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HEMATOZOA OF WOOD DUCKS (*Aix sponsa*) IN THE ATLANTIC FLYWAY ¹

JAMES E. THUL, ² ³ DONALD J. FORRESTER ² ³ and ELLIS C. GREINER ²

Abstract: A total of 213 wood ducks (*Aix sponsa*) from 24 localities in 12 states in the Atlantic Flyway was examined for blood parasites in 1976 and 1977. Hematozoa were present in birds from every collection site from Virginia northward to Maine. Only one infection was detected in birds from North Carolina southward to Florida. *Haemoproteus nettionis* was the most common parasite, occurring in 56% of the northern wood ducks; *Leucocytozoon simondi* (20%), *Plasmodium circumflexum* (6%), and microfilariae (18%) were found also. *Plasmodium*, *Leucocytozoon*, and microfilariae were more commonly observed in juvenile birds than adults. There was no difference in prevalence between male and female ducks. The prevalence of each parasite species varied among collection sites in the northern states.

INTRODUCTION

Blood parasites have been implicated as causes of disease and mortality in young waterfowl.^{2,10,18,23,25} Thousands of waterfowl have been surveyed for blood parasites in an attempt to assess the extent of this potential problem.¹⁴ *Haemoproteus nettionis*, *Leucocytozoon simondi*, *Plasmodium circumflexum*, *P. relictum*, *Trypanosoma* sp., and microfilariae have been reported from wood ducks in the northeastern United States and eastern Canada.^{1,3,4,7-9,11,13,14,16,17,19-22} The primary breeding grounds of most species of North American ducks are in Canada and the northern states, and surveys have been conducted almost exclusively within these areas. However, the breeding range of the wood duck extends much further south from the areas typically studied. The wood duck is an unusual species of

Nearctic anatid because it has a non-migratory population which breeds as far south as Florida, as well as a migratory population which moves to eastern Canada and the northeastern United States to breed.^{5,24} Resident breeding birds from the southern portion of the wood duck's range have not been examined for hematozoa. The present study was initiated to determine the prevalence and distribution of blood parasites of wood ducks in the Atlantic Flyway.

MATERIALS AND METHODS

A total of 213 wood ducks was collected from 24 counties in 12 states from 18 May to 8 October 1976, and 23 August to 4 October 1977 (Fig. 1). Birds were live-trapped or killed with shotguns.

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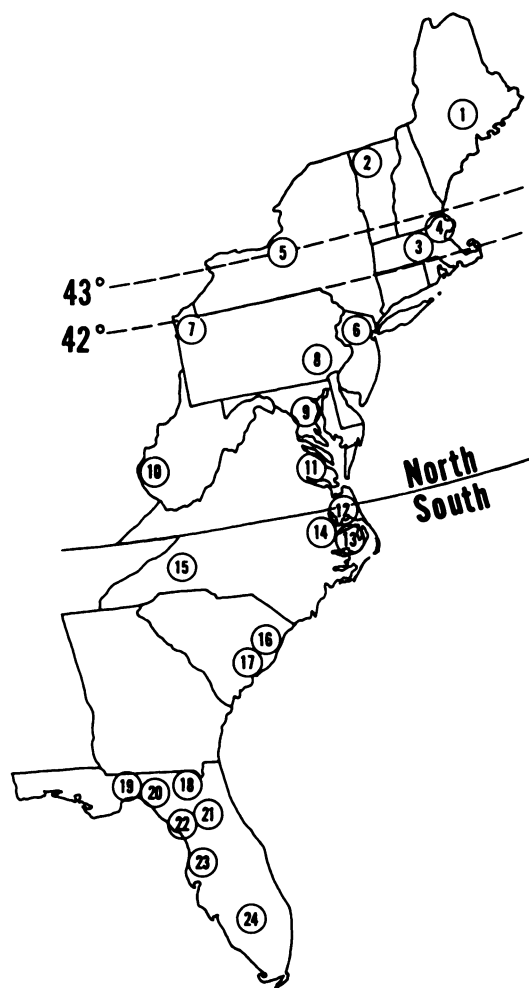


FIGURE 1. Collection sites of wood ducks collected in the Atlantic Flyway, 1976-1977. (1) Penobscot County, Maine (N=24); (2) Franklin County, Vermont (N=10); (3) Worcester County, Massachusetts (N=9); (4) Essex County, Massachusetts (N=3); (5) Cayuga County, New York (N=12); (6) Morris County, New Jersey (N=12); (7) Erie County, Pennsylvania (N=7); (8) Lancaster County, Pennsylvania (N=3); (9) Montgomery County, Maryland (N=11); (10) Mason County, West Virginia (N=5); (11) Charles City County, Virginia (N=12); (12) Chowan County, North Carolina (N=2); (13) Tyrrell County, North Carolina (N=4); (14) Washington County, North Carolina (N=8); (15) Burke County, North Carolina (N=12); (16) Georgetown County, South Carolina (N=2); (17) Berkeley County, South Carolina (N=15); (18) Hamilton County, Florida (N=4); (19) Gadsden County, Florida (N=10); (20) Leon County, Florida (N=24); (21) Alachua County, Florida (N=3); (22) Levy County, Florida (N=14); (23) Hernando County, Florida (N=6); and (24) Glades County, Florida (N=1).

Blood films were made with blood from the brachial vein or heart and stained with Giemsa after fixation in 100% methanol. The periphery of the smear was scanned at low power (160×) for evidence of large hematozoans. Medium (400×) and high (1000×) powers were used to scan further until at least 50,000 red blood cells were viewed. Representative blood films have been deposited in the National Parasite Collection, Beltsville, Maryland (Nos. 75323-75327) and in the International Reference Centre for Avian Haematozoa, St. John's, Newfoundland (Nos. 68861-68923).

RESULTS

Microfilariae and three species of haemosporidians were encountered, namely *Haemoproteus nettionis*, *Leucocytozoon simondi*, and *Plasmodium circumflexum*. The prevalences of these parasites at each

collection site are presented in Table 1. *Trypanosoma* was not detected.

Blood protozoan infections were restricted to the Northeast (Virginia to Maine) and, 63 of the 108 (58%) northern birds were infected. Nineteen cases of microfilariae (18%) were encountered in the northern birds, whereas one case of microfilariae was the only hematozoan infection in the 105 southeastern birds.

The overall prevalence of infections in northern birds showed no difference from 1976 (61%) to 1977 (60%). Because there were no statistical differences between prevalences of parasites from 1976 and 1977, the data were pooled for age analysis. Sixty percent of the adult and 58% of the immature northern birds were infected with one or more hematozoa. The high prevalence of *H. nettionis* in both ages (32 adult-55%, 28 immature-56%) was responsible for the similarity in this overall prevalence. Immature birds showed higher prevalences

TABLE 1. Prevalence of hematozoans* in wood ducks of the Atlantic Flyway, 1976-1977.

Location	Site Nos.**	No. Ducks Examined	% Infected				
			H	L	P	M	Total
Maine	1	24	83	83	21	46	96
Vermont	2	10	20	0	0	20	30
Massachusetts	3-4	12	67	0	0	0	67
New York	5	12	50	0	0	0	50
New Jersey	6	12	58	0	0	8	58
Pennsylvania	7	7	57	14	0	43	57
Pennsylvania	8	3	100	0	0	0	100
Maryland	9	11	45	9	9	9	45
West Virginia	10	5	20	0	0	20	20
Virginia	11	12	33	0	0	0	33
Northeast	1-11	108	56	20	6	18	59
North Carolina	12-14	14	0	0	0	0	0
North Carolina	15	12	0	0	0	0	0
South Carolina	16-17	17	0	0	0	0	0
Florida	18-24	62	0	0	0	2	2
Southeast	12-24	105	0	0	0	1	1
Flyway	1-24	213	28	10	3	9	31

*H = *Haemoproteus nettionis* L = *Leucocytozoon simondi*

P = *Plasmodium circumflexum* M = Microfilaria

**Numbers refer to legend of Figure 1.

of *L. simondi*, *P. circumflexum*, and microfilariae (Table 2). Multiple infections occurred in 27 (42%) of the infected birds. Seventeen (58%) of the infected immature birds and 10 (28%) of the infected adult birds harbored multiple infections. More immatures harbored triple and quadruple infections (10 birds-34%) than adults (2 birds-6%).

DISCUSSION

Haemoproteus nettionis was the most prevalent hematozoan. It was found in every collection site from Virginia to Maine (11 sites) and was absent in every collection site from North Carolina to Florida (13 sites). In the Northeast, it occurred in 94% of the infected birds. Wood ducks infected with *H. nettionis* have been reported from several northeastern states and Canadian provinces. The reports from New Jersey, West Virginia, and Virginia in the present study represent new state records for this host. Prevalence varied among collection sites with a general trend of higher prevalences in more northerly latitudes. Vermont, at approximately the same latitude as Maine, was an exception with only 2 of 10 birds infected (20%). Herman *et al.*¹⁷ found similar low prevalences in wood ducks from Vermont (14%-1952 and 24%-1953). Bennett *et al.*³ showed that higher prevalences occurred earlier in the year (peaks in April and early September) in Massachusetts. The southern limit of *H. nettionis* transmission in the Atlantic Flyway appears to occur approximately along the Virginia-North Carolina border.

Leucocytozoon simondi from Maryland and Pennsylvania represent new state records for the wood duck. Of the 64 infected northern birds, 22 (34%) were infected with *L. simondi*. Herman¹⁵ summarized the apparent transmission of this parasite noting that it is most common in northern areas and postulated that the southern boundary of *L. simondi* transmission was ap-

proximately 43° N Latitude. In our study we found that birds from Massachusetts, Vermont, and New York were negative, but records of *L. simondi* in wood ducks have been reported from those states by other authors.^{3,9,17} The high prevalence of infections in Maine is in agreement with previous studies.^{14,17,21,22} Herman *et al.*¹⁷ attributed the variation in prevalence between collection sites in their study to seasonal variations, distribution of insect vectors, or to other unrecognized factors.

The higher prevalence of *L. simondi* in immatures of the present study is not in agreement with the results of Bennett *et al.*³ in Massachusetts. They sampled over 730 wood ducks from various locations throughout the state and found a higher prevalence in adults. They hypothesized that the higher susceptibility of young birds could lead to death, either directly or indirectly, before these birds would be included in the sample. This would lead to a lower rate of infection detected in the surviving immatures. They suggested that this parasite, which is the most pathogenic of the four hematozoans, was a potential limiting factor to wood duck production in the state.

Bowers and Martin⁶ found that wood ducks banded in areas above 42° N Latitude had significantly lower survival rates than birds banded below this line. They arrived at this finding independently of Herman¹⁵ and went on to comment that the lower survival rates of northern birds could have been caused by high losses from natural mortality factors. As mentioned earlier, the range of transmission of *L. simondi* corresponds very closely with the area where low survival rates are found in wood ducks, leading to the possibility that this parasite plays an important role in mortality and limiting production in wood duck populations north of 42° N Latitude.

Microfilariae in wood ducks from Florida, Maryland, West Virginia and

TABLE 2. Prevalence of hematozoans* in adult and immature wood ducks in the northern half of the Atlantic Flyway, 1976-1977.

Location	Site Number**	Adults					Immatures				
		% Infected					% Infected				
		No. Examined	H	L	P	All	No. Examined	H	L	P	All
Maine	1	9	67	55	11	22	15	93	100	27	60
Vermont	2	5	20	0	0	40	5	20	0	0	20
Massachusetts	3-4	6	83	0	0	0	6	50	0	0	50
New York	5	6	50	0	0	0	6	50	0	0	50
New Jersey	6	7	71	0	0	14	5	40	0	0	40
Pennsylvania	7	2	100	0	0	100	5	40	0	0	40
Pennsylvania	8	2	100	0	0	0	1	100	0	0	100
Maryland	9	6	50	0	0	0	5	40	20	20	40
West Virginia	10	5	20	0	0	20	0	0	0	0	0
Virginia	11	10	40	0	0	0	2	0	0	0	0
Northeast	1-11	58	55	8	2	13	50	56	34	10	22
						60					58

*H = *Haemoproteus nettionis* L = *Leucocytozoon simondi*P = *Plasmodium circumflexum* M = Microfilaria

**Numbers refer to legend of Figure 1.

Vermont represent new state records. The unusual record of an infection in the South occurred in an adult male bird shot on 15 September 1977 in Florida.

Plasmodium circumflexum was found in 9% of the infected birds. Infections were recorded in Maine (10 September 1976 and 23 August 1977), and Maryland (5 October 1977) and constitute the first reports of this parasite in these states. Previous records of this parasite in wood ducks were in Vermont and Massachusetts.^{3,17} Experimental sub-inoculations of blood from wood ducks in Maryland by Herman *et al.*¹⁷ produced no infections in domestic mallard ducklings. The *Plasmodium*-positive Maryland bird was also infected with the other three hematozoans. Considering its capture date (5 October 1977), there remains the possibility that it originated from a point further north. Triple and quadruple infections were only found in birds from far northern states, primarily due to the distribution of *L. simondi*, which (except for the Maryland case) was restricted to areas north of 42° N Latitude. The same may hold true for *P. circumflexum*.

The geographic range of suitable vectors appears to be the best explanation for the limited range in the transmission of hematozoa. Schorger²⁴ suggested that male wood ducks may be migratory one year and not the next. A drake could pair one winter with a northern hen, the next with a southern hen, and then accompany the southern hen to her breeding ground. If this occurred, infected drakes originally from the North could pair with resident southern hens during the winter and undergo relapse of infection in the South during the spring. In addition,

crippled and diseased waterfowl unable to migrate north also could undergo relapse of infection in the South. These infected waterfowl would provide sources of infection for suitable vectors which could then transmit the infection to resident waterfowl in the South. This does not seem to occur. Other native waterfowl surveyed in Florida support these data. Sixty-two Florida ducks (*Anas f. fulvigula*) and 5 Florida duck-mallard hybrids (*A. f. fulvigula* × *A. platyrhynchos*) sampled during the summers of 1970-1971 and 52 non-migratory Canada geese (*Branta canadensis*) sampled during the summer of 1978 were negative for hematozoans (Forrester, unpubl.). The appropriate vectors were evidently absent. In the case of the wood ducks, the lack of infected male birds in the southern sample may indicate that northern migratory birds tend to remain migratory and that southern wood ducks remain resident from year to year, otherwise the relapse infections would have been detectable.

In conclusion, even though the hematozoa discussed herein are believed to be infective to the entire anatid community, non-migratory wood ducks breeding in the southern portion of the Atlantic Flyway are essentially free of these parasites. The migratory wood duck utilizing the northerly portions of the flyway harbor at least six hematozoan species. Because of similar collection dates for all of the samples made in the present study, factors other than season must explain the north/south dichotomy in hematozoan prevalence. The most likely explanation for this difference is geographical and/or temporal distribution of the appropriate vectors.

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