



Introduction to Springtails (Arthropoda: Hexapoda) fauna from Ilam province (western Iran) with a new record from Sminthuridae

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ABSTRACT. In order to extend the work on Iranian Collembolan fauna, several samplings from leaf litter and soils conducted in Ilam province (west of Iran). Specimens were collected from different localities and extracted by Berlese funnels. Results from the study lead to identification of 11 species of five families: Onychiuridae (with two genera and two species), Tullbergiidae (with one genus and one species), Hypogastruridae (with one genus and one species), Isotomidae (with four genera and four species) and Entomobryidae (with one genus and one species). *Sminthurus muscicolus* Betsch, 1977 from Sminthuridae was new for Iranian fauna. All species from the present study reported for the first time from Ilam province. Short explanation of each collected species including the material studied, a distribution and a short description for the new record and some illustrations are given.

Key words: Zagros Mountains, Collembola, new record, Ilam province, Iran

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Introduction

Collembola or springtails are about 9000 published species worldwide (Bellinger et al., 1996–2019). In Iran, described species is about 227 (Shayanmehr et al., 2019). They are small, entognathous and wingless hexapods with antennae always present. Most but not all Collembola may be

recognized by furca (posterior ventral forked abdominal appendage (Bellinger et al., 1996–2019). They are considered beneficial and only a few species are pest on crops (Hopkin, 1977; Chahartaghi-Abnieh, 2007). Collembola play an important role in decomposition processes,

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nutrient cycling, in forming soil microstructures and in modifying plant growth, and thus received considerable attention (Petersen, 2002; Filser et al., 2002).

Of province of western Iran, 88 species were published (Kahrarian, 2019) which Ilam Province shared only three recorded species (*Metaphorura riozoi* Castaño-Meneses, et al., 2000, *Hemisotoma quadrioculata* (Martynova, 1967) and *Isotoma anglicana* (Lubbock, 1862) (Shayanmehr et al., 2017). In this study, to extend the work on Iranian Collembola fauna, samplings were arranged in different localities of Ilam city.

Material and methods

Collembola specimens were collected from the surface layer of soil and leaf litter in different localities of Ilam province (33°38' N, 46°26' E), western Iran, during years 2014–2015. The soil samples were retained in white plastic boxes and transferred to the laboratory. Specimens were extracted by Berlese funnel (60 W lamp during one week) and preserved in 75% ethanol. The pigmented samples were cleared in KOH and their important taxonomic structures were made visible. After preparing slides by Hoyer medium, the specimens were identified and confirmed by Masoumeh Shayanmehr (Sari University of Agricultural Sciences and Natural Resources, Mazandaran province) and Igor Kaprus (National Academy of Sciences of Ukraine). All specimens and slides are deposited in Department of Plant Protection of Sari University of Agricultural Sciences and Natural Resources, and in the Collection of Department of Plant Protection, College of Agriculture, Ilam University, Iran (ILAMU).

Results

In the present study, 11 species from five different families were collected and identified which all recorded for the first

time from Ilam province. Amongst them, *Sminthurus muscicolus* Betsch, 1977 was recorded for the first time for Iranian fauna.

Family Onychiuridae

This family included 628 species in the world (Bellinger et al., 1996-2019), of which 27 species are known from Iran (Shayanmehr et al., 2019). Here, two following species are recorded for Ilam fauna.

Protaphorura levantina (Christiansen, 1956)

(Fig. 1)

Material studied. Iran, 5 specimens, Ilam province: soil under Oak trees (*Quercus brantii*), Arghavan Forest Park (33°38'57.694" N, 46°26'54.900"E, alt. 1517 m), Ilam, March 2014; soil under Oak trees (*Quercus brantii*), Gachan Mountain, Ilam (33°38'57" N, 46°30'31" E, 2383m alt.), March 2014, January 2015; soil and leaf litter under Cypress trees (*Cupressus* spp.), Ilam University, Ilam (33°45'6.806" N, 46°22'49.648" E, alt. 1395 m), September 2015; soil under Rose flowers (*Rosa* spp.), Ilam University (33°45'6.806" N, 46°22'49.648" E, alt. 1395 m), Ilam, August 2015.

Distribution: Iran: Kermanshah, collected on soil and leaf litter under Oak trees (Kahrarian et al., 2019); Lebanon and Syria (Christiansen, 1957).

Thalassaphorura zschokkei (Handschin, 1919)

(Fig. 2)

Material studied. Iran, 6 specimens, Ilam province: soil and leaf litter under Oak trees (*Quercus brantii*), Gachan Mountains (33°38'43.08" N, 46°29'9.96" E, alt. 2330 m), Ilam, February 2014.

Distribution: Iran: Lorestan, Khoram-Abad (Shayanmehr et al., 2016), Kermanshah (Kahrarian, 2017); Europe, North America and Russia (Bellinger et al., 1996–2019).

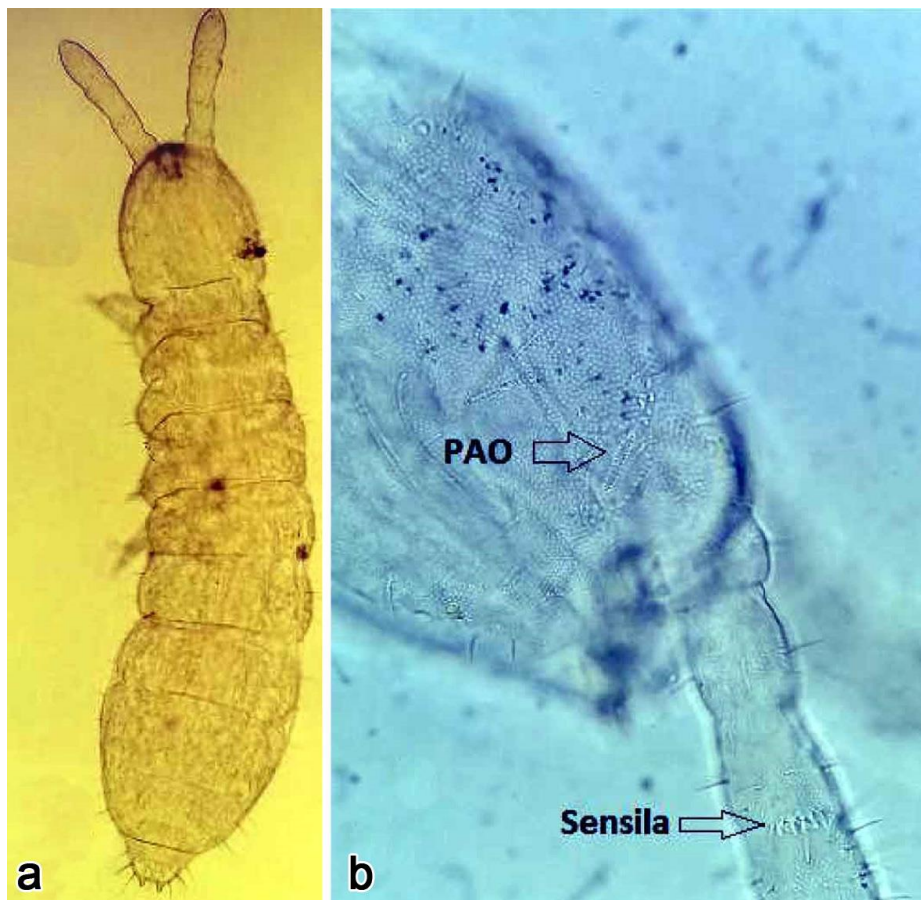


Figure 1. *Protaphorura levantina* (a) Adult; (b) Post antennal organ (PAO) and sensila on antennal segments III.

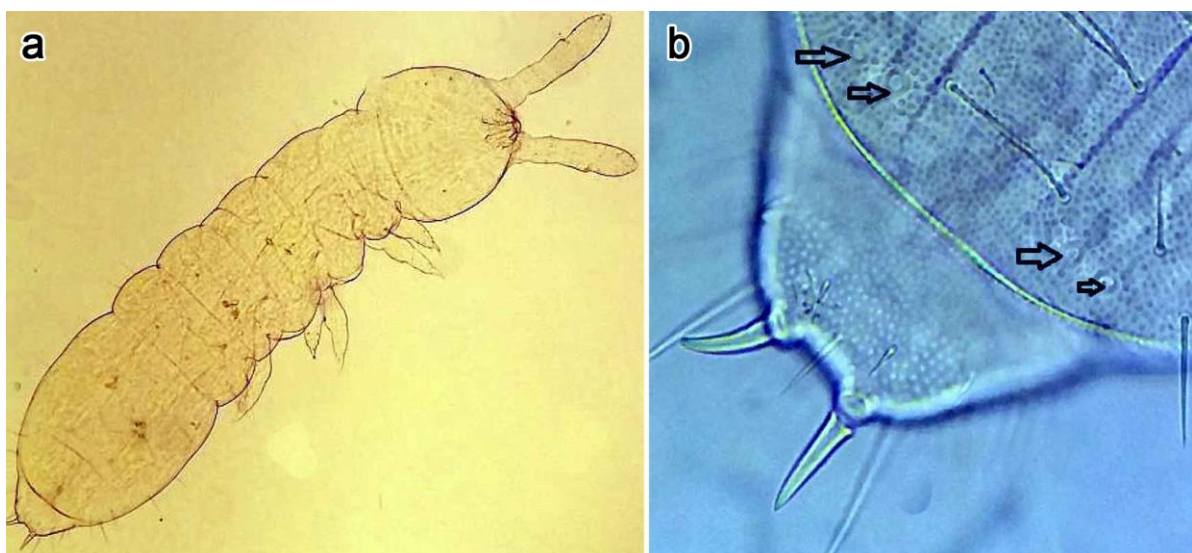


Figure 2. *Thalassaphorura zschokkei* (a) Adult; (b) Pseudocelli on dorsal body.

Family Tullbergiidae

This family included 217 species in the world (Bellinger et al., 1996-2019), of which only 12 species are known from Iran (Shayanmehr et al., 2019). Already *Metaphorura riozoi* Castaño-Meneses et al., 2000 reported from Ilam (Shayanmehr et al., 2017). Here, the following species is recorded from Ilam province.

Metaphorura affinis (Börner, 1902) (Fig. 3)

Material studied. Iran, 5 specimens, Ilam province: soil and leaf litter under Cypress trees (*Cupressus* spp.), Ilam University (33°45'6.806" N, 46°22'49.648" E, alt. 1395 m), Ilam, September 2015.

Distribution: Iran: Guilan, Azarbaijan, and Kermanshah (Cox, 1982; Ghahramani-nezhad et al., 2013; Daghighi et al., 2013a); from Palaeartic, wide spread Nordic countries, Europe, and Middle East (Dunger & Schlitt, 2011).



Figure 3. General habitus of *Metaphorura affinis* (original).

Family Hypogastruridae

This family included 699 species in the world (Bellinger et al., 1996-2019), of which 27 species are known from Iran (Shayanmehr et al., 2019). Here, two species were collected from Ilam province.

Ceratophysella denticulata (Bagnall, 1941)

(Fig. 4)

Material studied. Iran, 8 specimens, Ilam province: soil under Oak trees (*Quercus brantii*), Arghavan Forest Park (33°38'57.694" N, 46°26'54.900" E, alt. 1517 m), Ilam, March 2014; soil under Oak trees (*Quercus brantii*), Gachan Mountain (33°38'43.08" N, 46°29'9.96" E, alt. 2330 m), Ilam, March 2014, January 2015; soil and leaf litter under Cypress trees (Cupressaceae), Choqa-Sabz Forest Park (33°36'41" N, 46°23'47" E, alt. 1321 m), Ilam, March 2014 and March 2015; soil under Oak trees (*Quercus brantii*), Arghavan Forest Park (33°38'57.694" N, 46°26'54.900" E, alt. 1517 m), Ilam, May 2014.

Distribution: Iran: Mazandaran, Guilan, Zanjan, Kermanshah and Azerbaijan (Cox, 1982; Yahyapour, 2012; Kahrarian, 2019); cosmopolitan (Thibaud et al., 2004).

Xenylla welchi Folsom, 1916

Material studied. Iran, 5 specimens, Ilam province: soil under Oak trees (*Quercus brantii*), Arghavan Forest Park (33°38'57.694" N, 46°26'54.900" E, alt. 1517 m), Ilam, March 2014.

Distribution: Iran: Mazandaran and Kohgiluyeh and Boyer-Ahmad (Yahyapour, 2012; Falahati Hossein-Abad et al., 2012); Nearctic, Neotropical, Australia, Palearctic (Fjellberg, 1988).

Family Isotomidae

This family is one of the biggest included 1397 species in the world (Bellinger et al., 1996-2019), of which 51 species are known from Iran until 2019 (Shayanmehr et al.,

2019). Shayanmehr, et al. 2017, reported already species, *Isotoma anglicana* (Lubbock, 1862) as new record. Here, four species were collected from Ilam province.

Anurophorus sp. (Fig. 5)

Material studied. Iran, 5 specimens, Ilam province: soil and leaf litter under Cypress trees (*Cupressus* spp.), Choqa-Sabz Forest Park (33°36'41" N, 46°23'47" E, alt. 1321 m), Ilam, February 2014 and March 2015.

Remarks. In Iran, *A. coiffaiti* Cassagnau & Delamare, 1955 was collected from the north and Kermanshah (Kahrarian, 2019), and some specimens of this genus were also detected by Yoosefi Lafooraki &

Shayanmehr (2014b) from Mazandaran, however the species was unknown. In Iran from Golestan and Guilan provinces already collected some specimens which species also remained unknown (Falahati Hossein-Abad et al., 2012; Daghighi et al., 2013a, 2013b). Herein, the genus is being recorded for the first time from the Ilam province, and we need to check type specimens for species level. This species has dark color and furca completely reduced. The fourth antennal organ has apical bulb. The fifth abdominal segment covered with many setae on the dorsal side (Fjellberg, 1998; Potepov, 2001).

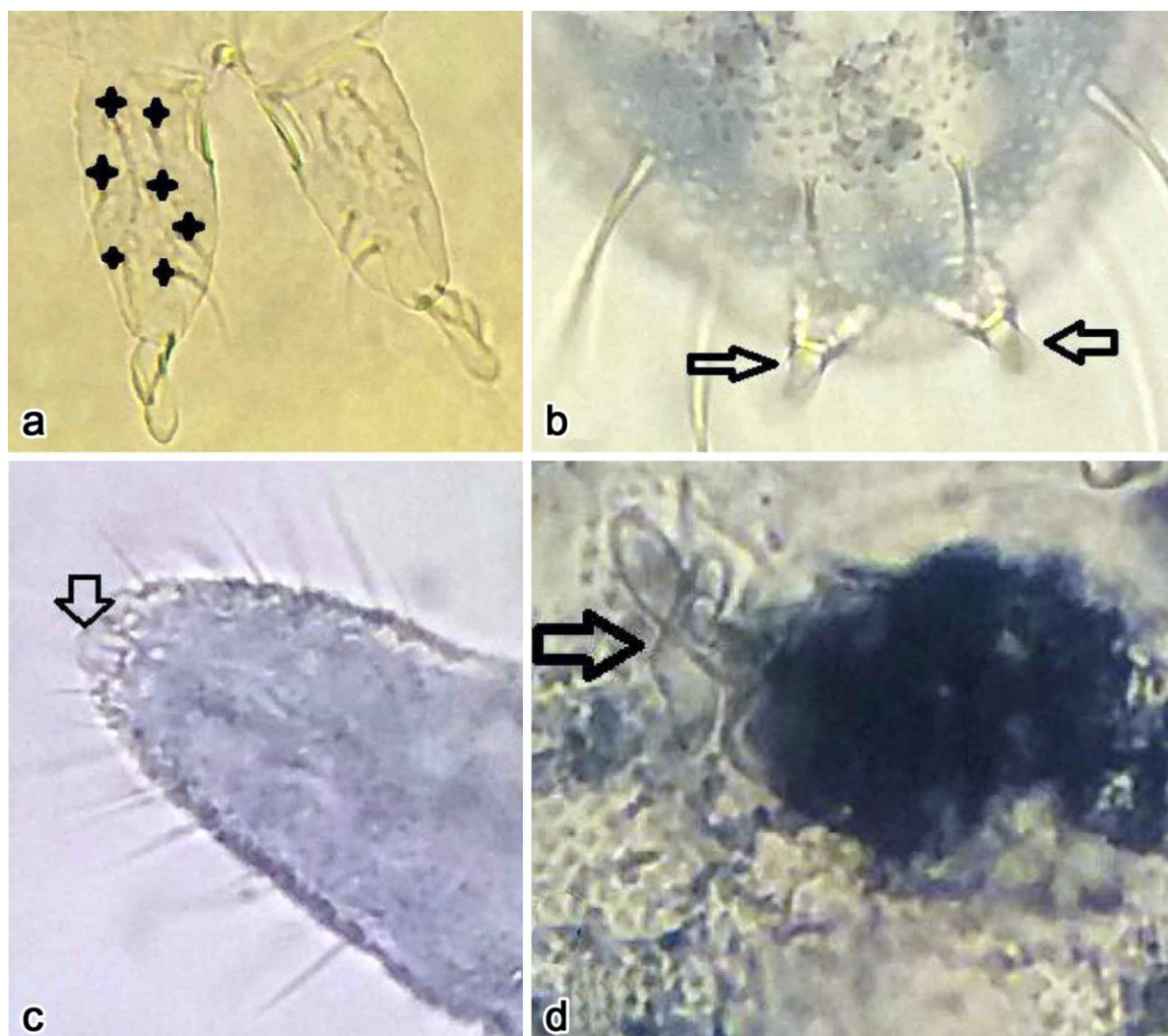


Figure 4. *Ceratophysella denticulata* (a) Seven setae on the dens; (b) Long anal spines; (c) Apical bulb on antennal segments IV; (d) Post antennal organ (PAO).

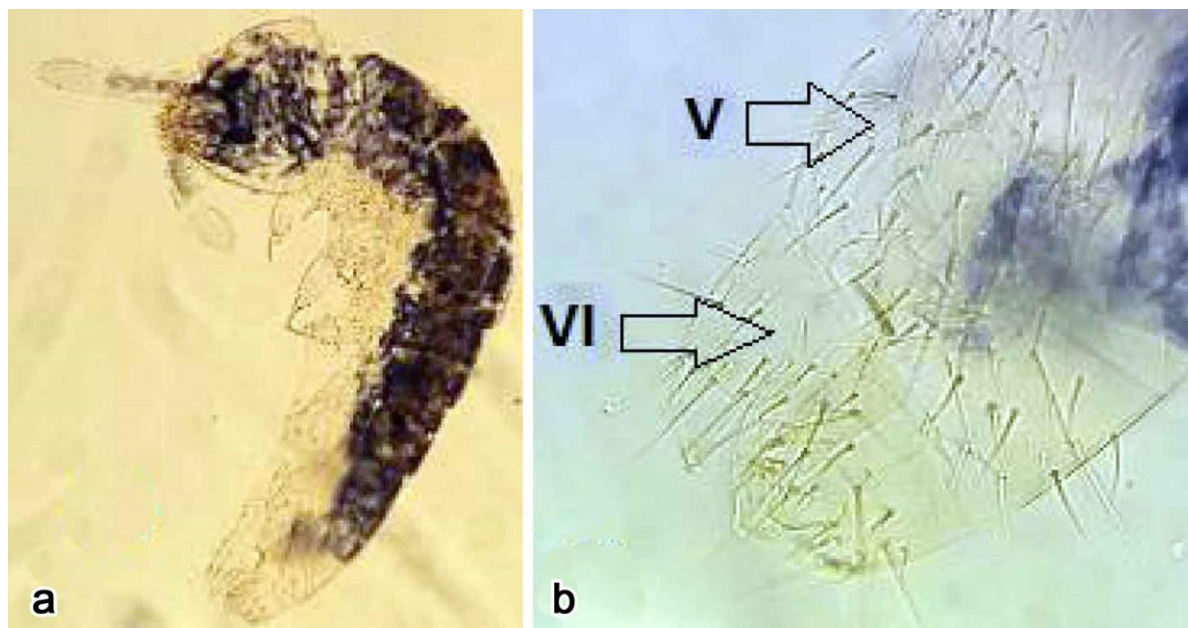


Figure 5. *Anurophorus* sp. (a) Adult; (b) Fifth and sixth abdominal segments.

***Folsomia quadrioculata* (Tullberg, 1871)**

Material studied. Iran, 12 specimens, Ilam province: soil and leaf litter under Cypress trees (*Cupressus* spp.), Choqa-Sabz Forest Park (33°36'41" N, 46°23'47"E, alt. 1321 m), Ilam, February 2014 and March 2015.

Distribution: Iran: Mazandaran, E. and W. Azerbaijan, Guilan and Kermanshah (Cox, 1982; Arbea & Kahrarian, 2015); Palaearctic and Holarctic regions (Potapov, 2001).

Diagnosis: Body pale and spotted. 2+2 ommatidia, far from each other. PAO narrow, constricted, longer than width of Ant. I. Claw without teeth. Ventral tube with 3+3 laterodistal and usually 6 posterior setae. Retinaculum with 4+4 teeth and 1 seta. Manubrium with 1+1 anterior setae. Posterior side of manubrium with 3+3 laterodistal, 2+2 central setae, 2+2 distal and 1 apical unpaired seta. 1+1 setae on lateral sides. Dens crenulated, normally with 8 anterior and 3 posterior setae. Mucro with two teeth.

***Folsomides marchicus* (Frenzel, 1941) (Fig. 6)**

Material studied. Iran, 10 specimens, Ilam province: soil and leaf litter under Scots

pine (*Pinus* spp.), Dalab Forest Park (33°40'20" N, 46°20'56"E, alt. 2650 m), Ilam, March 2014; soil and leaf litter under Cypress trees (*Cupressus* spp.), Choqa-Sabz Forest Park (33°36'41" N, 46°23'47" E, alt. 1321 m), Ilam, February 2014 and March 2015; soil and leaf litter under Cypress trees (*Cupressus* spp.), Ilam University (33°45'6.806" N, 46°22'49.648" E, alt. 1395 m), Ilam, September 2015; soil under Rose flowers (*Rosa* spp.), Ilam University (33°45'6.806" N, 46°22'49.648" E, alt. 1395 m), Ilam, August 2015; soil under wheat (*Triticum aestivum*), Sadd-e-Ilam, Ilam, April 2015; soil and leaf litter under Oak trees (*Quercus brantii*), Gachan Mountains (33°38'43.08" N, 46°29'9.96" E, alt. 2330 m), Ilam, February 2014.

Distribution: Iran: Kermanshah (Kahrarian et al., 2012); European countries (Potepov, 2001).

Diagnosis: It is greyish-blue with 5+5 Ommatidia. The length is 0.8–1 mm. Post antennal organ (PAO) 2–3 times as long as an Ommatidia. Dens with 3 posterior and no anterior setae. Retinaculum with 3+3 teeth and one seta. Empodium about 1/3 as

long as claw. Manubrium with 3+3 setae on basal and 8 setae on main part. Mucrodens with 2 posterior setae. Mucro bidentate appears separate from the dens (Potepov, 2001).

Hemisotoma pontica (Stach, 1947) (Fig. 7)

Material studied. Iran, 8 specimens, Ilam province: soil under Oak trees (*Quercus brantii*), Arghavan Forest Park (33°38'57.694" N, 46°26'54.900" E, alt. 1517 m), Ilam, May 2014.

Distribution: Iran: Central, Mazandaran, Guilan, East and West Azerbaijan, Tehran and Kermanshah (Cox, 1982; Morravvej, 2003; Kahrarian et al., 2012; Yahyapour &

Shayanmehr, 2013; Yoosefi Lafooraki & Shayanmehr, 2014b); Portugal, Spain, France, Australia, Germany, Italy, Hungary, Lebanon, and Afghanistan (Potepov, 2001).

Diagnosis: It is greyish with 5+5 Ommatidia. The length is about 1 mm. Post antennal organ (PAO) narrowly elliptical, constricted and 3–4 times as long as an Ommatidia. Claws with small inner tooth. Tibiotarsi without clavate hairs. Ventral tube with 4+4 laterodistal and 4–5 posterior setae. Retinaculum with 4+4 teeth and one setae. Dens with 6–7 setae on posterior side. The subapical seta a little longer than mucro. Mucro with two teeth (Potepov, 2001).



Figure 6. *Folsomides marchicus* (a) General characters; (b) 5+5 Ommatidia; (c) Dens with 3 posterior setae.

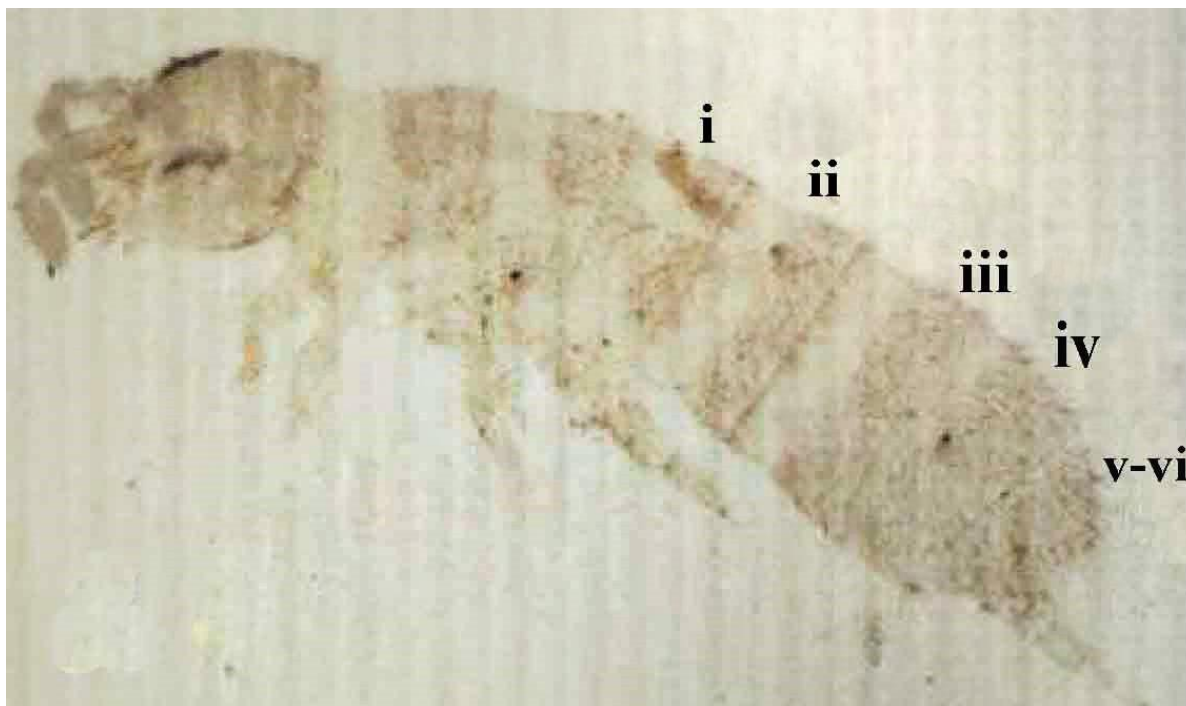


Figure 7. *Hemisotoma pontica*, General characters with fifth and sixth abdominal segments (from Yoosefi Lafooraki and Shayanmehr, 2014).

Family Entomobryidae

This family included up to 1000 species in the world (Bellinger et al., 1996-2019), of which 42 species are known from Iran until 2019 (Shayanmehr et al., 2019).

Pseudosinella octopunctata Börner, 1901

(Fig. 8)

Material studied. Iran, Ilam province: soil and leaf litter under Cypress trees (Cupressaceae), Choqa-Sabz Forest Park (33°36'41" N, 46°23'47" E, alt. 1321 m) Ilam, March 2014 and March 2015.

Distribution: Iran: Guilan, Zanjan, East and West Azerbaijan, Central, Mazandaran, Isfahan and Kermanshah (Cox, 1982; Yoosefi Lafooraki & Shayanmehr, 2013; Yahyapoor & Shayanmehr, 2013; Yoosefi Lafooraki & Shayanmehr, 2014a; Kahrarian et al., 2014); Cosmopolitan (Fjellberg, 2007).

Diagnosis: White, with diffuse bluish grey pigment on antenna and dorsal and ventral

side of head, body with scattered brownish red pigment. With 4+4 ommatidia. Maxillary outer lobe with three sublobal hairs and a small spine. Claws narrow, with small-paired inner teeth, posterior slightly larger and more distal than anterior. Lateral teeth small, set beyond middle of unguis. Fourth segment of abdomen with 3+3 macrochaetae in the median field (Fjellberg, 2007; Yoosefi Lafooraki & Shayanmehr, 2014a).

Family Sminthuridae

This family included 240 species in the world (Bellinger et al., 1996-2019), of which only seven species are known from Iran until 2019 (Shayanmehr et al., 2019). Here, the species *Sminthurus muscicolus* is recorded from Ilam province is newly recorded for Iran.

Sminthurus muscicolus Betsch, 1977 (Fig. 9)

Material studied. Iran, 5 specimens, Ilam province: soil and leaf litter under Cypress

trees (Cupressaceae), Choqa-Sabz Forest Park (33°36'41" N, 46°23'47" E, alt. 1321 m), Ilam, March 2014 and March 2015.

Distribution: Iran: The species is reported for the first time from Iran; Central and West Asia (Fjellberg, 2007).

Description. The Colour is yellow with some dark or violet marbling. Size of body 1-2.5 mm. Postantennal setae broad. Ant IV

with 16 subsegments. Ret with four setae. Anterior setae of dens with 3,3,2,2,1,1 setae. Both edges of mucro wavy, setae missing. Claws without tunica, with inner and weak, basal outer tooth; Empodium with tooth, all filaments very short and thin.

Remarks. The species is new for Iranian Collembola fauna.

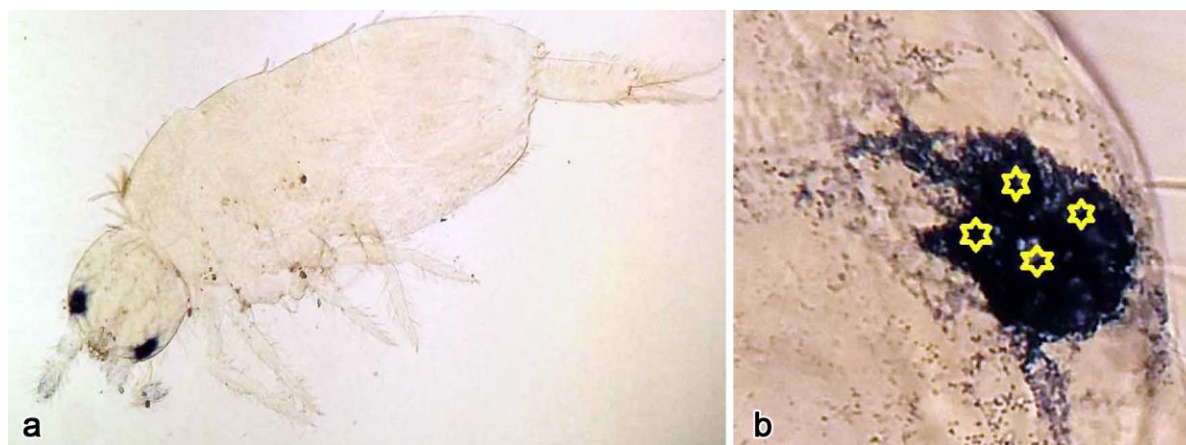


Figure 8. *Pseudosinella octopunctata* (a) General characters; (b) With 4+4 ommatidia in dark patch.

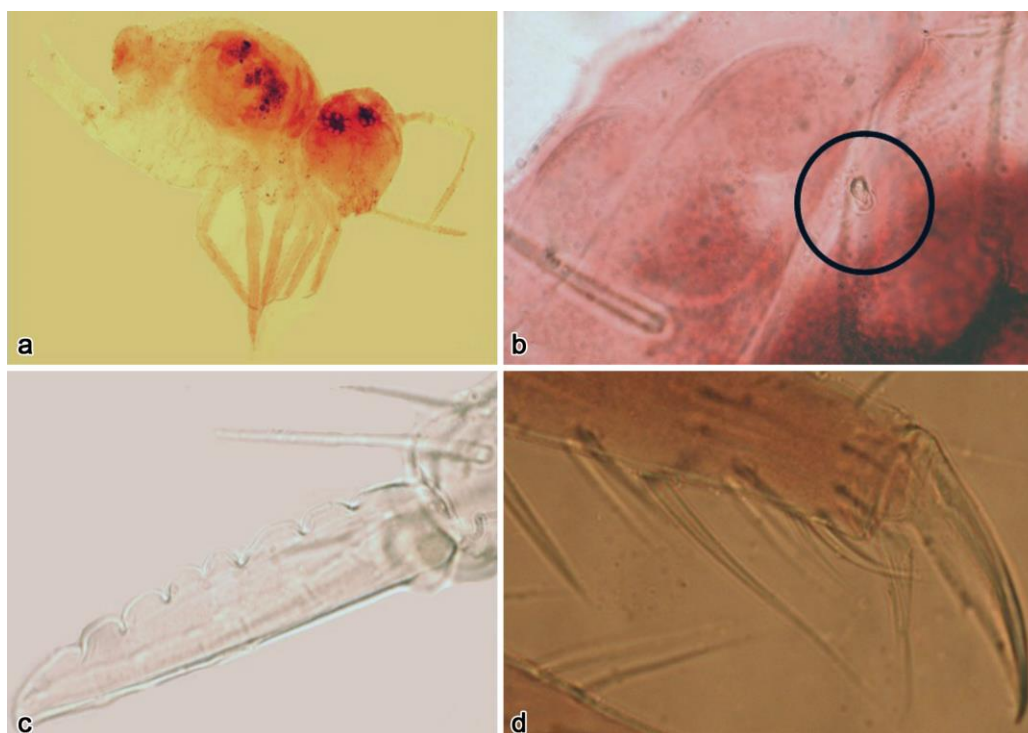


Figure 9. *Sminthurus muscicolus* (a) Body habitus, (b) postantennal setae broad, (c) mucro edges wavy, without setae, (d) claw with inner tooth.

Discussion

In order to add to Iranian Collembolan fauna, the study was conducted in Ilam province (west of Iran). From this province already three species including *Metaphorura riozoi* Castano-Meneses, Palacios-Vargas and Traser, 2000, *Hemisotoma quadrioculata* (Martynova, 1967) and *Isotoma anglicana* (Lubbock, 1862) were reported (Shayanmehr et al., 2017). Results of this study added 11 species of five families, e.g. Onychiuridae (2 species), Tullbergiidae (1 species), Hypogastruridae (1 species), Isotomidae (4 species) and Entomobryidae (1 species). *Sminthurus muscicolus* Betsch, 1977 from Sminthuridae was new for Iranian fauna. All species from the present study reported for the first time from Ilam province.

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Conflict of Interests

The authors declare that there is no conflict of interest regarding the publication of this paper.

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آشنایی با فون دم‌فتری‌ها (Arthropoda: Hexapoda) استان ایلام (غرب ایران) با گزارش جدید از خانواده Sminthuridae

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چکیده: به منظور گسترش دانش فون پادمان ایران، چندین نمونه‌برداری از خاک‌برگ و خاک در استان ایلام (غرب ایران) انجام شد. نمونه‌ها از مناطق مختلف جمع‌آوری و توسط قیف‌های برلیز استخراج شدند. نتایج حاصل از مطالعه منجر به شناسایی ۱۱ گونه از ۵ خانواده شد: خانواده Onychiuridae (با دو جنس و دو گونه)، Tullbergiidae (با یک جنس و یک گونه)، Hypogastruridae (با یک جنس و یک گونه)، Isotomidae (با چهار جنس و چهار گونه) و Entomobryidae (با یک جنس و یک گونه). *Sminthurus muscicolus* Betsch, 1977 از خانواده Sminthuridae برای فون ایران جدید بود. تمام گونه‌های مطالعه حاضر برای اولین بار از استان ایلام گزارش شده است. توضیح مختصری درباره هر گونه شامل مواد مورد مطالعه، پراکنش و توصیفی کوتاه برای رکورد جدید و برخی از تصاویر ارائه شده است.

واژگان کلیدی: کوه‌های زاگرس، پادمان، رکورد جدید، استان ایلام، ایران