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New data on lumbricid fauna from forests in the Western Stara Planina Mountains, Bulgaria

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Thematic field: Ecosystem biodiversity, conservation and environmental restoration

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Abstract

Between 2016 and 2018, during a study on deadwood biomass stocks and their role in forest ecosystems of the Berkovski Balkan region (Western Stara Planina Mountains, Bulgaria), we investigated earthworms (Oligochaeta: Lumbricidae) captured using pitfall traps. With the help of 156 pitfall traps set in 13 sampling plots, we collected over 500 individuals belonging to 20 species and 9 genera. There are four new records for the region of the Western Stara Planina Mts.: *Dendrobaena balcanica* (Černosvitov, 1937), *Dendrobaena depressa* (Fitzinger, 1833), *Dendrobaena hortensis* (Michaelsen, 1890) and *Dendrobaena rhodopensis* (Černosvitov, 1937); three of them are new for the whole territory of the Bulgarian part of Stara Planina Mts. as well. Along with these species, we found three Balkan endemics: *Cernosvitovia rebeli* (Rosa, 1897), *Dendrobaena balcanica*, *Dendrobaena rhodopensis* and one rare species: *Dendrobaena hortensis*. Zoogeographical analysis showed that the peregrine species dominated, which seems typical for the earthworm diversity of Bulgaria. Pitfall trapping proved to be a suitable method for assessing species composition and collecting ecological data on oligochaete communities. It also shows potential for future use in ecosystem biomonitoring. We aimed to survey lumbricid fauna in the Western Balkan forests using a non-traditional method for collection of earthworms.

Key words: deadwood, earthworms, mountain woodlands, Western Balkan Mts., zoogeography.

Introduction

The impact of earthworms can be so profound that they are considered as 'ecosystem engineers' (Le Bayon et al. 2017). Earthworms (Oligochaeta: Lumbricidae) are very important for the soil formation and the decomposition of organic matter in terrestrial habitats. With their activities, they contribute to the structuring of the soil profile, support physical, chemical and microbiological properties of the soil and improve soil fertility (Edwards 2004, Andriuzzi 2015). Their activities, such as digging of channels, significantly contribute to the increasing of surface water infiltration and soil aeration (Lionetto et al. 2012).

Studies on earthworms in Bulgaria began at the end of the 19th century with accidental studies by foreign specialists, with the first information coming from Rosa (1897), who collected material from the region of Sliven and identified the first 7 species for the country. Černosvitov (1934, 1935, 1937) continued the research on the lumbricid fauna from different parts of the country. Later, Plisko (1963) reported 20 species, 3 of which were identified for the first time. Mihailova (1964, 1965, 1966, 1968) identified 30 species, 10 of which were new for the lumbricid fauna of Bulgaria. Šapkarev (1986) and Zicsi and Csuzdi (1986) conducted separate studies of the lumbricid fauna in Bulgaria, then Duhlinska (1973, 1977, 1979, 1988, 1990) reported 32 species, of which 2 new to the country. In the 21st century, studies on the earthworm communities continued (Uzunov 2010, Stojanović et al. 2012, Szederjesi 2013). In recent years, intensive studies have been carried out by Valchovski and some foreign specialists (e.g. Szederjesi 2013, Valchovski 2016, Valchovski and Velizarova 2016, Valchovski and Mısırlıoğlu 2017, Valchovski et al. 2018, Valchovski and Teofilova 2024). A detailed study of the mountain lumbricid fauna has been carried out for the region of Sarnena Sredna Gora (Zdravkova et al. 2020). Currently, the earthworm fauna of Bulgaria includes 50 species, belonging to 15 genera and 2 families (Valchovski et al. 2018).

The Bulgarian part of Western Stara Planina Mountains is relatively well studied in terms of its fauna, but in-depth studies on earthworm communities are insufficient. The mountain range as a whole is also known as the Balkan Mountains. Previously published data for this region include a total of 21 earthworm species from different locations (Černosvitov 1937, Plisko 1963, Georgiev and Beron 1962, Beron and Georgiev 1967, Duhlinska 1979, Šapkarev 1986, Stojanović et al. 2013, Szederjesi 2013, Valchovski 2016, Valchovski et al. 2018).

The aim of this study was to survey lumbricid fauna in forests in the Western Stara Planina Mountains combining and summarising previous records on the earthworms with new data, as well as to characterise their zoogeographical distribution types and to discuss species of conservation importance.

Material and Methods

The field investigations were carried during 2016–2018 using the pitfall traps method. Each year, the material was collected seasonally in three collecting periods: spring-summer, summer-autumn, and autumn-spring. Earthworms were collected with 156 pitfall traps placed in 13 sampling sites (Fig. 1, Table 1). At each site, 10–12 traps were set. We focused exclusively on old-growth forests

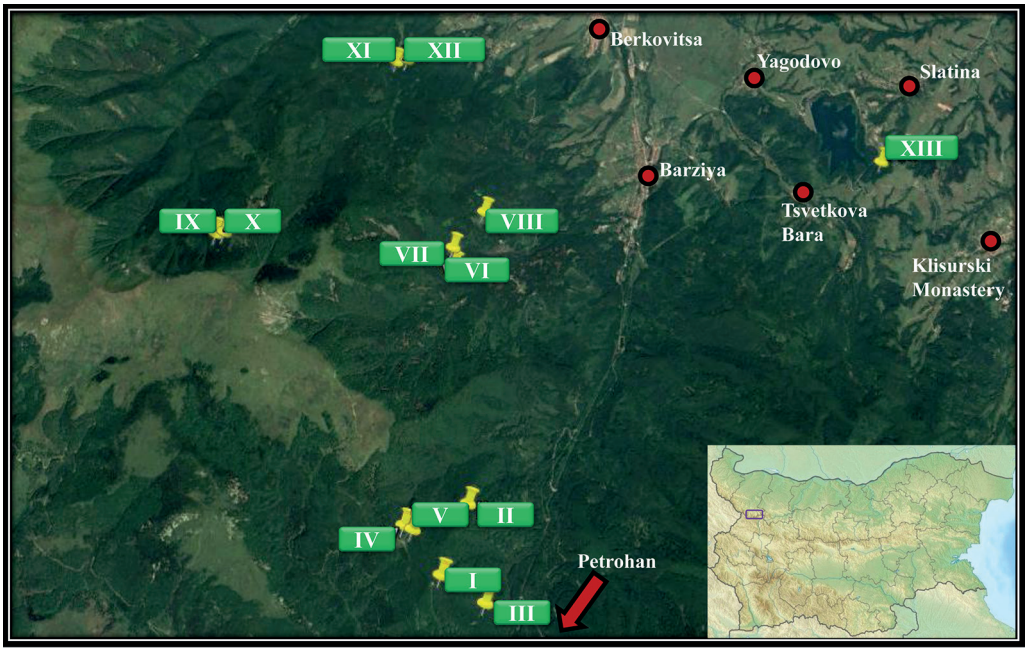


Fig. 1. Map of the locations of the sampling sites.

and searched for habitats with different amounts of very old trees and deadwood. It is worth to point out that the material was collected with a non-traditional method for collection of earthworms.

The traps were made of 2 L plastic bottles cut in the middle, buried at the level of the ground surface and filled with 300 mL of 4% formaldehyde as a fixative. They were placed in different habitats, expositions and altitudes throughout the studied region. The pitfall trap method is one of the oldest and most common ways for faunistic and ecological studies of the invertebrates such as ground beetles, spiders, ants, etc. and small terrestrial mammals. However, it has also been used experimentally and proved useful in earthworm studies as well (e.g. Zdravkova et al. 2020). Our studies on earthworms in Western Stara Planina Mts. can be divided into two periods: the first – 2016 and 2017, and the second – 2018. Some of the data on the material collected during the first period were published by Valchovski et al. (2018), but they concern material collected during the present study and are therefore discussed here as well. The material published in Valchovski et al. (2018) represents only a part of all collected specimens. Significant species were discovered during the second period as well, which is why we decided to publish them and combine the two periods to analyse the whole study. The information obtained from the first period is the reason to conduct a scientific experiment in the second period.

For the identification of the collected material, keys and tables by various authors for other territories (Chekanovskaia 1960, Perel 1979, Mršić 1991, Csuzdi and Zicsi 2003, Reynolds 2018) were used. Some of the main diagnostic characteris-

Table 1. Sampling sites in the Western Stara Planina Mts., with their average altitude, GPS coordinates, and habitat descriptions.

No	Latitude/ Longitude	Altitude, m a.s.l.	Locality and habitat
I	43°07′57″ N, 23°07′10″ E	1580–1630	N Petrohan Pass. Old beech forest with deadwood. Without anthropogenic impact.
II	43°08′33″ N, 23°07′27″ E	1390–1420	N Petrohan Pass. Clearing (100 % of the trees have been cut down), 30 % of the deadwood have not been extracted.
III	43°07′44″ N, 23°07′39″ E	1420–1440	N Petrohan Pass. Old beech forest with completely extracted deadwood.
IV	43°08′19″N, 23°06′49″ E	1520–1540	NW Petrohan Pass. Young beech coppice. The deadwood is formed by the left branches after the felling.
V	43°08′22″ N, 23°06′42″ E	1520–1540	NW Petrohan Pass. Ridge meadow with juniper bushes near the ecotone bordering young beech forest. No deadwood present.
VI	43°10′56″ N, 23°07′08″ E	about 930	SW Barziya village. Old beech forest with dense canopy but with small amount of deadwood.
VII	43°10′45″ N, 23°07′09″ E	920–940	SW Barziya village. Young beech forest formed after the final phase of logging; starting succession.
VIII	43°11′18″ N, 23°07′32″ E	850–875	SW Barziya village. Windthrow at the place of an old beech forest. Primary succession after removal of all deadwood.
IX	43°10′55″ N, 23°04′25″ E	1630–1700	SW Berkovitsa. Gorna Koriya Reserve. Centuries-old spruce forest without anthropogenic impact; preserved deadwood.
X	43°10′55″ N, 23°04′17″ E	1580–1650	SW Berkovitsa. Gorna Koriya Reserve. Beech forest without anthropogenic impact; all deadwood is preserved.
XI	43°12′59″ N, 23°06′25″ E	670–720	SW Berkovitsa. Mixed deciduous forest with some trees uprooted by snow; all deadwood is preserved.
XII	43°12′59″ N, 23°06′16″ E	620–670	SW Berkovitsa. Mixed deciduous forest and pasture near Berkovska River with partly preserved deadwood.
XIII	43°11′55″ N, 23°12′47″ E	about 525	SE Berkovitsa, NE Klisurski Monastery. Old oak forest (*Quercus petraea* (Matt.) Liebl., *Q. robur* L.).

tics are the prostomium type, body length, arrangement of setae, position of clitellum and tubercula pubertatis, etc.

Following the distribution types given by Omodeo and Rota (1999), and Csuzdi et al. (2011), this analysis of the earthworm taxa recorded in the entire territory of Western Balkan Mt. has identified different distribution ranges: Peregrine, Trans-Aegean, Balkan endemic, Holomediterranean, Balkanic-Alpine, Central European, Western and Central European and Central European.

Results and Discussion

During the investigation, the species composition of the lumbricid fauna in the region was revealed. Subsequently, its diversity (rare, mass, endemic species), taxonomic and zoogeographic structure were analysed.

During the entire three-year study period, we collected over 500 specimens with a total of 20 species from 9 genera of the family Lumbricidae. This represents 40 % of all established for Bulgarian lumbricid

species and 60 % of the genera. Similarly, an extremely rich lumbricid fauna has been found in other Bulgarian mountains, such as the Sarnena Sredna Gora Mts. (21 species, 42 % of Bulgarian lumbricids) (Zdravkova et al. 2020) and the Western Rhodopes (23 species, almost 50 %) (Valchovski and Teofilova 2024), as well.

During the first stage of the work (2016–2017), around 150 specimens were determined and the data were included in the general faunistic analysis. During the second stage (2018), 17 species from 6 genera were identified and the data from this period were used for quantitative analyses. A total of 264 specimens were identified to species level, representing 74 % of the total number of specimens. The remaining 26 % (91 specimens) were identified only to genus. This material includes torn, dried and crushed individuals. Of the preserved material, 63 % are sexually mature individuals, and the rest are juveniles.

The annotated species list below includes all species occurring in the Western Stara Planina Mts. (SPW), encompassing both those identified in our study and species known only from the literature, without new material. Species marked with an asterisks (*) represent part of the material from the first period of our survey; they were collected in 2016–2017 and were already published by Valchovski et al. (2018).

Species list

1. *Allolobophora chlorotica* (Savigny, 1826)

Distribution: Peregrine. **Distribution in SPW:** Slivnica (Šapkarev 1986)

Habitat: under rocks on river bank (Plisko 1963); meadow and forest (Stojanović et al. 2012)

Material examined: N/A

2. *Aporrectodea caliginosa* (Savigny, 1826)

Distribution: Peregrine. **Distribution in SPW:** Svoge – Iskar River (Plisko 1963)

Habitat: on river banks (Plisko 1963); oak forest (Stojanović et al. 2012)

Material examined: N/A

3. *Aporrectodea handlirschi* (Rosa, 1897)

Distribution: Trans-Aegean. **Distribution in SPW:** Slivnica (Šapkarev 1986)

Habitat: in oak forest, pasture and river bank (Zdravkova et al. 2020)

Material examined: N/A

4. *Aporrectodea jassyensis* (Michaelsen, 1891)

Distribution: Trans-Aegean. **Distribution in SPW:** Dragoman (Šapkarev 1986)

Habitat: meadows and cultivated soils (Mihailova 1966); forests (Szederjesi 2013); oak forest (Stojanović et al. 2012)

Material examined: N/A

5. *Aporrectodea rosea* (Savigny, 1826)

Distribution: Peregrine. **Distribution in SPW:** Todorova Dupka Cave, Vratsa (Plisko 1963), Dragoman (Šapkarev 1986)

Habitat: in caves (Plisko 1963); meadow and forests (Stojanović et al. 2012)

Material examined: site III: 1 ex.; site X: 1 ex.

6. *Aporrectodea trapezoides* (Dugès, 1828)

Distribution: Peregrine. **Distribution in SPW:** Dragoman (Šapkarev 1986)

Habitat: cultivated soils, river banks (Šapkarev 1986); meadow and forest (Stojanović et al. 2012); forests (Valchovski 2014)

Material examined: N/A

7. **Bimastos eiseni* (Levinsen, 1884)

Distribution: Peregrine. **Distribution in SPW:** Gorna Koriya Reserve, Berskovska River, Barzia, Petrohan (Valchovski et al. 2018)

Habitat: living on tree bark

Material examined: site I: 5 ex.; site II: 3 ex.; site X: 1 ex.

8. ****Bimastos rubidus* **(Savigny, 1826)

Distribution: Peregrine. **Distribution in SPW:** Magurata Cave, Belogradchik and Svetata voda Cave, Ginci (Plisko 1963), Ginci, Ledenika Cave (Beron and Georgiev 1967), Beledie Han (Duhlinska 1979), Dragoman (Šapkarev 1986), Svoge (Valchovski 2016), Gorna Koriya Reserve, Petrohan Pass, Srechenska Bara, Berkovitsa (Valchovski et al. 2018)

Habitat: in caves (Cernosvitov 1937, Plisko 1963)

Material examined: site I: 10 ex.; site II: 4 ex.; site IV: 3 ex.

9. ***Cernosvitovia biserialis*** **(Černosvitov, 1937)**

Distribution: Balkan endemic. **Distribution in SPW:** In a cave near Vratsa (Cernosvitov 1937), Dragoman (Šapkarev 1986)

Habitat: in caves (Cernosvitov 1937)

Material examined: N/A

10. ****Cernosvitovia rebeli* **(Rosa, 1897)

Distribution: Balkan endemic. **Distribution in SPW:** Lukovo, Svoge (Valchovski 2016), Petrohan (Valchovski et al. 2018)

Habitat: beech forest (Valchovski 2016)

Material examined: site XIII: 2 ex.

11. ****Dendrobaena misirlioglui* **Csuzdi & Szederjesi, 2023

Distribution: Balkan-Alpine. **Distribution in SPW:** Gorna Koriya Reserve (Valchovski et al. 2018)

Habitat: rich in rotting organics (leaf litter and deadwood) forests (Zdravkova et al. 2020)

Material examined: site III: 1 ex.; site XII: 2 ex.

12. ****Dendrobaena attemsi* **(Michaelsen, 1902)

Distribution: Trans-Aegean (Misirlioğlu and Stojanović 2020). **Distribution in SPW:** Gorna Koriya Peserve, Petrohan, Srechenska Bara, Berkovitsa, Barzia (Valchovski et al. 2018)

Habitat: We found it in many of the sampling sites, thus we could clain it is a forest dweller.

Material examined: site I: 4 ex.; site II: 1 ex.; site IV: 1 ex.; site V: 10 ex.; site VI: 2 ex.; site VII: 2 ex.; site VIII: 1 ex.; site IX: 2 ex.; site X: 7 ex.; site XII: 1 ex.

13. ***Dendrobaena balcanica*** **(Černosvitov, 1937)**

Distribution: Balkan endemic. **Distribution in SPW:** This is the first record here

Habitat: We found it in ridge meadow with juniper and young beech forest

Material examined: site V: 2 ex.

14. ***Dendrobaena byblica*** **(Rosa, 1893)**

Distribution: Holomediterranean. **Distribution in SPW:** Ledenika Cave (Duhlinska 1979)

Habitat: oak forest (Stojanović et al. 2012)

Material examined: site XI: 4 ex.; site XII: 1 ex.

15. ***Dendrobaena depressa*** **(Fitzinger, 1833)**

Distribution: Central European. **Distribution in SPW:** This is the first record here

Habitat: We found it in mixed deciduous forest

Material examined: site XI: 1 ex.

16. ***Dendrobaena hortensis*** **(Michaelsen, 1890)**

Distribution: Western and Central European. **Distribution in SPW:** This is the first record of this species here

Habitat: near river banks (Mihailova 1966), mixed forest (Zdravkova et al. 2020)

Material examined: site V: 1 ex.

17. ****Dendrobaena octaedra* **(Savigny, 1826)

Distribution: Peregrine. **Distribution in SPW:** Lakatnik (Plisko 1963), Gorna Koriya Reserve, Berkovska River, Petrohan (Valchovski et al. 2018)

Habitat: under rocks (Plisko 1963); forests (Stojanović et al. 2012)

Material examined: site II: 2 ex.; site III: 4 ex.; site V: 1 ex.; site VII: 1 ex.; site XII: 1 ex.

18. ****Dendrobaena platyura* **(Fitzinger, 1833)

Distribution: Central European. **Distribution in SPW:** Barziya, Gorna Koriya Reserve, Berkovska River, Petrohan Pass, Berkovitsa (Valchovski et al. 2018)

Habitat: We found it in clearing, old beech, young coppice beech forest, windthrow in old beech forest, mixed deciduous forest, pasture and river bank

Material examined: site II: 3 ex.; site VI: 1 ex.; site VII: 1 ex.; site VIII: 8 ex.; site XI: 4 ex.; site XII: 7 ex.

19. ***Dendrobaena rhodopensis*** **(Černosvitov, 1937)**

Distribution: Balkan endemic. **Distribution in SPW:** This is the first record here

Habitat: We found it in beech forests

Material examined: site II: 2 ex.; site X: 1 ex.

20. ***Eisenia fetida*** **(Savigny, 1826)**

Distribution: Peregrine. **Distribution in SPW:** Slivnica (Šapkarev 1986)

Habitat: meadow and forest (Stojanović et al. 2012); rich in organic matter places (Zdravkova et al. 2020)

Material examined: site III: 1 ex.

21. ****Eisenia lucens* **(Waga, 1857)

Distribution: Central European. **Distribution in SPW:** Magurata Cave (Plisko 1963), Lakatnik (Duhlinska 1979), Montana (Szederjesi 2013), Berkovitsa, Gorna Koriya Reserve, Petrohan (Valchovski et al. 2018)

Habitat: in caves (Plisko 1963), near road (Szederjesi 2013)

Material examined: site VI: 2 ex.; site XI: 3 ex.

22. ****Eiseniella tetraedra* **(Savigny, 1826)

Distribution: Peregrine. **Distribution in SPW:** Lakatnik (Plisko 1963), Dragoman (Šapkarev 1986), Berkovitsa (Valchovski et al. 2018)

Habitat: near river (Plisko 1963); oak forest (Stojanović et al. 2012)

Material examined: N/A

23. ****Lumbricus rubellus* **Hoffmeister, 1843

Distribution: Peregrine. **Distribution in SPW:** Lakatnik (Cernosvitov 1937, Plisko 1963), Beledie Han (Duhlinska 1979), Dragoman, Slivnica (Šapkarev 1986), Berkovska River, Petrohan Pass, Barzia, Berkovitsa (Valchovski et al. 2018)

Habitat: under rocks (Plisko 1963); meadow and forest (Stojanović et al. 2012)

Material examined: site VII: 1 ex.; site XII: 1 ex.

24. ****Lumbricus terrestris* **Linnaeus, 1758

Distribution: Peregrine. **Distribution in SPW:** Slivnica (Šapkarev 1986), Srechenska Bara (Valchovski et al. 2018)

Habitats: meadow (Stojanović et al. 2012)

Material examined: site XII: 1 ex.; site XIII: 12 ex.

25. ****Octodrilus transpadanus* **(Rosa, 1884)

Distribution: Trans-Aegean. **Distribution in SPW:** Berkovska River (Valchovski et al. 2018)

Habitat: mixed deciduous forest, pasture and river bank (Valchovski et al. 2018)

Material examined: N/A

26. ****Octolasion lacteum* **(Örley, 1881)

Distribution: Peregrine. **Distribution**

in SPW: Lakatnik (Cernosvitov 1937), Temnata Dupka Cave (Georgiev and Beron 1962), Caves near Ginci village. (Plisko 1963), Slivnica (Šapkarev 1986), Berkovitsa, Barzia (Valchovski et al. 2018)

Habitat: near river (Černosvitov 1937); in caves (Plisko 1963); meadow and forests (Stojanović et al. 2012)

Material examined: N/A

27. *Proctodrilus tuberculatus* (Černosvitov, 1935)

Distribution: Trans-Aegean. **Distribution in SPW:** Svoge (Plisko 1963), Dragoman (Šapkarev 1986)

Habitat: on the river bank (Plisko 1963)

Material examined: N/A

Taxonomic structure – genera and species

The species composition of earthworms for the Western Stara Planina, known to date, comprises 27 species from 11 genera. Of them, 20 species were collected during the present study, and 7 were registered only from the literature and were not discovered in our study: *Allolobophora chlorotica*, *Aporrectodea caliginosa*, *Aporrectodea handlirschi, Aporrectodea jassyensis*, *Aporrectodea trapezoides*, *Cernosvitovia biserialis* and *Proctodrilus tuberculatus*.

The genus *Dendrobaena* Eisen, 1873, which includes nine species, is the dominant faunal component, not only in our study but also in the earthworm fauna of Bulgaria (Stojanović et al. 2012). The quantitative data from 2018 showed that *Dendrobaena* species are also the most abundant (52 % of the total material). These are inhabiting mountain forest habitats and their large number in our material could be explained by the fact that the sampling sites were mainly located in beech, spruce and mixed forests. The relatively high presence of species from the genus *Bimastos* Moore, 1893 (7.4 %) and the genus *Eisenia* Malm, 1877 (5.4 %) could be explained by the fact that they are epigean (epigeic) species inhabiting the surface soil layer, in which a large amount of dead organic matter is present, and such habitats in the region are the forest ecosystems we studied. Other species with high presence are those of the genus *Lumbricus* Linnaeus, 1758, with 7.9 %. The species of the genus *Aporrectodea* Orley, 1885 (1.1 %) have a low presence, as these are species inhabiting flat, lowland areas, and our sampling sites were mountain habitats with an altitude from 525 m up to 1650 m. The species of the genus *Cernosvitovia* Omodeo, 1956 had the lowest occurrence (0.6 %).

The quantitative analysis of the separate species showed that the most abundant species were: *D. attemsi* (25 specimens, 7 % of all), *D. platyura* (24, 6.8 %), *B. rubidus* (17, 4.8 %) and *L. terrestris* (13, 3.7 %). With 9 specimens (2.5 %) each were *B. eiseni* and *D. octaedra*; with 5 (1.4 %) each were *E. lucens* and *D. byblica*; with 3 (0.8 %) each were *D. misirlioglui* and *D. rhodopensis*; with 2 (0.6 %) each were *Ap. rosea*, *C. rebeli*, *D. balcanica* and *L. rubellus*. The least represented (one specimen) were *D. depressa*, *D. hortensis* and *E. fetida*. The species *D. balcanica*, *D. depressa*, *D. hortensis* and *D. rhodopensis* were less abundant and have a limited distribution not only in the studied region, but apparently also on the territory of Bulgaria. Some of the less common species are of conservation importance and the small number of individuals caught proves how rare they are.

We can compare our study design and results with data from the Sarnena Gora region (Zdravkova et al. 2020), where a

total of 381 specimens and 17 species of earthworms were identified, and the most common species were *L. rubellus* (43 %), *D. misirlioglui* (31 %), *E. fetida* (27 %) and *C. rebeli* (19 %). Several rare species of conservation importance were also recorded, such as *Panoniona leoni* Michaelsen, 1891 (Navarro et al. 2023) and *D. hortensis*, together with endemic species (*D. balcanica* and *C. rebeli*). In both studies, a large amount of biological material was collected in different periods of the year and from various habitat types. With the obtained data, various ecological analyses for the group of earthworms and their potential as bioindicators of environmental quality and forest ecosystems could be carried out in the future.

Faunistic analysis – new, rare, endemic, and specific lumbricids/taxa

During our research, we identified some species of conservation and scientific importance: one species new to the fauna of Bulgaria; four new unpublished species for the Bulgarian part of the Western Stara Planina Mts. (*D. balcanica*, *D. depressa*, *D. hortensis*, *D. rhodopensis*) and three of them for the entire territory of the mountain, three Balkan endemics, and one rare species (Table 2). Some of the data have already been published by Valchovski et al. (2018), but they concern material collected during the present investigation and are therefore also considered here. *Dendrobaena hortensis* has been reported for the Serbian part of the mountain (Stojanović et al. 2013), so the fact that we have found it is not very surprising but it is still a new geographic record for the region of study.

Dendrobaena platyura is a species new to the territory of the Western Stara Planina Mts., as well as for Bulgaria. It was published by Valchovski et al. (2018) based on specimens collected by us in the period 2016–2017. Quantitative data from 2018 showed that it is among the most abundant and common species for the study region.

The other new species for the region is the Balkan endemic *Cernosvitovia rebeli*, found at only two sampling sites, with a small number of individuals, which probably confirms the hypothesis of its relative rarity. Previously published localities of *C. rebeli* in the Western Balkan include the village of Lukovo (Svoge municipality) (Valchovski 2016) and Petrohan Pass (Valchovski et al. 2018). In Bulgaria, it is widespread, and is also found in the other two parts of the Balkan Mts. – Botev Peak, Ribaritsa, Vasiliovo (Cen-

Table 2. Species of geographical and conservation importance captured for the entire study period (2016–2018).

Species	BG new	SPW new	SP new	BALe	Rare
Cernosvitovia rebeli				+	
Dendrobaena balcanica		+	+	+	
Dendrobaena depressa		+	+		
Dendrobaena hortensis		+	+		+
Dendrobaena platyura	+	+	+		
Dendrobaena rhodopensis		+		+	

Note: BG – Bulgaria, SPW – Western Stara Planina Mts., SP – whole Stara Planina Mts., BALe – Balkan endemic.

tral) (Černosvitov 1934, Duhlinska 1979, Valchovski and Mısırlıoğlu 2017) and Sliven, Stidovska Planina Mt. (Eastern) (Rosa 1897, Valchovski et al. 2018). The new localities of the species from our investigation are at 525 m a.s.l. (site XIII). Recent molecular studies have confirmed the distinct phylogenetic status of *Cernosvitovia* and provided an emended genus diagnosis, further supporting the systematic placement of *C. rebeli* (Popović et al. 2022).

Dendrobaena balcanica is an endemic species, also new to the Western Stara Planina Mts., but also new to the entire territory of the Stara Planina Mountains. Its was previously reported in Bulgaria from localities in Slavianka Mts. (Černosvitov 1937), Pirin Mts. (Zicsi and Csuzdi 1986), and Sarnena Sredna Gora Mts. (Zdravkova et al. 2020). During our study, it was recorded at 1526 m a.s.l. (site V).

The third endemic species, *D. rhodopensis*, is new to the Western Stara Planina Mts., but has also been found in the Central Stara Planina Mts. (Tetevenska Planina) (Plisko 1963), in different localities in Rila Mts. (Plisko 1963; Šapkarev 1986, Zicsi and Csuzdi 1986, Stojanović et al. 2012, Valchovski et al. 2018), Vitosha Mts. (Plisko 1963, Delchev et al. 1998) and Kostenets (Rila-Rhodopes Mts.) (Černosvitov 1937). According to Stojanović et al. (2020) *D. rhodopensis* is a strictly montane species, restricted to forest soils at high altitudes, with individuals found only between 1098 and 2518 m a.s.l. We can also confirm this, as we collected the species at 1405 m a.s.l. at site II and at 1625 m a.s.l. in Gorna Koriya Reserve, at the upper limits of the beech forests (site X).

The rare species *D. hortensis* was recorded for the first time in the studied area. In Bulgaria, the species has previously been recorded at Sarnena Sredna Gora Mts. (Mihailova 1966; Zdravkova et al. 2020) and the Strandzha Mts. (Szederjesi 2013). During our survey, it was collected at 1526 m a.s.l. (site V).

Zoogeographic characteristics of the lubricofauna

The analysis of our results obtained during this study and the data already known for the region showed that according to the zoogeographical distribution types, the earthworm fauna of the Western Balkan Mts. is dominated by peregrine species (12 taxa, 44.4 %) (*B. rubidus*, *L. rubellus*, *D. octaedra* and others), followed by Trans-Aegean (5 taxa, 18.5 %) (*A. handlirschi, A. jassyensis*, *D. attemsi*, *O. transpadanus*, *P. tuberculatus*), Balkan endemic (4 taxa, 14.8 %) (*C. biserialis*, *C. rebeli*, *D. balcanica*, *D. rhodopensis*), Central-European (3 taxa, 11.1 %) (*D. depressa*, *D. platyura*, *E. lucens*). Less numerous are the Balkanic-Alpine, Holomediterranean and Western and Central European categories with only one species each (3.7 %) (*D. misirlioglui, D. byblica* and *D. hortensis*, respectively). Similarly, peregrine species predominated in the Western Rhodopes (43.5 %), and were followed by the endemic species (21.7 %) (Valchovski and Teofilova 2024), as well. Such ratio is typical of the earthworm diversity of Bulgaria (Valchovski 2012, Stojanović et al. 2012). However, the degree of endemism is lower than the average for Bulgaria (Stojanović et al. 2012).

Quantitative representation of the species and individuals

We analysed the quantitative representation of lumbricid species at each sampling site and their dependence on the amount

of deadwood, based on the material collected in 2018. Some of the sites with a large amount of deadwood biomass and relatively large species diversity of earthworms were sites II (clearing) and VIII (windthrow with abandoned poor-quality deadwood). Other places with high quantitative activity were site XII (near a river), XI (mixed forest), and XIII (oak forest). The reason for such activity of earthworms in these places is that they are all characterised by a large amount of deadwood, a constant amount of moisture and diverse food base. Sampling sites poor in species and quantitative diversity were those with a limited amount of deadwood or the food supply had already been fully utilised (sites IV, VI and IX). These regularities showed the earthworms' activity at individual sites and confirmed their dependence on the food supply (see Edwards 2004).

The scientific experiment carried out to analyse biological material from earthworms collected with pitfall traps showed the suitability of the method for establishing the species composition and some qualitative and quantitative characteristics of lumbricid faunas. The method seems also suitable and promising for ecosystem biomonitoring, but experimental calibration and refinement of the system of biotic parameters used is necessary (see Zdravkova et al. 2020). Among the advantages of the method are its year-round duration, relatively low cost and the possibility to use it simultaneously with the collection of biological material and information on other epigeobionts and pedobionts. In practice, pitfall traps represent an independent sample or collection, and its exposure is constant. The method has some disadvantages, it is not quite proper for endogeic earthworm species, which inhabit permanently the humus soil layer. Nevertheless, the pitfall trapping is very useful method for epigeic and most of the anecic species.

Conclusions

The lumbricid fauna of the Western Stara Planina Mts. is extremely rich and represents 40 % of all established lumbricid species recorded in Bulgarian. This is probably due to the location of the studied areas, rather humid and stable habitats, the presence of rich food base and also the sampling efforts. Here we also report 5 new species for the territory of Western Stara Planina and some species with conservation and scientific significance (three Balkan endemic species and one rare species).

Faunistic analyses obtained from the experiment using pitfall traps proved the advantages of this method over traditional ones, which are narrowly limited in space and time. The identification of new species with this non-traditional method showed the need for future studies of the earthworm fauna to apply methods with a prolonged or frequent sampling period and a relatively large number of samples, which would guarantee the capture of rare, regionally specific and stenobiont species.

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