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Oribatid Mites (Oribatida) Associated with Nests of Open-Nesting Birds of the Genus Thrush (*Turdus*) in the Taiga Forests of the European North-East of Russia

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Abstract

For the first time, studies have been conducted aiming at the diversity of the oribatid mites (Oribatida) that inhabit the nests of open-nesting birds of the genus thrushes (*Turdus*), particularly fieldfare (*T. pilaris* Linnaeus, 1758) and redwing (*T. iliacus* Linnaeus, 1766), in the taiga forests of the European north-east. Long-term observations were carried out in the green belt of the city of Syktyvkar (N 61°40′ E 50°50′) in 2021–2025. Among 168 studied thrush nests (fieldfare—138, redwing—30), 1982 specimens of oribatid mites of 35 species from 33 genera and 26 families were found. The nests of thrushes contain a mixed fauna of oribatid mites, including the following: (a) Soil species that obviously enter the nest with building materials collected by birds from the soil surface. These are epigeic species such as *Eupelops plicatus*, *Neoribates aurantiacus*, and *Chamobates pusillus*; hemi-edaphic species such as *Heminothrus peltifer*; and euedaphic species such as *Oppiella nova* and *Quadroppia quadricarinata*. (b) Tree-dwelling species that have been recorded as inhabiting epiphytic lichens in the European north-east, such as *Ameronothrus oblongus*, *Ceratoppia quadridentata*, *Oribatula propinqua*, *Trichoribates berlesei*, and *Diapterobates oblongus*. (c) Eurybiont species such as *Tectocepheus velatus*, *Scheloribates laevigatus*, and *Oribatula tibialis*. An increase in the number and diversity of oribatid mites was noted in nests collected after the end of the nesting period and the flight of chicks compared to nests collected in the spring (overwintered nests).

Keywords: invertebrates in bird nests; *Turdus pilaris* Linnaeus, 1758; *Turdus iliacus* Linnaeus, 1766; seasonal dynamics; diversity

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1. Introduction

Bird nests are known to be habitats for a diverse fauna of invertebrates [1–10], including oribatid mites [11–13]. Based on the results of a literature review [1], the authors concluded that all invertebrates inhabiting the nests of birds of prey can be divided into three main groups: parasitic fauna, saprophagous animals, and humus fauna. Saprophagous animals are associated with the decomposition of organic residues in the nest. The third group includes invertebrates associated with the decomposition of nest material such as litter and wood.

Much attention has been paid to bird nests as micro-habitats for arthropods in the polar regions, namely the Arctic [5,6,14–16] and Antarctic [17]. Oribatid mites have repeatedly been found in the plumage of migratory birds [18–21]. The possibility of transferring

microarthropods in bird plumage to remote Arctic islands has been discussed [22,23]. Birds have been considered as a factor increasing the diversity of soil invertebrates in high Arctic conditions [14,23].

Napierała et al., 2021 [24], studied the mite complexes of the suborder Uropodina (Mesostigmata) and the superfamily Crotonioidea (Oribatida) inhabiting the nests of the ground-nesting wood warbler *Phylloscopus sibilatrix* (Bechstein, 1793) (Passeriformes), a migratory songbird which nests in temperate forests in Eurasia. The research was conducted in a protected forest in Belovezhskaya Pushcha. The authors discussed the results in the context of nests as a microenvironment for mite habitats. They tried to find out whether specialized nidicole species exist in the nests of wood warblers, but no specialized nidicoles were found.

Five species of oribatid mites were found in the nests of wood warblers. The most numerous and frequent species was *Heminothrus peltifer*. In addition, the species *Heminothrus longisetosus* (Willmann, 1925), *Camisia solhoeyi* Colloff, 1993 *Nothrus palustris* C.L. Koch, 1839 and *Nothrus anauniensis* Canestrini et Fanzago, 1877 were identified. All species are known as soil species [24].

The publication by Niedbała et al., 2023 [25], was also devoted to the study of nests of wood warblers in a protected forest in Belovezhskaya Pushcha. The authors called the birds' nests 'islands of diversity'. Remarkably, a higher diversity of oribatid mites was found in the nests of birds located on the ground than in leaf litter or soil. The species *Euphthiracarus cribrarius* (Berlese, 1904) and *Phthiracarus globosus* (Koch, 1841) were much more often associated with wood warbler nests than with nearby litter. There was a great similarity in the species composition of oribatid mites in nests of wood warblers and in the forest litter. The authors attributed this fact to the nests being located on the ground, which may contribute to the colonization of the nests by eurytopic soil mites.

The authors believe that the high similarity in the species composition of oribatid mites in nests and litter may also be due to the fact that saprophagous soil mites can enter nests along with the material that birds use to construct nests, such as moss, blades of grass, or tree leaves collected from the forest litter.

Also, the accumulation of organic matter in nests can contribute to a higher biodiversity of oribatid mites than in the nearby leaf litter. According to Niedbała et al., 2023 [25], bird nests may contribute to an increase in the local species diversity of mites.

Laska et al., 2023 [26], also studied oribatid mites in wood warbler nests in the Velikopolsky National Park (Poland). The authors discussed the importance of wood warbler nests for the distribution, survival, and reproduction of mites. The authors found 73 species of oribatid mites from 35 families in 45 nests of wood warbler. Like Niedbała et al. [25], the authors suggested that oribatid mites enter the nests within materials collected by birds for nest construction such as organic debris, grass, moss, and dry twigs. The authors also believed that mites can colonize the nest directly from the soil.

The authors considered the nests of wood warblers as an ephemeral single-season microenvironment for invertebrates, since wood warblers build a new nest every year. Therefore, the ability of mites to colonize habitats that are available only for a few months of the year is of particular interest. At the same time, the authors identified a wide variety of ticks (198 species in total) from the superorders Parasitiformes and Acariformes in the nests of wood warblers.

According to Krištofík et al., 2009 [27], the location of nests in trees is important. The microclimatic conditions in the nests depend on their location. The authors studied arthropods in nests of the lesser spotted eagle in Slovakia. The number of mites and beetles in lesser spotted eagle nests was small. The authors attributed this fact to the location

of nests on the treetops. Specific microclimatic conditions develop in such nests as they quickly dry out under the influence of the sun and wind.

On the territory of the European north-east of Russia, there are seven species of thrushes of two genera, such as thrushes (*Turdus*) (six species) and ground thrushes (*Zoothera*) (one species) from the family *Muscicapidae*, subfamily *Turdinae*, order Passeriformes [28]. Among them, thrushes, particularly fieldfare (*Turdus pilaris* Linnaeus, 1758) and redwing (*Turdus iliacus* Linnaeus, 1766), are widespread and highly numerous in the taiga zone.

Fieldfare and redwing readily settle on the outskirts of villages, in urban forest parks and parks, so they are convenient model study objects, including studies on the fauna of oribatid mites associated with their nests. Thrushes belong to the group of open-nesting bird species. Reasoning from this fact, we can compare the fauna of oribatid mites from such nests with the fauna of Oribatida from the nests of hollow-nesting birds using artificial nesting grounds (pied flycatcher (*Ficedula hypoleuca* Pallas, 1764), great tit (*Parus major* Linnaeus, 1758)).

Previously, we have studied the fauna and population structure of oribatid mites inhabiting the nests of pied flycatchers in the taiga zone of the European north-east of Russia. Observations concerned artificial nests (hollows) of the box type [13]. A total of 1762 specimens of 22 species of oribatid mites from 19 genera and 16 families were found and identified in 135 nests of pied flycatchers.

However, the diversity of oribatid mites in nests of open-nesting birds in the conditions of the north still remains largely understudied. The effect of factors such as the observation season, the duration of nesting, and the height of the nest location on the composition and structure of oribatid mite communities has not been studied yet.

The methods microatropods use to colonize bird nests, in particular, those of oribatid mites, are of interest. We drew attention to epiphytic lichens growing on the trunks and branches of the trees in which the nests of thrushes were located. We assumed that one method to populate nests with mites could be transferring to animals from lichens. In the 20 species of epiphytic lichens examined by us in the taiga zone of the European north-east of Russia, 46 species of oribatid mites from 29 families were found [29].

The purpose of our study was to investigate the diversity of oribatid mites in nests of open-nesting birds, particularly highly widespread species of thrushes such as fieldfare and redwing, in the taiga forests of the European north. The study tasks were as follows: (1) to identify the species composition of oribatid mites in nests of fieldfares and redwings; (2) to determine the seasonal dynamics of the population of oribatid mites in the nests; (3) to characterize the zoogeographic structure of the oribatid fauna; and (4) to try to follow the colonization methods of thrush nests by oribatid mites.

2. Materials and Methods

2.1. Study Area

The study area is located in the taiga zone of the European north-east of Russia within the limits of the Komi Republic, in the vicinity of Syktyvkar (N 61°40′ E 50°50′). The territory belongs to the Vychegda-Mezen district of spruce, birch, and pine forests of the middle taiga subzone located on the plain. Dark coniferous spruce forests dominate the drained interfluves. Spacious pine forests alternate with top peats on the pine terraces. Spruce-birch forests with an admixture of aspen occupy significant areas [30].

The climate of the study area is temperate continental with short and cool summers and snowy and long winters. The annual amplitude of the air temperature is 33 °C. The warmest month of the year is July (the average monthly temperature is +17 °C), and the coldest month is January (−16 °C). The average annual air temperature is 0 °C. The number

of days with an average daily air temperature above zero is 190. The average annual precipitation is 600 mm. The average height of the snow cover is 50 cm. The snow cover stays for 190 days [31,32].

The nests of thrushes, such as fieldfare and redwing, have been observed in the green belt of Syktyvkar. The observations were organized at the monitoring site located in the south-western outskirts of the city in a mixed spruce–birch forest area near the Radiobiological Complex of the Institute of Biology, Komi Science Centre of the Ural Branch of the Russian Academy of Sciences. The area of the monitoring site was 20 hectares. It includes both anthropogenically transformed territories (with one- and three-storey stone buildings) and natural plant communities (bilberry spruce forest with some birch) (Figure 1). Additionally, nests were collected in forest plantations along fields and meadows, in willow groves with mixed grasses, in the Ezhvinsky district of the city of Syktyvkar.

(**a**) (**b**) (**c**) (**d**)

Figure 1. The location of thrush nests on the territory of the Radiobiological Complex: stone buildings (**a**,**b**); spruce–birch stands (**c**,**d**). Photos by N.P. Selivanova.

2.2. Fieldfare, Distribution of the Species and Nesting Biology

Fieldfare is widespread in Eurasia, from Scandinavia, the Rhine River valley, and eastern France, eastward to the Aldan River basin and the Shilka River valley, northward in the European part of Russia to the Arctic coast, in Siberia to the 66–70th parallel, southward to Switzerland, Austria, Hungary and Ukraine, and to the east to the 51–53th parallel [28]. It winters in the south of its range. Wintering grounds are located in the Mediterranean, Central Asia, and North Africa [33] (Figure 2).

The bird prefers mixed forests with meadows and forest edges. It also settles in the outskirts of villages, in urban forest parks, and in parks. Fieldfare nests in sparse colonies or makes separate pairs. The nest is large, cup-shaped, made of rough grass, horsetail, and thin twigs cemented with mud; its inner lining is made of dried blades of grass. By the time the chicks fly out, there is usually no grass lining left in the nest. The nest is located in tree forks, on side branches, in half-hollows, on bushes, stumps, on the ground, and on human-made buildings, at a height of up to 20–25 m. Birds may reuse a nest for several years, building a new nest on top of the old one. The nesting development type of fieldfare chicks means a long (about one month) stay of birds in the nest. Females lay 4–8 eggs starting in April, more often 5–6 eggs, which incubate for about 13–14 days. Chicks leave the nest on the 14–16th day of life. Females make up to two clutches per year. The summer diet of adults and chicks includes earthworms, insects and their larvae, spiders, centipedes, and small mollusks, which the birds collect on the ground. In autumn and winter, fieldfare feeds on berries and fruits and makes autumn and winter migrations depending on yields [33]. In the taiga zone of the European north-east of Russia, fieldfare

is a breeding migratory species, which is numerous in the southern and middle taiga, few in the northern taiga, and rare in the extreme northern taiga [34–39].

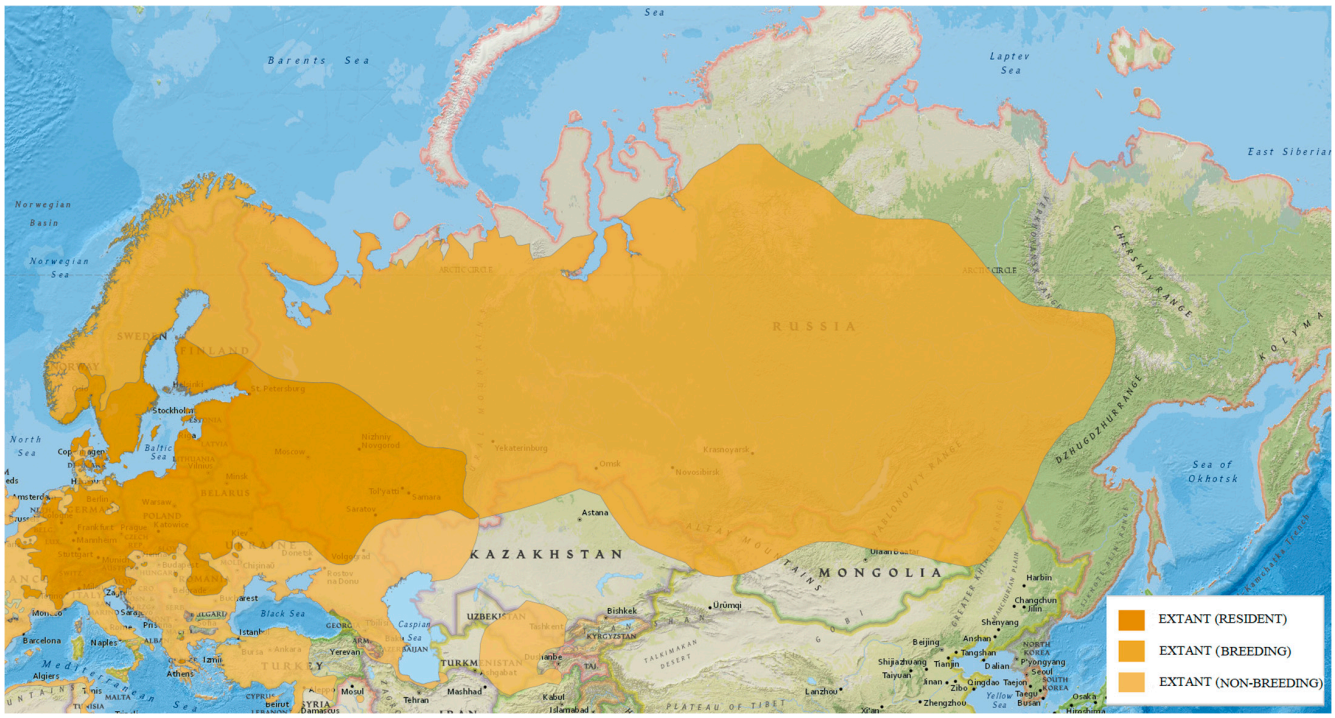


Figure 2. The distribution map of fieldfare in Eurasia according to the Red List (https://www.iucnredlist.org, date of access: 20 November 2023).

2.3. Redwing, Distribution of the Species, Nesting Biology

Redwing is widespread in Eurasia, from Scandinavia and the western border of Poland, eastward to the Kolyma River valley, northward in the European part of Russia to the Arctic coast, in Siberia to the 68th–71st parallel, southward in the European part of Russia to the 50th parallel and in western Siberia to the 56th parallel, and eastward to the western Sayan and the Khamar–Daban Range [28]. It winters in the south of its range. The wintering grounds are located in the Mediterranean, Transcaucasia, Central Asia, and North Africa (Figure 3). The bird inhabits sparse different-age forests with developed undergrowth, clearings, and burnt forest areas. It also settles in the outskirts of villages, in urban forest parks, and in parks.

Redwing settles in separate pairs or forms small colonies, most often in colonies of fieldfare.

Its nest is a mud bowl cemented with rough grass and leaves, like that of fieldfare, but is comparatively neat and small with a lining made of grass. Nests are located not far from the ground in trees, inclined trunks, on stumps, in shrubs, on the ground, and in human-made buildings at a height of up to 3–4 m. The nests built on the ground often do not have a mud bowl. The nesting development type of redwing chicks means a long (about one month) stay of adult birds in the nest. From the end of April, females lay 3–8 eggs, more often 5–6 eggs, which are incubated for 11–15 days. Chicks fly out of the nest on the 12th–14th day of life [33]. Females make up to two clutches per year. The summer diet of adults and chicks includes earthworms, insects and their larvae, spiders, centipedes, and small mollusks, which birds collect on the ground. In autumn and winter, redwing birds feed on berries and fruits [33]. In the territory of the European north-east of Russia, redwing is a breeding migratory species, which is common in the southern and middle taiga, few in the northern taiga, and rare in the extreme northern taiga [34–39].

Figure 3. The distribution map of redwing in Eurasia according to the Red List (https://www.iucnredlist.org, date of access: 20 November 2023).

2.4. Terms for Collecting the Material

About 35 nests have been monitored annually within an area of 20 hectares in the territory of the Radiobiological Complex (2021—30, 2022—44, 2023—38, 2024—33, 2025—29). The nests were inspected once a week or even more frequently. We recorded the beginning and the end of nesting, the size of the clutch, the number of hatched chicks, and the number of flown-out juveniles. We fixed the height of the nest and the lining substrate. At the end of the nesting period, the nests were collected. Some nests remained empty for a longer period after chicks had left them (the period of empty nest was 300 days or more—'overwintered nests'). The duration of the nesting cycle (nest habitation time) was calculated as the difference between the flying-out date and the first egg laying date. The analysis included data on 168 collected thrush nests over a five-year period (138 fieldfare (Figure 4) and 30 redwing nests (Figure 5)).

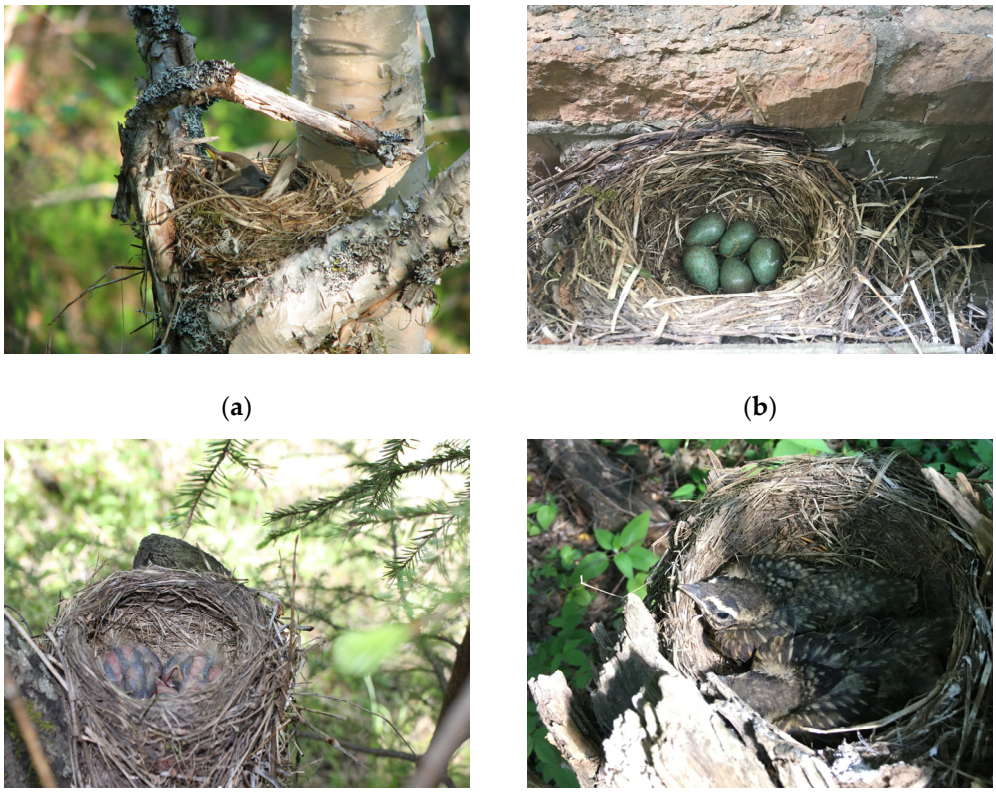
(**a**)

(**b**)

Figure 4. *Cont.*

(**c**) (**d**)

Figure 4. Fieldfare nests at different nesting stages: (**a**) adult; (**b**) clutch; (**c**) chicks; (**d**) juveniles. Photos by N.P. Selivanova.



(**a**) (**b**)

(**c**) (**d**)

Figure 5. Redwing nests at different nesting stages: (**a**) adult; (**b**) clutch; (**c**) chicks; (**d**) juveniles. Photos by N.P. Selivanova.

Additionally, twenty samples of epiphytic lichens (with an area of 100 cm^2) were collected from tree trunks on which thrush nests were located, as well as ten samples of dry grass and ten soil samples, with an area of 100 cm^2 each.

2.5. Material Processing

Invertebrates were extracted from the nests using Berlese–Tullgren thermo-eclectors under 40 W lamps in 96% alcohol for ten days [40]. Then, we made micro-preparations of oribatid mites using For–Berlese liquid [40]. Oribatid mites were identified by species by morphological taxonomic features using the guide [41]. In total, 1982 individuals of oribatid mites were counted and identified. The taxonomy and global distribution type of the species were given according to the classification of L. Subias [42].

To compare samples, the Menhinick, Shannon, and Berger–Parker indices were used. To identify differences between oribatid communities localized at altitudes of up to 2.5 m and 2.5 m and above, the PERMANOVA test was used (permutation n = 10,000). The SIMPER test was used to identify the species responsible for these differences (permutation n = 10,000). Communities were compared using the Bray–Curtis test. In this work, the median (Me) was used as a measure of central tendency, the Spearman correlation coefficient (r) was used to identify dependencies, and the Kruskal–Wallis test and the Mann–Whitney U-test (U-test) with Bonferroni's correction were used to compare data; *p*cr. = 0.05 [43]. Statistical processing of the numerical material and visualization of its results were carried out using the PAST 4.17 [44] and Microsoft Office Excel 2007 programs.

2.6. Temperature Data in Nests

To determine the thermal conditions of the habitat of oribatid mites, we compared the course of air temperatures obtained using loggers left in nests, fixed near the nests on tree trunks, and buried in the soil to a depth of 5 cm. The first nest (of a fieldfare) was located at a height of 4 m (the height of the logger on the tree was 4 m), the second (of a fieldfare) was at 2.5 m (1.5 m), and the third (of a redwing) was at1.5 m (1.5 m). The loggers recorded the temperature daily, six times a day.

The analysis used the average daily temperature determined as the arithmetic mean of six daily records. The difference between average daily temperatures in the nests and on the surface of tree trunks, as well as on the surface of a tree trunk and in the soil, was taken as an indicator of the thermal conditions of the oribatid mite habitat.

During the observation process, the second nest fell (analysis of the accumulation of temperature differences showed that the fall occurred in the first five days of October), due to which its logger recorded the temperature on the soil surface (covered with snow in winter), starting from 6 October 2023. The logger from the third nest disappeared (presumably thrown out by the bird) about two weeks after the observations had begun. The duration of the observation period for the temperature in the soil depth was 83 days (24 May–14 August 2024). Thus, the data collected are rather limited, but they nevertheless allow us to obtain some idea of the thermal conditions of the habitat of oribatid mites living in different environments.

The temperature course in the first and second nests (long-term observation series) and on the surface of tree trunks is almost identical. For the entire observation period, for the first nest, r = 0.995 ($p < 0.001$), and for the second one, r = 0.993 ($p < 0.001$); for the period from 6 October 2023 (after the fall of the second nest) and until the end of the observations, for the first nest, r = 0.988 ($p < 0.001$), and for the second one, r = 0.983 ($p < 0.001$). In the case of the third nest, r = 0.78 ($p = 0.002$). At the same time, significant differences are observed in the dynamics of the difference in average daily temperatures.

In the first nest (Figure S1), in the period from 6 October 2023 until the end of the observations, the temperature on average (Me = −4.8 °C, n = 201) was insignificantly (U-test, $p = 0.2$) lower than that on the trunk (Me = −3.8 °C, n = 198). In the second (fallen) nest (Figure S2), the average temperature (Me = −3.0 °C, n = 201) was statistically significantly (U-test, $p = 0.039$) higher than on the trunk (Me = −4.3 °C, n = 201). If we take the winter period (November–March), the difference becomes even more noticeable: −4.8 °C (n = 152) versus −7.7 °C (n = 152) (U-test, $p = 0.002$). During severe frosts, the difference in average daily temperatures here reached 13 °C. In the third (inhabited) nest (Figure S3), during incubation of eggs and feeding of chicks, the average temperature (Me = 27.2 °C, n = 13) was significantly higher (U-test, $p < 0.001$) than on the trunk (Me = 14.2 °C, n = 13).

The temperature course on the surface of the tree trunk and in the soil depth was highly correlated (r = 0.813, $p < 0.001$), with the average temperature on the tree

(Me = 16.4 °C, n = 83) being statistically significantly (U-test, $p < 0.001$) higher (Figure S4) than in the soil (Me = 14.8 °C, n = 83).

3. Results and Discussion

3.1. Taxonomic Composition

Thirty-five species of oribatid mites belonging to thirty-three genera and twenty-six families were found in thrush nests (Table 1). Almost all families were represented by just one species each; only the family *Ceratozetidae* had seven species, and the family *Oribatulidae* had three species.

Five life forms of oribatid mites were recorded: inhabitants of the soil surface and the upper soil litter horizons (epigeic), inhabitants of deeper horizons of the soil litter (hemi-edaphic), eurybiont species, inhabitants of small soil holes (euedaphic), and hydrobiont species, according to the classification by D. A. Krivolutsky [40].

Table 1. Oribatid mites in nest of thrushes according to the collection data of 2021, 2022, 2023, 2024, and 2025.

N	Taxon	Total Number of Individuals	Life Form	Distribution
	Palaeacaridae Grandjean, 1932			
1	*Palaeacarus hystricinus* s. str. Trägårdh, 1932	1	euedaphic	Holarctic
	Phthiracaridae Perty, 1841			
2	*Phthiracarus* sp. Perty, 1841	1	epigeic	
	Crotoniidae Thorell, 1876			
3	*Camisia* sp. Heyden, 1826	1	hemi-edaphic	
4	*Heminothrus (Platynothrus) peltifer* s. str. (Koch, 1839)	224	hemi-edaphic	Semi-cosmopolitan
	Nanhermanniidae Sellnick, 1928			
5	*Nanhermannia (Nanhermannia) sellnicki* Forsslund, 1958	3	epigeic	Palearctic
	Hungarobelbidae Miko et Travé, 1996			
6	*Belba* sp.	127	epigeic	
	Damaeidae Berlese, 1896			
7	*Damaeus (Epidamaeus) bituberculatus* (Kulczynski, 1902)	37	epigeic	Palearctic
	Cepheusidae Berlese, 1896			
8	*Cepheus cepheiformis* (Nicolet, 1855)	5	epigeic	Holarctic
	Astegistidae Balogh, 1961			
9	*Cultroribula* sp. Berlese, 1908	3	euedaphic	
	Ceratoppiidae Grandjean, 1954			
10	*Ceratoppia quadridentata* (Haller, 1882)	121	epigeic	Holarctic
	Liacaridae Sellnick, 1928			
11	*Adoristes (Adoristes) ovatus* s. str. (Koch, 1839)	19	epigeic	Holarctic
	Oppiidae Sellnick, 1937			
12	*Oppiella (Oppiella) nova* s. str. (Oudemans, 1902)	49	euedaphic	Cosmopolitan
	Quadroppiidae Balogh, 1983			

Table 1. *Cont.*

N	Taxon	Total Number of Individuals	Life Form	Distribution
13	*Quadroppia (Quadroppia) quadricarinata* (Michael, 1885)	5	euedaphic	Semi-cosmopolitan
	Carabodidae Koch, 1843			
14	*Carabodes (Carabodes) subarcticus* Trägårdh, 1902	1	epigeic	Palearctic
	Tectocepheidae Grandjean, 1954			
15	*Tectocepheus velatus* s. str. (Michael, 1880)	77	eurybiontic	Cosmopolitan
	Ameronothridae Vitzthum, 1943			
16	*Ameronothrus oblongus* Sitnikova, 1975	14	hydrobiontic	Holarctic
	Cymbaeremaeidae Sellnick, 1928			
17	*Cymbaeremaeus cymba* (Nicolet, 1855)	5	epigeic	Palearctic
	Phenopelopidae Petrunkevitch, 1955			
18	*Eupelops plicatus* (Koch, 1835)	17	epigeic	Holarctic
	Achipteriidae Thor, 1929			
19	*Achipteria* sp. Berlese, 1885	1	epigeic	
	Ceratozetidae Jacot, 1925			
20	*Ceratozetella (Ceratozetella) sellnicki* (Rajski, 1958)	15	epigeic	Palearctic
21	*Ceratozetes* sp. Berlese, 1908	1	epigeic	
22	*Edwardzetes* sp. Berlese, 1913	1	epigeic	
23	*Fuscozetes fuscipes* (Koch, 1844)	7	epigeic	Holarctic
24	*Melanozetes mollicomus* (Koch, 1839)	19	epigeic	Holarctic (Boreoalpina)
25	*Trichoribates (Trichoribates) berlesei* (Jacot, 1929)	16	epigeic	Holarctic
	Chamobatidae Thor, 1937			
26	*Chamobates (Chamobates) pusillus* (Berlese, 1895)	146	epigeic	Holarctic
27	*Globozetes* sp. Sellnick, 1928	1	epigeic	
	Humerobatidae Grandjean, 1971			
28	*Diapterobates oblongus* (L. Koch, 1879)	98	epigeic	Palearctic
	Oribatulidae Thor, 1929			
29	*Oribatula (Oribatula) tibialis* s. str. (Nicolet, 1855)	466	eurybiontic	Holarctic
30	*Oribatula (Zygoribatula) exilis* s. str. (Nicolet, 1855)	50	eurybiontic	Holarctic
31	*Oribatula (Zygoribatula) propinqua* (Oudemans, 1902)	38	eurybiontic	Palearctic
	Scheloribatidae Grandjean, 1933			
32	*Scheloribates (Scheloribates) laevigatus* (Koch, 1835)	291	eurybiontic	Semi-cosmopolitan
	Protoribatidae Balogh *et* P. Balogh, 1984			
33	*Protoribates* sp. Berlese, 1908	1	eurybiontic	
	Parakalummidae Grandjean, 1936			
34	*Neoribates (Neoribates) aurantiacus* (Oudemans, 1914)	93	epigeic	Holarctic
	Galumnidae Jacot, 1925			
35	*Pergalumna* sp. Grandjean, 1936	28	epigeic	
	Total	1982		

Note: Life forms of oribatid mites (according to D. A. Krivolutsky): epigeic—inhabitant of the soil surface and the upper soil litter horizons; hemi-edaphic—inhabitant of deeper horizons of the soil litter; euedaphic—inhabitant of small soil holes, eurybiontic—eurybiont; and hydrobiontic—hydrobiont.

By the number of species, inhabitants of the soil surface and upper soil litter horizons dominated (21 species, 65.6%) (Table 1). Eurybiont species were highly abundant in the collections (49.0%). The inhabitants of small soil holes and hydrobionts were represented by single species and were few in number.

By type of longitudinal distribution, the nests were dominated by Holarctic species (13 species, 52.0%). Palearctic species accounted for 28.0% (seven species), and cosmopolitan and semi-cosmopolitan accounted for 20.0% (semi-cosmopolitan—three species, 12.0%; cosmopolitan—two species, 8.0%). The type of longitudinal distribution was identified for 25 species. Ten taxa were classified to the genus level.

Soil species of oribatid mites have been found in thrush nests. These are species inhabiting the soil surface and the upper soil litter horizons, such as *E. plicatus*, *N. (N.) aurantiacus*, *C. (C.) pusillus* and others; inhabitants of deeper horizons of the soil litter *H. (P.) peltifer*; and inhabitants of small soil holes such as the *Oppiidae* and *Quadroppiidae* representatives. These species possibly enter the nest within building materials collected by birds from the soil surface such as broken tree branches, fallen leaves, and dry grass. Species *N. (N.) aurantiacus*, *C. (C.) pusillus*, and *H. (P.) peltifer* were found in soil and dry grass samples collected near the nests (Table 2). The species *Phthiracarus* sp., *C. (C.) subarcticus*, and *C. (C.) sellnicki* identified in the nests and known to inhabit the soil surface were also found in soil samples. The species *D. (E.) bituberculatus*, *D. oblongus*, and *Galumnidae* sp. were identified in the nests and also collected from dry grass (Table 2).

Table 2. Taxonomic composition and number of oribatid mites in soil (100 cm^2, n = 10) and dry grass (100 cm^2, n = 10), 14 May 2025.

Taxon	Dry Grass		Soil	
	N	P %	N	P %
Phthiracarus sp.	0	0	0.71 ± 0.71	4.03
H. (P.) peltifer s. str.	0.7 ± 0.59	6.6	3.86 ± 2.40	21.77
D. (E.) bituberculatus	0.1 ± 0.1	0.95	0	0
O. (O.) nova s. str.	0	0	1.0 ± 1.0	5.64
Q. (Q.) quadricarinata	0	0	0.86 ± 0.86	4.84
C. (C.) subarcticus	0	0	0.14 ± 0.14	0.81
T. velatus s. str.	0.1 ± 0.1	0.95	0	0
C. (C.) sellnicki	0	0	0.57 ± 0.57	3.23
C. (C.) pusillus	3.3 ± 2.56	31.14	3.0 ± 2.68	16.93
D. oblongus	0.3 ± 0.3	2.83	0	0
O. (O.) tibialis s. str.	0.2 ± 0.13	1.87	0.14 ± 0.14	0.81
O. (Z.) exilis s. str.	0.4 ± 0.4	3.77	0.14 ± 0.14	0.81
S. (S.) laevigatus	0.7 ± 0.42	6.6	2.43 ± 1.81	13.71
N. (N.) aurantiacus	0.4 ± 0.22	3.77	4.86 ± 3.42	27.42
Galumnidae sp.	0.1 ± 0.1	0.95	0	0
Nymphs of oribatid mites	4.3 ± 1.7	40.57	0	0
Total	10.6 ± 3.79	100	17.71 ± 7.60	100

Note: N is the average number, specimens/100 cm^2 (±standard error), and P is the relative abundance, %.

It is known that small thin-shelled oribatid mite species living in deeper soil horizons, such as representatives of the *Oppiidae* and *Suctobelbidae* families, like all oribatid mites, migrate vertically and can rise to the surface of forest litter and on herbaceous plants. From here, birds can also pick them up with building material and carry them to the nest. It is also possible that some soil mites may enter the nest with soil particles that the thrushes use to hold the nest building material together.

According to the authors, who studied mites in the nests of wood warbler, which nests on the ground, all species of found oribatid mites were representatives of the soil fauna.

Most of them inhabit forest litter and rotting wood [24–26]. Typical nidicoles were not detected. The authors suggested that oribatid mites were transported into the nests within nest material.

The nests contained tree-dwelling species of oribatid mites such as *A. oblongus*, *C. quadridentata*, *O. (Z.) propinqua*, and *D. oblongus*. The species *C. quadridentata*, *O. (Z.) propinqua*, and *D. oblongus* were also found in epiphytic lichens collected from tree trunks near the nests of thrushes. These species were earlier noted by us as inhabitants of epiphytic lichens in the taiga forests of the European north-east [29].

In the nests of pied flycatcher located in artificial nest boxes attached to the tree trunks, we also noted tree-dwelling species of oribatid mites: *O. (Z.) propinqua*, *O. (Z.) exilis*, *T. (T.) berlesei*, and *A. oblongus* [13]. Representatives of the families *Oribatulidae* and *Scheloribatidae* were highly abundant in the collections from the nests of pied flycatcher. These were *O. (Z.) propinqua*, *O. (Z.) exilis*, *O. (O.) tibialis*, and *S. laevigatus*. By the number of species, the inhabitants of the soil surface and the upper soil litter horizons dominated [13].

Barbara Mangová et al., 2022 [12], noted that the nests of two species of thrushes (songbird *Turdus philomelos* C.L. Brehm, 1831 and blackbird *Turdus merula* Linnaeus, 1758) hosted oribatid mite species found on tree bark and lichens, for example, *Liebstadia humerata* (Sellnick, 1928), as well as forest litter species that are also found in trees, for example, *Micreremus brevipes* (Michael, 1888). The authors studied the species composition and structure of oribatid communities in the nests of thrushes in urban parks and green spaces in the cities of Slovakia and Germany. The nest material was collected after the chicks left the nest. In 43 nests of two thrush species, 53 oribatid species from 24 families were identified.

According to the authors, the revealed differences in the number of mites were possibly related to the various nest arrangements of these two bird species. The lower number of oribatid mites in songbird nests was obviously associated with the fact that the bird covers the walls and base of its nest from the inside with a layer of clay, which prevents free movement of mites.

In the studied nests of thrushes, we identified a group of eurybiont species of oribatid mites that are known to inhabit a variety of substrates. These were *T. velatus*, *S. laevigatus*, and *O. tibialis*. They can be found on the soil surface, in soil lichens, and in epiphytic lichens. Previously, we already identified these species in the nests of birds such as pied flycatchers in the taiga zone [13] and the Lapland bunting on the Arctic Island of Vaigach [16]. Eurybiont species can move into bird nests from other substrates.

According to the study by Graczyk et al. [45], most oribatid mite species found in the nests of two stork species were eurytopic, preferring meadow habitats, but species typical of forest and arboreal communities were also present. A total of 62 species of oribatid mites were found. The study was conducted in central Poland. The diversity of oribatid species inhabiting the nests of white and black storks that nest in different environments—in agrocenoses and forest communities—was compared.

Both the white stork and the black stork use their nest for a long time (up to several decades) during the breeding season. As a result, the nest is regularly added with organic substances, which create favorable conditions for oribatids.

According to Barbara Mangová et al., 2022 [12], euryvalent species such as *Tectocepheus velatus sarekensis* (Trägårdh, 1910) and *O. tibialis* were found in the nests of thrushes (song thrush and blackbird) and were numerous in the collections.

3.2. Seasonal Dynamics

Among 27 overwintered nests of fieldfare, which were collected in March and April 2023, 19 (70.4%) were inhabited by oribatid mites. Seven species of oribatid mites were found in the nests of fieldfare (Table 3). Their average density was 23.42 ± 9.59 specimens

per nest. The eurybiont species *O. (O.) tibialis* and *S. (S.) laevigatus* were often encountered and dominated in abundance.

In the overwintered nests of the fieldfare and redwing birds collected on 24 April 2024, 247 specimens of oribatid mites were found. Their average number was insignificant and equaled 9.88 ± 3.46 specimens per nest (Table 4). The number of mites was unevenly distributed among the nests. Among 25 nests examined, oribatid mites were found in 20 (80%). Ten species were registered. Highly numerous were the eurybiont species *O. (O.) tibialis* and the soil surface inhabitant *Belba* sp. In the collections of 2024, a lower diversity of oribatid mites was identified compared to overwintered nests in 2023: their population density per nest was lower, and fewer species were observed in each nest.

In June 2022, in the nests collected after the nesting period and flying-out of chicks, an increase in the number of oribatid mites (up to 39.96 ± 12.18 specimens per nest) and in their taxonomic diversity (Table 5) was observed. In the same period, the *Oribatulidae* family species, as well as *H. (P.) peltifer* and *S. (S.) laevigatus*, were dominant in abundance in the nests. *C. (C.) pusillus* was among the subdominants (Table 6). In June 2024, the same species as in June 2022 were highly abundant: *S. (S.) laevigatus*, *O. (O.) tibialis*, *H. (P.) peltifer*, and *N. (N.) aurantiacus* (Table 6).

Table 3. Taxonomic composition and number of oribatid mites in overwintered nests of fieldfare, March–April 2023.

N	Taxon	Total Number of Individuals	Average Number, Specimens/Nest (±Standard Error)	Relative Abundance, %
1	*D. (E.) bituberculatus*	21	1.75 ± 0.85	7.47
2	*O. (O.) nova* s. str.	4	0.33 ± 0.23	1.42
3	*A. oblongus*	6	0.5 ± 0.5	2.14
4	*C. (C.) sellnicki*	1	0.08 ± 0.08	0.36
5	*O. (O.) tibialis* s. str.	145	12.08 ± 5.76	51.6
6	*S. (S.) laevigatus*	102	8.5 ± 5.12	36.3
7	*N. (N.) aurantiacus*	2	0.17 ± 0.17	0.71
	Total	281	23.42 ± 9.59	100

Table 4. Taxonomic composition and number of oribatid mites in overwintered nests of thrushes, April 2024.

N	Taxon	Total Number of Individuals	Average Number, Specimens/Nest (±Standard Error)	Relative Abundance, %
1	*Camisia* sp.	1	0.04 ± 0.04	0.41
2	*H. (P.) peltifer* s. str.	2	0.08 ± 0.05	0.81
3	*Belba* sp.	101	4.04 ± 3.02	40.89
4	*C. cepheiformis*	2	0.08 ± 0.05	0.81
5	*A. (A.) ovatus* s. str.	1	0.04 ± 0.04	0.41
6	*T. velatus* s. str.	7	0.28 ± 0.17	2.83
7	*A. oblongus*	1	0.04 ± 0.04	0.41
8	*D. oblongus*	5	0.2 ± 0.13	2.02
9	*O. (O.) tibialis* s. str.	125	5.0 ± 1.92	50.6
10	*S. (S.) laevigatus*	2	0.08 ± 0.05	0.81
	Total	247	9.88 ± 3.46	100

Table 5. Taxonomic composition and number of oribatid mites in nest of thrushes, June 2022.

N	Taxon	Total Number of Individuals	Average Number, Specimens/Nest (±Standard Error)	Relative Abundance, %
1	*Phthiracarus* sp.	1	0.04 ± 0.04	0.1
2	*H. (P.) peltifer* s. str.	180	7.5 ± 3.27	18.77
3	*Belba* sp.	22	0.92 ± 0.53	2.3
4	*D. (E.) bituberculatus*	5	0.21 ± 0.12	0.52
5	*C. cepheiformis*	3	0.12 ± 0.12	0.31
6	*C. quadridentata*	115	4.79 ± 2.83	12.0
7	*O. (O.) nova* s. str.	25	1.04 ± 0.60	2.61
8	*T. velatus*	40	1.67 ± 0.40	4.17
9	*A. oblongus*	3	0.12 ± 0.09	0.31
10	*C. cymba*	4	0.17 ± 0.09	0.42
11	*E. plicatus*	15	0.63 ± 0.58	1.46
12	*Achipteria* sp.	1	0.04 ± 0.04	0.1
13	*C. (C.) sellnicki*	1	0.04 ± 0.04	0.1
14	*Edwardzetes* sp.	1	0.04 ± 0.04	0.1
15	*M. mollicomus*	5	0.21 ± 0.12	0.52
16	*T. (T.) berlesei*	4	0.17 ± 0.17	0.42
17	*C. (C.) pusillus*	78	3.25 ± 2.40	8.14
18	*Globozetes* sp.	1	0.04 ± 0.04	0.1
19	*D. oblongus*	59	2.46 ± 1.87	6.15
20	*O. (O.) tibialis* s. str.	131	5.45 ± 3.34	13.66
21	*O. (Z.) exilis* s. str.	50	2.08 ± 1.47	5.21
22	*O. (Z.) propinqua*	38	1.58 ± 1.89	3.97
23	*S. (S.) laevigatus*	109	4.54 ± 1.74	11.37
24	*N. (N.) aurantiacus*	52	2.17 ± 0.92	5.42
25	*Pergalumna* sp.	16	0.67 ± 0.33	1.67
	Total	959	39.96 ± 11.73	100

Table 6. Taxonomic composition and number of oribatid mites in nest of thrushes, June 2024.

N	Taxon	Total Number of Individuals	Average Number, Specimens/Nest (±Standard Error)	Relative Abundance, %
1	*P. hystricinus* s. str.	1	0.08 ± 0.08	0.76
2	*H. (P.) peltifer* s. str.	20	1.54 ± 1.06	15.27
3	*N. (N.) sellnicki*	2	0.15 ± 0.10	1.53
4	*D. (E.) bituberculatus*	8	0.61 ± 0.47	6.10
5	*C. quadridentata*	1	0.07 ± 0.07	0.76
6	*O. (O.) nova* s. str.	3	0.23 ± 0.23	2.29
7	*T. velatus* s. str.	5	0.38 ± 0.38	3.82
8	*A. oblongus*	3	0.23 ± 0.17	2.29
9	*E. plicatus*	2	0.15 ± 0.10	1.53
10	*C. (C.) sellnicki*	1	0.08 ± 0.08	0.76
11	*M. mollicomus*	6	0.46 ± 0.46	4.58
12	*T. (T.) berlesei*	2	0.15 ± 0.10	1.53
13	*C. (C.) pusillus*	2	0.15 ± 0.15	1.53
14	*D. oblongus*	1	0.08 ± 0.08	0.76
15	*O. (O.) tibialis* s. str.	20	1.54 ± 0.59	15.27
16	*S. (S.) laevigatus*	26	2.0 ± 1.06	18.32
17	*N. (N.) aurantiacus*	16	1.08 ± 0.84	12.22

Table 6. *Cont.*

N	Taxon	Total Number of Individuals	Average Number, Specimens/Nest (±Standard Error)	Relative Abundance, %
18	*Pergalumna* sp.	11	0.85 ± 0.85	8.39
	Nymphs of oribatid mites	5	0.38 ± 0.31	3.82
	Total	**135**	10.54 ± 3.33	100

In nests collected from 20–23 June 2025, 23 species of oribatid mites were found. The highest abundance was noted for species inhabiting the soil surface (*C. (C.) pusillus* and *D. oblongus*) and eurybiont species (*S. (S.) laevigatus*, *O. (O.) tibialis*, and *T. velatus*) (Table 7).

Table 7. Taxonomic composition and number of oribatid mites in nest of thrushes, June 2025.

N	Taxon	Total Number of Individuals	Average Number, Specimens/Nest (±Standard Error)	Relative Abundance, %
1	*H. (P.) peltifer* s. str.	22	1.22 ± 0.53	6.06
2	*N. (N.) sellnicki*	1	0.06 ± 0.06	0.27
3	*Belba* sp.	4	0.22 ± 0.17	1.1
4	*D. (E.) bituberculatus*	3	0.17 ± 0.09	0.83
5	*Cultroribula* sp.	3	0.17 ± 0.12	0.83
6	*C. quadridentata*	5	0.28 ± 0.28	1.38
7	*A. (A.) ovatus* s. str.	18	1.0 ± 1.0	4.96
8	*O. (O.) nova* s. str.	17	0.94 ± 0.57	4.68
9	*T. velatus* s. str.	25	1.39 ± 1.22	6.89
10	*A. oblongus*	1	0.06 ± 0.06	0.27
11	*C. cymba*	1	0.06 ± 0.06	0.27
12	*E. plicatus*	3	0.17 ± 0.12	0.83
13	*C. (C.) sellnicki*	12	0.67 ± 0.46	3.31
14	*F. fuscipes*	7	0.39 ± 0.24	1.93
15	*M. mollicomus*	8	0.44 ± 0.29	2.2
16	*T. (T.) berlesei*	12	0.67 ± 0.52	3.31
17	*C. (C.) pusillus*	66	3.67 ± 3.11	18.18
18	*D. oblongus*	34	1.89 ± 1.15	9.37
19	*O. (O.) tibialis* s. str.	45	2.5 ± 1.24	12.4
20	*S. (S.) laevigatus*	50	2.78 ± 1.35	13.78
21	*Protoribates* sp.	1	0.06 ± 0.06	0.27
22	*N. (N.) aurantiacus*	23	1.28 ± 0.72	6.34
23	*Pergalumna* sp.	1	0.06 ± 0.06	0.27
	Nymphs of oribatid mites	1	0.06 ± 0.06	0.27
	Total	363	20.17 ± 7.91	100

O. (Z.) propinqua and *S. (S.) laevigatus* were the most common and numerous species in the nests of pied flycatcher [13]. The eurybiont species *S. (S.) laevigatus* was also among the dominant species in the collections from nests of thrushes. The species *H. (P.) peltifer*, *A. oblongus*, *S. piriformis*, and *D. oblongus* were rare in the nests of pied flycatcher, but the soil species *H. (P.) peltifer* was numerous in the nests of thrushes.

Thus, some species were found both in the nests of open-nesting thrushes and in the nests of cavity-nesting pied flycatchers. As a rule, these were eurybiont species from the families *Oribatulidae* and *Scheloribatidae*, which exceeded other species by abundance. Common to both the nests of thrushes and pied flycatchers was the presence of a complex

of tree-dwelling species of oribatid mites such *as A. oblongus*, *O. (Z.) propinqua*, *O. (Z.) exilis*, *T. (T.) berlesei*, and *D. oblongus*.

3.3. Diversity Indices of Oribatid Mites

A comparison of the Menhinick, Shannon, and Berger–Parker indices (Figures 6–8) calculated for each nest, taking into account the period of its collection, showed the presence of certain differences in species diversity between samples collected in spring and summer. In the case of the Menhinick index (Figure 6), the differences appear at the trend level (Kruskal–Wallis test, $p = 0.09$), while in the case of the Shannon index (Figure 7), they become statistically significant (Kruskal–Wallis test, $p < 0.001$).

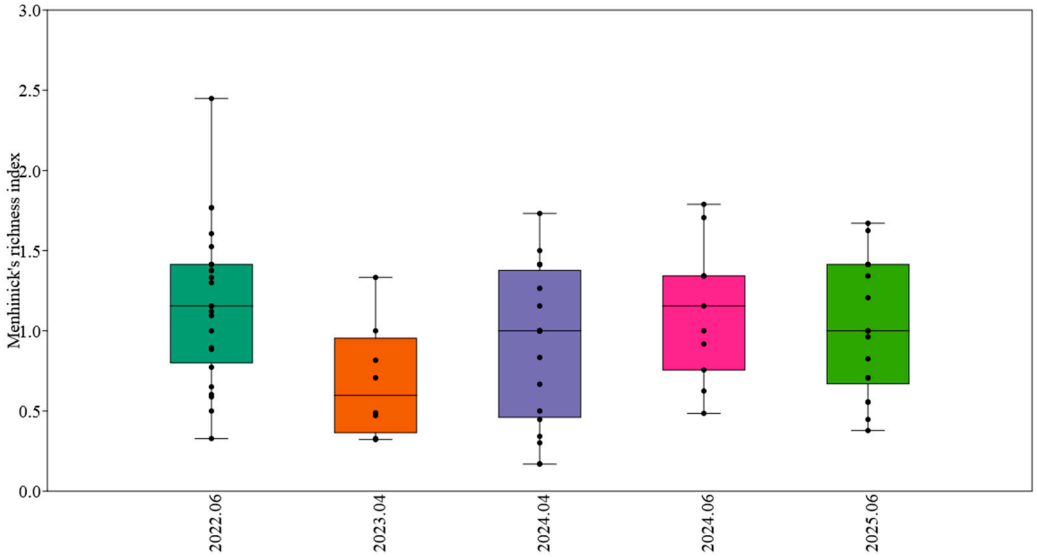


Figure 6. Comparison of Menhinick's richness index calculated from samples collected in different seasons.

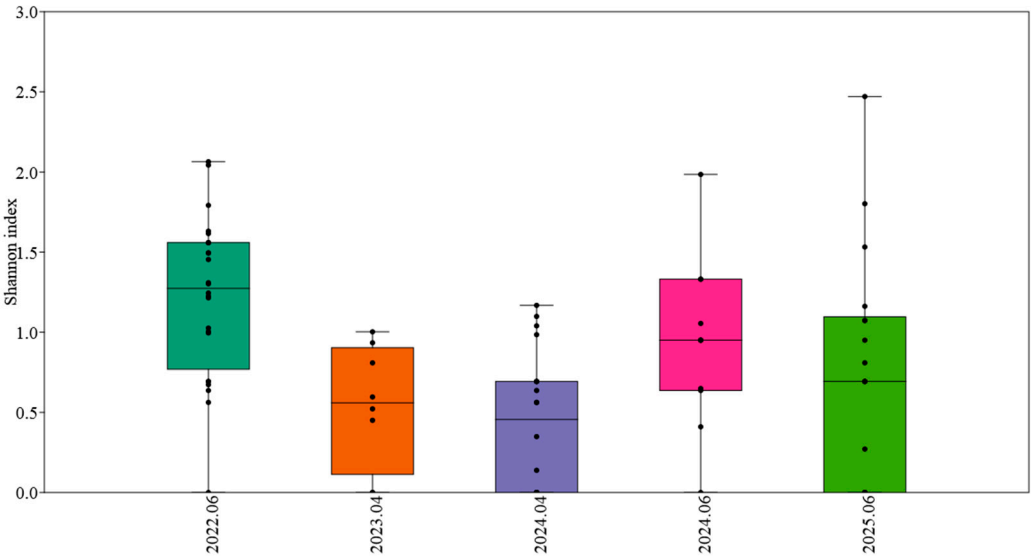


Figure 7. Comparison of the Shannon index calculated from samples collected in different seasons.

Pairwise comparison of samples by the Menhinick index (U-test) showed no statistically significant differences between the samples. A similar comparison by the Shannon index showed a statistically significant decrease in the index in April 2023 ($Z = 3.11$, $p = 0.019$) and 2024 ($Z = 4.25$, $p < 0.001$) compared to June 2022.

Significant differences were also observed for the Berger–Parker index (Kruskal-Wallis test, $p < 0.001$)(Figure 8): the index values in April 2023 (Z = 3.35, $p = 0.008$) and 2024 (Z = 3.61, $p = 0.003$) were higher than in June 2022, which indicates greater evenness in the oribatid mite community and, accordingly, higher diversity of oribatids in June compared to April.

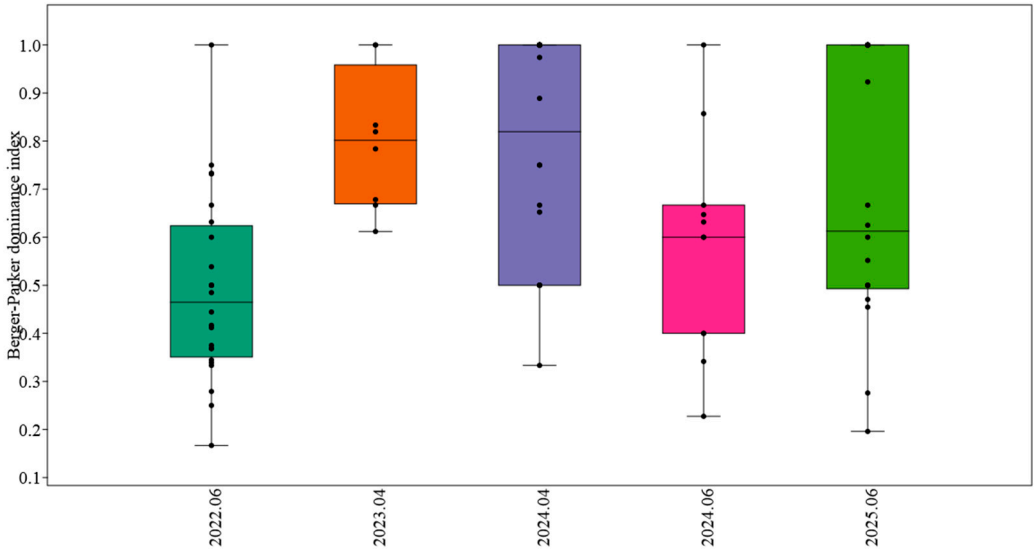


Figure 8. Comparison of Berger–Parker dominance index calculated from samples collected in different seasons.

To analyze the influence of the altitude factor on the structure of oribatid mite communities, materials collected in April 2024 and June 2025 were used. According to the PERMANOVA test, statistically significant differences were observed between the structures of summer oribatid communities localized at different altitudes (n = 8 for height up to 2.5 m and n = 10 for height 2.5 m and above) (F = 1.98, $p = 0.019$). The greatest contribution to the differences was made by the species *O. (O.) tibialis* (27.16%), *D. oblongus* (10.55%), and *S. (S.) laevigatus* (10.35%). The structures of communities of different altitudes (n = 5 for height up to 2.5 m and n = 20 for height 2.5 m and above) did not differ in the spring (F = 0.97, $p = 0.44$). However, even in this case, the greatest contribution to the dissimilarity was made by the species *O. (O.) tibialis* (47.42%).

4. Conclusions

The oribatid mite species with the highest abundance in the collected nests of fieldfare and redwing were *S. (S.) laevigatus*, *H. (P.) peltifer*, *C. (C.) pusillus,* and *C. quadridentata*.

The nests of thrushes located in trees and buildings form a mixed fauna of oribatid mites, which include: (a) soil species that obviously enter the nest within building material collected by birds from the soil surface; and (b) tree-dwelling oribatid species that were recorded as inhabiting epiphytic lichens in the European north-east. We identified a complex of eurybiont species, which belong to the dominant ones. Tree species, as well as eurybiont species, can actively inhabit the nests of thrushes in trees, as well as in buildings located in the forest. Common between the nests of thrushes and hollow-nesting birds (the pied flycatcher as an example) was the presence of a complex of tree-dwelling species of oribatid mites, such as *O. (Z.) propinqua*, *O. (Z.) exilis*, *T. (T.) berlesei*, and *A. oblongus.*

A low diversity of oribatid mites was found in overwintered nests of fieldfare and redwing, with the eurybiont species from the families *Oribatulidae* and *Scheloribatidae* dominating in abundance. In June, the nests collected after the nesting period and

flying-out of chicks demonstrated an increase in the number of oribatid mites (up to 39.96 ± 12.18 specimens per nest) and in their diversity.

According to the type of longitudinal distribution, the nests were dominated by Holarctic species (52.0%). Palearctic species accounted for 28.0%, and cosmopolitans and semi-cosmopolitans accounted for 20.0%.

Supplementary Materials: The following supporting information can be downloaded at: https://www.mdpi.com/article/10.3390/d17100735/s1, Figure S1: The dynamics of the average daily temperature difference between a logger from an uninhabited fieldfare nest (height 4 m) and a logger attached to a tree trunk (height 4 m); Figure S2: The dynamics of the average daily temperature difference between a logger from an uninhabited fieldfare nest (on the ground surface) and a logger attached to a tree trunk (height 1.5 m); Figure S3: The dynamics of the average daily temperature difference between a logger from an inhabited redwing nest (height 1.5 m) and a logger attached to a tree trunk (height 1.5 m); Figure S4: The dynamics of the average daily temperature difference between a logger attached to a tree trunk (height 1.5 m) and a logger buried in the ground (5 cm deep).

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