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# New data on helminth fauna of birds of prey (Falconiformes, Accipitriformes, Strigiformes) in the Slovak Republic

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## Article info

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## Summary

In the years 2012-2014, carcasses of 286 birds of prey from the territory of Slovakia were examined for the presence of helminth parasites. The number of bird species in the study was 23; five belonging to the Falconiformes order, eleven to Accipitriformes, and seven to Strigiformes. A finding of Cestoda class comprehended 4 families: Paruterinidae (4), Dilepididae (2), Mesocostoididae (2) and Anoplocephalidae (1). Birds of prey were infected with 6 families Nematoda species of the Secernentea class: Syngamidae (1), Habronematidae (2), Tetrameridae (3), Physalopteridae (1), Acuariidae (1), and Anisakidae (2). Out of the Adenophorea class, the Capillariidae family (1) was confirmed. The Acanthocephala group was represented by the Paleacanthocephala class, the Centrorhynchidae family (3). Out of the Trematoda class, 12 different species of flukes were found, belonging to the Diplostomidae (5), Cyathocotylidae (1), Strigeidae (4), Opisthorchidae (1), and Plagiorchiidae (1) families. The most frequent helminth species infecting diurnal birds of prey was *Strigea falconis*. This fluke was confirmed in one bird species from the Falconiformes order and in eight species from the Accipitriformes order. In nocturnal birds of prey, the most common finding was the acanthocephalan *Centrorhynchus aluconis*, identified in four different host species of the Strigiformes order. In total, 23 helminth species were recorded for the first time in Slovakia.

**Keywords:** helminth parasites; infection; nocturnal and diurnal birds of prey

## Introduction

Birds of prey are predatory animals residing at the top of a food chain and they usually get infected with parasites via ingestion of prey, thus serving as intermediate hosts of many parasite species. Types and diversity of the prey preferred by individual species represent one of the factors affecting the parasite diversity in those hosts.

Since majority of birds of prey species in Europe are protected, the research and knowledge of the parasite fauna is only fragmentary. Comprehensive research projects studying all helminth groups in birds of prey were accomplished by the Borgsteede *et al.* (2003),

Sanmartín *et al.* (2004), Illescas Gomez *et al.* (1993), and Santoro *et al.* (2012a, b).

Forty-three different species of birds of prey, belonging to the Falconiformes, Accipitriformes, and Strigiformes orders, nest or occur in Slovakia territory (Kovalík *et al.*, 2010). The most abundant species is the common buzzard (*Buteo buteo*) that nests in different forest biotopes, but it is very well adapted also to the agricultural land. However in low quantities, on the territory of Slovakia we can also find the species that are very sensitive to the environmental changes associated with anthropogenic impacts (*Circus pygargus*, *Milvus milvus*) (Krivjanský, 2009).

In Slovakia, only two research papers, aimed at parasites in birds

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of prey, have been published in the 20<sup>th</sup> century. Tenora & Lusk (1960) and Škarda (1964) studied the helminth fauna of birds in Czechoslovakia and published several findings in birds of prey from the Slovak part of the country. For a subsequent period of 50 years, at the times of dynamic climate changes, no comprehensive research of this host group has been carried out. Recently, two papers on flukes and thorny-headed worms were published (Komorová *et al.*, 2015; Komorová *et al.*, 2016).

The aim of our study was to obtain the complex knowledge about the current status of the parasite fauna in birds of prey in Slovakia.

## Material and Methods

During the period of 2012 – 2014, 286 carcasses of birds of prey belonging to 23 species of the Falconiformes, Accipitriformes, and Strigiformes orders were examined for the presence of helminths (Table 1). The research was conducted upon the permission issued by the Ministry of Environment of the Slovak Republic No. 6467/2012-2.26467/2012-2.2. The samples were collected from various locations of Slovakia in cooperation with departments of the State Nature Conservancy of the Slovak Republic – The Slovenský Kras National Park, The Slovenský Raj National Park, The Pieniny National Park, The Regional Conservation Centre in Prešov, and The Vihorlat Protected Area, as well as with the Museum of the Tatras National Park, the Clinic for Birds and Exotic Animals at the University of Veterinary Medicine and Pharmacy in Košice, The Raptor Protection of Slovakia, The Rehabilitation Station in The ZOO Bojnice, and The Košice Airport. Collected bird carcasses were frozen and subjected to helminthological necropsy. After de-freezing, all organ systems and body cavities were examined for the presence of parasites. Collected helminths were washed in distilled water and preserved in 70 % ethanol. For morphological identification, the species belonging to the Trematoda and Cestoda classes were stained with iron acetocarmine (Georgiev *et al.*, 1986). Lightening of specimens from the Adenophorea, Secernentea, and Paleacanthocephala classes was carried out using glycerine or lactophenol. The species identification was conducted according to Dubois (1968, 1970), Gibson *et al.* (2002), Sitko (1998, 2001), and Bray *et al.* (2008) for Trematoda; Joyeux & Timon-David (1934), Joyeux & Baer (1936), Rausch (1948), and Khalil *et al.* (1994) for Cestoda; Hartwich (1975), Baruš *et al.* (1978), and Gibbons (2010) for Adenophorea; and Secernentea and Meyer (1933), Petrochenko (1958), Dimitrova *et al.* (1997), and Dimitrova & Gibson (2005) for Paleacanthocephala. Ecological parameters (prevalence, mean intensity, diversity) were evaluated according to Bush *et al.* (2007).

The voucher specimens are deposited in the collection of The Institute of Parasitology at the SAS in Košice.

## Results

Out of 286 examined birds, 156 (54.5 %) were infected with hel-

minths, 17 out of 85 diurnal birds of prey from the Falconiformes order were infected (20 %), and the parasitic infection was confirmed in 114 out of 156 birds from the Accipitriformes order (73.1 %). In nocturnal birds of prey (Strigiformes order), helminths were found in 28 out of 45 individuals (62.2 %).

A total of 33 helminth taxa were registered. In the Falconiformes order, 9 different helminth taxa were determined – 2 Trematoda, 1 Cestoda, 4 Secernentea, and 1 Paleacanthocephala. In birds from the Accipitriformes order, in total 27 helminth species were found – 9 Trematoda, 6 Cestoda, 1 Adenophorea, 8 Secernentea, and 3 Paleacanthocephala. In nocturnal birds of prey (Strigiformes) 10 helminth species were detected – 2 Trematoda, 2 Cestoda, 1 Adenophorea, 4 Secernentea, and 1 Paleacanthocephala (Table 1). The information on parasite species, names and numbers of infected hosts (NIH), prevalence (P in %), intensity of infection (II), mean intensity (MI), and site of infection is summarized below.

### Platyhelminthes

#### Trematoda

Diplostomidae Poirier, 1886

#### ***Conodiplostomum perlatum* (Ciurea, 1911)**

Host: *H. albicilla* (NIH=1; P=100 %; II=43) – first record in Slovakia  
Site of infection: small intestine

#### ***Conodiplostomum spathula* (Creplin, 1829)**

Host: *A. heliaca* (NIH=1; P=16.7 %; II=13) – first record in Slovakia  
Site of infection: small intestine

#### ***Neodiplostomum attenuatum* (Linstow, 1906)**

Host: *B. buteo* (NIH=29; P=24.4 %; II=1-224; MI=25), *B. lagopus* (NIH=1; P=20 %; II=70), *B. rufinus* (NIH=2; P=50 %; II=6-10; MI=8), *P. apivorus* (NIH=1; P=100 %; II=3) – first records in Slovakia  
Site of infection: small intestine

#### ***Neodiplostomum canaliculatum* (Nicoll, 1914)**

Host: *B. bubo* (NIH=1; P=50 %; II=1), *S. uralensis* (NIH=5; P=33.3 %; II=5-23; MI=14) – first records in Slovakia  
Site of infection: small intestine

#### ***Neodiplostomum spathoides* Dubois, 1937**

Host: *B. rufinus* (NIH=1; P=25 %; II=4), *C. aeruginosus* (NIH=2; P=50 %; II=8-15; MI=11.5) – first records in Slovakia  
Site of infection: small intestine

Cyathocotylidae Mühling, 1898

#### ***Paracoenogonimus ovatus* Katsurada, 1914**

Host: *H. albicilla* (NIH=1; P=100 %; II=1) – first record in Slovakia  
Site of infection: small intestine

Strigeidae Railliet, 1919

#### ***Parastrigea flexilis* (Dubois, 1934)**

Table 1. List of birds of prey species investigated and numbers of hosts infected with individual parasite classes.

Order/bird species	No. of examined/ parasitized birds	No. of birds parasitized by:				
		Trematoda	Cestoda	Secernentea	Adenophorea	Paleacanthocephala
<b>Falconiformes</b>	<b>85/15</b>	<b>3</b>	<b>3</b>	<b>8</b>	<b>0</b>	<b>2</b>
<i>Falco cherrug</i> Gray, 1834	3/2	-	-	2	-	-
<i>Falco columbarius</i> L., 1758	1	-	-	-	-	-
<i>Falco peregrinus</i> Tunstall, 1771	5	-	-	-	-	-
<i>Falco subbuteo</i> L., 1758	3/3	1	-	3	-	-
<i>Falco tinnunculus</i> L., 1758	73/10	2	3	3	-	2
<b>Accipitriformes</b>	<b>156/114</b>	<b>63</b>	<b>51</b>	<b>55</b>	<b>19</b>	<b>13</b>
<i>Accipiter gentilis</i> L., 1758	5/3	2	1	1	-	-
<i>Accipiter nisus</i> L., 1758	9/5	1	-	4	1	-
<i>Aquila heliaca</i> Savigny, 1809	6/4	1	2	2	1	-
<i>Buteo buteo</i> (L., 1758)	119/89	48	44	41	16	12
<i>Buteo lagopus</i> (Pontoppidan, 1763)	5/4	2	-	4	1	-
<i>Buteo rufinus</i> (Cretzschmar, 1829)	4/3	3	2	2	-	1
<i>Circus aeruginosus</i> (L., 1758)	4/3	3	1	1	-	-
<i>Circus pygargus</i> (L., 1758)	1	-	-	-	-	-
<i>Haliaeetus albicilla</i> (L., 1758)	1/1	1	-	-	-	-
<i>Milvus milvus</i> (L., 1758)	1/1	1	-	-	-	-
<i>Pernis apivorus</i> (L., 1758)	1/1	1	1	-	-	-
<b>Strigiformes</b>	<b>45/28</b>	<b>10</b>	<b>6</b>	<b>5</b>	<b>17</b>	<b>19</b>
<i>Asio otus</i> (L., 1758)	13/7	2	-	-	6	1
<i>Athene noctua</i> (Scopoli, 1769)	1	-	-	-	-	-
<i>Bubo bubo</i> (L., 1758)	2/2	2	-	-	1	-
<i>Glaucidium passerinum</i> (L., 1758)	1	-	-	-	-	-
<i>Strix aluco</i> L., 1758	10/3	-	1	-	1	2
<i>Strix uralensis</i> Pallas, 1771	15/15	6	5	5	9	15
<i>Tyto alba</i> (Scopoli, 1769)	3/1	-	-	-	-	1

Host: *B. rufinus* (NIH=1; P=25 %; II=1), *C. aeruginosus* (NIH=2; P=50%; II=1-2; MI=1.5) – first records in Slovakia  
Site of infection: small intestine

***Strigea falconis* Szidat, 1928**

Host: *F. tinnunculus* (NIH=2; P=2.7 %; II=2; MI=2), *A. gentilis* (NIH=2; P=40 %; II=1-3; MI=2), *A. nisus* (NIH=1; P=11.1 %; II=3), *A. heliaca* (NIH=1; P=16.7 %; II=15), *B. buteo* (NIH=42; P=35.3 %; II=1-575; MI=35.4), *B. lagopus* (NIH=2; P=40 %; II=5-10; MI=7.5), *B. rufinus* (NIH=3; P=75 %; II=4-18; MI=10.7), *C. aeruginosus* (NIH=3; P=75 %; II=1-8; MI=4), *M. milvus* (NIH=1; P=100 %; II=2) – new host records in Slovakia except for *B. buteo*  
Site of infection: small intestine

***Strigea strigis* Schrank, 1788**

Host: *A. otus* (NIH=2; P=15.4 %; II=2-4; MI=3), *B. bubo* (NIH=1; P=50 %; II=2), *S. uralensis* (NIH=2; P=13.3 %; II=6-17; MI=11.5) – first records in Slovakia  
Site of infection: small intestine

***Strigea vandenbroekae* Dubois, 1936**

Host: *P. apivorus* (NIH=1; P=100 %; II=7) – first record in Slovakia  
Site of infection: small intestine

Opisthorchiidae Looss, 1899

***Metorchis bilis* (Braun, 1790)**

Host: *H. albicilla* (NIH=1; P=100 %; II=2), *B. rufinus* (NIH=1; P=25 %; II=21) – first records in Slovakia  
Site of infection: gall bladder

Plagiorchiidae Lühe, 1901

***Plagiorchis elegans* (Rudolphi, 1802)**

Host: *F. subbuteo* (NIH=1; P=33.3 %; II=4) – new host record in Slovakia  
Site of infection: small intestine

Cestoda

Paruterinidae Fuhrmann, 1907

***Cladotaenia circi* Yamaguti, 1935**

Host: *C. aeruginosus* (NIH=1; P=25 %; II=1) – first record in Slovakia  
Site of infection: small intestine

***Cladotaenia globifera* (Batsch, 1786)**

Host: *F. tinnunculus* (NIH=3; P=4.1 %; II=1-2; MI=1.33), *B. buteo* (NIH=43; P=36.1 %; II=1-20; MI=4.4), *B. rufinus* (NIH=1; P=25 %; II=1) – new host records in Slovakia except for *B. buteo*  
Site of infection: small intestine

***Cladotaenia spasskii* Kobyshev, 1971**

Host: *A. heliaca* (NIH=2; P=33.3 %; II=1-4; MI=2.5) – first record in Slovakia

Site of infection: small intestine

***Paruterina candelabraria* (Goeze, 1782)**

Host: *S. aluco* (NIH=1; P=10 %; II=4), *S. uralensis* (NIH=4; P=26.7 %; II=1-8; MI=3.25) – first records in Slovakia  
Site of infection: small intestine

Dilepididae Railliet et Henry, 1909

***Choanotaenia strigium* Joyeux & Timon-David, 1934**

Host: *S. uralensis* (NIH=1; P=6.7 %; II=4) – first record in Slovakia  
Site of infection: small intestine

***Spiniglans trapezoides* (Fuhrmann, 1906) Salamatin, 2000**

Host: *P. apivorus* (NIH=1; P=100 %; II=1) – first record in Slovakia  
Site of infection: small intestine

Mesocestoididae Perrier, 1897

***Mesocestoides perlatus* (Goeze, 1782)**

Host: *A. gentilis* (NIH=1; P=20 %; II=1) – first record in Slovakia  
Site of infection: small intestine

***Mesocestoides* sp.**

Host: *B. rufinus* (NIH=1; P=25 %; II=1)  
Site of infection: small intestine

Anoplocephalidae gen. sp.

Host: *B. buteo* (NIH=1; P=0.8 %; II=1)  
Site of infection: small intestine

Nematoda

Secernentea

Syngamidae Leiper, 1912

***Cyathostoma americana* Chapin, 1925**

Host: *B. rufinus* (NIH=1; P=25 %; II=2) – first record in Slovakia  
Site of infection: trachea

Habronematidae (Chitwood et Wehr, 1932)

***Cyrnea leptoptera* (Rudolphi, 1819)**

Host: *F. cherrug* (NIH=1; P=33.3 %; II=2), *F. subbuteo* (NIH=2; P=66.7 %; II=7-18; MI=12.5), *B. buteo* (NIH=11; P=9.2 %; II=1-12; MI=3.55), *C. aeruginosus* (NIH=1; P=25 %; II=1), *S. uralensis* (NIH=1; P=6.7 %; II=5) – new host records in Slovakia except for *B. buteo*  
Site of infection: gizzard

***Cyrnea spinosa* (Gendre, 1923)**

Host: *F. subbuteo* (NIH=1; P=33.3 %; II=13), *A. nisus* (NIH=1; P=11.1 %; II=6) – new host records in Slovakia  
Site of infection: gizzard

Tetrameridae Travassos, 1914

***Microtetrameres cloacitectus* Oshmarin, 1956**

Host: *F. tinnunculus* (NIH=2; P=2.7 %; II=4-6; MI=5), *B. buteo*

(NIH=8; P=6.7 %; II=1-183; MI=32.38) – first records in Slovakia  
Site of infection: gizzard

***Microtetrameres oshmarini* Sobolev, 1963**

Host: *S. uralensis* (NIH=3; P=20 %; II=3-25; MI=14.67) – first record in Slovakia  
Site of infection: gizzard

***Tetrameres* sp.**

Host: *S. uralensis* (NIH=1; P=6.7 %; II=1) – first record in Slovakia  
Site of infection: gizzard

Physalopteridae (Railliet, 1893)

***Physaloptera alata* Rudolphi, 1819**

Host: *A. nisus* (NIH=2; P=22.2 %; II=1-7; MI=4) – first record in Slovakia  
Site of infection: gizzard

Acuariidae Railliet, Henry et Sisoff, 1912

***Synhimantus laticeps* (Rudolphi, 1819)**

Host: *F. tinnunculus* (NIH=1; P=1.4 %; II=2), *A. heliaca* (NIH=1; P=16.7 %; II=3), *B. buteo* (NIH=1; P=0.8 %; II=2), *B. lagopus* (NIH=1; P=20 %; II=1), *B. rufinus* (NIH=1; P=25 %; II=17) – first records in Slovakia  
Site of infection: oesophagus

Anisakidae Railliet et Henry, 1912

***Porrocaecum angusticolle* (Molin, 1860)**

Host: *F. cherrug* (NIH=1; P=33.2 %; II=134), *A. gentilis* (NIH=1; P=20 %; II=6), *A. nisus* (NIH=1; P=11.1 %; II=3), *A. heliaca* (NIH=1; P=16.7 %; II=1), *B. buteo* (NIH=24; P=20.2 %; II=1-15; MI=3.63), *B. lagopus* (NIH=3; P=60 %; II=1-4; MI=2.33), *B. rufinus* (NIH=1; P=25 %; II=1), *S. uralensis* (NIH=4; P=26.7 %; II=1-5; MI=2.75) – new host records in Slovakia except for *B. buteo*  
Site of infection: stomach, small intestine

***Porrocaecum depressum* (Zeder, 1800)**

Host: *B. buteo* (NIH=8; P=6.7 %; II=1-49; MI=9.63), *B. rufinus* (NIH=1; P=25 %; II=3) – new host record in Slovakia except of *B. buteo*  
Site of infection: stomach, small intestine

Adenophorea

**Capillariidae gen. sp.**

Host: *B. buteo* (NIH=10; P=8.4 %; II=1-33; MI=8.5), *B. lagopus* (NIH=1; P=20 %; II=2), *A. otus* (NIH=5; P=38.5 %; II=3-15; MI=8), *B. bubo* (NIH=1; P=50 %; II=2), *S. aluco* (NIH=1; P=10 %; II=5), *S. uralensis* (NIH=4; P=26.7 %; II=2-7; MI=4.25)  
Site of infection: small intestine

***Baruscapillaria falconis* (Goeze, 1782)**

Host: *A. nisus* (NIH=1; P=11.1 %; II=6), *A. heliaca* (NIH=1;

P=16.7 %; II=3), *B. buteo* (NIH=6; P=5 %; II=1-14; MI=6.67), *A. otus* (NIH=1; P=7.7 %; II=2), *S. uralensis* (NIH=5; P=33.3 %; II=4-12; MI=8.2) – first records in Slovakia  
Site of infection: small intestine

Acanthocephala

Paleacanthocephala

Centrorhynchidae Golvan, 1960

***Centrorhynchus aluconis* (Muller, 1780)**

Host: *B. buteo* (NIH=1; P=0.8 %; II=5), *A. otus* (NIH=1; P=7.7 %; II=5), *S. aluco* (NIH=2; P=20 %; II=5-10; MI=7.5), *S. uralensis* (NIH=15; P=100 %; II=2-82; MI=22.4), *T. alba* (NIH=1; P=33.3 %; II=2) – new host records in Slovakia except for *B. buteo* and *S. aluco*  
Site of infection: small intestine

***Centrorhynchus buteonis* (Schränk, 1788)**

Host: *B. buteo* (NIH=10; P=9.2 %; II=1-15; MI=6.4), *B. rufinus* (NIH=1; P=25 %; II=39) – first records in Slovakia  
Site of infection: small intestine

***Centrorhynchus globocaudatus* (Zeder, 1800)**

Host: *F. tinnunculus* (NIH=2; P=2.7 %; II=1-2; MI=1.5), *B. buteo* (NIH=1; P=0.8 %; II=3), *B. rufinus* (NIH=1; P=25 %; II=5) – new host records in Slovakia  
Site of infection: small intestine

**Discussion**

In Europe, there are only few papers comprehensively studying the helminths in birds of prey. The published studies focused mainly on particular groups of birds or certain categories of helminths. Complex surveys involving all three major orders of birds of prey (omitting passeriform shrikes of the Laniidae family) were conducted in the Netherlands (Borgsteede *et al.*, 2003), Spain (Sanmartín *et al.*, 2004; Illescas Gomez *et al.*, 1993), and Italy (Santoro *et al.*, 2012a, b). Ferrer *et al.* (2004) examined the incidence of helminths only in owls from the territory of Spain. In the Czech Republic, Sitko published decades-long scientific studies of flukes in diurnal (1998) and nocturnal raptors (2001). Research from the territory of Slovakia was published in the former Czechoslovakia by Ryšavý (1957) and Tenora & Lusk (1960) and comprehensive analyses of flukes and thorny-headed worms were published recently by us (Komorová *et al.*, 2015; Komorová *et al.*, 2016).

Comparisons of the fluke species spectrum in bird orders studied within our research showed certain differences between diurnal (Accipitriformes and Falconiformes) and nocturnal birds of prey (Strigiformes). They are similar to findings of Santoro *et al.* (2012b) in Calabria (Italy) and Sanmartín *et al.* (2004) in Galicia (Spain) who observed a relatively narrow range of helminth species within the Strigiformes family, in particular the species specific for owls. This is consistent with our findings in owls with only two detected



trematode species (*Strigea strigis*, *Neodiplostomum canaliculatum*) as was already published by Komorová *et al.* (2016). Santoro *et al.* (2012b) found that the helminth fauna of diurnal birds of prey is much more diverse than nocturnal birds. This distinction could be explained by the fact that the ensemble of diurnal bird species includes hosts with different and varied diet spectrum. In consequence, their parasite richness will be the sum of the particular fauna of each bird species (e.g. fish-eating, insectivores, generalist, specialist, etc.) that form the set of hosts. Our results confirmed these findings, since among diurnal birds some flukes, e.g., *Conodiplostomum perlatum*, *Paracoenogonimus ovatus*, and *Metorchis bilis*, were detected exclusively in fish-eating birds of prey species, *Strigea vandenbroekae* was found only in insectivorous European honey buzzard, and *Parastrigea flexilis* parasitized members of the *Circus* genus. On the other hand, the fluke *S. falconis* has a wide host range among Accipitriformes and Falconiformes.

Our results showed that the incidence of flukes was the lowest in the Falconiformes order, where, no species-specific parasites were present (Komorová *et al.*, 2016). Only one species of liver flukes, *M. bilis*, detected in our material, was confirmed also by a DNA analysis (Sitko *et al.*, 2016).

Similarly, significant differences in the tapeworm species spectrum in nocturnal and diurnal birds of prey have been revealed. While diurnal raptors were hosts of several cestode species, such as *Cladotaenia globifera*, *Cladotaenia circi*, *Cladotaenia spasskii*, *Spiniglanis trapezoides*, and *Mesocestoides perlatus*, owls were parasitized with only two tapeworm species, *Paruterina candellabaria* and *Choanotaenia strigium*. Among diurnal raptors, the differences between Falconiformes and Accipitriformes orders were also observed. In Accipitriformes, six cestode species were identified, whereas in Falconiformes *C. globifera* was the only identified tapeworm. Birds of the Accipitriformes order were infected most frequently and the composition of the tapeworm community was the most diverse. This richness could be caused by the diversity of the order that includes species with different trophic habits. It also can be associated with a considerable variability of this bird order. Among tapeworms, *Cladotaenia globifera* was the less host-specific species and had the highest prevalence. In contrast, the other tapeworms, e.g., *C. circi* or *C. Spasskii*, appeared to be specific to their bird hosts. In older papers from the territory of Slovakia, the synonym *Cladotaenia cylindracea* was used for the species *C. globifera* (Ryšavý, 1957; Tenora & Lusk, 1960). In our material, fragments of cestodes of the Anoplocephalidae family were detected in *B. buteo*. It was probably the only an occasional post-cyclic transmission from infected small vertebrate prey, being the main food component of common buzzards.

Nematodes of the Secernentea class were found in almost all examined species. Parasites of the *Cyanea*, *Synhimantus* and *Porrocaecum* genera infect a broad spectrum of hosts among diurnal (Falconiformes, Accipitriformes) and also nocturnal (Strigiformes) birds of prey. It was confirmed also by previous findings (Krone,

2000; Borgsteede *et al.*, 2003; Sanmartín *et al.*, 2004; Santoro *et al.*, 2012a, b). *Physaloptera alata* was the species occurring exclusively in one species of diurnal raptors. As for the *Microtetrameres* genus, the *M. cloacitectus* species was confirmed in diurnal birds of prey and the *M. oshmarini* species only in the owls. The finding of a nematode belonging to the *Tetrameres* genus in Ural owl is remarkable. It requires more thorough examination based on a DNA analysis due to the detection of only a single female individual of this nematode. The *Tetrameres* genus is quite common in waterfowls (Sitko & Okulewicz, 2010) but very rare in birds of prey. Ferrer *et al.* (2004) confirmed *Tetrameres* sp. in *S. aluco* in Spain, but the specimen was not determined up to the species level. In Florida, Pence *et al.* (1975) described the *Tetrameres strigiphila* species from *Strix varia*, so the species affiliation of the nematode from Slovakia is highly interesting. The Secernentea class includes epidemiologically important species and can be considered as the most pathogenic helminth group in birds of prey. In particular, intense infections with species of the *Porrocaecum* genus identified in the widest range of hosts represent a serious impact on the health of the birds. It was, for instance, demonstrated by the death of a saker falcon infected with a large number of *Porrocaecum angusticolle* nematodes.

Regarding the nematode class of Adenophorea, the Capillariidae family was represented most often. These findings were quite common and involved a wide range of hosts. However, the species determination was not possible in most cases due to the bad conservation of materials, except for few specimens that could be identified, such as *Baruscapillaria falconis*.

Our results on the species spectrum of acanthocephalans (Paleacanthocephala) in the three orders of birds of prey revealed the exclusive presence of *Centrorhynchus aluconis* in Strigiformes, *Centrorhynchus buteonis* in Falconiformes, and *C. buteonis*, or *C. buteonis*. *Centrorhynchus globocaudatus* co-infections were most frequently found in Accipitriformes (Komorová *et al.*, 2015, and this paper). The presence of *C. aluconis* in diurnal birds of prey was demonstrated in one case but the parasite reproduction in the host was not confirmed.

Marked differences in helminth communities between the owls and the diurnal raptors (Accipitriformes and Falconiformes) have been reported by Santoro *et al.* (2012b) in southern Italy. The majority of literature data on acanthocephalans of birds of prey suggests a rather low host specificity of individual species of the *Centrorhynchus* genus. For instance, *C. aluconis* is considered as an owl parasite in Europe (Kutzer *et al.*, 1982; Kritscher 1985; Ewald & Crompton, 1993; McInnes *et al.*, 1994; Sitko 1994; Dimitrova *et al.*, 1995; Ferrer *et al.* 2004; Dimitrova & Dimitrova 2012; Santoro *et al.*, 2012b; Lisitsyna & Greben, 2015), but it has sometimes been observed also in diurnal raptors (Yamaguti 1963; Illescas Gomez *et al.* 1993; Borgsteede *et al.* 2003, Sitko 2011). On the other hand, *C. buteonis* has been documented not only in Falconiformes and Accipitriformes, but also in owls, especially in the *Strix* genus (Furmaga, 1957; Yamaguti, 1963; Michálek, 1984; Kritscher, 1985;

Sitko 2011; Dimitrova & Dimitrova, 2012; Shirazi *et al.*, 2014). The widest host range, as confirmed by the above mentioned authors, was observed in *C. globocaudatus*, primarily infecting diurnal raptors (Sanmartín *et al.*, 2004; Lisitsyna & Greben, 2015).

Within our research, a total of 23 helminth species consisting of ten Trematoda species, six Cestoda species, five taxa of the Secernentea class, and one species of Paleacanthocephala were observed for the first time in birds of prey from Slovakia. Regarding the helminths previously found in Slovakia, lots of new hosts were listed. The total number of new host observations is 31. Most of them were confirmed for the *S. falconis* fluke which was detected in eight new avian species.

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