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The Prevalence of Coccidian Parasites in Passerine Birds from South America

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ABSTRACT

Fecal samples were collected from 655 passerine birds representing 190 species from 13 collection sites in Guyana, Ecuador, Peru, and Argentina from August, 1990 - August, 1997. The fecal samples were stored in 2.5% $K_2Cr_2O_7$ and examined for coccidian oocysts within six weeks after collection. The overall prevalence of coccidian parasites in the samples was 20.9% (137/655). The one-sample test of equality of proportions was applied to the prevalence data comparing host behavior, habitat, and diet to the overall coccidial prevalence. Host behavior was divided into five groups according to the bird's gregariousness with other birds. Solitary foragers or birds that forage in pairs had significantly lower coccidia prevalence (12.6% and 1.0% respectively) than the overall average. More gregarious birds that spend approximately equal amounts of time with other birds in pairs or in flocks had higher prevalence of coccidial parasites. Birds that forage alone or as couples (single-pairs) and birds that are periodically social foragers (single-pairs-flocks) were significantly higher than the overall average with 39.1% and 42.9% respectively. Birds that forage in couples or flocks (pairs-flocks) were sightly below average with 16.0% parasite prevalence. Forest dwellers and ground feeders (22.5% and 23% respectively) had parasite infection rates near the overall average while canopy and forest border dwellers had significantly lower parasite prevalence (13.4% and 8.7% respectively). Pertaining to diet, fruit eaters showed a significant lack of coccidia with a one percent infection rate compared to a 22.8% for ground insect and 28.5% for bark and leaf insect eaters. A profile of the wedge-billed woodcreeper (Glyphorynchus spirurus) was used as an example of a passerine species with a high prevalence of coccidian parasites.

INTRODUCTION

The isosporan and eimerian coccidian parasites are protozoan parasites with a direct life cycle and no intermediate hosts. Oocysts develop endogenously, are passed in the feces, and sporulate in the environment. Birds become infected when they ingest the sporulated oocysts while feeding. Transmission of the parasite is facilitated by close contact with infected hosts who are actively passing oocysts in their feces. Although the transmission of coccidian parasites is well known, there are few reports of the prevalence of coccidian parasites in wild animal populations and no reports of the prevalence of coccidia in the avifauna of South America.

The South American continent supports the largest and most varied avifauna in the world. No less than 3,000 bird species belonging to 865 genera and representing 93 families have been recorded (Ridgely and Tudor, 1989). With over a third of the world's total avian species in one part of the world coupled with the fact that coccidian parasites are ubiquitous in vertebate populations, the prevalence of coccidian parasites in the passerine population could produce insight into the affect of the host's diet, habitat, and behavior on coccidia transmission in avian populations.

MATERIALS AND METHODS

During bird collecting expeditions, fecal samples were collected from the small and large intestines of 655 passerine birds representing 190 species from 13 collection sites in Guyana (2 sites), Ecuador (6 sites), Peru (3 sites), and Northern Argentina (2 sites) from August, 1990 - August, 1997 (Figure 1) and sent to the author's laboratory for examination. Procedures for preserving fecal material are described by McQuistion and Wilson (1989). Fecal samples were 1-2 months old when examined. Positive fecal samples were determined from possible spurious or false positives if fewer than five oocysts were found in the entire fecal sample and those oocysts did not sporulate, the sample was considered negative.

Calculation of overall coccidian prevalence

The number of positive fecal samples was divided into the total number of fecal samples collected to determine the overall prevalence of coccidian parasites in the sample population.

Comparison of coccidian prevalence with host behavior, habitat and diet

The overall coccidian prevalence was compared to various groups within the sample population related to host behavior, habitat, and diet as described by Ridgely and Tudor (1989,1994). The one sample test of equality of proportions was used to compare the overall prevalence of coccidian parasites in the passerine population with the various groups within the population. The formula used was:

$$\frac{Z = p - a}{\sqrt{a(1 - a) / n}}$$

p = sample proportion
a = overall parasitized proportion (.209)
n = sample size (must be greater than 25)
To reject H_o : if $Z \geq 1.96$, $P \leq 0.05$

Host behavior was divided into 5 catagories depending on the gregariousness of the avian host's foraging behavior with other birds. The catagories were: (1) Single - a solitary forager, (2) Pairs - bird always seen foraging with another bird, (3) Single/Pairs - bird spends approximately equal amounts of time foraging alone or with another bird, (4) Pairs/Flocks - bird spends all its time foraging with one or many other birds, (5) Single/Pairs/Flocks - bird maybe seen foraging alone, with another bird, or in a flock.

Host habitat was divided into four catagories: (1) Forest Borders - the wooded area at the edge of clearings or river banks, (2) Canopy Dwellers - birds confined to the forest canopy, (3) Forest Dwellers - the area from undergrowth to canopy, and (4) Ground Feeders - birds confined to the ground or low undergrowth.

Host diet was divided into three catagories: (1) Bark/Leaf Insects - insects found on the bark or leaves of trees, (2) Ground insects - insects found only on the ground, and (3) Fruit - birds whose primary diet is fruit.

Profile of an avian host with high coccidian prevalence
The wedge-billed woodcreeper (*Glyphorynchus spirurus),* one of the species sampled in this study, was used to create a profile of an avian species most likely to show a high prevalence of coccidian parasites in its population.

RESULTS

Overall parasite prevalence
One hundred thirty seven fecal samples were positive for coccidian parasites from a total of 655 samples. The fecal samples represented 190 avain species and had an overall parasite prevalence of 20.9%.

Host behavior and parasite prevalence
Exclusively solitary (single) or couple foragers (pairs) had significantly lower prevalence of coccidian parasites than the overall prevalence rate (12.6% and 1.0% respectively)(Table 1). Birds that divided their time as solitary and couple foragers (single/pairs) or engaged in the full range of foraging behavior (single/pairs/flocks) had a prevalence rate significantly higher than the overall prevalence rate (39.1% and 42.9% respectively). Birds that divided their foraging time as couples and flocks (pairs/flocks) had a 16% prevalence rate and was not significiantly different from the overall prevalence rate.

Host habitat and parasite prevalence
Hosts that inhabit forest borders or in the forest canopy had significantly lower prevalence rates than the overall parasite prevalence (8.7% and 13.4% respectively)(Table 2) while forest dwellers (22.5%) and ground feeders (23.0%) had parasite prevalences similar to the overall parasite prevalence.

Host diet and parasite prevalence
Fruit eaters had significantly lower parasite prevalence (1.1%) while birds that fed on bark or leaf insects showed a parasite prevalence (28.5%) significantly higher than the overall parasite prevalence (Table 3). Birds that fed on ground insects had a parasite prevalence (22.8%) near the overall parasite prevalence.

Profile of the Wedge-billed Woodcreeper (*Glyphorynchus spirurus)*
Sixty-eight adult wedge-billed woodcreepers (*Glyphorynchus spirurus)* were captured and sampled for coccidian parasites from Guyana, Ecuador, and Peru, more than any other single species. They showed a 45.6% prevalence of coccidian infection.

DISCUSSION

Coccidiosis, the disease caused by coccidia when the host ingests many oocysts of a pathogenic strain, is a frequent problem when raising large numbers of domesticated animals in a confined space (Fayer and Reid, 1982). Poultrymen, cattlemen, rabbit breeders, pigion raisers, etc. are familar with the mortality and morbidity effects of coccidiosis.

Coccidiosis is probably not a problem in wild populations because the hosts are widely distributed and not confined to limited areas where the oocysts concentration can increase in the environment to the point that the host would ingest large numbers of oocysts. However, from the parasite's point of view, distribution would be more difficult in the natural setting.

This study suggests that gregarious birds that spend much of their time foraging with other birds in a flock or with at least one other bird are more likely to be infected with coccidia than solitary or continuously paired foragers. Clustering behavior fosters oocyst transmission because of the close proximity of infected birds passing oocysts to potential new hosts.

Habitat is also a factor in the prevalence of coccidia in avian populations. Ground feeders and forest dwellers showed higher prevalence of coccidia than birds that prefer forest borders or the forest canopy. Oocysts viability is dependent on moisture and oxygen (Brotherston, 1948; Farr and Wehr, 1949; Marquardt et al., 1960). Oocysts are very suspectible to desiccation and oxygen is required for sporulation and development to the infective stage. The soil in dense, humid forests would be moist and conducive to oocysts survivial and development. Forest borders and the forest canopy would have more sunlight and higher temperatures that would enhance desiccation and reduce oocyst vialibity (Long, 1959: Farr and Wehr, 1949).

Host diet also plays a significant role in the prevalence of coccidia. Only one percent of birds that have fruit as the majority of their diet were infected with coccidia. Since most fruits are acidic, this would decrease the viability and retard the sporulation of oocysts (Yvoré, 1976). Birds whose diet are ground insects and bark and leaf insects, especially in the lower regions of the dense forests where there is more moisture, shade and cooler temperatures, had much higher prevalence levels of coccidia.

The wedge-billed woodcreeper (*Glyphorynchus spirurus)* is one of the most widespread and numerous birds in the Amazon River Basin. Indeed, 68 individuals were captured and sampled for coccidian parasites from Guyana, Ecuador, and Peru, more than any other single species. Because of its behavior, diet, and preferred habitat, it offered an excellent profile of an avian host most likely to be parasitized with coccidia. They eat bark insects, occur singley or in mixed flocks and favor the lower growth in dense humid forests. As a result, they showed a 45.6% prevalence of coccidian infection, well above the overall parasite prevalence with no apparent pathological effects.

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LITERATURE CITED

Brotherston, J.G. 1948. The effect of relative dryness on the oocysts of *E. tenella* and *E. bovis*. Transactions of the Royal Society of Tropical Medicine and Hygiene, 42:10-11.

Farr, M.M., and Wehr, E.E. 1949. Survival of *Eimeria acervulina, E. tenella* and *E. maxima* oocysts on soil under various conditions. Annals of the New York Academy of Sciences, 52:468-472.

Fayer, R., and Reid W.M. 1982. Control of coccidiosis. Pp 453-487 In: P.L. Long (ed.). The Biology of the Coccidia. University Park Press, Baltimore. 502pp.

Long, P.L. 1959. A study of *Eimeria maxima* Tyzzer, 1929, a coccidium of the fowl (*Gallus gallus)*. Annals of Tropical Medicine and Parasitology, 53:325-333.

Marquardt, W.C., Senger, C.M., and Seghetti, L. 1960. The effect of physical and chemical agents on the oocysts of *Eimeria zuernii* (Protozoa, Coccidia). Journal of Protozoology, 7:186-189.

McQuistion, T.E., and Wilson, M. 1989. *Isospora geospizae*, a new coccidian parasite (Apicomplexa: Eimeriidae) from the small ground finch (*Geospiza fuliginosa)* and the medium ground finch *(Geospiza fortis)* from the Galapagos Islands. Systematic Parasitology, 14:141-144.

Ridgely, R.S. and Tudor, G. 1989. The Birds of South America, the Oscine Passerines Vol. 1. University of Texas Press, Austin, Texas. 516 pp.

Ridgely, R.S. and Tudor, G. 1994. The Birds of South America,the Suboscine Passerines Vol. 2. University of Texas Press, Austin, Texas. 814 pp.

Yvoré, P. 1976. Revue sur la prevention des coccidioses en aviculture. Avian Pathology, 5:237-252.

Figure 1. Locations in South America where birds were collected for fecal samples.

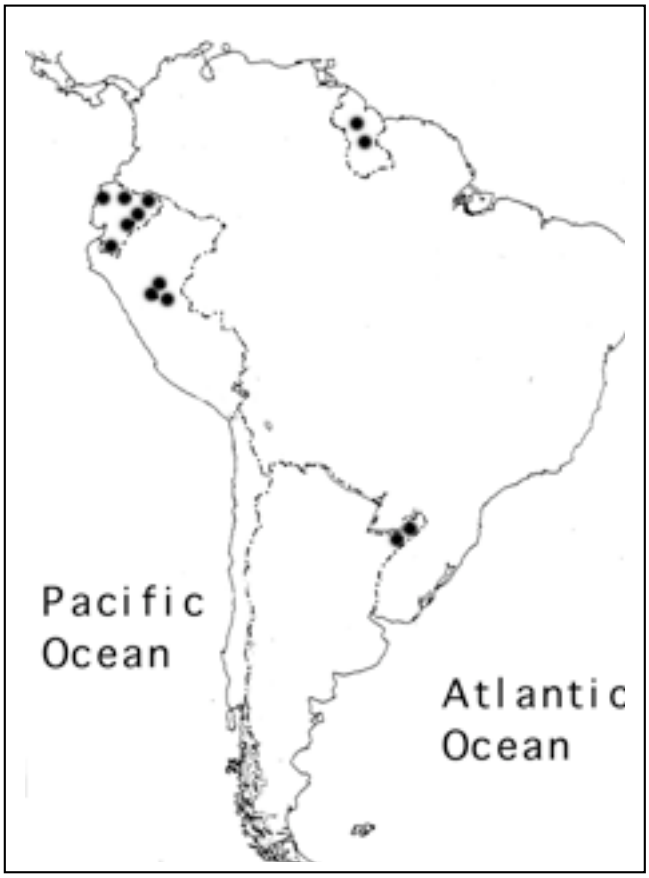

Table 1. Prevalence of coccidian parasites in passerine, South American birds according to behavior.

Behavior	Percentage	Parasitized/ Sample Size	Z Score z≥1.96 (P=0.05)
Single	12.6%	23/183	2.762 *
Pairs	1.0%	13/130	5.574 *
Single/Pairs	39.1%	25/64	3.580 *
Pairs/Flocks	16.0%	8/50	0.852
Single/Pairs/Flocks	42.9%	12/28	2.864 *

* Statistically significant at P ≤ 0.05 from the overall prevalence average of 20.9%.

Table 2. Prevalence of coccidian parasites in passerine, South American birds according to habitat.

Habitat	Percentage	Parasitized/ Sample Size	Z Score z≥1.96 (P=0.05)
Forest Borders	8.7%	4/46	2.038 *
Canopy	13.4%	25/186	2.517 *
Forest Dwellers	22.5%	102/453	0.838
Ground Feeders	23.0%	78/339	0.950

* Statistically significant at P ≤ 0.05 from the overall prevalence average of 20.9%.

Table 3. Prevalence of coccidian parasites in passerine, South American birds according to diet.

Diet	Percentage	Parasitized/ Sample Size	Z Score z≥1.96 (P=0.05)
Fruit	1.1%	6/81	4.406 *
Ground Insects	22.8%	43/189	0.642
Bark/Leaf Insects	28.5%	66/232	2.828 *

* Statistically significant at P ≤ 0.05 from the overall prevalence average of 20.9%.