

Murchieona minuscula (Rosa, 1906): first finding from Bulgaria with earthworm diversity and zoogeography of Yıldız (Strandja) Mountain in Turkey and Bulgaria

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Abstract: In this paper, we present the current knowledge on earthworm diversity and zoogeography of Yıldız (Strandja) Mountain in Bulgaria and Turkey. During the investigation in 2015 and 2016, 8 earthworm species altogether were registered. *Murchieona minuscula* proved to be new to the earthworm fauna of Bulgaria. In addition, there were 4 taxa recorded for the first time from Yıldız (Strandja) Mountain: *Aporrectodea jassyensis*, *Aporrectodea rosea*, *Octolasion lacteum*, and *Proctodrilus tuberculatus*. Using all existing information on the earthworms from Yıldız (Strandja) Mountain, we summarized our and previously published data and established a list for the whole territory of the mountain from both Bulgaria and Turkey. The list provides information about earthworm diversity, distribution, and zoogeographical position. Currently, 16 taxa belonging to 11 genera are known from the investigation area. According to the zoogeographic position, the largest number of earthworms belong to peregrine, endemic to Bulgaria, Mediterranean, and Trans-Aegean species.

Key words: Earthworms, Lumbricidae, Bulgaria, Turkey, Yıldız (Strandja) Mountain

Strandja or Strandha in Bulgarian and Yıldız or Istranca in Turkish is a mountain massif in southeastern Bulgaria and the European part of Turkey. The mountain is situated in the southeastern part of the Balkans between the plains of Thrace to the west, the lowlands near Burgas to the north, and the Black Sea to the east. Its highest peak is Mahya Dağı (1031 m a.s.l.) in Turkey, while the highest point on Bulgarian territory is Golyamo Gradishte (710 m a.s.l.). The total area of the massif is approximately 10,000 km². Central and southern parts of the mountain are in Turkish territory, which comprises two-thirds of the area. Bosna Hill, which is part of Yıldız (Strandja) Mountain, and the northern parts of the massif are situated in Bulgaria. The climate of the area is considerably influenced by the Black Sea and is predominantly humid continental in the mountains and humid subtropical on the coast.

Exploration of earthworm fauna of the Bulgarian part of Yıldız (Strandja) Mountain was begun by Černosvitov (1934). His work was continued by Plisko (1963) and Mihailova (1968). Recently, Uzunov (2010) and Szederjesi (2013) published new data from the region. The Turkish part of the mountain remains almost unexplored; only limited data have been registered by Szederjesi et al. (2014).

The aim of the paper is to present new data on the earthworm fauna of Yıldız (Strandja) Mountain and to

establish the first list of lumbricid biodiversity by analyzing the newly reported species together with literature data.

Investigations were carried out during 3 different periods: September 2015, December 2015, and April 2016. Earthworms were collected using the diluted formaldehyde method (Raw, 1959), complemented with digging and hand-sorting. The combination of both methods creates a more complete sampling of species than the formalin method alone, which is not efficient in collecting species living in horizontal burrows. The specimens were killed in 70% ethanol and temporarily fixed in 4% formalin solution. After fixation in the formalin solution, they were transferred to 95% ethanol and finally into 75% ethanol. All 5 sampling localities were situated in the northern part of Yıldız (Strandja) Mountain, near the border with Turkey.

The new finding, *Murchieona minuscula*, was deposited in the Invertebrates Department of the National Museum of Natural History, Sofia, Bulgaria (NMNHS). The other records were deposited in the Institute of Soil Science, Agrotechnologies and Plant Protection “N. Poushkarov”, Sofia, Bulgaria, in the private earthworm collection of Hristo Valchovski (PCHV). Specimens were described and dissected under a low-power microscope. Identification of species was done in accordance to Mršić (1991). The

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list, with synonymy of earthworm taxa, was selected from records registered in the territory of Bulgaria and Turkey.

Class Clitellata

Family Lumbricidae Rafinesque-Schmaltz, 1815

Genus *Aporrectodea* Örley, 1885

Aporrectodea jassyensis (Michaelsen, 1891)

Allolobophora jassyensis Michaelsen, 1891: 15; Mihailova, 1966: 188; Šapkarev, 1986: 83.

Aporrectodea jassyensis jassyensis: Valchovski, 2014: 3.

Aporrectodea jassyensis: Mısırlıoğlu, 2002: 18; Csuzdi et al., 2006: 6; Szederjesi, 2013: 77.

Material examined: PHCV/74 two ex., Carevo near camping Nestinarka, stream valley south of the village, 5 m, 42°09'28"N, 27°51'33"E, 28.04.2016, leg. H. Valchovski; PHCV/75 two ex., Izgrev, Marina River eco-path west of the village in the oak forest, 160 m, 42°08'04"N, 27°47'48"E, 28.04.2016, leg. H. Valchovski.

Aporrectodea rosea (Savigny, 1826)

Enterion roseum Savigny, 1826: 182.

Allolobophora prashadi: Mihailova 1964: 167.

Eisenia rosea var. *typica*: Mihailova 1966: 185.

Eisenia rosea var. *macedonica* (Rosa): Mihailova 1966: 186.

Eisenia rosea var. *bimastoides* (Rosa): Mihailova 1966: 186.

Allolobophora rosea: Plisko 1963: 428.

Allolobophora rosea rosea: Šapkarev 1986: 81.

Allolobophora rosea balcanica: Šapkarev 1986: 81.

Aporrectodea rosea rosea: Valchovski 2014: 3

Aporrectodea rosea: Csuzdi et al., 2007: 349; Stojanović et al., 2012: 9.

Material examined: PCHV/51 five ex., Sinemorets, near Veleka River, 3 m, 42°03'37"N, 27°57'56"E, 20.09.2015, leg. H. Valchovski; PHCV/74 one ex., Carevo near camping Nestinarka, stream valley south of the village, 5 m, 42°09'28"N, 27°51'33"E, 28.04.2016, leg. H. Valchovski.

Genus *Dendrobaena* Eisen, 1873

Dendrobaena byblica (Rosa, 1893)

Allolobophora (Dendrobaena) byblica Rosa, 1893: 4.

Dendrobaena ganglbaueri var. *bulgarica* Černosvitov, 1937: 84.

Dendrobaena byblica: Plisko, 1963: 437; Zicsi, 1973: 220; Omodeo and Rota, 1989: 185; Pavlíček et al., 2009: 119–120; Stojanović et al., 2012: 9.

Dendrobaena byblica byblica: Csuzdi et al., 2007: 350; Szederjesi, 2013: 79; Szederjesi et al., 2014: 558.

Material examined: PCHV/73 four ex., Butamia stream valley, 17 m, 42°02'56"N, 27°58'29"E, 28.04.2016, leg. H. Valchovski.

Genus *Lumbricus* Linnaeus, 1758

Lumbricus rubellus Hoffmeister, 1843

Lumbricus rubellus Hoffmeister, 1843: 187; Plisko, 1963: 438; Zicsi and Csuzdi, 1986: 120; Mısırlıoğlu, 2007:

354; Mısırlıoğlu, 2008b: 470; Mısırlıoğlu and Szederjesi, 2015: 100–101; Stojanović et al., 2012: 9; Valchovski, 2014: 5.

Material examined: PHCV/74 three Carevo near camping Nestinarka, stream valley south of the village, 5 m, 42°09'28"N, 27°51'33"E, 28.04.2016, leg. H. Valchovski; PCHV/73 two ex., stream valley, 17 m, 42°02'56"N, 27°58'29"E, 28.04.2016, leg. H. Valchovski; PHCV/72 two ex., Silistar, oak forest near the brook, 12 m, 42°01'21"N, 27°59'56"E, 28.04.2016, leg. H. Valchovski; PHCV/75 three ex., Izgrev, Marina River eco-path west of the village in the oak forest, 160 m, 42°08'04"N, 27°47'48"E, 28.04.2016, leg. H. Valchovski.

Genus *Murchieona* Gates 1978

Murchieona minuscula (Rosa, 1906)

Allolobophora minuscula Rosa, 1906: 38; Omodeo and Rota, 1991: 176.

Murchieona minuscula: Csuzdi et al., 2006: 23; Csuzdi et al., 2007: 356.

Material examined: PHCV/72 three ex., Silistar, oak forest near the brook, 12 m, 42°01'21"N, 27°59'56"E, 28.04.2016, leg. H. Valchovski.

External characteristics: Body length 15–20 mm, number of segments 80–90. Pigmentation pale. Clitellum saddle shaped on 26–32 without tubercula pubertatis. Prostomium epilobous. The first dorsal pores in intersegmental groove 12/13 or 14/15. Male aperture in segment 15. Setae closely paired (Figure).

Internal characteristics: Crop in segments 15–16, gizzard in segments 17–18. Two pairs of seminal vesicles in 11–12. Testes paired in segments 10–11. Spermathecae lacking. Calciferous diverticula in 10, oriented downwards. Nephridial bladders tube-shaped.

Remarks. For a long time, *Murchieona muldali* (Omodeo, 1956) was considered a synonym of *Murchieona minuscula* (Rosa, 1906). They have been treated as separate species following the paper by Zicsi and Csuzdi (1999). The main differences between the 2 species is the position of the clitellum and distribution. *M. muldali* has the clitellum in segments 27–33; *M. minuscula*, in segments 26–32 (Csuzdi and Pavlíček, 2002). *M. muldali* is distributed



Figure. *Murchieona minuscula*.

mainly in Western Europe, while *M. minuscula* is found in the Adriatic–Mediterranean region.

Genus *Octodrilus* Omodeo, 1956

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

Allolobophora transpadana Rosa, 1884: 45.

Octolasion rectum: Černosvitov, 1934: 76; 1937: 90.

Octolasion transpadanum: Zicsi and Csuzdi, 1986: 114; Šapkarev, 1986: 87.

Octodrilus transpadanus: Omodeo and Rota, 1989: 183; 1991: 1; Misirlioğlu, 2002: 18; Szederjesi, 2013: 81; Valchovski, 2014: 6.

Material examined: PCHV/51 four ex., Sinemorets, near Veleka River, 3 m, 42°03'37"N, 27°57'56"E, 09.2015, leg. H. Valchovski; PCHV/51 three ex., Sinemorets, near Veleka River, 3 m, 42°03'37"N 27°57'56"E, 27.12.2015, leg. H. Valchovski; PHCV/74 one ex., Carevo near camping Nestinarka, stream valley south of the village, 5 m, 42°09'28"N, 27°51'33"E, 28.04.2016, leg. H. Valchovski.

Genus *Octolasion* Örley, 1885

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

Lumbricus terrestris var. *lacteum* Örley, 1881: 584.

Octolasion lacteum: Černosvitov, 1934: 76, 1937: 89; Plisko, 1963: 432; Mihailova, 1966: 193; Zicsi and Csuzdi, 1986: 120.

Octolasion tyrtaeum: Mršić, 1991: 347.

Octolasion lacteum: Šapkarev, 1986: 84; Szederjesi, 2013: 81; Stojanović et al., 2012: 9; Valchovski, 2014: 6.

Material examined: PHCV/74 two ex., Carevo near camping Nestinarka, stream valley south of the village, 5 m, 42°09'28"N, 27°51'33"E, 28.04.2016, leg. H. Valchovski.

Genus *Proctodrilus* Zicsi, 1985

***Proctodrilus tuberculatus* (Černosvitov, 1935)**

Eophila antipae var. *tuberculata* Černosvitov, 1935: 58; Mihailova, 1966: 192.

Allolobophora antipai tuberculata: Plisko, 1963: 432; Šapkarev, 1986: 83; Zicsi and Csuzdi, 1986: 114; Omodeo and Rota, 1991: 177.

Proctodrilus antipai tuberculatus: Mršić and Šapkarev, 1988: 11; Valchovski, 2012: 98.

Proctodrilus tuberculatus: Misirlioğlu, 2004: 3.

Proctodrilus tuberculata: Stojanović et al., 2012: 13.

Material examined: PCHV/51 fourteen ex., Sinemorets, near Veleka River, 3 m, 42°03'37"N, 27°57'56"E, 20.09.2015, leg. H. Valchovski.

The earthworm fauna of Strandja (Yıldız) Mountain consists of 16 species and subspecies (Table). Three taxa—*Dendrobaena byblica*, *Dendrobaena hortensis*, and *Dendrodrilus rubidus rubidus*—were recorded on both the Bulgarian and Turkish sides of the explored massif. Two species, *Dendrobaena veneta* and *Eisenia fetida*, were recorded only on the Turkish side of the mountain. Eleven taxa—*Aporrectodea rosea*, *Aporrectodea jassyensis*, *Cernosvitovia bulgarica*, *Cernosvitovia rebeli*, *Eisenia*

lucens, *Eiseniella tetraedra*, *Lumbricus rubellus*, *Murchieona minuscula*, *Octodrilus transpadanus*, *Octolasion lacteum*, and *Proctodrilus tuberculatus*—were found on the Bulgarian side of Strandja (Yıldız) Mountain.

According to the zoogeographical position, the earthworm fauna of the Yıldız (Strandja) Mountain consists of peregrine, endemic, Trans-Aegean, Moesian, Central European, Circum-Mediterranean, and Adriatic–Mediterranean species. Peregrine taxa dominate, with 50% of the species and subspecies. Less numerous are Trans-Aegean (3 species: 18.75%). Endemic (*Cernosvitovia bulgarica*), Moesian (*Cernosvitovia rebeli*), Central European (*Eisenia lucens*), Circum-Mediterranean (*Dendrobaena byblica*), and Adriatic–Mediterranean (*Murchieona minuscula*) species take part with 1 taxon each (6.25%).

The new finding in the territory of Bulgaria, *Murchieona minuscula*, has been previously recorded in the Asian part of Turkey. In Turkey, *Murchieona minuscula* is found in Bursa (northern face of Uludağ), Bolu (between Bolu and Mudurnu) (Omodeo and Rota, 1991), and Hatay Province (near the road Harbiye to Yayladağı) (Csuzdi et al., 2007; Szederjesi et al., 2014). Additionally, this species has been registered in Italy (Rosa, 1906), Croatia (Hackenberger and Hackenberger, 2013), Cyprus (Pavliček and Csuzdi, 2006), Greece (Zicsi and Michalis, 1981), Israel (Csuzdi and Pavliček, 2002; Pavliček et al., 2003), and North Africa (Omodeo and Martinucchi, 1987; Omodeo et al., 2003).

Some species registered on the Bulgarian side of Yıldız (Strandja) Mountain have been recorded in the neighboring area on Turkish territory. For example, *Octodrilus transpadanus*, *Proctodrilus tuberculatus*, and *Lumbricus rubellus* are also found in Belgrade forest (Omodeo and Rota, 1989) near İstanbul. *O. transpadanus* has been registered in Mesopotamia (Pavliček et al., 2009). *P. tuberculatus* is common in the Trans-Aegean region (Mihailova, 1966; Omodeo and Rota, 1989). *L. rubellus* is a peregrine species that is widely distributed on the territory of Bulgaria and Turkey (Zicsi, 1973; Valchovski, 2012). It is to be expected that in further detailed research, new lumbricid species will be found in the unexplored Turkish side of the Yıldız (Strandja) Mountain.

Our study is a contribution to the earthworm knowledge of Yıldız (Strandja) Mountain. We registered 5 earthworm species new to the fauna of the explored region. *Murchieona minuscula* is a new finding in the territory of Bulgaria. The data of earthworm diversity in both the Bulgarian and Turkish parts of Yıldız (Strandja) Mountain are incomplete, and explorations are still insufficient. Further investigations are needed, especially in the border region between the two countries and in the central part of the mountain in Turkish territory.

Table. List of earthworm species from the territory of Yildiz (Strandja) Mountain.

Species	Authors' data (Bulgaria)	Literature data (Bulgaria)	Literature data (Turkey)	Zoogeographical type
<i>Aporrectodea jassyensis</i> (Michaelsen, 1891)	Carevo, Izgrev	-	-	Trans-Aegean
<i>Aporrectodea rosea</i> (Savigny, 1826)	Sinemorets	-	-	Peregrine
<i>Cernosvitovia bulgarica</i> (Černosvitov, 1934)	-	Primorsko (Černosvitov, 1934) Grudovo (Mihailova, 1968)	-	Endemic
<i>Cernosvitovia rebeli</i> (Rosa, 1897)	-	Primorsko (Černosvitov, 1937); Jasna Poljana (Szedzerjesi, 2013)	-	Moesian
<i>Dendrobaena byblica</i> (Rosa, 1893)	Sinemorets	Jasna Poljana, Mladezko (Szedzerjesi, 2013)	Demirköy (Szedzerjesi et al., 2014)	Circum-Mediterranean
<i>Dendrobaena hortensis</i> (Michaelsen, 1890)	-	Jasna Poljana, Mladezko, Zvezdec (Szedzerjesi, 2013),	Demirköy (Szedzerjesi et al., 2014)	Peregrine
<i>Dendrobaena veneta</i> (Rosa, 1886)	-	-	Demirköy (Szedzerjesi et al., 2014)	Peregrine
<i>Dendrodrilus rubidus rubidus</i> (Savigny, 1826)	-	Gramatikovo (Plisko, 1963)	Demirköy (Szedzerjesi et al., 2014)	Peregrine
<i>Eisenia fetida</i> (Savigny, 1826)	-	-	Demirköy (Szedzerjesi et al., 2014)	Peregrine
<i>Eisenia lucens</i> (Waga, 1857)	-	Gramatikovo (Plisko, 1963) Malko Tarnovo (Szedzerjesi, 2013)	-	Central European
<i>Eiseniella tetraedra</i> (Savigny, 1826)	-	Ropotamo and Veleka River (Uzunov, 2010); Veleka River (Szedzerjesi, 2013)	-	Peregrine
<i>Lumbricus rubellus Hoffmeister</i> , 1843	Carevo, Sinemorets, Silistar, Izgrev	Primorsko (Černosvitov, 1934)	-	Peregrine
<i>Murchieona minuscula</i> (Rosa, 1906)	Silistar	-	-	Adriatic–Mediterranean
<i>Octodrilus transpadanus</i> (Rosa, 1884)	Sinemorets, Carevo	Rezovo (Szedzerjesi, 2013)	-	Trans-Aegean
<i>Octolasion lacteum</i> (Örley, 1881)	Carevo	-	-	Peregrine
<i>Proctodrilus tuberculatus</i> (Černosvitov, 1935)	Sinemorets	-	-	Trans-Aegean

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References

- Černosvitov L (1934). Die Lumbriciden Bulgariens. Mitt Königl Naturw Inst Sofia 7: 71-78.
- Černosvitov L (1935). Monographie des tschechoslovakischen Lumbriciden. Arch. prir. Vizkum. Cech 19.
- Černosvitov L (1937). Die Oligochaetenfauna Bulgariens. Mitt Königl Naturw Inst Sofia 10: 69-92.
- Csuzdi Cs, Pavlíček T, Mısırlıoğlu M (2007). Earthworms (Oligochaeta: Lumbricidae, Criodrilidae and Acanthodrilidae) of Hatay Province, Turkey, with description of three new lumbricids. Acta Zool Hung 53: 347-361.
- Csuzdi Cs, Zicsi A, Mısırlıoğlu M (2006). An annotated checklist of the earthworm fauna of Turkey (Oligochaeta: Lumbricidae). Zootaxa 1175: 1-29.
- Csuzdi Cs, Pavlíček T (2002). *Murchieona minuscula* (Rosa, 1906), a newly recorded earthworm from Israel, and distribution of the genera *Dendrobaena* and *Bimastos* in Israel (Oligochaeta, Lumbricidae). Zool Middle East 25: 105-114.
- Eisen G (1873). Om Skandinaviens Lumbricider. Öfvers K Vetensk-Akad Förh 30: 43-56.
- Gates GE (1978). Contributions to a revision of the Lumbricidae. XXI. The earthworm genus *Lumbricus* in North America. Megadrilogica 3: 81-116.
- Hackenberger DK, Hackenberger BK (2013). Checklist of the earthworm fauna of Croatia (Oligochaeta: Lumbricidae). Zootaxa 3710: 001-030.
- Hoffmeister W (1843). Beitrag zur Kenntnis Deutscher Landanneliden. Arch Naturgesch 9: 183-198.
- Linnaeus C (1758). Systema naturae per regna tria naturae: secundum classes, ordines, genera, species, cum characteribus, differentiis, synonymis, locis. Systema Naturae (10th edition). Holmiae: Impensis Direct. Laurentii Salvii, 1758.
- Michaelsen W (1891). Oligochaeten des Naturhistorischen Museums in Hamburg IV. Jb Hamb Wiss Anst 8: 1-42.
- Mihailova P (1964). Njakoj vidove ot semejstvo Lumbricidae (Oligochaeta) novi za faunata na Blgarija. Annuaire de Université de Sofia 57: 163-169.
- Mihailova P (1966). Dzdovni cervi Lumbricidae (Oligochaeta) v Trakija. Fauna na Trakija, Bul Acad Sci Sofia 3: 181-200.
- Mihailova P (1968). Belezki vrhu njakoj lumbricidni vidove v Blgarija. Ann Uni Sofia 60: 129-138.
- Mısırlıoğlu M (2002). The earthworms (Oligochaeta: Lumbricidae) of Eskişehir City, Turkey. Megadrilogica 9: 17-20.
- Mısırlıoğlu M (2004). Earthworm records from different parts of Anatolia. Megadrilogica 10: 1-4.
- Mısırlıoğlu M (2007). The earthworm fauna of the Kocaeli (İzmit) city centre (Oligochaeta, Lumbricidae). Turk J Zool 31: 353-356.
- Mısırlıoğlu M (2008). Some earthworm records from Anatolia (Oligochaeta, Lumbricidae). Turk J Zool 32: 469-471.
- Mısırlıoğlu M, Szederjesi T (2015). Contributions to the earthworm fauna of Turkey. Megadrilogica 18: 99-102.
- Mršić N (1991). Monograph on Earthworms (Lumbricidae) of the Balkans I-II. Ljubljana, Slovenia: Slovenska Akademija Znanosti in Umetnosti.
- Mršić N, Šapkarev J (1988). Revision of the genus *Allolobophora* Eisen, 1874 (sensu Pop 1941) (Lumbricidae, Oligochaeta). Acta Mus Maced Sci Nat 19: 1-38.
- Omodeo P (1956). Contributo alla revisione dei Lumbricidae. Arch Zool Ital 41: 129-212.
- Omodeo P, Martinucci G (1987). Earthworms of Maghreb. In: Bonvicini-Pagliani AM, Omodeo P, editors. On Earthworms: Selected Symposia and Monographs. Mucci, Modena, Italy: U.Z.I., pp. 235-250.
- Omodeo P, Rota E (1989). Earthworms of Turkey. Boll Zool 56: 167-199.
- Omodeo P, Rota E (1991). Earthworms of Turkey II. Boll Zool 58: 171-181.
- Omodeo P, Rota E, Baha M (2003). The megadrile fauna (Annelida: Oligochaeta) of Maghreb: a biogeographical and ecological characterization. Pedobiologia 47: 458-465.
- Örley L (1881). A magyarországi Oligochaeták faunája. I. Terricolae. Matematikai és Természettudományok Köréből 16: 562-611.
- Örley L (1885). A palaearktikus övben élő Terrikoláknak revíziója és elterjedése. Értekezések a Természettudományok Köréből 15: 1-34.
- Pavlíček T, Csuzdi Cs (2006). Species richness and zoogeographic affinities of earthworms in Cyprus. Eur J Soil Biol 42: S111-S116.
- Pavlíček T, Csuzdi Cs, Coşkun Y (2009). First earthworm records in Mesopotamia (Oligochaeta). Zool Middle East 48: 119-120.
- Pavlíček T, Csuzdi Cs, Nevo E (2003). Species richness and zoogeographic affinities of earthworms in the Levant. Pedobiologia 47: 452-457.
- Plisko G (1963). Materialien zur Kenntnis der Regenwürmer (Oligochaeta, Lumbricidae) Bulgariens. Fragm Faun, Warsawa 10: 425-440.
- Rafinesque-Schmaltz C (1815). Analyse de la Nature ou tableau de l'univers et des corps organisés. Palermo, Italy: J. Barravecchia.
- Raw F (1959). Estimating earthworm population by using formalin. Nature 184: 1661-1662.
- Rosa D (1884). Lumbricidi del Piemonte. Torino, Italy: Unione Tipografico- Editrice.
- Rosa D (1893). Viaggio del Dr. E. Festa in Palestina, nel Libano e regioni vicin. II. Lumbricidi. Boll Mus Zool Anat Comp Torino 8: 1-14.

- Rosa D (1906). *L'Allobophora miniuscula* n. sp. Atti Soc Nat Modena (4) VII: 38-39.
- Šapkarev J (1986). Earthworm fauna of Bulgaria (Oligochaeta: Lumbricidae). *Fragm Balc* 13: 77-94.
- Savigny JC (1826). Analyse des Travaux de l'Académie royale des Sciences, pendant l'année 1821, partie physique. In: Cuvier G, editor. Mémoires de l'Académie des Sciences de l'Institut de France, Paris 5: 176-184.
- Stojanović M, Tsekova R, Milutinović T (2012). Earthworms (Oligochaeta: Lumbricidae) of Bulgaria: diversity and biogeographical review. *Acta Zool Bulg, Suppl.* 4: 7-15.
- Szederjesi T (2013). New earthworm records from Bulgaria (Oligochaeta, Lumbricidae). *Opusc Zool, Budapest* 44: 77-83.
- Szederjesi T, Pavliček T, Coşkun Y, Csuzdi Cs (2014). New earthworm records from Turkey, with description of three new species (Oligochaeta: Lumbricidae). *Zootaxa* 3764: 555-570.
- Uzunov Y (2010). Aquatic Oligochets (Oligochaeta Limicola). In: Deltchev C, Hubenov Z, and Dobrev D, editors. *Catalogus Faunae Bulgaricae*. No. 7, Sofia, Bulgaria: Professor Marin Drinov Academic Publishing House.
- Valchovski H (2012). Checklist of earthworms (Oligochaeta: Lumbricidae) from Bulgaria – a review. *Zootaxa* 3458: 86-102.
- Valchovski H (2014). Diversity of earthworms (Oligochaeta: Lumbricidae) in Sofia Plain, Bulgaria. *Zoonotes* 59: 1-9.
- Zicsi A (1973). Regenwürmer (Oligochaeta: Lumbricidae) aus der Türkei. *Acta Zool Hung* 19: 217-232.
- Zicsi A (1985). Regenwürmer (Oligochaeta: Lumbricidae) aus Israel und den benachbarten Ländern. *Rev Suisse Zool* 92: 323-331.
- Zicsi A, Csuzdi C (1986). Regenwürmer aus Bulgarien (Oligochaeta Lumbricidae). *Opusc Zool, Budapest* 22: 113-121.
- Zicsi A, Csuzdi C (1999). Further contribution to the earthworm fauna of France, with description of five new species and one subspecies. *Revue Suisse De Zoologie* 106: 983-1003.
- Zicsi A, Michalis K (1981). Übersicht der Regenwurm-fauna Griechenlands (Oligochaeta: Lumbricidae). *Acta Zool Hung* 27: 239-264.