v_2-v_2 29, sc_2-sc_2 34, c_1-c_1 24, $d-d$ 34, $e-e$ 43, $f-f$ 29, h_1-h_1 12, h_1-h_2 6.

Idiosomal venter (Figs 5B, 7B) — All ventral setae blunt-ended. Ap1 and ap2 well developed; prosternal apodeme not evident; sejugal apodeme (apsej) weakly developed laterally; ap3 and ap4 well developed. Coxal fields I-IV each with three pairs of setae. Genital setae (g_1 , g_2) very small, vestigial. Lengths of ventral setae: 1a 6, 1b 6, 1c 5, 2a 8, 2b 5, 2c 8, 3a 7, 3b 7, 3c 9, 4a 6, 4b 9, 4c 8, ag 7, g_1 1, g_2 1, ps 9.

Legs (Fig. 6) — Leg setation as in previous species. Leg I (Fig. 6A). Tarsus with two small claws and semioval empodium. Setae l' of femur, l' , v' of genu, k , l' and v' of tibia blunt-ended; other leg setae (except eupathidia) pointed. Trochanter dorsally probably without spine-like projections. Lengths of solenidia ω_1 6, ω_2 3, ϕ_1 6, ϕ_2 5; solenidia ω_1 , ϕ_2 and ω_2 weakly clavate, solenidium ϕ_1 distinctly clavate. Leg II (Fig. 6B). Tarsal claws simple, hooked; empodium large. Solenidia ω 5 and ϕ 3 weakly clavate. Trochanter probably without spine-like projections. All leg setae pointed. Leg III (Fig. 6C). Claws and empodium of same shape as on tarsus II. Seta d of femur blunt-ended, other leg setae pointed. Leg IV (Fig. 6D). Claws and empodium of same

Figure 7 DIC photomicrographs of *Pavana tadjikistanica* Sevastianov, 1980, female (holotype): A – dorsal view, B – ventral view.

Figure 8 *Pavana protracta* Sevastianov, 1980, female (paratype): A – dorsum of the body, B – venter of the body. Legs omitted.

shape as on tarsus III. Seta *d* of femur blunt-ended, other leg setae pointed.

Male unknown.

Material examined

Female holotype, and 2 female paratypes, slide No. T-D-3, Tadjikistan, vicinity of Dushanbe, under elytra of *Onthophagus* sp. (Coleoptera, Scarabaeidae), 25 Aug. 1969, Ilyasov I.N. leg.

***Pavania protracta* Sevastianov, 1980**

***Pavania protracta* Sevastianov, 1980, p.1459, Figs 8–10.
(Figs 8–10)**

Redescription

Female (Figs 8–10)

Length of idiosoma 150, width 75.

Gnathosoma — Gnathosomal capsule, excluding palps, almost round, rather small, its length 18, width 19. Dorsally with two pairs of weakly barbed cheliceral setae (*cha*, *chb*). Setae *cha* 9 pointed, distinctly longer than blunt-ended *chb* 5. Dorsal median apodeme weakly developed. Postpalpal setae (*pp*) short, peg-like. Venter of gnathosoma with one pair of pointed and smooth subcapitular setae *m* 11. Palps with smooth setae *dFe* and *dGe* dorsolaterally, setae *dGe* 8 pointed, two times longer than blunt-ended *dFe* 4. Palps ventrally with two solenidia. Inner solenidium much shorter than outer one. Palp tibiotarsus with short, blunt-ended ventrolateral seta (probably tibial *l''*). Palps terminated with well-developed tibial claw. Cheliceral stylets relatively small, curved. Pharynx not discernible.

Idiosomal dorsum (Figs 8A, 10A) — All dorsal shields smooth. Prodorsal shield with three pairs of setae (v_1 , v_2 , sc_2) and a pair of clavate and distinctly barbed trichobothria sc_1 . All dorsal setae weakly barbed. Setae v_2 blunt-ended, other dorsal setae pointed. Posterior margins of tergites without projections. Cupules not evident. Lengths of dorsal setae: v_1 18, v_2 7, sc_2 28, c_1 20, c_2 26, d 21, e 20, f 21, h_1 16, h_2 36. Distances between setae: v_1-v_1 9, v_2-v_2 18, sc_2-sc_2 20, c_1-c_1 21, $d-d$ 37, $e-e$ 38, $f-f$ 25, h_1-h_1 12, h_1-h_2 8.

Idiosomal venter (Figs 8B, 10B) — All ventral plates smooth. Setae $1a$, $1b$, $1c$, $2b$, $2c$, and g_1 blunt-ended; other ventral setae pointed. Setae $1a$, $1b$, $1c$, $2b$, and $2c$ weakly barbed; other ventral setae smooth. Only ap2 and ap3 present, weakly developed; other apodemes not evident. Coxal fields I–IV each with three pairs of setae. Lengths of ventral setae: $1a$ 5, $1b$ 3,

Figure 9 *Pavania protracta* Sevastianov, 1980, female (paratype): A – right leg I in dorsal view, B – right leg II in dorsal view, C – right leg III in dorsal view, D – right leg IV in dorsal view.

1c 5, 2a 9, 2b 4, 2c 8, 3a 8, 3b 8, 3c 10, 4a 8, 4b 9, 4c 10, ag 8, g₁ 5, g₂ 9, ps 11.

Legs (Fig. 9)— Leg setation as in previous species. Leg I (Fig. 9A). Tarsus with two small claws and very short empodium. Setae *v'* of genu, *k* and *v'* of tibia blunt-ended; other leg setae (except eupathidia) pointed. Setae *v''*, (*l*) of femur, *k* of tibia, *pl'*, (*u*) and all eupathidia of tarsus smooth; other leg setae weakly barbed. Trochanter dorsally with three spine-like projections; central projection distinctly smaller than lateral ones. Lengths of solenidia ω_1 9, ω_2 4, ϕ_1 8, ϕ_2 5; Solenidia ω_1 and ϕ_2 finger-shaped; solenidion ω_2 weakly clavate, solenidion ϕ_1 distinctly clavate. Leg II (Fig. 9B). Tarsal claws simple, hooked; empodium small, semioval. Solenidia ω 5 finger-shaped and ϕ 3 weakly clavate. Trochanter with one spine-like projection. All leg setae pointed and weakly barbed. Leg III (Fig. 9C). Claws and empodium of same shape as on tarsus II. Seta *pv'* of tarsus thickened, spiniform, blunt-ended; other leg setae pointed. Setae (*pv*) and *tc''* of tarsus smooth; other leg setae weakly barbed. Leg IV (Fig. 9D). Claws and empodium of same shape as on tarsus III. Seta *pv'* of tarsus thickened, spiniform, blunt-ended; other leg setae pointed. Setae *pv'* and *tc''* of tarsus smooth; other leg setae weakly barbed.

Figure 10 DIC photomicrographs of *Pavana protracta* Sevastianov, 1980, female (holotype): A – dorsal view, B – ventral view.

Figure 11 *Pavana tahanae* Sevastianov and Abo-Korah, 1985, female (holotype): A – dorsum of the body, B – venter of the body. Legs omitted.

Male unknown.

Material examined

Female holotype, and 1 female paratype, slide No. T-D-4, Russia, Tatarstan, vicinity of Kazan, soil under maize, 27 Aug. 1968, Artemjeva T.I. leg.

Remarks

The holotype is in rather bad condition (Fig. 13). One female paratype was remounted and description is based on this paratype specimen.

***Pavania tahanae* Sevastianov and Abo-Korah, 1985**

***Pavania tahanae* Sevastianov and Abo-Korah, 1985, p.35, Figs 1–4.
(Figs 11–13)**

Redescription

Female (Figs 11–13)

Length of idiosoma 135, width 80.

Gnathosoma — Gnathosomal capsule, excluding palps, almost round, its length 19, width 20. Dorsally with two pairs of smooth and blunt-ended cheliceral setae (*cha*, *chb*). Setae *cha* 14 distinctly longer than *chb* 11. Dorsal median apodeme indistinct. Postpalpal setae (*pp*) short, peg-like. Venter of gnathosoma with one pair of pointed and smooth subcapitular setae *m* 11. Palps with smooth setae *dFe* and *dGe* dorsolaterally, setae *dGe* 12 pointed, almost two times longer than blunt-ended *dFe* 7. Palps ventrally with two subequal solenidia. Palp tibiotarsus with short, blunt-ended ventrolateral seta (probably tibial *l''*). Palps terminated with well-developed tibial claw. Cheliceral stylets rather small, curved. Pharynx not discernible.

Idiosomal dorsum (Figs 11A, 13A) — All dorsal shields smooth. Prodorsal shield with three pairs of setae (v_1 , v_2 , sc_2) and a pair of clavate and weakly barbed trichobothria sc_1 . Setae *e* weakly barbed, other dorsal setae apparently smooth. Setae v_1 and v_2 blunt-ended, other dorsal setae pointed. Posterior margins of tergites without projections. Cupules not evident. Lengths of dorsal setae: v_1 18, v_2 9, sc_2 32, c_1 22, c_2 29, *d* 23, *e* 25, *f* 28, h_1 18, h_2 35. Distances between setae: v_1 – v_1 11, v_2 – v_2 20, sc_2 – sc_2 28, c_1 – c_1 37, *d*–*d* 53, *e*–*e* 46, *f*–*f* 42, h_1 – h_1 11, h_1 – h_2 9.

Idiosomal venter (Figs 11B, 13B) — All ventral plates smooth. All ventral setae smooth. Setae g_1 and g_2 blunt-ended, other ventral setae pointed. Only ap₂ and ap₃ clearly discernible; other apodemes not evident. Coxal fields I–V each with three pairs of setae. Lengths of ventral setae: 1*a* 7, 1*b* 8, 1*c* 6, 2*a* 13, 2*b* 6, 2*c* 15, 3*a* 9, 3*b* 7, 3*c* 13, 4*a* 7, 4*b* 8, 4*c* 8, *ag* 11, g_1 4, g_2 4, *ps* 10.

Figure 12 *Pavania tahanae* Sevastianov and Abo-Korah, 1985, female (holotype): A – right leg I in dorsal view, B – right leg II in dorsal view, C – right leg III in dorsal view, D – right leg IV in dorsal view.

Legs (Fig. 12) — Leg setation as in previous species. Leg I (Fig. 12A). Tarsus with two small claws, empodium not evident. All leg setae smooth. Seta k of tibia and all eupathidia of tarsus blunt-ended; other leg setae pointed. Trochanter dorsally without spine-like projections. Lengths of solenidia ω_1 9, ω_2 5, φ_1 8, φ_2 3; solenidion ω_1 finger-shaped; solenidion ω_2 baculiform, solenidia φ_1 and φ_2 distinctly clavate. Leg II (Fig. 12B). Tarsal claws simple, hooked; empodium very small, semioval. Solenidia ω 8 finger-shaped and φ 2 weakly clavate. Trochanter without spine-like projections. All leg setae pointed and smooth. Leg III (Fig. 12C). Claws and empodium of same shape as on tarsus II. Solenidion φ 2 weakly clavate. All leg setae pointed and smooth. Leg IV (Fig. 12D). Claws and empodium of same shape as on tarsus II. Solenidion φ 2 weakly clavate. All leg setae pointed and smooth.

Male unknown.

Figure 13 DIC photomicrographs of *Pavana tahanae* Sevastianov and Abo-Korah, 1985, female (holotype): A – dorsal view, B – ventral view.

Material examined

Female holotype, slide No. 704, Egypt, vicinity of Shibin El Kom, soil under cotton, 1 Sept. 1980, Abo-Korah leg.

Key to world species of *Pavanía* (based on Khaustov & Frolov 2018b)

1. Setae sc_1 absent 2
— Setae sc_1 present 5
2. Setae 1c and 2c present 3
— Setae 1c and 2c absent *P. neotropica* Khaustov and Frolov, 2017 (Brazil)
3. Setae v_1 shorter than distance between their bases; setae *cha* less than three times longer than *chb*; setae *e* never longer than *f*; setae h_2 at most seven times longer than h_1 4
— Setae v_1 longer than distance between their bases; setae *cha* three times longer than *chb*; setae *e* longer than *f*; setae h_2 15 times longer than h_1 *P. gymnopleuri* Hajiqanbar and Khaustov, 2010 (Iran)
4. Genu I with one seta (v'); dorsal idiosomal setae smooth; setae c_1 longer than c_2 ; setae c_1 and *d* pointed *P. sabzevarensis* Hajiqanbar and Khaustov, 2010 (Iran)
— Genu I with two setae (v' , l'); dorsal idiosomal setae weakly barbed; setae c_2 longer than c_1 ; setae c_1 and *d* distinctly blunt-ended *P. onthophagi* Hajiqanbar and Khaustov, 2010 (Iran)
5. Setae sc_1 capitate 6
— Setae sc_1 seta-like *P. setiformis* Loghmani and Hajiqanbar, 2013 (Iran)
6. Setae (*u*) and (*pv*) of tarsus I not lanceolate 7
— Setae (*u*) and (*pv*) of tarsus I lanceolate *P. lanceolata* Bahramian and Hajiqanbar, 2015 (Iran)
7. Coxal fields II with 3 pairs of setae 8
— Coxal fields II with 2 pairs of setae *P. equisetosa* Mahunka, 1975 (Ghana)
8. Empodium on tarsi II-IV small, not reaching beyond tips of claws, seta pv' on tarsi III and IV simple 9
— Empodium on tarsi II-IV large, reaching beyond tips of claws 10
9. Seta pv' on tarsi III and IV thickened, spiniform and blunt-ended, solenidia on tibiae III and IV absent *P. rotracta* Sevastianov, 1980 (Russia)
— Seta pv' on tarsi III and IV simple, solenidia on tibiae III and IV present *P. tahanae* Sevastianov and Abo-Korah, 1985 (Egypt)
10. Setae h_2 less than 3.5 times longer than h_1 11
— Setae h_2 more than 3.5 times longer than h_1 15
11. Setae c_1 never reaching beyond bases of setae *f*; setae c_1 shorter than h_2 ; setae *d* shorter than h_2 12
— Setae c_1 reaching beyond bases of setae *f*; setae c_1 longer than h_2 ; setae *d* and h_2 subequal *P. perhirsuta* Mahunka, 1973 (Ghana)
12. Setae sc_2 subequal to distance between their bases 13
— Setae sc_2 distinctly longer than distance between their bases 14

- *P. luisiae* Mahunka, 1974 (Ghana)
13. Setae c_1 , d , e and f blunt-ended 14
 — Setae c_1 , d , e and f pointed *P. bembidii* Khaustov, 2005 (Crimea)
14. Setae h_1 almost three times longer than ps , solenidion ϕ_2 with rounded tip
 P. carabidophila Khaustov, 2005 (Russia: Krasnodarskiy Kray, Primorskiy Kray)
 — Setae h_1 almost subequal with ps , solenidion ϕ_2 with attenuated tip
 P. africana Khaustov and Frolov, 2018b (South Africa)
15. Setae h_2 more than six times longer than h_1 16
 — Setae h_2 less than six times longer than h_1 19
16. Setae sc_2 less than 2.5 times longer than v_1 ; setae f less than twice as long as e ; setae e shorter than v_1 17
 — Setae sc_2 at least 3.5 times longer than v_1 ; setae f more than twice as long as e ; setae e longer than v_1 *P. endroedyi* Mahunka, 1975 (Ghana)
17. Setae sc_2 more than twice as long as v_1 ; setae f and d subequal; setae c_1 never reaching beyond posterior border of tergite C 18
 — Setae sc_2 less than twice as long as v_1 ; setae f longer than d ; setae c_1 reaching beyond posterior border of tergite C *P. brasiliensis* Mahunka, 1970b (Brazil)
18. Setae $2a$ as long as $2c$ and both longer than c_1 , d and f ; setae m protruding beyond anterior border of gnathosoma *P. elongata* Hajiqaanbar and Khaustov, 2010 (Iran)
 — Setae $2a$ longer than $2c$ and both shorter than c_1 , d and f ; setae m never protruding beyond anterior border of gnathosoma *P. simplex* Mahunka, 1973 (Ghana)
19. Setae f distinctly longer than e ; setae e and h_1 subequal 20
 — Setae e and f subequal; setae e longer than h_1
 P. tadjikistanica Sevastianov, 1980 (Tadjikistan, Iran)
20. Setae $2c$ subequal with $2a$ 21
 — Setae $2c$ about two times longer than $2a$.. *P. riparia* Sevastianov, 1980 (Ukraine, Slovakia)
21. Setae f more than two times longer than e 22
 — Setae f less than 1.5 times longer than e
 P. khiavensis Sobhi and Hajiqaanbar, 2017 (in Sobhi *et al.* 2017) (Iran)
22. Most dorsal idiosomal setae weakly barbed and blunt-ended; setae c_1 longer than c_2 ; setae sc_2 less than twice as long as c_1 *P. kamalii* Hajiqaanbar and Khaustov, 2010 (Iran)
 — Dorsal idiosomal setae smooth and pointed; setae c_2 longer than c_1 ; setae sc_2 more than twice as long as c_1 *P. fusiformis* Lombardini, 1949 (Italy, Iran)

Genus *Dolichocybe* Krantz, 1957

Type species: *Dolichocybe keiferi* Krantz, 1957, by original designation.

Dolichocybe firjusae Sevastianov and Chydyrov, 1994

Dolichocybe firjusae Sevastianov *et al.* 1994, p.3, Figs 1(1–4).
 (Figs 14–16)

Redescription

Female (Figs 14–16)

Figure 14 *Dolichocybe firjusae* Sevastianov and Chydyrov, 1994, female (holotype): A – dorsum of the body, B – venter of the body. Legs omitted.

Figure 15 *Dolichocybe firjusae* Sevastianov and Chydyrov, 1994, female (holotype): A – left leg I in dorsal view, B – left leg II in dorsal view, C – right leg III in dorsal view, D – right leg IV in dorsal view.

Body elongate, weakly sclerotized. Length of idiosoma 180, width 77.

Gnathosoma — Gnathosomal capsule, excluding palps, almost oval, its length 20, width 15. Dorsally with two pairs of smooth and pointed cheliceral setae (*cha*, *chb*). Setae *cha* 12 distinctly longer than *chb* 6. Dorsal median apodeme indistinct. Postpalpal setae (*pp*) rod-like. Venter of gnathosoma with one pair of smooth, pointed subcapitular setae *m* 17. Palps freely articulated to gnathosomal capsule, with smooth and pointed setae *dFe* and *dGe* dorsolaterally, setae *dGe* 12 pointed, more than two times longer than blunt-ended *dFe* 5. Palps ventrally with two subequal solenidia. Palp tibiotarsus with short ventrolateral seta (probably tibial *l'*) and distal eupathidium-like tiny seta. Palps terminated with well-developed tibial claw. Cheliceral stylets small, indistinct. Pharynx thin-walled, elongate, with weak lateral projections.

Idiosomal dorsum (Figs 14A, 16) — All dorsal shields smooth. Prodorsal shield with three pairs of setae (v_1 , v_2 , sc_2) and a pair of clavate, smooth trichobothria sc_1 with rounded apex; setae v_1 and v_2 located on the same transverse line. Setae v_1 , v_2 , and c_1 blunt-ended, other dorsal setae pointed. Setae h_1 and h_2 smooth, other dorsal setae weakly barbed. Cupules ia on tergite D and ip on tergite EF small, round; other cupules not evident. Lengths of dorsal setae: v_1 14, v_2 23, sc_2 44, c_1 13, c_2 25, d 18, e 19, f 25, h_1 13, h_2 76. Distances between setae: v_1-v_1 10, v_2-v_2 22, sc_2-sc_2 20, c_1-c_1 30, $d-d$ 36, $e-e$ 36, $f-f$ 30, h_1-h_1 13, h_1-h_2 5.

Idiosomal venter (Figs 14B, 16) — All ventral plates smooth. Setae 3*a*, 3*c*, and *ag* weakly barbed, other ventral setae smooth; setae *g*₁ and *g*₂ blunt-ended, other ventral setae pointed. Only ap3 and ap4 weakly developed, other apodemes indistinct. Coxal fields I-IV each with three pairs of setae. Lengths of ventral setae: 1*a* 13, 1*b* 11, 1*c* 10, 2*a* 17, 2*b* 11, 2*c* 23, 3*a* 12, 3*b* 13, 3*c* 15, 4*a* 9, 4*b* 10, 4*c* 12, *ag* 14, *g*₁ 3, *g*₂ 4, *ps* 7.

Figure 16 Phase-contrast photomicrographs of *Dolichocybe firjusae* Sevastianov and Chydyrov, 1994, female (holotype): A – dorsal view, B – ventral view.

Legs (Fig. 15) — Leg setation as in previous species. Leg I (Fig. 15A). Tarsus with two small claws; empodium indistinct. Setae *d* of femur, *l'* of genu, *d* of tibia, *tc'* and *pl''* of tarsus weakly barbed; over leg setae smooth. Seta *k* and eupathidia blunt-ended, other leg setae pointed. Trochanter dorsally with one large spine-like projection. Lengths of solenidia ω_1 3, ω_2 2, ϕ_1 7, ϕ_2 2; solenidia ϕ_2 and ω_2 peg-like, solenidion ϕ_1 distinctly clavate, solenidion ω_1 finger-shaped. Leg II (Fig. 15B). Tarsal claws simple, hooked; empodium large, flipper-like. Solenidion ω 4 finger-shaped, solenidion ϕ 1 very small, peg-like, difficult to discern. Trochanter dorsally without spine-like projections. All leg setae pointed. Setae *tc''*, *u''* and (*p_v*) of tarsus smooth, other setae weakly barbed. Leg III (Fig. 15C). Claws and empodium of same shape as on tarsus II. All leg setae pointed. Seta *d* of tibia and all tarsal setae smooth, other leg setae weakly barbed. Leg IV (Fig. 15D). Claws and empodium of same shape as on tarsus III.

All leg setae pointed. Seta *d* of tibia and all tarsal setae smooth, other leg setae weakly barbed.

Male unknown.

Material examined

Female holotype, slide No. 908, Turkmenistan, Chardzhou Prov., vicinity of settlement Karabekaul, soil on cotton field, 24 Sept. 1982, Chydyrov P.R. leg.

Discussion

The main differences between the genera *Dolichocybe* and *Pavania* according to Cross (1965) are the shape of cheliceral stylets (falcate and well developed in *Pavania* and small, indistinct in *Dolichocybe*) and position of palps (palps arising ventrolaterally in *Pavania* and laterally in *Dolichocybe*). In fact, the position of palps is rather uniform in all dolichocybid mites and can not be used as a generic-level character. The shape and size of stylets are also highly variable. In typical *Pavania* (like most species associated with dung beetles), stylets are really large and falcate. In typical *Dolichocybe* (*D. keiferi*, *D. subcorticalis* Khaustov, 2006, *D. sibiriensis* Khaustov, 2017, *D. firjusae*) stylets are small and indistinct. However, at least in *Pavania protracta* and *P. tahanae*, size of the cheliceral stylets is intermediate between typical for *Pavania* and for *Dolichocybe*. Therefore, the shape of cheliceral stylets is a vague character, difficult to use in separation of the genera *Dolichocybe* and *Pavania*. Rahiminejad *et al.* (2011) redefined the genus *Dolichocybe* and used the following characters to separate *Dolichocybe* from *Pavania*: “gnathosoma apparently longer than wide; chelicerae small and indistinct; tarsus I with 10 or 11 setae; tibiae III and IV with one minute solenidion each; with deep constriction between propodosoma and hysterosoma separated by soft and transversely striated cuticle” (in *Dolichocybe*); “gnathosoma almost as long as wide; chelicerae large and distinct; tarsus I with 11 setae; tibiae III and IV with no solenidia; without deep constriction between propodosoma and hysterosoma” (in *Pavania*). Based on our study, the number of setae on tarsus I is the same in *Pavania* and *Dolichocybe* and can not be used in separation of these genera. The presence of solenidia on tibiae III and IV in *Dolichocybe* is also problematic character. In fact, solenidia on tibiae III and IV are apparently absent in *D. keiferi* (type species) (Cross 1965), *D. hippocastani* Rack, 1967, *D. picea* Rack, 1967 (Rack 1967), and absent in *D. subcorticalis*, *D. sibiriensis* (Khaustov 2006, 2017) and *D. firjusae* (present study). Potentially solenidia on tibiae III and IV are present in *Pavania brasiliensis* Mahunka, 1970, at least Mahunka (1970) depicted a tiny solenidion on the tibia III. Therefore, the presence of solenidia on tibiae III and IV also can not be used for separation of these genera. It is also difficult to understand the extent of constriction between propodosomal and hysterosoma.

Two redescribed herein species, *Pavania protracta* and *P. tahanae*, have intermediate characters between *Dolichocybe* and *Pavania*: body shape is similar to that in *Pavania* (not strongly elongate), gnathosoma is rather small (as in *Dolichocybe*), cheliceral stylets are of medium size (intermediate), constriction between propodosomal and hysterosoma is not deep (as in *Pavania*). In addition, both of these species have unusually short — considerably shorter than tarsal claws — empodia on tarsi II-IV. *Pavania tahanae* also has solenidia on tibiae III and IV (like some “*Dolichocybe*”). Both species were collected in soil (not phoretic on insects) and potentially could represent a non-phoretic form of *Pavania/Dolichocybe* complex. At present female dimorphism has been evident only in the genus *Formicomotes* Sevastianov, 1980. Non-phoretic form of *F. heteromorphus* Magowski, 1988 has much shorter empodia than phoretic form (Magowski 1988). In this paper, we retain all species in the genera in which they were originally described. The redefinitions of the genera *Dolichocybe* and *Pavania* are necessary based on redescription of their type species and more discoveries of new species in these two close genera (particularly *Dolichocybe*) are required (phoretic or in soil) to see what characters are more variable.

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