

A puzzle about *Bombina* sp.: a yellow-bellied specimen of the fire-bellied toad (*Bombina bombina* Linnaeus, 1761) indicates the highest proven habitat of the species in Bulgaria

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Abstract. To date, the data published on the occurrence of the fire-bellied toad (*Bombina bombina*) and yellow-bellied toad (*B. variegata*) in the region of the Natural Park “Shumensko plato” (SE Bulgaria) are controversial. The species are included in the inventory of the protected territory, but none of them has been reported since 1934. In the range of this study we provide a field survey to investigate whether both *Bombina* species inhabit the park and where they can be located. We selected two study polygons where water basins are available for the toads at least in the spring. During our four year investigation we were able to detect only a single fire-bellied toad. One female specimen was captured in the spring of 2012 and recaptured in 2014. The specimen was found at an altitude of 472 m a.s.l. This is the highest habitat reported for *B. bombina* in Bulgaria.

Key words. amphibian, anuran, field survey, monitoring, elevation, zoogeography

Introduction

The fire-bellied toad (*Bombina bombina* Linnaeus, 1761) inhabits Central and Eastern Europe (Sillero et al., 2014) where it is usually associated with lowlands. However, there is no general geographic pattern in the altitudinal distribution of the species. It has been reported at 732 m a.s.l. in the Czech Republic (Zavadil, 1993); at 650 m a.s.l. in Slovakia (Lác, 1968); at 590 m a.s.l. in Austria (Cabela et al., 2001); up to approximately 420 m a.s.l. in Romania (Strugariu et al., 2008; Gherghel et al., 2008, but see the altitudinal range in Rozylowicz et

al., 2013). The highest altitude record for this species was reported from Russia (830 m a.s.l.) on the northern foothills of Caucasus (Kuzmin, 2012). In some areas the maximum altitude of *B. bombina* populations is lower: up to 250 m a.s.l. in Poland (Szymura, 2003), 350 m a.s.l. in Ukraine (Ščerbak and Ščerban, 1980) or up to 300 m a.s.l. in Germany (Günther and Schneeweiss, 1996).

Since the end of the 19th century, the general pattern of the species distribution in Bulgaria has been well studied and documented through the years (e.g. Kovachev, 1894, 1905, 1912; Buresch and Tsonkov, 1942; Angelov and Kalchev, 1961; Beškov and Beron, 1964; Beškov, 1972; Undjian, 2000; Beshkov and Nanev, 2002; Stojanov et al., 2011). In Bulgaria, *B. bombina* occurs in the Danubian and the Thracian lowlands and also sporadically along the Black sea coast (Stojanov et al., 2011). The species prefers natural and artificial lakes, temporary puddles or the vicinity of large running rivers and channels (Stojanov et al., 2011). According to these authors, *B. bombina* occurs from the sea level commonly up to an elevation of 250 m in Bulgaria. To date, the highest published record (450 m a.s.l.) is from the area “Devetashko plato” (Tzankov and Popgeorgiev, 2014).

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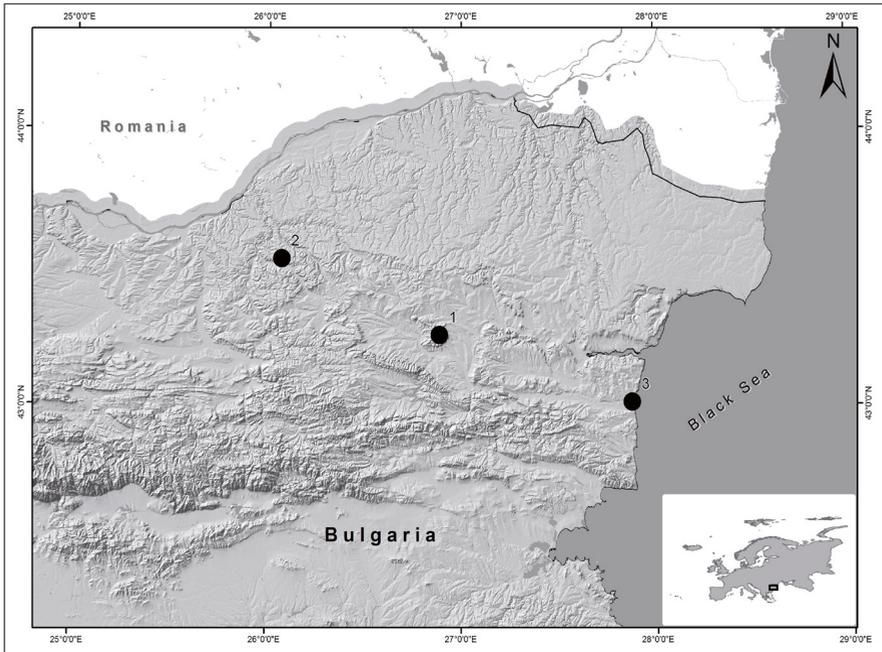


Figure 1. Geographic position of localities mentioned in the text: 1 represents „Shumensko plato“ (presented here); 2 represents Svalenik village [data from Unjian (2000)]; 3 represents the mouth of Kamchia river (presented here).

The Natural Park “Shumensko plato” is positioned on a plateau which is higher than the “Devetashko plato” and a potential record of the fire-bellied toad would indicate the highest habitat of the species on Bulgarian territory. The existing records on the presence of *B. bombina* and *B. variegata* in the region are very puzzling. The earliest descriptions are rather incomplete and inaccurate (see Kovachev, 1905; Buresch and Tsonkov, 1942). Neither of the two species has been confirmed in the area afterwards. To revise the presence of *B. bombina* and *B. variegata* in the territory of the Natural Park “Shumensko plato”, in the range of the present study we conducted field investigations in the region of the plateau.

Material and methods

We conducted surveys in the spring of the years 2011 to 2014. Investigation of the water bodies was carried out in two defined areas: “Kioshkovete place” and the Memorial “1300 Years Bulgaria” (respectively southwest and south from the center of the Shumen town, NE Bulgaria). Both localities were selected because the “Kioshkovete place” is positioned at the foothills of

“Shumensko plato” and the Memorial is on the top of the plateau (denivelation of about 150 m). In both areas water basins were available (at least in spring time). The monitoring took place from March to July at irregular intervals from 28 to 45 days.

During our herpetological research, a single specimen of *B. bombina* was captured in 2012 and recaptured in 2014. It was identified as fire-bellied toad based on the following characters (sensu Stojanov *et al.*, 2011): general pattern composition and arrangement of the ventral coloration with predominant dark base color instead of orange color patches; great fragmentation of the patches; head ratio (the length was greater than the width); dorsal tubercles rounded and smoothed, white spots around the dorsal tubercles.

Results and discussion

On 18 April 2012 in a temporary puddle on the forest road near the Memorial “1300 Years Bulgaria”, southwest from Shumen (43.246°N 26.911°E, 471 m a.s.l.; see Figure 1) we documented an adult *B. bombina* female and its eggs. On 26 April 2014 the same individual was recaptured in a water body (approximately 15x15



Figure 2. Ventral coloration of recorded *Bombina bombina* from Natural Park “Shumensko plato”: A, individual found in 2012; B, same individual recaptured in 2014).

m) at about 500 m southwest (43.247°N 26.905°E) from the spot of the first finding in 2012. For the second locality, based on GPS coordinates verified on a 1:5000 georeferenced topographic map, the altitude was 472 m a.s.l. This is the highest officially recorded elevation of a *B. bombina* habitat for Bulgaria. The ventral coloration of the specimen was orange in 2012 and pale yellow in 2014 (Figure 2). The documented specimen of *B. bombina* is the only toad of the genus *Bombina* ever recorded on the top of the plateau. Thus, we will discuss this finding with respect to several important factors.

Habitat specifications of the region of the Memorial “1300 Years Bulgaria” in the Natural Park “Shumensko plato” and recent occurrence of the species in NE Bulgaria

Both localities where the fire-bellied toad was found can be classified as the following habitat types: habitat type 41.2B Pannonic oak-hornbeam forests (according to Palearctic habitat classification of Moss and Davies, 2002); G1.A1 [*Quercus*] – [*Fraxinus*] – [*Carpinus betulus*] woodland on eutrophic and mesotrophic soils; G1.A1C Southeastern European oak-hornbeam forests; G1.A1C3 Moesian oak-hornbeam forests (according to EUNIS habitat classification) - The habitat is listed in Supplement I of the habitat directive 92/43 and respectively Supplement I of the Bulgarian Biodiversity Law as “91G0* Pannonic woods with *Quercus petraea* and *Carpinus betulus*“. The categories are included

in the management plan of Natural Park “Shumensko plato” from 2011. According to all classifications, the habitat is of high priority. It is classified as endangered within the European Union and is an object of strong protection (European Directive 92/43/EEC).

According to the hypothesis on the postglacial recolonization routes of *Bombina* species presented in Arntzen (1978), dispersal routes of *B. bombina* followed the main river floodplains including the region of the Danube valley. The population of fire-bellied toads in the region near the town of Shumen could be a remnant of a historical recolonization from close refuges located along the Black Sea coast and the Danube River (see Fijarzczyk et al., 2011). The dispersion and penetration towards smaller river valleys seem to have been greatly facilitated by human activity; e.g. Vines et al. (2003) proposed that the colonization of the Transylvanian Plateau happened about 10 Kya.

The microhabitat in “Shumensko plato” (Figure 3) is not typical for *B. bombina* (see Stojanov et al., 2011). In Bulgaria, the fire-bellied toad is associated with lowlands and permanent and predominantly stagnant water basins, mostly in open habitats. The present distribution of *B. bombina* in Bulgaria was summarized by Stojanov et al. (2011). However, the map presented there does not provide exact localities. The locality described in the present study is isolated from the core distribution area of this species. The closest known exact records of *B. bombina* are from Rusenski Lom valley near Svalenik



Figure 3. Photos of microhabitats where the female fire-bellied toad was captured: A, in 2012; B, in 2014.

village (Unjian, 2000) and at the mouth of Kamchia River (N. Tzankov, unpublished data). Both are over 70 km away from “Shumensko plato” (see Figure 1).

Historical impact on current situation of *Bombina* spp. in Shumensko plato

It was Kovachev (1905) who first mentioned “locality Shumen” for *B. bombina*, but without any further specifications. Buresch and Tsonkov (1942) reported the presence of *B. variegata* in puddles at “Kioshkovete” place. On 16th July 1934, I. Tsonkov euthanized two specimens of toads for the collection of the Bulgarian Royal museum, but these were not found in the collection of the National Museum of Natural History in Sofia. Apparently the specimens had been lost. Currently there is no reliable information whether the yellow-bellied toad is part of the batrachofauna of the Natural Park “Shumensko plato” and whether the two *Bombina* species hybridize as reported for other sympatric populations of toads (see Szymura, 1993).

Hybridization between *Bombina* species is well documented. Different species hybridize in contact

areas in a large scale all along their distributional ranges (Szymura, 1993). Clinal, mosaic or both types of hybrid zones were reported for, e.g. Austria (Gollmann, 1984), Poland (Szymura and Barton, 1986), Hungary and Slovakia (Gollmann *et al.*, 1988), Croatia (MacCallum *et al.*, 1998), Romania (Vines *et al.*, 2003) and Ukraine (Yanchukov *et al.*, 2006). Differences in habitat preferences have a crucial role in hybrid zones (see MacCallum *et al.*, 1998; Vines *et al.*, 2003; Yanchukov *et al.*, 2006). Extensive multidisciplinary studies (Gollmann, 1984, 1987; Gollmann *et al.*, 1988; Szymura and Barton, 1991; Nürnbergger *et al.*, 2005; Szymura, 1983, 1993, 1995; Kruuk *et al.*, 1999; Szymura *et al.*, 2000; Vines *et al.*, 2003) demonstrated that for the determination of hybrid individuals, morphological traits (color pattern, morphometrics *etc.*) are not a reliable indicator. For example, the quantification of geometric and color-defined characters of ventral patches proposed by Vörös *et al.* (2007) discriminated the parent species well enough, but could not be fully applied to hybrids.

Co-occurrence of the fire-bellied and the yellow-bellied toad in Bulgaria is rare. It was first mentioned by Beškov *et al.* (1967) and recently confirmed (N. Tzankov and M. Slavchev, unpublished data). Only one fertile hybrid population in Chernelka gorge was reported for Bulgaria (see Jameson *et al.*, 1982). It is possible that the identification of the specimens found by I. Tzankov in 1934 in “Kioshkovete” place as *B. variegata* was erroneous and he actually had found yellow-colored *B. bombina* specimens. The presently reported ontogenetic shift in the ventral coloration will be in the scope of future studies on the local population.

Photographic documentation as an important marking method for identifying *Bombina* individuals

There are different invasive marking methods for amphibians. The most important and frequently used are toe clipping and cutaneous coloration (for overview see Bayley and Nichols, 2009; Ferner, 2009). Most of the methods are very effective for short time monitoring (up to one season). Long time monitoring requires expensive marking with subcutaneous chips or the use of photo documentation. Thus, when estimating the population size of *B. bombina*, often individual identification is based on unique belly pattern features or on pattern mapping (Sas *et al.*, 2005). The color features change slightly during ontogenetic development (see Figure 2), but nevertheless are a reliable indicator for the identification of every single specimen.

Different widely used schemes for *Bombina* specific determination were adapted for populations from the northern part of the distribution area of the species. The pattern scheme presented in Michalowski (1958) and later adopted by Lác (1961) and Michalowski and Madej (1969) is based on the percentage of patch coverage. The system of Stugren (1959) is based on patch connectivity and is used mostly by Romanian herpetologists [for example recent work by Sas et al. (2005), Covaciu-Marcov et al. (2009) etc.]. Gollmann (1984) and Szymura & Barton (1991) proposed combined, optimized schemes.

In conclusion we have to point out that many of the traits listed in the proposed identification algorithms are not useful for the mixed East Balkan populations. The recognition schemes have to be adapted for the local populations and a databank of photos of the ventral coloration in *B. bombina* and *B. variegata* has to be established. This will allow scientists to identify individuals, to provide comparative morphological studies and to fine-tune the individual recognition system.

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