



A faunistic study of springtails (Hexapoda, Collembola) from Hezarjirib forests (Neka, Mazandaran) with three new records of Iran

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ABSTRACT. The focus of this study was to extend investigations on Collembola fauna in parts of Hyrcanian forests - Hezarjirib forests, located near Neka in Mazandaran province. For this, irregular samplings from leaf litter and soil in different localities were done during 2020–2021. The springtail specimens were extracted by Berlese funnel and after permanent slide mounting identified by relevant taxonomic keys. It resulted in the identification of 25 species belonging to eight families and 19 genera. Three species including *Hypogastrura papillata* Gisin, 1949 (Hypogastruridae), *Lepidocyrtus bicoloris* Mateos, 2012 (Entomobryidae) and *Folsomia trisetata* Jordana & Ardanaz, 1981 (Isotomidae) were recorded for the first time from Iran. Brief information for each species including the material studied, distribution and some illustrations of the new records are given.

Key words: Collembola fauna, Hyrcanian forest, new recorded, Mazandaran province

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INTRODUCTION

Springtails (Hexapoda: Collembola) are small terrestrial arthropods, comprising three tagmata, one pair of antennae, and three pairs of thoracic legs. They differ from other hexapods in entognathy, absence of

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wings and presence of three peculiar abdominal appendages: ventral tube (or collophore), tenaculum (or retinaculum) and furca (Cipola et al., 2018). Collembola also represents one of the most abundant and important taxa of the soil invertebrates inhabiting soils and leaf litters with high dominance (Olejniczak et al., 2021). These soil microarthropods play important roles in soil formation, fungal composition and activity (Hopkin, 1997; Chahartaghi et al., 2005). They accelerate microbial decomposition, and nutrient cycling and mediate substantial fluxes between the above-belowground components of terrestrial ecosystems by initiating the process of detrital decomposition including shredding, consuming and transforming (Addison et al., 2003; Chahartaghi et al., 2005). Mazandaran province is located transversely to the south of the Caspian Sea, with high climatic diversity. Different altitudinal ranges from areas below the free sea levels to mount Damavand (5,671 meters in height) have given a special climatic variety to Mazandaran province. Hyrcanian forests, a national, world wealth and heritage cover large parts of the province, while in the highlands; we see vast alpine and semi-alpine pastures with very high biodiversity (Mohammadi Fazel, 2020). In recent years, works on Iranian Collembola fauna have intensified in various provinces. In the last updated checklist of Iranian Collembola (Shayanmehr et al., 2020), 232 species within 95 genera were recorded from Iran, of which most species have been reported from Mazandaran province. The recent studies of the province have introduced more new records of Collembola species that were also new to science (Yahyapour et al., 2020a, 2020b, 2021, 2022a, 2022b; Mehrafrouz et al., 2021; Yoosefi Lafooraki et al., 2020a, 2020b). Despite these studies, still, there are many unidentified species that need to be known in Mazandaran province. Hezarjirib forests as a part of the Hyrcanian forests have rich flora and fauna. Deforestation, especially in the lowlands today, has wiped out many species or posed a serious threat. Thus, this study aimed to investigate the Collembola fauna in Hezarjirib forests (Neka, Mazandaran) and as a result, new records be added to the Iranian Collembola fauna.

MATERIAL AND METHODS

In this study, the part of Hezarjirib forests located in Neka city in Mazandaran province was selected as the study site (Fig. 1). In different localities of these areas, soil and leaf litter samples were collected from March 20, 2020, to February 28, 2021, and geographical data of the sampling sites were obtained by a GPS receiver. Samples were transferred to the laboratory of Sari Agricultural Sciences and Natural Resources University, Iran. Collembola specimens were extracted by a modified Berlese funnel and stored in 70% Ethanol (Yahyapour et al., 2021). The dark specimens were cleared in Nesbit's solution and mounted on Hoyer's medium. The Collembola were identified to genera and species levels using available taxonomical keys (Bellinger et al., 1996–2022). Microscopic slides and specimens preserved in alcohol are maintained in the laboratory of Sari University of Agricultural Sciences and Natural Resources (SARU).

RESULTS

In the present study, 25 species were collected and determined from different localities in Hezarjirib forests near Neka (Mazandaran province). Of these, three species including *Hypogastrura papillata* Gisin, 1949 (Hypogastruridae), *Lepidocyrtus bicoloris* Mateos, 2012 (Entomobryidae) and *Folsomia trisetata* Jordana & Ardanaz, 1981 (Isotomidae) were recorded for the first time from Iran.

Order Poduromorpha Börner, 1913

Family Neanuridae Börner, 1901

Subfamily Neanurinae Börner, 1901

Genus *Deutonura* Cassagnau, 1979

Deutonura persica Smolis & Shayanmehr & Yoosefi-Lafooraki, 2018

Materials examined: Four specimens, Iran, Mazandaran province, Neka, Kamshi village, Hezarjirib forests, and leaf litter, 36°31'59"N, 53°33'44"E, 856 m a.s.l., 28-V-2021, leg.: Arash Bakhshi.



Figure 1. The map of the Sampling area, Hezarjirib forests located in Neka city in Mazandaran province. The red circles (●) indicate the sampling locations.

Distribution in Iran: The species was first collected from soil and leaf litter in Mazandaran province and identified as *D. decolorata* (Gama & Gisin, 1964) by Cox (1982), but later it was described as a new species, *D. persica* based on the specimens collected in Mazandaran province (Neka, Hezarjirib forest) (Smolis et al., 2018).

General distribution: So far only known from the type locality in Mazandaran province, north of Iran (Smolis et al., 2018).

Remarks: the specimens were collected from the mosses on trees leaf litter, and dead wood in a hole of Persian Ironwood in Mazandaran province (Smolis et al., 2018).

Genus *Endonura* Cassagnau, 1979

Endonura agnieszkae Smolis & Skarżyński, 2020

Material examined: Two specimens, Iran, Mazandaran province, Neka, Sekile Sahra village, Hezarjirib forests, soil and leaf litter, 36°35'18"N, 53°25'38"E, 440 m a.s.l., 27-V-2021, leg.: Arash Bakhshi.

Distribution in Iran: This species was collected from tree holes and leaves in Mazandaran province (Nashtarud, and Kiasar) (Smolis & Skarżyński, 2020)

General distribution: So far only known from the type locality in Mazandaran province, north of Iran.

Endonura ceratolabralis Smolis, Kahrarian, Piwnik & Skarżyński, 2016

Material examined: One specimen, Iran, Mazandaran province, Neka, Kamshi village, Hezarjirib forests, leaf litter, 36°31'59"N, 53°33'44"E, 856 m a.s.l., 27-V-2021, leg.: Arash Bakhshi.

Distribution in Iran: This species was collected in Kermanshah province (Osmanevand) from the leaf litter in oak forest (Smolis et al., 2016). This is the first record of this species from Mazandaran province.

General distribution: So far only known from the type locality in Kermanshah province, western Iran.

Genus *Cryptonura* Cassagnau, 1979

Cryptonura sp.

Material examined: one specimen, Iran, Mazandaran province, Neka, Sekile Sahra village, Hezarjirib forests, soil and leaf litter, 36°35'18"N, 53°25'38"E, 440 m a.s.l., 27-V-2021, leg.: Arash Bakhshi.

Distribution in Iran: The specimen was collected from soil and leaf litter in Mazandaran province (Behshahr), but its identity remained unknown. Two endemic species, *Cryptonura persica* Smolis, Falahati & Skarżyński, 2012, and *Cryptonura maxima* Smolis, Falahati & Skarżyński, 2012 have been reported in the last checklist of Iranian Collembola (Shayanmehr et al., 2020). Three other endemic species, *Cryptonura dohezarensis* Arbea, Yahyapour & Shayanmehr; *Cryptonura abmalensis* Arbea, Yahyapour & Shayanmehr and *Cryptonura sariensis* Arbea, Yahyapour & Shayanmehr were also added to Iranian Collembola fauna (Yahyapour et al., 2022a).

Family Hypogastruridae Börner, 1906

Genus *Ceratophysella* Börner, 1932

Ceratophysella denticulata (Gisin, 1949)

Material examined: One specimen, Iran, Mazandaran, Neka, Sika village Hezarjirib forests, leaf litter, 36°24'16"N, 53°33'0.047"E, 1022 m a.s.l., 27-V-2021, leg.: Arash Bakhshi.

Distribution in Iran: This common species was collected from soil and leaf litter in East Azarbaijan, Guilan, Kermanshah, Kerman (Mahan), Mazandaran (Babol, Neka, Noor, Sari, and Savadkooh), West Azarbaijan and Zanjan (Shayanmehr et al., 2020).

General distribution: Cosmopolitan (Fjellberg, 1998; Thibaud et al., 2004).

Ceratophysella stercoraria (Stach, 1963)

Material examined: 16 specimens, Iran, Mazandaran, Neka, Sika village Hezarjirib forests, leaf litter, 36°24'16"N, 53°33'0.047"E, 1022 m a.s.l., 27-V-2021, five specimen, Neka, Sekile sahra village, Hezarjirib forests, soil and leaf litter, 36°35'18"N, 53°25'38"E, 440 m a.s.l., 28-V-2021, leg.: Arash Bakhshi.

Distribution in Iran: The species is common in soil and leaf litter in Golestan (the National Park), Kerman, Kermanshah, Kohgiluyeh and Boyer-Ahmad, Lorestan, Mazandaran (Neka) and Tehran provinces (Shayanmehr et al., 2020)

General distribution: Bulgaria, Russia, Ukraine, partly Middle Asia (Thibaud et al., 2004).

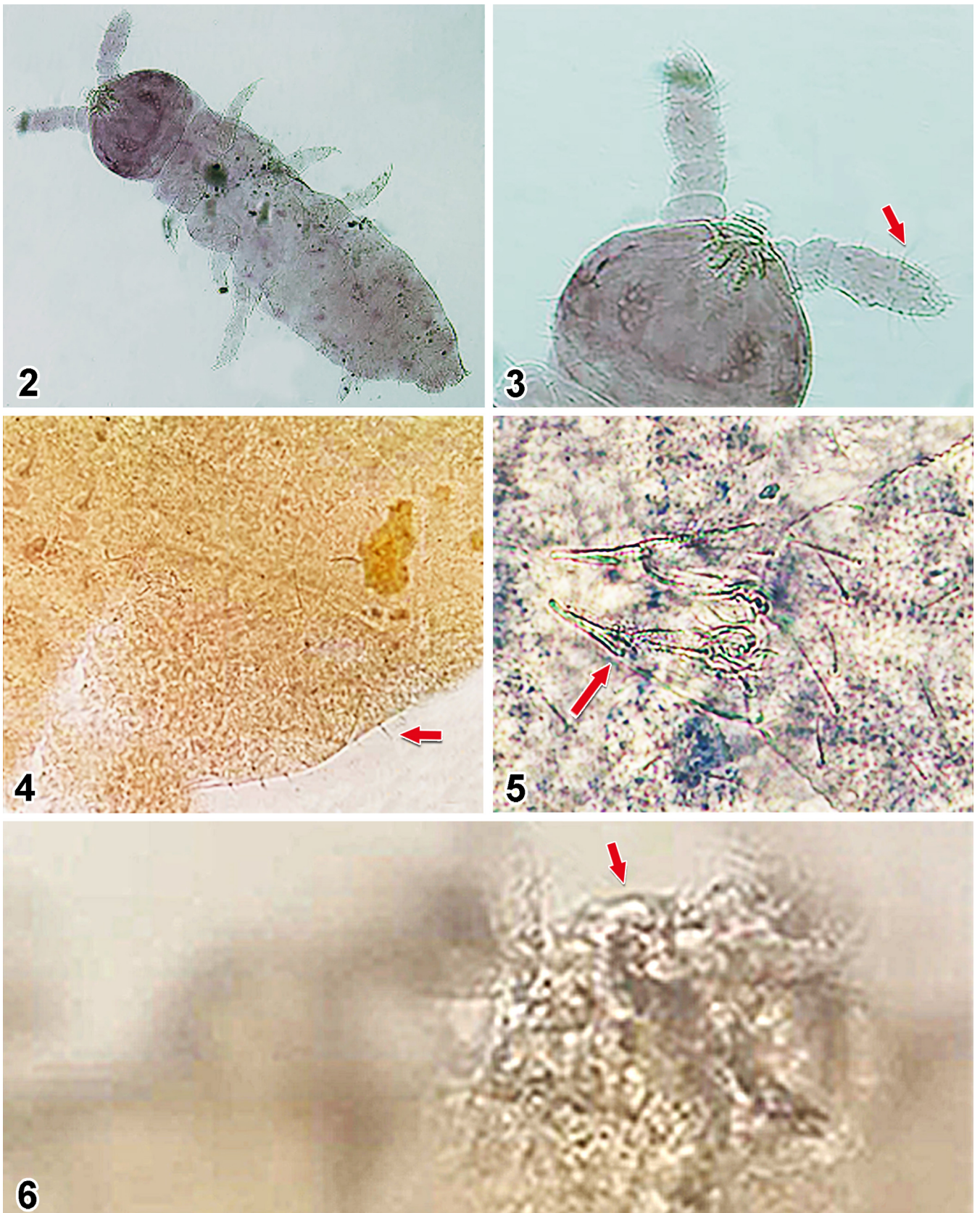
Genus *Hypogastrura* Bourlet, 1839

Hypogastrura papillata Gisin, 1949 (Figs. 2–6)

Material examined: One specimen, Iran, Mazandaran, Neka, Sika village Hezarjirib forests, leaf litter, 36°24'16"N, 53°33'0.047"E, 1022 m a.s.l., 27-V-2021, leg.: Arash Bakhshi.

Distribution in Iran: This species is a new record for the Iranian Collembola fauna.

General distribution: Europe (Thibaud, 2017).



Figures 2–6. *Hypogastrura papillata* Gisin, 1949 from Iran. 2. General habitus (10×); 3. Sensilla on Ant. 4 (40×); 4. Macroseta on Abd V (40×); 5. Furca (40×); 6. Setae on ventral tube (40×).

Family Onychiuridae Börner, 1913**Subfamily Onychiurinae Börner, 1901****Genus *Heteraphorura* Bagnall, 1948*****Heteraphorura iranica* Kaprus, Shayanmehr & Kahrarian, 2017**

Materials examined: Four specimens, Iran, Mazandaran, Neka, Sika village Hezarjirib forests, leaf litter, 36°24'16"N, 53°33'0.047"E, 1022 m a.s.l., 27-V-2021, leg.: Arash Bakhshi.

Distribution in Iran: This species was collected from Soil and leaf litter under oak and horn beam trees in Kermanshah (Chahar Zebar-e-oliya, Osmanevarand, Cheshmehsorkh, Paveh, Shabankareh) Mazandaran (Nowshahr, Kajour, Lashkenar; Babolsar, Bahnamir, Sari, Semeskandeh forest, Neka) and Golestan (Gorgan, Alangdarreh forest, Kordkuy, Imam Reza forest; the National Park) provinces (Shayanmehr et al., 2020; Yahyapour et al., 2020a).

General distribution: Iran (Shayanmehr et al., 2020; Yahyapour et al., 2020a).

Genus *Protaphorura* Absolon, 1901***Protaphorura golestanica* Kaprus, Shayanmehr & Kahrarian, 2017**

Materials examined: Seven specimens, Iran, Mazandaran province, Neka, Ghormaraz village, Hezarjirib forests, soil and leaf litter, 36°35'52"N, 53°24'13"E, 346 m a.s.l., 09-IV-2021, leg.: Arash Bakhshi.

Distribution in Iran: This species was collected from soil and leaf litter under horn beams in Golestan (Alangdarreh forest, Gorgan region, Kordkuy, Imam Reza forest, the National Park) and Mazandaran (Neka) provinces (Kaprus et al., 2017; Khanahmadi, 2018).

General distribution: So far only known from the type locality in Golestan and Mazandaran province, north of Iran Kaprus et al. (2017), Khanahmadi (2018).

***Protaphorura levantina* (Christiansen, 1956)**

Materials examined: One specimen, Iran, Mazandaran province, Neka, Ghormaraz village, Hezarjirib forests, soil and leaf litter, 36°35'52"N, 53°24'13"E, 346 m a.s.l., 09-IV-2021, leg.: Arash Bakhshi.

Distribution in Iran: Golestan, Kermanshah and Mazandaran provinces (Shayanmehr et al., 2020; Yahyapour et al., 2020a).

General distribution: Described from Lebanon and Syria (Christiansen, 1957). Also known from Israel and Iran (Arbea & Kahrarian, 2017).

Family Odontellidae Massoud, 1967**Genus *Superodontella* Stach, 1949*****Superodontella lamellifera* (Axelson, 1903)**

Materials examined: One specimen, Iran, Mazandaran province, Neka, Kamshi village, Hezarjirib forests, leaf litter, 36°31'59"N, 53°33'44"E, 856 m a.s.l., 27-V-2021, leg.: Arash Bakhshi.

Distribution in Iran: This species was collected from soil in East Azarbaijan and Mazandaran (Sari, Neka) provinces (Cox, 1982).

General distribution: Cosmopolitan (Fjellberg, 1998).

Order Entomobryomorpha Börner, 1913

Family Entomobryidae Schäffer, 1896

Subfamily Lepidocyrtinae Wahlgren, 1906

Genus *Lepidocyrtus* Bourlet, 1839

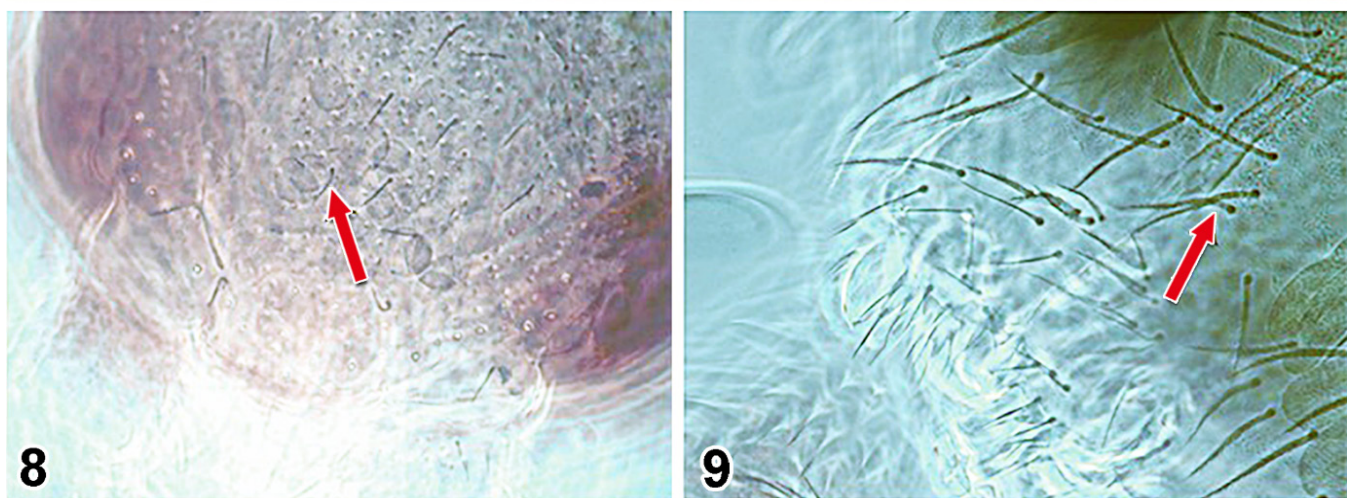
Lepidocyrtus bicoloris Mateos, 2012 (Figs. 7–9)

Materials examined: Two specimens, Iran, Mazandaran province, Neka, Sika village, Hezarjirib forests, Leaf litter, 36°24'16"N, 53°33'0.047"E, 1022 m a.s.l., 28-V-2021, leg.: Arash Bakhshi.

Distribution in Iran: This species is a new record for the Iranian Collembola fauna.

General distribution: only from Spain (Mateos, 2012).

Remark: Specimens were obtained from pine and oak litter and from herbaceous vegetation. They all have a gut content composed mainly of fungal hyphae and spores from Spain (Mateos, 2012).



Figures 7–9. *Lepidocyrtus bicoloris* Mateos, 2012 from Iran. 7. General habitus (10×); 8. Chaetotaxy of head (100×) and 9. Chaetotaxy of labrum (100×).

Lepidocyrtus lanuginosus (Gmelin, 1788)

Materials examined: Four specimens, Iran, Mazandaran province, Neka, Sika village, Hezarjirib forests, leaf litter, 36°24'16"N, 53°33'0.047"E, 1022 m a.s.l., 28-V-2021, leg.: Arash Bakhshi.

Distribution in Iran: It was collected from soil and leaf litter in Mazandaran, Guilan, East Azarbaijan, and Golestan (Gorgan, Palangpa forest) provinces (Cox, 1982; Hosseini et al., 2016; present study).

General distribution: Palaearctic species.

Family Orchesellidae Börner, 1906

Subfamily Heteromurinae Absolon & Kseneman, 1942

Genus *Heteromurus* Wankel, 1860*Heteromurus nitidus* (Templeton, 1835)

Materials examined: Two specimens, Iran, Mazandaran province, Neka, Okerka village, Hezarjirib forests, leaf litter, 2-IV-2021, 36°35'56"N, 53°26'23"E, 449 m a.s.l. and one specimen, Mazandaran province, Neka, Sekile Sahra village, Hezarjirib forests, soil and leaf litter, 36°35'18"N, 53°25'38"E, 440 m a.s.l., 27-V-2021, leg.: Arash Bakhshi.

Distribution in Iran: The species was collected from soil and leaf litter in Guilan, Mazandaran (Babol, Qaemshahr, Savadkooh, Sari), Kermanshah (Harsin), Golestan (Kordkouy - Crop field, Palangpa forest) (Kahrarian, 2019; Kahrarian et al., 2016).

General distribution: Holarctic, also present in Argentina, Chile, and New Zealand (Mari Mutt, 1980).

Heteromurus major (Moniez, 1889)

Materials examined: Three specimens, Iran, Mazandaran province, Neka, Sika village, Hezarjirib forests, leaf litter, 36°24'16"N, 53°33'0.047"E, 1022 m a.s.l., 28-V-2021, six specimens, Mazandaran province, Neka, Emamzade Yahya village, Hezarjirib forests, soil and leaf litter, 36°22'6.98"N, 53°33'21"E, 1334 m a.s.l., 28-V-2021; two specimens, Neka, Kamshi village, Hezarjirib forests, leaf litter, 36°31'59"N, 53°33'44"E, 856 m a.s.l., 28-V-2021, five specimens, Neka, Ghormaraz village, Hezarjirib forests, soil and leaf litter, 36°35'52"N, 53°24'13"E, 346 m a.s.l., 27-V-2021, one specimen, Neka, Okerka village, Hezarjirib forests, leaf litter, 36°35'56"N, 53°26'23"E, 449 m a.s.l., 25-V-2021, leg.: Arash Bakhshi.

Distribution in Iran: The species is common and collected from soil and leaf litter in different parts of Iran, East Azarbaijan, Golestan (Gorgan - Alangdarre forest), Guilan (Rasht), Mazandaran (Babol-Qaemshahr, Sari, Savadkooh, Lafoor, Noor, Katel-Shani, Noor, Forest of Sisangan wildlife refuge; Larijan), Tehran, Kermanshah (Kermanshah, Chalabeh, Char, Zabar, Paveh, Shahu, Quri Qal'eh, Harsin) and Lorestan provinces (Shayanmehr et al., 2020).

General distribution: Cosmopolitan species. Widely distributed in Australia, Chile, France, Germany, Greece, former Czechoslovakia, Hungary, Italy, Mexico, Palestine, Portugal, Romany, Spain, Switzerland, Republic of Azerbaijan, and former Yugoslavia (Mari Mutt, 1980).

Subfamily Entomobryinae Schäffer, 1896

Genus *Entomobrya* Rondani, 1861*Entomobrya nigrocincta* Denis, 1923

Materials examined: One specimen, Iran, Mazandaran province, Neka, Sika village, Hezarjirib forests, leaf litter, 36°24'16"N, 53°33'0.047"E, 1022 m a.s.l., 28-V-2021, leg.: Arash Bakhshi.

Distribution in Iran: This species was collected from soil under an elm tree in Kermanshah (Qal'eh, Harasam, Char Zebar) and Mazandaran (Sari) provinces (Shayanmehr et al., 2020).

General distribution: Europe, Mediterranean sea region, West Asia (Bellinger et al., 1996–2022).

Family Isotomidae Schäffer, 1869

Subfamily Anurophorinae Börner, 1901

Genus *Folsomia* Willem, 1902

***Folsomia trisetata* Jordana & Ardanaz, 1981 (Figs. 10–13)**

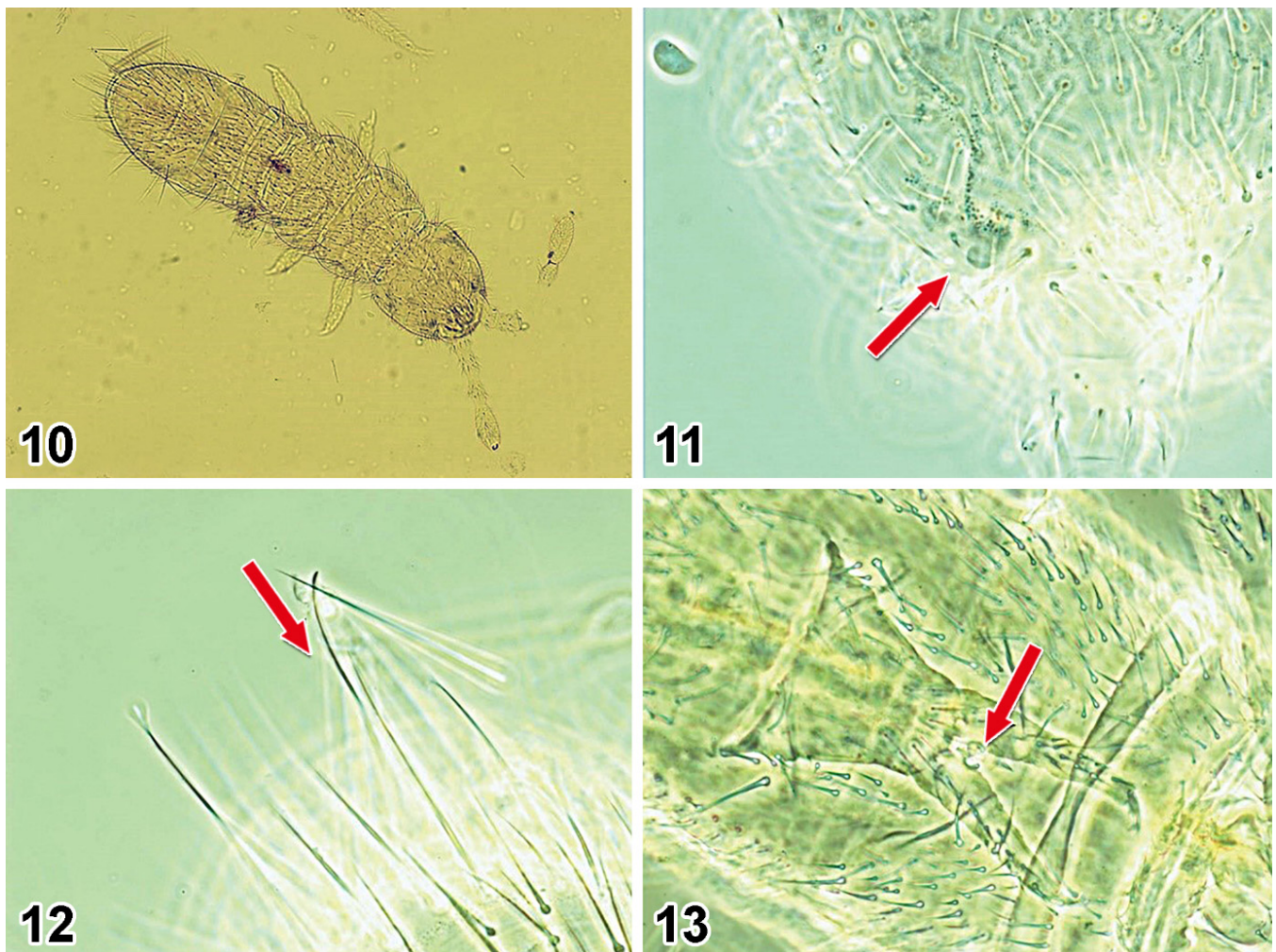
Materials examined: One specimen, Iran, Mazandaran province, Neka, Emamzade Yahya village, Hezarjirib forests, soil and leaf litter, 36°22'6.98"N, 53°33'21"E, 1334 m a.s.l., 28-V-2021, leg.: Arash Bakhshi.

Distribution in Iran: This species is a new record for the Iranian Collembola fauna.

General distribution: Europe (Bellinger et al., 1996-2022).

***Folsomia manolachei* Bagnall, 1939**

Materials examined: Two specimens, Iran, Mazandaran province, Neka, Emamzade Yahya village, Hezarjirib forests, soil and leaf litter, 36°22'6.98"N, 53°33'21"E, 1334 m a.s.l., 28-V-2021; two specimens, Neka, Sika village, Hezarjirib forests, leaf litter, 36°24'16"N, 53°33'0.047"E, 1022 m a.s.l., 27-V-2021, leg.: Arash Bakhshi.



Figures 10–13. *Folsomia trisetata* Jordana & Ardanaz, 1981 from Iran. **10.** General habitus (10×); **11.** 3+3 ocelli on the head (40×); **12.** Macrochaeta-shaped sens, apically swollen on abdominal tergum V (40×); **13.** Anterior face of manubrium with 3+3, 1+1 distal, and 4 proximal chaetae in axial part (40×).

Distribution in Iran: This species was collected from soil in Kermanshah (Bilevar) province (Arbea & Kahrarian, 2015).

General distribution: Palaearctic.

Folsomia penicula Bagnall, 1939

Materials examined: Nine specimens, Iran, Mazandaran province, Neka, Sekile sahra village, Hezarjirib forests, soil and leaf litter, 36°35'18"N, 53°25'38"E, 440 m a.s.l., 27-V-2021 19 specimens, Neka, Sika village, Hezarjirib forests, leaf litter, 36°24'16"N, 53°33'0.047"E, 1022 m a.s.l., 27-V-2021, leg.: Arash Bakhshi.

Distribution in Iran: It was collected from soil (*Quercus* sp.) and leaf litter under oak in East Azarbaijan, Golestan (Gorgan), Guilan (Rasht), Tehran, Mazandaran (Nowshahr, Kojur, Lashkenar, Bahnamir), and Kermanshah (Shikh Salaeh village, Ghap Gholi village) provinces (Shayanmehr et al., 2020).

General distribution: It is a widely distributed European species in the Palaearctic (Arbea & Kahrarian, 2015).

Subfamily Isotominae Schäffer, 1896

Genus *Isotomurus* Börner, 1903

Isotomurus afghanicus Yosii, 1963

Materials examined: One specimen, Iran Mazandaran province, Neka, Ghormaraz village, Hezarjirib forests, soil and leaf litter, 36°35'52"N, 53°24'13"E, 346 m a.s.l., 9-IV-2020; one specimen, Neka, Sika village Hezarjirib forests, leaf litter, 36°24'16"N, 53°33'0.047"E, 1022 m a.s.l., 27-V-2021, leg.: Arash Bakhshi.

Distribution in Iran: This species was collected from soil and leaf litter in Mazandaran (Mahmoodabad, Miandorud, Noor, Forest of Sisangan wildlife refuge, Amol, Neka, Hezarjerib forest) province (Shayanmehr et al., 2020).

General distribution: Afghanistan (Potapov, 2001).

Genus *Parisotoma* Bagnall, 1940

Parisotoma notabilis (Schäffer, 1896)

Materials examined: Three specimens, Iran, Mazandaran province, Neka, Emamzade Yahya village, Hezarjirib forests, soil and leaf litter, 28-V-2021, 36°22'6.98"N, 53°33'21"E, 1334 m a.s.l.; three specimens, Mazandaran, Neka, Sika village Hezarjirib forests, leaf litter, 36°24'16"N, E 53°33'0.047"E, 1022m a.s.l., 27-V-2021, leg.: Arash Bakhshi.

Distribution in Iran: This cosmopolitan species was collected from soil and leaf litter in different habitats in East Azarbaijan, West Azarbaijan, Zanjan, Tehran, Kermanshah, Guilan (Rasht), Mazandaran (Noor, Royan, Kodirsar), Kermanshah (Shabankareh village, Patagh), Golestan (Kordkuy, Palangpa forest, the National Park), Khuzestan, Kerman (Shahdad, Sirch, Mahan, Sekonj, Koohpayeh) and Lorestan province (Shayanmehr et al., 2020).

General distribution: Cosmopolitan (Bei-Bienko, 1967; Fjellberg, 2007; Hopkin, 1997).

Subfamily Proisotominae Börner, 1901

Genus *Folsomides* Stach, 1922

Folsomides parvulus Stach, 1922

Materials examined: One specimen, Iran, Mazandaran province, Neka, Sekile sahra village, Hezarjirib forests, soil and leaf litter, 36°35'18"N, 53°25'38"E, 440 m a.s.l., 27-V-2021, leg.: Arash Bakhshi.

Distribution in Iran: This species was collected from soil (*Morus* sp.), and leaf litter, soil of black cherry gardens in East Azarbaijan, West Azarbaijan, Kermanshah (Harsin, Chahar Zebare-e-Oliya), Guilan (Rasht), Tehran, Semnan (Mahdishahr), Mazandaran (Savadkooh, Forest of Jawarom wildlife refuge; Alasht, Serin village, Babolsar, Qaemshahr, Babol, Sari), Golestan (Kordkuy, Palangpa forest), Kerman (Mahan, Sekonj) and Lorestan provinces (Shayanmehr et al., 2020).

General distribution: Cosmopolitan (Potapov, 2001).

Family Tomoceridae Schäffer, 1896

Genus *Tomocerus* Nicolet, 1842

Tomocerus minor (Lubbock, 1862)

Materials examined: Three specimens, Iran, Mazandaran, Neka, Sika village Hezarjirib forests, leaf litter, 36°24'16"N, 53°33'0.047"E, 1022 m a.s.l., 27-V-2021, leg.: Arash Bakhshi.

Distribution in Iran: This species was collected from soil Mazandaran, Guilan, East Azarbaijan, Zanjan, Golestan and Kerman provinces (Cox, 1982; Hosseini et al., 2016; Abdolalizadeh, 2018; present study).

General distribution: Holarctic (Fjellberg, 2007).

Genus *Tomocerina* Yosii, 1955

Tomocerina minuta (Tullberg, 1876)

Materials examined: Two specimens, Iran, Mazandarn province, Neka, Okerka village, Hezarjirib forests, leaf litter, 36°35'56"N, 53°26'23"E, 449 m a.s.l., 02-IV-2021, leg.: Arash Bakhshi.

Distribution in Iran: So far only known from Mazandaran province (Yahyapour et al., 2021).

General distribution: The species has been reported from the Holarctic region (Fjellberg, 2007) and Turkey (Özata et al., 2017).

Order Symphypleona Börner, 1901

Family Sminthuridae Lubbock, 1862

Subfamily Sminthurinae Lubbock, 1862

Genus *Allacma* Börner, 1906

Allacma fusca (Linnaeus, 1758)

Materials examined: One specimen, Iran, Mazandaran, Neka, Sika village Hezarjirib forests, leaf litter, 36°24'16"N, 53°33'0.047"E, 1022 m a.s.l., 27-V-2021, leg.: Arash Bakhshi.

Distribution in Iran: This species was collected from pit-fall trap in forest in Mazandaran (Sari) province (Bakhshi et al., 2014).

General distribution: Holarctic. This large species, reaching sizes not matched by any other Symphypleona in this area, is commonly found in moist forests, where it is easily spotted on damp logs and stumps of wood. Widely distributed (Fjellberg, 2007; Busmachiu et al., 2014).

DISCUSSION

Mazandaran province in Northern Iran contains Hyrcanian forests which have many endemic species that have been formed due to isolation for hundreds of thousands of years after the last ice age. Today it is home to many species that are not found anywhere in the world (Mohammadi Fazel, 2020). Caspian Hyrcanian mixed forests, with a history of 59–55 million years, are considered the most valuable forests in the world, which have had the least impact in the Ice Age (Quaternary period)

compared to other forests in the world (Ghomi Avili et al., 2021). These forests are known as the mother of forests in North America and Europe (Eskandarpour & Hasani, 2015, Ghasemi Charati et al., 2022). Hyrcanian forests are under threat of losing their biodiversity due to different environmental extreme events like deforestation, soil degradation, municipal and agricultural wastes and so on and this faunistic study is a necessary step to give better knowledge and picture to decision-makers about forest biodiversity. In the present study, the fauna of Collembola in the Hezarjirib forests (Neka, Mazandaran) was investigated for the first time.

Totally, 25 Collembola species were reported from Hezarjirib forests. *Heteromurus major* is the most abundant species in Hyrcanian forest, Semeskandeh (Sari, Mazandaran) (Mehrafroz Mayvan et al., 2015). *Hypogastrura papillata* Gisin, 1949, *Lepidocyrtus bicoloris* Mateos, 2012 (Entomobryidae) and *Folsomia trisetata* Jordana & Ardanaz, 1981 were recorded for the first time for Iranian fauna. Previously, nine species of *Hypogastrura* have been recorded from Iran; *H. assimilis* (Krausbauer, 1898), *H. ellisi* Skarżyński & Kahrarian, 2017, *H. manubrialis* (Tullberg, 1869), *H. martiani* Skarżyński & Kaprus, 2009, *H. persica* Kahrarian, Vafaei-Shoushtari, Skarżyński & Konikiewicz, 2013, *H. purpurescens* (Lubbock, 1867), *H. socialis* (Uzel, 1891), *H. tullbergi* (Schäffer, 1900) and *H. vernalis* (Carl, 1901) (Shayanmehr et al., 2020). Only three species of *Lepidocyrtus* including *L. cyaneus* (Tullberg 1871), *L. lanuginosus* (Gmelin, 1788) and *L. ruber* (Schött, 1902) were already reported from Iran (Shayanmehr et al., 2020). From the genus *Folsomia*, 11 species were before recorded from Iran, *F. asiatica* Martynova, 1971, *F. binocolata* (Wahlgren 1899), *F. brevoifurca* (Bagnall, 1949), *F. candida* (Willem, 1902), *F. diplophthalma* (Axelson, 1902), *F. fimetaria* (Linnaeus, 1758), *F. penicula* (Bagnall, 1939), *F. quadrioculata* (Tullberg, 1871), *F. similis* (Bagnall, 1939), *F. ksenemani* (Stach, 1947) and *F. manolachei* (Bagnall, 1939) (Shayanmehr et al., 2020). Despite many researches on Collembola fauna were done in Mazandaran province, still there are species that needs to be introduced into science from this province in Northern Iran.

AUTHOR'S CONTRIBUTION

The authors confirm contribution to the paper as follows: A.B. performed the project as master science thesis, M.Sh. encouraged A.B. to investigate [a specific aspect] and supervised the project and the finding of this work, M.M.S. and E.Y. advised the project and took the lead in writing the manuscript and I.K. confirmed the identifications and findings of this work. All authors approved the final version of the manuscript.

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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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مطالعه فونستیک دم‌فتری‌ها (شش‌پایان، پادمان) از جنگل‌های هزار جریب (نکا، مازندران) با سه گزارش جدید از ایران

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چکیده: هدف از این مطالعه، گسترش تحقیقات بر روی فون پادمان در بخش‌هایی از جنگل‌های هیرکانی، جنگل‌های هزارجریب واقع در شهرستان نکا در استان مازندران بود. برای این منظور، نمونه‌برداری موردی از لاش‌برگ و خاک در مناطق مختلف طی سال‌های ۲۰۲۰-۲۰۲۱ انجام شد. نمونه‌های دم‌فتری توسط قیف برلیز استخراج و پس از نصب بر روی اسلاید توسط کلیدهای رده‌بندی شناسایی شدند. نتایج این تحقیق، منجر به شناسایی ۲۵ گونه متعلق به ۱۹ جنس از ۸ خانواده شد. سه گونه شامل *Lepidocyrtus* (Hypogastruridae) *Hypogastrura papillata* Gisin, 1949 *Folsomia trisetata* Jordana & *bicoloris* Mateos, 2012 (Entomobryidae) و برای اولین بار از ایران گزارش شدند. اطلاعات مختصر در مورد گونه‌ها از جمله مواد مورد مطالعه، دامنه انتشار و برخی از تصاویر گونه‌های جدید گزارش شده، ارائه شد.

واژگان کلیدی: فون پادمان، جنگل هیرکانی، گزارش گونه جدید، مازندران.