

**AN UPDATED DISTRIBUTION OF THE HERPETOFAUNA
FROM THE NATURA 2000 SITE RARĂU-GIUMALĂU
(ROSCI0212), ROMANIA**

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Amphibians and reptiles are among the most threatened animal species in Europe. Because of their legal conservation status, amphibians and reptiles may act as umbrella and flagship species in certain areas. The Rarău-Giumalău Natura 2000 site (ROSCI 0212) is such an area that, despite its conservation status, is still exposed to human activities alterations. In addition, the standard data form of the site mentions only three amphibian species, which is notably below the herpetofauna diversity of the region. Therefore, the aim of this study is to update the existing knowledge on the local herpetofauna. To this end, herpetological field surveys were conducted in the area between May–September, 2015, ten species being identified, as follows: six amphibians (*Salamandra salamandra*, *Lissotriton montandoni*, *Ichthyosaura alpestris*, *Bombina variegata*, *Bufo bufo* and *Rana temporaria*) and four reptiles (*Anguis colchica*, *Lacerta agilis*, *Zootoca vivipara* and *Vipera berus*). Species distribution is influenced by human activities, among which grazing seems to be the most important. The diversity of herpetofauna is not evenly distributed between the perimeters of the site. The Giumalău perimeter has only six species probably because of a lower habitat diversity compared to the Rarău perimeter. Nine of the identified species are protected by European and national regulations, whereas the standard data form of the site lists only two of them, and one not confirmed by our study. Therefore, the standard data form, a tool for protective management, does not reflect the real situation of the herpetofauna of the site and for this reason, it should be updated.

Keywords: amphibians, reptiles, distribution, conservation, Rarău-Giumalău site.

1. INTRODUCTION

Amphibians and reptiles are among of the most endangered animal species. In Europe, almost a quarter of the amphibian species and nearly one fifth of the reptile species are considered in danger of extinction [13, 29]. Besides, given their conservation status according European and Romanian environmental regulations [11, 18], amphibians and reptiles are important for nature conservation because they may act as umbrella and even flagship species [2], therefore providing powerful arguments for the perpetual conservation of the areas they inhabit. Therefore, surveillance of herpetofauna in certain areas could be very important for nature

protection. Examples of such areas are the Rarău and Giumalău mountains that, although included in the Natura 2000 site (ROSCI0212), are not completely safe from human influence and alteration, even if, as part of the alpine biogeographical region, they represent high priority areas for herpetofauna conservation [24]. In addition, the standard data form of the site lists only three amphibian species, whereas, according to recent reviews on this subject [9, 10], the herpetofauna diversity of the region appears to be much richer.

Having all these in view, the aim of this study is to update the existing knowledge regarding the herpetofauna of the Rarău-Giumalău Natura 2000 site (ROSCI0212) and to provide scientific arguments for its protective management.

The study was carried out in two mountainous areas of Rarău and Giumalău, in Eastern Carpathians. The study area is represented by the Rarău-Giumalău Natura 2000 site – ROSCI0212 – (site coordinates: 47° 26' 53" N, 25° 33' 31" E), as confirmed in 2008. With an altitude between 819 m and 1710 m a.s.l., the site belongs to the alpine biogeographical region, it has 2547 ha, it is divided into two perimeters (Rarău and Giumalău), and includes several previously-designed nature reserves: Pietrele Doamnei (970.5 ha), Fânețele montane Todirescu (38.1 ha), Codrul secular Slătioara (1064 ha), and Codrul secular Giumalău (309.5 ha) [31] (Fig. 1).



Fig. 1. Geographic position of Rarău-Giumalău ROSCI0212 (white rectangle) and its components (left perimeter – Giumalău, right perimeter – Rarău, 1 – Pietrele Doamnei, 2 – Fânețele montane Todirescu, 3 – Codrul secular Slătioara, 4 – Codrul secular Giumalău).

Vegetation is generally represented by various types of forests and shrubs (phytosociological alliances: *Loiseleurio-Vaccinion*, *Rhododendro-Vaccinion*, *Juniperion nanae*, *Piceion abietis*, *Abieti-Piceion*, *Pinion mugii* [6]) and natural grasslands (phytosociological alliances: *Magnocaricion elatae*, *Juncion trifidi*, *Rhynchosporion albae*, *Caricion nigrae*, *Caricion davallianae*, *Gypsophilion petraeae*, *Papavero-Thymion pulcherrimae*, *Nardion strictae*, *Oxytropido-Elynon*, *Festuco saxatilis-Seslerion bielzii*, *Alnion viridis* [3]), accompanied by anthropized meadows and weedy areas (phytosociological alliances: *Cirsio-Brachypodium pinnati*, *Deschampsion caespitosae*, *Cynosurion*, *Arrhenatherion*, *Phyteumo-Trisetion*, *Poion alpinae*, *Potentillion anserinae*, *Trifolion medii* [4, 5]).

The investigation, focused on the parts of the site offering optimal habitats for amphibian and reptile species, consisted in conducting complete observations along extensive transect surveys [7, 28]. Field investigations were carried out in 2015, from May till September (the first survey intent, on April 19, failed because of the compact snow cover), with an average frequency of five days per month.

Each species was morphologically identified using field guides [1, 8, 15, 16, 22], photographed and located (geographic coordinates were taken with Garmin handled GPS). Specimens that required handling for identification purposes were released immediately afterwards, at the exact place of capture.

2. RESULTS AND DISCUSSION

During our field investigations, ten species, six amphibians and four reptiles were recorded (Table 1).

Table 1
Amphibians and reptiles of Rarău-Giumalău ROSCI0212 and their classification
(amphibians [14], reptiles [30])

Class	Order	Family	Species
Amphibia Linnaeus, 1758	Caudata Fischer von Waldheim, 1813	Salamandridae	<i>Salamandra salamandra</i> (Linnaeus, 1758)
		Goldfuss, 1820	<i>Lissotriton montandoni</i> (Boulenger, 1880)
			<i>Ichthyosaura alpestris</i> (Laurenti, 1768)
	Anura Fischer von Waldheim, 1813	Bombinatoridae Gray, 1825	<i>Bombina variegata</i> (Linnaeus, 1758)
		Bufo Gray, 1825	<i>Bufo bufo</i> (Linnaeus, 1758)
		Ranidae Batsch 1796	<i>Rana temporaria</i> (Linnaeus, 1758)
Reptilia Laurenti, 1768	Squamata Oppel, 1811	Anguidae Oppel, 1811	<i>Anguis colchica</i> (Nordmann, 1840)
		Lacertidae Oppel, 1811	<i>Lacerta agilis</i> (Linnaeus, 1758)
			<i>Zootoca vivipara</i> (von Jacquin, 1787)
		Viperidae Oppel, 1811	<i>Vipera berus</i> (Linnaeus, 1758)

SPECIES DISTRIBUTION

Salamandra salamandra (fire salamander) lives in hilly and mountainous areas, in oak, beech and deciduous-coniferous mixed forests, between 200 m and 800 m a.s.l. (sometimes reaching higher altitudes) [15]. The presence of the species in the Northern part of Eastern Carpathians has been previously recorded [12, 17, 26]. We found the fire salamander (Fig. 2) in a few locations of Slătioara Forest (Rarău perimeter), between 841m and 897 m a.s.l. (Fig. 3). We observed both adults (on forest floor, near streams) and larvae (in the swampy area at the forest edge).

Lissotriton montandoni (Carpathian newt) occurs between 500–1900 m a.s.l., in temporary ponds, slow flowing waters, ditches, and lakes [15]. The species has been previously recorded from the region of the study area [12, 17, 26]. We found the Carpathian newt (Fig. 4) mainly in Slătioara Forest, on the alpine plateau of Rarău, and on the lower part of the perimeter of Giupalău (Fig. 5). Most of the specimens were observed in small ponds and swampy areas and, by the end of the investigation period, in terrestrial shelters (leaf litter, beneath logs and rocks), of meadows and forests, between 818 m and 1.628 m of altitude.

Ichthyosaura alpestris (alpine newt) lives in mountainous areas, at altitudes between 500 m and 2,000 m [15], having been previously recorded in the Northern region of Eastern Carpathians [12, 17, 26]. During our investigations, the alpine newt (Fig. 6) of both perimeters of the Natura 2000 site were identified (Fig. 7). Most of the specimens have been observed in permanent ponds from alpine meadow and forest. We also found adults in terrestrial phase, sheltered in dead logs at the edge between the Giupalău Forest and the alpine meadow. The altitudinal range of the records was of 834–1,628 m.

Bombina variegata (yellow-bellied toad) is a species inhabiting relatively small temporary and permanent ponds from hilly and mountainous areas [15], previously reported in the Northern region of Eastern Carpathians [12, 17, 26]. Our investigations revealed the presence of the yellow-bellied toad (Fig. 8) especially in the Rarău and Slătioara Forests (Fig. 9). In Giupalău, although we could not find the species within the perimeter of the Natura 2000 site, we recorded it in nearby areas. The main habitats occupied by this species were small alpine ponds, swampy areas, ditches and springs, meadows and forested zones of various altitudes (818–1,628 m a.s.l.).

Bufo bufo (common toad) is a mainly terrestrial species that lives in various natural and anthropic habitats, between 40 m and 1,200 m of altitude [15]. It has been previously recorded in the Northern part of Eastern Carpathians [12, 17, 26]. We identified common toad adults and clutches (Fig. 10) mainly within the Rarău perimeter (Fig. 11), in ponds from alpine meadows and forest areas, at altitudes

between 820–1,628 m a.s.l. In the Giumalău perimeter, this species has not been observed, however it was recorded in neighbouring areas.

Rana temporaria (common frog) is characteristic for terrestrial and humid mountainous habitats, between 300 m and 2,000 m a.s.l. [15]. The species has been previously recorded in the Northern part of Eastern Carpathians [12, 17, 26]. During our field investigations, we have recorded the common frog (Fig. 12) within both Rarău and Giumalău perimeters (Fig. 13), in aquatic and terrestrial habitats in alpine meadows and forests, between 827 m and 1,628 m of altitude.

Anguis colchica (slow worm) occurs in relatively humid, rich in vegetation habitats, like open meadows in forests, mainly from hilly and mountainous areas [16]. The species has been identified before, in the Northern region of Eastern Carpathians [12, 17, 27]. We found the slow worm (Fig. 14) within both Rarău and Giumalău perimeters (Fig. 15), in typical habitats, between 836 m and 1,227 m of altitude.

Lacera agilis (sand lizard) is found in plains to mountains (1000–1500 m a.s.l.), in open and sometimes humid areas [16]. It had been previously recorded in the Northern region of Eastern Carpathians [12, 17, 27]. We found the sand lizard (Fig. 16) inside the Rarău perimeter, whereas in Giumalău it occurred in the vicinity of the corresponding perimeter (Fig. 17). The species occupies typical habitats, between 879 m and 1,140 m of altitude.

Zootoca vivipara (viviparous lizard) dwells preponderantly in mountainous habitats with relatively high humidity [16]. It has been previously recorded in the Northern region of Eastern Carpathians [12, 17, 27]. We recorder the viviparous lizard (Fig. 18) within both Rarău and Giumalău perimeters (Fig. 19), in alpine meadow-forest edge and open forest habitats with an altitude range of 842–1,683 m a.s.l.

Vipera berus (common European adder) occupies habitats represented mainly by forest borders and meadows from hilly and mountainous regions [16]. The species has been previously recorded in the Northern part of Eastern Carpathians [12, 17, 27]. We found the common European viper (Fig. 20) in both Rarău and Giumalău perimeters (Fig. 21), in relatively open habitats, between 860 m and 1,599 m of altitude.

The most widespread species in the Natura 2000 site is *Zootoca vivipara*, followed by *Bombina variegata*, *Lissotriton montandoni*, *Rana temporaria* and *Bufo bufo*. All these species encounter optimal habitat conditions. However, the viviparous lizard thrives because, unlike the afore-mentioned amphibians, it can disperse relatively far from water bodies, occupying completely the dry substrata, as far as sufficient atmospheric humidity is present [16]. The yellow-bellied toad and the Carpathian newt co-occurred in almost all locations. On the high plateau of Rarău, these two species exist mainly in small permanent ponds, whereas, at lower altitude, they inhabit both ponds and swampy areas. Although the common frog

exhibits a more or less similar habitat preference, it tends to disperse more in areas inside or closer to the forest edge. The common toad occurred in fewer forest and alpine habitats, being almost always accompanied by the yellow-bellied toad and the Carpathian newt.

A particular case was that of *Ichthyosaura alpesteris* which, despite the theoretically optimal habitat conditions, displayed a relatively narrow distribution. The alpine newt co-occurred with the yellow-bellied toad and the Carpathian newt, in permanent ponds, which are larger and deeper than the ones inhabited only by these two species.

A group of species less present in the Natura 2000 site includes *Salamandra salamandra*, *Anguis colchica*, and *Lacerta agilis*. All three were found at lower altitudes. This situation seems normal for fire salamander, whose occurrences from Slătioara Forest, are probably at the upper limit of its altitudinal range. However, the slow worm and the sand lizard could theoretically go higher. Probably, these species are confined to lower altitudes rather by climatic factors than lack of habitat. This is especially obvious in the case of sand lizard distribution, which seems to be restricted to the Southern slopes of the Rarău Mountain, whereas fire salamander occurs on the Eastern slopes and the slow worm, on the Southern, Eastern and Western ones.

The distribution of *Vipera berus* parallels – at a lower scale – the one of *Zootoca vivipara*. The common European adder occupies areas at the meadow-forest limit and areas with low density of trees, which provide various microclimates that the snake can use for thermoregulation.

The distribution patterns based on habitat and climate variation may be also altered by the impact of human activities (Table 2). One of the main identified threats for herpetofauna is grazing and other related activities. Grazing alters both terrestrial and aquatic habitats of the amphibian and reptile species from the alpine meadows of Rarău, the one next to the Southern edge of Giumalău Forest, and the Eastern edge of Slătioara Forest (towards Slătioara Village). Touristic and leisure activities are more intense in the Eastern part of the alpine meadows of Rarău, whereas the ones from Giumalău are altered by the collectors of wild berries. Roads and paths may have some sort of positive influence, through the “creation” of new suitable habitats (ponds, ditches), especially for aquatic species. However, intense traffic, particularly motor vehicles (mainly in the Rarău perimeter), annuls such positive influences.

A comparison of the Rarău and Giumalău species richness reveals a notable difference: four of the species – *Salamandra salamandra*, *Bombina variegata*, *Bufo bufo* and *Lacerta agilis* – have not been found within the Giumalău perimeter (Table 2). Such less rich herpetofauna may be related to the obvious difference

between the two perimeters, the area of Giumalău perimeter being smaller than the one of Rarău perimeter. Although plausible, we tend to dismiss this explanation and favour instead a habitat diversity hypothesis. If we ignore the fire salamander (the lowest altitude of Giumalău perimeter, a little less than 1200 m, is higher than the altitudinal upper limit of the species) and the sand lizard (which seems to be accidental in the Rarău perimeter), there would be no reason for the yellow-bellied toad and the common toad (both very adaptable species) to be absent from the Giumalău perimeter, apart from the lack of suitable habitats. Indeed, the Giumalău perimeter includes a dense and continuous forest that spreads over relatively steep slopes (in contrast with the Slătioara Forest) towards the top of the mountain. In addition, all the other species from the Giumalău perimeter have been found on its edges, represented by very narrow stripes of suitable habitat in terms of vegetation cover and slope inclination. Thus, the Rarău perimeter is richer in various types of habitats than the Giumalău perimeter – therefore, the former contains ten species whereas the latter, only six.

Table 2

Species of amphibians and reptiles identified in each of the perimeters of ROSCI0212 Rarău-Giumalău and the main human activities with potential impact on herpetofauna

Perimeter	Species	Human activities
Rarău	<ol style="list-style-type: none"> 1. <i>Salamandra salamandra</i> 2. <i>Lissotriton montandoni</i> 3. <i>Ichthyosaura alpestris</i> 4. <i>Bombina variegata</i> 5. <i>Bufo bufo</i> 6. <i>Rana temporaria</i> 7. <i>Anguis colchica</i> 8. <i>Lacerta agilis</i> 9. <i>Zootoca vivipara</i> 10. <i>Vipera berus</i> 	<ul style="list-style-type: none"> – grazing and related activities – touristic activities – nearby localities – roads and paths
Giumalău	<ol style="list-style-type: none"> 1. <i>Lissotriton montandoni</i> 2. <i>Ichthyosaura alpestris</i> 3. <i>Rana temporaria</i> 4. <i>Anguis colchica</i> 5. <i>Zootoca vivipara</i> 6. <i>Vipera berus</i> 	<ul style="list-style-type: none"> – grazing and related activities – collection of wild berries and mushrooms – roads and paths – touristic activities

Given that we found the yellow-bellied toad, the common toad, and the sand lizard relatively close to the Giumalău perimeter, it is our opinion that drawing of the perimeter border exactly over the forest limit, ignoring the various neighbouring habitats, is an inefficient way to protect the biodiversity or, at least, the herpetological richness of the species.



Fig. 2. *Salamandra salamandra* adult from Slătioara Forest (Photo P.C. Dincă).



Fig. 3. Distribution of *Salamandra salamandra* in Rarău-Giumalău ROSCI0212.



Fig. 4. *Lissotriton motandoni* adult from the Slătioara Forest (Photo P.C. Dincă).



Fig. 5. Distribution of *Lissotriton motandoni* in the Rarău-Giumalău site – ROSCI0212.



Fig. 6. *Ichthyosaura alpestris* male from the Slătioara Forest (Photo P.C. Dincă).



Fig. 7. Distribution of *Ichthyosaura alpestris* in the Rarău-Giumalău site – ROSCI0212.



Fig. 8. Specimen of *Bombina variegata* from Rarău (Photo P.C. Dincă).



Fig. 9. Distribution of *Bombina variegata* in Rarău-Giumalău ROSCI0212.



Fig. 10. Pair of *Bufo bufo* in amplexus and clutch – Rarău (Photo S.R. Zamfirescu).



Fig. 11. Distribution of *Bufo bufo* in Rarău-Giumalău ROSCI0212.



Fig. 12. *Rana temporaria* adult from Rarău (Photo A. Strugariu).



Fig. 13. Distribution of *Rana temporaria* in Rarău-Giumalău ROSCI0212.



Fig. 14. *Anguis colchica* adult from Giupalău (Photo S.R. Zamfirescu).



Fig. 15. Distribution of *Anguis colchica* in Rarău-Giupalău ROSCI0212.



Fig. 16. *Lacerta agilis* adult from Rarău (Photo P.C. Dincă).



Fig. 17. Distribution of *Lacerta agilis* in Rarău-Giumalău ROSCI0212.



Fig. 18. *Zootoca vivipara* adult from Giupalău (Photo S.R. Zamfirescu).



Fig. 19. Distribution of *Zootoca vivipara* in Rarău-Giupalău ROSCI0212.



Fig. 20. *Vipera berus* adult from Rarău (Photo A. Strugariu).



Fig. 21. Distribution of *Vipera berus* in Rarău-Giumalău ROSCI0212.

SPECIES CONSERVATION

Among the ten species of amphibians and reptiles that have been recorded in the studied area, nine are under various protection levels (Table 3).

Table 3
Species of amphibians and reptiles identified in the Rarău-Giumalău ROSCI0212 site and their conservation status

Species	N2000 Code	Directive 92/43 EEC ¹ annexe	OU 57/2007 ² annexe	Red list [20]	IUCN [21]
<i>Salamandra salamandra</i>	2351	–	4B	Vulnerable	Least concern
<i>Lissotriton montandoni</i>	2001	II, IV	3, 4A	Vulnerable	Least concern
<i>Ichthyosaura alpestris</i>	2353	–	4B	Vulnerable	Least concern
<i>Bombina variegata</i>	1193	II, IV	3, 4A	Near threatened	Least concern
<i>Bufo bufo</i>	2361	–	4B	Near threatened	Least concern
<i>Rana temporaria</i>	1213	V	4B, 5A	Vulnerable	Least concern
<i>Anguis colchica</i> ³	2432	–	4B	Vulnerable	Least concern
<i>Lacerta agilis</i>	1261	IV	4A	–	Least concern
<i>Zootoca vivipara</i>	5910	–	–	–	Least concern
<i>Vipera berus</i>	2473	–	4B	Endangered	Least concern

¹ Directive 92/43/ CEE [11]:

Appendix II – Animal and plant species of community interest whose conservation requires designation of special areas of conservation

Appendix IV – Animal and plant species of community interest in need of strict protection

Appendix V – Animal and plant species of community interest whose taking in the wild and exploitation may be subject to management measures

² OU 57/2007 [18] regarding the regime of natural protected area, conservation of natural habitats, of wild flora and fauna, adopted by Law 49/2011 [23]

Appendix 3 – Animal and plant species of community interest whose conservation requires designation of special areas of conservation and special protection areas for birds

Appendix 4A – Species of community interest – Animal and plant interest in need of strict protection

Appendix 4B – Species of national interest – Animal and plant interest in need of strict protection

Appendix 5A – Animal and plant species of community interest except bird species whose taking in the wild and exploitation may be subject to management measures

³ *Anguis colchica* is listed as *Anguis fragilis* in Appendix 4B. The populations of North-Eastern Romania previously considered as *A. fragilis colchica* [16] are now reported as *A. colchica* [19, 25].

The two species (*Bombina variegata* and *Lissotriton montandoni*) included in Appendix II of the Habitats Directive (Directive 92/43/ CEE) are the only ones listed in the standard data form [31] of the Natura 2000 site (*Lissotriton montandoni* is listed as *Triturus montandoni*, which is an older synonym). Alongside these two species, the standard data form contains species *Triturus cristatus*, which is also

listed in the Appendix II of the Habitat Directive. Despite our efforts, the presence of this species could not be confirmed in the studied area, although it has been previously recorded in the near-by locality of Câmpulung Moldovenesc [26]. In addition, none of the other identified species of community or of national interest that could have been listed as “other important species” appear in the standard data form. Thus, the current standard data form fails to reflect the diversity of the amphibians and reptiles of the site. Consequently, management measures may ignore the unlisted species, which creates the premise of their conservation status alteration. Thus, based on our field investigation, we recommend updating of the information regarding amphibians and reptiles in the standard data form of the ROSCI0212 Rarău-Giumalău.

3. CONCLUSIONS

Our investigations on the amphibian and reptile fauna of the Rarău-Giumalău Natura 2000 site ROSCI0212 revealed the presence of ten species: six amphibians (*Salamandra salamandra*, *Lissotriton montandoni*, *Ichthyosaura alpestris*, *Bombina variegata*, *Bufo bufo* and *Rana temporaria*) and four reptiles (*Anguis colchica*, *Lacerta agilis*, *Zootoca vivipara* and *Vipera berus*).

Species distribution is generally influenced by climatic variation and suitable habitat availability. In some areas of the site, species distribution may be influenced by human activities, among which the one with the most harmful impact is grazing and related activities. All these alter both individuals and their habitats.

All species were present in the Rarău perimeter, whereas only six were confirmed in the Giumalău perimeter. This difference may be the result of a lower habitat diversity in Giumalău perimeter, that was probably designed to protect only the forest, disregarding the whole biodiversity.

Among the identified species of amphibians and reptiles, nine are protected by European and national regulations. However, only two species are listed in the standard data form of the Natura 2000 site. In addition, the standard data form lists a species whose presence was not confirmed through our field investigations. Thus, the standard data form, a tool for protective management, does not reflect the situation of the herpetofauna of the site and therefore, it should be updated.

Acknowledgements. We thank Petronel Spaseni, Cristina Strugariu, Rada Zamfirescu and Oana Zamfirescu for their invaluable assistance during the field surveys, and also Emil Palamaru for providing information regarding routes and accommodation in the study area. This paper was funded by the “Al. I. Cuza” University of Iași, as project 06/3.12.2015, code: GI-2015-03, Grant Competition for Young Researchers of UAIC.

Authors contributions: All authors had equal contributions to this study.

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Received March 12, 2016