Helminth infections of urban hibernating *Nyctalus noctula* groups (Chiroptera, Vespertilionidae) in Belarus

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**ABSTRACT.** The city of Brest is one of the places in southwestern Belarus where common noctules *Nyctalus noctula* (Schreber, 1774) spend the winter. The aim of the study is to investigate the helminth infection of urban hibernating groups of this species of bats. The bat carcasses were subjected to a post-mortem examination. Organs and tissues compression was used to examine 26 of common noctules three groups that died in Brest city during the hibernation period from causes beyond our control. All of the examined common noctules were infected with helminths. Eight species of helminths were found: 4 species of trematodes, 1 species of cestode and 3 species of nematodes. Six species were localized in the intestine, 1 species in the stomach and larvae of 1 species in the wall of the stomach. More often, the common noctule was infected with the nematode *Molinostrongylus skrjabini* Skarbilovich, 1934 (92.3%), the trematodes *Paralecithodendrium chilostomum* (Mehlis, 1831) (88.5%), *Lecithodendrium linstowi* Dollfus, 1931 (84.6%) and *Plagiorchis koreanus* Ogata, 1938 (84.6%). The finding represents the first record of the trematode *P. koreanus* in bats in Belarus. The results further represent the first record of *N. noctula* as host for larvae of nematode *Physaloptera myotis* (Babos, 1954) in Belarus.

Keywords: parasite biodiversity, common noctule, *Nyctalus noctula*, urban ecology, Brest city, Belarus

**Introduction**

The common noctule *Nyctalus noctula* (Schreber, 1774) is a widespread species of migratory bats in Europe. Until the end of the 20th century, the hibernation range of this bat species began 0.7–0.9 km south and west of the borders of Belarus [1–3]. After 1999, regular hibernations of the common noctule were established in the extreme southwest of Belarus and adjacent regions of Poland and Ukraine [1,4–6]. In 2019–2021 the largest hibernation colonies of the common noctule in Belarus were identified in Brest. Helminth infections of common noctules were studied in various European countries, for example, in Belarus [7–10], Bulgaria [11], Hungary [12], Moldova [13–18], Poland [19–24], Romania [25], Ukraine [26–29]. To date, no helminthological study of representative batches of the common noctule in the state of hibernation in Belarus and neighboring regions of other countries has been carried out. The aim of the study is to investigate the helminth infection of hibernating groups of this species of bats in Brest, South-West Belarus.

**Materials and Methods**

The search and monitoring of hibernating groups (colonies) of chiropters in different regions of Belarus has been carried out by the authors since the early 1990s. During the monitoring of the largest migratory groups (Brest, Belarus) of the common noctule, a significant number of individuals died in the third decade of March 2022. A part of the individuals (a total 26 bats were examined: 19 males and 7 females) that died on March 15 and 16, 2022 during hibernation in Brest from the three largest groups of the common noctule (these groups were...
Results and Discussion

The total rate of helminth infection of the 26 common noctules was 100%. Eight species of helminths were found in the analyzed common noctules. Four trematode species, one cestode species and three nematode species were among them. These species are: *Lecithodendrium linstowi* Dollfus, 1931; *Paralecithodendrium chilostomum* (Mehlis, 1831) [=*Prostho dendrium chilostomum* (Mehlis)=*Prostho dendrium (Prostho dendrium) chilostomum* (Mehlis, 1831)], *Parabascus semisquamosus* (Braun, 1900), *Plagiorchis koreanus* Ogata, 1938; *Vampirolepis skrjabinariana* (Skarbilovich, 1946), *Aonchotheca eubursata* (Skarbilovich, 1946) [=*Skrjabinocapillaria eubursata* Skarbilovich, 1946= *Capillaria eubursata* (Skarbilovitsch, 1946)], *Molinostrongylus skrjabini* Skarbilovich, 1934 and *Physaloptera myotis* (Babos, 1954). The results of helminthological examination are presented in table 1.

Infections by 2–6 species of helminths were localized in animals. Cases of infection by 5 and 6 species were more often noted (30.8% and 38.5% of examined common noctules, respectively). The prevalence of trematodes, cestodes and nematodes was 100%, 23.1% and 92.3%, respectively. Animals were more often infected with trematodes. The range of intensity of the helminths was 1–560 for trematodes (overall mean was 232.2 specimens), 1–2 for cestodes (overall mean was 1.2 specimens) and 1–318 for nematodes (overall mean was 61.5 specimens). All these species of helminths are ordinary parasites of bats in various European countries [7,10,12–23,25–29,35–37].

A total 7,520 helminth specimens were found in common noctules, and this is an average of 289.2 individuals per animal. In one male of the common noctule, in which 6 species of helminths were found, a total the number of parasitic worms were reached 1,305 individuals.

The vast majority of helminth species were localized in the intestine of common noctules, and only the nematode *A. eubursata* was localized in the stomach, while the encapsulated larvae of the nematode *P. myotis* in the stomach wall.

The nematode *M. skrjabini*, the trematodes *P. chilostomum, L. linstowi* and *P. koreanus* were more often to infected common noctules. The prevalence of these helminths was 92.3%, 88.5%, 84.6% and 84.6%, respectively. The larvae of nematode *P. myotis* has been found in common noctules in Belarus for the first time. The literature provides, for instance, well-documented cases for *P. myotis* parasitizing northern bats and serotine bats on larval stage in this country [10,38].

High rates of infection of common noctules with these helminth species were noted in other regions of Belarus and abroad. Thus, 75.0% of common noctules in Belovezhskaya Pushcha [7], 47.0% in the Berezinsky Reserve [8] and 75.0% in other areas of Belarus [9] are infected with the nematode *M. skrjabini* at an intensity of infection being 2–32, 5–48 and 1–179 specimens, respectively. 84.6% of examined common noctules were infected with this helminth (intensity of infection was 16–200 specimens) in Ukraine [27], 100% (10–136 specimens) in Białowieża Forest, Poland [23], 63.75% in Wrocław city, Poland [24], 66.68% (1–179 specimens) in Moldova [17].

Trematodes *P. chilostomum* and *L. linstowi* were found in 39.3% and 14.3% of common noctules in Belovezhskaya Pushcha [7], in 23.5% (the first helminth) in the Berezinsky Reserve [8], in 63.9% and 5.6% in other areas of Belarus [9]. The number of trematode *P. chilostomum* in one infected common noctule reached 661 (Belovezhskaya Pushcha) and 996 specimens (other areas of Belarus). 100% of common noctules were infected with these both trematode species in Białowieża Forest, Poland with a large number of collected helminths (1951 and 1570 specimens, respectively) [20] and 86.0% (the first helminth) in Wrocław city, Poland [24].

Trematodes *L. linstowi, P. chilostomum* and *P. semisquamosus* were marked by high numbers of specimens (Tab. 1). The mean number of helminths was 111.2, 100.9 and 107.7 specimens, respectively. Although in our case the infection of common noctules with trematode *P. semisquamosus* was 38.5% with a high intensity of infection (up to 390 specimens), in Poland it was detected in 28.6% (Lublin Palatinate) [19] and 15.0% (1–3 species in Białowieża Forest) [21], and in Moldova in 73.01% with mean intensity of infection being 37.5 specimens [15].
<table>
<thead>
<tr>
<th>Helminth species</th>
<th>Group 1, n=20</th>
<th>Group 2, n=3</th>
<th>Group 3, n=3</th>
<th>Total, n=26</th>
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<tr>
<td></td>
<td>Number of infected</td>
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<td>Prevalence %</td>
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<td>No. helminths (min-max; total; mean)</td>
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<td>No. helminths (min-max; total; mean)</td>
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<tr>
<td><strong>Trematoda</strong></td>
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<td><em>Lecithodendriidae</em> Lühe, 1901</td>
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<tr>
<td><em>Lecithodendrium linstowi</em> Dollfus, 1931</td>
<td>16</td>
<td>2–520; 1626; 101.6</td>
<td>3</td>
<td>52–560; 746; 248.7</td>
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<tr>
<td><em>Paralecithodendrium chilotostomum</em> (Mehlis, 1831)</td>
<td>18</td>
<td>4–380; 1908; 106</td>
<td>2</td>
<td>8–66; 74; 37</td>
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<td><em>Phaneropsolidae</em> Mehra, 1935</td>
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<td><em>Parabascus semisquamosus</em> (Braun, 1900)</td>
<td>7</td>
<td>2–106; 321; 45.9</td>
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<td>390; 390; 390</td>
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<td><em>Plagiocochiidae</em> Lühe, 1901</td>
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<td><em>Plagiorchis koreanus</em> Ogata, 1938</td>
<td>16</td>
<td>1–70; 171; 10.7</td>
<td>3</td>
<td>3–4; 10; 3.3</td>
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<td><strong>Cestoda</strong></td>
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<td><em>Hymenolepididae</em> Ariola, 1899</td>
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<td><em>Vampirolepis skrjabinariana</em> (Skarbilovich, 1946)</td>
<td>6</td>
<td>1–2; 7; 1.2</td>
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<td><strong>Nematoda</strong></td>
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<td><em>Capillariidae</em> Neveu-Lemaire, 1936</td>
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<tr>
<td><em>Aonchotheca eubursata</em> (Skarbilovich, 1946)</td>
<td>12</td>
<td>1–4; 21; 1.8</td>
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<td>1; 1</td>
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<tr>
<td><em>Molineidae</em> Durette-Desset et Chabaud, 1977</td>
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<tr>
<td><em>Molinostrongylus skrjabini</em> Skarbilovich, 1934</td>
<td>19</td>
<td>4–182; 656; 34.5</td>
<td>2</td>
<td>14–16; 30; 15</td>
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<tr>
<td><em>Physalopteridae</em> Leiper, 1908</td>
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<tr>
<td><em>Physaloptera myotis</em> (Babos, 1954), larvae</td>
<td>6</td>
<td>8–318; 593; 98.8</td>
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</table>
The trematode *P. koreanus* is found for the first time in Belarus. According to Krasnolobova [39], the trematode *P. koreanus* could in some cases be mistaken for *P. vespertilionis* (Müller, 1784) by researchers in various countries. In our study the trematode *P. koreanus* fully corresponded to the differential diagnosis given by Tkach and Sharpilo [28]. We paid special attention to the size of the suckers (the oral sucker is noticeably larger than the ventral sucker), the presence of a well-defined esophagus, and the fact that the yolk fields ended, without merging, at the level of the posterior edge of the ventral sucker.

Previously, other trematode from genus *Plagiorchis as P. vespertilionis* was recorded in *N. noctula* in Belarus [8–10]. The trematode *P. vespertilionis* was found in 35.3% of common noctules (intensity of infection was 3–15 specimens) in the Berežinsky Reserve [8], in 25.0% (1–8 specimens) in the Pinsk district of the Brest region, Minsk and Nesvizh districts of the Minsk region [9] and one specimen was localized in the intestine of one common noctule from the Zhabinka district of the Brest region of Belarus [10]. 16.3% of common noctules were infected with this helminth species in Lublin Palatinate [19], 30.8% in Białowieża Forest [22] and 78.75% in Wrocław city of Poland [24]. As in our case, a high percentage of *helminth infection in common noctules* (96.25), a high total number of collected helminths (10.240), a high average number of helminths found (132.9) was noted, similar helminth species were identified (trematode *P. chilostomum*, cestode *V. skrjabinariana*, nematodes *M. skrjabini* and *P. myotis*).

Unfortunately, the authors did not indicate the season of the year when the studies were conducted.

In conclusion, eight species of helminths (four species of trematodes, one species of cestodes, three species of nematodes) were found in 26 common noctules during the hibernation period in Brest in March 2022. The total infection with helminths was 100%, with the average intensity of infection being 289.2 specimens. The major group of helminth species found in this study are the nematode *M. skrjabini*, and the trematodes *P. chilostomum*, *L. linstowi* and *P. koreanus*. The trematode *P. koreanus* is registered for the first time in Belarus. The common noctule is a new host for larvae of nematode *P. myotis* in Belarus.

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