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HAEMATOZOAN PARASITES OF MOURNING DOVES IN FLORIDA[1]

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Abstract: A total of 918 mourning doves *(Zenaida macroura)* collected from six localities in Florida over a three year period (1973-1976) was examined for haematozoan infections. Three species of haematozoans were encountered: *Haemoproteus maccallumi* (92% prevalence), *H. sacharovi* (3% prevalence), and *Leucocytozoon marchouxi* (0.1% prevalence). No trypanosome or *Plasmodium* infections were found. Adult doves did not show sexually or seasonally-related differences in infection intensity. Immature doves, however, had parasitemias which showed cyclic seasonal fluctuations, but since these decreased with age, this seasonal fluctuation was interpreted to be due to changes in age composition of the population and not season itself. Doves from northern Florida showed significantly lower parasitemias than doves from the southern part of the state.

INTRODUCTION

An estimated 500 million mourning doves exist throughout North America.[7] Although considered a songbird in many northern states, a national bag of 49 million doves annually makes this species the most abundantly harvested game animal in the U.S.[7] In general, little is known of the impact of protozoan parasites on mourning dove populations, particularly in Florida. Only three studies have reported protozoan parasites in mourning doves in Florida, and these found only *Trichomonas gallinae* and *Haemoproteus maccallumi*.[2,11,22]

Florida is unique in the U.S. in having doves breeding nearly year-round,[22] and also in possessing a generally non-migratory population of this species.[17,22] The present study therefore was initiated to study the distribution of haematozoans of mourning doves in relation to host age, sex, location, and prevalence and levels of parasitemia; to determine the seasonal dynamics of mourning dove haematozoans from one study area in central Florida; and to test for the presence of *Plasmodium* in a population of doves in north-central Florida.

MATERIALS AND METHODS

A total of 918 doves was collected from six counties in Florida between October, 1973 and August, 1976 (Fig. 1). Most of the doves were live-trapped in modified Stoddard box traps, while some were killed with shotguns. Doves were aged by analysis of feather development; immature doves were assigned age classes according to their successive primary wing feather moult.[21] Adults were sexed by external characteristics, occasionally supplemented by cloacal examination or by internal examination at necropsy.[10,18]

Blood smears were stained with Giemsa after fixation in absolute methyl alcohol, and examined under oil immersion (1,000X) until approximately 10,000 erythrocytes were viewed. Forty doves collected between June and August, 1976 in north-central Florida (Alachua Co.)

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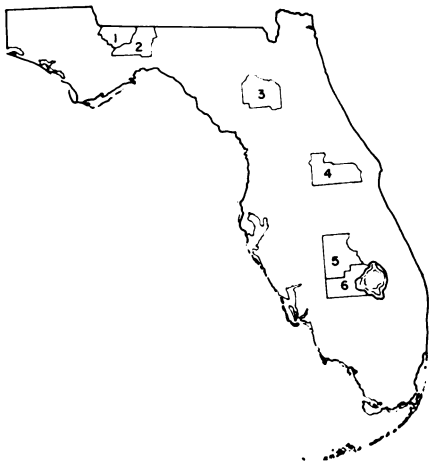

FIGURE 1. Location of mourning dove collection sites in Florida, 1973-1976. (1) Gadsden Co., (2) Leon Co., (3) Alachua Co., (4) Orange Co., (5) Highlands Co., (6) Glades Co.

were studied further, utilizing the following technique. Whole blood was subinoculated into Pekin ducklings, which were judged as suitable recipients on the basis of their susceptibility to a variety of *Plasmodium* species and in particular to most of those known from columbids.[6] Forty ducklings, each subinoculated intraperitoneally with 0.5 - 1.0 cc. of whole blood from as many doves, and 18 control ducklings were bled every second or third day for five weeks.

Haematozoan infections were recorded in terms of numbers of parasites per 10,000 erythrocytes. Haemoproteids were recorded by species, but since most immature forms (trophozoites) could not be differentiated, identified gametocytes and unidentified trophozoites were treated collectively and subsequently are referred to as *Haemoproteus* spp. The recording of actual numbers of parasites undoubtedly includes variations due to smear scanning and sampling errors, temporal and spatial variation within the month and location being sampled, etc. Diurnal variation was considered insignificant in view of Coatney's finding of aperiodicity of daily gametocyte production of *H. columbae* in pigeons.[4] We feel that such variations sufficiently average out with our large sample. To further minimize these variations, the data were grouped into four relative classes according to levels of parasitemia: "0" for absence of haemoproteids, "1" for 1-100 observed parasites per 10,000 erythrocytes, "2" for 101-300 observed parasites per 10,000 erythrocytes, and "3" for greater parasitemias.

The data were analyzed utilizing the Statistical Analysis System library of computer programs.[1] Analysis of variance, regression, and least significant difference tests were all conducted at $p \leq 0.05$.[20] Models suggested by the available, quantifiable data (such as age, sex, county and month of sampling) were developed and tested for significance of the data under consideration as predictors of the variable (infection level or 1/mean age) being analyzed. Because of differences in sample size, location and time, models were tested using all data from the entire Florida sample, data from Orange Co. only, or Florida data excluding Orange Co. as deemed appropriate.

Representative blood films have been deposited in the U.S. National Parasite Collection, Beltsville, Maryland (Nos. 74476-74477) and in the collection of the International Reference Centre for Avian Haematozoa, St. John's, Newfoundland (Nos. 57514-57516).

RESULTS AND DISCUSSION

No trypanosome or *Plasmodium* infections were found. *Leucocytozoon marchouxi* was found in only one lightly-infected adult dove in central Florida (Orange Co.); perhaps this was one of the small number of doves believed to migrate between Florida and other states.[17,22]

Two species of *Haemoproteus* were encountered: *Haemoproteus maccallumi* (92% prevalence) and *H. sacharovi* (3% prevalence). Further details are presented in Table 1. Although previous studies have shown that the prevalence of *Haemoproteus* in doves varies greatly,[18,19] our data showed a lower prevalence of *H. sacharovi* and a higher prevalence of *H. maccallumi* than has been reported for most other areas.

Since the prevalence of *H. sacharovi* was so low while *H. maccallumi* and *Haemoproteus* spp. were both so high, only these latter two were used in subsequent data analysis. Although both *H. maccallumi* and *Haemoproteus* spp. treatments were modeled and tested (including actual parasitemia and relative parasitemia presentations of each), only *Haemoproteus* spp. expressed as classes of relative parasitemia is presented here. This represents the most statistically conservative approach and therefore the most reliable analysis of the data. Results from tests of the data thus analyzed agreed with those from the other data treatments which are presented in detail elsewhere.[10]

County of sampling was found to be a significant factor when tested as a predictor of relative parasitemia ($F = 17.69$, $p \leq 0.05$) for the entire sample (excluding Orange Co.). Mean relative parasitemias for all June, 1976 - August, 1976 observations were compared both individually and as aggregates of adjacent counties. While individual county differences were generally not significant, the mean intensities observed in the northern counties (Gadsden and Leon) were significantly lower than those of both the north-central sample (Alachua Co.) and the southern counties (Glades and Highlands), though none of these latter three counties were significantly different ($p \leq 0.05$). Similar conclusions can be made for the prevalence data (Table 1). The sharpness and location of the transition line (or zone) between the two differing areas of infection thus defined may possibly be determined by further field work. It would appear that one or more environmental factors are involved here, probably acting on the vectors, parasite development within the vectors and/or hosts, or combinations of these. By assessing the known mortality factors such as hunting, exposure, predation, etc., any remaining significant mortality differences in the two areas could possibly be attributable to debilitation by parasites, including *Haemoproteus*.

Analysis of the relationship of maturity and season as predictors of relative parasitemia demonstrated that these factors comprised a significant model ($F = 32.03$, $p \leq 0.05$) at least in central Florida (Orange Co.). The maturity differences are obvious in the graph developed from this model (Fig. 2). Accordingly, these two groups were subsequently analyzed as distinct populations. Adult doves have been found to be more frequently infected than immature doves by several studies,[8,9,14] although significant differences could not be demonstrated in the present study (Table 1).

TABLE 1. Haematozoan infections of mourning doves in Florida.

			Prevalence* (percent)							
	Sample Size‡		Immatures				Adults			
County+	Im.	Ad.	Hs	Hm	Ha	Lm	Hs	Hm	Ha	Lm
1	15	4	0	7	7	0	0	25	25	0
2	16	3	0	25	25	0	0	33	33	0
3	88	71	6	73	73	0	7	99	99	0
4	428	255	<1	98	98	0	1	98	98	<1
5	2	13	0	100	100	0	8	92	92	0
6	3	20	0	100	100	0	35	95	100	0
Total	552	366	1	94	94	0	2	98	98	<1

\+ 1 = Gadsden Co.; 2 = Leon Co.; 3 = Alachua Co.; 4 = Orange Co.; 5 = Highlands Co.; 6 = Glades Co.

‡ Im. = immatures; Ad. = adults

* Hs = *Haemoproteus sacharovi;* Hm = *Haemoproteus maccallumi;* Ha = *Haemoproteus* spp.; Lm = *Leucocytozoon marchouxi*

Sex of adults was found insignificantly related to relative levels of parasitemia, considering the entire sample ($F = 0.65$, $p \leq 0.05$). It follows that it makes little difference that sex data were not available for immature doves. As adult doves are very similar in appearance, size, and behavior, remaining sexually-related differences (such as reproductive stresses and hormonal differences) are apparently insignificant for level of parasitemia.

The specific age of immature doves as a predictor of relative level of parasitemia was found to be significant ($F = 36.32$, $p \leq 0.05$) for all observations. In the graph developed from this model (Fig. 3), it is apparent that observed parasitemias decreased as older birds were sampled. This was most likely due to one or both of the following: (1) highly infected young nestlings suffered high mortality due either to direct or indirect effects of high parasitemia; or more likely, (2) the high infection levels of young nestlings decreased with time as the infections themselves matured and the hosts and parasites adapted to one another. The slope of the regression line in Fig. 3 was found to be more negative than a corresponding graph developed for *H. maccallumi*.[19] Since the *Haemoproteus* spp. data included the trophozoites of new infections that the *H. maccallumi* data lacked, this larger decrease with age for *Haemoproteus* spp. suggested the presence of older infections, thereby supporting statement (2) above.

Time of year of sampling was found insignificantly related to relative parasitemia of adults in central Florida (Orange Co.) ($F = 0.26$, $p \leq 0.05$) and also for the entire sample ($F = 0.22$, $p \leq 0.05$). However, time of year did prove to be significant for the immature doves (as a group) of the entire sample ($F = 53.84$, $p \leq 0.05$). These contrasting conclusions are consistent with those expected from Fig. 2 for central Florida (Orange Co.). Both observed and best fit values indicated a peak in parasitemia between February and April, and a low between September and December. However, analysis of the relationship between month of sampling and mean age $^{-1}$ (or 1/mean age) for immatures, suggested both by casual observation of age tables for each month's samples and by the inverse relationship of age and infection level that was found, resulted in the graph shown in Fig. 4. Note the similarity of the curve to the immature curve in Fig. 2. We conclude that time of year is

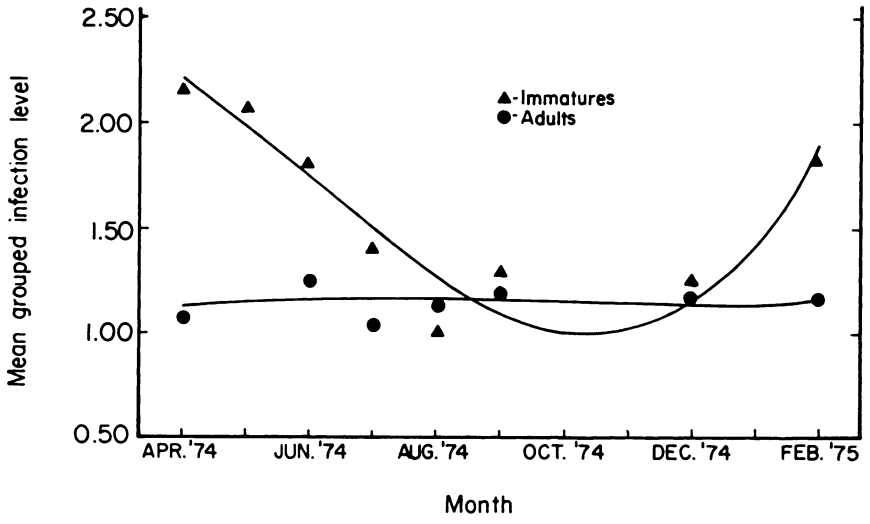

FIGURE 2. Temporal changes of parasitemias of **Haemoproteus** in mourning doves in Florida.

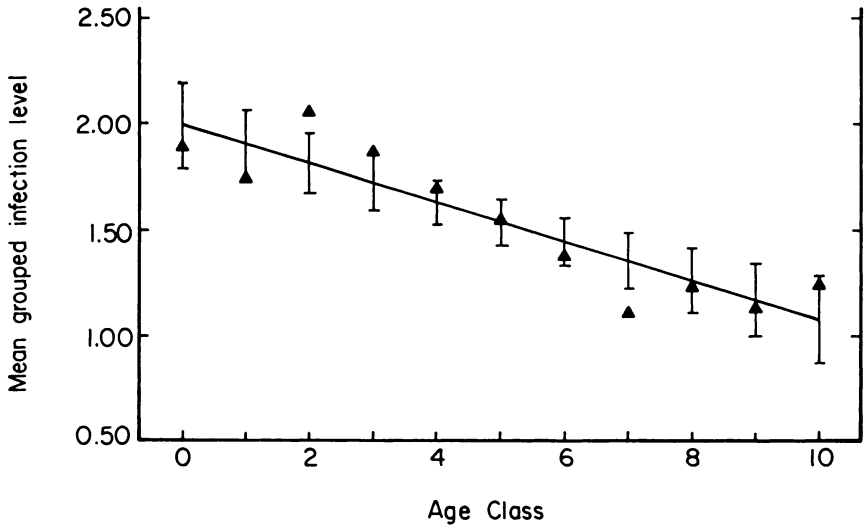

FIGURE 3. Relationship of age with parasitemias of **Haemoproteus** in mourning doves in Florida (vertical bars designate 95% confidence intervals).

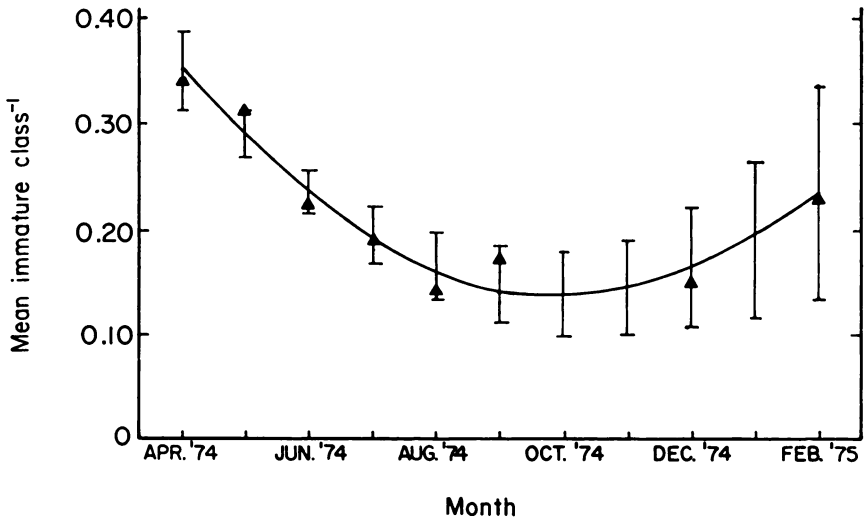

FIGURE 4. Temporal changes of mean ages of immature mourning dove collections in Orange Co., Florida (vertical bars designate 95% confidence intervals).

significantly related to infection levels of immatures as a group but this seems to be a function of changes in the age distribution of the group from month to month rather than of age of the individual bird.

Most researchers feel that the imporance of haemoproteids has not been demonstrated.[3,12] Others, however, have found indirect evidence suggesting at least occasional seriousness of haemoproteid infection.[5,10,15] Garnham[6] reported enlarged, congested livers and hypertrophied, blackened spleens in domestic pigeons *(Columba livia)* at the peak of *H. columbae* infections. So it certainly seems reasonable to consider that at least at the heights of infection (and during other phases, but to lesser extents) that interactions with other disease agents, with normal daily stresses of living, and with periodic or irregular stresses such as breeding, prolonged temperature extremes, etc., may result in a significant contribution of *Haemoproteus* to mortality among doves in Florida. Particular attention needs to be directed to infections of immature doves, since levels of parasitemia dramatically greater than those found in adult doves were found during this study.

Our findings suggest that future considerations of parasitism of doves in Florida concentrate more on the highly prevalent haemoproteids than on *Plasmodium, Trypanosoma,* and *Leucocytozoon.* Definitive evaluations of the impact of the observed parasites were not meant to be developed in this study. There is simply too little known about the interactions of haemoparasites with their hosts while in their natural habitat with its many variables. Hopefully this study provides some assistance for researchers in the future seeking to obtain a better understanding of these interactions.

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