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Collyriclum faba (Digenea: Collyriclidae) in migrant *Phylloscopus trochilus* (Aves: Sylvidae) in Egypt: the first record of the parasite on the African continent

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Abstract: The aim of this paper is to document the presence of the avian trematode *Collyriclum faba* in Egypt. During bird migration, parasitological research was carried out along the East European bird migration flyway (Jordan, Palestine, Egypt) in 2012–2014. A total of 1783 birds belonging to 87 species, mainly passerines, were macroscopically examined for the presence of parasites. An adult male individual of the willow warbler, *Phylloscopus trochilus*, examined in Aswan, southern Egypt, presented 5 subcutaneous cysts containing parasites identified as *C. faba* located on its thighs, above the eye, and on the body under the wing. The parasites were probably transported by the migrating bird over the Balkan Peninsula or Turkey. *Collyriclum faba* had never been recorded from Africa before.

Key words: *Collyriclum faba*, Digenea, *Phylloscopus trochilus*, bird migration, Egypt

Collyriclum faba (Bremser in Schmalz, 1831) Kossak 1911 (Digenea: Collyriclidae) is a parasite of numerous bird species in Europe, northern Asia, and the Americas, both migrants (Literák et al., 2003; Literák and Sitko, 2006; Heneberg et al., 2011) and residents (Literák et al., 2011). The life cycle of *C. faba* is unknown; its first intermediate host is unknown and its second intermediate hosts are probably insects (Parker, 2009). The parasite can be found in subcutaneous cysts located in various parts of the body of its avian host (Literák et al., 2003). Intensive epidemiological research has been carried out on many bird species in Europe, Asia, and the Americas, and recent phylogenetic molecular studies on 3 host-specific ecotypes of this parasite have been published (Heneberg and Literák, 2013). The hypothesis of cryptic speciation among *C. faba* and host specificity of the ecotypes tested by the above authors has not been corroborated by molecular data (Heneberg and Literák, 2013). To the best of our knowledge, *C. faba* has not been found in Africa before.

In 2012–2014, during interdisciplinary ornithological and parasitological studies on helminth parasites conducted along the eastern bird migration flyway in Jordan, Palestine, and Egypt, a total number of 1783 birds belonging to 87 species, mainly passerines, were examined while the ringed birds were migrating (Table 1). In Jordan (spring 2012), 23 birds belonging to 13 species were examined in the Wadi Dana Reserve (30°21′N, 35°17′E; 23 March to 3 April), and 465 birds of 38 species were examined in Azraq (31°50′N, 36°49′E; 7–16 April). In Egypt (autumn 2012), the studies were carried out in Wadi Allaqi, a partially artificial oasis supported by waste water from the town of Aswan, overgrown by reeds and bushes (24°04′N, 32°52′E; 13 September to 5 October), where 366 birds of 35 species were examined. In Palestine, near Jericho (autumn 2013 and spring 2014) (31°50′N, 35°30′E; 12 September to 22 October), 929 birds of 61 species were examined. The field work was a part of the SE European Bird Migration Network (SEEN) activity supported by the Bird Migration Research Foundation of Poland. Applied methods of the ornithological research followed SEEN standards (Busse, 2000) and the ringing involved making measurements and testing scores (wing length, tail length, wing formula, fat determination, and body mass), as well as testing directional preferences of birds. The helminthological methods included visual inspection of live birds for the presence of cysts of digeneans and traditional parasitological examination of birds dead due to different causes, e.g., exhaustion or raptor attack. Parasites were collected only from dead birds. Inspection of the bodies of live birds included visual examination of legs, the abdominal region from the vent to the furcula, the neck, the region under the wings, the upper part of

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Table 1. Species and numbers of birds evaluated for occurrence of *Collyriclum faba* during ornithological and parasitological studies carried out in Jordan, Palestine, and Egypt in 2012–2014.

No.	Scientific name	English common name	Spring			Autumn		Total
			Jericho 2014	Azraq 2012	Wadi Dana 2012	Jericho 2013	Wadi Allaqi 2012	
	Passerines:							
1	*Sylvia curruca*	Lesser Whitethroat	133	107	4	7	10	261
2	*Acrocephalus scirpaceus*	Reed Warbler	8	72		9	152	241
3	*Sylvia atricapilla*	Blackcap	85	75	2	20		182
4	*Passer hispaniolensis*	Spanish Sparrow	22	1		95		118
5	*Phylloscopus trochilus*	Willow Warbler		15		43	27*	85*
6	*Phylloscopus collybita*	Chiffchaff	23	50		4		77
7	*Passer moabiticus*	Dead Sea Sparrow	55			16		71
8	*Passer domesticus*	House Sparrow	25	37		5	1	68
9	*Hirundo rustica*	Barn Swallow	6	25		2	26	59
10	*Lonchura malabarica*	Indian Silverbill	2			46		48
11	*Lanius nubicus*	Masked Shrike	3	1		37	7	48
12	*Hippolais pallida*	Olivaceous Warbler	33	2		8	1	44
13	*Pycnonotus xanthophygos*	Yellow-vented Bulbul	17			19		36
14	*Luscinia svecica*	Bluethroat	14	9		10		33
15	*Acrocephalus schoenobaenus*	Sedge Warbler		4		9	19	32
16	*Locustella luscinioides*	Savi's Warbler		1		5	23	29
17	*Lanius collurio*	Red-backed Shrike	1			24	3	28
18	*Sylvia borin*	Garden Warbler				4	23	27
19	*Phylloscopus orientalis*	Eastern Bonelli's Warbler	10	13				23
20	*Acrocephalus stentoreus*	Clamorous Reed Warbler					20	20
21	*Phoenicurus phoenicurus*	Redstart	3	6	3	2	4	18
22	*Sylvia communis*	Whitethroat	8	4		2	3	17
23	*Muscicapa striata*	Spotted Flycatcher				5	8	13
24	*Sylvia hortensis*	Orphean Warbler	7	1	2	1		11
25	*Cercotrichas galactotes*	Rufous Bush Robin	8	1		1		10
26	*Acrocephalus palustris*	Marsh Warbler	1			5	4	10
27	*Luscinia megarhynchos*	Nightingale	4	6				10
28	*Saxicola rubetra*	Winchat	1			3	3	7
29	*Sylvia melanocephala*	Sardinian Warbler	1	2	1	2		6
30	*Emberiza caesia*	Cretzschmar's Bunting	1			5		6
31	*Acrocephalus arundinaceus*	Great Reed Warbler		2		1	2	5
32	*Oenanthe hispanica*	Black-eared Wheatear		3		2		5
33	*Turdus merula*	Blackbird	1	3				4
34	*Galerida cristata*	Crested Lark	3			1		4
35	*Motacilla flava*	Yellow Wagtail				1	3	4
36	*Oenanthe oenanthe*	Northern Wheatear		2			1	3
37	*Pycnonotus barbatus*	Common Bulbul					3	3
38	*Riparia riparia*	Sand Martin		2		1		3
39	*Luscinia luscinia*	Thrush Nightingale	1			2		3
40	*Phylloscopus sybilatrix*	Wood Warbler	1	1			1	3
41	*Hirundo daurica*	Red-rumped Swallow					3	3
42	*Bucanetes githagineus*	Trumpeter Finch					2	2
43	*Fringilla coelebs*	Chaffinch			2			2
44	*Scotocerca inquieta*	Scrub Warbler			1		1	2

Table 1. (Continued).

No.	English common name	English common name	Spring			Autumn		Total
			Jericho 2014	Azraq 2012	Wadi Dana 2012	Jericho 2013	Wadi Allaqi 2012	
45	*Turdus philomelos*	Song Thrush	2					2
46	*Parus major*	Great Tit						
47	*Erithacus rubecula*	Robin	2					2
48	*Anthus trivialis*	Tree Pipit	1			1		2
49	*Oenanthe isabellina*	Isabelline Wheatear					1	1
50	*Oenanthe leucopyga*	White-crowned Wheatear					1	1
51	*Locustella fluviatilis*	River Warbler					1	1
52	*Lanius senator*	Woodchat Shrike		1				1
53	*Lullula arborea*	Woodlark			1			1
54	*Prinia gracilis*	Graceful Prinia				1		1
55	*Pycnonotus leucotis*	White-eared Bulbul		1				1
56	*Saxicola rubicola*	Stonechat				1		1
57	*Sylvia rueppelli*	Rueppell's Warbler		1				1
58	*Sylvia melanothorax*	Cyprus Warbler	1					1
59	*Cettia cetti*	Cetti's Warbler		1				1
60	*Emberiza hortulana*	Ortolan Bunting				1		1
61	*Ficedula albicollis*	Collared Flycatcher					1	1
62	*Delichon urbica*	House Martin	1					1
63	*Ficedula semitorquata*	Semicollared Flycatcher		1				1
64	*Acrocephalus dumetorum*	Blyth's Reed Warbler		1				1
65	*Motacilla alba*	White Wagtail	1					1
	Nonpasserines:							
66	*Jynx torquilla*	Wryneck	6	5	1	4		16
67	*Otus scops*	Scops Owl	3	3	2	2		10
68	*Merops orientalis*	Green Bee-eater				8		8
69	*Halcyon smyrnensis*	White-throated Kingfischer	5					5
70	*Upupa epops*	Hoopoe		2	1		1	4
71	*Streptopelia decaocto*	Collared Dove	2	2				4
72	*Vanellus spinosus*	Spurn Lapwing	1			1	2	4
73	*Merops apiaster*	Bee-eater					4	4
74	*Oena capensis*	Namaqua Dove	1				2	3
75	*Tringa glareola*	Wood Sandpiper				2		2
76	*Streptopelia senegalensis*	Laughing Dove	2					2
77	*Rostratula bengalensis*	Painted Snipe					2	2
78	*Tringa ochropus*	Green Sandpiper				1		1
79	*Rallus aquaticus*	Water Rail				1		1
80	*Coturnix coturnix*	Quail	1					1
81	*Calidris temminckii*	Temminck's Stint				1		1
82	*Ardeola ralloides*	Squacco Heron					1	1
83	*Alcedo atthis*	European Kingfisher		1				1
84	*Actitis hypoleucos*	Common Sandpiper	1					1
85	*Accipiter nisus*	Sparrowhawk			1			1
86	*Dendrocopos syriacus*	Syrian Woodpecker	1					1
87	*Ixobrychus minutus*	Little Bittern		1				1
	Total		508	465	23	421	366	1783

*: Number contains 1 individual infected with *Collyriclum faba*.

the body around the coccygeal gland, and the head. After the ringing and examination of birds for *C. faba* cysts, the birds were released.

Collyriclum faba specimens were removed from the cysts and preserved in 75% ethyl alcohol. The specimens were stained with alum carmine, dehydrated using different ethanol concentrations (50%, 75%, 96%, and 100%), and cleared in clove oil. Microscope slides were prepared by mounting the parasite specimens in Canada balsam.

Parasites were measured and described. Parasite identification keys and original studies were used for morphological identification of the collected parasites (Skrjabin, 1947; Bykhovskaya-Pavlovskaya, 1962; Bykhovskaya-Pavlovskaya and Khotenovsky, 1964; Borgarenko, 1978; Bray et al., 2002).

A total of 27 willow warblers *Phylloscopus trochilus* (Sylvidae) were examined in Aswan. In 1 individual (adult male) of the willow warbler examined on 24 September 2012, 10 individuals of *C. faba* were found in 5 subcutaneous cysts. The bird was found in the net in very bad condition and died during handling; it was very thin, with a fatness score of 0 on a scaled range of 0 to 8 (Busse, 2000) and a body mass of 9.9 g. The cysts were about 4–6 mm in diameter (Figures 1A and 1B), located on the thighs (3 cysts), over the eye (1 cyst), and on the body under the wing (1 cyst). Two individual parasites were found in each cyst. Description of the parasites was based on 8 specimens: body hemispherical, concave ventrally and convex dorsally. Spine clusters regularly distributed over the tegument. Oral sucker situated subterminally, small, located on the dorsal surface. Ventral sucker absent. Intestinal bifurcation in the anterior part of the body. Testes ovoid-shaped, symmetrical. The ovary anterior to the right testis. The uterus in the posterior half of body. All parasites were sexually mature, with eggs in the uterus. Vitelline follicles, grouped in 2 groups consisting of 7 to 9 clusters, located anterolaterally to each testis. The measurements of the parasites obtained in the present study are presented in Table 2. They are within the range given by different authors, although smaller individuals were reported in the paper by Bykhovskaya-Pavlovskaya and Khotenovsky (1964): 1100–2670 × 760–2750 µm. The collected specimens of *C. faba* are deposited in the helminthological collection of the Department of Ecology and Environmental Protection, University of Szczecin, Poland (accession number: 1613).

Collyriclum faba has been reported from many species of birds in Europe, Asia, and North, Central, and South America (Farner and Morgan, 1944; Stunkard, 1971; Kirmse, 1987; Literák et al., 2003; Literák and Sitko, 2006; Heneberg et al., 2011; Literák et al., 2011); it has never been reported from Africa before. At the place where the infected specimen was found, *P. trochilus* was not a breeding species, which meant that it was migrating from central/northern Europe to its winter quarters located in the central and southern parts of Africa (Moreau, 1972). It is highly probable that the parasite was transferred from Europe, where it has been known to occur. Literák and Sitko (2006) pointed to the fact that *C. faba* was known from a number of species during spring and postbreeding migrations. Considering the dates in autumn when the specimens were found, the time needed for the development of cysts on the bird body, and the known endemic areas of the parasite occurrence, the above authors supposed that a probable area of infection was

Figure 1. Subcutaneous cysts with *Collyriclum faba* in the leg **(A)** and head **(B)** of *Phylloscopus trochilus* found naturally infected in Egypt. Photos by I Rząd, Wadi Allaqi, Egypt, 24 September 2012.

Table 2. Measures of specimens of *Collyriclum faba* (n = 3–8) recovered from naturally infected *Phylloscopus trochilus* in Egypt. All measurements given in µm (mean ± standard deviation).

Feature	Length	Width	Diameter
Body	3811 ± 578	4414 ± 710	-
Spines	19 ± 3	-	-
Oral sucker	-	-	324 ± 19
Pharynx	151 ± 15	182 ± 18	-
Ovary	1550 ± 169*	843 ± 121*	-
Right testis	867 ± 73	605 ± 66	-
Left testis	863 ± 112	607 ± 78	-
Clusters of vitelline follicles	-	-	390 ± 66
Vitelline follicles	-	-	91 ± 17
Eggs	16 ± 1	11 ± 1	-

*: Dimensions estimated because of the irregular shape of the ovary.

located in the central Carpathian region. During studies on European hirundines (164,582 sand martins, *Riparia riparia*, and 100,443 barn swallows, *Hirundo rustica*) in 10 European countries and 1 Middle Eastern country (Bahrain), only 9 samples (7 sand martins and 2 barn swallows) from central Europe (Czech Republic, Hungary, and Poland) were positive for *C. faba* (Heneberg et al., 2011). These data suggest that the individuals of *C. faba* found by us in Aswan originated from the abovementioned area. This means that the parasites found by us in Egypt were probably transported by the migrating bird over the Balkan Peninsula or Turkey, which would suggest that the area of *C. faba* occurrence ought to be extended to these territories as well as to Egypt.

The willow warbler breeds in Europe as 2 subspecies: *Phylloscopus trochilus trochilus* (central and western Europe), which migrates SW to western and central Africa, and *Phylloscopus trochilus acredula* (northern and northeastern Europe), which migrates S-SSE via the Balkan Peninsula, Turkey, the Middle East, and eastern Africa as far as the northern parts of South Africa (Zink, 1973; Svensson, 1992). In autumn, willow warblers stay for some time in the Balkans and Turkey to reach a high level of fatness (fat scores of 5–7) (Ścisłowska and Busse, 2005; Kesapli Didrickson et al., 2007), which allows them to fly quickly over 2 migration barriers: the Mediterranean Sea and the Sahara belt. Migrating willow warblers stop in northern Africa only for a while; dense concentrations have been observed only in rich localities in the Nile Delta (Burullus, Ashtoum) (Ibrahim and Busse, 2012), and birds caught there had fat scores of 4–5 (unpublished results). Aswan is situated just on the migration route, but it is not a stopover area for migrants (low numbers of individuals landing, and an average fat score of 3). Thus, the individual of the willow warbler carrying *C. faba* was at that stage of migration. The subspecies of willow warblers caught in Aswan was not defined, but they probably belonged exclusively to *P. t. acredula*.

Out of 27 *P. trochilus* specimens caught at that site, only 2 had fat scores of 0 (average fat score was 3). The body mass of the infected individual was above average (8.44 g), so the bird was relatively big, while its condition was very bad. It is not clear how infection of birds by *C. faba* can handicap the infected birds. Some authors claim that the influence of the parasite on the host is negligible (Heneberg et al., 2011; Literák et al., 2011). However, it has been pointed out that helminth infections can be related to infection with the avian poxvirus (Grove et al., 2005), so the influence may be indirect. In the literature, there have been reports that infection by helminth parasites may be a cause of death in passerines (Okulewicz and Sitko, 2012). It is not possible to claim that the condition of the discussed individual was caused by the infection with *C. faba*, but further studies of this problem in areas that are crucial to bird migration are highly advisable and may cast light on parasite–host relations during critical times of the host's life—in this case, when the bird must cross important migration barriers.

Long-term studies on avian hosts of helminth parasites carried out during the last century in Eurasia and America did not reveal infection of the willow warbler by *C. faba* (see Literák et al., 2003; Literák and Sitko, 2006; Heneberg et al., 2011). The only available reports about the hosting of *C. faba* by a willow warbler dates from 8 June 1831 in southern Germany (Farner and Morgan, 1944) and from 15 May 1961 in the former Soviet Union (Bykhovskaya-Pavlovskaya and Khotenovsky, 1964).

Collyriclum faba was found in a migrating *P. trochilus* in southern Egypt. The source of infection was probably in central Europe, but because the bird presumably originated

from northern Europe and passed through the Balkans/Turkey and northern Egypt during migration, there was no certainty about the geographical origin of the parasite. Therefore, further studies on this species during migration could lead to interesting results.

The importance of studies on host–parasite relations during long-distance migration of birds as well as the exchange of parasites between local and migrating populations along the route should be emphasized. Moreover, this approach has provided a unique opportunity to study parasites and their avian hosts during a period that was highly demanding (especially physiologically) for the latter (Awad et al., 2013). Thus, the combination of parasitological work in the context of bird migration with ringing activity, as shown in the present study, may provide new information on the distribution of parasites of migratory birds. As Africa is generally poorly covered by ringing activity, it would provide a good opportunity to study parasites without intentional killing of their hosts; if cooperation between ringers and parasitologists all over the continent was achieved, it would be helpful for gaining a deeper insight into the faunistics and ecology of parasites.

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