

## **CONTRIBUTION TO KNOWLEDGE OF BATRACHO- AND HERPETOFAUNA OF SOUTHERN AND SOUTH-EASTERN SERBIA**

LJILJANA TOMOVIĆ<sup>1</sup>, TIJANA VUČIĆ<sup>1</sup>, MARKO ANĐELKOVIĆ<sup>2</sup>,  
ALEKSANDAR UROŠEVIĆ<sup>2</sup>, VUKAŠIN BJELICA<sup>1</sup>, MARKO MARIČIĆ<sup>1</sup>,  
MARGARETA LAKUŠIĆ<sup>3</sup>, GORANA DANON<sup>1</sup>, ANA IVANOVIĆ<sup>1</sup>

<sup>1</sup> University of Belgrade, Faculty of Biology, Studentski trg 16, 11000 Belgrade, Serbia, e-mail: lili@ibiss.bg.ac.rs

<sup>2</sup> University of Belgrade, Institute for Biological Research “Siniša Stanković” – National Institute of Republic of Serbia, Bulevar despota Stefana 142, 11000 Belgrade, Serbia

<sup>3</sup> CIBIO/InBIO, Research Center in Biodiversity and Genetic Resources of the University of Porto, 4485-661 Vairão, Portugal

We present the updated distribution of batracho- and herpetofauna in southern and south-eastern Serbia, based on literature and new field records for 16 amphibian and 22 reptile species. In these two biogeographic regions, already recognized as biodiversity hotspots, we discovered two new amphibian species with limited distribution: *Hyla orientalis* and *Pelobates balcanicus*. Also, one species (*Triturus ivanbureshi*) has restricted distribution, while one (*Bombina bombina*) is rare. Four reptile species have limited distributions and six are rare in these regions. The presence of hybrid zones and the influence of the Mediterranean climate make southern and south-eastern Serbia areas of great importance and the target for future ecological and conservation studies in Serbia.

**Key words:** Amphibians, Reptiles, biodiversity

## INTRODUCTION

It is generally known that a comprehensive knowledge of the biodiversity of a certain region is the most important and mandatory step that precedes ecological, biogeographic and conservation studies. Therefore, systematic faunistic studies are of increasing importance, especially in the regions (or countries) with incomplete data on the species distribution (Margules *et al.* 2002). Detailed distribution data are crucial for identifying biodiversity “hotspots” i.e. areas with exceptional species compositions, high levels of endemism and/or areas under significant threats (Gaston *et al.* 2002).

The most recent publications of the complete batracho- and herpetofauna of Serbia provided broad overviews of distributions of amphibian and reptile species, without precise distribution records (Vukov *et al.* 2013, Tomović *et al.* 2014). The complete fauna was recently published for Kosovo & Metohija province only (Tomović *et al.* 2018), while for other biogeographic regions the precise data on batracho- and herpetofaunal diversity are generally missing.

According to our knowledge, the studies which focused on batracho- and herpetofauna of southern and south-eastern Serbia were published for particular areas: Vranje (Nedeljković 1958), Leskovac (Janjić 1969), Grdelička gorge (Stamenković 1970), Lebane (Stanković 2005) and for Bosilegrad (Sterijovski 2014).

Southern and south-eastern Serbia were already identified as regions with a relatively high diversity of amphibian and reptile species. Out of 21 amphibian species occurring in Serbia, 12 and 14 species were recorded in southern and south-eastern Serbia, respectively (Kalezić *et al.* 2015). Furthermore, a very high diversity of reptiles, with 17 and 19 species (out of a total of 24 species) in these two regions was recorded (Tomović *et al.* 2015a). New reptile species for Serbian fauna were discovered particularly in southern and south-eastern Serbia: *Platyceps najadum* (Crnobrnja-Isailović & Aleksić 1999), *Elaphe quatuorlineata* (Ristić *et al.* 2006), *Testudo graeca* (Tomović *et al.* 2004, Ralev *et al.* 2012) and *Lacerta trilineata* (Anđelković *et al.* 2022).

Several species- or group-oriented papers provided complete distribution summaries and filled up the gap concerning the distribution of amphibians and reptiles in southern and south-eastern Serbia: *Triturus* spp. (Vučić *et al.* 2020), *Hyla* spp. (Urošević *et al.* 2022a), *Rana* spp. (Urošević *et al.* 2018), *Emys orbicularis* (Krizmanić *et al.* 2015, Golubović *et al.* 2017), *Testudo graeca* (Tomović *et al.* 2019a), *Testudo hermanni* (Ljubisavljević *et al.* 2014, Golubović *et al.* 2019), *Ablepharus kitaibelii* (Ljubisavljević *et al.* 2015), *Anguis fragilis* complex (Urošević *et al.* 2020),

Lacertidae (Urošević *et al.* 2015), Colubridae (Tomović *et al.* 2015b) and Viperidae (Tomović *et al.* 2019b). However, data concerning the precise distribution of common and generally widespread amphibian species (e.g. *Bombina variegata*, *Bufo bufo*, *Bufo viridis*, *Pelophylax ridibundus*,

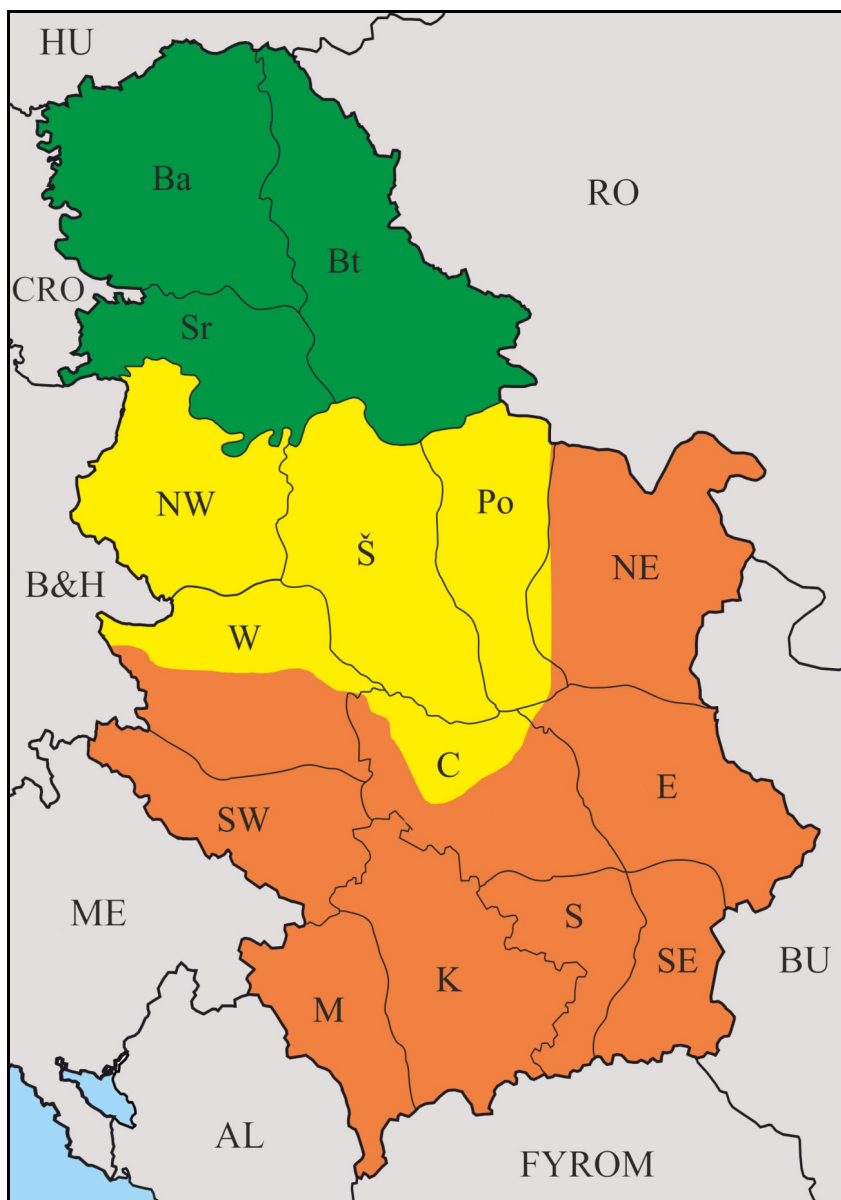


Fig. 1. – Division of biogeographic regions of Serbia proposed by Stevanović (1992), and accepted by Kalezić *et al.* (2015) and Tomović *et al.* (2015b).

*Ichthyosaura alpestris*, *Lissotriton vulgaris* and *Salamandra salamandra*) are relatively poor and scattered.

Therefore, with this study we aim to: (i) publish a complete dataset of distribution records of amphibian and reptile species in southern and south-eastern Serbia, summarizing previously published and new distribution data, and (ii) provide standardized 10 × 10 km UTM maps of the summarized data.

## MATERIALS AND METHODS

The data was collected from various sources and included: 785 distribution records (386 new and 399 published data) for 16 amphibian species and 916 distribution records (264 new and 652 published data) for 22 reptile species in southern and south-eastern Serbia.

For each species, the new distribution records (with broad locations, exact localities, toponyms, UTM coordinates, geographic coordinates, altitudes, observer/legator names who provided data, dates and years of observation) are given in Appendix 1. Data from the literature (with broad locations, exact localities, toponyms, UTM coordinates and literature/internet sources) are presented in Appendix 2.

The data was mapped on the standard 10 × 10 km UTM grid. For delineation of southern and south-eastern Serbia, we used the standard division of biogeographic regions of Serbia proposed by Stevanović (1992), and accepted by Kalezić *et al.* (2015) and Tomović *et al.* (2015b) (Figure 1).

## RESULTS

In Figures 2–8, detailed distribution records of all amphibian and reptile species found in southern and south-eastern Serbia are provided.

According to our dataset, two new amphibian species were recorded in these two biogeographic regions: eastern tree frog (*Hyla orientalis*) in south-eastern Serbia and Balkan spadefoot toad (*Pelobates balcanicus*) in southern Serbia. The most widespread (i.e. more than 20 UTM coordinates) amphibian species in southern and south-eastern Serbia are: fire salamander (*Salamandra salamandra* – 41), yellow-bellied toad (*Bombina variegata* – 38), marsh frog (*Pelophylax ridibundus* – 33), Greek stream frog (*Rana graeca* – 28), common toad (*Bufo bufo* – 26), agile frog (*Rana dalmatina* – 26), Macedonian crested newt (*Triturus macedonicus* – 25) and green toad (*Bufo viridis* – 25). Relatively common species (i.e. between 10 and 20 UTM coordinates) are:

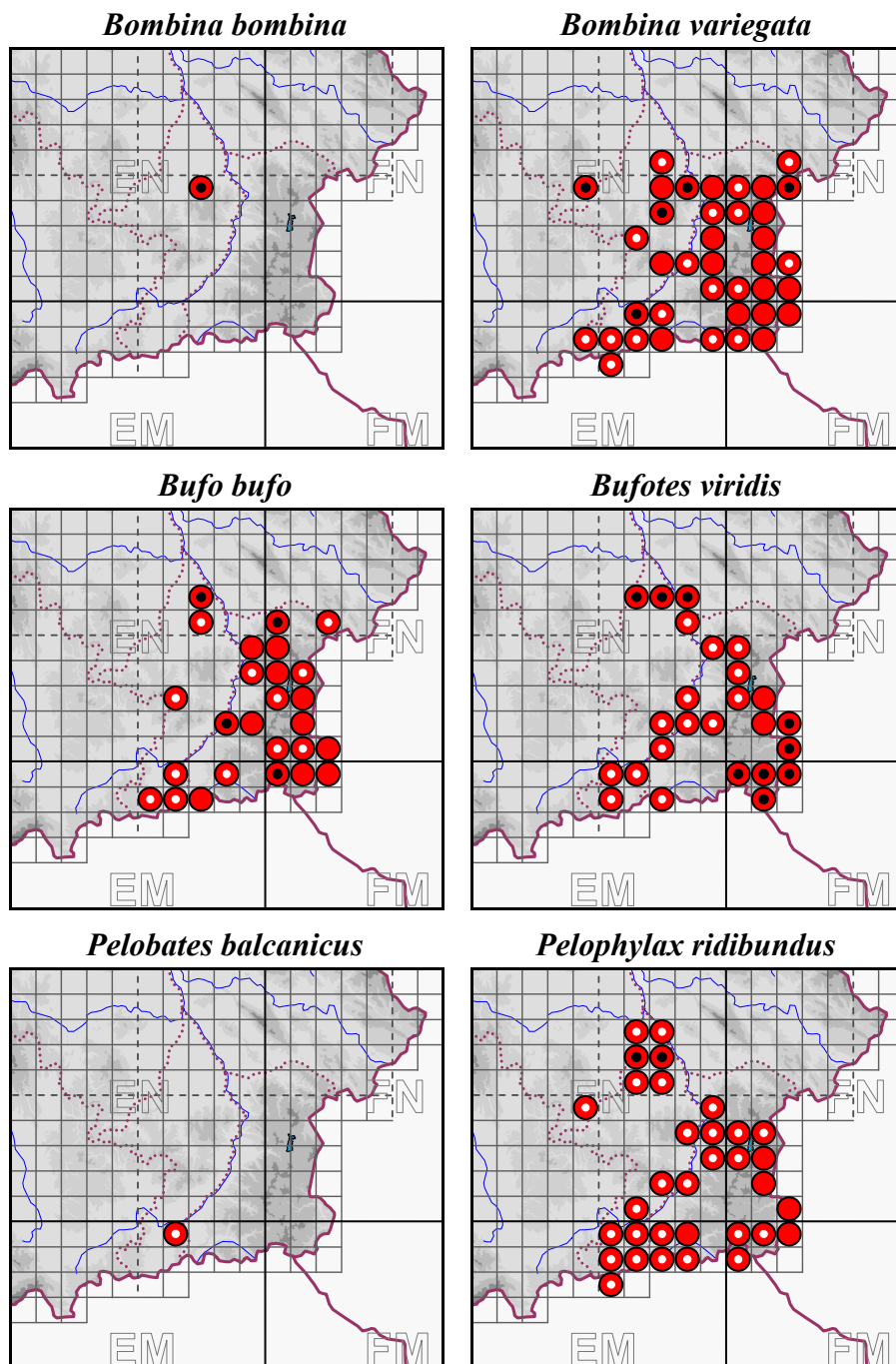


Fig. 2. – Distribution records of amphibian species in southern and south-eastern Serbia; red dots – confirmed published data; red-black dots – published data; red-white dots – new data.

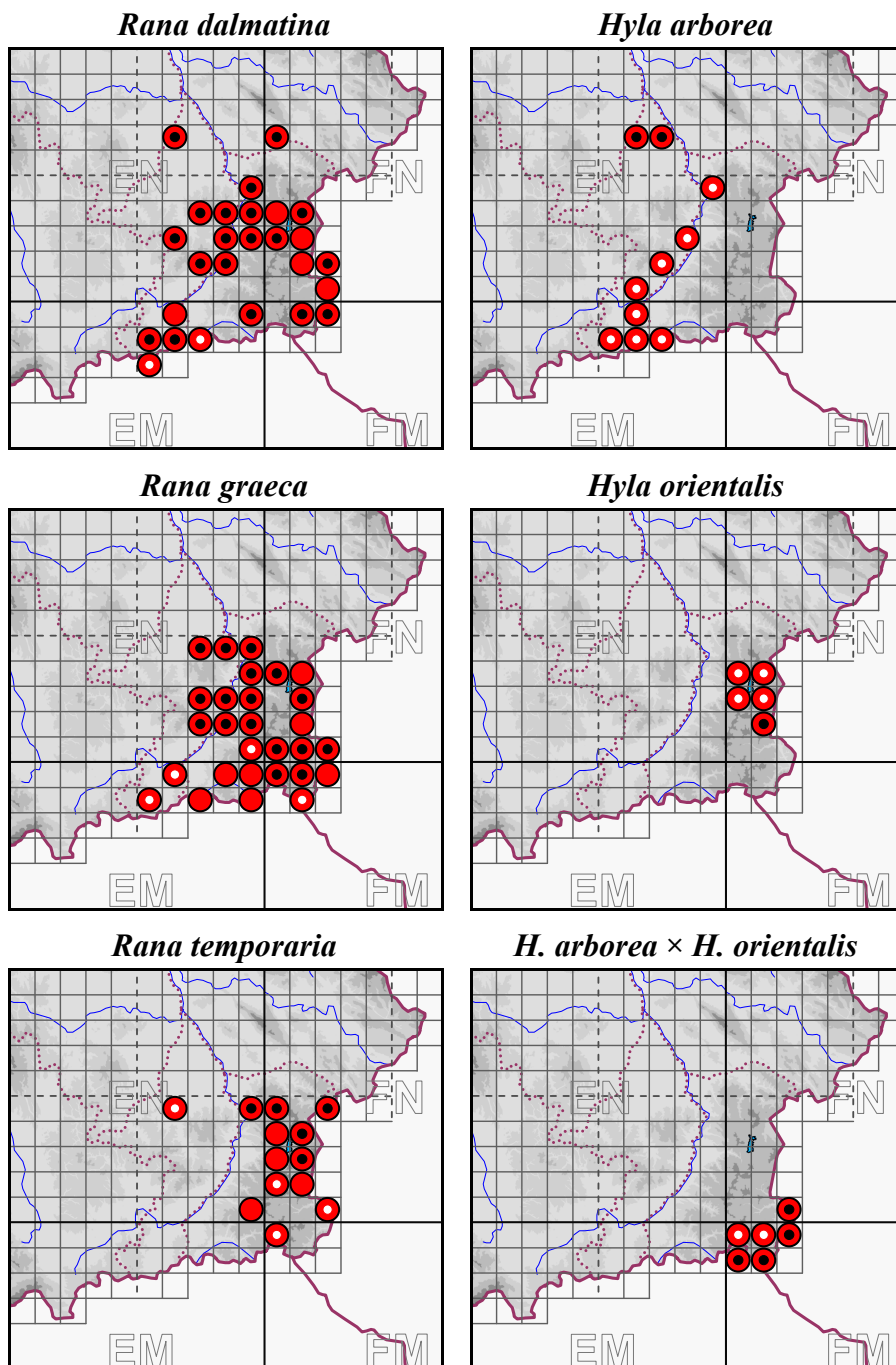


Fig. 3. – Distribution records of amphibian species in southern and south-eastern Serbia; red dots – confirmed published data; red-black dots – published data; red-white dots – new data.

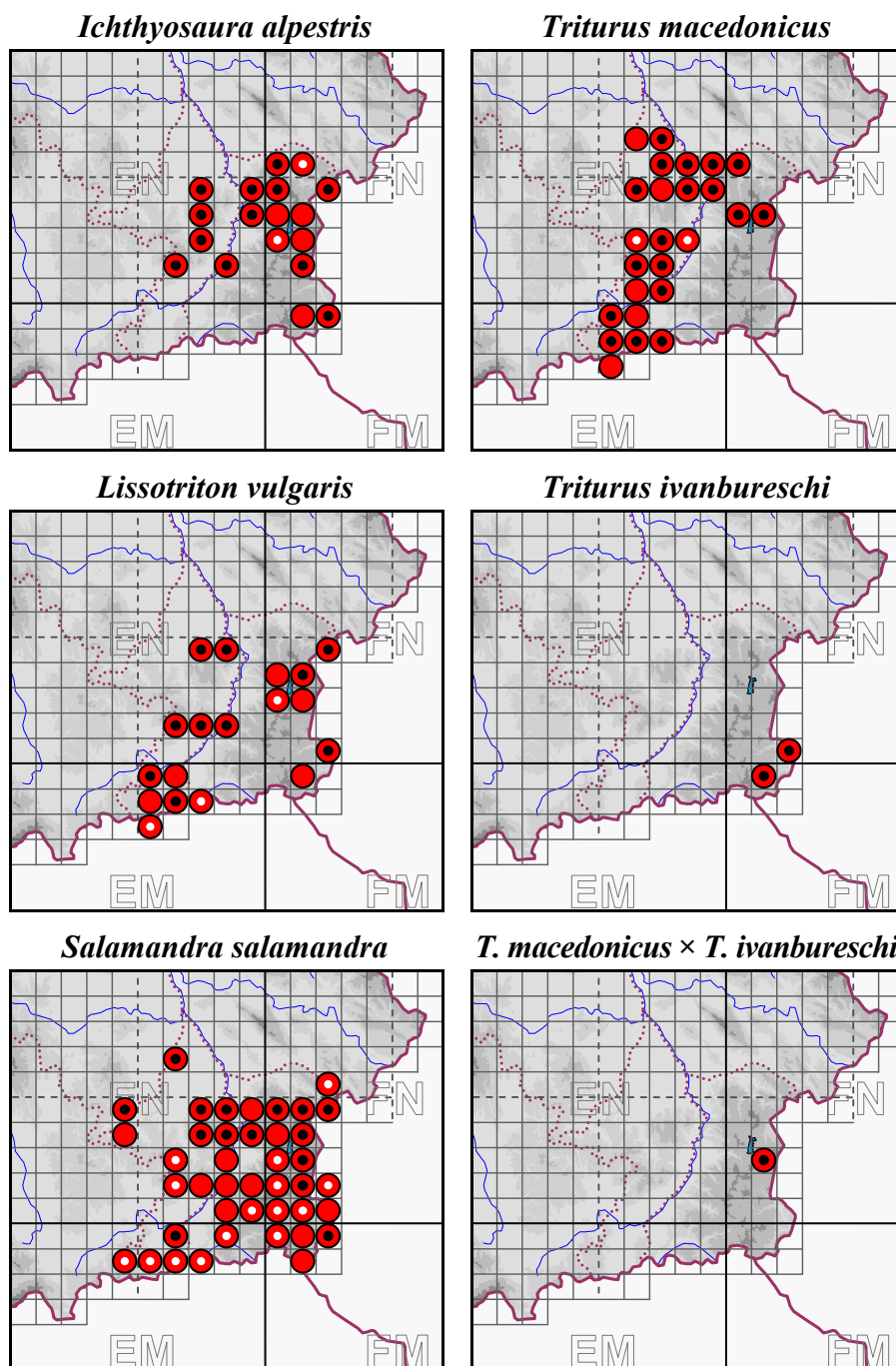


Fig. 4. – Distribution records of amphibian species in southern and south-eastern Serbia; red dots – confirmed published data; red-black dots – published data; red-white dots – new data.

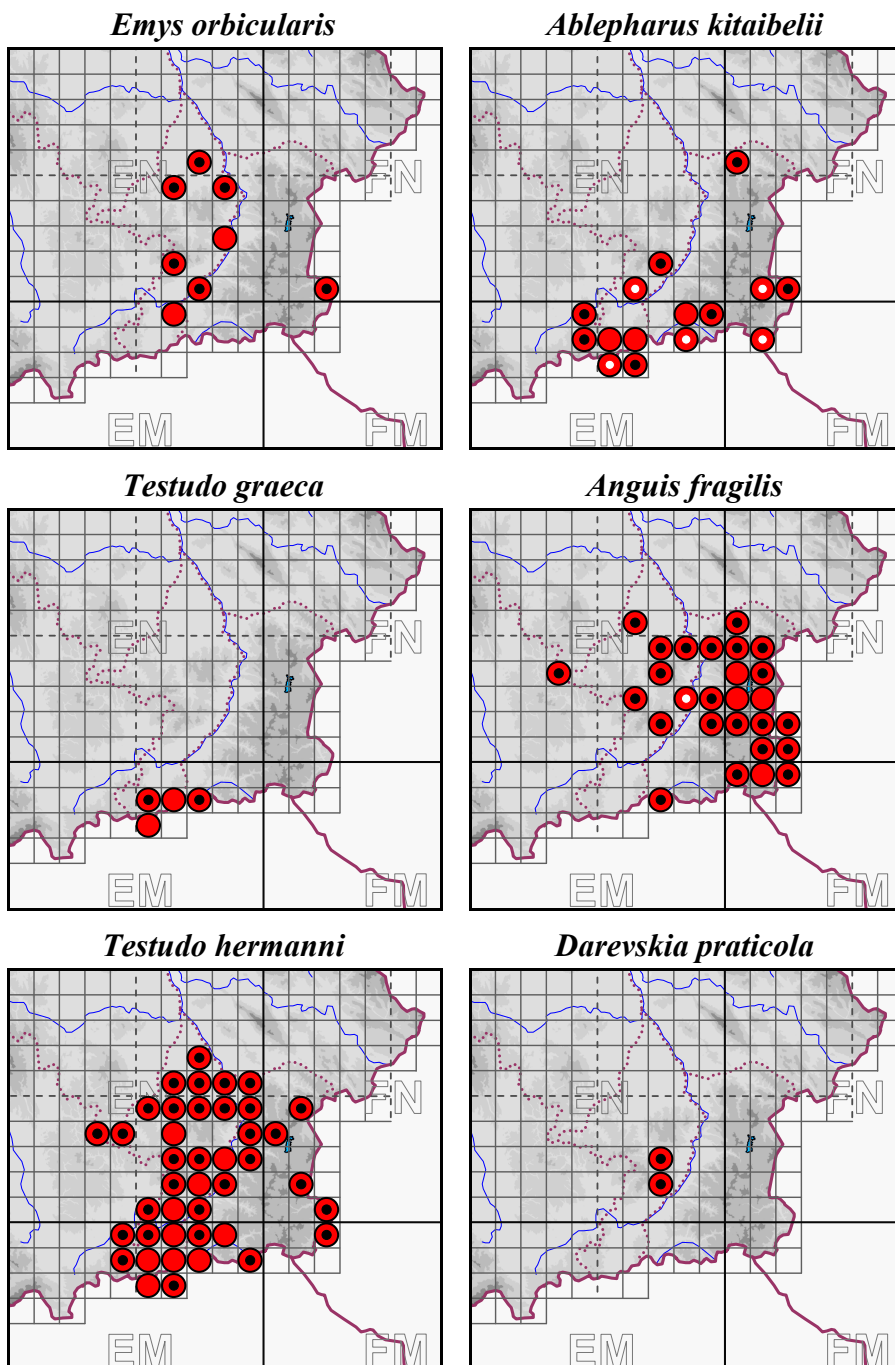


Fig. 5. – Distribution records of reptile species in southern and south-eastern Serbia; red dots – confirmed published data; red-black dots – published data; red-white dots – new data.



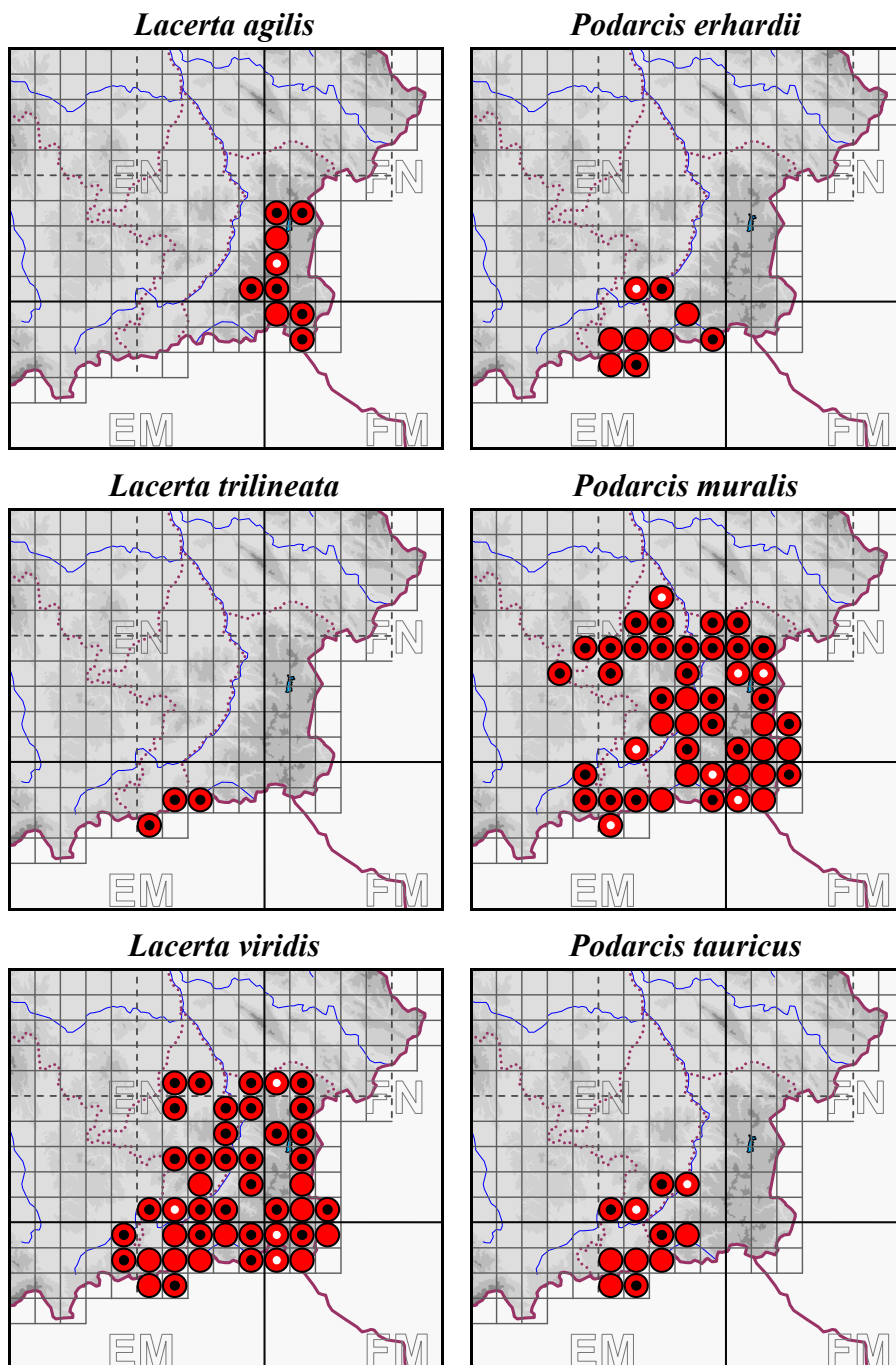


Fig. 6. – Distribution records of reptile species in southern and south-eastern Serbia; red dots – confirmed published data; red-black dots – published data; red-white dots – new data.

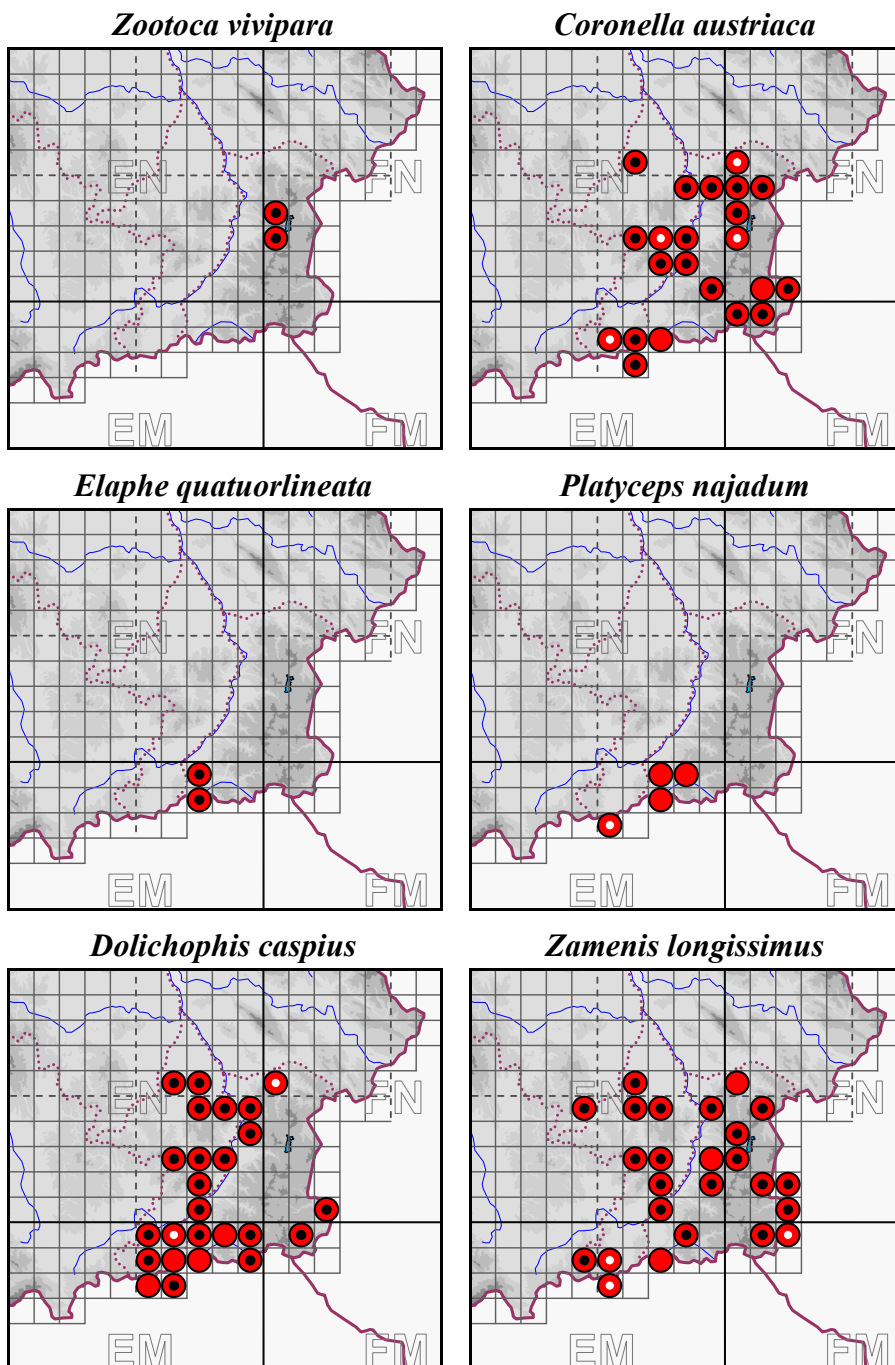


Fig. 7. – Distribution records of reptile species in southern and south-eastern Serbia; red dots – confirmed published data; red-black dots – published data; red-white dots – new data.

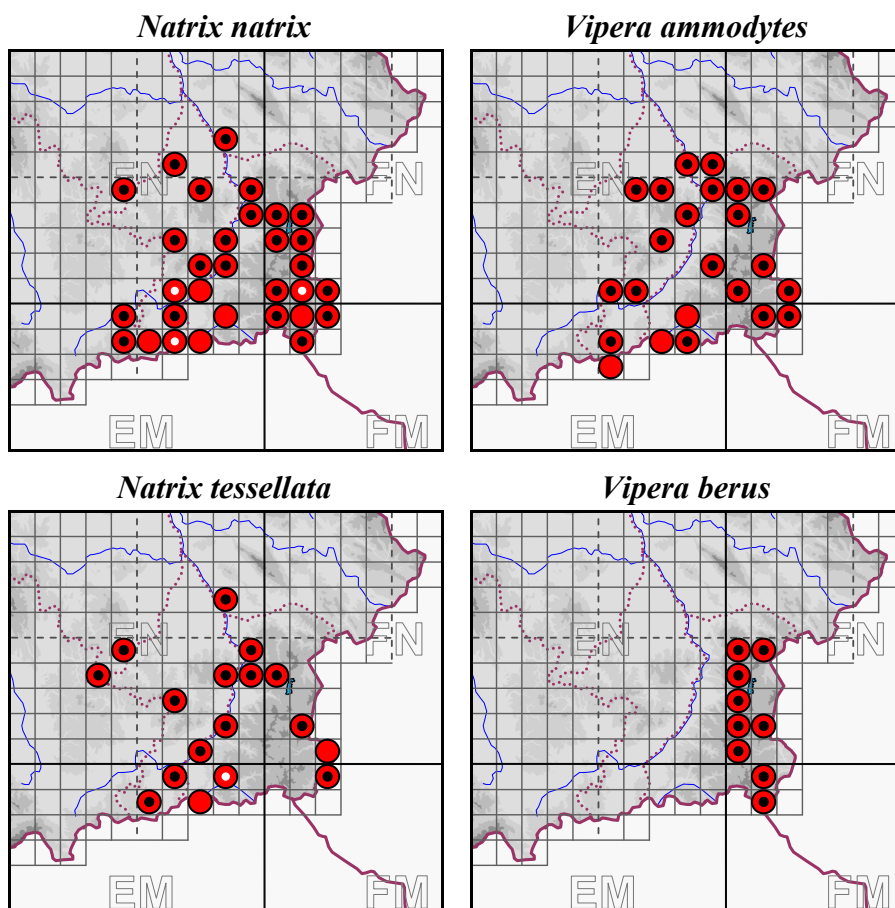


Figure 8. – Distribution records of reptile species in southern and south-eastern Serbia; red dots – confirmed published data; red-black dots – published data; red-white dots – new data.

smooth newt (*Lissotriton vulgaris* – 19), Alpine newt (*Ichthyosaura alpestris* – 18), common frog (*Rana temporaria* – 13) and tree frog (*Hyla arborea* – 10). Species with very limited distribution (i.e. less than 10 UTMs) are: eastern tree frog (*Hyla orientalis* – 5) and Balkan crested newt (*Triturus ivanbureschi* – 2). Amphibian species with only one record (UTM) in southern and south-eastern Serbia are: fire-bellied toad (*Bombina bombina*) and Balkan spadefoot toad (*Pelobates balcanicus*) (Figures 2–4).

Among reptiles, the most common (i.e. more than 20 UTMs) species in southern and south-eastern Serbia are: wall lizard (*Podarcis muralis* – 46), green lizard (*Lacerta viridis* – 44), Hermann's tortoise (*Testudo hermanni* – 41), grass snake (*Natrix natrix* – 31), slow-worm (*Anguis fragilis* – 27), Caspian whip-snake (*Dolichophis caspius* – 25), Aesculapian snake (*Zame-*

*nis longissimus* – 25), nose-horned viper (*Vipera ammodytes* – 23) and smooth snake (*Coronella austriaca* – 22). Relatively common species (i.e. between 10 and 20 UTMs) are: dice snake (*Natrix tessellata* – 17), snake-eyed skink (*Ablepharus kitaibelii* – 15) and Balkan wall lizard (*Podarcis tauricus* – 11). Species with limited distribution (i.e. between 5 and 10 UTMs) are: sand lizard (*Lacerta agilis* – 9), Erhard's wall lizard (*Podarcis erhardii* – 9), adder (*Vipera berus* – 9) and European pond turtle (*Emys orbicularis* – 8). Rare reptile species (i.e. less than 5 UTMs) are: Greek tortoise (*Testudo graeca* – 4), Dahl's whip snake (*Platyceps najadum* – 4), Balkan green lizard (*Lacerta trilineata* – 3), meadow lizard (*Darevskia praticola* – 2), viviparous lizard (*Zootoca vivipara* – 2) and four-lined snake (*Elaphe quatuorlineata* – 2) (Figures 5–8).

## DISCUSSION

According to the latest update, the Serbian batracho- and herpetofauna consist of 48 autochthonous species, with 22 amphibians and 26 reptiles (Urošević *et al.* 2022b).

A review of the published data (Džukić *et al.* 2005, Vukov *et al.* 2013, Urošević *et al.* 2022a) revealed that there are two new species of batrachofauna of southern and south-eastern Serbia: *Hyla orientalis* and *Pelobates balcanicus*. Thus, in these regions, there are now 16 amphibian species, in comparison with 14 provided by Kalezić *et al.* (2015).

The new finding of the Balkan spadefoot toad in Levosoje (Bujanovac) significantly extends its distribution range to the south (app. 120 km) from the previously known locality (Bobovište, Aleksinac). Both findings are located in the Južna Morava valley; however, Džukić *et al.* (2005) hypothesized that the Grdelica canyon demarcates the border between two portions of the Balkan spadefoot toad's range within the Balkans. Thus, we can assume that *Pelobates balcanicus* spreads from the south (through the Moravica river valley), as it is recorded in the northern part of North Macedonia, very close to the Serbian border (Džukić *et al.* 2008). Therefore, it is necessary to intensify research in southern Serbia where habitats are suitable for this species.

The only record of *Bombina bombina* in southern Serbia (Vukov *et al.* 2006, 2013), in addition to its discovery in central Serbia (Jović *et al.* 2016), represents the southernmost limit of the species distribution in our country.

The presence of peripheral populations and hybrid zones of crested newts (*T. ivanburechi* × *T. macedonicus* – Wielstra *et al.* 2017, Vučić *et al.* 2020) and tree frogs (*H. arborea* × *H. orientalis* – Dufresnes *et al.* 2015,

Urošević *et al.* 2022a) in south-eastern Serbia, makes this region particularly interesting. Future faunistic and genetic studies should provide more accurate data about the extent of the hybrid zones of these amphibian taxa in Serbia.

Concerning other, widespread amphibians for which detailed distribution data are lacking (e.g. *Bombina variegata*, *Bufo bufo*, *Bufo viridis*, *Pelophylax ridibundus*, *Ichthyosaura alpestris*, *Lissotriton vulgaris* and *Salamandra salamandra*), results of this study showed that these species are quite common in southern and south-eastern Serbia.

Biogeographic regions of southern and south-eastern Serbia, with the presence of 22 (out of a total 26) reptile species, have already been recognized as herpetological “hotspots” in our country (Tomović *et al.* 2015a). This particularly stands for the Mediterranean reptile species (*Testudo graeca*, *Lacerta trilineata*, *Podarcis erhardii*, *Elaphe quatuorlineata* and *Platyceps najadum*), as distribution of these species is almost exclusively (besides Kosovo & Metohija province) restricted to southern and south-eastern Serbia. Furthermore, potential future findings of some other Mediterranean snakes (e.g. *Malpolon insignitus*, *Telescopus fallax*, *Zamenis situla*) in these regions could be expected (Tomović *et al.* 2014), as their distribution limits in North Macedonia are very close to the Serbian border (Sterijovski *et al.* 2014). Finally, there is a possibility for the presence of *Anguis graeca* or its contact zone with *A. fragilis* in southern or south-eastern Serbia (Jablonski *et al.* 2016, Urošević *et al.* 2020).

Of 38 species of amphibians and reptiles registered in southern and south-eastern Serbia, six are considered vulnerable/near threatened according to the IUCN Red Lists, eight are listed on the Annexes II of the Habitats Directive, and two are on the Appendices II of the CITES (see Urošević *et al.* 2022b, Table 1). At the national level, ten species are considered critically endangered, endangered or vulnerable according to the IUCN criteria (Kalezić *et al.* 2015, Tomović *et al.* 2015a); additionally, three species are protected and 29 are strictly protected by law (Official Gazette of the Republic of Serbia No. 5/2010) (see Urošević *et al.* 2022b, Table 1).

Considering the abovementioned, as a result of projects conducted during the last three years (see acknowledgements), we proposed two locations in southern Serbia for legal protection in the frame of the establishment of national ecological networks in Serbia: marsh near Levošoje (Bujanovac) and surroundings of Slavujevac (Preševo).

### Acknowledgements

This study was funded through the projects: “Data collecting for implementation of Natura 2000 network in Republic of Serbia (2020–

2022)”, Ministry of Environment of Republic of Serbia, and “EU for Serbia – Continued support to implementation of chapter 27 in the area of nature protection (Natura 2000)”, by the Ministry of Education, Science and Technological development of Republic of Serbia – grant nos. 451-03-47/2023-01/200007 and 451-03-47/2023-01/200178, as well as Rufford small Grants, grant no. 25196-1 “Conservation Threat Assessment to Reptile Habitats in Pčinja Region (Southern Serbia) through Distributional and Fitness Traits of *Podarcis erhardii* Populations”.

## REFERENCES

- Andelković, M., Lakušić, M., Bjelica, V., Maričić, M., Danon, G., Urošević, A., Tomović, Lj. (2022): Balkan green lizard, *Lacerta trilineata* (Squamata: Lacertidae): a new species for the Serbian herpetofauna. – **Herpetology notes** 15: 211–214.
- Balej, P., Jablonski, D. (2006-2014): Balcanica.info. [<http://www.balcanica.cz/>]
- Balej, P., Jablonski, D. (2006-2019): Balcanica.info.
- Crnobrnja-Isailović, J. (1988): Genetička strukturiranost populacija velikog mrmoljka, *Triturus cristatus* (Amphibia, Salamandridae) u Jugoslaviji. – Biološki fakultet, Univerzitet u Beogradu, Beograd. (Master’s Thesis, manuscr.) [in Serbian]
- Crnobrnja-Isailović, J., Aleksić, I. (1999): First record of *Coluber najadum* Eichwald (1831) in Serbia. – **Archives of Biological Sciences** 51: 47–48.
- Crnobrnja-Isailović, J., Dinov, J., Randelović, V. (2011): Occurrence of European Adder (*Vipera berus*, Viperidae, Ophidia) on Vlasina Plateau (Southeastern Serbia). – **Biologica Nyssana** 2: 81–84.
- Crnobrnja-Isailović, J., Dinov, J., Isailović, O., Randelović, V. (2015): Westernmost record of *Zootoca vivipara* (Lichtenstein, 1823), in the Rhodope Massif, Serbia. – **Herpetozoa** 27: 162–165.
- Dufresnes, C., Brelsford, A., Crnobrnja-Isailović, J., Tzankov, N., Lymberakis, P., Perrin, N. (2015): Timeframe of speciation inferred from secondary contact zones in the European tree frog radiation (*Hyla arborea* group). – **BMC Evolutionary Biology** 15: 155.
- Dorđević, Ž. (1900): Amfibije i reptilije u Srbiji. – Državna štamparija Kraljevine Srbije, Beograd. [in Serbian]
- Džukić, G. (1972): Herpetološka zbirka Prirodnjačkog muzeja u Beogradu. – **Glasnik prirodnjačkog muzeja B** 27: 165–180. [in Serbian]
- Džukić, G. (1980): Drugi prilog herpetofauni Srbije. 5. Simpozijum biosistematičara Jugoslavije, Rezime referata, Donji Milanovac: 85. [in Serbian]
- Džukić, G. (1987): Taxonomic and biogeographic characteristics of the slow-worm (*Anguis fragilis* Linnaeus 1758) in Yugoslavia and on the Balkan Peninsula. – **Scopolia** 12: 1–47.

- Džukić, G. (1991): Vodozemci i gmizavci (Amphibia and Reptilia) – građa za faunu vodozemaca i gmizavaca Durmitora. In: Nonveiller, G. (ed.): Fauna Durmitora, Posebna izdanja 24, Odeljenje prirodnih nauka 15, sveska 4: 9–78. – CANU Titograd. [in Serbian]
- Džukić, G. (1993): Fauna, zoogeografija i zaštita repatih vodozemaca (Caudata) Srbije. – Prirodno-matematički fakultet Univerziteta u Beogradu, Beograd. (PhD Thesis, manuscr.) [in Serbian]
- Džukić, G., Beškov, V., Sidorovska, V., Cogalniceanu, D., Kalezić, M. L. (2005): Historical and contemporary ranges of the spadefoot toads (*Pelobates* spp., Amphibia: Anura) in the Balkan Peninsula. – *Acta zoologica cracoviensia* 48A: 1–9.
- Džukić, G., Beškov, V., Sidorovska, V., Cogalniceanu, D., Kalezić, M. L. (2008): Contemporary chorology of the spadefoot toads (*Pelobates* spp.) in the Balkan Peninsula. – *Zeitschrift für Feldherpetologie* 15: 61–78.
- Džukić, G., Cvijanović, M., Urošević, A., Vukov, T. D., Tomašević Kolarov, N., Slijepčević, M., Ivanović, A., Kalezić, M. L. (2015): The batrachological collections of the Institute for Biological Research “Siniša Stanković”, University of Belgrade. – *Bulletin of the Natural History Museum, Belgrade* 8: 118–167.
- Džukić, G., Vukov, T. D., Kalezić, M. L. (2016): Repati vodozemci Srbije. – Srpska akademija nauka i umetnosti, Beograd.
- Džukić, G., Tomović, Lj., Anđelković, M., Urošević, A., Nikolić, S., Kalezić, M. (2017): The herpetological collection of the Institute for Biological Research “Siniša Stanković”, University of Belgrade. – *Bulletin of the Natural History Museum, Belgrade* 10: 57–104.
- Gaston, K. J., Pressey, R. L., Margules, C. R. (2002): Persistence and vulnerability: Retaining biodiversity in the landscape and in protected areas. – *Journal of Biosciences* 27: 361–384.
- Golubović, A., Grahovac, D., Popović, M. (2017): Actual and potential distribution of the European pond turtle, *Emys orbicularis* (L., 1758) in Serbia, with conservation implications. – *Acta zoologica Bulgarica* 10: 49–56.
- Golubović, A., Tomović, Lj., Nikolić, M., Nikolić, S., Anđelković, M., Arsovski, D., Iković, V., Gvozdenović, S., Popović, M. (2019): Distribution of Hermann’s tortoise across Serbia with implications for conservation. – *Archives of Biological Sciences, Belgrade* 71: 509–516.
- Jablonski, D., Jandzik, D., Mikuliček, P., Džukić, G., Ljubisavljević, K., Tzankov, N., Jelić, D., Thanou, E., Moravec, J., Gvoždik, V. (2016): Contrasting evolutionary histories of the legless lizards slow worms (*Anguis*) shaped by the topography of the Balkan Peninsula. – *BMC Evolutionary Biology* 16: 99.
- Janjić, M. (1969): Vodozemci i gmizavci okoline Leskovca. – PMF, Skopje. (Bachelor’s Thesis, manuscr.) [in Serbian]
- Jelić, D., Ajtić, R., Sterijovski, B., Crnobrnja-Isailović, J., Lelo, S., Tomović, Lj. (2012): Distribution of the genus *Vipera* in the western and central Balkans (Squamata: Serpentes: Viperidae). – *Herpetozoa* 25: 109–132.

- Jović, D., Ajtić, R., Tomović, Lj. (2016): New records of fire-bellied toad (*Bombina bombina* (Linnaeus, 1761)), and common spadefoot toad (*Pelobates fuscus* (Laurenti, 1768)) in Serbia. – **Bulletin of the Natural History Museum, Belgrade** 9: 107–112.
- Kalezić, M., Tomović, Lj., Džukić, G. (2015): Red book of fauna of Serbia I – Amphibians. – Univerzitet u Beogradu-Biološki fakultet i Zavod za zaštitu prirode Srbije, Beograd.
- Krizmanić, I., Urošević, A., Simović, A., Krstić, M., Jović, D., Ajtić, R., Anđelković, M., Slijepčević, M., Đorđević, S., Golubović, A., Žikić, V., Džukić, G. (2015): Updated distribution of the European pond turtle *Emys orbicularis* (Linnaeus, 1758) and its conservation issues in Serbia. – **Archives of Biological Sciences, Belgrade** 67: 1043–1053.
- Ljubisavljević, K., Džukić, G., Vukov, T. D., Kalezić, M. L. (2014): Distribution patterns of Hermann's tortoise *Testudo hermanni* Gmelin, 1789, in the region of former Yugoslavia (Testudines: Testudinidae). – **Herpetozoa** 26: 125–138.
- Ljubisavljević, K., Tomović, Lj., Simović, A., Krizmanić, I., Ajtić, R., Jović, D., Urošević, A., Labus, N., Đorđević, S., Golubović, A., Anđelković, M., Džukić, G. (2015): Distribution of the Snake-eyed skink *Ablepharus kitaibelii* Bibron and Bory, 1833 (Squamata: Scincidae) in Serbia. – **Ecologica Montegrina** 2: 247–254.
- Margules, C. R., Pressey, R. L., Williams, P. H. (2002): Representing biodiversity: Data and procedures for identifying priority areas for conservation. – **Journal of Biosciences** 27: 309–326.
- Maričić, M., Golubović, A. (2020): *Anguis fragilis*. In: Popović, M., Golubović, A., Živanović, N. (eds): Biologer.org. [<http://www.biologer.org/>]
- Mehély, L. (1903): Adatok a deliblat homokpuszta es a Lokvahegyseg faunajahoz. – **Allattani Kozlemenyek** 2: 93–105. [in Hungarian]
- Nedeljković, D. (1958): Vodozemci i gmizavci u okolini Vranja. – PMF Beograd. (Bechelor's Thesis, manuscr.) [in Serbian]
- Radovanović, M. (1941): Zur Kenntnis der Herpetofauna des Balkans. – **Zoologischer Anzeiger** 136: 145–159.
- Radovanović, M. (1951): Vodozemci i gmizavci naše zemlje. – Naučna knjiga, Beograd. [in Serbian]
- Radovanović, M. (1964): Die Verbreitung der Amphibien und Reptilien in Jugoslawien. – **Senckenbergiana biologica** 45: 553–561. [in German]
- Ralev, A., Popović, M., Ružić, M., Shurulinkov, P., Daskalova, G., Crnobrnja-Isailović, J. (2012): A new record of *Testudo graeca iberica* Pallas, 1814, in southern Serbia. – **Herpetozoa** 25: 151–153.
- Ristić, N., Tomović, Lj., Ajtić, R., Crnobrnja-Isailović, J. (2006): First record of the four-lined snake *Elaphe quatuorlineata* (Lacépède, 1789) in Serbia. – **Acta Herpetologica** 1: 135–139.
- Spasić-Bošković, O., Krizmanić, I., Vujošević, M. (1999): Population composition and genetic variation of water frogs (Anura: Ranidae) from Yugoslavia. – **Caryologia** 52: 9–20.



- Stamenković, V. (1972): Herpetofauna Grdeličke klisure. – PMF Skopje. (Beche-  
lor's Thesis, manuscr.) [in Serbian]
- Stanković, M. (2005): Prilog poznavanju vodozemaca i gmizavaca opštine Lebane.  
In: Marković, Z. (ed.): Zbornik radova EcoIst'05, Bor: 37–42. [in Serbian]
- Sterijovski, B. (2014): Systematic survey of amphibian and reptile fauna in the  
Bosilegrad region of southern Serbia. – **Biologia Serbica** 36: 65–68.
- Sterijovski, B., Tomović, Lj., Ajtić, R. (2014): Contribution to the knowledge of  
the Reptile fauna and diversity in FYR of Macedonia. – **North-Western Journal  
of Zoology** 10: 83–92.
- Stevanović, V. (1992): Floristička podela teritorije Srbije sa pregledom viših  
horiona i odgovarajućih flornih elemenata. In: Sarić, R. (ed.): Flora Srbije 1. –  
Srpska akademija nauka i umetnosti, Beograd. [in Serbian]
- Tomović, Lj., Ajtić, R., Đoković, Đ., Antić, S. (2004): Records of *Testudo graeca  
ibera* Pallas, 1814 in Serbia and Montenegro. – **Herpetozoa** 17: 189–191.
- Tomović, Lj., Ajtić, R., Ljubisavljević, K., Urošević, A., Jović, D., Krizmanić, I.,  
Labus, N., Đorđević, S., Kalezić, M. L., Vukov, T., Džukić, G. (2014):  
Reptiles in Serbia – Distribution and diversity patterns. – **Bulletin of the Natural  
History Museum, Belgrade** 7: 129–158.
- Tomović, Lj., Kalezić, M., Džukić, G. (2015a): Red book of fauna of Serbia II –  
Reptiles. – Univerzitet u Beogradu-Biološki fakultet i Zavod za zaštitu prirode  
Srbije, Beograd.
- Tomović, Lj., Urošević, A., Ajtić, R., Krizmanić, I., Simović, A., Labus, N., Jović,  
D., Krstić, M., Đorđević, S., Anđelković, M., Golubović, A., Džukić, G.  
(2015b): Contribution to the knowledge of distribution of Colubrid snakes in  
Serbia. – **Ecologica Montenegrina** 2: 162–186.
- Tomović, Lj., Timotijević, M., Ajtić, R., Krizmanić, I., Labus, N. (2018):  
Contribution to the herpetofauna of Serbia – Distribution of Reptiles in  
Kosovo and Metohija province. – **University Thought** 8: 1–6.
- Tomović, Lj., Ajtić, R., Golubović, A. (2019a): New records of *Testudo graeca*  
(Pallas, 1814) in Republic of Serbia. – **Bulletin of the Natural History Museum,  
Belgrade** 12: 209–215.
- Tomović, Lj., Anđelković, M., Krizmanić, I., Ajtić, R., Urošević, A., Labus, N.,  
Simović, A., Maričić, M., Golubović, A., Čorović, J., Paunović, A., Jović, D.,  
Krstić, M., Lakušić, M., Džukić, G. (2019b): Distribution of three *Vipera*  
species in the republic of Serbia. – **Bulletin of the Natural History Museum,  
Belgrade** 12: 217–242.
- Urošević, A., Ljubisavljević, K., Tomović, Lj., Krizmanić, I., Ajtić, R., Simović,  
A., Labus, N., Jović, D., Golubović, A., Anđelković, M., Džukić, G. (2015):  
Contribution to the knowledge of distribution and diversity of lacertid lizards  
in Serbia. – **Ecologica Montenegrina** 2: 197–227.
- Urošević, A., Tomović, Lj., Krizmanić, I., Anđelković, M., Golubović, A.,  
Maričić, M., Ajtić, R., Čorović, J., Čubrić, T., Tomašević-Kolarov, N.,  
Cvijanović, M., Vukov, T., Jovanović, B., Vučić, T., Ajduković, M., Tot, I.,  
Nadaždin, B., Labus, N., Džukić, G. (2018): Distribution and diversity of

- brown frogs (*Rana* spp., Anura, Amphibia) in Serbia. – **Bulletin of the Natural History Museum, Belgrade** 11: 227–245.
- Urošević, A., Tomović, Lj., Crnobrnja-Isailović, J., Krizmanić, I., Ajtić, R., Labus, N., Anđelković, M., Nikolić, S., Jović, D., Krstić, M., Maričić, M., Simović, A., Paunović, A., Žikić, V., Čorović, J., Vučić, T., Čubrić, T., Džukić, G. (2020): Distribution of the slow worm (*Anguis fragilis* complex) with possible species delimitation in Serbia. – **Bulletin of the Natural History Museum, Belgrade** 13: 253–265.
- Urošević, A., Anđelković, M., Crnobrnja-Isailović, J., Krizmanić, I., Ajtić, R., Simović, A., Krstić, M., Maričić, M., Vučić, T., Jović, D., Džukić, G., Tomović, Lj. (2022a): Distribution of tree frogs (*Hyla* spp.) in Serbia – implications of the recent taxonomic revision. – **Bulletin of the Natural History Museum, Belgrade** 15: 137–148.
- Urošević, A., Crnobrnja-Isailović, J., Ljubisavljević, L., Anđelković, M., Ivanović, A., Golubović, A., Vučić, T., Tomović, Lj. (2022b): An updated checklist of the Serbian batracho- and herpetofauna. – **Bulletin of the Natural History Museum, Belgrade** 15: 149–169.
- Vučić, T., Tomović, Lj., Ivanović, A. (2020): The distribution of crested newts in Serbia: An overview and update. – **Bulletin of the Natural History Museum, Belgrade** 13: 237–252.
- Vukov, T., Džukić, G., Lelo, L., Borkin, L. J., Litvinchuk, S. N., Kalezić, M. L. (2006): Multivariate morphometrics of the yellow-bellied toad (*Bombina variegata*) on the Central Balkans: taxonomical and biogeographical implications. – **Zoological Studies** 45: 213–222.
- Vukov, T., Kalezić, M. L., Tomović, Lj., Krizmanić, I., Jović, D., Labus, N., Džukić, G. (2013): Amphibians in Serbia – Distribution and diversity patterns. – **Bulletin of the Natural History Museum, Belgrade** 6: 90–112.
- Wallis, G. P., Arntzen, J. W. (1989): Mitochondrial DNA variation in the crested newt superspecies: limited cytoplasmic gene flow among species. – **Evolution** 43: 88–104.
- Wielstra, B., Sillero, N., Vörös, J., Arntzen, J. W. (2014): The distribution of the crested and marbled newt species (Amphibia: Salamandridae: *Triturus*) – an addition to the New Atlas of Amphibians and Reptiles of Europe. – **Amphibia-Reptilia** 35: 376–381.
- Wielstra, B., Burke, T., Butlin, R. K., Arntzen, J. W. (2017): A signature of dynamic biogeography: enclaves indicate past species replacement. – **Proceedings of the Royal Society of London, Series B: Biological Sciences** 284: 20172014.

## SUPPORTING INFORMATION

### Online Appendices:

Appendix 1. – Unpublished (field) records.

Appendix 2. – Previously published records.

## ПРИЛОГ ПОЗНАВАЊУ БАТРАХО- И ХЕРПЕТОФАУНЕ ЈУГОИСТОЧНЕ И ЈУЖНЕ СРБИЈЕ

ЉИЉАНА ТОМОВИЋ, ТИЈАНА ВУЧИЋ, МАРКО АНЂЕЛКОВИЋ,  
АЛЕКСАНДАР УРОШЕВИЋ, ВУКАШИН БЈЕЛИЦА, МАРКО МАРИЧИЋ,  
МАРГАРЕТА ЛАКУШИЋ, ГОРАНА ДАНОН, АНА ИВАНОВИЋ

### РЕЗИМЕ

У овом раду дато је ажурирано и систематизовано распрострањење батрахо и херпетофауне јужне и југоисточне Србије, на основу публикованих литературних, као и нових теренских података за 16 врста водоземаца и 22 врсте гмизаваца. У ова два биогеографска региона, претходно препознатих као подручја високог специјског диверзитета, забележене су две нове врсте водоземаца са ограниченим распрострањењем: *Hyla orientalis* и *Pelobates balcanicus*. Такође, једна врста репатих водоземца (*Triturus ivanbureshi*) има ограничено распрострањење, док је *Bombina bombina* веома ретка. Четири врсте гмизаваца су са ограниченом дистрибуцијом, а још шест су веома ретке у ова два биогеографска региона.

Од укупно 38 врста водоземаца и гмизаваца потврђених у регионима јужне и југоисточне Србије, шест је рањиво/готово угрожено према критеријумима IUCN-а, осам су на анексу II Директиве о стаништима, а две су на апендиксу II CITES-а. На националном нивоу, 10 врста се сматра критично угроженим, угроженим или рањивим по критеријумима IUCN-а, три врсте су заштићене, а 29 строго заштићене законом.

Као резултат ових истраживања, две локације у јужној Србији: Левосоје (Бујановац) и Славујевац (Прешево), предложене су за заштиту у оквиру успостављања националних еколошких мрежа у Србији.

Присуство хибридних зона и утицаја Медитеранске климе чине регионе јужне и југоисточне Србије подручјима од великог значаја за диверзитет наше земље, и фокусом за будуће еколошке и конзервационе студије.