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Tyrannosaurid teeth from the Lomas Coloradas Formation, Cabullona Group (Upper Cretaceous) Sonora, México

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ABSTRACT

The Lomas Coloradas Formation (Cabullona Group, Upper Cretaceous) in the state of Sonora, Mexico, has yielded a great diversity of continental vertebrates, especially dinosaurs. In this study we describe, analyze and illustrate six theropod teeth (ERNO specimens) that were found isolated and surface collected. Identification of the specimens is based upon the methodology provided by Smith (2005), Smith et al. (2007) and Smith et al. (2005). The results showed that the ERNO teeth are comparable to those of tyrannosaurid dinosaurs and some of them probably correspond to a new taxon. Their referral to the Tyrannosauridae family is supported by the presence of semi-conical, laterally compressed crowns with an ovoid cross-sectional base; slightly offset carinae with chisel-shaped denticles that are wider labio-lingually than longer proximo-distally; and the presence of enamel wrinkles at the base of some denticles on the labial surface. These wrinkles are not prominent adjacent to the serrations but they take the form of high relief deep enamel bands across the labial and lingual crown faces. Statistical principal component analysis (PCA) and discriminant function analysis (DFA) corroborated the taxonomically assignation of these teeth into this family. Particularly, the DFA analysis yielded very interesting results. This analysis classified ERNO 8549, 8550, 8551 and 8552 specimens as belonging to *Tyrannosaurus*, so they represent the most southern record of this genus in Western North America. Finally, the misclassification of ERNO 005 and ERNO 006 specimens remains puzzling. It probably was the result of the presence of juvenile individuals.

1. Introduction

Tyrannosaurids are one of the best-represented clades of large bodied theropods in the fossil record. During late Campanian the high diversity of tyrannosaurids on western North America represents the evolutionary radiation of a successful predatory morphotype that culminated with the apparition of *Tyrannosaurus rex* by the end of the Cretaceous period (Currie, 2003; Holtz, 2004; Brusatte et al., 2009; Carr et al., 2011; Brusatte et al., 2010; Loewen et al., 2013). Their fossils have a widespread occurrence ranging from the North Slope of Alaska (Brouwers et al., 1987; Clemens and Nelms, 1993; Rich et al., 1997) south to Coahuila Province of Mexico (Hernández-Rivera, 1997). However the bulk of articulated skeletal remains have been collected from Alberta (Cope, 1892; Lambe, 1902, 1914, 1917), Montana (Cope, 1876; Osborn, 1905, 1912; Horner et al., 1992), Wyoming (Osborn, 1905, 1912) and recently from Utah (Carr et al., 2011; Loewen et al., 2013). Tyrannosaurid fossils to the north and south of those regions tend to consist of isolated bones and teeth (e.g., Brouwers et al., 1987).

Tyrannosaurid tooth remains have been reported by Leidy since 1856. The dentition inside this group is markedly heterodont (Holtz, 1994, 1996, 2000; Farlow et al., 1991; Smith, 2005). Tyrannosaurid crowns correspond to semi-conical structures made up of

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stacked dentine cones with a thin external layer of enamel (Abler, 1992). Premaxillary tooth have D-shaped bases in cross section and have two serrated ridges – also known as carinae – located on the lingual side. Maxillary and dentary teeth are more laterally compressed and less recurved than in other theropods. These teeth have a round to ovoid cross-sectional base and stout saddle or chisel-shaped serrations on the mesial and distal margins of the tooth crown (Sankey, 2001; Samman et al., 2005). The carinae are slightly offset from the rostral and caudal margins of the tooth, especially in more robust teeth than in slender ones (Holtz, 2004). Sometimes the serrations are angled towards the apex of the tooth and are generally aligned along the carinae that curve lingually (Smith and Dodson, 2003). Distinct enamel wrinkles and bands are present at the denticle bases and across the labial and lingual surfaces (Brusatte et al., 2007).

Tyrannosaurid denticles on the maxillary and dentary teeth have additional characteristics: they are larger and more widely spaced than in other theropods (Farlow et al., 1991); the mesial and distal serrations are equivalent in size (Chandler, 1990); they are wider labially–lingually than they are long proximo-distally; generally they decrease in size towards the base and apex of the tooth; they possess sharp ridges of enamel along the midline and they are smaller relative to tooth length in larger individuals, but are larger in basal diameter and height (Samman et al., 2005; Chandler, 1990; Currie et al., 1990).

In this work we described and analyze six unknown theropod teeth that were found isolated and surface collected in the Lomas Coloradas Formation of the Cabullona Group (Upper Cretaceous) in northeastern Sonora, Mexico. This formation has yielded a great diversity of continental vertebrates, especially dinosaurs.

2. Geological setting

The teeth described in this study were collected from the upper part of the Lomas Coloradas Formation (Taliaferro, 1933). This formation is the uppermost unit of the 2.5-km-thick Cabullona Group (Taliaferro, 1933; González-León and Lawton, 1995) that crop out in northeastern Sonora (Fig. 1). The Cabullona Group composed from base upwards of the Corral de Enmedio Formation, Camas Sandstone, Packard Shale and Lomas Coloradas Formation represent fluvial, lacustrine and deltaic deposits, while the El Cemento Conglomerate which is laterally equivalent of these units represent

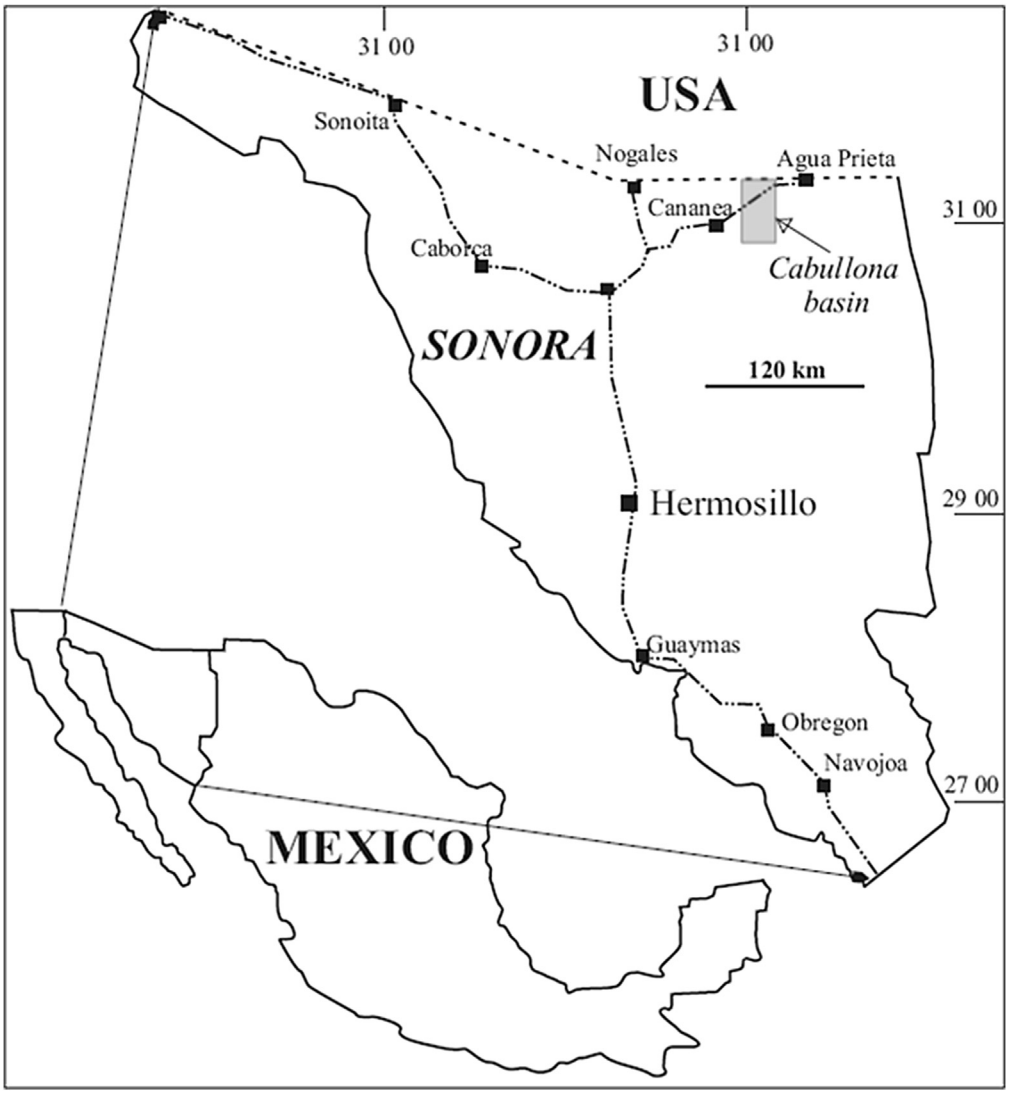

Fig. 1. Study area in the Lomas Coloradas Formation: the specimens were collected in localities 23 and 33.