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Comments on: “An anthropogenic modification in an *Eremotherium* tooth from northeastern Brazil”

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Over 150 years ago, Peter W. Lund proposed that late Quaternary extinct megafauna (henceforth just megafauna) and *Homo sapiens* coexisted in Brazil (Lund, 1844), but only recently his hypothesis was supported by direct radiocarbon dating on megafauna bones (Neves and Piló, 2003; Hubbe et al., 2007, 2009, 2011). These dates showed that in some Brazilian regions, at least some species survived until the beginning of the Holocene and became extinct after the arrival of the first human groups. Besides the chronological evidence which indicates that humans and megafauna lived in the same region at the same time, there are also claims that they may have interacted more actively based on the finding of single (or very few) bones or bone fragments associated with human occupation levels, near archeological material, or showing marks that suggest their usage by humans. However, based on the meticulous revision provided by Prous (2002) it is possible to rule out most of these cases due to their controversial nature. In fact, few of those, if any, can be held as solid evidence of this close interaction (not considering scavenging on bones from a long ago deceased animal; Prous and Fogaça, 1999).

Recently Dantas et al. (in press) reported the finding of a single tooth fragment of the ground sloth *Eremotherium* in Sergipe State, northeastern Brazil that, according to the authors, presents anthropogenic marks that favor the coexistence of this species and *H. sapiens*. However, in our opinion their work does not provide solid evidence of an interaction of this nature and, therefore, the aim of this comment is to discuss the validity of their finding as reliable evidence of megafauna (more specifically *Eremotherium*) and humans coexistence in Sergipe. The coexistence and notably the close interaction between the former and the later may have

important implications to the understanding of the initial human occupation of South America, hence this kind of finding should not be taken as granted, but rather should be analyzed with rigorous criteria. In the following comments, we question the interpretation of the marks seen in the tooth as human-made cutmarks based on 1) the nature and location of the cutmarks and 2) the archaeological and paleontological context of the finding. Furthermore, we discuss reasons why the conclusions based on this finding could be severely distorted.

Dantas et al. (in press: 1) described the marks found on the reported tooth as an “effort to build a ‘triangular’ object”. Based on the material, the location of the marks and the scant information provided (e.g., it is not clear if more bones from *Eremotherium* were found, if there are more bones from other species with marks, which other species were found), it is hard to accept that the marks observed are the result of human intervention on the tooth. The marks are described by Dantas et al. (in press: 1) as being human because they have “parallel grooved striations, narrower and deeper, which follow the curvature of the tooth along apical and lateral borders.” Unfortunately, these characteristics are unclear to us in the pictures presented by the authors. Fig. 2F shows only striations; Fig. 2G appear to show microwear striations, when the scale of the photo (0.1 mm) is taken into account; and Fig. 2H shows a network of shallow striations that crisscross the surface in every direction. In summary, it is not possible to see the diagnostic features in the pictures presented by the authors to justify their conclusions of an anthropogenic origin for them.

Added to the diagnostic difficulties of the marks in this tooth, their occurrence is not in accordance to the standard patterns observed for food processing in ethnographic and archaeological contexts (e.g., Walker, 1978; Lupo, 2002; Lyman, 2005; Martinez, 2009), thus diminishing the possibility of butchering marks on this tooth. Indeed, Dantas et al. (in press) never claimed these marks were the result of butchering, however it is very hard to

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identify cutmarks related to the production of objects without considering the original physical, historical and behavioral context of the finding (Binford, 1981; Fisher, 1995; Martinez, 2009). Unfortunately, as it stands, Dantas and colleagues' work does not provide information to judge these elements.

Dantas et al. (in press) referred to Domínguez-Rodrigo et al. (2009) to support the differentiation between human-made and natural marks. However, this same publication cites 16 diagnostic characteristics associated with cutmarks, the majority of which were apparently not considered by Dantas and colleagues. Furthermore, it should be noticed that the differentiation between trampling and butchering marks is not straightforward (Domínguez-Rodrigo et al., 2009). Even using multivariate statistical analysis, Domínguez-Rodrigo et al. (2009) were not able to correctly classify all cases between trampling and butchering marks (although they had a high accuracy of correct classification). These same authors pointed out to the fact that in some particular conditions (when trampling occurred for a short period of time) there are some features that are not distinguishable between butchering and trampling marks.

Moreover, Dantas et al. (in press) mentioned the occurrence of lithic artifacts in the same deposit of the *Eremotherium* tooth, and suggested that some of these were used to work the material found. Nonetheless, the description of the association between the artifacts and the tooth is vague and does not allow assessment of how these elements were related. Such information should be presented, since a clear association would have strengthened their argument of causal relationship between the artifacts and the tooth marks. It is important to note that spatial proximity alone should not be used as evidence of temporal association in tank deposits, since most of the sediments found inside them are usually transported through runoffs by pluvial waters during the rainfall seasons (Oliveira and Hackspacher, 1989; Mabesoone et al., 1990). In such processes, all kind of detritus available at surface (sedimentary particles, bones, teeth, partially decomposed vegetation, lithic artifacts, etc.) are carried inside the tank and mixed, forming the massive and poorly selected deposits observed nowadays. Although there is some debate whether bones found inside tanks are the result of the fall and imprisonment of animals looking for water (e.g., Oliveira et al., 1989; Mabesoone et al., 1990), recent studies have concluded that bones are most likely transported by rain-washes along with sediment (Bergqvist et al., 1997; Santos et al., 2002). These conclusions are drawn mainly because in these contexts articulated skeletons are rare, most bones are fragmented and isolated, and the number of bones and teeth collected is much smaller than expected considering the number of individuals found (even considering the effect of weathering of the most fragile pieces).

For all the above, the deposit discussed by Dantas et al. (in press) could have been formed in several different sedimentation events, not necessarily temporally related, and particles in a stratum could represent a mixture of elements available in its vicinities, each one of different age. Júnior et al. (2008), for example, studying tank deposits that contained both megafauna remains and lithic artifacts, did not propose a causal relationship between both elements, because they were studying a completely disturbed deposit. As noted by Araújo-Júnior and Porpino (2011), if the information obtained is not supported by previous stratigraphic and taphonomical studies, the idea that elements found in the same assemblage are synchronous – in this case the *Eremotherium* tooth and the lithic artifacts – becomes dubious. If Dantas and colleagues have stratigraphic or taphonomical data favoring the synchronicity of these elements, they are not presented.

Furthermore, even if one assumes that the tooth marks are anthropogenic, a few more points should be stressed. Based on

their finding, Dantas et al. (in press: 3) concluded that *Eremotherium* and *H. sapiens* coexisted and they proposed that either: "(1) *E. laurillardii* lived until the beginning of the Holocene, and interacted with humans, as recorded in Piauí, northeastern Brazil; or, (2) Humans arrived in South America earlier than is accepted today, about 15,000 BP, as indicated by the finding of this species in northeastern Brazil (Auler et al., 2006; Drefahl, 2010), and the human interaction with the megafauna". Such conclusions are made because according to the authors there is a gap between the latest records for *Eremotherium* and the first lithic traditions in the region. However, potential problems with the chronological framework adopted by them for *Eremotherium* could distort their conclusions. Dantas et al. (in press) rely solely on two dates to draw their hypothesis that humans arrived in South America earlier than 15,000 BP. One of these dates comes from an *Eremotherium* found in Toca das Onças cave (Auler et al., 2006), Bahia, more than 300 km away from the tank in Sergipe and the other was obtained on a specimen found in a tank (Drefahl, 2010), also in Bahia, more than 150 km from the place where the tooth reported by Dantas et al. (in press) was found. As pointed out by Barnosky and Lindsey (2010) few dates are not adequate to properly constrain the last dated appearance (LDA) of megafauna's species and, therefore, the second hypothesis is possibly (and probably) unreliable because it is biased towards an older LDA for *Eremotherium*. Most likely this species survived until later moments of the Pleistocene, maybe even into the Holocene, which in fact is their first hypothesis. As a consequence, the second hypothesis presented – an early human occupation – lacks more data to be supported. Indeed, there is a younger *Eremotherium* radiocarbon date of ~13,000 cal yr BP for the Amazonia region (Rossetti et al., 2004), Brazil, although roughly 2000 km from the tank deposit discussed by Dantas et al. (in press). Following Barnosky and Lindsey's (2010) rationale, dating plenty new *Eremotherium* remains especially from Sergipe, and in Brazil more generally, are of uttermost importance to establish a reliable temporal framework for that species in the regional and national scale.

Finally, besides the hypotheses presented by Dantas et al. (in press) there is a third competing hypothesis, not discussed by them, that could explain their finding: *Eremotherium* and humans did not coexist in Sergipe and the human marks are the result of anthropogenic modifications on an already extinct animal tooth found either scattered over the landscape or near the surface, through shallow excavation (during a burial ceremony, for example). Although this scenario seems unlikely, one cannot exclude a priori any alternative explanations due to the lack of data concerning the context of the finding (e.g. was it found at the surface of the tank deposit or during excavations? What was the depth? What were the sediments' characteristics?).

The argument here is not against the idea that humans and megafauna may have coexisted or that megafauna may have survived until the beginning of the Holocene, because as noticed earlier, there are chronological evidences favoring these interpretations in other regions of Brazil. Nonetheless, the finding of Dantas et al. (in press) – at least with the data and level of detail presented – cannot be used to affirm that this coexistence occurred. It would have been beneficial if they had provided details of the findings' context that support their remarks.

In conclusion, as it stands we believe that caution should be adopted in interpreting the data presented by Dantas et al. (in press) as reliable evidence of *Eremotherium* and *H. sapiens* coexistence in Sergipe, Brazil, and more evidences should be gathered before considering the tooth's marks as undeniably anthropogenic. We hope that the comments presented here will stimulate the authors to provide more valuable information regarding this particular finding and also provide some reference for future

studies directed to correlate megafauna and ancient human populations in Brazil.

Reply: Mário André Trindade Dantas

We think this discussion is good for the scientific community and for the journal. When we discovered this fossil, we chose to make a rapid publication, because this kind of information is scarce in Brazil. Our research continues, and soon we will publish an article with more complete information about: the location of the findings, lithic material, new analyses and dating of the tooth, which will reinforce our interpretations.

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