Second Report of *Isospora boulengeri* from Satanic Leaf-Tailed Geckos, *Uroplatus phantasticus* (Sauria: Gekkonidae), with a New Host Record for *Choleoeimeria* (Apicomplexa: Eimeriidae) and a Summary of the Choleoeimerians from the Gekkonidae

Chris T. McAllister*
Division of Natural Sciences, Northeast Texas Community College, Mt. Pleasant, TX 75455

John A. Hnida
Department of Microbiology and Immunology, Midwestern University, Glendale, AZ 85308

Henry W. Robison
602 Big Creek Drive, Sherwood, AR 72120

**Abstract:** Five adult captive specimens of satanic leaf-tailed geckos, *Uroplatus phantasticus*, housed at the Dallas Zoo, Dallas County, Texas, were examined for coccidian parasites. One was found to harbor *Isospora boulengeri* in its feces while another was infected with an unknown species of *Choleoeimeria*. Spheroidal to subspheroidal oocysts of *I. boulengeri* averaged (L × W) 16.9 × 16.1 μm; one (typically) or two polar granule(s) were present but an oocyst residuum and micropyle were absent. Ovoidal sporocysts of *I. boulengeri* averaged 9.6 × 6.9 μm and possessed a sporocyst residuum and Stieda and sub-Stieda bodies. Cylindroidal to elongate oocysts of a *Choleoeimeria* sp. averaged 28.0 × 14.8 μm. Here, we provide the second report of *I. boulengeri* from *U. phantasticus* as well as the first report of a *Choleoeimeria* sp. from this host. In addition, we provide a summation of the choleoeimerians from the family Gekkonidae.

**Introduction**

Geckos are excellent hosts of coccidian parasites (El-Toukhy et al. 2013; McAllister et al. 2016, 2020) and the satanic leaf-tailed gecko, *Uroplatus phantasticus* Boulenger is no exception. McAllister et al. (2016) described *Isospora boulengeri* and *Eimeria schneideri* from *U. phantasticus* originally collected in Madagascar and housed at the Dallas Zoo, Dallas County, Texas. Here, we report *I. boulengeri* for the second time from *U. phantasticus* housed at the Dallas Zoo as well as documenting, for the first time, a *Choleoeimeria* from this host. We also provide a summary of the choleoeimerians from geckos of the world.

**Methods**

Between July 2018 and June 2019, feces from five adult *U. phantasticus* housed at the Dallas Zoo were collected and placed in individual vials containing 2.5% (w/v) aqueous potassium
dichromate ($K_2Cr_2O_7$). They were not shipped to the senior author until July 2023 for initial coccidial examination. Those samples found positive were sent to JAH for further examination via flotation in a 15-ml conical centrifuge tube (with centrifugation) containing Sheather’s sugar solution (Ricca Chemical Company, Arlington, Texas; specific gravity: 1.25) using an Olympus BX43 light microscope (Olympus Corporation, Center Valley, Pennsylvania). All morphological measurements are reported in micrometers (µm) with the means followed by the ranges in parentheses. Oocysts were ~1,825 days old once they were deposited, measured, and photographed using Nomarski interference-contrast optics at ×1,000 magnification. Oocyst and sporocyst descriptions follow the standard guidelines of Wilber et al. (1998) including oocyst length (L) and width (W), their ranges and ratios (L/W), micropyle (M), oocyst residuum (OR), polar granule(s) (PG), sporocyst length (L) and width (W), their ranges and ratio (L/W), sporocyst (SP), Stieda body (SB), sub-Stieda body (SSB), para-Stieda body (PSB), sporocyst residuum (SR), sporozoites (SZ) anterior (ARB) and posterior (PRB) refractile bodies, and nucleus (N).

A photovoucher of a *U. phantasticus* was accessioned into the Eastern Oklahoma State Collection, Idabel, Oklahoma. Photovouchers of sporulated oocysts of the coccidians were accessioned into the Harold W. Manter Laboratory of Parasitology (HWML), Lincoln, Nebraska.

## Results and Discussion

Two coccidians were recovered from the fecal samples and identified as: *Isospora boulengeri* and *Choleoeimeria* sp. Data are provided on each in an annotated format below.

**Isospora boulengeri** McAllister, Seville, and Hartdegen, 2016

(Figs. 1–3)

*Description of sporulated oocyst:* Oocyst shape (n = 15): spheroidal to subspherical; bilayered wall, ~1.2 (1.0–1.5) tan outer layer smooth to lightly pitted, ~/2/3 total thickness; darker inner layer. L × W (n = 15): 16.9 × 16.1 (15–20 × 14–19); L/W ratio: 1.1 (1.0–1.1); M and OR absent; 1 (typically) or 2 PG(s) present.

*Description of sporocyst and sporozoites:* Sporocyst shape (n = 15): ovoidal; L × W (n = 15): 9.6 × 6.9 (9–11 × 6–8); L/W ratio: 1.4 (1.3–1.7); knob-like SB and rounded SSB present, PSB: absent; SR: present; SR characteristics: compact rounded or irregular mass of various-sized granules. Sporozoite (not measured) shape: sausage-shaped, small subspherical ARB, large subspherical PRB, N posterior to midpoint.

### Taxonomic Summary

**Host:** Satanic leaf-tailed gecko, *Uroplatus phantasticus* (Boulenger, 1888); photovoucher host deposited in the EOSC collection.

**Geographic distribution:** USA: Texas, Dallas, Dallas Zoo Herpetarium (32°44’26.28”N, -96°49’00.12”W).

**Type host and locality:** *U. phantasticus*, Madagascar (exact locale unknown) (McAllister et al. 2016).

**Other localities:** Dallas Zoo (McAllister et al. 2016).

**Prevalence:** 1/5 (20%).

**Sporulation:** Oocysts were completely sporulated when samples were received in July 2023.

**Site of infection:** Unknown; oocysts passed in feces.

**Materials deposited:** Photovoucher of sporulated oocysts are deposited as HWML 217049.

### Remarks

All morphological and mensural characteristics of the present oocysts and sporocysts were quite similar to those from *I. boulengeri* previously reported for *U. phantasticus* (McAllister et al. 2016).
is the second report of *I. boulengeri* from *U. phantasticus* since the original report more than seven years ago.

**Choleoeimeria sp.**
(Fig. 4)

**Taxonomic Summary**

*Host*: Satanic leaf-tailed gecko, *Uroplatus phantasticus* (Boulenger, 1888); photovoucher host deposited in the EOSC collection.

*Description of sporulated oocyst, sporocysts and sporozoites*: Regrettably, all cylindroidal oocysts possessed collapsed sporocysts likely due to aging (~5 yr); five oocysts measured (L × W) 28.0 × 14.8 (27–29 × 14–15), with a L/W ratio of 1.9.

*Geographic distribution*: USA: Texas, Dallas, Dallas Zoo Herpetarium (32°44’26.28”N, -96°49’00.12”W).

*Prevalence*: 1/5 (20%).

*Site of infection*: Unknown; oocysts passed in feces. However, choleoeimerians develop in the gallbladder and biliary epithelium.

*Materials deposited*: Photovoucher of sporulated oocysts are deposited as HWML 217050.

**Remarks**

There are 17 choleoeimerians (Table 1) that have been previously reported from the gallbladder of gekkonid lizards of the world. Of these, only two taxa possess oocysts that are (1) similar in size, (2) elongate-ellipsoidal or cylindroidal in shape, and (3) with L/W ratios...
similar to this unidentified taxon. They include: *Hemidactylus frenatus* Duméril and Bibron from Taiwan, an unnamed choleoeimerian from *Hemidactylus* (Yamamoto 1933) and *Choleoeimeria scabrum*

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**Table 1. Comparison of the sporulated oocysts of elongate-ellipsoidal/cylindroidal *Choleoeimeria* (syn. *Eimeria*) spp. from the gallbladder of gekkonids.**

<table>
<thead>
<tr>
<th>Choleoeimeria spp.</th>
<th>Type host or host and type locality or locality</th>
<th>Oocyst shape, size*†</th>
<th>Sporocyst shape, size, features*†</th>
<th>References</th>
</tr>
</thead>
</table>
| *Choleoeimeria* sp. | *Uroplatus phantasticus*  
Dallas Zoo, USA | Cylindroidal  
28.0 × 14.8; L/W 1.9  
27–29 × 14–15 | Unknown‡ | This study |
| *Choleoeimeria* sp. (III) | *Hemidactylus frenatus*  
Taiwan | Elongate-ellipsoidal  
26.0–27.6 × 14.4–15.6; L/W 1.8  
Not given | Not given | Yamamoto (1933) |
| C. banopusi | *Banopus tuberculatus*  
Saudi Arabia | Ellipsoidal  
31.0 × 21.0; L/W 1.5  
30–33 × 20–22  
PG: – | Ellipsoidal  
12.0 × 7.0; L/W 1.4  
11–13 × 6–8  
SR: + | Al-Quraishy et al. (2013) |
| C. delalandii | *Tarentola delalandii*  
Canary Islands | Cylindroidal  
45.1 × 21.7; L/W 2.1  
42–48 × 20–26  
PG: – | Subspheroidal-ovoidal  
13.8 × 10.3; L/W 1.3  
12–15 × 10–11  
SR: + | Matushka and Bannert (1986) |
| C. dusznzskii | *Stenodactylus doriae*  
Saudi Arabia | Ellipsoidal  
24.0 × 17.0; L/W 1.4  
23–25 × 16–18  
PG: – | Ellipsoidal  
9.0 × 5.0; L/W 1.7  
8–10 × 4–6  
SR: + | Abdel-Baki (2014) |
| C. flaviviridis | *Hemidactylus flaviviridis*  
India | Ellipsoidal  
25–34 × 11–14; L/W 2.4  
Not given  
PG: – | Ovoidal  
8.0–6.0; L/W 1.3  
Not given  
SR: + | Setna and Bana (1935) |
| C. gehyrae n. comb. | *Gehyra variegata*  
Australia | Elongate-ellipsoidal  
32.8 × 20.5; L/W 1.6  
30–35 × 20–22  
PG: – | Elongate-ellipsoidal  
13.6 × 7.7; L/W 1.8  
13–14 × 7–8  
SR: + | Cannon (1967) |
| C. hailensis n. comb. | *Ptyodactylus hasselquistii*  
Saudi Arabia | Cylindroidal  
36.7 × 17.2; L/W 2.1  
36–38 × 16–20  
PG: + | Subspheroidal to ovoidal  
10.1 × 8.1; L/W 1.2  
8–12 × 8–9  
SR: + | Abdel-Aziz (2001) |
| C. heteronotis | *Heteronotia binoei*  
Australia | Oblong  
32.8 × 16.9; L/W 1.9  
33–34 × 16–18  
PG: – | Ellipsoidal  
9.9 × 7.6; L/W 1.3  
8–10 × 6–8  
SR: + | Paperna (2007) |
| C. japonicus n. comb. | *Gekko japonicus*  
Japan | Cylindroidal  
31.0 × 15.0; L/W 2.1  
28–35 × 14–19  
PG: – | Ellipsoidal  
12.0 × 7.0; L/W 1.8  
11–14 × 7–10  
SR: + | Bovee (1971) |
| C. koidzumii n. comb. | *G. japonicus*  
Japan | Elongate-ellipsoidal  
30.0 × 14.0; L/W 2.1  
Not given  
PG: – | Ovoidal  
13.0 × 9.0; L/W 1.4  
Not given  
SR: + | Matubayasi (1941) |
| C. pachydauctyi | *Pachydactylus capensis*  
South Africa | Cylindroidal  
28.3 × 13.9; L/W 2.1  
25–31 × 11–17  
PG: – | Ellipsoidal  
11.4 × 6.9; L/W 1.7  
10–13 × 6.5–7.2  
Abdel-Haleem, 2015 from rough-tailed geckos, *Cyrtopodion scabrum* (Heyden) from Egypt. Unfortunately, the only information reported on Yamamoto’s (1933) sample was some measurements on oocysts; no other morphological data is available. Comparison of our oocysts to *C. scabrum* is similar in size and shape but Abdel-Haleem (2015) did not report a polar granule for *C. scabrum*. Unfortunately, without fresh samples containing viable oocysts and sporocysts, it is impossible to distinguish our form and provide a complete description.

Paperna and Landsberg (1989) erected the genus *Choleoeimeria* to accommodate eimeriid-like coccidians infecting the lumen of the gallbladder and biliary epithelium of reptiles and their view has been supported (Megía-Palma et al. 2015; and others). This genus is further characterized by elongate-ellipsoidal oocysts that usually have an L/W ratio $\geq 1.4$ and sporocysts without a SB/SSB complex, but with two plates with meridional sutures in their walls (Kruth et al. 2020). Therefore, as our oocysts conform to this description, we document the first report of a *Choleoeimeria* sp. from *U. phantasticus*.
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References


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