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AMPHIBIANS OF RAMSAR SITE "BARDAČA WETLAND" – A CHECKLIST WITH ECOLOGICAL NOTES

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Summary

The goal of this study was to create a faunistic list of amphibians of the Ramsar site "Bardača Wetland" based on literature data and original field studies by the authors, with reference to certain aspects of the ecology of the recorded species. Field data were collected using the transect method, in the period from 2012 to 2022, providing data on nine species of amphibians. Presence of five species previously cited in literature sources was not confirmed. Therefore, the batrachofauna of the Ramsar site "Bardača Wetland" reliably consists of nine species of amphibians: two species of caudate amphibians (*Lissotriton vulgaris* and *Triturus dobrogicus*) and seven species of anurans (*Bombina bombina, Bufo bufo, Bufotes viridis, Hyla arborea, Pelophylax* kl. *esculentus, Pelophylax ridibundus* and *Rana dalmatina*). In this paper, the ecological data collected in the field (habitat types of adults and larvae, the season of their activity within the annual cycle, general state of populations of some species) and corresponding ecological data from literature sources are systematically presented, separately for each species.

Key words: batrachofauna, ecology, conservation of biodiversity, Bosnia and Herzegovina

INTRODUCTION

The Ramsar site "Bardača Wetland" (Figure 1) was declared a Wetland of International Importance by the decision of the Ramsar Convention Secretariat on February 2, 2007. This is the only wetland area in the territory of the Republic of Srpska that is included in the Ramsar list. It is situated in the north-western part of Bosnia and Herzegovina, and territorially it belongs to the municipality of Srbac. The Ramsar site "Bardača Wetland" is an integral part of Lijevče Polje, at the altitude between 85 and 95 meters above sea level. Its northern boundary is river Sava and its north-eastern and eastern boundaries are formed by river Vrbas. In the southeast and south, the Osorna-Borna-Ljevčanica canal represents the border, while at the southwest and west, there is some agricultural land and the river Matura. The Ramsar site "Bardača Wetland" occupies a total area of 3500 hectares, and includes five settlements: Gaj, Bardača, Bajinci, Dugo Polje and part of the settlement Glamočani (https://www.ramsar.org).

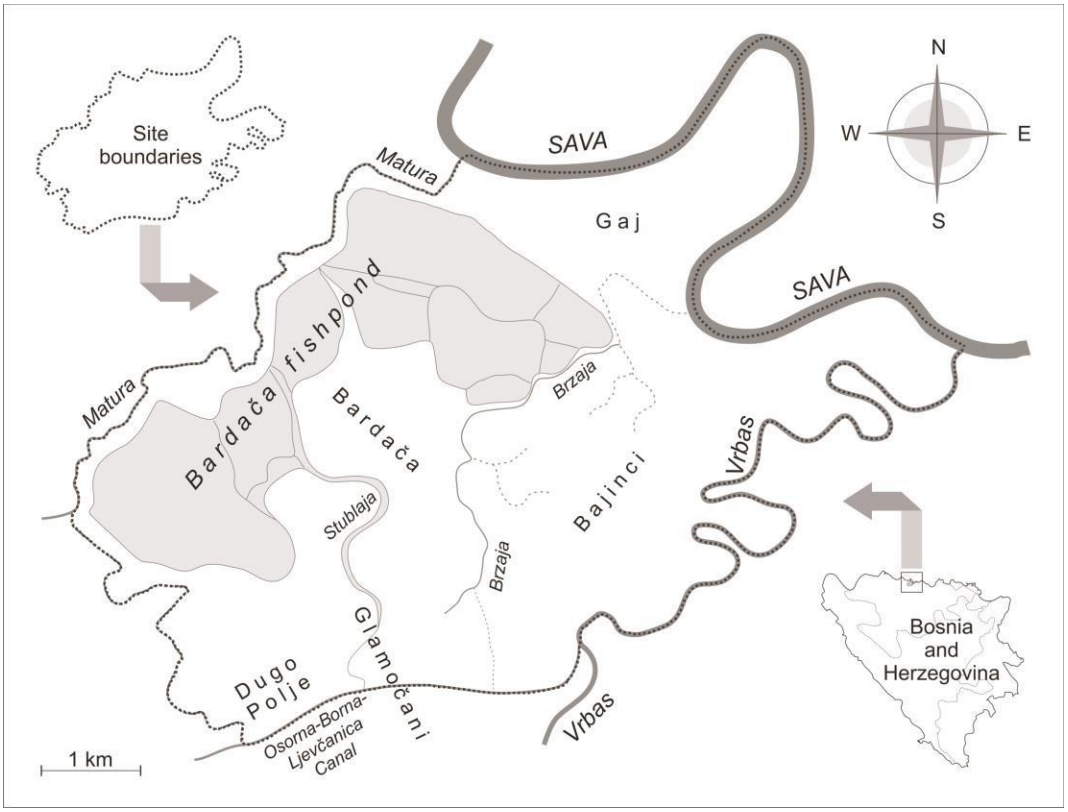

Figure 1. Ramsar site "Bardača Wetland"
(modified from: Miličić *et al*., 2022)

Bardača fishponds, with a total area of 675 ha (Obratil, 1980/1981; Gašić and Dujaković, 2009), are an integral part of the Ramsar site "Bardača Wetland" (https://www.ramsar.org). In the spring of 2012., eight out of a total of 11 fishpond basins were completely drained (Šukalo *et al*., 2014a), and in the recent period only one or two fishponds exist (Šukalo and Dmitrović, pers. obs.). Dried fishponds are mostly used as arable land, which has led to the increased use of pesticides on these areas. Other wetland habitats within the Ramsar site "Bardača Wetland" are also threatened by afforestation with Canadian poplar plantations, which further dries them out, as well as by the reduced amount of precipitation during the spring, which could be linked with global climate change (Miličić *et al*., 2022).

Although the Ramsar site "Bardača Wetland" represents one of the three Ramsar areas in Bosnia and Herzegovina (https://www.ramsar.org), there is still a visible absence of consolidated and reliable data on the amphibian diversity of this area. Svjetoslav Obratil published the first literature data on amphibian fauna pertaining to the Ramsar site "Bardača Wetland" within its current boundaries 42 years ago (Obratil, 1980/1981). All other available literature sources with data on diversity and ecology of amphibians in this area are more recent (Radević, 2007; Gašić and Dujaković, 2009; Gašić, 2012; Lelo *et al*., 2015; Miličić *et al*., 2022). In this sense, the goal of this study was to create a faunistic list of amphibians of the Ramsar site "Bardača Wetland", based on both literature data and author's original multi-year field studies, with reference to certain aspects of the ecology of the recorded species.

MATERIALS AND METHODS

Field research of the Ramsar site "Bardača Wetland" was conducted in the several-years within the period from 2012 to 2022. Records were collected by using the transect method, and the research was carried out in different weather conditions and at different periods during the day. Amphibians were captured using a hand net attached to a long stick. After capture, the individuals were photographed, identified to the closest taxonomic level according to the standard herpetological literature (Radovanović, 1951; Đurović *et al.*, 1979; Speybroeck *et al.*, 2016), and released to the same location where they were captured. Nomenclature and systematics follow Speybroeck *et al.* (2020).

RESULTS AND DISCUSSION

The field studies at the Ramsar site "Bardača Wetland", conducted in the period 2012 - 2022, have shown the presence of nine species of amphibians from eight genera, five families and two orders (Table 1).

Table 1. Amphibian fauna of the Ramsar site "Bardača Wetland" according to available literature sources (Obratil (1980/1981) - I, Radević (2007) - II, Gašić and Dujaković (2009) - III, Gašić (2012) - IV, Lelo *et al.* (2015) – V, Miličić *et al.* (2022) – VI) and according to our multi-year field studies (VII)

Taxon	I	II	III	IV	V	VI	VII
Classis: Amphibia Linnaeus, 1758							
Ordo: Caudata Scopoli, 1777							
Familia: Salamandridae Goldfuss, 1820							
Genus: *Ichthyosaura* Sonnini and Latreille, 1801							
1. *Ichthyosaura alpestris* (Laurenti, 1768)				+			
Genus: *Lissotriton* Bell, 1839							
2. *Lissotriton vulgaris* (Linnaeus, 1758)	+	+	+	+			+
Genus: *Salamandra* Garsault, 1764							
3. *Salamandra salamandra* (Linnaeus, 1758)	+	+					
Genus: *Triturus* Rafinesque, 1815							
4. *Triturus dobrogicus* (Kiritzescu, 1903)		+				+	+
Ordo: Anura Duméril, 1805							
Familia: Bombinatoridae Gray, 1825							
Genus: *Bombina* Oken, 1816							
5. *Bombina bombina* (Linnaeus, 1761)	+	+	+	+			+
6. *Bombina variegata* (Linnaeus, 1758)		+			+		
Familia: Pelobatidae Bonaparte, 1850							
Genus: *Pelobates* Wagler, 1830							
7. *Pelobates fuscus* (Laurenti, 1768)	+	+					
Familia: Bufonidae Gray, 1825							
Genus: *Bufo* Garsault, 1764							
8. *Bufo bufo* (Linnaeus, 1758)		+			+		+

9. *Bufotes viridis* (Laurenti, 1768)		+				+
Familia: Hylidae Rafinesque, 1815						
Genus: *Hyla* Laurenti, 1768						
10. *Hyla arborea* (Linnaeus, 1758)				+		+
Familia: Ranidae Batsch, 1796						
Genus: *Pelophylax* Fitzinger, 1843						
11. *Pelophylax* kl. *esculentus* (Linnaeus, 1758)	+	+	+	+	+	+
12. *Pelophylax ridibundus* (Pallas, 1771)	+	+	+	+	+	+
Genus: *Rana* Linnaeus, 1758						
13. *Rana dalmatina* Fitzinger in Bonaparte, 1838		+		+		+
14. *Rana temporaria* Linnaeus, 1758		+				

Ordo: Caudata

1. *Lissotriton vulgaris* (Linnaeus, 1758) – Smooth Newt

The smooth newt is the most frequently recorded caudate amphibian of the Ramsar site "Bardača Wetland". Adult males and females were captured in large numbers in diverse aquatic habitats (canals, ponds, temporary stagnant water in wet meadows and pastures), from the second half of February to the second half of May. On the other hand, smooth newt larvae were also captured in large numbers in the same habitats from the second half of May to the second half of August. According to the data provided by Gašić and Dujaković (2009), the onset of the activity of adults of this species at the Ramsar site "Bardača Wetland" is in March and April, when they lay eggs in puddles and ponds. In the Collection of the Natural History Department of the Museum of the Republic of Srpska in Banja Luka there are specimens of three immature individuals of smooth newt, collected along the river Matura, in Bardača, in late March (Gašić, 2012). According to the "Decree on Strictly Protected and Protected Wild Species" in the Republic of Srpska this species is listed under the category of protected wild species (Anonymous, 2020).

2. *Triturus dobrogicus* (Kiritzescu, 1903) – Danube Crested Newt

The Danube crested newt is a rarely found caudate amphibian in the Ramsar site "Bardača Wetland". Adult males and females were recorded in canals along embankments, in ponds, temporary standing water in wet meadows and pastures, as well as along the edges of gallery forest fragments, from the second half of March to the end of April. On the other hand, larvae of the Danube crested newt were captured in temporary stagnant water in flooded meadows and pastures in late May and early June. The total number of individuals recorded during our field studies in the area of the settlements Bajinci and Bardača included about 20 adults and several larvae. Radević (2007) and Miličić et al. (2022) previously reported presence of the Danube crested newt within the boundaries of the Ramsar site "Bardača Wetland". According to the "Decree on Strictly Protected and Protected Wild Species" in the Republic of Srpska this species is listed under the category of strictly protected wild species (Anonymous, 2020).

Ordo: Anura

3. *Bombina bombina* (Linnaeus, 1761) – Fire-bellied Toad

At the beginning of our fieldwork, fire-bellied toad was a common anuran species. Adult individuals were recorded in large numbers in canals, road ruts, ponds and temporary standing water in wet meadows and pastures, from the first half of March to the end of July. On the other hand, tadpoles were found in the same habitats in the second half of May and during the month of June. According to the data provided by Gašić and Dujaković (2009), the fire-bellied toads at the Ramsar site "Bardača Wetland" deposit their eggs in larger lowland waters, lakes, ponds, wells and permanent ponds, first in March and April, and either once or twice again until the end of the summer. The same authors stated that representatives of this species are very abundant and active from spring to autumn. In the Collection of the Natural History Department of the Museum of Republic of Srpska in Banja Luka, there are five specimens of this species (of different ages), collected in the forest on Lake Sinjak and along the Matura River in March and April, as well as one model (cast) made according to the specimen caught along the Matura River in March (Gašić, 2012). During the last few years of our field research, a noticeable decline in the population numbers of the fire-bellied toad was recorded, most likely a consequence of the ever increasing degradation of aquatic habitats at the Ramsar site "Bardača Wetland", as recently indicated by Miličić *et al.* (2022). According to the “Decree on Strictly Protected and Protected Wild Species” in the Republic of Srpska this species is listed under the category of protected wild species (Anonymous, 2020).

4. *Bufo bufo* (Linnaeus, 1758) – Common Toad

Adult common toads were recorded on several occasions in late March and the first half of April, immediately next to the local road, as well as in the canal close to Lake Necik. Individuals in the larval stage (tadpole) and recently metamorphosed young individuals were also captured. Tadpoles were recorded during the second half of May, in a canal with clear and cold water, while young, recently metamorphosed individuals were recorded in forest fragments and Canadian poplar plantations, in the second half of June and during July. The collections of the National Museum of Bosnia and Herzegovina in Sarajevo include specimens collected in this area in May and October (Lelo *et al.*, 2015).

5. *Bufotes viridis* (Laurenti, 1768) – Green Toad

Individuals of green toad were recorded on several occasions in June and July. All observations were of the stage of recently metamorphosed young individuals, in wet meadows and pastures. In the available scientific literature, Radević (2007) mentions the presence of green toad in the Bardača area.

6. *Hyla arborea* (Linnaeus, 1758) – Common Tree Frog

Common tree frog is a common anuran species of the Ramsar site "Bardača Wetland". Adult individuals were captured in wet meadows and pastures, from the second half of March to the first half of May, while in mid-April they were observed in amplexus. Large groups of tadpoles were recorded in May and June in various water bodies (canals, ponds, road ruts, temporary stagnant water in wet meadows and pastures). Young, recently metamorphosed individuals were also recorded in large numbers during the second half of June. An adult specimen of this species collected at river Matura in April is included in the collection of the

Natural History Department of the Museum of the Republic of Srpska in Banja Luka (Gašić, 2012).

7. *Pelophylax* kl. *esculentus* (Linnaeus, 1758) – Edible Frog

Edible frog is the most frequently recorded and most abundant anuran of the Ramsar site "Bardača Wetland". The onset of activity in adult individuals was recorded in late February or during the first half of March, while a large number of individuals were observed and captured from the second half of March to the second half of September. They are mostly recorded in various slow-flowing and stagnant water habitats or in their immediate vicinity. Tadpoles before metamorphosis were recorded at the end of June, and young recently metamorphosed individuals were also observed and captured in large numbers during July. The beginning of the activity of adults of this species in the Ramsar site "Bardača Wetland", according to the data provided by Gašić and Dujaković (2009), occurs soon after the beginning of the activity of smooth newt and fire-bellied toad, and eggs are laid in April. In the collection of the Natural History Department of the Museum of the Republic of Srpska in Banja Luka there are two specimens of edible frog, a juvenile caught in the forest on Lake Sinjak and an adult caught on an embankment between two fishponds. Both specimens were collected in April (Gašić, 2012). According to the data provided by Lelo *et al*. (2015), a specimen of this species collected in May is an integral part of the collection of the National Museum of Bosnia and Herzegovina in Sarajevo.

8. *Pelophylax ridibundus* (Pallas, 1771) – Marsh Frog

Marsh frog was recorded on several occasions. Adult individuals were caught in canals and ponds, and they were recorded together with the more numerous edible frog. The onset of activity in adults of this species in the Ramsar site "Bardača Wetland", according to the data provided by Gašić and Dujaković (2009), occurs soon after the beginning of the activity of smooth newt and fire-bellied toad, and eggs are deposited in April. In the collection of the Natural History Department of the Museum of Republic of Srpska in Banja Luka, there are seven specimens of marsh frog (of different ages), which were collected in different habitats (river, embankment, forest) in April and June (Gašić, 2012). According to the data provided by Lelo *et al*. (2015), a specimen of this frog species collected in May is an integral part of the collection of the National Museum of Bosnia and Herzegovina in Sarajevo.

9. *Rana dalmatina* Fitzinger in Bonaparte, 1838 – Agile Frog

Agile frog was the first recorded anuran during our study. Adult individuals were mainly captured not in the water, but in moist places on land (forest fragments, Canadian poplar plantations, wet meadows and pastures) from the second half of February to the end of May, as well as during September. At the end of February and during the first half of March, numerous accumulations of eggs (spawn) were recorded in various waterbodies (canals, ponds, road ruts, temporary stagnant water in wet meadows and pastures). Agile frog tadpoles were also caught in large numbers in the same waterbodies from the second half of March to the second half of May. Young, recently metamorphosed individuals were recorded during the second half of May, and were observed and captured in large numbers in June. The collection of the Natural History Department of the Museum of Republic of Srpska in Banja Luka

includes three specimens of this species (of different ages), which were collected at the Trstenac locality (one adult) in April and along the river Matura (two recently metamorphosed specimens) in March.

For two species of amphibians mentioned by Obratil (1980/1981) there were no direct captures during our multi-year field studies at the Ramsar site "Bardača Wetland", but there is circumstantial evidence. One individual of species *Pelobates fuscus* was found in stomach contents of a black-crowned night-heron (*Nycticorax nycticorax*), while an individual of species *Salamandra salamandra* was found in the stomach contents of a little egret (*Egretta garzetta*). Radević (2007) classified these two amphibian species as “the most well-known amphibians on Bardača”. However, although *Pelobates fuscus* was not recorded during our multi-year field studies, the species was recently recorded at the locality Sitneši (Šukalo *et al.*, 2014b), situated less than 10 km away from the Ramsar site "Bardača Wetland". It is also important to note that activities of our field research at the Ramsar site "Bardača Wetland" were not conducted at night, while *Pelobates fuscus* is known for its fossorial lifestyle and nocturnal activity (Speybroeck *et al.,* 2016). However, despite several years of field research, no easily recognizable tadpoles of this type of amphibian have been recorded. Taking into account all the above, the possibility that the individual found in the bird's stomach was caught and swallowed outside the boundaries of the Ramsar site "Bardača Wetland" should not be excluded, nor the possibility that the species *Pelobates fuscus* has disappeared from the Ramsar site "Bardača Wetland". The same applies to the fire salamander (*Salamandra salamandra*). During the field studies, presence of this species of caudate amphibians was not recorded within the boundaries of the Ramsar site "Bardača Wetland". However, our field research recorded the presence of fire salamander larvae in the settlement of Kočićevo, which is situated about 5 km from the boundaries of the Ramsar site "Bardača Wetland". According to the residents of the Bardača and Bajinci settlements, the fire salamander is also present in the Gornji Kladari settlement, which is about 6 km from the borders of the Ramsar site "Bardača Wetland". Based on all abovementioned, the authors of this paper have concluded that the records of these two species of amphibians in the Ramsar site Bardača Wetland should be expected in the future.

On the other hand, the record of the Alpine newt (*Ichtyosaura alpestris*), cited by Gašić (2012), is based on a wrong determination (Gašić, B. pers. com.). In addition, despite intensive field research, presence of the species *Bombina variegata*, which was reported by Radević (2007) as well as by Lelo *et al*. (2015), was not confirmed either within or close to the boundaries of the Ramsar site "Bardača Wetland". *B. variegata* inhabits the hilly and mountainous belt of Bosnia and Herzegovina (Đurović *et al.*, 1979), which ecologically excludes this species from the batrachofauna of the studied area. Presence of species *Rana temporaria*, mentioned by Radević (2007), is also disputed. This species has never been recorded in the scientific literature before (or since) within the boundaries of the Bardača Ramsar site, and it was also absent during our field research, both in this (Table 1) and neighboring areas. The most likely reason for this issue is erroneous determination of the species, hence it was most probably confused with the species *Rana dalmatina*. Taking into account all abovementioned, the authors of this paper assumes that these three species of

amphibians (*Ichtyosaura alpestris*, *Bombina variegata* and *Rana temporaria*) should be excluded from the checklist of amphibian fauna for the Ramsar site "Bardača Wetland".

CONCLUSION

Batrachofauna of the Ramsar site "Bardača Wetland" encompasses nine species: *Lissotriton vulgaris*, *Triturus dobrogicus*, *Bombina bombina*, *Bufo bufo*, *Bufotes viridis*, *Hyla arborea*, *Pelophylax* kl. *esculentus*, *Pelophylax ridibundus* and *Rana dalmatina*. Presence of two additional species of amphibians, *Salamandra salamandra* and *Pelobates fuscus*, was expected but not confirmed. *L. vulgaris* was the most frequently recorded caudate amphibian, while the most common anuran was *P.* kl. *esculentus*. This study has enriched the existing knowledge about the ecology of amphibians at the Ramsar site "Bardača Wetland", and they mostly fit within the already known ecological parameters. A decline in the population of *B. bombina* was observed by the end of the study period, and it is probably linked to the increasingly intense devastation of their aquatic habitats. Three recorded species were listed on the "Decree on Strictly Protected and Protected Wild Species" in the Republic of Srpska.

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VODOZEMCI RAMSARSKOG PODRUČJA BARDAČA – SPISAK VRSTA SA EKOLOŠKIM PODACIMA

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Sažetak

Cilj rada bio je da se na osnovu literaturnih podataka i terenskih istraživanja autora formira faunistički spisak vodozemaca Ramsarskog područja Bardača, sa osvrtom na određene aspekte ekologije zabilježenih vrsta. Terenski podaci su prikupljeni metodom transekta, u period od 2012.-2022. godine, kada je zabilježno devet vrsta vodozemaca. Prisustvo još pet vrsta, koje su navođene u literaturi, nije potvrđeno. Stoga, batrahofaunu Ramsarskog područja Bardača pouzdano čini devet vrsta vodozemaca: dvije vrste repatih vodozemaca (*Lissotriton vulgaris* i *Triturus dobrogicus*) i sedam vrsta bezrepih vodozemaca (*Bombina bombina, Bufo*

bufo, Bufotes viridis, Hyla arborea, Pelophylax kl. *esculentus, Pelophylax ridibundus* i *Rana dalmatina*). Ekološki podaci prikupljeni na terenu (tip staništa adulata i larvi, vrijeme njihove aktivnosti tokom godine, generalno stanje populacija nekih vrsta), kao i ekološki podaci iz literature, sistematično su predstavljeni za svaku vrstu posebno.

Ključne riječi: batrahofauna, ekologija, zaštita biodiverziteta, Bosna i Hercegovina

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