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black and white ruffed lemur (*Varecia variegata variegata*) and  
Milne-Edwards' sifaka (*Propithecus edwardsi*) in  
southeastern Madagascar**

Stanley E. Vaughn and Elizabeth M. McGee, *Department of Biological Sciences, San  
Jose State University, San Jose, California 95192-0100*

**Association of *Allobosca crassipes* (Diptera: Hippoboscidae) with the black and white ruffed lemur (*Varecia variegata variegata*) and Milne-Edwards' sifaka (*Propithecus edwardsi*) in southeastern Madagascar**

Field research on the relationship between lemurs and their ectoparasites in Ranomafana National Park (RNP, 21°16' S, 47°20' E, elevation 900–1200 m) in southeastern Madagascar has resulted in a new association of the hippoboscid *Allobosca crassipes* (Speiser 1899) with the black and white ruffed lemur (*Varecia variegata variegata* (Kerr 1792)) and a confirmed association with Milne-Edwards' sifaka (*Propithecus edwardsi* (Grandidier 1871)). Previously, Maa (1969) noted host records for the lemurids *Eulemur macaco* (Linnaeus 1766) and *E. rubriventer* (I. Geoffroy 1850), the lepilemurid *Lepilemur mustelinus* (I. Geoffroy 1851), and the indriids *Avahi laniger* (Gmelin 1788) and *Propithecus diadema* (Bennett 1832). Ferris & Cole (1922) collected six specimens of *A. crassipes* from a skin of *Propithecus edwardsi* housed in the collections of the United States National Museum, but did not provide specific locality or specimen information of the host, and the repository of the six flies is unstated and currently unknown.

*A. crassipes*, an obligate ectoparasite restricted to Madagascar, historically has been a little collected species. During San Jose State University expeditions to southeastern Madagascar in 2000–2001, individuals of two lemur species (*V. variegata variegata* and *P. edwardsi*) were tranquilized as part of a larger study investigating the biogeochemical effects of anthropogenic disturbance in lemur populations within RNP (McGee & Vaughn 2007, McGee et al. 2008). Collection methods are in accordance with the protocol approved by San Jose State University's Institutional Animal Care and Use Committee (SJSU IACUC #728). A total of 101 specimens of *A. crassipes* were obtained from *V. variegata variegata* and *P. edwardsi*. Ectoparasites were collected within 30 min of capture using forceps and a flea comb. Specimens were preserved in 80% ETOH. Precautions to prevent host contamination by ectoparasites from different individuals included separation and isolation of lemurs prior and during ectoparasite collection. Cetyl chloride II was used to cleanse and disinfect all examination surfaces.

On 7 December 2000, three hippoboscids were collected from an immature male of *V. variegata variegata* (identified by University of Texas banding collar as Blue Green Group II, a male weighing 5.7 kg) from the Vatoharanana trail system in RNP. The following year, 11 additional hippoboscids were collected between 13 November and 17 November 2001 from five individuals of *V. variegata variegata*: Red Gold II, male, 3.4 kg (3 flies); Yellow Green, male, 3.3 kg (2 flies); Radio I, male, 3.0 kg (2 flies); Red Blue, female, 4.05 kg (2 flies); and Blue Green I, male, 3.85 kg (2 flies) also from the Vatoharanana trail system. A total of 5 male and 9 female flies were collected from *V. variegata variegata*.

The 2000–2001 expeditions also yielded 87 specimens of *A. crassipes* from another species of lemur, *P. edwardsi*, in RNP. These confirm a host record that previously

was noted only from a single museum specimen of *P. edwardsi* by Ferris & Cole (1922).

Since Speiser's (1899) initial identification of an association of *A. crassipes* with the diademed sifaka, *P. diadema*, and Ferris & Cole's (1922) subsequent identification of *A. crassipes* with *P. edwardsi*, the taxonomy of *Propithecus* has undergone significant reinterpretation and rearrangement, which may lead to some confusion about host records. *P. diadema* and *P. edwardsi* were initially described as separate species in the 1800s by Bennett (1832) and Grandidier (1871), respectively. Petter et al. (1977) and Tattersall (1982), however, considered the diademed sifaka and Milne-Edwards' sifaka as polytypics of a single species, *P. diadema*. Following Tattersall (1986), four subspecies of *P. diadema* were recognized (*P. diadema diadema*, *P. diadema edwardsi*, *P. diadema candidus* (Grandidier 1871), and *P. diadema perrieri* (Lavauden 1931)), each distinct phenotypes with nonoverlapping ranges in eastern and northern Madagascar. The use of subspecific designations, however, predates Petter et al. (1977) and Tattersall (1982, 1986); one particularly noteworthy example comes from Bequaert (1953) who refers to an association of *A. crassipes* with *P. diadema edwardsi*. The subspecies designations of *Propithecus* remained in use until Mayor et al. (2004) gave all subspecies specific status on the basis of morphometric and genetic data. Groves and Helgen (2007) supported this classification with additional morphometric data. With *P. diadema* and *P. edwardsi* once again considered distinct species, the associations of Speiser (1899) and Ferris & Cole (1922) are consistent with current taxonomic usage.

Between 19 November and 29 November 2000, flies were collected from seven individuals of *P. edwardsi* from the Talatakely trail system: Turquoise, male, 4.8 kg (1 fly); Blue Blue, female, 5.3 kg (7 flies); Blue Green IV, female, 5.2 kg (2 flies); Blue Purple, male, 5.3 kg (6 flies); "No collar", female, 4.5 kg (9 flies); Pink IV, male, 5.4 kg (4 flies); and Purple IV, male, 4.9 kg (2 flies). The following year on 11 November 2001, flies were collected from three individuals of *P. edwardsi* from the Talatakely trail system: Blue IV, male, 5.3 kg (1 fly); Green Orange I, male, 5.9 kg (4 flies); and "No collar I", male, 2.9 kg (2 flies). A total of 21 male and 17 female flies were collected from *P. edwardsi* at Talatakely.

*A. crassipes* was also collected from *P. edwardsi* along the Vatoharanana and Valohoaka trail systems in RNP. Between 27 November and 5 December 2000, 12 flies were collected from four individuals of *P. edwardsi* from the Vatoharanana trail system: Red I, male, 5.3 kg (1 fly); Green Gold III, female, 5.5 kg (2 flies); Purple Gold III, male, 5.4 kg (2 flies); and Yellow Blue III, female, 5.6 kg (7 flies). The following year, between 12 November and 16 November 2001, 35 flies were collected from eight individuals of *P. edwardsi* along the Vatoharanana trail system: Brown Blue III, male, 5.8 kg (4 flies); Green Gold III, male, 5.0 kg (4 flies); Green Silver I, male, 3.5 kg (6 flies); Green Silver Red II, male, 3.05 kg (1 fly); Pink Silver II, male, 4.60 kg (6 flies); Purple Blue I, male, 5.4 kg (4 flies); Radio I, male, 5.35 kg (9 flies); Radio II, male, 5.90 kg (1 fly). A total of 26 male and 21 female flies were collected from *P. edwardsi* at Vatoharanana. Lastly, on 8 November 2001, specimens were collected from an individual of *P. edwardsi* along the Valohoaka trail system: Pink Blue IV, female, 6.25 kg (2 flies). A total of 2 male flies (no females) were collected from *P. edwardsi* at Valohoaka.

The type specimen of *A. crassipes* referred to by Speiser (1899) is believed to have been destroyed during the World War II bombings of Dresden (N. L. Evenhuis,

personal communication 2009). The 14 specimens taken from *V. variegata variegata* from Vatoharanana represent a new host record in Madagascar. The 87 specimens collected from *P. edwardsi* confirm an association previously identified and add to the record detailed information on localities and host animals. Collected specimens are housed at the J. Gordon Edwards Museum of Entomology at San Jose State University, San Jose, CA 95192-0100.

Maa (1963) commented that host specificity in hippoboscids is moderately high, noting in particular that louse flies are found on unrelated species in similar habitats. However, our documentation of the presence of *A. crassipes* on several species of related lemurs that vary in diet and habitat suggest a different type of host specificity of this parasite. The plasticity of the louse fly is rather remarkable given the differences between ruffed lemurs and sifakas. Ruffed lemurs and sifakas occur sympatrically in eastern Madagascar but have different niches. Ruffed lemurs are obligate frugivores and are patchily distributed in low densities in mid-latitude and lowland rainforests (Garbutt 1999). Ruffed lemurs are behaviorally and demographically highly sensitive to the availability of fruit, particularly in the dry season (Balko & Underwood 2005). Sifakas, in contrast, rely less heavily on fruit, switching to leaves during the dry season (Balko & Underwood 2005). Whereas elsewhere ruffed lemurs and sifakas inhabit primary and secondary forest, in Ranomafana National Park, the black and white ruffed lemur inhabits only primary forest. Milne-Edwards' sifaka is more broadly distributed, inhabiting both primary and disturbed forests. On the other hand, these species have comparable home ranges (i.e., distance traveled for food and cover), and at least half of the fruit species consumed by Milne-Edwards' sifaka are also consumed by species of *Varecia* (Dew & Wright 1998, Arrigo-Nelson 2006). Both *V. variegata variegata* and *P. edwardsi* have been observed to be geophagous (i.e., deliberately ingesting soil). Otherwise habitually arboreal, these lemurs descend to the ground on a regular basis to consume dirt (White 1989, Arrigo-Nelson et al. in press). The geophagous behavior of *V. variegata variegata* and *P. edwardsi* afford the flies increased opportunities for contact and feeding on these hosts. Although *A. crassipes* most likely emerges from the pupa with fully developed wings, the basal membrane is lost after it locates its host (Theodor & Oldroyd 1965). All flies collected in 2000–2001 exhibit significant wing reduction (i.e., are flightless). Finally, differences due to habitat disturbance are likewise not likely to differentiate the distribution or abundance of *A. crassipes*. Wright et al. (2009) found that there was no significant difference in infection intensity of hippoboscids on *P. edwardsi* inhabiting disturbed and undisturbed forests in Ranomafana National Park: on average, 1.25 to 2.48 flies were found on *P. edwardsi* in Ranomafana. Of the two lemur species, *V. variegata variegata* has the most narrow or specialized dietary and habitat requirements. Future study might then focus on characteristics that are restrictive in the life history of the host species, i.e., in the case of *V. variegata variegata*, the distribution and phenology of fruiting tropical trees, that may have played a role in the ecology and evolution of this host-parasite interaction.

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Stanley E. Vaughn and Elizabeth M. McGee, *Department of Biological Sciences, San Jose State University, San Jose, California 95192-0100*

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