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SEASONAL DIET DIFFERENCES OF THE COMMON TOAD *BUFO BUFO* (LINNAEUS, 1758) IN UKRAINIAN ROZTOCHIA (WESTERN UKRAINE)

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A question of nutrition of amphibians as key-components in ecosystems is becoming increasingly important and actual. This study needs detail and regular research. We surveyed nutrient content and seasonal diet spectra of the Common Toad *Bufo bufo*, which is one of the key amphibian species in the forest habitats of Ukrainian Roztochia. Both traditional method (Barber traps invertebrate sampling) and improved approach for amphibian stomach contents research (*Bufo bufo* stomach preparation and analysis of its nutrient content was made on the specimens crushed on the roads of the region) were used. We found out that Myriapoda (23.5 %) and Diptera (17.6 %) dominate in the autumn diet of *Bufo bufo*, Coleoptera (54.2 %) dominate in the species' diet in spring, and the most common victims of *Bufo bufo* in summer are Hymenoptera representatives, particularly Formicidae (25.6 %). The amphibian stomach contents differences can be attributable to the abundance of invertebrate taxa in the habitats during the appropriate seasons.

Key words: Common Toad, diet, stomach contents, invertebrates, Ukrainian Roztochia, Ukraine.

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INTRODUCTION

The Common Toad *Bufo bufo* (Amphibia, Anura, Bufonidae) is one of the most common anuran amphibian species in Ukraine, and in Ukrainian Roztochia particularly (Horban 2010, Polushyna & Shaitan 1991). The Common Toad inhabits almost all Europe, except Ireland, North of Scandinavia and some Mediterranean islands, on East *B. bufo* is present up to Trans-Baikal region, it is also known from North-West Africa. In Ukraine the Common Toad occurs in various forest landscapes, where it inhabits diverse biotopes – from coniferous, deciduous, mixed forests to different plantations like groves, parks, garden areas, city greenery etc. *B. bufo* is associated with water reservoirs only during the reproductive period; other part of seasonal cycle it lives nearby the ponds, preferring wet habitats. Seasonal activity usually starts in the first half – middle of March and is associated with 5…10° C level of air temperature. In the breeding period the Common Toad can be observed in reservoirs during the day, but till

the end of breeding it displays twilight activity. After the breeding period *B. bufo* individuals are located in radius of 500 – 1500 m from breeding sites, but in August – October they begin migrations to hibernation sites. One of the characteristic features of the species feeding process is weak activity in patrolling of the area of stay. Invertebrates (ants & beetles mostly) limit nutrition content of the Common Toad (Pysanets 2007, Tatarynov 1973, Shcherbak & Scherban 1980). These results are supported by Ruchin and Alekseev (2008, 2012), who studied spectrum of nutrition of the Common Toad in Russia in pine forest, where they confirmed a significant level of myrmecophagy for the species, in particular.

Despite the large number of publications about the diet of amphibians, this survey is actual and necessary for the understanding the trophic role of *Bufo bufo* as one of the most common and numerous amphibian species in ecosystems of Ukrainian Roztochia. It is also important to highlight the habitat loss and transformation trend nowadays, which is leading towards depletion and simplification of not only amphibian, but also animal communities in total, including the destruction of natural food chains. Consequently, we can witness the process of amphibian habitats fragmentation by the roads and the increasing of traffic volume, which are significant barriers for their seasonal migrations in the region (Reshetylo et al. 2019). The amphibian population decline and extinction have resulted in the appearance of free ecological niches. This process causes significant adjustments in trophic chains, which are not clear and need to be investigated. So, the aim of this work is to study the diet of the Common Toad *Bufo bufo* in Ukrainian Roztochia and compare its seasonal differences.

MATERIALS AND METHODS

Material sampling was made during spring, summer and autumn seasons in 2018 – 2019 in the research area of Ukrainian Roztochia within Roztochia Nature Reserve and Yavorivskyi National Nature Park (Fig. 1).

For the study of litter invertebrate diversity, we used Barber traps sampling in both sites (ten 0.5 l traps in one row with 10 m distance between).

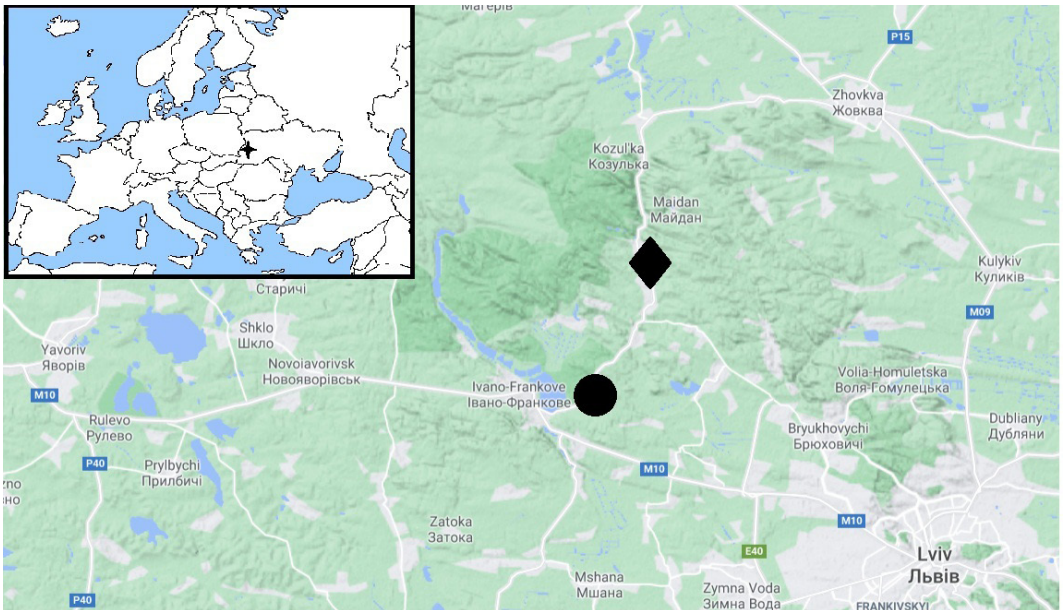

Fig. 1. Sampling sites in Ukrainian Roztochia: ● - Roztochia Nature Reserve (49.913734, 23.759444), ◆ - Yavorivskyi National Nature Park (49.974459, 23.820374), ✦ - location of Ukrainian Roztochia.

4% solution of formaldehyde was used as a trap conservation fluid (Barber 1931). The traps had been used for two months during each of three periods of the Common Toad seasonal activity: September – October 2018, March – April 2019, and July – August 2019.

We surveyed the stomach content of *Bufo bufo* to determine the species composition of its victims. For the environmental and bioethics reasons we sampled only dead, especially crushed on the roads specimens of the Common Toad to check their stomach contents. The improved approach avoids premeditated elimination of animals and let us use the natural material in full measure. Stomachs and their contents were conserved in ethanol (70 %). Every stomach sample was labeled by the date and place of collection. Stomach content was disassembled into fractions in a Petri dish by water flushing and using the magnifying glass (7x). The identification of taxa composition of the Common Toad diet was based on the victim remnants and realized using binocular magnification (16x) and appropriate keys for invertebrate determination (Medvedev 1974, Plavilschikov 1994, Mueller 1985).

RESULTS AND DISCUSSION

We sampled and analyzed the stomach contents of 31 specimens of the Common Toad during the research period and compared it with the results of invertebrates sampling over the course of *Bufo bufo* seasonal cycle.

Analysis of Barber traps contents. We sampled 480 specimens of invertebrates in the research sites of Ukrainian Roztochia. According to the results, Coleoptera and Isopoda representatives showed the highest level of occurrence during all the period of research irrespective of the season (Fig. 2). Such a result is confirmed by literature data (Rizun et al. 2010), where we can see almost the same invertebrate taxa composition within the territory of Roztochia Biosphere Reserve.

Diet of the Common Toad. According to our results, nearly 90 % of *Bufo bufo* diet are represented by herpetobiotic invertebrate species in total; the rest ones are larvae and imago of Diptera. Carabidae (14.6 %) and Formicidae (18.9 %) prevail among the herpetobiotic victims of the Common Toad along the whole season on

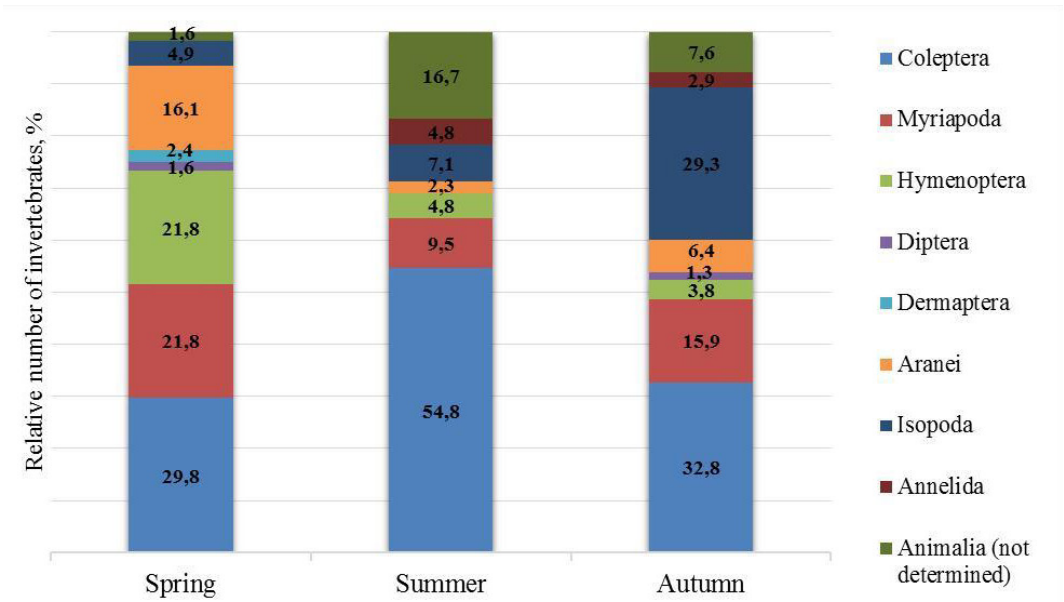

Fig. 2. Seasonal composition of herpetobiotic invertebrate taxa in the forest research area of Ukrainian Roztochia.

Table 1. Seasonal spectra of *Bufo bufo* diet on the sampling sites of Ukrainian Roztochia

Taxa	Spring		Summer		Autumn	
	Victims, n	%	Victims, n	%	Victims, n	%
Carabidae	**83**	**31.5**	11	12.3	-	-
Coccinelidae	2	0.7	-	-	-	-
Tenobrionidae	11	4.2	-	-	-	-
Staphylinidae	-	-	3	3.4	-	-
Cerambycidae	-	-	-	-	1	5.9
Curculionidae	24	9.1	-	-	-	-
Elateridae	7	2.7	-	-	-	-
Chrysomelidae	14	5.3	-	-	-	-
Silphidae	2	0.7	3	3.4	-	-
Hemiptera	7	2.7	1	1.1	-	-
Diptera	-	-	4	4.4	**3**	**17.6**
Dermaptera	7	2.7	5	5.6	2	11.8
Lithobiidae	6	2.3	-	-	-	-
Polydesmidae	-	-	6	6.7	1	5.9
Julidae	10	3.8	2	2.1	**3**	**17.6**
Formicidae	**51**	**19.3**	**23**	**25.6**	2	11.8
Acari	2	0.7	6	6.6	-	-
Aranei	21	7.9	7	7.7	-	-
Isopoda	5	1.9	-	-	2	11.8
Lumbricidae	1	0.4	1	1.1	-	-
Mollusca	6	2.2	**14**	**15.6**	-	-
Animalia (not det.)	5	1.9	4	4.4	3	17.6
Total	**264**	**100**	**90**	**100**	**17**	**100**

Notes: dominant taxa groups of victims are given in bold

average. Number of victims per one stomach depends on the season and averages 4 specimens in autumn period, 16 in spring, and 10 in summer. It seems the number of victims depends on each season conditions, air temperature mainly, as amphibian activity becomes lower following the temperature decreasing. It is obvious in autumn when amphibians having enough glycogen resources stored are focused on hibernation. It is also important to mention that low air temperature impacts the invertebrates activity as *Bufo bufo* victims too (Ruchyn & Alekseyev 2008, 2012). It should be noted as well that approximately half of the surveyed stomachs contained some plant remains and small stones. They possibly were captured together with the food objects as we assume. Besides that, Nematoda parasites were found in one of the stomachs. The parasites penetrated into stomach from the reproductive ponds as we suppose. It is known that parasitic nematodes can spend winter period in inactive host organism causing particular dehydration of amphibian organism (Aralkhanova 2010, Toft 1981).

Seasonal spectra and list of victims (orders and families) of the Common Toad are presented in Table 1.

Comparing data on the composition of sampled invertebrates and *Bufo bufo* stomach contents, we have to notice some similarity in between. In

Table 2. The comparison of Barber traps and the Common Toad stomach contents on the sampling sites of Ukrainian Roztochia

Taxa	Barber traps			Stomach contents of *Bufo bufo*		
	Spring, %	Summer, %	Autumn, %	Spring, %	Summer, %	Autumn, %
Coleoptera	**29.8**	**54.8**	**32.8**	**54.2**	**19.1**	5.9
Dermaptera	2.4	-	-	2.7	5.6	11.8
Hemiptera	-	-	-	2.7	1.1	-
Acari	-	-	-	0.7	6.6	-
Diptera (larvae)	1.6	-	1.3	-	4.4	**17.6**
Myriapoda	**21.8**	9.5	15.9	6.1	8.8	**23.5**
Hymenoptera	**21.8**	4.8	3.8	**19.3**	**25.6**	11.8
Isopoda	4.9	7.1	**29.3**	1.9	-	11.8
Aranei	16.1	2.3	6.4	7.9	7.7	-
Mollusca	-	-	-	2.2	15.6	-
Annelida	-	4.8	2.9	0.4	1.1	-
Animalia (not det.)	1.6	16.7	7.6	1.9	4.4	17.6
Total	**100%**					

Notes: dominant taxa groups of invertebrates are given in bold

accordance to the results, Coleoptera show the highest values on average (39.1 and 26.4 %); other invertebrate taxa having the same ratios, e.g. Myriapoda, Aranei, are lower in values. The results are presented in Table 2.

As we can see from Table 2, hit frequency of some groups of invertebrates in both cases supposes relatively low victim selectivity for the Common Toad. For example, high numbers of Coleoptera specimens in spring, both in stomachs and in the traps can be explained by their abundance in the research habitats. Therefore, in many cases it feeds on the objects, which are the most common due to season. Nevertheless, we registered some food selectivity in autumn while it was not supported significantly: the Common Toad diet consisted of Myriapoda and Diptera mostly, when Coleoptera, Isopoda and Myriapoda were often registered in the traps in that period. Similar situation can be described also for summer values of Hymenoptera – they are more common in the stomachs compare to the traps. Rest of the taxa are represented in low numbers. Besides that, considerable *Bufo bufo* diet differences are noticeable for Acari and Mollusca victims, which numbers differ essentially between spring and summer periods. Overall, number of invertebrate taxa detected in autumn in the Common Toad stomachs is 6, while in the traps we sampled 7 ones (Sorenson index of similarity (S) is 0.77). During spring period we registered 10 victim taxa and 7 ones in Barber traps (S=0.71). In summer we also noted 10 taxa in the Common Toad stomachs, but only 6 in the traps (S=0.63). So, we can assume that in warm seasons (spring and summer) *Bufo bufo* demonstrates higher diversity and lower similarity of victims compare to the habitat herpetobiotic invertebrate composition, while in colder season (i.e. autumn) the list of victims is less diverse and more similar to the habitat invertebrate surroundings.

CONCLUSIONS

So, we collected field material and analyzed spectra and seasonal differences of the Common Toad *Bufo bufo* diet on the research areas of Ukrainian Roztochia.

We sampled 480 objects in Barber traps during the full season cycle (autumn, spring and summer). According to the results, the most

common invertebrate taxa sampled in the traps are Coleoptera (39.1%) and Isopoda (13.8%) on average. Spring period revealed Coleoptera, Dermaptera, larvae of Diptera, Myriapoda, Hymenoptera, Isopoda, Aranei and some indetermined invertebrates as well. The list of summer period taxa was as follows: Coleoptera, Myriapoda, Hymenoptera, Isopoda, Aranei and Annelida. During the autumn period we registered 7 taxa in the traps: Coleoptera, larvae of Diptera, Myriapoda, Hymenoptera, Isopoda, Aranei, Annelida and some indetermined specimens. Hence, the whole-season activity in Ukrainian Roztochia is demonstrated by Coleoptera, Myriapoda, Hymenoptera, Isopoda and Aranei.

We surveyed the qualitative and quantitative victim composition of the Common Toad. We used 31 stomach of the species for that, which were sampled from the specimens crushed on the roads of the region. Carabidae (14.6 %) and Formicidae (18.9 %) prevails in the Common Toad diet in general. The whole diet spectrum of the species includes the herpetobiotic invertebrates, which belong to Mollusca, Annelida and Arthopoda. The most common victim taxa of *Bufo bufo*, which are presented in stomach contents regardless of the season are: Coleoptera, Dermaptera, Myriapoda and Hymenoptera.

We compared seasonal dynamics of the Common Toad diet to invertebrate species diversity of the mixed forest litter of Ukrainian Roztochia. Hence, we found out much higher feeding activity in spring and summer seasons (16 and 10 objects per stomach in accordance) than in autumn period (only 4 objects per stomach). According to our research the most common victims of *Bufo bufo* are representatives of Coleoptera (dominate in spring), Hymenoptera (dominate in summer), Myriapoda (autumn season dominant). So, we can assume some insignificant seasonal selectivity of the Common Toad diet in Ukrainian Roztochia, but this study has to be continued and detailed to confirm it.

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