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An annotated checklist of the springtails (Hexapoda: Collembola) recorded from the foothill and mountain parts of the Republic of North Ossetia–Alania, North Caucasus, Russia

Аннотированный список ногохвосток (Hexapoda: Collembola), найденных в предгорной и горной частях Республики Северная Осетия–Алания

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KEY WORDS: soil fauna, taxonomy, pioneer community, mountains, glacier forelands
КЛЮЧЕВЫЕ СЛОВА: почвенная фауна, пионерные сообщества, горы, приледниковая территория

ABSTRACT: The present review of the springtail fauna of the Republic of North Ossetia–Alania is based on both existing published information and new material collected recently in the Tsey Gorge by the authors. The generic position and morphological peculiarities of some problematic forms are discussed. General distribution ranges of all species concerned, as well as their distributions within the study region are given. A checklist of the springtails of the Republic of North Ossetia–Alania has been compiled, amounting to 146 species in 68 genera and 18 families, being supplemented by 31 and 19 species new to the republic and the entire Caucasus, respectively.

РЕЗЮМЕ: Настоящий обзор фауны ногохвосток Республики Северная Осетия–Алания основан как на имеющейся опубликованной информации, так и на новом материале, собранном авторами в последнее время в Цейском ущелье. Обсуждаются родовое положение и морфологические особенности некоторых проблемных форм. Приведены общие ареалы всех рассматриваемых видов, а также их распространение в пределах изучаемого региона. Составленный список ногохвосток Республики Северная Осетия–Алания насчитывает 146 вид из 68 родов и 18 семейств и включает 31 новый вид для республики и 19 видов — для всего Кавказа в целом.

Introduction

The first information on the springtail fauna of the Caucasus and Transcaucasia was published by Jan Stach in his famous series of monographs [Stach, 1947, 1949, 1949a, 1951, 1954, 1956, 1960, 1963]. In total, 35 species were recorded from this region. At least 11 species of these, including three new ones, were found in the highlands of North Ossetia. Moreover, all data for the North Caucasus were based on the collections of a single Polish expedition held in the mid-1930s [Wojtusiak, 1937].

The attention of zoologists to the North Caucasus began to increase since the mid-1980s. Both ecological and taxonomic works dedicated specifically to the springtail fauna of the Republic of North Ossetia–Alania appeared [Kuchiev, 1982, 1984; Babenko, 1987; Potapov, Stebaeva, 1990; Potapov, Kuchiev, 1993]. Information concerning the springtails of the region, including descriptions of new species, can also be found in a few papers published later [Babenko, 1994; Stebaeva, Potapov, 1994; Potapov, 2001; Skarżyński, Babenko, 2010; Jordana, 2012; Smolis, Kuznetsova, 2016; Lafooraki et al., 2020; Shveenkova, Babenko, 2022]. The first annotated list of the springtails of the North Ossetian Nature Reserve, published by Kuchiev [2006], proves to be quite outdated as the taxonomy of many genera has since changed considerably and at least some of his records require a cautious approach. There are also a number of ecological studies [Kremenitsa, 2002; Kuznetsova et al., 2019] carried out over the territory of the North Ossetian Nature Reserve or in its immediate vicinities. The above contributions have significantly expanded the list of springtails of North Ossetia, although it is clearly premature to con-

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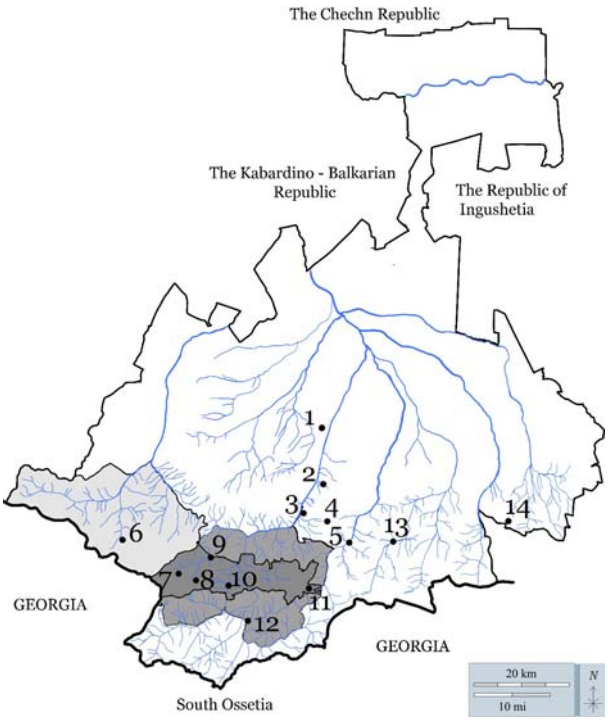

Fig. 1. Collecting localities: 1 — Alagir; 2 — the Shubi-Nykhasskaya Cave; 3 — Zintsar; 4 — Mt. Karyuhokh; 5 — Verkhny Fiagdon; 6 — Karaugom Gorge in the Alaniya National Park; 7 — Tsey Glacier; 8 — Skazsky Glacier; 9 — Verkhny Tsey; 10 — Kassar Gorge; 11 — Mt. Tepli in the Kurtat Gorge; 12 — Nar; 13 — Fazikau; 14 — Mt. Stolovaya.

Рис. 1. Места сбора материала: 1 — Алагир; 2 — Шуби-Ныхасская пещера; 3 — Зинцар; 4 — г. Кариухох; 5 — Верхний Фиагдон; 6 — ущ. Караугом в Национальном парке "Алания"; 7 — Цейский ледник; 8 — Сказский ледник; 9 — Верхний Цей; 10 — ущ. Кассар; 11 — г. Тепли в ущ. Куртат; 12 — Нар; 13 — Фазикау; 14 — г. Столовая.

sider the springtail faunas both of the republic and the entire Caucasus as being well studied.

The present checklist is based on all published data on Collembola (Fig.1), as well as on our own research carried out in the upper part of the Tsey Gorge from July 18th to July 30th, 2021, as part of a comprehensive study of the pioneer invertebrate communities of a post-glacial zone. The material was collected in the area where the Tsey Glacier (2070–2350 m a.s.l.) had existed until the middle of the 19th century (Fig. 2). Since that time, the glacier has receded by about 1.8 km. On the ice-free surface aged from 0 to 170 years, 10 sample plots were selected, covering the main stages of succession: from bare ground to mixed, and then mature pine forest (*Pinus sylvestris* L. ssp. *hamata*) (Figs 3–6). Additionally, we examined two lower areas: a maple forest (*Acer trautvetteri*) located at the confluence of Medik and Tseydon rivers, as well as a beech forest (*Fagus orientalis*) in the lower reaches of Skazdon River.

On each plot, soil samples (125 cm^3) were taken in 10 replicates for subsequent extraction. To catch surface-dwelling springtails, pitfall trapping was used on all plots except the beech forest. Flotation methods were applied in areas with bare ground and, when litter appeared, we used sifting. Springtails were also captured with an aspirator.

Furthermore, thanks to the generosity of N.A. Kuznetsova, we were able to get acquainted with her collections from the pine forests of the nature reserve (near the villages of Verkhniy Tsey and Nar), which made it possible to clarify the taxonomic status of a number of species.

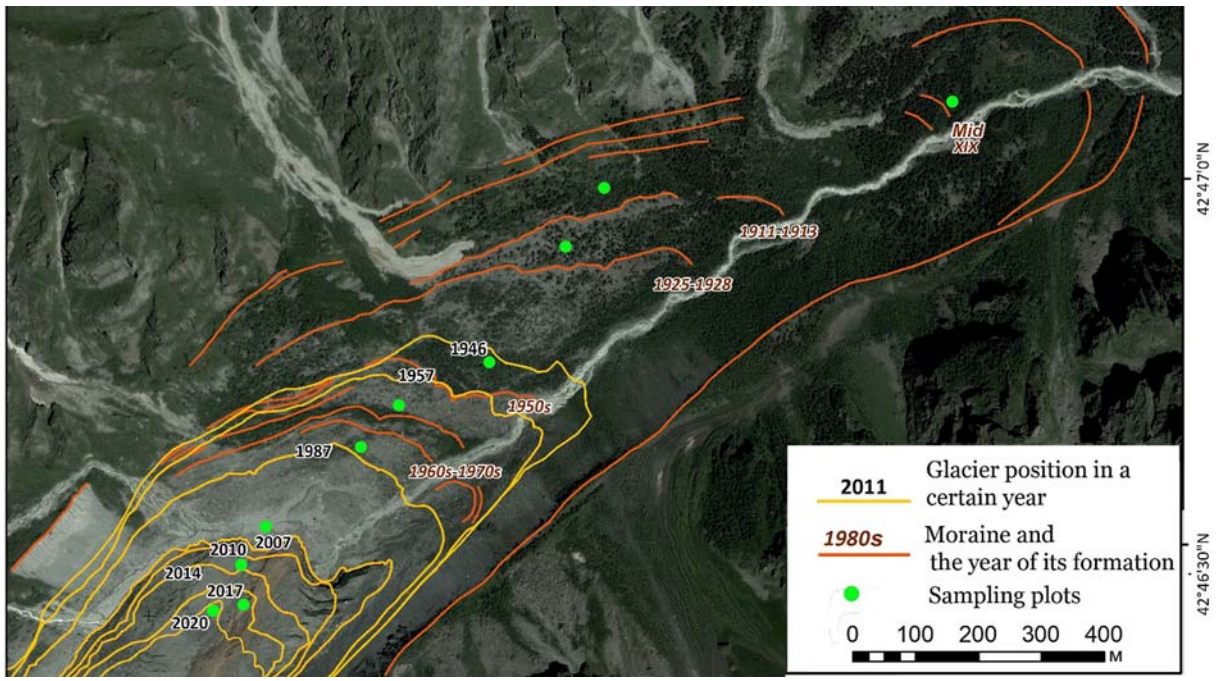

Fig. 2. The sampling plots along the Tsey Glacier chronosequence.

Рис. 2. Места отбора проб в зоне отступания Цейского ледника.

Figs 3–6. The main successional stages of the Tsey foreland: 3 — edge of Tsey Glacier; 4 — meadow overgrowing stage (2300 m s.a.l.); 5 — shrub successional stage (2295 m a.s.l.); 6 — young mixed forest (2250 m a.s.l.).

Рис. 3–6. Основные стадии сукцессии при отступании Цейского ледника: 3 — край Цейского ледника; 4 — луговая стадия (2300 м н.у.м.); 5 — кустарниковая стадия (2295 м н.у.м.); 6 — стадия молодого леса (2250 м н.у.м.).

List of species[1]

Order Poduromorpha
Family Poduridae

Podura aquatica Linnæus, 1758. A Holarctic species generally inhabiting still waters in ponds and along the shores of lakes [Fjellberg, 1998]. It is widely distributed in the forest belt of the nature reserve [Kuchiev, 2006].

Family Tullbergiidae

Mesaphorura critica Ellis, 1976. A polyzonal Palaearctic species ranging in Europe from the Mediterranean to northern Norway [Zimdars and Dunger, 1994], also occurring in the southwestern part of Greenland [Fjellberg, 2015] and in Central Siberia [Babenko, 2007]. In the nature reserve, it was recorded from mature pine forests with well-developed litter [Kuznetsova et al., 2019]. At Tsey, we have found this species in a mixed forest at an altitude of 2193 m a.s.l., as well as in a maple and a beech forest (1984 m and 1865 m a.s.l., respectively).

M. hylophila Rusek, 1982. The known distribution area covers central and northern Europe, as well as southwestern Greenland. In the nature reserve, it was found in low abundance in pine forests [Kuznetsova et al., 2019]. In our material, the species has been found dominating among the other congeners in a developed birch forest at an altitude of 2244 m a.s.l., and one specimen has been recorded at a grassy successional stage (2320 m a.s.l.).

M. italica (Rusek, 1971). This is a mainly European and highly polyzonal species, also recorded from Greenland and the Antilles. According to Kuznetsova et al. [2019] and our collections from the nature reserve, the species is confined to varied mature forests.

***M. macrochaeta* Rusek, 1976. A common and widespread Holarctic species. It was recorded among the first colonizers in brown coal dumps in Germany [Dunger et al., 2002]. In the Caucasus, reliable records were restricted to the vicinity of Sochi [Scherbina, 2020]. In the area previously occupied by the Tsey glacier, *M. macrochaeta* appears earlier than other congeners and has been found throughout the foreland (2070–2320 m a.s.l.). Apparently, it is more tolerant to dry habitats than other representatives of the genus.

***M. pongei* Rusek, 1982. The species was described from a pine forest in central France. Probably, it is Palaearctic in distribution [Fjellberg, 1998]. It also occurs in the mountainous landscapes of Spain [Simón Benito and Martinez, 1988]. Over the territory of the nature reserve, we have found

[1] The species marked by * are new to the Republic of North Ossetia–Alania, while those denoted by ** are new to the entire Caucasus.

only a few specimens in a maple and in pine forests (1984–2070 m a.s.l.). This is the first record of *M. pongei* from North Ossetia, and the Caucasus as a whole.

***M. sylvatica* Rusek, 1971. The species is probably Palaearctic in distribution [Zimdars and Dunger, 1994] and populates a wide range of habitats in Northern Europe [Fjellberg, 1998]. In the nature reserve, a few specimens of *M. sylvatica* have been found in pine and mixed forests. Until now, it has not been recorded from the Caucasus.

M. tenuisensillata Rusek, 1974. A trans-Palaearctic species common both in forest [Kuznetsova et al., 2019; our data] and grassy stations of the nature reserve. Along with *M. macrochaeta*, it has been recorded among the species inhabiting the earlier stages of overgrowth.

In addition, *Mesaphorura krausbaueri* Börner, 1901 was recorded from the North Ossetian Nature Reserve (Tsey Gorge) [Kuchiev, 2006]. Because this species is absent from our material coming from the same region, its occurrence requires confirmation. In reality, this record may belong to any of the above species of the genus.

Metaphorura affinis (Börner, 1902). This Palaearctic species prefers drained meadow soils [Zimdars and Dunger, 1994]. In the territory of North Ossetia, it was recorded from the upper soil layer of a perennial pasture located east of Alagir [Kremenitsa, 2002].

***M. denisi* Simón Benito, 1985. Originally, this species was described from Crete. The known distribution covers the Mediterranean, Ukraine, Turkey, Bulgaria, Slovakia, France and Spain [Pomorski and Skarżyński, 1997]. We record the species from North Ossetia for the first time. We have found it at the shrub successional stage (2295 m a.s.l.) and in a developed birch forest (2244 m a.s.l.).

Family Onychiuridae

Subfamily Tetrodontophorinae

Tetrodontophora bielanensis (Waga, 1842). The species was referred to as "*a common inhabitant of the subalpine meadows with a thick soil layer in the Tsey Gorge*" [Kuchiev, 2006]. In our opinion, the occurrence of this species endemic to Central Europe and clearly preferring moist broad-leaved forests in the main part of its distribution area [see, e.g., Kaprus' et al., 2006], in the highlands of the Caucasus is doubtful.

Subfamily Onychiurinae

Tribe Hymenaphorurini

**Hymenaphorura* sp. No members of this genus have previously been recorded from the republic, albeit it was listed in the Caucasian fauna [Petrova and Dobrolyubova, 1997] as *Onychiurus sibiricus* (Tullberg, 1876). Our material contains two individuals, probably belonging to two different species. The poor condition of these specimens has not allowed us to properly identify them.

Tribe Oligaphorurini

Oligaphorura absoloni (Börner, 1901). A widespread Holarctic species common in forests, including North Caucasian ones [Dobrolyubova, 1988; Kuznetsova et al., 2019]. Therefore, it appeared with the forests overgrowing the Tsey foreland. In addition to the pine forests, it also lives in a maple and a beech forest of the nature reserve.

O. montivaga Shveenkova et Babenko, 2022. A recently described species from the *marcuzzii*-group. In the fauna of the republic, it was found near the village of Nar and referred to as *O.* sp.n.1 aff. *kremenitsai* Shvejonkova et Potapov, 2012 [Kuznetsova et al., 2019].

Oligaphorura sp. 1. Probably a new species, characterized by the presence of 9 distal setae on the tibiotarsus and the absence of pso on the subcoxae [Yu.B. Shveenkova, personal communication]. In the nature reserve (Tsey), only two specimens were captured, both in a green-moss-grassless-azalea pine forest, 1676 m a.s.l., referred to as *O.* cf. *caucasica* (Weiner et Kaprus, 2014) [Kuznetsova et al., 2019].

Oligaphorura sp. 2. The species was recorded from a pine forest in the vicinity of Verkhniy Tsey, referred to as *O.* cf. *pieninensis* (Weiner, 1988) [Kuznetsova et al., 2019]. Most likely, this is another undescribed species distinguished from *O. absoloni* by the presence of 5 protective papillae in the antennal organ, and from *O. pieninensis* (Weiner, 1988) by the absence of pso on the fourth abdominal sternite [Yu.B. Shveenkova, personal communication].

Oligaphorura sp. 3. A few juveniles of this likely undescribed species were known from the Tsey Valley [see Shveenkova and Babenko, 2022]. In the paper of Kuznetsova et al. [2019], this species was referred to as *O.* sp.n.2 aff. *kremenitsai* Shveenkova et Potapov, 2012.

***Oligaphorura* sp. 4. Still another possibly new species of the genus, which is characterized by 2 pso on thorax I and an increased number of pso on the abdomen. In our material, we have only three specimens (2 females and one juvenile) from the Tsey Gorge, which have been found in two plots: a young birch forest at an altitude of 2240 m a.s.l. and a mixed forest at 2190 m a.s.l.

Tribe Protaphorurini

Protaphorura sakatoi (Yosii, 1966). Originally, this species was described from Kabul and Badakhshan, both Afghanistan. It has since been considered as the xerophile of a steppe fauna [Kaprus' and Pomorski, 2008]. The current distribution covers the southern Palaearctic, ranging from Eastern Europe to the Altais. It has also been recorded from the western and central Caucasus [Kaprus' and Pomorski, 2008]. According to N.A. Kuznetsova et al. [2019], *P. sakatoi* is a dominant species in mature pine forests in the vicinity of Verkhniy Tsey and Nar. Most likely, this species was included in the annotated list of springtails of the North Ossetian Nature Reserve [Kuchiev, 200] as *Onychiurus octopunctatus* Stach. In our material, the species has been found in a young birch-willow forest (2233 m a.s.l.) and in a lower beech forest (1865 m a.s.l.).

P. subarctica (Martynova, 1976). In the republic, it was recorded by N.A. Kuznetsova et al. [2019] in pine forests of the nature reserve. Prior distribution of the species was said to be restricted to the northern regions of the Palaearctic, not before 60º latitude [Babenko and Kaprus', 2014]. In our opinion, the conspecificity of northern and Caucasian individuals attributed to this species is doubtful, although it is not easy to reliably distinguish them. Caucasian specimens with pseudocellar formulae 32/022/33342 referred to by N.A. Kuznetsova et al. are characterized by a noticeably less distinct differentiation of dorsal setae, in particular, their M/s ratio on Abd.5 is = 12–15/6–9, AD = 10. In the northern populations assigned to this species, the length of these setae as regards to the anal spines is almost twice as large (M/ s = 21–25/12–15). In addition, these forms differ in the structure of the claw (in Caucasian individuals, there is no inner tooth) and the position of the prespinal setae (in Caucasian individuals, these are located almost in a row). Possibly the same form has been recorded from the North Caucasus (Teberda), referred to as *P. pulvinata* (Gisin, 1954) [Petrova and Dobrolyubova, 1987].

****P. unari** Rusek, 1995. This species was described from alpine, subalpine and mountain forest ecosystems of the western Carpathians (Slovakia). The Caucasian specimens we found at the shrub successional stage in the Tsey foreland (2295 m a.s.l.) are very similar to the typical *P. unari* by the number and arrangement of the dorsal pseudocelli (d.pso 33/02(3)3/33342, v.pso 1/–), the absence of m chaetae on Th.1 (i3–), rather clearly differentiated sensilla on the dorsal side of the body, as well as the absence of a tooth on the claw. The only distinguishing feature is a smaller PAO with 22–24 vesicles (vs 33 in the type material).

****Protaphorura** sp. This is presumably a new species with the pseudocellar formulae 32/02(3)3/33342, found at the shrub stage of overgrowth (2295 m a.s.l.), as well as at the stages of young mixed forests (2240–2250 m a.s.l.). In terms of most morphological features, it is very close to *P.* cf. *subarctica* (see above), but clearly differs in the number of pso on Th.2–3.

In North Ossetia, several undetermined individuals were also recorded, e.g. *P.* sp. gr. *armata* from a perennial pasture east of Alagir [Kremenitsa, 2002]. It is likewise impossible to establish the identity of *Onychiurus armatus*, referred to in the list of the springtails of the North Ossetian Nature Reserve [Kuchiev, 2006] as a rare species of the alpine belt of Tsey Range (above 2800 m a.s.l.).

Tribe Thalassaphorurini

****Thalassaphorura** sp. Several juveniles were found in the Ardon floodplain in the southern outskirts of Alagir (collection of O.L. Makarova).

Tribe Onychiurini

***Vibronychiurus caucasicus** Pomorski, 2006. Originally, this endemic Caucasian species was described based on material from the Elbrus region (Kabardino-Balkaria), probably being quite widespread in the highlands of the North Caucasus. We have revealed the species in North Ossetia (pass between Karmadon and Midagrabin Gorges, ~1600–1700 m a.s.l., collected by O.L. Makarova) for the first time.

Family Hypogastruridae

****Hypogastrura assimilis** (Krausbauer, 1898). This subcosmopolitan species has been recorded from the republic (winter collections in the floodplain of Ardon River in the outskirts of Alagir, O.L. Makarova) for the first time.

H. hohi Babenko, 1994. The Caucasian endemic, known only from the type locality in North Ossetia: basin of the Ardon River, Rocky Ridge, western spurs of Mt. Karyuhokh at 2800 m a.s.l. The species was described based on material of I.T. Kuchiev.

H. manubrialis (Tullberg, 1869). Cosmopolitan (?), often occurring in composts. In North Ossetia, it was recorded within the Alaniya National Park (upper reaches of the Karaugom River near the glacier) [Stach, 1949] and in a pasture east of Alagir [Kremenitsa, 2002, as sp.gr.].

H. socialis (Uzel, 1891). A species currently considered to be Palaearctic [Fjellberg, 1998], although its easternmost records are restricted to the southern Urals [Buinova et al., 1963; Stebaeva, 1976]. In North Ossetia (floodplain of the Ardon River, vicinity of Alagir, winter collections by O.L. Makarova), the species has been found for the first time.

H. tepli Skarżyński et Babenko, 2010. Endemic to the Caucasus, belonging to the *crassaegranulata*-group, described based on collections of I.T. Kuchiev from a protected area of the nature reserve (Kurtat Gorge, 3410 m a.s.l.). In the springtail list of the reserve [Kuchiev, 2006], the species is erroneously listed as *H. ossetica* Babenko (nomen nudum). No records outside the type locality are known.

H. vernalis (Carl, 1901). A Palaearctic species distributed almost throughout Russia [Babenko, 1994]. In the nature reserve, the species is common in low-mountain broad-leaved forests, and in spring it can form large aggregations in damp places [Kuchiev, 2006]. We have found only one adult individual in a developed birch forest at an altitude of 2244 m above sea level.

Ceratophysella alani (Babenko, 1994). A Caucasian endemic, known only from the type locality: Tsey Gorge, moraine of the Skazsky glacier, 2100 m a.s.l. [Kuchiev, 2006, as species of the genus *Hypogastrura*]. Initially, the species was assigned to the subgenus *Mitchellania* Wray, 1953, which included a rather clear group of species occurring in eastern Asia and North America. *Ceratophysella alani* is the only species of this group with such a western distribution. Despite the currently accepted synonymy of *Mitchellania* and *Ceratophysella* [see Skarżyński and Christiansen, 2008], the species occupies a quite distinct position among the European congeners.

C. caucasica Martynova, 1964. This was originally described from Abkhazia. Apparently, it is widespread not only in Transcaucasia, but also in the North Caucasus, in particular at Teberda [Dobrolyubova, 1984, 1984a]. In the territory of the nature reserve, it was recorded by N.A. Kuznetsova et al. [2019] from pine forests near Verkhniy Tsey and Nar. Unfortunately, the species could not be found in the relevant material of these authors. This is also absent from our collections from the higher elevations of Tsey.

C. denticulata (Bagnall, 1941). A Holarctic or even cosmopolitan species, possibly due to introduction. In our material from the nature reserve, only a single specimen has been found at an altitude of 2295 above sea level.

C. sp. aff. *succinea* (Gisin, 1949). Probably a new species differing from *C. succinea* by the small size and a complete set of labial papillae. In the upper reaches of Tsey River, it inhabits a wide range of biotopes: from bare ground around the glacier to forest ecosystems of different age. In the paper of N.A. Kuznetsova et al. [2019], it was this species, recorded from the vicinity of Verkhniy Tsey and Nar, that was referred to as *Ceratophysella* sp. Based on available data, the species also occurs in other regions of the North Caucasus (e.g., in our collections from the vicinity of Mount Elbrus). Possibly some old records of *C. succinea* from the highlands of the Western Caucasus [Petrova and Dobrolyubova, 1987; Dobrolyubova, 1988, 1995] also belong to this species. There is only one record of *C. succinea* from the lowlands of North Ossetia [Kremenitsa, 2002], but considering all above evidence, the species identity requires verification.

There are also a number of unidentified records of the genus, but it is very difficult to judge about their species identity [Kuchiev, 1984, Kuchiev, 2006 referred to as *C. armata*; Kuznetsova et al. 2019].

Orogastrura parva (Gisin, 1949). The species was listed as a common inhabitant of the forest belt of the nature reserve [Kuchiev, 2006, as a member of *Hypogastrura*]. From our point of view, the occurrence of this species, previously known only from the Alps, Apennines, Sudetes and Carpathians [Skarzynski, 2011; Thibaud et al., 2004], in the Caucasus needs to be confirmed.

Choreutinula inermis (Tullberg, 1871). A widespread species also recorded from the Caucasus [Dobrolyubova, 1984, 1984a; Petrova and Dobrolyubova, 1997]. According to the list of the springtails [Kuchiev, 2006], this species is rare in the nature reserve and inhabits the litter of pine forests of Tsey Gorge.

****Schoettella ununguiculata** (Tullberg, 1869). A Holarctic species. The only available record from South America is considered doubtful [Mari Mutt and Bellinger, 1990]. In the Tsey Gorge, it has been collected from the bark of a maple forest located at the confluence of Medik and Tsey rivers, at 1865 m a.s.l. Previously, this species has not been recorded from the republic.

Xenylla osetica Stebaeva et Potapov, 1994. A Caucasian endemic, known only from the type locality: vicinity of the village of Zintsar (collections of I.T. Kuchiev).

****X. szeptyckii** Skarżyński, Piwnik et Porco, 2018. One of the species of the *maritima*-group recently revised and reliably known from Poland, Slovakia, Hungary, France and Sweden. Given the rather wide distribution of the preferred habitats (mosses and lichens on rocks, dry sandy soils, forest litter, anthills, bird nests, mountainous and flat areas) and the tendency to synanthropy, it can prove to be much more widespread. The species has been discovered in the nature reserve for the first time (Tseydon Valley, a mature pine forest with a thick moss cover), but most likely this very species was previously recorded from the forest belt of this nature reserve and referred to as *X. maritima* [Kuchiev, 2006].

Typhlogastrura preobrazhenskyi Babenko, 1987. A Caucasian endemic and troglobiont [Kuchiev, 2006], described from the Shubi-Nykhasskaya Cave in the Alagir Gorge (corpses of *Myotis blythii*, about 150–200 m from the entrance).

Willemia anophthalma Börner, 1901. A Holarctic species, common in taiga and southern tundra regions, rarely found beyond. In the nature reserve, the species clearly prefers developed forests [Kuchiev, 2006; Kuznetsova et al., 2019].

W. denisi Mills, 1932. One of the most common Holarctic species occurring in coniferous litter in the taiga zone. Only one individual was recorded from the nature reserve [Kuznetsova et al., 2019]. In the higher part of Tsey Valley, it has not been revealed.

****W. intermedia** Mills, 1934. Holarctic. Previously, the species has not been recorded from North Ossetia. We have found it in the Tsey Gorge at an altitude of 2250 m a.s.l. in a young mixed forest.

W. scandinavica Stach, 1949. Holarctic. From the nature reserve, it was recorded so far only from pine forests in the vicinity of Verkhniy Tsey [Kuznetsova et al., 2019].

Family Neanuridae

Subfamily Pseudachorutinae

Micranurida forsslundi Gisin, 1949. A European species, found in North Ossetia for the first time, but previously recorded from the northwestern Caucasus (Teberda) [Kuznetsova et al., 2019; possibly also Dobrolyubova, 1984a, referred to as *A. anophthalmica* Stach, 1949]. It is possible that the obscure record of *M. papillosa* Axelson, 1902 by Kuchiev [2006] also belongs to this species. Based on our material, *M. forsslundi* is not abundant in the Tsey Gorge, but it occurs in a variety of habitats of the forest belt.

M. pygmaea Börner, 1901. A cosmopolitan, usually not abundant in the nature reserve, where it was mainly encountered in forests with developed litter [Kuznetsova et al., 2019].

M. sensillata (Gisin, 1953). Probably a European species, ranging from the Canary Islands to Denmark [Fjellberg, 1998]. In the nature reserve, it was first recorded from a pine forest near the village of Nar [Kuznetsova et al., 2019, referred to as *Anurida* sp.].

****Pseudachorutes vitalii** Kaprus et Weiner, 2009. The species was rather recently described from beech forests of Crimea. In the Tsey Gorge, it is abundant in the forest successional stages of the foreland, especially in a mixed forest with pine, birch and willow. We also found this species in the relevant material of N.A. Kuznetsova from the pine forests of the nature reserve. In that paper, it was referred to as *P. dubius* Krausbauer, 1898 [Kuznetsova et al., 2019]. The latter species had also been recorded from the North Caucasus earlier [Stach, 1949; Dobrolyubova, 1984; Kuchiev, 2006]. However, taking into account the high degree of morphological similarity of these two species, at least some of these records can prove to belong to *P. vitalii*, not to *P. dubius*.

Subfamily Friesinae

Friesea albida Stach, 1949. The species is characterized by a reduced number of ocelli, 3 anal spines, the absence of a mucro [stage 3 furcal reduction, according to Massoud, 1967] and the poorly developed clavate setae. Originally, *F. albida* was described from mountain forests of Eastern Europe (Poland and Ukraine) and considered as endemic to these regions. Later [Cassagnau, 1958], several Western European forms of this species were distinguished, differing in the number of ocelli: 5+5 in *albida albida*, 4+4 in *a. pyrenaica* Cassagnau, 1958, 6+6 in *a. atypica* Cassagnau, 1958, and 3+3 in *a. montechristii* Dallai, 1969. All these "forms" are presently considered as full species on www.collembola.org. *Friesea albida* was already recorded from the North-Ossetian Nature Reserve [Kuchiev, 2006] and some other parts of the Northern Caucasus [Dobrolyubova, 1984, 1984a; Petrova and Dobrolyubova, 1987]. Two clearly distinguished forms of this complex were discovered in the Tsey Gorge. The first one was referred to as *Friesea* sp. 2 [Kuznetsova et al., 2019], characterized by the presence of 4+4 large ocelli and 17-17-16 setae on the tibiotarsi (as in *F. pyrenaica*). The second one is present in our material from the upper reaches of Tsey Gorge: immature specimens with 5+5 ocelli and a more complete set of tibiotarsal setae (18-18-17, i.e. only M setae are missing). The true species identity of these forms requires clarification.

F. mirabilis (Tullberg, 1871). A cosmopolitan species quite common in the North Ossetian Nature Reserve, occurring from the subalpine zone to glaciers, including nunataks [Kuchiev, 2006]. Based on our material, several specimens have been found in the Tsey Gorge on a 60-year old moraine with a developed birch forest at an altitude of 2244 m a.s.l.

F. stachi Kseneman, 1936. According to the list of the springtails of the nature reserve, this species is common in the high mountainous parts, occurring from the alpine belt to glaciers [Kuchiev, 2006]. The reliability of the record of this western Carpathian endemic [Kaprus' et al., 2006] in the Caucasus region needs to be verified.

F. sp.aff. *subterranea* Cassagnau, 1958. A representative of the European mountain group characterized by the presence of 4 anal spines, 17-17-16 tibiotarsal setae (neither setae M nor A4) and the complete absence of colour, eyes and a furca. This species was referred to as *Friesea* sp. 1 by N.A. Kuznetsova et al. [2019] found in a pine forest near the village of Nar.

Subfamily Neanurinae

Biloba (?) *caucasica* Stach, 1951. The generic allocation of this species, described by J. Stach from Kabardino-Balkaria (Cherek-Bezenghiysky), has not yet been established. According to the list of the springtails of the North Ossetian Nature Reserve [Kuchiev, 2006], the species is rare and

occurs in the forest belt of the Tsey and Kassar gorges. The identity requires confirmation, since the species clearly needs to be redescribed.

Endonura alticola (Stach, 1951). A Caucasian endemic, described by J. Stach from a pine forest of the Karaugom Gorge, where the only known specimen was collected at about 1800 m a.s.l. Now this territory belongs to the Alaniya National Park. Originally, the species was placed in the genus *Biloba.* Only recently, after an analysis of type material, it was transferred to the genus *Endonura* [Smolis and Kuznetsova, 2016].

E. ossetica Smolis et Kuznetsova, 2016. Another endemic Caucasian species described from a maple forest near Verkhniy Tsey. At a location close (beech forest) to the type habitat we have found specimens almost identical in morphology to the types. The only difference from the real *E. ossetica* is an intense dark blue colour (in the original description, the colour was white). These forms seem to be conspecific, while the difference in colouration may be due to of type specimens having got faded as a result of prolonged storage (the date of the typical collections was September 16th, 1990). In addition, *E. ossetica* was described from one adult female and several juveniles, whereas our collections comprise both males and females, this complementing the information about the biology of this species.

Neanura minuta Gisin, 1963. A European species, but also recorded from Turkey [Özata et al., 2017]. Only a single record is known from the nature reserve: pine forests near the village of Nar [Kuznetsova et al., 2019].

N. muscorum (Templeton, 1835). The species is considered cosmopolitan, being quite common in the Tsey Gorge [Kuchiev, 2006]. We have recorded it in a mixed forest (2190 m a.s.l), as well as a lower beech forest.

Neanurinae gen. sp. The record given in the paper by N.A. Kuznetsova et al. [2019] concerns pine forests near the Nar village. The condition of the single specimen upon which this record was based does not allow us to identify it closer.

Paravietnura insolita Smolis et Kuznetsova, 2018. The species has recently been described from the Tsey Gorge: a pine forest on the southern slope of Kalpersky Range, 2160 m a.s.l. It is known only from the type locality.

Family Odontellidae

Superodontella cf. *montemaceli* Arbea et Weiner, 1992. The species was described from Poland. There are numerous records from beech and fir forests of the Ukrainian part of the Carpathian Mountains at various altitudes [Kaprus, 2009]. The individuals collected in the Tsey Gorge slightly differ from the typical specimens and their taxonomic status requires clarification. Possibly, the record of *Odontella pseudolamellifera* Stach, 1949 from the Tsey Gorge [Kuchiev, 2006] belongs to the above species.

Order Entomobryomorpha

Family Isotomidae

Anurophorus alpinus Potapov et Stebaeva, 1990. A montane species described from the nature reserve (Tsey Gorge). It is widely distributed in the North Caucasus, often reaching high densities. There are also records available from Dagestan and the Swiss Alps [Potapov, 1997]. In the nature reserve, it tends to occur in the moss-lichen cover on rocks and moraines, often being dominant [Kuchiev, 1984, referred to as *A. laricis* Nicolet, 1842; Kuchiev, 2006].

**A. palearcticus* Potapov, 1997. A boreal species distributed in the northern and eastern parts of European Russia, all of Siberia up to the Far East and Mongolia. In the Caucasus, the species is known from Kabardino-Balkaria [Potapov, 2001] and the environs of Sochi [Scherbina, 2020]. In the North Ossetian Nature Reserve it has been found for the first time (Tsey Gorge) and collected from the moss-lichen cover of moraine stones, where it usually prevailed in abundance over *A. alpinus*.

Ballistura sp. In our material, there are only two specimens of the genus, both collected on an almost bare rocky surface, one freed from ice only 4 years earlier. An exact identification of these specimens is difficult. Among the known European congeners, it is seems to be the closest to *B. albertinae* Ellis, 1976 by a similar structure of the furca, but it is easily distinguishable by the absence of a tooth on the claw. Kuchiev (1984) seems to have referred to this particular form as *Proisotoma* sp., as one of the dominants in plant communities on the rocks of the eastern slopes of Kalper Peak (3500 m a.s.l.).

***Desoria* sp. aff. *duodecimoculata* Denis, 1927. Most likely, this is a new species belonging to the alpine *nivalis*-complex [see Potapov, 2001], which is common in the European highlands. The identity is possible to establish only upon a complete revision of the European congeners of this complex. In the nature reserve, it has been encountered exclusively inside a bare ground at the edge of Tsey Glacier This seems to be a member of a unique glacial complex of springtails inhabiting exclusively areas in the affinity to glaciers. It is probable that *Isotoma nivalis* (Carl, 1910), listed by Kuchiev [2006] as an inhabitant of high mountains of the nature reserve, is actually a representative of this species.

***D. fennica* (Reuter, 1895). A hygrophilous species with a wide Palaearctic distribution. This is the first record of this species from North Ossetia (vicinity of Fazikau, close to Dargavs collected by O.L. Makarova).

***D. grisea* (Lubbock 1870). A member of the genus widespread throughout Europe, usually associated with decaying plant material of both natural and anthropogenic origin. It has not been recorded from North Ossetia before. In our collections from the Tsey Gorge, there is only one specimen of this species, collected in a maple forest.

***Desoria nivea* (Schäffer, 1896). A European species collected under the bark and in the litter of the upper part of Tsey Gorge. The specimens found were identical to the summer form of the real *D. nivea*. Yet it is distinguished by the presence of a weak diffuse pigment throughout the body (even in juveniles) and the absence of any pronounced facets along with maintaining the colour of the ocelli. Nevertheless, M. Potapov (personal communication) confirmed the species identity of these individuals as representing the true *D. nivea*, which morphs, as it turns out, can be eyeless indeed.

Desoria cf. *tolya* Fjellberg, 2007. The presence of this northern European species in such a southern region definitely requires confirmation. Unfortunately, our material contains only a single juvenile specimen. The record of *Isotoma violacea* (*D. violacea* at present) from the pine-birch forests of Tsey Gorge (1750 m a.s.l.) [Kuchiev, 2006] supposedly belongs to this species. There is also evidence on the presence of the other congeners in the republic [Kremenitsa, 2002; Kuchiev, 2006, sub *Isotoma olivacea* Tullb.]. The species identity of these records remains unknown.

Folsomia alpina Kseneman, 1936. A European alpine species common in the highland forests of the Caucasus, Carpathians and Alps. It was recorded from the alpine belt of

the nature reserve at altitudes over 3000 m [Kuchiev, 2006], where rarely reached high density levels. We have found one specimen each on a lateral moraine of the Skazsky Glacier at an altitude of ~2400 m s.a.l. and at the meadow overgrowing stage in the Tsey foreland at an altitude of 2300 m s.a.l.

F. inoculata Stach, 1947. A widespread montane species distributed almost throughout the Palaearctic and the Pacific coast of North America [Potapov et al., 2018]. In the North Ossetian Nature Reserve, this species is quite common [Kuchiev, 2006]. Kuznetsova et al. [2019] recorded it from a pine forest near the village of Nar. In our material, the species was abundant in a beech forest at an altitude of 1865 m a.s.l.

F. litsteri Bagnall, 1939. A European species mainly confined to forest litter [Potapov, 2001, referred to as *F. lawrencei* Rusek, 1984]. In the European part of Russia, it is common in anthropogenic landscapes, probably introduced [Kuznetsova, 1995, sub *F. lawrencei* Rusek, 1984]. In the nature reserve, it was earlier recorded from pine forests [Kuznetsova et al., 2019]. In the Tsey Gorge, we have encountered the species in a birch forest (2240 m a.s.l.), a mixed pine forest and a blueberry pine forest (2070–2205 m a.s.l.), especially abundant in a beech forest at 1865 m a.s.l.

**F. manolachei* Bagnall, 1939. An eurytopic species. In our collections, it has been found in two places: at the shrub stage of overgrowing in the Tsey foreland and in a young mixed forest with rich herbs (2295 m and 2250 m a.s.l., respectively).

F. penicula Bagnall, 1939. A mesophilic forest species from the *spinosa*-group, distributed almost throughout Europe, known also from North America [Potapov, 2001]. Abundant in mountain rendzinas of the Carpathians [Rusek 1993, 1996]. In the eastern Alps, it was recorded only from subalpine coniferous woods [Kopezski, Meyer, 1996]. In the Caucasus, including North Ossetia was first listed by Stach [1947] and [Kuchiev, 2006], sub *F. multiseta* (Stach, 1945), also found in a pine forest near the village of Nar [Kuznetsova et al., 2019].

F. ksenemani Stach, 1947. Another representative of the *spinosa*-group. Due to unclear distinguishing features largely depending on age, in the fauna of the Caucasus the species has usually appeared under the name *F. pseudodiplophthalma* Stach, 1947 [Dobrolyubova, 1984a; Kuznetsova et al., 2019]. At present, these two species considered synonyms [Poinsot, 1972; Potapov, 2001]. In the nature reserve, the species was recorded by Kuchiev [1984, 2006, in the latter paper referred to as *F. diplophthalma* and perhaps *F. spinosa* as well] and later also from the vicinity of the village of Nar [Kuznetsova et al., 2019]. Based on our material, *F. ksenemani* is common in the belt of pine forests of the Tsey Gorge. In the foreland, it appears first in a forb shrub community (a 14-year old surface since the glacier's retreat).

F. quadrioculata (Tullberg, 1871). A Holarctic polyzonal species characterized by the absence of obvious habitat preferences. It was recorded from the republic earlier [Kuchiev, 1984, 2006; Kuznetsova et al., 2019]. Based on our material, it occurs in a wide range of habitats in the Tsey Gorge, often together with *F. manolachei*, in fairly large abundance.

Folsomides parvulus Stach, 1922. A xerophilic and psammophilic cosmopolitan of soils in open habitats. In North Ossetia, it was recorded from a pasture located east of Alagir [Kremenitsa, 2002]. Our data confirm the xerophile status of this species, because we have found it in two rather dry areas: the herbaceous and shrubby stage of overgrowth of the postglacial surface.

Hemisotoma orientalis (Stach, 1947). A xerothermic species. In North Ossetia, it was known from the collections of A.M. Kremenitsa (as a species of the genus *Cryptopygus*) in a pasture located east of Alagir [Kremenitsa, 2002].

H. pontica (Stach, 1947). A xerothermic and ruderal species distributed in the Palaearctic. It was recorded by the same author on the same sampling plot [Kremenitsa, 2002].

H. thermophila (Axelson, 1900). A thermophilic and nitrophilic cosmopolitan [Potapov, 2001]. It was recorded from North Ossetia as a species of the genus *Cryptopygus* [Kremenitsa, 2002]. In our material from the Tsey Gorge, it has been found in a pine forest with admixture of birch and rhododendron at 2205 m a.s.l.

Hydroisotoma schaefferi (Krausbauer, 1898). A neuston species common in Europe and South America. From the Caucasus (Georgia), it was first recorded by Stach [1947], while from North Ossetia by Potapov [2001], the latter record originate from the outskirts of Alagir. According to Kuchiev [2006], the species is widespread on the northern macro slope of the Caucasus from valley alder forests to mid-mountain pine woodlands.

Isotoma viridis Bourlet, 1839. One of the most common and polytopic species in the Holarctic. In the nature reserve, it was first found on Mount Kalper at an altitude of 3500–3800 m a.s.l. [Kuchiev, 1984, 2006]. It was also recorded as a subdominant on a perennial pasture near Alagir [Kremenitsa, 2002]. In the Tsey Gorge, we have found it in forests of different ages (areas 34–96 years after the glacier's retreat), 2200–2250 m a.s.l.

Isotomiella minor (Schäffer, 1896). The species has been recorded all over the world, but most likely it occurs only in the temperate zone of the Holarctic [Potapov, 2001]. In the nature reserve it is quite abundant [Kuchiev, 2006; Kuznetsova et al., 2019]. Based on our material, in the Tsey Gorge the species is mainly confined to forest communities, where it is often dominant. Along the successional series, this species has appeared in a developed birch forest (2244 m a.s.l.), where it immediately reached high density. Farther down the slope, the species retained high density, occasionally yielding only to *Parisotoma notabilis*.

Isotomodella alticola (Bagnall, 1949). A predominantly northern Palaearctic species, the southern records of which, including North Ossetia [Kremenitsa, 2002, referred to as *Pseudanurophorus* cf. *inoculatus*] clearly require clarification.

Isotomodes productus (Axelson, 1906). A cosmopolitan species of dry open spaces, usually not reaching high abundance levels [Potapov, 2001], even though in North Ossetia it was recorded as a subdominant from pastures near Alagir [Kremenitsa, 2002].

***Isotomurus* sp. No species of this genus have previously been recorded from the republic. Obviously, this is due to the poor knowledge of hydromorphic habitats of the region. Unfortunately, our material from the Tsey Gorge contains only one immature individual and its identification is impossible. The most notable feature of this individual is elongated claws (especially on the first and second pairs of legs). Several undetermined individuals were also recorded from the vicinity of Verkhny Fiagdon (collection of O.L. Makarova).

Pachyotoma caucasica (Stach, 1947). The species was described from Transcaucasia (Georgia), but it is also known from the Alps (Italy) [Dallai, 1970]. From North Ossetia, it was recorded by Potapov [2001], possibly based on the collections of I.T. Kuchiev from Mount Kalper [1984, referred to as *Proisotoma* sp.].

***P. crassicauda* (Tullberg, 1871). Several juvenile specimens have been found in our material from the Tsey Gorge (a

birch forest in the upper part of the forest belt, near a temporary stream, 2244 m a.s.l.).

Parisotoma notabilis (Schäffer, 1896). The species is considered cosmopolitan. It seems to occur almost everywhere in the republic [Kuchiev, 1984, 2006, Kremenitsa, 2002, Kuznetsova et al., 2019]. Based on our material, *P. notabilis* colonizes the Tsey foreland at the shrub stage, quickly reaching high abundance levels and becoming a dominant in the forest belt.

Parisotoma sp. An undetermined species of the genus, found in the collections of Kuznetsova et al. [2019] from a pine forest of the Tsey Gorge. It is characterized by the presence of 1+1 large ocelli, 3+3 postlabial setae, VT with 2+2 lateral setae, and the absence of setae on the lower subcoxa of the first pair of legs. Unfortunately, there is only one immature individual in this material.

***Proisotoma minima* Absolon, 1901. A widespread Holarctic species. The available South American records require confirmation. The species usually lives under bark and is rare in the forest litter. This is the first record from North Ossetia: only a few individuals in a mature forest of the Tsey Gorge.

P. minuta (Tullberg, 1871). A thermophilic ruderal cosmopolitan, common in composts. In North Ossetia, it was recorded from near Alagir [Kremenitsa, 2002]. In the Tsey foreland, it has been found in a birch forest (2244 m a.s.l.) and in a lower maple forest (1984 m a.s.l.).

Pseudanurophorus binoculatus Kseneman, 1934. A Holarctic boreo-montane species. In the nature reserve, it was recorded from a pine forest in the vicinity of Nar [Kuznetsova et al., 2019]. This is a species quite common in coniferous and deciduous communities of the forest belt of Tsey Gorge.

Pseudisotoma sensibilis (Tullberg, 1876). According to Potapov [2001], *P. sensibilis auct*. is a complex of closely related species. In the currently accepted broad interpretation, the species occurs almost throughout the Holarctic, including North Ossetia [Stach, 1947; Kuchiev, 2006]. In the Tsey Gorge, several specimens of this "species" have also been found, but the exact identification requires revision of the entire genus.

Tetracanthella caucasica (Stach, 1947). A high-mountainous Caucasian endemic described from the foots of Karaugom and Bezenghi-glaciers [Stach, 1947] as a subspecies of *T. afurcata* Handschin, 1919. It occurs mainly in the central and eastern parts of the North Caucasus, often reaching high abundance levels [Potapov, 2001]. The species was also recorded from the region of Mount Kazbeg (Georgia) [Kováč, 1993] and from the Republic of Dagestan [Potapov, Kuchiev, 1993]. Regarding North Ossetia, this species is quite common in the highlands, including the nature reserve [Kuchiev, 1982, 1984, sub *T. afurcata*; Potapov, Kuchiev, 1993; Kuchiev, 2006]. In the Tsey Gorge, we have found it only in one of the 12 surveyed plots: the shrub stage of overgrowing of the Tsey foreland (2295 m a.s.l.).

T. osetica Potapov et Kuchiev, 1993. An endemic Caucasian species described from the North Ossetian Nature Reserve [Kuchiev, 2006] and still known only from two locations of the republic: Mount Karyukhokh (Skalisty Mountain Range) and Mount Stolovaya (Gerchoch Gorge). According to Kuchiev [2006], another closely related species of the genus, *T. arctica* Cassagnau, occurs in the nature reserve (Nikolaev peak, 3700 m a.s.l.). The real species identity of this record needs clarification.

Uzelia setifera Absolon, 1901. The species is distributed throughout Europe, mainly in the mountains. There are records from Crimea and the North Caucasus [Potapov, 2001], including the nature reserve [Kuchiev, 2006]. In the Tsey Gorge, we have found only one individual in a maple forest located near the Medik River.

Vertagopus cinereus Nicolet, 1842. A mostly European species, but many "old" records need to be confirmed due to new descriptions of some related species (in particular, *V. pseudocinereus* Fjellberg, 1973 and *V. haagvari* Fjellberg, 1996). In the fauna of North Ossetia, *V. cinereus* was listed by Stach [1947], but its presence in the region has only recently been confirmed [Lafooraki et al., 2020]. It seems to occur throughout the Caucasus, being a typical inhabitant of spaces under barks and lichens.

***V. haagvari* Fjellberg, 1996. Supposedly a widespread species often occurring together with the previous one. In North Ossetia and in the Caucasus in general, it has not been recorded yet. In the Tsey Gorge, we have revealed it in a pine forest with admixture of birch (2200 m a.s.l.), as well as in a lower beech forest (1865 m a.s.l.).

***Vertagopus* sp. Obviously, a new species characterized by weakly developed clavate setae on the tibiotarsi, which brings it similar to species of the genus *Desoria*. In a recent review of the genus from the Caucasus [Lafooraki et al., 2020], similar forms have already been observed in the region. These forms seem to be related to high-mountain European species of the genus. In Kuznetsova et al. [2019], this form was listed as *Desoria* sp. from a pine forest surrounding the village Nar. In our material from the Tsey Gorge, we have found the same form, which turned out to be quite common in forest communities of different ages.

Family Orchesellidae

***Heteromurus* sp. Apparently, a new species differing from other congeners by the presence of a strong spiny macrochaeta at the base of the dens, similar to that observed in the recently described genus *Falcomurus* Mandal. 2018. The species has been found in rhododendron thickets near the Skazsky Glacier (2490 m a.s.l). Only two species of the genus have been recorded earlier from the Caucasus and Transcaucasia: *H nitidus* (Templeton, 1835) and *H. major* (Moniez, 1889), as well as *H. caucasicus* Tshelnokov, 1974, subsequently synonymized (Mari Mutt, 1980) with *H. major*.

Orchesella cf. *caucasica* Stach, 1960. This species has been found in the Tsey foreland at the early successional stages of overgrowing (from meadow to young mixed forest), being especially abundant in the meadow stage at 2320 m a.s.l. Originally, *O. caucasica* was described by Stach [1963] from the Karaugom Gorge, located next to the Tsey Gorge. We have found some individuals of the form similar in body colouration to the typical variety as given in the original description of *O. caucasica*. However, the high intraspecific colour variability and the absence of a chaetotactic analysis in the original description, neither allows us to establish the identity of these forms.

O. cf. *irregularilineata* Stach, 1960. A Caucasian species described from the Karaugom Gorge. In the nature reserve, it has been found in the Tsey Gorge at the late succession stages, represented by various forests (pine, maple, beech). The published list of the springtails in the nature reserve [Kuchiev, 2006] includes a similarly coloured species, *O. orientalis* Stach, 1960, described from western Ukraine. In our opinion, the probability that these records belong to the same species is high enough.

There are also some published records of closer unidentified representatives of *Orchesella* from North Ossetia: the vicinity of Nar and Verkhniy Tsey [Kuznetsova et al., 2019]. Nothing definite can be said about their status.

Family Entomobryidae

Entomobrya elegans Stach, 1963. The species was described from the Karaugom Gorge (1800 m a.s.l). Subsequently, it was recorded from the Stavropol Krai (near Pyatigorsk) and Georgia [Jordana, 2012]. There are also unconfirmed records from beech forests of Serbia [Koledin et al., 1988; Matic et al., 1997].

**E. kuznetsovae* Jordana, Potapov, Baquero, 2011. The species was described based on collections from the Elbrus region. Based on our material from the Tsey Gorge, this is the most common representative of the genus, inhabiting a very wide range of habitats.

E. lanuginosa (Nicolet, 1842). This species is the most frequently cited in the literature, but most of these citations are uncertain and its real distribution area is apparently restricted to Central and Northern Europe [Jordana, 2012]. In the Caucasus, the species was recorded as ranging from Adygea [Kremenitsa et al., 2010] to Azerbaijan [Samedov and Rassulova, 1975]. According to Kuchiev [2006], the species is "*common in the forest belt in all forest types throughout the nature reserve*." However, the species is absent from our material coming from the upper part of Tsey Gorge. We believe that the presence of this species in the territory of the nature reserve is possible, but requires confirmation. Since, on the one hand, "*it may be confused with the pale forms of E. schoetti Stach, 1922, E. nivalis (Linnæus, 1758) and E. nicoleti (Lubbock, 1870)*" [Jordana, 2012]. On the other hand, the typical *E. lanuginosa* has been found in our material from the more western region of the North Caucasus (Kabardino-Balkaria).

E. nicoleti (Lubbock, 1870). A predominantly European species introduced to Australia [King et al., 1985]. There are two Caucasian records of this species: the first one from Dagestan [Baquero et al., 2021] and the second one is devoted to the synonymy of *E. nicoleti* and *E. bimaculata* Stach, 1963 [Jordana, 2012]. The original description of the latter was based on rather large material from the northern Caucasus (from the Karaugom Gorge to the Elbrus region). It seems noteworthy that the colouration of *E. bimaculata* is almost identical to that of *E. kuznetsovae*, but the chaetotaxy of *E. bimaculata* from Karaugom turned out to be similar to that of *E. nicoleti* [see Jordana, 2012]. The species *E. nicoleti* has not been found by us in the Tsey Gorge, although it occurs in similar landscapes of the Karachay-Cherkess Republic (our unpublished data).

**E. nivalis* (Linnæus, 1758). One of the most widespread species of the genus, which was recorded almost all over the world, but most of the "old" records outside the northern Holarctic need to be confirmed [Jordana, 2012]. In the Caucasus region, the species has previously been known from Georgia [Stach, 1963] and the environs of Sochi [Scherbina, 2020]. Based on our material, this species is common, but not abundant, in the young mixed and pine forests of the Tsey Gorge.

E. cf. *multisetis* Baquero, Potapov et Jordana, 2021. A recently described Caucasian species known from the republics of Ingushetia, Chechnya and Dagestan. The taxonomic status of the form we encountered in many areas of the Tsey foreland requires further exploration. Its polychaetosis, colouration and habitus bring the form closer to the original description of *E. multisetis*, but a careful analysis of the available samples is necessary for a more accurate identification.

E. wojtusiaki (Stach, 1963). The species was originally described from the republic of North Ossetia (Karaugom Gorge). Its type material was lost, and the chaetotaxy of omitted from the original description [Jordana, 2012]. In the forest belt of the Tsey Gorge, we have found a form with a colour same to that given in the description, but its conspecificity with the true *E. wojtusiaki* requires comparison with topotypes.

Several other published records of members of the genus *Entomobrya* from North Ossetia remain undetermined: the vicinity of Alagir [Kremenitsa, 2002] and Nar [Kuznetsova et al., 2019].

***Entomobryoides purpurascens* (Packard, 1873). A Holarctic species usually inhabiting Formicidae ant nests, only rarely found outside them [Jordana, 2012]. In the Tsey Gorge, it has been captured in two areas marked by high ant activity and the presence of ant nests (2233 m and 2295 m a.s.l.).

Lepidocyrtus spp. There have been no special taxonomic studies devoted to Caucasian representatives of this genus. The known publications [Dobrolyubova, 1984, 1984a; Petrova and Dobrolyubova, 1987; Kremenitsa, 2002; Kuchiev, 2006; Kuznetsova et al., 2019] include records of six species: *L. lanuginosus* Linnaeus, 1788, *L. cyaneus* Tullberg, 1871, *L. lignorum* Fabricius, 1775, *L. violaceus* Geoffroy, 1785, *L. curvicollis* Bourlet, 1839, and *L. paradoxus,* Uzel, 1890. All of them concern the Republic of North Ossetia. Given the modern approaches to the taxonomy of the genus, it is difficult to judge about the true species identity of these forms. In our material from the Tsey Gorge, a light-coloured form of the *lignorum*-group is present in rhododendron thickets on a lateral moraine of the Skazsky Glacier (2490 m a.s.l.) and in the upper part of the Tsey foreland (2295 m a.s.l.). In contrast, a dark-coloured form of the same group, (*L.* cf. *violaceus*) has been found in a beech forest down the slope (1865 m a.s.l.). Besides the above species, *L.* cf. *lanuginosus* was also recorded from pine forests near the villages Verkhniy Tsey and Nar [Kuznetsova et al., 2019].

Pseudosinella alba (Packard, 1873). A cosmopolitan species inhabiting a wide range of habitats. In the republic, it was recorded only from pine forests near the village of Nar [Kuznetsova et al., 2019].

P. cf. *immaculata* (Lie-Pettersen, 1896). A Palaearctic species. In North Ossetia, only one individual was found in a pine forest near the village of Nar [Kuznetsova et al., 2019]. No exact species identity was possible to establish.

P. cf. *zygophora* (Schille, 1908). Several specimens of this European species were recorded from pine forests around the village of Nar [Kuznetsova et al., 2019]. More material is needed to establish the exact species status.

P. cf. *octopunctata* (Börner, 1901). A cosmopolitan species preferring dry habitats with fragmented vegetation and sandy soil. In the Tsey Gorge, the species is common on the plot with sparse willow, birch and young pines (2295 m a.s.l.).

**Willowsia buski* (Lubbock, 1870). A cosmopolitan, often synanthropic species preferring dry places and tree trunks [Fjellberg, 2007]. The species was also recorded from the Caucasus (Azerbaijan) [Zhang et al., 2011]. In the nature reserve, we have encountered it in rhododendron thickets on a lateral moraine of the Skazsky Glacier (2490 m a.s.l.). Because all specimens were captured by hand with an aspirator, accidental transfers from neither flower pots nor other anthropogenic habitats can be presumed.

W. nigromaculata (Lubbock, 1873). Another cosmopolitan synanthrope. In outdoor habitats, it can be encountered on tree trunks [Fjellberg, 2007; Zhang et al., 2011]. This species was found in a perennial pasture near Alagir [Kre-

menitsa, 2002]. In the nature reserve, we have recorded it in the floodplain of the Tseyson River.

**W. platani* (Nicolet, 1842). Considered as an indoor species [Fjellberg, 2007]. Similarly to both the previous ones, this prefers open dry places and tree bark, but most often it is confined to human buildings (fences, house walls, window sills, flower pots, shells etc.). The species is widely distributed across Europe and Asia, including the Caucasus region [Zhang et al., 2011]. In the Tsey Gorge, it has been captured by sifting litter in a pine forest with admixture of birch (2205 m a.s.l.), as well as with pitfall trapping in a lower maple forest (1984 m a.s.l.).

Family Tomoceridae

Pogonognathellus flavescens (Tullberg, 1871). According to the list of the springtails of the nature reserve [Kuchiev, 2006], this Holarctic species is common and "*occurs in the forest belt and subalpine meadows throughout the nature reserve*." It has not been found in our collections.

Tomocerina minuta (Tullberg, 1876). A boreal Holarctic species, in the southern regions it is common in the mountains, including the Caucasus and Transcaucasia [Martynova, 1969]. In the Republic of North Ossetia, the species was recorded from the forests of the nature reserve [Kuchiev, 2006; Kuznetsova et al., 2019]. Based on our material from the Tsey foreland, the species is common in a wide range of communities, but not abundant as a rule.

Tomocerus vulgaris (Tullberg, 1871). A cosmopolitan typical inhabitant of the forest leaf litter and rotten wood. In the Tsey Gorge, this species populates leaf litter of all types of forest communities in large numbers [Kuchiev, 2006; Kuznetsova et al. 2019, our data]. Moreover, in the successional series of the Tsey foreland, this has been found along with the appearance of young trees (1984–2250 m a.s.l.).

Tomocerus minor (Lubbock, 1862). A widespread Holarctic species. In the territory of the nature reserve, this is a rare species recorded from the forest belt [Kuchiev, 2006].

***Tomocerus* sp. The taxonomic status of this form, which clearly prefers alpine communities near glaciers, is unclear. We have revealed this form only in the early stages of postglacial succession (4–14-year old plots since the glacier's retreat in the Tsey Gorge: 2320–2295 m a.s.l.). In addition, the species has also been recorded from a lateral moraine of the Skazsky Glacier (2490 m a.s.l.). It differs clearly from *T. vulgaris*, the most widespread species of the genus in the area, primarily by the number and arrangement of spiny setae on the dens.

Order Neelipleona

Family Neelidae

Megalothorax willemi Schneider et D'Haese, 2013. Apparently, a widespread European species. In the Tsey Gorge, it is abundant in a wide variety of habitats, first appearing at the shrub stage of overgrowth of the foreland (2295 m a.s.l.), then lower down the slope it occurs everywhere, down to beech forests (1865 m a.s.l.). Kuznetsova et al. [2019] quote an indefinite representative of the genus, recorded from pine forests near the villages of Verkhniy Tsey and Nar. Verification of pertinent material shows that mainly it contains *M. willemi*, but the type species of the genus is also present (see below).

M. minimus Willem, 1900. For a long time the species was considered cosmopolitan, but due to changes in the taxonomy [Schneider a D'Haese, 2013], it is clearly premature to presume the real distribution area of the species. We have found individuals of this species in the relevant collections of Kuznetsova et al. [2019] from pine forests of Verkhniy Tsey and Nar.

**Neelus murinus* Folsom, 1896. Considered cosmopolitan, but many "old" records probably need to be revised. This is the first record from North Ossetia: a maple forest of the Tsey Gorge (1984 m a.s.l).

Order Symphypleona

Family Mackenziellidae

***Mackenziella psocoides* Hammer, 1953. The known sporadic records of this species cover almost the entire Holarctic from northern Canada to Norway and the Canary Islands. Possibly, the distribution area of *M. psocoides* is wider. Considering the rather small size and the body shape not typical of springtails, the species may be confused for a mite when sorting out the material [Fjellberg, 2007]. In addition, the eggs of the species can to be quite resistant to drought, this contributing to survival in harsh habitats. In the Tsey foreland, we have found only two females of *M. psocoides* in a rather dry plot covered with young shrubs (2295 m a.s.l.). These the first records of the species from both North Ossetia and Kabardino-Balkaria (in preparation).

Family Sminthurididae

Sphaeridia pumilis (Krausbauer, 1898). The species is considered cosmopolitan. In the nature reserve, it prefers forests, e.g. pine [Kuznetsova et al., 2019] and maple forests of the Tsey Gorge (our data).

Family Arrhopalitidae

Pygmarrhopalites cochlearifer (Gisin, 1947). A European species recorded from pine forests around Verkhniy Tsey and Nar [Kuznetsova et al., 2019].

P. pygmaeus (Wankel, 1860). A Holarctic species recorded from the forests of Tsey and Kassar gorges in the nature reserve [Kuchiev, 2006].

P. principalis (Stach, 1945). A Holarctic species common in boreal regions, but also recorded from the mountains, including the Caucasus and Transcaucasia [Grinbergs, 1960; Kuchiev, 2006; Scherbina, 2020]. In our material from the Tsey Gorge, only one specimen has been found in a young birch-willow forest (2233 m a.s.l.).

P. secundarius (Gisin, 1958). A Palaearctic species. One of the most abundant species in pine forests near the village of Nar [Kuznetsova et al., 2019].

Family Katiannidae

Sminthurinus elegans (Fitch, 1863). The only species of the genus occurring both in the Palaearctic and the Nearctic [Bretfeld, 1999], mainly preferring meadow communities. It was recorded earlier in the western Caucasus [Kuznetsova et al., 2019]. In North Ossetia, the species was found only on pastures east of Alagir [Kremenitsa, 2002].

***S. gisini* Gama, 1965. The species occurs in Southern and Central Europe (Portugal, Czech Republic, Slovakia, Poland, Austria). In the nature reserve, it has been encountered only in a mixed forest (moss on stones). This is the first record from the Republic of North Ossetia.

Family Sminthuridae

Caprainea marginata (Schött, 1893). A European species, found in the nature reserve only in a pine forest near the village of Nar [Kuznetsova et al., 2019].

Lipothrix lubbocki (Tullberg, 1872). The species occurs in Europe and North Africa. It is very common in the forests of the North Caucasus [Dobrolyubova, 1984a; Kuchiev, 2006, both sub as species of the genus *Sphyrotheca*; Kuznetsova et al., 2019; our material].

****Sminthurus** sp.1. The light-coloured form of unclear taxonomic identity with a small dark spot on Abd.6. In contrast to the similarly coloured and widespread *S. viridis* (Linnaeus, 1758), this one is characterized by the presence of two setae on the lower subcoxae of the third pair of legs, and a short anal appendage (< ½ mucro). The species has been found in the upper part of the Tsey Gorge in the belt of young mixed forests.

****Sminthurus** sp.2. Unlike the previous species, this form, found on a lateral moraine of the Skazsky Glacier, shows a contrasting pattern and claws without pronounced tunic. It can prove to be *S. multipunctatus tristrigata* Stach, 1956, known from a nearby area (based on the collection date, the Stach's material was taken somewhere in the Cherek Balkarsky Valley). Since our material contains only two immature males and a juvenile, comparisons are difficult to draw.

Spatulosminthurus flaviceps (Tullberg, 1871). A European species common in the forests of the North Caucasus [Stach, 1956; Grinbergs, 1960], including the North Ossetian Nature Reserve [Kuchiev, 2006; Kuznetsova et al., 2019; our material].

Family Dicyrtomidae

Dicyrtomina sp. (or spp.). The species of the genus are quite common in the forests in the mountainous parts of the nature reserve [Kuznetsova et al., 2019]. Several colour forms are known to occur in the nature reserve: from almost devoid of dark pigment (except for the eye fields) (as in *D. minuta* f. *pallida* Ågren, 1903) to uniformly purple with small lighter spots (as in *D.* cf. *violacea* (Krausbauer, 1898)). An intermediate variant similar to the colouration of *D. ornata* (Nicolet, 1842) was also recorded [Kuznetsova et al., 2019]. The question of whether these forms are independent species or just colour variations of one remains open.

Dicyrtoma fusca (Lubbock, 1873). A widespread Holarctic species [Bretfeld, 1999] said to be common in the forest belt of the nature reserve [Kuchiev, 2006], but absent from our material.

Ptenothrix atra (Linnaeus, 1758). This species is considered Holarctic, although the synonymy of *P. atra* and the Nearctic *P. unicolor* (Harvey, 1893) is questionable [see Christiansen and Bellinger, 1981; Bretfeld, 1999]. In the nature reserve, it was found in a pine forest of the Tsey Gorge [Kuznetsova et al., 2019].

Family Bourletiellidae

****Fasciosminthurus obtectus** Bretfeld, 1992. A widespread Palaearctic species with a known range extending from central Europe to southern Siberia. It has not been recorded from the Caucasus yet. According to our pitfall trapping data, it was especially active in a dry area with young shrubs of the Tsey foreland (2295 m a.s.l.), but also found singly in the forest belt.

Discussion and conclusion

The springtail fauna of the Republic of North Ossetia–Alania is presently known to contain at least 146 species from 68 genera, 18 families and 4 orders, being supplemented by 31 and 19 species new to the republic (*) and the entire Caucasus (**), respectively, and taking into account not fully identified species, this value is 43 and 30 species, respectively.

In our opinion, the present diversity of springtails in North Ossetia can barely be termed rich. For example, the checklist of Pieniny National Park (Poland), located in the northern part of the Carpathians, includes at least 191 species [Weiner, 1981], considering that more than 440 species are known from Poland [Skarżyński et al., 2002]. Of course, the areas of North Ossetia and Poland are hardly comparable (8,000 vs 322,500 km^2). However, the Pieniny National Park alone takes a much smaller area than the North Ossetian Nature Reserve (ca 29,000 ha vs 51,000 ha). Such a not very great diversity is evidently associated with the confinement of the main sampling to the highlands of the republic. Conceivably, the rather harsh conditions of these locations set a trend for the depletion of the fauna compared to the mid-mountain territories. Unfortunately, as there are virtually no data available on the fauna of the latter, it is impossible to make an exact comparison today. In addition, when assessing species diversity, one cannot dismiss the degree of taxonomic development of individual groups in a region. Thus, the most problematic groups in North Ossetia include the following families: Onychiuridae, Orchesellidae, Entomobryidae and some Symphypleona. On the contrary, the family Isotomidae and Hypogastruridae demonstrate the greatest taxonomic knowledge in the region, which automatically entails a higher diversity.

In terms of distribution, most of the springtail fauna of the republic consists of Holarctic and European species (25 and 20%, respectively). At the same time, the proportion of widespread species is large (14%). Endemism of the Collembola of North Ossetia at the species level is not especially high for such a varied region. This is quite evident in comparison with other poorly vagile soil animals [Abdurakhmanov, 2017; Golovatch and Antipova, 2022]. Among the 146 species and 68 genera of Collembola yet recorded from the republic, only 18 species (nearly 12%) from 11 genera (16%) show a Caucasian distribution pattern, being endemic or subendemic to the Caucasus region. Besides this, at least presently 11 species (7.5%) of them seem to be endemic to the Republic of North Ossetia–Alania. The low endemism is not so surprising, given that springtails can be spread by air, the mountain gorges probably not serving as fatal obstacles to their dispersal [Hawes et al., 2007; Flø and Hågvar, 2013]. However, the number of indeterminables can be assumed as most likely to also contain further endemics. If so, this will increase this estimate.

A significant part of the present checklist covers the North Ossetian Nature Reserve, this obviously being related to more careful sampling efforts in its territory. Thus, a total of 132 (90%) collembolan species with a few uncertain identifications, altogether belonging to 62 genera and 18 families, are presently recorded from the North Ossetian Nature Reserve. It seems noteworthy that ca 35% of the springtail fauna of the nature reserve have been noted thanks to our investigation. Considering both the latter and the number of species provisionally identified as new (at least 14), such a highly diverse region can generously be regarded still far from being fully explored yet.

There is little doubt that further interesting collembolan novelties are still ahead along with future explorations of various habitats, especially in the unexplored caves and gorges, across North Ossetia and its remarkable North Ossetian Nature Reserve.

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