



Analysis of seasonal mobility of sheep in Iron Age Catalonia (north-eastern Spain) based on strontium and oxygen isotope analysis from tooth enamel: First results



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ABSTRACT

This pilot study investigates the existence of seasonal movements of sheep – transhumance – in Iron Age Catalonia (North-Eastern Spain). The occurrence of seasonal movement of livestock between the coast and the interior, perhaps in relation to the Mediterranean market, was suggested for this area based on landscape and palynological studies. This hypothesis was tested on the basis of strontium, carbon and oxygen isotope analysis from seven sheep lower third molars. The evidence obtained suggests that the animals did not move across geological areas during the time of enamel mineralization. In addition, the paper provides valuable isotopic evidence that can be used in further studies.

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1. Introduction

Transhumance – understood here as the seasonal movement of livestock between complementary pastures (Geddes, 1983; Khazanov, 1984) – is a highly specialized economic system, the adoption of which has important implications for a community's socio-political structure, practices and cultural ideology (Walker, 1983; McDonnell, 1988). For years, the subject has generated an intense academic debate concerning the presence/absence of transhumance in different areas of prehistoric Europe, as well as its temporal origin (e.g.: Higgs, 1976; Cunliffe, 1978; Chapman, 1979; Davidson, 1980; Halstead, 1987, 1996; Cherry, 1988; Greenfield, 1999; Hill, 1995; Kienlin and Valde-Nowak, 2002–2004; Arnold and Greenfield, 2006; Tullett, 2011). The Iberian Peninsula also featured in this debate (e.g.: Molina González and Arteaga, 1976, Molina González, 1978, Walker, 1983; Cara and Rodríguez, 1987; Galán and Martín, 1991–1992; Delibes and Romero, 1992; Harrison, 1993, 1995; Cura, 1995; Sánchez-Moreno, 1998; Cebrià et al., 2003; Riera et al., 2007).

Up to now, most studies have used indirect evidence to address this issue. This includes typological similarities in artefacts between distant territories (e.g.: Molina González and Arteaga, 1976, Molina González, 1978, Delibes and Romero, 1992; Kienlin and Valde-Nowak, 2002–2004), settlement patterns (e.g.: Higgs, 1976; Cara and Rodríguez, 1987; Galán and Martín, 1991–1992; Cebrià et al., 2003), as well as the absence of cereal storage structures – silos – in some areas (e.g.: Cura, 1995; Hill, 1995).

This paper aims to provide direct evidence to inform the debate on seasonal movement of livestock in Iron Age Catalonia (north-eastern Spain), based on data from stable isotopes of strontium ($^{87}\text{Sr}/^{86}\text{Sr}$), oxygen ($^{18}\text{O}/^{16}\text{O}$) and carbon ($^{13}\text{C}/^{14}\text{C}$) obtained from archaeological sheep teeth. It represents the first isotopic study applied to Iron Age sheep remains in this region.

The Iberian culture (6th–2nd century BC) developed in the eastern area of the Iberian Peninsula as the result of the evolution of the small-scale societies of the Late Bronze Age into more complex ones in the Iron Age, organized in political entities (e.g. Sanmartí, 2001a, 2004, 2009a; Sanmartí et al., 2006). Each Iberian territory contained settlements of different sizes and functions (towns of different scales, villages, fortified sites, rural settlements), which were organized following a hierarchical pattern and according to a proto-state structure probably in

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place from the 6th to the 5th century BC (Asensio et al., 1998; Sanmartí, 2002; Sanmartí et al., 2006). On the basis of landscape studies (Grau, 2003; Sanmartí, 2001b, 2002, 2004; Sanmartí and Santacana, 2005), the proposed boundaries between the different proto-states were found to correspond approximately to different ethnic groups, as indicated by ancient sources (Ptolemy – *Geographia*, II, 6, and Pliny the Elder – *Naturalis Historia*, III, 4, 20), and already suggested by Bosch Gimpera (1932).

The archaeological record of the Iberians inhabiting present-day Catalonia indicates close trade links with other Mediterranean populations – Phoenicians and Greeks (Sanmartí and Asensio, 2005; Rouillard, 2009; Sanmartí, 2009b) – as well as an economy based on intensive cereal farming and animal husbandry (Sanmartí, 2001a; Iborra, 2004; Pérez-Jordà et al., 2007; López et al., 2011). According to zooarchaeological analysis, caprines were the most abundant taxon, followed by pigs and cattle (Albizuri and Nadal, 1999; Franquesa et al., 2000; Valenzuela-Lamas, 2008; Albizuri et al., 2010; López et al., 2011). Hunting is represented by the remains of red deer and rabbit in low proportions (usually less than 5% NISP), whereas equids and dogs were not part of the usual meat diet, though were occasionally consumed (Albizuri et al., 2010; López et al., 2011).

The presence of a number of stone enclosures dating from the early Iron Age (7th c. BC) in the central coast of Catalonia (Miret and Miret, 1981; Mestres et al., 1994–1996; Cebrià et al., 2003) led to the hypothesis that an intensive pastoralism, perhaps in relation to colonial markets, could have existed in this geographic zone (Cebrià et al., 2003). Progressive deforestation was attested by palynological evidence, which led to the hypothesis that movement of livestock between the coast and the interior in this area may have occurred (Riera et al., 2007).

The Iron Age site of Turó de la Font de la Canya was selected for a variety of reasons. Firstly, the site provides good bone preservation and a reliable chronology. Secondly, it is a central storage site for cereals, and it could be a gathering point also for livestock. Thirdly, it is located in the area where palynological evidence suggests movement of livestock in the Iron Age (Riera et al., 2007), and a number of stone enclosures were interpreted as livestock enclosures built in this period (Miret and Miret, 1981; Mestres et al., 1994–1996; Cebrià et al., 2003). Finally, the site is located at the junction of two historical transhumant routes (Rovira and Miralles, 1999), on distinctive geological bedrock (Fig. 1).

2. Materials and methods

Turó de la Font de la Canya (Avinyonet del Penedès, Catalonia) is an Iron Age site located 40 km south of Barcelona. It represents a ‘silos champ’ – a site specialized in cereal storage. These sites are characterized by a small habitation area compared to the extension devoted to cereal storage (Asensio et al., 1998; Sanmartí, 2002; Sanmartí et al., 2006; Fig. 2). Cereals are stored in holes excavated in the ground – ‘silos’ – where anaerobic conditions favour preservation. According to archaeobotanical evidence, the most common cultivated species was barley (*Hordeum vulgare*), followed by common wheat (*Triticum aestivum*) and durum wheat (*Triticum durum*), among others (López, 2004). After several years of use, these structures were back-filled with all kinds of domestic waste, and therefore they provide precious evidence of human activity (López, 2004).

The site was built in the 7th century BC on a small promontory (230 m a.s.l.), about 15 km from the present-day coastline, and it was abandoned in the first half of the 2nd century BC, during the Roman period. Excavations conducted in the last fifteen years indicate that this settlement was a central point of cereal storage, and it provided the first evidence of wine production in this region, as well as numerous Phoenician imports (López, 2004; López et al., 2011, 2013). The site has very good visual connection with other sites in the surrounding area, and it is located on the natural way that connects the pre-littoral valley with the coast. The underlying geology is composed of Early Miocene chalk, which is highly recognizable from the surrounding Cretaceous, Triassic and Pleistocene sediments (Fig. 1).

Seasonal changes in the strontium, carbon and oxygen isotopic ratios of diet are preserved in the mineral fraction of the enamel (hereafter referred to as bioapatite) during tooth growth, and they can be detected by sequential sampling of enamel along the tooth crown (Sharp and Cerling, 1998; Gadbury et al., 2000; Bocherens et al., 2001; Balasse et al., 2002; Bogaard et al., 2014).

Seven archaeological third lower sheep molars were chosen for isotopic analysis. Despite the higher inter-individual variation in the enamel mineralization of the third molar in comparison to the second (Blaise and Balasse, 2011; Tornero et al., 2013), and the possible averaging of isotope ratios (Montgomery et al., 2010), this

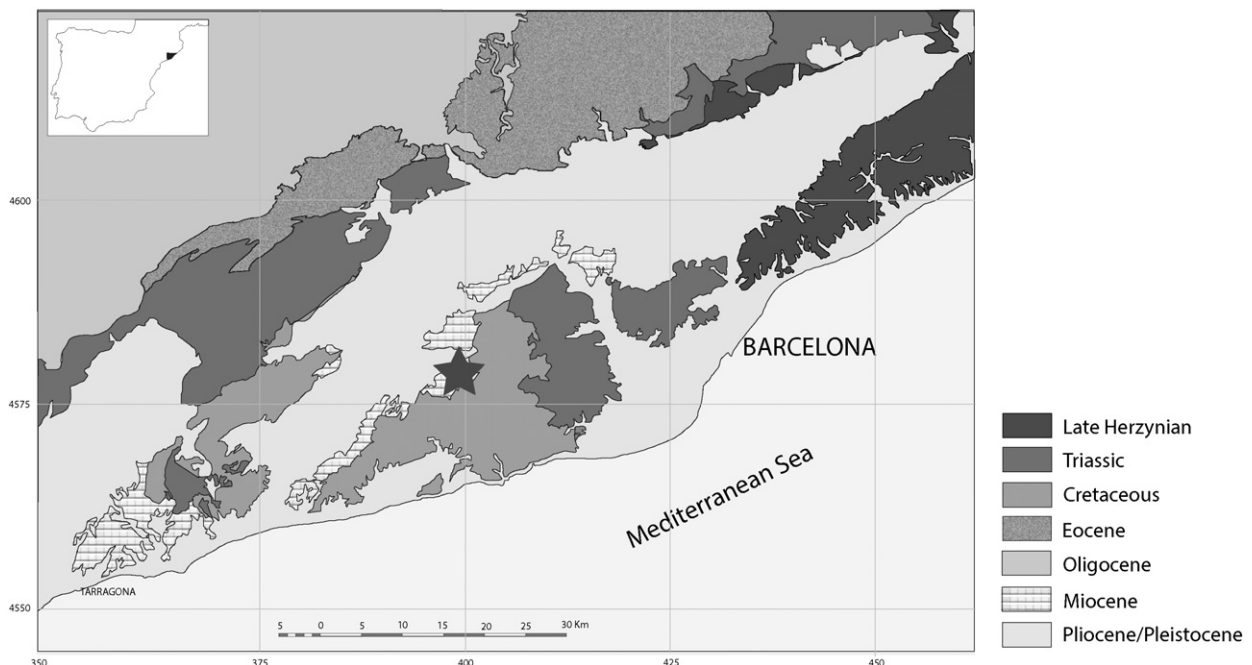


Fig. 1. Simplified geological map of the area of study, and location of the Iron Age site of Turó de la Font de la Canya (star).

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