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NEW CASES OF WINTER-ACTIVE AMPHIBIANS IN THE THERMAL WATERS OF BANAT, ROMANIA

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Abstract - In the winter of 2010/2011 we identified 6 new thermal habitats, with winter-active amphibian populations in the Banat region of south-western Romania. The diversity of the amphibian species was small, only 2 species were observed: *Bombina bombina* and *Pelophylax ridibundus*. In waters with high flow and temperature, the number of winter-active frogs reached several hundred. All the new thermal habitats are artificial, being subjected to a powerful anthropogenic pressure.

Key words: Thermal waters, winter-active amphibians, temperature, human impact, Banat, Romania

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INTRODUCTION

The features of thermal water organisms have held the interest of biologists for a long time; there are many studies on different groups of water organisms from such environments (Brues, 1924; Mason, 1939; Menni et al., 1998; Chen et al., 2001; Stavreva-Vaselinovska and Todorovska, 2010). Typical species were identified in such thermal waters (Hoeppli and Chu, 1932; Kulkoyluoglu et al., 2003), but also general species normally found in non-thermal waters (Hoeppli and Chu, 1932; Menni et al., 1998). Some of these show some modifications in their biology in thermal waters in comparison with the populations from non-thermal waters (Chen et al., 2001; Covaciu-Marcov et al., 2006; Sas et al., 2010). However, these studies are far from complete: the data on the influence of thermal waters on amphibians are poor (Covaciu-Marcov et al., 2006; Oruçi, 2010) and have mainly been collected from areas with a warmer climate (Mason, 1939; Chen et al., 2001; Wu and Kam, 2005). In the past years in Romania, some active amphibians have been found in thermal waters. At present, the number of these localities adds up to 27 (Covaciu-Marcov et al., 2003, 2006, 2010, 2011a; Sas et al., 2007). Only 2 of these are in Banat (Covaciu-Marcov et al., 2006, 2010), although the area is as rich in thermal waters as the western region of Romania. Therefore, the apparent scarcity of winter-active amphibians in the thermal waters from Banat is due to the low number of such studies. However, it is likely that in the Banat area the waters aren't suitable for amphibians, because they are recipients of the sewerage system, an aspect that was noted before (Covaciu-Marcov et al., 2006, 2010). The present paper presents an explanation of these issues, being dedicated to the study of the influence of Banat thermal waters on amphibians.

MATERIALS AND METHODS

The Banat region is located in south-western Romania, with large areas of plain in the western area, but also many mountain areas in the eastern part (Posea and Badea, 1984). Like other regions in Romania, Banat houses many geothermal water deposits that are localized especially at the boundaries of the Pannonian Plain and surrounding higher units (Oncescu, 1959). The abundance of thermal waters in the western plain and their direct economic usage for heating (Antal et al., 2009; Petrescu-Mag et al., 2009) is expressed by the large number of thermal pools found, especially in the fields of eastern Banat. Also, wells that were drilled in the area are now abandoned, clogged or used by locals for household activities, as in north-western Romania (Covaciu-Marcov et al., 2010). Our activity began from the knowledge of the existence of many thermal sources that were exploited in Banat in the context of the scarcity of data about amphibians, coupled with the theoretical and practical importance of such studies. The identification of thermal water sources in the field was made after maps of geothermal wells from western Romania, in conjunction with information from locals. The study was conducted during the cold season of 2010/2011. Ten localities with thermal waters, one of which comprising 2 habitats, were investigated. The amphibians were observed and counted on the banks of the thermal habitats. They were captured with a round net mounted on a long metallic pole. Some habitats were checked 2 or even 3 times during the winter season. The water and air temperatures were measured.

RESULTS

We did not identify any winter-active amphibians in all 10 sources. Some thermal pools were closed in winter and some wells are clogged so that there was no thermal water flow. All thermal habitats are artificial and all localities are administratively belong to the Timis County.

Thermal waters with winter-active amphibians were identified in 5 localities. In one of these, Teremia Mare, we identified 2 different habitats. In all 6 new thermal habitats we observed *Pelophylax ridibundus* populations were active during the cold season while 3 habitats were inhabited by *Bombina bombina* specimens, too (Table 1). *Pelophylax ridibundus* has the biggest populations. The human impact is high in all thermal habitats due to pollution with household wastes. Also, habitats associated with local spas or pools are used by locals for washing and are thus heavily polluted with detergents and soap.

The only clearly observed modification of amphibian biology is the disappearance of hibernation, all frogs being active on days with sub-zero diurnal temperatures. In the bigger thermal habitats, mainly in Sanmihaiu German, we could hear frogs calling. However, we were unable to capture larvae, either because of the large size of the thermal channels and water flow which makes their capture more difficult, or because frogs do not reproduce during winter.

DISCUSSION

The sizes of winter-active *P. ridibundus* populations in the thermal habitats from Banat differ considerably. There are habitats in which we observed a single frog, but also habitats in which their number was over 300. In the latter case, the population was much larger than observed in similar habitats in north-western Romania (Covaciu-Marcov et al. 2010) where the populations were usually small, with the exception of the thermal lake from 1 Mai Spa (Covaciu-Marcov et al. 2006). The differences between the sizes of the populations are a consequence of the habitat's morphology, temperature and thermal water flow which fuels them. The largest populations were registered in thermal habitats where the water temperature is high. In Sanmihaiu German where we counted over 300 lake frogs, the temperature of the thermal water that fuels the channel was 47°C. Also, the flow of thermal water has to have a specific consistency to be able to heat a long portion of the channel and in turn to allow for the establishment of non-hibernating populations of amphibians. Therefore, the frogs from Sanmihaiu German are at an advantage due to the high temperature of the water and since the pool functions at high capacity in the winter season.

For a larger number of frogs to utilize a channel, the thermal channel must possess certain features

Table 1. The localization of the investigated thermal waters, thermal habitats with winter-active amphibian species and the number of observed amphibian specimens.

Locality	Type of the habitat	Species and number of counted specimens	
		Bombina bombina	*Pelophylax ridibundus*
Sources of active thermal waters with winter-active amphibians			
Lovrin	Thermal pool channel	-	15
Sâmnihaiu German	Thermal pool channel	13	Over 300
Beba Veche	Thermal wells channel	8	Over 70
Ciacova	Thermal pool channel	-	1
Teremia Mare I	Heating thermal channel	5	Over 250
Teremia Mare II	Thermal wells channel	-	30
Inactive thermal sources, without winter-active amphibians			
Cherestur	Closed thermal well	-	-
Sânicolau Mare	Closed pool (in winter)	-	-
Tomnatec	Closed thermal well	-	-
Cebza	Clogged thermal well	-	-
Biled	Closed pools (in winter)	-	-

to maintain water temperature at long distance. As noted previously, the deeper channels in which the water level is lower than the surrounding areas are favorable to amphibians as they are protected from winds (Covaciu-Marcov et al., 2006). This is also the case in Banat where due to the large area of lowlands, the thermal habitats are even more exposed to winds. Furthermore, the most favorable channels are the ones with relatively natural banks that are slightly above the water level and covered by grassy vegetation. The banks are often used by frogs, which generally leave very warm waters and sit on the grassy banks in close proximity to the heated waters. This phenomenon is observed frequently, especially in areas where the water temperature is higher than 25°C, as reported previously in Romania (Covaciu-Marcov et al., 2006, 2011a), as well as in thermal waters in other areas (Mason 1939, Schaepfer et al., 2007). As it has been observed in Romania and in Algeria, frogs only transitorily reside in very hot thermal waters, preferring to stay on land, on the banks (Mason 1939). Due to Algeria's hot climate, the presence of frogs on the banks has a different value; the actual thermal water probably does not provide a selective advantage to the populations of amphibians. In contrast, winter-active frogs from thermal habitats in temperate climates benefit differently from the uniform and constant thermal regime in the waters they live in. For these amphibians the banks are a very narrow buffer zone, between two areas that have become hostile: the water where the temperatures are too high, and the frozen land where the temperatures are too low. For frogs, a very high temperature is lethal, as it decreases the time before the onset of death (Mason 1939). At Sanmihaiu German we observed only a few frogs in waters that were 40°C. These frogs resided in the water for short spells, while crossing the channel and in case of immediate danger. However, in all cases the majority of the population colonized the channel's segments where the water temperature was between 25 and 15°C. Thus, frogs from thermal waters from the temperate region, manifest to this factor as the ones from the warm area (Mason 1939), only that here there is also a negative factor, the low air temperature.

An example of a habitat where the water temperature and its flow rate, along with its morphology, are not favorable for frogs is the one in Ciacova. Here we observed a single winter-active frog in a 5 meters long and 50 cm wide thermal channel that was located at ground level. The channel flowed after only 5 meters into a 2-3 meters wide permanent channel that was completely frozen during the study. In addition, the thermal water's flow was very low and its temperature was only 13°C which is very close to the minimum point at which *P. ridibundus* stays winter-active (Covaciu-Marcov et al., 2006). At Ciacova, the thermal channel did not house an actual active population but only isolated individuals that arrived in the short thermal channel from the main non-thermal channel in the area, and once they arrive in the warm water they cannot hibernate. In contrast, large thermal habitats as the one from Teremia Mare and especially the one from Sanmihaiu German shelter large and stable populations.

Besides the localities in which we identified winter-active amphibians we also investigated 5 other locations with other sources of thermal waters. In all cases, the thermal waters were not used in the winter season or the wells were clogged, the water flow being practically nonexistent. Therefore, there were no winter-active amphibians. The water temperature of the thermal springs is a factor that stops the frog's from entering into hibernation (Covaciu-Marcov et al., 2006). In the past, in north-western Romania there were cases of thermal waters with high flows and elevated temperature that did not harbor amphibians for reasons related to their specific morphology (Covaciu-Marcov et al., 2010).

All 6 new thermal habitats are the result of human activities. All are situated in or in the immediate proximity of towns or human settlements that affect these habitats in complex ways, including wells that are not used economically on a local scale but by people from surrounding villages. This is the case of Beba Veche where a probe from a pasture outside the village has been transformed by the locals into public showers. The probe was continued with a fitted pipe and showers where the locals wash their clothes and even themselves on warm winter days. Consequently, the thermal channel contains washing products, numerous household wastes, mainly bottles of alcohol. A similar situation is present in Lovrin, where the thermal water's evacuation channel in the pool is located in the town center, containing, aside from household waste, animal carcasses. The frogs survive in these habitats precisely because they spend a lot of time on the banks of the water. Despite the heavy pollution of the water at Beba Veche, the frogs reach large sizes and high numbers.

The thermal habitats from Banat that are under high anthropogenic influencecontain diverse amphibian species. Normally in the thermal waters of north-western Romania 8 species of winter-active amphibians are found (Covaciu-Marcov et al., 2006, 2011a, Sas and Covaciu-Marcov 2007). However, in Banat there are 2 species of frogs: a species typical for lowlands, *B. bombina* (Cogalniceanu et al., 2000), and a common species in Romania, *P. ridibundus*, whose ability to adapt allows for it to expand into new habitats (Sils, 2010). Other cases of amphibian species with large ecological valences in thermal waters have been reported (Oruçi, 2010). The absence of species such as *Rana dalmatina* can be explained by the absence of favorable habitats in Banat's plains. The newts' absence may be a consequence of the penetration of some invasive fish species, such as *Perccottus glenii* in the waters of Banat's plains (Copilas-Ciocianu and Parvulescu 2011, Covaciu-Marcov et al., 2011b). This species which is known for the elimination of newts from water habitats (Reshetnikov, 2003), was recently reported at Sanmihaiu German (Covaciu-Marcov et al., 2011b), one of the best identified thermal habitats from Banat.

The diversity of amphibian species from the thermal waters in Banat is low compared to north-western area of Romania (Covaciu-Marcov et al., 2006). However, in some cases due to the high thermal regime and certain morphological aspects of the habitat, the populations of *P. ridibundus* are extremely large. Despite local particularities, the 6 winter-active amphibian thermal habitats from Banat are added to the previously known 27 habitats (Covaciu-Marcov et al., 2006, 2010, 2011a, Sas et al., 2007), bringing their number to a total of 33. Although some of the oldest habitats have disappeared over time as a result of human activity (Covaciu-Marcov et al., 2006, Sas et al., 2009), the populations of amphibians from the thermal waters of Romania proceed through a separate evolutionary direction that emphasizes the broad ecological valence of the species. Moreover, the regional differences accompanying the emergence of non-hibernating amphibians reveal the value of artificial thermal waters in western Romania.

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