Neandertal adaptations to Interglacial conditions – a case study from the Eemian site Neumark-Nord 2 (Germany)

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6. Conclusion

The purpose of this thesis was to establish *how Neandertals maintained themselves in Interglacial environments*, and more specifically within *Eemian Interglacial environments*, which are characterised by conditions very different from the preceding and following glacial periods. By using high-resolution data of the Interglacial basin site Neumark-Nord 2 (Germany) as a case study, the papers address the two main components important for the study of Neandertals in Eemian environments: the environmental conditions, offering both challenges and opportunities for hominins, and Neandertal behaviour, reflecting adaptations to these environments. Environmental conditions may have been imposed on Neandertals, but in environments with a certain degree of diversity in landscape forms or vegetation, Neandertals most likely exploited the most favourable areas. A specific correlation between environmental conditions and hominin presence (as reflected in the archaeological record) could therefore reflect environmental preferences. Neandertal behaviour is also intrinsically documented by the archaeological record, informing us on adaptations geared towards meeting the challenges and opportunities offered by the environment. The analysis of the lithic material as well as fire proxies from the Neumark-Nord 2 locality provide interesting perspectives on Neandertal behaviour within a small, but well-studied part of the Eemian environment.

6.1 Eemian environmental conditions

The Eemian Interglacial climate is characterized by temperatures and precipitation levels comparable to those observed during the Holocene. Although climatic conditions within the Eemian are considered to be relatively stable, phases within the Eemian show variation in temperature and precipitation. The first part (3000 years; see table 1 introduction) are relatively warmer and drier compared to the middle part (ca. 4000 years). The later part (ca. 4000 years) shows decreasing temperatures and drier conditions compared to both the early and middle part of the Eemian (Kühl et al., 2007; Kühl and Litt, 2003). Climatic conditions did not only fluctuate over time but also geographically. Many Eemian localities are known from an area known as the *Mitteldeutsches Trockengebiet*, which is, thanks to its position in the rain shadow of the Harz Mountains, characterized by relatively dry, subcontinental, conditions (Döring et al., 1995). Other Eemian localities are known from the Thuringian Basin which is largely mountain-locked except for the eastern part where it meets the *Mitteldeutsches Trockengebiet,* and is characterized by similar dry conditions (Kahlke, 1990). These climatic conditions are, on both continental and regional scales, important factors affecting the character of the vegetation and the density and taxa representation of fauna.

Most of our knowledge of Eemian environments and hominin behaviour is coming from small sedimentary basins, of which many littered the postglacial landscape of the late Saalian. Apart from several travertine localities, these basins are generally formed by erosional processes related the Saalian glacier, or represent glacial remnants in the landscape (kettle holes). Postglacial basin formation also took place in the Neumark-Nord area at the end of the Saalian glacial, in this case as the result of a diapir of thawing, frost-weathered and water-saturated lignite deposits. The sloping sides of these basins in combination with sufficient precipitation to saturate the subsoil led to overland flow, which transported water and sediment into the basin (Chapter 2). This led to virtually continuous sedimentation and wet, anaerobic conditions favourable for the preservation of the detailed environmental and archaeological records studied in this work. The detailed environmental record of the small Neumark-Nord 2 basin made it possible to identify phases of increased and decreased presence of water in the basin (Chapter 2). Fluctuating precipitation levels could have easily brought forth varying water levels in a small and shallow basin like Neumark-Nord 2. When precipitation was sufficient, these basins contained standing water, affecting floral

and faunal communities on a local scale.

The Eemian landscape is generally considered to have been predominantly covered with a forest vegetation (Svenning, 2002 and references therein). The structure of this forest vegetation (closed forest, wood pasture, mosaic environments or intermediate conditions) is however a matter of debate. Environmental data including pollen, molluscs and faunal assemblages provide evidence for the presence of open elements in the environments of most Eemian archaeological sites (Chapter 5). Well-preserved environmental proxies from the Neumark-Nord basins provided the opportunity to reconstruct the local vegetation. Chapter 5 shows that within the direct surroundings of the small Neumark-Nord 2 basin, conditions fluctuated between a semi-open vegetation and a forest vegetation. During the studied early part of the Eemian Interglacial, the overall Neumark-Nord landscape was covered with a semi-open vegetation. These predominantly semi-open environmental conditions may be partly related to the drier conditions that characterize the early Eemian or the geographical position of Neumark-Nord 2 in the *Mitteldeutsches Trockengebiet*. This latter scenario has been brought forward as an explanation for the subcontinental elements present in the flora of both basins (Strahl et al., 2011).

As a result of the specific climatic and vegetational conditions, the Eemian is characterized by a specific Interglacial fauna, which includes, unlike the Holocene, megafauna. Furthermore, most faunal assemblages contain browsers as well as mixed feeders and grazers. This co-occurrence of species suggests mosaic environments with both open as well as forested patches (Svenning, 2002; van Kolfschoten, 2002, 2000). Such an Eemian fauna is also recovered from both Neumark-Nord basins (Gaudzinski-Windheuser et al., 2014; Kindler et al., 2014; Mania, 1990), providing an environmental signal that matches the palynological and malacological records. Large herbivores even left foot-prints at the small NN2 basin and trampled the margins of both basins, as indicated by the presence of a plant characteristic of trampled soils: *Polygonum aviculare* (Bakels, 2014, see also Chapter 5). The correlation between semi-open environmental conditions and an increased supply for freshwater in the Neumark-Nord 2 basin may indicate that large herbivores, attracted to the water, played an important role in keeping the environment open (Chapter 2). This argument has also been put forward for open conditions at Eemian and earlier Interglacial floodplain localities in the UK (e.g. Gibbard and Stuart, 1975; Turner, 1975) and may explain the semi-open conditions observed at other Eemian freshwater localities.

6.2 Hominin behaviour and adaptations

In freshwater contexts like Neumark-Nord 2, thorough analysis of site formation- and post-depositional processes is required before attempts can be made to interpret archaeological patterns in terms of hominin behaviour. The archaeological record is usually situated at the basin margin, where conditions are more variable, and chances of disturbance are higher compared with the centres of these basins. Low-energy overland flow has been documented as an important depositional process at Neumark-Nord 2, but transported mostly sediments, while evidence for significant transport of archaeological finds is lacking (Chapter 2). This is reflected in the absence of significant size sorting (Chapter 2) and to some degree in the "fresh" state of the lithic artefacts (Chapter 3). The transport of sediments resulted in lower net sedimentation rates at the basin margin and a certain vertical enrichment of finds, but were sufficient to encase the archaeological record in protective deposits of significant thickness. These find-bearing deposits could be correlated with the basin centre and therefore with the high-resolution environmental record, allowing detailed, time-bracketed reconstructions of the environment during phases of hominin presence (Chapters 2 and 5).

The correspondence between semi-open conditions and an increased presence of water in the Neumark-Nord 2 basin has been interpreted as large herbivores keeping the immediate environment open when the basin provided a sufficient supply of water. As a result, the basin environment provided an abundance of subsistence opportunities (game animals, edible plants), and we can therefore expect increased levels of hominin activity during these phases. This is indeed reflected by the strong link between the distinct find levels, representing phases of hominin activity, and the environmental record of Neumark-Nord 2 (Chapter 5). The fact that find level NN2/2b deviates from this pattern may result from a different use of the locality: at this time the abundant evidence for on-site knapping and the butchery of numerous game animals may indicate a very intensive use of the locale, which may have had a detrimental effect on the presence of large herbivores and therefore the vegetation openness around the basin locality. Open environments and the richness of resources that they provided were however still present in the wider environment, e.g. at Neumark-Nord 1. As most other Eemian sites come from freshwater contexts with semi-open conditions in their environment, a similar interrelationship between hominins, game animals and environmental conditions can be expected.

Another important resource, particularly available at the Neumark-Nord 2 basin and most likely also at other basins with a similar genesis, consists of lithic raw materials. Lithic material, including Baltic flint, was transported by the Saalian ice sheet, ending up in till deposits that dominated the postglacial landscape. These till-deposits were often covered by loess and a rich vegetation, rendering them inaccessible or invisible for hominins. The underlying lignite diapir, pushing up these till deposits, created exposures at the rim of the basin which were eroded into gravel deposits accessible to hominins. At Neumark-Nord 2, the character of the lithic assemblage produced from these raw materials shows both similarities and differences with assemblages from other Eemian localities. Where most other Eemian basin sites yield a few, larger flakes associated with carcasses of large herbivores, indicative of kill and direct butchery of game on the spot, Neumark-Nord yields a very large assemblage of predominantly smaller flint artefacts. Affecting both the size of the assemblage as well as the size of the debitage is the fact that on-site knapping took place at the locale, which was most likely facilitated by the local availability of flint (Chapter 3). The till deposits also provided the required hammerstones, as evidenced by non-flint rocks of which many show wear indicative of such use (Langejans et al., in prep.). Another factor contributing to the small dimensions of the debitage and tools is the limited size and variable quality of the lithic nodules available, which has also been brought forward as an explanation for the dominance of small-sized lithic elements observed at the Eemian Interglacial site Taubach (Schäfer, 1990). Despite the local availability of raw material, there is evidence for a conservative use of this resource: cores were used to the point of exhaustion and sometimes reused as a tool, which is also the case for small, natural pieces of flint.

The small lithic assemblages comprised of only large, unretouched flakes found at most kill and butcher localities are thought to represent actual tool-use, as opposed to tool production. The composition of the Neumark-Nord 2 assemblage, with a dominance of small debitage as well as many cores, is indicative of core reduction/blank production, while the low ratio of core trimming elements to retouched tools at least indicates that resharpening took place away from the site. Whether large flakes are underrepresented or missing at Neumark-Nord 2 as a result of off-site tool-use can be tested using the cortex ratio method (Dibble et al., 2005; Douglass et al., 2008) or lithic refitting. On the other hand, on-site tool-use is indicated by the abundance of cut-marks on the faunal remains, representing the exploitation of especially horse, bovids, and deer (Kindler et al., 2014, Kindler pers. comm.). Tool production at Neumark-Nord 2 could have provisioned both hominin activities taking place at the margin of the basin, as well as in the wider Neumark-Nord landscape. Apart from the exploitation of food sources, the tools could have been used to extend the technological repertoire by producing wooden implements, for which raw materials were in abundant supply. The low variety of lithic tool types at Neumark-Nord 2 and other Eemian localities may have been balanced by substitutes made of bone (Kindler et al., 2014) and/or wood. The retouched tool types that are present and dominating the assemblage, denticulates and notches, are often associated with woodworking tasks (Rots, 2012). Actual wooden implements did not survive in the Neumark-Nord 2 record, but the exceptional find of a wooden spear at Lehringen illustrates the skill with which wood was worked by Last Interglacial Neandertals (Thieme et al., 1985).

Another benefit of the presence of forested environments in the Eemian Interglacial landscape is the abundance of fuel. This reduces the energetic costs of pyrotechnology compared to periods with more open environmental conditions. Nevertheless, evidence for the use of fire at Eemian sites is limited. Although hearth features have not been observed at Neumark-Nord 2, which may be related to the site formation as well as post-depositional processes (Chapter 2) that affected the basin margin, Chapter 4 has shown that the use of fire was part of the technological repertoire of Neandertals at this locality. Several functions of these fires can be considered based on the general archaeological context of the fire-related finds, of which food preparation seems the most likely. Fire can be used to maximize the nutritional value of animal resources by cooking and grease rendering, while it can minimize the loss of nutrients through putrification by heat treatment (e.g. drying/smoking). Such intensification of the exploitation of food sources would have made a significant difference in surviving in environments where overall large herbivore densities are expected to be lower compared to more open environments. Deterring various carnivores, of which remains have been found in the faunal assemblages of both basin localities, and thermoregulation could have been secondary functions of fire at Neumark-Nord 2.

The rich archaeological record of both Neumark-Nord basins and the evidence they provide for recurrent activities at these localities may be strongly related to the richness in resources that these environments provided. These localities provided subsistence opportunities including water, game and plant foods, as well as the resources necessary to exploit these

food sources, including flint nodules, hammerstones and possibly (but archaeologically invisible) wooden tools.

6.3 Beyond the Eemian – Hominins in Pleistocene Interglacials

This thesis presented Neumark-Nord as a case study of a well-studied Interglacial archaeological record that could be correlated to specific vegetation phases within the Eemian, providing, together with data from other know Eemian sites, detailed information on Neandertal behaviour during the Eemian Interglacial. The results of this research are at odds with Gamble's notion (Gamble, 1987, 1986) that Neandertals were not able to cope with the challenges that Interglacial environments offered (see chapter 1 - introduction). Of the large number of pre-Eemian Interglacials, some were very similar to the last Interglacial, in terms of for example sea-levels, duration, or reconstructed vegetation, while others show marked differences. Were hominins, Neandertals as well as earlier hominin species, able to survive during these Interglacials?

Recent discoveries at Pakefield and Happisburgh allow us to trace back the history of hominin occupation of Interglacial environments, and occupation of northern Europe in general, to the late Early Pleistocene and early Middle Pleistocene (~900-700 ka). While the discoveries at Pakefield document hominin presence in full interglacial, Mediterranean-like conditions in a fluvial/coastal setting (Parfitt et al., 2005), discoveries at Happisburgh showed hominin presence in late interglacial environments characterized by boreal forests (Parfitt et al., 2010). This showed that rather than tracking favourable habitats, hominins were probably adapting to different environments (Parfitt et al., 2010).

From about half a million years the record changes significantly. Rather than being limited to interglacial environments, hominins were present in the full range of environmental conditions that northern Europe had to offer, ranging from cool and glacial to full interglacial conditions (Klein, 2009; Roebroeks, 2006; Roebroeks et al., 1992). Some of the oldest sites from this time period include Boxgrove and Miesenheim, which can both be attributed to Interglacial periods. At Boxgrove (OIS13?), hominin presence at a coastal locality is associated with a faunal assemblage that indicates the presence of both open environments and deciduous forests (Roberts, 1990; Roberts et al., 1986). The pollen record at Miesenheim suggests that hominin presence at the site took place at the end of an Interglacial (Boscheinen et al., 1984; Turner, 1991, 1989), which is most likely correlated with MIS13. The fauna recovered from this site near the floodplain of a Rhine tributary indicates both forested and open environments (Kolfschoten and Turner, 1996; Turner, 1989).

A substantial number of Hoxnian/Holsteinian (OIS 11/9?) sites is known from the British Isles (Ashton et al., 2006; Ashton, 2010). Several of these basin sites have fine-grained lacustrine infills, which are eventually overlain by fluvial sediments indicating a transition in drainage and hydrology (Ashton et al., 2006). The early Interglacial sites (HoI/II) Barnham and Elveden may have been part of the same fluvial system (*ibid.*). At Hoxne, archaeology bearing fluvial deposits from a similar context date to a temperate phase after the Hoxnian sensu stricto (Ashton et al., 2008). The environments surrounding these fluvial systems were relatively open, most likely because of large herbivores drinking and feeding in these environments (Ashton et al., 2006). A different signal is obtained from Beeches Pit, where hominins carried out activities and built fires near a small pool, which was, as documented by the molluscan fauna, surrounded by deciduous forest vegetation (Gowlett et al., 2005; Preece et al., 2006). Sites from OIS 11 are also known on the continent: at La Celle, France, hominins were present in a forested environment, although molluscs characteristic of open environments were also found (Limondin-Lozouet et al., 2010, 2006).

The low-sea level Interglacial(s) within the Saalian complex are generally thought to be less oceanic than the Eemian and the Holsteinian. Hominin presence on mainland Europe is documented by, amongst others, Maastricht-Belvédère (Roebroeks, 1988) and Weimar-Ehringsdorf (Steiner, 1979). These sites, known from fluviatile and travertine contexts respectively, yielded a fully interglacial environmental signal in terms of local flora and fauna (Meijer, 1985; Steiner, 1979). Several British sites dating to OIS 7 are known, which are predominantly associated with fluviatile environments. Where available, the environmental data from these sites reflects a dominance of grasslands with a smaller component of forested elements (White et al., 2006). The following period covering OIS6-4, which includes the Eemian Interglacial, is characterized by a complete absence of hominins on the British Isles (Ashton, 2002). This is probably caused by a decreased accessibility of Britain as a result of subsidence of the North Sea basin and a breach of the land bridge between Britain and continental Europe (Ashton and Lewis, 2002).

This short review of pre-Eemian Interglacial sites shows that they are known from a variety of contexts, including fluviatile, lacustrine, travertines

situated close to river valleys, or coastal settings with (or without) terminating rivers/streams. It is notable that where these sites yield sufficiently detailed environmental data, it often indicates mixed environmental conditions with both forested areas as well as open patches. For fluvial environments, this has been attributed to aggregating herbivores, with both grazers as well as browsers ending up in the faunal assemblages of these sites (Ashton et al., 2006; Turner, 1975). These relatively diverse environments provided a wealth of resources not found in the wider environment (Brown et al., 2013). These environments also provided lithic resources more difficult to obtain in upland environments (Ashton et al., 2006; Wenban-Smith, 1998). This seems to suggest that the lack of sites from interfluves is not merely a product of a taphonomic bias, but also a direct consequence of differential resource availability. The Neumark-Nord case study presented here has shown that some lacustrine environments were, compared to intermediate, upland environments, equally rich in resources as fluviatile environments and able to support Neandertal populations during full interglacial conditions. Even when small basin localities did not attract large herbivores resulting in more closed environmental conditions, direct access to a nearby river system (e.g. Beeches Pit) may have provided the resources necessary for hominin survival.

As the record clearly shows that hominins were present in micro environments characterized by somewhat more open environmental conditions (near rivers, floodplains, ponds and lakes): how dependent were they on these types of environments? To answer this question we need to consider, apart from habitat preferences within a given landscape, the geographical and temporal patterning of sites during Interglacial periods.

The Eemian record for example shows that most sites are known from the early and late parts of the interglacial (Gaudzinski-Windheuser and Roebroeks, 2011; Wenzel, 2007), while the middle parts - characterized by a high-forest vegetation - seem more or less deserted. This may reflect geological biases affecting the record of these specific phases but possibly also (or again) a preference for more open environments. Similarly, we can observe a geographical focus on sites situated in central Europe for the Eemian, which is possibly a product of the large exposures created here, but may also represent a preference for the somewhat more continental, open conditions at that time in this part of the continent. How do these patterns compare to the archaeological records of other Interglacials of which some are similar in climate and vegetation (OIS11/9), while others are drier and probably more open (OIS25/21 and 17, but also OIS7). This requires sites with environmental data – specifically a sufficiently long pollen record – that can be used to attribute the find bearing deposits to a specific phase within an Interglacial period. A consideration of the taphonomical biases, as some have done for the Eemian (Roebroeks and Speleers, 2002; Speleers, 2000) needs to be expanded to other Interglacial periods, in order to establish whether current geographical patterns, including potential new discoveries, are the product of hominin preference or of archaeological preservation and visibility.

The question of habitat choice/preference is only one part of the equation. The interglacial sites ranging from Pakefield to Neumark-Nord yield a diverse archaeological record, reflecting various lithic technologies, land-use strategies, and subsistence patterns. A comparative analysis of the archaeological finds from these sites can potentially identify long-term trends in dealing with interglacial environments, but may also identify specific adaptations to the more oceanic, high sea-level Interglacials, as opposed to the more continental, low sea-level Interglacials.

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