Oecologia Australis
26(4):637–645, 2022
https://doi.org/10.4257/oeco.2022.2604.11

FIRST REPORT AND DESCRIPTION OF MELANISM AND ALBINISM IN GIANT ANTEATER, *Myrmecophaga tridactyla* (XENARTHRA, MYRMECOPHAGIDAE)

Leonardo Cotts[1*] *& Stella Barbara Serodio Prestes*[2]

[1] Universidade Federal do Rio de Janeiro, Campus Professor Geraldo Cidade - Duque de Caxias, Núcleo Multidisciplinar de Pesquisa em Biologia, Estrada de Ferro Xerém, 27, Mantiquira, CEP: 25250-470, Duque de Caxias, RJ, Brasil.

[2] Instituto Federal de Educação, Ciência e Tecnologia do Rio de Janeiro, Campus Nilópolis, Rua Lúcio Tavares, 1045, Centro, CEP: 26530-060, Nilópolis, RJ, Brasil.

E-mails: cottsleon@gmail.com (*corresponding author); telababi@gmail.com

Abstract: *Myrmecophaga tridactyla*, the giant anteater, is a monospecific genus of anteater endemic to South and Central America. This species is marked by a predominantly brown or black coat, with anterolaterally elongated black and white stripes in its body and anterior black bands on its forelimbs. Chromatic variations are so far unknown for this species. Herein, we report and describe the first formal records of melanism and albinism in *M. tridactyla* and discuss the possible causes and environmental relationships of these color anomalies in the species.

Keywords: chromatic disorders; hyperpigmentation; hypopigmentation; Mammalia; Pilosa

Myrmecophaga tridactyla (Pilosa, Myrmecophagidae), the giant anteater, is a monospecific genus of anteater present in a broad range of lowland habitats, from dry scrub and savannah to rainforests, distributed in southern Central America and northern South America, from Honduras to Bolivia and northern Argentina (Gaudin *et al.* 2018). This species is characterized by a large size, a very elongated and tube-shaped rostrum, the presence of a thicker braincase, small eyes and ears, a forelimb musculature strongly developed and adapted for plantigrade terrestrial locomotion, three well-developed claws on the *manus*, with its unguals on the 4th and 5th digits being strongly reduced or absent, and little sexual dimorphism (Reeve 1940, Eisenberg *et al.* 1999, Medri *et al.* 2006, Gaudin *et al.* 2018).

Myrmecophaga tridactyla presents a brown or black dense coat color, with predominate brown in its tail, and elongated and triangular blackstripes bordered by white stripes located anterolaterally in its body (Medri *et al.* 2006). The stripes beginning just below the ears, expand in the anterior portion of the neck and extend diagonally backwards above the shoulders, becoming gradually thinner up to the mid-back. Two black bands are seen anteriorly on the forelimbs, and the hair on these limbs is commonly white or grizzled (Caro & Melville 2012). Studies on chromatic disorders in *M. tridactyla*, as far as we are aware, are unknown. In fact, melanism and albinism are known for many mammal species such as rodents (*e.g.*, *Oxymycterus dasytrichus* [Stumpp *et al.* 2018], *Proechimys* sp. [Dalapicolla *et al.* 2020]), tapirs (*e.g.*, *Tapirus terrestris* [Tokuda *et al.* 2021]), mustelids (*e.g.*, *Eira barbara* [Aximoff & Rocha 2016]), felids (*e.g.*, *Leopardus colocola braccatus* [Aximoff *et al.* 2021]), canids (*e.g.*, *Canis lupus* [Anderson *et al.* 2009]) and marsupials (*e.g.*, *Didelphis virginiana* [Cuxim-Koyoc *et al.* 2019)]). In anteaters, melanism and albinism records are few and restricted to the genus *Tamandua* (Ríos *et al.* 2019, Ríos-Alvear & Cadena-Ortiz 2019). Here we report and describe the first formal

records of two chromatic disorders, melanism and albinism, for *M. tridactyla* based on photographs reported in two informal media (web portal and communication from the Environmental Military Police) and unknownledged in the scientific literature.

The first chromatic disorder is the albinism, which is a hypopigmentary genetic disorder commonly associated with TYR gene mutations, which affects the production of melanin and causes the reduction or absence of pigmentation in eyes, skin and hair/feathers of vertebrates (Fertl & Rosel 2009). In fact, albino animals have, as one of the most remarkable characteristics, the presence of translucent irises and retinas, with reddish or pink eye coloration due the translucent condition of their ocular structures. This makes visible the blood vascularization in the posterior portion of the eyes (van Grouw 2006, Cuxim-Koyoc *et al*. 2019, Dunlop *et al*. 2019). Albinism is distinct of other hypopigmentation disorders, such as leucism (depigmentation in whole body), piebaldism (partial depigmentation with marked white spots) and "flavism" (depigmentation with predominance of red and yellow tones) (Lucati & López-Baucells 2017, Zortéa & Silva 2018). In these anomalies, only parts of animal's body are affected and decoloured, whereas eyes, nails and skin preserve the typical coloration of the species. We add that "flavism" is a confusing terminology and should be avoided. In fact, Scorer (1980) proposed that a low concentration of eumelanin causes the disorder known as erythrism, whereas a very low concentration causes flavism. However, currently "flavism" is attributed to any individual with a reddish or yellowish coloration in the tegument, without a clear criterion for this definition. Due to this ambiguity, we recommend the use of erythrism (reddish coloration gradients) and xanthochromism (yellowish coloration gradients) instead of this terminology, as used by other authors (*e.g.*, Palacios-Salgado & Rojas-Herrera 2012, Pirie *et al*. 2016).

The albino individual of *M. tridactyla* here reported was found in the Barra Bonita Farm (21° 1' 36.84" S, 52° 5' 5.27" W) near the district of Arapuá, Municipality of Três Lagoas, state of Mato Grosso do Sul, Brazil, on August 02, 2021 (Figure 1). The photograph of this individual was initially published in a local news portal (Arapuá News, link: https://arapuanews.com.br/tamandua-alpino-raro-e-encontrado-em-fazenda-da-regiao-de-arapua/). This is a young individual with a mostly white coloration in its coat, with the exception of elongated and yellowish-white hairs that extend in the dorsal, caudal and lateroventral portions of its body and form a dense coat similar to a "mane" (Figure 2). In fact, this "mane" appears to be more voluminous and denser than what is observed in non-albino individuals of *M. tridactyla*. The skin of the albino individual has a very evident pinkish-white color, observable mainly on their head, ears and nostrils, which have regions with very short or absent hair. The head of this individual has hypopigmented and irregular spots, dispersed mainly in the mid-portion of its rostrum and in the region adjacent to its eyes. The eyes, in turn, are also hypopigmented, showing a marked pinkish iris.

The second chromatic disorder is the melanism, often caused by an increase or independent expression of eumelanin, responsible for the production of brown or black pigments, which results in the dark coloration typical of this disorder (Majerus & Mundy 2003, van Grouw 2017). The melanistic individual of *M. tridactyla* was photographed by the Environmental Military Police of Mato Grosso do Sul during a wildlife rescue on September 17, 2015 (Figure 1). This individual is also a young of *M. tridactyla* found hit by a car on the BR-262 highway (20° 27' 9.49" S, 54° 50' 44.34" W), in the Municipality of Terenos, state of Mato Grosso do Sul, Brazil. After the rescue, the individual was taken to the Wild Animal Rehabilitation Center of the Environment Institute of Mato Grosso do Sul (CRAS-IMASUL). This individual has dense and black hair on the dorsal and lateral portions of its body, whereas the ventral portion has very dark brown hairs (Figure 2). The head of this individual has a brown coloration throughout its lateral and inferior portion, which communicates with the ventral brown hairs of the neck and extending to the lateral surface adjacent to the nostrils. The upper portion of the head has a black coloration, continuous with the black hairs on the back and extending to the region close to the upper portion of the nostrils. A light brown stripe extends from the latero-superior portion of the head just above the eyes to the mid-portion

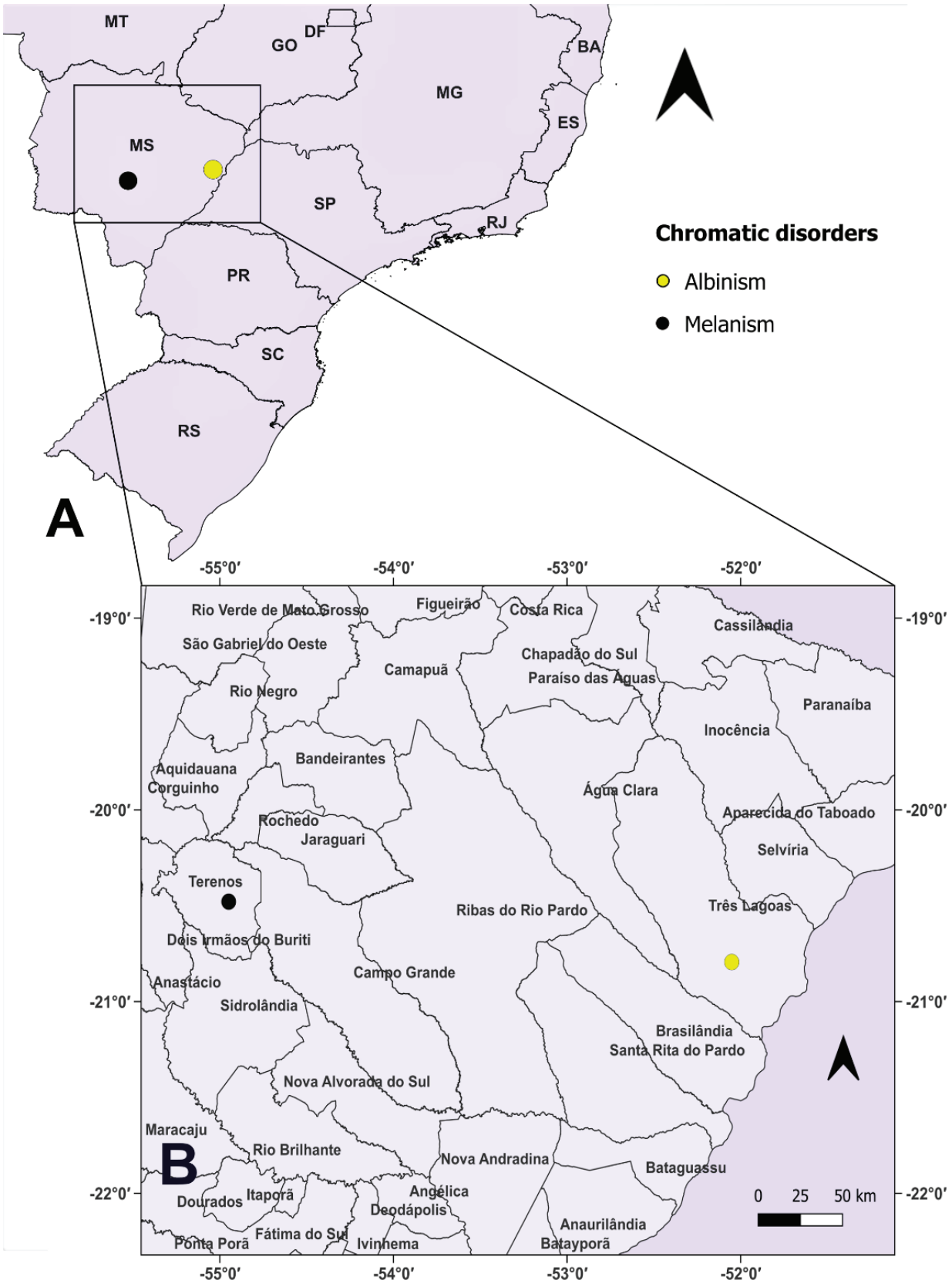

Figure 1. Record locations of the melanistic and albino individual of *Myrmecophaga tridactyla* (Pilosa, Myrmecophagidae) in Brazil (A), with location points highlighted in the state of Mato Grosso do Sul (B).

Figure 2. Albino (A, B) and melanistic (C) individuals of *Myrmecophaga tridactyla* (Pilosa, Myrmecophagidae). Photos reproduced with permission by Portal Arapuá News (albino *M. tridactyla*) and Batalhão de Polícia Militar Ambiental do Mato Grosso do Sul, Brazil (melanistic *M. tridactyla*).

of the rostrum, with its coloration being most evident in the mid-posterior portion of the head. The palpebral perimeter of the eyes and the helix of the ears of this individual are also light brown. The claws of the *manus* of this individual are pale black (Figure 2). The *pes*, in turn, could not be observed due to the position in which the animal is in the photographic record. The tail hairs of this individual are slightly lighter black than the rest of the body.

Cases of albinism and melanism in anteaters are rare (*e.g.*, Ríos *et al.* 2019, Ríos-Alvear & Cadena-Ortiz 2019) and poorly studied. Some causes have been correlated with the emergence of albinos in vertebrate populations, such as alterations in diet, environmental contamination (*e.g.*, radiation), habitat fragmentation, inbreeding and, consequently, low genetic diversity (Møller *et al.* 2013, Espinal *et al.* 2016, Cuxim-Koyoc *et al.* 2019). Albino mammals have morphophysiological characteristics that are harmful to their survival, such as high sensitivity to sunlight in their skin and eyes. In fact, the absence of pigmentation in the eyes of albinos contributes to a progressive loss of vision, commonly leaving them nearly blind (Edmunds 1949, Pérez-Carpinell *et al.* 1992, Ríos *et al.* 2019). Albinism is a chromatic disorder rarely found in mammals, with abundant taxonomic groups (*e.g.*, Rodentia) presenting less than 2% of individuals with this condition (Dalapicolla *et*

al. 2020). Melanism, in turn, is often attributed to other species of anteaters, such as *Tamandua tetradactyla* (*e.g.*, Wetzel 1975, Ríos *et al*. 2019). This anomaly is more often in mammals than the albinism and may be found in 20% of individuals in some populations (Caro 2005). The occurrence of melanistic individuals in mammal populations has been correlated with some environmental disturbances, such as deforestation and wildfires, and variation in vegetation structure, as tree density (Caudill & Caudill 2015). The persistence of melanism in some mammal populations indicates a benefit of this condition for the survival of these groups, being favorable mainly for the crypsis and thermoregulation of these animals (Ciurej *et al*. 2019). Indeed, dark coloration is presumed to have a positive correlation with darkened substrates, offering an adaptive advantage for camouflaging predators (*e.g.*, *Canis latrans* [Caudill & Caudill 2015]) as well as prey (*e.g.*, *Peromyscus maniculatus* [Majerus & Mundy 2003]) in forested habitats. However, in *M. tridactyla*, albinism and melanism seem to be occasional and uncommon cases in their populations.

The albino individual of *M. tridactyla* is geographically separated from the melanistic individual by a distance of ca. 355 km, being sighted in a transition region between the Cerrado and the Pantanal. This region has been afflicted by strong anthropogenic impacts, including frequent wildfires, deforestation and inadequate landscape management, leading to the death of a large number of vertebrates (Oliveira-Júnior *et al*. 2020, Tomas *et al*. 2021). We hypothesized that the albino individual of *M. tridactyla* is an indicator of recurrent impacts in this region, possibly being derived from fragmented populations and inbreeding between animals surviving these catastrophic events. Collevatti *et al*. (2007) observed a low level of polymorphism and high levels of inbreeding in a population of *M. tridactyla* in Emas National Park, Brazil. These authors comment that the reduction in population size and the isolation of the remaining population due to agricultural expansion and fragmentation of environments may have led to a higher frequency of crosses between relatives in the park areas. This information reinforces the possibility that the albino individual presented here comes from a population subjected to similar events of fragmentation, isolation and frequent inbreeding. The melanistic individual of *M. tridactyla*, in turn, comes from a Cerrado region closer to closed forest areas belonging to the Atlantic Forest. Considering the presence of this individual in an area with frequent anthropogenic impacts, such as wildfires and fragmentation, we consider two hypotheses for the appearance of the melanistic phenotype: 1) The occurrence of melanism is derived from mutations caused by isolation and population size reduction, possibly of individuals of a restricted population of dense forest; 2) Melanism is an adaptive response to frequent wildfires in the Pantanal and Cerrado regions. Some studies comment on the possibility of wildfire areas influence abundance of melanistic mammals in other countries (*e.g.*, Guthrie 1967, Pausas & Parr 2018), with these animals having specializations for survival in the burned and darkened substrate (*e.g.*, black squirrels; Schorger 1949, Creed and Sharp 1958, Guthrie 1967, Kiltie 1989). In this context, darker coat and skin would favor crypsis in wildfire-burned areas. However, the record of only one melanistic individual reported in this study does not favor this hypothesis. In fact, further studies on chromatic disorders in *Myrmecophaga*, as well as in other anteaters, are needed to understand the origin of these anomalies in anteaters. In addition, the continuous recording of chromatic disorders in anteaters will make it possible to test the use of these anomalies as indicators of environmental and climatic disturbances.

ACKNOWLEDGMENTS

The authors are grateful to the Environmental Military Police of Mato Grosso do Sul, mainly Lieutenant Colonel Ednilson Paulino Queiroz, and the staff of the website "Arapuá News" for their contribution and permission to use the photographs of the melanistic and albino individuals, respectively, in this manuscript.

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Submitted: 13 July 2022
Accepted: 13 October 2022
Published online: 24 October 2022
Associate Editor: Ana Cláudia Delciellos