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Original article

Earthworm (*Lumbricidae*) diversity in the Central Balkans: An evaluation of their conservation status

Mirjana Stojanović, Tanja Milutinović, Spasenija Karaman*

Institute of Biology and Ecology, Faculty of Science, R. Domanovića 12, 34000 Kragujevac, Serbia

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ABSTRACT

In this paper we summarize the current knowledge on earthworm diversity in the central part of the Balkans, in the State of Serbia. Up to now, 71 species and 8 subspecies, belonging to 18 genera, are known from investigated territory. Our aim was to produce a single priority list for earthworm conservation, particularly as the Balkan countries did not have their own Red Lists for earthworms and none of the species had a legally protected status. The list underlines the diversity of earthworms, zoogeographical position as well as category of threat. The analysis based on the IUCN (2001) Red List Categories shows that 17 of 79 taxa are Critically Endangered (5 species are serious Critically Endangered, but 12 species are only suspect for the Critically Endangered category), 9 species are Endangered and 14 species are Vulnerable. Serious candidates for their inclusion in CR category within the IUCN (2001) Red List are: *Cernosvitovia biserialis*, *Dendrobaena kozuvensis*, *Lumbricus improvisus*, *Serbiona kosowensis montenegrina* and *Serbiona serbica*. Of all registered earthworms, 34 taxa (43.1%) were identified only as endemic species. Unfortunately, most of the high-priority species are endemic (23 taxa). The position of the Central Balkans contributes to the great biodiversity of earthworms on its territory, but the fact that nearly 36% of its lumbricids are threatened is a strong signal that action is required.

1. Introduction

The Balkan Peninsula is very rich in earthworm species with about 200 reported from this region [33]. Endemic species, particularly those of local and stenolocal distribution greatly contribute to species diversity.

Earthworm fauna of the Balkans is influenced by the diversity of its climate and edaphic factors (crossing of various zoogeographic regions), as well as great changes in the past. This is why the Balkans area is an important center of earthworm development and the identification. The identification of target species for conservation is therefore a topic of particular interest.

The aim of the present work was to assess earthworm status of threat according to the 2001 IUCN threat categories and criteria, in order to establish a Red List of Earthworms distributed in the Central part of the Balkans, in the State of Serbia. The List underlines the diversity of earthworms and provided a general overview of their distribution, species richness, zoogeographical position and possibility of survival throughout the various regions of the Central Balkans.

The first data on the earthworm fauna of Serbia was provided by Cognetti [7], Černosvitov [2,4,5,6], then later by Pop [41], Karaman [15,16], Zicsi [74], Šapkarev [48–50], and Zicsi

* *Corresponding author*. Tel.: +381 34 310 674.
E-mail address: mirast@kg.ac.yu (M. Stojanović).
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and Šapkarev [81]. The earthworm fauna of Serbia has now been widely studied [17–24,32–35,55–58].

Although the earthworm taxonomy and distribution from a certain part of the Balkans area are well known (that is from the former Yugoslavian territories), Greece and Bulgaria are far less studied and there is hardly anything known from Albania. Unfortunately, there is a lack of overall knowledge concerning their conservation status. Only one paper exists concerning conservation status for the endemic earthworm genus *Helodrilus* on the Balkans [68]. None of the Balkan countries has a Red List for earthworms, hence none of the species has a legally protected status.

This paper proposes a Red List of earthworms for the territory of Serbia based on more than 20 years of field investigation and literature data. This is therefore the first attempt of assessing conservation priorities for earthworms of Serbia.

2. Materials and methods

2.1. Study area

The application area is Serbia, central part of SE Europe and the Balkan Peninsula, comprising 88,361 km^2. The length of the Serbian border is 2114.2 km.

Our extensive investigation was carried out during the period from 1995 to 2007, but we also included our data from 1987 to 1995 and our sporadic investigation before 1987. Data on species were obtained from the literature and from fieldwork. As far as possible, we included all published and unpublished data presently known. Field data were collected at more than 120 sites (over 3200 specimens).

In the last investigation period throughout the whole territory, we collected earthworms from various habitats. The specimens were obtained by digging and hand sorting as well as by turning over rocks, debris and logs. The earthworms were killed in 70% ethanol and stored in 90% ethanol. Identification of species was made in accordance with Blakemore [1], Csuzdi and Zicsi [10], Mršić [33], Šapkarev [51], and Zicsi [77].

2.2. Regional distribution

Relatively few works deal with the biogeography of earthworms and especially little work has been undertaken to understand the distribution of earthworms [10,33,36–38,40]. We have to agree with Mršić [33] as well as with Csuzdi and Zicsi [10]. Bearing this in mind we tried to summarize the biogeographical patterns of earthworms with a special interest in the Balkan fauna. The different distribution ranges were as follows: Peregrine (Per), Holarctic (Hol), Palearctic (Pal), European (Eur), Central European (CEu: central part of Europe), Southern European (SEu: Moldavia, Romania, the Balkan Peninsula, without Slovenia), Transaegean (Tra: Europe from the Alps to the Ural Mts., Anatolia, Levant and Mesopotamia), Dinaric-Carpathian (DC), Alpino-Dinaro-Carpathian (ADC: northern Aegeida), Alpine-Dinaric (AD), larger endemite (EL: only on the Balkan Peninsula, widespread distribution) and Endemite (End: only in the restricted area of the Balkan Peninsula).

2.3. Assessment of conservation priority

This paper proposes a Red List of earthworms for the territory of Serbia based on the IUCN [12] threat categories. We classified threatened species in three IUCN [12] categories: Vulnerable (VU), Endangered (EN) and Critically Endangered (CR). The other taxa qualified as Near Threatened category (NT: they are close to qualifying in a threatened category in the near future), Least Concern category (LC: including widespread and abundant taxa) and Data Deficient category (DD: inadequate information). In order to determine the area of occupancy and the extent of occurrence, an exhaustive bibliographical survey was carried out [6,8,9,11,14–17,25–28,32–34,36,38,43,44,46,47,49,51–53,55,60,62,65,71,72,75–82].

3. Results

3.1. Taxonomic richness

This study has been accomplished by reference to more than 3000 classifiable specimens belonging to 51 taxa, six of which are new for Serbia: *Dendrobaena rhodopensis*, *Octodrilus bretscheri*, *Octodrilus argoviensis*, *Proctodrilus opisthoductus*, *Cernosvitovia rebelii* and *Helodrilus balcanicus balcanicus*. By adding these new findings to the previous records, the number of species living in Serbia rises to 79 (18 genera, 71 species and 8 well-characterized subspecies). The definitive list of earthworm taxa known today and their conservation status, as well as their zoogeographical position, is given in Table 1.

3.2. Zoogeographic analysis

Regarding the zoogeographical position (Table 1) of the earthworms of Serbia, the largest number is that of endemites. The degree of endemism is quite high, exceeding 43% (EL: 14%; End: 29.1%). Holarctic (8.9%), Peregrine (16.4%) and European (6.3%) taxa represent practically two thirds of all taxa. There follow Transaegean (7.6%) and not so numerous Alpino-Dinaro-Carpathian (3.8%), Alpine-Dinaric (3.8%), Central European (3.8%), Dinaric-Carpathian (2.5%), Palearctic (2.5%) and Southeast European (1.3%) taxa.

3.3. Species vulnerability

The analysis based on the IUCN [12] Red List Categories shows that 17 of 79 taxa are CR (5 species are serious CR, but 12 species are only suspect for the CR category), 9 species are EN and 14 species are VU. The remaining 39 species were assigned to the no-risk group (8 species are NT, 29 species belong to the LC category and 2 species are DD).

Serious candidates for their inclusion in CR category within the IUCN [12] Red List are: *Cernosvitovia biserialis*, *Dendrobaena kozuvensis*, *Lumbricus improvisus*, *Serbiona kosowensis montenegrina*, and *Serbiona serbica*. Nine species belong to the EN category: *Dendrobaena rhodopensis*, *Serbiona paratuleskovi*, *Helodrilus balcanicus plavensis*, *Italobalkaniona getica*, *Cernosvitovia rebelii*, *Octodrilus bretscheri*, *Serbiona dofleini*, *Serbiona kosowensis kosowensis*, and *Microeophila nematogena*.