

EARTHWORMS (ANNELIDA: OLIGOCHAETA) OF KRAGUJEVAC BASIN - A REVIEW

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ABSTRACT. In this paper, we have summarized the current knowledge on earthworm diversity in the central part Serbia, Kragujevac basin. The complete list of earthworm taxa comprises 37 species and subspecies, belonging to 13 genera of the family Lumbricidae. Among them, *Dendrobaena serbica* (Šapkarev, 1977) is registered for the first time in the study area. With respect to the zoogeographic situation, most of the earthworm species belong to Peregrine, Endemic, and Central European chorological groups. The endemic species take part of 21.05% in the total number of the species. The most of endemic species belong to the genus *Allolobophora*. Summing up the endemics and the Balkanic species, 31.58% of the total lumbricid fauna shows an autochthonous character.

Key words: Kragujevac basin, Lumbricidae, earthworms, diversity, zoogeography

INTRODUCTION

One of the European hotspots of biodiversity is the Balkan Peninsula (GRIFFITHS *et al.* 2004). Faunistic research of Serbia, as part of the Balkan Peninsula contributed significantly to understanding the extremely diverse and complex soil fauna of the Balkan Peninsula.

Kragujevac basin is located in central part of Serbia. The earthworm taxonomic composition and species distribution from the Kragujevac basin are well known. The first data on the earthworms from this area were provided by KARAMAN (1972, 1983, 1987) and ŠAPKAREV (1980) recording altogether eight taxa. ŠAPKAREV (1988) lists 16 taxa, belonging to 14 species, while MRŠIĆ (1991) in his comprehensive study of the Balkans and neighboring territories found five species. During the 90s, studies were intensified by two authors (STOJANOVIĆ, 1989, 1996; KARAMAN and STOJANOVIĆ, 1993, 1994, 1995, 1996a, 1996b). BLESIĆ *et al.* (1998) listing altogether 26 taxa from nine genera in Kragujevac basin. After this work, several other papers dealt with the earthworms of Kragujevac basin as well (KARAMAN *et al.*, 1998; KARAMAN and STOJANOVIĆ, 2002; ŠAPKAREV, 2002; STOJANOVIĆ and KARAMAN, 2005, 2007; STOJANOVIĆ *et al.*, 2008).

Therefore, the aim of this paper is to summarize the published data on the earthworm fauna of the Kragujevac basin in order to establish the definitive list of known earthworm taxa. The list underlines earthworm diversity and provides a general overview of their distribution and zoogeographical position.

MATERIAL AND METHODS

Our investigations were carried out in the area of Kragujevac basin in the Central part of Serbia (Figure 1). Kragujevac basin is surrounded by Šumadija mountains Rudnik, Crni Vrh and Gledić Mountains. These mountains are rich in forests, river flows, pastures and mineral resources. The lowland part of the Kragujevac basin makes valley plains Lepenica and its tributaries, the left Drača and Petrovac River, and on the right Grošnica and Ždraljica River. The climate is moderate continental. Self-sown vegetation makes the environment of Kragujevac: woodland, meadow and wetland vegetation. Forests occupy 23% of the total area.

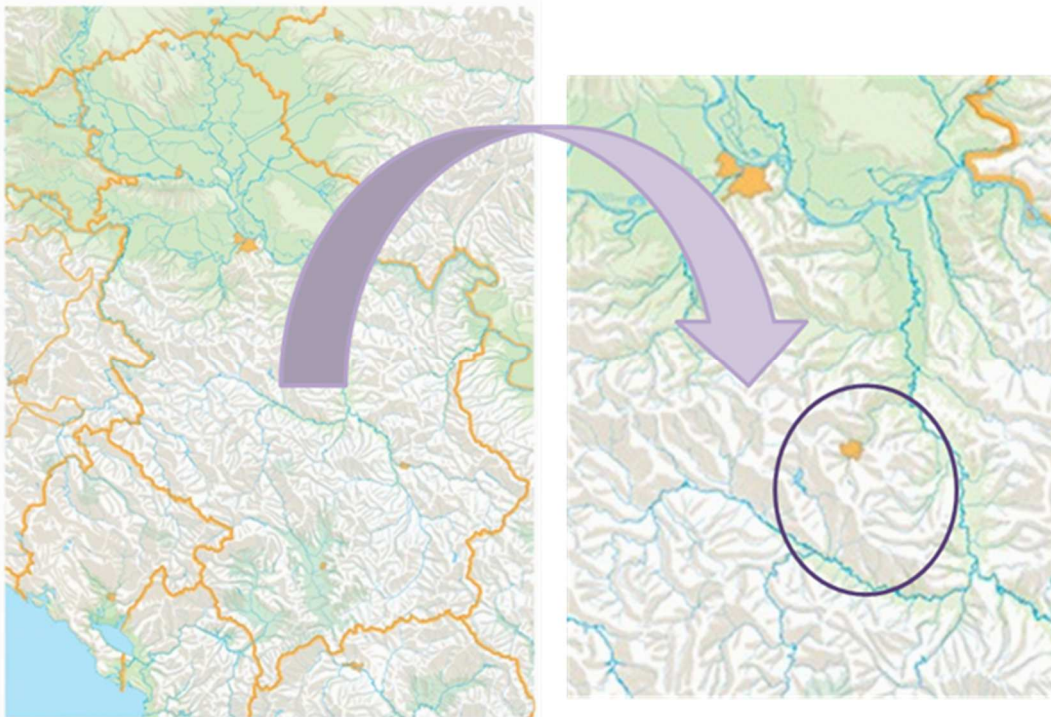


Figure 1. Study area: Kragujevac basin.

On all over the territory of Kragujevac basin earthworms were collected from various habitats which included natural (river banks, meadows, forest community: *Quercetum-confertae cerris* and *Fagetum montanum*; mountain pastures) and cultivated biotopes.

Earthworms were collected using the diluted formaldehyde method complemented with digging (0.4x0.4 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 transferred and stored in 90% ethanol.

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

We collected all available literature data on earthworms in order to establish the definitive list of biogeographic type. It was used categorization of lumbricid species on the basis of their geographical distribution proposed by CSUZDI and ZICSI (2003), POP *et al.* (2010), CSUZDI *et al.* (2011).

RESULTS

Starting from the total number of earthworms listed by BLESIĆ *et al.* (1998) and taking into account recent researches (mentioned above), as well as the fact that one species was found to be synonymous (*Aporrectodea rosea bimastoides* (Cognetti, 1901), the total number of earthworm species in the basin of Kragujevac comprises 38 taxa belonging to 13 genera (Tab. 1).

Table 1. List of the earthworms taxa with distribution type.

Species	Distribution type
<i>Allolobophora chlorotica</i> (Savigny, 1826)	Peregrine
<i>Allolobophora dofleini</i> (Ude, 1922)	Endemic
<i>Allolobophora kosowensis</i> Karaman, 1968	Endemic
<i>Allolobophora leoni</i> (Michaelsen, 1891)	Trans-Aegean
<i>Allolobophora paratuleskovi</i> Šapkarev, 1975	Endemic
<i>Allolobophora serbica</i> (Šapkarev, 1977)	Endemic
<i>Allolobophora spasienijakaramani</i> (Blakemore, 2004)	Endemic
<i>Apporectodea caliginosa</i> (Savigny, 1828)	Peregrine
<i>Aporrectodea georgii</i> (Michaelsen, 1890)	Atlantic-Mediterranean
<i>Aporrectodea handlirschi</i> (Rosa, 1897)	Trans-Aegean
<i>Aporrectodea jassyensis</i> (Michaelsen, 1891)	Trans-Aegean
<i>Apporectodea macvensis</i> (Šapkarev, 1986)	Endemic
<i>Apporectodea rosea</i> (Savigny, 1826)	Peregrine
<i>Apporectodea sineporis</i> (Omodeo, 1952)	Balkan-Alpine
<i>Aporrectodea smaragdina</i> (Rosa, 1892)	Central European
<i>Apporectodea trapezoids</i> (Duges, 1828)	Peregrine
<i>Dendrobaena alpina</i> (Rosa, 1844)	Balkan-Alpine
<i>Dendrobaena attemsi</i> (Michaelsen, 1902)	Balkan-Alpine
<i>Dendrobaena byblica</i> (Rosa, 1893)	Circum-Mediterranean
<i>Dendrobaena hortensis</i> (Michaelsen, 1890)	Peregrine
<i>Dendrobaena jastrebensis</i> Mršić and Šapkarev, 1987	Endemic
<i>Dendrobaena octaedra</i> (Savigny, 1826)	Peregrine
<i>Dendrobaena serbica</i> Karaman, 1973	Endemic
<i>Dendrobaena vej dovskyi</i> (Černosvitov, 1935)	Balkan-Alpine
<i>Dendrobaena veneta</i> (Rosa, 1885)	Peregrine
<i>Dendrodrilus rubidus rubidus</i> (Savigny, 1826)	Peregrine
<i>Dendrodrilus rubidus subrubicundus</i> (Eisen, 1874)	Peregrine
<i>Dendrodrilus rubidus tenuis</i> (Eisen, 1874)	Peregrine
<i>Eisenia fetida</i> (Savigny, 1826)	Peregrine
<i>Eisenia lucens</i> (Wage, 1857)	Central European
<i>Eiseniella tetraedra</i> (Savigny, 1826)	Peregrine
<i>Fitzingeria platyura platyura</i> (Fitzinger, 1833)	Central European
<i>Lumbricus polyphemus</i> (Fitzinger, 1833)	Central European
<i>Lumbricus rubellus</i> Hoffmeister, 1843	Peregrine
<i>Octolasion lacteum</i> (Oerley, 1881)	Peregrine
<i>Octodrilus complanatus</i> (Dugès, 1828)	Circum-Mediterranean
<i>Octodrilus transpadanus</i> (Rosa, 1884)	Trans-Aegean
<i>Proctodrilus antipai antipai</i> (Michaelsen, 1891)	Central European

For each species in the list below, the following abbreviations are used: "E": Ecology; "D": Distribution in the Kragujevac basin; "Z": Zoogeographical type.

Checklist and classification

Classis Oligochaeta

Family Lumbricidae Rafinesque-Schmaltz, 1815

Genus *Allolobophora* Eisen, 1874

Allolobophora chlorotica chlorotica (Savigny, 1826)

Enterion chloroticum Savigny, 1826: 182.

Allolobophora chlorotica: Šapkarev 1980: 171; Stojanović 1996: 26.

E. Valley meadow, anthropogenic biotopes (ŠAPKAREV, 1980; STOJANOVIĆ, 1996); forest soils, cultivated soils, meadows (ŠAPKAREV, 1980). **D.** Kragujevac (ŠAPKAREV, 1980); Lepenica, Petrovac River, (STOJANOVIĆ, 1996); **Z.** Peregrine.

Allolobophora dofleini (Ude, 1922)

Helodrilus (Allolobophora) dofleini Ude, 1922: 157.

Allolobophora dofleini: Stojanović 1996.

E. Mixed forests, pastures, oak forest and beech (STOJANOVIĆ, 1996). **D.** Lepenica, Petrovac River (STOJANOVIĆ, 1996). **Z.** Broad range Balkan endemism.

Allolobophora kosowensis kosowensis Karaman, 1968

Allolobophora kosowensis Karaman, 1968: 50.

Serbiona kosowensis kosowensis: Stojanović & Karaman 2007: 129.

Allolobophora kosowensis kosowensis: Stojanović 1996: 37; Milutinović et al. 2015b: 5.

E. Beech forest, pastures, anthropogenic biotopes (STOJANOVIĆ, 1996; STOJANOVIĆ and KARAMAN, 2007; MILUTINOVIĆ *et al.*, 2015b). **D.** Kragujevac, (STOJANOVIĆ, 1996; STOJANOVIĆ and KARAMAN, 2007; MILUTINOVIĆ *et al.*, 2015b). **Z.** Broad range Balkan endemism. Registered in the Balkan part of Serbia and in the only one locality on the border between the Pannonian Basin and the Balkan Peninsula (STOJANOVIĆ and MILUTINOVIĆ, 2014; MILUTINOVIĆ *et al.*, 2015b).

Allolobophora leoni Michaelsen, 1891

Allolobophora leoni Michaelsen, 1891: 15.

Allolobophora leoni: Stojanović, 1996: 39.

E. Beech and oak forests, wet meadows (STOJANOVIĆ, 1996). **D.** Beloševac, Ždraljica River, (STOJANOVIĆ, 1996). **Z.** Trans-Aegean.

Allolobophora paratuleskovi Šapkarev, 1975

Allolobophora paratuleskovi Šapkarev, 1975: 55.

Serbiona paratuleskovi: Stojanović and Karaman 2003: 25; Milutinović et al. 2010: 629.

Allolobophora paratuleskovi: Stojanović 1996: 43.

E. Meadows (STOJANOVIĆ, 1996; STOJANOVIĆ and KARAMAN, 2003; MILUTINOVIĆ *et al.*, 2010). **D.** Beloševac (STOJANOVIĆ, 1996); Kragujevac (STOJANOVIĆ and KARAMAN, 2003; MILUTINOVIĆ *et al.*, 2010); **Z.** Broad range Balkan endemism.

***Allolobophora spasenijakaramani* (Blakemore, 2004)**

Allolobophora robusta serbica Karaman, 1983: 51; Stojanović 1996: 49.

Serbiona robusta serbica: Stojanović and Karaman 2003: 25; Stojanović and Karaman 2007: 24; Milutinović et al. 2010: 629.

E. Beech and oak forest, anthropogenic biotopes, pastures, meadows, gardens (STOJANOVIĆ, 1996; STOJANOVIĆ and KARAMAN, 2003, 2007). **D.** Gledić Mts., Kragujevac, Brzan (STOJANOVIĆ, 1996; STOJANOVIĆ and KARAMAN, 2003, 2007; MILUTINOVIĆ et al., 2010). **Z.** Broad range Balkan endemism.

***Allolobophora serbica* (Šapkarev, 1977)**

Eophila serbica Šapkarev, 1977: 93.

Allolobophora serbica: Stojanović 1996: 53.

E. Valley meadow (STOJANOVIĆ, 1996). **D.** Gledić hillsides (STOJANOVIĆ, 1996). **Z.** Broad range Balkan endemism.

Genus *Aporrectodea* Örley, 1885***Aporrectodea caliginosa* (Savigny, 1826)**

Enterion caliginosum + *Enterion carneum* Savigny, 1826: 180.

Allolobophora caliginosa caliginosa: Stojanović 1996: 23.

Aporrectodea caliginosa caliginosa: Milutinović et al. 2010: 629.

E. Beech and oak forests, river banks, forest soils, wet meadows (STOJANOVIĆ, 1996; MILUTINOVIĆ et al., 2010). **D.** Lepenica, Erdeč (STOJANOVIĆ, 1996); Gledić Mts. (STOJANOVIĆ, 1996; MILUTINOVIĆ et al., 2010). **Z.** Peregrine.

***Aporrectodea georgii* (Michaelsen, 1890)**

Allolobophora georgii Michaelsen, 1890: 3.

Allolobophora georgii: Stojanović 1996: 31.

E. Beech and oak forests, valley meadow (STOJANOVIĆ, 1996). **D.** Erdeč, Vračješnica (STOJANOVIĆ, 1996). **Z.** Atlanto-Mediterranean.

***Aporrectodea handlirschi* (Rosa, 1897)**

Allolobophora handlirschi Rosa, 1897:3.

Allolobophora handlirschi: Stojanović 1996: 33.

E. Pastures, oak forest and beech forest (STOJANOVIĆ, 1996). **D.** Rudnik hillsides, Petrovac (STOJANOVIĆ, 1996). **Z.** Trans-Aegean.

***Aporrectodea jassyensis* (Michaelsen, 1891)**

Allolobophora jassyensis Michaelsen, 1891: 15.

Allolobophora jassyensis: Stojanović 1996: 35.

E. Valley meadow, forests (STOJANOVIĆ, 1996). **D.** Petrovac River (STOJANOVIĆ, 1996). **Z.** Trans-Aegean.

***Aporrectodea macvensis* (Šapkarev, 1987)**

Allolobophora macvensis Šapkarev, 1987: 299.

Allolobophora macvensis: Stojanović et al., 2008: 59.

E. Forest (STOJANOVIĆ *et al.*, 2008). **D.** Sugubina (STOJANOVIĆ *et al.*, 2008). **Z.** Endemic. Registered in the Balkan part of Serbia and in the only one locality on the border between the Pannonian Basin and the Balkan Peninsula (STOJANOVIĆ and MILUTINOVIĆ, 2014; MILUTINOVIĆ *et al.*, 2015a).

***Aporrectodea rosea* (Savigny, 1826)**

Enterion roseum Savigny, 1826: 182.
Allolobophora rosea: Stojanović 1996: 44.
Allolobophora rosea bimastoides: Stojanović 1996: 48.
Allolobophora rosea interposita: Stojanović 1996: 48.
Aporrectodea rosea: Milutinović *et al.* 2010: 629.

E. Pastures, cave, beech forest and oak forest, cultivated soils, meadows (STOJANOVIĆ, 1996; MILUTINOVIĆ *et al.*, 2010). **D.** Beloševac, Ždraljica River, Žeželj, Šumarice, Rudnik, Lepenica, Drača, Ždraljica, Rogojevac, Erdeč, Petrovac, Bešnjaja, Vračješnica (STOJANOVIĆ, 1996); Kalenić, Gledić Mts, Duleni (STOJANOVIĆ, 1996; MILUTINOVIĆ *et al.*, 2010). **Z.** Peregrine.

***Aporrectodea sineporis* (Omodeo, 1952)**

Eiseniella balcanica sine-poris Omodeo, 1952: 31.
Allolobophora sineporis: Stojanović 1996: 51.

E. Oak and beech forest (STOJANOVIĆ, 1996). **D.** Vračješnica (STOJANOVIĆ, 1996). **Z.** Balkanic-Alpine.

***Aporrectodea smaragdina* (Rosa, 1892)**

Allolobophora smaragdina Rosa, 1892: 1.
Allolobophora smaragdina: Stojanović 1996: 53.

E. Pastures, oak forest, subalpine meadow (STOJANOVIĆ, 1996). **D.** Rudnika hillsides (STOJANOVIĆ, 1996). **Z.** Central European.

***Aporrectodea trapezoides* (Duges, 1828)**

Lumbricus trapezoides Duges, 1828: 289.
Allolobophora caliginosa trapezoides: Stojanović 1996: 24.

E. Beech forest, valley meadow, river banks, anthropogenic biotopes (STOJANOVIĆ, 1996). **D.** Sušica, Lepenica, Petrovac River, Ždraljica, Kragujevac, Erdeč, Bešnjaja, Ždraljica River (STOJANOVIĆ, 1996). **Z.** Peregrine.

Genus *Dendrobaena* Eisen, 1873

***Dendrobaena alpina alpina* (Rosa, 1884)**

Allolobophora alpina Rosa, 1884: 28.
Dendrobaena alpina: Milutinović *et al.* 2010: 630.

E. Forest soil (MILUTINOVIĆ *et al.*, 2010). **D.** Kalenić (MILUTINOVIĆ *et al.*, 2010). **Z.** Balkanic-Alpine.

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

Helodrilus (Dendrobaena) attemsi Michaelsen, 1902: 47.
Dendrobaena attemsi: Stojanović 1996: 62.

Dendrobaena jastrebensis Mršić and Šapkarev, 1987: 69.

Dendrobaena jastrebensis: Stojanović 1996: 67.

Dendrobaena attemsi attemsi: Csuzdi 2012: 97-99.

E. Beech and oak forest, pastures (MRŠIĆ and ŠAPKAREV, 1987; STOJANOVIĆ, 1996). **D.** Kragujevac, Gledić (MRŠIĆ and ŠAPKAREV, 1987; STOJANOVIĆ, 1996); Bešnjaja (STOJANOVIĆ, 1996). **Z.** Balkanic-Alpine.

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

Allolobophora byblica Rosa, 1893a: 4.

Dendrobaena byblica: Stojanović 1996: 64.

E. Beech and oak forests, meadows, river bank (STOJANOVIĆ, 1996). **D.** Bešnjaja (STOJANOVIĆ, 1996). **Z.** Circum-Mediterranean.

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

Allolobophora subrubicunda var. *hortensis* Michaelsen, 1890: 15.

Dendrobaena hortensis: Milutinović et al. 2010: 630.

E. Beech forest (MILUTINOVIĆ et al., 2010). **D.** Kalenić (MILUTINOVIĆ et al., 2010). **Z.** Peregrine.

***Dendrobaena jastrebensis* Mršić and Šapkarev, 1987**

Dendrobaena jastrebensis Mršić and Šapkarev, 1987: 69.

Dendrobaena jastrebensis Stojanović 1996: 67.

E. Beech and oak forests, forest soils, pastures (MRŠIĆ and ŠAPKAREV, 1987; STOJANOVIĆ, 1996). **D.** Kragujevac, Gledić, Bešnjaja (MRŠIĆ and ŠAPKAREV, 1987; STOJANOVIĆ, 1996). **Z.** Endemic.

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

Enterion octaedrum Savigny, 1826: 183.

Dendrobaena octaedra: Stojanović 1996: 69; Milutinović et al. 2010: 630.

E. Beech forest and meadows (STOJANOVIĆ, 1996; MILUTINOVIĆ et al., 2010). **D.** Lepenica, Rudnik (STOJANOVIĆ, 1996); Kalenić (MILUTINOVIĆ et al., 2010). **Z.** Peregrine.

***Dendrobaena serbica* Karaman, 1973**

Dendrobaena serbica Karaman, 1973: 180.

Dendrobaena serbica: Stojanović et al. 2008: 60.

E. Pasture, meadow (STOJANOVIĆ et al., 2008). **D.** Kragujevac (STOJANOVIĆ et al., 2008). **Z.** Broad range Balkan endemism.

***Dendrobaena vej dovskyi* (Černosvitov, 1935)**

Bimastus vej dovskyi Černosvitov, 1935: 66.

Dendrobaena vej dovskyi Stojanović 1996: 71; Milutinović et al. 2010: 630.

E. Beech forest, pastures, forest soils, meadows (STOJANOVIĆ, 1996; MILUTINOVIĆ et al., 2010). **D.** Gledić hillsides, Žeželj (STOJANOVIĆ, 1996); Kalenić (STOJANOVIĆ, 1996; MILUTINOVIĆ et al., 2010). **Z.** Balkanic-Alpine.

***Dendrobaena veneta veneta* (Rosa, 1886)**

Allolobophora veneta Rosa, 1886: 674.

Dendrobaena veneta: Stojanović 1996: 72.

E. Beech forest (STOJANOVIĆ, 1996). D. Lepenica, Kragujevac (STOJANOVIĆ, 1996). Z. Peregrine.

Genus *Dendrodrilus* Omodeo, 1956; sensu Perel, 1976

***Dendrodrilus rubidus rubidus* (Savigny, 1826)**

Enterion rubidum Savigny, 1826: 182.

Dendrodrilus rubidus rubidus: Stojanović 1996: 74.

E. Beech and oak forest (STOJANOVIĆ, 1996). D. Rudnik hillsides (STOJANOVIĆ, 1996) Z. Peregrine.

***Dendrodrilus rubidus subrubicundus* (Eisen, 1874)**

Allolobophora subrubicunda Eisen, 1873: 51.

Dendrodrilus rubidus subrubicunda: Stojanović 1996: 74.

E. Pastures, meadow, anthropogenic biotopes (STOJANOVIĆ, 1996). D. Rudnik, Lepenica (STOJANOVIĆ, 1996). Z. Peregrine.

***Dendrodrilus rubidus tenuis* (Eisen, 1874)**

Dendrodrilus rubidus tenuis Eisen, 1874: 44.

Dendrodrilus rubidus tenuis: Stojanović 1996: 76.

E. Beech forest (STOJANOVIĆ, 1996). D. Petrovac River (STOJANOVIĆ, 1996). Z. Peregrine.

Genus *Eisenia* Malm, 1877

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

Enterion fetidum Savigny, 1826: 182.

Eisenia foetida: Zicsi 1982; Stojanović 1996: 82.

E. Anthropogenic biotopes (STOJANOVIĆ, 1996). D. Beloševac, Lepenica (STOJANOVIĆ, 1996). Z. Peregrine.

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

Lumbricus lucens Waga, 1857: 166-169

Eisenia lucens: Stojanović 1996: 84.

E. Mixed forest, oak forest, valley meadow (STOJANOVIĆ, 1996). D. Rudnik, Lepenica, Bešnjaja, (STOJANOVIĆ, 1996). Z. Central European.

Genus *Eiseniella* Michaelsen, 1900

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

Enterion tetraedrum Savigny, 1826: 184.

Eiseniella tetraedra tetraedra: Stojanović 1996: 86.

E. Beech and oak forests, wet meadows, river bank (STOJANOVIĆ, 1996). D. Ždraljica River, Rudnik, Lepenica (STOJANOVIĆ, 1996). Z. Peregrine.

Genus *Fitzingeria* Zicsi, 1978

Fitzingeria platyura platyura (Fitzinger, 1833)

Enterion platyurum Fitzinger, 1833: 553.

Fitzingeria platyura platyura: Stojanović 1996: 90.

E. Beech and oak forests (STOJANOVIĆ, 1996). **D.** Rudnik hillsides (STOJANOVIĆ, 1996). **Z.** Central European.

Genus *Lumbricus* Linnaeus, 1758

Lumbricus polyphemus (Fitzinger, 1883)

Enterion polyphemus Fitzinger 1833: 551.

Lumbricus polyphemus: Stojanović 1996: 97.

E. Oak forest, valley meadows, pastures, anthropogenic biotopes (STOJANOVIĆ, 1996). **D.** Rudnik, Vračješnica (STOJANOVIĆ, 1996). **Z.** Central European.

Lumbricus rubellus (Hoffmeister, 1843)

Lumbricus rubellus Hoffmeister 1843: 187.

Lumbricus rubellus: Stojanović 1996: 99; Milutinović et al. 2010: 630.

E. Oak and beech forests (STOJANOVIĆ, 1996), cultivated soils, meadows (MILUTINOVIĆ *et al.*, 2010). **D.** Beloševac, Rudnik, Šumarice, Gledić hillsides, Kragujevac, Lepenica, Rogojevac, Bešnjaja, Vračješnica (STOJANOVIĆ, 1996); Kalenić (STOJANOVIĆ, 1996; MILUTINOVIĆ *et al.*, 2010); Baljkovac, Dulen (MILUTINOVIĆ *et al.*, 2010). **Z.** Peregrine.

Genus *Octodrilus* Omodeo, 1956

Octodrilus complanatus (Duges 1828)

Lumbricus complanatus: Duges 1828: 289.

Octodrilus complanatus: Milutinović et al. 2010: 630.

E. Forest soils (MILUTINOVIĆ *et al.*, 2010). **D.** Kalenić (MILUTINOVIĆ *et al.*, 2010). **Z.** Circum-Mediterranean.

Octodrilus transpadanus (Rosa, 1884)

Allolobophora transpadana Rosa 1884: 45.

Octodrilus transpadanus: Stojanović 1996: 110.

E. Forest soils (STOJANOVIĆ, 1996). **D.** Gledić hillsides, Rudnik hillsides (STOJANOVIĆ, 1996). **Z.** Trans-Aegean.

Genus *Octolasion* Örley, 1885

Octolasion lacteum (Örley, 1881)

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

Octolasion lacteum: Stojanović 1996: 106; Milutinović et al. 2010: 630.

E. Pastures (STOJANOVIĆ, 1996), forest soils, cultivated soils, meadows (STOJANOVIĆ, 1996; MILUTINOVIĆ *et al.*, 2010). **D.** Beloševac, Rudnik, Šumarice, Gledić hillsides, Lepenica, Drača, Petrovac River, Petrovac, Bešnjaja, Vračješnica (STOJANOVIĆ, 1996); Gledić Mts., Kalenić, Duleni, Baljkovac (MILUTINOVIĆ *et al.*, 2010). **Z.** Peregrine.

Genus *Proctodrilus* Zicsi, 1985

***Proctodrilus antipai antipai* (Michaelsen, 1891)**

Allolobophora antipae Michaelsen, 1891: 16.

Proctodrilus antipae: Stojanović, 1996: 113.

E. Meadows, cultivated soils (STOJANOVIĆ, 1996). **D.** Šumarice, Bešnjaja (STOJANOVIĆ, 1996). **Z.** Central European.

DISCUSSION

Our analysis showed that the largest number of species belongs to the Peregrine group (36.84%). Endemics take part with 21.05%, followed by Central European (13.16%), Trans-Aegean species (10.53%), Balkanic-Alpine (10.53%), and slightly less Circum-Mediterranean (5.26%) and Atlantic-Mediterranean (2.63%) chorotypes.

Allolobophora dofleini belongs to an archaic group whose center of development must have been situated on the Serbo-Vardarian and Rhodopian tectonic plates (STOJANOVIĆ and KARAMAN, 2007). It is widely distributed in the central and southern parts of the Balkans and in Macedonia (ŠAPKAREV, 1978), Greece (ZICSI and MICHALIS, 1981) and in the southern, central and western parts of Serbia (ZICSI, 1972; ŠAPKAREV, 1980; KARAMAN and STOJANOVIĆ, 1994; STOJANOVIĆ *et al.*, 2008; MILUTINOVIĆ, 2014; MILUTINOVIĆ *et al.*, 2010, 2015a).

Allolobophora kosowensis is exclusively endemic to Serbia. Considering that *A. kosowensis* species that lives deep in the soil, can be found in different biotopes. On the basis of data on the distribution of this species, it can be safely concluded that the mountainous region of Serbia has a crucial role in its distribution, so that the valley of the river Velika Morava indicates the only possible migratory route of this species to the north to the northernmost point of its spread (Pančevo, Pannonian basin) (MILUTINOVIĆ *et al.*, 2015b). It was first described from the southern part of Serbia (KARAMAN, 1968). Later on, it has been registered in several localities in the southern, southeastern, central and southwestern parts of Serbia (ŠAPKAREV, 1988; KARAMAN and STOJANOVIĆ, 1996; STOJANOVIĆ, 1996; STOJANOVIĆ and KARAMAN, 2005, 2007; STOJANOVIĆ *et al.*, 2008).

Allolobophora paratuleskovi has so far found only in Serbia. It is described from the locality Raška (ŠAPKAREV, 1975). Its typical habitats are meadows. The distribution of this species in the broader area of Serbia, is known to each other very distant localities: Raška, Novi Pazar (MRŠIĆ, 1991); Kragujevac (STOJANOVIĆ, 1996; STOJANOVIĆ and KARAMAN, 2003; MILUTINOVIĆ *et al.*, 2010); Zaječar (STOJANOVIĆ and KARAMAN, 2007; STOJANOVIĆ *et al.*, 2008).

Apart from Serbia, *Allolobophora serbica* is endemic species, which is not found in other parts of the Balkan Peninsula (TRAKIĆ *et al.*, 2016). It is described in the genus *Eophila* (*E. serbica* ŠAPKAREV, 1977) from the site Niš. Its typical habitats are river banks and pastures (TRAKIĆ *et al.*, 2016). The distribution of these types of extends and on areas of eastern and central Serbia, Niš (ŠAPKAREV, 1977; MRŠIĆ, 1991); Žagubica, Gledić (STOJANOVIĆ, 1996); Rasina (STOJANOVIĆ and KARAMAN, 2003, 2007; STOJANOVIĆ *et al.*, 2008; MILUTINOVIĆ *et al.*, 2010).

Allolobophora spasenijakaramani belongs to an archaic group whose center of development must have been situated on the Serbo-Macedonian tectonic plates that is a belt stretching in north-south direction along the Great and South Morava valleys, into western Republic of Macedonia and northern Greece (MRŠIĆ, 1991). It was first described from the

central part of Serbia (KARAMAN, 1983; MRŠIĆ, 1991). Since then, it has been discovered in several localities in central, southeastern (KARAMAN, 1987; MRŠIĆ, 1991; STOJANOVIĆ and KARAMAN, 2007; STOJANOVIĆ *et al.*, 2008; MILUTINOVIĆ *et al.*, 2010), and northeastern part of Serbia (STOJANOVIĆ *et al.*, 2013).

Aporrectodea macvensis until now was found only in the territory of Serbia. Its typical habitats are wet meadows. The distribution of this species includes Western Serbia (Banja Koviljača: MRŠIĆ, 1991; ŠAPKAREV, 2002; Tara, Perućac, Mitrovac: MILUTINOVIĆ, 2014; MILUTINOVIĆ *et al.*, 2015a), Central Serbia (Smederevo: STOJANOVIĆ *et al.*, 2008). Also, one location is located on the border between the Pannonian Basin and the Balkans (Pančevo) (STOJANOVIĆ and MILUTINOVIĆ, 2014; MILUTINOVIĆ *et al.*, 2015a).

Dendrobaena jastrebensis is endemic species registered in Serbia and at one site in Montenegro, Biogradska Gora (STOJANOVIĆ and KARAMAN, 2003). Its typical habitats are riverbanks, pastures and woodlands.

Dendrobaena serbica is endemic species of Serbia. Its typical habitats are pasture and meadow. The first time discovered in place Čakor near Peć (KARAMAN, 1973; MRŠIĆ, 1991), and later discovered in Niš (ŠAPKAREV, 1980; MRŠIĆ, 1991) and Kragujevac (STOJANOVIĆ *et al.*, 2008).

Besides the endemic species, the earthworm fauna of Kragujevac basin consists of species that are classified into six zoogeographic categories. One of the most common zoogeographical types of central Serbia is the widespread Peregrine group consists of species of the genera *Allolobophora*, *Aporrectodea*, *Dendrobaena*, *Dendrodrilus*, *Eisenia*, *Eiseniella*, *Lumbricus* and *Octolasion*.

Widely distributed Trans-Aegean species group (*Allolobophora leoni*, *Aporrectodea handlirschi*, *Ap. jassyensis* and *Octodrilus transpadanus*) shows a range of distribution extending from Italy to Turkey (MISIRLIOĞLU, 2008; CSUZDI *et al.*, 2011).

Four species of central Serbia belong to the Balkanic-Alpine type of distribution (*Aporrectodea sineporis*, *Dendrobaena alpina*, *D. attemsi* and *Dendrobaena vej-dovskyi*).

Aporrectodea smaragdina, *Fitzingeria platyura platyura*, *Lumbricus polyphemus*, *Proctodrilus antipai* and *Eisenia lucens* show a typical Central-European distribution. *E. lucens* occurring in Central Europe from the Alps to the Balkans, but it can be found also outside of this area, in the Pyrenean mountains. It could be said that it is an expanded Central European type of distribution.

In the Kragujevac basin, we registered only two species, *Dendrobaena byblica* and *Octodrilus complanatus* having typical Circum-Mediterranean type of distribution (CSUZDI and PAVLIČEK, 2005), as well as *Aporrectodea georgii* with Atlantic-Mediterranean type of distribution.

The diversity of fauna of Kragujevac basin is conditioned by variety of factors such as moderate continental and Mediterranean climate, variety of geological substrates, and the presence of different types of soils. The relief is dominated by vast networks of river valleys, between which rises isolated the island's mountains, up to 1200 m. Besides that, this area, as a part of the Balkan Peninsula, was refuge for many species of Europe, during the last ice age. All these factors have caused the heterogeneity of biotopes and, consequently, great biodiversity earthworms in this area.

CONCLUSION

Our results indicate interesting, diverse and rich earthworm fauna in the Kragujevac basin. From a total of 38 taxa recorded for this area the peregrine species are predominant (36.84%). Analysis showed a high percentage of endemic species (21.05%). Such a high proportion of endemic species on a small territory of Kragujevac basin can be explained by climatic and orographic conditions, but also the geological history of the area. Summing up the endemics and the Balkanic species, 31.58% of the total lumbricid fauna shows an autochthonous character. Based on the results presented in this paper, it is necessary to continue the intensive research in order to preserve the biological diversity of the area.

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