Two new species of the genus *Premicrodispus* (Acari: Microdispidae) associated with beetles (Coleoptera: Lucanidae: Tenebrionidae), with a key to Palaearctic species of the genus

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Two new species of mites of the genus *Premicrodispus* Cross, 1965 (Acari: Microdispidae) are described and illustrated from northern Iran: *Premicrodispus paramaevi* Hosseininaveh and Hajiqanbar sp. nov. recovered from *Lucanus ibericus* (Col.: Lucanidae) and *Premicrodispus spinosus* Hosseininaveh and Hajiqanbar sp. nov. from *Corticeus unicolor* (Col.: Tenebrionidae). It is the first phoretic record of the microdispid mites on beetles of the family Tenebrionidae. A key to Palaearctic species of the genus *Premicrodispus* is provided.

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**Keywords:** Heterostigmatina; mite; beetle; phoretic relationship; Iran

**Introduction**

Mites of the cohort Heterostigmatina (Acari: Prostigmata) usually have phoretic, parasitoid or parasitic associations with various orders of insects. Within the Heterostigmatina, phoretic relationships have been evolved mostly in the superfamily Pygmephoroidea (Kaliszewski et al. 1995; Khaustov 2008). Based on Khaustov (2008), this superfamily includes four families, one of them the family Microdispidae. The microdispid mites are inhabitants of soil, forest litter and the nests of insects, and many of them use insects for phoretic dispersal (Khaustov 2009). Fungivory appears to be the primitive feeding behaviour of this family (Kaliszewski et al. 1995). The family consists of 17 genera and more than 109 species (Zhang et al. 2011). One of the speciose microdispid genera is the genus *Premicrodispus*. Khaustov (2006) reviewed the history of the genus. This genus currently includes three subgenera, *Premicrodispus* sensu stricto with about 27 species (according to Khaustov and Maslov 2013) and two monotypic subgenera *Premicrodispulus* Khaustov and Chydyrov, 2010 and *Premicrodispoides* Khaustov and Maslov, 2013. Hitherto, the subgenus *Premicrodispus* (*Premicrodispus*) included 20 described species in the Palaeartic region (Khaustov 2006, 2009; Khaustov and Chydyrov 2010). Mites of this family have been found on beetles of the families Carabidae, Scarabaeidae and Lucanidae (Hajiqanbar et al. 2012) but this study reports, for the first time, these mites on beetles of the family Tenebrionidae.

During a preliminary study of the heterostigmatic mites associated with Coleoptera in Iran, we found two new species of the genus *Premicrodispus*. This paper describes these new species and is the first record of the phoretic association

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between mites of the family Microdispidae and beetles of the family Tenebrionidae. A key to Palearctic species of the genus *Premicrodispus* is provided.

**Material and methods**

Host beetles were captured directly in their habitats from Naharkhoran forest, Golestan province, northern Iran in 2009. Mite specimens were collected from a vial containing host beetles in alcohol, cleared in lactophenol and mounted in Hoyer's medium. The morphology of the mites was studied using a light microscope with phase contrast (Olympus BX51, Tokyo, Japan). The terminology used in the description follows that of Lindquist (1986). All measurements in the descriptions are given in micrometres for the holotype and five paratypes, if available (in parentheses). Details of the geographical position were recorded using a global positioning system (GPS model: eTrex).

The holotypes of the new species are deposited in the Acarological Collection, Department of Entomology, Faculty of Agriculture, Tarbiat Modares University, Tehran, Iran. One paratype of each species is deposited in the Zoological Institute, University of Hamburg, Hamburg, Germany. The insect hosts and the rest of the paratypes are retained with the holotype.

**Systematics**

**Family** MICRODISPIDAE Cross, 1965  
**Genus** *Premicrodispus* Cross, 1965  
*Premicrodispus (Premicrodispus) paramaevi* Hosseininaveh and Hajiqanbar sp. nov.  
(Figures 1–5)

**Description**

**Female.** Length of idiosoma 181 (178–184), width 95 (91–97).

Gnathosoma (Figure 3A,B). Gnathosomal capsule about twice as long as its width, dorsally with two pairs of cheliceral setae *ch1* 7 (7–8) and *ch2* 9 (8–10); ventrally with one pair of subcapitular setae *su* 7 (7–9); palps short, terminated to small tibial claw, and compressed to gnathosomal capsule, with two pairs of setae, *dFe* 5 (4–5) and *dGe* 4 (3–4); cheliceral styles indiscernible; pharyngeal system (Figure 3C) with three pumps, pumps 1 and 3 reduced, pump 2 large and striated.

Idiosomal dorsum (Figure 1). Prodorsal shield (PrS) with elongate stigmata and distinct tracheal system; all dorsal setae smooth and pointed; prodorsal shield with one pair of capitate trichobothria and one pair of setae *sc2* 19 (16–19); all tergites smooth, tergite C with two pairs of setae *c1* 22 (19–22) and *c2* 24 (20–24); tergite D with one pair of setae *d* 29 (25–29) and one pair of rounded cupuli *ia*; tergite EF with two pairs of setae *e* 21 (18–21) and *f* 25 (22–26), setae *f* longer than setae *e*; tergite H with two pairs of setae *h1* 21 (18–21), *h2* 20 (16–20) and one pair of rounded cupuli *ih*; Distances between dorsal idiosomal setae: *sc2–sc2* 22 (22–23), *c1–c1* 31 (27–31), *c2–c2* 52 (52–58), *d–d* 13 (13–15), *e–e* 55 (48–55), *e–f* 13 (12–14), *f–f* 23 (23–26), *h1–h1* 13 (13–14), *h1–h2* 18 (13–18), *h2–h2* 47 (40–47).
Figure 1. *Premicrodispus paramaevi* sp. nov., female. Dorsum of the body.
Figure 2. *Premicrodispus paramaevi* sp. nov., female. Venter of the body.
Idiosomal venter (Figure 2). Ventral plates smooth; all ventral setae smooth and pointed; apodemes 1 and 2 reaching to presternal apodeme (appr), sejugal apodeme (apsej) joined with appr, apodemes 3 extending beyond setae 3a and apodemes 4 reaching to setae 3b, apodeme 5 short; anterior border of poststernal plate concave and posterior border of poststernal plate tripartite; coxal field I with two pairs of setae 1a 14 (13–14) and 1b 14 (13–14); coxal field II with two pairs of setae 2a 19 (16–19) and 2b 17 (14–17); coxal field III with three pairs of setae 3a 14 (12–14), 3b 14 (13–14) and 3c 13 (10–13), setae 3b, 3a and 3c subequal; coxal field IV with three pairs of setae 4a 11 (10–11), 4b 18 (16–18) and 4c 14 (12–14); pseudoanal segment PS with two pairs of setae ps1 12 (11–12) and ps3 11 (10–11).

Figure 3. Premicrodispus paraevi sp. nov., female. (A) Gnathosoma, dorsal view; (B) gnathosoma, ventral view; (C) pharyngeal pumps.
Legs. All legs five-segmented except leg I (four-segmented).

Leg I (Figure 4A). Setal formula: Tr1-Fe3-Ge4-TiTa15(4) (number of solenidia in parentheses). Tibiotarsus with solenidion $\omega_1$ 8 (7–8), $\omega_2$ 4 (4–5), $\varphi_1$ 6 (6–6) and $\varphi_2$ 3 (3–3), solenidia $\omega_1$, $\varphi_1$ and $\varphi_2$ finger-shaped and striated, $\omega_1$ longer than $\varphi_1$ and $\varphi_2$, solenidion $\omega_2$ uniformly thin; with five eupathidial setae ($p''$, $ft'$, $ft''$, $tc'$, $tc''$), setae $tc'$ longer than $tc''$, setae $pv'$ longer than $pv''$; setae $d$ longer than $k$, setae $v''$ longer than $v'$, setae $l'$ longer than $l''$; genu with setae $l'$ longer than other setae of the segment, setae $v'$ and $v''$ subequal; femur with setae $l'$ and $v''$ subequal and both shorter than $d$; trochanter with seta $v'$.

Leg II (Figure 4B). Setal formula: Tr1-Fe3-Ge3-Ti4(1)-Ta6(1). Tarsus with solenidion $\omega$ 6 (6–7) finger-shaped, setae $pv''$, $pv'$ and $pl''$ subequal, setae $u'$ shortest on this
segment; tibia with a finger-shaped solenidion $\varphi$ 4 (3–4), setae $v'$ longer than $v''$, setae $v''$ longer than $d$ and $l'$; genu with three setae, $v'$ longer than $l'$ and setae $l'$ longer than $l''$; femur with seta $d$ longer than $v''$ and setae $v''$ longer than $l'$; trochanter with seta $v'$.

Leg III (Figure 5A). Setal formula: Tr1-Fe2-Ge2-Ti4(1)-Ta6. Tarsus with setae $pl''$, $pv'$, $pv''$, $tc''$ and $tc'$ subequal, setae $pv''$ weakly barbed, setae $u'$ shortest on this segment; tibia with solenidion $\varphi$ 2 (2–3) and setae $d$, $l'$ and $v''$ shorter than $v'$; genu with seta $l'$ weakly barbed and shorter than $v'$; femur with setae $d$ longer than $v'$; trochanter with seta $v'$.

Leg IV (Figure 5B). Setal formula: Tr1-Fe2-Ge1-Ti4(1)-Ta6. Tarsus with seta $tc'$ longer than $tc''$ and weakly barbed, setae $pv'$ longer than $pv''$, setae $u'$ as long as $pv''$, setae $pl''$ shortest on the leg; tibia with small solenidion $\varphi$ 2 (1–2), setae $v''$, $v'$ and $l'$

Figure 5. *Premicrodispus paramaevi* sp. nov., female. (A) Leg III; (B) leg IV.
subequal and almost two times shorter than \( d \), setae \( d \) and \( v' \) weakly barbed; genu with seta \( v' \) as long as femoral seta \( v' \); femur with setae \( d \) about two times longer than \( v' \); trochanter with seta \( v' \).

Male and larva unknown.

**Differential diagnosis**

The new species is distinguished from congeners by having two pairs of cheliceral setae, rounded cupuli and reduced pump 3 of pharyngeal system. On the other hand, due to presence of setae \( 4a \), absence of setae \( ps_2 \) and subequal setae \( ps_1 \) and \( ps_3 \), the new species is similar to *Premicrodispus parasilvestris* (Rack, 1974) but differs from it by setae \( d \) distinctly longer than distance between their bases (setae \( d \) distinctly shorter than distance between their bases in *P. parasilvestris*). The new species is similar to *Premicrodispus dzumaevi* (Sevastianov and Chydyrov, 1991) because of setae \( d \) distinctly longer than distance between their bases but differs from it by subequal setae \( ps_1 \) and \( ps_3 \) (setae \( ps_1 \) distinctly longer than \( ps_3 \) in *P. dzumaevi*). The new species is also similar to *Premicrodispus lambi* (Krczal, 1964) but differs from it by setae \( sc_2 \) shorter than distance between their bases (setae \( sc_2 \) longer than distance between their bases in *P. lambi*), by setae \( d \) longer than distance between their bases (setae \( d \) shorter than distance between their bases in *P. lambi*), by setae \( f \) subequal to distance between their bases (setae \( f \) as half as distance between their bases in *P. lambi*), by setae \( h_1 \) longer than distance between their bases (setae \( h_1 \) shorter than distance between their bases in *P. lambi*) and by shorter setae in coxal fields I–IV (longer setae in coxal fields I-IV in *P. lambi*).

**Type material**

Three females found in a vial containing the beetle *Lucanus ibericus* (Col.: Lucanidae) in 75% ethanol. The host beetle was collected in Naharkhoran forest, Golestan province, northern Iran, 36.46° N, 54.27° E, altitude 450 m., coll. V. Rahiminejad, 27 July 2010.

**Etymology**

The name of the new species ‘*Paramaevi*’ is derived from combination of two species names *parasilvestris* and *dzumaevi*, two species that are most similar to the new species.

**Premicrodispus spinosus** Hosseininaveh & Hajiqanbar sp. nov. (Figures 6–10)

**Description**

**Female.** Length of idiosoma 152 (152–156), width 80 (74–88).

Gnathosoma (Figure 8A,B). Gnathosomal capsule about twice as long as its width, dorsally with one pair of cheliceral setae \( ch \) 3 (3–3); ventrally with one pair of
Figure 6. *Premicrodispus spinosus* sp. nov., female. Dorsum of the body.
Figure 7. *Premicrodispus spinosus* sp. nov., female. Venter of the body.
subcapitular seta su 5 (4–5); palps short, terminated to small tibial claw, and compressed to gnathosomal capsule, with two pairs of setae, dFe 3 (3–4) and dGe 4 (3–4), cheliceral stylets indiscernible; pharyngeal system (Figure 8C) with three pumps, pump 1 reduced, pump 2 the largest and striated, pump 3 small and rounded.

Idiosomal dorsum (Figure 6). Stigmata oval-shaped and situated in anterior part of prodorsal shield; all dorsal setae smooth and pointed except setae d, f and h1, which are blunt-ended; prodorsal shield with one pair of capitate trichobothria.
and one pair of setae sc₂ 19 (18–19); all tergites smooth, tergite C with two pairs of setae c₁ 11 (11–13) and c₂ 15 (13–15), setae c₂ longer than c₁, posterior border of tergite C with distinct median depression; tergite D with seta d 9 (9–10) and one pair of rhombic cupuli ia, posterior border of tergite D with distinct median depression; tergite EF with two pairs of setae e 10 (10–11) related to one thin apodeme and f 10 (10–11); tergite H with two pairs of setae h₁ 10 (10–11), h₂ 11 (11–12) and one pair of rhombic cupuli ih. Distances between dorsal idiosomal setae: sc₂–sc₂ 26 (25–26), c₁–c₁ 25 (25–26), c₂–c₂ 57 (50–60), c₁–c₂ 17 (17–20), d–d 24 (24–26), e–e 41 (41–44), e–f 5 (5–6), f–f 31 (31–35), h₁–h₁ 12 (11–13), h₁–h₂ 12 (11–12), h₂–h₂ 36 (36–39).

Figure 9. Premicrodispus spinosus sp. nov., female. (A) Leg I; (B) leg II.
Idiosomal venter (Figure 7). Ventral plates smooth; all ventral setae smooth and pointed; apodemes 1 and 2 reaching to appr, appr not reaching to apsej, apodemes 3 extending beyond bases of setae 3a, apodemes 4 short and not reaching to bases of setae 3b, apodemes 5 short; anterior border of poststernal plate convex and posterior border of poststernal plate tripartite; coxal field I with two pairs of setae 1a 10 (9–10) and 1b 10 (10–11); coxal field II with two pairs of setae 2a 11 (11–12) and 2b 14 (13–15), 2b longer than 2a; coxal field III with three pairs of setae 3a 10 (9–10), 3b 7 (7–8) and 3c 7 (7–10), 3b and 3c subequal and shorter than 3a; coxal field IV with two pair of setae 4b 8 (8–9) and 4c 7 (7–8); pseudanal segment PS with three pairs of setae ps1 11 (10–11), ps2 6 (5–6) and ps3 18 (16–18), ps3 distinctly longer than ps1 and ps2.
Legs. Leg chaetotaxy as in previous species.

Leg I (Figure 9A). Tibiotarsus with solenidia $\omega_1$ 5 (4–5), $\omega_2$ 1 (1–2), $\varphi_1$ 2 (1–2), and $\varphi_2$ 4 (3–4), all finger shaped, $\omega_1$ and $\varphi_1$ striated, with five eupathidial setae ($p''$, $ft'$, $ft''$, $tc'$, $tc''$), setae $tc'$ longest on leg I, setae $pl''$ and $pl'$ subequal, setae $pv'$ longer than $pv''$, setae $v''$ longer than $v'$, setae $l'$ and $l''$ subequal; genu with setae $l''$, $l'$, $v'$ and $v''$, all subequal; femur with setae $d$ and $v''$ subequal and both longer than $l'$; trochanter with seta $v'$.

Leg II (Figure 9B). Tarsus with solenidion $\omega$ 3 (2–3) finger shaped, $pl''$ modified and spine-like, the rest of setae of the segment subequal; tibia with a small finger-shaped solenidion $\varphi$ 2 (1–2), setae $l'$ modified and spine-like, setae $d$ longer than $v'$ and $v''$; genu with setae, $l''$ and $v'$ subequal and longer than $l'$; femur with setae $d$ longer than $l'$ and $v''$; trochanter with seta $v'$.

Leg III (Figure 10A). Tarsus with modified and spine-like setae $pl''$ and $tc'$, setae $tc''$ longest setae on the leg, setae $pv''$ and $pv'$ subequal and shorter than $u'$; tibia with a small solenidion $\varphi$ 2 (1–2) and setae $d$ modified and spine-like, seta $v''$ and $v'$ subequal and longer than $l'$; genu with setae $l'$ and $v'$ subequal; femur divided into basifemur and telofemur, setae $d$ and $l'$ inserted on telofemur, setae $d$ longer than $l'$; trochanter with seta $v'$.

Leg IV (Figure 10B). Tarsus with subequal setae $pl''$, $pv'$ and $pv''$, setae $u'$ and $tc''$ subequal, seta $tc'$ longest on the segment; tibia with small solenidion $\varphi$ 1 (1–1), seta $d$ and $v'$ subequal and longer than $l'$ and $v''$; genu with seta $v'$ as long as femoral seta $v'$; femur divided into basifemur and telofemur, setae $d$ and $v'$ inserted on telofemur, seta $d$ longer than $v'$; trochanter with seta $v'$.

Male and larva unknown.

**Differential diagnosis**

The new species is readily distinguished from other species of the genus by some spine-like setae on tarsi and tibiae II and III. Other species of the genus *Premicrodispus* have unmodified setae on these segments. Disregarding this character, the new species is similar to *Premicrodispus tenuisetus* Khaustov, 2006 but differs from it by setae $d$ blunt and not extending to posterior border of tergite D (seta $d$ pointed and extending to posterior border of tergite D in *P. tenuisetus*) and setae $f$ and $h_1$ blunt (setae $f$ and $h_1$ pointed in *P. tenuisetus*).

**Type material**

Five females found in a vial containing the beetle *Corticeus unicolor* (Col: Tenebrionidae) in 75% ethanol. The host beetle was collected from oak trees in Naharkhoran forest, Golestan province, northern Iran, 36.46° N, 54.27° E, and altitude 450 m., coll. V. Rahiminejad, 30 July 2010.
**Etymology**

The species epithet refers to some spine-like setae on tarsi and tibiae II and III.

**Key to subgenera and Palaearctic species of the genus Premicrodispus (females) (modified from Khaustov 2006)**

1. Genu I with four setae, genu II with three setae ............................................... 2
   - Genu I with three setae, genu II with one seta .......................................................
     ............ subgenus *Premicrodispulus, P. reductus* Khaustov and Chydyrov, 2010

2. Coxal fields I with two pairs of setae, pharyngeal pump 2 much longer than
   pharyngeal pump 3 ..........................................................................................
   - Coxal fields I with one pair of setae, pharyngeal pump 2 distinctly shorter than
     pharyngeal pump 3 ..........................................................................................
     ............ subgenus *Premicrodispoides, P. punctatus* Khaustov and Maslov, 2013

3. Setae 4a present ................................................................................................. 4
   - Setae 4a absent ................................................................................................. 8

4. Setae *ps*2 present ........................................................................... *P. stenops* (Mahunka, 1969)
   - Setae *ps*2 absent ................................................................................................. 5

5. Bases of setae *f* associated with well-developed apodeme .................................. ........................ *P. lineatus* (Mahunka, 1986)
   - Apodemes associated with bases of setae *f* absent ............................................. 6

6. Setae *ps*1 distinctly longer than *ps*3 ...................................................................... P. *dzumaevi* (Sevastianov and Chydyrov, 1991)
   - Setae *ps*1 and *ps*3 subequal in length ................................................................... 7

7. Setae *d* distinctly longer than distance between their bases, bases of setae *e*
   without apodemes ............................................................................. *P. paramaevi* sp. nov.
   - Setae *d* distinctly shorter than distance between their bases, bases of setae *e*
     with apodemes ............................................................................. *P. parasilvestris* (Rack, 1974)

8. Setae *ps*2 present ................................................................................................. 9
   - Setae *ps*2 absent ................................................................................................. 12

9. Setae *h*2 distinctly shorter than *h*1 ................................................................. P. *akermanae* (Sevastianov and Zahida Al Douri, 1988)
   - Setae *h*2 subequal or longer than *h*1 .................................................................. 10

10. Setae *h*1 much shorter than *h*2, pseudanal setae distinctly shorter than setae of
    posterior sternal plate ........................................................................ *P. subvarsoviensis* (Mahunka and Zyromska-Rudska, 1975)
    - Setae *h*1 and *h*2 subequal, pseudanal setae and setae of posterior sternal plate
      subequal ........................................................................................................... 11

11. Setae *h*1, *d* and *f* blunt-ended, tarsi and tibiae II and III with spine-like setae......
    - Setae *h*1, *d* and *f* pointed, tarsus and tibia III with setiform setae ....................
      ...................................................................................................................... 12
12. Setae $sc_2$ and $d$ subequal ................................................................. 13
- Setae $sc_2$ distinctly longer than $d$ ................................................. 16
13. Tergites C and D with distinct emarginations in central part .............................................. $P. incisus$ Khaustov and Chydyrov, 2010
- Tergites C and D without distinct emarginations in central part .......... 14
14. Setae $ps_1$ and $ps_3$ subequal in length ................................................. 15
- Setae $ps_3$ distinctly longer than $ps_1$ .............................................. $P. heteroecaudatus$ Khaustov and Chydyrov, 2010
15. Setae $f$ short and distinctly not reaching to posterior margin of the body .......... $P. acutisetus$ Khaustov, 2009
- Setae $f$ long and protruding the posterior margin of the body ................ $P. longisetosus$ (Mahunka, 1970)
16. Setae $ps_3$ distinctly longer than $ps_1$ ................................................. 17
- Setae $ps_1$ and $ps_3$ subequal in length ............................................. 18
17. Tarsus III with well-developed solenidion .............................................. $P. paradoxus$ Khaustov and Chydyrov, 2010
- Tarsus III without well-developed solenidion .... $P. longicaudus$ Khaustov, 2006
18. Anterior margin of posterior sternal plate distinctly convex ..................... 19
- Anterior margin of posterior sternal plate straight ................................ $P. kaliszewskii$ Khaustov, 2006
19. Bases of setae $e$ associated with well-developed apodemes ..................... 20
- Apodemes associated with bases of setae $e$ absent or vestigial .............. 21
20. Setae $sc_2$ and $c_1$ subequal, setae $c_2$ and $c_1$ situated almost at the same level .... $P. rackae$ Khaustov, 2006
- Setae $sc_2$ distinctly longer than $c_1$, setae $c_2$ situated distinctly anterior to $c_1$ .... $P. brevisetus$ Khaustov, 2006
21. Setae $e$ shorter than setae $f$ ................................................................. 22
- Setae $e$ longer than setae $f$ ......................................................... $P. krczali$ Khaustov, 2006
22. Setae $c_1$ and $e$ blunt ended .......... $P. obtusisetosus$ Khaustov and Chydyrov, 2010
- Setae $c_1$ and $e$ pointed ............................................................... 23
23. All dorsal setae long and barbed ......................... $P. karadagensis$ Khaustov, 2009
- Dorsal setae short and usually smooth ................ $P. montanus$ Khaustov, 2006

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