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THE ROBIN, ERITHACUS RUBECULA (PASSERIFORMES, TURDIDAE), AS A COMPONENT OF HETEROTROPHIC CONSORTIA OF FOREST CENOSES, NORTHEAST UKRAINE. PART 2

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The Robin, *Erithacus rubecula* (Passeriformes, Turdidae), as a Component of Heterotrophic Consortia of Forest Cenoses, Northeast Ukraine. Part 2. Chaplygina, A. B., Yuzyk, D. I., Savynska, N. O. — The role of the robin as a determinant of heterotrophic consortia is considered. 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, *Tilia cordata* Miller, 1768, *Acer platanoides* Linnaeus, 1753, *Acer campestre* Linnaeus, 1753), and also by sedges (*Carex* sp.) and grasses (Poaceae), connected with the determinants by fabric links. The robin also belongs to the concentr of the second and higher orders as a component of forest biogeocenoses and it is also the main determinant in species composition of the insects inhabiting bird nests. As a result of the taxonomic analysis of invertebrates in the robin nests, it has been found out that the most numerous class was Insecta (9 orders and 27 families), with the dominance of Coleoptera (30.7 %). The nidicolous fauna of the robin (38 species) was dominated by zoophages along with parasites and hematophages such as Hippoboscidae (46.4 %). The percentage of phytophages and saprophages among the invertebrate nest inhabitants was somewhat less (21 % each), then followed necrophages (12 %). Zoophages and parasites also dominated according to the number of objects in the nests (42 %; n = 150), the less was the portion of phytophages (34 %), saprophages (18 %), and necrophages (6 %). The highest number of species and objects of zoophages was recorded for climax and mature biocenoses (oak forests in NNP "HL" and pine cenoses in NNP "H").
Key words: *Erithacus rubecula* Linnaeus, nidicoles, fabric links, consortia, consortial relations.

Introduction

Bird nests attract attention of various invertebrate animals (nidicoles), where they found forage and favourable microclimatic conditions for their living (Nartshuk, Krivokhatsky, 2001; Bulakhov et al., 2015). Representatives of nidicolous fauna enter into relations between each other and the host of the nest, and therefore can be regarded as an integral biocenosis (Golubets, 2000). By now, nidicolous communities of the gender *Acrocephalus* (Tsaryk, Hnatyna, 2015), *Corvus frugilegus* L., 1758 (Efremova, Tchaikovsky, 2004.), *Chloris chloris* L., 1758 (Meleshchuk, 2008 a), *Turdus philomelos* Brehm, 1831 (Meleshchuk, 2008 b), and *T. merula* L., 1758 (Meleshchuk, Skilsky, 2007) have been studied. Our studies cover the nidicolous fauna of hole-nesting birds — *Ficedula albicollis* Temminck, 1815 (Chaplygina et al., 2015), *Parus caeruleus* L., 1758 (Yuzyk, Chaplygina, 2016), and *Passer montanus* L., 1758 (Yuzyk, Chaplygina, 2015), as well as *Sylvia atricapilla* L., 1758 (Chaplygina, 2016). In some studies, certain taxa of arthropods are considered as a composite part of nest inhabitants — Hemiptera (Kirichenko, 1949), Diptera (Krivokhatskij, Narchuk, 2001), Coleoptera (Lundyshev, 2011), Araneae (Meleshchuk and Fedoryak, 2013).

However, so far there is no available data on robins, as a component of heterotrophic consortia in forest cenoses of Left-bank Ukraine.

Material and methods

The research was carried out in 2013–2015 in the forest-steppe zone of Left-bank Ukraine of Kharkiv and Sumy Regions. The research was conducted from 10 May to 30 June in the first half of the day. To identify nidicoles of robins we collected nests at the end of the reproductive season in upland oakwoods of the National Nature Park "Homilshanski Forests", Zmiiv District (hereinafter NNP "HF") and in pine forests of NNP "Hetmanskyi" in Okhtyrka District, Sumy region (NNP "H"), processed them with chloroform in tightly tied plastic bags with the labels attached on them. To identify composition of nidicolous fauna each nest was completely disassembled and thoroughly investigated using tweezers and magnifying devices. A total of 48 robin nests were collected and analyzed; they contained 155 specimens of arthropods. 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.

Results and discussion

The nidicolous fauna of the robin is represented by the following trophocenotical groups: a) the third order consumers — parasites of robin nestlings (lice, louse flies or keds, fleas and mites); b) the inhabitants of the nest litter — nidicolous fauna of different ranges (obligate, facultative, accidental, alien species, etc.) — representatives of consumers and decomposers in a food chain of the breeding habitat.

The first, second and higher order consumers in the robin consortium includes representatives of the order Aranei, class Arachnida. They are an integral component in nests of dendrophilous birds in the Carpathian region of Ukraine, where 76 species of them have been found (Meleshchuk and Fedoryak, 2013). The spiders may use open or close bird nests for wintering.

The analysis of the robin representatives of nidicolous fauna in the nest litter 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) parasites.

Saprophages are consumers of dead organic matter of vegetative origin. They include Oniscoidea sp. from Malacostraca, *Julus* sp. from Diplopoda. From the superclass Hexapoda, saprophages include representatives of Psocoptera that inhabit the nest litter. According to the published data, saprophages include *Liposcelis divinatorius* Moller, 1776, a typical inhabitant of bird nests.

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 saprophages. Tineidae sp. is among them.

Below we consider characteristics of a trophocenotical structure of the arthropod nidicolous population, taking into account specific features of trophocenotical links of arthropods with the core of the robin consortium that is created on the one hand by a host of the nest and on the other hand by the nest itself as an inanimate part of the concortium.

We have revealed a set of permanent ectoparasites of the robin, mostly in nest microcenoses of Northeast Ukraine. Hexapoda include: 1) the order Diptera, family Sarcophagidae; 2) the family Hippoboscidae, *Ornithomya avicularia* Linnaeus, 1758. Arachnida include the subclass of mites Acarina. Using published sources (Balashov, 2009), further we make comparative analysis of the robin parasite fauna of Diptera and Acarina.

Diptera. In the robin nests we have registered pupae of the louse fly (*O. avicularia*), a permanent bird ectoparasite. Earlier, in nests of the white collared flycatcher, we had observed emergence of adult flies after wintering in the third decade of April (Chaplygina et al., 2015). According to V. A. Krivokhatskij and E. P. Narchuk (Krivokhatskij, Narchuk, 2001), imagoes of *O. avicularia* are bloodsuckers, not selective in respect to their host and parasitizing on about 25 bird species (mostly large birds of prey and corvids). This species as a nest inhabitant belongs to obligate nidicolous fauna.

According to the published data (Grunin, 1970; Prokofieva, 2000; Krivokhatskij, Narchuk, 2001; Chaplygina et al., 2015), flies from the family Calliphoridae should be classified as ectoparasites; they are nestling parasites of many passerines (*Muscicapa striata* Pallas, 1754, *Turdus philomelos* Brehm, 1831, *Phoenicurus phoenicurus* Linnaeus, 1758, *Anthus trivialis* Linnaeus, 1758, *Anthus pratensis* Linnaeus, 1758, *Sturnus vulgaris* Linnaeus, 1758, *Delichon urbicum* Linnaeus, 1758, *Phylloscopus trochilus* Linnaeus, 1758, *Ficedula albicollis* Temminck, 1815). We frequently registered empty pupae of Calliphoridae in robin nests after fledglings had left them.

Acarina. The class of Mites (Acarina) includes the highest number of bird's ectoparasite species from the family Mucicapidae. Three taxonomic groups of Acarina are permanent ectoparasites: astigmatic mites (cohorts Psoroptilidae), prostigmatic mites (Prostigmata) of the superfamilies Myobioidea, Cloacaroidea, Cheyletoidea and gamasoid mites (Gamasoidea) (Balashov, 2009; Chaplygina et al., 2015). For these arthropod groups the host organism is a feeding source and a habitat during their entire life cycle.

In robin nests we found 155 specimens of invertebrates and identified 38 taxa (table 1) belonging to 2 types of Mollusca and Arthropoda, among which Insecta dominated (fig. 1, A). In trophocenotical aspect, the species composition of invertebrates is as follows: 1) phy-

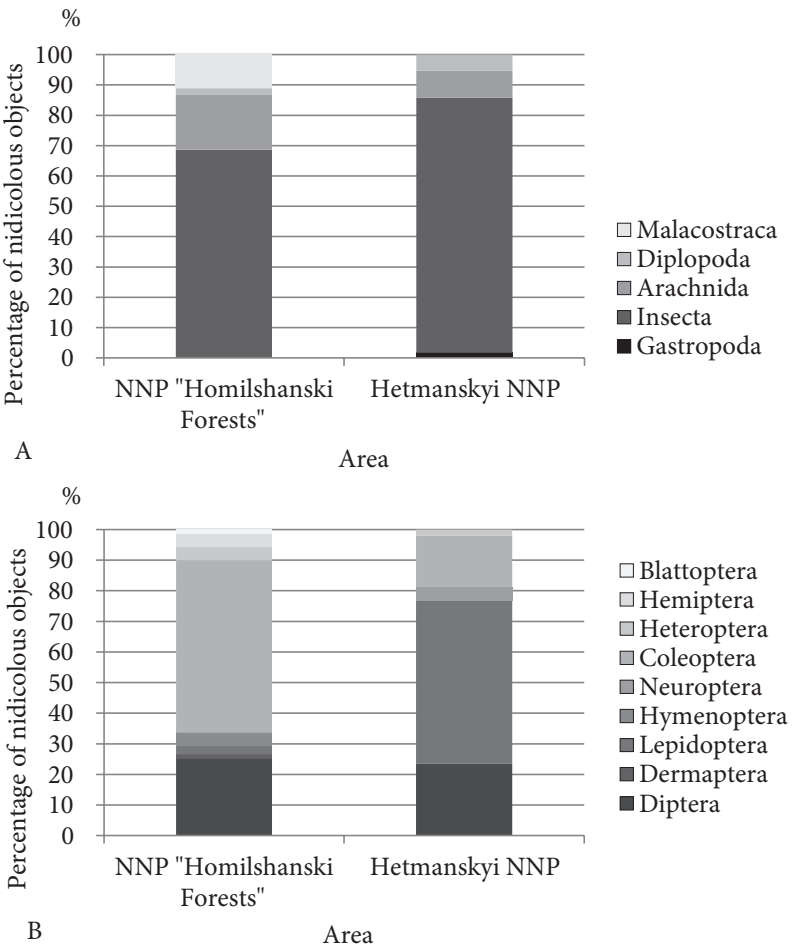

Fig. 1. Taxonomic diversity of the robin nidicolous fauna in different areas (A — main groups of invertebrates; B — main orders of insects).

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

Name of taxon	Territory		
	NNP "Homilshanski Forests"	Hetmanskyi NNP	Total number of records for all areas, %
MALACOSTRACA **Isopoda** Oniscoidea sp.	11		11 (7.1)
DIPLOPODA **Julida** *Julus* sp.	2	3	5 (3.2)
ARTHROPODA ARACHNIDA Arachneae Aranei sp.		5 **cocoons**	5 (3.2)
Acarina sp.	18		18 (11.6)
HEXAPODA **INSECTA** **Blattoptera** Blattellidae *Ectobius lapponicus* L.	1 **larv**		1 (0.6)
Hemiptera Pyrrhocoridae *Pyrrhocoris apterus* L.	3 **juv**		3 (1.9)
Heteroptera Pentatomidae *Pentatoma rufipes* L.	3 **juv**		3 (1.9)
Palomena prasina L.		1	1 (0.6)
Coleoptera Carabidae sp.		1 **pup**	1 (0.6)
Silphidae *Silpha* sp.	2 **larv**		2 (1.3)
Staphilinidae sp.	1, 2 **juv**		3 (1.9)
Scarabaeidae *Anomala dubia* Scop.	2		2 (1.3)
Lucanidae *Aesalus scarabacoides* Panzer	3		3 (1.9)
Elateridae *Elater* sp.	2	2	4 (2.6)
Athous sp.	1		1 (0.6)
Prosternon tesselatum L.		1	1 (0.6)
Tenebrionidae *Cylindronotus gilvipes* Menetries	1	2	3 (1.9)
Lagriidae *Lagria hirta* L.		1	1 (0.6)
Curculionidae *Mylacus* sp.	20 **pup**		20 (12.9)

Histeridae *Gnathoncus buyssoni* Auz.	4		4 (2.6)
Trogidae *Trox scaber* L.		1	1 (0.6)
Neuroptera Chrysopidae *Chrysopa cornea* L.		2 **pup**	2 (1.3)
Hymenoptera Formicidae *Lasius* sp.	3		3 (1.9)
Lepidoptera sp.	1 **pup**	3 **pup**	4 (2.6)
Noctuidae sp.		3 **larv**	3 (1.9)
Agrotis sp.	1		1 (0.6)
Tineidae sp.		3 **larv**	3 (1.9)
Orgyia antiqua L.		16 **larv**	16 (10.3)
Dermaptera Forficulidae *Forficula auricularia* L.	1		1 (0.6)
Diptera sp.	3 **juv**	2 **pup**, 1 **cocoon**	6 (3.9)
Asilidae sp.		1 **pup**	1 (0.6)
Muscidae sp.	3 **juv**		3 (1.9)
Sarcophagidae sp.		2 **larv**	2 (1.3)
Hippoboscidae *Ornithomya avicularia* L.		3 **larv**	3 (1.9)
Calliphoridae sp.	8 **larv**		8 (5.2)
Fanniidae *Fannia* sp.	3 **pup**		3 (1.9)
Tachinidae sp.		2 **cocoons**	2 (1.3)
MOLLUSCA **GASTROPODA** Pulmonata *Succinea* sp.		1	1 (0.6)
Total	99	56	155

Note. larv — larva; pup — pupa; juv — immature individuals.
For the unmarked taxa the data for their imago stage are indicated.

tophages (the first order consumers); 2) zoophages (the second and higher orders consumers); 3) saprophages (decomposers), creating spatially and functionally a consortium around the nest and its host. This consortium has no its own producer; it is related to the above-mentioned composite parts of the heterotrophic consortium where the robin plays a role of the determinant creating trophic and topical links. The animal species that inhabit bird nests or mammal holes are called "nidicoles" or "nidicolous fauna" in scientific literature. In widely accepted classifications of nidicoles they have such important characteristics as a type of relations between a host and inhabitants of the nest, a foraging type of imagoes and larvae, a topical connection of different development stages to the double core of the consortium (nest or body of the host), conditions of this connection (foraging, reproduction, survival, diapause), the extent of obligation, trophic and topical links, their value in general life strategy of the species.

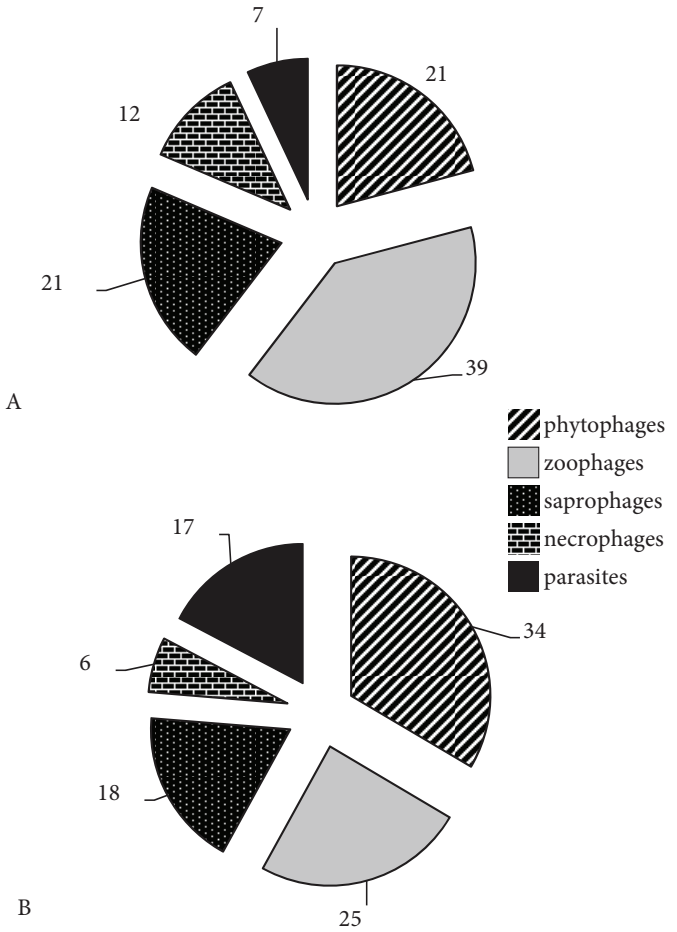

Fig. 2. Distribution of the robin nidicolous fauna per trophic groups, total for all areas (A — percentage of the total number of species; B — percentage of the total number of registered food items).

The nidicolous fauna is classified basing on links of arthropods with alive and inanimate parts of the consortium (Krivokhatskij, Narchuk, 2001). As for the type of their links with the core of consortium (created by a host bird and its nest as an inanimate part of consortium) they are distinguished in three groups according to two characteristics: a) consorts, trophically connected with the host; b) trophically or topically connected with the nest substrate; c) topically related with the nest, and trophically — with other consorts (Chaplygina et al., 2015).

According to the level of trophic and topical links with the bird nest, arthropods are divided into obligate, facultative, accidental and alien species (Krivokhatskij, Narchuk, 2001).

The analysis of arthropod species composition of inhabitants in robin nests has revealed a set of species which are difficult to view as one trophocenotical group (they are at the same time occur in the bird diet and are nidicoles). First of all, they are species that demonstrate characteristics of several trophic groups, i. e. have a wide range of forage links and are mixophages (Homenko et al., 1988). A representative of these species is a representative of the order Blattoptera — *Ectobius lapponicus* Linnaeus, 1758 which is a permanent inhabitant of the nest. It winters in foliage litter at the stage of ootheca and belongs to facultative nidicoles. This species is typical for mature deciduous forests and also occur in the robin diet. Another species is a representative of the order Dermaptera — *Forficula*

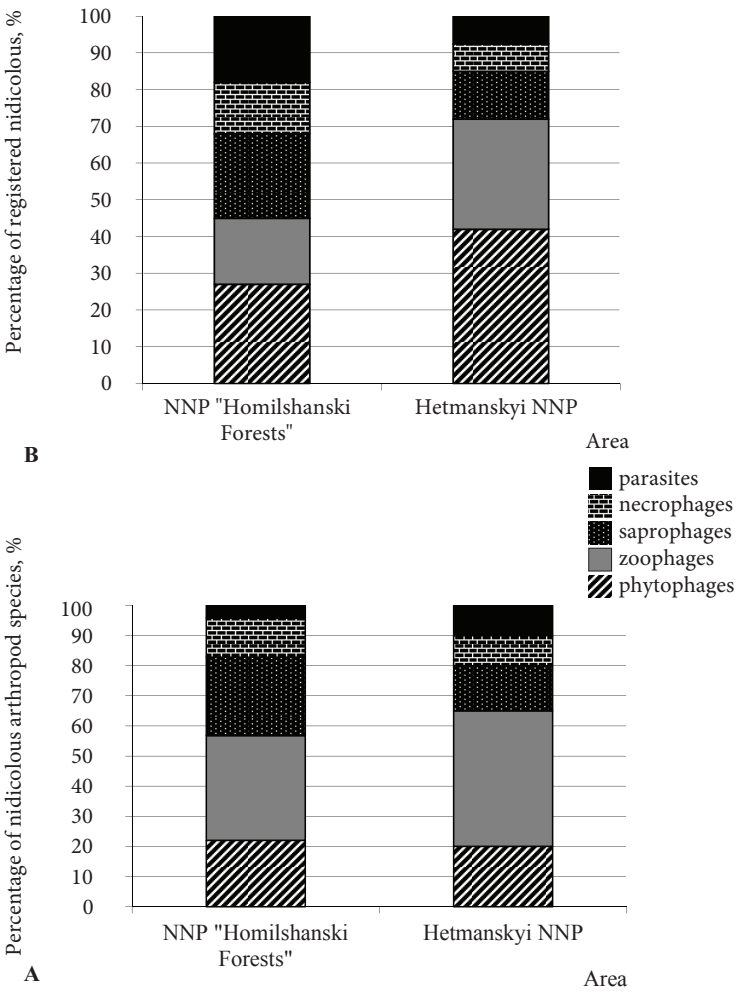

Fig. 3. Distribution of the robin nidicolous fauna per trophic groups on different areas (A — percentage of the total number of species; B — percentage of the total number of registered food items).

auricularia Linnaeus, 1758. It feeds on small insects, vegetables, nectar of flowers, and immature seeds (sapro-, necro-, phyto- and zoophage).

Saprophages and necrophages play an important role in a functional structure of forest ecosystems. They serve as indicators of succession processes in nidicolous fauna of arthropods and generally in the forest biogeocenosis. From the order Diptera they include the families Sarcophagidae, Calliphoridae, Muscidae and Fanniidae, which larvae feed on remnants of nestling food and organic matter. They are the first who fly to the odour of dead flesh, lay eggs, and in two weeks produce a new generation of flies. Then louse flies *O. avicularia*, one of common obligate nidicoles fly. They lay their pupae in the nest litter, one specimen in a certain interval of time. Calliphoridae, Sarcophagidae, Muscidae from Diptera, and also carrion beetles Silphidae from Coleoptera live on dead nestlings. In addition, from Coleoptera it should be mentioned a representative of the family Lucanidae (*Aesalus scarabaeoides* Panzer, 1794) that feeds on juice flowing from stalks and branches of deciduous trees. Later, the dead bodies of nestlings are visited by trogids (*Trox scaber* Linnaeus, 1767), and after that — by keratophages (Tineidae). A permanent representative of bird nests is *Gnathoncus buyssoni* Auzat, 1917 occupying its own ecological niche among zoophages in a functional structure of the nest. Characteristics of its biology require additional investigation. It is quite possible that this beetle hunts on small insects and perhaps

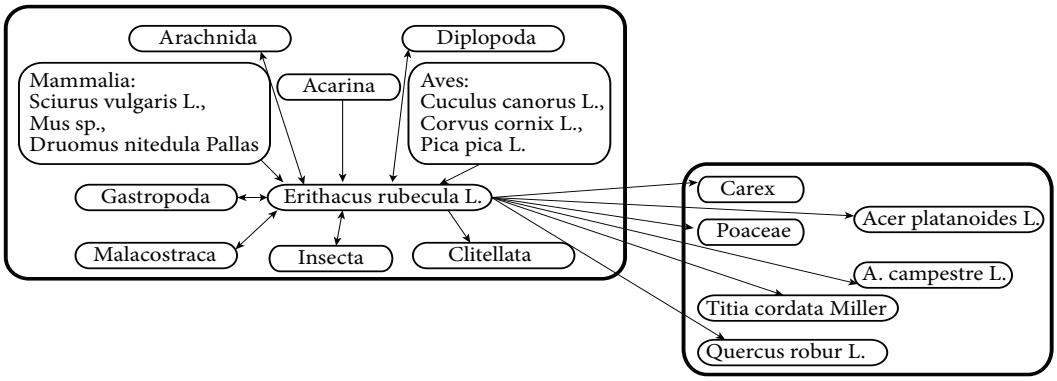

Fig. 4. Direct consortial relations of robins.

also on numerous mites that inhabit bird nests. During raising of nestlings they are parasitized by louse flies (*O. avicularia*), representatives of the third order consumers. Pupae of louse flies winter in the nest, and in spring, after arrival of robins, the adult louse flies came out from pupae and easily find their victims.

Taxonomical analysis of invertebrates in robin nests showed that the most numerous class is Insecta, consisting of 9 orders (fig. 1, B) and 27 families. Among them the dominating orders are Coleoptera — 30.7 % (n = 150), Diptera — 18.7 %, and Hymenoptera — 17.3 %. Species composition of nidicolous fauna is represented by 38 species with the prevalence of zoophages (17 species, 46.4 %), including parasites and also such hematophages as Hippoboscidae. Phytophages are subdominants (9 species, 20.9 %), then follow saprophages (9 species, 20.9 %) and necrophages (5 species, 12.2 %). According to quantitative composition in the nests, zoophages and parasites also prevailed (41.8 %; n = 150), phytophages ranked second (33.5 %). The number of saprophages and necrophages were considerably smaller: 18.3 % and 6.3 %, respectively (fig. 2). This dominance of zoophages according to the number of species and specimens, common for both habitats, were recorded in oak forests of NNP "HF" and in pine cenoses of NNP "H" (fig. 3). It should be also noted a relatively high abundance of zoophages and saprophages, typical for climax and mature biocenoses.

Using the last year foliage of decidious trees and other plants for nest-building, the robins are a composite part of autotrophic determinative consortia. They have the closest fabric links with the consortia of main dominating decidious tree species (*Quercus robur* Linnaeus, 1753, *Tilia cordata* Miller, 1768, *Acer platanoides* Linnaeus, 1753, *Acer campestre* Linnaeus, 1753). Sedges (*Carex* sp.) and grasses (*Poaceae*) (fig. 4) also occur among their nest materials. For nest-building the robins mostly use dead parts of determinants of autotrophic consortia. The nest has a moss (*Bryophyta*) base. The cup is made of horse hair (*Equus* sp.) and lined with thin twigs and sometimes animal fur. In pine-dominating forests of NNP "H" robins also build nests from fallen leaves of decidous trees in contrast to white collared flycatchers which use pine needles (original data).

Conclusion

1. A network of consortial relations is unstable, and therefore the heterotrophic consortia may alter as a result of destruction of robin habitats. In the species composition of arthropod inhabitants of the nest, the main determinant are robins as the second order consumers, whereas nestling parasites (louse flies, mites) are the third order consumers interacting with nidicolous fauna of different levels (obligate, facultative, accidental, alien species, etc.) which represent consumer and decomposer links of nesting biocenosis. Heterotrophic consortia of robin nests provide habitat for invertebrates of 38 taxa belonging

to the type Arthropoda, classes Insecta, Arachnida, Malacostraca, Diplopoda and sometimes the type Mollusca. Trophocenotical structure of the robin nest population is dominated by representatives of Hexapoda (33 species), where the first place is occupied by zoophages (47.4 %), including parasites and such hematophages as Hippoboscidae. Phytophages (26.3 %) are on the second place, followed by saprophages and scavengers (13.2 % each). As for quantitative composition, zoophages and parasites dominated in the nests (41.8 %; n = 150), and phytophages ranked second (33.5 %). The number of saprophages (18.3 %) and scavengers (6.3 %) were significantly lower.

2. In their nest-building activity the robins use fabric links with dead parts of determinants of autotrophic consortia of decidous tree species (*Quercus robur* Linnaeus, *Tilia cordata* Miller, *Acer platanoides* Linnaeus, *Acer campestre* Linnaeus) as well as sedge (*Carex* sp.) and grasses (*Poaceae*).

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