



NEW RECORD OF AN IMMATURE *NOTIOMASTODON* CF. *PLATENSIS* (MAMMALIA, PROBOSCIDEA) FROM PERNAMBUCO STATE, NORTHEASTERN BRAZIL

LUANA CARDOSO DE ANDRADE , ÉDISON VICENTE OLIVEIRA

Programa de Pós-Graduação em Geociências, Departamento de Geologia, Laboratório de Paleontologia, Universidade Federal de Pernambuco. Av. Acadêmico Hélio Ramos s/n, Cidade Universitária, 50740-530, Recife, Pernambuco, Brazil.
luanacardosodeandrade@gmail.com, vicenteedi@gmail.com

DIMILA MOTHÉ

Laboratório de Mastozoologia, Instituto de Biociências, Universidade Federal do Estado do Rio de Janeiro, Av. Pasteur, 458, sala 501, Urca, 22290-240, Rio de Janeiro, Rio de Janeiro, Brazil. Programa de Pós-Graduação em Biodiversidade e Biologia Evolutiva, Universidade Federal do Rio de Janeiro, Centro de Ciências da Saúde. Av. Carlos Chagas Filho, 373, Cidade Universitária, Rio de Janeiro, Rio de Janeiro, Brazil.
dimothe@hotmail.com

VANDERLEI MANIESI

Departamento de Geografia, Grupo de Pesquisa Geociências Universidade Federal de Rondônia, Av. Presidente Dutra, 2965, Centro, 76801-974, Porto Velho, Rondônia, Brazil.
maniesi@unir.br

ABSTRACT – Proboscideans are megamammals widely recorded in South America Quaternary deposits, especially in Brazil, where many specimens are found in tanks and caves. In tank deposits, the fossil remains are usually recognized as adult individuals, although highly and usually fragmented. The records of immature proboscideans are rare, consisting of isolated teeth and jaw fragments, especially from tank deposits. Here we describe a new and rare occurrence of an immature proboscidean – a second upper left deciduous premolar (DP2) of *Notiomastodon* cf. *N. platensis* – from Pernambuco State, Brazil. This record increases the number of immature individuals known for *Notiomastodon* in Brazil, contributes to the understanding of the frequency of immature individuals in tank deposits, and increases *Notiomastodon* geographic distribution in South America.

Keywords: South America, Quaternary, Proboscidea, immature, tank deposit.

INTRODUCTION

The diversity of fossil proboscideans in South America comprises two species: *Notiomastodon platensis* Ameghino, 1888 and *Cuvieronius hyodon* Fischer, 1814 (Mothé *et al.*, 2017). The latter is recorded in Bolivia, Peru, Colombia, and Ecuador (in addition to Central and North America), while the first is endemic to South America, being recorded all over the continent (Ferretti, 2008; Lucas, 2013; Mothé *et al.*, 2017). All Brazilian records are recognized as the proboscidean *Notiomastodon platensis*, although several specimens are

not identified at species level due to the lack of diagnostic features (Mothé & Avilla, 2015).

Most of South America records of proboscideans comprise remains of adult individuals, although a few localities have provided remains of newborn/immature proboscideans, such as Tarija (Bolivia, with records of *Cuvieronius hyodon*, Liendo-Lazarte, 1946; Mothé *et al.*, 2016), Valle del Cauca (Colombia, with records of *Notiomastodon platensis*, Mothé *et al.*, 2017; *pers. comm.*), Toca dos Ossos (Bahia, Brazil, with records of *N. platensis*, Simpson & Paula Couto, 1957; Cartelle, 1992; Mothé, 2010), Coronel João de Sá (Bahia, Brazil, with records of *N. platensis*, Dantas & Zucon, 2007) and Lage Grande (Pernambuco, Brazil, with records of *N. platensis*, Vidal, 1946; Castellanos, 1948; Simpson & Paula Couto, 1957; Araújo-Júnior *et al.*, 2013a).

In northeast Brazil, there is a significant record of *Notiomastodon platensis*, mainly from tank deposits (*e.g.* Rolim, 1974a,b; Alves *et al.*, 2007; Araújo-Júnior *et al.*, 2013a,b, 2015, 2017), and the same age profile is recognized (predominance of adults of *N. platensis*, with rare exceptions, such as Lage Grande tank and the Toca dos Ossos cave). The tanks are natural depressions developed in outcrops of basement rocks, filled by sediments that usually contain remains of Quaternary vertebrates, such as megafauna fragmented bones and teeth, among others (Araújo-Júnior *et al.*, 2013b, 2017).

In this paper, we describe a new fossil specimen of an immature proboscidean from a Quaternary tank deposit in Pernambuco, northeastern Brazil.

MATERIAL AND METHODS

The material described here is a small and partially fragmented tooth, collected in the Zabelê tank (ZPS; UTM: 24L 0759782 E, 9035190 S), in Capoeiras municipality, Pernambuco State, northeastern Brazil (Figure 1).

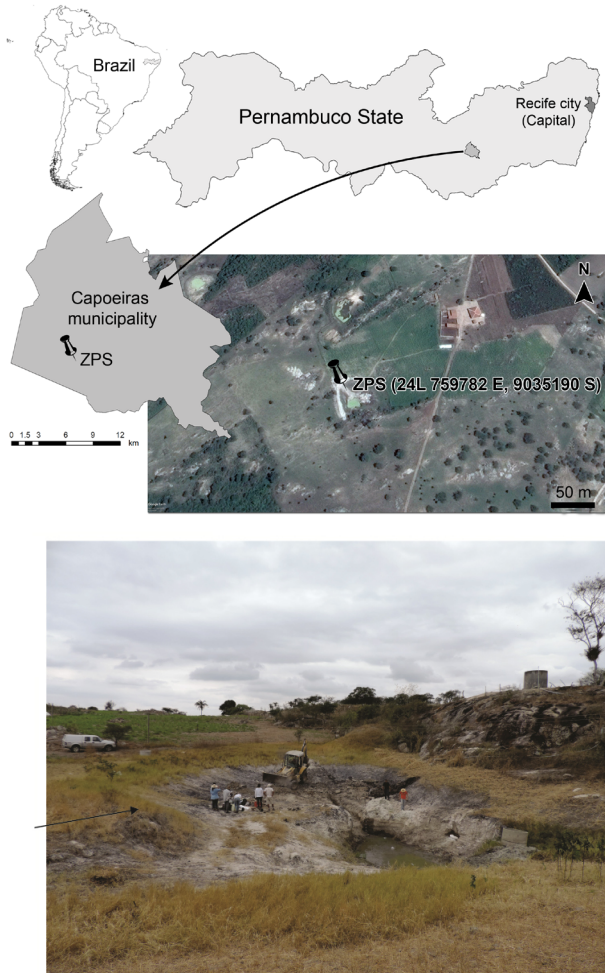


Figure 1. Location of the Zabelê tank, Capoeiras municipality, Pernambuco State, Brazil.

The material is housed at the collection of the Laboratory of Paleontology at Department of Geology (DGeo), Universidade Federal de Pernambuco (UFPE), Recife municipality, Pernambuco, Brazil, under the Collection number DGeo-CTG-UFPE 8912. The specimen morphology was compared to specimens from a Colombian collection (GKS, in the ICESI University, Cali, Colombia) and from specific literature of South American proboscideans, such as Simpson & Paula-Couto (1957), Mothé (2010) and Mothé *et al.* (2012, 2013, 2017). The dental morphology nomenclature followed Tassy (1996), Green & Hulbert (2005) and Mothé (2010).

RESULTS AND DISCUSSION

The specimen DGeo-CTG-UFPE 8912 (Figure 2) was identified as the second upper left deciduous premolar (DP2) due to several morphological features, such as bunodont cusps (tooth with cusps in the shape of inflated cones) and bilophodonty, *i.e.*, presence of only two pairs of main cusps/lophs, a feature diagnostic for *Notiomastodon* (Mothé & Avilla, 2015). The tooth measures approximately 29.2 mm in length and 36.8 mm in width. The metaloph (second pair of main cusps) is wider than the protoloph (first pair of main cusps) and, even fragmented, it is possible to note the characteristic “pear shape” (in occlusal view) of the DP2. The distal cingulum is also preserved, although fragmented in the pretrites region (Figure 2).

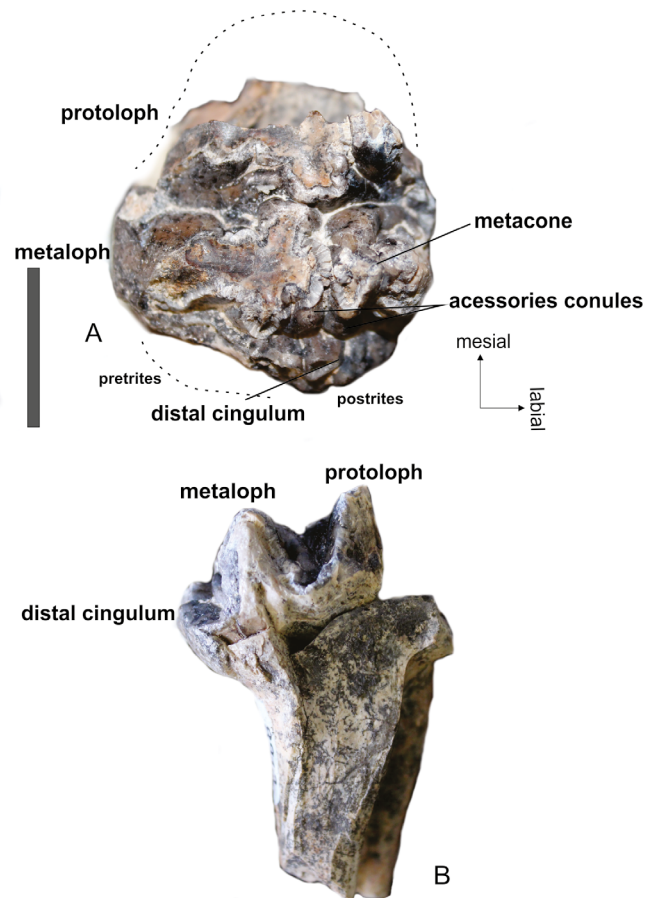


Figure 2. DGeo-CTG-UFPE 8912, the second upper left deciduous premolar (DP2) of *Notiomastodon* cf. *N. platensis* in occlusal (A) and lateral (B) views. Scale bar = 30 mm.

Due to the fragmentary nature of the specimen, only part of the anterior cusps (protoloph) is visible. The metaloph is formed by a pair of cusps united by the base, where it is possible to note the metacone. There are several small accessory cusps near the central sulcus and distal cingulum (Figure 2). Only the distal cingulum is preserved (in the

pretrite region, this structure is slightly worn), being formed by small cusps, arranged laterally, and reaching the lingual region. In the specimen, it is possible to note the preserved dental roots (lateral view, Figure 2B), which could indicate that the tooth was still in use by the animal at the time of death. Compared to another DP2 specimen of *Notiomastodon* (GKS 000082) and specialized literature, we observed the similarity of the dental crown morphology (Figure 3).

Regarding the specimen level of dental wear, we recognized the wear stage 3 (advanced wear with cusps still visible, Simpson & Paula-Couto, 1957), which allowed us to infer that it belonged to an individual between 2–3 years old, *i.e.*, an immature individual (Mothé *et al.*, 2016). In Quaternary proboscideans, it is estimated that the deciduous second premolar erupts between 6 months and one year old and is lost at about 2–3 years old (Moss, 1996; Vaughan *et al.*, 2000). At this age, the calf is in the process of weaning, *i.e.*, its diet includes the mother's milk and soft vegetation (Moss, 1996). The wear pattern observed on the dental crown is caused by the mastication of abrasive particles in the consumed vegetation (Simpson & Paula Couto, 1957; Mothé & Avilla, 2015). In the South American proboscideans, the deciduous dentition is completely replaced by the permanent teeth as soon as the proboscidean reaches sexual maturation (Mothé, 2010).

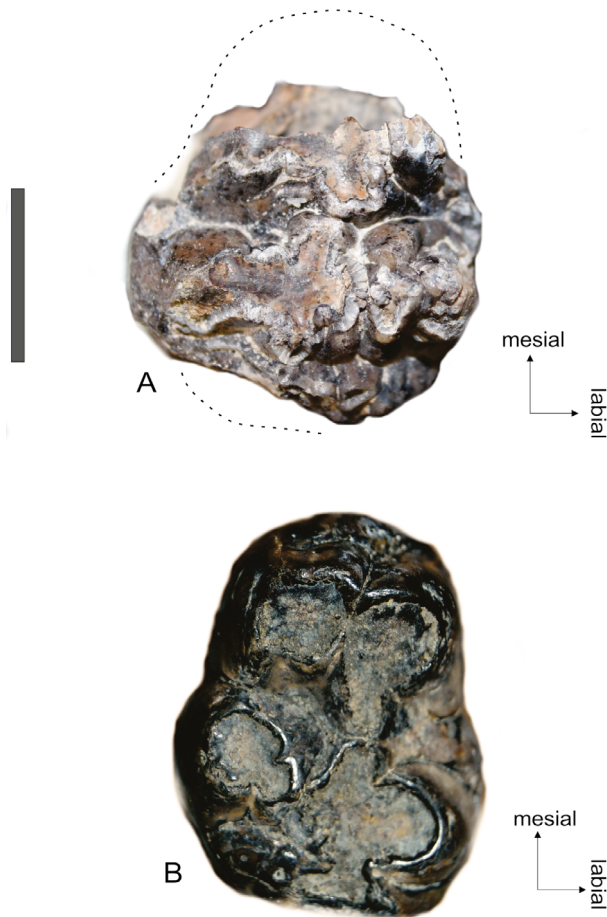


Figure 3. Comparison of the second upper left deciduous premolar (DP2, DGE0-CTG-UFPE 8912) of *Notiomastodon* cf. *N. platensis* (A) with GKS 000082 - Valle del Cauca, Cali, Colombia (B). Scale bar = 30 mm.

Overall, DGE0-CTG-UFPE 8912 is fragmented and worn, which turns difficult to describe its dental crown structures. In addition, no papers describe the differences of the deciduous premolars structures of *Notiomastodon* and *Cuvieronius*, the two proboscideans known for South America, and only the calf mandibles are better described in the literature (*e.g.* Liendo-Lazarte, 1946; Mothé *et al.*, 2016). Both DP2 of *Notiomastodon* (GKS 000082 and DGE0-CTG-UFPE 8912) are bunodonts and have molariform aspect. However, the wear pattern of DGE0-CTG-UFPE 8912 is a simple trefoil pattern, a diagnostic feature of *Notiomastodon* deciduous premolars (Mothé, 2010; Mothé *et al.*, 2017). Thus, considering the dental crown morphology of the specimen described and the fossil record of *Notiomastodon platensis* in Brazil, including previously described immature individuals from Pernambuco (*e.g.* Simpson & Paula-Couto, 1957; Rolim, 1974a,b; Cartelle, 1992; Alves, 2007; Silva *et al.*, 2010; Araújo-Júnior *et al.*, 2013a, b, 2015, 2017), we identified DGE0-CTG-UFPE 8912 as *Notiomastodon* cf. *N. platensis*.

In tank deposits from northeast Brazil, there is a predominance of adult specimens of *Notiomastodon platensis*, instead of immature individuals (*e.g.* Araújo-Júnior *et al.*, 2013a, b, 2015). In this study, considering the lack of distribution of distinct age groups of *N. platensis* from the ZPS biocenosis, the unique record of an immature *Notiomastodon* cf. *N. platensis* represents a rare preservation of immature remains of proboscideans in South America (Liendo-Lazarte, 1946; Simpson & Paula Couto, 1957; Mothé, 2010; Mothé *et al.*, 2016). It is difficult to infer the type of death of individuals preserved in fossiliferous assemblages from tank deposits, as they are usually affected by temporal mixing (Araújo-Júnior *et al.*, 2013b, 2015, Araújo-Júnior & Bissaro-Júnior, 2017). It is possible to infer that the tooth described here was in use at the moment of death, since it is in an intermediary wear stage (stage 3 of Simpson & Paula-Couto, 1957) with roots, which excludes the possibility of natural loss or discard of the completely worn tooth (in an expected wear stage 4).

This occurrence might indicate that, probably, in other tanks deposits, newborn or immature *Notiomastodon platensis* specimens might have not been preserved due to taphonomic processes (transport, tank shape, *e.g.* size of the material, resistance to transport and frequency of immature individuals). In tank deposits, specimens with size between 50–100 mm (Araújo-Júnior *et al.*, 2013b; 2015) are common, in contrast to the size of the specimen described here (<50 mm); in addition, the deciduous teeth have lower resistance compared to other elements of adult proboscideans (*e.g.* teeth, vertebra, long bones), more abundant in tanks deposits, since they have a thinner layer of enamel, smaller cusps and smoother dentine. However, the record an immature Proboscidean in a tank deposit described here offers new evidence for discussions about taphonomic bias related to the osseous resistance of the remains found in these accumulations. In addition, even as an isolated finding, the specimen DGE0-CTG-UFPE 8912 widens the sparse record of newborn and immature

Notiomastodon platensis individuals in South America and contributes to the understanding of individual variations in proboscideans.

FINAL REMARKS

We registered here a new occurrence of a DP2 of an immature proboscidean (between 2–3 years old) corresponding to *Notiomastodon* cf. *N. platensis* from a tank of Pernambuco State, Brazil, to Quaternary of South America. This occurrence provides new data for the understanding the record of immature proboscideans in tank deposits, which is related to lower osseous resistance. It is a rare occurrence, increasing the number of immature individuals of *N. platensis* recorded for assemblages from the Quaternary deposits of South America.

ACKNOWLEDGEMENTS

This study was funded by the Coordenação de Aperfeiçoamento de Pessoal de Nível Superior (CAPES), and Fundação Carlos Chagas Filho de Amparo à Pesquisa do Estado do Rio de Janeiro (FAPERJ) for the Post-doctoral scholarship 202.375/2018 and 202.376/2018 of author D.M. The authors thank the City council and the Department of Culture of the Capoeiras city (PE) for the support and the PaleoLab/UFPE paleontology team for the assistance during fieldwork. The authors thank the ICESI University (Cali, Colombia) for allowing access to the fossil collection. The authors thank the anonymous reviewer and editor who made important contributions to this work.

REFERENCES

- Alves, R.S.; Barreto, A.M.F.; Borges, L.E.P. & Farias, C.C. 2007. Aspectos tafonômicos no depósito de mamíferos pleistocênicos de brejo da Madre de Deus, Pernambuco. *Estudos Geológicos*, **17**:114–122.
- Araújo-Júnior, H.I. & Bissaro-Júnior, M.C. 2017. Tafonomia de vertebrados em ambientes continentais. In: R.S. Horodyski & F. Erthal. (orgs.) *Tafonomia: métodos, processos e aplicações*, Editora CRV, p. 175–236.
- Araújo-Júnior, H.I.; Porpino, K.O. & Bergqvist, L.P. 2013a. Taphonomic analysis of a late Pleistocene vertebrate accumulation from Lage Grande Paleontological Site, Pernambuco State, Northeastern Brazil: new remarks on preservational aspects of tank deposits. *Quaternary International*, **317**: 88–101. doi:10.1016/j.quaint.2013.08.016
- Araújo-Júnior, H.I.; Porpino, K.O. & Bergqvist, L.P. 2015. Vertebrate taphonomy and paleoecology in an Upper Pleistocene tank deposit of Paraíba, Brazil: taphonomic modes, evidence of temporal and spatial resolutions and paleoecological patterns of the Brazilian Intertropical Region. *Palaeogeography, Palaeoclimatology, Palaeoecology*, **437**:1–17. doi:10.1016/j.palaeo.2015.07.009
- Araújo-Júnior, H.I.; Porpino, K.O.; Bergqvist, L.P. & Ávila, L.S. 2017. Nova ocorrência de mamíferos do Quaternário nos Tanques de Taperoá (Paraíba) e Alagoinha (Pernambuco), Nordeste do Brasil: implicações paleoambientais. *Anuário do Instituto de Geociências-UFRJ*, **40**:37–46. doi:10.11137/2017_2_37_46
- Araújo-Júnior, H.I.; Porpino, K.O.; Ximenes, C.L. & Bergqvist, L.P. 2013b. Unveiling the taphonomy of elusive natural tank deposits: a study case in the Pleistocene of northeastern Brazil. *Palaeogeography, Palaeoclimatology, Palaeoecology*, **378**:52–74. doi:10.1016/j.palaeo.2013.04.001
- Castellanos, A. 1948. *Ney Vidal e contribuição ao conhecimento da Paleontologia do Nordeste brasileiro: notícia sobre a descoberta de vertebrados pleistocênicos no município de Pesqueira, em Pernambuco*. Instituto de Física Geológica, p. 138–140.
- Cartelle, C. 1992. *Edentata e megamamíferos herbívoros extintos da Toca dos Ossos (Ourolândia, Bahia, Brasil)*. Programa de Pós-Graduação em Morfologia, Universidade Federal de Minas Gerais, Tese de Doutorado, 700 p.
- Dantas, M.T. & Zucon, M.H. 2007. Sobre a ocorrência de fósseis da megafauna do Pleistoceno Final em Coronel de Sá, Bahia, Brasil. *Revista UnG-Geociências*, **6**:191–200.
- Ferretti, M.P. 2008. Enamel structure of *Cuvieronius hyodon* (Proboscidea, Gomphotheriidae) with a discussion on enamel evolution in elephantoids. *Journal of Mammalian Evolution*, **15**:37–58. doi:10.1007/s10914-007-9057-3
- Green, J.L. & Hulbert, R.C. 2005. The deciduous premolar of *Mammot americanum* (Mammalia, Proboscidea). *Journal of Vertebrate Paleontology*, **25**:702–715. doi:10.1671/0272-4634(2005)025[0702:tdpoma]2.0.co;2
- Holz, M. & Simões, M.G. 2002. Elementos fundamentais de tafonomia. Porto Alegre, Editora da UFRGS, 231 p.
- Liendo-Lazarte M. 1946. *Algunas consideraciones sobre los Mastodontes de Tarija*. Tiahuanacu, Museo Nacional Tiahuanacu, 14 p.
- Lucas, S.G. 2013. The palaeobiogeography of South American gomphotheres. *Journal of Palaeogeography*, **2**:19–40. doi:10.3724/sp.j.1261.2013.00015
- Moss, C. 1996. Getting to know a population. In: K. Kangwana (ed.) *Studying elephants*, African Wildlife Foundation, p. 58–74.
- Mothé, D. 2010. *A dentição decidua dos mastodontes sul-americanos (Proboscidea, Gomphotheriidae): morfologia e padrões de substituição e desgaste*. Especialização em Geologia do Quaternário, Museu Nacional, Monografia, 36 p.
- Mothé, D.; Avilla, L.S.; Asevedo, L.; Borges-Silva, L.; Rosas, M., Labarca-Encina, R.; Souberlich, R.; Soibelzon, E.; Roman-Carrion, J.L.; Ríos, S.D.; Rincon, A.D.; Oliveira, G.C. & Lopes, R.P. 2017. Sixty years after ‘the mastodonts of Brazil’: the state of the art of South American proboscideans (Proboscidea, Gomphotheriidae). *Quaternary International*, **443**: 52–64. doi:10.1016/j.quaint.2016.08.028
- Mothé, D. & Avilla, L.S. 2015. Mythbusting evolutionary issues on South American Gomphotheriidae (Mammalia: Proboscidea). *Quaternary Science Reviews*, **110**:23–35. doi:10.1016/j.quascirev.2014.12.013
- Mothé, D.; Avilla, L.S. & Cozzuol, M. 2013. The South American gomphotheres (Mammalia, Proboscidea, Gomphotheriidae): taxonomy, phylogeny and biogeography. *Journal of Mammalian Evolution*, **20**:23–32. doi:10.1007/s10914-012-9192-3
- Mothé, D.; Avilla, L.S.; Cozzuol, M. & Winck, G.R. 2012. Taxonomic revision of the Quaternary gomphotheres (Mammalia: Proboscidea: Gomphotheriidae) from the South American lowlands. *Quaternary International*, **276–277**:2–7. doi:10.1016/j.quaint.2011.05.018
- Mothé, D.; Ferretti, M.P. & Avilla, L.S. 2016. The dance of tusks: rediscovery of lower incisors in the pan-american

- proboscidean *Cuvieronius hyodon*. Revises Incisor Evolution in Elephantimorpha. *PLoS ONE*, **11**:e0147009. doi:10.1371/journal.pone.0147009
- Rolim, J.L. 1974a. Calcário secundário com restos fósseis de mamíferos pleistocênicos em Pernambuco. *Anais da Academia Brasileira de Ciências*, **46**:417–422.
- Rolim, J.L. 1974b. *Paleontologia e estratigrafia do Pleistoceno continental do Nordeste Brasileiro “Formação Cacimbas”*. Programa de Pós-Graduação em Geociências, Universidade Federal do Rio Grande do Sul, Dissertação de Mestrado, 117 p.
- Silva, F.M.; Filgueiras, C.F.; Barreto, A.M.F. & Oliveira, E.V. 2010. Mamíferos do Pleistoceno Superior de Afrânio, Pernambuco, Nordeste do Brasil. *Quaternary and Environmental Geosciences*, **2**:1–11. doi:10.5380/abequa.v2i1-2.14182
- Simpson, G.G. & Paula Couto, C. 1957. The mastodonts of Brazil. *Bulletin of American Museum of Natural History*, **112**:1–65.
- Tassy, P. 1996. Dental homologies and nomenclature in the Proboscidea. In: J. Shoshani & P. Tassy (eds.) *The Proboscidea: evolution and palaeoecology of elephants and their relatives*, Oxford University Press, p. 21–25.
- Vaughan, T.R.; Ryan, J.M. & Czaplewski, N.J. 2000. *Mammalogy*. New York, Saunders College Publishing, 576 p.
- Vidal, N. 1946. Contribuição ao conhecimento da paleontologia do Nordeste Brasileiro: notícia sobre a descoberta de vertebrados pleistocênicos no município de Pesqueira, em Pernambuco. *Boletim do Museu Nacional*, **6**:1–15.
- Wiest, L.A.; Esker, D. & Driese, S.G. 2016. The Waco mammoth national monument may represent a diminished watering-hole scenario based on preliminary evidence of post-mortem scavenging. *Palaeos*, **31**:592–606. doi:10.2110/palo.2016.053

Received in 24 March, 2019; accepted in 16 December, 2019.