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Biostratigraphy, palaeogeography and palaeoenvironmental significance of *Sorex runtonensis* Hinton, 1911 (Mammalia, Soricidae): First record from the Iberian Peninsula

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ABSTRACT

Sorex runtonensis (Mammalia, Soricidae) is a well-known Pleistocene taxon with a broad distribution in Europe. However, no record of the species had been reported from the Iberian Peninsula up to now. Here we present nearly two hundred specimens of *S. runtonensis* recovered from the Lower Red Unit (levels TE7–14) of Sima del Elefante (Sierra de Atapuerca, Burgos, Spain), dated to ~1.1–1.5 Ma. Rigorous morphometrical and morphological analyses allowed the assignation of the items from Sima del Elefante confidently to this taxon, distinguishing them from the several other Pleistocene species of similar size that inhabited Europe. *Sorex runtonensis* survived all through the Pleistocene (and maybe more), but the remains from Sima del Elefante exhibit some traits that appear to be particular to the Early Pleistocene, which agrees with the pre-Jaramillo chronology inferred for the lower levels of the site. Western Palearctic *S. runtonensis* has been regarded as a proxy of patchy and relatively arid, open past biotopes due to its similarity to recent Eastern Palearctic *S. tundrensis*. In light of this fact, and given the high relative quantities of this taxon at the site, previous palaeoenvironmental reconstructions proposed for the lowermost unit of Sima del Elefante should be revised to present a more ecologically diverse scenario than previously thought.

1. Introduction

Recently, some specimens of *Sorex* (*Drepanosorex*) *margaritodon* (Kormos, 1930) have been indisputably identified and described at the Lower Red Unit (levels TE7–14) of Sima del Elefante (Sierra de Atapuerca, Burgos, Spain), biochronologically dated to ~1.1–1.5 Ma (Rofes and Cuenca-Bescós, 2013). Therefore, all the items provisionally called *Sorex* sp.2 in Cuenca-Bescós et al. (2013) are now regarded as *S.* (*D.*) *margaritodon*. However, there is another type of *Sorex* in the same levels, provisionally called *Sorex* sp.1 in Cuenca-Bescós et al. (2013, 2015) and Rofes and Cuenca-Bescós (2013). It is smaller in size and much more numerous than *S.* (*D.*) *margaritodon*.

The combination of characteristics such as the large and triangular internal fossa, the mandibular condyle with articular facets moderately separated and a relatively broad interarticular area, the pigmented teeth, the serrated first lower incisors, and the presence of entoconid crests in the lower molars makes it possible to assign the specimens to the genus *Sorex* (Reumer, 1998). Figuring out the specific identity of the specimens, whose size falls roughly between current representatives of *Sorex minutus* (Linnaeus, 1766) and *S. araneus* (Linnaeus, 1758), is not an easy task. There are several *Sorex* species from the European Pleistocene that are intermediate in size between *Sorex minutus* and *S. araneus*. Among them we have *S. hundsheimensis* (Rabeder, 1972), *S. casimiri* (Rzebik-Kowalska, 1991), *S. prealpinus* (Heller, 1930), *S. bor* (Reumer, 1984), *S. subaraneus* (Heller, 1958), and *S. runtonensis* (Rzebik-Kowalska, 1998).

Primary aim of this paper is to describe the Sima del Elefante remains and assign them first to the *S. runtonensis-subaraneus* group and then specifically to *S. runtonensis* using detailed morphological and morphometrical analyses. Next, we question the status of *S. subaraneus* as a valid taxon in light of the current evidence. We then provide a comprehensive overview of the biostratigraphy and evolution of *S. runtonensis* in Europe. Finally, we follow the continental palaeogeography of the species throughout the Pleistocene and discuss the significance of its relative abundance at Sima del Elefante Lower Red Unit, which may alter previous palaeoenvironmental reconstructions made for the site.

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2. The site

The Sima del Elefante site (TE from now on) is a major cave infill with a stratigraphic sequence of 16 litho-stratigraphic units, called TE7 to TE21 from lowermost to uppermost. The sequence is 25 m thick and 15 m wide in the exposed section, being located at the Trinchera del Ferrocarril (railway cutting) of the Sierra de Atapuerca (Fig. 1). A palaeomagnetic study has detected a polarity change at the base of unit TE17. The sediments below this unit, from TE7 to TE16, have reversed polarity and have been assigned to the Matuyama chron (>780 ka) (Parés et al., 2006).

The lowermost levels of Sima del Elefante (TE7 to TE14) are collectively known as the Lower Red Unit (TE-LRU), which is extremely rich in palaeontological remains, providing one of the best collections of fossil vertebrates from the Early Pleistocene in Europe (Cuenca-Bescós and García, 2007; García et al., 2008; Blain et al., 2010; Cuenca-Bescós et al., 2013; Galán et al., 2015; Núñez-Lahuerta et al., 2015). Burial dating based on terrestrial cosmogenic nuclides (TCN) Al-Be measured in quartz grains yielded an age of 1.22 ± 0.16 Ma for level TE9, and 1.13 ± 0.18 Ma for level TE7, located a few meters below (Carbonell et al., 2008). These two ages are in good agreement with the Matuyama chronology and suggest a Pre-Jaramillo age for the deposits. This chronology is confirmed by the small mammal assemblage (see Cuenca-Bescós et al., 2015 for an updated list of species), key in dating the TE-LRU as the oldest one in Atapuerca (i.e., ~1.1–1.5 Ma, Cuenca-Bescós and Rofes, 2004; Rofes and Cuenca-Bescós, 2006, 2009, 2011, 2013; Cuenca-Bescós et al., 2010, 2013, 2015). The sample of fossil shrews analyzed here comes from this Lower Red Unit.

The TE-LRU represents the oldest and most accurately dated record of human occupation in Europe (but see also Toro-Moyano et al., 2013). This takes the form of a hominin mandible and a proximal hand phalanx (from TE9c), 86 Mode 1 stone tools, and many large-mammal bones with clear evidence of human processing (Carbonell et al., 2008; Lorenzo et al., 2015; De Lombera-Hermida et al., 2015).

3. Material and methods

The specimens were taken from the sedimentary materials coming from the excavations of Sima del Elefante site since 1998. All excavated sediments are water-screened using a stack of nested sieves of decreasing mesh size (5 mm, 2 mm and 0.5 mm, respectively). The product is a concentrate of calcareous fragments from the cave walls, fossil remains of small vertebrates, and fragments of large vertebrates. These concentrates are labelled to maintain rigorous stratigraphic and spatial control. Except for the coarsest concentrate, which is separated using fine forceps without magnification, fossil extraction is done with the aid of a binocular microscope at a magnification of 10× to 20×. Afterwards, a preliminary classification of the microfossils is undertaken, and the information is recorded in the database of the microfauna of Atapuerca.

Fig. 1. Geographic location of the Sierra de Atapuerca (Burgos, Spain) and a plan view of the sites and the cave system (left). The underground galleries are shaded.