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Terra incognita: The Palaeolithic record of northwest Europe and the information potential of the southern North Sea

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Abstract

For major parts of the Palaeolithic substantial areas of the current southern North Sea and what later became the English Channel were dry land. Those areas, now covered by tens of metres of sea, were occasionally core areas for large herds of herbivores and the animals that preyed upon them, including Palaeolithic hunter-gatherers. This is demonstrated by the large amounts of Pleistocene mammal fossils, artefacts and a Neanderthal fossil recovered during the last one and a half centuries. Any consideration of the Pleistocene occupation history of northwest Europe needs to deal with the fact that a major part of the landscape available to Pleistocene hunter-gatherers is currently submerged under the waters of the North Sea, one of the most prolific Pleistocene fossil-bearing localities world-wide. One also needs to take into account the complex landscape evolution of the southern North Sea basin, with geographically varying successions of marine, lacustrine, fluvial and glacial sedimentation and erosion. This paper gives a short overview of the occupation history of northwest Europe, from its earliest traces at the very end of the Lower and the beginning of the Middle Pleistocene up to the middle part of the Upper Palaeolithic, when this part of Europe became deserted for a period of about 10,000 years. Tentative interpretations and questions raised by the overview will be situated in the context of the information potential of the deposits in the southern North Sea and the Channel area.

Keywords: biogeography, Neanderthals, Palaeolithic, range limits, seabed prehistory

Introduction

Europe, that cul-de-sac of the Eurasian continent as it was once called by the French prehistorian Abbé Breuil, is an interesting area for the study of early human behaviour for a number of reasons, which especially apply to its northwestern tip. First, for the largest part of the Pleistocene it constituted the (north)western margin of the distribution of hominins. During extreme cold and arid phases of the Pleistocene the area was mostly deserted, as it was also after it had become part of the modern human geographic range (Verpoorte, 2008). Marginal areas are interesting, as they may yield evidence for understanding the factors that set limits to the range of organisms, including Palaeolithic humans (Hublin & Roebroeks, 2009). After all, hominins were not present everywhere in the Pleistocene Old World, and studying why that was the case might yield important information about the human niche and its changes over time. Which factors determined where humans were present, where they could survive and what led them to abandon specific areas or drove them to regional extinction (Verpoorte, 2008)? During much of the Palaeolithic, the British Isles formed 'the edge of the world' (Lang & Keen, 2005), which makes this northwestern tip of the Eurasian landmass a good laboratory for monitoring the ebb and flow of human occupation and hence hominin adaptations. In fact this was an important rationale behind the Ancient Human Occupation of Britain Project (Stringer, 2006).

Second, at these northern-temperate latitudes the climatic oscillations of the last two million years had major impacts on temperature and flora and fauna, as well as on the physical landscape. During the interglacials, sea levels rose close to their present positions, whereas in glacial periods they dropped substantially, sea turned into dry land where rivers started to cut their ways and occasionally major parts of northwest Europe became covered by thick ice sheets, advancing into this area using these river valleys (Cohen et al., 2012, 2014). These same processes also created sedimentary settings within which traces of these climatic oscillations have occasionally been preserved. Troughs of some sort carved out by the scouring effect of glaciers and other (peri-)glacial structures, such as kettle holes, created the 'accommodation space' (Turner, 2000) for sedimentation associated with interglacial environments. Hence, interglacial deposits - and the occasionally associated traces of human presence - are to some degree strongly correlated to the former distributions of glaciers. Loess sediments, deposited during the driest parts of the glacials, are likewise an important matrix for archaeological sites, though obviously more biased in favour of traces of hominin presence during colder and drier stages of the Pleistocene.

Third, it was in this rich part of the Old World that Palaeolithic archaeology and Pleistocene studies were 'born' back in the 19th century (Gamble & Kruszynski, 2009; Antoine et al., 2011). The area has a very long history of intensive research of exposures of Quaternary deposits, and its density of sampling points in Pleistocene time and space is matched by only a very small number of other regions anywhere in the world. Hence, this is an ideal area to study hominin adaptations to changing environments and the factors which may have set limits to the geographical distribution of various hominin (and other animal) species through time.

Any consideration of the Pleistocene occupation history of the area needs to deal with the fact that a major part of the landscape available to Pleistocene hunter-gatherers is currently submerged under the waters of the North Sea, one of the most prolific Pleistocene fossil-bearing localities world-wide (Glimmerveen et al., 2004; Hijma et al., 2012). One also needs to take into account the complex landscape evolution of the southern North Sea basin, with geographically varying successions of marine, lacustrine, fluvial and glacial sedimentation and erosion. Cohen et al. (2014) discuss landscapes in the submerged North Sea from the perspective of the palaeolandscapes preserved in its immediate offshore surroundings. It is an impressive overview that gives the geological background to this chapter, and reviews the significant amount of Quaternary studies in this area. Landscapes do change, and the current land–sea division is a temporary one, characterised by the high sea level of our present interglacial. It is estimated that during the 700,000 years period at stake here sea level was at least 50 m below the present-day one for *c.* 40% of the period and at least 10 m lower for *c.* 65% of Pleistocene time (Gamble, 1986). For major periods of the Pleistocene relatively coarse-grained maps of land–sea divisions are available, thanks to, for instance, work by Phil Gibbard and colleagues at Cambridge and ongoing work by Cohen, Hijma and others (Gibbard, 1988; Cohen et al., 2012; Hijma et al., 2012; Cohen et al., 2014). It is to be expected that ongoing and future extraction of sands and gravels as well as other activities at the bottom of the North Sea will generate fresh data regarding the age and character of sediments in the North Sea. These can serve to test the accuracy of the existing maps and allow refinement of the various models (Hijma et al., 2012).

What is relevant here is that for major parts of the Palaeolithic substantial areas of the current North Sea and what later became the English Channel were dry land. Those areas, now covered by tens of metres of sea, were occasionally core areas for large herds of herbivores and the animals that preyed upon them (including Palaeolithic hunter-gatherers), as demonstrated by the large amounts of Pleistocene mammal fossils and artefacts recovered during the last one and a half centuries (Hublin et al., 2009).

After the breach of the chalk ridge that connected England to France, somewhere in the second part of the Middle Pleistocene, between 450,000 and 150,000 years ago (Gibbard, 2007; Gupta et al., 2007; Toucanne et al., 2009; Cohen et al., 2014), the rivers Thames, Rhine, Meuse, Seine, Somme and others occasionally were tributaries of a large river that flowed through the Channel, the Fleuve Manche as it is called in the French literature (cf. Antoine et al., 2007). Buried beneath the waters of the Channel, the sheer size of that ancient river system has only recently become known (Gupta et al., 2007). In some places its palaeovalley is still 50 m deep and more than 10 km wide; in the past this river system may have confronted early humans with a formidable obstacle to northwestward range expansion. After the breach, interglacial high sea levels may have set physical limits to the range, but during colder periods this river could have acted as a barrier when sea levels were low, hence the archaeological significance of setting solid age constraints on the breach of the Channel (see below).

This paper gives a (necessarily very short) overview of the occupation history of northwest Europe, from its earliest traces at the very end of the Lower and the beginning of the Middle Pleistocene up to the Mid Upper Palaeolithic (MUP), when this part of Europe became deserted for a period of about 10,000 years. Data on the occupation history following the Last Glacial Maximum (LGM) are presented elsewhere in this volume (Peeters & Momber, 2014). Tentative interpretations and questions raised by this overview will be put in the context of the information potential of the deposits in the southern North Sea and the Channel area. What can we expect (or hope) to learn from the record from this *terra incognita*, which, for the time being, is covered by tens of metres of sea?

Lower Palaeolithic occupation (>800–300 ka)

Compared to other parts of the Old World, such as China at possibly 1.66 Ma (see Li et al., 2008) or, at the 'Gates of Europe', Dmanisi in Georgia at 1.8 Ma (Ferring et al., 2011), the traces of the earliest occupation by hominins are thus far roughly half a million years younger in Europe. The earliest traces uncovered thus far date to the end of the Lower Pleistocene, at around 1–1.2 million years ago, and are restricted to two Spanish site complexes. The southernmost one of these is situated in lacustrine and fluvial deposits exposed in the Orce basin, which yielded only lithic artefacts (Toro-Moyano et al., 2009). The more prolific northern one is Atapuerca, near Burgos, where exposures of karstic settings in an abandoned railway trench

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have yielded a treasure trove of hominin fossils and artefacts of Lower Pleistocene age. Excavations in the late Matuyama deposits at Atapuerca yielded an astonishing series of site complexes, with a rich assemblage of hominin remains, associated with a lithic industry in the Trinchera exposures (Carbonell et al., 1999, 2008). These hominin remains have been ascribed to a new species, *Homo antecessor* (the younger - possibly older than 500 ka (Bischoff et al., 2007) - infill of the Sima de los Huesos, also at Atapuerca (Arsuaga et al., 1997), contained a large group of hominin fossils (minimum number of individuals (MNI) > 30) ascribed by some to *Homo heidelbergensis*, but interpreted by others (Stringer, 2012) as the earliest representatives of the Neanderthal lineage in Europe).

Other claims for Lower Pleistocene sites are known from around the Mediterranean area, but none of these are comparable to the Atapuerca site complex in terms of fossil remains, artefacts and quality of dating evidence (Cohen et al., 2012). Late Lower Pleistocene and early Middle Pleistocene sites are in fact very rare in Europe, and it is only from 600,000 years ago onwards that hominin occupation seems to have become more substantial, with larger numbers of sites known from southern as well as northwestern parts of Europe (Cohen et al., 2012). However, some earlier forays into the north are indicated by the finds from exposures of the Cromer Forest Bed formation in East Anglia. A first group of artefacts was excavated near Pakefield, East Anglia (UK) (Parfitt et al., 2005). On the basis of the palaeoenvironmental evidence retrieved from the sediments which yielded the small lithic assemblage there, the Pakefield artefacts may have been discarded by hominins during a temporary northward range expansion in parallel with an expansion of their familiar warm, Mediterranean-like habitat. In such an interpretation Pakefield would not testify to a colonisation of the colder temperate environments of northern Europe per se (Roebroeks, 2005). However, results of studies of exposures near the village of Happisburgh, north of Pakefield, have shown that hominins were present there in what may have been a late Lower Pleistocene cool-temperate period, possibly at the southern edge of the boreal zone (Parfitt et al., 2010). On the basis of biostratigraphical evidence and palaeomagnetic studies, the Happisburgh finds are indeed substantially earlier than the finds from Pakefield and they derive from sediments deposited during cooler conditions than the ones prevailing during discard of the artefacts at Pakefield.

A more substantial adaptation to the temperate latitudes seems to be indicated by the larger number of finds in this part of the world from around the Boxgrove-Miesenheim-Mauer time horizon (marine isotope stage (MIS) 13?) onward. Furthermore, hominins seem to have been present over large areas of southern and western Europe, and in a wide range of environments, from temperate woodland conditions as testified at Boxgrove and Beeches Pit (Preece et al., 2007) in England and Miesenheim in Germany to colder steppic settings as known from the Kärlich loess sequence in the German Neuwied Basin (Roebroeks et al., 1992; Bosinski, 2008) and the higher parts of the Boxgrove sequence (Roberts & Parfitt, 1999). Traces of these hominins are found in various types of landscapes, from dissected limestone valley systems in southern Europe via the loess plains of northern France, and the *Mittelgebirge* of Germany up to the coastal plains at Boxgrove. When hominins became established in western Europe around MIS 13, their distribution seems to have been limited to the western, 'Atlantic' parts of Europe - there were still large areas of central and eastern Europe that saw no human presence for at least one glacial–interglacial cycle, as far as the current distribution of finds suggests (see Cohen et al. (2012) for a discussion and possible explanation of this pattern).

The English record contains a strong signal of a pre-Anglian (pre-MIS 12?) hominin presence that has been the subject of recent studies in the Ancient Human Occupation of Britain Project (cf. Stringer, 2006). A wide range of sediments (fluvial, lacustrine, karstic, marginal marine) have yielded traces of occupation of about 500,000 years ago and somewhat older, of which Boxgrove, with its pristine and prolific archaeological record, has become the most well-known. On the other side of the Channel, in northern France, this pre-Anglian temperate period is only reflected by stray finds collected from fluvial deposits of the river Somme (Antoine et al., 2007). This is remarkable as the chalk ridge connecting Artois to present-day Britain was still in existence around that time period. According to Smith (1985) and Gupta et al. (2007), overflow of the Anglian (MIS 12?) pro-glacial lake may have created a first breach, possibly for the first time isolating Britain from the continent during high sea level interglacials (see also Toucanne et al., 2009; Cohen et al., 2014). The subsequent warm-temperate phase, the Holsteinian (MIS 11), was such a high sea level interglacial. It is in fact the first period with rich *in situ* assemblages in northern France, as in the fluvial deposits at Cagny-la-Garenne and in the Saint Acheul tufa (Antoine et al., 2007). On the English side, Hoxnian interglacial deposits, thought to correlate to MIS 11, are abundant and well-developed in the 'accommodation space' (Turner, 2000) created during the Anglian glaciation. They are prolific in terms of Palaeolithic archaeology: Barnham, Beeches Pit, Elveden, Swanscombe and Clacton are just some of the flagship sites associated with this warm-temperate period (Ashton & Lewis, 2012). A recent revision of the Hoxne archaeological evidence and its stratigraphical context has shown that the archaeology at that site was not deposited during the Hoxnian interglacial s.s., but during an episode of boreal woodland separated from the underlying type Hoxnian interglacial sediments by a cold-climatic period, later within MIS 11 (Ashton et al., 2008).

The deposits of the rivers Somme, Seine and Yonne contain primary context traces of hominin presence from around the next interglacial (MIS 9), with the Soucy sites in the Yonne, a tributary of the Seine, being a recent addition to this rich database (Lhomme, 2007). It is interesting to note that Antoine and colleagues have been able to map the large palaeovalley of the Seine and its associated stepped terraces beneath the

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modern Channel – a potentially very informative area for Lower (and Middle) Palaeolithic archaeology (Antoine et al., 2003a). On the other side of the Channel, primary context sites dating to the Purfleet interglacial (MIS 9) are relatively rare in England compared to what is known from the previous periods.

All of the sites mentioned thus far belong to the Lower Palaeolithic world, and most assemblages contain handaxes. The physical appearance of the hominins responsible for the production of the assemblages is known through a few fossils only, recovered from the Boxgrove sediments and at Swanscombe. The Swanscombe skull neatly fits into the view that from the first substantial occupation of Europe onwards, European populations underwent a 'Neanderthalisation process' (e.g. Hublin, 2007, 2009), which culminated in the classical Neanderthals of the last glacial, in this area represented by the type specimen of the Feldhofer Grotte and the Spy individuals. In that sense there may have been a degree of continuity between Lower and Middle Palaeolithic populations, though not necessarily within the area at stake here, where populations may have crashed repeatedly (cf. Hublin & Roebroeks, 2009), but on the larger, European or western Eurasian scale.

The Middle Palaeolithic evidence (300–40 ka)

The transition from the Lower to the Middle Palaeolithic does not constitute a sharp break in the archaeological record, even though the period MIS 9–7 witnessed the appearance of a new technological system organised around the Levallois method of core reduction, the hallmark of the Middle Palaeolithic. The transition was gradual, with handaxes remaining in use as well as the earlier, simpler forms of core reduction. The exact age of this transition is to some degree still unclear, but certainly around MIS 7 Levallois technology was widespread (White et al., 2011). One of the key sites with early – but well developed – Levallois is Maastricht-Belvédère, in the southern tip of the Netherlands. Ascribed to MIS 7 on the basis of a wide range of dating evidence (Vandenberghe et al., 1993), recent amino acid racemisation (AAR) studies suggest that the site might date from a warm-temperate period correlated to MIS 9 (Meijer & Cleveringa, 2009). In general Levallois is regarded as a more mobile technology than what preceded it, with Levallois products often being the transported component in Middle Palaeolithic assemblages, as seen by the non-local raw material in which they were produced (Roebroeks et al., 1988). That is not to say that all Levallois products were made to be used elsewhere in the landscape, but in general if we find artefacts made with 'exotic' raw materials these are more often than not produced by means of prepared core techniques (Geneste, 1985; Roebroeks et al., 1988). One of the reasons may be that Levallois products yield a good compromise between length of cutting edge and weight (to be transported).

The abundant occurrence of burnt material in the archaeological record from the beginning of the Middle Palaeolithic onward indicates that controlled use of fire certainly existed around 250,000–300,000 years ago. Even if it appears difficult to imagine how hominins could have moved into northern Europe without controlling fire, the archaeological record suggests that they may have done so. As discussed by Roebroeks & Villa (2011), there is a strong archaeological signal for the absence of fire use prior to *c.* 300,000–400,000 years ago in Europe.

The Middle Palaeolithic occupation of the area at stake here has created very different signals on both sides of the North Sea and Channel. As discussed by Ashton & Lewis (2002), there is good evidence for at least some human occupation during MIS 7, as at Northfleet or at Pontnewydd in Wales, but the low numbers of sites and artefacts compared to the MIS 11 and possibly the MIS 9 sites have been interpreted as reflecting low population densities or only intermittent occupation. In general, well-preserved early Middle Palaeolithic sites are relatively rare in the UK, but significantly less so on the continent, where Maastricht-Belvédère (MIS 7 or 9?), Biache-Saint-Vaast in northern France (MIS 7/6) and Rheindahlen in Germany (MIS 7–5) are amongst the flagship sites of European Palaeolithic archaeology. The first two owe their good preservation to fine-grained fluviatile deposits, the last to loessic sedimentation that covered the various flint scatters produced during the Saalian and early Weichselian periods at Rheindahlen.

The last part of the Saalian complex (MIS 6) may have witnessed the beginning of a human absence from Britain, which is inferred to have lasted more than 100,000 years and ended only during the final phases of the Middle Palaeolithic, during MIS 3, when humans returned to Britain together with a 'mammoth steppe' fauna (Currant & Jacobi, 2002). This long absence, especially during MIS 5, constitutes a marked contrast between the occupation history of the two sides of the Channel: in northern France, Belgium and their hinterlands, hominin occupation is known from a large number of sites, from open-air settings as well as from rock shelters for this period, ranging from full interglacial conditions at the Eemian site of Caours in the Somme valley (Antoine et al., 2006) to substantially colder occupations, well preserved by ensuing loess deposition. The number of Middle Palaeolithic sites datable to the variable cool–cold earlier part of the Weichselian period (MIS 5a-d) in France, Belgium and Germany is very high, with most of them also preserved in a loessic matrix (cf. Figure 5 in Antoine et al., 2002; see also Goval, 2008). Some of these sites are remarkable because they contain good evidence for blade technology — once the inferred hallmark of the Upper Palaeolithic — at 90 ka (Seclin: Tuffreau et al., 1994) or because they are 'mega-sites' containing hundreds of thousands of artefacts, such as Bapaume (Tuffreau, 1993). Many of the Belgian cave sites were excavated in the 19th century, but the Scladina cave at Sclayn still contained good evidence for MIS 5 presence, including Neanderthal fossils. The large-scale rescue excavations carried out by the INRAP teams in northern France keep on adding rich sites to this already prolific record (cf. Goval, 2008).

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Compared to the Early Weichselian, MIS 4 and MIS 3 are less rich in terms of numbers of sites, but it is during MIS 3 that Britain sees the return of Neanderthals, who discarded a few *bout-coupé* (White & Jacobi, 2002) cordiform and sub-triangular handaxes together with side-scrapers and flakes, probably attributable to a Mousterian of Acheulean tradition, for which an age of 40–60 ka is inferred in the British Isles. The type fossil of the Neanderthal lineage, Feldhofer 1, an adult male, and the recently discovered second adult individual, with their ^{14}C age of 39–40 ka, can also be placed in MIS 3 and belong to the latest Neanderthals in Europe. At the Feldhofer Grotte we are possibly dealing with a burial, and a third individual seems to be present in the material from the excavations of the 19th century refuse heaps (Schmitz, 2006). The Middle Palaeolithic population of the area at stake here is known through a larger number of hominin fossils than available for the whole of the Lower Palaeolithic: there are remains of two individuals at the open-air site of Biache-Saint-Vaast (MIS 7) in northern France (Guipert et al., 2011), in Belgium there are the Scladina (MIS 5) material and various cave sites, including the two Spy Neandertals discovered in 1886 (Semal et al., 2009), and the previously mentioned Feldhofer Grotte individuals. Pontnewydd Cave in Wales contained the remains of a minimum of five individuals, mostly in the form of teeth, about 250,000 years old (Green, 1984; Aldhouse-Green et al., 2012). A recent addition to this sample consists of the frontal skull fragment of a young adult Neanderthal, retrieved from below the waters of the North Sea 15 km off the coast of the province of Zeeland, in the southwest of the Netherlands (Hublin et al., 2009; Hijma et al., 2012).

The Upper Palaeolithic, prior to the Last Glacial Maximum (40–20 ka)

The transition from the Middle to the Upper Palaeolithic is one of the most discussed issues in palaeoanthropology, not least because of the confusion arising from the fact that varying perspectives and different disciplines are involved in this field of study. For instance, from an archaeological perspective, predominantly flake-based technologies become replaced by mostly blade and bladelet-based technologies, and tools made on a wide range of organic materials become a common phenomenon, especially in projectile technology. Figurative art, totally absent in the Middle Palaeolithic, becomes a not uncommon attribute of the Upper Palaeolithic record, as do personal ornaments. From a biological perspective, large-bodied stocky Neanderthals disappear from the European scene between approximately 39,000 and 36,000 ^{14}C years ago (Jöris & Street, 2008), and anatomically modern humans appear at their latest around 35,000, with the remains from Pestera cu Oase (Romania) being their earliest undisputed representatives in Europe (Trinkaus et al., 2003), with a few claims for earlier occurrences in Italy (Benazzi et al., 2011) and Kent's cavern in England (Higham, 2011), though there are problems with the context of this find (White & Pettit, 2012). The fact that the most commonly applied chronometric tool for these transition studies, the ^{14}C method, has severe limitations in this time range (Higham, 2011) makes it difficult to come up with a precise estimate for the overlap of the two species. In fact, a recent survey of the dating evidence suggests that the Neanderthals from the Feldhofer Grotte in Germany, with their ^{14}C dates of 40–39 ka, as well as the Spy individuals mentioned above and dated to approximately 36 ka (Semal et al., 2009; Crevecoeur et al., 2010) may have been amongst the latest in Europe, possibly a few thousand years before the arrival of the Pestera cu Oase humans (Jöris & Street, 2008). This does not imply that there must have been a hiatus in occupation between these two datum points; turning ^{14}C years into calendar years in this period is not unproblematic, and it is furthermore also not probable that our small sample of hominin remains samples both the very latest Neanderthals as well as the earliest modern humans.

The Early Upper Palaeolithic (EUP) and MUP of northwest Europe, that is, Britain, the Low Countries and northern France, has been described as 'A Marginal Matter' (Roebroeks, 2000). Aurignacian and Gravettian sites are few in number on both sides of the Channel and in general are poor in archaeological remains. Furthermore, the area attracted attention from antiquarians in the very early days of the discipline of archaeology, and many of the main sites, such as Paviland Cave in Wales and the Belgian Ardennes cave sites such as Spy and Trou Magrite, were excavated before the 19th century ended, so that the quality of the documentation available is generally poor. On both sides of the Channel some traces of an Initial Upper Palaeolithic seem to exist in the form of a few leaf points ('Jerzmanowice' points). The British record is very poor in traces of the Aurignacian and the Gravettian, but does contain a probable burial from this time period, the 'Red Lady' of Paviland, recently (re)dated to just over 29,000 ^{14}C years and attributed to an early Gravettian (Jacobi & Higham, 2008). On the western fringe of the continent, the Aurignacian and Gravettian cultures are somewhat better represented, and mainly restricted to the upland areas on the southern borders of the northern plain, especially in southern Belgium. In northern France no well-stratified Aurignacian artefacts are known, and the Gravettian is also very poorly documented there thus far, at two loess sites only (Fagnart, 1988). In Belgium, the small number of sites and the small size of the assemblages indicate that EUP and MUP occupation was marginal. For one of the most prolific Gravettian sites, Spy, Otte (1979) stresses that the cultural layer was thin, insignificant in both thickness and extension, and not testifying to a long occupation or to frequent short intermittent visits. The relative scarcity of Aurignacian and Gravettian remains is not a matter of lack of research; on the contrary, the loess sections in this area have been and still are subjected to detailed studies, but EUP and MUP archaeological material remains very rare. As for the earlier periods, a large part of the Aurignacian and Gravettian landscapes is missing, that is, the vast plains now hidden by the North Sea and the Channel, and the former coastal areas themselves. These plains must have been filled with large grazers, and sea food procurement may have been an important activity for at least some individuals living near the sea shores. We have direct evidence for this in the form of the stable isotopes values of the bones of the 'Red Lady': studied by M. Richards, these are indicative of a marine contribution to dietary protein of 15–20% (Aldhouse-Green & Pettitt, 1998).

From around 25,000 ^{14}C years ago this part of the Old World became deserted, with humans appearing on the scene again about 10,000 years later, after the LGM, with the arrival of Magdalenian hunters on the northern European plains (see Peeters & Momber, 2014). Occasional forays into these areas may have occurred prior to the substantial recolonisation of Magdalenian hunter-gatherers, however, as suggested on the basis of a few traces of hominin presence around the LGM in central Germany.

Discussion

One of the tantalising issues resulting from this review is the different archaeological signals from the two sides of the Channel, that is, the inferred 100,000 years absence of human occupation in Britain whilst, judging from the number of sites only, Neanderthals may have been abundant in northern France, or at least their flint artefacts are. Ashton and colleagues (Ashton & Lewis, 2002) infer that this MIS 6 to MIS 4 absence might have been the culmination of a process that started much earlier. These authors used the relative richness of assemblages retrieved from various terrace deposits to make inferences about demographic changes during the English Lower and Middle Palaeolithic. Based on the number of handaxes and Levallois products collected from river deposits, they see MIS 9 and 8 as the last period of a substantial occupation, gradually decreasing during MIS 7 and finally crashing during the penultimate glacial period, MIS 6. A basic assumption of this interpretation seems to be that in the period MIS 11 to MIS 7, Britain - or its wider surroundings - always saw some human population, gradually decreasing in numbers, but with always enough individuals present to create an archaeological signal. Others (e.g. Gamble, 1986) have suggested that human presence was more of an ebb and flow, with abandonment of areas and retreats into refuge areas when conditions deteriorated. A recently advanced possibility is that local populations became extinct repeatedly in the Palaeolithic when climatic conditions worsened: they were not able to track their preferred habitats to the south, unable to move into refuge areas, as these were occupied by other groups of Neanderthals, specialised hunters of larger mammals, high in the food chain and with low population densities (Hublin & Roebroeks, 2009; Roebroeks et al., 2011). Seen from such a perspective, the British signal might suggest that during the various phases of Neanderthal-range expansion, England became a more marginal area for these hominins, for whatever reasons.

The early human occupation of Britain was controlled by at least two main limiting factors: the possible physical barriers of a high sea level or of major river systems, and the prevailing climate and environment in Britain. We can assume that the Channel was there when France was seeing a substantial occupation during MIS 5. Gupta et al. (2007) suggest that two catastrophical floods arising from the drainage of huge glacial lakes in the area of the southern North Sea did the job, somewhere between 450 and 180 ka. Was the Channel River indeed a barrier that Neanderthals were unable to cross?

The different signals might also be the result of differences in sedimentary history on both sides of the Channel, with the inferred absence of hominin occupation being caused by the absence of preserving sediments. Most of the continental record is from loessic deposits, with cave sites obviously important too – as discussed above, they yielded the last glacial Neanderthal remains. Loess and cover sands do occur on both sides of the English Channel, but in southern England loess cover is significantly thinner and much more discontinuous than in northern France and other areas of the continental northern European loess belt. In a recent comparative study, Antoine et al. (2003b) have shown that most of the English loess and cover sand deposits date to the Late Devensian cold stage (MIS 2), with some older pockets locally present (e.g. at Boxgrove). While in Britain the maximum loess thickness is about 4 m (reached in Kent), in northern France (as in Belgium and Germany) loess is widespread and locally very thick (up to 12 m), with the main phases of accumulation situated in MIS 2 and MIS 6. Before 160–170 ka loess accumulation did occur in northern France, but accumulation and preservation were often restricted to sediment traps such as valley bottoms or fluvial and marine terraces exposed to the east or the northeast (Antoine et al., 2003b). According to Antoine et al. (2003b), the main differences in thickness and extent of the loess deposits between southern England and northern France are linked to their location in relation to the source area of the loess, the vast and dry North Sea and the Channel areas, respectively, and to the main wind directions, northwest to north–northwest in France and western England, but northeast in eastern England.

From this perspective, the inferred hiatus in hominin presence in what is now England could indeed be a matter of taphonomy, but how can we evaluate this option? The discovery of artefacts in the Early Weichselian loess deposits in southern England could lead to falsification of the 'hiatus' model, obviously, and some tantalising finds indicate that this is indeed a distinct possibility (Wenban-Smith et al., 2010). In parallel, might data from the North Sea be helpful here? Are we really on the edge of the Neanderthal-range limits? In order to make inferences about the types of limits to the range, and thus to learn about hominin adaptive strategies, we must be able to exclude the possibility that physical boundaries were determining the pattern. Were the physical boundaries of a Channel River in place? Gupta et al. (2007) clearly think so. If not, might Britain just have been an inhospitable place because of Pleistocene environments? These are important research questions that relate to the value we can attach to the patterns we think we see in our data. After all, as Cohen et al. (2014) point out, a North Sea with a sea level approximately as high as the

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extant one existed for only 10% of the last odd 200,000 years. For the most part, it was dry land, with major river valleys separating what now are northern France and Britain. These valleys must have constituted migration routes for large numbers of herbivores and the carnivores preying upon them. These included Neanderthals (Hublin et al., 2009), who had lots of time to expand their range in a western direction, that is, into present-day Britain. What we know about Neanderthals' environmental tolerances, about the Pleistocene history of the North Sea area (Cohen et al., 2014), about the importance of 'accommodating structures' (Turner, 2000), about the unambiguous presence of a Neanderthal population in northern France during the Last Interglacial and especially during the earlier Weichselian, can be translated into the prediction that the English invisibility of traces of a Neanderthal presence in the MIS 6 to MIS 4 time range is a matter of taphonomy, and that such traces will be unearthened, one day. Given the evidence from northern France and the data on the history of the North Sea basin (Cohen et al., 2014), an MIS 5d–5a presence is very possible (Wenban-Smith et al., 2010).

From a wider perspective, the area at stake here has always been a marginal one in terms of the distribution of hominins over the Old World. However, to turn that simple observation into information on the behaviour of hominins calls for more detailed studies. After all, there are different kinds of limits to the geographic range of a species. Entomologist Gorodkov's (1986) scheme (reproduced here as Fig. 1), for instance, distinguishes five different kinds, in order of increasing distance from the range centre, from the zone of continuous distribution up to the zone where no live individuals are present and only remains of dead individuals end up. As Gaston (2003) has pointed out, Gorodkov's scheme is but one of many ways to structure discussion on range limits, all neatly illustrating the fact that *the* range limit does not exist. Archaeologists only rarely mention what kind of range limit is under discussion; see Housley et al. (1997) on the recolonisation of northern Europe after the Last Glacial Maximum for a notable exception. This is understandable given the coarse palimpsest character of the distributions that are involved. The issue addressed by Gorodkov's scheme is an important one though: where does the 'Red Lady' fit in, where are the *bout coupé* handaxes of MIS 3 in Britain? How might we find out? Where were the centres of the range of the hominins who left their traces in the working area or, to stick to Gorodkov's terminology, where were the limits of the zone of continuous distribution? Data from the North Sea and the Channel could be informative here, linking up the records from the continent and from Britain.

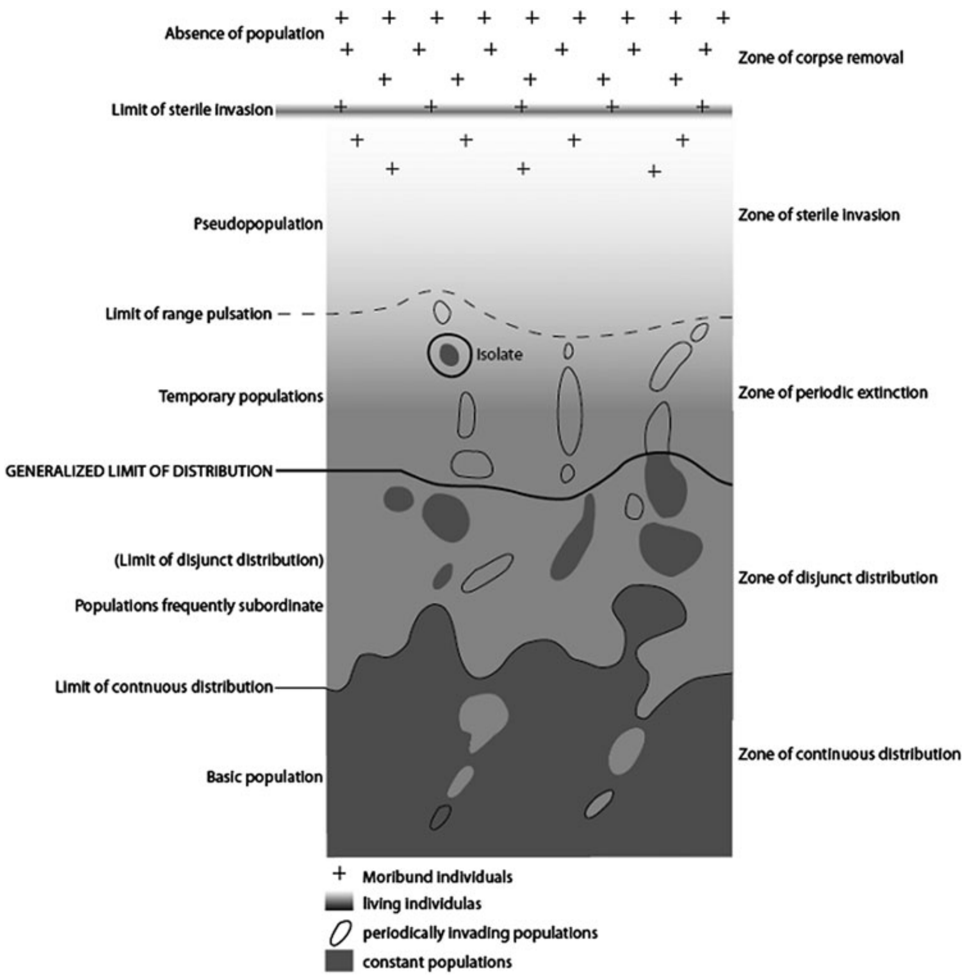

Fig. 1. A schematic presentation of the structure of the limits to geographic ranges, following Gorodkov (1986), redrawn from Gaston (2003). See text for explanation.

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After all, many of the sedimentary units preserved below the waters of the North Sea are simply the (now offshore) continuation of river deposits that have yielded traces of more than 800,000 years of (intermittent) occupation in both the UK and other parts of western Europe. The large scale of current quarrying activities, such as those for Rotterdam-Maasvlakte 2 (Hijma et al., 2012), imply that large quantities of these sediments may become accessible for study, but in a form that is more challenging than in a dry on-land exposure.

This is one of the research issues in which data from the now submerged parts of the European continental shelf might become very relevant, but there are more. Dealing with the question of how to retrieve information from once dry but now submerged landscapes forces us to appreciate the magnitude of changes in the morphology of our familiar environments on – in geological terms – relatively short timescales (cf. Westley et al., 2004). Such a perspective requires us to deal with dramatic changes in time and space, to take into consideration that most of us who work in the Pleistocene have trouble escaping extant political boundaries and present-day coastlines as a backdrop for colonisation studies (Hosfield, 2007). As illustrated by Westley et al. (2004), we more often than not treat once submerged landscapes as 'land bridges' between – in this case – continental Europe and the British Isles, instead of possible core areas of the landscapes of Pleistocene hunter-gatherers. There is much to gain from such a conceptual shift in spatial perspective.

From a low sea level perspective, many of the archaeological sites discussed here would have been situated in the hinterland of the main rivers that run over what is now the bottom of the North Sea and the Channel (many, but not all: the earliest sites in the Cromer Forest bed area, while not at the coast proper, were formed close to the former land–sea boundary, and the same applies to the site of Boxgrove (Roberts & Parfitt, 1999)). It is even possible that the presence of these earliest sites close to former coastal areas reflects the preferred environments of these early colonisers (cf. Cohen et al., 2012).

Both the Channel and the southern North Sea have yielded significant amounts of Pleistocene faunal remains as well as - in much smaller numbers - Palaeolithic (and Holocene) artefacts, retrieved by the fishing industry, by aggregate companies and during dredging operations relating to the maintenance of navigation routes such as the Eurogeul approach to Rotterdam harbour. Current information on the location and context of these finds is highly variable and often very limited, but GPS technology has improved this in some instances (Glimmerveen et al., 2004). Recent spectacular finds include the Neanderthal frontal fragment retrieved from the Zeeland ridges (Hublin et al., 2009), discovered some 15 km off the Dutch coast during shell extraction activities, and a rich Middle Palaeolithic flint assemblage dredged up from British waters. Here the exploitation of gravel deposits in water depths of about 25 m, some 13 km off Great Yarmouth (UK), led to the find. The assemblage contains dozens of handaxes and some Levallois flakes, recovered alongside bones and teeth of Pleistocene mammals, including mammoth (Russell and Tizzard, 2011; ongoing research by de Loecker et al.).

The record from these off-shore areas might enable us to retrieve information on hominin subsistence from coastal environments and river systems that we have not tapped yet, and from areas that may have formed the heartland of former hunter-gatherers, given the richness of these ecosystems. Refining the spatiotemporal resolution of these finds is a high priority, as it is there that much of the information potential of these finds may lie (Hijma et al., 2012).

Dating these finds poses challenges. The application of ^{14}C dating to a random sample of reindeer remains from the North Sea (Glimmerveen et al., 2006) suggested that there were three age sets, one of reindeer contemporaneous with the 'Red Lady' of Paviland (around 29 ka), a larger one between approximately 45 and 39 ka, that is, overlapping with the Feldhofer Neanderthals, and a third one older than 45 ka. Everything else being equal, submitting large amounts of random samples from various mammal species to ^{14}C dating might yield a solid overview of the presence and absence of various species through time, as a backdrop to understanding human occupation history of the wider area. For palaeontologists, such a programme might enable study of the co-occurrence of individual species and hence reconstruction of the changing palaeocommunities through time. That would add an extra dimension to the monolithic concept of mammoth steppe fauna and important information on where, when and (hopefully) why humans were occasionally part of these unique Pleistocene communities. However, at least two complicating factors need to be taken into consideration here. First, it is known that periodical recycling of sediments and associated fossils in the North Sea has led to the formation of units characterised by faunas from different time periods (cf. Cohen et al., 2014; Hijma et al., 2012). Hence, the associations of fossils in fishing nets and in the sieves of dredging operations need in the first instance to be treated as coarse-grained palimpsests of materials from different places and time periods, unless circumstantial evidence can falsify such interpretations. Second, radiocarbon dating in this period is not unproblematic, and many of the fossils retrieved from the (mixed up) top part of the sea bed are from a time range where the radiocarbon dating method is at its limits. Various authors have recently pointed out some of the discrepancies between radiocarbon dating results and other chronological and/or palaeoenvironmental proxies. Meijer (2008), for instance, has highlighted the difficulties involved in reconciling inferred low sea level stands in the southern North Sea during MIS 3 to MIS 2 with radiocarbon dates suggesting the presence of marine mammals in this area in the period 24–55 ka (Mol et al., 2008). Radiocarbon dates have also placed full interglacial (Eemian) molluscs in this 20–50 ka range, providing a mismatch with all biostratigraphical observations on some of these species thus far.

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It is clear that such problems need to be addressed and sorted out before any type of serious study of the Late Pleistocene archaeology of the North Sea area can be pursued. Put another way, the very rich palaeontological assemblages retrieved from the North Sea bed thus far need to be contextualised within data relating to the geological history of the North Sea, focusing on long sedimentary sequences of Pleistocene material, where the ubiquitous problem of mixing and remixing of material from different time periods can be excluded, or rather dealt with, with some precision (Hijma et al., 2012).

The North Sea record, no matter how interesting, is from a world archaeology perspective only one case study in the question of how to approach the study of the prehistoric record from continental shelves. After all, the large landscapes once united in Sahul, the enlarged Pleistocene landmass that incorporated Australia, Tasmania and New Guinea or the areas formerly exposed along the western coast of current North and South America in all probability contain crucial evidence concerning the Pleistocene colonisation of these New Worlds. For the Americas, the Coastal Migration model postulates an initial and fast colonisation down along the coast, where a degree of resource continuity could be maintained and – very convenient for supporters of a Long Chronology for the Americas – these earliest sites were subsequently covered by rising sea levels and hence remain largely invisible to present-day archaeologists. We should, of course, not build models on evidence that 'might be out there', but at the same time we should not close our eyes to what we might be missing. The evidence thus far recovered from the bottom of the North Sea does show that there is a rich *terra incognita* out there, waiting for us to discover it.

References

Aldhouse-Green, S. & Pettitt, P., 1998. Paviland Cave: Contextualizing the 'Red Lady'. Antiquity 72: 756-772.

Aldhouse-Green, S., Peterson, R. & Walker, E.A., 2012. Neanderthals in Wales: Pontnewydd and the Elwy Valley Caves. National Museum of Wales (Cardiff): 360 pp.

Antoine, P., Frechen, M., Locht, J.-L., DePaepe, P., Munaut, A.-V., Rousseau, D.D. & Sommé, J., 2002. Eemian and Weichselian early glacial pedosedimentary records in northern France: the background of Middle Palaeolithic occupations during OIS 5 and early OIS 4. *In:* Tuffreau, A. & Roebroeks, W. (eds): Le dernier interglaciaire et les occupations humaines de Paléolithique Moyen. CERP, Université des Sciences et Technologies de Lille (Lille): 75-88.

Antoine, P., Auguste, P., Bahain, J.-J., Coudret, P., DePaepe, P., Fagnart, J.-P., Falguères, C., Fontugne, M., Frechen, M., Hatté, C., Lamotte, A., Laurent, M., Limondin-Lozouet, N., Locht, J.-L., Mercier, N., Moigne, A.-M., Munaut, A.-V., Ponel, P. & Rousseau, D.-D., 2003a. Paléoenvironments pléistocènes et peuplements paléolithiques dans le bassin de la Somme (Nord de la France). Bulletin de la Société Préhistorique Française 100: 5-28.

Antoine, P., Catt, J., Lautridou, J.-P. & Sommé, J., 2003b. The loess and coversands of northern France and southern England. Journal of Quaternary Science 18: 309-318.

Antoine, P., Limondin-Lozouet, N., Auguste, P., Locht, J.-L., Galheb, B., Reyss, J.-L., Escudé, E., Carbonel, P., Mercier, N., Bahain, J.-J., Falguères, C. & Voinchet, P., 2006. Le tuf de Caours (Somme, France): mise en évidence d'une séquence eemienne et d'un site paléolithique associé. Quaternaire 17: 281-320.

Antoine, P., Limondin Lozouet, N., Chaussé, C., Lautridou, J.-P., Pastre, J.-F., Auguste, P., Bahain, J.-J., Falguères, C. & Galehb, B., 2007. Pleistocene fluvial terraces from northern France (Seine, Yonne, Somme): synthesis, and new results from interglacial deposits. Quaternary Science Reviews 26: 2701-2723.

Antoine, P., Bahain, J.J., Auguste, P., Fagnart, J.P., Limondin-Lozouet, N., Locht, J.L., 2011. Quaternaire et préhistoire dans la vallée de la Somme: 150 ans d'histoire commune. *In*: Hurel, A. & Coye, N. (eds): Dans l'épaisseur du temps. Archéologues et géologues inventent la préhistoire. Publications scientifiques du Muséum National d'Histoire Naturelle (Paris): 341-381.

Arsuaga, J.L., Martinez, I., Gracia, A. & Lorenzo, C., 1997. The Sima de los Huesos crania (Sierra de Atapuerca, Spain): A comparative study. Journal of Human Evolution 33: 219-281.

Ashton, N.M. & Lewis, S.G., 2002. Deserted Britain: declining populations in the British late Middle Pleistocene. Antiquity 76: 388-396.

Ashton, N. & Lewis, S.G., 2012. The environmental contexts of early human occupation of northwest Europe: The British Lower Palaeolithic record. Quaternary International 271: 50-64.

Ashton, N., Lewis, S.G., Parfitt, S.A., Penkman, K.E.H. & Coope, G.R., 2008. New evidence for complex climate change in MIS 11 from Hoxne, Suffolk, UK. Quaternary Science Reviews 27: 652-668.

Benazzi, S., Douka, K., Fornai, C., Bauer, C., Kullmer, O., Svoboda, J., Pap, I., Mallegni, F., Bayle, P., Coquerelle, M., Condemi, S., Ronchitelli, A., Harvati, K. & Weber, G.W., 2011. Early dispersal of modern humans in Europe and implications for Neanderthal behavior. Nature 479: 525-528.

Bischoff, J.L., Williams, R.W., Rosenbauer, R.J., Aramburu, A., Arsuaga, J.L., García, N. & Cuenca-Bescós, G., 2007. High-resolution U-series dates from the Sima de los Huesos hominids yields 600 ± 66 kyrs: implications for the evolution of the early Neanderthal lineage. Journal of Archaeological Science 34: 763-770.

Bosinski, G., 2008. Urgeschichte am Rhein. Kerns Verlag (Tübingen): 534 pp.

Carbonell, E., García-Antón, M., Mallol, C., Mosquera, M., Ollé, A., Rodríguez, X.P., Sahnouni, M., Sala, R., Vergès, J.M., 1999. The TD6 level lithic industry from Gran Dolina, Atapuerca (Burgos, Spain): production and use. Journal of Human Evolution 37: 653-693.

Carbonell, E., Bermúdez de Castro, J.M., Parés, J.M., Pérez-González, A., Cuenca-Bescós, G., Ollé, A., Mosquera, M., Huguet, R., van der Made, J., Rosas, A., Sala, R., Vallverdú, J., Garcia, N., Granger, D.E., Martinón-Torres, M., Rodríguez, X.P., Stock, G.M., Vergès, J.M., Allué, E., Burjachs, F., Cáceres, I., Canals, A., Benito, A., Díez, C., Lozano, M., Mateos, A., Navazo, M., Rodríguez, J., Rosell, J. & Arsuaga, J.L., 2008. The first hominin of Europe. Nature 452: 465-470.

Cohen, K.M., MacDonald, K., Joordens, J.C.A., Roebroeks, W. & Gibbard, P.L., 2012. The earliest occupation of north-west Europe: a coastal perspective. Quaternary International 271: 70-83.

Cohen, K., Gibbard, Ph. **and** ***Weerts, H.***, 2014. North Sea palaeogeographical reconstructions of the last 1 Ma. Netherlands Journal of Geosciences. (In press)

Crevecoeur, I., Bayle, P., Rougier, H., Maureille, B., Higham, T., van der Plicht, J., de Clerck, N. & Semal, P., 2010. The Spy VI child: A newly discovered Neandertal infant. Journal of Human Evolution 59: 641-656.

https://doi.org/10.1017/njg.2014.1 Published online by Cambridge University Press

Currant, A. & Jacobi, R., 2002. Human presence and absence in Britain during the early part of the Late Pleistocene. *In*: Tuffreau, A. & Roebroeks, W. (eds): Le dernier interglaciaire et les occupations humaines du Paléolithique Moyen. CERP, Universite des Sciences et Technologies de Lille (Lille): 105-113.

Fagnart, J.-P., 1988. Le Paléolithique Supérieur Ancien. Revue archéologique de Picardie 7: 19-31.

Ferring, R., Oms, O., Agustí, J., Berna, F., Nioradze, M., Shelia, T., Tappen, M., Vekua, A., Zhvania, D. & Lordkipanidze, D., 2011. Earliest human occupations at Dmanisi (Georgian Caucasus) dated to 1.85–1.78 Ma. Proceedings of the National Academy of Sciences 108: 10432-10436.

Gamble, C., 1986. The Palaeolithic Settlement of Europe. Cambridge University Press (Cambridge): 471 pp.

Gamble, C. & Kruszynski, R., 2009. John Evans, Joseph Prestwich and the stone that shattered the time barrier. Antiquity 83: 461-475.

Gaston, K.J., 2003. The Structure and Dynamics of Geographic Ranges. Oxford University Press (Oxford): 280 pp.

Geneste, J.-M., 1985. Analyse d'industries moustériennes du Périgord: une approche technologique du comportement des groupes humains au Paléolithique moyen. PhD Dissertation, Bordeaux University (Bordeaux): 572 pp.

Gibbard, P.L., 1988. The history of the great northwest European rivers during the past three million years. Philosophical Transactions of the Royal Society of London Series 318: 559-602.

Gibbard, P.L., 2007. Europe cut adrift. Nature 448: 259-260.

Glimmerveen, J., Mol, D., Post, K., Reumer, J.W.F., van der Plicht, H., de Vos, J., van Geel, B., van Reenen, G. & Pals, J.P., 2004. The North Sea project: the first palaeontological, palynological, and archaeological results. *In:* Flemming, N. (ed.): Submarine prehistoric archaeology of the North Sea. CBA research report 141, English Heritage/Council for British Archaeology (York): 43-52.

Glimmerveen, J., Mol, D. & van der Plicht, H., 2006. The Pleistocene reindeer of the North Sea – initial palaeontological data and archaeological remarks. Quaternary International 142–143: 242-246.

Gorodkov, K.B., 1986. Three-dimensional climatic model of potential range and some of its characteristics. Entomological Review 65: 1-18.

Goval, E., 2008. Définitions, analyses et caractérisations des territoires des Néandertaliens au Weichselien ancien en France septentrionale (Approches technologiques et spatiales des industries lithiques, élargissement au Nord-Ouest de l'Europe). Thèse de doctorat, Université des Sciences et Technologies de Lille (Lille): 540 pp.

Green, H.S., 1984. Pontnewydd Cave, a Lower Palaeolithic hominid site in Wales: 1st report. Sutton Publishing (Cardiff): 244 pp.

Guipert, G., de Lumley, M.-A., Tuffreau, A. & Mafart, B., 2011. A late Middle Pleistocene hominid: Biache-Saint-Vaast 2, North France. Comptes Rendus Palevol 10: 21-33.

Gupta, S., Collier, J.S., Palmer-Felgate, A. & Potter, G., 2007. Catastrophic flooding origin of shelf valley systems in the English Channel. Nature 448: 342-346.

Higham, T., 2011. European Middle and Upper Palaeolithic radiocarbon dates are often older than they look: problems with previous dates and some remedies. Antiquity 85: 235-249.

Hijma, M.P., Cohen, K.M., Roebroeks, W., Westerhoff, W.E. & Busschers, F.S., 2012. Pleistocene Rhine–Thames landscapes: geological background for hominin occupation of the southern North Sea region. Journal of Quaternary Science 27: 17-39.

Hosfield, R., 2007. Terrestrial implications for the maritime geoarchaeological resource: A view from the Lower Palaeolithic. Journal of Maritime Archaeology 2: 4-23.

Housley, R.A., Gamble, C.S., Street, M. & Pettitt, P., 1997. Radiocarbon evidence for the late glacial human recolonisation of northern Europe. Proceedings of the Prehistoric Society 63: 25-54.

Hublin, J.-J., 2007. Origine et évolution des Néandertaliens. *In*: Vandermeersch, B. & Maureille, B. (eds): Les Néandertaliens. Biologie et cultures. Comité des Travaux Historiques et Scientifiques (Paris): 95-107.

Hublin, J.-J., 2009. The origin of Neandertals. Proceedings of the National Academy of Sciences 106: 16022-16027.

Hublin, J.-J. & Roebroeks, W., 2009. Ebb and flow or regional extinctions? On the character of Neandertal occupation of northern environments. Palevol 8: 503-509.

Hublin, J.J., Weston, D.A., Gunz, P., Richards, M.P., Roebroeks, W., Glimmerveen, J. & Anthonis, L., 2009. Out of the North Sea: the Zeeland ridges Neandertal. Journal of Human Evolution 57: 777-785.

Jacobi, R.M. & Higham, T.F.G., 2008. The 'Red Lady' ages gracefully: new ultrafiltration AMS determinations from Paviland. Journal of Human Evolution 55: 898-907.

Jöris, O. & Street, M., 2008. At the end of the ^{14}C time scale – the Middle to Upper Paleolithic record of western Eurasia. Journal of Human Evolution 55: 782-802.

Lang, A.T.O. & Keen, D.H., 2005. 'At the edge of the world …' Hominid colonisation and the Lower and Middle Palaeolithic of the West Midlands. Proceedings of the Prehistoric Society 71: 63-83.

Lhomme, V., 2007. Tools, space and behaviour in the Lower Palaeolithic: discoveries at Soucy in the Paris Basin. Antiquity 81: 536-554.

Li, H., Yang, X., Heller, F. & Li, H., 2008. High resolution magnetostratigraphy and deposition cycles in the Nihewan Basin (North China) and their significance for stone artifact dating. Quaternary Research 69: 250-262.

Meijer, T., 2008. Kanttekeningen bij ^{14}C dateringen uit de periode van ca. 15–50 Ka. Palaeomal, WMC Kwartair Consultants: 1-15.

Meijer, T. & Cleveringa, P., 2009. Aminostratigraphy of Middle and Late Pleistocene deposits in The Netherlands and the southern part of the North Sea Basin. Global and Planetary Change 68: 326-345.

Mol, D., van Logchem, W., van Hooijdonk, K. & Bakker, R., 2008. The Saber-Toothed Cat of the North Sea. DrukWare (Norg): 160 pp.

Otte, M., 1979. Le Paléolithique supérieur ancien en Belgique. Musées Royaux d'Art et d'Histoire (Bruxelles): 684 pp.

Parfitt, S.A., Barendregt, R.W., Breda, M., Candy, I., Collins, M.J., Coope, G.R., Durbidge, P., Field, M.H., Lee, J.R., Lister, A.M., Mutch, R., Penkman, K.E. H., Preece, R.C., Rose, J., Stringer, C.B., Symmons, R., Whittaker, J.E., Wymer, J.J. & Stuart, A.J., 2005. The earliest record of human activity in northern Europe. Nature 438: 1008-1012.

Parfitt, S.A., Ashton, N., Lewis, S.G., Abel, R.L., Coope, G.R., Field, M.H., Gale, R., Hoare, P.G., N.R., L., Lewis, M.D., Karloukovski, V., Maher, B.A., Peglar, S.M., Preece, R.C., Whittaker, J.E. & Stringer, C.B., 2010. Early Pleistocene human occupation at the edge of the boreal zone in northwest Europe. Nature 466: 229-233.

Peeters, H.* and *Momber, G., 2014. The southern North Sea and the human occupation of northwest Europe after the Last Glacial Maximum. Netherlands Journal of Geosciences. (In press)

Preece, R.C., Parfitt, S.A., Bridgland, D.R., Lewis, S.G., Rowe, P.J., Atkinson, T.C., Candy, I., Debenham, N.C., Penkman, K.E.H., Rhodes, E.J., Schwenninger, J.-L., Griffiths, H.I., Whittaker, J.E. & Gleed-Owen, C., 2007.

https://doi.org/10.1017/njg.2014.1 Published online by Cambridge University Press

Terrestrial environments during MIS 11: evidence from the Palaeolithic site at West Stow, Suffolk, UK. Quaternary Science Reviews 26: 1236-1300.

Roberts, M.B. & Parfitt, S.A., 1999. Boxgrove: A Middle Pleistocene Hominid Site at Eartham Quarry, Boxgrove, West Sussex. English Heritage (London): 456 pp.

Roebroeks, W., 1988. From Find Scatters to Early Hominid Behaviour. A Study of Middle Paleolithic Riverside Settlements at Maastricht-Belvédère (The Netherlands). Leiden University Press (Leiden): 196 pp.

Roebroeks, W., 2000. A marginal matter: the human occupation of northwestern Europe – 30,000 to 20,000 years bp. *In*: Roebroeks, W., Mussi, M., Svoboda, J. & Fennema, K. (eds): Hunters of the Golden Age. The Mid Upper Palaeolithic of Eurasia 30,000–20,000 BP. University of Leiden (Leiden): 299-312.

Roebroeks, W., 2005. Life on the Costa del Cromer. Nature 438: 921-922.

Roebroeks, W. & Villa, P., 2011. On the earliest evidence for habitual use of fire in Europe. Proceedings of the National Academy of Sciences 108: 5209-5214.

Roebroeks, W., Kolen, J. & Rensink, E., 1988. Planning depth, anticipation and the organization of Middle Palaeolithic technology: the 'archaic natives' meet Eve's descendants. *Helinium* 28: 17-34.

Roebroeks, W., Conard, N.J. & van Kolfschoten, T., 1992. Dense forests, cold steppes, and the Palaeolithic settlement of northern Europe. Current Anthropology 33: 551-586.

Roebroeks, W., Hublin, J.-J. & MacDonald, K., 2011. Continuities and discontinuities in Neandertal presence: A closer look at northwestern Europe. *In*: Ashton, N.M., Lewis, S.G. & Stringer, C.B. (eds): The Ancient Human Occupation of Britain. Elsevier (Amsterdam): 113-123.

Russell, J. & Tizzard, L., 2011. Seabed Prehistory: Site Evaluation Techniques (Area 240) Synthesis. Wessex Archaeology (Salisbury): 60 pp.

Schmitz, R.W.E. (ed.), 2006. Neanderthal 1856–2006. Philipp von Zabern (Mainz): 380 pp.

Semal, P., Rougier, H., Crevecoeur, I., Jungels, C., Flas, D., Hauzeur, A., Maureille, B., Germonpré, M., Bocherens, H., Pirson, S., Cammaert, L., de Clerck, N., Hambucken, A., Higham, T., Toussaint, M. & van der Plicht, J., 2009. New data on the Late Neandertals: Direct dating of the Belgian Spy fossils. American Journal of Physical Anthropology 138: 421-428.

Smith, A.J., 1985. A catastrophic origin for the palaeovalley system of the eastern English Channel. Geology 64: 65-75.

Stringer, C., 2006. Homo Britannicus. The Incredible Story of Human Life in Britain. Allen Lane (London): 242 pp.

Stringer, C.B., 2012. The status of *Homo heidelbergensis* (Schoetensack 1908). Evolutionary Anthropology 21: 101-107.

Toro-Moyano, I., de Lumley, H., Fajardo, B., Barsky, D., Cauche, D., Celiberti, V., Grégoire, S., Martínez-Navarro, B., Espigares, M.P. & Ros-Montoya, S., 2009. L'industrie lithique des gisements du Pléistocène inférieur de Barranco León et Fuente Nueva 3 à Orce, Grenade, Espagne. L'Anthropologie 113: 111-124.

Toucanne, S., Zaragosi, S., Bourillet, J.F., Cremer, M., Eynaud, F., van Vliet-Lanoë, B., Penaud, A., Fontanier, C., Turon, J.L., Cortijo, E. & Gibbard, P. L., 2009. Timing of massive 'Fleuve Manche' discharges over the last 350 kyr: insights into the European ice-sheet oscillations and the European drainage network from MIS 10 to 2. Quaternary Science Reviews 28: 1238-1256.

Trinkaus, E., Moldovan, O., Milota, S., Bîlgăr, A., Sarcina, L., Athreya, S., Bailey, S.E., Rodrigo, R., Mircea, G., Higham, T., Bronk Ramsey, C. & van der Plicht, J., 2003. An early modern human from the Pestera cu Oase, Romania. Proceedings of the National Academy of Sciences 100: 11231-11236.

Tuffreau, A., 1993. Riencourt-les-Bapaume (Pas-de-Calais). Un gisement du Paleolithique moyen. Documents d'Archeologie Francaise (Paris): 126 pp.

Tuffreau, A., Révillion, S., Sommé, J. & van Vliet-Lanöe, B., 1994. Le gisement paléolithique moyen de Seclin (Nord). Bulletin de la Société Préhistorique Française 91: 23-46.

Turner, C., 2000. The Eemian interglacial in the North European plain and adjacent areas. Netherlands Journal of Geosciences/Geologie en Mijnbouw 79: 217-231.

Vandenberghe, J., Roebroeks, W. & van Kolfschoten, T., 1993. Maastricht-Belvédère: stratigraphy, palaeoenvironment and archaeology of the Middle and Late Pleistocene deposits: Part II. Mededelingen Rijks Geologische Dienst 47: 1-91.

Verpoorte, A., 2008. Limiting factors on early modern human dispersals: The human biogeography of late Pleniglacial Europe. Quaternary International 201: 77-85.

Wenban-Smith, F., Bates, M.R. & Schwenninger, J.-L., 2010. Early Devensian (MIS 5d–5b) occupation at Dartford, southeast England. Journal of Quaternary Science 25: 1193-1199.

Westley, K., Dix, J. & Quinn, R., 2004. A re-assessment of the archaeological potential of continental shelves. English Heritage (London): 207 pp.

White, M.J. & Jacobi, R.M., 2002. Two sides to every story: bout coupé handaxes revisited. Oxford Journal of Archaeology 21: 109-133.

White, M. & Pettitt, P., 2012. Ancient digs and modern myths: the age and context of the Kent's Cavern 4 maxilla and the earliest Homo sapiens specimens in Europe. European Journal of Archaeology 15: 1-30.

White, M., Ashton, N. & Scott, B., 2011. The emergence, diversity and significance of mode 3 (prepared core) technologies. *In*: Ashton, N.M., Lewis, S.G. & Stringer, C.B. (eds): The Ancient Human Occupation of Britain. Elsevier (Amsterdam): 53-65.

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