THERYA NOTES 2022, Vol. 3 : 164-167 DOI: 10.12933/therya_notes-22-90 ISSN 2954-3614

First case of piebaldism in *Eumops auripendulus* in Costa Rica

Primer caso de piebaldismo en *Eumops auripendulus* en Costa Rica

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Pigmentation anomalies are caused either by a deficiency in, or an excess of melanin, resulting in chromatic disorders of the skin and fur or feathers. The anomaly consisting of white spotting has been reported in bats as leucism or piebaldism. We present the first record of piebaldism in *Eumops auripendulus* in Costa Rica. While monitoring bats in urban areas we measured the forearm of all specimens and noted (among other traits) coat color and length of ears. We checked individuals for the presence of glands and assessed the degree of ossification of the epiphyseal plates in the phalangeal joints. On September 13, 2021, we found a dead male *E. auripendulus* in San Ramón, Costa Rica. The forearm measured 57.5 mm, which is within the range of 57 – 63 mm reported for the species. The bat was a juvenile individual with a white spot in the middle of the abdominal region. Similar instances of aberrant coloration have been defined as piebaldism. The record of a piebald *E. auripendulus* is the second one for a molossid bat done in Costa Rica in a total of 6 cases of chromatic disorders. These aberrant colorations could be related to potentially detrimental circumstances; for example, the presence of white spots may be associated with deafness, which in the case of bats would prevent individuals from using echolocation. Knowledge of cases of color anomalies in bats will help to understand the ecological and physiological implications of this condition.

Key words: Chromatic disorder; hypopigmentation; leucism; mammal; Molossidae.

Las anomalías pigmentarias son causadas por deficiencia o exceso de melanina, lo que resulta en alteraciones cromáticas de la piel y el pelaje o las plumas. La anomalía que consiste en manchas blancas se ha definido en murciélagos como leucismo o piebaldismo. Presentamos el primer registro de piebaldismo en *Eumops auripendulus* en Costa Rica. Mientras monitoreamos murciélagos en áreas urbanas, medimos el antebrazo de todos los individuos y notamos (entre otros rasgos) el color del pelaje y la longitud de las orejas. Buscamos la presencia de glándulas y evaluamos el grado de osificación de las placas epifisarias en las articulaciones falángicas. El 13 de septiembre de 2021 encontramos un macho muerto de *E. auripendulus* en San Ramón, Costa Rica. Su antebrazo midió 57.5 mm, que está dentro del rango de 57 – 63 mm registrado para esta especie. El murciélago era un individuo juvenil con una mancha blanca en la región abdominal media. Casos similares de coloración aberrante se han definido como piebaldismo. El registro de piebaldismo en *E. auripendulus* es el segundo para Molossidae en Costa Rica en un total de 6 casos de desórdenes cromáticos. Estos casos de coloración aberrante podrían estar relacionados con circunstancias potencialmente perjudiciales; por ejemplo, la presencia de manchas blancas puede estar asociada a la sordera, lo que en el caso de los murciélagos les impediría utilizar la ecolocalización. El conocimiento de casos de anomalías cromáticas en murciélagos ayudará a comprender las implicaciones ecológicas y fisiológicas de esta condición.

Palabras clave: Hipopigmentación; leucismo; mamífero; Molossidae; trastorno cromático.

Chromatic disorders in wild fauna are pigmentation anomalies caused by a deficiency in or excess of melanin, both of which result in abnormal skin coloration, fur and feathers (Lucati and López-Baucells 2017). Chromatic disorders are due mainly to genetic alterations (Acosta 2007). However, these disorders can also be caused by environmental factors (Nemésio 2001) and even by the type of food ingested by the animals (Fox 1962; McGlothlin *et al.* 2007; Hudon *et al.* 2013). Abnormal colorations, often called color or chromatic aberrations, occur in all groups of vertebrates (Ueida 2000). Many cases of abnormal colorations have not been reported in the scientific literature, particularly in bats in the tropics (Aguilar-López *et al.* 2021). Detailed reports of atypical colorations are important to identify the different groups of animals affected, the types of chromatic disorders, and the distribution of the anomalies.

In mammals, abnormal colorations have been reported in members of various orders (Veloso-Frías *et al.* 2020). Like other mammals, bats are susceptible to genetic disorders that affect pigmentation (Zortéa and Silva 2017). Chromatic disorders are the most frequent type of anomalies recorded in bats (Lucati and López-Baucells 2017; Zalapa *et al.* 2016; Mahabal *et al.* 2019). White spots have been reported in species of 4 bat families of North and Central

America, including bats of the family Molossidae, although some of those cases have been reported as leucism (*e.g.*, Gamba-Ríos 2010; Zalapa *et al.* 2016; Mejía-Quintanilla *et al.* 2017; Escobar-Anleu and Mora 2018). Bats with white spots are piebald (the color aberration affects only a part of the body) rather than leucistic, a condition that results from total or partial lack of pigmentation on the skin or fur of the whole body (Lucati and López-Baucells 2017). A total lack of pigmentation on the whole body is also found in albino individuals, a condition generally characterized by reduced or absent melanin biosynthesis in melanocytes of the skin, coat, and eyes (Oetting and King 1999; Montilla and Link 2022).

Chromatic disorders previously reported in Costa Rican bats involve only 6 instances, in 5 species of the 120 reported for the country (York *et al.* 2019). There was 1 reported case of albinism in *Micronycteris minuta* (Phyllostomidae; Gamba-Ríos 2010), and several others of leucism: 2 in *Carollia sowelli* (Phyllostomidae; Gamba-Ríos 2010; Escobar-Anleu and Mora 2018), 1 case in *C. castanea* (Mejía-Quintanilla *et al.* 2017), 1 case in *C. perspicillata* (Escobar-Anleu and Mora 2018), and 1 case in *Molossus sinaloae* (Molossidae; Zalapa *et al.* 2016). However, based on the description of these chromatic aberrations, it would appear that all these reported cases of leucism represented piebaldism because these bats only presented white spots rather than a lack of pigmentation in the whole body.

The black bonneted bat *Eumops auripendulus* (Shaw, 1800) is distributed from México to Bolivia and northern Argentina, as well as on the island of Trinidad (Simmons 2005). In Costa Rica, this species can be present throughout the country (Barquez *et al.* 2015). *Eumops auripendulus* is a medium-sized bat with a body length of 74 – 100 mm, a tail length of 42 – 64 mm, and a forearm length of 57 – 63 mm (Mora *et al.* 2021). The species inhabits a wide variety of habitats, including dry forests, rain forests, and coastal plains, and presumable feeds on large insects (Reid 2009). Bats fly very high and fast and perch in small groups of up to 15 individuals in tree hollows, cliffs, and building roofs (Mora *et al.* 2018). They are seldom captured in mist nets (Barquez *et al.* 2015). Although *E. auripendulus* is a rare and little-known species, it is classified as Least Concern (LC) by the IUCN Red List (Barquez *et al.* 2015). This species has long, dark reddish-brown or black fur and without long hairs on the rump (Reid 2009). Here, we report a case of piebaldism in a black bonneted bat found in Costa Rica.

As a part of a project on monitoring bats in urban areas, we found a dead bat at the base of a tree trunk near a coffee plantation (Figure 1). The area is located within the Tropical Premontane Rain Forest life zone (Holdridge 1967). This life zone is characterized by the presence of evergreen trees with heights between 30 and 40 m, and an average rainfall of over 4,000 mm of rain per year. The forest canopy has 2 or 3 strata, a very dense understory, and the forest's ground surface is covered by mosses and ferns (Holdridge 1967). We photographed the dead bat and preserved it in

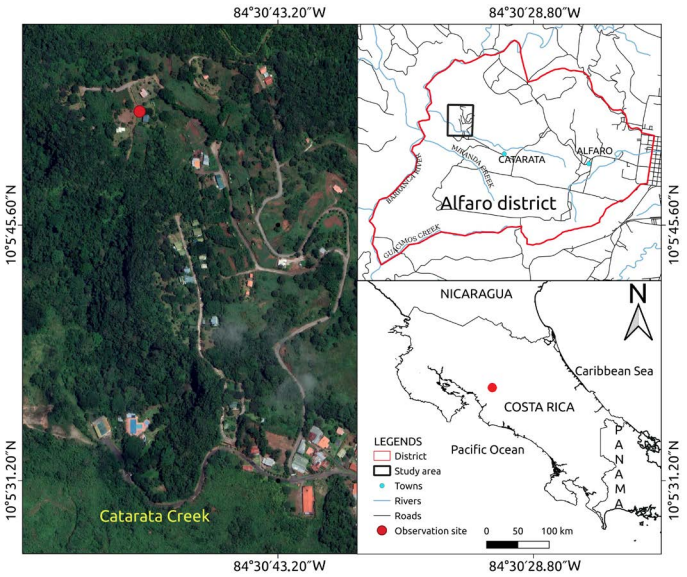

Figure 1. A location where a piebald *Eumops auripendulus* was found dead (red dot) in Cataratas de Alfaro, San Ramón, Alajuela, Costa Rica. Figure made by G. Chaves (Cachí).

alcohol. The specimen was deposited in the Portland State University Museum of Vertebrate Biology (PSU MVB Mammals 5064). We measured the forearm of the individual and evaluated other characteristics such as coat color, length of fur, length of ears, the shape of the antitragus, the presence or absence of long bristles on the rump, and hair on the edge of the calcar. We followed the field keys of Mora *et al.* (2020, 2021), and the reviews of Reid (2009) and Best *et al.* (2002) to determine the species identity of the individual. We checked the individual for the presence of a gular gland and assessed the age of the bat by verifying the degree of ossification of the epiphyseal plates at the phalangeal joints by examining them against the light of a lantern.

On 13 September 2021, we found an individual of *E. auripendulus* in Cataratas de Alfaro, San Ramón, Alajuela, Costa Rica (10° 05' 52" N, 84° 30' 51" W; 988 m). Its forearm measured 57.5 mm, within the range of 57 – 63 mm previously reported for this species. The individual was a juvenile male, with incompletely ossified phalanges and no gular gland. When we examined the bat during the identification process, we noticed a white spot on the lower abdomen (Figure 2), a case of piebaldism as defined above.

White spotting is perhaps the most common chromatic aberration occurring, or at least reported in bats. Zalapa *et al.* (2016) reported 3 species of molossid bats with chromatic aberrations (*M. sinaloae*, *Nyctinomops femorosaccus*, and *Tadarida brasiliensis*). We add the present instance of *E. auripendulus* documented in Costa Rica as piebaldism. It has been suggested that individuals with chromatic aberrations may have problems in conspecific communication, potentially not being able to mate due to the abnormal coloration, or even have greater exposure to predators by standing out among their conspecific group (Martínez-Coronel *et al.* 2020). More importantly, chromatic aberrations could be associated with other potentially harmful effects. For example, the presence of white spots may be associ-

Figure 2. A piebald male *Eumops auripendulus* (PSU MVB Mammals 5064) with a white spot on the fur on the middle of the abdominal region, Cataratas de San Ramón, Alajuela, Costa Rica. Photo: J. M. Mora.

ated with congenital sensorineural deafness (Webb and Cullen 2010), a condition in which disease affects the neural structures of the hearing pathway, which in the case of bats would prevent them from using echolocation. Survival and life expectancy would be severely limited under these circumstances (Martínez-Coronel *et al.* 2020).

We did not find records of any chromatic disorder for *E. auripendulus* within its whole range of distribution. It is only the sixth species reported for Costa Rica with a chromatic disorder, and the second record of piebaldism in the country for bats of the family Molossidae (*M. sinaloae* was reported as a case of white spots without being defined specifically as piebaldism by Zalapa *et al.* 2016).

Molossid bats are much less well known than, for example, phyllostomids, because they are much less commonly captured with mist nets for their study (Kalko and Schnitzler 1998). As a result, reports of chromatic disorders may be biased toward phyllostomids. Species of Molossidae found in Costa Rica generally are dark brown to black in color (Mora *et al.* 2020), thus, it was easy to note the abnormal coloration of the bat we are reporting here. However, the cause of this abnormality is unknown, nevertheless, it may have been influenced by the KIT gene which has been reported as producing the genotypes white spots and general white coloration in laboratory mice (Barsh 2001; Zalapa *et al.* 2016). Its appearance could be related to elevated levels of inbreeding in populations, which would favor mutations that increase the frequency of certain phenotypes (Summers 2009). However, we are unable to indubitably ascertain the direct cause of the abnormal coloration of the black bonneted bat we report here, nor to say whether it played a part in its death. Notwithstanding, the finding of a dead individual marked by piebaldism and no unusual markings certainly is suggestive.

Acknowledgements

We deeply appreciate the help of G. Chaves, he elaborated the Figure 2. J. M. Mora acknowledges E. Rivera, director of Carrera de Gestión Ecoturística, Universidad Técnica Nacional, for continuous academic support. We also express our gratitude to the 2 anonymous reviewers who provided valuable observations to enrich this work.

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Associated editor: Romeo A. Saldaña Vázquez.

Submitted: February 8, 2022; Reviewed: October 18, 2022.

Accepted: November 15, 2022; Published on line: November 22, 2022.