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INFLUENCE OF BLOOD PARASITES ON THE BODY MASS OF PASSERIFORM BIRDS

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ABSTRACT: Body masses of 3,739 birds representing immature and adult males and females of 15 species of passeriforms (both uninfected and infected with *Haemoproteus* spp. and *Leucocytozoon* spp.) were compared. There was some interaction among year, month and area of capture for several host species, but there was no discernible effect of either parasite genus on body mass. There were no effects due to high intensity parasitemia for eight host species examined. Either parasitism does not cause loss of body mass, or the techniques used were too insensitive to separate effects of parasitism from other natural causes.

Key words: Blood parasites, haemoproteids, leucocytozoids, passerine birds, effects on body mass, natural infections.

INTRODUCTION

A correlation was not found between the presence of haemoproteids and the amount of migratory fat in birds studied at Lake Chad by Ashford (1971). However, Peirce (1984) suggested that the presence of both *Leucocytozoon* sp. and *Haemoproteus* sp. in a dove from Zambia resulted in a reduction of body mass. During the summers of 1981–1983, a program to monitor the impact of the insecticide Matacil (aminocarb) on non-target organisms provided the opportunity to sample a passiform community and evaluate the impact of blood parasites on the body mass of the host birds. It was hoped that such a study, based on a larger sample size of several host species in a breeding population, would corroborate either one or the other of the above conclusions.

MATERIALS AND METHODS

Birds were netted using Japanese mist nets in two study areas near Glenwood, Newfoundland (48°50′N, 54°50′W) during the months June through August in each of the years 1981–1983. Immature birds first appeared in mid July. One of the study areas received aerial applications of Matacil (4-dimethylamino-m-tolyl methylcarbamate) to control an outbreak of spruce budworm (*Choristoneura fumiferana*), while the second was used as an untreated control. Netting was conducted twice a week in each area. Upon capture, the birds were identified, banded with U.S. Fish and Wildlife Service bands, sexed, aged and weighed on a portable electronic balance accurate to 0.1 g. A blood smear was taken from the brachial vein of each bird. Blood smears were subsequently fixed in 100% methanol and stained with Giemsa's stain. The blood smears were examined for parasites and a crude measure of intensity of infection was obtained by counting the number of parasites per 100 fields (×100 objective for haemoproteids; ×40 for leucocytozoids). Representative blood smears were placed in the collection of the International Reference Centre for Avian Haematozoa (accession number series 92668–94571).

Where numbers permitted (three species), factorial analyses of variance (SPSS-X User's Guide, 1983; SPSS-X ANOVA) were performed on logarithmical transformed (base 10) body mass values using as factors the presence or absence of parasites, year, month and area of capture. For 12 other species, where numbers did not permit the full factorial model, data were pooled across year, month and area of capture. The possibility of masking effects was recognized. Effects of parasite presence or absence were tested using a one-way ANOVA (SPSS-X ONEWAY). Tests of homoscedasticity were also performed (both Cochran's and Bartlett's test of homogeneity, SPSS-X ANOVA).

Haemoproteid infections >500 parasites/100 fields examined, and leucocytozoid infections >25 parasites/100 fields examined represented high intensity infections (an average infection for *Haemoproteus* sp. was 30 parasites/100 fields; for *Leucocytozoon* sp. it was two parasites/100 fields).

One-way ANOVA (SPSS-X ONEWAY) was used to test differences in body mass between uninfected birds and birds having high intensity *Haemoproteus* sp. and/or *Leucocytozoon* sp. infections. For this analysis, birds were cate-

TABLE 1. *F* values generated from a factorial ANOVA across log transformed body masses of three species of birds infected and uninfected with blood parasites at Glenwood, Canada, 1981 to 1983.

Factor	*Seiurus noveboracensis*			*Zonotrichia albicollis*			*Catharus ustulatus*		
	M*	F	HY	M	F	HY	M	F	HY
Parasite occurrence	0.03	0.91	1.89	0.33	0.86	0.12	0.68	0.77	0.04
Month	2.95	0.24	8.60*	0.16	1.78	3.32	0.54	0.45	0.44
Year	0.16	1.45	4.13*	1.23	3.82*	15.44*	2.23	2.08	3.84*
Area	0.10	2.41	0.75	2.35	2.16	0.00	0.02	0.02	0.78
Parasite status × Month	2.18	0.39	0.38	0.56	1.18	5.65*	4.32*	1.35	2.28
Parasite status × Year	0.16	2.30	0.50	0.02	0.66	1.00	2.07	1.12	0.71
Parasite status × Area	0.04	1.00	0.20	2.23	0.38	0.08	0.36	0.25	0.30
Month × Year	0.80	0.23	1.81	0.99	4.64*	5.08*	0.93	0.68	1.26
Month × Area	0.28	0.07	0.42	0.92	4.37	0.34	0.46	0.50	3.57
Year × Area	0.25	1.76	1.34	1.29	5.27*	0.02	6.02*	2.52	8.48*

* M, male; F, female; HY, immature (hatching year bird).
* $P < 0.05$.

gorized as having a high intensity *Haemoproteus* sp. or a high intensity *Leucocytozoon* sp. infection, regardless of whether one or both genera were present. Further to this analysis, white-throated sparrows (*Zonotrichia albicollis*) immatures only were categorized as having a high intensity *Haemoproteus* sp. infection with no *Leucocytozoon* sp., a high intensity *Leucocytozoon* sp. infection with no *Haemoproteus* sp. infection, or a high intensity infection of both *Haemoproteus* sp. and *Leucocytozoon* sp. These categories were chosen to remove the possible influence of interactive effects of the presence of both genera. Masses for these three categories of parasitism were compared with body masses of uninfected birds using univariate ANOVA (SPSS-X ONEWAY).

RESULTS

Approximately 6,000 passeriforms representing 36 species were banded, weighed, and examined for blood parasites over the course of the study. Of these, 3,739 birds of 15 species were obtained in sufficient numbers for analysis (Tables 1, 2). The blood parasites found in this study area were *Haemoproteus tyranni, H. majoris, H. fallisi, H. mazzai, H. fringillae* complex, *Leucocytozoon fringillinarum, L. majoris* and *L. dubreuili*. Less than 1% of the sample also was infected with *Trypanosoma avium* complex and *Plasmodium vaughani*.

Factorial ANOVA revealed interactive effects between year and month (*Zonotrichia albicollis* females and immatures), year and area (*Z. albicollis* females; *Catharus ustulatus* males and immatures), and parasite presence or absence and month (*Z. albicollis* immatures; *C. ustulatus* males) (Table 1). There were significant main effects due to year in *Z. albicollis* females and immatures, *Seiurus noveboracensis* immatures and *C. ustulatus* immatures. However, there were no significant interactions between year and parasite presence or absence in these cases, indicating there was no effect due to parasite presence or absence. The only other main effect was due to month for *S. noveboracensis* immatures, and there was no interaction between month and parasite presence or absence for this case. Where there was interaction between month and parasite presence or absence (*Z. albicollis* immatures; *C. ustulatus* males) separate analysis for each month showed no differences for *C. ustulatus* males, and a significant effect of parasite presence or absence for *Z. albicollis* immatures in July. In the latter case, there was a disproportionate sample size (seven uninfected birds, 102 infected). In several of these cases unequal sample sizes among years, months and parasite presence or absence may have been a contributing factor to these significant interactions.

TABLE 2. Comparison of the body masses of 15 species of birds infected and uninfected with blood parasites at Glenwood, Canada, 1981 to 1983.

Family and species	Age : sex	Weight (g)			
		Uninfected		Infected	
		$\bar{x}$ (SD)[a]	n	$\bar{x}$ (SD)	n
Tyrannidae					
Empidonax flaviventris	AHY[b]	10.9 (1.3)	141	11.1 (1.2)	13
(Yellow-bellied flycatcher)	HY	10.7 (1.2)	58	10.4 (1.4)	16
Paridae					
Parus atricapillus	AHY:F	11.0 (1.2)	16	11.5 (0.9)	15
(Black-capped chickadee)	HY	11.3 (1.5)	19	11.1 (1.6)	14
Muscicapidae					
Turdinae					
Turdus migratorius	AHY:M	82.3 (5.7)	15	81.7 (7.4)	51
(American robin)	HY	77.8 (5.7)	10	78.3 (7.9)	24
Catharus guttatus	AHY:M	29.8 (2.0)	10	29.4 (2.1)	9
(Hermit thrush)	AHY:F	30.7 (3.2)	14	32.0 (4.8)	10
	HY	28.9 (2.9)	28	29.0 (1.9)	53
Emberizidae					
Parulinae					
Mniotilta varia	AHY:M	10.6 (1.5)	41	10.3 (1.1)	36
(Black-and-white warbler)	AHY:F	11.6 (2.2)	31	11.1 (1.2)	16
	HY[c]	10.0 (1.3)	17	10.8 (0.9)	17
Dendroica magnolia	AHY:M	8.9 (1.4)	36	8.9 (1.0)	36
(Magnolia warbler)	AHY:F	9.7 (1.5)	24	9.0 (1.3)	22
	HY	9.2 (1.7)	21	9.2 (1.5)	42
Dendroica coronata (Yellow-rumped warbler)	HY	12.4 (1.5)	17	11.9 (1.9)	52
Dendroica striata	AHY:M	12.5 (1.5)	69	12.5 (1.1)	47
(Blackpoll warbler)	AHY:F	12.3 (2.0)	35	12.6 (2.9)	42
	HY	12.0 (1.6)	22	12.4 (2.2)	37
Vermivora peregrina (Tennessee warbler)	HY	9.7 (1.7)	19	9.8 (1.7)	28
Wilsonia pusilla (Wilson's warbler)	AHY:M	8.1 (1.5)	37	7.6 (0.9)	13
Emberizinae					
Melospiza lincolnii	AHY:M	19.0 (2.2)	19	18.1 (2.2)	39
(Lincoln's sparrow)	AHY:F	18.6 (4.1)	9	17.7 (2.5)	23
	HY	17.7 (1.9)	25	17.5 (1.8)	68
Passerella iliaca	AHY:M	38.7 (2.1)	8	37.4 (2.8)	49
(Fox sparrow)	AHY:F	36.8 (3.8)	20	36.2 (5.3)	23
	HY[d]	33.4 (2.8)	14	36.3 (3.7)	33

[a] Mean (standard deviation).
[b] AHY, after hatching year, sex unknown; HY, hatching year, sex unknown; AHY:F, after hatching year, female; AHY:M, after hatching year, male.
[c] One-way ANOVA, infected versus uninfected; $F = 4.81$, df = 1,32, $P < 0.04$.
[d] One-way ANOVA, infected versus uninfected; $F = 6.53$, df = 1,45, $P < 0.01$.

One-way ANOVA for the remaining 12 species revealed only two differences in body mass (Table 2). In both instances, parsitized immature black-and-white warblers (*Mniotilta varia*) and fox sparrows (*Passerella iliaca*) had greater mass than did uninfected birds. Variances were homogeneous in 23 of 27 analyses. The vari-

TABLE 3. Comparison of body masses of eight species of birds having high intensity parasitemias with those of uninfected birds at Glenwood, Canada, 1981 to 1983.

Host species	Host status[a]	Parasite species: *Haemoproteus* sp. $\bar{x}$ (SD)[b]	*n*	*Leucocytozoon* sp. $\bar{x}$ (SD)	*n*	Uninfected $\bar{x}$ (SD)	*n*
American robin	M	—		80.8 (4.7)	8	82.3 (5.7)	15
	HY	—		77.5 (9.9)	11	77.8 (5.7)	10
Swainson's thrush	M	31.0 (3.4)	6	31.4 (3.5)	19	31.0 (3.4)	95
	F	31.7 (3.7)	5	—		31.0 (2.8)	56
	HY	—		31.3 (2.4)	23	31.6 (2.5)	109
Hermit thrush	HY	—		29.3 (2.8)	13	28.9 (2.9)	28
Magnolia warbler	HY	—		9.5 (1.5)	6	9.2 (1.7)	21
Yellow-rumped warbler	M	12.6 (2.6)	7	—		11.8 (2.1)	5
	HY	13.3 (1.4)	7	13.0 (3.3)	6	12.4 (1.5)	17
Northern waterthrush	HY	—		16.4 (1.8)	83	16.5 (1.7)	150
Fox sparrow	M	38.2 (1.7)	7	—		38.7 (2.1)	8
	F	35.8 (2.1)	3	—		36.8 (3.8)	20
	HY	36.3 (5.5)	7	35.1 (4.6)	8	33.4 (2.8)	14
White-throated sparrow	M	26.1 (2.2)	21	—		26.3 (3.6)	28
	F	25.4 (2.3)	14	27.0 (2.4)	9	26.1 (2.4)	29
	HY	24.4 (3.1)	50	24.0 (2.6)	44	25.6 (3.2)	48

[a] M, male; F, female; HY, immature (hatching year bird).
[b] Mean (standard deviation).

ability of body mass values was not affected greatly by parasitism. In only one case was the variance of parasitized birds significantly greater than that of uninfected birds.

Body masses for eight species selected for analysis of the effects of high intensity infections are presented in Table 3. There were no differences among birds with high intensity infections of *Haemoproteus* or *Leucocytozoon* and uninfected birds. Further testing of the different categories of infection for white-throated sparrows did not reveal any differences that could be attributed to high intensity infections.

DISCUSSION

The present study does not reveal any effect on host body mass due to the presence or absence of infections with haemoproteid or leucocytozoid parasites. Interactive effects of independent variables on body mass as analyzed by the factorial ANOVA might be expected due to the influence of weather, season and other extrinsic factors. Effects of unequal sampling across all variables might also be reflected in these results. In fact, most interactive effects included a factor of time (month, year); interactive effects due to parasite presence or absence were demonstrated in only two instances.

When making a number of pairwise comparisons between body masses of parasitized and nonparasitized birds, a few significant differences might be expected due to chance. The fact that there were only two differences in parasitized versus nonparasitized comparisons is therefore notable; in these two cases, birds with parasites actually had greater body mass than did nonparasitized birds.

If blood parasites had an effect on body mass, it is probable that this would be maximal under conditions of high intensity parasitemia. Variability within the wide range of parasitemia observed might have masked such effects. There were no significant differences among birds with high intensity infections of either *Haemoproteus* sp. or *Leucocytozoon* sp. or uninfected birds. Also, there were no differences when the categories were further subdivided to represent exclusive infec-

tions of either the *Haemoproteus* genus or *Leucocytozoon*.

It is difficult to understand why the presence of blood parasites did not have a greater measurable impact on the body mass of their avian hosts. Either (1) parasitism does not cause loss of body mass in these birds or (2) our techniques were too insensitive to detect a small change in body mass.

Loss of body mass in parasitized domestic turkeys has been elegantly demonstrated by the experimental studies of Atkinson et al. (1988). Presumably, similar reduction in body mass also could occur in other avian species. However, it is probable that given the small mass of the individuals of the bird species involved, changes due to haematozoa (although potentially significant to the bird) are too small to distinguish from other naturally occurring fluctuations. In addition, the data do not allow for the study of the function of body size on body mass. A measure of size as a covariate in analyses of covariance might be useful if, for example, an infection in a very young bird affects its growth rate.

The proper evaluation of the impact of avian blood parasites on their passeriform hosts will require more subtle methods, perhaps related to breeding behavior or mate selection (Hamilton and Zuk, 1982). Alternatively, the lack of response in body mass to blood parasites as demonstrated in this study may reflect the normal condition in which a community of birds has coevolved with parasites to produce a minimum of impact on the survival of the host species.

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