Blood Parasites of Some Common Texas Birds[1]

Andrew B. Couch, Jr.[2]

Danilwesky observed and recorded avian plasmodia in 1885. Laveran (1891) emphasized the importance of this discovery and suggested that research on bird malaria might help to solve questions on human malaria. Since then, significant papers on bird malaria have been presented by such investigators as R. W. Hegner, W. H. and Lucy G. Taliaferro, C. G. Huff, R. D. Manwell, and R. Hewitt, who studied morphology, physiology, immunity, and transmission of the parasites. Hewitt (1940) made these earlier findings readily available in his monograph on bird malaria.

The life histories of avian and human plasmodia are essentially much alike. Most of the 14 recognized species of avian malaria have a 24-hour asexual cycle. This cycle varies, specifically, from 12 to 72 hours, the period usually being a multiple of 12 hours. Within the same species, the period may exceptionally range from 12 to 36 hours. Known insect vectors of bird malaria include 24 species of the dipteran genera *Aedes, Anopheles, Culex,* and *Culiseta.*

Kruse (1890) described *Haemoproteus,* a crescent or halter-shaped parasite. Grassi & Feletti (1891) (using Laveran's 1890, 1891 malarial taxonomic characteristics) described several species of *Haemoproteus.* MacCallum recorded the processes of exflagellation and fertilization in the genus (1897); and next year discovered the same processes in *Plasmodium falciparum.* His work stimulated research and brought about re-interpretation of the cycle; as a result, Ross (1898) demonstrated the mosquito's role in malaria. Exoerythrocytic stages of *Haemoproteus* attack white and reticulo-endothelial cells, and the gametocytes are found in peripheral blood. Insects of the family *Hippoboscidae* (Diptera) are the only proved vectors for this genus.

Laveran (1900) described a type of parasite in bird blood; later, Nicolle and Manceaux (1909) discovered a similar

[1]Thesis, submitted in partial fulfilment of the requirements for the M.S. degree in Biology, Southern Methodist University.

[2]My best thanks are due to Dr. Clay G. Huff, Naval Medical Center, Bethesda, Md. who verified my identifications and gave valuable suggestions; to Professor E. P. Cheatum for direction and guidance; to Professor J. P. Harris Jr., for helpful suggestions; and to Professor S. W. Geiser, for critical reading of the manuscript and emending it for publication.

parasite in rodents, and described the genus *Toxoplasma*. At present, *Toxoplasma* is not well understood, but it is generally agreed that the avian variety is not a true *Toxoplasma* (Huff, 1952). Infections are not common in the peripheral blood of birds, but usually localized in highly vascular tissues, as also in the brain and mesenteries. Manwell (1941) saw a case of avian toxoplasmosis in which large numbers of erythrocytes were parasitized.

Filarial worms of the superfamily *Filarioidea* (Weinland, 1885) commonly parasitize birds. The adult worms inhabit the lymphatic system and the viscera. Fertilized females produce pre-larval microfilariae which require a dipterous insect as intermediate host for transmission. Long association with infected vectors is necessary for heavy infections.

In some species of birds malarial infections occur often, in others, but rarely. The overall incidence of malarial surveys made on birds ranges from 1% to slightly over 19%. Huff (1939) reported that about one third of his 545 birds were infected with *Haemoproteus*. Of his 201 mourning doves, 149 (74%) were infected with *Haemoproteus*.

Methods

Birds were collected by trap or shotgun. All (except the mourning doves) were collected from April 8, 1951 to July 2, 1951; the doves, on Sept. 1, 2, and 3, 1951. New slides were numbered with a diamond-point pen and cleansed with absolute alcohol. Blood samples were taken from toe, leg, heart, or from cutaneous bleeding, as circumstances directed. The numbered slide was smeared immediately and recorded. Before a lapse of 4 days, smears were fixed in absolute alcohol and stained in dilute Giemsa by the Coplin jar method. Fixing- and staining-times were variable, depending on thickness of the smear and quality of the stain. Finally, the smears were allowed to air-dry and were then examined under a 4 mm. objective. Identification was made under oil-immersion. In both operations 6× oculars were used.

Discussion

Identification of plasmodia in wild birds, without laboratory study of the host and sub-inoculation of the infection, may present a difficult problem. For some species such as *P. relictum*, identification may be almost absolute, while for others doubtful or inadvisable.

Differentiation between *Plasmodium* and *Haemoproteus* in double and light infections may usually be made as follows: In *Plasmodium* (1) the life cycle includes erythrocytic segmentation (Fig. 2); (2) the nucleus of the host cell is not displaced, slightly displaced, or terminally displaced (Fig. 1); (3) the mature gametocytes do not enlarge, or but slightly enlarge, the host cell; and (4) the granules are small and clearly defined. In contrast, in *Haemoproteus* (1) the life cycle does not include erythrocytic segmentation; (2) the nucleus of the host cell is displaced laterally; (3) the mature gametocytes enlarge the host cell; and (4) the granules are usually large and may be in close proximity to each other (Fig. 15).

An English sparrow trapped on a hot afternoon in June, was heavily infected with *P. relictum*. The blood of this bird was gray, with a flaky-ash appearance. Although investigators do not consider malarial infections in birds fatal (except when infection is heavy), Huff (1939) reported that "sick" birds were infected with blood parasites. My bird, first-above mentioned, was weak, and had a markedly higher body temperature than that of other birds handled at the same time. The bird died in my hand a few seconds after the leg was removed and the blood collected.

The overall incidence of malaria infection in this survey was 2.3% (or 10) out of 434 birds infected. Excluding the mourning doves (none of which was infected with *Plasmodium*), the incidence among all other birds was 4.5%. This incidence is lower than the incidence of 5.3% of 8,877 birds which have been reported by other investigators (Hewitt, 1940; Micks, 1949; Herman, 1951). Hewitt (1940) pointed out that splenic smears and sub-inoculations should be more accurate for work on incidence, and that (contrary to expectations) the highest incidences were reported by investigators using peripheral blood. The diversity of species represented in these surveys and their diverse migratory habits may also help to account for the variation in reported results.

The incidence of *Toxoplasma* infection in this survey is 4.4%, or 19 infections out of 434 birds. This may be considered high, in view of the rarity of *Toxoplasma* infections in peripheral blood. Corpuscles infected by this organism have a characteristic appearance — the white cells stain

Station	Habitat	Method Collected	Number	Bird	Infected	Incidence Infected(%)
3223 Mabry, Dallas	Gravel street	Trap	123	English sparrow	12	9.8
			1	Blue jay	0	
4618 Bryan, Dallas	In pigeon enclosure	Trap	10	English sparrow	1	10
Couch Ranch, Denton Co. 4 miles west of Celina. Bordering on Little Elm Creek and Collin Co. Line (1)	Blackland, from fields, ponds, and buildings	Shotgun and trap	17	Dickcissel	0	
			3	Eastern kingbird	0	
			1	English sparrow	0	
			9	Field sparrow	0	
			5	Gamecock	0	
			1	Killdeer	0	
			23	Meadowlark	1	4.4
			213	Mourning dove	201	94.4
			1	Orchard oriole	0	
			1	Painted bunting	0	
			2	Purple martin	1	50
			1	Redwing	1	100
			3	Scissortail	0	
			4	Shrike	0	
			8	Sparrow hawk	7	87.5
Frankston (2)	Sandyland Pine Belt in East Texas	Shotgun	2	Blue jay	2	100
			1	Eastern lark sparrow	1	100
			3	Orchard oriole	1	33.3
			1	Redwing	0	
			1	Scissortail	0	

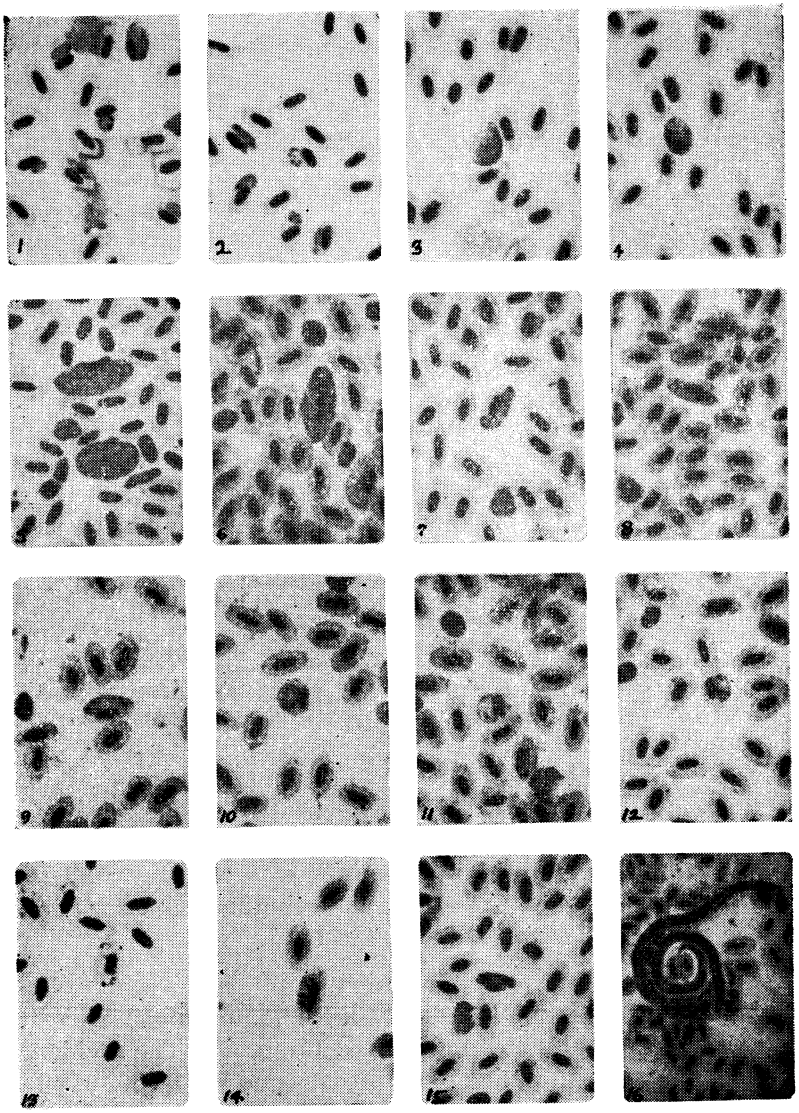
(1) The total of 293 birds collected from Couch Ranch showed an infection incidence of 75.8%.
(2) The total of 8 birds collected from Frankston showed an infection incidence of 50%.

sharply, showing little if any disintegration; and their included parasites appear cup-shaped, with reddish granules localized in the center. While the exact nature of avian *Toxoplasma* is uncertain, some investigators (Hegner and Wolfson, 1938) believe that it is closely associated with and may be a part of the life cycle of *Plasmodium*. Manwell (1945) believes that toxoplasmosis may be a manifestation of coccidiosis.

The incidence of *Haemoproteus* infection in my mourning doves was 94.4%, or 201 infections out of 213 birds. Of these 201 infected birds, 21.9% (44 birds) were infected with only one type of parasite. Infections by *H. sacharovi* made up 28.9% (58) of the total number of infections and *H. maccallumi* 58.8% (118). Huff (1939) reported that 37% of his birds had mixed infections of these two species. In my survey, only 1.5%, or three out of 201 cases, showed this mixed infection. The questionable form (Figs. 10-12) that infected 78.1%, or 157 of the birds, was characterized by rounded gametocytes. Huff (1952) observed this rounded form in the blood of infected birds that have been dead for as short a time as 15 minutes, and noted that the granules were similar to those of *H. maccallumi*. Further investigation, using different techniques in the collection of blood, will probably clarify the taxonomic status of this form, found in 19 birds as single infections. Included in the mixed infections of *Haemoproteus* were 47 cases that had 3 types of parasites, 11 with 4 types, 1 with 5, and three cases unidentifiable.

The aberrant form of *Haemoproteus* is characterized by having a rather long and thin gametocyte that lies along the side of a slightly displaced nucleus (Fig. 15). Large, closely compacted and deeply stained granules fill the parasite, and an irregular margin may appear.

As to what time of year and under what conditions the transmission of *Haemoproteus* takes place is a perplexing problem, particularly in view of the high incidence of infection and the few reports on infestation by proved vectors. I have "picked" (defeathered) at least 500 mourning doves, and observed the picking of at least 1000 more, but have never observed ectoparasites on the birds, nor heard hunters mention the presence of such parasites. It is possible, of course, that a few parasites may have passed unnoticed. My experience in handling these birds has been limited to the



EXPLANATION OF THE FIGURES

FIG. 1. Gametocyte of *Plasmodium relictum* (English sparrow). FIG. 2. Segmenter of *Plasmodium relictum* (English sparrow). FIGS. 3-4. *Toxoplasma* (English sparrow). FIGS. 5-6. Gametocytes of *Haemoproteus sacharovi* (mourning dove). FIGS. 7-9. Gametocytes of *Haemoproteus maccallumi* (mourning dove). FIGS. 10-12. Questionable forms of *Haemoproteus* (mourning dove). FIG. 13. *Haemoproteus* found in sparrow hawk. FIG. 14. *Haemoproteus* found in blue jay. FIG. 15. Aberrant form of *Haemoproteus* (mourning dove). FIG. 16. Microfilariae (blue jay). (Figs. 1-15, ×500; Fig. 16, ×324.)

September hunting season in Texas. The extremely high incidence of *Haemoproteus* infection in mourning doves lends support to the belief of other investigators that such infections are not fatal. The nature of the September, 1951 mourning dove population in relation to age (i.e., young or mature birds), physical condition, and incidence of infection induces speculation as to the effect on the host of *Haemoproteus* infection. Our summer of 1951 was extremely dry, and the birds were "spotty" in distribution during the hunting season. My observations on the number of birds taken in the last ten years in the area of the 1951 collections confirm reports by others of "spotty" distribution. The birds in the season of 1951 were less widely distributed; and when found, were in smaller flocks than in previous years, unless the flocks were located in timbered lowlands. Among the 213 birds collected, the blood of 8% (17) showed erythrocytic mitotic divisions indicative of young birds, but only 2 out of these 17 birds had the feathers and body-form of young birds. About 70% of the rest of the birds examined were in very good condition, as evidenced by their large size and abundant fat. In past seasons such birds would have been considered prize specimens. Eliminating such factors as the possibilities of altered migratory routes and pre-seasonal migration, it might be inferred that infection of young birds by *Haemoproteus*, the disturbing presence of the vector, or a combination of both, reduces the urge to nest in mourning doves. Instead of producing three or four broods each season (Pearson, 1936) the number may be limited to one or two. These facts may help to explain the small number of young birds, as compared with mature birds, in 1951.

Summary

A survey was made of the incidence of blood parasite infection in 434 birds representing 17 species. The incidence of *Plasmodium* infection in all birds was 2.3% or 10 infected out of 434 birds. The incidence of *Haemoproteus* infection in mourning doves was 94.4% or 201 infected out of 213 birds. Microfilariae and *Toxoplasma* infections were also observed. Based on the age and physical condition of the mourning doves taken during the 1951 hunting season, one could infer that infection of young birds by *Haemoproteus*, the disturbing presence of the *Haemoproteus* vector, or a combination of both tends to reduce the nesting urge of mourning doves.

Host	Number collected	P. relictum	P. elongatum	P. vaughani	Toxoplasma	Microfilariae	Haemoproteus	Plasmodium Unidentified	Unidentified Parasite	Number Infected	Incidence Percentage
Blue jay (Cyanocitta cristata cristata L.)	3					1	2			2	66.7
Dickcissel (Spiza americana Gmel.)	17										
Eastern lark sparrow (Chonestes grammacus grammacus Say)	1					1				1	100
English sparrow (Passer domesticus domesticus L.)	134	6	1	1*	3				2	13	9.8
Field sparrow (Spizella pusilla pusilla Wils.)	9										
Gamecock (Gallus domesticus L.)	5										
Killdeer (Oxyechus vociferus L.)	1										
Kingbird (Tyrannus tyrannus L.)	3										
Meadowlark (Sturnella magna magna L.)	23							1		1	4.4
Mourning dove (Zenaidura macroura carolinensis L.)	213				16	1	201			201	94.4
Orchard oriole (Icterus spurius L.)	4					1				1	25
Painted bunting (Passerina ciris L.)	1										
Purple martin (Progne subis subis L.)	2							1		1	50
Redwing (Agelaius phoeniceus phoeniceus L.)	2								1	1	50
Scissortail (Muscivora forticata forticata Gmel.)	4										
Shrike (Lanius borealis Vieill.)	4										
Sparrow hawk (Falco sparverius sparverius L.)	8						7			7	87.5
Total	434	6	1	1	19	4	210	2	3	228	52.5

* Single segmenter found that resembled P. vaughani

Infection of the Mourning Dove by Haemoproteus	
Number of birds collected	213
Number of birds infected	201 (94.4%)
Species of Haemoproteus infecting	
H. sacharovi	58 (11 single)
H. maccallumi	118 (14 single)
Questionable form *	157 (19 single)
Aberrant form	39
H. sacharovi and H. maccallumi	3
H. sacharovi and questionable form	39
H. maccallumi and questionable form	118

* Explanation on page 150

LITERATURE CITED

BARRETTO, M. PEREIRA. Infection of *Anopheles noroestesis* by *Plasmodium cathemerium*. Acta Med., Rio de Janeiro, 11:67-73, 1942.

BELDING, DAVID L. *Clinical Parasitology*. Appleton-Century-Crofts, 1952.

CERQUEIRA, N. L. & W. L. PARAENSE. *Aedes lepidus*, n.sp., transmitter of *Plasmodium gallinaceum*. Mem. Inst. Oswaldo Cruz, 42:11-15, 1945.

COATNEY, G. R. & R. L. ROUDABUSH. A catalog and host-index of the genus *Plasmodium*. Jour. Parasitol., 22:338-353, 1936.

HERMAN, CARLTON M. Blood parasites from California ducks and geese. Jour. Parasitol., 37(3):280-282, 1951.

HEWITT, R. *Bird Malaria*. Amer. Jour. Hygiene, Monogr. Ser., No. 15, 1940.

HUFF, CLAY G. A survey of the blood parasites of birds caught for banding purposes. Jour. Amer. Veter. Med. Assn., 90:615-620, 1939.

———— Studies on *Haemoproteus* of mourning doves. Amer. Jour. Hygiene, 16:618-623, 1932.

———— Personal communications, 1952.

HURLBUT, H. S. & R. HEWITT. Transmission of *Plasmodium lophure* by *Anopheles quadrimaculatus*. Publ. Health Rep., 57:1891-1892, 1942.

LINCOLN, F. C. Instructions for banding birds. U.S. Dept. Agric., Department Circular 170, 1921.
MANWELL, R. D. Avian toxoplasmosis with invasion of the erythrocytes. Jour. Parasitol., 27:245-251, 1941.
———— Experiments in toxoplasmosis. Jour. Infect. Dis., 76(1):1-14, 1945.
MICKS, DAN W. Malaria in the English sparrow. Jour. Parasitol., 35(5):543-544, 1949.
MOK, F. F. Transmission of *Plasmodium relictum* Grassi & Feletti by *Anopheles freeborni* Aitken. Science, [n.s.] 113:485, 1951.
PEARSON, T. G. *Birds of America.* Garden City Publishing Company, Inc., 1936.
TREMBLEY, H. L. *Aedes atropalus* (Coq.), new mosquito vector of *Plasmodium gallinaceum* Brumpt. Jour. Parasitol., 32:499-501, 1946.

Note

CLARK GRIFFITH DUMAS'S STUDY OF "APICULTURE IN EARLY TEXAS." ——A weighty thesis presented for the M.S. degree at Southern Methodist University, 1952, includes in its 257 pages (13 chapters, two appendices, bibliography) discussion of the following matters: Early Accounts of Bees in Texas; Factors Responsible for Scientific Apiculture; Leaders in American Apiculture; The Invention of Beekeeping Implements; The Importation of Foreign Bees; Queen-Rearing, Diseases of Bees, and Migratory Beekeeping; The Influence of Early Journals and Societies; Leaders in early Texas Apiculture; Women Beekeepers in early Texas; The Eckman Apiary at Richmond, Texas; Bee Magazines of early Texas; Beekeepers' Societies in early Texas; Sketches of early Texas Beekeepers. The period of time covered extends from the founding of Austin's Colony in the 1820's to about the turn of the century; and an extensive appendix gives census returns for the 1850 to 1900 Censuses. Fourteen plates, giving portraits of early notables in beekeeping practice (chiefly in Texas) accompany the text. Extensive correspondence, scrutiny of the manuscript minutes of Texas beekeepers' societies, and a thoroughgoing study of the history of beekeeping in Europe, and elsewhere in the United States, make the thesis of exceptional interest. Copies in manuscript are available in the Fondren Library of Southern Methodist University. Chapter XIII, "Sketches of Early Texas Beekeepers" (folios 172-227) gives a surprising amount of data on the lives and work of some 172 students of bees in our State. The thesis is a mine of accurate information on beekeeping and beekeepers in Early Texas.——*S. W. Geiser.*

Book Review

THE HERMIT PHILOSOPHER OF LIENDO [Edmund Montgomery]. By *I. K. Stephens.* (Dallas, Texas: Southern Methodist University Press. 1951. Pp. x, 402. $5.00.)

April 17, 1951 was the fortieth anniversary of the death of Edmund Montgomery; and on that date the Southern Methodist University Press published the first biography of this eminent British-American philosopher. Handsome, urbane, educated in medicine at Heidelberg, Berlin, Bonn, Würzburg, Prague, and Vienna, member of the Royal College of Physicians of London, this scientist-philosopher whose work was admired by Europe's keenest intellects, lived for many years obscurely, on a plantation at Hempstead, Texas. A less likely cultural home for this illegitimate son of a Scottish lord could scarcely be imagined. . . .

This admirable biography of Edmund Montgomery (1835-1911), philosopher and scientist, and of his wife Elisabet Ney (1833-1907), Bavarian sculptor, leaves little to be desired. Montgomery, of Scottish ancestry, came to America with his wife in 1871, and to Texas in 1873. At the time of his advent in Texas, that State was still frontier or semi-frontier country. The biography is a dual one of Edmund and Elisabet; this is inevitable as their lives were in ideals and actions inextricably interwoven from the time they met in Heidelberg in 1852 until her