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Investigations on *Philornis downsi* Dodge and Aitken (Diptera: Muscidae) in Trinidad: a Parasite of the Darwin Finches

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ABSTRACT

The larvae of *Philornis downsi* (Diptera: Muscidae) are external haematophagous parasites of nestling birds. It is an invasive fly to the Galapagos Islands that poses a threat to several endemic bird species. Preliminary investigations were conducted in Trinidad on suitable hosts from which to source *Philornis* for laboratory rearing and with which to conduct field studies on *P. downsi* within its natural range. Bird nests were collected from 13 locations around Trinidad and all examined for parasitism by *Philornis* species. The most abundant *Philornis* species by far was *P. trinitensis*. Several common birds from residential and agricultural areas were found to be hosts of *P. downsi* including the Carib Grackle, Greater Kiskadee, Tropical Mockingbird, House Wren and Palm Tanager. Of these the House Wren, *Troglodytes aedon* and Carib Grackle, *Quiscalus lugubris* appear to be most suited for field studies and collection.

Key words (not in title): laboratory rearing, host range, parasitoids, House Wren, Carib Grackle.

INTRODUCTION

Philornis Meinert is a genus of fly which in its larval stages parasitizes nestling birds, particularly in the Neotropics (Dudaniec and Kleindorfer 2006). Ten species of the genus were recorded in Trinidad by Wilbur Downs and Thomas Aitken in the 1950s during the course of taking blood samples from nestling birds for the study of arboviruses. Eight of the *Philornis* species were new to science (Dodge and Aitken 1968). One of these, *Philornis downsi* Dodge and Aitken, has become of particular interest as it is an invasive species in the Galapagos Islands and it threatens populations of the islands' endemic bird species. The 17 bird species threatened by *P. downsi* include the Darwin Finches, the very rare Mangrove Finches, the Floreana Mockingbird and the Medium Tree Finch (Weiden *et al.* 2007). Field observations in the Galapagos Islands indicated that first and early second instar *Philornis downsi* larvae infested finch nostrils and other tissues while older second and third instars were haematophagous, feeding externally and dwelling in the nest material. The infestations resulted in high nestling mortalities, (76%) and in deformed beaks, anaemia and poor fitness potential in surviving nestlings (Fessl *et al.* 2006).

Control of *P. downsi* might be possible using sterile insect release techniques. However, management of the *Philornis* threat is likely to ultimately rely on their natural enemies, either native to the Galapagos Islands or introduced from other parts of their geographic range. Either approach requires a thorough understanding of the life cycle of *P. downsi* and a reliable means of rearing the species under laboratory conditions.

The current work in Trinidad, in conjunction with The Charles Darwin Foundation, is part of an international initiative to conserve the Galapagos finches. It aims to establish the conditions for laboratory rearing of *P. downsi*. This will facilitate field studies on *P. downsi* and their natural enemies within its natural range, and potentially, the rearing and quarantining of candidate parasitoids for introduction elsewhere. There have been previous records of parasitoids of *Philornis* in Trinidad (Couri *et al.* 2006).

This paper describes the first phase of these investigations; to find a reliable supply of wild-caught *Philornis downsi* to support laboratory studies and initiate cultures and find suitable hosts for life history studies. As *Philornis downsi* is comparatively rare, for these initial studies all species of *Philornis* were considered.

The host range of *Philornis* from Trinidad identified by Dodge and Aitken (1968) included 29 species but there was no indication of relative infestation levels. These comprise a wide taxonomic range of forest birds including several common garden birds. If suitable hosts with comparatively high infection levels are available within a residential or disturbed area, this would be preferred.

There is no suggestion from previous observations that *P. downsi* is limited in distribution within Trinidad. However to increase coverage, collections included the north, south and west Trinidad. The approach adopted involved collecting and examining easily accessible bird nests. The search was centered on (but not limited to) residential, agricultural and other easily accessed areas where the vegetation was such that it permitted the detection and collection of nests.

METHODOLOGY

Collections were made between February 2012 and March 2013 from thirteen locations around Trinidad (Figure). Vegetation was searched for nests at each location. Any nests found were examined for evidence of *Philornis* parasitism, including intact pupae, larvae and old pupal cases. Active nests and nestlings were carefully examined on site for larvae. Vacant nests were collected and placed in plastic bags. Any adult flies observed resting around nests were also collected with a small net, placed in vials and transported to the laboratory. In the laboratory, nests were meticulously deconstructed and any *Philornis* puparia seen were collected and placed in screened vials to await emergence of the adult. Field collected adult flies, as well as those reared from puparia, were kept in netted cages (30 x 30 x 30 cm) in the laboratory and initially fed on a mixture of milk, egg powder and papaya. Various

(Steyskal 1977). A combination of attractants was used including papaya, guava and mango mixed with sugar, egg powder and milk.

A papaya and sugar mixture had been previously demonstrated to be the most successful attractant used to trap *P. downsi* (Lincango and Causton 2008). Traps were hung on branches of trees within easy reach for examination (approximately 1.5 m high) in areas where there would be minimal disturbance from people.

RESULTS

Parasitism by *Philornis* was fairly common as indicated by the prevalence of empty pupal cases found in the nests examined. Overall, 223 nests were examined from 19 host species (see Table). Many of the nests containing *Philornis* that were collected were found in highly altered human environments such as in the eaves of buildings and shrubs near to houses. The presence of *Philornis* in nests was detected in both north and south Trinidad.

All the birds found to host *Philornis* in this study were included in the initial list of species parasitized in Trinidad as determined by Dodge and Aitken in 1968 except for the Carib Grackle.

The most productive sources of *Philornis* were House Wren, Great Kiskadee and Tropical Mockingbird. The House Wren and Great Kiskadee were productive due to high infestation levels. The Tropical Mockingbird showed lower infestation levels but more nests were found resulting in a relatively large total number of puparia. The nests of Bananaquits and Ruddy Ground Doves yielded fewer pupae per nest. Bananaquits are unusual as they build nests for sleeping in and it is likely that many of the nests examined were of this kind and therefore not attractive to *Philornis*. Ruddy Ground Dove nests are composed partly of faecal matter and are compact. This might make

the lower layers of the nest impenetrable to *Philornis* larvae and pupae and less attractive as a host.

Overall, 999 *Philornis* puparia were collected, of which 931 (93%) were empty. However, from the 68 viable puparia collected, 44 eclosed. Twelve puparia failed to eclose and were considered dead.

Puparia were identified following taxonomic keys by Couri (1999), Dodge and Aitken (1968) and Skidmore (1985). Puparia which keyed out as *P. downsi* were found in the nests of: Great Kiskadee, Tropical Mockingbird, Yel-

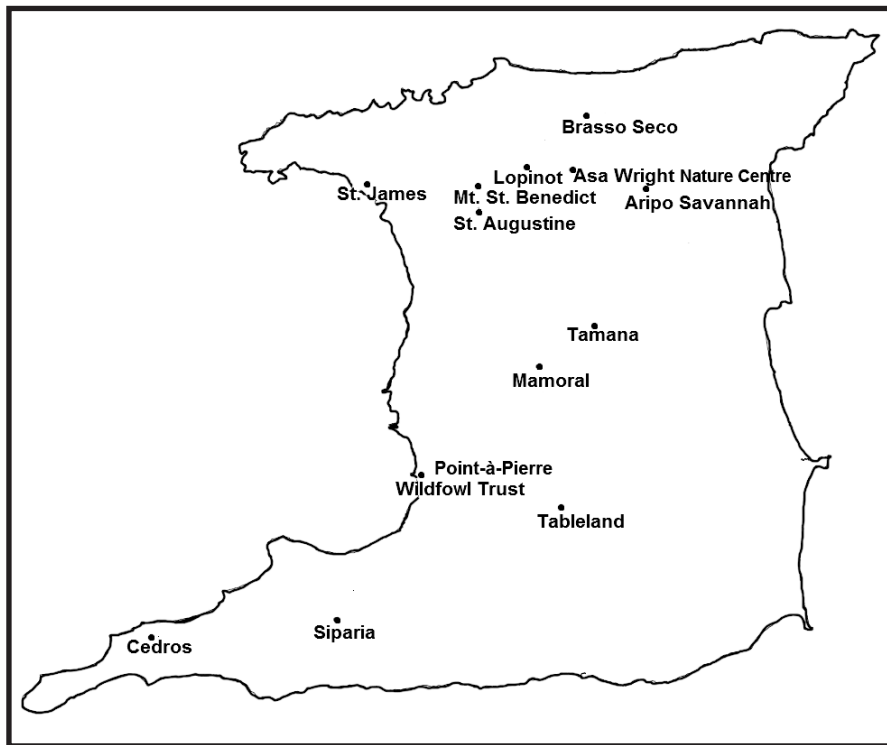


Fig. *Philornis* study sites in Trinidad (February 2012 - March 2013).

foods were offered and watermelon, banana, raisins and papaya appeared to be the preferred diet of the flies. The oviposition of the flies was recorded and attempts made to hatch the eggs by incubating them at various temperatures (24°C, 26°C, 28°C and 30°C) at relative humidity 80%.

Twenty-five yellow McPhail traps were also set up at study sites in an attempt to capture adult flies. These are plastic containers containing an attractant and are used to trap a variety of muscids. They have a transparent lid and coloured bottom and are designed to be hung in trees

Table. *Philornis* collected from nests by bird species (February 2012 - March 2013).

Bird Species	Common Name	Number of Nests Examined	Total Puparia (Number Intact)	Enclosed
<i>Coragyps atratus</i>	Black Vulture	1	0	0
<i>Columbina talpacoti</i>	Ruddy Ground Dove	22	3	0
<i>Amazilia tobaci</i>	Copper-rumped Hummingbird	3	0	0
<i>Myrmotherula axillaris</i>	White-flanked Antwren	1	0	0
<i>Pitangus sulphuratus</i>	Great Kiskadee	16	426	0
<i>Tyrannus melancholicus</i>	Tropical Kingbird	4	0	0
<i>Troglodytes aedon</i>	House Wren	7	289 (12)	0
<i>Mimus gilvus</i>	Tropical Mockingbird	35	103 (16)	10
<i>Turdus nudigenis</i>	Spectacled Thrush	2	0	0
<i>Turdus fumigatus</i>	Cocoa Thrush	1	0	0
<i>Ramphocelus carbo</i>	Silver-beaked Tanager	3	0	0
<i>Thraupis palmarum</i>	Palm Tanager	35	37 (36)	30
<i>Coereba flaveola</i>	Bananaquit	50	22 (4)	4
<i>Psarocolius decumanus</i>	Crested Oropendola	7	0	0
<i>Cacicus cela</i>	Yellow-rumped Cacique	3	0	0
<i>Icterus nigrogularis</i>	Yellow Oriole	17	99	0
<i>Molothrus bonariensis</i>	Shiny Cowbird	1	0	0
<i>Quiscalus lugubris</i>	Carib Grackle	14	20	0
<i>Euphonia violacea</i>	Violaceous Euphonia	1	0	0
Total		223	999 (68)	44

low Oriole, House Wren, Palm Tanager and Carib Grackle.

Three of the House Wren nests were recovered from nest boxes, all of which contained numerous *Philornis* pupal cases. While five were identified as *P. downsi*, the majority of these were found to be *P. trinitensis*. Fewer puparia were found in Carib Grackle nests; however the majority of these were found to be *P. downsi*.

The collection of living specimens was limited as few nests were found with intact pupae. Several species of *Philornis* were identified from material collected in the field and reared in the laboratory. Two of these species, recovered from a Bananaquit nest, were tentatively identified as *P.sp.nr. blanchardi* and *P.sp.nr. pici*, which have not been previously recorded from Trinidad. Taxonomic work on these as well as the other adult flies is ongoing.

There was evidence of the emergence of parasitoids from many of the pupae. One puparium of *P. trinitensis* yielded 17 parasitoids. The species is yet to be identified. Two specimens of *Philornis downsi* puparia were observed

with dead wasps inside from a Yellow Oriole nest in Tableland, Trinidad, September 2012.

No adult *Philornis* were captured in the McPhail traps although a variety of other muscids were collected. Two adult *Philornis trinitensis* were captured on an overcast day resting near to regularly used Palm Tanager nests. The nests were situated under the eaves of a house and were found to contain *P. downsi* puparia.

Adult flies were successfully kept alive for several weeks and laid eggs in the cages provided. However these eggs failed to hatch. Longevity of the four *P. downsi* females ranged from 19 to 28 weeks while the two males survived for 6 and 12 weeks respectively. The twelve *P. trinitensis* females survived between 8 and 25 weeks and the 8 males; between 6 and 14 weeks.

The *P. downsi* females laid an average of 18.5 eggs each and the *P. trinitensis*, an average of 32.3 eggs each over time.

DISCUSSION

Philornis species, and more specifically *P. downsi*, and parasitoids can be collected and studied within residential, agricultural and other disturbed habitats. Common bird species including Palm Tanager, Great Kiskadee, Tropical Mockingbird, Carib Grackle and House Wren serve as suitable hosts for further study.

The present study was suitable for selecting host species for collection but was too all-encompassing for quantitative assessment of seasonality or life history parameters for *P. downsi*. In addition, as nests were examined well after fledging, the periods of occupation and those of *Philornis* infestation were not known.

House Wrens would appear to be a particularly suitable host for further study. House Wrens are common in residential areas. They can be facilitated by the installation of nest boxes which can be constructed and positioned for efficient observation and access. Amongst the candidate species, House Wrens are best habituated to human presence and will better tolerate nest inspections. House Wrens also regularly reuse nesting sites so a series of nests can be observed in a single nest box. It is further possible that the high numbers collected were due to the nest box providing a suitable microhabitat for *Philornis* to pupate. In light of this, the construction and use of bird nest boxes for the further study of *Philornis* is suggested.

Carib Grackles might also be suitable hosts for study. Carib Grackles nest collectively at persistent sites making observations efficient. They are comparatively tolerant of human presence and indeed often 'buzz' persons nearing their nest sites.

For efficiency, collection of *Philornis* for laboratory rearing should be done together with field studies on *P. downsi* as the nest monitoring inherent in field studies can potentially yield more *Philornis* adults than collection of old nests. Focused field studies can also be supplemented by opportunistic examinations of other host species.

The microhabitat created for reproduction and rearing may need to be modelled on the conditions the *Philornis* may experience in the field. For example, these may include conditions met in the nest such as CO₂ levels or requisites of diet of the adult flies. This can be further investigated as a more reliable supply of field-collected flies is available.

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