Acarina 26 (1): 133–140

A NEW SPECIES OF *PAVANIA* (ACARI: HETEROSTIGMATA: DOLICHOCYBIDAE) ASSOCIATED WITH *FRANKENBERGERIUS GOMESI* (COLEOPTERA: SCARABAEIDAE) FROM SOUTH AFRICA

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ABSTRACT: A new species from South Africa, *Pavania africana* sp.n. (Acari: Heterostigmata: Dolichocybidae), phoretic on the dung beetle *Frankenbergerius gomesi* (Coleoptera: Scarabaeidae), is described. The key to species of the genus *Pavania* is also provided.

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

DOI: 10.21684/0132-8077-2018-26-1-133-140

INTRODUCTION

The family Dolichocybidae is a small group of early-derivative heterostigmatic mites that currently includes 2 subfamilies, 6 genera and 44 species (Hajiqanbar and Khaustov 2010; Rahiminejad *et al*. 2011; Zhang *et al*. 2011; Loghmani *et al*. 2013; Bahramian *et al*. 2015; Sobhi *et al*. 2017; Khaustov and Frolov 2017, 2018; Khaustov and Trach 2017; Khaustov 2017). Little is known about the behavior of dolichocybid mites, except that all of them are probably fungivorous (Rack 1967; Magowski 1988; Kaliszewski *et al*. 1995). Adult females of dolichocybid mites utilize many species of insects for phoresy. This phoretic association is predominantly with beetles, including species that belong to the following families: Bostrichidae, Carabidae, Curculionidae, Prostomidae, Scarabaeidae, Silvanidae, Tenebrionidae and Zopheridae (Sevastianov 1980; Magowski and Moser 1993; Khaustov 2005; Hajiqanbar and Khaustov 2010; Rahiminejad *et al*. 2011; Loghmani *et al*. 2013; Katlav *et al*. 2014, 2015; Bahramian *et al*. 2015; Mortazavi *et al*. 2015; Khaustov and Trach 2017; Khaustov 2017). However, *Formicomotes octipes* Sevastianov, 1980 and *Acanthomastix minor* Magowski and Moser, 1993 have been recorded in association with ants (Sevastianov 1980; Magowski and Moser 1993), while *Formicomotes brasiliensis* Khaustov and Frolov, 2018 is known to be associated with termites *Nasutitermes* sp. (Khaustov and Frolov 2018).

The African fauna of Dolichocybidae is poorly studied. Only six species of the genus *Pavania* Lombardini, 1948 have been described: *Pavania perhirsuta* Mahunka, 1973, *P. simplex* Mahunka, 1973, *P. luisiae* Mahunka, 1974, *P. endroedyi* Mahunka, 1975, *P. equisetosa* Mahunka, 1975 from Ghana (Mahunka 1973, 1974, 1975), and *P. tahanae* Sevastianov and Abo-Korah, 1985 from Egypt (Sevastianov and Abo-Korah 1985).

The genus *Pavania* Lombardini, 1949 includes 22 described species distributed in Europe, Asia, Africa and South America (Khaustov and Frolov 2017; Sobhi 2017). Khaustov and Frolov (2017) provided the latest key to 21 species of the genus *Pavania*. Most species of the genus *Pavania* are associated with dung beetles of the family Scarabaeidae, for which records exist for the genera *Scarabaeus*, *Onthophagus*, *Gymnopleurus*, *Canthon*, *Copris* and *Euoniticellus* (Sevastianov 1980; Hajiqanbar and Khaustov 2010; Katlav *et al*. 2015b; Loghmani *et al*. 2013; Khaustov and Frolov 2017).

During the study of mites associated with scarab beetles in South Africa, a new species of *Pavania* was recovered; it was phoretic on the scarab beetle species *Frankenbergerius gomesi* Ferreira. This is the first record of the genus *Pavania* and the family Dolichocybidae in South Africa. The aim of this paper is to describe this new species. Moreover, the updated key to species of the genus *Pavania* is provided.

The host species belongs to the genus that is endemic to South Africa and is comprised of seven small to medium-sized species (Frolov and Scholtz, 2005). Although *Frankenbergerius* Balthasar are classified as "true dung beetles" (Scarabaeinae), the beetles of this genus were never found in association with dung. *Frankenbergerius* belongs to the *Sarophorus* group within the genera—a lineage comprised of peculiar "dung beetles" that are morphologically and biologically distinct from other scarabaeines, with many members adapted to feeding on fruit bodies of higher fungi. As opposed to

two other members of the *Sarophorus* group, *Coptorhina* Hope and *Delopleurus* Erichson, which have been studied in more detail and are known to be an obligatory basidial mushroom eaters (Frolov *et al*. 2008, Frolov 2014), *Frankenbergerius* presumably retained a more ancestral lifestyle with no strict preference to mushrooms but rather to any rotten organic matter. These beetles are most frequently collected in dense vegetation in association with litter, decomposing plant matter, and carrion. However, several records imply a close association with mushrooms, at least in some species.

MATERIAL AND METHODS

The host beetles were collected in a native bush area approximately 20 km W of Nelspruit, Mpumalanga, South Africa, with the help of pitfall traps baited with carrion (chicken wings). The beetles were kept in 70% ethanol until dissecting. On the beetles' bodies, mites were found attached to the membrane that connects the 1st abdominal tergite to the metanotum. Collected mites were kept in 70–80% ethanol and later mounted in Hoyer's medium. Mite morphology was studied using a Carl Zeiss AxioImager A2 compound microscope with phase contrast and DIC objectives. Photomicrographs 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 for the holotype and one paratype (in parentheses) are given in micrometers (μm). For leg chaetotaxy, the number of solenidia is given in parentheses.

RESULTS

Family Dolichocybidae Mahunka, 1970
Genus *Pavania* Lombardini, 1949
Type species: *Pavania fusiformis*
Lombardini, 1949, by original designation.

Pavania africana sp.n.

(Figs. 1–4)

Description. *Female* (Figs. 1–4). Body weakly sclerotized. Length of idiosoma 100 (110), width 65 (69).

Gnathosoma (Fig. 1). Gnathosomal capsule, excluding palps, almost round, its length 19 (20), width 21 (21). Dorsally with two pairs of cheliceral setae (*cha, chb*). Setae *cha* 15 (16) blunt-ended, distinctly thicker than pointed *chb* 13 (14). Dorsal median apodeme well developed. Postpalpal setae (*pp*) rod-like, situated posterolaterally to setae *cha*. Venter of gnathosoma with one pair of smooth, pointed subcapitular setae *m* 11 (13). Palps freely articulated to gnathosomal capsule, with smooth setae *dFe* and *dGe* dorsolaterally, setae *dGe* 10 (11) pointed, more than two times longer than blunt-ended *dFe* 4 (4). Palps ventrally with two solenidia. Inner solenidion very small, about four times shorter than outer one. Palps terminated with well-developed tibial claw. Cheliceral stylets strong, curved. Pharynx not discernable.

Idiosomal dorsum (Figs. 1A, 4A). All dorsal shields with very small sparsely distributed dimples (Fig. 4A). Prodorsal shield with three pairs of setae (v_1, v_2, sc_2) and a pair of clavate, barbed trichobothria sc_1 with pointed apex (Fig. 4A). Setae sc_2 and c_2 pointed; other dorsal setae blunt-ended. Setae c_1, *d*, *e*, *f*, and h_1 weakly barbed, other dorsal setae smooth. Tips of setae h_2 thickened into tiny clubs. Cupules not evident. Posterior margins of tergites C, D, and EF with several very weak projections. Lengths of dorsal setae: v_1 21 (20), v_2 6 (8), sc_2 24 (25), c_1 17 (19), c_2 27 (27), *d* 16 (16), *e* 17 (18), *f* 16 (16), h_1 16 (16), h_2 43 (40). Distances between setae: v_1–v_1 17 (18), v_2–v_2 25 (25), sc_2–sc_2 31 (33), c_1–c_1 27 (27), *d*–*d* 33 (34), *e*–*e* 41 (42), *f*–*f* 27 (28), h_1–h_1 9 (10), h_1–h_2 7 (7).

Idiosomal venter (Figs. 1B, 4B). All ventral plates with very small sparsely distributed dimples (Fig. 4B). All ventral setae smooth; setae 2*a*, 3*c*, 4*c* pointed, other setae blunt-ended. Apodemes 1 (ap1) and apodemes 2 (ap2) well developed and joined with prosternal apodeme (appr), sejugal apodeme (apsej) well developed; apodemes 3 (ap3) and 4 (ap4) well developed. Poststernal apodeme absent. Coxal fields I–V each with three pairs of setae (Fig. 4B). Lengths of ventral setae: 1*a* 7 (6), 1*b* 6 (7), 1*c* 6 (6), 2*a* 11 (11), 2*b* 5 (5), 2*c* 12 (13), 3*a* 7 (8), 3*b* 8 (8), 3*c* 11 (13), 4*a* 9 (9), 4*b* 12 (11), 4*c* 12 (11), *ag* 8 (8), g_1 1 (2), g_2 1 (1), *ps* 14 (14).

Legs (Figs. 2, 3). All legs subequal in length. 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 *v*′ of genu, *k* and *v*′ of tibia blunt-ended; other leg setae (except eupathidia) pointed. Trochanter dorsolaterally with three projections. Tarsus I with ventrodistal membranous flange. Lengths of solenidia ω_1 7 (7), ω_2 3 (4), φ_1 7 (7), φ_2 5 (5); solenidion φ_2 weakly clavate with attenuated tip, solenidia ω_2 and φ_1 clavate, solenidion ω_1 finger-shaped. Leg II (Fig. 2B). Setal formula: 0–2–1–4(1)–6(1). Tarsal claws simple, hooked; empodium large. Solenidion ω 5 (4)

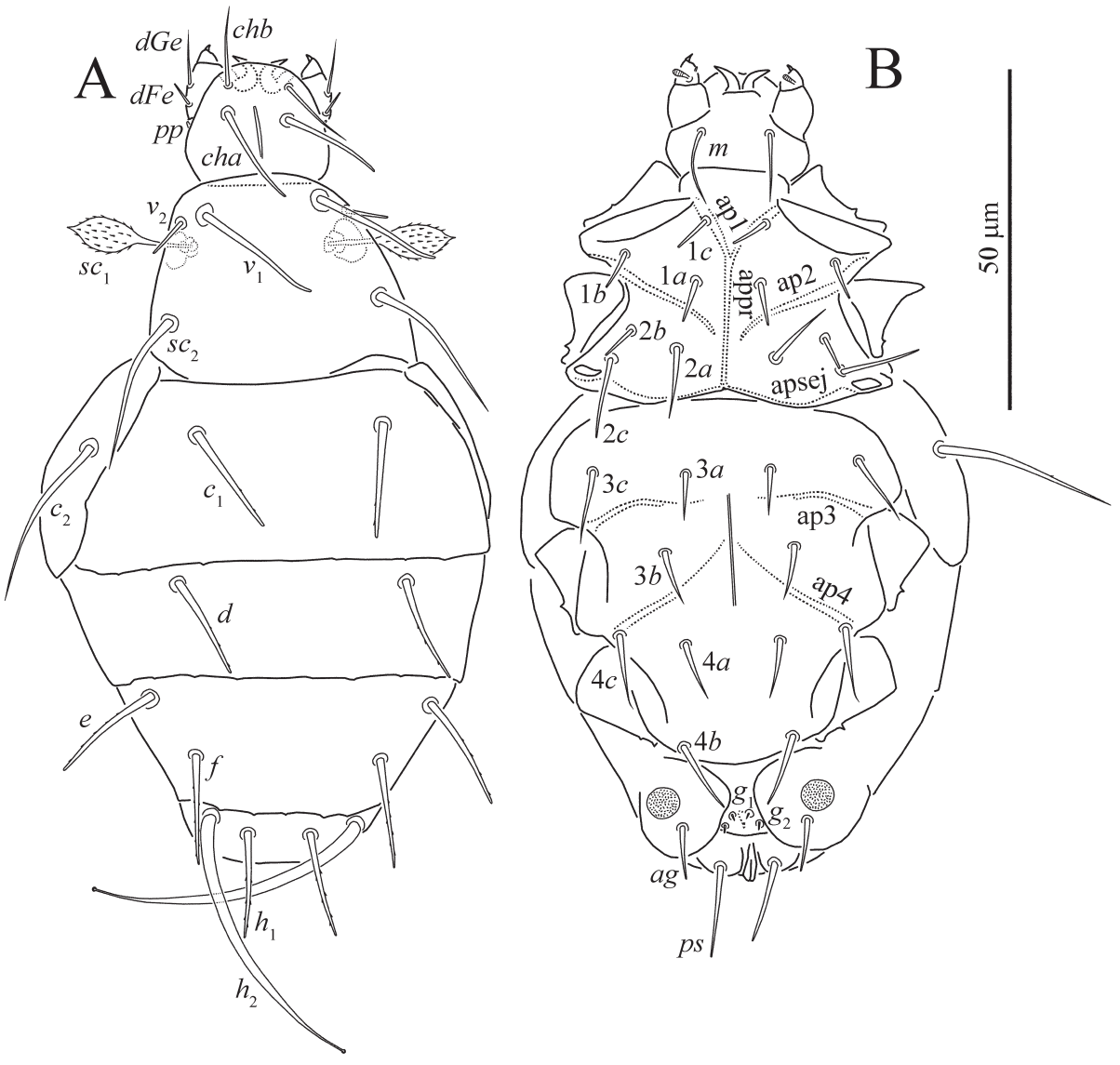

Fig. 1. *Pavania africana* sp.n., female: A—dorsum of the body, B—venter of the body. Legs omitted.

finger-shaped, solenidion φ 3 (4) clavate. Trochanter dorsolaterally with two projections. All setae pointed. Seta *l′* of genu weakly barbed, other setae smooth. 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 *d*, *l′* of tibia and *tc′* of tarsus weakly barbed; other leg setae smooth. 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 blunt-ended, other leg setae pointed. Setaa *tc′* of tarsus weakly barbed; other leg setae smooth.

Male unknown.

Type material. Female holotype, slide No. ZISP T-Dol-001, Republic of South Africa, Mpumalanga, Nelspruit Distr., Sodwala, bush, traps with carrion bait, 15.XII.2003, Frolov and Deschodt leg., under elytra of *Frankenbergerius gomesi* Ferreira; paratype: one female, same data.

Type deposition. The holotype and paratype are deposited in the collection of the Zoological Institute of RAS, Saint Petersburg, Russia.

Differential diagnosis. The new species is most similar to *Pavania carabidophila* Khaustov, 2005 by similar relative length and shape of dorsal idiosomal setae and the same legs setation. The new species differs from *P. carabidophila* by much longer pseudanal setae, which almost subequal to setae h_1 (vs. setae h_1 almost three times longer than *ps* in *P. carabidophila*), by solenidion φ_2 with attenuated tip (vs. rounded in *P. carabidophila*), and by shorter solenidion ω_1 7 (vs. solenidion ω_1 11 in *P. carabidophila*).

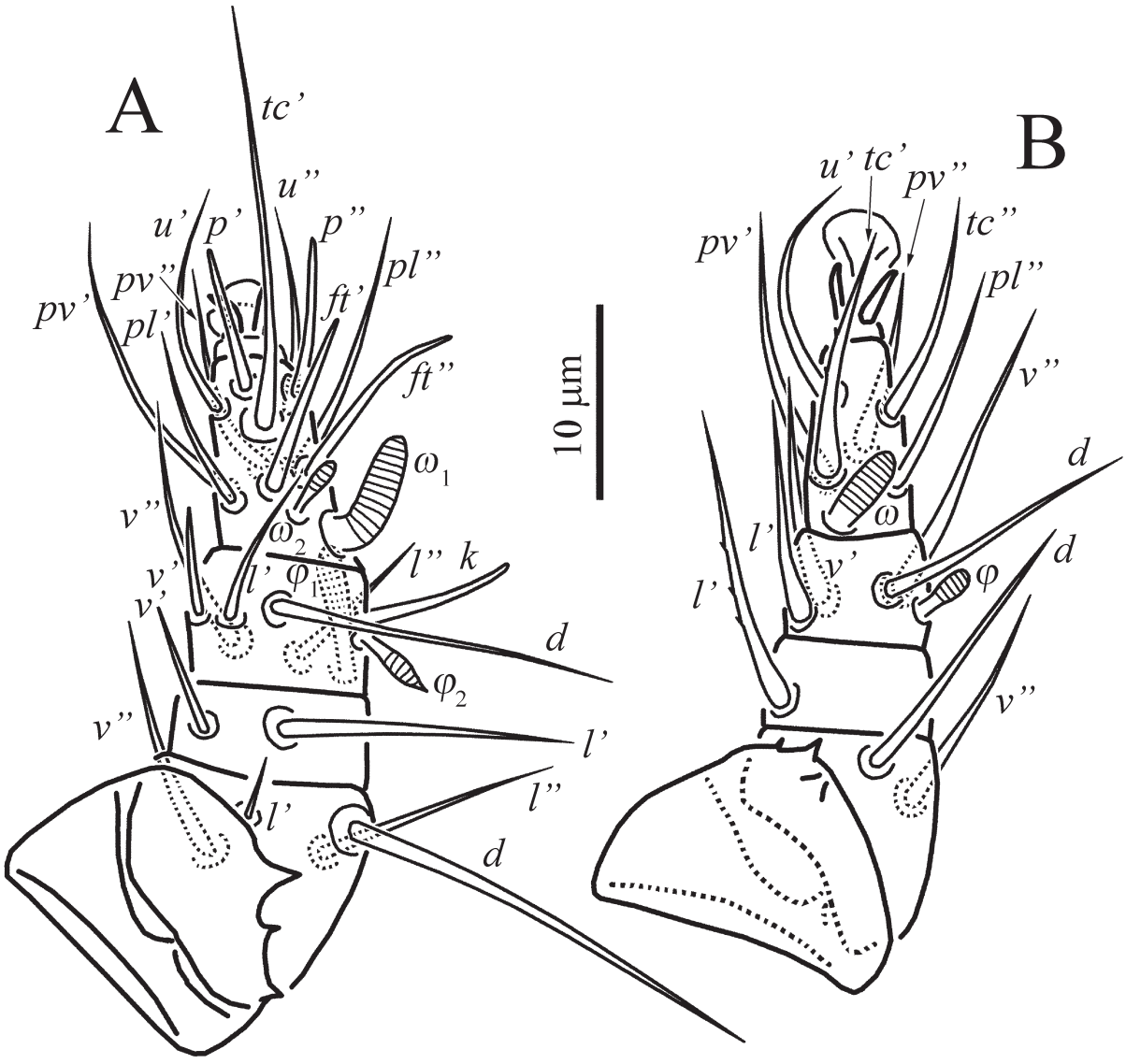

Fig. 2. *Pavania africana* sp.n., female: A—right leg I in dorsal view, B—right leg II in dorsal view.

Etymology. The name of the new species refers to its distribution in Africa.

Key to world species of *Pavania* (based on Khaustov and Frolov 2017)

1. Setae sc_1 absent 2
— Setae sc_1 present 5
2. Setae 1*c* and 2*c* present 3
— Setae 1*c* and 2*c* 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

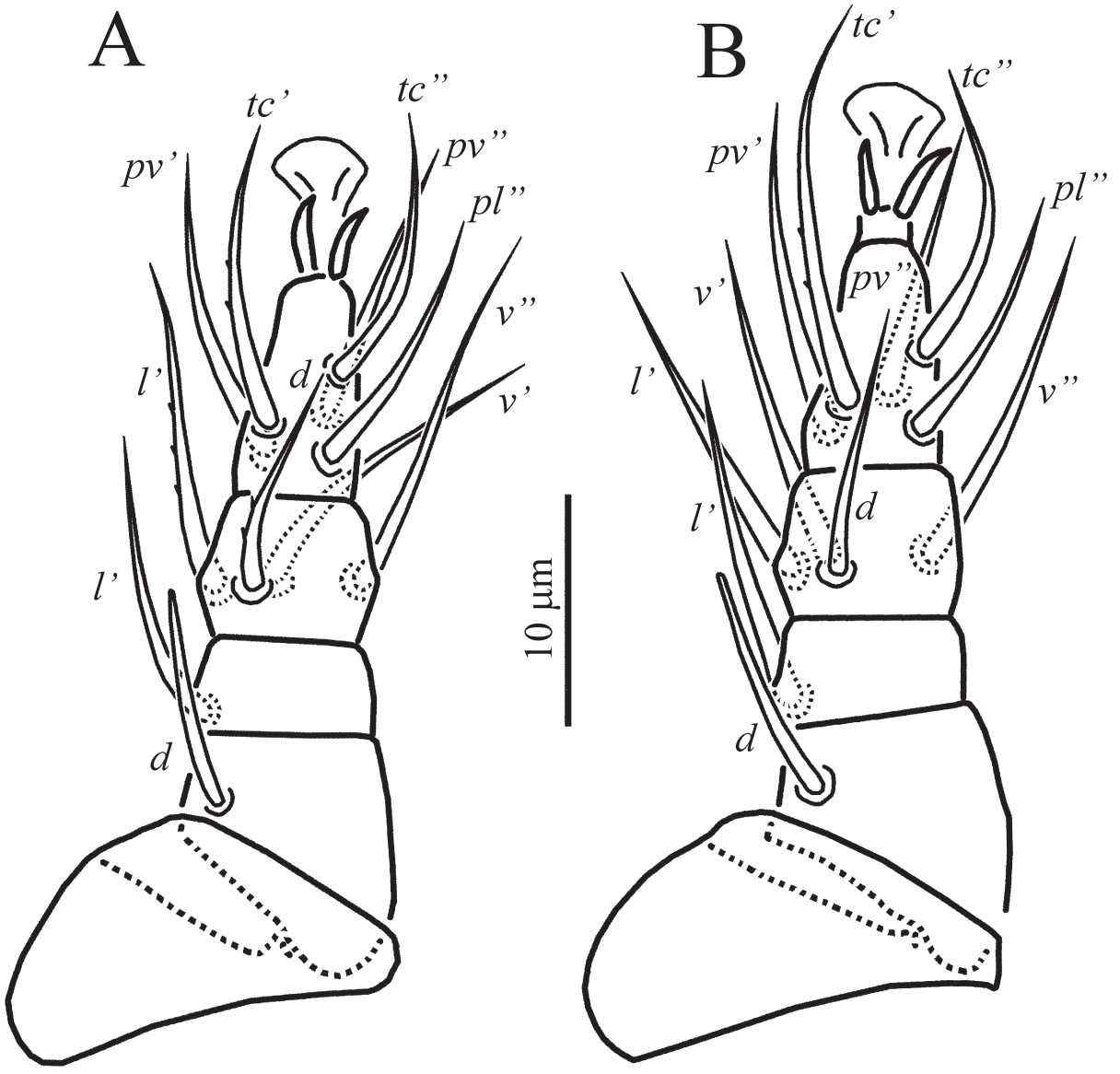

Fig. 3. *Pavania africana* sp.n., female: A—right leg III in dorsal view, B—right leg IV in dorsal view.

— Setae (*u*) and (*pv*) of tarsus I lanceolate..... ....*P. lanceolata* Bahramian and Hajiqanbar, 2015 (Iran)

7. Setae h_2 less than 3.5 times longer than h_1 8
— Setae h_2 more than 3.5 times longer than h_1 .. 16

8. Setae c_1 never reaching beyond bases of setae *f*; setae c_1 shorter than h_2; setae *d* shorter than h_2 ... 9
— 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)

9. Setae h_1 longer than or subequal to *d*, *e* and *f*....10
— Setae h_1 shorter than *d*, *e* and *f*..... 15

10. Setae h_1 shorter than sc_2; setae sc_2 longer than or subequal to distance between their bases; seta *f* inserted posteriorly to seta *e* 11
— Setae h_1 longer than sc_2; setae sc_2 distinctly shorter than distance between their bases; seta *e* inserted at the same level as seta *f* .... *P. equisetosa* Mahunka, 1975 (Ghana)

11. Setae sc_2 distinctly longer than distance between their bases..... 12
— Setae sc_2 subequal to distance between their bases..... 13

12. Setae c_1 longer than c_2; setae h_1 longer than *e*; setae h_1 and v_1 subequal..... ...*P. riparia* Sevastianov, 1980 (Ukraine, Slovakia)
— Setae c_2 longer than c_1; setae h_1 and *e* subequal; setae h_1 longer than v_1..... .....*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 (Russia: Crimea)

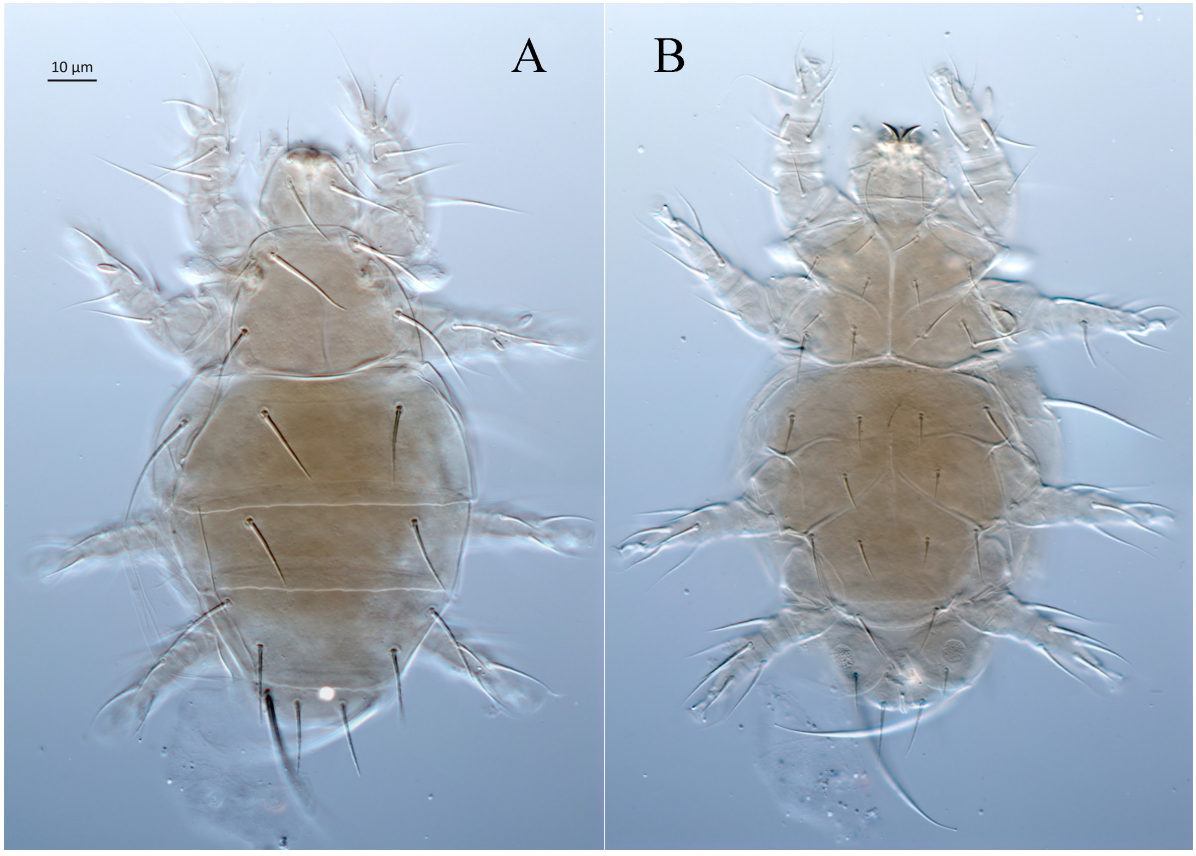

Fig. 4. DIC Photomicrographs of *Pavania africana* sp.n., female (holotype): A—dorsal view, B—ventral view.

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* sp.n. (South Africa)
15. Setae h_2 more than twice as long as h_1; setae *e* and *f* subequal and both longer than *d*; setae *f* distinctly longer than c_1 .... *P. tahanae* Sevastianov and Abo-Korah, 1985 (Egypt)
— Setae h_2 less than twice as long as h_1; setae *e* and *d* subequal and both longer than *f*; setae c_1 and *f* subequal ..... *P. protracta* Sevastianov, 1980 (Russia, Turkmenistan, Iran)
16. Setae h_2 more than six times longer than h_1.. 17
— Setae h_2 less than six times longer than h_1 ...20
17. 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 18
— 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)
18. 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..... 19
— 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)
19. Setae 2*a* as long as 2*c* and both longer than c_1, *d* and *f*; setae *m* protruding beyond anterior border of gnathosoma .... *P. elongata* Hajiqanbar and Khaustov, 2010 (Iran)
— Setae 2*a* longer than 2*c* and both shorter than c_1, *d* and *f*; setae *m* never protruding beyond anterior border of gnathosoma..... ..... *P. simplex* Mahunka, 1973 (Ghana)
20. Setae *f* distinctly longer than *e*; setae *e* and h_1 subequal; setae on coxal fields II not subequal. 21
— Setae *e* and *f* subequal; setae *e* longer than h_1; setae on coxal fields II subequal ....*P. tadjikistanica* Sevastianov, 1980 (Tadjikistan, Iran)
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 Hajiqanbar, 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* Hajiqanbar 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)

ACKNOWLEDGEMENTS

We are thankful to Clarke Scholtz and Christian Deschodt (University of Pretoria, Pretoria, South Africa) for the opportunity to collect the host beetles and for logistical support.

The study was supported by the Russian Foundation for Basic Research (RFBR), research project No. 18-04-01092A.

REFERENCES

Bahramian, M., Hajiqanbar, H. and Talebi, A.A. 2015. Two heterostigmatic mite species (Acari: Dolichocybidae, Podapolipidae) associated with *Scarabaeus pius* (Coleoptera: Scarabaeidae) from Iran. *Acta Zoologica Academiae Scientiarum Hungaricae*, 61: 25–32.

Frolov, A.V. 2014. Revision of the genus *Delopleurus* Erichson (Coleoptera: Scarabaeidae: Scarabaeinae) with description of new species from Africa. *Journal of Natural History*, 49: 129–154.

Frolov, A.V. and Scholtz, C.H. 2005. Revision of the southern African genus *Frankenbergerius* Balthasar with description of new taxa (Coleoptera: Scarabaeidae: Scarabaeinae). *Journal of Natural History*, 39: 2355–2377.

Frolov, A.V., Akhmetova, L.A. and Scholtz, C.H. 2008. Revision of the obligate mushroom-feeding African "dung beetle" genus *Coptorhina* Hope (Coleoptera: Scarabaeidae: Scarabaeinae). *Journal of Natural History*, 42: 1477–1508.

Grandjean, F. 1944. Observations sur les Acariens de la famille des Stigmaeidae. *Archives des Sciences Physiques et Naturelles*, 26: 103–131.

Hajiqanbar, H. and Khaustov, A.A. 2010. A new species group and five new species of the genus *Pavania* (Acari: Dolichocybidae) associated with insects, with notes on leg chaetotaxy and the distribution of genera. *European Journal of Entomology*, 107: 441–453.

Kaliszewski, M., Athias-Binche, F. and Lindquist, E.E. 1995. Parasitism and parasitoidism in Tarsonemina (Acari: Heterostigmata) and evolutionary considerations. *Advances in Parasitology*, 35: 335–367.

Katlav, A., Hajiqanbar, H. and Talebi, A.A. 2014. First record of the genus *Acanthomastix* Mahunka, 1972 (Acari: Dolichocybidae) from Asia, with the description of a new species. *International Journal of Acarology*, 40: 7–14.

Katlav, A., Hajiqanbar, H. and Talebi, A.A. 2015. A contribution to the knowledge of heterostigmatic mites (Acari: Prostigmata) in western Mazandaran Province, Northern Iran. *Acarologia*, 55: 311–320.

Khaustov, A.A. 2005. Two new mite species of the genus *Pavania* (Heterostigmata, Dolichocybidae) from the Crimea and southern European Russia. *Zoologicheskiy Zhurnal*, 84: 1515–1521. [In Russian]

Khaustov, A.A. 2017. A new species of *Dolichocybe* (Acari: Dolichocybidae) from Western Siberia, Russia. *Systematic and Applied Acarology*, 22: 1678–1687.

Khaustov, A.A. and Frolov, A.V. 2017. New species of heterostigmatic mites (Acari: Heterostigmata: Athyreacaridae, Dolichocybidae, Pygmephoridae) associated with scarab beetles (Coleoptera: Geotrupidae, Scarabaeidae) from Brazil. *Zootaxa*, 4294: 501–521.

Khaustov, A.A. and Frolov, A.V. 2018. A new species of *Formicomotes* Sevastianov (Acari: Heterostigmata: Dolichocybidae) associated with termites (Isoptera: Termitidae) from Brazil, with redescription of *Formicomotes octipes* Sevastianov, 1980. *Zootaxa*, 4382: 393–400.

Khaustov, A.A. and Trach V.A. 2017. On the phoresy and morphology of *Pavania carabidophila* Khaustov, 2005 (Acari: Dolichocybidae). *Acarina*, 25 (1): 25–28.

Lindquist, E.E. 1986. The world genera of Tarsonemidae (Acari: Heterostigmata): a morphological, phylogenetic, and systematic revision, with a reclassification of family-group taxa in the Heterostigmata. *Memoirs of Entomological Society of Canada*, 118: 1–517.

Loghmani, A., Hajiqanbar, H. and Talebi, A. 2013. A new species group and species of the genus *Pavania* (Acari: Dolichocybidae), phoretic on *Onthophagus vitulus* (Coleoptera: Scarabaeidae) from Iran. *Zootaxa*, 3693: 320–328.

Magowski, W.Ł. 1988. Description of a new species of *Formicomotes* Sevastianov, 1980 (Acari: Dolichocybidae) with notes on the female dimorphism within this genus. *Mitteilungen aus dem Hamburgischen Zoologischen Museum und Institut*, 85: 163–182.

Magowski, W.Ł. and Moser, J.C. 1993. Three new species of the genus *Acanthomastix* Mahunka, 1972 from United States and Poland (Acari: Dolichocybidae). *Entomologische Mitteilungen aus dem Zoologischen Museum Hamburg*, 11 (147): 1–20.

Mahunka, S. 1973. Auf Insecten lebende Milben (Acari: Acarida, Tarsonemida) aus Africa II. Acta *Zoologica Academiae Scientiarum Hungaricae*, 19: 289–337.

Mahunka, S. 1974. Auf Insecten lebende Milben (Acari: Acarida, Tarsonemida) aus Africa IV. *Acta Zoologica Academiae Scientiarum Hungaricae*, 20: 367–402.

Mahunka, S. 1975. Auf Insecten lebende Milben (Acari: Acarida und Tarsonemida) aus Africa V. *Acta Zoologica Academiae Scientiarum Hungaricae*, 21: 39–72.

Mortazavi, A., Hajiqanbar, H. and Kamali, K. 2015. A new species of the family Dolichocybidae Mahunka, 1970 (Acari: Heterostigmata) associated with *Sinoxylon pugnax* Lesne (Coleoptera: Bostrichidae) from Iran. *Systematic and Applied Acarology*, 20: 441–448.

Rack, V.G. 1967. Untersuchungen über die biologie von *Dolichocybe* Krantz, 1957 und beschreibung von zwei neuen Arten (Acarina, Pyemotidae). *Mitteilungen aus dem Hamburgischen Zoologischen Museum und Institut*, 64: 29–42.

Rahiminejad, V., Hajiqanbar, H. and Fathipour, Y. 2011. Redefinition of the genus *Dolichocybe* (Acari: Dolichocybidae), with description of two new species associated with insects. *Annals of the Entomological Society of America*, 104: 627–635.

Sevastianov, V.D. 1980. New taxa of mites of the family Dolichocybidae (Trombidiformes, Tarsonemina) and phylogenetic relations of its subfamilies. *Zoologicheskiy Zhurnal*, 59: 1453–1462. [In Russian]

Sevastianov, V.D. and Abo-Korah, S.M. 1985. New mite species of the cohort Tarsonemina (Trombidiformes) from agrocoenoses of Egypt. *Vestnik Zoologii*, 19(4): 35-41. [In Russian]

Sobhi, M., Hajiqanbar, H. and Mortazavi, A. 2017. New species and records of heterostigmatic mites (Acari: Prostigmata: Heterostigmata) phoretic on scarabaeid dung beetles (Coleoptera: Scarabaeidae) from northwestern Iran. *Zootaxa*, 4276: 427–434.

Zhang, Z.-Q., Fan, Q.-H., Pesic, V., Smit, H., Bochkov, A.V., Khaustov, A.A., Baker, A., Wohltmann, A., Wen, T.-H., Amrine, J.W., Beron, P., Lin, J.-Z., Gabrys, G. and Husband, R. 2011. Order Trombidiformes Reuter, 1909. *In*: Z.-Q. Zhang (Ed.). *Animal biodiversity: an outline of higher-level classification and survey of taxonomic richness*. *Zootaxa*, 3148: 129–138.