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Nota científica/Scientific note

FIRST RECORD OF *NOTIOMASTODON PLATENSIS* (MAMMALIA, PROBOSCIDEA) FROM BOLIVIA

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ABSTRACT – Proboscideans are common constituents of the Quaternary megafauna in South America and their remains have been recovered over the entire continent; however, the records of *Notiomastodon platensis* are unknown in Bolivia, Guyana, French Guyana and Suriname. In this study, we describe the first record of *Notiomastodon platensis* from Bolivia. A *N. platensis* upper tusk was found in the Gran Chaco province, Tarija, a region widely known by its Quaternary megafauna, especially of the proboscidean *Cuvieronius hyodon*. The geographic distribution of both proboscideans suggests that they did not occur in sympatry, probably due to competitive exclusion (similar mixed-feeding diet) during the middle-late Pleistocene.

Key words: South America, Tarija, Proboscidea, Megafauna, *Notiomastodon.*

INTRODUCTION

Although completely extinct, the proboscideans are one of the most common and abundant representants of the Quaternary megafauna in South America, especially the genus *Notiomastodon* (Mothé *et al.,* 2012, *in press*; Mothé & Avilla, 2015). The records of *Notiomastodon platensis* are distributed from the Ensenadan (early Pleistocene) to the early Holocene and occur all over the South American continent, with more than 140 localities, but there are no records in Bolivia, Guyana, French Guyana and Suriname (Prado *et al.*, 2005; Avilla *et al*., 2013; Dantas *et al*., 2013; Mothé & Avilla, 2015; Mothé *et al*., *in press*). In this study, we describe the first record of *Notiomastodon platensis* in the department of Tarija, Bolivia.

MATERIAL AND METHODS

The analyzed specimen consists of an upper tusk of a proboscidean, discovered in 2014, during the construction of a road between the cities of Tigüipa and Capirenda (21º05'40.11"S 63º01'10.05"W), north of Villa Montes city, Gran Chaco Province, Department of Tarija, Southern Bolivia (Figure 1). The specimen was collected by Mrs. Cristina Romero Pérez and the Paleontology technician prof. Willer Flores Aguanta, from the Secretaria Departamental de Protección del Patrimonio Cultural y Natural, Bolivia. The specimen was prepared by the Dirección de Culturas y Turismo del Municipio de Villa Montes, Bolivia, and it is under this institution's care (V.M.001).

The specimen morphology was described following the literature about upper tusk anatomy of proboscideans (Shoshani & Tassy, 1996; Ferretti, 2010; Mothé *et al*., 2012), measured (length and diameter at the proximal and distal regions) using the software ImageJ (http://rsb.info.nih.gov/ij/) and compared with other specimens of Proboscidea from South America, housed at the paleontological collections of Museu de Ciências da Terra of the Departamento Nacional de Produção Mineral; Museu de Ciências Naturais da Pontifícia Universidade Católica de Minas Gerais, Museu Nacional (Brazil); Museo de Historia Natural 'Gustavo Orces V' (Ecuador); Museo de Ciencias Naturales 'Bernardino Rivadavia', Museo de La Plata (Argentina); Universidad de La Republica, Museo Nacional de Historia Natural y Antropología (Uruguay); Instituto Colombiano de Geología y Minería (Colombia); Museo Nacional de Historia Natural de Santiago (Chile); Museo Nacional de Paleontología y Arqueología de Tarija (Bolivia); Museo de Historia Natural de

Lima; Museo de Historia Natural de la Universidad Nacional de San Antonio Abad del Cusco (Peru); American Museum of Natural History, and the Florida Museum of Natural History (United States of America).

RESULTS AND DISCUSSION

The specimen in question is a right upper tusk of an adult individual of Proboscidea, measuring approximately 153 cm (length), 15 cm (diameter at the proximal region) and 9 cm (diameter at the distal region). The tusk is slightly upcurved (Figure 2A), and presents oval cross-section (Figure 2B), although some regions are fragmented. The internal structure and the external arrangement are not twisted, and the distal region is the most fragmented and worn, probably due taphonomic processes. No enamel was observed on the tusk, especially because of the poor state of preservation of the fossil surface, however, it is not possible to infer if an enamel layer or band was present on the tusk before the action of taphonomic processes (Figure 2B).

Proboscidean records in South America are very abundant and tusks, due its valuable diagnostic features, are usually well identified taxonomically (see Mothé & Avilla, 2015). In South America, the diversity of Proboscidea consists of two species: *Notiomastodon platensis* (Mothé *et al*., 2012; Lucas, 2013) and *Cuvieronius hyodon* (Lucas, 2008b). The diagnostic features of *C. hyodon* include a low-domed cranium with large forehead, rounded top of the frontal bone and flattened profile, divergent lateral borders of the premaxillary bones, developed incisive fossae, upper tusks are elongated and markedly twisted (the configuration of the dentin cones follows the twisted general structure, as the spiraled external enamel band) and may vary from straight to slightly upcurved and from parallel to divergent, with sub-circular cross-section. In addition, a longitudinal enamel band is present, following the tusk torsion (Lucas, 2013; Mothé & Avilla, 2015). The diagnostic features of *N. platensis* are a high-domed cranium with a large forehead and deep medial fossa, high cranium profile, upper tusks are never twisted (i.e., the dentin cones which form the internal structure of the upper tusks have no torsion among themselves; feature externally obsevable) and have a great morphological variation in length, robustness and curvature (Mothé *et al*., 2012). Enamel may be absent or present on the upper tusks, shaped as a single band or covering the entire tusk in juvenile and some adult individuals. The upper tusks have a circular to oval cross-section, and the lower tusks are absent (Mothé *et al*., 2012, 2016; Mothé & Avilla, 2015). In accordance with the description of the specimen from Gran Chaco province, which is slightly upcurved, not twisted, with oval cross-section outline, it is here recognized as *Notiomastodon platensis*, because its diagnostic features match the characteristics of the V.M.001 tusk. Despite the poor preservation of the tusk, we are certain that it does not represent *Cuvieronius* because the arrangement of the hollow dentin cones is not twisted; and they follow the configuration of the *Notiomastodon platensis* tusk (untwisted and even, see fig 4 of Mothé *et al*., 2016).

Figure 1. Map of the record of *Notiomastodon platensis* from the Department of Tarija, Bolivia. The black star represents the locality where the upper tusk of *Notiomastodon platensis* was found, the white stars represent the records of *Cuvieronius hyodon* in Bolivia.

The Proboscidea records in Bolivia are from the localities of Ulloma (Lucas, 2008a) and the Tarija valley (Boule & Thevenin, 1920; Ferretti, 2008) and all are recognized as *Cuvieronius hyodon*, based on the presence of diagnostic remains such as upper tusks and skull specimens. The Tarija valley records of *C. hyodon* are considered one of the largest and most important occurrences of Quaternary proboscidean megafauna in South America (Prado *et al.*, 2005; Ferretti, 2010; Mothé *et al*., *in press*) due the numerous complete individuals from all age classes (Boule & Thevenin, 1920; Mothé *et al*., 2016). However, although the fossil fauna from the Tarija valley has great diversity, including proboscideans, xenarthrans, carnivores, artiodactyls and perissodactyls (Tonni *et al*., 2009), no specimens with the diagnostic features of *Notiomastodon platensis* have been reported from this locality.

Thus, the Gran Chaco specimen is the first record of *Notiomastodon platensis* from Bolivia and, although *N. platensis* records are abundant in South America, from lowlands to highlands (see Ficcarelli *et al*., 1995; Ferretti, 2008; Mothé & Avilla, 2015), the two South American proboscidean species were never recorded in the same locality. The Gran Chaco *N. platensis* record is 180 km from the Tarija valley, the locality with the most significant *C. hyodon* records in South America. The closest records of *Cuvieronius hyodon* and *N. platensis* are from Pichincha Province, Ecuador (Guayllabamba and Alangasí, respectively), and are 27 km from each other. In this way, none of the South American proboscideans occurred in sympatry, which suggests that both taxa probably did not overlap their geographical distribution (allopatry or limited

Figure 2. *Notiomastodon platensis* upper tusk from Tarija, Bolivia. **A**, lateral view of the tusk; **B**, oval cross-section outline of the proximal region of the tusk. The arrow points the anterior portion of the tusk.

sympatry, Ferretti, 2008). It suggests that a competitive exclusion may have occurred, since *C. hyodon* and *N. platensis* would have similar mixed-feeding habits (Sanchez *et al*., 2004; Asevedo *et al*., 2012) and both were probably able to live in a broad range of environmental conditions.

Paleoecological studies used analysis of carbon and oxygen isotopes from mineralized tissues (MacFadden & Cerling, 1996; Sánchez *et al*., 2004; Viana *et al*., 2011; Domingo *et al*., 2012; Dantas *et al*., 2013; Lopes *et al*., 2013; Pérez-Crespo *et al*., 2016), analyses of tooth enamel microwear (Asevedo *et al*., 2012), evaluation of plant microfossils recovered from tooth calculus (Asevedo *et al*., 2012, 2015) and the functional morphology of the mandibular apparatus (Borges-Silva *et al*., 2015) to infer the paleodiet of *Notiomastodon platensis*. They suggest generalist feeding habits for *Notiomastodon platensis* and *Cuvieronius hyodon*, which was a very important factor for the wide distribution of South American proboscideans, which probably occupied a wide range of environmental conditions (both cold and warm habitats, humid and arid environments, such as the tropical Andes, the Argentinean Gran-Chaco and Pampas, and the semi-arid Caatinga in Brazil, respectively (Asevedo, 2015; Mothé & Avilla, 2015). Although grasses are recorded as food item in the diet of *Cuvieronius hyodon* from Tarija, Bolivia (MacFadden & Cerling, 1995; Asevedo, 2015), a mixed feeder habit is attributed to this species at this locality (Sánchez *et al*., 2004; Asevedo, 2015). Differently, the *Notiomastodon platensis* at the middle Pleistocene had a mixed diet with a high frequency of C_3 plants from Buenos Aires Province (Sánchez *et al*., 2004).

The lack of sympatry between *Cuvieronius hyodon* and *Notiomastodon platensis* in the countries where both are recorded (Peru, Ecuador and Bolivia) may suggest a hypothesis of competitive exclusion between them during the middle-late Pleistocene. The evolutionary history of proboscideans indicates that sympatry of closely related species is very rare, and the most common ecological pattern was distantly related species, from different lineages, in sympatry. One example is the sympatry among gomphotheres, mastodons (Mammutidae) and mammoths (Elephantidae) during the Pleistocene in Central and North America (Lucas & Alvarado, 2010). This evolutionary characteristic is associated with the more specialized feeding habits of mammoths and mastodons (Pérez-Crespo *et al*., 2016), and may have acted as a barrier to both lineages at the Panamanian Isthmus, creating an ecological barrier (filter) to their migration to South America (Dudley, 1996; Pérez-Crespo *et al*., 2016).

CONCLUSIONS

In this study, the first record of the proboscidean *Notiomastodon platensis* was described from the Gran Chaco province, department of Tarija, Bolivia - a right upper tusk slightly fragmented. Although proboscidean records are abundant and widely distributed in South America, the Bolivian fossil record was represented only by *Cuvieronius hyodon* until now. The South American proboscidean almost taxa did not occur in sympatry, although they are closely recorded in Ecuador, Peru and Bolivia, which suggests that both taxa almost did not overlap their geographical distribution probably due to competitive exclusion (similar mixed-feeding diet) during the middle-late Pleistocene.

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