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THE PRESENCE OF AMPHIBIANS AND REPTILES IN THE GOLIJA MOUNTAIN COMPARED WITH FAUNA OF OTHER AREAS

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ABSTRACT: Batracho- and herpetofauna of the Golija Mountain have not yet been sufficiently explored. During nine years of research, a total of 22 species of amphibians and reptiles were recorded in the Nature Park "Golija", and in the area of the "Golija-Studenica" Biosphere Reserve, which comprises 45.83% of all autochthonous amphibians and reptiles in Serbia. The presence of the species was ascertained by direct or indirect observation. Some species were recorded for the first time. Most species have the status of strictly protected. Sorensen's similarity coefficient had high values between Golija Mt. and all compared areas. The presented data are not final, but they significantly contribute to the knowledge of the fauna of these areas. It is necessary to establish long-term research and a system of active or passive monitoring.

Keywords: Golija Mt., Nature Park, Biosphere Reserve, amphibians, reptiles, similarity coefficient

INTRODUCTION

Amphibians occur widely throughout the world, even edging north of the Arctic Circle in Eurasia; they are absent only in Antarctica, the most remote oceanic islands, and extremely xeric deserts. Approximately 8,798 species of recent amphibians are known (https://amphibiaweb.org). Amphibians, particularly anurans, play an important role in controlling insect populations that damage crops or spread diseases. Since the 1980s, a severe decline in the populations of many frog species has been observed (BLAUSTEIN and WAKE, 1990).

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Amphibians are important global indicators of environmental health, yet they have experienced some of the most significant population declines among all groups assessed by the International Union for Conservation of Nature (IUCN). According to estimates of IUCN (2018), almost 41% of all amphibian species are endangered. Being particularly sensitive to environmental changes, amphibians are severely threatened by habitat destruction, pollution, the spread of a disease called amphibian chytridiomycosis, and climate change.

In the Republic of Serbia, there are 22 species of amphibians: 14 anurans (order Anura) and eight newts and salamanders (order Caudata) (UROŠEVIĆ *et al*., 2022). In our country, factors that affect amphibian populations the most are the destruction or degradation of habitats, deforestation, also drying of wet habitats to form agricultural lands, urbanization, and pollution (COLLINS and STORFER, 2003; KRIZMANIĆ *et al*., 2015).

Reptiles (Class Reptilia) also show a diversity of morphologies. Some groups possess strongly developed limbs, whereas other groups (for example snakes) are limbless. Reptilian body flexibility varies from the highly flexible snakes to the rigid, armored bodies of turtles (SPEYBROECK *et al*., 2016).

Compared to other vertebrates, this group of animals has narrower distribution areas, due to their specific traits and life requirements. Consequently, they are very susceptible to various anthropogenic influences (AJTIĆ *et al*., 2015). That is why nearly 21% of reptiles have the status of endangered or vulnerable species, and are at risk of extinction (IUCN, 2018).

The 26 autochthonous reptile species are present in the Republic of Serbia. Among these 26 species, there are three species of chelonians (order Testudines), 13 species of lizards (suborder Lacertilia), and 10 species of snakes (suborder Serpentes). In our country, reptiles are widespread, however comprehensive studies of species diversity, distribution patterns, and zoogeographic analysis of the herpetofauna of our country have rarely been conducted (TOMOVIĆ *et al*., 2014).

As the case with the amphibians, the most significant factors threatening reptiles in Serbia are the degradation and destruction of habitats, disturbance by humans, urbanization, pollution, and biological (internal) factors (AJTIĆ *et al*., 2015).

Based on the review of the literature and expert opinion, supplemented by a visit to Golija Mt. for eight years (from 2016 to 2024), it was concluded that within the mountain there are quality habitats suitable for numerous species of amphibians and reptiles. Aquatic ecosystems are of particular importance for amphibians, especially in terms of reproductive centers, and open habitats (forest edges and glades, and high mountain grassy habitats) for reptiles. The presence of relicts in the flora of Golija Mt. indicates the possibility that some specific animal species survived in the refugial habitats.

In the year 2000, the Institute for Nature Protection of Serbia produced a study based on which Golija Mt. was declared a Nature Park: in 2001, it was placed under protection (category I) as a natural asset of exceptional importance (ANONYMUS, 2001). In the same year, 72.5% of the Park's surface was declared a Biosphere Reserve “Golija-Studenica” within the UNESCO program “Man and Biosphere.”

Golija Mt. represents an area of distinct landscape values that is the center of genetic, species, and ecosystem diversity in the Republic of Serbia, the Balkans, and Europe. However, not many areas were covered by specific multi-year research in this area. Work was done on studying the ornitho- and ichthyofauna, the fauna of diurnal butterflies and macrozoobenthos, and there was little research on the fauna of amphibians and reptiles (MILJANOVIĆ, 2005).

The primary objective of this study is to provide comprehensive data on the diversity of amphibians and reptiles in the investigated area and to present a list of the primary factors that have the highest impact on their populations in this mountain region. Additionally, one of the objectives of this article is to calculate the similarity coefficient between this region and other comparable regions within our country, in terms of the richness of batracho- and herpetofauna.

MATERIALS AND METHODS

Investigated area

The Nature Park "Golija" and Biosphere Reserve "Golija-Studenica" (Fig. 1) encompasses a portion of the mountainous region in western Serbia, such as Golija Mountain, Radočelo and Čemerno Mountains. The protected area covers a wide range of altitudes: from 329 m a.s.l. at the confluence of Studenica and Ibar to the 1,833 m a.s.l. high peak of Jankov Kamen. Geotectonically, they are part of the inner Dinarides (MILJANOVIĆ, 2005).

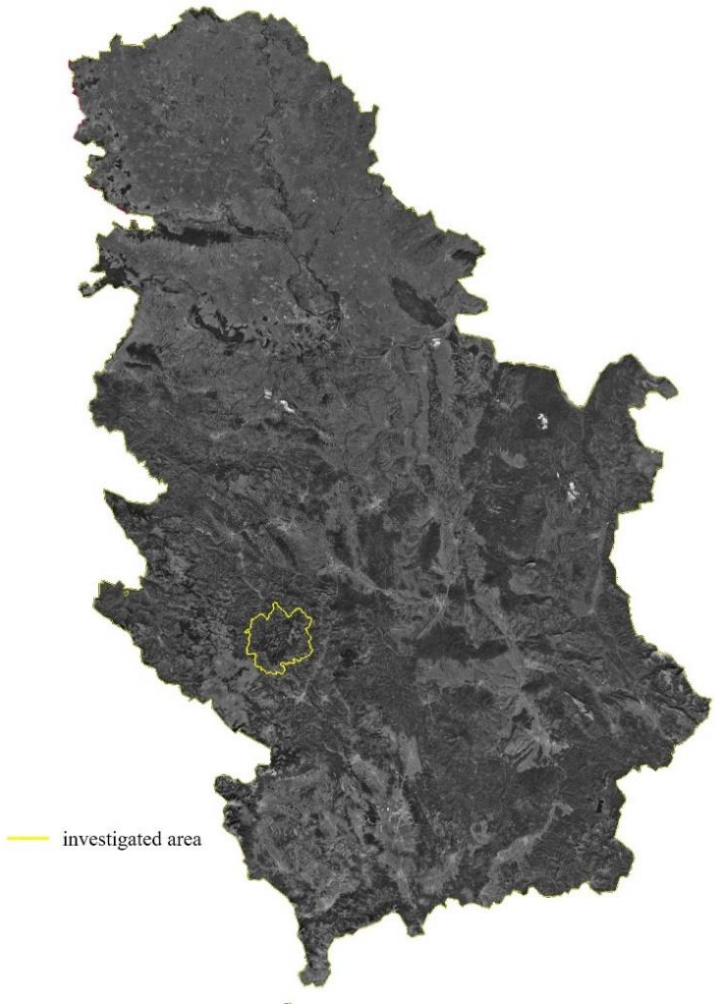

Figure 1. Investigated area of Golija Mountain (https://earth.google.com/).

Data collection

Most of the data were collected during field surveys in the period between 2016 and 2024. All species were recorded through direct visual observation and simple catching. In addition to direct observation of adults, juvenile, and/or larval forms, indirect methods were also used, that is laid eggs for anuran amphibians and molts for snakes. To observe as many species as possible, a detailed search of several habitat types was practiced, in all parts of the period of activity of amphibians and reptiles.

Specimens were identified by visual inspection of diagnostic features according to standard batrachological and herpetological literature (ARNOLD and OVENDEN, 2002; SPEYBROECK *et al*., 2016). Taxonomy and current nomenclature were given according to UROŠEVIĆ *et al*. (2022).

Similarity index

To assess the resemblance between the batracho- and herpetofauna in the Golija Mt., Sorensen's index of similarity (SØRENSEN, 1948) was used. This index is commonly used in ecological studies and provides a simple tool for comparing the species composition of two communities.

Sorensen's Index represents a numerical result obtained with formula (1):

$$S_s = \frac{2a}{2a+b+c} \quad (1)$$

where S_s is Sorensen's similarity coefficient; a is the number of species in sample A and sample B (joint occurrences); b is the number of species in sample B, but not in sample A; and c is the number of species in sample A, but not in sample B.

Index values are from 0 (less similar) to 1 (completely similar).

The comparison was made with five other areas in Serbia, including Rudnik Mountain, Mojstirsko-Draške Mountains, Sićevačko-Jelašnička George, Avala, and Radan Mountains, for the batracho- and herpetofauna separately. The selection of these habitats was because there is existing data on the fauna of amphibians and reptiles (SIMOVIĆ *et al*., 2013; ĆIRKOVIĆ and AJTIĆ, 2024; authors unpublished data).

RESULTS AND DISCUSSION

List of amphibians and reptiles detected in the investigated area.

Class **Amphibia** Linnaeus, 1758
Order **Caudata** Scopoli, 1777 or **Urodela** Duméril, 1805
Family Salamandridae Goldfuss, 1820
Genus *Ichthyosaura* Sonnini and Latreille, 1801
1. Ichthyosaura alpestris (Laurenti, 1768) – Alpine Newt
Genus *Lissotriton* Bell, 1839
2. *Lissotriton vulgaris* (Linnaeus, 1758) – Smooth Newt
Genus *Salamandra* Garsault, 1764
3. *Salamandra salamandra* (Linnaeus, 1758) – Fire Salamander
Genus *Triturus* Rafinesque, 1815
4. *Triturus macedonicus* (Karaman, 1922) – Macedonian Crested Newt

Order **Anura** Duméril, 1805
Family Bombinatoridae Gray, 1825
Genus *Bombina* Oken, 1816
5. *Bombina variegata* (Linnaeus, 1758) – Yellow-bellied Toad

Family Bufonidae Gray, 1825
Genus *Bufo* Garsault, 1764
6. *Bufo bufo* (Linnaeus, 1758) – Common Toad
Genus *Bufotes* Rafinesque, 1815
7. *Bufotes viridis* (Laurenti, 1768) – Green Toad

Family Hylidae Rafinesque, 1815
Genus *Hyla* Laurenti, 1768
8. *Hyla arborea* (Linnaeus, 1758) – Common Tree Frog

Family Ranidae Batsch, 1796
Genus *Pelophylax* Fitzinger, 1843
9. *Pelophylax ridibundus* (Pallas, 1771) – Marsh Frog
Genus *Rana* Linnaeus, 1758
10. *Rana dalmatina* Fitzinger in Bonaparte, 1838 – Agile Frog
11. *Rana temporaria* Linnaeus, 1758 – Common Frog

Class **Reptilia** Laurenti, 1768
Order **Squamata** Oppel, 1811
Family Lacertidae Batsch, 1788
Genus *Lacerta* Linnaeus, 1758
1. *Lacerta agilis* Linnaeus, 1758 – Sand Lizard
2. *Lacerta viridis* (Laurenti, 1768) – Eastern Green Lizard
Genus *Podarcis* Wagler, 1830
3. *Podarcis muralis* (Laurenti, 1768) – Common Wall Lizard

Family Anguidae Gray, 1825
Genus *Anguis* Linnaeus, 1758
4. *Anguis fragilis* Linnaeus, 1758 – Slow Worm

Family Natricidae Bonaparte, 1840
Genus *Natrix* Laurenti, 1768
5. *Natrix natrix* (Linnaeus, 1758) – Grass Snake
6. *Natrix tessellata* (Laurenti, 1768) – Dice Snake

Family Colubridae Oppel, 1811
Genus *Coronella* Laurenti, 1768
7. *Coronella austriaca* Laurenti, 1768 – Smooth Snake
Genus Dolichophis Gistel, 1868
8. *Dolichophis caspius* (Gmelin, 1789) – Caspian Whip Snake
Genus *Zamenis* Wagler, 1830
9. *Zamenis longissimus* (Laurenti, 1768) – Aesculapian Snake

Family Viperidae Oppel, 1811
Genus *Vipera* Garsault, 1764
10. *Vipera ammodytes* (Linnaeus, 1758) – Nose-horned Viper
11. *Vipera berus* (Linnaeus, 1758) – Adder

According to national legislation, three of all named species (*P. muralis*, *L. viridis*, and *A. fragilis*) are not under protection, while species *V. ammodytes* and *P. ridibundus* are protected by national legislation, and all others are strictly protected.

Obtained results showed that 22 amphibian and reptile species were recorded in the study area, which comprises 45.83% of all autochthonous batracho- and herpetofauna species known in the Republic of Serbia. These species used to have a much larger distribution, but due to the mosaic character of their habitats, their distribution is limited to smaller areas. As in other parts of their distribution area, the most threatening factors for these species are habitat destruction by construction and harassment, which causes declay in the population number in some areas.

The most frequently recorded species were *I. alpestris*, *R. temporaria*, *B. bufo*, and *L. viridis*, and the rarest recorded species was *V. berus*. During our research, this species was recorded for the first time in this area.

The proven presence of a large number of strictly protected species would raise the importance of the entire mountain area. In terms of a higher level of protection, one can think about the umbrella species: it is a common practice in the world to protect other species and entire habitats "at the expense" of one, especially important (extremely rare, highly endangered, etc.) species. In the case of Golija Mt. the umbrella species could be *V. berus* because its presence was established in suitable habitats.

According to Sorensen's similarity coefficient, Golija Mt. has a high similarity with all compared localities (Tab. 1), both for amphibian and reptile fauna. For batrachofauna, three localities (Rudnik Mt., Mojstirsko-Draške Mt., and Sićevačko-Jelašnička George) have the same Sorensen's coefficient value of 0.84, and for herpetofauna, the highest similarity is with Mojstirsko-Draške Mt. (coefficient value 0.87). The reason for this can be that Golija and Mojstirsko-Draške Mt. are geographically close and have similar ecosystems, and ecological and environmental conditions.

Table 1. Sorensen's similarity coefficient.

		RK	MD	SJ	AV	RD
Amphibians	**GO**	0.84	0.84	0.84	0.74	0.80
Reptiles	**GO**	0.78	0.87	0.83	0.76	0.74

GO – Golija Mountain, RK – Rudnik Mountain, MD – Mojstirsko-Draške Mountains, SJ – Sićevačko-Jelašnička george, AV – Avala Mountain, RD – Radan Mountain.

As mentioned earlier, Golija Mt. is a Nature Park and even the Biosphere Reserve, but despite all of that it faces various problems in terms of habitat loss caused by human activities, and reduction in the populations of some species. Also, pollution and climate change are important factors that additionally pressure ecosystems and sensitive and vulnerable species such as amphibians and reptiles. Our data does not represent a true picture of the state of the fauna of amphibians and reptiles in Golija Mt., but they make a significant contribution to the knowledge of the fauna of these areas. In order to assess the number and condition of amphibian and reptile populations, to establish the position of the reproductive centers of amphibians, and the position of the wintering grounds of these species, it is necessary to carry out additional long-term field research in the mountain.

CONCLUSION

The area of Golija Mountain is very important for biodiversity, having various ecosystems that are suitable for the life, survival, and reproduction of many animal species, including amphibians and reptiles. Twenty-two species of amphibians and reptiles are recorded in this area during investigation: four species of tailed amphibians (order Caudata), seven species of anurans (order Anura), four species of lizards (suborder Lacertilia), and seven species of snakes (suborder Serpentes). This number of recorded species of amphibians and reptiles is not final but represents the initial step in exploring the fauna in this area. To get detailed information and the right picture of biodiversity on Golija Mt. it is important to conduct long-term research at several levels. Even though the investigated area is protected it faces different conservation problems and population decline. Certainly, there is a way to preserve the populations of these two groups of animals, and some of the ways include, above all, education, more compliance with legal measures, additional scientific research, long-term monitoring, and revitalization of certain habitats.

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