THERYA NOTES 2020, Vol. 1 (1): 62-66 DOI: 10.12933/therya_notes-20-15

First records of leucism in small rodents for Argentina

Primeros registros de leucismo en pequeños roedores para Argentina

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Leucism appears in various groups of vertebrates, although it is rare in mammals. For Argentina, we do not know of any documented registry for small rodents. The objective of our work is to report the first cases of leucism in cricetid rodents in the Puna Desert of Argentina. Field work was carried out in the Multiple Use Provincial Reserve Don Carmelo (San Juan, Argentina), located in the Puna Desert. The animals were captured in 9 grids formed by 36 Sherman-type traps, established in plots located between 3.100 and 3.300 m, in the years 2013-2014. We recorded 6 cases of leucism in 3 species of cricetids: *Eligmodontia* sp. ($n = 3$), *Abrothrix andina* ($n = 2$), and *Phyllotis xanthopygus* ($n = 1$). This work represents the first report of cases of leucism in small mammals from Argentina. The cases in the studied population could be due to the low gene flow imposed by the high environmental severity of an extreme desert, probably related to genetic causes derived from climatic and ecological factors, as these are non-anthropized environments.

Key words: Cricetids; leucism; pigment disorder; Puna Desert; rodents.

El leucismo aparece en varios grupos de vertebrados, aunque es menos frecuente en mamíferos. Para Argentina no conocemos ningún registro documentado para roedores pequeños. El objetivo de nuestro trabajo es informar los primeros casos de leucismo en roedores cricétidos en la Puna Desértica de Argentina. El trabajo de campo se llevó a cabo en la Reserva Provincial de Uso Múltiple Don Carmelo (San Juan, Argentina), ubicada en la Puna Desértica. Los animales fueron capturados en 9 cuadrículas formadas por 36 trampas tipo Sherman, establecidas en parcelas situadas entre los 3,100 y 3,300 m, en los años 2013-2014. Registramos 6 casos de leucismo en 3 especies de cricétidos: *Eligmodontia* sp. ($n = 3$), *Abrothrix andina* ($n = 2$) y *Phyllotis xanthopygus* ($n = 1$). Este trabajo representa el primer reporte de casos de leucismo en mamíferos pequeños para Argentina. Los casos en la población estudiada podrían deberse al bajo flujo génico impuesto por la alta rigurosidad ambiental de un desierto extremo, probablemente relacionándose con causas genéticas derivadas de factores climáticos y ecológicos, al tratarse de ambientes no antropizados.

Palabras clave: Cricétidos; desorden pigmentario; leucismo; Puna Desértica; roedores.

Genetic abnormalities that affect color expression are known as albinism, leucism, and melanism. Albinism is the condition defined by the total absence of melanin pigment in the eyes, skin and hair (Lamoreux *et al.* 2010). In leucism, animals have a lighter color or are stained, with pigmented eyes (Miller 2005; García-Morales *et al.* 2012; Liu *et al.* 2019). In melanism, animals are overproduced with melanin, resulting in completely black fur (Jimbow *et al.* 1976; Silvers 2012).

In natural populations, these pigmentation abnormalities often occur in isolated and small populations, reflecting low levels of genetic diversity (Holyoak 1978; Bensch *et al.* 2000; Brito and Valdivieso-Bermeo 2016; Rubio and Simonetti 2018). They have also been related to contamination in urban areas (Il'enko 1960) and radioactive contamination, as in the case of areas near Chernobyl (Møller and Mousseasu 2001).

Pigmentation abnormalities associated with albinism, such as leucism, appear in various vertebrate groups although they are less frequent in mammals (Dunlop *et al.* 2019). Cases were reported in fish (Mena-Valenzuela and Valdiviezo-Riveira 2016; Nugra *et al.* 2018; Liu *et al.* 2019); amphibians and reptiles (Krecsák 2008; López and Ghirardi 2011; Escoriza 2012), and birds (Comisso 2012; Chiale and Gerardo 2014; Atauchi 2015; Cadena-Ortíz *et al.* 2015).

In mammals, the leucism was found in various species such as bats (*Artibeus fraterculus*; Fernández de Córdova *et al.* 2017), agouti (*Dasyprocta azarae* and *D. fuliginosa*; Vilges de Olivera 2009; Mejía-Valenzuela 2019), two-furred fur sea wolf (*Arctocephalus australis*; Abreu *et al.* 2013), opossum (*Didelphis albiventris*; Abreu *et al.* 2013), squirrel (*Funambulus palmarum*; Samson *et al.* 2017), guanaco (*Lama guanicoe*; Puig *et al.* 2017), among other.

Likewise, in several genera of small rodents such as *Reithrodontomys* (Egoscue 1958), *Otomys* (Pirlot 1958), *Mus musculus* (Winston and Lindzey 1964), *Perognathus* (Egoscue and Lewis 1968), *Microtus* (Brewer *et al.* 1993; Peles *et al.* 1995), *Myodes* (Steen and Sonerud 2012), *Peromyscus* (Camargo *et al.* 2014), *Akodon*, *Nephelomys*, *Transandinomys*, *Thomasomys* and *Mesomys* (Brito and Valdivieso-Bermeo 2016), *Akodon* (Montoya- Bustamante *et al.* 2017), and *Abrothrix* (Rubio and Simonetti 2018). Currently for Argentina, we do not know of any documented record for small rodents. Thus, the objective of this work is to report the first cases of leucism in small rodents in the Argentine Puna Desert.

The study site is located in the Multiple Use Provincial Reserve Don Carmelo, at the southernmost tip of the Argentina Puna Desert. The protected area is located in the west center of Ullum department, in the province of San Juan-Argentina (31° 10′ S, 69° 46′ W; Figure 1), with an altitude that ranges from 3,000 to 3,800 m. It has an average annual temperature of 8.15 °C, an absolute maximum temperature of 26 °C, and an absolute minimum temperature of -22 °C (Andino and Borghi 2017). The vegetation consists of low xerophilous shrubs and grasses, with immature, stony or sandy soils (Martínez-Carretero 1995; Beninato *et al.* 2019).

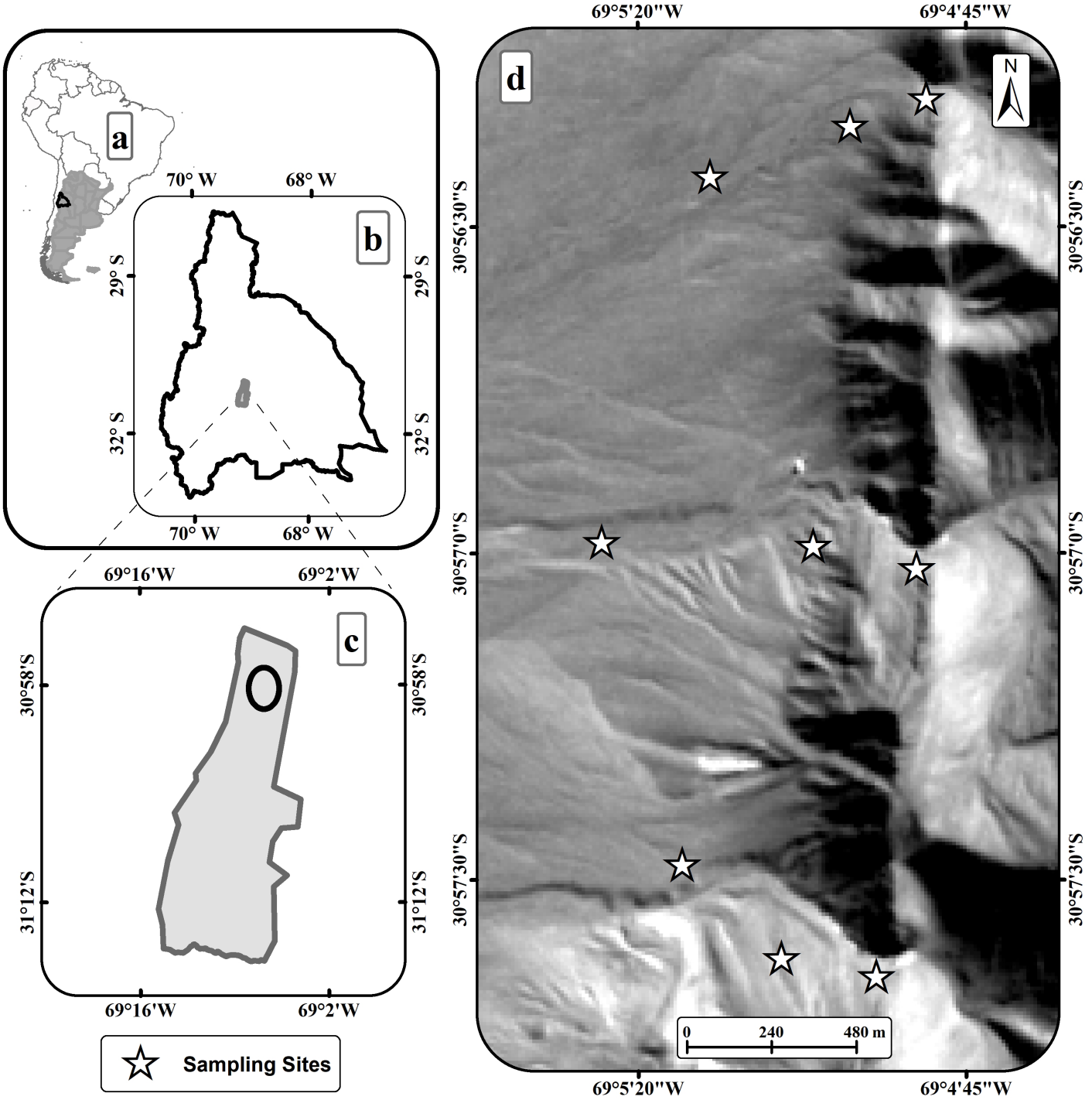

Figure 1. Location of the study area located in the Argentina Puna Desert, province of San Juan, Argentina. a) South America (in gray Argentina); b) San Juan; c) Don Carmelo Multiple Use Reserve, d) Study sites.

The work was carried out in the 3 dominant environments of this sector of the Puna: rocky outcrop, hillside and plain, in plots located between 3,100 and 3,300 m, between the years 2013-2014. Sampling was carried out on 9 fixed grids, separated by a minimum of 500 m, made up of 36 Sherman-type traps 15 m apart (more details in Beninato *et al.* 2019). The captures were carried out during the 4 stations. The sampling effort was 2,592 traps nights.

From a total of 309 captured individuals, 6 individuals with leucism were registered, belonging to 3 species of cricetid rodents, thus representing 2 % of the total captured animals. There were 3 adult individuals of *Eligmodontia* sp. (15 %; *n* = 20), 1 juvenile and 1 adult individual of *Abrothrix andina* (2.1 %; *n* = 93) and 1 adult individual of *Phyllotis xanthopygus* (0.51 %; *n* = 196; Figure 2a-f; Table 1). The individuals presented small spots of white coloration on the back and / or lateral parts, with the pigmentation of the retinas and normal eyelids. The individuals of *Eligmodontia* sp. had spots on the back, head and sides; that of *P. xanthopygus* spots on the head; and that of *A. andina* spots on one of the ears and one of the flanks (Figure 2a-f).

Coloring patterns in wildlife are fundamental ecological adaptations for species survival because they facilitate camouflage, mimicry, sexual selection, and thermoregulation (Caro 2005; Mullen and Hoekstra 2008; Protas and Patel 2008; Hubbard *et al.* 2010). In individuals with pigmentation abnormalities, such as leucism, the condition is considered a disadvantage because they are more likely to be detected by predators than individuals with normal coloration (Owen and Shimmings 1992; Vignieri *et al.* 2010).

In South America, so far there are few records of leucism in small rodents and all have been associated with anthropogenic effects. In Ecuador, leucism was recorded in an anthropized environment of the Cordillera in the genera *Akodon*, *Nephelomys*, *Transandinomys*, *Thomasomys* and *Mesomys* (Brito and Valdivieso-Bermeo 2016) and in a valley near Quito (*Reithrodontomys mexicanus*; Ramírez-Jaramillo *et al.* 2019). In Colombia, leucism was found in specimens of *Akodon affinis* (Montoya- Bustamante *et al.* 2017) which was associated with possible inbreeding effects due to discontinuous distribution and habitat fragmentation in the Andes. In Chile, the presence of specimens with leucism in *Abrothrix hirta* and *A. olivacea* was associated with a possible decrease in genetic diversity due to the effect of human disturbances

Figure 2. Leucism in 3 species of small rodents in the Argentina Puna Desert, province of San Juan Argentina. *Eligmodontia* sp. (a, b, c), *Phyllotis xanthopygus* (d) and *Abrothrix andina* (e, f). Photography: V. A. Beninato.

(Rubio and Simonetti 2018). For the genus *Eligmodontia* so far there is no documentation of any pigment disorder, while for *Phyllotis andium* there is a record of albinism in the coastal desert of Perú (Ramírez and Arana 2005). With respect to Argentina, total melanism, another pigmentary disorder, had previously only been registered in two species of small mammals (*Scapteromys tumidus* and *Oligoryzomys flavescens*) from the Paraná Delta (Massoia 1978).

The cases of leucism reported in this work for *P. xanthopygus*, *A. andina* and *Eligmodontia* sp. in the Argentina Puna Desert, could have an origin in low genetic variability, as has been suggested for other vertebrates (Owen and Shimmings 1992; Bensch *et al.* 2000), and other small mammals (Brito and Valdivieso-Bermeo 2016; Rubio and Simonetti 2018). The Argentina Puna Desert presents extreme climatic conditions, with scarce vegetation cover, except in the rocky outcrops, which appear as patchy and scarce environments (Beninato *et al.* 2019), in addition to the presence of air and land predators. Beninato *et al.* (2019) found

Table 1. Cases of leucism in 3 species of small rodents in the Argentina Puna Desert, province of San Juan Argentina.

Species	Latitude	Longitude	Altitude	Environment	Sex	Season	Photography
Eligmodontia sp.	30°57'26.8"	69°5'15.8"	3.115	Plain	Female	Spring	a
Eligmodontia sp.	30°56'26.2"	69°5'12.7"	3.096	Plain	Male	Winter	b
Eligmodontia sp.	30°56'26.3"	69°5'12.1"	3.120	Hillside	Male	Winter	c
Phyllotis xanthopygus	30°57'2.4"	69°4'50.04"	3.096	Rock	Male	Autumn	d
Abrothrix andina	30°57'0.0"	69°4'50.7"	3.165	Rock	-	Summer	e
Abrothrix andina	30°56'56.8"	69°4'48.2"	3.175	Rock	-	Summer	f

that *P. xanthopygus* and *A. andina*, restricted their distribution almost exclusively to the rocky areas and *Eligmodontia* sp. to the plains. The cases of leucism in the studied population could be due to the low gene flow imposed by the high environmental rigor.

This work represents the first report of cases of leucism in small rodents for Argentina. In this case, the presence of leucism is probably related to the effect of natural ecological factors in these extreme non-anthropic environments. However, genetic studies are required to advance the causality that this type of condition is generating in the wild fauna of the small mammal of the arid end of the Argentina Puna Desert.

Acknowledgements

We thank A. Curatola for his hospitality and for allowing us to use the facilities of the Don Carmelo Multiple Use Provincial Reserve. We want to thank T. Gonzalez for providing the map and L. Cella for english revision. This research was partially funded by the CICITCA E / 920 grant (Carlos E. Borghi, UNSJ, Argentina).

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Associated editor: Cristian Kraker-Castañeda
Submitted: April 22, 2020; Reviewed: June 29, 2020.
Accepted: July 11, 2020; Published on line: July 20, 2020.