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U-series dating and taphonomy of Quaternary vertebrates from Brazilian caves

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Abstract

The geochronology and taphonomy of internationally important fossil bearing cave deposits were studied, both in the semi-arid Northern Bahia area and the subtropical southeastern Lagoa Santa area of Brazil. Taphonomic analysis suggests that the processes responsible for bone accumulation in the Brazilian caves vary between sites, and taphonomic bias can therefore be significant in causing differences in faunal composition. In the Toca da Boa Vista caves the presence of single articulated skeletons, and the entrance-related distribution indicate that random penetration of animals is the main mechanism of fossil accumulation, a process that biases the assemblage to smaller species, and takes place over extended time periods. In nearby Toca dos Ossos cave transport by runoff in the cave river is predominant, and biases the fauna remains to larger more robust bones and species. Deposition probably also occurred only at times of enhanced runoff giving a more contemporaneous assemblage. Similar processes were responsible for emplacement of the copious fossil remains in the more humid Lagoa Santa area, where terrigenous fossil deposits are found intercalated by massive speleothem calcite layers. In this area runoff under a drier climate probably accounts for the sediment emplacement inside caves. In both areas the mode of emplacement implies bias in the fossil record, resulting in fossil assemblages that do not mirror surface faunas, limiting palaeoenvironmental reconstruction.

Mass spectrometric U-series analysis of speleothem calcite overlaying fossil remains gives minimum ages for fossil deposition. These ages confirm the previous view that many of the deposits derive from the late glacial, but also show that much older material (some >350,000 yr) is also present. The habitat requirements of critical fossil species such as bats and monkeys strongly suggest that they derive from much wetter periods when forest cover was present in the currently semi-arid Northern Bahia area. Taphonomy exerts a major control on the diversity and mode of emplacement of cave fossil deposits in eastern Brazil and thus detailed sedimentological and hydrological studies coupled with a sound geochronological approach are essential in quantifying the relative importance of each taphonomic processes before faunal and palaeoecological interpretations can be attempted.

Keywords: Late Quaternary; Speleothems; Taphonomy; Palaeontology; Palaeoecology

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1. Introduction

Since the pioneering studies by Lund (1840) in early 19th century, cave deposits have provided a remarkable number of well-preserved fossil remains, which have formed the basis for Pleistocene vertebrate palaeontological research in Brazil (Paula Couto, 1953). However, despite the significance of cave-derived fossil remains, stratigraphic control has often been poor, and there has been limited research on both the geochronology and taphonomy of the deposits. The failure to establish a regional cave-derived chronology in Brazil has led researchers to seek a correlation with similar but much better chronologically constrained faunas in Argentina (Paula Couto, 1975), and a generalised "late Quaternary" age has been assigned for the Brazilian

Table 1
Reported ages (uncalibrated and calibrated radiocarbon, ESR and alpha spectrometric U-series) of fossil remains in Brazilian caves

Cave site, locality	Method	Age (yr BP)	Age (cal yr BP)	Correlation	Fossil mammal
Bahia					
Toca da Boa Vista[a]	AMS ^{14}C in bone	20,060±290	>22,850	D	*Moormops*
Gruta dos Brejões[a]	AMS ^{14}C in bone	12,200±120	15,450 (41.2%) 14,550 14,450 (54.2%) 13,750	D	Coprolite of *Nothrotherium*
Piaui					
Toca do Garrincho[b]	^{14}C in charcoal	10,020±290	12,850 (95.4%) 10,650	MI	*Hippidium*, *Palaeolama*, *Pampatherium*, *Toxodon*, *Catonyx*
Toca do Serrote do Artur[c]	^{14}C in charcoal	6890±60 8490±120	7840 (94.3%) 7610 9900 (95.4%) 9100	MI MI and C	*Dasypus*, *Propaopus*, *Hoplophorus*, *Glyptodon*, *Conepatus*, *Panthera*, *Dicotyles*, *Tayassu*, *Palaeolama* and *Mazama*
Minas Gerais					
Gruta do Baú, Lagoa Santa[d]	Calcite $^{230}Th/^{234}U$	77,700±6100		MI	*Hoplophorus euphractus* and *Pampatherium humboldti*
Lapa Vermelha, Lagoa Santa[e]	^{14}C in charcoal	9580±200	11,550 (95.4%) 10,150	C	*Catonyx cuvieri*
Lapa da Escrivânia 5, Lagoa Santa[f]	AMS ^{14}C in bone	16,900±70	20,850 (95.4%) 19,450	D	*Equus neogaeus*
Lapa da Escrivânia 5, Lagoa Santa[f]	AMS ^{14}C in bone	16,550±60	20,450 (95.4%) 19,050	D	*Equinae* (sp. indet.)
Lapa da Escrivânia 5, Lagoa Santa[f]	AMS ^{14}C in bone	16,250±60	20,050 (95.4%) 18,750	D	*Equus neogaeus*
Lapa da Escrivânia 5, Lagoa Santa[f]	AMS ^{14}C in bone	16,180±70	19,950 (95.4%) 18,650	D	*Equus neogaeus*
Lapa dos Tatus, Lagoa Santa[f]	AMS ^{14}C in bone	14,030±50	17,350 (95.4%) 16,350	D	*Catonyx cuvieri*
Lapa dos Tatus, Lagoa Santa[f]	AMS ^{14}C in bone	13,920±50	17,200 (95.4%) 16,200	D	*Catonyx cuvieri*
Gruta Cuvieri, Lagoa Santa[f]	AMS ^{14}C in bone	9960±40	11,570 (95.4%) 11,220	D	*Catonyx cuvieri*
Lapa da Escrivânia 5, Lagoa Santa[f]	AMS ^{14}C in bone	9130±150	10,700 (95.4%) 9750	D	*Smilodon populator*
Mato Grosso					
Santa Elina Rock Shelter[g]	^{14}C in charcoal	10,120±60	12,150 (94.2%) 11,300	C	*Glossotherium* aff. *G. lettsomi*
Sao Paulo					
Abismo Ponta de Flecha[h]	ESR in bone	6700±1300[i] 5000±1600[j]		D	*Toxodon platensis*

Bracketed figures are probabilities that calibrated radiocarbon dates lie within the quoted range. D — Direct determination on fossil; C — Correlative age (charcoal in same stratigraphical layer); MI — Minimum age (dating of overlying material).
Doubtful determinations such as radiocarbon ages on speleothem calcite and $^{230}Th/^{234}U$ analysis of fossil bone are not included.
[a] Czaplewski and Cartelle (1998).
[b] Guérin et al. (1996) and Peyre et al. (1998).
[c] Faure et al. (1999).
[d] Piló (1998).
[e] Laming-Emperaire et al. (1975) and Prous (2002).
[f] Neves and Piló (2003).
[g] Vialou et al. (1995).
[h] Baffa et al. (2000).
[i] Dentine.
[j] Enamel.