

Earthworms (Oligochaeta: Lumbricidae) of Bulgaria: Diversity and Biogeographical Review

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Abstract: In this paper we summarize the current knowledge on earthworm diversity in the eastern part of the Balkans – in Bulgaria. During the earthworm investigations in 2009, 2010 and 2011 in the western and south-western parts of Bulgaria, fifteen earthworm species were recorded altogether. Among them, *Lumbricus meliboeus* was recorded for first time, which represents the easternmost occurrence of this species at the European scale. On the basis of existing information on the earthworms from the entire territory of Bulgaria, we have summarized all published data and have established the list for the whole Bulgaria. The list underlines the diversity and zoogeographical position of earthworms. Now, on the grounds of the previous and our investigations, the lumbricids from the entire territory of Bulgaria are represented by 53 taxa, belonging to 15 genera of the family Lumbricidae. With respect to the zoogeographic situation, the largest number of them belongs to Endemic, Peregrine, and Trans-Aegean species. The endemic species take part with 30% in the total number of the species. The most of endemic species belong to the genera *Cernosvitovia*, *Octodrilus* and *Dendrobaena*.

Key words: Bulgaria, Lumbricidae, earthworms, diversity, zoogeography

Introduction

Balkan Peninsula is a territory with a high level of earthworm diversity. About 200 species of earthworms have been reported from the Balkans (Mršić 1991). However, the earthworm fauna of the eastern part of the Balkans, in the territory of Bulgaria have only a few works which have been published, dealing with the distribution of various earthworm species (Table 2). The first data of earthworms spreading in Bulgaria was done by ROSA (1897). He had established 7 species, collected from Sliven. Almost 40 years later, ČERNOSVITOV (1934, 1937) analyzed the collection of Natural Museum in Sofia and he has established 32 taxa.

Subsequently, some other scientists had been presenting data about earthworms in this area (PLISKO 1963, MIHAILOVA 1964, 1965, 1966a, 1966b, ZISCI, CSUZDI 1986, KVAVADZE, MILOJKOVA 1991). Meanwhile, some of species given by earlier authors,

especially by (MIHAILOVA 1966b) and ŠAPKAREV (1986), are synonyms of other species, or some of these species are ranked in other genera. So, the aim of this paper is to present the inventory gathered as well as the earlier data from other authors and, by analyzing the whole list of records, established the definitive list of known earthworm taxa from Bulgaria. The List underlines the diversity of earthworms and provided a general overview of their distribution and zoogeographical position.

Materials and Methods

Study area

The study was carried out over the 2009-2011 period in the western and southwestern part of Bulgaria. In the last investigations period on all over the territory of the investigated region we had collected earthworms from

various habitats which included natural forest communities (oak, beech, fir and spruce), lake surroundings and urban biotopes. The habitats are situated between 520 m and 1900 m altitude (Table 1):

Borisova gradina – the Central Park of Sofia town located at 520 m; meadow (N 42° 68' E 23° 33'), habitat number 1;

two lakes situated near Sofia:

Pancharevo Lake – an artificial lake in Western Bulgaria, at the end of Pancharevo Gorge of Iskar River, located at 700 m between Vitosha and Lozenska mountains; oak forest (N 42° 36' E 23° 24'), habitat number 2;

Boyana Lake – a small semi-artificial lake, situated on the northern slopes of Vitosha Mountain at 1900 m; oak forest (N 42° 38' E 23° 16'), habitat number 3;

two small areas in two different mountains situated in Southwestern Bulgaria:

Senokos village – a small village in Northern Pirin Mountain, Pirin National Park, located at 1000 m; meadow (N 41° 50' E 23° 12'), habitat number 4;

Parangalitz Nature Reserve's surroundings in Southwestern side of Rila Mountain at 1700 m; forest (beech, fir, spruce) (N 42° 11' E 23° 24'), habitat number 5.

Methods

The specimens were obtained by the diluted formaldehyde method complemented with digging and hand sorting. The earthworms were killed in 70% ethanol, fixed in 4% formalin solution and stored in 90% ethanol. Identification of species was done in accordance to: BLAKEMORE (2004), MRŠIĆ (1991), ZICSI (1982), ŠAPKAREV (1978), CSUZDI, ZICSI (2003).

The collected species were identified in the laboratory of Faculty of Science in Kragujevac, Serbia. Data on species were obtained from the literature and from fieldwork. Based on our investigation and examined literature records, our database includes localities, collecting date and the number of sample site.

Regional distribution

Relatively few works deal with the biogeography of earthworms and especially little work has been undertaken to understand the distribution of earthworms (CSUZDI, ZICSI 2003; MRŠIĆ 1991; OMODEO, ROTA 1991; POP *et al.* 2010). Bearing this in

mind, we have tried to summarize the biogeographical patterns of earthworms from the whole territory of Bulgaria. Following the distribution types given by CSUZDI, ZICSI (2003), POP *et al.* (2010) and CSUZDI *et al.* (2011), our distribution analysis has shown different distribution ranges: Peregrine (Per), Central European montane (mountains of the central part of Europe), Trans-Aegean (Europe from the Alps to the Ural Mts., Anatolia, Levant and Mesopotamia), Moesian (East Balkan), Eastern-Alpine, Southern-Alpine, Illyric (West Balkan), Balkanic-Alpine, Larger Endemite (only on the Balkan Peninsula, widespread distribution) and Endemite (only in the restricted area of the Balkan Peninsula).

Results and Discussion

Taxonomic richness

During the earthworm investigations in 2009, 2010 and 2011 in the western and Southwestern part of Bulgaria, fifteen earthworm species were recorded altogether (Table 1). Among them, *Lumbricus meliboeus* was recorded for the first time in Bulgaria, which represents the easternmost occurrence of this species at the European scale. So, on the grounds of the previous and our investigations, the lumbricids from the entire territory of Bulgaria are now represented by 53 taxa, belonging to 15 genera (Table 2). We did also discover new localities for the greater number of species.

When analyzing the total collection gathered in the investigation area, *Aporrectodea rosea* appears to be the most common and widespread taxa and occurs from east to west across the whole region. The next most common species are *Octolasion lacteum* and *Aporrectodea trapezoides*.

The species *Aporrectodea jassyensi* and *A. trapezoides* were few times recorded for Sofia town, but newly recorded for the investigated part of Vitosha Mountain. The species *Eisenia foetida* has been recorded in different regions of Bulgaria, and now in Northern Pirin too. *Dendrobaena octaedra* was several times in different years recorded for Rila Mountain and our investigation confirmed their distribution in the mountain. The species *Dendrodrilus rubidus subrubicunds* and *Octolasion lacteum* were recorded several times in the same locations where we found them in the present study, respectively Pirin and Vitosha Mountain.

Table 1. List of the collected lumbricid taxa and their localities (2009-2011)

Species	Habitat	Localities
<i>Allolobophora chlorotica</i> (Savigny, 1826)	meadow and forest	1 exp., May 2009, 1000 m (4)*
<i>Aporrectodea caliginosa caliginosa</i> (Savigny, 1826)	oak forest	6 exp., May 2009, (4); 2 exp., September 2010, (3); 3 exp., June 2011, (3)
<i>Aporrectodea jassyensis</i> (Michaelsen, 1891)	oak forest	1 exp., June 2011, (3)
<i>Aporrectodea rosea</i> (Savigny, 1826)	meadow and forest; oak forest	4 exp., October 2010, (4); 3 exp., September 2010, (3); 5 exp., June 2011, (3); 1 exp., June 2011, (1); 13 exp., June 2010, (2); 1 exp., May 2009, (4)
<i>Aporrectodea rosea leocernosvitovi</i> (Blakemore, 2004)	meadow	2 exp., October 2010, (1)
<i>Aporrectodea trapezoides</i> (Duges, 1828)	meadow and forest; oak forest	2 exp., May 2009, (4); 1 exp., October 2010, (4); 2 exp., September 2010, (3); 3 exp., June 2011, (3)
<i>Dendrobaena byblica</i> (Rosa, 1893)	oak forest	2 exp., June 2011, (1)
<i>Dendrobaena octaedra</i> (Savigny, 1826)	forest: beech, fir, spruce	2 exp., May 2009, (5)
<i>Dendrodrilus rubidus subrubicundus</i> (Eisen, 1874)	meadow and forest	1 exp., October 2010, (4)
<i>Eisenia fetida</i> (Savigny, 1826)	meadow and forest	1 exp., October 2010, (4)
<i>Eiseniella tetraedra tetraedra</i> (Savigny, 1826)	oak forest	1 exp., September 2010, (3); 1 exp., June 2010, (2)
<i>Lumbricus meliboeus</i> Rosa, 1884	forest: beech, fir, spruce	2 exp., May 2009, (5)
<i>Lumbricus rubellus</i> Hoffmeister, 1843	meadow and forest	1 exp., (4)
<i>Lumbricus terrestris</i> Linnaeus, 1758	meadow	1 exp., October 2010, (1)
<i>Octolasion lacteum</i> (Oerley, 1891)	meadow and forest: beech, fir, spruce	7 exp., May 2009, (5); 1 exp., October 2010, (4); 7 exp., September 2010, (3); 5 exp., June 2011, (3); 13 exp., June 2010, (2)

* – the number of investigated habitats are given in the text – see Study area

Most of the taxa belong to the genera *Aporrectodea*, *Dendrobaena* and *Allolobophora*, 10, 9 and 8 taxa respectively.

Biogeographical consideration

The previous investigations and our additional new data on the earthworms in the whole territory of Bulgaria. (Table 2) make it possible to determine the zoogeographical position of all taxa. Peregrine (33.96%), Endemics (30.18%) and Trans-Aegean (11.32%) represent practically two thirds of all the taxa. There follow Central European montane taxa (7.54%), Balkanic-Alpine (3.77%), Moesian (3.77%), Circum-Mediterranean (3.77%) and not so numerous Alpine-Balkan (1.87%) and Atlanto-Mediterranean (1.87%).

The degree of endemism is relatively high. The endemic species take part with 30.18% in the total

number of the species. The endemic species belong to the genera *Cernosvitovia* (3 taxa), *Octodrilus* (3 taxa), *Allolobophora* (3 taxa), *Dendrobaena* (3 taxa), *Aporrectodea* (2 taxa), *Helodrilus* (1 taxon) and *Spermophorodrilus* (1 taxon).

In the distribution area of endemic earthworms, CSUZDI, ZICSI (2003) have recognized four large biogeographic domains (the Franco-Iberian, Aegean, Turanian, and North American domains). The territory of Bulgaria belongs to North-Aegean sub-domain (POP *et al.* 2010). North-Aegean region is characterized by the presence of endemic species from the genera *Octodrilus*, *Cernosvitovia*, *Fitzingeria* and *Dendrobaena*. But, it is important to notice the absence of *Fitzingeria* endemics from the area of Bulgaria. Endemics from the genus *Fitzingeria*, are present in large numbers in the neighbouring Apuseni Mts. (POP *et al.* 2010). Out of 17 Dacian

endemic species, whose distribution centre is in the Apuseni Mts. (POP *et al.* 2010), only three Dacian endemic species (*Octodrilus exacystis*, *Octodrilus gradinescui* and *Allolobophora mehadiensis*) are presented in Bulgaria. This situation can be related to the fact that the Carpathians represent a natural barrier to earthworm distribution. *Octodrilus exacystis* was found in Romania in Apuseni Mts. and hilly parts of Transilvania (POP *et al.* 2010) and in Bulgaria (MIHAILOVA 1964, 1965, 1966a, 1966b, 1968) while *Octodrilus gradinescui* occurring in Romania, Slovakia, Ukraine and Hungary (CSUZDI, ZICSI 2003) and Bulgaria (MIHAILOVA 1964, 1965, 1966a, 1966b, 1968, DELČEV *et al.* 1998, KVAVADZE, MILOIKOVA 1991). On the other hand, *Octodrilus frivaldszkyi* was found only in the narrow area of Apuseni Mts. in Romania (POP *et al.* 2010) and in the restricted part of Bulgaria (MIHAILOVA 1964, 1965, 1968). Till now three *Allolobophora* endemics were recorded in Bulgaria of which only *Allolobophora mehadiensis* is Dacian endemics. *Allolobophora hrabei* is typical endemic lowland species in Bulgaria (ČERNOSVITOV 1934, 1937, ZICSI, CSUZDI 1986, DELČEV *et al.* 1998, KVAVADZE, MILOIKOVA 1991) and in Romania (CSUZDI *et al.* 2011). *Allolobophora tuleskovi* is exclusively endemic from Pirin Mts. in Bulgaria (ČERNOSVITOV 1934, 1937, ZICSI, CSUZDI 1986, DELČEV *et al.* 1998, KVAVADZE, MILOIKOVA 1991). Among the endemic species *Aporrectodea carpathica* is the typical Carpathian endemic species which occurs in the higher regions of Northern and North-Eastern Carpathian Mts. (CSUZDI *et al.* 2011), Poland, Moldavia, Czech Republic (MRŠIĆ 1991) and in higher part of Bulgaria (MIHAILOVA 1964, 1965, 1966a, 1966b, 1968).

Among the endemics there are several typical ones which exclusively occur in the Balkans. Such is the *Cernosvitovia* endemics, which is classified into the archaic group. It spreads primarily throughout the Rhodopes (Balkan) tectonic plate. Eight *Cernosvitovia* species are endemic to the Balkans. One species inhabits Western Spain (possibly introduced from the Balkans) and one inhabits NW Turkey. Out of all *Cernosvitovia* species from the Balkans, three of them inhabit the territory of Bulgaria. *Cernosvitovia bulgarica* is an exclusively Bulgarian endemic from eastern part of Stara Planina Mts. (ČERNOSVITOV 1934, 1937, PLISKO 1963, ŠAPKAREV 1986). *Cernosvitovia biserialis*

is spread mainly in the western and sporadically in the eastern parts of Bulgaria and in a very few localities in eastern Serbia (STOJANOVIĆ *et al.* 2008). *Cernosvitovia dobroagena* is endemic for Bulgaria (NW Stara Planina Mts.) and Romania, as well.

On the Balkans, the genus *Helodrilus* is the one which especially has a lot of endemic species (out of 16 taxa, 12 or 75% are endemic), unfortunately with poorly known species and their records (STOJANOVIĆ, KARAMAN 2006). Its species have a restricted territory and some of them are only known from the type locality. Only one endemic *Helodrilus* taxa inhabit the territory of Bulgaria. *Helodrilus duhlinskae* is known only from the type locality and little can be said about their possible distribution.

Up to now, three *Dendrobaena* endemic species were recorded. *Dendrobaena rhodopensis* was first described from Bulgaria, Rila Mts. (Kostenets). Also, it was known from a few localities in the central and the western part of Stara Planina Mts. in Bulgaria. Later on it has been found in several localities of the Balkans: Bulgaria (PLISKO 1963, ŠAPKAREV 1986, ZICSI, CSUZDI 1986, DELČEV *et al.* 1998), Greece (ŠAPKAREV 1972), Montenegro (KARAMAN, STOJANOVIĆ 1995) and Serbia (STOJANOVIĆ *et al.* 2008). Stara Planina Mts. (STOJANOVIĆ *et al.* 2008) are the northernmost border and Greece (ŠAPKAREV 1972) is the southernmost limit of distribution of this species. *D. balcanica* and *D. hrabei* were exclusively endemics (ZICSI, CSUDI 1986, MRŠIĆ 1991) to a restricted part of Bulgaria (Pirin Mt. and Rila Mt.). Endemic species *Spermophorodrilus antiquus* inhabits northern Greece, Albania, Macedonia and Northern Anatolia. It is registered in southern part of Bulgaria (PLISKO 1963), as well.

Apart from their endemic earthworm species, the fauna of Bulgaria is enriched by several other species belonging to different zoogeographical types. One of the most important elements is the Trans-Aegean group (11,32%), whose species show disjunct distribution around the Southern or the eastern shore of Black sea (*Octodrilus transpadanus*, *Proctodrilus tuberculatus*, *Allolobophora leoni*, *Aporrectodea handlirschi*).

There is one southern element in Bulgaria which consists of the Moesian (East Balkan) species (3.77%) which have reached the Carpathian Basin (*Cernosvitovia rebeli* and *Allolobophora robusta robusta*). Additionally, it is not surprising

Table 2. List of the earthworms taxa, collected in Bulgaria, the authors and areagographical position.

Species	Literature and authors data	Areagographical position
<i>Allolobophora chlorotica</i> (SAVIGNY, 1826)	PLISKO 1963; MIHAILOVA 1964, 1965, 1966a, 1966b, 1968; ŠAPKAREV 1986	Peregrine
<i>Allolobophora dubiosa</i> (ORLEY, 1880)	MIHAILOVA 1964, 1965, 1966a, 1966b, 1968; ЈАПКAREV 1986; DELTCHEV <i>et al.</i> , 1998; KVAVDZE, MILOIKOVA 1991	Trans-Aegean
<i>Allolobophora hrabei</i> (ČERNOSVITOV, 1935)	ČERNOSVITOV 1934, 1937; ZISCI and CSUZDI 1986; DELTCHEV <i>et al.</i> 1998; KVAVDZE, MILOIKOVA 1991	Endemite
<i>Allolobophora leoni</i> MICHAELSEN, 1891	MIHAILOVA 1964, 1965, 1966a, 1966b, 1968; DELTCHEV <i>et al.</i> 1988; KVAVDZE, MILOIKOVA 1991	Trans-Aegean
<i>Allolobophora melhadiensis</i> (ROSA, 1895)	MIHAILOVA 1964, 1965, 1966a, 1966b, 1968; DELTCHEV <i>et al.</i> 1998; KVAVDZE, MILOIKOVA 1991	Dacian endemism
<i>Allolobophora robusta robusta</i> ROSA, 1895	MIHAILOVA 1964, 1965, 1966a, 1966b, 1968; DELTCHEV <i>et al.</i> 1998; KVAVDZE, MILOIKOVA 1991; DELTSHEV <i>et al.</i> 1998	Moesian
<i>Allolobophora tuleskovi</i> (ČERNOSVITOV, 1934)	ČERNOSVITOV 1934, 1937; MIHAILOVA 1964, 1965, 1966a, 1966b, 1968; DELTCHEV <i>et al.</i> 1998; KVAVDZE, MILOIKOVA 1991	Endemite
<i>Allolobophoridela eiseni</i> (LEVINSEN 1884)	ČERNOSVITOV 1934, 1937	Peregrine
<i>Aporrectodea caliginosa caliginosa</i> (SAVIGNY, 1826)	ROSA 1897; ČERNOSVITOV 1934, 1937; PLISKO 1963; MIHAILOVA 1964, 1965, 1966, 1968; ŠAPKAREV 1986; authors data	Peregrine
<i>Aporrectodea carpathica</i> COGNETTI, 1927	MIHAILOVA 1964, 1965, 1966a, 1966b, 1968; DELTCHEV <i>et al.</i> 1998; KVAVDZE, MILOIKOVA 1991	Carpathian endemism
<i>Aporrectodea georgii</i> MICHAELSEN, 1890	PLISKO 1963; ŠAPKAREV 1986; DELTCHEV <i>et al.</i> 1998; KVAVDZE, MILOIKOVA 1991	Atlanto-Mediterranean
<i>Aporrectodea handlirschi</i> ROSA, 1897	ČERNOSVITOV 1934, 1937; PLISKO 1963; MIHAILOVA 1964, 1965, 1966a, 1966b, 1968; ŠAPKAREV 1986	Trans-Aegean
<i>Aporrectodea jassyensis</i> MICHAELSEN, 1891	PLISKO 1963; MIHAILOVA 1964, 1965, 1966, 1968; ŠAPKAREV 1986; authors data	Trans-Aegean
<i>Aporrectodea longa</i> UDE, 1885	ČERNOSVITOV 1934, 1937; PLISKO 1963; MIHAILOVA 1964, 1965, 1966a, 1966b, 1968	Peregrine
<i>Aporrectodea phoebea</i> (COGNETTI, 1913)	MIHAILOVA 1964, 1965, 1966, 1968	?
<i>Aporrectodea rosea</i> (SAVIGNY, 1826)	ROSA 1897; ČERNOSVITOV 1934, 1937; PLISKO 1963; MIHAILOVA 1964, 1965, 1966a, 1966b, 1968; ŠAPKAREV 1986; authors data	Peregrine
<i>Aporrectodea rosea leocernosvitovi</i> (BLAKEMORE, 2004)	ČERNOSVITOV 1934, 1937; MIHAILOVA 1964, 1965, 1966a, 1966b, 1968; authors data	Larger Endemite
<i>Aporrectodea trapezoides</i> (DUGES, 1828)	ČERNOSVITOV 1934, 1937; MIHAILOVA 1964, 1965, 1966a, 1966b, 1968; ŠAPKAREV 1986; authors data	Peregrine

Table 2. Continued.

Species	Literature and authors data	Areographical position
<i>Bimastos parvus</i> EISEN, 1874	PLISKO 1963; MIHAILOVA 1964, 1965, 1966, 1968	Peregrine
<i>Cernosvitovia biserialis</i> (ČERNOSVITOV, 1937)	ČERNOSVITOV 1934, 1937; MIHAILOVA 1964, 1965, 1966a, 1966b, 1968; ŠAPKAREV 1986; DELTICHEV <i>et al.</i> 1998; KVAVADZE, MILOIKOVA 1991	Larger Endemite
<i>Cernosvitovia bulgarica</i> (ČERNOSVITOV, 1939)	ČERNOSVITOV 1934, 1937; PLISKO 1963; ŠAPKAREV 1986	Endemite
<i>Cernosvitovia dobrogeana</i> (POP, 1938)	MIHAILOVA 1964, 1965, 1966, 1968; DELTICHEV <i>et al.</i> 1998; KVAVADZE, MILOIKOVA 1991	Larger Endemite
<i>Cernosvitovia rebeli</i> (ROSA, 1897)	ROSA 1897; ČERNOSVITOV 1934, 1937; MIHAILOVA 1964, 1965, 1966, 1968; DELTICHEV <i>et al.</i> 1998; KVAVADZE, MILOIKOVA 1991	Moesian
<i>Dendrobaena alpina</i> (ROSA, 1884)	ČERNOSVITOV 1934, 1937; PLISKO 1963; MIHAILOVA 1964, 1965, 1966a, 1966b, 1968; ŠAPKAREV 1986; ZISCI and CSUZDI 1986	Balkanic-Alpine
<i>Dendrobaena attemsi</i> (MICHAELSEN, 1902)	ČERNOSVITOV 1934, 1937; PLISKO 1963; MIHAILOVA 1964, 1965, 1966a, 1966b, 1968; ŠAPKAREV 1986; ZISCI and CSUZDI 1986	Balkanic-Alpine
<i>Dendrobaena balcanica</i> (ČERNOSVITOV, 1937)	ZISCI and CSUZDI 1986	Endemite
<i>Dendrobaena byblica</i> (ROSA, 1893)	ČERNOSVITOV, 1934, 1937; PLISKO 1963; ŠAPKAREV 1986	Circum-Mediterranean
<i>Dendrobaena hortensis</i> (MICHAELSEN, 1980)	MIHAILOVA 1964, 1965, 1966a, 1966b, 1968; DELTICHEV <i>et al.</i> 1998; KVAVADZE, MILOIKOVA, 1991	Peregrine
<i>Dendrobaena hrabei</i> (ČERNOSVITOV, 1934)	ČERNOSVITOV 1934; ZISCI and CSUZDI 1986	Endemite
<i>Dendrobaena octaedra</i> (SAVIGNY, 1826)	ČERNOSVITOV 1934, 1937; PLISKO 1963; MIHAILOVA 1964, 1965, 1966a, 1966b, 1968; ŠAPKAREV 1986; ZISCI and CSUZDI 1986; authors data	Peregrine
<i>Dendrobaena rhodopensis</i> (ČERNOSVITOV, 1937)	ČERNOSVITOV 1934, 1937; PLISKO 1963; MIHAILOVA 1964, 1965, 1966a, 1966b, 1968; ŠAPKAREV 1986; ZISCI and CSUZDI 1986; DELTICHEV <i>et al.</i> 1998; KVAVADZE, MILOIKOVA 1991; authors data	Larger Endemite
<i>Dendrobaena veneta</i> (ROSA, 1886)	ČERNOSVITOV 1934, 1937; ZISCI and CSUZDI 1986	Peregrine
<i>Dendrodritilus rubidus rubidus</i> (SAVIGNY, 1826)	PLISKO 1963	Peregrine
<i>Dendrodritilus rubidus subrubicundus</i> (EISEN, 1874)	ČERNOSVITOV 1934, 1937; MIHAILOVA 1964, 1965, 1966a, 1966b, 1968; ZISCI and CSUZDI 1986; ŠAPKAREV 1986; authors data	Peregrine
<i>Dendrodritilus rubidus tenuis</i> (EISEN, 1874)	ČERNOSVITOV 1934, 1937; MIHAILOVA 1964, 1965, 1966a, 1966b, 1968; ZISCI and CSUZDI 1986; ŠAPKAREV 1986	Peregrine

Table 2. Continued.

Species	Literature and authors data	Areographical position
<i>Eisenia fetida</i> (SAVIGNY, 1826)	ROSA 1897; ČERNOSVITOV 1934, 1937; MIHAILOVA 1964, 1965, 1966a, 1966b, 1968; ŠAPKAREV 1986; authors data	Peregrine
<i>Eisenia lucens</i> (WAGA, 1857)	ČERNOSVITOV 1934, 1937; PLISKO 1963; ŠAPKAREV 1986	Central European montane
<i>Eiseniella tetraedra tetraedra</i> (SAVIGNY, 1826)	ČERNOSVITOV 1934, 1937; PLISKO 1963; MIHAILOVA 1964, 1965, 1966a, 1966b, 1968; JAPKAREV 1986; ZISCI and CSUZDI 1986; authors data	Peregrine
<i>Fitzingeria platyura depressa</i> (ROSA, 1893)	MIHAILOVA 1964, 1965, 1966, 1966b, 1968	Central European montane
<i>Helodrilu duhlińskae</i> ZISCI and CSUZDI 1986	ZISCI and CSUZDI 1986	Endemite
<i>Lumbricus meliboeus</i> ROSA, 1884	authors data	Alpine-Balkanic
<i>Lumbricus polyphemus</i> (FITZINGER, 1833)	MIHAILOVA 1964, 1965, 1966a, 1966b, 1968; JAPKAREV 1986	Central European montane
<i>Lumbricus rubellus</i> HOFFMEISTER, 1843	ROSA 1897; ČERNOSVITOV 1934, 1937; PLISKO 1963; MIHAILOVA 1964, 1965, 1966a, 1966b, 1968; ZISCI and CSUZDI 1986; ŠAPKAREV 1986; authors data	Peregrine
<i>Lumbricus terrestris</i> LINNAEUS, 1758	ČERNOSVITOV 1934, 1937; PLISKO 1963; ZISCI and CSUZDI 1986; ŠAPKAREV 1986	Peregrine
<i>Octodrilus complanatus</i> (DUGES, 1828)	ČERNOSVITOV 1934, 1937; MIHAILOVA 1964, 1965, 1966, 1968	Circum-Mediterranean
<i>Octodrilus exacystis</i> (ROSA, 1896)	MIHAILOVA 1964, 1965, 1966a, 1966b, 1968	Dacian endemism
<i>Octodrilus frivaldszkyi</i> (OERLEY, 1885)	MIHAILOVA 1964, 1965, 1966a, 1966b, 1968	Endemite
<i>Octodrilus gradinescui</i> (POP, 1938)	MIHAILOVA 1964, 1965, 1966b, 1968; DELTICHEV <i>et al.</i> 1998; KVAVDZE, MILOIKOVA 1991	Dacian endemism
<i>Octodrilus transpadanus</i> (ROSA, 1884)	ROSA 1897; ČERNOSVITOV 1934, 1937; MIHAILOVA 1964, 1965, 1966, 1968	Trans-Aegean
<i>Octolasion lacteum</i> (OERLEY, 1891)	ROSA 1897; ČERNOSVITOV 1934, 1937; PLISKO 1963; MIHAILOVA 1964, 1965, 1966a, 1966b, 1968; ZISCI and CSUZDI 1986; ŠAPKAREV 1986; authors data	Peregrine
<i>Proctodrilus antipai</i> MICHAELSEN, 1891	MIHAILOVA 1964, 1965, 1966, 1968	Central European
<i>Proctodrilus tuberculata</i> (ČERNOSVITOV, 1935)	ČERNOSVITOV 1934, 1937; PLISKO 1963; MIHAILOVA 1964, 1965, 1966a, 1966b, 1968; ŠAPKAREV 1986	Trans-Aegean
<i>Spermophorodrilus antiquus</i> (ČERNOSVITOV, 1938)	PLISKO 1963; DELTICHEV <i>et al.</i> 1998; KVAVDZE, MILOIKOVA 1991	Larger Endemite

that several wider Central European range species (*Fitzingeria platyura depressa*, *Proctodrilus antipai*, *Lumbricus polyphemus* and *Eisenia lucens*) as well as Balkan-Alpine elements, are also found in the earthworm fauna due to the fact that Stara Planina Mts. borders the Carpathian Basin, which reaches the Alps. For example, Balkanic-Alpine element (3.77%) starting from the Balkan centre has dispersed up to the Alpine area (*Dendrobaena attemsi* and *Dendrobaena alpine*), while the Alpine-Balkan element (1.87%) starts from the Alps as a distribution centre (*Lumbricus meliboeus*) spreads to the eastern part of the Balkans. Taking into account these facts, it is clear that the connection of Stara Planina Mts. with the Carpathians and Alpine area is a natural pathway for northern species to reach areas further south.

The genus *Dendrobaena* with 9 species is the one of the dominant faunal component of earthworm fauna of Bulgaria. This is not surprising because of the fact that one of the three distribution centres of it occupies Carpatho-Balkan area (OMODEO, ROTA 1991). The genus *Octodrilus* comprises about fifty species living in Carpatho-Balkan Alpine region, but only two non-endemic species are living in the area of Bulgaria, *O. complanatus* (circum-Mediterranean) and *O. transpadanus*. An analogous situation is that of the genera *Octolasion*, and *Lumbricus* which

comprise wide spread species. It must be noted that the percentage of peregrine species in the area of Bulgaria is relatively high (33.96%). The possible reasons can be the deforestation of the mountains' natural forests and soil pollution, both of which could especially affect endemic earthworms that have narrower ecological valences. Contrary to this, peregrine species are more resistant and could replace them.

Conclusions

The impressive earthworm diversity of 53 earthworm species shows that Bulgaria is a territory of considerable species richness. This conclusion is also supported by the existence of fifteen endemic species. *Lumbricus meliboeus* was recorded for the first time in Bulgaria. Such a discovery is of a considerable faunistic interest: it represents the new faunistic element in Bulgaria.

However, our knowledge of the distribution and abundance of earthworm species in Bulgaria is far from complete and earthworm investigations in Bulgaria are still insufficient. Hopefully, our study of the earthworms from Bulgaria may be taken as a starting point for further research.

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