

The helminth fauna of the Eurasian goshawk (*Accipiter gentilis*) in northwest Russia

Fauna helmintov jastraba veľkého (*Accipiter gentilis*) na severozápade Ruska

Galina YAKOVLEVA  & Evgeny IESHKO 

Abstract: The challenges in researching the parasite fauna of rare and red-listed species, such as the Eurasian goshawk (*Accipiter gentilis*), render the study of accidental findings of these birds highly valuable and important. This paper discusses the results regarding the species diversity and occurrence of helminths in the Eurasian goshawk in northwest Russia. In July and September 2024, parasites were collected from the respiratory and gastrointestinal tracts of two birds that had died in the City of Petrozavodsk and the Village of Porosozero. This is the first report of the occurrence of nine helminth species (trematodes *Neodiplostomum attenuatum*, *Srtigea falconis*, *Prosthogonimus cuneatus* and nematodes *Cyathostoma americana*, *Eucoleus dispar*, *Porrocaecum depressum*, *Baruscapillaria falconis*, *Capillaria tenuissima*, *Microtetrameres* sp.) in the Eurasian goshawk, which is actively expanding its distribution in northwest Russia. Karelia is the only region where the trematode *P. cuneatus* has been found in the Eurasian goshawk. With the new findings, we provide an overview of Eurasian goshawk's parasite fauna, with reference to available information on other regions of Russia and Europe. A list of 43 helminth species documented for hawks has been compiled using published data. Another important outcome of our study is that, having analysed the birds, we managed to describe the ecological characteristics of the birds adapting to urbanised environments (cities and rural communities). This adaptation likely involves changes in the birds' dietary spectrum and, accordingly, the species composition and infection rates of their common helminth parasites.

Abstrakt: Pri výskume parazitofauny vzácných druhov a druhov uvedených v červenom zozname, ako je jastrab veľký (*Accipiter gentilis*), sú náhodné nálezy týchto vtákov veľmi cenným a dôležitým zdrojom údajov. Príspevok prináša výsledky týkajúce sa druhovej diverzity a výskytu helmintov u jastraba veľkého v severozápadnom Rusku. V júli a septembri 2024 boli parazity odobraté z dýchacích a gastrointestinálnych ciest dvoch vtákov, ktoré uhynuli v meste Petrozavodsk a obci Porosozero. Toto je prvá správa o výskyte deviatich druhov helmintov (motolice *Neodiplostomum attenuatum*, *Srtigea falconis*, *Prosthogonimus cuneatus* a hlístovce *Cyathostoma americana*, *Eucoleus dispar*, *Porrocaecum depressum*, *Baruscapillaria falconis*, *Capillaria tenuissima*, *Microtetrameres* sp.) u jastraba veľkého, ktorý aktívne zvažuje svoje rozšírenie v severozápadnom Rusku. Karélia je jediný región, kde sa u jastraba veľkého zistila motolice *P. cuneatus*. Vďaka novým zisteniam poskytujeme prehľad parazitickej fauny jastraba veľkého s odkazom na dostupné informácie o iných regiónoch Ruska a Európy. Na základe publikovaných údajov bol zostavený zoznam 43 druhov helmintov zdokumentovaných u jastrabov. Ďalším dôležitým výsledkom našej štúdie je, že po analýze vtákov sa nám podarilo opísať ekologické charakteristiky vtákov adaptujúcich sa na urbanizované prostredie (mestá a vidiecke komunity). Táto adaptácia pravdepodobne zahŕňa zmeny v stravovacom spektre vtákov a podľa toho aj v druhovom zložení a miere infekcie ich bežnými helmintovými parazitmi.

Key words: parasitic communities, trematodes, nematodes, Accipitridae, bird of prey, urbanisation, Karelia

Galina Yakovleva, Evgeny Ieshko, Institute of Biology, Karelian Research Centre, Russian Academy of Sciences, 11 Pushkinskaya St., Petrozavodsk, 185910 Russia, E-mail: galina18071987@gmail.com.

Acknowledgements: We thank Dr. Alexandr Artemyev (Institute of Biology, Karelian Research Centre, Russian Academy of Sciences) for identifying bird species and the ages of birds collected in Karelia. We are also grateful to Olga Kislova for translating the manuscript into English. Finally, we thank Marek Kouba and an anonymous reviewer for their comments on improving the manuscript.

Introduction

Birds of prey are a crucial component of natural communities. They occupy a special place in scientific research as model objects in studying fundamental ecology questions and as indicators of environmental change. The helminth fauna of raptors is shaped by multiple abiotic and biotic factors, among which dietary patterns play a leading role. The invertebrate and vertebrate species that raptors feed on act as intermediate helminth hosts. The habitat use and dietary behaviours of birds are essential for realising helminth life cycles. That is why studying their parasite fauna is of great interest to science. However, most of the data available are accidental and single findings. Few papers deal with parasites hosted by raptors in Russian Karelia or northwest Russia in general. For instance, data on the parasite fauna of an osprey (*Pandion haliaetus*) found dead at a trout farm in Karelia (Lake Ladoga), obtained for the first time using both molecular and morphological methods, have resulted in the identification and description of a trematode species, *Nematostrigea serpens*, new for Karelia (Lebedeva et al. 2013; Lebedeva & Yakovleva 2016). This fluke is an obligate parasite of the osprey, but it also sometimes occurs in other predatory and piscivorous birds. The life cycle of this trematode is poorly known and involves fish as intermediate hosts (Zhokhov & Mishina 2011).

The Eurasian goshawk is the largest species in the *Accipiter* genus, with a body up to 56-58 cm long, a wingspan of 105-127 cm, and a weight of 1.2-2 kg. The species is widespread throughout the forest zone of Eurasia and North America, as well as in the forest-tundra and forest-steppe. In Russia, the goshawk nests from the western borders to Kamchatka, Kuril Islands and Sakhalin. Its numbers have been growing, the distribution has expanded, and encounters in urban parks and forests have been reported (Stepanyan 2003, Noskov et al. 2016). The Eurasian sparrowhawk (*Accipiter nisus*) and the Eurasian goshawk leave Karelian forests for the winter, but some birds stay, settling near farms and preying on small birds and corvids (Neufeldt 2019, Tolstoguzov et al. 2022). The factors determining the species diversity of helminths in this raptor are their diet and the prey diversity and availability.

There is diverse data in the literature on the parasite fauna of hawks, but most of these papers are reports on certain species with descriptions of the parasites found in either captive (in aviaries) or wild birds. Eurasian goshawks have been best studied in Central Europe: in the Czech Republic and Slovakia (Komorová et al. 2016; Sitko 2011; Sitko & Okulewicz 2010; Sitko et al.

2006), Spain (Sanmartín et al. 2004; Ferrer et al. 2004), Italy (Santoro et al. 2012), Greece (Papazahariadou et al. 2008), and Germany (Krone 2000). In Russia, the greatest number of Eurasian goshawk individuals (20 birds) have been examined for helminths by full dissection at rehabilitation facilities and animal clinics of Moscow City, Moscow and Tula Regions (Dorohov & Davydova 2020). The goshawks were found to host eight species: two trematode species (*Neodiplostomum attenuatum*, *Strigea falconis*) and six nematode species (*Cyathostoma americana*, *Physaloptera apivori*, *Porrocaecum angusticolle*, *P. depressum*, *Capillaria tenuissima*, *Baruscapillaria falconis*). Singular birds have been examined in central parts of Bashkortostan (Valuev 2010), where a female Eurasian goshawk contained three helminth species – *Porrocaecum depressum*, *Strigea falconis*, and *Neodiplostomum cochleare*, one specimen each. Another type of data available is the results obtained by coprological methods (Mailyan 2003, Davydova et al. 2016, Dorokhov 2021, Kravchenko et al. 2023). Eurasian goshawks have been studied alongside other birds of prey in several aviaries by sampling droppings for analysis. This method is ineffective in fully revealing the species diversity of helminths in birds.

This paper presents the first study of the helminth fauna of the Eurasian goshawk in urbanised areas of Karelia, northwest Russia.

Material and methods

In July and September 2024, two cadavers of the Eurasian goshawk specimens were received from residents of the City of Petrozavodsk (61.79° N, 34.38° E) and the Village of Porosozero (62.71° N, 32.70° E) of the Suojarvi District, located 135 km north of Petrozavodsk. Both birds were found dead (Fig. 1) and were later examined by the full helminthological dissection method. They were young, first-year male and female. The collection of parasitological samples, fixation and ex-situ treatment followed standard techniques (Dubinina 1971). The birds' digestive tract and organs (stomach, heart, liver, kidneys, lungs, trachea, bursa of Fabricius) were examined for helminths. Helminth identification was based on keys and original descriptions (Baruš et al. 1978, Sonin 1985, 1986, Sonin & Barush 1996, Oyarzún-Ruiz et al. 2024). After identifying and counting the helminths retrieved, the quantitative parameters of the infection were calculated. The morphology of the parasites was studied using the Olympus BX-53 microscope with the DIC option (equipment provided by the Core Facility of the Karelian Research Centre RAS, Petrozavodsk, Russia).

Fig. 1. Schematic map of sampling sites in northwest Russia: 1 – City of Petrozavodsk, 2 – Village of Porosozero.

Obr. 1. Schématická mapa miest odberu vzoriek v severozápadnom Rusku: 1 – mesto Petrozavodsk, 2 – dedina Porosozero.



Results

The two goshawk specimens in our study contained nine helminth species (Table 1). The first specimen (from the city) hosted seven species, and the second one (from the village) had five species. The trematodes *Neodiplostomum attenuatum* and *Strigea falconis* (Fig. 2) and the nematodes *Baruscapillaria falconis*, *Capillaria tenuissima*, *Cyathostoma americana*, *Eucoleus dispar*, *Microtetrameres* sp., *Porrocaecum depressum* are the first records for Karelia. The trematode *Prosthogonimus cuneatus* is, for the first time, reported for the new host, the Eurasian goshawk (Fig. 3). The morphological traits and dimensions of helminths in our samples match those in the Keys (Baruš et al. 1978, Sonin 1985, 1986, Sonin & Barush 1996, Oyarzún-Ruiz et al. 2024), so we omitted the measurements.

Among the nine species found (Table 1), only three were shared by the two birds – the trematode *S. falconis*, infecting the birds at similar intensities (10 and 8 worms), and two nematode species – *C. americana* (Fig. 4), which was more abundant in the bird from the village (64 vs 16 worms), and *P. depressum*, also with a higher infection rate in the bird from the village (19 worms) than in the one from the city (10 worms). The trematodes *N. attenuatum* and *P. cuneatus* and two nematode species, *B. falconis* and

Eucoleus dispar, were found only in the goshawk picked up in the city (Table 1). Three of the above species were found as singular specimens. Only *B. falconis* showed a relatively high infection intensity (Table 1). The bird from the village specifically featured two nematodes – *C. tenuissima* and *Microtetrameres* sp., represented by nine and four specimens, respectively.

Having assembled the available published data, we compiled a list of 43 species of helminths documented from hawks (Table 2), including nematodes (24 species), trematodes (12 species), cestodes (5 species), and acanthocephalans (2 species).

Discussion

The helminths found in the two examined goshawks have a complex life cycle involving obligatory intermediate and reservoir hosts, ensuring the successful completion of the parasite's life cycle. For instance, the life cycle of the nematode *Cyathostoma americana* has not been studied, but inferring by analogy with the related species, it likely uses earthworms as intermediate hosts, and probable supplementary hosts are small mammals, which can transmit the nematodes to the raptors that prey on them (Fernando & Barta 2008). The infection with the nematode *Porrocaecum depressum* in the birds

Tab. 1. Species composition of helminths found in the two Eurasian goshawk cadavers from northwest Russia (Karelia).

Tab. 1. Druhové zloženie helmintov nájdených v dvoch mŕtvych telách jastraba veľkého zo severozápadného Ruska (Karélia).

Parasite group	Parasite species	Localization	Number of helminths, ind.	
			female bird,	male bird,
			City of Petrozavodsk	Village of Porosozero
Trematoda	<i>Neodiplostomum attenuatum</i>	small intestine	1	–
	<i>Prosthogonimus cuneatus</i>	bursa of Fabricius	3	–
	<i>Strigea falconis</i>	duodenum, small intestine	10	8
	<i>Baruscapillaria falconis</i>	small intestine	15	–
	<i>Capillaria tenuissima</i>	small intestine, oral cavity	–	9
Nematoda	<i>Cyathostoma americana</i>	lungs, trachea, airways, nasal cavity	16	64
	<i>Eucoleus dispar</i>	esophagus	1	–
	<i>Microtetrameres</i> sp.	glandular stomach	–	4
	<i>Porrocaecum depressum</i>	small intestine	10	19
Total			7	5

examined is also presumably associated with the fact that the reservoir hosts in the life cycle of these nematodes are earthworms and small mammals (Hartwich 1975). For the rest of the nematodes (*Eucoleus dispar*, *Baruscapillaria falconis*, *Capillaria tenuissima*), the presumed main pathway for infecting raptors is through the consumed gulls, crows, and partridges, which had ingested nematode-infected earthworms (Heidenreich 1997).

The *Microtetrameres* sp. nematodes in our samples were females, making identification down to species impossible. The available data suggest that their life cycle may include insects of the order Orthoptera (Anderson 2000) and beetles of the Tenebrionidae or Blattidae families as intermediate hosts (Schell 1953). The reservoir host is passerines whose diet includes insects (Kirillov et al. 2018). Goshawks are invaded by these nematodes when consuming infected passerine birds.



Fig. 2. Microphotograph of *Strigea falconis* found in a Eurasian goshawk from northwest Russia. Scale bar 0.5 mm.

Obr. 2. Mikrofotografia *Strigea falconis* nájdená v jastrabovi veľkom zo severozápadného Ruska. Mierka 0,5 mm.

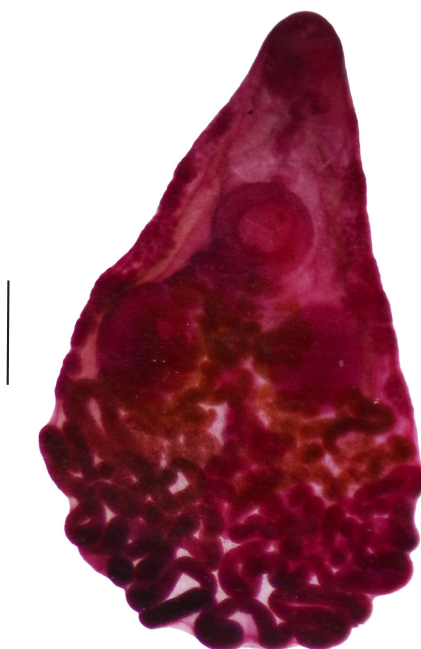


Fig. 3. Microphotograph of *Prosthogonimus cuneatus* found in a Eurasian goshawk from northwest Russia. Scale bar 1 mm.

Obr. 3. Mikrofotografia *Prosthogonimus cuneatus* nájdená v jastrabovi veľkom zo severozápadného Ruska. Mierka 1 mm.

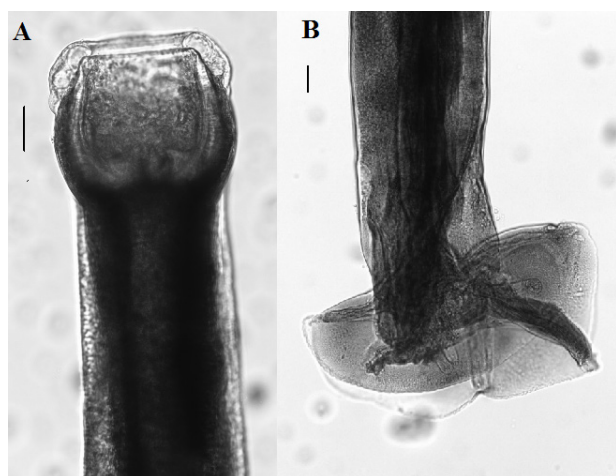


Fig 4. Microphotograph of a male *Cyathostoma americana* from Eurasian goshawk from northwest Russia: anterior region (A) and posterior region (B). Scale bar 0.05 mm.

Obr. 4. Mikrofotografia samca *Cyathostoma americana* z jastraba veľkého zo severozápadného Ruska: predná časť (A) a zadná časť (B). Mierka 0,05 mm.

The trematodes retrieved from the examined goshawk individuals belong to three species – *Neodiplostomum attenuatum*, *Prosthogonimus cuneatus* and *Strigea falconis*. The life cycle of *S. falconis* involves gastropods as the first intermediate host. The second intermediate (reservoir) host options include amphibians, reptiles, birds and small mammals (Odening 1967), preying on which appears to be the pathway for infecting goshawks. The other two species were found only in the bird from Petrozavodsk. The life cycle of the trematode *Neodiplostomum attenuatum* involves amphibians and reptiles, which act as reservoir hosts for this parasite (Odening 1965). *Prosthogonimus cuneatus* was also retrieved from the goshawk found in the city. This fluke species has previously been reported for Anatidae and the Eurasian Coot (Yakovleva 2013). Its first intermediate hosts are gastropods of the genera *Bythynia* and *Gyraulus*. Second intermediate hosts are larvae and imagoes of Odonata genera *Libellula* Linnaeus, 1758, *Aeschna* Fabricius, 1775, *Anax* Leach, 1815, *Sympetrum* Newman, 1833, etc., mayflies and caddis flies (Panin 1957, Sharpilo & Iskova 1989). Attacks on waterfowl, especially ducklings, are a likely pathway to goshawk infestation with *Prosthogonimus cuneatus*.

In Karelia, the hawk genus (*Accipiter* Brisson, 1760) is represented by two species – the Eurasian sparrowhawk and the Eurasian goshawk. According to the literature, the hawks studied in the Czech Republic

and Slovakia feature the highest parasite species richness (Table 2). In these countries, the parasite fauna has been studied in different raptor species of the orders Accipitriformes, Falconiformes, and Strigiformes (Sitko et al. 2006, Sitko & Okulewicz 2010, Sitko 2011, Komorová et al. 2016). The general helminth diversity in birds from Central Europe is relatively high (Table 2). It is specifically worth mentioning the data on the species richness and diversity of the helminth fauna of captive *Accipiter* birds (Table 2). For instance, Davydova et al. (2016) reported that infection with *Ascaridia* sp. nematodes in sparrowhawks and goshawks in an aviary in the Tula Region could be the result of their diet necessarily including quails (*Coturnix* Garsault, 1764), which are common hosts for ascarids (Mozgovoy 1953). Most of the helminths found in aviary-kept hawks, except for capillariids and ascarids, have a complex life cycle with a change of hosts, suggesting the infestation had taken place in the wild before the birds were removed from their natural habitats (Davydova et al. 2016).

The difference in the helminth fauna of Eurasian goshawks in urbanised areas of Karelia from data in the literature is the absence of cestodes and acanthocephalans. All the helminths found in our study can parasitise other species of raptors as well as hawks (Dorokhov & Davydova 2020). The nematodes *Baruscapillaria falconis*, *Capillaria tenuissima*, *Microtetrameres* sp., and *Eucoleus dispar* have been documented for goshawks (*A. nisus* and *A. gentilis*) in the Czech Republic and Slovakia (Sitko et al. 2006, Sitko & Okulewicz 2010, Sitko 2011, Komorová et al. 2016), Spain (Ferrer et al. 2004, Sanmartín et al. 2004), Italy (Santoro et al. 2012), Greece (Papazahariadou et al. 2008), and Germany (Krone 2000). A curious finding is nematodes of the genus *Microtetrameres*, previously reported for hawks only in Spain (Ferrer et al. 2004, Sanmartín et al. 2004). However, helminths of this genus can also occur in other raptor species (Sitko & Okulewicz 2010). The nematode *Baruscapillaria falconis* is the most frequently encountered parasite of the family Capillariidae in diurnal and nocturnal birds of prey. It has mostly been found in the European part of Russia (Valuev 2010, Dorokhov & Davydova 2020, Kirillov & Kirillova 2017).

A unique finding in our sample is the species *Prosthogonimus cuneatus*. This is the first record for the Eurasian goshawk, both in northwest Russia and Europe. A possible reason for its absence in the literature on raptors is that no young birds have previously been

Tab. 2. The list of helminth species documented from the genus *Accipiter* (*A. nisus*, *A. gentilis*) in Russia and Europe.**Tab. 2.** Zoznam druhov helmintov zdokumentovaných z rodu *Accipiter* (*A. nisus*, *A. gentilis*) v Rusku a Európe.

Groups and species of parasites	Russia										Czechia and Slovakia (8)	Netherlands (9)	Greece (10)	Germany (11)
	Our data	Data from various nurseries (1)	Central Russia (2)	Middle Volga region (3)	Lake Baikal catchment area (4)	Bashkortostan (5)	Italy (6)	Spain (7)						
TREMATODA														
<i>Apharyngostrigea flexilis</i>														+
<i>Australapatemon minor</i>										+				
<i>Cotylurus cornutus</i>										+				
<i>Neodiplostomum attenuatum</i>	+	+	+				+	+			+			
<i>N. spathoides</i>										+				+
<i>N. cochleare</i>							+							
<i>Plagiorchis elegans</i>										+				
<i>Prosthogonimus cuneatus</i>	+													
<i>Strigea falconis</i>	+	+	+	+	+	+	+	+	+	+	+			+
<i>S. strigis</i>					+									
<i>Strigea</i> spp.		+						+						
<i>Tylodelphys excavata</i>										+				
NEMATODA														
<i>Ascaridia galli</i>		+												
<i>Ascaridia</i> sp.		+	+											
<i>Baruscapillaria falconis</i>	+	+	+	+				+		+	+			
<i>Capillaria caudinflata</i>		+												
<i>C. tenuissima</i>	+	+	+					+		+		+	+	+
<i>Capillaria</i> sp.		+									+			
<i>Cardiofilaria pavlovskyi</i>														+
<i>Contracaecum rudolphii</i>										+				
<i>Cyathostoma americana</i>	+		+								+			
<i>Eucoleus dispar</i>	+	+					+	+		+		+	+	+
<i>Hovorkonema variegatum</i>								+						+
<i>Microtetrameres inermis</i>				+										
<i>Microtetrameres</i> sp.	+							+						
<i>Porrocaecum angusticollae</i>			+				+	+		+	+			
<i>P. depressum</i>	+	+	+	+		+				+	+			
<i>Porrocaecum</i> sp.											+			+
<i>Procyrnea mansioni</i>							+							+
<i>P. leptoptera</i>								+		+	+			+
<i>Physaloptera alata</i>		+	+			+	+	+		+	+			+
<i>Physaloptera apivori</i>			+							+				
<i>Physocephalus sexalatus</i>				+										
<i>Streptocara crassicauda</i>					+									
<i>Syngamus trachea</i>			+											
<i>Synhimantus laticeps</i>							+	+		+	+			+
CESTODA														
<i>Cladotaenia globifera</i>			+				+	+						+
<i>Passerilepis passeris</i>						+								
<i>Spiniglanis constricta</i> (<i>Pseudanomotaenia constricta</i>)						+								
<i>Mesocestoides perlatus</i>						+								
<i>Dilepis undula</i>						+								
ACANTHOCEPHALA														
<i>Centrorhynchus globocaudatus</i> (<i>Centrorhynchus</i> spp.)						+		+	+	+	+	+	+	+
<i>Acantocephala</i> sp.		+												
Total	9	13	12	5	8	4	10	13		16	11	3	13	

Note: 1 – Mailyan 2003, 2011, Davydova et al. 2016, Dorokhov 2021, Kravchenko et al. 2023; 2 – Kozlitsin 2018, Dorokhov & Davydova 2020; 3 – Kirillov & Kirillova 2013, 2017, Kirillov et al. 2018; 4 – Nekrasov 2000; 5 – Valuev 2010; 6 – Santoro et al. 2012; 7 – Ferrer et al. 2004, Sanmartín et al. 2004; 8 – Sitko et al. 2006, Sitko & Okulewicz 2010, Sitko 2011, Komorová et al. 2016, 2017; 9 – Borgsteede et al. 2003; 10 – Papazahariadou et al. 2008; 11 – Krone 2000, Krone et al. 2007.

examined, considering that the primary localisation for this species is the bursa of Fabricius, which atrophies in adult birds. Apparently, the diet of young goshawks includes insectivorous birds since the life cycle of *P. cuneatus* involves insects (Panin 1957, Sharpilo & Iskova 1989).

The Eurasian goshawk individuals studied here provide a ground for describing the ecology of the birds that are beginning to use urbanised habitats. In addition, we summarised and provided a list of available literature on the helminth fauna of Eurasian goshawks in Russia and Europe.

Funding

This study was performed using federal funding within the State Assignment to the Karelian Research Centre, Russian Academy of Sciences (FMEN-2022-0005, no. 122032100130-3). No additional grants were received to implement or supervise this specific study.

Ethics approval statement

There are no human or animal studies in this paper that meet the criteria of Directive 2010/63/EU. The birds were found dead.

Conflicts of interest

All authors declare that they have no conflicts of interest.

References

- Anderson R 2000: Nematode parasites of vertebrates. Their Development and Transmission. Department of Zoology, University of Guelph, Ontario, Canada.
- Baruš V, Sergeeva TP, Sonin MD & Ryzhikov KM 1978: Helminths of Fish-Eating Birds of the Palearctic Region. I. Nematoda, Moscow: Academia Praha.
- Borgsteede FHM, Okulewicz A, Zoun PEF & Okulewicz J 2003: The helminth fauna of birds of prey (Accipitriformes, Falconiformes and Strigiformes) in the Netherlands. *Acta Parasitologica* 48(3): 200–207.
- Davydova OE, Dorokhov VV & Arslanyan GG 2016: K voprosu o zarazhennosti gel'mintozami hishchnyh ptic otryada Sokoloobraznyh (Falconiformes: Falconidae, Accipitridae) v usloviyah soderzhaniya v pitomnike [To the question of helminth infection rates in wild birds attributed to the order Falconiformes: Falconidae, Accipitridae in the conditions of nursery]. *Theory and Practice of Parasitic Disease Control* 17: 148–150. [In Russian with English summary]
- Dorokhov VV 2021: Sravnitel'naya ocenka antigel'mintnoj effektivnosti ivermektina i levamizola pri kapillyarioze hishchnyh ptic (Falconidae, Accipitridae, Strigidae), soderzhashchihsya v usloviyah nevoli [Comparative evaluation of the anthelmintic efficacy of ivermectin and levamisole of capillariasis in birds of prey (Falconidae, Accipitridae, Strigidae) kept in captivity]. *International Journal of Veterinary Medicine*. 1: 66–72. [In Russian with English summary]
- Dorokhov VV & Davydova OE 2020: Gel'mintofauna hishchnyh ptic (Falconiformes: Falconidae, Accipitridae) v nechernozemnoj zone Rossijskoj federacii [Helminthofauna of predatory birds (Falconiformes: Falconidae, Accipitridae) in the territory of the non-black-earth zone of the Russian Federation]. *Russian Journal of Veterinary Pathology* 4: 49–55. DOI: 10.25690/VETPAT.2020.22.57.006. [In Russian with English summary]
- Dubinina MN 1971: Parazitologicheskoe issledovanie ptic [Parasitological Study of Birds], Leningrad: Nauka. Leningr. Otd. [In Russian]
- Fernando MA & Barta JR 2008: Tracheal Worms, 343–354. In: Atkinson CT, Thomas NJ & Hunter DB (eds), *Parasitic diseases of wild birds*. Wiley. DOI:10.1002/9780813804620.ch19.
- Ferrer D, Molina R, Adelantado C & Kinsella JM 2004: Helminths isolated from the digestive tract of diurnal raptors in Catalonia, Spain. *Veterinary Record* 154: 17–20.
- Hartwich GI 1975: Rhabditida und Ascaridida. *Die Tierwelt Deutschlands*. 62 Teil. Gustav Fischer Verlag, Jena.
- Heidenreich M 1997: Parasitic diseases, 131–148. In: *Birds of prey, Medicine and management*. Blackwell Science, Oxford, UK.
- Kirillov AA & Kirillova NY 2013: Trematody ptic Srednego Povolzh'ya. 2. Otryady Plagiorchiida, Rencolida, Strigeida i Schistosomatida [Trematodes of birds (Aves) from the Middle Volga region. 2. Orders Plagiorchiida, Rencolida, Strigeida, and Schistosomatida]. *Parazitologiya* 47(2): 136–177. [In Russian with English summary]
- Kirillov AA & Kirillova NY 2017: Faunisticheskij analiz gel'mintov ptic (AVES) Samarskoj Luki [Faunistic analyses of helminthes of birds of the Samarskaya Luka]. *Izvestia of Samara Scientific Center of the Russian Academy of Sciences* 19(2): 17–28. [In Russian with English summary]

- Kirillov AA, Kirillova NY & Chikhlyayev IV 2018: Parazity pozvonochnykh zhivotnykh Samarskoj oblasti [Parasites of vertebrates of the Samara Region]. Togliatti, Poliar. [In Russian with English summary]
- Komorová P, Sitko Ji, Špakulová M & Hurníková Zu 2016: Intestinal and liver flukes of birds of prey (Accipitriformes, Falconiformes, Strigiformes) from Slovakia: uniform or diverse compound? Parasitology Research 115: 2837–2844. DOI: 10.1007/s00436-016-5034-1.
- Komorová P, Sitko J, Špakulová M, Hurníková Z, Sařamatin R, Chovancová G 2017: New data on helminth fauna of birds of prey (Falconiformes, Accipitriformes, Strigiformes) in the Slovak Republic. Helminthologia 54(4): 314–321. DOI: 10.1515/helm-2017-0038.
- Kozlitin VE 2018: Mikoplazmoz u yastrebateterevyatnika, oslozhnennyj singamozom, askaridozom i kapillyariozom [Mycoplasmosis in a Goshawk complicated by syngamosis, ascariasis and capillariasis]. Clinical case from the Kazan Raptor Rehabilitation Center Solnyshko. Retrieved November, 11, 2024 from <https://birds.vc/bolezni-ptitc/diagnostika-dlya-ptitc/mikoplazmoz-yastrebateterevyatnika.html>. [In Russian]
- Kravchenko IA, Musaev MB, Ankudinova ES 2023: Gel'mintofauna dnevnykh hishchnykh ptic otryada Sokolobraznye (Falconiformes) [Helminth fauna in diurnal birds of prey of the order Falconiformes]. Russian Journal of Parasitology 17(2): 198–205. DOI: 10.31016/1998-8435-2023-17-2-198-205. [In Russian with English summary]
- Krone O 2000: Endoparasites of free-ranging birds of prey in Germany, 101–116. In: Lumeij JT, Remple JD Reding PT, Lierz M & Cooper JE (eds), Raptor Biomedicine III. Zoological Educational Network.
- Krone O, Friedrich D & Honisch M 2007: Specific status and pathogenicity of syngamid nematodes in bird species (Ciconiformes, Falconiformes, Gruiformes) from Germany. Journal of Helminthology 81: 67–73. DOI:10.1017/S0022149X07214129.
- Lebedeva DI & Yakovleva GA 2016: Trematoda *Nematostrigea serpens* (Nitzsch 1819) Sandground 1934, a new species in the parasite fauna of birds in Karelia. Biology Bulletin 43: 1018–1023. DOI: 10.1134/S1062359016090065.
- Lebedeva DI, Yakovleva GA & Artemiev AV 2013: K izucheniyu parazitov skopy (*Pandion haliaetus*) Severo-Zapada Rossii [Parasites of the Osprey (*Pandion haliaetus*) in Northwestern Russia]. Parazitologiya 47(2): 130–135. [In Russian with English summary]
- Mailyan ES 2003: Gel'mintozy hishchnykh ptic [Helminthoses of birds of prey]. Veterinarian 1: 6–15 [In Russian]
- Mailyan ES 2011: Gel'mintozy ptic semeistva Falconidae [Helminthoses of birds of the Falconidae family]. Topical Problems of Infectology and Parasitology: Proceedings of the 1st International Jubilee Conference dedicated to the 110th anniversary of the discovery of Siberian liver fluke in humans by Prof. K.N. Vinogradov Tomsk, 2-5 April: 41–42. [In Russian]
- Mozgovoy AA 1953: Fundamental'naya nematologiya [Fundamentals of Nematodology. Ascaridates of Animals and Man and Diseases Caused by Them]. Moscow, Nauka. [In Russian]
- Nekrasov AV 2000: Gel'minty dikikh ptits basseina ozera Baikal [Helminths of Wild Birds in the Lake Baikal Catchment], Ulan-Ude. [In Russian]
- Neufeldt IA 2019: Pitanie nekotorykh lesnykh ptic Yuzhnoj Karelii [Nutrition of some forest birds of South Karelia]. Russian Journal of Ornithology 28, Express issue 1781: 2639–2655. [In Russian]
- Noskov GA, Rymkevich TA & Gaginskaya AR 2016: Migratsii ptits Severo-Zapada Rossii. Nevorob'inye [Migrations of Birds in Northwest Russia. Non-Passerines], St. Petersburg, ANO LA Professional. [In Russian]
- Odening K 1967: Die lebenszyklen von *Strigea falconis palumbi* (Viborg), *S. strigis* (Schränk) und *S. sphaerula* (Rudolphi) (Trematoda, Strigeida) im Raum Berlin. Zool. Jahrbücher Abteilung für Systematik 94: 1–67.
- Odening K 1965: Der Lebenszyklus von *Neodiplostomium attenuatum* (Trematoda, Strigeida) im Raum Berlin. Biologische Rundschau 3: 250–253.
- Sonin M 1985: Opredelitel' trematod ryboyadnykh ptits Palearktiki (brakhilaimidy, klinostomidy, tsiklotseidy, fastsiolidy, notokotilidy, plagiorkhidy, shistosomatidy) [Key to trematodes of fish-eating birds of the Palearctic region. (Brachilimides, Clinostomides, Cyclocellides, Fasciolids, Notocotillides, Plagiorchids, and Schistosomiads)], Vol. 1, Moscow, Nauka. [In Russian]
- Sonin M 1986: Opredelitel' trematod ryboyadnykh ptits Palearktiki (opistorkhidy, renikolidy, strigeidy) [Key to trematodes of fish-eating birds of the Palearctic region (Opisthorchids, Renicolides, and Strigeids)], Vol. 2, Moscow, Nauka. [In Russian]
- Oyarzún-Ruiz P, Navarro MA, Donoso-Erč S & Muñoz-Leal S 2024: Integrative description and

- histopathological lesions of *Cyathostoma americana* (Nematoda, Syngamidae) parasitizing a barn owl (*Tyto alba*) in Chile. Veterinary Research Communications 48: 4141–4147. DOI: 10.1007/s11259-024-10544-4.
- Panin VYa 1957: Biologiya trematod *Prasthgonimus ovatus* (Rud., 1803) i *Pr. cuneatus* (Rud., 1803), parazitov fabricievoj sumki i jajcevoda dikih i domashchnih ptic [Biology of the trematodes *Prasthgonimus ovatus* (Rud., 1803) and *Pr. cuneatus* (Rud., 1803), parasites of the bursa of Fabricius and oviduct of wild and domestic birds]. Collected Papers on Zoology 2(14): 53–65. [In Russian]
- Papazahariadou M, Diakou A, Papadopoulos E, Georgopoulou I, Komnenou A & Antoniadou-Sotiriadou K 2008: Parasites of the digestive tract in free-ranging birds in Greece. Journal of Natural History, 42(5-8): 381–398. DOI: 10.1080/00222930701835357.
- Sanmartín ML, Álvarez F, Barreiro G & Leiro J 2004: Helminth fauna of Falconiform and Strigiform birds of prey in Galicia, Northwest Spain. Parasitology Research 92: 255–263. DOI: 10.1007/s00436-003-1042-z.
- Santoro M, Kinsella JM, Galiero G, Uberti BD & Aznar FJ 2012: Helminth Community Structure in Birds of Prey (Accipitriformes and Falconiformes) in Southern Italy. Journal of Parasitology 98(1): 22–29. DOI: 10.1645/GE-2924.1.
- Schell SC 1953: Four new species of *Microtetrameres* (Nematoda: Spiruroidea) from Nort American birds. Translation American Microscopy Society 72(3): 227–236.
- Sharpilo VP & Iskova NI 1989: Fauna Ukrainy. Plagiorchiata (Plagiorchiata). [Trematody.Fauna of Ukraine. Trematodes. Plagiorchiata (Plagiorchiata)]. Vol. 34(3). Kiev, Naukova Dumka. [In Russian]
- Sitko J 2011: Checklist of the Acanthocephala in birds in the Czech Republic and the Slovak Republic. Comenius Museum, Přerov.
- Sitko J, Faltýnková A & Scholz T 2006: Checklist of the Trematodes (Digenea) of Birds of the Czech and Slovak Republics. Academia, Praha. Sitko J & Okulewicz A 2010: Checklist of the Nematodes in Birds in the Czech Republic and the Slovak Republic. Comenius Museum, Přerov.
- Sitko J & Okulewicz A 2010: Checklist of the Nematodes in Birds in the Czech Republic and the Slovak Republic. Comenius Museum Přerov.
- Sonin MD & Barush V 1996: Nematody dikikh kurinykh ptits Palearktiki (Nematodes of Wild Gallinaceous Birds of the Palearctic), Moscow: Institut Parazitologii Rossiiskoi Akademii Nauk. [In Russian]
- Stepanyan LS 2003: Konspekt ornitologicheskoi fauny Rossii i sopredel'nykh territorii (v granitsakh SSSR kak istoricheskoi oblasti) [Summary of the Avifauna of Russia and Adjacent Territories (within the Borders of the USSR as a Historical Region)], Moscow. Akademkniga. [In Russian]
- Tolstoguzov A, Artemyev A & Prokhorov A 2022: Ornitofauna Botanicheskogo sada Petrozavodskogo gosudarstvennogo universiteta [Avifauna of the Botanic Garden of Petrozavodsk State University]. Hortus botanicus 17: 274–288. DOI: 10.15393/j4.art.2022.8505. [In Russian with English summary]
- Valuev VA 2010: Gel'minty dikih ptic Bashkortostana [Helminths of wild birds in Bashkortostan]. Parazitologiya 44(5): 419–427. [In Russian with English summary]
- Yakovleva GA 2013: Fauna trematod vodno-bolotnykh ptic Karelii [The fauna of trematodes of wetland birds of Karelia]. PhD Thesis, Petrozavodsk State University [In Russian]
- Zhohov AE, Mishina EE 2011: Novaya metacerkariya *Nematostrigea vietnamiensis* sp. n. (Trematoda, Strigeidae) iz presnovodnoj ryby *Channa gachua* (Perciformes, Channidae), Central'nyj V'etnam [The new metacercaria *Nematostrigea vietnamiensis* sp. n. (Trematoda, strigeidae) from the freshwater fish *Channa gachua* (Perciformes, channidae), Cenral Vietnam]. Biology Bulletin 90: 1268–1270. [In Russian with English summary]

Received: 13.4.2025

Accepted: 30.6.2025