

HERPETOFAUNA OF THE NATURAL RESERVES FROM CAREI PLAIN: ZOOGEOGRAPHICAL SIGNIFICANCE, ECOLOGY, STATUTE AND CONSERVATION

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Abstract. The three natural reserves from Carei Plain harbour 11 species of amphibians, 7 species of reptiles and populations of the hybrid *Rana kl. esculenta*. The reserves conserve two extremely important categories of habitats: wetlands represented by large swamps and dry habitats represented by sand dunes. The first category of habitats maintains the glacial relict species attached to a moister and colder climate and from the second it is present *Podarcis taurica*, an element of dryness and higher temperatures that reaches in the region the northern limit of its distribution range. The overlap of these two groups of herpetofaunal elements is unique for the region, representing one of the defining particularities of the zone. At present, this is possible due to the special inlay of the area's habitats.

Key words: herpetofauna, Carei Plain, nature reserves, ecology, conservation, zoogeography

1. INTRODUCTION

Understanding the composition, distribution and ecology of herpetofauna from protected areas is an actual study direction at European level (Kati et al., 2007). Establishing the geographical distribution of a group is the first step in estimating abundance and settling up the local priorities of conservation (Haila & Margules, 1996), no efficient program of protection can be realized in the absence of these

information (Ghira et al., 2002). Data concerning the biodiversity from Romania are still missing at European level (Hartel et al., 2008), although in the past years there were carried out studies regarding the herpetofauna of some protected zones from the country (Covaciu-Marcov et al., 2008a, 2009, Gherghel et al., 2007, Strugariu & Gherghel 2008, Rozyłowics, 2008). The reserves from Carei Plain are some of the few protected zones from Romania situated in the Pannonian biogeographical region (EEA 2001). The Carei Plain displays a remarkable variety of habitats that resembles a mosaic, represented predominantly by an alternation of sand dunes and interdunes occupied by large marshes. In addition, in the region, there are recorded some anomalies from the general situation concerning the distribution and ecology of some species from Romania, for example there were noticed here several lowland populations of *Zootoca vivipara* (Covaciu-Marcov et al., 2008b). All these emphasize the uniqueness of the region, underlining the demand of knowledge about its herpetofauna for the purpose of an adequate protection.

The aims of the study were: **i.)** establishing the composition of the reserves' herpetofauna, **ii.)** estimating the effectives of the identified species' populations, **iii.)** assigning the rare, vulnerable and important species from the territory, **iv.)** determining the most important zones for different species, the used habitats and the vital habitats for their conservation, **v.)** evaluating the anthropic impact, the main threats against the herpetofauna.

2. MATERIALS AND METHODS

The field activity was carried out in autumn 2007 and along the warm season of the year 2008. Previously, our team had realized studies regarding the herpetofauna of Satu-Mare County (Covaciu-Marcov et al., 2004, 2005a,b), including the areas from the western part of it (Covaciu-Marcov et al., 2008c). However, these studies do not discuss about the herpetofauna of the three reserves. Thus, in the present paper, only the protected zones (*Vermeș Marsh*, *The Sand Dunes from Foieni* and *The Forest from Urziceni* – Fig.1.) and the buffer sectors around them are included, the study being realized from an ecological and zoogeographical point of view and not from a faunistical one.

The transects method was used (Cogălniceanu, 1997) and there were made several in all habitats from the region, from where we identified the species and counted the individuals. The transect method has been recently applied in other similar studies as well (Kati et al., 2007), being efficient excepting the snakes because of their life style. Transects were made in all periods of the year, both day and night. In every month there were performed three days of field activity, starting from March. The animals were not usually captured rather being used the direct observation method (Brown, 1997). Nevertheless, some situation required the capture of certain individuals, this being generally realized by hand. We used nets for newts at spring, in turbid waters, when the animals could not have been identified visually or for green water frogs with large size which move quickly. After identification and sometimes photographing, the captured animals were released in their habitats. Occasionally we also determined the animals killed by local people or cars.

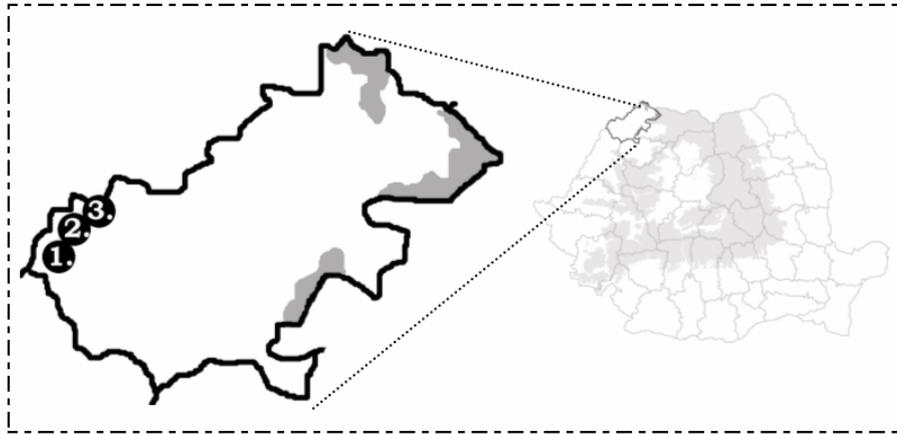


Figure 1. The geographical position of the Natural Reserves from the Carei Plain (1.-The Vermeș Marsh; 2.-The Sand Dunes from Foieni; 3.-The Forest from Urziceni;)

The estimation of effectives of the populations was fulfilled with the use of quantitative transects about different type of habitats. Thus, we counted the individuals along transects of different length and different time frame, in the most favourable periods for the meeting of each species. Then, we extrapolated these results for the entire territory of the involved habitat relating to the entire studied zone. In the case of amphibians we numbered the laid clutches, in the breeding season. For newts the estimation was made in their breeding period, in the aquatic environment by pulling out the individuals from populations, these data, however, being only informative due to the size of the lowland aquatic habitats.

3. RESULTS

The three natural reserves from Carei Plain and their neighbouring areas host 18 species of the herpetofauna and one category of hybrids between amphibian species (Tab. 1). There are no great surprises concerning the composition of the herpetofauna compared to the surrounding areas, only *Anguis fragilis* was recorded for the first time in the region, although its presence was known in the neighbouring zones from Hungary (Puky et al., 2005). These data indicate the utilization manner of habitats on limited areas, emphasizing the coexistence in the same territory of some species with very different ecological requirements.

The herpetofauna of the three reserves from Carei Plain is in general a typical one for the lowland regions from western Romania, a fact proved for example by the presence of *Triturus dobrogicus* (Fig. 2A.), *Bombina bombina* (Fig. 2B.) or *Pelobates fuscus*. However, there are some obvious differences and particularities of the area that place it in a special category due to the presence of *Zootoca vivipara*, *Podarcis taurica* (Fig. 2C.) species or some very large populations of green water frogs.

Table 1. Distribution of herpetofauna's species in the three reserves from Carei Plain, their Natura 2000 status and the measured approximate effectiveness

	Species presence			N2K status				AE
	VM	SD	FU	SpCA	CI-SP	NI-SP	CI-M	
Amphibians								
<i>Triturus vulgaris</i>	Yes	Yes	Yes	-	-	X	-	500-1000
<i>Triturus dobrogicus</i>	Yes	Yes	Yes	X	-	-	-	300-500
<i>Bombina bombina</i>	Yes	Yes	Yes	X	-	-	-	9000-10000
<i>Pelobates fuscus</i>	Yes	Yes	Yes	X	X	-	-	3000-5000
<i>Hyla arborea</i>	Yes	Yes	Yes	-	X	-	-	1000-1500
<i>Bufo bufo</i>	Yes	Yes	Yes	-	-	X	-	800-1000
<i>Bufo viridis</i>	Yes	Yes	Yes	-	X	-	-	1000-1300
<i>Rana ridibunda</i>	Yes	Yes	Yes	-	-	-	X	300-400
<i>Rana lessonae</i>	Yes	Yes	-	-	-	X	-	3000-5000
<i>Rana kl. esculenta</i>	Yes	Yes	Yes	-	-	-	X	3000-5000
<i>Rana dalmatina</i>	Yes	Yes	Yes	-	X	-	-	500-800
<i>Rana arvalis</i>	Yes	Yes	Yes	-	X	-	-	1000-2000
Reptiles								
<i>Emys orbicularis</i>	Yes	Yes	-	X	X	-	-	500-800
<i>Lacerta agilis</i>	Yes	Yes	Yes	-	X	-	-	2000-3000
<i>Lacerta viridis</i>	-	Yes	-	-	-	-	-	200-300
<i>Zootoca vivipara</i>	Yes	Yes	Yes	-	X	-	-	2000-3000
<i>Podarcis taurica</i>	Yes	Yes	-	-	X	-	-	800-1000
<i>Anguis fragilis</i>	-	Yes	-	-	-	X	-	50-60
<i>Natrix natrix</i>	Yes	Yes	Yes	-	-	-	-	1000-2000

Legend:

VM= The Vermeş Marsh; SD= The Sand Dunes from Foieni; FU= The Forest from Urziceni;
 N2K=Natura 2000 status; SpCA=species needed special conservation areas; CI-SP=species with community interest – strictly protected; NI-SP= species with nationally interest – strictly protected; CI-M= species with community interest with exploitation management.
 AE= Approximate effective (no. of individuals)

4. DISCUSSIONS

The reserves from Carei Plain include a diverse and special herpetofauna concerning its origin, structure, history and ecological requirements. Thus, beside the species typical for plain zones or the common and widespread species in Romania, there are many glacial relict species, together with a Balkan steppe species, *Podarcis taurica*, that reaches here the northern limit of its distribution range (Chondropoulos, 1997). The glacial relicts are represented by *Rana arvalis* (Fig. 2D.) and *Zootoca vivipara*, the latter being considered for a long time a mountainous element in Romania (Fuhn & Vancea, 1961), although it was recorded at lowlands in the neighbouring zones from Hungary (Dely, 1978a,b). Recently, it was also noticed at field in Romania

(Strugariu et al., 2006, Covaciu-Marcov et al., 2008b) in several localities from the northern part of the Western Plain where it can be observed together with *Rana arvalis* (Covaciu-Marcov et al., 2004, 2005a,b) or even with lowland populations of *Vipera berus* (Covaciu-Marcov et al., 2004). The two species appear together in the reserves from Carei Plain as well, in habitats with high level of humidity. Moreover, there are glacial relict vegetal elements in the region, like some species of Sphagnum (Ardelean & Karácsonyi, 2002).

The survival of these elements of cold climate, glacial relicts, in the plain zones can only be explained by taking into account the history and evolution of fauna in the glacial period and its postglacial dynamics. Therefore, these species probably survived in this territory including the last glacial utmost. This fact is assayed by the presence of the northernmost forest from Europe right in the Pannonian Basin in the last glacial maximum (Ravazzi, 2002, Willis & van Andel, 2004). In addition, there was recently postulated the existence of a refuge in the Carpathian Basin for certain species attached to a colder climate (Brunhoff et al., 2003, Babik et al., 2005, Ursenbacher et al., 2006). Otherwise, it is presently debated the idea of fragmentation of the different classical refuges in several sub refuges (Gomez & Lunt, 2006).

If this assemblage of species and the explanation of its presence is valid for the entire north-western part of Romania, there is added another element which makes it even more unique, the presence of a species with exactly contrary ecological requirements and history, namely *Podarcis taurica*. Though the two lizards are present in the same territory, they do not inhabit the same habitat *Zootoca vivipara* appearing in marshes and damp zones and *Podarcis taurica* in dry, sandy, usually open zones. Nevertheless, they occur exceptionally together at the border of the two habitats, solitary individuals being probably at hunting, at the limit of their main habitat. The two glacial relict species and *Podarcis taurica* are co-occurring only here and in the neighbouring zones from Hungary (Puky et al., 2005), this being, to our knowledge, the one and only region from their distribution area where such an overlapping exists.

Podarcis taurica is one of the most recently arrived species in the region, from the warmest period of postglacial, lately being noticed in Carei Plain (Covaciu-Marcov et al., 2003). Currently it is lasting here and actually its incursion was possible just because of the sand dunes which maintain a higher thermal regime. Apart from this, the related populations from Hungary seem to be isolated as well from the rest of the populations from Danube and Tisa (Dély & Kovács, 1961, Puky et al., 2005). Therefore, the entire group represent a relict of a previously wider extension of the species' area from the warm and dry periods of postglacial. The importance and uniqueness of the reserves is given by the inlaid habitats that allow the coexistence of these elements in the same territory and even their overlapping in the intermediate habitats.

Podarcis taurica arrived in the region lengthwise of Danube and Tisa, using then the springboard of the sand dunes from the zone. Thus, the habitats and landscape from here allow the coexistence of some distinctive forms concerning the ecological requirements, postglacial history and significance. In the region there are present both the glacial relicts and the most recent thermophile immigrants that seem to have turned in the meantime into relicts of the warmer period of the postglacial. As a result, on the

whole, the zone has the value of a complex refuge for different elements from different periods, being a refuge over other refuges so a refuge above refuge. This particular “stratification” is possible due to the existence of the special landscapes and habitats from the region. From this point of view, the essential particularity of the zone is given by the overlap of different refuges for elements with diverse origin, in the same territory.

In the reserves from Carei Plain there are species attached to moist zones with different levels of spreading in all the three reserves and species attached to dry zones that appear accordingly only at Foieni and less at Vermeş. The situation from Vermeş is a consequence of the considerable anthropogenic involvement on the neighbouring zones of the marsh, especially overgrazing. From the first category, beside the strict aquatic amphibian species there are also brown ranids, *Hyla arborea* (Fig. 2E.), and from the reptiles *Zootoca vivipara*. The typical aquatic species inhabit any kind of puddle beginning with the open area of the swamps to the ditches and artificial habitats. However, exceptionally, in the rainy days even the green water frogs can appear far from the marshes, on the peaks of the sand dunes. At spring, especially the *Bombina* but also the newts colonize the temporary ponds created on the fields from Foieni, where can be found hundreds of *Bombina* sp. These are dangerous habitats, at least for newts, being identified individuals with amputations likely caused by birds.

The amphibian species as the brown ranids live in the moist zones with grassy vegetation around the marshes, but in the clammy days they move quite far away from the wetland. Occasionally, at Vermeş, *Rana arvalis* gets into the agricultural lands next to the swamp. At Foieni, both brown frog species occur in the forested zones too, including the edge of the acacia plantation, but next to a permanent channel, thus they occupy similar moist zones with plentiful grassy vegetation. Between the two species *Rana arvalis* prevails clearly, being represented by large populations though in western Romania the majority of its populations are very small (Sas et al., 2006). Still in the natural oak forest with sandy substrate only *Rana dalmatina* (Fig. 2F.) is present. Hylids are very abundant in the bushes from marshy zones. *Zootoca vivipara* lives in similar habitats, in the rich grassy vegetation of permanent wetlands, which are typical habitats for the lowland populations from the west of the country (Covaciu-Marcov et al., 2008c). It occurs even beside the channels situated at skirts of forest entering also in the pasture and hay fields located next to the main habitats; at Urziceni these lizards use the hayracks as shelter in autumn.

The terrestrial species are represented by bufonids, *Pelobates fuscus*, *Podarcis taurica* and *Lacerta viridis*. Nocturnal frogs were identified even on the top of the dunes from Foieni or in the agricultural lands beside the swamp from Vermeş, the populations at least in the case of the common spadefoot being very large. *Lacerta viridis* occurs only at Foieni, mostly at the edge of the sand dunes, at the oak forest’s outskirts. However, it is also present at the edge of the acacia plantation or of the bushes or shrubs groups. *Podarcis taurica* can be found only in the open zones occupying the sand dunes from Foieni in the properly reserve as well as in the neighbouring zones. At Vermeş it appears more rarely, only in sandy zones beside the swamp. Here, the number of individuals is much smaller due to the destruction of the grassy vegetation by overgrazing.

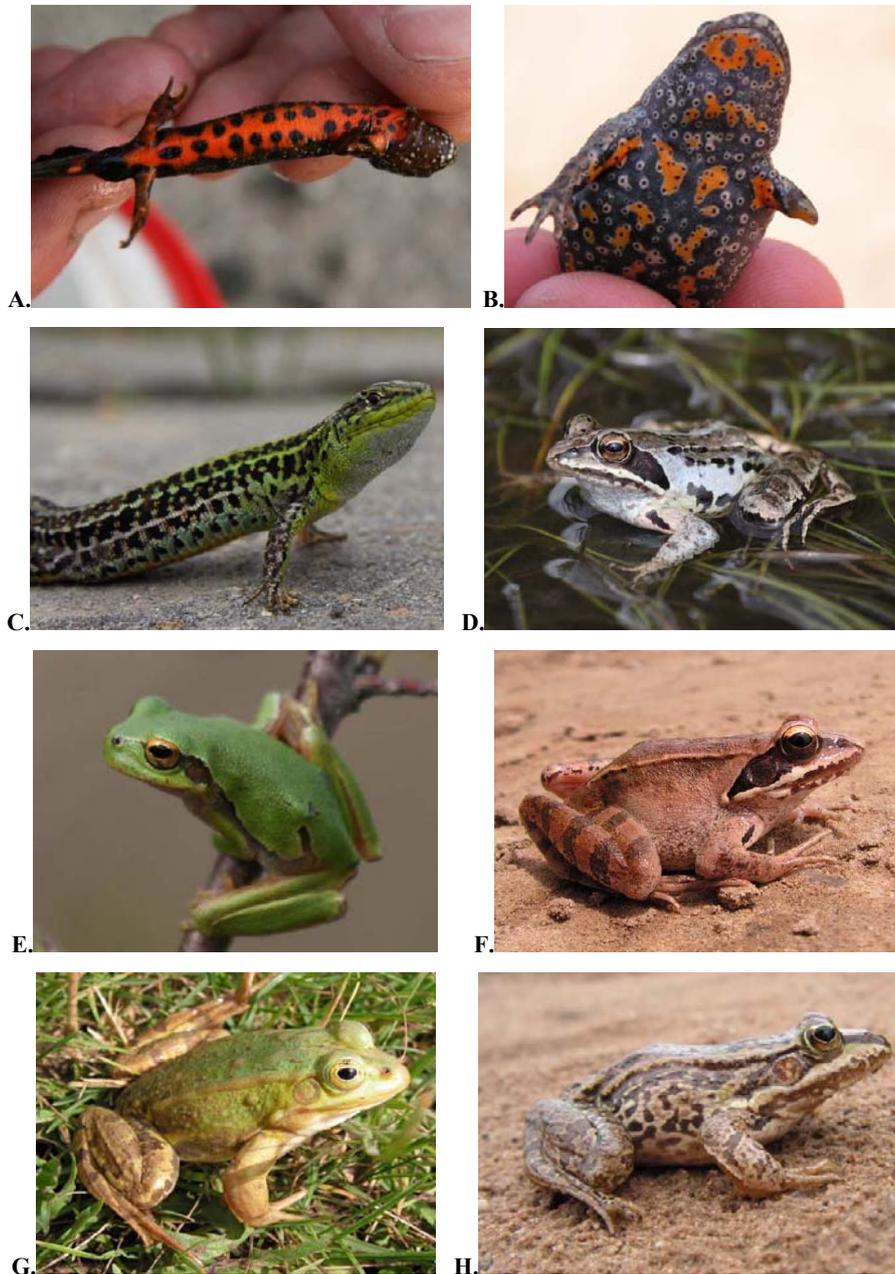


Figure 2, Photographs with some of the identified herpetofauna species from the The Vermeş Marsh
 (A.- *Triturus dobrogicus* male; B.- *Bombina bombina* male with malformation; C.- *Podarcis taurica* male; D.- *Rana arvalis* male; E.- *Hyla arborea* female; F.- *Rana dalmatina* female; G.- *Rana lessonae* male; H.- *Rana kl. esculenta* female)



Figure 3, Anthropogenic impact in the natural reserves from the Carei Plain
 (A.- Burned habitat at The Vermeş Marsh; B.- Wastes thrown at The Vermeş Marsh;
 C.- Road traffic killed *Emys orbicularis* near The Sand Dunes from Foieni; D.- Human killed
Lacerta agilis at The Vermeş Marsh; E.- Human killed *Natrix natrix* at The Vermeş Marsh)

Species relatively insensible are *Lacerta agilis*, *Anguis fragilis* and *Natrix natrix*. *Lacerta agilis* occurs both in moist and dry zones, therefore is present with all of the other lizard species. In most of the cases it appears in the moist zones with *Zootoca vivipara*. It was also observed with *Podarcis taurica* a fact considered exceptional at least in Romania because it is believed that in the south of the country the two species exclude each other concerning their distribution area and ecological requirements (Cruce, 1971).

From the three reserves the most complex landscape is at Foieni, where there are four distinct types of habitats: the marsh, the nude sand dune, the oak forest and the

acacia plantation, as well as the transit zones between them. The swamp hosts the glacial relicts and the dune the postglacial immigrant. A high abundance of species and individuals can be recorded at the limit of the swamp and forest.

There are large populations of green water frogs in the zone. What is different regarding the most of the regions from Romania is the high proportion of *Rana lessonae* species which was considered in the past, one of the rarest species in the country (Cogălniceanu et al., 2000). The species is not just common in two of the three reserves from Carei Plain but is also represented by large populations. Empirical speaking, at Vermeș there is probably the third concentration of the species from the country after Reci, north of Romanian Moldavia and maybe even Arginești. The hybrid form *Rana* kl. *esculenta* is also very abundant. Much rarer is the parental species *Rana ridibunda* though generally in western Romania this is the best represented form of the complex (Covaciu-Marcov et al., 2007). In addition, it was recently identified near Foieni an E-system population (Sas et al. 2009). Thus, in the natural reserves from Carei Plain is generally present the REL system or rarer the RE system not the E-system. We did not notice independent populations of *Rana* kl. *esculenta* (Fig. 2G.) or *Rana lessonae* (Fig. 2H.).

The three reserves from Carei Plain gain individuality in addition to the zoogeographical and ecological particularities by the presence of some very large populations of some species with conservation interest, such as *Triturus dobrogicus*, *Bombina bombina*, *Rana arvalis*, *Emys orbicularis*, etc. These are present in all reserves having favourable habitats and suitable ecological conditions. In 2008 all amphibian species bred successfully, having offspring, a fact also proved by the very large number of juveniles from that year encountered in August.

At present, the anthropogenic impact upon the reserves is not very significant, but it was very evident in the past, at least at Vermeș and Foieni confirmed mainly by the replacement of the oak trees with acacia. The actual relatively low impact on the region is a consequence of its reduced economical value which allowed the conservation of the biodiversity. This low economical value correlated with the special conservation and theoretical value will have to be emphasized in the future too by avoiding the changes in the structure of the landscapes.

The most evident human activities that affect negatively the herpetofauna of the reserves are represented by the burning of the marsh (Fig. 3A.), the wastes thrown at Vermeș (Fig. 3B.), the agriculture expanded till the edge of wetlands, overgrazing, road mortality (Fig. 3C.), mowing and occasional deforestation. The burning of the marsh was observed at spring at Vermeș, having an immediate impact upon the small sized species but killing also lizards or frogs. This is an activity that has to be completely stopped in the future, the reptiles being sensible indicators of fire-raising type anthropogenic activities (Wilgers & Horne, 2006). Mowing might also cause injuries to animals displayed by different amputations but it is an action with reduced and localized effects that might have even positive ones. Different kind of household wastes are present in all reserves but especially at Vermeș, affecting principally their aspect. Agriculture is being practised at Vermeș till the edge of the swamp and it has to be ceased any further advancement of this kind of fields in the future. Deforestation is small and realized usually by inhabitants, but at Foieni it altered larger zones of acacia plantation.

Road mortality is a phenomenon that has impact upon the herpetofauna of many regions (Krecsák et al., 2004, Tóth et al., 2006, Sos, 2007, Hartel et al. 2009), generally being the amphibians subjected to it, because they perform annually several migrations between three living habitats (Hartel et al., 2007). There were not recorded victims of the road traffic in close proximity of the reserves, still, even on the land roads with reduced traffic and low speed there are sometimes dead animals, especially frogs. The killed reptiles were represented by two snakes at Vermeş and a lizard at Foieni (Fig. 3D.-3E.), but at hundreds metres away from the proper reserves. The amphibians killed by road traffic belong to several species (*Bombina bombina*, *Pelobates fuscus*, *Bufo viridis*, *Rana arvalis*), nevertheless their number were not very high, approximately 10-20 / year / reserve. In order to avoid this threat it has to be prevented the construction of modernized roads in the neighbourhood of the reserves.

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