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The Trophic Spectrum of the Northern White-Breasted Hedgehog (Erinaceus roumanicus Barrett-Hamilton, 1900) in Plovdiv City, Bulgaria

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Abstract. The food spectrum of the Northern white-breasted hedgehog (*Erinaceus roumanicus* Barrett-Hamilton, 1900) was studied based on the number of specimens/fruits in its excrements. A total of 181 scats (19 food items) from hedgehog were collected in park "Otdih i Kultura" in Plovdiv City, Bulgaria and were analyzed during the spring-summer period of 2017. In the study area, the hedgehog consumed mainly beetles (Coleoptera undet.) - 49.19%, followed by the ants (Hymenoptera, Formicidae undet.) - 10.69%. The value of Berger-Parker dominance index was 0.49, which determines the hedgehog as a polyphagous rather than an oligophagous. The food niche of the species in Plovdiv City during the spring-summer season was with a value of 0.19.

Key words: *food spectrum, Northern white-breasted hedgehog, Erinaceus roumanicus, Plovdiv City.*

Introduction

The food spectrum of the Northern white-breasted hedgehog (*Erinaceus roumanicus* Barrett-Hamilton, 1900) in Plovdiv City has not been investigated so far.

Hedgehogs consume a variety of food, but mainly of animal origin – different invertebrates, small vertebrates (rodents, amphibians, reptiles, eggs of birds and their young). Of secondary importance are fruits, mushrooms and others (PESHEV *et al*., 2004).

A study of the diet of hedgehogs, mainly *Erinaceus concolor* but possibly also some *Erinaceus europaeus,* in an urban environment by OBRTEL & HOLISOVA (1981), found that the diet was consisted with mainly arthropods from the litter on the surface of the soil. Millipedes, earwigs and beetles were important year round, while chafers, weevils, ants, aquatic insects attracted to street lights and comatose bees were taken opportunistically.

Vegetable matter including fruits, acorns and berries, same as fungi constitute a relatively small proportion of the natural diet (REEVE, 1994).

The diet of hedgehogs is affected by food availability, as well as the diet of urban hedgehogs may vary from that of rural hedgehogs. A study of the contents of the gastrointestinal tract of 87 hedgehogs showed that suburban hedgehogs ate more fruit, isopods and tipulid larvae than did rural individuals, while the rural animals ate more lepidopteran larvae (caterpillars) (DICKMAN, 1988).

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In New Zealand, a study examining stomach contents of 10 hedgehogs plus 90 hedgehog droppings found that slugs and millipedes were the main items in the diet of suburban hedgehogs (snails were also eaten frequently) (BROCKIE, 1959).

The aim of this study is to study the food spectrum of the Northern white-breasted hedgehog (*Erinaceus roumanicus* Barrett-Hamilton, 1900) in Plovdiv City, Bulgaria.

Material and Methods

The food spectrum of the Northern white-breasted hedgehog (*Erinaceus roumanicus*) in the city of Plovdiv was studied based on the number of specimens/fruits in its excrements.

A total of 181 scats from hedgehog were collected in park "Otdih i Kultura" in Plovdiv City, Bulgaria and were analyzed during the spring-summer period of 2017.

The excrement collection method does not allow complete and accurate yield and determination of the animal's food spectrum and there is a significant error. Moreover, this method does not make it possible to specify the number of animals leaving the excrement, their sex and age. However, such studies have made a significant contribution to the research of mammalian feeding ecology.

The excrements were placed in 75% ethanol and then dried for 14 days. The food components were defined in the Department of Ecology and Environmental Conservation, Faculty of Biology, University of Plovdiv "Paisii Hilendarski", by morphological criteria, by means of a binocular magnifying glass at a 10x magnification lens.

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 quantitative analysis of the hedgehog's food spectrum was done by taking into account the percentage of the individual food components in the scat contains (DAAN, 1973).

Food specialization was calculated using the Berger-Parker (d) dominance index (MAGURRAN, 1988):

$$d = \frac{n_{imax}}{N},$$

where: d is the index of dominance; N is the number of individuals from all food components; $n_{i\ max}$ is the number of the most numerous food component. 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 food niche breadth (B) of the hedgehog was calculated by the Levin index (HURLBERT, 1978):

$$B = \frac{1}{R\sum P_i^2},$$

where: B is the food niche breadth; R is the number of individual categories of food components; P_i is the relative rate of occurrence (proportion) of each category of food component.

The proportion (P_i) was calculated using the formula (MAGURRAN, 1988):

$$P_i = \frac{n_i}{N},$$

where: n_i is the number of taxon i; N is the number of all taxa from the food spectrum.

Results and Discussion

A total of 19 food items were determined in the diet of hedgehog from Plovdiv city - 15 insect species, 3 plant species and 1 mammal

species. The sampling adequacy is considered sufficient - 0.68.

The percentage of the individual food components mentioned above was calculated and presented in Table 1.

The main components of hedgehog's trophic spectrum in the study area were beetles (Coleoptera undet.) - 49.19%, followed by ants (Formicidae undet.) - 10.69%. These insects are widespread in the city of Plovdiv and are relatively easy to capture and rich in protein, spending the least foraging costs. The other food components had a significantly lower percentage, more important of which are: Hemiptera undet. - 6.88%, Asian ladybeetle (*Harmonia axyridis*) - 6.44%, firebug (*Pyrrhocoris apterus*) - 5.86%, earwigs (*Forficula* sp.) - 5.42 %, Coccinellidae undet. - 3.95%, seven-spot ladybird (*Coccinella septempunctata*) - 3.81%, 24-spot ladybird (*Subcoccinella vigintiquatuorpunctata*) - 3.51%.

For comparison in the spring-summer period of 2014-2016, in the region of Sashtinska Sredna Gora (MIKOV & GEORGIEV, 2016) hedgehogs consumed mainly ants (Formicidae undet.) – 77.04%, followed by beetles (Coleoptera undet.) – 14.97%, indicating that these two food components were essential to the hedgehog.

In Europe, *H. axyridis* is considered to be an invasive alien species because of its potential to disrupt native ladybird communities (ADRIAENS *et al.*, 2008). Feeding on this ladybug, the hedgehog assists the populations of native species of ladybirds.

Although alfalfa ladybird *Subcoccinella vigintiquatuorpunctata* attacks mainly alfalfa (*Medicago sativa* L.) it was recorded as a pest of more than 70 plant species belonging to the families Leguminosae and Caryophyllaceae (ALI, 1976). Feeding on this ladybird, the hedgehog has a positive effect on agronomy, reducing the population of this species.

The value of the Berger-Parker dominance index for the hedgehog's diet in Plovdiv was 0.49 considering the species as a polyphagous rather than an oligophagous. In contrast, MIKOV & GEORGIEV (2016) determined the hedgehog from Sashtinska Sredna Gora Mts. as oligophagus predator using Berger-Parker dominance index – 0.77 (Table 1). It is possible that the reason for the difference in the two study areas is that the ants (Formicidae undet.) and the beetles (Coleoptera undet.) in Plovdiv City were not as widespread and abundant as in the region of Sashtinska Sredna Gora Mts., and hence the hedgehog has supplemented its food spectrum with true bugs (Hemiptera undet.), asian ladybeetle (*Harmonia axyridis*) and firebug (*Pyrrhocoris apterus*).

The food niche of the hedgehog in Plovdiv City during the spring-summer period was 0.19, while during the period of 2014-2016, in the region of Sashtinska Sredna Gora Mts. it was 0.05 (MIKOV & GEORGIEV, 2016) (Table 1). These values indicated that the hedgehog niche in Plovdiv City was nearly 4 times wider than in the region of Sashtinska Sredna Gora Mts. This is probably due to lesser distribution and lower abundance of true bugs (Hemiptera undet.), asian ladybeetle (*Harmonia axyridis*) and firebug (*Pyrrhocoris apterus*), in the region of Sashtinska Sredna Gora Mts., which in Plovdiv City were relatively often consumed.

According to a study of the food spectrum of the similar European hedgehog (*Erinaceus europaeus*) in the upper Waitaki Basin, New Zealand, the most commonly eaten prey were Coleoptera (present in 81% of 192 guts), Lepidoptera (52%; n = 192), Dermaptera (49%; n = 192), Hymenoptera (42%; n = 192) and Orthoptera (31%; n = 319). Weta remains occurred in 22% of guts, with the gut of one adult male containing 283 *Hemiandrus* legs. Eggshell was recorded in 4% of 615 guts. Native lizard remains were found in 6% of 615 guts (JONES *et al.*, 2005).

Another study of European hedgehog (*Erinaceus europaeus*) diets revealed that although a wide variety of invertebrates were consumed, the bulk of energy was provided by only four prey types (carabid beetles, earthworms, Lepidoptera larvae, and tipulid larvae). Within these four types, hedgehogs showed a clear tendency to concentrate on only one type at a time and to switch from one

Table 1. Number and percentage of individual food components in the composition of the food spectrum, Berger-Parker dominance index and food niche breadth of the Northern white-breasted hedgehog (*Erinaceus roumanicus*) in Plovdiv City (current study) and the region of Sashtinska Sredna Gora Mts. (after MIKOV & GEORGIEV, 2016).

Taxa	Plovdiv City		Sashtinska Sredna Gora Mts.	
	N	%	N	%
Scolopendra cingulata	-	-	1	0.07
Total Chilopoda	**-**	-	**1**	**0.07**
Adalia bipunctata	6	0.88	-	-
Anisodactylus sp.	-	-	2	0.13
Carabidae undet.	-	-	5	0.33
Carabus sp.	-	-	1	0.07
Cerambycidae undet.	-	-	3	0.20
Cetoniinae undet.	-	-	4	0.26
Coccinella septempunctata	26	3.81	-	-
Coccinellidae undet.	27	3.95	1	0.07
Coleoptera undet.	336	49.19	227	14.97
Harmonia axyridis	44	6.44	-	-
Harpalus sp.	-	-	1	0.07
Neodorcadion sp.	-	-	4	0.26
Oodes sp.	-	-	1	0.07
Otiorhynchus sp.	1	0.15	32	2.11
Scarabaeinae undet.	1	0.15	1	0.07
Subcoccinella vigintiquatuorpunctata	24	3.51	-	-
larva of Coccinellidae undet.	1	0.15	-	-
Total Coleoptera	**466**	**68.23**	**282**	**18.60**
Forficula sp.	37	5.42	26	1.72
Total Dermaptera	**37**	**5.42**	**26**	**1.72**
Coreus sp.	-	-	3	0.20
Hemiptera undet.	47	6.88	2	0.13
Nezara viridula	-	-	1	0.07
Pyrrhocoris apterus	40	5.86	-	-
Total Hemiptera	**87**	**12.74**	**6**	**0.40**
Formicidae undet.	73	10.69	1168	77.04
Vespula sp.	1	0.15	-	-
Total Hymenoptera	**74**	**10.83**	**1168**	**77.04**
Insecta undet.	-	-	2	0.13
larva/pupa of Insecta undet.	-	-	1	0.07
Total Insecta	**-**	**-**	**3**	**0.20**
Mammalia undet.	2	0.29	1	0.07
Total Mammalia	**2**	**0.29**	**1**	**0.07**
♀ Acrididae undet.	-	-	1	0.07
♀ Caelifera undet.	-	-	3	0.20
Acrididae undet.	-	-	2	0.13
Caelifera undet.	2	0.29	2	0.13
Total Orthoptera	**2**	**0.29**	**8**	**0.53**
Plantae undet.	-	-	3	0.20
Total Plantae	**-**	**-**	**3**	**0.20**
Rodentia undet.	-	-	3	0.20
Total Rodentia	**-**	**-**	**3**	**0.20**
Ficus carica	-	-	1	0.07
Morus sp.	13	1.90	-	-
Rosa canina	-	-	2	0.13
Rubus sp.	-	-	2	0.13
undefined fruit	1	0.15	5	0.33
Total fruits	**14**	**2.05**	**10**	**0.66**
undefined herbaceous plant	1	0.15	5	0.33
Total herbaceous plants	**1**	**0.15**	**5**	**0.33**
Total specimens/fruits:	**683**	**100.00**	**1516**	**100.00**
Berger-Parker dominance index:	**0.49**		**0.77**	
Food niche breadth:	**0.19**		**0.05**	

group to another on a seasonal basis. Preference indices (which relate diet and availability) suggested that these four prey types plus the gastropods and dermapterans were the preferred prey (WROOT, 1984).

In studying the food spectrum of introduced European hedgehog (*Erinaceus europaeus*) in a dryland habitat of the South Island, New Zealand, it was found that the most commonly eaten foods were beetles, including rare native species (in 94% of droppings), earwigs (92%), spiders (25%) and native skinks (14%). Remains of at least three skinks were found in one dropping. Earwigs and darkling beetles (Tenebrionidae) were the most preferred food types, and Hymenoptera and cylindrical bark beetles (Colydiidae) were least preferred (JONES & NORBURY, 2010).

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