Studies on the influence of thermal water from Western Romania upon Amphibians

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Abstract
Under conditions of high and constant temperatures of thermal waters, aquatic *Amphibian* species can not start hibernating, and therefore remain active in winter time. The influence of thermal water is especially noticeable upon the Marsh Frog *Rana ridibunda*, which is present in all studied thermal habitats, and to a lesser extent, upon the species *Bombina bombina*, which can be found in two habitats. The life cycle of *Rana ridibunda* populations inhabiting five thermal habitats from Western Romania is characterized by lack of hibernation, an early and extended period of reproduction, and an increased frequency of tadpole gigantism. In all of these studied sites the species is able to reproduce successfully. We found giant tadpoles in three of the thermal habitats investigated, but not in other nearby non-thermal sites in the region. Besides *Rana ridibunda*, during winter time we also found isolated individuals of more terrestrial species like *Rana dalmatina*, *Triturus cristatus* and Triturus vulgaris in thermal habitats. These are terrestrial species that hibernate at the level of substratum of aquatic habitats, which is impossible in thermal waters; thus, they remain active in the cold season.

Key words: *Rana ridibunda*, hibernation, giant tadpole, thermal habitats

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INTRODUCTION

Amphibians are dependent on aquatic environments, some species spending their entire lives in the water, while others use it only for reproduction. The influence of aquatic environmental factors on different amphibian species varies.

Temperature has a significant impact on a variety of biological processes, from the cellular level to the population level (Rome et al. 1992). It is an extremely important factor in Amphibian biology (Cogalniceanu et al. 2000). Rome et al. (1992) showed that temperature influences the majority of the biochemical processes involved in amphibian physiology. In general, Anuran tadpoles develop faster in warmer rather than colder waters (Bachmann 1969, McLaren & Cooley 1972, Zweifel 1977).

Thermal wetlands in the Western Romanian Plain are different from other wetlands, the emerging waters having a high and relatively constant temperature. These particular ecological conditions may cause major changes in the life cycle of some aquatic *Amphibian* species, but have received little attention and are poorly represented in the scientific literature, despite the fact that thermal habitats occur in many countries. Previous studies on *Rana ridibunda* from Bâile 1 Mai (Fuhn & Niculescu 1963, Ghira et al. 1997) refer only to the feeding habits of this species, and not to the way it adapts to the ecological situation of thermal ponds.

In the present paper we show the results of our study on the life changes in amphibians caused by the consistently high level of water temperature which makes them much less dependent on the seasonal climatic oscillations typical of this geographic region.

MATERIALS AND METHODS

From 1997 to 2002, we investigated five thermal biotopes situated in North-Western Romania. All are found in Bihor District: Bâile 1 Mai, Bâle Felix, Râbâgani, Livada and Mâdâras. Our preferred work method was to monitor the amphibians in the studied thermal waters; for this reason we went repeatedly to the five selected habitats. In order to point out the alterations induced by the particular conditions of the thermal waters on amphibian reproduction, we monitored mating pairs in amplexus and egg clutches. The number of tadpoles and their size were noted.

The amphibians were not generally captured, their habitats allowing us to observe the amphibians with no direct intervention being required. When we captured some specimens in order to measure or photograph them, this was done directly by hand or using a round net at the end of a 2 meter long telescopic rod which enabled us capture them from the shore. Under some circumstances we used the method of dredging. Tadpoles were captured with a net with small mesh. The captured individuals were released back into their original habitats, thus avoiding any adverse impact upon these special populations. Under some circumstances we measured some collected tadpoles at different periods of the year with sliding calipers.

For determining the physico-chemical parameters of the water (temperature, pH, dissolved oxygen) we used standard equipment (a Consort P 902 pH-meter and a YSI 52 Dissolved Oxygen meter that also measured the temperature).

Observation intervals

Our study lasted 6 years, between 1997 - 2002. During this period, depending on the habitat, observations were made at different intervals of time, some of them weekly and others monthly. During September 1999 - March 2000 the observations were made weekly at Baile Felix and Baile 1 Mai. Weekly observations were made in Bâile Felix between September 2001 - September 2002. In Baile Felix and Baile 1 Mai the studies started in 1997, in Rabagani they started in 1999, and in Livada and Madaras they started in 2000. Between 2001 - 2002, at all five stations the physico-chemical water parameters were measured as well as the air temperature at several locations.

Habitat description

The thermal lakes from Baile 1 Mai, Baile Felix and Rabagani are situated at the contact zone between the Western Subcarpathians and the Pannonic Plain. The thermal lake formed by the Peaea Stream at Baile 1 Mai (47°2'N, 22°3'E) is the most important one in the region, having a surface area of about 1200 ma and high species richness. The maximum depth in the spring area is 3 m, and the average depth is less than 0.5 m; there is a layer of silt of about 15 cm on the bottom. The lake is supplied by one thermal spring with a relatively constant discharge and by a permanent non-thermal tributary with variable flow (Glighii Valley), formed by the waters gathered from the nearby Somleu Hill. In the area surrounding the thermal spring, outlet water temperature is around 31° C throughout the year. During and after rain, cold water inputs from Glighii Valley may induce a temporary decrease of the water temperature down to around 28° C. Around the shores, water temperature varies during winter between 30° C to 20° C, decreasing from the spring outlet. The dissolved oxygen level varies throughout the year from 1.4 to 3.5 mg/l. The pH of the lake is slightly acid, between 6.8 - 6.9, shifting towards basic (7.1) in autumn when aquatic vegetation and the litter that reaches water decomposes. Aquatic plants have invaded the lake waters (*Ceratopteris thalichtroides, Cabomba carolingiana, Lymnophyla sessiliflora*) and are reported to disturb the growth of the relict endemic water lilies (*Nymphaea lotus var. termalis*) (Marrosy 1999).

The natural status of the Baile Felix thermal habitat (47°1 N, 22°0'E) has been severely altered by man. It now consists of four individual basins surrounded by concrete walls, with a total surface of approximately 1400 ma, situated at 150 m altitude. The mean water depth is around 25 - 30 cm, and the pH is a slightly acid 6.6 - 6.8. Water supply is provided through pipes from a unique spring. The thermal waters are considered to be the hottest in Romania, with a discharge temperature of more than 40° C. Inside the basins, because of the relatively low flow, water temperature may drop significantly towards the margins, sometimes below the freezing point during cold days. Generally, it varies between 35° C and 20° C, and the dissolved oxygen varies between 1.2 - 3.5 mg/l. The water surface of all four basins is almost entirely covered by exotic lotuses and native water lilies. The water body is also rich in vegetal biomass (*Myriophyllum sp., Spirogyra sp., etc.*) which offers shelter to amphibians and food for their tadpoles. Amphibians inhabiting the Baile Felix ecosystem are subject to anthropogenic stress as a result of the reduced surface of the basins and their location inside the health resort. In the summer of 2001, several exotic fish species *Molinesia* sp. were introduced into the largest of the four basins (600 m^2).

The thermal habitat at Rabagani (46°45'N, 22°14'E) may be considered as intermediate between the previous two, being only partially impacted by human activities. The thermal pond that initially existed there was transformed into a swimming pool by dyking the spring and building a concrete pool on the other side of the dyke. Presently, the pool is no longer used, and has been emptied, whereas the thermal basin on the other side is overgrown with vegetation

(*Myriophyllum sp., Typha sp., Spirogyra sp., etc.*) and shelters a fauna characteristic of thermal environments. The surface of the basin is of about 300 m2; it has a mean depth of 1.20 m, and a gravelly bottom. The temperature of the thermal spring is around 25° C, but may drop to 19° C towards the margins. The dissolved oxygen level varies between 2.5 and 4.0 mg/l, and the pH of the water is slightly acid (6.7). A deciduous forest nearby has a positive influence on amphibian populations that inhabit its surroundings.

The habitat at Livada de Bihor (47°1'N, 21°18'E) consists of a 100 m long ditch through which thermal water (20 to 30 cm deep) flows. The area is at about 100 m altitude. The hot water is pumped and emerges from the supply pipe at a temperature of 43° C. Presently, these waters are partly drained by the Alceu Stream and by its afferent channels, and also flow inside a basin belonging to a former fish farm. Abundant vegetation, *Salix* sp., *Juncus* sp., *Phragmites* sp., covers the margins, whereas the slow-moving waters of the ditch are rich in green algae. The substrate is covered by a 15 cm thick silt layer.

In Madaras (46°51'N, 22°14'E) we studied the amphibian amphibians inhabiting the canal through which thermal waters are evacuated from the village swimming pool. Madaras is situated 3 km north of Salonta, at approximately 100 m altitude. The canal is about 1 m wide and 50 m long, and the water is 30 cm deep. The bottom is covered by a layer of silt (20 - 30 cm). The vegetation is similar to that found in the Livada de Bihor habitat.

All of the five studied sites are located near human settlements, and are thus subject to the threat of being destroyed by man. The anthropogenic impact varies in intensity, from very intense at Baile Felix, where the frog habitat is situated inside the health resort, to Baile 1 Mai, which is declared a Natural Reserve, being formally protected by law, and to Rabagani, which is less affected, being found in a rural area close to a forest.

RESULTS

The changes induced by thermal waters upon amphibians include: 1. Lack of hibernation, 2. Changes in reproduction biology, 3. Increased frequency of tadpole gigantism. In the studied thermal habitats, five amphibian species were affected by thermal waters, to different extents according to species and habitat.

Tabele 1. Non-hibernating amphibian species in thermal biotopes and years of observation.

Thermal habitat	Species	Year
Băile 1 Mai	*Rana ridibunda*	1997 – 2002
	Rana dalmatina	1998 – 2002
	Triturus cristatus	1999 – 2001
	Triturus vulgaris	2000 – 2001
Băile Felix	*Rana ridibunda*	1997 – 2002
Răbăgani	*Rana ridibunda*	1999 – 2001
	Triturus vulgaris	2000
Livada	*Rana ridibunda*	2000 – 2002
	Bombina bombina	2001 – 2002
Mădăras	*Rana ridibunda*	2000 – 2002
	Bombina bombina	2001 – 2002

Lack of hibernation is the most constant change induced by thermal waters, and this factor results in the occurrence of other changes. In the studied habitats we identified 5 species of Amphibians which are active throughout the cold season: *Rana ridibunda, Bombina bombina, Rana dalmatina, Triturus cristatus* and *Triturus vulgaris*. Most of these species are active during winter in the Baile 1 Mai habitat (Table 1).

Rana ridibunda is the only species which was identified in all five thermal habitats throughout the year, being active regardless of air temperature. In this studied area *Rana ridibunda* is a common species, being widespread in different types of aquatic habitats (Covaciu - Marcov et al 2000). *Rana ridibunda* is present in all thermal habitats we studied, no matter their size, being a highly aquatic species (Fuhn 1960, Cogalniceanu et al 2000). In large habitats like Baile 1 Mai and Baile Felix, frogs are found both in areas adjacent to shores and in the habitat center where they stay at the level of aquatic vegetation, especially water lily leaves. In canal-like habitats, they populate the areas at shore level, sometimes hiding in soil cracks beside the water or in adjacent vegetation. During the winter months when the soil was frozen, we met sporadic individuals outside the water in humid areas heated by warm water near the shore. Frogs probably avoid the canal proper because of the fast-moving water which threatens to be carry them downstream where the effect of thermal water can not be felt, or because of the very high temperatures of the canal water.

Bombina bombina was identified in Madaras and Livada, habitats that are situated in the plain region. In both habitats we found fewer *Bombina bombina* than *Rana ridibunda*, 5 individuals at most at one exit. In Romania *Bombina bombina* is often met in the plain (Cogalniceanu et al 2000), being, like *Rana ridibunda*, a highly aquatic species (Madej 1973), preferring large sized habitats. It is missing from the other studied habitats as a result of its being entirely missing from these regions; in this region its range does not ascend to more than 140 m altitude (Covaciu - Marcov et al 2000).

Besides the two aquatic species constantly present in thermal waters, we also met three species active in the cold season: *Rana dalmatina, Triturus cristatus* and *Triturus vulgaris*. These species are normally aquatic only during the egg laying period, but they also hibernate on the bottom of aquatic habitats.

The Agile Frog *Rana dalmatina* was repeatedly encountered at Baile 1 Mai (December 1998, January 1999, February 1999, November 1999, December 1999, February 2000, and November 2001), numbering as many as seven individuals per day. We suggest that they probably entered the lake to hibernate, but the thermal conditions prevented them from doing so. *Rana dalmatina* is present at Baile 1 Mai, because this habitat is situated in the neighborhood of a forest. Crested Newt *Triturus cristatus* and Common Newt *Triturus vulgaris* appeared accidentally; we found only one individual of the first species at Baile 1 Mai in 1999 and 2000 and two individuals of *Triturus vulgaris*, one at Baile 1 Mai, and one at Rabagani in 2000. One *Triturus vulgaris* was also captured at Baile 1 Mai on January 2001.

Besides these species, *Bufo bufo* also reproduces in Baile 1 Mai thermal habitat, as does *Bufo viridis* in Baile Felix. At Baile 1 Mai, Baile Felix and Rabagani we also found Bombina variegata and *Hyla arborea* in the neighborhood of thermal waters, but they are not often identified in thermal habitats. At Livada and Madaras, *Pelobates fuscus* reproduce in the canals neighboring thermal habitats, and in Livada we found Common Spadefoot corpses which died as a result of thermic shock caused by thermal waters where they came to reproduce. None of these species was ever found during winter time.

Generally, the effect of high and constant temperature levels of thermal waters is manifested upon aquatic amphibian species. However, we met an exceptional situation at Baile 1 Mai, where thermal waters induce modifications even in the biology of a *Reptile* species. Accordingly, we identified here an active sample of *Emys orbicularis* at the end of December 2001, when daily temperatures were negative and the first snow had fallen three weeks before. *Emys orbicularis* is a species found in aquatic habitats (Fuhn & Vancea 1961), being thus subjected to the influence of thermal water like *Rana ridibunda*.

The changes in reproductive biology affecting *Rana ridibunda* were noticed in Baile 1 Mai, Baile Felix, and Rabagani ai Livada. In these habitats *Rana ridibunda* does not reproduce annually, with egg clutches being produced at the end of April (Fuhn 1960); rather, the reproduction takes place all year round. In the thermal habitats of Baile 1 Mai ai Baile Felix, some portion of the population reproduces in each season, so that pairs in amplexus, egg clutches and tadpoles of different ages were found all the year round.

Pairs in amplexus were encountered in January 2000 at Rabagani and Baile 1 Mai, and in the second half of March 1999 at Baile Felix. At Baile Felix, in January 2002, under the conditions of negative daily temperature, up to 20 pairs were noticed in amplexus. These pairs are commonly met on calm days, no matter what the air temperature.

Freshly laid egg clutches of *Rana ridibunda* were observed at Baile Felix and Baile 1 Mai in February 2000. During October 2001 - September 2002 we found egg clutches every month in Baile Felix, in some cases for several weeks on end. There were situations when we counted tens of them at one time.

In the thermal habitats of Baile Felix ai Baile 1 Mai, tadpoles of *Rana ridibunda* can be found all year round, no matter the season. In some cases we collected, at the same time, tadpoles of different sizes and so of different ages (Figure 1). These tadpoles come from different egg clutches, this being an argument for continuous reproduction of some of the population. In Baile 1 Mai ai Baile Felix we met tadpoles, no matter the season, in the period between 1999-2002. In Rabagani we identified only once tadpoles outside the period during which they are usually found, in February 2000, when we identified tens of 1 cm long tadpoles. Later this part of the habitat was changed into a swimming pool.

Giant tadpoles were recorded in the thermal habitats at Baile Felix and Baile 1 Mai. This condition is characterized by hypertrophy of tadpole sizes from the normal maximum of this species (8.8 cm - Fuhn 1960) to 9.5 - 12 cm (Figure 2). We encountered 30 giant tadpoles in June 1998 at Baile Felix and many more during July-August 2000. At Baile 1 Mai, we observed giant tadpoles on two occasions in April 2000 (9.5 and 10.2 cm long). In the two habitats tadpoles longer than 8.8 cm were identified in the warm seasons of 2001 and 2002. The fact that we did not meet gigantic tadpoles in Livada and Madaras is explained by the fact that the habitats here are canals with low water levels but high water speed; thus the tadpoles were swept away downstream.

In addition to these modifications induced upon some highly aquatic species, thermal waters also influence terrestrial species which only reproduce in an aquatic habitat. The Common Toad *Bufo bufo*, a mainly terrestrial species, reproduces up to three weeks earlier than usual in the thermal ponds at Baile Felix

Figure 1. Tadpoles of different sizes found on February 26th 2000 in the Baile Felix thermal habitat

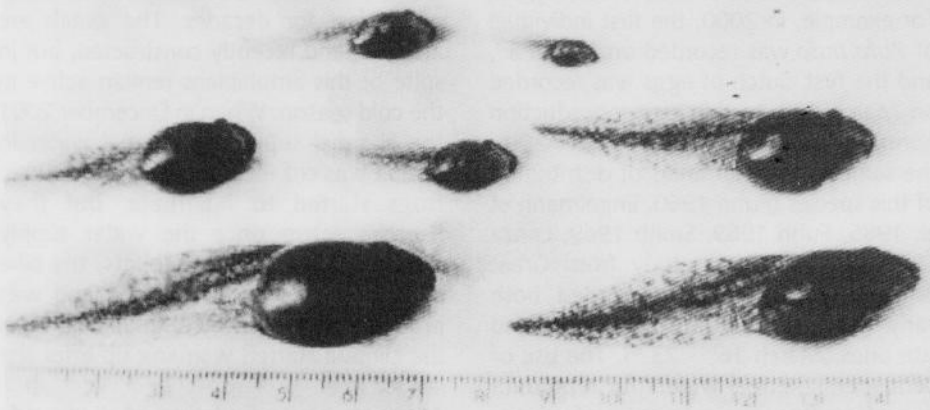

Figure 2. Gigantic tadpole found at Baile Feli on June 3rd 1998.

and Baile 1 Mai. We mentioned that several non-thermal ponds that could potentially be used for reproduction by *Bufo bufo* situated in the vicinity of the thermal habitats are never used in this regard. For example, in 2000, the first individual of *Bufo bufo* was recorded on March 3rd, and the first clutch of eggs was recorded on March 12th. In this area reproduction normally occurs only after March 20th, the same as in other areas of distribution of this species (Fuhn 1960, Engelmann et al. 1985, Fuhn 1969, Smith 1969, Lanza 1983). In a 19-year study from Great Britain, Reading (1998) recorded both early clutches (February 2 - 1- th) and late ones (March 16th - 23 rd). The use of permanent thermal waters for reproduction offers this species a series of advantages including higher water temperature and abundance of vegetal food, both allowing for fast tadpole growth.

DISCUSSION

Temperature is an important factor in triggering hibernation in amphibians, the water temperature being most important for aquatic species. Because of this, the effect of thermal water manifests itself especially on aquatic species whose entire life cycle occurs in water. The most severely affected are *Bombina bombina* and *Rana ridibunda*, which are active in winter time in all habitats they populate. Of the three taxa that form the *Rana esculenta complex*, *Rana ridibunda* is the most aquatic species, and prefers to hibernate in the water, unlike *Rana lessonae*, which hibernates only in the ground (Berger 1982).

Five thermal habitats were investigated. In all regions with thermal water over 10° - 15°C in winter time and where the habitats correspond to the ecological requirements of *Rana ridibunda*, this species will probably be active in the cold season. Amphibians that are active in winter time in the thermal habitats studied can not hibernate as a result of the water temperature. This fact is demonstrated by the existence of non-hibernating populations in Livada and Madaras. The two habitats are the effect of anthropical activities which last for decades. The canals are artificial, and recently constructed, but in spite of this amphibians remain active in the cold season. When in December 2001 the channel supply of thermal water in Livada was cut for a short period of time, frogs started to hibernate, but they became active once the water supply resumed. Unlike these habitats, the lake at Baile 1 Mai is much older, and was probably populated by amphibians when the climate started warming up after the last ice age.

Although any population of *Rana ridibunda* which can be found in thermal waters will probably remain active in winter time, it seems that these populations show some functional modifications, too. In Madaras, *Rana ridibunda* and *Bombina bombina* populate areas where water temperature is higher than 30°C. If some samples from normal habitats arrive in these areas, they experience thermic shock characterized by quick and irregular movements, falling to the bottom of the water in a few seconds. Frogs probably populated the thermal canals going upstream and thus slowly became used to the new conditions. Sudden contact with thermal waters can be fatal to non-thermal habitat samples, which is proved in spring by corpses of *Pelobates fuscus* or *Triturus cristatus* which come to reproduce in waters that exceed 25 - 30°C. In Baile 1 Mai and Baile Felix, water temperature near shore reach 20°C at the most, allowing reproduction of terrestrial species.

To a lesser extent, thermal waters affect terrestrial amphibians in two ways, depending on their connection to the aquatic background. Species hibernating in substrata of aquatic habitats, like *Rana* *dalmatina, Triturus cristatus* and *Triturus vulgaris*, are more affected. Some samples of these species come in autumn to hibernate in thermal habitats, but in contact with high water temperatures this is not possible, and they remain active during the cold season. Thermal waters also have a weak influence regarding the quickening of egg laying and choice of habitat for egg laying upon species that only reproduce in water.

If lack of hibernation can be considered a direct consequence of frog contact with thermal waters, to disorganize the period of egg laying requires more factors. We found populations with continuous reproduction only in natural habitats, of large dimensions, with stagnant or slow running water. In order to show reproductive modifications, the population must probably spend a longer period in thermal water conditions.

Water temperature, a determinant factor for egg-laying in *Amphibian* physiology, is not a limiting factor in the quasi-uniform conditions of thermal lakes. Different individuals of the studied populations reproduce at various times, a fact proved by the series of larvae of different stages simultaneously present in the same biotope that come from clutches deposited at different time. In the south of Italy, Rastogi et al. (1983) discovered that *Rana esculenta* may deposit up to three clutches a year, while in Greece *Rana ridibunda* may reproduce up to two times a year (Kyriakopoulou-Sklavonou & Loumbourdis 1990). In the climatic conditions characteristic of Romania, only one clutch is normally deposited in one year. Multiple clutches per year occur only in thermal habitats in Western Romania, those offering a rich and accessible trophic supply during the cold season to adults (Covaciu - Marcov, unpublished data).

Even though dissolved oxygen concentration in thermal waters is low (1.4 - 3.5 mg/l) in comparison to other non-thermal ponds, *Rana ridibunda* tadpoles not only survive, but they develop well, and may reach very large sizes. The cause for gigantism in tadpoles is probably related to the thermal regime and the rich algal phytomass during summer that represents the trophic base of the tadpoles, offering them optimal conditions for developing. The absence of giant tadpoles during the cold seasons could be explained by the reduction of food availability in winter (algal and macrophyte biomasses are very low in this season) or by other unknown causes. Giant tadpoles (11 - 12 cm, 7 individuals) have also been encountered in another thermal habitat at Geoagiu Bai, Hunedoara district (Ghira, unpublished data, Hunedoara County Museum).

Larval gigantism in Rana ridibunda was previously recorded in the literature (Angel 1946, Borkin et al. 1982, Dély 1967, Engelmann et al. 1985, Lanza 1983, Smith 1969). Some authors (Engelmann et al. 1985, Smith 1969) consider that gigantism is an effect of thyroid deficiency, while others (Lanza 1983) argue that gigantism is only present in triploid hybrids of *Rana ridibunda* x *Rana lessonae*. Borkin et al. (1982) point out the main factors that, in their opinion, may cause tadpole gigantism: geographic variation, overpopulation, polyploidy, temperature and light conditions, hibernation, and hormonal control. Based on the fact that giant tadpoles have been encountered throughout the species area of distribution, they conclude that temperature cannot be the only cause for larval gigantism. Because in Romania, giant tadpoles have been reported until now only in thermal habitats, and since the presence of *Rana lessonae* was not confirmed in any of the studied sites, we suggest that the appearance of giant tadpoles is caused by the specific conditions of the thermal waters.

Regarding the influence of dissolved oxygen concentration on tadpole development, our results do not confirm the hypothesis of Berger (1982) that Rana ridibunda tadpoles are highly sensitive to low oxygen levels. Results similar to our own were obtained by Plenet et al. (1998) in a controlled laboratory experiment on Rana ridibunda tadpoles in which they found that survival rates, growth and development of tadpoles are not influenced by a highly fluctuating oxygen regime. When hypoxic conditions develop, behavioral responses include increased activity levels, increased respiratory frequency, and efficiency of oxygen extraction through the gill membrane (Burggren et al. 1983). Tadpoles of several frog species can develop functional lungs before metamorphosis (Duellman & Trueb 1986). If lungs are present, hypoxic conditions may lead to an increase in the aerial respiration frequency (Wassersug & Seibert 1975). The oxygen obtained through aerial respiration may reach 100% of the oxygen consumed by the tadpoles under hypoxic conditions (Feder & Wassersug 1984).

For amphibians, and especially for *Rana ridibunda*, thermal waters are a kind of laboratory, natural (Baile 1 Mai) or artificial (Madaras and Livada). Amphibian populations present a series of particularities that distinguish them from all other populations in non-thermal habitats in the region. In spite of this, thermal habitats are fragile, being situated in regions anthropically affected, especially tourist resorts, where human impact is very pronounced. Habitats were polluted with oil products and affected by dam construction. The fragility and uniqueness of thermal habitats render them special candidates for environmental protection, not just for the presence of relict species (*Nymphaea lotus var. termalis*), but also because they are "laboratories" which allow the study of *Amphibians*' response to changed environmental conditions. These studies could clarify aspects connected to reproduction and the life cycle of *Amphibians* and the extent of their dependence on environment factors. However, in some situations, human activities can lead to the appearance of non-hibernating populations (Madaras and Livada), these involuntary experiments leading to the understanding of mechanisms that form non-hibernating populations.

CONCLUSIONS

The influence of thermal water upon amphibians populations is manifested primarily by lack of hibernation. In the five thermal studies habitats studied, the following species remain active during winter time: *Rana ridibunda, Bombina bombina, Rana dalmatina, Triturus cristatus and Triturus vulgaris.* Those most affected by the conditions of thermal habitats are the aquatic species which have their whole life cycle at this level, while the terrestrial species that hibernate in water are less influenced. *Rana ridibunda* is especially affected because, besides lack of hibernation, we also noticed dislocation of the egg laying period and the occurrence of gigantic tadpoles. In Baile Felix ai Baile 1 Mai, *Rana ridibunda* reproduce all the year round.

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