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Abtract. During 1957, 1958, and 1959, blood smears from 568 birds were examined. Ninety-nine (17.25%) of these birds were found to harbor haemosporidian parasites. Four species of birds harbored *Plasmodium,* four species were infected with *Leucocytozoon,* and five species with *Haemoproteus.* Trypanosomes and microfilariae were observed in two species.

The following observations on the protozoan genera *Haemoproteus, Leucocytozoon, Plasmodium,* and *Trypanosoma,* are based for the most part on material collected at Ames, Boone, and Gilbert, Iowa, from 1957 to 1959. During this period, 1,006 blood smears from 568 birds were examined. Ninety-nine (17.2%) of these birds were found to harbor blood parasites. The study included 13 species of birds, of which six species were infected. As recorded in Table 1, four species harbored *Plasmodium,* four species were infected with *Leucocytozoon* and five species with *Haemoproteus.* Non-haemosporidian organisms, i.e., trypanosomes and microfilariae, were observed in two species of birds.

Blood samples were obtained by puncturing the toes of living birds with the blade of a scalpel. Obtaining blood from nestling birds proved to be more difficult. If unsatisfactory smears resulted due to insufficient blood, the tip of a claw was cut off with a pair of scissors. Blood was easily obtained using this method, but, since bleeding generally persisted, the toe puncture method was preferred. In examining dead birds, samples of blood were obtained, when possible, from the heart. Otherwise, tissue smears of the liver, lungs, or kidney were made. All blood smears were fixed in methyl alcohol and stained with Giemsa.

Since direct microscopic examination of stained blood films did not take into consideration subpatent or latent infections, isodiagnosis was sometimes used. This procedure, used extensively by Sergent (1920) in disclosing subpatent *Plasmodium* infections, involved transfusing previously uninfected birds with the blood of suspect birds.

Preliminary examination of an entire smear was made under low power of a Bausch and Lomb binocular microscope equipped

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Table 1
Occurrence of Intra- and Extracellular Parasites in Birds Examined from Story and Boone Counties, Iowa, During the Period 1957-1959

		Number infected						
	Number examined	*Haemoproteus* spp.	*Leucocytozoon* spp.	*Plasmodium* spp.	*Trypanosoma* sp.	Microfilariae	Total number of birds infected	Percentage of birds infected
Agelaius phoeniceus Redwing	4		2	1			2	50.0
Anas platyrhynchus Domestic duck	6						0	
Bubo virginianus Great horned owl	25	5	3				7	28.0
Chordeiles minor Common nighthawk	2						0	
Columba livia Common pigeon	451	50		1			51	11.30
Cyanocitta cristata Blue jay	6	2				1	3	50.0
Dumetella carolinensis Catbird	2						0	
Quiscalus quiscula versicolor Bronze grackle	16	1	5	1	1	1	5	31.25
Streptopelia risoria Ringed turtle dove	5						0	
Sturnus vulgaris Starling	7						0	
Turdus migratorius Robin	3						0	
Zenaidura macroura Mourning dove	41	29	6	1*			31	75.6
	568	87	16	4	1	2	99	17.25

*Subpatent infection disclosed using isodiagnosis

with 10X oculars. If during this examination erythrocytes and leucocytes were suspected of infection, the area in question was inspected under oil immersion. Smears which were apparently negative were also examined under oil for a period of five minutes. During this time care was taken not to re-examine the same fields, thus permitting observation of approximately 250 to 300 different fields. All identifications of parasites were made by using oil immersion. Specific identifications of parasites were confirmed by

careful measurements which were compared with published accounts of the species in question.

Plasmodium Infections

Plasmodium circumflexum Kikuth was diagnosed from a nestling redwing (*Agelaius phoeniceus*) in which 28 percent of the erythrocytes were parasitized.

In August, 1959, a three-week-old pigeon (*Columba livia*) belonging to a pigeon colony at Gilbert, Iowa, was found to harbor a heavy infection of *P. relictum* Grassi and Feletti. The natural occurrence of *P. relictum* had been described by Becker and coworkers (1956, 1957) from pigeons maintained in the same location. Unfortunately, subinoculations were not made from this most recent occurrence, so that its particular characteristics could not be compared with those from Becker's strain.

Examination of the blood of a single juvenile grackle (*Quiscalus quiscula*) revealed a heavy infection with a species of *Plasmodium* resembling *P. relictum.* While re-examining blood films from this bird, it was observed that pigment granules within gametocytes were often elongate and coarse. Also, in the case of mature gametocytes, the host-cell nucleus was sometimes extruded. According to Hewitt (1940), these characters indicate an infection with *P. cathemerium* Hartman.

An adult mourning dove (*Zenaidura macroura*) captured in August, 1957, initially was believed to harbor an infection of *Haemoproteus.* This bird, however, was included with six other doves in isodiagnostic experiments which resulted in disclosing a subpatent *Plasmodium* infection. A young pigeon, recipient of 0.6 ml of blood from this particular dove, died as a result of this plasmodial strain. Examination of tissue impressions of the liver, lungs, kidneys, spleen, and brain revealed in these organs exoerythrocytic schizonts similar in appearance to schizonts described by Farmer (1959) from organs of pigeons infected with *Plasmodium relictum.* Three other pigeons transfused with blood from this dove developed patent infections. In each instance, however, the recipient bird recovered.

Leucocytozoon Infections

Since *Leucocytozoon* cannot be transferred by blood inoculations, and since all cases of *Leucocytozoon* observed during this study (with one exception) were low grade infections, species allocation was difficult. In several instances, however, the parasites observed closely resembled well-described species.

Examination of blood films from great horned owls (*Bubo virginianus*) revealed three birds harboring *Leucocytozoon* infections. One of the birds possessed two distinct species. One species, common to all three birds, was characterized by rounded gametocytes. Its identity has not been established.

The gametocytes of the other species of *Leucocytozoon* are unusually conspicuous, for the host-cells are peculiarly spindle-shaped. The host-cell nucleus is distorted to such an extent that it resembles a dumbbell in appearance. A somewhat incomplete description of *L. ziemani* var. *bubonis*, observed in the blood of the owl (*Bubo maculosus*), was presented by Fantham (1926). Coatney and Roudabush (1937) published a detailed description of this species which they recovered from the great horned owl. Since my specimens of the spindle-shaped *Leucocytozoon* species found in the great horned owl closely resemble their description, these sporozoans are considered to be *L. ziemani* var. *bubonis*.

Rounded gametocytes belonging to a species of *Leucocytozoon* were observed in one nestling and in five adult mourning doves. Two species of *Leucocytozoon* have been recorded from the avian order Columbiformes. An unnamed elongate *Leucocytozoon* was described by Minchin (1910) from the dove (*Streptopelia semitorquata*). Mathis and Léger (1910) described a rounded form, *L. marchouxi*, from four of nine doves (*Streptopelia tranquebarica*) (= *Turtur humilis*). Recently, a detailed review of the literature concerning *L. marchouxi* was published by Levine (1954), who found this species in five adult, one juvenile, and four nestling mourning doves. He considered as *L. marchouxi* only those strains in the mourning dove having rounded gametocytes. Accordingly, the rounded gametocytes observed in the blood of moruning doves examined during this study are considered to be *L. marchouxi*.

Unidentified *Leucocytozoon* infections involving species forming rounded gametocytes were observed in an adult and juvenile redwing and in three adult and two juvenile grackles. One of the juvenile grackles possessed such a massive infection that one suspects this species to be pathogenic.

Haemoproteus Infections

Infections of *Haemoproteus*, as with *Leucocytozoon*, usually are not easily transferred by blood inoculations. Morphology of gametocytes becomes the only characteristic useful in differentiating species. Due to the similarity in the appearance of some gametocytes, identification of species is often not possible. In some cases, however, gametocytes vary sufficiently to permit species allocation to be undertaken with some reliability. For example, *H. sacharovi*

Novy and MacNeal of the mourning dove may be recognized by the characteristic appearance of its gametocytes. Other well-described species may be differentiated according to the tendency of the gametocytes either to encircle the erythrocyte nucleus or to displace it laterally.

Examination of blood smears made from great horned owls revealed one immature and four adults possessing light *Haemoproteus* infections.

Celli and San Felice (1891) described three species of *Haemoproteus* from owls, namely, *H. aluci, H. bubonis,* and *H. noctuae,* varieties A and C. The investigations of Wolfson (1936), however, showed that *H. noctuae* variety C is really a species of *Plasmodium* and was named *P. oti.* The true *H. noctuae* of Celli and San Felice, however, is generally recognized as being the true halteridium of the owl. The gametocytes of this species displace the host-cell nucleus laterally, but do not enclose this structure. Gametocytes resembling *H. noctuae* were harbored in two of the four infected adults.

Coatney and Roudabush (1937) described *H. noctuae* var. *nebraskensis* from a great horned owl. They described these parasites as similar in appearance to *H. noctuae,* except that the gametocytes enclosed the host-cell nucleus. Accordingly, gametocytes observed in one immature and two mature great horned owls are considered to belong to this species.

H. sacharovi was observed in the blood of 50 of 414 colonized pigeons. Blood samples from 37 barn pigeons, however, were parasite-free. *H. sacharovi* was also recovered from the blood of 22 of 41 mourning doves. Three of these infections were harbored in nestling birds.

Twenty-two of the 41 doves examined harbored what is considered to be *H. maccallumi* Novy and MacNeal. Huff (1932) questioned the validity of *H. maccallumi* as a distinct species, since he was unable to recognize any constant morphological differences between *H. maccallumi* of the dove and *H. columbae* Kruse in the pigeon's blood. Although Huff (1932) reported transmitting both *H. sacharovi* and *H. maccallumi* to the pigeon by using the hippoboscid fly, *Pseudolynchia maura* Bigot, Coatney (1933) was unable to transmit *H. columbae* to the dove, using the same species of fly. In view of this Coatney (1937) treated *H. maccallumi* as a distinct species. Recently, the author, using the hippoboscid fly, *Pseudolynchia canariensis* (Macquart), was unable to transmit either *H. sacharovi* or *H. maccallumi* to pigeons. Because of this and because *H. columbae* was absent in 451 pigeons (although local doves were infected with gametocytes morphologically similar to it), *H. maccallumi* is considered here to be a distinct species.

An unidentified *Haemoproteus* species similar to that mentioned by Coatney and West (1938) was harbored in two of six bluejays. One of the 16 grackles examined possessed a very light infection with *Haemoproteus*. Only macrogametocytes of this species were observed, however. The cytoplasm of these female cells possessed a distinctive vacuole. Coatney and West (1938) described *H. quiscalus* from the blood of an adult and an immature bronzed grackle. The macrogametocytes of this species showed a large, irregular vacuole near the center of the parasite. Since microgametocytes were not seen, however, the species observed during the present study were not identified.

Incidence of Trypanosoma and Microfilariae

Of the 568 birds examined, one grackle was found to harbor an extremely light infection with a species of *Trypanosoma*. Infections with microfilariae were noted in a single bluejay and a grackle.

The following birds were negative for blood-inhabiting organisms: Six domestic ducks (*Anas platyrhynchus*), two common nighthawks (*Chordeiles minor*), two catbirds (*Dumetella carolinensis*), five ringle turtle doves (*Streptopelia risoria*), seven starlings (*Sturnus vulgaris*), and three robins (*Turdus migratorius*).

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