

A NEW SPECIES OF *PAVANIA* (ACARI: HETEROSTIGMATA: DOLICHOCYBIDAE) ASSOCIATED WITH *SCARABAEUS TYPHON* (COLEOPTERA: SCARABAEIDAE) FROM RUSSIA

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ABSTRACT: A new species *Pvania foliata* sp.n. (Acari: Heterostigmata: Dolichocybidae), phoretic on dung beetle *Scarabaeus typhon* Fischer-Waldheim (Coleoptera: Scarabaeidae) from southwest Russia, is described. The updated key to the species of the genus *Pvania* is provided.

KEY WORDS: Systematics, phoresy, dung beetle, Palaearctic region, key.

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INTRODUCTION

Dolichocybidae—a small family of early-derivative heterostigmatic mites—currently includes 2 subfamilies, 6 genera and 56 species (Hajiqaanbar and Khaustov 2010; Rahiminejad *et al.* 2011; Loghmani *et al.* 2013; Katlav *et al.* 2014, 2020; Bahramian *et al.* 2015; Mortazavi *et al.* 2015; Sobhi *et al.* 2017; Khaustov and Frolov 2017, 2018a, b, 2020; Khaustov and Trach 2017, 2018; Khaustov 2017; Hajiqaanbar *et al.* 2019). Little is known about the behavioral patterns 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). However, most dolichocybid mites are associated with insects (mostly beetles), utilizing them for phoresy (Khaustov and Trach 2017). The genus *Pvania* Lombardini is the largest in the family and includes 33 species, described from Eurasia, Africa, South America and Australia (Khaustov and Frolov 2020; Katlav *et al.* 2020).

At present, only three species of *Pvania* have been reported from Russia, namely *P. bembidii* Khaustov, 2005, *P. carabidophila* Khaustov, 2005 and *P. protracta* Sevastianov, 1980 (Khaustov and Trach 2017; Khaustov and Frolov 2020). *Pvania carabidophila* and *P. bembidii* are phoretic on carabid beetles of the genus *Bembidion* (Coleoptera: Carabidae) (Khaustov 2005; Khaustov and Trach 2017). The third species, *P. protracta*, was collected from soil (Sevastianov 1980).

During a study of mites associated with scarab beetles, a new species of *Pvania* was recovered in the southwest of Russia; it was phoretic on scarab beetle *Scarabaeus typhon* Fischer-Waldheim. The aim of this paper is to describe this new species. Moreover, the updated key to the species of the genus *Pvania* is provided.

MATERIALS AND METHODS

The host beetles were collected in a sandy semi-desert area located along the Akhtuba River (a tributary of the Volga River), about 90 km upstream of the Volga Delta, Astrakhan Region, European Russia. The beetles were preserved in 96% ethanol prior to dissection. The mites were found attached to the membrane that connects the 1st abdominal tergite and the metanotum. Collected mites were kept in 96% ethanol prior to being mounted in Hoyer's medium. Mite morphology was studied using a Carl Zeiss AxioImager A2 compound microscope with phase contrast and DIC objectives. Micrographs were taken with an AxioCam 506 color 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 the holotype and five paratypes (in parentheses). For leg chaetotaxy, the number of solenidia is given in parentheses.

RESULTS

Family **Dolichocybidae Mahunka, 1970**

Genus ***Pvania* Lombardini, 1949**

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

***Pvania foliata* sp.n.**

(Figs. 1–4)

Description. *Female* (Figs. 1–4). Body weakly sclerotized. Length of idiosoma 130 (130–135), width 82 (80–87).

Gnathosoma. Gnathosomal capsule, excluding palps, almost round, its length 28 (24–28), width

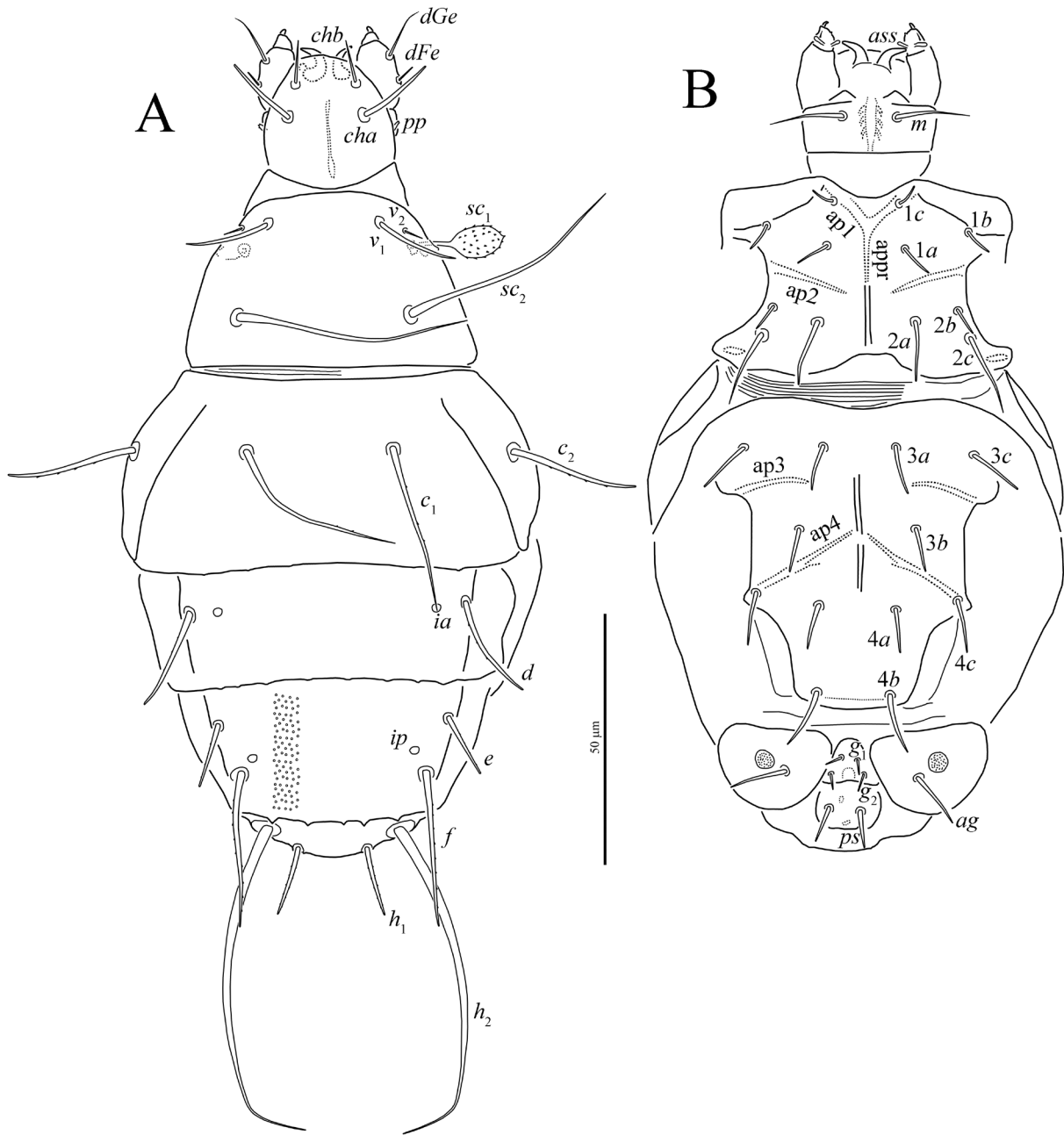


Fig. 1. *Pavana foliata* sp. n., female: A—dorsum of the body, B—venter of the body. Legs omitted.

27 (27–28). Dorsally with two pairs of blunt-ended and smooth cheliceral setae (*cha*, *chb*). Setae *cha* 15 (15–18) distinctly longer and thicker than *chb* 9 (9–10). Dorsal median apodeme weakly developed. Postpalpal setae (*pp*) rod-like with tiny distal projections, situated posterolaterally to setae *cha*. Venter of gnathosoma with one pair of smooth, pointed subcapitular setae *m* 15 (15–17). Palps freely articulated to gnathosomal capsule, with smooth setae *dFe* and *dGe* dorsolaterally, setae *dGe* 10 (10–12) pointed, about two times longer than blunt-ended *dFe* 5 (4–5). Palps ventrally with so-

lenidion and accessory setigenous structure subequal in length. Palps terminated with well-developed tibial claw. Palp tibiotarsus with tiny eupathid-like distal seta and small lateral seta. Cheliceral stylets strong, curved. Pharynx poorly visible, with at least three lateral projections.

Idiosomal dorsum (Figs. 1A, 4A). Tergite EF with clearly visible numerous round and very small dimples, other tergites smooth or with few poorly visible dimples. Prodorsal shield with three pairs of setae (*v*₁, *v*₂, *sc*₂) and one pair of clavate, barbed trichobothria *sc*₁ with slightly attenuated apex.

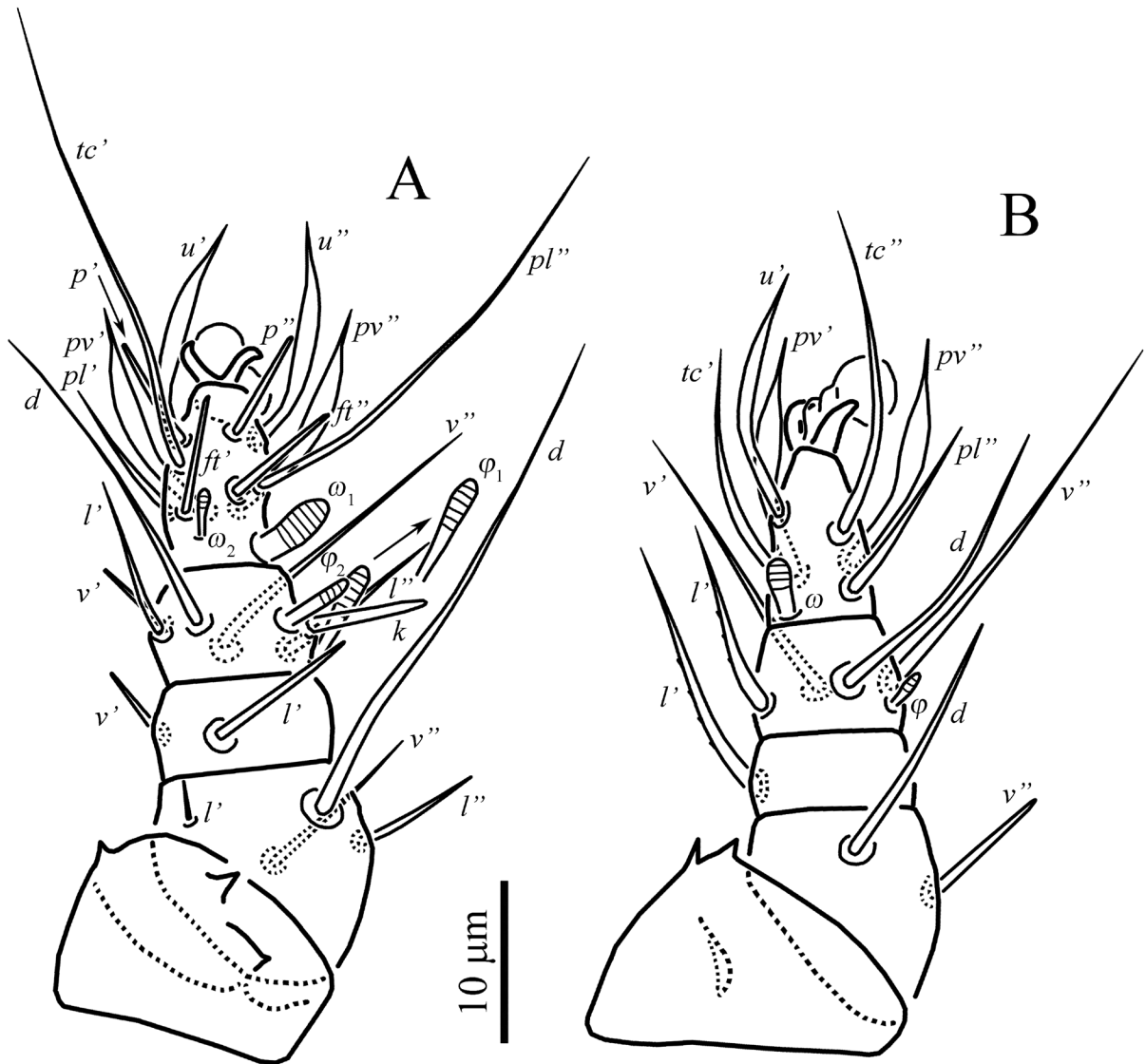


Fig. 2. *Pavania foliata* sp. n., female: A—right leg I in dorsal view, B—right leg II in dorsal view.

Setae sc_2 and c_1 pointed; other dorsal setae blunt-ended. Setae c_1 , c_2 , d , f and h_1 weakly barbed, other dorsal setae smooth. Tips of setae h_2 not club-shaped. 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 18 (17–18), v_2 5 (5–6), sc_2 49 (48–50), c_1 37 (35–37), c_2 26 (26–27), d 22 (21–22), e 13 (13–14), f 32 (32–34), h_1 14 (14–16), h_2 69 (66–70). Distances between setae: v_1-v_1 23 (23–24), v_2-v_2 32 (32–33), sc_2-sc_2 35 (34–35), c_1-c_1 29 (29), $d-d$ 55 (55–57), $e-e$ 46 (45–46), $f-f$ 37 (35–37), h_1-h_1 14 (13–14), h_1-h_2 7 (7–8).

Idiosomal venter (Figs. 1B, 4B). All ventral plates with very small sparsely distributed dimples

(Fig. 4B). All ventral setae smooth; setae $2c$ pointed, other ventral setae blunt-ended. Apodemes 1 (ap1) and apodemes 2 (ap2) well developed and joined with short and poorly visible prosternal apodeme (appr), sejugal apodeme represented by pair of small sclerites located posterolaterad setae $2c$; apodemes 3 (ap3) and 4 (ap4) well developed. Poststernal apodeme absent. Covisternal fields I–IV each with three pairs of setae. Lengths of ventral setae: $1a$ 7 (7–8), $1b$ 6 (6–7), $1c$ 5 (5–6), $2a$ 12 (12–14), $2b$ 6 (6–7), $2c$ 16 (16–20), $3a$ 11 (10–11), $3b$ 9 (9–10), $3c$ 12 (12–13), $4a$ 9 (9–10), $4b$ 13 (12–13), $4c$ 11 (11–13), ag 12 (12–13), g_1 3 (3–4), g_2 4 (4), ps 8 (8–9).

Legs (Figs. 2, 3). All legs subequal in length. Leg I (Fig. 2A). Setal formula: 0–4–2–6(2)–11(2). Tarsus

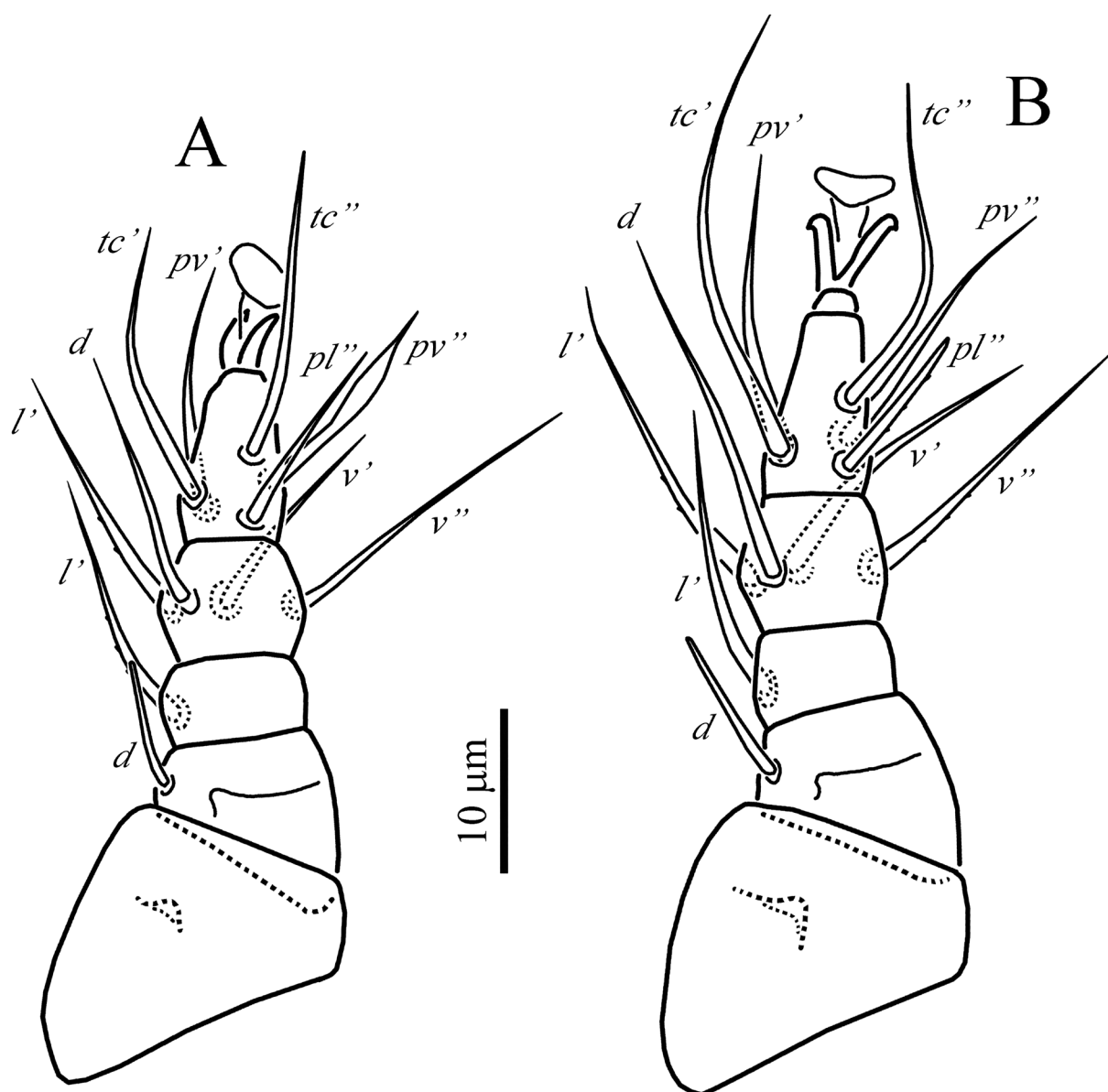


Fig. 3. *Pavana foliata* sp. n., female: A—right leg III in dorsal view, B—right leg IV in dorsal view.

with two small claws and semioval empodium. All leg setae smooth. Setae l' , l'' of femur, l' and v' of genu, k and v' of tibia blunt-ended; other leg setae (except eupathidia p' , p'' , ft' , ft'') pointed; setae (u) and (pv) of tarsus clearly foliate in distal half. Trochanter dorsolaterally with three projections. Tarsus I with ventrodiscal membranous flange. Lengths of solenidia ω_1 5 (5–6), ω_2 3 (3), φ_1 7 (7–8), φ_2 5 (5); solenidium φ_2 baculiform, solenidia ω_2 and φ_1 weakly clavate, solenidium ω_1 digitiform. Leg II (Fig. 2B). Setal formula: 0–2–1–4(1)–6(1). Tarsal claws simple, hooked; empodium large, extending beyond tips of claws. Solenidium ω 4 (4) digitiform, solenidium φ 3 (3) weakly clavate. Trochanter dorsolaterally with two projections. Setae d and v'' of femur weakly

blunt-ended, other setae pointed; setae u' and (pv) of tarsus clearly foliate in distal half. Setae l' of femur and genu weakly barbed, other setae smooth. Trochanter ventrally with short lobe. Leg III (Fig. 3A). Setal formula: 0–1–1–4–5. Claws and empodium of same shape as on tarsus II. Setae d of femur blunt-ended, other leg setae pointed. Setae l' of genu and tibia weakly barbed; other leg setae smooth; seta pv'' clearly foliate in distal half. Trochanter ventrally with short lobe. Leg IV (Fig. 3B). Setal formula: 0–1–1–4–5. Claws and empodium of same shape as on tarsus III. Setae d of femur and pl'' of tarsus blunt-ended, other leg setae pointed. Setae l' , v'' of tibia and pl'' of tarsus weakly barbed; other leg setae smooth. Trochanter ventrally with short lobe.

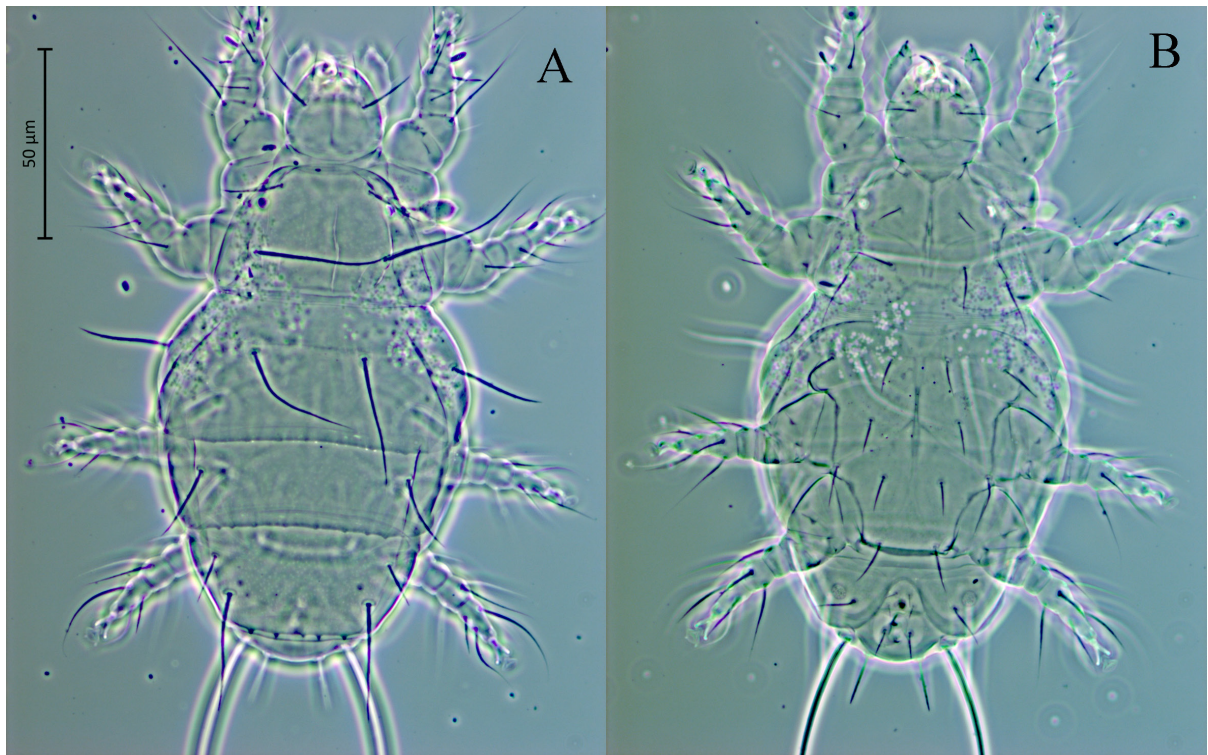


Fig. 4. Phase-contrast photomicrographs of *Pavania foliata* sp. n., female (holotype): A—dorsal view, B—ventral view.

Male unknown.

Type material. Female holotype, slide No. ZISP T-Dol-002, Russia, Astrakhan Province, Dosang locality, 46°54'56"N, 047°55'04"E, 12–14 July 2020, A. V. Frolov leg. on beetles of *Scarabaeus typhon* attracted to fresh horse dung and collected manually. Paratypes: 9 females, same data.

Type deposition. The holotype and two paratypes are deposited in the collection of the Zoological Institute of RAS, Saint Petersburg, Russia; other paratypes are deposited in the collection of the Tyumen State University Museum of Zoology, Tyumen, Russia.

Differential diagnosis. The new species is most similar to *Pavania lanceolata* Bahramian and Hajiqaanbar, 2015 in the presence of distinctly foliate setae (*u*), (*pv*) on tarsus I and *u'* and (*pv*) on tarsus II. The new species differs from *P. lanceolata* in: 1) having seta *tc''* of tarsus II not modified (vs. foliate), 2) setae *c*₁ being distinctly longer than *c*₂ (vs. *c*₁ being distinctly shorter than *c*₂), and 3) setae *2c* being clearly longer than *2b* (vs. setae *2b* and *2c* being subequal in length).

Etymology. The name of the new species is derived from Latin *foliata*, meaning *foliate* and refers to the presence of foliate setae on the legs.

Remarks. The host beetles belong to a large Palearctic/Paleotropical genus of dung beetles,

Scarabaeus Linnaeus. The adults of all species feed on herbivore dung. The larvae live in and feed on the brood balls, which the adults roll out of dung and bury in the soil. A few species of *Scarabaeus*, mostly from Iran, are known as hosts of *Pavania* spp. *Pavania fusiformis* Lombardini was described from *Scarabaeus sacer* Linnaeus from Tortona, Italy (Lombardini 1949). *Pavania kamalii* Hajiqaanbar and Khaustov was described from *Scarabaeus* sp. from North Khorasan Province, Iran (Hajiqaanbar and Khaustov 2010). *Pavania lanceolata* Bahramian and Hajiqaanbar was described from *Scarabaeus pius* (Illiger) from Southern Isfahan Province, Iran (Bahramian *et al.* 2015). *Pavania scarabaeophilus* Hajiqaanbar, Khaustov and Mortazavi was described from *Scarabaeus* sp. from Kerman Province, southern Iran (Hajiqaanbar, Khaustov and Mortazavi 2019). *Scarabaeus typhon* is recorded for the first time as a host of *Pavania* and heterostigmatic mites.

**Key to world species of *Pavania*
(based on Khaustov and Frolov 2020)**

1. Setae *sc*₁ absent 2
- Setae *sc*₁ present 9
2. Setae *2b* present 5
- Setae *2b* absent 3
3. Setae *1c* present, seta *d* of femur IV absent 4

- Setae $1c$ absent, seta d of femur IV present
.....*P. neotropica* Khaustov and Frolov, 2017
(Brazil)
- 4. Seta d of femur III present; setae d pointed,
distinctly longer than c_2
.....*P. semireducta* Khaustov and Frolov, 2020
(French Guiana)
- Seta d of femur III absent; setae d blunt-ended,
distinctly shorter than c_2
.....*P. brevicaudata* Khaustov and Frolov, 2020
(French Guiana)
- 5. Seta d absent on each femora III and IV..... 6
— Seta d present on each femora III and IV..... 7
- 6. All dorsal setae blunt-ended; setae c_2 only
slightly longer than c_1
.....*P. pusilla* Khaustov and Frolov, 2020
(French Guiana)
- Setae sc_2 , c_2 and d pointed; setae c_2 about three
times longer than c_1
.....*P. hansreiaphila* Khaustov and Frolov, 2020
(French Guiana)
- 7. 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 8
— 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)
- 8. Genu I with one seta (v'); dorsal idiosomal setae
smooth; setae c_1 longer than c_2 ; setae c_1 and d point-
ed...*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)
- 9. Setae sc_1 capitate..... 10
— Setae sc_1 seta-like.....
.....*P. setiformis* Loghmani and Hajiqanbar, 2013
(Iran)
- 10. Setae (u) and (pv) of tarsus I not lanceolate 14
— Setae (u) and (pv) of tarsus I lanceolate..... 11
- 11. Seta pv'' of tarsus III lanceolate..... 12
— Seta pv'' of tarsus III not modified..... 13
- 12. Seta tc'' of tarsus II lanceolate, setae c_2 dis-
tinctly longer than c_1
.....*P. lanceolata* Bahramian and Hajiqanbar, 2015
(Iran)
- Seta tc'' of tarsus II not modified, setae c_1 dis-
tinctly longer than c_2 *P. foliata* sp. n.
- 13. Setae c_1 , c_2 and d pointed; setae $2c$ distinctly
longer than $2a$ *P. kermaniensis* Hajiqanbar,
Khaustov and Mortazavi, 2019 (Iran)
- Setae c_1 , c_2 and d blunt-ended; setae $2c$ and $2a$
subequal*P. scarabaeophilus* Hajiqanbar,
Khaustov and Mortazavi, 2019 (Iran)
- 14. Coxal fields II with 3 pairs of setae 15
— Coxal fields II with 2 pairs of setae
.....*P. equisetosa* Mahunka, 1975 (Ghana)
- 15. Empodium on tarsi II–IV small, not reaching
beyond tips of claws..... 16
— Empodium on tarsi II–IV large, reaching beyond
tips of claws 17
- 16. Seta pv' on tarsi III and IV thickened, spiniform
and blunt-ended, solenidia on tibiae III and IV
absent*P. protracta* 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)
- 17. Setae h_2 less than 3.5 times longer than h_1 18
— Setae h_2 more than 3.5 times longer than h_123
- 18. Setae c_1 never reaching beyond bases of setae f ;
setae c_1 shorter than h_2 ; setae d shorter than h_2 ... 19
— 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)
- 19. Setae sc_2 subequal to distance between their
bases..... 21
— Setae sc_2 distinctly longer than distance between
their bases..... 20
- 20. Setae h_2 more than twice longer than h_1 ; posterior
margins of tergites C, D and EF with distinct tooth-
shaped projections.....*P. luisiae* Mahunka, 1974
(Ghana)
- Setae h_2 less than twice longer than h_1 ; poste-
rior margins of tergites C, D and EF with very weak
projections.....*P. megasolenidia* Hajiqanbar,
Khaustov and Mortazavi, 2019 (Iran)
- 21. Setae c_1 , d , e and f blunt-ended 22
— Setae c_1 , d , e and f pointed
.....*P. bembidii* Khaustov, 2005
(Russia: Crimea)
- 22. Setae h_1 almost three times longer than ps ,
solenidion ϕ_2 with rounded tip
.....*P. carabidophila* Khaustov, 2005
(Russia: Krasnodar Territory, Primorye Territory)
- Setae h_1 almost subequal with ps , solenidion ϕ_2
with attenuated tip.....
.....*P. africana* Khaustov and Frolov, 2018
(South Africa)

23. Setae h_2 more than six times longer than h_124
 — Setae h_2 less than six times longer than h_1 ...27
24. 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_125
 — 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)
25. 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.....26
 — 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, 1970 (Brazil)
26. 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.....27
27. Setae c_1 , d and f subequal and shorter than c_2 ...
*P. gazellatris* Katlav and Seeman, 2020 (Australia)
 — Setae c_1 , d , f and c_2 subequal
*P. simplex* Mahunka, 1973 (Ghana)
28. Empodium on tarsus I with rounded anterior margin; solenidia on tibiae III and IV absent....29
 — Empodium on tarsus I with 3 lobes; tibiae III and IV with tiny solenidion...*P. magowskii* Hajiqaanbar, Khaustov and Mortazavi, 2019 (Iran)
29. Setae f distinctly longer than e ; setae e and h_1 subequal30
 — Setae e and f subequal; setae e longer than h_1 ..
*P. tadjikistanica* Sevastianov, 1980 (Tadjikistan, Iran)
30. Setae $2c$ subequal with $2a$32
 — Setae $2c$ about two times longer than $2a$ 31
31. Setae c_1 distinctly longer than c_2 ; setae chb blunt-ended
*P. riparia* Sevastianov, 1980 (Ukraine, Slovakia)
 — Setae c_1 and c_2 subequal; setae chb pointed.....
*P. copridis* Khaustov and Frolov, 2020 (Borneo island)
32. Setae f more than two times longer than e33
 — Setae f less than 1.5 times longer than e
*P. khiavensis* Sobhi and Hajiqaanbar, 2017 (Iran)
33. 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)

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