Feeding Biology of the Marsh Frog, *Rana ridibunda* Pallas 1771, (Anura, Ranidae) In Turkey's Lake District**

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Abstract. We examined the food composition of the marsh frog, *Rana ridibunda*, populations inhabiting Turkey's Lake District. Stomach contents of 82 (32 ♂♂, 50 ♀♀) adult individuals were investigated. It was found that the species mainly fed on invertebrates and especially on terrestrial preys belonging to arthropod groups (75.17%). The most frequently consumed preys with respect to numeric proportion were Diptera (19.85%), Coleoptera (12.72%) and Hymenoptera (10.02%). There are no differences in diet between sexes and among the populations examined.

Key Words: *Rana ridibunda*, feeding biology, Lake District, Turkey, cannibalistic behavior

Introduction

The first step towards understanding the ecology of the *Rana ridibunda* is to collate information on its feeding biology (Hodar, 1997); furthermore, determination of its feeding habits helps scientists understand how this animal uses the food resources in its immediate environment (Bellocq et al., 2000). Thus, its relationship with other populations of other species living in the same biotope can be clearly demonstrated by establishing where the species stands within the food chain (Duellman & Trueb, 1986).

The marsh frog, *Rana ridibunda*, is distributed in Central and South Europe as well as North Africa and East Asia (Tok et al., 2000). The species is mostly aquatic and rarely leaves water. It is often seen inside water, on banks or on top of leaves or branches on the surface. Prefered habitats include ponds, rivers and lakes with dense vegetation and often plains. The largest specimens among Turkish anurans belong to this species (Başoğlu & Özeti, 1973).

Until today, many researchers have carried out a number of studies on the feeding habits of the *Rana ridibunda* species (e.g. Popovic et al., 1992; Simic et al., 1992; Cogãlniceanu et al., 2000; Ruchin & Ryzhov, 2002; Covaciu-Marcov et al., 2005). However, we still lack sufficient infor-

mation on the food content of the Turkish populations (e.g. Atatür et al., 1993; Turgay, 2001). On the other hand, the studies conducted have revealed that collecting the frogs for export purposes damages the population in the Lakes District despite the fact that they have a suitable biotope for survival (Baran et al., 1992).

The objective of the present study is to collect detailed information on the feeding habits of the species by analyzing the stomach contents of individuals from five populations inhabiting the Lakes District, with the aim to pave the way for future studies on the ecology of *Rana ridibunda*.

Materials and Methods

The study site is located in the Lake District, Central Anatolian and Mediterranean Region of Turkey. The 82 (32 ♂♂, 50 ♀♀) adult *Rana ridibunda* preserved specimens analyzed in the study were collected from five sites in the Lakes District between July 1990 and June 1993. They were used for stock determination of Turkish *Rana ridibunda* populations in a previous study (Baran et al., 1992) and are still registered in Ege University - Faculty of Science - Zoology Department - Museum (ZDEU) (Figure 1). Ten specimens from Lake Çavuşçu (38° 25′ N, 31° 53′ E, 1024 m a.s.l.) were captured between 09 ^{00}-12 ^{00}, while those from the other four sites [Lake Eğirdir (38° 15′ N, 30° 52′ E, 929 m a.s.l.), Lake Akşehir (38° 32′ N, 31° 28′ E, 960 m a.s.l.), Lake Gölcük (37° 45′ N, 30° 33′, 1400 m a.s.l.), and Lake Suğla (37° 19′ N, 31° 58′ E, 1040 m a.s.l.)] were collected between 22^{00} - 24^{00}. The individuals were etherized right after they were captured and fixed in 5 % formalin, 70 % ethyl alcohol solution. They were then placed in glass jars for protection.

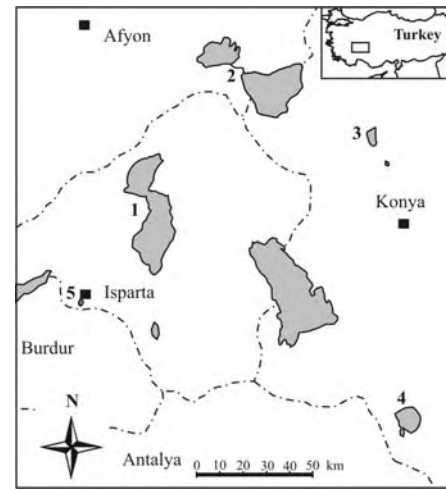

Figure no.1 Map showing the examined *Rana ridibunda* specimens' localities.
1- Lake Eğirdir (Isparta) [ZDEU. 35/1990, 18 (4 ♂♂ ,14 ♀♀), 17 07 1990], 2- Lake Akşehir (Taşköprü, Konya) [ZDEU. 38/1990, 18 (7 ♂♂,11 ♀♀), 18 07 1990], 3- Lake Çavuşçu (Ilgın, Konya) [ZDEU. 39/1990, 10 (1 ♂♂ ,9 ♀♀), 18 07 1990], 4- Lake Suğla (Seydişehir, Konya) [ZDEU. 40/1990, 19 (7 ♂♂ ,12 ♀♀), 19 07 1990], 5- Lake Gölcük (Isparta) [ZDEU.49/1993, 17 (13 ♂♂ ,4 ♀♀), 21 06 1993].

Snout-vent length, mouth width and body mass of the specimens were measured and recorded. They were then dissected and their stomachs were removed after their esophagus and duodenum regions were cut open. Food volume as well as stomach fullness rate was calculated using the alcohol displacement method.

Factors such as the general shape and size of the prey, as well as the head, antennas, wings and another pattern's were taken into consideration for identification. As for the distinctive characteristics, the prey

items were identified to the lowest taxon possible. Parker (1982) was taken as a general reference.

The SPSS Statistical Program (Version, 10.00) was used for the statistical analyses of the data obtained at the end of the study. The Mann-Whitney U Test was used for the comparison between males and females, whereas the Kruskal-Wallis Test was applied for the comparison of the populations. All the analyses were made and evaluated at a 95 % confidence interval (Zar, 1996).

Results

According to morphometric measurements taken from 82 (32 ♂♂; 50 ♀♀) adult *Rana ridibunda* specimens, the snout-vent length of the individuals in the whole population ranged between 59.35–108.34 mm (mean±CI - 82.63±2.948). The mouth width of the specimens was between 23.17–43.11 mm (31.85±1.194) and the body mass ranged between 13.63–151.98 g (66.82±7.662) in the whole population. The average number of prey per stomach was 1-53 (median= 4.5±6), whereas the stomach fullness rate was ranging between 12.5 %-89.28 % (Table 1).

Prey items belonging to groups such as Lymnaeidae, Planorbidae, Gammaridae, Ephemeroptera, Odonata, Corixidae, Dytiscidae, Gyrinidae, Hydrophilidae, Geotrupidae, Cyprinidae and Ranidae were considered to be aquatic, while the others were regarded as terrestrial prey. Some stomach contents were seen to contain pebbles, feathers, leaves, algae and twigs. Nevertheless, such data were not taken into consideration in the present study believing that the individuals must have swallowed these pieces accidentally during feeding.

A total of 518 prey items were found, with body lengths ranging between 1-105.81 mm, belonging to 6 classes, 18 orders and 42 families in the 82 *Rana ridibunda* specimens examined (Table 2). The prey groups included the classes Insecta (Ephemeroptera, Odonata, Dermaptera, Heteroptera, Homoptera, Neuroptera, Coleoptera, Mecoptera, Diptera, Lepidoptera, Orhoptera and Hymenoptera), Crustacea (Isopoda and Amphipoda), Osteichthyes (Cypriniformes), Gastropoda (Basommatophora), Arachnida (Aranea) and Amphibia (Anura). Insecta is the class containing the highest number of prey groups (82.47%). Twelve orders were identified within the class Insecta. Among these prey orders the largest groups by frequency of occurrence (f %) encountered in the stomach contents were orders Diptera (51.22%), Coleoptera (47.56%) and Hymenoptera (30.49%), respectively. The largest rate by numeric proportion also belonged to these groups. The order exhibiting the largest variety among the marsh frog prey groups was the order Coleoptera with twelve families. Carabidae, Staphylinidae, Scarabaeidae, Cocci-

nellidae, Tenebrionidae, Chrysomellidae and Curculionidae were the terrestrial families belonging to the order Coleoptera. Aquatic families, on the other hand, included Dytiscidae, Gyrinidae, Hydrophilidea and Geotrupidae. A total of 330 (75.17 %) terrestrial and 109 (24.82 %) aquatic prey items were discovered in the stomach contents of all the specimens. Moreover, 346 (80.84 %) adult and 82 (19.16 %) larval prey animals were found within the class Insecta.

It was found that a greater number of preys from the orders Homoptera (23.13 %), Diptera (17.01 %) and Coleoptera (15.65 %) were consumed by specimens belonging to the Lake Eğirdir population compared to the other prey groups. The most frequently encountered groups were Diptera (55.56 %), Coleoptera (44.44 %) and Lepidoptera (33.33 %). As for the numeric proportion, the orders Odonata (12.62 %), Cypriniformes (12.62 %) and Coleoptera (8.74 %) were consumed at greater amounts by the Lake Akşehir population. Lake Akşehir was the population consuming the greatest amount of Osteichthyes (12.62%) and Gastropoda (4.85 %). An examination of the food contents of the Lake Çavuşçu population, on the other hand, revealed that Lepidoptera (22.50 %), Orhoptera (15 %), Odonata (12.50 %) and Coleoptera (12.50 %) were the prey groups having the greatest numeric proportion. Lake Çavuşçu was the population consuming the greatest amount of Arachnida (5 %). In the Lake Suğla population, the orders Diptera (35 %) and Coleoptera (18.75 %) are the most widely consumed prey groups. In the Lake Gölcük population, on the other hand, the orders Diptera (33.94 %), Hymenoptera (26.61 %) and Coleoptera (8.26 %) are the prey groups having the greatest numeric proportion.

Despite the fact that females are larger than males, there is no difference between the food volume and other findings such as stomach fullness and the number of prey per stomach between them (Mann Whitney U; $P>0.05$). Despite some minor differences among the numeric proportions of the prey animals, no difference was observed among the frequency of occurrence (Mann Whitney U; $P>0.05$). However, there are certain differences among the populations with respect to stomach fullness and number of prey per stomach (Kruskal Wallis; $P\leq0.05$). Although there were some differences among the numeric proportions of the prey, no difference was found among the frequency of occurrence (Kruskal Wallis; $P>0.05$).

Table no.1 Some biological values of the investigated specimens from Lake District.
[N: Number of specimens, M: Mean (Median for Number of prey per stomach), SD: Standard deviation, SE: Standard error of the mean, SVL: Snout-vent length, MW: Mouth width, BM: Body mass, NPPS: Number of prey per stomach, SFR: Stomach fullness rate]

	♀♀ (N=50)				♂♂ (N=32)				♂♀ (N=82)			
Characters	**M**	**Range**	**SD**	**SE**	**M**	**Range**	**SD**	**SE**	**M**	**Range**	**SD**	**SE**
SVL (mm)	87.22	59.35 - 108.34	12.65	1.78	75.45	61.50 - 97.98	11.18	1.97	82.63	59.35 - 108.34	13.34	1.47
MW (mm)	33.87	24.06 - 43.11	5.09	0.72	28.71	23.17 - 37.53	4.31	0.76	31.85	23.17 - 43.11	5.4	0.59
BM(g)	78.49	13.63 - 151.98	34.58	4.89	48.58	18.37 - 118.18	26.3	4.64	66.82	13.63 - 151.98	34.69	3.83
NPPS	4.50	1 - 53	9.02	1.27	4.5	1 - 18	3.54	0.62	4.5	1 - 53	7.34	0.81
SFR (%)	38.65	12.5 - 70	17.78	2.51	40.87	12.5 – 89.29	18.93	3.34	39.51	12.5 – 89.29	18.16	2.00

Table no.2 Food composition (in %) of marsh frog, *Rana ridibunda* in Turkey's Lake District
[518 prey items from 82 (32 ♂♂, 50 ♀♀) stomachs, %f= frequency of occurrence, %n= numeric proportion].

	Whole Population		Lake Eğirdir		Lake Akşehir		Lake Çavuşçu		Lake Suğla		Lake Gölcük	
Prey Taxa	f %	n %	f %	n %	f %	n %	f %	n %	f %	n %	f %	n %
Gastropoda	4.88	1.93	5.56	1.36	11.11	4.85	10.00	1.25	10.53	2.50	-	-
Basommatophora	7.32	1.93	5.56	1.36	11.11	4.85	10.00	1.25	10.53	2.50	-	-
*Lymnaeidae	7.32	1.54	5.56	1.36	11.11	2.91	10.00	1.25	10.53	2.50	-	-
*Planorbidae	1.22	0.39	-	-	5.56	1.94	-	-	-	-	-	-
Arachnida	8.54	1.54	-	-	5.56	0.97	40.00	5.00	5.26	2.50	5.88	0.92
Aranea	8.54	1.54	-	-	5.56	0.97	40.00	5.00	5.26	2.50	5.88	0.92
Linyphiidae	1.22	0.19	-	-	-	-	-	-	5.26	1.25	-	-
Tetragnathidae	4.88	0.77	-	-	5.56	0.97	20.00	2.50	5.26	1.25	-	-
Lycosidae	2.44	0.39	-	-	-	-	10.00	1.25	-	-	5.88	0.92

Table no.2 (continued)

	Whole Population		Lake Eğirdir		Lake Akşehir		Lake Çavuşçu		Lake Suğla		Lake Gölcük	
Prey Taxa	f %	n %	f %	n %	f %	n %	f %	n %	f %	n %	f %	n %
Crustacea	2.44	7.32	5.56	1.36	5.56	30.10	-	-	-	-	-	-
Isopoda	1.22	5.97	-	-	5.56	30.10	-	-	-	-	-	-
Oniscidae	1.22	5.20	-	-	5.56	26.21	-	-	-	-	-	-
Oniscus sp.	1.22	5.20	-	-	5.56	26.21	-	-	-	-	-	-
Philosciidae	1.22	0.77	-	-	5.56	3.88	-	-	-	-	-	-
Philoscia sp.	1.22	0.77	-	-	5.56	3.88	-	-	-	-	-	-
Amphipoda	2.44	1.35	11.11	4.76	-	-	-	-	-	-	-	-
*Gammaridae	2.44	1.35	11.11	4.76	-	-	-	-	-	-	-	-
Elasmopus sp.	2.44	1.35	11.11	4.76	-	-	-	-	-	-	-	-
Insecta	96.34	82.47	100.00	91.84	94.44	45.63	100.00	91.25	89.47	86.25	100.00	95.41
larvae	1.22	0.19	-	-	-	-	-	-	-	-	5.88	0.92
*nymph	6.10	0.96	11.11	1.36	5.56	0.97	-	-	5.26	1.25	5.88	0.92
Ephemeroptera	6.10	1.16	16.67	2.72	11.11	1.94	-	-	-	-	-	-
*nymph	6.10	1.16	16.67	2.72	11.11	1.94	-	-	-	-	-	-
Odonata	24.39	8.67	27.78	10.20	44.44	12.62	40.00	12.50	-	-	17.65	6.42
*nymph	6.10	2.12	11.11	4.76	11.11	1.94	-	-	-	-	5.88	1.83
*Subordo: Zygoptera	9.76	2.89	5.56	1.36	11.11	1.94	40.00	11.25	-	-	5.88	1.83
*Subordo: Anisoptera	7.32	1.73	-	-	22.22	5.83	10.00	1.25	-	-	5.88	1.83
Orthoptera	8.54	2.31	-	-	-	-	70.00	15.00	-	-	-	-
Gryllotapidae	8.54	2.31	-	-	-	-	70.00	15.00	-	-	-	-
Gryllotapa gryllotalpa	8.54	2.31	-	-	-	-	70.00	15.00	-	-	-	-
Dermaptera	1.22	0.19	-	-	-	-	10.00	1.25	-	-	-	-
Labiduridae	1.22	0.19	-	-	-	-	10.00	1.25	-	-	-	-
Heteroptera	6.10	1.54	-	-	11.11	1.94	20.00	2.50	-	-	5.88	3.67
*Corixidae	2.44	0.39	-	-	11.11	1.94	-	-	-	-	-	-
Corixa sp.	2.44	0.39	-	-	11.11	1.94	-	-	-	-	-	-
Pyrrhocoroidae	2.44	0.39	-	-	-	-	20.00	2.50	-	-	-	-
Pyrrhocoris sp.	2.44	0.39	-	-	-	-	20.00	2.50	-	-	-	-

Table no.2 (continued)

	Whole Population		Lake Eğirdir		Lake Akşehir		Lake Çavuşçu		Lake Suğla		Lake Gölcük	
Prey Taxa	f %	n %	f %	n %	f %	n %	f %	n %	f %	n %	f %	n %
Homoptera	6.10	7.71	11.11	23.13	-	-	10.00	1.25	10.53	6.25	-	-
nymph	1.22	5.20	5.56	18.37	-	-	-	-	-	-	-	-
Cicadellidae	3.66	1.16	-	-	-	-	10.00	1.25	10.53	6.25	-	-
Neuroptera	1.22	0.19	-	-	5.56	0.97	-	-	-	-	-	-
Coleoptera	47.56	12.72	44.44	15.65	38.89	8.74	70.00	12.50	52.63	18.75	41.18	8.26
larvae	2.44	0.39	-	-	-	-	-	-	10.53	2.50	-	-
Carabidae	9.76	1.54	16.67	2.04	11.11	1.94	20.00	2.50	-	-	5.88	0.92
Carabus sp.	2.44	0.39	5.56	0.68	-	-	10.00	1.25	-	-	-	-
Harpalus sp.	1.22	0.19	-	-	5.56	0.97	-	-	-	-	-	-
Zabrus sp.	1.22	0.19	-	-	5.56	0.97	-	-	-	-	-	-
*Dytiscidae	9.76	2.31	16.67	3.40	-	-	-	-	21.05	7.50	5.88	0.92
Acilius sp.	1.22	0.19	-	-	-	-	-	-	-	-	5.88	0.92
Dytiscus sp.	3.66	0.96	5.56	0.68	-	-	-	-	10.53	5.00	-	-
larvae	1.22	0.19	5.56	0.68	-	-	-	-	-	-	-	-
Ilybius sp.	1.22	0.19	-	-	-	-	-	-	5.26	1.25	-	-
Noterus sp.	1.22	0.19	5.56	0.68	-	-	-	-	-	-	-	-
*Gyrinidae	1.22	0.19	-	-	5.56	0.97	-	-	-	-	-	-
Gryrinus sp.	1.22	0.19	-	-	5.56	0.97	-	-	-	-	-	-
Staphylinidae	3.66	0.58	-	-	5.56	0.97	10.00	1.25	5.26	1.25	-	-
Staphylinus sp.	1.22	0.19	-	-	5.56	0.97	-	-	-	-	-	-
Hydrophilidae	1.22	0.19	-	-	-	-	-	-	5.26	1.25	-	-
Hydrobius sp.	1.22	0.19	-	-	-	-	-	-	5.26	1.25	-	-
*Geotrupidae	1.22	0.19	-	-	-	-	10.00	1.25	-	-	-	-
Geotrupes sp.	1.22	0.19	-	-	-	-	10.00	1.25	-	-	-	-
Melalontidae	1.22	0.19	-	-	-	-	-	-	-	-	5.88	0.92
Rhizotrobus sp.	1.22	0.19	-	-	-	-	-	-	-	-	5.88	0.92

Table no.2 (continued)

	Whole Population		Lake Eğirdir		Lake Akşehir		Lake Çavuşçu		Lake Suğla		Lake Gölcük	
Prey Taxa	f %	n %	f %	n %	f %	n %	f %	n %	f %	n %	f %	n %
Scarabaeidae	2.44	0.39	-	-	5.56	0.97	-	-	-	-	5.88	0.92
Aphodius sp.	1.22	0.19	-	-	5.56	0.97	-	-	-	-	-	-
Coccinellidae	1.22	0.19	-	-	-	-	10.00	1.25	-	-	-	-
Tenebrionidae	3.66	0.58	5.56	0.68	5.56	0.97	10.00	1.25	-	-	-	-
Crypticus sp.	1.22	0.19	-	-	5.56	0.97	-	-	-	-	-	-
Chrysomelidae	1.22	0.19	-	-	-	-	10.00	1.25	-	-	-	-
Curculionidae	6.10	2.70	16.67	8.16	-	-	-	-	-	-	11.76	1.83
Hynobius sp.	2.44	0.39	5.56	0.68	-	-	-	-	-	-	5.88	0.92
Polydrusus sp.	2.44	2.12	11.11	7.48	-	-	-	-	-	-	-	-
Mecoptera	1.22	0.19	-	-	-	-	-	-	5.26	1.25	-	-
Diptera	51.22	19.85	55.56	17.01	33.33	7.77	60.00	6.25	42.11	35.00	70.59	33.94
larvae	7.32	1.35	-	-	11.11	1.94	10.00	1.25	15.79	5.00	-	-
Culicidae	14.63	3.28	11.11	2.72	16.67	3.88	10.00	1.25	10.53	3.75	23.53	4.59
Asilidae	1.22	0.58	-	-	-	-	-	-	-	-	5.88	2.75
Therevidae	1.22	0.58	-	-	-	-	-	-	-	-	5.88	2.75
Phoridae	1.22	0.19	-	-	-	-	-	-	-	-	5.88	0.92
Syrphidae	9.76	2.12	-	-	5.56	1.94	-	-	10.53	2.50	29.41	6.42
Volucella sp.	1.22	0.19	-	-	-	-	-	-	-	-	5.88	0.92
Muscidae	17.07	6.55	16.67	5.44	-	-	20.00	2.50	26.32	25.00	23.53	3.67
Tachinidae	1.22	0.19	-	-	-	-	-	-	-	-	5.88	0.92
Alophora sp.	1.22	0.19	-	-	-	-	-	-	-	-	5.88	0.92
Lepidoptera	20.73	7.32	33.33	8.84	16.67	2.91	50.00	22.50	15.79	5.00	-	-
larvae	10.98	4.24	5.56	0.68	5.56	0.97	40.00	21.25	15.79	3.75	-	-
Noctuidae	10.98	2.89	33.33	8.16	11.11	1.94	-	-	5.26	1.25	-	-

Table no.2 (continued)

	Whole Population		Lake Eğirdir		Lake Akşehir		Lake Çavuşçu		Lake Suğla		Lake Gölcük	
Prey Taxa	f %	n %	f %	n %	f %	n %	f %	n %	f %	n %	f %	n %
Hymenoptera	30.49	10.02	27.78	6.12	22.22	3.88	30.00	5.00	15.79	7.50	58.82	26.61
Ichneumonidae	6.10	0.96	-	-	-	-	30.00	3.75	5.26	1.25	5.88	0.92
Formicidae	17.07	4.43	22.22	3.40	11.11	1.94	-	-	10.53	2.50	35.29	12.84
Formica sp.	3.66	1.93	-	-	5.56	0.97	-	-	-	-	11.76	8.26
Eumenidae	1.22	0.39	-	-	-	-	-	-	-	-	5.88	1.83
Sphecidae	4.88	0.96	-	-	5.56	0.97	10.00	1.25	5.26	1.25	5.88	1.83
Colletidae	2.44	0.58	-	-	5.56	0.97	-	-	-	-	5.88	1.83
Coelioxys sp.	1.22	0.19	-	-	5.56	0.97	-	-	-	-	-	-
Colletes sp.	1.22	0.39	-	-	-	-	-	-	-	-	5.88	1.83
Apidae	3.66	0.58	11.11	1.36	-	-	-	-	5.26	1.25	-	-
Osteichthyes	9.76	2.50	-	-	38.89	12.62	-	-	-	-	-	-
Cypriniformes	9.76	2.70	-	-	38.89	12.62	-	-	-	-	5.88	0.92
*Cyprinidae	9.76	2.70	-	-	38.89	12.62	-	-	-	-	5.88	0.92
Alburnus sp.	2.44	0.39	-	-	5.56	0.97	-	-	-	-	5.88	0.92
Amphibia	4.88	0.77	5.56	0.68	5.56	0.97	10.00	1.25	5.26	1.25	-	-
Anura	4.88	0.77	5.56	0.68	5.56	0.97	10.00	1.25	5.26	1.25	-	-
*Ranidae	3.66	0.58	-	-	5.56	0.97	10.00	1.25	5.26	1.25	-	-
Rana ridibunda	3.66	0.58	-	-	5.56	0.97	10.00	1.25	5.26	1.25	-	-
Unidentified	20.73	3.28	11.11	1.36	27.78	4.85	10.00	1.25	31.58	7.50	17.65	2.75

* Aquatic and semiaquatic preys.

Discussion

The present study has established that *Rana ridibunda* mainly feeds on invertebrates, and especially on terrestrial prey belonging to the arthropod group, which shows that the feeding of the species largely occurs on land. Previous studies conducted on this particular species reported that it predominantly fed on prey belonging to the class Insecta (e.g. Popovic et al., 1992; Atatür et al., 1993; Turgay, 2001).

The results obtained have revealed that adult prey belonging to the class Insecta are consumed in greater amounts compared to larval prey with respect to numeric proportion determined from stomach contents. Popovic et al. (1992) reported that the Yugoslavian population of the species consumed smaller amounts of larvae compared to adult insects. In anurans, the eye is known as an important sensory organ for hunting (Stebbins & Cohen, 1995). This difference probably stems from the fact that adult prey animals are more active compared to larval prey.

Although sampling was carried out at daytime, individuals from Lake Çavuşçu were not found to be different from other populations with respect to food volume and the number of prey per stomach. This indicates that the species *Rana ridibunda* carry on their feeding activities all day long. Similar situation was observed on the *Rana esculenta* complex from Romania (Cogălniceanu et al. 2000).

Assessment of the food contents of *Rana ridibunda* has revealed that the species consumes greater amounts of terrestrial prey compared to the aquatic one. Studies conducted on highly aquatic species belonging to the family Ranidae showed that terrestrial prey had a significant place in the feeding of this family (e.g. Popovic et al., 1992; Simic et al., 1992). On the other hand, samplings made on the Mordovian population of *Rana ridibunda* during the months of June and July revealed that aquatic animals were consumed more than terrestrial prey (Ruchin & Ryzhov, 2002), indicating that the species can modify its feeding habits depending on the existing conditions of the habitat they live in (Covaciu-Marcov et al. 2005).

An examination of the prey animals consumed by all the populations of the species revealed that neither a family nor an order was dominant over the others; nevertheless, preys belonging to the orders Diptera, Coleoptera and Hymenoptera were found to be consumed at greater amounts compared to other prey groups. Results obtained in previous studies on the food content of similar groups of the species were also compatible with our results. In a study conducted

on the food content of the genus *Rana*, Kminiac (1978), and Popovic and Mikes (1989), encountered 44.5% and 54.1% preys belonging to the order Coleoptera, as well as 7.6% and 13% preys belonging to the order Diptera (Popovic et al., 1992). In a series of food content analyses conducted on the Yugoslavian populations of *Rana* kl. *esculenta*, *Rana lessonae* and *Rana ridibunda*, Popovic et al. (1992) established that prey animals belonging to the class Insecta were predominantly consumed at a rate of 62.3 %, of which 49.1 % were adults, 13.2 % larvae; furthermore, other prey included classes such as Crustacea, Gastropoda, Arachnida, Myriapoda, and Bivalvia. Stomach contents indicated that the order Hymenoptera and the family Formicidae were the most frequently encountered insect groups within the class Insecta. Most frequently seen prey orders in *Rana* kl. *esculenta* stomachs following Hymenoptera were the orders Coleoptera (60.9%), and Diptera (56.5%). Prey animals belonging to Hymeoptera, Coleoptera, Orthoptera, and Gastropoda groups were determined in prey items recovered from 4 *Rana ridibunda* specimens used in the present study. In a study carried out on the *Rana ridibunda* population in Tisza (Yugoslavia), Simic et al. (1992) established the prey items as 74.9 % Insecta, 14.8 % Crustacea, 6.6 % Gastropoda, 3.3 % Arachida, and 0.5 % Chilopoda. The dominant order within the classes Insecta was Diptera. The remaining preys were Coleoptera, Hymenoptera, Odonata, Lepidoptera, Heteroptera, Homoptera and Orthoptera. The families include Syrphidae, Tipulidae and Culicidae from the order Diptera as well as Scarabaeidae, Carabidae, Cantharidae, Elateridae, Chrysomelidae, Hydrophillidae, Curculionidae, Siphidae and Coccinellidae from the order Coleoptera. The dominant family within the order Hymenoptera was Formicidae. The closest study conducted in the study area is a preliminary study by Atatür et al. (1993) on Beyşehir populations of *Rana ridibunda*. The percentage of food in the stomach contents included 97.83 % Insecta and 2.17 % Gastropoda on the basis of classes, and it was found that the most widely consumed orders were Orthoptera and Coleoptera. Researchers also established that *Gryllotalpa gryllotalpa* was the dominant food for the Lake Beyşehir population of *Rana ridibunda*. A great resemblance was observed between the Lake Beyşehir population and the Çavuşçu population with respect to consumption of the class Orthoptera as a food item. A study conducted on *Rana esculenta* complex set forth that Coleoptera was the most widely consumed prey followed by Diptera and that the family Formicidae of the order Hymenoptera

was an important source of food for *R. esculenta* (Cogãlniceanu et al, 2000). In another study carried out in the Central Taurus Region, Turgay (2001) reported that the classes Hymenoptera, Diptera and Coleoptera were the most widely consumed prey groups within the class Insecta.

Considering the variety of food groups determined in the stomach contents, it could be stated that *Rana ridibunda* has a wide range of prey in its diet. Food contents of the populations found in the study area also revealed that certain groups had a greater numeric proportion compared to others. The differences observed in the numeric proportions indicate that the feeding habits of the individuals change depending on the population density of the preys found in the area. The fact that food groups in the five populations examined are different from one another shows that the members of the species are opportunistic feeders. Many researchers have also reported that many species belonging to the family Ranidae are not fussy eaters (Kovács & Török, 1995; Cogãlniceanu et al., 2000).

Various researchers reported that they had encountered not only invertebrates but also other preys such as fish, amphibians, turtles, snakes, mammals in the stomach content of *Rana ridibunda* (Angelov & Bacvarov, 1972; Turgay, 2001; Ruchin & Ryzhov, 2002, Covaciu-Marcov et al. 2005). The Lakes District population of the species can easily consume vertebrate prey such as Cypriniformes and Ranidae.

As far as feeding is concerned, no difference was found between females and males examined in the present study. This is probably associated with the fact that females and males use the same area for foraging. Studies conducted on various other species also revealed no difference between females and males with respect to feeding (Measey, 1998; Hirai & Matsui, 2000; Parker & Goldstein, 2004). But, other feeding studies conducted on the species *Rana lessonae* and *Rana arvalis* from Romania showed that females consume more taxon-rich prey compared to males (Sas et al. 2005)

According to our observations, the relationship among the morphological characters established in all of the populations showed that morphology had a significance effect on the feeding behaviour of the species as well. The larger an individual is, the wider range of food it has. Fish and frogs recovered from the stomach contents showed that the marsh frogs did not limit their diet to the class Insecta and that they could easily consume different prey groups too. Many researchers emphasized that morphological characters were also important for feeding (Huey &

Pianka, 1981; Pough & Magnusson, 1992; Perry & Pianka, 1997). No particular relationship was observed among the morphological characters compared with the number of prey per stomach. This is associated with the fact that small-size individuals feed on small preys, while bigger individuals consume not only large preys but also small ones (Berry, 1966; Houston, 1973).

Certain differences were determined among the rates of stomach fullness of the populations. The reason for these differences was associated with their hunting preferences in different areas. Although the numeric proportion of the prey groups demonstrated some variations among populations, no difference was determined among the frequency of occurrence. Five populations of *Rana berlandieri* were examined in Texas, and it was reported that their food compositions (and) numeric proportions were different (Parker & Goldstein, 2004). Parker & Goldstein (2004) along with many other researchers have the opinion that the numeric proportion of prospective prey in the habitat of a species is the main factor affecting the food- related differences in different populations of the species (Berry & Bullock, 1962; Jenssen & Klimstra, 1966; Houston, 1973; Werner et al., 1995). Five populations of *Rana ridibunda* were examined in the present study and they were found to have different rates of food contents. Habitat is probably the main factor causing these differences.

Four juvenile *Rana ridibunda* individuals were encountered in the studied marsh frog stomach contents, showing that the species has started exhibiting cannibalistic behaviour under the stress of hunger. Stebbins and Cohen (1995) reported that cannibalism could be observed in certain species of frogs, especially where the number of juveniles in the population is excessively high. If changes in the ecological conditions in the habitat occur or the population outgrows the area it inhabits in time, this could force individuals towards cannibalism. If the amount of food in the environment starts to decrease, cannibalism emerges as a mechanism of increasing the survival rate of the individuals (Polis, 1981; Crump, 1992; Pfennig, 1992). A number of researchers have also reported cannibalism in the family Ranidae in their studies (Berry, 1966; Hodar et al., 1990, Covaciu-Marcov et al., 2005). In a study they conducted on *Rana esculenta* complex, Cogãlniceanu et al. (2000) encountered at least one juvenile prey of its own species in the stomach contents of 23 % of the population. The authors concluded that individuals of this particular species had become cannibals. Ruchin & Ryzhov (2002) also reported

widespread cannibalism among *R. ridibunda*.

Some Insecta individuals found in the food content are agricultural pests. By preying on the class Insecta, *Rana ridibunda* help decrease or counterbalance the insect population in the area it inhabits. Thus, it can be considered a contributing factor in preventing pests from destroying the agricultural land in the area. In a study they conducted, Atatür et al., (1993) stated that this species could contribute to biological struggle for pest-control due to the fact that *Gryllotalpa gryllotalpa* was the predominant species in the diet of the population they examined. Furthermore, another study conducted by Turgay (2001) emphasized the fact that the species could play an important role in biological struggle. Based on the results obtained in the present study, it can be asserted that the species specializes on prey belonging to the class Insecta, and thus helps reduce the harmful effects of the pest individuals of this group on the environment. However, the direct role of a species in biological struggle occurs when it prefers to feed on a particular group of pests. In our case, it is hard to state that *Rana ridibunda* has a direct role in biological struggle. Nevertheless, its indirect contribution to biological struggle is a fact that cannot be denied.

Rana ridibunda is a species with great commercial value. Collection for export purposes causes extensive damage to the Lakes District population of the species in particular. This species will probably have to be culturegrown in future. Until that time, however, over-collection and thus the reduction of the population sizes will unfortunately continue. On this subject, Baran et al. (1992) refers to the need for adoption of a series measures so as to minimize the loss suffered by the species. Moreover, ecologists and herpetologists have agreed that the amphibian populations have declined at alarming rates and that many species are faced with a serious risk of extinction (e.g. Blaustein & Wake, 1990; Alfold & Richards, 1999; Houlahan et al., 2000). We still lack sufficient precise information on the condition of amphibian populations in our country, due to the fact that we have a limited number of studies related to this particular issue at present. Improper utilization and loss of wetlands leads to destruction of the habitats of several species. This means that many species in our country are under the threat of extinction and that even species with a wide distribution such as *Rana ridibunda* will eventually suffer from the consequences of this situation. Therefore, studies related to the ecology of these species are urgently needed.

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