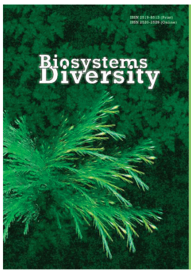

Biosystems Diversity

ISSN 2519-8513 (Print)
ISSN 2520-2529 (Online)
Biosyst. Divers., 2020, 28(1), 92–97
doi: 10.15421/012013

Trophic links of the chaffinch (*Fringilla coelebs*) in transformed forest ecosystems of North-Eastern Ukraine

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Article info
Received 19.01.2020
Received in revised form 07.02.2020
Accepted 10.02.2020

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Chaplygina, A. B., Pakhomov, O. Y., Yevtushenko, H. A., & Brygadyrenko, V. V. (2020). Trophic links of the chaffinch (Fringilla coelebs) in transformed forest ecosystems of North-Eastern Ukraine. Biosystems Diversity, 28(1), 92–97. doi:10.15421/012013

The chaffinch (*Fringilla coelebs* Linnaeus, 1758; Passeriformes, Fringillidae) is one of the most colourful forest species of birds living in Europe, West Asia and North Africa. The diet of this species was studied as a contribution to the conservation of the population of this species in transformed forests of the north-eastern part of Ukraine. Four forest ecosystems were studied: three model sites in oak forests, transformed under intensive recreation pressure, and one model site in a pine-oak forest. A total of 39 invertebrate taxa, dominated by Insecta (93.0%) were found. The orders Coleoptera (32.6%) and Lepidoptera (63.5%) prevailed in the diet of finch nestlings, the highest number of taxa (52.3–76.2%) was represented by phytophages. The phytophagous species also constituted the majority of the consumed prey items (44.0–55.6%). Environmental conditions provided an important effect on the diet structure. The most favourable foraging conditions for the species were found in protected natural areas. According to the analysis, the finch foraging efficiency was similar in all the studied sites. The highest biodiversity indices were found in a protected area of Homilshanski Forests National Nature Park. Results of the research have indicated the crucial role of *Fringilla coelebs* in the population management of potentially dangerous agricultural pests.

Keywords: transformed areas; trophic groups; zoophages; phytophages; saprophages.

Introduction

The increasing rate of anthropogenic environmental changes, recorded since the second half of the XX century has led to the formation of urban coenoses (Blinkova & Shupova, 2017). Ecosystem monitoring can be carried out by ecological indicators to preserve and manage the natural environment. Since it is impractical to monitor all ecosystem components, a few individual species or groups of species can be used as indicators of wider conditions. To monitor changes, birds are often used, since their mobility makes them convenient indicators of the environment (Gregory et al., 2003; Blair & Johnson, 2008; Bulakhov et al., 2008; Chaplygina et al., 2019). Bioindicators are also the best tools to measure the progress made in biodiversity conservation, to assess the impacts and threats to biodiversity, to evaluate sustainable use of biodiversity (Chaplygina, 2000, 2009; Dranga et al., 2016; Gorlov et al., 2016). Birds are excellent bioindicators for the health of the environment and ecological change. Generally, birds have been used as indicator species for a range of environmental parameters. They act as biodiversity indicators for a number of reasons (Peach et al., 2004; Sobolev et al., 2017; Matsyura, 2018). The cause-and-effect link between an environmental change and birds is a direct and simple one.

Therefore, study of the status of insectivorous passerines in natural communities, exposed to a growing anthropogenic pressure, is one of the main objectives in contemporary ornithology (Hernández, 2009; Assandri et al., 2017; Koshelev et al., 2020).

The chaffinch (*Fringilla coelebs* Linnaeus, 1758) is a common insectivorous bird and a principal contributor to forest ecosystem communities of the temperate climate zone (Browne, 2004; Amar et al., 2006; Baillie et al., 2006; Domokos & Domokos, 2016; Ramdani et al., 2019). It is also a migrant of global conservation concern (Bern Convention) and studies on the foraging ecology of the species will definitely assist in its conservation. It has been already revealed that habitat conditions of the chaffinch are crucial for the successful breeding and stability of its population in forests of England (Whittingham et al., 2001; Macleod et al., 2004), Turkey, Germany (Bergen & Abs, 1997; Batary et al., 2014), Sweden (Felton et al., 2016), Romania (Domokos & Domokos, 2016), Spain (Moreno-Rueda & Pizarro, 2009; Peris & Montelongo, 2014) and North East Algeria (Ramdani et al., 2019). The role of artificial light and noise for the finches when they search for food has also been studied (Quinn et al., 2006; Kempenaers et al., 2010). The latter is especially vital for the North-Eastern Ukraine, where the natural communities experience strong transformation (Brygadyrenko, 2015a, 2015b; Chaplygina et al., 2016a, 2016b, 2018). In addition, the knowledge of foraging patterns of insectivorous birds is important to prevent outbreaks of arthropods, being potential carriers of dangerous human diseases (James et al., 2011; Lommano et al., 2014; Bulakhov et al., 2015; Brobi et al., 2017), and to mitigate outbreaks of forestry and agricultural pests (Faly & Brygadyrenko, 2014; Chaplygina et al., 2015; Caprio & Rolando, 2017). It also gives an opportunity to control bird flocks which may otherwise destroy part of the harvest (Whittingham et al., 2001; Paralikidis et al., 2009). The chaffinch is known as a distributor of seeds of wild plants (zoochory) (Heleno et al., 2010; Perea & Gil, 2014).

The high number of chaffinches in the forests of North-Eastern Ukraine allows us to consider it as a subdominant species (Chaplygina & Savinskaya, 2016). Its biotope is diverse, including man-made landscapes (parks, orchards, gardens, boulevards, cemeteries); light oak forests; birch, willow and pine groves; flooded non-dense forests and island-type forests in grasslands. *F. coelebs* tends to avoid large wet dark coniferous forests, restricting its habitats to their edges (Fesenko & Bokotej, 2002). The timing of migrations of this bird (Nadtochiy & Chaplygina, 2010) and the characteristics of their nest locations in Ukraine have been studied as well (Zimaroeva et al., 2015). The some researchers suggest that foraging patterns of the species can determine the management and conservation of the bird diversity in natural and transformed areas (Macleod et al., 2004; Amrhein, 2013; Korňan & Adamík, 2017). Changes in habitats at nesting sites are potential causes of a decrease in the number of birds during nesting (Kirby et al., 2005; Paker et al., 2014). Consequently, they lead to the decline in invertebrates and the loss of feeding habitats for ground-foraging birds (Chaplygina, 2016; Markova, 2016; Chaplygina et al., 2019). One of the ways to support the species number and improve the foraging and distribution conditions is suburban river catchments, proposed in South Africa (Suri et al., 2017). The some scientists recommend planting shrubs and trees that have fruits and berries (Vanderhoff & Eason, 2008; Jackson & Kannan, 2018).

The author has already studied chaffinches in the forest-steppe zone of Ukraine in comparison with other species of finches (Kryvitsky & Chaplygina, 2010). However, the diet of this bird in transformed areas requires more thorough investigation as it is the main factor that limits the species number.

The aim of this study is to make a qualitative and quantitative analysis of the diet structure and foraging pattern of the chaffinch to reveal trophic links and enhance the conservation of populations of this species in the transformed ecosystems of North-Eastern Ukraine.

Materials and methods

The research was carried out over the period 2010–2019, in the forest-steppe zone of Left-bank Ukraine (Kharkiv and Sumy regions). The diet structure of the nestlings was studied in an upland oak forest of Homilshanski Forests National Nature Park (Zmiiv District), in a forest park of Kharkiv, in a pine-oak forest of Hetmanskyi National Nature Park (Okhtyrka District), and in Vakalivshchyna Area (Sumy Region). According to Gensiruk's classification (2002), three trial plots, selected in the oak forests, were characterized by different stages of recreational digression (transformed as a result of heavy recreation pressure). The fourth trial plot was located in a pine-oak forest.

Trial plot 1 (TP1) is situated far from settlements, on the eastern bedrock bank of the Psel River in Vakalivshchyna Area and is represented by an oak forest mixed with some maple and linden trees. The crown closure makes up circa 85%, and the proportion of damaged trees does not exceed 10% of their total number. The understory and shrub layers, without traits of noticeable damage, are typical for the habitat. The grassy cover is mainly undisturbed and typical for this forest type. In some areas, excessive development of forest herbs is observed, due to the falling of overmature trees. The forest floor is undisturbed and thick. The recreational coefficient of the site, based on the area of forest paths, comprised 5%. Trial plot 1 (TP 1) has the first stage of recreational digression.

Trial plot 2 (TP 2) is located within a recreational zone of Homilshanski Forests National Nature Park, in the vicinities of research sites of H. S. Skovoroda Kharkiv National Pedagogical University and Karazin Kharkiv National University. This area is exposed to intensive recreation pressure during the bird breeding season. The forest includes damaged and diseased trees (about 35%); the crown closure is about 70%. The understorey and shrub layers are present but poorly differentiated. The grassy layer is partly disturbed; projective cover reaches 85% in some places. The forest floor is slightly disturbed. Forest paths cover up to 30% of the site. This model site has the 3d stage of recreation digression, and the management of recreation pressure is required.

Trial plot 3 (TP 3) is in the forest park of Kharkiv City. It is a predominantly natural upland oak forest with a small admixture of artificially planted species, located in the interfluve of the Lopan and Kharkiv rivers. The crown closure is circa 60%. The species, typical for the forest edge, as well as meadow, riparian, aquatic, and ruderal plants are recorded. There is an extended network of forest paths and roads, used for jogging. Increased recreation pressure leads to the expansion of open glades and the increasing density of paths. The maple *Acer negundo* forms dense thickets at the forest edge; in some places, garbage dumps can be found. The number of ruderal species increases as one approaches the forest border. The site has the 4th level of recreational digression.

Trial plot 4 (TP 4) is situated in Hetmanskyi National Nature Park, in a pine forest near the villages of Kamianka and Klymetovo, in the area called "Lytovskyi Bir". The oak-pine and maple-linden-oak woodlands near Kamianka have slight signs of human-caused disturbance; diseased trees are found; the crown closure is circa 20%. The understory and shrub layer are typical for the habitat; 5–20% of the trees have insignificant damages. The grassy layer includes meadow grasses (5–10%), which is not typical for this type of the forest. The forest floor is slightly disturbed. The area of paths is not extensive and covers up to 10% of the model site. In the section, lying in Lytovskyi Bir, the area of paths exceeds 20%. In July–August, the recreation pressure increases due to a high number of visitors. However, most bird species finish the breeding season before that time. The site has the third level of recreational digression.

A total of 52 chaffinch nests with 161 nestlings were inspected and 465 food pellets were collected. Of 838 invertebrate specimens, found in the trial plot, 110 (from 38 nestlings) in the oak forest TP 1, 138 (taken from 46 nestlings) were in the oak forest TP 2, 120 (from 35 nestlings) in the oak forest TP3 and 97 (from 42 nestlings) in the pine-oak forest TP 4.

The research was carried out from May 25th to June 15th (period 2010–2017) in the first half of the day. The nestling diet was investigated by applying neck ligatures to 5- to 8-day-old chicks (Malchevskij & Kadochnikov, 1953). The forage samples were fixed in a 70% soluteon of ethanol, and the arthropods were further identified in the laboratory. All the invertebrates were identified to the species, genus or family (in case of significant damage) by Associate Professor PhD Viktor Gramma by standard methods, using reference books. Similarity coefficients in the species composition of the invertebrates, found in the diet in different sites, were calculated using the formulas of Jaccard ($Cj = 100 \times j / (a + b - j)$) and Sorensen ($Cs = 100 \times 2j / (a + b)$), 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 ranged from 0 (no similarity between compared parameters) to 1 (complete similarity).

Results

In forest biogeocenoses, the chaffinch, as a representative of open nest birds, can collect food from various tree species. Moreover, the most important thing for this species is not the species composition of the vegetation, but the architectonics of the crown of the stand. In the nesting period, the finch prefers to collect food on trees and on the ground in the open parts of the forest litter, sometimes on the undergrowth and shrubs. When feeding and nesting on different species of trees, birds choose the same microstations: strong, rigid branches, mostly of the first or third order (Fig. 1). The most inaccessible for birds are the final branches on the periphery and top of the trees, since they rarely use the maneuver of "suspension" and "throw into the air." The trophic connections of birds are mainly similar when feeding on trees and land. In the crown of trees, the chaffinch moves along thick horizontal branches with lateral steps, jumps and acrobatics, pecking food from the surrounding branches and leaves, mainly with the help of "reaching out".

Our research revealed trophic links of the chaffinch with 39 taxa of invertebrate animals (Table 1). Representatives of Insecta (93.0%; n = 838) constituted an absolute majority, while Arachnida (4.3%), Malacostraca (1.7%) and Diplopoda (1.0%) were found in smaller percentages (Fig. 2a). The among insects, representatives of Coleoptera predominated (32.6%; n = 768), including Curculionidae (65.4%; n = 254), as well as Lepidoptera (28.2%; n = 768), with Noctuidae dominating (56.8%; n = 220). Hymenoptera (16.2%; n = 768), Diptera (14.2%) and Hemiptera (8.5%), Neuroptera (0,4%) had a lower value (Fig. 2b). Chaffinches pick up Lepidoptera caterpillars from grassy vegetation or from the ground surface in the period when they descend to the ground for pupation or fall on the grass due to strong wind.

Fig. 1. Chaffinch nesting and feeding places

Table 1
Macrofauna species in the *F. coelebs* diet

Taxon name			Trophic group	TP 1	TP 2	TP 3	TP 4	Total, abs. (%)	Notes
order	family	species							
Homoptera	Aphididae	Aphididae sp.	ph	–	8	–	36	44 (5.3)	34 imagoes, 10 larvae
Hemiptera	Miridae	Miridae sp.	ph	–	1	–	–	1 (0.1)	imago
	Acanthosomatidae	*Elasmostethus* sp.	ph	–	2	–	–	2 (0.2)	–"–
		Elasmucha grisea (Linnaeus, 1758)	ph	–	7	–	–	7 (0.9)	–"–
	Pentatomidae	*Palomena prasina* (Linnaeus, 1761)	ph	–	–	–	1	1 (0.1)	larva
		Pentatomidae sp.	ph	5	2	3	–	10 (1.2)	imagoes
		Eurydema oleracea (Linnaeus, 1758)	ph	1	–	–	–	1 (0.1)	larvae
Coleoptera	Carabidae	Carabidae sp.	z	2	–	2	2	6 (0.7)	4 imagoes, 2 larvae
	Staphylinidae	*Philonthus* sp.	z	–	5	–	–	5 (0.6)	imagoes
	Scarabaeidae	*Oryctes nasicornis* (Linnaeus, 1758)	s	–	1	–	–	1 (0.1)	pupa
		Anisoplia segetum (Herbst, 1783)	ph	2	–	4	2	8 (1.0)	imagoes
		A. austriaca (Herbst, 1783)	ph	–	5	–	–	5 (0.6)	–"–
	Cantharidae	*Malthinus flaveolus* (Herbst, 1786)	z	–	4	–	–	4 (0.5)	imagoes
		Cantharidae sp.	z	3	5	4	4	16 (1.9)	12 imagoes, 4 larvae
	Elateridae	*Agriotes gurgistanus* (Faldermann, 1835)	p	–	1	–	–	1 (0.1)	imago
		A. lineatus (Linnaeus, 1767	p	–	3	–	–	3 (0.4)	–"–
		A. obscurus (Linnaeus, 1758)	p	4	4	4	2	14 (1.7)	–"–
		A. ustulatus (Schaller, 1783)	p	–	1	–	–	1 (0.1)	–"–
		Agriotes sp.	p	3	4	–	–	7 (0.8)	–"–
		Selatosomus aeneus (Linnaeus, 1758)	p	2	3	–	–	5 (0.6)	–"–
	Chrysomelidae	*Chrysomela* sp.	ph	3	3	–	3	9 (1.1)	–"–
		Chrysomelidae sp.	ph	–	3	–	–	3 (0.4)	–"–
	Curculionidae	*Otiorrhinchus* sp.	ph	1	–	–	–	1 (0.1)	–"–
		Brachyderes incanus (Linnaeus, 1758)	ph	2	3	–	2	7 (0.9)	–"–
		Curculionidae sp.	ph	25	50	58	25	158 (19.0)	–"–
Neuroptera	Chrysopidae	Chrysopidae sp.	z	–	2	–	–	2 (0.2)	–"–
		Chrysopa sp.	z	–	1	–	–	1 (0.1)	–"–
Hymenoptera	Tenthredinidae	Tenthredinidae sp.	ph	4	4	4	4	16 (2.0)	8 imagoes, 8 larvae
	Ichneumonidae	Ichneumonidae sp.	z	–	7	–	4	11 (1.3)	imagoes
	Formicoidae	*Lasius niger* (Linnaeus, 1758)	z	10	2	1	1	14 (1.7)	–"–
		L. fuliginosus (Latreille, 1798)	z	8	2	3	1	14 (1.7)	–"–
		L. alienus (Förster, 1850)	z	15	10	–	–	25 (3.0)	–"–
		Lasius sp.	z	14	6	7	7	34 (4.1)	–"–
		Formica rufa (Linnaeus, 1761)	z	3	9	–	–	12 (1.4)	–"–
Lepidoptera	Tortricidae	Tortricidae sp.	ph	5	3	4	4	16 (1.9)	6 imagoes, 5 pupae, 5 larvae
		Tortrix viridana (Linnaeus, 1758)	ph	3	3	3	4	13 (1.6)	imagoes
	Nymphalidae	Liparidae sp.	ph	–	2	–	–	2 (0.2)	–"–
	Noctuidae	Noctuidae sp.	ph	30	25	50	20	125 (14.9)	102 imagoes, 3 pupae, 20 larvae
	Geometridae	Geometridae sp.	ph	8	8	40	8	64 (7.6)	20 imagoes, 44 larvae
Diptera	Bibionidae	Bibionidae sp.	ph	1	–	–	–	1 (0.1)	imago
	Opomyzidae	*Opomyza florum* (Fabricius, 1794)	ph	–	1	–	–	1 (0.1)	–"–
	Phoridae	Phoridae sp.	s	–	2	–	–	2 (0.2)	–"–
	Tephritidae	Tephritidae sp.	ph	18	10	–	10	38 (4.5)	–"–
	Sarcophagidae	Sarcophagidae sp.	n	–	6	–	–	6 (0.7)	3 imagoes, 1 pupa, 2 larvae
	Tachinidae	Tachinidae sp.	z	8	6	–	7	21 (2.5)	imago
		Diptera sp.	s	10	2	20	10	42 (5.0)	–"–
Araneae	Araneae	Araneidae sp.	z	10	10	6	10	36 (4.3)	–"–
Polydesmida	Polydesmidae	*Polydesmus complanatus* (Linnaeus, 1761)	s	–	1	–	–	1 (0.1)	–"–
Julida	Julidae	*Rossiulus kessleri* (Lochmander, 1927)	s	–	–	7	–	7 (0.9)	–"–
Isopoda	Porcellionidae	*Porcellio scaber* Latreille, 1804	s	–	14	–	–	14 (1.7)	–"–
		Total	–	200	251	220	167	838 (100.0)	–

Notes: macrofauna trophic groups: ph – phytophages, z – zoophages, p – polyphages, s – saprophages, n – necrophages; TP 1–4 – model sites, described in Materials and methods.

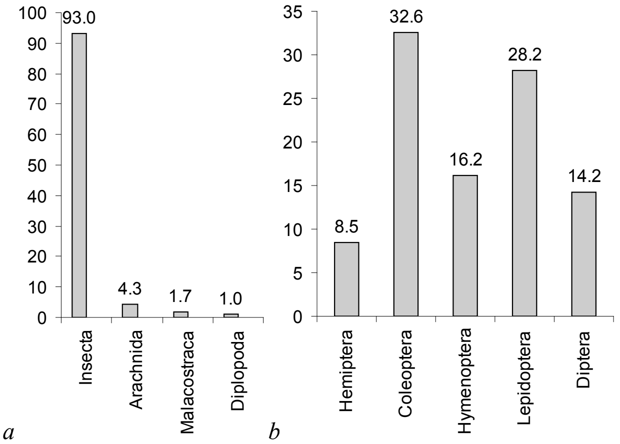

Fig. 2. Diversity of trophic links in the *F. coelebs* (data are summarized for all model plots, n = 838): *a* – main groups of invertebrates; *b* – main orders of insects; the ordinate is shown percentage in the total number (%)

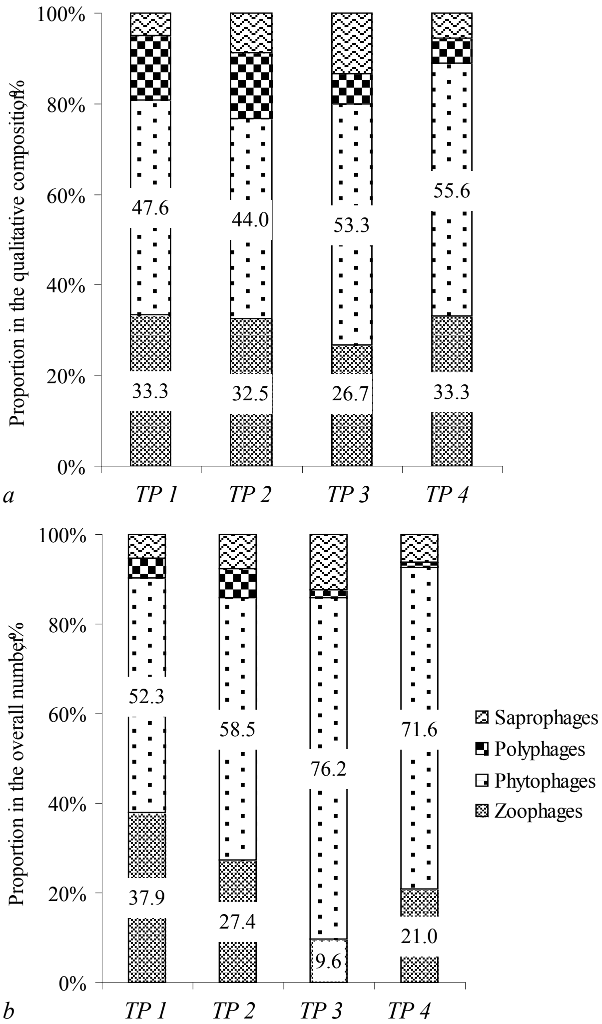

Fig. 3. Distribution of trophic groups of the *F. coelebs* in model sites (n = 838): *a* – proportion in the qualitative composition, *b* – proportion in the overall number

The diet of the *F. coelebs* nestlings in all the trial plots (Fig. 3a), according to the proportion in the overall number of consumed species, was dominated by phytophages: from 44.0% (TP 2) and 47.6% (TP 1) to 53.3% (TP 3) and 55.6% (TP 4). Phytophages (Fig. 3b) dominated among prey items as well: 52.3% (TP 1) and 58.5% (TP 2) to 71.6% (TP 4) and 76.2% (TP 3). In the breeding period, the *F. coelebs* eliminate phytophages of forest plantations, in particular, the adult imagoes of Coleoptera with the majority of Curculionidae (20.4%; n = 838) and larvae of Noctuidae (14.9%) Lepidoptera had a noticeable share. Zoophages occupied the second place (31.5%), significantly fewer polyphages (10.3%), saprophages (8.1%) and necrophages (0.2%). The dominance of phytophages among forage objects indicates the significant role of the *F. coelebs* in regulating the number of phytophages of forest ecosystems. Thus, *F. coelebs* can undoubtedly be classified as an important insectivorous bird.

Analysis of average values of the indices of the trophic diversity of *F. coelebs* in different plots indicates its increase in the rows: nature reserve areas (TP 2 and 4), low- (TP 1) and highly transformed oak forest (TP 3). The highest number of taxonomic objects in the food of chaffinches' chicks was found in TR 2, where the highest values in all the indices of biodiversity: Margalef – 6.20, Menchinick – 2.25, Shannon – 3.11. In other plots, the diversity indices decrease with increase in the level of recreation. In TP 3 oak forest the indices were the lowest: Margalef – 2.78, Menchinick – 1.08, Shannon – 2.13. Balance according to Macintosh and Pielou indicates evenness of selecting food objects in oak forests TP 1, 2 and 4, by contrast to oak forest TP 3 (Table 2).

Table 2
Indices of diet diversity of the *F. coelebs* in model sites of North-Eastern Ukraine

Parameters	TP 1	TP 2	TP3	TP4
Margalef index	4.15	6.20	2.78	3.73
Manhinick index	1.62	2.25	1.08	1.56
Shannon index	2.81	3.11	2.13	2.56
Simpson dominance index	0.89	0.86	0.93	0.88
Simpson diversity index	1.12	1.17	1.07	1.13
Berger-Parker dominance index	0.15	0.20	0.26	0.22
McIntosh dominance index	0.78	0.78	0.63	0.73
McIntosh evenness	0.91	0.88	0.79	0.86
Pielou evenness	2.06	2.02	1.77	1.96

Table 3
Invertebrate similarity in the *F. coelebs* diet in model sites of North-Eastern Ukraine

Pair of model sites	Number of invertebrate species	Similarity index	
		Jaccard	Sorensen
TP 2 – TP 1	19	0.69	0.76
TP 1 – TP 4	19	0.72	0.84
TP 2 – TP 4	17	0.45	0.62
TP 2 – TP 3	13	0.34	0.51
TP 1 – TP 3	12	0.63	0.67
TP 4 – TP 3	11	0.64	0.68

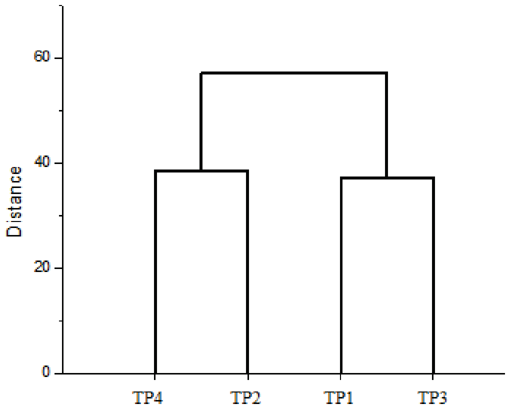

Fig. 4. Similarity of trophic links of *F. coelebs* in studied sites of North-Eastern Ukraine

Analysis of the similarity of diversity of trophic relations of chicks of *F. coelebs* indicates the highest similarity by 19 species of invertebrates in oak forests TP 1 and 2, Jaccard and Sørensen indices equaled 0.69 and 0.76 respectively in oak forest TP 1 and 4. Indices of Jaccard and Sørensen equaled 0.72 and 0.84, respectively (Table 3). In general the analysis of the average parameters of the species diversity of the diet of

F. coelebs indicates significant similarity of the diet in different ecosystems and evenness of use of the bird's food objects. This explains the wide distribution and abundance of *F. coelebs* on different plots the species being undemanding in the location of nests (Fig. 4).

Discussion

In the trophic relations of chaffinch and common species of birds of forest ecosystems, the highest values of indices of similarity were found with *Erithacus rubecula* (Linnaeus, 1858): 0.25 – Jaccard, 0.47 – Sørensen. In general, low values of the mentioned indices represent absence of overlapping of the trophic niches of *F. coelebs* with common species of birds of forest ecosystems of North-Eastern Ukraine (Chaplygina, 2016; Chaplygina et al., 2016a, 2016b, 2018, 2019). Dominance of phytophage insects in the diet of *F. coelebs* and their high share in the forest park (TP3) indicates the possibility of involvement of the birds in forest plantations of urban landscapes.

In the trophic relations of *F. coelebs* during the nesting and pre-nesting periods, the dominance of Curculionidae in Belarus (Domancevich, 2017) and Leningrad Oblast (Prokofieva, 1963) was discovered. In Dnipropetrovsk Oblast (Bulakhov et al., 2015), the insects also dominated (92.0%), among which lepidopterans (50.3%) and coleopterans (27.8%) dominated. Also, 7.9% comprised of mollusks (2.7%), earthworms (2.4%), spiders (1.8%) and Diplopoda (0.8%). Oniscidae, Dorilaimidae and Acari accounted only for 0.1%. Therefore, the birds are observed to have a certain specialization of nutrition, which somewhat limits the feeding activity of birds during adaptation to new types of food. However, in most territories, *F. coelebs* is considered one of the less specialized species among the forest Passeriformes, the high flexibility and broad diet range, and diversity of its ethological relations makes this species eurytopic and dominant in most natural and anthropogenically transformed ecosystems (Marochkina, 2004; Shemiakina, 2009).

Conclusion

The diet of *F. coelebs* in four forest ecosystems (three model sites in the oak forests, transformed under intensive recreation pressure, and one model site in a pine-oak forest consisted of 39 invertebrate taxa. In the diet of chaffinch, insects dominated (93.0%). Coleoptera (32.6%) and Lepidoptera (63.5%) dominated among the insects, most of the species were represented by phytophages. Protected natural areas are most suitable for life of this species. The results of the research have indicated the crucial role of *F. coelebs* in the population management of potentially dangerous agricultural pests.

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