

1-1-2013

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MIRJANA STOJANOVIC

RALITSA TSEKOVA

SNEZANA PESIC

JOVANA MILANOVIC

TANJA MILUTINOVIC

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### Recommended Citation

STOJANOVIC, MIRJANA; TSEKOVA, RALITSA; PESIC, SNEZANA; MILANOVIC, JOVANA; and MILUTINOVIC, TANJA (2013) "Diversity and a biogeographical review of the earthworms (Oligochaeta: Lumbricidae) of the Balkan Mountains (Stara Planina Mountains) in Serbia and Bulgaria," *Turkish Journal of Zoology*. Vol. 37: No. 5, Article 13. <https://doi.org/10.3906/zoo-1301-33>  
Available at: <https://journals.tubitak.gov.tr/zoology/vol37/iss5/13>

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## Diversity and a biogeographical review of the earthworms (Oligochaeta: Lumbricidae) of the Balkan Mountains (Stara Planina Mountains) in Serbia and Bulgaria

Mirjana STOJANOVIĆ<sup>1\*</sup>, Ralitsa TSEKOVA<sup>2</sup>, Snežana PEŠIĆ<sup>1</sup>, Jovana MILANOVIĆ<sup>1</sup>, Tanja MILUTINOVIĆ<sup>1</sup>

<sup>1</sup>Institute of Biology and Ecology, Faculty of Science, University of Kragujevac, Kragujevac, Serbia

<sup>2</sup>Faculty of Biology, Department of Ecology, Sofia University, Sofia, Bulgaria

Received: 25.01.2013 • Accepted: 13.05.2013 • Published Online: 12.08.2013 • Printed: 06.09.2013

**Abstract:** In this paper we summarize the knowledge on earthworm diversity in the Balkan Mountains (Stara Planina Mountains) based on new findings and published data in order to establish the first list of known earthworm taxa from the entire area of the Balkan Mountains. During investigations in the western part of the Balkan Mountains (western Stara Planina Mountains), 24 earthworm species were recorded altogether. Among them, 10 taxa represented the first findings for the whole territory of the Balkan Mountains (*Allolobophora robusta spassenjakaramani*, *Aporrectodea smaragdina*, *Dendrobaena byblica*, *Dendrobaena hortensis*, *Dendrobaena illyrica*, *Dendrobaena jastrebenensis*, *Dendrobaena vejovskyi*, *Dendrobaena veneta*, *Helodrilus balcanicus balcanicus*, and *Helodrilus cernovitovianus*). The complete list of lumbricids from the Balkan Mountains contains 40 taxa belonging to 14 genera. With respect to the zoogeographic situation, the majority of them belong to peregrine, endemic, and trans-Aegean species. Our data show that the degree of endemism for the whole Stara Planina Mountains is relatively high (20%). Summing up the 9 endemics and the Balkanic (Moesian and Illyric) species, 27.5% of the total lumbricid fauna shows an autochthonous character. The impressive earthworm diversity shows that the Balkan Mountains are a territory of considerable species richness.

**Key words:** Earthworms, Balkan Mountains (Stara Planina Mountains), western Stara Planina Mountains, Serbia, Bulgaria, zoogeographical position

### 1. Introduction

Regions of the Balkan Mountains (in further text referred to as the Stara Planina Mountains) have always attracted attention because of the vast diversity of landforms and species. A literature survey of the biota on the Serbian side of these mountains yielded an extremely high number of different titles. However, when it comes to earthworm investigations, up to now there have been few, and mainly sporadic ones (Šapkarev, 1986; Mršić, 1991; Stojanović, 1996; Stojanović and Karaman, 2006). These studies assign to the Serbian Stara Planina 15 taxa of lumbricids altogether. In contrast, to date there have been several papers dealing with the Bulgarian side of the Stara Planina Mountains. These publications (Rosa, 1897; Černovitov, 1937; Plisko, 1963; Mihailova, 1964; Šapkarev, 1986; Delchev et al., 1998; Szederjesi, 2013) list 28 lumbricid taxa altogether for the Bulgarian Stara Planina Mountains.

The aim of this paper is to present new data on the earthworm fauna of the Serbian Stara Planina Mountains and, by analyzing the newly reported species together with literature records, to establish the first list of earthworm

taxa and distributional types from the entire area of the Stara Planina Mountains.

### 2. Materials and methods

#### 2.1. Study area

The Stara Planina Mountains are an extension of the Carpathian mountain range, separated from the latter by the Danube River. They run 560 km from eastern Serbia eastward through central Bulgaria to the Black Sea and can be divided into the western (from Vrška Čuka to the Pass of Arabakonak, with a total length of 190 km), middle (207 km long, with Botev Peak at 2376 m), and eastern (the lowest part of the range) Stara Planina. Less than one-third of the Stara Planina Mountains (the western stretches of the western Stara Planina) are in Serbia, while more than two-thirds are in Bulgaria.

All of our collecting locations were situated in eastern Serbia (between 43°10'N, 22°21'E and 43°60'N, 22°90'E), near the border with Bulgaria. The border itself coincides for 70 km with the highest mountain range, which lies in the NW-SE direction. The highest peak is Midžor

\* Correspondence: mirast@kg.ac.rs

(2169 m), which is also the highest point in Serbia. In orographic and geomorphological terms, this area is extremely heterogeneous and complex. On the proposal of the Institute of Nature Protection of Serbia, in 1997 the western Stara Planina Mountains were placed under strict protection as having “natural merit of first class”. They are also the object of an agreement of cooperation between the ministries of Bulgaria and Serbia for the formation of a transboundary protected area. In addition, due to their geographic position and paleogeographic history, the Stara Planina Mountains represent 1 of the 6 biodiversity hotspots in Europe (Papp and Erzberger, 2007; Jakšić, 2008).

## 2.2. Methods

Investigations were carried out during 3 different periods: in July 1997, extensively from April to September 1998, and in July 2008. All main habitat types, such as forests, grasslands, and stream valleys, were visited (Table 1).

The specimens were obtained by the diluted formaldehyde method complemented with digging and hand sorting as well as turning over rocks, debris, and logs. The earthworms were killed in 70% ethanol, fixed in 4% formalin solution, and stored in 90% ethanol. Identification and nomenclature of species were in accordance with Zicsi (1985), Šapkarev (1978), Mršić (1991), Csuzdi and Zicsi (2003), and Blakemore (2004).

## 2.3. Regional distribution

Relatively few works deal with the biogeography of earthworms, and in particular little work has been undertaken to understand the distribution of earthworms (Mršić, 1991; Omodeo and Rota, 1999, 2008; Csuzdi and Zicsi, 2003; Pop et al., 2010; Csuzdi et al., 2011). Following the distribution types given by Omodeo and Rota (1999) and Csuzdi et al. (2011), our analysis of the earthworm taxa recorded in the entire territory of the Stara Planina Mountains has identified different distribution ranges: peregrine, central European, trans-Aegean (Europe from the Alps to the Ural Mountains, Anatolia, Levant, and Mesopotamia), circum-Mediterranean, Moesian (East Balkan), eastern Alpine, southern Alpine, Illyric (west Balkan), wider endemics (only on the Balkan Peninsula, widespread distribution), and restricted endemics (only in a restricted area of the Balkan Peninsula).

## 3. Results

A total of 24 lumbricid species were collected during our investigations (Table 1). Only 5 of them were already known on the Serbian side of the western Stara Planina Mountains (Table 2). Two species are new records for the western Stara Planina Mountains (*Dendrobaena attemsi* and *Dendrobaena veneta*), and 10 others represent the first records for the whole territory of the Stara Planina Mountains (*Allolobophora robusta spasenijkaramani*,

*Aporrectodea smaragdina*, *Dendrobaena byblica*, *Dendrobaena hortensis*, *Dendrobaena illyrica*, *Dendrobaena jastrebensis*, *Dendrobaena vejdvoskyi*, *Dendrobaena veneta*, *Helodrilus balcanicus balcanicus*, and *Helodrilus cernosvitovianus*). Two taxa, *Helodrilus balcanicus balcanicus* and *Helodrilus balcanicus plavensis*, are rare (Dojkinci, Knjaževac) and known only from a few recent localities (Stojanović, 1996; Stojanović and Karaman, 2006). Thus, on the grounds of the previous and present investigations, the lumbricids from the entire territory of the Stara Planina Mountains comprise 40 taxa belonging to 14 genera (Table 2). *Lumbricus rubellus* appears to be the most common and widespread taxon (80.95% of the localities), occurring from east to west across the whole region. The next most common species are *Aporrectodea rosea* (47.62% of the localities), *Octolasion lacteum* (52.38% of the localities), *Dendrobaena byblica* (33.33% of the localities), and *Aporrectodea trapezoides* (23.81% of the localities). Most of the taxa belong to the genera *Dendrobaena* and *Aporrectodea*, at 9 and 6 taxa, respectively.

The zoogeographical composition of the earthworm fauna inhabiting the whole Stara Planina Mountains appears as follows: peregrine (37.5%), endemics (wider endemics: 5%; restricted endemics: 17.5%), and trans-Aegean (16%) representing together almost two-thirds of the fauna; along with central European (7.5%), Moesian (5%), and not so numerous circum-Mediterranean (2.5%), Illyric (2.5%), eastern Alpine (2.5%), and southern Alpine (2.5%) taxa.

## 4. Discussion

In the distribution area of endemic lumbricids, Csuzdi and Zicsi (2003) recognized 4 large biogeographic domains (the Franco-Iberian, Aegean, Turanian, and North American domains). The Stara Planina Mountains belong to the north-Aegean subdomain (Pop et al., 2010). The latter is characterized by the presence of endemic species from the genera *Octodrilus*, *Cernosvitovia*, *Fitzingeria*, and *Dendrobaena*. It is important to notice the absence of *Octodrilus* and *Fitzingeria* endemics from the area of the Stara Planina Mountains, while endemics from these genera are present in large numbers in the neighboring areas. In addition, there are no Dacian endemic species, whose distribution center is in the Apuseni Mountains (Pop et al., 2010). This situation may be related to the fact that the Carpathians represent a natural barrier to Dacian endemics, as these species are lacking from the higher areas of Carpathians (Csuzdi et al., 2011).

The endemic species represent 20% of the total number of the species and belong to the genera *Cernosvitovia* (3 taxa), *Dendrobaena* (2 taxa), *Helodrilus* (2 taxa), *Eisenia*

**Table 1.** List of the lumbricid taxa collected at new sampling locations on the Serbian side of the western Stara Planina Mountains.

Species	Habitat	Localities
<i>Allolobophora leoni</i> Michaelsen, 1891	Meadow	3 exp., Timok (43°54'N, 22°17'E), 600 m, 07.04.1998; 3 exp., Timok (43°54'N, 22°17'E), 600 m, 20.04.1998.
<i>Allolobophora robusta</i> <i>spasenijakaramani</i> (Blakemore, 2004)	Oak forest	1 exp., Babin zub (43°22'N, 22°36'E), 700 m, 15.09.1998.
<i>Aporrectodea caliginosa</i> (Savigny, 1826)	Rivers and pastures	1 exp., Stanjanska reka (43°41'N, 22°43'E), 22.07.1997; 2 exp., Timok (43°54'N, 22°17'E), 600 m, 20.04.1998; 1 exp., Babin zub (43°22'N, 22°36'E), 1500 m, 10.05.1998.
<i>Aporrectodea handlirschi</i> (Rosa, 1897)	Cave, oak forest, and beech forest	1 exp., Babin zub (43°22'N, 22°36'E), 1000 m, 10.05.1998; 1 exp., Babin zub (43°22'N, 22°36'E), 850 m, 15.09.1998; 41 exp., Topli Do (43°20'N, 22°40'E), 06.11.1998.
<i>Aporrectodea rosea</i> (Savigny, 1826)	Rivers, pastures, cave, beech forest, and oak forest	3 exp., Timok (43°54'N, 22°17'E), 600 m, 20.04.1998; 7 exp., Babin zub (43°22'N, 22°36'E), 1500 m, 10.05.1998; 7 exp., Babin zub (43°22'N, 22°36'E), 700 m, 15.09.1998; 19 exp., Babin zub (43°22'N, 22°36'E), 850 m, 15.09.1998; 1 exp., Topli Do (43°20'N, 22°40'E), 06.11.1998; 18 exp., Babin zub (43°22'N, 22°36'E), 1500 m, 20.04.1998; 21 exp., Babin zub (43°22'N, 22°36'E), 1000 m, 10.05.1998; 10 exp., Babin zub (43°22'N, 22°36'E), 900 m, 10.05.1998; 2 exp., Timok (43°54'N, 22°17'E), 600 m, 10.05.1998; 9 exp., Timok (43°54'N, 22°17'E), 600 m, 07.04.1998.
<i>Aporrectodea smaragdina</i> (Rosa, 1892)	Pastures and oak forest	6 exp., Babin zub (43°22'N, 22°36'E), 1500 m, 20.04.1998; 3 exp., Babin zub (43°22'N, 22°36'E), 1000 m, 10.05.1998; 1 exp., Babin zub (43°22'N, 22°36'E), 1500 m, 10.05.1998.
<i>Aporrectodea trapezoides</i> (Duges, 1828)	Rivers and meadows	4 exp., Timok (43°54'N, 22°17'E), 600 m, 07.04.1998; 14 exp., Timok (43°54'N, 22°17'E), 600 m, 20.04.1998; 1 exp., Javor (43°15'N, 22°32'E), 07.07.2008; 2 exp., Dojkinci (43°13'N, 22°47'E), 08.07.2008; 1 exp., Dojkinci (43°13'N, 22°47'E), 09.07.2008.
<i>Dendrobaena attemsi</i> (Michaelsen, 1902)	Beech forest	1 exp., Jabučko ravnište (43°22'N, 22°36'E), 1500 m, 25.07.1997.
<i>Dendrobaena byblica</i> (Rosa, 1893)	Beech forest, meadows, and oak forest	Serbia: 9 exp., Midžor (43°23'N, 22°40'E), 2150 m, 23.07.1997; 1 exp., Jabučko ravnište (43°22'N, 22°36'E), 1500 m, 19.07.1997; 3 exp., Babin zub (43°22'N, 22°36'E), 1000 m, 10.05.1998; 2 exp., Timok (43°54'N, 22°17'E), 600 m, 10.05.1998; 1 exp., Timok (43°54'N, 22°17'E), 600 m, 07.04.1998; 3 exp., Timok (43°54'N, 22°17'E), 600 m, 20.04.1998; 3 exp., Dojkinci (43°13'N, 22°47'E), 09.07.2008; 2 exp.
<i>Dendrobaena hortensis</i> (Michaelsen, 1980)	Beech forest, meadows, and pine forest	47 exp., Golema reka (43°09'N, 22°35'E), 1363 m, 23.07.1997; 38 exp., Babin zub (43°22'N, 22°36'E), 1577 m, 20.07.1997; 33 exp., Jabučko ravnište (43°22'N, 22°36'E), 1500 m, 19.07.1997; 28 exp., Jabučko ravnište (43°22'N, 22°36'E), 1500 m, 25.07.1997; 6 exp., Midžor (43°23'N, 22°40'E), 23.07.1997.
<i>Dendrobaena illyrica</i> (Cognetti, 1906)	Beech forest and meadows	1 exp., Golema reka (43°09'N, 22°35'E), 1363 m, 23.07.1997; 1 exp., Dojkinci (43°13'N, 22°47'E), 10.07.2008.
<i>Dendrobaena jastrebenensis</i> Mršić and Šapkarev, 1987	Beech forest, meadows, oak forest, and stream	1 exp., Golema reka (43°09'N, 22°35'E), 1363 m, 23.07.1997; 74 exp., Jabučko ravnište (43°22'N, 22°36'E), 1500 m, 18.07.1997; 3 exp., Babin zub (43°22'N, 22°36'E), 1000 m, 10.05.1998; 4 exp., Lom (43°15'N, 22°32'E), 08.07.2008.

Table 1. (continued).

Species	Habitat	Localities
<i>Dendrobaena octaedra</i> (Savigny, 1826)	Beech forest and meadows	2 exp., Golema reka (43°09'N, 22°35'E), 1363 m, 23.07.1997; 1 exp., Babin zub (43°22'N, 22°36'E), 1750 m, 20.07.1997; 1 exp., Jabučko ravnište (43°22'N, 22°36'E), 1500 m, 19.07.1997; 4 exp., Golema reka (43°09'N, 22°35'E), 1450 m, 22.07.1997; 1 exp., Jabučko ravnište (43°22'N, 22°36'E), 1500 m, 18.07.1997.
<i>Dendrobaena rhodopensis</i> (Černosvitov, 1937)	Beech forest	1 exp., Golema reka (43°09'N, 22°35'E), 1363 m, 23.07.1997.
<i>Dendrobaena vej dovskiyi</i> (Černosvitov, 1935)	Beech forest	Serbia: 10 exp., Golema reka (43°09'N, 22°35'E), 1363 m, 23.07.1997; 2 exp., Babin zub (43°22'N, 22°36'E), 1577 m, 20.07.1997.
<i>Dendrobaena veneta</i> (Rosa, 1886)	Beech forest	15 exp., Babin zub (43°22'N, 22°36'E), 850 m, 15.09.1998.
<i>Dendrodri lus rubidus rubidus</i> (Savigny, 1826)	Beech forest	2 exp., Golema reka (43°09'N, 22°35'E), 1363 m, 23.07.1997.
<i>Eisenia fetida</i> (Savigny, 1826)	Beech forest	7 exp., Timok (43°54'N, 22°17'E), 600 m, 10.05.1998.
<i>Eisenia lucens</i> (Waga, 1857)	Stream	1 exp., Javor (43°15'N, 22°32'E), 07.07.2008; 1 exp., Dojkinci (43°13'N, 22°47'E), 08.07.2008; 3 exp., Dojkinci (43°13'N, 22°47'E), 09.07.2008.
<i>Eiseniella tetraedra tetraedra</i> (Savigny, 1826)	Stream	2 exp., Dojkinci (43°13'N, 22°47'E), 09.07.2008.
<i>Helodrilus balcanicus balcanicus</i> (Černosvitov, 1931)	Stream	1 exp., Dojkinci (43°13'N, 22°47'E), 08.07.2008.
<i>Helodrilus cernosvitovianus</i> (Zicsi, 1967)	Cave	Serbia: 1 exp., Topli Do (43°20'N, 22°40'E), 06.11.1998.
<i>Lumbricus rubellus</i> Hofmeister, 1843	Oak forest, beech forest, meadows, and pastures	1 exp., Midžor (43°23'N, 22°40'E), 2150 m, 21.07.1997; 2 exp., Midžor (43°23'N, 22°40'E), 23.07.1997; 3 exp., Stanjanska reka (43°41'N, 22°43'E), 22.07.1997; 3 exp., Golema reka (43°09'N, 22°35'E), 1363 m, 23.07.1997; 2 exp., Jabučko ravnište (43°22'N, 22°36'E), 1500 m, 25.07.1997; 24 exp., Babin zub (43°22'N, 22°36'E), 1500 m, 20.04.1998; 8 exp., Babin zub (43°22'N, 22°36'E), 1000 m, 10.05.1998; 1 exp., Babin zub (43°22'N, 22°36'E), 900 m, 10.05.1998; 1 exp., Timok (43°54'N, 22°17'E), 600 m, 10.05.1998; 6 exp., Timok (43°54'N, 22°17'E), 600 m, 07.04.1998; 2 exp., Timok (43°54'N, 22°17'E), 600 m, 20.04.1998; 6 exp., Babin zub (43°22'N, 22°36'E), 1500 m, 10.05.1998; 2 exp., Babin zub, 700 m, 15.09.1998; 1 exp., Babin zub (43°22'N, 22°36'E), 850 m, 15.09.1998; 1 exp., Topli Do (43°20'N, 22°40'E), 06.11.1998; 1 exp., Dojkinci (43°13'N, 22°47'E), 08.07.2008; 2 exp., Dojkinci (43°13'N, 22°47'E), 09.07.2008.
<i>Octolasion lacteum</i> (Oerley, 1891)	Oak forest, beech forest, meadows, and pastures	5 exp., Jabučko ravnište (43°22'N, 22°36'E), 1500 m, 25.07.1997; 5 exp., Midžor (43°23'N, 22°40'E), 23.07.1997; 16 exp., Babin zub (43°22'N, 22°36'E), 1500 m, 20.04.1998; 4 exp., Babin zub (43°22'N, 22°36'E), 1000 m, 10.05.1998; 3 exp., Timok (43°54'N, 22°17'E), 600 m, 07.04.1998; 4 exp., Timok (43°54'N, 22°17'E), 600 m, 20.04.1998; 3 exp., Babin zub (43°22'N, 22°36'E), 1500 m, 10.05.1998; 2 exp., Babin zub (43°22'N, 22°36'E), 850 m, 15.09.1998; 2 exp., Javor (43°15'N, 22°32'E), 07.07.2008; 5 exp., Dojkinci, 08.07.2008; 2 exp., Dojkinci (43°13'N, 22°47'E), 09.07.2008; 13 exp.
<i>Proctodrilus tuberculatus</i> (Černosvitov, 1935)	Beech forest	1 exp., Midžor (43°23'N, 22°40'E), 2150 m, 21.07.1997.

**Table 2.** List of the earthworm taxa from the entire territory of the Balkan Mountains (Stara Planina Mountains).

Species	Serbian side	Bulgarian side	Zoogeographical position
<i>Allolobophora chlorotica</i> (Savigny, 1826)	Mršić, 1991; Stojanović, 1996	Šapkarev, 1986 (W)	Peregrine
<i>Allolobophora leoni</i> Michaelsen, 1891	Stojanović, 1996; authors' data		Trans-Aegean
<i>Allolobophora robusta robusta</i> Rosa, 1895	Mršić, 1991	Delchev et al., 1998 (C)	Moesian
<i>Allolobophora robusta spassenjakaramani</i> (Blakemore, 2004)	Authors' data**		Restricted endemic
<i>Allolobophoridela eiseni</i> (Levinsen 1884)		Černosvitov, 1937 (E)	Peregrine
<i>Aporrectodea caliginosa</i> (Savigny, 1826)	Mršić, 1991; Stojanović, 1996; authors' data	Rosa, 1897 (E); Černosvitov, 1937 (E); Šapkarev, 1986 (E)	Peregrine
<i>Aporrectodea handlirschi</i> (Rosa, 1897)	Stojanović, 1996, authors' data	Šapkarev, 1986 (W)	Trans-Aegean
<i>Aporrectodea jassyensis</i> (Michaelsen, 1891)	Mršić, 1991; Stojanović, 1996	Šapkarev, 1986 (W)	Trans-Aegean
<i>Aporrectodea rosea</i> (Savigny, 1826)	Mršić, 1991; Stojanović, 1996; authors' data	Rosa, 1897 (E); Černosvitov, 1937 (E); Šapkarev, 1986 (W, E)	Peregrine
<i>Aporrectodea smaragdina</i> (Rosa, 1892)	Authors' data**		Central European
<i>Aporrectodea trapezoides</i> (Duges, 1828)	Authors' data	Černosvitov, 1937 (E); Šapkarev, 1986 (W, E)	Peregrine
<i>Cernosvitovia biserialis</i> (Černosvitov, 1937)	Mršić, 1991	Šapkarev, 1986 (W); Deltshev et al., 1998 (W, E)	Restricted endemic
<i>Cernosvitovia bulgarica</i> (Černosvitov, 1939)		Plisko, 1963 (E); Mihailova, 1964 (E)	Restricted endemic
<i>Cernosvitovia krainensis</i> (Šapkarev, 1987)	Mršić and Šapkarev, 1987; Mršić, 1991		Restricted endemic
<i>Cernosvitovia rebeli</i> (Rosa, 1897)		Rosa, 1897 (E); Deltshev et al., 1998 (C, E)	Moesian
<i>Dendrobaena attemsi</i> (Michaelsen, 1902)	Authors' data*	Plisko, 1963 (C)	Trans-Aegean
<i>Dendrobaena byblica</i> (Rosa, 1893)	Authors' data**		Circum-Mediterranean
<i>Dendrobaena hortensis</i> (Michaelsen, 1980)	Authors' data**		Peregrine
<i>Dendrobaena illyrica</i> (Cognetti, 1906)	Authors' data**		Illyric
<i>Dendrobaena jastrebensis</i> Mršić and Šapkarev, 1987	Authors' data**		Restricted endemic
<i>Dendrobaena octaedra</i> (Savigny, 1826)	Authors' data	Plisko, 1963 (W)	Peregrine
<i>Dendrobaena rhodopensis</i> (Černosvitov, 1937)	Stojanović et al., 2008; authors' data	Plisko, 1963 (C); Deltshev et al., 1998 (C)	Wider endemic
<i>Dendrobaena vejvodskyi</i> (Černosvitov, 1935)	Authors' data**		Eastern Alpine
<i>Dendrobaena veneta</i> (Rosa, 1886)	Authors' data*	Szederjesi, 2012 (E)	Peregrine
<i>Dendrodriilus rubidus subrubicundus</i> (Eisen, 1874)	Stojanović, 1996; Stojanović et al., 2008	Černosvitov, 1937 (E); Šapkarev, 1986 (W)	Peregrine
<i>Dendrodriilus rubidus rubidus</i> (Savigny, 1826)	Authors' data	Šapkarev, 1986 (E)	Peregrine

Table 2. (continued).

Species	Serbian side	Bulgarian side	Zoogeographical position
<i>Eisenia fetida</i> (Savigny, 1826)	Authors' data	Rosa, 1897 (E); Černosvitov, 1937 (E); Šapkarev, 1986 (E, W)	Peregrine
<i>Eisenia lucens</i> (Waga, 1857)	Authors' data	Rosa, 1897 (E); Černosvitov, 1937 (E); Plisko, 1963 (E); Šapkarev, 1986 (W, C, E); Szederjesi, 2012 (E)	Central European montane
<i>Eisenia storkani</i> (Černosvitov, 1934)		Szederjesi, 2012 (E)	Restricted endemic
<i>Eiseniella tetraedra tetraedra</i> (Savigny, 1826)	Authors' data	Šapkarev, 1986 (W, C, E); Plisko, 1963 (W)	Peregrine
<i>Helodrilus balcanicus balcanicus</i> (Černosvitov, 1931)	Authors' data**		Wider endemic
<i>Helodrilus balcanicus plavensis</i> (Karaman, 1972)	Stojanović, 1996; Stojanović and Karaman, 2006		Restricted endemic
<i>Helodrilus cernosvitovianus</i> (Zicsi, 1967)	Authors' data**		Unclear type
<i>Lumbricus rubellus</i> Hoffmeister, 1843	Mršić, 1991; Stojanović, 1996; authors' data	Černosvitov, 1937 (C); Plisko, 1963 (W); Šapkarev, 1986 (C, W)	Peregrine
<i>Lumbricus polyphemus</i> (Fitzinger, 1833)		Rosa, 1897 (E); Šapkarev, 1986 (C)	Central European montane
<i>Lumbricus terrestris</i> Linnaeus, 1758	Mršić, 1991	Černosvitov, 1937 (E); Šapkarev, 1986 (W, E)	Peregrine
<i>Octolasion lacteum</i> (Orley, 1891)	Mršić, 1991; Stojanović, 1996; authors' data	Černosvitov, 1937 (C); Rosa, 1897 (E); Plisko, 1963 (C); Šapkarev, 1986 (W, C, E)	Peregrine
<i>Octodrilus transpadanus</i> (Rosa, 1884)		Rosa, 1897 (E)	Trans-Aegean
<i>Perelia nematogena</i> (Rosa 1903)	Stojanović, 1996; Stojanović et al., 2008	Rosa, 1897(E); Černosvitov, 1937 (C); Plisko, 1963 (C); Šapkarev, 1986 (W, C, E)	Southern Alpine
<i>Proctodrilus tuberculatus</i> (Černosvitov, 1935)	Authors' data	Šapkarev, 1986 (W)	Trans-Aegean

\*First finding in the western Stara Planina Mountains.

\*\*First finding for the whole Stara Planina Mountains.

W- Western Stara Planina Mountains; C- Central Stara Planina Mountains; E- Eastern Stara Planina Mountains.

(1 taxon), *Allolobophora* (1 taxon), and *Aporrectodea* (1 taxon). *Allolobophora robusta* is a Moesian element and has 1 subspecies, *A. robusta spasiensijakaramani*, which is exclusively endemic to Serbia. This taxon is lacking in higher mountain areas and invades lower-altitude hilly habitats. Its present finding is the first in the Stara Planina Mountains. The genus *Eisenia* is represented by a single endemic species, *Eisenia storkani*, recorded in southwestern Bulgaria (Černosvitov, 1934) as well as in the eastern part of the Stara Planina Mountains (Sjederjezi, 2012).

Among the endemics, several species exclusively occur in the Balkan Peninsula. This includes the *Cernosvitovia* endemics, which are spread primarily throughout the

Rhodope (Balkan) tectonic plate. Of the 8 species endemic to the Balkan Peninsula (Rota, 2005), 3 are exclusive to the Stara Planina Mountains. *Cernosvitovia bulgarica* lives only in Bulgaria (eastern Stara Planina), *Cernosvitovia biserialis* is spread in the western region (Serbia and Bulgaria) (Šapkarev, 1986; Mršić, 1991; Delchev et al., 1998) and sporadically in the eastern Stara Planina Mountains (Delchev et al., 1998), and *Cernosvitovia krainensis* is exclusively endemic to Serbia [NW Stara Planina Mountains (Mršić and Šapkarev, 1987)].

*Helodrilus* is another genus with many endemics in the Balkan Peninsula (out of 16 taxa, 12 are endemics). Unfortunately, most species have a restricted territory and are poorly known, having been collected at just one or a

few localities (Šapkarev, 1978; Stojanović and Karaman, 2006). Two endemic Balkan *Helodrilus* taxa inhabit the western Stara Planina Mountains. One of them, *Helodrilus balcanicus plavensis*, is known from several distant localities in Montenegro and southern and eastern Serbia. *Helodrilus balcanicus balcanicus* inhabits Macedonia, Montenegro, and the southwestern part of Serbia.

The genus *Dendrobaena*, with 9 species, is the dominant faunal component of the earthworm fauna of the Stara Planina Mountains. This is not surprising because 1 of the 3 distribution centers of *Dendrobaena* occupies the Carpatho-Balkan area (Omodeo and Rota, 1991, 1999, 2008). However, up to now, only 2 endemic species have been recorded from the Stara Planina Mountains. *Dendrobaena rhodopensis*, which occurs at several high localities in Bulgaria and Montenegro, was only known from the central part of the Stara Planina (Plisko, 1963; Delchev et al., 1998); we have found it for the first time in the Serbian Stara Planina Mountains. Teteven, in the central part of the Stara Planina Mountains (Bulgaria), represents the eastern limit of the species' natural range, while the Serbian Stara Planina Mountains are its northernmost border. Taking into account that *Dendrobaena rhodopensis* is a high-mountain species, we can only suppose that it has been moving along the mountain ranges of the Balkan Peninsula. According to Šapkarev (1986) and Zicsi and Csuzdi (1986), the central finding of *Dendrobaena rhodopensis* is at Rila Mountain in the southern part of Bulgaria. Keeping in mind the fact that the easternmost point in its distribution is in the central part of the Stara Planina Mountains, we suppose that its possible migration from Rila Mountain could be towards the north to the Stara Planina Mountains. This supposed northern migration could cross Vitosha Mountain, reaching the western and central Stara Planina Mountains. Until now, *Dendrobaena jastrebensis* was exclusively endemic to a restricted part of Serbia (Stojanović et al., 2008). Now it has been recorded in the western part of the Stara Planina Mountains, and this represents its westernmost occurrence. Moreover, this is its first record for the Stara Planina Mountains.

Apart from the endemic species, the earthworm fauna of the Stara Planina Mountains is enriched by other zoogeographical types. One of the most important elements is the widely distributed trans-Aegean group, whose species (*Allolobophora leoni*, *Aporrectodea handlirschi*, *A. jassyensis*, *Dendrobaena attemsi*, *Octodrilus transpadanus*,

and *Proctodrilus tuberculatus*) show a range of distribution extending from Italy to Turkey (Mısırlıoğlu, 2008).

On the other hand, there are 2 southern elements in the earthworm fauna from the area of the Stara Planina Mountains that belong to the Moesian (East Balkans) and Illyric (West Balkans) species. Moesian elements, such as *Cernosvitovia rebeli* and *Allolobophora robusta robusta*, spread from the Balkan area and have reached the Carpathian Basin. On the other side, only one Illyric species (*Dendrobaena illyrica*) has dispersed from Serbia and Montenegro along the edge of the Carpathian Basin and throughout the Alps to Germany. Additionally, several wider central European range species (*Aporrectodea smaragdina*, *Eisenia lucens*, and *Lumbricus polyphemus*) as well as the Alpine elements are also found in the earthworm fauna due to the fact that the Stara Planina Mountains border the Carpathian Basin, which reaches the Alps. For example, *Perelia nematogena* is a southern Alpine element dispersed from the southern part of the Alps, while an eastern Alpine, such as *Dendrobaena vejdvovskyi*, spreads from the western part of Austria up to the Stara Planina Mountains across the eastern Carpathians. Taking into account these facts, it is clear that the connection of the Stara Planina Mountains with the Carpathians forms a natural pathway for northern species to reach areas further south.

The genus *Octodrilus* comprises about 50 species living in the Carpatho-Balkan Alpine region, but only 2 widespread species occur in the area of the Stara Planina Mountains. An analogous situation is that of the genera *Octolasion* and *Lumbricus*, only represented by widely distributed species.

The impressive lumbricid diversity (40 species) shows that the Stara Planina Mountains are a territory of considerable earthworm richness. However, the investigations are still insufficient and the earthworm inventory of the Stara Planina Mountains is far from complete. On the other hand, our data show that the degree of endemism for the Stara Planina Mountains is relatively high (20%). Summing up the 9 endemics and the Balkanic (Moesian and Illyric) species, 27.5% of the total lumbricid fauna shows an autochthonous character.

### Acknowledgments

This work was supported by the Ministry of Education and Science of Republic of Serbia (Grant No. 41010).

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