



Paleoecology and radiocarbon dating of the Pleistocene megafauna of the Brazilian Intertropical Region

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ABSTRACT

During the Pleistocene a fauna composed of large (biomass > 44 kg) and giant mammals (biomass > 1000 kg) that are usually associated with open environments lived in the Brazilian Intertropical Region. We present here new information concerning the paleoecology and chronology of some species of this megafauna. Carbon isotope analyses were performed for a better understanding of the paleoecology of the species *Eremotherium laurillardii* (Lund, 1842), *Notiomastodon platensis* (Ameghino, 1888) and *Toxodon platensis* (Owen, 1849). The $\delta^{13}\text{C}$ data allow attributing a generalist diet to these species, which varied according to the kind of habitat in which they lived. In more open habitats all species were grazers; in mixed habitats *E. laurillardii* and *T. platensis* were mixed feeders, and *N. platensis* was grazer; and in more closed habitats all species were mixed feeders.

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Introduction

The Brazilian Intertropical Region (BIR: sensu Cartelle, 1999) is characterized by the presence of several endemic giant mammals, which lived during the end of the Pleistocene and beginning of the Holocene. The BIR includes all states of the northeastern Brazil (except Maranhão) as well as Goiás, Minas Gerais, Espírito Santo and Rio de Janeiro states (Fig. 1).

According to Cartelle (1999), some species from the southern regions of the continent (allochthonous fauna) would have migrated to the BIR at the end of the Pleistocene and beginning of the Holocene. In the BIR, these species would have coexisted sympatrically with the autochthonous fauna of this region, which was adapted to live in dry forests (savannah or steppic savannah). However, chronological data gathered by Dantas et al. (2011) suggested that this fauna was not restricted to the end of the Pleistocene as previously considered and, therefore, they questioned the traditional interpretation regarding the paleoecology of these faunas. The main purpose of the present contribution is to show and to discuss stable carbon isotope and radiocarbon data for *Eremotherium laurillardii* (Lund, 1842), *Notiomastodon platensis*

(Ameghino, 1888) (= *Stegomastodon waringi*; Mothé et al., in press) and *Toxodon platensis* (Owen, 1849) from some localities of the BIR.

Materials and methods

Sixteen skeletal samples of *Eremotherium laurillardii*, *N. platensis*, and *T. platensis* from localities in Bahia (BA), Sergipe (SE) and Rio Grande do Norte (RN) (Table 1) were measured to obtain the carbon isotopic composition of bone, dentin and enamel carbonate. Some of these samples (Table 1) were dated using accelerator mass spectrometry (AMS) at the Center for Applied Isotope Studies of the University of Georgia/USA, calibrated using IntCal98 (Reimer et al., 2009). Samples were collected from fossil specimens housed at the following institutions: Laboratório de Geologia/Universidade Estadual do Sudoeste da Bahia (Bahia, Brazil); Laboratório de Paleontologia/Universidade Federal de Sergipe (Sergipe, Brazil); Memorial de Sergipe/Universidade Tiradentes (Sergipe, Brazil); and Museu Câmara Cascudo/Universidade Federal do Rio Grande do Norte (Rio Grande do Norte, Brazil).

Data from the ^{13}C analyses ($\delta^{13}\text{C}\text{‰}$) were used to infer the diet of the studied mammals. In medium- to large-sized animals $\delta^{13}\text{C}$ can be enriched by 12‰ to 14‰ (Cerling and Harris, 1999). Values of $\delta^{13}\text{C} < -10\text{‰}$, which were found in the tooth enamel, represent a pure C_3 feeder, whereas values of $\delta^{13}\text{C} > -1\text{‰}$ represent a diet based on C_4 grasses. Values of $\delta^{13}\text{C}$ between -10‰ and -1‰ indicate a mixed

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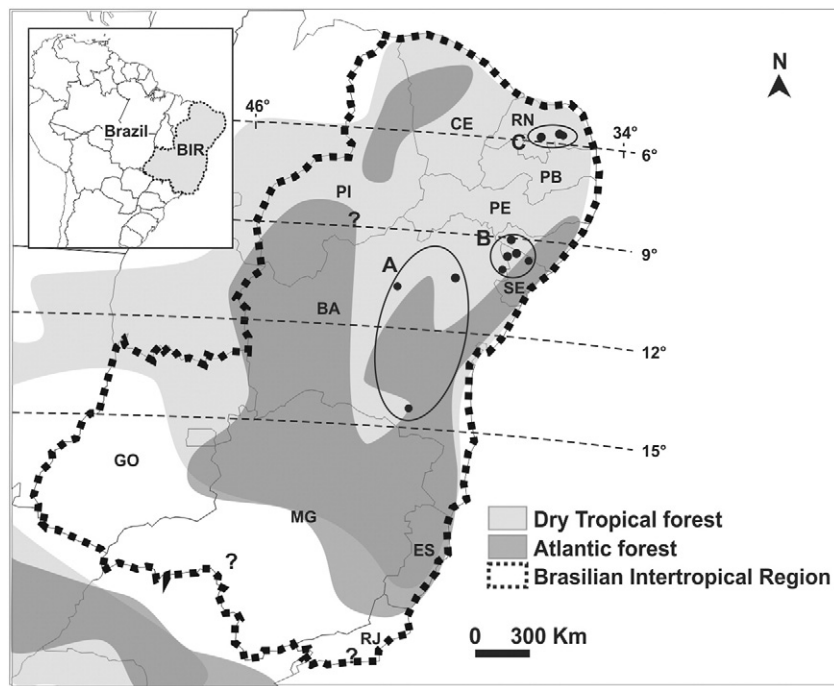


Figure 1. Brazilian Intertropical Region (BIR) map, showing the potential distribution of the Atlantic Forest (modified from Carnaval and Moritz, 2008) and the Dry Tropical Forest (after Werneck et al., 2011). (A) Represents a region which includes the municipalities of: Vitória da Conquista/BA, Morro do Chapéu/BA, Ouro-lândia/BA, Quinjingue/BA, and, tentatively, Toca do Gordo do Garrincho/PI (?), Águas de Araxá/MG (?) and São José do Itaboraí/RJ (?). (B) Region that includes the municipalities of Coronel João Sá/BA, Poço Redondo/SE, Gararu/SE, Canhoba/SE and Maravilha/AL. (C) Region that includes the municipalities of Rui Barbosa/RN, Barcelona/RN and Currais Novos/RN. States that comprise the BIR: GO – Goiás; MG – Minas Gerais; RJ – Rio de Janeiro; ES – Espírito Santo; BA – Bahia; SE – Sergipe; AL – Alagoas; PE – Pernambuco; PB – Paraíba; RN – Rio Grande do Norte; CE – Ceará; PI – Piauí (sensu Cartelle, 1999).

diet of C_3 and C_4 plants (MacFadden et al., 1999; MacFadden, 2005). These values were here considered in the interpretation of isotopes values for both bone and dentin. Examples of recent studies with this

approach were conducted by MacFadden et al. (1999) for *Equus*; Sánchez et al. (2004) for *Notiomastodon* and *Cuvieronius*; and MacFadden (2005) for *Toxodon* and *Mixotoxodon*.

Table 1

^{13}C analyses and radiocarbon dating for skeletal elements of Brazilian Intertropical Region fossils. Legends – skeletal tissue (st): d (dentine); b (bone); or e (enamel).

Species	Sample number	Localities	Lat (°S)	$\delta^{13}\text{C}$ (‰) on st	^{14}C age $\pm 1\sigma$ on st (^{14}C yr BP)	Calibrated age* (2σ range, cal yr BP)
<i>Eremotherium laurillardii</i>	UGAMS 4935 ⁽³⁾	Currais Novos/RN ^(A)	6	0.50 (d)	15,490 \pm 40 (b)	18,580–18,850
<i>Eremotherium laurillardii</i>	UGAMS 4936 ⁽³⁾	Barcelona/RN ^(A)	6	5.22 (d)	–	–
<i>Eremotherium laurillardii</i>	SM-1 ⁽¹⁾	Maravilha/AL	9	0.30 (d)	–	–
<i>Eremotherium laurillardii</i>	MA-1 ⁽¹⁾	Maravilha/AL	9	–12.00 (d)	–	–
<i>Eremotherium laurillardii</i>	UGAMS 4931 ⁽³⁾	Poço Redondo/SE ^(B)	9	–6.65 (d)	–	–
<i>Eremotherium laurillardii</i>	UGAMS 4932 ⁽³⁾	Poço Redondo/SE ^(B)	9	–3.85 (d)	22,440 \pm 50 (d)	26,690–27,690
<i>Eremotherium laurillardii</i>	UGAMS 4933 ⁽³⁾	Poço Redondo/SE ^(B)	9	–2.45 (d)	–	–
<i>Eremotherium laurillardii</i>	UGAMS 4934 ⁽³⁾	Gararu/SE ^(B)	10	–3.25 (d)	–	–
<i>Eremotherium laurillardii</i>	UGAMS 6136 ⁽²⁾	Quijingue/BA	10	–18.20 (b)	15,770 \pm 40 (b)	18,730–19,280
<i>Notiomastodon platensis</i>	UGAMS 4940 ⁽³⁾	Barcelona/RN ^(A)	6	0.44 (e)	16,150 \pm 40 (e)	18,930–19,450
<i>Notiomastodon platensis</i>	SM-3 ⁽¹⁾	Maravilha/AL	9	0.00 (d)	–	–
<i>Notiomastodon platensis</i>	MA-3 ⁽¹⁾	Maravilha/AL	9	1.47 (d)	–	–
<i>Notiomastodon platensis</i>	UGAMS 4937 ⁽³⁾	Poço Redondo/SE ^(B)	10	0.76 (e)	–	–
<i>Notiomastodon platensis</i>	UGAMS 4938 ⁽³⁾	Cel. João Sá/BA ^(B)	10	–1.04 (e)	13,980 \pm 40 (e)	16,800–17,380
<i>Notiomastodon platensis</i>	UGAMS 4939 ⁽³⁾	Canhoba/SE ^(C)	10	–1.86 (e)	17,910 \pm 50 (e)	21,180–21,550
<i>Notiomastodon platensis</i>	UGAMS 4941 ⁽³⁾	Cel. João Sá/BA ^(B)	10	–0.49 (e)	–	–
<i>Notiomastodon platensis</i>	s/n ⁽⁴⁾	Ouro-lândia/BA	10	–8.20 (e)	–	–
<i>Notiomastodon platensis</i>	s/n ⁽⁴⁾	Ouro-lândia/BA	10	–5.00 (e)	–	–
<i>Toxodon platensis</i>	UGAMS 4942 ⁽³⁾	Rui Barbosa/RN ^(A)	6	–1.32 (e)	10,730 \pm 30 (e)	12,560–12,720
<i>Toxodon platensis</i>	SM-5 ⁽¹⁾	Maravilha/AL	9	–4.10 (d)	–	–
<i>Toxodon platensis</i>	MA-5 ⁽¹⁾	Maravilha/AL	9	1.51 (d)	–	–
<i>Toxodon platensis</i>	UGAMS 4946 ⁽³⁾	Poço Redondo/SE ^(B)	9	–3.68 (e)	10,050 \pm 30 (e)	11,400–11,750
<i>Toxodon platensis</i>	UGAMS 4943 ⁽³⁾	Cel. João Sá/BA ^(B)	10	–1.08 (e)	–	–
<i>Toxodon platensis</i>	UGAMS 4944 ⁽³⁾	Cel. João Sá/BA ^(B)	10	–1.00 (e)	–	–
<i>Toxodon platensis</i>	U-96-150 ⁽⁵⁾	Pedra Vermelha/BA	10	–5.50 (e)	–	–
<i>Toxodon platensis</i>	U-96-148 ⁽⁵⁾	Ouro-lândia/BA	10	–12.60 (e)	–	–
<i>Toxodon platensis</i>	U-96-149 ⁽⁵⁾	Ouro-lândia/BA	10	–7.70 (e)	–	–
<i>Toxodon platensis</i>	UGAMS 4944 ⁽³⁾	Vitória da Conquista/BA ^(D)	14	–13.24 (e)	10,970 \pm 30 (e)	12,660–13,050

*Calibrated with IntCal98 (Reimer et al., 2009) and calculated with Calib 6.0 (<http://calib.qub.ac.uk/calib/calib.html>; last accessed 25 September 2012).

⁽¹⁾Silva (2009); ⁽²⁾Drefahl (2010); ⁽³⁾Our data; ⁽⁴⁾Sánchez et al. (2004); ⁽⁵⁾MacFadden (2005) Institutions. ^(A)Museu Câmara Cascudo/Universidade Federal do Rio Grande do Norte; ^(B)Laboratório de Paleontologia/Universidade Federal de Sergipe; ^(C)Memorial de Sergipe/Universidade Tiradentes; ^(D)Laboratório de Geologia/Universidade Estadual do Sudoeste da Bahia.

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