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A contribution to the knowledge of scutacarid mites (Acari: Pygmephoroidea: Scutacaridae) associated with Coleoptera and Hymenoptera (Arthropoda: Insecta) from northwestern Iran

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ABSTRACT — During the survey of heterostigmatic mites (Acari: Prostigmata) associated with insects in northwestern Iran, Ardabil province, 11 species from three genera of the family Scutacaridae were identified: Heterodispus (one species), Scutacarus (three species) and Imparipes (seven species). Among these, three species are recorded for the first time in Asia including Iran: Imparipes (Imparipes) rafalškii Dastych, 1978, I. (I.) comatus Mahunka, 1970 and Scutacarus remissus Khaustov, 2008. I. (I.) lentus Khaustov, 2008 is recorded for the first time in Iran. All host insects were captured directly from their habitats. Eight new insect host records are reported and the world distribution of these mites is reviewed. A key to Iranian scutacarid mites is also provided.

KEYWORDS — Heterostigmatina; new hosts record; Scutacarus; Imparipes; Heterodispus

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INTRODUCTION

The family Scutacaridae Oudemans, 1916 (Acari: Heterostigmatina) includes 25 genera and more than 800 species; all of them are fungivorous (Khaustov, 2008; Zhang et al., 2011; Khaustov et al., 2017). Most scutacarid mites are mainly associated with beetles, flies, and hymenopterans, especially various ants and bees (Ebermann, 1988; Khaustov, 2008; Ebermann and Moser, 2008; Ebermann et al., 2013). All species of this family have free living habits and some of them have both phoretic and non phoretic female forms (dimorphism) for example, the genus Archidispus Karafiát, 1959 which dimorphic forms are typical for these mites (Ebermann, 1990, 1991a, b). Among the 25 described genera of this family, only six have been recorded from Iran until now: Heterodispus Paoli, 1911; Scutacarus Gros, 1845; Imparipes Berlese, 1903; Pygmodispus, Archidispus Karafiát, 1959 and Lophodispus Kurosa, 1972 (Mahunka and Rohde, 1970; Ebermann et al., 2003; Hajiqanbar and Khaustov, 2014; Loghani et al., 2014; Katlav et al., 2015, 2016; Sobhi et al., 2017). In order to better characterize the fauna of this country, surveys were carried out in northwestern Iran.

MATERIALS AND METHODS

The study was conducted from June 2015 to May 2016 in northwestern Iran. The insect specimens
were captured directly from their habitats and all sampled specimens were adults. Mite specimens were retrieved from their hosts using an Olympus stereomicroscope. Mites were cleared in lacto-Nesbitt solution and mounted on slides in Hoyer’s medium. The morphology of mites was studied using a compound microscope (model BX51, Olympus, Tokyo, Japan) equipped with phase contrast illumination. The bee genus *Andrena* was identified with the help of Dr. A. Talebi (Department of Entomology, Faculty of Agriculture, Tarbiat Modares University, Tehran, Iran). The Tenebrionidae beetles were identified with the help of Maxim Nabozhenko (Russian Academy of Science, Russia). All ants were identified with the help of Dr. Bernhard Seifert (Department of Entomology, Senckenberg Museum für Naturkunde, Berlin, Germany). Materials were collected by the senior author and deposited in the Acarological Collection, Department of Entomology, Faculty of Agriculture, Tarbiat Modares University (TMU), Tehran, Iran.

**RESULTS**

**SYSTEMATICS**

**Family Scutacaridae Oudemans, 1916**

**Genus *Heterodispus* Paoli, 1911**

*Heterodispus (Heterodispus) turkmenistaniensis* Khaustov and Chydyrov, 2005

*Heterodispus (Heterodispus) turkmenistaniensis* Khaustov and Chydyrov, 2005, p. 155, Figures 1-5.

Material examined — Eight females, Ardabil province, Meshgin-shahr, Koli Olia village, 38°41’N, 47°55’E, 29 May 2015, phoretic on the beetle *Blaps mortisaga* Reitter, 1904 (Coleoptera: Tenebrionidae).

World distribution — Turkmenistan, collected from soil of cucumbers (Khaustov and Chydyrov, 2005); Iran, Kerman province, associated with beetle *Scarites (Scarites) procerus eurytus* Fischer von Waldheim (Coleoptera: Carabidae) (Mortazavi, 2010), Northeastern Iran, associated with beetle *Gonocephalum pubiferum* Reitter (Coleoptera: Tenebrionidae) (Loghmani, 2013), Northwestern Iran, Ardabil province (current study).

**Remarks** — Association between this mite and beetles of the tenebrionid genus *Blaps* is new. Considering previous and current records of this mite in Iran, it probably has a preference to be phoretic on beetles than on other insects.

**Genus *Imparipes* Berlese, 1903**

Type species: *Imparipes histricinus* Berlese, 1903, by original designation.

**Imparipes (Imparipes) comatus Mahunka, 1970**

Material examined — Two females, Ardabil province, Meshgin-shahr, Ahmad Abad village, 38°21’N, 47°35’E, 14 May 2016, on ants *Tapinoma tauridis* Emery, 1925 (Hymenoptera: Formicidae). It was also reported from France and Crimea to be phoretic on ants *Tapinoma erraticum* (Latreille) (Hymenoptera: Formicidae), *Lasius niger* (L.), *Mymica rufa* Jerdon and *Tetramorium caespitum* (L.) (Khaustov, 2008); Iran (current study).

**Remarks** — Record of this species is new for mite fauna of Asia. Association between this mite and ant species *Tapinoma tauridis* is also new.

**Imparipes (Imparipes) histricinus Berlese, 1903**

Material examined — Two females, Ardabil province, Meshgin-shahr, Koli Olia village, 38°41’N, 47°55’E, 25 May 2016, on ants *Messor* sp. (Hymenoptera: Formicidae).

World distribution — Angola, Australia, Austria, Bolivia, Brazil, Denmark, France, Germany, Hungary, Ireland, Italy, Lithuania, Malaya, Mongolia, Russia, Tunisia, Ukraine and former Yugoslavia associated with ants *Tetramorium caespitum* L. and *Messor* sp. (Hymenoptera: Formicidae) (Khaustov, 2008; Khaustov and Tolstikov, 2016); Iran, Razavi Khorasan province, associated with...
Cataglyphis cf. nodus (Brulle) (Hymenoptera: Formicidae) (Hajiqanbar, 2010); Northeastern Iran, associated with Temnothorax sp. (Hymenoptera: Formicidae) (Loghmani et al., 2014); Northwestern Iran, Ardabil province (current study).

Imparipes (Imparipes) imaginatus Mahunka, 1981


Material examined — Four females, Ardabil province, Meshgin-shahr, 38°21'N, 47°43'E, 25 May 2016, on ants Tetramorium sp. (Hymenoptera: Formicidae).

World distribution — Hungary, from ant nest (Mahunka, 1981); Austria (Ebermann, 2004); Russia, on ant Tetramorium caespitum L. (Khaustov and Tolstikov, 2016); Iran, Golestan province, phoretic on an unidentified ant (Hymenoptera: Formicidae) (Badoodam, 2014); Ardabil province (current study).

Remarks — The ant genus Tetramorium is a new phoretic host for this mite species.

Imparipes (Imparipes) lentus Khaustov, 2008

Imparipes (Imparipes) lentus Khaustov, 2008: p. 120, Figures 76 (1-4).

Material examined — Five females, Ardabil province, Meshgin-shahr, altitudes of Mount Sabalan, 38°21’N, 47°54’E, 25 May 2016, on ants Tetramorium sp. (Hymenoptera: Formicidae).

World distribution — Crimea, Western Siberia, on ants Tetramorium caespitum L. (Hymenoptera: Formicidae) (Khaustov, 2008; Khaustov and Tolstikov, 2016); Iran (current study).

Remarks — This species is new for mite fauna of Iran.

Imparipes (Imparipes) placidus Khaustov and Chydyrov, 2004


World distribution — Turkmenistan, associated with the ant Messor excursionis Ruszky (Hymenoptera: Formicidae) (Khaustov and Chydyrov, 2004); Iran, Isfahan province, phoretic on an unidentified ant (Hymenoptera: Formicidae) (Tajodin, 2013); Ardabil province (current study).

Remarks — Ants of the genera Tetramorium and Lasius are new phoretic hosts for this species.

Imparipes (Imparipes) rafalskii Dastych, 1978


World distribution — Poland, phoretic on Dasyypoda hirtipes (Fabricius) (Hymenoptera: Melittidae) (Dastych, 1978); Ukraine, phoretic on Bombus terrestris L. (Hymenoptera: Apidae) (Zaloznaya and Khaustov, 2007); Iran (current study).

Remarks — Record of this species is new for mite fauna of Asia. Bees of the family Andrenidae are also new recorded hosts for this mite species.

Imparipes (Imparipes) tenuis Mahunka, 1981


Material examined — Three females, Ardabil province, Meshgin-shahr, altitudes of Mount Sabalan, 38°21’N, 47°54’E, 25 May 2016, on ants Tetramorium sp. (Hymenoptera: Formicidae).

World distribution — Hungary, from ant nests (Mahunka, 1981); Austria (Ebermann, 2004); Iran, Kerman province associated with an unidentified ant (Mortazavi et al., 2016); Ardabil province (current study).

Remarks — Association between this mite and ants of the genus Tetramorium is new.
Genus *Scutacarus* Gros, 1845

Type species: *Scutacarus femoris* Gros, 1845, by monotypy.

*Scutacarus remissus* Khaustov, 2008

*Scutacarus remissus* Khaustov, 2008: p. 246, Figures 173 (1-3).

Material examined — Five females, Ardabil province, Meshgin-shahr, Koli Olia village, 38°41’N, 47°55’E, 25 May 2016, on ants *Messor* sp. (Hymenoptera: Formicidae).

World distribution — Crimea, phoretic on *Messor* sp. (Hymenoptera: Formicidae) (Khaustov, 2008); Iran (current study)

Remarks — This species is new for mite fauna of Asia.

*Scutacarus shivicki*

*Lazauskene and Sevastianov, 1974*

Synonyms: *S.* *frumentaceus* Sevastianov, 1983; *S.* *iharosi* Mahunka & Zaki, 1985; *S.* *diversisetus* Sevastianov & Chydyrov, 1992; *S.* *furatensis* Sevastianov & Zahida Al Douri, 1988.

Material examined — One female, Ardabil province, Meshgin-shahr, Koli Olia village, 38°41’N, 47°55’E, 25 May 2016, on ants *Messor* sp. (Hymenoptera: Formicidae).

World distribution — Russia, Kazakhstan, Turkmenistan, Lithuania and Hungary from Soil and litter (Lazauskene and Sevastianov, 1974; Sevastianov, 1983; Mahunka and Zaki, 1985; Sevastianov and Chydyrov, 1992; Sevastianov and Zahida Al Douri, 1988); Iran, East Azarbaijan province, soil of alfalfa fields (Lotfollahy et al., 2009); Razavi Khorasan province associated with *Cataglyphis* cf. *nodus* (Brulle) (Hymenoptera: Formicidae) (Hajiqanbar, 2010); northeastern Iran, associated with *Tricholabioides* sp. (Hymenoptera: Mutillidae) and *Cataglyphis* cf. *nodus* (Loghmani et al., 2014); Ardabil province (current study).

Remarks — This species has been recorded several times from soil and litter, and its phoretic relationship was hitherto unknown. Therefore, it is first record of phoresy (including ant genus *Messor*) for this mite species.

**DISCUSSION ON THE SCUTACARID-FAUNA OF IRAN**

Forty five species of scutacarid mites recorded from Iran are distributed in genera *Scutacarus* (17 species), *Imparipes* (16), *Archidispus* (7), *Heterodispus* (2), *Pygmodispus* (2) and *Lophodispus* (1). Some species are well adapted to live in soil and litter, such as both representatives of the genus *Pygmodispus* (Ebermann et al., 2003) and some species of the genera *Scutacarus* and *Imparipes* (see Kamali et al., 2001; Lotfollahy et al., 2009; Hashemi Khabir et al., 2013). All *Archidispus* species, *Lophodispus* and many *Scutacarus* and *Imparipes* species have been found associated to various coleopterans and hymenopterans. Mites were found on beetles of the families Carabidae and rarely Staphylinidae (Hajiqanbar and Khaustov, 2014; Loghmani et al., 2014; Katlav et al., 2015, 2016). Ants constitute the most dominant insect hosts for *Lophodispus*, *Imparipes* and *Scutacarus* species (Loghmani et al., 2014; Katlav et al., 2015; Sobhi et al., 2017a, b). However, a few species of *Imparipes* (*I. paulyi*, *I. burgeri* and *I. rafalskii*) and *Scutacarus acarorum* are phoretic on bees (Kazemi and Kamali, 2006; Loghmani et al., 2014;...
Kiani Bakiani et al., 2016). All 45 Iranian scutacarids could be identified using the following key.

**Key to Iranian scutacarid mites (females)**

1. Legs IV with four segments ................................. 29
   — Legs IV with five segments .............................. 2

2. Tibia IV with four setae ................................. Pygmodispus .......................... 3
   — Tibia IV with three setae ................................ 4

3. Posterior sternal plate expanded; setae c₂ longer than c₁; setae 4c spine-like.............................................. P. (Allodispus) latisternus Paoli, 1911
   — Posterior sternal plate not expanded; setae c₁ and c₁ subequal; setae 4c setiform.............................................. P. (Pygmodispus) calcaratus Paoli, 1911

4. Setae c₁ inserted on free margin of tergite C; tarsus IV seta u’ absent .................. Heterodispus ....... 5
   — Setae c₁ inserted on central part of tergite C; tarsus IV seta u’ usually present ............ 6

5. Tibia IV seta I’ extending beyond base of pretarsus; femur IV seta d longer than genu IV seta o’ .......... H. verrucosus Mahunka and Rohde, 1970
   — Tibia IV seta I’ never reaching to base of pretarsus; femur IV seta d shorter than genu IV seta o’ .................. H. turkmenistaniensis Khaustov and Chydyrov, 2005

6. Second pharyngeal pump weakly discernible; anterior margin of anterior sternal plate with crown of thin process ................. Lophodispus tapinoma Sobhi and Hajiqanbar, 2017
   — Second pharyngeal pump much larger than first and third; anterior margin of anterior sternal plate without process .............................................. 7

7. Tarsus IV gradually tapering to the apex; with two types of females, non-phoretic and phoretic, the latter with massive tibiotarsus I and large claw .................................................. Archidispus .......... 8
   — Tarsus IV with expanded base and abruptly becoming thin distally; with only one type of females, tibiotarsus I with middle-size claw, sometimes absent ................................. Imparipes ........ 14

8. Setae ps₂ apart from ps₁; pretarsus IV short (6-7); setae 4c modified, thickened basally .................... A. irregularis Katlav and Hajiqanbar, 2016
   — Setae ps₂ and ps₁ generally with joined basal rings; pretarsus IV with various sizes but longer than 7; setae 4c not modified .................................................. 9

9. At least dorsal setae c₁, d and f modified, expanded basally .................................. 10
   — All dorsal setae not modified, setiform .......................... 11

10. Dorsal setae c₂ modified, expanded basally; among ventral setae, only setae 4a modified, dilated .......................... A. armatus (Karafiat, 1959)
   — Dorsal setae c₂ not modified, setiform; among ventral setae, 4a and 4b modified, expanded basally .......................... A. insolitus (Kurosa, 1974)

11. Setae f distinctly longer than h₂; setae 2b shorter than 2a .......................... A. bembidii (Karafiat, 1959)
   — Setae f distinctly shorter than h₂; setae 2b longer than 2a .............................................. 12

12. Setae 3b and 4a not modified, setiform .............................................. A. esfarayenicus Hajiqanbar and Khaustov, 2014
   — Setae 3b and 4a modified .............................................. 13

13. Setae 4b modified, thickened basally; setae 1a setiform .......................... A. minor Karafiat, 1959
   — Setae 4b not modified, setiform; setae 1a modified, dilated .......................... A. conspicuus Kurosa, 1978

14. Gnathosoma very wide, with subequal length and width .......................... Subgenus I. (Sporichneutes) .............................................. I. (S.) intermedius Paoli, 1911

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15. Tibiotarsus I with three solenidia; pretarsus IV with no claws ............ Subgenus I. (Apicacarus).............I. (A.) paulyi Ebermann and Fain, 2002
— Tibiotarsus I with four solenidia; pretarsus IV usually with claw ...... Subgenus I. (Imparipes)......

16. Pretarsus IV very short, with thickening end........................................ I. rafalski Dastych, 1978
— Pretarsus IV not as above ........................................... 17

17. Setae 3b, 4a and 4b modified, expanded basally.................... I. insulanus Delfinado et al. 1976
— Setae 3b, 4a and 4b not modified, setiform ...... 18

18. Setae f and h1 lanceolate .................. I. tataricus Sevastianov, 1964
— Setae f and h1 not lanceolate .................. 19

19. Setae 3c at the same level or posterior to 3b ... 20
— Setae 3c anterior to 3b ............................. 21

20. Setae c1 and d subequal; setae f longer than h1; setae 4a shorter than ps1..................... I. imaginatus Mahunka, 1981
— Setae c1 shorter than d; setae f and h1 subequal; setae 4a longer than ps1 .... I. tenuis Mahunka, 1981

21. Setae ps2 longer than half of ps1 length ....... 22
— Setae ps2 not longer than half of ps1 length .... 23

22. Setae e and h2 longer than f and h1; interval between setae 4a longer than that between 4b ...................... I. longisetosus Willman, 1951
— Setae e and h2 shorter than f and h1; interval between setae 4a shorter than that between 4b ...................... I. comatus Mahunka, 1970

23. Setae ps2 equal to half of ps1 length................
— Setae ps2 shorter than half of ps1 length ....... 24

24. Setae f longer than h1 ....................... 25
— Setae f not longer than h1 ....................... 26

25. Setae d longer than h2; trochanter IV seta d not reaching to base of tarsus ................ I. placidus Khaustov and Chydyrov, 2004
— Setae d shorter than h2; trochanter IV seta d protruding base of tarsus .... I. lentus Khaustov, 2008

26. Setae f shorter than interval between their bases ................................. 27
— Setae f longer than interval between their bases ................................. 28

27. Setae d never reaching to bases of tergite EF setae; setae 4b never reaching to posterior border of idiosoma .................. I. kugitangensis Khaustov and Chydyrov, 2004
— Setae d extending beyond bases of tergite EF setae; setae 4b reaching to posterior border of idiosoma .................. I. burgeri Ebermann and Jagersbacher-Baumann, 2013

28. Setae h1 distinctly longer than h2; setae ps1 and h2 subequal ................ I. histrinicus Berlese, 1903
— Setae h1 shorter than h2; setae h2 distinctly longer than ps1 ........ I. parapicola Delfinado et al., 1976

29. Tibiotarsus I without claw .................. 30
— Tibiotarsus I with claw .......................... 32

30. Setae h1 and h2 distinctly thickened, with extremely large barbs ...... S. eucomus (Berlese, 1908)
— Setae h1 and h2 not thickened, with no large barbs .................. 31
31. Setae $h_1$ shorter than interval between their bases; setae $4a$ and $h_1$ subequal... $S. quadrangularis$ (Paoli, 1911)
   — Setae $h_1$ longer than interval between their bases; setae $h_1$ longer than $4a$... $S. contiguus$ Delfinado et al., 1976
32. Setae $4b$ absent... $S. ebermanni$ Sobhi and Hajiqanbar, 2017
   — Setae $4b$ present... 33
33. Setae $e$ and $h_2$ reduced... 34
   — Setae $e$ and $h_2$ well developed... 36
34. Apodemes 5 well developed; secondary transverse apodeme (sta) present... $S. shajariensis$ Sobhi and Hajiqanbar, 2017
   — Apodemes 5 reduced; secondary transverse apodeme (sta) absent... 35
35. Setae $ps_1$ and $ps_2$ subequal, barbed, longer than $4a$... $S. remissus$ Khaustov, 2008
   — Setae $ps_1$ longer than $ps_2$; $ps_1$ weakly barbed, $ps_2$ smooth, both shorter than $4a$... $S. iranicus$ Ebermann et al., 2003
36. Setae $f$ characteristically short, at least five times shorter than $e$ and $h_2$... $S. transfusionis$ Mahunka and Mahunka-Papp, 1980
   — Setae $f$ well developed, not as above... 37
37. Tibiotarsus IV with six setae... 38
   — Tibiotarsus IV with seven setae... 39
38. Setae $4b$ more than four times longer than $4a$; setae $ps_1$ and $ps_2$ subequal... $S. subquadratus$ Khaustov and Chydyrov, 2004
   — Setae $4b$ about twice as long as $4a$; setae $ps_1$ twice as long as $ps_2$... $S. apodemi$ Mahunka, 1963
39. Setae $f$ and $h_1$ pinnate; $h_2$ thickened with large barbs... $S. plulosus$ (Paoli, 1911)
   — Setae $f$, $h_1$ and $h_2$ not as above... 40
40. Setae $c_1$, $d$, $f$ and $h_1$ clavate... $S. claviger$ (Paoli, 1911)
   — Setae $c_1$, $d$, $f$ and $h_1$ not clavate... 41
41. Setae $e$ and $h_2$ subequal, spine-like... $S. acarorum$ (Goeze, 1780)
   — Setae $e$ and $h_2$ in various length, not spine-like... 42
42. Barbed setae $f$ at least eight times longer than smooth setae $e$... $S. communis$ Delfinado et al., 1976
   — Setae $e$ longer than $f$ or $f$ only slightly longer than $e$... 43
43. Setae $e$ distinctly longer than $f$; setae $f$ and $h_1$ lanceolate... $S. shivicki$ Lazauskene and Sevastianov, 1974
   — Setae $f$ slightly longer than $e$; setae $f$ and $h_1$ not lanceolate... 44
44. Setae $ps_1$ and $ps_2$ subequal, longer than $ps_3$; setae $f$ and $h_1$ subequal... $S. fragariae$ Rack, 1975
   — Setae $ps_1$ longer than subequal setae $ps_2$ and $ps_3$; setae $h_1$ longer than $f$... $S. serotinus$ Sevastianov and Chydyrov, 1992

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