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Poduromorpha fauna of Ordu province in Turkey (Hexapoda: Collembola)

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ÖZ

Ordu ili Poduromorpha faunası (Hexapoda: Collembola)

2012-2013 yıllarında Ordu ilinde yapılan arazi çalışmaları sonucunda Poduromorpha (Collembola) takımına ait dört familyadan (Hypogastruridae, Neanuridae, Odontellidae, Onychiuridae) toplam 340 örnekten 13 cinse ait 18 tür teşhis edilmiştir. Bu türlerin hemen tamamı Türkiye faunası için ilk tespittir. Tespit edilen 17 yeni kayıtla birlikte, Türkiye Collembola faunasına ait tür sayısı 100'e yükselmiştir. Bu sayı mevcut tespitin yaklaşık %20'sine denk gelmektedir. Bu sonuçlar Türkiye'de yayılış gösteren Collembola taksonlarının çok az bilindiğini ve yeni populasyonların keşfedilmeyi beklediğini ortaya koymaktadır.

Anahtar kelimeler: Hexapoda, Collembola, Poduromorpha, kuyrukla sıçrayanlar, Türkiye, Ordu, yeni kayıtlar

ABSTRACT

During the survey (2012-2013) in Ordu province, a total of 340 specimens of Poduromorpha springtails (Collembola) belonging to 18 species, 13 genera belonging to four families (Hypogastruridae, Neanuridae, Odontellidae, Onychiuridae) were collected. Almost all species are reported for the first time from Turkey. With our 17 new records, the grand total of the Collembola fauna of Turkey rises to 100 species. This represents an increase about 20% over the current data in the fauna of Turkey. These results suggest that the biodiversity of springtails of Turkey is undoubtedly still waiting to be discovered.

Keywords: Hexapoda, Collembola, Poduromorpha, springtails, Turkey, Ordu, new records

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INTRODUCTION

Invertebrates which constitute about 90% of all animal species on Earth and dominate every global ecosystem in terms of biodiversity and ecological function (Mora et al. 2011). Unfortunately, limited sampling and lack of faunal and taxonomic information on various invertebrate animals (e. g. Hexapoda) to date has prevented to get a full picture of the diversity patterns and evaluating of the biodiversity in a region. Moreover, biodiversity is greatly reduced when large areas of natural habitat in the world are fragmented due to largely caused by human activities (Şekercioglu et al. 2011).

The first step for conservation of biodiversity in a region is the faunal and taxonomic studies. Although biodiversity is remarkable rich in Turkey which has a variety of climates, habitats and ecosystems (Şekercioglu et al. 2011), some invertebrate fauna of Turkey is little known and it is clear that numerous species wait to be discovered. For example, Collembola fauna of Turkey is still poorly known and it is possible that they may eventually be shown to be most diverse in various habitats (Skarzynski and Pomorski 1999, Sevgili and Özata 2014, Özata et al. 2017a,b).

Springtails (Collembola) are among the widespread and abundant animals that adapted to almost all terrestrial habitats from seashore to the highest altitudes (Deharveng et al. 2008, Hopkin 1997). The springtails are extremely abundant in soil materials and leaf litter, they are able to influence on decomposition and respiration of soils (Hopkin 1997). These effects must be significant in many ecosystems. Unfortunately, since there are very few studies on fauna of Collembola in Turkey, any studies have not been conducted on their ecological significance in both natural and agricultural lands.

Although Collembola (Hexapoda) fauna of Turkey is little known, the fauna of many European countries is well studied and species checklists of some countries have been largely provided (Ulrich and Fiera 2009). The first preliminary checklist of springtails of Turkey was published by Sevgili and Özata (2014) and 53 species which are mostly recorded in South Anatolia were listed. Their distribution in Turkey is documented by original publications and several faunal surveys (see Sevgili and Özata 2014). Until now, 13 families belong to four collembolan orders are known from Turkey. Within the Collembola, the order Poduromorpha Börner, 1913 is one of the large order of springtails, mostly short and less mobile species, differing from other orders by having distinct prothorax that bears dorsal setae, similar size of third and fourth abdominal segments, short legs and a plump body (D'Haese 2004, Fjellberg 1998). Poduromorpha comprises more than 2600 species in approximately 260 genera in the world (Bellinger et al. 2016; D'Haese 2004). This order is represented by five families (Hypogastruridae, Odontellidae, Neanuridae, Onychiuridae and Tullbergiidae) in Turkey. Since 2016, 19 species and 13 genera of these families were recorded from Anatolia (Sevgili and Özata 2014, Özata et al. 2017a,b).

This study is a part of the project that aims to know the faunal composition of Collembola of Ordu province in Blacksea Region of Turkey. Except a few studies, so far there is no any documented study about the springtails fauna of this region.

MATERIAL AND METHOD

The study area is Ordu province which is located between Samsun and Giresun provinces in Middle Blacksea coast of Turkey (40°04'-41º08' N, 36º41'-38º07' E). Ordu covers an area of 6000 square kilometers with a widely varied topographies including some plateus at high altitudes. The climate of Ordu as in the whole Blacksea region is wet, humid and receives the high amount of precipitation in Turkey. Although natural habitats have been moderately degraded by rural settlements, productive *Fagus orientalis* forests with admixtures of *Castanea sativa*, *Prunus* spp. and *Carpinus betulus* and *Rhododendron flavum* (Kaya and Raynal 2001).

The springtails were collected between April 2012 and August 2013 by M. Ali Özata and H. Sevgili. All the specimens recorded in this study were sampled from a total of 26 different sites ranging in altitudes from sea level to about 1800 m (Figure 1). Specimens were generally sampled from leaf litters and they were collected in plastic bags from field sites. In same day, the specimens extracted using Berlese-Tullgren funnels (with 75 watts light bulbs) for two days, stored in 80% ethanol and cleared the dark specimens in a Nesbitt solution in the laboratory. The springtails specimens were mounted on microscope slides in Faure's solution (slide numbers for each specimen were given in the each examined materials). The specimens were identified by taxonomic keys of published papers/books and web data such as Stach (1954), Gisin (1960), Fjellberg (1998), Thibaud et al. (2004), Bellinger et al. (2016). Observations of the specimens was done under a microscope with a multi-viewing system and phase contrast.

When localities of collected materials are given, the following format is used: Town of Ordu province, village or district, collection date, altitude, GPS coordinates, habitat, specimens and slide number. All materials are deposited in Zoology Laboratory of Molecular Biology and Genetic Department (Ordu University).

RESULTS

In 2012-2013, from the sampled areas we recorded 18 species from 13 genera belonging to four families. 17 species of them are new records for Turkey. These results were not surprising, since the sampled region had not been studied previously, as other provinces of Turkey. With 18 species, the total of the Collembola fauna of Turkey rises to 100 species. This represents an increase about 20% over the current data in the fauna of Turkey. While most of the species, listed in this study, have a wide range distribution (Cosmopolitan or Palearctic), others are known only from Balkans or other European countries.

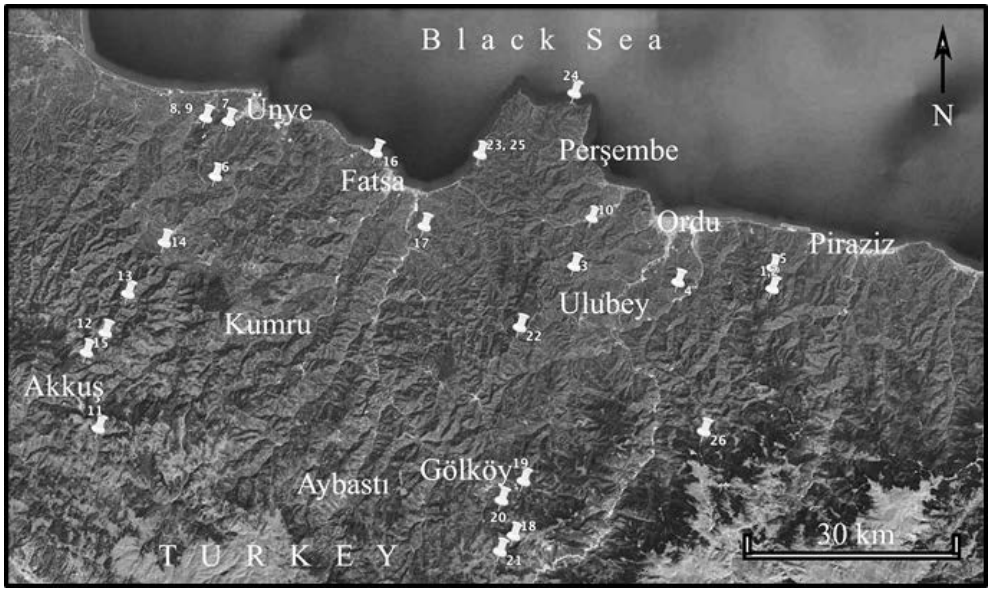

Figure 1. Sampling localities of springtails in Ordu province of Turkey (modified from Google Map, 2017).

Taxonomy

Class: Collembola Lubbock, 1870

Order: Poduromorpha Börner, 1913

Family Hypogastruridae Börner, 1906

***Ceratophysella denticulata* (Bagnall, 1941)**

Examined materials: Fatsa (Cıngırt Castle), 10.07.2012, 30.09.2012, 161-240 m, 37° 26' 68" N, 37° 04' 49"N, 41º 03' 92" E, 41º 06' 55" E, Moss, Chestnut, Oak forest, 6 juvenile, 228, N6-11; - Gölköy, Tilkini district, 17.07.2012, 1199 m, 37° 62' 09" N, 40º 63' 29" E, Beech forest, 1 juvenile, 136; - Ünye, İnkur (Çet picnic spot), 01.06.2012, 01.06.2013, 348-446 m, 37° 19' 59" N, 41º 06' 45"E, Pine forest and soil, 3 juvenile, 206d.

Distribution: Cosmopolitan (Fjellberg 1998, Thibaud et al. 2004). New to Turkey.

Remarks: External morphology is clearly variable for the species (Babenko et al. 1994). For this reason, there may be species very close to each other within the genus, and species with very different morphologies may have different populations of the same species. Fjellberg (1998) has shown that the identification of the V. abdominal segment can be made more precisely by using chaetotaxy. However, chaetotaxy was not studied on the samples collected in this study, therefore the diagnosis is based on

other morphological characters. Habitus, antenna, PAO (Post antennal organ) and anal spines as in Fig. 2. This species was extracted from the leaf litters of beech and pine and it has been found that the till spreads from 200 m to 1500 m on high mountainous areas.

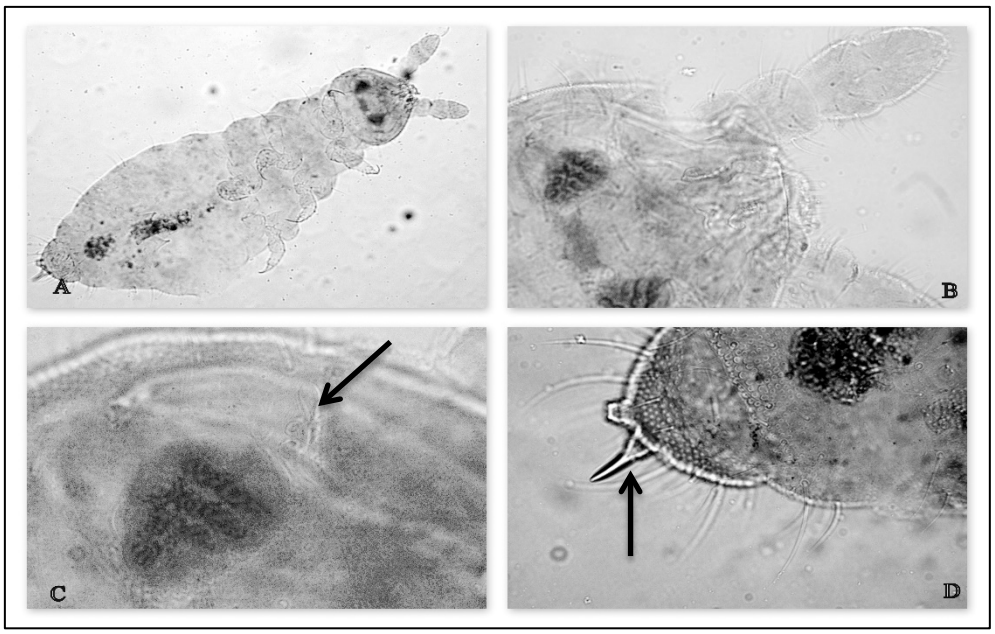

Figure 2. *Ceratophysella denticulata* (Bagnall, 1941); A: Habitus dorsal, B: Antenna, C: PAO (postantennal organ); D: Anal spines.

***Ceratophysella stercoraria* (Stach, 1963)**

Examined materials: Fatsa (Cıngırt Castle), 10.07.2012, 30.09.2012, 161-240 m, 37° 26' 68" N, 37° 04' 49"N, 41º 03' 92" E, 41º 06' 55" E, Moss, Chestnut, Oak forest, 31♂♂, 5 juvenile, N8-15, N7-13.

Distribution: Bulgaria, Russia, Ukraine, partly Middle Asia (Thibaud et al. 2004) and Iran (Shayanmehr et al. 2013). New to Turkey.

Remarks: This species is quite similar to *C. gibbosa, C. caucasica* and *C. denticulata* (Skarzynski 2000). However, it differs from these similar species by the chaetotaxial characters reported by Thibaud et al. (2004). Habitus, eyes and PAO, IV. antennal segment, anal spines and furca as in Fig. 3. The materials studied from the province of Ordu has been collected from the Redwood forest rubble and near the shore. However, since the adult population of the species cannot be studied in this work, the possible morphological differences within the local population have not been addressed here.

***Ceratophysella succinea* (Gisin, 1949)**

Examined materials: Akkuş, 08.07.2012, 1254 m, 37° 02' 00" N, 40º 84' 35" E, Beech forest, 1 juvenile, 15.

Distribution: Holoarctic, including China (Fjellberg 1998; Thibaud *et al.* 2004; Wu and Yin 2007). New record from Turkey.

Remarks: *C. succinea* and *C. denticulata* are very similar to each other. In this study, both species were found in the province of Ordu. It is possible to distinguish these two species based on the morphological difference of the chaetotaxy of the dens. In adults, it is possible to distinguish the body from *C. succinea* by darker coloring and detailed chaetotaxical studies. Anal part and furca as in Fig. 4. Samples were extracted from the leaf litter of hornbeam forest at around 1250 m.

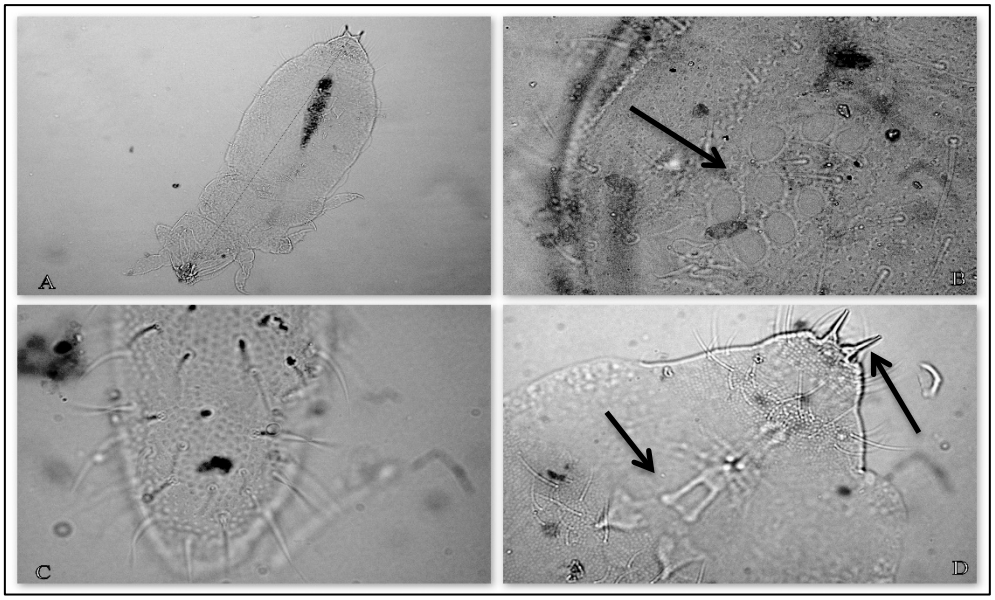

Figure 3. *Ceratophysella stercoraria* (Stach, 1963); A: Habitus dorsal, B: Eye and PAO, C: IV. Antennal segment, D: Anal spines and furca.

Figure 4. *Ceratophysella succinea* Gisin, 1949; Anal part and furca.

***Hypogastrura vernalis* (Carl, 1901)**

Examined materials: Kabadüz, Çambaşı yolu, 21.07.2013, 1625 m, 37° 55' 75" N, 40° 43' 58" E, Leaf litter of Maple, 1♂, 27 juvenile, 134b, 33s, 33v, 33y, 33ş, 33t, 7a, 6e, 7.

Distribution: Known from Palearctic (Thibaud et al. 2004). A new record for Turkey.

Remarks: It has been reported in the literature that this species occurs in many different habitats (Thibaud et al. 2004). Other species belonging to this genus have also been collected from Ordu. However, possible populations were not included in this study because the entire material which were collected from *Acer* sp. leaf litter at about 1600 m could not be identified.

***Schoetella ununguiculata* (Tullberg, 1869)**

Examined materials: Ordu – Tokat - Between Akkuş and Niksar, 08.07.2012, 1218 m, 37° 34' 12" N, 40º 75' 30"E, Pine and Oak forest, 1♂, 3♀♀, 6 juvenile, 146a.

Distribution: Nearctic region: Canada, USA. Palearctic region: Austria, Czech Republic, Ukraine, England, Germany, France, Hungary, Ireland, Italy, Lithuania, Morocco, Poland, Portugal, Romania, Russia, Scandinavia and Spain (Jordana et al. 1990, Thibaud et al. 2004). Recently reported from Iran (Balvasi et al. 2015). New record for Turkey.

Remarks: The body size varies between 1.2-1.7 mm (average 1.3 mm in Ordu population). According to other species of the family, the body is a little big and robust and the color of the body is a bluish black. The granulation on cuticle is thinly and slightly rough towards the end of the abdomen. First antennal segment with 7 setae and there are specific sensory organs on the III. and VI. antennal segments

(Thibaud et al. 2004). Each tibia with 3-4 thick elongated hair-like setae. Dens relatively thick with 5 dorsal setae and 2 rows of fine granules. Habitus dorsal, apex of tibiotarsus and furca as shown in Fig. 5.

It is known that there are ten species of the genus in the world (Bellinger et al. 2016). From these other species, *S. ununguiculata* may be distinguished by the number of hair-like setae on the tibiotarsus. The specimens were collected from mixture of pine and oak forest at about 1200 m. It is a hemiedaphic species that has been reported to spread in many habitats (Thibaud et al. 2004).

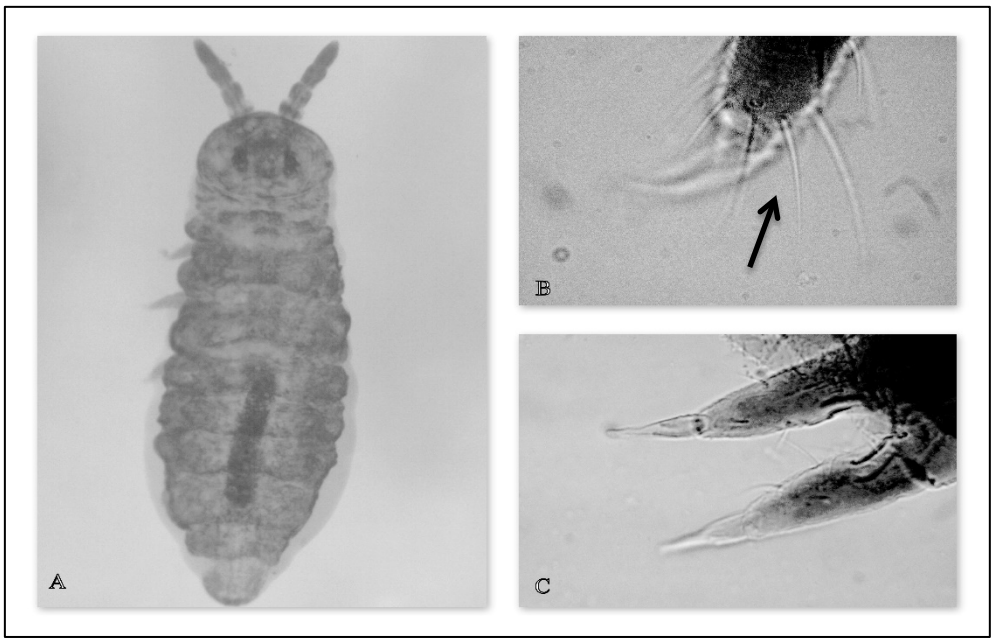

Figure 5. *Schoetella ununguiculata* (Tullberg, 1869); A: Habitus dorsal, B: Tibiotarsus, C: Furca.

Xenylla brevisimilis Stach, 1949

Examined materials: Gülyalı, Turnasuyu village, Divane district, 08.04.2012, 17.05.2012, 41 m, 38° 11' 81" N, 40º 53' 22" E, Pine forest and Moss, 1♀, 197c; - Perşembe, Kurtulmuş village, 05.07.2012, 30.09.20123, 136 m, 37° 75' 35" N, 40º 97' 64" E, Redwood forest, 1♂, 2 juvenile 142; - Ünye, İnkur (Çet picnic spot), 01.06.2012, 01.06.2013, 348-446 m, 37° 19' 59" N, 41º 06' 45"E, Pine forest and soil, 2♂♂, 3♀♀, 8 juvenile, 247c, 247d.

Distribution: Europe, Canary Islands and North Africa (Thibaud et al. 2004). New to Turkey.

Remarks: The body size (1.15 mm) is slightly shorter than indicated in the literature (1.5 mm) (Thibaud et. al. 2004). The apical part of IV. antennal segment with a

typical bulb shape (Fig. 6B) and distinct sensory organs. Tibiotarsi with two thickened bristles at the end. Claw with a small tooth on the inside part. Mucrodens 1.25 times longer than the length of inner edge of third claw. Mucro without lamella and with a small hook at the top. Retinaculum with 3+3 teeth. Furca short, anal spine small with weak papillae. Habitus lateral, Retinaculum and furca shown as in Fig. 6.

The materials were extracted from leaf litters of alder and pine trees, locate in near to coast of Ordu.

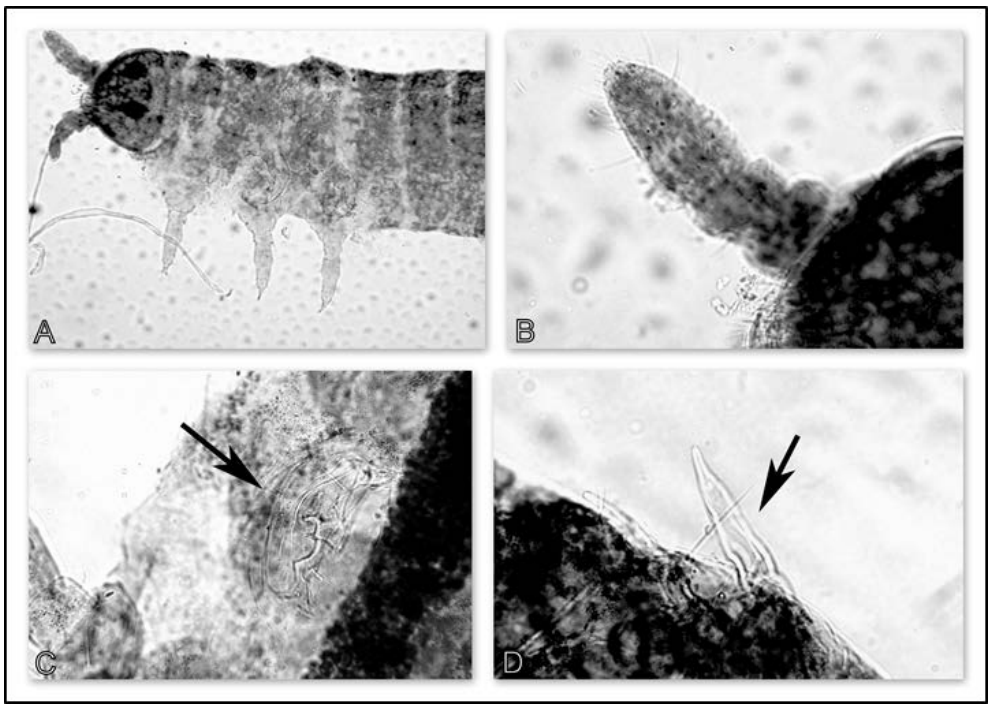

Figure 6. *Xenylla brevisimilis* Stach, 1949; A: Habitus lateral, B: Antennal segments, C: Retinaculum, D: Furca.

Xenylla mediterranea Gama, 1964

Examined materials: Gölköy, Kozören village, 17.07.2012, 1004 m, 37° 66' 54" N, 40º 68' 44" E, Oak Forest, 1 juvenile, 59; - Ünye, İnkur (Çet picnic spot), 01.06.2012, 01.06.2013, 348-446 m, 37° 19' 59" N, 41º 06' 45"E, Pine forest and soil, 1♀, 3 juvenile, 206b, 206d.

Distribution: Balears and Canary Islands, Corsica, Croatia, Greece, Italy, Morocco Sicily, Portugal, Scandinavia, Spain and Ukraine (Fjellberg 1998; Thibaud et al. 2004). New to Turkey.

Remarks: It has been determined that *X. mediterranea* was a different species, although it was given as a subspecies of *X. brevissimilis* in some previous studies.

(Fjellberg 1998). It is distinguished from it by the fact that the number of teeth in the retinaculum is 2 + 2 (3 + 3 in *X. brevisimilis*). The specimens were collected from leaf litters of pines and on the moss, at 1200-1300 m altitudes. According to the present data, it can be said that the species prefer the relatively high lands in this region.

Family Neanuridae Börner, 1901

***Friesea mirabilis* (Tullberg, 1871)**

Examined materials: Ordu- Fatsa (Cıngırt Castle), 10.07.2012, 161-240 m, 37° 26' 68" N, 41º 03 '92" E, Moss, Chestnut, Oak forest, 2 juvenile, N8-15.

Distribution: Cosmopolitan (Fjellberg 1998). Holoarctic and some regions of Australia, Southern Africa, South-eastern Asia and Central America (Bellinger et al. 2016). New record from Turkey.

Remarks: *Friesea* Dalla Torre, 1895, the richest genus of the subfamily Frieseinae Massoud, 1967, comprises 181 species and it is known that many of them are taxonomically controversial (Bellinger et al. 2016). Only one species belong to the genus was identified from the forest puddle in Ordu at about 500 m. However, with more detailed work to be done later in the area, it can be determined that there may be more species of genus.

***Neanura minuta* Gisin, 1963**

Examined materials: Altınordu, Bayadı village, Kurul Kayası district, 13.05.2012, 280-298 m, 37° 89' 50" N, 40º 90' 32" E, Redwood forest and soil, 1 juvenile, 214; - Ünye, Castle around, 05.07.2012, 166 m, 37° 23' 72" N, 41º 09' 55" E, Redwood forest, 2 juvenile 189, 112b; - Ünye, Tekkiraz, 08.07.2012, 696 m, 37° 02' 00" N, 40º 84' 35" E, Oak forest, 2♂♂, 175.

Distribution: Bosnia and Herzegovina, France, Moldova, Romania and Ukraine (Buşmachiu 2011, Deharveng and Fjellberg 2015, Fiera 2007). New to Turkey.

Remarks: General habitus of the species shown as in Fig. 7. *Neanura* MacGillivray, 1893 is one of the largest genera of the subfamily Neanurinae Börner, 1901 with 41 species in the world and *N. minuta* has a wide distribution in Southern Europe (Bellinger et al. 2016, Buşmachiu et al. 2015). It is understood that this species has wide spread within the study area according to the preliminary field surveys.

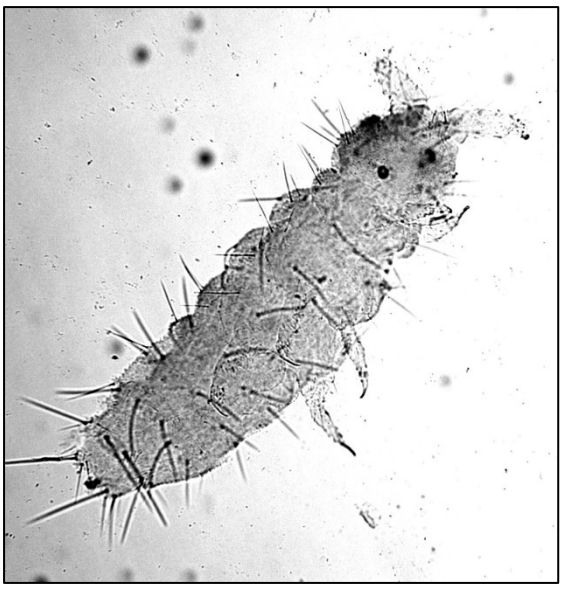

Figure 7. Habitus dorsal of *Neanura minuta* Gisin, 1963.

Pseudachorutella balcanica Cassagnau and Peja, 1979

Examined materials: Akkuş, 08.07.2012, 1014 m, 37° 08' 36" N, 40º 90' 94" E, Oak forest, 3 juvenile, 89, 90; - Akkuş, 08.07.2012, 1226 m, 37° 35' 54" N, 40º 86' 14" E, Oak forest, 1♂, 1♀, 1juvenile, 20; - Altınordu, Bayadı village, Kurul Kayası district, 13.05.2012, 280-298 m, 37° 89' 50" N, 40º 90' 32" E, Redwood forest and soil, 3 juvenile, 214e; - Fatsa (Cıngırt Castle), 10.07.2012, 30.09.2012, 161-240 m, 37° 26' 68" N, 37° 04' 49" N, 41º 03' 92" E, 41º 06' 55" E, Moss, Chestnut, Oak forest, 2 juvenile, 193b, N7-13; - Fatsa, around Gaga lake, 10.07.2012, 59 m, 37° 50' 42" N, 40º 97' 36" E, 3 juvenile, 124; - Kabadüz, Çambaşı yolu, 21.07.2013, 1625 m, 37° 55' 75" N, 40° 43' 58" E, Leaf litter of Maple, 1 juvenile, 36a; - Perşembe, Kurtulmuş village, 05.07.2012, 30.09.20123, 136 m, 37° 75' 35" N, 40º 97' 64" E, Redwood forest, 2 juvenile, 117; - Ulubey, Refahiye village, 17.07.2012, 14.07.2013, 1056-1078 m, 37° 40' 49" N, 37° 67' 27" N, 40º 51' 56" E, 40º 85' 89" E, Spruce forest and soil, 1 juvenile, N3-5; - Ünye, İnkur (Çet picnic spot), 01.06.2012, 01.06.2013, 348-446 m, 37° 19' 59" N, 41º 06' 45"E, Pine forest and soil, 2 juvenile, 247e.

Distribution: Albania and Greek mainland (Cassagnau and Peja 1979, Deharveng and Fjellberg 2015). Newly recorded from Turkey (Özata et al. 2016).

Remarks: 12 species belong to the genus were reported from the World (Bellinger et al. 2016). The species is quite similar to the *Pseudahorutes dibius*, which is collected from the study area. However, it can easily be distinguished from the species by without PAO, which is a key character of the genus. This species is very common in the region and has been collected from many areas, both coastal and high regions.

This species has been reported by Özata et al. (2017) from Rize (Turkey), but there was no complete decision on precise taxonomic diagnosis of this population.

***Pseudachorutes dubius* Krausbauer, 1898**

Examined materials: Gölköy, Kozören village, 17.07.2012, 1004 m, 37° 66' 54" N, 40º 68' 44" E, Oak forest, 2 juvenile, 58; - Kabadüz, Çambaşı yolu, 21.07.2013, 1625 m, 37° 55' 75" N, 40° 43' 58" E, Leaf litter of Maple, 1 juvenile, 7; - Ünye, Tekkiraz, 08.07.2012, 696 m, 37° 02' 00" N, 40º 84' 35" E, Oak forest, 1♀, 175; - Ünye (10 km southern part of Ünye), 05.07.2012, 93 m, 37 23' 22" N, 41º 09' 86" E, Redwood and soil, 1juvenile, 165.

Distribution: Western Europe (Fjellberg 1998, Kaprus and Weiner 2009). New record from Turkey.

Remarks: *Pseudachorutes* Tullberg, 1871 is the largest genus, spreading throughout the globally Holoarcthic region and nowadays 116 species have been identified (Bellinger et al. 2016). *P. dibius*, the only species identified in the study area, has a wide distribution in the world. This species was extracted from the Alder leaf litters located at many habitats in the study area. The morphological details have been extensively studied by Kaprus and Weiner (2009).

***Thaumanura carolii* (Stach, 1920)**

Examined materials: Altınordu, Bayadı village, Kurul Kayası district, 13.05.2012, 280-298 m, 37° 89' 50" N, 40º 90' 32" E, Redwood forest and soil, 1 juvenile, 214e.

Distribution: Austria, Bulgaria, Croatia, Czech Republic, Germany, Hungary, Poland, Serbia, Slovakia, Slovenia, Switzerland, Romania and Ukraine (Smolis 2009). New to Turkey.

Remarks: *Thaumanura* Börner, 1932 is one of the smallest genera of the subfamily Neanurinae with 5 species (Berlinger et al. 2016). The detailed morphological description of the both genus and species, and key to species of the genus were given by Smolis (2009). Habitus dorsal shown as in Fig. 8. The body length is 2.4 mm except for the antenna and it corresponds to the measurements given in the literature (Smolis 2009). Dorsal tubercles well developed. This species is similar to that of the *T. ruffoi* (having 5 setae), but differs from it in terms of De setae on the thoracic terga II (4 setae in *T. carolii*) (Smolis 2009). The working sample was found in a dark and quite humid habitat and it was collected from alder leaf letter.

Figure 8. *Thaumanura carolii* (Stach, 1920); Habitus dorsal (because the body color deforms, the appearance in the photo does not reflect the real in terms of the pattern).

Family Odontellidae Massoud, 1967

***Superodontella lamellifera* Axelson, 1903**

Examined materials: Gölköy, Tilkini district, 17.07.2012, 1199 m, 37° 62' 09" N, 40º 63' 29" E, Beech forest, 1 juvenile, 170.

Distribution: Cosmopolitan (Fjellberg 1998). Southern Palearctic and some regions of Nearctic, Southern Africa, Australia and Antartica (Bellinger et al. 2016). New to Turkey.

Remarks: Now, the genus *Superodontella* Stach, 1949 contains 63 species (Bellinger et al. 2016). Body size was given as 1.5 mm in the literature, but our juvenile sample is smaller, 1.2 mm. Body color is bluish grid. Only one species was reported from the study area and collected from leaf litters of pine forest at about 1200 m altitudes.

Family Onychiuridae Lubbock, 1867

***Heteraphorura variotuberculata* (Stach, 1934)**

Examined materials: Akkuş, 08.07.2012, 1014 m, 37° 08' 36" N, 40º 90' 94" E, Oak forest, 1 juvenile, 127; - Akkuş, 08.07.2012, 1226 m, 37° 35' 54" N, 40º 86' 14" E, Pine forest, 3♂♂, 2♀♀, 21a, 21b, 21c, 21d, 21e; - Akkuş, 08.07.2012, 1014 m, 37° 08' 36" N, 40º 90' 94" E, Oak forest, 1 juvenile, 87; - Altınordu, Bayadı village, Kurul Kayası district, 13.05.2012, 280-298 m, 37° 89' 50" N, 40º 90' 32" E, Redwood forest and soil, 1♀, 214R, 214S, 214g, 214a; - Fatsa (Cıngırt Castle), 10.07.2012 -

30.09.2012, 161-240 m, 37° 26' 68" N, 37° 04' 49" N, 41º 03' 92" E, 41º 06' 55" E, Moss, Chestnut, Oak forest, 2♀♀, 7 juvenile, 193a, N8; - Fatsa, Yalıköy, 12.05.2013, 33 m, 37° 37' 11" N, 41° 03' 88" E, Leaf litter of *Diospyros kaki* Thunb. and soil, 1♀, 1 juvenile, 222, 186; - Gülyalı, Turnasuyu village, Divane district, 08.04.2012, 17.05.2012, 16.09.2012, 41-70 m, 38° 11' 81" N, 40º 53' 22" E, Pine forest, Moss, Chestnut forest and soil, 3 juvenile, 75a; Gölköy, Ulugöl, 17.07.2012, 1216 m, 37° 64' 63" N, 40º 62' 81" E, Beech forest, 2 juvenile, 99; - Gölköy, Haçbeli district, 17.07.2012, 1409 m, 37° 62' 40" N, 40º 60' 51" E, Beech forest, 1♀, 8 juvenile, 130; - Gölköy, Kozören village, 17.07.2012, 1004 m, 37° 66' 54" N, 40º 68' 44" E, Oak Forest, 1♀, 5 juvenile, 55, 241a; - Gülyalı, Kestane Village, Kurt kayası district, 13.05.2012, 550 m, 38° 06' 07" N, 40 º 91' 37" E, Mixed forest and soil, 3 juvenile, 207c, 249a; - Ünye, İnkur (Çet picnic spot), 01.06.2012, 01.06.2013, 348-446 m, 37° 19' 59" N, 41º 06' 45"E, Pine forest and soil; 1♀, 13 juvenile, 188c, 210b, 168a, 30, 168d, 206c, 168b, 206b, 212, 246b; - Gölköy, Tilkini district, 17.07.2012, 1199 m, 37° 62' 09" N, 40º 63' 29" E, Beech forest, 2♂♂, 1♀, 3juvenile, 158, 121; -Perşembe, Kurtulmuş village, 05.07.2012, 30.09.20123, 136 m, 37° 75' 35" N, 40º 97' 64" E, Redwood forest, 2 juvenile, 45; - Ulubey, Refahiye village, 17.07.2012, 14.07.2013, 1056-1078 m, 37° 40' 49" N, 37° 67' 27" N, 40º 51' 56" E, 40º 85' 89" E, Spruce forest and soil, 8 juvenile, N3-6, 226; - Ünye, Asarkale (Kent ormanı), 05.07.2012, 12.05.2013, 160-356 m, 37° 34' 75" N, 37° 20' 83" N, 41º 10' 13" E, 41º 05' 62" E, Pine, Spruce and Beech mixed forest, 1 juvenile, 155.

Distribution: Austria, Hungary, Italy, Poland, Slovenia, Slovakia and Ukraine (Deharveng and Fjellberg 2015, Pomorski 1998). New record from Turkey.

Remarks: The body shape is cylindrical (Fig. 9A). The general coloration of body is dirty white and body granulation is regular on the dorsal part of it. In general, except for the antenna, the body size varies from 1.6 to 2 mm. The antenna is shorter than head. The furca is reduced. The PAO is multilobed (Fig. 9B).

Only one species of the genus was identified from the study area. Nowadays 17 species have been described in the world under three species-groups of the genus (Bellinger et al. 2016). Detailed morphological descriptions of the species were made by Pomorski (1998). It is a common species in almost all localities in Ordu province.

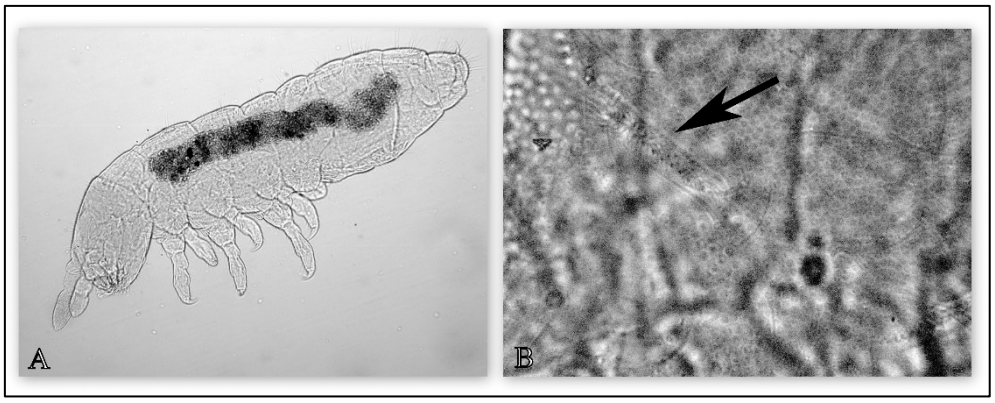

Figure 9. *Heteraphorura variotuberculata* (Stach, 1934); A: Habitus lateral, B: PAO.

***Onychiuroides bureschi* (Handschin, 1928)**

Examined materials: Altınordu, Günören village, Kurşunçal forest, 28.04.2012, 580 m, 37° 68' 45" N, 40º 92' 82" E, Redwood forest, 1 juvenile, 219c; - Altınordu, Bayadı village, Kurul Kayası district, 13.05.2012, 280-298 m, 37° 89' 50" N, 40º 90' 32" E, Redwood forest and soil, 1♀, 1 juvenile, 214p.

Distribution: Bulgaria and Balkan Mountains (Pomorski 2006). New record from Turkey.

Remarks: Morphologically, it is very similar to *O. pseudogranulosus* (Fig. 10). However, it differs in that there are 5 guarded setae on the Antennal III organ (Pomorski 2006). This species was found from only one location in mixed forest litters.

***Onychiuroides pseudogranulosus* (Gisin, 1951)**

Examined materials: Akkuş, 08.07.2012, 1014 m, 37° 08' 36" N, 40º 90' 94" E, Oak forest, 1 juvenile, 89; - Altınordu, Bayadı village, Kurul Kayası district, 13.05.2012, 280-298 m, 37° 89' 50" N, 40º 90' 32" E, Redwood forest and soil, 1♂, 1♀, 7juvenile, 214R, 214a, 214s, 214, 214N, 214g; - Altınordu, Günören village, Kurşunçal forest, 28.04.2012, 580 m, 37° 68' 45" N, 40º 92' 82" E, Redwood forest, 1♂, 1 juvenile, 219c; - Fatsa (Cıngırt Castle), 10.07.2012 - 30.09.2012, 161-240 m, 37° 26' 68" N, 37° 04' 49" N, 41º 03' 92" E, 41º 06' 55" E, Moss, Chestnut, Oak forest, 1 juvenile, 193; - Gülyalı, Turnasuyu village, Divane district, 08.04.2012, 17.05.2012, 41 m, 38° 11' 81" N, 40º 53' 22" E, Pine forest and Moss, 3♂♂, 2♀♀, 3juvenile, 79a; - Ünye, İnkur (Çet picnic spot), 01.06.2012, 01.06.2013, 348-446 m, 37° 19' 59" N, 41º 06' 45"E, Pine forest and soil, 5♂, 1♀, 12juvenile, 135, 206e, 206b, 116c, 206c; - Ünye (10 km southern part of Ünye), 05.07.2012, 93 m, 37 23' 22" N, 41º 09' 86" E, Redwood and soil, 8 juvenile, 123; - Ünye, Asarkale (Kent ormanı), 05.07.2012,

12.05.2013, 160-356 m, 37° 34' 75" N, 37° 20' 83" N, 41º 10' 13" E, 41º 05' 62" E, Pine, Spruce, Beech mixed forest, 2♂♂, 1juvenile, 179, 155, 120; - Ünye, Castle around, 05.07.2012, 166 m, 37° 23' 72" N, 41º 09' 55" E, Redwood forest, 1♂, 1♀, 3juvenile, 128, 183; - Ünye, Tekkiraz, 08.07.2012, 696 m, 37° 02' 00" N, 40º 84' 35" E, Oak forest, 3 juvenile, 106.

Distribution: Austria, Belgium, France, Germany, Hungary, Italy, Switzerland, Ukraine, Moldova, Kroatia and Slovenia (Pomorski 2006, Deharveng and Fjellberg 2015). New to Turkey.

Remarks: In the literature, the body size has been reported to vary between 1.05-1.1 mm in males and 1.25-1.4 mm in females (Pomorski 2006), but the samples we have examined are slightly smaller. The body is chunky and proportionally widened transversely (Fig 10). The antennas have short and blunt segments. The extremities are rather shortened and the furca is reduced. PAO is small and nearly three times longer than pseudocells. There is no tooth in the claws. In males, there are 4+4 modified setae on the ventral tube located in the posterolateral position.

Two species were identified from the study area together with *O. pseudogranulosus*. The species differs from *O. bureschi* by having 4 guard seta of antennal III sense organ (5 in *O. bureschi*) (Pomorski 2006). The species have been collected from both coastal and high altitudes in Ordu.

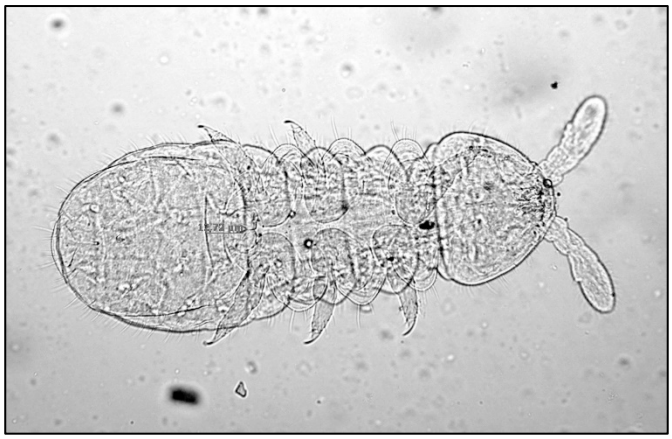

Figure 10. *Onychiuroides pseudogranulosus* (Gisin, 1951), habitus ventral.

Protaphorura pulvinata **(Gisin, 1954)**

Examined materials: Gülyalı, Kestane Village, Kurt kayası district, 13.05.2012, 550 m, 38° 06' 07" N, 40 º 91' 37" E, Mixed forest and soil, 1♀, 1 juvenile, 207c; - Gülyalı, Turnasuyu village, Divane district, 08.04.2012, 17.05.2012, 41 m, 38° 11' 81" N, 40º 53' 22" E, Pine forest and Moss, 1 juvenile, 72; - Ünye, İnkur (Çet picnic spot), 01.06.2012, 01.06.2013, 348-446 m, 37° 19' 59" N, 41º 06' 45"E, Pine forest and soil, 2 juvenile, 206b.

Distribution: Portugal, Spain and Switzerland (Babenko and Kaprus 2014, Jordana et al. 1990). New to Turkey.

***Protaphorura sakatoi* (Yosii, 1966)**

Examined materials: Fatsa (Cıngırt Castle), 10.07.2012 - 30.09.2012, 161-240 m, 37° 26' 68" N, 37° 04' 49" N, 41º 03' 92" E, 41º 06' 55" E, Moss, Chestnut, Oak forest, 1♀, 9 juvenile, N8-U3.

Distribution: Afghanistan, Central and South East Europe, Crimea mountains, Kazakhstan, Russia (Caucasus mountains, and Southern Siberia), Tadzhikistan (Deharveng and Fjellberg 2015, Kaprus and Pomorski 2008) and newly recorded from Iran (Kahrarian et al. 2016). New to Turkey.

Remarks: The genus *Protaphorura* Absolon, 1901, widespread throughout Holarctic, is the most diverse taxon with almost 140 species described to date and most of them are taxonomically problematic species (Bellinger et al. 2016, Kaprus et al. 2016). Two species belonging to the genus were recorded from the study area. Other species of the genus were also identified among the samples, but were not involved in this article since their diagnosis could not be finalized. Recently, seven new species have been described from the Eastern Palearctic region, most of them from Russia (Kaprus et al. 2016).

DISCUSSION

The checklist of Collembola from Turkey including 18 species, 13 genera and five families belonging to Poduromorpha were listed from Turkey (Sevgili and Özata 2014). Although any species of the family Tullbergidae was recorded in this study, 11 genera belonging to four families were also new records for Turkey. With our new records in this study, the number of Poduromorpha species known from Turkey increases to a total of 36. Biodiversity of springtails differs remarkably among nearby countries of Turkey and European regions. For example, the collembolan fauna of Iran is well known when comparing with species list of Turkey, and 44 species belonging to seven families of Poduromorpha was listed by Shayanmehr et al. (2013). The results of this study reveal the Collembola fauna in Turkey and neighboring countries is little known and that more detailed surveys are needed.

It is natural that the autumn and soil fauna of Ordu province is still incompletely studied. Even though sample collections have been made from generally forest leaf litters, some types of biotopes (aquatic, caves and species living in deeper soil horizons) remain insufficiently not examined all. Therefore, in our opinion, the actual springtail fauna of Ordu province comprises more than 100 species.

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