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THREE NEW EIMERIANS IN CAPYBARA (*HYDROCHAERIS HYDROCHAERIS*) POPULATIONS FROM EASTERN BOLIVIA AND SOUTHERN VENEZUELA

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ABSTRACT: From June to August 1993, fecal samples were collected from the intestinal tract of 13 juvenile, 4 pre-adult, and 25 adult capybaras (*Hydrochaeris hydrochaeris* L.) from 10 localities in eastern Bolivia; additionally, 19 fresh fecal samples were collected in 1994 from capybara herds at 2 localities in south central Venezuela. Oocysts of 3 eimerians were recovered from the capybara populations in both countries and, after study, are described here as new species. Sporulated oocysts of *Eimeria trinidadensis* n. sp. are subspheroidal, 20.9×18.1 ($18\text{--}23 \times 16.5\text{--}21$) μm with sporocysts ovoidal, 9.8×6.1 ($8\text{--}12 \times 5\text{--}8$) μm . Micropyle and oocyst residuum are absent, but polar bodies, Stieda bodies, and sporocyst residua are present. Sporulated oocysts of *Eimeria ichiloensis* n. sp. are ellipsoidal, 26.2×21.0 ($23\text{--}33 \times 18\text{--}24$) μm with sporocysts ovoidal, 11.6×7.4 ($9\text{--}13.5 \times 7\text{--}9$) μm . Micropyle and oocyst residuum absent, but polar bodies, Stieda bodies, and sporocyst residua are present. Sporulated oocysts of *Eimeria boliviensis* n. sp. are ellipsoidal, 35.9×25.7 ($29\text{--}45 \times 20\text{--}30$) μm with sporocysts elongate ovoidal, 16.0×10.4 ($12\text{--}20 \times 8\text{--}12$) μm . Micropyle and oocyst residuum are absent, but polar bodies, Stieda bodies, and sporocyst residua are present.

The largest living rodents in the world are capybaras, *Hydrochaeris hydrochaeris* (Linnaeus, 1766), which first appeared in the fossil record in South America during the upper Pliocene (Patterson and Woods, 1982). They are semiaquatic herbivores, with an average body mass of 59 kg, rarely found feeding greater than 500 m from water (Azcarate, 1980; Ojasti, 1991). Capybaras occur in a wide range of habitats, from forested riversides to open savannas to brackish mangrove swamp areas (Mones and Ojasti, 1986). In undisturbed ecosystems, they are gregarious and live in family groups of up to 30 individuals in a herd (Robinson and Redford, 1991). As semiaquatic herbivores whose range spans much of South America, they commonly are encountered from Colombia southward to Uruguay and northern Argentina, west of the Andes (Mones and Ojasti, 1986). In a separate study designed to look at the genetics of capybaras on the eastern part of their range in South America, we had the opportunity to collect feces from them and study their helminth (Casas et al., 1995) and coccidian parasites. Here we summarize our findings on their coccidians with the description of 3 new species from these unusual wild rodents.

MATERIALS AND METHODS

Hosts from 10 localities in Bolivia were collected by shooting and were necropsied immediately in the field. Pieces of liver, kidney, heart, and spleen were collected and preserved in liquid N₂ for later genetic analysis. All internal organs were examined separately for the presence of metazoan parasites and feces were removed from the large intestine of each animal and preserved in vials containing 2.0% aqueous potassium dichromate (K₂Cr₂O₇). In Venezuela, a local herd was disbursed in 2 collection localities and only fresh fecal samples, presumed to be from adults (by size of stool) and from different individuals, were collected in K₂Cr₂O₇. Intestinal helminths from Bolivian hosts were collected, fixed, and, upon return from Bolivia, were processed and identified as reported elsewhere (Casas et al., 1995); likewise, once in Albuquerque, all fecal samples were filtered, incubated, processed, and stored also as noted previously (Lambert et al., 1988). Samples were examined by coverslip flotation (Duszynski et al., 1982). Oocysts were

measured 99–160 days after they had been collected; they were photographed with Panatomic-X 35-mm film within a Zeiss universal photomicroscope equipped with both Nomarski and Neofluar oil-immersion objective lenses. All measurements are in μm with size ranges in parentheses following the means.

RESULTS

We found 3 eimerian species in the capybaras collected from 11 localities in Bolivia (9) and in Venezuela (2) in 1993–1994 (Fig. 1; Table I); all are new species.

Eimeria trinidadensis n. sp.

(Figs. 2–4, 11)

Oocyst subspheroidal to ellipsoidal, wall ~ 1.5 ($1.0\text{--}2.0$), composed of 2 layers: outer smooth, colorless to light yellow, $\sim 1/2\text{--}2/3$ of total thickness; inner smooth, light blue; micropyle and oocyst residuum absent; 1 large polar body (2.5×4) present, highly refractile; sporulated oocysts ($n = 53$) 20.9×18.1 ($18\text{--}23 \times 16.5\text{--}21$) with length/width ratio (L/W) 1.2 ($1.0\text{--}1.35$); sporocysts ovoidal, 9.8×6.6 ($9\text{--}12 \times 5\text{--}8$) with L/W ratio 1.5 ($1.3\text{--}2.0$); Stieda body present, but sub- and parastieda bodies absent; sporocyst residuum a few small granules between sporozoites; sporozoites each with a large, rounded, posterior refractile body, 1 at each end of sporocyst.

Taxonomic summary

Type host: *Hydrochaeris hydrochaeris* L.

Type locality: South America, Bolivia, Beni, Cercado, 10 km S Trinidad, $14^{\circ}49'S$, $64^{\circ}46'W$.

Prevalence: Found in 32 of 42 (76%) and in 7 of 19 (37%) capybaras from Bolivia and Venezuela, respectively.

Site of infection: Unknown. Oocysts collected from feces.

Material deposited: Phototype (see Bandoni and Duszynski, 1988) of sporulated oocysts in the U.S. National Museum Parasite Collection (USNMPC), Beltsville, Maryland, no. 84091. Symbiotype (see Frey et al., 1992) of this easily identified host species was not collected, but frozen tissues available for genetic analysis are in the University of New Mexico Museum of Southwest Biology (UNM-MSB) frozen tissue collection (NK 27269; adult female, 34 kg), collected: L. M. Zalles, 6 August 1993.

Etymology: The nomen triviale is derived from the name of the town near which the host was collected and *-ensis* (L., belonging to).

Remarks

Sporulated oocysts of this species superficially resemble those of *Eimeria hydrochoeri* Carini, 1937 described from the same host species

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FIGURE 1. Map of northern South America, showing the 11 localities in Venezuela (1, 2) and Bolivia (3–11) where capybaras (*Hydrochaeris hydrochaeris*) used in this study were collected. Shaded area shows the distribution of *H. hydrochaeris* in South America. Numbers on x, y axes = latitude and longitude, respectively.

from São Paulo, Brazil because their sizes are similar. However, those of *E. trinidadensis* differ from those of *E. hydrochoeri* by having an oocyst wall that is thicker (1.5 vs. 0.8) with 2 distinct layers (vs. 1), by having a distinct polar body (Fig. 2), which is lacking in *E. hydrochoeri*, and by having ovoidal sporocysts with a distinct Stieda body. In Carini's (1937) original description of *E. hydrochoeri*, he says that the sporocysts are oval and that they have a slight thickening at 1 pole, which is "not projecting" and was not always visible; his line drawing shows ellipsoidal sporocysts with 1 end slightly thickened. Finally, the sporozoites of *E. hydrochoeri*, as drawn by Carini (1937), do not have a refractile body, nor does he make mention of this structure, which is clearly seen in the sporozoites of *E. trinidadensis* (Figs. 2–4).

Eimeria ichiloensis n. sp.

(Figs. 5–7, 12)

Oocyst ellipsoidal, wall ~2.0, composed of 2 layers: outer wall yellow, appears striated in optical section, but is actually sculptured, $\frac{3}{4}$ of total thickness; inner layer smooth, light green; micropyle and oocyst residuum absent, but 1 (usually) or 2–3 (rarely) highly refractile polar bodies, always present; sporulated oocysts ($n = 74$) 26.2×21.0 ($24\text{--}30 \times 18\text{--}23$) with L/W ratio 1.3 (1.1–1.4); sporocysts ovoidal, 11.6×7.4 ($9\text{--}14 \times 7\text{--}9$) with L/W ratio 1.6 (1.2–1.85); large, nipplelike Stieda body present, but sub- and parastieda bodies absent; sporocyst residuum present as a compact mass of tightly packed granules between sporo-

FIGURES 2–10. Photomicrographs of sporulated oocysts of coccidia recovered from the feces of *Hydrochaeris hydrochaeris* in Venezuela and Bolivia. 2–4. *Eimeria trinidadensis* n. sp. 5–7. *Eimeria ichiloensis* n. sp. 8–10. *Eimeria boliviensis* n. sp. Scale bar = 10 μ m for all figures. Abbreviations: pb, polar body; sr, sporocyst residuum; sb, Stieda body.

zoites; sporozoites each with a prominent posterior refractile body, 1 at each end of sporocyst.

Taxonomic summary

Host: *Hydrochaeris hydrochaeris* L.

Locality: South America, Bolivia, Beni, Magdalena, 20 km N Ichilo, 13°27'S, 64°10'W.

Prevalence: Found in 36 of 42 (86%) and in 16 of 19 (84%) of capybaras from Bolivia and Venezuela, respectively.

Material deposited: Phototype of sporulated oocysts in the USNMPC no. 84090. No symbiotype; tissues in the UNM-MSB frozen tissue

collection (NK 27259; juvenile female, 14 kg); collected: L. M. Zalles, 2 August 1993.

Etymology: The nomen triviale is derived from the town near which the host was collected and *-ensis* (L., belonging to).

Remarks

Sporulated oocysts of this species superficially resemble, in shape, those of *Eimeria capibarae* Carini, 1937, first found in the same host species from São Paulo, Brazil. They differ, however, by being smaller in mean size (26.2 $\times$ 21.0 vs. 30 $\times$ 26), by always having 1 or more polar bodies that are absent in *E. capibarae*, and by having smaller

11

12

13

sporocysts (11.6×7.4 vs. $14\text{--}15 \times 8$) with a smaller L/W ratio (1.6 vs. 1.8).

***Eimeria boliviensis* n. sp.**

(Figs. 8–10, 13)

Oocyst ellipsoidal, wall ~ 3.0 , of uniform thickness, composed of 2 obvious layers: outer very thick and highly sculptured, dark brown, $\sim 1/3$ of total thickness and appears braided or ropelike in optical section; inner layer thin, smooth; micropyle and oocyst residuum absent; 1 polar body present, ~ 3 , highly refractile and generally rounded; sporulated oocysts ($n = 44$) 35.9×25.7 ($29\text{--}45 \times 20\text{--}30$) with L/W ratio 1.4 (1.3–1.8); sporocysts elongate ovoidal, 16.0×10.4 ($12\text{--}20 \times 8\text{--}12$) with L/W ratio 1.55 (1.4–2.0); Stieda body present, but sub- and parastieda bodies absent; sporocyst residuum composed of scattered coarse granules; sporozoites each with a large, spheroidal refractile body.

Taxonomic summary

Type host: *Hydrochaeris hydrochaeris* L.

Type locality: South America, Bolivia, Beni, Cercado, 8 km SE Trinidad, $14^{\circ}50'S$, $64^{\circ}47'W$.

Prevalence: Found in 11 of 42 (26%) and in 5 of 19 (26%) capybaras from Bolivia and Venezuela, respectively.

Site of infection: Unknown. Oocysts collected from feces.

Material deposited: Phototype of the sporulated oocyst in the USNMPC no. 84089. No symbiotype; tissues in the UNM-MSB frozen tissue collection (NK 27271; juvenile female, 3 kg); collected: L. M. Zalles, 9 August 1993.

Etymology: The nomen triviale is derived from the host country and -ensis (L., belonging to).

Remarks

This species resembles neither of the 2 previously described eimerians reported from capybaras by Carini (1937), nor does it resemble the other 2 new species described above.

DISCUSSION

Increasingly, human dependence upon domesticated plants and animals is endangering natural areas, especially in developing countries. To protect ecosystems, while continuing to meet nutritional needs of the world's increasing populations, new ideas in food production using wild animals need to be considered as essential for sustainable development in many areas of the world. The capybaras of the lowlands of South America, because of their size and wide distribution (Fig. 1), seem especially well suited for exploitation as a resource for food, hides, and other byproducts. In some parts of Latin America such as Venezuela and Brazil, for example, capybara meat is highly prized and consumed in large quantities (Ojasti, 1991). Wildlife laws and policies of many countries also encourage breeding native species either in a semi-intensive or intensive system, but confining capybaras in high density may create serious health problems for them. Infectious diseases and parasite outbreaks (both coccidiosis, helminthosis) are as bad or worse in capybaras as those that occur in conventional livestock (L. M. Zalles, pers. obs.), yet little is known of these problems in wild populations, even though more than 80 helminth parasites have been reported from South American capybaras (see Casas et al., 1995, for review). Also, even though it is well established that coccidiosis can be a devastating disease of domestic food animals,

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FIGURES 11–13. Composite line drawings of sporulated oocysts of coccidia from feces of *Hydrochaeris hydrochaeris* in Venezuela and Bolivia. 11. *Eimeria trinidadensis*. 12. *Eimeria ichiloensis*. 13. *Eimeria boliviensis*. Scale bar = 10 μ m.

TABLE I. Collection localities of capybaras (*Hydrochaeris hydrochaeris*) from Venezuela and Bolivia. See Figure 1 for specific field collection localities.

Collection locality	No. infected/ no. collected (%)	<i>Eimeria</i> spp. found	No. of capybaras infected with 0–3 spp.			
			0	1	2	3
1	10/10 (100)	<i>boliviensis</i> , <i>ichiloensis</i> , <i>trinidadensis</i>	0	6	2	2
2	9/9 (100)	<i>boliviensis</i> , <i>ichiloensis</i> , <i>trinidadensis</i>	0	7	1	1
3	4/4 (100)	<i>ichiloensis</i> , <i>trinidadensis</i>	0	0	4	0
4	5/5 (100)	<i>boliviensis</i> , <i>ichiloensis</i> , <i>trinidadensis</i>	0	3	1	1
5	3/4 (75)	<i>ichiloensis</i> , <i>trinidadensis</i>	1	1	2	0
6	5/5 (100)	<i>ichiloensis</i> , <i>trinidadensis</i>	0	0	5	0
7	5/5 (100)	<i>boliviensis</i> , <i>ichiloensis</i> , <i>trinidadensis</i>	0	1	1	3
8	8/8 (100)	<i>boliviensis</i> , <i>ichiloensis</i> , <i>trinidadensis</i>	0	4	4	0
9	2/3 (67)	<i>boliviensis</i> , <i>ichiloensis</i> , <i>trinidadensis</i>	1	1	1	0
10	4/4 (100)	<i>ichiloensis</i> , <i>trinidadensis</i>	0	2	2	0
11	3/4 (75)	<i>ichiloensis</i> , <i>trinidadensis</i>	1	1	2	0
Total 11	58/61 (95)	3	3	26	25	7

e.g., cattle, chickens, under crowded conditions, only 2 eimerians have been described previously from capybaras (Carini, 1937). Here we have shown that wild capybaras have a very high prevalence of infection (95%) with coccidians, even in uncrowded natural circumstances (Table I). Nothing is known about the life cycle of these species, nor do we have any information on their potential pathogenicity, especially under crowded conditions of domestication. Clearly, there is still much basic biology to be learned about the parasites of these large rodents.

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