

We cannot hibernate again: new amphibian populations active during winter in the thermal habitats from Western Romania

Severus-Daniel COVACIU-MARCOV^{1*}, István SAS^{1*}, Cornel ANTAL²,
Alfred-Ştefan CICORT-LUCACIU¹ and Mihaela BUNCAN¹

1. Department of Biology, Faculty of Sciences, University of Oradea, Universitatii str.1, 410087 Oradea, Romania

2. Faculty of Energy Engineering, University of Oradea, Universitatii str.1, 410087 Oradea, Romania

* Corresponding authors, S.D. Covaciu-Marcov, e-mail: scovaciu@uoradea.ro, I. Sas, e-mail: isas@uoradea.ro

Abstract. During two cold seasons (between the years 2007/2008 and 2008/2009) we investigated 16 localities with thermal waters from western Romania. We identified *Pelophylax ridibundus* populations that were active during winter in 5 of them (Cheşa, Roşiori, Săcuieni, Cărpiniş and Şimleul Silvaniei), and *Rana dalmatina* was present in one habitat together with this species. The only modification induced by the thermal waters in the case of the amphibian populations from the new thermal habitats is represented by the disappearance of hibernation. The explanation of the absence of active amphibians during winter from the other 11 investigated thermal habitats is provided by their particularities. Thus, in some of the cases the thermal water is turned off during winter, while in other cases the flow of thermal water is insufficient, not being able to adequately warm the non-thermal waters in which they flow into.

Key words: *Pelophylax ridibundus*, *Rana dalmatina*, thermal water, populations, nonhibernating, Romania.

Introduction

Knowing the relation between the environmental factors and the distribution of a species is essential for the conservation of its habitats (Manenti et al. 2009). A present challenge for the conservationist biology is to understand the environmental factors that are responsible for the distribution and the persistence of the organisms in the habitats (Hartel & Öllerer 2009). Knowing the habitats and the requirements of some species towards them allow their suitable protection. Regarding the conservative importance of Romania's herpetofauna, it is a special one, presenting many species with great conservative value (Iftime 2005, OUG 57/2007). Among these, the herpetofauna from north-western Romania can be slightly individualised, due to the existence of important species in many areas (Covaciu-Marcov et al. 2007a,b, 2008a, 2009a). Meanwhile, species of the herpetofauna that have a special history are present here, which have probably survived in the area during the glacial periods (Covaciu-Marcov et al 2009a,b). Together with these, the north-western part of the country can be remarked through the perspective of the amphibians and some special habitats, represented by the thermal ones (Covaciu-Marcov et al. 2003, 2004, 2006, Sas & Covaciu-Marcov 2007, Sas et al. 2007, 2010). The thermal regime of the thermal waters has gradually modified the amphibian populations that

are present here and has determined some modifications to their biology (Covaciu-Marcov et al. 2006). Thermal waters are naturally present in the region, but in the past years the contact of the amphibians with thermal waters has been eased by the anthropogenic activities provided by the economical exploitation of these waters. Thus, the western part of the country stores thermal waters that can be economically directly used for heating (Antal & Roşca 2008, Antal et al. 2009). Although usually the amphibians from the thermal waters do not present a special conservative interest, they hold a high theoretic value, presenting a reproduction manner distinct from the other amphibians (Sas et al. 2010).

Consequently, our study highlights in a premier 5 new thermal habitats in which amphibians are actively present during winter.

Material and Methods

The study was realised during the cold seasons of the years 2007/2008 and 2008/2009. We investigated 16 localities with thermal waters situated in 5 counties from western Romania (Table 1, Fig.1). All of the 16 thermal habitats were visited at least twice during each study year. In each habitat we observed and determined the amphibian species and measured the water temperature, as well as the air temperature. The observed amphibians and their habitats were photographed in all of the cases.

Table 1. The amphibian species that are active during winter in the 14 investigated thermal habitats. (BH- Bihor County; SJ- Sălaj County; SM- Satu-Mare County; TM- Timiș County) (A-E, a-m - locality codes on Fig.1).

Species	<i>Pelophylax ridibundus</i>		<i>Rana dalmatina</i>		
	Cold season	2007/2008	2008/2009	2007/2009	2008/2009
Cărpiniș (TM) [A]	X	X	-	-	-
Cheșa (BH) [B]	X	X	X	X	X
Roșiori (BH) [C]	X	X	-	-	-
Săcuieni (BH) [D]	X	X	-	-	-
Șimleul Silvaniei (SJ) [E]	X	X	-	-	-
Macea (AR) [a]	-	-	-	-	-
Salonta (BH) [b]	-	-	-	-	-
Tinca (BH) [c]	-	-	-	-	-
Tămășeu (BH) [d]	-	-	-	-	-
Mihai Bravu (BH) [e]	-	-	-	-	-
Sărsig (BH) [f]	-	-	-	-	-
Ciocaia (BH) [g]	-	-	-	-	-
Valea lui Mihai (BH) [h]	-	-	-	-	-
Mihăieni (SM) [i]	-	-	-	-	-
Tășnad (SM) [k]	-	-	-	-	-
Beltiug (SM) [m]	-	-	-	-	-

We used the direct visual observation method (Brown 1997), technique which has been previously used at the studies regarding the amphibians from the thermal waters (Covaciu-Marcov et al. 2006). Most of the times, the observed amphibians were not captured, being directly identified. In the other cases, they were caught directly by hand or using a net that was mounted on a long metallic rod. The captured amphibians were released in their habitat of origin after they had been determined and photographed.

Results

From the 16 studied localities with thermal waters we observed modifications of the amphibians' biology in 5 of them, the affected species being *Pelophylax ridibundus* and *Rana dalmatina* (Table 1). We did not encounter active amphibians during winter in the other 11 investigated thermal habitats (Fig. 1). The only species that was present in all of the studied thermal habitats was *P. ridibundus*. The 5 new thermal habitats are represented by localities where the presence of thermal waters has been previously known, these being exploited either through drill holes or swimming pools. Similarly, in the localities in which we did not observe active amphibians during winter, the thermal waters are used for the swimming pools or come from the drill holes used by the locals at different domestic activities. The only influence expressed by the thermal waters upon the amphibians is, in the case of all 5 habitats, represented by the disappearance of hibernation.

The thermal habitat from Cheșa (Fig.2A,C) is situated in the southern part of Bihor County, in Crișuri Valley, at 127m altitude. The habitat is an artificial one, being represented by a canal with thermal waters originated from a drill hole. The thermal waters are used by the locals at different domestic activities. The canal is several hundred metres in length, being surrounded by a pasture. The maximum width of the canal is 1 m, generally slightly surpassing 0.5m. The water depth is of only 20-30cm, exceptionally reaching 0.5m. The aquatic vegetation lacks. The water temperature at exiting the drill hole is 27°C.

The thermal habitat from Roșiori (Fig.2F,G) lies in the north western part of Bihor County, at 25km north of Oradea, in Ier Valley. The habitat is the result of the presence of a drill hole with thermal waters that have a high flow, localised at the margin of the village. The thermal canal has parts where it is bordered by shrubs, as well as areas lacking in vegetation. The length of the canal is of maximum 1m, while the water depth reaches 50cm, the substrate being covered with silt. Only green algae are present in the water, being more abundant in the vicinity of the drill hole. The water temperature is high, reaching 65°C at the level of the drill hole.

The thermal habitat from Săcuieni (Fig.2D,E) is found in the northern part of Bihor County, at an altitude of 105m, in Ier Valley. It is represented by a canal of approximately 2m in width, having steep shores, situated at the outskirts of the locality. The vegetation is rich both on the shores and in the water. The area that is found under the influence of the thermal waters is only

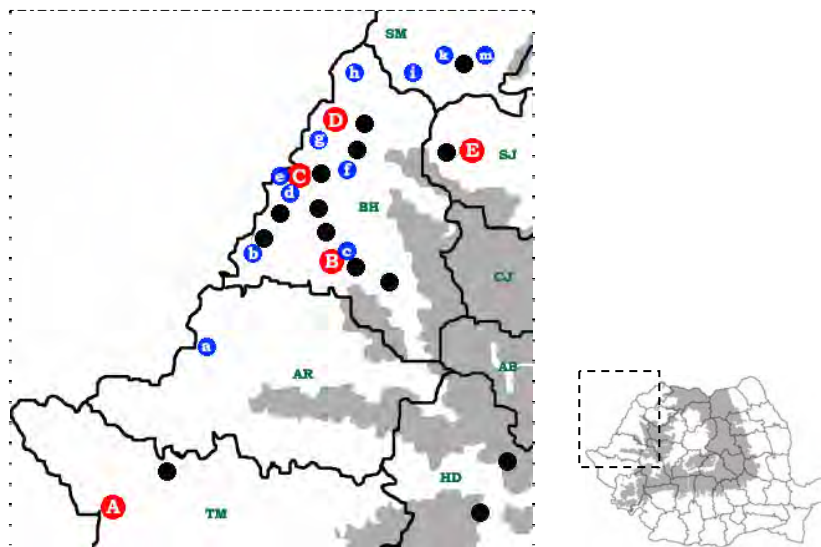


Figure 1. Distribution map of the all thermal habitats from north-western Romania.

Red dots, A-E, represent new thermal habitats with non-hibernating populations of *Pelophylax ridibundus* (A.- Cărpiniș; B.- Cheșa; C.- Roșiori; D.- Săcuieni; E.- Șimleul Silvaniei); **Blue dots, a-m**, represent new possible thermal habitats, without winter-active amphibians (a.- Macea; b.- Salonta; c.- Tinca; d.- Tămășeu, e.- Mihai Bravu; f.- Sărsig; g.- Ciocaia, h.- Valea lui Mihai; i.- Mihăieni; k.- Tășnad; m.- Beltiug); **Black dots** represent thermal habitats known from literature with non-hibernating populations of *Pelophylax ridibundus* (see in: Covaciu-Marcov et al. 2006, Sas et al. 2007) [AR- Arad county, BH- Bihor county, HD- Hunedoara county, SJ- Sălaj county, SM- Satu-Mare county, TM- Timiș county]



Figure 2A-E. Aspects of the newly discovered thermal habitats in North-Western Romania. A-C. the habitat at Cheșa, the drill hole with anthropogenic impact and a dead *P. ridibundus* individual (20.XII.2007); D-E. the habitat at Săcuieni (24.XII.2007).

about 50m in length. Thermal waters are discharged here through two pipes, the rest of the canal being frozen during winter. The water temperature at the level of the shores is only 15°C, as a consequence of the large surface of the canal referred to the reduce flow of thermal waters.

The thermal habitat from Cărpiniș (Fig.2H,I) is situated in the western part of Timiș County, neighbouring Jimbolia town, at an altitude of 81m. The thermal water originates from a drill hole that supplies a thermal canal bordered by agricultural land. In most of its parts the canal is surrounded by thick stretches of reed. The water width is of maximum 0.5m, while the water depth is of 20-30cm. The substrate of the canal presents silt. The water presents green algae, similar to the ones from Roșiori, but less developed. The water temperature at exiting the drill hole is of 30°C.

The thermal habitat from Șimleul Silvaniei is situated near the locality, at 206m altitude. It is a consequence of a thermal swimming pool, being represented by a canal with the width of 3-4m, which was probably present prior to the swimming pool, in which the thermal waters originating from it are being discharged. The habitat is similar to the one from Săcuieni, being wide and deep. The water temperature on the shores is of only 18°C.

Discussions

The 5 thermal habitats newly identified can be added to the other 14 previously known (Covaciu-Marcov et al. 2006, Sas et al. 2007), rising the number of these special habitats from western Romania to 19. These results underline once more that, in the presence of high water temperatures, the amphibians from their level will not be able to go into hibernation, remaining active during winter (Covaciu-Marcov et al. 2006). The number of thermal habitats involving the presence of active amphibians during winter could seem high, but we did not identify active amphibians during winter in most of the localities with thermal waters. Thus, it must be explained why the phenomenon takes place in some of the habitats, while in others the frogs go into hibernation, especially because some of them are similar to the habitats in which the active frogs are present. Meanwhile, in the warm season, in the respective habitats or near them there are present amphibian populations from the same species, which remain active during winter in other habitats. We believe that the explanation for the absence of the amphibians from these habitats is not represented by the frogs, but by certain particularities of the respective habitats, even if they are harder to see at first sight.

The simplest explanation of the absence of active frogs during winter is provided by the absence of thermal water during the cold season. Such situations are registered at the swimming pools that do not function during winter. These types of swimming pools are located in the rural area, where there are not sufficient tourists so as to assure its working during the cold season. The swimming pools that are closed during winter are found in Valea lui Mihai, Mihai Bravu, Salonta and Macea. However, there are swimming pools in the rural area that are used during winter, such as the case of Mădăras, where the frogs are also active during winter (Covaciu-Marcov et al. 2006).

A second situation is the one of the thermal waters with insufficient flow. Such cases can be found at Tinca, Sălsig, Mihăieni and Tășnad. In the respective habitats the water flow is so slow, so the water temperature drops so rapidly that there isn't a long enough thermal segment as to maintain an active frog population during winter. However, the flow of the discharged thermal waters is high enough at the swimming pools from Tășnad and Tămășeu, but in this case they flow into canals or puddles with large surfaces. Thus, the large volume of non-thermal water practically instantly annuls the effect of the thermal waters, its temperature decreasing very rapidly. As a result the affected segment by the thermal waters is very short, not allowing the existence of non-hibernating amphibian populations.

If the above mentioned cases have visible explanations, there are situations in which both the flow of thermal waters and the aspect of the canal are proper for the amphibians and still active populations are not registered during winter. This is the case of the habitat from Ciocaia and Beltiug. Both are canals supplied by drill holes with adequate temperatures of the thermal waters during a sufficient length of the canal. The absence of active frogs during winter can be caused in these cases either by certain particularities of the riverbed, the water chemism, recent pollution episodes, or even the water birds of the locals that can consume the tadpoles. Cases in which some non-hibernating populations had completely disappeared due to the anthropogenic activities have also been signalled in the past (Covaciu-Marcov et al. 2006).

The only species present in all of the localities is *P. ridibundus*, as in the case of the other previously known thermal habitats (Covaciu-Marcov et al. 2006, Sas et al. 2007), *R. dalmatina* appearing only in one locality. Other amphibian species have been occasionally recorded in the thermal waters (Covaciu-Marcov et al. 2006, Sas & Covaciu-Marcov 2007), but these are present only in certain habitats and under special conditions. The presence of *P. ridibundus* in all of the habitats is a natural



Figure 2F-L. Aspects of the newly discovered thermal habitats in North-Western Romania. **F-G.** the habitat at Roşiori with the drill hole (24.XII.2007); **H-I.** the habitat at Cărpiniş, the drill hole and the visible anthropogenic impact (25.III.2009); **J.** the habitat at Beltiug (02.I.2008); **K.** the habitat at Ciocaia (24.XII.2008); **L.** the habitat at Tămăşeiu (24.XII.2008).

one (see in Sas et al. 2009), this being a mainly aquatic species, which is normally found in the water (Cogălniceanu et al. 2000). The species is widely distributed in the western part of Romania (Sas 2009), in comparison to the other two forms from the green frog complex which are present only in some areas (Covaciu-Marcov et al. 2007a, 2009a). Even if *Pelophylax esculentus* was signalled at Săcuieni (Covaciu-Marcov et al. 2008b), it does not appear in the thermal canal. It prefers the wide boggy areas and not the canals with abrupt walls, which are more characteristic to *P. ridibundus*. Moreover, at Săcuieni *P. esculentus* was observed outside of the town, in wide moist areas.

Together with *P. ridibundus*, we found 4 *R. dalmatina* individuals at Cheșa. These were spread only in the sector in which the water temperature was lower, being observed at the water-land limit. An individual was observed in an area where the water temperature was only 5°C, not appearing to be affected by the low temperature. The fact can be related to the species' adaptation to a quick reproduction, during intervals with low temperatures, the beginning of the agile frog's reproduction being connected to the low temperatures from the beginning of spring (Hartel 2005).

The presence in the water of a terrestrial species such as the agile frog is a consequence of the fact that it can hibernate both on land and in the water (Fuhn 1960). Generally, *R. dalmatina* avoids hibernating in the water from large habitats, with fish and aquatic vegetation (Hartel 2005). Both fish and aquatic vegetation lack from Cheșa, thus the agile frogs are not prevented from coming to hibernate in this habitat, fact which cannot be realised due to the water temperature. On the other hand, although it has been rarely identified in the thermal waters during winter, the species' presence in the respective habitats has been set upon the attempt of some individuals to hibernate in the aquatic medium (Covaciu-Marcov et al. 2006). *Rana temporaria* has also been recently observed in the thermal habitat from Răbăgani (Sas & Covaciu-Marcov 2007), its presence being explained in a similar manner.

Two other modifications of the amphibians' biology from the thermal waters have been previously recorded in the scientific literature, beside the disappearance of the hibernation, respectively the continuous reproduction and the appearance of the larvae gigantism (Covaciu-Marcov et al. 2006). We identified only the disappearance of hibernation in the 5 newly identified thermal habitats, which is considered to be the most common modification, being the only one that was previously signalled in all of the cases (Covaciu-Marcov et al. 2006). The explanation of the absence of two of the previously described modifications is held by the particularities of the new habitats. Thus, these are artificial

and generally of small size. Moreover, in all of the cases, the new habitats are represented by flowing waters, where the eventual larvae are rapidly taken to sectors with low temperatures, where they eventually die. Thus, the conditions that are considered to be necessary for the triggering of the more complex biological modifications of the amphibians than the mere annulment of hibernation, are not fulfilled (Covaciu-Marcov et al. 2006). In addition, it seems that the time period necessary for the appearance of the other two modifications is much greater, these being registered in the thermal waters that have been known for a long period, since roman time (Sas et al. 2010), while the 5 new habitats have only several tens of years. Meanwhile, the populations from the new habitats seem to be more reduced than the ones observed in the larger habitats, where the continuous reproduction has been identified. Thus, the most important case was registered at Cărpiniș, where we counted 29 *P. ridibundus* individuals at one transect, in the other cases the populations were even smaller.

It has been observed in the case of other studies that the thermal waters are not tolerated in the same measure by all the amphibian species present in a certain region. Thus, in Albania, only one species from two present in a region tolerates these waters (Oruçi 2010). This does not seem to be our case, the absence of certain species from a specific habitat not being a consequence of their difficulty in adapting to the thermal waters, but to the fact that the morphologic characteristics of the thermal habitats do not match the ecologic needs of the respective species. However, it has been observed that amphibians avoid spending a lot of time in the sectors with very warm waters, being present on the shores on many occasions, including in the days with negative air temperature. This fact has also been previously recorded (Covaciu-Marcov et al. 2006).

The anthropogenic impact upon the five new thermal habitats and upon the amphibians from these is extremely high, being a consequence of their artificial character. Their existence is connected to the people and their usage brings them closer. Thus, domestic wastes are present in all of the habitats (Fig.2A,H). Moreover, at Cheșa and Cărpiniș the thermal waters from the drill holes are used by the locals at washing their laundry or even their cars or agricultural machines. This fact induces water pollution with chemical agents, which sometimes can lead to the death of some frogs, fact that has been observed at Cheșa (Fig.2C). In addition, in the habitats situated inside of some localities, the amphibians are exposed to the contact with the locals' water birds, which consume the tadpoles. Despite of this strong pressure, the populations from the thermal waters fully reflect the great ecological adaptability of *P. ridibundus*.

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