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# A checklist of springtails (Hexapoda, Collembola) from Kosovo and Metohija province, Republic of Serbia

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**ABSTRACT.** The knowledge of Collembola diversity is far from complete, especially on the territory of the Republic of Serbia. This paper presents a summary of all identified species of springtails in the area of Kosovo and Metohija. The list of species includes a total of 119 species of springtails classified into 65 genera, 16 families, and 4 orders. Representatives of all four recent orders of Collembola are present in this checklist. The order with the greatest number of species is Entomobryomorpha with 55 determined species, while the order Neelipleona is present with only one endemic cave species *Neelus klisurensis* Kovác & Papác, 2010, which is found in the aphotic zone of the cave in Velika Klisura at the foot of Prokletije mountains. The family with the most number of species is Entomobryidae Schäffer, 1896 with 21 species, while the most scarce families are Poduridae, Paronellidae and Neelidae, each with one representative. The family with the most genera is Isotomidae with a total of 11 genera. The genus *Entomobrya* Rondani, 1861 is the genus with the most species, with a total of 11 species. The fauna of the springtails of Kosovo and Metohija has not been properly and sufficiently investigated, although great diversity and high endemism can be expected in this territory, especially in the unexplored caves and gorges. The importance of springtail research is manifold. This paper is a contribution to add knowledge to the existing fauna of Kosovo and Metohija and the starting point for further research of springtails in this area.

**Key words:** checklist, Collembola, species, diversity, Serbia.

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## INTRODUCTION

Springtails (Collembola) today represent a special class of arthropods with their four recent orders Poduromorpha Börner, 1913, Entomobryomorpha Börner, 1913, Symphypleona Börner, 1901, and Neelipleona Massoud, 1971 (Bellinger et al., 1996–2022). They are cosmopolitan, living mostly in soil and litter, but also on the surface layers of fresh and saltwater. In most terrestrial ecosystems, springtails, together with mites, are considered to be the most numerous groups of the terrestrial mesofauna, reaching a density of up to 100,000 individuals per $m^2$, in soils without direct anthropogenic impact (Hopkin, 1997). Known springtail fossils date back to the Early Devonian and are over 400 million years old (Daly et al., 1998). Their body consists of three tagma: head, thorax, and abdomen. Most species have a characteristic structure on the ventral side of the fourth abdominal segment - a

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bouncing fork (furcula), which serves them for jumping (Brajković, 2004; Zhang et al., 2015). Springtails are a significant component of many ecosystems in terms of nutrient circulation and energy flow because of the numerous functions they play in trophic networks, as well as their high densities and biomass (Rusek, 1998). They play an important role in the soil ecosystem as a key soil decomposer group that regulates nutrient cycling and has an impact on soil fertility and water retention (Daghighi & Hajizadeh, 2019). Many studies have shown that soil contamination can alter the composition of species within Collembola compared to "clean habitats" and their importance in assessing soil status (Abel & Larink, 1994; Nüss, 1994; Chernova et al., 1995; Filser et al., 1995; Moldenke & Thies, 1996; Salminen & Haimi, 1996; Frampton, 1997; Kuznetsova & Potapov, 1997; Chernova & Kuznetsova, 2000; Rebecchi et al., 2000; Cole et al., 2001; Abbas & Parwez, 2020; Joimel et al., 2021; Bhagawati et al., 2021). Collembola are also hosts of many parasitic Protozoa, Nematoda, Trematoda and pathogenic bacteria, but also victims of various predators (Yahyapour et al., 2022). Today, about 9,000 species (more than 8,700) of springtails are known and described, but many authors estimate that there are between 50 and 65,000 of them, still unidentified (Hopkin, 1998; Porco et al., 2013). According to the data from 2001, the number of species in the Republic of Serbia is 228 (Radović & Ćetković, 2001). According to the same authors, based on the fauna records of Collembola of The Socialist Federal Republic of Yugoslavia and Serbia, one could expect an increase in the registered number of species by about 20-40%. According to Lučić (2006), 243 species of springtails were listed in Serbia. Most endemic and relict forms live in caves and pits, and some inhabit forests and cultivated steppes. Two centers of endemic differentiation of Collembola are recognized on the territory of Serbia and Montenegro: in the northern and eastern Serbia, and in the southern and western parts (Montenegro, western and south-western Serbia) (Ćurčić & Lučić, 1997).

The area of the Autonomous Province of Kosovo and Metohija in the center of the Balkan Peninsula, only 90 km away from the Adriatic Sea and 220 km from the Aegean Sea, with its openness to these seas, the Drim Valley and Lepenc and Vardar valleys, surrounded by high mountains along the periphery - west Prokletije, north Kopaonik and in the south, Shara Mountains, have very different climatic influences, but also numerous climatic modifications (Jakšić & Belij, 1995). There are three climatic types in Kosovo and Metohija - the altered Mediterranean, continental and mountainous type (Ivanović et al., 2016). Within these climatic types, several climatic sub-regions are present. Based on the geographical features of this area, which is divided into many micro-units, we can expect a high diversity of species. The accidental finding of an endemic species in one of the dozens of known caves in this area also speaks in favor of the expectation of a certain degree of endemism (Kováč & Papáč, 2010). It should be mentioned that none of them has been explored so far, and there are many caves that no one has ever entered. A major environmental problem in Kosovo and Metohija is dozens of tailings of the Trepca Metallurgical Industry, which are located in many locations. It is important to point out that the total volume of industrial tailings in this area exceeds one hundred million tons. Extremely few of these industrial landfills have been rehabilitated, some to a greater extent whereas some to a lesser extent. Urban landfills have been rehabilitated in recent years. Considering the sensitivity of Collembola to environmental changes, and by investigating the composition and structure of their communities, we can monitor the processes of soil recovery and remediation. In the light of climate change, which mildly affects this area as well, it is important to determine the diversity of species and monitor their adaptation to them (Jucevica & Melecis, 2006; Xu et al., 2012; Yin et al., 2019; Bonfanti et al., 2022).

## MATERIAL AND METHODS

The list of species was compiled based on all collected and published data on Collembola on the territory of the AP of Kosovo and Metohija (Koledin & Bogojević, 1976; Kováč & Papáč, 2010; Jakšić, 2013; Jakšić et al., 2018). So far, only two studies of the Collembola fauna have been conducted in the study area. The other two sources are accidental findings.

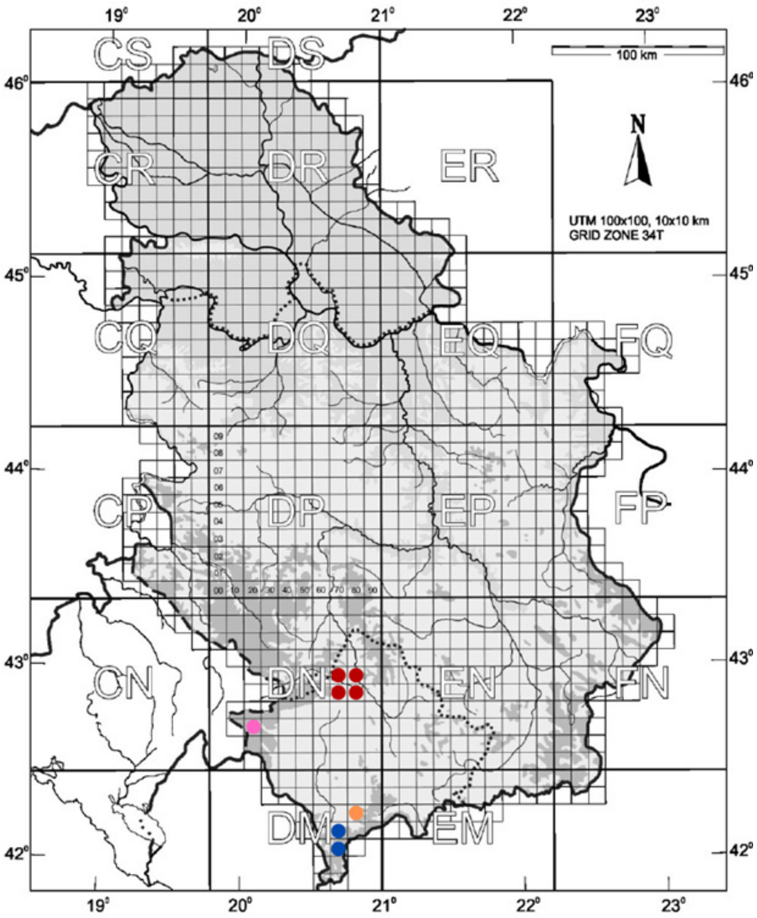


**Figure 1.** Map of the localities where Collembola were investigated in Kosovo and Metohija (in Serbia) in UTM projection (grid zone 34T; basic square 10 km × 10 km). Red circles – Kosovska Mitrovica region – KM (Jakšić, 2013; Jakšić et al., 2018), Pink circle – Velika Klisura, Prokletije Mountain – PK (Kováč & Papáč, 2010), Orange circle – Ošljak Mountain – OŠ (Koledin & Bogojević, 1976), Blue circles – Šar Planina Mountain – ŠP (Koledin & Bogojević, 1976).

The identification of Collembola relies on the known keys for European springtails in the collected literature. Classification of the taxa as well as a nomenclature used, almost entirely follows the information collected by the International Collembology Community at www.collembola.org (Bellinger et al., 1996–2022), so the nomenclature used in the sources has been adapted. Species within genera are arranged alphabetically. The UTM map of Serbia marks the areas where Collembola has been explored so far, and which are included in this paper (Fig. 1).

## RESULTS

Based on the literature data, 119 species of springtails were found on the territory of the Autonomous Province of Kosovo and Metohija (Table 1). The highest frequency percentage of species belonged to the order Entomobryomorpha (46%), and order Poduromorpha (34%) respectively (Fig. 2). The nomenclature in the works of Jakšić (2013) and Koledin and Bogojević (1976) was revised in this work. In both cases, the localities of species *Bourletiella repanda* Agren, 1903 were added to the localities of species *Deuterosminthurus pallipes* Bourlet, 1843 as these are the same species according to Bellinger et al. (1996–2022). From Jakšić (2013), the localities of species *Entomobrya bimaculata* Stach, 1963 were added to the localities of species *Entomobrya nicoleti* Lubbock, 1870 as these are the same species according to Bellinger et al. (1996–2022). When merging the locality sites, there was no overlap.

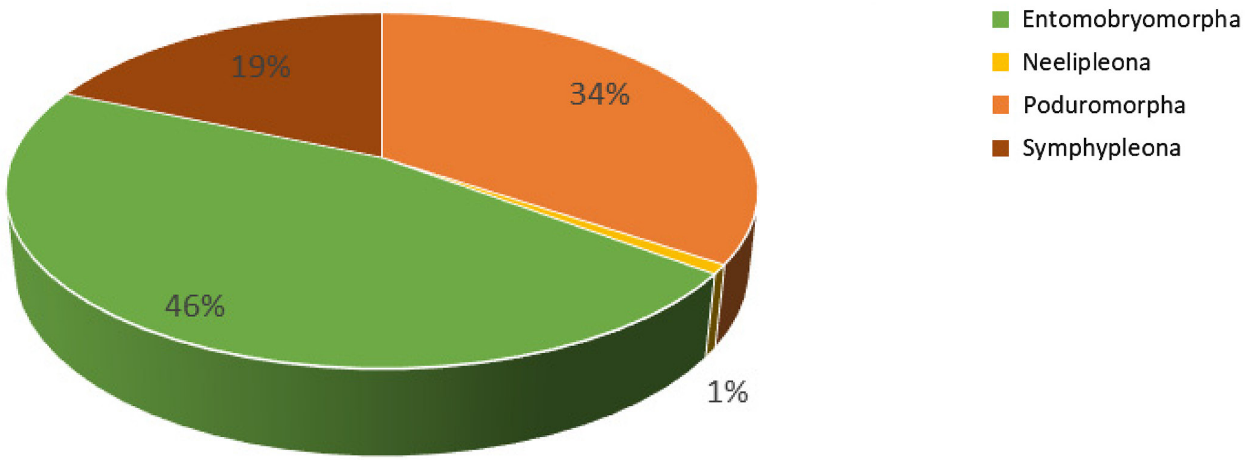


**Figure 2.** The frequency percentage of the different species of Collembola for each order on the territory of Kosovo and Metohija.

*Taxonomic Hierarchy*

**Phylum Arthropoda Latreille, 1829**

**Superclassis Hexapoda Blainville, 1816**

**Classis Collembola Lubbock, 1871**

**Table 1.** Checklist of the Collembola of Autonomous Province, Kosovo and Metohija, Serbia.

| | KM | ŠP | OŠ | PK |
|---|---|---|---|---|
| ORDER **PODUROMORPHA** Börner, 1913 | | | | |
| SUPERFAMILIY **PODUROIDEA** Latreille, 1804 | | | | |
| FAMILIY **PODURIDAE** Latreille, 1804 | | | | |
| Genus ***PODURA*** Linnæus, 1758 | | | | |
| 1. *Podura aquatica* Linnaeus, 1758 | + | - | - | - |
| SUPERFAMILY **HYPOGASTRUROIDEA** Börner, 1906 | | | | |
| FAMILIY **HYPOGASTRURIDAE** Börner, 1906 | | | | |
| Genus ***CERATOPHYSELLA*** Börner, 1932 | | | | |
| 2. *Ceratophysella armata* (Nicolet, 1842) | + | + | + | - |
| 3. *Ceratophysella bengtssoni* (Ågren,1904) | + | - | - | - |
| 4. *Ceratophysella granulata* Stach, 1949 | - | + | + | - |
| Genus ***CHOREUTINULA*** Paclt, 1944 | | | | |
| 5. *Choreutinula inermis* (Tullberg, 1871) | - | - | + | - |
| Genus ***HYPOGASTRURA*** Bourlet, 1839 | | | | |
| 6. *Hypogastrura distincta* (Axelson, 1902) | + | - | - | - |
| 7. *Hypogastrura crassaegranulata* (Stach, 1949) | - | + | - | - |
| 8. *Hypogastrura manubrialis* (Tullberg, 1869) | + | - | - | - |
| 9. *Hypogastrura sigillata* (Uzel, 1891) | + | + | - | - |
| 10. *Hypogastrura viatica* (Tullberg, 1872) | + | - | - | - |
| Genus ***MICROGASTRURA*** Stach, 1922 | | | | |
| 11. *Microgastrura duodecimoculata* Stach, 1922 | - | + | - | - |
| Genus ***WILLEMIA*** Börner, 1901 | | | | |

**Table 1. Continued.**

| | KM | ŠP | OŠ | PK |
|---|---|---|---|---|
| 12. *Willemia anophthalma* Börner, 1901 | - | + | - | - |
| Genus ***XENYLLA*** Tullberg, 1869 | | | | |
| 13. *Xenylla acauda* Gisin, 1947 | + | - | - | - |
| 14. *Xenylla brevicauda* Tullberg, 1869 | - | + | + | - |
| 15. *Xenylla maritima* Tullberg, 1869 | + | - | + | - |
| 16. *Xenylla schillei* Börner, 1903 | - | - | + | - |
| SUPERFAMILIY **ONYCHIUROIDEA** Börner, 1901 | | | | |
| FAMILIY **ONYCHIURIDAE** Börner, 1901 | | | | |
| Genus ***AGRAPHORURA*** Pomorski, 1998 | | | | |
| 17. *Agraphorura naglitschi* (Gisin, 1960) | + | - | - | - |
| Genus ***HYMENAPHORURA*** Bagnall, 1948 | | | | |
| 18. *Hymenaphorura alticola* (Bagnall, 1935) | + | - | - | - |
| Genus ***KALAPHORURA*** Absolon, 1901 | | | | |
| 19. *Kalaphorura burmeisteri* (Lubbock, 1873) | + | + | - | - |
| Genus ***PROTAPHORURA*** Absolon, 1901 | | | | |
| 20. *Protaphorura armata* (Tullberg, 1869) | + | - | - | - |
| 21. *Protaphorura cancellata* (Gisin, 1956) | + | - | + | - |
| 22. *Protaphorura fimata* (Gisin, 1952) | + | + | - | - |
| 23. *Protaphorura glebata* (Gisin, 1952) | - | - | + | - |
| 24. *Protaphorura meridiata* (Gisin, 1952) | - | - | + | - |
| Genus ***TETRODONTOPHORA*** Reuter, 1882 | | | | |
| 25. *Tetrodontophora bielanensis* (Waga, 1842) | - | + | - | - |
| Genus ***THALASSAPHORURA*** Bagnall, 1949 | | | | |
| 26. *Thalassaphorura zschokkei* (Handschin, 1919) | + | + | + | - |
| FAMILIY **TULLBERGIIDAE** Bagnall, 1935 | | | | |
| Genus ***MESAPHORURA*** Börner, 1901 | | | | |
| 27. *Mesaphorura krausbaueri* Börner, 1901 | + | - | + | - |
| Genus ***METAPHORURA*** Bagnall, 1936 | | | | |
| 28. *Metaphorura affinis* (Börner, 1902) | + | - | + | - |
| Genus ***NEONAPHORURA*** Bagnall, 1935 | | | | |
| 29. *Neonaphorura sp.* | + | - | - | - |
| Genus ***PARATULLBERGIA*** Womersley, 1930 | | | | |
| 30. *Paratullbergia callipygos* (Börner, 1902) | + | - | - | - |
| Genus ***TULLBERGIA*** Lubbock, 1876 | | | | |
| 31. *Tullbergia sp.* | + | - | - | - |
| SUPERFAMILIY **NEANUROIDEA** Börner, 1901 | | | | |
| FAMILIY **NEANURIDAE** Börner, 1901 | | | | |
| Genus ***ANURIDA*** Laboulbène, 1865 | | | | |
| 32. *Anurida maritima* (Guérin-Méneville, 1836) | + | - | - | - |
| Genus ***BILOBELLA*** Caroli, 1912 | | | | |
| 33. *Bilobella aurantiaca* (Caroli, 1912) | - | - | + | - |
| Genus ***ENDONURA*** Cassagnau, 1979 | | | | |

**Table 1. Continued.**

| | KM | ŠP | OŠ | PK |
|---|---|---|---|---|
| 34. *Endonura cantabrica* (Deharveng, 1979) | + | - | - | - |
| Genus ***FRIESEA*** von Dalla Torre, 1895 | | | | |
| 35. *Friesea mirabilis* (Tullberg, 1871) | + | + | + | - |
| Genus ***IMPARITUBERCULA*** Stach, 1951 | | | | |
| 36. *Imparitubercula villosa* (Kos, 1940) | + | - | - | - |
| Genus ***NEANURA*** MacGillivray, 1893 | | | | |
| 37. *Neanura muscorum* (Templeton, 1836) | + | - | - | - |
| Genus ***PSEUDACHORUTES*** Tullberg, 1871 | | | | |
| 38. *Pseudachorutes dubius* Krausbauer, 1898 | - | - | + | - |
| 39. *Pseudachorutes parvulus* Börner, 1901 | - | - | + | - |
| Genus ***PSEUDACHORUTELLA*** Stach, 1949 | | | | |
| 40. *Pseudachorutella asigillata* (Börner, 1901) | - | + | + | - |
| Genus ***THAUMANURA*** Börner, 1932 | | | | |
| 41. *Thaumanura carolii* (Stach, 1920) | + | - | - | - |
| ORDER **ENTOMOBRYOMORPHA** Börner, 1913 | | | | |
| SUPERFAMILIY **ISOTOMOIDEA** Schäffer, 1896 | | | | |
| FAMILIY **ISOTOMIDAE** Schäffer, 1896 | | | | |
| Genus ***AGRENIA*** Börner, 1906 | | | | |
| 42. *Agrenia bidenticulata* (Tullberg, 1877) | + | - | - | - |
| Genus ***ANUROPHORUS*** Nicolet, 1842 | | | | |
| 43. *Anurophorus laricis* Nicolet, 1842 | - | - | + | - |
| Genus ***DESORIA*** Agassiz & Nicolet, 1841 | | | | |
| 44. *Desoria canadensis* (Brown, 1932) | + | - | - | - |
| 45. *Desoria olivacea* (Tullberg, 1871) | + | - | - | - |
| 46. *Desoria violacea* (Tullberg, 1877) | + | + | - | - |
| Genus ***FOLSOMIA*** Willem, 1902 | | | | |
| 47. *Folsomia decemoculata* Stach, 1946 | + | - | - | - |
| 48. *Folsomia diplophthalma* (Axelson, 1902) | - | - | + | - |
| 49. *Folsomia inoculata* Stach, 1946 | + | | + | - |
| 50. *Folsomia manolachei* Bagnall, 1939 | + | + | - | - |
| 51. *Folsomia quadrioculata* (Tullberg, 1871) | - | + | + | - |
| 52. *Folsomia similis* Bagnall, 1939 | + | - | - | - |
| Genus ***ISOTOMA*** Bourlet, 1839 | | | | |
| 53. *Isotoma riparia* Nicolet, 1842 | + | - | - | - |
| 54. *Isotoma viridis* Bourlet, 1839 | + | + | + | - |
| Genus ***ISOTOMURUS*** Börner, 1903 | | | | |
| 55. *Isotomurus fucicolus* (Schött, 1893) | + | - | - | - |
| 56. *Isotomurus graminis* Fjellberg, 2007 | + | - | - | - |
| 57. *Isotomurus nebulosus* Lek & Carapelli, 1998 | + | - | - | - |
| Genus ***ISOTOMIELLA*** Bagnall, 1939 | | | | |
| 58. *Isotomiella minor* (Schäffer, 1896) | + | + | + | - |
| Genus ***PARISOTOMA*** Bagnall, 1940 | | | | |

**Table 1. Continued.**

| | KM | ŠP | OŠ | PK |
|---|---|---|---|---|
| 59. *Parisotoma notabilis* (Schäffer, 1896) | + | + | + | - |
| Genus ***PSEUDISOTOMA*** Handschin, 1924 | | | | |
| 60. *Pseudisotoma monochaeta* (Kos, 1942) | + | + | + | - |
| Genus ***TETRACANTHELLA*** Schött, 1891 | | | | |
| 61. *Tetracanthella transylvanica* Cassagnau, 1960 | - | - | + | - |
| Genus ***VERTAGOPUS*** Börner, 1906 | | | | |
| 62. *Vertagopus arboreus* (Linneus, 1758) | + | - | - | - |
| SUPERFAMILIY **ENTOMOBRYOIDEA** Schäffer, 1896 | | | | |
| FAMILIY **ENTOMOBRYIDAE** Schäffer, 1896 | | | | |
| Genus ***ENTOMOBRYA*** Rondani, 1861 | | | | |
| 63. *Entomobrya albanica* Stach, 1922 | + | - | - | - |
| 64. *Entomobrya arborea* (Tullberg, 1871) | + | - | - | - |
| 65. *Entomobrya elegans* Stach, 1963 | + | - | - | - |
| 66. *Entomobrya handschini* Stach, 1922 | + | - | + | - |
| 67. *Entomobrya lanuginosa* (Nicolet, 1842) | - | - | + | - |
| 68. *Entomobrya multifasciata* (Tullberg, 1871) | + | - | - | - |
| 69. *Entomobrya muscorum* (Nicolet, 1842) | + | - | - | - |
| 70. *Entomobrya nicoleti* (Lubbock, 1870) | + | - | - | - |
| 71. *Entomobrya nigriventris* Stach, 1930 | + | - | - | - |
| 72. *Entomobrya nivalis* (Linnæus, 1758) | + | - | - | - |
| 73. *Entomobrya quinquelineata* Börner, 1901 | + | - | - | - |
| Genus ***ENTOMOBRYOIDES*** Maynard, 1951 | | | | |
| 74. *Entomobryoides* sp. | + | - | - | - |
| Genus ***COECOBRYA*** Yosii, 1956 | | | | |
| 75. *Coecobrya caeca* (Schött, 1896) | + | - | - | - |
| Genus ***LEPIDOCYRTUS*** Bourlet, 1839 | | | | |
| 76. *Lepidocyrtus curvicollis* Bourlet, 1839 | + | - | - | - |
| 77. *Lepidocyrtus cyaneus* Tullberg, 1871 | + | + | + | - |
| 78. *Lepidocyrtus lanuginosus* (Gmelin, 1790) | - | - | + | - |
| 79. *Lepidocyrtus violaceus* (Geoffroy, 1762) | + | - | - | - |
| Genus ***PSEUDOSINELLA*** Schäffer, 1897 | | | | |
| 80. *Pseudosinella alba* (Packard, 1873) | + | - | - | - |
| 81. *Pseudosinella duodecimocellata* Handschin, 1928 | + | - | - | - |
| Genus ***PRODREPANURA*** Stach, 1963 | | | | |
| 82. *Prodrepanura musatica* (Stach, 1935) | + | - | - | - |
| Genus ***WILLOWSIA*** Shoebotham, 1917 | | | | |
| 83. *Willowsia platani* (Nicolet, 1842) | + | - | - | - |
| FAMILIY **PARONELLIDAE** Börner, 1906 | | | | |
| Genus ***CYPHODERUS*** Nicolet, 1842 | | | | |
| 84. *Cyphoderus bidenticulatus* (Parona, 1888) | + | - | - | - |
| FAMILIY **ORCHESELLIDAE** Börner, 1906 | | | | |
| Genus ***ORCHESELLA*** Templeton, 1836 | | | | |
| 85. *Orchesella balcanica* Stach, 1960 | + | + | + | - |

**Table 1. Continued.**

| | KM | ŠP | OŠ | PK |
|---|---|---|---|---|
| 86. *Orchesella bulba* Christiansen & Tucker, 1977 | + | - | - | - |
| 87. *Orchesella capillata* Kos, 1936 | - | - | + | - |
| 88. *Orchesella flavescens* (Bourlet, 1839) | + | - | - | - |
| 89. *Orchesella villosa* (Geoffroy, 1764) | + | - | - | - |
| Genus ***HETEROMURUS*** Wankel, 1860 | | | | |
| 90. *Heteromurus major* (Moniez, 1889) | + | - | - | - |
| 91. *Heteromurus nitidus* (Templeton, 1836) | + | - | - | - |
| SUPERFAMILIY **TOMOCEROIDEA** Schäffer, 1896 | | | | |
| FAMILIY **TOMOCERIDAE** Schäffer, 1896 | | | | |
| Genus ***POGONOGNATHELLUS*** Paclt, 1944 | | | | |
| 92. *Pogonognathellus flavescens* (Tullberg, 1871) | - | + | + | - |
| 93. *Pogonognathellus longicornis* (Müller, 1776) | - | + | - | - |
| Genus ***TOMOCERUS*** Nicolet, 1842 | | | | |
| 94. *Tomocerus minor* (Lubbock, 1862) | + | + | + | - |
| 95. *Tomocerus vulgaris* (Tullberg, 1871) | + | - | - | - |
| Genus ***TRITOMURUS*** Frauenfeld, 1854 | | | | |
| 96. *Tritomurus terrestralis* Stach, 1922 | + | - | - | - |
| ORDER **NEELIPLEONA** Massoud, 1971 | | | | |
| FAMILIY **NEELIDAE** Folsom, 1896 | | | | |
| Genus ***NEELUS*** Folsom, 1896 | | | | |
| 97. *Neelus klisurensis* Kovác & Papác, 2010 | - | - | - | + |
| ORDER **SYMPHYPLEONA** Börner, 1901 | | | | |
| SUPERFAMILIY **KATIANNOIDEA** Börner, 1913 | | | | |
| FAMILIY **ARRHOPALITIDAE** Stach, 1956 | | | | |
| Genus ***ARRHOPALITES*** Börner, 1906 | | | | |
| 98. *Arrhopalites acanthophthalmus* Gisin, 1958 | + | - | - | - |
| Genus ***PYGMARRHOPALITES*** Vargovitsh, 2009 | | | | |
| 99. *Pygmarrhopalites principalis* (Stach, 1945) | + | - | - | - |
| 100. *Pygmarrhopalites sericus* (Gisin, 1947) | + | - | - | - |
| 101. *Pygmarrhopalites terricola* (Gisin, 1958) | + | + | - | - |
| FAMILIY **KATIANNIDAE** Börner, 1913 | | | | |
| Genus ***SMINTHURINUS*** Börner, 1901 | | | | |
| 102. *Sminthurinus aureus* (Lubbock, 1862) | + | + | + | - |
| 103. *Sminthurinus elegans* (Fitch, 1862) | + | - | - | - |
| 104. *Sminthurinus niger* (Lubbock, 1862) | + | - | + | - |
| SUPERFAMILIY **SMINTHUROIDEA** Lubbock, 1862 | | | | |
| FAMILIY **SMINTHURIDAE** Lubbock, 1862 | | | | |
| Genus ***ALLACMA*** Borner, 1906 | | | | |
| 105. *Allacma fusca* (Linnaeus, 1758) | + | - | - | - |
| 106. *Allacma gallica* (Carl, 1899) | + | - | - | - |
| Genus ***CAPRAINEA*** Dallai, 1970 | | | | |
| 107. *Caprainea bremondi* (Delamare Deboutteville & Bassot, 1957) | + | - | - | - |
| 108. *Caprainea marginata* (Schött, 1893) | + | + | - | - |

**Table 1. Continued.**

| | KM | ŠP | OŠ | PK |
|---|---|---|---|---|
| Genus ***SPATULOSMINTHURUS*** Betsch & Betsch-Pinot, 1984 | | | | |
| 109. *Spatulosminthurus flaviceps* (Tullberg, 1871) | - | + | - | - |
| Genus ***LIPOTHRIX*** Börner, 1906 | | | | |
| 110. *Lipothrix lubbocki* (Tullberg, 1872) | - | + | - | - |
| FAMILIY **BOURLETIELLIDAE** Börner, 1913 | | | | |
| Genus ***BOURLETIELLA*** Banks, 1899 | | | | |
| 111. *Bourletiella viridescens* Stach, 1920 | + | + | + | - |
| Genus ***DEUTEROSMINTHURUS*** Börner, 1901 | | | | |
| 112. *Deuterosminthurus pallipes* (Bourlet, 1843) | + | + | + | - |
| 113. *Deuterosminthurus bicinctus* (Koch, 1840) | - | + | - | - |
| Genus ***HETEROSMINTHURUS*** Stach, 1955 | | | | |
| 114. *Heterosminthurus novemlineatus* (Tullberg, 1871) | + | - | - | - |
| Genus ***PSEUDOBOURLETIELLA*** Stach, 1956 | | | | |
| 115. *Pseudobourletiella spinata* (MacGillivray, 1893) | + | - | - | - |
| SUPERFAMILIY **DICYRTOMOIDEA** Börner, 1906 | | | | |
| FAMILIY **DICYRTOMIDAE** Börner, 1906 | | | | |
| Genus ***DICYRTOMA*** Bourlet, 1842 | | | | |
| 116. *Dicyrtoma fusca* Lubbock, 1873 | + | + | + | - |
| Genus ***DICYRTOMINA*** Börner, 1903 | | | | |
| 117. *Dicyrtomina minuta* (Fabricius, 1783) | + | - | - | - |
| 118. *Dicyrtomina ornata* (Nicolet, 1842) | + | - | - | - |
| 119. *Dicyrtomina saundersi* (Lubbock, 1862) | + | - | - | - |

## DISCUSSION

In conclusion, 119 species of springtails in 10 superfamilies and 16 families, and also 65 genera were recorded on the territory of the Autonomous Province of Kosovo and Metohija (Serbia). Representatives of all four recent orders of Collembola are present. The order with the most species is Entomobryomorpha with 55 species, while the order Neelipleona has only one representative - endemic cave species *Neelus klisurensis* found in the aphotic zone of the cave in Velika Klisura at the foot of Prokletije mountains. The family with the most species is Entomobryidae Schäffer, 1896 with 21 species, while the most scarce families are Poduridae, Paronellidae and Neelidae with one representative each. The family with the most genera is Isotomidae with a total of 11 genera. The genus *Entomobrya* Rondani, 1861 is the genus with the most species, with a total of 11 species. Considering that only two local surveys were conducted and that two samples were random, a total number of 119 species is significant. By comparison, the checklist of Iranian Collembola includes 232 species in a territory about 150 times larger than the territory of Kosovo and Metohija (Shayanmehr et al., 2020). In relation to neighbouring countries, the Hungarian checklist, which is 8.5 times larger in area, has 414 species (Dányi & Traser, 2008). A checklist of the springtails (Collembola) of Romania is presented with 338 species in a territory about 22 times larger than our investigated area (Fiera, 2007).

The order Neelipleona is the smallest in the number of species, so a small number of species was expected (Schneider, 2017). This correlates with most checklist of Collembola (Fiera, 2007; Dányi & Traser, 2008; Buşmachiu, 2010; Sevgili & Özata, 2014; Babenko et al., 2019; Brahim-Bounab et al., 2020; Shayanmehr et al., 2020; Abdul-Rassoul, 2021; Arbea, 2021). Some of the possible reasons why no representative of this order was found in earlier research in Kosovo and Metohija are possible errors at the time of separation (due to the small size of these species), lack of proper identification keys, or simply the very biology of the species of this order.

The fauna of the springtails of Kosovo and Metohija has been poorly studied, although a great diversity and high endemism can be expected in this territory, especially in the unexplored caves and gorges. As was previously mentioned, ecology-related factors have a significant impact on the composition and structure of the Collembola communities (Paul et al., 2011; Rendoš et al., 2016; Pollierer & Scheu, 2017; Vincent et al., 2018; Potapov et al., 2020; Suhadi et al., 2020; Herta et al., 2021). In this regard, climate changes represent a strong selective pressure on the Collembola communities, giving a big significance to their research on this territory in the aspect of conservation biology.

There are several studies on the responses of soil arthropod communities to climate change that use Collembola as a model group (Alatalo et al., 2015; Yan et al., 2015; Daghighi et al., 2017). The successional dynamics of Collembola communities on a rubble and debris dump in Bremen, Germany were studied between 1980 and 2000 and it was turned out to be correlated with temporal shifts of species between early and late years of succession, but are also significantly influenced by soil temperature (Daghighi et al., 2017). The area of Kosovo and Metohija is contaminated by industrial landfills as a consequence of long-term exposure to heavy metal industry and other chemical industries. In this aspect, it would be interesting to observe differences among communities located in clean and polluted environments. By monitoring changes in the composition and structure of springtails communities, we can monitor the recovery of rehabilitated landfills as well. Research in the northern part of the province has shown specifics in terms of distribution, community composition and abundance of certain species in relation to sources of pollution (Jakšić, 2013).

Finally, the Balkan Peninsula lying at the crossroads of Europe and Asia are also renowned as a focus of Pleistocene glacial refugia (Griffiths et al., 2004). The area of Kosovo and Metohija is located in the central part of the Balkan Peninsula, which is one of the world's centers of biodiversity, as well as the former refugee, due to socio-political situations has not received the proper attention. This review can be a starting point and impetus for future studies on the Collembola fauna of Kosovo and Metohija province.

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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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# چک‌لیست گونه‌های دم‌فنری‌ها (Hexapoda, Collembola) از استان‌های کوزوو و متوهیا، جمهوری صربستان

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**چکیــده:** هنوز راه زیادی تا تکمیل اطلاعات مربوط به تنوع دم‌فنری‌ها، به‌ویژه در کشور صربستان باقی‌مانده است. این مقاله به جمع‌بندی اطلاعات کل گونه‌های شناسایی شده دم‌فنری‌ها در نواحی دو استان کوزوو و متوهیا می‌پردازد. فهرست تهیه شده شامل نام ۱۱۹ گونه از دم‌فنری‌ها متعلق به ۶۵ جنس، ۱۶ خانواده و ۴ راسته است. بنابراین از هر ۴ راسته این گروه گونه‌هایی در این فهرست وجود دارند. راسته Entomobryomorpha بزرگترین گروه و شامل ۵۵ گونه است، در حالی‌که از راسته Neelipleona تنها یک گونه غارزی به نام *Neelus klisurensis* Kovác et Papác, 2010 گزارش شده است. این گونه از ناحیه آفوتیک غار در منطقه ولیکا کلیسورا در دامنه کوهستان پروکلتیا جمع‌آوری شده است. خانواده Entomobryidae دارای بیشترین تعداد گونه (۲۱) بوده، در حالی‌که خانواده‌های Poduridae، Paronellidae و Neelidae هر یک تنها دارای یک گونه در این مناطق هستند. خانواده Isotomidae دارای بیشترین تعداد جنس (۱۱) می‌باشد. در بین جنس‌های مختلف بیشترین تعداد گونه (۱۱) در جنس *Entomobrya* Rondani قرار دارند. فون دم‌فنری‌های کوزوو و متوهیا به خوبی بررسی نشده، با این حال انتظار می‌رود سطح بالایی از تنوع گونه‌ای و گونه‌های داخلی به‌ویژه در غارها و درّه‌های بررسی نشده یافت شود. مطالعه دم‌فنری‌ها از جنبه‌های مختلف دارای اهمیت است. در این تحقیق سعی شده تا اطلاعات مربوط به فون شناخته شده کوزوو و متوهیا به عنوان نقطه شروعی برای تحقیقاتی بعدی روی دم‌فنری‌های این منطقه، گردآوری شوند.

**واژگـان کلیدی:** چک‌لیست، دم‌فنری‌ها، گونه، تنوع، صربستان.