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BLOOD PARASITES IN ADULT AND NESTLING BIRDS IN THE ECUADORIAN ANDES

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Parásitos de sangre en pájaros adultos y pichones de los Andes de Ecuador.

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The Equatorial Andes are home to an amazing diversity of birds, and as a result many aspects of Neotropical avian biology are understudied. For example, the occurrence of blood parasites in Neotropical bird species has been relatively unexplored. In other parts of the world, studies have documented prevalence of parasites within different species of bird and at various stages in development (nestlings, adults), linking parasites with their respective avian host species (Peirce 1984, Bennett *et al.* 1993, Young *et al.* 1993, Sehgal *et al.* 2005). Haematozoa species are a common form of avian blood parasite that can significantly impact individual condition (Merino *et al.* 1998, Merino *et al.* 2000), life history traits (MacDougall-Shackleton *et al.* 2002, Ricklefs & Wikelski 2002), and fitness (Korpimäki *et al.* 1995, Merino *et al.* 2000, Marzal *et al.* 2005), and could have a significant negative impact on nestling development (e.g., Remple 2004). Haematozoa have been reported in temperate nestling birds (e.g., Ashford *et al.* 1991, Weatherhead & Bennett 1991, Telford *et al.* 1992, Merino & Potti 1995, Cosgrove *et al.* 2006), but, to our knowledge, have not been studied in tropical nestling birds.

We conducted a survey of blood parasites in 11 species of passerine birds at high elevations in the Ecuadorian Andes, documenting the occurrence of three genera of haematozoa in adult and nestling birds. Between October 2006 and January 2007 we collected blood samples from 59 individual birds near the town of Papallacta, Napo Province, Ecuador (nine species sampled at 00.363°S, 78.154°W, ~3300 m a.s.l.; Plumbeous Sierra Finch, *Phrygilus unicolor*, sampled at 00.321°S, 78.196°W, ~4200 m a.s.l.; Brown-bellied Swallow, *Notiochelidon murina*, sampled at both sites). We used mist nets to catch adult birds, and sampled nestlings at their nests. We collected

blood samples into heparinized capillary tubes via puncture of the brachial vein in adults, and metatarsal or brachial vein in nestlings. We then smeared a small drop of blood (~5 μL) on a microscope slide and allowed the slide to air dry. We fixed all blood smears in methanol and stained them using a Wright-Giemsa stain within one week of collection.

An observer (HM) who was unfamiliar with the sex, age, and species identities of individuals used a standard counting technique to score all blood smears using a light microscope at 1000x magnification with oil immersion. We screened slides following a standard protocol for avian clinical pathology by viewing successive fields perpendicular to the direction of the smear and counting white blood cells (WBCs) until we reached a total of 100 cells (Campbell & Ellis 2007). We identified WBCs as lymphocytes, monocytes, eosinophils, heterophils, and basophils (WBC data not presented here), and noted any parasitized red blood cells (RBCs) in the peripheral blood and identified parasites to genus level. This method is not sensitive enough to conclude that birds without visual evidence of parasites were entirely parasite free (Fallon *et al.* 2003), but does detect intensity of infection, which is potentially a more important parameter for impact on the bird's reproductive success (Merino *et al.* 2000). To determine repeatability, we rescored 20 randomly selected slides. All rescored slides confirmed previous findings.

We found one or more genus of blood parasite in 26 of the 59 adults and nestlings sampled (44%). Eleven of 28 adults were infected by blood parasites (39%), and 15 of 31 nestlings were also infected (48%). We found three genera of haematozoa (Fig. 1), but did not find any individuals infected with *Trypanosoma* or *Microfilaria*. *Haemoproteus* (Fig. 1a) was detected in 4 of 11 species, *Plasmodium* (Fig. 1b) in 6 of 11 species, and *Leukocytozoon* (Fig. 1c) in 2 of 11 species. We included samples from nestlings of six species. Of these, we found parasites in individuals from four species (Fig. 2).

Blood parasites were present in at least one adult or nestling in 7 of the 11 avian species examined. Blood parasites had not been reported previously in four of these species. We found *Plasmodium* infections in Spectacled Whitestart (*Myioborus melanocephalus*) and Cinereous Conebill (*Conirostrum cinereum*), *Haemoproteus* in Masked Flowerpiercer (*Diglossa cyanea*), and both *Plasmodium* and *Haemoproteus* in Black-crested Warbler (*Basileuterus nigrocristatus*) and Brown-bellied Swallow. In addition to *Plasmodium* and *Haemoproteus*, we also found *Leukocytozoon* in Rufous-collared Sparrow (*Zonotrichia capensis*), which was the only species we studied that was infected with parasites from all three genera. In Great Thrush (*Turdus fuscater*) we found *Plasmodium* and *Leukocytozoon*. No evidence of parasites was found in Hooded Siskin (*Carduelis magellanica*), Plain-coloured Seedeater (*Catamenia inornata*), Plumbeous Sierra-Finch, and Tufted Tit-Tyrant (*Anairetes parulus*).

In previous studies, Black-crested Warbler (Bennett & Borrero 1976) and Masked Flowerpiercer (Bennett & de Souza Lopes 1980) were found to have no blood parasites. *Haemoproteus*, *Plasmodium*, and *Trypanosoma* have been documented in Rufous-collared Sparrow (Bennett & de Souza Lopes 1980). Low prevalence of *Leukocytozoon* in the tropics has been previously documented, and is thought to be due to the low levels of insect vectors that transport this parasite among avian species (Rodríguez & Matta 2001). *Microfilaria* infection has been reported in Cinereous Conebill (Forrester *et al.* 1977), but we found only *Plasmodium,* which is a new record for this species. *Haemoproteus* and *Leukocytozoon* infections have been documented in Great Thrush (Gabaldon *et al.* 1974). *Plasmodium* infection has been found in Hooded Siskin (Bennett & de Souza Lopes 1980), but we did not find

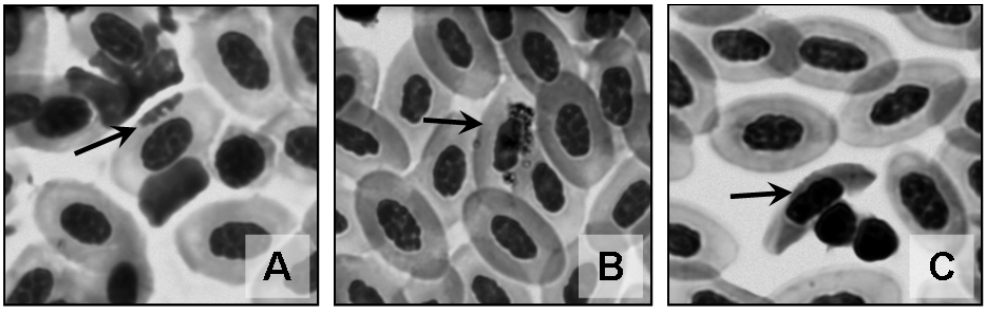

FIG. 1. Examples of each genus of parasite found in this study, with arrow indicating infected red blood cell. A. *Haemoproteus*, B. *Plasmodium*, and C. *Leukocytozoon*.

any evidence of infection in the one individual that we examined from this species. To our knowledge, no previous studies have investigated blood parasite infections in Brown-bellied Swallow, Spectacled White-start, Plain-coloured Seedeater, Plumbeous Sierra Finch, or Tufted Tit-Tyrant.

Past studies examining a range of tropical species report a blood parasite infection rate of between 5.1–24% (Bennett & Borrero 1976, Bennett *et al.* 1991, Young *et al.* 1993, Basto *et al.* 2006), consistent with observations of relatively low infection rates in the tropics (Ricklefs 1992, Basto *et al.* 2006). For the seven species from which we sampled four or more individuals, we noted infection rates ranging from 0 to 60% (Fig. 2).

Here we provide the first reports of parasitemia in nestling tropical birds, and the number of species with nestlings infected by blood parasites is among the highest recorded in the literature. In all of the previous reports of parasitemia in nestlings, individuals were suspected to have been parasitized post hatching, with haematozoa appearing in the later stages of the nestling period due to the long development period required for parasites to be visible under a microscope. We found all three genera of haematozoa in the nestlings we sampled, including *Haemoproteus* infections in nestlings from three species, the first record of *Haemoproteus* in young nestlings (<14 days old). The lack of previous records was thought to be caused by the longer development period (14 days) of this parasite as compared to the other two genera, which have a development period of approximately 5 days (Fallis & Bennett 1961). Thus the occurrence of *Haemoproteus* in our samples may be a result of either a faster development rate of *Haemoproteus* than has previously been described or vertical transmission of the parasites through the egg. Vertical transmission in avian species is plausible, but has not yet been documented (Ashford *et al.* 1991). Of the nestlings with *Haemoproteus* infection, only the Brown-bellied Swallow was over 14 days old. All three of the Rufous-collared Sparrow nestlings with *Haemoproteus* infection were less than 12 days old, including one chick of known age (based on knowledge of hatch date) that was 5 days old. The Black-crested Warbler was 8 days old. For 2 of the 5 chicks with *Haemoproteus*, we also scored maternal blood smears. In one case (Black-crested Warbler), the mother was infected with *Haemoproteus*, and in the other case (the 5-day old Rufous-collared Sparrow) we did not find visible evidence of infection in the mother's blood smear.

Our results add to previous work on the prevalence of blood parasites in Neotropical birds, with some remarkable findings that could have important ramifications for the life histories of these birds. We found blood para-

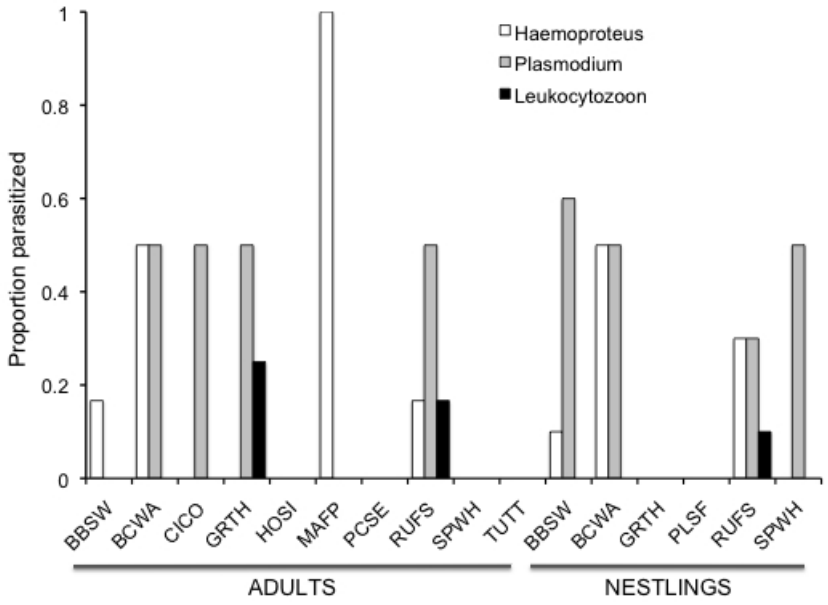

FIG. 2. Proportion of individuals with blood parasites across species examined in this study. Alpha codes and sample sizes are as follows: BBSW – Brown-bellied Swallow, 6 adults, 10 nestlings; BCWA – Black-crested Warbler, 2 adults, 2 nestlings; CICO – Cinereous Conebill, 4 adults; GRTH – Great Thrush, 4 adults, 3 nestlings; HOSI – Hooded Siskin, 1 adult; MAFL – Masked Flowerpiercer, 1 adult; PCSE – Plain-coloured Seedeater, 1 adult; PLSF – Plumbeous Sierra-Finch, 4 nestlings; RUFS – Rufous-collared Sparrow, 6 adults, 10 nestlings; SPWH – Spectacled Whitestart, 2 adults, 2 nestlings; and TUTT – Tufted Tit-Tyrant, 1 adult.

site infections in four species for which parasites had not previously been documented. We report notably high rates of parasite prevalence, particularly for tropical species. Finally, we report incidence of blood parasite infection in nestlings at a younger age than has previously been found, suggesting the possibility of faster development time of blood parasites in the tropics, or vertical transmission of parasites.

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