



## New records of springtails (Hexapoda: Collembola) for Iran from Mazandaran forests

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**ABSTRACT.** Specimens of springtails were collected from soil and leaf litter in the forests of Mazandaran province, north of Iran during 2016–2017. Three species were recorded in this country for the first time, *Xenylla szeptyckii* Skarżyński, Piwnik & Porco, 2018 (Hypogastruridae), *Friesea espunaensis* Arbea & Jordana, 1993 (Neanuridae) and *Tomocerina minuta* (Tullberg, 1877) (Tomoceridae). Detailed descriptions of these species are provided based on the materials collected from Mazandaran province, Iran.

**Key words:** Hypogastruridae, Neauridae, Tomoceridae

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### Introduction

Even though Collembola are known to be the most abundant of soil hexapods in almost all habitats and all regions of the world (Hopkin, 2002), The Iranian fauna of Collembola is poorly known. The first Iranian species of Collembola were recorded from wheat and alfalfa fields in Khuzestan (Farahbakhsh, 1961). Later five families of the Collembola including 70 species of 30 genera were recorded by Cox (1982) through his travel to the northern provinces of Iran. Recent studies (Kahrarian et al., 2012; Daghighi et al., 2013; Shayanmehr et al., 2013; Yoosefi-Lafooraki & Shayanmehr, 2013; Kahrarian, 2019; Shayanmehr et al., 2020; Vargovitsh & Kahrarian, 2020) increased the knowledge of the Iranian Collembola. In this study, three species are added to the Iranian fauna of Collembola.

### Material and methods

The specimens of this study were collected from soils and leaf litters of the forests of Mazandaran province (north of Iran) during 2016 and 2017 (Fig. 1). The geographical data of the sampling sites were determined using GPS device (Table 1). The soil and leaf litter

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samples were transferred to the laboratory of Sari University of Agricultural Sciences and Natural Resources, Mazandaran, where Collembola specimens were extracted using Tullgren funnels (Fig. 2), and separated. Some specimens were cleared in Nesbitt's solution, and then slide mounted using Hoyer as preserving media. The following abbreviations were used for nomenclature of body chaetotaxy: the a, m, p system (Yosii, 1956), the non-adaptative characters for *Xenylla* (Gama, 1988), and the chaetal group system for *Friesea* (Di – dorsointernal group, De – dorsoexternal group, DL – dorsolateral group (Potapov & Banasco, 1985); for tibiotarsal chaetotaxy (Deharveng, 1983); for chaetotaxy of labium and labrum (Massoud, 1967); for sensilla of Ant. III – IV (Skarżyński et al., 2018) for *Xenylla* and D'Haes et al., 2003 for *Friesea*). In the description of *Tomocerina* notation by Yu et al. (2014) was followed for cephalic dorsal macrochaetotaxy and Christiansen (1964) for body macrochaetotaxy. The dental spine formula follows that proposed by Folsom (Folsom, 1913), in which the dental spines are arranged from base to apex, with a slash indicating the separation between basal and medial subsegments, and Roman numerals referring to spines that are noticeably larger.

**Abbreviations:** Ant. I – IV – antennomeres I – IV; Th. I – III – thoracic segments I – III; Abd. I – VI – abdominal segments I – VI; PAO – postantennal organ; ms – microsensillum; S – sensillum.



**Figure 1.** The distribution of the forest type sampled. Black circles (●) indicate the location of samples.

**Table 1.** Forest name, height and the coordinates of the sampling sites.

Forest Name	Elevation (m)	county	Latitude	Longitude
Zare	113	Sari	N 36°32'44"	E 53°07'53"
Dohezar	443	Tonekabon	N 36°40'21"	E 50°49'28"
Langar	1800	Kiyasar	N 36°14'20"	E 53°39'10"

**Figure 2.** The Tullgren funnels that used for extraction of the collembolans from the soil samples.

## Results

Among the collected specimens from the three sampling sites in forests of Mazandaran, three species of Collembola were identified and presented here as new record for the fauna of Iran.

## Taxonomic part

### Family Hypogastruridae

*Xenylla szeptyckii* Skarżyński, Piwnik & Porco, 2018 (Figs. 3–5)

**Material examined:** 1♂, 2♀♀, Iran, Mazandaran province, Tonekabon, Dohezar forest (36°40'21" N, E 50°49'28" E), 04-May-2016, leaf litter and soil, E. Yahyapour leg. (Deposited in Entomology Department, Islamic Azad University).

**Distribution:** The species has been reported from Poland, Slovakia, Hungary, France and Sweden, but the global range of distribution might be much wider (Skarżyński et al., 2018). This species is a new record for the Iranian Collembola fauna.

**Description:** Body length 1.2–1.4 mm. Colour blue-grey. Integument verrucose (Fig. 3). Chaetotaxy typical of *Xenylla maritima* complex as described by Skarżyński et al. (2018); head dorsally with chaeta c1 absent, chaeta L1 longer than chaeta L3; Th. II and III with chaeta a2 displaced posteriorly compared to chaeta a1, chaeta p2 displaced anteriorly compared to chaeta p1, with chaetae m3 and la1 present; Abd. I – III with chaeta p5 present; Abd. IV without chaetae a3; chaetae a2 on abd. V absent; head with ventral chaetae p1 and m3; Th. II and III with 1 + 1 ventral chaetae; Abd. II with ventral chaetae a5 absent and chaetae p1 and p2 present; Abd. IV without ventral chaeta m1. The species is characterized by Abd. tergum IV without chaetae m5 (Fig. 4), Anal spines small, situated on low basal papillae (Fig. 4). and Abd. sternum III with 2 chaetae in front of tenaculum (Fig. 5). Ant. IV with simple apical vesicle, subapical organite, microsensillum and 4 (3 dorsoexternal and 1 dorsointernal) cylindrical sensilla (A and B thicker than C and D). Ant. III-organ with two long (outer) and two short (inner) sensilla. Microsensillum on Ant. III present. Ant. I with 7 chaetae. Ocelli 5 + 5. PAO absent. Outer lobe of maxilla with 2 sublobal hairs. Tibiotarsi I, II and III with 19, 19 and 18 chaetae respectively, with chaetae A2 and A7 capitate (ratio capitate chaetae / claw III = 1.7). Femora I, II and III with 12, 11 and 10 chaetae respectively, trochantera with 5, 5 and 4 chaetae respectively, coxae I, II and III with 3, 7 and 7 chaetae, subcoxae 2 of legs I, II and III with 0, 2 and 2 chaetae, subcoxae 1 of legs I, II and III with 1, 2 and 3 chaetae respectively. Claws with indistinct inner tooth. Ventral tube with 4 + 4 chaetae. Tenaculum with 3 + 3 teeth (Fig. 5). Mucrodens 1.5 – 1.7 × longer than inner edge of claws III, with 2 posterior chaetae, mucro narrow and weakly upturned (Fig. 5).

### Key to the known Iranian species of *Xenylla*

1. Mucro separated from dens that has 2 chaetae. Th. III with dorsal p2 chaeta at the same level than p1 ..... 2
- Mucro fused to dens that has 2 chaetae (Fig. 5). Th. III with dorsal a2 chaeta displaced distally relative to a1 and dorsal p2 chaeta displaced apically relative to p1..... 3
2. Th. III with dorsal a2 chaeta at the same level than a1. Mucro with rounded upturned apex and broad inner lamella, nearly reaching the apex..... *X. welchi*
- Th. III with dorsal a2 chaeta displaced distally relative to a1. Mucro with a small inner lamella not reaching the apex..... *X. humicola*
3. Three sublobal hairs on outer lobe of maxilla. Chaetae in front of retinaculum on Abd. III and chaetae m5 on Abd. IV absent..... *X. maritima*
- One or two sublobal hairs on outer lobe of maxilla. With 1-2 chaetae in front of retinaculum on Abd. III (Fig. 5) ..... 4
4. One sublobal hairs on outer lobe of maxilla. Retinaculum with 2+2 teeth. Chaetae m5 on Abd. IV present ..... *X. mediterranea*
- Two sublobal hairs on outer lobe of maxilla. Retinaculum with 3+3 teeth (Fig. 5). Chaetae m5 on Abd. IV absent (Fig. 4) ..... *X. szeptyckii*

## Family Neanuridae

### *Friesea espunaensis* Arbea & Jordana, 1993 (Figs. 6–14)

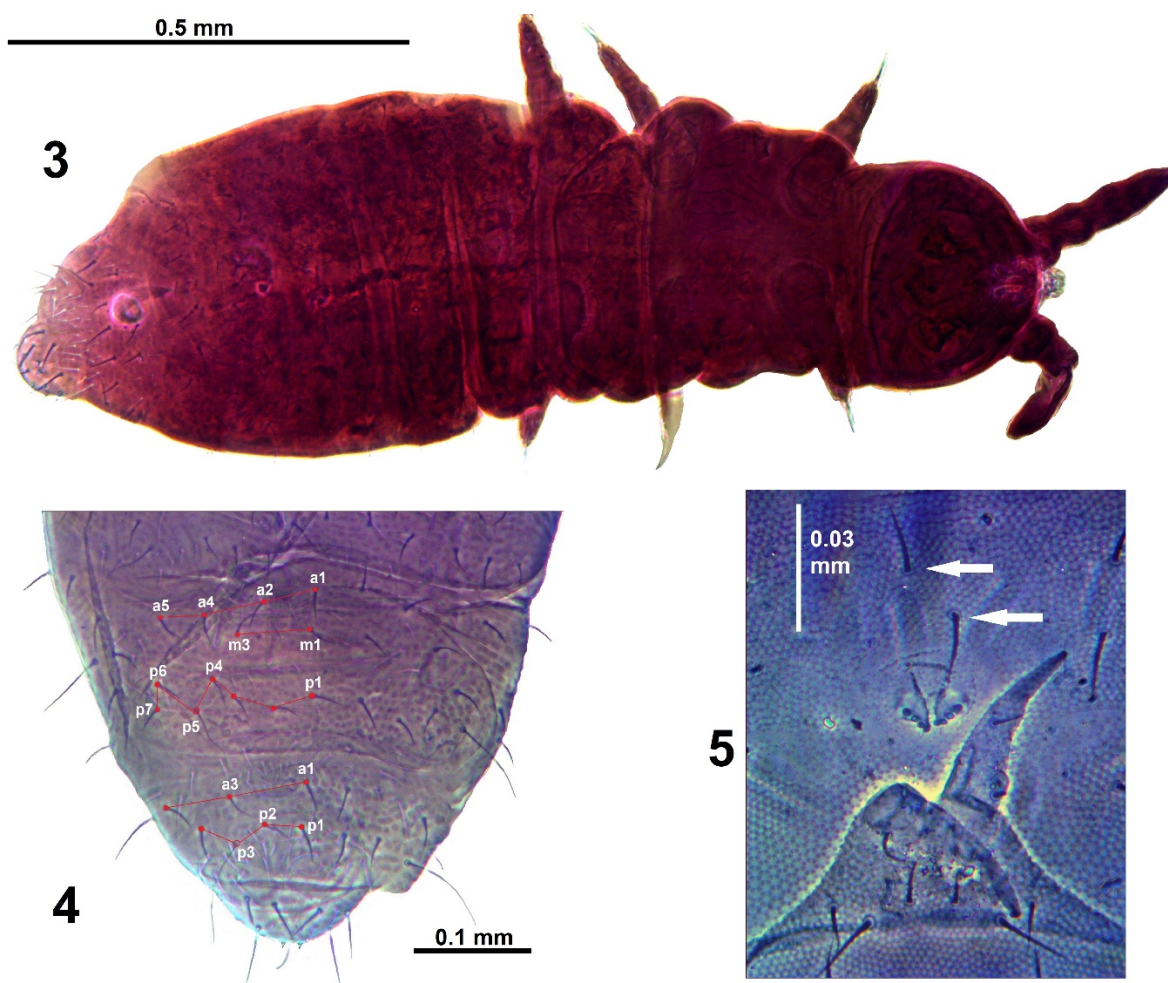
**Material examined:** 1♂, 1♀, Iran, Mazandaran province, Tonekabon, Dohezar forest (36°40'21" N, 50°49'28" E), 04-May-2016, leaf litter and soil, E. Yahyapour leg. (Deposited in Entomology Department, Islamic Azad University).

**Distribution:** Mediterranean species, found in south eastern regions of Spain and North Africa, in Algeria (Brahim-Bounab et al., 2017). This species is a new record for the Iranian fauna.

**Description:** Habitus (Fig. 6) and buccal cone typical for the genus *Friesea*. Length: 0.6–0.8 mm. Colour blue-grey. Integument secondary granules rather small. Antennae about 3/4 of head length. Antennal segment I with 7 chaetae, antennal segment II with 13 chaetae. Sensory organ of antennal segment III consisting of two small subcylindrical internal micro sensilla, two subcylindrical guard sensilla, and a ventral microsensillum. Antennal segment IV with 6 subcylindrical sensilla (S1–4, S7–8 present), sensilla S1, S2 and S3 slender, a small microsensillum between S7 and S8, a small subapical organite; apical vesicle simple (Figs. 13–14). Ocelli 8+8, PAO absent (Fig. 7). Chaetotaxy of labrum: 4/3,5,2. Labium with papillated chaeta L. Maxilla and mandible heads usual for the genus (Massoud, 1967). Mandible with 8 teeth. Dorsal chaetotaxy as in Figs. 11–12. Dorsal chaetae short, subequal, acuminate and slightly shorter than S-chaetae. Some stronger and feebly capitate chaetae on Abd. terga V and VI (Fig. 8). S-chaetae formula per half tergum: 022/11111, ms present on Th. II. Head with chaetae a0, d0 and three ocular chaetae. Thoracic tergum I with 4+4 chaetae. Th. tergum II with 11+11 chaetae (4 chaetae Di including a2, 4 chaetae De including S-chaeta in third position of the p-row, 3 chaetae DL including one S-chaetae) and 1+1 s-microchaeta (near the s-chaeta of the DL group). Th. tergum III with 10+10 chaetae (same arrangement as previous tergum, but without a2). Th. sterna II and III without chaetae. Abd. tergum V with 1+1 chaetae in p-row between S-chaetae (p2); p3 is capitate macrochaeta. Abd. tergum VI with three curved spines (2 a1 and p0), each on a small papilla, and 3+3 capitate macrochaetae (a2, m1 and m2) (Fig. 8). Ventral tube with 4+4 chaetae. Abd. sternum II with 6+6, Abd. sternum III with 9-10+9-10 chaetae. Each anal valve with 2 small chaetae hr (longer on the distal valve). Tibiotarsi I, II and III with 17, 17 and 16 chaetae respectively (10 in a distal whorl), 5, 5, 5 of which are capitate tenent hairs (Fig. 9). Femora I, II and III with 12, 11 and 10 chaetae respectively, trochanters with 5, 5 and 5 chaetae, coxae I, II and III with 3, 8 and 8 chaetae, subcoxae 2 of legs I, II and III with 0, 2 and 2 chaetae, subcoxae 1 of legs I, II and III with 1, 2 and 2 chaetae. Claw untoothed. Tenaculum and furca present. Tenaculum with two teeth by ramus. Dens with 3 chaetae each, mucro very small and fused with dens (stage 2 according to Cassagnau) (Cassagnau, 1958) (Fig. 10).

### Key to the known Iranian species of *Friesea*

1. 4 bristle-like anal spines. Furca absent ..... *F. afurcata*
- 3 curved anal spines (Fig. 8). Furca present; dens with 3 chaetae each; mucro small, fused with dens (Fig. 10) ..... 2
2. Tibiotarsi I, II, III with 17, 17, 16 chaetae respectively, 5, 5, 5 of which are clavate tenent hairs (Fig. 9). Abd VI chaetae slightly clavate (Fig. 8) ..... *F. espunaensis*
- Tibiotarsi I, II, III with 18, 18, 17 chaetae respectively ..... 3
3. Tibiotarsi and Abd. VI with acuminate chaetae ..... *F. mirabilis*
- Tibiotarsi with 5 clavate tenent hairs. Abd VI macrochaetae strongly clavate ..... *F. claviseta*



**Figures 3–5.** *Xenylla szeptyckii*. **3.** Habitus; **4.** Abd. IV–VI chaetotaxy; **5.** Mucrodens and tenaculum.

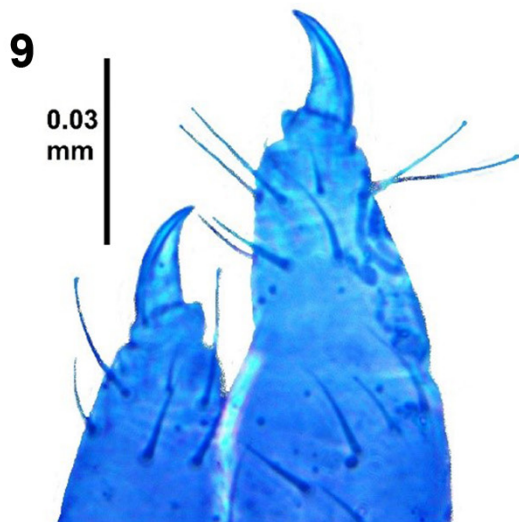
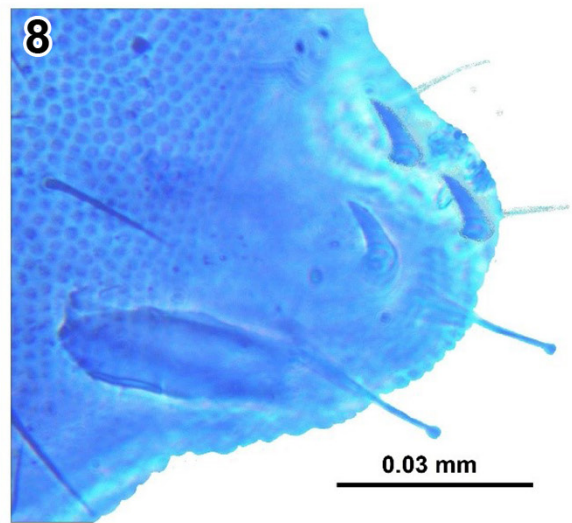
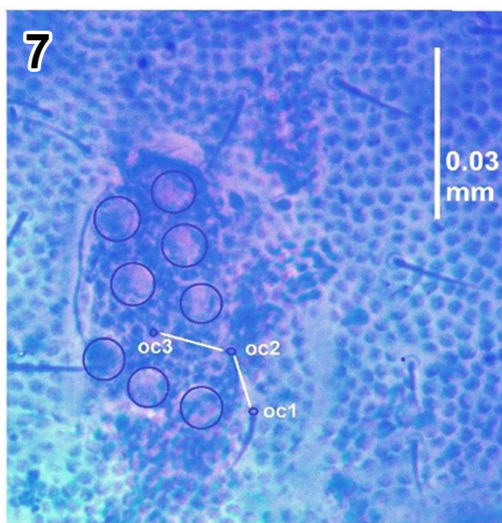
### Family Tomoceridae

*Tomocerina minuta* (Tullberg, 1876) (Figs. 15–21)

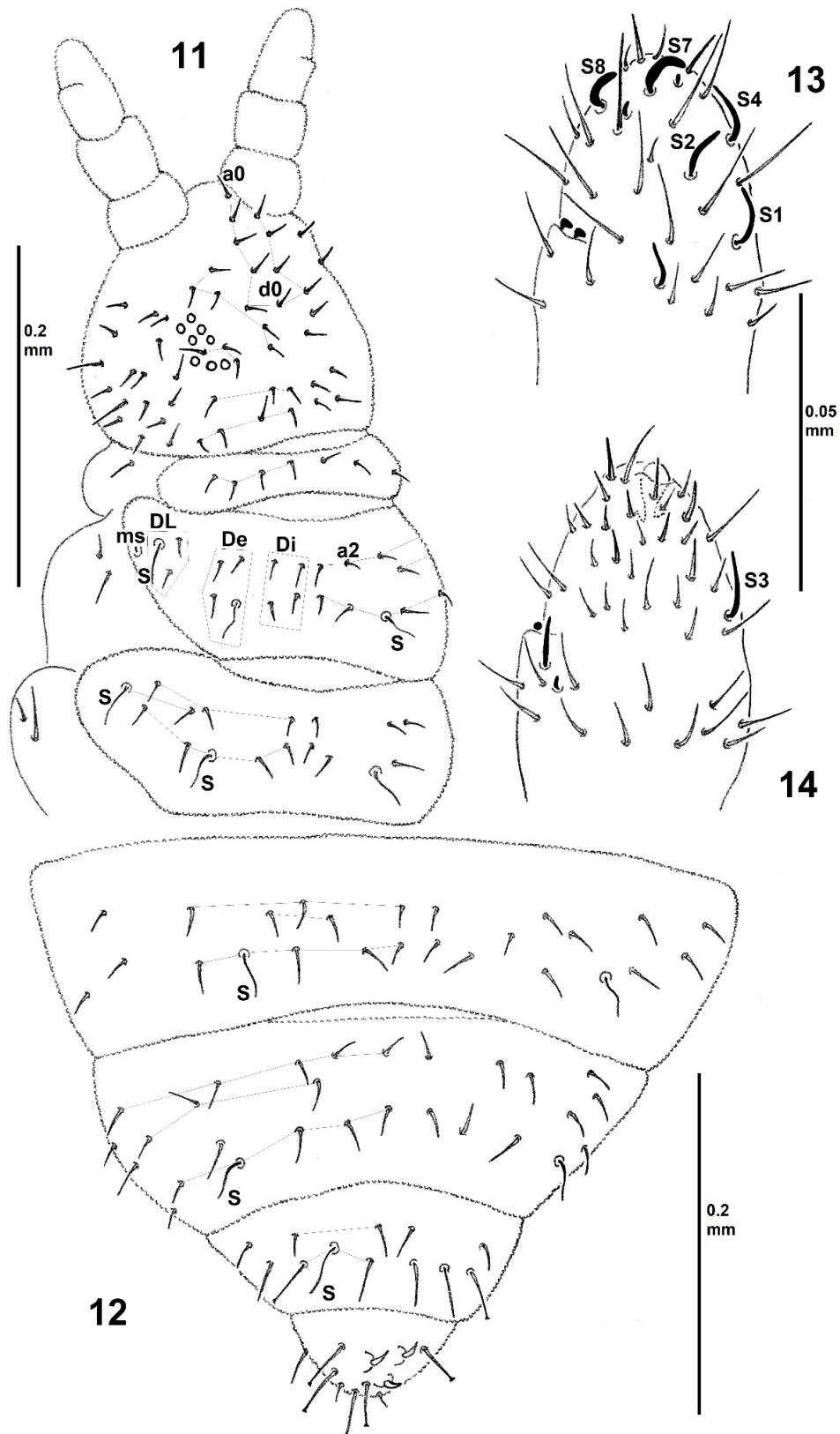
**Material examined:** 2 ex., Iran, Mazandaran province, Sari, Zare forest (36°32'44" N, 53°07'53" E), 15-March-2016, leaf litter and soil, E. Yahyapour leg. (Deposited in Entomology Department, Islamic Azad University).

**Distribution:** The species has been reported from the Holarctic Region (Fjellberg, 2007) and Turkey (Özata et al., 2017). The genus *Tomocerina* and the species *T. minuta* are recorded for the first time from Iran.

**Description:** Body length 1.8–2 mm. Body ground colour pale yellow, with diffuse grey pigment (Fig. 15). Antennae short, 0.6–0.7 times as long as body. Length ratio of Ant. I:II:III:IV= 1.0:1.6:6.1:2.4. PAO absent. Eyes 6+6. Labral formula 4/5, 5, 4. Distal edge of labrum with four curved spines. Maxillary outer lobe with trifurcate palp and one basal chaeta, sublobal plate with 4 hairs. Labium with 11–12 basolateral chaetae. Cephalic dorsal macrochaetotaxy: anterior area (a): 2, 4; interocular area (io): 2, 7, central unpaired macrochaeta present; postocular area (po): 3+3; posterior area (p): 2, 2 in two rows (Fig. 19).



Figures 6–10. *Friesea espunaensis*. 6. Habitus; 7. Eyes; 8. Abd. VI with anal spines; 9. Tibiotarsus and claw III; 10. Furcula.



**Figures 11-14.** *Friesea espunaensis*. **11-12.** dorsal chaetotaxy of head and Th. (**11**) and Abd. (**12**); **13-14.** Ant. III-IV dorsal (**13**) and ventral (**14**).



Pattern of body chaetotaxy as in Fig. 20. Bothriotricha 1, 1/ 0, 0, 1, 2, 0, 0 on Th. II–Abd. VI. Macrochaetae densely arranged along anterior margin of Th. II (not shown in figure). Th. II with an irregular row of 4+4 macrochaetae behind anterior margin. Number of macrochaetae or large mesochaetae in the posterior row as 3, 3/ 3, 3, 4, 2, 4 from Th. II to Abd. V. Th. II with five central and two lateral macrochaetae; Th. III with anterior macrochaeta; Abd. III with two anterior macrochaetae; Abd. IV with one antero-lateral macrochaeta; Abd. VI with 5+5 macrochaetae and numerous chaetae of different sizes. Pseudopores near the axis of terga, 1, 1/ 1, 1, 1, 1, 0, 0 from Th. II to Abd. VI. Trochanterofemoral organ with 1, 1 slender chaetae. Tibiotarsi dorsally with 0, 1, 1 prominent chaetae from front to hind leg, ventrally with 1–2 strong blunt chaetae. Each tibiotarsus with a distal whorl of 11 chaetae, dorsally with one clavate tenent hair, about 1.0–1.1 times as long as inner edge of unguis. Unguis slender, lateral teeth pointed, of moderate size. Inner edge of unguis with distinct basal tooth, large sub-basal tooth, and 3–4 obscure distal teeth. Unguiculus lanceolate, about 0.6–0.7 times as long as unguis, without tooth on inner or outer edge. Pretarsus with 1+1 chaetae (Fig. 21). Ventral tube scaled on both anterior and posterior faces, lateral flaps unscaled. Anterior face with 28–30 chaetae on each side, posterior face with 13–18 chaetae, each lateral flap with 20–14 chaetae. Rami of tenaculum with 4+4 teeth, anterior face with 2 chaetae and without scales (Fig. 18). Ratio manubrium:dens:mucro=2.6–2.7:3.6–3.8:1.0. Dens basally without distinct prominent dorsal chaeta, large modified inner scale or strong outer chaetae. Proximal portion of dens with 4 spines not arranged in a longitudinal row; distal portion of dens with 4(3) short spines and terminating in one large spine; dental spine formula as 4/4(3), I (Fig. 16); all spines simple, “smooth” with fine longitudinal ribs. Mucro long and slender, approximately one-quarter length of dens; mid-section with 4 teeth; outer basal tooth of mucro without a denticle (Fig. 17).

### Key to the known Iranian species of Tomoceridae

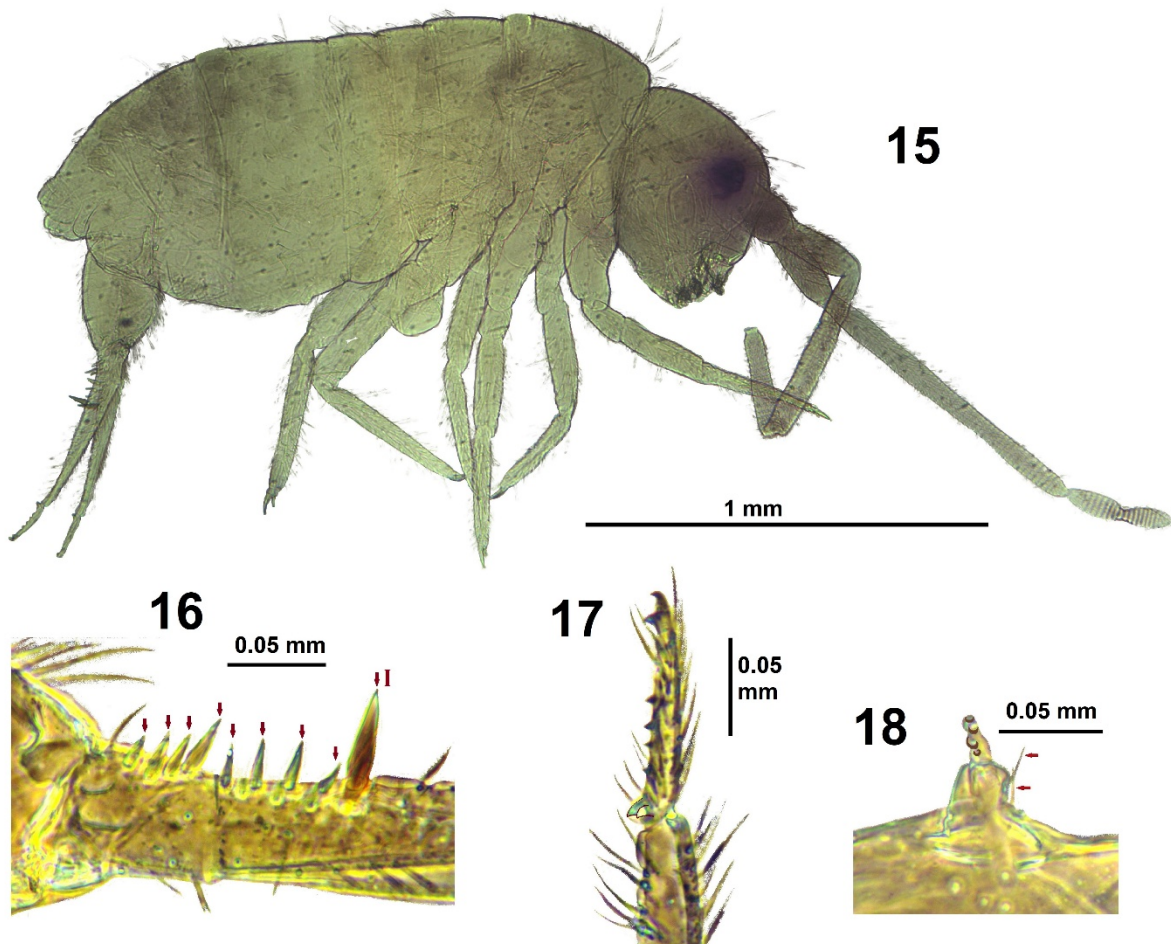
1. Inner side of dens with a broad pointed scale near base. Basolateral field of labium with more than five chaetae ..... *Pogonognathellus flavescens*
- Inner side of dens without broad scale. Basolateral field of labium with five chaetae ..... 2
2. Mid-section of mucro with 4 teeth, outer basal tooth simple (Fig. 14) ..... *Tomocerina minuta*
- Mid-section of mucro with more than 5 teeth, outer basal tooth with a small secondary tooth (Genus *Tomocerus*) ..... 3
3. Dorsal spines of dens 3-forked. Mid-section of mucro with 5–7 teeth ..... *T. minor*
- Dorsal spines of dens simple. Mid-section of mucro with up to 10 teeth ..... *T. vulgaris*

### Discussion

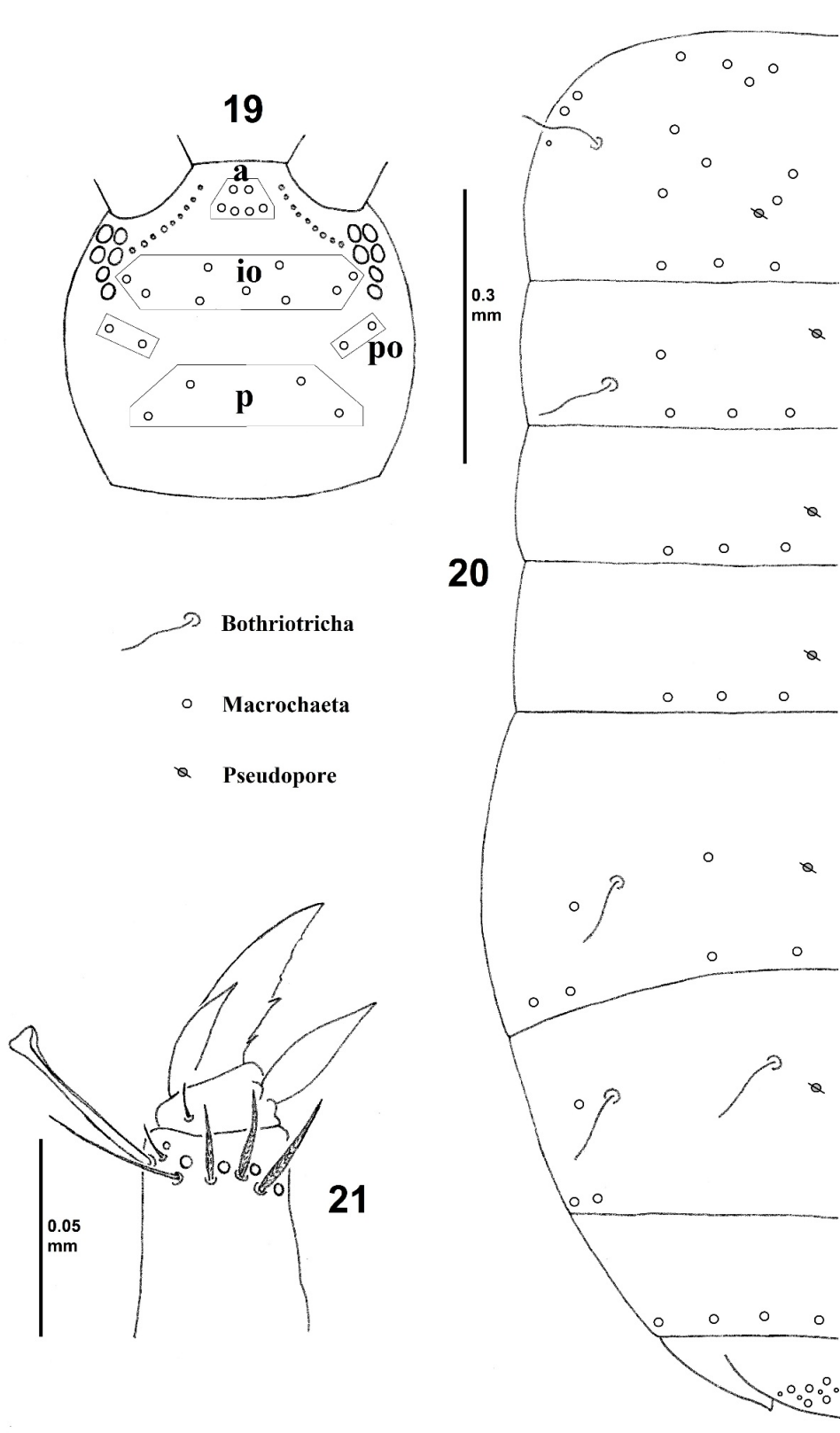
In order to add to Iranian Collembolan fauna, the study was conducted in Mazandaran province (North of Iran). From these forests already five species including *Heteraphorura kaprusi* Arbea, Yahyapour & Shayanmehr, 2020, *Onychiuroides mazandaranensis* Arbea, Yahyapour & Shayanmehr, 2020, *Protaphorura hyrcanica* Arbea, Yahyapour & Shayanmehr, 2020, *Protaphorura iranica* Arbea, Yahyapour & Shayanmehr, 2020, *Protaphorura golestanica* Kapruš, Shayanmehr & Kahrarian, 2017, were reported (Kapruš et al., 2017; Yahyapour et al., 2020). Results of this study added three species of three families (*Xenylla szeptyckii*, *Friesea espunaensis* and *Tomocerina minuta*) was new for Iranian fauna. Among them one species has a Holarctic distribution (*T. minuta*), one is known from Europe (*X. szeptyckii*)

and another has a mediterranean distribution (*F. espunaensis*). The species *X. szeptyckii* and *F. espunaensis* are rare, with few individuals found in the studied biotopes, and their geographical distribution was expanded.

To date five species of *Xenylla* have been recorded from Iran (Shayanmehr & Yahyapour, 2019; Shayanmehr et al., 2013): *Xenylla humicola* (Fabricius, 1780), *X. maritima* Tullberg, 1869, *X. mediterranea* Gama, 1964, *X. szeptyckii* and *X. welchi* Folsom, 1916; only four species of *Friesea* (Khanahmadi et al., 2018; Qazi & Shayanmehr, 2016; Shayanmehr et al., 2013): *Friesea afurcata* Tullberg, 1869, *F. claviseta* Axelson, 1900, *F. espunaensis* and *F. mirabilis* (Tullberg, 1871); and four species of the family Tomoceridae (Shayanmehr & Yahyapour, 2019), belonging to three genera *Pogonognathellus* cf. *flavescens* (Tullberg, 1871), *Tomocerus minor* (Lubbock, 1862), *T. vulgaris* (Tullberg, 1871) and *Tomocerina minuta*.



Figures 15–18. *Tomocerina minuta*, 15. Habitus; 16. Dental spines; 17. Mucro; 18. Tenaculum.



**Figures 19-21.** *Tomocerina minuta*. 19-20. dorsal macrochaetotaxy of head (19) and body (20); 21. unguis III.

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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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## گزارش‌های جدید از پادمان از جنگل‌های استان مازندران

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**چکیده:** نمونه‌های پادمان از خاک و خاک‌برگ از جنگل‌های استان مازندران واقع در قسمت شمالی ایران در طی سال‌های ۱۳۹۵-۱۳۹۶ جمع‌آوری شده است. سه گونه از پادمان شامل: *Xenylla szeptyckii* Skarżyński, *Friesea espunaensis* Piwnik & Porco, 2018 (Hypogastruridae) و *Tomocerina minuta* Arbea & Jordana, 1993 (Neanuridae) (Tomoceridae) (Tullberg, 1877) برای اولین بار از ایران گزارش شدند. توصیف این گونه‌ها براساس نمونه‌های جمع‌آوری شده از استان مازندران، ایران ارائه شد.

**واژگان کلیدی:** Tomoceridae, Neanuridae, Hypogastruridae