A survey on Entomobryomorpha (Collembola) fauna in northern forests of Iran

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ABSTRACT. Present study was done in forests of northern Iran during 2016 to investigate Entomobryomorpha (Collembola) fauna. Seven genera and nine species belonging to families Tomoceridae and Entomobryidae were found. The genus Pogonognathellus Paclt, 1944 and species P. flavescens (Tullberg, 1871) belonging to Tomoceridae family are recorded for the first time from Iran, also three new records from Entomobryidae of genus Entomobrya Rondani, 1861 are reported for Mazandaran province fauna.

Key words: Pogonognathellus, Entomobryomorpha, Mazandaran

Introduction

Hyrcanian forests are located in northern Iran and mostly are composed of deciduous trees. The climate of south Caspian region is humid with most precipitation occurring in autumn, winter and spring (Siadati et al., 2010). Soil and leaf litter in these forest occupied by different soil-dwelling animals especially Collembola.

The class of Collembola or springtails is the most abundant soil-living arthropods which found everywhere especially in forest soils (Petersen & Luxton, 1982). More than one fourth of collembolan species belong to superfamly Entomobryoidea possessing a well-developed furcula (Zhang et al., 2015). Furca or furcula which comprised from three parts manubrium, dens and mucro, give them ability to jumping and it is perhaps the most characteristic feature of Collembola especially in Entomobryomorpha (Christian & Vollenkle, 1979). Characteristics of all three parts of furcula and distribution and morphology of body scales are also important diagnostic characters at generic and suprageneric levels in Entomobryoidea (Zhang et al., 2015). Different researchers classified Entomobryomorpha in different way for example Entomobryomorpha...
classified as four superfamilies including Tomoceroidea Szeptycki, 1979, Isotomoidea Szeptycki, 1979, Entomobryoidea Womersley, 1934 and Coenaletoidea Bellinger, 1985 and eight families (Soto-Adames et al., 2008). Entomobryoidea classified by Soto-Adames et al. (2008) as three families (Table 1).

Most Entomobryoidea species are belonging to Entomobryidae family, which is the most diverse family of Collembola sometimes called "slender springtails" (Bellinger et al., 1996–2018; Soto-Adames et al., 2008). The species of this family usually characterized by having an enlarged fourth abdominal segment, a well-developed appendages such as antennae, legs and furca, like other Entomobryomorpha (Bellinger et al., 1996–2018; Christiansen & Bellinger, 1998). Additionally, Entomobryoidea distinguishes itself from other families by the presence of multiciliated setae on body, crenulate dens and a small mucro with one or two well-developed teeth (Zeppelini & Bellini, 2006; Soto-Adames et al., 2008). Some species in this family may be heavily scaled and can be very colorful. The scaleless Entomobryoidea are commonly caught in pitfall traps around the plants, and also occur in canopy faunas high up in trees. There are more than 700 described species in Entomobryoidea (Bellinger et al., 1996–2018). Tomoceridae with 201 described species formerly treated as part of Entomobryoidea. The species in this family have elongate antennal segments as compared to Entomobryoidea which are evenly sized (Bellinger et al., 1996–2018).

First report of Colembola in the Middle East is ascribed to Brown (1926) who reported 20 species from Mesopotamia region. Christiansen (1957) studied Cyphoderidae and Oncopoduridae families in Lebanon and Syria. Özata et al. (2017) studied Entomobryomorpha fauna in Ordu province, Turkey and identified 20 new species. Study of Collembola fauna have been received more attention in recent decade in Iran. Several researchers worked on springtail fauna in different ecosystems as well as northern forests in Iran (Shayanmehr et al., 2013; Yahyapour & Shayanmehr, 2013; Qazi & Shayanmehr, 2014a, 2014b, 2016; Kahrarian & Arbea, 2013; Yoosfi-Lafooraki & Shayanmehr, 2014; Kahrarian et al., 2014, 2015; Ahmadirad & Kahrarian, 2015; Amiri & Kahrarian, 2015; Arbea & Kahrarian, 2015a, 2015b; Balvasi et al., 2015; Mehrafrooz-Mayvan et al., 2015; Potapov et al., 2015; Hosseini et al., 2016; Shayanmehr & Zamani, 2016; Alijani-Ardeshir et al., 2017; Arbea & Kahrarian, 2017; Shayanmehr et al., 2017; Ramezani & Mossadegh, 2017). In Iran from Entomobryidae 42 species (Shayanmehr et al., 2018) and from Tomoceridae only two species were recorded until yet (Shayanmehr et al., 2013).

In this project, we present new information on the occurrence of some colembolan species of Entomobryomorpha group in Mazandaran province. However, many more species presumably exist in Iran yet to be discovered. The objective of this study as a part of our ongoing research on the Colembola fauna of Iran is to improve our knowledge of Entomobryomorpha group.

### Table 1. Classification of Entomobryomorpha group according Soto-Adames et al. (2008).

<table>
<thead>
<tr>
<th>Superfamilies</th>
<th>Families</th>
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<tr>
<td>Coenaletoidea</td>
<td>Coenaletidae</td>
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<td>Entomobryoidea</td>
<td>Microfalculidae</td>
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<td>Entomobryidae</td>
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<td>Isotomoidea</td>
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<td>Tomoceroidea</td>
<td>Oncopoduridae</td>
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<td>Tomoceridae</td>
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Material and methods
The materials of present study were collected during 2016 in forests of Mazandaran province. The specimens were collected from pitfall traps or soil and leaf litter sampling method. Geographical data of sampling sites was fixed using GPS receiver. Soil and leaf litter samples were transferred to the laboratory of Sari University of Agricultural Sciences and Natural Resources, Mazandaran. Where Collembola specimens were extracted by Tullgren funnels and Entomobryomorpha specimens were isolated for more study. Some specimens were cleared in Nesbit’s solution, then were mounted on Hoyer’s medium to make microscopic slides. Then they were identified to genera and species levels using valid keys including: Fjellberg (2007) and Jordana (2012). Microscopic slides and in alcohol preserved specimens are maintained in laboratory of the university.

Results
Totally, seven genera and nine species were found of these Pogonognathellus flavescens (Tullberg, 1871) together with genus, Pogonognathellus Paclt, 1944, are recorded for the first time from Iran. Besides that three species of Entomobrya are recorded for the first time from Mazandaran province. Below are some considerations about each of the collected specie.

Family: Entomobryidae
Subfamily: Entomobryinae

Entomobrya schoetti Stach, 1922
Materials examined: Two specimens, Neka, Hezar jrib forest, leaf litter, 12-viii-2016, 36°37'12" N, 53°21'31" E, 198 m a.s.l.; leg.: E. Yahyapour.
Distribution in Iran: Kermanshah (Kahrarian et al., 2014) and it is recorded for the first time from Mazandaran province.

Distribution in the world: Europe, Mediterranean, West Asia (Bellinger et al., 1996–2018).

Entomobrya corticalis (Nicolet, 1842)
Materials examined: Three specimens, Sari, Shahid Zare forest, leaf litter, 30-vi-2016, 36°32'44" N, 53°07'53" E, 113 m a.s.l., leg.: E. Yahyapour.
Distribution in Iran: Guilan (Cox, 1982) and it is recorded for the first time from Mazandaran province.
Distribution in the world: North Eurasia, West and central Asia, Europe (Bellinger et al., 1996–2018).

Entomobrya nigrocincta Denis, 1923 (Figs 1–2)

Figure 1. Habitus of Entomobrya nigrocincta (male) (original 10x).
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Distribution in Iran: Kermanshah (Kahrarian et al., 2014) and it is recorded for the first time from Mazandaran province.

Distribution in the world: Europe, Mediterranean, West Asia (Bellinger et al., 1996–2018).

Figure 2. Habitus of *Entomobrya nigrocincta* (female) (Original, 10x).

Family: Tomoceridae

*Pogonognathellus flavescens* (Tullberg, 1871) (Figs 3–4)

Materials examined: Two specimens, Babol, Filband, soil and leaf litter, 25-viii-2016, 52°30′45″ N, 36°22′12″ E, 1950 m a.s.l.; Two specimens, Babol, Filband, soil and leaf litter, 25-viii-2016, 52°30′45″ N, 36°22′12″ E, 1950 m a.s.l.; Three specimens, Sari, Salar Darreh forest, leaf litter, 28-iv-2016, 36°27′10″ N, 53°07′11″ E, 178 m a.s.l.; Two specimens, Qaemshahr, Jadeh-Nezami, leaf litter, 12-vi-2016, 36°27′17″ N, 52°49′16″ E, 188 m a.s.l.; leg.: E. Yahyapour.

Distribution in Iran: The genus and species are recorded for the first time from Iran.

Distribution in the world: Arctic and subarctic, Europe, North Eurasia, Mediterranean (Bellinger et al., 1996–2018).

Figure 3. Habitus of *Pogonognathellus flavescens* (Original, 10x).

Figure 4. The spines on the inner side of the dens *Pogonognathellus flavescens* and large leaf-shaped scale next to manubrium. (Original, 40x).

Family: Entomobryidae

Subfamily: Seirinae

*Seira domestica* (Nicolet, 1842) (Fig. 5)

Materials examined: One specimens, Neka, Hezar Jrib forest, leaf litter, 12-viii-2016, 36°37′12″ N, 53°21′31″ E, 198 m a.s.l.; Two specimens, Babol, Filband, soil and leaf litter, 25-viii-2016, 52°30′45″ N, 36°22′12″ E, 1950 m a.s.l.; Three specimens, Sari, Salar Darreh forest, leaf litter, 28-iv-2016, 36°27′10″ N, 53°07′11″ E, 178 m a.s.l.; Two specimens, Qaemshahr, Jadeh-Nezami, leaf litter, 12-vi-2016, 36°27′17″ N, 52°49′16″ E, 188 m a.s.l.; leg.: E. Yahyapour.

Distribution in Iran: Mazandaran (Yahyapour & Shayanmehr, 2013), Kermanshah (Kahrarian et al., 2012), Guilan (Daghighi et al., 2013), Golestan (Hosseini et al., 2016).


Figure 5. Habitus of *Seria domestica* (Original, 10x).
Family: Entomobryidae
Subfamily: Heteromurinae

*Heteromurus major* (Moniez, 1889) (Fig. 6)

**Materials examined:** 10 specimens, Neka, Hezar Jrib forest, leaf litter, 12-viii-2016, 36°37’12” N, 53°21’31” E, 198 m a.s.l.; 15 specimens, Babol, Filband, soil and leaf litter, 25-viii-2016, 52°30’45” N, 36°22’12” E, 1950 m a.s.l.; Eight specimens, Sari, Salar Darreh forest, leaf litter, 28-iv-2016, 36°27’10” N, 53º07’12” E, 178 m a.s.l.; Nine specimens, Qaemshahr, Jadeh-Nezami, leaf litter, 12-vi-2016, 36°27’17” N, 52º49’16” E, 188 m a.s.l.; Four specimens, Sari, Dasht-e-Naz, soil and leaf litter, 24-v-2016, 36°71’10” N, 53º09’11” E, -11 m a.s.l.; 20 specimens, Sari, Shahid Zare forest, leaf litter, 30-iv-2016, 36°32’44” N, 53°07’53” E, 113 m a.s.l., leg.: E. Yahyapour.

**Distribution in Iran:** Central, Mazandaran, Guilan, E. Azarbaijan (Cox, 1982; Yahyapour & Shayanmehr, 2013; Yoosifi-Lafooraki & Shayanmehr, 2014; Balvasi et al., 2015; Mehrafrooz-Mayvan et al., 2015; Daghighi et al., 2013), Tehran (Qazi & Shayanmehr, 2014a), Golestan (Hosseini et al., 2016), Kermanshah (Kahrarian et al., 2014, 2016).

**Distribution in the world:** Europe, West and central Asia, Mediterranean, Macaronesian, Pacific North America, Andean, Australia (Bellinger et al., 1996-2018).

*Figure 6. Habitus of Heteromurus major* (Original, 10x).

Family: Entomobryidae
Subfamily: Lepidocyrtinae

*Lepidocyrtus* sp. (Fig. 7)

**Materials examined:** Two specimens, Sari, Chahardangeh, Langar village, soil and leaf litter, 29-iv-2016, 36°14’20” N, 53º39’10” E, 1800 m a.s.l., leg.: E. Yahyapour.

**Distribution in Iran:** Central, Mazandaran, Guilan, E. Azarbaijan, Zanjan (Cox, 1982), Golestan (Hosseini et al., 2016).

**Distribution in the world:** The genus has worldwide distribution (Fjellberg, 2007) but the species is unknown.

*Figure 7. Habitus of Lepidocyrtus sp.* (Original 10x).

*Pseudosinella* sp.

**Materials examined:** Two specimens, Neka, Hezar Jrib forest, leaf litter, 12-viii-2016, 36°37’12” N, 53°21’31” E, 198 m a.s.l., leg.: E. Yahyapour.

**Distribution in Iran:** Central, Mazandaran, Guilan, E. Azarbaijan, W. Azarbaijan, Zanjan (Cox, 1982; Yahyapour & Shayanmehr, 2013; Daghighi et al., 2013; Yoosifi-Lafooraki & Shayanmehr, 2013, 2014; Balvasi et al., 2015; Mehrafrooz-Mayvan et al., 2015; Alijani-Ardeshir et al., 2016).
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Distribution in the world: The genus has worldwide distribution (Fjellberg, 2007) but the species is unknown.

Family: Entomobryidae
Subfamily: Orcheseliinae
Orchesella cincta (Linnaeus, 1758)

Materials examined: Two specimens, Neka, Hezar jrib forest, leaf litter, 12-viii-2016, 36°37′12″ N, 53°21′31″ E, 198 m a.s.l.; one specimens, Babol, Filband, soil and leaf litter, 25-viii-2016, 52°30′45″ N, 36°22′12″ E, 1950 m a.s.l., leg.: E. Yahyapour.

Distribution in Iran: Mazandaran (Yoosefi-Lafooraki & Shayanmehr, 2013, 2014; Balvasi et al., 2015), Golestan (Hosseini et al., 2016).

Distribution in the world: Arctic and sub-arctic, Europe, Mediterranean, North America, West Asia, Ascension and St. Helena (Bellinger et al., 1996-2018).

Discussion
The specie, Pogonognathellus flavescens, is distributed in the Holarctic region and recently it was recorded by Özata et al. (2017) from Turkey, wherein it was found in the debris of Pinus at Ordu province. This specie belongs to Tomoceridae a family of Entomobryoidea that are recorded for the first time from Iran as well as the genus Pogonognathellus and P. flavescens. This record increases the number of Entomobryomorpha's genera and species of family reaches two and three, respectively. Also, from Entomobryidae family, up to now, 11 genera and 42 species were recorded. With new record of this study, species number of family reaches to 43. Three species from genus Entomobrya are also reported for the first time of Mazandaran province. But still impel-mentary researchs need to describe species were remained as unknown species.

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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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بررسی فون انتوموبرومورفا (پادمان) در جنگل‌های شمال ایران

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چکیده: مطالعه حاضر به منظور بررسی فون پادمان گروه انتوموبرومورفا (پادمان) در سال ۱۳۹۵ در جنگل‌های شمال ایران انجام گرفت. هفت جنس و نه گونه از خانواده‌های Tomoceridae و Entomobryidae جمع‌آوری و شناسایی شد. جنس Pogonognathellus Paclt, 1944 و گونه P. flavescens (Tullberg, 1871) از خانواده Tomoceridae و گونه Pogonognathellus Paclt, 1944 از خانواده Entomobryidae برای اولین بار از ایران گزارش شدند. همچنین سه گونه از خانواده Entomobryidae از جنس Entomobrya Rondani, 1861 و گونه Entomobrya Pogonognathellus لزه و گزارش جدید هستند.

واژگان کلیدی: Pogonognathellus، Entomobryomorpha، مازندران.

Entomobryomorpha in northern forests of Iran