

THE COMPARATIVE ANALYSIS OF THE TROPHIC SPECTRUM OF THREE POPULATIONS OF *Bombina variegata* FROM THE ȘUȘTIU AREA (BIHOR COUNTY, ROMANIA)

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Abstract. We investigated the stomach contents of 288 specimens of *Bombina variegata* from three different habitats. Besides the contents of an animal origin, represented mostly by Coleopterans, Dipterans, Gastropods, Hymenopterans and Collembolans, the toads also consumed vegetal remains, minerals and spawns. The preys with a terrestrial origin reach the biggest amount despite the fact that the species is strongly bonded to aquatic habitats. Among the three biotopes there are some differences of some factors of the trophic spectrum mostly due to the unique appearance of each habitat. Of course, *Bombina variegata*'s feeding is influenced by the season, too.

INTRODUCTION

Amphibians have access to both aquatic and terrestrial environments, being active at the borderline between the two ecosystems (Burton & Likens 1975). This is how the toads can use trophic elements specific to each environment. The energy needs of the amphibians can be satisfied just by acquiring their meal, fact that takes a lot of time and also represents the key factor of their ecology (Perry et al 1990).

Bombina variegata is one of the most common species of amphibians from the herpetofauna of Romania, being widely spread in the hills and the mountain regions (Cogălniceanu et al 2000a). With all that, studies of its trophic spectrum are very scarce in our country (Sârbu 1976, Sas et al. 2004a, Nemes & Petrás 2003). Actually, on a world wide scale there is little information about the food composition of this species (Taraščuk 1959, Kminiak 1978, Ščerbak & Ščerban 1980, Kuzmin 1990).

This is why we set off to compare the food composition of three populations of *Bombina variegata*. We also wanted to analyze the variations of the trophic spectrum of these toads during all of their active period. Last but not least, we looked forward to establishing the environment where the preys come from: aquatic or terrestrial.

MATERIAL AND METHODS

We studied the stomach contents of three populations of *Bombina variegata* from near the locality of Șuștiu (Beiuș Depression, Bihor County, Romania). The three populations occupied habitats with different ecological conditions. The first population was present in a big semi permanent swamp, full of vegetation. The second population occupied a small temporary pond, situated at the skirt of a forest and the third one was present at Valea Brihenilor (Briheni valley). The populations of yellow belied toads were only recently identified in this region (Covaciu – Marcov et al 2003). We collected the samples in the warm period of the year 2004 (April – October). The samples were taken monthly or, some, once each two months. We analyzed the trophic spectrum of 288 specimens of *Bombina variegata* (175-from the swamp, 34 from the skirt of the forest, 78-from the valley). The animals were captured either by hand or with the help of some nets with a handler.

We took the stomach contents by using the stomach wash method (Legler & Sullivan 1979, Opatriny 1980). The big advantage of this method is that it allows the study of the feeding of amphibians without killing the animals (Cogălniceanu et al 2000b). The analyzed specimens were afterwards set free in their habitats, our study not affecting the effective of the populations.

To suppress the stomach contents we used 20-50 ccm syringes on top of which we mounted plastic tubes with different lengths and diameters (40-60mm X 1.5-2.5mm) depending on the size of the toads. Keeping in mind that the toads digest their preys rather quickly, fact that can interfere with our results (Caldwell 1996), we tried to reduce as much as possible the time between capturing the toads and actually washing their stomachs. The samples were conserved separately in 4% formalin and stocked in labeled sealed

test tubes. The preys were determined at a binocular magnifying glass, with the help of the specific literature (Crişan & Mureşan 1999, Crişan & Cupşa 1999, Radu & Radu 1972, Ionescu et al 1971).

We were interested in the following aspects of the trophic spectrum: the taxonomic appurtenance of the preys, the variation of the maximum and average number of preys / individual, the amount of each prey taxa in the trophic spectrum of the species and the frequency with which the prey taxa was consumed by individuals of *Bombina variegata*.

RESULTS AND DISCUSSIONS

We did not identify specimens without any stomach content, but we encountered contents with vegetal remains and shaded skin in all of the three habitats. The consumption of shaded skin is considered accidental at this species (Sas et al 2004b). We also encountered stomachs with a mineral content and at some specimens from the big swamp we found amphibian spawn, too. With all that, the most common food source for the yellow bellied toads is animal based food, with much higher energy content.

Taking into consideration the origin of the prey animals, the biggest amount is represented by the terrestrial preys, in all three biotopes (Fig. 1). These preys are captured either on the banks or from the luster of the water. The amount of the terrestrial preys is almost constant, around 90% during the whole length of our study, with the exception of July and August, in which the amount drops a little bit (Table 1). The consumption of mostly terrestrial preys has been documented at other species of amphibians that are bonded to the aquatic environment, too (Low at al 1990, Covaciu – Marcov et al 2000, Sas et al 2003a, Sas et al 2004c).

The majority of the aquatic preys were consumed in the habitat represented by the big swamp. This is a predictable fact because in this almost permanent habitat there is a much more evolved zoocenosis than in the case of the small temporary ponds from the skirt of the forest. Here, the offer of more terrestrial preys is caused by the proximity with the forest. In the permanent valley from Briheni it is highly possible that an evolved zoocenosis could exist but, the number of consumed aquatic preys is smaller than the one from the swamp. This fact is a consequence of the difficulty of the toads in consuming these preys. Thus, in the valley the toads are tied to the banks or the areas with shallower water and rocks, otherwise they could get caught in high floods. This may be why the toads cannot use the full capacity of the trophic resources in the valley.

Table 1. The seasonal variation of the aquatic/terrestrial amount of preys

	21 IV	28 IV	8 V	26 V	16 VI	21 VII	12 VIII	18 IX	Total
% of aquatic preys	8.57	13.85	8.28	4.88	12.5	27.89	25.33	12.17	15.04
% of terrestrial preys	91.4	86.15	91.72	95.1	87.5	72.10	74.66	87.83	84.95

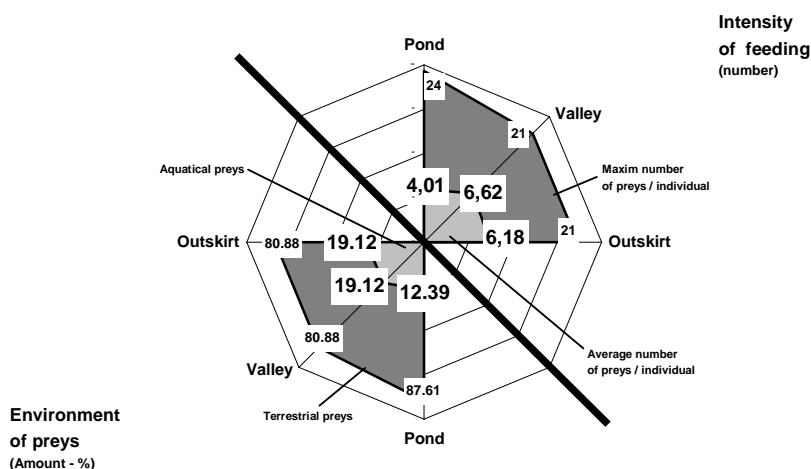


Fig.1. The amount of aquatic / terrestrial preys and the intensity of the feeding in the three habitats.

In the measurement of the feeding intensity of the specimens of *Bombina variegata* from the habitats we took as parameters the maximum and the average number of preys / individual, as represented in Fig. 1. When it comes to the yellow bellied toads from the big swamp even if the maximum number of preys

/ individual is the highest one, the average number of preys / individual is smaller than the one from the two other habitats. Larger preys than in the other biotopes were consumed in the big swamp (Cantharides, Staphilinides, Crizomelides, Trihopterans (imago), Aphids, Inneumonides). Some tadpoles were also consumed here, the big pond being a great breeding habitat. The fact that only specimens from the swamp had spawns in their stomach contents is proof to this. The consumption of this category of large preys, even if in small number, is followed by the release of a big quantity of energy that covers the necessities of the organism.

The maximum number of preys / individual is reached in the summer (Table 2) when the frequency of the terrestrial prey animals is lower; as a consequence the toads will consume more aquatic animals than in the spring or autumn, a necessary fact to satisfy their energy needs. It is probable that for the toads capturing the aquatic preys is more difficult and it might consume more energy therefore they resort in eating terrestrial animals.

Table 2. The seasonal variation of the intensity of the feeding

	21 IV	28 IV	8 V	26 V	16 VI	21 VII	12 VIII	18 IX	Total
Average number of prey items	4.667	2.6	3.204	5.721	7	6.297	4.093	7.667	5.039
Maxim number of prey items	15	17	15	19	24	21	20	18	24

After analyzing the stomach contents of the 288 studied individuals from the three habitats, we identified comparable values between the number of prey categories and the one of prey taxa (Fig 2). The number of taxa is the same in the big swamp and the pond from the skirt of the forest as consequence of the similar conditions but it is smaller in the habitat from the valley. The categories of consumed preys are more numerous in the big pond, fact that can be explained by the bigger size of this biotope which leads to a longer existence and creation of a biocenosis. The smaller pond from near the forest has the smallest number of prey categories, probably because it is only present in the rainy periods.

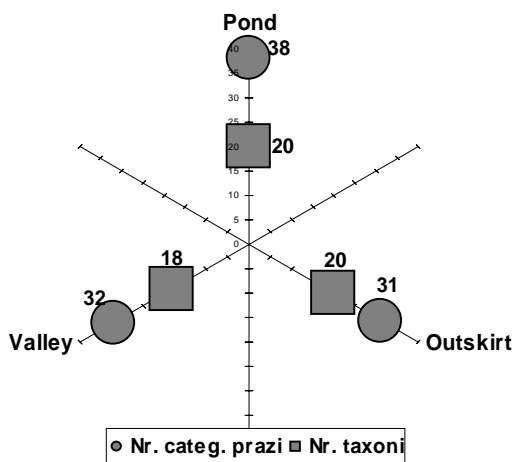


Fig. 2. The number of taxa and the number of prey categories in the two habitats

The majority of the identified taxa from the analyzed stomach contents are included in the invertebrates' category; the vertebrates are represented only by the amphibian larvae. The most consumed prey taxa are Coleopterans, Dipterans, Hymenopterans, Gastropods and Collembolans.

In the contents of the individuals that we analyzed from the big swamp the highest amount is that of the Coleopterans (Table 3). Even if the yellow bellied toads are very bonded to the aquatic environment (Fuhn 1960), the consumption of terrestrial Coleopterans in high amounts has been observed at other previous studies made on *Bombina variegata* (Kuzimin 1990) and *Bombina bombina* as well (Kovács & Török, 1997, Medvedev, 1974, Goncharenko et al 1978). Coleopterans, terrestrial prey animals, are captured by the yellow bellied toads when they get out on the banks of the pond or from the air, by the luster of the water. Gastropods, preys with an aquatic origin, were very predictable to be found in large quantities in the stomach contents, having in perspective the large size of the pond, very fitting for their development. Dipterans (larvae and imago) and Hymenopterans, consumed in significant quantities by numerous individuals, represent important prey taxa for the specimens from the big swamp.

Table 3. The amount of the prey taxa in the three habitats

	Pond P%	Outskirt P%	Valley P%	
Lumbricida		4.416	2.02	4.104
Gasteropoda		16.1	1.01	6.157
Izopoda		1.709	0.505	0.746
Amphipoda		0.285	1.01	1.493
Ostracoda		0	6.566	0
Copepoda		0	0	0.187
Cladocera		0	1.515	0
Acaria		0.285	1.01	0.56
Araneida		6.125	3.03	3.731
Opilionida		0	0.505	0
Chilopoda		0.427	0.505	0.187
Diplopoda		0.285	0	0
Colembola		11.25	37.37	1.493
Efemeroptera-larva		0	1.01	6.903
Efemeroptera-imago		0	0	1.679
Ortoptera		0.285	3.03	0
Ortoptera-larva		0.142	0	0
Ortoptera-imago		0.142	3.03	0
Coleoptera-larva		2.564	6.566	0.373
Coleoptera-larva undet.		1.567	4.04	0.187
Dytiscida-larva		0.997	2.525	0.187
Coleoptera-imago		17.24	8.586	16.23
Coleoptera-imago undet.		14.1	6.566	14.93
Dytiscida		0	0	0.187
Stafilinida		0.855	0	0
Cantarida		0.142	0	0
Elaterida		0.997	0	0.373
Scarabeida		0.285	0	0
Carabida		0.57	0.505	0.56
Coccinelida		0.142	0.505	0.187
Curculionida		0	1.01	0
Crysolmelida		0.142	0	0
Dermaptera		0.285	0.505	0.187
Heteroptera		1.282	1.01	1.306
Homoptera		3.989	5.051	3.172
Homoptera-Afida		2.849	4.04	0.746
Cicadina		1.14	1.01	2.425
Lepidoptera-larva		0.285	2.02	0.187
Lepidoptera-imago		0.142	0	0.373
Trichoptera		0.142	0	0
Diptera-larva		11.25	2.02	4.104
Nematocera-larva		5.271	1.515	1.306
Brahicera-larva		5.983	0.505	2.799
Diptera-imago		7.407	8.586	29.85
Nematocera-imago		5.271	7.071	18.66
Brahicera-imago		2.137	1.515	11.19
Hymenoptera		13.82	6.061	13.81
Hymenoptera-undet.		1.567	1.515	0.933
Formicida		11.97	4.545	12.87
lhneumonida		0.142	0	0
Apida		0.142	0	0
Plecoptera-larva		0.142	0.505	2.239
Plecoptera-imago		0	0	0.933
Tadpoles		0.285	0	0

After investigating the stomach contents of the specimens from the smaller pond, the one from the skirt of the forest, the highest amount of preys revealed to be the one of the Collembolans (Table 3). Their life style is apparently bonded to the leafage of the nearby forest, environment that determines their very high abundance in this habitat and therefore in the toad's stomachs. Also from the category of prey animals whose presence in the stomach contents is caused by the closeness to the forest are spiders (which are very numerous at the skirt of the forest) and aphides (as consequence of the rich vegetation). Coleopterans are pretty plenty at the individuals from this pond, just like Dipterans and Hymenopterans (Table 3).

The specimens from the valley usually consume Dipterans, Coleopterans and Hymenopterans, terrestrial prey animals which have a bigger accessibility in this habitat, the valley being quite narrow. From the aquatic preys we've identified, in significant proportions, only Gastropods, but their amount reaches a mere 6.15% (Table 3).

The seasonal variation of the amount of the main prey taxa (Coleopterans, Gastropods, Dipterans, Hymenopterans and Collembolans) identified in the stomach contents is not that important having in mind that we've collected the specimens from different types of habitats fact that determines the differences of the amounts from the samples. The statement from above is accurate especially in the case of the aquatic preys: Gastropods reach high values of their amounts (36.92% and 33.33%) in April and July (Fig.3); we took samples from the big pond both of the times, this being the best habitat for the abundant development of these animals. Collembolans present high values of their amounts in April and May, when the samples were taken from the big swamp and the pond from the outskirts of the forest, appropriate biotopes for their development either because of the large quantities of water or because of the proximity to the forest. When it comes to the more important terrestrial prey taxa (Coleopterans, Dipterans and Hymenopterans), which are not influenced so much by the conditions of the three habitats, their amount reaches high values in all of the three biotopes. In their case, the amount presents a seasonal variation: the highest values were noted in the spring and early summer (April, May, June) but in September as well (Fig.3). The high amounts occur exactly in that time of the year when the prey taxa are very abundant in their environment.

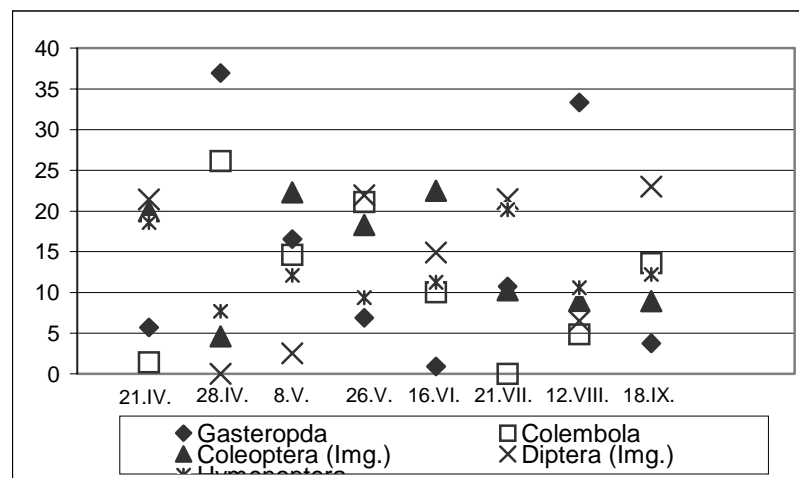


Fig. 3. The seasonal variation of the main prey taxa

The prey taxa consumed in large quantities generally correspond to the ones found most frequently in the stomach contents (Fig. 4) with the exception of the Collembolans which are eaten in large numbers but aren't consumed by many individuals. From the category of the taxa found in many stomach contents but in smaller numbers are Lumbricid, Homopterans, and Araneids.

The food of the studied populations of *Bombina variegata* is represented mostly by Coleopterans, Gastropods, Dipterans, Hymenopterans and Collembolans. Besides these taxa and other groups of Invertebrates (from the Vertebrates we've identified only amphibian larvae), in the stomach contents we discovered vegetal fragments, minerals and spawns as well.

Although the yellow bellied toad is a primarily aquatic toad, it too is considered to be part of those amphibians that consume in large proportions preys with a terrestrial origin, situation that is maintained all along the active period. However, during the summer months, the amount of the aquatic preys raises and with this, a growth in the maximum and average number of preys / individual is noted. The feeding of the investigated populations of *Bombina variegata* is influenced by the season. In all the three habitats in the summer months there is a decrease in the number of terrestrial preys due to the high temperatures and the

dryness of this period. All these narrow the spectrum of the available terrestrial preys, the toads being forced to restrain their selves to the resources of their own habitats.

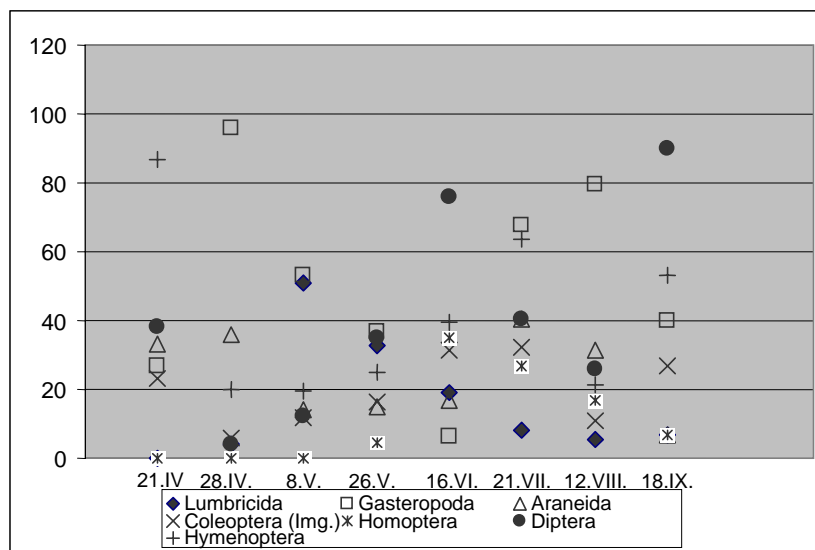


Fig.4 The seasonal variation of the frequency of the main prey taxa

There are significant differences among the food of the individuals from the three biotopes. At the specimens from the valley, the highest amounts are reached by the terrestrial prey taxa like: Dipterans, Coleopterans and Hymenopterans (as consequence to their bigger accessibility). When it comes to the individuals from the big pond, the aquatic preys reach high amounts probably because of the large dimensions of the water. The stomachs of the specimens from the smaller pond, the one at the outskirts of the forest, contain Collembolans in the highest amount (their source – the leafage of the forest). The habitat's characteristics influence the ratio between the aquatic and terrestrial preys, as well. As an example, in the big swamp, much more aquatic preys were consumed than in the other two biotopes.

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