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Original article

# A new Miocene vertebrate assemblage from the Río Yuca Formation (Venezuela) and the northernmost record of typical Miocene mammals of high latitude (Patagonian) affinities in South America☆

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ABSTRACT

Geological explorations of the basal beds of the Río Yuca Formation (Tucupido region, Portuguesa State, western Venezuela) resulted in the recognition of a new vertebrate assemblage that includes eight taxa: the toxodont cf. *Adinotherium*, a Peltephilidae armadillo, the freshwaters fishes *Platysilurus* and *Phractocephalus*, the caiman *Purussaurus*, an indeterminate dolphin, turtles, and the previously recognized sloth *Pseudoprepotherium venezuelanum*. When compared with the higher latitudes faunas of Argentina and Chile, the presence of cf. *Adinotherium* and peltephilids in the Rio Yuca Formation is consistent, but not conclusive, with a Santacrucian to Frisian SALMA age. The associated fauna, as well recent apatite fission track analysis, indicates that the Río Yuca assemblage is more likely younger in age, specifically Middle to Late Miocene. So far, the Miocene localities of the northern part of South America have provided a less prolific fossil record compared to the southern part of the continent (e.g., Santacrucian and Friasian faunas of Patagonia), but the present work documents the surprising occurrence of two taxa (Peltephilidae and Nesodontinae) common in southern high latitude faunas of South America, implying the persistence of the Santacrucian-Friasian genus *Adinotherium* in younger strata from northern South America, and that peltephilids were much more widespread during the Miocene than previously recognized. The presence of these common Patagonian taxa (Peltephilidae and Nesodontinae) in Río Yuca also supports the hypothesis of prior researchers for the existence of biogeographical connections between the northern and southern portions of South America during the Late Oligocene or Early Miocene, which facilitated faunal interchange between the two regions. Finally, the biogeographical affinities of the freshwater fishes and the giant caiman (*Purussaurus*) indicate close relationships of the Tucupido region with the ancestral distribution of the Orinocoan–Amazonian drainage system.



## 1. Introduction

The modern South American (SA) neotropics harbor some of the most species-rich terrestrial ecosystems in the world. This present-day biodiversity is the result of a long evolutionary history of extreme complexity in terms of tectonic activity and changing environmental conditions, as exemplified by the outstanding fossil records contained in some Neotropical Miocene formations (Kay et al., 1997; Myers et al., 2000; Croft, 2007; Sánchez-Villagra et al., 2010; Hoorn et al., 2010; Tejada-Lara et al., 2015; Antoine et al., 2016). Molecular data indicate the origin of several clades of modern neotropical plants and animals by the Middle to Late Miocene, but from the northernmost portions of SA (a wide area with a high level of modern biodiversity), there are only a few well-known continental vertebrate assemblages of this age (e.g., Hoorn et al., 2010; Tejada-Lara et al., 2015; Moreno et al., 2015). Among these, the widely sampled and better studied faunas come from La Venta (Middle Miocene, Colombia; Kay et al., 1997) and the Urumaco sequence (Middle to Late Miocene, Venezuela; Sánchez-Villagra et al., 2010). The recent discoveries of continental

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vertebrates from the Castilletes Formation (Early to Middle Miocene, Colombia; Moreno et al., 2015) still need to be described in detail. In Venezuela (northern SA), there are additional but minimally studied and/or sampled Miocene vertebrate assemblages of continental affinities from the La Puerta, Cumaca, Parángula and Río Yuca formations (see Sánchez-Villagra et al., 2010, for details), but some of these require a revision of their chronostratigraphical framework.

In 1988, the Aguasuelos Engineering Company initiated a contract with Corpoven S.A., a Petróleos de Venezuela S.A. (PDVSA) subsidiary, to conduct a geological study of the eastern part of the Venezuelan Andean mountain system. During this study, one of us (OM) collected several fossil specimens from the same area where Collins (1934) described the sloth *Pseudoprepotherium venezuelanum* based on an isolated femur. The Río Yuca Formation has been usually inferred to be Late Miocene or Pliocene in age, although in older descriptions it was considered Early Miocene in age (Aguasuelos, 1990; Macsotay et al., 1998). Bermúdez et al. (in press) recognized the difficulty in obtaining a detailed chronostratigraphic framework from several Miocene formations of the Venezuelan Andean system (including the Río Yuca Formation), mainly due to discontinuous outcrops, poor fossil content, and the difficulty to date them using magnetostratigraphy because of their coarse-grained lithologies. Because of these limitations, new paleontological evidence can help to evaluate or refine the chronostratigraphical affinities of this geological unit.

Today, the original Collins' (1934) locality (Río Tucupido, in the southwestern portion of Portuguesa State, Venezuela) is probably under the lake formed by the "Virgen de la Coromoto" reservoir. However, in the eastern part of this reservoir, an outcrop of the basal beds of the Río Yuca Formation above the water level has produced new vertebrate remains (freshwater fishes, dolphins, armadillos, toxodonts, crocodiles and turtles). The recovery of these remains improves our understanding of the Neogene continental vertebrate records from an area in the northernmost SA portion, which previously has barely been sampled. A new vertebrate fossil assemblage from the Río Yuca Formation is described here, with discussions of their systematics, biostratigraphic significance, and biogeographical implications.

## 2. Geological context

The Barinas-Apure Basin is located in western Venezuela, southeast of the Mérida Andes (Fig. 1). The Paleogene sedimentation of the Barinas Basin lacks Paleocene and lower Eocene strata, and begins with the Middle and Upper Eocene sedimentation of the El Cobre, Gobernador, and Pagüey formations, grading from typical fluvial sandstones to neritic shales that constitutes a single

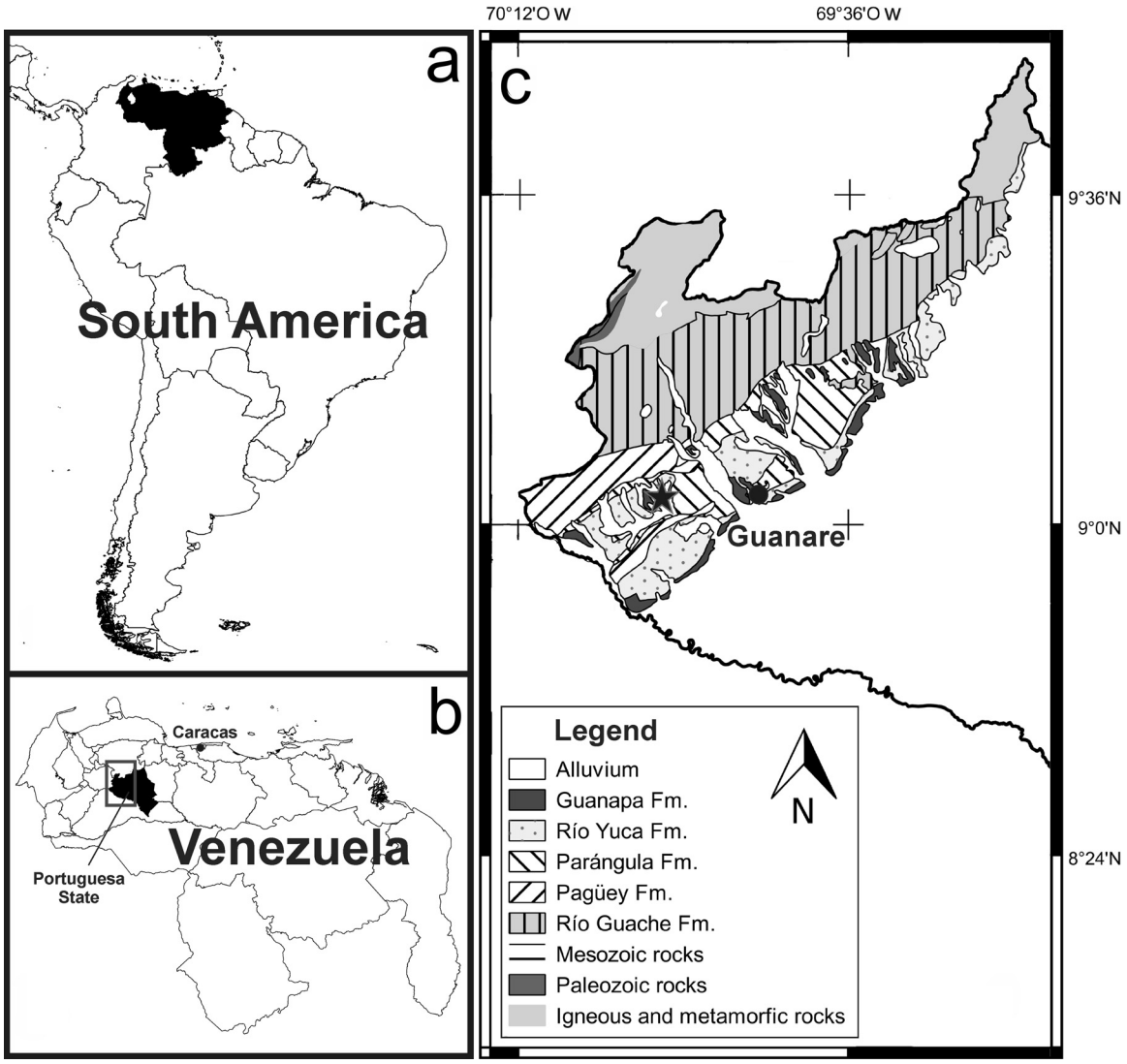


**Fig. 1.** Location maps showing the continental (**a**), regional (**b**) and local (**c**) location of the fossil assemblage here described.