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Tale of two timescales: Combining tooth wear methods with different temporal resolutions to detect seasonality of Palaeolithic hominin occupational patterns

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ABSTRACT

Seasonality in archaeological sites can be inferred using different methods such as tooth eruption and wear patterns, stable isotopes or cementochronology. In this paper we propose to use the analysis of tooth microwear and mesowear methods combined with the analysis of the tooth eruption patterns in ungulates. The aim is to gain a better understanding about Neanderthal occupations that occurred at two Middle Palaeolithic sites, Teixoneres cave (North-Eastern Spain) and Portel-Ouest cave (Southern France). The tooth wear methods are referring to two techniques which provide information about diet traits of mammals. However tooth meso- and microwear are recording diets on different temporal scales. Because of this difference, the discrepancies sometimes observed in the results between the two methods could be considered as a bias in one of the two methods. The purpose of this research is to understand, for a methodological point of view, what the differences between microwear and mesowear mean when integrated for the study of ungulate assemblages from archaeological sites. The data reveal that larger differences between the results are related to greater seasonality in the accumulation of the prey at the archaeological level. The differences due to the distinct temporal scales appear as a good proxy to infer seasonality in the accumulation of the preys by Neanderthals in archaeological sites. Therefore, the application of methods with different temporal resolutions, instead of being limiting, appears as a good proxy to improve the knowledge of hominin occupational patterns.

1. Introduction

The study of behaviour and subsistence strategies of past hunter–gatherers requires to understand the behavioural ecology of their prey. Among other factors, distribution, seasonal movements, and feeding ecology are defining the availability of preys and the reconstruction of these patterns in the archaeological record permits a better understanding of the human past. Tracking ungulates seasonal feeding behaviours is not only necessary for appreciating the seasonal hunting strategies employed by human populations, but also it has implications for palaeoenvironmental or palaeoclimatic studies.

This research is focusing on the Middle Palaeolithic timeframe, characterized in Western Europe by Neanderthal populations with a high mobility (Conard et al., 2012; Niven et al., 2012; Richards et al., 2008) and a high behavioural diversity (De la Torre et al., 2013; Miller and Barton, 2008). The purpose of this paper is to reply to methodological questions that appear when applying two distinct techniques based on different temporal scales.

Different methods are available to analyse ungulate dental remains from archaeological sites to infer the seasonality of prey procurement by hominins. (1) The analysis of carbon and oxygen stable isotopes provide information such as the ecological conditions and the dietary preferences of an individual during the formation of the teeth (Marín-Leyva et al., 2013; Julien, 2011; Balasse et al., 2003; Feranec et al., 2009). (2) The cementochronology technique is useful to obtain information about the age and season of death through the analysis of differential deposition of cementum layer on the teeth, alternating a fast-growth deposit during the warm season and a slow-growth deposit during the cold season (Rendu, 2007; Rendu, 2010; Rendu et al., 2009-2010, Wall-Scheffler and Foley, 2008; Pike-Tay, 1991). (3) The study of tooth eruption patterns is also a good proxy to access prey seasonality. The method is based on the comparison of extant animals of known age used as references to estimate the age of death of the archaeological specimens (Wilson et al., 1982). The extant samples are collected following a strict control to obtain accurate data like the date of birth,

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the feeding and environmental conditions, and their stages of development at the exactly moment of their death (Morris, 1972; Carter, 1988).

In addition to these techniques, in the last decades the tooth wear analysis i.e. the study of wear pattern at micro- and macroscale, had a significant development due to the diversity of situations in which these methods can be applied. The first and main purpose of the dental wear methods is to infer palaeodiets (Teaford, 1988; Solounias and Semprebon, 2002) and provide palaeoenvironmental information (Semprebon et al., 2004a,2004b; Merceron et al., 2004; Rivals, 2012). Recently these methods also have been applied successfully in an archaeological point of view (Sánchez-Hernández et al., 2014; Henton, 2012; Rivals and Semprebon, 2012; Rivals et al., 2009a). The techniques are presented as a great complement to the classical zooarchaeological studies especially because tooth wear analyses are non-destructive methods.

The dental wear methods are referring to two techniques, namely mesowear and microwear analyses. As we said previously, their patterns provide information about diet, but at different temporal scales. Tooth mesowear, which study macroscopically the cusp shape and occlusal relief of the teeth, corresponds to a longer temporal scale of months-years. It gives a close approximation of overall diet and about generalized annual ecological conditions. Tooth microwear, which analyse microscopically the enamel surface of the teeth, instead is focused on a short temporal scale. It reflects the diet an animal had during the last days or weeks of its life.

We propose to use the combined analysis of tooth meso- and microwear patterns as a tool to detected seasonality in archaeological sites. The aim is to gain a better understanding about Neanderthal occupations that occurred at two sites in North-Eastern Spain and Southern France. This will allow to characterize the behavioural patterns associated to the environment in which these human groups developed their activities.

As microwear and mesowear indicate diets on different temporal scales, the discrepancies sometimes observed in the results between the two methods on a sample could be considered as a bias in one of the two methods. In paleontological localities, where the temporal resolution of the deposits is usually low, the results of both methods usually coincide (Semprebon and Rivals, 2007; Semprebon and Rivals, 2010). Instead, in archaeological sites where deposits have a higher temporal resolution the results sometimes differ (Rivals, 2012; Rivals et al., 2009b). The aim of this study is to test the hypothesis that the differences between the results obtained from the mesowear and microwear methods indicate seasonality in game procurement. Therefore we propose that the larger is the difference between the results, the stronger is the seasonality. If the hypothesis is verified, this combined approach will provide more accurate information about the season of the human occupations.

1.1. Localities studied

1.1.1. Teixoneres cave

Teixoneres cave is an archaeological site located in the Northeast of the Iberian Peninsula (Moià, Barcelona) at an altitude of about 760 m a.s.l. The cave is developed in a Neogene limestone (Colluspina Formation) resulting in the formation of a karstic system drained by the Torrent del Mal. The cave has a size of approximate 30 m length with three distinct areas (namely areas X, Y, and Z). The sedimentary sequence is 6 m thick (Serra and Albert, 1973; Serra et al., 1957) and 10 different stratigraphic units were identified (so far, four archaeological subunits have been excavated, from top to bottom: IIa, IIb, IIIa, and IIIb). These subunits are comprised between two speleothems dated using U-series between 14 ka BP (unit I) and 100 ka BP (unit IV) (Tissoux et al., 2006). More recently, on the basis of the rodent assemblages (presence of *Pliomys lenki*, *Microtus* (*Iberomys*) *cabrerae* and *Hystrix* sp.) the chronology was reduced for units II and III to between ca 30 and 90 ka BP (López-García et al., 2012).

The site is characterized by a duality in the archaeological record. This duality is due to the alternation of human and carnivore presence in the cave. The anthropogenic remains tend to be close to the main entrance while the carnivores have a stronger presence at the inner part of the cave. Human activity is identified by the presence of burned bones, cut-marks and intentional bone breakage on large mammal remains, and lithic tools.

The lithic assemblage shows a diversity of materials and the combination of local raw materials (orthogonal and discoid debitage) with non-local materials (Levallois method) seem to support the hypothesis of high mobility of the groups (Rosell et al., 2010a).

A wide diversity of taxa has been identified. This includes carnivores such as *Ursus spelaeus*, *Crocuta crocuta*, *Canis lupus*, *Vulpes vulpes*, *Lynx spelaea* and *Meles meles*; as well as a large range of herbivores, such as *Stephanorhinus hemitoechus*, *Equus ferus*, *Equus hydruntinus*, *Cervus elaphus*, *Capreolus capreolus*, *Bos primigenius*, *Capra* sp., and *Rupicapra* sp. Small animals (leporids and, to a lesser extent, Erinaceidae, tortoises and birds) are also present.

Moreover, the human presence at the cave has been identified with two different patterns but with similarities between them. Firstly we observed a succession of events at the same season through the time (subunits IIa and IIb). The second pattern (subunits IIIa and IIIb) is also a succession of short term events but with the particularity than there are at different season of the year (Sánchez-Hernández et al., 2014). Both patterns help us to support the hypothesis of Neanderthal groups with high mobility (Conard et al., 2012; Niven et al., 2012; Richards et al., 2008; Rosell et al., 2010b). Previous studies permitted to characterize the Neanderthal settlements at Teixoneres as a succession of short-term occupations (Sánchez-Hernández et al., 2014; Rosell et al., 2010a).

1.1.2. Portel-Ouest cave

The Portel-Ouest cave is situated on the northern slope of the Pyrenees (Ariège, France) at 490 m a.s.l. The stratigraphical sequence is about 5 m thick with twenty archaeological levels (from the deepest one, level M, to the uppermost level A). Excavations permitted to distinguish four archaeological groups of levels (Vezián, 1989): the basal group composed by levels M, L, K, J, I and H is an archaeologically sterile level with very low presence of small vertebrates and carnivores remains. It is followed by the Mousterian sequence of levels G and F, with very abundant assemblages of lithic, fauna (high concentrations of dental and bones series) and Neanderthal remains. Level E is a sterile clay loam layer that separates the first Mousterian sequence from the second one. The second Mousterian sequence includes levels D and C characterized by the presence of faunal remains, hyena coprolites and lithic remains. Finally, the Upper Palaeolithic sequence covers the level B and provided faunal remains and Chatelperronian industry. However the level has been disturbed by animals. All the deposits correlate with MIS 5 to 2 (Vezián, 1989; Gardeisen, 1994; Gardeisen, 1999).

The fauna from the site is composed by carnivores such as *U. spelaeus*, *M. meles*, *Mustela putorius*, *Martes* sp., *Crocuta spelaea*, *Panthera spelaea*, *Lynx lynx*, *Felis silvestris*; as well by herbivores like *Mammuthus primigenius*, *E. ferus*, *C. elaphus*, *Megaloceros giganteus*, *Rangifer tarandus*, *Sus scrofa*, *Bison priscus*, *Capra pyrenaica*, *Rupicapra pyrenaica* (Gardeisen, 1994).

The material we sampled comes from levels F, C–D, and B. Level F, the oldest Mousterian level, corresponds to the end of the MIS 4. It produced the most important archaeological sample from Portel-Ouest including faunal and Neanderthal remains, and stone tools. Level C–D is related to the MIS 3 and level B to the end of MIS 3. Both provided faunal remains and artefacts (Vezián, 1989; Gardeisen, 1994; Gardeisen, 1999; Bahain, 2007).

2. Material and methods

This work is analysing the dental remains recovered during the archaeological excavations at Teixoneres cave (subunits IIa, IIb, IIIa, IIIb)