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Environmental conditions vs. landscape. Assessment of the factors that influence small mammal fauna distribution in Southern Iberia during the latest Messinian by mean of stable isotopes

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ABSTRACT

Tropical conditions during the late Miocene in southwestern Europe influenced the continental environments. Although there are previous qualitative environmental interpretations of these continental landscapes during the late Miocene, quantitative environmental and paleohydrological data are scarce. A very long sequence of small mammals allowed to date the different continental drainage stages of the Granada Basin from latest Tortonian to the Holocene and to reconstruct qualitatively its environmental evolution. The study of the isotopic record of these fossil small mammals and sediments in the stratigraphic sequence of a latest Messinian paleo-lake in the Granada Basin has provided quantitative environmental and paleohydrological data, in order to know if the fluctuations in the faunal distribution were mainly influenced by the paleogeographic configuration, such as changes in the landscape of the basin, or by the climatic conditions. Open habitats with C3 plants predominated. Estimated quantitative data suggest an oxygen isotopic composition of meteoric waters ranging from −4.9 to −3.9‰, past temperatures from ~2.5 °C to 4.7 °C higher than the current ones, and summer relative paleohumidity from ~60% to ~70%. In this context, changes in the landscape, such as the reduction of the lacustrine system caused by tectonic activity, would affect taxa with high dependence on humid conditions.

1. Introduction

The Betic Cordillera is the largest mountain range in southwesternmost Europe. It began to rise in the early and middle Miocene (Sanz de Galdeano and Vera, 1992; van Geel et al., 1992; Vera et al., 2004; among others). During the late Miocene (late Tortonian) several post-orogenic basins were generated, some of which registered a continental history starting in the Messinian (Fernández et al., 1996; Soria et al., 1998, 1999; Viseras et al., 2004; among others). There are scarce quantitative environmental and paleohydrological data for these continental areas. It is of interest to know data about the conditions during the Messinian because tropical climate has been hypothesized for coastal and continental areas in southern Iberia (Martín and Braga, 1994, 2001; Sánchez-Almazo et al., 2001; García-Alix et al., 2008c).

The use of fossil mammals to reconstruct past environmental conditions of continental areas during Cenozoic has been widely applied (especially fossil small mammals) (Daams et al., 1999; van Dam and Weltje, 1999; Montuire, 1999; Martín Suárez et al., 2001; García-Alix et al., 2008c; Cuenca-Bescós et al., 2011; López-García et al., 2013; among others). However, such records cannot be found in all continental sections, may be scarce, or/and may provide occasional information. Associated paleohydrological interpretations are also difficult. In these cases, isotopic records from sediments and/or fossil mammals may complete this past environmental information.

A high quality continuous sequence of small mammals from different drainage systems of the Granada Basin from the latest Tortonian to the Holocene has been previously described (e.g. García-Alix et al., 2007a,b, 2008a,b,c, 2009a,b). This paper is focused on a lacustrine sequence of the western area of the Granada Basin (southern Iberia) during the latest Messinian (Fig. 1) because it constitutes an important stage in its paleogeographical evolution: it is the latest phase of a completely endorheic configuration. In this stage, the lacustrine system, which previously occupied almost the whole basin, was reduced to the western sector (García-Alix et al., 2008a). During this phase, a decrease in the percentage of small mammals with wet ecological preferences is registered (García-Alix et al., 2008c) (Fig. 2).

The reduction of the lacustrine system may be due to climatic or tectonic causes, or both. The general continental climatic evolution

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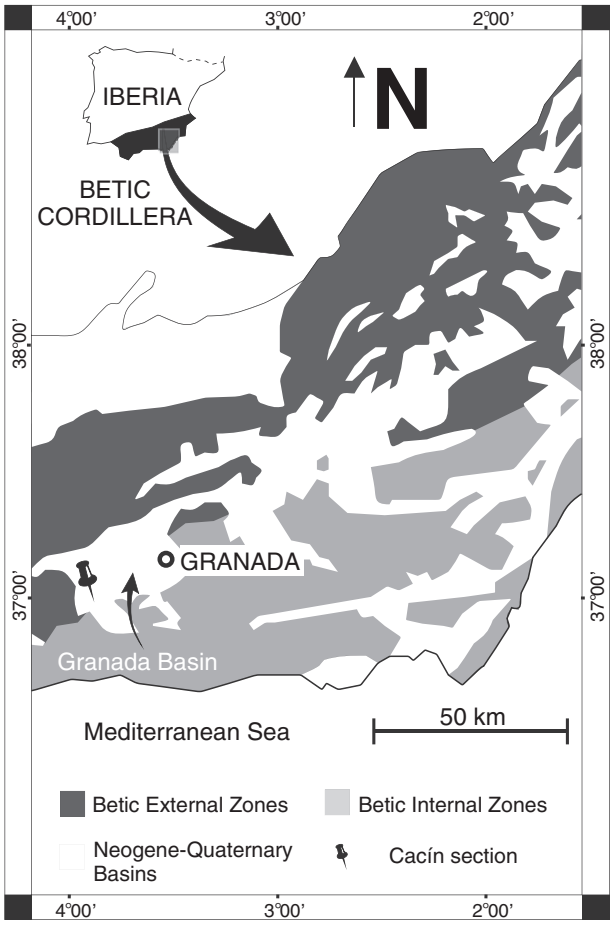

Fig. 1. Geographic and geologic location of Granada Basin and the Cacín section. After Minwer-Barakat et al., 2009.

of this sector was deduced by means of small mammals (García-Alix et al., 2008c), because these are very sensitive to minimum changes in their habitats. However, they do not allow us to discern between the possible scenarios: climatic change or change in the physical environment (landscape), or both. Therefore, we propose a multiproxy approach (isotopic geochemistry, sediments, and fossil small mammals) in order to test climatic or tectonic forcing of the changes in the lacustrine configuration of the basin.

The Cacín section belongs to this latest Messinian stage. In this stratigraphic sequence three small mammal levels have been recognized, which have yielded scarce remains. So, the approach developed in this paper, by means of isotopic composition of sediments (organic material and carbonate) and from tooth phosphate and carbonate, will complete the partial environmental information from this section, and will provide new paleohydrological and quantitative environmental information for the area.

2. Regional setting

The Granada Basin (southern Iberia) is a Neogene intramontane basin in the central sector of the Betic Cordillera, covering the contact between the Internal and the External Zones of the Cordillera (Fig. 1). Nowadays, it is an exorheic basin, with outflows in the Genil River, that crosses the basin (E–W) longitudinally, and the Guadalfeo River, which drains the eastern sector of the basin, flowing southward into the Mediterranean Sea. However, the drainage conditions of the basin have changed through time (Martín et al., 1984; Fernández and Soria, 1987; García-Alix et al., 2008a, 2009a). Its infilling ranges from the Tortonian to the Holocene. The oldest records (Tortonian) belong to a marine stage (Dabrio et al., 1978; Martín et al., 1984; Fernández et al., 1996; Braga et al., 2003, among others). In the latest Tortonian the basin emerged, and successive continental fluvio-lacustrine systems developed through time (Braga et al., 1990; Fernández et al., 1996; García-Alix et al., 2008a; among others).

The first continental stage was endorheic, from the latest Tortonian to the latest Messinian. At the beginning of this continental phase, a

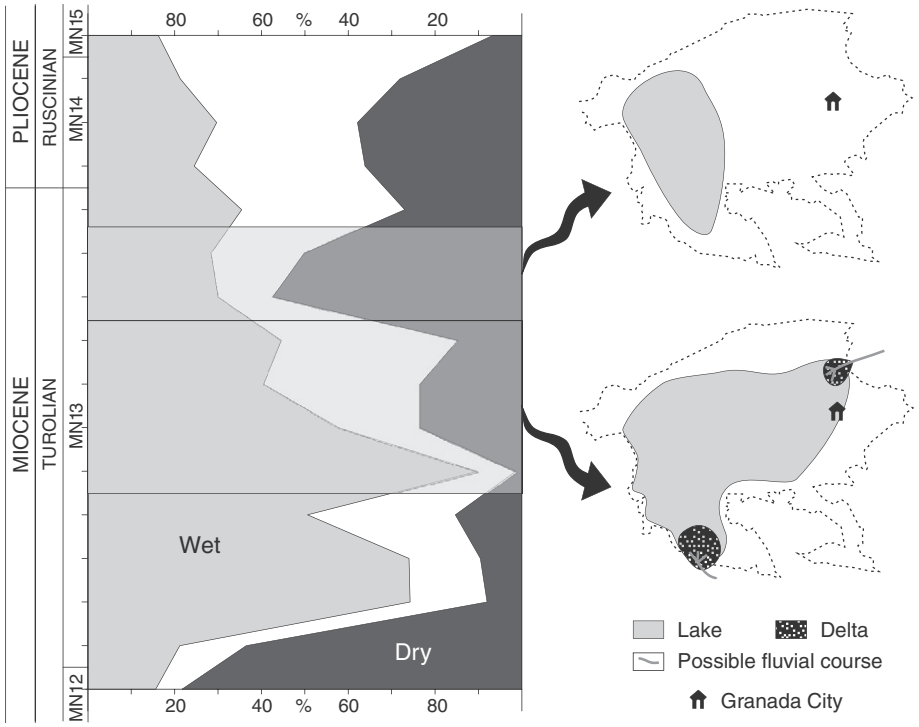

Fig. 2. Relative abundances of taxa with wet/dry preferences (after García-Alix et al., 2008c) and relationship with the sedimentary and paleogeographical context of the Granada Basin (dotted line; after García-Alix et al., 2008a).