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Distribution and threat status of the endemic earthworm *Allolobophora dofleini* (Oligochaeta, Lumbricida) on the Balkan Peninsula

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Abstract. The objective of this paper is to analyze the whole list of records of *Allolobophora dofleini* in order to present a general overview of its distribution and threat status on the Balkan Peninsula. *All. dofleini* belongs to the widespread endemite on the Balkan Peninsula. During the last 30 years this species has been recorded from many localities in Macedonia and southeastern part of Serbia, while it is sporadically found in northern Greece. Until the present, the northernmost finding of the species has been in the central part of Serbia, while the southernmost point is in northern Greece. The investigation in last ten years has recorded *All. dofleini* in the Dinaric part of western Serbia. Mitrovac (National park Tara) is the westernmost locality reported so far, extending its known distribution area more than 150 km to the west. Its area of occupancy is around 200 km^2. According to the IUCN (2011) Red List Categories analysis, the conservation status of *All. dofleini* in the Balkan Peninsula is Endangered (EN) (B2 b (ii; iv; v;); c (ii; iv)). However, the conservation analysis still requires some decisions based on the study of future research and, therefore, our status assessment must be viewed as a working hypothesis based on the best available information.

Key words: Allolobophora dofleini, Balkan Peninsula, conservation status.

Introduction

Allolobophora dofleini (Ude, 1922) belongs to the endemic species (Mršić 1991), distributed in a southeast part of the Balkan Peninsula. It was discovered in Macedonia and described under the name *Eophila dofleini* Ude, 1922. *All. dofleini* is a typical lowland endemic species widespread in Macedonia (Karaman 1969, Šapkarev 1970, 1972, 1973, 1975, 1977, 1978, 1994, Šapkarev & Pavlovski 1984) and south Serbia (Zicsi 1972, Šapkarev 1980, Karaman & Stojanović 1994, 1996, Stojanović 1996, Stojanović et al. 2008), and sporadically, in central (Karaman & Stojanović 2002, Stojanović 1996, Stojanović & Karaman 2005, Stojanović et al. 2008, Milutinović et al. 2010), and western Serbia (Stojanović & Karaman 2007, Milutinović et al. 2015), Greece (Zicsi & Michalis 1981, Omodeo 1988) and in the very eastern region of Kosovo (Šapkarev 1977).

Until now, the northernmost limit of the species is the central part of Serbia (Stojanović 1996), whereas the southernmost point of its distribution is in northern Greece (Zicsi 1972, Zicsi & Michalis 1981, Omodeo 1988). Our recent investigations have revealed new records for *All. dofleini* in the western, central and south parts of Serbia. New investigated localities could contribute to better insight into the spread of this species.

The objective of this paper is to analyze the whole list of records of *All. dofleini*, in order to present a general overview of its distribution and current conservation status on the Balkan Peninsula. Additionally, our study represents a contribution toward the understanding of the exceptionally heterogeneous fauna of the Balkan Peninsula.

Materials and methods

Study area

Our extensive investigations were carried out in different parts of the Balkan Peninsula: western and southern parts of Serbia, northern part of Montenegro, northern part of Greece (Pieria and Pilion area), northwestern part of Bosnia and Herzegovina and western part of Macedonia.

The Balkan Peninsula is a specific region with rich biodiversity and a wide variety of ecosystems (Mršić 1991, Džukić & Kalezić 2004). The extraordinary complexity of abiogenic and biogenic factors are a result of turbulent geological history, that caused its rich and complex fauna. The largest part of Serbian territory lies in a temperate climate zone, but some of the border regions are in contact with Mediterranean and continental climate. Western Serbia has also a very specific combination of climatic, geodiversity and biodiversity elements. Western Serbia is characterized by well-maintained communities of old deciduous and coniferous forests that represent a unique example of well-preserved forests in southeast Europe with numerous endemic and relict species of indigenous flora and fauna (Milutinović

2014). There are a number of specific circumstances that have caused such a richness and diversity in this part of Serbia. First of all, this mountain region is located on the border with continental and sub-Mediterranean (Mediterranean) parts of the Balkans, and, therefore, its geographical position made it possible to appear, in the same place, different elements from continental and Mediterranean areas. On the other hand, openness to the river Drina allows penetration of climate impacts from the Pannonian Region. Western Serbia belongs to the Illyrian biogeographic area (Stojanović 1996, Milutinović 2014). Specific geological basis (mainly of silicate) and moist soil and cooler temperatures are characteristic of this area. Furthermore, mountain ranges in this area are very significant because they represent a bridge that enables movement of elements from the south (mountain ranges in Macedonia) to the western and northern massifs, as well as, elements from the Alps to the Rhodope Mountains (Stojanović 1996). The mountains in western Serbia are part of the Dinaric Alps. They reach the Sava River, on the north, and the valley of the Kolubara and Ibar, on the east, where bordering the Rhodope Mountains. On the other hand, southeastern part of Serbia belongs to Moesian biogeographic area, which is under the influences of the Mediterranean climate that extends along the Moravian-Vardar valley, and also under the humid climate from the west (Stojanović 1996).

In Bosnia and Hercegovina, the northwestern part with heterogenous relief (mountain ranges, mountain hills, karst fields, valleys and basin) was investigated. The largest part of this area belongs to Dinarides with extremely mountain climate where prevails thick forest vegetation.

The northern part of Montenegro where the largest part of the relief consists of mountainous terrain, with deep river canyons, has been researched. Mountains of Montenegro belong the southernmost part of the Dinaric mountain system. This region is characterized by the mountain climate.

Macedonia is located in the south of the Balkan Peninsula between the western part of the Rhodope Mts. and northern parts of Šar-Pindus mountains. We have explored the mountain valley in the western part of the country. The climate is characterized by a mix of continental and Mediterranean influences.

Greece is one of the most mountainous countries of Europe. We researched northern part of this country. Olympus is the highest point in Greece with 2,919 m above sea level. The Pindus, a continuation of the Dinaric Alps, reaches a maximum elevation of 2,637 m a.s.l. Northeastern Greece is characterized by another high-altitude mountain range, the Rhodope range, spreading across the region of East Macedonia and Thrace. This area is covered with vast and thick forests.

The extensive field survey was carried out since 2006 up to now. We used data on species obtained from the old Institute's collection (from Faculty of Science, Kragujevac, Serbia) that relate to undetermined material collected in southeastern part of Serbia. As far as possible, all published and unpublished data currently known were included. The data from the remaining area of the Balkans were included only from literature information. Based on field investigation we found a large number of earthworm genera and species, but in this paper we included only the data of *Allolobophora dofleini*. Data were collected from about 1000 sample sites (40x40 cm) distributed all over the investigation area. Based on the specimens and examined literature records, our database included species identity, locality, collecting date and the number of sample sites. Earthworms were collected throughout the territory from various habitats, which included natural biotopes (river banks, meadows, forest communities, mountain pastures) and cultivated ones. The habitats were situated between 750 and 1850 m altitude.

Earthworms were collected by the formalin method, digging (0.4 x 0.4 m) and hand sorting (Csuzdi & Zicsi 2003), as well as by turning over rocks, debris and logs. The earthworms were killed in 70% ethanol, immediately fixed in 4% formalin solution and later stored in 90% ethanol. Lumbricid earthworms have been classified according to the keys by Šapkarev (1978), Zicsi (1982), Mršić (1991), Csuzdi & Zicsi (2003) and Blakemore (2004).

To determine the conservation status of *Allolobophora dofleini*, we have applied an analysis based on the IUCN Red List Categories (IUCN 2011). The IUCN (2011) Red List attempts to classify species according to their likelihood of extinction within a given period, on a global scale and provides a rigorous range of categories. These categories classify threatened species in three categories: Vulnerable (VU), Endangered (EN) and Critically Endangered (CR). Other taxa are categorized as Near Threatened (NT: they are close to qualifying in a threatened category in the near future), Least Concern (LC: including widespread and abundant taxa) and Data Deficient (DD: inadequate information). To determine the area of occupancy and the extent of occurrence of *All. dofleini*, an exhaustive bibliographical survey was carried out.

Results

Allolobophora dofleini is widely distributed on the central and south area of the Balkan Peninsula. Our research has revealed new locations in the western, and southeastern parts of Serbia. *All. dofleini* is rarely represented in the area of western Serbia. Analysis of a very old Institute collection has shown that *All. dofleini* was also present at several new sites in the southeast part of Serbia (Table 1). Our additional data on its distribution and habitats from Serbia could contribute to better insight into the spread of this species on the Balkan Peninsula. Regarding the zoogeographical distribution type, *All. dofleini* belongs to widespread endemic species on the Balkan

Peninsula (Mršić 1991, Stojanović et al. 2008, Milutinović 2013).

***Allolobophora dofleini* (Ude, 1922)**

Helodrilus (Allobophora) dofleini Ude 1922: 157.
Eophila dofleini Omodeo 1956: 187.
Allolobophora savigny Michalis 1972: 27. (syn.)
Eophila dofleini dofleini Šapkarev 1978: 94.
Allolobophora dofleini Zisci & Michalis 1981: 251.
Allolobophora dofleini Zisci 1982: 427.
Eophila dofleini Easton 1983: 481.
Allolobophora (Serbiona) dofleini dofleini Mršić & Šapkarev 1988: 24.
Serbiona dofleini: Mršić 1991: 180.
Allolobophora dofleini Stojanović 1996: 28.
Serbiona dofleini Stojanović & Karaman 2007: 23, Stojanović et al. 2008: 60.

External characters

Diluted brown pigment on dorsum, lacking in intersegmental grooves. Body cylindrical, slightly broader in segments 6-12 and at caudal region.

The lenght of body 75-104 mm (acc. to Šapkarev 110 to 140, 80 to 240 mm), and consisting of 132 to 227 (acc. to Šapkarev (1978), 148 to 246, 137 to 292 mm) segments. The prostomium is epilobous. The first dorsal pore is in intersegmental groove 10/11 (11/12). The male aperture with a glandular atrium is on the 15th segment. Glandular papillae surround setae ab on segments 8 to 16, 18 to 33 or 8 to 33 or 24 to 27 or 8 to 12, 18 (acc. to Ude 1922, 12 to 17). The clitellum extends from segments 30, 31, 32 to 42, 43, 44,45 (acc. to Šapkarev (1978), 30, ½ 30, 31, 32 to 43, ½ 43, 44, ½ 44, 45, ½ 45), and the tubercula pubertatis are present from segments 32 to 40,41,42, 43 (acc. to Šapkarev (1978) 35, 36, 37, 38 to 42, ½ 42, 43, 44).

Internal characters.

Four pairs of seminal vesicles in the 9th to the 12th th segment (acc. to Omodeo (1988), only two pair of seminal vesicles). Testes and sperm funnels in 10 and 11 segments, free. Ovaries and ovarian receptacles in usual site. Two pairs of spermathecae in the 10th and 11th segments with openings at intersegments 9/10, 10/11 along the line of setae cd. The calciferous glands have lateral tubercles in the in 10th segment. Lateral hearts 5-11 (7 pairs). The crop occupies segments 15 and 16 and the gizzard is in 17-19. The septa are markedly thickened from 5/6 to the 9/10, or 6/7-11/12. The nephridial bladder is U-shaped.

Examined material

Old Institute collection: 1 exp., Lebane, 07. 07.1989.; 4 exp., Prokuplje, 26.04.1993.; 13 exp., Vranje, 20.05.1993. 1 exp., Jastrebac, 03.05.1995.; 1 exp., Bukovik, 26.04.1997.; 2 exp., Ražanj, 29.03.1997.; 8 exp., Leskovac, 1998.

Author's new data: 1 exp., oak forest, Ljubiš, Zlatar, 26.04.2009.; 1 exp., beech forest, Besna Kobila, 02.05.2010.; 1 exp., beech forest, Mitrovac, 22.05.2010.

Discussion

Biogeographical considerations

Based on all available data on the distribution of *Allolobophora dofleini*, it is clear that this species belongs to the widespread endemics on the Balkan Peninsula. According to the data from Fauna Europaea (Rota 2005), this species inhabits Serbia, Macedonia, Slovenia, Croatia, Bosnia and Hercegovina, Montenegro and Greece. However, it has never been recorded in Montenegro (Stojanović & Milutinović 2013, Szederjesi 2014) or in other former countries from Yugoslavia (Slovenia, Croatia, Bosnia and Herzegovina) (Szederjesi 2012). Additionally, in spite of the intensive researches in Bulgaria (Valchovski 2012, Stojanović et al. 2012, Szederjesi 2013) no specimens have been found and *All. dofleini* has not been reported so far from Albania (Szederjesi & Csuzdi 2012). In Greece, this species was recorded in Litochoro (Pieria) (Zisci 1972) and in Nomos Drama Mt. Falacro, (Omodeo 1988). Despite the extensive research in the north Greece (Zisci & Michalis 1981, Omodeo 1988, Szederjesi & Csuzdi 2012) and even, after our recent unpublished surveys in Pieria and Pilion area, *All. dofleini*.has not been found.

Our research indicates that this species is very common in the southeast part of Serbia, diminishing its presence towards the north and west direction. However, to date, this species has not migrated into north Panonian Serbia across the Danube river, which suggests that the Danube is its natural limit of distribution.

Concerning the distribution map of *All. dofleini* (Fig. 1) it is clear that its largest density exists along the Morava river in Serbia and along the Vardar river in Macedonia. However, in Macedonia, 67% of the localities were situated in hill pasture areas, while in Serbia it was registered in 54% of localities situated in river valley. Accordingly, *All. dofleini* follows the direction of

the river flow and appears in the humid biotopes beside river banks or in hilly habitats above the river.

All. dofleini belongs to an archaic group whose center of development must have been situated on the Serbo-Vardarian and Rhodopian tectonic plates (Stojanović & Karaman 2007). The high number of locations from south Serbia, north Kosovo and Macedonia and also the patterns of the present distribution of *All. dofleini,* prove the important role of these tectonic plates. Taking into account all the facts mentioned for *All. dofleini*, it is possible to assume that the Serbo-Vardarian valley is the area of origin and also a distribution center. We assume that *A. dofleini* could spread from this area to the west (to the Dinaric Alps), to the north (toward central Serbia), and to the east (toward the Balkan Mountains i.e. Stara Planina Mountain and Bulgaria).

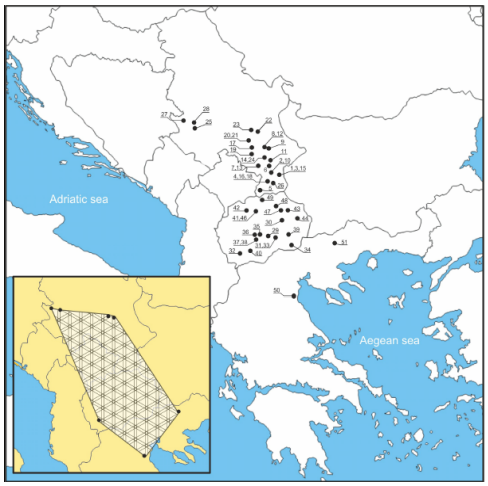

Figure 1. Distribution map of *Allolobophora dofleini* in the Balkan Peninsula and the current estimated EOO (insert).

Habitat preferences

Based on the literature this species is often found in mixed forests and pastures at higher altitudes (Stojanović 1996, Stojanović & Karaman 2005). According to Šapkarev & Pavlovski (1984), *Allolobophora dofleini* lives in hilly and mountainous areas and completely avoids lowland areas. They surveyed *All. dofleini* in the area of the Skopje valley (Gazi Baba) for the period of more than ten years following the size of population, vertical distribution, age structure and variation in population density. They found out that the soil of the explored habitats was clay (cinnamon-brown type of soils) with relatively high temperature and very low moisture. The density of population decreases with the depth of soil and can penetrate to 80 cm and the seasonal changes of the population density and vertical distribution were conditioned by temperature and moisture of the soil. Out of all 21 localities in Macedonia, 33% are those that are below the 500 m and most registered individuals are at the mentioned altitudes. However, considering all published data it is clear that the natural environment where *All. dofleini* finds the most favorable conditions for its existence is mainly at higher altitudes, in hilly mountain habitats. However, in Serbia most of the recorded localities (about 54%) appear under 500 m in altitude but, nevertheless, most individuals were found at altitudes above 500 m (Table 1). Therefore, it can be said that *All. dofleini* prefered hilly habitats at high altitudes.

Accordingly, based on Karaman & Stojanović (1996), there are differences in the position and length of the clitellum and tubercula pubertatis in individuals of *All. dofleini* from different localities from the Balkans (Macedonia, Greece, Serbia). Based on a detailed comparative analysis they found some regularity of the position and length of tubercula pubertatis, but there was not regularity in the position and number of segments in clitellial part. They concluded that the individuals found under 500 m altitude have a tubercula pubertatis moved ahead and have a greater number of segments (31., 32., 33., 34., 35.-39., 40., 42., hold of 6-12 segments). However, the individuals from localities over 500 m have a shorter tubercula pubertatis with a smaller number of segments. Additionally, tubercula pubertatis is moved back (35., 36., 37., 38.-40., 41., 42., 43., hold of 4-8 segments). Exemplars from our localities confirm this standpoint (Table 2).

Based on data from Omodeo (1988), the individuals collected at the lower altitudes were larger than those collected at a higher altitude.

Threat status

The IUCN categories have been widely accepted throughout the world, but the experts considered the IUCN system not suitable for use in the case of invertebrates (Gärdenfors 2003, Popescu & Davideanu 2009). Only criterion B (geographically restricted distribution in combination with population decrease, fragmentation or fluctuation)

Table 1. Geographic information on new localities of *Allolobophora dofleini* and data from the literature.

Country	No	Localities	GPS	Altitude (m)	No. ind.	Sampling date	Sources
Serbia	1	Vlasinsko jezero	42°41′N 22°19′E	1200	47	06.05.1971	Zisci 1972
	2	Vladičin Han	42°42′N 22°03′E	386	1	11.05.1975.	Šapkarev 1980
	3	Vlasina	42°40′N 22°18′E	1230	3	13.05.1975.	Šapkarev 1980
	4	Vranjska Banja	42°33′N 21°59′E	498	5	13.05.1975.	Šapkarev 1980
	5	Srpsak kuća	42°28′N 21°48′E	381	8	13.05.1975.	Šapkarev 1980
	6	Grdelička klisura	42°50′N 22°05′E	716	7	14.06.1976.	Šapkarev 1980
	7	Lebane	42°55′N 21°44′E	275	8	26.05.1976.	Šapkarev 1980
	8	Niš	43°19′N 21°54′E	300	1	08.05.1976.	Šapkarev 1980
	9	Niška banja	43°17′N 22°00′E	248	3	08.05.1976.	Šapkarev 1980
	10	Ostrozub	42°52′N 22°14′E	550	2	10.07.1988.	Karaman & Stojanović 1996
	11	Kukavica	42°56′N 22°05′E	372	1	06.05.1989.	author's data (old Institute collection)
	12	Niš	43°19′N 21°54′E	300	1	12.05.1989.	Karaman & Stojanović 1996
	13	Lebane	42°55′N 21°44′E	275	1	07.07.1989.	author's data (old Institute collection)
	14	Leskovac	42°59′N 21°57′E	300	2	19.04.1990.	Karaman & Stojanović 1996
	15	Vlasina	42°40′N 22°18′E	550	3	02.05.1990.	Karaman & Stojanović 1996
	16	Vranje	42°33′N 21°54′E	200	1	25.04.1993.	Karaman & Stojanović 1996
	17	Prokuplje	43°14′N 21°35′E	255	4	26.04.1993.	author's data (old Institute collection)
	18	Vranje	42°33′N 21°54′E	480	13	20.05.1993.	author's data (old Institute collection)
	19	Vidojevica	43°08′N 21°33′E	390	4	05.06.1993.	Karaman & Stojanović 1996
	20	Jastrebac	43°23′N 21°26′E	1491	1	03.05.1995.	author's data (old Institute collection)
	21	Jastrebac	43°23′N 21°26′E	800	1	01.06.1995.	Karaman & Stojanović 1996
	22	Bukovik	43°41′N 21°38′E	894	1	26.04.1997.	author's data (old Institute collection)
	23	Ražanj	43°40′N 21°32′E	338	2	29.03.1997.	author's data (old Institute collection)
	24	Leskovac	42°59′N 21°57′E	228	8	1998.	author's data (old Institute collection)
	25	Ljubiš-Zlatar	43°37′N 19°51′E	840	1	26.04.2009.	author's new data
	26	Besna Kobila	42°31′N 22°13′E	1923	1	02.05.2010.	author's new data
	27	Mitrovac	43°52′N 19°33′E	1082	1	22.05.2010.	author's new data
	28	Sirogojno	43°41′N 19°53′E	910	1	28.04.2011.	Milutinović et al. 2015
Macedonia	29	Vataša	41°25′N 22°01′E	300	3	11.04.1963.	Šapkarev 1974, Mršić 1991
	30	Vrteška-Pčinja river	41°45′N 22°25′E	1060	1	22.04.1963.	Šapkarev 1970, Mršić 1991
	31	Demir Kapija	41°23′N 22°13′E	260	3	02.03.1967.	Šapkarev 1974, Mršić 1991
	32	Bitola	41°00′N 21°12′E	576	2	25.05.1967.	Šapkarev 1972, Mršić 1991
	33	Demir Kapija	41°23′N 22°13′E	700	10	01.07.1969.	Karaman & Stojanović 1996
	34	Dojran	41°11′N 22°43′E	160	2	28.09.1969.	Karaman & Stojanović 1996
	35	Rakle	41°25′N 21°44′E	520	2	14.05.1970.	Šapkarev 1974, Mršić 1991
	36	Pletvar	41°22′N 21°39′E	761	10	07.04.1972.	Šapkarev 1972, Mršić 1991
	37	Volkovo	41°18′N 21°34′E	780	11	08.04.1972.	Šapkarev 1972, Mršić 1991
	38	Prilep	41°19′N 21°34′E	620	1	08.04.1972.	Šapkarev 1972, Mršić 1991
	39	Strumica	41°25′N 22°37′E	280	18	11.05.1972.	Šapkarev 1973
	40	Gazi Baba	41°10′N 21°29′E	250	14	04.1978.	Šapkarev 1984, 1994
	41	Katlanovo	41°53′N 21°40′E	250	5	04.1978.	Šapkarev 1994
	42	Vodno	41°57′N 21°23′E	800	1	04.1978.	Šapkarev 1994
	43	Kalimanci	41°57′N 22°35′E	840	2	13.05.1978.	Šapkarev 1983
	44	Pehčevo	41°45′N 22°53′E	1000	8	27.05. 1978.	Šapkarev 1983
	45	Ponikva	42°01′N 22°21′E	1600	14	13. 06.1979.	Šapkarev 1983
	46	Katlanovo-Rudnik	41°53′N 21°40′E	240	?	20.04.1990.	Mršić 1991

Continued on next page

Table 1. (continued)

Country	No	Localities	GPS		Altitude (m)	No. ind.	Sampling date	Sources
	48	Probištip	42°00′N	22°13′E	792	?	24.04.1990.	Mršić 1991
	49	Staro Nogoričane	42°13′N	21°49′E	420	?	25.04.1990.	Mršić 1991
Greece	50	Pieria	40°12′N	22°14′E	705	1	20.04.1971.	Zisci & Michalis 1981
	51	Drama M.Falacro	41°17′N	24°10′E	1300	2	18.05.1987.	Omodeo 1988

Table 2. The position of the clitellum and tubercula pubertatis in specimens of *Allolobophora dofleini* collected at different localities in the Balkan Peninsula (localities under 500m-; over 500m+).

	Clitellum	Tubercula pubertatis
Ude (1922) +	31,32-45	36,37-42,43
Karaman (1969) -	30-43	31,32,34,35-42
Šapkarev (1972) -	30,31,32-43,44,45	32,33,34,35-39,40
Zicsi (1972) +	31-44,45	37,38-42,43
Omodeo (1988) +	30-45,46	36,37-43
Mršić (1991) +	30,31,32-42,43	35-42
Karaman & Stojanović (1996) +	30,31-42,43,44	34,35,36,37,38-40,41,42,43
Author's data +	30,31,32-42,43,44,45	34-39,40,41,42,43
Author's data -	30,31,32-44	32-40,41,42

was thought to be applicable, while data to apply criteria A (population decrease) and E (quantitative analysis) were not available, and criteria C and D (restricted number of individuals) were not applicable. Criterion B is based on the range size of a species (Area of Occupancy, AOO, and Extent of Occurrence, EOO). EOO is defined by the IUCN as "the area contained within the shortest continuous imaginary boundary that can be drawn to encompass all sites of present occurrence of a taxon". AOO is defined as the area which is occupied by a taxon within its extent of occurrence.

Until the present, the northernmost findings of the species have been in the central part of Serbia, while the southernmost point in its distribution has been in northern Greece.

Mitrovac (National park Tara), as a part of Dinaric Alps in western Serbia, is a new location and is also the westernmost point of occurrence of this species in the Balkans. As a result of our survey, the new records of *Allolobophora dofleini* extend the known distribution range of the species 150 km to the west.

Considering the data from all investigations conducted so far, it is possible to determine the threat status of *All. dofleini* on a global level. *All. dofleini* is a species registered in less than 50 locations on the Balkan Peninsula. AOO for *All. dofleini* is around 200 km^2. The analysis based on the IUCN (2011) Red List Categories shows that *All. dofleini* belongs to the Endangered category (EN) in the Balkan Peninsula (B 2 b (ii; iv; v;); c (ii; iv)).

Nevertheless, despite our intensive search in Serbia for the last 20 years, *All. dofleini* was found only on several localities in Serbia (Table 1).

In Greece, it is clear that *All. dofleini* appears sporadically. Despite the fact that earthworm fauna in Greece has been not investigated in detail, the absence of *All. dofleini* is relatively disturbing. However, the most alarming situation is in Macedonia. Namely, the population of *All. dofleini* was widespread in Macedonia, only about twenty years ago. Unfortunately, *All. dofleini* was not registered in published recent research (Szederjesi 2012) and neither in our unpublished data from Macedonia.. We can only assume that this species still exists in Macedonia. But, what happened in the meantime and why it is now much harder to find this species? Answers on such disturbing questions certainly are very complex and only future surveys will be able to give explanations. For now, a reasonable explanation for this situation can be found in the fragmentation of habitats affected by different anthropogenic impacts. On the other side, our finds of *All. dofleini* in the western mountain area in the Balkans are surprising, and suggest that it is possible that global warming is causing population movement toward the northwest, accompanying the Vardar Morava direction, which indicates that it may be possible to expect infiltration of a greater number of individuals into

the colder northwestern area of the Balkans.

All data mentioned above also indicate that *All. dofleini* is an endemic species that potentially is in need of conservation or at least needs monitoring for future negative changes. However, threat status does not always reflect actual conservation requirements (Gärdenfors et al. 2001) and it is necessary to determine the importance (i.e. responsibility) of a specific area for the global survival of a species. As a biogeographic criterion for assessing conservation priorities the concept of national or regional responsibility was developed to underline the importance of a localized population for the global survival of a species (Schmeller et al. 2008). This criterion reflects whether the study area encloses a large part of the distribution of a species. Considering the fact that the major distribution center for *All. dofleini* is the area of the Serbo-Vardarian tectonic plate, it is clear that the states of Serbia and Macedonia have a very high responsibility for the global survival of *All. dofleini.*

The evaluation of the conservation status of *Allolobophora dofleini* is necessary to successfully prevent its extinction. However, the conservation analysis still requires some decisions based on future research and, therefore, our status assessment must be viewed as a working hypothesis based on the best available information. Any increase in knowledge about particular taxa could result in changes in threat category. Nevertheless, our analysis represents a significant contribution toward the understanding of the status and distribution of a very sensible endemic earthworm species restricted to the Balkan Peninsula.

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