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Climate and landscape in Italy during Late Epigravettian. The Late Glacial small mammal sequence of Riparo Tagliente (Stallavena di Grezzana, Verona, Italy)

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ABSTRACT

The site of Riparo Tagliente (north-eastern Italy) contains one of the main Upper Pleistocene archaeological sequences of south-western Europe. It also represents a key site for the study of human adaptation to Late Glacial environmental changes in the southern Alpine area. These climatic and environmental conditions are here reconstructed based on small mammal assemblages, using the Bioclimatic model and Habitat Weighting methods. Climate proxies indicate a rise in temperature during the transition between HE1 and the Bølling-Allerød interstadial, while the landscape surrounding the shelter was still dominated by open grasslands. By comparing the data obtained from Riparo Tagliente with other coeval small mammal faunas from the Italian Peninsula and Europe we contribute to the reconstruction of the processes of faunal renewal registered during the Late Glacial across the continent and of the climatic and environmental context in which the Late Epigravettian hunter-gatherer groups lived.

1. Introduction

The late Upper Pleistocene is characterized by several climatic oscillations which correspond to the Marine Isotopic Stage 2 (MIS 2) and to the beginning of MIS 1 (ca 14.7 ka cal BP) (Lisiecki and Raymo, 2005). After the end of the Last Glacial Maximum (LGM), the final phase of MIS 2 is characterized by three different climatic events. Heinrich Event 1 (H1, Bond et al., 1993) is an arid phase, resulting across the Alpine region in a series of dramatic glacial collapses and periglacial rearrangements (Ravazzi et al., 2014, 2007a). Then, a rapid increase in the temperatures and the development of forest environments is recorded. This marks the beginning of the Bølling-Allerød Interstadial (corresponding roughly to Greenland Interstadial 1 – GI-1), a relatively warm period with several minor oscillations, which have been observed in particular in the northern Alps region (Ravazzi et al., 2007a). Finally, the Upper Pleistocene ends with the cold oscillation called Younger Dryas, broadly equivalent to the Greenland Stadial 1 (GS-1, Rasmussen et al., 2014), the beginning of which is dated at around 12,800 years cal BP (Andersen et al., 2006; Rasmussen et al., 2014; Svensson et al., 2006).

In this climatic context, the faunal assemblages of the Italian Peninsula are characterized by a strong regionalism, which is already evident before the end of Upper Pleistocene (Gliozzi et al., 1997; Masini and Sala, 2011, 2007; Sala, 2007; Sala et al., 1992; Sala and Masini, 2007). Differences between the assemblages of the northern and southern areas of the peninsula are clearly visible (Sala, 2007), especially during the Late Glacial (Sala, 2007, 1990a). However, a variability related to the site's geographic settings (i.e. mountains, valleys, coastal areas) must also be considered. These faunal discontinuities are mainly the effect of relevant geographical features: the Alpine chain, which is considered as a barrier especially for gregarious ungulates (i.e. *Rangifer tarandus* and *Saiga*

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tatarica), the Apennines, which divide the peninsular area into two regions, the East and the West, and the Mediterranean sea with its climatic influence on the central and southern areas of the Italian Peninsula (Berto, 2013; Sala, 2007, 1990b).

We present here the palaeoclimatic and palaeo-environmental data which have been inferred from the small mammal sequence of Riparo Tagliente. A special focus is kept on the variations of rodent communities in the Italian Peninsula during the Late Glacial, through comparisons with other major sites of this territory.

The Late Glacial sequence of Riparo Tagliente has vastly contributed to the knowledge of the technological and subsistence strategies of Late Epigravettian hunter-gatherers in the Southern Alps (Bartolomei et al., 1982; Bertola, 2015; Fontana et al., 2011, 2009; Ravazzi et al., 2007b). This study will help to reconstruct the local climatic and environmental conditions that the human groups inhabiting this region faced in a period of great climatic fluctuations (Bartolomei et al., 1982; Fontana et al., 2009; Pini et al., 2010a).

2. The site

Riparo Tagliente (Stallavena di Grezzana, Verona) is considered to be a key site for the Middle and Upper Palaeolithic in Italy (Bartolomei et al., 1982; Fontana et al., 2009; Thun Hohenstein and Peretto, 2005). It is located on the left slope of Valpantena, one of the main valleys of the Pre-alpine massif of Monti Lessini, at 226 m a.s.l. (Fig. 1, A).

The site was discovered in 1958 (Zorzi, 1962). It was initially investigated by the Museo Civico di Storia Naturale di Verona, and, from 1967, by the University of Ferrara. The research was initially focused on two trenches (called internal and external), in order to investigate the whole sequence (Bartolomei et al., 1982). Starting from the late '70s, excavations in the Late Epigravettian deposit were extended over an area of about 80 m^2 (Fig. 1, B).

The stratigraphy of this site is characterized by two main deposits that are separated by a river erosion: (Fig. 1, C). The lower deposit (Mousterian and a thin Aurignacian layer detected only in the internal area) has been referred to ancient Würm or MIS 4-3 (Arnaud et al., 2016; Bartolomei et al., 1982). The small mammal assemblage of this part of the sequence is dominated by *Microtus arvalis*, with the presence of cold indicators, especially in the lower layers, such as *Microtus gregalis*, *Microtus oeconomus* and *Ochotona* sp. (Bartolomei et al., 1982).

The upper part of the deposit (Late Epigravettian) is irregular, thinner in the inner part of the shelter (about 50 cm) and thicker in the external one (over 2 m). This is due to the different uses of the two areas by the Epigravettian groups, and to a medieval excavation that destroyed most of the inner parts of the sequence (Bartolomei et al., 1982; Fontana et al., 2009). The Epigravettian deposit is divided into two sub-units, both set in a loess matrix. The lower one (cuts 18-15) is marked by debris, and is closed by a collapse (Bartolomei et al., 1982). Both sub-units (cuts 14-5) are characterized by an intense human occupation, testified not only by lithic industries and faunal remains, but also by spatial organization, ornaments, mobile art objects, and a burial (Bartolomei et al., 1982, 1974; Fontana et al., 2009).

Two different phases have been recognized from the analysis of the Epigravettian lithic assemblages: phase I (layers 17 to 12) is characterized by four different reduction sequences, each one aimed at obtaining a specific type of blank, and phase II (layers 11 to 6) is marked by a simplification of the reduction sequences (Bertola et al., 2007; Fontana et al., 2015). The radiometric dates of the Late Epigravettian sequence show that the formation of the deposit took place between GS-2.1a and GI-1c1 (Rasmussen et al., 2014), during the latest part of the Older Dryas and the first half of the Bølling-Allerød Interstadial, 17,219 to 13,472 years cal BP (Fig. 2). However, results from the recent ^{14}C dates of the lower part of the inner Epigravettian sequence (SUs 13aα, 13a and 300) appear older than the dates from the lowermost layers of the outer series (SUs 15–16). This suggests to consider with caution the latter radiometric dates (SUs 15–16 and 10) that were performed in the early '80s on charcoal samples from the trench area.

The large mammal remains, both from the external trench and from the extensive excavation (Bartolomei et al., 1982; Capuzzi and Sala, 1980; Fontana et al., 2009), testify to a change in the trophic community over time especially among ungulates. In the lower layers (18-13), *Capra ibex* is the most represented ungulate, while in the upper ones, starting from layer 10, *Cervus elaphus*, *Capreolus capreolus*, and *Sus scrofa* dominate the assemblage. This variation is also visible in the pollen diagrams and in the malacological assemblages recovered in the external trench (Bartolomei et al., 1982; Capuzzi and Sala, 1980). It has been linked (Bartolomei et al., 1982; Fontana et al., 2009) to the advance of the broadleaf forests in the eastern Prealps during the Bølling-Allerød Interstadial. A brief cold event, related to the Older Dryas (Greenland Interstadial 1c2), has also been detected from ungulates in layers 7b-5, where an increase in *Capra ibex*, *Alces alces*, and *Marmota marmota* is recorded.

3. Materials and methods

From the three investigated areas (Fig. 1, B) only the external one, excavated during the last thirty years, has been considered in this study. This choice derives from the presence in this area of a higher MNI with respect to the other two. In this area, 48 Stratigraphical Units/sedimentological layers have yielded small mammals. The Units have been grouped into six Macrounits following the stratigraphic reconstruction proposed in previous works (Bartolomei et al., 1982; Berto, 2013; Fontana et al., 2009; Scoz, 2007).

The sample is made of disarticulated bone fragments collected by water-screening during the last forty years of excavation campaigns and using 2 and 1 mm mesh sieves.

The assemblage includes a total of 1431 identified remains, corresponding to a minimum number of 839 individuals (Table 1; Fig. 3). The specific attribution of this material was based on the best diagnostic elements: mandible, maxilla and isolated teeth for rodents, mandible and maxilla for shrews, mandible, maxilla, isolated teeth and postcranial bones for *Talpidae*.

The taxonomic classification follows Wilson and Reeder (2005), except for *Clethrionomys glareolus* (for the priority over *Myodes*, see Tesakov et al. (2010)). Data on the distribution and habitat of the species were taken from Amori et al. (2008), Boitani et al. (2003), and Mitchell-Jones et al. (1999).

Biodiversity has been calculated using the Simpson index of Evenness $= 1-\sum(pi^2)$, where pi is the proportion of individuals in the ith species (Harper, 2005; Magurran, 2004). The evenness index is constrained between 0 and 1. The index has been calculated using PAST 3.04 avoiding redundant determinations (i.e., for *Arvicola amphibius*, the individuals determined as *Arvicola* cf. *amphibius* and *Arvicola* sp. have not been included) (Hammer et al., 2001).

3.1. Palaeoenvironmental and climatic reconstruction

In order to propose a palaeoenvironmental reconstruction for the Late Glacial sequence of Riparo Tagliente we used the Habitat Weighting method (Andrews, 2006; Evans et al., 1981), assigning each small mammal taxon to the habitat(s) where it can be presently found in Europe. For this purpose, habitats have been divided into six types (Cuenca-Bescós et al., 2009; López-García et al., 2014, 2010): open land with either dry and wet meadows (OD and OH,