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Source: Comparative Parasitology, 82(1):148-150.

Published By: The Helminthological Society of Washington

DOI: <http://dx.doi.org/10.1654/4693.1>

URL: <http://www.bioone.org/doi/full/10.1654/4693.1>

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Research Note

Eimeria marmosopos (Coccidia: Eimeriidae) from the Opossum *Didelphis marsupialis* L., 1758 (Didelphimorphia: Didelphidae), in Costa Rica

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ABSTRACT: Oocysts of a coccidium found in the small intestine of a road-killed opossum, *Didelphis marsupialis* (Didelphimorphia: Didelphidae), are described and identified as *Eimeria marmosopos*. Sporulated oocysts ($n = 57$) were subspherical to spherical and measured 21.9×22.1 ($20\text{--}25 \times 20\text{--}25$); oocyst wall rough and striated, yellowish and bilayered; micropyle, polar body, and oocyst residuum all absent, but some oocysts have a polar granule. Sporocysts were ovoidal, 9.8×8.7 ($8\text{--}13 \times 7\text{--}12$), with both a conspicuous Stieda body and sub-Stieda body, but para-Stieda body was absent. The sporocyst residuum was composed of 2–5 globules (1–4 wide) and several smaller ones. Sporozoites ($n = 10$) were comma-shaped, $\sim 7 \times 2.7$ and had 1 refractile body at their wider end and a centrally located nucleus. These morphological characters were compared with other *Eimeria* species found in related genera of New World marsupials; based on oocyst morphology, we identified this species as *Eimeria marmosopos* Heckscher, Wickesberg, Duszynski, and Gardner 1999. This finding constitutes both a new host genus and new geographical record for this species.

KEY WORDS: Coccidia, Eimeriidae, *Eimeria marmosopos*, Marsupialia, Didelphimorphia, Didelphidae *Didelphis marsupialis*, Atenas, Alajuela, Costa Rica, sporulated oocysts.

To our knowledge, eimerians parasitizing opossum, *Didelphis marsupialis*, have not been recorded in Costa Rica or in Central America to date. The reports of coccidia from the American opossum are rare (Carini, 1936, 1937, 1938; Joseph, 1974; Lainson and Shaw, 1989; Heckscher et al., 1999; Teixeira et al., 2007). These authors described 12 *Eimeria* and *Isospora* species. Within the family Didelphidae 7 eimerians are described from 3 genera (Table 1). Within the genus *Didelphis*, oocysts of *Eimeria didelphydis* Carini, 1938; *Eimeria gambai* Carini, 1936; *Eimeria indianensis*, Joseph, 1974; and *Eimeria auritanensis* Teixeira, Rauta, Albuquerque, and Lopes 2007 have been studied morphologically. Within members of the genus *Philander*, *Eimeria*

philanderi Lainson and Shaw, 1989, is the only known eimerian, and from members of the *Marmosops*, only *Eimeria marmosopos* Heckscher, Wickesberg, Duszynski, and Gardner 1999 is known. Members of the genera *Philander* and *Didelphis* are known to share similar environments, and *Marmosops dorothea* apparently also is present in Costa Rica (Mora, 2000). The relative paucity of published reports of coccidian parasites from *D. marsupialis*, 1 of the 63 species belonging to the family Didelphidae in Costa Rica (Gardner, 1993; Mora, 2000), is the reason of the report herein.

Feces from a road-killed opossum were examined for coccidian oocysts after suspension in a 0.85% saline solution followed by placement in 2.5% aqueous (w/v) potassium dichromate ($K_2Cr_2O_7$) solution in petri dishes at room temperature. Conventional methods for concentration, preservation, and description of oocysts were used (Bandoni and Duszynski, 1988; Duszynski and Wilber, 1997). After sporulation, the oocysts were examined with an Olympus BX41 microscope and photographed with an Olympus C-60 camera. All measurements are given in micrometers (μm), with means followed by ranges in parenthesis. Morphological features were then compared with those eimerian species previously reported from members of the genera *Didelphis*, *Philander*, and *Marmosops* (family Didelphidae; Table 1). We use the standardized abbreviations of Wilber et al. (1998): length (L) and width (W) and their ratio (L/W); micropyle (M); oocyst residuum (OR); polar granule (PG); sporocyst L and W and their L/W ratio; Stieda body (SB) sub-Stieda body (SSB), para-Stieda body (PSB); sporocyst residuum (SR); sporozoite (SZ); refractile body (RB), and nucleus (N). A 2-tailed test for the 95% confidence interval on the difference between the means was done for statistical purposes.

Fecal samples contained sufficient numbers of sporulated oocysts to allow morphological characterization.

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Table 1. Comparison of morphologic characteristics of *Eimeria* species infecting hosts of the genera *Didelphis*, *Marmosops*, and *Philander* (family Didelphidae).

<i>Eimeria</i> sp.	Hosts	Oocyst and sporocyst features*						
		Mean L × W (μ)	OR	PG	Mean L × W (μ)	SB	SSB	SR
<i>E. philanderi</i>	<i>P. opossum</i>	23.5 × 22.4	–	+	11.4 × 8.1	+	–	+
<i>E. auritanensis</i>	<i>D. aurita</i>	31.6 × 29.6	–	+	13.2 × 10.4	+	–	+
<i>E. indianensis</i>	<i>D. virginiana</i>	17.6 × 16.4	–	+	9.1 × 6.2	+	–	+
<i>E. didelphydis</i>	<i>D. aurita</i>	16.0 × 16.0	+	–	10.0 × 6.0	+	–	+
<i>E. gambai</i>	<i>D. aurita</i>	26.5 × 24.8	–	+	12.5 × 10.0	+	–	–
<i>E. marmosopos</i>	<i>M. dorothea</i>	22.2 × 19.9	–	+	11.1 × 6.8	+	+	+
<i>E. marmosopos</i>	<i>D. marsupialis</i>	21.9 × 22.1	–	+	9.8 × 8.7	+	+	+

*L, length; W, width; OR, oocyst residuum; PG, polar granule; SB, Stieda body; SSB, sub-Stieda body; SR, sporocyst residuum.

Eimeria marmosopos (Figs. 1, 2)

Type host: *Marmosops dorothea* Thomas, 1911, mouse opossum.

Type locality: SOUTH AMERICA: Bolivia, Santa Cruz.

Other hosts: *Didelphis marsupialis* Linnaeus, 1758, opossum.

Other locality: CENTRAL AMERICA: Costa Rica, Alajuela, Atenas, 9°58'51"N; 84°24'23"E; elevation 550 m, average temperature 21°C, relative humidity 82%, rainfall 1,500–2,500 mm/yr.

Geographic distribution: South America: Bolivia; Central America: Costa Rica.

Description of sporulated oocyst: Oocyst shape: spherical or subspherical; number of walls: 2; outer, ~1 thick, yellowish, rough and striated; inner is beige with a dotted appearance in optical cross section; L × W ($n = 57$): 21.9 × 22.1 (20.0–25.0 × 20.0–25.0); L/W: 1; M, OR: both absent; PG: slightly elongated, ~3 × 2.

Description of sporocyst and sporozoites: Sporocyst shape: elongate–ovoidal; L × W ($n = 79$): 9.8 × 8.7 (8.0–13.0 × 7.0–12.0); L/W: 1.2; SB: present (2 × 1.5) as a knob-like extension of the sporocyst wall; SSB: present, L × W about the same width as SB; PSB: absent; SR present; SR characteristics: 2–5 round globules (~1.5–4 wide) and several smaller ones; SZ: elongated, smooth or finely granular; L × W ($n = 10$) 7 × 2.7.

Sporulation: Exogenous, 6–7 days at 21 ± 3°C.

Prepatent period: Unknown.

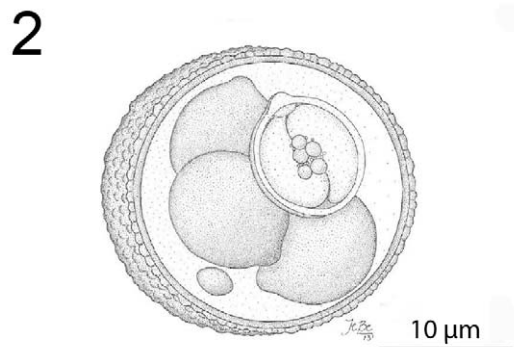
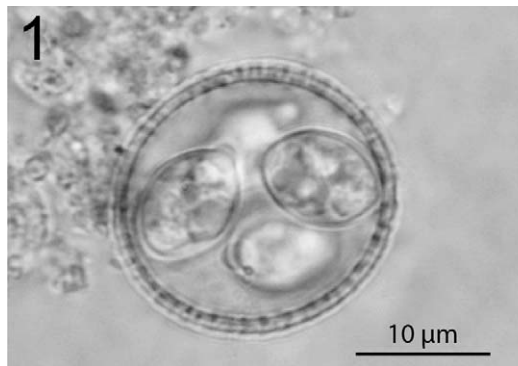
Site of infection: Unknown

Endogenous stages: Unknown.

Cross-transmission: None to date.

Pathology: Unknown.

Material deposited: Photosyntypes of sporulated oocysts, IB-1-D-1,2 are in the Department of Parasitology Research, Universidad de Ciencias Médicas, San José Costa Rica, Central America. Host skin and skeleton in the Museo Nacional (MNCR-432), San José Costa Rica.



Figures 1, 2. Sporulated oocyst of *Eimeria marmosopos* from *Didelphis marsupialis* from Costa Rica. **1.** Photomicrograph. **2.** Line drawing from the feces of *D. marsupialis*.

Remarks: We compared all known *Eimeria* species from 3 genera of marsupials that have overlapping ranges in Costa Rica, including *Didelphis*, *Marmosops*, and *Philander* (Table 1). Our conclusion is that the mensural and qualitative characters found for the species reported here correspond with those already described for *E. marmosops* (Heckscher et al., 1999). Comparative statistical analysis of our measurements to those of *E. marmosops* showed that there are not significant differences ($P = 0.0734$) between them.

Heckscher et al. (1999) reported on how little we know about *Eimeria* species in various genera and species of the family Didelphidae, and little has changed since then. There are 4 eimerians known from *D. marsupialis*, but none in *D. marsupialis* throughout Central and South America from Mexico to Brazil, Bolivia, and Peru according to Gardner (1993) and Mora (2000). We believe that *E. marmosops*, previously described and reported only in *M. dorothea* from Bolivia, to be the coccidium that we found infecting *D. marsupialis* in Costa Rica. The fact that little is known about what coccidians are found in the marsupials of the Americas, not to mention their relationships with their natural host species, led Heckscher et al. (1999) to conclude that it is unclear whether *Eimeria* species from Bolivian marsupials were either generalists or specialists. One eimerian Heckscher et al. (loc. cit.) studied, *Eimeria cochabambensis*, was found in hosts from 3 genera (*Monodelphis*, *Thylamys*, and *Marmosops*); they argued that the structural and mensural differences of oocysts from the 3 were not enough to distinguish each as a separate species, leading them to call all of them *E. cochabambensis* until molecular and cross-transmission studies could be used to determine definitively whether their oocysts represented 1 or more species from the different host genera. Thus, we will consider them the same species until molecular or cross-transmission or both studies can confirm or refute our decision.

This report adds one more species to the coccidia already known from Costa Rica: *Eimeria sigmodontis*, *Eimeria tuskegensis*, *Eimeria roperi*, and *Eimeria webbiae* from *Sigmodon hispidus* (Castro et al., 1998; Rodríguez et al., 1999), as well as *Eimeria melanomytis* and *Eimeria rebambensis* from *Melanomys caliginosus* (Chinchilla et al., 2013) and represents another contribution to the knowledge of parasites infecting the diverse assemblage of animals from Costa Rica. Significantly, this report also represents a new geographic record for *E. marmosops* and adds a new host genus for this species.

This work was partially supported by the Universidad de Ciencias Médicas (UCIMED), Ministerio de Ciencia y Tecnología (MICIT), and Consejo Nacional de Ciencia y Tecnología (CONICIT). We thank Juan Carlos Vanegas for statistical comparative analysis.

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