ACTA
PROTOZOOLOGICA

Acta Protozool. (2012) 51: 329–333
http://www.eko.uj.edu.pl/ap
doi:10.4467/16890027AP.12.026.0786

A New Species of *Eimeria* Schneider, 1875 (Apicomplexa: Eimeriidae) from the Common Wood Pigeon *Columba palumbus* Linnaeus, 1758 (Aves: Columbidae)

Ján JAMRIŠKA[1,2] and David MODRÝ[1,3]

[1]Department of Pathological Morphology and Parasitology, Faculty of Veterinary Medicine, University of Veterinary and Pharmaceutical Sciences Brno, Czech Republic; [2]Department of Zoology, Comenius University in Bratislava, Bratislava, Slovakia; [3]Institute of Parasitology, Biology Centre, AS CR, České Budějovice, Czech Republic

Abstract. New species of eimeriid coccidia (Apicomplexa: Eimeriidae) is described from the Common Wood Pigeon *Columba palumbus* (Aves: Columbidae). Sporulated oocysts of *Eimeria columbapalumbi* sp. n. are ellipsoidal 24–17 × 18–15 µm. Micropyle and oocyst residuum are absent. Sporocysts are broadly ellipsoidal, 11–16 × 6–7 µm, with Stieda body. Substiedal body is absent. Sporocyst residuum is scattered, composed of hundreds of small granules. Sporozoites are elongate and slightly curved, each with two refractile bodies. There are two irregularly shaped polar granules present in the oocyst. The endogenous development takes place within the enterocytes of jejunum.

Key words: Coccidia, *Eimeria columbapalumbi*, Columbiformes, *Columba palumbus*.

INTRODUCTION

The family Eimeriidae Minchin, 1903 contains apicomplexan protists parasitizing mostly in the digestive system of vertebrates. The genus *Eimeria* Schneider, 1875 is typical by its monoxenous life cycle and high host specificity resulting in enormous diversity (Pellérdy 1974, Levine 1985, Duszynski *et al*. 1999).

Address for correspondence: Ján Jamriška, Dept. of Pathological Morphology and Parasitology, Faculty of Veterinary Medicine, University of Veterinary and Pharmaceutical Sciences Brno, Palackeho 1–3, 612 42 Brno, Czech Republic; E-mail: jan.jamriska5@gmail.com

The world-wide distributed family Columbidae comprises more than 310 avian species (Baptista *et al*. 1997) which contrasts with only 16 species of eimeriid coccidia that have been described from members of the family using the traditional morphological species concept (Pellérdy 1974, Varghese 1980, Duszynski *et al*. 1999, Adriano *et al*. 2003, Bandyopadhyay *et al*. 2006, Alyousif *et al*. 2009). Obviously, great deal of the diversity of coccidia of pigeons awaits the description. The Common Wood Pigeon is one of five pigeon/dove species occurring in Central Europe. This species is further classified into several subspecies, with almost world-wide distribution. In last decades, Wood pigeons tend to expand from forested areas to urban and suburban ecosystems. It breeds on trees in woods, parks and

gardens even in city centers, with increasing population trend. Even though that the Common Wood Pigeon has different life strategy than the Rock pigeon *Columba livia*, these species get often in touch in urban areas (Baptista *et al*. 1997, IUCN 2012). To cover part of the gap in our knowledge, we investigated the coccidian fauna of *Columba palumbus* based on the samples collected from the Czech and Slovak Republics in order to evaluate also possible exchange of coccidian species between above mentioned two pigeon species.

MATERIAL AND METHODS

Fecal samples were collected from 96 free ranging Common Wood Pigeons *Columba palumbus* Linnaeus, 1758 from urban habitats within the Czech (Brno, 49°12′8.78″N; 16°36′22.40″E) and Slovak (Bratislava, 48°8′4.35″N; 17°6′47.20″E) Republics. Fresh fecal samples were collected from the ground right after defecation and placed into the vials containing 2.5% aqueous (w/v) potassium dichromate ($K_2Cr_2O_7$) solution. Vials were maintained at room temperature (~ 23°C) for 4–6 days to allow the oocysts to sporulate (Long *et al*. 1976). Oocyst were concentrated by modified Sheather's sugar solution (SG = 1.30) flotation (Sheather 1923) and examined using Olympus AX 70 microscope equipped with Nomarski interference contrast optics. Histological slides were prepared from two naturally infected birds to examine the stages of the endogenous life cycle. Tissue samples of liver, gall bladder, heart, lungs, stomach, and equidistantly spaced 6 portions of small and large intestine were fixed in 10% formalin and processed for light microscopy using standard histological methods.

Oocysts and histological slides were photographed using Olympus DP 70 digital camera. All measurements were taken using a calibrated ocular micrometer and are presented in micrometers as means followed by the ranges in parentheses.

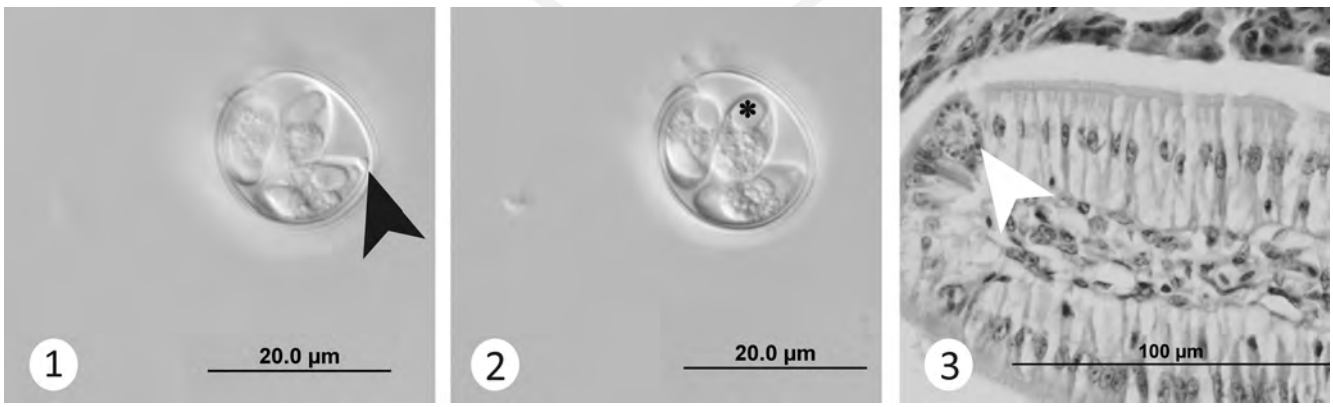
RESULTS

This is the first record of coccidia for this host species. Thirty six out of 96 (37.5%) Common Wood Pigeons were positive and shed unsporulated coccidian oocysts, which appeared to represent a single species of *Eimeria*, description of which is presented below. Intracytoplasmic endogenous stages were found developing within the epithelial cells of jejunum, where the macrogamonts were observed (Fig. 3).

Eimeria columbapalumbi n. sp.

Description of oocyst

Sporulated oocysts are ellipsoidal, 21.3 × 16.9 (17–24 × 15–18, N = 33); shape index (length/width ratio), 1.26 (1–1.44). Oocyst wall bi-layered, 0.9 (0.6–1.5, N = 33). Outer layer is thicker, 1.0, light brownish in color, slightly pitted externally; inner layer is 0.5. Micropyle and oocyst residuum are absent. Two irregularly-shaped polar granules were present, each about 1.5 × 2.0. Sporocysts are elongate ovoidal, slightly asymmetrical, cramped on one pole, 13.5 × 6.5 (11–16 × 6–7, N = 33), with smooth, single layered, colorless wall; shape index 1.09 (1.69–2.17). Stieda body is pres-



Figs 1–2. Nomarski interference micrograph of oocyst of *Eimeria columbapalumbi* n. sp. isolated from the feces; note Stieda body (Fig. 1, black arrow) and elongated sporozoite anterior refractile body (Fig. 2, asterisk).

Fig. 3. Microphotograph of mucosa of the jejunum showing macrogametocyte (white arrow).

ent, 1.3 high × 1.5 wide (1.0–1.2 × 1.5 –1.6, N = 15) (Fig. 2), substiedal body is absent. Sporocyst residuum is scattered, composed of hundreds of small granules (Fig. 1). Sporozoites are elongate, slightly curved, each with two refractile bodies. Anterior refractile body is spherical 3.0 × 2.4 (3.0 × 2.4–2.5, N = 10); the posterior one is elongate 5.4 × 2.5 (5.3–5.5 × 2.3–2.5, N = 10) (Fig. 4). The nuclei of the sporozoites were not well discernible.

Type-host: *Columba palumbus* Linnaeus, 1758 (Aves: Columbidae), Common Wood Pigeon.

Type-locality: Bratislava, Slovak Republic.

Site of infection: Endogenous stages observed in jejunum; oocysts were recovered from feces.

Sporulation: Exogenous, oocysts became sporulated within 6 days at ~ 23°C.

Type-specimens: Digital photomicrographs are deposited at the type parasitological collection of the Institute of Parasitology, Biology Centre, Academy of Sciences of the Czech Republic, České Budějovice, No.: IP ProtColl P20.

Etymology: The specific epithet *columbapalumbi* is derived from the host binominal name *Columba palumbus.* Latin word *palumbus* (= wood pigeon) is of the second declension and is of masculine gender, having a genitive ending *-i*.

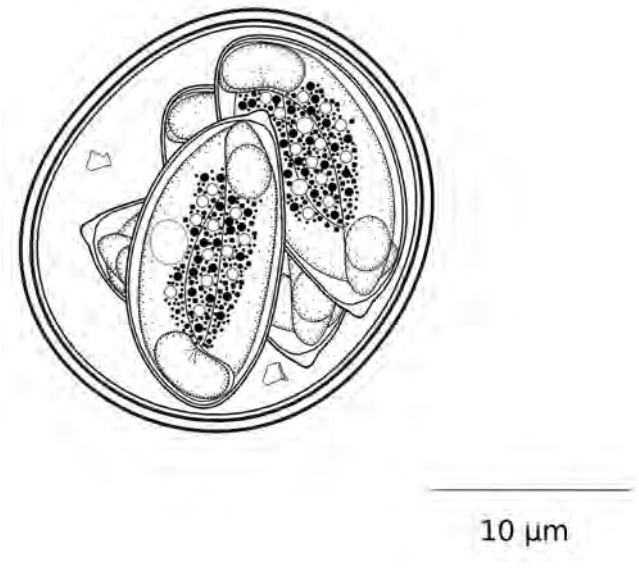


Fig. 4. Composite line drawing of sporulated oocyst of *Eimeria columbapalumbi* n. sp.

REMARKS AND DISCUSSION

Levine (1962) once calculated that, theoretically, there could be at least 2,654,736 different oocysts in the coccidian genus *Eimeria* alone, which is probably highly overrated estimation. Later estimation by Duszynski *et al*. (1999) suggested that the genus might comprise around 35,000 species, instead of the 1,300 taxa named. Generally, the coccidia parasitizing members of the family Columbidae are poorly studied and many species are described incompletely without data on important morphological structures. We listed known species of eimeriid coccidia from hosts of this family (Table 1) and compared published data with our findings. Oocysts of *Eimeria columbapalumbi* are similar in size to those of *E. columbarum* Nieschulz, 1935, *E. livialis* Alyousif, Al-Shawa and Al-Asiri, 2009 and *E. janovyi* Bandyopadhyay, Bhakta and Shukla, 2006, all of them being named from *Columba livia* Gmelin, 1879. Oocysts of *E. columbarum* differ in the oocyst shape index (0.92–0.95); all other characters important for the species identification (like data about polar granule, Stieda body, substiedal body, sporocyst shape index) are unfortunately missing in the original description. *E. livialis* compared to *E. columbapalumbi* has oocyst residuum and no polar granule. *E. janovyi,* in contrary, has a polar granule and also differs from *E. columbapalumbi* in sporocyst shape index. Two other species *E. columbae* Mitra and Das Gupta, 1937 and *E. labbeana* (Pinto 1928) are also poorly described, missing important characters for the species indentification in original descriptions.

All other eimerid coccidia recorded from the Columbidae differ in oocyst/sporocyst dimensions and shape indexes (when present in original descriptions). Several species further differ in structural details of the oocysts: those of *E. columbae* have oocyst residuum and no Stieda body, oocysts of *E. kapotei* Chaterjee and Ray, 1969 and *E. phenocercae* Ray, 1952 possess oocyst micropyle, *E. tropicalis* Malhotra and Ray, 1961 has oocysts with oocyst residuum. The rest of the species, namely *E. gourai* Varghese, 1980, *E. duculai* Varghese, 1980, *E. waiganiensis* Varghese, 1978, *E. zenaidae* Adriano, Thyssen and Cordeiro, 2003, *E. turtui*, Golemansky, 1976, *E. choudari* Bhatia, Chauhan, Arora and Agrawal, 1973, *E. curvata* Adriano, Thyssen and Cordeiro, 2000 and *E. palumbi* McQuistion, 1990 were recorded from other genera of family Columbidae.

Table 1. Eimeriid coccidia of the family Columbidae listed in alphabetical order.

Species	Host	Oocyst	Oocyst shape index	Oocyst residuum	Micropyle	Polar granule	Sporocyst	Sporocyst shape index	Sporocyst residuum	Stieda body	Substieda body	References
E. columbae	*C. intermedia*	16.4 × 14.35	–	–	no	–	7.2 × 4.8	–	–	–	–	Mitra and Das Gupta 1937
E.columbapalumbi n. sp.	*C. palumbus*	17–24 × 15–18	1–1.44	no	no	yes (2)	11–16 × 6–7	1.69–2.17	scattered	yes	no	Present study
E. columbarum	*C. livia*	19–21 × 17.5–20	0.92–0.95	no	no	–	–	–	yes	–	–	Nieschulz 1935
E. curvata	*Columbina talpacoti, Scardafella squammata*	17–19 × 15–17	1.1–1.3	no	no	yes (1)	11.5–13 × 5.5–6	2.1	compact	yes	no	Adriano *et al.* 2000
E. duculai	*Ducula spilorrhoa*	26–31 × 23–27	1.1	no	inconspicous	yes	14–16 × 6.5–8	–	granular	yes	no	Varghese 1980
E. gourai	*Goura victoria*	19–22 × 18–21	1.0	no	no	yes	10–13 × 4–6	–	granular	yes	no	Varghese 1980
E. choudari	*Streptopelia decaocto*	16.9–22.1 × 13–18.2	–	no	no	yes	13.6 × 7.2	–	no	yes	–	Bhatia *et al.* 1973
E. janovyi	*C. livia*	24.3 × 19.8	1.2	no	no	yes (1)	12.06 × 10.1	1.2	granular	yes	–	Bandyopadhyay *et al.* 2006
E. kapotei	*C. intermedia*	24–30 × 21.6–26.4	–	–	yes	–	–	–	scattered	yes	–	Chatterjee and Ray 1969
E. labbeana	*C. domestica, C. livia, Streptopelia orientalis mecna*	20–21 × 16–18	–	–	–	–	12.4 × 6.4	–	yes	–	–	Pinto 1928
E. livialis	*C. domestica*	19.5–23.2 × 14.3–16.5	1.35–1.49	yes	no	no	9.5–11.7 × 6.2–8.1	–	scattered	yes	no	Alyousif *et al.* 2009
E. palumbi	*Zenaida galapagoensis*	22–27 × 19–24	1.05–1.21	yes	no	no	15–17 × 8–8.5	2.12–1.76	–	yes	no	McQuistion 1991
E. sphenocercae	*Sphenocercus sphenurus*	17.5–25.0 × 12.5–15	–	no	yes	–	17.5–18.75 × 12.5–13.75	–	no	–	–	Ray 1952
E. tropicalis	*C. intermedia*	19–24 × 18–23	–	yes	–	–	10 × 6	–	yes	yes	–	Malhotra and Ray 1961
E. turturi	*Streptopelia turtur*	22.8–29.2 × 17.8–25.4	–	no	no	no	11.5–13 × 6–7.5	–	dispersed	no	–	Golemansky 1976
E. waiganiensis	*Chalocphaps indica, Otidiphaps nobilis*	22–25 × 19–23	1.08–1.2	no	yes	yes (2–4)	9–10.5 × 6–7.5	–	yes	yes	yes	Varghese 1978
E. zenaidae	*Zenaida auriculata*	22.1–26.4 × 19.2–22.1	1.2	no	no	yes (1)	12.0–14.4 × 7.2–7.7	1.8	scattered	yes	no	Adriano *et al.* 2003

Evaluation of diversity and host specificity of eimeriid coccidia can contribute not only to the field of taxonomy and phylogeny of these parasites, but can greatly improve the care in captive and semicaptive populations of endangered columbiform hosts and to help to estimate the risks associated with contact between different pigeon species. Comparing *E. columbapalumbi* with previously described eimeriid species from columbid birds, we consider it as a new species. Interestingly, in the urban habitats, *C. palumbus* and *C. livia* do not share the coccidian species, regardless frequent contacts on their foraging sites.

Aknowledgement. We thank to the anonymous referees for their comments on an earlier draft of this paper. Many thanks to Terézia Lučeničová for her help with sampling. This work was, in part, funded by IGA VFU nr. 36/2011 and by GUK nr. UK/300/2010 and nr. UK 34/2011.

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Received on 12th September, 2012; revised on 18th October, 2012; accepted on 21st October, 2012