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Classifying vertebrate assemblages preserved in Quaternary tank deposits: Implications for vertebrate taphonomy and paleoecology

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ABSTRACT

Paleoecological interpretations require detailed taphonomic analyses which can reveal how fossil accumulations are related to the original site of life and death of organisms. In other words, only a taphonomic approach can unveil the quality of a fossil concentration and its potential for paleoecology. A frequent issue in vertebrate taphonomy and paleoecology is the definition of autochthony, parautochthony and allochthony. These terms are widely employed to translate the spatial quality of a fossil assemblage. However, its application in terrestrial vertebrate accumulations, especially in natural tank ones, is quite confused. This work proposes a form of classification of fossil vertebrate accumulations of natural tanks in relation to their proximity to the original place of death of the biocoenoses. The terms "autochthonous", "parautochthonous" and "allochthonous", originally defined based on the analysis of marine shelly faunas are reinterpreted in attempt to clarify their application to vertebrate assemblages preserved in natural tank deposits. This classification can also be applied to other trap assemblages, such as fissures, sinkholes and caves.

1. Introduction

A frequent issue in vertebrate taphonomy and paleoecology is the definition of autochthony and allochthony and how fossil vertebrates are related to their original site of death and, consequently, to their habitats and paleocommunities (Behrensmeyer, 1991). The terms "autochthonous", "parautochthonous" and "allochthonous", widely employed and accepted in the paleontological literature, were proposed by Kidwell et al. (1986) through analyses of bioclastic accumulations of marine shelly faunas. The terminology proposed by those researchers is undeniably applicable to the marine invertebrate communities, as them have organisms occupying a wealth of epistratal and endostratal niches. This variety of niches can be occupied by organisms that can be buried and preserved in life position (autochthonous sensu Kidwell et al., 1986), such as the benthic ones; and by epifaunal organisms, which can be remobilized (parautochthonous sensu Kidwell et al., 1986) or even transported and preserved out of their original life habitat (allochthonous sensu Kidwell et al., 1986). Regarding fossil assemblages, sedimentological and taphonomic evidence can demonstrate how a final burial site corresponds to the life habitat of an organism. Unfortunately, these evidence cannot be enough to distinguish a genuine death site of a place where a vertebrate carcass was deposited after be transported (Behrensmeyer, 1991).

In terrestrial vertebrate accumulations, the terms of Kidwell et al. (1986) seem not be applicable, because it is rare to recognize individuals preserved in life position. Exceptions are observed for individuals of burrow dweller species (e.g. crocodiles and xenarthrans), which can be buried in life (forming obrution deposits; Rogers and Kidwell, 2007). Additionally, it is hard to establish boundaries between parautochthony and allochthony, as actualistic studies have revealed that vertebrates can use different habitats seasonally or even during different periods of a day (Behrensmeyer and Dechant-Boaz, 1980; Cutler et al., 1999). Thus, the classification of fossil vertebrate accumulations as "parautochthonous" or "allochthonous" cannot be perceptible and will depend of the degree of spatial resolution required for paleoecological reconstructions, as previously advised by Behrensmeyer (1991). Therefore, this work proposes a form of classification of fossil vertebrate accumulations preserved in natural tanks in relation to their proximity to the original life habitat of the biocoenoses. It will reflect on the knowledge about spatial resolution, ecological partitioning and characterization of niches based on the vertebrate fossil record of tank deposits.

2. Background

Tank deposits consist of terrigenous infillings of natural depressions in basement rocks (Proterozoic and Paleozoic) in northeastern Brazil (Araújo-Júnior et al., 2013a) (Fig. 1). These deposits preserved remains of mammals, reptiles, avians and anurans (Paula-Couto, 1980; Bergqvist et al., 1997; Fig. 2). The former group is represented mainly by taxa of the Quaternary megafauna. Tank deposits represent one of the main sources of information on vertebrate paleobiodiversity and

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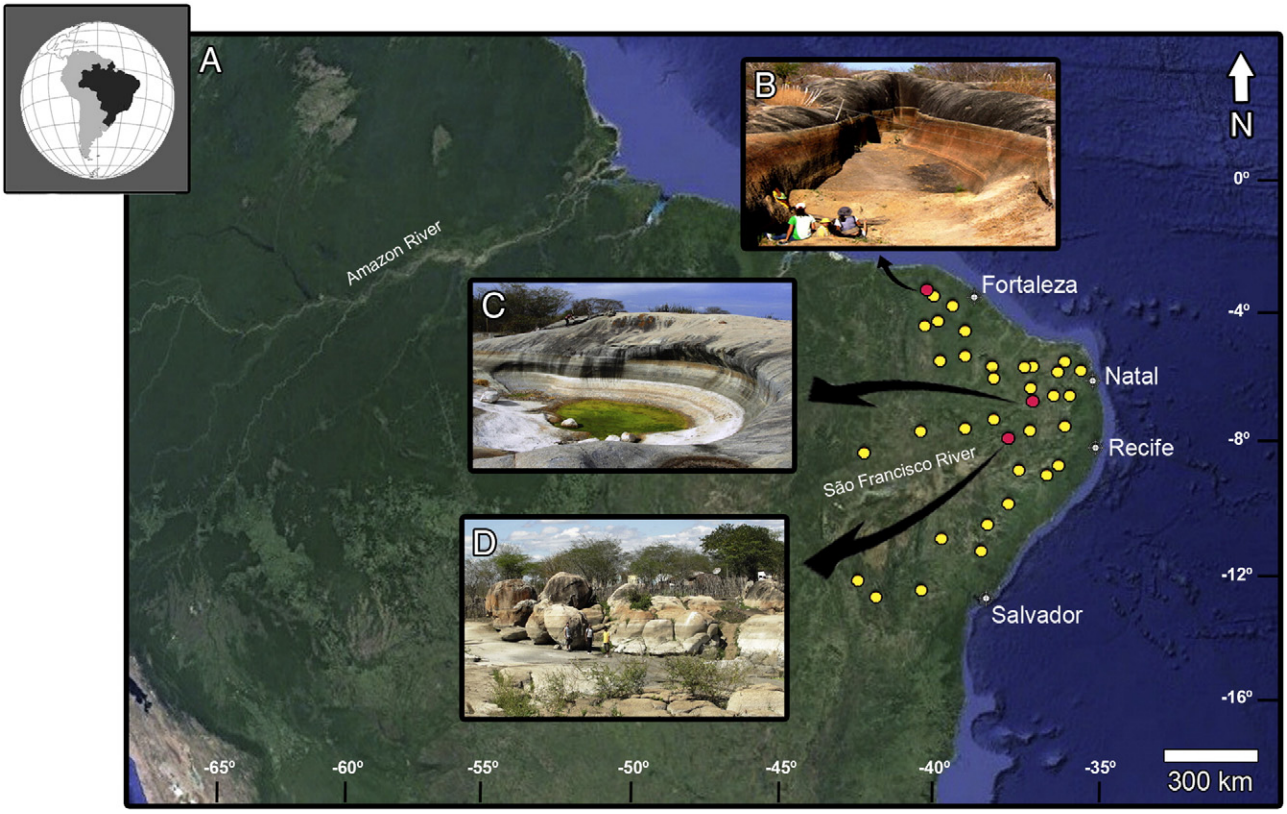

Fig. 1. Map of the occurrence of tank deposits in the Brazilian Intertropical Region. A. Occurrence of tank deposits in northeastern Brazil (dots represent tank assemblages evaluated in terms of taxonomy, taphonomy or paleoecology; red dots are tanks represented in B–D); B. Tank of Jirau, at Jirau Paleontological Site, Itapipoca, state of Ceará; C. Tank at Curimatãs Paleontological Site, Pocinhos, state of Paraíba; D. Tank at Lage Grande Paleontological Site, Alagoinha, state of Pernambuco; scale in B–D: human scale (see images); source of map: Google Earth.

paleoecology from the Quaternary of Brazil; for example, most of the taxa recorded in the Quaternary of Brazil are often found in tanks (Table 1).

Taphonomic analyses involving fossil accumulations performed up to now have contributed significantly to elucidate aspects related to the deposition and preservation of remains in natural tank deposits. In this sense, there are numerous studies that include megafauna from the Quaternary of Brazil (Santos et al., 2002; Alves et al., 2007; Araújo-Júnior et al., 2012, 2013a, 2013b, 2015; Ribeiro et al., 2013). According to the groups of Kidwell et al. (1986), some researchers (e.g. Ribeiro, 2014) have assumed that some paleontological sites include "parautochthonous" assemblages based in the Voorhies' groups analysis (Voorhies, 1969). In parallel, other researchers have employed (besides the Voorhies' groups) further analyses – bioclastic sorting or degree of transport using the Fluvial Transport Index (FTI groups) of Frison and Todd (1986) – and have then assumed that tank deposits preserved "autochthonous" assemblages (e.g. Araújo-Júnior and Porpino, 2009). Others, using only the FTI groups and analysis of bioclastic sorting, have classified some tank accumulations as "parautochthonous" (Araújo-Júnior et al., 2013a, 2013b; Silva, 2014).

Clearly, this confusion is not related to the differences in the methods employed, but seems to be concerned in the mode of classifying their fossil accumulations according to a consensual and adequate classification. Thus, it is necessary the proposal of a standardized terminology applicable to tank vertebrate accumulations. The usage of the classification proposed in this work will allow the direct comparison between results of different researchers and the integration of data to permit a better comprehension of the deposition and preservation of megafaunal remains in natural tanks, and probably of other natural traps (fissures, caves and sinkholes).

3. A proposal of classification of vertebrate accumulations of tank deposits

Behrensmeyer (1991) suggests that the terms "autochthonous", "parautochthonous" and "allochthonous" can be clearly defined by researchers taking into account the data available for each type of sedimentary deposit and the issues being addressed. Furthermore, it is important to define terminologies that are in line with the reality of the type of deposit analyzed; and to realize how taphonomic features identified in each type of deposit can respond to the question of autochthony/allochthony.

Taphonomic signatures observed in megafauna remains of tank deposits from Brazil do not by themselves allow inference of whether these accumulations were preserved in or out of the original habitat of the organisms (Araújo-Júnior et al., 2013a). Additionally, the preferential habitat of life of the taxa recorded in tank deposits is far of being established. Thus, it is necessary to adjust the terms coined by Kidwell et al. (1986), allowing further comparison between the data obtained for tank accumulations.

Here, I propose the following classification for fossil vertebrate concentrations preserved in tank deposits:

- In situ-preserved assemblage: a skeletal accumulation derived from individuals that died inside the tanks and then were preserved inside them;
- Peripheral assemblage: a skeletal accumulation derived from individuals that died around the tanks, were transported and then preserved inside the tanks;
- Ex situ-preserved assemblage: a skeletal accumulation derived from individuals that died far from the tanks, were transported and then preserved inside the tanks.