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A NEW CARYOSPORAN AND EIMERIAN (APICOMPLEXA: EIMERIIDAE) FROM GREEN ANOLES, *ANOLIS CAROLINENSIS* (SAURIA: DACTYLOIDAE), FROM ARKANSAS AND LOUISIANA, WITH A SUMMARY OF THE COCCIDIA OF DACTYLOIDAE

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Abstract

Between April 2012 and September 2013, feces from 18 green anoles, *Anolis carolinensis* from Arkansas ($n = 14$), Louisiana ($n = 1$), and Oklahoma ($n = 3$) were examined for coccidia. Two species of coccidians were found, including a new caryosporan and a new eimerian. Oocysts of *Caryospora natchitochesensis* n. sp. from a single *A. carolinensis* from Louisiana were subspheroidal to ovoidal with a smooth, yellow to brown pigmented, bi-layered wall of equal thickness ($\sim 0.3\text{--}0.7$) and measured ($L \times W$) $13.1 \times 12.3 \mu\text{m}$, with a length/width (L/W) ratio of 1.1. A micropyle and oocyst residuum were absent but a polar granule was present. Sporocysts were ovoidal and measured $10.1 \times 7.4 \mu\text{m}$, L/W was 1.4. A Stieda body ($\sim 1.0 \mu\text{m}$) was present, but substieda and parastieda bodies were absent. The sporocyst residuum was composed of dispersed granules or globules among sporozoites. Oocysts of *Eimeria robisoni* n. sp. from 1 of 12 (8%) green anoles from Arkansas were ellipsoidal with a smooth, uni-layered wall ($\sim 0.4\text{--}0.5$) and measured ($L \times W$) $14.5 \times 10.5 \mu\text{m}$, with L/W ratio of 1.4. A micropyle and oocyst residuum were absent, but 1–4 (usually 2) polar granules were present. Sporocysts were subspheroidal to ovoidal and measured $5.8 \times 4.9 \mu\text{m}$, L/W was 1.2. Stieda, substieda and parastieda bodies were absent. The sporocyst residuum was composed of dispersed granules between sporozoites. None of the anoles from Oklahoma were found to be passing oocysts. This is the second time an eimerian and a caryosporan have been reported from green anoles. A summary of the coccidians of lizards of the family Dactyloidae is provided, with special emphasis on the *Anolis* of the United States.

The green anole, *Anolis carolinensis* (Voigt), the sole member of the genus native to the continental United States, is a small brownish to green lizard that ranges from southern New Jersey south to the Florida Keys, and westward to eastern Kansas and westcentral Texas; isolated geographic distribution records are from central Illinois, northeastern Missouri, and Coahuila, Mexico (Conant and Collins, 1998). *Anolis carolinensis* occurs in counties northward up to the Arkansas River Valley in Arkansas (Trauth et al., 2004; McAllister et al., 2009), statewide in Louisiana (Conant and Collins, 1998), and in the southeastern corner of Oklahoma (Sievert and Sievert, 2011). This arboreal anole is commonly seen on fences,

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old buildings, on vines and shrubs, or climbing up in trees where it feeds on insects, spiders, and a variety of other invertebrates (Conant and Collins 1998; Trauth et al., 2004). Two coccidians have been previously reported from *A. carolinensis*. Upton et al. (1984) provided a description of a caryosporan from *A. carolinensis* housed in Georgia but originating from a supply house in Louisiana, and Daszak and Ball (1991) described an eimerian from Florida specimens. McAllister et al. (1994) reported *Caryospora ernsti* from 2 *A. carolinensis* from Louisiana but did not find any of 4 other lizards (from Arkansas) passing oocysts. Therefore, nothing, to our knowledge, has been published on coccidia of *A. carolinensis* from Arkansas. Here, we describe a new species of *Caryospora* and *Eimeria* from green anoles from Louisiana and Arkansas, respectively.

MATERIALS AND METHODS

Between April 2012 and September 2013, 18 juvenile and adult *A. carolinensis* (mean $\pm$ 1 SD snout–vent length [SVL] = 40.3 ± 7.7 , range 37–68 mm) were collected by hand from Garland ($n = 2$), Ouachita ($n = 1$) and Union ($n = 11$) counties, Arkansas; Natchitoches ($n = 1$) Parish, Louisiana; and Atoka ($n = 1$) and McCurtain ($n = 2$) counties, Oklahoma. Anoles were placed in individual bags on ice and returned to the laboratory within 48 hr for necropsy. They were overdosed with an injection of concentrated Chloretone (chlorobutanol) solution and fresh fecal samples were collected from the rectum of each individual for examination of coccidia. Feces were placed in individual vials containing 2.5% (w/v) aqueous potassium dichromate ($K_2Cr_2O_7$) and screened for coccidia by light microscopy after flotation in Sheather's sugar solution (specific gravity = 1.30). Positive samples containing both unsporulated and partially sporulated oocysts and were placed in Petri dishes containing 2.5 % $K_2Cr_2O_7$ and allowed to complete sporulation for 5 days at room temperature ($\sim 23^\circ C$). Samples were again examined after flotation and measurements were taken on 22 oocysts (*Caryospora*) and 11 oocysts (*Eimeria*) using a calibrated ocular micrometer or Olympus® cellSens 1.7 digital imaging software and reported in micrometers (μm) with means followed by the ranges in parentheses; photographs were taken using Nomarski interference-contrast optics. Oocysts were ~ 430 days old (*Caryospora*) and ~ 575 days old (*Eimeria*) when measured and photographed. Descriptions of oocysts and sporocysts follow guidelines of Wilber et al. (1998) as follows: oocyst length (L) and width (W), their ranges and ratios (L/W), micropyle (M), oocyst residuum (OR), polar granules (PG), sporocyst length (L) and width (W), their ranges and ratio (L/W), sporocysts (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). Photosyntypes of sporulated oocysts were accessioned into the United States National Parasite Collection (USNPC), Beltsville, Maryland. Host voucher specimens were deposited in the Arkansas State University Herpetological Collection (ASUMZ), State University, Arkansas, U.S.A. Scientific names of reptiles follow the Reptile Database (Uetz, 2012).

Two of 18 (11%) *A. carolinensis* were found to be passing oocysts of a new caryosporan and eimerian, the descriptions of which follows:

DESCRIPTION

Caryospora natchitochesensis n. sp. (Figs. 1–2, 5)

Description of sporulated oocyst—Oocyst shape: sub-spheroidal to ovoidal; smooth, yellow-brown pigmented, bi-layered wall of equal thickness (~0.3–0.7); $L \times W$: 13.1×12.3 ($11\text{--}15 \times 10\text{--}14$), L/W : 1.1 (1.0–1.2); M, OR absent, 1 PG present. Distinctive feature of oocyst: colored, bi-layered wall of equal thickness.

Description of sporocyst and sporozoites—SP shape: ovoidal, with a smooth single-layered wall; $L \times W$: 10.1×7.4 ($7\text{--}13 \times 6\text{--}10$), L/W 1.4 (1.1–1.5); SB present, SSB, PSB: absent; SR: present as dispersed granules or globules among sporozoites. SZ: sausage-shaped, with spheroidal-ovoidal PRB and spheroidal ARB; single N slightly posterior to midpoint of body. Distinctive feature of sporocysts and sporozoites: absence of SSB.

Taxonomic summary

Type host—Green anole, *Anolis carolinensis* Voigt, 1832 (Sauria: Dactyloidae), adult male, 68 mm SVL. Collected 15 September 2012. Symbiotype host ASUMZ 32453.

Type specimens—Photosyntype deposited as USNPC 107677.

Type locality—8.5 km SE of Natchitoches, Natchitoches Parish, Louisiana ($31^{\circ}41'48.4''N$, $93^{\circ}03'10.8''W$).

Prevalence—One of 18 (6%) overall; 1/1 (100%) Natchitoches Parish, Louisiana.

Sporulation—Endogenous. Oocysts were passed partially or fully sporulated.

Prepatent and patent periods—Unknown.

Site of infection—Unknown, oocysts recovered from feces.

Endogenous stages—Unknown.

Cross-transmission—None to date.

Etymology—The specific epithet is derived from Natchitoches Parish, Louisiana, from which the type-host was collected. Natchitoches Parish was created by the act of April 10, 1805, that divided the Territory of Orleans into 12 parishes.

Remarks

Caryospora natchitochesensis is most similar in size to *Caryospora ernsti* Upton, Current, and Barnard, 1984 described from green anoles housed at the Atlanta Zoo, Georgia, but originated from a supply house in La Place, St. John the Baptist Parish, Louisiana (Upton et al., 1984). However, *C. natchitochesensis* differs as follows: (1) oocysts are subspherical to ovoidal and possess a bi-layered wall that contains yellowish to dark brown pigments while those of *C. ernsti* are spheroidal and have a uni-layered, colorless wall, and (2) the new

species does not have SP with a SSB that *C. ernsti* clearly possesses. These distinct differences in oocysts and SP are enough evidence that the 2 species are different. We are not aware of any additional caryosporans described from anoles to date.

***Eimeria robisoni* n. sp. (Figs. 3–4, 6)**

Description of sporulated oocyst—Oocyst shape: ellipsoidal; smooth, uni-layered wall (~0.4–0.5); $L \times W$: 14.5×10.5 ($13\text{--}16 \times 10\text{--}11$), L/W : 1.4 (1.2–1.5); M, OR absent, 1–4 (usually 2) PG present. Distinctive feature of oocyst: small size and presence of up to 4 polar granules.

Description of sporocyst and sporozoites—SP shape: subspheroidal to ovoidal, with a smooth single-layered wall without valve sutures; $L \times W$: 5.8×4.9 ($5\text{--}6 \times 4\text{--}6$), L/W 1.2 (1.0–1.3); SB, SSB, PSB: absent; SR: present as dispersed granules among sporozoites. SZ: (not measured), elongate, with ellipsoidal PRB and spherical ARB; single N slightly posterior to midpoint of body. Distinctive feature of sporocysts and sporozoites: absence of valve sutures.

Taxonomic summary

Type host—Green anole, *Anolis carolinensis* Voigt, 1832 (Sauria: Dactyloidae), adult male, 59 mm SVL. Collected 25 April 2012. Symbiotype host ASUMZ 32812.

Type specimens—Photosyntype deposited as USNPC 107678.

Type locality—0.4 km S Junction US 63 and Grady Bell Road, 8 km E El Dorado, Arkansas ($33^{\circ}12'48.7''N$, $92^{\circ}35'9.5''W$).

Prevalence—One of 18 (6%) overall; 1/11 (9%) Union County, Arkansas.

Sporulation—Endogenous. Oocysts were passed partially or fully sporulated.

Prepatent and patent periods—Unknown.

Site of infection—Unknown, oocysts recovered from feces.

Endogenous stages—Unknown.

Cross-transmission—None to date.

Etymology—The specific epithet is named in honor of Dr. Henry W. Robison, Emeritus Distinguished Professor of Biology, Southern Arkansas University, Magnolia, Arkansas, in recognition of his many contributions to the natural history of Arkansas.

Remarks

When compared to the only eimerian previously reported from *A. carolinensis*, *Eimeria anolidis* Daszak and Ball, 1991, from lizards collected in Florida, oocysts of *E. robisoni* are considerably smaller (14.7×10.6 vs. 31.0×15.8). Of the 7 other eimerians reported from

anoles belonging to the family Dactyloidae (Table I), only 2, *Eimeria intermedia* Ruiz, 1959 from intermediate anole, *Anolis intermedius* from Costa Rica (Ruiz, 1959) and *Eimeria schwartzi* Cisper, Huntington, Smith, Powell, Parmalee, and Lanthrop, 1995 (Cisper et al., 1995) from armoured anole, *Anolis armouri* from the Dominican Republic share oocysts that have a similar ellipsoidal shape with *E. robisoni*. However, *E. intermedia* and *E. schwartzi* have considerably larger oocysts (20.3×15.7 and 22.7×15.7 , respectively).

DISCUSSION

The lizard family Dactyloidae contains 388 species, all belonging to the genus *Anolis* (Uetz, 2013). Although several species have been surveyed for coccidia, as far as we can determine and including our descriptions herein, there are only 15 species of coccidians (2 caryosporans, 8 eimerians, 5 isosporans) reported from *Anolis* spp. (Table I). Not surprisingly, the majority (80%) of these coccidians have been described from anoles collected in Central America and the Caribbean (particularly Cuba and other islands), areas of greatest *Anolis* diversity (Nicholson et al., 2005; Losos, 2009). Cuba has been identified as the likely point of origin of *A. carolinensis* and other West Indian members of the *carolinensis* subgroup (Williams 1969, 1989). In addition, Campbell-Staton et al. (2012) reported that a monophyletic *A. carolinensis* was well supported and *A. carolinensis* was most closely related to populations of the Cuban green anole, *A. porcatius* Gray, 1840 from western Cuba. It is not known if *A. porcatius* shares similar coccidia with *A. carolinensis* since it has not yet been reported as a host. Obviously, the diversity of coccidians within this family is underestimated and one would predict many additional species as other anoles, particularly those from biological hotspots of the Western Hemisphere, are examined for these protists.

Within the United States, only *A. carolinensis* naturally occurs with its range extending southward into Mexico (Conant and Collins 1998). However, the Florida bark anole, *A. distichus floridanus* Smith and McCauley, 1948, is thought to have colonized Florida recently, either by natural dispersal or human introduction. Since the historical distribution of *A. distichus* is unresolved (Schwartz, 1968; Crother et al., 2012), we agree that this species is considered exotic. There are currently 10 exotic species of *Anolis* that are established within the United States: the Northern Hispaniolan green anole, *A. chlorocyanus* Duméril and Bibron, 1837, common Puerto Rican anole, *A. cristatellus* Duméril and Bibron, 1837, Hispaniolan stout anole, *A. cybotes* Cope, 1862, *A. distichus*, knight anole, *A. equestris* Merrem, 1820, Morne Constant Anole, *A. ferreus* Cope, 1864, Jamaican anole, *A. garmani* Stejneger, 1899, *A. porcatius*, Cuban brown anole, *A. sagrei* Duméril and Bibron, 1837 and Saint Vincent's bush anole, *A. trinitatis* Reinhardt and Lütken, 1862. All of these species are established in Florida (Meshaka, 2011), with *A. distichus* being established in 2 states, *A. equestris* being established in both Florida and Hawaii, and *A. sagrei* has been reported from 13 states and is established in Alabama, Florida, Georgia, Hawaii, Louisiana, North Carolina, South Carolina, and Texas (Crother et al., 2012). Even though *A. carolinensis* has a rather wide ranging distribution within the United States, only individuals from Florida, Georgia (these originated from Louisiana) and Louisiana have previously been reported to be passing coccidia. None of the exotic species of *Anolis* collected from the

United States (including the closely related *A. porcatus*) have been reported to be infected with coccidian, nor has *E. anolidis* from Florida. *A. carolinensis* been reported from any other anole, either exotic or native. Furthermore, of the 10 established exotic species of *Anolis* known to occur within the United States, only *A. distichus* (infected with *Isospora guarocuyai* from the Dominican Republic [Bui et al. 1992]) has been previously reported to harbor coccidia. This isosporan has not yet been reported from hosts within the United States. Therefore, the potential for the number and diversity of coccidia from *Anolis* within the United States could easily increase dramatically with further surveys of *A. carolinensis* from other areas of its range and novel surveys of the known established exotic species of *Anolis* in the United States. For example, another known exotic lizard, the Mediterranean Gecko (*Hemidactylus turcicus*), that is widely distributed within the United States has been reported from Louisiana and Texas to harbor both *Acrooimeria* (= *Eimeria*) *lineri* McAllister, Upton and Freed, 1988 and *Choleoeimeria* (= *Eimeria*) *turcicus* Upton, McAllister and Freed, 1988 (Upton et al. 1988; McAllister et al. 1988). McAllister et al. (1988) stated that it was possible that these coccidia from *H. turcicus*, were Old World species introduced into the New World. Interestingly, 1 year later, Paperna and Landsberg (1989a, b) reported both *C. turcicus* and *A. lineri* from *H. turcicus* from Israel. Bearing this in mind, the impact of the establishment of exotic species infected with their non-native endoparasites could have severe consequences. Therefore, additional studies are warranted for both native and exotic species to determine the diversity, abundance, and distribution of coccidia from *Anolis* within the United States and elsewhere.

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FIGURE 1.

Nomarski interference-contrast photomicrographs of oocysts of *Caryospora natchitochesensis* n. sp. and *Eimeria robisoni* n. sp. (1–2) *Caryospora natchitochesensis* showing oocyst wall (OW), PG (polar granule), Stieda body (SB), and sporocyst residuum. (3–4) *Eimeria robisoni* showing PG and sporocyst (SP). Scale bar for all figures = 10 μ m.

FIGURE 2.

Nomarski interference-contrast photomicrographs of oocysts of *Caryospora natchitochensis* n. sp. and *Eimeria robisoni* n. sp. (1–2) *Caryospora natchitochensis* showing oocyst wall (OW), PG (polar granule), Stieda body (SB), and sporocyst residuum. (3–4) *Eimeria robisoni* showing PG and sporocyst (SP). Scale bar for all figures = 10 μ m.

FIGURE 3.

Nomarski interference-contrast photomicrographs of oocysts of *Caryospora natchitochesensis* n. sp. and *Eimeria robisoni* n. sp. (1–2) *Caryospora natchitochesensis* showing oocyst wall (OW), PG (polar granule), Stieda body (SB), and sporocyst residuum. (3–4) *Eimeria robisoni* showing PG and sporocyst (SP). Scale bar for all figures = 10 μ m.

FIGURE 4.

Nomarski interference-contrast photomicrographs of oocysts of *Caryospora natchitochensis* n. sp. and *Eimeria robisoni* n. sp. (1–2) *Caryospora natchitochensis* showing oocyst wall (OW), PG (polar granule), Stieda body (SB), and sporocyst residuum. (3–4) *Eimeria robisoni* showing PG and sporocyst (SP). Scale bar for all figures = 10 μ m.

FIGURE 5.

Composite line drawings of oocysts of (5) *Caryospora natchitochesensis* n. sp and (6) *Eimeria robisoni* n. sp.

FIGURE 6.

Composite line drawings of oocysts of (5) *Caryospora natchitochesensis* n. sp and (6) *Eimeria robisoni* n. sp.

Comparison of the sporulated oocysts of 8 *Eimeria* species, 7 *Isospora* species, and 2 *Caryospora* species now known from anoles that are classified within the Family Dactyloidae.

Table 1

<i>Eimeria, Isospora, Caryospora</i> spp.	Type host & Locality	Oocyst shape, size, features	Sporocyst shape, size, features	References
<i>E. anolis</i> [*]	<i>Anolis carolinensis</i> USA: Florida	Cylindrical 31 × 15.8 (L/W 2.0); 30-35 × 15-18 M, OR: both – PG: + OW: 1 layer, smooth, 0.8 thick	Ellipsoidal 9.4 × 7.5 (L/W 1.3); 8-12 × 7-8 SB, SSB, PSB: all – SR: +	Daszak and Ball (1991)
<i>E. avilae</i> [*]	<i>Anolis olssoni</i> Dominican Republic	Cylindrical 29.3 × 15.9 (L/W 1.9); 26-33 × 14-19 M, OR, PG: all – OW: 2 layers, 1.2 thick	Ellipsoidal 10.2 × 6.8 (L/W 1.5); 9-13 × 5-8 SB, SSB, PSB: all – SR: +, granular	Cisner et al. (1995)
<i>E. chamaeleonidisbarbati</i>	<i>Anolis barbatius</i> Cuba	Ovoidal 19.0 × 15.7 (L/W 1.2); 17-21 × 15-17 M, OR: both – PG: +, 1-4 granules OW: 2 layers, smooth, 0.8 thick	Ovoidal 7.4 × 6.1 (L/W 1.2); 7-9 × 6-7 SB, SSB, PSB: all – SR: +	Modrý et al. (1999)
<i>E. intermedia</i>	<i>Anolis intermedius</i> Costa Rica	Ellipsoidal 20.3 × 14.9 (L/W 1.4); 15-24 × 10-18 M, OR, PG: all – OW: 1 layer, smooth, 0.8 thick	Spheroidal/subspheroidal 7.0 × 7.5 SB, SSB, PSB [†] : all – SR +, granular [†]	Ruiz (1959)
<i>E. limifrons</i>	<i>Anolis limifrons</i> Panama	Ovoidal 22.5 × 16.0 (L/W 1.4) 20-26 × 15-18 M, OR, PG: all – OW: 2 layers, smooth, 1.3 thick	Ovoidal 8.4 × 7.5 (L/W 1.1) SB, SSB, PSB: all – SR +, single mass	Telford (1998)
<i>E. robisoni</i>	<i>Anolis carolinensis</i> USA: Arkansas	Ellipsoidal 14.7 × 10.6 (L/W 1.4); 13-17 × 10-11 M, OR: both – PG: +, 1-4 present OW: 1 layer, smooth, 0.5 thick	Subspheroidal/ovoid 5.9 × 5.0 (L/W 1.2); 5-6 × 4-6 SB, SSB, PSB: all – SR: +, granular	This study
<i>E. santaluciae</i>	<i>Anolis luciae</i> St. Lucia, Lesser Antilles	Spheroidal/subspheroidal 17.3 × 16.5 (L/W 1.1); 16-18 × 16-18 M, OR: both – PG: +, 60% of oocysts OW: 1 layer, smooth, 1.0 thick	Spheroidal/subspheroidal 7.7 × 5.5 (L/W 1.4); 6-8 × 5-6 SB, SSB, PSB: all – SR: + 3-4 granules	Daszak and Ball (1998)
<i>E. schwartzi</i>	<i>Anolis amourei</i> Dominican Republic	Ellipsoidal 22.7 × 15.6 (L/W 1.4); 21-25 × 15-18 M, OR: both – PG: + (fragmented) OW: 2 layers, smooth 0.7 equal thickness	Spheroidal/subspheroidal 7.9 × 7.4 (L/W 1.1) SB, SSB, PSB: all – SR: +	Cisner et al. (1995)
<i>I. achioteensis</i>	<i>Anolis limifrons</i> Panama	Subspheroidal/ovoid 22.0 × 19.8 (L/W 1.1); 20-24 × 18-23	Ovoidal 12.6 × 9.5 (L/W 1.3)	Telford (1998)

<i>Eimeria</i> , <i>Isospora</i> , <i>Caryospora</i> spp.	Type host & Locality	Oocyst shape, size, features	Sporocyst shape, size, features	References
<i>I. chamaeleontidis</i>	<i>Anolis barbatulus</i> Cuba	M, OR, PG: all – OW: 2 layers, smooth 1.8 thick	SB, SSB, PSB: all – SR: +	Modrý et al. (1999)
<i>I. guarocuyai</i>	<i>Anolis distichus</i> Dominican Republic	Spheroidal/subspheroidal 16.1 × 15.6 (L/W 1.0); 13–21 × 13–19 M, OR: both – PG: + OW: 2 layers, outer markedly pitted 1.0–1.5 thick	Ellipsoidal 10.8 × 7.8 (L/W 1.4) SB, SSB: both + SR: +	Bui et al. (1992)
<i>I. hendersoni</i>	<i>Anolis armouri</i> Dominican Republic	Spheroidal/subspheroidal 20.2 × 17.2 (L/W 1.2); 19–22 × 15–19 M, OR: both – PG: + OW: 2 layers, outer rough 1.5 thick	Ovoidal 13.0 × 8.6 SB, SSB: both + SR: +	Cisper et al. (1995)
<i>I. limifrons</i>	<i>Anolis limifrons</i> Panama	Spheroidal/subspheroidal 23.2 × 21.1 (L/W 1.1); 21–26 × 18–24 M, OR: both – PG: + OW: 2 layers, outer heavily pitted 1.6–2.0 thick	Ellipsoidal 14.7 × 10.0 (L/W 1.5) SB, SSB: both + SR: +	Telford (1998)
<i>I. reui</i>	<i>Anolis bahorucoensis</i> Dominican Republic	Subspheroidal/ovoidal 24.5 × 22.4 (L/W 1.1); 20–27 × 19–25 M, OR, PG: all – OW: 2 layers, rough outer 1.8 thick	Ovoidal 14.7 × 10.2 (L/W 1.4) SB, SSB: both + SR: +	Cisper et al. (1995)
<i>I. tahuayoensis</i>	<i>Anolis fuscoauratus</i> Peru	Spheroidal/subspheroidal 23.2 × 22.1 (L/W 1.1); 20–25 × 19–24 M, OR: both – PG: + OW: 2 layers, rough heavily pitted 2.0 thick	Ovoidal 11.9 × 8.5 (L/W 1.4) SB, SSB: both + SR: +	Upton et al. (1989)
<i>C. emsti</i>	<i>Anolis carolinensis</i> USA: Louisiana	Spheroidal 12.5 (L/W 1.0); 11.0–14.5 M, OR: both – PG: + OW: 1 layer, smooth, colorless 1.0 thick	Ovoidal 10.7 × 8.3 (L/W 1.3) SB, SSB: both + SR: +	Upton et al. (1984)
<i>C. natchitochensis</i>	<i>Anolis carolinensis</i> USA: Arkansas	Subspheroidal/ovoidal 13.1 × 12.3 (L/W 1.1); 11–15 × 10–14 M, OR: both – PG: + OW: 2 layers, smooth, pigmented	Ovoidal 10.1 × 7.4 (L/W 1.4) SB: + SSB, PSB: both – SR: +	This study

<i>Eimeria</i> , <i>Isospora</i> , <i>Caryospora</i> spp.	Type host & Locality	Oocyst shape, size, features	Sporocyst shape, size, features	References
		0.3–0.7, equal thickness		

* May be *Choleoecimeria*; for discussion, see Modrý and Jirk (2006) of former cylindroidal eimerians from scincid lizards now transferred to *Choleoecimeria* sensu Paperna and Landberg (1989b).

† Inferred from line drawing.