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Vegetation history, climate and human impact in the Spanish Central System over the last 9000 years

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ABSTRACT

In this paper we present a review of the available Holocene pollen records from the Spanish Central System (113 sites and 150 ^{14}C dates). Palynological data obtained from pollen analyses of peat-bogs, lakes and archaeological sites, as well as radiocarbon dating, were used to infer the human impact on vegetation and landscape during the last 9 millennia. The Neolithic contribution to the configuration of landscape is scarce, limited to the valleys, while Chalcolithic settlements and their related activities (agriculture and grazing) represent the first evidence of significant human impact on the high-mountains. The pollen record has allowed us to relate two cultural periods of changing, the Copper Age–Early Bronze Age and Late Bronze Age–Early Iron Age transitions, to abrupt climate disruptions, the so-called 4.2 and 2.8 ka cal BP events respectively. From the Iron Age to the Early Middle Ages, anthropic activities were still sporadic, mainly located in the lowlands, but from the Feudal Period onwards, when La Mesta transhumance system takes place, high-mountain landscapes changed dramatically. Late Modern Period brings a further intensification of human pressure, especially related to forestry, with widespread pinewood afforestation.

1. Introduction

Human disturbance has been suggested as the major driver of vegetation change in the Iberian Peninsula at least for the last ~7500 years (Riera et al., 2004; Pérez-Obiol et al., 2011). Nevertheless, direct evidence of anthropogenic transformations in later prehistoric times is not uniform in Spain, especially in mountainous areas (Carrión et al., 2010). In this sense, the improved linkage of archaeological and palaeoecological records is essential to understand the timing and extent of anthropogenic and/or climatic alterations on natural vegetation during the Holocene (Carrión et al., 2001a, 2007). Detailed investigations from Central Spain have demonstrated the suitability of palaeoecological analyses to provide environmental information comparable with archaeological and historical evidence (e.g. Blanco-González et al., 2009; López-Sáez et al., 2009b; Valbuena-Carabaña et al., 2010). By comparing pollen diagrams from several sites (bogs, lakes, archaeological sites) within a region, it is possible to obtain information on vegetation history, human impact and dynamics of agro-pastoral strategies on different spatial and temporal scales (López-Sáez et al., 2003a; Carrión et al., 2010; Gil-Romera et al., 2010). Along with archaeological data, palaeoecological information allows the reconstruction of interactions and/or adaptations of the past societies to Holocene climate changes during different historical periods (Carrión et al., 2000; Berglund, 2003; Gaillard, 2007; López-Sáez et al., 2009a).

The Spanish Central System acquires special interest for studies on this topic as its natural vegetation has been influenced by anthropogenic activity since at least 6000 years ago, starting with the introduction of Neolithic farming in the intramountain valleys,

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and continuously increasing throughout several millennia of human occupation of these environments. The peculiar topography of Central Iberia, with two sub-plateaus surrounded by high-mountains ranges, has allowed humans to implement mobile pastoralism practices to exploit available pastures in every season. This mountain system has been traditionally considered as one of the main routes for prehistoric transhumance (Klein, 1990), but current data only allow to envisage short seasonal livestock movements at least since the Iron Age (Sánchez-Moreno, 1998; Álvarez-Sanchís, 1999; Sánchez-Moreno, 2001). This long history of human settlements and movements in the Spanish Central System has shaped a landscape with broad extensions of grasslands and shrublands, complemented with livestock resources located in the plains on either side of the mountain range. In this sense, fire and grazing pressure are considered the main modeling factors of the landscape in highland areas in southwestern Europe (e.g. Carrión et al., 2001b, 2007; Pausas and Keeley, 2009; López-Sáez et al., 2009b). Moreover, this mountainous massif shows a great biogeographical value, as it is located in a transition area between Eurosiberian and Mediterranean regions (Rivas-Martínez, 1963; Rivas-Martínez et al., 1987). It actually shelters a large number of endemic species (Peinado-Lorca and Rivas-Martínez, 1987) and has played an important role as refugia of forest species during glacial times (Ashcroft, 2010). These features allow its consideration as a biodiversity "hot spot" (Médail and Diadema, 2009).

Apart from the western sector of the Iberian Central System (Estrela Range), where the Lateglacial and the full Holocene are recorded in pollen sequences (e.g. van der Knaap and van Leeuwen, 1994, 1995, 1997), the Spanish Central System is scarce in Holocene records that extend back beyond the last 6000 years (Ruiz-Zapata et al., 1998). Most of them are short-term pollen records. In order to assess the degree of human impact in this region, a great number of investigations combining pollen analysis, archaeological studies, radiocarbon dating and information on past climate changes have been carried out by several researchers over a period of 30 years. These studies have focused on human–environment interactions, synchronism between environmental and cultural changes, and also on palaeo-phytogeographical issues (e.g. López-Sáez and López-García, 1994; López-García, 1997; Ruiz-Zapata et al., 1997, 1998; Pulido et al., 2007; Franco-Múgica, 2009; López-Sáez et al., 2009b, 2010a).

The main sources of information for this study are the palynological and archaeological data from the Spanish Central System. The presence of a large number of deposits susceptible of being analyzed (>100), have allowed the achievement of numerous palaeopalynological works (including 9 PhD theses) throughout the whole mountainous range and valleys. However, the absence in many cases of reliable dating hinders the establishment of any diachronic vegetation model and the proposal of any anthropogenic evolution during the Holocene. This paper provides a first comprehensive overview and addresses a critical evaluation of past vegetation changes in relation to human occupation and climate changes for the whole Spanish Central System.

2. Physical settings

The Iberian Central System is a mountain range of about 500 km long which divides the Duero and Tagus Basins (northern and southern Iberian plateaus respectively), so it has been considered as the "great Castilian borderline" (Pedraza and Carrasco, 1999), thanks to its WSW–ENE general layout (Rivas-Martínez et al., 1987; Ubanell, 1994). It consists of a series of mountainous ranges ("sierras") separated by depressions or troughs which represent natural corridors between the two sub-plateaus (De Vicente et al., 1994; Martín-Velázquez and Elorza, 2007). The ranges that make up this mountain chain are, from east to west (Fig. 1): Pela and Ayllón (~1400–1500 and 2000–2273 m asl respectively), Guadarrama (~1750–2428 m asl), Gredos (with the highest peak: Almanzor 2592 m asl), Béjar (with similar elevation), Francia and Gata (both below 1800 m asl), and finally Estrela in Portugal (where the altitude again reaches 2000 m asl close to the Atlantic coast).

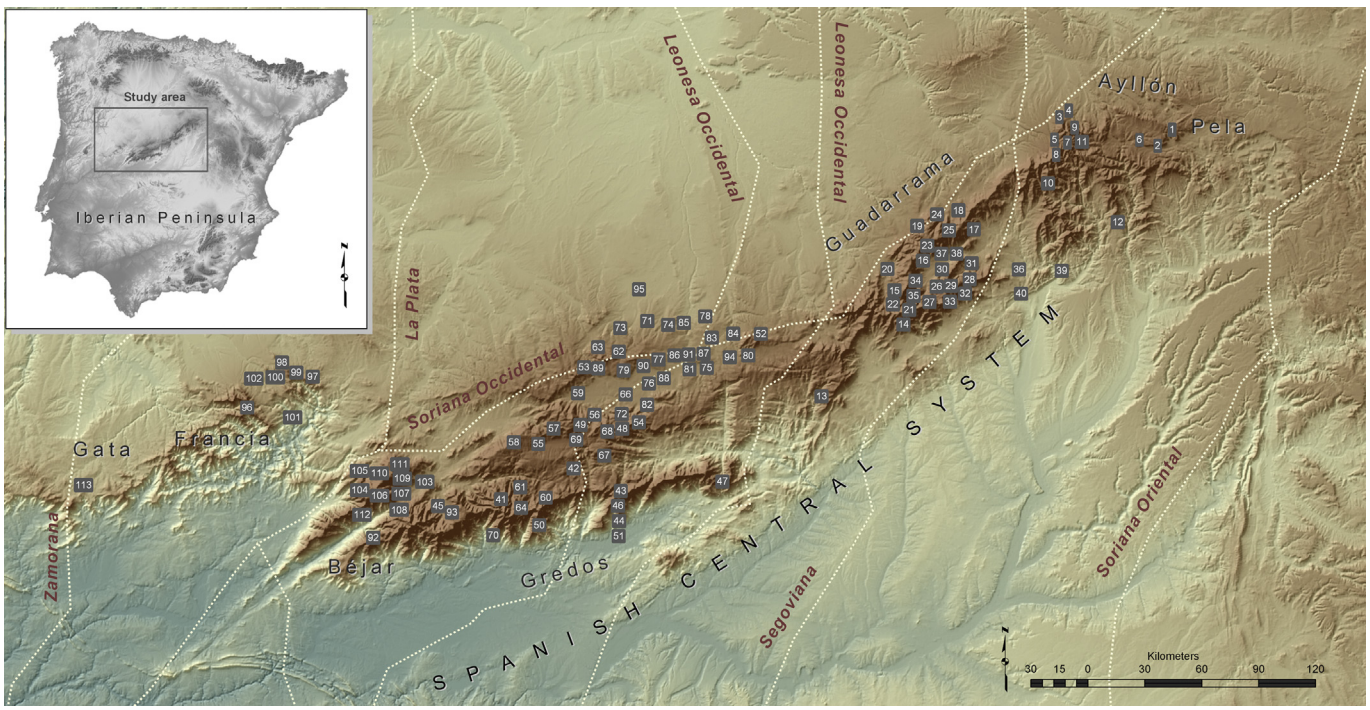

Fig. 1. Geographical position of the study area, location of the pollen sequences, and main livestock tracks crossing the Spanish Central System during La Mesta. The number of sites is reflected in Table 1.

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