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A Redescription of *Eimeria macyi* (Apicomplexa: Eimeriidae) from the Eastern Pipistrelle, *Pipistrellus subflavus* (Mammalia: Chiroptera), from Arkansas

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In the class Mammalia, the bats (order Chiroptera) are second only to rodents (order Rodentia) in the number of recognized taxa: 920 vs. 2,016 species (Feldhamer et al., 1999). Unlike rodents, however, which have been reported to harbor more than 400 eimerian parasites (Scott and Duszynski, 1997), only about 30 species of bat eimerians have been described (Duszynski, 2001), and few have been reported since their original descriptions. It has been speculated that this low diversity of coccidia in bats was due to the lack of surveying bats for parasites (Ubelaker et al., 1977); however, even with increased interest in the coccidian parasites of bats over the last two decades, most bat species still remain to be examined (Duszynski, 2001 for summary). Except for the report by Yang-Xian and Fu-Qiang (1983) who noted a prevalence of 70% for a Chinese bat (*Myotis ricketti*), overall prevalence of *Eimeria* spp. in 86 species of chiropterans of the world was reported by Duszynski (2001) to be quite low (number infected/number examined, 234/2114 = 11%). When compared to similar surveys on large sample sizes of rodents by Stout and Duszynski (1983), who reported a prevalence of 29%, prevalence of infection in bats ranges from less than 1% to about 10% on average (Marinkelle, 1968; Scott and Duszynski, 1997; Duszynski, 2001). With this dichotomy in mind, there is obviously a need to further investigate the ecology of coccidia of bats.

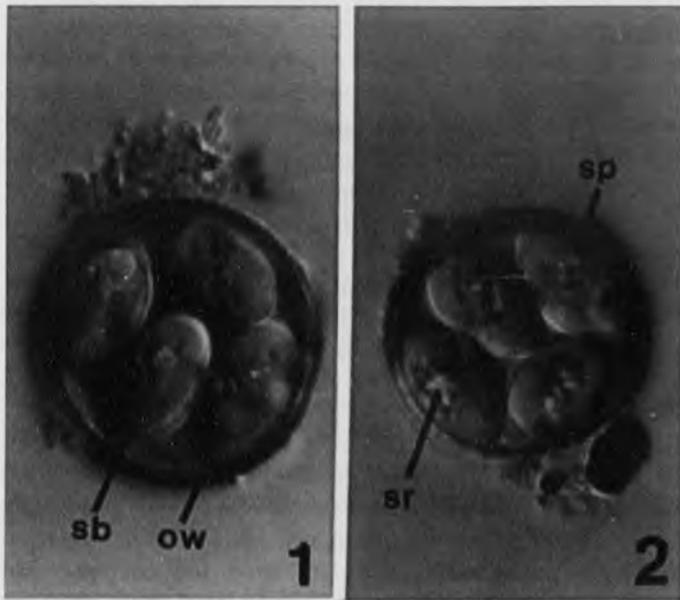
Wheat (1975) provided a description of *Eimeria macyi* from 2 of 3 eastern pipistrelles (*Pipistrellus subflavus*) from Clarke County, Alabama; sporulation of oocysts took place within one week at 23°C. A line drawing of the parasite was included in the description, but no photomicrographs were published. Herein, we provide, the first photomicrographs of *E. macyi* and document additional information on the species, including the second report of the parasite since its original description >25 years ago.

Five adult eastern pipistrelles were collected by hand from Twin Mines, Polk County, Arkansas (34° 27' 35" N, 94° 11' 41" W) on 1 September 2000. They were returned to the laboratory, overdosed with an intraperitoneal

injection of sodium pentobarbital (Nembutal®), and intestinal contents and feces were placed in vials containing 2.5% aqueous (w/v) potassium dichromate solution (K₂Cr₂O₇). Samples were screened for coccidia and positive samples containing unsporulated oocysts were allowed to sporulate exogenously at room temperature (ca. 23°C) for one week in Petri dishes containing a thin layer of K₂Cr₂O₇. Fully sporulated oocysts were concentrated by flotation in modified Sheather's sugar solution (specific gravity = 1.30) or examined as wet mounts and photographed with Nomarski interference-contrast (DIC) optics. Measurements were made on 20 parasites using a calibrated ocular micrometer and are reported in micrometers (µm) with the mean length and width followed by the ranges in parentheses. Oocysts were 60 days old when measured and photographed. Photosyntypes (see Bandoni and Duszynski, 1988) of sporulated oocysts have been deposited in the Harold W. Manter Laboratory of Parasitology, University of Nebraska, Lincoln as HWML 16566.

Two of five (20%) individuals of *P. subflavus* (Arkansas State University Museum of Zoology, ASUMZ 26060-26061) were passing an eimerian that closely matched Wheat's (1975) description of *E. macyi* (Figs. 1-2). Subspherical oocysts measured 22.2 x 20.5 (19.2-24.8 x 18.4-24.0), with a rough-pitted bilayered oocyst wall ca. 1.6 thick (outer wall 1.0, inner wall 0.6), and a shape index of 1.1 (1.0-1.2). A micropyle and oocyst residuum are absent, but polar granules (mostly two to several fragments) are present. The sporocysts are ovoid, 12.4 x 8.3 (11.2-13.8 x 7.2-9.6), with a shape index of 1.5 (1.3-1.7). Stieda and substieda bodies and clusters of 100 or more sporocyst residua are present. The sporozoites are elongate and reflex within the sporocyst, 16.4 x 3.4 *in situ*, and contain both anterior and posterior refractile bodies.

Our isolate of *E. macyi* possessed oocyst and sporocyst (mean) measurements that were slightly larger than those provided by Wheat (1975). Oocysts of Wheat's original isolate measured 19.0 x 17.6 (16-21 x 15-19), and sporocysts



Figs.1-2. Oocysts of *Eimeria macyi* from *Pipistrellus subflavus* in Arkansas. x 1,800. Abbreviations: bilayered oocyst wall (ow); sporocyst (sp), Stieda body (sb); sporocyst residuum (sr).

measured 11 x 7 (10-12 x 6-8). Sporozoites were not measured by Wheat (1975). The differences between the isolates may be the result of several factors: (1) patent period sampling times which have been documented to affect mean measurement results (Duszynski, 1971), (2) calibration of the microscopes, and/or (3) wet mount measurements vs. Wheat's (1975) measurements on oocysts and sporocysts in concentrated sucrose solution. However, other morphological comparisons (both quantitative and qualitative) between the two isolates were identical, and there is little doubt that our isolate represents *E. macyi*.

There appears to be 9 species of *Eimeria* from North American bats (Table 1), all in hosts from the family Vespertilionidae. With the exception of *E. macyi* reported from *P. subflavus* in Alabama (Wheat, 1975) and now Arkansas (present study, new geographic record), *E. jacksonensis* from the evening bat (*Nycticeius humeralis*) in South Carolina (Duszynski et al., 1999), and *E. californicensis* from the California myotis (*Myotis californicus*) in California (Duszynski et al., 1999), the majority of eimerians have been reported from bats collected in New Mexico. This reflects the fact that the principal investigator of these hosts (Duszynski) resides in New Mexico.

In conclusion, of the 16 species of bats found in Arkansas (Sealander and Heidt, 1990), only *P. subflavus* is known to have been surveyed for coccidia. We plan to survey additional species of Arkansas bats for coccidians and determine whether they share the low prevalence of

Eimeria spp. observed in other chiropterans.

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Chris T. McAllister, Steve J. Upton, Stanley E. Trauth, and David W. Allard

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Table 1. Summary of the valid and named *Eimeria* species from North American bats.*

Bat species	Locality	<i>Eimeria</i> spp.	Reference(s)
<i>Antrozous pallidus</i>	NM	<i>antrozoi</i>	Scott and Duszynski, 1997; Duszynski et al., 1988, 1999
<i>Myotis californicus</i>	CA, NM	<i>californicensis</i> , <i>humboldtensis</i>	Duszynski et al, 1999
<i>Myotis ciliolabrum</i>	NM	<i>pilarensis</i> , <i>rioarribaensis</i>	Scott and Duszynski, 1997 Duszynski et al., 1999
<i>Myotis evotis</i>	NM	<i>evoti</i>	Scott and Duszynski, 1997; Duszynski et al., 1999
<i>Myotis lucifugus</i>	NM	<i>catronensis</i>	Scott and Duszynski, 1997; Duszynski et al., 1999
<i>Myotis yumanensis</i>	NM	<i>catronensis</i> , <i>pilarensis</i>	Scott and Duszynski, 1997 Duszynski et al., 1999
<i>Nycticeius humeralis</i>	SC	<i>jacksonensis</i>	Duszynski et al., 1999
<i>Pipistrellus subflavus</i>	AL, AR	<i>macyi</i>	Wheat, 1975; present study

*At least seven North American bat taxa from California and New Mexico have been reported to be infected with unsporulated or a few partially sporulated oocysts of 12 *Eimeria* spp. (see Scott and Duszynski, 1997; Duszynski et al., 1988, 1999; Duszynski, 2001). These have not been included in our table and await further study.