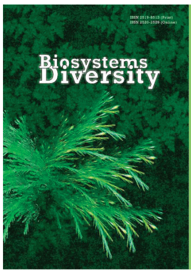


Biosystems Diversity

ISSN 2519-8513 (Print)
ISSN 2520-2529 (Online)
Biosyst. Divers.,
2019, 27(1), 51–55
doi: 10.15421/011908


# Trophic links of the song thrush (*Turdus philomelos*) in transformed forest ecosystems of North-Eastern Ukraine


A. B. Chaplygina*, O. Y. Pakhomov**, V. V. Brygadyrenko**

**H. S. Skovoroda Kharkiv National Pedagogical University, Kharkiv, Ukraine*
***Oles Honchar Dnipro National University, Dnipro, Ukraine*



*Article info*

*Received 28.01.2019*
*Received in revised form 07.03.2019*
*Accepted 09.03.2019*



*H. S. Skovoroda Kharkiv National Pedagogical University, Alchevsky st., 29, Kharkiv, 61002, Ukraine. Tel.: +38-050-61-81-896. E-mail: iturdus@ukr.net*

*Oles Honchar Dnipro National University, Gagarin ave., 72, Dnipro, 49010, Ukraine. Tel.: +38-050-93-90-788. E-mail: brigad@ua.fm*



***Chaplygina, A. B., Pakhomov, O. Y., & Brygadyrenko, V. V. (2019). Trophic links of the song thrush (Turdus philomelos) in transformed forest ecosystems of North-Eastern Ukraine. Biosystems Diversity, 27(1), 51–55. doi:10.15421/011908***



The diet spectrum of the song thrush (*Turdus philomelos* Brehm, 1831; Passeriformes, Turdidae) was studied with the aim of supporting the population of the species in transformed forests of North-Eastern Ukraine. Four forest ecosystems were surveyed: three model sites in oak woodlands with different stages of recreational digression, and the fourth model site in a pine-oak forest. A total of 45 invertebrate taxa with the dominance of Insecta (64.6%, n = 1321), Oligochaeta (16.7%), and Gastropoda (12.0%) were revealed in the diet of the song thrush. At the level of orders, Lepidoptera (66.2%) was dominant. In the qualitative structure of the song thrush nestling diet, the highest number of taxa (40.5–59.1%) was represented by phytophages. Phytophagous species also comprised the majority of the consumed prey items (44.7–80.3%). Environmental conditions are an important factor, affecting the diet composition of birds. The most favourable foraging conditions for the thrushes were revealed in natural protected areas. The analysis has shown a fairly even foraging efficiency of the thrushes in all the studied sites. The highest biodiversity indices were found in a protected area of the National Nature Park "Homilshanski Forests". The results of the research indicate an important role of *T. philomelos* in the population management of potentially dangerous agricultural pests.



*Keywords*: foraging stereotype; transformed areas; trophic groups; diet; dendrophilous birds; zoophages; phytophages; saprophages.


## Introduction

Monitoring of the status of insectivorous passerines under constantly increasing human pressure on natural biocoenoses is a priority task for contemporary ornithology (Assandri et al., 2017; Blinkova & Shupova, 2017). Due to their mobility, birds are regarded as convenient environmental indicators (Gregory et al., 2003; Blair & Johnson, 2008; Bulakhov et al., 2008; Dranga et al., 2016; Matsyura, 2018).

The song thrush (*Turdus philomelos* Brehm, 1831) is a principal contributor in communities of forest ecosystems of the temperate climate zone (Amar et al., 2006; Domokos & Domokos, 2016). Studies of its foraging ecology uncover the potential for the conservation of this species as a numerous insectivorous bird and a migrant with a global (Bern Convention) conservation status (Newton, 2007). It has been established that habitat conditions of *T. philomelos* are crucial for the successful breeding and population stability of the species in forests of Germany (Batary et al., 2014), Sweden (Felton et al., 2016), Romania (Domokos & Domokos, 2016), Spain (Moreno-Rueda & Pizzaro, 2009), and for equivalent species in Southeast Asia (Hamer et al., 2015). This issue becomes especially urgent in the north-eastern part of Ukraine, characterised by the intensive transformation of natural communities (Brygadyrenko, 2014, 2015; Chaplygina et al., 2016; Shupova, 2017). Understanding of particular foraging characteristics of insectivorous birds is important to mitigate invasions of arthropods, which are potential carriers of diseases dangerous to humans (Anderson & Magnarelli, 1993; Lommano et al., 2014), as well as mitigate invasions of pests of forestry and agriculture (Faly & Brygadyrenko, 2014; Chaplygina et al., 2015; Caprio & Rolando, 2017). It is also important to regulate the size of bird flocks which could otherwise destroy part of the harvest (Barnard, 1980; Paralikidis et al., 2009).

In Great Britain, the population of the song thrush tends to a large-scale decrease, which started in 1968 (Robinson et al., 2004). Since the middle of the 1970s, its abundance has been falling in agricultural lands of lowland Great Britain (Peach et al., 2004). The abundance of the song thrush in forests of North-Eastern Ukraine allows us to consider it as a subdominant species according to its abundance (Chaplygina & Savinskaya, 2016; Chaplygina, 2018). The timing of migrations (Nadtochiy & Chaplygina, 2010) and nest location characteristics of this species in Ukraine (Chaplygina, 2009) have been studied.

Up to now, research has considered foraging characteristics of a species as those that determine the management and conservation of bird diversity in natural and transformed areas (Amrhein, 2013; Luke, 2015; Korňan & Adamík, 2017; Chaplyhina, 2018). Potential causes of the decrease in bird numbers in the breeding season are changes in the status of natural associations in their breeding habitats (Kirby et al., 2005; Paker et al., 2014). It leads to the reduction in the available invertebrates and loss of feeding habitats of ground-foraging birds (Chaplygina et al., 2016a, 2016b; Markova, 2016).

In order to support the abundance of birds and improve their for aging and distribution conditions, the suburban drain pits are proposed in South Africa (Suri et al., 2017), and the extension of marginal vegetation is promoted in cities of Central Italy (Morelli, 2013). Our studies of the song thrush in the forest-steppe zone of Ukraine were made in comparison with other thrush species (Chaplygina, 2000). Characteristics of the bird's diet in different transformed areas definitely require thorough investigation since it is the main reason that limits this species' abundance.

The aim of this study is to analyse the qualitative and quantitative diet composition and the foraging stereotype of the song thrush in order to reveal trophic links and conserve bird populations in transformed ecosystems of North-Eastern Ukraine.

## Materials and methods

The research was carried out over the period 2000–2017, in the forest-steppe zone of Left-bank Ukraine (Kharkiv Region and Sumy Region). The diet composition of the song thrush nestlings was studied in upland oak groves of the National Nature Park "Homilshanski Forests", (Zmiiv District), a forest park in the city of Kharkiv, pine-oak forests of the National Nature Park "Hetmanskyi" (Okhtyrka District), and in the site "Vakalivshchyna" (Sumy Region). According to Gensiruk's classification (2002), three model sites, selected in the oak forests, were characterized by different stages of recreational digression. The fourth model site was located in a pine-oak forest.

Model site 1 (MS1) is situated far from settlements, on the eastern bedrock bank of the Psel River in the site "Vakalivshchyna" and is represented by an oak forest mixed with maple and linden trees. The crown closure makes up circa 85% (Table 1), and the share of damaged trees does not exceed 10% of their total abundance. The understory and shrub layer are typical for the habitat, without traits of noticeable damage. The herbaceous cover is mainly undisturbed and typical for the 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 was determined by the area of forest paths comprising 5%. Model site 1 is characterized by the 1st stage of recreational digression.

Model site 2 (MS2) is located within the recreational zone of the National Nature Park "Homilshanski Forests" in the vicinities of study plots of H. S. Skovoroda Kharkiv National Pedagogical University and Karazin Kharkiv National University. These areas are exposed to intensive recreation pressure during the bird's breeding season. The wood includes damaged and diseased trees (about 35%); the crown closure is about 70%. The understory and shrub layer are available but poorly differentiated. The herbaceous layer is partly disturbed; projective cover reaches 85% in some areas. The forest floor is little disturbed. Forest paths occupy up to 30% of the site. The model site is characterized by the 3d stage of recreation digression and requires management of recreational pressure.

Model site 3 (MS3) lies in the forest park of Kharkiv City. It is a predominantly a natural upland oak grove with a small part of planted species, located in the watershed of the rivers Lopan and Kharkiv. Its crown closure is circa 60%. Species of forest edge, meadow, riparian-aquatic and ruderal plants are also recorded. There is an extended network of forest paths and roads, which people use for jogging. Increasing recreation pressure leads to the expansion of open glades and increasing density of paths. The maple *Acer negundo* forms dense thickets at the forest edge; in some places, garbage dumps are scattered. The closer to the forest border, the more ruderal species can be found. The site has the 4th level of recreational digression.

Model site 4 (MS4) is situated in the National Nature Park "Hetmanskyi", in a pine forest near Kamianka and Klymetovo villages, in the area called "Lytovskyi Bir". Oak-pine and maple-linden-oak woodlands near Kamianka are little disturbed by people, with diseased trees; the crown closure is circa 20%. The understory and shrub layer are typical for the habitat; 5–20% of trees have insignificant damage. The herbaceous layer includes meadow grasses (5–10%), not typical for this type of the forest. The forest floor is little disturbed. The area of paths is not large, up to 10% of the model site. In the section, lying in Lytovskyi Bir, the area of paths exceeds 20%. In July-August, the recreational pressure increases due to a high number of visitors but by this time the breeding season of most of the birds has already finished. The site has the 3d level of recreational digression.

A total of 52 nests of the song thrush with 125 nestlings were inspected. 733 food pellets were collected, and 1,321 specimens of invertebrates were studied: 441 (from 42 nestlings) in the oak forest MS2, 233 (from 21 nestlings) in the pine-oak forest MS4, 372 (from 38 nestlings) in the oak forest MS1, and 275 (from 24 nestlings) in the oak forest MS3.

The research was carried out from 25 May to 15 June in the first half of the day. The nestling diet was investigated by applying neck ligatures to 5–8-day old chicks (Mal'chevskij & Kadochnikov, 1953). The forage samples were fixed in a 70% solution of ethanol, and the arthropods were further identified in the laboratory. All the invertebrates were identified to species, genus or family (in case of significant damage) by Associate Professor PhD Viktor Gramma by standard methods using reference books.

Statistical treatment of the data was performed in the program Statistica 8.0 (StatSoft Inc., USA). Similarity coefficients in the species composition of invertebrates found in the diet in different sites were calculated using the formulae of Jaccard ($C_j = 100 \cdot j / (a + b - j)$) and Sorensen ($Cs = 100 \cdot 2j / (a + b)$), 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 had values from 0 (no similarity between compared parameters) to 1 (complete similarity).

## Results

The song thrush belongs to the birds which forage in the above-ground layer and, ethologically, is associated with forest areas rich in herpetobionts. All thrushes feed on the ground surface, not pulling invertebrates out of the ground but finding prey under fallen leaves, stirring the litter, which positively influences ground-forming processes. Thus, they prefer habitats with the availability of fallen leaves and well-developed ground litter, the upper layers of which are difficult to transform. These birds are often found in areas with pronounced micro-relief: depressions, ground hills and other roughness. These conditions create a sharp gradient of soil moisture. While feeding, a thrush moves quickly, usually making 26.5 ± 1.2 (25–30) hops and 16.4 ± 1.5 (2–20) pecks per minute. The duration of visual inspection of prey is 1–5 seconds.

Our research revealed trophic links of the song thrush with 45 taxa of invertebrate animals (Table 1). Representatives of Insecta (64.6%; n = 1321; Lepidoptera caterpillars (66.2%; n = 825) dominated) constituted an absolute majority, while Oligochaeta (16.7%) and Gastropoda (12.0%) were found in smaller amounts. Other invertebrate groups (0.6–6.3%) played an insignificant role (Fig. 1a, b). The birds 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.

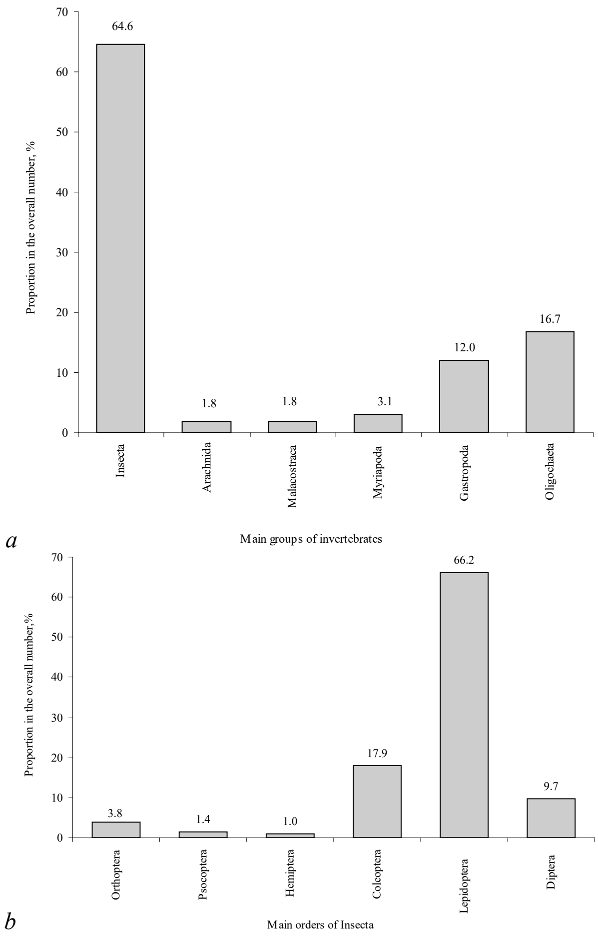


**Fig. 1.** Diversity of trophic links in the song thrush: *a* – main groups of invertebrates; *b* – main orders of insects

**Table 1**
Macrofauna species in the song thrush diet (*Turdus philomelos* Brehm, 1831)

| Order | Family | Species | Trophic group | MS1 | MS2 | MS3 | MS4 | Total | Notes |
|---|---|---|---|---|---|---|---|---|---|
| Odonata | Gryllidae | *Gryllus* sp. | p | 5 | 13 | 14 | – | 32 (2.4) | imag. |
| Psocoptera | Psocoptera fam. | Psocoptera sp. | s | 6 | 6 | – | – | 12 (0.9) | –"– |
| Hemiptera | Miridae | Miridae sp. | ph | 2 | – | – | – | 2 (0.2) | –"– |
| | Pentatomidae | *Palomena prasina* (Linnaeus, 1761) | ph | – | 6 | – | – | 6 (0.6) | –"– |
| Coleoptera | Carabidae | Carabidae sp. | z | – | – | – | 4 | 4 (0.4) | –"– |
| | | *Harpalus rufipes* (De Geer, 1774) | z | – | 11 | 12 | – | 23 (1.7) | –"– |
| | Silphidae | Silphidae sp. | n | 7 | 2 | – | – | 9 (0.7) | –"– |
| | | *Nicrophorus vespilloides* (Herbst, 1783) | n | 3 | 2 | – | – | 5 (0.4) | –"– |
| | Staphylinidae | Staphylinidae sp. | z | – | – | – | 3 | 3 (0.2) | –"– |
| | Scarabaeidae | *Anisoplia austriaca* (Herbst, 1783) | ph | 10 | 8 | – | 6 | 24 (1.8) | –"– |
| | | *Cetonia aurata* (Linnaeus, 1758) | ph | 6 | – | – | 12 | 18 (0.1) | –"– |
| | | Scarabaeidae sp. | ph | 9 | 8 | 5 | 5 | 27 (2.0) | –"– |
| | Elateridae | *Elater sanguineus* (Linnaeus, 1758) | p | – | 6 | – | 8 | 14 (1.1) | –"– |
| | | Elateridae sp. | p | – | 6 | – | 6 | 12 (0.9) | –"– |
| | Curculionidae | *Polydrosus* sp. | ph | – | 2 | – | 4 | 6 (0.5) | –"– |
| | | Curculionidae sp. | ph | – | 2 | – | 6 | 8 (0.6) | –"– |
| Lepidoptera | Tortricidae | Tortricidae sp. | ph | 7 | 5 | 14 | 11 | 37 (2.8) | 6 imag. + 31 larv. |
| | | Pyraloidea sp. | ph | 12 | 18 | – | 18 | 48 (3.6) | 42 imag. + 6 larv. |
| | Nymphalidae | Nymphalidae sp. | ph | – | 11 | – | 17 | 28 (2.1) | 18 imag. + 10 larv. |
| | Noctuidae | Noctuidae sp. | ph | 18 | 16 | 21 | 19 | 74 (5.6) | 74 imag. |
| | Geometridae | Geometridae sp. | ph | 18 | 18 | 23 | 21 | 80 (6.1) | 24 imag. + 56 larv. |
| | Pieridae | Pieridae sp. | ph | 44 | 38 | 37 | 46 | 165 (12.5) | 28 imag. + 137 larv. |
| | Lycaenidae | Lycaenidae sp. | ph | 7 | 17 | – | – | 24 (1.8) | 24 larv. |
| | Notodontidae | Notodontidae sp. | ph | 17 | 21 | 12 | 13 | 63 (4.8) | 12 imag. + 51 larv. |
| | Lepidoptera fam. | Lepidoptera sp. | ph | 11 | 12 | 14 | 9 | 46 (3.5) | 46 larv. |
| Diptera | Bibionidae | Bibionidae sp. | s | 23 | 19 | 8 | – | 50 (3.8) | –"– |
| | Tipulidae | *Tipula* sp. | ph | 6 | 15 | – | – | 21 (1.6) | –"– |
| | Rhagionidae | *Rhagio* sp. | z | – | 2 | – | – | 2 (0.2) | –"– |
| | Tabanidae | Tabanidae sp. | z | – | 2 | – | – | 2 (0.2) | –"– |
| | Syrphidae | *Chrysotoxum festivum* (Linnaeus, 1758) | z | – | 4 | – | – | 4 (0.4) | –"– |
| | Muscidae | Muscidae sp. | s | – | – | 2 | – | 2 (0.2) | –"– |
| | Calliphoridae | Calliphoridae sp. | z | – | 2 | – | – | 2 (0.2) | –"– |
| Araneae | Araneae | Aranea sp. | z | 2 | 2 | – | 1 | 5 (0.4) | –"– |
| | Philodromidae | *Philodromus rufus* (Walckenaer, 1826) | z | 2 | 2 | – | 3 | 7 (0.5) | 4 imag., 3 juv. |
| | Thomisidae | *Cozyptila blackwalli* (Simon, 1875) | z | 4 | 6 | – | 2 | 12 (0.9) | 7,4 juv., 1 larv. |
| Julida | Julidae | *Rossiulus kessleri* (Lohmander, 1927) | s | 16 | 5 | 17 | – | 38 (2.9) | – |
| Polydesmida | Polydesmidae | *Polydesmus scabratus* (Koch, 1847) | s | 3 | – | – | – | 3 (0.2) | –"– |
| Isopoda | Oniscoidea | *Oniscus asellus* (Linnaeus, 1758) | s | 6 | – | 18 | – | 24 (1.8) | –"– |
| Pulmonata | Arionidae | *Arion subfuscus* (Draparnaud, 1805) | s | 28 | 20 | 17 | – | 65 (4.9) | –"– |
| | | *Trichia hispida* (Linnaeus, 1758) | s | 17 | 11 | – | 7 | 35 (2.7) | –"– |
| | | *Succinea oblonga* (Draparnaud, 1801) | s | 14 | 15 | 29 | – | 58 (4.4) | –"– |
| Haplotaxida | Lumbricidae | *Dendrodrilus rubidus* (Eisen, 1874). | s | 27 | 53 | – | – | 80 (6.1) | –"– |
| | | *Lumbricus terrestris* (Linnaeus, 1758) | s | 42 | 39 | 32 | 12 | 125 (9.5) | –"– |
| | | *Apporectodea rosea* (Savigny, 1826) | s | – | 16 | – | – | 16 (1.2) | –"– |
| | | Total | – | 372 | 441 | 275 | 233 | 1321 (100.0) | |

*Notes*: trophic groups of the macrofauna: ph – phytophages, z – zoophages, p – polyphages, s – saprophages, n – necrophages; MS1–MS4 – model sites described in Materials and Methods; imag. – imagoes; larv. – larvae; juv. – immature specimens.

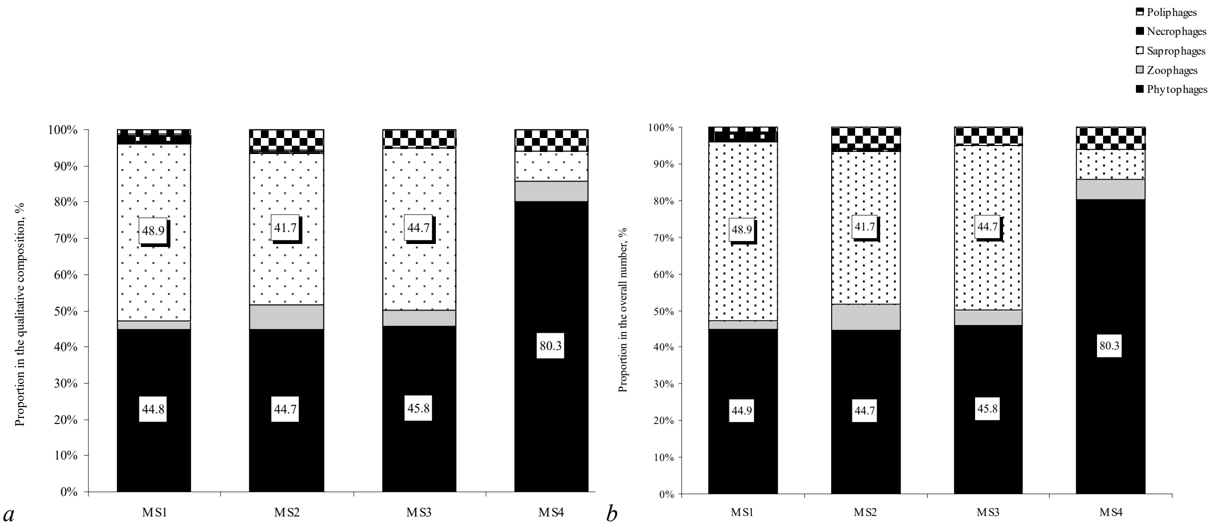


**Fig. 2.** Distribution of trophic groups of the song thrush in model sites:
*a* – proportion in the qualitative composition, *b* – proportion in the overall number

The diet of the song thrush nestlings in all the model sites, according to the proportion in the overall number of consumed species, was dominated by phytophages: from 40.5% (MS2) and 43.8% (MS3) to 44.8% (MS1) and 59.1% (MS4) (Fig. 2a). Phytophages dominated among prey items as well: 44.7% (MS2), 45.8% (MS3), 80.3% (MS4); whereas in MS1 saprophages dominate (48.9%, Fig. 2b). In the breeding period, the song thrushes eliminate phytophages of forest plantations, in particular, larvae of Lepidoptera and Diptera, beetles from the families Curculionidae, Scarabaeidae, etc. Irrespectively of availability of saprophages (Oligochaeta) in their diet, the thrushes can undoubtedly be classified as important insectivorous birds.

The highest values of biodiversity indices were revealed in trophic links of the song thrush nestlings in the oak grove of the 3d stage of recreational digression (Fig. 3). They decrease according to the increasing transformation of the environment in the oak groves of the 1st and 5th stages. McIntosh's and Pielow's evenness indicates a uniform use of prey items in different model sites (Table 2). All of this proves the absence of specificity in the song thrush diet (Aleksandrova, 1959). Shannon diversity index of the song thrush diet increases from 2.62 (MS3) and 2.74 (MS4) to 3.22 (MS2) and 3.03 (MS1). Therefore, the song thrush has the highest diet similarity in natural protected areas of the oak grove of the 3d st. of recr. digr. (MS2) and the pine-oak stand of the 3d st. of recr. digr. (MS4) (Table 3).

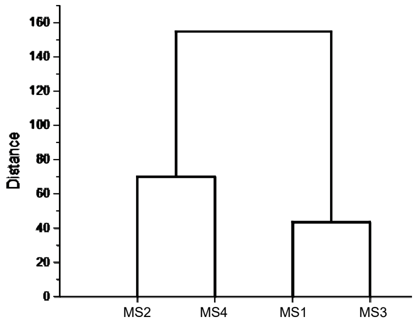


**Fig. 3.** Similarity of trophic links of the song thrush in studied sites of North-Eastern Ukraine

**Table 2**
Indices of diet diversity of the song thrush in model sites of North-Eastern Ukraine

| Parameters | MS1 | MS2 | MS3 | MS4 |
|---|---|---|---|---|
| Number of species | 29 | 37 | 16 | 22 |
| Total number of specimens | 372 | 441 | 275 | 233 |
| Margalef index | 4.39 | 5.58 | 2.67 | 3.49 |
| Manhinick index | 1.40 | 1.67 | 0.96 | 1.31 |
| Shannon index | 3.03 | 3.22 | 2.62 | 2.74 |
| Simpson dominance index | 0.93 | 0.92 | 0.95 | 0.92 |
| Simpson diversity index | 1.08 | 1.08 | 1.06 | 1.09 |
| Berger-Parker dominance index | 0.12 | 0.12 | 0.13 | 0.20 |
| McIntosh diversity index | 90.93 | 100.08 | 77.94 | 67.18 |
| McIntosh dominance index | 0.80 | 0.81 | 0.76 | 0.76 |
| McIntosh evenness | 0.94 | 0.93 | 0.96 | 0.92 |
| Pielow evenness | 0.61 | 0.62 | 0.70 | 0.64 |

**Table 3**
Invertebrate similarity in the song thrush diet in model sites of North-Eastern Ukraine

| Pair of model sites | Number of invertebrate species | Similarity index | |
|---|---|---|---|
| | | Jaccard | Sorensen |
| MS1 – MS2 | 25 | 37.9 | 75.8 |
| MS2 – MS4 | 18 | 30.5 | 61.0 |
| MS1 – MS4 | 15 | 29.4 | 58.8 |
| MS1 – MS3 | 13 | 28.9 | 57.7 |
| MS2 – MS3 | 14 | 26.4 | 52.8 |
| MS3 – MS4 | 8 | 21.1 | 42.1 |

## Discussion

In general, in surveyed ecosystems, thrushes play a significant role in regulating the number of invertebrates (Bulakhov et al., 2008). For one nesting cycle (5 chicks on the average), song thrushes consume 13,850 g of biological production, blackbirds – 18,360 g, fieldfares – 21,450 g (the impact of adult birds on biocoenoses biomass was not taken into account) (Chaplygina, 2000).

Song thrushes are characterized by lack of foraging preferences (Alexandrov, 1959), which makes the birds quite plastic in occupying anthropogenic landscapes (Chaplygina, 1998). However, we found a foraging stereotype, dominated by representatives of three groups: earthworms, caterpillars and gastropods, which had been also indicated (Berezantseva, 1997; Baranovsky et al., 2008). There are also myriapods (Myriapoda), mentioned in studies in Belarus and click beetles (Elateridae) (Abramova & Haiduk, 2017). While migrating to wintering grounds, the birds eat fruits of *Cornus sanguinea* L., *Sambucus nigra* L. and *Rubus* sp. The prevalence of dogwood fruit is probably explained by the high content of lipids required by birds before their long-distance migration (Hernández, 2009).

## Conclusions

The diet of the song thrush in anthropogenically transformed sites is quite diverse. It allows the birds to change the species composition of their prey depending on the dominance of prey in each particular model site. Studies of the diet of other species of insectivorous birds in these model sites will help to identify the differentiation peculiarities of trophic niches in various species of insectivorous birds. The song thrush, which feeds on the soil surface, has a diverse variety of forage in anthropogenically transformed sites, with the dominance of Lepidoptera caterpillars, Oligochaeta and Mollusca. Birds change the species composition of their prey depending on the dominance of prey in a particular model site. The development of similar studies will help to identify the functioning characteristics of trophic networks in natural and anthropogenically transformed areas, a special role in the regulation of which is played by polyphages with a wide diet spectrum, such as the song thrush.

## References


Abramova, I. V., & Haiduk, V. E. (2017). Ecology of thrush breeding (*Turdus*, Turdidae, Passeriformes) in South-Western Belarus. In: Current issues of zoological science in Belarus: Proceedings of the 11th International zoological conference dedicated to the 10-year anniversary of the foundation of the Scientific-Practical Bioresources Centre of National Academy of Sciences of Belarus. A. N. Varaksin Press, Minsk. Vol. 1. Pp. 8–17.

Aleksandrova, I. V. (1959). Materialy po pitaniyu pevchego drozda v gnezdovoy period [Materials on the song thrush diet in the breeding period]. Zoologicheskii Zhurnal, 38(1), 137–138 (in Russian).

Amar, A., Hewson, C. M., Thewlis, R. M., Smith, K. W., Fuller, R. J., Lindsell, J., Conway, G., Butler, S., & MacDonald, M. A. (2006). What's happening to our woodland birds? Long-term changes in the populations of woodland birds. RSPB research report number 19, BTO research report number 169. Sandy and Thetford, RSPB/BTO, Anon. 1998.

Amrhein, V. (2013). Wild bird feeding (probably) affects avian urban ecology. Avian Urban Ecology, 29–38.

Anderson, J. F., & Magnarelli, L. A. (1993). Epizootiology of Lyme disease-causing borreliae. Clinics in Dermatology, 11(3), 339–351.

Assandri, G., Bogliani, G., Pedrini, P., & Brambilla, M. (2017). Insectivorous birds as "non-traditional" flagship species in vineyards: Applying a neglected conservation paradigm to agricultural systems. Ecological Indicators, 80, 275–285.

Baillie, S., Marchant, J. H., Crick, H. Q. P., Noble, D. G., Balmer, D. E., Coombes, R. H., Downie, I. S., Freeman, S. N., Joys, A. C., Leech, D. I., Raven, M. J., Robinson, R. A., & Thewlis, R. M. (2006). Breeding birds in the wider Countryside: Their conservation status 2005. BTO Research Report No. 435. BTO, Thetford.

Baranovsky, A. V. (2008). Ryabinnik (*Turdus pilaris*), belobrovik (*T. iliacus*), pevchiy drozd (*T. philomelos*) i chernyy drozd (*T. merula*) [The fieldfare (*Turdus pilaris*), redwing (*T. iliacus*), song thrush (*T. philomelos*) and common blackbird (*T. merula*)]. Birds of Ryazan Meshchera. Golos Hubernii, Ryazan. Pp. 144–153 (in Russian).

Barnard, C. J. (1980). Flock feeding and time budgets in the house sparrow (*Passer domesticus* L.). Animal Behaviour, 28(1), 295–309.

Batáry, P., Fronczek, S., Normann, C., Scherber, C., & Tscharntke, T. (2014). How do edge effect and tree species diversity change bird diversity and avian nest survival in Germany's largest deciduous forest? Forest Ecology and Management, 319, 44–50.

Berezantseva, M. S. (1997). Pitanie gnezdovykh ptentsov chernogo drozda *Turdus merula* i sravnenie ego s pitaniem ptentsov pevchego drozda *T. philomelos* v lesostepnoy dubrave "Les na Vorskle" [The diet of the common blackbird nestlings *Turdus merula* and its comparison with the diet of the song thrush nestlings *T. philomelos* in the forest-steppe oak grove "Forest on the Vorskla"]. Russian Ornithological Journal, 20(6), 12–20 (in Russian).

Blair, R. B., & Johnson, E. M. (2008). Suburban habitats and their role for birds in the urban-rural habitat network: Points of local invasion and extinction? Landscape Ecology, 23(10), 1157–1169.

Blinkova, O., & Shupova, T. (2017). Bird communities and vegetation composition in the urban forest ecosystem: Correlations and comparisons of diversity indices. Ekológia (Bratislava), 36(4), 366–387.

Brygadyrenko, V. V. (2014). Influence of soil moisture on litter invertebrate community structure of pine forests of the steppe zone of Ukraine. Folia Oecologica, 41, 8–16.

Brygadyrenko, V. V. (2015). Community structure of litter invertebrates of forest belt ecosystems in the Ukrainian steppe zone. International Journal of Environmental Research, 9(4), 1183–1192.

Bulakhov, V. L., Gubkin, A. A., Ponomarenko, O. L., Pakhomov, O. Y. (2008). Biologichne riznomanittya Ukrainy. Dnipropetrovska oblast'. Ptahy: Negorobcepodibni (Aves: Non-Passeriformes) [Biological diversity of Ukraine. Dnipropetrovsk region. Aves: Non-Passeriformes]. Dnipropetrovsk University Press, Dnipropetrovsk (in Ukrainian).

Bulakhov, V. L., Gubkin, A. A., Ponomarenko, O. L., Pakhomov, O. Y. (2015). Biologichne riznomanittya Ukrainy. Dnipropetrovska oblast'. Ptahy: Gorobcepodibni (Aves: Passeriformes) [Biological diversity of Ukraine. Dnipropetrovsk region. Aves: Passeriformes]. Dnipropetrovsk University Press, Dnipropetrovsk (in Ukrainian).

Caprio, E., & Rolando, A. (2017). Management systems may affect the feeding ecology of great tits *Parus major* nesting in vineyards. Agriculture, Ecosystems and Environment, 243, 67–73.

Chaplygina, A. B. (2000). K voprosu o biotsenoticheskoy roli ptits v ekosistemakh (na primere roda *Turdus*) [On the issue of a biocoenotical role of birds in ecosystems (by the example of the genus *Turdus*)]. In: Birds of the Seversky Donets basin. Proceedings of the 6th and 7th conference "Study and protection of birds of the Seversky Donets basin". Donetsk. Pp. 51–57 (in Russian).

Chaplygina, A. B. (2009). Osoblyvosti roztashuvannya gnizd drozdiv rodu *Turdus* v transformovanyh landshaftah Pivnichno-Shidnoyi Ukrayini [Characteristics of nest locations of thrushes of the genus *Turdus* in transformed landscapes of North-Eastern Ukraine]. Berkut, 18(1–2), 131–138 (in Ukrainian).

Chaplygina, A. B. (2018). Dendrofil'ni gorobcepodibni (Rasseriformes) yak strukturno-funkcional'nyj element antropogenno transformovanyh lisovyh biogeocenoziv Pivnichno-Shidnoyi Ukrayiny [Dendrophilic passerines (Passeriformes) as a structural-functional element of anthropogenically transformed forest biogeocoenoses of North-Eastern Ukraine]. Oles Honchar Dnipro National University, Dnipro (in Ukrainian).

Chaplygina, A. B., & Savinskaya, N. O. (2016). Sovremennoe sostoyanie ornitofauny transformirovannyh landshaftov Severo-Vostochnoy Ukrainy na primere Muscicapidae i Turdidae [Current status of the avifauna of transformed landscapes of North-Eastern Ukraine by the example of Muscicapidae and Turdidae]. Russian Ornithological Journal, 25(1252), 615–647 (in Russian).

Chaplygina, A. B., Gramma, V. N., Bondarets, D. I., & Savynska, N. O. (2015). Arthropods in trophic-cenosis structure of collared flycatcher consortium in conditions of forest ecosystems of North-Eastern Ukraine. Visnyk of Dnipropetrovsk University, Biology, Ecology, 23(1), 74–85.

Chaplygina, A. B., Yuzyk, D. I., & Savynska, N. O. (2016). The Robin, *Erithacus rubecula* (Passeriformes, Turdidae), as a component of autotrophic consortia of forest cenoses, Northeast Ukraine. Vestnik Zoologii, 50(4), 369–378.

Chaplygina, A. B., Yuzyk, D. I., & Savynska, N. O. (2016). The Robin, *Erithacus rubecula* (Passeriformes, Turdidae), as a component of heterotrophic consortia of forest cenoses, Northeast Ukraine. Part 2. Vestnik Zoologii, 50(6), 493–502.

Domokos, E., & Domokos, J. (2016). Bird communities of different woody vegetation types from the Niraj Valley, Romania. Turkish Journal of Zoology, 40, 734–742.

Dranga, A. O., Gorlov, P. I., Matsyura, A. V., & Budgey, R. (2016). Breeding biology of rook (*Corvus frugilegus*) in the human transformed steppe ecosystems (the case of Botievo Wind Farm). Biological Bulletin of Bogdan Chmelnitskiy Melitopol State Pedagogical University, 6(1), 41–62.

Faly, L., & Brygadyrenko, V. (2014). Patterns in the horizontal structure of litter invertebrate communities in windbreak plantations in the steppe zone of the Ukraine. Journal of Plant Protection Research, 54(4), 414–420.

Felton, A., Hedwall, P. O., Lindbladh, M., Nyberg, T., Felton, A. M., Holmström, E., Wallin, I., Lof, M., & Brunet, J. (2016). The biodiversity contribution of wood plantations: Contrasting the bird communities of Sweden's protected and production oak forests. Forest Ecology and Management, 365, 51–60.

Gensiruk, S. A. (2002). Lisy Ukrainy [Forests of Ukraine]. Schevchenko Scientific Society, Lviv (in Ukrainian).

Gregory, R. D., Noble, D. G., Field, R., Marchant, J. H., Raven, M. J., & Gibbons, D. W. (2003). Using birds as indicators of biodiversity. Ornis Hungarica, 12–13, 11–24.

Hamer, K. C., Newton, R. J., Edwards, F. A., Benedick, S., Bottrell, S. H., & Edwards, D. P. (2015). Impacts of selective logging on insectivorous birds in Borneo: The importance of trophic position, body size and foraging height. Biological Conservation, 188, 82–88.

Hernández, Á. (2009). Summer-autumn feeding ecology of Pied Flycatchers *Ficedula hypolueca* and Spotted Flycatchers *Muscicapa striata*: The importance of frugivory in a stopover area in North-West Iberia. Bird Conservation International, 19(3), 224.

Kirby, W., Black, K., Pratt, S., & Bradbury, R. (2005). Territory and nest-site habitat associations of Spotted Flycatchers *Muscicapa striata* breeding in Central England. Ibis, 147(2), 420–424.

Korňan, M., & Adamík, P. (2017). Tree species preferences of foraging insectivorous birds in a primeval mountain mixed forest: Implications for management. Scandinavian Journal of Forest Research, 32(8), 671–678.

Lommano, E., Dvořák, C., Vallotton, L., Jenni, L., & Gern, L. (2014). Tick-borne pathogens in ticks collected from breeding and migratory birds in Switzerland. Ticks and Tick-Borne Diseases, 5(6), 871–882.

Malchevskij, A. S., & Kadochnikov, A. S. (1953). A method of *in vivo* study of the nestlings' diet of insectivorous birds. Zoologicheskij Zhurnal, 32(2), 227–282 (in Russian).

Markova, A. O. (2016). Aggressive behaviour of Robins *Erithacus rubecula* (Passeriformes, Muscicapidae) at watering places in the forest steppe zone of Ukraine. Visnyk of Dnipropetrovsk University, Biology, Ecology, 24(2), 283–289.

Matsyura, A. V. (2018). Effectiveness of antiperching devices against the feral pigeons. Ukrainian Journal of Ecology, 8(2), 326–328.

Morelli, F. (2013). Relative importance of marginal vegetation (shrubs, hedgerows, isolated trees) surrogate of HNV farmland for bird species distribution in Central Italy. Ecological Engineering, 57, 261–266.

Moreno-Rueda, G., & Pizarro, M. (2008). Relative influence of habitat heterogeneity, climate, human disturbance, and spatial structure on vertebrate species richness in Spain. Ecological Research, 24(2), 335–344.

Nadtochiy, A. S., & Chaplygina, A. B. (2010). Dolgovremennyie izmeneniya srokov prileta ptits v Harkovskuyu oblast [Long-term changes in timing of bird arrival in Kharkov region]. Branta, 13, 50–62 (in Russian).

Newton, I. (2007). The Palaearctic-Afrotropical migration system. In: Newton, I. (Ed.). The migration ecology of birds. Academic Press. Pp. 699–727.

Paker, Y., Yom-Tov, Y., Alon-Mozes, T., & Barnea, A. (2014). The effect of plant richness and urban garden structure on bird species richness, diversity and community structure. Landscape and Urban Planning, 122, 186–195.

Paralikidis, N., Papageorgiou, N., Tsiompanoudis, A., & Kontsiotis, V. (2009). Song thrush *Turdus philomelos* winter diet in Mediterranean habitats: A case study in Greece. Avocetta, 33, 109–111.

Peach, W. J., Robinson, R. A., & Murray, K. A. (2004). Demographic and environmental causes of the decline of rural Song Thrushes *Turdus philomelos* in lowland Britain. Ibis, 146, 50–59.

Robinson, R. A., Green, R. E., Baillie, S. R., Peach, W. J., & Thomson, D. L. (2004). Demographic mechanisms of the population decline of the song thrush *Turdus philomelos* in Britain. Journal of Animal Ecology, 73(4), 670–682.

Shupova, T. V. (2017). Transformatsiya raznoobraziya ornitofauny pod deystviem rekreatsionnoy nagruzki [Transformation in the diversity of avifauna under the influence of recreational load]. Biosystems Diversity, 25(1), 45–51 (in Russian).

Suri, J., Anderson, P. M., Charles-Dominique, T., Hellard, E., & Cumming, G. S. (2017). More than just a corridor: A suburban river catchment enhances bird functional diversity. Landscape and Urban Planning, 157, 331–342.