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COCCIDIAN PARASITES (APICOMPLEXA: EIMERIIDAE) FROM TWO SPECIES OF CAIMANS, *CAIMAN YACARE* DAUDIN AND *CAIMAN LATIROSTRIS* DAUDIN (ALLIGATORIDAE), FROM PARAGUAY

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ABSTRACT: From October 1986 to January 1987, feces from 119 *Caiman yacare* and 12 *Caiman latirostris* were collected in Paraguay and later examined for coccidian oocysts; 69 of 119 (58%) samples from *C. yacare* and 3 of 12 (25%) samples from *C. latirostris* contained coccidian oocysts. Two eimerians infected *C. yacare* and both are described as new species. Sporulated oocysts of *Eimeria paraguayensis* n. sp. are ellipsoid, 34.0×23.6 ($26\text{--}38 \times 20\text{--}29$) μm with sporocysts ovoid, 14.0×7.1 ($10\text{--}19 \times 6\text{--}10$) μm . Sporulated oocysts of *Eimeria caimani* n. sp. are spheroid, 22.4 ($19\text{--}29$) μm with sporocysts ovoidal, 12.9×6.5 ($8\text{--}17 \times 5\text{--}8$) μm . *Isospora jacarei* infected *C. latirostris* and is redescribed. Sporulated oocysts of *I. jacarei* are sub-spheroid, 13.2×12.1 ($10\text{--}18 \times 10\text{--}15$) μm with sporocysts ellipsoid, 10.4×5.8 ($7\text{--}13 \times 4\text{--}11$) μm . To date, members of the Eimeriidae found in Crocodylia include 5 species of *Eimeria* and 2 of *Isospora* including the new species described here.

From October 1986 to January 1987, a group of biologists from the University of New Mexico had the opportunity to work throughout Paraguay surveying many aspects of caiman biology, systematics, and population status. One part of that study was to determine the species and distribution of coccidian parasites of caimans in Paraguay. This paper reports our findings.

MATERIALS AND METHODS

Caimans were collected from 11 localities in Paraguay (Fig. 1). All were captured alive and fecal samples collected and placed in 2% (w/v) aqueous potassium dichromate ($\text{K}_2\text{Cr}_2\text{O}_7$) solution. After returning from South America, samples were processed by filtering the fecal suspension through 60-mesh wire screens and then incubating the material at room temperature (ca. 23°C) for 2 wk in covered petri dishes. Following the methods of Duszynski et al. (1982) the material was examined for oocysts. Oocysts were measured and photographed with a Zeiss universal photomicroscope equipped with both Neofluar and Nomarski-interference 100 $\times$ objective lenses. All measurements are in μm with ranges of measurements in parentheses following the means. Oocysts were measured when they were 535 days old or younger.

RESULTS

Coccidian species found, hosts, and host localities are presented in Table I and Figure 1.

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Sixty-nine of 119 (58%) *Caiman yacare* and 3 of 12 (25%) *Caiman latirostris* were passing coccidian oocysts. All infected *C. yacare* discharged only eimerian oocysts representing 2 species, whereas the infected *C. latirostris* discharged only isosporan oocysts. Two species of *Eimeria* are described here as new species and the isosporan redescribed.

Eimeria paraguayensis n. sp.

(Figs. 2–4, 11)

Description

Oocyst ellipsoid, wall ~ 1.0 , composed of 2 layers of equal thickness: outer layer pitted (Fig. 4), pale yellow to colorless, inner layer smooth; micropyle absent; 1 highly refractile polar body sometimes present (Fig. 2); oocyst residuum composed of tiny granules that form a diffuse, irregular mass ≤ 15 in diameter (Fig. 3); sporulated oocysts ($n = 55$) 34.0×23.6 ($26\text{--}38 \times 20\text{--}29$) with length/width (L/W) ratio 1.4 (1.1–1.7); sporocysts ($n = 55$) ovoid, 14.0×7.1 ($10\text{--}19 \times 6\text{--}10$) with L/W ratio 1.9 (1.5–2.4); Stieda body present at pointed end of sporocyst (Fig. 2), sub- and parastieda bodies absent; sporocyst residuum (Figs. 2, 4) of highly refractile granules in a compact mass ($\sim 6\text{--}8$); sporozoites with 2 large refractile bodies that are usually spheroid (~ 4) and located in the middle and posterior of each sporozoite.

Taxonomic summary

Type host: *Caiman yacare* Daudin, 1802, Florida State Museum, Herpetology Section, Aquino-Scott C18, 12 October 1986.

Type locality: Laguna Vicente, 1 km W headquarter Estancia Juan de Zalazar, Departamento Presidente Hayes, Paraguay.

Prevalence: Found in 51 of 119 (43%) *C. yacare*.

Site of infection: Unknown, oocysts recovered from feces.

Material deposited: Syntypes (=phototypes, see

FIGURE 1. Map of Paraguay, South America, showing its 20 departments (states). Shaded areas show the distributions of *Caiman latirostris* (▨) and *Caiman yacare* (▩). Solid circles (●) show localities where *C. yacare* was collected, open circles (○) where *C. latirostris* was collected, and half open circles (◐) where both species were collected.

Bandoni and Duszynski, 1988) of sporulated oocysts, U.S. National Museum Parasite Collection (USNMPC) No. 80580.

Etymology: The nomen triviale combines the name of the country from which infected hosts were taken and -ensis (L., belonging to).

TABLE I. Coccidians collected from *Caiman latirostris* and *Caiman yacare* from 11 localities in Paraguay, South America.

Location	Number infected/ number examined (%)	<i>Eimeria/Isospora</i> spp.
Alto Paraguay		
(1)* Estancia Dona Julia	9/21 (43)	<i>E. paraguayensis</i> , <i>E. caimani</i>
(2) Estancia P. Ramos	12/24 (50)	<i>E. paraguayensis</i> , <i>E. caimani</i>
(3) Estancia Gral. Diaz	11/15 (73)	<i>E. paraguayensis</i> , <i>E. caimani</i>
Amambay		
(4) near Bella Vista	2/3 (67)	<i>E. paraguayensis</i> , <i>E. caimani</i>
Boqueron		
(5) Estancia Tinfunque	3/10 (30)	<i>I. jacarei</i>
Misiones		
(6) Estancia Sarandy	3/8 (38)	<i>E. paraguayensis</i> , <i>E. caimani</i>
Ñeembucu		
(7) Estancia 26	8/10 (80)	<i>E. paraguayensis</i> , <i>E. caimani</i>
Presidente Hayes		
(8) Estancia J. de Zalazar	8/15 (53)	<i>E. paraguayensis</i> , <i>E. caimani</i>
(9) Estancia La Golondrina	4/8 (50)	<i>E. paraguayensis</i> , <i>E. caimani</i>
(10) Estancia Tinfunque	11/16 (69)	<i>E. paraguayensis</i> , <i>E. caimani</i>
San Pedro		
(11) Estancia Santa Maria	0/1 (0)	—

* Map locality, Figure 1.

Remarks

Three other eimerians have been described from reptiles in the order Crocodylia (Simond, 1901; Carini, 1932; Lainson, 1968; Levine, 1988), but only *Eimeria pinto* Carini, 1932, an ellipsoid form, remotely resembles *E. paraguayensis*. Unfortunately, Carini's description (1932) is incomplete; he described oocysts of *E. pinto* to be 33×22 and sporocysts to be 11×8 , but he made no mention of a pitted wall, a polar granule, or a sporocyst residuum and he described the oocyst as ovoidal. Carini examined just 1 small "caiman" of an unknown species.

Eimeria caimani n. sp.

(Figs. 5–7, 12)

Description

Oocyst spheroid, wall ~ 1.0 consisting of 2 layers of equal thickness: outer layer pitted (Fig. 7), inner layer smooth; micropyle and polar body absent; oocyst residuum compact, spheroid mass (Fig. 5) of small refractile granules, ~ 9 – 10 ; sporulated oocysts ($n = 50$) 22.4 (19 – 29); sporocysts ($n = 50$) ovoid, 12.9×6.5 (8 – 17×5 – 8) with L/W ratio 1.9 (1.2 – 2.1); Stieda body at slightly pointed end of sporocyst (Fig. 5), sub- and parastieda bodies absent; sporocyst residuum compact, irregular mass of highly refractile granules (Figs. 5, 6), ~ 6 wide; sporozoites with 1 round refractile body near posterior end, but not always terminal.

Taxonomic summary

Type host: *Caiman yacare* Daudin, 1802, Florida State Museum, Herpetology Section, Aquino-Scott C37, 31 October 1986.

Type locality: Retiro Pozo Arias on Rio Monte Lindo, 18 km S Fortin Avalos Sanchez, Estancia Tinfunque, Departamento Presidente Hayes, Paraguay.

FIGURES 2-10. Photomicrographs of sporulated oocysts of coccidia found in caimans collected in Paraguay. $\times 1,860$. 2-4. *Eimeria paraguayensis* n. sp. 2. Note Stieda body (arrow), sporocyst residuum (large arrowhead), and sporozoite refractile bodies (*). 3. Oocyst residuum (*) that sometimes embeds the sporocysts. 4. Pitted outer oocyst wall. 5-7. *Eimeria caimani* n. sp. 5. Note large oocyst residuum (*) and Stieda body (arrow). 6. Sporozoite refractile body (*). 7. Pitted outer oocyst wall. 8-10. *Isospora jacarei*. Note sporocyst residuum (arrow), sporozoite refractile bodies (arrowheads), lack of a Stieda body on sporocysts, and small size of oocysts compared to the 2 eimerians.

Prevalence: Found in 56 of 119 (47%) *C. yacare*.

Site of infection: Unknown, oocysts recovered from feces.

Material deposited: Syntypes (=phototypes, see Bandoni and Duszynski, 1988) of sporulated oocysts, USNMPC No. 80579.

Etymology: The nomen triviale is derived from the generic name of the host.

Remarks

The other 2 eimerians described from Crocodylia have spheroid/subspheroid oocysts (*Eimeria crocodyli* Lainson, 1968, from *Crocodylus acutus* and *Eimeria*

kermoganti [Simond, 1901] Braun, 1908, from *Gavialis gangeticus*), but they both lack an oocyst residuum and Stieda bodies. Thus, sporulated oocysts of *E. caimani* do not resemble those from the other eimerians described to date from Crocodylia.

Isospora jacarei Carini and Biocca, 1940

(Figs. 8-10)

Description

Oocyst subspheroid to spheroid; wall ≤ 1 , composed of 2 smooth layers of equal thickness; micropyle, oocyst residuum, and polar body absent; sporulated oocysts

FIGURES 11, 12. Line drawings show suggested morphology of sporulated oocysts of coccidia collected from the feces of *Caiman yacare*; bar = 10 μ m. 11. *Eimeria paraguayensis* n. sp. 12. *Eimeria caimani* n. sp.

($n = 73$) 13.2×12.1 ($10-18 \times 10-15$) with L/W ratio 1.1 (1.0–1.5); sporocysts ($n = 73$) ellipsoid, 10.4×5.8 ($7-13 \times 4-11$) with L/W ratio 1.7 (1.1–2.2); Stieda body, sub-, and parastieda bodies absent; sporocyst residuum a small compact mass of granules (Figs. 8, 10); sporozoites with 1 round refractile body near posterior end (Fig. 9).

Taxonomic summary

Locality: Retiro Alonsito, 8.5 km NW Fortin Avalos Sanchez, Estancia Tinfunque, Departamento Boquerón, Paraguay.

Prevalence: Found in 3 of 12 (25%) *C. latirostris*.

Site of infection: Unknown, oocysts recovered from feces.

Remarks

The oocysts we describe here are nearly identical to those described by Carini and Biocca (1940) from *C. latirostris* from Brazil. The only significant difference was that we found considerable variation in oocyst shape due to the flexible thin wall that was not mentioned by Carini and Biocca. We also provide photomicrographs of sporulated oocysts that the original description lacked. There is 1 other *Isospora* described from a Crocodylia, *Isospora wilkiei* Lainson, 1968, from *Crocodylus acutus*, but the oocysts of this species are ellipsoid and larger than the form we describe here.

DISCUSSION

Caiman species are distributed from southern Mexico to northern Argentina (Medem, 1983). The genus may include as many as 3 species, but the exact number of species has not yet been resolved (Scott et al., 1989). *Caiman yacare* is distributed in Argentina, Bolivia, Brazil, and Paraguay (Aquino-Ortiz, 1988) where they inhabit permanent waters of large rivers and swamps (Scott et al., 1989). *Caiman latirostris* is distributed in northern Argentina, southern Brazil, Paraguay, and Uruguay (Medem, 1983) being sympatric to *C. yacare* in some parts of its distribution, including in Paraguay (Fig. 1). The

habitat of *C. latirostris* is ephemeral, such as stock tanks and seasonal swamps, and this species is more aggressive in colonizing new sources of water than is *C. yacare* (Scott et al., 1989).

In Paraguay, *C. yacare* is still abundant in the lower Chaco especially in regions where hunting is prohibited. However, *C. latirostris* has suffered a high degree of exploitation for hides and its population has declined considerably in recent years.

In this paper we have described 2 new species of *Eimeria* and redescribed 1 *Isospora* sp. It is curious that *C. yacare* was infected only with eimerian species and *C. latirostris* only by *I. jacarei*, even though there is considerable overlap in habitat between the 2 host species; we have no explanation for this difference. Forty-four of the 69 (64%) infected *C. yacare* had both species of *Eimeria* when examined, whereas 13 of 69 (19%) had oocysts of only *E. caimani* and 8 of 69 (12%) had oocysts of only *E. paraguayensis*.

Prior to this study, only 5 species of Eimeriidae from 3 species of Crocodylia had been described, but the descriptions of most of these were rather incomplete and some of the analyses were done with very few host samples. Therefore, phylogeny of hosts and parasites and coevolutionary relationships that may exist are unknown at present.

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