CONTRIBUTIONS TO THE KNOWLEDGE ON SOME INVERTEBRATES FROM THE COBÎLENI NATURE RESERVE, REPUBLIC OF MOLDOVA

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Abstract. The paper includes first data about the species diversity of Collembola and Coleoptera from the Cobîleni Nature Reserve**,** Republic of Moldova. A total number of 52 invertebrate species were revealed, of which 35 Collembola and 17 Coleoptera species. From the last, two rare and protected species – *Lucanus cervus* and *Oryctes nasicornis* – stand out. Revealed invertebrates are associated with the xerothermic ecosystem and have in general a wide geographic occurrence. One species of Collembola – *Sminthurus multipunctatus* is new for the Republic of Moldova. In the pine plantation, one Coleoptera species – *Rhagium inquisitor* – was revealed, which is considered harmful.

Keywords: Collembola, Coleoptera, new record, Reserve, Republic of Moldova.

Rezumat. Contribuții la cunoașterea unor nevertebrate din Rezervația Naturală Cobîleni, Republica Moldova. Lucrarea prezintă primele date faunistice și ecologice privind diversitatea colembolelor și coleopterelor din Rezervația Naturală „Cobâleni". În total au fost identificate 52 de specii, dintre care 35 de colembole și 17 de coleoptere. Din ultimul grup, două specii – *Lucanus cervus* și *Oryctes nasicornis* sunt rare și protejate. Nevertebratele identificate sunt asociate, în general, cu ecosisteme uscate și au o distrubuție geografică largă. O specie de colembole – *Sminthurus multipunctatus* este nouă pentru fauna Republicii Moldova. În plantația de pin a fost identificată o specie de coleoptere – *Rhagium inquisitor*, considerată ca dăunătoare.

Cuvinte cheie: Collembola, Coleoptera, date noi, Rezervație, Republica Moldova.

INTRODUCTION

There are 51 forest Nature Reserves on the territory of the Republic of Moldova, occupying an area of 5001 ha. One of them is the Cobîleni Nature Reserve (47°30'48"N, 29°01'32"E) with a surface of 33.5 ha, situated 3 km north to the Lopatna village, Orhei district, on the right bank of the Dniester River, with hills and terraces at 40-160 m height. This territory has been protected by the state since 1975, and in 1998 it has been included in the list of protected natural areas according to Law nr. 1538 as the Cobîleni Nature Reserve (POSTOLACHE & LAZU, 2018).

The flora of the Cobîleni Nature Reserve is well known, but the fauna of invertebrates, especially Collembola and Coleoptera remains poorly studied. The reserve includes patches of flooded meadows, natural forests based on oak, mixed forests and plantations on the limestone rocks located on the steep slopes with 15-35º with an eastern exposure located on the right bank of the Dniester River. In some places, the rains expose the soil, forming ravines of different sizes, there are places with bare rocks. The soil is superficial, of the rendzina type. The Reserve is assigned to category IV Habitat/Species Management Area according to the International Union for Conservation of Nature (IUCN).

The present study provides the first report regarding the species diversity of Collembola and Coleoptera from the Cobîleni Nature Reserve from the Republic of Moldova in which these groups have not been studied to date. The objective of the present study was to investigate the species of Collembola and Coleoptera collected in decomposed wood and moss and their ecological preference.

MATERIAL AND METHODS

The study area. The Cobîleni Nature Reserve includes flooded meadows, mixed forests and calcareous rocks covered by moss, specific to the steep slopes of the Dniester River. The rocky forest specific to the steep slopes of the Dniester Valley is dominated by *Quercus robur* and as subdominant being *Fraxinus excelsior*. Around the natural forest there are 40 year-old trees of *Pinus sylvestris* and *P. nigra* plantation. Also, the reserve includes a section of steppe vegetation. Near the water edge, alder (*Alnus glutinosa*) grows frequently and dominates such bushes as Cornelian cherry (*Cornus mas*), wayfarer (*Viburnum lantana*), European smoketree (*Cotinus coggygria*) and bladdernuts (*Staphylea pinnata*). The limestone cliffs are covered with many species of moss, lichens and ferns, which form a mosaic similar to mountainous areas (BEGU & BEGU, 2005) (Figure 1).

Collection of materials. The invertebrates were collected from the litter, wood decompose and moss of the Cobîleni Nature Reserve in February 2020, May 2021 and February 2022. The list of species and number of specimens are included.

Collembola were extracted from the litter, moss and wood, using the modified flotation method according to BUŞMACHIU et al. (2015). The specimens were fixed in 96% ethyl alcohol, sorted under binocular Meiji Techno, cleared in lactic acid and KOH and mounted on permanent slides using Marc André II solution. The specimens were identified at the species level using the LEICA 2500 phase contrast microscope and the following major taxonomical sources: FJELLBERG (1998), POTAPOV (2001) and JORDANA (2012). The distribution of species is presented according to the Fauna Europaea and FJELLBERG (1998, 2007). Photo of collembola species was made using the

BEL Eurekam 5 Plus camera, from the Laboratory of Entomology. Species that are new for the fauna of the Republic of Moldova is marked in Table 1 with an asterisk (*).

Coleoptera were collected manually from standing dry or cut stumps of oak and ash trees in different stages of decomposition. Some insect species were found and collected by hand under the bark of the felled and dry trees of *Pinus sylvestris* and *P. nigra*. Small beetles from Staphylinidae family were extracted from substrate using modified flotation method according to BUŞMACHIU et al. (2015).

Collected specimens of Coleoptera were mortified in alcohol, cleaned of impurities and mounted. The taxonomic identification of beetle species were performed using MBS-10 and some modern keys by GÎDEI & POPESCU (2012, 2014) and KRYZHANOVSKIJ (1965).

Figure 1. Location of Cobîleni Nature Reserve and its relief (Google Earth, accessed March 18, 2022) (http://www.maplandia.com/moldova/orhei/lopatna).

RESULTS AND DISCUSSIONS

As a result of investigation in the Cobîleni Nature Reserve, a total number of 52 species of invertebrates from two classes, 42 genera and 21 families were revealed. Brief information regarding the numbers of individuals, ecological traits and biogeographic distribution is presented for each species (Table 1).

Altogether, 403 individuals of Collembola belonging to 35 species, 24 genera and 11 families were found in moss and decomposed wood of the studied habitats. One species – *Sminthurus multipunctatus* Schäffer, 1896 is new for the fauna of the Republic of Moldova (Photo 1).

The Entomobryidae family was represented by 11 species, followed by the families Tullbergiidae – 5 species, Isotomiodae and Hypogastruridae – 4 species each, Katiannidae – 3, Neaniridae and Onychiuridae – 2 species each. Four families – Tomocedidae, Sminthurididae, Neelidae and Sminthuridae – were represented by one species each (Table 1).

The first study concerning collembolan fauna of canyons located along the Dniester River near the localities Lalova, Țipova, Saharna, Vîșcăuți and Butuceni recorded 56 species (BUŞMACHIU, 2011). In 2015 (BUŞMACHIU et al., 2015) cited a total 98 species from the 49 genera and 15 families, collected in five studied calcareous canyons of the Republic of Moldova.

The Cobîleni Natural Reserve, located on the bank of the Dniester River, has similar ecological settings to the calcareous canyons covered by natural forests, but here only 35 Collembola species were found, almost half of the number of species identified in the Vîșcăuți canyon, where 63 species were recorded (BUŞMACHIU et al., 2015). The small number of identified species can be explained by the predominant study of moss and decomposed wood, a fact confirmed by the proportion of life forms dominated by 17 epiedaphic, followed by 10 hemiedaphic and only 8 euedaphic collembolan species.

The studied habitats of the Cobîleni Nature Reserve revealed the large portions of xerophylic and xerothermophylic species, followed by mesophylic and only two higrophylic species. Most of the revealed species prefer forest and forest – grassland (12), only grassland (6), while the others are eurytopic (Table 1).

Most species have a wide geographic occurrence, namely European (34.3%), Palaearctic (25.7%), Cosmopolitan (17.1%) and Holarctic species (11.4%). Two species have a Mediterranean distribution range and one species *Neanura moldavica* has a range limited to Moldova. In the papers published by BUŞMACHIU (2021) and BUŞMACHIU & WEINER (2021) a total of 271 collembolan species were cited in the country and, with the newly identified species, the number has increased to 272.

Table 1. Collembola species from the Cobîleni Nature Reserve with overall numbers of individuals collected, ecological traits and biogeographic distribution (BD).

Taxa (Family/Species)	Nr. ind.	Ecological traits	BD
Hypogastruridae family			
Hypogastrura sp.	33	epiedaphic	-
Xenylla boerneri Axelson, 1905	1	epiedaphic, briophil, in forest	Palaearctic
Xenylla brevicauda Tullberg, 1869	14	epiedaphic, briophil, in forest	Palaearctic
Xenylla brevisimilis brevisimilis Stach, 1949	1	epiedaphic, meso-thermophilic, in forest	Mediterranean
Neanuridae family			
Neanura moldavica Buşmachiu & Deharveng, 2008	2	hemiedaphic, mesophilic, in forest	Endemic
Micranurida pygmaea Börner, 1901	1	hemiedaphic, higrophilic, eurytopic	Holarctic
Onychiuridae family			
Protaphorura cancellata (Gisin, 1956)	14	euedaphic, in forest	European
Protaphorura sakatoi (Yosii, 1966)	23	euedaphic, xerothermophilic, eurytopic	European
Tullbergiidae family			
Doutnacia xerophila Rusek, 1974	1	euedaphic, xerothermophilic, eurytopic	European
Jevania weinerae Rusek, 1978	5	euedaphic, in forest	European
Mesaphorura critica Ellis, 1976	14	euedaphic, mesophilic, eurytopic	Palaearctic
Mesaphorura hylophila Rusek, 1982	4	euedaphic, eurytopic	European
Mesaphorura krausbaueri Börner, 1901	24	euedaphic, eurytopic	Palaearctic
Isotomidae family			
Folsomides angularis (Axelson, 1905)	27	hemiedaphic, xerothermophilic, forest-grassland	Holarctic
Parisotoma notabilis (Schäffer, 1896)	42	hemiedaphic, mesophilic, eurytopic	Cosmopolit
Isotoma viridis Bourlet, 1839	10	epiedaphic, mesophilic, eurytopic	Holarctic
Vertagopus cinereus (Nicolet, 1841)	8	epiedaphic, in forest	Palaearctic
Entomobryidae family			
Heteromurus major (Moniez, 1889)	19	hemiedaphic, mesophilic, eurytopic	Mediterranean
Entomobrya multifasciata (Tullberg, 1871)	2	epiedaphic, xerothermophilic, eurytopic	Cosmopolit
Entomobrya nigrocincta Denis, 1923	9	epiedaphic, mesophilic, grassland	European
Lepidocyrtus lignorum (Fabricius, 1775)	70	epiedaphic, meso-higrophilic, grassland	Palaearctic
Orchesella multifasciata Stscherbakow, 1898	59	epiedaphic, xerophilic, forest-grassland	European
Orchesella orientalis Stach, 1960	7	epiedaphic, xerothermophilic, grassland	European
Orchesella xerothermica Stach, 1960	5	epiedaphic, xerothermophilic, in forest	European
Pseudosinella horaki Rusek, 1985	2	hemiedaphic, xerothermophilic, forest-grassland	European
Pseudosinella moldavica Gama & Buşmachiu, 2002	3	hemiedaphic, thermophilic, grassland	European
Pseudosinella ocopunctata Börner, 1901	1	hemiedaphic, xerothermophilic, grassland	Cosmopolit
Willowsia nigromaculata (Lubbock, 1873)	7	epieraphic, mesophilic, eurytopic	Cosmopolit
Tomoceridae family			
Tomocerus vulgaris (Tullberg, 1871)	2	Hemiedaphic, mesophilic, in forest	Holarctic
Sminthurididae family			
Sphaeridia pumilis (Krausbauer, 1898)	7	hemiedaphic, mesophilic, eurytopic	Cosmopolit
Neelidae family			
Neelus murinus Folsom, 1896	8	euedaphic, mesophilic, eurytopic	Cosmopolit
Katiannidae family			
Gisinianus flammeolus (Gisin, 1957)	6	epiedaphic, fores-grassland	Palaearctic
Sminthurinus elegans (Fitch, 1863)	4	epiedaphic, xerothermophilic, eurytopic	Palaearctic
Smintghurinus juv.?	1	epiedaphic	-
Sminthuridae family			
**Sminthurus multipunctatus* Schäffer, 1896	1	epiedaphic, xerothermophilic, grassland	Palaearctic

Photo 1. *Sminthurus multipunctatus* (photo Buşmachiu G.)

Photo 2. Dry *Pinus sylvestris* attacked by *Rhagium inquisitor* (photo Buşmachiu G.)

A total of 17 species of beetles were identified in the Reserve. Most of the beetle species identified in the Cobîleni Nature Reserve are saproxylic beetles, collected from decomposed wood. From the family Staphylinidae, 3 species were identified, followed by the families Lucanidae, Tenebrionidae, Carabidae, Coccinellidae and Scarabaeidae with 2 species each, the other 4 families were highlighted by only one species each. Among the revealed beetles, two species – *Lucanus cervus* and *Oryctes nasicornis*, are included in the third edition of the Red Book of the Republic of Moldova (RED BOOK, 2015). *Lucanus cervus* is also included in Annexes II and IV of the Habitats Directive (92/43 / EEC).

According to the trophic relationship, the highlighted beetles belonged to 6 groups (zoophagous – 5 species, xylophagous – 5, mycophagous – 3, phytophagous – 2, coprophagous – 1 and saprophagous – 1 species). In some species the adults and larvae are either zoophagous or phytophagous, while in the other species the adults are phytophagous and their larvae are xylophagous. The beetles collected from the Cobileni Nature Reserve are part of 9 zoogeographic elements: European (4 species) and Euroasian (3), Palaearctic (3), Transpalaearctic (2), Westpalaearctic (2), Eurosiberian (1) and Cosmopolitan (1 species) (Table 2).

The knowledge of the beetle species diversity from the Cobîleni Nature Reserve and the adjacent pine plantation is of great importance, especially to highlight the relationship between useful and harmful beetles. One species – *Rhagium inquisitor* is a xilophagous species, was the only species collected from the pine plantation and had the largest number of specimens. Bibliographic sources describe it as a forest pest BACAL et al., 2022 (Photo 2).

After the trophic analysis of the other identified species, it was established that they are zoophagous, xylophagous, mycetophagous and do not affect the forest ecosystem.

Table 2. Coleoptera from the Cobîleni Nature Reserve with overall numbers of specimens collected, trophic group, ecology and biogeographic distribution (BD).

Taxa (Family/Species)	Nr. ind.	Trophic group	Ecological traits	BD
Lucanidae family				
Dorcus parallelipipedus (Linnaeus, 1758)	9	xylophagous	xylobiont	Europe
Lucanus cervus (Linnaeus, 1758)	1	xylophagous	xylobiont	Europe
Elateridae family				
Melanotus brunnipes (Germar, 1824)	4	xylophagous	xylobiont	Euroasian
Tenebrionidae family				
Gnaptor spinimanus (Pallas, 1781)	1	coprophagous	pedobiont	Europe
Uloma culinaris (Linnaeus, 1758)	1	mycetophagous	xylobiont	Euroasian
Staphylinidae family				
Ocypus nitens (Schrank, 1781)	1	zoophagous	saprobiont	Palaearctic
Scaphidium quadrimaculatum Olivier, 1790	2	mycetophagous	xylobiont	Westpalaearctic
Tachinus corticinus Gravenhorst, 1802	1	mycetophagous	xylobiont	Palaearctic
Carabidae family				
Calathus fuscipes (Goeze, 1777)	5	zoophagous	xylobiont	Westpalaearctic
Carabus convexus Fabricius, 1775	1	zoophagous	pedobiont	Euroasian
Chrysomelidae family				
Chrysolina sturmi (Westhoff, 1892)	1	phytophagous	pedobiont	Eurosiberian
Cantharidae family				
Cantharis rustica Fallen, 1807	3	zoophagous	pedobiont	Europe
Coccinellidae family				
Coccinela septempunctata Linnaeus, 1758	2	zoophagous	saprobiont	Palaearctic
Harmonia axyridis (Pallas, 1773)	1	polyphagous	detritobiont	Cosmopolitan
Cerambycidae family				
Rhagium inquisitor (Linnaeus, 1758)	27	xylophagous	xylobiont	
Scarabaeidae family				
Oryctes nasicornis (Linnaeus, 1758)	1	xylophagous	xylobiont	Transpalaearctic
Valgus hemipterus (Linnaeus, 1758)	1	saprophagous	xylobiont	Transpalaearctic

CONCLUSIONS

A total of 52 species of invertebrates from two classes Collembola and Coleoptera, belonging to 42 genera and 21 families are the first results of the research carried out in the Cobîleni Natural Reserve. The studied habitats of the Cobîleni Nature Reserve revealed the large portions of xerophilic and xerothermophilic Collembola species. The revealed invertebrates prefer the forest ecosystem and have in general a wide geographic occurrence. Two rare protected insect species – *Lucanus cervus* and *Oryctes nasicornis,* one new collembolan species *Sminthurus multipunctatus* and two species described from the Republic of Moldova were identified in the reserve. The species diversity of beetle from natural oak forest and adjacent pine plantation has a great importance, especially to highlight the relationship between useful and harmful beetles. Only one potential pest species – *Rhagium inquisitor* was collected from the pine plantation, having the largest number of specimens.

ACKNOWLEDGEMENTS

The study was performed under the project Nr. 20.80009.7007.02 "Evolutionary changes in economically important terrestrial fauna, rare and protected species under anthropogenic and climatic changes".

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Received: April 10, 2022
Accepted: 06 July, 2022