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Source: Journal of Wildlife Diseases, 16(1) : 29-38

Published By: Wildlife Disease Association

URL: https://doi.org/10.7589/0090-3558-16.1.29

BLOOD PARASITES OF SOME JAMAICAN BIRDS

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Abstract: The prevalence of avian hematozoa in 1791 birds of 80 species and 22 families from Jamaica was determined. Species of *Haemoproteus* were the most common hematozoan encountered. Species of *Leucocytozoon* were diagnosed only in three over-wintering North American migrants and the genus was absent in native Jamaican birds. The low prevalence of infection (7.4%) of blood parasites in Jamaican birds was closely similar to that seen in Neotropical birds and far below that noted for the Nearctic avifauna of the same families. Prevalence in adult and young birds was virtually identical; transmission occurred primarily during the period February-April.

INTRODUCTION

Numerous surveys of the hematozoa of the avifauna of North and South America, summarized by Greiner *et al.*[5] and White *et al.*,[10] have been carried out over the years. Few such surveys have been carried out on the avifauna of the Caribbean and none on the rich avifauna of Jamaica. Recently, one of us (HW) had the opportunity to sample the Jamaican avian population for their hematozoa over an 18 month period. Bird communities sampled included those in the St. Cruz mountains, in the Blue Mountains and those in the lowlands on the marine littoral. In addition, a sample from overwintering North American migrants was obtained. A number of birds were recaptured at intervals and the change in their blood parasite burdens noted. This report summarizes the findings of this study.

MATERIALS AND METHODS

Birds were caught in Japanese fowler's nets, ringed with numbered bands for identification on recapture and a blood smear was obtained by cutting a toe. The blood films were air-dried, fixed in 100% methanol or ethanol and sent to the International Reference Centre for Avian Haematozoa for staining with Giemsa's stain and subsequent examination.

Birds were netted in four ecologically distinct locations as follows:

Malvern - 17°58′40″ N; 77°42′20″ W. On a ridge of the St. Cruz mountains, 100 km west of Kingston, 650 m above sea level. Mean annual rainfall of 120 cm, with a mean daily humidity of 80%, higher at night. Relatively few biting flies noted about man.

Greenhills - 15°03′ N; 77°31′ W. On the north slope of the Blue Mountains at a height of 1200 m above sea level, near Hardware Gap. Mean annual rainfall of more than 200 cm producing an evergreen (mist) forest. Mean daily humidity of 90%. Mosquitoes present in great numbers all year round.

Mandeville - 18°03′ N; 77°31′ W. On a plateau, on the St. Cruz mountains, 750 m above sea level. Mean annual rainfall of 200 cm. Mosquitoes always present in large numbers about man.

Treasure Beach - 17°53′ N; 77°46′ W. At sea level in the rain shadow of the St.

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Cruz mountains. Mean annual rainfall less than 100 cm. Mosquitoes always abundant about man.

RESULTS AND DISCUSSION

A total of 1791 birds of 80 species and 22 families (Table 1) were examined for hematozoa. Only 133 (7.4%) were infected, with haemoproteids (4.2%) being the most common hematozoan, followed by species of *Plasmodium* (1.4%), *Atoxoplasma* (0.9%), microfilaria (0.6%), *Trypanosoma* (0.4%) and *Leucocytozoon* (0.2%) in order of frequency of occurrence. *Leucocytozoon* was seen only in overwintering North American migrants and appeared to be absent in the resident Jamaican birds, a situation paralleling observations[10] for birds in Central and South America. Overwintering migrants are those birds which, according to Edwards,[4] normally breed in North America. This does not preclude the possibility that a few individuals of these species may breed in Jamaica.

The overall low prevalence of blood parasites observed in Jamaican birds is quite at variance with the comparatively high levels encountered in the avifauna of the Nearctic[5] but closely similar to that observed in the Neotropical birds,[10] a situation suggesting relationships between the two avifaunas. However, the relationship between the Caribbean and Neotropical avifauna is not that close. Bond[2] postulated that the main colonization of the Greater Antilles was by bird families of Neartic, not Neotropic, origin. In 1948, Bond[3] suggested that most of the West Indies birds were derived from the avifauna adapted to the tropical conditions in the southernmost part of North America. Mayr[7] regarded the Thraupidae and Icteridae as North American families which colonized the West Indies and Lack[6] regarded the Mimidae, Parulidae and Vireonidae as mainly derived from the Nearctic with the Trochilidae and Tyrannidae representing the Neotropical component of the West Indian avifauna. Presumably, therefore, the major differences in prevalence of blood parasites noted between Jamaican birds and the Nearctic avifauna (with which they have their closest affinities) is not a result of host-induced aspects, but more probably due to a paucity of suitable vector species.

It is interesting to note that families of birds of presumed Nearctic origin in the Caribbean - viz. - Columbidae, Icteridae, Mimidae, Turdidae, Thraupidae, Vireonidae - have among the highest prevalence of blood parasites of all the families (with the exception of the Thraupidae), while those of presumed Neotropical origin (Trochilidae, Tyrannidae) have among the lowest (Table 1). Whether these observations have any significance in suggesting the presumed origin of the Jamaican avifauna is highly questionable, however, and must await detailed studies on the presence or absence and the host specificity of the biting fly vectors on the island.

Species of hematozoa.

Haemoproteids encountered included *Haemoproteus columbae* and *H. sacharovi* in the Columbiformes, *H. quiscalus* in the icterids, *H. beckeri* in *Mimus polyglottis*, *H. fringillae/orizivorae* in the parulids and the fringillids, *H. fallisi* in *Turdus aurantius*, *H. witti* in *Trochilus polytmus* and as yet unnamed haemoproteids in the Coerebidae and Vireonidae. *Plasmodium* infections included *P. vaughani* in *Loxigilla violacea*, *Tiaris bicolor* and *Turdus jamaicensis; P. relictum* in *Turdus jamaicensis* and *Tiaris olivacea* and *P. pinotti* in *Tiaris bicolor*, *Loxipasser anoxanthus*, *Coereba flaveola* and *Euneornis campestris*, while an undiagnosed *Plasmodium* was seen in *Anthrocothorax mango* and *Vireo modestus*. Trypanomastigotes of the *Trypanosoma avium* complex were seen in *Vireo osburni*, *T. padda* was noted in *Tiaris bicolor* and trypanosomes resembling *T. calmietti* were seen in

TABLE 1. Prevalence of hematozoa in birds of Jamaica.

Family and species	Total birds exam.	Total birds infect.	Total birds with H.	P.	T.	Mic.	O.
APODIDAE							
Tachornis phoenicobia Gosse (M)	26	1					1
CAPRIMULGIDAE							
Chordeiles minor (J. R. Forster) (M)	1	0					
CHARADRIIDAE							
Charadrius wilsonia Ord (T)	1	0					
COEREBIDAE							
Coereba flaveola (Linnaeus) (M, G, [illegible])	139	12	5	6		1	1
Euneornis campestris (Linnaeus) (M, G, Ma)	182	18	11	3		2	2
COLUMBIDAE							
Columba leucocephala Linné) (M)	2	2	2				
Columbina passerina (Linnaeus) (M, G, T)	34	15	15				
Geotrygon montana (Linnaeus) (M, G)	3	0					
Leptotila jamaicensis (Linné) (M)	6	0					
Zenaida aurita (Temminck) (M)	3	2	2				
CUCULIDAE							
Coccyzus minor (Gmelin) (M)	1	0					
Crotophaga ani Linné (M)	3	0					
FALCONIDAE							
Falco sparverius Linné (M)	1	0					
FRINGILLIDAE							
Ammodramus savannarum (Gmelin) (M)	13	0					
Loxigilla violacea (Linnaeus) (M, G, Ma)	76	4	3	1			
Loxipasser anoxanthus (Gosse) (M, G)	195	2		1		1	
Passerina amoena (Say) (*)	1	0					
Passerina cyanea (Linnaeus) (*)	4	0					
Pheucticus ludovicianus (Linnaeus) (*)	3	0					
Sicalis flaveola (Linnaeus) (M)	2	0					
Tiaris bicolor (Linnaeus) (M, G)	46	3		1	2		
Tiaris olivacea (Linnaeus) (M, G)	176	8		7		1	
HIRUNDINIDAE							
Petrochelidon fulva (Vieillot) (Ma)	126	8					8

TABLE 1. (continued)

Family and species	Total birds exam.	Total birds infect.	Total birds with H.	P.	T.	Mic.	O.
ICTERIDAE							
Icterus leucopteryx (Wagler) (M, G)	10	5	5		1		
Icterus spurius (Linnaeus) (*)	1	1	1				
Nesopsar nigerrimus (Osburn) (G)	2	0					
MIMIDAE							
Mimus polyglottos (Linnaeus) (M)	8	1	1				
PARULIDAE							
Dendroica caerulescens (Gmelin) (*)	12	2		1			1
Dendroica cerulea (Wilson) (*)	1	0					
Dendroica discolor (Vieillot) (*)	11	1	1				
Dendroica magnolia (Wilson) (*)	1	0					
Dendroica palmarum (Gmelin) (*)	6	0					
Dendroica pensylvanica (Linnaeus) (*)	1	0					
Dendroica petechia (Linnaeus) (T)	1	0					
Dendroica pharetra (Gosse) (G)	6	0					
Dendroica tigrina (Gmelin) (*)	12	2	1				1
Dendroica virens (Gmelin) (*)	1	0					
Geothlypis trichas (Linnaeus) (M)	3	0					
Helmitheros vermivorus (Gmelin) (*)	4	0					
Limnothlypis swainsonii (Audubon (*)	3	0					
Mniotilta varia (Linnaeus) (*)	30	2	1			1	
Parula americana (Linnaeus) (*)	5	0					
Seiurus aurocapillus (Linnaeus) (*)	21	1		1			
Seiurus motacilla (Vieillot) (*)	1	0					
Setophaga ruticilla (Linnaeus) (*)	4	0					
PICIDAE							
Melanerpes radiolatus (Wagler) (M, G)	4	0					
Sphyrapicus varius (Linné) (*)	11	0					
PSITTACIDAE							
Aratinga nana (Vigors) (M)	1	0					
Forpus passerinus (Linné) (M)	11	0					

TABLE 1. (continued)

SCOLOPACIDAE							
Calidris alba (Pallas) (*)	2	0					
Calidris mauri (Cabanis) (*)	2	0					
Calidris minutilla (Vieillot) (*)	27	0					
Calidris pusilla (Linnaeus) (*)	12	0					
Micropalma himantopus (Bonaparte) (*)	2	0					
STURNIDAE							
Sturnus vulgaris (Linnaeus) (M)	2	0					
THRAUPIDAE							
Piranga olivacea (Gmelin) (*)	1	0					
Pyrrhuphonia jamaica (Linnaeus) (M, G)	62	1					1
Spindalis zena (Linnaeus) (M, G)	44	0					
TODIDAE							
Todus todus (Linnè) (M, G)	20	1				1	
TROCHILIDAE							
Anthrococorax mango (Linnè) (M, T)	19	1		1			
Mellisuga minima (Linnè) (M)	1	0					
Trochilus polytmus Linnè (M, G)	129	1	1				
TURDIDAE							
Catharus fuscescens (Stephens) (*)	1	0					
Catharus minimus (Lafresnaye) (*)	1	0					
Catharus ustulatus (Nuttall) (*)	1	1					1
Myadestes genibarbis Swainson (G)	12	1				1	
Turdus aurantius Gmelin (M, G)	31	4	2	2			
Turdus jamaicensis Gmelin (M, G)	17	1					1
TYRANNIDAE							
Contopus caribaeus (d'Orbigny) (M, G)	5	0					
Elaenia fallax Sclater (M)	9	1				1	
Myiarchus barbirostris (Swainson) (M, G)	19	0					
Myiarchus stolidus (Gosse) (M)	7	0					
Myiarchus validus Cabanis (G)	1	0					
Myiopagis cotta Ridgway (M, G, T)	9	0					
Tyrannus caudifasciatus d'Orbigny (M)	14	2			1		1
Tyrannus dominicensis (Gmelin) (M, G)	39	1			1		

TABLE 1. (continued)

Family and species	Total birds exam.	Total birds infect.	Total birds with H.	P.	T.	Mic.	O.
VIREONIDAE							
Vireo altiloquus (Vieillot) (M, G)	55	25	24		1		
Vireo modestus Sclater (M, G)	19	1		1			
Vireo olivaceus (Linnaeus) (*)	7	0					
Vireo osburni (Sclater) (G)	6	2			1	1	
GRAND TOTAL:	1791	133	75	25	7	10	16
Percent infected		7.4	4.2	1.4	0.4	0.6	0.9

* = North American overwintering migrants;
M = Malvern;
G = Greenhills;
Ma = Mandeville;
T = Treasure Beach;

H = *Haemoproteus;*
P = *Plasmodium;*
T = *Trypanosoma;*
Mic. = microfilaria;
O = *Atoxoplasma, Haemogregarina, Leucocytozoon.*

Icterus leucopteryx, Vireo altiloquus and *Tyrannus dominicensis.* The *Atoxoplasma,* haemogregarines and microfilariae were not specifically identified. *Leucocytozoon fringillinarum* was seen in two migrant *Dendroica* warblers and *L. dubreuili* in a migrant *Catharus ustulatus.*

Overwintering migrants

A total of 182 overwintering migrants representing 29 species was examined for blood parasites; only 10 (5.5%) harbored hematozoa (Table 2). The only *Leucocytozoon* infections seen in Jamaica were in North American migrants. Presumably, species of this genus do not occur in indigenous Jamaican birds of the same family; possibly there is a lack of ornithophilic blackfly vectors. The prevalence of hematozoa in the migrant birds is remarkably low. These birds are essentially inhabitants of Zones 1 and 5 of North America,[5] where the average prevalence of blood parasites is 35% (Zone 1) and 40% (Zone 5). The low prevalence of blood parasites in these migrants in Jamaica indicates that (i) parasitaemias are at a low (or chronic) level and may be too low to detect with routine blood smear techniques; (ii) there is no relapse or recrudescence of infection on the overwintering grounds as is noted when the birds return to their summer breeding grounds in spring[1] and (iii) there is little or no transmission of blood parasites in Jamaica during the months the migrants are resident. These observations would suggest that there is little southward or northward transportation of avian blood parasites by migrant birds, supporting the views by White *et al.*[10] and Greiner *et al.*[5] that birds contract their blood parasites on the breeding grounds, not during migration. Since the overwintering migrant birds are the source (along with the northern non-migrants) of the hematozoa on the northern breeding grounds, the migratory birds must be carrying a biologically significant number of

TABLE 2. Prevalence of hematozoa in resident and non-resident populations of Jamaican birds.

Population	Total birds exam.	Total birds infect.	Total birds with H.	L.	P.	T.	Mic.	O.
Non-resident overwintering migrants	192	10	4	3	2	0	1	0
Percent infected		5.2						
Resident Jamaican birds								
TREASURE BEACH	6	2	2					
MANDEVILLE	129	8						8
Percent infected		6.2						
MALVERN	999	70	41		16	4	4	5
Percent infected		6.9						
GREENHILLS	465	43	28		7	3	5	3
Percent infected		9.2						
TOTAL JAMAICAN RESIDENTS	1599	123	71		23	7	9	16
Percent infected		7.7						

H = *Haemoproteus;* T = *Trypanosoma;*
L = *Leucocytozoon;* Mic. = microfilaria;
P = *Plasmodium;* O = *Atoxoplasma, Haemogregarina.*

hematozoan infections. These infections are being carried south (and north) with the migrants, but the level of parasitaemia is too low to facilitate transmission on the overwintering grounds, providing functional vectors are available. In addition, the lack of relapse of hematozoan infections following the fall migration southwards, together with the marked relapse noted following the spring migration northwards and onset of breeding, suggests that the relapse is in some way triggered by the onset of breeding activity.

Regional distribution of avian blood parasites in Jamaica

The prevalence of blood parasites in birds from different localities in Jamaica was remarkably uniform (Table 2), considering the variations in the environments sampled.

Treasure Beach

A total of 51 birds of 11 species was examined for blood parasites; only two doves were infected with *Haemoproteus columbae*. However, the sample was composed primarily of 45 individuals of overwintering scolopacids which were not infected with blood parasites. While this lack of blood parasites is normal for scolopacids,[5] the deletion of these birds from our data reduces the Treasure Beach sample to a level too low for further consideration.

Mandeville

A total of 129 resident birds of 4 species was examined; 8 individuals (6.2%) harbored Atoxoplasma (Table 2). The bulk of the sample (126 birds) was composed of the colonial-nesting *Petrochelidon fulva*, and all the *Atoxoplasma* infections were in this species. This is another example of the association of high *Atoxoplasma* prevalence with colonial-nesting birds as noted by Greiner *et al.*[5] The overall prevalence of parasitism is similar to that experienced elsewhere in Jamaica (Table 2).

Greenhills

Blood smears from 465 resident birds of 25 species were examined; 43 (9.2%) harbored blood parasites, primarily species of *Haemoproteus*. Although representing the highest prevalence of parasitism of the 4 areas studied, the prevalence is not significantly different (P = 1%) from that noted in other regions. At Greenhills, mosquitoes were noted in great abundance attacking man all year round (as they were at Mandeville), but the prevalence of *Plasmodium* in the avifauna here was a little less than at Malvern (Table 2), where mosquitoes around man were less abundant. Presumably, therefore, the common anthropophilic mosquitoes of this region are not involved in the transmission of avian *Plasmodium*. Probably, ornithophilic species are involved as demonstrated for *Plasmodium circumflexum*[8] and *P. vaughani*.[11]

Malvern

Blood smears from 999 resident birds of 41 species were examined; 70 (6.9%) harbored hematozoa, mainly species of *Haemoproteus* (Table 2). The prevalence of blood parasites was not significantly different from that observed in other areas. A total of 1464 birds of 43 species were examined from both Greenhills and Malvern. Although the Coefficient of Community[9] was only 0.56, the 23 species common to both areas represented 1332 birds (91%) of the individuals sampled. The two samples, therefore, were based on essentially the same species composition, all other factors being equal, similar rates of prevalence of blood parasites would be anticipated, as is the case. The gross difference in environment between Greenhills and Malvern apparently did not influence the prevalence rates as might have been anticipated on the basis of experience elsewhere.[10]

Possibly the similarity of prevalence of blood parasites in both Greenhills and Malvern is due to a certain degree of movement by local resident birds within Jamaica which operates to mix local populations and equilibrate prevalence levels. There is some justification for this view based on observations made on a flock of yellow-faced grassquits *(Tiaris olivacea)* netted at Malvern. This flock (with a maximum of 30 individuals) first appeared in late March and then disappeared in late April of 1977; they were never recaptured. Comparison of the wing length of individuals of this flock indicated a significantly shorter wing-length (t-Test, P = 1%) than that of resident Malvern grassquits recaptured on numerous occasions. This flock apparently moved in from lowland areas (where wing lengths were shorter) or even possibly from other Caribbean islands. This latter possibility is unlikely as migrants usually have longer wing lengths than non-migrants. This particular flock harbored *Plasmodium pinotti* and represented six (37.5%) of the *Plasmodium* records for Malvern (Table 2) and 50% of the *Plasmodium* records for the month of April (Table 3). These infections are probably acquired at some place other than Malvern.

Recaptured birds

Over the course of the 20 months of this study, 303 birds were recaptured one or more times following their initial capture, usually with an interval of 3 months or more between captures. Twenty of these birds (6.6%) harbored a blood parasite on initial capture; the blood parasite status of 11 birds remained unchanged over the course of the study while 9 birds lost an infection and 9 birds gained one. Thus the actual prevalence of parasitism in these birds was essentially the same as that for the overall Jamaican sample (Table 2).

Seasonal Transmission

The prevalence of blood parasites in the resident Jamaican bird population was determined for each month (Table 3). Initially, two-by-two tests were performed to determine whether the prevalence of blood parasites was significantly different between years and between the same months of different years. Prevalence rates were not significantly different between years (P=1%) or between the same months of different years (P=1-5%). Therefore, the data were pooled. Blood parasites were present in the bird population through-

TABLE 3. Seasonal prevalence of hematozoa in resident Jamaican birds (September, 1976 to July, 1978). Abbreviations as in Table 2.

Month	Total birds	Total infect.	Percent infect.	Birds infected with H.	P.	T.	Mic.	O.
January	168	8	4.8	5	2	0	1	1
February	141	10	7.1	2	6	1	0	2
March	238	21	8.8	16	4	1	1	0
April	304	31	10.2	21	12	1	1	0
May	57	7	12.3	7	0	0	0	0
June	279	21	7.5	11	1	0	2	8
July	35	4	12.1	3	0	0	1	0
August	—	—	—	—	—	—	—	—
September	148	9	6.1	5	1	2	0	1
October	230	15	6.5	9	1	2	0	3
November	41	0	0	—	—	—	—	—
December	52	0	0	—	—	—	—	—

Note: Overwintering migrants caught as follows: — January - 27; February - 15; March - 38; April - 72; May - 4; June - 1; July - 0; September - 21; October - 26; November - 8; December - 0.

The total of birds examined exceed the number seen in Table 2 as 94 birds captured in 1977 and recaptured in 1978 are added to the figures.

out the year except in November and December (Table 3). Highest prevalence rates were noted in the period March through July.

Comparison of the prevalence of parasites in young birds of the year with that in birds one year older was interesting. The prevalence of parasitism in the young birds of the year was 8.3%, compared to an 8.4% prevalence of parasitism in older birds. However, most of the infected young birds were encountered in September-October (79% of the total infected young). On the other hand, most infected adults (70%) were found in February through April, and only 3% of the total infected adults were found in September-October. In this latter period, 22% of the total sample was obtained, while 32% was obtained in March-April. These observations suggest that there are two periods of transmission in Jamaica, one in March-April and one in September-October. However, if this were the case, the one year and older birds should be subjected to two periods of transmission and thus show both a higher overall prevalence rate of blood parasites and an increase in prevalence in September-October. On the contrary, the prevalence of parasitism in both age classes of birds is virtually identical and the older birds show a marked decline in parasitism during September-October. Presumably, therefore, transmission in Jamaica occurs primarily in March-April. However, the breeding season in resident Jamaican birds is far from synchronised, but extended over the period January to October (HW - personal observations). This extended breeding period makes analysis of the prevalence of hematozoans in immature birds extremely complex, and the present data is insufficient to permit a satisfactory explanation of the results.

CONCLUSIONS

The blood parasite fauna of the birds of Jamaica closely reflects the prevalence levels and species distribution observed in Neotropical birds and significantly differs from that in North America. North American winter migrants have a low prevalence of hematozoa, indicating a lack of recrudescence of infection during the winter season in contrast to the spring.[1] This, coupled with an active transmission season in March-April for resident birds (when many migrants are returning to their summer breeding grounds), reduces the possibility of active interchange of parasite species in this overwintering area.

Acknowledgements

Robert Sutton, Mandeville, made the visits to Greenhills, Mandeville and Treasure Beach possible. The financial assistance of the National Research Council of Canada to the first author materially assisted in making this study possible.

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Received for publication 24 April 1979