Journal of Wildlife Diseases, 46(3), 2010, pp. 1000–1004

Alopecia in Bats from Tabasco, México

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ABSTRACT: We report alopecic syndrome (hair loss in areas of the body, including chest, abdomen, and back) in four frugivorous bat species (*Artibeus jamaicensis*, *Artibeus lituratus*, *Sturnira lilium*, and *Sturnira ludovici*) within urban and periurban areas of Villahermosa, Tabasco, México, during 2007 and 2008. The overall prevalence of alopecic syndrome was 5.25% (135/2,567 bats). The highest prevalence was found in *A. lituratus* (5.6%; 62/1,105), followed by *A. jamaicensis* (5%; 3/1,462). We found a higher prevalence in the dry season, when more than 90% of the alopecic individuals ($n=122$) were captured. Higher prevalence of alopecia was recorded in urban areas (80% of captured alopecic bats, $n=108$) than in periurban areas (20%, $n=27$). Histopathologic studies revealed no evidence of infectious agents. The syndrome may be related to nutritional or endocrinal deficiencies. Spatial and seasonal aggregation in urban areas suggests that anthropogenic activities may interfere with nutritional processes. Further studies are needed to confirm the etiology of the syndrome as well as its impact on population dynamics. This is the first report of alopecic syndrome in sylvatic bats.

Key words: Alopecic syndrome, *Artibeus*, histopathology, *Sturnira*, urban wildlife.

Bats are one of the most ecologically and taxonomically diverse group of mammals and are excellent sentinels for ecosystem degradation. Bat populations have declined more than any other group of mammals (Medellín et al., 2000), and little is known about the effects of anthropogenic activities and global changes on bat health.

Habitat loss and degradation are frequently linked to urbanization. Urban landscapes have increased worldwide resulting in changes to wildlife community structures, including biodiversity loss (Shochat et al., 2006). As a result, invasive species have increased in abundance in urban settings (Medellín, 2000; McKinney, 2002), and remnant native species that persist tend to be synanthropic generalists (Shochat et al., 2006) with a broad habitat tolerance (Bonier et al., 2007). Species inhabiting urban areas face novel stresses, including pollutants, pathogen exposure, and changes in the quality and availability of food and roosting places (Bradley and Altizer, 2007). To understand the effects of urbanization on biodiversity, health, species distribution, and community assemblages, comparative studies between urban and periurban sites are needed. This is especially important in Latin American urban areas where human population expansion is expected to grow in the next 30 yr (United Nations, 2008).

Our aim was to describe the effect of urbanization on bat diversity in a tropical city, during the dry (March–June) and wet seasons (July–February), of 2007 and 2008. We sampled 60 sites (one sampling session per season) in the city of Villahermosa, Tabasco, Mexico (17°59′N, 92°55′W). Sites were located in the city and its surrounding areas (30 sites in urban areas and 30 sites in periurban). Bats were captured using six mist nets (12×2.5 m; Avinet Inc., Dryden, New York, USA). Mist nets were opened at sunset for 5 hr. Data recorded for each bat included sex, weight, measurements, and identification to species level (Medellín et al., 1997; Redondo et al., 2008).

During the fieldwork, we diagnosed alopecic syndrome in four species of frugivorous bats (*A. jamaicensis*, *A. lituratus*, *S. lilium*, and *S. ludovici*). The syndrome was characterized by hair loss, mostly on the chest and abdomen, and in some cases on

the back. Alopecia was found in males and females and was light (1–5 cm^2) to severe (chest and abdomen completely alopecic; Fig. 1).

We captured 2,969 bats of four species. The mean number of bats captured per net was three. The highest prevalence of alopecic syndrome was in *A. lituratus* sp. (5.6%; 62/1,105 bats), followed by *A. jamaicensis* sp. (5%; 73/1,462). Only 1/228 *S. lilium* sp. and 1/174 *S. ludovici* sp. were affected. Because of the small number of alopecic *Sturnira* spp., we only analyzed the results of the two *Artibeus* species.

Using a *G*-test with the Williams correction for small sample size (Sokal and Rohlf, 1995), we found spatial differences for *A. lituratus* and *A. jamaicensis* species, with the highest percentage of alopecic individuals captured in urban (vs. periurban) areas (Table 1). We also found differences between sexes in 2008, but not 2007, for *A. lituratus* and *A. jamaicensis* species, with a higher prevalence in females during the dry season for both species in 2008 (Table 1). The *G*-test does not allow testing simultaneously for seasonal differences related to urbanization for 2007 and 2008. Therefore, we used a χ^2 test for independence (Sokal and Rohlf, 1995). We found seasonal prevalence of alopecic syndrome was not independent of urbanization for either *A. lituratus* or *A. jamaicensis* species (*A. jamaicensis*: $\chi^2=39.9$, df=3, $P<0.001$; *A. lituratus*: $\chi^2=11.9$, df=3, $P<0.01$). Thus, in both species, prevalence of alopecia was higher in periurban areas during the dry season. We also tested for seasonal differences related to sex for 2007 and 2008 using the same test for independence. We found that seasonal prevalence of alopecic syndrome in both species was not independent of sex (*A. jamaicensis*: $\chi^2=17.6$, df=3, $P<0.001$; *A. lituratus*: $\chi^2=13.1$, df=3, $P<0.01$), indicating that the prevalence of alopecic syndrome is higher in females than in males during the dry season.

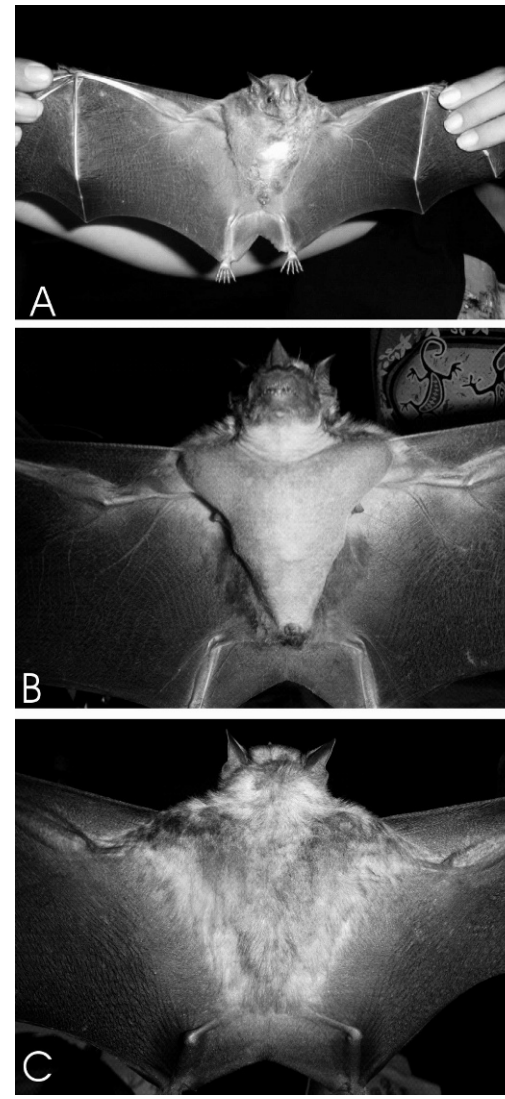

FIGURE 1. Images of alopecic bats captured in urban and exurban areas in the city of Villahermosa, Tabasco, México, 2007–08. (A) A *Artibeus jamaicensis* bat with light alopecia on the chest. (B) A male, *A. lituratus* bat, with severe alopecia on the chest. (C) A male, *A. lituratus* bat, with signs of alopecia on the back.

Histopathologic studies were completed on 10 alopecic bats captured in two trapping events in 2008. Animals were euthanized by an overdose of isoflurane (Abbott Laboratories, Distrito Federal, Mexico) and frozen until studied. Skin, liver, kidney, spleen, and lung samples were fixed in 10% buffered formalin and

TABLE 1. Seasonal, year, and gender variation in the prevalence (percentage) of alopecic syndrome in two bat species in urban and periurban sites in the city of Villahermosa, Tabasco, Mexico. Values in parenthesis are the total number of captured individuals. *G*-value refers to the *G*-test comparing the alopecic bats observed in urban, versus periurban, environments (df=1).[a]

		Artibeus jamaicensis		*Artibeus lituratus*	
Season	Parameter	2007	2008	2007	2008
Dry season	Urban	10.7 (280)	17.5 (160)	8.7 (263)	18 (111)
	Periurban	2.4 (297)	0.9 (109)	3.9 (258)	2.8 (106)
	G-value	17.22**	30.96**	5.18*	13.77**
	Males	4.9 (283)	5.6 (107)	6.7 (193)	4.1 (96)
	Females	7.8 (294)	14.2 (162)	6.1 (327)	15.7 (121)
	G-value	2.18	10.45**	1.47	10.4**
Wet season	Urban	1.4 (221)	0 (106)	2.4 (169)	0 (82)
	Periurban	1.7 (229)	0 (60)	1.2 (162)	0 (58)
	G-value	0.13	NT	0.62	NT
	Males	1.9 (209)	0 (71)	0.7 (153)	0 (73)
	Females	1.2 (241)	0 (95)	2.8 (177)	0 (67)
	G-value	0.13	NT	2.68	NT

* $P<0.05$; ** $P<0.001$.

[a] NT = not tested.

processed to form paraffin blocks. Section (6 μm) were cut and stained with hematoxylin and eosin. Slide tissue samples were examined under a photon microscope. In the skin samples, we found a random absence of hair follicles and sparse hair follicles in the catagen phase. There was no evidence of inflammation, infection, or tumors in skin samples or other histologically examined tissues.

Bat in the genera found with alopecia in this study, *Artibeus* and *Sturnira*, have been recognized as tolerant to habitat fragmentation (Medellin et al., 2000; Galindo-González, 2004) and usually tend to be dominant species in tropical regions. Alopecia in mammals has been attributed to several causes, including parasites and infectious disease; vitamin imbalance; copper, zinc, and iron disorders and deficiencies; genetic diversity loss; mutations; or immunologic disorders (Novack and Meyer, 2009). Fur loss in wild bats has been observed rarely, but when noted, it has been frequently related to ectoparasite infestations or normal physiologic conditions, such as reproductive behavior or molting (Olsson and Barnard, 2009). In captivity, alopecia in bats has been attributed to poor nutrition (Olsson and Barnard, 2009) and is resolved or appears nonspecifically responsive to increases in dietary micronutrients (Heard, 1999). Alopecia in captive bats has been attributed to endocrine disorders (Olsson and Barnard, 2009).

Histopathologic results indicated that infectious agents were not involved in the alopecic syndrome. Differences in the prevalence of alopecic bats in urban and periurban areas suggest that anthropogenic activities may be involved. Several studies have shown species (including mammals, birds, and frogs) inhabiting urban areas may have differences in the prevalence of infectious diseases compared with those inhabiting periurban and rural areas. Also, urban wildlife usually is exposed to higher pollutant concentrations and other stresses (Bradley and Altzier, 2007).

Reproduction and foraging behavior may be a factor in seasonal alopecic cycles. Bats of the genus *Artibeus* are frugivorous and reproduce all year, with peaks in births in June and July (Ortega and Castro-Arellano, 2001). The greatest number of pregnancies, therefore, would be in

April and May, the dry season in Villahermosa, when fruit resources, as in other tropical areas of Mesoamerica, tend to be less abundant. Reproductive activities (pregnancy, lactation, and parental care) in most bats, including *Artibeus*, are the role of the female (Kunz and Hood, 2000; Ortega and Castro-Arellano, 2001). The higher prevalence of alopecic syndrome in adult females suggests that elevated reproductive effort combined with the resource scarcity could be producing nutritional or endocrine disorders. We did not find differences in prevalence of alopecia among the sexes in 2007; this could be related to higher availability of resources in 2007, but we do not have data to corroborate this hypothesis.

Although mist nets were not disinfected between captures, we did not find signs of infection with bacteria, fungi, or other infectious agents or signs of infestation with mites that could be transmitted in the mist nets to other captured bats. Possible causes of alopecic syndrome could be environmental contaminants, endocrine disorders, physical stress, and changes in resource availability and essential minerals, such as zinc and iron, in the urban areas during the dry season. This would have implications for urban planning, land use changes, and waste management that would help protect wildlife health. There are no official records of alopecic syndrome in bats in the wild, with the exception of personal communications, anecdotic reports, notes on the Internet, and occasional reports from Megachiropteran bats in captivity (Heard, 1999). This is the first report, to our knowledge, of alopecic syndrome in bats in the wild. Ecotoxicologic studies are in process, and further studies are needed to confirm the etiology and impact on bat populations.

This research was funded by the SEP-PIFI-Programa de Fortalecimiento de las actividades de vinculación y producción del Cuerpo Académico en Ecología y Conservación de Fauna Silvestre Neotropical. We thank the Universidad Juárez Autónoma de Tabasco for logistic support and the biology and ecology students of the UJAT-DACBiol for valuable help in field. Liliana Suarez made important comments on previous versions of the manuscript.

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Submitted for publication 24 July 2009.
Accepted 12 February 2010.