



Amphibians and Reptiles in the City of Plovdiv and Comparison with other Bulgarian Cities

Ivelin A. Mollov*

University of Plovdiv “Paisii Hilendarski”, Faculty of Biology, Department of Ecology and
Environmental Conservation, 24 Tzar Assen Str., BG-4000 Plovdiv, BULGARIA
*Corresponding author: mollov_i@uni-plovdiv.bg

Abstract. The current study presents the contemporary species composition of the amphibians and reptiles in the city of Plovdiv. During the current study we identified 6 amphibian species and 9 reptile species plus 1 invasive freshwater turtle species (10 in total). A clear differentiation of the fauna of the studied cities can be seen on a geographical principle, however, it seems that not only the geographical location of the cities has an influence on the qualitative composition of the fauna, but also some specific urban factors. In general, Stara Zagora, Varna and Ruse are with highest species richness.

Key words: Amphibia, Reptilia, species richness, urban fauna, Plovdiv.

Introduction

As urbanization is spreading rapidly, a basic challenge for conservation ecology is to understand how it affects biodiversity. The complex nature of urban land use can have a complicated influence on local biodiversity. Several studies have described the effects of urbanization on species richness, indicating that urbanization can affect species richness either positively or negatively, depending on several variables. Some of these variables include: taxonomic group, spatial scale of analysis, and intensity of urbanization (McKinney, 2008).

In the past few decades there is increasing attention to the study of various animal groups in cities, namely amphibians and reptiles, which are important part of urban biodiversity. A better understanding of the ecological processes governing the species composition and distribution of animals in an urban environment is necessary for adequate management and conservation (Husté, 2005).

The purpose of the current study is to present the contemporary species composition of the amphibians and reptiles in the city of Plovdiv and to compare it with that of other major Bulgarian cities.

Materials and Methods

For the purposes of the present study literary data were used and a series of observations in more recent years (2020-2022) in the city of Plovdiv (South Bulgaria) were conducted. Amphibians and reptiles were determined visually using the field guide of Biserkov et al. (2007). For each species are given a valid Latin name after Stojanov et al. (2011) and Fauna Europaea (de Jong et al., 2014). A cluster analysis was performed in order to compare the batracho- and herpetofauna between cities (Rho similarity index, unweighted per-group average), using the program “PAST”, version 4.11 (Hammer et al., 2001).

Results and Discussion

During the current study we identified 6 amphibian species and 9 reptile species plus 1 invasive freshwater turtle species (10 in total), which is 25.00% from the Bulgarian batrachofauna and 27.78% from the Bulgarian herpetofauna, respectively (Stojanov et al., 2011; de Jong et al., 2014).

A comparative cluster analysis (based on the presence/absence data) of the batracho- and

herpetofauna of several Bulgarian cities with those of the city of Plovdiv was conducted. For Bulgaria, literary sources were used for the following cities: Sofia (Tsankov et al., 2015), Varna (Delov et al., 2005), Ruse (Undjian, 2000), Stara Zagora (Georgiev & Georgiev, 2019) and Blagoevgrad (Pulev & Sakelarieva, 2013). The data are presented in Table 1 and Fig 1 and 2.

Table 1. Species composition of the recorded amphibian and reptile species in the city of Plovdiv and literary data for the batracho- and herpetofauna of other major Bulgarian cities

Species	Plovdiv (Current study)	Sofia	Varna	Ruse	Stara Zagora	Blagoev- grad
AMPHIBIANS						
<i>Salamandra salamandra</i> (Linnaeus, 1758)	-	+	-	-	+	+
<i>Lissotriton vulgaris</i> (Linnaeus, 1758)	-	-	+	+	+	-
<i>Triturus ivanbureshi</i> (Arntzen et Wielstra, 2013)	-	+	+	+	+	+
<i>Bombina bombina</i> (Linnaeus, 1761)	-	+	-	-	+	-
<i>Bombina variegata</i> (Linnaeus, 1758)	-	-	-	-	-	-
<i>Pelobates fuscus</i> (Laurenti, 1768)	-	-	-	+	-	-
<i>Pelobates syriacus</i> Boettger, 1889	+	-	-	-	-	-
<i>Bufo bufo</i> (Linnaeus, 1758)	+	+	+	-	+	+
<i>Bufo tes viridis</i> (Laurenti, 1768)	+	+	+	+	+	+
<i>Hyla arborea</i> (Linnaeus, 1758)	-	-	-	-	-	+
<i>Hyla orientalis</i> Bedriaga, 1890	+	+	+	+	+	-
<i>Pelophylax ridibundus</i> (Pallas, 1771)	+	+	+	+	+	+
<i>Rana dalmatina</i> Fitzinger in Bonaparte, 1838	+	+	+	+	+	+
<i>Rana temporaria</i> Linnaeus, 1758	-	+	+	+	+	-
REPTILES						
<i>Emys orbicularis</i> (Linnaeus, 1758)	+	+	+	+	+	+
<i>Trachemys scripta</i> (Thunberg & Schoepff, 1792)	+	+	-	-	+	-
<i>Testudo graeca</i> Linnaeus, 1758	-	-	+	-	+	-
<i>Testudo hermanni</i> Gmelin, 1789	-	-	+	-	+	+
<i>Mediodactylus koetschy</i> (Steindachner, 1870)	+	+	-	-	-	+
<i>Mediodactylus daniliewski</i> (Strauch, 1887)	-	+	-	+	+	-
<i>Ablepharus khatibeli</i> Bignon et Bory de Saint-Vincent, 1833	-	-	-	-	+	-
<i>Anguis fragilis</i> Linnaeus, 1758	-	+	+	+	-	-
<i>Pseudopus apodus</i> (Pallas, 1775)	-	-	+	-	-	-
<i>Darevskia praticola</i> (Eversmann, 1834)	-	-	-	+	-	-
<i>Lacerta agilis</i> Linnaeus, 1758	-	+	+	-	-	-
<i>Lacerta trilineata</i> Bedriaga, 1886	+	-	+	+	+	-
<i>Lacerta viridis</i> (Laurenti, 1768)	+	+	+	+	+	+
<i>Podarcis erhardii</i> (Bedriaga, 1876)	-	-	-	-	-	+
<i>Podarcis muralis</i> (Laurenti, 1768)	+	+	+	+	+	+
<i>Podarcis tauricus</i> (Pallas, 1814)	-	-	-	+	+	-
<i>Coronella austriaca</i> Laurenti, 1768	-	+	-	+	+	-
<i>Dolichophis caspius</i> (Gmelin, 1789)	+	-	+	+	+	+
<i>Elaphe sauromates</i> (Pallas, 1814)	-	-	-	+	+	-
<i>Natrix natrix</i> (Linnaeus, 1758)	+	+	+	+	+	+
<i>Natrix tessellata</i> (Laurenti, 1768)	+	+	+	+	+	+
<i>Platyceps najadum</i> (Eichwald, 1831)	-	-	-	-	-	+
<i>Zamenis longissimus</i> (Laurenti, 1768)	+	+	+	-	+	+
<i>Vipera ammodytes</i> (Linnaeus, 1758)	-	-	+	-	+	+

The contemporary species composition of the amphibians and reptiles in the city of Plovdiv, doesn't differ significantly from our previous study (Mollov & Georgiev, 2015) with the exception of the record of *Zamenis longissimus* in the area between Maritsa River and The Rowing Canal. Also the invasive species (*Trachemys scripta*) was once again registered in the city of Plovdiv with two subspecies - *T. s. scripta* (individuals were observed on occasion near the bridge next to the Gerdjika Hotel) and *T. s. elegans*, which was also observed in a spill off the island of Adata, spills at the 4 km west of the city and in the Rowing Canal itself (numerous occasions). At this stage there is no data for breeding of this species in the area, but it is a possibility.

The cluster analysis shows similar results for both classes. For the amphibians (Fig. 1), the batrachofauna of Blagoevgrad is divided into an independent cluster with 45% similarity, followed by another independent cluster of the batrachofauna of the city of Plovdiv with 47%

similarity. The amphibian fauna of the largest city - Sofia separates into a third independent cluster with about 57% similarity, and those of Varna, Stara Zagora and Ruse separate into a fourth cluster with about 70% similarity.

For the reptiles (Fig. 2), the herpetofauna of Ruse separates into a first independent cluster with about 33% similarity, followed by that of Stara Zagora with about 36% similarity and Varna, which forms a third independent cluster with about 38% similarity. Blagoevgrad, Sofia and Plovdiv together form a fourth cluster with about 50% similarity.

In the case of amphibians, a clear differentiation of the fauna of the studied cities can be seen on a geographical principle from the southwest-northeast direction. A similar trend is observed for the reptiles, but in the opposite direction - northeast-southwest. However, it seems that not only the geographical location of the cities has an influence on the qualitative composition of the fauna, but also some specific urban factors.

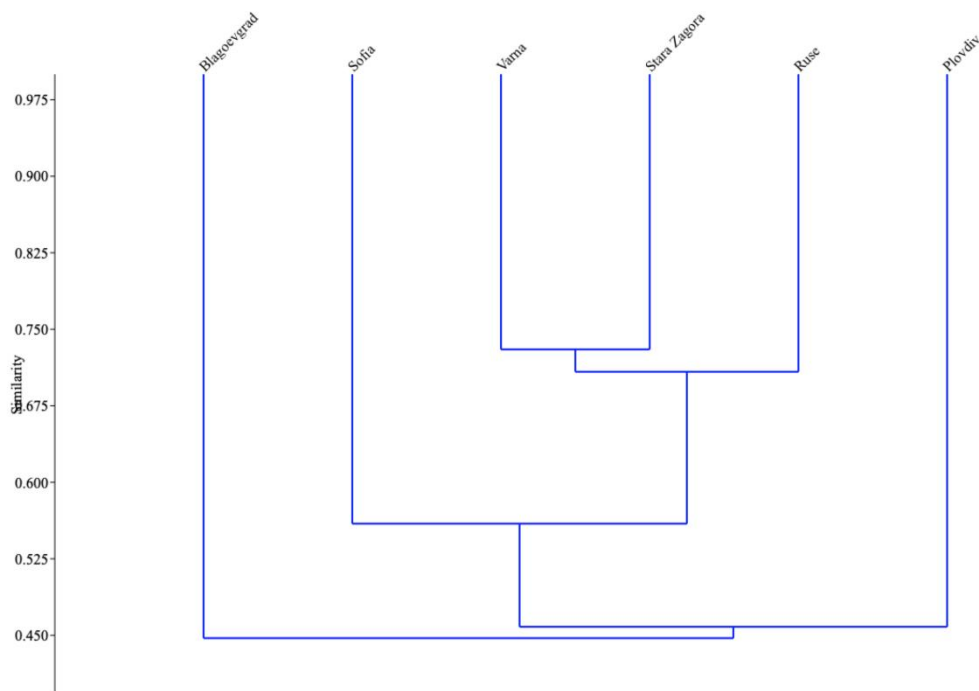


Fig. 1. Cluster analysis of the species composition of the amphibians in the city of Plovdiv and other major Bulgarian cities.

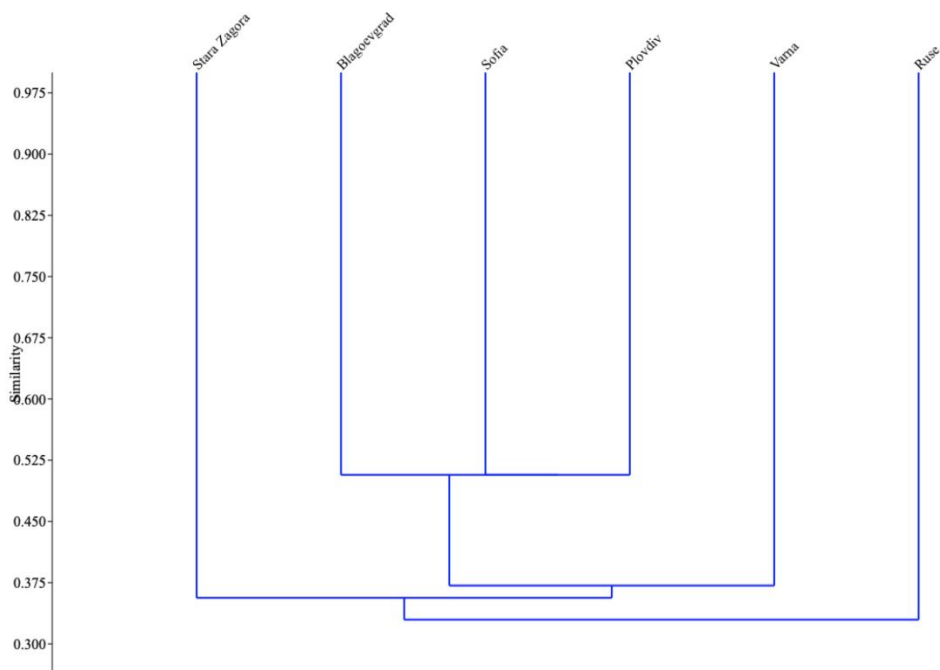


Fig. 2. Cluster analysis of the species composition of the reptiles in the city of Plovdiv and other major Bulgarian cities.

One of the principles of the Theory of Island Biogeography states that the number of species that can occur on an island depends on its area (MacArthur & Wilson, 1967). If we

conditionally consider the investigated six Bulgarian cities as “islands”, we can check whether this principle will apply in this case (Table 2).

Table 2. Area of the studied Bulgarian cities and the number of species of amphibians and reptiles registered in each city.

City	Area, km ²	Number of amphibian species	Number of reptile species
Blagoevgrad	28,91	7	12
Stara Zagora	85,11	10	17
Plovdiv	102,00	6	10
Ruse	127,12	8	13
Varna	238,00	8	14
Sofia	492,00	9	12

From the results presented in the table, it can be seen that in both groups of animals, this principle does not apply. A probable reason for this is most likely the fact that many other factors play a role in cities that determine the species richness of amphibians and reptiles - human population density (and hence the higher anthropogenic pressure on amphibians and reptiles), heterogeneity of suitable habitats (mostly suitable water bodies),

degree of pollution and other specific urban conditions that are different for each city.

In general, Stara Zagora, Varna and Ruse are with highest species richness. This is probably due, on the one hand, to the geographical location of the cities - close proximity to the Black Sea and the Danube River (in the case of Varna and Ruse) and the close proximity of Samena Sredna Gora Mts (in the case of Stara Zagora). They have a direct

effect on the presence of certain species of amphibians and reptiles, and they have a beneficial indirect effect, as they determine to a large extent the regional climatic conditions. On the other hand, the smaller human population density (compared to the city of Sofia and the city of Plovdiv), as well as probably other factors specific to these cities, which are not the subject of the present study, further shape the species composition of the batracho- and herpetofauna

References

- Biserkov, V., B. Naumov, N. Tzankov, A. Stojanov, B. Petrov, D. Dobrev, P. Stoev. 2007. [A Field Guide to Amphibians and Reptiles of Bulgaria.] Sofia, Green Balkans, 196 p. (In Bulgarian).
- de Jong, Y., Verbeek, M., Michelsen, V., Bjørn, P., Los, W., Steeman, F., Bailly, N., Basire, C., Chylarecki, P., Stloukal, E., Hagedorn, G., Wetzel, F.T., Glöckler, F., Kroup, A., Korb, G., Hoffmann, A., Häuser, C., Kohlbecker, A., Müller, A., Güntsch, A., Stoev, P., Penev, L. 2014. Fauna Europaea - all European animal species on the web. *Biodiversity Data Journal*, 2: e4034. doi: 10.3897/BDJ.2.e4034.
- Delov, V., D. Peshev, A. Vasilev. 2005. Species composition and tendencies in the distribution of the vertebrates in the region of the Botanical garden - Varna. - *Annuaire de l'Université de Sofia "St. Kliment Ohridski" - 10ème session scientifique, Sofia '03, Partie 2*, 96(4): 191-196.
- Georgiev, D., D. Georgiev. 2018. Herpetofauna of Stara Zagora, Southern Bulgaria: species composition and distribution along the natural habitat–urban areas gradient. - *Trakia Journal of Sciences*, 4: 270-274. doi: 10.15547/tjs.2018.04.002.
- Hammer, Ø., D. Harper, P. Ryan. (2001). PAST: Paleontological statistics software: Package for education and data analysis. *Palaeontologia Electronica*, 4(1), pp. 9.
- Husté, A. 2005. Ecological Processes Responsible for the Spatial Distribution and Dynamics of Biodiversity in an Urban Landscape. PhD Thesis, Paris, 72 p.
- MacArthur, R.H., E.O. Wilson. (1967). *The Theory of Island Biogeography*. Princeton, N.J.: Princeton University Press, 203 p.
- McKinney, M. 2008. Effects of urbanization on species richness: A review of plants and animals. - *Urban Ecosystems*, 11: 161–176.
- Mollov, I., D. Georgiev. 2015. Plovdiv. In: Kelcey, J.G. (Ed.), *Vertebrates and Invertebrates of European Cities: Selected Non-Avian Fauna*, Springer Science + Business Media New York, p. 78-80. doi: 10.1007/978-1-4939-1698-6_3.
- Pulev, A., L. Sakelarieva. 2013. Herpetofauna in the city of Blagoevgrad, south-western Bulgaria - *Biodiscovery*, 27, 3 1-6. doi: 10.7750/BioDiscovery.2013.7.3.
- Tzankov, N., G. Popgeorgiev, Y. Komilev, B. Petrov, S. Zidarova, T. Stefanov. 2015. Sofia. In: Kelcey, J.G. (Ed.), *Vertebrates and Invertebrates of European Cities: Selected Non-Avian Fauna*, Springer Science + Business Media New York, p. 78-80. doi: 10.1007/978-1-4939-1698-6_7.
- Stojanov, A., N. Tzankov, B. Naumov. 2011. Die Amphibien und Reptilien Bulgariens, Chimaira, Frankfurt und Main, 586 p.
- Undjian, E. 2000. [Studies on the vertebrates in the valley of “Lomovete” and the territory of nature park “Russenski Lom”, district Russe and Razgrad, III. Amphibians, IV. Reptiles.] Publ. NP “Russenski Lom”, Russe, 88 p. (In Bulgarian).

Accepted: 03.12.2021
Published: 31.12.2022