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On the absence of *Rana dalmatina* from the Ciuc basin, Romania

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Abstract. *Rana dalmatina* was recorded from the Ciuc basin, Romania by two papers and from two localities. In this paper we synthesize the distribution data available for this species within the basin and in its neighbourhood. Based on our quantified sampling effort we consider that there is not enough evidence for the presence of this species in the basin. We consider that this observation can help in the understanding of the ecology of this species.

Key words: *Rana dalmatina*, Ciuc basin, sampling effort, biogeographical barriers

Introduction

The agile frog (*Rana dalmatina*) is a widespread species in Europe (Gasc et al. 1997). In Romania it occurs at elevations between 0-900 m above sea level, in or near deciduous forests (Fuhn 1960, Cogălniceanu 1991, Ghira et al. 2002, Covaciu-Marcov et al. 2006b). However, it has also been recorded in areas of high humidity and abundant vegetation, but without a forest cover (Covaciu-Marcov 2004). Its breeding localities include a wide range of aquatic habitats from temporary to permanent ponds and deeper sections of streams, with an observed preference towards well vegetated areas (Covaciu-Marcov 2004, Hartel et al. 2006, Hartel et al. 2007).

Although the distribution of *R. dalmatina* in Romania is relatively well documented on a large scale (Fuhn 1960, Cogălniceanu 1991, Ghira et al. 2002, Covaciu-Marcov 2004, Covaciu-Marcov et al. 2006 a, b), very little information is available on its small scale distribution and population sizes. Long term data on the dynamics of a *R. dalmatina* population are available from only one locality in the Târnava Mare valley (Hartel 2004, 2005). However, small scale data would be vital for the conservation of this species, given that it is listed as vulnerable in the Romanian Red List of Vertebrates (Iftimie 2005), strictly

protected according to the Romanian legislation (Law nr. 462/2001) and endangered according to the Bern Convention (Annex II).

The Ciuc basin is one of the large tectonic mountain basins of the Eastern Carpathians (Coteţ 1973). With a minimum altitude of 640-700 m, it is theoretically within the recorded limits for *R. dalmatina* in Romania. Ghira et al. (2002) and Mara et al. (1999) mention this species from two localities of the basin. However, Demeter et al. (2006) did not find the species in the basin.

In this paper we synthesize the available distribution data in the basin and its surroundings, present our sampling effort between 2004 and 2006 and propose several hypotheses to explain the apparent absence of this species from the basin.

Materials and methods

Research area

The Ciuc basin is one of the large tectonic mountain basins of the Eastern Carpathians, characterized by a large alluvial-proluvial accumulation surface (Coteţ 1973). It has a minimum altitude between 640 m (Tuşnad Nou) and 700 m (Sândominic), and is surrounded by 1000-1800 m high mountains (Fig. 1). The lowest passes in the surrounding mountains are the Tuşnad gorge (630-640 m) (Fig. A) to the south, the Casinu pass (875 m) to the southeast, the Vlăhiţa pass (950 m) (Fig. B) to the west and the Izvoru Mureş pass to the north (850 m). The surface area of the basin is approximately 1400 km^2, of which approximately 15% is between 640-700 m, and 50% is between 640-900 m (Fig. 2). The mean annual temperature is between 3.8-7.6^{o}C in the basin, and the amount of annual precipitation is between 406.4-852.7 mm (calculated from data collected between 1955 and 2002 by the Meteorological Station of Miercurea-Ciuc).

Forests cover 33.5% of the whole basin, with spruce forests above 1100 m and mixed spruce-beech forests between 900-1100 m (Russu 2004). Deciduous forests (mostly beech *Fagus sylvatica*) cover very small areas and below 700 m forests are lacking due to historic deforestation. The prehistoric vegetation of the lower altitude areas of the basin was probably deciduous forest, as indicated by isolated patches of mixed deciduous forest containing *Tilia chordata* and *Quercus robur* (e.g. Jigodin-Băi; Russu 1998), scattered individuals of *Q. robur* on the terraces of the Olt river (Demeter pers. obs.) and by numerous toponyms with the name „Csere"=Oak forest (Csomortáni 2001) that are today hay meadows or arable land.

Survey methods

The regular mapping and monitoring of brown frog populations and breeding habitats in the basin was started in 2004 (Demeter et al. 2006, Hartel et al. 2006), but observations on one site were made from 1999 (Demeter 2004). During the surveys, brown frogs were identified based on adult morphology (Fuhn 1960) and male vocalization (personal experience). The differrentiation between the egg clumps of these species is also possible, but not unambiguous; therefore in this paper we consider only adult observations (morphology and call). The surveys were performed in the main breeding season of brown frogs in the low altitude areas of the Ciuc basin, from the end of March to mid

April, and they involved day and night surveys at sites with potential breeding habitats, i. e. every type of standing water bodies. A visit to a site lasted up to 4 hours, depending on the number and density of potential breeding habitats. In order to quantify sampling effort we calculated:

- the number of survey days (days of survey on at least one site) in a breeding season, i.e. from the first observation of frog breeding activity to the last;

- the number of habitat checks (a habitat was checked once during a visit, and up to 16 times during a breeding season);

- the total number of potential breeding habitat visits;

- the number of frog records (the number of observations of frog presence, based on morphology or call during a habitat visit, independent of abundance).

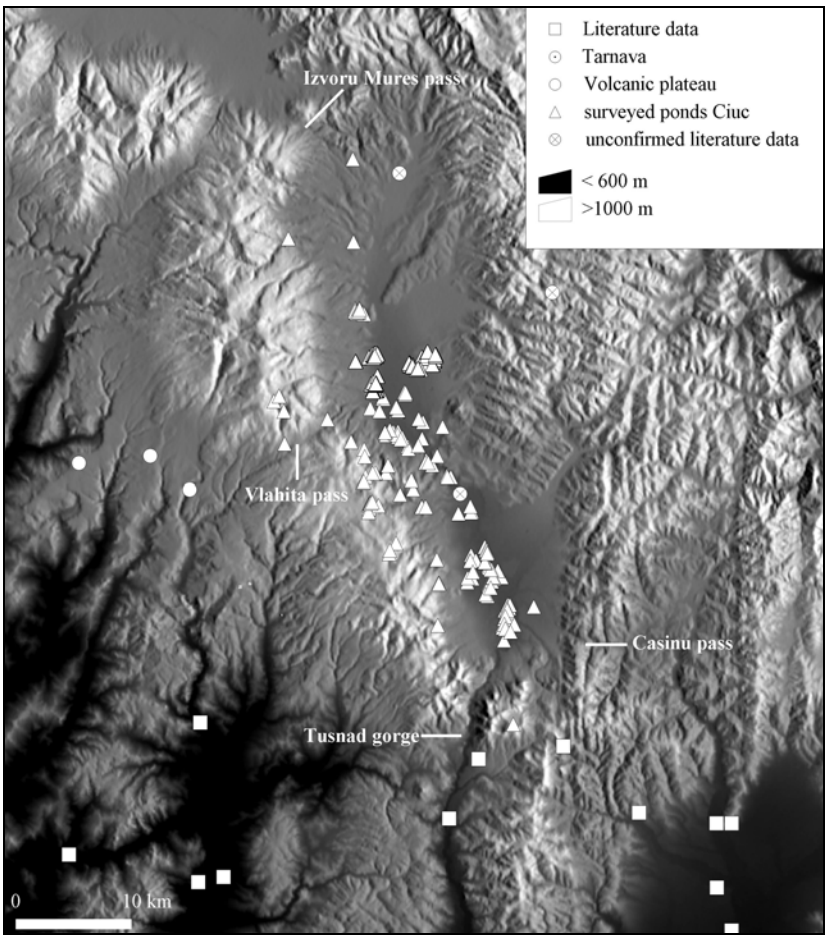

Fig. 1. The topography of the research area with the accepted and unconfirmed literature data (Ghira et al. 2002) and own records of *R. dalmatina.* The lowest passes are highlighted.

The geographic location of every habitat was recorded with a handheld GPS. Data were visualized with the Manifold software, version 6.00. For vegetation cover we used the Corine 2000 Land Cover Map (Corine land cover, Romania, DDNI, 2004).

Results

Sampling effort

The breeding activity of *R. arvalis* and *R. temporaria* was observed between March 20 and April 5 in 2004, March 23 and April 8 in 2005 and March 28 and April 11 in 2006. Surveys were made on 14-17 days and totalled between 140 and 235 habitat visits per season. We visited nine to 13 sites per season, and the number of frog records ranged from 31 to 43 for *R. temporaria* and five to 28 for *R. arvalis* (Table 1). The number of visits per sites varied between one and 16, and the mean number of visits per sites was 2.89 in 2004, 3.38 in 2005 and 3.09 in 2006. *R. dalmatina* was not found during these surveys.

Spatial distribution of the surveyed habitats

The surveyed sites are situated between 640 and 720 m above sea level (Fig. 2) and comprise the areas with the highest known potential breeding habitat density in the Ciuc basin (Demeter unpublished data). Further surveys were made in higher altitude areas of the Ciuc basin (Fig. 2, 3).

From the two localities mentioned in the literature, Sâncrăieni was visited several times, and around 20 potential breeding habitats were checked both to the north and to the south of this locality. We detected only *R. arvalis* and *R. temporaria*. A few habitats in the surroundings of Tomeşti were checked during 2004, *R. dalmatina* was not detected.

Table 1. Descriptive data of survey effort and frog records between 2004-2006

	2004	2005	2006
duration of breeding activity (days)	17	17	15
number of survey days	15	17	14
number of sites visited	9	13	11
number of habitat visits	141	235	140
R. arvalis records	5	28	10
R. temporaria records	36	48	57

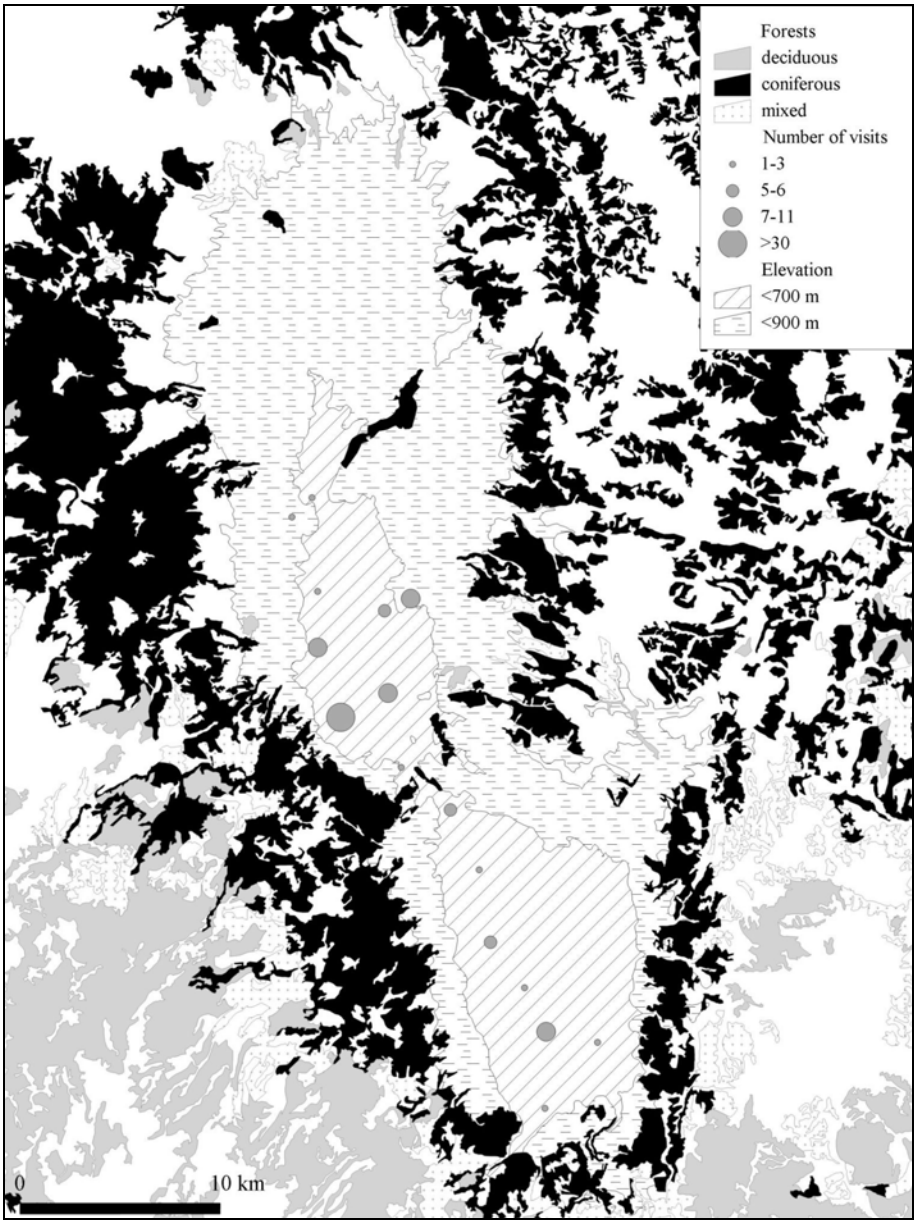

Fig. 2. Distribution of surveyed sites and survey effort (total number of visits in three years) in the low altitude areas of the basin.

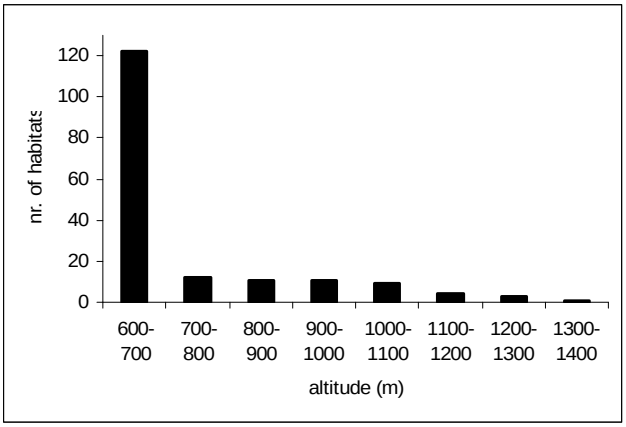

Fig. 3.
Altitudinal distribution of surveyed habitats in 2004.

Discussion

The quality of literature data

In their paper about the distribution of Transylvanian herpetofauna, Ghira et al. (2002) mention the presence of *R. dalmatina* from two localities in our study area. In the Ciuc basin, the species is mentioned from Sâncrăieni (650 m) and Tomeşti (730 m). One further locality, Făgeţel (1150 m), on the eastern border of the basin is also mentioned (Fig. 1). Mara et al. (1999) mention the species only from Sâncrăieni. Ghira et al. (2002) list the species from almost 40 localities within the Gheorgheni basin (a mountain basin similar to and north from the Ciuc basin, with an altitude above 700 m).

Both cited studies provide presence-absence data on the settlement level for Transylvania, but none of them provide information about the habitats, population sizes or survey effort. Most probably the abundant data on *R. dalmatina* in the Gheorgheni basin (the species is mentioned from almost all localities of this area) were misidentifications (Gál pers. com.). Our observations in the Gheorgheni basin (in 2005 and 2006 around 60 potential breeding habitats surveyed near Ditrău and Remetea in the breeding season) did not confirm the presence of this species (Demeter unpublished data). On the other hand, we accept the data provided by Ghira et al. (2002) for the areas south and southwest from the Ciuc basin (the Braşov basin, the Baraolt basin, lower Homorod valley), as these areas include typical *R. dalmatina* habitats (i.e. deciduous forests with high humidity) (Fig. C-F) and our personal observations confirmed the presence of this species.

No published data are available for the areas immediately to the west from the Ciuc basin. In 2006 April we made a one-day survey of an area situated on the volcanic plateau of the Harghita mountains (Fig. 1). We identified three breeding habitats of *R. dalmatina* (with up to 36 egg clumps per pond), at 844 m altitude (Fig. D, E), and in 2006 May we found the species in deciduous forests near Vlăhița Băi, at 830 m altitude.

West from the volcanic plateau, in the Târnava Mare valley, the distribution of amphibians is well documented and *R. dalmatina* was found to be the most frequent anuran species (Hartel et al. 2006) (Fig. F).

The problem of sampling effort and the probability of detecting presence

Detectability depends on many factors including the life history of the species, life stage, population size, environmental conditions at the time of survey (e. g. condition of the habitat, temperature) etc. Adults are generally easier to find during reproduction due to the fact that they are concentrated in the breeding habitats and due to the species-specific vocalisations of adult males.

Gooch et al. (2006) found that multiple visits to a site increase detection probability more than increasing the amount of time spent on each site during a visit. An eight year study conducted on a permanent pond in the Târnava Mare valley showed that the number of visits per site and the number of years for which a given habitat is studied are important in detecting locally rare amphibian species, like *Bufo viridis* (identified in three years), *R. arvalis* (two years) *Bombina variegata* (one year). Put simply, rare species or species that infrequently use a specific habitat were much more difficult to identify (Hartel 2004).

The weather and the condition (availablility of water and degree of humidity) of terrestrial and breeding habitats may influence the activity of anurans. In the Ciuc basin *R. arvalis* and *H. arborea* were detected in more habitats in wet years than in dry years (Demeter & Mara 2006, Demeter pers. obs.).

Our sampling effort in the Ciuc basin consists of three years of observations in the peak breeding season on low altitude areas (<700 m) with high densities of potential breeding habitats, and eight years of survey on one site near Miercurea-Ciuc. In addition to this, around 50 habitats were surveyed in higher altitude areas of the Ciuc basin, but the effort spent on higher elevations is much smaller. However, we sampled what we know as the best potential breeding habitats of anurans in the Ciuc basin (the areas with the highest known breeding habitat density).

Further thoughts

Given the altitude of the area and the previous literature records of this species from two localities, the fact that we failed to detect this species' presence is surprising. Also, it is very interesting that a few kilometers away from the geographical borders of the basin, at Bicsad and Vlăhița, the species is present. The breeding habitats identified at Vlăhița are situated at an altitude 200 m higher than the lowest habitats of the Ciuc-basin (840 m vs. 640 m).

Theoretically, there are two possibilities regarding the presence of *R. dalmatina* in the Ciuc basin:

(i) The species is present in the basin, but it was not detected by us. To verify this, we suggest a more intense survey on the contact areas of the basin with the neighbouring areas where the presence of the species has been confirmed, i. e. on the southern and western borders of the basin.

(ii) The species is absent from the basin, as the available data suggest. The potential factors that keep the species from colonizing the basin: the relatively high mountains that surround the area except one point (the Tuşnad gorge), the cold climate of the basin, and the lack of deciduous forests inside the basin.

The Tuşnad gorge is a roughly 10 km long gorge that connects the Ciuc basin with the Braşov basin to the south (Fig. A). *R. dalmatina* is present immediately to the south from the gorge (Fig. C), but it was not detected by us inside it and on its northern side. The climate of the gorge is cold, as indicated by vegetation: the lower parts are covered by coniferous forest made of *Abies alba* and *Picea abies* due to thermal inversion, while higher parts are covered by mixed spruce-beech forests. The amount of potential breeding habitats is small in the gorge, being mostly restricted to the narrow floodplain of the Olt river. The steep slopes that dominate the valley with a relative altitude up to 500 m (Schreiber 1994) are not favorable for the formation of standing water bodies.

The cold climate of the basin may be another possible reason for the absence of *R. dalmatina.* The basin is known from its thermal inversions especially during winter, resulting in minimum monthly average temperatures of under -10°C and mean monthly average temperatures of under -5°C for three winter months (December-February, calculated from data between 1955-2002). However, the lower altitude areas of the basin fall between the isotherms of 6 and 8°C, while the areas surrounding Vlăhița where the species is present are between the isotherms of 4 and 6°C (Badea et al. 1983), suggesting

Fig. A. *R. temporaria* breeding habitat near Vrabia (640 m)
on the floodplain of the Olt river, in the background the Tuşnad-gorge

Fig. B. View on the Vlăhiţa pass from the Ciuc-basin (northeastern view)

Fig. C. *R. dalmatina* breeding habitat near Bicsad (657 m)

Fig. D. *R. dalmatina* breeding habitat near Băile Homorod (844 m)

Fig. E. *R. dalmatina* and *R. arvalis* breeding habitat near Băile Homorod (844 m)

Fig. F. *R. dalmatina* breeding habitat near Dumbrăveni (Târnava Mare valley, 380 m)

Fig. G. *R. temporaria* breeding habitat near Miercurea-Ciuc (657 m)

Fig. H. *R. temporaria* and *R. arvalis* breeding habitat near Delniţa (697 m)

that the temperature of the basin is not a limiting factor for this species. Furthermore, another frog species typical of warmer climate, *Hyla arborea*, is present in the low altitude areas of the Ciuc basin (Demeter et al. 2006).

The lack of forested vegetation in the low altitude areas of the basin (see Fig. G, H) is a third potential limiting factor, as *R. dalmatina* is generally considered a deciduous forest species,

although in north-western Romania it has been found in landscapes lacking forests (see Introduction).

Although competition may result in the exclusion of some species from optimal habitats as suggested by Riis (1988) for the case of *R. temporaria* and *R. dalmatina* in Southern Scandinavia, this is less probable in our study area, as all the anuran species that were recorded in the Ciuc basin were recorded in the low altitude areas of the basin, and the largest populations of all anurans in the study area were found below 700 m (Demeter et al. 2006, Demeter unpublished data).

However, even if the species is currently missing from the basin, there is no reason to believe that this was always the case. It is highly probable that in the warm postglacial ages *R. dalmatina* colonized the basin. If we accept this idea, an interesting question arises: when and why did it go locally extinct? As the paleontological record on recent anurans in Romania is poor (Venczel & Damm 2000), this problem is difficult to discuss. The prehistoric vegetation of the low altitude areas of the Ciuc basin was probably deciduous forest (see Methods: Research area). A dramatic change of the tree cover of the basin happened only in the last few centuries, oak forest patches disappeared from the basin probably before 1562 (Russu 2004).

Conclusions

Based on the available data we consider that there is not enough evidence to prove the presence of *R. dalmatina* in the Ciuc basin. Further surveys should be conducted in the "contact areas" of the basin with areas where the presence of the species is confirmed. These areas are the Tuşnad gorge, the eastern part of the Ciomatu mountains and the areas west from the Vlăhița pass. In the event that further surveys fail to identify the species in the basin, we suggest that local topography (acting as a geographical barrier), climate (especially at the borders of the basin, and combined with topography) and vegetation (the lack of deciduous tree cover inside the basin) are potential causes of its local absence. If the lack of deciduous forests is an important factor, a relatively recent local extinction of the species from the basin is suggested.

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