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NOTES ON GEOGRAPHIC DISTRIBUTION

Odocoileus virginianus, Zimmermann, 1780 (Mammalia: Cervidae): Confirmed records and distribution extension in the northern Brazilian Amazon

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ABSTRACT: We present details of five new field records of *Odocoileus virginianus* from the northern Brazilian Amazon, extending its known range from Suriname to the Brazilian state of Pará. We also document four sight records and four records based on specimens held in collections of white-tailed deer distribution from the states of Amapá and Roraima, reinforcing this inferred distribution. Confirmation of the occurrence of *O. virginianus* in the Brazilian Amazon is important for its conservation, since it is an important game species for traditional human populations and requires population-level management.

The white-tailed deer, *Odocoileus virginianus* (Zimmermann, 1780) has a broad distribution in the Americas, occurring from Canada south to northern South America, including the United States, Mexico, Central America, Venezuela, Guyana, Suriname, French Guyana, parts of Colombia, Ecuador, Peru, northwestern Bolivia, and Brazil. In Brazil this species has only been reported from northern Roraima state and in the eastern portion of Amapá state (Brokx 1984; Eisenberg and Redford 1999; Smith 1991; Gallina *et al.* 2010).

The taxonomic arrangement of the genus *Odocoileus* is still under discussion given a lack of study of this species in many parts of its range; especially in South America (Cabrera 1961; Molina and Molinari 1999; Moscarella *et al.* 2003; Molinari 2007). Also to this part of America, the ecology and distribution of the white-tailed deer has been the subject of only a few studies in Venezuela, Bolivia, and Ecuador (Brokx 1984; Molina and Molinari 1999; Gallina and Lopez-Arevalo 2008). In this context, the oldest name available for the "South American" white-tailed deer is *O. v. cariacou* (Boddaert, 1784), whose type locality is "Guyana and Brazil" (Cabrera and Yepes 1960). Unfortunately, this inaccurate provenience and lack of habitat description have made it difficult to understand the geographic distribution of the white tailed deer in Brazil (Smith 1991; Tiepolo and Tomas 2006; Gallina *et al.* 2010). In this way, the objective of this study is to present new field records of *O. virginianus* in Amapá, Pará and Roraima states, extending its current geographical distribution in northern Brazilian Amazon.

Between January 2008 and November 2010, the scientific collections of the Emílio Goeldi Museum - MPEG (Belém, Pará, Brazil) and University of São Paulo Museum - MZUSP (São Paulo, Brazil) were searched for specimens of *O. virginianus*. In addition, the database of the American Museum of Natural History (New York, U.S.A) and the Field Museum – FMNH (Chicago, U.S.A) were also consulted. At the same period, we conducted field studies at two sites in Pará and Amapá states.

One of these sites, the Tumucumaque´s Indigenous Reserve (TIR), is located at Pará state in northern Brazilian Amazon (Figure 1A), on the border with Suriname. About 3000 Indians, of six different ethnicities, inhabit the TIR, including: Wayana, Aparai, Kaxuyana, Tiriyó, Wajãpi and Tikuyana (Velthem 1990). These indigenous are proficient hunters and live on villages distributed on approximately 2,350,000 hectares of typical tropical Amazonian rainforest (Figure 2A) and 750,000 hectares of natural savanna (Figure 2B), that constitute the principal TIR´s ecosystems (Figures 1B, 2A and 2B). At this site we conducted research on bushmeat offtake in four indigenous villages, the: Missão Tiriyó, Kuxare, Urunai and Apalaí (Figure 1B). We spent 15 days in each village recording kill profiles and collecting the skulls when possible. All records of *O. virginianus* from this study site were hunted animals recorded during this indigenous game research, in partnership with the IEPÊ Foundation, the National Indigenous Foundation of Brazil (FUNAI) and the Federal University of Pará (UFPA).

All skulls or antlers of *O. virginianus* were photographed, but only two skulls were donated by the hunters (Table 1). These collected skulls were deposited at the Museum of Federal University of Pará – Laboratory of Ecology and Zoology of Vertebrates, Belém, Pará, Brazil (UFPA accession numbers 388, 389). In most cases, the exactly geographical coordinates of where the animals were killed was recorded (using a GPS) but when this was not possible, we used the geographical coordinates of the village and ask to the hunter for the description of the habitat where the animal was killed.

The second study site, is located in Amapá state and encompasses a mosaic of Amazonian ecosystems, including 100,900 hectares of natural savannas (Figure 2C) and 95,000 hectares of *Eucalyptus* plantations, embedded in a

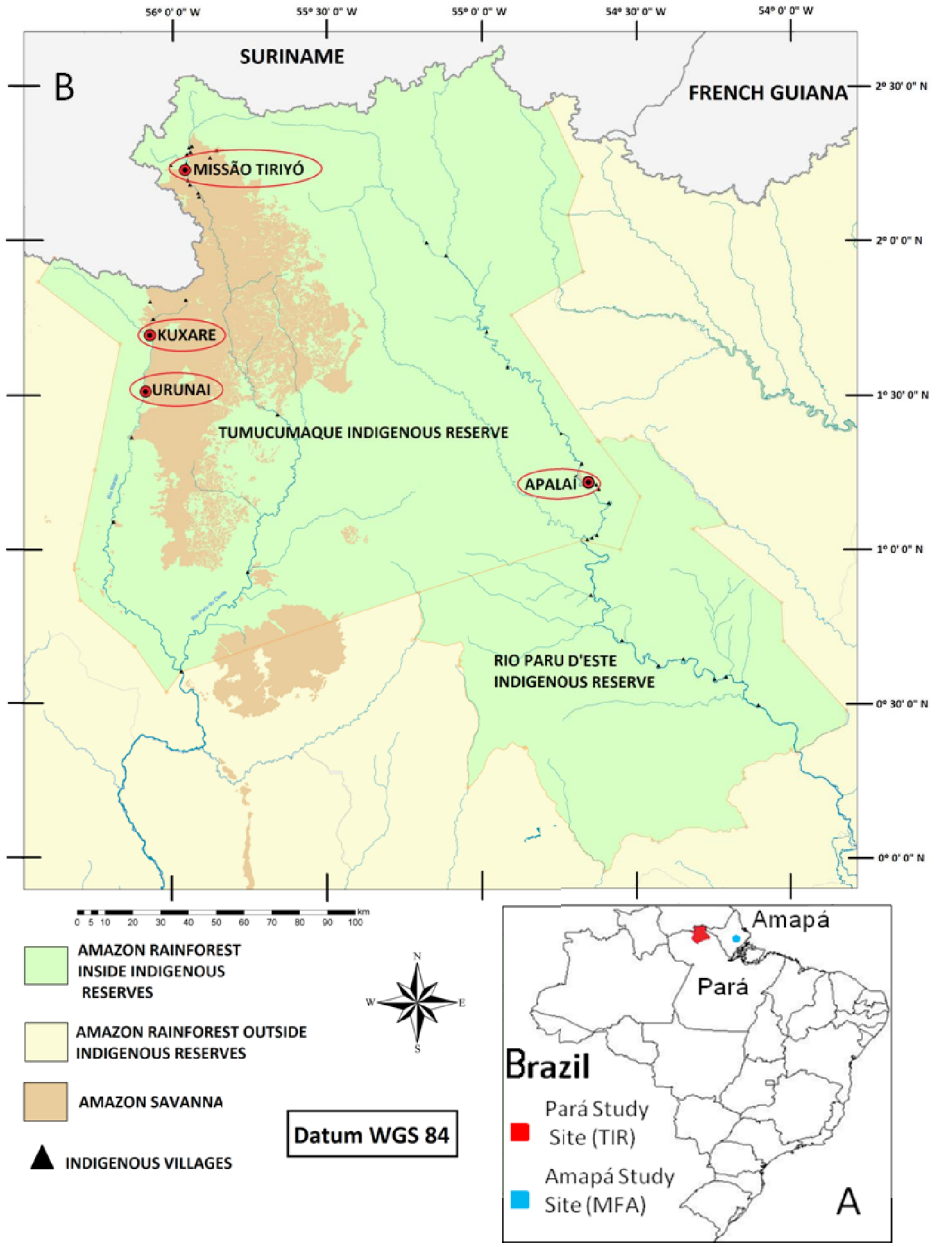

Figure 1. Location of new field records of *Odocolieus virginianus*. A – Pará and Amapá study sites in Brazil; B – Detail of Pará study site, with indigenous villages where *O. virginianus* was recorded.

matrix of savanna and riparian forests (Figure 2D). This *Eucalyptus* plantation belongs to an international forestry company and is located about 100 Km north of Macapá (the capital of Amapá) (Figure 1A).

The records of *Odocolieus virginianus* recorded from this site formed part of a terrestrial mammalian inventory conducted in natural savanna and *Eucalyptus* plantations. This study's principal objective was to analyze the use of *Eucalyptus* plantation by large mammals, using line transects censuses (cumulative total of 900 km walked). We recorded two visual detections of *O. virginianus* and one skull was collected in the field. This specimen was also deposited at the Museum of Federal University of Pará – Laboratory of Ecology and Zoology of Vertebrates, Belém, Pará, Brazil (UFPA 395: Table 1). A second skull collected in the same region, years ago, was deposited at the Emilio Goeldi Museum, Belém, Pará, Brazil, (MPEG 39486; Table 1).

Using these new records we were able to draw up a new distribution map for the species (Figure 4) extending

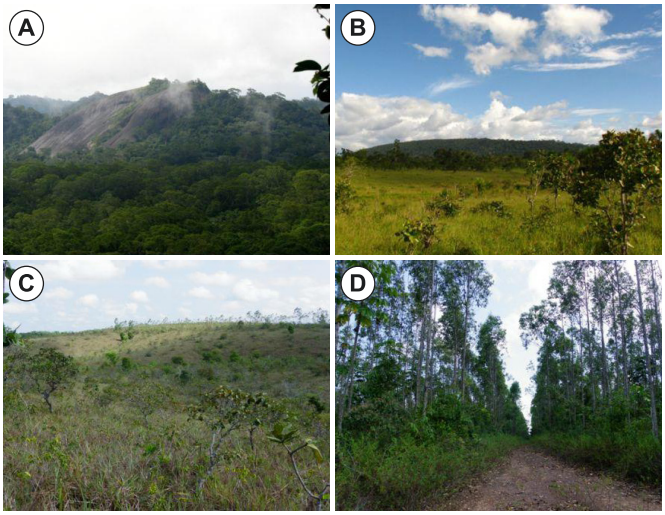

Figure 2. Habitats within the study areas. A – Rainforest habitat at Tumucumaque´s Indigenous Reserve (Pará); B – Savanna habitat at Tumucumaque´s Indigenous Reserve (Pará); C – Savanna habitat at Management Forest Area (Amapá); and D – Forestry of *Eucalyptus* spp. habitat (Amapá).

its known occurrence from Suriname to the state of Pará. Thirteen records of *O. virginianus* in the Brazilian Amazon are indicated on the map in the Amazonian states of Amapá, Pará and Rondônia (Figure 4; Table 1). These records came from savanna habitats or adjoining anthropogenic land-uses (two records inside *Eucalyptus* plantations at the Amapá study site).

Given that *O. virginianus* is one of the largest Brazilian cervids and inhabits open habitats, the shortage of records can be attributed to a lack of field studies given that access to most of its Amazonian distribution is difficult. However, it also possible that a lack of records may reflect local

Table 1. Records of *Odocoileus virginianus* in the Brazilian Amazon. *According to Figure 4. ** MPEG – Emílio Goeldi Museum (Pará, Brazil); MZUFPA – University of Pará Zoological Museum (Pará, Brazil); MZUSP - University of São Paulo Museum (São Paulo, Brazil); and FMNH - Field Museum (Chicago, U.S.A).

MAP SITE*	SPECIMEN**	LOCALITY	STATE	COORDINATES	HABITAT	RECORD DESCRIPTION	RECORD YEAR
A	MPEG 1779	Oiapoque municipality	Amapá	01°36'0.14" S 50°53'0.21" W	???	Skull (branch, jaw missing)	1956
B	MZUSP 24901	Fazenda Salvamento	Roraima	3°18'0.19" S 61°06'0.55" W	???	Skull (branch, jaw missing)	1988
C	MPEG 39486	Amapá municipality	Amapá	3°43'0.56" S 51°33'0.13" W	Amazon Savanna	Complete skull	1989
D	MZUFPA 388	TIR-Apalai Village	Pará	01°12'8.38'' S 54°39'3.36'' W	Amazon Savanna	Skull (branch, jaw missing)	2008
E	not collected	TIR-MissãoTirió Village	Pará	02°13'5.50" S 55°57'3.93" W	Amazon Savanna	Skull photographed in the field (branch, jaw missing)	2008
F	MZUFPA 389	TIR-Urunai Village	Pará	01°31'1.15" S 56°04'5.61" W	Amazon Savanna	Branch	2008
G	not collected	TIR-Urunai Village	Pará	01°31'1.15" S 56°04'5.61" W	Amazon Savanna	Skull photographed in the field (branch, jaw missing)	2009
H	not collected	TIR-Kuxaré Village	Pará	01°42'0.89" S 56°04'0.52" W	Amazon Savanna	Skull photographed in the field (branch, jaw missing)	2009
I	MZUFPA 395	MAF	Amapá	00°38'0.53" S 51°14'0.58" W	Amazon Savanna	Skull (branch, jaw missing)	2010
J	not collected	MAF	Amapá	00°41'0.15" S 51°07'0.48" W	Road (between *Eucalyptus* spp. forestry)	Visual record of live animal (line transect method)	2010
K	not collected	MAF	Amapá	00°41'0.15" S 51°07'0.48" W	Road (between *Eucalyptus* forestry)	Visual record of live animal (line transect method)	2010
L	MPEG 34153	Tartarugalzinho municipality	Amapá	01°43'0.43" S 50°53'0.24" W	Amazon Savanna	Fragmented skull	???
M	FMNH 20029	Serra da Lua (near Boa Vista)	Roraima	02°15'0.01" S 60°45'0.01" W	???	Skull (branch, jaw missing)	1912

hunting pressure in areas where access is easier. Hunting is an important cultural and economic subsistence strategy in Amazonia (Vickers 1984; 1991; Bodmer *et al*. 1994). Even at a subsistence level, this activity can have negative effects on the diversity of medium and large mammals (Redford and Robison 1987; Robinson and Bennett 2000; Peres 2000; 2001; 2007).

We were unable to confirm that *O. virginanus* is a commonly hunted species at the Amapá study site, but given our low detection rate, it seems to be rare at this site. A relevant issue is that the human access and pressure at Amapá´s savanna is much greater than in TIR (Pará´s Savanna). Since 1980´s part of the Amazon savannas in Amapá state has been replaced by *Eucalyptus* and *Pinus* as alternative to the lack of land in southern and southeastern Brazil (Nepstad *et al.* 1997). Despite the fact that TIR is located on a relatively well-protected and preserved area, we can confirm that *O. virginianus* is a valued game species for indigenous hunters. Thus the species is locally threatened by both hunting and land-use change.

Hershkovitz (1958) and Quay (1971) corroborated by Molina and Molinari (1999) suggested that *O. virginianus* evolutionary origins lay in Central America, subsequently dispersing to North America and South America after the rise of the Panama Isthmus, about 3 million years ago. Occurring from northern temperate to subtropical and semi-arid environments in North, Central and South America, the white tailed deer exhibits a great degree of ecological plasticity (Molinari 2007; Smith 1991; Walter *et al.* 2009; Gallina *et al.* 2010). They are also able to persist in anthropogenically-moderated habitats such as secondary forests (Mendez 1984; Walter *et al.* 2009).

Figure 3. Skull of *Odocoileus virginianus* collected in the Pará study area.

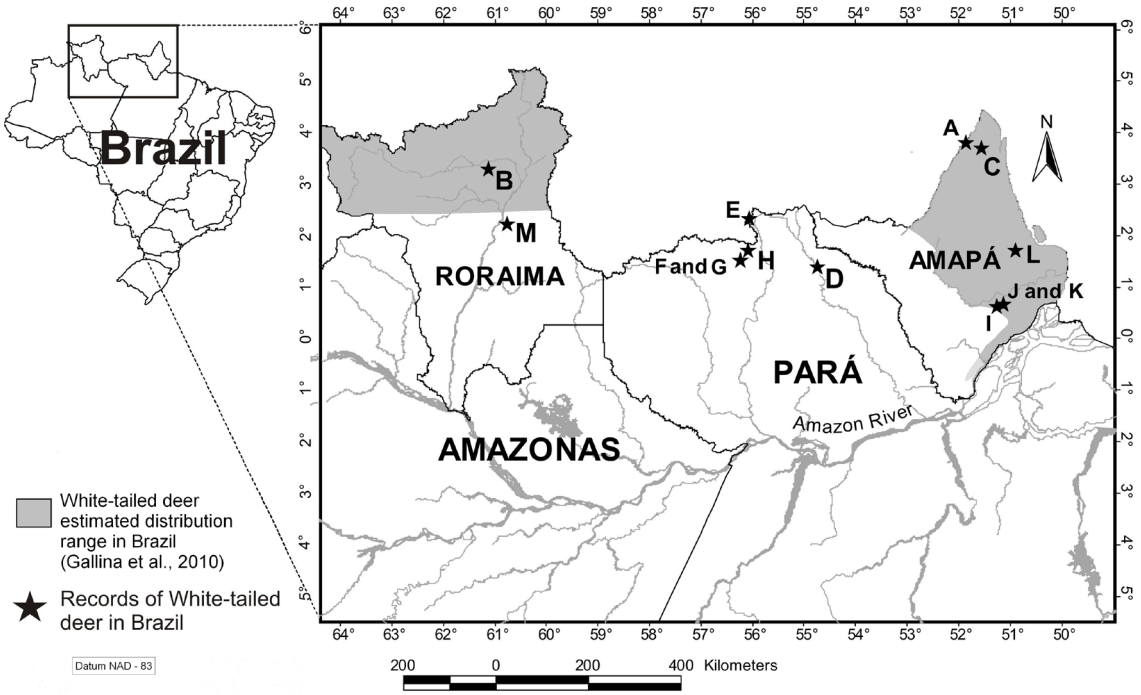

Figure 4. Estimated geographic distribution of *Odocoileus viginianus* (shaded area) and new records for the species (stars) obtained by this study in Brazil. The details of localities are specified in Table 1.

However, despite this apparent ecological plasticity, in Brazil the white tailed deer seems to prefer open areas, such as savannas, and although it have been reported from the borders of primary rainforest (by indigenous peoples at the Tumucumaque´s Reserve) it is not considered a rainforest species (Emmons and Feer 1997). The tall stature and branched antlers make *O. virginianus* maladapted to life inside dense forest. Although it is quite difficult to prove the absence of a species in any area, the few mammalian inventories conducted in forested habitats to the north of the Amazon river, in Pará and Amapá states, did not detect the presence of *O. virginianus* (Barlow *et al*. 2007; Silva 2008). Thus, the species preference for open areas is probably an important factor limiting its geographical spread in Brazilian Amazonia, which it will be probably restricted to Amazon savannas.

Considering the restricted geographical distribution of *O. virginianus* in the Brazilian Amazon, coupled with anthropogenic pressures this study suggests the need for further investigation, including assessment of this subspecies taxonomic status to guide conservation actions, and create effective management plans.

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