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FIRST REPORT OF THE GENUS *AETHIOPELLA* HANDSCHIN, 1942 AND SPECIES *FOLSOMIA INOCULATA* STACH, 1947 (HEXAPODA, COLLEMBOLA) FROM IRAN

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Abstract

Collembola are a widespread and abundant group of arthropods with distribution all over the world. Collembola fauna is less well-known in the northern districts of Iran. This study was conducted to investigate the Collembola fauna in the forests of Mazandaran province, North Iran, during 2016. During this study, 13 genera and 9 species belonging to 6 families were found. The genus *Aethiopella* Handschin, 1942 and the species *Folsomia inoculata* Stach, 1947 are reported for the first time from Iran, with the genus *Arrhopalites* Börner, 1906 recorded for the first time from Mazandaran province.

KEY WORDS: fauna, Isotomidae, Mazandaran, Neanuridae

Introduction

Collembola (springtails) are primarily wingless insects, with numerical dominance in soils. These arthropods play important roles in soil formation, especially in the process of decomposition and in nutrient cycling. They also can affect fungal composition and activity (Hopkin, 1997). Over the last few years, the study of Collembola fauna in Iran has become more intensive. Firstly, a list of Collembola families, genera and species was recorded from Iran up to 2013 (Masoumeh Shayanmehr, Yahyapour, Kahrarian, & Lafooraki, 2013), and then the study of Collembola was expanded by some faunal research in the different parts of Iran (Kahrarian, 2015; Qazi & Shayanmehr, 2014; Smolis, Shayanmehr, & Yoosefi-Lafooraki, 2018; E Yoosefi Lafooraki & Shayanmehr, 2015b).

Aethiopella species were included in *Ceratrimeria* Börner, 1906, which was then divided into two new genera, *Aethiopella* and *Neotropiella*, after a revision of the genus by Handschin (1942). Both new genera are characterized by the presence of a moruliform postantennal organ and a well-developed furcula, but in contrast to species of the genus *Aethiopella*, which have 8 eyes per side, *Neotropiella* are characterized by the presence of 5-7 eyes. *Folsomia* Willem, 1902, as a cosmopolitan genus, is found on all continents. Its members have a reduced number of ocelli. They live in soil and leaf litter and some of them are parthenogenetic (Potapov & Greenslade, 2010).

In the current study, we present new information on the occurrence of some collembolan species in Mazandaran province. However, it is presumed that many more species are yet to be discovered in Iran. The main objective of this study, which is a part of our research on the Collembola fauna of Iran, is to improve knowledge about this group of Hexapods.

Materials and methods

Soil and leaf litter samples were collected during 2016 from forests in Mazandaran province by Elliyeh Yahyapour. Geographical data of the sampling sites were obtained by GPS receiver. Samples were transferred to the laboratory of Sari Agricultural Sciences and Natural Resources University, Mazandaran. After extraction by Tullgren funnels, Collembola specimens were isolated for further study. The specimens, some of which were cleared in Nesbit's solution, were mounted on Hoyer's medium to make microscopic slides, after which they were identified to genera and species levels using valid keys. Data on the examined material are presented in Table I. Microscopic slides and specimens preserved in alcohol are maintained in the laboratory of the University.

Table I. Data about sampling taxa

Taxon	Forest name	County	Latitude	Longitude	Altitude
Arrhopalites sp.	Dasht naz	Sari	N 36° 71' 10"	E 53° 9' 11"	11
Tomocerus vulgaris	Dasht naz	Sari	N 36° 71' 10"	E 53° 9' 11"	11
	Dohezar	Tonekabon	N 36° 40' 21"	E 50° 49' 28"	443
Heteromurus gigans	Dasht naz	Sari	N 36° 71' 10"	E 53° 09' 11"	11
	Filband	Babol	N 52° 30' 45"	E 36° 22' 12"	1950
	Zare	Sari	N 36° 32' 44"	E 53° 07' 53"	113
Entomobrya atrocincta	Dasht naz	Sari	N 36° 71' 10"	E 53° 09' 11"	11
Lepidocyrtus sp.	Dasht naz	Sari	N 36° 71' 10"	E 53° 09' 11"	11
Seira domestica	Dasht naz	Sari	N 36° 71' 10"	E 53° 09' 11"	11
Orchesella cincta	Filband	Babol	N 52° 30' 45"	E 36° 22' 12"	1950
Folsomia inoculata	Dasht naz	Sari	N 36° 71' 10"	E 53° 09' 11"	11
	Zare	Sari	N 36° 71' 10"	E 53° 09' 11"	113
Anurophorus sp.	Dasht naz	Sari	N 36° 71' 10"	E 53° 09' 11"	11
Isotomurus italicus	Dasht naz	Sari	N 36° 71' 10"	E 53° 09' 11"	11
	Zare	Sari			113
Proisotoma minima	Zare	Sari	N 36° 32' 44"	E 53° 07' 53"	443
Aethiopella sp.	Dohezar	Tonekabon	N 36° 40' 21"	E 50° 49' 28"	443
Ceratophysella denticulata	Dasht naz	Sari	N 36° 71' 10"	E 53° 09' 11"	11

Results

A total of 13 genera and 9 species belonging to 6 families were found in forests of Mazandaran province, of which three species have been identified. Characteristics of the other collected material are not in concordance with the data in the identification keys and with the description of existing species. Genus *Aethiopella* and species *Folsomia inoculata* are new for Iranian fauna. Additionally, the genus *Arrhopalites* Börner, 1906 is reported for the first time from Mazandaran province.

Family: Arrhopalitidae Stach, 1956

***Arrhopalites* sp.**

Analyzed material: Mazandaran, Sari, Dasht-e-Naz, 36º71'10" N; 53º09'11" E, 11 m, 13.08.2016.

General distribution: The genus occurs in North America, Asia, Europe, Australia, Brazil, Mediterranean, New Zealand, Caribbean Mainland, Arctic and Subarctic, Malaysia.
Distribution in Iran: Reported from Guilan, East Azerbaijan and Kermanshah provinces (Cox, 1982; Daghighi, Hajizadeh, Hosseini, & Moravvej, 2013b; F. Ghahramaninezhad & Agheli, 2010; Kahrarian, 2015). It is the first report of *Arrhopalites* Börner, 1906 from Mazandaran province.

Family: Tomoceridae Schäffer, 1896

***Tomocerus vulgaris* (Tullberg, 1871)**

Analyzed material: Mazandaran, Sari, Dasht-e-Naz, 36º71'10" N; 53º09'11" E, 11 m, 13.08.2016; Tonekabon, 36º40'21" N; 50º49'28" E, 443 m, 20.01.2016.

General distribution: Arctic and Subarctic, Asia, Europe, North America, Caribbean Mainland, Antarctic and Subantarctic, North and East Australia, Malaysia.
Distribution in Iran: *Tomocerus* Nicolet, 1842 was reported from Mazandaran, Guilan, East Azerbaijan, Zanjan, Golestan, Kerman and Kermanshah provinces (Abdolalizadeh, 2018; Alijani-Ardeshir, Shayanmehr, & Amiri-Besheli, 2017; Balvasi, Chelav, Khashaveh, & Shayanmehr, 2016; Cox, 1982; Ghasemi Cherati, 2017; Kahrarian *et al*., 2014; Kahrarian, Vafaei-Shoushtari, Soleyman-Nejadian, Shayanmehr, & Shams Esfandabad, 2016; Mehrafrooz Mayvan, Shayanmehr, & Scheu, 2015; Elham Yoosefi Lafooraki & Shayanmehr, 2014).

Family: Entomobryidae Schäffer, 1896

***Heteromurus gigans* Mari Mutt& Stomp, 1980**

Analyzed material: Mazandaran, Sari, Dasht-e-Naz, 36º71'10" N; 53º09'11" E, 11 m, 13.08.2016; Sari, Shahid Zare forest, 36º32'44" N; 53º07'53" E, 113 m, 04.04.2016; Babol, Filband, 52º30'45" N; 36º22'12" E, 1950 m, 04.09.2016.

General distribution: Mediterranean.
Distribution in Iran: Recorded from Mazandaran (Ghasemi Cherati, 2017).

***Entomobrya atrocincta* Schött, 1896**

Analyzed material: Mazandaran, Sari, Dasht-e-Naz, 36º71'10" N; 53º09'11" E, 11 m, 13.08.2016.

General distribution: North America.

Distribution in Iran: Recorded from Mazandaran, Tehran, Kermanshah and Golestan (Darvish-Motevalli, 2016; Ghasemi Cherati, 2017; Hosseini, Shayanmehr, & Amiri Besheli, 2016; Kahrarian *et al*., 2016; Qazi & Shayanmehr, 2014; E Yahyapour, Shayanmehr, & Damavandian, 2011; Yoosefi-Lafooraki & Shayanmehr, 2013).

***Lepidocyrtus* sp.**

Analyzed material: Mazandaran, Sari, Dasht-e-Naz, 36º71'10" N; 53º09'11" E, 11 m, 13.08.2016.

General distribution: It has a worldwide distribution.
Distribution in Iran: *Lepidocyrtus* Bourlet, 1839 was reported from Mazandaran, Guilan, East Azerbaijan, Zanjan and Golestan provinces (Cox, 1982; Hosseini, Shayanmehr, *et al*., 2016).

***Seira domestica* Nicolet, 1842**

Analyzed material: Mazandaran, Sari, Dasht-e-Naz, 36º71'10" N; 53º09'11" E, 11 m, 13.08.2016.

General distribution: Africa, North and South America, Caribbean Mainland, Australia, Asia, Europe, Mediterranean.
Distribution in Iran: *Seira* Lobbuock, 1869 was reported from Mazandaran, Kermanshah, Guilan, and Golestan provinces (Arbea & Kahrarian, 2015; Daghighi, Hajizadeh, Hosseini, & Moravvej, 2013a; Daghighi *et al*., 2013b; Kahrarian, Nikpai, & Mohammadinoor, 2012; Kahrarian *et al*., 2016; E Yahyapour *et al*., 2011; Elham Yoosefi Lafooraki & Shayanmehr, 2014).

***Orchesella cincta* (Linnaeus, 1758)**

Analyzed material: Mazandaran, Babol, Filband, 52º30'45" N; 36º22'12" E, 1950 m, 04.09.2016.

General distribution: Eurasia, Mediterranean, African-Indian desert, New Zealand.
Distribution in Iran: *Orchesella* (Linnaeus, 1758) was reported from Mazandaran and Golestan provinces (Balvasi *et al*., 2016; Ghasemi Cherati, 2017; Hosseini, Shayanmehr, *et al*., 2016; Elliyeh Yahyapour, Vafaei-Shoushtari, Shayanmehr, & Arbea, 2018; Elham Yoosefi Lafooraki & Shayanmehr, 2014).

Family: Isotomidae Schäffer, 1896

***Folsomia inoculata* Stach, 1946**

Analysed material: Mazandaran, Sari, Dasht-e-Naz, 36º71'10" N; 53º09'11" E,11 m, 13.08.2016; Sari, Shahid Zare forest, 36º32'44" N; 53º07'53" E, 113 m, 04.04.2016.

General distribution: Eurasia, Mediterranean.
Distribution in Iran: The species is recorded for the first time from Iran.

Description: With 0+0 omma (Ommatidae), reaching a maximum length of 0.2 mm. Manubrium with 2+2 or 2+3 anterior setae (Fig. 1A), dens with 8-12 anterior and 4 posterior setae (3 in base and 1 in middle that is sometimes absent), claw-like chitinous outgrowths near the base of dens (Fig. 1B). Postantennal organ narrow and constricted, slightly longer than width of Ant. I. Apical pair of posterior setae on ventral tube much longer than others.

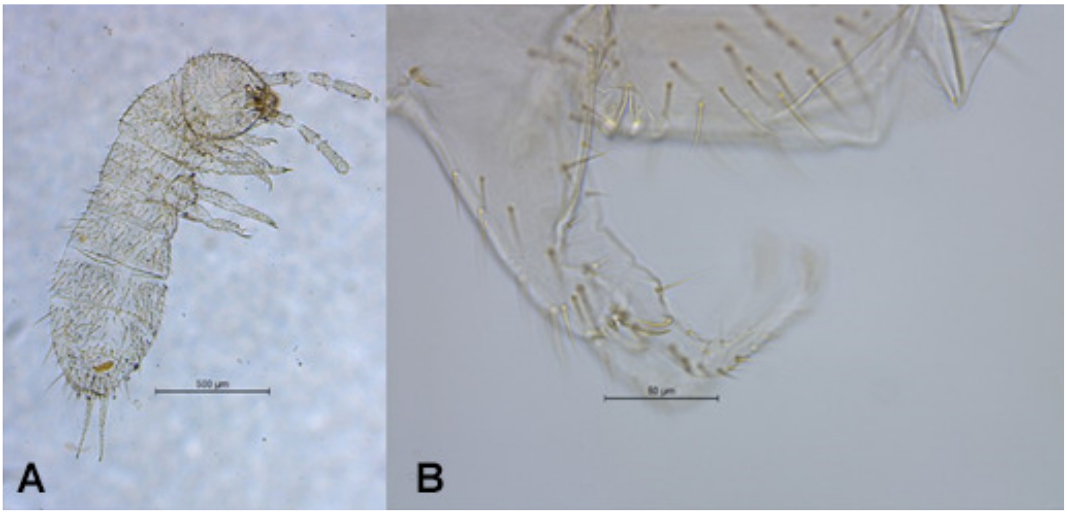

Figure 1. A - Depiction of *Folsomia inoculata* including body habitus. B - Claw-like chitinous outgrowths near the base of dens.

***Anurophorus* sp.**

Analyzed material: Mazandaran, Sari, Dasht-e-Naz, 36º71'10" N; 53º09'11" E, 11m, 13.08.2016.

General distribution: Arctic and Subarctic, Eurasia and North America.
Distribution in Iran: *Anurophorus* Nicolet, 1842 was reported from Mazandaran, Golestan, Guilan and Kermanshah provinces (Arbea & Kahrarian, 2015; Daghighi *et al*., 2013a, 2013b; Falahati Hossein Abad, Potapov, Sarailoo, Shyanmehr, & Yazdanian, 2013; Kahrarian *et al*., 2016; Elham Yoosefi Lafooraki & Shayanmehr, 2014).

***Isotomurus italicus* (Carapelli *et al*., 1995)**

Analyzed material: Mazandaran, Sari, Dasht-e-Naz, 36º71'10" N; 53º09'11" E, -11m, 13.8.2016; Sari, Shahid Zare forest, 36º32'44" N; 53º07'53" E, 113m, 4.4.2016.

General distribution: Arctic and Subarctic, Eurasia, North and South America, Australia, Mediterranean.
Distribution in Iran: *Isotomurus* Börner, 1903 was reported from Mazandaran, Guilan, Khuzestan and Golestn (Alijani-Ardeshir *et al*., 2017; Cox, 1982; Daghighi *et al*., 2013a, 2013b; Darvish-Motevalli, 2016; Ghasemi Cherati, 2017; Hosseini, Shayanmehr, *et al*., 2016; Hosseini, Shyanmehr, & Amiri-Besheli, 2016; Mehrafrooz Mayvan *et al*., 2015; Ramezani & Mossadegh, 2017; Yoosefi-Lafooraki & Shayanmehr, 2013; Elham Yoosefi Lafooraki & Shayanmehr, 2014).

***Proisotoma minima* (Absolon, 1901)**

Analyzed material: Mazandaran, Sari, Shahid Zare forest, 36º32'44" N; 53º07'53" E, 113 m, 04.04.2016.

General distribution: This genus has a worldwide distribution.
Distribution in Iran: *Proisotoma* Börner, 1901 was reported from Mazandaran, Guilan, East and West Azerbaijan, Golestan, Tehran, Kermanshah and Lorestan provinces (Arbea & Kahrarian, 2015; Balvasi *et al*., 2016; Cox, 1982; Daghighi *et al*., 2013a, 2013b; Ghavami, 2016; Hosseini, Shayanmehr, *et al*., 2016;

Moravvej, Potapov, Kamali, & Hodjat, 2007; Nematollahi, Bagheri, & Radwanski, 2009; Elham Yoosefi Lafooraki & Shayanmehr, 2014).

Family: Neanuridae Börner, 1901

***Aethiopella* sp.**

Analyzed material: Mazandaran, Tonekabon, 36º40'21" N; 50º49'28" E, 443 m, 20.01.2016.

General distribution: Caribbean Mainland, Brazil and Africa.
Distribution in Iran: *Aethiopella* Handschin, 1942 is reported for the first time from Iran.

Description: Body pigmented, different in shape, with paratergites or paratergal areas always present. Third and fourth antennal segments dorsally fused and ventrally separated. Ant. III with sensory organ. This inclusive of two bars of different forms under a cuticular wrinkle. Ant. IV with apical pit, apical bulb with 1-3 vesicles, dorsally mostly with up to 8 sensilla, microsensillae present or absent, ventrally with smaller chaetae and/or blunt modified chaetae. Ant. III shorter than Ant. IV. Oral cone elongated; mandibles with 4-20 apical teeth; maxillae are always shaped like a rod, sometimes with two lamellae, but never toothed or fringed; labial papillae missing or undeveloped. Postantennal organ present and morula-shaped, with at least two rings of 12-60 vesicles; 8 ommatidia on each side of the head. Tibiotarsi I-III with or without M chaeta; unguis with at least one internal tooth, unguiculi absent (Fig. 2). Capitate tenent hairs absent. Furca present, always with individualized manubrium, dentes and mucro, each dens with 3-7 chaetae; anal spines absent (Palacios-Vargas & Montejo-Cruz, 2014).

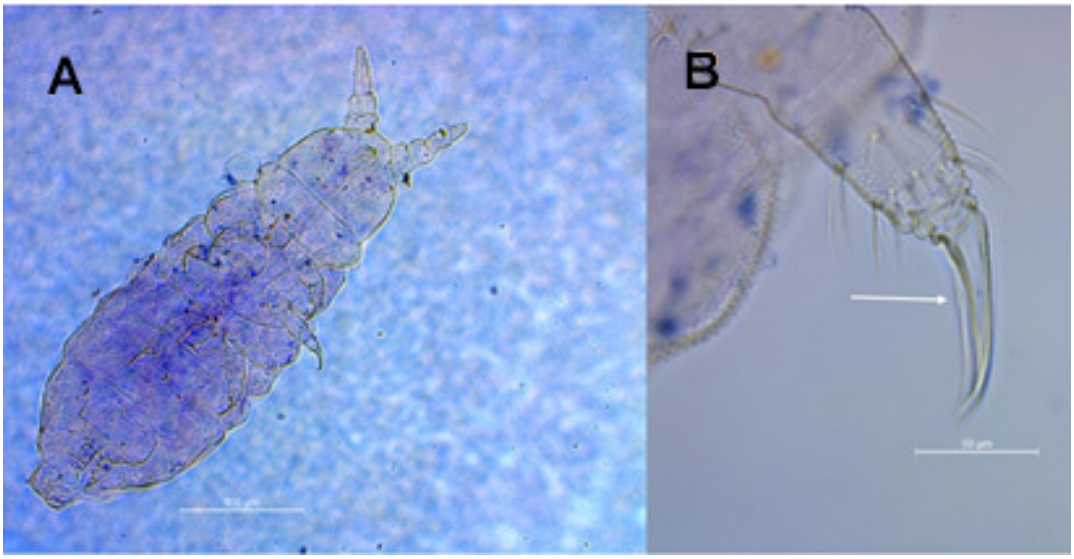

Figure 2. (A) Depiction of *Aethiopella* sp. including body habitus. (B) Unguis with one internal tooth, indicated by arrow.

Family: Hypogastruridae

***Ceratophysella denticulate* (Bagnall, 1941)**

Analyzed material: Mazandaran, Sari, Dasht-e-Naz, 36º71'10" N; 53º09'11" E, 11 m, 13.08.2016.
General distribution: Arctic and Subarctic, North and South America, Eurasia, Africa, Australia, Antarctic and Subantarctic.

Distribution in Iran: *Ceratophysella* Börner, 1932 was reported from Mazandaran, Guilan, East and West Azerbaijan, Zanjan, Kohgiluyeh and Boyer-Ahmad, Kermanshah, Kerman, Golestan, Tehran and Khorasan-e-Shomali provinces (Abdolalizadeh, 2018; Alijani-Ardeshir *et al*., 2017; Cox, 1982; Falahati Hossein Abad, 2012; S. Ghahramaninezhad, Shayanmehr, & Yoosefi Lafooraki, 2012; Ghasemi Cherati, 2017; Kahrarian *et al*., 2012; Kahrarian *et al*., 2016; Kahrarian, Vafaei, & Soleiman, 2017; Khanahmadi, 2018; Mehrafrooz Mayvan *et al*., 2015; Qazi & Shayanmehr, 2014; M Shayanmehr & Zamani, 2016; E Yahyapour *et al*., 2011; E Yoosefi Lafooraki & Shayanmehr, 2015a, 2015b).

Discussion

In total, 9 species and 13 genera belonging to families Arrhopalitidae, Tomoceridae, Entomobryidae, Hypogastruridae, Isotomidae and Neanuridae were found in forests of Mazandaran province, of which three species were identified, including: *Heteromurus gigans*, *Entomobrya atrocincta* and *Folsomia inoculata*. *Entomobrya atrocincta* and *Folsomia inoculata* are reported for the first time from Iran. To date, 11 species of Folsomia (Isotomidae) have been known. We identified a new genus for Iran fauna belonging to the Neanuridae family i.e. *Aethiopella*. To date, 14 genera of Neanuridae are reported from Iran.

The attention paid to the identification of Iran's Collembola fauna has been increasing for several years, with particular attention to specific fauna of the northern forests of Iran, which are among the most important forests in the world as regards age and genetic treasures. In one study, 20 species were identified from Semeskandeh forest located in northern Iran (Mehrafrooz Mayvan *et al*., 2015). This is despite the fact that the number of forest species in Iran should be much higher, indicating that many species may still not have been collected and identified.

Conclusion

In this study, faun of Collembola were investigated relatively more precise in different forests of northern Iran. Moreover, *Aethiopella* and *Folsomia inoculata* are identified for Iranian fauna for the first time, and the genus *Arrhopalites* Börner, 1906 is new for Mazandaran province in particular.

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ПРВИ НАЛАЗ РОДА *AETHIOPELLA* HANDSCHIN, 1942 И ВРСТЕ *FOLSOMIA INOCULATA* STACH, 1947 (HEXAPODA, COLLEMBOLA) У ИРАНУ

ЕЛИЈЕХ ЈАХИАПУР, РЕЗА ВАФАЕИ-ШУШТАРИ И МАСУМЕХ ШАЈАНМЕХР

Извод

Скокуни су широко распрострањена и обилна група зглавкара у целом свету. Фауна скокуна је слабо позната у северним окрузима Ирана. Ова студија је спроведена како би се истражила фауна скокуна у шумама провинције Мазандаран, Северни Иран, током 2016. године. Током ове студије, пронађено је 13 родова и 9 врста из 6 породица. Род *Aethiopella* Handschin, 1942 и врста *Folsomia inoculata* Stach, 1947, су први пут забележени у Ирану, при чему је род *Arrhopalites* Börner, 1906, први пут забележен из провинције Мазандаран.

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