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Distribution and conservation status of amphibians in the Ciuc basin, Eastern Carpathians, Romania

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Verbreitung und Schutzstatus der Amphibien im Ciuc-Becken, Ostkarparten, Rumänien

Das Vorkommen der Amphibien im Ciuc-Becken und seiner Umgebung in den Ostkarpaten wurde untersucht. Zwölf Arten wurden beobachtet: sieben Frosch- und fünf Schwanzlurcharten. *Bombina variegata*, *Rana temporaria* und *Bufo bufo* haben eine weite Verbreitung, auch auf die Höhenlage bezogen, während *Rana arvalis*, *Hyla arborea* und der *Rana esculenta*-Komplex eine enger begrenzte Höhenverbreitung aufweisen. *R. arvalis* und *H. arborea* sind auf wenige Fundorte beschränkt. Die Molche sind im Allgemeinen ziemlich weit verbreitet. *Triturus cristatus* und *T. vulgaris* sind bis 1000 m NN zu finden, *T. montandoni* und *T. alpestris* fehlen unterhalb 800 m NN. Die wenigen Vorkommen und die beschränkte Höhenverbreitung von *Rana arvalis* und *Hyla arborea* weisen sie als die am meisten gefährdeten Arten aus, die spezielle Schutzmaßnamen brauchen.

Schlüsselbegriffe: Amphibia, Verbreitung, Höhenverbreitung, Populationsgrößen, Schutzmaßnamen, Ciuc Bassin, Rumänien.

Abstract

We made a survey of amphibians and their breeding habitats in the Ciuc Basin, Eastern-Carpathians. Twelve species of amphibians were identified, seven anurans and five urodelans. *Bombina variegata*, *Rana temporaria*, and *Bufo bufo* have a wide altitudinal and spatial distribution, while *R. arvalis*, *Hyla arborea* and *R. esculenta* complex have a narrow altitudinal distribution. *R. arvalis* and *H. arborea* populations are localized to a few sites. Newts are relatively widespread. *Triturus cristatus* and *T. vulgaris* occur up to 1000 m, *T. montandoni* and *T. alpestris* are absent from altitudes below 800 m. Based on their narrow altitudinal and spatial distribution and low frequency we consider that *Rana arvalis* and *Hyla arborea* are the most vulnerable on the local level.

Key words: Amphibians, spatial and altitudinal distribution, population size, conservation, Ciuc basin, Romania.

1 Introduction

The first step in developing a conservation plan for amphibians at the local or regional level is to get detailed data about the distribution of their breeding habitats and popu-

lation sizes. The mapping of amphibian distribution at a European level was done using 50 x 50 km grid squares (GASC et al. 1997). In Romania the mapping of amphibians was made on the national level in 10 x 10 km UTM grid squares (COGĂLNICEANU et al. 2001), while a regional inventory in Transylvania used local administrative borders for mapping (GHIRA et al. 2002). These studies included records collected over a large time range, the smallest units were human settlements, and the data were presence-absence data. However, to obtain spatially and temporally comparable data, habitat-based studies are needed. Studies of amphibian distribution using a habitat based approach were only recently published in Romania, for the Retezat-mountains (COGĂLNICEANU et al. 2001), Târnava Mare valley (HARTEL 2004), Beiuş area (COVACIU-MARCOV et al. 2003) and Ciuc Basin (DEMETER 2004, MARA & DEMETER 2005).

There is limited information on the distribution of amphibians in the Ciuc Basin (FUHN 1960, STUGREN 1966, MARA et al. 1999, GHIRA et al. 2002), and only one study on the size and dynamics of a *Rana temporaria* population (DEMETER 2004). In 2004 we carried out a survey in the Ciuc Basin to (i) map the spatial and altitudinal distribution of amphibians and their breeding habitats, and (ii) assess their conservation status based on the relative frequency of species and their distribution patterns.

2 Materials and methods

Research area

The Ciuc Basin is located in the Eastern Carpathians, in the upper catchment area of the Olt river (46°39′ N, 25°29′ E and 46°11′ N, 25°59′ E), and has an area of approximately 1400 km^2 (Fig. 1). The altitude ranges from 600 m a.s.l. at the southern end of the river floodplain to 1000–1800 m in the surrounding mountains. The climate of the area is much colder than the Romanian average (5.5 °C mean annual temperature) and relatively dry (average annual precipitation 600 mm) (KRISTÓ 1994).

The area is rich in temporary wetland habitats. Natural permanent water habitats are mostly dead river arms that were heavily degraded during the regulation of the Olt river at the turn of the 1970's and 1980's. Presently most permanent standing waters are man-made. The agricultural land-use structure of the area has changed little during the 20th century, and generally follows the geomorphological structure of the basin (DEMETER 2001). Low altitude and dry areas are used as arable land, wet areas as hay meadows, high altitude areas as pastures or forests.

Sampling methods and data analysis

We surveyed standing water habitats between March and July 2004. We used visual and auditive sampling (DODD et al. in press) of adults both during daylight and at night and visual observation of larvae to identify the presence of amphibians. As a measure of population size we used egg clump counts (MEYER et al. 1998, HARTEL 2005) in the case of *R. temporaria* and *R. arvalis*, and the intensity of the calling chorus in the case of *H. arborea* (ANTHONY & PUKY 2001, CORN et al. 2000).

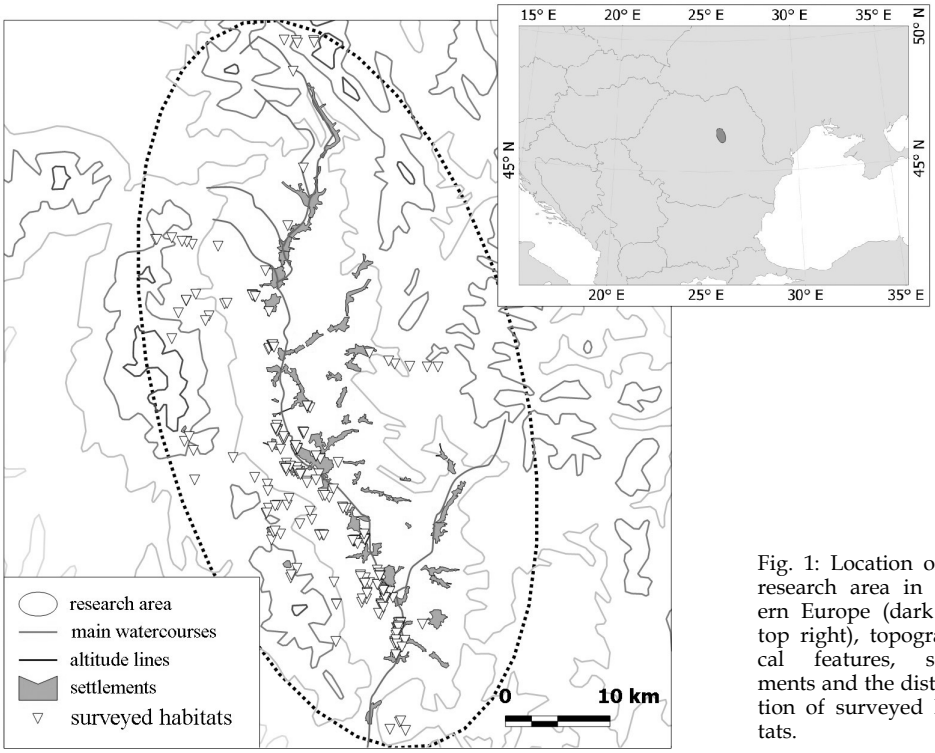

Fig. 1: Location of the research area in Eastern Europe (dark dot, top right), topographical features, settlements and the distribution of surveyed habitats.

We recorded the physical characteristics of the breeding habitats (maximum length, width and depth). As an approximation for the surface area of habitats we used the surface of the ellipse. The geographical coordinates of habitats were recorded with a handheld GPS Garmin 72, and spatial data were analysed using the Manifold GIS software, version 6.00.

In order to quantify and compare the local distribution of species we calculated the area of the minimum convex polygon containing all points where the species was found in the Ciuc Basin, similar to large scale zoogeographical studies (BĂNĂRESCU 1975). For convenience we call this »local area«, keeping in mind that it is only a relative measure of distribution on the research area and ignoring the distribution patterns of the species within this area. The usage of this parameter is justified by the isolated nature of the basin and its geomorphological unity. Because of this natural isolation, it can be expected that some animal populations are isolated within the basin. *Salamandra salamandra* was excluded from this calculation because of only two records. Local altitudinal range of a species was calculated by extracting the lowest altitude occurrence from the highest occurrence.

3 Results

A total number of 275 aquatic habitats were inventoried. The number and density of amphibian habitats is much larger on low altitudes (193 between 630–750 m) than on

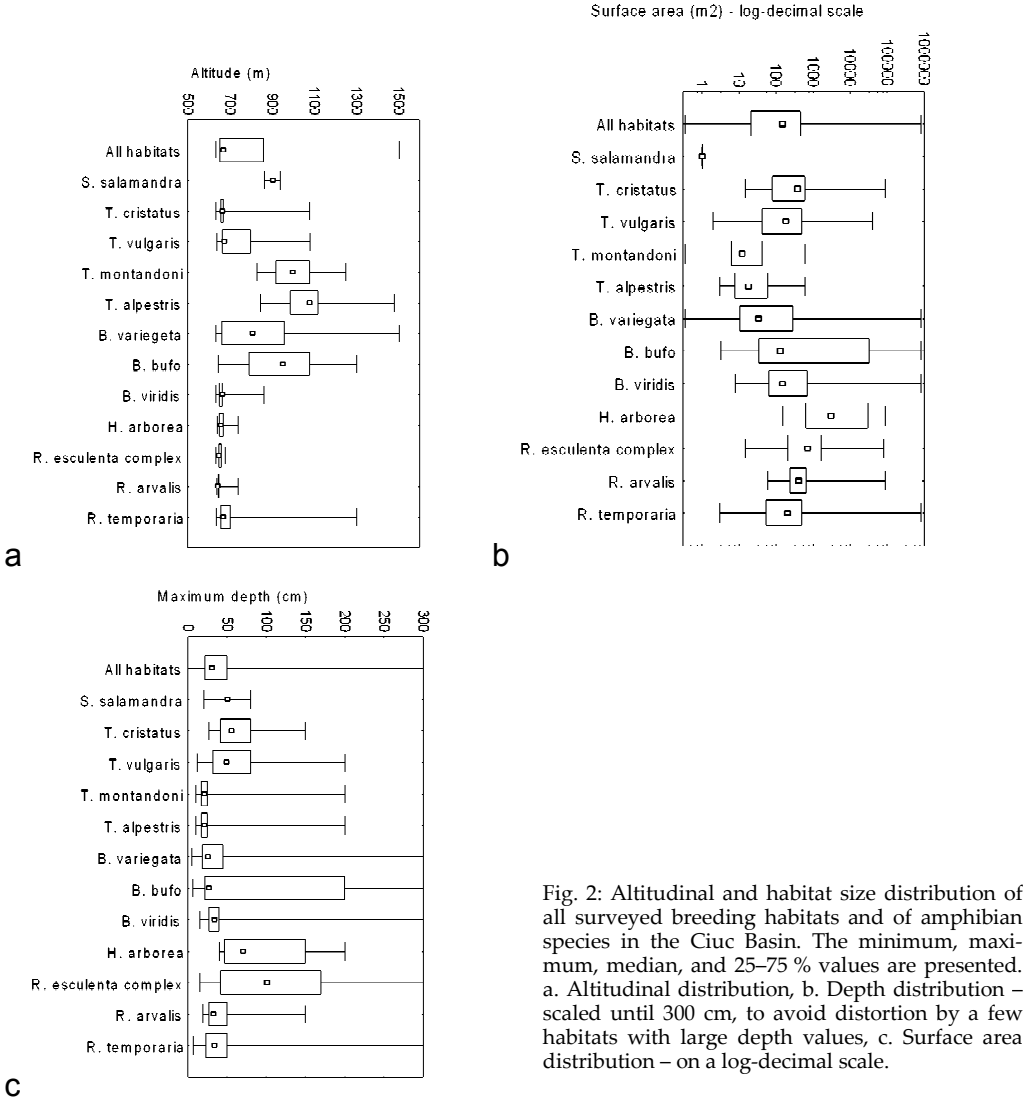

Fig. 2: Altitudinal and habitat size distribution of all surveyed breeding habitats and of amphibian species in the Ciuc Basin. The minimum, maximum, median, and 25–75 % values are presented. a. Altitudinal distribution, b. Depth distribution – scaled until 300 cm, to avoid distortion by a few habitats with large depth values, c. Surface area distribution – on a log-decimal scale.

high altitudes (82 above 750 m). Surface area is smaller than 1000 m² for 90 % of the ponds and 77 % of the ponds have a maximum depth smaller than 60 cm (Fig. 2). We found 12 species of amphibians, five urodelans and seven anurans (Tab. 1). At least one amphibian species was present in 228 habitats (82.9 % of the total sampled). *Rana temporaria* and *Bombina variegata* were the most frequent species (around 100 habitats each). *Bufo bufo*, *Bufo viridis, Rana esculenta* complex and the four *Triturus* species were found in between 20 and 40 habitats. *R. arvalis, H. arborea* and *S. salamandra* were the rarest species (below 15 habitats) (Tab. 1).

The altitudinal range of amphibian species varies from less than 110 m (*S. salamandra*, *H. arborea, R. esculenta* complex and *R. arvalis*) to above 1500 m (*T. alpestris*, *B. bufo*, *R. temporaria* and *B. variegata*) (Tab. 1, Fig. 2a). The variability of habitat size is highest for

Tab. 1: The number of habitats, frequency (relative to the total number of habitats in %), altitudinal range (m) and size of local distribution (km²) of amphibian species in the Ciuc Basin.

	No. habitats	Frequency	Altitudinal range	Local area
Salamandra salamandra	2	0.9	75 [864–939]	-
Triturus cristatus	23	10.1	446 [634–1080]	296
T. vulgaris	32	14.0	443 [638–1081]	526
T. montandoni	27	11.8	422 [830–1252]	162
T. alpestris	24	10.5	633 [847–1480]	154
Bombina variegata	101	44.3	871 [634–1505]	1034
Bufo bufo	24	10.5	656 [645–1301]	846
B. viridis	21	9.2	229 [634–863]	216
Hyla arborea	11	4.8	99 [641–740]	38
Rana esculenta complex	29	12.7	46 [634–680]	90
R. arvalis	11	4.8	102 [638–740]	17
R. temporaria	113	49.6	664 [637–1301]	715

B. bufo, *B. variegata* and *R. temporaria*, and lowest for *S. salamandra* and *T. alpestris*. The size of *T. montandoni*, *T. alpestris* and *Bombina variegata* habitats is generally smaller and of *H. arborea* larger than the habitat size of other species (Fig. 2b). The variability of habitat depth is largest for *B. bufo*, *R. esculenta* complex and *H. arborea*, smallest for *T. montandoni*, *T. alpestris* and *B. viridis* (Fig. 2c).

B. variegata, B. bufo and *R. temporaria* have the largest spatial distribution (above 700 km²), and *R. esculenta* complex, *H. arborea* and *R. arvalis* have the smallest (below 100 km²) (Tab. 1). There is a positive correlation between the altitudinal range and local area of species (Pearson correlation, $r = 0.84$, $p = 0.001$, $n = 11$).

The egg clump number per breeding habitat varies from 1 to 1100 in the case of *R. temporaria* (mean 188.1, n = 64) and from 2 to 99 for *R. arvalis* (mean 45.8, n = 7). The number of *R. temporaria* egg clumps per habitat correlates negatively with altitude (Pearson correlation $r = -0.21$, $n = 64$, $p < 0.05$). We found only three strong choruses of *H. arborea*, i.e. more than 10 calling males in a habitat, and in six habitats only one or few calling individuals were recorded. We observed hybrids between *T. montandoni* and *T. vulgaris* at four sites between 847 m and 1165 m.

4 Discussion

Altitudinal and spatial distribution. There are clear differences in the altitudinal distribution of the species. The data generally correspond to the altitudinal ranges cited in the Romanian literature (FUHN 1960, COGĂLNICEANU 1991, COGĂLNICEANU et al. 2000, GHIRA et al. 2002). It is likely that the local altitudinal distribution of species is limited not by altitude alone but by a series of other factors as the availability and quality of the aquatic and terrestrial habitats. For example, *H. arborea* is known to occur in Romania at altitudes between sea level and 1 000 m, *B. viridis* between sea level and 1 700 m (Fuhn 1960), but both species occupy narrower altitudinal range than it is available in the studied area. There are no precise data on the upper limit of *R. esculenta* complex in Romania, but this species group is typical of low and middle altitude areas and usually lacking from mountain regions, so the narrow local altitude range could be explained by the relatively high altitude of the study area. The mean

distribution of newt species is divided to low altitude species as *T. vulgaris* and *T. cristatus* and high altitude species as *T. montandoni* and *T. alpestris*. The altitudinal range of *T. alpestris* found during this study was larger than that of *T. montandoni.*

The spatial distribution of species is very different. Three species have a local area smaller than 100 km² (*H. arborea*, *R. esculenta* complex and *R. arvalis*), and *H. arborea* and *R. arvalis* has a local area less than 50 km². Other species have comparatively much larger local areas (for example *B. variegata*, *B. bufo*). Although the real local area of all species is probably larger than the values calculated by us, species with a small distribution have an increased chance of an isolated and/or fragmented local distribution compared with species with a large distribution**.**

We hypothesise that the isolated distribution of *R. arvalis* and *H. arborea* is connected with the regulation of the Olt river in the 1970–1980s. This dramatically altered wetlands on the floodplain by the filling up of the old riverbed, oxbow lakes and lowering of the groundwater table. The length of the river was reduced by more than 50 % (DEMETER, unpubl.). The regulation of the river, followed by a dry period, decreased the mean water table level on the floodplain by 22 cm between 1981 and 1986, while on the terraces and foothills by 40 cm between 1982 and 1986 (PÁSZTOHY 1988). The creation of channels could have favored *R. esculenta* complex, and possibly *T. cristatus* and *T. vulgaris* but do not provide suitable breeding habitat for species like *R. arvalis*, *H. arborea*, *R. temporaria* (MARA & DEMETER 2005).

Local status of species. Existing protected areas in the Ciuc Basin are small botanical reserves in the low altitude part (1–5 hectares, mean 3.7 ha, n = 6), and larger areas in the mountain region (3–800 ha, mean 227 ha, n = 7). A few hundred ha area in the southern part of the basin was proposed recently as a Natura 2000 site by the EPA of Harghita county.

No amphibian breeding habitat was identified inside the existing low altitude protected areas. However, these may serve as a terrestrial habitat for some species (*R. arvalis*, *R. temporaria*). Around 20 identified breeding habitats are situated inside the mountain reserves. However, the best identified reproduction habitats (e. g. largest reproductive populations) of all the anurans fall outside the existing protected areas. Regarding the intensity of human activities that may have a negative effect on the breeding or terrestrial habitats, the research area can be divided in two parts. The lower altitude areas are characterized by a more intense human presence and a larger risk of habitat fragmentation and destruction. The mountain region is affected by logging activities. Roads created here may have a positive effect on mountain species by the creation of roadside habitats, but these are often unpredictable. Species that are concentrated in low altitudes (*T. vulgaris*, *T. cristatus*, *B. viridis*, *R. esculenta* complex, *H. arborea* and *R. arvalis*) are more exposed to human activities, both to negative ones (habitat destruction and alteration) and to positive ones (creation of fishing or recreational ponds, ditches with permanent water).

R. temporaria, *B. variegata* and *B. bufo* are distributed both in low altitudes and in the mountains, so on the whole they are less vulnerable to human activities. However, large aggregations of breeding *R. temporaria* and *B. bufo* are found in low altitude areas and breeding frogs are killed for their legs regularly (*R. temporaria*) or occasionally (*B. bufo*) (DEMETER 2004, DEMETER unpubl. obs.)

R. esculenta complex, *R. arvalis* and *H. arborea* have a restricted spatial distribution. *R. esculenta* complex is frequent and abundant within its local area. On the contrary, the restricted spatial distribution of *R. arvalis* and *H. arborea* is associated with low abundance, as indicated by the number of egg clumps and intensity of calling choruses. This is probably the combined result of a more pronounced habitat specialization of these species and limited availability of their habitats. Moreover, the habitats of *R. arvalis* and *H. arborea* overlap with an intense human presence since they occur close to settlements. We hypothesise that they went through a regress due to habitat changes caused by the regulation of the Olt river. Continued studies of distribution, a monitoring and a study of the genetic structure of known populations could help confirm this. Genetic evidences for long term isolation and low variability in a *R. arvalis* population from Reci, (50 km south from our study site) were found by RAFIŃSKI & BABIK (2000).

Until more detailed studies on local amphibian populations are carried out, we recommend the protection of the identified breeding habitats together with the surrounding terrestrial habitats of the locally most vulnerable species: *H. arborea* and *R. arvalis*.

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Annex 1. List and geographic and size parameters of recommended protected breeding habitats of *Rana arvalis* and *Hyla arborea* in the Ciuc basin. Species: Ha – *H. arborea*, Ra – *R. arvalis*.

Closest settlement	Latitude	Longitude	Altitude (m)	Surface of spawning habitat (ha)	Species
Cetățuia	46.238	25.882	648	1.92	Ha
Cetățuia	46.240	25.882	645	0.30	Ha
Cetățuia	46.230	25.906	642	0.05	Ra
Cosmeni-Ciuc	46.219	25.928	674	3.00	Ha
Miercurea-Ciuc	46.353	25.760	671	4.00	Ha, Ra
Sâncrăieni-Ciuc	46.296	25.807	740	9.00	Ha, Ra
Sânsimion-Ciuc	46.246	25.860	652	0.06	Ha
Sânsimion-Ciuc	46.259	25.858	654	0.02	Ha
Sânsimion-Ciuc	46.261	25.852	658	0.04	Ha
Sântimbru-Ciuc	46.291	25.843	663	0.09	Ha, Ra
Sântimbru-Ciuc	46.290	25.844	662	0.03	Ra
Tuşnad-Nou	46.199	25.901	639	0.02	Ra
Tuşnad-Sat	46.204	25.893	641	0.60	Ha
Tuşnad-Sat	46.202	25.893	643	0.06	Ha
Vrabia	46.220	25.898	640	0.01	Ra
Vrabia	46.213	25.899	640	0.06	Ra
Vrabia	46.216	25.896	639	0.50	Ra
Vrabia	46.214	25.899	639	0.01	Ra
Vrabia	46.216	25.898	638	0.02	Ra
Vrabia	46.211	25.896	648	0.06	Ra