

Diet composition of a *Triturus dobrogicus* (Amphibia) population from Arad County, western Romania

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Abstract. The present study analyses the diet of a *Triturus dobrogicus* population from Cermeiului Plain, with regards to period, sex and size classes. The aquatic Isopods were the most important prey item considering numeric proportion and frequency of occurrence. Juveniles mostly used the aquatic perizone habitat for feeding and thus they managed to eat larger preys than the adults did, such as the Oligochaeta. Concerning foraging strategy, the females were more active than the males, consuming more terrestrial or aquatic preys with a gregarious life. The small number of prey categories and the big number of preys belonging to one category raised the similarity between samples and homogenized the one between the two sexes. In the case of the juveniles, the abandonment of the aquatic biotope lead to a smaller number of prey categories and to a lower feeding intensity in comparison with the adults.

Key words: *Triturus dobrogicus*, trophic spectrum, period, sex, size classes.

Introduction

Triturus dobrogicus is an endemic species in the Romanian and Pannonian Plain (Litvinchuk & Borkin 2000). Although it is present in the Western Plain as well as in the Romanian Plain, southern Moldavia and the Danube Delta (Fuhn 1960, Coğălniceanu et al. 2000, Covaciu-Marcov et al. 2004, 2005a,b,c, 2006a,b, 2008, 2009, Strugariu & Gherghel 2008), *Triturus dobrogicus* is an endangered species in Romania, due to the powerful disturbance of its breeding habitats (Coğălniceanu et al. 2000). Information about the food composition of the Amphibians are very important because they indicate the quality of the habitat which they occupy (Gunzburger 1999). Whereas, newts reproduce in aquatic habitats, is essential to gather data about the necessary conditions for reproduction, for example the prey diversity, the presence of the hunters or of the aquatic vegetation (Skei et al. 2006).

Considering the fact that only two feeding studies have been carried out so far in Romania (Cicort-Lucaciu et al. 2005a, Kovacs et al. 2006), we focused our analysis on a Danube crested newt population from the Cermeiului Plain. As a difference from previous studies, we statistically analyzed the diet composition from a period, sex and size-class point of view.

Materials and methods

We captured the newts with the help of a limnological net (Fuhn 1969). In the areas where we could enter using boots, we used limnological nets with a rectangular metallic frame. In deeper areas, we used rounded metallic frames, attached at the end of long metallic rods. We used the stomach flushing method in order to preserve the trophic spectrum samples (Legler & Sullivan 1979; Leclerc & Curtois 1993). The advantage of this method is that it allows the release of the newts after collecting stomach contents.

The following dietary parameters were analyzed: frequency of occurrence of empty stomachs and of stomachs with plants and shed-skin, the taxonomic affiliation of the preys, the affiliation of the preys to the aquatic or terrestrial environment, the maximum and average number of preys, the numeric proportion of a specific prey item, the frequency of occurrence of a certain prey item, the Shannon diversity index (Shannon 1948, Shannon & Weaver 1949) and the Sorenson and Pianka similarity indexes (Chao et al. 2005, Pianka 1973). We used the EstimateS 7.0 software (Colwell 2005) for the Shannon and Sorenson indexes, and the EcoSim 7.0 software (Gotelli & Enstlinger 2001) for the Pianka index.

The habitat near Cermei locality is situated in Arad County, at a 20m distance from the road that leads to Şomoşcheş village. It stretches parallel to this road for a 70m distance. Represented by a marsh in a flooding area of the Teuz River, it is heavily dominated by *Phragmites* sp., which is totally covered by water in the rainy season. In the contact zone with the agricultural fields, which surrounds the marsh, the *Juncus*

sp. replaces the reed. The location, which is situated on a plane relief at 105m, permitted the formation of a large marsh. The average depth of the water is approximately 50-60cm, and the maximum one exceeds 1m. In the warm season, the marsh does not completely dry out. The silt layer is very thin or there is none at all. The habitat has a rich fauna, partially represented by fish species (*Carassius auratus*, *Cobitis taenia*).

The stomach contents of the 78 newts were collected in spring 2006 in three stages: 6th April, 5th May and 21st May. Sufficient juveniles for the statistical calculations were captured only in April.

Results and Discussions

We identified 316 preys in the stomach contents of the 78 newts, together with plant and shed-skin fragments. The preys were grouped in 16 categories, from which the aquatic Isopods were the most important ones concerning the numeric proportion (66.14%) and frequency of occurrence (51.28%). In general, the swallowing of plants is considered to be accidental (Whitaker et al. 1977), while the consumption of shed-skin by amphibians is a way of recycling epidermal proteins (Weldon et al. 1993). This phenomenon also appears at other newt species from Romania (Covaciu-Marcov et al. 2002a,b, Cicort-Lucaciu et al. 2005a,b)

At the beginning of the aquatic period, a fundamental prey item following Isopods was the Lumbricidae. This fact indicates that, in this period, the newts foraged more in the terrestrial environment than in the other two periods. The leaving of the aquatic environment for feeding is most likely due to the lack of potential prey in this environment. Together with the approaching of the warm season, the Nematoceran larvae became the most important prey after aquatic Isopods.

In the case of the females, the Lumbricidae and Nematoceran larvae were the most important prey categories after the aquatic Isopods concerning the numeric proportion and frequency of occurrence. The presence of preys with a gregarious life, indicate the fact that females move more than males in search of food. In the case of other populations studied in the north-western part of Romania, the most important preys also had a gregarious life (Cicort et al. 2005a).

The juveniles, although they are smaller in size, consumed more large-sized preys (Lumbricidae) than adults did (Nematocerae larvae). Thus it seems that juveniles used the terrestrial environment for hunting more than adults did, at the beginning of the aquatic period. Although, as we mentioned before, the females have chosen the terrestrial environment for feeding more than males, because of a higher flexibility in hunting strategy, we can state that in the adults' case there is a higher restraint in leaving the aquatic

environment. And this fact is most likely due to the sexual behaviour. The species that use a "sit-and-wait" kind of strategy capture larger preys while the species that use a "active forging" type of strategy capture smaller ones (Duellman & Trueb 1986).

Although, concerning the numeric proportion and the frequency of occurrence, the terrestrial preys were consumed especially at the beginning of the aquatic period, qualitatively speaking, most of the categories of terrestrial preys were consumed in the middle of the aquatic period. At the beginning of the aquatic period, probably the reduced potential aquatic preys determined first the juveniles and then the females to forage in the terrestrial environment. In the middle of the aquatic period, probably the terrestrial preys accidentally reached the surface of the water, from where they could have been captured by newts, especially by the females. The rich swamp vegetation, which covers the majority of the habitat, supports the accidental fall of terrestrial preys, such as Arachnida-Araneae, Heteroptera, or Coleoptera (Table 1).

The numeric proportion of aquatic Isopods is at least six times higher than that of any other prey category. On 21 May all the captured newts consumed Isopods. This numerical dominance of the aquatic Isopods in the diet, regardless of period, sex or age class, raised the average and maximum number of preys. On 21 May, the slight increase in the consumption of small-sized preys was probably due to the presence of Nematoceran larvae in the food composition of that period. These types of preys were also encountered in the food composition of the populations studied by Cicort et al. (2005a). In the case of the juveniles, the lower values of the average and maximum number is due to their smaller size, and on the other hand, to the consumption of larger preys (Lumbricidae). The parallelism in variation between the average and maximum number of preys is related to the fact that the aquatic Isopods were present almost anywhere in the habitat, where the newts foraged for preys. This is how we can explain the almost null values of intersexual differences.

Regardless of the compared categories, the overlap between them is a very high one ($Q > 0.9$). The similarities between the study periods indicates a slight diversification of food in time ($Q_{6th\ April \times 5th\ May} > Q_{5th\ May \times 21st\ May} > Q_{5th\ May \times 21st\ May}$) through the continuous appearance of certain prey categories which have not been consumed until then. In the case of juveniles, the difference in size and the higher usage of the terrestrial environment for feeding than the adults (females), made that the likelihood in feeding, to be lowest ($Q=0.94$). The higher feeding intensity in the case of the females, with comparison to that of the males, did not create differences in diet with regards to the niche overlap.

Table 1. The number of prey categories, Number of preys; The numeric proportion of preys; The frequency of occurrence of animal content; The frequency of occurrence of other organic elements. (aq.- aquatic, t.- terrestrial)

	6th April	5th May	21st May	Males	Females	Adults	Juveniles	Total
Number of prey categories								
No. of prey categories	7	14	7	11	12	16	5	16
No. of preys	118	127	71	108	186	294	22	316
Maximum no. of preys	7	7	8	8	8	8	5	8
Average no. of preys	3.47	3.96	5.91	4	4.22	8.11	3.14	4.44
No. of aquatic preys	104	110	71	104	163	267	18	285
- (%) numeric proportion	88.13	86.61	100	96.29	87.63	90.81	81.81	90.18
No. of terrestrial preys	14	17	-	4	23	27	4	31
- (%) numeric proportion	11.86	13.38	-	3.70	12.36	9.18	18.18	9.81
Numeric proportion of preys (%)								
Oligocheta - Lumbricida	11.86	5.51	-	2.77	7.52	5.78	18.18	6.65
Gastropoda - <i>Planorbis</i> sp.	-	3.14	-	0.92	1.61	1.36	-	1.27
Bivalva - Lamelibranhiata	-	3.93	4.22	0.92	3.76	2.72	-	2.53
Arahnida - Araneida	-	0.78	-	-	0.53	0.34	-	0.32
Crustacea - Isopoda (aq.)	69.94	59.05	59.15	74.07	62.90	67.00	54.54	66.14
Crustacea - Isopoda (t.)	-	5.51	-	-	3.76	2.38	-	2.22
Crustacea - Gamarida	8.47	7.87	-	7.40	4.83	5.78	13.63	6.33
Efemeroptera - larvae	1.69	2.36	1.40	-	2.15	1.36	9.09	1.90
Odonata - larvae	-	-	1.40	0.92	-	0.34	-	0.32
Heteroptera (aq.)	-	-	2.81	1.85	-	0.68	-	0.63
Heteroptera (t.)	-	0.78	-	0.92	-	0.34	-	0.32
Coleoptera (t.)	-	0.78	-	-	0.53	0.34	-	0.32
Coleoptera - Dytiscida - larvae	0.84	0.78	1.40	-	1.61	1.02	-	0.95
Tricoptera - larvae	8.47	4.72	-	5.55	4.83	5.10	4.54	5.06
Diptera - Nematocera - larvae	2.54	4.72	8.45	3.70	5.91	5.10	-	4.75
Amphibia - larvae	-	0.78	-	0.92	-	0.34	-	0.32
Frequency of occurrence of animal content (%)								
Oligocheta - Lumbricida	29.41	15.62	-	11.11	20.45	16.90	42.85	19.23
Gastropoda - <i>Planorbis</i> sp.	-	9.37	-	3.70	4.54	4.22	-	7.69
Bivalva - Lamelibranhiata	-	9.37	8.33	3.70	6.81	5.63	-	5.13
Arahnida - Araneida	-	3.12	-	-	2.27	1.40	-	1.28
Crustacea - Isopoda (aq.)	79.41	75	100	85.18	81.81	83.09	57.14	51.28
Crustacea - Isopoda (t.)	-	3.12	-	-	2.27	1.40	-	1.28
Crustacea - Gamarida	23.52	25	-	25.92	15.90	19.71	13.63	21.79
Efemeroptera - larvae	2.94	6.25	8.33	-	6.81	5.63	9.09	7.69
Odonata - larvae	-	-	8.33	3.70	-	1.40	-	1.28
Heteroptera (aq.)	-	-	16.66	7.40	-	2.81	-	3.85
Heteroptera (t.)	-	3.12	-	3.70	-	1.40	-	1.28
Coleoptera (t.)	-	3.12	-	-	2.27	1.40	-	1.28
Coleoptera - Dytiscida - larvae	2.94	3.12	8.33	-	6.81	4.22	-	5.13
Tricoptera - larvae	23.52	18.75	-	22.22	15.90	18.30	4.54	20.51
Diptera - Nematocera - larvae	5.88	12.5	41.66	14.81	15.90	15.49	-	14.10
Amphibia - larvae	-	3.12	-	3.70	-	1.40	-	1.28
Frequency of occurrence of other organic elements (%)								
% of Plant fragments	73.52	59.37	41.66	59.25	63.63	61.97	71.42	62.82
% of Shed-skin	2.94	21.87	8.33	11.11	11.36	11.26	14.28	11.54

Between the two sexes, the obtained food niche overlap for the entire period of study, has an almost maximum value ($Q = 0.99$). This fact is most likely due to the reduced prey categories from the trophic offer of the habitat and to the high number of preys belonging to just one of the categories.

The numerical dominance of aquatic Isopods between other prey categories influenced the variation in time of the food similarities between individuals. This influence is obvious from the parallelism between the variations in time of the frequency of occurrence of preys and from Sorensen's similarity index. The dominance of aquatic Isopods determined that the food similarity of the two sexes have the same value ($S_{is} = 0.427$). The juveniles, which proved to be the most active in achieving food, have the lowest value of the Sorensen index ($S_{is} = 0.247$). This fact is also due to their smaller

size, which limits the range of potential preys. The average values of the similarities between the two sexes correlated with the high values of the similarities concerning the class sizes support once again the assumption that the trophic offer of the habitat is qualitatively poor.

The ratio between the efforts made in order to obtain food and the trophic offer of the habitat was most rentable on 5 May, because then the population fed the most diversely ($H = 1.43$). The relatively high H value of the females ($H=1.31$), in comparison to that of the males ($H=0.98$), confirms once again the females' more active feeding behaviour; even if the similarity between class sizes was high and in the case of the two sexes was equalized by different factors, as the low number of prey categories and the high number of preys from just one of the prey categories. In the case of this population

Table 2. The recorded feeding niche values (Shannon Weaver Index, Sorensen Index, Pianka Index)

Shannon Index (H)				
Period	6 IV	5 V	21 V	Total
Total	1.05 ± 0.12	1.43 ± 0.16	0.69 ± 0.20	1.29 ± 0.12
Males	0.72 ± 0.18	0.99 ± 0.13	0.66 ± 0.20	
Females	1.00 ± 0.14	1.50 ± 0.18	0.61 ± 0.19	
Juveniles	0.99 ± 0.19	-	-	
Sex	Males	Females		
	0.98 ± 0.12	1.31 ± 0.16		
Maturity	Adults	Juveniles		
	1.27 ± 0.13	0.99 ± 0.19		
Sorensen Index (S_{is})				
Period	6 IV	5 V	21 V	Total
Total	0.456	0.329	0.634	0.413
Males	0.459	0.392	0.555	
Females	0.526	0.288	0.672	
Juveniles	0.247	-	-	
Sex	males	females		
	0.427	0.427		
Maturity	adults	juveniles		
	0.429	0.247		
Pianka Index (Q)				
Period	Sex	Maturity		
6 April x 5 May	0.986			
5 May x 21 May	0.976	0.991	0.949	
6 April x 21 May	0.964			

the food diversity value was low, in comparison to the one registered at other Amphibian populations (Sas et al. 2005, 2006).

Conclusions

Concerning the diet composition of the studied population, the aquatic Isopods have the highest numeric proportion and frequency of occurrence values. After this prey category, from the same point of view, the most important prey categories are the Lumbricidae, at the beginning of the aquatic period, the Gammaridae in the apogee of the aquatic period and the Nematoceran larvae in the last part of the aquatic period.

Quantitatively, the highest consumption of terrestrial preys took place in the first period of the study, and from a qualitative point of view, in the second part. From terrestrial preys, the Lumbricidae are the most important ones. These were consumed in the terrestrial environment by juveniles, which proved the highest mobility in feeding behaviour, followed by females.

The highest dietary diversity for the studied newts was obtained for the second of the three periods. In the first period of study the low number and diversity of available preys have led to the leaving of the aquatic environment by newts in order to obtain food. In that period, juveniles, which lack sexual behaviour, also used for feeding mostly the terrestrial environment.

Regardless of the fact that females also had a more active foraging strategy in comparison to the males, they mostly used, at the beginning of the aquatic period, the perizone of the aquatic habitat and consumed more preys with a gregarious life. However, their diet is very similar to that of the males, because in the aquatic environment the number of prey categories was low, while the number of preys from a certain prey category was very high, in comparison to the other categories. These two factors determined the very high values of similarity between class sizes in comparison to the one between sexes. The numerical dominance of aquatic Isopods compared to other prey categories, created a parallelism of variation in time between the frequency of occurrence of them in the stomach contents and the similarity in feeding between the individuals.

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