



New records of springtails (Hexapoda, Collembola) for Iran from the Bula Hyrcanian forest

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ABSTRACT. The present study reports new records of the Collembola (Arthropoda: Hexapoda) from the Bula Hyrcanian forest located in Mazandaran province, north of Iran. The results show two genera *Spatulosminthurus* Betsch & Betsch-Pinot, 1984 (Sminthuridae) and *Wankeliella* Rusek, 1975 (Tullbergiidae) and five species including *Anurophorus alpinus* Potapov & Stebaeva, 1990 (Isotomidae), *Pseudosinella* cf. *decipiens* Denis, 1924 and *P. immaculata* (Lie Pettersen, 1896) (Entomobryidae), *Superodontella tyverica* Kaprus, 2009 (Odontellidae), and *Wankeliella bescidica* Smolis & Skarżyński, 2004 (Tullbergiidae) are new records for Collembola fauna of Iran.

Key words: Hyrcanian forest, new records, Springtails, UNESCO World Heritage

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INTRODUCTION

The Hyrcanian forests extend from the south of Azerbaijan to about 900 km of eastern to Northern provinces of Iran including Gilan, Mazandaran and Golestan. These forests form the outermost boundary of the west-Eurasian deciduous forests to alpine thorn cushion corridors and forest-free dry vegetation of the Iranian highlands and Central Asia (Akhani et al., 2010; Tohidifar et al., 2016). Recognition of these forests as a World Heritage site will increase the worldwide popularity of these forests, which additionally can enhance the realization of the people in the region of their outstanding heritage through awareness raising and exchange of experiences with other world heritage sites (Tohidifar et al., 2016; IUCN Evaluation Report, 2023; Homami Totmaj et al., 2020). UNESCO World

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Heritage List in Hyrcanian forests are located in 15 regions including Golestan National Park, Abr Forest, Jahan-Nama Forest, Bula Forest, Alimestan Forest, Vaz Forest, Kojur region of Nowshahr, Chahar-Bagh region of Chalus, Khoshkeh Daran forest, Gasht-e Rudkhan, Siahrudbar of Gilan, Lisar protected area with a rich plant and animal variety (Vakili et al., 2021; Nourzad Moghaddam et al., 2018; Homami Totmaj et al., 2020). These forests are one of the major glacial refugia arcto-tertiary forest vegetation where some tertiary relics survived the Ice Age and developed numerous endemic taxa of flora and fauna (Vakili et al., 2021).

Collembola (Springtails) are one of the earliest colonizers in the soil of terrestrial systems especially forests (Chahartaghi et al., 2005). They play an important role in plant litter decomposition, nutrient cycling, forming soil microstructures and promoting plant growth, and thus received considerable attention (Hopkin, 1997; Gange, 2000; Petersen, 2002; Filser, 2002). In the soil of forests containing high amounts of organic carbon, the species diversity of Collembola can be very rich, reaching over 100 species per site and densities as high as 200,000 individuals per square meter (Rusek, 1998; Hopkin, 2002; Harta et al., 2020). There are ca 9000 published Collembola species worldwide (Bellinger et al., 1996–2023), while Iran's share of this number until 2020 was only 232 species (Shayanmehr et al., 2020). More than half of these species (ca 107 species) were reported from Hyrcanian forests (Shayanmehr & Yahyapour, 2019). The number of published endemic species from these forests is on the rise (Shayanmehr et al., 2013; Mehrafrooz Mayvan et al., 2015; Yahyapour et al., 2020a, 2020b, 2021; Yoosefi Lafooraki et al., 2020a, 2020b; Ghasemi Charati et al., 2021). However, many species remain unknown in various areas of these forests, especially in the UNESCO-listed areas (IUCN Evaluation Report, 2023).

This paper reports two new genera and five new species for Iranian Collembola fauna collected from the Bula Hyrcanian forest which is included in the UNESCO World Heritage List. Besides, the paper also includes identification keys related to new records.

MATERIAL AND METHODS

The present study is a survey of Collembola fauna in Bula forest (53°23'37.5"E, 36°5'55.8"N, area of nominated component of the property (17,516.47 ha), Northern Iran, Mazandaran province, Sari region close to Farim city (Fig. 1). Samples were taken from leaf litter and soil, moss and wood. Collembola specimens were extracted using Berlese funnels and then sorted in ethanol 70%. Specimens were cleared using 10% KOH and Nesbitt's solution, mounted on slides using Hoyer's medium and identified using keys available in the literature. Mounted specimens are deposited in the entomology laboratory of Sari Agricultural Sciences and Natural Resources University, Iran and in the Apterygota collections of the Muséum national d'Histoire naturelle (MNHN-EA072723), Paris, France. The morphological terminology used in this study follows that of Potapov (2001), and Fjellberg (1998, 2007).

Abbreviations. Abd.—Abdominal segment; Ant.—Antennal segment; PAO—Postantennal organ; sens.—Sensillum; Th.—Thoracic segment.

RESULTS

In the present study, two genera *Spatulosminthurus* Betsch & Betsch-Pinot, 1984 (Sminthuridae) and *Wankeliella* Rusek, 1975 (Tullbergiidae) and five species including *Anurophorus alpinus* Potapov & Stebaeva, 1990 (Isotomidae), *Pseudosinella* cf. *decipiens* Denis, 1924 and *P. immaculata* (Lie Pettersen, 1896) (Entomobryidae), *Superodontella tyoverica* Kaprus, 2009 (Odontellidae), and *Wankeliella bescidica* Smolis & Skarżyński, 2004 (Tullbergiidae) were reported for the first time for Collembola Iranian fauna from Bula forest as part of Hyrcanian forest.

Taxonomic hierarchy

Phylum Arthropoda von Siebold, 1848

Subphylum Hexapoda

Class Collembola Lubbock, 1871



Figure 1. Map of Hyrcanian forests in northern Iran including Bula forest (6) in Farim city located in Sari region in Mazandaran province (retrieved from <http://www.ichto.ir>).

Order Poduomorpha Börner, 1913

Family Odontellidae Massoud, 1967

Genus *Superodontella* Stach, 1949

***Superodontella tyverica* Kaprus, 2009 (Fig. 2)**

Material examined. One specimen, Iran, Mazandaran province, Sari, Farim, Bula forest, soil, N36°03'46.18", E53°18'39.35", 1687 m a.s.l., 19-IV-2021, leg. E. Yoosefi Lafooraki.

Distribution. Palearctic (Kaprus, 2009). This species is reported for the first time from Iran.



Figure 2. *Superodontella tyverica* Kaprus, 2009 (Odontellidae) habitus. Scale bar: 10 μ m.

Diagnosis. The identification of the species was done according to Kaprus (2009) as below: The colour body is greyish and the length about 1 mm. Head with 5+5 ommatidia. PAO amoeboid-like, with four lobes. Ant. IV with 8 subcylindrical curved sens. Abdominal sternum II with 3+3 chaetae, abdominal sternum III with 6+6 chaetae. Furca well developed with 5 chaetae on each dens, three internal chaetae are stronger and serrate lightly. Empodial appendage and anal spines absent.

Key to the known Iranian species of Odontellidae (adapted from Kaprus, 2009)

- 1 Mucro with one or no intermediate lamellae or teeth. *Axenyllodes caecus* (Gisin, 1952)
- Mucro with two intermediate lamellae or teeth. 2
- 2 Exsertile sac ventrally between third and fourth antennal segments absent. [Genus *Superodontella* Stach, 1949] 3
- Exsertile sac ventrally between third and fourth antennal segments present. *Odontella* sp.
- 3 Thoracic terga II, III and fourth abdominal tergum without m_1 chaetae. ...*S. lamellifera* (Axelson, 1903)
- Thoracic terga II, III and fourth abdominal tergum with m_1 chaetae. 4
- 4 Head without c_2 chaetae; second and third thoracic tergum with three m-chaetae.
.....*S. montemaceli* Arbea & Weiner, 1992
- Head with c_2 chaetae; second and third thoracic tergum with four m-chaetae. 5
- 5 First, second and third tibiotarsus with 14, 14 and 14 chaetae, respectively; anal spines present; antennal segment III with 12 chaetae. *S. rotunda* Kaprus, 2009
- First, second and third tibiotarsus with 17, 17 and 16 chaetae, respectively; anal spines absent; antennal segment III with 16–17 chaetae.*S. tyverica* Kaprus, 2009

Family Tullbergiidae Bagnall, 1935

Genus *Wankeliella* Rusek, 1975

Diagnosis. PAO with 6 v-shaped vesicles. Abd. VI with two simple anal spines and a pair of transverse crescentic ridges near the anterior border of the segment (Fjellberg, 1998).

***Wankeliella bescidica* Smolis & Skarzynski, 2004**

Material examined. One specimen, Iran, Mazandaran province, Sari, Farim, Bula forest, soil, N36°03'46.18", E53°18'39.35", 1687 m a.s.l., 19-IV-2021, leg. E. Yoosefi Lafooraki.

Distribution. Asia and Europe (Smolis & Skarzynski, 2004). The genus and species are reported for the first time from Iran.

Diagnosis. The identification of the species was done according to Smolis and Skarżyński (2004): Habitus typical of the genus *Wankeliella*. Body length (without antennae) 0.5 mm. Colour of the body white. Granulation fine and uniform. Antennae shorter than head. Ventral side of Ant. III with a thick sensory club. Ant. I and II with 7 and 11 chaetae respectively. PAO 2.2 times longer than the nearest pseudocellus, with 6–7 vesicles in two parallel rows. Chaetae differentiated into macro- and microchaetae (macrochaetae two times longer than microchaetae). Ventral tube with 4+4 distal chaetae and 2+2 chaetae in basal part. Clavate tibiotarsal chaetae absent. Claws without teeth. Empodial appendage short.

Remarks. In the original description of the species, sensillae behind the genital plate were mentioned to be spindle-like, but in specimens found in this study, these sensillae are not spindle-like

Key to the known Iranian species of Tullbergiidae (adapted from Fjellberg, 1998; Castaño-Meneses et al., 2000)

- 1 Sense organ of antennal segment III in adults with one greatly thickened dorsal sensory club.
.....*Doutnacia xerophila* Rusek, 1974
- Sense organ of antennal segment III in adults with 2–3 greatly thickened dorsal sensory clubs. 2

2	Abdominal segment VI without midventral projection.	3
–	Abdominal segment VI with midventral projection-best seen in ventral view. [Genus <i>Metaphorura</i> Stach, 1954]	7
3	Sense organ of Antennal segment III with 2 sense clubs.	4
–	Sense organ of Antennal segment III with 3 sense clubs.	6
4	Post antennal organ with six v-shaped vesicles. <i>Wankeliella bescidica</i> Smolis & Skarzynski, 2004	
–	Post antennal organ with simple vesicles in two rows.	5
5	Abdominal segment VI with additional dorsal or lateral tubercles bearing strong bristles.	
 <i>Paratullbergia callipygos</i> (Börner, 1902)	
–	Abdominal segment VI dorsally smooth except for crescentic ridges. [Genus <i>Mesaphorura</i> Börner, 1901]	9
6	Sixth abdominal segment with 1+1 dorsolateral spines in front of posterior anal spines.	
 <i>Fissuraphorura duplex</i> (Lucianez & Simon, 1992)	
–	Sixth abdominal segment without dorsolateral spines in front of posterior anal spines.	
 <i>Tullbergia simplex</i> Gisin, 1958	
7	Median process spiniform or stout; Post antennal organ with 18–25 bilobated or trilobated vesicles.	
 <i>Metaphorura riozoi</i> Castaño-Meneses, Palacios-Vargas & Traser, 2000	
–	Median process spiniform; Post antennal organ with 20–25 simple vesicles.	8
8	Pseudocellar formula 11/111/11111.	<i>Metaphorura affinis</i> Börner, 1902
–	Pseudocellar formula 11/122/22221.	<i>Metaphorura denisi</i> Simon, 1985
9	Abdominal segment with 3+3 short a-setae between long a ₄ setae.	10
–	Abdominal segment with 2+2 short a-setae between long a ₄ setae.	13
10	Abdominal segment with p ₁ –p ₁ distance shorter than p ₂ –p ₂	11
–	Abdominal segment with p ₁ –p ₁ distance longer than p ₂ –p ₂	12
11	Anal lobe with l ₂ present.	<i>Mesaphorura macrochaeta</i> (Rusek, 1976)
–	Anal lobe with l ₂ absent.	<i>Mesaphorura krausbaueri</i> (Börner, 1901)
12	Thoracic segments II–III with pseudocelli in median position, between p ₃ –p ₄ ; Abdominal segment IV without m ₅	<i>Mesaphorura yosii</i> (Rusek, 1867)
–	Thoracic segments II–III with pseudocelli in lateral position, between p ₅ –p ₅ ; Abdominal segment IV without m ₅ present.	<i>Mesaphorura italica</i> (Thibaud, 1996)
13	Thoracic segments III with a ₂ present.	<i>Mesaphorura critica</i> Ellis, 1976
–	Thoaxic segments III with a ₂ absent.	<i>Mesaphorura jirii</i> Rusek, 1982

Order Entomobryomorpha Börner, 1913

Family Isotomidae Börner, 1913

Genus *Anurophorus* Nicolet, 1841

Anurophorus alpinus Potapov & Stebaeva, 1990 (Fig. 3)

Material examined. 14 specimens, Iran, Mazandaran province, Sari, Farim, Bula forest, soil, N36°03'45.98", E53°18'36.96", 1675 m a.s.l., 19-IV-2021, leg. E. Yoosefi Lafooraki.

Distribution. Caucasus (Potapov, 2001). This species is reported for the first time from Iran.

Diagnosis. The identification of the species was done according to Potapov (2001) as below: Body length about 1 mm and the colour is blackish blue. Dorsal integument with rather weak reticulation, on Abd. V much stronger (Fig. 3A). Eye-patches with 8+8 ommatidia. PAO is 2 times as long as the diameter of the ommatidium. Claw without the inner tooth. Empodium is reduced, shorter than ¼ of

the inner edge of the claw on the legs of all pairs (Fig. 3C). Tibiotarsi with distinctly clavate hairs. Th. I-III with 1+1, 1+1, 3-6+3-6 ventromedial setae, tenacular area (a small organ, appended to the third abdominal segment, which holds the furcula in position under the abdomen) with 3-4 area (Fig. 3D).

Remarks. In the original description of the species, Ant. IV was mentioned with a distinctly divided apical bulb, but in specimens found in this study, the apical bulb on Ant. IV is simple (Fig. 3B).

Key to the known Iranian species of the genus *Anurophorus* (adapted from Potapov, 2001)

- 1 Third empodium at last 1/3 as long as inner edge of claw. 2
- Third empodium at most 2/7 as long as inner edge of claw. 3
- 2 Last abdominal segments strongly wrinkled. Sensillae on the abdominal tergites shorter than half the length of common setae. *A. coiffaiti* Cassagnau & Delamare, 1955
- Last abdominal segments almost smooth or insignificantly wrinkled. Sensillae on the abdominal tergites longer than half the length of common setae. *A. silvaticus* Potapov & Stebaeva, 1990
- 3 Thoracic segment I with 1+1 ventromedial setae. *A. alpinus* Potapov & Stebaeva, 1990
- Thoracic segment I without ventromedial setae. *A. septentrionalis* Palisia, 1966

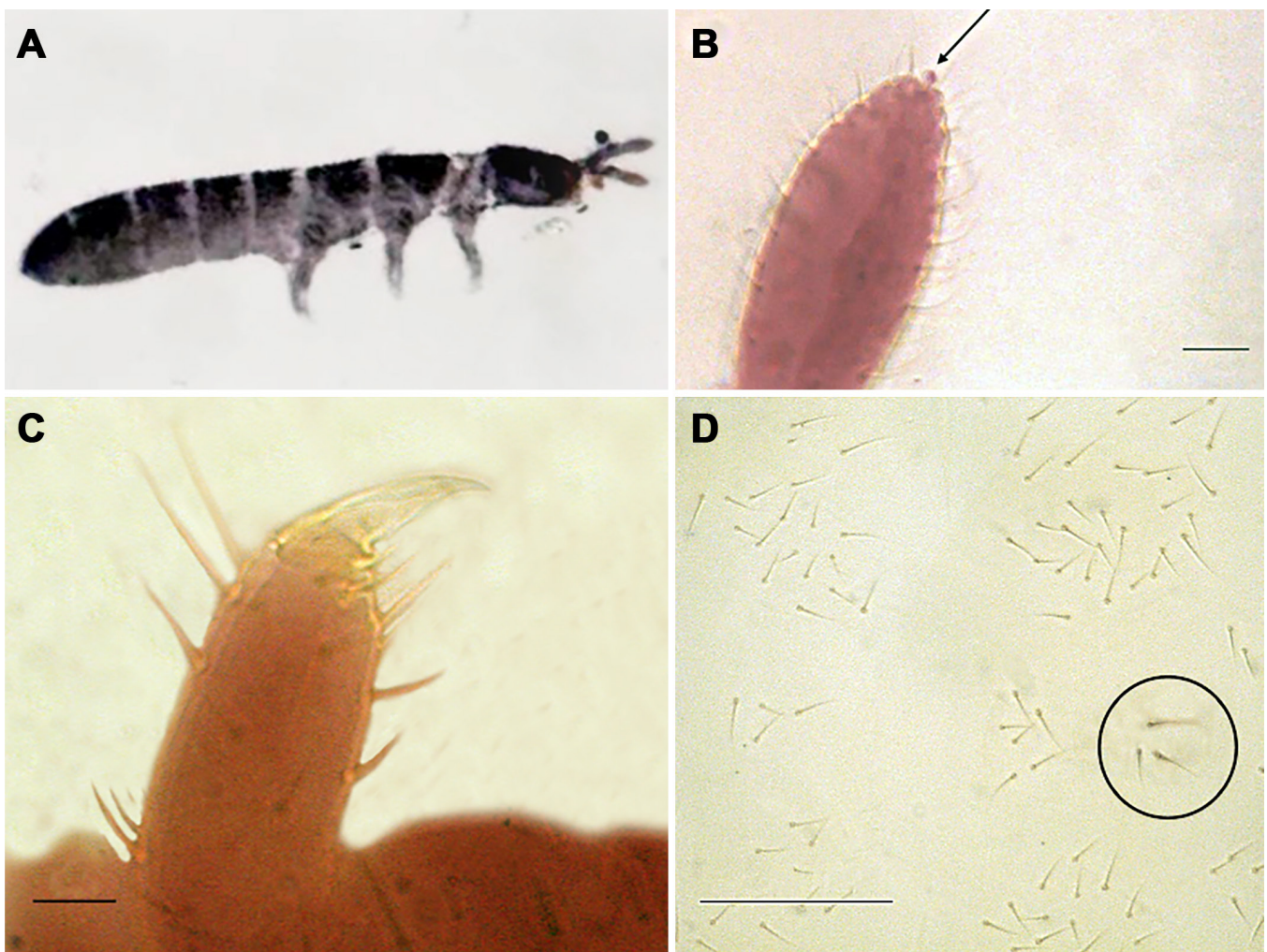


Figure 3. *Anurophorus alpinus* (Isotomidae); **A.** General habitus; **B.** Apical bulb on the antenna. scale bar: 10 μ m; **C.** Tibiotarsi. Scale bar: 10 μ m; **D.** Tenacular area with 3 setae. Scale bar: 50 μ m.

Family Entomobryidae Schäffer, 1896

Genus *Pseudosinella* Schäffer, 1897

Pseudosinella cf. *decipiens* Denis, 1924 (Fig. 4A)

Material examined. One specimen, Iran, Mazandaran province, Sari, Farim, Bula forest, soil, N36°02'11.34", E53°16'51.94", 1611 m a.s.l., 19-IV-2021, leg. E. Yoosefi Lafooraki.

Distribution. Palaearctic (Potapov, 2001). This species is reported for the first time from Iran.

Diagnosis. The identification of the species was done according to Fjellberg (2007) as below: the body is whitish and about 1.5 mm long. The eyes absent. Claws in inner edge with two unpaired distal teeth. The inner one set beyond the middle of the inner edge, clearly outside the paired teeth. Dorsal tenent hair of Tita strong, bent and clavated at tip, longer than claw (Fig. 4A). The claw structure readily separates this species from *P. immaculata*.

Pseudosinella *immaculata* (Lie Pettersen, 1896) (Fig. 4B)

Material examined. Three specimens, Iran, Mazandaran province, Sari, Farim, Bula forest, soil, N36°02'10.72", E53°16'51.68", 1599 m a.s.l., 19-IV-2021, leg. E. Yoosefi Lafooraki.

Distribution. Palaearctic (Potapov, 2001). This species is reported for the first time from Iran.

Diagnosis. The identification of the species was done according to Fjellberg (2007) as below: The length of the body is about 2 mm with white colour. The eyes absent. Claws with large, unequal inner pairs of teeth. One distal tooth set in the middle of the inner edge, between the paired teeth. Lateral teeth set near base. Empodium at most with 2-3 delicate serrations on the ventral edge. Dorsal tenent hair (A₁) of tibiotarsus is thin and pointed, shorter than Empodium (Fig. 4B). The claw resembles that of *decipiens*, but that species has two distal teeth on the inner edge, the inner one set clearly beyond the tips of the paired teeth. Also, *decipiens* has a much longer tenent hair which is distinctly clavate (Fig. 4B).

Key to the known Iranian species of the genus *Pseudosinella* (adapted from Fjellberg, 2007)

- 1 Eyes absent, no dark eye spots. 2
- Eyes present, eye spots dark. 3
- 2 Unpaired distal tooth of unguis set between the paired teeth. Tenent hair short, pointed.
 *P. immaculata* (Lie Pettersen, 1896)
- Unpaired distal tooth set beyond the paired teeth. Tenent hair long, clavate. *P. decipiens* Denis, 1924



Figure 4. *Pseudosinella* spp. (Entomobryidae) on slide; **A.** *Pseudosinella* cf. *decipiens* tibiotarsus with dorsal clavate tenent hair; **B.** *P. immaculata* tibiotarsus with dorsal pointed tenent hair. Scale bar: 10 µm.

3	Two eyes per side.	4
–	Three or more eyes per side.	6
4	Empodium without teeth.	<i>P. imparipunctata</i> Gisin, 1953
–	Empodium with teeth.	5
5	Maximum length 1.2 to 1.39.	<i>P. alba</i> (Packard, 1873)
–	Maximum length 0.61 to 0.79.	<i>P. baghdadica</i> Rusek, 1981
6	Three eyes per side.	<i>P. sexoculata</i> (Schött, 1902)
–	Four or more eyes per side.	7
7	Four eyes per side.	<i>P. octopunctata</i> Böner, 1901
–	Six eyes per side.	<i>P. duodecimpunctata</i> Denis, 1931

Order Symphyleona

Family Sminthuridae

Subfamily: Sminthurinae

Genus *Spatulosminthurus* Betsch & Betsch-Pinot, 1984

Spatulosminthurus sp.

Material examined. One specimen, Iran, Mazandaran province, Sari, Farim, Bula forest, moss, N36°02'10.74", E53°10'50.71", 1605 m a.s.l., 19-IV-2021, leg. E. Yoosefi Lafooraki.

Distribution. Palaearctic. This genus is reported for the first time from Iran.

Diagnosis. The identification of the genus was done according to Fjellberg (2007): Large abdomen posteriorly without large cuticular glands. Eye-patches with 8+8 ommatidia. Postantennal setae is present. Antennae are generally shorter than the body. Basal ½ of Ant. III with 3–5 long, thick setae. Ant. IV with about subsegmented. Trochanter III posteriorly with 1 normal seta. Tita distally with spatulate setae. Claws without cavity. Inner setae on Dens with normal form. Circumanal setae in females are in normal forms.

Key to the known genera of Sminthuridae of Iran (adapted from Bretfeld, 1999; Mehrafrooz Mayvan et al., 2015)

1	Neosminthuroid setae present, dens with 0–6 anterior setae.	2
–	Neosminthuroid setae absent, dens with 9–15 anterior setae.	5
2	Thoracic segment II without vesicles.	<i>Sphyrotheca</i> Börner, 1906
–	Thoracic segment II always with vesicles.	3
3	Antennal segment IV undivided or weakly subsegmented.	<i>Neosminthurus</i> Mills, 1934
–	Antennal segment IV subsegmented.	4
4	Claws with tunica and serrated basolateral edges, Dens with three ventral setae, inner dorsal edge of mucro with seven to eight blunt teeth, outer edge almost smooth, head with thick, blunt-tipped rough macrochetæ.	<i>Lipothrix</i> Börner, 1906
–	Claw broad with inner tooth, large tunica, dens with four anterior seta, inner dorsal edge of mucro coarsely serrate, outer smooth, head with short, truncate, almost smooth spine.	<i>Paralipothrix</i> Bretfeld, 1999
5	Trochanter III with normal posterior seta.	6
–	Trochanter III with posterior spine.	7
6	Tibiotarsi only pointed distal setae.	<i>Sminthurus</i> Latreille, 1802
–	Tibiotarsi with also spatulate distal setae.	<i>Spatulosminthurus</i> Betsch & Betsch-Pinot, 1983
7	Head frons without postantennal setae.	<i>Caprainea</i> Dallai, 1970
–	Postantennal seta present.	<i>Allacma</i> Börner, 1906

DISCUSSION

The present research deals with the study of Collembola in the Bula protected area, a UNESCO-listed Hyrcanian forest. In this study, two genera and five species are reported for the first time for Iranian Collembola fauna. The genus *Wankeliella* Rusek, 1975 and species *W. bescidica* Smolis & Skarzynski, 2004 from the family Tullbergiidae were reported for the first time from Iran, but they were already reported from Asia and Europe (Smolis & Skarzynski, 2004). Of this family, six genera and 13 species were reported from Iran (Shayanmehr et al., 2023) and now these reach seven genera and 14 species. Sminthuridae are not well known in Iran, only seven genera and eight species have been reported to date (Mehrafrooz Mayvan et al., 2015). They are surface soil dwellers, and they are mostly residing on vegetation and in forest canopies. That is why they are found in low densities and diversities in soil depth.

As a result of the findings of the current study, one more genus, *Spatulosminthurus* Betsch & Betsch-Pinot, 1984, has been added to the above already existed list of Collembola from the family Sminthuridae from Iran. Members of the genus are characterized by having spatulate distal setae on Tita, but the species remained unknown. Members of the Isotomidae are found worldwide and are among the most abundant soil invertebrates. They are usually considered primary and secondary decomposers which feed on litter with adhering fungi and bacteria (Chahartaghi et al., 2005). Species of the genus *Anurophorus* Nicolet, 1842 mostly occur in forests in different microhabitats (Potapov, 2001). From the genus *Anurophorus* already two species *A. coiffaiti* Cassagnau & Delamare, 1955 and *A. silvaticus* Potapov & Stebaeva, 1990 were reported from Iran. Also, some specimens of unknown species, *Anurophorus* sp. have been published from Mazandaran and Golestan collected from leaf litter and soil of forest by Yoosefi Lafooraki (2014) and Hosseini et al. (2016). In the present study, we found *A. alpinus* Potapov & Stebaeva, 1990 from the Bula forest, which is distributed in the Caucasus (Potapov, 2001), but is reported for the first time from Iran. Six species of *Pseudosinella* Schäffer, 1897 from the family Entomobryidae have been reported so far from Iran bearing two to six ommatidia in their eye patches. According to this study, two new records including *P. cf. decipiens* Denis, 1924 and *P. immaculata* (Lie Pettersen, 1896) lack ommatidia. They can be separated by the number of teeth on the claw and the shape of the tenent hair on Tita. In the genus *Superodontella* Stach, 1949 in Odontellidae, three species including *S. lamellifera* (Axelson, 1903), *S. montemaceli* Arbea & Weiner, 1992 and *S. rotunda* Kaprus, 2009 were reported from Iran (Shayanmehr et al., 2023), and *S. tyverica* is added in the list by the present study.

AUTHOR'S CONTRIBUTION

The authors confirm their contribution to the paper as follows: M. Shayanmehr: Performed the project as executor of the plan and acquiring the funds; E. Yoosefi Lafooraki: Cooperated in the project and the collecting materials; M. Ghajar Sepanlou and T. Tully: Advised the project and took the lead in writing the manuscript and findings of this work; C. D'Haese: Confirmed the identifications. All authors approved the final version of the manuscript.

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AVAILABILITY OF DATA AND MATERIAL

The specimens listed in this study are deposited in the entomology laboratory of Sari Agricultural Sciences and Natural Resources University, Iran and the Apterygota collections of the Muséum national d'Histoire naturelle (MNHN-EA072723), Paris, France, and are available from the curator, upon request.

ETHICS APPROVAL AND CONSENT TO PARTICIPATE

Not applicable.

CONSENT FOR PUBLICATION

Not applicable.

CONFLICT OF INTERESTS

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

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گزارش جدید از پادمان (Hexapoda, Collembola) برای ایران از جنگل هیرکانی بولا

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چکیده: در این مطالعه جنس و گونه‌های جدیدی از پادمان (شاخه بندپایان، زیرشاخه شش پایان) از جنگل هیرکانی بولا واقع در شمال ایران در استان مازندران برای فون ایران گزارش شد. نتایج نشان داد که دو جنس *Wankeliella* Rusek، و *Sminthuridae* از خانواده *Spatulosminthurus* Betsch & Betsch-Pinot, 1984 از خانواده *Tullbergiidae* و پنج گونه *Anurophorus alpinus* Potapov & Stebaeva, 1990 از خانواده *Isotomidae* *P. immaculata* (Lie Pettersen, 1896) و *Pseudosinella* cf. *decipiens* Denis, 1924 از خانواده *Entomobryidae* *Superodontella tyverica* Kaprus, 2009 از خانواده *Odontellidae* و *Wankeliella* از خانواده *Tullbergiidae* برای فون پادمان ایران جدید هستند. *bescidica* Smolis & Skarżyński, 2004

واژگان کلیدی: جنگل‌های هیرکانی، گزارش جدید، پادمان، میراث جهانی یونسکو