1. RESEARCH UPON THE TROPHIC SPECTRUM OF A *TRITURUS CRISTATUS* POPULATION IN THE BRIHENI AREA (COUNTY OF BIHOR, ROMANIA)

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ABSTRACT. We studied the trophic spectrum of 131 exemplars of *Triturus cristatus* compared to the trophic offer available at the level of the habitat and depending on the sex of the individuals. The composition of the trophic spectrum varies during the whole year, as the feeding is influenced by the environmental factors and by the life cycle of different aquatic organisms that serve as prey for the tritons. There are differences of the trophic spectrum depending on the sex; the females eat immobile preys or less mobile preys than the males, as a consequence of the fact that the comb is missing. *Triturus cristatus* shows selectivity towards the accessibility, the dimension and the easy digestion of the prey. The combed tritons will consume the most spread taxon preys in the populated habitat, with the requirement that they have a certain size and are easy to capture.

Key words: Trophic spectrum, prey taxa, *Triturus cristatus*

INTRODUCTION

During the last few years the trophic spectrum of the *Triturus cristatus* species was intensively studied in Bihor county [4, 5, 6, 7]. Research upon the feeding of the newts was conducted abroad as well [14, 21]. The results of these studies provided many details on the composition of the food of the newts. Yet, in spite of the relatively large number of articles dealing with this issue, there is only one work in Romania that compares the trophic spectrum of the Warty Newts with the trophic offer available in the habitat they populate [7]. The trophic spectrum depending on the sex was not analyzed in Romania, as well. It is important to not that the trophic spectrum is analyzed compared with the trophic offer, as the food is the main link between an animal and its environment [24]. The knowledge on the trophic spectrum of the amphibians has a special importance, as they live in the limit between the aquatic and terrestrial ecosystems [1]. In this context, we studied the trophic spectrum of a *Triturus cristatus* population compared with the trophic offer and in the same time to analyze their feeding depending on their sex.

MATERIALS AND METHODS

Our study was developed during the month of April 2004. The stomach contents were sampled during three days (Table 1). In the same data were included samples of benthos and plankton from the habitat. We analyzed the stomach contents of 131 Warty Newts. They were sampled using the stomach – flushing method [3, 19, 26, 27, 28]. This method was recently used for different Amphibian species in Romania [8, 10, 11, 31, 32]. The stomach contents were sampled as soon as possible after the specimens were captured, as the amphibians have a rapid digestion [2]. The samples were stored in airtight test tubes and preserved in 4 % concentration formaldehyde solution and the assessing was done under laboratory conditions using the binocular magnifying glass and using the classic identification keys [12, 13, 22, 30]. In order to quantify the trophic offer at the level of the habitat we used a rectangular metallic drag with a thick net. The samples were preserved in a 4 % concentration formaldehyde solution and the assessing was done in the laboratory.

We analyzed the following parameters of the trophic spectrum:

1. The taxonomic belonging of the identified prey in the stomach contents.
2. The variation of the maximum and average number of preys / amphibian individual.

3. The amount of a certain taxon prey of the total identified prey (the ratio between the preys belonging to that respective taxon prey and the total number of identified preys).
4. The frequency of which the amphibians consume a certain taxon prey (the ration between the number of amphibians that consumed the respective taxon prey and the total number of investigated amphibians).
5. The belonging of the taxon preys to the aquatic or terrestrial environment and the amount of the preys in the two environments.

The locality where the study was conducted, Briheni, is located in the southern part of Bihor county, in Crişul Negru river basin, in the adjacency of the Brihenilor valley. The habitat lies in the area of the Codru – Moma Mountains, at about 350 m a.s.l.

RESULTS

We identified 14 taxon preys in the stomach contents of the *Triturus cristatus* population at Briheni that we separated in several categories depending on the environment of origin. For example, we separated the adults from he larvae of *Ephemeropterans*, as the first are terrestrial and their larvae are aquatic [13]. We identified only 10 taxons in the samples taken at the level of the habitat. The difference is due to the fact that the Warty Newts also consumed terrestrial taxon preys that are missing in the samples from the habitat. This is the case of the *Araneids, Diplopods Myriapods* or of the adult *Ephemeropterans*. There are 9 taxon preys in the trophic spectrum of the tritons that do not appear in the habitat (Table 2). There are only two taxons that do not appear in the stomach contents, namely *Acaroids* and the *Cladoceran Crustaceans*, as small sized forms represent both taxons.

Table 1.

The number of studied samples, The weight of empty stomachs, of stomachs with vegetal remains, of stomachs with shed-skin, of stomachs with eggs (F – females, M – males, T - total)

	07.04			21.04			28.04			Total		
	F	M	T	F	M	T	F	M	T	F	M	T
Number of studied samples	17	19	36	21	14	35	33	27	60	71	60	131
% of the empty stomachs	–	5.26	2.77	9.52	–	2.85	–	–	–	2.81	1.66	2.29
% of the stomachs with vegetal remains	52.94	68.42	61.11	71.42	71.42	71.42	75.75	59.25	68.33	69.01	65	67.17
% of the stomachs exclusively with vegetal remains	–	–	–	–	–	–	27.27	18.51	23.33	12.67	8.33	10.68
% of the stomachs with Amphibian eggs	–	–	–	57.14	28.57	51.42	6.06	7.40	6.66	19.71	13.33	16.79
% of the stomachs with shed-skin	23.52	5.26	13.88	23.80	33.33	34.28	27.27	51.85	38.33	25.35	36.66	29.77

Table 2

The trophic offer at Briheni

	07.04	21.04	28.04	Total
Vegetal	p	p	p	p
Amphibian eggs		p	p	p
Nematoda	20	28.39	10.69	18.77
Oligochota	0.68			0.19
Gasteropoda	43.44	64.19	33.95	45.97
Acaria	0.68			0.19
Copepoda			50.23	20.68
Colembola	0.68			0.19
Trichoptera larva	31.72	5.55	2.36	11.49
Coleoptera	0.68	1.23	0.46	0.76
Dytiscida larva	1.37		0.46	0.76
Nematocera larva	0.68	0.61	1.86	1.14

Only few Warty Newts we investigated had empty stomachs. We identified individuals without any stomach contents during the first two dates of sample collecting (Table 1). The presence of some amphibian individuals that did not feed was generally associated with the existence of some unfavorable environmental conditions [8, 10, 31]. Most of the animals we investigated had vegetal remains in their stomach contents next to different taxon preys. The consumption of vegetal fragments was priory signaled at other Amphibian species [23, 20, 29], including *Triturus cristatus* [5, 6, 7] and it was considered accidental [34]. On the first two dates of sampling the stomach contents, the vegetal fragments always accompany different taxon preys. Yet, on the last date 23.33 % of the investigated newts exclusively consumed different vegetal fragments. The phenomenon must be linked with the accentuated drop in the water level during this interval, a fact that forced the combed tritons to start leaving the aquatic environment.

Important trophic basis for the combed tritons are the amphibian eggs [7]. In our case the eggs were consumed only during the last two dates of sampling and they had great amounts only on 21.04.2004, when 51.42 % of the investigated newts consumed eggs. Important trophic basis to the newts are the eggs, but only for a short period of time when they are abundant in their habitat. Trophic elements that are constantly present in the stomach contents of the *Triturus cristatus* population at Briheni are the exuviae. They are easy to consume, as the small–sized habitat facilitates their access to exuviae, and thus allowing the existence of this form of epidermal protein recycling [33]. Exuviae were identified in the stomach contents of other species of Amphibians [17, 18, 31].

We identified a total of 361 preys in the stomach contents of the *Triturus cristatus* population at Briheni. The most preys were consumed on the first date of sampling and the least preys were consumed on the last date of sampling (Table 3). The average number of preys / *Triturus cristatus* individual is greater in the case of the females. But, the maximum number of preys / individual is greater in the case of the males (17 compared to 14 at females).

Table 3

The number of prey items, the average and the maxim number of preys / individual; The weight of aquatic and terrestrial preys (F – females, M – males, T – total)

	07.04			21.04			28.04			TOTAL		
	F	M	T	F	M	T	F	M	T	F	M	T
Total number of preys	136	102	238	42	22	64	32	27	59	210	151	361
The maxim number of preys / individual	14	17	17	6	8	8	6	5	6	14	17	17
The average of the number of preys / individual	8	5.36	6.61	2	1.57	1.82	0.96	1	0.98	2.95	2.51	2.75

The greatest amount of the total number of preys consumed by the Warty Newts is the *Gastropods*. They represent 72.57 % of the total number of preys. The *Coleopterans* are on the second place with only 7.47 %. The other taxon preys have reduced amounts. A great part of the taxon preys identified in the stomach contents were accidentally consumed and they only represent 0.27 % of the total. This is the case of some terrestrial preys that accidentally reached the aquatic habitat that the newts populate (*Myriapods*, *Hymenopterans*). There is an important yearly variation of the amount the preys that belong to the identified taxon preys are consumed (Table 4, 5).

The *Gastropods* are also on the first place for the frequency of their consumption. The *Coleopterans* are on the second place; the frequency of their consumption is close to the frequency of the *Gastropods* in spite of the great difference between the amounts of the two taxons (Table 4). This fact shows that the Coleopterans have a great importance for the *Triturus cristatus* population at Briheni, as a high number of individuals are accessible in spite of the fact that they are less important than the *Gastropods* (as quantity). And regarding the frequency, a lot of taxon preys show little importance and are consumed accidentally by only one *Triturus cristatus* individual.

Most of the preys consumed by the Warty Nets are aquatic preys, originating from the habitat they populate. However, we identified numerous terrestrial taxon preys in the stomach contents, but they have an extremely reduced amount of the total of preys.

Table 4

The weight of preys items (F – females, M – males, T – total)

	07.04			21.04			28.04			TOTAL		
	F	M	T	F	M	T	F	M	T	F	M	T
Turbelariata	–	0.98	0.42	–	9.09	3.12	3.12	–	1.69	0.47	1.98	1.10
Lumbricida	0.73	1.96	1.26	2.38	4.54	3.12	21.8	11.1	16.9	4.28	3.97	4.15
Hirudinea	–	–	–	2.38	–	1.56	6.25	–	3.38	1.42	–	0.83
Gasteropoda	91.91	82.3	87.8	78.5	54.5	54.6	18.7	7.40	13.5	78.0	64.9	72.57
Izopoda	–	–	–	2.38	–	1.56	–	–	–	0.47	–	0.27
Araneida	–	–	–	2.38	–	1.56	–	7.40	3.38	0.47	1.32	0.83
Diplopoda	0.73	–	0.42	–	–	–	–	–	–	0.47	–	0.27
Colembola	–	–	–	–	–	–	3.12	–	1.69	0.47	–	0.27
Efemeroptera – Total	–	–	–	–	–	–	18.7	22.2	23.7	2.85	3.96	4.98
imago	–	–	–	–	–	–	–	7.40	6.77	–	1.32	2.21
larva	–	–	–	–	–	–	18.7	14.8	16.9	2.85	2.64	2.77
Trichoptera larva	4.41	8.82	6.30	2.38	13.6	6.25	–	3.70	1.69	3.33	9.93	5.54
Coleoptera – Total	1.47	5.88	3.36	2.38	13.6	6.25	9.37	44.4	25.4	2.84	13.8	7.47
larva undet.	1.47	5.88	3.36	2.38	13.6	6.25	–	–	–	1.42	5.96	3.32
Ditiscida larva	–	–	–	–	–	–	3.12	14.8	8.47	0.47	2.64	1.38
imago undet.	–	–	–	–	–	–	6.25	29.6	16.9	0.95	5.29	2.77
Diptera – Total	0.73	–	0.42	2.38	–	1.56	–	3.70	1.69	0.95	0.66	0.82
Brahicora larva	0.73	–	0.42	2.38	–	1.56	–	–	–	0.95	–	0.55
Nematocera larva	–	–	–	–	–	–	–	3.70	1.69	–	0.66	0.27
Himenoptera – Ihneumonida	–	–	–	–	4.54	1.56	–	–	–	–	0.66	0.27
Tadpoles	–	–	–	–	–	–	12.5	–	6.77	1.90	–	1.10
Triturus – Total	–	–	–	4.76	–	3.12	6.25	–	6.77	0.95	–	1.10
larva undet.	–	–	–	2.38	–	1.56	3.12	–	3.38	0.47	–	0.55
adult *T. vulgaris*	–	–	–	2.38	–	1.56	3.12	–	3.38	0.47	–	0.55

Table 5

The frequency of prey items (F – females, M – males, T – total)

	07.04			21.04			28.04			TOTAL		
	F	M	T	F	M	T	F	M	T	F	M	T
Turbelariata	–	5.26	2.77	–	14.2	5.71	3.03	–	1.66	1.40	5	3.05
Lumbricida	5.88	10.5	8.33	4.76	7.14	5.71	21.2	11.1	16.6	12.6	10	11.45
Hirudinea	–	–	–	4.76	–	2.85	6.06	–	3.33	4.22	–	2.29
Gasteropoda	88.23	73.6	80.5	66.6	35.7	54.2	3.03	7.40	5	42.2	35	38.93
Izopoda	–	–	–	4.76	–	2.85	–	–	–	1.40	–	0.76
Araneida	–	–	–	4.76	–	2.85	–	7.40	3.33	1.40	1.66	1.52
Diplopoda	5.88	–	2.77	–	–	–	–	–	–	1.40	–	0.76
Colembola	–	–	–	–	–	–	3.03	–	1.66	1.40	–	0.76
Efemeroptera – Total	–	–	–	–	–	–	15.1	18.5	16.6	7.04	4.99	6.09
imago	–	–	–	–	–	–	–	3.70	1.66	–	1.66	0.76
larva	–	–	–	–	–	–	15.1	14.8	15	7.04	3.33	5.33
Trichoptera larva	14.64	26.3	22.2	4.76	21.4	11.4	–	3.70	1.66	5.63	15	9.92
Coleoptera – Total	11.76	21	16.6	4.76	14.2	8.57	9.09	29.6	18.3	16.8	24.9	20.59
larva undet.	11.76	21.0	16.6	4.76	14.2	8.57	–	–	–	12.6	11.6	11.21
Ditiscida larva	–	–	–	–	–	–	3.03	11.1	6.66	1.40	5	3.05
imago undet.	–	–	–	–	–	–	6.06	18.5	11.6	2.81	8.33	5.33
Diptera – Total	5.88	–	2.77	–	–	–	–	3.70	1.66	1.40	1.66	1.52
Brahicera larva	5.88	–	2.77	–	–	–	–	–	–	1.40	–	0.76
Nematocera larva	–	–	–	–	–	–	–	3.70	1.66	–	1.66	0.76
Himenoptera – Ihneumonida	–	–	–	–	7.14	2.85	–	–	–	–	1.66	0.76
Tadpoles	–	–	–	–	–	–	9.09	–	5	4.22	–	2.29
Triturus – Total	–	–	–	9.52	–	5.7	6.06	–	3.32	5.62	–	3.04
larva undet.	–	–	–	4.76	–	2.85	3.03	–	1.66	2.81	–	1.52
adult *T. vulgaris*	–	–	–	4.76	–	2.85	3.03	–	1.66	2.81	–	1.52

DISCUSSIONS

There are certain differences of the trophic spectrum between the males and the females. Thus, the number of females that consumed spawns (eggs) is twice as large than of males. Also, more females consumed vegetal fragments exclusively on the last date of the sampling. The average number of preys / individual is higher in the case of the females than in the case of the males, but the maximum number of preys / individual is higher than males. The number of the taxon preys consumed by females is larger. The females exploit, in most of the cases, the additional trophic resources represented by the terrestrial taxon preys that occasionally reach the water. In the same time, the females consume tadpoles and even *Triturus cristatus* adults. The females constantly consume more *Gastropods* than the males. Generally, it is noticed that the females consume more immobile or less mobile preys compared to the males. This is the case of the spawns or the *Gastropods*. The consumption of immobile or less mobile preys by the females is a consequence of the fact that they do not have the dorsal comb [16]. Because of their reduced mobility, the females are forced to direct themselves towards certain trophic resources. This difference can raise the issue on a different trophic strategy depending on their sex. Anyway, the fact that the two sexes exploit different trophic resources (and to some extent, different areas of the habitat) is an advantage in a small – sized habitat like the one at Briheni.

Triturus cristatus mostly consumes the most frequent taxon prey in the habitat, namely the *Gastropods*. Thus, the snails are on the first place regarding their amounts in the stomach contents and the amount in the trophic offer. A conclusion can be drawn that the combed tritons do not actively select certain preys, as they consume the most abundant preys in the habitat, considering that the amphibians consume all the prey of the right size and mobility they come in contact with [35]. The newts, however, are selective regarding the size of their prey, which will be avoided if they have small dimensions even if they are abundant in the habitat. This is the case of the Copepods (crustaceans) that represent 20.68 % of the trophic offer, but no representative of this group was consumed by the Warty Newts. Perhaps these small – dimensioned preys require a far greater effort to be consumed, given the fact that there are larger and more accessible larger preys in the habitat. Yet, it is known that, in some cases, the Copepods represent a great part of the total preys consumed by the Warty Newts [9]. This fact must be considered an indicator of the lack of trophic resources in the respective habitat. The *Trichoptera larvae* are included in the same category. They have a trophic offer amount of 11.48 %, but only 5.54 % of the total preys. The *Trichopterans* are large – sized, are relatively abundant in the habitat, but, yet, they are not a primary target-preys for the Warty Newts. This fact is probably due to the shell of the *Trichoptera larvae* that contains elements that are hard to digest, pebbles etc. Consequently, it can be considered that the Warty Newts have selectivity towards three characteristics of the potential preys:

The accessibility of the prey – manifested through the preferential consumption of the most abundant preys in the habitat (*Gastropods*, *Amphibian* spawns when they are present in the water). The dimensions of the prey – manifested through the avoidance of the consumption of small – sized preys, under the circumstances that there are large – sized trophic resources in the habitat that are easy to consume. The easiness of prey digestion, manifested through the reduced consumption of preys that have elements hard to digest, like the shells of the *Trichoptera larvae*. The consumption of some large sized preys and the avoidance of the small-sized ones seem to indicate the fact the *Triturus cristatus* population at Briheni employs a "sit-and-wait" strategy of obtaining prey [15].

The parameters of the trophic spectrum of the Warty Newts at Briheni have a yearly variation. The feeding is generally influenced by the environmental conditions, primary by the thermic regime. The trophic spectrum is at the same time influenced by the life cycle of other organisms in the populated habitat; the variations of the trophic spectrum are, in the most cases, consequences of the seasonal changes in the life cycle of the preys [25]. The other species of amphibians, that offer to the newts a supplementary abundant trophic base during the spawning period, have this kind of influence.

Generally, in the case of amphibians it is considered that the average number of preys / individual rises from the beginning of spring towards the hot season once with the warming of the weather, fact that allow the activity of more and more taxon preys [9, 10]. Yet, in this case, the situation is totally opposite, as the most preys / individual were consumed on the first date of sampling, the least on the last date. We believe that this

situation has two parallel explanations. On one hand, on the first date of sampling was on the 7th of April, when the temperatures were already high. On the other hand, the habitat at Briheni has reduced dimensions and a weak ecological diversity. In this context, the habitat is affected by drought and the water level falls quickly, fact that narrows the potential preys. As a consequence to these two factors, the average number of preys / individual evolves at Briheni according to another rule than in the most cases described in the specialty literature [9, 10]. Yet, the number of consumed taxon preys grows from the first date to the last date of sampling. This growth is accomplished through the consumption of some terrestrial prey, or through the apparition of the tadpoles in the habitat.

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