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# Two new species of microdispid mites (Acari: Heterostigmata: Pygmephoroidea) associated with *Lucanus ibericus* (Coleoptera: Lucanidae)

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**Original research**

**ABSTRACT**

Two new species of the microdispid mites (Acari: Microdispidae) phoretic on *Lucanus ibericus* are described from Iran: *Premicrodispus gorganiensis* Rahiminejad & Seyedein **sp. nov.** and *Neomicrodispus lucani* Rahiminejad & Seyedein **sp. nov.** The mites were collected from forests with Hornbeam trees (*Carpinus* spp.) and Oak trees (*Quercus* spp.) in Gorgan, northern Iran. The distribution of the heterostigmatic mites on lucanid beetles is reviewed. Also, a key to species of the *Neomicrodispus* is provided.

**Keywords** Microdispidae; forest; fauna; Insect; phoresy; stag beetle; Iran

**Zoobank** http://zoobank.org/7FD7D3DB-1488-4C29-9519-AD8B6262D005

## Introduction

Although many of heterostigmatic mites (Acari: Prostigmata) prefer to be free-living, almost all of them take advantage of phoresy in some periods of their life to distribute and establish their populations (Hermann *et al.* 1970; Kaliszewski *et al.* 1995). Heterostigmata have a wide range of associations with arthropods, including predation, parasitism and mutualism; so that different host–symbiont interactions could lead to speciation (Okabe *et al.* 2012). More than 2000 described species in eight superfamilies are classified in Heterostigmata (Walter *et al.* 2009; Zhang *et al.* 2011). The four families Microdispidae, Scutacaridae, Neopygmephoridae and Pygmephoridae constitute the largest superfamily in Heterostigmata (Acari: Prostigmata), known as Pygmephoroidea (Khaustov 2004). The least diverse family in the superfamily, Microdispidae Cross, 1965, includes 28 described genera and more than 120 species (Khaustov and Minor 2020) that are mostly fungivorous, inhabiting soil, litter, mosses or decaying plant material, and some are in relation with various arthropods by phoresy or parastitism with the most prevalent hosts for this family being beetles and ants (Kaliszewski *et al.* 1995; Walter *et al.* 2009; Hajiqanbar *et al.* 2012a; Rahiminejad et al. 2015a; Khaustov and Minor 2020). The taxonomic placement of many microdispid mites was as doubtful, hereupon, Khaustov (2018) provided a key for genera. There are various reports about microdispid mites in Iran (Rahiminejad *et al.* 2010, 2015a; Hajiqanbar *et al.* 2012a, b; Hosseininaveh *et al.* 2013, 2015; Loghmani *et al.* 2014a, b; Katlav *et al.* 2015; Hajiqanbar and Hasseininaveh 2014; Filekesh *et al.* 2014; Abbasi-Moghadam *et al.* 2014; Badoodam *et al.* 2015; Azhari *et al.* 2018; Hajiqanbar and Arjomandi 2019; Rahiminejad and Hajiqanbar 2020). Until now, six genera and 23 species have been recorded from Iran (Hajiqanbar and Sobhi 2018).

A very diverse group of scarabaeoid beetles (Coleoptera: Scarabaeoidea), including Lucanidae, could be identified as hosts for microdispid mites (Kaliszewski *et al.* 1995; Walter

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*et al.* 2009; Hajiqanbar and Sobhi 2018; Khaustov and Frolov 2018). Lucanid beetles feed on honeydew or on sap from leaves and trees in their adult stage and their larvae breed in or beneath the decaying wood of logs or stumps (Holloway 2007).

During a survey on mite fauna of the cohort Heterostigmata associated with insects in Golestan province, Northern Iran, in summer 2019, two new species of the genera *Premicrodispus* and *Neomicrodispus* phoretic on beetles (Coleoptera: Lucanidae) were collected by light trap. The aim of this paper is to describe these new species. In addition, the representatives of the Heterostigmata associated with lucanid beetles are reviewed. A key for species of the genus *Neomicrodispus* is provided as well.

## Materials and methods

Host beetles were captured by light trap in Alangdareh Forest, in Golestan province, northern Iran, during summer 2019. Mite specimens were cleared in lactophenol and mounted in Hoyer's medium. The morphology of the mites was studied by a light microscope with phase contrast illumination (Olympus BX51, Tokyo. Japan). The terminology of the idiosoma and legs follows that of Lindquist (1986), the designation of cheliceral setae follows Grandjean 1947 and the nomenclature of subcapitular setae follows Grandjean (1944). All measurements in the descriptions are given in micrometers (μm) for the holotype and four paratypes (in parentheses). Details of geographical position were recorded using a global positioning system (GPS model: eTrex).

The beetle host was identified by the help of a key for Iranian lucanid beetles provided by Bartolozzi *et al.* (2014).

The type materials of the new species and host beetles are deposited in the Arthropods Collection, Acari section, Department of Plant Protection, Faculty of Plant Production, Gorgan University of Agricultural Science and Natural Resource, Golestan, Iran.

## Systematics

### Family Microdispidae Cross, 1965

### Genus *Premicrodispus* Cross, 1965

Type species: *Microdispus (Premicrodispus) chandleri* Cross, 1965, by original designation

Three subgenera, *Premicrodispus* Cross, 1965, *Premicrodispulus* Khaustov & Chydyrov, 2010, *Premicrodispoides* Khaustov & Maslov, 2013, and about 31 species constitute the cosmopolitan genus *Premicrodispus* (Khaustov and Minor 2020). Khaustov (2006) provided the diagnosis of the genus.

#### *Premicrodispus gorganiensis* Rahiminejad & Seyedein sp. nov.

Zoobank: 686F49BC-B7F0-409F-A406-96217D5A4CCA

(Figures 1–3)

**Diagnosis** — The new species is characterized by posterior margin of tergites C and D with a distinct median incision; setae *d*, *e* and *f* blunt-ended; setae *e* not associated with ridge; distance *d–d* about 1.5 times longer than seta *d*; seta $h_1$ less than 1.5 times longer than $h_2$; seta 4*a* absent and seta $ps_2$ present; tibiotarsus I with four solenidia; all dorsal setae extending posterior border of their tergites; cupuli *ia* and *ih* rhombic.

**Description** — **Female**. Length of body (including gnathosoma) 236 (229–241), width 121 (118–125).

Gnathosoma (Figs 1A & B)– gnathosomal capsule elongated, dorsally with one pair of cheliceral setae, *cha* 11 (10–11). Palpal femorogenu with subequal setae *dFe* 5 (5–6) and *dGe* 7 (6–8). Gnathosoma ventrally with one pair of subcapitular setae *m* 11 (10–11). Pharyngeal

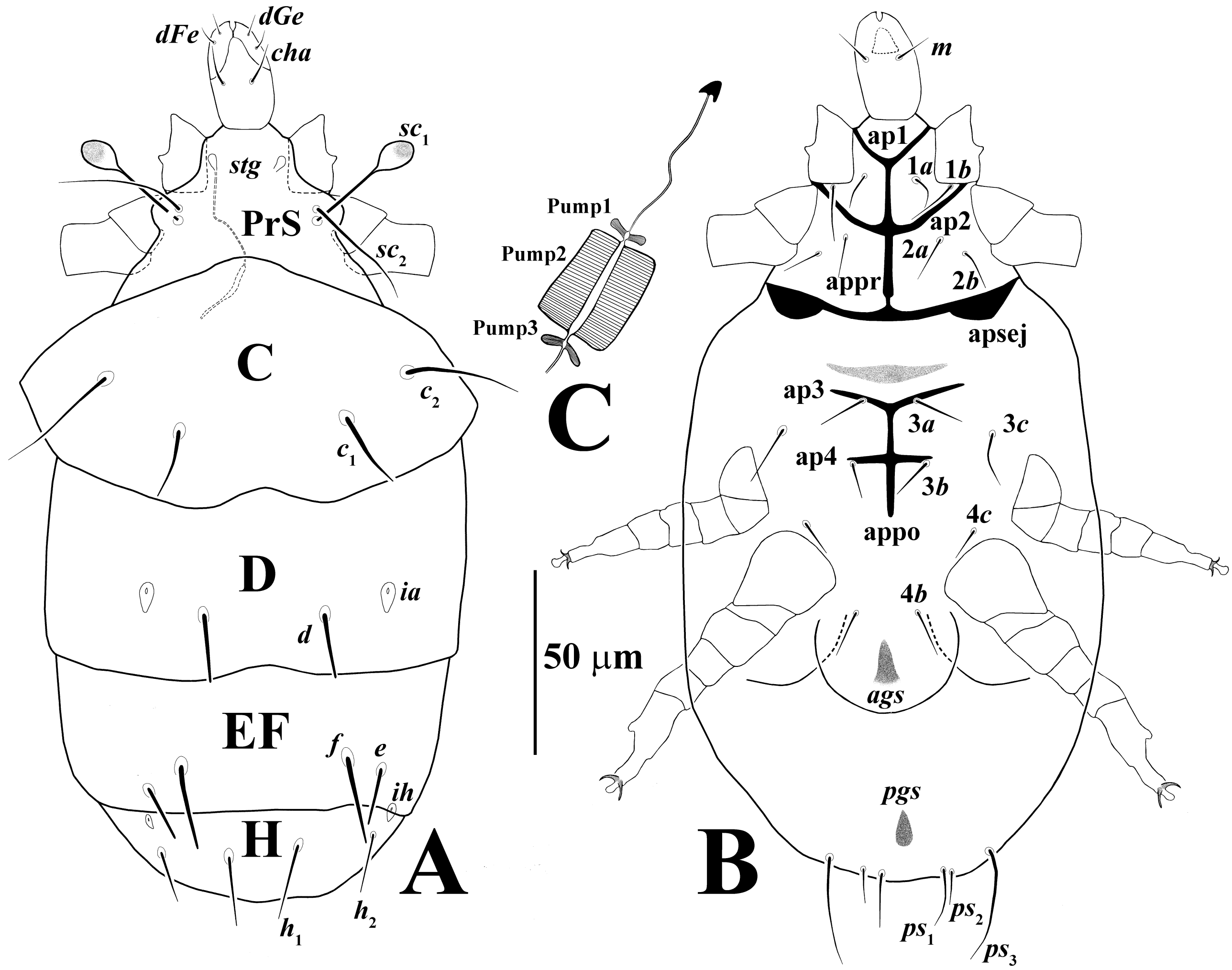


**Figure 1** *Premicrodispus gorganiensis* **sp. nov.**, female. A – body in dorsal view, B – body in ventral view, C – pharyngeal system.

system well sclerotized (Fig. 1C), including three pumps, pump 2 developed with transversely striate and pumps 1 and 3 vestigial.

Idiosomal dorsum (Fig. 1A) – Body elliptic, all tergites smooth; stigmata oval and associated with thin tracheal trunks; all dorsal setae smooth; setae *d*, *e* and *f* blunt-ended, other dorsal setae pointed; prodorsal shield with elliptic stigmata, trichobothria with long stem, clavate and sparsely barbed, setae $sc_2$ 36 (32–37); tergite C with two pairs of setae $c_1$ 21 (20–24) and $c_2$ 32 (30–35), setae $c_2$ longer than $c_1$, posterior border of tergites C and D with distinct median incision; tergite D with setae *d* 18 (17–19), and cupuli *ia* rhombic and situated postero-laterad setae *d*; tergite EF with two pairs of setae *e* 14 (13–14) and *f* 23 (21–24), bases of setae *e* not associated with linear ridge; tergite H with setae $h_1$ 21 (20–22), $h_2$ 16 (15–16), cupuli *ih* rhombic and situated posteriad setae $h_2$; distance $h_1$–$h_1$ subequal to $h_1$–$h_2$; all dorsal setae reach to posterior border of their tergites. Distances between dorsal setae: $sc_2$–$sc_2$ 37 (35–39), $c_1$–$c_1$ 45 (41–48), $c_2$–$c_2$ 80 (79–83), $c_1$–$c_2$ 22 (20–23), *d*–*d* 31 (30–32), *e*–*e* 80 (76–84), *e*–*f* 11 (10–12), *f*–*f* 45 (44–48), $h_1$–$h_1$ 18 (18–20), $h_2$–$h_2$ 57 (54–58), $h_1$–$h_2$ 19 (19–20).

Idiosomal venter (Fig. 1B) – Apodemes 1 (ap1) and 2 (ap2) well developed and joined with prosternal apodeme (appr), sejugal apodeme (apsej) thick, well sclerotized and joined with appr; all ventral plates smooth; all ventral setae pointed and smooth; setae 4*a* absent; anterior margin of posterior sternal plate straight, without lobe; apodemes 3 (ap3) extending beyond bases of setae 3*a*; apodemes 4 (ap4) short and reaching to bases of setae 3*b*; apodemes 5 absent; posterior margin of posterior sternal plate tripartite; coxal field I with setae 1*a* 11 (11–12), 1*b* 16 (15–17); coxal field II with setae 2*a* 11 (11–12), 2*b* 11 (10–12); coxal field III with setae 3*a* 14 (13–14), 3*b* 11 (9–11), 3*c* 16 (16–18); coxal field IV with setae 4*b* 14 (13–15) and 4*c* 11 (11–12), setae 1*b* and 3*c* subequal and longest on idiosomal venter; pseudanal plate with setae $ps_1$ 17 (16–18), $ps_2$ 9 (8–9) and $ps_3$ 31 (30–34).

Legs (Figs 2, 3) – Leg I (Fig. 2A). Thinner and shorter than other legs. Setal formula: (number of solenidia in parentheses): Tr1–Fe3–Ge4–TiTa15 (4). Tibiotarsus I with seta *k* and five other blunt-ended eupathidial setae (*p″*, *tc′*, *tc″*, *ft′* and *ft″*), solenidion $\omega_1$ 6 (6–7) digitiform, solenidion $\omega_2$ 3 (3–3) baculiform, solenidion $\varphi_1$ 3 (2–3) weakly clavate, $\varphi_2$ 3 (2–3) baculiform, setae *pl′* and *pl″* whip-like; genu with three barbed setae and seta *l″* smooth; femur with setae *d*, *v″* and *l′* subequal. Leg II (Fig. 1B). Setal formula: Tr1–Fe3–Ge3–Ti4(1)–Ta6(1).

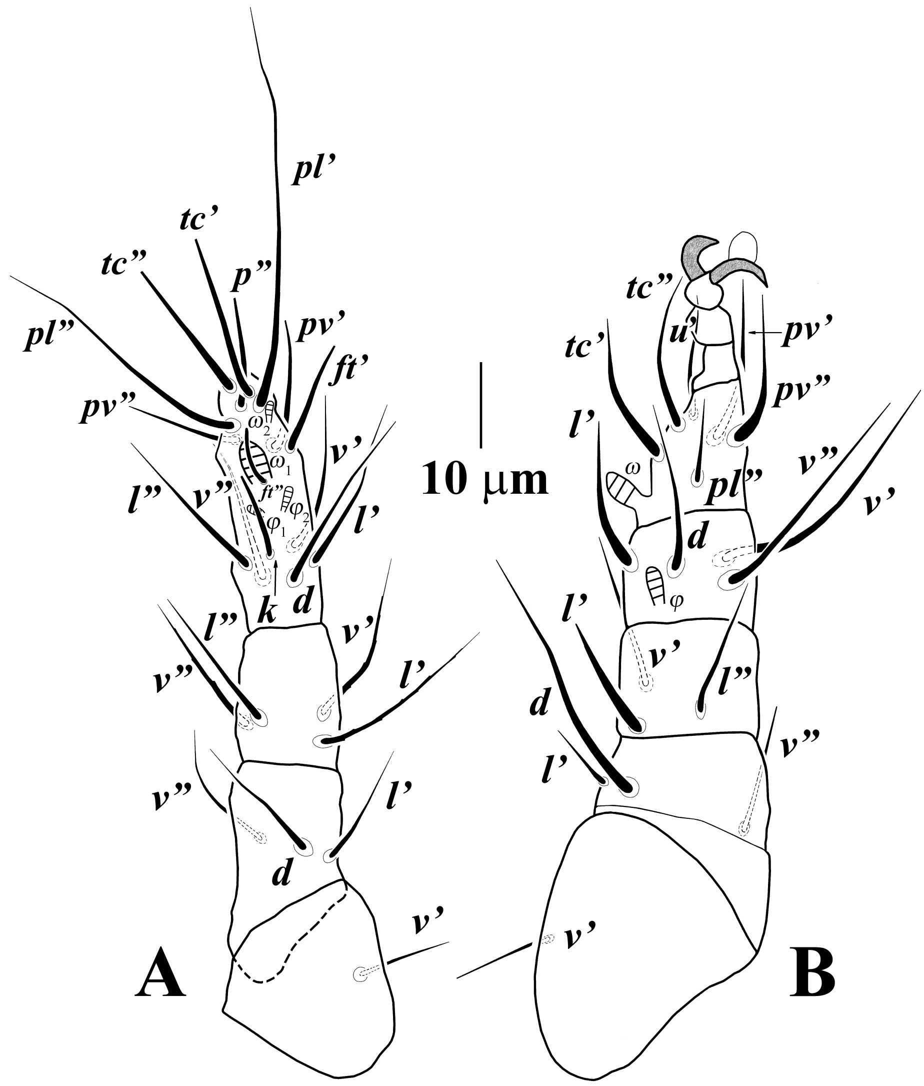

**Figure 2** *Premicrodispus gorganiensis* **sp. nov.**, female. A – leg I, B – leg II.

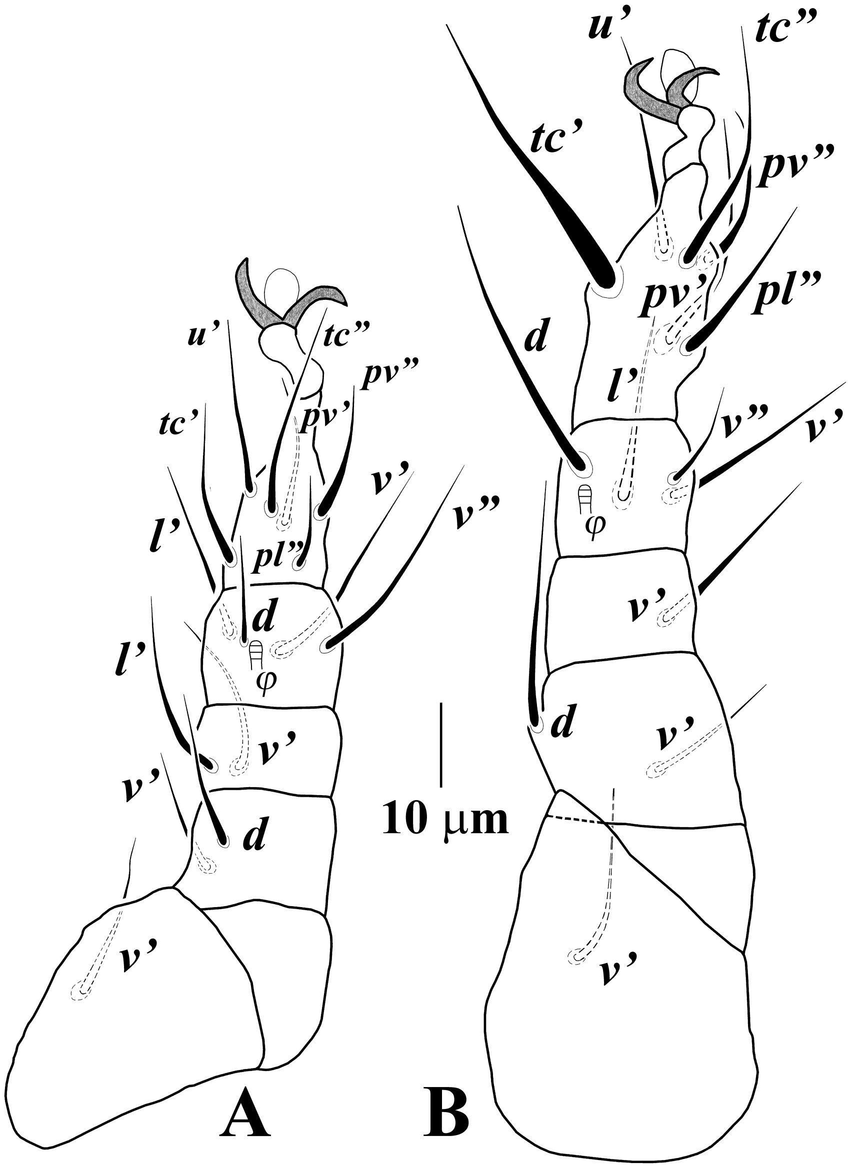


**Figure 3** *Premicrodispus gorganiensis sp. nov.*, female. A – leg III, B – leg IV.

Tarsus with sickle-like simple claws, solenidion $\omega$ 4 (3–4) digitiform, seta $pl''$ shortest on tarsus I; tibia with solenidion $\varphi$ 3 (2–3) weakly clavate, setae $v'$ and $v''$ subequal and longer than two others; genu with setae $l'$ thickened; femur with setae $l'$ and $d$, shortest and longest setae on legII, respectively; trochanter with seta $v'$ as long as $v'$ on first leg. Leg III (Fig. 3A). Setal formula: Tr1–Fe2–Ge2– Ti4(1)–Ta6. All leg setae smooth and pointed; tibia with solenidion $\varphi$ 3 (2–3) digitiform, seta $l'$ shorter than three others; genu with two subequal setae $l'$ and $v'$; femur divided into basi- and telofemur with seta $d$ longer than seta $v'$; trochanter with seta $v'$ longer than femoral seta $v'$. Leg IV (Fig. 3B). Setal formula: Tr1–Fe2–Ge1– Ti4(1)–Ta6. Setae $tc'$ thickened; tibia with solenidion $\varphi$ 3 (2–3) digitiform, seta $v''$ on tibia and $tc'$ on tarsus are shortest and longest on leg IV, respectively; genu with seta $v'$ as long as seta $v''$ on tibia;

femur divided into basi- and telofemur with seta $v'$ longer than $d$; trochanter with seta $v'$ longer than $v'$ on femur.

**Male and larva**. Unknown.

**Differential diagnosis** — The new species is most similar to *Premicrodispus spinosus* Hosseininaveh & Hajiqanbar, 2015 by seta 4*a* absent, seta $ps_2$ present, seta $ps_3$ longer than $ps_1$ and seta $ps_1$ longer than $ps_2$, setae $d$ and $f$ blunt-ended, but differs in having tarsi and tibiae II and III with simple setae (tarsi and tibiae II and III with spine-like setae in *P. spinosus*) and seta $e$ with no linear ridge (setae $e$ associated with a linear ridge in *P. spinosus*). On the other hand, the new species is similar to *P. tenuisetus* Khaustov, 2006 and *P. novaezealandicus* Khaustov and Minor, 2020 by absence of setae 4*a* and presence of setae $ps_2$, but differs from them by setae $d$, $e$ and $f$ blunt-ended (setae $d$, $e$ and $f$ pointed in *P. tenuisetus*), setae $e$ shorter than $f$ (setae $e$ longer than $f$ in *P. novaezealandicus* and subequal with $f$ in *P. tenuisetus*), setae $e$ not associated with ridge (setae $e$ associated with well-developed oblique ridges in *P. tenuisetus*), pump 3 of pharyngeal system reduced (pump3 of pharyngeal system ovate in *P. novaezealandicus* and *P. tenuisetus*), seta $ps_1$ two times longer than $ps_2$ (seta $ps_1$ and $ps_2$ subequal in *P. novaezealandicus*), seta $ps_3$ longer than $ps_1$ and seta $ps_1$ longer than $ps_2$ (setae $ps_3$ and $ps_1$ subequal and longer than seta $ps_2$ in *P. tenuisetus*), posterior border of tergites C and D with distinct median incision (posterior border of tergites C and D straight in *P. novaezealandicus* and *P. tenuisetus*).

**Type material** — Female holotype (VRSS-20190812-1) and 5 female paratypes, in a vial containing *Lucanus ibericus* Motschulsky, 1845 (Col.: Lucanidae). The hosts were captured by a light trap from Alangdareh forest, with Hornbeam trees (*Carpinus* spp.) and Oak trees (*Quercus* spp.), Gorgan town, Golestan province, northern Iran, 36.46°N, 54.26°E, altitude, 408 m., coll. V. Rahiminejad, 12 August 2019.

**Etymology** — The name of the new species refers to its sampling site, the city of Gorgan, northern Iran.

## Genus *Neomicrodispus* Hajiqanbar & Hosseininaveh, 2014

Type species: *Neomicrodispus iranicus* Hajiqanbar & Hosseininaveh, 2014, by original designation.

Type species along with *N. sibiriensis* Khaustov, 2018, constitute the genus (Hajiqanbar and Hosseininaveh 2014; Khaustov 2018).

### *Neomicrodispus lucani* Rahiminejad & Seyedein sp. nov.

Zoobank: AC91F8E7-794C-4C96-B19C-97A7FD76E88C

(Figures 4–6)

**Diagnosis** — The new species is characterized by having all dorsal setae pointed and sparsely barbed; setae 4*a* absent; setae *cha* and $m$ subequal; setae $e$ and $h_2$ subequal; setae $ps_1$ and $ps_3$ subequal and two times longer than $ps_2$.

**Description** — **Female**. Length of body (including gnathosoma) 182 (175–184), width 98 (94–103).

Gnathosoma (Figs 4A & B) – Length of gnathosoma 23 (22–23), width 15 (14–15); without dorsal median apodeme; cheliceral setae *cha* 11 (10–12) smooth and pointed; postpalpal setae (*pp*) 3 (3) needle-like, located laterad bases of *cha*. Setae *dFe* 7 (6–7) and *dGe* 4 (3–4) smooth, pointed, *dFe* longer than *dGe*; subcapitular setae $m$ 10 (10–11) smooth and pointed; accessory setigenous structure indiscernible; pharyngeal pump system (Fig. 4C) with three pumps, second pharyngeal pump large, subrectangular and transversely striated, pharyngeal pumps 1 and 3 reduced and bow-shaped; pharyngeal pump 1 clearly separated from pharyngeal pump 2.

Idiosomal dorsum (Fig. 4A) – Body oval; prodorsum only slightly covered by anterior part of tergite C; oval stigmata and related tracheal trunks visible; trichobothria with long stem, clavate, weakly barbed, with two short apical projections; seta $sc_2$ 24 (23–27), barbed; idiosomal length 155 (147–158); posterior margins of tergites C, D, EF and H tanned and with row of U-shaped elevations; all dorsal hysterosomal setae sparsely barbed and pointed; tergite C with two pairs of setae $c_1$ 38 (36–39) and $c_2$ 38 (35–39), setae $c_1$ and $c_2$ subequal; tergite D with setae *d* 40 (36–41), cupuli *ia* indiscernible; tergite EF with two pairs of setae *e* 17 (17–18) and *f* 39 (37–41), bases of setae *e* not associated with ridges and one pair of round porous areas situated besides of the base of setae *e*, distance *e-f* subequal to *f-f*; tergite H with setae $h_1$ 31 (29–32), $h_2$ 16 (15–16), cupuli *ih* round and placed posteriad seta $h_2$; all dorsal setae extended from posterior border of their tergites. Distances between dorsal setae: $sc_2$–$sc_2$ 33 (30–34), $c_1$–$c_1$ 29 (28–32), $c_2$–$c_2$ 74 (70–77), $c_1$–$c_2$ 21 (20–23), *d–d* 20 (18–21), *e–e* 61 (59–66), *e–f* 19 (18–21), *f–f* 21 (20–22), $h_1$–$h_1$ 32 (30–33), $h_2$–$h_2$ 51 (50–53), $h_1$–$h_2$ 9 (9–10).

Idiosomal venter (Figs. 4B) – All apodemes (ap1 to ap4, apsej, appr and appo well developed, except ap5, absent; ap3 extending beyond bases of setae 3*a*; ap4 reach to bases of setae 3*b*; ventral plates smooth. All ventral setae pointed and weakly barbed except smooth 4*b*;

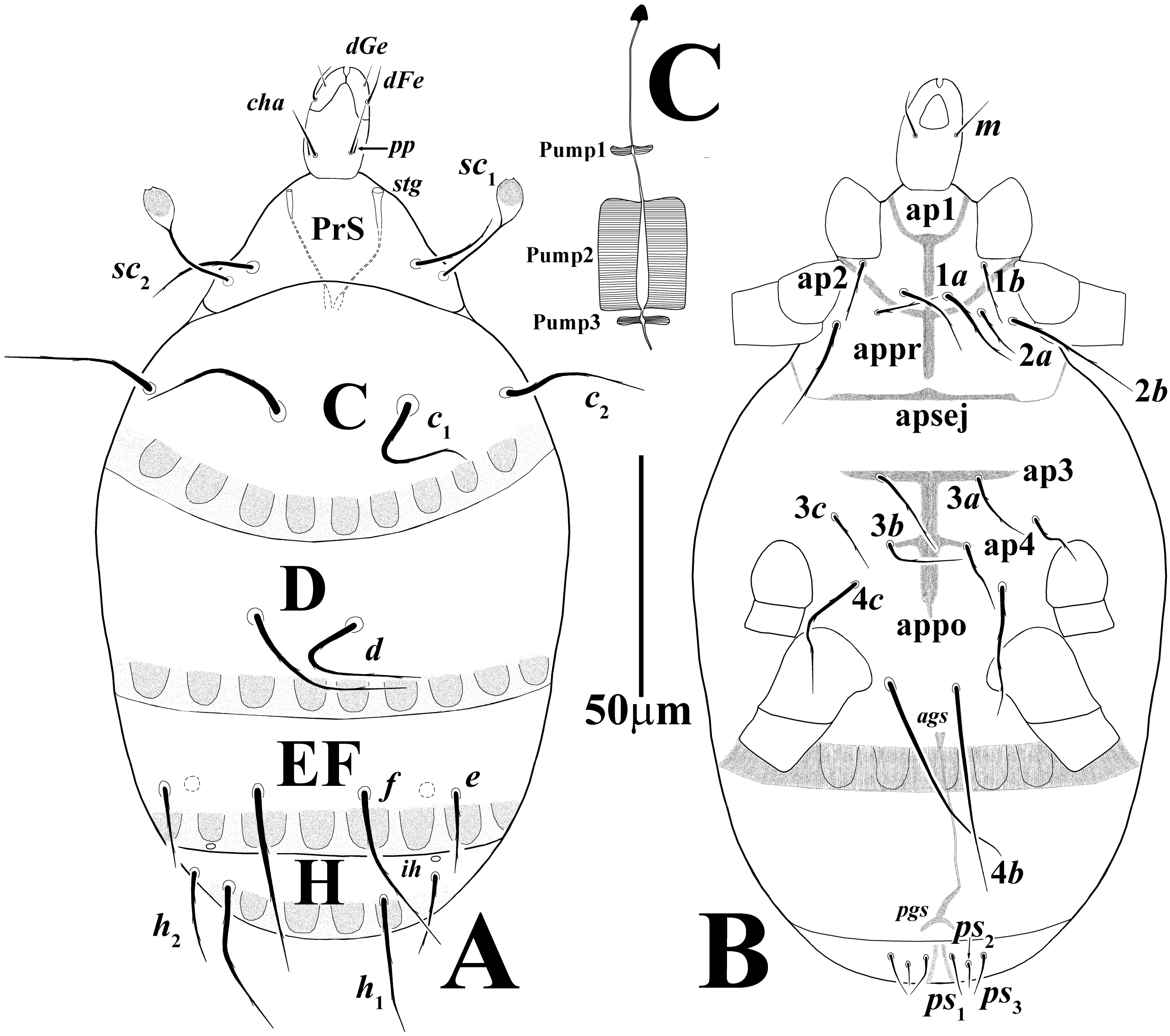


**Figure 4** *Neomicrodispus lucani* **sp. nov.**, female. A – body in dorsal view, B – body in ventral view, C – Pharyngeal system.

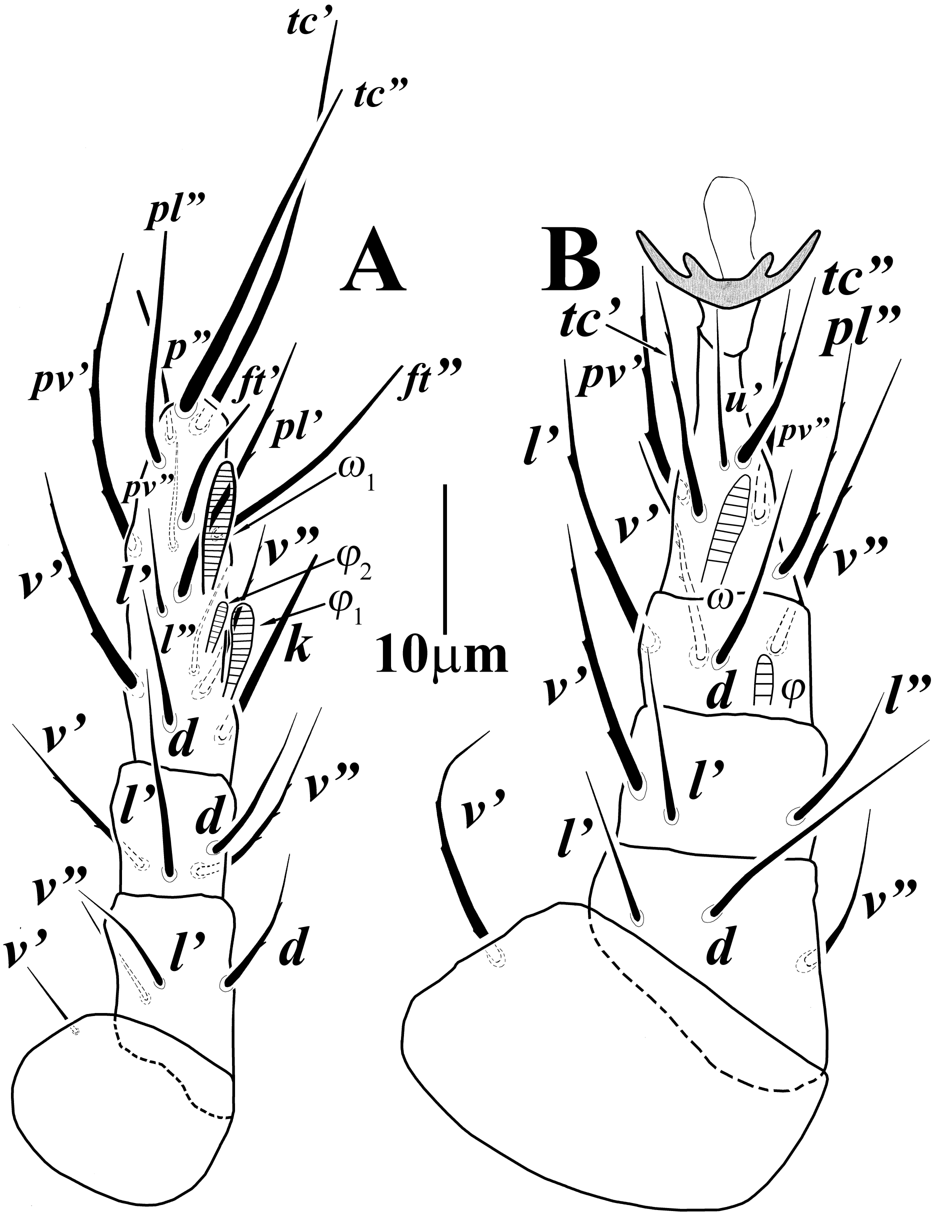


**Figure 5** *Neomicrodispus lucani* **sp. nov.**, female. A – leg I, B – leg II.

setal formula of coxal fields: 2,2,3,2; setae 1*b* and 2*a* subequal, setae 2*b* longest on anterior sternal plate; setae 3*a* and 3*b* subequal and longer than 3*c*; setae 4*a* absent and setae 4*b* longest setae on ventral plates; posterior part of poststernal plate tanned and with U-shaped elevations; posterior margin of aggenital plate almost straight; anterior genital sclerite (ags) small, bell-like and posterior genital sclerite (pgs) bow-shape; setae $ps_{1-3}$ smooth. Lengths of ventral setae: 1*a* 23 (21–23), 1*b* 12 (11–13), 2*a* 12 (10–12), 2*b* 32 (31–32), 3*a* 23 (21–25), 3*b* 20 (19–21), 3*c* 12 (12–13), 4*b* 42 (40–45), 4*c* 30 (29–32), *ps*1 8 (7–10), *ps*2 4 (4–5), *ps*3 8 (7–10).

Legs (Figs 5 & 6) – Leg I (Fig. 5A). Setal formula: (number of solenidia in parentheses): Tr1–Fe3–Ge4–TiTa15 (3). Tibiotarsus with five eupathidial setae *tc*′, *tc*″, *ft*′, *ft*″ and *p*″, setae

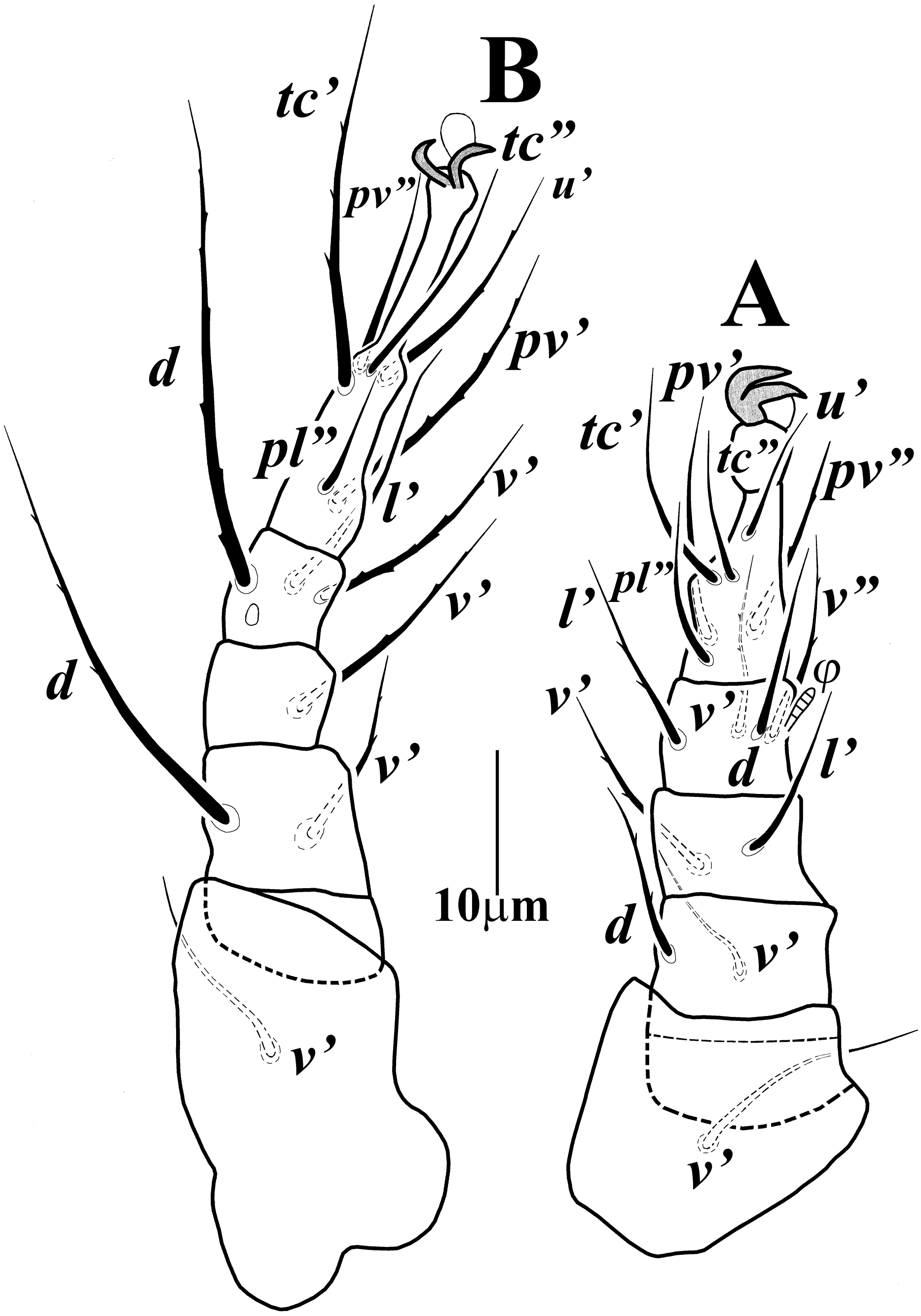


**Figure 6** *Neomicrodispus lucani* **sp. nov.**, female. A – leg III, B – leg IV.

*tc′* shorter than *tc″*, setae *pv′*, *v′*, *l″* and *pl″* barbed, other leg setae smooth, solenidia $\omega_1$ 9 (8–9) > $\varphi_1$ 7 (6–7) > $\varphi_2$ 3 (3–4), solenidion $\omega_1$ weakly clavate, longer than other solenidia, solenidion $\varphi_1$ clubbed, solenidion $\varphi_2$ baculiform; genu with setae *v′* and *v″* barbed and subequal to *l″* and shorter than *l′*; femur with setae *d* barbed and longer than subequal *v″* and *l′*; seta *v′* on trochanter shortest setae of leg. Leg II (Fig. 5B). Setal formula: Tr1–Fe3–Ge3–Ti4(1)–Ta6(1). Tarsus with setae *tc″* and *u′* smooth and subequal, other setae of segment barbed, solenidion $\omega$ 8 (7–8) digitiform; all setae on tibia barbed except smooth *d*, setae *d* shorter than other tibial setae, solenidion $\varphi$ 4 (3–4) digitiform; genu with setae $v'$ barbed and longer than setae $l''$ and $l'$; all setae on femur smooth, setae $l'$ and $v''$ subequal and distinctly shorter than seta $d$; seta $v'$ on trochanter barbed and longer than $v'$ of genu. Leg III (Fig. 6A). Setal formula: Tr1–Fe2–Ge2–Ti4(1)–Ta6. All setae on tarsus smooth except barbed $pv'$; all setae on tibia subequal and barbed except smooth $d$, solenidion $\varphi$ 3 (3–4) weakly clavate; genu with setae $v'$ and $l'$ subequal, seta $v'$ barbed; seta $v'$ on femur barbed and subequal with smooth $v'$; trochanter with seta $v'$ smooth and longer than $v'$ on femur. Leg IV (Fig. 6B). Setal formula: Tr1–Fe2–Ge1–Ti3–Ta6. Longer than other legs. Tarsus with setae $u'$, $pv'$ and $tc'$ barbed, seta $pl''$ shortest and $tc'$ longest setae of segment; all setae on tibia barbed except smooth $l'$, seta $d$ longest on segment; pore-like structure visible below base of seta $d$; genu with seta $v'$ barbed; femur with seta $d$ more than twice longer than $v'$, both barbed; seta $v'$ on trochanter smooth and slightly longer than femoral seta $v'$.

**Male and larva**. Unknown.

**Differential diagnosis** — The new species can be distinguished from *N. sibiriensis* by the absence of setae 4*a* (present in *N. sibiriensis*). Also *N. lucani* sp. nov. differs from *N. iranicus* by seta *cha* and *m* subequal (seta *cha* two times longer than *m* in *N. iranicus*), seta *e* and $h_2$ subequal (seta *e* more than 1.5 times longer than $h_2$ in *N. iranicus*), setae $ps_1$ and $ps_3$ subequal and two times longer than $ps_2$ (setae $ps_{1\text{-}3}$ subequal in *N. iranicus*).

**Type material** — Female holotype (VRSS-20190705-8) and three female paratypes, in the vial containing *Lucanus ibericus* Motschulsky, 1845 (Col.: Lucanidae). The hosts captured by a light trap from Alangdareh forest, with Hornbeam trees (*Carpinus* spp.) and Oak trees (*Quercus* spp.), Gorgan town, Golestan province, northern Iran, 36.46°N, 54.26°E, altitude, 408 m., coll. V. Rahiminejad, 5 July 2019.

**Etymology** — The name of the new species refers to generic name of the host beetle, *Lucanus*.

**Remark** — This is the first record of association between *Neomicrodispus* mites and lucanid beetles. Previously, *N. iranicus* was found in a vial containing beetle *Oryctes nasicornis* (L.) (Col.: Scarabaeidae) in northern Iran and *N. sibiriensis* collected from a decaying tree stump in Western Siberia, Russia.

## Discussion

Stag beetles (Col.: Lucanidae) with about 1700 species, have a worldwide distribution (Bartolozzi *et al.* 2014). Ten species of lucanid beetles are listed for the arthropod fauna of Iran and it seems that *Lucanus ibericus* is the dominant lucanid beetle in northern Iran. This beetle feeds for several (3–7) years on decaying wood of stumps and roots in its larval stage, and the adults are related with leaves, litter and trees, therefore, it could be possible that the beetles had a close association with wide range of mites in soil or on the trees (Walter *et al.* 2009; Harvey *et al.* 2011; Okabe *et al.* 2012; Bartolozzi *et al.* 2014). Mite fauna associated with Lucanidae is poorly studied. Hitherto, three orders of mites (Mesostigmata, Trombidiformes and Sarcoptiformes) have been found to be associated with the beetles (Haitlinger 2008; Walter *et al.* 2009). Until now, nine species belonging to five genera and two families of Heterostigmata have been recorded as phoretic on three different species of lucanid beetle, *L. ibericus*, *Dorcus parallelipipedus* (L.) and *D. parallelus* (Say, 1823) (Table 1).

As *N. iranicus* was collected from *Oryctes nasicornis* (Scarabaeidae), *N. sibiriensis* extracted from a decaying stump and *N. lucani* sp. nov. found in association with *L. ibericus*, it seems that a range of arthropods that dwell in decaying wood habitats could be chosen as a hosts for *Neomicrodispus* mites. However, more investigations on the biology and life history of *Neomicrodispus* can clear the nature of the associations.

Presently, the genus *Neomicrodispus* includes three described species based only on females that could be separated by the following key.

**Table 1** List of heterostigmatic mites associated with stag beetles.

| Mite species | Family | Lucanid host | Reference(s) |
|---|---|---|---|
| *Metapygmephorellus colydius* Rahiminejad & Hajiqanbar, 2015 | Pygmephoridae | *D. parallelipipedus* | Rahiminejad et al. (2015b) |
| *Propygmephorus crossi* Katlav & Hajiqanbar, 2016 | Pygmephoridae | *L. ibericus* | Hajiqanbar and Arjomandi (2019) |
| *Premicrodispus turkmenus* Badoodam & Hajiqanbar, 2015 | Microdispidae | *L. ibericus* | Badoodam et al. (2015) |
| *Premicrodispus paramaevi* Hosseininaveh & Hajiqanbar, 2014 | Microdispidae | *L. ibericus* | Hosseininaveh et al. (2014) |
| *Paramicrodispus scarabidophilus* Hajiqanbar & Rahiminejad, 2012 | Microdispidae | *D. parallelus* | Badoodam et al. (2015) |
| *Paramicrodispus crenulatus* (Sevastianov, 1978) | Microdispidae | *L. ibericus* | Hajiqanbar et al. (2012) |
| *Premicrodispus longicaudus* Khaustov, 2006 | Microdispidae | *L. ibericus* | Rahiminejad and Hajiqanbar (2020) |
| *Premicrodispus gorganiensis* Rahiminejad **sp. nov.** | Microdispidae | *L. ibericus* | Current Study |
| *Neomicrodispus lucani* Rahiminejad **sp. nov.** | Microdispidae | *L. ibericus* | Current Study |

1. Setae *e* shorter than *f*; setae $ps_1$ and $ps_3$ subequal and two times longer than $ps_2$ . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . ***N. lucani*** Rahiminejad & Seyedein **sp. nov.**

— Setae *e* and *f* subequal; setae $ps_1$, $ps_2$ and $ps_3$ subequal . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . 2

2. Seta 4*a* present, dorsal hysterosomal setae longer (*d* 40, *f* 42, $h_1$ 35) . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . *N. sibiriensis* Khaustov, 2018

— Seta 4*a* absent, dorsal hysterosomal setae relatively shorter (*d* 30, *f* 32, $h_1$ 23) . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . *N. iranicus* Hajiqanbar & Hosseininaveh, 2014

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