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First report of complete albinism in *Mazama americana* (Erxleben, 1777) in the Biological Reserve of Tapirapé, Oriental Amazon, Brazil

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ABSTRACT. Albinism is a genetic condition that results in total hypopigmentation of the eyes, fur, skin, hair, scales, and feathers of an organism. Albinism might result in a selective disadvantage for affected animals. Cases of albinism have been previously recorded in Neotropical vertebrates, such as reptiles, mammals, birds, and fish. However, observing albinism in a wild population is still considered to be a rare event. This paper reports a unique case of complete albinism in a red-brocket deer (*Mazama americana*) living in the Brazilian Amazon rainforest. The individual was observed within the Biological Reserve of Pará State, one of the most deforested regions of the Brazilian Amazon. The survival of the albino red-brocket deer in the wild can be related to mechanisms of apostatic selection, which theorize the survival of individual prey animals whose mutations make them less likely to be attacked by predators. In other words, the more different a prey animal is from others, the less likely it will be targeted by predators. The high abundance prey animals within the Biological Reserve of Tapirapé seems to support this prediction. This report exemplifies the importance of monitoring the biodiversity and promoting the conservation of favorable habitats to support species multiplicity in highly fragmented regions, as in the Brazilian Amazon.

Keywords: apostatic selection; camera-trapping; cervids; hypopigmentation; Pará State.

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Introduction

Albinism is a group of genetic conditions passed from parents to offspring through a recessive gene that results in hypopigmentation of the eyes, scales, hair, feathers and skin. The degree of albinism varies among animal groups. Researchers working with mammals estimate that true albinos occur with a frequency of about one in 10,000 births (Binkley, 2001). Some factors can increase the chances for albinism, such as inbreeding among small isolated populations or between closely related individuals (Caro, 2008). Albinism can be defined in different ways depending on the magnitude of the hypopigmentation. Complete or true albinism is characterized by a complete lack of melanin. This results in pale skin, white fur, and pink eyes (Summers, 2009). Partial albinism occurs when pigmentation is reduced or absent from the integument, feather, scales or eyes. Animals with partial albinism have the capability to produce a limited set of colors (Berdeen & Otis, 2011). Leucism is frequently reported as synonymous with partial albinism. However, in contrast to partial albinism, leucism is controlled by a single recessive allele, and leucistic animals retain the pigmentation of their eyes, bills, and legs. That said leucistic animals have no pigmentation in their skin or plumage (Forrest & Naveen, 2000).

Some pathologies are associated with albinism and partial albinism. These include visual disorders (Creel, Summers, & King, 1990; Prusky, Harker, Douglas, & Whishaw, 2002) and immunodeficiency (Griscelli et al., 1978). Some researchers believe that albino and leucistic wild animals are more visually conspicuous and may lack critical species-specific camouflaging patterns. Thus, albinism may increase the likelihood of being preyed upon, confer a disadvantage in hunting, and disrupt the process of attracting

mates (Acevedo, Aguayo-Lobo, & Torres, 2009; Uieda, 2000). Poor eyesight is another disorder associated with albinism. Hypopigmentation of the eyes affects visual acuity and may prevent albinos from finding food or avoiding threats (Gronskov, Ek, & Nielsen, 2007).

Both albinism and leucism have been recorded in many species of Neotropical vertebrates, including small mammals (Brito & Valdivieso-Bermeo, 2016; Romero, Racines-Márquez, & Brito, 2018), bats (Abreu, 2013; Martinez-Coronel, 2013), reptiles (Mira-Mendes et al., 2017), birds (Nogueira & Alves, 2011; Zilio, 2013), and fish (Brito & Caramaschi, 2005; Nobile, Souza, Lima, Acosta, & Silva, 2016). That said, albinism remains a rare event within wild populations.

Here, a new case of total albinism is recorded and detailed for *Mazama americana* (Erxleben, 1777) within the Biological Reserve of Tapirapé. This reserve lies within one of the most vulnerable areas of Pará State, the so-called Amazon arch of deforestation.

Material and methods

Over the last two years (2016-2018), a monitoring program for medium and large mammals has been active within the Biological Reserve of Tapirapé (REBIOTA), a Conservation Unit of Integral Protection Program located at Marabá municipality, Southeast of Pará State, Brazil (Figure 1).

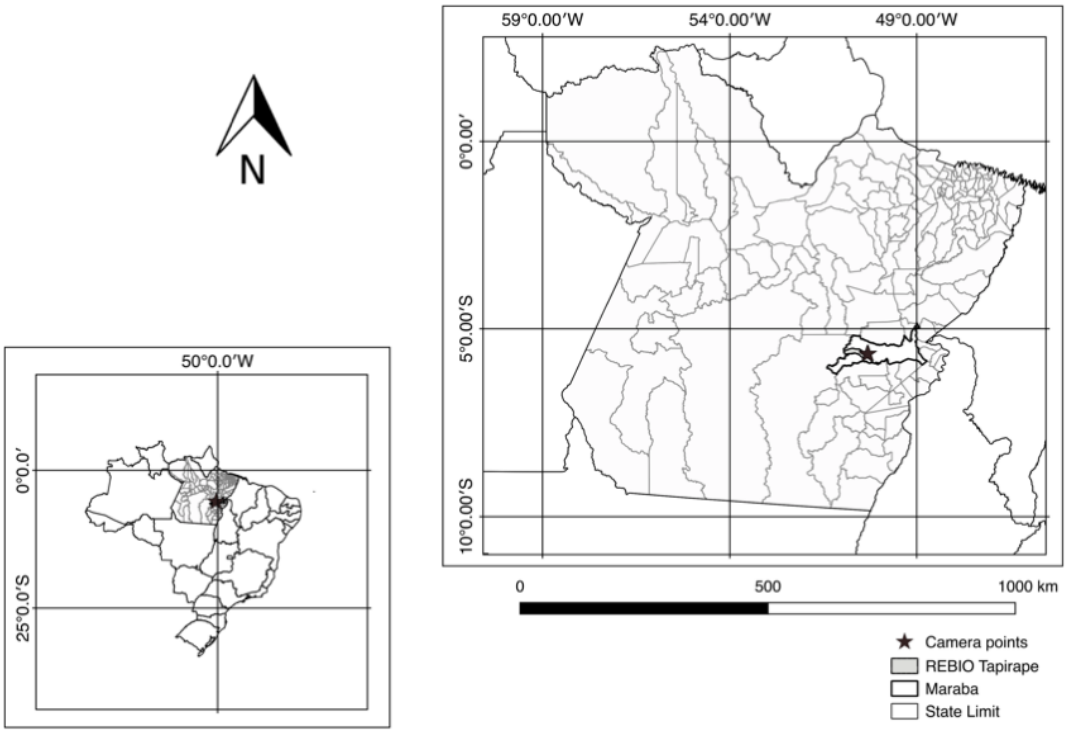

Figure 1. Map of Biological Reserve of Tapirapé, located in Marabá, Pará, Brazil

The research project consists of two sampling periods, each with an average of 60 days, in both wet and dry seasons. A set of ten camera traps was positioned along two trails five kilometers in length within the Amazonia lowland forest. Cameras were typically positioned at a height of 30-50 cm above the ground and were angled to maximize the field of view. In order to maximize the efficiency of the equipment, each camera was spatially separated by at least 1 km from the next camera. Cameras operated 24 hours a day, seven days a week during all sampling periods.

All images were analyzed for species identification purposes using specialized literature (Emmons & Feer, 1997; Paglia et al., 2012) and expert researchers. We considered images of each species from a given camera in an one-hour-period to be independent records (Tobler, Carrillo-Percastegui, Pitman, Mares, & Powell, 2008). All the photographs were catalogued and deposited in the Zoological Collection at the *Universidade Federal do Sul e Sudeste do Pará*. The research was performed in accordance with ICMBio authorization (number 52979-1/SISBIO).

Results

Mazama americana is a species commonly observed within the REBIOTA. During the sampling period, at least 60 independent records of *Mazama americana* were obtained. These animals are evasive and were frequently observed alone. Only during the mating season were these deer observed with other members of its species, presumably its partner.

The dominant color is reddish-brown for most body parts. The neck and face are typically grey. The inner parts of limbs and tails are usually white; as are the submandibular area, the tip of the maxilla, and the inner edge of the ears. Hind legs are black on the posterior with the anterior being various shades of black (Figure 2). Despite the low levels of morphologic differentiation, the *Mazama* species show extensive genetic variation, with at least two evolutionary units (independent species) being recognized with respect to karyotypes and mitochondrial DNA sequences (Abril, Carnelossi, González, & Duarte, 2010).

Figure 2. A typical female specimen of *Mazama americana* observed during the rainy season at the Biological Reserve of Tapirapé, Marabá, Pará, Brazil.

The abnormal *Mazama americana* specimen was photographed alone, near the transect on October 11th, 2017 at 1:54 pm (Figure 3), and again on June 23rd, 2018 at 11:44 pm (Figure 4). Both sightings occurred at the geographic coordinates 50º 20' 25.4"W; 5º 42'' 30.48''S. Although we recorded the animal on two different occasions, we preferred to be conservative and consider the records as a single specimen due to the low probability of finding two albino animals in the same area. However, it is not impossible that the photographs represent two distinct individuals of albino deer.

Figure 3. The first observation of an albino *Mazama americana* at the Biological Reserve of Tapirapé, Marabá, Pará, Brazil. This photograph was taken during October 2017. Note the complete white color of fur, legs, ears, nose and red eyes.

Figure 4. Albino *Mazama americana* recorded during the rainy season at the Biological Reserve of Tapirapé, Marabá, Pará, Brazil. The individual was registered in June 2018.

The observed, albino individual is a young male, presenting white color all over the body, including all legs and both sides of the tail. The deer exhibits an unpigmented snout and posterior sides of the ears, while also presenting red eyes, a distinctive characteristic of an albino animal. Its movement and activity seem normal and there are no signs of scarring or injuries on its body.

Discussion

A total albino *Mazama americana* has never observed with photographic evidence in Brazil before. There are only two brief communications about leucistic cervids, both reported at least 20 years ago, and one more recent paper reporting partial albinism in *Mazama gouazoupira* (Oliveira, 2009). A partial albinism case in *Ozotocerus bezoarticus* (Linnaeus, 1758) was reported in Emas National Park - Cerrado domain, Central Brazil (Rodrigues, Silveira, Jácomo, & Monteiro-Filho, 1999). Rovedo reported a sighting of an albino *Mazama americana* in the Atlantic Forest of Paraná State, South of Brazil (Veiga, 1994).

Currently, the relative predation rate of albino prey animals to normally pigmented prey animals is actively debated with the research community. (Mueller, 1975; Sazima & Pombal, 1986; Smallwood, 1987). Some authors defend the inexistence of differential predation rates for albino versus normal-pigmented prey (Balgooyen, 1971; Troncone & Silveira, 2001). Moreover, it is believed that for some prey animals, unusual coloring might be an evolutionary advantage. This perspective calls on frequency-dependent selection theory or the apostatic mechanism of selection (Clarke, 1962). The author argues that if there is a positive relationship between the prey type frequency and predation rates, then the rare prey type is favored. In other words, the more different a prey animal is from others, the less likely it is to be killed. Considering that there are no distinguishable, morphological differences between normally-pigmented *Mazama americana* specimens; and that their predators are visually oriented to search for a stable phenotype (Bond, 2007), the absence of color could be interpreted as a significant difference sufficient to avoid predation.

The opposite of apostatic selection is negative selection, which favors the most common alleles or phenotypes (Greenwood, 1985). According to this selection theory, the most common phenotypes are favored in detriment of the rarest ones. It is possible that albino animals are more visible, or more conspicuous, due to their unusual pigmentation. In their studies with fish (Sazima & Pombal, 1986) and vipers (Sazima & Di-Bernardo, 1991) suggest albino animals exhibit a higher probability of success when they display nocturnal habits or efficient defense strategies. However, these do not apply to cervids such *Mazama americana*, since they are both diurnal and nocturnal, and demonstrate a low-harm power, anti-predation strategy against their specialized predators, like jaguars and pumas.

The existence of a large, albino mammal in REBIOTA is a rare event that calls into question its ability to survive and avoid predation. The closed vegetation environment is beneficial to the albino animal as it offers protection from the deleterious effects of sunlight and provides ample feeding opportunities. Another explanation for its persistence in REBIOTA is the high population number of *Mazama americana* and *Mazama nemourivaga* (Cuvier, 1817) cervids, which makes the likelihood of encountering an albino deer less likely. In addition, there are large population densities of peccaries, anteaters, tapirs and agoutis, which are

also preyed upon by the same predators which hunt *Mazama* species. Such a large number of prey animals make the selection of an albino animal by a predator less likely, thus favoring its survival. Had only a small number of other prey species been available, the risk of predation for albino *Mazama americana* individuals would increase significantly. In fact, the presence of an adult, albino deer is evidence of ecosystem equilibrium; and indicates that the multiplicity of prey species is a key factor in maintaining high levels of biodiversity, including specimens with rare, genetic characteristics.

Conclusion

The survival of an albino red-brocket deer in the wild habitat can be related to mechanisms of apostatic selection, which may favor the rare prey type. In other words, the more different a prey animal is from others, the more likely is not to be killed. The high abundance of prey species within the Biological Reserve of Tapirapé seems to support this notion. This report emphasizes the importance of biodiversity monitoring and the conservation of favorable habitats with high levels of prey species multiplicity in highly fragmented regions, such as the Brazilian Amazon.

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