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NEW ACCELERATOR MASS SPECTROMETRY (AMS) AGES SUGGEST A REVISION OF THE ELECTRON SPIN RESONANCE (ESR) MIDDLE HOLOCENE DATES OBTAINED FOR A *TOXODON PLATENSIS* (TOXODONTIDAE, MAMMALIA) FROM SOUTHEAST BRAZIL

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ABSTRACT. In a paper published in *Applied Radiation and Isotopes*, Baffa et al. (2000) reported a Middle Holocene date (~6.5 kyr BP) for a specimen of *Toxodon platensis* from Ribeira do Iguape, southeast Brazil, using the emergent technique electron spin resonance (ESR). Through an accelerator mass spectrometry (AMS) procedure applied on tooth collagen, we provide a new set of dates to test the accuracy of the ages generated by ESR. We obtained 2 dates more than 4500 BP older than the previous one, suggesting a minimum Late Pleistocene age for the specimen.

INTRODUCTION

One of the most conspicuous contributions to the understanding of the extinction of megafauna in Brazil is the work of Baffa et al. (2000) published in *Applied Radiation and Isotopes*. Through an emergent technique, electron spin resonance (ESR), they dated a *Toxodon platensis* (an extinct huge herbivore of South America) pre-molar from Ribeira do Iguape, southeast Brazil. Two dates were obtained by them: 1 on the dentine (6.7 ± 1.3 kyr BP) and 1 on the enamel (5.0 ± 1.6 kyr BP). Despite the differences between the dates, "statistical tests" performed by these authors resulted in no significant differences, probably due to the large standard deviations applied. Thus, Baffa et al. (2000) concluded that the dates generated were in agreement with each other and therefore should be used as reliable absolute dates for the specimen.

These dates are relevant because they are the youngest absolute dates found for a megafauna specimen in Brazil, where the other most recent absolute date obtained by accelerator mass spectrometry (AMS) is 9260 ± 150 BP for a specimen of *Smilodon populator* from Lagoa Santa, Minas Gerais (Neves and Piló 2003). De Vivo and Carmignotto (2004), among others, used the Middle Holocene dates generated by Baffa et al. (2000) to support a late survival of megafauna in South America.

METHODS

Considering the important implications of the dates obtained by Baffa et al. (2000) on understanding megafauna extinction in Brazil, we decided to generate a new set of dates for the same specimen of *T. platensis* based on the well-accepted technique of AMS on collagen, to test the accuracy of the ESR dates. Two samples from the same tooth used for the ESR analysis (PF997) were removed and sent independently to be dated by AMS in the Beta Analytic Radiocarbon Dating Laboratory (Miami, Florida, USA).

RESULTS AND DISCUSSION

The dates obtained for these samples were both Late Pleistocene. The detailed results can be seen in Table 1. Despite the differences between the 2 dates, the age statistical overlap was within the 2-σ calibrated results (Table 1), showing that they are consistent with each other.

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Table 1 AMS dating results for the *T. platensis* tooth (PF997).

Sample	Beta number	$^{13}C/^{12}C$	Conventional ^{14}C age	Age cal BP[a] (2 σ)
PF997	215330	–23.5‰	11,380 ± 40 BP	13,150–13,770 cal BP
PF997*1	218193	–26.3‰	11,090 ± 40 BP	12,900–13,180 cal BP

[a]Ages calibrated according to Stuvier et al. (1998) and Talma and Vogel (1993).

One of our samples (PF997) showed poorly preserved collagen. Accordingly, the $^{13}C/^{12}C$ ratio is a little lower than the optimum range accepted by the laboratory for dentine, suggesting contamination. On the other hand, the other sample (PF997*1) presented well-preserved collagen. However, its $^{13}C/^{12}C$ ratio is still lower than the levels accepted by the laboratory for a reliable age, indicating possible contamination. Given that the place where the tooth was collected has had massive intrusions of recent organic debris, the sources of possible contaminants for the tooth are more recent than the specimen. Thus, following the advice of Beta Analytic staff, the dates presented here should be interpreted as minimum dates.

When analyzing other lines of evidence, such as the already published chronological data for the Brazilian megafauna (see Auler et al. [2006] for a compilation), our ages fit well into the chronological span already generated. This suggests that even if the dates are biased by recent contaminants, they are still within the normal range of dates available.

We believe that the dates presented here can be taken as absolute dates instead of minimum ages. The values observed for the $^{13}C/^{12}C$ ratio in Table 1 could be a result of *T. platensis* ecology, which is until now poorly understood (MacFadden 2005), and not an indication of contamination. Further studies will be necessary to clarify this point.

In conclusion, not only do the AMS ages contrast with the ESR dates by more than 4500 BP, but they also fit better in the already known chronological distribution of the megafauna in Brazil. In our opinion, until the ESR limitations are better understood, the minimum age of approximately 11,240 BP must be considered a more consistent chronological framework for specimen PF997.

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