Feeding of three syntopic newt species
(*Triturus cristatus*, *Mesotriton alpestris* and *Lissotriton vulgaris*) from Western Romania

Severus D. COVACIU-MARCOV[1,*], Alfred Ş. CICORT-LUCACIU[1],
Ion MITREA[2], Istvan SAS[1], Aurel V. CĂUŞ[3]   and   Diana CUPŞA[1],

1. University of Oradea, Faculty of Sciences, Department of Biology, 1 Universitatii str., Oradea - 410387, Romania
2. University of Craiova, Faculty of Horticulture, 13 „A.I.Cuza" str., Craiova - 200585, Romania
3. University of Oradea, Faculty of Sciences, Department of Mathematics and Computer Sciences,
1 Universitatii str., Oradea - 410387, Romania
* Corresponding author, E-mail: scovaciu@uoradea.ro, sever.covaciu@yahoo.com

Abstract. The feeding of three newt species from western Romania is different in the aquatic period regarding both the composition and the time needed. Thus, *Mesotriton alpestris* spends shorter time in the water compared to *Triturus cristatus* and *Lissotriton vulgaris*, having the weakest feeding habit in this environment. This is probably a consequence of its relationship with mountainous and harsher climate areas that shortens its aquatic environment period, which also affects the species in a lower altitude habitat. The difference in the food of the three species results from their different sizes and hunting territories. *L. vulgaris* mainly hunts near puddle banks, in areas with lower and warmer water and the other two species hunt near the bottom, in the deeper areas. The crested newts have the longest aquatic period and the highest affiliation for hunting in this habitat. This species consumes larger sized preys while the common newts consume numerous reduced sized preys, having an intensive feeding and high food diversity. Meanwhile, differences between the food ingested by male and female individuals are not significant in any newt species.

Key words: feeding, trophic niche, syntopic newts, *T. cristatus, L. vulgaris, M. alpestris*, Romania.

Introduction

The food preference differences of some syntopic amphibian species are caused by their size, their microhabitat range and their activity periods (Van Sluys & Rocha 1998). Their different hunting microhabitats range prevents food competition (Lima & Magnusson 1998). Thus, the knowledge regarding the feeding ecology of syntopic species is important in understanding the organization of their respective communities (Juncá & Eterovick 2007). The reproduction of several species (up to five) in the same habitat is characteristic to the newts from Europe (Arntzen & De Wijer 1989). Therefore, a lot of feeding studies of syntopic

newt species were conducted in Europe (e.g. Dolmen & Koksvik 1983, Griffiths & Mylotte 1987, Joly & Giacoma 1992, Griffiths 1986, 1987, Fasola 1993). There are five newt species in Romania (Cogălniceanu et al. 2000a), but a maximum of four can be encountered in the same habitat. In western Romania, in the higher altitude sectors, three newt species (*Triturus cristatus*, *Mesotriton alpestris* and *Lissotriton vulgaris*) reproduce in the same place. The feeding studies of these newts were only recently started in Romania, most of which are descriptive, focused on a single species, on limited periods and on few individuals (e.g. Covaciu-Marcov et al. 2002a,b,c, 2003, Cicort-Lucaciu et al. 2004, 2005a,b, 2006a,b, 2007, David et al

2007, 2008a,b). Only two studies compared the feeding of two newt species, *T. cristatus* and *L. vulgaris* (Cicort-Lucaciu et al. 2007, David et al 2009).

In this context, the aim of the study was to compare the feeding of three syntopic newt species (*T. cristatus* – the crested newt, *M. alpestris* – the Alpine newt, and *L. vulgaris* – the common newt) from the western part of Romania. The food diversity is an indicator of the quality of the environment where the amphibians live (Kovács et al. 2007). Theoretically, in a small or average habitat, it is difficult for the newts to avoid competition and to be able to exploit the different hunting microhabitats. The objectives of the study are: i.) establishing the food composition of the three species; ii.) comparing analytically the evolution in time of the feeding; and iii.) establishing food preferences difference of the three species and of different sexes in those species.

Materials and Methods

The study took place between April and June 2006, in the area of Mădrigeşti locality, Arad County, western Romania. The locality lies in the Zărand Mountain from the Occidental Carpathians. The habitat is situated at 450 m altitude. It is a quasi-permanent pond, supplied by a low-flow spring and mostly from precipitation. In the droughty summers, the water level highly decreases, but never drains. The habitat lies at the basis of a slope covered with beech forests. It is approximately 3 m wide and 15 m long, and the maximum depth of the water is 1 m. The substratum of the puddle is covered with silt, in the centre there is a group of reeds, and the bank areas are teemed with pewter. The habitat is situated several kilometers from a village, the nearby country road is poorly circulated and the anthropic impact is relatively low. However, forest cutting takes place in the area, and there is a household with several horned cattles in the vicinity, which drink from the pond.

The stomach contents of 449 newts were drawn (123 of *M. alpestris*, 164 of *T. cristatus* and 162 of *L. vulgaris*). The samples were drawn at four dates (9 April, 6 May, 20 May, 17 June) with the exception of *M. alpestris* which became the first species to step out of the water, thus on the last date no individual was found (Table 1). The

newts were captured using round nets set onto long metallic handles. The drawing of the contents was done immediately after the capturing, the samples being obtained by using the stomach flushing method (Solé et al. 2005). Afterwards, the newts were released back into their habitat. The samples were preserved in airtight test tubes containing formaldehyde and were analysed in the laboratory. The food composition was evaluated by percentage abundance (%A) and frequency of occurrence (%f). The Kruskal-Wallis test was applied to compare the data sets for a particular species, for their males or females, and for different sampling events. The Mann-Whitney U-test was used to compare the males-females or species-species feeding differences. To determine differences in the frequency of occurrence of vegetal remains, shed skin, and anuran eggs consumed; the Chi-square test was used. Dietary diversity was estimated with the Shannon-Wiener (1949) diversity index (*H*), and the similarity with Sorrensen index. All the analyses were assessed with a 95% confidence interval.

Results

The three newt species presented a wide variety of stomach contents. First of all, animal preys were found (Table 2-4). Together with these, vegetal remains, amphibian shed-skin fragments (determined in many cases as being newt shed-skin), amphibian eggs and sometimes inorganic elements were identified (Table 1). Although the majority of the newts consumed all of these elements, there were also individuals without any stomach contents. The individuals without food belonged to *M. alpestris* and *L. vulgaris* species (Table 1). On May 20, most of the *M. alpestris* individuals had empty stomach. In the case of the crested newts, all of the individuals' stomach contained food, but some did not contain animal prey. The phenomenon was noted in the first period, during which in the other two species individuals without food were found. The stomachs without contents had the highest frequency at the beginning of the aquatic period; and a second increase, less pronounced, appeared at the end of it. This evolution is the most obviously expressed at *M. alpestris*.

Table 1. The number of analyzed individuals. The frequency of occurence of empty stomachs; and of stomachs with vegetal remains, shed skin, and amphibian eggs. (Lv – *Lissotriton vulgaris*, Tc – *Triturus cristatus*, Ma – *Mesotriton alpestris*, m- males, f- females).

		9 April 2006			6 May 2006			20 May 2006			17 June 2006	
		Lv	Tc	Ma	Lv	Tc	Ma	Lv	Tc	Ma	Lv	Tc
Number of stomachs	m=	21	15	20	20	14	20	20	13	22	21	23
	f=	20	26	20	20	23	20	20	13	21	20	26
% of empty stomachs	m=	4.76	60.00	50.00	5.00	-	20.00	10.00	-	50.00	9.52	-
	f=	-	20.00	2.56	20.00	-	19.57	25.00	4.76	76.19	30.00	-
% of vegetal remains	m=	85.71	60.00	65.00	60.00	20.00	30.00	30.00	17.40	36.36	76.19	65.00
	f=	75.00	70.00	60.00	70.00	30.00	75.00	75.00	23.80	38.10	55.00	75.00
% of shed skin	m=	38.10	65.00	65.00	20.00	15.00	45.00	15.00	4.35	50.00	9.52	5.00
	f=	30.00	65.00	60.00	10.00	10.00	20.00	5.00	4.76	52.38	25.00	10.00
% of anuran eggs	m=	-	85.00	5.00	50.00	-	5.00	10.00	8.7	9.09	4.76	5.00
	f=	10.00	90.00	15.00	75.00	10.00	35.00	40.00	14.3	4.76	25.00	-

Table 2. The number of consumed prey items, the mean and maximum number of preys/individuals, the percentage abundance of the aquatic and terrestrial preys, the feeding diversity according to the Shannon-Wiener H, and the feeding similarity according to the Sorrensen index (S). (Lv – *Lissotriton vulgaris*, Tc – *Triturus cristatus*, Ma – *Mesotriton alpestris*, m- males, f- females).

		9 April 2006			6 May 2006			20 May 2006			17 June 2006	
		Lv	Tc	Ma	Lv	Tc	Ma	Lv	Tc	Ma	Lv	Tc
Number of preys	m=	162	30	22	402	116	40	212	121	29	211	172
	f=	75	77	78	270	220	46	70	115	5	114	247
Mean No. of preys	m=	7.71	1.50	1.10	20.10	5.80	2.00	10.60	5.26	1.32	10.04	8.60
	f=	3.75	3.85	3.90	13.50	11.00	2.30	3.50	5.47	0.24	5.70	12.40
Maxim No. of preys	m=	24	15	6	52	14	13	36	13	5	29	23
	f=	11	26	19	46	23	22	18	13	1	29	26
% of aquatic preys	m=	97.5	100.00	100.00	98.50	97.41	82.50	97.16	93.40	79.31	71.56	97.09
	f=	100.00	94.8	96.15	98.88	100.00	91.30	97.14	100.00	60.00	85.08	98.80
% of terrestrial preys	m=	2.5	-	-	1.5	2.59	17.50	2.84	6.60	20.69	28.44	2.91
	f=	-	5.20	3.85	1.12	-	8.70	2.86	-	40.00	14.92	1.20
Prey diversity (H)	m=	1.201	.714	1.135	.452	.488	1.482	.774	.657	.506	1.101	.744
	f=	1.460	1.035	1.288	.359	.148	.908	1.053	.265	.878	1.511	.737
Mean food similarity (S)	m=	.224	.100	.111	.318	.713	.076	.228	.649	.147	.354	.442
	f=	.312	.278	.317	.217	.808	.087	.135	.737	.011	.115	.570

Both the maximum and average number of preys/individual have the highest values in *L. vulgaris*, as opposed to *M. alpestris* (Table 2). In *T. cristatus* the feeding by the females was more intense in all dates, as they constantly consumed a higher number of preys than the males. The same aspect was also true in *M. alpestris*, with the exception of the last period in which the newts fed very poorly after leaving the aquatic environment. Unexpectedly, in *L.*

vulgaris the average number of preys/ individual was always higher in males (Table 2).

The majority of the consumed preys were aquatic animals and only a few were terrestrials. However, there are also great prey differences between these three species. Thus, in *M. alpestris* the abundance of the terrestrial preys percentage was high (%A=40). Generally, this percentage increases through the end of the aquatic period, when the newts leave the water. This evolution was not noted in *T. cristatus*, where the terrestrial preys accidentally appear in reduced abundance during the entire aquatic period.

The vegetales were present in all species, at both the sexes and on all of the dates (Table 1),

without significant differences (p>0.05). The shed-skins were also constantly consumed. With the exception of *M. alpestris*, where the shed-skin consumption frequencies remained relatively homogenous during the aquatic period, in the other two species the shed-skin consumption gradually decreases as the warm season approaches (Chi-square, p>0.05). The amphibian eggs were also constantly found in the food of the newts, but the peak of their consumption differs between the species. *T. cristatus* consumed eggs the most often in the first period, but in the case of the other two species the eggs consumption registered higher frequencies at the later dates (Chi-square, p<0.05).

Table 3. The percentage abundance (%A) of the consumed prey items. (Lv – *Lissotriton vulgaris*, Tc – *Triturus cristatus*, Ma – *Mesotriton alpestris*, m- males, f- females, aq- aquatic, t- terrestrial, L- larvae).

		9 April 2006			6 May 2006			20 May 2006			17 June 2006	
		Lv	Tc	Ma	Lv	Tc	Ma	Lv	Tc	Ma	Lv	Tc
Oligocheta-Lumbricidae	m=	-	-	-	-	-	-	-	-	-	-	-
	f=	-	-	2.56	-	-	-	-	-	-	-	-
Gasteropoda (aq.)	m=	6.79	3.33	13.64	.49	-	12.50	-	.82	-	-	3.48
	f=	22.66	-	62.82	.74	-	2.17	1.43	-	-	25.44	9.30
Gasteropoda (t.)	m=	-	-	-	-	.86	-	-	1.65	-	-	-
	f=	-	1.29	-	.37	-	4.35	-	-	-	.87	-
Bivalva	m=	15.43	-	4.55	3.48	-	45.00	13.68	5.78	79.31	1.89	83.72
	f=	8.00	-	2.56	-	-	76.09	5.71	-	20.00	2.63	81.37
Ostracoda	m=	-	43.33	13.64	-	-	-	-	-	-	-	1.74
	f=	-	16.88	-	-	-	-	-	-	-	-	-
Copepoda	m=	17.28	-	-	1.49	-	-	-	-	-	-	-
	f=	18.67	-	-	-	-	-	-	-	-	2.63	4.04
Cladocera	m=	52.47	-	-	90.55	-	-	77.83	-	-	48.82	-
	f=	-	-	-	91.85	-	-	67.14	-	-	25.44	-
Isopoda (t)	m=	-	-	-	-	-	-	-	-	-	-	-
	f=	-	1.29	-	-	-	-	-	-	-	-	-
Aranea	m=	-	-	-	.25	1.72	-	-	.82	-	-	-
	f=	-	-	-	-	-	-	1.42	-	-	-	.40
Miriapoda-Chilopoda	m=	-	-	-	-	-	-	-	-	-	-	-
	f=	-	2.59	-	-	-	-	-	-	-	-	-
Collembola	m=	-	-	-	-	-	-	-	-	-	-	-
	f=	-	-	-	-	-	-	-	-	20.00	-	-
Efemeroptera (L.)	m=	-	-	-	-	-	-	-	-	-	-	-
	f=	-	-	-	-	-	-	-	-	-	2.63	-

Table 3. (Continued).

		9 April 2006			6 May 2006			20 May 2006			17 June 2006	
		Lv	Tc	Ma	Lv	Tc	Ma	Lv	Tc	Ma	Lv	Tc
Efemeroptera	m=	-	-	-	-	-	-	.47	-	-	-	-
	f=	-	-	-	-	-	-	-	-	-	-	-
Odonata (L.)	m=	-	-	-	.50	.86	-	-	-	-	-	.58
	f=	-	-	1.28	-	-	-	-	1.73	-	-	.80
Odonata	m=	-	-	-	-	-	-	-	-	-	-	.58
	f=	-	-	-	-	-	-	-	-	-	-	-
Plecoptera	m=	-	-	-	-	-	-	-	-	-	-	.58
	f=	-	-	-	-	-	-	-	-	-	-	-
Heteroptera (aq.)	m=	-	-	-	-	-	-	-	-	-	.47	1.16
	f=	-	-	-	-	-	-	-	-	-	-	-
Heteroptera (t.)	m=	-	-	-	-	-	2.50	-	.82	-	-	-
	f=	-	-	-	-	-	-	-	-	-	-	-
Homoptera-Aphididae	m=	-	-	-	-	-	2.50	-	-	-	27.49	-
	f=	-	-	-	-	-	-	-	-	-	12.28	-
Homoptera-Cicadellidae	m=	-	-	-	-	-	-	.47	-	-	-	-
	f=	-	-	-	-	-	-	-	-	-	-	-
Coleoptera-Dytiscidae (l.)	m=	.61	-	-	-	.86	2.50	.94	-	-	1.42	1.16
	f=	-	-	-	-	-	-	11.43	3.47	-	2.63	.40
Coleoptera-Dytiscidae	m=	-	-	-	-	-	2.50	-	-	-	-	-
	f=	-	-	-	-	-	-	-	-	-	-	-
Coleoptera (L.aq.)	m=	-	-	-	-	-	-	-	-	-	-	-
	f=	-	-	-	1.85	-	-	-	-	-	-	-
Coleoptera (t.)	m=	1.23	-	-	.50	-	5.00	.47	1.65	3.45	.94	1.74
	f=	-	-	1.28	.74	-	2.17	-	-	-	1.75	.40
Lepidoptera (L.)	m=	-	-	-	.50	-	-	.47	1.65	17.24	-	-
	f=	-	-	-	-	-	2.17	1.43	-	20.00	-	.40
Trichoptera (L.)	m=	4.93	46.66	45.45	-	8.62	7.50	-	3.30	-	-	-
	f=	12.00	35.06	19.23	-	3.63	4.35	2.85	-	-	-	-
Diptera-Nematocera (L.)	m=	-	6.66	18.18	1.74	-	12.50	3.77	-	-	18.01	4.06
	f=	37.33	41.55	10.26	4.07	-	4.35	7.14	.86	-	23.68	2.02
Diptera-Nematocera	m=	-	-	-	-	-	7.50	.94	-	-	-	-
	f=	-	-	-	-	-	-	-	-	-	-	-
Diptera-Brahicera (L.,aq.)	m=	-	-	4.55	-	-	-	-	-	-	-	1.16
	f=	1.33	1.29	-	-	-	-	1.43	-	-	-	-
Hymenoptera	m=	1.23	-	-	.25	-	-	-	-	-	-	-
	f=	-	-	-	-	-	-	-	-	-	-	-
Amphibia-Urodela (L.)	m=	-	-	-	-	-	-	-	.82	-	.47	-
	f=	-	-	-	-	-	-	-	-	-	-	.80
Amphibia-Anura (L.)	m=	-	-	-	.25	87.06	-	.94	82.64	-	.47	-
	f=	-	-	-	.37	96.36	4.35	-	93.91	40.00	-	-

As a total, the three newt species consumed 2844 preys. *L. vulgaris* consumed the highest number of preys (1526), while *M. alpestris* consumed the lowest number (just 220). Despite having the biggest stature, *T. cristatus* occupied a middle position, consuming 1098 preys (Table 2). With the number of the consumed prey taxa, the situation is similar. *L. vulgaris*

occupying the first place, while *M. alpestris* the last. *M. alpestris* consumed the most taxa at the middle of the aquatic period, while the other two species towards the end of it. The global changes in the consumption of prey types during the study were not significant for the three newt species (Kruskal-Wallis *H*=2.22, *P*=.329), neither for males nor females (for all comparison Kruskal-Wallis-test, *P*>0.05). As for the species-species, males-females differences, there were no significant changes (for all comparison *U-test, P*>0.05). The only significant differences found were for the males of *T. cristatus* between the first-last (*Z*=2.31, *P*=.02) and second-last periods (*Z*=2.14, *P*=.03).

In the case of *L. vulgaris* the Cladocera crustacean preys register the highest percentage abundance (%A) followed by the Nematocera larvae, smaller-sized preys responsible for the large number of preys/ individual. In *T. cristatus* there was no dominating groups on all of the four dates. On the first date, the Trichoptera larvae register the highest percentage abundance, on the following two dates the tadpoles, and at the end the shells become a majority. *M. alpestris* consumes high percentage abundance of Trichoptera larvae and snails in the beginning, followed by shells. In the case of all three species, the groups that have high percentage abundance were in general consumed with high frequency of occurrence (Table 3-4). *L. vulgaris,* the species with the smallest stature has the highest trophic diversity (Table 2). On the contrary, the maximum similarity between the preys from the stomach contents was noticed at the other two species. Also, regarding the food diversity, there were differences between the periods (Table 2).

Discussions

Although the habitat has relatively reduced sizes, there is however a portioning between the three newt species, which is noticed ever

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since *L. vulgaris* was spotted and captured from the bank of the water, while *T. cristatus* mainly stayed in the deeper areas at the substratum level. *M. alpestris* was caught from the water mass, but also in the deeper areas and previously it signalled the adults' preference for open areas without vegetation (Denoël & Andreone 2003). *T. cristatus* was sometimes noticed near the banks, but *M. alpestris* had always avoided this area. The differences of these newts' hunting territories were also previously described, i.e. *T. cristatus* is considered prevalently benthonic and *L. vulgaris* prevalently nektonic (Dolmen & Koksvik 1983). Differences of the microhabitat in a smaller spatial scale were also indicated in the case of other amphibian species (Santos et al 2004). The consumed food denotes that while *T. cristatus* hunts at the substratum level, *L. vulgaris* hunts both in the water mass and at the substratum level, but near the banks. The stomach contents indicate that *M. alpestris* also hunts at the substratum level, and its presence in the water mass probably just for the nuptial parade. Thus, the trophic niche of *T. cristatus* and *M. alpestris* is similar, while *L. vulgaris'* niche is clearly different. The first two species can exploit the same hunting territory probably because of a high trophic accessibility, a fact that was previously remarked by Griffiths (1986).

The establishing of *L. vulgaris'* hunting territory near the banks, in areas with lower and warmer waters, is also revealed by the massive consumption of microcrustacean, which forms great agglomerations in the respective areas of the ponds. Proof that *T. cristatus* and *M. alpestris* hunt at the substratum level of the deeper areas is shown by the consumption of trichopteran larvae and shells. The fact the *M. alpestris* and *L. vulgaris* hunt in different areas of the puddle is confirmed by their microcrustacean consumption. In other cases, the Alpine newts massively consume microcrustaceans (Schebetsberger et al. 1995),

Table 4. The frequency of occurrence (%f) of the consumed prey items. (Lv – *Lissotriton vulgaris*, Tc – *Triturus cristatus*, Ma – *Mesotriton alpestris*, m- males, f- females, aq- aquatic, t- terrestrial, L- larvae).

		9 April 2006			6 May 2006			20 May 2006			17 June 2006	
		Lv	Tc	Ma	Lv	Tc	Ma	Lv	Tc	Ma	Lv	Tc
Oligocheta-Lumbricidae	m=	-	-	-	-	-	-	-	-	-	-	-
	f=	-	-	5.00	-	-	-	-	-	-	-	-
Gasteropoda (aq.)	m=	28.57	5.00	10.00	5.00	5.00	15.00	-	4.35	-	-	20.00
	f=	45.00	-	65.00	10.00	-	5.00	5.00	-	-	35.00	35.00
Gasteropoda (t.)	m=	-	-	-	-	5.00	-	-	-	-	-	-
	f=	-	5.00	-	5.00	-	10.00	-	4.35	-	5.00	-
Bivalva	m=	19.05	-	5.00	15.00	-	25.00	40.00	4.35	31.82	9.52	85.00
	f=	10.00	-	5.00	-	-	30.00	10.00	-	4.76	10.00	95.00
Ostracoda	m=	-	5.00	5.00	-	-	-	-	-	-	-	5.00
	f=	-	15.00	-	-	-	-	-	-	-	-	-
Copepoda	m=	19.05	-	-	10.00	-	-	-	-	-	-	-
	f=	20.00	-	-	-	-	-	-	-	-	5.00	15.00
Cladocera	m=	42.86	-	-	70.00	-	-	45.00	-	-	47.62	-
	f=	-	-	-	50.00	-	-	25.00	-	-	10.00	-
Isopoda (t)	m=	-	-	-	-	-	-	-	-	-	-	-
	f=	-	5.00	-	-	-	-	-	-	-	-	-
Aranea	m=	-	-	-	5.00	10.00	-	-	4.35	-	-	-
	f=	-	-	-	-	-	-	5.00	-	-	-	5.00
Miriapoda-Chilopoda	m=	-	-	-	-	-	-	-	-	-	-	-
	f=	-	10.00	-	-	-	-	-	-	-	-	-
Collembola	m=	-	-	-	-	-	-	-	-	-	-	-
	f=	-	-	-	-	-	-	-	-	4.76	-	-
Efemeroptera (L.)	m=	-	-	-	-	-	-	-	-	-	-	-
	f=	-	-	-	-	-	-	-	-	-	15.00	-
Efemeroptera	m=	-	-	-	-	-	-	5.00	-	-	-	-
	f=	-	-	-	-	-	-	-	-	-	-	-
Odonata (L.)	m=	-	-	-	10.00	5.00	-	-	-	-	-	5.00
	f=	-	-	-	-	-	-	-	9.52	-	-	10.00
Odonata	m=	-	-	-	-	-	-	-	-	-	-	5.00
	f=	-	-	-	-	-	-	-	-	-	-	-
Plecoptera	m=	-	-	-	-	-	-	-	-	-	-	5.00
	f=	-	-	-	-	-	-	-	-	-	-	-
Heteroptera (aq.)	m=	-	-	-	-	-	-	-	-	-	4.76	10.00
	f=	-	-	-	-	-	-	-	-	-	-	-
Heteroptera (t.)	m=	-	-	-	-	-	5.00	-	4.35	-	-	-
	f=	-	-	-	-	-	-	-	-	-	-	-
Homoptera-Aphididae	m=	-	-	-	-	-	5.00	-	-	-	28.57	-
	f=	-	-	-	-	-	-	-	-	-	20.00	-
Homoptera-Cicadellidae	m=	-	-	-	-	-	-	5.00	-	-	-	-
	f=	-	-	-	-	-	-	-	-	-	-	-
Coleoptera-Dytiscidae (l.)	m=	4.76	-	-	-	5.00	5.00	10.00	-	-	14.29	10.00
	f=	-	-	-	-	-	-	40.00	19.00	-	15.00	5.00
Coleoptera-Dytiscidae	m=	-	-	-	-	-	5.00	-	-	-	-	-
	f=	-	-	-	-	-	-	-	-	-	-	-

Table 4. (Continued).

		9 April 2006			6 May 2006			20 May 2006			17 June 2006	
		Lv	Tc	Ma	Lv	Tc	Ma	Lv	Tc	Ma	Lv	Tc
Coleoptera (L.aq.)	m=	-	-	-	-	-	-	-	-	-	-	-
	f=	-	-	-	5.00	-	-	-	-	-	-	-
Coleoptera (t.)	m=	9.52	-	-	10.00	-	5.00	5.00	8.70	4.55	9.52	10.00
	f=	-	-	5.00	10.00	-	5.00	-	-	-	5.00	5.00
Lepidoptera (L.)	m=	-	-	-	10.00	-	-	5.00	4.35	18.18	-	-
	f=	-	-	-	-	-	5.00	5.00	-	4.76	-	5.00
Trichoptera (L.)	m=	38.10	30.00	35.00	-	40.00	15.00	-	17.4	-	-	-
	f=	45.00	60.00	55.00	-	25.00	10.00	10.00	-	-	-	-
Diptera-Nematocera (L.)	m=	-	10.00	10.00	20.00	-	15.00	30.00	-	-	57.14	25.00
	f=	45.00	20.00	10.00	15.00	-	10.00	15.00	4.76	-	30.00	10.00
Diptera-Nematocera	m=	-	-	-	-	-	5.00	10.00	-	-	-	-
	f=	-	-	-	-	-	-	-	-	-	-	-
Diptera-Brahicera (L.,aq.)	m=	-	-	5.00	-	-	-	-	-	-	-	10.00
	f=	5.00	5.00	-	-	-	-	5.00	-	-	-	-
Hymenoptera	m=	9.52	-	-	5.00	-	-	-	-	-	-	-
	f=	-	-	-	-	-	-	-	-	-	-	-
Amphibia-Urodela (L.)	m=	-	-	-	-	-	-	-	4.35	-	4.76	-
	f=	-	-	-	-	-	-	-	-	-	-	10.00
Amphibia-Anura (L.)	m=	-	-	-	5.00	95.00	-	10.00	91.30	-	4.76	-
	f=	-	-	-	5.00	95.00	5.00	-	95.20	9.52	-	-

but at Mădrigeşti this does not occur. It appears that the Alpine newts hunt in areas where the microcrustacean habitats are very limited or lacking. Habitat sharing between *T. cristatus* and *L. vulgaris* and the avoidance of the other species' area are also the result of the reduced number of common newts consumed by the crested ones, a fact that happens more frequently in other habitats (Cicort-Lucaciu et al. 2005a). These results confirm the previous postulate which states that food composition might provide the basis of the ecological and behavioral studies (Santos et al. 2004).

M. alpestris has the most reduced feeding, which is demonstrated by the high number of individuals without food, by the reduced number of preys and by the high and constant shed-skin consumption. The feeding of *M. alpestris* indicates that the newt has short aquatic period, with maximum intensity at the middle of it, followed by a sudden decrease.

The low feeding intensity of the Alpine newts could be a consequence of the lack of the dorsal crest, which could affect their capacity to hunt in the water. However, neither females of the two other species has dorsal crest, and at least *T. cristatus* females feed more intensely than the males. The differences between males' and females' food are not significant (*U-test, P>0.05*) at species in which the males have dorsal crests. In other newt species, weaker feeding of the females was not observed, since the females either eats larger and slower preys (Dobre et al 2007, Ferenţi et al. 2008) or has no significant food differences with the males (Ovlachi et la 2007). Thus, the lack of the dorsal crest is not the cause of the less intensive feeding of the Alpine newts.

The differences between the food of the newt species are mainly the result of their relationship with the aquatic environment. The most distinct species from this point of view is

M. alpestris. It stays the least in the water and it seems that, in comparison to the other two species, it is the least adapted to hunting in the water. Thus, *M. alpestris* rarely hunts in the water regarding the time and the food diversity, consuming just the essential in its egg-laying period. The behavior of *M. alpestris* probably should be connected to the adjustment to areas with high altitude and cold climate, where the advantageous period is short, thus the eggs must be rapidly deposited so the larvae would develop. Even at Mădrigeşti, when the Alpine newts stay under the lower altitudinal limit (Covaciu-Marcov et al. 2009), the species behaves according to the remained program from the period with a cold and hostile climate. Therefore, between the three species, *M. alpestris* is the most different due to certain acts that belong to its past evolution, its formation and its adjustment to specific climatic requirements. The feeding is a consequence, modified by the species' evolutionary history. The fact is remarkable, since especially in Romania, it was thought that the Alpine newts spend a lot of their time in water, being a species attached to the aquatic environment (Cogălniceanu et al. 2000a). Here, on the contrary, it seems that *M. alpestris* is the least connected species, being the first to leave the aquatic environment and having lower abilities to feed in the water.

The differences between *T. cristatus* and *L. vulgaris* are a consequence of their distinctive sizes and hunting territories, although generally in amphibians the larger species consume higher prey diversity (Cogălniceanu et al 2000b). *L. vulgaris* consumed an extra taxa, having the highest trophic diversity (Table 2). Some of the consumed taxa are not found in the food of the other newt species *vice versa*. The additional taxa consumed by the *L. vulgaris* have reduced sizes, and are terrestrial, being accidentally consumed. On the contrary, *T. cristatus* has, due to its size, access to larger preys, sometimes even consuming *L. vulgaris*

individuals (eg. Cicort-Lucaciu et al. 2007, or even *M. alpestris* see in: Burlacu et al. 2009). This fact is obvious in the case of the tadpoles, which have larger dimensions and are almost exclusively consumed by *T. cristatus*. Among amphibians, the connections between the size of the preys and the predator is established: the size of the consumer determines the size of the consumed preys (Arroyo et al. 2008).

When the end of the aquatic period is near, the percentage abundance of the terrestrial preys grows. This phenomena is the most obvious at *M. alpestris*. The consumption of the terrestrial preys by the newts in the aquatic period is considered a consequence of the preys' accidental presence in the aquatic habitat (Denoël et al. 1999, Denoël & Joly 2001, Kutrup et al. 2005). This fact is acceptable especially in the case of the flying preys, such as the mosquitoes, but it is difficult for terrestrial preys such as caterpillars to accidentally fall in the water in large number. Their consumption pattern seems to suggest that at least at the end of the aquatic period, the Alpine newts also hunt in the terrestrial environment, probably at night. Similar situations were also previously observed (Kuzmin 1990). This kind of evolution is most distinctly observed in *T. cristatus*, species for which the terrestrial preys as a whole have the lowest values. However, in exceptional situations these terrestrial preys are the most consumed (Covaciu-Marcov et al. 2002b, Cicort-Lucaciu et al. 2007). The reduced abundance of the terrestrial preys of *T. cristatus* in the last period may have two explanations. Either the crested newt was yet to finish its aquatic period, which means that it is a species with the longest aquatic period, or *T. cristatus* is probably the most adapted species in hunting in the aquatic environment. The improved adaptation in hunting in the water can be deduced from the species' morphology and dimensions, and the development of a longer tail to increase its swimming speed into maximum (Gvoždík & Van Damme 2006). If in *M.*

alpestris and in other cases, the feeding in the aquatic environment is reduced (Covaciu-Marcov et al. 2003), in *L. vulgaris* this fact does not usually happen (Ovlachi et al. 2007, David et al. 2008b). Anyhow, *T. cristatus* still normally feeds in the water in the middle of June.

The caterpillars are a group of terrestrial preys consumed by the newts from Mădrigeşti. All of the three species consumed them, but they were important only for *M. alpestris* in the last date. Although terrestrial, caterpillars were also identified in a large number in the food of other newts species, such as *T. cristatus* for which in some cases the caterpillar is the most important trophic element (Cicort-Lucaciu et al. 2007). However, at Mădrigeşti the crested newts consumed very few caterpillars. This might be the consequence of the abundance of tadpoles, prey that is equally large but easier to catch and lives in the water, thus need not be hunted on the banks. Also there were cases when the caterpillars were the most abundant and there were other preys in the water, but they were microcrustacean (Cicort-Lucaciu et al. 2007). These are small-sized preys and do not interest *T. cristatus*, which although sometimes it massively consumes them (Covaciu-Marcov et al. 2002c), but when there are choices, the newt will avoid them (Covaciu-Marcov et al. 2002a). As the crested newts have the possibility to feed easily in the water, they do not have to leave this habitat to hunt in the vegetation near the banks. In contrast, *M. alpestris* is somehow preparing to leave the water, therefore it naturally hunts in the terrestrial environment, which is advantaged by the presence of the caterpillars on the banks. With *M. alpestris* it has been demonstrated in the laboratory that the adults captured large-sized terrestrial preys more efficiently (Denoël 2004). In *L. vulgaris* the caterpillars found are very few, since this species is more aquatic and of small size, which makes it hard for the newt to swallow large sized caterpillars.

At the beginning of *T. cristatus* activity period, an obviously weak feeding was obseved on males. This happens as a consequence of the low temperatures, as it does in other amphibians, i.e. the thermic regime affects the feeding, which is lower in the beginning of the activity period (Hirai & Matsui 2000, Kovács et al. 2007). However, at the beginning, *L. vulgaris* feeds intensively, a behaviour that can be explained since the habit of the average newts is to stay in the low-water areas near the banks, where the maximum depth is 10 cm. In these zones the water warms up faster, allowing an increased activity of both the preys and the predators. A very intense feeding was observed for *T. cristatus*, species resides near the substratum, in deep and colder areas, where the low temperatures changed both the predators and especially the preys (Guidali et al. 1999, Sas et al. 2003). Although *M. alpestris* was also present in the same areas, it fed better, probably because of the adjustment to a more reduced thermic regime.

The number of preys/individual is the highest in *L. vulgaris*, because it consumes small-sized preys, while *T. cristatus,* which has the largest size, registers a lower amount of preys/individual, since its preys are also larger. In *M. alpestris* the number of preys consumed is the lowest. The general evolution of the feeding intensity in the aquatic period is the most easily observed at this species, with two minimums at the beginning and the end of the aquatic period and an intermediary maximum.

The high percentage abundance and consumption frequencies of the same prey taxa indicate a homogenous trophic offerings in the hunting territory of each of the three species and a homogenous distribution of these in the respective territory. There were also exceptions, such as in the last period of female *M. alpestris*, when the tadpoles had high percentage abundance but the frequency of consumption was much lower. Probably some females

encountered tadpoles, but for them these preys were not important. Differences of the food composition between periods are conspicuous as a consequence of the preys' accessibility in the habitats, a result of their life cycles (Fasola & Canova 1992). The consumptions frequencies' time of the prey taxa also fluctuates, like those observed in other newt species (Kutrup et al. 2005, David et al. 2008b).

From the three species, only the stomach of all *T. cristatus* individuals were found to contiously contain food. This is an indicator of the existence of optimum feeding, since in amphibians individuals without food is associated with its trophic conditions (Sas et al. 2009). However, in the first period of this species, many individuals did not consume animal preys; only vegetales, shed skins or eggs. Those with empty stomachs or with stomach contents other than the usual preys might have faced with less favorable feeding conditions, at the beginning and the end of their activity periods (Covaciu-Marcov et al. 2005). At Mădrigeşti this evolution is most obvious in *M. alpestris* and *L. vulgaris*, but not in *T. cristatus*, which continues to remain in the water.

There are feeding differences between the periods in all three species. These differences are not only dependent on the life cycle of the newts, but also on the life cycle of the potential preys and as a consequence of prey abundance in the environment (Fasola & Canova 1992, Denoël & Andreone 2003). The first phenomenon is observable in *M. alpestris*, which feeds extremely weak in the last period, although at that time the trophic offer was rich, as shown by the extremely intensive feeding of the other two newt species. Thus, although the food was sufficient, *M. alpestris* did not feed itself because its aquatic stage ended just after egg-laying and then moves into terrestrial environment. With the other two species, which are more aquatically pronounced, the chronological distinctions of the food compo-

sitions are firstly a consequence of the prey reserve in the habitat.

The fact that at least *T. cristatus* is an opportunistic predator is already known (Ferenţi et al. 2008). Still, the crested newts opt for a certain selection from the most abundant preys in the habitat depending on their size and their facility to be captured (Covaciu-Marcov et al. 2002a, Cicort-Lucaciu et al. 2005). Thus, the crested newts constantly consume the most numerous and easy to catch preys, as it was evident by their tadpole consumption. Copious amount of *Rana temporaria* eggs were present in the pond at the beginning of the study. The eggs were found in low water areas, but situated towards the forest where the bank was steeper and therefore were accessible to the crested newts. Once they appeared, the tadpoles with the diameter of approximately 1 - 1.5 cm were the food basis for the crested newts. After these larvae grew out of their proper feeding size, the next food option was placed on the shells, easy to capture preys which concurrently present at the substratum level with *T. cristatus*.

The differences between the sexes are not significant in either of the species (for all comparison *U-test, P*>0.05). However, the distinctive differences between the feeding behaviours of the three species are present. With the exception of *L. vulgaris*, in general the female amphibians' feeding is more intense, they consume even larger preys, due to the increased energetic consumption necessary for the formation of the eggs (Biavatti et al. 2004, Ferenţi et al. 2007). Thus, it is difficult to explain why in the case of *L. vulgaris* the situation is exactly the opposite, although in laboratory conditions the males of this species, including the hungry ones, were less interested in the food than the females, being absorbed by the nuptial parade (Ranta et al. 1987). However, the situation is probably less highlighted. Even if the males consume more preys, they are focused on reduced sized preys such as

microcrustacean, while the females consume larger sized preys such as gastropods. Thus, even if the males swallow more preys, the consumed preys of the females can be more consistent and energetically richer. The males can hunt easier preys such as daphnias, which form floating agglomerations with their dorsal crest. The females, heavier, are situated at the level of the substratum, where therefore have easier access to the snails from the bottom of the water. These differences between the males and females are observable in the other two species, although less pronounced.

References

Arntzen, J.W., De Wiejer, P. (1989): On the distribution of palearctic newts (genus Triturus) including the description of a five species pond in western France. British Herpetological Society Bulletin 30: 6-11.

Arroyo, S.B., Serrano-Cardozo, V.H., Ramirez-Pinilla, M.P. (2008): Diet, microhabitat and time of activity in a *Pristimantis* (Anura, Strabomantidae) assemblage. Phyllomedusa 7 (2): 109-119.

Biavatti, G.M., Wiederhecker, H.C., Colli, G.R. (2004): Diet of *Epipedobates flavopictus* (Anura: Dendrobatidae) in a Neotropical savanna. Journal of Herpetology 38: 510-518.

Burlacu, L., Radu, C. F., Sahlean, T., Gavriloaie, I.C. (2009): Inter and intra specific cannibalism and aggressiveness within the *Triturus cristatus* superspecies: hungry or crowded? AACL Bioflux 2(2):161-183.

Cicort-Lucaciu, A.Ş., Covaciu-Marcov, S.D., Cupşa, D., Purgea, I., Romocea, M. (2004): Research upon the trophic spectrum of a *Triturus vulgaris* (Linnaeus 1758) population of the Beiuş depresion area (Romania). Studii şi Cercetări Ştiinţifice, Universitatea din Bacău, seria Biologie 9: 201-206.

Cicort-Lucaciu, A.Ş., Ardeleanu, A., Cupşa, D., Naghi, N., Dalea, A. (2005a): The trophic spectrum of a *Triturus cristatus* (Laurentus 1768) population from Plopiş Mountains area (Bihor County, Romania). North-Western Journal of Zoology 1: 31-40.

Cicort-Lucaciu, A.Ş., Covaciu-Marcov, S.D., Cupşa, D., Purgea, I., Sas, I. (2005b): Research upon the trophic spectrum of a *Triturus cristatus* population in the Briheni area (County of Bihor, Romania). Scientific Annals of the Danube Delta Institute for Research and Development, Tulcea, Romania 11: 2-8.

Cicort-Lucaciu, A.Ş., Bogdan, L., Toth, A., Orban, I., Băbuţa, O. (2006a): Notă asupra hrănirii unei populaţii de *Triturus cristatus* de la Şuştiu (jud. Bihor, Romania). Analele Universităţii din Oradea, Fascicula Biologie 13: 24-28.

Cicort-Lucaciu, A.Ş., Bogdan, H.V., Toth, A., Benzar, M., Balaj, L., Vidican, A.M. (2006b): Research upon the feeding of the species *Triturus vulgaris* (Amphibia) from Poiana Tăşad (Bihor county, Romania). Analele Universităţii din Craiova, s. Horticultură, Biologie 11(47): 307-312.

Cicort-Lucaciu, A.Ş., Cupşa, D., Lazăr, V., Ferenţi, S., David, A. (2007): The feeding process of two newt species (*Triturus* sp.) from the northern part of Satu Mare district (Romania). Analele Universităţii din Craiova, s. Horticultură, Biologie 12(48): 271-276.

Cogălniceanu, D., Aioanei, F., Bogdan, M. (2000a): Amfibienii din România, Determinator. Editura Ars Docendi, Bucharest, Romania. [in Romanian]

Cogălniceanu, D., Palmer, M.W., Ciubuc, C. (2000b): Feeding in Anuran comunities on islands in the Danube floodplain. Amphibia-Reptilia 22: 1-19.

Covaciu-Marcov, S.D., Cupşa, D., Telcean, I., Cicort, A. (2002a): Spectrul trofic al unei populaţii de *Triturus cristatus* (*Amfibia, Urodela*) din zona Şerghiş, jud. Bihor, România. Oltenia, Studii şi Comunicări, Ştiinţele Naturii 18: 188-194. [in Romanian]

Covaciu-Marcov, S.D., Cupşa, D., Telcean, I.C., Cicort, A. (2002b): Studiul spectrului trofic al unor populaţii de *Triturus cristatus* (Laurentus 1768) din zona Dealurilor Tăşadului (Jud. Bihor). Nymphaea, Folia Naturae Bihariae 29: 117-145. [in Romanian]

Covaciu-Marcov, S.-D., Cupşa, D., Cicort, A., Telcean, I. C., Sas, I. (2002c): Contribuţii la cunoaşterea spectrului trofic al speciei *Triturus cristatus* (*Amphibia, Urodela*) din regiunea Marghita şi Munţii Pădurea Craiului (jud. Bihor, România). Analele Universităţii din Oradea, Fascicula Biologie 9: 157-169. [in Romanian]

Covaciu-Marcov, S.D., Cupşa, D., Cicort, A., Naghi, N., Vesea, L. (2003): Date despre spectrul trofic al unor populaţii de *Triturus alpestris* din zona Muntelui Şes (jud. Bihor, România). Oltenia, Studii şi Comunicări, Ştiinţele Naturii 19: 171-176. [in Romanian]

Covaciu-Marcov, S.D., Sas, I., Cupşa, D., Rois, R., Bogdan, H. (2005): The trophic spectrum of a population of *Bufo viridis* (Amphibia) from the campus of the University of Oradea, Romania. Biota 6(1-2): 5-12.

Covaciu-Marcov, S.D., Cicort-Lucaciu, A.Ş., Sas, I., Ilieş, D.C., Josan, I. (2009): Explaining the presence of low altitude *Mesotriton alpestris* (Laurenti, 1768) populations from the Apuseni Mountains, western Romania – a possible zoogeographical scenario. North-Western Journal of Zoology 5 (2): 406-419.

David, A., Cicort-Lucaciu, A.Ş., Szabo, A., Ciuca, A.S., Cservid, K. (2007): Hrănirea unei populaţii de *Triturus vulgaris* din regiunea Văii Teuzului, jud. Arad, România. Biharean Biologist 1: 57-61.

David, A., Cicort-Lucaciu, A.Ş., Bogdan, H.V., Suciu, I.C., Gale, O. (2008a). The feeding of a *Triturus cristatus* population from the north-west of Arad county, Romania. Oltenia, Studii şi Comunicări, Ştiinţele Naturii, 24: 149-153.

David, A., Cicort-Lucaciu, A.Ş., Lazăr, O., Boroş, A., Indrei, C. (2008b): Compoziţia hranei la newtul comun (*Lissotriton vulgaris*) din zona localităţii Prunişor (judeţul Arad, România). Biharean Biologist 2: 38-42.

David, A., Cicort-Lucaciu, A.Ş., Roxin, M., Pal, A., Nagy-Zachari, A.S. (2009): Comparative trophic spectrum of two newt species, *Triturus cristatus* and *Lissotriton vulgaris* from Mehedinţi County, Romania. Biharean Biologist 3(2): 133-137.

Denoël, M. (2004): Feeding Performance in Heterochronic Alpine Newts is Consistent with Trophic Niche and Maintenance of Polymorphism. Ethology 110: 127-136.

Denoël, M., Joly, P., Poncin, P. (1999): Facultative paedomorphosis in the Alpine newt, *Triturus a. alpestris*: feeding habits and habitat use in an Alpine lake. Pp. 89-94. In: Miaud, C., Guyetant, G. (eds): Current studies in Herpetology. Societas Europaea Herpetologica, Le Bourget du Lac, France.

Denoël, M., Joly, P. (2001): Adaptative significance of facultative paedomorphosis in *Triturus alpestris* (Amphibia, Caudata): resource partitioning in an Alpine lake. Freshwater Biology 46: 1387-1485.

Denoël, M., Andreone, F. (2003): Trophic habits and aquatic microhabitat use in gilled immature, paedomorphic and metamorphic Alpine newt *Triturus alpestris apuanus* in a pond in central Italy. Belgian Journal of Zoology 133 (2): 95-102.

Dobre, F., Bucur, D.M., Mihuţ, R., Birceanu, M., Gale, O. (2007): Date asupra compoziţiei hranei a unei populaţii de *Triturus cristatus* (Laur. 1768) din Parcul Naţional "Defileul Jiului", România. Biharean Biologist 1: 23-28.

Dolmen, D. Koksvik, J.I. (1983): Food and feeding habits of *Triturus vulgaris* (L.) and *T. cristatus* (Laurenti) (Amphibia) in two bog tarns in central Norway. Amphibia-Reptilia 4: 17-24.

Fasola, M. (1993): Resource partitioning by three species of newts during their aquatic phase. Ecography 16: 73-81.

Fasola, M., Canova, L. (1992): Feeding-habits of *Triturus vulgaris*, *Telenomus cristatus* and *T. alpestris* (Amphibia) in the northern Apennines. Bolletino di Zoologia [Italian Journal of Zoology] 59: 273-280.

Ferenţi, S., Citrea, L., Nagy, H., Indrei, C., Bandi, F. (2007): Analiza comparativă a spectrului trofic a patru populaţii hibride între *Bombina bombina* şi *B. variegata* din bazinul hidrografic al Râului Tur (Jud. Satu-Mare, România). Biharean Biologist 1: 15-22.

Ferenţi, S., Cupşa, D., Lazăr, V., Dimancea, N., Ancău, M. (2008): Note on the trophic spectrum of a *Triturus cristatus* population from Livada Forest, Satu Mare district, Romania. Analele Universităţii din Craiova, s. Horticultură, Biologie 13(49): 77-82.

Griffiths, R.A. (1986): Feeding niche overlap and food selection in smooth and palmate newts, *Triturus vulgaris* and *T. helveticus* at a pond in mid-Wales. Journal of Animal Ecology 55: 201-214.

Griffiths, R.A. (1987): Microhabitat and seasonal niche dynamics of smooth and palmate newts, *Triturus vulgaris* and *T. helveticus* at a pond in mid-Wales. Journal of Animal Ecology 56: 441-451.

Griffiths, R.A., Mylotte, V.J. (1987): Microhabitat selection and feeding relations of smooth and warty newts, *Triturus vulgaris* and *T. cristatus*, at an upland pond in mid-Wales. Holarctic Ecology 10: 1-7.

Guidali, F., Scali, S., Carettoni, A., Fontaneto, D. (1999): Feeding habits, niche breadth and seasonal dietary shift of *Rana dalmatina* in northern Italy. Pp. 161-166. In: Miaud, C., Guyetant, G. (eds): Current studies in Herpetology. Societas Europaea Herpetologica, Le Bourget du Lac, France.

Gvoždík, L., Van Damme, R. (2006): *Triturus* newts defy the running-swimming dilemma. Evolution 60(10): 2110-2121.

Hirai, T., Matsui, M. (2000): Feeding habits of the Japanese Tree Frog, *Hyla japonica*, in the Reproductive season. Zoological Science 17: 977-982.

Joly, P., Giacoma, C., (1992): Limitation of similarity and feeding habits in three syntopic species of newts (Triturus, Amphibia). Ecography 15: 401-411.

Juncá, F.A., Eterovick, P.C. (2007): Feeding Ecology of Two Sympatric Species of Aromobatidae, *Allobates marchesianus* and *Anomaloglossus stepheni*, in Central Amazon. Journal of Herpetology 41: 301-308.

Kovács, É.H., Sas, I., Covaciu-Marcov, S.D., Hartel, T., Cupşa, D., Groza, M. (2007): Seasonal variation in the diet of a population of *Hyla arborea* from Romania. Amphibia-Reptilia 28: 485-491.

Kutrup, B., Çakir, E., Yilmaz, N. (2005): Food of the Banded Newt, *Triturus vittatus ophryticus* (Berthold, 1846) at Different Sites in Trabzon. Turkish Journal of Zoology 29: 83-89.

Kuzmin, S.L. (1990): Trophic niche overlap in syntopic postmetamorphic amphibians of the Carpathian Mountains (Ukraine: Soviet Union). Herpetozoa 3 (1/2): 13-24.

Lima, A.P., Magnusson, W.E. (1998): Partitioning seasonal time interactions among size, foraging activity and diet in leaf-litter frogs. Oecologia 116: 259-266.

Ovlachi, K.B., Ilona, H.R., Erdei, A., Blaga-Lungulescu, R., Petruţ, M. (2007): The trophic spectrum of a *Triturus vulgaris* population from Cărand area (Arad county, Romania). Analele Universităţii din Craiova, s. Horticultură, Biologie 12(48): 199-203.

Ranta, E., Tossem, S.F., Leikola, N. (1987): Female-male activity and zooplankton foraging by the smooth newt (*Triturus vulgaris*). Annales Zoologici Fennici 24: 79-88.

Santos, E.M., Almeida, A.V., Vasconcelos, S.D. (2004): Feeding habits of six anuran (Amphibia: Anura) species in a

rainforest fragment in Northeastern Brazil. Iheringia, Serie Zoologia 94 (4): 433-438.

Sas, I., Covaciu-Marcov S.D., Cupşa, D., Aszalos, L., Kovacs, E.H., Telcean, I.C. (2003): Data about the trophic spectrum of a population of *Rana arvalis* of the Andrid area (Satu-Mare county, România). Studii şi Cercetări Ştiinţifice, Universitatea din Bacău, seria Biologie 8: 216-223.

Sas, I., Covaciu-Marcov, S.D., Strugariu, A., David, A., Ilea, C. (2009): Food Habit of *Rana* (*Phelophylax*) *kl. esculenta* Females in a New recorded E-System Population from a Forested Habitat in North-Western Romania. Turkish Journal of Zoology 33: 1-5.

Schabetsberger, R., Jersabek, C.D., Brozek, S. (1995): The impact of Alpine newts (*Triturus alpestris*) and minnows (*Phoxinus phoxinus*) on the microcrustacean communities of two high altitude karst lakes. Alytes 12 (4): 183-189.

Shannon, C.E., Wiener, W. (1949): The mathematical theory of communication. Univ. Illinois Press, Urbana.

Solé, M., Beckmann, O., Pelz, B., Kwet, A., Engels. W. (2005): Stomach-flushing for diet analysis in anurans: an improved protocol evaluated in a case study in *Araucaria* forests, southern Brazil. Studies on Neotropical Fauna and Environment 40 (1): 23-28.

van Sluys, M., Rocha, C.F.D. (1998): Feeding habits and microhabitat utilization by two syntopic Brazilian Amazonian frogs (*Hyla minuta* and *Pseudopaludicola* sp (gr. *falcipes*). Revista Brasiliera de Biologia 58: 559-562.