

Original article

Beyond hippos: Evidence of an introduced deer in Colombia

Más allá de los hipopótamos: evidencia de un venado introducido en Colombia

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Abstract

More than 18% of the cases of invasive mammals worldwide correspond to South America, including small rodents and large species such as deer and hippos. Among exotic mammals in Colombia, we can mention pigs (*Sus scrofa*), which are well established, mainly in the Orinoquía region of the country, and more recently, hippos (*Hippopotamus amphibius*) with a growing area of occurrence in the middle and lower basin of the Magdalena River in the inter-Andean zone. In May 2022, a spotted exotic deer was documented in the area based on direct and indirect observations (photographs and videos) of living individuals and a partial skeleton. The spotted pattern of the photographed adults (absent in native or other exotic deer) and the juvenile individuals and the shape of the antlers show that they are chitals (*Axis axis*), a species native to Asia. Compared with the white-tailed deer *Odocoileus*, the largest native deer species in Colombia, the *Axis* skeleton was one-third bigger, which corroborated the identification. According to local inhabitants' communications, the number of *Axis* has increased, and groups of up to 18 individuals have been recorded. This is the first time that exotic deer have been documented in Colombia. Their presence may impact natural regeneration and competitively displace other native herbivores, which calls for the mitigation and control of the population since its establishment and dispersal can be cryptic.

Keywords: Cervidae; Exotic species; Introduction; Mammalia, Northern Andes.

Resumen

Los mamíferos invasores en Sudamérica representan más del 18 % de los casos a nivel mundial, que incluyen desde roedores pequeños hasta especies de gran tamaño como los venados e hipopótamos. En Colombia los cerdos (*Sus scrofa*) son los mamíferos exóticos de gran tamaño que se consideran bien establecidos, principalmente en la Orinoquía. Otro caso es el de los hipopótamos (*Hippopotamus amphibius*), que han aumentado su área de presencia en la cuenca media y baja del río Magdalena en la zona interandina. En mayo de 2022, a partir de observaciones directas e indirectas (fotografías y videos) de individuos vivos y de un esqueleto parcial, se documentó la presencia de un ciervo manchado exótico en la misma área de los hipopótamos. El patrón de manchas en las fotografías de los individuos adultos (ausente en ciervos nativos) y juveniles, así como la forma de las astas, permitieron confirmar que se trataba del chital (*Axis axis*), una especie originaria de Asia. Al comparar el esqueleto con el de especímenes de venado de cola blanca *Odocoileus*, la especie de ciervo nativa de mayor tamaño en Colombia, se encontró que el de *Axis* era un tercio más grande, lo que corroboró la identificación. Según habitantes locales, el número de *Axis* ha aumentado y se han visto grupos de hasta de 18 individuos. Esta es la primera vez que se documenta la presencia de venados exóticos en Colombia, lo que puede impactar la regeneración natural y desplazar competitivamente otros herbívoros nativos. En ese sentido, la mitigación y el control de su población debe ser prioritaria, toda vez que su establecimiento y dispersión pueden ser crípticos.

Palabras clave: Andes del norte; Cervidae; Especies exóticas; Introducción; Mammalia.

Citation: Ramírez-Chaves HE, Roncancio-Duque N, Morales-Martínez DM. Beyond hippos: Evidence of an introduced deer in Colombia. Revista de la Academia Colombiana de Ciencias Exactas, Físicas y Naturales. 47(185):882-888, octubre-diciembre de 2023. doi: <https://doi.org/10.18257/raccefyn.1953>

Editor: Martha Patricia Ramírez Pinilla

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Received: July 19, 2023

Accepted: December 1, 2023

Published on line: December 14, 2023



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Introduction

Invasive mammals in South America represent more than 18% of the cases worldwide (Speziale & Lambertucci, 2010); they range from small-sized species of rodents (e.g., *Rattus rattus*) and rabbits (e.g., *Oryctolagus cuniculus*) to large species such as deer (*Axis axis*, *Dama dama*, *Rangifer tarandus*) and horses (*Equus caballus*) (Patiño, 1970; Novillo & Ojeda, 2008; Ramírez-Chaves *et al.*, 2011). One of the most mediatic cases of invasive mammals in South America has been the hippos (*Hippopotamus amphibius*) introduced in the inter-Andean valley of the Magdalena River in Colombia, extensively documented in recent years (Valderrama-Vásquez, 2012; Dembitzer, 2018; Castelblanco-Martínez *et al.*, 2021).

Hippos are at an establishment phase in Colombia (Montenegro *et al.*, 2019) and have been the focus of much controversy due to their origin and the ineffective methods used to control their population growth (Valderrama Vásquez, 2012; Monsalve-Buriticá & Ramírez-Guerra, 2018; Castelblanco-Martínez *et al.*, 2021). Among other artiodactyls in Colombia, only feral pigs (*Sus scrofa*) are well-established (Montenegro *et al.*, 2019), while other species, such as goats (*Capra aegagrus hircus*), have had effects on natural ecosystems (endangered dry-forest) (Valencia-Duarte *et al.*, 2012). Exotic cervids had not been documented in the country yet. Here, we present evidence of an exotic deer species in the inter-Andean valley of the Magdalena River.

Methodology

We used two approaches to confirm the species' presence in Colombia. First, we reviewed a partial skeleton of a large mammal recovered in May 2022 in the municipality of Puerto Triunfo (5.89 N, -74.70 W; 190 m a.s.l.), Department of Antioquia, and donated to the Mammal Collection at the Museo de Historia Natural, Universidad de Caldas (MHN-UCa-M). The partial skeleton (MHN-UCa-M 4047) includes the femora, scapula, pelvis, tibia, 12 ribs, eight thoracic vertebrae, two cervical and two lumbar, metatarsus, one phalanx, and sacrum. We took linear measurements (Table 1) of the femora (greatest length), scapula (diagonal height), pelvis (greatest length of one half), tibia (greatest length), metatarsus (greatest length) following von Den Driesch (1976). We compared them with the largest native deer naturally distributed in Colombia (the white-tailed deer, *Odocoileus gr. virginianus*), and with morphometric information in the literature (Yadav *et al.*, 2013, 2015) of exotic deer in South America (Novillo & Ojeda, 2008), such as *Axis axis*, *Dama dama*, *Cervus elaphus*, and *Rangifer tarandus*. We also compared the femora of MHN-UCa-M 4047 with *A. axis* skeletons from zoo specimens deposited at the Zoologische Staatssammlung München (ZSM) in Munich (ZSM 1963/27♀). Second, we asked unstructured questions with no standard methodology about the presence of large deer to inhabitants in the area where the partial skeleton was recovered and searched for photographs to confirm their observations. These were compared with cervid illustrations (Burgin *et al.*, 2020) to verify the identification using external traits like the coat pattern and the antlers shape.

Results and discussion

The partial skeleton belonged to an adult cervid given the degree of ossification: the bones were longer than those of *Odocoileus* (Table 1) and matched the size of *A. axis* individuals. We confirmed that the MHN-UCa-M 4047 femora belonged to an *A. axis* individual based on the following traits: The femora show a weak indent between the articular head and the great trochanter in *A. axis* and a strong one in *O. virginianus*; the proximal border of the great trochanter is flat in *A. axis* and more rounded in *O. virginianus* (Figure 1).

We also confirmed the identification based on the photographs and videos provided by the locals and our team's observations (NR-D) of individuals of all ages (Figure 2). The spotted pattern of adult and juvenile individuals (not present in *R. tarandus* and *C.*

Table 1. Linear measurement (mm) of some postcranial bones of *Axis axis* and *Odocoileus gr. virginianus* from Colombia. ¹ *Yadav et al.* (2013). ² *Yadav et al.* (2015)

	<i>Axis axis</i> MHN-UCa-M 4047	<i>Axis axis</i> 227 ± 2.3 ¹	<i>O. gr. virginianus</i> MHN- UCa-M 2078 (Colombia)
Femora greatest length	241.85 and 242.18		199.43-199.48
Scapula diagonal height	190.65		
Pelvis greatest length, one half	238.57		
Tibia greatest length	262.28		222.52
Metatarsus greatest length	201.60	168 ± 0.7 ²	180.48
Sacrum greatest length	124.65		80.99
Phalanx	42.35		34.91

**Figure 1.** Comparison of the femur of (A) the exotic *Axis axis*, and (B) the white-tailed deer *Odocoileus gr. virginianus* from Colombia. The comparison shows a weak indent (white arrow) between the articular head and the great trochanter in *A. axis* and a strong one in *O. gr. virginianus*.

elaphus), and the long antlers with three lines (broad and palmate in *D. dama*) confirmed the identification as *A. axis* (Figure 2). The locals commented that the number of *A. axis* had increased, and groups of up to 18 individuals had been recorded. Very likely, their origin is the same as the introduced hippos because they have been seen near the Hacienda Napoles (Figure 3).

This is the first time an exotic deer has been reported in Colombia. There are records of introduced *A. axis* in Argentina (Novillo & Ojeda, 2008) and Brazil (Preuss *et al.*, 2020; Foster *et al.*, 2021), and *C. elaphus* and *D. dama* in Argentina and Chile (Vásquez, 2002;



Figure 2. *Axis axis* adult and juveniles (male and female) introduced in Colombia. Photographs: Román Jiménez.

Novillo & Ojeda, 2008). Introduced deer and other ungulates increase native predators' densities and play a critical role as reservoirs and vectors of parasites and infectious diseases (**Dolman & Wäber, 2008**), which may negatively affect native deer species. Specifically, *A. axis* may impact the natural regeneration of the native forest and generate competitive displacement of native deer as in other areas where it has been introduced (**Novillo & Ojeda, 2008**). Considering the lack of data on the local diversity of deer species in Colombia and the conservation status of these populations (**Solari *et al.*, 2013**;

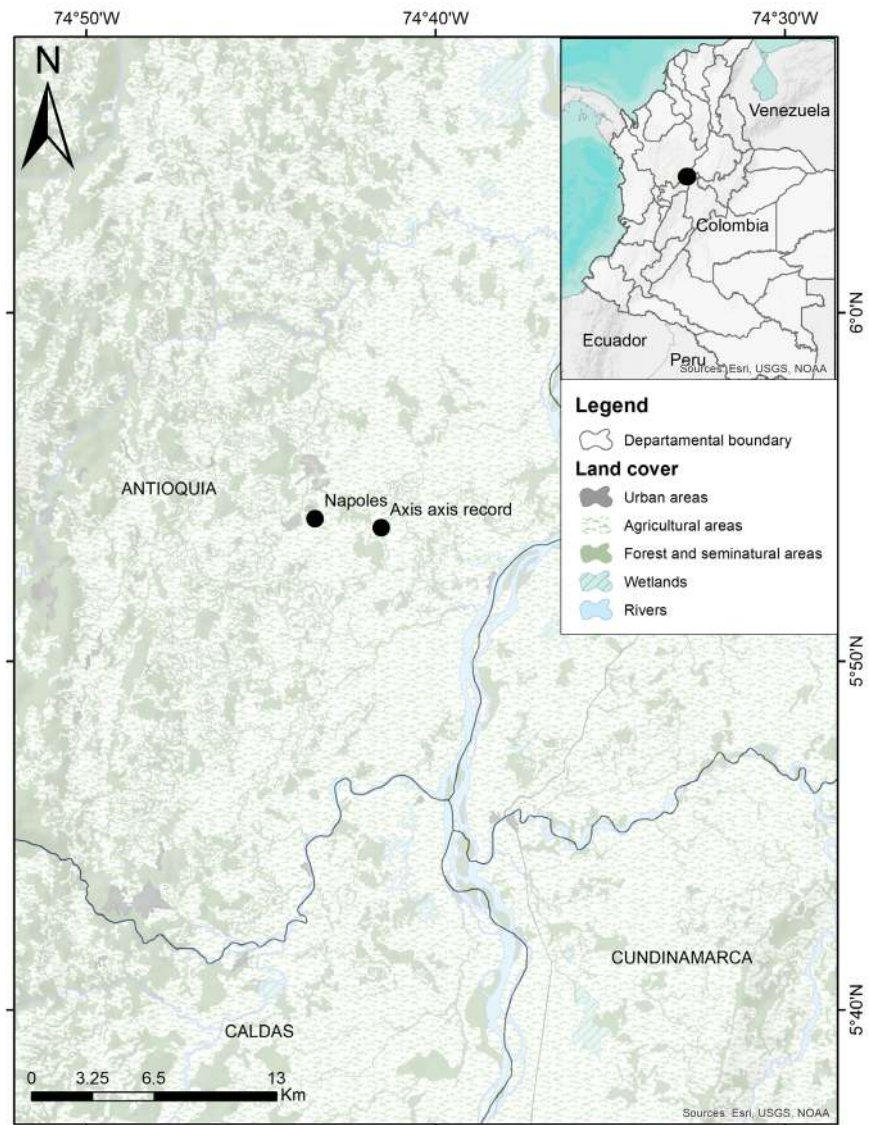


Figure 3. Location of introduced *Axis axis* in Colombia

Ramírez-Chaves *et al.*, 2021a, b), the presence of exotic deer represents a serious threat to native deer populations. For instance, red brockets such as *Mazama zetta*, which is likely a valid species endemic to the Andean cordilleras and inter-Andean valleys between the Colombian departments of Antioquia and Tolima (Sarría-Perea, 2012), are potentially threatened by high deforestation rates (Rodríguez *et al.*, 2013), and its direct interaction with *A. axis* can be harmful. In this context, mitigation and population control of exotic deer should be a priority.

Acknowledgements

We thank Román Jiménez for the photographs of the *Axis axis* individuals. DMMM thanks the Ministerio de Ciencia, Tecnología e Innovación and the Fulbright-Colombia Commission's support for his doctoral studies (Fulbright-MinCiencias 2022 scholarship), and NSF DEB 1754393: Rates of lineage, phenotypic, and genomic diversification in replicated radiations of murine rodents. HERC thanks Fulbright Colombia (Colombian visiting researcher, 2023 cohort scholarship).

Author contribution

HERC: Project design, data collection, analysis, and interpretation, manuscript writing-review and editing. NRD, DMMM: data collection, analysis, and interpretation, manuscript writing-review and editing.

Conflicts of interest

None.

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