A contribution to the knowledge of the trophic spectrum of the Common toad (*Bufo bufo* L., 1758) (Amphibia: Anura) from Bulgaria

IVELIN MOLLOV

University of Plovdiv "Paisii Hilendarski", Faculty of Biology, Department of Ecology and Environmental Conservation, 24 Tzar Assen Str., Plovdiv, BG-4000 Bulgaria
mollov_i@yahoo.com

PETAR BOYADZHIEV

University of Plovdiv "Paisii Hilendarski", Faculty of Biology, Department of Zoology,
24 Tzar Assen Str., Plovdiv, BG-4000 Bulgaria
boyadz@uni-plovdiv.bg

Abstract. During our study we identified 500 prey items in 20 prey categories in the trophic spectrum of *Bufo bufo* with average number of prey items per stomach 25.00. The most important prey taxon is Formicidae (70.20%), followed by Coleoptera (especially Carabidae – 11.40%), as well as non-insect invertebrates (Isopoda, Gastropoda, Arachnida) which also play significant role. The estimated trophic niche breadth is low – 1.96.
Key words: *Bufo bufo*, trophic spectrum, niche breadth, Plovdiv, Bulgaria.

Introduction. Some species of the Bulgarian batrachofauna are still poorly studied concerning their trophic spectrum and feeding ecology (Mollov *et al.* 2006). The Common toad (*Bufo bufo* Linnaeus, 1758) is the largest anuran species occurring in Bulgaria and its trophic spectrum is very poorly known. Partial data about the throphic spectrum of the species in Bulgaria can be found in the works of Kovachev (1912), Buresh & Tsonkov (1942), Angelov (1960) and Beshkov & Nanev (2002). Currently there is only one specialized study on the diet of the Common toad, conducted in Bulgaria (Angelov & Batschwarov 1972).

The aim of the current study is to supplement the knowledge about the trophic spectrum and feeding ecology of the Common toad (*Bufo bufo*) in Bulgaria.

Material and Methods. We examined 8 stomachs of adult specimens of the Common toad (*Bufo bufo*), preserved in 70% alcohol and kept in the herpetological collection of the Department of Zoology at the University of Plovdiv, Bulgaria. The material was collected in 27.V.1967 from the urban park "Otdih i kultura" (former "Ostrova" Area) near the Rowing Channel in Plovdiv City (South Bulgaria), UTM LG16.

The stomachs were dissected in Petri dishes and the stomach contents were analyzed by means of binocular microscope. The prey taxa were identified to the lowest possible taxon, based on its degree of composition. The systematic of the identified invertebrate taxa follows Fauna Europaea (2007).

We classified each prey item as either terrestrial or aquatic on the basis of the habitats in which it typically occurs.

Sampling adequacy was determined using Lehner`s formula (Lehner 1996):

$$Q = 1 - \frac{N_1}{I},$$

rising from 0 to 1, where N_1 is the number of the food components occurring only once, and I is the total number of the food components.

The diversity of the diet (niche breadth) was calculated, using the reciprocal value of the Simpson's diversity index (Magurran 1986):

$$S = \frac{1}{\sum p_i^2},$$

where: S – trophic niche breadth; P_i – proportion of food component i.

To determine the level of the food specialization we used the index of dominance of Berger-Parker (d), calculated by the following formula (Magurran 1988):

$$d = \frac{n_i \max}{N},$$

where: N – the number of all recorded food components (taxa); $n_i$max – the number of the specimens form taxon i (the most numerous taxon in the diet). The Berger-Parker index (d) varies between 1/N and 1. A value closer to 1 means a higher specialization in the choice of food; a value closer to 1/N is typical for a species that is a general feeder (polyphage).

The results were statistically processed using descriptive statistics with the software package "Statistica 7.0" (StatSoft Inc. 2004). For the calculations of Simpson's diversity index and the Berger-Parker index we used the computer software "Bio-DAP" (Thomas & Clay 2000).

Results. The analyzed stomach contents of total 8 stomachs of *Bufo bufo* contained 500 prey items, divided in 20 prey categories. The average number of prey items per stomach is 25.00 (SD=77.81). The sampling adequacy is considered sufficient - 0.70.

Table 1 presents the qualitative and quantitative proportion and frequency of occurrence of the trophic spectrum of *Bufo bufo*.

The predominated food type in the diet of the Common toad is insects (94.4%). The most numerous prey taxon is the Formicidae family (70.20%) from the Hymenoptera order (71.20%), followed by Carabidae family (11.40%) from the Coleoptera order (21.00%). The Berger-Parker index showed considerably high value - 0.70 (Table 1). From the non-insect invertebrates the Isopoda order shows the highest value (4.20%).

Most of the recorded prey taxa are classified as terrestrial (99.00%).

Unidentified insects in this study usually consisted of a wings, legs, or body segments, which may indicate that either the toad was unable to capture the entire prey item or the remaining portion of the prey item was not detected because it had passed through the digestive system at a different rate.

Because of the fact that the material was collected only in one season it is impossible to analyze the seasonal variations of the trophic spectrum.

Discussion. According to Angelov & Batschwarov (1972) the predominated prey taxon in the Common toad's diet is Carabidae (22.95%), respectively Coleoptera (36.36%) followed by Formicidae (19.67%), respectively Hymenoptera (27.27%). The trophic niche breadth calculated from the data of the same authors is 9.13 and the Berger-Parker index is 0.36. Based on that data and due to the fact that the study of Angelov & Batschwarov (1972) is based only on the contents of 6 stomachs Mollov *et al.* (2006) concluded that *Bufo bufo* is probably a polyphage. Our study showed much lower value of the trophic niche – 1.96 and much higher value of the Berger-Parker – 0.70, which indicates that, depending on the season, there might be a slight preference to the ants as a food source.

The most important prey category - the ants (Formicidae) and the beetles (Coleoptera), being consumed frequently by the Common toad, are basic food most probably due to the abundance of this food and the wide range of habitats where it could be found.

Table 1. *Results from the food niche study of the diet of Bufo bufo (n=8).*
Legend: *n – number of prey items; n % - numeric proportion (percentage proportion from the total number of prey items); f % - frequency of occurrence (percentage proportion of the frogs that consumed the prey taxon).*

Prey taxa	n	n %	f %
Mollusca (Gastropoda)	2	0.40	25.00
Arachnida (Aranei)	3	0.60	37.50
Crustacea (Isopoda, Oniscidea)	21	4.20	25.00
Entognatha: Collembola	2	0.40	12.50
Insecta			
Hemiptera: Heteroptera	2	0.40	12.50
Hemiptera: Auchenorrhyncha (larvae)	1	0.20	12.50
Hymenoptera (undet.)	1	0.20	12.50
Apoidea	1	0.20	12.50
Formicidae	351	70.20	62.50
Proctotrupoidea Proctotrupdae	4	0.80	25.00
Diptera (Nematocera)	1	0.20	12.50
Diptera (larvae)	5	1.00	12.50
Coleoptera (undet.)	3	0.60	25.00
Carabidae	57	11.40	87.50
Chrysomelidae	19	3.80	50.00
Coccinellidae	1	0.20	12.50
Curculionidae	10	2.00	50.00
Scarabaeoidea	5	1.00	37.50
Staphylinidae	10	2.00	62.50
pebbles, soil, sand	1	0.20	12.50
Sampling adequacy		**0.70**	
Berger-Parker index		**0.70**	
1/Simpson		**1.96**	

The diet of the Common toad is consisted with almost only terrestrial prey. Aquatic preys probably become accessible when the puddles dry out or in puddles with an extremely low water level. According to Buresh & Tsonkov (1942) this species forages primarily at night and is very well adapted to hunt in terrestrial biotopes. Considering the fact that ants are the most preferred prey type by the Common toad it is possible that this species hunts during the day as well, especially in the spring season.

From some of the stomachs we obtained little pebbles and soil. Their presence in the trophic spectrum should be considered as accidental, because they are probably being digested with the captured insects.

Other authors report only partial data about the trophic spectrum of the Common toad, without any quantative values. According to Kovatchev (1912) the Common toad feeds on "worms, slugs, beetles, ants, spiders and centipedes". Buresh & Tsonkov (1942) report based on the feces from two specimens that the Common toad feeds mainly on Coleopterans, especially form the Carabidae, Scarabeidae, Curculionidae, Tenebrionidae and Chrysomelidae families, as well as earth worms. During an entomological study of the urban park "Otdih i kultura" in Plovdiv City, Angelov (1960) reported that he found in the stomach contents of *Bufo bufo* "a large number of insects, especially Carabidae". Beshkov & Nanev (2002) reported that "the main food source of the Common toad are insects – ants

and beetles, but also centipedes, spiders, collembolans, earth worms, slugs and snails and sometimes even small snakes, mice and rodents".

In our opinion further studies on the trophic spectrum of *Bufo bufo*, based on large number of studied specimens and conducted during several seasons, are needed in order to determine the variations in the diet, the food specialization of the species as well as its niche breadth.

Conclusions. 1. During our study we identified 500 prey items in 20 prey categories in the trophic spectrum of *Bufo bufo* with average number of prey items per stomach 25.00.

2. The most important prey taxon is Formicidae (70.20%). Other important prey animals are Coleoptera (especially Carabidae – 11.40%), as well as non-insect invertebrates (Isopoda, Gastropoda, Arachnida) which also play significant role.

3. The Common toad hunts primarily at night, but it is possible that the hunting may be occurring during the day as well, especially in the spring season.

4. The toads consume almost only terrestrial prey and aquatic preys probably become accessible only when the puddles dry out or with extreme low water level.

5. The estimated trophic niche breadth is low – 1.96.

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