

Revision of the Chewing Louse Genus *Formicaphagus*
(Phthiraptera: Philopteridae) from Neotropical Antbirds
and Gnateaters (Aves: Passeriformes)

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ABSTRACT: Examination of specimens of the 15 recognized species of *Formicaphagus* resulted in 6 new synonymies: *F. laemostictus*, *F. latifrons*, and *F. peruvianus* are junior synonyms of *F. picturatus*; *F. hulae* of *F. angustifrons*; and *F. bolivianus* and *F. thoracicus* of *F. minutus*. Two new species are described from material collected by the junior author in Peru: *F. arnoldi* (type host *Conopophaga ardesiaca*) and *F. donpetersi* (type host *Conopophaga peruviana*); these are the first louse species described from hosts in the family Conopophagidae, the gnateaters. Keys are provided for the identification of the 11 species and host-parasite relationships are considered.

Carriker (1957) described the philopterid chewing louse genus *Formicaphagus* to include 15 species described by him at the same time, with the hosts of these species being in 9 genera of the passerine family Formicariidae, the antbirds. Carriker surmised that *Formicaphagus* might eventually be found on all genera of Formicariidae except *Formicarius*. He classified the lice from *Formicarius* in another new genus, *Formicariicola*, also described at the same time (Carriker, 1957) and recently reviewed by Price and Clayton (1995a).

Recently, we attempted to use the Carriker (1957) descriptions to identify 3 excellent series of *Formicaphagus* collected during a faunal study in Peru (Clayton et al., 1992). This task proved impossible owing to the imprecise nature of the descriptions. For precautionary remarks about the use of Carriker descriptions and materials, see Price and Clayton (1993). Our intent here is to present the results of a re-examination of material for all *Formicaphagus* species and to describe 2 new species from the newly collected Peruvian material.

All measurements are in millimeters. Host classification of species follows Sibley and Monroe (1990), that of subspecies follows Peters (1951). Holotypes of the new species will be deposited in The Field Museum (Chicago) and paratypes, as numbers allow, will be located in the collections of that museum and of The Natural History Museum (London), Oklahoma State University (Stillwater), and University of Minnesota (St. Paul).

Formicaphagus Carriker

Formicaphagus Carriker, 1957:411. Type species: *Formicaphagus picturatus* Carriker, 1957.

This genus is characterized by the male (Fig. 1) having abdominal tergites II-IX distinctly separated medially, the terminal abdominal segment evenly rounded, and the genitalia unique, with lobate parameres (Fig. 3); the female (Fig. 2) having tergites on abdominal segments II-VIII distinctly separated medially, the terminal segment evenly rounded, the subgenital plate with both fine and short heavier setae near its posterior margin, and the absence of prominent stout setae on a ventral tubercle lateroposterior to the subgenital plate; and both sexes having a relatively broad head approximately as wide as long, similar antennae, and a distinct medioanterior dorsal head plate.

Sibley and Monroe (1990) divided the Formicariidae into 2 families: the Thamnophilidae (typical antbirds) and Formicariidae (ground antbirds). The 15 species of Carriker (1957) thus have 12 in the former family and 3 in the latter. The only other philopterid genera presently recognized from hosts in these 2 families are *Rallicola* Johnston and Harrison and *Formicariicola*. Species of *Rallicola*, reviewed by Price and Clayton (1994), are readily separated from *Formicaphagus* by the female with stout setae on a ventral tubercle lateroposterior to the subgenital plate and the male with grossly different genitalic details. Species of *Formicariicola*, reviewed by Price and Clayton (1995a), while having many features in common with *Formicaphagus*, have a consistently slender head that is much narrower than long.

The species of *Formicaphagus* represent an assemblage of morphologically very similar forms. We have found little evidence to support the statement of Carriker (1957) that "... male genitalia are especially useful . . . since no two . . . species represented by males have similar genitalia." We do, however, concur with his observation that the genus contains taxa that are "... extremely homogeneous . . . considering the fact that the species comprising it are parasitic on very distinct genera of hosts." Even in the absence of supporting meaningful morphological features, Carriker (1957) deemed it "... best to classify . . . all [series] as distinct species." We take strong exception to Carriker's a priori assumption of this high degree of host-louse specificity. We have studied Carriker's type specimens and have found at most only minimal differences among the 15 species. To further complicate matters, 7 of these species were represented only by females, when supposedly male genitalia are so critical for separation!

The *Formicaphagus* species may be characterized as follows. Male (Fig. 1) with chaetotaxy of head as shown; preantennal margin essentially straight (Figs. 1, 5) to slightly concave (Figs. 8, 10); anterior head notch narrow (Fig. 1) to wide (Fig. 5). Pronotum with single lateroposterior seta on each side; each side of metanotum with 6-9 marginal setae of varying lengths; thoracic sternum with 1-2 anterior, 2-5 posterior setae. Each abdominal tergite II (first apparent tergite)-III with 1 median seta, IV with 2 setae mediad of spiracle, V with 2-4, VI with 2-5, VII with 4-7, VIII with 1-2 (Fig. 9) or 3-5 (Fig. 1); IX with row of 5-9 setae. Total sternal setae on each of II-IV, 2; V, 2, much less often 3; VI, 4. Lateral margin of II-III without setae, IV-V with 1, VI-VII with 2, and VIII with 2-3. Genitalia much as in Fig. 3, from 0.07-0.10 wide at widest point of basal apodeme; parameres shaped from circular and well separated (Fig. 7) to ovoid and moderately separated (Fig. 4) to large, angulate, and often closely apposed (Fig. 6). Female head, thorax, abdominal segments II-IV, and sternites V-VI (Fig. 2) as for male, except for . . .

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mediad of spiracle, VIII with 1, and each side of IX with 2-5. Posterior margin of subgenital plate with 7-13 short spiniform setae on each side; sparse patch of 11-16 ventral setae on each side lateroposterior to subgenital plate.

With the paucity of strong separating qualitative characters, we have relied heavily on dimensional differences. Aside from dimensions, useful characters are limited to (1) general head shape, (2) the narrow to wide anterior head notch, (3) the different chaetotaxies for male tergite VIII, and (4) the male genitalia types involving the size and shape of the parameres. The descriptive details for each species will deal primarily with these 4 character states and with dimensions; characters apply to both sexes unless specified as male or female.

Formicaphagus picturatus Carriker
(Figs. 1-4)

Formicaphagus picturatus Carriker, 1957:413. Type host: *Myrmeciza immaculata* (Lafresnaye).

Formicaphagus laemostictus Carriker, 1957:415. Type host: *Myrmeciza laemosticta bolivari* de Schauensee. New synonymy.

Formicaphagus latifrons Carriker, 1957:420. Type host: *Cercomacra nigricans nigricans* Sclater. New synonymy.

Formicaphagus peruvianus Carriker, 1957:422. Type host: *Myrmotherula schisticolor interior* (Chapman). New synonymy.

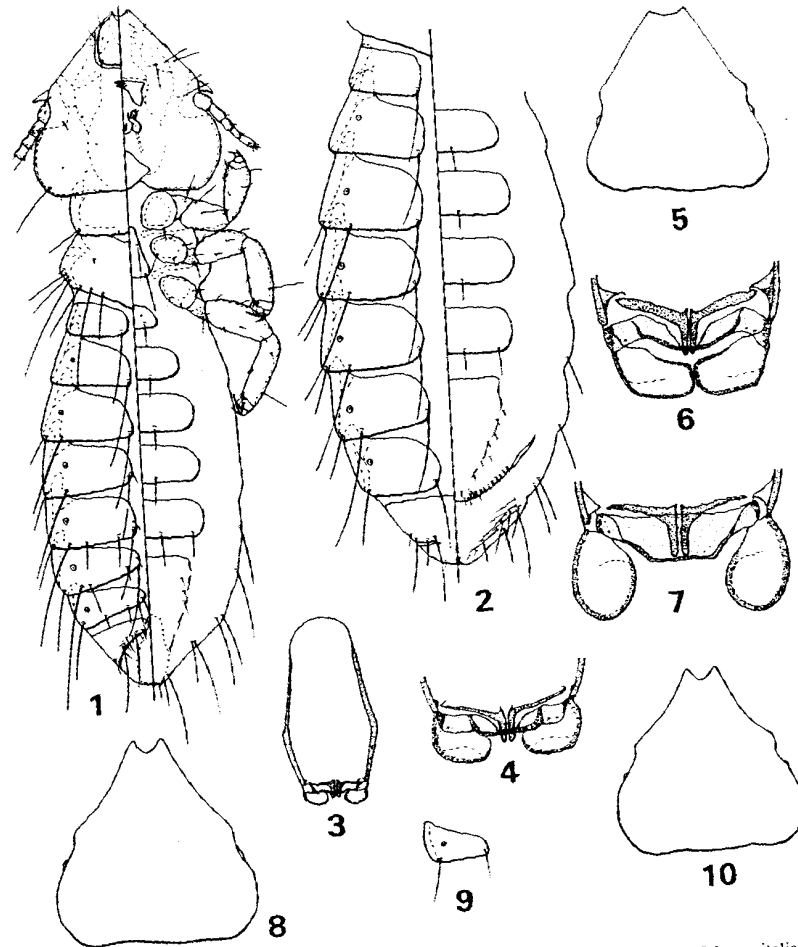
DESCRIPTION: Head (Fig. 1) with straight preantennal margin; anterior notch narrow, 0.04-0.05 wide for male, 0.05-0.06 for female. Each male tergite VIII with 3-5 setae mediad of spiracle (Fig. 1). Male genitalia (Fig. 3) 0.07-0.08 wide, with ovoid parameres wider than long, moderately separated (Fig. 4).

DIMENSIONS: Male: temple width (TW), 0.40-0.45; head length (HL), 0.42-0.45; dorsal anterior head plate width (DPW), 0.10-0.11; dorsal anterior head plate length (DPL), 0.11-0.12; prothorax width (PW), 0.22-0.25; metathorax width (MW), 0.33-0.36; abdomen width at segment V (AWV), 0.44-0.46; total length (TL), 1.51-1.56. Female: TW, 0.45-0.50; HL, 0.44-0.49; DPW, 0.11-0.12; DPL, 0.12-0.13; PW, 0.27-0.29; MW, 0.36-0.42; AWV, 0.49-0.58, TL, 1.76-1.95.

REMARKS: Carriker (1957) states that his material of *F. picturatus* consisted only of the male holotype and female allotype, but there are also 2 female paratypes accompanying the type specimens. For *F. laemostictus*, Carriker (1957) speaks of the male holotype, a female paratype, and another female specimen, when there actually is a female holotype, no female paratype, and no male specimen. When discussing *F. latifrons*, Carriker (1957) says "One of the larger specimens, equal in size to *F. magnus*, with practically the same head and body measurements . . ."; however, the measurements given in his table of dimensions are consistently smaller, in the range of *F. picturatus*, agreeing with our measurements of the same specimen. Another error involves *F. peruvianus*, for which the slide is labeled female holotype, whereas the specimen is a male and is so stated by Carriker (1957).

This species represents the first of 6 from hosts in the family Thamnophilidae. It is recognized by its head shape, narrow anterior head notch, and dimensional differences.

MATERIAL EXAMINED: Male holotype, female allotype, 2 female paratypes of *F.*



Figs. 1-4. *Formicaphagus picturatus* Carriker. 1. Male. 2. Female abdomen. 3. Male genitalia. 4. Terminal portion of male genitalia. Figs. 5, 6. *F. rhanphasti* (Carriker). 5. Outline of male head. 6. Terminal portion of male genitalia. Fig. 7. *F. splendidus* Carriker, terminal portion of male genitalia. Figs. 8, 9. *F. arnoldi* n. sp. 8. Outline of male head. 9. Male abdominal tergite VIII. Fig. 10. *F. donpetersi* n. sp., outline of male head.

picturatus, ex *M. i. immaculata*, Colombia; 2 females, 1 male, ex *M. immaculata*, Ecuador. Female holotype of *F. laemostictus*, ex *M. l. bolivari*, Colombia; 1 female, ex *M. l. bolivari*, Colombia. Female holotype of *F. latifrons*, ex *C. n. nigricans*, Colombia; 1 female ex *C. t. tyrannina* (Sclater), Colombia. Male holotype of *F.*

Formicaphagus magnus Carriker

Formicaphagus magnus Carriker, 1957:415. Type host: *Myrmeciza laemosticta palliata* Todd.

DESCRIPTION: Male unknown. Female near that of *F. picturatus*, but with anterior head notch 0.07 wide and larger dimensions.

DIMENSIONS: Female: TW, 0.53; HL, 0.55; DPW & DPL, 0.14; PW, 0.32; MW, 0.47; AWV, 0.58; TL, 1.97.

MATERIAL EXAMINED: Female holotype of *F. magnus*, ex *M. l. palliata*, Colombia.

Formicaphagus angustifrons Carriker

Formicaphagus angustifrons Carriker, 1957:416. Type host: *Myrmeciza hemimelaena hemimelaena* Sclater.

Formicaphagus huilae Carriker, 1957:418. Type host: *Myrmeciza longipes boucardi* Berlepsch. New synonymy.

DESCRIPTION: Close to *F. picturatus*. Anterior head notch only 0.04 wide and with smaller dimensions.

DIMENSIONS: Male: TW & HL, 0.39–0.40; DPW & DPL, 0.10; PW, 0.21–0.23; MW, 0.30–0.31; AWV, 0.40–0.42; TL, 1.25–1.26. Female: TW, 0.39–0.43; HL, 0.41–0.44; DPW & DPL, 0.10–0.11; PW, 0.21–0.25; MW, 0.32–0.35; AWV, 0.39–0.49; TL, 1.38–1.69.

MATERIAL EXAMINED: Male holotype, female allotype, 1 male, 5 female paratypes of *F. angustifrons*, ex *M. h. hemimelaena*, Bolivia. Female holotype, 2 female paratypes of *F. huilae*, ex *M. l. boucardi*, Colombia.

Formicaphagus clypeatus Carriker

Formicaphagus clypeatus Carriker, 1957:420. Type host: *Pernostola leucostigma brunneiceps* (Zimmer).

DESCRIPTION: Close to *F. picturatus*. Anterior head notch 0.07 wide, but some other dimensions smaller.

DIMENSIONS: Male: AWV, 0.42–0.43; TL, 1.31–1.32. Female: TW, 0.43; HL, 0.43; PW, 0.24; MW distorted; AWV, 0.47; TL, 1.45.

REMARKS: Although Carriker (1957) emphasized the species specific male genitalia of this group, he made no mention of the genitalia in the description of this species even with 2 males available. His illustration appears similar to that of *F. picturatus*, with which we are in full agreement.

MATERIAL EXAMINED: Male holotype, female allotype, 1 male paratype of *F. clypeatus*, ex *P. l. brunneiceps*, Peru.

Formicaphagus minutus Carriker

Formicaphagus minutus Carriker, 1957:423. Type host: *Herpsilochmus rufimarginatus frater* Sclater and Salvin.

Formicaphagus thoracicus Carriker, 1957:423. Type host: *Gymnopithys leucaspis bicolor* (Lawrence). New synonymy.

Formicaphagus bolivianus Carriker, 1957:426. Type host: *Momyia* sp. n.

DESCRIPTION: Close to *F. picturatus*. Anterior head notch 0.04 wide for male, 0.04–0.05 for female. Tendency for dimensions intermediate between those of *F. picturatus* and *F. angustifrons*.

DIMENSIONS: Male: TW, 0.39; HL, 0.41; DPW & DPL, 0.10; PW, 0.23; MW, 0.32; AWV, 0.45; TL, 1.41. Female: TW, 0.42–0.44; HL, 0.43–0.45; DPW, 0.11; DPL, 0.10–0.12; PW, 0.24–0.27; MW, 0.33–0.38; AWV, 0.51–0.61; TL, 1.69–1.99.

MATERIAL EXAMINED: Female holotype, male allotype, 1 female paratype of *F. minutus*, ex *H. r. frater*, Venezuela. Female holotype of *F. thoracicus*, ex *G. l. bicolor*, Colombia. Female holotype, 1 female paratype of *F. bolivianus*, ex *M. a. fresnayana*, Bolivia.

Formicaphagus brevifrons Carriker

Formicaphagus brevifrons Carriker, 1957:424. Type host: *Pyriglena leucoptera* (Vieillot).

DESCRIPTION: Close to *F. picturatus*. Anterior head notch 0.06 wide. Male dimensions largest of any known males from thamnophilid hosts; female dimensions also large, nearest to *F. picturatus*.

DIMENSIONS: Male: TW & HL, 0.48; DPW & DPL, 0.12; PW, 0.28; MW, 0.39; AWV, 0.57; TL, 1.69. Female: HL, 0.50; PW, 0.30; AWV, 0.64; TL, 1.95.

MATERIAL EXAMINED: 1 female, 1 male, ex *P. leucoptera*, Brazil.

Formicaphagus rhamphasti (Carriker)

(Figs. 5, 6)

Nirmus rhamphasti Carriker, 1903:135. Type host: *Rhamphastos tocard* (= *R. swainsonii* Gould)—error.

Formicaphagus grallariae Carriker, 1957:426. Type host: *Hylopezus perspicillatus intermedius* (Ridgway).

DESCRIPTION: Head (Fig. 5) with straight preantennal margin; anterior notch 0.07–0.08 wide. Each male tergite VIII with 3–4 setae mediad of spiracle. Male genitalia with basal apodeme 0.07–0.08 wide and parameres large, angulate, much wider than long, often closely apposed at midline (Fig. 6).

DIMENSIONS: Male: TW, 0.42–0.43; HL, 0.44; DPW & DPL, 0.11–0.12; PW, 0.26–0.27; MW, 0.34–0.36; AWV, 0.46–0.48; TL, 1.47–1.52. Female: TW, 0.47; HL, 0.46; DPW, 0.12; DPL, 0.11; PW, 0.28; MW, 0.37; AWV distorted; TL, 1.63.

REMARKS: This is the first of 3 species of *Formicaphagus* known from hosts in the family Formicariidae. As a group, their male genitalia exhibit different parameral shapes than those of *Formicaphagus* species from thamnophilid hosts. All 3 species also have a relatively wide anterior head notch, and 2 of them have relatively large dimensions. Both sexes of *F. rhamphasti* are much smaller than those of the other 2 *Formicaphagus* species from formicariids.

Emerson (1981) established the synonymy of *F. grallariae* with *N. rhamphasti* and discussed the problem of the erroneous type host and the difficulty of placing *N. rhamphasti* in its correct genus. After examining the type for both names, we concur with the synonymy.

MATERIAL EXAMINED: Male holotype of *N. rhamphasti*, ex *R. swainsonii*—

Formicaphagus splendidus Carriker
(Fig. 7)

Formicaphagus splendidus Carriker, 1957:428. Type host: *Pittasoma michleri zeledoni* Ridgway.

DESCRIPTION: Close to *F. rhamphasti*. Anterior head notch 0.06–0.07 wide. Male genitalia with small widely separated circular parameres (Fig. 7).

DIMENSIONS: Male: TW & HL, 0.49; DPW, 0.12; DPL, 0.13; PW, 0.31; MW, 0.41; AWV, 0.54; TL, 1.80. Female: TW, 0.52–0.54; HL, 0.52–0.56; DPW & DPL, 0.12–0.13; PW, 0.32–0.34; MW, 0.44–0.45; AWV, 0.59–0.63; TL, 1.92–2.15.

REMARKS: The unique male genitalic parameres, in conjunction with the large dimensions of both sexes, set this species apart from the others.

MATERIAL EXAMINED: Female holotype, 2 female paratypes of *F. splendidus*, ex *P. m. zeledoni*, Panama; 1 female, 1 male, ex *P. michleri*, Costa Rica.

Formicaphagus pittasomae Carriker

Formicaphagus pittasomae Carriker, 1957:429. Type host: *Pittasoma rufopileatum rosenbergi* Hellmayr.

DESCRIPTION: Close to *F. rhamphasti*. Anterior head notch 0.06–0.08 wide. Male genitalia near Fig. 6, with basal apodeme 0.09–0.10 wide.

DIMENSIONS: Male: TW, 0.47–0.51; HL, 0.48–0.51; DPW, 0.13–0.14; DPL, 0.13–0.15; PW, 0.27–0.30; MW, 0.37–0.40; AWV, 0.49–0.57; TL, 1.60–1.75. Female: TW, 0.48–0.54; HL, 0.50–0.53; DPW, 0.12–0.14; DPL, 0.14–0.16; PW, 0.28–0.32; MW, 0.39–0.43; AWV, 0.53–0.66; TL, 1.85–2.09.

REMARKS: This species, even though from the same genus of host as that of *F. splendidus*, differs from it more than one would anticipate. The male genitalia of the 2 species appear to have quite different paramere structure; the female is only tenuously separated on dimensional features. We could find no meaningful differences between the series collected in Peru from *Myrmothera campanisona* (Hermann) and those in the type series.

MATERIAL EXAMINED: Female holotype, male allotype of *F. pittasomae*, ex *P. rufopileatum rosenbergi*, Colombia. 17 males, 22 females, ex *M. campanisona*, Peru.

Formicaphagus arnoldi n. sp.
(Figs. 8, 9)

Type host. *Conopophaga ardesiaca* d'Orbigny and Lafresnaye.

DESCRIPTION: Head (Fig. 8) with preantennal margin slightly concave, giving more tapered appearance to anterior portion; dorsal plate longer than wide; anterior notch 0.05–0.06 wide for male, 0.06–0.07 for female. Each male tergite VIII usually with only 1 seta mediad of spiracle (Fig. 9), less often 2. Male genitalia near Fig. 4.

DIMENSIONS: Male: TW, 0.43–0.45; HL, 0.43–0.46; DPW, 0.11–0.12; DPL, 0.14–0.15; PW, 0.23–0.26; MW, 0.32–0.36; AWV, 0.46–0.54; TL, 1.48–1.61. Female: TW, 0.47–0.48; HL, 0.48–0.49; DPW, 0.12–0.13; DPL, 0.14–0.15; PW, 0.27–0.29; MW, 0.39–0.41; AWV, 0.56–0.63; TL, 1.80–1.94.

REMARKS: This species represents the first chewing louse to be described from a host within the passerine family Conopophagidae, the gnateaters. It is morphologically quite close to the species from the Thamnophilidae, but the head shape, the dorsal head plate longer than wide, and the unique chaetotaxy of male tergite VIII readily separate it.

TYPE MATERIAL: Male holotype, ex *C. ardesiaca*, Peru: Dept. Madre de Dios, Cerro de Pantiacolla, 1350 m, above Rio Palotoa, 2 September 1985, D. H. Clayton. Paratypes: 3 males, 7 females, same as holotype; 9 males, 43 females, same except 1030 m, 24 August 1985; 1 male, 6 females, same except 1300 m, 5 September 1985; 8 males, 30 females, same except 6 September 1985; 1 male, 1 female, same except no elevation, 3 September 1985.

ETYMOLOGY: This species is named for Don C. Arnold, Curator of the K. C. Emerson Museum at Oklahoma State University, in recognition of his deep interest and efforts in support of its ectoparasite collection.

Formicaphagus donpetersi n. sp.
(Fig. 10)

Type host. *Conopophaga peruviana* Des Murs.

DESCRIPTION: Close to *F. arnoldi*. Head (Fig. 10) shorter, with anterior notch 0.06–0.07 wide for male, 0.07–0.08 for female.

DIMENSIONS: Male: TW, 0.42–0.46; HL, 0.40–0.43; DPL, 0.11–0.13; AWV, 0.45–0.51; TL, 1.31–1.44. Female: TW, 0.48–0.49; HL, 0.45–0.47; DPL, 0.13–0.14; MW, 0.37–0.40; AWV, 0.51–0.60; TL, 1.56–1.79.

REMARKS: This species, representing the second louse species to be described from the Conopophagidae, resembles *F. arnoldi* in general head shape and reduced chaetotaxy of male tergite VIII, thereby also distinguishing it from others of the genus. The shorter head and total length reliably separate *F. donpetersi* from *F. arnoldi*.

TYPE MATERIAL: Female holotype, ex *C. peruviana*, Peru: Dept. Madre de Dios, Cerro de Pantiacolla, 820 m, 13 November 1985, D. H. Clayton. Paratypes: 5 males, 5 females, same as holotype; 1 female, same except 680 m, 10 November 1985.

ETYMOLOGY: This species is named for Don C. Peters, Oklahoma State University, in recognition of his outstanding efforts in support of the ectoparasite collection in the K. C. Emerson Museum.

Formicaphagus and Host Classification

The distribution of the species of *Formicaphagus* and their host species may be summarized as follows:

- (1) On hosts within the Thamnophilidae (typical antbirds)—
F. picturatus ex *Myrmeciza immaculata*, *M. laemosticta*, *Cercomacra nigricans*, *C. tyrannina*, *Myrmotherula schisticolor*
F. magnus ex *Myrmeciza laemosticta*
F. angustifrons ex *Myrmeciza hemimelaena*, *M. longipes*
F. clypeatus ex *Percnostola leucostigma*
F. minutus ex *Herpsilochmus rufimarginatus*, *Gymnopithys leucaspis*,
Myrmotherula axillaris

- F. brevifrons* ex *Pyriglena leucoptera*
 (2) On hosts within the Formicariidae (ground antbirds)—
F. rhamphasti ex *Hylopezus perspicillatus*
F. splendidus ex *Pittasoma michleri*
F. pittasomae ex *Pittasoma rufopileatum*, *Myrmothera campanisona*
 (3) On hosts within the Conopophagidae (gnateaters)—
F. arnoldi ex *Conopophaga ardesiaca*
F. donpetersi ex *Conopophaga peruviana*

As can be seen from the above summary, species of *Formicaphagus* range in specificity from that found on 1 species of host to that collected from as many as 5 species in 3 genera. Of the 3 species found on multiple host genera, none is found on the members of both antbird families, which supports the division by Sibley and Monroe (1990) of the antbirds into 2 families, the Thamnophilidae and Formicariidae. These 2 antbird families are further separated into the mono-familial parvorder Thamnophilida and the parvorder Furnariida, which also contains the Furnariidae, Conopophagidae, and Rhinocryptidae. We find it puzzling that *Formicaphagus* has not been collected from members of the Furnariidae or Rhinocryptidae, both of which have been as thoroughly examined for lice as the antbirds (Clayton et al., 1992; Price and Clayton, 1993, 1994, 1995a, b). The absence of *Formicaphagus* from these families suggests either that typical antbirds are more closely related to the ground antbirds and gnateaters than Sibley and Monroe (1990) indicate, or that *Formicaphagus* lice do not cospeciate with their hosts, which could be true for a variety of reasons (Page et al., 1996).

Key to the Species of *Formicaphagus*

Males

1. Abdomen tergite VIII each with usually 1, less often 2, setae mediad of spiracle (Fig. 9) 2
- Abdomen tergite VIII each with at least 3 such setae (Fig. 1) 3
2. Total length over 1.46; dorsal head plate length at least 0.14; head length at least 0.43 (Fig. 8) *arnoldi* n. sp.
- Total length under 1.46; dorsal head plate length not over 0.13; head length not over 0.43 (Fig. 10) *donpetersi* n. sp.
3. Head notch width only up to 0.05 4
- Head notch width at least 0.06 6
4. Total length under 1.30 *angustifrons* Carriker
- Total length over 1.35 5
5. Total length under 1.45 *minutus* Carriker
- Total length over 1.47 *picturatus* Carriker
6. Genitalia (Fig. 7) with small widely separated circular parameres; total length over 1.78 *splendidus* Carriker
- Genitalia (Figs. 4, 6) with parameres closer together, wider than long; total length under 1.78 7
7. Temple width under 0.45; head length under 0.45 8
- Temple width over 0.45; head length over 0.46 9

8. Genitalia near Fig. 6; abdomen width at segment V at least 0.45; total length over 1.42 *rhamphasti* (Carriker)
- Genitalia near Fig. 4; abdomen width at segment V not over 0.44; total length under 1.38 *clypeatus* Carriker
9. Dorsal head plate width and length not over 0.12; genitalia near Fig. 4 *brevifrons* Carriker
- Dorsal head plate width and length at least 0.13; genitalia near Fig. 6 *pittasomae* Carriker

Females

1. Head notch width 0.04–0.05 and temple width not over 0.44 2
- Either head notch width 0.05 and temple width at least 0.45 or head notch width over 0.05 and temple width at least 0.43 3
2. Abdomen width at segment V under 0.50; total length not over 1.69 *angustifrons* Carriker
- Abdomen width at segment V over 0.50; total length at least 1.69 *minutus* Carriker
3. Total length under 1.50; temple width under 0.44 *clypeatus* Carriker
- Total length over 1.50; temple width over 0.44 4
4. Temple width over 0.51 5
- Temple width under 0.51 7
5. Dorsal head plate length not over 0.13; prothorax width at least 0.32 *splendidus* Carriker
- Dorsal head plate length at least 0.14; prothorax width not over 0.32 ... 6
6. Head length over 0.54; metathorax width over 0.45 *magnus* Carriker
- Head length under 0.54; metathorax width under 0.45 *pittasomae* Carriker (in part)
7. Preantennal margin slightly concave, giving attenuate appearance to anterior head portion (Figs. 8, 10) 8
- Preantennal margin essentially straight, giving conical appearance to anterior head portion (Figs. 1, 5) 9
8. Head length at least 0.48; total length at least 1.80 *arnoldi* n. sp.
- Head length not over 0.47; total length not over 1.79 ... *donpetersi* n. sp.
9. Total length under 1.70 *rhamphasti* (Carriker)
- Total length over 1.70 10
10. Dorsal head plate length at least 0.14; head length at least 0.50 *pittasomae* Carriker (in part)
- Dorsal head plate length not over 0.13; head length not over 0.50 11
11. Abdomen width at segment V over 0.61; head length at least 0.50; prothorax width at least 0.30 *brevifrons* Carriker
- Abdomen width at segment V under 0.61; head length not over 0.49; prothorax width not over 0.29 *picturatus* Carriker

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Literature Cited

- Carriker, M. A., Jr. 1903. Mallophaga from birds of Costa Rica, Central America. *Nebraska Univ. Stud.* 3:123-192.
- Carriker, M. A., Jr. 1957. Studies in Neotropical Mallophaga, XVI: bird lice of the suborder Ischnocera. *Proc. U.S. Nat. Mus.* 106:409-439.
- Clayton, D. H., R. D. Gregory, and R. D. Price. 1992. Comparative ecology of Neotropical bird lice (Insecta: Phthiraptera). *J. Anim. Ecol.* 61:781-795.
- Emerson, K. C. 1981. Status of five species of Mallophaga described by M. A. Carriker, Jr. *Proc. Entomol. Soc. Wash.* 83:137-139.
- Page, R. D. M., D. H. Clayton, and A. M. Paterson. 1996. Lice and cospeciation: A response to Barker. *Int. J. Parasit.* 26:213-218.
- Peters, J. L. 1951. Check-list of birds of the world, vol. III. *Mus. Comp. Zool., Cambridge, MA.*
- Price, R. D. and D. H. Clayton. 1993. Review of the species of *Rallicola* (Phthiraptera: Philopteridae) from the woodcreepers (Passeriformes: Dendrocolaptinae). *J. Med. Entomol.* 30:35-46.
- Price, R. D. and D. H. Clayton. 1994. Review of the species of *Rallicola* (Phthiraptera: Philopteridae) from the antbirds, ovenbirds, and tapaculos (Passeriformes). *J. Med. Entomol.* 31:649-657.
- Price, R. D. and D. H. Clayton. 1995a. Review of *Formicariicola* (Phthiraptera: Philopteridae) from ground antbirds (Passeriformes: Formicariidae). *Ann. Entomol. Soc. Am.* 88:718-721.
- Price, R. D. and D. H. Clayton. 1995b. A new genus and three new species of chewing lice (Phthiraptera: Philopteridae) from Peruvian ovenbirds (Passeriformes: Furnariidae). *Proc. Entomol. Soc. Wash.* 97:839-844.
- Sibley, C. G. and B. L. Monroe, Jr. 1990. Distribution and taxonomy of birds of the world. Yale Univ. Press, New Haven, CT.

**Parasitism of *Lygus lineolaris* Palisot de Beauvois
(Heteroptera: Miridae) by *Anaphes iole* Girault
(Hymenoptera: Mymaridae) in Strawberries**

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ABSTRACT: *Anaphes iole* Girault has been reported to parasitize *Lygus lineolaris* Palisot de Beauvois eggs in several crops but not in strawberries. The ability of *A. iole* to parasitize *L. lineolaris* eggs in strawberries was evaluated. *A. iole* will parasitize and inhibit the development of *L. lineolaris* eggs in strawberry plants.

Lygus lineolaris Palisot de Beauvois, the tarnished plant bug (TPB), is the primary insect pest of strawberries (*Fragaria* × *ananassa* Duschene) in Iowa and the north-central United States. *L. lineolaris* feed on developing achenes (seeds) of strawberry flowers and green fruit. Fed-upon achenes are hollow and brown and cluster in a spiral pattern at the tip of ripe strawberries. This deformation is called apical seediness or "buttoned" berries (Schaefer, 1966; Handley and Pollard, 1993). Consumers will not purchase "buttoned" berries; therefore, strawberries damaged by *L. lineolaris* are unmarketable as fresh fruit. Current *L. lineolaris* management practices in Iowa involve spraying insecticides on a calendar, or preventive, basis.

Anaphes iole Girault (Hymenoptera: Mymaridae) is an egg parasitoid that occurs throughout North America from Alaska to southern Mexico. Studies have shown that *A. iole* will parasitize the eggs of *L. lineolaris* and *L. hesperus* Knight (considered the tarnished plant bug of the west) in several crops (Sohati et al., 1989; Graham et al., 1986). It is the primary egg parasitoid of *Lygus* spp. in the United States and occurs on plants where its hosts feed and oviposit (Jones and Jackson, 1990; Huber and Rajakulendran, 1988).

A. iole has been shown to parasitize *L. hesperus* eggs in strawberries in California (Norton et al., 1992), but no study has been reported that evaluates the possibility of using this parasitoid as a biological control agent of *L. lineolaris* in strawberries. The experiment reported here is the first step in determining if *A. iole* can be used as a biological control for *L. lineolaris* in strawberries. The purpose of this experiment was to determine if *A. iole* will parasitize *L. lineolaris* eggs oviposited in strawberry stems.

Materials and Methods

This experiment was conducted three times. On each occasion, strawberry plants (Jewel cultivar) were planted in 15-cm-diameter plastic pots and grown in the greenhouse. Flowers were periodically removed to stimulate vegetative growth. At the time of the experiment, plants were removed from the greenhouse and thinned to two stems per pot. Strawberry plants were kept in a Rheem® puffer hubbard environmental growth chamber and maintained at a constant temperature of 36°C and photoperiod of 16:8 L:D hr for the duration of the experiment.