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THE ROBIN, *ERITHACUS RUBECULA* (PASSERIFORMES, TURDIDAE), AS A COMPONENT OF AUTOTROPHIC CONSORTIA OF FOREST CENOSES, NORTHEAST UKRAINE

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The Robin, *Erithacus rubecula* (Passeriformes, Turdidae), as a Component of Autotrophic Consortia of Forest Cenoses, Northeast Ukraine. Chaplygina, A. B., Yuzyk, D. I., Savynska, N. O. — The role of the robin, *Erithacus rubecula* Linnaeus, 1758 as a consort of autotrophic consortia is considered. It has been found that representatives of 9 higher taxa of animals (Mammalia, Aves, Gastropoda, Insecta, Arachnida, Acarina, Malacostraca, Diplopoda, Clitellata) have trophic and topical links with the robin. At the same time, the robin is a consort of determinants of autotrophic consortia, which core is represented mostly by dominating species of deciduous trees (*Quercus robur* Linnaeus, 1753 (24.6 %), Tilia *cordata* Miller, 1768 (17.5 %), *Acer platanoides* Linnaeus, 1753 (22.8 %), *Acer campestre* Linnaeus, 1753), and also by sedges (*Carex* sp.) and grasses (Poaceae). The robin also belongs to the concentre of the second and higher orders as a component of forest biogeocenoses and forms a complex trophic system. In the diet of its nestlings, there have been found 717 objects from 32 invertebrate taxa, belonging to the phylums Arthropoda (99.2 %, 31 species) and Annelida (0.8 %, 1 species). The phylum Arthropoda was represented by the most numerous class Insecta (76.9 %), in which 10 orders (Lepidoptera (46.8 %) dominates) and 20 families were recorded, and also by the classes Arachnida (15.0 %), Malacostraca (5.3 %) and Diplopoda (1.9 %). The invertebrate species composition was dominated by representatives of a trophic group of zoophages (14 species; 43.8 %); the portion of phytophages (7 species; 21.9 %), saprophages (18.7 %), and necrophages (15.6 %) was the less. The highest number of food items was represented by phytophages (N = 717; 51 %), followed by zoophages (34 %), saprophages (12 %), and necrophages (3 %). The difference among study areas according to the number of food items and the number of species in the robin nestling diet is shown. In NNP "HF", the highest number of food items was represented by phytophages — 47 % (N = 443), whereas zoophages were the most species-rich group (43.3 %, 13 species). In NNP "H", phytophages also prevailed in food items — 62.3 % (N = 164), but the number of phyto-, zoo- and saprophage species was equal (30.8 %, 13 species). In the forest park, zoophages were more frequent — 45.5 % (N = 110), but phytophages were the most species-rich (42.9 %).

Key words: *Erithacus rubecula* Linnaeus, trophic links, consortia, consortial relations.

Introduction

In times of M. M. Somov (1897), the Robin, *Erithacus rubecula* Linnaeus, 1758 was a common breeding and migratory species occurring in different types of forests of Kharkiv Region. However, it is still poorly studied in Ukraine. The most detailed monographic description of this bird in the north-eastern part of Ukraine was provided by M. P. Knyish (Knyish, 2008). Migration phenology was studied in Sumy Region (Belik, Moskalenko, 1992, Gavrys et al., 2007; Knyish, 2008, Grishenko, 2008). Post-embryogenesis of nestlings was investigated by L. A. Smogorzhevskaya and L. I. Smogorzhevskiy (Smogorzhevskiy, Smogorzhevskaya, 1988). Studies of birds in the functioning of consortia was always ambiguous and relevant (Selivanov, 1990, Chashchin et al., 1976, Bulakhov, 2015). In Ukraine, birds in a system of consortial relations were studied in oak forests of the Dnieper steppes (Ponomarenko, 1997, 1998, 2000, 2004) and Central Polissia (Klimchuk, 2012). By now, few researchers have focused their attempts on studying birds in individual consortia (Tsaryk, Hnatyna, 2015; Chaplygina et al., 2015, Chaplygina, 2016; Yuzyk, Chaplygina, 2016).

However, so far there is no available data on robins, as a component of autotrophic consortia in forest cenoses of Left-bank Ukraine. Considering the pan-European protected status of this species under the Bern Convention and its sensitivity to anthropogenic pressure as a ground-nesting bird (Chaplygina, 2013), the study of its consortial relations is especially important.

The goal of this research was to analyze food and consortial relations of robins in different parts of the Left-bank Ukraine for the bird conservation in transformed areas.

Material and methods

The research was carried out in 2013–2016 in the forest-steppe zone of Left-bank Ukraine of Kharkiv and Sumy Regions. The diet of robin nestlings was studied in upland oakwoods of the National Nature Park "Homilshanski Forests", Zmiiv District (hereinafter NNP "HF"), in a forest park of Kharkiv (forest park) and in pine forests of NNP "Hetmanskyi" in Okhtyrka District, Sumy Region (NNP "H"). The location of 57 robin nests was found. A total of 158 nestlings in 32 nests were observed, 70 of them (n = 15) in NNP "HF", 47 (n = 9) in NNP "H", and 41 (n = 8) in the forest park. The research was conducted from 10 May to 30 June in the first half of the day. The nestling diet was investigated by applying neck ligatures to 4–12 day old chicks (Malchevskij, Kadochnikov, 1953). A total of 206 forage samples were collected and 717 specimens, mainly arthropods, were studied. The forage samples were fixed in 70 % ethanol and the arthropods were further identified in the laboratory. All invertebrates were identified to species, genus or family (in case of significant damage) by Associate Professor Ph.D. Viktor M. Gramma by standard methods using reference books.

Statistical processing was performed in the "Statistica" programme. Similarity coefficients in species composition of invertebrates found in the diet in different areas were calculated by the Jaccard: $C_j = j / (a + b - j)$ and Sorensen: $C_s = 2j / (a + b)$ coefficients; where j — the number of invertebrate species found in both groups, a — the number of species in the first group, b — the number of species in the second group. These coefficients had values from — 1 (no similarity between compared parameters) to 1 (complete similarity).

Results and discussion

Robins breed in upland oakwoods with maximal density reaching 44 pairs/km^2. In the forests with dominating pine species they are as frequent as 32 pairs/km^2, in floodplain oakwoods — 24 pairs/km^2. The species occur in bird population of dry meadows with sparse thickets — 15 pairs/km^2 (Chaplygina, Savynska, 2011). In parks of Kharkiv the bird density does not exceed 23 pairs/km^2. In forest stands robins prefer the sites located near glades, cuttings and paths. When nesting, they choose areas with non-continuous grass cover, convenient to pick up prey from the litter, under fallen leaves. They prefer walking, not flying insects.

Consortial relations of robins were considered as a structural unit of the biogeocenosis that unites autotrophic organisms (producers) and heterotrophic organisms (the first, second and higher order consumers, decomposers) on the basis of spatial (topical) and food (trophic) relations (Beklemishev, 1951). In this hierarchical system the robin is viewed as a heterotrophic core of the determinative consortium, as a part of a large autotrophic community (biogeocenosis). In more detail, robins, being zoophages in the forest biogeocenosis, belong to the core of the second order consumers and create a complex system made of two blocks distinguished according to their trophic and topical links: 1) the diet of robin nestlings (list of arthropod species composition), based on trophic links (table 1); 2) the species composition of robin's nidicolous insects, mainly based on spatial (topical links), where the main determinant are robins as the second order consumers.

Analysis of the robin nestling diet showed that a basic trophic group is represented by the first order consumers — phytophages; from the superclass Hexapoda they include the order Homoptera, in particular the suborder Cicadinea. Among Coleoptera, the phytophages include Chrysomelidae and Nitidulidae, particularly the blossom weevil of the order Meligethes. In the Hymenoptera order, a herbivorous representative of the family Tenthredinidae is especially noticeable. It was numerous in Hetmansky NNP and developed on plants of pine cenosis of the park. Among phytophages, in trophic terms, herbivorous representatives of the order Lepidoptera prevailed. The nestling diet is dominated by representatives of such familes as Noctuidae, Tortricidae, Geometridae, and caterpillars (larvae) with soft bodies (fig. 1).

The first, second and higher order consumers in the robin consortium includes representatives of the order Aranei, class Arachnida that frequently occur in the diet of the flycatchers (Polchaninova and Prisada, 1994; Lezhenina et al., 2009) and blue tits (Berezantseva, 1998). Spiders in forage samples of robins were mostly immature. Analysis of

Table 1. The species composition and frequency of records of invertebrates in the diet of robin nestlings (*Erithacus rubecula*)

Name of the taxon	Territory			
	NNP "Homilshanski Forests"	Hetmanskyi NNP	Forest park	Total number of records for all areas, %
OLIGOHAETA				
Haplotaxida				
Lumbricidae sp.	4		10	14 (2)
MALACOSTRACA				
Oniscoidea				
Porcellio scaber Latreille	27	6		33 (4.6)
MYRIAPODA				
Glomerida				
Glomeridae				
Glomeris connexa C. L. Koch	4	8		12 (1.7)
ARACHNIDA				
Arachneae	40. 25 **juv**	16. 8 **juv**	27. 13 **juv**	129 (18)
Aranei sp.				
ARTHROPODA				
INSECTA				
Odonata				
Psocoptera sp.		3		3 (0.4)
Blattoptera				
Phaneropteridae				
Leptophyes albovittata Kol.	3			3 (0.4)
Homoptera				
Cicadinea	3			3 (0.4)
Hemiptera				
Miridae sp.				
Megacoelum infusum H.- S.		3		3 (0.4)
Coleoptera				
Carabidae sp.	10	9	10	29 (40)
Carabus sp.	3 **larv**			3 (0.4)
Chrysomelidae sp.	2		10	12 (1.6)
Cantharidae sp.	4			4 (0.6)
Nitidulidae				
Meligethes sp.	2			2 (0.3)
Neuroptera				
Chrysopidae				
Chrysopa sp.	3			3 (0.4)
Hymenoptera				
Vespidae sp.	4			4(0.6)
Formicidae				
Lasius alienus Forster	35	5		40(5.6)
Lasius niger L.	5			5(0.6)
Myrmicinae sp.			11	11(1.5)
Myrmica sp.	7			7(0.9)
Silphidae				
Silpha sp.	6			6(0.8)
Silpha obscura L.	3			3(0.4)
Tenthredinidae	9	6		15(2.1)
Lepidoptera				
Noctuidae sp.	22. 125 **larv**	7. 45 **larv**	19	218 (30.0)
Geomethridae	35 **larv**	36 **larv**		71(9.9)
Tortricidae sp.	4.4 **pupe**	3. 5 **pupe**	7.3 **pupe**	26(3.6)
Rhaphidioptera				
Rhaphidiidae				
Rhaphidia flavipes Stein.	6 **larv**			6(0.8)
Diptera				
Larvivoridae	4			4(0.6)
Stratiomyidae				
Geosargus sp.	16			16(2.2)
Syrphidae				
Chrysotoxum festivum L.	8			8(1.1)
Tabanidae sp.	15			15(2.1)
Sarcophagidae sp.		4		4(0.6)
Phoridae sp.	5			5 (0.7)
Total	443	164	110	717

Note. larv — larva; pupe — pupa; juv — immature individual.
The imago stage is given for the taxa unmarked.

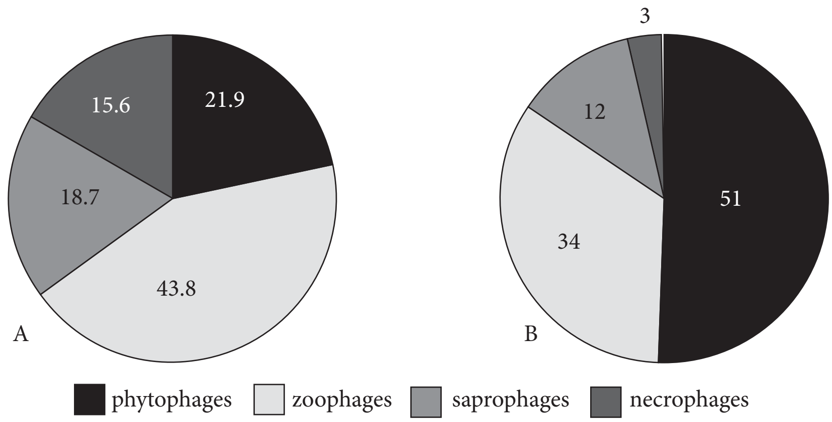

Fig. 1. Distribution of the robin nestling diet per trophic groups, total for all areas (A — percentage of the total number of species; B — percentage of the total number of registered food items).

arachnofauna of open-nesting dendrophilous (Meleshhuk and Fedoryak, 2013) and hollow-nesting (our data) birds shows that the highest diversity of spider species is observed in April, whereas the maximal number of specimens in one nest concentrates in the winter season (Chaplygina et al., 2015).

In the robin diet, among Hexapoda, representatives of the following orders are zoophages: Blattoptera (some Phaneropteridae, *Leptophyes albovittata* Kollar, 1833); Hemiptera (some Miridae, *Megacoelum infusum* Fallen, 1807), Coleoptera (Carabidae: *Carabus* sp., Cantharidae).

Neuroptera in the robin nestling diet are rather scanty. The order Chrysopa with predaceous larvae and imagoes is the most frequent.

Hymenoptera is represented by the following families: Vespidae, Formicidae, among which two species are numerous in the robin nestling diet: *Lasius niger* Linnaeus, 1758, *Lasius alienus* Förster, 1850. Robins catch them during swarming and also peck up insects from soil or grassy plants. That is why these two insect species are permanent and reliable source of forage for their nestlings. From Silphidae, only several scavengers are registered, particularly *Silpha obscura* Linnaeus, 1758.

The order Raphidioptera in the nestling diet is represented by a forest species *Rhaphidia flavipes* Stein., 1863. Its larvae often occur in the nest litter of robins. The first age larvae feed on aphids, and later attack larvae of bark beetles and other tree stalk inhabitants. Zoophages in the robin diet were represented by *Chrysotoxum festivum* Linnaeus, 1758 (Diptera, Syrphidae), which feeds on aphids and small caterpillars. Hematophages include such a taxonomic group as Tabanidae. Their larvae, detritophages, develop in water bodies.

As it has been mentioned, the Diptera insects are the most diverse in trophic terms. They include not only the first, second and higher order consumers but also decomposers, first of all necrophages and saprophages (Sarcophagidae, Larvivoridae, Stratiomyidae, Phoridae), which feed on dead insects in digestive and urinary tracts of humans, in bee colonies, thereby playing a sanitary role in nature.

The analysis of the robin nestling diet allowed us to reveal a set of decomposer species in the robin consortium. According to trophical links the decomposers are divided into: 1) saprophages and detritophages (mycetophages); 2) necrophages; 3) coprophages, keratophages (skin eaters).

Saprophages are consumers of dead organic matter of vegetative origin. They include *Porcellio scaber* Latreille, 1804 from Malacostraca, *Glomeris connexa* C. L. Koch, 1847 from Diplopoda. From the superclass Hexapoda, saprophages include representatives of Psocoptera that inhabit the nest litter. From Annelida, saprophages are represented by earthworms of the order Lumbricus.

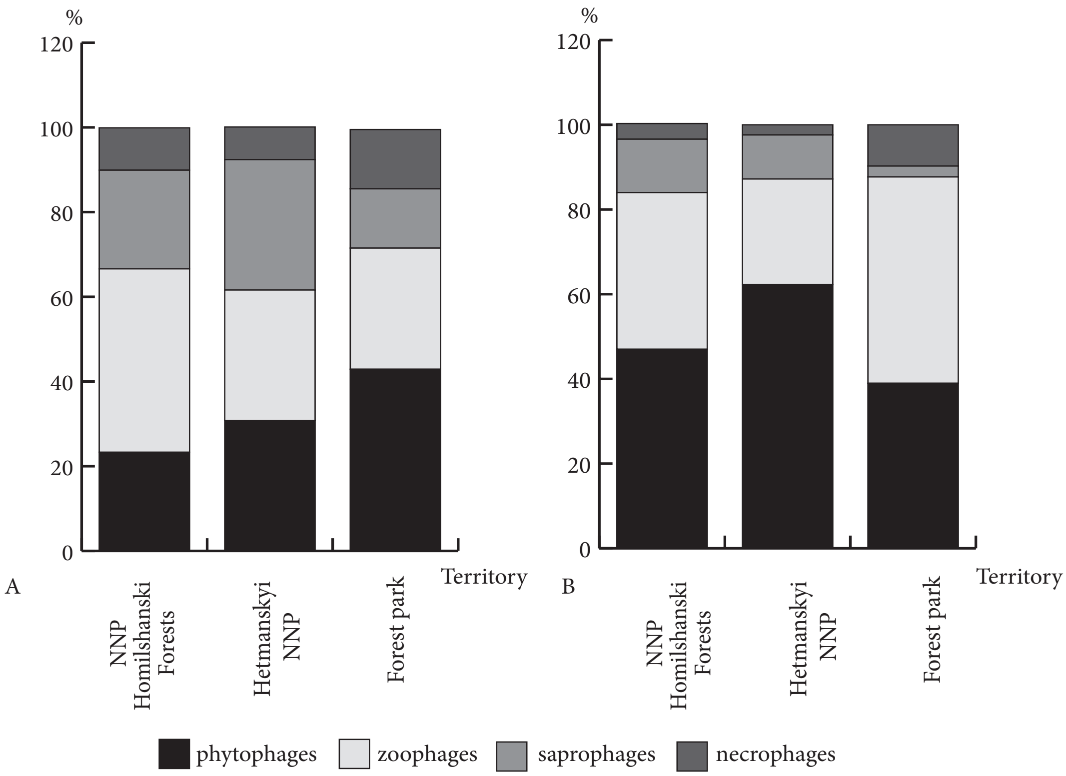

Fig. 2. Distribution of the robin nestling diet per trophic groups in different areas (A — percentage of the total number of species; B — percentage of the total number of registered food items).

Necrophages or scavengers are those feeding on dead animals. They play an important role in natural ecosystems mostly decomposing remnants of dead animals. The order Hymenoptera is considered to be the richest among families and orders that can be regarded as necrophages. Among them are Formicidae (*Myrmica* sp.) and Silphidae (*Silpha* sp.).

As a result of the research it was established that insectivorous birds play an important role in biological control of a great number of arthropods. In the robin nestling diet there were found 618 specimens of invertebrates belonging to 32 taxa of two types: Arthropoda — 99.2 % and Annelida — 0.8 %. The type Arthropoda (31 species) is represented by the following classes: Insecta (76.9 %), Arachnida (15.0 %), Malacostraca (5.3 %), Diplopoda (1.9 %) (fig. 3, A). The most numerous class Insecta includes 10 orders and 20 families. Among them prevail representatives of the orders Lepidoptera (3 families, 46.8 %), Hymenoptera (4 families, 12.9 %), Diptera (6 families, 8.5%), and Coleoptera (4 families, 5.2%) (fig. 3, B). In species composition of the arthropods, revealed in the robin diet, the dominants are zoophages (14 species; 43.8 %), and phytophages are subdominants (7 species; 21.9 %). Saprophages (18.7 %) and necrophages (15.6 %) are represented by only 11 species. However, phytophages dominated in the robin diet (n = 717; 51 %), and zoophages have a smaller portion (34 %). The role of saprophages and necrophages are quite small: 12 % and 3 %, respectively (fig. 1).

The number of items found in the robin nestling diet varies between areas. Thus, the phytophages prevail (47 %; n = 443) in NNP "HF". However, the species diversity of the predacious insect caught by birds in this area is higher in zoophages (13 species; 43.3 %). In the NNP "H" the majority of food items were also phytophages 62.3 % (n = 164), but the number of species in phytophages, zoophages and saprophages were the same (n = 13; 30.8 %). In the forest park the birds more frequently took representatives of zoophages —

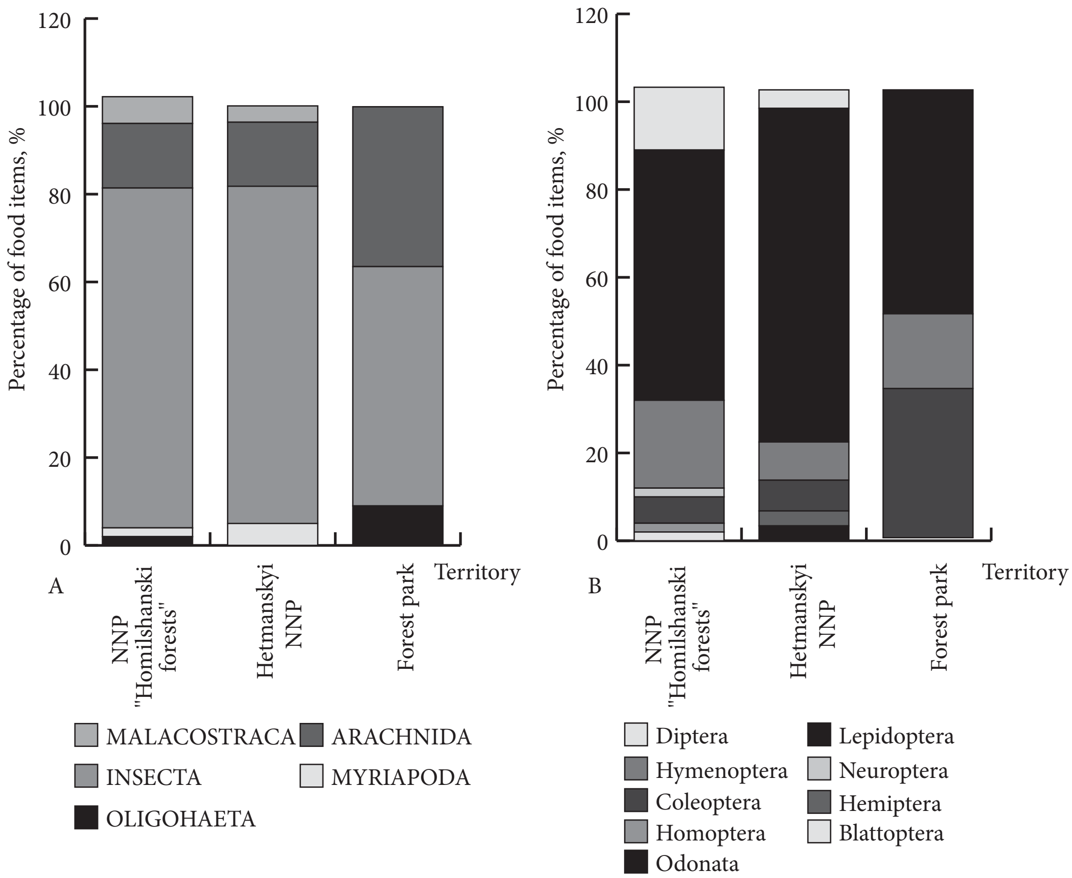

Fig. 3. Taxonomic diversity of the robin diet in different areas (A — main groups of invertebrates; B — main orders of insects).

45.5 % (n = 110) than phytophages — 36.4 % (fig. 2, B). Though, according to the species number in the diet, the phytophage species were more frequent — 42.9 % (fig. 2, A).

From June and during the entire post-breeding cycle the robin diet include additional plant foods, namely various kinds of berries: mulberry (*Morus* sp.), elderberry (*Sambucus nigra* Linnaeus, 1753, *S. racemosa* Linnaeus, 1753), strawberry (*Rubus idaeus* Linnaeus, 1753), bird cherry (*Prunus padus* Linnaeus, 1753), ashberry (*Sorbus aucuparia* Linnaeus, 1753), and seeds of tree species with which the birds are closely related by phorical links (i.e. transportation of one species by another). It promotes distribution of certain species of plants and arthropods for large distances including wintering grounds.

Saprophages mainly develop in rotten bark of old-age trees. High abundance of some phytophages such as aphids (Aphididae) and zoophages, in particular insects of the order Lasius, is controlled by numerous zoophages including birds, so there is no outbreak in the numbers of these species. Besides, they are reliable and permanent food source for robins and other passerines. Due to species diversity of arthropods (mainly insects) in these forest cenoses we did not observe cases of mass propagation of definite insect species, since there is a certain dynamic balance in a trophic chain of climax biogeocenosis (Chaplygina et al., 2015). The similarity analysis of species diversity of food items showed the highest resemblance between NNP "HF" and NNP "H" in 9 species (table 2). Mainly, these are caterpillars of Lepidoptera and Arachnida. During a year, in different forest ecosystems, passerines can take 61.9–195.4 kg/ha of biomass (Bulakhov et al., 2015). Removal of biomass volume by zoocomponents is important for the forma-

Table 2. Similarity of food items in different cenoses

Pair of biotopes	Number of common species	Similarity	
		Stugren-Radulescu	Jaccard
Oakwood of NNP "HF" — Pine cenosis of NNP "H"	9	0.5	0.6
Oakwood of NNP "HF" — Oakwood of forest park	6	0.4	0.5
Pine cenosis of NNP "H" — Oakwood of forest park	4	0.3	0.3

Table 3. Location of robin nests in niches of natural and artificial origin

Location of nest		N of nests	
		absolute	%
On the ground	A recess in the forest ravine	16	27.9
	The root collar of the tree	8	14
Hollow, half hollow		13	23.3
An artificial nesting place		12	18.6
Constructions of anthropogenic origin		8	16.3

Table 4. Topical links of the robin with trees and bushes

Species of trees and shrubs under which the nests are located	N of nests	
	absolute	%
Quercus robur L.	14	24.6
Acer platanoides L.	13	22.8
Tilia cordata Miller	10	17.5
Acer campestre L.	4	7.0
Ulmus sp.	4	7.0
Betula pendula Roth.	3	5.3
Fraxinus excelsior L.	2	3.5
Euonymus verrucosa L.	2	3.5

tion of ecosystem homeostasis and to a great extent is an indicator of cycle of matter and energy balance. Birds participate not only in creating mechanism of biological resilience but also in optimization of environment.

The robin is also included in the first concentre of many heterotrophic determinative consortia. Eggs and nestlings are food for the hooded crow (*Corvus cornix* Linnaeus, 1758), magpie (*Pica pica* Linnaeus, 1758), red squirrel (*Sciurus vulgaris* Linnaeus, 1758), mouse (*Mus* sp.), forest dormouse (*Dryomys nitedula* Pallas, 1778). The latter can tear the adult birds incubating clutches in articifial nests (fig. 4).

Some animals use robin nests for raising their own broods. A direct topical relationship is recorded for the cuckoo (*Cuculus canorus* Linnaeus, 1758) which lay eggs in robin nests and use adult birds as breadwinners (direct trophic relationship) and caregivers for its own offpsrings (fig. 5).

Robin nests were found in niches of artificial and natural origin. The most frequently they were located in recesses on the ground in the forest ravine (27.9 %) (table 3). For nest-building robins prevailed *Quercus robur* L. (24.6 %), *Acer platanoides* L. (22.8 %), and *Tilia cordata* (17.5) (table 4) among tree and bush species.

Thereby, knolwedge of the species consortia structure is important to predict consequences of changes in certain components of environment as well as impact of anthropogenic activity on populations and consequently on the ecosystem structure.

Fig. 4. An adult bird of *Erithacus rubecula* Linnaeus, killed by *Dryomys nitedula* Pallas in the artificial nest.

Fig. 5. Consortial relations of *Cuculus canorus* Linnaeus and *Erithacus rubecula* Linnaeus.

Conclusion

1. Within the consortium there is a complex trophocenotical system where robins as a component of forest biogeocenosis belong to the second and higher consort. The trophic relations of their nestlings are based on recorded 32 taxa of invertebrates of two types: Arthropoda (99.2 %, with the prevalence of 28 species of Hexapoda — 54 %) and Annelida (0.8 %). According to the arthropod species composition in the robin diet, zoophages (43.8 %) are the dominants, phytophages (21.9 %) — subdominants, smaller percentage is recorded for saprophages (18.7 %) and necrophages (15.6 %). Phytophages dominate in quantitative composition of the diet (n = 717; 51 %), with a slightly smaller proportion of zoophages (34 %). The role of saprophages and necrophages are quite low: 12 % and 3 %, respectively.

2. Topical and trophic links are recorded with *Cuculus canorus* Linnaeus.

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