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Paleoenvironmental and paleoclimatic context during the Upper Palaeolithic (late Upper Pleistocene) in the Italian Peninsula. The small mammal record from Grotta Paglicci (Rignano Garganico, Foggia, Southern Italy)

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A B S T R A C T

Changes in large mammal population and biotic regionalism of the Italian Peninsula during Upper Pleistocene have been well documented over the last twenty years. On the other hand, only few studies have focused on the changes in small mammal fossil assemblages.

Grotta Paglicci is a key archaeological site for Italian prehistory. It is well dated and it shows an uninterrupted chronological sequence of Upper Palaeolithic lithic industries, ranging from the Aurignacian to the Late Epigravettian.

Small mammal remains from the Upper Palaeolithic layers of this cave have been identified and the assemblage has been analysed through the application of Simpson diversity index, Habitat Weighting and Bioclimatic model methods. The results show remarkable differences through the record: major climatic changes (GS2 is particularly well defined) are visible and a clear turning point is observable at the Bølling-Allerød interstadial transition. This is in line with environmental and climatic oscillations already detected in the Italian Peninsula. These data also suggest that a strong regionalism characterized the south-eastern Italian Peninsula during the Late Pleistocene.

1. Introduction

In the Italian Peninsula faunal assemblages dating to the Upper Pleistocene and especially to its last phases (end of MIS 3 and MIS 2) are characterized by a strong regionalism (Gliozzi et al., 1997; Masini and Sala, 2011, 2007; Sala, 2007; Sala et al., 1992; Sala and Masini, 2007). This is mostly due to the geomorphology and to the position of the Peninsula. Differences are clearly visible between assemblages from northern and southern areas (Sala, 2007) especially during the Late Glacial (Sala, 2007, 1990). Nonetheless, differences due to site position (i.e. mountain, valley, coastal area) must also be taken into account.

Among ungulates, *Capra ibex* and *Rupicapra rupicapra* were dominant in the Pre-Alps during glacial phases and were replaced by *Cervus elaphus* during warming up phases. On the other hand, in the Po plain, the dominant species was *Bison priscus* accompanied by the noteworthy presence of *Alces alces* (Sala, 2007). In Southern Italy, ungulate assemblages reflect differences between Adriatic and Tyrrhenian sides. During cold phases on the eastern side *Capra ibex*, *Bos primigenius* and *Equus ferus* were dominant, replaced by *Equus hydruntinus* and *Cervus elaphus* probably during the Bølling-Allerød Interstadial. During the Greenland Interstadial 1 on the western side, *Sus scrofa* and *Capreolus capreolus* tend to replace

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Cervus elaphus dominated assemblages (Boscato, 2007; Sala, 2007, 1983). Such East-West difference continues during the first phases of the Holocene (Bon and Boscato, 1996).

Recent studies on small mammal assemblages (Berto, 2013; López-García et al., 2015, 2014) show a division of the Italian Peninsula in at least four biogeographic regions: two in Northern-central Italy and two in Southern Italy. The Apennine chain acts as a divide between the eastern and western sides especially in Southern Italy. The presence of *Microtus* (*Terricola*) *savii* among arvicolids is a common element between the two regions. Although the origins and evolution of this species are still unclear, the molecular data shows that it originated in Italy probably during the Middle Pleistocene, even if no fossil evidences related to this Age have been found (Tougard et al., 2008). Morphological differences between MIS 5 and MIS 3 *Microtus* (*Terricola*) *savii* populations, especially at Cavallo Cave (Salento, Southern Apulia), have been interpreted as the result of geographic isolation during the warm phases. Nevertheless, during the Upper Pleistocene this species seems to be endemic to the southern Italian Peninsula (Berto, 2013; Petruso et al., 2011).

In the eastern side of the southern Italian peninsula, small mammal assemblages attest to arid conditions. The biodiversity is always low, one species (*Microtus arvalis* or *Microtus* (*Terricola*) *savii*) usually dominates the assemblages and forest adapted species are rare or absent.

The climate of the western side was influenced by Atlantic disturbances. Therefore, small mammal assemblages are characterized in this area by high percentages of forest adapted species (*Apodemus* gr. *sylvaticus-flavicollis* and *Glis glis*), sometimes dominant during warming up phases (Berto, 2013; Bon and Boscato, 1996; López-García et al., 2014).

In this context, Grotta Paglicci is a key sequence for the knowledge of climatic changes and environmental conditions in Southern Italy during the Upper Palaeolithic. This site also contributes to understand the evolution of regional differences among small mammal communities in the Italian Peninsula.

2. Grotta Paglicci

Grotta Paglicci is one of the most important Upper Palaeolithic sites in the Mediterranean Basin. It is located on the western slope of the Gargano promontory (Foggia, Apulia, Southern Italy), 143 m above sea level (Fig. 1A and B). The Cave's position was of strategic importance for Paleolithic populations, as it lies not far both from the Foggia plain and from the highest rocky peaks of the promontory. The site comprises the present-day cave and a rock shelter that was once part of the same cave system (Palma di Cesnola, 2004a, 1993).

Research at Grotta Paglicci has a long history. The site was discovered at the end of the 1950s and first excavated by the Natural History Museum of Verona between 1961 and 1963. From 1971 up to now research has been carried out by the University of Siena in collaboration with the local Soprintendenza Archeologica (Palma di Cesnola, 2004a; Zorzi, 1964).

Two main areas have been excavated, one in the present external rock-shelter and one in the underground cave. The external area yielded archaeological artefacts ranging from the late Acheulean to the ancient Mousterian (Crezzini et al., 2016; Palma di Cesnola, 2004a). In the excavation of the inner cave, a 12-m-thick sequence with 26 archaeological layers (Fig. 1C) was investigated. This covers a time span from the Lower-Middle Palaeolithic (layers 30-25) through the whole Upper Palaeolithic which is present in a continuous sequence comprising Aurignacian with marginally backed bladelets (layer 24), Gravettian (Ancient: layers 23 and 22; Evolved: layers 21 to 19b; Late: layers 19a to 18b) and Epigravettian (Ancient: layers 18a to 12; Evolved: layers 11 to 8; Late: layers 7 to 3a) (Cremaschi and Ferraro, 2007; Palma di Cesnola, 2004a, 2004b, 2004c; Ricci et al., 2016; Wierer, 2013).

The discovery of two Gravettian burials (Pa12 and Pa25) and 146 human remains attributed to *Homo sapiens* (69 in the Gravettian layers and 47 in the Epigravettian layers) and the presence of the only example of Palaeolithic rock painting in Italy make of Grotta Paglicci one of the most important sequences of the European Upper Palaeolithic (Arrighi et al., 2008, 2012a, 2012b; Bietti, 1990; Borgia et al., 2016; Fu et al., 2016; Palma di Cesnola, 1993; Posth et al., 2016; Ricci et al., 2016; Ronchitelli et al., 2015). Recently, also important evidences of Gravettian plant food processing and consumption were discovered (Mariotti Lippi et al., 2015; Revedin et al., 2015).

Most of the radiocarbon dates have been obtained during the 1970's and, therefore, without decontamination of sample by pretreatment chemistry (i.e. ABOX-SC treatment) (Higham et al., 2009; Higham, 2011). However, the 52 available radiocarbon dates (Fig. 2) indicate that the sequence accumulated quite continuously during the last phases of MIS 3, MIS 2, and the first phases of MIS 1 (from 40,939–36,570 years cal BP to 13,712–12,970 years cal BP) (Palma di Cesnola, 2004a). Considering available radiocarbon dates, a possible chronological gap is present between ca 20,000 and 24,000 years cal. BP.

A first paleoenvironmental study based on macro-mammal remains was carried out by Sala (1983) on a limited sample of materials recovered before 1983 (Layers 3a-22a). Boscato (2004) analysed large mammal remains from layers 22a-24b.

The ungulate assemblage comprises *Bos primigenius*, *Equus ferus*, *Equus hydruntunus*, *Capra ibex*, *Rupicapra* sp., *Cervus elaphus*, *Sus scrofa* and *Capreolus capreolus* (Arobba et al., 2004; Boscato, 2007, 2004; Boschin, 2013; Sala, 1983). From layer 24b to layer 6d associations are generally dominated by more or less open-environment ungulates (*Bos primigenius*, *Equus ferus*, and *Capra ibex*). A change is visible at the end of the sequence: from layer 6c to layer 3a *Cervus elaphus*, *Sus scrofa*, *Bos primigenius* and *Equus hydruntinus* become dominant suggesting a more forested environment and the presence of more abundant water sources. With regard to carnivores, the Aurignacian-Early Gravettian sequence and the Epigravettian one are dominated by *Canis lupus* and *Vulpes vulpes* (Boscato, 2004; Boschin, 2013). *Crocuta crocuta spelaea* has been individuated in layers 24 and 23 (Boscato and Crezzini, 2005; Crezzini et al., 2016). No data are available for the evolved/final Gravettian sequence.

A complete revision of the large mammal record is underway, and its description and interpretation will be the aim of further works.

Bartolomei (2004, 1980, 1975) published preliminary studies on small mammals from the lower sequence (layers 24, 23, 22, and 21). According to this author, *Microtus arvalis* dominates the sequence suggesting an environment characterized by wooden or continental steppe with a cooling phase recorded from layer 22D to layer 21A.

Further paleoenvironmental studies on avifauna from the Aurignacian and Ancient Gravettian layers (layers 24, 23 and 22) have highlighted the presence of steppe or grassland with bare rocks and rocky substrata, as testified by the high percentage of *Pyrrhocorax graculus* and *Columba livia*. In layer 23B, the occurrence of boreal and alpine species suggests a cold climatic oscillation (Tagliacozzo and Gala, 2004).

Finally, the study of stable isotopes on *Cervus elaphus*, *Bos primigenius* and *Equus ferus* bones from the Gravettian and Epigravettian layers shows the occurrence of a climatic improvement between 19,500 ka and 16,000 ka related to a shift from arid to humid conditions with the development of forest habitats (Delgado