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Middle Miocene vertebrates from the Amazonian Madre de Dios Subandean Zone, Perú

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ABSTRACT

A new middle Miocene vertebrate fauna from Peruvian Amazonia is described. It yields the marsupials *Sipalocyon* sp. (Hathliacynidae) and *Marmosa* (*Micoureus*) cf. *laventica* (Didelphidae), as well as an unidentified glyptodontine xenarthran and the rodents *Guiomys* sp. (Caviidae), "*Scleromys*" sp., cf. *quadrangulatus-schurmanni-colombianus* (Dinomyidae), an unidentified acaremyid, and cf. *Microsteiromys* sp. (Erethizontidae). Apatite Fission Track provides a detrital age (17.1 ± 2.4 Ma) for the locality, slightly older than its inferred biochronological age (Colloncuran-early Laventan South American Land Mammal Ages: ~15.6–13.0 Ma). Put together, both the mammalian assemblage and lithology of the fossil-bearing level point to a mixture of tropical rainforest environment and more open habitats under a monsoonal-like tropical climate. The fully fluvial origin of the concerned sedimentary sequence suggests that the Amazonian Madre de Dios Subandean Zone was not part of the Pebas mega-wetland System by middle Miocene times. This new assemblage seems to reveal a previously undocumented "spatiotemporal transition" between the late early Miocene assemblages from high latitudes (Patagonia and Southern Chile) and the late middle Miocene faunas of low latitudes (Colombia, Perú, Venezuela, and ?Brazil).

1. Introduction

The middle Miocene period is characterised by the last climatic optimum (MMCO, for Middle Miocene Climatic Optimum) before a sustainable deterioration culminating with Pliocene–Pleistocene ice ages (Zachos et al., 2001, 2008). In Northern South America, this MMCO coincides with the emergence of the "Pebas system", a large wetland with marine influence partly engulfing what is lowland Amazonia today (for review, see Hoorn et al., 2010a,b).

This environment was particularly favourable to biodiversity and it allowed a wide array of organisms, such as molluscs, arthropods, and plants to be fossilised (e.g., Hoorn, 1993; Antoine et al., 2006; Pons and De Franceschi, 2007; Jaramillo et al., 2010; Wesselingh and Ramos, 2010). By contrast, and with the notable exceptions of La Venta (late middle Miocene, Colombia; Kay et al., 1997) and Fitzcarrald local fauna (eastern Perú; Antoine et al., 2007; Goillot et al., 2011; Pujos et al., in press), middle Miocene mammals are virtually unknown in tropical-equatorial South America (e.g., Negri et al., 2010).

The present work aims to report a new vertebrate locality from the Subandean Zone of Southwestern Peru, designated MD-67 (S12°38.683′; W71°19.284′; ~428 m Above Sea Level) and documenting the concerned interval. MD-67 was discovered by one of us (MR) nearby Pilcopata (Cusco) in 2007 (Fig. 1). The corresponding results are exposed hereunder in systematic, biostratigraphical, and biogeographical perspectives.

1.1. Geological context

The western Amazon drainage basin extends today from southern Colombia to northern Bolivia (Hoorn et al., 2010a). Since Pliocene times (Espurt et al., 2007, 2010), the Amazonian foreland

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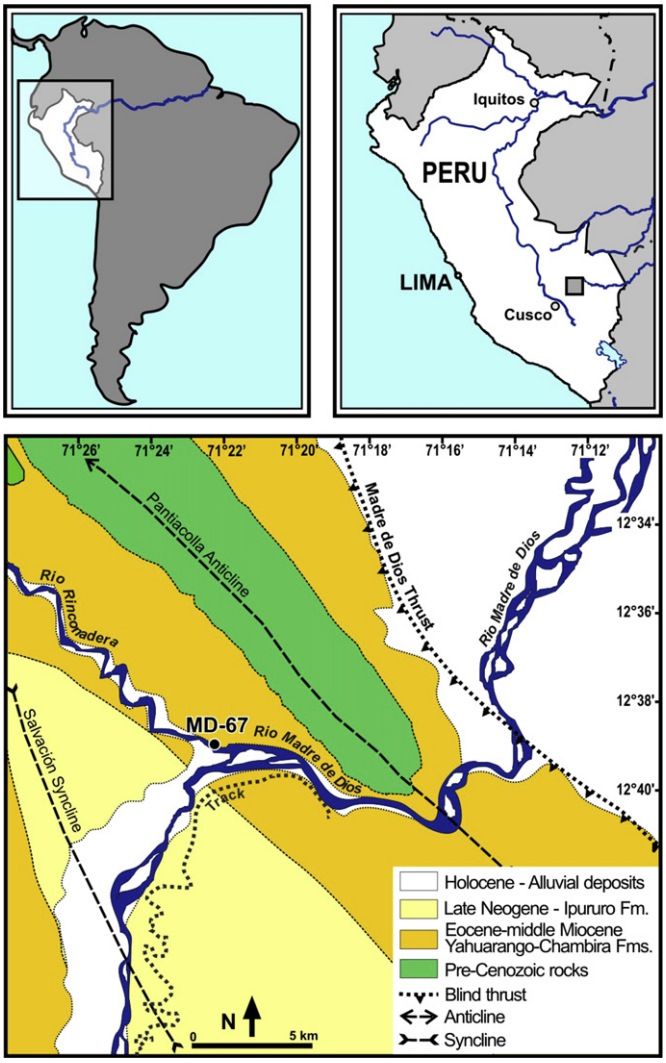

Fig. 1. Location and geological map of the studied area, in the Amazonian Madre de Dios Subandean Zone, Perú; modified after Vargas and Hipólito (1998).

basin has been divided into two foreland basin systems (*sensu* DeCelles and Giles, 1996): the North Amazonian foreland basin system and the South Amazonian foreland basin, separated by the Fitzcarrald Arch (Roddaz et al., 2005). The South Amazonian foreland basin system comprises the Southern Peruvian and Northern Bolivian foreland basins. The Subandean Zone is part of the Madre de Dios foreland basin (Fig. 1). The southernmost part of the Subandean Zone is structured by a syncline (Salvación Syncline) followed by a thrust-related anticline (Pantiacolla Anticline) and the Madre de Dios blind thrust front (Fig. 1).

The fossiliferous outcrop dips 35° SW with a N130 strike (Fig. 2). It crops out in the southern flank of the Pantiacolla anticline and was originally mapped as part of the Paleocene–Eocene Yahuarango Formation, based on sedimentary facies, but without any biostratigraphic constraint (Vargas and Hipólito, 1998). The Yahuarango Formation (northern Perú) is poorly dated and it consists mainly of red siltstones and mudstones forming distal fluvial deposits (see Roddaz et al., 2010 for a review).

The fossiliferous level corresponds to a 1 m-thick sand-and-gravel channel of fluvial origin, with iron-rich pisolites and topped by a ferruginous duricrust (Fig. 2A). These features coincide with a lateritic profile (e.g., Tardy, 1992). The fossiliferous channel developed over paleosol mudstones (Fig. 2A and B).

2. Material and methods

2.1. Paleontology

All the vertebrate fossil remains described here were recovered either by hand-picking on the ferruginous crust topping the MD-67 locality during the exploratory 2007 field trip, or by excavating and by screen-washing of the corresponding sediment during the 2009 field season. In 2009, ca. 200 kg of rough sediment were screen-washed, using a 1 mm mesh. A new survey in 2011 unfortunately showed the fossil-yielding outcrop had been washed away by the Madre de Dios River in the meantime (Fig. 2C).

Fragments of turtle plates and crocodile teeth were also recovered in MD-67. As they do not display diagnostic features, they will not be described here. By contrast, neither fish nor plant remains were unearthed in MD-67.

Among mammalian remains, a mesio-labial fragment of a hypselodont upper tooth referable to a toxodontid notoungulate was recognised in MD-67. This specimen, of poor biochronological and environmental use, is the only remain unambiguously assignable to native ungulates in the concerned locality.

The nomenclature used for marsupial dentition is adapted from that of Goin and Candela (2004). Morphological features of the cavioid rodent are described and diagnosed following the terminology and phylogenetic characters proposed by Pérez (2010). For dental features of the dinomyid, octodontoid, and erethizontid rodents, we follow the nomenclature of Wood and Wilson (1936), as modified by Antoine et al. (2012).

Except when mentioned, dimensions are given in mm.

2.2. Apatite fission track analysis (AFTA)

Apatite grains were mounted and polished for etching to several the natural spontaneous fission tracks. Apatites were etched using 5 N HNO_3 at 20 °C for 20 s. Etched grain mounts were packed with mica external detectors and corning glass (CN5) dosimeters and irradiated in the FRM 11 thermal neutron facility at the University of Munich in Germany. Following irradiation the external detectors were etched using 48% HF at 20 °C for 25 min. Analyses were carried out on a Zeiss Axioplan microscope at a magnification of ×1250, using a dry (×100) objective. Confined track length measurements were made using a drawing tube and digitising tablet, calibrated against a stage micrometre. Single-grain AFT ages were calculated using the external detector method and the zeta calibration approach, as recommended by the I.U.G.S. Subcommission on Geochronology (Hurford, 1990). Track length measurements were restricted to confined tracks parallel to the c-crystallographic axis.

2.3. Institutional abbreviations

AMNH, American Museum of Natural History, New York, USA; IGM, Ingeominas (Instituto Nacional de Investigaciones en Geociencias, Minería y Química, Museo Geológico, Bogotá, Colombia; ISE-M, Institut des Sciences de l'Évolution, Montpellier, France; MACN, Museo Argentino de Ciencias Naturales Bernardino Rivadavia, Buenos Aires, Argentina; MLP, Museo de Ciencias Naturales de La Plata, La Plata, Argentina; MNHN, Muséum National d'Histoire Naturelle, Paris; MUSM, Museo de Historia Natural de la Universidad Nacional Mayor San Marcos, Lima, Perú; UCMP, University of California Museum of Paleontology, Berkeley, USA; UFAC, Laboratório de Pesquisas Paleontológicas, Universidade Federal do Acre, Rio Branco, Brazil.