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Leucism in rodents: the first record for the mocó (*Kerodon rupestris* Wied-Neuwied, 1820), a rodent endemic to Brazil

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ABSTRACT
Leucism is a skin color disorder that causes a total white or whitish coloration of the skin or parts of the skin of the affected individual. In the present study, we present the first record of leucism in mocó *Kerodon rupestris*. The animal was observed twice in a rocky outcrop inside a Caatinga forest on November 2020 and April 2021. To date, this is the first record of leucism in any rodent species of the Family Caviidae. The long-term isolation of populations limits the flux of individuals, reduces genetic variability, and increases the chance of the occurrence of leucistic individuals.

Keywords: hypo-pigmentation, mocó, skin coloration disorder

RESUMO - Leucismo em roedores: primeiro registro para o mocó (*Kerodon rupestris* Wied-Neuwied, 1820), roedor endêmico do Brasil

Leucismo é um distúrbio da cor da pele que causa coloração totalmente branca ou esbranquiçada na pele ou partes da pele do indivíduo afetado. No presente estudo, apresentamos o primeiro registro de leucismo para um mocó *Kerodon rupestris*. O animal foi observado em um afloramento rochoso dentro de uma mata da Caatinga em novembro de 2020 e abril de 2021. Até o momento, este é o primeiro registro de leucismo para qualquer espécie de roedor Caviidae. O isolamento prolongado das populações limitou o fluxo de indivíduos, reduzindo a variabilidade genética e aumentando a chance de ocorrência de indivíduos leucísticos.

Palavras-chave: distúrbio da coloração da pele, hipopigmentação, mocó

Leucism is a skin color disorder caused by a reduction in melanin pigment in the skin and epidermal-derived features, such as scales, feathers, or hairs (Miller 2005;

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Acevedo & Aguayo 2008). Individuals with this disorder have partial or total white or whitish coloration (Jehl 1985; Fertl & Rosel 2002; Acevedo & Aguayo 2008). This condition, however, does not change the color of the mucosa or eyes (Fertl & Rosel 2002; Miller 2005). Such disorders have been recorded in many vertebrate groups, as fish (e.g., Clark 2002; Quigley et al. 2018), amphibians (e.g., Lunghi et al. 2017; Mitchell & Church 2002), reptiles (e.g., Krecsák 2008; Entiauspe-Neto et al. 2018; Silva et al. 2020), birds (e.g., Comisso 2012; Atauchi 2015; Cadena-Ortíz et al. 2015; Cavarzere & Tonetti 2015; Corrêa et al. 2017), and mammals (e.g., Rodrigues et al. 1999; Oliveira, 2009b; Abreu et al. 2013).

Similar to other groups, the natural coloring of mammals is important for their survival. It is mainly related to camouflage, preventing predation, and/or increasing foraging success (Miller 2005; Pough & Janis 2018). On the other, leucistic and albino individuals face challenges to their survival, as they are more visible to predators or prey (Owen & Skimmings 1992; Camargo et al. 2014). Such individuals may decrease survival success due to the ease of sighting affected individuals (Camargo et al. 2014) or a negative effect on social interaction (Oliveira 2009a). However, some individuals reach the adult age and reproduce (Arriaga-Flores et al. 2016), which can affect the frequency throughout the population (Hofmeester et al. 2021). Although uncommon, leucism and albinism have been observed in many mammalian taxa, such as Marsupialia (Abreu et al. 2013; Ortiz-Hoyos et al. 2020; Gorta et al. 2021), Carnivora (Arriaga-Flores et al. 2016; Talamoni et al. 2017; Descalzo et al. 2021), Chiroptera (Rocha et al. 2013; Romano et al. 2015; Fernández de Córdova et al. 2017), Primates (Aximoff et al. 2020; Barros-Diaz et al. 2022), and Rodentia (Oliveira 2009a; Camargo et al. 2014; Samson et al. 2017; Mejía-Valenzuela 2019; Beninato et al. 2020), among others.

Rodentia is the most diverse order among mammals, with about 2,470 species belonging to 512 genera (ITIS 2022; IUCN 2022). Leucism and partial albinism have been reported in species belonging to some taxa, without any known records for the genus *Kerodon*, Caviidae Family. This Family comprises six genera, all of which are typically robust, with large heads, short ears and limbs (except for *Dolichotis*), no tail (except for *Dolichotis*), generally long-lived, and a variety of social systems from monogamous to promiscuous (Dunnum 2015). Typical *Kerodon* individuals have agouti coat coloration (Fig. 1). Its coat is grayish-yellow or grayish-orange, spattered with white and black hairs with shades of yellowish (hind); having white, yellow, and gray chin, throat, and belly, respectively, and brownish posterior parts of the hindlimbs and feet (Bonvicino et al. 2008; Oliveira & Bonvicino 2011).

Here, we present the first record of a leucistic mocó or rocky cavy, *Kerodon rupestris* Wied-Neuwied, 1820. The species is endemic to Caatinga and Brazil and is considered as Vulnerable to extinction according to the Brazilian Environmental Ministry (MMA 2022) and Least Concern according to the IUCN (Catzeflis et al. 2016).

Observations were made opportunistically and took place in an area of native forest (mandatory forest reserve) at Fazenda Lagoa do Capim (latitude -10.01819;

longitude -37.47264; WGS84), municipality of Porto da Folha, Sergipe, Northeastern Brazil. The study site is part of the Caatinga Biome. The local climate is between *As* and BSh, according to Köppen (i.e., between a tropical savanna and a semi-desert; Alvares et al. 2013), with dry summers (September to April) and rainy winters (May to August). The mean annual temperature is 26˚C, and the annual precipitation is lower than 1,000 mm. The forest reserve has ca. 70 ha with predominantly arboreal vegetation and a dense shrubby understory. Some rocky outcrops were observed throughout the forest. The matrix was mainly composed of pastures and seasonal corn plantations. Mocós are commonly observed in rocky outcrops, which is a typical microhabitat for this species (Patton et al. 2015).

We observed the leucistic individual twice, on November 11, 2020, and April 15, 2021 (Fig. 2). Considering the distance between sightings (ca. 50 m), we believe it is the same individual. It has a white coat color, with a whitish-yellow color in the hind limbs. The eyes are dark brown, which guarantees that it is a leucistic individual. As usual, the animal avoided the observer from approaching, limiting the appreciation of any specific detail beyond the photographic record. The animal was observed in three rocky outcrops separated by a maximum distance of ca. 50 m. Occasionally, the individual fled to the nearest rocky refuges as soon as it became aware of the observer's presence.

Among the 75 records of leucism for the order Rodentia, this is the first report of any species of *Kerodon* (Table 1). Among the rodent families, Cricetidae had the highest frequency (n=44; 58.7%), followed by Sciuridae (n=17; 22.7%), Muridae (n=6; 8.0%), and Dasyproctidae and Echimyidae (both n=2; 2.7%). Each of the other rodent families, including the Caviidae (present study), presented a single record (Table 1). The higher frequency of Cricetidae may be related to its high species richness. Despite reports of albinism in the Family Caviidae (Dunn 1921; Ramirez et al. 2019; Almeida et al. 2022), to date, this is the first record of leucism in this family. The general low frequency for any given family indicates the rarity of this phenomenon of color disorder.

The occurrence of leucism does not have a single explanation. Thus, a variety of mechanisms can result in coat color anomalies. Exogenous issues such as disease, aging, diet, nutrition, and ecological and physiological factors (Küderling et al. 1984; Camargo et al. 2006; Safronov & Zakharov 2014; Konter 2015; Caro & Mallarino 2020; Mendes-Pontes et al. 2020) can cause anomalies. In addition, as previously mentioned, there are various genetic factors.

Among the genetic origins, its occurrence can provide evidence about the genetic health of wild populations (Jehl 1985; Camargo et al. 2014). The frequency of coat color anomalies, such as leucism, tends to be higher in smaller populations due to genetic drift, bottleneck effect, and founder effect, among others (Bensch et al. 2000; Hofmeester et al. 2021). Such abnormalities can reflect negative social effects and predation-prey interactions (Oliveira 2009a; Caro & Mallarino 2020). Conversely, once a leucistic or albino individual becomes an adult, its reproductive fitness may not be compromised (Toledo et al. 2014; Arriaga-Flores et al. 2016).

Adult leucistic individuals are undoubtedly a condition that does not limit the normal growth of the affected individual. Once the individual becomes an adult, its presence can increase the frequency of such abnormalities in the population, mainly isolated ones (Hofmeester et al. 2021).

In the present study, the long-term isolation of populations restricted to forest reserves on different farms probably limited the flux of individuals between populations. That restriction could lead to genetic constraints, reducing genetic variability and increasing the frequency of leucistic individuals. Contrary to expectations, the abnormality of the mocó coat color did not seem to limit its normal growth, as it was already an adult. According to Ortiz-Hoyos et al. (2020), diurnal leucistic and albino individuals may have a lower predation risk compared to nocturnal individuals since the latter can be tracked more easily in the dark. In addition to being diurnal, the present individual inhabits the forest floor, avoiding raptors, whereas the current degraded landscape reduces the population of potential terrestrial predators.

We agree with Abreu et al. (2013) that the observations of leucism or other coat color abnormalities and their subsequent report will allow a better understanding of such phenomena in wild animals, as well as of the environmental context in which they are inserted.

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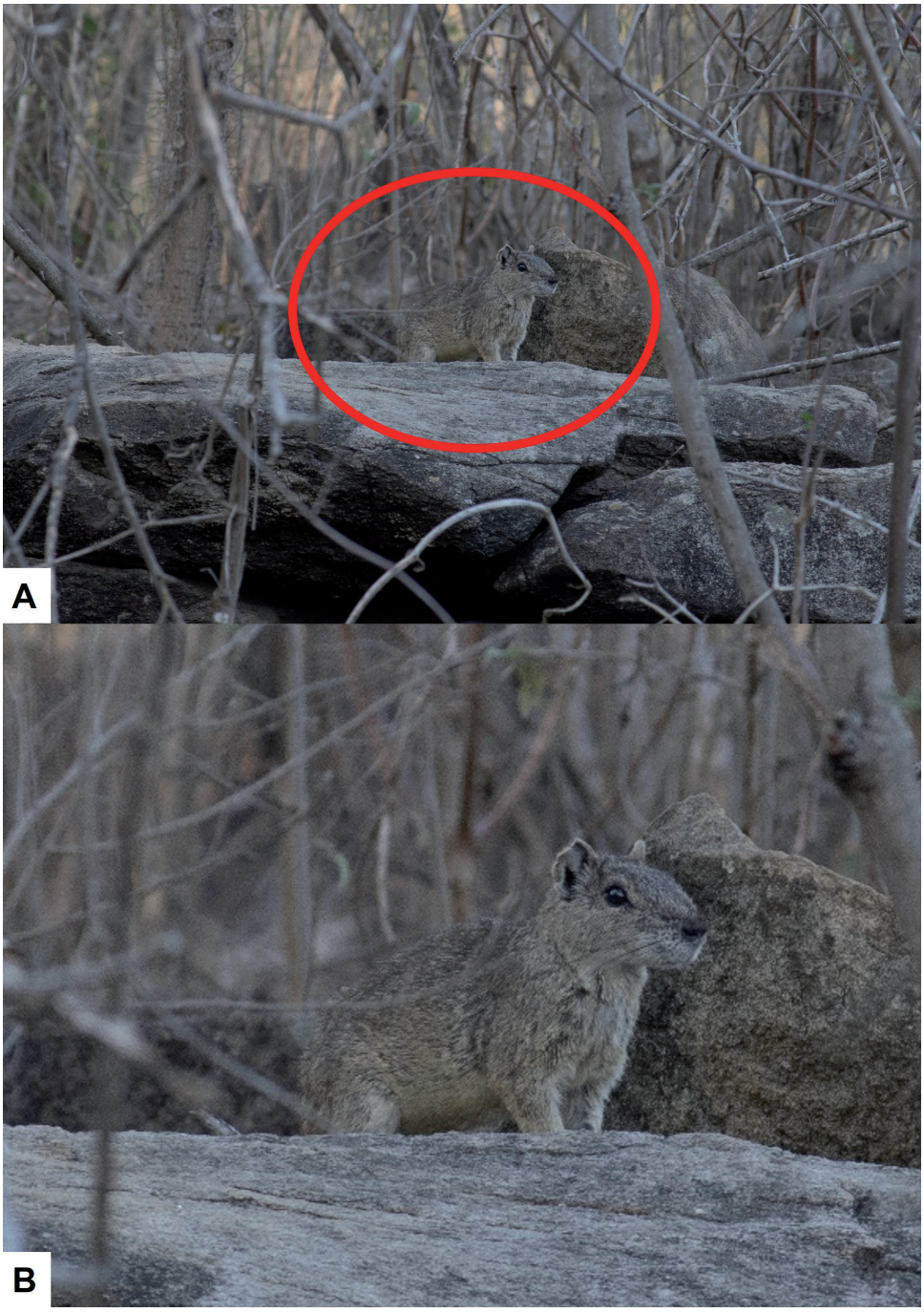

Figure 1. An adult *Kerodon rupestris* with its typical agouti coloration observed at Lagoa do Capim farm, municipality of Porto da Folha, Sergipe. In (A) the image accurately shows the camouflage effect of the species in its environment (red cycle) and (B) a detail of the animal.

Figure 2. An adult *Kerodon rupestris* presenting leucism observed at Lagoa do Capim farm, municipality of Porto da Folha, Sergipe, in (A) November 11, 2020, detailed by the red cycle and (B) April 15, 2021.

Table 1. Leucism records in rodents with frequency details for families and genera.

FAMILY	GENERAL FREQUENCY (%)	NUMBER OF RECORDS BY GENUS	SPECIES (NUMBER OF RECORDS)	REFERENCES
Caviidae	1 (1.3%)	1	*Kerodon rupestris* (1)	Present study
Cricetidae	44 (58.7%)	5	*Abrothrix andina* (2) *Abrothrix longipilis* (1) *Abrothrix olivaceus* (2)	Rubio & Simonetti 2019; Beninato et al. 2020
		16	*Akodon affinis* (11) *Akodon mollis* (5)	Brito & Valdivieso-Bermeo 2016; Montoya-Bustamante et al. 2017
		3	*Eligmodontia* sp. (3)	Beninato et al. 2020
		1	*Myodes gapperi* (1)	Bowman & Curran 2000
		11	*Nephelomys albigularis* (5) *Nephelomys moerex* (6)	Brito & Valdivieso-Bermeo 2016
		2	*Peromyscus fraterculus* (2)	Camargo et al. 2014
		1	*Phyllotis xanthopygus* (1)	Beninato et al. 2020
		1	*Reithrodontomys mexicanus soederstroemi* (1)	Ramírez-Jaramillo et al. 2019
		3	*Thomasomys auricularis* (1) *Thomasomys paramorum* (1) *Thomasomys taczanowskii* (1)	Brito & Valdivieso-Bermeo 2016
		1	*Transandinomys talamancae* (1)	Brito & Valdivieso-Bermeo 2016
Ctenodactylidae	1 (1.3%)	1	*Ctenodactylus gundi* (1)	El-Farhati & Nouira (2023)
Dasyproctidae	2 (2.7%)	2	*Dasyprocta fuliginosa* (1) *Dasyprocta azarae* (1)	Oliveira 2009a; Mejía-Valenzuela 2019
Echimyidae	2 (2.7%)	1	*Mesomys hispidus* (1)	Brito & Valdivieso-Bermeo 2016
		1	*Trinomys albispinus* (1)	Pessôa & Reis 1995
Erethizontidae	1 (1.3%)	1	*Coendou prehensilis* (1)	Romero-Briceño & González-Carcacía 2020
Heteromyidae	1 (1.3%)	1	*Chaetodipus formosus incolatus* (1)	Egoscue & Lewis 1968
Muridae	6 (8.0%)	4	*Mus musculus* (4)	Čanády 2015
		1	*Mus* sp. (1)	Nedyalkov et al. 2014;
		1	*Rattus exulans* (1)	van der Geer 2019
Sciuridae	17 (22.7%)	4	*Funambulus palmarum* (1) *Funambulus pennantii* (2) *Funambulus tristriatus* (1)	Sayyed et al. 2015; Sayyed & Mahabal 2016; Samson et al. 2017; Yadav et al. 2019
		1	*Notosciurus granatensis* (1)	Ramírez-Jaramillo 2019
		9	*Sciurus vulgaris* (1) *Sciurus carolinensis* (6) *Sciurus niger* (2)	Hoekstra 2004; McCardle 2012
		3	*Simosciurus nebouxii* (3)	Salazar et al. 2021

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