Blood Parasites of Birds from Almirante, Panama with ecological notes on the hosts*

by

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There have been few comprehensive surveys of blood parasites of neotropical birds. The only published information on the subject from Panama and surrounding areas is that by Renjifo et al. (5) and Takos (6). Both of these surveys were limited in their scope as the samples were small and only a relatively low percentage of the species of the local avifauna was included.

As part of a general survey for arthropod-borne viruses in a tropical rainforest area of Panama, large numbers of birds were captured and bled between 1960 and 1963. A thin smear from each bird collected was prepared to be used for blood parasite studies. In this manner, over 3,500 individual smears were obtained. The present publication presents an annotated list of the avian species sampled during the survey and a general account of the main groups of blood parasites found in each species of bird. Plans have been drawn to have this publication followed by additional reports covering parasitological studies conducted on several species of Plasmodium isolated during the survey.

DESCRIPTION OF THE STUDY AREA

The study area surrounds the town of Almirante, between the Changuinola and Western Rivers, in extreme northwestern Panama. It extends from the sea shore to 3,000 ft. above sea level. The area has a tropical rain forest climate and, as a consequence, is mainly covered by evergreen broad-leaf forest. This apparently homogeneous type of vegetation actually is composed of a number of ecological associations which have developed under the influence of special

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orographic, hydrographic and edaphic conditions or of human activity. The main types of ecological associations sampled for birds were: 1) swamp forests; 2) open fresh water marshes; 3) upland tropical rain forest; 4) peridomestic and second-growth associations. Collecting sites were selected at or near sea level in the general vicinity of Almirante with the exception of the Changuena station which is located deep within an upland tropical rain forest between 2,500 and 3,000 ft. above sea level about 40 kms to the southwest of Almirante. GALINDO et al. (3) give a more complete ecological description of the study area and of the sites where collections of birds were carried out.

METHODS

In the arbovirus survey, birds that were to be sacrificed were bled from the heart without the use of an anticoagulant, while those to be banded and released were bled from the external jugular vein using heparin as anticoagulant. In the first case the thin smear was prepared by placing on a slide a drop of blood from the syringe, while in birds to be banded, blood was obtained by pricking a leg vein before drawing the sample from the jugular vein. At the end of daily activities all smears obtained that day were fixed for one minute in absolute methyl alcohol. Slides were shipped by air from the field station to the laboratory in Panama City twice a week. All slides were numbered with a diamond pencil at the time the slide was prepared. In the case of banded specimens, the number of the band was written on the slide. When birds were sacrificed as museum specimens, the number of the specimen label was used. At the laboratory, slides were stained with Giemsa by conventional methods. Every smear was examined under an oil-immersion objective and a 6X ocular for at least 10 minutes before discarding it as negative. Most positive slides were examined for longer periods in search of mixed infections or of additional stages of the parasite in case of Plasmodium infections.

RESULTS

A total of 3,634 blood smears representing 249 species, 48 families and 19 orders of birds was examined during the survey. Results are summarized in Table 1. As may be noted 926 smears, or 25.5% of the sample, were found positive for blood parasites. The commonest of the groups of parasites found was Haemoproteus, followed by Plasmodium, microfilariae, trypanosomes and Leucocytozoon.

Table 2 presents a breakdown by avian families of the types of blood parasites found in passerine birds. It will be noted that there were some families, like Thraupidae and Cotingidae, which exhibited very high infection rates. It may be observed also that Plasmodium and Haemoproteus infections were more prevalent in highly specialized families, such as Icteridae, Thraupidae and Fringillidae, while trypanosome infections appeared more frequently in the more
TABLE 1.
Types of blood parasites found by orders of birds

<table>
<thead>
<tr>
<th>Order</th>
<th>No. of species examined</th>
<th>Smears examined</th>
<th>Total positive</th>
<th>% positive</th>
<th>Types of parasites</th>
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<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Plasmodium</td>
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<tr>
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<td>0.0</td>
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<td>Totals</td>
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<td>249</td>
<td>3634</td>
<td>926</td>
<td>233</td>
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</table>

primitive groups such as Cotingidae and Tyrannidae.

Types of parasites — No special effort was made to study specifically *Haemoproteus* and trypanosomae observed. However, a careful study was carried out with *Plasmodium* and microfilariae infection in an attempt to identify them to species. Of the 233 positive smears for *Plasmodium*, 16 could not be placed beyond the generic limits because of the lack of stages of the parasite showing key characters. The remaining 217 infections were found to belong to 10 distinct morphological types. Seven of these types corresponded closely to the morphology of known species, while three did not seem to agree with any of the described avian plasmodia. These unknown types are referred to in this report as “Butorides” “Casmerodius” and “Piaya” plasmodia, according to the generic name of the host. Following is a list of the morphological types of *Plasmodium* observed during the survey, together with the number of infections of each type. *Plasmodium relictum* (22), *P. catamerium* (15), *P. polare* (2), *P. hexamerium* (= oti, Manwell, 4) (105), *P. vaughani* (165), *P. circumflexum* (9), *P. nucleophilum* (7), “Butorides” (5), “Casmerodius” (1), “Piaya” (2).
### TABLE 2.
Types of blood parasites found by families of passerine birds

<table>
<thead>
<tr>
<th>Avian families</th>
<th>No. of species examined</th>
<th>Blood smears</th>
<th>Types of parasites</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Smears examined</td>
<td>Total positive</td>
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<tr>
<td>Dendrocolaptidae</td>
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<td>Sylviidae</td>
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<td>1</td>
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<td>Vireonidae</td>
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<td>2</td>
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<td>Parulidae</td>
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<td>Icteridae</td>
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<td>119</td>
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<tr>
<td>Unidentified</td>
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<td>5</td>
<td></td>
</tr>
<tr>
<td>Totals</td>
<td>151</td>
<td>2687</td>
<td>738</td>
</tr>
</tbody>
</table>

Adames (1) made a detailed study of 134 blood smears containing microfilariae taken early in the survey. He described 12 distinct morphological types, two of which corresponded closely to already known species, namely, Splendidofilaria webri Anderson and Pseudophelina inornata Anderson, described from Swainson's Thrush (Hylocichla mustelina) and the Wood Thrush (Hylocichla mustelina) respectively. These two species of filaria were found in our study area in migrating specimens of the original host species.

Leucocytozoon infections were rarely encountered and 12 of the 18 positive specimens belong to northern species captured during migration. The six local infections of Leucocytozoon detected corresponded to birds belonging to four different families, namely, a heron, a swallow, a flycatcher and an oriole.

**ANNOTATED LIST OF BIRDS FOUND POSITIVE**

The following species of birds were found to harbor blood parasites. Scientific and common names are those currently accepted by Dr. Alexander Wetmore (personal communication).
Tinamidae (Tinamous)

*Tinamus major* (Great Tinamou) - This inhabitant of virgin forest was formerly common around Almirante but is becoming rare as human activity expands. Three specimens were examined, two of which were found infected, one with *Haemoproteus* and one with trypanosomes.

Ardeidae (Heron and Egrets)

*Butorides virescens* (Green Heron) - This is a common inhabitant of the lowland swamps near Almirante. Twenty-three smears were examined, 6 of which, or 26.1%, showed blood parasites. Three of the 6 showed infections with an undescribed species of *Plasmodium* (''Butorides'' type), 2 specimens harbored *Leucoctozaoon* and there were single infections of trypanosomes and microfilarias. The *Plasmodium* infection was studied in naturally infected nestlings and will be the subject of a separate publication.

*Casmerodius albus* (Common Egret) - Thirty-one specimens examined revealed a single positive smear with an undetermined species of *Plasmodium* (''Casmerodius'' type) close to but apparently different from *P. circumflexum*.

Ciconiidae (Storks)

*Myceria americana* (Wood Ibis) - This species of stork was observed but once during 3 years. A group of 5 was found roosting high above a fresh water swamp. One of these birds was shot and found infected with a *Plasmodium* morphologically similar to *P. hexamerium*.

Cathartidae (American Vultures)

*Cathartes aura* (Turkey Vulture) - Seen only during migratory flights in fall and spring and mainly a migrant in Almirante. On the evening of April 2, 1962 a large flight was seen coming in from the southeast and dropping down to roost for the night on the tall branches of a grove of *Ficus* trees at the edge of town. Next morning 4 birds were captured and bled. All of these specimens were found to harbor hemoparasites. Three were infected with a species of *Haemoproteus* and 1 with a microfilaria. Three additional birds of this species captured at other times were negative for blood parasites.

Accipitridae (Hawks, Eagles, and allies)

*Buteo platypterus* (Broad-winged Hawk) - A common winter visitant in Almirante. Juveniles often remain behind during the summer after adults leave for the north. Fifteen smears were examined and 5 were found positive. Three had *Haemoproteus* and 2 harbored an undetermined *Plasmodium*.

*Ictinia plumbea* (Plumbeous Kite) - The only specimen examined was positive with a *Plasmodium* much like *P. hexamerium*. 
FALCONIDAE (Falcons)

*Microstur ruficollis* (Barred Forest-Falcon) - Two specimens examined were found infected with *Haemoproteus.*

CRACIDAE (Guans and Curassows)

*Penelope purpurascens* (Crested Guan) - This is a common species in virgin tropical rain forest in Panama but is rarely seen around Almirante. Specimens reported were taken in the Changuena area. Four smears were examined, all of which showed blood parasites. One had a mixed infection of *Haemoproteus* and trypanosomes, the other 3 showed gametocytes of *Haemoproteus.*

*Ortalis cinereiceps* (Gray-headed-Chachalaca) - Although fairly common around the edges of swamps in the vicinity of Almirante, they are very wary and only 2 specimens were captured. A blood smear of one showed a mixed infection of *Haemoproteus* and trypanosomes. The other had *Haemoproteus* gametocytes.

RALLIDAE (Rails)

*Aramides cajanea* (Gray-necked Wood-Rail) - Common around the edges of swamps in Almirante. Only 1 out of 9 smears examined showed hemoparasites, it being a *Plasmodium* infection of the *P. vaughnii* type.

SCOLOPACIDAE (Sandpipers)

*Tringa solitaria* (Solitary Sandpiper) - One out of 11 specimens of this winter visitant was found infected with a *Plasmodium vaughnii*-like parasite.

COLUMBIDAE (Pigeons and Doves)

*Clarinis pretiosa* (Blue Ground-Dove) - A common inhabitant of second-growth thickets in Almirante. Of 37 specimens examined, 14 were found infected with a species of *Haemoproteus* and 1 with a *P. vaughnii*-like parasite.

*Columba cayennensis* (Pale-vented Pigeon) - A very common pigeon in the mangrove swamps near Almirante. Specimens are often seen also in second growth thickets near the coast. Five out of 38 smears showed blood parasites. Three had *Haemoproteus* gametocytes, 1 a *Plasmodium relutum*-like parasite and 1 microfilariae.

*Columba nigrorostris* (Short-billed Pigeon) - The preferred habitat of this species is virgin tropical rain forest, but in the Almirante area it is often seen along the forest edge and in second growth. Out of 22 specimens examined, 10 had *Haemoproteus* gametocytes in the blood. One of these was found to be a mixed infection showing also microfilariae and a *Plasmodium relutum*-like organism.

*Columba speciosa* (Scaled Pigeon) - Not infrequently seen around edges of forest and of thick second growth in the vicinity of Almirante. Nine blood smears were examined and 4 had *Haemoproteus* gametocytes.
Columbigallina talpacoti (Ruddy Ground-Dove) - Commonest of the Columbidae in Almirante, frequently encountered in second growth thickets, open fields and fruit orchards. Fifty-seven specimens were examined, 24 of which were positive. Of these, 23 harbored Haemoproteus, 1 had Plasmodium and 2 showed microfilariae.

Geotrygon lawrencii (Lawrence’s Quail-Dove) - This species occurs in upland tropical rain forest. Two specimens were obtained in the Changuena area both of which showed microfilariae in the blood.

Leptotila verreauxi (White-fronted Dove) - An inhabitant of open areas and rather uncommon around Almirante. Fourteen specimens were examined and 1 was found with Haemoproteus.

Zenaidura macroura (Mourning Dove) - A migrant from the north rarely seen in Almirante. A single specimen examined was found harboring Haemoproteus.

Psittacidae (Parrots and Macaws)

Pionopsitta haematotis (Red-eared Parrot) - Large flocks of this small parrot are commonly seen along the edges of forest. Out of 49 smears examined 21 showed blood parasites. Of these, 19 were found with microfilariae, 2 with Haemoproteus and 3 with a Plasmodium nucleophilum-like parasite.

Pionus menstruus (Blue-headed Parrot) - A common parrot in the Almirante area. Forty-five specimens were examined for blood parasites and only 3 were positive. All of these positive smears showed Haemoproteus gametocytes, 1 being a mixed infection also harboring microfilariae and Plasmodium circumflexum-like parasites.

Cuculidae (Cuckoos and Anis)

Crotophaga sulcirostris (Groove-billed Ani) - Common in grassy fields in the outskirts of Almirante. Out of 44 specimens examined the only positive was a heavy microfilaria infection.

Pitaya cayana (Squirrel Cuckoo) - Common along the forest edge. Thirty one specimens were examined and 15 had microfilariae. Two of these also revealed an undetermined species of Plasmodium (“Piaya” type).

Strigidae (Owls)

Otus guatemalae (Vermiculated Screech Owl) - Two specimens from the Changuena area showed Haemoproteus gametocytes.

Pulsatrix perspicillata (Spectacled Owl) - Two specimens were examined, of which 1 had Haemoproteus and the other a mixed infection of Haemoproteus and microfilariae.

Caprimulgidae (Goatsuckers and Nightjars)

Chordeiles minor (Common Nighthawk) - A migrant from the north which also breeds on the Pacific slopes of Panama. On the evening of September 16, 1962 a large flight was observed coming into Almirante. A flock of birds
from this flight came in low over our field station and remained until dark busily capturing winged termites. A single specimen shot on the wing showed a mixed infection of *Haemoproteus* and trypanosomes.

**Trochilidae (Hummingbirds)**

*Threnetes ruckeri* (Rucker’s Hermit) - The only species of hummingbird found infected with blood parasites during the survey. Of 12 specimens examined 1 was found with *Haemoproteus*.

**Trogonidae (Trogons)**

*Trogon clathratus* (Lattice-tailed Trogon) - Nine specimens were collected during the study period all from the Changuena region. Two of the smears examined had microfilariae, 1 had *Haemoproteus* and 1 a mixed *Haemoproteus*-microfilariae infection.

*Trogon violaceus* (Gartered Trogon) - A fairly common species in the lowland woods near Almirante. Of 9 specimens examined 2 were found infected with microfilariae and 1 with *Haemoproteus*.

**Momotidae (Motmots)**

*Baryphthengus martii* (Rufous Motmots) - Six out of 7 specimens examined were found infected. Three showed microfilariae, 1 trypanosomes and 2 mixed infections of trypanosomes and microfilariae.

**Bucconidae (Puffbirds)**

*Malacoptila panamensis* (White-whiskered Puffbird) - Commonest of the puffbirds in Almirante. Three out of 12 specimens showed microfilariae.

*Nasbarychus macrorhynchus* (White-necked Puffbird) - Five smears were examined resulting in the detection of 2 single infections of *Haemoproteus* and 1 mixed infection of microfilariae and a *Plasmodium reticulatum*-like parasite.

**Ramphastidae (Toucans)**

*Pteroglossus torquatus* (Collared Aracari) - Very common in Almirante. Thirty four specimens were examined 4 of which were found with microfilariae.

*Ramphastos sulphuratus* (Keel-billed Toucan) - Commonest of the toucans in the woods near Almirante. A total of 35 birds was examined and 19 were positive. Thirteen were found harboring a *Plasmodium* resembling morphologically *P. vaughani* 10 had microfilariae and 1 specimen each was found with trypanosomes and *Haemoproteus*.

*Ramphastos swainsonii* (Swainson’s Toucan) - Seen together with the Keel-billed Toucan, but in lesser numbers, in the lowland forests near Almirante. Eight smears were examined 3 of which showed blood parasites. Two had trypanosomes and 1 microfilariae.

*Selasphorus rufus* (Cassin’s Aracari) - Very rare in the woods near Almirante. Two specimens were examined 1 of which was found harboring microfilariae.
PICIDAE (Woodpeckers)

*Ceridura pucherani* (Pucheran’s Woodpecker). Commonest of the woodpeckers in the study area. It prefers the edges of forest and old rotting trees in pastures. A total of 56 smears was examined and a single *Plasmodium nucleophilum*-like infection was found.

*Phleocryptes guatemalensis* (Flint-billed Woodpecker). Commonest of the large species of woodpeckers with a conspicuous red crest. Two smears out of 18 were found to have microfilariae.

*Dryocopus lineatus* (Lineated Woodpecker). Rarer and more secluded than the preceding species, found mainly in primary forest. Four specimens were examined and 1 had microfilariae.

DENDROCOLAPTIDAE (Woodhewers)

*Dendrocolaptes certhia* (Barred Woodhewers). This large species is an inhabitant of upland tropical rainforest. Four specimens were captured in the Changuena area and 1 was found positive for microfilariae.

*Lepidocolaptes souleyetii* (Streak-headed Woodhewer). Commonest of the woodhewers in the lowlands of Almirante. One out of 16 smears revealed an infection with microfilariae.

FURNARIIDAE (Ovenbirds)

*Automolus ochroloemus* (Buff-throated Automolus). An inhabitant of the deep forest occurring in both swamp and upland forest. Three specimens were obtained in the Changuena area, 1 of which was found to harbor an unidentified species of *Plasmodium*.

*Synallaxis brachyura* (Slaty spinetail). A very common bird in the lowlands of Almirante. Two out of 34 specimens showed blood parasites. One had trypanosomes and the other a mixed *Haemoproteus*-trypanosomes-microfilariae infection.

FORMICARIIDAE (Antbirds)

*Cercomacra tyrannina* (Tyrannine Antbird). An inhabitant of densely wooded areas. Five specimens were captured in Changuena, 1 of which had trypanosomes.

*Cymbilaimus lineatus* (Fasciated Antshrike). Not infrequently seen along the edges of clearings in upland tropical rain forest. Three smears were examined and 1 was found positive for trypanosomes.

*Dysithamnus mentalis* (Plain Antvireo). This species occurs in the upper canopy of upland tropical rain forests frequenting the edge of forest clearings. One out of 3 smears obtained in the Changuena area showed microfilariae.

*Formicarius analis* (Black-faced Antthrush). Also an inhabitant of upland forests, but in contrast to former species it is usually seen in shrubbery near
the forest floor. A single specimen captured in Changuena had microfilariae in
the blood.

Grallaria guatemalensis (Scaled Antpitta) - All Antpittas in Panama are
inhabitants of upland tropical rain forest moving not far above the forest floor.
The single smear of this species examined showed an unidentified Plasmodium
infection.

Grallaricula flavirostris (Common Pygmy Antpitta) - Two specimens were
taken in the Changuena forest, 1 of which exhibited parasites much like Plas-
modium nucleophilum.

Cotingidae (Cotingas)

Attila spadiceus (Yellow-rumped Attila) - A rather rare inhabitant of the
lowland forests near Almirante. The single smear of this species examined
had microfilariae.

Carpodectes nitidus (Snowy Cotinga) - This beautiful bird can be
frequently seen high up in the upper canopy of trees along the edges of swamp
forests in Almirante. Four out of 7 specimens examined showed blood parasites.
Two had trypanosomes and 2 microfilariae.

Erator inquisitor (Black-crowned Tityra) - This is the commonest of the
Cotingas around Almirante occurring along the edges of forest swamps in the upper
branches of trees. Of 18 specimens examined, there were 13 positive for blood
parasites. Eleven showed trypanosomes, 8 had microfilariae and 1 exhibited
gametocytes of Haemoproteus.

Pachyrhampbus cinnamonorum (Cinnamon Becard) - This species is less
arboreal than other Cotingas and is commonly seen in low cacao trees. Three
of 7 specimens showed blood parasites. All 3 were infected with a Plasmodium
similar to P. circumflexum mixed with a trypanosome infection. Two of them
also exhibited microfilariae.

Pachyrhampbus polychropterus (White-winged Becard) - Rarely seen in
the forests of Almirante. A single specimen examined showed a mixed Plas-
modium-trypanosome-microfilaria infection.

Querula purpurata (Purple-throated Fruit-Crow) - A common bird along
the edges of swamp forests in the vicinity of Almirante. Eighteen smears were
examined and 2 were found positive for trypanosomes.

Tityra semijacuta (Masked Tityra) - One of 2 specimens seen was found
infected with microfilariae.

Pipridae (Manakins)

Corapipo leucorhoa (White-throated Manakin) - Four smears were
examined, 1 of which exhibited Haemoproteus gametocytes and 1 a mixed
Haemoproteus-microfilaria infection.

Manacus vitellinus (Gould’s Manakin) - Very common in second growth
and along the edge of swamp forests around Almirante. A total of 36 specimens
was examined, 1 of which had microfilariae and 1 a *Plasmodium vaughani*-like infection.

**Tyrannidae** (Tyrant Flycatchers)

*Colonia colunus* (Long-tailed Tyrant) - Commonly seen on dead trees along the edges of swamp forests in Almirante. Three specimens were examined during the survey. One was positive for *Haemoproteus* and 1 for microfilariae.

*Megarhynchus pitangus* (Boat-billed Flycatcher) - This is a large, conspicuous species commonly encountered along the edges of town in Almirante. Twenty smears out of 64 were found to have blood parasites. Twelve had *Haemoproteus* gametocytes, 7 microfilariae, 4 trypanosomes, 1 a *Plasmodium circumflexum*-like parasite and 2 a *P. relictum*-like infection.

*Nuttaliornis borealis* (Olive-sided Flycatcher) - A migrant from the north which is occasionally encountered in Almirante during the fall. One specimen out of 4 examined had trypanosomes in the blood.

*Pipremorpha oleaginea* (Ochre-bellied Flycatcher) - Common along the edges of swamp forest around Almirante. Six smears of this species were examined and 2 were found to harbor blood parasites. One showed *Leucocytozoon* gametocytes and 1 microfilariae.

*Pitangus sulphuratus* (Kiskadee Flycatcher) - This is a large conspicuous species commonly seen around mangrove swamps. Out of 12 specimens, 2 were found positive. One had trypanosomes and the other microfilariae.

*Tyrannus vilisimus* (Paltry Tyrannulet) - A small species very common in lowland forests in the study area. Out of 41 smears seen, 6 had blood parasites. Five showed *Haemoproteus* and 1 a *Plasmodium* similar to *P. relictum*.

*Tyrannus melancholicus* (Tropical Kingbird) - Very common in peri-domestic habitats. One specimen out of 21 was found to harbor a mixed *Haemoproteus*-microfilariae infection.

Unidentified Tyrannidae - There were 97 smears examined from tyrant flycatchers not specifically determined. Of these, 8 showed blood parasites. Two had mixed *Haemoproteus*-trypanosome infections, 1 a *Plasmodium circumflexum*-like parasite and 5 microfilariae.

**Hirundinidae** (Swallows)

*Petrochelidon pyrrhonota* (Cliff Swallow) - A migrant from the north seen in early fall perching on wires and in upper canopy of swamp forests. Four smears of this species were seen and 2 were found infected with *Plasmodium polare*.

*Progne chalybea* (Gray-breasted Martin) - A common swallow around Almirante. Fifty-two specimens were examined and 3 were found with blood parasites. Of these, 2 had *Leucocytozoon* and 1 microfilariae.
TROGLODYTIDAE (Wrens)

Cyphorhinus phoeocephalus (Song Wren) - In the study area this species is common along clearings in upland forests. Thirteen smears were examined and 1 exhibited microfilariae.

Thryothorus nigricapillus (Black-capped Wren) - Rare in the study area. Five specimens were examined and 1 was found infected with an unidentified Plasmodium parasite.

MIMIDAE (Mockingbirds)

Dumetella carolinensis (Catbird) - A migrant from the north that stays in numbers as a winter visitant in the study area from mid-October to early May. A total of 29 specimens was collected and 1 was found to harbor microfilariae.

TURDIDAE (Robins and Thrushes)

Hylocichla mustelina (Wood Thrush) - A migrant occurring as a winter visitant in Almirante from about October 8 through the month of April. A specimen banded in Charleston, S.C. on October 8, 1963 was recovered by Galindo and Méndez (2) in Almirante 18 days later. Eleven smears of this species were examined and 4 were found positive. Three of these had a species of Leucocytozoon and 2 had microfilariae.

Hylocichla ustulata (Swainson’s Thrush) - A common migrant seen frequently in the study area from late September through November and again from late March through April. A total of 121 smears was seen, 18 of which had blood parasites. Of these, 7 had microfilariae, 6 Leucocytozoon, 1 a Plasmodium circumflexum-like parasite, 1 a P. hexamerium-like infection, 1 an undetermined species of Plasmodium, 2 trypanosomes and 1 Haemoproteus.

Hylocichla minima (Gray-cheeked Thrush) - An early migrant from the north. It is common in the Almirante area from the last week in September through the second week in November, but is very rarely seen in the spring. Of 4 specimens examined, 1 had a Leucocytozoon infection.

Myiastes melanops (Black-faced Solitaire) - This species is frequently encountered in the upland tropical rainforest covering the slopes to the west of Almirante. Three smears were prepared from specimens taken in the Changuena area and 1 was positive for Haemoproteus.

Turdus obsolitus (Cocoa Robin) - A highland species chiefly found in cloud forest habitats. A single specimen collected in the Changuena area was found to harbor Haemoproteus.

Turdus grayi (Clay-colored Robin) - One of the commonest birds in the vicinity of Almirante. Out of 52 specimens which came to hand, 3 were positive for blood parasites. Two of these had microfilariae, 1 trypanosomes and 2 Haemoproteus.
VIREONIDAE (Vireos)

*Vireo flavifrons* (Yellow-throated Vireo) - A North American migrant. The single specimen examined had a mixed *Haemoproteus*-trypanosome infection.  
*Vireo olivaceus* (Red-eyed Vireo) - An early migrant from North America appearing in the study area as early as the second week in August. Five smears were seen and 1 was positive for *Leucocytozoon*.

COEREIDAE (Honey creepers)

*Coereba flaveola* (Bananaquit) - A common bird in peri-domestic habitats, nesting the year-around in our study area. Out of 17 specimens examined, 2 were found positive. One had a mixed *Plasmodium*-microfilariae infection and 1 harbored microfilariae alone.

PARULIDAE (Wood Warblers)

*Dendroica petechia* (Yellow Warbler) - A migrant from the north. Nineteen smears of this species were seen and 4 were found positive. Two of these had trypanosomes, 1 *Haemoproteus* and 1 a *Plasmodium vaughnian*-like parasite.  
*Geothlypis semiplana* (Baird’s Yellowthroat) - A rather common species seen chiefly along the margins of swampy forests. Five specimens came to hand, 1 of which was found positive for *Haemoproteus*.  
*Seiurus noveboracensis* (Northern Waterthrush) - A common North American migrant seen in the study area throughout the fall and winter. Single infections of *Leucocytozoon*, trypanosomes and a *Plasmodium hexamers*-like parasite were seen in 24 smears examined.  
*Unidentified Parulidae* - Five blood smears were examined from warblers not identified to species and 1 was found positive for microfilariae.

ICTERIDAE (Orioles and allies)

*Dolichonyx oryzivorus* (Bobolink) - A rare migrant from the north, chiefly seen around open fields in the fall. Five specimens were examined and 11 had a mixed *Plasmodium-Haemoproteus*-trypanosome infection. The *Plasmodium* parasite resembled *P. vaughnian*.  
*Gymnostomops montezuma* (Montezuma Oropendola) - Colonies of nests of this species are seen high up in the upper branches of trees at the edge of forests from March through June. Twelve specimens were collected and 2 were found with microfilariae.  
*Cacicus microrhynchos* (Scarlet-rumped Cacique) - Rare in the Almirante area. Out of 3 smears examined 2 were found positive. Both specimens had microfilariae while 1 had additional infections of *Plasmodium* sp. and *Leucocytozoon*.
Amblycercus holosericeus (Prevost’s Cacique) - Rather common in lowland rain forests. Four out of 14 specimens examined exhibited blood parasites. Three had Plasmodium vaughnii-like infections and 1 P. relictum-like parasites.

Icterus galbula (Baltimore Oriole) - A North American migrant rather rare in the study area. It is chiefly seen early in the fall. Five smears were examined and 2 were positive for blood parasites. One had a mixed Plasmodium-Haemoproteus infection and the other microfilariae. The Plasmodium parasite resembled P. circumflexum.

Icterus mesomelas (Yellow-tailed Oriole) - A common bird around banana plantations and along edges of open marshes. Two Plasmodium infections were observed in 14 smears examined. One resembled P. relictum and the other P. hexamerium.

Icterus spurius (Orchard Oriole) - A North American migrant not commonly seen in the Almirante area. One of 2 specimens were found infected with a Plasmodium nucleophilum-like parasite.

Thraupidae (Tanagers)

Tanagra laticeps (Yellow-crowned Euphonia) - Fairly common in second growth thickets. A single specimen out of 3 examined was found to harbor a mixed infection of Haemoproteus and a Plasmodium relictum-like parasite.

Thraupis viridis (Blue-gray Tanager) - A common bird in peridomestic habitats. Seventy-seven smears were examined and 5 were found positive with the following blood parasites: microfilariae (4), trypanosomes (1), Haemoproteus (1).

Ramphocelus passerinii (Scarlet-rumped Tanager, Passerini’s Tanager) - One of the commonest birds in peridomestic habitats and along the edges of open marshes. Out of 707 blood smears of this species examined 433, or 61.2%, were found positive for parasites. One hundred and ten specimens had Plasmodium, 386 Haemoproteus, 4 trypanosomes and 49 microfilariae. Of the plasmodia, the commonest was a species morphologically like P. hexamerium with 101 infections. Three additional species similar to P. relictum, P. calibemeri and P. vaughnii were also observed in 7, 3 and 3 smears respectively.

Phlogothraupis sanguinolenta (Crimson-collared Tanager) - A rare species found together with the preceding one. Of 2 specimens examined, 1 had a mixed infection caused by a Plasmodium vaughnii-like parasite and microfilariae.

Piranga rubra (Summer Tanager) - A common migratory from North America. Fifteen out of 23 smears had blood parasites. Of these, 12 exhibited Haemoproteus gametocytes, 4 microfilariae, 2 trypanosomes, and 1 a Plasmodium circumflexum-like infection.

Piranga olivacea (Scarlet Tanager) - A North American migrant much rarer than the preceding species. In Almirante it appears from late fall to early spring in its drab olive-green winter plumage. Ten specimens came to hand, 5 of which had blood parasites. Three were found with Haemoproteus and 2 with unidentified species of Plasmodium.
Habia fuscicauda (Dusky-tailed Ant-Tanager) - Fairly common in deeply shaded shrubs in swamp forests around Almirante. Four out of 6 smears examined had blood parasites. Three showed microfilariae and 1 had a trypanosome infection.

Tachyphonus rufus (White-shouldered Tanager) - A common species around fruit orchards. Sixteen specimens were examined and 3 were found positive. One showed a Plasmodium vaughnii-like infection and 2 had microfilariae.

Heterospingus rubrifrons (Sulphur-rumped Tanager) - A rare species. In the study area it was found only in upland tropical rain forest. Two specimens taken in the Changuena area harbored mixed infections of Haemoproteus and trypanosomes.

Mirospingus cassini (Cassin’s Tanager) - Rather common in well-drained rain forests in the study area. Six specimens were examined, 1 of which had trypanosomes and 1 microfilariae.

Fringillidae (Sparrows and allies)

Sporophila aurita (Variable Seedeater) - Very common in second growth thickets around Almirante. Out of 358 specimens examined, 52 showed parasites in the blood. Haemoproteus gametocytes were found in 46 of these, microfilariae in 6 and Plasmodium in 5. Three of the latter infections were much like P. cathemerium and 2 could not be studied beyond generic limits.

Volatinia jacarina (Blue-black Grassquit) - In Almirante, this species occurs together with S. aurita but in lesser numbers. A total of 38 smears were examined and 7 were found to harbor blood parasites. Five birds had Haemoproteus gametocytes, 1 a Plasmodium cathemerium-like parasite and there was 1 mixed Haemoproteus-Plasmodium infection.

Oryzoborus funereus (Lesser Rice Grosbeak) - Another inhabitant of grassy thickets in the Almirante area. Three Haemoproteus infections were observed in 48 specimens examined.

Cyanocompsa cyanoides (Blue-black Grosbeak) - Fairly common in low shrubs within swamp forests. One out of 17 specimens showed a mixed Plasmodium relictum-microfilariae infection.

Phoenicus ludovicianus (Rose-breasted Grosbeak) - A North American migrant seen chiefly in early fall. One out of 2 blood smears examined showed Haemoproteus parasites.

Saltator atriceps (Black-headed Saltator) - Common along the edges of swamp forests and in cacao groves in the Almirante area. A total of 123 specimens were examined, 28 of which were found with blood parasites. Of these, 18 had plasmodia and 11 microfilariae. Fifteen of the Plasmodium infections resembled P. vaughnii, 2 appeared like P. relictum and 1 was a mixed relictum-vaughani infection.

Saltator maximus (Buff-throated Saltator) - Common in second growth scrub. Two out of 50 smears showed blood parasites. One had Haemoproteus gametocytes and the other a mixed Haemoproteus-Plasmodium relictum infection.

Arremon aurantirosor (Orange-billed Sparrow) - Common in upland
tropical rain forest also occurring, but in lesser numbers, in swamp forests. A single *Plasmodium vanghani*-like infection was found in 16 specimens examined.

*Arremonops contrastris* (Green-backed Sparrow) - Very Common in second-growth scrub around Almirante. A total of 60 smears was examined, 24 of which showed blood parasites. There were 22 specimens with *Plasmodium*, 5 with microfilariae and 1 with *Haemoproteus* parasites. To species of *Plasmodium* were observed, one closely resembling *P. vanghani* with 21 infections and the other much like *P. caribemium* with 8 positive smears.

**Unidentified passerine birds** - There were 3 smears of passerine birds without specific identification which showed blood parasites. Two had *Haemoproteus* infections and 1 showed microfilariae.

**SPECIES OF BIRDS NOT FOUND INFECTED WITH BLOOD PARASITES**

The following species of birds were found free of blood parasites in the present survey. Numbers in parentheses refer to specimens examined. **Tinamidae**: Crypturellus soni, Pileated Tinamou (15). **Podicipedidae**: Podiceps dominicus, Least Grebe (3). **Pelecanidae**: Pelecanus occidentalis, Brown Pelican (1). **Phalacrocoracidae**: Phalacrocorax olivaceus, Olivaceous Cormorant (2). **Anhingidae**: Anhinga anhinga, Anhinga (1). **Ardeidae**: Ardea herodias, Great Blue Heron (1); Hydrornis ictericus, Tricolored Heron (1); Agania agani, Agami Heron (1); Florida caerulea, Little Blue Heron (10); Lencophaix thula, Snowy Egret (1); Nyctanassa violacea, Yellow-crowned Night-Heron (1); Tigrisoma solomone, Salmon's Tiger-Bittern (1); Bubulcus ibis, Cattle Egret (3). **Anatidae**: Anas discors, Blue-winged Teal (4). **Cathartidae**: Sarcorhamphus papa, King Vulture (1); Coragyps atratus, Black Vulture (4). **Accipitridae**: Harpagus bidentatus, Double-toothed Kite (3); Buteo magnirostris, Large-billed Hawk (2); Luecopterus semiplumbeus, Semiplumbeous Hawk (1); Luecopterus princeps, Barred Hawk (1); Leptodon cayanensis, Cayenne Kite (1); Buteogallus anthracinus, Lesser Black Hawk (1). **Falconidae**: Harpetotheres cachinnans, Laughing Falcon (1); Daptrius americus, Red-throated Caracara (1); Falco abigularis, Bat Falcon (1). **Cracidae**: Crax rubra, Central American Curassow (1). **Rallidae**: Laterallus abigularis, White-throated Rail (30); Porzana carolina Sora Rail (1); Porphyria martinica, Purple Gallinule (1). **Jacanidae**: Jacana spinosa, Northern Jacana (3). **Scolopacidae**: Capella gallinago, Common Snipe (1). **Laridae**: Thalasseus maximus, Royal Tern (1). **Columbidae**: Geotrygon veraguensis, Olive backed Quail-Dove (1); Geotrygon montana, Rudy Quail Dove (1). **Psittacidae**: Aratinga finschi, Finsch's Parakeet (14); Aratinga astec. Aztec Parakeet (1); Amazona autumnalis, Redfronted Parrot (1); Amazona farinosa, Mealy Parrot (8); Unidentified species (2). **Cuculidae**: Neomorphus geoffroyi, Rufous-vented Ground Cuckoo (1). **Caprimulgidae**: Caprimulgus rufus, Rufous Nightjar (1); Nyctidromus albicollis, Pauraque (4). **Trochilidae**: Amazilia tzacatl, Rieffer's Hummingbird (71); Glanis hispida, Hairy Hermit (2); Phaethornis superciliosus, Long-tailed Hermit (5); Enteles aquila, Com-
mon sicklebill (2), Heliodoxa jacula, Green-crowned Brilliant (1); Unidentified species (10). APODIDAE: Chaetura pelagica, Chimney Swift (5). TROGONIDAE: Trogon rufus, Graceful Trogon (1); Trogon massena, Massena Trogon (9). ALCEDINIDAE: Chloroceryle americana, Green Kingfisher (11); Chloroceryle inda, Green-and-rufous Kingfisher (2); Megaceryle torquata, Ringed Kingfisher (6). GAMBILIDAE: Galbula ruficauda, Rufous-tailed Jacamar (1); Jacamperops avara, Great Jacamar (1). BUCCONIDAE: Monasa morphoeus, White-fronted Nunbird (1); Nystalus tectus, Pied Puffbird (1). PICIIDAE: Celus castaneus, Chestnut-colored Woodpecker (8); Piculus simplex, Bugaba Woodpecker (1); Unidentified species (1). DENDROCOLAPTIIDAE: Campylopterus pusillus, Brown-billed Sicklebill (2); Dendrocinclia fuliginosa, Brown Dendrocincla (3); Dendrocinclia homochroma, Ruddy Dendrocincla (2); Xiphornis guttatus, Buff-throated Woodcreeper (10); Xiphornis lachrymosus, Black-striped Woodcreeper (5); Xiphornis triangularis, Spotted Woodcreeper (1); Glyphea spinosa, Wedge-billed Woodcreeper (1). FURNARIIDAE: Premnoplex brunnescens, Spotted Barbtaill (2); Scleronura guatemalensis, Scaly-throated Leafcreeper (2); Xenops minutus, Plain Xenops (2). FORMICARIIDAE: Cercomacra nigriceps, Black Tyrannine Antbird (1); Thamnophilus punctatus, Slaty Antshrike (1); Dicybamus puncticeps, Spot-crowned Antvireo (3); Gymnopithys leucopus, Bicolored Antbird (4); Hylotrichas naeviodes, Spotted Antbird (3); Myrmiriza immaculata, Immaculate Antbird (2); Myrmotherula uncinata, Streaked Antwren (1); Pheastosticus macleannani, Occinated Antthrush (1); Pittasoma media, Black-crowned Antpitta (1); Taxama major, Great Antshrike (2); Unidentified species (3). Cotingidae: Lipaugus unirufus, Rufus Piha (4); Procnias tricarunculata, Three-wattled Bellbird (4); Rhytipterna holothurica, Rufous Mourner (1). Pipridae: Pipra mentalis, Yellow-thighed Manakin (6). Tyrannidae: Contopus sordidus, Western Wood-Pewee (5); Empidonax traillii, Traill’s Flycatcher (4); Mionectes olivaceus, Olive-striped Flycatcher (3); Muscivora forficata, Scissor-tailed Flycatcher (1); Todus dominicus, Common Tody Flycatcher (1); Myiobius sulphureipennis, Sulphur-rumped Flycatcher (4); Myiodynastes luteiventris, Sulphur-bellied Flycatcher (1); Onychorhynchus mexicanus, Northern Royal Flycatcher (1); Platyrhynchos coronatus, Golden-crowned Spadebill (1); Tyrannus clausus, Yellow-crowned Tyrannulet (1); Legatus leucophthalmus, Striped Flycatcher (1). Hirundinidae: Hirundo rustica, Barn Swallow (29); Unidentified Swallows (5). Corvidae: Psilorhinus morio, Brown Jay (1). Troglodytidae: Campylopterus zonatus, Banded Wren (1); Thryothorus atroruginaris, Black-throated Wren (13); Thryothorus thoracicus, Stripe-breasted Wren (6); Thryothorus zeledonii, Zeledon’s Wren (5); Thryothorus spp. (6); Henicorhina leucosticta, White-breasted Wood Wren (1). Turdidae: Catharus mexicanus, Black-headed Nightingale Thrush (9); Hylocichla fuscescens, Veery (2). Sylviidae: Microhynus cinereiventris, Halfcollared Gnatchatch (1). Coerebidae: Dacnis cayana, Blue Dacnis (1); Chlorophanes spiza, Green Honeycreeper (1); Cyanerpes lucidus, Shining Honeycreeper (1). Parulidae: Dendroica pennsylvanica, Chestnut-sided Warbler (5); Dendroica coronata, Myrtle Warbler (1); Icteria virens, Yellow-breasted Chat (2); Wilsonia canadensis, Canada Warbler
(1); Helmintheros vermivorus, Worm-eating Warbler (1); Oporornis formosus, Kentucky Warbler (2); Oporornis philadelphia, Mourning Warbler (4); Seiurus aurocapillus, Ovenbird (1); Seiurus motacilla, Louisiana Water-thrush (2); Phaeohippis fulvicauda, Buff-rumped Warbler (1); Protonotaria citrea, Protonotary Warbler (1); Setophaga ruticilla, Redstart (1); Vermivora percgrina, Tennessee Warbler (2); Vermivora pinus, Blue-winged Warbler (1); Vermivora chrysoptera, Golden-winged Warbler (1) Icteridae: Icterus procthemelus, Lesson's Oriole (12); Zarkynchos wagleri, Wagler's Oropendola (3). Thraupidae: Tanagra aeneae, Tawny-capped Euphonia (1); Tanagra minuta, White-vented Euphonia (1); Tanagra gouldi, Gould's Euphonia (12); Tanagra laniirostris, Thick-billed Euphonia (1); Tangara floridana, Emerald Tanager (1); Tangara inornata, Plain-colored Tanager (2); Tangara larvata, Golden-masked Tanager (14); Tangara icteroniceps, Silverthroated Tanager (1); Thraupis palmarum, Palm Tanager (5). Fringillidae: Atlapetes brunneinucha, Chestnut-capped Atlapetes (2); Caryapectes poliocephalus, Bishop Grosbeak (4); Pitylus groenii, Slate-colored Grosbeak (2); Spiza americana, Dickcissel (1); Sporophila torquata, White-collared Seedeater (1); Passerina cyanea, Indigo Bunting (1). Unidentified passerine birds (22).

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SUMMARY

A single-smear survey for blood parasites was conducted among birds of an area with a tropical rain forest climate in Panama. Birds were collected from a variety of habitats including swamp forests, open fresh water marshes, peri-domestic and second growth association and upland tropical rain forests. Smears from 3,634 birds belonging to 249 species, 48 families and 19 orders were examined and 926, or 25.5%, were found to harbor blood parasites. There were 5 main groups of parasites observed, namely, Plasmodium with 233 positive smears, Haemoproteus with 589, microfilariae with 224, trypanosomes with 61 and Leucocytozoon with 18. Ten different types of Plasmodium were recognized, of these, thrice did not seem to agree morphologically with any of the described forms of avian plasmodia and were designated in this survey as "Butorides", "Casmrodius" and "Paya" types. They were recorded from the Green Heron, the Common Egret and the Squirrel Cuckoo, respectively. The remaining seven
types resembled morphologically the following species: P. rletum, P. cahemer-
ium, P. hexamerium, (= oti), P. nucleophilum, P. vaughani, P. polare, and P. circumflexum. Twelve distinct types of microfilariae were recognized from 134
smears collected early in the survey. Of these, 2 resembled closely Splendidofilaria webri Anderson and Pseudoproctoria inornata Anderson. Infections of Leu-
cytocytozoon were mainly found in North American migrants. There were only 6
smears found positive with this genus of blood parasites from four species of
local birds, namely, a heron, a swallow, a flycatcher and an oriole. A list of all
avian species collected is presented, giving the scientific and common names of
each species. Brief notes on the habits and blood parasites of the species found
infected are also included.

RESUMEN

El material objeto de este informe fue colectado en el área de Almirante,
Provincia de Bocas del Toro, durante los años de 1960 a 1963. Muestras de san-
gre de las aves capturadas durante ese período, fueron sometidas a examen para-
sitológico con el objeto de determinar los tipos de hemoparásitos que afectan la
avifauna de esta área tropical.

Las principales asociaciones ecológicas del área son las siguientes:

1) Pluviselas pantanosas.
2) Ciénagas expuestas al sol.
3) Pluviselas de altura.
4) Asociaciones peridomésticas y de crecimiento secundario.

Los sitios de colectas fueron seleccionados en su mayoría a nivel del mar,
cerca del pueblo de Almirante, pero algunos ejemplares fueron obtenidos en la
foresta entre los 2,500 a 3,000 pies de altura.

Un total de 3,634 aves fueron examinadas, pertenecientes a 249 especies,
48 familias y 19 órdenes. El examen de extensiones de sangre reveló que 926
animales, o sea un 25.5% del total examinado, se encontraban parasitados por
hematozoarios al momento de captura. Se encontraron 233 casos de infecciones
por Plasmodium, 589 con Haemoproteus, 224 con microfilarias, 61 con Trypa-
nosoma, y 18 con Leucocytozoon.

De acuerdo con sus características morfológicas se pudieron apreciar diez
tipos distintos de Plasmodium; tres de los cuales presentaron características un
 tanto distintas a las de especies ya conocidas, por esta razón son reportados en el
presente trabajo como tipo “Butorides” (en Butorides virescens), tipo “Casme-
roidus” (en Casmerodius albus) y tipo “Piaya” (en Piaya cayana). Los siete
tipos restantes de Plasmodium presentaron características morfológicas compati-
bles con las siguientes especies: P. rletum, P. cahemerium, P. hexamerium
(= oti), P. nucleophilum, P. vaughani, P. polare, y P. circumflexum.

Se distinguieron doce tipos distintos de microfilarias aún cuando sólo se
pudo lograr la identificación específica en dos casos; Splendidofilaria webri An-
derson (ex Hylocichla ustulata) y la Pseudaprocotella inornata Anderson (ex Hylocichla mustellina).

El género \textit{Leucocytozoon} fue observado principalmente en aves migratorias. Solamente cuatro especies de aves no-migratorias fueron encontradas con infecciones por \textit{Leucocytozoon}.

Se presenta una lista de todas las especies de aves colectadas, y se incluyen comentarios acerca de los hábitos y parásitos de las especies reportadas infectadas.

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