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The trophic spectrum of two brown frog populations (*Rana dalmatina* and *Rana temporaria*) from Baia de Fier area, Romania

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Abstract. In the scientific literature from Romania there are no comparative data regarding the trophic spectrum of the two species from the area of Baia de Fier locality. The feeding intensity is moderate for both of the species, the registered values being average in comparison to other studies performed in other regions. The stomach contents also contained, beside animal prey, vegetal fragments, which were identified in high percentages for both of the species, shed-skin and minerals. The prey taxa consumed by *Rana dalmatina* that recorded the highest amount and frequency values are represented by Cicada and Coleoptera. The beetles, respectively the Carabidae and caterpillars hold the main values in the case of *Rana temporaria* species. There was not observed any food competition between the two species.

Key words: *Rana dalmatina, Rana temporaria*, feeding, shed-skin, prey taxa.

Introduction

Rana dalmatina and *Rana temporaria* are widely distributed in central and western Europe (Gasc et al. 1997), being considered as common species. *R. dalmatina* is a species that occupies lower altitudes than *R. temporaria*. In Romania, *R. dalmatina* ascends up to 900 m altitude (Fuhn 1960) but it can also reach 1700m (IUCN 2009), while *R. temporaria* can be recorded up to 2700 m in the Pirinei Mountains (Vences

et al. 2000). However, *R. temporaria* has been recently encountered in the western part of the country at altitudes below 150m (Covaciu-Marcov & Ferenți 2008). There are also some differences regarding the habitat occupied by the two species, *R. dalmatina* being recorded in glades and deciduous forests, and also in areas with high humidity, rich in vegetation but not forested (Covaciu-Marcov 2004). On the other hand, it is not found in arable areas and coniferous forests. *R. temporaria* also prefers forested habitats, being present in coniferous and deciduous forests, parks and gardens, urban areas (Denton 2001).

Despite the fact that these species are widely distributed and common in Europe, there are considered to be vulnerable in Romania, being included in the Red Vertebrate Book (Iftime 2005). The main threats come from different draining works, the eutrophisation of the reproducing puddles and the forest exploitations causing changes in their habitat (Cooke 1972, 1975, Ishchenko 1996).

There is only one comparative study that has been realised in our country and deals with the feeding of these two species (Kovacs et al. 2010), most of the articles referring to aspects concerning their ecology (Hartel 2005, 2008). This fact, connected to the status of the species in our country, confirm the useful purpose of this study, in which we have comparatively followed the analysis of the trophic composition of the two brown frogs.

Material and methods

The study took place at the beginning of august 2009, in the area of Baia de Fier locality (Gorj County), which is situated on the Getic Depression. The area taken into account is situated near Muierii Cave, at an altitude of 610m, near the Yellow River. The habitat from which the frogs were collected is represented by a stream that had its spring modified and a sandy bank that crosses an alder grove. The stream presents several bogging areas, being situated at the base of a slope and bordered by a paved road. It is an area rich in grassy and woody vegetation.

The frogs were captured directly by hand and stored in plastic buckets, while the stomach content was drawn with the help of the stomach flushing method (Sole et al. 2005). The time between the capturing of the individuals and the performing of the flushing was short, due to the fact that amphibians quickly digest the food (Caldwell 1996).

The method used is especially very important for the amphibian species that are declared vulnerable, because of the fact that they can be released in the habitat from which they were collected, the method being thus recommended by many authors (Sole & Pelz 2007, Caputo & Vogt 2008).

On a whole we analysed the stomach contents drawn from 61 frogs, 27 *R. dalmatina* individuals and 34 *R. temporaria* samples, all of them being adults. The stomach samples were stored in air tight test tubes, preserved in formaldehyde, following their determination in the laboratory using the scientific literature (Crişan & Mureşan 1999).

Results and discussions

Both of the studied species are terrestrial (with the exception of the reproduction period), fact confirmed by the consumed preys. All of the preys were terrestrial in the case of *R. dalmatina*, while *R. temporaria* consumed mosquito larvae (aquatic) in a very low percentage, 4%. The Nematocera larvae are easily accessible in the aquatic habitat. All of the analysed individuals presented stomach contents at the moment of capturing. The food of the amphibians was represented by invertebrates, adult amphibians being carnivorous – insectivorous, only their larvae feeding with vegetal parts (Reeder 1964). Beside the animal preys, we also identified vegetal fragments, shed-skin and mineral particles. A single *R. temporaria* individual presented only shed-skin in its stomach content, this component being additional to the animal preys for the rest of the individuals.

The fact that all of the individuals fed suggests the presence of optimum feeding conditions in the habitat, therefore a rich trophic offer available to the frogs, case that is also indicated in the situation of other amphibian species (Sas et al. 2009). The feeding of amphibians is generally more intense during autumn (Kovacs et al. 2007, Yu et al. 2009), thus the low values of the average number of preys/individual (5 preys / individual) registered in our study for both species is understandable, the study taking place in the summer, when the frogs did not begin to feed intensely. The moderate values can also be associated with the large dimensions of the consumed preys. The maximum number of preys consumed by *R. dalmatina* is of 12, value that is close to the one consumed by *R. temporaria* (11 preys). Our values differ from the ones registered in a recent study by Kovacs and collaborators (2010), where the feeding intensity was much higher. This is due to

the different period in which the two studies were performed, the one undertaken by Kovacs and collaborators being realised during autumn.

Table 1. The number of studied individuals. The frequency of occurrence of the vegetal remains, minerals and shed-skin fragments. The total, maximum and average number of the consumed prey items.

	Rana dalmatina	*Rana temporaria*
% stomachs with vegetal content	59.26	79.41
% stomachs with minerals	7.40	17.41
% stomachs with shed-skin	14.81	32.35
Max. No. prey / individuals	12	11
Average No. prey / individuals	5.37	5.14
Total No. of preys	145	175

Regarding the vegetal fragments, both of the species registered important values at this aspect. Thus, almost 80% of the *R. temporaria* individuals consumed vegetal parts, while 60 % of the *R. dalmatina* population ingested this element. The high percentage of vegetal debris can be easily understood due to abundance of vegetation in the area. Blades of grass were accidentally swallowed with the aimed prey (the consumed insects being mostly terrestrial), (Whitaker et al. 1977). The higher values recorded in the case of *R. temporaria* species, can indicate a more intense feeding activity, a more active predation, often resulted in failure, which increases the possibility of swallowing vegetal parts. A situation in which almost similar percentages of vegetal fragments were consumed can also be encountered in the recent study realised by Kovacs and collaborators (2010).

R. temporaria also registered double values in comparison to *R. dalmatina* in the case of shed-skin and mineral consumption. Therefore, the hypothesis that *R. temporaria* searched for its food more actively than the second species is once again confirmed. Shed-skin consumption is often encountered in the case of amphibians, being a form of epidermal protein recycling (Weldon et al. 1993). The high consumption of shed-skin is usually registered in the aquatic medium, where fragments of this type can be more easily swallowed. This is accidentally realised through the association with different preys (Ferenți et al. 2008), while in the

terrestrial medium the contact with the shed-skin of other individuals is harder to obtain. The shed-skin consumption is associated on many occasions with the lack of trophic elements from the habitat, which is not valid in this case. Thus, it can be stated that the epidermis is frequently consumed following shedding, due to its nutritive contents, fact also recorded in other comparative studies for Ranide (Sas et al 2005, Kovacs et al. 2007, Kovacs et al. 2010).

The presence of minerals in the stomach contents is due to the sandy substratum of the stream where the frogs hunted and also to the fact that the habitat is bordered by a rocky road. Thus, the frogs could have hunted the insects from the rocky area, once with the captured food also swallowing the minerals. Their consumption is considered to be accidental (Ferenți & Covaciu-Marcov 2009), these elements not having a nutritive value.

There are certain differences between the two species of brown frogs concerning the categories of animal preys. Although they share the same habitat, it can be noticed that there are certain preferences towards certain prey categories. Thus, *R. dalmatina* consumed cicadas in important percentages (30.34%), insects that are abundant this time of the year, but also numerous beetles, which register an amount of 24.82 %. If the first two positions are occupied by preys belonging to the Insect class, the third one is held by spiders, which represent 11.72 % from the preys consumed by this species. The beetles are the most important preys for *R. temporaria*, registering 38.85% from the entire consumed preys. From these, the Carabidae were consumed in the highest proportion (14.29%), and also the beetles found in a high degree of decomposition did not allow us to determine them at a family level. Caterpillars (9.14%) and respectively spiders (8.57%) were consumed by *R. temporaria* in smaller, but important percentages.

The differences between the consumption amounts of some prey taxa indicate the fact that there are differences between the two species regarding the hunting territory, as well as the day time in which the species fed the most intensely. Thus, in the case of *R. dalmatina*, the consumption of Cicadae, thermophilic insects (Crişan & Mureşan 1999), seems to indicate that this species fed in the open areas situated at a larger distance from the stream. On the contrary, at *R. temporaria*, the consumption of Carabidae, insects with nocturnal activity (Crişan & Mureşan 1999) suggests that it mainly hunts during the night. Therefore, the differences between the two species regarding the period and hunting territory probably allow them to use the same habitat without creating a trophic competition between them.

Table 2. The percentage abundance and the frequency of occurrence of the consumed prey items.

Prey categories	*Rana dalmatina*		*Rana temporaria*	
	Amount (%)	Frequency (%)	Amount (%)	Frequency (%)
Oligocheta-Lumbricidae	-	-	1.14	5.88
Gasteropoda -snails	3.44	7.40	2.85	14.71
Gasteropoda - Limax	2.75	11.11	2.85	8.82
Isopoda	3.75	11.11	2.85	5.88
Arahnida-Araneida	11.72	48.15	8.57	41.18
Arahnida - Opilionida	1.37	7.40	1.71	8.82
Miriapoda - Diplopoda	0.69	3.70	1.14	5.88
Orthoptera	2.06	11.11	3.42	17.65
Dermaptera	1.37	7.40	5.71	23.53
Homoptera - Cicadelloidae	30.34	55.56	4.57	20.59
Heteroptera	6.89	37.04	3.42	14.71
Blatoidea	-	-	0.57	2.94
Coleoptera - Cantharidae	-	-	0.57	2.94
Coleoptera - Crysomelidae	-	-	1.71	8.82
Coleoptera - Coccinelidae	-	-	0.57	2.94
Coleoptera - Carabidae	8.27	29.63	14.29	47.06
Coleoptera - Curculionidae	0.69	3.70	2.85	11.76
Coleoptera - Elateridae	-	-	0.57	2.94
Coleoptera - Stafilinidae	0.69	3.70	1.71	8.82
Coleoptera - undeterm.	15.17	55.56	14.86	52.94
Coleoptera (L)	-	-	1.14	2.94
Lepidoptera	-	-	0.57	2.94
Lepidoptera (L)	6.89	33.33	9.14	32.35
Diptera - Nematocera	-	-	0.57	2.94
Diptera - Nematocera (L) (aq)	-	-	2.85	2.94
Diptera - Brahicera (Muscidae)	1.37	7.40	2.28	11.76
Diptera - Brahicera (Tabanidae)	0.69	7.40	-	-
Hymenoptera - Formicidae	1.37	7.40	4.57	20.59
Hymenoptera - undeterm.	1.37	7.40	2.85	14.71

Despite the fact that the Cicadae occupy the most important place in the food of *R. dalmatina*, they were consumed in a small percent by the other species, respectively 4.57 %. Thus, if the main prey consumed by *R. dalmatina* has small

dimensions, the preys that were captured by *R. temporaria* and record maximum values present much bigger dimensions. Within these larger preys, the beetles are the most important ones for both species. A much higher consumption of beetles can be observed in the case of *R. temporaria* in comparison to *R. dalmatina*, registering a difference of 14% at the level of the two species. This fact highlights once more the affirmation that *R. temporaria* displays a more active predation activity.

The presence of spiders can be noticed in the case of both species, these preys being easily captured and available in the analysed grassy habitat. Regarding the amount values, the data obtained by us with respect to the insects that registered high values are similar to the ones recorded in an actual comparative trophic spectrum study between the two species (Kovacs et al. 2010), where beetles and spiders also occupied the main positions. There are species that were exclusively consumed by *R. temporaria*, such as various beetle families (Cantharidae, Crysomelidae, Coccinelidae, Elateridae), as well as Lepidoptera, Blatoidea and Nematocera. All of these preys are large ones, rich in nutritive content, while the fact that *R. dalmatina* does not consume them, although the two species share the same habitat, could suggest a certain selectivity of the frogs. The fact that they did not consume the same prey taxa with high amount values denotes that there isn't a competitive relation between the two Ranids, even if they hunted in the same territory. The species could have created their own microhabitats in order to hunt freely. The usage of hunting microhabitats is very important because it avoids food competition (Vignoli et al. 2009).

In the case of *R. dalmatina* species, there are low differences regarding the maximum frequency and amount values. Thus, *R. dalmatina* consumed beetles (66.67%) and Cicadae (55.56%) most frequently, followed by spiders (48.15%). We also often encountered heteropterans in the stomach contents of this species, as well as butterfly larvae and Carabidae. Their frequency in the stomach contents indicates that these insects are homogenously spread in the habitat populated by the frogs. Carabidae are large preys, therefore the frogs consume them in lower quantities. Beside this fact, they are rich in nutritive substances, as well as butterfly larvae, which explains why they did not have to be consumed in large quantities, these species covering the necessary lipid and nutritive substances content.

Regarding *R. temporaria*, the highest frequency is held by the beetles (85.29%), from which the Carabidae were the most consumed (47.06%), being followed by

spiders (41.18%). The presence of both large species (Dermaptera, snails, Orthoptera) and small ones (ants, Cicadae, butterfly larvae) can be noticed. It can be stated that *R. temporaria* consumed a higher variety of preys in comparison to the other species, while *R. dalmatina* consumed fewer insect groups but in larger quantities. The absence of trophic competition was also observed between *R. temporaria* and *R. arvalis* with which it often appears in the same habitats (Stojanova & Mollov 2008). The obtained results could infirm the hypothesis following which *R. temporaria* and *R. dalmatina* are in competition, excluding each other (Riss 1988). The idea of trophic competition between the two species was also infirmed by the recent study realised in Romania regarding their feeding (Kovacs et al. 2010). Depending on the consumed preys it is confirmed that *Rana temporaria* is a nonselective predator and more sedentary (Blackith & Speight 1974) in comparison with *R. dalmatina*.

Conclusions

There are certain differences and similarities between the two brown frog species regarding the composition of the trophic spectrum. Thus, both of the species have a moderate feeding intensity. Within the stomach contents, there were identified important percentages of vegetal fragments, together with shed-skin and minerals. The most important trophic category, respectively the animal prey, mostly originates from the terrestrial environment. The differences can be observed in the case of the consumed prey taxa. Thus, the Cicadae and beetles, followed by spiders, register the highest frequency and amount values in the case of *Rana dalmatina* species. *Rana temporaria* mostly consumed insects belonging to the beetle group, from which the most important ones were the Carabidae, followed by Lepidoptera larvae and spiders. Their high amount coincides with the frequency with which they were consumed. It seems that there are no relations of competition between the two species, which use different microhabitats and time periods for feeding.

References

Blackith, R.M., Speight, M.C.D. (1974): Food and feeding habits of the frog *Rana temporaria* in bogland habitats in the West of Ireland. Journal of Zoology (London) 172: 67-79.

Caldwell, J.P. (1996): The evolution of myrmechophagy and its correlates in poison frogs (Family Dendrobatidae). Journal of Zoology (London) 240: 75-101.

Caputo, F.P., Vogt, R.C. (2008): Stomach flushing Vs. Fecal Analysis: The example of *Phrynops rufipes* (Testudines: Chelidae). Copeia 2: 301-305.

Cooke, A.S. (1972): Indications of recent changes in status in the British Isles of frog (*Rana temporaria*) and toad (*Bufo bufo*). Journal of Zoology 167: 161-178.

Cooke, A.S. (1975): Spawn site selection and colony size of the frog (*Rana temporaria*) and the toad (*Bufo bufo*). Journal of Zoology 175: 29-38.

Covaciu-Marcov, S.D. (2004): Studiul herpetofaunei din Câmpia de Vest şi de pe versantul vestic al Munţilor Apuseni. Doctoral Thesis, Universitatea Babeş-Bolyai, Cluj-Napoca. [in Romanian]

Covaciu-Marcov, S.D., Ferenţi, S. (2008): About the presence of *Rana temporaria* (Amphibia) at 150 m altitude in the Livada Forest (North-Western Romania). Oltenia, Studii şi Comunicări, Ştiinţele Naturii 24: 147-148.

Crişan, A., Mureşan, D. (1999): Clasa Insecte, Manual de Entomologie generală. Presa Universitară Clujeană,: Cluj-Napoca, Romania. [in Romanian]

Denton, J. (2001): *Rana temporaria* (Common Frog): Occurrence in ground water springs. Herpetological Bulletin 76: 30.

Ferenţi, S., Covaciu-Marcov, S.D. (2009): The food composition of some Bombina populations from Livada forest (Satu-Mare County, Romania). Biharean Biologist 3(2): 143-150.

Ferenţi, S., Cupşa, D., Lazăr, V., Dimancea, N., Ancău, M. (2008): Note on the trophic spectrum of a *Triturus cristatus* population from Livada Forest, Satu Mare district, Romania. Analele Universităţii din Craiova, Biologie, Horticultura, Ingineria Mediului 13: 77-82.

Fuhn, I.E. (1960): Amphibia. Fauna Republicii Populare Române, Vol. 16. Editura Academiei Republicii Populare Române, Bucharest. [in Romanian].

Gasc, J.P., Cabela, A., Cronbrjna-Isailovic, J., Dolmen, D., Grossenbacher, K., Haffner, P., Lescure, J., Martens, H., Martinezka, J.P., Maurin, H., Oliveira, M.E., Sofianidou, T.S., Veith, M., Zuidervijk, A. (eds.) (1997): Atlas of amphibians and reptiles in Europe. Societas Europaea Herpetologica & Museum National d'Histoire Naturelle (IEGB/SPN), Paris.

Hartel, T.R. (2005): Aspects of breeding activity of *Rana dalmatina* and *Rana temporaria* reproducing in a seminatural pond. North-Western Journal of Zoology 1: 5-15.

Hartel, T.R. (2008): Weather conditions, breeding date and population fluctuation in *Rana dalmatina* from Central Romania. Herpetological Journal 18: 40-44.

Iftimie, A. (2005): Amphibia. p.112. In: Botnariuc, N., Tatole, V. (eds.), Cartea roşie a vertebratelor din Romania. Academia Româna & Muzeul Naţional de Istorie Naturală "Grigore Antipa", Bucharest. [in Romanian]

Ishchenko, V.G. (1996): Problems of demography and declining populations of some Euroasiatic brown frogs. Russian Journal of Herpetology: 143-151.

IUCN (2009): Red List of Threatened Species. << http://www.iucnredlist.org>>.

Kovacs, I., David, A., Ferenţi, S., Dimancea, N. (2010): The food composition of two brown frog populations *(Rana dalmatina* and *Rana temporaria*) from Sălaj County, Romania. Biharean Biologist 4: 7-14.

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.

Reeder, W.G. (1964): The digestive tract. Pp.99-149. In: Moore, J.A. (ed), Physiology of Amphibia. Academic Press, New York.

Riss, N. (1988): The present distribution of *R. dalmatina* and *R. temporaria* in Southern Scandinavia explained by a theory of competitive exclusion. Memoranda Societatis Fauna Flora Fennica 64: 104-106.

Sas, I, Covaciu-Marcov, S.D., Cupşa, D., Cicort-Lucaciu, A.Ş., Antal, B. (2005): Food habits of *Rana lessonae* and *Rana arvalis* in Covasna County (Romania). Mediul Cercetare, Protecţie şi Gestiune, Proceedings volume, Cluj–Napoca 5: 359-367.

Sas, I., Covaciu-Marcov, S.D., Strugariu, A., David, A., Ilea, C. (2009): Food Habit of *Rana* (*Phelophylax*) *kl. esculenta* Females in a new recorded E-System Population from a forested habitat in North-Western Romania. Turkish Journal of Zoology 33: 1-5.

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., Pelz, B. (2007). Do male tree frogs feed during the breeding season? Stomach flushing of five syntopic hylid species in Rio Grande do Sul, Brazil. Journal of Natural History 42: 2757-2763.

Stojanova, A.M., Mollov, I.A. (2008). Diet and trophic niche overlap of the moor frog (*Rana arvalis* Nilsson, 1842) and the common frog (*Rana temporaria* L., 1758) from Poland. pp.181-190. In: Velcheva, I.G., Angel, G., Tsekov, P. (eds.), Proceedings of the Anniversary Scientific Conference of Ecology. Plovdiv, Bulgaria.

Vences, M., Galán, P., Palanca, A., Vieites, D.R., Nieto, S., Rey, J. (2000). Summer microhabitat use and diel activity cycles in a high altitude Pyrenean population of *Rana temporaria*. Herpetological Journal 10: 49-56.

Vignoli, L., Luiselli, L., Bologna, M.A. (2009). Dietary patterns and overlap in an amphibian assemblage at a pond in Mediterranean central Italy. Vie et Milieu - Life and Environment 59(1): 47-57.

Weldon, P.J., Demeter, B.J., Rosscoe, R. (1993). A survey of shed skin - eating (dermatophagy) in *Amphibians* and *Reptiles*. Journal of Herpetology 27: 219-228.

Witaker, J., Rubin, O.D., Munsee, J.R. (1977)**.** Observations of food habits of four species of spadefoot toad, genus Scaphiopus. Herpetologica 33: 468-475.

Yu, T.L., Gu, Y.S., Du, J., Lu, X. (2009). Seasonal variation and ontogenetic change in the diet of a population of *Bufo gargarizans* from the farmland, Sichuan, China. Biharean Biologist 3(2): 99-104.