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First record of albinism in white-tailed deer *Odocoileus virginianus* in South America recorded in the Ecuadorian Andes

Primer registro de albinismo en venado de cola blanca *Odocoileus virginianus* para Suramérica en los Andes del Ecuador

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The white-tailed deer *Odocoileus virginianus* is a widely distributed species across the Americas, inhabiting diverse temperate and tropical ecosystems. Both a lowland and highland subspecies occur in Ecuador. Color variation in vertebrates is mainly driven by changes in melanin concentration and can produce conditions like albinism, leucism, and melanism. Such pigmentation disorders have been reported in cervids worldwide but here we report the first case of albinism for *O. virginianus* in South America. The observation was made during a camera trap study conducted from October 2020 to February 2021 in Ecuador's eastern Andes, approximately 50 km east of Quito, on private lands in páramo and montane forest ecosystems. An albino white-tailed deer, presumed to be female, was recorded once on January 8, 2021, at 3,969 m. in páramo habitat. Characterized by completely white fur, red eyes, and pink nose, hooves and ears. This individual represents the only record of albinism from 147 white-tailed deer detections during the study period. This is the first record of albinism in a white-tailed deer in Ecuador and South America. Albinism is rare in wild mammals and may affect survival, reproduction, and increase predation risk. This observation adds to and highlights color variations in Andean mammals, suggesting genetic constraints in populations.

Key words: Albinism, Andes, camera traps, Cervidae, color variations, Ecuador, genetic mutations, melanin, *Odocoileus virginianus*, white-tailed deer.

El venado de cola blanca *Odocoileus virginianus* es una especie ampliamente distribuida en América, habitando diversos ecosistemas. En Ecuador dos subespecies son reconocidas: los venados de la costa y andinos. Las anomalías de coloración, principalmente determinadas por cambios en la concentración de melanina, puede producir condiciones como albinismo, leucismo y melanismo. Estas variaciones se han registrado en cérvidos a nivel mundial, pero aquí reportamos el primer caso de albinismo para *O. virginianus* en Sudamérica. La observación se realizó en un estudio con 30 cámaras trampas entre octubre de 2020 y febrero de 2021, en los Andes orientales de Ecuador aproximadamente a 50 km de Quito, desarrollado en terrenos privados de páramo y bosque montano. Una presunta hembra de venado de cola blanca albino fue registrada una sola vez el 8 de enero de 2021, a 3,969 m en hábitat de páramo. Caracterizada por pelaje completamente blanco, ojos rojos y nariz, pezuñas y orejas rosadas, este individuo representa el único registro de albinismo entre 147 registros de venados de cola blanca durante el período de estudio. Este es el primer registro de un venado cola blanca albino en Ecuador y para Sudamérica. El albinismo es poco común en mamíferos silvestres y puede afectar su supervivencia, reproducción y aumentar su riesgo de depredación. Esta observación contribuye al conocimiento de las variaciones de color en mamíferos andinos, sugiriendo posibles limitaciones genéticas en sus poblaciones.

Palabras clave: Albinismo, Andes, cámaras trampa, cérvidos, Ecuador, melanina, mutaciones genéticas, *Odocoileus virginianus*, venado de cola blanca, variaciones de coloración

The white-tailed deer *Odocoileus virginianus* is a widely distributed member of the Cervidae family, found across the Americas, from Canada to Peru and Bolivia. They occur in a variety of ecosystems, feed principally on plants, and are an important component of many trophic networks (Waller and Alverson 1997; Weber and Gonzales 2003; Ortega-S *et al.* 2011; McShea 2012; Tirira *et al.* 2017; Gallina-Tessaro *et al.* 2019; Tirira *et al.* 2019). Although some subspecies of *O. virgnianus* have been proposed for taxonomic revision or elevation, most continue to be recognized as subspecies throughout the species' range (Molinari 2007; Mandujuano *et al.* 2010; Gallina-Tessaro *et al.* 2019; Tirira *et al.* 2019). In Ecuador, two subspecies are recognized: the Peruvian white-tailed deer (*Odocoileus virginianus peruvianus*), found in the lowlands of southwestern Ecuador, and the Andean white-tailed deer (*Odocoileus virginianus ustus*), found along the Andes in páramo ecosystems between 3,000 and 4,600 m (Tirira *et al.* 2017; 2019).

Color variation is widespread in vertebrates and is generally linked to differences in melanin concentrations

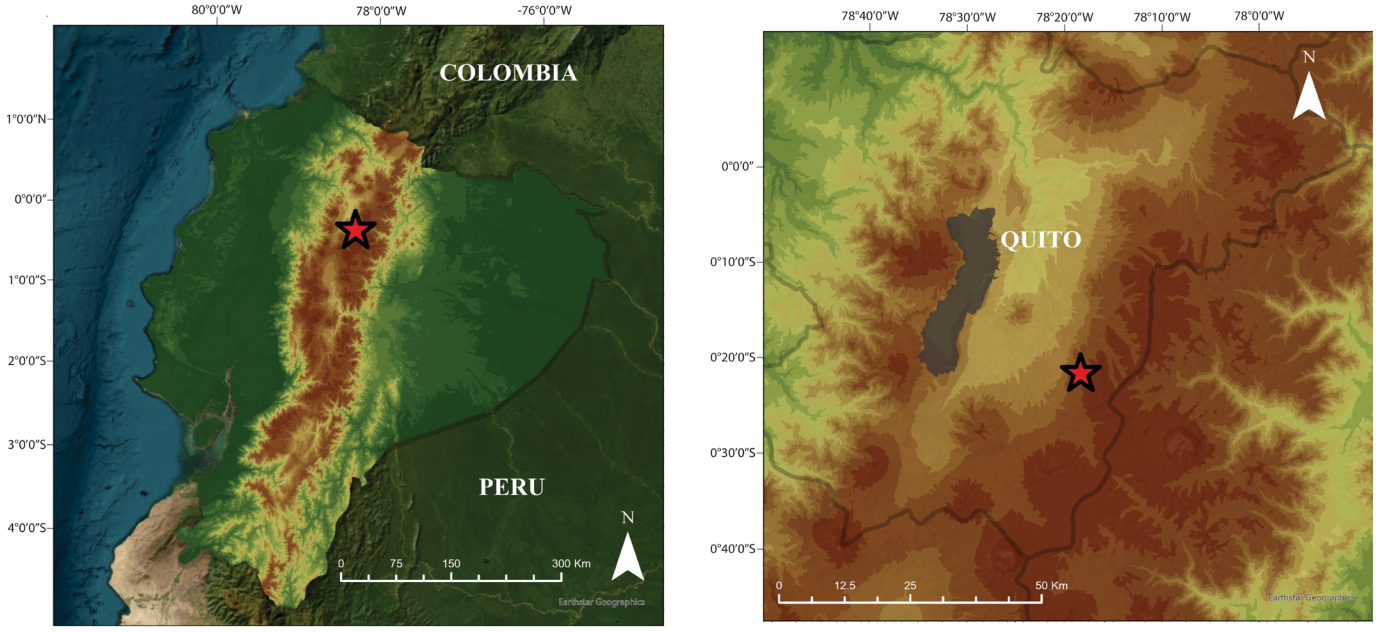

Figure 1. Location of the camera trap observation of the albino white-tailed deer in the Andes region in Ecuador. Quito's urban area is shaded grey.

in skin, fur, and feathers (van Grouw 2013; Lindgren *et al.* 2015; Galván *et al.* 2016). Melanin is a genetically regulated biopolymer derived from tyrosine. Eumelanin produces black, grey and brown tones, while pheomelanin generates yellow to reddish coloration (Prota 1992; Ito and Wakamatsu 2003; van Grouw 2006; 2013). These can be inhibited by genetic mutations influencing tyrosinase, leading to color alterations such as albinism, where body tissues lack pigmentation and eyes appear reddish due to visible blood vessels (Pawelek and Körner 1982; Hoekstra 2006; van Grouw 2006; Lindgren *et al.* 2015). Increased reporting of cases of albinism, melanism, and other pigmentation disorders in mammals show the need to understand their genetic and environmental drivers, as these have historically been linked to localized or limited populations and conditions (Hubbard *et al.* 2010; Mooring *et al.* 2020). Albinism, leucism, and melanism have been recorded in various cervid species around the world (Ribeiro and de Siqueira-Silva 2020; Guastalla *et al.* 2021; Pereria *et al.* 2023; Chaudhary *et al.* 2024), including reports of all three for white-tailed deer in the United States (Ryel 1963; Baccus and Posey 1999; D' Angelo and Baccus 2007).

Here we report the first record of albinism in a white-tailed deer in Ecuador and for South America, specifically for the Andean subspecies, *Odocoileus virginianus ustus*, in the highlands of the country. This individual was recorded by camera traps and contributes to reports of color variations in deer, which are especially limited for tropical America.

The observation came from a mammal-focused camera trap study in the eastern Andes region of northern Ecuador, approximately 50 km east of Quito's urban area. The study was carried out on private lands with a mix of páramo ecosystems, upper montane forest, and agriculture areas (crops, livestock pastures). The study area was bordered to the north and south by roads, to the west by rural communities, and adjoined Cayambe-Coca National Park and Antisana Ecological Reserves to the north and northeast (Figure 1). From mid-October 2020 until late February 2021, 30 camera trap stations were monitored for a total of 3,229 camera trap days.

An albino white-tailed deer was recorded once on January 8, 2021, at 08:21 hr, moving through the páramo (0°21'28.7"S 78°18'16.9"W) at 3,969 m. The deer is recognized as albino because of the white fur over its entire body, red eyes, and pink nose, hooves, and ears (Figure 2). In comparison, the normal coloration of the species in this area is brown-gray with a black nose, hooves and eyes (Tirira 2017). Throughout the monitoring, we registered 147 events from white-tailed deer, with the albino individual appearing on only one occasion. The individual appeared to be alone and based on body size and lack of antlers, was likely a female.

To our knowledge, after an extensive literature review, this is the first reported record of an albino white-tailed deer in Ecuador and in South America. In cervids, color alterations such as albinism and leucism have been reported in South America for *Mazama* deer species (Ribeiro and de Siqueira-Silva 2020; Guastalla *et al.* 2021), and leucism was reported in the marsh deer *Blastocerus dichotomus* in Argentina (Pereria *et al.* 2023). Other anomalies observed in cervids include albinism in spotted deer *Axis axis* and in swamp deer *Rucervus duvaucelii* (Chaudhary *et al.* 2024). Color variations have been reported for white-tailed deer including melanism (Baccus and Posey 1999; D' Angelo and Baccus 2007), albinism, and leucism (Ryel 1963). However, all reports come from the United States, which could be explained by large population

Figure 2. First record of an albino white-tailed deer, subspecies *O. virginianus ustus*, in the Andes region of northern Ecuador, recorded by a camera trap. a) Normal coloration of an adult individual of *O. v. ustus* captured in the same camera trap. b) Frontal view: note the white coloration of the body, pink coloration of nose and ears, and red eyes. c) Lateral view: note overall white coloration across body and pink ears. d) Posterior view of albino deer individual.

sizes, a history of translocations, relaxed predation pressure due to predator decline, and variable genetic structure. These factor may increase both the prevalence of encounters and studies involving deer, as well as the likelihood of rare color morphs by increasing mutation rates, reducing selective pressures, and promoting local genetic drift or founder effects that favor their persistence (Ellsworth *et al.* 1994; Waller and Alverson 1997; Deyoung *et al.* 2003: Lang and Blanchong 2012; McShea 2012, Blanchong *et al.* 2013; Russell *et al.* 2017).

Albinism is a condition seen in many different vertebrate groups, including fish, amphibians, birds, and mammals of various sizes (Uieda 2000; Hoekstra 2006; Wang *et al.* 2007; van Grouw 2013; Lindgren *et al.* 2015). However, although widespread, it remains a rare color alteration in wild mammal populations (Pawelek and Körner 1982; Lindgren *et al.* 2015). This and other color alterations may arise from diet, environmental stressors, or, more commonly, from specific genetic mutations found in small or isolated populations (Hubbard *et al.* 2010). Because

the individual reported here represents the first case of albinism in white-tailed deer from Ecuador, and in South America, the underlying cause of the condition in this population remains unknown. However, the record adds to growing evidence of color abnormalities in mammals from Ecuador's western Andean slopes, where one case of albinism was reported for stump-tailed porcupine (Romero *et al*. 2018), cases of piebaldism have been reported in mountain coatis, brown-nosed coatis, black agoutis, and tayras (Viteri-Basso *et al*. 2024), and melanism has been recorded with high prevalence in clouded tiger cats and in tamanduas (Ríos-Alvear and Cadena-Ortiz 2019; Viteri-Basso *et al*. 2024). These abnormalities are likely the result of underlying genetic constraints. Such recurring observations may reflect naturally occurring genetic variations, but they also raise the possibility of reduced genetic diversity in certain highland mammal populations confined to isolated areas in the country (Brito and Valdivieso-Bermeo 2016; Cueva *et al*. 2024).

Color alterations such as albinism can impact probability of survival, reproductive success, and affect stress levels by increasing conspicuousness towards predators, reducing sexual competitiveness, or altering temperature regulation (van Grouw 2006; Peacock 2011; Abreu *et al*. 2013; Mooring *et al*. 2020; Streeting *et al*. 2023). For white-tailed deer in páramo populations, where grasses and shrubs are brown and green, albinism may affect their ability to hide from predators such as pumas *Puma concolor*, as well as human hunters who are considered the main conservation threat in Ecuador (Tirira 2011; Tirira *et al*. 2019). The páramo is also a high-altitude ecosystem with low temperatures but intense solar and UV exposure during daylight hours, along with strong diurnal temperature changes (Ramsay 2001; Madriñán *et al*. 2013; Cabay *et al*. 2025). These factors could put pigment deficient mammals under thermal regulation pressure or stress. Lack of melanin may also cause altered depth perception, increased sensitivity to light and poorer eyesight- all of which may affect foraging and vigilance (Pawelek and Körner 1982; Hoekstra 2006; Gronskov and Nielsen 2007; Gough 2008).

This first case of albinism in white-tailed deer in South America broadens our understanding of color variation in highland mammals and ungulates and provides valuable baseline data for future ecological and conservation studies. Apart from the rarity of this record, it highlights the importance of long-term monitoring in the páramo, where extreme environmental conditions and increasing anthropogenic pressures may affect both the causes and consequences of these such traits. As with other records of unusual coloration in Andean mammals, this observation underscores the need to include these phenotypic anomalies into bigger assessments of population health, genetic diversity, and species vulnerability, since they are usually linked (Hubbard *et al*. 2010; Brito and Valdivieso-Bermeo 2016), and ensuring that unique individuals such as this one can also inform strategies for conserving ecosystems of the Tropical Andes.

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