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Species or environment? Who has more influence on the feeding of two syntopic newt species (Amphibia) from Carpathian Mountains in unusual conditions?

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Abstract. The habitat and climatic conditions are of more importance for feeding than the species in the case of the newts *Mesotriton alpestris* and *Lissotriton vulgaris* in Romanian Carpathians. Both on land and in the water, individuals from this species consumed mostly terrestrial preys. In the water, *L. vulgaris* has fed more intensely than *M. alpestris*, but the situation was reversed on land. The newts feeding differed in comparison to other populations in the aquatic period, due to the extremely low water levels from their habitat. This data shows once again the newts trophic plasticity, but also their vulnerability to climate change.

Key words: opportunity, environment, climatic conditions, newts, feeding plasticity.

Introduction

The feeding habits of newts seem to be well known in Romania, where studies have been conducted on all species from the country (e.g. Bogdan et al. 2011, 2013, Cicort-Lucaciu et al. 2007, Covaciu-Marcov et al. 2010a,b, 2012, Kovács et al. 2010, Roşca et al. 2013). However, these studies were performed only during their aquatic phase and so, to our best knowledge, there is an absence of data concerning their feeding habits during the terrestrial phase. Such data are rare even in European literature (Kuzmin 1990), where information concerning the aquatic period predominates as well (e.g. Fasola & Canova 1992, Denoël & Andreone 2003, Kutrup et al. 2005, Vignoli et al. 2009, Kopecký et al. 2011, Romano et al. 2012). The newts` feeding is easier to study in the water, where generally many individuals are present in relatively small aquatic habitats (e.g. Bogdan et al. 2012a). Subsequently, the newts disperses in terrestrial habitats (e.g. Schabetsberger et al. 2004, Jehle & Arntzen 2000, Malmgren 2002) and even they would stay in the vicinity of their aquatic habitat (Jehle & Arntzen 2000, Müllner 2001) they would stay hidden under different shelters (e.g. Schabetsberger et al. 2004), the contact with them being determined by chance. In the spring of the year 2012 we were lucky to encounter two newt species, *Mesotriton alpesteris* (Laurenti 1768) and *Lissotriton vulgaris* (Linnaeus 1758), in a partially dried up puddle in the Southern Carpathians. Due to a dry spring, the water level in the newts breeding habitat was very low, many newts being found on land in its vicinity. Therefore, this paper aimed to present the feeding of the two species, both in water and on land, in a period in which the newts should have been in the water.

Material and Methods

The field work was performed in April 14, 2012. The newts were found a few kilometers upstream from the Olteț Gorge, at 700 m altitude. The gorge is situated in Parâng Mountains, in the Southern Carpathians (Posea & Badea 1984). The aquatic habitat was a small wet area, measuring up to approximately 2 m² when the study was conducted. Normally this area would have been larger, but due to the dryness of the spring, the water level was greatly reduced. The habitat is surrounded by a spruce plantation and beyond that by a natural beech forest. Although the puddle is located in a relatively flat area, immediately next to it there are steep rocky slopes. From the water we've captured newts using a net with a long handle and from the terrestrial habitat by hand from underneath fallen tree trunks or rocks up to a distance of about 50 m from the water. Because of the small size of the aquatic habitat, as well as the expanse and uniformity of the terrestrial one, we've captured more newts from the water (Table 1). The stomach contents were sampled using the stomach flushing method (Solé et al. 2005), the newts being subsequently released in their habitats. The data was processed separately by species and habitat. We calculated the percentage abundance (%A), frequency of occurrence (%f) and feeding intensity, separating the terrestrial and aquatic preys. The food diversity was estimated using the Shannon-Wiever index (1949) and the similarity with the Sorensen index (1948), computed with EstimateSWin 7.5.0 (Colwell 2005). The trophic niche overlap was calculated using the Pianka index (Pianka 1973) computed with EcoSim 7.7.1. (Gotelli & Entsminger 2004). Using the obtained Pianka index pairwise values we obtained a cluster analysis cladogram (Statistica 6.0). We used Mann-Whitney *U*-test (Zar 1999) test to determine significance level between the feeding of the studied species, and for the same species between the two feeding environment.

Results

With the exception of a single *M. alpestris* individual from the terrestrial environment, all newts had stomach contents (Table 1). In both species the highest number of preys was captured by individuals from the aquatic habitat. In the water, *L. vulgaris* has fed more intensely than *M. alpestris* but in the terrestrial environment the intensity of feeding was alike for both species. Terrestrial preys were more numerous in both species` food. The newts from the terrestrial environment consumed only terrestrial preys. The aquatic *M. alpestris* individuals had the greatest food diversity (H_{Ma_ter}=2.01), but lesser equitability than the terrestrial individuals ($E_{H\_(Ma\_aq)}$=0.695, $E_{H\_(Ma\_ter)}$=0.764).

M. alpestris has captured more prey taxa than *L. vulgaris*, both in water and on land (Table 2). Amphibian spawns were consumed only by individuals from the aquatic habitat in the case of both species. Out of the 32 prey taxa consumed in total, only two (oligochaeta and araneida) were found in the stomach contents of both species from both environments. For both species, in the aquatic environment annelida was the most important prey taxa, while in the terrestrial environment the most important prey taxa was araneida. The correlation between the percentage abundance and the frequency of occurrence of the prey taxa were significant

Table 1. The number of the studied individuals, number of individuals without food, preys number, average and maximum number of preys / individual, the percentage abundance of aquatic and terrestrial preys, food diversity and similarity.

	M. alpestris aquatic	*M. alpestris* terrestrial	*L. vulgaris* aquatic	*L. vulgaris* terrestrial
Number of studied individuals	30	11	17	8
Number individuals without stomach content	-	1	-	-
Number preys consumed	96	18	111	12
Maximum number of preys/individual	14	4	19	3
Average number of preys/individual	3.2	1.8	6.53	1.5
Percentage abundance of aquatic preys (%)	25	-	19.82	-
Percentage abundance of terrestrial preys (%)	75	100	80.18	100
Food similarity - Sorensen Index (mean value)	0.139	0.180	0.525	0.163
Food diversity - Shannon-Wiener Index (H)	2.01	1.96	1.06	1.79
Shannon's equitability index (E_H)	0.695	0.764	0.366	0.697

Table 2. Percentage abundance (%A) and frequency of occurrence (%f) of preys.

	M. alpestris aquatic		*M. alpestris* terrestrial		*L. vulgaris* aquatic		*L. vulgaris* terrestrial	
	% A	% f	% A	% f	% A	% f	% A	% f
Plant debris	-	73.33	-	50	-	58.82	-	50
Shed skin	-	53.33	-	40	-	35.29	-	37.50
Inorganic elements	-	13.33	-	20	-	23.53	-	12.50
Amphibian spawn	-	50	-	-	-	5.88	-	-
Oligochaeta Annelida	29.17	36.67	5.56	10	72.07	88.24	8.33	12.50
Gastropoda (terrestrial)	22.92	33.33	5.56	10	-	-	-	-
Gastropoda (Limax)	-	-	11.11	20	-	-	-	-
Gastropoda (aquatic)	3.13	6.67	-	-	9.91	23.53	-	-
Pseudoscorpionida	1.04	3.33	-	-	-	-	16.67	25
Opilionida	3.13	6.67	11.11	20	-	-	-	-
Araneida	6.25	13.33	33.33	50	1.80	11.76	33.33	50
Acari	4.17	10	16.67	30	3.60	23.53	-	-
Crustacea Ostracoda	-	-	-	-	8.11	11.76	-	-
Crustacea Isopoda (terrestrial)	4.17	10	5.56	10	0.90	5.88	-	-
Diplopoda	1.04	3.33	-	-	-	-	-	-
Chilopoda	1.04	3.33	-	-	-	-	-	-
Collembola	-	-	-	-	0.90	5.88	-	-
Heteroptera (terrestrial)	1.04	3.33	-	-	-	-	-	-
Trichoptere larvae	1.04	3.33	-	-	-	-	-	-
Coleoptera Dytiscida larvae	1.04	3.33	-	-	1.80	11.76	-	-
Coleoptera Curculionida	-	-	5.56	10	-	-	-	-
Coleoptera Carabida	-	-	-	-	-	-	8.33	12.50
Coleoptera undetermined	-	-	-	-	-	-	16.67	25
Brachycera	-	-	-	-	0.90	5.88	-	-
Brachycera larvae	1.04	3.33	5.56	10	-	-	8.33	12.50
Hymenoptera Formicida	-	-	-	-	-	-	8.33	12.50
Anura larvae	19.79	10	-	-	-	-	-	-
No. prey taxa	15		9		9		7	

with $p<0.0001$ for all species in all environments.

The trophic niches have overlapped a lot more in the case of the individuals from the aquatic environment ($Q_{Ma/Lv\_aq}=0.682$) than in the case of the ones from the terrestrial environment ($Q_{Ma/Lv\_ter}=0.645$) (Fig. 1). The feeding was more alike between individuals of the two species that hunted in the same environment, than between individuals of the same species that hunted in the two different environments ($Q_{Lv\_aq/ter}=0.204$, $Q_{Ma\_aq/ter}=0.345$) (Fig.1). The differences between the feeding of the two species and for the same species between the different feeding environments were not significant (Mann-Whitney *U*-test, $p > 0.05$).

Discussion

The high consumption of terrestrial preys by both newt species, even from the aquatic habitat, is a consequence of the very low water level. This is probably a confirmation of the fact that during the aquatic phase newts consume mostly terrestrial preys only in unusual cases, either because of an unfavorable aquatic habitat (e.g. Covaciu-Marcov *et al*. 2002, 2003) or because of a terrestrial habitat with a special trophic offer (e.g. Cicort-Lucaciu *et al*. 2007). Normally, during the aquatic phase newts consume mostly aquatic preys (e.g. Fasola & Canova 1992, Vignoli et al. 2009, Kovács et al. 2010, Covaciu-Marcov et al. 2010a, Bogdan et al. 2013). In the Olteţ Gorge, responsible for the large amount of terrestrial preys is

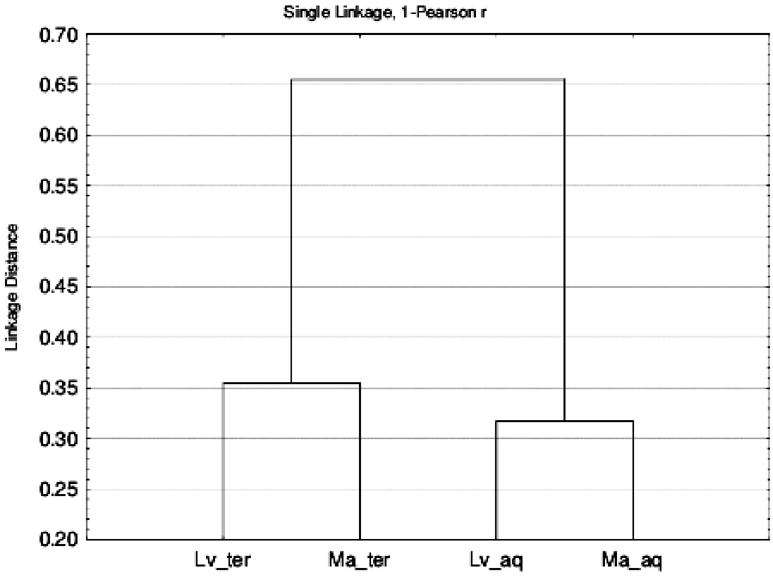

Figure 1. Tree clustering based on Pianka's pairwise values, representing the trophic niche overlap between the studied species and feeding environment (Ma – *Mesotriton alpestris*, Lv – *Lissotrion vulgaris*, aq- aquatic, ter - terrestrial)

the reduction of the aquatic habitat because of the drought. Not having enough preys in the very shallow water, some of the newts have hunted on land and then returned into the water, *L. vulgaris* being present also in their terrestrial phase near the aquatic habitat (Müllner 2001). In other cases too, the large amount of terrestrial preys consumed by *M. alpestris* in an aquatic habitat was explained by the fact that newts had hunted on land before the study (Kuzmin 1990).

Although normally *L. vulgaris* spend more time in the water than *M. alpestris* (Cicort-Lucaciu et al. 2011), in the Olteț Gorge it is forced to hunt on land. Thus, the feeding of both species differ compared to other populations from aquatic habitats (e.g. Covaciu-Marcov et al. 2010a, Kovács et al. 2010, Dimancea et al. 2011, Bogdan et al. 2013, Roşca et al. 2013). For the newts that had hunted on land, these differences were even more pronounced. It seems that in the unusual conditions from Olteț Gorge the differences between the two species are not so important in comparison to the environment and its trophic offer. Therefore, both in water and on land, the feeding of each species resemble more to the one of the syntopic species, than to the one of same species from the other environment.

Usually, the disparity in feeding between syntopic newt species was explained by differences between their size (e.g. Griffiths & Mylotte 1987, Bogdan et al. 2013) or between the sector of the pond in which they hunt in (e.g. Covaciu-Marcov et al. 2010a). In Olteț Gorge, there are also differences between the feeding of the two species in both environments, even if those differences are not significant. Thus, for example *M. alpestris* had consumed more spawn than *L. vulgaris*. The predilection of this species for spawn appears to be common (Denoël & Demars 2008, Kopecký et al. 2012), probably as a consequence of its reduced ability to hunt in water (see in: Covaciu-Marcov et al. 2010a). Being more mobile, with males having a dorsal crest (Fuhn 1960), *L. vulgaris* is more active into the water body (e.g. Dolmen & Koksvik 1983). Normally, this fact represents an advantage compared with *M. alpestris*, but in this case the reduced water level diminishes its chances to feed properly. Contrarily, *M. alpestris* manages to feed satisfyingly compared to other populations (e.g. Covaciu-Marcov et al. 2003, Bogdan et al. 2011), the low water level favoring its contact with spawns. The same is true in the case of anuran larvae, a food frequently consumed by *M. alpestris* (e.g. Covaciu-Marcov et al. 2003, Dimancea et al. 2011). In the same time, while *M. alpestris* is feeding on spawn, *L. vulgaris* is feeding on lots of microcrustaceans, like in other situations (e.g. Vignoli et al. 2009, Bogdan et al. 2013). However due to the low temperature and water level this prey taxa hasn't had the same importance as in other cases (Bogdan et al. 2013). Also, larger preys like terrestrial snails were consumed only by the larger species, *M. alpestris*. Similar to other newts, the earthworms seem to compensate the absence of aquatic preys (Covaciu-Marcov et al. 2002), being consumed intensely by both species in both environments. The newts captured in the water had hunted immediately next to it, in humid areas, consuming more earthworms than the newts from the terrestrial environment, which hunted also other preys (ants, pseudoscorpions, etc).

The fortuitous situation from Olteț Gorge has permitted a special glance into the feeding of two newt species. Thus, despite noticeable differences, the two species have feed similarly depending on their environment and not according to species, the environment deciding the food composition. The differences in mobility and size between species only modified the parameters established by the environment. Our results seems important from the perspective of climate changes that can affect in the future the Romanian herpetofauna, even causing the disappearance of some species from the country (see in: Popescu *et al.* 2013). Thus, it seems that the two species are managing to feed even in the case of climatic oscillations that affect their aquatic habitat and their life cycle. However, it remains to be seen if this species, both protected (O.U.G. 57/2007), will be capable to survive if such phenomenon were to amplify or become permanent, because even if they could feed, their reproduction will be affected. Lately in Romania, the effect of climatic oscillations becomes noticeable in the feeding of other amphibians (Bogdan et al. 2012b).

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