

BIRD-BANDING

A JOURNAL OF ORNITHOLOGICAL INVESTIGATION

VOL. XV

JULY 1944

No. 3

THE BLOOD PROTOZOA OF NORTH AMERICAN BIRDS

By CARLTON M. HERMAN¹

INTRODUCTION

Blood protozoa were first reported from avian hosts by Danilewsky in 1885 from the Russian Ukraine only five years after malaria parasites were first described from the blood of man. During the next decade several European workers, including Danilewsky, reported further on the occurrence of organisms in the blood of birds but no investigations were made in North America until the summer of 1897 when Opie(74)² and MacCallum(58) studied blood smears of birds from Maryland and Ottawa. Novy and MacNeal(72, 73) published in 1904 and 1905 on blood parasites of Michigan birds. No further investigations on wild birds were made until Whitmore(97) isolated a strain of *Plasmodium* from "sparrows" (probably *Passer domesticus domesticus*) in New York in 1913. This strain is still being carried in canaries and has been subjected to numerous biological studies during the intervening years. In the early 1920's the Department of Protozoology and Medical Entomology of the Johns Hopkins University School of Hygiene and Public Health began its extensive studies on the biology of avian *Plasmodium*, particularly because of its similarity to the malarias of man. The emphasis of the work of this department has continued to be on these parasites, but in recent years related investigations have been undertaken on other blood parasites of birds. Many of the former students of this department, now connected with other institutions, have carried on or directed further investigations on the biology of malaria as well as surveys on the occurrence of parasites in wild birds.

The first extensive survey in North America was made on ducks in Michigan by O'Roke(79). From the introduction to his paper it is evident that he received much help from bird banders. The first extensive survey of a variety of wild birds was conducted in the region around Syracuse, New York(33, 68, 69). Most of the 652 birds studied were banded and released. During the summers of 1936 and 1937 the author had an opportunity to study birds trapped for banding at

¹Parasitologist, Bureau of Game Conservation, California Division of Fish and Game.

²Numerals in parentheses refer to the references at the end of the paper.

the O. L. Austin Ornithological Research Station, Cape Cod, Massachusetts, and has published a series of papers on the blood protozoa of these birds(34, 35, 36, 37, 38, 39, 40, 41, 42). Huff was probably the first parasitologist to see the advantage of cooperation with bird banders. The results of about 10 years of such cooperative endeavors were published in 1939(53). Wood and Herman(103) have just completed an extensive study of blood smears from a large series of birds made possible through the cooperation of bird banders in California and Arizona. The cooperation between parasitologists and bird banders throughout the country should, in the ensuing years, add greatly to our knowledge of blood parasites of birds.

The first check-list was published by Lühe(57) in 1906. In 1926, Wenyon(94) published a complete check-list of all the protozoan blood parasites reported from birds in the world up to that time. Coatney(8, 9) and Coatney and Roudabush(14) in 1936 and 1937 published check-lists of *Plasmodium*, *Leucocytozoon* and *Haemoproteus*. Calkins(3) in 1933, published a list of the bird hosts of *Trypanosoma*. Lucena(55) in 1939 and Hewitt(47) in 1940 published review monographs on bird malaria and included host lists of avian *Plasmodium*. Lucena(56) in 1941 published a check-list of all protozoan blood parasites of birds in neotropical America. The present paper is intended to supplement this last check-list of Lucena and thus bring up to date the host distribution of blood protozoa in birds of the western hemisphere.

PARASITE LIST

The classification of the blood protozoa of birds is in need of clarification. Many important phases have not been solved and much of the published information is controversial.

All trypanosomes reported from birds belong to the genus *Trypanosoma*. These flagellated organisms are extracellular and in birds have been recorded only in the blood stream. In general morphology they are similar to the trypanosomes which occur in other vertebrates. These organisms, as they occur in birds, are known to be extremely pleomorphic and therefore are difficult to differentiate on the basis of morphology alone. Most trypanosomes from avian hosts have been classified as *Trypanosoma avium*. Many authors, however, have preferred to report avian trypanosomes simply as *Trypanosoma* sp. Other species have been described, and even varieties have been set up within species, but the evidence for their validity is very slim. There has been a scarcity of investigations on the possible pathogenicity of this genus in birds and most protozoologists consider them of no pathological significance. In man these parasites and those of the related genus *Leishmania* cause severe tropical diseases. They are transmitted by various blood-sucking insects. In birds the only

evidence available incriminates mosquitoes as the intermediate host but the complete life cycle has not been worked out.

All other protozoan blood parasites which have been reported from avian hosts apparently belong to the Sporozoa. The chief group is classified in this paper as belonging to the family Plasmodiidae, which includes the genera *Plasmodium*, *Haemoproteus* and *Leucocytozoon*. In the early stages recognizable in blood smears it is not possible to differentiate between these genera, and several workers have reported such findings simply as Plasmodiidae. Most protozoologists have considered these forms as belonging to two families: Plasmodiidae, including the genus *Plasmodium*, and Haemoproteidae, including *Haemoproteus* and *Leucocytozoon*. Current investigations on the exoerythrocytic stages of *Plasmodium* are presenting much information which may settle this controversy. Recently Huff(54) has pointed out that *Leucocytozoon*, in some respects, may be more closely related to *Plasmodium* than to *Haemoproteus*.

The genus *Plasmodium* is observed most readily within red blood cells. The nature of its development within the vertebrate host makes possible the transmission of the infection to susceptible birds by blood transfusion. Recent work has demonstrated exoerythrocytic stages as well as the more common intracellular forms. More than a dozen valid species are recognized. Manwell(65) has reviewed the methods of classification of species in this genus. Evaluation of species and differentiating keys are available in several American publications(47, 55, 63, 67). All species investigated are transmitted by culicine mosquitoes. Very little is known of the pathogenicity of these parasites in wild birds, but canaries readily succumb to experimental infections in the laboratory and have been known to contract a fatal infection spontaneously(44).

The genus *Haemoproteus* occurs in birds and reptiles. In one stage of its development it parasitizes red blood cells but in other stages occurs only in internal organs. It is not possible to transmit parasites of either this genus or *Leucocytozoon* by blood transfusion. Most investigators have assumed that these parasites are extremely host specific and thus many species have been named with hardly more of a basis than the fact of being observed in a previously unreported host. Some investigators have attempted to avoid this discrepancy simply by reporting their findings as *Haemoproteus* sp. The inability to transmit these parasites by simple blood transfusion makes it difficult to investigate the host-specificity and thus clarify the validity of named species. Only two species have been successfully transmitted, the definitive host in both cases was hippoboscoid blood-sucking flies. Information on pathogenicity is in about the same state as our knowledge of avian *Plasmodium*.

The genus *Leucocytozoon* occurs only in birds. Students of this parasite are not agreed on the type of host cells infected. The host cells containing adult parasites are so distorted from the infection as to make their identification impossible. For a review and recent information on this controversy the reader is referred to a paper by Huff(54). The validity of reported species is in much the same status as species of the genus *Haemoproteus*. Only two species have been successfully transmitted, the definitive host in both cases was simuliid blood-sucking flies. O'Roke(79) has reported high mortalities among ducks due to infections with *Leucocytozoon simondi*.

The other Sporozoa which occur in birds have been reported comparatively infrequently from North America. These include the family Haemogregarinidae (hemogregarines) and other parasites the family position of which is not agreed upon by workers in this field: the genera *Toxoplasma*, *Hepatozoon* and *Spirogregarina*, intra-leucocytic parasites and an unclassified parasite of monocyte cells.

Hemogregarines are sporozoan parasites primarily infecting red blood cells of reptiles and amphibians. Extra-cellular stages also occur. A few cases of infection with this parasite in birds have been reported. The pathogenicity is unknown.

Toxoplasma has been reported from mammals, including man, and from reptiles as well as birds. The life cycle is not known and it is questionable whether all organisms classified in this genus in birds are of this genus or new genera. Wenyon(94) has suggested that Novy and MacNeal's *Haemoproteus rouxi* belongs in the genus *Toxoplasma* and it is so classified in this review. The author(34) has suggested that all toxoplasmas of avian hosts belong to one species. These parasites are rare in the peripheral blood but are readily observed in smears prepared from the liver, lung, spleen, and other organs of infected birds. They infect many types of host cells and also have extracellular stages. The pathogenicity is not known.

The genus *Hepatozoon* has been reported from mammals and birds. It is a parasite of monocytes of the white cell complex. Some stages also infect cells of internal organs and extracellular forms occur. In the rodent infection a blood-sucking mite has been shown to be the transmitting host but the life cycle in avian hosts has not been elucidated. The pathogenicity in avian hosts is not known.

Intra-leucocytic parasites referred to in the following check-lists were first reported by Hewitt(48) from birds in Mexico. These same parasites were observed by Wood and Herman(103). The life cycle or significance of these parasites has not been investigated.

Other parasites listed have been reported only once from birds.

Class: MASTIGOPHORA Diesing, 1865
Family: TRYPANOSOMIDAE Doflein, 1901

Genus: **Trypanosoma** Gruby, 1843

Trypanosoma avium Laveran, 1903

Agelaius phoeniceus phoeniceus(73); *Bubo virginianus virginianus*(15); *Butorides virescens anthonyi*(103); *Butorides virescens virescens*(12); *Carpodacus purpureus californicus*(103); *Coccyzus americanus americanus*(15, 17); *Coccyzus erythrophthalmus*(15); *Colaptes auratus luteus*(73, 103); *Corvus brachyrhynchos brachyrhynchos*(17, 70); *Cyanocitta cristata cristata*(15, 17, 73); *Dafila acuta tzitzihoa* (103); *Dendroica aestiva aestiva*(17); *Dendroica aestiva brewsteri*(103); *Dendroica auduboni auduboni*(103); *Empidonax difficilis difficilis*(103); *Euphagus cyanocephalus*(103); *Hedymeles ludovicianus*(15); *Hedymeles melanocephalus melanocephalus*(103); *Hesperiphona vespertina montana*(103); *Hyllocichla ustulata ustulata*(103); *Icteria virens longicauda*(103); *Icterus bullocki*(103); *Icterus cucullatus nelsoni*(103); *Icterus galbula*(15, 17, 73); *Icterus spurius*(17); *Melopelia asiatica nearnsi*(103); *Melospiza melodia melodia*(33, 73); *Molothrus ater obscurus*(103); *Nycticorax nycticorax hoactli*(12); *Otus asio naevius*(12, 80); *Oporornis tolmiei*(103); *Penthestes atricapillus septentrionalis*(17); *Piranga ludoviciana*(103); *Progne subis subis* (15); *Quiscalus quiscula aeneus*(17); *Sialia sialis sialis*(73); *Spinus tristis salicamans*(103); *Spiza americana*(15); *Strix occidentalis occidentalis*(103); *Toxostoma rufum*(17); *Turdus migratorius migratorius*(73); *Wilsonia pusilla chryseola*(103); *Zenaidura macroura carolinensis*(17, 73); *Zonotrichia leucophrys gambeli*(103).

Trypanosoma gallinarum Bruce, Hamerton, Bateman, Mackie and Bruce, 1911
Bonasa umbellus togata(6).

Trypanosoma laverani Novy and MacNeal, 1905

Spinus tristis tristis(73).

Trypanosoma laverani var. **toxostomae** Roudabush and Coatney, 1935
Toxostoma rufum(87).

Trypanosoma mesnili Novy and MacNeal, 1905

Buteo lineatus lineatus(73).

Trypanosoma sp.

Agelaius phoeniceus phoeniceus(36, 40); *Aphelocoma californica californica*(88); *Bonasa umbellus umbellus*(92); *Coccyzus americanus americanus*(53); *Cyanocitta cristata cristata*(36, 40, 73, 93a); *Dendroica auduboni auduboni*(46, 102); *Dryobates villosus villosus*(73); *Dumetella carolinensis*(36, 40); *Euphagus carolinus*(73); *Hesperiphona vespertina*(28); *Hyllocichla ustulata ustulata*(102); *Icteria virens longicauda*(98); *Icterus spurius*(90); *Junco hyemalis*(28); *Molothrus ater ater*(36, 40, 93a); *Passer domesticus domesticus*(53, 54a, 73, 80); *Passerculus sandwichensis savanna*(36, 40); *Passerina cyanea*(53); *Pipilo fuscus crissalis* or *Pipilo fuscus senicula*(98); *Pipilo erythrophthalmus*(54a); *Poocetes gramineus*(93a); *Pyrocephalus rubinus mexicanus*(46); *Pyrrhuloxia sinuata*(21, 24); *Quiscalus quiscula aeneus*(53, 96); *Quiscalus quiscula quiscula*(96); *Richmondia cardinalis cardinalis*(23, 53, 54a, 93a); *Seiurus noveboracensis*(36, 40); *Sialia sialis sialis*(53, 81, 96); *Spinus tristis tristis*(73); *Strix varia varia*(96); *Toxostoma rufum*(53, 73, 93a); *Tringoides aedon aedon*(73); *Turdus migratorius propinquus*(29); *Zenaidura macroura carolinensis*(53); *Zonotrichia albicollis*(54a).

Class: SPOROZOA Leuckart, 1879

Family: PLASMODIIDAE Mesnil, 1903

Agelaius phoeniceus phoeniceus(96); *Anas rubripes tristis*(36, 40); *Cyanocitta cristata cristata*(93a, 96); *Iridoprocne bicolor*(36, 40); *Melospiza melodia melodia*(36, 40); *Mimus polyglottus*(93a); *Molothrus ater ater*(36, 40, 93a); *Passerculus sandwichensis savanna*(36, 40); *Passerella iliaca iliaca*(96); *Pipilo erythrophthalmus erythrophthalmus*(36, 40, 96); *Poocetes gramineus*(93a); *Quiscalus quiscula quiscula*(96); *Richmondia cardinalis cardinalis*(96); *Sialia sialis sialis*(36, 40); *Sturnus vulgaris vulgaris*(96); *Turdus migratorius migratorius*(96).

Genus: **Plasmodium** Marchiafava and Celli, 1885**Plasmodium cathemerium** Hartman, 1927

Agelaius phoeniceus phoeniceus(*31, 35, 38, 39, 40); *Bubo virginianus virginianus*(*100, *101); *Carpodacus mexicanus frontalis*(103); *Cyanocitta cristata tata*(*17); *Hylocichla mustelina*(101); *Melospiza melodia melodia*(33, 68); *Mimus polyglottos leucopterus*(103); *Molothrus ater ater*(*31, 38, 40); *Passer domesticus domesticus*(31, 53, 54a); *Pica pica hudsonia*(15); *Quiscalus quiscula aeneus*(53); *Quiscalus quiscula quiscula*(33, 36, 40, 68); *Richmondia cardinalis*(54a); *Sturnus vulgaris vulgaris*(33, 68); *Toxostoma rufum*(54a); *Troglodytes aedon*(53); *Turdus migratorius*(54a); *Zonotrichia albicollis*(33, 68).

Plasmodium circumflexum Kikuth, 1931

Agelaius phoeniceus phoeniceus(35, 36, 38, 39, 40, †74); *Cyanocitta cristata cristata*(93a); *Dendroica tigrina*(53); *Dumetella carolinensis*(53); *Junco hyemalis hyemalis*(33, 68); *Melospiza melodia melodia*(33, 68); *Molothrus ater ater*(38, 40); *Richmondia cardinalis cardinalis*(93a); *Toxostoma rufum*(93a); *Turdus migratorius migratorius*(33, 36, 40, 68); *Zonotrichia albicollis*(33, 59, 68, 93a).

Plasmodium elongatum Huff, 1930

Synonym: **Plasmodium praecox** Hartman, 1927.

Butorides virescens anthonyi(103); *Carpodacus mexicanus frontalis*(46); *Colinus virginianus virginianus*(2, 96); *Dumetella carolinensis*(53); *Melospiza melodia melodia*(33, 53, 68); *Mimus polyglottos polyglottos*(54a); *Otus asio naevius*(96); *Passer domesticus domesticus*(31, 49, 53, 54a); *Pipilo erythrophthalmus*(93a); *Quiscalus quiscula aeneus*(53); *Richmondia cardinalis cardinalis*(54a); *Spizella passerina passerina*(36, 40, 68); *Spizella pusilla pusilla*(53, 54a); *Sturnella magna magna*(53); *Toxostoma rufum*(54a); *Zenaidura macroura carolinensis*(53); *Zonotrichia leucophrys gambeli*(48).

Plasmodium hexamerium Huff, 1935

Cyanocitta cristata cristata(93a); *Dumetella carolinensis*(51); *Geothlypis trichas brachidactyla*(51); *Geothlypis trichas trichas*(53); *Melospiza melodia melodia*(36, 40, 66); *Pipilo erythrophthalmus*(54a); *Quiscalus quiscula*(54a); *Sialia sialis sialis*(51, 53); *Toxostoma rufum*(54a); *Turdus migratorius*(54a); *Zenaidura macroura macroura*(51).

Plasmodium inconstans Hartman, 1927 = **Plasmodium relictum**

Grassi and Feletti, 1891

Plasmodium nucleophilum Manwell, 1935

Synonym: **Plasmodium vauhani** Novy and MacNeal, 1904(62)

Dumetella carolinensis(33, 36, 40, 68, 69); *Passer domesticus domesticus*(*66); *Progne subis subis*(17); *Spizella passerina passerina*(36, 40).

Plasmodium oti Wolfson, 1936

Otus asio naevius(99, *100).

Plasmodium polare Manwell, 1934

Petrochelidon albifrons albifrons(33, 59, 60, 64, 68, 69).

Plasmodium praecox Grassi and Feletti, 1890 = **Plasmodium relictum**

Grassi and Feletti, 1891

Plasmodium praecox Hartman, 1927 = **Plasmodium elongatum** Huff, 1930**Plasmodium relictum** Grassi and Feletti, 1891

Synonym: **Plasmodium praecox** Grassi and Feletti, 1890

Synonym: **Plasmodium inconstans** Hartman, 1927

Aphelocoma californica californica(103); *Bubo virginianus virginianus*

*Experimental.

†Originally classified as *halteridium*(74), reclassified(39).

anus(*32, *100, *101); *Carpodacus mexicanus frontalis*(46, 103); *Corvus brachyrhynchos brachyrhynchos*(17, 70); *Dumetella carolinensis*(54a); *Euphagus cyanocephalus*(46, 103); *Fulica americana americana*(86); *Hyllocichla mustelina*(83, 100, 101); *Icterus cucullatus nelsoni*(103); *Junco hyemalis hyemalis*(33, 68); *Melospiza melodia melodia*(33, 36, 40, 68, 73); *Melospiza melodia cooperi*(103); *Mimus polyglottos polyglottos*(54a); *Mimus polyglottos leucopterus*(103); *Molothrus ater ater*(36, 40, 93a); *Molothrus ater obscurus*(103); *Myiarchus crinitis boreus*(15); *Passer domesticus domesticus*(17, 31, 33, 53, 54a, 68, 93a, 103); *Pipilo erythrophthalmus*(54a, 93a); *Pipilo fuscus crissalis*(103); *Pooecetes gramineus*(93a); *Quiscalus quiscula aeneus*(53); *Quiscalus quiscula quiscula*(54a, 59, 61); *Richmondia cardinalis cardinalis*(54a, 90); *Spizella passerina passerina*(36, 40, 68); *Spizella pusilla*(54a); *Sturnus vulgaris vulgaris*(59, 61); *Toxostoma rufum*(54a); *Troglodytes aedon*(53); *Turdus migratorius migratorius*(17, 33, 36, 40, 53, 68, 69, 84); *Zenaidura macroura carolinensis*(10, 11); *Zonotrichia leucophrys gambeli*(46).

Plasmodium relictum matutinum Huff, 1937

Turdus migratorius migratorius(52, 93).

Plasmodium subpraecox (Grassi and Feletti 1892)

Otus asio naevius(99).

Plasmodium vauhani Novy and MacNeal, 1904

Cyanocitta cristata cristata(15); *Junco hyemalis hyemalis*(*68); *Passer domesticus domesticus*(*68); *Turdus migratorius migratorius*(15, 33, 36, 40, 53, 54a, 59, 60, 62, 68, 69, 72, 73, 93); *Sturnella magna magna*(53); *Sturnus vulgaris vulgaris*(32, 93a); [Several reports of this parasite from *Dumetella carolinensis*(59, 60, 62) were later reclassified as a new species, **P. nuecleophilum** (63).]

Plasmodium wasielewski Brumpt, 1910 = **Plasmodium subpraecox**

(Grassi and Feletti, 1892)

Plasmodium sp.

Agelaius phoeniceus phoeniceus(74); *Aphelocoma californica californica*(98, 103); *Bubo virginianus virginianus*(96); *Carpodacus mexicanus frontalis*(103); *Centurus carolinus*(96); *Colinus virginianus virginianus*(*95); *Corvus brachyrhynchos brachyrhynchos*(96); *Cyanocitta cristata cristata*(93a); *Dendroica pinus*(36, 40); *Dumetella carolinensis*(54a, 93, 96); *Euphagus cyanocephalus*(103); *Junco hyemalis hyemalis*(69, 96); *Limnodromus griseus griseus*(36, 40); *Melopelia asiatica mearnsi*(103); *Melospiza georgiana*(74); *Melospiza melodia melodia*(33, 53, 68, 69); *Mimus polyglottos polyglottos*(54a); *Mimus polyglottos leucopterus*(98, 103); *Molothrus ater ater*(36, 40, 93a); *Molothrus ater obscurus*(104); *Oreortyx picta*(29); *Passer domesticus domesticus*(53, 54a, 74, 93a, 103); *Passerculus sandwichensis savanna*(36, 40); *Passerina ciris*(23); *Pica pica hudsonia*(13, 15); *Pipilo erythrophthalmus erythrophthalmus*(36, 40, 54a); *Piranga erythromelas*(96); *Pediocetes phasianella campestris*(95); *Pooecetes gramineus gramineus*(36, 40); *Pyrrhuloxia sinuata*(24, 91); *Quiscalus quiscula aeneus*(53); *Quiscalus quiscula quiscula*(96); *Richmondia cardinalis cardinalis*(23, 24, 27, 54a); *Seiurus noveboracensis noveboracensis*(36, 40); *Sialia sialis sialis*(96); "sparrow"(97); *Spizella passerina passerina*(68, 93, 96); *Spizella pusilla*(54a); *Sterna forsteri*(12); *Strix varia varia*(96); *Toxostoma redivivum redivivum*(98); *Toxostoma rufum*(54a, 93a, 96); *Turdus migratorius migratorius*(29, 53, 96); *Zenaidura macroura carolinensis*(53, 96); *Zonotrichia albicollis*(53, 93a, 96); *Zonotrichia coronata*(53).

Genus: **Haemoproteus** Kruse, 1890

Haemoproteus archilochus Coatney and West, 1938

Archilochus colubris(17).

*Experimental.

Haemoproteus beckeri Roudabush and Coatney, 1935
Toxostoma rufum(12, 85, 87, 96).

Haemoproteus columbae Celli and Sanfelice, 1891
Synonym: **Haemoproteus maccallumi** Novy and MacNeal, 1904
Columba fasciata fasciata(103); *Melopelia asiatica mearnsi*(103); *Zenaidura macroura carolinensis*(15, 18, 36, 40, 50, 53, 72, 73, 96); *Zenaidura macroura marginella*(46, 103).

Haemoproteus danilewskyi Kruse, 1890
Buteo lineatus lineatus(73); *Corvus brachyrhynchos brachyrhynchos*(17, 70); *Cyanocitta cristata cristata*(73); *Melospiza melodia melodia*(73); *Spinus tristis tristis*(73); *Turdus migratorius migratorius*(73).

Haemoproteus hedymelis Coatney and Roudabush, 1937
Hedymeles ludovicianus(15).

Haemoproteus lophortyx O'Roke, 1929
Lophortyx californica(45, 76, 77, 78); *Lophortyx californica catalinensis*(76, 77, 78); *Lophortyx californica plumbea*(103); *Lophortyx californica vallicola*(43, 103); *Lophortyx gambeli*(76, 77, 78, 103).

Haemoproteus maccallumi Novy and MacNeal, 1904 = **Haemoproteus columbae** Celli and Sanfelice, 1891

Haemoproteus majoris Laveran, 1902 = **Leucocytozoon majoris** (Laveran, 1902)

Haemoproteus noctuae var. **cellii** Coatney and Roudabush, 1937
Otus asio asio(12, 15).

Haemoproteus noctuae var. **nebraskensis** Coatney and Roudabush, 1937
Bubo virginianus virginianus(12, 15).

Haemoproteus picae Coatney and Roudabush, 1937
Pica pica hudsonia(15).

Haemoproteus prognei Coatney and Roudabush, 1937
Progne subis subis(15).

Haemoproteus quiscalus Coatney and West, 1938
Quiscalus quiscula aeneus(17, 96); *Quiscalus quiscula quiscula*(96).

Haemoproteus rouxii Novy and MacNeal, 1904 = **Toxoplasma rouxii** (Novy and MacNeal, 1904)

Haemoproteus sacharovi Novy and MacNeal, 1904
Melopelia asiatica mearnsi(103); *Zenaidura macroura carolinensis*(15, 18, 36, 40, 53, 72, 73, 96); *Zenaidura macroura marginella*(46, 103).

Haemoproteus velans Coatney and Roudabush, 1937
Colaptes auratus luteus(12, 15).

Haemoproteus ziemanni Laveran, 1902 = **Leucocytozoon ziemanni** (Laveran, 1902)

Haemoproteus sp.

Accipiter cooperi(98); *Accipiter velox velox*(33); *Agelaius phoeniceus phoeniceus*(40, 53, 74, 96); *Aix sponsa*(71); *Anas platyrhynchos platyrhynchos*(96, 103); *Anas rubripes*(71); *Anas rubripes tristis*(36, 37, 40); *Apelocoma californica californica*(78, 98); *Asio flammeus*(25); *Bonasa umbellus togata*(7); *Branta canadensis canadensis*(96); *Bubo virginianus virginianus*(16, 74, 96); *Buteo borealis borealis*(96); *Buteo platypterus platypterus*(96); *Buteo swainsoni*(13); *Carpodacus mexicanus clementis*(103); *Carpodacus mexicanus frontalis*(102, 103); *Carpodacus purpureus purpureus*(53); *Casmerodius albus egretta*(20); *Cathartes aura septen-*

trionalis(96); *Colaptes auratus luteus*(53); *Colinus virginianus virginianus*(96)
Corvus brachyrhynchos brachyrhynchos(36, 40, 58, 74, 96); *Cyanocitta cristata cristata*(17, 53, 54a, 93a, 96); *Cygnus columbianus*(96); *Dafila acuta tzitzihoa*(103);
Dendroica auduboni auduboni(103); *Dendroica magnolia*(36, 40); *Dendroica nigrescens*(103); *Dendroica tigrina*(53); *Dumetella carolinensis*(53, 96); *Fulica americana americana*(71, 86); *Geothlypis trichas trichas*(53); *Hedymeles ludovicianus*(81); *Hedymeles melanocephalus melanocephalus*(103); *Hesperiphona vespertina*(30); *Hylocichla guttata faxoni*(97); *Hylocichla ustulata ustulata*(102, 103);
Icteria virens virens(53); *Icterus bullocki*(103); *Icterus cucullatus nelsoni*(103);
Icterus galbula(17, 36, 40); *Junco hyemalis*(22); *Junco hyemalis hyemalis*(33, 53);
Lophortyx californica vallicola(75, 98); *Melanerpes erythrocephalus*(53); *Melospiza georgiana* (74); *Melospiza lincolni lincolni*(17); *Melospiza melodia melodia*(33, 36, 40, 53, 74); *Mimus polyglottos polyglottos*(54a, 93a); *Mycteria americana*(21);
Nyroca collaris(71); *Oreortyx picta picta*(103); *Otocoris alpestris*(20); *Otus asio naevius*(53, 96); *Otus trichopsis*(103); *Passer domesticus domesticus*(74); *Passerina cyanea*(53); *Passerina versicolor*(20); *Pipilo erythrophthalmus*(54a); *Pipilo fuscus crissalis* or *Pipilo fuscus senicula*(98); *Pipilo maculatus megalonyx*(98); *Piranga ludoviciana*(103); *Poocetes gramineus gramineus*(36, 40, 93a); *Pyrrhuloxia sinuata*(24, 91); *Quiscalus quiscula*(28); *Quiscalus quiscula aeneus*(53); *Quiscalus quiscula quiscula*(33, 54a); *Richmondia cardinalis cardinalis*(21, 23, 24, 27, 29, 53, 54a, 90, 93a, 96); *Sialia sialis sialis*(53, 89, 90); *Spinus pinus pinus*(29, 36, 40);
Spinus tristis tristis(53); *Spizella passerina passerina*(33, 36, 40, 54a, 73, 96); *Strix occidentalis occidentalis* (103); *Strix varia varia*(96); *Toxostoma redivivum redivivum*(98); *Toxostoma rufum*(53, 54a); *Turdus migratorius migratorius*(33, 53);
Zenaidura macroura carolinensis(53, 93a); *Zenaidura macroura marginella*(98);
Zonotrichia albicollis(29, 33, 53, 54a, 96); *Zonotrichia coronata*(53); *Zonotrichia leucophrys*(26); *Zonotrichia leucophrys gambeli*(53, 98, 103); *Zonotrichia leucophrys leucophrys*(33, 53); *Zonotrichia leucophrys nuttalli*(53); *Zonotrichia querula*(53).

Genus: **Leucocytozoon** Danilewsky, 1890

Leucocytozoon anatis Wickware, 1915 = **Leucocytozoon simondi** Mathis and Leger, 1910

Leucocytozoon berestneffi Sambon, 1908

Corvus brachyrhynchos brachyrhynchos(13); *Pica pica hudsonia*(13, 15).

Leucocytozoon bonasae Clarke, 1935

Bonasa umbellus (subsp. ?)(19); *Bonasa umbellus togata*(5, 6, 7).

Leucocytozoon coccyzus Coatney and West, 1938

Coccyzus americanus americanus(17).

Leucocytozoon iowense Coatney, 1938

Butorides virescens virescens(12).

Leucocytozoon laverani Franca, 1912

Cyanocitta cristata cristata(15).

Leucocytozoon majoris (Laveran, 1902)

Synonym: **Haemoproteus majoris** Laveran, 1902

Cyanocitta cristata cristata(73); *Turdus migratorius migratorius*(72, 73).

Leucocytozoon mathesi var. **buteonis** Coatney and Roudabush, 1937

Buteo borealis borealis(15); *Buteo swainsoni*(13).

Leucocytozoon sakharrowi Sambon, 1908

Corvus brachyrhynchos brachyrhynchos(17, 70).

Leucocytozoon simondi Mathis and Leger, 1910

Synonym: **Leucocytozoon anatis** Wickware, 1915

Aiz sponsa(71); *Anas platyrhynchos platyrhynchos*(54, 79, 79a, 103); *Anas rubripes*(71, 79, 79a); *Anas rubripes tristis*(36, 40, 41); *Anser albifrons albifrons*(103);

Branta canadensis canadensis(79a); *Branta canadensis minima*(103); *Dafila acuta tzitzihoa*(79, 79a, 103); *Glaucionetta clangula americana*(71, 79a); *Lophodytes cucullatus*(71); *Mergus merganser americanus*(71, 79a); *Mergus serrator*(41, 79a, 103); *Nettion carolinense*(71); *Nyroca affinis*(79a); *Nyroca americana* (79a, 103); *Nyroca collaris*(79a); *Nyroca marila*(79a); *Nyroca valisineria*(79, 79a); *Querquedula discors*(41, 79a); *Spatula clypeata*(79a).

Leucocytozoon ziemanni (Laveran, 1902)

Synonym: **Haemoproteus ziemanni** Laveran, 1902

Buteo lineatus lineatus(73); "hawk"(72); *Strix occidentalis occidentalis*(103).

Leucocytozoon ziemanni var. **bubonis** Fantham, 1926

Bubo virginianus virginianus(15).

Leucocytozoon ziemanni var. **nebraskensis** Coatney and Roudabush, 1937

Otus asio naevius(15).

Leucocytozoon sp.

Accipiter velox velox(33, 103); *Agelaius phoeniceus phoeniceus*(36, 40); *Anas platyrhynchos platyrhynchos*(96); *Aphelocoma californica californica*(98, 103); *Asio wilsonianus*(25); *Bonasa umbellus*(88); *Branta canadensis canadensis*(36, 40); *Bubo virginianus virginianus*(16); *Buteo borealis borealis*(16, 96); *Butorides virescens anthonyi*(103); *Canachites canadensis*(6); *Carpodacus mexicanus frontalis*(103); *Carpodacus purpureus*(90); *Cathartes aura septentrionalis*(96); *Columba fasciata*(103); *Corvus brachyrhynchos brachyrhynchos*(33, 96); *Cyanocitta cristata cristata*(93a, 96); *Dafila acuta tzitzihoa*(96); *Dendroica aestiva brewsteri*(103); *Dendroica auduboni auduboni*(103); *Euphagus cyanocephalus*(103); *Hedymeles melanocephalus melanocephalus*(103); *Hesperiphona vespertina montana*(103); *Hyllocichla guttata nanus*(103); *Hyllocichla mustelina*(96); *Hyllocichla ustulata ustulata*(102, 103); *Icterus bullocki*(103); *Junco hyemalis*(28, 30); *Junco hyemalis hyemalis*(33, 53, 96); *Lagopus lagopus albus*(1); *Mareca americana*(96); *Melospiza georgiana*(36, 40); *Melospiza melodia melodia*(33, 40); *Mergus serrator*(53); *Mimus polyglottos leucop-terus*(103); *Molothrus ater ater*(36, 40, 93a); *Molothrus ater obscurus*(103); *Nycticorax nycticorax hoaccli*(12); *Otus asio (quercinus?)*(98); *Otus asio naevius*(53, 96); *Passerella iliaca iliaca*(96); *Passerina amoena*(103); *Passerina ciris*(84); *Pedioecetes phasianellus campestris*(88); *Petrochelidon albifrons albifrons*(33); *Peucedramus olivaceus*(103); *Pipilo fuscus crissalis* or *Pipilo fuscus senicula*(98); *Pipilo erythrophthalmus erythrophthalmus*(36, 40, 93a); *Piranga ludoviciana*(103); *Poocetes gramineus*(93a); *Progne subis subis*(33, 96); *Quiscalus quiscula aeneus*(53, 96); *Quiscalus quiscula quiscula*(96); *Richmondia cardinalis cardinalis*(93a, 96); *Riparia riparia*(33); *Sialia sialis sialis*(36, 40, 53, 90, 96); *Spilopelia chinensis chinensis* (103); *Spinus pinus*(29); *Spinus tristis salicamans*(103); *Spizella passerina passerina*(36, 40, 96); *Strix varia varia*(96); *Sturnella magna magna*(53); *Toxostoma redivivum redivivum*(98, 103); *Turdus migratorius migratorius*(33, 36, 40, 96); *Turdus migratorius propinquus*(103); *Vermivora celata lutescens*(103); *Vermivora ruficapilla ridgu ayi*(103); *Zenaidura macroura carolinensis*(40, 93a, 96); *Zenaidura macroura marginella*(103); *Zonotrichia albicollis*(29, 33, 96); *Zonotrichia leucophrys gambeli*(103); *Zonotrichia leucophrys leucophrys*(53).

Family: **HAEMOGREGARINIDAE** Neveu-Lemaire, 1901

Zenaidura macroura carolinensis(53).

Family: Controversial or Undetermined

Genus: **Spirogregarina** Wood and Herman, 1943

Spirogregarina fusiformis Wood and Herman, 1943

Salpinctes obsoletus(103).

Genus: **Hepatozoon** Miller, 1900

Hepatozoon sp.

Baeolophus inornatus transpositus(103); *Carpodacus mexicanus frontalis*(103);

Chamaea fasciata henshawi(103); *Dendroica auduboni auduboni*(103); *Hedymeles melanocephalus melanocephalus*(103); *Toxostoma redivivum redivivum*(103).

Genus: **Toxoplasma** Nicolle and Manceaux, 1909

Toxoplasma rouxii (Novy and MacNeal, 1904)

Synonym: **Haemoproteus rouxii** Novy and MacNeal, 1904

Cyanocitta cristata cristata(73); *Icterus galbula*(73); "sparrow"(72).

Toxoplasma sp.

Dumetella carolinensis(34, 36, 40, 93, 96); *Icterus galbula*(36, 40); *Melospiza georgiana*(34, 36, 40); *Melospiza melodia melodia*(34, 36, 40); *Molothrus ater ater*(36, 40); *Passer domesticus domesticus*(33, 34, 36, 40, 69, 96); *Passerculus sandwichensis savanna*(36, 40); *Pipilo erythrophthalmus erythrophthalmus*(34, 36, 40); *Quiscalus quiscula quiscula*(40, 96); *Richmondia cardinalis cardinalis*(27); *Spizella passerina passerina*(34, 36, 40); *Sturnus vulgaris vulgaris*(33, 34, 36, 40); *Tyrannus tyrannus*(34, 36, 40). [Wood and Wood(102) reported *Toxoplasma* from *Carpodacus mexicanus frontalis* which was later reclassified as a *Leucocytozoon*(103).]

Intra-leucocytic parasite

Carpodacus mexicanus frontalis(103); *Mimus polyglottos leucopterus*(103); *Molothrus ater obscurus*(103); *Passer domesticus domesticus*(103).

Unidentified parasite (in monocytes)

Chamaea fasciata henshawi(98).

HOST LIST

The hosts are listed according to the order of the Check List of North American Birds, American Ornithologists' Union, 1931. Only the genera of protozoa are listed for each bird; for more complete information refer to the previous section.

Order: CICONIIFORMES

Family: ARDEIDAE

Casmerodius albus egretta (*Herodias egretta*). American Egret.

Haemoproteus(20).

Butorides virescens virescens. Eastern Green Heron.

Leucocytozoon(12); *Trypanosoma*(12).

Butorides virescens anthonyi. Anthony Green Heron.

Leucocytozoon(103); *Plasmodium*(103); *Trypanosoma*(103).

Nycticorax nycticorax hoactli. Black-crowned Night Heron.

Leucocytozoon(12); *Trypanosoma*(12).

Family: CICONIIDAE

Mycteria americana. Wood Ibis.

Haemoproteus(21).

Order: ANSERIFORMES

Family: ANATIDAE

Cygnus columbianus. Whistling Swan.

Haemoproteus(96).

Branta canadensis canadensis. Common Canada Goose.

Haemoproteus(96); *Leucocytozoon*(36, 40, 79a).

Branta canadensis minima. Cackling Goose.

Leucocytozoon(103).

Anser albifrons albifrons. White-fronted Goose.

Leucocytozoon(103).

Anas platyrhynchos platyrhynchos. Common Mallard.

Haemoproteus(96, 103); *Leucocytozoon*(54, 79, 79a, 96, 103).

Anas rubripes (ssp.)? Black Duck.

- Haemoproteus*(71); *Leucocytozoon*(71, 79, 79a).
Anas rubripes tristis. Common Black Duck.
Haemoproteus(36, 37, 40); *Leucocytozoon*(36, 40, 41); Plasmodiidae(36, 40).
Mareca americana. Baldpate.
Leucocytozoon(96).
Dafla acuta tzitzihoa. American Pintail.
Haemoproteus(103); *Leucocytozoon*(79, 79a, 96, 103); *Trypanosoma*(103).
Nettion carolinense. Green-winged Teal.
Leucocytozoon(71).
Querquedula discors. Blue-winged Teal.
Leucocytozoon(40, 41, 79a).
Spatula clypeata. Shoveller.
Leucocytozoon(79a).
Aix sponsa. Wood Duck.
Haemoproteus(71); *Leucocytozoon*(71).
Nyroca americana. Redhead.
Leucocytozoon(79a, 103).
Nyroca collaris. Ring-necked Duck.
Haemoproteus(71); *Leucocytozoon*(71, 79, 79a).
Nyroca valisineria. Canvas-back.
Leucocytozoon(79, 79a).
Nyroca marila. Greater Scaup Duck.
Leucocytozoon(79a).
Nyroca affinis. Lesser Scaup Duck.
Leucocytozoon(79a).
Glucionetta clangula americana. American Golden-eye.
Leucocytozoon(71, 79a).
Lophodytes cucullatus. Hooded Merganser.
Leucocytozoon(71).
Mergus merganser americanus. American Merganser.
Leucocytozoon(71, 79a).
Mergus serrator. Red-breasted Merganser.
Leucocytozoon(40, 41, 53, 79a, 103).

Order: FALCONIFORMES

Family: CATHARTIDAE

- Cathartes aura septentrionalis.** Turkey Vulture.
Haemoproteus(96); *Leucocytozoon*(96).

Family: ACCIPITRIIDAE

"Hawk"

- Leucocytozoon*(72).
Accipiter velox velox. Sharp-shinned Hawk.
Haemoproteus(33); *Leucocytozoon*(33, 103).
Accipiter cooperi. Cooper Hawk.
Haemoproteus(98).
Buteo borealis. Red-tailed Hawk.
Leucocytozoon(15, 16).
Buteo borealis borealis. Eastern Red-tailed Hawk.
Haemoproteus(96); *Leucocytozoon*(96).
Buteo lineatus lineatus. Northern Red-shouldered Hawk.
Haemoproteus(73); *Leucocytozoon*(73); *Trypanosoma*(73).
Buteo platypterus platypterus. Broad-winged Hawk.
Haemoproteus(96).
Buteo swainsoni. Swainson Hawk.
Haemoproteus(13); *Leucocytozoon*(13).

Order: GALLIFORMES
Family: TETRAONIDAE

- Canachites canadensis.** Spruce Grouse.
Leucocytozoon(6).
Bonasa umbellus. Ruffed Grouse.
Leucocytozoon(19, 88); *Trypanosoma*(92).
Bonasa umbellus togata. Canada Ruffed Grouse.
Haemoproteus(7); *Leucocytozoon*(4, 5, 6, 7); *Trypanosoma*(6).
Lagopus lagopus albus. Willow Ptarmigan.
Leucocytozoon(1).
Pediocetes phasianellus campestris. Prairie Sharp-tailed Grouse.
Leucocytozoon(88); *Plasmodium*(95).

Family: PERDICIDAE

- Colinus virginianus virginianus.** Eastern Bob-white.
Haemoproteus(96); *Plasmodium*(2, 96); experimental(96).
Lophortyx californica californica. California Quail.
Haemoproteus(45, 76, 77, 78).
Lophortyx californica vallicola. Valley Quail.
Haemoproteus(43, 75, 76, 77, 78, 98, 103).
Lophortyx californica catalinensis. Catalina Quail.
Haemoproteus(76, 77, 78).
Lophortyx californica plumbea. San Quintin Quail.
Haemoproteus(103).
Lophortyx gambeli gambeli. Gambel Quail.
Haemoproteus(76, 77, 78, 103).
Oreortyx picta. (Mountain Quail?)
Plasmodium(29).
Oreortyx picta picta. Plumed Quail.
Haemoproteus(103).

Order: GRUIFORMES
Family: RALLIDAE

- Fulica americana americana.** American Coot.
Haemoproteus(71, 86); *Plasmodium*(86).

Order: CHARADRIIFORMES
Family: SCOLOPACIDAE

- Limnodromus griseus griseus.** Eastern Dowitcher.
Plasmodium(36, 40).

Family: LARIDAE

- Sterna forsteri.** Forster Tern.
Plasmodium(12).

Order: COLUMBIFORMES
Family: COLUMBIDAE

- Columba fasciata fasciata.** Band-tailed Pigeon.
Haemoproteus(103); *Leucocytozoon*(103).
Zenaidura macroura carolinensis (*Zenaidura macroura macroura*). Eastern Mourning Dove.
Haemoproteus(15, 18, 36, 40, 50, 53, 72, 73, 93a, 96); *Hemogregarina*(53); *Leucocytozoon*(40, 93a, 96); *Plasmodium*(10, 11, 51, 96); *Trypanosoma*(17, 53, 73).
Zenaidura macroura marginella. Western Mourning Dove.
Haemoproteus(46, 98, 104); *Leucocytozoon*(103).

Spilopelia chinensis chinensis. Chinese Spotted Dove.

Leucocytozoon(103).

Melopelia asiatica mearnsi. Western White-winged Dove.

Haemoproteus(103); *Plasmodium*(103); *Trypanosoma*(103).

Order: CUCULIFORMES

Family: CUCULIDAE

Coccyzus americanus americanus. Yellow-billed Cuckoo.

Leucocytozoon(17); *Trypanosoma*(15, 17, 53).

Coccyzus erythrophthalmus. Black-billed Cuckoo.

Trypanosoma(15).

Order: STRIGIFORMES

Family: STRIGIDAE

Otus asio naevius. Eastern Screech Owl.

Haemoproteus(12, 15, 53, 96); *Leucocytozoon*(15, 53, 96); *Plasmodium*(96, 99), experimental(100); *Trypanosoma*(12, 80).

Otus asio (quercinus?). (Pasadena) Screech Owl.

Leucocytozoon(98).

Otus trichopsis. Spotted Screech Owl.

Haemoproteus(103).

Bubo virginianus virginianus. Great Horned Owl.

Haemoproteus(12, 15, 16, 74, 96); *Leucocytozoon*(15, 16); *Plasmodium*(96), experimental(32, 100, 101); *Trypanosoma*(15).

Strix varia varia. Northern Barred Owl.

Haemoproteus(96); *Leucocytozoon*(96); *Plasmodium*(96); *Trypanosoma*(97).

Strix occidentalis occidentalis. California Spotted Owl.

Haemoproteus(103); *Leucocytozoon*(103); *Trypanosoma*(103).

Asio wilsonianus (*Asio otus*). Long-eared Owl.

Leucocytozoon(25).

Asio flammeus flammeus. Short-eared Owl.

Haemoproteus(25).

ORDER: MICROPODIIFORMES

Family: TROCHILIDAE

Archilochus colubris. Ruby-throated Hummingbird.

Haemoproteus(17).

Order: PICIFORMES

Family: PICIDAE

Colaptes auratus luteus. Northern Flicker.

Haemoproteus(12, 15, 53); *Trypanosoma*(73, 103).

Centurus carolinus. Red-bellied Woodpecker.

Plasmodium(96).

Melanerpes erythrocephalus. Red-headed Woodpecker.

Haemoproteus(53).

Dryobates villosus villosus. Eastern Hairy Woodpecker.

Trypanosoma(73).

Order: PASSERIFORMES

Family: TYRANNIDAE

Tyrannus tyrannus. Eastern Kingbird.

Toxoplasma(34, 36, 40).

Myiarchus crinitus boreus. Northern Crested Flycatcher.

Plasmodium(15).

Empidonax difficilis difficilis. Western Flycatcher.

- Trypanosoma*(103).
Pyrocephalus rubinus mexicanus. Vermilion Flycatcher.
Trypanosoma(46).
Family: ALAUDIDAE
- Otocoris alpestris.** Horned Lark.
Haemoproteus(20).
Family: HIRUNDINIDAE
- Iridoprocne bicolor.** Tree Swallow.
Plasmodiidae(36, 40).
Riparia riparia. Bank Swallow.
Leucocytozoon(33).
Petrochelidon albifrons albifrons (*Petrochelidon lunifrons*). Northern Cliff Swallow.
Leucocytozoon(33); *Plasmodium*(33, 59, 60, 64, 68, 69).
Progne subis subis. Purple Martin.
Haemoproteus(15); *Leucocytozoon*(33, 97); *Plasmodium*(17); *Trypanosoma*(15).
Family: CORVIDAE
- Cyanocitta cristata cristata.** Northern Blue Jay.
Haemoproteus(17, 53, 54a, 73, 93a, 96); *Leucocytozoon*(15, 73, 93a, 96); Plasmodiidae(93a, 96); *Plasmodium*(15, 93a), experimental(17); *Toxoplasma*(73); *Trypanosoma*(15, 17, 36, 40, 73, 93a).
Aphelocoma californica californica. California Jay.
Haemoproteus(77, 78); *Leucocytozoon*(98, 103); *Plasmodium*(98, 103); *Trypanosoma*(98).
Pica pica hudsonia. American Magpie.
Haemoproteus(15); *Plasmodium*(13, 15); *Leucocytozoon*(13, 15).
Corvus brachyrhynchos brachyrhynchos (*Corvus americanus*). Eastern Crow.
Haemoproteus(17, 36, 40, 58, 70, 74, 96); *Leucocytozoon*(13, 17, 33, 70, 96); *Plasmodium*(17, 70, 96); *Trypanosoma*(17, 70).
Family: PARIDAE
- Penthestes atricapillus septentrionalis.** Long-tailed Chickadee.
Trypanosoma(17).
Baeolophus inornatus transpositus. San Diego Titmouse.
Hepatozoon(103).
Family: CHAMAEIDAE
- Chamaea fasciata henshawi.** Pallid Wren-tit.
Hepatozoon(103); unidentified parasite(98).
Family: TROGLODYTIDAE
- Troglodytes aedon.** House Wren.
Plasmodium(53).
Troglodytes aedon aedon. Eastern House Wren.
Trypanosoma(73).
Salpinctes obsoletus. Rock Wren.
Spiroregarina(103).
Family: MIMIDAE
- Mimus polyglottos polyglottos.** Eastern Mockingbird.
Haemoproteus(54a, 93a); Plasmodiidae(93a); *Plasmodium*(54a).
Mimus polyglottos leucopterus. Western Mockingbird.
Leucocytozoon(103); *Plasmodium*(98, 103); Intra-leucoeytic parasite(103).
Dumetella carolinensis. Catbird.
Haemoproteus(53, 96); *Plasmodium*(33, 36, 40, 51, 53, 54a, 59, 60, 62, 68, 69, 93,

- 96); *Toxoplasma*(34, 36, 40, 93, 96); *Trypanosoma*(36, 40).
Toxostoma rufum (*Harporhynchus rufus*). Brown Thrasher.
Haemoproteus(12, 53, 54a, 86, 88, 96); *Plasmodium*(54a, 93a, 96); *Trypanosoma*(17, 53, 87, 92, 93a).
Toxostoma redivivum redivivum. California Thrasher.
Haemoproteus(98); *Leucocytozoon*(98, 103); *Plasmodium*(98); *Hepatozoon*(103).

Family: **TURDIDAE**

- Turdus migratorius migratorius** (*Merula migratoria*, *Planesticus migratorius*). Eastern Robin.
Haemoproteus(33, 53, 73); *Leucocytozoon*(33, 36, 40, 96); *Plasmodiidae*(96); *Plasmodium*(15, 17, 33, 36, 40, 52, 53, 54a, 59, 60, 62, 68, 69, 72, 73, 84, 94, 96); *Trypanosoma*(73).
Turdus migratorius propinquus. Western Robin.
Leucocytozoon(103); *Plasmodium*(29); *Trypanosoma*(29).
Hylocichla mustelina (*Turdus mustelinus*). Wood Thrush.
Leucocytozoon(96); *Plasmodium*(83, 101).
Hylocichla guttata nanus. Dwarf Hermit Thrush.
Leucocytozoon(103).
Hylocichla guttata faxoni. Eastern Hermit Thrush.
Haemoproteus(96).
Hylocichla ustulata ustulata. Russet-backed Thrush.
Haemoproteus(102, 103); *Leucocytozoon*(102, 103); *Trypanosoma*(102, 103).
Sialia sialis sialis. Eastern Bluebird.
Haemoproteus(53, 89, 90); *Leucocytozoon*(36, 40, 53, 90, 96) *Plasmodiidae*(36, 40); *Plasmodium*(51, 53, 89, 90, 96); *Trypanosoma*(53, 73, 82, 96).

Family: **STURNIDAE**

- Sturnus vulgaris vulgaris**. Starling.
Plasmodiidae(96); *Plasmodium*(32, 33, 59, 61, 68, 93a); *Toxoplasma*(33, 34, 36, 40).

Family: **COMPSOTHTYPIDAE**

- Vermivora celata lutescens**. Lutescent Warbler.
Leucocytozoon(103).
Vermivora ruficapilla ridgwayi. Calaveras Warbler.
Leucocytozoon(103).
Peucedramus olivaceus. Olive Warbler.
Leucocytozoon(103).
Dendroica aestiva aestiva. Eastern Yellow Warbler.
Trypanosoma(17).
Dendroica aestiva brewsteri. California Yellow Warbler.
Leucocytozoon(103); *Trypanosoma*(103).
Dendroica magnolia. Magnolia Warbler.
Haemoproteus(36, 40).
Dendroica tigrina. Cape May Warbler.
Haemoproteus(53); *Plasmodium*(53).
Dendroica auduboni auduboni. Audubon Warbler.
Haemoproteus(103); *Hepatozoon*(103); *Leucocytozoon*(103); *Trypanosoma*(46, 102, 103).
Dendroica nigrescens. Black-throated Gray Warbler.
Haemoproteus(103).
Dendroica pinus pinus. Northern Pine Warbler.
Plasmodium(36, 40).
Seiurus noveboracensis noveboracensis. Northern Water-thrush.
Plasmodium(36, 40); *Trypanosoma*(36, 40).

- Oporornis tolmiei.** Macgillivray Warbler.
Trypanosoma(103).
Geothlypis trichas brachidactyla. Northern Yellow-throat.
Plasmodium(51).
Geothlypis trichas trichas. Maryland Yellow-throat.
Haemoproteus(53); *Plasmodium*(53).
Icteria virens virens. Yellow-breasted Chat.
Haemoproteus(53).
Icteria virens longicauda. Long-tailed Chat.
Trypanosoma(98, 103).
Wilsonia pusilla chryseola. Golden Pileolated Warbler.
Trypanosoma(103).

Family: **PLOCEIDAE**

- "Sparrow" (probably **Passer domesticus domesticus.**)
Plasmodium(97); *Toxoplasma*(72). [Novy and MacNeal(72) list a number of sparrows" which were rich in *halteridia* (*Haemoproteus* sp.) and/or *proteosoma* (*Plasmodium* sp.). It is not possible to determine whether they were dealing with a fringillid or *Passer domesticus domesticus.*]
Passer domesticus domesticus. English Sparrow.
Haemoproteus(74); Intra-leucocytic parasite(103); *Plasmodium*(17, 31, 33, 49, 53, 54a, 68, 93a, 103); experimental(66); *Toxoplasma*(33, 34, 36, 40, 69, 96); *Trypanosoma*(54a, 73, 80).

Family: **ICTERIDAE**

- Sturnella magna magna.** Eastern Meadowlark.
Leucocytozoon(53); *Plasmodium*(53).
Agelaius phoeniceus phoeniceus. Eastern Red-Wing.
Haemoproteus(53, 74, 96); *Leucocytozoon*(36, 40); Plasmodiidae(97); *Plasmodium*(35, 36, 38, 39, 40, 74); experimental(31); *Trypanosoma*(36, 40, 73).
Icterus spurius. Orchard Oriole.
Trypanosoma(17, 90).
Icterus cucullatus nelsoni. Arizona Hooded Oriole.
Haemoproteus(103); *Plasmodium*(103); *Trypanosoma*(103).
Icterus galbula. Baltimore Oriole.
Haemoproteus(17, 36, 40); *Toxoplasma*(36, 40, 72); *Trypanosoma*(15, 17, 73).
Icterus bullocki. Bullock Oriole.
Haemoproteus(103); *Leucocytozoon*(103); *Trypanosoma*(103).
Euphagus carolinus (*Scolecophagus carolinus*). Rusty Blackbird.
Trypanosoma(73).
Euphagus cyanocephalus. Brewer Blackbird.
Leucocytozoon(103); *Plasmodium*(46, 103); *Trypanosoma*(103).
Quiscalus quiscula. Grackle.
Haemoproteus(28).
Quiscalus quiscula quiscula. Purple Grackle.
Haemoproteus(33, 54a, 96); *Leucocytozoon*(96); Plasmodiidae(96); *Plasmodium*(33, 36, 40, 54a, 59, 68, 96); *Toxoplasma*(40, 96); *Trypanosoma*(96).
Quiscalus quiscula aeneus. Bronzed Grackle.
Haemoproteus(17, 53, 96); *Leucocytozoon*(53, 96); *Plasmodium*(53); *Trypanosoma*(17, 53, 96).
Molothrus ater ater. Eastern Cowbird.
Leucocytozoon(36, 40, 93a); Plasmodiidae(36, 40, 93a); *Plasmodium*(36, 38, 40, 93a), experimental(31); *Toxoplasma*(36, 40); *Trypanosoma*(36, 40, 93a).
Molothrus ater obscurus. Dwarf Cowbird.
Intra-leucocytic parasite(103); *Leucocytozoon*(103); *Plasmodium*(103); *Trypanosoma*(103).

Family: **THRAUPIDAE**

- Piranga ludoviciana.** Western Tanager.
Haemoproteus(103); *Leucocytozoon*(103); *Trypanosoma*(103).
Piranga erythromelas. Scarlet Tanager.
Plasmodium(96).

Family: **FRINGILLIDAE**

- Richmondia cardinalis cardinalis** (*Cardinalis cardinalis*). Eastern Cardinal.
Haemoproteus(21, 23, 24, 27, 29, 53, 54a, 90, 93a, 96); *Leucocytozoon*(93a, 96);
Plasmodiidae(96); *Plasmodium*(23, 24, 27, 54a, 90, 93a); *Toxoplasma*(27); *Trypanosoma*(23, 53, 54a, 93a).
Pyrrhuloxia sinuata. Pyrrhuloxia.
Haemoproteus(24, 91); *Plasmodium*(24, 91); *Trypanosoma*(21, 24).
Hedymeles ludovicianus. Rose-breasted Grosbeak.
Haemoproteus(15, 81); *Trypanosoma*(15).
Hedymeles melanocephalus melanocephalus. Black-headed Grosbeak.
Haemoproteus(103); *Hepatozoon*(103); *Leucocytozoon*(103); *Trypanosoma*(103).
Passerina cyanea. Indigo Bunting.
Haemoproteus(53); *Trypanosoma*(53).
Passerina amoena. Lazuli Bunting.
Leucocytozoon(103).
Passerina versicolor. Varied Bunting.
Haemoproteus(20).
Passerina ciris (*Cyanospiza ciris*). Painted Bunting.
Plasmodium(23, 84).
Spiza americana. Dickcissel.
Trypanosoma(15).
Hesperiphona vespertina. Evening Grosbeak.
Haemoproteus(30); *Trypanosoma*(28).
Hesperiphona vespertina montana. Mexican Evening Grosbeak.
Leucocytozoon(103); *Trypanosoma*(103).
Carpodacus purpureus. Purple Finch.
Leucocytozoon(90).
Carpodacus purpureus purpureus. Eastern Purple Finch.
Haemoproteus(53).
Carpodacus purpureus californicus. California Purple Finch.
Trypanosoma(103).
Carpodacus mexicanus frontalis. Common House Finch.
Haemoproteus(102, 103); *Hepatozoon*(103); Intra-leucocytic parasite(103);
Leucocytozoon(102, 103); *Plasmodium*(46, 103). [*Toxoplasma* sp. reported by
Wood and Wood(102) was later reclassified as *Leucocytozoon* sp. (103).]
Carpodacus mexicanus clementis. San Clemente House Finch.
Haemoproteus(103).
Spinus pinus. Pine Siskin.
Haemoproteus(29); *Leucocytozoon*(29).
Spinus pinus pinus. Northern Pine Siskin.
Haemoproteus(36, 40).
Spinus tristis tristis. Eastern Goldfinch.
Haemoproteus(53, 73); *Trypanosoma*(73).
Spinus tristis salicamans. Willow Goldfinch.
Leucocytozoon(103); *Trypanosoma*(103).
Passerculus sandwichensis savanna. Savannah Sparrow.
Haemoproteus(33); *Plasmodiidae*(36, 40); *Plasmodium*(36, 40); *Toxoplasma*(36,
40); *Trypanosoma*(36, 40).
Pipilo erythrophthalmus erythrophthalmus. Red-eyed Towhee.

- Haemoproteus*(54a); *Leucocytozoon*(36, 40, 93a); Plasmodiidae(36, 40, 96); *Plasmodium*(36, 40, 54a); *Toxoplasma*(34, 36, 40); *Trypanosoma*(54a).
- Pipilo maculatus megalonyx.** San Diego Towhee.
Haemoproteus(98).
- Pipilo fuscus senicula.** Brown Towhee.
Haemoproteus(98); *Leucocytozoon*(98); *Trypanosoma*(98).
- Pipilo fuscus crissalis.** California Towhee.
Plasmodium(103).
- Poocetes gramineus gramineus.** Eastern Vesper Sparrow.
Haemoproteus(36, 40, 93a); *Leucocytozoon*(93a); Plasmodiidae(93a); *Plasmodium*(36, 40, 93a); *Trypanosoma*(93a).
- Junco hyemalis.** Junco.
Haemoproteus(22); *Leucocytozoon*(28, 30); *Trypanosoma*(28).
- Junco hyemalis hyemalis.** Slate-colored Junco.
Haemoproteus(33, 53); *Leucocytozoon*(33, 53, 96); *Plasmodium*(33, 68, 69, 96).
- Spizella passerina passerina.** Eastern Chipping Sparrow.
Haemoproteus(33, 36, 40, 73, 96); *Leucocytozoon*(36, 40, 96); *Plasmodium*(36, 40, 68, 93, 96); *Toxoplasma*(34, 36, 40).
- Spizella pusilla pusilla.** Eastern Field Sparrow.
Plasmodium(53, 54a).
- Zonotrichia querula.** Harris Sparrow.
Haemoproteus(53).
- Zonotrichia leucophrys.** White-crowned Sparrow.
Leucocytozoon(26).
- Zonotrichia leucophrys leucophrys.** White-crowned Sparrow.
Haemoproteus(33, 53); *Leucocytozoon*(53).
- Zonotrichia leucophrys gambeli.** Gambel Sparrow.
Haemoproteus(53, 98, 103); *Leucocytozoon*(103); *Plasmodium*(13, 90); *Trypanosoma*(103).
- Zonotrichia leucophrys nuttalli.** Nuttall Sparrow.
Haemoproteus(53).
- Zonotrichia coronata.** Golden-crowned Sparrow.
Haemoproteus(53); *Plasmodium*(53).
- Zonotrichia albicollis.** White-throated Sparrow.
Haemoproteus(29, 33, 53, 54a, 96); *Leucocytozoon*(29, 33, 96); *Plasmodium*(33, 53, 59, 68, 93a); *Trypanosoma*(54a).
- Passerella iliaca iliaca.** Eastern Fox Sparrow.
Leucocytozoon(96); Plasmodiidae(96).
- Melospiza lincolni lincolni.** Lincoln Sparrow.
Haemoproteus(17).
- Melospiza georgiana.** Swamp Sparrow.
Haemoproteus(74); *Leucocytozoon*(36, 40); *Plasmodium*(74); *Toxoplasma*(34, 36, 40).
- Melospiza melodia melodia** (*Melospiza fasciata*). Eastern Song Sparrow.
Haemoproteus(33, 36, 40, 53, 73, 74); *Leucocytozoon*(33); Plasmodiidae(36, 40); *Plasmodium*(33, 36, 40, 53, 66, 68, 69, 73); *Toxoplasma*(34, 36, 40); *Trypanosoma*(33, 73).
- Melospiza melodia cooperi.** San Diego Song Sparrow.
Plasmodium(103).

REFERENCES

1. ALLEN, A. A. and LEVINE, P. P. 1935. A brief study of the willow ptarmigan and its relation to predators and the leucocytozoon disease. *Trans. 21st Amer. Game Conf.*, 381-386.
2. ALLEN, E. A. 1931. The Bobwhite Quail, edited by E. L. Stoddard,

- Scribners*, N. Y., 559 pp.
3. CALKINS, G. N. 1933. *Biology of the Protozoa*. Lea and Febiger, Phila., 607 pp.
 4. CLARKE, C. H. D. 1934. Causes of mortality of young grouse. *Science*, 80: 228-229.
 5. ——— 1935. The dying-off of ruffed grouse. *Trans. 21st Amer. Game Conf.*, 402-405.
 6. ——— 1935. Blood parasites of ruffed grouse (*Bonasa umbellus*) and spruce grouse (*Canachites canadensis*), with description of *Leucocytozoon bonasae*, n. sp. *Can. Jour. Res.*, 12: 646-650.
 7. ——— 1938. Organisms of a malarial type in ruffed grouse with description of the schizogony of *Leucocytozoon bonasae*. *Jour. Wildlife Management*, 2: 146-150.
 8. COATNEY, G. R. 1936. A check-list and host-index of the genus *Haemoproteus*. *Jour. Parasit.*, 22: 88-105.
 9. ——— 1937. A catalog and host-index of the genus *Leucocytozoon*. *Jour. Parasit.*, 23: 202-212.
 10. ——— 1937. A strain of *Plasmodium relictum* from doves and pigeons. *Jour. Parasit.*, 23: 556.
 11. ——— 1938. A strain of *Plasmodium relictum* from doves and pigeons infective to canaries and the common fowl. *Amer. Jour. Hyg.*, 27: 380-389.
 12. ——— 1938. Some blood parasites from birds of the Lake Okaboji region. *Amer. Midl. Naturalist*, 20: 336-340.
 13. ——— and JELLISON, W. L. 1940. Some blood parasites from Montana birds. *Jour. Parasit.*, 26: 158-160.
 14. ——— and ROUDABUSH, R. L. 1936. A catalog and host-index of the genus *Plasmodium*. *Jour. Parasit.*, 22: 338-353.
 15. ——— and ——— 1937. Some blood parasites from Nebraska birds. *Amer. Midl. Naturalist*, 18: 1005-1030.
 16. ——— and WEST, E. 1937. Some notes on the effect of atebriane on the gametocytes of the genus *Leucocytozoon*. *Jour. Parasit.*, 23: 227-228.
 17. ——— and ——— 1938. Some blood parasites from Nebraska birds, II. *Amer. Midl. Naturalist*, 19: 601-612.
 18. ——— and ——— 1940. Studies on *Haemoproteus sacharovi* of mourning doves and pigeons, with notes on *H. maccallumi*. *Amer. Jour. Hyg.*, 31: 9-14.
 19. ERICKSON, A. 1943. *Pittman-Robertson Quarterly*, 3: 20-21.
 20. HAMERTON, A. E. 1929. Report on the deaths occurring in the Society's gardens during the year 1928. *Proc. Zool. Soc., London*, 1929: 49-59.
 21. ——— 1930. Report on the deaths occurring in the Society's gardens during the year 1929. *Ibid*, 1930: 357-380.
 22. ——— 1931. Report on the deaths occurring in the Society's gardens during the year 1930. *Ibid*, 1931: 527-555.
 23. ——— 1932. Report on the deaths occurring in the Society's gardens during the year 1931. *Ibid*, 1932: 613-638.
 24. ——— 1933. Report on the deaths occurring in the Society's gardens during the year 1932. *Ibid*, 1933: 451-482.
 25. ——— 1934. Report on the deaths occurring in the Society's gardens during the year 1933. *Ibid*, 1934: 389-422.
 26. ——— 1935. Report on the deaths occurring in the Society's gardens during the year 1934. *Ibid*, 1935: 443-474.
 27. ——— 1936. Report on the deaths occurring in the Society's gardens during the year 1935. *Ibid*, 1936: 659-686.
 28. ——— 1937. Report on the deaths occurring in the Society's gardens during the year 1936. *Ibid*, 107, Ser. B: 443-474.

29. ——— 1938. Report on the deaths occurring in the Society's gardens during the year 1937. *Ibid*, 108, Ser. B: 489-526.
30. ——— 1939. Review of mortality rates and report on the deaths occurring in the Society's gardens during the year 1938. *Ibid*, 109, Ser. B: 281-327.
31. HARTMAN, E. 1927. Three species of bird malaria, *Plasmodium praecox* P. cathemerium n. sp., and P. inconstans n. sp. *Arch. f. Protist.*, 60: 1-7.
32. HEGNER, R. and WOLFSON, F. 1938. Association of *Plasmodium* and *Toxoplasma*-like parasites in birds. *Amer. Jour. Hyg.*, 28: 437-454.
33. HERMAN, C. M. 1935. The incidence of blood parasites in birds of the Syracuse region with special reference to *Toxoplasma* and malarial plasmodia. Master's thesis, Syracuse Univ., Syracuse, N. Y., 108 pp.
34. ——— 1937. *Toxoplasma* in North American birds and attempted transmission to canaries and chickens. *Amer. Jour. Hyg.*, 25: 303-312.
35. ——— 1937. Occurrence of malaria in young and adult red-wing black-birds (*Agelaius phoeniceus phoeniceus*). *Jour. Parasit.*, 23: 553-554.
36. ——— 1938. The relative incidence of blood protozoa in some birds from Cape Cod. *Trans. Amer. Micr. Soc.*, 57: 132-141.
37. ——— 1938. *Haemoproteus* sp. from the common black duck, *Anas rubripes tristis*. *Jour. Parasit.*, 24: 53-56.
38. ——— 1938. Mosquito transmission of avian malaria parasites *Plasmodium circumflexum* and P. cathemerium. *Amer. Jour. Hyg.*, 27: 345-350.
39. ——— 1938. Epidemiology of malaria in eastern redwings (*Agelaius p. phoeniceus*). *Amer. Jour. Hyg.*, 28: 232-243.
40. ——— 1938. Epidemiological studies on the blood-inhabiting protozoa of wild birds. Doctorate thesis, Johns Hopkins Univ. Sch. of Hyg. and Publ. Health, Baltimore, Md. 106 pp.
41. ——— 1938. *Leucocytozoon anatis* Wickware, a synonym for L. simondi Mathis and Leger. *Jour. Parasit.*, 24: 472-473.
42. ——— 1938. Bird malaria and mosquito control. *Bird-Banding*, 9: 25-31.
43. ——— and GLADING, B. 1942. The protozoan blood parasite *Haemoproteus lophortyx* O'Roke in quail at the San Joaquin Experimental Range. California. *Calif. Fish and Game*, 28: 150-153.
44. ——— and VAIL, E. L. 1942. A fatal case of spontaneous malaria in a canary. *Jour. Amer. Vet. Med. Assoc.*, 101: 502.
45. HERMS, W. B. and KADNER, C. G. 1937. The louse fly, *Lynchia fusca*, parasite of the owl, *Bubo virginianus pacificus*, a new vector of malaria of the California valley quail. *Jour. Parasit.*, 23: 296-297.
46. ———, GALINDO, P. V. and ARMSTRONG, D. F. 1939. Blood parasites of California birds. *Jour. Parasit.*, 25: 511-512.
47. HEWITT, R. I. 1940. Bird Malaria. Johns Hopkins Press, Baltimore, Md. 228 pp.
48. ——— 1940. Studies on blood protozoa obtained from Mexican wild birds. *Jour. Parasit.*, 26: 287-295.
49. HUFF, C. G. 1930. *Plasmodium elongatum* n. sp., an avian malarial organism with an elongate gametocyte. *Amer. Jour. Hyg.*, 11: 385-391.
50. ——— 1932. Studies on *Haemoproteus* of mourning doves. *Amer. Jour. Hyg.*, 16: 618-623.
51. ——— 1935. *Plasmodium hexamerium*, n. sp., from the bluebird, inoculable to canaries. *Amer. Jour. Hyg.*, 22: 274-277.
52. ——— 1937. A new variety of *Plasmodium relictum* from the robin. *Jour. Parasit.*, 23: 400-404.
53. ——— 1939. A survey of blood parasites of birds caught for banding purposes. *Jour. Amer. Vet. Med. Assoc.*, 90: 615-620.

54. ——— 1942. Schizogony and gametocyte development in *Leucocytozoon simondi*, and comparisons with *Plasmodium* and *Haemoproteus*. *Jour. Inf. Dis.*, 71: 18-32.
- 54a. JORDAN, H. B. 1943. Blood protozoa of birds trapped at Athens, Georgia. *Jour. Parasit.*, 29: 260-263.
55. LUCENA, D. T. 1939. Malaria aviaria, subsidios para sua sistemática e transmissão. *Jornal do Commercio Recife*, 126 pp.
56. ——— 1941. Lista dos protozoários hemoparasitas de aves da região neotrópica. *Anais Soc. Biol. Pernambuco*, 2: 1-61.
57. LÜHE, M. 1906. Die im Blute schmarotzenden Protozoen und ihre nächsten Verwandten. In *Mense's Handbuch der Tropenkrankheiten*, 3: 69-268.
58. MACCALLUM, W. G. 1898. On the hematozoan infections of birds. *Jour. Exp. Med.*, 3: 117-136.
59. MANWELL, R. D. 1934. Blood parasites of the Syracuse (N. Y.) region. *Anat. Rec.*, 60 (Supplement): 78.
60. ——— 1934. How many species of avian malaria parasites are there? *Jour. Parasit.*, 20: 334.
61. ——— 1934. Avian malaria infections as classroom material. *Science*, 79: 544-555.
62. ——— 1935. *Plasmodium vaughani* (Novy and MacNeal). *Amer. Jour. Hyg.*, 21: 180-187.
63. ——— 1935. How many species of avian malaria are there? *Amer. Jour. Trop. Med.*, 15: 265-282.
64. ——— 1936. *Plasmodium polare* in the vertebrate host. *Jour. Parasit.*, 22: 412-413.
65. ——— 1936. The problem of species, with special reference to the malarial parasites. *Ann. Trop. Med. and Hyg.*, 30: 435-439.
66. ——— 1938. Reciprocal immunity in the avian malarias. *Amer. Jour. Hyg.*, 27: 196-211.
67. ——— 1938. The identification of the avian malarias. *Amer. Jour. Trop. Med.*, 18: 565-575.
68. ——— and HERMAN, C. M. 1935. The occurrence of the avian malarias in nature. *Amer. Jour. Trop. Med.*, 15: 661-673.
69. ——— and ——— 1935. Blood parasites of birds of the Syracuse (N. Y.) region. *Jour. Parasit.*, 21: 415-416.
70. MORGAN, B. B. and WALLER, E. F. 1941. Some parasites of the eastern crow (*Corvus brachyrhynchos brachyrhynchos* Brehm). *Bird Banding*, 12: 16-22.
71. NELSON, E. C. and GASHWEILER, J. S. 1941. Blood parasites of some Maine waterfowl. *Jour. Wildlife Management*, 5: 199-205.
72. NOVY, F. G. and MACNEAL, W. J. 1904. Trypanosomes and bird malaria. *Amer. Med.*, 8: 932-934.
- 72a. ——— and ——— 1905. Trypanosomes and bird malaria. *Proc. Soc. Exp. Biol. and Med.*, 2: 23-28. (This paper is a reprint of No. 72.)
73. ——— and ——— 1905. On the trypanosomes of birds. *Jour. Inf. Dis.*, 2: 256-308.
74. OPIE, E. L. 1898. On the haematozoa of birds. *Jour. Exp. Med.*, 3: 79-101.
75. O'ROKE, E. C. 1928. Parasites and parasitic diseases in the California valley quail. *Calif. Fish and Game*, 14: 194-198.
76. ——— 1929. The morphology of *Haemoproteus lophortyx* sp. nov. *Science*, 70: 432.
77. ——— 1930. The morphology, transmission and life history of *Haemoproteus lophortyx* O'Roke. *Univ. Calif. Publ. Zool.*, 36: 1-50.

78. ——— 1932. Parasitism of the California valley quail by *Haemoproteus lophortyx*, a protozoon blood parasite. *Calif. Fish and Game*, 18: 223-238.
79. ——— 1934. A malaria-like disease of ducks. *Univ. Michigan Sch. of Forestry and Conserv. Bull.* 4, 44 pp.
- 79a. ——— 1943. Host list of Leucocytozoon infections in waterfowl from records taken by Earl C. O'Roke, University of Michigan, 1929 to 1943. Personal communication.
80. PACKCHANIAN, A. 1934. On the cultivation of seven species of trypanosomes in vitro. *Science*, 80: 407-408.
81. PLIMMER, H. G. 1912. On the blood-parasites found in animals in the Zoological Gardens during the four years 1908-1911. *Proc. Zool. Soc. London*, 1912: 406-419.
82. ——— 1913. Report on the deaths which occurred in the Zoological Gardens during 1912, together with the blood-parasites found during the year. *Proc. Zool. Soc. London*, 1913: 141-149.
83. ——— 1914. Report on the deaths which occurred in the Zoological Gardens during 1913, together with a list of the blood-parasites found during the year. *Proc. Zool. Soc. London*, 1914: 181-190.
84. ——— 1916. Report on the deaths which occurred in the Zoological Gardens during 1915, together with a list of the blood-parasites found during the year. *Proc. Zool. Soc. London*, 1916: 77-86.
85. ROUDABUSH, R. L. 1937. Microgamete formation of *Haemoproteus* in the blood of the brown thrasher. *Jour. Parasit.*, 23: 565-566.
86. ——— 1942. Parasites of the American coot (*Fulica americana*) in central Iowa. *Iowa State Coll. Jour. Sci.*, 16: 437-441.
87. ——— and COATNEY, G. R. 1935. *Haemoproteus beckeri* n. sp. and *Trypanosoma laverani* var. *toxostomae* n. var. from the brown thrasher (*Toxostoma rufum*). *Iowa State Coll. Jour. Sci.*, 10: 1-6.
88. SAUNDERS, G. B. 1935. Michigan's studies of sharp-tailed grouse. *Trans. 21st Amer. Game conf.*, 342-344.
89. SCOTT, H. H. 1926. Report on the deaths occurring in the Society's gardens during the year 1925. *Proc. Zool. Soc. London*, 1926: 231-244.
90. ——— 1927. Report on the deaths occurring in the Society's gardens during the year 1926. *Proc. Zool. Soc. London*, 1927: 173-198.
91. ——— 1928. Report on the deaths occurring in the Society's gardens during the year 1927. *Proc. Zool. Soc. London*, 1928: 81-119.
92. STAFSETH, H. J. and KOTLAN, A. 1925. Report of investigations on an alleged epizootic of ruffed grouse in Michigan. *Jour. Amer. Vet. Med. Assoc.*, 67: 260-267.
93. STAUBER, M. F. and STAUBER, L. A. 1942. Bird malaria in southern New Jersey. *Proc. 29th Annual Meeting, N. J. Mosq. Control Assoc.*: 45-46.
- 93a. THOMPSON, P. E. 1943. The relative incidence of blood parasites in some birds from Georgia. *Jour. Parasit.*, 29: 153-155.
94. WENYON, C. M. 1926. Protozoology. Wm. Wood & Co., N. Y., 1563 pp.
95. WETMORE, P. W. 1939. A species of *Plasmodium* from the sharp-tailed grouse infective to other birds. *Jour. Wildlife Management*, 3: 361-364.
96. ——— 1941. Blood parasites of birds of the District of Columbia and Patuxent Research Refuge vicinity. *Jour. Parasit.*, 27: 379-393.
97. WHITMORE, E. R. 1918. Observations on bird malaria and the pathogenesis of relapse in human malaria. *Johns Hopkins Hosp. Bull.*, 29: 62-67.
98. WOHNUS, J. F. and RYERSON, D. L. 1941. Hematozoa from California birds. *Jour. Parasit.*, 27: 540-541.
99. WOLFSON, F. 1936. *Plasmodium oti* n. sp., a plasmodium from the eastern screech owl (*Otus asio naevius*) infective to canaries. *Amer. Jour. Hyg.*, 24: 94-101.

100. ——— 1937. Experimental infections in owls and pigeons with plasmodia of the wood thrush. *Amer. Jour. Hyg.*, 26: 53-59.
101. ——— 1937. A strain of *Plasmodium praecox* with highly synchronous matinal sporulation. *Amer. Jour. Hyg.*, 25: 177-186.
102. WOOD, F. D. and WOOD, S. F. 1937. Occurrence of haematozoa in some California birds and mammals. *Jour. Parasit.*, 23: 197-202.
103. WOOD, S. F. and HERMAN, C. M. 1943. The occurrence of blood parasites in birds from southwestern United States. *Jour. Parasit.*, 29: 187-196.

Ferry Building, San Francisco 11, California.

COLOR-BANDED ADULT HERRING GULLS¹

By HUSTACE H. POOR

THIS paper discusses 52 sight records of Herring Gulls (*Larus argentatus smithsonianus*) marked as adults with colored bands by Dr. A. O. Gross and his associates at Kent Island, New Brunswick (Bay of Fundy, Lat. 44°35'N., Long. 66°45'W.). The banding of these birds was part of a cooperative Herring Gull color-banding project, sponsored by the Linnaean Society of New York, which has been summarized in a previous article (Poor, 1943). At Kent Island 200 adult Herring Gulls were color-banded in 1937, 720 in 1938, and 110 in 1939 (total 1030). Analysis of records of birds found dead or captured alive is reserved for a paper planned by Dr. Gross covering ten years of banding.

All sight records of these 1030 marked gulls, except records from Kent Island and its immediate environs, are plotted in Fig. 1, which shows the dates of observations and the distances of the birds from the banding station. (Some points have been shifted slightly from their true positions to prevent overlapping.) All are along the coast southwest of Kent Island except one 33 miles southeast.

Sight records from Kent Island and vicinity by the Bowdoin Scientific Station personnel were numerous, and repeated duplication in such records was unavoidable. They have therefore been omitted from Fig. 1. These records support Gross's statement (*in litt.*), based on numerous recoveries of aluminum-banded gulls: "Of all the banded birds we have recovered on Kent Island not a one has been a bird banded in another colony other than the nearby islands which are essentially the same population."

The New York region (here considered as the area enclosed within

¹Contribution Number 11, Bowdoin-Kent Island Scientific Station, Kent Island, Bay of Fundy, New Brunswick, Canada.