Feeding Ecology of the *Pelophylax ridibundus* (Anura, Ranidae) in Dobromir, Romania

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Abstract. We examined the food composition of the Marsh Frog, *Pelophylax ridibundus* Pallas 1771, population from Dobromir, Constanța County, Romania. Stomach contents of 100 (27 juveniles, 10 ♂, 63 ♀) individuals were investigated. We found that the species mainly fed on terrestrial invertebrates preys belonging mostly to arthropod groups. The most frequently consumed were Curculionida and Carabida (50%), Araneida (46%) and Muscida (41%). There are differences in diet between sexes.

Key words: *Pelophylax ridibundus* , differences determinate by sex, predator-prey size correlation

Introduction

Most anuran species are known to be general predators consuming mainly invertebrates, with some vertebrates being ingested by large frogs (Pough et al 2001). There is also a relationship between the abundance of prey in the environment and in the diet of anurans (Turner 1959, Houston 1973). When studying on the diet composition of any anuran species, the seasonal diet variation and the correlation of food composition to prey availability in large sample sizes are important factors. Here we present results of a study on differences detminate by sex and by predator-prey size correlation on the diet of *Pelophylax ridibundus* from Dobromir, Constanța county, Romania.

*Pelophylax ridibundus (*synonym: *Rana ridibunda* Pallas 1771) is the largest frog native to Europe, and to Romania, too. In Dobrudja region was found by Covaciu-Marcov in 2006 (Covaciu-Marcov et al 2006). It is very similar in appearance to the closely related Edible Frog and Pool Frog. These three species are often referred to as „green frogs"and formate the *Pelophylax esculentus* complex. Marsh Frog is a highly opportunistic amphibian. It lives in mixed and deciduous forests, forest steppe, steppe, semidesert and desert zones. Inhabits a wide variety of flowing and stagnant water habitats, from shallow puddles and ponds to large lakes and rivers, as well as mountain streams. In general, the Marsh Frog prefers open, well-warmed areas with abundant herbaceous vegetation. Tadpoles consume detritus, algae, and higher plants in addition to animals (mainly invertebrates) and their corpses. Benthic objects remain the most important component of their diet. Adults consume mainly terrestrial and aquatic insects. Feeding does not cease during the breeding season. *Pelophylax ridibundus* is quite voracious and sometimes attacks not only animals but even the branches of riparian vegetation moving in the wind. Marsh Frog adults, being the largest frogs in Romania, often eat conspecific and other amphibians, as well as reptiles and even small birds and rodents. Cannibalism becomes especially severe during periods of low humidity and precipitation, as well as high temperature.

Materials and Methods

We analized 100 individulas of Marsh Frog, at 10th April 2007, at Dobromir, Constanța county, Romania. Much of the territory of Constanța county comprises a low-lying plateau with a continental semi-arid climate. The Black Sea coast - stretching about 144 km - has a maritime climate with fewer contrasts than the interior. The average January temperature in Constanța County is 0°C (32°F), while the average July temperature reaches 23°C (75°F). Constanta's neighbours are the Black Sea to the east, Călăraşi County and Ialomița County to the west, Tulcea County and Brăila County to the north and Bulgaria (Dobrich province and Silistra Province) to the south. Dobromir is a south commune. The studied habitats populated by Marsh Frog are not too deep, large watersurfaces with abundent vegetation, in the neighbourhood of a commune road. The antropic effects here are having a low value.

The Marsh Frog individs were captured by hand, or using nets with a handle, at dayligyt. The method we used to obtain the stomach contents was the stomach flushing method (Fraser 1976, Legler & Sullivan 1979, Opatriny 1980, Griffiths 1986, Jolly 1987, Leclerc and Curtois 1993, Cogălniceanu 1997). The stomach contents were collected immediately after capturing, due to rapid prey digestion in amphibians (Caldwell 1996). As soon as the stomach contents were collected the individuals were released in the provenience biotope, our research not affecting the effective of the population.. The stomach contents were placed in airtight test tubes and they were preserved with a 4% solution of formalin. Prey were sorted, and identified to the lowest taxonomic level possible, with a binocular microscope 10x40, using the literature (Móczár et al 1950, Radu & Radu 1967, Ionescu & Lăcătuşu 1971, Móczár 1990, Crişan & Mureşan 1999). The main goal of our research was to make a comparative analysis of the trophic spectrum, determining the taxonomic affiliation of the identified preys, the variation of the maximum and average number of preys / toad, the habitat of origin of preys, and the weight and the frequency of prey items. The dietary overlap among months was evaluated using the Pianka index (1973):

$$Q = \frac{\sum p_{ij} p_{ik}}{\sqrt{\sum p_{ij}^2 p_{ik}^2}}$$

where: pij and pik represents the abundance of prey category i in the food of predators j and k. The value of Q varies between 0 (no common resource) and 1 (perfect overlap). We used EcoSim 7.0 software (Gotelli and Entsminger 2001).

With Statistica 6.0 software (Zar 1999) we analized the ontogenetic changes in prey consumption, making regressions between prey size (mean, maximum and minimum lenght in each stomach) and SVL of captured frogs (Maneyro et al 2004), as well as between number of preys and SVL of predators.

Results

We captured 27 juvenile, 63 female and 10 male individs of *Pelophylax ridibundus*. All juveniles presented stomach contents, but one male and two female individuals did not consume anything. The 738 consumed animals were grouped in 34 categories of invertebrates. We separated the larvae and adults for Ephemeroptera's, Coleoptera's, Lepidoptera's, and Diptera Brahicera's, because we considered the fact that, they represent different categories, as far as the mobility and the provenience environment are concerned.

The most essential prey categories were represented by bugs (divided to 10 categories), flies, spiders and mosquitos (Tabel no. 1). We noticed variation, depending on the sex of individuals.

The other prey categories (consumed in low amounts, such as: worms, snails, isopods, grasshoppers, butterflies, mimetic flies) had no importance in the feeding of Marsh Frog, and we will counted these, only to estimate the food niche overlap.

Juveniles consumed spiders, flies and mosquitos most frequently, then Coleopterans, Hymenopterans, Homopterans, dragonfly larvas less frequently. Females consumed Coleopterans (Curculionidae, Carabidae), spiders and flies most ferquently. In the males diet Carabidae's are frequent (70%), then Coleopterans, Dipterans and spiders.

There are differences between the weight of preys, too. Taking in consideration the weight of preys, the following categories have been consumed in large amounts: Curculionida, Muscida, Carabide, Araneide. We found prey categories consumed only by juveniles, like Odonata larvae, and prey items consumed only by males, as terrestrial snails. Female individs consumed 32 prey categories, males and juveniles 21. Taking in consideration the provenience of the prey items, we identified 82,36% terrestrial preys, and only 17,64% acvatic preys (Tabel no. 2). This data reveals that the population from Dobromir feeds mostly on terrestrial invertebrate preys. Previous studies of ranids reveals same datas (Berry 1965, Jenssen and Klimstra 1966, Beschkov 1970, Whitaker et al 1981, Hirai and Matsui 1999, 2001, Covaciu-Marcov et al 2000, 2003).

We found in 37% stomachs with vegetal remains and in 10% stomachs with shed skin. This relative high value of vegetal presence is correlated with the habitat. The populated habitat is full with vegetation, so frogs "ate" vegetal remains only by accident, capturing them at the same time with preys. The low value of shed skin may indicate high foodsources of the environment, so frogs fell not back on shed skin intake.

Sexual size dimorphism, with larger females than males, is generally seen in anurans (Shine 1979). In our samples, maximum size was measured at females (9,7 cm), but if we look at the average size males presented a higher value of 6,95 cm, so we can not affirme significant difference between sizes. Diet compositions were quite similar between juveniles, males and females, indicated by a high dietary / niche overlap, Pianka index beeing 0.76. The cause of this dietary overlap is that individuals use the same microhabitat for foraging (Lima and Moreira 1993, Measey 1998, Hirai and Matsui 2000, Cross and Gerstenberger 2002, Parker and Goldstein 2004). Mostly adult insects were eaten, indicating that Marsh Frog primarily fed on active preys. Feeding mechanisms of most anurans is based on detection of prey by visual cues followed by capture and retrieval with the tongue (Stebbins and Cohen 1995). Dietary studies of green frogs indicate that prey choice reflects prey availability as well as habitat characteristics (Berry and Bullock 1962, Jenssen and Klimstra 1966, Houston 1973, Whitaker et al 1981, Duellman and Trueb 1986, Popovic et al 1992, Kovács and Török 1995, Werner et al 1995, Das 1996, Hirai and Matsui 1999, 2001). Diverse food items found in the stomachs illustrate the ability to utilize a wide variety of taxa.

We analized the ontogenetic changes in prey consumption. Regressions between frog size and prey size (minimum, maximum and mean lenght), and between frog size and prey number were made using all stomachs contents, without 3 individuals presenting empty stomachs. In 3 of the 10 regressions (Fig. 1-10) a positive and statistically significant ($p < 0.05$) slope was found, in the other 7 regressions the slope was also positive but not statistically significant ($p > 0.05$).

Analizes regarding correlations beetween individulas SVL and consumated prey number (Fig. 1) results a positive slope but not statistically significant, $p = 0.3558$.

Tabel no.1 Frequency and weight of prey items

	Frequency %				Weight%			
	J	F	M	T	J	F	M	T
Nematomorfa Gordius aquaticus	0	1,58	0	1	0	0,2	5,26	0,13
Oligocheta - Lumbricidae	3,7	12,69	20	11	0,54	1,85	1,69	1,79
Gasteropoda - melci T	0	0	10	1	0	0	1,69	0,13
melc	0	1,58	10	2	0	0,4	1,69	0,4
Crustaceae - Isopodae T	7,4	7,93	0	7	1,65	2,06	0	1,79
Gamaride acv	0	1,58	0	1	0	0,2	0	0,13
Arahnida - Araneidae	48,14	49,2	20	46	9,52	12,78	3,44	11,14
Efemeroptera - L acv	0	1,58	0	1	0	0,2	0	0,13
Odonatae - L A	3,7	0	0	1	0,54	0	0	0,13
Ortoptera	3,7	11,11	10	9	0,54	1,64	1,69	1,37
Dermaptera	3,7	4,76	0	4	0,54	0,61	0	0,54
Homoptera - Afidae	22,22	3,17	0	8	3,37	0,4	0	1,09
Cicadae	3,7	3,17	0	3	0,54	0,4	0	0,4
Heteroptera	29,62	23,8	10	24	4,54	4,21	1,69	4,09
Pyrrhocoris apterus	0	1,58	0	1	0	0,2	0	0,13
Coleoptera - Dytiscide - L acv	3,7	11,11	0	8	0,54	1,85	0	1,37
Dytiscidae	0	3,17	0	2	0	0,81	0	0,54
Staphylinida	7,4	7,93	0	7	1,09	0,81	0	0,95
Carabida	22,22	58,73	70	50	5,14	14,61	15,38	12,15
Coccinelidae	14,81	20,63	20	19	2,22	3,66	15,38	4,23
Elateridae	0	11,11	10	8	0	1,43	1,69	1,09
Chrysomelidae	0	11,11	20	9	0	1,43	9,43	1,65
Curculionidae	25,92	63,49	30	50	8,87	19,61	12,06	16,22
Scarabeidae	3,7	6,34	10	6	0,54	0,81	1,69	0,81
Coleoptera nedet.	40,74	39,68	20	38	15	8,09	9,43	9,82
Lepidoptera - L	0	7,93	10	6	0	1,02	1,69	0,81
Diptera- Brahicerae - L acv	0	7,93	0	5	0	2,7	0	1,79
Muscidae	48,14	41,26	20	41	26,89	10,76	3,44	13,71
Syrphidae	0	3,17	0	2	0	0,4	0	0,27
Nematocera Tipulidae	7,4	4,76	10	6	1,09	0,61	1,69	0,81
Culex pipiens	44,44	25,39	20	30	13,58	4	5,26	6,34
Hymenoptera - Formicidae	22,22	15,87	10	17	3,95	2,27	3,44	2,78
Apidae	0	3,17	0	2	0	0,4	0	0,27
Hymenoptera nedet.	22,22	15,87	10	17	3,37	2,48	1,69	2,64

Tabel no.2 Data about number of preys, % stomachs with vegetal remains and shed-skin, % of terrestrial and acvatic preys, lenght of preys and marsh frog individuals

	M	F	J	T
Number of toads	10	63	27	100
Average number of preys	5,6	7,61	6,33	7,07
Maximum number of preys	19	18	14	19
% stomachs with vegetal remains	30	37	41	37
% stomachs with shed-skin	30	7,9	7,4	10
% of aquatic preys	0	15.62	9.52	17.64
% of terrestrial preys	100	84.38	90.48	82.36
L min of prey (mm)	3	2	2	2
L max of prey (mm)	48	82	20	82
L average of prey (mm)	25,5	42	11	4,64
L min of frog (cm)	4,7	4	2,5	2,5
L max of frog (cm)	8,7	9,7	3,9	9,7
L average of frog (cm)	6,95	5,23	3,43	4,92

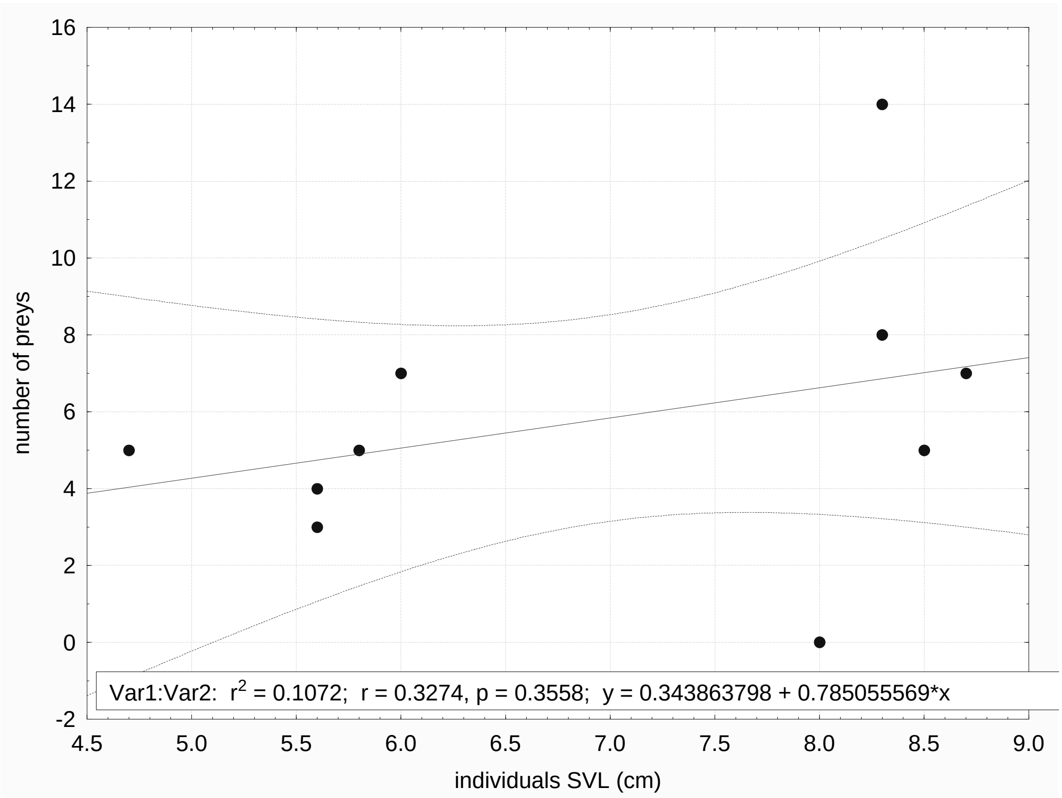

Figure no.1 Correlation between individuals SVL and preys number

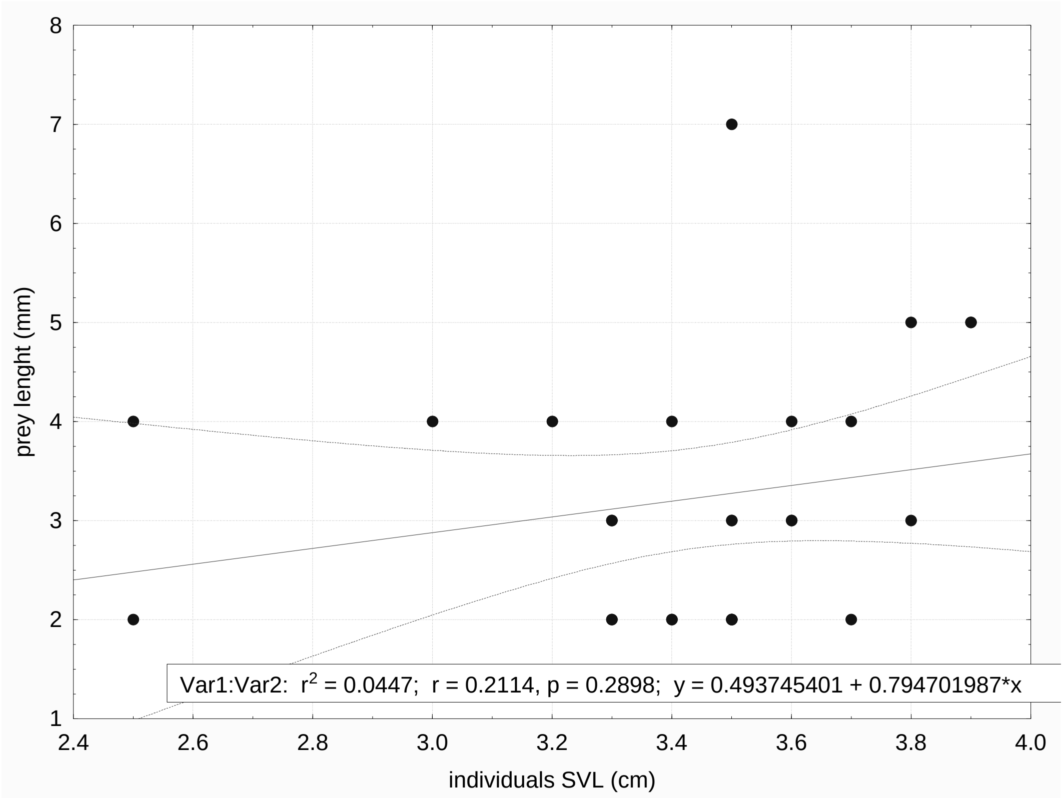

Figure no. 2 Regression between juveniles SVL and minimum lenght of preys

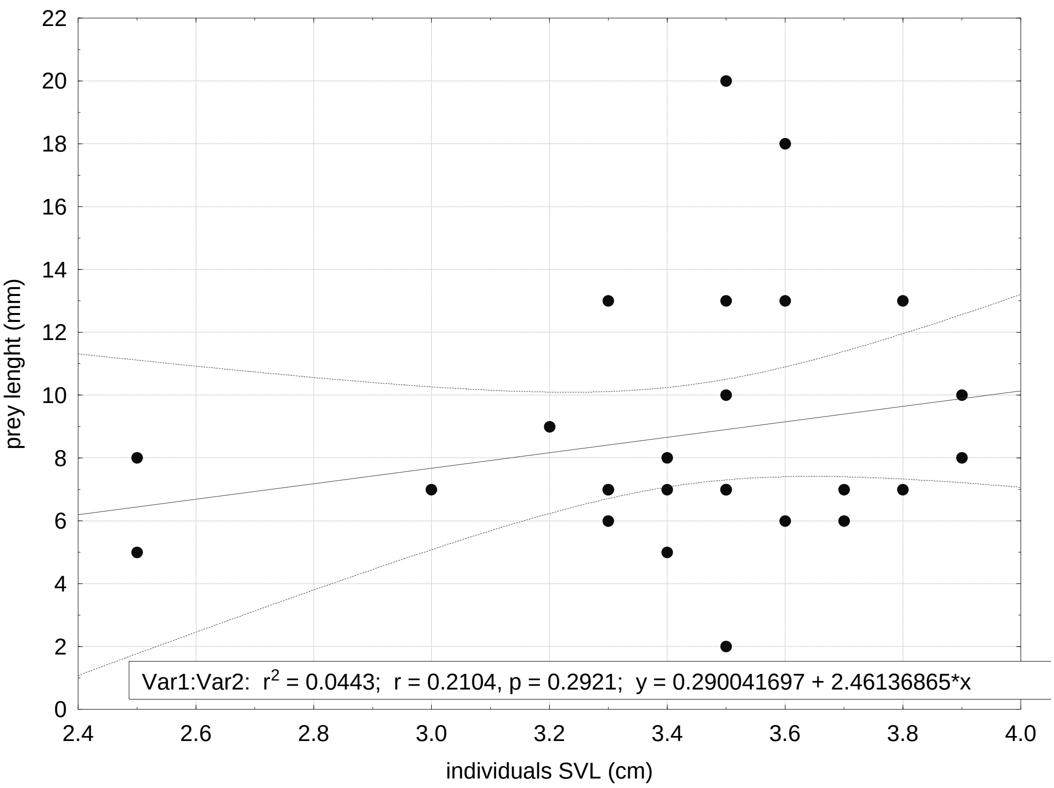

Figure no.3 Regression between juveniles SVL and maximum lenght of preys

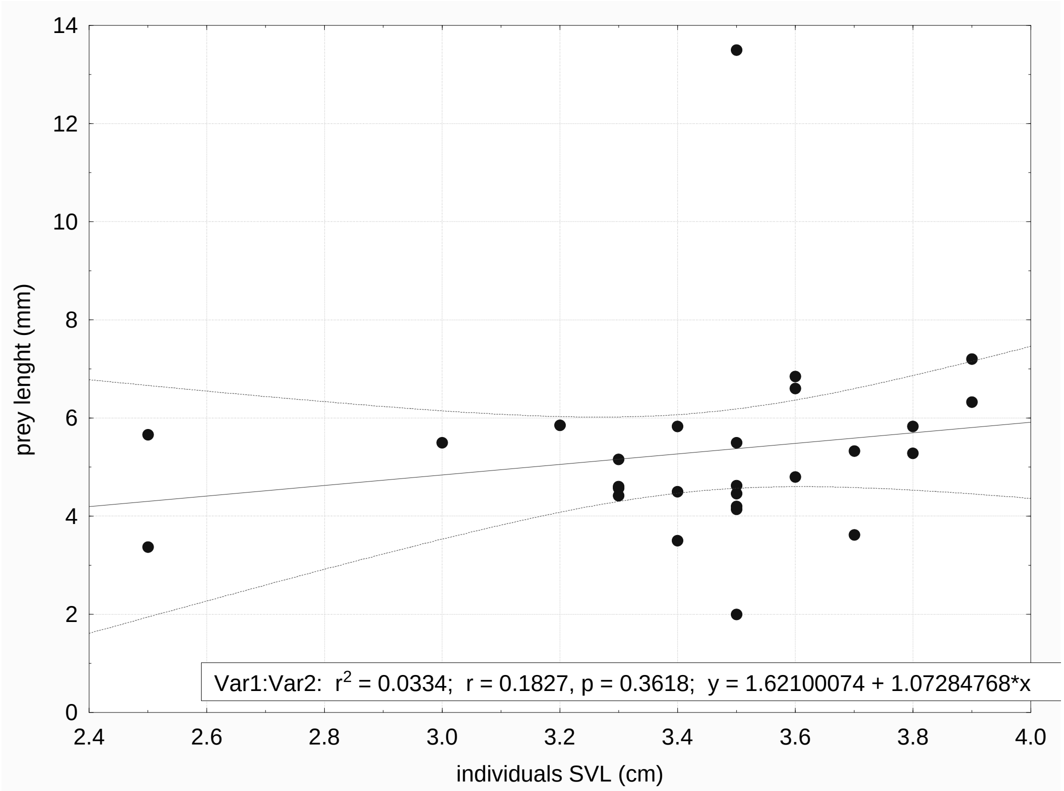

Figure no.4 Regression between juveniles SVL and average lenght of preys

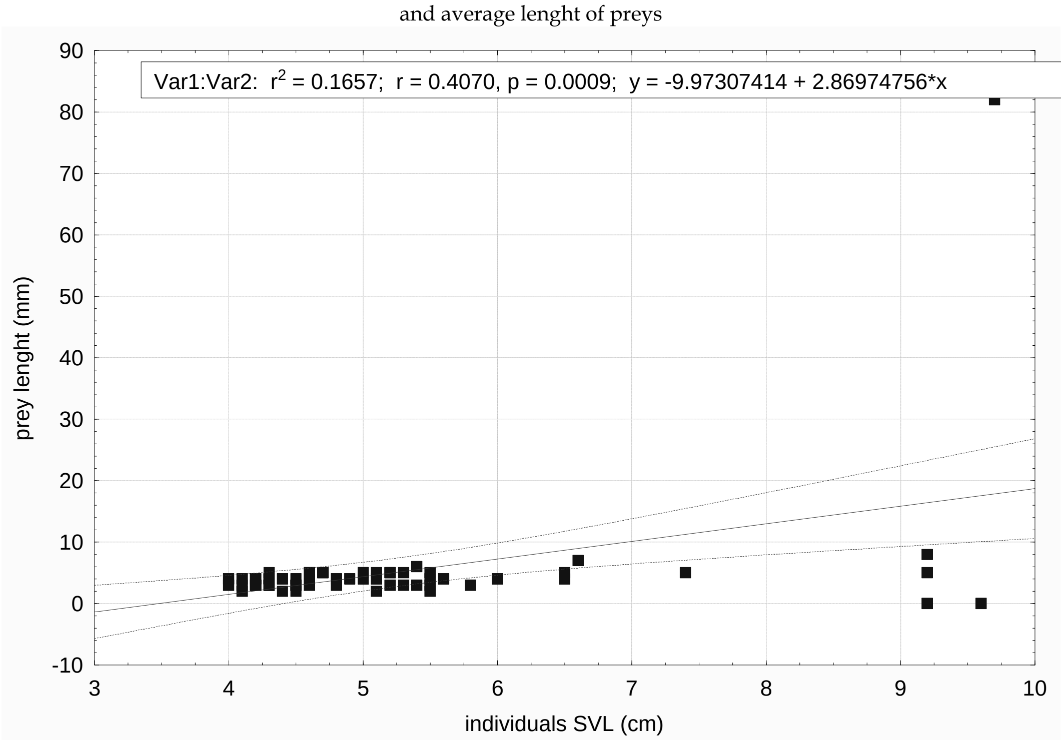

Figure no.5 Regression between females SVL and minimum lenght of preys

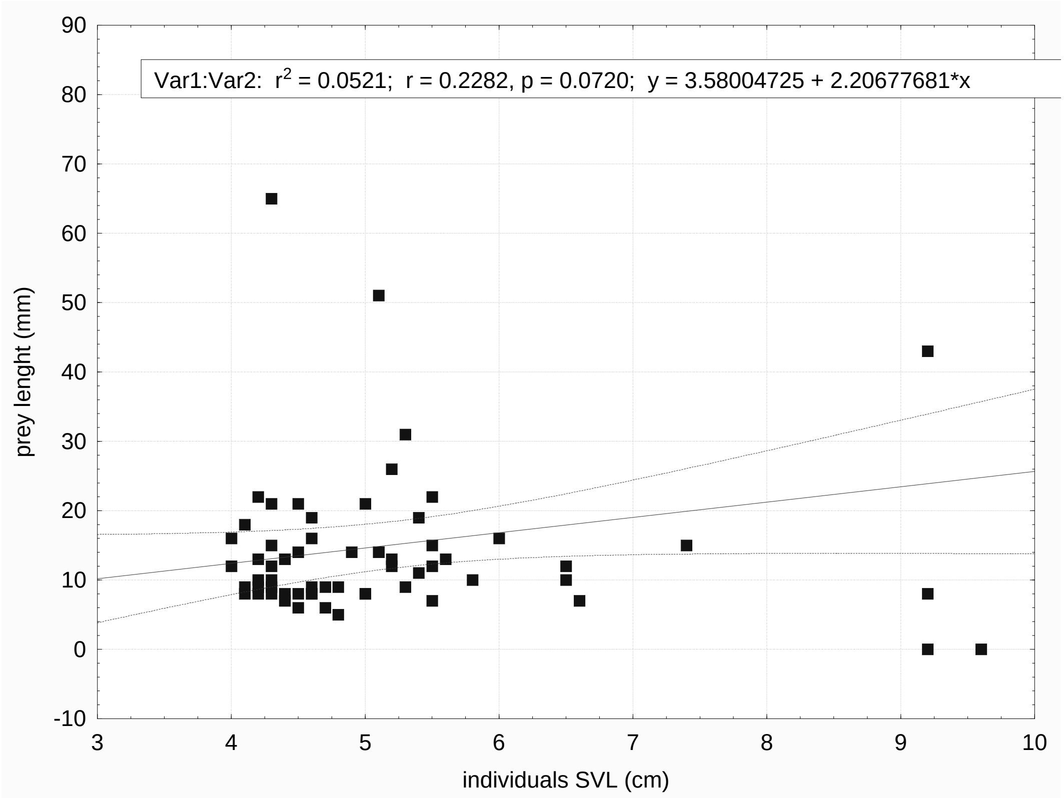

Figure no.6 Regression between females SVL and maximum lenght of preys

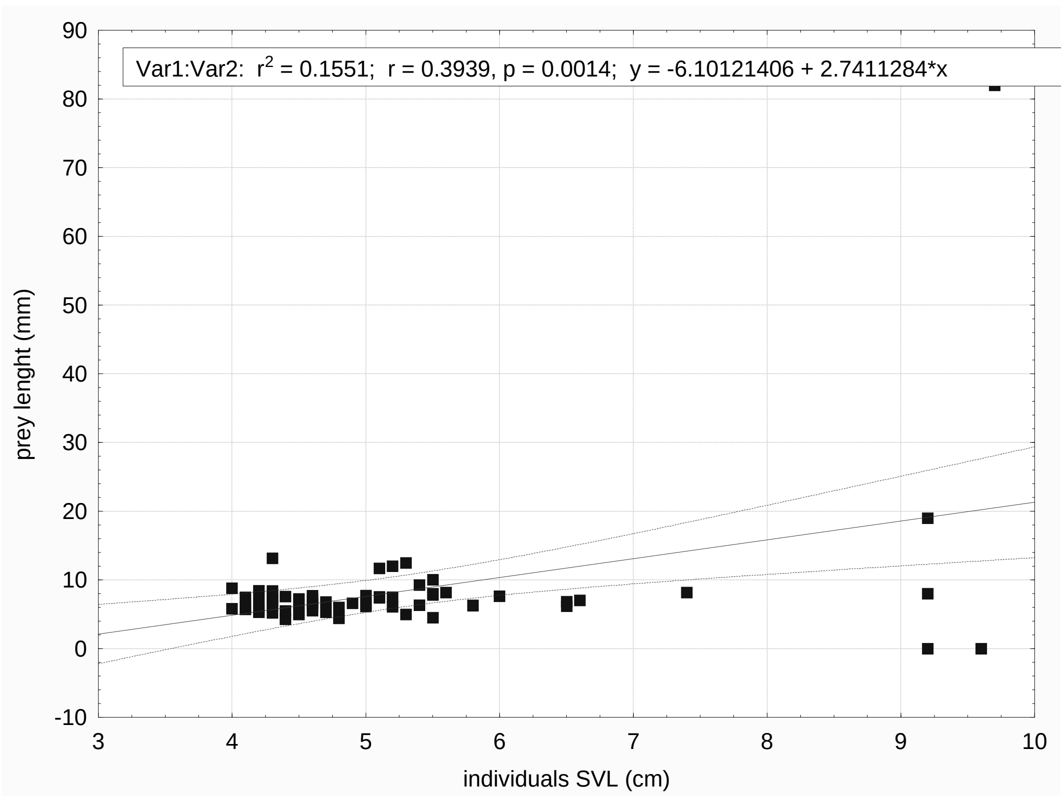

Figure no.7 Regression between females SVL and average lenght of preys

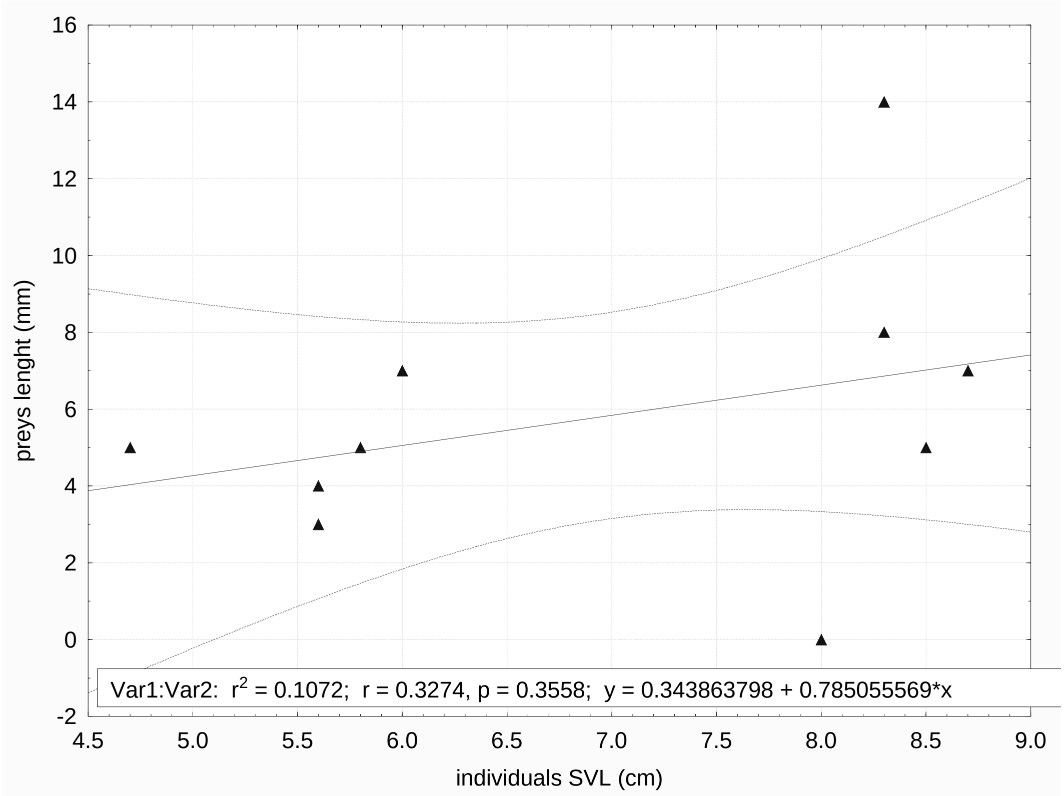

Figure no.8 Regression between males SVL and minimum lenght of preys

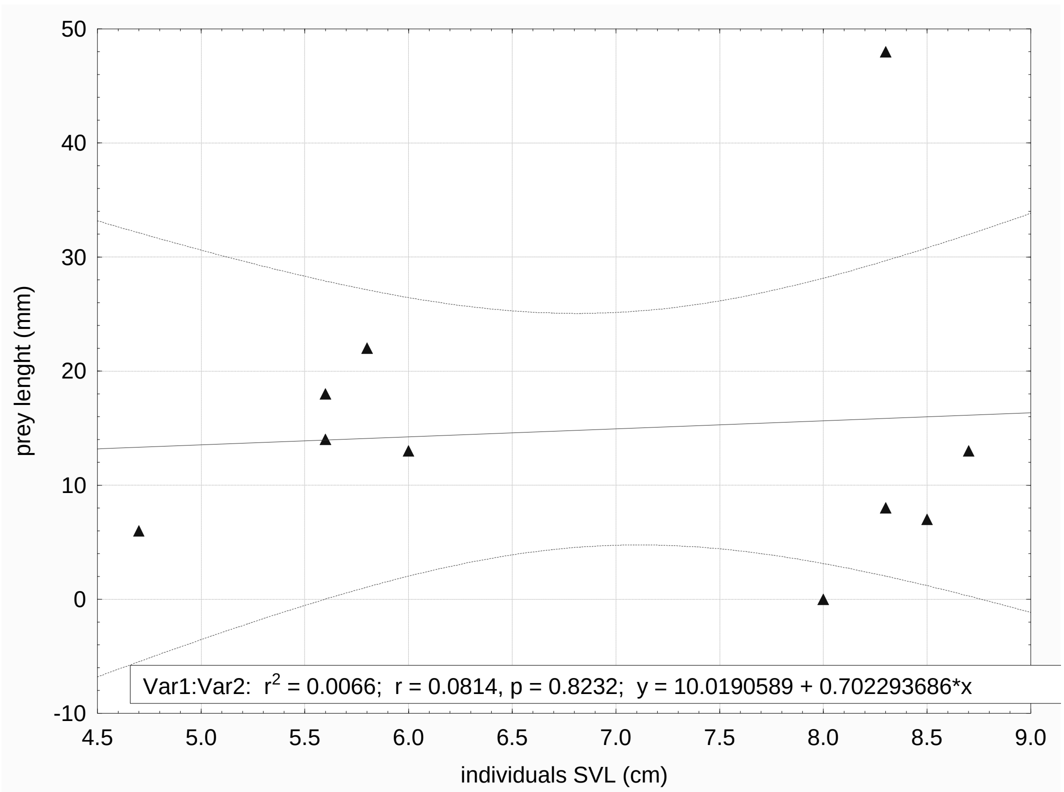

Figure no.9 Regression between males SVL and maximum lenght of preys

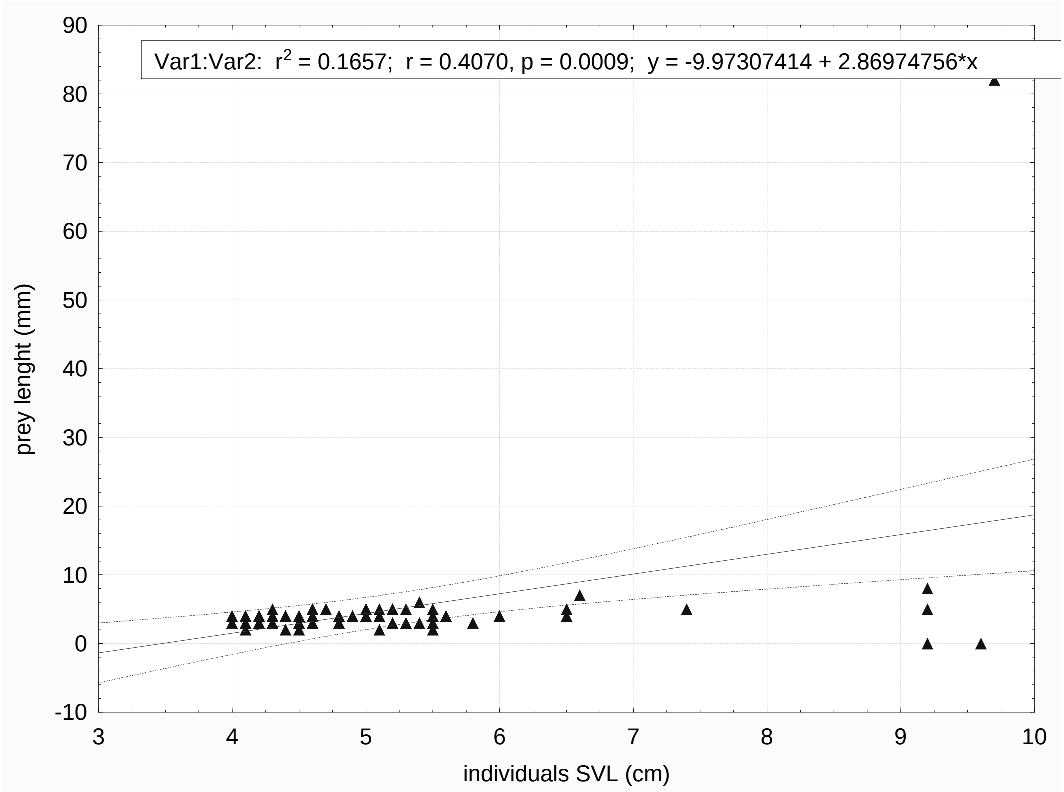

Figure no.10 Regression between males SVL and average lenght of preys

Regressions between female frog size and prey size were psitive and statistically significant in two of three regressions p=0,0009, p=0,0014, regarding the minimum and mean prey size. Females presented positive and statistically significant results, p=0,0009 in case of mean size of preys.

Discussion

The trofic niche of *Pelophylax ridibundus* in Dobromir is not known, our study beeing the first in this region. We found minor intersexual differences, we can not affirme significant size difference between sexes Also the food composition was very similar, caused by a high niche overlap, the Pianka index beeing 0.76. The cause of this dietary overlap is that individuals use the same microhabitat for foraging (Lima and Moreira 1993, Measey 1998, Hirai and Matsui 2000, Cross and Gerstenberger 2002, Parker and Goldstein 2004).

Our study results the Marsh Frog samples from Dobromir mostly fed on terrestrial preys, as it is noticed in previous studies about ranids (Berry 1965, Jenssen and Klimstra 1966, Beschkov 1970, Whitaker et al 1981, Hirai and Matsui 1999, 2001, Covaciu-Marcov et al 2000, 2003, Sas et al 2003).

Only three individuals were without stomach content. This low proportion of empty stomachs indicate a positive energy balance. This is suported by the low shed skin intake, too. Regardindg the taxonomic affiliation of preys, we idebtified 738 preys grouped in 34 categories of invertebrates. The most frequently consumed were Curculionida and Carabida (50%), Araneida (46%) and Muscida (41%). In greatest amounts were consumed Curculionidae (16,22%), Muscida (13,71%) and Araneidae (11,14%). Females fed the most divers, consuming 32 prey items. This may be explained with the period of the study, which was April. Frogs were in reproducing period and in this period females presents a growth in the metabolic rata to supports the reproduction function.

Regression between females size and prey lenght showed positive correlations. This fact may be interpreted as an ontogenetic change on diet, but because the other regressions results a statistically not significant positive slope (p > 0,05), it is not so obvious that the differences in prey consumption are caused by ontogenetic changes. We need to efectuate more studies for elucidate this problem.

In conclusion, there can be seen an ecological adaptability/plasticity of these frogs. They are using the most accessible food resources, depending on the environment conditions, similarly to other species of Amphibians.

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