North-Western Journal of Zoology, Vol.1, pp. 25-30

Food composition of two *Rana* species on a forest habitat (Livada Plain, Romania)

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Abstract. The aim of this study was to bring new information regarding the feeding of two amphibian species, *Rana arvalis* (moor frog) and *Rana dalmatina* (agile frog), in a forest habitat (Livada Plain, Romania). We have focused our attention upon the trophical spectrum variations that occur, depending on the species and the studying period. We noticed an increased diversity of prey taxa in the stomachal contents of the agil frog. The bugs, spiders and butterfly larvas are the most important prey for both species. There is an increased high mobility prey taxa amount (flying insects for instance) only in the agile frog's stomachal contents. We'd like to emphasize the fact that both species were hunting in terrestrial habitat.

Introduction

The first studies in Romania, referring to moor frog's trophical spectrum, were realized by Covaciu-Marcov and his collaborators (2002a,b) and by Sas and his collaborators (2002a,b) in Ier Valley region (Western Plain). In other countries, there are as well studies made on this specie's trophical spectrum: Hungary (Lőw et al. 1990, Kovács & Török 1992, Török & Csörgő 1992), Sweden (Loman 1979), Finland (Itäimes 1982), Poland (Mazur 1966, Zimka 1966, 1974) and Russia (Vershinin & Seredyuk 2000, Izometzev 1969). The information related to the agile frog,s trophical spectrum, though, is much less (Guibaldi et al. 1999, Török & Csörgő 1992) and is missing from the Romanian literature (Andrei & Török 1997).

The objective of our activity was to compare, for the first time in Romania, the feeding particularyties of the two Ranidae populations (*Rana dalmatina* and *Rana arvalis*) in the same forest habitat (Livada Plain, Satu-Mare county, Romania).

Materials & Methods

We have realized our study in the warm season of 2003, from april to october, with monthly samples collections. We've tried to capturate a constant number of frogs every month, even if in summer time it is more difficult to capture them compared to spring and autumn time (Gelder & Oomen 1970).

The studied forest habitat is situated in North-West Romania, close to Livada town (Livada Plain, Satu-Mare county). This habitat is a moist forest where the water table is found at a high level. The two studied populations of *Rana arvalis* and *Rana dalmatina*, were recently identified in this area (Covaciu Marcov et al. 2002d)

All in all we have realized 314 stomachal contents, 93 from *Rana arvalis*, and 221 from *Rana dalmatina*. The samples were collected using the "stomach flushing" method (Legler & Sulivan 1979, Opatrny 1980, Cogălniceanu 1997). This procedure allows the samples prelevation without killing the studied Amphibians (Cogălniceanu et al. 2000a, Bulakhov 1966), and once the frogs are analyzed, they're released in the same habitat they've been captured from (Legler & Sulivan 1979). This is a verry important procedure, specially for the endangered Amphibians, as the moor frog is in Romania (Cogalniceanu et al. 2000b). The frogs were captured with bare hands, from the terrestrial environment. To collect the samples we used 15 ml syringes with a 10 cm perfussion tube joined at the end of it. Due to the ability to digest the food very quickly, we tried to reduce as much as possible the time between the capturing moment of the frogs and the probes prelevation moment, time length that can affect the results of the study (Caldwell 1996). A result error can occur due to the different digestibility degree for different prey animals. These digestibility differences of the prey taxa affects only their relative proportions in the frog's trophical spectrum. Considering all these, we have immediately analyzed the captured frogs.

The stomachal contents of each frog were placed in a 4% formaldehid solution in airtight test tubes. The determination of the samples was accomplished with the add of the stereomicroscope and the specialty literature in the domain (Ionescu & Lăcătuşu 1971, Móczár et al. 1950, Radu & Radu 1967). The prey animals were determined at an order and family level, considering that for this type of study it is not necessary to make a more detailed ranking of the prey animals (Mescherski 1997).

Results and Discussions

Not all the analyzed individuals of *Rana arvalis* had stomachal content and nor did all the *Rana dalmatina* analyzed individuals (tab. 1). We have this situation, most probably, due to the unfavorable environmental conditions in certain periods of the year, which are having a negative effect on frog's feeding. Thus, we noticed an important seasonal variation of the amount of empty stomachs encountered. The ratio with the fewest individuals with stomachal content was analyzed in April, the first month of activity in the year for these two species. The low temperature of this month had a negative influence on the predators (the frogs) and aswell on the prey (there were identified in the stomachal contents only cold resisting taxa).

Table 1. The amount of stomachs with content, with vegetal remains and with shed-skin (SD_P- the standard deviation of value to whole period)

	stomachs with content		stomachs with vegetal remains		stomachs with shed-skin	
	%	SD_P	%	SD_P	%	SD_P
Rana arvalis	94.45	7.25	72.22	11.96	9.25	9.75
Rana dalmatina	85.64	23.97	56.35	16.78	11.6	8.3

Generally the Amphibians food is uniform and consists of different species of unvertebrats, the adult frogs being carnivore. In the stomachal contents that we've

examined, there was beside animal provenience content, vegetal provenience content aswell and shed-skin too (tab. 1).

The more vegetal fragments were found the more the prey number raised. This observation and the reduced number of exclusive vegetal contents suggests that the vegetals were consumed by accident, being swallowed at the same time with the hunted prey (Whitaker et al. 1977). Similar situations were encountered to other populations of *Rana arvalis* (Covaciu-Marcov et al. 2002c, Sas et al. 2003a).

Both studied populations had some individuals that had consumed fragments of shed-skin mixed with all other types of stomachal contents. In the specialty literature there were described similar situations of shed-skin eating to *Rana arvalis* (Sas et al. 2003b) and to *Rana dalmatina* aswell (Guidali et al. 1999). In some studies it is thought that this aspect represents the recycling of Amphibians epidermal proteins (Weldon et al. 1993). But there is another more likely explanation that the frogs take action at the movements of other conspecific individuals, trying to capture them, without any success, and the only thing they swallow is the shed-skin that sticks to their tongue.

The most common things, though, in the stomachal contents are the animal provenience ones. The identified prey taxa were placed in several categories (tab. 2); there were distinguished the larvae and the adults of Lepidopteras, Coleopteras and Dipteras, considering that these are different categories regarding their mobility and provenience environment. Bell (1990) states that insects adults are less nutritiv than the holo-metabolic insects larvae which are fats richer (Brooks et al. 1996).

Table 2. The amount (A%) and the frequency of occurrence (F%) of preys in the stomach contents (SD_P- the standard deviation of value to whole period)

	Rana arvalis				*Rana dalmatina*			
	A (%)	SD_P	F (%)	SD_P	A (%)	SD_P	F (%)	SD_P
Oligocheta-Lumbricida	1,25	1,85	3,70	9,09	0,59	0,82	1,65	1,61
Gasteropoda snails.	1,88	2,48	5,55	8,6	0,59	1,18	1,10	4,81
Gasteropoda Limax sp.	0,62	0,92	1,85	4,54	0,19	0,96	0,55	4,72
Opilionida	-	-	-		0,39	1,08	1,10	5,33
Araneida	11,94	9,8	24,07	7,05	17,98	5,41	37,56	26,97
Crustacea Izopoda	3,14	1,21	9,25	3,89	3,55	6,82	8,83	9,06
Miriapoda undet.	-	-	-	-	0,39	0,85	1,10	3,97
Miriapoda Chilopoda	3,14	2,04	9,25	7,96	4,34	2,96	10,49	11,64
Miriapoda Diplopoda	1,25	1,67	3,70	6,73	-	-	-	-
Blatoidea	1,25	3,03	3,70	14,28	1,58	1,26	3,86	3,46
Homoptera Cicadina	0,62	2,38	1,85	3,84	1,38	1,52	3,86	5,4
Ortoptera	1,25	1,38	3,70	2,5	1,97	3,67	5,52	18
Heteroptera	3,14	5,74	9,25	27,83	7,11	5,93	16,02	20,48
Coleoptera larva	2,51	1,21	7,40	3,89	8,69	5,71	16,02	13,03
Coleoptera undet.	30,18	4,21	55,55	14,14	13,04	7,6	24,86	19,05
Coleoptera Chrysomelida	-	-	-	-	0,79	1,19	2,21	6,18
Coleoptera Cantarida	0,62	0,92	1,85	4,54	0,19	0,65	0,55	1,51
Coleoptera Curculionida	1,88	2,68	5,55	7,22	1,97	2,46	5,52	6,1
Coleoptera Elaterida	1,88	1,38	5,55	4,39	1,18	2,6	2,76	5,51
Coleoptera Stafilinida	1,88	2	5,55	5,9	0,59	0,5	1,65	1,74
Coleoptera Carabida	1,25	0	1,85	0	2,37	1,81	5,52	5,59
Coleoptera Lampirida	-	-	-	-	0,19	0,65	0,55	1,51
Lepidoptera larva	17,61	12	33,33	37,78	15,81	11,48	29,83	25,72
Lepidoptera imago	-	-	-	-	2,17	14,45	6,07	9,84
Plecoptera	-	-	-	-	0,19	0,42	0,55	1,98
Tricoptera	-	-	-	-	0,39	0,43	1,10	1,97

Table 2. Continued

	Rana arvalis				*Rana dalmatina*			
	A (%)	SD_P	F (%)	SD_P	A (%)	SD_P	F (%)	SD_P
Diptera Culicida larva	-	-	-	-	0,99	4,84	0,56	4,72
Diptera Brahicera larva	0,62	1,51	1,85	7,14	0,79	0,67	1,10	1,16
Diptera Brahicera	2,51	1,63	5,55	6,06	2,96	2,04	8,28	10,16
Diptera Nematocera	-	-	-	-	2,76	2,23	7,18	12,23
Diptera Nematocera Culicida	-	-	-	-	0,39	0,85	1,10	1,66
Diptera Nematocera Typulida	3,14	5,34	9,25	22,72	2,37	2,48	6,07	12,71
Hymenoptera undet.	3,77	4,15	11,11	6,5	2,37	7,04	6,62	5,23
Hymenoptera Formicida	1,88	1,97	5,55	4	2,37	1,84	4,97	6,76
Mecoptera	0,62	1,38	1,85	2,5	-	-	-	-

Only five main prey taxa constantly appear in the stomachal contents. These are Araneas, Isopodas, Coleopteras, Lepidopteras larvae and Hymenopteras. The most variable prey taxa are for *Rana dalmatina.* Török and Csörgő (1992) though have observed a wider variety of prey animals for *Rana arvalis* compared to *Rana dalmatina.*

We can estimate the feeding intensity by observing the maximum and medium number of animals fallen prey to each individual and the variations of this number across the seasons (tab. 3). In our study the average feeding intensity values were 2.94 prey animals for *Rana arvalis* and 2.79 for *Rana dalmatina*. This parameter has a low monthly deviation. Different studies show an increased value for the feedind intensity both for the moor frog and agile frog compared to those obtained in this study (Sas et al. 2003a, Zimka 1971, Kovács & Török, 1997).

Table 3. The total number of preys, the average and maxim number of prey items / samples; the amount of terrestrial preys for the whole period

	No. of preys	Average no. of prey items / samples	Maxim no. of preys / samples	% of terrestrial preys
Rana arvalis	273	2.94	11	100
Rana dalmatina	617	2.79	14	98.81

We also focused our attention on the amount and frequency of the prey animals. The amount is the percentage of the total number of prey animals accounted for by the particular prey type. The frequency of occurrence expressed as the percentage of stomachs containing a particular prey / total number of stomachs analyzed.

The most important prey category is Coleopteras, being consumed frequently by both analyzed species. The beetles are also basic food for other populations of *Rana arvalis* (Itäimes 1982, Török & Csörgő 1992) and *Rana dalmatina* (Török & Csörgő 1992), most probably due to the abundance of this food and the wide range of environments where it can be found. Other important prey animals are the spiders and the caterpillars. The Coleoptera larvas and the Heteropteras are a more frequent prey for the *Rana dalmatina* population. It is obvious that the high mobility taxa are consumed more often only by the *Rana dalmatina* population. This feeding feature difference is explained by the increased mobility of the agile frog compared to the moor frog's.

Both studied species are adapted to terrestrial environment, where they obviously

hunt too. Thus in the moor frog's stomachal contents we only found terrestrial preys. Different to them we found by accident in the agile frog's stomachal contents aquatic preys too (tab. 3). We say by accident because the agile frog dose not hunt in aquatic environment. Feeding with aquatic prey was only possible when the temporary swamps dried out and this type of food was accessible (Covaciu-Marcov et al. 2002a, Lőw & Török 1998, Sas et al. 2003a). This different feeding habit was possible once again due to agile frog's increased mobility.

Conclusions

In the stomachal contents obtained from the two species we've identified besides prey animals and vegetal fragments, shed-skin fragments aswell proceeding from individuals in the same population. The vegetal fragments and the shed-skin was eaten accidentally. The more animals they had eaten the more vegetal fragments were found in their stomachal content. The highest diversity of prey taxa was found in *Rana dalmatina*'s stomachal contents. The average and maximum number of prey animals / individual for both studied species was similar each month, the feeding intensity being almost identical each month. The prey animals were basically Coleopteras, Araneas and Lepidoptera larvas. Both species are terrestrial environment hunters. The prey taxa with increased mobility (eg. flying insects) are more frequent in agile frog's stomachal contents which more mobile than the moor frog.

Aknowledgments. This document forms a part in Aszalós Lilla's licence thesis. At this int. we would like to thank dr. S.D. Covaciu-Marcov (University of Oradea) and I. Sas (University of Oradea) for the guidance of this study, for assistance in the wild environment activities and for helpful comments on an early version of the manuscript. I would like to thank also the anonymous reviewers for the valuable comments on the draft of this paper. We'd also like to thank D. Cupşa (University of Oradea) for the assistance in prey animals determination. We would also like to thank to M. Groza, N. Szeibel and other students from Herpetological Club - Oradea for their priceless help in the field. We also thank R.D. Ile (London) for the English checking of this manuscript.

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Received 21 December 2004; Accepted 12 March 2005