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Early and Middle Pleistocene climate-environment conditions in Central Europe and the hominin settlement record

Marcin Szymanek [a], [*], Marie-Anne Julien [b]

[a] University of Warsaw, Faculty of Geology, Żwirki i Wigury 93, PL-02-089, Warsaw, Poland
[b] Unité Histoire Naturelle de l'Homme Préhistorique (UMR 7194), CNRS, MNHN, UPVD, 1 rue René Panhard, 75013, Paris, France

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ABSTRACT

This paper focuses on the interactions between hominin settlements and the palaeoecological contexts of the Early/Middle Pleistocene, in the central European lowlands and highlands. The palaeoenvironmental data from twenty-one natural sites with pollen, vertebrate and/or mollusc records (e.g. Voigstedt, Dethlingen, Ossówka) are compared and discussed in regard to seventeen localities with clear hominin occurrence (e.g. Kärlich, Stránská skála, Bilzingsleben, Vértesszölös, Schöningen). This contribution provides the first attempt of a large scale qualitative compilation of palaeoenvironmental and palaeoclimatic data from key, multidisciplinary investigated late Early Pleistocene and Middle Pleistocene archaeological and non-archaeological sequences in Central Europe, mostly from MIS 22 to MIS 9. As such, this work is key for our understanding of the potential impact of climate-environment conditions upon hominin settlement dynamics *vs.* sites preservation in the region.

Lower Palaeolithic hominin in Central Europe occupied a variety of environments, and despite the fragmentary nature of the record, warm and humid climate and partly forested landscapes appear as the most favourable conditions for hominin settlements.

Prior to 0.5 Ma the record is however limited and the earliest hominin settlements of Central Europe appear largely unexplored in comparison to other European regions. During MIS 11-9, the increase of both natural and anthropogenic records seems to highlight the better sedimentary record from that time period in comparison to the previous ones, and lessens the assumption of an intensification of hominin settlement and increase of population during MIS 11-9 in Central Europe, such as proposed in Western Europe.

1. Introduction

In Central Europe (thereafter CE) the Lower Palaeolithic (thereafter LP) covers the time span from approximately 1 to 0.3 M years (MIS 29-9), corresponding to the late Early Pleistocene (MIS 29-19; 1–0.78 Ma), the early Middle Pleistocene (MIS 19-12; 0.78–0.45 Ma) and the mid-Middle Pleistocene (MIS 11-9; 0.45–0.3 Ma) (Bridgland et al., 2006; Burdukiewicz, 2009). During this period, the CE environments and faunal assemblages were mostly affected by climatic cyclicity connected with oscillations between cold (glacials) and warm (interglacials) periods and by several transgressions and subsequent regressions of the Scandinavian ice sheet in the northern part of the continent (e.g. Ehlers and Gibbard, 2007; Litt et al., 2007; Marks et al., 2016). Moreover, the characteristics of the late Early and Middle Pleistocene interglacials were stimulated by the orbital forcing and the gradual transition from 41-ka to 100-ka obliquity cycles known as 'the Mid-Pleistocene revolution' or 'the Early-Middle Pleistocene transition' (e.g. Head and Gibbard, 2005, 2015; Clark et al., 2006).

Between 1 and 0.6 Ma, the transitions in climatic periodicity and vegetation, and the increased intensity of the glacial cycles, generated a significant reorganisation of the mammalian fauna across Europe. The late Early Pleistocene (Villafranchian) taxa typical of open and arid environmental conditions were gradually replaced by the Galerian taxa at the early Middle Pleistocene, predominated by large and mega-herbivores and characteristic of wetter and rather cooler conditions (Head and Gibbard, 2005, 2015; Palombo et al., 2005; Kahlke et al., 2011).

The first occurrence of hominin occupation at the periphery of

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[*] Corresponding author.
E-mail addresses: m.szymanek@uw.edu.pl (M. Szymanek), marie-anne.julien@mnhn.fr (M.-A. Julien).

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Central Europe is dated of about 0.95 Ma, and the earliest evidence of hominin dispersal throughout Central Europe known to date starts around 0.7–0.6 Ma. Signs of somehow longer and widespread occupations are notable between c. 0.4 and 0.3 Ma, i.e. during the mid-Middle Pleistocene (e.g. Head and Gibbard, 2005, 2015; Rocca, 2016, and references therein). Current anthropological and genetic data, highlight the variability of the European Middle Pleistocene hominin, with Neanderthal features emerging c. 0.6 to 0.45 Ma (e.g. Hublin, 2009; Meyer et al., 2014). In CE, human remains from that period are assigned either to *Homo heidelbergensis*, archaic *Homo sapiens* or pre-Neanderthal (cf. Street et al., 2006; Haidle and Pawlik, 2010 for a summary of the record from Germany), and for convenience will be referred here as hominin.

LP hominin made and used tools made of wood, stones and bones, that were found in various types of deposits and in various palaeoecological contexts. Abundant palaeoproxy data, mainly inferred from the animal and plant fossils, document both the general climatic and environmental trends, and the low-scale fluctuations with noticeable seasonality in CE. A few recent syntheses have been proposed for different parts of Europe (e.g. Bridgland et al., 2006; Auguste, 2009; Kahlke et al., 2011; Schreve et al., 2015; Moncel et al., 2016a,b), but implications of palaeoenvironmental conditions for hominin occupations in the late Early Pleistocene and Middle Pleistocene have not been considered in detail in the studied area.

The main goal of this paper is to produce the basis for a qualitative compilation of palaeoenvironmental and palaeoclimatic data from key, multidisciplinary investigated late Early and Middle Pleistocene archaeological and non-archaeological sequences in CE, and to assess for potential impact of climate-environment conditions upon hominin settlement dynamics in the region *vs.* sites preservation, mostly between MIS 22 and MIS 9. Keeping in mind the fragmented preservation of these records, and without aiming to be an overarching review, this paper is particularly meant:

1) to highlight the diverse palaeoclimates and palaeoenvironments that the LP hominin dealt with in different CE regions,
2) and to evaluate the range of conditions that hominin were or were not able to tolerate.

As important as the hominin presence, their absence (i.e. hiatuses of occupation and/or potential gaps in the archives) and their possible significances will be discussed and compared to the natural record. The hominin technological and social behaviours will not be considered here.

2. The late Early and Middle Pleistocene in Central Europe: background

2.1. Chrono-stratigraphy of the late Early and Middle Pleistocene in Central Europe

Chrono-stratigraphical subdivision of the late Early and Middle Pleistocene and basic correlations for CE are presented in Fig. 1. The Early-Middle Pleistocene boundary is placed conventionally within the Matuyama/Brunhes palaeomagnetic reversal (Richmond, 1996; Gibbard, 2003; Head and Gibbard, 2005, 2015), dated approximately at 780 ka ago and correlated with MIS 19 (e.g. Bassinot et al., 1994; Head and Gibbard, 2005, 2015). In contrast, its position may be considered somewhere between MIS 25 and 19 (Reale and Monechi, 2005), exactly at MIS 25 (Palombo et al., 2005; Palombo and Valli, 2005) or MIS 21 (Dodonov, 2005), or within the MIS 23/22 boundary, when the transition between orbital cycles started (Lindner et al., 2013). The MIS 23/22 boundary was also a time of the first significant cooling recorded in the oxygen isotope records of deep-sea sediments and the first advance of Scandinavian ice sheet in CE (Lindner et al., 2013; Head and Gibbard, 2015).

The late Early and Middle Pleistocene comprise six main glacial stages (MIS 22, 16, 12, 10, 8, 6) and five interglacials (MIS 21-17, 15-13, 11, 9, 7) recorded in CE sequences (Fig. 1). There is no evidence of ice sheet advance during MIS 18 and 14 in CE (Ehlers and Gibbard, 2007; Böse et al., 2012; Marks et al., 2016). Because the position of some interglacials is still debated in CE (cf. Koutsodendris et al., 2012 and references therein), the Marine Isotope Stages (thereafter MIS) will be mainly used in this paper for easier inter-regional correlations.

Marine Isotope Stages 8 to 6 see the development of the Middle Palaeolithic and are not discussed in this study.

2.2. Glacial limits and global climate boundary conditions of the late Early and Middle Pleistocene

Prior to MIS 22 the ice sheets covered only the polar regions as the temperatures were too high and the cooling episodes were too short for substantially changing the global ice volume and the expansion of the continental ice sheet in Europe (Ehlers and Gibbard, 2007). In the late Early and Middle Pleistocene (and after MIS 22) the Scandinavian ice sheet occupied large parts of northern CE at five times. However, a detailed palaeogeographic reconstruction of ice cover in the region is not easy due to limited terrestrial evidence of ice advances, asynchronous extents of ice cover in different (even neighbouring) areas, and/or different resolution of the available data (Ehlers and Gibbard, 2007; Böse et al., 2012). In Poland reliable reconstructions of glacial limits of all glacial stages are based on the presence of glacial deposits (Marks et al., 2016), whereas in Germany the first unequivocal glacial record occurred during MIS 12, i.e. the Elsterian Glaciation (Ehlers et al., 2004; Böse et al., 2012; Lee et al., 2012), corresponding to the Pleistocene Glacial Maximum (Ehlers and Gibbard, 2007; Toucanne et al., 2009) (Fig. 2).

The MIS 12 ice sheet covered northern and central Germany, the northern forelands of the Carpathians, and the Sudetes in Poland (where it has a lesser extent than during the previous MIS 16 glacial stage, see Marks et al., 2016), reaching up to 400–500 m a.s.l. (Ehlers et al., 2004; Böse et al., 2012). Glacial deposits of MIS 12 were also reported from the northernmost part of the Czech Republic, being accumulated by the ice advance in the east German plains and Poland (Růžička, 2004).

Even if not recorded in glacial sediments, the glacial/interglacial cycles of the last 0.8 M years (MIS 20 – MIS 1) may be distinguished in ice- (e.g. Jouzel et al., 2007; Loulergue et al., 2008) and deep-sea cores (e.g. Toucanne et al., 2009; Koutsodendris et al., 2014; Rodrigues et al., 2017). Their amplitude was mostly affected by orbital forcing, climate cyclicity, insolation patterns, CO_2 and CH_4 concentrations and changes in the circulation of Atlantic Ocean (Ehlers and Gibbard, 2007; Jouzel et al., 2007; Koutsodendris et al., 2014; Rodrigues et al., 2017). Based on deuterium δD and oxygen $\delta^{18}O$ isotope records and biomarker data, MIS 14 was 2 °C warmer, and MIS 18, 16 and 12 about 1 °C warmer than the coldest glacial stage MIS 2. The warmest MIS 5e sub-stage of MIS 5 was 4.5 °C warmer than the last millennium (Jouzel et al., 2007; Rodrigues et al., 2017).

In the late Early and Middle Pleistocene, the pre-MIS 11 interglacials were cooler than the younger warm interglacials (Jouzel et al., 2007; Rodrigues et al., 2017). Between MIS 22 and MIS 12 they were composed of 2–3 interglacial-rank warmings separated by non-glacial coolings (e.g. Candy et al., 2010, 2014; Lindner et al., 2013). However, MIS 19 appears relatively warm with greenhouse gas concentration comparable with interglacials of the past 450 ka (MIS 11-1, CH_4 in the range of 700–800 parts per 10^9 by volume