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# Prevalence and Intensity of Parasitic Insects on Puerto Rican Birds

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ABSTRACT: Birds are host to four orders of parasitic insects: flies (Diptera), lice (Psocodea: Phthiraptera), true bugs (Hemiptera), and fleas (Siphonaptera). These parasites can lower host fitness and thus require birds to invest in defenses to minimize fitness losses. In Puerto Rico, virulent parasites, such as *Philornis* spp. flies, threaten endangered species and subspecies of birds. *Philornis* larvae are hematophagous and burrow beneath the skin of both nestling and adult birds. Unfortunately, little is known regarding the prevalence and intensity of subcutaneous *Philornis* flies of adult birds in Puerto Rico. Here, we inspected 430 birds, representing 38 species, for *Philornis* infestation. We found *Philornis* larvae on only four birds, despite previous studies reporting high *Philornis* prevalence on adults of a single Puerto Rican species, Pearly-eyed Thrashers (*Margarops fuscatus*). Our results are consistent with other studies suggesting that the prevalence and intensity of *Philornis* is low in most adult and fledgling birds, compared to nestlings. Our data suggest that *Philornis* infestation is not a major threat to adult birds in Puerto Rico. In contrast, we show that parasitic lice are relatively common on Puerto Rican birds. Of 309 birds dusted for ectoparasites, 163 (53%) were infested with lice. None of the 309 birds were infested with parasitic fleas or bugs. Our results confirm other recent work showing relatively high prevalence and intensity of lice on birds in humid regions of the world.

*Key words:* Bird lice, intensity, *Philornis*, parasite, Psocodea, Phthiraptera, prevalence.

## INTRODUCTION

Birds are host to four orders of parasitic insects: flies (Diptera), lice (Psocodea: Phthiraptera), true bugs (Hemiptera), and fleas (Siphonaptera). These parasitic insects reduce host fitness by exploiting resources that hosts might otherwise use to meet life history demands, such as survival, growth, and reproduction (Owen et al. 2010; Møller et al. 2009). Parasitic insects can also vector pathogens and other parasites, including protozoa, bacteria, viruses, and nematodes (Lehane 2005). In short, direct and indirect effects of parasitic insects contribute to morbidity and mortality in bird populations, yet little is known about avian parasites in many geographical regions. This is particularly true for avian parasites in Puerto Rico. Thus, our objective was to determine the diversity, prevalence, and intensity of parasitic insects infesting Puerto Rican birds.

*Philornis* spp. nest flies are a group of parasites known to be particularly virulent. The genus *Philornis* contains about 50 known species that are distributed throughout the neotropics. Adult *Philornis* flies are not parasitic, but feed on decaying organic matter (McNew and Clayton 2018). By contrast, the larvae of most *Philornis* spp. are obligate parasites of birds, and most are subcutaneous parasites that burrow into the skin, where they feed on the blood and tissue. *Philornis* larvae commonly infest nestlings, but they can also be found in adult birds (Quiroga et al. 2020). *Philornis* infestation, which can negatively affect the mass and growth rates of nestlings, can also cause high nestling mortality (Couri 1999; McNew and Clayton 2018). In the Galápagos, the introduced species *Philornis downsi* has had devastating effects on the survival and reproductive success of Darwin's finches and other endemic species (Wikelski et al. 2004) with nestling mortality reaching 100% in some years (Koop et al. 2011; O'Connor et al. 2014).

Although adult mortality from *Philornis* has been documented (Arendt 2006; LaPergola et al. 2023), it is probably relatively uncommon compared to nestling mortality. However, there may also be sublethal costs to infestation. Galapagos

Mockingbirds (*Mimus parvulus*) parasitized by *Philornis* on their first nesting attempt have fewer and smaller chicks on second nesting attempts than uninfested mockingbirds (McNew et al. 2020). Birds parasitized by *Philornis* also mount immune responses that could be costly (Uhazy and Arendt 1986; Koop et al. 2013; Manzoli et al. 2018).

*Philornis* spp. flies are common in Puerto Rico and are known to infest at least 22 species of Puerto Rican birds (Pérez-Rivera and Collazo Algarín 1976; Snyder et al. 1987; Arendt 2006; Schubert 2018). These flies pose a severe threat to the endemic, endangered, Puerto Rican Parrot (*Amazona vittata*; Snyder et al. 1987; Arendt 2000). *Philornis* flies also cause high nestling mortality in the endemic Puerto Rican Sharp-shinned Hawk (*Accipiter striatus venator*), which is an endangered subspecies (Delannoy and Cruz 1991; McClure et al 2023). Four *Philornis* species have been recorded from Puerto Rico, including *P. pici* (Arendt 1985), *P. deceptivus* (Arendt 1985), *P. angustifrons* (Rivera Irizarry 1991), and *P. obscura* (Wolcott 1948). However, the identification of *Philornis* is particularly challenging because only larvae infest birds and the larval stages have few distinguishing morphological characters; moreover, connecting different fly life stages requires rearing immatures to adulthood or using molecular techniques (Quiroga et al. 2016). Molecular work also suggests there are several cryptic species within known taxa (Quiroga et al. 2016). Thus, the exact number of *Philornis* spp. in Puerto Rico is unknown (Arendt 2000).

The documented prevalence and intensity of flies in some Puerto Rican species is quite high. Arendt (1985) found that 31% of adult and 96% of nestling Pearly-eyed Thrashers (*Margarops fuscatus*) were infested. Moreover, *Philornis* infestation can cause high nestling mortality. In a study spanning 14 breeding seasons, 56% (1,391/2,467) of nestling thrashers died from *Philornis* infestation (Arendt 2000). In contrast, the prevalence of flies on other species is much lower. For example, Quiroga et al (2020) recorded a prevalence of 5.3% (1/19) for *Philornis* flies on adult Puerto Rican Sharp-shinned Hawks. Although *Philornis* infests many Puerto Rican species, information about the prevalence and intensity of *Philornis* infestations of most species is unknown.

Our major objective was to more thoroughly document which host species are parasitized by *Philornis*, to estimate the prevalence and intensity of *Philornis* on wild birds and to collect and preserve *Philornis* specimens for future molecular studies. A secondary goal was to quantify the diversity, prevalence and intensity of other parasitic insects by "dust-ruffling" birds after visual examination (see methods).

## MATERIALS AND METHODS

Fieldwork was carried out in four municipalities in western Puerto Rico: Cabo Rojo, San Germán, Sabana Grande, and Adjuntas. Fieldwork was conducted March–June 2024, during the peak breeding season for Puerto Rican birds, when individuals were expected to be at greatest risk of *Philornis* exposure (Castro-Prieto et al. 2021). Birds were captured with mist-nets and ectoparasite prevalence and intensity were estimated by visual examination for *Philornis* flies, and/or dust-ruffling for other ectoparasitic insects. Freshly captured birds were carefully removed from mist nets and examined for *Philornis* larvae. Skin surfaces were inspected by blowing apart feathers to examine the head, throat, belly, vent, legs, patagial skin, and back. Larvae were photographed and removed by applying petroleum jelly to the spiracles. Larvae with blocked spiracles try to back out of the host's skin, at which point they can be grabbed with blunt forceps and removed from the skin. Once removed, larvae were transferred to a vial of 95% ethyl alcohol, for future identification with molecular methods. Larval *Philornis* cannot be identified to species reliably on the basis of morphology.

Following visual examination, most birds were also "dust-ruffled" to quantify other ectoparasites (Walther and Clayton 1997; Clayton and Drown 2001; Koop and Clayton 2013). Birds were isolated in single-use paper bags stapled shut. The bags prevented mixing of mobile ectoparasites between individuals while birds waited to be dust ruffled. Each bird was removed from its bag and dust-ruffled, during which the bird was held in one hand over a cafeteria tray lined with clean, white paper. Over the course of about 1 min, the other hand was used to work about a teaspoon of flea powder (1.0% pyrethrin and 0.1% piperonyl butoxide, Wellmark International, Schaumburg, Illinois, USA) into the plumage of the wings, tail, keel, vent, back, head, and neck, with care to avoid getting dust in the bird's nostrils or eyes. Birds were held for another 2 min to allow the powder to take effect, then feather tracts were ruffled for 3 min with the fingers of the free hand. Ectoparasites falling onto the paper were located under a 4x jeweler's headset and transferred to a vial of 95% ethyl alcohol with a fine-tipped brush. Each bird was subject to a single ruffling bout. Before release, birds were weighed, aged, measured, and marked with a numbered metal band, which allowed us to avoid re-processing any birds recaptured during the study.

Generic level identification of lice was by examination of unmounted specimens under a dissecting microscope and reference to generic-level keys (Price et al. 2003), and the reference collection in the Price Institute of Parasite Research (University of Utah, Salt Lake City, Utah, USA; https://darwin.biology.utah.edu/PIPeRX.html). Species-level identification of lice was based on published descriptions and host association data. In a few cases, lice were identified through detailed examination of slide-mounted material. However, we chose to freeze most of the lice collected in this study for future molecular work, rather than mounting them on microscope slides. Voucher specimens and micrographs of all taxa of lice were deposited in the Price Institute of Parasite Research (PIPR050090–PIPR050300, accessible via ecdysis.org). We calculated the prevalence of infestation (percent of birds infested with parasites) and intensity of infestation (number of parasites per infested bird; Bush et al. 1997).

## RESULTS

We captured and examined 430 birds of 38 species for *Philornis* infestation (Table 1). When possible, birds were aged according to their plumage (Pyle 2022) and the presence of a brood patch or cloacal protuberance. Of the birds we captured, 325 were adults, 17 were fledglings, and 88 birds could not be aged with certainty (in some species it is difficult discern older fledglings from adults). Of the 325 adult birds, 295 had a brood patch and/or a cloacal protuberance, indicating that most adults in our study were breeding close to the time of capture. *Philornis* flies were found on only 4/430 individual birds, from three species (*Vireo latimeri*, 33.33% prevalence, 1/3; *V. altiloquus,* 1% prevalence, 1/95; *Coereba flaveola,* 2% prevalence, 2/90; Table 2), for an overall prevalence of 0.93% (Figure 1). Two of these host associations are new records (Table 2). During the course of our fieldwork, we opportunistically sampled two Pearly-eyed Thrasher fledglings for *Philornis*. The first Pearly-eyed Thrasher was standing in the road and was so infested with *Philornis* that it was unable to fly. We caught it and removed 43 *Philornis* larvae and counted another 40 cutaneous lesions (~3–4mm in diameter) throughout the body. These lesions had probably been caused by larvae as they left the bird to pupate. We estimate that the thrasher had a total infestation of at least 83 larvae (Table 2). The thrasher was nearly dead when it was caught and died while we were removing *Philornis* larvae. We also recovered 57 *Philornis* larvae from a dead young Pearly-eyed Thrasher that was found beneath a nest. We did not include either of these thrashers in the calculations of prevalence or intensity of *Philornis* infestation as both birds were only encountered because of the severe consequences of the intensity of their *Philornis* infestations.

Hippoboscid flies (Insecta: Diptera) were seen on occasion, but many of these escaped from birds as they struggled in mist nets; they could thus not be identified. No fleas, bugs, nor ticks were found on any birds.

We dust-ruffled 310/430 birds captured, representing 38 species of birds (Table 1). Most of the birds that were not dust-ruffled were one of the two most commonly captured species, *Coereba flaveola* and *Vireo altiloquus*.

TABLE 1. Occurrence of *Philornis* spp. fly larvae (Diptera) and parasitic lice (Pscodea: Phthiraptera) associated with the 38 species of birds surveyed for parasitic insects in Puerto Rico in 2024. Birds are listed in taxonomic order, based on AviList v2025 (AviList Core Team 2025; Rheindt et al. 2025). Species on which *Philornis* spp. fly larvae were found are in bold.

| Family | Species | Birds examined for *Philornis* spp. (*n*) | Birds infested with *Philornis* spp. (*n*) | Birds dust-ruffled (*n*) | Birds infested with lice (*n*) | Lice per bird (range) |
|---|---|---|---|---|---|---|
| Culiciformes | | | | | | |
| Cuculidae (cuckoos) | | | | | | |
| | *Crotophaga ani* Smooth-billed Ani | 1 | 0 | 1 | 1 | 26 |
| | *Coccyzus minor* Mangrove cuckoo | 1 | 0 | 1 | 0 | –[a] |
| | *Coccyzus vieilloti* Puerto Rican Lizard Cuckoo | 1 | 0 | 1 | 0 | – |
| Columbiformes | | | | | | |
| Columbidae (pigeons and doves) | | | | | | |
| | *Columbina passerina* Common Ground Dove | 5 | 0 | 5 | 5 | 1–9 |
| | *Geotrygon montana* Ruddy Quail Dove | 1 | 0 | 1 | 0 | – |
| | *Zenaida asiatica* White-winged Dove | 9 | 0 | 7 | 5 | 1–13 |
| | *Zenaida macroura* Mourning Dove | 1 | 0 | 1 | 1 | 8 |
| | *Zenaida aurita* Zenaida Dove | 1 | 0 | 1 | 0 | – |
| | *Patagioenas squamosa* Scaly-naped Pigeon | 6 | 0 | 5 | 5 | 5–83 |
| | *Patagioenas leucocephala* White-crowned Pigeon | 1 | 0 | 1 | 1 | 7 |
| | *Streptopelia roseogrisea* African Collared Dove | 4 | 0 | 3 | 3 | 8–44 |
| Coarciiformes | | | | | | |
| Todidae (todies) | | | | | | |
| | *Todus mexicanus* Puerto Rican Tody | 25 | 0 | 25 | 11 | 2–25 |
| Piciformes | | | | | | |
| Picidae (woodpeckers) | | | | | | |
| | *Melanerpes portoricensis* Puerto Rican Woodpecker | 6 | 0 | 6 | 0 | – |
| Falconiformes | | | | | | |
| Falconidae (falcons) | | | | | | |
| | *Falco sparverius* American Kestrel | 1 | 0 | 1 | 1 | 9 |

Table 1. Continued.

| Family | Species | Birds examined for *Philornis* spp. ($n$) | Birds infested with *Philornis* spp. ($n$) | Birds dust-ruffled ($n$) | Birds infested with lice ($n$) | Lice per bird (range) |
|---|---|---|---|---|---|---|
| Passeriformes | | | | | | |
| Tyrannidae (New World tyrant flycatchers) | | | | | | |
| | *Myiarchus antillarum* Puerto Rican Flycatcher | 11 | 0 | 11 | 1 | 1 |
| | *Tyrannus dominicensis* Gray Kingbird | 7 | 0 | 7 | 5 | 1–5 |
| | *Contopus latirostris* Lesser Antillean Pewee | 8 | 0 | 8 | 7 | 1–31 |
| Vireonidae (vireos) | | | | | | |
| | ***Vireo altiloquus* Black-whiskered Vireo** | 95 | 1 | 44 | 5 | 1–3 |
| | ***Vireo latimeri* Puerto Rican Vireo** | 3 | 1 | 3 | 0 | – |
| Mimidae (mockingbirds and thrashers) | | | | | | |
| | *Margarops fuscatus* Pearly-eyed Thrasher | 12 | 0 | 11 | 11 | 2–81 |
| | *Mimus polyglottos* Northern Mockingbird | 3 | 0 | 2 | 2 | 12–28 |
| Turdidae (thrushes) | | | | | | |
| | *Turdus plumbeus* Red-legged Thrush | 12 | 0 | 12 | 9 | 1–39 |
| Estrildidae (waxbills and allies) | | | | | | |
| | *Estrilda melpoda* Orange-cheeked Waxbill | 7 | 0 | 7 | 0 | – |
| Passeridae (sparrows) | | | | | | |
| | *Passer domesticus* House Sparrow | 2 | 0 | 2 | 1 | 11 |
| Spindalidae (spindalis) | | | | | | |
| | *Spindalis portoricensis* Puerto Rican Spindalis | 32 | 0 | 29 | 25 | 1–24 |
| Icteridae (New World blackbirds) | | | | | | |
| | *Icterus portoricensis* Puerto Rican Oriole | 1 | 0 | 1 | 0 | – |
| | *Icterus icterus* Venezuelan Troupial | 4 | 0 | 3 | 2 | 1–4 |
| | *Molothrus bonariensis* Shiny Cowbird | 5 | 0 | 5 | 2 | 1–2 |
| | *Quiscalus niger* Greater Antillean Grackle | 11 | 0 | 10 | 10 | 4–46 |
| Parulidae (New World warblers) | | | | | | |
| | *Parkesia noveboracensis* Northern Waterthrush | 1 | 0 | 1 | 0 | – |
| | *Setophaga ruticilla* American Redstart | 1 | 0 | 1 | 1 | 4 |
| | *Setophaga caerulescens* Black-throated Blue Warbler | 2 | 0 | 2 | 1 | 1 |
| | *Setophaga americana* Northurn Parula | 6 | 0 | 6 | 0 | – |
| | *Setophaga tigrina* Cape May Warbler | 2 | 0 | 2 | 1 | 13 |

TABLE 1. Continued.

| Family | Species | Birds examined for *Philornis* spp. (*n*) | Birds infested with *Philornis* spp. (*n*) | Birds dust-ruffled (*n*) | Birds infested with lice (*n*) | Lice per bird (range) |
|---|---|---|---|---|---|---|
| Thraupidae (tanagers and allies) | | | | | | |
| | ***Coereba flaveola* Bananaquit** | 90 | 2 | 32 | 16 | 1–14 |
| | *Tiaris olivaceus* Yellow-faced Grassquit | 5 | 0 | 5 | 5 | 6–16 |
| | *Melopyrrha portoricensis* Puerto Rican Bullfinch | 27 | 0 | 27 | 25 | 6–84 |
| | *Melanospiza bicolor* Black-faced Grassquit | 20 | 0 | 20 | 1 | 3 |
| | Total | 430 | 4 | 310 | 163 | |

[a] — = no data (when no lice were found).

For both species, we had large sample sizes to estimate prevalence and abundance of ectoparasites. We did not dust-ruffle all individuals of common species to allow for more time to dust-ruffle relatively rarer species. Lice were found on 163/310 (52.6%) birds, representing 28 species. We documented 42 host associations involving twelve genera of lice (Table 3; 14 of the host associations are new records).

## DISCUSSION

Lice were the most common ectoparasite of Puerto Rican birds. We also observed Hippoboscid flies, but most escaped from birds in the mist nets, therefore the percentage of birds infested could not be determined. We did not find fleas or bugs on any of the birds. Since most species of fleas and parasitic bugs are found primarily in bird nests (Rothschild and Clay 1952; Marshall 1981) their absence from birds in mist nets was not altogether surprising.

*Philornis* fly larvae were quite rare; to our knowledge, infestation of *Philornis* in *Vireo altiloquus* and *Vireo latimeri* has not been recorded previously (Pérez-Rivera and Collazo Algarín 1976; Arendt 2006; McNew and Clayton 2018). These two new host records raise the number of Puerto Rican species infested by *Philornis* to at least 24 (Pérez-Rivera and Collazo Algarín 1976; Snyder et al. 1987; Arendt 2006; Schubert 2018). The low prevalence of *Philornis* on mist netted birds in our study is similar to published estimates of the prevalence of *Philornis* on adult birds in the Dominican Republic, Grenada, and Ecuador (Quiroga et al. 2020; Cadena-Ortiz et al. 2022). Adult birds tend to have lower prevalences and intensities of *Philornis* than nestling birds (Arendt 1985; Texeira 1999; Quiroga et al. 2020; but see LaPergola 2023). Although both adult and nestling birds are exposed to *Philornis* larvae in the nest, adult birds are covered with feathers that may protect most of the body from infestation (Quiroga et al 2020). Adults with prior exposure to *Philornis* may also be able to mount effective adaptive immune responses (Koop et al. 2013) that are stronger than the responses immunologically naïve nestlings can

TABLE 2. The species, sampling method, age, and number of flies found on each Puerto Rican bird detected to be infested with *Philornis* larvae in 2024.

| Species | Bird sampling method | Age | Number of *Philornis* |
|---|---|---|---|
| *Vireo latimeri*[a] Puerto Rican Vireo | Mist-netted | Adult | 1 larva |
| *Vireo altiloquus*[a] Black-whiskered Vireo | Mist-netted | Adult | 9 larvae |
| *Coereba flaveola* Bananaquit | Mist-netted | Fledgling | 6 larvae |
| *Coereba flaveola* Bananaquit | Mist-netted | Adult | 1 larva |
| *Margarops fuscatus* Pearly-eyed Thrasher | Opportunistic salvage | Fledgling | 57 larvae |
| *Margarops fuscatus* Pearly-eyed Thrasher | Opportunistic salvage | Fledgling | 43 larvae, ~40 additional lesions |

[a] New host record.

mount. Consistent with the high prevalence and intensity of *Philornis* on nestling birds, both of the recently-fledged Pearly-eyed Thrashers that we found dead or near-death were infested with many more larvae than any of the mist netted birds (Table 2).

Our results in a wide variety of bird species contrast with the high *Philornis* prevalence (31%) reported by Arendt (1985) for adult Pearly-eyed Thrashers in Puerto Rico. *Philornis* prevalence may be influenced by a variety of factors, including humidity and temperature, both of which are known to influence *Philornis* distributions (Manzoli et al. 2013; Cuervo et al. 2021). Although we surveyed montane forest in Western Puerto Rico at similar elevations to Arendt's (1985) study in Eastern Puerto Rico, other environmental factors may differ between these sites and influence the prevalence of *Philornis*. Additionally, some *Philornis spp.* show a strong preference to infest certain host species; for example, *Philornis torquans* infests over half of the passerine species in central Argentina yet shows a strong preference for infesting Great Kiskadees (*Pitangus sulphuratus*) over other common species (Manzoli et al. 2013, 2021). If Puerto Rican *Philornis* spp. preferentially infest Pearly-eyed Thrashers, it may contribute to the difference in our results and Arendt's (1985) results. However, none of the 12 Pearly-eyed Thrashers captured in mist nets in our study were infested by *Philornis*. Future work should investigate how environmental factors and host preference influence the distribution of Puerto Rican *Philornis* spp.

We may have underestimated the prevalence of *Philornis* on adult birds due to the reliance on mist netting birds for this survey. Among

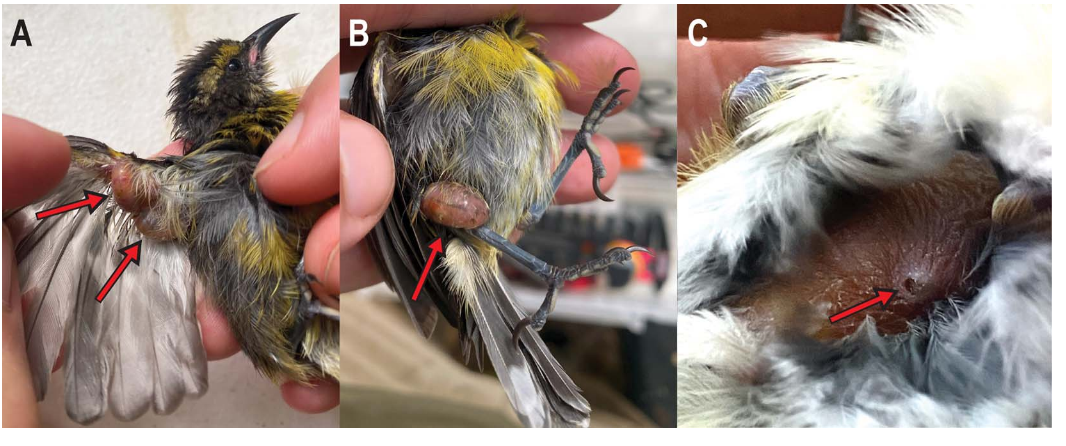


FIGURE 1. *Philornis* (arrows) infesting Puerto Rican Birds. A) Two subcutaneous larvae in the patagium of a young Bananquit (*Coereba flaveola*). B) One larva in the leg of a Bananaquit (*Coereba flaveola*). C) One larva in the brood patch of a Puerto Rican Vireo (*Vireo latimeri*). Photos by authors NAA and MMW.

TABLE 3. Louse species, intensity, and voucher catalog numbers for all lice collected from Puerto Rican birds in 2024. Birds are in taxonomic order, based on AviList v2025 (AviList Core Team 2025; Rheindt et al. 2025). Voucher catalogue numbers refer to the Price Institute of Parasite Research, University of Utah, Salt Lake City, Utah, USA.

| Host family | Host species (*n*) | Lice | Birds infested (*n*) | Intensity (range) | Voucher catalog number |
|---|---|---|---|---|---|
| Culiciformes | | | | | |
| Cuculidae (cuckoos) | | | | | |
| | *Crotophaga ani* (1) | *Osborniella crotophagae*[b] | 1 | 5 | PIPR050272 |
| | Smooth-billed Ani | *Vernoniella guimaraesi*[c] | 1 | 21 | PIPR050273 |
| Columbiformes | | | | | |
| Columbidae (pigeons and doves) | | | | | |
| | *Columbina passerina* (5) | *Columbicola passerinae*[d] | 5 | 1–5 | PIPR050229 |
| | Common Ground Dove | *Physconelloides eurysema*[e] | 5 | 1–6 | PIPR050230 |
| | *Zenaida asiatica* (7) | *Columbicola macrourae*[d] | 5 | 1–13 | PIPR050222 |
| | White-winged Dove | *Physconelloides wisemani*[e] | 1 | 1 | PIPR050269 |
| | *Zenaida macroura* (1) | *Columbicola macrourae*[d] | 1 | 8 | PIPR050123 |
| | Mourning Dove | | | | |
| | *Patagioenas squamosa* (5) | *Columbicola waggermani*[d] | 5 | 5–65 | PIPR050295 |
| | Scaly-naped Pigeon | *Physconelloides sp.*[a,c] | 4 | 5–18 | PIPR050296 |
| | *Patagioenas leucocephala* (1) | *Columbicola waggermani*[d] | 1 | 6 | PIPR050270 |
| | White-crowned Pigeon | *Physconelloides rufaxilla*[c] | 1 | 1 | PIPR050271 |
| | *Streptopelia roseogrisea* (3) | *Columbicola bacillus*[d] | 3 | 8–44 | PIPR050225 |
| | African Collared Dove | | | | |
| Coraciiformes | | | | | |
| Todidae (todies) | | | | | |
| | *Todus mexicanus* (25)* | Menoponidae[a] | 11 | 2–25 | PIPR050150 |
| | Puerto Rican Tody | | | | |
| Falconiformes | | | | | |
| Falconidae (falcons) | | | | | |
| | *Falco sparverius* (1) | *Deegeriella carruthi*[c] | 1 | 9 | PIPR050266 |
| | American Kestrel | | | | |

TABLE 3. Continued.

| Host family | Host species (*n*) | Lice | Birds infested (*n*) | Intensity (range) | Voucher catalog number |
|---|---|---|---|---|---|
| Passeriformes | | | | | |
| Tyrannidae (New World tyrant flycatchers) | | | | | |
| | *Myiarchus antillarum* (11) | *Myrsidea sp.*[a,f] | 1 | 1 | PIPR050119 |
| | Puerto Rican Flycatcher | | | | |
| | *Tyrannus dominicensis* (7) | *Menacanthus tyranni* [c] | 2 | 1–4 | PIPR050250 |
| | Gray Kingbird | *Picicola foedus.*[g] | 4 | 1–4 | PIPR050283 |
| | | *Ricinus sp.*[c] | 1 | 2 | PIPR050252 |
| | *Contopus latirostris* (8) | *Myrsidea sp.*[a,f] | 7 | 1–31 | PIPR050184 |
| | Lesser Antillean Pewee | | | | |
| Vireonidae (vireos) | | | | | |
| | *Vireo altiloquus* (44) | *Ricinus sp.*[h] | 5 | 1–3 | PIPR050212 |
| | Black-whiskered Vireo | | | | |
| Mimidae (mockingbirds and thrashers) | | | | | |
| | *Margarops fuscatus* (11) | *Myrsidea sp.*[h] | 9 | 1–80 | PIPR050097 |
| | Pearly-eyed Thrasher | *Philopterus sp.*[h] | 6 | 1–12 | PIPR050098 |
| | *Mimus polyglottos* (2) | *Myrsidea sp.*[h] | 2 | 11–27 | PIPR050134 |
| | Northern Mockingbird | *Brueelia brunneinucha*[i] | 2 | 1 | PIPR050135 |
| Turdidae (thrushes) | | | | | |
| | *Turdus plumbeus* (12) | *Myrsidea sp.*[a,f] | 9 | 1–39 | PIPR050154 |
| | Red-legged Thrush | | | | |
| Passeridae (sparrows) | | | | | |
| | *Passer domesticus* (2) | *Myrsidea quadrifasciata*[j] | 1 | 11 | PIPR050227 |
| | *House Sparrow* | | | | |
| Spindalidae (spindalis) | | | | | |
| | *Spindalis portoricensis* (29) | *Menacanthus sp.*[a] | 1 | 24 | PIPR050167 |
| | Puerto Rican Spindalis | *Myrsidea sp.*[a,f] | 24 | 1–21 | PIPR050142 |
| Icteridae (New World Bbackbirds) | | | | | |
| | *Icterus icterus* (3) | *Myrsidea sp.*[f] | 2 | 1–4 | PIPR050090 |
| | Venezuelan Troupial | | | | |

TABLE 3. Continued.

| Host family | Host species (*n*) | Lice | Birds infested (*n*) | Intensity (range) | Voucher catalog number |
|---|---|---|---|---|---|
| | *Molothrus bonariensis* (5) Shiny Cowbird | *Myrsidea sp.*[a,f] | 2 | 1–2 | PIPR050206 |
| | *Quiscalus niger* (10) | *Myrsidea fuscomarginata*[f] | 10 | 4–46 | PIPR050223 |
| | Greater Antillean Grackle | *Brueelia sp.*[a,i] | 1 | 4 | PIPR050103 |
| | | *Philopterus sp.*[a,c] | 2 | 1 | PIPR050118 |
| Parulidae (New World warblers) | | | | | |
| | *Setophaga ruticilla* (1) American Redstart | *Myrsidea sp.*[a,f] | 1 | 4 | PIPR050217 |
| | *Setophaga caerulescens* (2) Black-throated Blue Warbler | *Menacanthus sp.*[a,c] | 1 | 1 | PIPR050168 |
| | *Setophaga tigrina* (2) Cape May Warbler | *Myrsidea sp.*[h] | 1 | 13 | PIPR050218 |
| Thraupidae (tanagers and allies) | | | | | |
| | *Coereba flaveola* (32) | *Brueelia phasmasoma*[i] | 3 | 1–2 | PIPR050186 |
| | Bananaquit | *Machaerilaemus sp.*[h] | 2 | 2–10 | PIPR050236 |
| | | *Myrsidea coerebicola*[f] | 13 | 1–13 | PIPR050161 |
| | *Tiaris olivaceus* (5) Yellow-faced Grassquit | *Myrsidea sp.* [a,f] | 5 | 6–16 | PIPR050130 |
| | *Melopyrrha portoricensis* (27) Puerto Rican Bullfinch | *Myrsidea sp.*[a,f] | 25 | 6–84 | PIPR050192 |
| | *Melanospiza bicolor* (20) Black-faced Grassquit | *Ricinus sp.*[a,c] | 1 | 3 | PIPR050129 |

* indicates a new host record for the entire family of birds. No lice have been previously recorded from Todidae.
[a] New host record.
[b] Wiseman 1963.
[c] Price et al 2003.
[d] Clayton and Price 1999.
[e] Price et al. 1999.
[f] Kolencik et al. 2024.
[g] Williams 1979.
[h] Bush et al. 2024.
[i] Gustafsson and Bush 2017.
[j] Sychra et al. 2021.

adult birds, incubating and brooding birds may have the greatest risk of *Philornis* infestation. Increased time in the nest prolongs their exposure to *Philornis* larvae. Additionally, the featherless brood patch may allow larvae to more easily infest incubating adults (Quiroga et al. 2020). Other studies have shown that the sex that does the majority of incubation can have *Philornis* prevalences that are three times higher than the sex that does less of the incubation (Arendt 1985; LaPergola 2023). This creates a potential sampling bias because incubating and brooding birds probably have a lower chance of being caught in a net due to the large amount of time they spend in the nest (Amrhein et al. 2012). Arendt (1985) trapped most of the Pearly-eyed Thrashers inside nest boxes; consequently, the estimate of 31% *Philornis* prevalence may be inflated as birds on nests are the most likely to be infested with *Philornis*. This difference in trapping methods probably contributes to the difference in prevalence between our results and Arendt's results (1985). Despite our potential underestimation of *Philornis* prevalence due to differences in trapping methodology, many of the adult birds in our study had brood patches or cloacal protuberances indicating that we were sampling some birds that were breeding, incubating, or brooding close to the time of capture.

Our data shows that the birds that are actively moving through the habitat are not frequently infested with *Philornis;* consequently, these birds are probably not facilitating *Philornis* dispersal and are probably not a source of *Philornis* that infest endangered Puerto Rican Parrots or Sharp-shinned Hawks. Current management of *Philornis* in Puerto Rico focuses on managing *Philornis* in nestlings of endangered species through fumigation of hawk and parrot nests, and double clutching of hawks (U.S. Fish and Wildlife Service 2009; McClure et al. 2023). Low host density and intensive management efforts make transmission within host species unlikely within endangered Puerto Rican parrots and hawks. Instead, common species that are infested with *Philornis* as nestlings, such as Pearly-eyed Thrashers, may act as sources of flies that ultimately infest endangered hawks and parrots. Future work should survey nestlings of Puerto Rican birds to identify which species are most frequently infested by *Philornis* in order to identify potential sources of flies for endangered species.

Lice were far more common on Puerto Rican birds than *Philornis* larvae were. Unlike *Philornis* larvae, which only temporarily infest birds, lice are permanent parasites and spend their entire lives on the host. Consequently, louse infestations are often chronic (Potti and Merino 1995; Clayton 1990; Clayton et al. 2008; Galloway and Lamb 2021), whereas *Philornis* infestations primarily occur during the breeding season (Arendt 1985; Quiroga et al. 2020). Bird lice feed on feathers, dead skin, and blood (Clayton et al. 2015). Although louse infestations are often small and subclinical, infestations can reduce bird survival and mating success (Clayton 1990; Booth et al. 1993; Clayton et al. 2008). Lice can also act as vectors for other parasites, such as filarial worms (Seegar et al. 1976; Bartlett 1993; Clayton et al. 2008).

Birds in humid regions of the world, such as Puerto Rico, tend to have higher prevalences and intensities of lice than birds in more arid regions (Bush et al. 2024). Our results support this pattern, as the prevalence of lice in Puerto Rico was relatively high at 53%; this is similar to those reported in other studies of birds on humid Caribbean islands (Bush et al. 2023, 2024; Frixione et al. 2025). Conversely, birds in arid regions have much lower prevalences of lice, for example 6% in Bush et al. (2024). Mirroring the patterns of prevalence, intensities of lice in Puerto Rico were higher than those reported from arid regions in Bush et al. (2024). Future work should continue quantifying louse prevalence and abundances across diverse host populations to better understand how patterns of louse infestations are influenced by environmental conditions.

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