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## Knemidokoptic Mange in Hawai'i `Amakihi (*Hemignathus virens*) on the Island of Hawai'i

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**ABSTRACT:** Lesions resembling knemidokoptic mange on the feet and tarsometatarsi of two Hawai'i `Amakihi (*Hemignathus virens*) were observed while the researchers were mist-netting wild passerines at Manuka Natural Area Reserve on the island of Hawai'i between 14 June 2007 and 19 June 2007. During subsequent mist-netting from September 2007 through February 2008, we found 26% (7/27) of the Hawai'i `Amakihi caught were similarly affected. Microscopic examination of skin scrapings from lesions of affected individuals revealed *Knemidokoptes jamaicensis* (Acari: Knemidokoptidae). This is the first report of *Knemidokoptes* spp. found in wild passerines in Hawai'i. No other wild passerines ( $n=573$ ) have been found with knemidokoptic mange during our islandwide study of Hawai'i `Amakihi.

**Key words:** Hawaiian Islands, *Hemignathus virens*, *Knemidokoptes jamaicensis*, knemidokoptic mange.

Mites of the genus *Knemidokoptes* (Acari: Knemidokoptidae) cause knemidokoptic mange in birds, more commonly known as scaly face, scaly leg, or tassel foot. The lesions are formed when mites burrow into the skin, causing a thickening of skin that can lead to nasal obstruction or deformities of the feet or bill. Early, acute lesions can superficially resemble the lesions caused by avian poxvirus (Wade, 2006). These mites commonly infect poultry or caged birds, and are less common in wild populations. Three species infect both the face and legs of domestic and caged birds. *Knemidokoptes mutans* is commonly found in domestic fowl, *Knemidokoptes pilae* is most often found in parrots, and *Procnemidokoptes janssensi* is restricted to lovebirds (*Agapornis* spp.). In addition, there are two

species of *Knemidokoptes* known to infect only the legs of birds.

*Knemidokoptes jamaicensis* is well documented in domesticated and caged birds. Reports of this species occurring in wild populations have become increasingly common (Pence et al., 1999; Latta, 2003). *Knemidokoptes jamaicensis* has been reported in several migratory species, including Red-winged Blackbirds (*Agelaius phoeniceus*), Common Grackles (*Quiscalus versicolor*), and Brown-headed Cowbirds (*Molothrus ater*) in Ontario (Kirmse, 1966); Chaffinches (*Fringilla coelebs*) in Russia (Voinov et al., 1978); American Robins (*Turdus migratorius*) in southern North America (Pence et al., 1999); and the Prairie Warbler (*Dendroica discolor*) and Palm Warbler (*Dendroica palmarum*) in the neotropics (Latta, 2003). The rarer *Knemidokoptes intermedius* has been reported in wild populations of several bird species in Australia, including Forest Ravens (*Corvus tasmanicus*; Mason and Fain, 1988), Currawongs (*Strepera graculina*; Jaensch et al., 2003), and Superb Lyrebirds (*Menura novaehollandiae*; Holz et al., 2005). Although *K. mutans* and *Neognemidokoptes gallinae* have been reported from domestic chickens in Hawai'i (Bice, 1932) and *K. pilae* was found in caged parakeets on Oahu (Goff, 1987), knemidokoptid mites are not known to occur on any wild Hawaiian bird species (Goff, 1980; van Riper and van Riper, 1985).

Between 14 June 2007 and 19 June 2007 two adult Hawai'i `Amakihi (*Hemi-*



FIGURE 1. An adult male Hawai'i 'Amakihi with knemidokoptic mange, caught at Manuka Natural Area Reserve, Hawai'i on 14 June 2007.

*gnathus virens*), hereafter 'Amakihi, with lesions on their feet and tarsal joints were captured in a dry ohia (*Metrosideros polymorpha*) forest at Manuka Natural Area Reserve (19°49'N, 155°49'W) on the island of Hawai'i. The lesions were unlike the avian pox (*Avipoxvirus*) lesions commonly seen on Hawaiian passerines. The extensions of the lesion protruded from each individual scale of all digits, extending up the tarsometatarsus with a large lesion on the notch of each tibiotarsal joint (Fig. 1). Lesions were found only on the feet and legs. The feet of one bird appeared encased in the lesion; the left foot was deformed and immobile. During subsequent mist-netting from September 2007 through February 2008, four more adult male 'Amakihi and one hatch-year 'Amakihi (unknown sex) were caught with lesions at Manuka Natural Area Reserve.

One of the males did not have lesions present when first banded in mid-June, but, upon recapture in early September, exhibited small, localized lesions on the lower tarsometatarsi. The lesions on the remaining three males were also small and localized, suggesting an early stage of the condition. The scales on the lower tarsometatarsus were uplifted perpendicular to the tarsal bone. Some small dry and crusty lesions were forming on top of these scales and encroaching on the feet. The hatch-year bird exhibited lesions on both tarsal joints that appeared more advanced, but not as extensive as seen in the recaptured adult female and one of the subsequent males. The lesions of the recaptured female and remaining male were more extensive than localized lesions. In both of these birds some digits were deformed and immobilized.

Microscopic examination (60 $\times$ ) of scrapings taken from the lesions of affected birds revealed knemidokoptid mites. The mites were cleared (10% KOH and a 1:1 solution of lactic acid and glycerol; Krantz, 1978), slide mounted in Hoyer's medium, and later identified as *K. jamaicensis* (James W. Mertins, USDA-NVSL, Ames, Iowa; Fain and Elsen, 1967; Lombert et al., 1984). Voucher specimens were deposited in the National Veterinary Services Laboratories, Ames, Iowa (accession number: 522612) and in the Bishop Museum, Honolulu, Hawai'i (accession number: 2008.037).

To date, seven out of 27 (26%) 'Amakihi caught at Manuka Natural Area Reserve had detectable lesions caused by *K. jamaicensis* infestation. These include five adult males, one adult female with a brood patch, and one hatch-year bird (unknown sex). Similar lesions were not found on Japanese White-eyes (*Zosterops japonicus*;  $n=88$ ), House Finch (*Carpodacus mexicanus*;  $n=8$ ), Northern Cardinal (*Cardinalis cardinalis*;  $n=3$ ), Red-billed Leiothrix (*Leiothrix lutea*;  $n=4$ ), and 'Elepaio (*Chasiempis sandwichensis*;  $n=6$ ) mist-netted at Manuka Natural Area Reserve. No lesions were found on 'Amakihi ( $n=315$ ) or other native and nonnative passerines ( $n=258$ ) mist-netted at additional locations on the island of Hawai'i between April 2007 and February 2008.

Two 'Amakihi with very advanced knemidokoptic mange also exhibited extensive feather degradation. An adult female 'Amakihi had extensive feather degradation on the primaries of both wings. Extensive feather degradation on the primaries of both wings and on both the right and left retrices of the tail was seen on one adult male 'Amakihi, caught in December 2007. A heavy infestation of feather mites (Analgidae: *Analges* sp.) was observed on the adult male caught in December.

This is the first report of a knemidokoptid mite found in wild passerines in Hawai'i and a new host species for *K.*

*jamaicensis*. Van Riper (1991) conducted a comprehensive survey of the parasite community of 'Amakihi ( $n=1,768$ ), including the microscopic examination of excised foot and facial lesions ( $n=25$ ), but did not detect *Knemidokoptes*. Our site is located 75 km distant from van Riper's study site; however, populations of 'Amakihi nearer to our site ( $\leq 4$  km) have been banded in recent years with no observations of knemidokoptic mange (Atkinson et al., 2005). We therefore believe this mite infestation to be relatively new to our study population.

The transmission of *Knemidokoptes* spp. likely requires direct contact between birds (Jaensch et al., 2003), and interspecies transmission is thought to occur rarely, if at all (Wade, 2006). Kirmse (1966) reported transmission among caged Red-winged Blackbirds but did not observe transmission to nine other species housed with the infested Red-winged Blackbirds. *Knemidokoptes jamaicensis* has been reported from four species of birds introduced to the island of Hawai'i, including Northern Mockingbird (*Mimus polyglottos*; Latta and O'Connor, 2001), Spotted Doves (*Streptopelia chinensis*; Mainka et al., 1994), Eurasian Skylark (*Alauda arvensis*; Kirmse, 1966), and House Sparrow (*Passer domesticus*; Carothers et al., 1974), and a host shift from nonnative species to native avifauna may have occurred. Because direct contact between domestic, captive, or wild introduced birds in Hawai'i and 'Amakihi is unlikely (van Riper and van Riper, 1985), a biting insect is a good candidate for the phoretic transfer of mites to this endemic passerine. For example, louseflies (Hippoboscidae) function as a vector of some skin mites (*Cheyletiellidae* and *Epidermoptidae*) in feral Rock Pigeons (*Columba livia*) in Spain (Jovani et al., 2001). Because the louseflies' feeding behavior entails piercing the host's skin for blood, skin mites may meanwhile attach to flies for their own opportunistic dispersal. Although the hippoboscid (*Ornithoica vicina*) has been

reported from `Amakihi as well as nonnative passerines in Hawai'i (van Riper and van Riper, 1985), hippoboscids were not observed on birds mist-netted in this study.

A severe infestation can be life threatening because of the deformity or loss of digits, resulting in an inability to forage, perch, or preen (Pence et al., 1999). Although a high prevalence of infestation may occur in wild populations, there is no indication that mite infestation has an effect on overall population size (Pence et al., 1999; Latta, 2003). In Hawai'i, introduced avian malaria (*Plasmodium relictum*) and *Avipoxvirus* are thought to have a significant impact on population abundance of many native bird species (van Riper et al., 1986; van Riper et al., 2002). Clinical infestations of *K. jamaicensis* may be a reflection of infection with either or both pathogens. A better understanding of this new parasite–host relationship and effects on host fitness, is needed to assess its risk to Hawaiian avifauna accurately.

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