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The herpetofauna of the Jiului Gorge National Park, Romania

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Abstract. In the Jiului Gorge National Park we identified 11 species of amphibians (*Salamandra salamandra, Mesotriton alpestris, Triturus cristatus, Lissotriton vulgaris, Bombina variegata, Bufo bufo, Bufo viridis, Hyla arborea, Pelophylax ridibundus, Rana dalmatina, Rana temporaria*) and 12 species of reptiles (*Lacerta agilis, Lacerta viridis, Podarcis muralis, Darevskia praticola, Zootoca vivipara, Anguis fragilis, Natrix natrix, Natrix tessellata, Coronella austriaca, Zamenis longissimus, Vipera ammodytes* and *Vipera berus*). The region is characterized by the presence of several species linked to warmer climates, with Sub-Mediterranean influences, such as *Podarcis muralis, Darevskia praticola* and *Vipera ammodytes*. Darevskia praticola was recorded for the first time in both the national park and Gorj County in general. The species linked to colder and moister climates such as: *Mesotriton alpestris, Zootoca vivipara* and *Vipera berus* appear at higher altitudes than in other regions of Romania, being present only from 1100-1200m a.s.l. Species which are representative of forested, hilly and mountain areas are well represented in the National Park. Amphibians are relatively less abundant and few areas exist in which large populations are present. This fact is a result of the extreme rarity of spawning habitats, due to the steep slopes which characterize the park's landscape.

Key words: The Jiului Gorge National Park, amphibians, reptiles, distribution, conservation.

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CONTENTS

1. Introduction S02
2. Materials and Methods S04
3. Results S08
4. Discussions S39
4. 1. Previously recorded species that were absent from this study S39
4.2. Zoogeographical aspects S40
4.3. Ecology and Biology S42
4.4. Status and conservation S42
4.5. Perspectives S48
Acknowledgements S48
References S50
Appendix - Distribution maps S55

1. INTRODUCTION

The Jiului Gorge National Park (J.G.N.P.) was recently established (2005) in response to the need to increase Romania's protected areas in line with the European Union. The park is primarily comprised of highlands, the minimum altitude (300m a.s.l.) being recorded at the extreme southern limit. The J.G.N.P. lies along the sides of the Jiu River which flows for approximately 30km through a pristine gorge in the region. The Jiu is one of the most important rivers of the Oltenia region of South-Western Romania and the gorge, with characteristic landscapes and vegetation and also a lack of populated localities have both contributed to the establishment of the National Park.

Due to the recent establishment of the J.G.N.P., there are very few papers dedicated to the herpetofauna of the area. Thus, prior to the establishment of the Park, two small scale studies were undertaken (Petrescu et al 2004, Tudor et al 2004). The two papers are primarily comprised of data from previous literature, with very few observations made by the authors, some of which are erronous, along with speculations about the presence or absence of some species, based also

on the old literature. This fact is justefyable when taking into consideration the fact that these studies were relatively incomplete since they were conducted over short time periods - not sufficient for establishing the composition of the herpetofauna. Contradicting data, from a zoogeographical view point, such as the recording of Montandon's newt (*Lissotriton montandoni*) within the J.G.N.P. are also presented by these papers (Tudor et al. 2004). Apart from these papers dedicated to research within J.G.N.P., the older literature contains limited data about the presence of some species in areas located near the park (Fuhn 1960, Fuhn & Vancea 1961). More recently, data with regard to the amphibian species of the park and surrounding areas are included in the monograph dedicated to the amphibians of Romania (Cogălniceanu et al. 2000), and data on both reptiles and amphibians is included in Romanian Red Data Book of Vertebrates (Iftime 2005). The most recent data with regard to the herpetofauna of the park is presented by a study on the trophic spectrum of a crested newt population (Dobre et al. 2007).

Studies of the composition and geographical distribution of the herpetofauna of Romania are still much needed. In 2002 it was thought that the previous studies only covered approximately 5-10% of the region (Ghira et al. 2002). Knowing the geographical distribution of a species is the first step towards estimating the abundance and establishing local conservation priorities (Haila & Margules 1996). Thus, in recent years, studies of the geographical distribution of the herpetofauna of Romania have had impressing results, from a zoogeographical, faunistic and conservation point of view (Andrei 2002, Covaciu-Marcov et al. 2007a, Ghira 2007, Ghira et al. 2002, Iftime 2002, 2004, Lazăr et al. 2005, Strugariu et al. 2006, 2008). This study dirrection is a general one at a european and global level with numerous important data regarding the distribution of amphibians and reptiles being recently published (Naumov 2005, Razzetti et al. 2006, Ilgaz et al. 2005, Ghielmi et al. 2001, Göcmen et al. 2002, Olgun et al. 2007, Tóth et al. 2006, Trakimas 2005), including national parls (Kati et al. 2007). All these data should be interpreted as the support for the future conservation of the herpetofauna in the context of the global decline of this group (Alford & Richards 1999).

Therefore, the aims of the present study were:

i.) to establish the composition and geographical distribution of the herpetofauna in the J.G.N.P;

ii). To establish which species are rare, vulnerable or important in the territory;

iii). To determine the most important areas for the herpetofauna;

iv). To examine the anthropogenic impact and the main threats to the herpetofauna of J.G.N.P.;

v). On the basis of the previous aims, suggest measures to protect species at risk.

2. MATERIALS AND METHODS

The Study area

The Jiului Gorge National Park is located in South-Western Romania, in the Southern Carpathians, occupying a surface area of 11.127 Ha (Fig.1). The Jiu River flows through the centre of the park. East of the park is the Parâng Massif and the Vâlcan Mountains are to the West (Posea & Badea 1984). In the J.G.N.P., the Jiu River has several tributaries, the most important being the Chitul and Bractul rivers. The Jiului Gourge has a length of about 30km. The area located at the lowest altitude in the park (300 m a.s.l.) (Fig.2) is located in the southern area, near the town of Bumbeşti Jiu (Fig.3). The maximum altitude is around 1400-1500m a.s.l. The largest part of the J.G.N.P. is located in Gorj County, being located in the Hunedoara County only in the northern tip. The 66 National Road is present, along the Jiu River, in the central parts of the park. Other small forest roads are also present in the park. Parallel to the Jiu River and the National Road is the 202 railroad, a simple electrified line, on which 4 train stations occur within the park boundaries.

Study period

The study was conducted in the years 2007 and 2008. During this period we made 5 trips to the field, each comprising 5 days. Two trips were made in 2007 (3-7 June and 10-14 September) and three trips in 2008 (12-16 April, 26-30 May and 21-25 July). On average, 4 people were present during each trip.

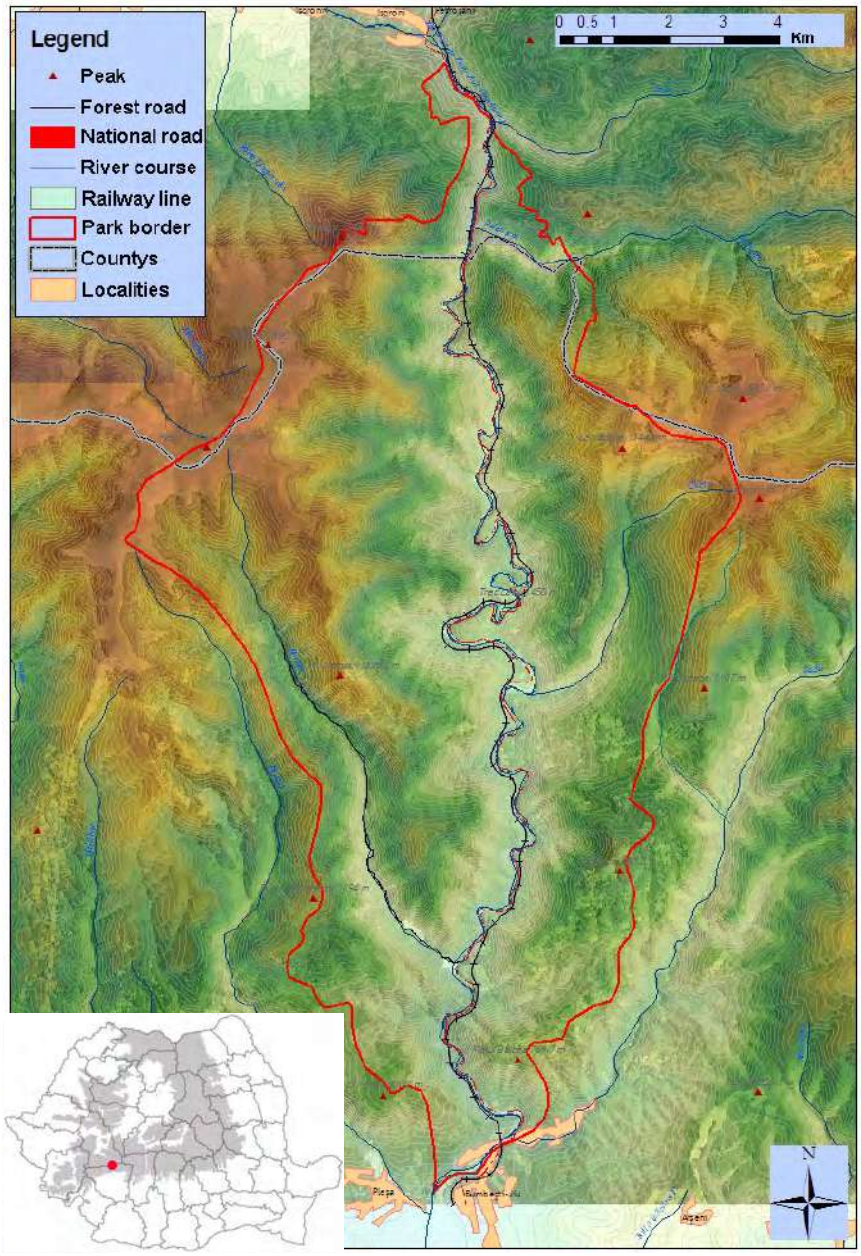

Figure 1. The geographical position and the map of the Jiului Gorge National Park

Figure 2. The Jiul River at Bumbeşti Jiu (300m a.s.l.)

Field methods

The method used to establish the composition and geographical distribution of the herpetofauna of the J.G.N.P. was by searching established transects (Cogălniceanu 1997a). We conducted numerous transects over a large area of the park, in diverse habitats, trying to investigate all the regions we perceived to be important for herpetofauna. In general, animals were identified by direct observation (Brown 1997). In the case of some amphibian species, such as *Hyla arborea,* identification was made based on calls emitted. For amphibians, we have also used surveys of egg clutches to establish the presence of several species.

In the majority of cases, animals were not captured. When animals were captured (e.g. for taking photographs), this was done by hand. During the reproductive period, amphibians were captured from the water with the help of scoop nets. In all cases, animals were subsequently released at the point of capture.

Figure 3. Landscape from the J.G.N.P. at Argele

Figure 4. Landscape from the J.G.N.P. at Bumbeşti

In addition to identifying live animals, an important role in establishing the composition and the geographical distribution of the herpetofauna of the J.G.N.P. was played by identifying dead animals, killed either directly by people or by road traffic. The best preserved specimens were collected in alcohol and are now deposited in the collections of the J.G.N.P. administration or at the University of Oradea.

Quantitative studies were not conducted. However, in the case of some species, a superficial estimation of the population numbers was attempted. Therefore, we counted the specimens of some species on transects of different lengths and time periods, in the most favourable periods for observing those species. The results were reported in comparison to the surface occupied by that specific habitat in the park's territory. In the case of amphibians, we have counted the number of egg clutches found. For newts, the estimate was made during the reproductive period, by direct counting.

3. RESULTS

We identified a total of 23 reptile and amphibian species within the Jiului Gorge National Park (Appendix 1). Of these, 11 were amphibians (*Salamandra salamandra, Mesotriton alpestris, Triturus cristatus, Lissotriton vulgaris, Bombina variegata, Bufo bufo, Bufo viridis, Hyla arborea, Pelophylax ridibundus, Rana dalmatina* and *Rana temporaria*). At the lower limit of the park, within the *Bombina variegata* populations, *B. bombina* phenotypes are present. However, on average, those populations are closer to *B. variegata,* eventually entering the *B. variegata* – like category.

Twelve species of reptiles are present in J.G.N.P.: *Lacerta agilis, Lacerta viridis, Podarcis muralis, Darevskia praticola, Zootoca vivipara, Anguis fragilis, Natrix natrix, Natrix tessellata, Coronella austriaca, Zamenis longissimus, Vipera ammodytes* and *Vipera berus*. Of these, one lizard species, *Darevskia praticola*, was recorded for the first time in the research area as well as in the whole of the Gorj County, the species being present in the area at its northern range limit. *Vipera berus* could also be considered a new species for the region due to the fact that previous papers only considered its presence in the area as probable (Petrescu et al. 2004).

Salamandra salamandra (Linnaeus, 1758) is a common species in the J.G.N.P., being recorded throughout the park (Fig.5-7), despite the fact that it was previously reported from a single location (at Meri, Tudor et al. 2004). The largest populations seem to be present in the central regions of the park with the species being rare at the northern and southern limits. In the southern area, this is may be a result of high anthropogenic pressure which has resulted in natural forests being cleared and replaced either by acacia plantations on the western side of the Jiu River or coniferous plantations on the eastern side. As a consequence of these actions, the *S. salamandra* populations have been severely affected. However, the species is still present in these areas with specimens being recorded inside the pine forest from near to the first rail road tunnel at Bumbeşti. In the northern region of the park, the landscape is very steep and lacks slow flowing streams necessary for larval development or shaded forests for the adults.

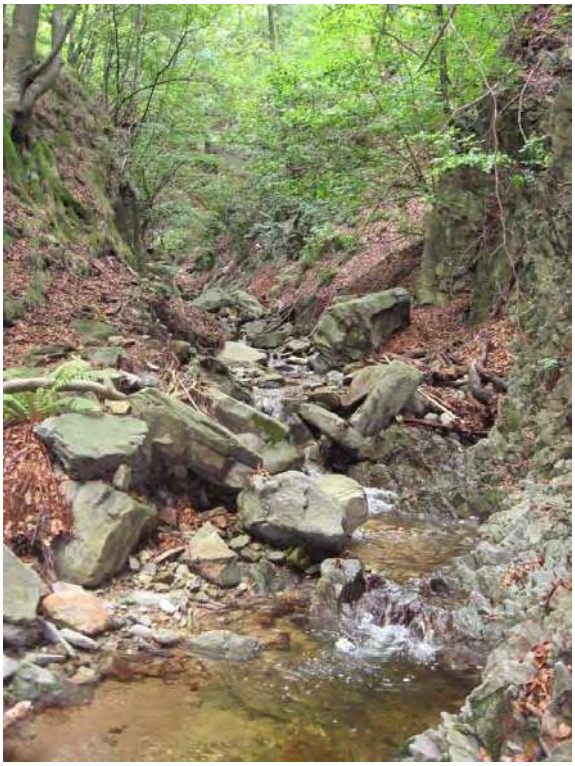

Figure 5. Habitat of *S. salamandra* at Valea Trântorului

Figure 6. *Salamanadra salamanadra* individual from Lainici

Figure 7. Habitat of *Salamanadra salamandra* at Valea Ursului

In the central parts of the gorge, there are numerous streams with a constant flow and calm areas, suitable for larval development. Natural, compact and humid beech forests with flat surfaces and thick leaf litter are present. 50-60 adults were identified along a 1 km long transect in the Chituc valley area. This number is close to those reported other regions of the species' range, where at an altitude of 400m a.s.l., in Hungary, on the "best" transects, 90 specimens can be counted per 1 km (Puky et al. 2005).

The presence of the salamander in the area was unsurprising from the zoogeographical aspect of Romania at this altitude and vegetation, being a species characteristic of European deciduous forests (Veith 1997). It is probable that several thousand individuals are present in J.G.N.P. Despite this large number, the species is affected by anthropogenic impact with numerous specimens killed by cars being recorded upstream from Lainici.

Mesotriton alpestris (Laurentus 1768) is extremely rare in J.G.N.P., being observed in only two locations, both of them east of the Jiu River, at the lower limit of the Reciu mountain meadow. In the two previous papers, the species was either reported from a locality also given by Fuhn (1960), Vulcan – located outside the park (Tudor et al. 2004) or mentioned as "certain" but with no locality mentioned (Petrescu et al. 2004). The species is present in the area at altitudes above 1200m a.s.l. despite the fact that in most regions of Romania it is present from altitudes of 500 or 700m a.s.l. (Fuhn 1960, Cogălniceanu et al. 2000) or, in the western part of the country, at altitudes of 150 or 200m a.s.l. (Micluţă 1970, Covaciu-Marcov et al. 2003a, 2005a,b, 2006a). Taking these data into consideration, we have searched for the species at altitudes of 500m a.s.l. or higher on the Trântorului and Bumbeştilor areas in April 2008 without success.

The pond at Comandă, located 900m a.s.l., resembles a typical alpine newt habitat offers a further argument for the species' range restriction. We have observed hundreds of newts belonging to all the other species at this site. However, we have not observed any alpine newts in the area, despite the altitude at which the habitat is located at or its general aspect. This high altitude range restriction is probably a consequence of the southern positioning of the park in Romania, *Mesotriton alpestris* being typically found in mountain with cold climates.

The altitudes at which the species can be found are usually higher if they are located more in the South, whilst at the northern edge of its range it can be found at sea-level (Miaud & Merila 2001). However, the average annual temperatures from the J.G.N.P. are not higher than that from western Romania where the species appears at 200m a.s.l. (Stoenescu et al. 1966).

The locations where *M. alpestris* was identified are located at the highest limit of the forests, where these come into contact with mountain meadows. In these areas, the beech forests come directly into contact with the mountain meadow as coniferous forests are absent. One of the habitats (Fig.8-9), located in the Argele mountain meadow, is represented by a system of puddles formed by a spring, which is used by *Sus scrofa.* The largest of the puddles has a diameter of 1-2 m and a depth of approximately 40cm and has no vegetation. The other habitat is a pond, about twice the size of this one, formed on a spring, near a sheep ranch.

Both these habitats are extremely vulnerable, being under a strong anthropogenic impact due to the fact that they are located in close proximity to a sheep ranch. The populations are also very small. Larval development is also a problem in these shallow waters which are affected by large mammals. Thus, *M. alpestris* is one of the most endangered amphibian species from the J.G.N.P.

Triturus cristatus (Laurenti 1768) is also rare in J.G.N.P., being identified in only four locations. It is present from the lower limit of the park to the pond at Comandă (Fig.10), at altitudes between 300 and 900m a.s.l. The pond from Comandă is the only stabile newt habitat in the park, being inhabited by a viable population. In two of the habitats we have captured only 1-2 animals. These are a puddle from the Trântorului Plateau and a man made canal, located on the edge of the railroad, at the entrance of first tunnel from Bumbeşti. The fourth habitat, the pond from the Meri train station, although large and permanent, is under a constant pressure from use by waterfowl. In 2007, 30 specimens were observed but in April 2008, less than 10 newts could be seen.

In the pond at Comandă, around 100-200 specimens are probably present. No other stabile populations have been found in the park despite intense searches. This is probably a result of the rarity of suitable spawning habitats. The slopes are very steep and the valleys very narrow resulting in few ponds establishing naturally. The population from the pond at Comandă is also threatened by the fact

Figure 8. Habitat of ***Triturus alpestrtis*** at Argele

Figure 9. ***Triturus alpestrtis*** individual from Argele

Figure 10a. Habitat of *Triturus cristatus* and *Lissotriton vulgaris* at Comandă

Figure 10b. *Triturus cristatus* individual from Comandă

that the pond is used by cattle and polluted with excrement. Also, the local people have introduced *Carassius* fish in the pond, thinking they will survive at 900m a.s.l. *T. cristatus* frequently cohabitates with *Lissotriton vulgaris.* We have not identified it cohabitating with *M. alpestris,* the latter species only appearing by its self despite the fact that in other regions, the three species can frequently be observed in the same habitats (Covaciu-Marcov et al. 2005a,b, 2006a, 2007b). This fact is a consequence of the high altitudes at which *M. alpestris* is found in the J.G.N.P.

Lissotriton vulgaris (Linnaeus, 1758) is much more widespread than the previous species in J.G.N.P., being recorded in 5 locations. As with the previous species, the largest population of smooth newts has been recorded at the pond in Comandă (Fig.12), where several hundred specimens reproduce. Only a few specimens have been observed in the other habitats (Fig.11,13). These are in either small temporary ponds inside the forest or at the forest's edge or by artificial habi-

Figure 11. Artificial habitat of *Triturus vulgaris* at Lainici

Figure 12. *Lissotriton vulgaris* individual from Comandă

Figure 13. Artificial habitat of *Lissotriton vulgaris* near Meri railway station

tats such as concrete pools, polluted with various waste products from tourists. This species is also severely affected by the rarity of its breeding habitats and those existing habitats are threatened by the same factors as mentioned for the previous species. It is therefore, important that the degradation of the existing habitats be stopped and that artificial habitats are constructed.

Bombina variegata (Linnaeus, 1758) (Fig.14) is one of the most common amphibian species from J.G.N.P. It is present from the lower altitudinal limit of the park, at 300m a.s.l., up towards the limit of the mountain meadow at 1200-1300m a.s.l. It is relatively uniformly distributed throughout the park, inhabiting streams and temporary puddles (Fig.15) due to the rarity of larger water accumulations. The species is also present, in large densities, in artificial habitats such as concrete pools and road side ditches. The number of observed specimens was very high, probably exceeding 10,000. However, the species is subjected to anthropogenic stress factors. For example, in the Meri quarry, a population disappeared during the autumn of 2007 due to the quarry related activities which completely destroyed the habitats.

We observed a single specimen of *B. bombina* (Fig.16) with a population of *B. variegata* in an artificial ditch on the edge of the railroad near Bumbeşti at the lower altitudinal limit of J.G.N.P. (at 300m a.s.l.). This specimen only presented 15% of the features of *B. variegata*, which in Romania usually represents a relatively "pure" *B. bombina* specimen (Covaciu-Marcov et al. 2003b, 2005c, Vesea et al. 2004). However, the distinct presence of the species in the area cannot be accepted due to the large number of *B. variegata* specimens in that population. Thus, the presence of the *B. bombina* phenotype is probably an accident. However, the situation could also be explained by the fact that, further south, the Jiu River valley has a meadow like appearance, with flat surfaces, acting as a gateway for *B. bombina.* Therefore, prior to anthropogenic disturbance of the area, *B. bombina* may have been present up to the lower limits of the mountains, which currently is the limit of the actual park. However, the species has not been recorded this far upstream on the Jiu River (Cogălniceanu et al. 2000, Iftime 2005).

Five specimens with intermediary features have also been recorded in the previously mentioned population, a fact which supports the previously postulated

Figure 14. *Bombina variegata* individual from Valea Chitu

Figure 15. Habitat of *Bombina variegata* at Tăul Porcului

hypothesis. Another acceptable scenario would be that, at the lower limit of the park, there exists a residual hybrid sector, in which *B. bombina* recently disappeared due to anthropogenic factors. A similar situation, only in the case of *B. variegata* has been previously reported in the Marghita region of the Bihor County (Covaciu-Marcov et al. 2004a). These data indicate the necessity for further studies on the populations in J.G.N.P. including identifying their taxonomic position, as well as surveying for B. *bombina* downstream from the park and the Bumbeşti Jiu area.

Figure 16. The single *Bombina bombina* individual observed at Bumbeşti

Bufo viridis (Laurenti, 1768) (Fig.17) is only present in the southern part of J.G.N.P., where it is relatively common, despite the fact that one of the previous studies have failed to identify it in the park (Petrescu et al. 2004). *B. viridus* was observed upstream from Meri, along the Bratcului valley. For example, in the Meri train station specimens could be readily observed at night under the lights from the station.

In the north of the gorge, the species was not observed. The fact is supported by the absence of the species in the Pietrele Albe train station where it should be as

well represented as at Meri. The Pietrele Albe train station is also equipped with night lights. Despite visiting the train station on several nights, on three separate occasions and at different times, we failed to observe any green toads. This absence might be a result of lack of breeding habitats. The most significant anthropogenic impact upon this species is likely to be via road mortality.

Bufo bufo (Linnaeus, 1758) is much rarer than the previous species, being observed in only two locations: on the road near Lainici and in the pond from Comandă. Also, the number of observed specimens was very small. At Lainici we only observed one specimen dead on a road and at Comandă, egg clutches deposited by 2 – 3 females. The rarity of the species is likely to be a consequence of the rarity of breeding habitats for this species, which prefers larger, more permanent accumulations. Also, the rarity of the common toad could be related to the general low abundance of the elements more characteristic of cold, moist areas in J.G.N.P. For this rare species, road mortality may be an important problem.

Hyla arborea (Linnaeus, 1758) (Fig.18) has a distribution similar to that of the green toad, being present only in the southern sector of the park, where it is very abundant. Large numbers of specimens were observed and heard calling (males) during rainy periods. The absence of the species from the northern parts of the park is firmly indicated by the fact that no specimens were seen or heard. *Hyla arborea* is one of the species less subjected to anthropogenic stress factors. Thus, its rarity in the region must also be related to the general rarity of breeding habitats.

Pelophylax ridibundus (Pallas 1771) is a very rare species in J.G.N.P., being recorded in only 4 locations. Three of these are in the southern limit of the park, being represented by the main body of the Jiu River itself, in areas where the water flows more slowly. The fourth location is localized inside the gorge, in the Meri train station. It is a large, artificial pond, filled by a spring located between the train tracks and the mountain slope. Several specimens (probably around 20) are

Figure 17. *Bufo viridis* individual from Meri

Figure 18. *Hyla arborea* individual from Plaiul Trântorului

present here and form an isolated population. It is probable that the presence of the species in the area has an anthropogenic origin, being linked to the actions with regard to the railroad.

The rarity of the species in J.G.N.P. is expectable, Romanian populations of *R. ridibunda* are typically associated with large, permanent, vegetated aquatic habitats in the lowlands (Cogălniceanu et al. 2000). Thus, despite the fact that from an altitudinal point of view the species could inhabit the majority of the park, the topology of the habitats and relief stop the species from migrating inwards. Downstream from Bumbeşti Jiu, in the wetlands from the river meadow, the species is much more common.

Rana dalmatina (Bonaparte 1839) is relatively well represented in region, being present throughout the national park. It is present from the 300 to 1200m a.s.l. This altitude is very high for this species in Romania, its previously known superior limit being 900m a.s.l. (Cogălniceanu et al. 2000, Iftime 2005). The presence of the species at high altitudes is probably possible due to the warm influences coming from the south, the species climbing to higher altitudes in other regions as well (Cabela et al. 2001).

Despite the relatively uniform distribution of the species, the populations are numerically reduced, with few specimens being observed on a regular basis. It is present, but much rarer, in the plantations at the lower limit of the park. This fact is a consequence of the rarity of the breeding habitats. In the upper sector of the park, towards Petroşani, the small number of observed specimens is likely to be a consequence of consumption of the frogs by local people. The most important anthropogenic factor which affects the species, which we have observed, is road mortality. During the two year survey we have only observed 10 specimens dead on the road.

Rana temporaria (Linnaeus 1758) is also a well represented species in J.G.N.P. but it is absent from the extreme southern tip of the region. Otherwise, it is uniformly distributed in the park, from 350m a.s.l. to 1300m a.s.l. As in the case of the previous species, the populations are small, a reflection of the rarity of breeding habitats (Fig.19). At the limit of the mountain meadow it reproduces in

Figure 19a. *Rana temporaria* individual from Valea Chitu

Figure 19b. Habitat of *Rana temporaria* at Valea Chitu

streams and in thousands of larva can be observed waterholes dug up by *Sus scrofa* which are in many cases temporary.

In the area towards Petroşani, the rarity of this species could also be due to local consumption of the frogs. In many areas, *R. temporaria* was likely to have been affected in the past by clear cutting, which destroyed entire populations. Even if the forests are naturally regenerating, the frog populations recover at a slower pace, being affected by the destruction of their breeding sites and by limited food resources.

As with the case of *Rana dalmatina,* occasional specimens killed on roads have been observed. The small number of dead specimens is also a reflection of the small size of the populations. Thus, we stress the need for protecting this species in J.G.N.P. by establishing artificial breeding ponds.

Lacerta agilis (Linnaeus 1758) (Fig.20) is an uncommon species in J.G.N.P. despite the fact that in other regions of Romania it is the most common lizard species (Covaciu-Marcov et al. 2000, 2002, 2003a,b, 2004b, 2005a,b, 2006a,b). However, the sand lizard is present in most of the park's territory. Most populations are very small and a few, isolated, specimens have been observed in the more humid areas. The status of the species in the area is also a consequence of the southern position of the park in Romania and its sub-Mediterannean influences.

Even if the species is present throughout J.G.N.P., it is more abundant at altitudes of over 700m a.s.l. In the extreme southern part of the park, south of Meri, we have not observed any sand lizards but it is most likely that the species is present in the area but is less common. The only region of the park where the species is well represented, reaching an abundance similar to other regions of its range is the Cândreț Massif, located in the extreme north of the park. This peak, however, has a northern exposure, towards the Petroşani Depression resulting in a cooler and moister climate. Here, *L. agilis* is wide spread, from the level of the Jiu River up 1300m a.s.l under the Cândeț Peak. The species constantly reaches 1200-1300m a.s.l., being observed in the vegetation along streams and small rivers in the mountain meadow at Reciu. It is also present at forest margins and forest openings. It is also present in moist meadows but only in the area under the Cândeț Peak. It is also present in the Lainici train station on the No. 3 Railway

which is abandoned, in moist areas near the forest and the ditch between the railway and the forest.

Figure 20. *Lacerta agilis* adult male from Plaiul Trântorului

Lacerta viridis (Laurenti 1768) (Fig.21) was observed in more localities than the *L. viridis* but its total distribution within J.G.N.P is more reduced. *L. viridis* is present in the southern areas of the park and upstream along the Jiu River, in addition to wider areas along the more important tributaries of the park, such as the Chitu and Bratcu. The species is limited to 600m a.s.l. in the southern areas. *L. viridis* wide distribution and high abundance is also a consequence of the southern location of the park. *L. viridis* is present on steep slopes with rock covering and bushes, road margins, forests and areas with plantations. Numerous specimens are present on the railroad embankments almost throughout the park, this being one of the most favourable habitats of the species in the area.

Figure 21a. Habitat of *Lacerta viridis* and *Podarcis muralis* at Bumbeşti

Figure 21b. *Lacerta viridis* individual from Bumbeşti

Podarcis muralis (Laurenti, 1768) (Fig.22-23) is the species of lizard which is best represented in the J.G.N.P. This is especially true if we refer to the number of locations where we observed the species as well as the number of observed specimens. *P. muralis* occupies an area similar to that of *L. viridis*. The wall-lizards are present mainly along the Jiu River but also reaches the valleys of the main tributaries Chitu and Bractu, reaching an altitude of 900m a.s.l. The populations are extremely large, probably totalling tens of thousands within the park. The abundance of the species in the area is also an indicator of the sub-mediterannean influences which are felt in the region. It is present along road margins, rocky outcrops and railroad embankments. In the Pietrele Albe train station, *P. muralis* is readily observed on the concrete supporting walls that protect the railroad from landslides.

Zootoca vivipara (Jacquin, 1787) (Fig.24-25) is much rarer than the previous species, being observed in very few locations. The viviparous lizard is present only in areas located at an altitude of 1200m a.s.l. or more, in many cases, appearing only at the limit of the mountain meadow. Generally, the species is observed at altitudes higher than 800m a.s.l. in Romania (Fuhn & Vancea 1961) but, in northern Romania, in the Oaş region it can be found in lower areas (Covaciu-Marcov et al. 2004b). We have not identified the species at lower altitudes in the park, despite our effort. *Z. vivipara* can be found at 900m a.s.l. in the Polatiştei Valley, outside the park's boundaries However, the cool mountain conditions found there are generally more characteristic of the species.

In the J.G.N.P., *Z. vivipara* is present in moist forest margins, at the limit of the mountain meadow or in the vegetation on the edges of streams. On the Polatiştei valley the species is also present on piles of old logs near the river. The rarity of the species and its isolation at altitudes higher than in other parts of the country is another indicator of how the different climate within J.G.N.P. and of the mechanisms which control the partition of the herpetofauna in the region. Even if the species is present at high altitudes, it was never observed in the actual mountain meadow but only at its lower limit, in areas with bushes.

Figure 22. Habitat of *Podarcis muralis* and *Vipera ammodytes* at Valea Chitu

Figure 23. *Podarcis muralis* adult male from Meri

Figure 24. *Zootoca vivipara* adult female from Reciu

Figure 25. Habitat of *Zootoca vivipara* and *Vipera berus* at Tenia-Dumitra

Darevskia praticola (Eversman 1834) (Fig.26) is the rarest species of lizard recorded within J.G.N.P., being observed in only one location (Meri). *D. praticola* is a thermophilous species, being at its northern range limit in Romania (Darevsky 1997). We have now recorded the species for the first time in the region as well as in the Gorj county as a whole. The species is present above the tunnel from south of the Meri train station, at 400m a.s.l. Its habitat is characterised by a meadow with dense herbaceous vegetation, in close proximity to a beech forest. It is highly probable that this represents the northern limit of the populations within the region, the colonisation of such a northern place being made possible by the warm air influences from the south which permits the existence of a climate with sub-Mediterranean influences.

Anguis fragilis (Linnaeus, 1758) (Fig.27) is a constant presence in the J.G.N.P, being found throughout. It is present in natural forest areas but was also observed in meadows or near the forests. The number of the specimens observed was very high suggesting it is extremely abundant.

A. fragilis is likely to be the reptile species most affected by anthropogenic pressure within J.G.N.P. This is particularly apparent during their reproductive period in May, when numerous individuals are killed by cars and people. It was not uncommon to observe 3 dead slow-worms per day during our survey. The large number of dead specimens (Fig.28) is also a probable indicator of the large size of the populations, but also an indicator of the necessity of protecting the species. The number of observed specimens indicates optimum conditions for the species in the park. *Anguis fragilis* was observed up to 1300m a.s.l., at the limit of the mountain meadow from Reciu.

Natrix natrix (Linnaeus, 1758) (Fig.29) is a rare species in the J.G.N.P., being recorded in a small number of locations. Also, the number of observed specimens is low. This is an important aspect considering that in other regions of Romania it is the most common snake species (Covaciu-Marcov et al. 2000, 2002, 2003a,c, 2004, 2005a,b, 2006a,b, 2007b). The three locations where we have observed the species are located in the central and northern sectors of the park. The species is present at

Figure 26a. Habitat of *Darevskia praticola* near Meri Railway Station

Figure 26b. *Darevskia praticola* individual from Meri Railway Station

Figure 27. *Anguis fragilis* individual from Meri

Figure 28. Human Killed *Anguis fragilis* individual at Argele

Figure 29a. Habitat of *Natrix natrix* near Lainici railway Station

Figure 29b. *Natrix natrix* individual from Lainici

the railroad from the Lainici train station but it also appears in forested and rocky areas, up to 800m a.s.l.

Natrix tessellata (Laurenti, 1768) is better represented than the previous species, being found along the Jiu River in addition to its main tributaries in the Bratcului valley. The records of this fish-eating species are important considering the fact that the Jiu River was, until recently, extremely polluted. The presence of the dice snake in the Jiu River suggests that the river is improving at present. It is possible that during the time of maximum pollution levels in the Jiu River, the snakes persisted by retreating to the main tributary rivers and subsequently re-colonized the Jiu. A future perspective will be to analyze the effect of the hydrotechnical work currently in progress on the dice snake populations. A small number of fatalities have been recorded as a result of traffic.

Coronella austriaca (Laurenti, 1768) is a rare species in J.G.N.P, being observed in only two locations. The species is present at forest margins and on the edges of forest roads which go along the main tributary rivers of the Jiu, the Bracul and Chitul rivers. This might be evidence that the species tries to avoid areas which are affected by anthropogenic impact. The fact that both of the observed specimens were juveniles might suggest that the species is well represented but more difficult to observe.

Zamenis longissimus (Laurenti, 1768) is the most commonly recorded snake within J.G.N.P. This is surprising, given its general rarity in western Romania (Covaciu-Marcov et al. 2000, 2002, 2003a,b, 2004b, 2005a,b, 2006a,b). The high abundance of the species is also a consequence of the sub-Mediterranean influences of the area, especially from the southern region.

The Aesculapian snake is frequently observed along the Jiu River and along its main tributaries from the region, up to an altitude of 600m a.s.l. The highest number of specimens was observed at the southern limit of the park. *Z. longissimus* inhabits forest and road margins, railroad embankments, and even in the train

stations, where they bask on different concrete elements. *Z. longissimus* uses the signal boxes, or concrete tubes which covers the different wires, from the railway stations as refuges (Fig.30). A large number of specimens fall victim to road traffic, particularly in the southern region of the park. During our survey we counted 10 dead specimens and rescued one juvenile which was basking on the road in the Bumbeşti area. The area is inhabited by very large specimens in comparison to other regions of the country, with individuals with lengths of 180 cm being recorded.

Vipera ammodytes (Linnaeus, 1758) (Fig.31-32) is relatively well represented in the study area but its presence is restricted to the lower regions. The nose-horned viper is present along the Jiu River and its tributaries. The number of observed specimens was typically high. For example, during a period of 30 minutes in a survey conducted in April, we observed 4 specimens near the Jiu River, upstream from the Meri caban. The number of juvenile specimens observed was also high. The species is a thermophilous species present in Romania at its northern range limit and its presence in the study area is also a reflection of the southern influences which are felt there. It inhabits rocky areas located in forested sectors and the forest road margins which follow the Chitu and Bratcu valleys. Due to its habitat preferences it does not frequently come into contact with humans and no killed specimens have been found.

Vipera berus (Linnaeus, 1758) (Fig.33) is much rarer than *V. ammodytes*, being present in a much smaller area of J.G.N.P. Its range is similar to that of the viviparous lizard probably as a result of their similar ecological requirements (Sugren 1957). The presence of the two species in the same habitats has previously been observed in other regions of Romania as well (e.g. Covaciu-Marcov et al 2004b). The species is present at a minimum altitude of 1100m a.s.l., from the limit of the mountain meadow. However, the number of observed specimens was high. At Mt. Tenia, in June 2007, six specimens were observed in one day. *V. berus* typically inhabits forest margins, areas with shrubs and dense herbaceous vegetation. Due to its high altitudinal range it is unlikely to be impacted by anthropogenic pressures.

Figure 30a. Habitat of *Zamenis longissimus* near Lainici railway station

Figure 30b. *Zanemis logissimus* individual from Lainici

Figure 31. Habitat of *Vipera ammodytes* at Meri

Figure 32a. Self attack of a *Vipera ammodytes* individual from Meri

Figure 32b. The same*Vipera ammodytes* individual from Meri

Figure 33. *Vipera berus* individual from Dumitra

4. DISCUSSIONS

4. 1. Previously recorded species that were absent from this study

Our study established the certain existence of 23 reptile and amphibian species within J.G.N.P. Four other species have been mentioned as being present, or probably present, in the area (Petrescu et al. 2004, Tudor et al. 2004). These are *Lissotriton montandoni, Bombina bombina, Pelobates fuscus* (Tudor et al. 2004) and *Testudo hermanni* (Petrescu et al. 2004). These records are highly questionable from a zoogeographical point of view. During our two year study we have not observed any of these species despite the effort invested in fieldwork.

The most important problem is that of the record of the Montandon's Newt *Lissotriton montandoni.* Its presence in the J.G.N.P. is highly unlikely since it is endemic to the Tatra Mountains and some areas from the Carpathians Mountains (Cogălniceanu et al. 1997b). In Romania it is present up to the Mâra valley from the Iezer Mountains (Cogălniceanu et al. 2000, Iftime 2005). This is the closest area to the J.G.N.P. where the species has previously been recorded - several hundred kilometres away and separated by several natural barriers. The presence of the species in the J.G.N.P. is impossible from a zoogeographical view point particularly given the fact that no authors have reported *L. montandoni* from anywhere between the J.G.N.P. and the Iezer Mountains. Consequently, we consider that the recording of *L. montandoni* in the J.G.N.P. is the result of a misidentification of *L. vulgaris* specimens. Numerous *L. vulgaris* specimens with relatively uniform ventral coloration are present in the park and these could have been more easily mistaken for *L. montandoni*.

Also, we consider that *Testudo hermanni* is not present in the J.G.N.P., although its presence in the region was considered plausible (Pestrescu et al. 2004); given the fact that *T. hermanni* is well represented in the neighbouring county of Mehedinți (Iftime 2005). However, the areas in which the species is present in Mehedinți have a warmer climate (Stoenescu et al. 1966, Mândruț 2006). In addition, the primary vegetation of the park (Beech forests) is different from that of areas inhabited by tortoises which are typically found in rare, open forests with rich undergrowth (Rozylowicz et al. 2003, Rozylowicz 2008). Therefore, whilst the presence of *T.*

hermanni would be somewhat possible from a zoogeographical view point, the Hermann's tortoise is absent from the J.G.N.P. due to ecological aspects. It is also difficult to believe that in 25 days of field work, a species as visible would not have been observed.

The previous reports of two species characteristic of the plain areas (*Bombina bombina* and *Pelobates fuscus*) within J.G.N.P.is also considered unlikely. These species were reported from far upstream of the Jiu River, up to Lainici and even Pietrele Albe (Tudor et al. 2004). In the case of *Pelobates fuscus,* its presence would be possible from an altitudinal point of view but it is contradicted by the hard soil of the park, unsuitable for the burrowing toad species such as this (Fuhn 1960). *B. bombina* is not acceptable either zoogeographically or ecologically, being linked to the plain areas with large, permanent water accumulations (Madej 1973). However, the presence of the species is acceptable at and in close proximity to the southern limits of the park, where similar phenotypes appear amongst *Bombina variegata* populations, as was mentioned at the results chapter.

Both of the previous articles mention the *Rana esculenta* form in the area, one article mentioning the locality (Tudor et al. 2004). We have studied every "green frog" specimen captured in the J.G.N.P. but no specimens belonging to the *Rana esculenta* form were identified and no *Pelophylax ridibundus* specimens with any similar features have been identified. This is unsurprising given *Rana esculenta* is usually found in sympatry with *Rana lessonae* in Romania's lower, swampier regions (Covaciu-Marcov et al 2004b, 2007a). These types of habitats are absent from J.G.N.P. However, the presence of this form is plausible in the area, especially considering the fact that it was previously recorded in the neighbouring counties of Mehedinți and Dolj (Fuhn 1970, Lazăr et al 2005). Also, in other regions of its range *Rana esculenta* can climb to higher regions (Zavadil 1994).

4.2. Zoogeographical aspects

Within the J.G.N.P., thermophilous species located at their northern range limit in Romania are relatively numerous. These are mostly reptiles (*Podarcis muralis, Vipera ammodytes* and *Darevskia praticola*) and well represented both at numerous locations and as individual animals observed. Thus, the park receives sub-Mediterranean influences, an aspect also proven by the presence of the scorpions

and particular species of millipedes. An important aspects is the first record of *Darevskia praticola* at Meri, this being a first record for the park as well as for the entire Gorj county. This is also the first record for the species in the area located between the Jiu and Olt rivers. Previously, in Romania, the species was only recorded west of the Jiu River or further east of the Olt River, in the Cozia Massif, Bucharest area or in Dobrudja (Fuhn & Vancea 1961, Fuhn & Hârsu 1962, Iftime 2005, Iftime& Iftime 2006). Our observations suggest a much wider distribution of the species to the east, given that suitable habitats and climatic conditions are present further east, towards the Olteţului Plateau. Although it would be expectable to find the species further to the south of Meri, inside the park, it is most probable that the species once existed there but is now extinct due to forest clearings. The population from Meri is probably isolated in the respective area. It is imperative that further studies should focus on the possible occurrence of the species in the central-southern regions of the park as well as south of the J.G.N.P.

The species generally linked to cooler climates, such as *Mesotriton alpestris, Zootoca vivipara* or *Vipera berus* are restricted to the areas located above 1100 m, which is much higher than other regions of Romania. The fact that these species are restricted to such high altitudes is partially explained by the climatic conditions of the region but it should also be correlated with their postglacial dynamics. In north-western Romania, under similar thermal conditions, these species can be found at much lower altitudes (Covaciu-Marcov et al. 2002, 2003a,c, 2004b, 2005a,b, 2006a,b, 2007b, Ghira et al. 2002). In the cases of the two reptile species mentioned above, the warmer climate determines the lack of suitable habitats at a lower altitude.

Based on these observations it ould be that the species characteristic of colder climates are present on the plains of North-Western Romania as a result of a glacial refuge being present in those areas (Brunhoff et al. 2003, Palme et al. 2003, Ursenbacher et al. 2006, Willis et al. 2000, Willis & van Andel 2004), as suggested by paleobotanical investigations (Ravazzi 2002). The present survey area is a recently recolonized one or an area in which the cold linked elements have been gradually "pushed" to highert altitudes by the increasing temperatures. The abundance of warm climate elements, correlated with the localization of the cold linked elements represents particularities of the herpetofauna of the J.G.N.P.

The J.G.N.P. is split into two sectors by a limit located between Lainici and Pietre Albe. This is the northern limit at which the sub-Mediterranean elements are

still abundant. To the north of this area, the herpetofauna begins to resemble one more characteristic of the mountainous regions of Romania. To the south, the sub-mediterannean, thermophilous character becomes more obvious, especially near the Oltenien hills with obvious differences in many environmental characteristics such as; vegetation, climate, the number of snow days and levels of rainfall, etc.

4.3. Ecology and Biology

In addition to the herpetofauna characteristic of southern regions J.G.N.P. also has relatively large populations of those the species which are linked to forested hilly and mountain areas. For example, *S. salamandra* and the Aesculapian snake, which, surprisingly, is the most common snake species in the area.

The most important habitats within J.G.N.P. are the remnants of natural forest. These are inhabited by the highest number of species and specimens. The most important habitats of this type are located in the central area of the park, in the Meri-Lainici sector, as well as the courses of the Chitului and Bratcului valleys. Also important are the areas located at the limit between the forests and the mountain meadow, where the species characteristic for cold climates are restricted, as well as the rocky outcrops which are inhabited by the nose-horned vipers and wall lizards. The least important areas are the plantations from the southern limit of the park, especially the coniferous plantations. West of the Jiu River which contain a limited diversity and abundance of species.

4.4. Status and conservation

Whilst reptiles are well represented in terms of species richness and abundance, amphibians would appear to be less so. In the case of the amphibians, species richness does not appear to be significantly different when compared to other regions of Romania. However, there are disparities in terms of abundance of certain species. The amphibian fauna composition is characteristic of the mountain areas of Romania. However, the species characteristic of colder climates are either restricted to the highest altitudes or very rare. This is a consequence of the extreme rarity of favourable spawning habitats due to the topology of the gorge, which is

very steep and, thus, makes the formation of these habitats very difficult. As a result, we recommend the creation of artificial breeding habitats for the amphibians. These measures should be implemented as soon as possible to avoid the probable extinction of amphibians, particularly the newts, from the area. Artificial breeding habitats are usually accepted by amphibians and cases of success, even with newt species, have been recorded in certain areas (Nečas et al. 1997). The creation of artificial habitats is crucial in the areas with *Mesotriton alpestris* and the existing habitats need to be protected (e.g. by fencing) from livestock. In parallel, new watering places for livestock should be created to avoid the destruction of the fences by the local people.

The scarcity of the amphibians from the areas of the J.G.N.P. which are located close to the Jiu River is general, being obvious when comparing it with other regions from Gorj county. For examples one rainy night at the end of April, we surveyed the road sector between the localities of Scoarța and Târgu Jiu for one hour as well as a sector from inside the park, between Bumbeşti and Lainici. In the first locality, we observed ca. 100 animals killed by cars, belonging to the species: *Hyla arborea, Bufo bufo, B. viridis, Pelophylax ridibundus and Rana dalmatina.* In the J.G.N.P., on the same distance, we observed only two *B. viridis* and one *Rana dalmatina.* We consider it probable that the recent construction of the railway and road have both had a considerable negative effect on the populations from the respective areas, and, in combination with the absence of the breeding habitats, has accelerated the population decline for a numbers of the species.

The reptiles have numerous habitats: forest openings, forest skirts, rocky outcrops, etc. However, one of the most important favourable habitats is represented by the railroad. Numerous species with numerous individuals are present in these areas where they find optimal conditions for thermoregulation. Previously, in Romania the use of these types of habitats was reported for *Podarcis muralis* (Covaciu-Marcov et al. 2006c).

In the J.G.N.P., *P. muralis* is not represented by typical "railroad populations" because the species is naturally present on the rocky outcrops near the railroads. Despite the anthropogenic impact, the impact caused by railroad traffic is low. Thus, reptiles from the railroad embankments start their daily activity earlier than specimens from natural environments. This is an important advantage, because lizards with higher body temperatures move and observe predators faster (Amo et al. 2004). This phenomenon is more obvious on days with cloudy weather, when

reptiles seek out the railroads, which represent more favourable thermal microhabitats (Grbac & Bauwens 2001). Also, the railroad offers numerous shelters for the lizards, which react to disturbance faster when they are further away from the shelters (Amo et al. 2003).

Anthropogenic activities appear to affects numerous species, particularly as a result of road mortalities or deliberate killing by the locals. The road traffic affects numerous species, a fact which has been recorded in other regions of Romania (Krecsák et al. 2004). From the snake species, the most affected is the aesculapian snake (*Zamenis longissimus*) and, from the lizards, *Anguis fragilis* is most often killed. Amphibians are also threatened by the consumption of frog meat by local people.

We have observed situations in which amphibians have deposited their clutch in artificial pools with concrete walls which were formed during the managing of some springs. In this type of habitats the water is permanent and the larva can develop but, after their metamorphosis, the juveniles cannot get out (Fig.34). This is the case of the managed spring from the road which goes along the Bumbeştilor Plateau. In this spring salamander larva were observed to have died by drowning since they were unable t leave the water following metamorphosis.

Another important factor which negatively affects the herpetofauna is habitat loss through logging (Fig.35). The south of J.G.N.P. is almost completely replanted with coniferous trees (Fig.36) or acacias and, as a consequence, has a limited herpetofauna. In many areas, the deforestation has affected the forests up to the level of the mountain meadow. These activities have reduced abundance of the herpetofauna species present. In the immediate future, the replanting of the areas with non-native species should be halted and the deforested areas must be allowed to naturally regenerate. Only in this way, could the fauna from the intact habitats repopulate the areas which are regenerating. A less significant anthropogenic factor is represented by the quarrying activities at Meri, the hydrotechnical works on the Jiu River and the depositing of some residual waste.

Within J.G.N.P., there are many important areas for herpetofauna of national importance in terms of their rarity and conservation value. These include; the area from above the tunnel from upstream of the Meri train station, the only area in the J.G.N.P. in which *Darevskia praticola* has been identified so far. Also important are the central areas of the park, in the Lainici area, where wider, less steep sectors are present. Large populations of most species from the park are present in the area. Of

Figure 34a. Fountain with *Salamandra salamandra* larvae near Plaiul Bumbeştilor

Figure 34b. Death *Salamandra salamandra* larvae from the same fountain

Figure 35. Deforestation at Argele

Figure 36. Coniferous plantation at Plaiul Bumbeştilor

Figure 37. Polution with domestic animal excrement at Reciu

Figure 38. Human killed *Bufo bufo* individual from Lainici

special interest are the valleys of the two main tributaries of the Jiu River- the Chitu and Bractu rivers. More characteristically southern species are present in the area, as well as species linked to forested, moister areas such as the "brown frogs" or the salamander. The rocky outcrops from near the Jiu River are also important since they are inhabited by numerous nose-horned vipers. The last, but not least important area is the higher altitude regions containing species such as *Mesotriton alpestris, Zootoca vivipara* and *Vipera berus* which are characteristic of colder climates.

4.5. Perspectives

The data presented in this paper are not complete should be considered only as a preliminary overview. This fact is a consequence of the short study period in relation to the large area covered by J.G.N.P. and the diversity of the habitats which it contains. The climatic conditions in September 2007 and April 2008 it were less than optimum with cold temperatures and snow present at altitudes above 1500m. In June and July, the temperatures were very high and drought conditions were present. These have equally affected the herpetofauna. Therefore, the present data probably represent a maximum of 50% of the real distribution of the herpetofauna in the J.G.N.P. However, the species composition of the region's herpetofauna is likely to be complete. Therefore, future studies should focus on the least known areas and the most important from a zoogeographical and conservation point of view. Monitoring actions aimed at the rare species, or at species of great national or European importance should be undertaken in the future. The estimation of population sizes and of the main anthropogenic factors which affect them should be seen as a priority. First of all, the precise distribution and population size of *Darevskia praticola* should be studied.

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Figure 39. Aspects on the field work conducted in Jiului Gorge National Park by the Herpetological Club of Oradea with S.D.Covaciu-Marcov leadership together with the Park field agents. On figure "C" is presented an large *Z. longissimus* individual)

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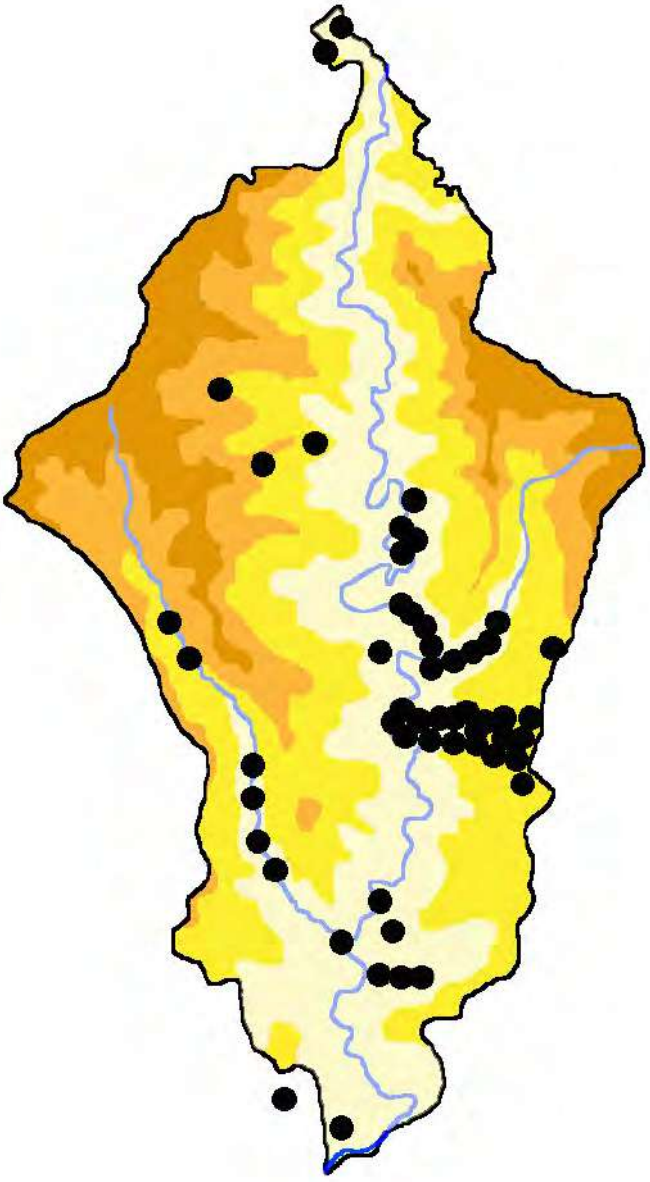
Appendix 1. Distribution maps of the recorded amphibian and reptile species in the J.G.N.P.

Amphibians

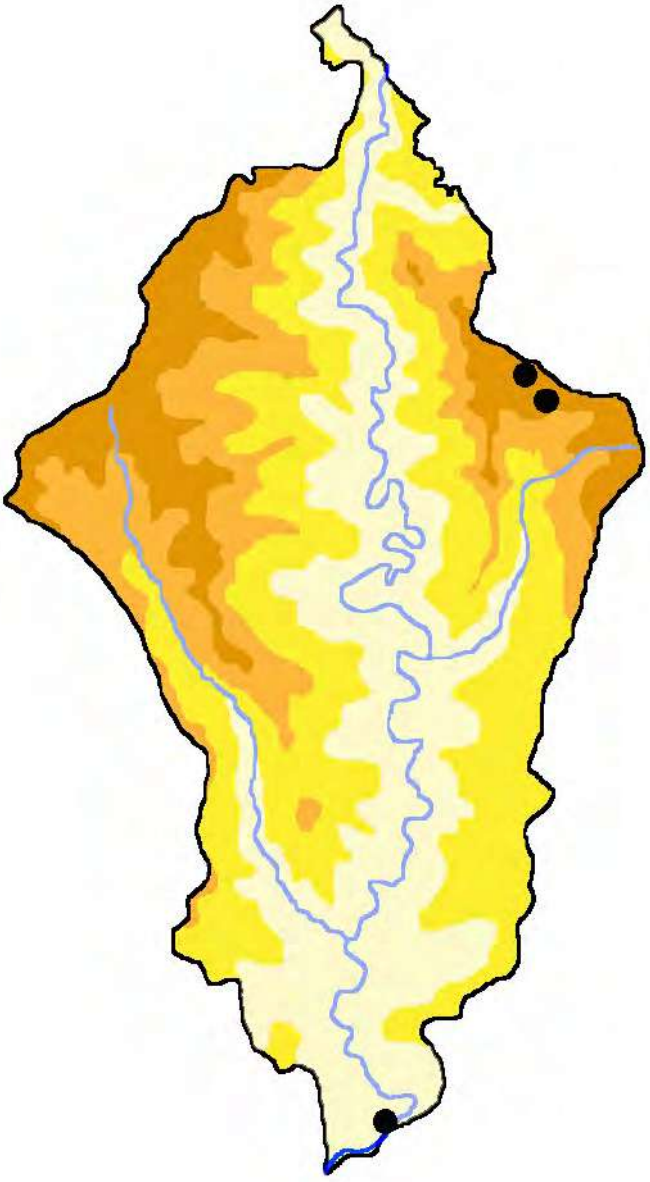
Salamandra salamandra S56
Mesotriton alpestris S57
Triturus cristatus S58
Lissotriton vulgaris S59
Bombina variegata S60
Bufo viridis S61
Bufo bufo S62
Hyla arborea S63
Pelophylax ridibundus S64
Rana dalmatina S65
Rana temporaria S66

Reptiles

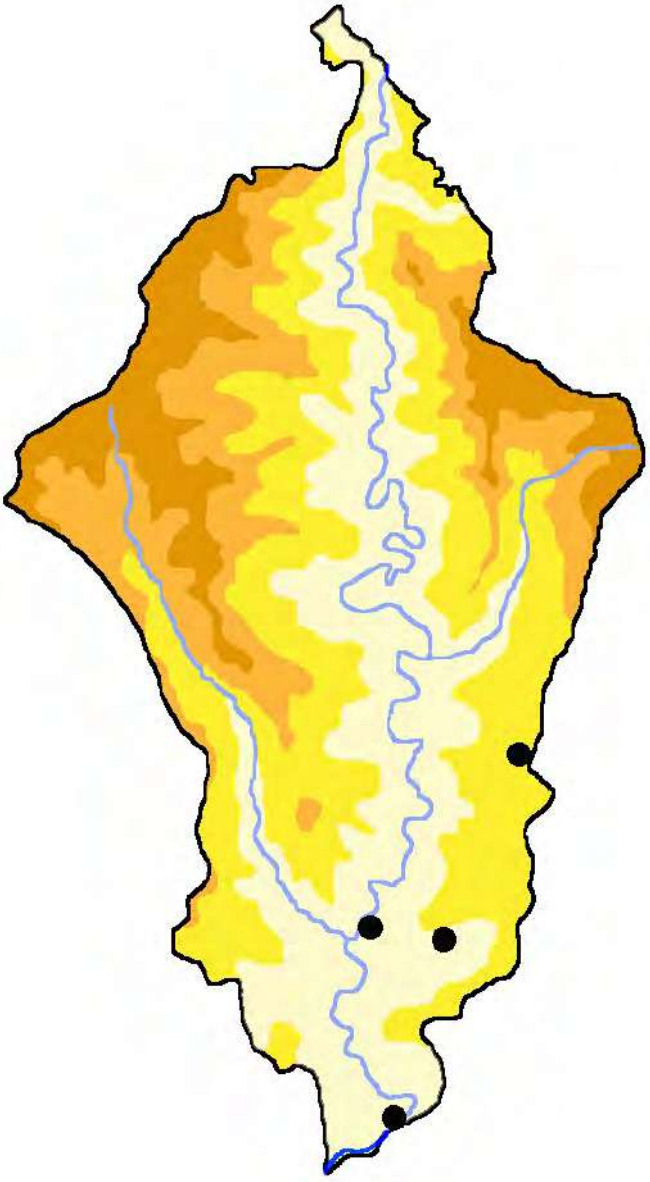
Lacerta agilis S67
Lacerta viridis S68
Podarcis muralis S69
Zootoca vivipara S70
Darevskia praticola S71
Anguis fragilis S72
Natrix natrix S73
Natrix tesselata S74
Coronella austriaca S75
Zamenis longissimus S76
Vipera ammodytes S77
Vipera berus S78



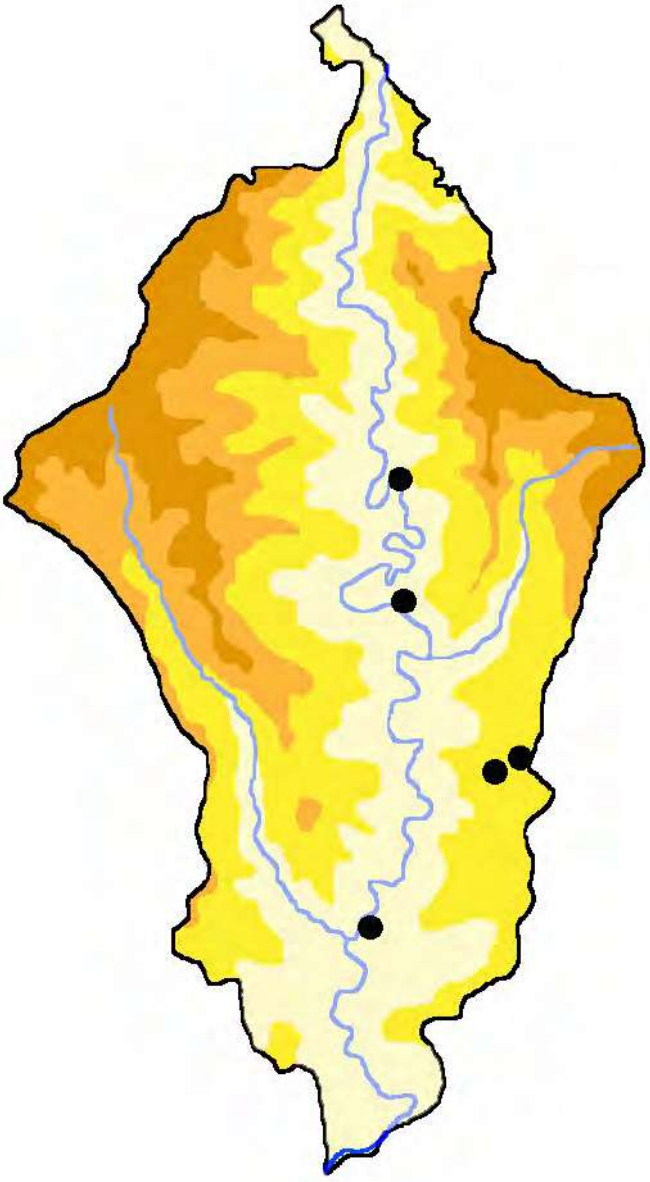
Appendix 1/A. Geographical distribution of *Salamandra salamandra* in the J.G.N.P.



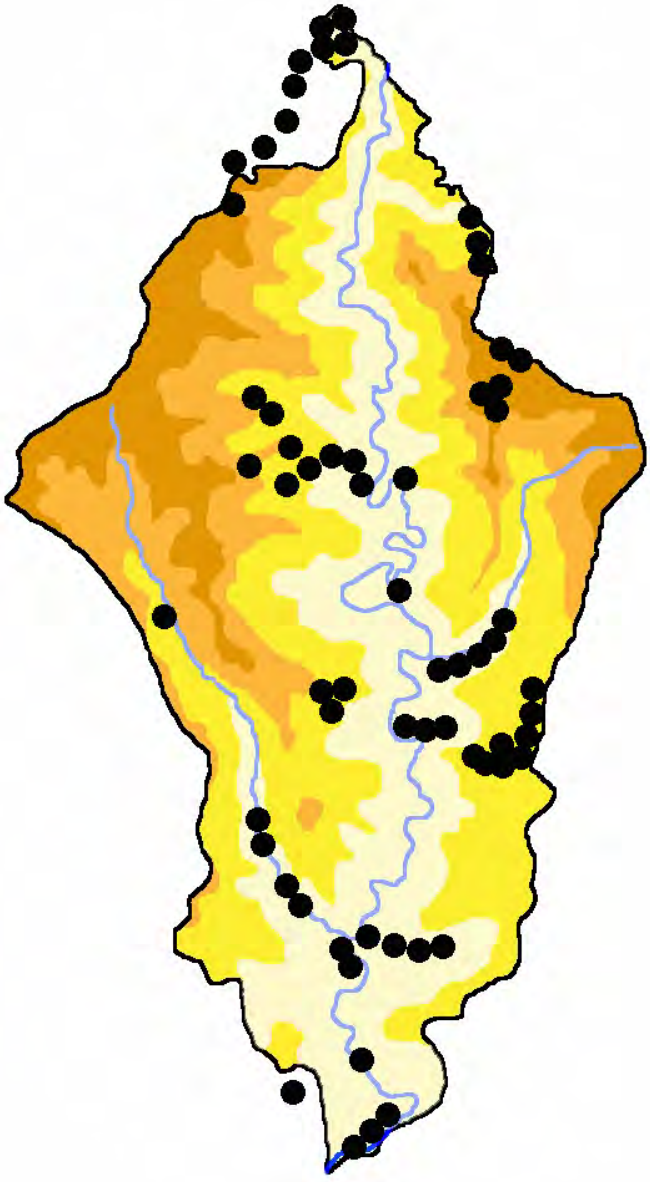
Appendix 1./B. Geographical distribution of *Mesotriton alpestris* in the J.G.N.P.



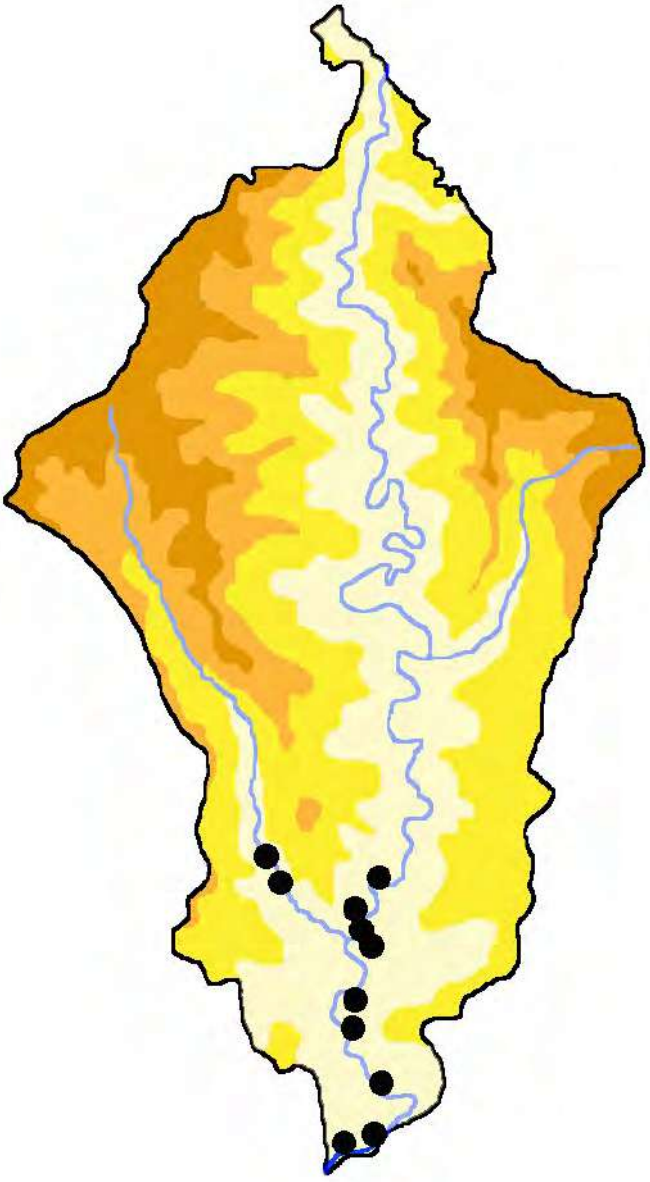
Appendix 1./C. Geographical distribution of *Triturus cristatus* in the J.G.N.P.



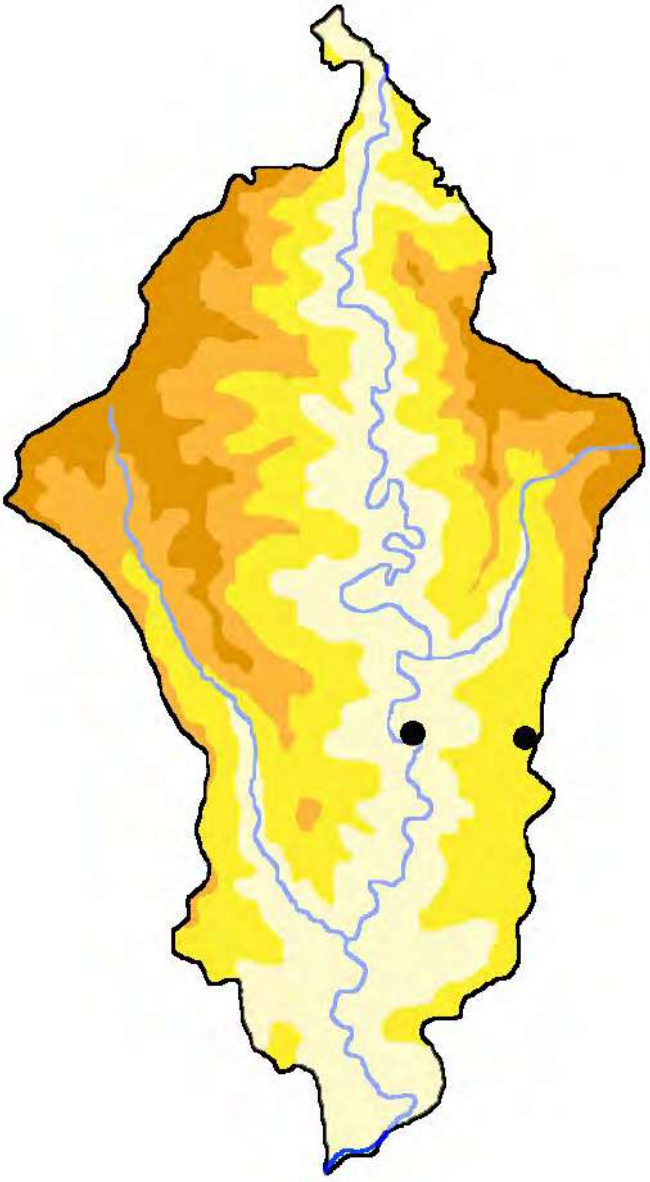
Appendix 1./D. Geographical distribution of *Lissotriton vulgaris* in the J.G.N.P.



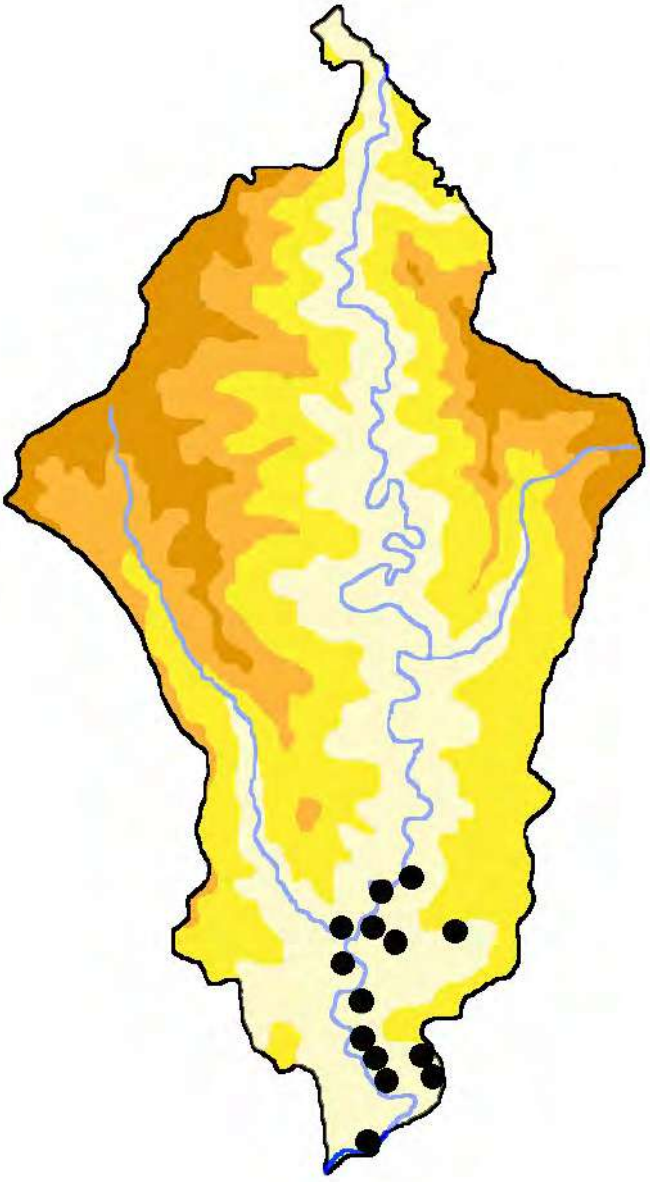
Appendix 1./E. Geographical distribution of *Bombina variegata* in the J.G.N.P.



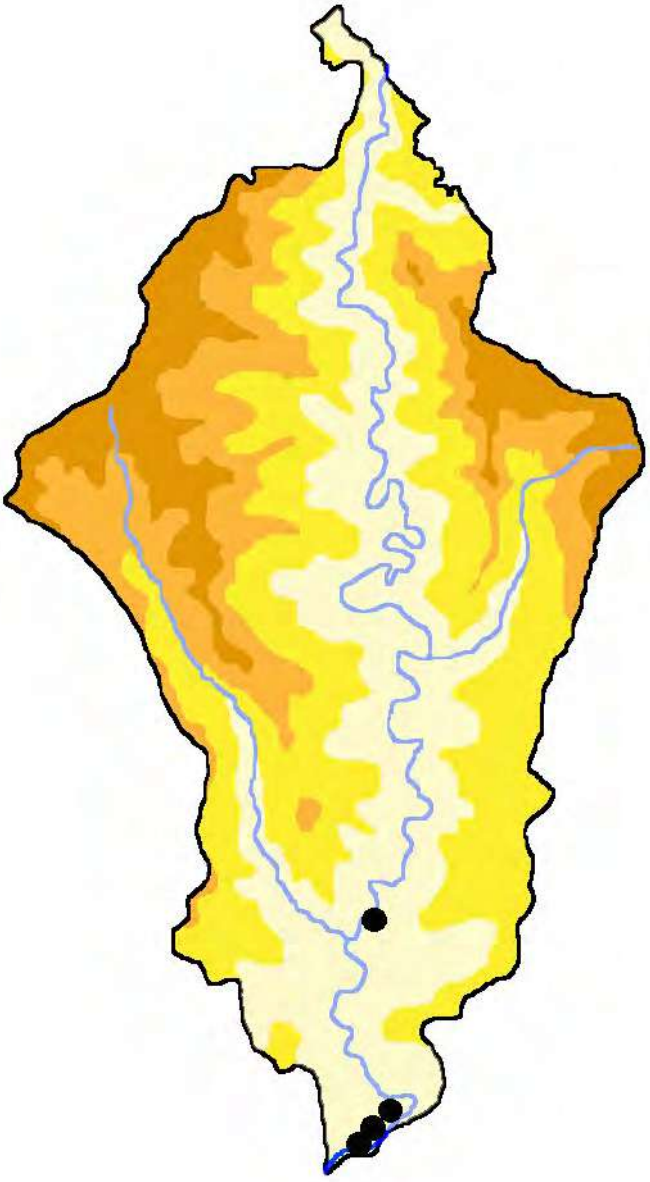
Appendix 1./F. Geographical distribution of *Bufo viridis* in the J.G.N.P.



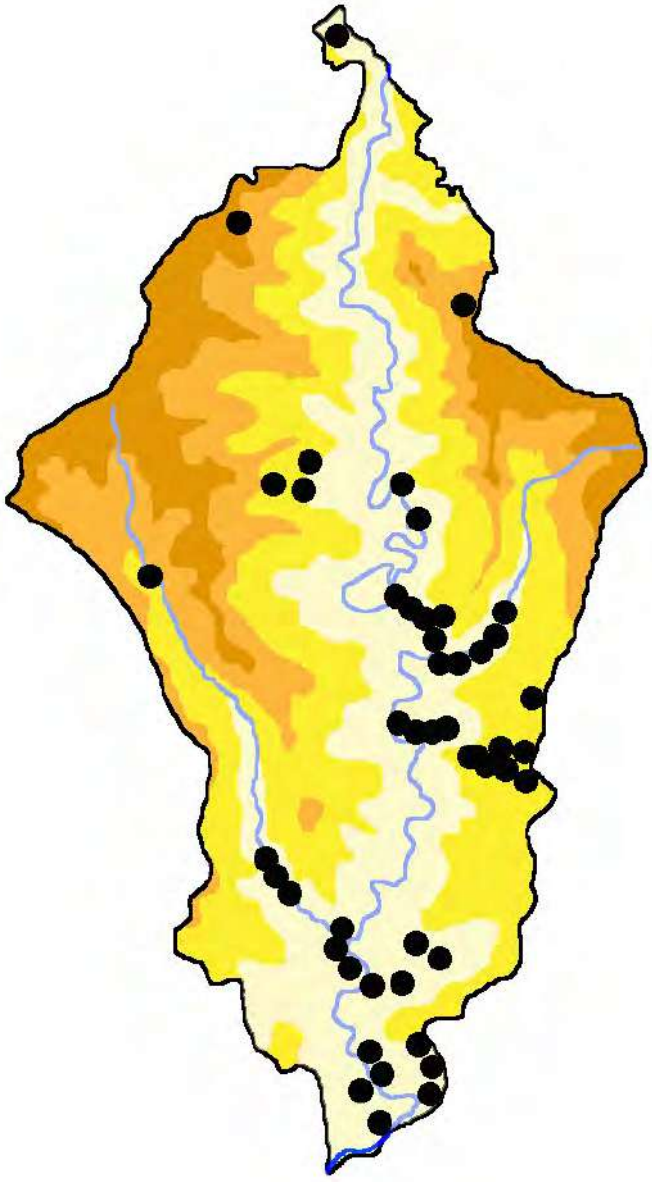
Appendix 1./G. Geographical distribution of *Bufo bufo* in the J.G.N.P.



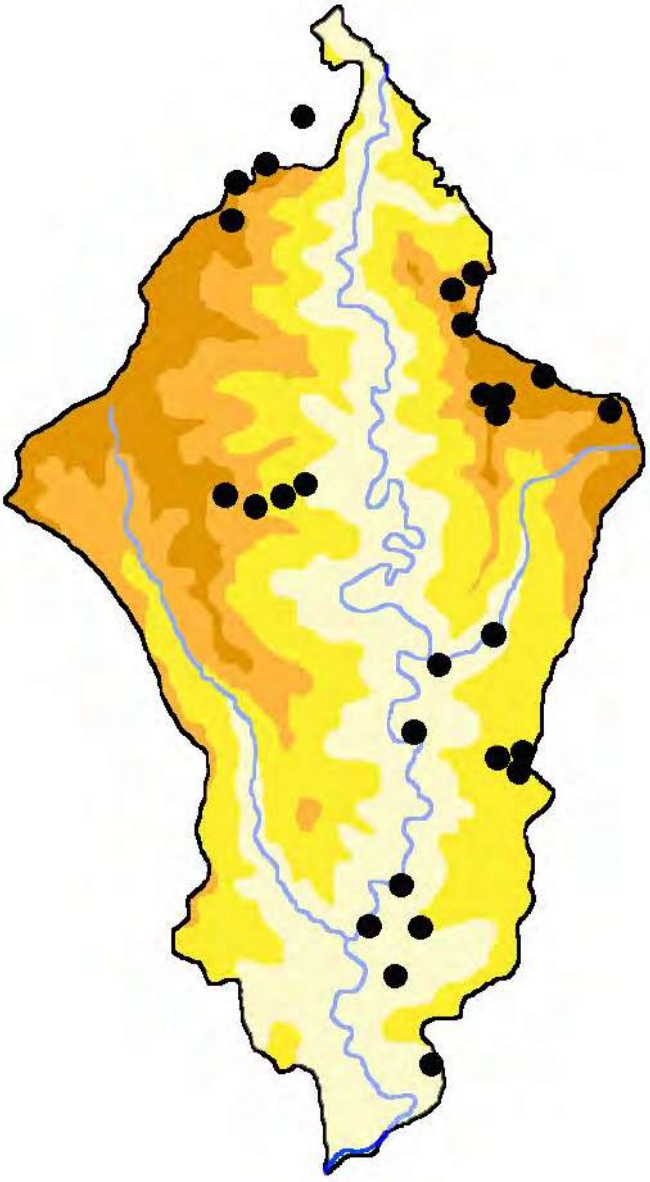
Appendix 1./H. Geographical distribution of *Hyla arborea* in the J.G.N.P.



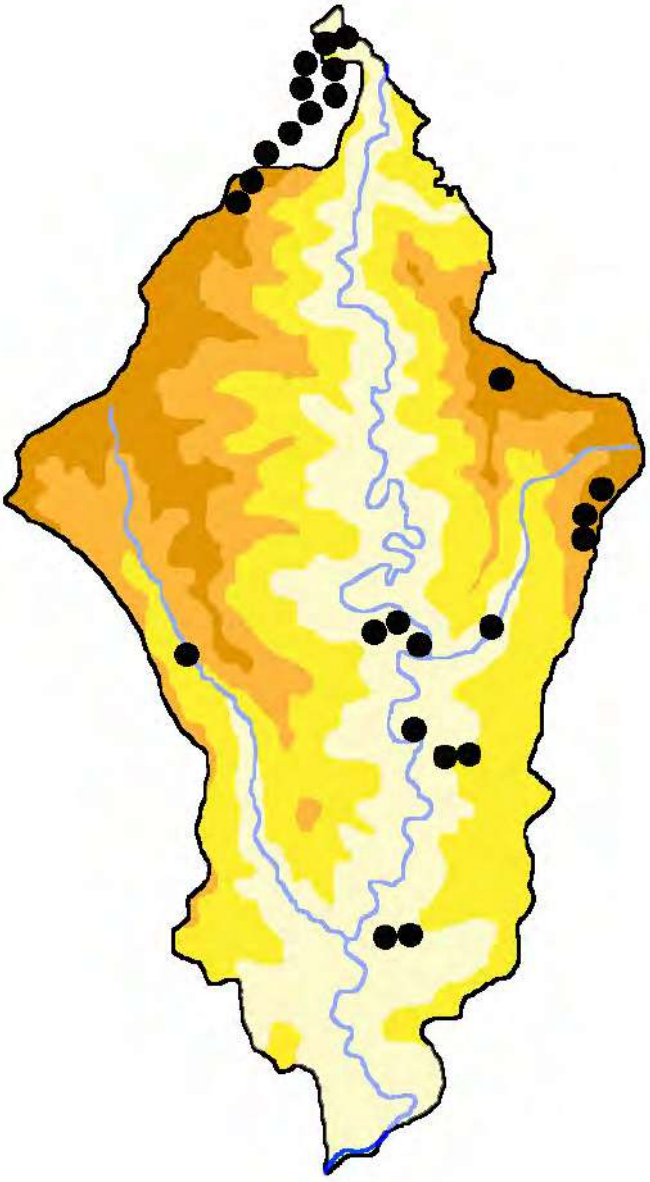
Appendix 1./I. Geographical distribution of *Pelophylax ridibundus* in the J.G.N.P.



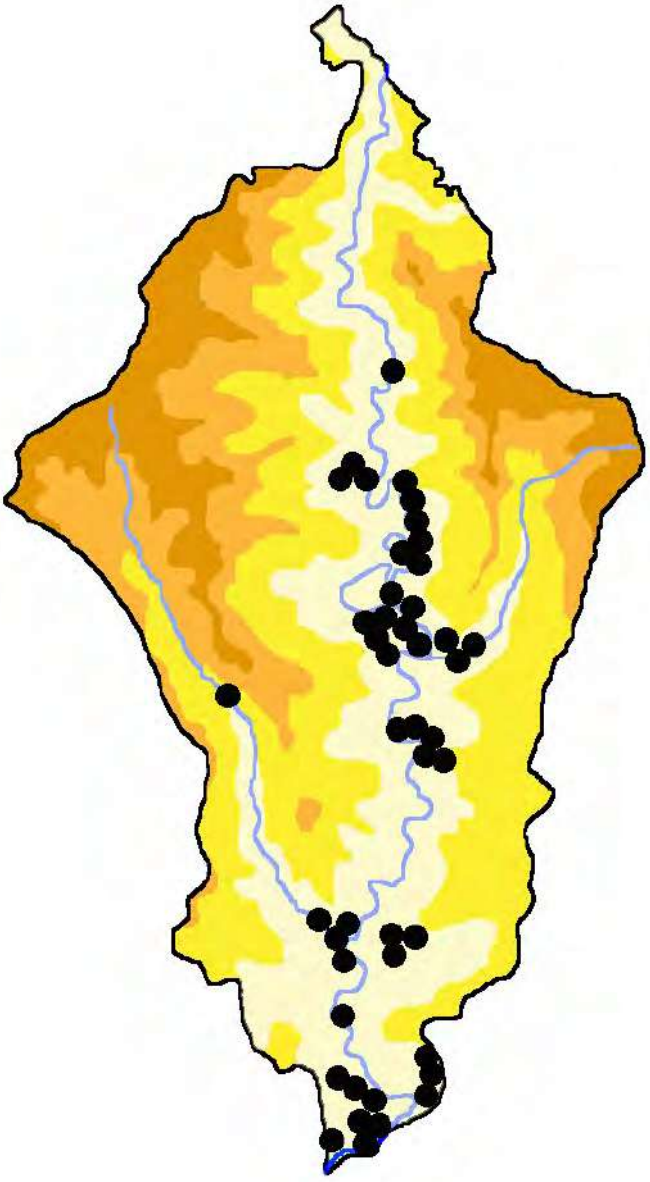
Appendix 1./J. Geographical distribution of *Rana dalmatina* in the J.G.N.P.



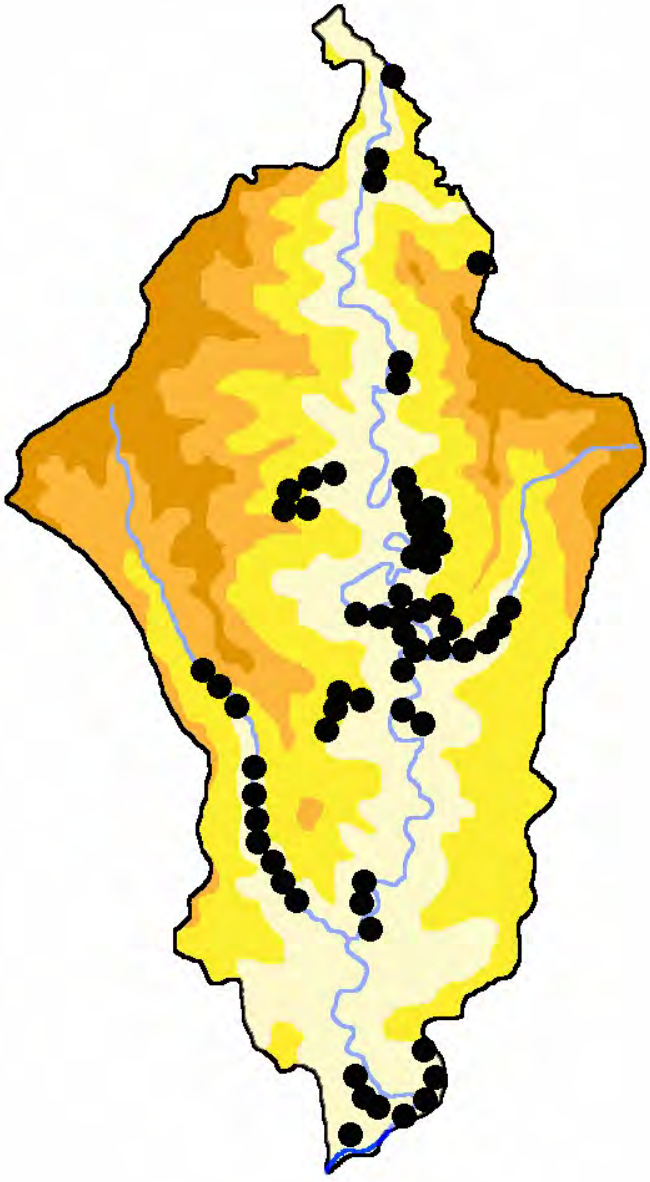
Appendix 1./K. Geographical distribution of *Rana temporaria* in the J.G.N.P.



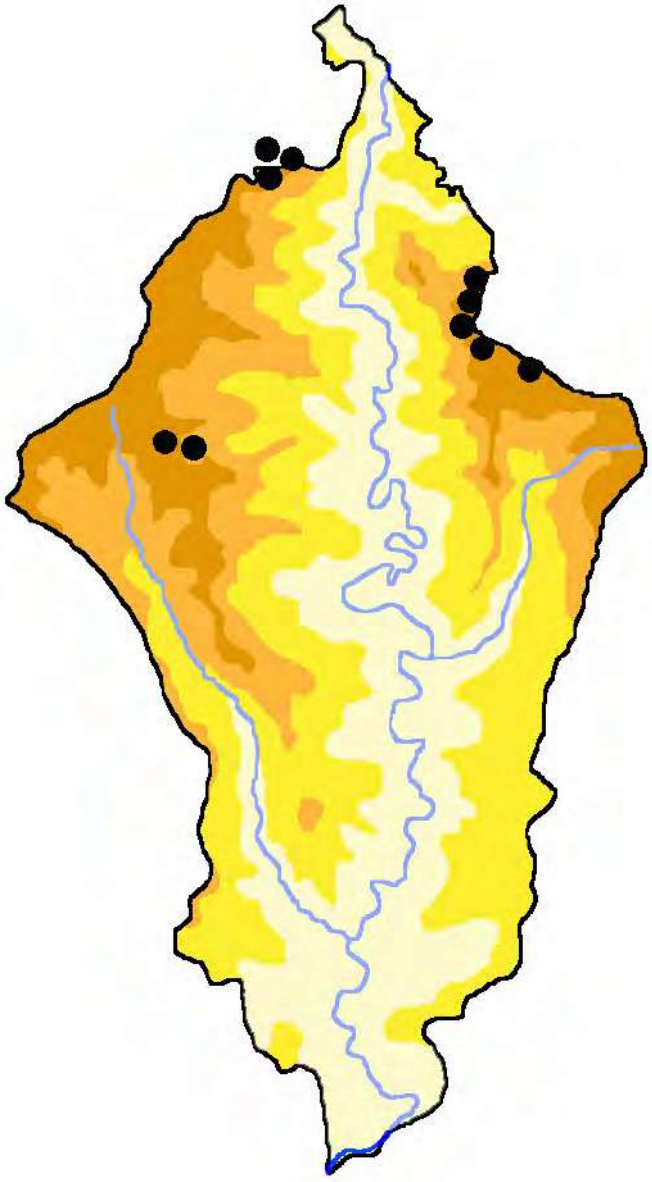
Appendix 1./L. Geographical distribution of *Lacerta agilis* in the J.G.N.P.



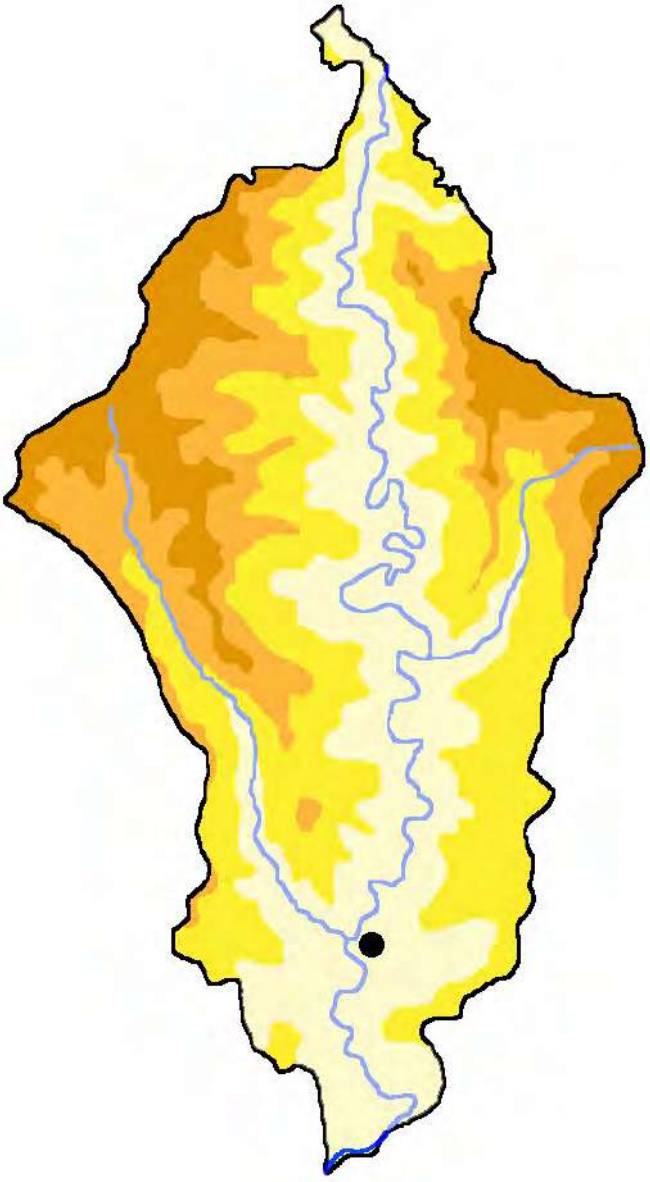
Appendix 1./M. Geographical distribution of *Lacerta viridis* in the J.G.N.P.



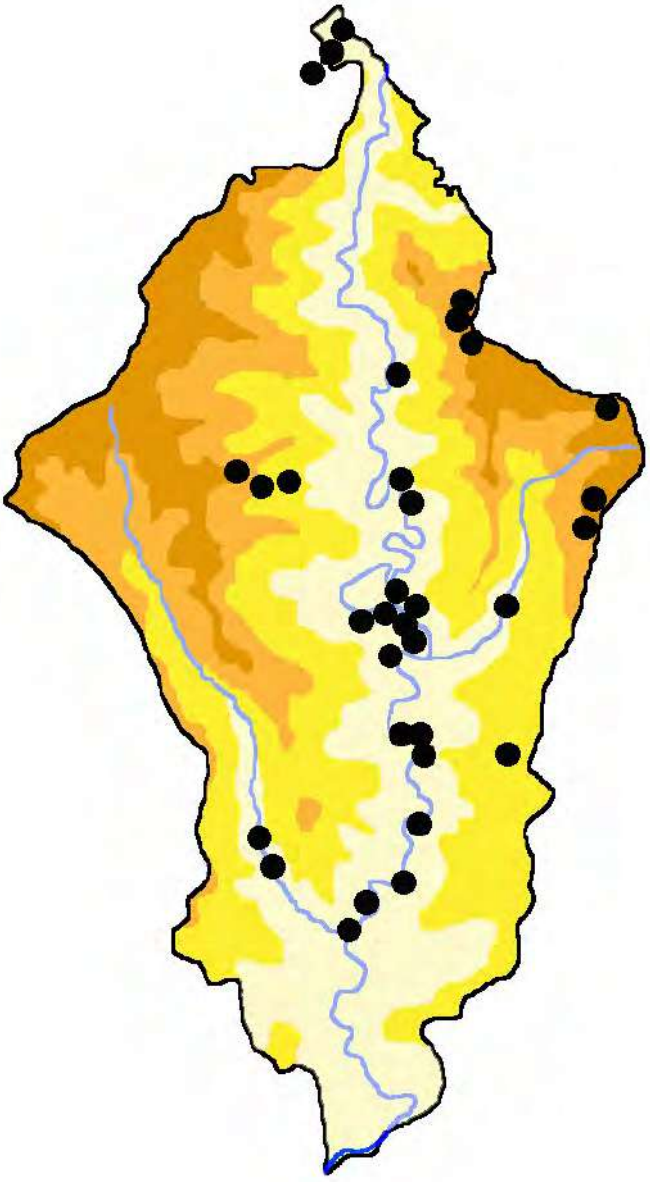
Appendix 1./N. Geographical distribution of *Podarcis muralis* in the J.G.N.P.



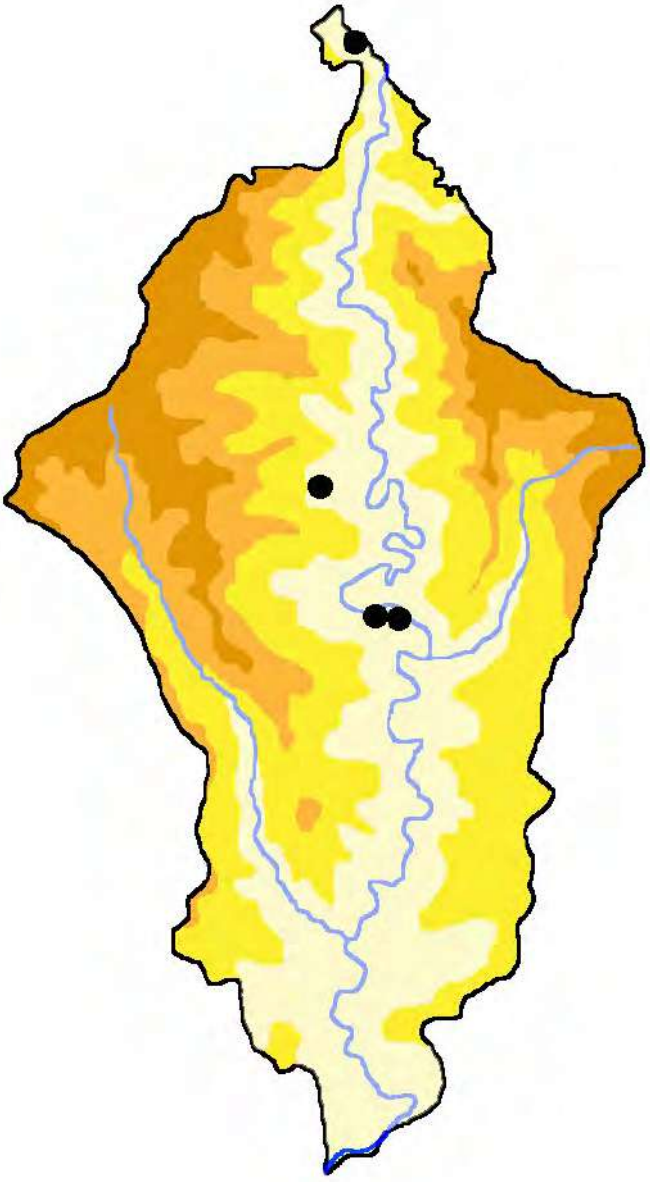
Appendix 1./O. Geographical distribution of *Zootoca vivipara* in the J.G.N.P.



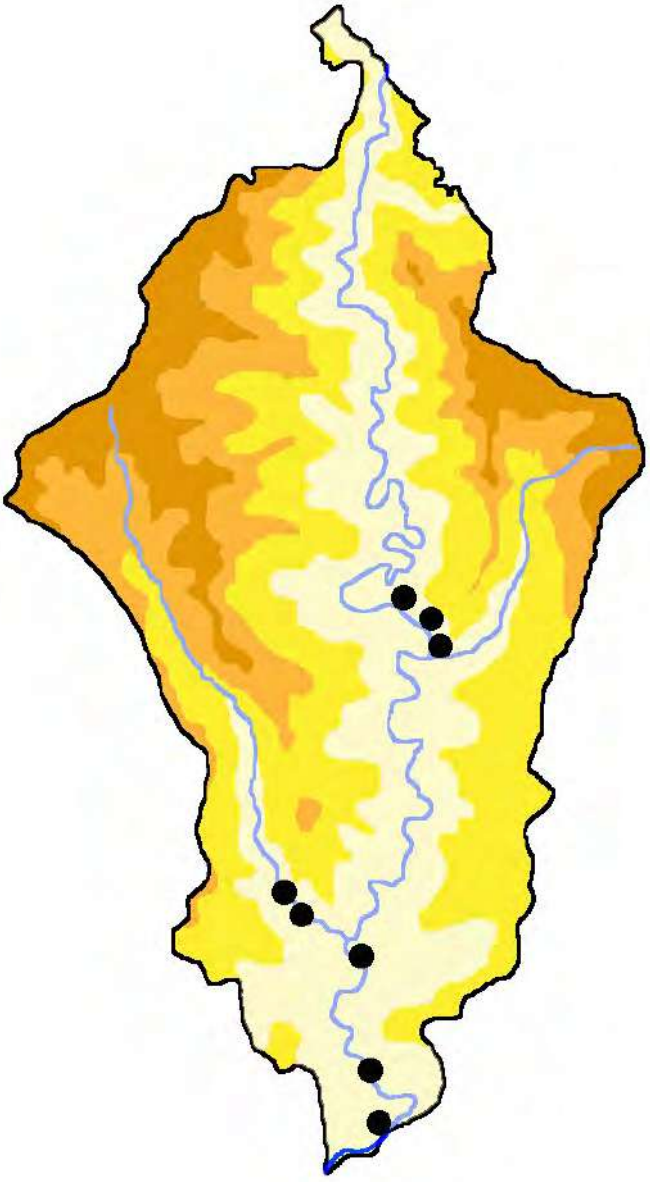
Appendix 1./P. Geographical distribution of *Darevskia praticola* in the J.G.N.P.



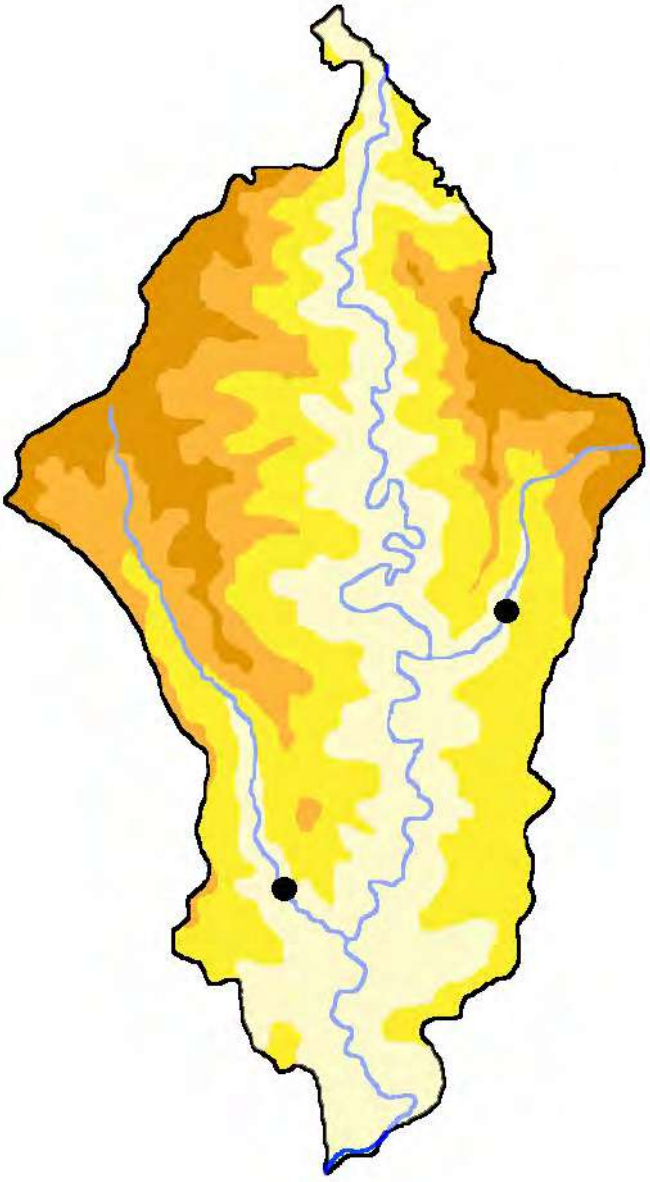
Appendix 1./Q. Geographical distribution of *Anguis fragilis* in the J.G.N.P.



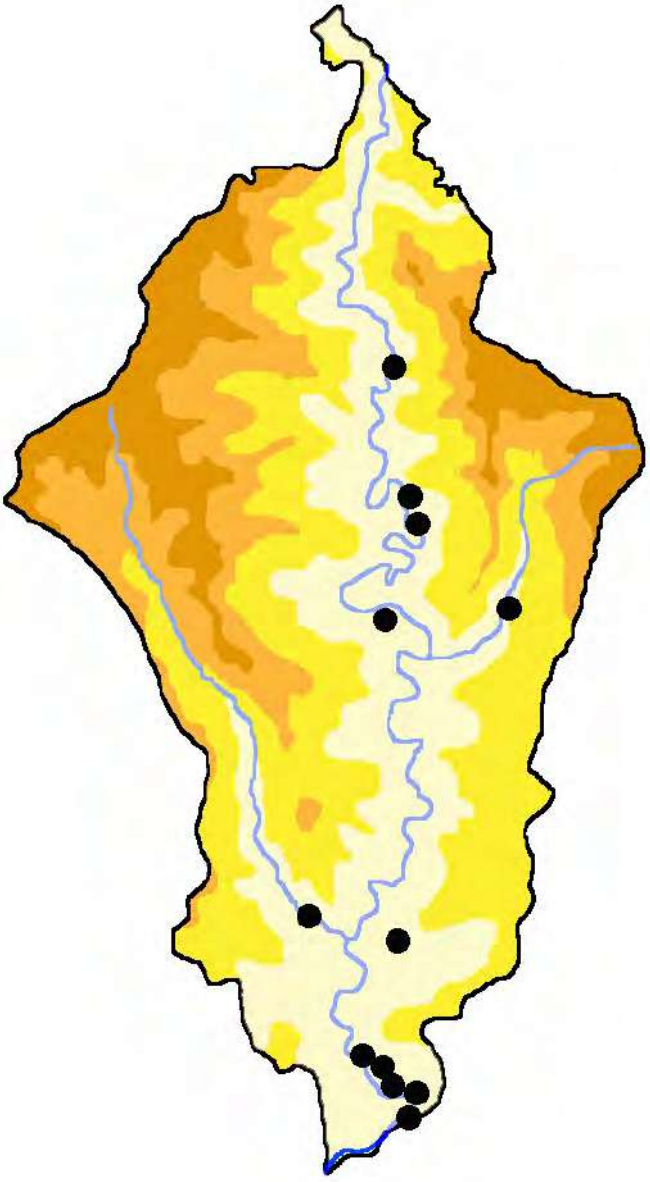
Appendix 1./R. Geographical distribution of *Natrix natrix* in the J.G.N.P.



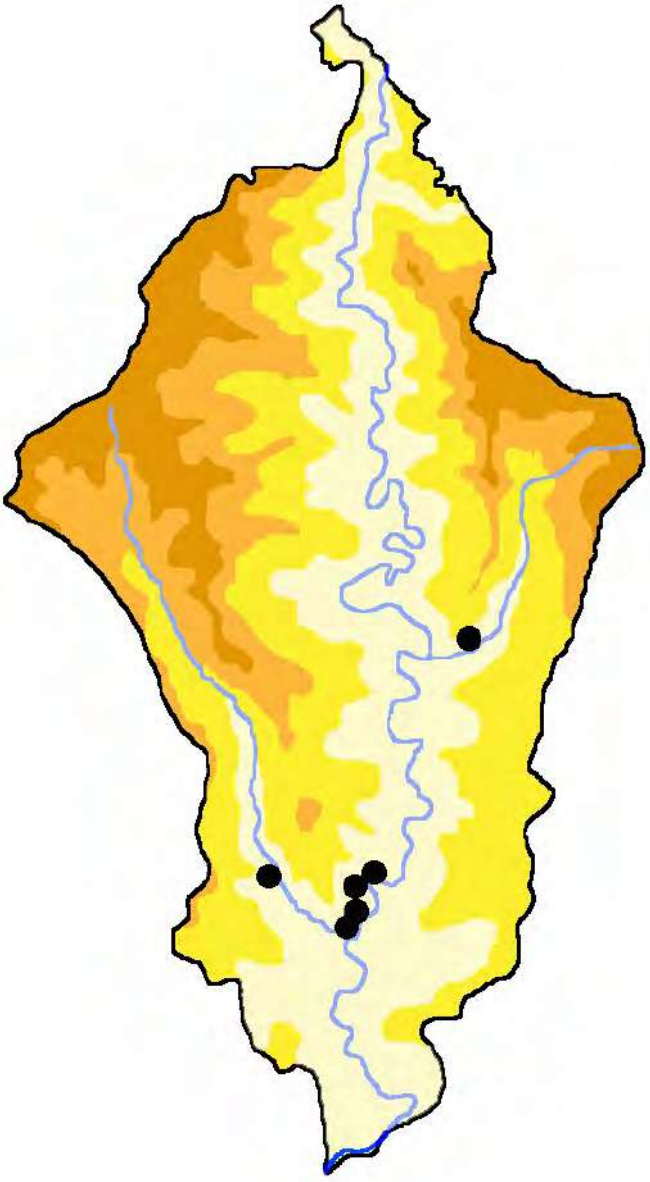
Appendix 1./S. Geographical distribution of *Natrix tesselata* in the J.G.N.P.



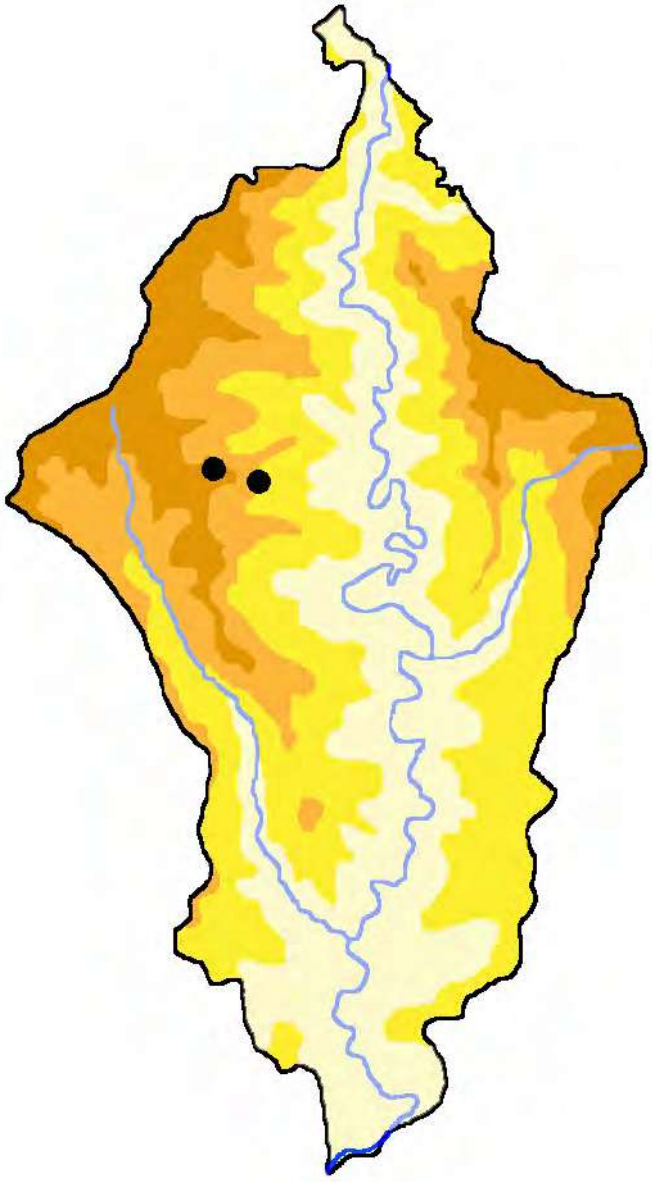
Appendix 1./T. Geographical distribution of *Coronella austriaca* in the J.G.N.P.



Appendix 1./U. Geographical distribution of *Zamenis longissimus* in the J.G.N.P.



Appendix 1./V. Geographical distribution of *Vipera ammodytes* in the J.G.N.P.



Appendix 1./Z. Geographical distribution of *Vipera berus* in the J.G.N.P.