



New Records of Earthworms (Annelida: Clitellata) from the Kopaonik Mountain, with the First Finding of *Allolobophora treskavicensis* (Mršić, 1991) in Serbia

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Abstract: The aim of the study is to present new data on earthworm diversity in the Kopaonik Mountain, which is situated in the central part of southern Serbia and is a part of the Dinaric Range. A list of species including both published data and newly-recorded species of the family Lumbricidae is presented. It comprises 26 species-group taxa of 10 genera. The genera represented by the largest numbers of species are *Aporrectodea* (5) and *Dendrobaena* (5), while the genera *Bimastos*, *Eophila*, *Eiseniella* and *Octolasion* are represented by one species. The published data about two species-group taxa have not been confirmed by the recent studies. With respect to the zoogeographical analysis, the majority of the recorded taxa belong to the group of peregrine species (11). The endemic species are represented by three taxa and belong to the genus *Allolobophora*. The Balkan endemic *Allolobophora treskavicensis* (Mršić, 1991), known from a single locality from the Republic of North Macedonia, is a new species for the fauna of Serbia; the recorded new sites from the Kopaonik Mountain represent the northernmost limit of the geographical range of this species.

Key words: zoogeography, *Allolobophora treskavicensis*, Lumbricidae, Balkan Peninsula, fauna

Introduction

According to the data of the European Environment Agency (EEA 2011), two biogeographical regions are present in Serbia: Pannonian (Vojvodina Province) and Continental (Balkan Peninsula). The Kopaonik Mountain is located in the continental part of the Balkan Peninsula. It represents the largest mountain in central Serbia, having a total surface of 2,758 km². The highest part is Suvo Rudište Range, reaching an altitude of 2,017 m (Pančić Peak). Due

to its natural features, this most important and preserved part of the mountain was declared a protected territory of 11,809 ha in 1981 as the National Park Kopaonik (BOJOVIĆ 2012).

The Balkan Peninsula is a hotspot of the diversity of earthworms in Europe (CSUZDI et al. 2011), containing an exceptionally rich earthworm fauna (MRŠIĆ 1991, STOJANOVIĆ et al. 2008, SZEDERJESI & CSUZDI 2012, SZEDERJESI 2013). MRŠIĆ (1991) published a complete list of an earthworm of the Balkan Peninsula presenting altogether 135 taxa. Dur-

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ing the last years, the earthworm studies in Serbia gained a new momentum and several papers added new data to the earthworm fauna of various regions such as the Stara Planina Mountains (STOJANOVIĆ et al. 2013), western Serbia (MILUTINOVIĆ 2014), Pannonian Region (STOJANOVIĆ & MILUTINOVIĆ 2014), Kragujevac basin (STOJANOVIĆ et al. 2017) and Central Serbia (STOJANOVIĆ et al. 2018). The updated list of earthworms of Serbia (STOJANOVIĆ et al. 2018) registered altogether 75 taxa. Before we had launched the present survey, there was little information on the earthworm species composition in the Kopaonik Mountain. The first data on earthworm fauna of this mountain were provided by ŠAPKAREV (1972, 1980) who registered altogether 11 taxa. Later, STOJANOVIĆ (1996) found four taxa for the Kopaonik Mountain.

In this article, we aim to present the results of the recent survey of the earthworm fauna of the Kopaonik Mountain. The presented list provides a general overview of the ecology and zoogeographical relations of the species. We also report the first record of *Allolobophora treskavicensis* (Mršić, 1991) in Serbia, thus updating the knowledge of its geographical range.

Materials and Methods

Study area

Our studies were carried out in 2017–2019 in the Kopaonik Mountain (43°16'N, 20°49'E). This mountain is located between the rivers Ibar and

Sitnice in the west, Laba in the southeast, Jošanice and Koznik in the north, while the eastern side is surrounded by rivers Rasina and Toplice. Relatively recent studies have shown that this mountain system belongs to the inner Dinarides (PETKOVIĆ 1965, VASOVIĆ 1985). This territory is located at the overlapping area of the coastal to the continental climate. The diverse geological structure with rocks of different origin and age (serpentinites, granites, shards, marbles, andesites, limestone) are present. At the foothill of the Kopaonik, the prevailing habitats are pastures and mixed forests of oak and hornbeam, while on the higher parts there are mixed forests of beech and fir as well as coniferous forests of spruce and fir. The Kopaonik Mountain is distinguished by a high level of biodiversity, with more than 1600 species of vascular plants, 170 bird species and 39 mammal species (AMIDŽIĆ 2007).

The majority of sampling sites were located on the western foothill region the Kopaonik Mountain (Table 1).

Methods

Earthworms were collected from various natural habitats: river banks, meadows, humid meadows, pastures, oak forest, beech forest and spruce forest. The habitats were situated between 400 m and 1,950 m a.s.l. Earthworms were collected using the diluted formaldehyde method complemented with digging (0.4 x 0.4 m²) and hand sorting as well as turning over rocks, debris and logs. The earthworms were killed in 70% ethanol, immediately fixed in 4% formalin solution and stored in 90% ethanol. Data

Table 1. Sampling sites in the Kopaonik Mountain.

Localities	Coordinates	Habitat
Raška (416 m)	43°17'08"N, 20°36'33"E	Oak forest and meadows
Rudnica (441 m)	43°14'07"N, 20°41'02"E	Meadow
Jošanička banja (550 m)	43°21'23"N, 20°45'08"E	Beech forest, river banks and meadow
Kokorevac (605 m)	43°21'36"N, 20°45'36"E	Meadow
Mure (612 m)	43°14'01"N, 20°42'00"E	Oak forest and meadows
Novo Selo (711 m)	43°14'19"N, 20°42'21"E	Oak forest and meadows
Beljak (750 m)	43°15'15.66"N, 20°43'28.38"E	Oak forest and meadows
Semeteš (1.000 m)	43°17'45"N, 20°43'08"E	Beech forest and humid meadow near lake
Kriva Reka (1.100 m)	43°20'25"N, 20°52'01"E	River banks
Lisina (1.300 m)	43°16'32"N, 20°45'06"E	Beech forest and river banks
Crna Glava (1.397 m)	43°22'11"N, 20°49'7"E	Beech forest
Čajetina (1.500 m)	43°16'28"N, 20°45'58"E	Beech forest
Gvozdac (1.550 m)	43°17'32"N, 20°45'49"E	Meadow
Treska (1.622 m)	43°16'10"N, 20°48'54"E	Beech forest and pastures
Malo Jezero (1750 m)	43°17'11"N, 20°48'35"E	Humid meadows
Marine Vode (1950 m)	43°17'34"N, 20°49'06"E	Spruce forest

on species were obtained from both recent fieldwork and our old collections. Species identification was made according to the complex features provided in ŠAPKAREV (1978), ZICSI (1982), MRŠIĆ (1991), CSUZDI & ZICSI (2003) and BLAKEMORE (2004).

The categorisation of lumbricid species was based on their zoogeographic distribution as proposed by CSUZDI & ZICSI (2003), POP et al. (2010) and CSUZDI et al. (2011).

For each species in the list below, we use the following abbreviations: “E”: Ecology; “D”: Distribution in the Kopaonik Mountain (number of species, place, date of sampling); “Z”: Zoogeographical distribution.

Results

Class Oligochaeta

Family Lumbricidae Rafinesque-Schmaltz, 1815

Genus *Allolobophora* Eisen, 1874

Allolobophora kosowensis kosowensis Karaman, 1968

Allolobophora kosowensis KARAMAN, 1968: 50.

Allolobophora kosowensis kosowensis: CSUZDI 2012: 97–99; STOJANOVIĆ & MILUTINOVIĆ 2014: 308; MILUTINOVIĆ et al. 2015b: 5; TRAKIĆ et al. 2016: 255.

E. Beech forest, meadows, pastures, anthropogenic biotopes (STOJANOVIĆ 1996, STOJANOVIĆ & KARAMAN 2003, MILUTINOVIĆ et al. 2010); D. 7 exp., Mure, 06.04.2018; 4 exp., Rudnica 10.04.2019; Z. Broad-ranged Balkan endemic.

Allolobophora leoni Michaelsen, 1891

Allolobophora leoni MICHAELSEN 1891: 15.

Allolobophora leoni ŠAPKAREV 1980: 167; STOJANOVIĆ 1996: 39; STOJANOVIĆ & KARAMAN 2005: 128; STOJANOVIĆ et al. 2008: 59; STOJANOVIĆ et al. 2013: 637; STOJANOVIĆ & MILUTINOVIĆ 2014: 308; MILUTINOVIĆ 2014: 54; MILUTINOVIĆ et al. 2015a: 280.

E. Arable land and river banks (ŠAPKAREV 1980); beech and oak forests, wet meadows (STOJANOVIĆ 1996, MILUTINOVIĆ et al. 2010, STOJANOVIĆ et al. 2013). D. 1 exp., Novo selo, 06.04.2018; 2 exp., Rudnica 15.05.2019. Z. Trans-Aegean.

Allolobophora (s. l.) paratuleskovi Šapkar, 1975

Allolobophora paratuleskovi ŠAPKAREV 1975: 55.

Allolobophora paratuleskovi: CSUZDI 2012: 97–99; TRAKIĆ et al. 2016: 256.

E. Meadows (STOJANOVIĆ & KARAMAN 2003, MILUTINOVIĆ et al. 2010), beech forest, oak forest. D. 2 exp., Raška, 29.04.1975 (ŠAPKAREV 1980); 12 exp., Mure, 06.04.2018; 1 exp., Semeteš, 17.05.2018; 4 exp., Rudnica, 10.04.2019. Z. Broad-ranged Balkan endemic.

Allolobophora (s. l.) treskavicensis (Mršić, 1991)

Italobakaniona treskavicensis MRŠIĆ 1991: 165.

Allolobophora treskavicensis CSUZDI 2012: 97–99.

E. Humid meadows (MRŠIĆ 1991). D. 21 exp., Semeteš, 17.05.2018; 4 exp., Treska 30.05.2019; 18 exp., Semeteš 31.05.2019. Z. Broad-ranged Balkan endemic.

Description (based on the present specimens). External characters: Length 42–70 mm, diameter 2.5–3.5 mm. Number of segments 140–164. Prostomium prolobius. Setae arranged



Fig. 1. A living specimen of *Allolobophora treskavicensis* found in the course of the present study.

in closely set pairs. Body grey, clitellum orange (Fig. 1). Male aperture in intersegmental groove 15/16th, heart shape. Glandular papillae surrounding setae ab on segments 12, 13 and 14. Clitellum from 21 to 31 segments, while tubercula pubertatis from 21 to 28, ½ 29, 1/3 29 segments. Internal characters: Two pairs of large seminal vesicles present in segments 11th and 12th. Spermathecae three pairs in 14th to 16th segment on the septa 13/14 to 15/16. Septa thickened from 5/6 to the 11/12. Calciferous glands situated in 10th to 12th segment. Crop in 15th to 16th segments, gizzard from 17th to 20th segment. Nephridial bladder U-shaped.

Genus *Aporrectodea* Örley, 1885

Aporrectodea caliginosa caliginosa (Savigny, 1826)

Enterion caliginosum SAVIGNY 1826: 180.

Aporrectodea caliginosa caliginosa STOJANOVIĆ & KARAMAN 2005: 128; STOJANOVIĆ et al. 2008: 59; MILUTINOVIĆ et al. 2010: 629; CSUZDI 2012: 97–99; MILUTINOVIĆ et al. 2015a: 280.

E. Arable land (ŠAPKAREV 1980); beech and oak forests, river banks, wet meadows (STOJANOVIĆ 1996, STOJANOVIĆ et al. 2008, MILUTINOVIĆ et al. 2010); rivers and pastures (STOJANOVIĆ et al. 2013, MILUTINOVIĆ 2014). D. 2 exp., Raška, 02.04.1988 (STOJANOVIĆ 1996); 1 exp., Gvozdac, 14.05.2017; 9 exp., Mure, 06.04.2018; 1 exp., Kokorevac, 17.05.2018; 4 exp., Jošanička banja, 14.05.2017., 10.04.2019; 1 exp., Rudnica, 10.04.2019; 1 exp., Semeteš, 31.05.2019. Z. Peregrine.

Aporrectodea caliginosa trapezoides (Duges, 1828)

Lumbricus trapezoides DUGES 1828: 289.

Aporrectodea (Aporrectodea) caliginosa trapezoides: MRŠIĆ 1991: 328; CSUZDI 2012: 97–99.

E. Beech forest, valley meadow, river banks, anthropogenic biotopes (ŠAPKAREV 1980, STOJANOVIĆ 1996, MILUTINOVIĆ et al. 2010); rivers and meadows (STOJANOVIĆ et al. 2013, MILUTINOVIĆ 2014); oak forest. D. 2 exp., Raška, 17.07.1962 (ŠAPKAREV 1972); 2 exp., Gvozdac, 11.05.2017; 1 exp., Mure, 06.04.2018; 2 exp., Kokorevac, 17.05.2018; 3 exp., Jošanička Banja, 10.04.2019; 2 exp., Semeteš, 31.05.2019. Z. Peregrine.

Aporrectodea rosea (Savigny, 1826)

Enterion roseum SAVIGNY 1826: 182.

Aporrectodea rosea STOJANOVIĆ & KARAMAN 2005: 128; SZEDERJESI 2013: 64; STOJANOVIĆ et al. 2013: 637.

E. Rivers, pastures, cave, beech forest, and oak forest, cultivated soils, meadows (ŠAPKAREV 1980, STOJANOVIĆ

1996, MILUTINović et al. 2010, STOJANOVIĆ et al. 2013). D. 4 exp., Crna Glava, 14.05.2017; 4 exp., Raška, 23.04.1970 (ŠAPKAREV 1980); 4 exp., Raška, 02.04.1988., 10.04.1988 (STOJANOVIĆ 1996); 25 exp., Mure, 06.04.2018; 26 exp., Novo Selo, 16.05.2018; 13 exp., Beljak 16.05.2018; 23 exp., Semeteš, 17.05.2018; 27 exp., Kokorevac, 17.05.2018; 9 exp., Jošanička Banja, 10.04.2019; 7 exp., Rudnica, 10.04.2019; 33 exp., Rudnica, 15.05.2019; 5 exp., Kriva Reka 30.05.2019; 7 exp., Marine Vode, 30.05.2019; 12 exp., Semeteš, 31.05.2019; 2 exp., Treska, 30.05.2019. Z. Peregrine.

Aporrectodea georgii (Michaelsen, 1890)

Allolobophora georgii MICHAELSEN 1890: 3.

Aporrectodea (Aporrectodea) georgii MRŠIĆ 1991: 315; STOJANOVIĆ et al. 2008: 59; MILUTINović et al. 2010: 629; MILUTINović 2014: 63; MILUTINović et al. 2015a: 280.

E. Beech and oak forests, valley meadow, humid meadows (STOJANOVIĆ 1996, MILUTINović et al. 2010). D. 1 exp., Raška, 17.07.1962 (ŠAPKAREV 1972). Z. Atlanto-Mediterranean.

Aporrectodea jassyensis (Michaelsen, 1891)

Allolobophora jassyensis MICHAELSEN 1891: 15.

Aporrectodea jassyensis CSUZDI 2012: 97–99; STOJANOVIĆ & MILUTINović 2014: 308.

E. Arable land and river banks (ŠAPKAREV 1980); valley meadow, forests, under oak trees, under stones (CSUZDI & PAVLIČEK 2005). D. 1 exp., Raška, 17.07.1962 (ŠAPKAREV 1972); 4 exp., Čajetina, 14.05.2017. Z. Trans-Aegean.

Genus ***Bimastos*** Moore, 1893

Bimastos rubidus (Savigny, 1826)

Enterion rubidum SAVIGNY 1826: 182.

Bimastos rubidus CSUZDI 2012: 97–99.

E. Under rocks and river banks (ŠAPKAREV 1980), beech and oak forest, pastures, meadow, anthropogenic biotopes (STOJANOVIĆ 1996, MILUTINović et al. 2010, STOJANOVIĆ et al. 2013, MILUTINović 2014), hill meadows and alder forest along a stream (SZEDERJESI 2013, MILUTINović 2014). D. 4 exp., Raška, 04.05.1973 (ŠAPKAREV 1980); 7 exp., Crna Glava, 14.05.2017; 1 exp., Gvozdac, 14.05.2017; 7 exp., Beljak, 16.05.2018; 4 exp., Semeteš, 17.05.2018; 22 exp., Lisina, 17.05.2018; 10 exp., Jošanička Banja, 10.04.2019; 1 exp., Kriva Reka, 30.05.2019; 1 exp., Treska, 30.05.2019. Z. Peregrine (native in the Palaearctic).

Remark: CSUZDI et al. (2017) proved that the genus *Dendrodrilus* Omodeo, 1956 is a synonym for the genus *Bimastos*. Therefore, the subspecies *D. rubidus rubidus* and *D. rubidus subrubicundus* belong to *B. rubidus*.

Genus ***Dendrobaena*** Eisen, 1873

Dendrobaena alpina alpina (Rosa, 1884)

Allolobophora alpina ROSA 1884: 28.

Dendrobaena alpina alpina ŠAPKAREV 1980: 166; MRŠIĆ 1991: 627; STOJANOVIĆ et al. 2008: 59; CSUZDI 2012: 97–99; SZEDERJESI 2013: 66.

E. Pastures (ŠAPKAREV 1980), anthropogenic biotopes, forest soil (STOJANOVIĆ 1996, MILUTINović et al. 2010, SZEDERJESI 2013); D. 2 exp., Kopaonik, 17.07.1962 (ŠAPKAREV 1980); 2 exp., Lisina, 30.05.2019. Z. Balkanic-Alpine species distributed in the Balkans, Alps and Carpathian arcs (CSUZDI et al. 2011, POP et al. 2007, HACKENBERGER KUTUZOVIĆ & HACKENBERGER KUTUZOVIĆ 2013).

Dendrobaena byblica byblica (Rosa, 1893)

Allolobophora byblica ROSA 1893: 4.

Dendrobaena byblica byblica STOJANOVIĆ et al. 2008: 59; SZEDERJESI 2013: 67.

E. Beech forest, oak forest, meadows, river bank (ŠAPKAREV 1980, STOJANOVIĆ 1996, MILUTINović et al. 2010, SZEDERJESI 2013, STOJANOVIĆ et al. 2013). D. 4 exp., Raška, 02.04.1988 (STOJANOVIĆ 1996); 1 exp., Gvozdac, 14.05.2017; 1 exp., Jošanička Banja 14.05.2017; 4 exp., Malo Jezero, 30.05.2019. Z. Circum-Mediterranean subspecies.

Dendrobaena illyrica (Cognetti, 1906)

Helodrilus (Dendrobaena) illyricus COGNETTI 1906: 1.

Dendrobaena illyrica MRŠIĆ 1991: 599; STOJANOVIĆ 1996: 66; STOJANOVIĆ et al. 2008: 59; STOJANOVIĆ et al. 2013: 637; MILUTINović 2014: 78; MILUTINović et al. 2015a: 280.

E. Near the stream, beech forest and meadows (STOJANOVIĆ 1996, STOJANOVIĆ et al. 2013). D. 7 exp., Jošanička Banja, 10.04.2019; 3 exp., Kriva Reka, 30.05.2019; 3 exp., Lisina, 30.05.2019; 5 exp., Malo Jezero, 30.05.2019; 1 exp., Semeteš, 31.05.2019; 1 exp., Treska, 30.05.2019. Z. Illyric (the North-Western Balkans) species that has reached the southern part of Serbia. It has dispersed from Serbia and Montenegro along the edge of the Carpathian Basin and throughout the Alps to Germany.

Dendrobaena octaedra (Savigny, 1826)

Enterion octaedrum SAVIGNY 1826: 183.

Dendrobaena octaedra MILUTINović et al. 2010: 630; SZEDERJESI 2013: 68; STOJANOVIĆ et al. 2013: 638; MILUTINović 2014: 80; MILUTINović et al. 2015a: 280.

E. Beech forest and meadows (STOJANOVIĆ 1996, MILUTINović et al. 2010, SZEDERJESI 2013, STOJANOVIĆ et al. 2013). D. 2 exp., Kopaonik, 07.10.1992 (STOJANOVIĆ 1996); 5 exp., Gvozdac, 14.05.2017; 9 exp., Čajetina, 31.05.2017; 23 exp., Jošanička Banja, 17.05.2018; 3 exp., Kriva Reka, 30.05.2019; 12 exp., Lisina, 30.05.2019; 5 exp., Malo Jezero 30.05.2019; 26 exp., Marine Vode 30.05.2019; 5 exp., Semeteš, 31.05.2019; 12 exp., Treska, 30.05.2019. Z. Peregrine.

Dendrobaena vej dovskyi (Černosvitov, 1935)

Bimastos vej dovskyi ČERNOSVITOV 1935: 66.

Dendrobaena vej dovskyi STOJANOVIĆ & KARAMAN 2005: 130; STOJANOVIĆ et al. 2008: 59; MILUTINović et al. 2010: 630; STOJANOVIĆ et al. 2013: 638.

E. Beech forest, pastures, forest soils, meadows (STOJANOVIĆ 1996, MILUTINović et al. 2010, STOJANOVIĆ et al. 2013). D. 1 exp., Mure, 06.04.2018; 7 exp., Novo Selo, 16.05.2018; 24 exp., Semeteš, 17.05.2018; 1 exp., Lisina, 15.10.2018; 12 exp., Jošanička Banja, 17.05.2018., 10.04.2019; 3 exp., Semeteš, 31.05.2019. Z. Balkanic-Alpine species distributed in the Balkan part of Serbia, Austria, Southern Germany, Slovakia and Hungary.

Genus ***Eisenia*** Malm, 1877

Eisenia fetida (Savigny, 1826)

Enterion fetidum SAVIGNY 1826: 182.

Eisenia fetida MRŠIĆ 1991: STOJANOVIĆ et al. 2008: 59; STOJANOVIĆ et al. 2013: 638; STOJANOVIĆ & MILUTINović 2014: 308; MILUTINović 2014: 86; MILUTINović et al. 2015a: 280.

E. Anthropogenic biotopes, beech forest, meadows (STOJANOVIĆ 1996, STOJANOVIĆ et al. 2013, MILUTINović 2014); oak forest. D. 16 exp., Crna Glava, 14.05.2017; 5 exp., Gvozdac, 14.05.2017; 5 exp., Mure, 06.04.2018; 2 exp., Novo

Selo, 16.05.2018. Z. Peregrine.

Eisenia lucens (Waga, 1857)

Lumbricus lucens WAGA 1857: 166–169

Eisenia lucens ŠAPKAREV 1980: 166; MRŠIĆ 1991: 500; STOJANOVIĆ 1996: 84; STOJANOVIĆ & KARAMAN 2005: 130; STOJANOVIĆ et al. 2008: 59; MILUTINOVIĆ et al. 2010: 630; SZEDERJESI 2013: 70; STOJANOVIĆ et al. 2013: 638; STOJANOVIĆ & MILUTINOVIĆ 2014: 308; MILUTINOVIĆ 2014: 88; MILUTINOVIĆ et al. 2015a: 280.

E. Mixed forest, old beech forest, oak forest, valley meadow, stream, pastures (STOJANOVIĆ 1996, MILUTINOVIĆ et al. 2010, STOJANOVIĆ et al. 2013, SZEDERJESI 2013). D. 4 exp., Crna Glava 14.05.2017; 7 exp., Jošanička Banja 17.05.2018., 10.04.2019. Z. Central European (montane) species occurring in the Pyrenean Mts. and in Central Europe from the Alps to the Balkan Peninsula.

Genus *Eiseniella* Michaelsen, 1900

Eiseniella tetraedra (Savigny, 1826)

Enterion tetraedrum SAVIGNY 1826: 184.

Eiseniella tetraedra CSUZDI 2012: 97–99; STOJANOVIĆ & MILUTINOVIĆ 2014: 308; MILUTINOVIĆ 2014: 90.

E. Beech and oak forests, wet meadows, river bank, stream (ŠAPKAREV 1980, STOJANOVIĆ 1996, MILUTINOVIĆ et al. 2010, STOJANOVIĆ et al. 2013). D. 1 exp., Raška, 17.07.1962 (ŠAPKAREV 1972); 1 exp., Raška, 02.04.1988 (STOJANOVIĆ 1996); Z. Peregrine.

Genus *Eophila* Rosa, 1893

Eophila gestroi (Cognetti, 1905)

Helodrilus (Eophila) gestri COGNETTI 1905: 114.

Eophila gestroi DE SOSA et al. 2019: 103–114

E. Meadows, oak and beech forests (STOJANOVIĆ 1996, STOJANOVIĆ et al. 2008, MILUTINOVIĆ 2014). D. 10 exp., Mure, 06.04.2018; 3 exp., Novo Selo, 16.05.2018; 1 exp., Beljak, 16.05.2018; Z. Balkanic-Alpine species.

Description (based on the present specimens). External characters: Length 85–165 mm, diameter 3.5–4 mm. Number of segments 130–222. Body light pink or colourless. Setae closely-paired. Prostomium prolobic, first dorsal pore in intersegmental furrows 9/10. Male aperture small, located in 15th segment. Glandular papillae present on segments 10 and 13, or 24, 31, 36, 43, or only 41 and 42. Clitellum from 29–30 to 40–41 segments. Tubercula pubertatis from 33–34 to 39–40 segments. Internal characters: Two pairs of large seminal vesicles present in segments 11th and 12th. Spermathecae in 10th and 11th segments. First distinct septum 5/6. Calciferous glands situated in 10th–12th segments. Crop in 15th–16th segments. Gizzard in 17th–19th segments. Nephridial vesicles proclinate. Longitudinal musculature of fasciculate type. Typhlosole bifid.

Remarks: *Eophila gestroi* is a Balkanic-Alpine species, distributed in the north part of Italy, western part of Slovenia as well as in the western and the south-west part of Serbia (ZICSI 1970, MRŠIĆ 1991, STOJANOVIĆ 1996, MILUTINOVIĆ 2014). It was first found in Serbia at the beginning of the 1990s at the Pešter Plateau (village Batraga) (STOJANOVIĆ 1996). Later on, MILUTINOVIĆ (2014) found this species at several localities in western Serbia (Tara Mt., Sirogojno, Mokra Gora and Zlatibor Mt.). Based on the results of the present study, we recognise the Kopaonik Mountain as the easternmost limit of the distribution range of *E. gestroi*.

Genus *Lumbricus* Linnaeus, 1758

Lumbricus castaneus (Savigny, 1826)

Enterion castaneum SAVIGNY 1826: 180.

Lumbricus castaneus MRŠIĆ 1991: 466; KARAMAN & STOJANOVIĆ 2002: 224;

E. In humid beech forest and pasture soils rich in organic material (STOJANOVIĆ 1996). D. 1 exp., Crna Glava, 14.05.2017; 2 exp., Jošanička Banja, 10.04.2019. Z. Peregrine species native in the Palaearctic.

Lumbricus polyphemus (Fitzinger, 1833)

Enterion polyphemus FITZINGER 1833: 551.

Lumbricus polyphemus ŠAPKAREV 1980: 167; MRŠIĆ 1991: 473; STOJANOVIĆ 1996: 97; STOJANOVIĆ et al. 2008: 59; SZEDERJESI 2013: 71; STOJANOVIĆ & MILUTINOVIĆ 2014: 308; MILUTINOVIĆ 2014: 95; MILUTINOVIĆ et al. 2015a: 280.

E. Mixed beech forest, riverside (SZEDERJESI 2013), oak forest, meadows (MILUTINOVIĆ 2014). D. 1 exp., Jošanička Banja, 10.04.2019; 4 exp., Kriva Reka, 30.05.2019. Z. Central European montane.

Lumbricus rubellus Hoffmeister, 1843

Lumbricus rubellus HOFFMEISTER 1843: 187.

Lumbricus rubellus rubellus STOJANOVIĆ et al. 2008: 60; STOJANOVIĆ & MILUTINOVIĆ 2014: 308; MILUTINOVIĆ et al. 2015a: 280.

E. Forest soils, cultivated soils, meadows (MILUTINOVIĆ et al. 2010, STOJANOVIĆ et al. 2013); 2 exp., Raška, 17.07.1962 (ŠAPKAREV 1972); 11 exp., Raška, 02.04.1988 (STOJANOVIĆ 1996); 4 exp., Crna Glava, 14.05.2017; 2 exp., Gvozdac, 14.05.2017; 1 exp., Čajetina, 31.05.2017; 1 exp., Mure, 06.04.2018; 6 exp., Novo Selo, 16.05.2018; 13 exp., Beljak, 16.05.2018; 6 exp., Semeteš, 17.05.2018; 3 exp., Kokorevac, 17.05.2018; 2 exp., Lisina, 15.10.2018; 3 exp., Jošanička Banja, 10.04.2019; 2 exp., Rudnica, 10.04.2019; 4 exp., Rudnica, 15.05.2019; 4 exp., Kriva Reka, 30.05.2019; 2 exp., Lisina, 30.05.2019; 4 exp., Malo Jezero, 30.05.2019; 4 exp., Marine Vode, 30.05.2019; 3 exp., Treska, 30.05.2019. Z. Peregrine species native in the Palaearctic.

Lumbricus terrestris Linnaeus, 1758

Lumbricus terrestris LINNAEUS 1758: 647.

Lumbricus terrestris ŠAPKAREV 1980: 167; MRŠIĆ 1991: 481; STOJANOVIĆ 1996: 102; STOJANOVIĆ et al. 2008: 60; STOJANOVIĆ & MILUTINOVIĆ 2014: 308; MILUTINOVIĆ 2014: 99; MILUTINOVIĆ et al. 2015a: 280.

E. Pastures, meadows (MILUTINOVIĆ 2014). D. 14 exp., Jošanička Banja 10.04.2019; 2 exp., Malo Jezero, 30.05.2019. Z. Peregrine species native in the Palaearctic.

Genus *Octolasion* Örley, 1885

Octolasion lacteum (Örley, 1881)

Lumbricus terrestris var. *lacteus* ÖRLEY 1881: 584.

Octolasion lacteum STOJANOVIĆ & KARAMAN 2005: 130; MILUTINOVIĆ et al. 2010: 630; CSUZDI 2012: 97–99; SZEDERJESI 2013: 72; STOJANOVIĆ et al. 2013: 638; STOJANOVIĆ & MILUTINOVIĆ 2014: 308; MILUTINOVIĆ 2014: 103.

E. Oak and beech forest, meadows, pastures, cultivated soil (MILUTINOVIĆ et al. 2010, SZEDERJESI 2013, STOJANOVIĆ et al. 2013). D. 9 exp., Raška, 02.04.1988 (STOJANOVIĆ 1996); 7 exp., Gvozdac, 14.05.2017; 6 exp., Mure, 06.04.2018; 8 exp., Novo Selo, 16.05.2018; 1 exp., Beljak, 16.05.2018; 1 exp., Semeteš, 17.05.2018; 2 exp., Kokorevac, 17.05.2018; 21 exp., Jošanička Banja, 14.05.2017, 10.04.2019; 6 exp., Rudnica, 10.04.2019; 3

exp., Lisina, 30.05.2019; 5 exp., Malo Jezero, 30.05.2019; 1 exp., Treska, 30.05.2019. Z. Peregrine species native in the Palaearctic.

Genus *Proctodrilus* Zicsi, 1985

Proctodrilus antipai (Michaelsen, 1891)

Allolobophora antipae MICHAELSEN 1891: 16.

Proctodrilus antipai CSUZDI 2012: 97–99; STOJANOVIĆ & MILUTINOVIĆ 2014: 308.

E. Hilly meadows, wet soil (STOJANOVIĆ 1996). D. 7 exp., Mure, 06.04.2018; 1 exp., Novo Selo, 16.05.2018; Z. Central European.

Proctodrilus tuberculatus (Černosvitov, 1935)

Eophila antipae tuberculata ČERNOSVITOV 1935: 58.

Proctodrilus tuberculatus STOJANOVIĆ et al. 2008: 60; CSUZDI 2012: 97–99; STOJANOVIĆ et al. 2013: 638; STOJANOVIĆ & MILUTINOVIĆ 2014: 308.

E. Beech forest (STOJANOVIĆ et al. 2013). D. 3 exp., Raška, 17.07.1962 (ŠAPKAREV 1980); Z. Trans-Aegean.

Discussion

The present list of the earthworm fauna recorded for the Kopaonik Mountain contains 26 species-group taxa (21 species and five subspecies), which belong to ten genera of the family Lumbricidae. The genera *Aporrectodea* and *Dendrobaena*, each represented by five species, are the dominant faunal component of the earthworms from Kopaonik. The remaining registered taxa belong to the following genera: *Allolobophora* (4), *Lumbricus* (4), *Eisenia* (2), *Proctodrilus* (2), *Bimastos* (1), *Eiseniella* (1), *Eophila* (1) and *Octolasion* (1). Our list of earthworms includes the presence of 14 taxa mentioned by previous authors (ŠAPKAREV 1972, 1980, STOJANOVIĆ 1996), while 12 taxa are listed for this area for the first time. However, during our field studies, we have not found *A. georgii* and *P. tuberculatus*; therefore,

Table 2. List of the earthworm species from the Kopaonik Mountain classified to ecological categories and distribution types.

Species	Ecological category	Distribution type	Source
<i>Allolobophora kosowensis kosowensis</i> Karaman, 1968	Anecic	Endemic	Present study
<i>Allolobophora leoni</i> Michaelsen, 1891	Endogeic	Trans-Aegean	Present study
<i>Allolobophora paratuleskovi</i> Šapkarev, 1975	Anecic	Endemic	ŠAPKAREV (1975), Present study
<i>Allolobophora treskavicensis</i> (Mršić, 1991)	Endogeic	Endemic	Present study
<i>Aporrectodea caliginosa caliginosa</i> (Savigny, 1826)	Endogeic	Peregrine	STOJANOVIĆ (1996), Present study
<i>Aporrectodea caliginosa trapezoides</i> (Duges, 1828)	Endogeic	Peregrine	ŠAPKAREV (1980), Present study
<i>Aporrectodea georgii</i> (Michaelsen, 1890)	Endogeic	Atlanto-Mediterranean	ŠAPKAREV (1980), Present study
<i>Aporrectodea jassyensis</i> (Michaelsen, 1891)	Endogeic	Trans-Aegean	ŠAPKAREV (1980), Present study
<i>Aporrectodea rosea</i> (Savigny, 1826)	Endogeic	Peregrine	ŠAPKAREV (1980), STOJANOVIĆ (1996), Present study
<i>Bimastos rubidus</i> (Savigny, 1826)	Epigeic	Peregrine	ŠAPKAREV (1980), Present study
<i>Dendrobaena alpina alpina</i> (Rosa, 1884)	Epigeic	Balkan-Alpine	ŠAPKAREV (1980), Present study
<i>Dendrobaena byblica byblica</i> (Rosa, 1893)	Epigeic	Circum-Mediterranean	STOJANOVIĆ (1996), Present study
<i>Dendrobaena illyrica</i> (Cognetti, 1906)	Epigeic	Illyric	Present study
<i>Dendrobaena octaedra</i> (Savigny, 1826)	Epigeic	Peregrine	STOJANOVIĆ (1996), Present study
<i>Dendrobaena vejvodskyi</i> (Černosvitov, 1935)	Epigeic	Balkan-Alpine	Present study
<i>Eisenia fetida</i> (Savigny, 1826)	Epigeic	Peregrine	Present study
<i>Eisenia lucens</i> (Waga, 1857)	Epigeic	Central European	Present study
<i>Eiseniella tetraedra tetraedra</i> (Savigny, 1826)	Epigeic	Peregrine	ŠAPKAREV (1972), Present study
<i>Eophila gestroi</i> (Cognetti, 1905)	Anecic	Balkan-Alpine	Present study
<i>Lumbricus castaneus</i> (Savigny, 1826)	Epigeic	Peregrine	Present study
<i>Lumbricus polyphemus</i> (Fitzinger, 1833)	Anecic	Central European	Present study
<i>Lumbricus rubellus</i> Hoffmeister, 1843	Epigeic	Peregrine	ŠAPKAREV (1972), Present study
<i>Lumbricus terrestris</i> Linnaeus, 1758	Anecic	Peregrine	Present study
<i>Octolasion lacteum</i> (Örley, 1881)	Endogeic	Peregrine	STOJANOVIĆ (1996), Present study
<i>Proctodrilus antipai</i> (Michaelsen, 1891)	Endogeic	Central European	Present study
<i>Proctodrilus tuberculatus</i> (Černosvitov, 1935)	Endogeic	Trans-Aegean	ŠAPKAREV (1980)

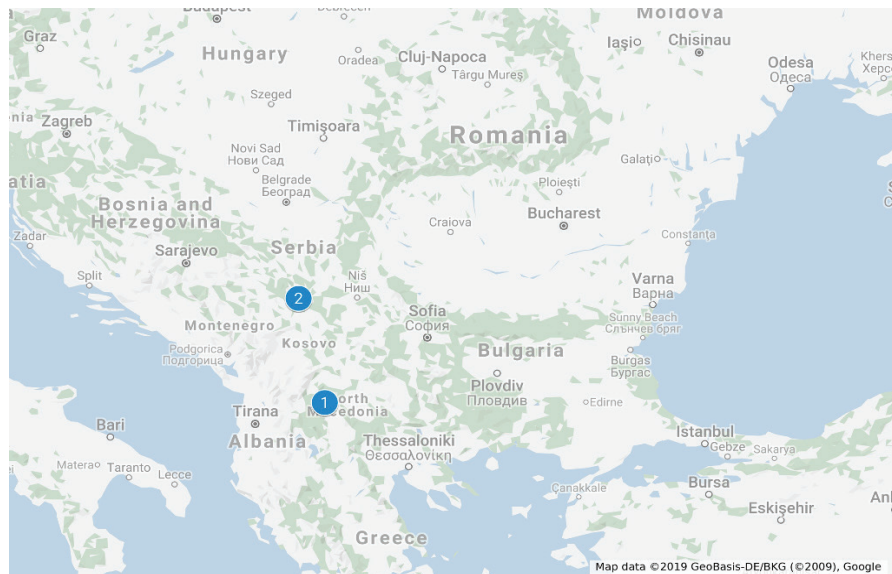


Fig. 2. Distribution of *Allolobophora treskavicensis* in North Macedonia (1) and Serbia (2).

we have provided only citation of the data published by ŠAPKAREV (1980).

From chorological point of view, the recorded species can be allocated to eight types of zoogeographical distribution (Table 2). The earthworm fauna of the Kopaonik Mountain is highly peregrine (11 taxa = 42.3%). The other important elements are Balkanic-Alpine (three taxa = 11.53%), Central-European (three taxa = 11.53%), Trans-Aegean (two taxa = 7.69%) and not so numerous Atlanto-Mediterranean (one taxon = 3.84%), Circum-Mediterranean (one taxon = 3.84%) and Illyric (one taxon = 3.84%).

According to the ecological category classification (BOUCHE 1977), 10 taxa were endogeic, 11 taxa were epigeic and five taxa were anecic (Table 2).

CSUZDI & ZICSI (2003) recognised four large biogeographic domains in the distribution area of endemic earthworm: Franco-Iberian, Aegean, Turanian and North American domains. The Kopaonik Mountain belongs to the North-Aegean Subdomain (POP et al. 2010). This subdomain is characterised by the presence of endemic species of the genera *Octodrilus* Omodeo, 1956, *Černosvitovia* Omodeo, 1956, *Fitzingeria* Zicsi, 1978 and *Dendrobaena*. It is interesting that endemic species of these genera have not been found in our research area before to the present study. In the area of the Kopaonik Mountain, the endemic taxa represent 11.53% (3 taxa) of the total number of the taxa and belong to the genus *Allolobophora*.

Allolobophora kosowensis kosowensis belongs to broad-range Balkan endemic species; so far, this

species has been registered in the Balkan part of Serbia, Montenegro (ŠAPKAREV 1975, MRŠIĆ 1991, STOJANOVIĆ & MILUTINOVIĆ 2013), Greece (SZEDERJESI et al. 2017) and in the only one locality situated on the border between the Pannonian Basin and the Balkan Peninsula (STOJANOVIĆ & MILUTINOVIĆ 2014, MILUTINOVIĆ et al. 2015b).

Allolobophora paratuleskovi has been described by ŠAPKAREV (1975) from localities in south-western Serbia (Raška and Novi Pazar). MRŠIĆ & ŠAPKAREV (1988) have believed that *A. paratuleskovi* is an endemic species for the central part of Serbia. However, subsequent studies (STOJANOVIĆ 1996, KARAMAN & STOJANOVIĆ 2002) have shown that this species is more widespread in Serbia occupying also eastern and western parts of the country. The last record of *A. paratuleskovi* was found in the early 2000s in the east part of Serbia (STOJANOVIĆ et al. 2008). After almost twenty years, we have found this species for the first time from the Kopaonik Mountain.

The Balkan endemic *A. treskavicensis* has been found for the first time in Serbia by the present study. This record increases the number of earthworms in Serbia to 76. So far, MRŠIĆ (1991) has found this species only at one locality in the Republic of North Macedonia (Treska near Skopje), describing it as *Italobalkaniona treskavicensis* (named after the Treska River). Interestingly, we have found this species on a location that is also called Treska on the Kopaonik Mountain. According to TRAKIĆ et al. (2016), *A. treskavicensis* has a narrow geographical range on the Balkans. Our study has shown that this species belongs to the group of broad-ranged Balkan

endemics. The new localities from the Kopaonik Mountain represent the northernmost limit of the geographical range of this species for now (Fig. 2). However, the taxonomy of this species has not been resolved. OMODEO & ROTA (2004) claimed that the genus *Italobalkaniona* Mršić & Šapkarev, 1988 is a synonym of the genus *Eophila* Rosa, 1983. CSUZDI (2012) classified this species in the genus *Allolobophora*.

Conclusion

The Kopaonik Mountain is distinguished by a high level of biodiversity. However, the list of known earthworm taxa in the area of the Kopaonik Mountain comprises 26 taxa, with only three endemic species. This is a very low proportion compared to 26 endemic earthworm species occurring in Serbia. Despite the fact that our knowledge of the distribution and abundance of earthworm species in the Kopaonik Mountain is far from complete, our study has noted several significant points. Namely, we have found an extension of the known distribution of the endemic species *Allolobophora treskavicensis* to the north, in Serbia. Such a discovery is of considerable faunistic interest, since it represents the first record for Serbia and the northernmost locality reported for this species so far. On the other hand, our list of earthworm species-group taxa includes the presence of 14 taxa mentioned by previous authors while 12 taxa are listed for this area for the first time. If we take into account the fact that the territory of the Balkan Peninsula (including the Kopaonik Mountain) represents one of the three major glacial refugia in Europe, we expect more species, particularly endemic species, in further investigations in this mountain. The current study could be considered as a significant part of investigations aiming at completing knowledge of earthworms of the Kopaonik Mountain. Moreover, it is a contribution toward understanding the very complex distribution of earthworm species on the Balkan Peninsula.

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