

Specific association between the mites *Androlaelaps fahrenheiti* (Acari: Laelapidae) and birds *Premnoplex brunnescens* in Costa Rica: possible evidence of a recent host switch

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Abstract *Androlaelaps fahrenheiti* is a common, cosmopolitan mite constituting a species complex. This mite is found in nests or on mammal hosts and occasionally on birds. The specific host association between *A. fahrenheiti*-like mites and *Premnoplex brunnescens* in Costa Rica is reported here. Adults (females and males), deutonymphs and protonymphs were found on 14 *P. brunnescens* examined (prevalence was 100 %) with mean abundance 42 (2–222). The nest environment plays an important role in the evolution of parasites and could explain the evolutionary path of Laelapinae towards parasitism. We hypothesize that the colonization of *P. brunnescens* took place in this context quite recently, from sympatrically living rodents. Morphology and ecology of *A. fahrenheiti* from *P. brunnescens* may constitute at least a new variation of *A. fahrenheiti*, and possibly a new species.

Keywords Mesostigmatic · Laelapinae · Ectoparasite · Spotted barbtail

Introduction

Dermanyssoid mites belong to the largest and one of the biologically most diverse groups of the Arachnida. Among them, the Laelapidae family includes a variety of life history strategies: laelapids are free-living predators, nidicoles are facultative or obligate ectoparasites of vertebrates and arthropods, and some are endoparasites of mammals (Radovsky 1985; Dowling and OConnor 2010). Studies based on the ecology and host

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associations, as well as on the morphology of the chelicerae, of some laelapids support a view that dermanyssoid parasites have evolved to parasitism through first becoming commensal nidicoles (Radovsky 1985). Recent molecular studies also accord with this view (Dowling and OConnor 2010). The nest habitat provided the basis for a close association between the mite and the nest occupant. The association may initially have been one of commensalism, with the mite feeding on small ectoparasites and on blood exuding from abrasions on the body of the nest inhabitant (Evans 1992).

Molecular studies have shown that parasitism has evolved a minimum of eight independent times among dermanyssoids (Dowling and OConnor 2010). The principal association in those lines that led to nest dwelling and then to parasitism were with mammals, mainly rodents, and the major exploitation of reptilian and avian hosts was secondary by parasite colonization (Radovsky 1985). This process is common in the evolution and historical biogeography of host–parasite interactions, and it takes place when parasites disperse and switch their hosts (Hoberg and Brooks 2010).

Mites of the genus *Androlaelaps* (Parasitiformes, Laelapidae, Laelapinae) are found worldwide and exhibit varying degrees of dependence on various vertebrate hosts, their nests and arthropods living there (Radovsky 1985). *Androlaelaps fahrenheitzi* (Ewing) is a common cosmopolitan mite which constitutes a species complex that is not yet well defined (Strandtmann and Wharton 1958; Furman 1972). This mite has been found in nests or on hosts including a great variety of small mammals and occasionally birds, but these are primarily rodents (Radovsky 1985). *A. fahrenheitzi* represents an interesting stage in the evolution of dermanyssoid parasitism, since it has a highly adapted relationship with the host and the nest, probably based on its generalized type of feeding (Radovsky 1985). Mites identified as *A. fahrenheitzi* include distinct forms (and possibly species) in association with different host species and locations (Strandtmann and Wharton 1958; Tipton et al. 1966; Furman 1972). The *A. fahrenheitzi* species complex needs further study. Although the variation of this species complex has been recorded (for examples, see Strandtmann and Wharton 1958; Till 1963; Furman 1972), only few morphological characters and measurements related to this variation are included in the literature. The one exception is Strandtmann (1949). This scarcity of morphological information in previous papers makes the revision of *A. fahrenheitzi* difficult.

Herein, we study the host-specific association between spotted barbtail, *Premnoplex brunnescens* (Sclater) (Passeriformes: Furnariidae)—a small bird inhabiting the interior of Neotropical montane evergreen forests (Remsen 2003)—and *A. fahrenheitzi*-like mites, in Costa Rica. Detailed morphological characteristics of all stages of the mites are reported and compared to data published formerly.

Materials and methods

Bird ectoparasites were collected in two locations in Costa Rica: (1) Tapanti National Park, Sector Tapanti in the Cordillera de Talamanca (09°46'N, 83°47'W; 1,200 m asl), from 31 July to 11 August 2009; and (2) Braulio Carrillo National Park, Sector Barva in the Cordillera Volcanica Central (10°07'N, 84°07'W; 2,600 m asl) from 30 July to 8 August 2010. Birds were mist-netted, identified and visually checked for the presence of feather mites and other ectoparasites, followed by using the fumigation chamber method (Clayton and Drown 2001) to collect lice, fleas, flies and also some mites. The collection procedure was conducted in a way to cause minimum stress to the birds examined.

Collected mites were preserved in 96 % alcohol and prepared following conventional methodology used for their study under a light microscope. They were also photographed. Mites were measured using a stage-calibrated ocular micrometer. In studying the most important diagnostic characteristics for *A. fahrenheiti*, we followed the works by Strandtmann (1949) and Till (1963). Measurements are presented in μm . Prevalence and mean abundance (minimum–maximum number of mites in an individual host) were calculated (Bush et al. 1997). Voucher specimens are deposited at the Colección de Entomología del Museo de la Plata, Argentina and in the National Biodiversity Institute, Santo Domingo de Heredia, Costa Rica (INBio).

Results

In Tapanti National Park, 351 birds of 62 species were examined, of which 12 were identified as *P. brunnescens*. In Braulio Carrillo National Park, 295 birds of 39 species were examined, including two *P. brunnescens*. Of the 646 birds examined, only *P. brunnescens* were parasitized with dermanysoid mites identified as *A. fahrenheiti*. In total, 585 individual *A. fahrenheiti* were collected, prevalence in *P. brunnescens* was 100 %, and mean abundance was 42 (2–222). Adult females and males, deutonymphs and protonymphs were morphologically characterized.

Females (Figs. 1, 2, 3, 4, 5, 6, 7, 8, 9)

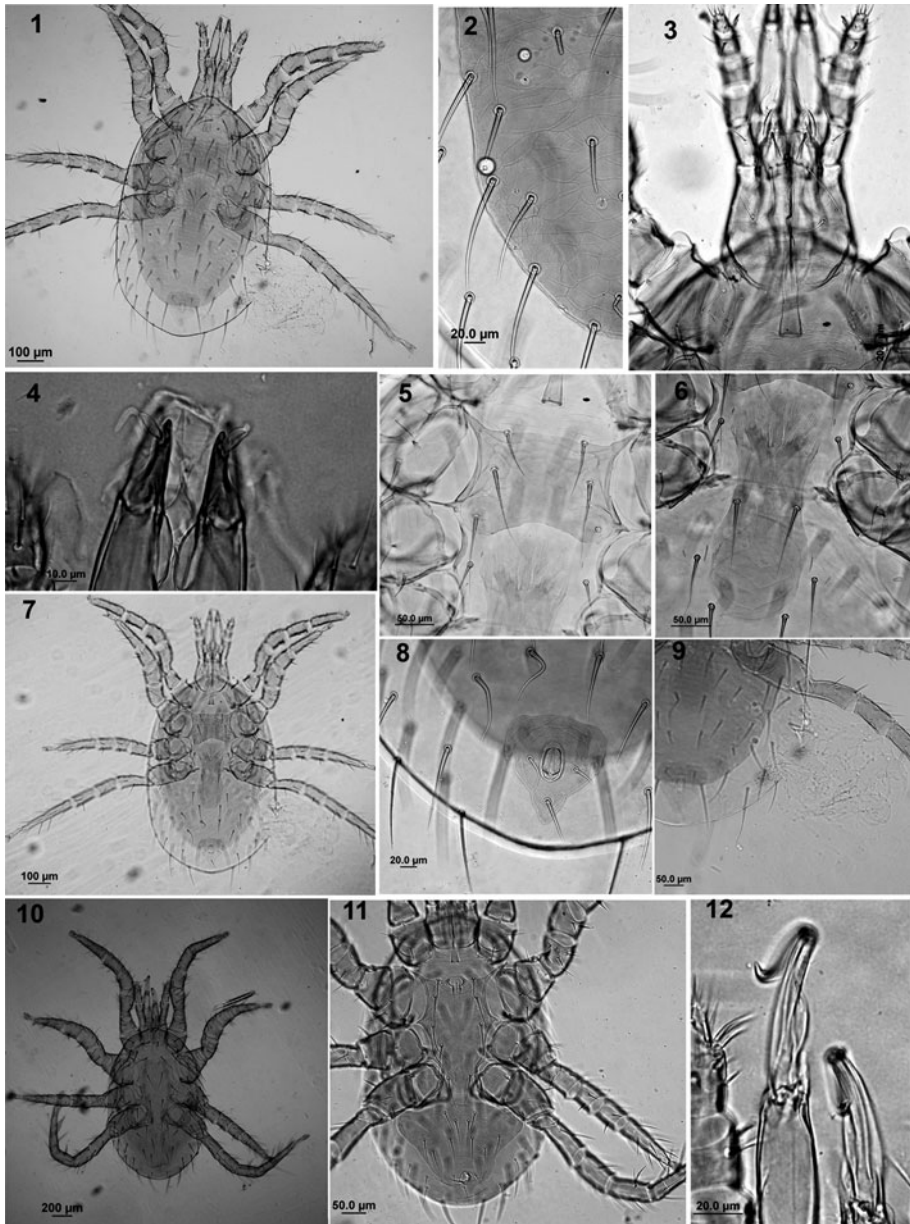
Idiosoma length and width average 778 (720–810) and 500 (470–520), respectively; thus, it is about 1.5 times longer than wide (Fig. 1). Dorsal shield reticulate, with 39 pairs of setae (Fig. 2). Central setae long, 80–120. Gnathosoma with subcapitular groove having 6 files of teeth; chelicerae have movable and fixed chelas with hooked tips and two teeth each; pilus dentilis basally inflated (Figs. 3, 4). Sternal shield reticulate, almost twice broader than long; anterior margin right, expanded at level of first sternal seta; posterior margin concave with 3 pairs of sternal setae, each with tips passing over the following setal base with 2 pairs of elongate/lyriform pores on shield (Fig. 5). Epigynal shield reticulate, broad, linguiform, almost parallel sided and rounded posteriorly, anterior margin convex, bearing a single pair of setae (Fig. 6). Peritrematic shield well sclerotized, extending 35 μm posterior to stigma. Metapodial shields well sclerotized, twice longer than wide, with a pair of small shields situated at each side of the epigynal shield (Fig. 6). Opisthogaster with 7 pairs of strong setae (Fig. 7). Anal shield triangular, almost as long as broad; cribrum well developed, composed of 3 rows of teeth (Fig. 8). All legs thin, leg IV (752) longer than leg I (622) (Fig. 1). No eggs were observed inside the females; outline of larvae were observed inside some specimens (Fig. 9).

Males (Figs. 10, 11, 12)

Idiosoma 531–549 long. Length of dorsal shield 522–531, width 333–342. Dorsal shield similar to that of female (Fig. 10). Holventral shield bearing anterior genital pore (Fig. 11). Peritremes and legs as in female. Chelicerae as in Fig. 12.

Deutonymph (Figs. 13, 14)

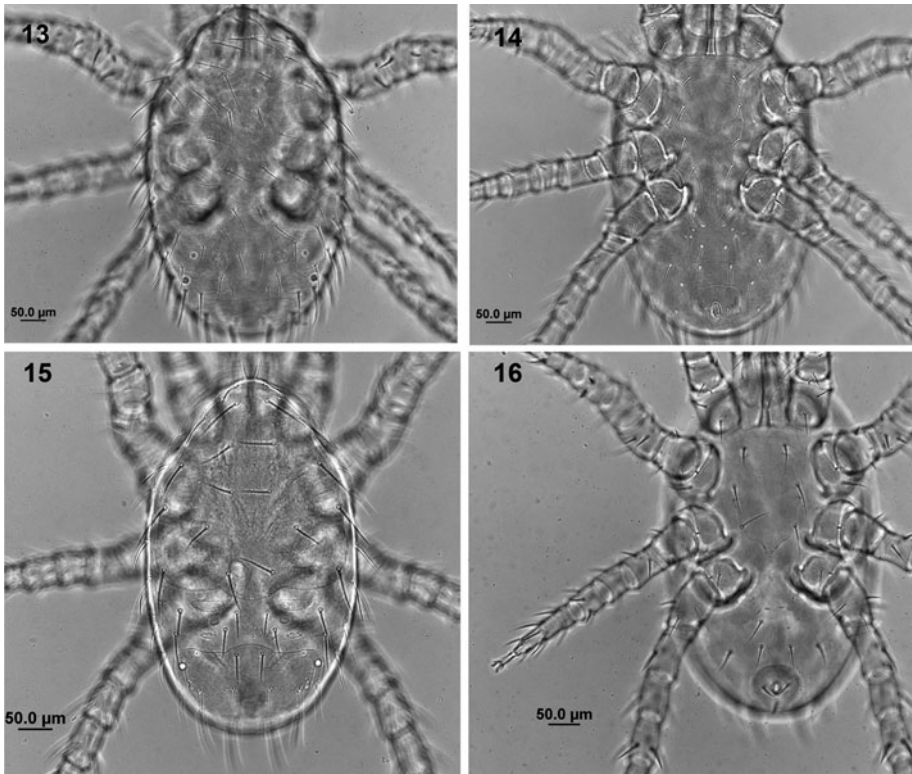
Idiosoma 585 long, 387 wide. Dorsal shield similar to that of female (Fig. 13). Sternal shield reticulate, tapers posteriorly, with 4 pairs of setae (Fig. 14).



Figs. 1–16 *Androlaelaps fahrenheitzi* on *Premnoplex brunescens* from Costa Rica. Females: **1** Dorsum, **2** Detail of dorsal shield, **3** Gnathosoma, **4** Chelicerae, **5** Sternal shield, **6** Epigynal shield, **7** Venter, **8** Anal shield, **9** Outline of a larva. Males: **10** Dorsum, **11** Venter, **12** Chelicerae. Deutonymphs: **13** Dorsum, **14** Venter. Protonymphs: **15** Dorsum, **16** Venter

Protonymph (Figs. 15, 16)

Idiosoma 486 long, 300 wide. Dorsal shield divided into two, with complementary small lateral shields (Fig. 15). Sternal shield with 3 pairs of setae (Fig. 16).



Figs. 1–16 continued

Measurements (10 females) (Figs. 1, 2, 3, 4, 5, 6, 7, 8, 9)

Length of dorsal shield, 699 (684–711), width of dorsal shield, 428 (405–450); length of setae J5, 48 (40–50); length of setae Z5, 129 (123–135); length of sternal plate at mid-ventral line, 118 (110–125); width of sternal plate at narrowest point, 171 (165–175); width of sternal plate at widest point, 243 (238–250); length of genitoventral plate, measured from base of sternal plate to tip of genitoventral plate, 272 (238–279); width of genitoventral plate at widest point, 119 (115–125); length of anal plate, measured from anterior border of the plate to the base of the odd seta, 33 (30–38); width of the anal plate at widest point, 124 (120–128); distance from the posterior tip of the genitoventral plate to the anterior border of the anal plate, 120 (75–155); length of leg I from base of coxa to tip of tarsus (exclusive of the ambulacral apparatus), 622 (603–630); length of leg IV, 752 (720–774); length of tarsus I (exclusive of the ambulacral apparatus), 161 (150–175); width of tarsus I at about the middle, 42 (38–45).

Discussion

Androlaelaps fahrenheitzi (= *Laelaps glasgowi*) was described on the basis of specimens collected from forest murines from Germany (Ewing 1925). The species is cosmopolitan

(Strandtmann and Wharton 1958) and a wide range of variation exists in the *A. fahrenheiti* species complex in association with different host species and locations, although no morphological measurements were provided to support this statement (Tipton et al. 1966; Furman 1972). Specimens from hosts of one species differ slightly from mites of another host species (Strandtmann and Wharton 1958). Specimens analysed in the present study correspond to this rule. Females, males and nymphs well fit the descriptions given for *A. fahrenheiti* (Ewing 1925; Strandtmann 1949; Till 1963; Furman 1972), although some differences were found. Primarily, these differences are in most of the relative measurements. For example, female specimens from *P. brunnescens* are bigger (length 699, width 428) than type specimens (600, 400) and all those characterized by Strandtmann (1949) (<550, <350). Moreover, specimens from *P. brunnescens* are slightly different from mites from other host species in that they lack 2–3 unpaired accessory setae between setae J2 and J4, as well as the double margin as mentioned in Till (1963) for Ethiopic specimens. Unfortunately, as mentioned above, few characteristics are present in the literature, so comparison with data provided in the present study is not possible, neither analyzing the variation of characters seen across the species complex, nor postulating which population previously known is more similar to mites from *P. brunnescens*. Nevertheless, differences observed in mites from *P. brunnescens* suggest that these mites constitute at least a new variation of *A. fahrenheiti*, possibly a new species. We consider, however, that the mostly quantitative differences reported herein are insufficient to erect a new species within the *A. fahrenheiti* species complex. Further studies, including morphometric revisions of specimens from other hosts and localities, will allow identifying the taxonomic status of *A. fahrenheiti* from *P. brunnescens*. Moreover, DNA analysis could be a useful tool for the next study of the *A. fahrenheiti* species complex.

The presence of immature stages, as well as adult females and males of *A. fahrenheiti* on the body of *P. brunnescens*, supports the idea that this bird is not an accidental host. On the contrary, this host association is probably solid (100 % prevalence), and the mite's specific host association supports the view that it possibly constitutes a new species within the *A. fahrenheiti* species complex.

Premnoplex brunnescens build large, mossy, ball-shaped nests with downward facing entrance tubes and have an exceptional pattern of incubation behaviour (Greeney 2008, 2009). Nests are built along streams in a variety of situations, including inside cavities, in hanging clumps of epiphytes, on rock faces, and under fallen logs. The nest environment plays an important role in the evolution of parasites and could explain the evolutionary path of Laelapinae towards parasitism. This subfamily has been suggested as the source of most parasitic lineages (Dowling and OConnor 2010). *A. fahrenheiti* usually occupies nests of small mammals, and less commonly of birds (Strandtmann and Wharton 1958). Based on our specific findings of huge numbers of *A. fahrenheiti* on full-grown *P. brunnescens*, we presume that these mites are also plentiful colonizers of *P. brunnescens* nests. Compared to other bird nests, the nest of *P. brunnescens* might have an advantage for *A. fahrenheiti* in that it is similar to nests built by some common rodent hosts of this mite. We hypothesize that the colonization of *P. brunnescens* took place in this sense relatively recently, from sympatrically living rodents. The nests of *P. brunnescens* offer a range of possibilities for *A. fahrenheiti* to colonize a new host (Radovsky 1985). *Andropaelaps fahrenheiti* associated with rodents may have dispersed and acquired *P. brunnescens* through their nests as a new host (host switch). *P. brunnescens* has a remarkable incubation rhythm. After providing near-constant coverage during the morning, adult birds leave the eggs unattended for most of the afternoon, returning to the nest only in the late afternoon (Greeney 2009). Moreover, the 27- to 31-day-long incubation period of *P. brunnescens* is the longest reported for any

furnariid (Greeney 2009). This exceptional incubation behaviour of *P. brunnescens* can fit well to the scenario of recent host switch. Further investigation on the host range of *A. fahrenheiti* in the study area may contribute to the elucidation whether this mite realized a host switch from any mammal host. The results obtained may support the importance of nest usage and syntopy for laelapids in the colonization of new hosts. Since some laelapids are vectors of pathogens, these processes of the new host colonization are also important from an epidemiological point of view. Moreover, due to their mobility, birds are important for spreading the parasites over long distances (Esch et al. 1990).

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