Spatial distribution of herpetofauna in the Retezat Mountains National Park (Romania)

Dan COGALNICEANU[1], Ioan GHIRA[2] & Anca ARDELEANU[2]

[1]Bucharest University, Faculty of Biology, Department of Ecology, Splaiul Independentei 91-95, 76201-Bucharest, Romania
E-mail: danco@bio.bio.unibuc.ro
[2]Babe-Bolyai University, Faculty of Biology and Geology, Department of Zoology, Kogalniceanu Str., Nr.1, 3400 Cluj-Napoca, Romania
E-mail: ighira@biolog.ubbcluj.ro
E-mail: dianaa3@yahoo.com

Abstract
A survey of the herpetofauna in the Retezat National Park has revealed the presence of seven species of amphibians and seven of reptiles in the 94 habitats investigated. The average number of species was 3.25 for terrestrial habitats, in both the crystalline and limestone areas, and only 1.61 species in aquatic habitats. Species richness was negatively correlated with altitude, the only species found at altitudes higher than 2100 m a.s.l. being *Rana temporaria*, which is the most common species, present in more than half of the aquatic habitats surveyed.

Key words: inventory, amphibians, reptiles, altitudinal distribution

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INTRODUCTION

The Retezat Mountains are situated in the Southern Carpathians, covering an area of about 466 km², with a perimeter of 170 km. In 1935 it became the first National Park in Romania, covering about 13,000 ha. Presently, the area covered by the park is 54491 ha. It is located between 45°15'15" and 45°28'52" North and 22°43'0" and 23°4'36" East.

The area is formed of Danubian metamorphic rocks, dominated by slightly metamorphosed crystalline schists. The Retezat tectonic opening has revealed two impressive granodiorite massifs, where the highest peaks have developed. In the Southern part there are sedimentary formations, of which the most noteworthy are the Mesozoic limestone.

High peaks characterize the relief and massive appearance conveyed by two parallel crests, both over 2000 m high. There are 20 peaks higher than 2000 m, the highest being Peleaga of 2,509 m. Less than 30% of the surface is in the alpine area.

Both glacial (cirques, valleys, moraines etc.) and cryonival relief are extremely widespread (Schreiber & Sorocovschi 1992).

The Retezat Mountains have a moderate climate, cold and humid, with yearly average temperatures between 6°C at the mountain base and -2°C in the alpine zone. In the latter, the number of days with sub zero temperatures is between 250-275, compared to 175-200 at lower altitudes. Annual rainfall varies between 900 mm/year at the mountain base and 1400 mm elsewhere. The highest number of rainy days (175-180) is at altitudes between 1800-2000 m, and decreases at higher altitudes to about 150 days. Above 2000 m snow may occur throughout the year. The snow layer had a depth of 70-80 cm at the mountain base, about 95-100 cm on the top, with maximal depths records of 3-4 m (Farcas & Sorocovschi 1992).

In the Retezat Mountains there are about 100 alpine lakes, of which 58 are permanent (Pisota 1971). The lake water is pure, with conductivity lower on average than 10 (μS/cm, and a pH slightly acid between 5.8-6.9. Fish were historically known only from 7 lakes, but starting in the sixties, repeated stockings were made so that 28 lakes supported fish populations. Introductions were carried out with some native species, but mostly with exotic ones (*Salvelinus fontinalis*, *Salmo trutta lacustris*, *Coregonus peled*, *Oncorhynchus mykiss*). The impact of introduced fish species on the existing amphibian populations was not recorded at that time (Decei 1980). Presently, fish have disappeared from at least eight lakes previously stocked with exotic species.

The Retezat Mountains have high species diversity and a high proportion of endemic species. Thus, there are more than 1,500 inventoried invertebrate species, of which 35 are endemic and 91 are new for science. Vertebrate species number at least 134 species. The number of plant species described is 1,182 species, 104 subspecies and 312 varieties, belonging to 348 genus and 80 families. Of these, 62 species are endemic. A total of 61 different herbal and

wood associations have been described (Coldea 1992). Most forested and dwarf pine *Pinus mugo* covered areas are pristine. Grazing in alpine pastures was forbidden until 1920 and greatly limited after 1959. In alpine areas affected by cattle and sheep grazing, the surface covered by dwarf pine and the relict *Pinus cembra* was strongly reduced, but overall the area covered is still important. During the last decade the dwarf pine has been regenerating and extending.

Several studies have been done on the herpetofauna of the Retezat National Park (Cogalniceanu 1993, Ghira 1989, Ghira & Stugren 1988, Stugren & Ghira 1987, 1992). The present paper contains the results of the inventory and the habitat preference analysis of the herpetofauna in this area conducted during 1985-1990 and 1999-2000.

MATERIAL AND METHODS

The presence of amphibians was recorded either from the direct observation of adults during the breeding season, of the spawn in the case of Common Toad *Bufo bufo* and Common Frog *Rana temporaria*, or of the tadpoles. In temporary ponds with abundant vegetation or low transparency, we used dip netting. Further records were obtained from accidental captures in pitfall traps used for invertebrate survey.

In terrestrial habitats, well-determined areas were investigated and the presence/absence of reptiles and amphibians was recorded. The specific habitats included beech, mixed, spruce fir, and dwarf-pine forests and forest boundaries, rock piles, boulders, screes, and pebble flows, hayfields, mountain and alpine pastures, and one floodplain forest.

41 sites were investigated during the study. Some sites included a single type of habitat while others covered up to six different habitats. In all, 94 habitats were surveyed, 34 aquatic and 60 terrestrial, of which 33 were on limestone and 61 on crystalline. The altitude of the investigated sites was between 800 and 2260 m a.s.l.

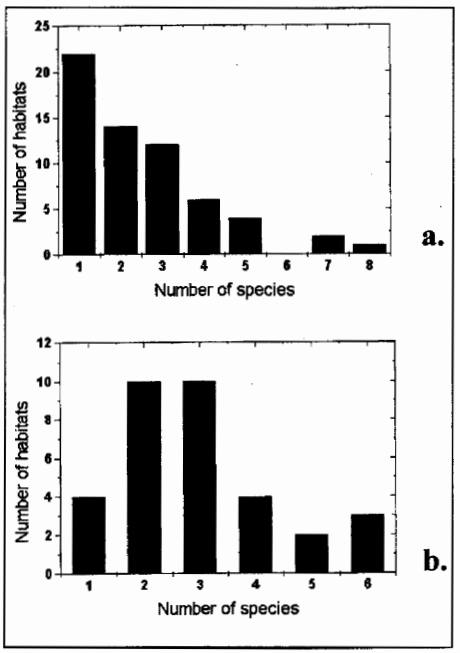
The degree of association between species was computed using Jaccard's index and the dendrogram constructed by UPGMA using MVSP 3.1 (Kovach 1999).

RESULTS

Seven species of amphibians (Fire Salamander *Salamandra salamandra*, Common Newt *Triturus vulgaris*, Alpine Newt T. alpestris, Yellow-bellied Toad *Bombina variegata*, Common Toad *Bufo bufo*, Common Frog *Rana temporaria* and Agile Frog *R. dalmatina*) and seven species of reptiles (Sand Lizard *Lacerta agilis*, Common Lizard *Lacerta (Zootoca) vivipara*, Wall Lizard *Podarcis muralis*, Slow Worm *Anguis fragilis*, Smooth Snake *Coronella austriaca*, Grass Snake *Natrix natrix* and Adder *Vipera berus*) were recorded in the Retezat National Park. A total of 250 records were made, not counting multiple observations.

The average number of species per habitat surveyed varied between 2.96 in limestone area and 2.46 in the crystalline part (Figure 1). The lower value for the crystalline habitats was partly due to the alpine lakes that had

Figure 1. The frequency distribution of the number of species of amphibians and reptiles recorded per habitat in crystallin (a) and limestone (b) areas in the Retezat National Park.



an average of only 1.61 species of amphibians. When comparing only the terrestrial habitats, the average number of species per habitat is 3.25 for both types of substrate.

The number of records for each species varied between two for Common Newt and 66 for Common Frog (Figure 2).

Based on presence-absence data, we computed the degree of association between species (Figure 3). The species that occur at high altitudes (Adder, Common Lizard, Common Frog and Alpine Newt) appeared grouped together, similar to the low altitude species Agile Frog, Wall Lizard and Common Newt.

Two species of amphibians are widespread in lakes at altitudes beyond the tree line (Alpine Newt and Common Frog) while Common Toad and Yellow-bellied Toad are known only from several sites at high altitudes (Table 1).

The Alpine Newt, is quite selective in its choice of habitats. It was recorded mostly in smaller lakes, without fish and surrounded by dwarf pine. The Common Frog, has a wider range, showing no particular preference for

Figure 2. The number of records for the 14 species of amphibians and reptiles present in the Retezat National Park.

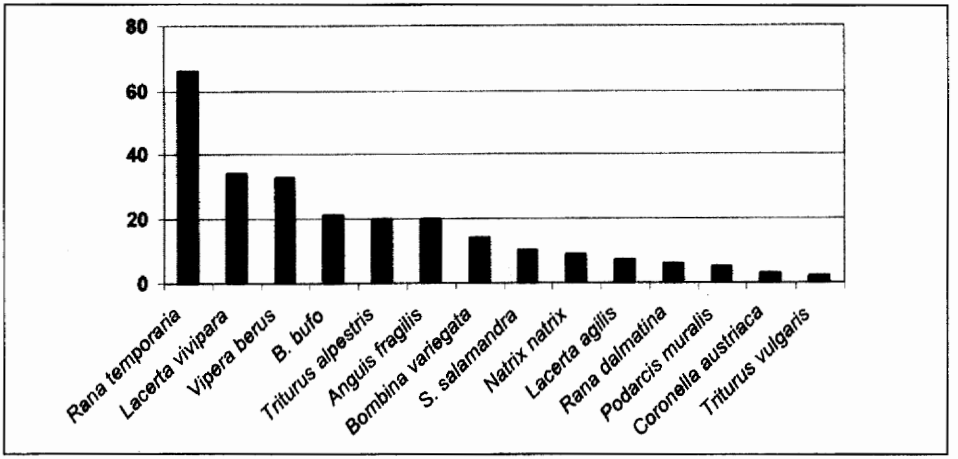
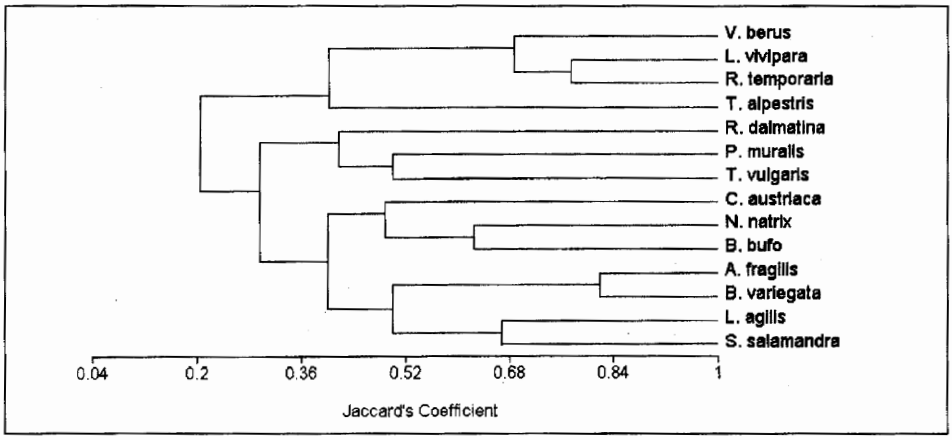


Table 1. The distribution of amphibians in temporary and permanent alpine lakes situated at altitudes above 1500 m.

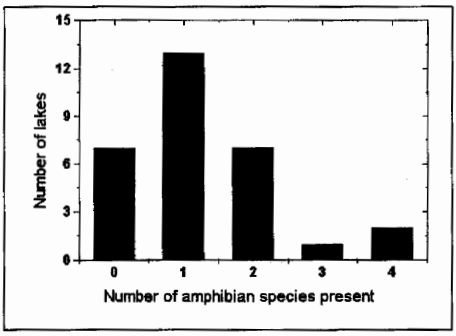
Species	Lakes populated (%) n = 29	Temporary lakes used for reproduction (%) n = 9	pH range	Maximum altitude (m)
Rana temporaria	51.7	100	5.7-7.5	2260
Triturus alpestris	31.0	45	5.7-6.3	2100
Bufo bufo	13.8	11	6.7-7.5	1997
Bombina variegata	10.3	11	5.7-6.1	1990

Figure 3. The degree of association between species based on Jaccard's similarity index. Dendrogram constructed using the UPGMA clustering method.



a specific type of habitat. It occurs even in lakes with large fish populations or in temporary pools. Tadpole survival is extremely low in the latter species. All four species were recorded in only two lakes. There was no apparent association between species (Figure 4).

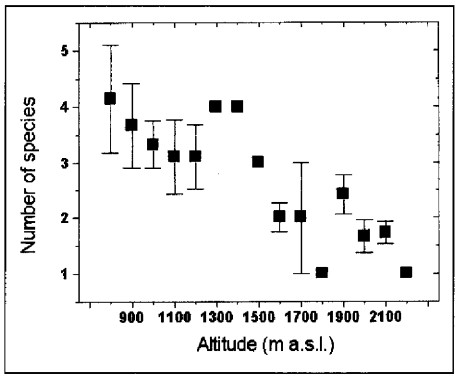
Figure 4. The degree of association between the four species of amphibians inhabiting alpine lakes.



Fuhn (1974) reported catching a subadult of Green Toad *Bufo viridis* at about 2000 m in a pitfall trap, but the persistence of this species was not confirmed during the recent survey.

Species richness decreased with altitude, being negatively correlated with altitude ($r=-0.48$, $P < 0.001$, $n = 94$). When computing the average number of species per 100 m altitude classes, the correlation improved ($r = -0.57$, $P < 0.02$, $n = 15$) (Figure 5).

Figure 5. The average number of species (± SE) computed for 100 m altitudinal classes.



The density of herpetofauna varies depending on the type of habitat (Table 2). Marshes and puddles are preferred by amphibians, followed by forest boundaries. Reptiles prefer screes and rock piles followed by pastures with bushes and shrubs. Very young grass snakes were found several times in small puddles eating *R. temporaria* tadpoles but were not considered typical inhabitants of this habitat. The very large density of amphibians in marshes and puddles is not very important for the Retezat herpetofauna because the number of these types of habitats is small.

DISCUSSION

Although the number of species is low, there is a clear pattern of distribution, mainly controlled by altitude. Comparative analysis of the crystalline and limestone areas reveals no differences in the average number of species. Species composition differs nevertheless, but no definite trends were identified. The densities of amphibians and reptiles are very different in the main habitat types of

Table 2. Density of herpetofauna in different types of habitat in the Retezat National Park (Romania).

Amphibians	
Habitat type	density individuals/ha
marsh and puddle	12725
forest boundary	35
pasture	25
forest	15
hayfield	4
scree and rock piles	1
Reptiles	
scree and rock piles	265
pasture	26
forest boundary	14
hayfield	4
marsh and puddle	0
forest	0

Retezat National Park. Further studies are needed on the habitat choice of different species.

Of special interest is the comparison between hayfields and pastures. Hayfields are the only studied habitats heavily impacted twice a year by human activities. The very low density of herpetofauna is a consequence of anthropic impact. Pastures, though apparently similar, have a much higher herpetofauna density (51 individuals/ha, instead of 8 individuals/ha in hayfields).

The Common Frog, was the most abundant species, but the relative abundance should not be inferred from the number of records, since it is quite active during daylight and its presence is easily recorded. Cryptic or nocturnal species (like Slow Worm and Common Toad) are less likely to be observed during an inventory and can cause biased results.

Overall, population sizes are relatively small (Cogalniceanu 1993) and thus vulnerable to both direct human impact and global changes. Adequate management can insure the survival of the high-altitude populations most vulnerable to UV-B increase and temperature fluctuations.

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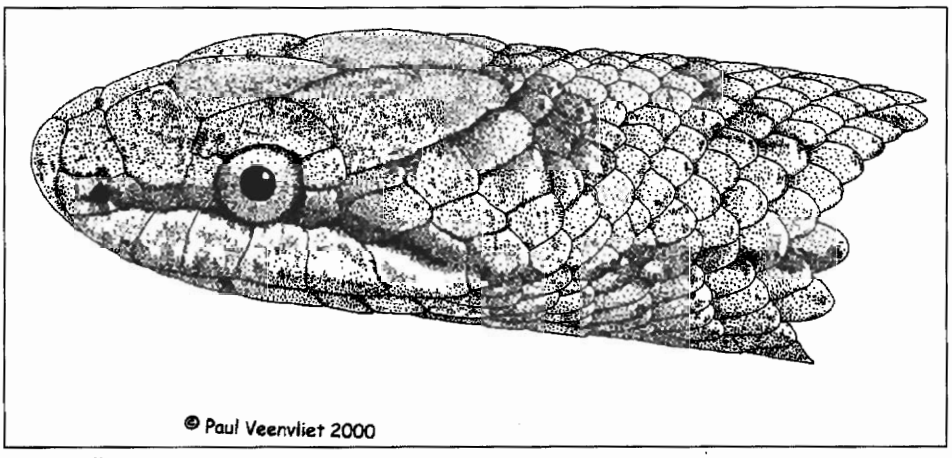

Coronella austriaca