

THE COMPARATIVE ANALYSIS OF THE FEEDING OF *Bombina variegata* POPULATIONS FROM THE ALMĂȘ-AGRIJ DEPRESSION, SALAJ COUNTY, ROMANIA

Irina KOVÁCS^{1*}, Severus-Daniel COVACIU-MARCOV², Carmen DOBLE²,
Ruxandra-Maria BLAGA-LUNGULESCU² and Gabriela TOTH²

1. "Wesseleny" Reformed Theological High School, Bd. Mihai Viteazu 56 / A,
450090 - Zalău, Romania

2. University of Oradea, Faculty of Sciences, Department of Biology,
Universității str. 1. 410087 – Oradea, Romania

* Corresponding author, I. Kovács, E-mail: bioirina@yahoo.com

Abstract. *In the spring of 2009 we studied the trophic spectrum of 306 Bombina variegata individuals from 7 habitats from Almăș-Agrij Depression. They consumed a total number of 1799 prey, belonging to 44 prey taxa, along with vegetal remains, shed amphibian skin and mineral elements. For most habitats, the majority of preys were terrestrial, but there were cases for which the aquatic preys were dominant. The most important differences of the feeding of the studied populations are determined by the morphology of the habitats in which the toads live. This is how the most intense feeding is recorded in the natural habitats, the most favorable being represented by smaller ponds situated inside forests. On the opposite pole, there are the artificial habitats surrounded by anthropogenically affected fields, where the feeding of the toads is more reduced. This is a consequence of the fact that the populations in cause cannot find the most appropriate habitats and therefore cannot hunt around them. The consumption of vegetal remains is in relation with the intensity of the feeding – the frequency of the consumption of vegetal remains is higher when the intensity of the feeding is higher respectively. On contrary, shed skin seems to be consumed mostly in habitats with a poor trophic offer. Between adults and juveniles there are certain differences of the feeding, the juveniles generally eating smaller preys.*

Key words: feeding, *Bombina variegata*, habitats, prey taxa, feeding intensity, shed skin, Romania

INTRODUCTION

Amphibians occupy special positions in trophic chains, representing important predators in both aquatic and terrestrial habitats (Whiles et al.

2006). Food is considered the primary link between an animal and its environment (Kennett & Tory 1996). Obtaining food is the key factor of the ecology of every animal, because getting the food takes up a long period of its life (Perry et al. 1990). Knowing the trophic habits of an animal allows for a better understanding of how animals utilize the trophic resources from their environment (Bellocq et al. 2000). In the same time, knowledge regarding feeding can offer information about the quality of the environment where the amphibians live (Kovács et al. 2007). This fact is very important for the protection of rare species, species with a conservation value, along with the protection of special habitats that meet the ecological demands of those rare species. Knowing the trophic needs and of the way in which different habitats allow their gratification is even more important for *Bombina variegata*. This is because according with the laws on the environment from Romania the yellow-bellied toad is a species that needs special conservation areas assigned (O.U.G. 27 / 2007). Despite the fact that in Romania *B. variegata* is widely distributed in the hill and mountain regions (Fuhn 1960, Cogălniceanu et al. 2000), it is still considered a nearly threatened species (Iftime 2005).

B. variegata is a species adapted to temporary habitats (Barandun 1992). Its survival depends on the conservation of some interconnected temporary habitats (Hartel 2008). Different studies about this species were done in Romania in the last few years (e.g. Covaciu-Marcov et al. 2003, 2007, Sos 2007, Hartel 2008). Although some of these recent works undertook the problematic of the specie's feeding, most of these were from the western part of the country, namely the Bihor, Arad and Satu-Mare counties. (Sas et al. 2004, 2005a, Groza et al. 2006, 2008, Ferenti et al. 2007, Peter et al. 2006, 2007, Toth et al. 2007). Data upon the feeding of certain populations of the species from other areas of Romania are much rarer (Ghiurcă & Zaharia 2005, Dimancea & Cvaciu-Marcov 2009, Hodişan et al. 2009). Despite the fact that the yellow-bellied toad is common in Salaj County (Ghira et al. 2002, Covaciu-Marcov et al. 2006, 2009), there aren't any information regarding its feeding from this region.

Thus, the aim of our present paper is to present, for the first time ever, data upon the feeding of some *B. variegata* populations from Salaj County. The objectives of our study were the following:

- 1.) to identify the trophic elements consumed by the *B. variegata* from the Almăş-Agrij Depression, Salaj County,
- 2.) to establish the differences between the trophic spectrums of the two sexes,
- 3.) to highlight the differences between the feeding of adults and juveniles,

- 4.) to identify the seasonal changes of the composition of the food and
- 5.) to establish the differences between the trophic spectrums depending on the occupied habitat.

MATERIAL AND METHODS

The study took place in spring 2009, between the months of April and June. Due to the drought from the summer of 2009, the study couldn't continue in July, the toad's habitats already being dried out. We analyzed the stomach contents from a total number of 306 *B. variegata* specimens from 7 different habitats. In the habitats where the number of captured samples allowed it, we also analyzed the feeding regarding on sex, age and size of the toads. Thus, in 4 out of the 7 biotopes the feeding was analyzed differentially concerning the sexes, while in one habitat, split between adults and juveniles (Table 1.). The habitats where the toads come from are found in the Almăș-Agrij Depression, situated at different altitudes and having distinct characteristics.

The studied specimens were usually captured by hand from their small, temporary habitats that they inhabited. For bigger habitats, we used nets mounted on long (2m) metallic poles. The captured toads were kept in buckets with water. Collecting their stomach contents was done at a maximum of 2 hours after they were captured. Prolonging this interval leads to a more extensive digestion of the ingested food, a fact that makes it more difficult to determine the prey taxa, the amphibians digesting their food rather quickly. In order to collect the samples, we used the stomach wash method (Solé et al 2005). This method has the advantage of not hurting the animal and after applying it, the toads were then set free in their habitats of origin. Once gathered, the stomach contents were stocked in test-tubes, conserved in formalin and later determined in the lab, under a stereo-microscope with the help of the specialty literature.

Results and Discussions

The general composition of the food of the studied populations

We identified a total number of 1799 preys in the stomach contents of the 306 studied *B. variegata* specimens. They belonged to 44 prey taxa. Most of the consumed preys were invertebrates, the toads only consuming amphibian larvae among the vertebrates. Tadpoles were identified in the toads' stomach contents only in 2 habitats, but in little amounts. Among the 44 prey taxa, there were cases in which the adult of one taxon was treated separately than its larvae. This difference derives from the fact that the larvae and the adult of one taxon may live in different environments, have different mobility and thus represent preys with a different chance of

capturing. It is the case of the Diptera Nematocera, where the larvae are aquatic and the adults terrestrial, being winged, flying forms.

Table 1.

The number of analyzed individuals. The frequency of occurrence of the empty stomachs, of the stomachs with vegetal remains, shed skin and minerals. 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. (M-males, F-females, J-juveniles, T-total).

Locality	Gâlgăul Almasului	Mestecănu	Ciglean
Date	22.04.'09	22.04.'09	13.05.'09
	T	T	T
No. of analyzed individuals	30	28	20
% vegetal remains	56.7	39.3	60
% shed skin	23.3	21.4	15
% minerals	-	-	-
Total no. of prey	227	132	178
Max. no. of prey/individual	28	12	28
Aver. No. of prey /individual	7.56	4.71	8.9
% terrestrial prey	43.62	93.19	98.32
% aquatic prey	56.38	6.81	1.68
Feeding diversity (H)	2.57	2.43	2.34
Empty stomachs	-	10.7	-

Locality	Poic			Gălpaia		
Date	13.05.'09			27.06.2009		
	M	F	T	M	F	T
No. of analyzed individuals	19	28	47	26	26	52
% vegetal remains	52.6	42.9	46.8	34.6	38.5	36.5
% shed skin	15.8	14.3	14.9	30.8	15.4	23.1
% minerals	-	-	-	-	-	-
Total no. of prey	78	256	334	116	62	178
Max. no. of prey/individual	8	17	17	14	6	14
Aver. No. of prey /individual	4.1	9.14	7.10	4.46	2.38	3.42
% terrestrial prey	69	37.5	44.32	98.28	100	98.88
% aquatic prey	41	62.5	55.68	1.72	-	1.12
Feeding diversity (H)	2.51	1.89	2.17	1.75	2.33	2.14
Empty stomachs	10.5	21.05	12.76	7.69	23.08	15.38

Table 1. (continued)

Locality	Jebuc			Dragu			
Date	27.06.2009			28.06.2009			
	M	F	T	M	F	J	T
No. of analyzed individuals	27	26	53	24	26	26	76
% vegetal remains	22.2	50	35.85	33.3	53.8	53.8	47.4
% shed skin	37	23.1	30.19	8.33	23.1	23.1	18.4
% minerals	-		1.88	-	7.69	-	2.63
Total no. of prey	61	105	166	210	216	158	584
Max. no. of prey/individual	6	12	12	28	19	12	28
Aver. No. of prey /individual	2.25	4.03	3.13	8.75	8.3	6.07	7.68
% terrestrial prey	93.45	82.86	86.75	81.9	95.37	97.47	91.44
% aquatic prey	6.55	17.14	13.25	18.1	4.63	2.53	8.56
Feeding diversity (H)	2.43	1.98	2.18	2.5	2.6	2.25	2.61
Empty stomachs	29.6	11.54	20.75	-	-	-	-

Both the number of prey taxa and the number of consumed preys differ among the 7 habitats, among the different periods of time and between the sex of the animals (Table 2 and Table 3). Among the 44 prey taxa, only 6 were consumed in all 7 locations. These are the Araneidae, Coleoptera, Diptera Brachycera, Diptera Nematocera, undeterminable Hymenoptera and Hymenoptera Formica. Among the coleopterans, members of the Carabidae and the Elatridae families were the only ones consumed in all the 7 habitats. A number of 7 prey taxa were consumed in only one of the 7 habitats. They are the Crustacea Ostracoda, Pseudoscorpionida, Lepidoptera, Trioptera larvae, Dermaptera, Hymenoptera Apidae and Blatoidea. The consumption of bees must be associated to the closeness to a locality where the locals tend to apiculture. Thus, for the *B. variegata* population from Gâlgăul Almaşului, 23.3% of the analyzed specimens consumed bees. Although they are poisonous invertebrates, the bees were frequently consumed by other amphibian species, too (Sin et al 1975).

Generally, the prey taxa that record high amounts were consumed by a large number of *B. variegata* specimens and thus have high frequencies, too. This fact usually indicates a uniformity of the trophic offer (Covaciu-Marcov et al 2010), and is mostly recorded in smaller habitats where the trophic opportunities of the amphibians are more reduced. This is the case of the population from Poic where the Diptera Brachycera are on top both

as an amount and as frequency, followed by Crustacea Gammaridae. The same situation is documented at Gălpaia, a habitat represented by a ditch from alongside a road. In this case, the highest amount and frequency are represented by the ants, while second place goes to the coleopterans. Meanwhile, in the larger habitats, automatically with a more diverse trophic offer, certain differences are usually recorded between the orders of the prey taxa in terms of amount and frequency. In these larger biotopes, the chance that a small number of individuals from the population will encounter some preys in high amounts is greater than in the smaller habitats. In such a situation, the amount of that particular taxon will be high but the frequency will be low as a consequence that only a small number of toads had access to them.

Two prey taxa recorded rather constant values for the amount and frequency in the majority of the studied habitats. We are talking about firstly the coleopterans and secondly the ants. The coleopterans represent for other *B. variegata* populations, but actually for other species of amphibians, too, the most important prey taxon (Angelov & Batschwarov 1972, Sas et al. 2005b, Ghiurcă & Zaharia 2006). This fact is expectable, the coleopterans being an extremely diverse group that encompasses a great number of species that in turn occupy a great diversity of habitats (Radu & Radu 1972). Thus, being very numerous and distributed in different habitats, the coleopterans represent an accessible and quantitatively important trophic base for the studied *B. variegata* populations. Especially the frequency with which the coleopterans were consumed is high, indicating that they are an abundant trophic resource in the environment, but out of which not that many were actually consumed. This latter fact is more likely a consequence of their big sizes, particularly the Cerambycidae, Carabidae and Scarabeidae species. Hence, the toads don't really need to eat many specimens from these taxa in order to satisfy their trophic needs.

The ants aren't generally fundamental components of the amphibian's food. Although they were identified in the food of many amphibians, they mostly represented small amounts and frequencies (Çiçek & Mermer 2006, Radu et al. 2007, Ferenti et al. 2009a). It was also the case of *B. variegata* before, for which they were found in the stomach contents of some populations but they weren't there as main food components (Ghiurcă & Zaharia 2005, Dimancea & Covaciu-Marcov 2009, Hodişan et al. 2009). However, there are other cases of *B. variegata* for which ants did in fact represent high amounts and frequencies from their consumptions (Groza et al. 2008). There are also amphibian species for which the consumption of ants is preferential and those respective amphibians actually are selective in favor of the Formicidae. Such is the case of the green toad, *Epidalea*

viridis, for which the Formicidae do represent main elements of their food (Opatrny 1980, Nicoară et al. 2005, Ferentî et al. 2009b). The fact the green toads generally eat ants is considered a consequence of the formic acid that they contain. This formic acid is necessary for these toads for producing their skin toxins (Jones et al. 1999). The same explanation could be extrapolated for the yellow-bellied toads, too, which are in turn toxic so could very well use the formic acid from the ants. However, it could also be that the consumption of ants be related to them only being in the proximity of their habitat (Groza et al. 2008).

It is likely that *B. variegata* doesn't selectively consume ants. This fact can be deduced from the ascertainment that the ants don't always represent an important part of their meal. It is likely that for those cases, they simply are abundant in the environment and thus be eaten in larger amounts by the toads. As a result, the massive consumption of ants only maybe indicates the trophic opportunism of the yellow-bellied toads, a fact stated for other populations, too (Sas et al. 2004). Such similar situations had been encountered before for other amphibian species that don't selectively consume ants yet they still represent a significant amount of their diet. They were also explained by the fact the toads simply don't avoid the preys abundant in their habitat (Hirai & Matsui 2000). Furthermore, since the ants are so small and have a hard body, they aren't very nutritious and therefore need to be eaten in large number in order to satisfy one's needs.

The studied *B. variegata* populations ate both flying and, mostly, non-flying preys. Most preys belonged to humidity preferring groups, but other groups linked to sunny, drier grasslands weren't excluded either (e.g. Orthoptera). Many prey taxa comprise forest related forms, most habitats being situated in or right outside woodlands. Although all the studied specimens were captured from the aquatic environment, most of the animals they consumed were terrestrial. In other studies regarding this species it was also pointed out that the majority of preys were represented by terrestrial invertebrates (Groza et al. 2006, Peter et al. 2006, 2007, Hodişan et al. 2009). There are even habitats where the amount of terrestrial preys consumed reaches 98.32% (Table 1). However, for two of the studied populations the amount of terrestrial preys was smaller, the majority belonging to the aquatic preys.

Alongside animal preys, the studied *B. variegata* populations presented other categories of stomach contents, too. This is the case of vegetal remains, shed skinfragments and mineral elements. Among these, the first two were consumed in all 7 habitats, by both sexes and by both adults and juveniles. Both the consumption of vegetal remains and that of shed

skinpresent important differences among habitats and between the sexes. In all the cases, the shed skinconsumed was that of their own species. There were also populations with individuals without any stomach contents. These, too, were recorded for both sexes, in 4 of the 7 studied habitats. In certain locations, like the habitat form Jebucu, the frequency of unfed animals was rather high. The differences among the diversity of the food are small (Table 1). However, in habitats where fewer prey taxa had been consumed there is also a smaller diversity of the trophic offer.

The analysis of the feeding for each habitat

The most important differences among the trophic spectrum of the studied 7 *B. variegata* populations are recorded among different habitats, being determined by their particularities. Certain prey taxa were consumed only in some habitats, their presence also being linked to particular local characteristics. Thus, there are habitats in which the feeding of the yellow-bellied toads is very intense. In these biotopes, the toads ate numerous preys, belonging to many prey taxa, the number of preys / individual being high while the frequency of empty stomachs reduced or even none. In the same time, there are habitats in which the feeding of the toads is reduced, the values of the investigated parameters being the opposite as to those presented above. All these dissimilarities have to do with the distinctiveness of each aquatic biotope inhabited by the yellow-bellied toads and equally with their surrounding sectors – especially the presence of forest in their vicinity.

The habitats situated inside forests or right near some seem to suit *B. variegata* most. This is quite expectable, the yellow-bellied toads being a species linked with afforested areas. Even though there are certain amphibian species that, from their feeding point of view, seem to be less affected by human activities on their habitats (Solé et al. 2009), *B. variegata* appears to feel this impact at some level. The species is mainly affected by the destruction of forests. Thus, even though it inhabits artificial biotopes - e.g. canals or ditches (Iftime 2005) – being rather frequent in such areas, its trophic necessities aren't really met here. Furthermore, in these habitats, the surrounding areas aren't favorable for the species either and as such the toads can't sometimes leave their aquatic environment and hunt around it. The yellow-bellied toad usually makes long trips around its habitat, sometimes even migrating between pools (Hartel 2008). In the case of many artificial habitats, this is impossible due to the modifications brought to by man to the surrounding areas. The anthropogenic impact on their feeding is evident but its consequences will be much more dramatic in time.

Table 2.
The percentage abundance (%A) and the frequency of occurrence (%f) of the consumed prey items by the studied *Bombina variegata* populations (t-terrestrial, a-aquatic, L-larvae).

Locality	Gălgăul Almasului		Mestecănu		Ciglean		Poic		Gălpaia		Jebuc		Dragu		
	Date	A%	f%	A%	f%	A%	f%	A%	f%	A%	f%	A%	f%	A%	f%
Anelida-Oligochetae		-	-	0.76	3.57	0.56	5	0.3	2.13	-	-	4.82	9.43	0.68	5.26
Gasteropoda - snails (t)		-	-	3.79	10.7	-	-	0.3	2.13	-	-	2.41	7.55	-	-
Gasteropode - snails (a)		0.72	3.33	0.76	3.57	-	-	0.3	2.13	-	-	-	-	-	-
Gasteropode - limax		-	-	3.79	10.7	-	-	0.6	4.26	-	-	-	-	-	-
Crustacea - Ostracoda		-	-	-	-	-	-	-	-	-	-	-	-	0.34	2.63
Crustacea - Gamarida		-	-	-	-	-	-	35	51.1	1.12	1.92	-	-	-	-
Crustacea - Isopoda		1.81	16.7	-	-	20.8	40	0.3	2.13	3.93	13.5	-	-	1.71	13.2
Arahnida - Pseudoscorpionidae		-	-	0.76	3.57	-	-	-	-	-	-	-	-	-	-
Arahnida - Acaria		0.72	6.67	-	-	-	-	-	-	-	-	-	-	0.68	5.26
Arahnida - Araneidae		5.78	33.3	19.7	53.6	10.7	65	4.79	29.8	5.62	19.2	9.04	24.5	8.9	60.5
Arahnida - Opilionidae		-	-	-	-	-	-	0.9	6.38	-	-	-	-	1.71	7.89
Miriapoda - Chilopoda		0.36	3.33	-	-	0.56	5	-	-	-	-	-	-	2.05	7.89
Miriapoda - Diplopoda		1.08	10	4.55	21.4	1.69	10	0.6	4.26	2.25	7.69	-	-	13.0	63.2
Colembola		-	-	-	-	0.56	5	0.3	2.13	-	-	-	-	1.02	5.26
Plecoptera (L)		42.6	36.7	-	-	1.12	10	20.4	46.8	-	-	-	-	-	-
Plecoptera		1.08	6.67	-	-	-	-	3.59	8.51	1.12	3.85	-	-	-	-
Orthoptere		0.36	3.33	-	-	0.56	5	0.6	4.26	1.12	3.85	-	-	0.34	2.63
Heteroptere		0.72	6.67	3.03	14.3	-	-	0.3	2.13	2.81	9.62	-	-	1.37	10.5
Homoptera - Afidinae		-	-	-	-	-	-	0.3	2.13	1.69	5.77	1.81	5.66	0.34	2.63
Homoptera - Cicadelloidea		0.72	6.67	1.52	7.14	-	-	0.3	2.13	6.74	17.3	1.2	3.77	3.76	18.4
Lepidoptera (L)		0.72	6.67	-	-	7.87	35	4.19	19.1	0.56	1.92	0.6	1.89	4.79	28.9

1. The habitat from Gălgăul Almaşului seems to be one favorable for the toads' feeding. Here, the intensity of the feeding is high, with 29 prey taxa consumed, a fact that places this habitat in the first place, tied with the one from Dragu. In addition, the average number of preys / individual is also high (7.56 preys / individual), ranking this habitat as third from this point of view. Regarding the maximum number of preys / individual, the habitat from Gălgăul Almaşului is again first, with 28 preys / individual, but again on par with the biotopes from Dragu and, this time, Ciglean, too. This habitat is also one of the few in which the number of aquatic preys is greater than that of the terrestrial ones.

The consumption of shed skins is great for the habitat from Gălgăul Almaşului, however, and these trophic elements are usually associated with a deficit in the feeding, when other types of preys are missing (Cicort-Lucaciu et al. 2006). This fact seems logical nevertheless, the stomach contents being sampled in April here, in the beginning of the toads' aquatic period, when the temperatures were still quite low. On top of that, there was also a colder temperature wave recorded during that interval. The existence of harsh climate influences on their feeding was also noted in terms of the origin of the preys. Thus, since the terrestrial environment lacked in preys, the toads turned to the aquatic one. In this habitat, the highest amount was that of the Plecoptera larvae – aquatic preys generally associated with small slow-flowing streams. The Plecoptera larvae represented 42.6% from the total number of consumed preys for this population. Second spot, at a considerable distance, goes to the coleopterans.

In terms of the frequency, things are a bit different than for the amount. Here, the first place goes to the coleopterans. They were consumed by 86.7% of the *B. variegata* individuals from the population, despite the fact that their amount represented only 19.49% out of all the preys. Therefore, for the whole Gălgăul Almaşului population, coleopterans are the most important trophic element, not the Plecoptera larvae. They were accessible to most toads, even if not in great numbers. We should also mention that most coleopterans were terrestrial forms, meaning that, even though they represent a lesser amount, the terrestrial preys were still very important for the *B. variegata* population from Gălgăul Almaşului. The second most frequent prey corresponds to the Diptera Brachycera, preys that were ranked third as an amount. The flies are, in turn, terrestrial and flying forms. Although not many flies were eaten, they constituted a trophic base for numerous *B. variegata* specimens. The flies are also rather big and therefore the toads don't need to consume a large number in order to satisfy their needs. Since they are terrestrial forms, the consumption of flies indicates that the terrestrial preys were the most important for this

population, even though their amount doesn't clearly reflect that. Moreover, these results suggest the orientation of this species towards hunting strategies for the terrestrial environment. The rest of the preys had little amounts, but many times high frequencies. For example, the spiders – terrestrial preys – represented only 5.78% from the total number of the preys but were consumed by 33.3% of the studied *B. variegata* individuals.

The intense feeding of the *B. variegata* population from Gălgăul Almaşului is somewhat contradictory. This is because, on the same sampling date, the feeding of a *Lissotriton vulgaris* population from here was far more precarious (Kovács et al. 2010). It gets even more confusing since the smooth newt is an aquatic species during its breeding period – therefore during our study – while for *B. variegata* the most quantitatively important preys were, in fact, the aquatic ones. So, a “more” terrestrial species – the yellow-bellied toad – fed better on aquatic preys than a “more” aquatic species despite the fact that they both occupied the same habitat. The dissimilarities could be explained by them taking on different sections of the habitat. On one side, *Lissotriton vulgaris* is found mostly in the stagnant, wider and deeper areas of the stream, closer to the village. On the other side, the majority of the toads were captured from the higher part of the habitat, where there's a narrow, slow-flowing and shallow stream – a more typical setting for the yellow-bellied toads. It could be that the sector inhabited by the newts had lower water temperatures which determined their diminished feeding. On the contrary, the toads present in the other sectors of the habitat might have benefited by a different thermal regime of the water and thus from a different trophic offer.

The differences between the hunting territory of the *Lissotriton vulgaris* populations and the *B. variegata* population from Gălgăul Almaşului can be deduced from the different Plecoptera larvae consumption, too. As such, in the case of the common newts they represented an amount of 18.8% whereas for the toads, 42.6% respectively, all this while the newts are considered a more aquatic species. This fact can only be explained through the dissimilar occupation of the habitat by the two species, the Plecoptera larvae being more accessible in the sector inhabited by *B. variegata*. Furthermore, these larvae weren't available for all the toads, but just for those individuals that occupied certain areas of the habitat, where the Plecoptera were abundant. Thus, chance determined the amount of aquatic preys for the entire *B. variegata* population but in fact aided only those individuals that actually fed on them. The fact that the yellow-bellied toads usually hunted in different sectors of the same habitat than the common newt indicates a partitioning of the aquatic biotope between the two species. This partitioning of the habitat among amphibians allows the

coexistence of various species, while the use of different hunting microhabitats reduces the competition for food (Lima & Magnusson 1998). In addition, the data show that results of different studies mustn't be generalized for various species as they can relate differently to several environment factors.

2. The habitat from Mesteacănu is less favorable for the feeding of the toads despite the fact that the samples were taken in the same day as the ones from Gălgăul Almaşului. Thus, at Mesteacănu, the unfed animals represented 10.7% out of the entire population. The presence of toads without stomach content indicates difficult feeding conditions (Covaciu-Marcov et al. 2002, Sas et al. 2003). Furthermore, the number of preys and prey taxa, the average and the maximum number of preys / individual are all much more reduced than in the previous habitat. Only 20 prey taxa were consumed in the habitat from Mesteacănu, about a third less from the number from Gălgăul Almaşului. Correlated with a lower feeding intensity, the frequency of consumed vegetal remains is also smaller, these being usually swallowed together with the hunted preys (Sas et al. 2005b, Çiçek et al. 2007). Thus, once the number of preys dropped, so did the chance of accidentally ingesting vegetal material.

There are no Plecoptera larvae in the food of the *B. variegata* population from Mesteacănu, preys that positively influenced the feeding of the population from Gălgăul Almaşului. The Plecoptera larvae are probably totally absent from this habitat and therefore the toads couldn't consume them. Additionally at the Mesteacănu habitat, some more terrestrial preys occurred, but preys linked with a more humid environment – like worms and slugs. So, together with the absence of the Plecoptera larvae and the appearance of other terrestrial preys instead, it resulted in a sheer dominance of the terrestrial preys in this habitat, summing up to a total amount of 93.19%. For the habitat from Mesteacănu, the first place both as an amount and frequency is taken by the coleopterans. Second as amount are the ants while as frequency the spiders (Araneae). Anyhow, these 3 taxa (coleopterans, ants and spiders) are the most important ones from the population, having rather similar amount and frequency values while being all terrestrial.

The differences between the feeding of the two yellow-bellied toad populations studied on the same date are relatively difficult to explain. However, during the cold wave recorded then, the habitat from Mesteacănu was harsher for the toads, being more exposed. It is situated on a pasture from a hill slope. There is a forest in the region, but it is situated downhill from the habitat and, thus, the aquatic basin here is exposed to the cold winds which come from the nearby mountains (the Vlădeasa Massif) which

were at that point covered in snow. Furthermore, this is a temporary habitat, much more prone to dry out than the previous. This is how there is little chance for rich aquatic biodiversity to settle here as opposed to the biotope from Gălgăul Almaşului, which makes the trophic offer for the toads much more reduced. The lack of aquatic preys – like the Plecoptera larvae – is evident in the feeding of the toads. It is likely that these Plecoptera are present in the stream from the valley, though, situated at about 200m from our habitat.

3. The feeding of the population from the habitat from Ciglean seems to be more intense than that from Mesteacănu. Here there aren't any toads without any stomach content. The number of prey taxa isn't that great as the one from Gălgăul Almaşului or Dragu, but it is however greater than the one from Mesteacănu, reaching 21 prey taxa. Although the number of prey taxa isn't that high, the average number of preys/individual has its highest value from all the studied populations. Thus, the toads from Ciglean didn't consume preys belonging to many taxa but ate a large number of individuals from those fewer taxa they did prey on. Therefore, we have a case here where the intensity of the feeding is great but the diversity of the food isn't that high. Correlated with the high intensity of the feeding, thus, with the large number of preys eaten, the frequency of vegetal material swallowed is also great, confirming its link between its frequency and the intensity of the feeding (Sas et al. 2005b).

Regardless of the rather large size and the permanent character of the habitat Ciglean, the greater majority of the preys were terrestrial animals, their amount exceeding even that from Mesteacănu. This fact probably indicates a tendency of the toads to hunt on land, element favored by the great abundance of some terrestrial preys like isopods, flies, spiders or ants from the vicinity of the inhabited biotope. Consequently, despite the fact that *B. variegata* can easily hunt in the water, the terrestrial environment favors the species more, identifying the preys being perhaps easier for the toads on land.

For the *B. variegata* population from Ciglean, the greatest amount from their food is that of the Crustacea Isopoda, followed by Diptera Brachycera. In terms of frequency, 3 prey taxa are tie on first place: Araneae, Coleoptera and Diptera Nematocera. After them, the Diptera Brachycera have the second value in terms of amount, just like they are second in term of frequency. The elevated consumption of some terrestrial preys like the spiders suggests that the toads often leave the water and hunt in the sectors around or near it.

4. The feeding of the population from the habitat from Poic is different from that of the one from Ciglean, although the samples were taken in the

same day from the two habitats. As a result, 26 prey taxa were consumed by the Poic population, 5 more than from Ciglean. In the trophic spectrum of the yellow-bellied toads from Poic, there are 5 extra preys that are linked to a higher humidity – like the different types of gastropods. They are all favored by the fact that the habitat is situated in a humid beech forest. The presence of Cerambicidae can be similarly explained. They were only consumed in afforested habitats or biotopes found right next to woodlands. Moreover for this population, Crustacea Gammaridae occur in some stomach contents, an element found abundantly in mountain streams with a reduced flow. The habitat from Poic is fed by such a stream in which the Gammaridae are very numerous. Additionally, the habitat from Poic is found at the highest altitude among all our studied habitats.

Although in the habitat from Poic there were many prey taxa consumed, some empty stomachs do occur and their frequency is even higher than the one recorded in April at Mesteacănu, reaching 12.76%. The feeding intensity is high, the toads consuming an average of 7.1 preys / individual. Associated to this, the consumption of vegetal matter is also high, 46.8% of the toads having some vegetal remains in their stomachs. Together with the habitat from Gălgăul Almaşului, the one at Poic is the only biotope where the aquatic preys had the majority. Just as in the Gălgăul Almaşului's case, their high amount was determined by the Plecoptera larvae. Alongside these, the Gammaridae also represented high amounts in the habitat from Poic. Both the Plecoptera larvae and the Gammaridae find very suitable conditions here, thus representing an important trophic offer for the *B. variegata* population. It should also be mentioned that the shallow depth of the water in the habitat from Poic facilitates the contact between the toads and these preys.

At Poic, in terms of amount and frequency, the first place goes to Diptera Brachycera. The second place, again as an amount and as frequency, is taken by Crustacea Gammaridae. This is also the habitat where the coleopterans record their lowest amounts and frequencies. This fact is not so much a consequence of the rarity of coleopterans - since from this prey taxa, representatives of several families were consumed – but of the fact that the toads have other preys much easier to capture around them. These data therefore underline the trophic opportunism of the yellow-bellied toads, a feature of most amphibian species (Guidali et al. 1999, Santos et al. 2004, Çiçek et al. 2007, Solé et al. 2009, de Paula-Lima et al. 2010).

5. The habitat from Gălpaia offers more precarious trophic conditions for its *B. variegata* population than its predecessor, despite the fact that the samples from here were taken in June. Here, the toads consumed only 24 prey taxa. Another indicator of the poorer feeding from Gălpaia is the high

frequency of empty stomachs, reaching 15.38% - more than in any of the previous habitats. Furthermore, the feeding intensity is more reduced in the case of the population from Gălpaia, both the maximum and the average number of preys / individual being smaller than in most of the prior biotopes. Associated with this, the consumption of shed skin records higher values, almost as high as the ones from Gălgăul Almaşului in April, in a much less favorable thermal context. The massive consumption of shed skin should definitely be considered an indicator for less favorable trophic conditions as they are regarded as a solution for when other trophic elements are absent (Cicort-Lucaciu et al. 2007).

The feeding of the yellow-bellied toads from Gălpaia is a consequence of inhabiting an artificial biotope. The population utilizes the most anthropogenically affected habitat out of the 7 studied ones – a ditch from alongside a road. The canal is relatively deep and has steep banks. Outside the ditch, on the road side, the toads have little to nothing to hunt as there are no preys on the road. Even if the road isn't used that much, being a country road, it still had asphalt and thus the few cars that pass by travel with rather high speeds, taking their toll on the toads. On the opposite side, the habitat is bordered by a pasture, while the forest in this region is only at a few hundred meters away. Towards this side, the bank is at its steepest, but this fact shouldn't affect the yellow-bellied toads as they are able to climb even vertical concrete walls. However, it is likely that the pasture that's bordering the canal is relatively dry and therefore lacking in wet areas favorable for the toads. As such, we can state that the *B. variegata* population from Gălpaia is a prisoner in an artificial habitat.

The habitat's vicinity with a pasture can also be deduced from the trophic spectrum of the toads. Here, the Orthoptera have the highest amount in comparison to any of the other 6 habitats. Despite the fact that the terrestrial preys hold the great majority, there are still aquatic preys consumed here, but in smaller amounts. It is also the case of the Gammaridae, which were consumed only in this habitat and the one from Poic. The biotope from Gălpaia is situated in a hilly region and is probably supplied with water from small streams that form around here or maybe it once was exactly such a stream itself. The Plecoptera larvae are missing from the stomach contents of the yellow-bellied toads from here, but, strangely, there are records of their adults being consumed. It is likely that the larvae don't find suitable development conditions in this small and temporary ditch, but some adults may be drawn here by the water and end up as preys for the toads. It is also possible that there are several habitats in this hilly region that are more suitable for the development of these invertebrates.

Table 3.
The percentage abundance (%A) and the frequency of occurrence (%f) of the consumed prey items by meles, females and juveniles (t- terrestrial, a-aquatic, L-larvae).

Locality Date	Poic				Gálpaia			
	Males		Females		Males		Females	
	A%	f%	A%	f%	A%	f%	A%	f%
Anelida Oligochetae	1.28	5.26	-	-	-	-	-	-
Gasteropoda - snails (t)	1.28	5.26	-	-	1.72	7.69	3.23	7.69
Gasteropode - snails (a)	1.28	5.26	-	-	-	-	-	-
Gasteropode - limax	-	-	0.78	7.14	-	-	-	-
Crustacea - Ostracoda	-	-	-	-	-	-	-	-
Crustacea - Gamarida	11.5	31.6	42.2	64.3	1.72	3.85	-	-
Crustacea - Isopoda	1.28	5.26	-	-	2.59	11.5	6.45	15.4
Crustacea - Isopoda (a)	-	-	-	-	-	-	-	-
Arahnida - Acaria	-	-	-	-	-	-	-	-
Arahnida - Araneidae	10.3	42.1	3.13	21.4	1.72	7.69	12.9	30.8
Arahnida - Opilionidae	1.28	5.26	0.78	7.14	-	-	-	-
Miriapoda - Chilopoda	-	-	-	-	-	-	-	-
Miriapoda - Diplopoda	-	-	0.78	7.14	-	-	6.45	15.4
Colembola	1.28	5.26	-	-	-	-	-	-
Plecoptera (L)	20.5	42.1	20.3	50	-	-	-	-
Plecoptera	-	-	4.69	14.3	-	-	3.23	7.69
Ortoptera	-	-	0.78	7.14	-	-	3.23	7.69
Heteroptera	1.28	5.26	-	-	0.86	3.85	6.45	15.4
Homoptera - Afidinae	1.28	5.26	-	-	0.86	3.85	3.23	7.69
Homoptera - Cicadelloidae	1.28	5.26	-	-	5.17	19.2	9.68	15.4
Lepidoptera (L)	2.56	5.26	4.69	28.6	0.86	3.85	-	-
Panorpata	-	-	-	-	0.86	3.85	-	-
Dermaptera	-	-	-	-	-	-	-	-
Coleoptera - Dytiscidae (L)	-	-	-	-	-	-	-	-
Coleoptera - undet.	5.13	21.1	0.78	7.14	4.31	19.2	3.23	7.69
Coleoptera - Carabidae	-	-	0.78	7.14	1.72	3.85	0	0
Coleoptera - Cerambicidae	1.28	5.26	-	-	-	-	3.23	7.69
Coleoptera - Elateridae	-	-	1.56	14.3	2.59	11.5	6.45	15.4
Coleoptera - Stafilinidae	-	-	-	-	-	-	-	-
Coleoptera - Curculionidae	-	-	-	-	0.86	3.85	3.23	7.69
Coleoptera - Cantaridae	-	-	-	-	0.86	3.85	-	-
Coleoptera - Scarabeidae	-	-	-	-	2.59	11.5	-	-
Diptera - Nematocera (L)	-	-	-	-	-	-	-	-
Diptera - Nematocera	11.5	31.6	5.47	28.6	6.03	19.2	-	-
Diptera - Brahicera	12.8	36.8	10.2	57.1	1.72	7.69	-	-
Diptera - Brahicera (L)	7.69	15.8	-	-	0.86	3.85	-	-
Hymenoptera- undet.	2.56	10.5	0.78	7.14	1.72	7.69	-	-
Hymenoptere - Formicidae	2.56	10.5	2.34	14.3	60.3	73.1	29	53.8
Blatoida	-	-	-	-	-	-	-	-

Table 3. (continued)

	Jebuc				Dragu					
	Males		Females		Males		Females		Juveniles	
	A%	f%	A%	f%	A%	f%	A%	f%	A%	f%
Anelida Oligochetae	6.56	7.41	3.81	11.5	0.95	8.33	0.93	7.69	-	-
Gasteropoda - snails (t)	3.28	7.41	1.9	7.69	-	-	-	-	-	-
Gasteropode - snails (a)	-	-	-	-	-	-	-	-	-	-
Gasteropode - limax	-	-	-	-	-	-	-	-	-	-
Crustacea - Ostracoda	-	-	-	-	-	-	0.93	7.69	-	-
Crustacea - Gamarida	-	-	-	-	-	-	-	-	-	-
Crustacea - Isopoda	-	-	-	-	-	-	1.85	15.4	3.8	23.1
Crustacea - Isopoda (a)	-	-	-	-	-	-	-	-	-	-
Arahnida - Acaria	-	-	-	-	-	-	1.85	15.4	8.86	46.2
Arahnida - Araneidae	14.8	25.9	5.71	23.1	9.52	75	8.33	61.5	-	-
Arahnida - Opilionidae	-	-	-	-	0.95	8.33	3.7	15.4	-	-
Miriapoda - Chilopoda	-	-	-	-	2.86	16.7	2.78	7.69	-	-
Miriapoda - Diplopoda	-	-	-	-	14.3	66.7	12	69.2	12.7	53.8
Colembola	-	-	-	-	-	-	1.85	7.69	1.27	7.69
Plecoptera (L)	-	-	-	-	-	-	-	-	-	-
Plecoptera	-	-	-	-	-	-	-	-	-	-
Ortoptera	-	-	-	-	0.95	8.33	-	-	-	-
Heteroptera	-	-	-	-	0.95	8.33	0.93	7.69	2.53	15.4
Homoptera - Afidinae	1.64	3.7	1.9	7.69	-	-	0.93	7.69	-	-
Homoptera - Cicadelloidae	3.28	7.41	-	-	4.76	33.3	4.63	15.4	1.27	7.69
Lepidoptera (L)	1.64	3.7	-	-	1.9	8.33	2.78	23.1	11.4	53.8
Panorpata	-	-	-	-	-	-	-	-	-	-
Dermaptera	-	-	-	-	0.95	8.33	-	-	-	-
Coleoptera-Dytiscidae(L)	-	-	-	-	0.95	8.33	-	-	-	-
Coleoptera - undet.	4.92	11.1	5.71	23.1	0.95	8.33	2.78	23.1	3.8	15.4
Coleoptera - Carabidae	3.28	7.41	3.81	7.69	1.9	16.7	1.85	15.4	2.53	15.4
Coleoptera - Cerambycidae	-	-	-	-	-	-	0.93	7.69	-	-
Coleoptera - Elateridae	-	-	2.86	11.5	4.76	25	0.93	7.69	2.53	15.4
Coleoptera - Stafilinidae	1.64	3.7	-	-	-	-	-	-	-	-
Coleoptera - Curculionidae	-	-	1.9	7.69	0.95	8.33	1.85	15.4	1.27	7.69
Coleoptera - Cantaridae	-	-	0.95	3.85	-	-	0.93	7.69	1.27	-
Coleoptera - Scarabeidae	-	-	-	-	0.95	8.33	-	-	-	7.69
Diptera - Nematocera (L)	6.56	3.7	17.1	23.1	17.1	8.33	3.7	15.4	2.53	7.69
Diptera - Nematocera	11.5	14.8	1.9	7.69	1.9	16.7	2.78	15.4	-	-
Diptera - Brahicera	6.56	14.8	6.67	26.9	14.3	66.7	18.5	61.5	13.9	38.5
Diptera - Brahicera (L)	-	-	0.95	3.85	0.95	8.33	-	-	-	-
Hymenoptera- undet.	1.64	3.7	1.9	7.69	1.9	16.7	0.93	7.69	1.27	7.69
Hymenoptere - Formicidae	31.1	37	42.9	61.5	15.2	66.7	21.3	69.2	29.1	76.9
Blatoida	1.64	3.7	-	-	-	-	-	-	-	-

As a consequence of the small size and the scarce trophic offer from this habitat, the same taxa occupy the first position both as amounts and frequencies. Thus, the first place goes to the ants and second to coleopterans. The ants had actually the highest amount here than in any other habitat. This fact is probably due to the presence of an ant's nest right next to the ditch. It can't, however, be ruled out that this exposed population, from an artificial environment, needs and has a higher level of toxins than other populations, in response to its whereabouts. Therefore, it may be that the high consumption of ants is voluntary, the toads selecting this prey. In the case of another hybrid population between *B. variegata* and *Bombina bombina*, situated in an artificial ditch as well, the consumption of ants recorded high frequencies (Sas et al. 2005c). The fact may be plausible, because as we captured and took our samples, we noticed a greater quantity of toxins secreted by the toads here than by any other of the 7 populations. Even if they don't actively search for the ants, it is possible that the toads that ate more ants have a higher quantity of toxins which presents an advantage in this harsh habitat.

6. The habitat from Jebucu may very well be the least favorable for *B. variegata*'s feeding. It is here that the lowest number of prey taxa was recorded (only 19), lower even than that from Mesteacănu, in April. Furthermore at Jebucu, the frequency of empty stomachs is at its highest, unfed individuals exceeding 20% from the total number of studied samples. In concordance with the precedent data, the feeding intensity from this habitat is diminished, the number of preys / individual having its lowest value among all the studied populations: 3.13 preys / individual. This value is also very low in comparison to other *B. variegata* populations from Romania (Sas et al. 2005a, Groza et al. 2006). Unlike these, the shed skin consumption records here its highest value, over 30% of the studied individuals eating their own shed skin. This fact underlines again the idea that generally, the consumption of shed skins is a response to the poor trophic offer, its frequency growing together with the reduction of the trophic offer (Cicort-Lucaciu et al. 2006, 2007). The terrestrial preys have the majority in this habitat, too, but the aquatic ones reach respectable amounts as well, representing 13.25% out of the total number of consumed preys. These aquatic preys were represented almost entirely by Diptera Nematocera larvae.

Just like the habitat from Gălpaia in which the feeding of the *B. variegata* populations was diminished, at Jebucu the same prey taxa occupy the same spots in terms of amounts and frequencies as well. They are, just like at Gălpaia, the ants and the coleopterans. After these taxa, the spiders present somewhat higher values, consumed most likely around the habitat.

The diminished feeding of the population from Jebucu can be somewhat surprising. The habitat seems to be, at first sight at least, one favorable for the species, being a system of temporary pools situated on a grassland, *B. variegata* being known to use temporary habitats (Barandun & Reyer 1997). These pools are close to one another while at a few hundred meters there's a forest. However, the population here is not feeding well. The poor feeding is a cause by the very ephemeral character of the ponds, which are usually dried out. It is likely that the toads migrate to the pools, coming from different streams from the area, only when these are filled by rain water. The ponds are possibly used only for breeding, the yellow-bellied toads living otherwise in or around streams. Moreover, the areas surrounding the habitat are uniform and poor in a trophic offer, being actually intensely exploited grasslands. Although there are forests nearby, the preys usually linked to them cannot reach to the habitat, the toads not being therefore able to consume them. This is how, Diplopoda, Chilopoda and Cerambicidae are missing from the stomach contents of the population from Jebucu, a fact that indicates the high impact on the surrounding pasture.

The habitat from Jebucu seems to be a harsh one for the nutrition of amphibians, the feeding of a studied *Triturus cristatus* population from here being also diminished (Kovacs et al. 2010). The crested newts also consumed a low number of prey taxa and of preys from those taxa, respectively. Just like the toads, in the case of the newts there's also the Diptera Nematocera and the worms that had high amounts and frequencies. Those taxa aren't though major for the toads even if they presented high amount and frequency values. It is a consequence of the higher grade of liberty of the toads from their aquatic environment. The yellow-bellied toads hunt on ground further away from the water than the newts and thus have access to terrestrial preys such as ants. However, the *B. variegata* individuals that stay in or just around the aquatic habitat eat a very similar food to that of the crested newts.

7. The habitat from Dragu appears to be the most favorable one for the yellow-bellied toads out of all the 7 studied ones. The number of prey taxa here is the biggest from all the biotopes, the toads capturing preys belonging to 29 taxa. Despite the fact that we captured the most individuals from Dragu, there was no record of any empty stomach. Together with the high feeding intensity, the frequency of vegetal remains is also high. Furthermore, in correlation with a rich trophic offer, there is a low frequency of eaten shad skin. The frequency of nonorganic elements was, though, higher than in other habitats. This fact is probably a consequence of the localization of the population in a forest and of the majority of hunting being

done on land, where the probability of ingesting soil elements together with their food is higher. Anyway, just like in the case of the vegetal remains, the frequency of consuming nonorganic material rises together with the feeding intensity. Both the maximum and the average number of preys / individual have high values. The majority of preys consumed at Dragu were terrestrial, the aquatic preys representing only 8.56% out of the total.

The differences among the first prey taxa consumed at Dragu are little. Thus, the first spot goes to the ants, consumed by 21.2% of the toads, the second place, the flies with an amount of 15.8% and third there are the Diplopoda, consumed by 13.01% of the individuals. These differences are quite little in comparison with the population from Gălpaia, where the amount of the first taxon reached 49.4% out of the entire number of preys. This aspect indicates a rich trophic offer, both quantitatively and qualitatively as well as suggests a uniform accessibility to the trophic offer for most of the individuals from the population. In the case of the frequency, the first place goes again to the ants, followed by Diplopoda and spiders. The high amount and frequency of the Diplopoda are in conformity with the characteristics of the habitat occupied by the toads, the Diplopoda being invertebrates linked with the forest environment.

The habitat from Dragu is a very favorable one for *B. variegata*, meeting the ecological needs of this species. Thus, the biotope is situated inside a forest and comprises some puddles and wet areas found at little distances from one another. It is known that interconnected puddles are the favorite habitat of the species (Hartel 2008). In this habitat the toads can easily go out in the terrestrial environment, having vast, totally natural and unaffected surfaces at their disposal where they can search for their trophic resources. Also, in case of need, the yellow-bellied toads can always retreat to the aquatic environment as the day advances and the temperatures are higher. Furthermore, the forest environment allows for a rich trophic offer and includes a great diversity of invertebrates. It should also be mentioned that our study period at the Dragu habitat was one favorable for the toads; in June the high temperatures combined with precipitations allow the activity of a great diversity of preys.

The analysis of the food in terms of period

The differences among the feeding in terms of period aren't very evident. The smaller differences could be a consequence of the fact that the samples were taken in the beginning of their activity period, in spring, the feeding being thus uniform. In addition, it is possible the differences are less determinable because the samples from each month of our study were taken from different habitats. Generally for amphibians, the feeding is most

diminished in the beginning of their active period, after hibernation, when the low temperatures negatively affect both the preys and the predators (Covaciu-Marcov et al. 2002). In the case of our study, this evolution isn't that obvious; even the populations analyzed only in April had an intense feeding. The maximum number of preys / population – 29 – was recorded for one population in April and for another one in June. The lowest number of preys / population – 19 – was consumed in June as well. In this case, it wasn't the period but the characteristics of the habitat that affect the feeding.

However, even if less evident, the general evolution of the feeding is documented for the *B. variegata* populations from the Almăș-Agrij Depression. Thus, the most diverse feeding was recorded in June, in the case of the population from Dragu. Although that for other species the frequency of empty stomachs was high in the beginning of the study and then declined maybe even completely (Covaciu-Marcov et al 2002), here the stomachs without any content were recorded in all the three months of the study. Surprisingly, the highest frequency of unfed toads was in June, in the same habitat where the least number of preys was consumed. Thus, again, it's not the period but the particularities of that habitat that were responsible for this situation.

There are prey taxa that were consumed only in some periods of our study. It is firstly the case of tadpoles that were consumed only in April in the habitats from Gâlgăul Almașului and Poic. During the sampling, in these two habitats there were many brown *Rana* larvae, corresponding in size with something the yellow-bellied toads could swallow. The high frequency of tadpoles in both habitats can be indirectly deduced from their massive consumption by the newts present there (Kovács et al 2010). During May, the tadpoles are absent from the menu of the toads even if they were present in the habitat, but simply because they were too large to be captured anymore.

The analysis of the food in terms of the sex of the toads

In many cases for amphibians, the feeding of females is more intense than that of the males (Lőw & Török 1998, Ao et al. 2001, Sas et al. 2005a,b). This fact is determined by their more elevated energetic needs, associated with forming and laying the spawn (Guidali et al. 1999, Sas et al. 2005a). In the case of the *B. variegata* populations from the Almăș-Agrij Depression this rule doesn't seem to check out. There are indeed differences between the sexes (Table 3), but the variations of the feeding judging by the sex of the toads seem more likely to be random, not following a certain rule for their evolution. This is how we encountered populations where the feeding

of females was more intense but also other populations where the males fed more intensively. Furthermore, in the same habitat, according to some feeding parameters the intensity of the females' feeding was more intense while according to other parameters, it was the males that had a more intensive feeding. For example, at Poic, the diversity of the food was greater for the males but it was the females that consumed more preys / individual. In this case, the number of preys / individual is more important, because even if they didn't eat different preys, the females consumed a large number of preys. On contrary, at Gălpaia, the females had a diversified feeding, but it's the males that consumed a higher number of prey / individual.

The vegetal remains had higher frequencies for the males in two of the studied habitats while in the other two the same went for the females. In regards with shad skin, 3 of the habitats presented higher frequencies of consumption for males with only one for the females. In other cases of *B. variegata* populations the males consumed shed skin more frequently (Peter et al. 2006). This fact could indicate a high trophic opportunism for the males and their smaller implication in predatory activities, the males preferring to satisfy their trophic needs with more available elements, conserving their energy for reproduction. But, the habitat in which the females consumed more shed skins actually the one from Dragu, in which the feeding of the toads was optimal. Meanwhile, in one of the biotopes where the males consumed more shad skin, they ate an almost double amount of preys / individuals than the females. Thus, for those males the feeding is generally more intense, the risen consumption of shed skin being a way of expressing that.

Similar to the consumption of vegetal remains, in two of the habitats but in others than the ones with vegetal remains, the number of preys / individual was greater for the females while in the other two it was greater for the males. The situation is identical for the maximum and average number of prey / individual. Furthermore, in two habitats the males consumed more aquatic preys, while in other two, it was the females that fed predominantly on aquatic prey. However, overall, the females from the population from Gălpaia are the only ones that consumed exclusively terrestrial preys. This fact underlines the more terrestrial way of life of the females in comparison with the males (Fuhn 1970).

Only in the most difficult habitat, at Jebucu, the number of consumed prey taxa was identical for both the males and females. At Poic and Gălpaia the males ate more prey taxa whereas at Dragu the females consumed 2 extra prey taxa than the males. At Gălpaia alone, the same prey taxa occupied the first two places as amounts and frequencies for both

males and females. These two are the ants and the coleopterans. At Gălpaia, the females ate 6 prey taxa less than the males. The additional prey taxa consumed by the males are generally aquatic – like Gammaridae. Moreover, the males also preyed on flying invertebrates, too, such as the Diptera and the Panorpata, while the females were the only ones that consumed slow terrestrial prey like the Diplopoda. In this case, there seem to be differences in the hunting territory and the in trophic strategy of the males and females. Thus, the males took over the areas with deeper water, hunting for aquatic preys. In addition, they were also oriented towards flying preys. In opposition, the females mostly consumed terrestrial preys.

In the habitat from Poic, despite the fact that the females consumed fewer prey taxa than the males, they fed mostly on aquatic preys, such as Gammaridae. Additionally, the females from the *B. variegata* population from Poic consumed flying preys such as flies more frequently. At Poic, the males were the ones to take incursions on land, preying on more terrestrial invertebrates (e.g. spiders). The situation is therefore exactly the opposite from the one at Gălpaia. It thus seems that the sectors occupied by the two sexes are more likely random than dictated by predictable factors, especially since the samples from Poic and Gălpaia were taken in the same day.

Comparing the feeding between adults and juveniles

In the population from Dragu, all the studied individuals had stomach content. This is not a situation caused by the differences between adults and juveniles, but one determined by the period of sampling and by the particularities of the habitat. The development stage of the amphibians also seems to have no effect on the consumption of vegetal material. Thus, the same number of females and the juveniles ingested vegetal material, but this consumption is less for the males. This fact is probably arbitrary, because the intensity of the feeding for the males was greater than in for the females or juveniles. It was thus expectable that the males consumed more vegetal matter together with the swallowed preys, and hence present a higher frequency of vegetal remains in their stomachs, just like it was the case for other amphibians for which the frequency of vegetal remains went hand in hand with the intensity of the feeding (Peter et al 2006). In this case here, the discrepancies between the males on one side and the females and juveniles on the other were probably caused by the different hunting territory of the three groups. Thus, the males from population from Dragu consumed more aquatic preys than the females and the juveniles. By doing that, the males couldn't ingest that many vegetal elements, as these vegetal remains were represented by terrestrial vegetation for the

population from Dragu. The puddles from this habitat are temporary and small and therefore don't present their own aquatic vegetation. As a consequence, the males which hunt mostly in the water have little chance of accidentally ingesting vegetal material together with their aimed prey.

The consumption of shed skins is again irrelevant, their amount being again the same for the females and the juveniles and greater for the males. We can therefore conclude that the females and the juveniles use the same areas and similar tactics for hunting, while the males use different sectors of the habitat and have other techniques for capturing their prey. The consumption of shed skin may however indicate a higher trophic opportunism or higher energy needs for the females and juveniles. Due to this higher energy need, the females are pressed to use any trophic elements that they identify. The shed skins are very important from this point of view, their consumption not implying a great effort, thus reducing the amphibian's energy consumption. For the juveniles, their higher trophic needs are a consequence of their growth and development, while for the females, a consequence of forming and laying the spawn. In the case of the *B. variegata* females, their trophic necessities are accentuated by the fact that they lay more than one spawn in a year (Cogălniceanu et al. 2000).

Overall, the feeding of the juveniles is less intense than that of the adults. Their average and maximum numbers of preys / individuals as well as the total number of preys are all smaller than those of the adults. The number of prey taxa was again smaller (just 16 as opposed to 28 for the adults). The absence from the juveniles' diet of some preys is probably arbitrary. This is the case of Aphids, which are well small enough to be ingested by the juveniles. However, Aphids also represented a small amount from the adult's diet, too, and are therefore only consumed accidentally. In other cases, the dissimilarities are determined by the different hunting territory of the juveniles. Thus, hunting mostly in the terrestrial environment, the juveniles can't consume strictly aquatic preys such as Ostracods. Other preys can't be consumed by them simply because they are too small compared to those preys. This is the case of Chilopoda, Orthoptera, Coleoptera Scarabaeidae or Cerambycidae, for instance, animals that the juveniles simply can't swallow. It may be that sometimes these preys are even larger than the *B. variegata* juveniles themselves. The consumption of smaller preys by the juveniles was recorded for other amphibian species as well (Hirai & Matsui 2000, Sas et al. 2005a, Ferenți et al. 2009c), being also considered a consequence of the ratio between the sizes of the prey and the predator (Arroyo et al. 2008). Other species – like the flies – are probably too mobile for the young

juveniles. The adults being faster, capable of sudden moves or with higher amplitude, can however catch flying preys.

In relation with the smaller numbers of preys and of prey taxa consumed by the juveniles, the diversity of their feeding is therefore more reduced than that of the adults (Table 3). On the opposite end there are the females, with the greatest food diversity, that consumed both more prey taxa and more preys. In regards to their environment of origin, the terrestrial preys have higher amounts for the juveniles than for the adults. This fact indicates that the juveniles hunt mostly on land, while the adults – and especially the males – frequently remain in and around the aquatic environment. It was previously recorded that the males much more bond to their aquatic habitat whereas the females and juveniles are found at somewhat of a distance from it, in the terrestrial environment, under rocks or logs (Fuhn 1970). However, there are some differences between the juveniles and the females, too, the juveniles being more nocturnal (Fuhn 1970).

The differences of the amounts and frequencies of the consumed prey taxa between adults and juveniles don't seem to be all that great at first glance. As such, for both juveniles and adults, the first place is taken by the ants. However, the value of the amount of this prey taxon in the case of the juveniles is much greater than for the adults. This fact is also very like to be another consequence of the little size of the ants, which are therefore very suitable to be consumed by the young, taking first place in terms of frequency, too. Although the ants record important frequency values for the adults, too, they don't occupy the first place anymore. For the females, the ants are on top but tie with the Diplopoda – much larger preys. This detail demonstrates again the similarities between the hunting territory and strategies of the females and juveniles, in opposition with the males. In the case of the adults, ants aside, larger preys have higher amounts and frequencies. For the juveniles, we have the reversed situation, with high values for smaller preys. This is the case of the mites (Acarina) which were consumed by 46.2% of the juveniles. This prey taxon is absent, however, from the stomach contents of the males, while the females only consumed it in very little numbers.

Also for the juveniles, high amount and frequency values are recorded for the Lepidoptera larvae. This prey taxon is found in the stomach contents of the adults, too, but again with smaller values, especially for the males. Although they are rather large, the caterpillars were consumed by more than half of the juveniles from the *B. variegata* population from Dragu. This fact is the outcome of their high trophic value, the larvae of the holometabolic insects being very rich in fats (Brooks et al. 1996). In addition, the caterpillars are slow, thus easier to capture. Their high

frequency indicates again the hunting territory of the juveniles – the terrestrial environment. Hence, even if they generally consume smaller preys, the juveniles compensate their trophic poverty with the consumption of some larger and energy valuable prey.

Trophic strategies

Due to the big differences among the conditions of the 7 studied habitats, it is very difficult to establish a unitary trophic strategy of the *B. variegata* populations from them. However, for the habitats where the ants prevail in the toads' food, the small size of this taxon together with the high number of consumed individuals seems to indicate an active foraging strategy. On contrary, in the habitats where larger preys are dominant, but from which only fewer individuals were consumed, the toads seems to have adopted a sit and wait strategy. The latter strategy was used in the habitats from Gâlgăul Almaşului, Ciglean and Poic. Thus, only in 3 out of the studied 7 biotopes, the sit and wait strategy seems to work. If we would do the math, it would turn out that the yellow-bellied toads from the Almăş-Agrij Depression mostly use the active foraging strategy type. However, it is very difficult to establish that indeed those populations chose their trophic strategy, or that it's just mechanically dictated by the abundance of a certain prey category from the toads' habitat.

The juveniles, most likely due to their sizes, are obligated to act like active predators. For the, it would be useless to wait for prey to come along and find only large ones that they couldn't consume. Thus, limited by their sizes, the juveniles are forced to actively forage for smaller food. Between the two sexes, the differences of trophic strategies are difficult to set apart because of the general random variation of their feeding's parameters.

CONCLUSIONS

The differences among the feeding of the 7 analyzed *B. variegata* populations are mostly determined by the characteristics of the habitats they live in. The particularities of these habitats limit the trophic offer and condition the movement of the toads and ultimately the territory and the hunting strategies used by them. To a smaller extent, the trophic spectrum is also influenced by the sampling period, our study taking only 3 months. There are some dissimilarities observed between the feeding of adults and juveniles. Between the sexes, the differences are quite difficult to explain, the variations appearing to be arbitrary. The variations among the habitats are explainable, because the particularities of the biotopes are evident and

observable and thus the way in which they influence the feeding is revealed to the observer. The differences between the sexes are arbitrary, because their causing factors are much more difficult to scrutinize or simply because their variation does indeed follow no rule.

There are habitats in which the toads' feeding is optimal but also habitats which it is difficult. For the first category, we have the habitat from Dragu, where the species' trophic needs are very well met. This fact is a consequence of the natural and afforested site, with many puddles of water that the toads can migrate through. On the opposite pole, there is firstly the habitat from Jebucu, which, due to its ephemeral character and its vicinity to heavily exploited grassland, has a very reduced trophic offer, thus negatively affective the toads' feeding. Difficult feeding conditions are usually encountered in anthropogenically affected biotopes or in habitats situated in anthropogenically affected regions. In such places, the trophic offer is reduced and the movement of the amphibians limited. The most favorable conditions for *B. variegata* are recorded in habitats from inside or right near forests.

The yellow-bellied toads consumed 1799 preys belonging to 44 prey taxa. The number of preys and the amount and frequency of the consumption varies a lot among the populations, periods and sexes. However, in many of the habitats, the ants represent an important prey in terms of quantity. This fact can indicate a certain selection of the toads for this prey which could be used for the production of their own toxins. In the majority of the habitats, the majority of preys were generally terrestrial. Yet, there are cases where aquatic preys are dominant, too. Actually, all these differences probably indicate only the trophic opportunism and the trophic plasticity of the species.

Together with the animal preys, toads also consumed vegetal remains, shed skinfragments and nonorganic elements. Their consumption frequency seems to be influenced by the intensity of the feeding. Thus, a more intense feeding raises the frequency of vegetal material, proving that they are ingested accidentally together with the natural, animal prey consumed. On contrary, a more reduced feeding makes the frequency of shed skingrow, pointing towards the fact that these are emergency trophic elements that compensate the lack of preys.

REFERENCES

Angelov, P., Batschwarov, G. (1972): Die Nahrung der Amphibien in Bulgarien. II. Über die Nahrung Einiger Amphibia - Ecaudata. *Natura* 5(1): 115-119.

South west J Horticult Biol Environ (2010)

- Ao, M., Bordoloi, S., Dutta, A. (2001): Food and feeding behaviour of *Hyla annectans* (Jerdon, 1870) in Nagaland, India. *Zoos' Print Journal* 16(7): 535-536.
- 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.
- Barandun, J. (1992): Reproductive flexibility in *Bombina variegata* (Anura: Discoglossidae). Pp. 65-68. In: Korsós, Z., Kiss, Z. (eds). Proceedings of the 6th Ordinary General Meeting of the Societas Europaea Herpetologica, 19-23 August 1991, Budapest, Hungary.
- Barandun, J., Reyer, H.U. (1997): Reproductive ecology of *Bombina variegata*: characterisation of spawning ponds. *Amphibia-Reptilia* 18: 143-154.
- Belloq, M.I., Kloosterman, K., Smith, S.M. (2000): The diet of Coexisting Species of Amphibian in Canadian Jack Pine Forests. *Herpetological Journal* 10: 63-68.
- Brooks, J.S., Calver, C.M., Dickman, R.C., Meathrel, E.C., Bradley, S.J., 1996. Does intraspecific variation in the energy value of a prey species to its predators matter in studies of ecological energetics? A case study using insectivorous vertebrates. *Ecoscience* 3(3): 247-251.
- Cicort-Lucaciu, A.Ş., Bogdan, H.V., Toth, A., Benzar, M., Balaj, L., Vidican, A.M. (2006): Research upon the feeding of the species *Triturus vulgaris* (Amphibia) from Poiana Tăşad (Bihor county, Romania). *Analele Universitatii din Craiova, seria Biologie, Horticultură, Tehnologia Prelucrării Produselor Agricole, Ingineria Mediului* 11: 307-312.
- Cicort-Lucaciu, A.Ş. David, A., Covaci, R., Toader, S., Diaconu, I. (2007): Feeding of some *Triturus cristatus* population in Turţ area (Oaş Mountains, Romania). *Herpetologica Romanica* 1: 30-37.
- Cogălniceanu, D., Aioanei, F., Bogdan, M. (2000): Amfibienii din România, Determinator. Editura Ars Docendi, Bucharest. [in Romanian]
- Covaciu-Marcov, S.D., Cupşa, D., Sas, I., Ghira I. (2002): The study of the trophic spectrum of two populations of *Rana arvalis* Nils., 1842 from the north of Bihor county. *Analele Ştiinţifice ale Universităţii "Al. I. Cuza" Iaşi, s. Biologie Animală* 48: 160-171.
- Covaciu-Marcov, S.D., Sas, I., Sala, G., Cicort-Lucaciu, A.Ş., Puie, T. (2003): Studiul unor populaţii de *Bombina variegata* din Depresiunea Beiuşului (Jud. Bihor, Romania). *Analele Universitatii din Oradea, Fascicula Biologie* 10: 119-130. [in Romanian]
- Covaciu-Marcov, S.D., Sas, I., Cicort-Lucaciu, A.Ş., Bogdan, H., Ardelean, R. (2006): The herpetofauna of the north-western region of Sălaj County. *Studii şi Cercetări Ştiinţifice, Universitatea Bacău, seria Biologie* 11: 85-91.
- Covaciu-Marcov, S.-D., Toth, A., Ile, R. D., Iaba, I., Lazăr O. (2007): Researches on some populations of *Bombina variegata* from south-west of Mehedinţi county (Romania). *Analele Universitatii din Craiova, seria Biologie, Horticultură, Tehnologia Prelucrării Produselor Agricole, Ingineria Mediului* 12: 277-282.
- Covaciu-Marcov, S.D., Kovacs, I., Cicort-Lucaciu, A.Ş., Sas, I., Secare, P. (2009): Data upon the composition and geographic distribution of the herpetofauna of the Almăş-Agrij Depression (Sălaj County, Romania). *Oltenia, Studii şi Comunicări, Ştiinţele Naturii* 25: 173-179.
- Covaciu-Marcov, S.D., Cicort-Lucaciu, A.Ş., Mitrea, I., Sas, I., Căuş, A. V., Cupşa, D. (2010): Feeding of three syntopic newt species (*Triturus cristatus*, *Mesotriton*

- alpestris* and *Lissotriton vulgaris*) from Western Romania. North-Western Journal of Zoology 6(1): 95-108.
- Çiçek, K., Mermer, A. (2006): Feeding Biology of the Marsh Frog, *Rana ridibunda* Pallas 1771, (Anura, Ranidae) in Turkey's Lake District. North-Western Journal of Zoology 2(2): 57-72.
- Çiçek, K., Tok, C.V., Mermer, A., Tosunglu, M., Ayaz, D. (2007): Food Habits of the Lycian Salamander, *Lyciasalamandra fazilae* (Basoglu & Atatur, 1974): Preliminary data on Dalyan Population. North-Western Journal of Zoology 3(1): 1-8.
- de Paula-Lima, J.E., Rödder, D., Solé, M. (2010): Diet of two sympatric *Phyllomedusa* (Anura: Hylidae) species from a cacao plantation in southern Bahia, Brazil. North Western Journal of Zoology 6(1): 13-24.
- Dimancea, N., Covaciu-Marcov, S.D. (2009): Research regarding the yellow-bellied toad, *Bombina variegata* from Lerești area, Argeș county, Romania. Oltenia, Studii și Comunicări, Științele Naturii 25: 187-192.
- Ferenți, S., Lazăr, V., Groza M., David, A., Covaci, R. (2007): Study over the food spectrum of two *Bombina variegata* populations in Turț Bai. Oltenia, Studii și Comunicări, Științele Naturii 23: 149-155.
- Ferenți, S., Dimancea, N., David, A., Țânțar, A., Dărăban, D. (2009a): Data on the feeding of a *Rana ridibunda* population from Sarighiol de Deal, Tulcea County, Romania. Bihorean Biologist 3(1): 45-50.
- Ferenți, S., Cupșa, D., Dimancea, N., Bogdan, H.V., Filimon, A. (2009b): Data upon the feeding of two *Epidalea viridis* population from Dobroudja, Romania. Oltenia, Studii și Comunicări, Științele Naturii 25: 193-198.
- Ferenți, S., Covaciu-Marcov, S.D., Blaga-Lungulescu, R.M. (2009c): The comparative analysis of the trophic spectrum of some populations of *Pelophylax ridibundus* and *Pelophylax kl. esculentus* from Arad County, Romania. Herpetologica Romanica 3: 31-39.
- Fuhn, I. (1960): Amphibia. "Fauna R.P.R.", vol. XIV, fasc. I. Editura Academiei R.P.R., Bucharest. [in Romanian]
- Fuhn, I. (1970): Asupra structurii și dinamicii unor populații de *Bombina variegata*. Comunicări Zoologice ale Societății de Științe Biologice 9: 249-264. [in Romanian]
- Ghiurcă, D., Zaharia, L. (2005): Data regarding the trophic spectrum of some population of *Bombina variegata* from Bacău county. North-Western Journal of Zoology 1: 15-24.
- Ghiurcă, D., Zaharia, L. (2005): Data regarding the trophic spectrum of a population of *Rana esculenta* Complex from Bacău County. Analele Universitatii din Oradea, Fascicula Biologie 13: 29-31.
- Ghira, I., Venczel, M., Covaciu-Marcov, S.D., Mara, Gy., Ghile, P., Hartel, T., Török, Zs., Farkas, L., Rácz, T., Farkas, Z., Brad, T. (2002): Mapping of Transylvanian Herpetofauna. Nymphaea, Folia Naturae Bihariae 29: 145-203.
- Groza, M.I., Szeibel, N., Letai, V., Toth, A., Radu, N.R. (2006): Trophic spectrum of a *Bombina variegata* population from Vadu Crișului (Bihar county, Romania). Analele Universitatii din Oradea, Fascicula Biologie 13: 32-34.
- Groza, M.I., Suci, I.C., Ancău, M., Pali, I.N., Letai, V. (2008): Comparison between males and females feeding habits from three populations of *Bombina variegata* from Vadu Crișului, Pădurea Craiului Mountains, Romania. Bihorean Biologist 2: 50-57.
- 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., Guyétant, R. (eds) Current studies in Herpetology, Proceedings of the 9th Ordinary General Meeting of the *Societas Europaea Herpetologica* 25-29 August 1998, Le Bourget du Lac, France.
- Hartel, T. (2008): Movement activity in a *Bombina variegata* population from a deciduous forested landscape. *North-Western Journal of Zoology* 4(1): 79-90.
- Hirai, T., Matsui, M. (2000): Myrmecophagy in a Ranid Frog *Rana rugosa*: Specialization or Weak Avoidance to Ant Eating? *Zoological Science* 17: 459-466.
- Hodişan, O., Cupşa, D., Dimancea N., Benedek, N., Băcanu, E. (2009): The trophic spectrum of a *Bombina variegata* population from Jugureni locality, Prahova county. *Herpetologica Romanica* 3: 57-61.
- Iftime, A. (2005): Amfibieni. Pp.173-196. In: Botnariuc, N., Tatole, V. (eds.): Cartea Roşie a Vertebratelor din România. Editura Academiei Române, Bucharest. [in Romanian]
- Jones, T.H., Gorman, S.T., Snelling, R.R., Delabie, J.H.C., Blum, M.S., Garraffo, H.M., Jain, P., Daly, J.W., Spande, T.F. (1999): Further alkaloids common to ants and frogs: decahydroquinolines and quinolizidine. *Journal of Chemical Ecology* 25: 1179-1193.
- Kenett, R., Tory, O. (1996): Diet of Two Freshwater Turtles, *Chelodina rugosa* and *Elseza dentata* (*Testudines: Chelide*) from the Wet / Dry Tropics of Northern Australia. *Copeia* 2: 409-419.
- 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.
- Kovacs, I., Bodenciu, E., Bodenciu, C., Nagy, R., Pinte, C. (2010): Data upon the feeding of some newt populations (*Triturus cristatus* and *Lissotriton vulgaris*) from Almăş-Agrij Depression, Sălaj County, Romania. *South-Western Journal of Horticulture, Biology and Environment* 1(1): 29-55.
- 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.
- Lőw, P., Török, J. (1998): Prey size selection and food habits of Water Frogs and Moor Frogs from Kis - Balaton, Hungary (Anura: Ranidae). *Herpetozoa* 11(1/2): 71-78.
- Nicoară, A., Nicoară, M., Bianchini, F. (2005). Diet composition during breeding period in populations of *Bufo viridis*, *Pelobates fuscus* and *Rana esculenta* complex from Ciriş River's basin (iaşi, Romania). *Analele Ştiinţifice ale Universităţii "Al. I. Cuza" Iaşi, s. Biologie Animala* 51: 180-187.
- Opatrný, E. (1980): Die Nahrung der wechselkrote *Bufo viridis* Laurenti, 1768. *Acta Universitatis Palackianae Olomucensis, Facultas Rerum Naturalium* 67: 187-202.
- Perry, G., Lampl, I., Lerner, A., Rothenstein, D., Shani, N., Sivan, N., Werner, Y.L. (1990): Foraging mode in lacertid lizards: variation and correlates. *Amphibia-Reptilia* 11: 373-384.
- Peter, V.I., Citrea, L., Aszalos, A., Batta, Z., Szabo, M., Cioara, C. (2006): Analiza comparativă a spectrului de hrănire a două populaţii de *Bombina variegata* din Băiţa Plai (Judeţul Bihor, România). *Analele Universitatii din Oradea, Fascicula Biologie* 13: 18-23. [in Romanian]
- Peter, V.I., Bogdan H.V., Toth, A., Radu, N.R., Groza, M.I., Lazăr, O. (2007): Spectrul trofic al unei populaţii de *Bombina variegata* din regiunea Mădrigeşti, Judeţul Arad, România. *Bihorean Biologist* 1: 44-49. [in Romanian]

- Radu, G.V., Radu, V.V. (1972): Zoologia Nevertebratelor, Vol.2, Editura Didactică și Pedagogică, Bucharest. [in Romanian]
- Radu, N.R., Bogdan, H.V., Bata, Z., Popa, C., Osvat-Szabo, E.G. (2007): The trophic spectrum of a *Bombina bombina* (Linnaeus 1761) population from the Cermei region (Arad County, Romania). *Herpetologica Romanica* 1: 17-21.
- 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, sererie Zoologia* 94(4): 433-438.
- Sas, I., Covaciu-Marcov, S.D., Cupșa, D., Schirchanici, A., Aszalos, L. (2003): Studiul spectrului trofic al unei populații de *Bombina bombina* (Linnaeus1761) din zona Resighea, (județul Satu-Mare, România). *Oltenia, Studii și Comunicări, Științele Naturii* 19: 183-188.
- Sas, I., Covaciu-Marcov, S.D., Cupșa, D., Kovács, É.-H., Gabora, M. (2004): Data about the trophic spectrum of a population of *Bombina variegata* from Vârciorog area (Pădurea Craiului Mountains, Bihor county, Romania). *Studii și Cercetări Științifice, Universitatea Bacău, seria Biologie* 9: 124-130.
- Sas, I., Covaciu-Marcov, S.D., Cupșa, D., Cicort-Lucaciu, A.Ș., Popa, I. (2005a): Food analysis in adults (males/females) and juveniles of *Bombina variegata*. *Analele Științifice ale Universității "Al. I. Cuza" Iași, s. Biologie Animală* 51: 169-177.
- Sas, I., Covaciu-Marcov, S.D., Cupșa, D., Cicort-Lucaciu, A.Ș., Antal, B. (2005b): Food habits of *Rana lessonae* and *Rana arvalis* in Covasna County (Romania). *Environment & Progress (Cluj-Napoca)* 5: 359-367.
- Sas, I., Covaciu-Marcov, S.D., Pop, M., Ile, R.D., Duma, C. (2005c): About a closed hybrid population between *Bombina bombina* and *Bombina variegata* from Oradea (Bihor County, Romania). *North-Western Journal of Zoology* 1: 41-60.
- Sin, G., Lăcătușu, M., Teodorescu, I. (1975): Hrana la broasca de lac (*Rana r. ridibunda* Pall). *Studii și Cercetări Biologice, seria Biologie Animală* 27(4): 331-343. [in Romanian]
- Sos, T. (2007): Thermoconformity even in hot small temporary water bodies: a case study in yellow-bellied toad (*Bombina v. variegata*). *Herpetologica Romanica* 1: 1-11.
- 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.
- Solé, M., Dias, I. R., Rodrigues, E.A.S., Marciano-Jr, E., Branco, S.M.J., Cavalcante, K. P., Rödder, D. (2009): Diet of *Leptodactylus ocellatus* (Anura: Leptodactylidae) from a cacao plantation in southern Bahia, Brazil. *Herpetology Notes* 2: 9-15.
- Toth, A., Ferentzi, S., Toth, G., Teodorescu, A., Totos, M. (2007): The trophic spectrum of some populations of *Bombina variegata* in Poiana Tășad locality area (county of Bihor, Romania). *Herpetologica Romanica* 1: 12-16.
- Whiles, M.R., Lips, K.R., Pringle, C.M., Kilham, S.S., Bixby, R.J., Brenes, R., Connely, S., Colon-Gaud, J.C., Hunte-Brown, M., Huryn, A.D., Montgomery, C., Peterson, S. (2006): The effects of amphibian population decline on the structure and function of neotropical stream ecosystems. *Frontiers in Ecology and the Environment* 4: 27-34.
- ***** OUG nr. 27 / 2007 privind regimul ariilor naturale protejate, conservarea habitatelor naturale, a florei și faunei sălbatice. [in Romanian]