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GASTROINTESTINAL PARASITES AND ECTOPARASITES OF *BRADYPUS VARIEGATUS* AND *CHOLOEPUS HOFFMANNI* SLOTHS IN CAPTIVITY FROM COSTA RICA

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Abstract: Sloths may serve as host to a wide range of parasites. However, there is little information available on the types of parasites that affect Costa Rica's sloth population. During a 1-yr period, 65 specimens of Costa Rican sloth species (*Choloepus hoffmanni*; $n = 56$) and *Bradypus variegates*; $n = 9$) from a local zoo were sampled. Fecal samples were evaluated using two different diagnostic techniques, Sheather's flotation and sedimentation. Concurrently, these sloths were examined for ectoparasites. Gastrointestinal parasites were found in 14 sloths (21.5%), from which 13 animals were *C. hoffmanni* and one was *B. variegatus*. Gastrointestinal parasites were recognized as Coccidia 71.4% (10/14), Cestoda 21.4% (3/14), and Spiruroidea 7.1% (1/14). Coccidia and cestodes were seen in *C. hoffmanni*, and spirurids were identified in *B. variegatus*. Among 27 sloths examined, only six had dermal problems (five *C. hoffmanni* and two *B. variegatus*). Ectoparasites recovered were *Sarcoptes scabiei* (Acari, Sarcoptidae) mites and *Amblyomma varium* (Acari, Ixodidae) ticks. This is the first time that cestode strobilae and nematode eggs are reported in sloth feces and that *Monezia benedeni* and *L. leptocephalus* were found in captive sloths.

Key words: *Bradypus variegatus*, *Choloepus hoffmanni*, ectoparasites, gastrointestinal parasites, sloths, zoo.

INTRODUCTION

Bradypus variegatus (Xenarthra, Bradypodidae) and *Choloepus hoffmanni* (Xenarthra, Megalonychidae) are species from the tropical rain forest of the Caribbean and Pacific regions of Costa Rica. Both species are considered in serious threat of extinction.[21] Deforestation, agricultural activity, and an increase in human settlements are among the main factors driving sloth populations to extinction. Due to this new proximity to humans, sloths are also becoming a popular "pet" among local people. Costa Rica maintains numerous captive sloths in zoos and rescue centers, primarily for educational purposes.

Sloths are host to a variety of gastrointestinal parasites,[11,14–16,23] which are frequently associated with diarrhea.[10] Ectoparasites, such as ticks and mites, are generally considered to be nonpathogenic to sloths under natural conditions[3,4,6,18,29] Sloths also harbor a varied number of specialized commensal arthropods such as moths, mites, and coprophagic beetles, in association with their feces.[14,20,28–30] Accurate identification of sloth parasites can help zoos and other institutions assess the risk associated with severe parasitism in their captive populations. Identification of these parasites will also lead to the establishment of effective prevention and control measures. Currently, there is a lack of information on the prevalence of parasites in Costa Rica's captive sloth population. Thus, the aim of this study was to identify gastrointestinal parasites and ectoparasites in Costa Rica's captive sloth population.

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MATERIALS AND METHODS

Aviarios Sloth Sanctuary is located in the Caribbean region of Costa Rica (9.73°N 82.85°W). Among Costa Rica's zoos, it is the only one that works exclusively with sloths; it maintains both species of Costa Rica's sloths, which are confiscated by the wildlife national service (Ministry of Environment and Energy) or turned in by local people. The sanctuary is organized in four sectors: public exhibits, feeding station, nursery–adult maintenance area, and veterinary clinic. The animals for exhibition and maintenance are kept in cages with concrete floors, enclosed by metal bars, and separated from each other by a galvanized mesh. The animals may rest on wooden platforms located high above the ground and can move on wooden bars and branches for natural enrichment.

The study sample consisted of 65 specimens of sloths (56 *C. hoffmanni* and 9 *B. variegatus*). Sex and age were not used as selection criteria. All

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Table 1. Prevalence of gastrointestinal parasites of *Bradypus variegatus* and *Choloepus hoffmanni* sloths in captivity from Costa Rica.

Parasite	*B. variegatus* (n^a = 1)		*C. hoffmanni* (n^a = 13)		Total (n^a = 14)	
	P^b	%	P^b	%	P^b	%
Helminths:						
Spiruroidea	1	100	0	0	1	7.1
Cestoda	0	0	3	23.1	3	21.4
Protozoa:						
Coccidia	0	0	10	76.9	10	71.4

[a] Total number of parasitized hosts.
[b] Number of positive animals by parasite group.

sloths were dewormed 3 mo prior to the start of the study and then again at the end of the study. During a 1-yr period (June 2005–2006), fecal samples were collected twice per month at an interval of 15 days. Fresh fecal samples from the floor were collected with a wooden spatula, and the portion of the feces in direct contact with the floor was avoided.[12] Each sample was identified and stored in sterilized plastic bags and kept at 4°C until analyzed.

Sheather's flotation (hypersaturated sugar solution, density 1.3) and sedimentation techniques were performed on each fecal sample.[12] Cysts, oocysts, eggs, and larvae were identified according to their morphologic features.[16,24] Identification was performed to the genera level.

Coccidian oocysts present in the feces were placed in a 2% potassium dicromate solution at 28°C for 30 days to achieve sporulation for subsequent identification.[16] Ectoparasites were collected and preserved in 70% alcohol and stored until identification.

During this study, a captive adult of *B. variegatus* was brought into the zoo. Although the animal was in good health at physical examination, a fecal exam revealed proglottids and nematode eggs. These specimens were stored in glacial acetic acid, formalin, and alcohol for further identification.

A manual search was done for ectoparasites in all 65 specimens. Recovered parasites were stored in glycerol–alcohol for later identification. A skin scraping was performed on all sloths with dermatitis, and the specimens were placed in a 10% potassium hydroxide solution.[18] The ectoparasites were identified based on their morphologic features.[1–4,18]

RESULTS

Fourteen (13 *C. hoffmanni* and one *B. variegatus*) out of 65 (21.5%) sloths evaluated in this study were infected with gastrointestinal parasites. Coccidia (71.4%; 10/14) and Cestoda (21.4%; 3/21) were found in *C. hoffmanni*, and Spiruroidea (7.1%; 1/14) were found in one *B. variegatus* (Table 1). The unsporulated coccidian oocysts and cestodes eggs were obtained via the flotation technique, while the Spiruroide eggs were obtained by the sedimentation technique.

The *B. variegatus*, which was introduced into the refuge during the study, had cestode proglottides and adult nematodes that were later identified as *Moniezia benedeni* (Moniez, 1879) Blanchard, 1891 (Cyclophyllida, Anoplocephalidae)[11] and *Leiuris leptocephalus* (Rudolphi, 1819) Leuckart, 1850 (Spiruroidea, Spirocercidae),[15,26,27] respectively.

Amblyomma varium Koch, 1844 (Ixodida, Ixodidae) was found in two *C. hoffmanni* and in one *B. variegatus*. In this current study, 27 (19 *C. hoffmanni* and 8 *B. variegatus*) sloths had evidence of pruritic lesions, scabby skin with erythema, hyperkeratosis, and alopecia located on the back, thorax, forearms, abdomen, legs, or face. Seven sloths (five *C. hoffmanni* and two *B. variegatus*) had *Sarcoptes scabiei* mites De Geer, 1778 (Acari, Sarcoptidae). No fungus was found on skin scraping. Table 2 lists the sloth parasites recovered from this study.

Table 2. Gastrointestinal parasites and ectoparasites from captive Costa Rican sloths.

Sloths	Gastrointestinal parasites	Ectoparasites
Choloepus hoffmanni	Helminths:	*Amblyomma varium*
	Cestodes (eggs)	*Sarcoptes scabiei*
	Protozoa:	
	Coccidia (nonsporulated oocysts)	
Bradypus variegatus	Helminths:	*A. varium*
	Moniezia benedeni (proglottides)	*S. scabiei*
	Leiuris leptocephalus (adults)	
	Spiruroidea (eggs)	

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DISCUSSION

This is the first study identifying parasites in a captive sloth population in Costa Rica, and it was confirmed that these animals are hosts to gastrointestinal- and ectoparasites. This is also the first report of cestode and nematode Spiruroidea eggs in the feces of *C. hoffmanni* and *B. Variegates*, respectively.

These findings are in contrast to other reports,[10,13] wherein *Ancylostoma* spp., *Trichuris* spp., *Ascaris* spp., and pinworms eggs; and *Entamoeba* sp. and *Acanthamoeba* sp. cysts were reported in captive sloths. According to Lainson and Shaw,[16] the size of the nonsporulated oocysts correlates with the only report of *Eimeria choloepi* in free-ranging *C. didactylus* sloths in Brazil. This study is in agreement with that of Diniz and Oliveira,[10] who reported coccidian nonsporulated oocysts in the feces of captive *Choleopus* spp. sloths in Brazil. It appears that coccidial infections have been known to occur in sloths as *Archeococcidia antiquuus*, and *A. nothrotheriopsae* were reported in the coprolites of the extinct Shasta ground sloth, *Nothrotheriops shastensis*, in Rampart Cave, Arizona (USA).[23] In this current study, the presence of Coccidia (71.4%) and Cestoda (21.4%) could be the consequence of using ivermectin once a year as a wide-spectrum deworming drug, and this drug has not been effective on these parasites.

Gastrointestinal parasites are a serious health issue. Stress factors in captivity, deficient nourishment, and the incidence of other diseases make captive sloths more susceptible to infection.[25] Under nonnatural conditions such as captivity, the balance between host and parasites is lost, which can result in disease.[6,9,12,25] Under captive conditions, gastrointestinal parasites are common, and clinical signs are frequently associated with diarrhea.[10,25] Nevertheless, none of the sloths in this study demonstrated clinical signs related to gastrointestinal parasitism, including the infected *B. variegates*. Due to their arboreal behavior, sloths have a limited contact time with the ground. They only descend once-a-week in order to defecate on the ground, and that limits the potential for fecal–oral infection.[18] This behavior could explain the reduced variety of gastrointestinal parasites reported in free-ranging sloths.[14,19] On the other hand, the prevalence (21.5%) and diversity of gastrointestinal parasites in this captive population could be a reflection of the husbandry used at this facility. The use of individual cages with concrete floors, plus daily cleaning and disinfection, reduces the likelihood of fecal–oral transmission. However, as part of their nutritional diet, these captive sloths are fed leaves and fruits that were collected in the wild and that might be contaminated with arthropods containing Spiruroidea eggs and oocysts; these arthropods could act as intermediate parasitic hosts. The sloth keepers also stated that, once the sloths are in contact with soil, they present with geophagia, which could increase the possibility of ingesting arthropods or coccidian oocysts.

The identification of the helminths *L. leptocephalus* and *M. benedeni* are consistent with the result reported by Jimenez-Quiros and Brenes[15] and Flores-Barroeta et al.,[11] respectively; they described this finding in the necropsy of a free-ranging sloth (*B. variegatus*) in Costa Rica. Their findings were also corroborated in our study by evidence of cestode and nematode (Spiruroidea) eggs, via flotation and sedimentation techniques, respectively. *Moniezia* spp. have a wide range of definitive hosts among bovines, ovines, caprines, and also artiodactylus such as Africa's hippopotamus.[11,22,31] The intermediate hosts are Oribatidae mites.

Some species of the genera *Leiuris*, *Paraleiuris*, and *Physocephalus* (Spiruroidea, Spirocercidae) were identified as gastric- and small-intestinal parasites of *Bradypus* sp.[15,26,27] However, there is no information available on sloth parasitic intermediate hosts, but it is suggested that some arthropods could play that role. Using the standard coprologic diagnostic techniques, it was possible to confirm *C. hoffmanni* as a definitive cestode host.

The insects in feces of *C. hoffmanni* were identified as *Onttophagus* sp. (Coleoptera: Scarabaeidae: Coprinae), which are coprophagic beetles and have not been associated with species known to be associated with sloth feces, including *Trichillum bradyporum*, *T. adisi*, and *Uroxys besti*.[14,28] In addition, no moths were identified in the samples analyzed; this may be related to the fact that the sloths are kept in captivity and, due to the daily cleaning procedures used at the facility, do not have contact with feces. Under natural conditions, *Cryptoses choloepi*, *Bradypophila garbei*, and *B. hahneli* have an obligate relationship with sloth feces.[28–30]

The *A. varium* tick was previously reported in sloths from Costa Rica in the Alajuela, Limon, and San José provinces.[5] Other *Amblyomma* spp. ticks are known to parasitize sloths, but only *A. varium* and *A. geayi* are considered sloth-specific parasites, even though under natural conditions they are not considered pathogenic organisms.[1–4,6,17,28] Nevertheless, the *A. varium* have been associated with the transmission of hemoparasites such as *Babesia choloepi* in *Choloepus* sp.[8]

Sarcoptes scabiei is the mange mite in both an-

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imals and humans.[18] All lesions observed in the infected animals in this study confirmed the previous report by Oliveira et al.[18] that reported this mite for the first time in *B. variegatus* sloths in Brazil. This present study documents both the first case of this parasite affecting *C. hoffmanni* and also the presence of this mite in sloths in Costa Rica. All of the sloths that presented with sarcoptic mange were received by individuals. In addition, four people developed sarcoptic mange after having been in contact with these infected sloths, although this was not confirmed by skin scrapings. However, these individuals were treated with acaricides and all of them responded satisfactory. This also demonstrates the importance of preventive medicine and the public health concerns with zoonotic diseases in captive wildlife populations. Identification of the parasites can reduce the potential risk for zoonosis. The infestation with *S. scabiei* demonstrates the necessity to set up biosecurity measures in order to avoid transmission to personnel involved in the care of the sloths, as well as to the general public.

The role of ectoparasites in the health of wild animals is not clear due to the limited information available. Nonetheless, ticks are well documented to play an important role in the transmission of diseases to both humans and animals.[3,5] According to Costa et al.[7] and Diniz et al.,[9] ectoparasites are involved in about 35% of the dermatoses in zoo animals and are frequently associated with nutritional deficiencies and systemic diseases.

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