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Hunter–gatherer responses to environmental change during the Pleistocene–Holocene transition in the southern North Sea basin: Final Palaeolithic–Final Mesolithic land use in northwest Belgium

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ABSTRACT

Situated along the southern fringe of the North Sea basin, northwest Belgium holds great potential for understanding hunter–gatherer responses to environmental change at the Pleistocene–Holocene transition. Recent intensive fieldwork has yielded valuable data on the palaeoenvironment, chronology, and hunter–gatherer mobility and land use in this region. At the Late Glacial/Early Holocene transition this region was comprised of a landscape of coversand ridges and lakes that flanked the northern part of the Scheldt river basin. This landscape was highly productive for hunter–gatherer populations. As the landscape developed in response to the increasing water table caused by the inundation of the North Sea populations responded by changing their forms of mobility and land use. These changes are indicated by the reduction in the number and density of sites, as well as their geographical settings, from the Late Glacial (*Federmesser*) and Early Mesolithic to the Middle-Final Mesolithic. Late Glacial/Early Mesolithic sites indicate much higher mobility comprised of rapid displacements of camps and re-occupation of the same coversand ridges over long time-spans. Middle/Late Mesolithic sites indicate a reduction in mobility, increasing focus on prolonged riverside settlement, and a more rigid organization of residential sites.

Introduction

The southern North Sea basin is an important region for the investigation of human responses to environmental change at the Pleistocene–Holocene transition. This is due to the number of different natural variables to consider that might have impacted human societies, as well the many different ways in which societies could have responded to environmental change over many generations. The Pleistocene–Holocene transition in this region was characterized by an enormous loss of land (>250,000 km^2), and the typical warming and correspondent changes in vegetation that occurred throughout Europe. A further characteristic of the transition in this region is that the lowland margins of the basin were highly sensitive to the changes and variability of local water tables. The loss of land and the changes in vegetation and water tables would have placed significant organizational constraints on the hunter–gatherer societies living in the region.

In this paper, we take a first step in the investigation of the responses of hunter–gatherers to environmental change at the Pleistocene–Holocene transition in the southern North Sea basin. This first step requires that we take a broad-scale 'landscape approach' which entails a "concentration on land use, potentially synergistic relationships among environmental systems, landscape physiography, and the spatial aspects of human land use strategies" (Rossignol, 1992, p. 4). The relationships between hunter–gatherer social organization and environmental change have traditionally been understood in Mesolithic research in terms of Binford's (1980) forager-collector model or Woodburn's (1980) immediate-delayed return model because they focus on the role of key resource distribution in the structuring of hunter–gatherer settlement systems. However, in recent years these models' focus on the linear development of complexity in hunter–gatherer societies has come under increasing criticism by Mesolithic researchers due to the lack of empirical evidence indicating a gradual rise in complexity through increasingly structured organization of people and/or increasing intensification of exploitation (Rowley-Conwy, 2001; Spikins, 2008). Within the southern North Sea basin, evidence from the southern Netherlands suggests the opposite of a linear development to complexity, where there appears to be greater specialization, intensification, and larger settlement sites in the Early

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Mesolithic than in the Late Mesolithic (Verhart, 2008, p. 181), which might appear like an actual decrease in complexity according to the Binford and Woodburn models. Despite widespread recognition of coastal locations as the regions where "the most 'organized' societies tend to exist" (Spikins, 2008, p. 10), the evidence from the southern Netherlands and from other regions of Europe (cf. Rowley-Conwy, 2001) suggests that we take caution when attempting to read complexity or intensification into our datasets for diachronic change in Mesolithic land use, even if these datasets come from coastal locations.

The considerable temporal and spatial variability of Mesolithic mobility and social interaction (Lovis et al., 2006a,b) requires that researchers investigate diachronic change in hunter–gatherer land use on a regional basis. Once regional-scale data is recorded and analyzed the next step is a comparative study between regions in order to understand the full extent of responses to environmental change. Assessment of long-term change in Mesolithic land use systems and their placement along the forager–collector continuum should come as a later stage of analysis once in-depth regional and inter-regional comparative studies have been carried out. Before interpreting whether a Mesolithic population is a 'forager' or 'collector' system there are many fundamental archaeological problems that hinder knowledge of hunter–gatherer land use systems—such as taphonomic (e.g. site covering, bioturbation, erosion) and/or research biases (e.g. survey intensity and excavation contexts)—that must be dealt with first. For instance, for the southern North Sea basin problems of taphonomic processes and research biases have greatly hindered the potential for analysis of Mesolithic land use systems. However, as we show in this paper, intensively utilized agricultural areas can offer good opportunities because most sites are situated at the present surface due to long histories of ploughing. We focus on the region of Sandy Flanders in northwest Belgium, which comprises an area where the majority of prehistoric sites can be detected by field-walking. Intensive fieldwork over the last 25 years has resulted in detailed distribution maps of the occupation of the last 12,000 years. In this paper all of this evidence will be examined for its contribution to our knowledge of hunter–gatherer responses to environmental change at the Pleistocene–Holocene transition, specifically the Late Glacial (*Federmesser*)–Final Mesolithic (ca. 12,000–4000 cal BC).

The (palaeo)environment

Sandy Flanders encompasses a low-lying area situated between 3 and 15 m above sea-level extending from the North Sea coast in the west to the lower course of the Scheldt River in the (south)east (Fig. 1). It is covered mainly by coversand sediments deposited by aeolian activity during the Pleniglacial and the colder Dryas stages of the Late Glacial (Heyse, 1979). These coversands are lying unprotected at the present surface, except for the westernmost (coastal polders) and northernmost (Scheldt polders) parts where they are covered by Holocene peat and/or (peri)marine clay.

The general topography of Sandy Flanders is characterized by numerous coversand ridges which were formed primarily by sediments blown from the bottom of the southern North Sea plain by dominant northwestern winds during the Late Glacial (Heyse, 1979). Most of these ridges are rather small, low (ca. 1–2 m height) and elongated, covering anywhere from ten to hundreds of meters. One pariticular sandridge, called the Great Ridge of Verrebroek (Stekene) – (Maldegem) Gistel, stands out by its larger dimensions as it traverses the entire area of Sandy Flanders from east to west (ca. 80 km) and is locally 1.5–3 km wide (Fig. 1). This massive dune also reaches higher (mean 5 m) and has a typical dune profile characterized by a rather steep southern edge (1–4%) and a gently sloping northern side (1–1.5%). The dune was formed gradually during different series of deflation in the cold stages of the Late Glacial, which alternated with wet phases. The latter are exhibited by the presence of several humiferous to peaty sub-aquatic sediments (palaeosols) dating to the Bølling (ca. 12,300–12,100 cal BC) and Allerød (ca. 11,950–10,700 cal BC) interstadials. These horizons represent the bottom of large depressions filled with shallow (<1 m) to deep freshwater (3–6 m) (Heyse, 1979; Verbruggen et al., 1996). Most of these depressions, except for the youngest ones formed during the Younger Dryas (ca. 10,700–9600 cal BC), had a rather restricted lifetime as they were quickly filled in by drifting sand.

Other types of wet depressions were formed along the foot of the steep southern edge of the Great Ridge. These depressions were created, probably already from the very beginning of the Late Glacial, by local erosion induced by a blocking of the natural surface water runoff of the area caused by the formation of the Great Ridge (De Moor and Heyse, 1978; Verbruggen et al., 1996). Surface

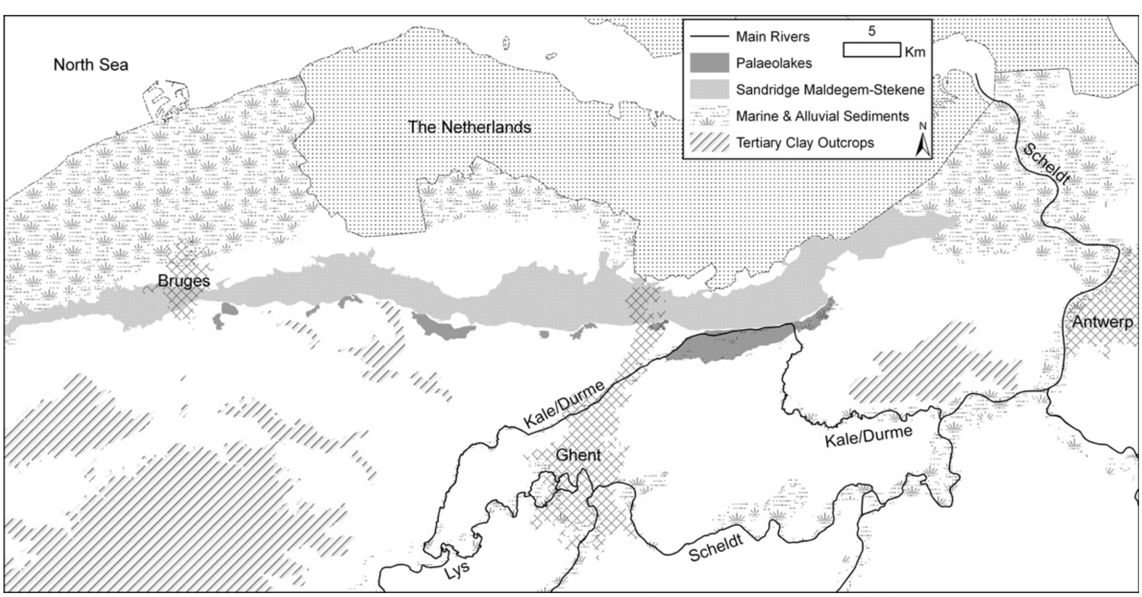

Fig. 1. Map of Sandy Flanders in NW Belgium showing the main landscape features.

water and groundwater accumulated in local depressions forming numerous shallow lakes along the entire southern edge of the Great Ridge. Different from the windblown depressions mentioned above, these lakes were present throughout the entire Late Glacial and were filled gradually with lacustrine sediments, mainly marl. Most of them dried out during the Younger Dryas or the start of the Holocene, as a result of a drastic lowering of the groundwater table caused by increased evapotranspiration and eventually turned into marshland at least from the Boreal/early Atlantic onwards (Verbruggen, 1971; Denys et al., 1990). The largest lake of the area, called the Moervaart, measures approx. 15 × 2.5 km (Bats et al., 2009, 2010); however, most other lakes are much smaller spreading over just a few hundreds of meters.

Summarizing, the prehistoric landscape of Sandy Flanders was dominated by hundreds of small sand ridges and shallow palaeolakes, the latter disappearing ultimately at or soon after the onset of the Holocene.

South of the Great Ridge and its palaeolakes some tertiary outcrops called cuestas occur which dominate the landscape due to their height, rising up to 25 m above the landscape. Outcrops of flint are situated on these low hills. Despite the mediocre quality of this flint it made up the primary stone procurement source for Late Glacial and Early Holocene forager societies.

The river system in Sandy Flanders is dominated by the Scheldt basin, which runs along its southern and eastern border towards the large prehistoric delta of the Meuse–Rhine–Scheldt situated in the western Netherlands. The Scheldt developed into a meandering river with large oxbows at the start of the Late Glacial (Kiden, 1991). The Kale/Durme river makes up the most important tributary in Sandy Flanders, flowing to the northwest of the Scheldt and joining it after having cut through the Moervaart lake. Results of recent research have indicated that start of the incision of the Kale/Durme took place during the transition from the Late Glacial to Holocene, after the Moervaart lake had already dried up (Bats et al., 2009).

Sandy Flanders has a rich history of palaeovegetational study. At least fifty Late Glacial lake deposits have been analyzed palynologically (Verbruggen, 1971, 1979; Verbruggen and Van Dongen, 1976; Verbruggen et al., 1996; Deforce et al., 2005). However, the Early Holocene has received much less investigation due to the scarcity of organic sediments. Recent research has started to fill in the gaps of knowledge relating the diachronic evolution of this dynamic physical landscape. At present we are finally able to develop a broader understanding of the different developmental processes of this region. This new research has established the following understanding of landscape development in Sandy Flanders.

The Late Glacial period was comprised of a complex series of different vegetation phases, beginning with a treeless tundra rich in various herbs, followed by a shrub tundra with dwarf birch, willow, juniper and sea buckthorn (Bølling s.l.). During the Bølling an open birch forest covered the landscape. During the subsequent Allerød this forest gradually got denser until the arrival of pine around ca. 11,200 cal. BC; at that time a pine-birch taiga forest interspersed with many open patches was developed and covered large parts of the area. Despite the ultimate climatic deterioration of the Younger Dryas the vegetation persisted rather well, during which an open woodland with birch and pine and a rich herbaceous undergrowth appeared. At the onset of the Holocene, when the lake landscape disappeared, a more closed and probably dry forest re-appeared, dominated first by birch and later on by pine and hazel (Preboreal). From the Boreal onwards hazel expanded rapidly, followed by the gradual arrival of the first deciduous trees, e.g. oak and elm. Around the transition from Boreal to Atlantic (ca. 7000 cal. BC) "Quercetum mixtum" or Atlantic climax-forests cover the drier grounds, with alder in wetter parts.

Archaeological evidence

Database[1]

Since the mid-80s large parts of Sandy Flanders—excluding the polder and river floodplain areas—have been intensively (e.g. yearly) and systematically surveyed by means of field-walking mainly by amateur-archaeologists (Van der Haegen et al., 1999; Crombé and Verbruggen, 2002; Van Vlaenderen et al., 2007; Sergant et al., 2009). This resulted in the discovery of a large number of prehistoric sites, dating to the Final Palaeolithic and Mesolithic, while some Neolithic sites have also been reported (Crombé and Sergant, 2008). Some of these sites have been further investigated by means of (salvage) excavations (Crombé, 1998, 2005) and drillings (Crombé, 2006; Bats, 2007). In the context of a recent research project all this data has been put into a geographical information system (GIS) database, which has enabled a detailed analysis of the site distribution throughout different stages of the Late Glacial and Early Holocene. The database contains information for both the archaeological (artifact typology and technology, raw material, etc.) as well as the environmental (soil type, drainage, position, height, etc.) characteristics of each site.

The database comprises 744 sites and more than 128,000 artifacts. The vast majority of sites are very small, possessing less than 50 finds (Fig. 2). Some may be interpreted as ephemeral sites, but most small assemblages probably represent sites which have not yet been surveyed long enough to yield a substantial artefact assemblage. As a result these small sites cannot be dated accurately because most of the key chronologically diagnostic artefacts are missing. Even the larger surface sites are not always easy to date; assemblages smaller than ca. <400 artifacts generally contain too few diagnostic types, e.g. armatures, burins, etc., to be datable with some precision (Table 1). In addition the larger a site/assemblage gets, the greater the chance it represents a mixture of different occupation events (e.g. palimpsests; Bailey, 2007). Determining which finds belong to which occupation phase is a difficult if not sometimes impossible task. After a critical analysis of the database just 126 sites could be dated with enough confidence on the basis of techno-typological criteria to one of the chronological stages within the Final Palaeolithic and Mesolithic.

Chronological distribution

The sites have been attributed to five different chronological stages (Table 2). The oldest Late Glacial sites so far date back to the *Federmesser* culture, which is currently dated in Belgium—by just a few radiocarbon dates—to the Older Dryas and Allerød interstadial (De Bie and Vermeersch, 1998; Crombé et al., 1999). Thus far no traces of the Ahrensburgian culture have been reported, indicating that the area of Sandy Flanders might have been unoccupied during the colder Younger Dryas. However, this demands further investigation as it is not entirely excluded that, comparable to southern areas such as central France, the *Federmesser* continued to exist, albeit in a somewhat hybrid form (Epi-Labourian) (Valentin, 2008; Crombé et al., in press).

From the middle Preboreal onwards (ca. 8800/8700 cal. BC) renewed occupation is attested by numerous Mesolithic sites. Contrary to the Late Glacial period, the Mesolithic in Sandy Flanders is well-dated (Crombé, 1999; Crombé et al., 2009a,c). Based on a series of more than 150 radiocarbon dates mainly obtained on carbonized hazelnut shells, the Mesolithic can be subdivided into an Early, Middle, Late and Final stage (Table 2). The Final Mesolithic

[1] The most important data from this database has been gathered in an appendix, available in the online version of this paper.

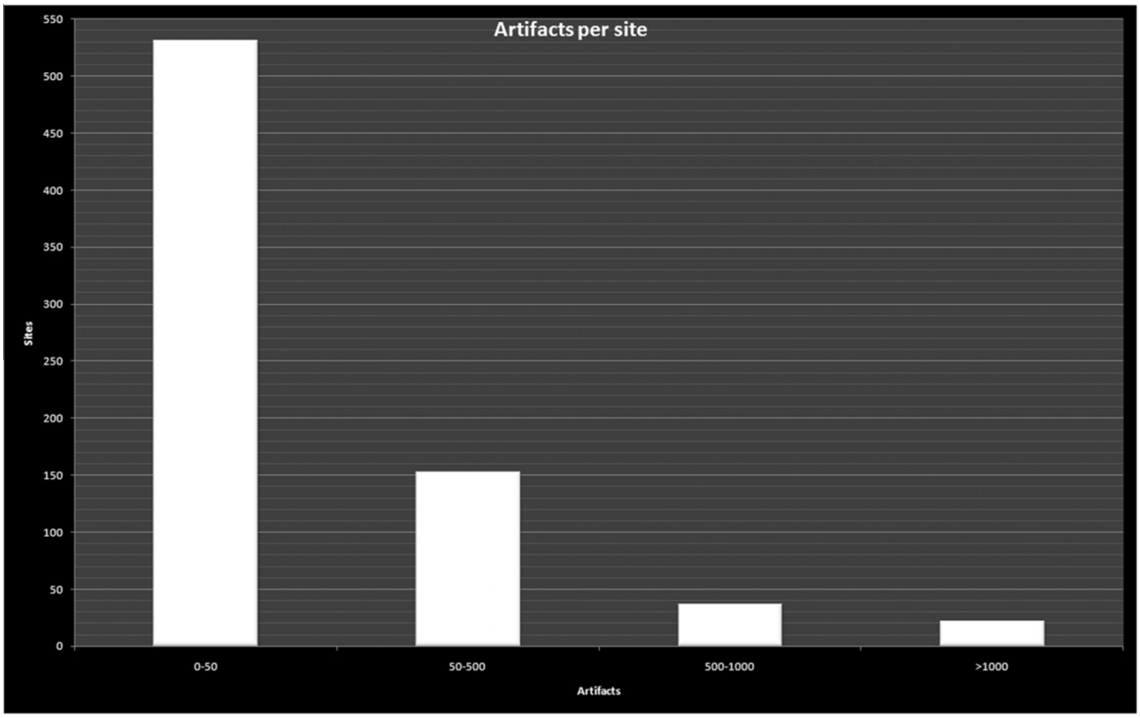

Fig. 2. Distribution of prehistoric sites according to the size of the lithic assemblage.

Table 1
Overview of diagnostic elements used for relatively dating the sites.

Stage	Typological diagnostics	Technological diagnostics
Final Palaeolithic	Backed (*Federmesser*) points and bladelets, numerous burins (dihedral, on truncation)	Regular blades
Early Mesolithic	Points with (un)retouched base, (scalene) triangles, crescents, very few (atypical) burins	Irregular (Coincy-style) blade(let)s
Middle Mesolithic	Small backed bladelets, microliths with flat retouch	Irregular (Coincy-style) blade(let)s
Late Mesolithic	Trapezes, regular blades with Montbani retouch	Regular (Montbani-style) blade(let)s, broad microburins
Final Mesolithic	Small trapezes, regular blades with Montbani retouch, (Swifterbant) pottery	Regular (Montbani-style) blade(let)s, absence of microburins

Table 2
Chronological list of Final Palaeolithic and Mesolithic sites in NW Belgium.

Stage	Time range (cal BC)	Absolute number of sites	Corrected number of sites per 100 years calibrated
Final Palaeolithic	12,100–10,750	30	2.22
Early Mesolithic	8750–7400	49	3.63
Middle Mesolithic	7400–6500	16	1.77
Late Mesolithic	6500–4500	26	1.00
Final Mesolithic	4500–4000	5	1.00

corresponds to the stage in which pottery associated with the Swifterbant culture appeared in hunter–gatherer contexts (Crombé et al., 2002; Crombé et al., 2011).

The chronological distribution of the sites shows an important variability in the number of sites per phase (Fig. 3). Looking at the raw data expressed in absolute numbers, there is a marked dominance of sites belonging to the Early Mesolithic, followed by those of the *Federmesser* and the Late Mesolithic. Middle Mesolithic and Final Mesolithic sites on the other hand are less numerous. However, considering the difference in the duration of each chronological phase, another pattern emerges. The corrected figures (Fig. 4) demonstrate a marked decrease of sites after the Early Mesolithic; from the Middle Mesolithic to the Final Mesolithic the number of sites decreases gradually. Only for the Final Mesolithic the data may be somewhat biased by taphonomic factors (cf. below) and the minor differences with Late Mesolithic industries (cf. Table 1).

Geographical distribution

The general distribution map of all surface sites—those which are not accurately dated to one of the above stages included—shows a non-random distribution over the study-area (Fig. 5). This is also confirmed by means of an average nearest neighbor analysis (Hodder and Hassall, 1971; Pinder et al., 1979; Whallon, 1974) (Fig. 6). Using kernel density estimates (Baxter and Beardah, 1996; Baxter et al., 1997), it is possible to roughly demarcate micro-areas with a high density of sites. These cluster areas are from west to east:

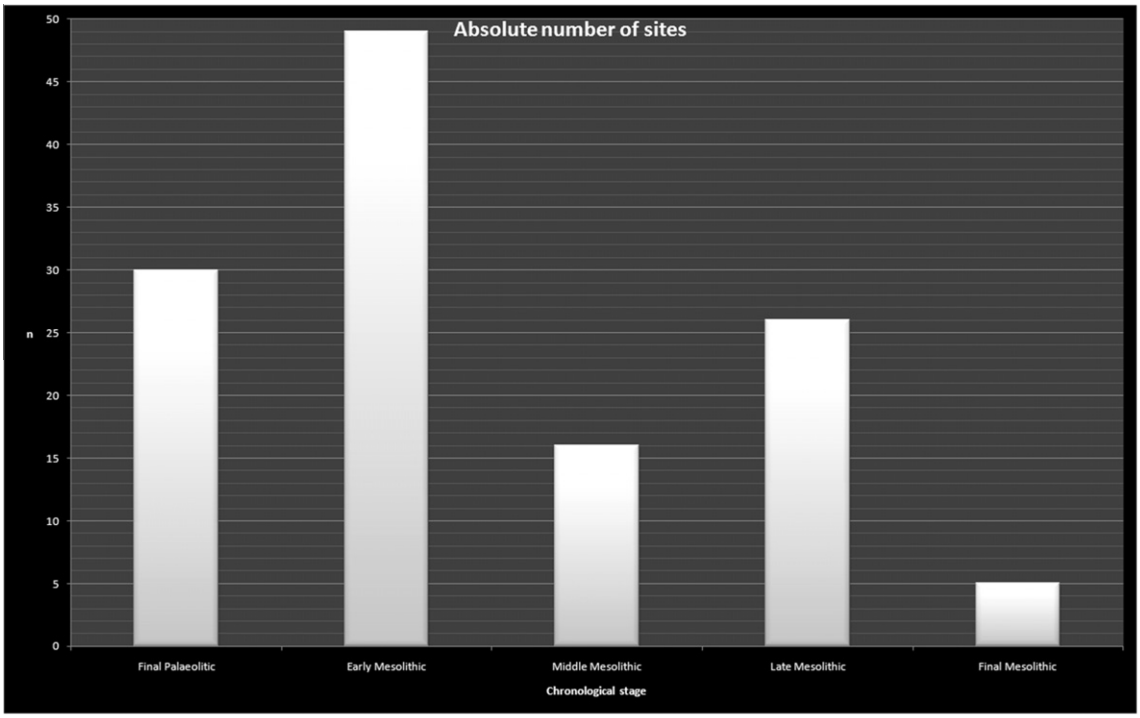

Fig. 3. Chronological distribution of prehistoric sites in real numbers (cf. Table 2).

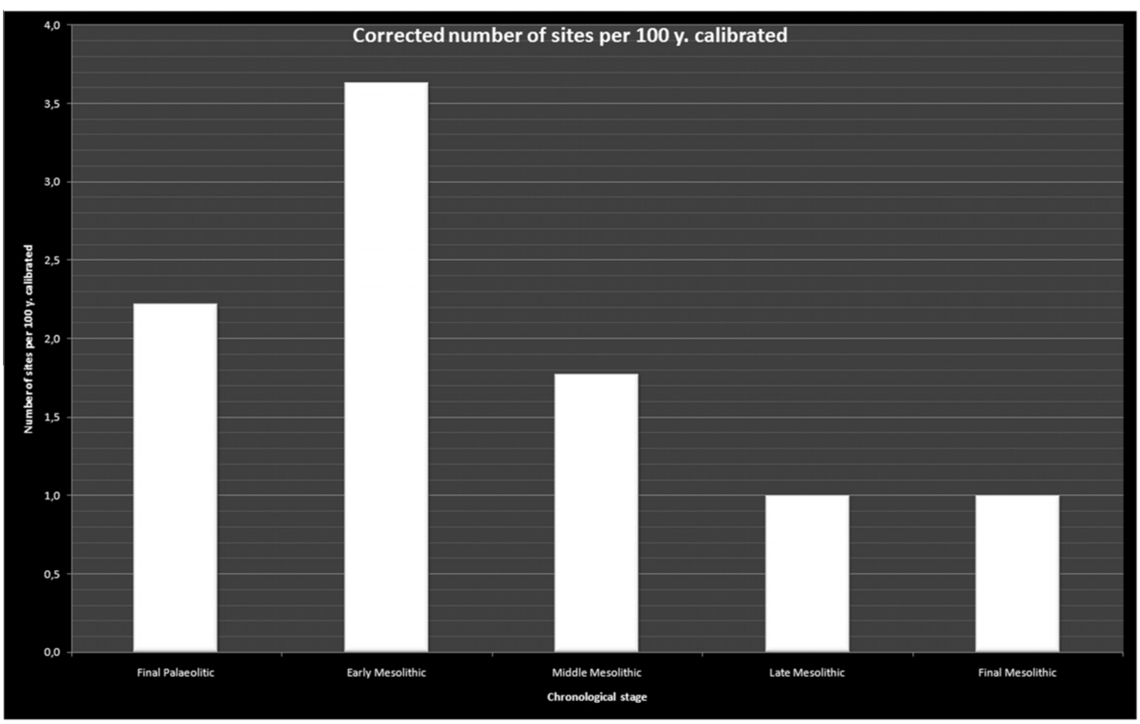

Fig. 4. Chronological distribution of prehistoric sites in corrected numbers (cf. Table 2).

– the region around the cuestas halfway between the cities of Bruges and Ghent, called the "Meetjesland" (Fig. 5.1).
– the dry banks of the Kale/Durme river (Fig. 5.2a and b).
– the area around the Moervaart palaeolake, northeast of Ghent (Fig. 5.3).
– the adjacent area west of the city of Antwerp, called the "Waasland", with a dense clustering along the southern edge of the Great Ridge (Fig. 5.4).

In the remaining parts of Sandy Flanders the density of sites is much lower. In some areas this is certainly the result of a bias in the database, caused by a lack of survey intensity. This holds for the area south of Bruges where field-walking has commenced recently (Fig. 5.5) (Sergant et al., 2009), which has already indicated a site density comparable to the adjacent "Meetjesland" area. Another slightly biased area is situated in the southern part of the "Waasland" area (Fig. 5.6); here the presence of numerous "bolle

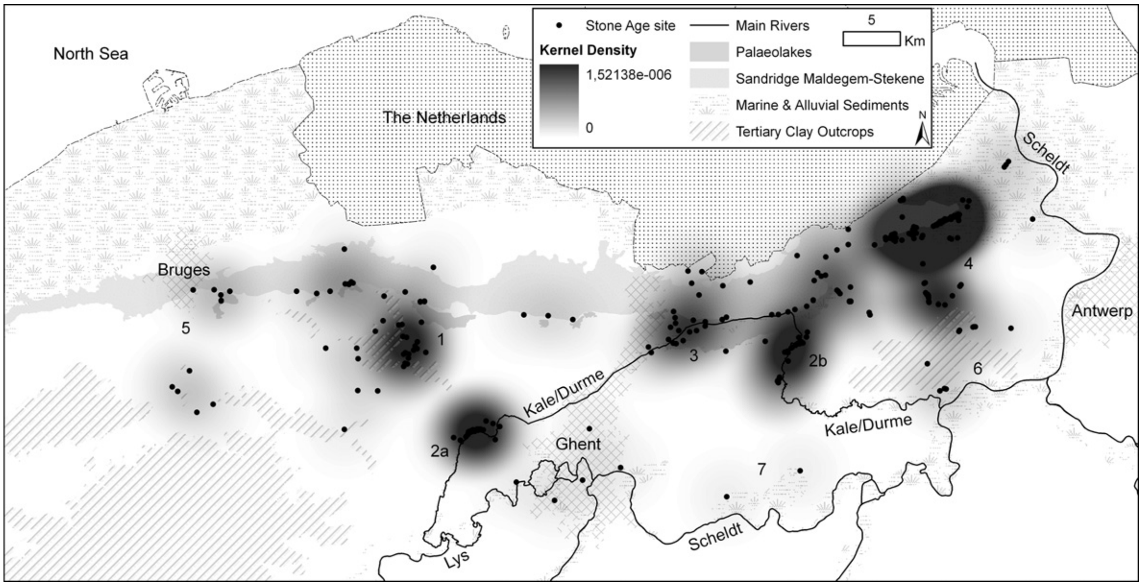

Fig. 5. Spatial distribution of all Final Palaeolithic and Mesolithic sites in Sandy Flanders using kernel density estimates. Keys = cf. text.

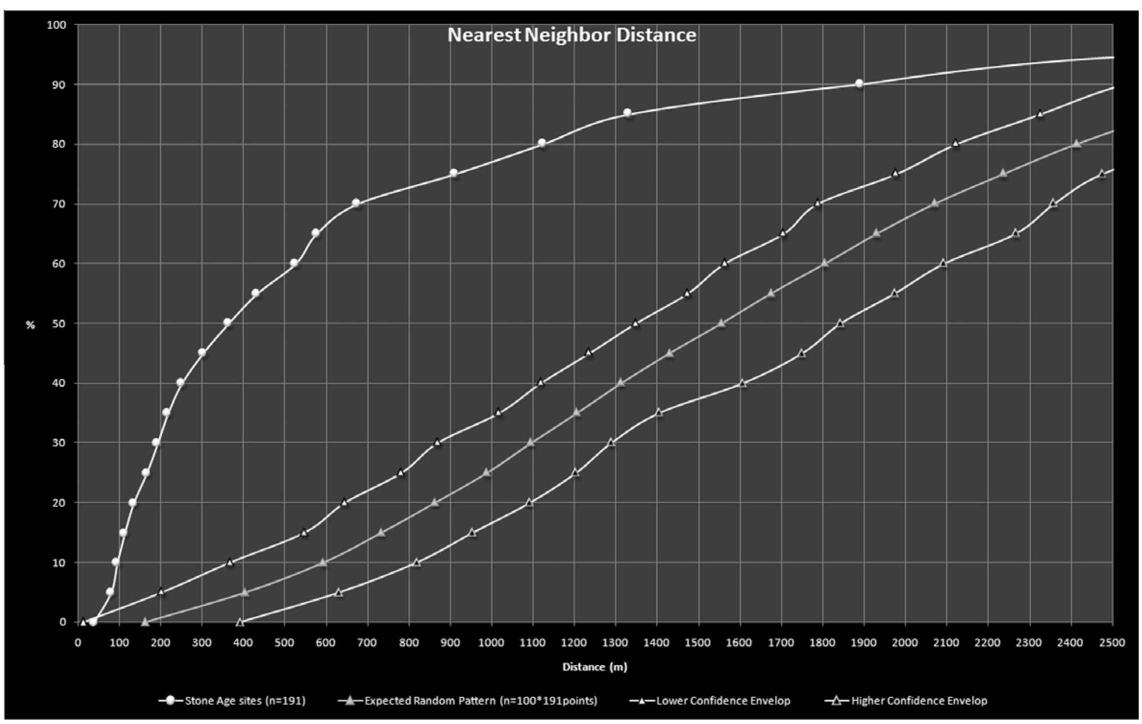

Fig. 6. Nearest neighbor analysis of Stone Age sites in Sandy Flanders against 100 sets of random distributed points, indicating the clustered distribution of Stone Age sites.

akkers'' or ''raised fields''(Van Hove, 1997) hinders the detection of prehistoric sites considerably as they are covered by Medieval deposits. The dry grounds along the Scheldt floodplain and its Late Glacial oxbows have not yet been intensively surveyed, explaining the rather low number of sites (Fig. 5.7). Recent drilling research into the Scheldt floodplain, however, has revealed numerous sealed sites indicating intense exploitation of these wet environments (Crombé, 2005, 2006; Bats, 2007; Perdaen et al., 2009b).

On the other hand the significant lack of sites in the areas immediately to the north(west) and east of Ghent, corresponding to the sedimentation plain of the Pleistocene Flemish Valley (De Moor and Heyse, 1978), cannot be explained by a lack of research. In both areas, besides targeted field-walking, several very large salvage excavation projects, covering many tens of hectares (Ryssaert et al., 2007; Laloo et al., 2009), and follow-ups of gas pipeline construction (In t'Ven and De Clercq, 2006) yielded only few traces of hunter–gatherer activity. An explanation might be sought in the near absence of large enough sand ridges for occupation in these areas, except along the banks of the Kale/Durme River which runs diagonally through them.

Thus, taking into consideration the bias caused by limited research in some micro-areas, we can conclude that practically all of Sandy Flanders was intensively exploited during the Late Glacial and Early Holocene. The only area attesting a lack of intensive

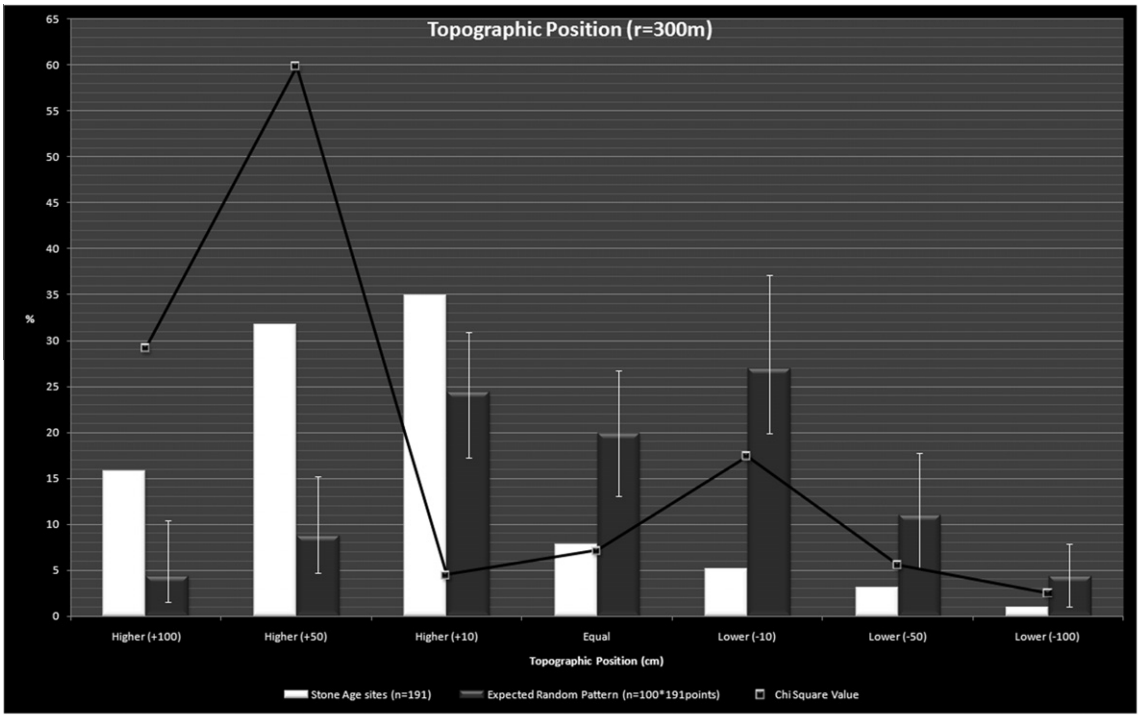

Fig. 7. Spatial analysis of the topographical position (difference between the height at the site and the average height of the surrounding areas, within a radius of 300 m) of Stone Age sites, against 100 sets of random distributed points, indicating the preference for slightly higher grounds for settlement location. The significance of the observed pattern is confirmed by a chi square test.

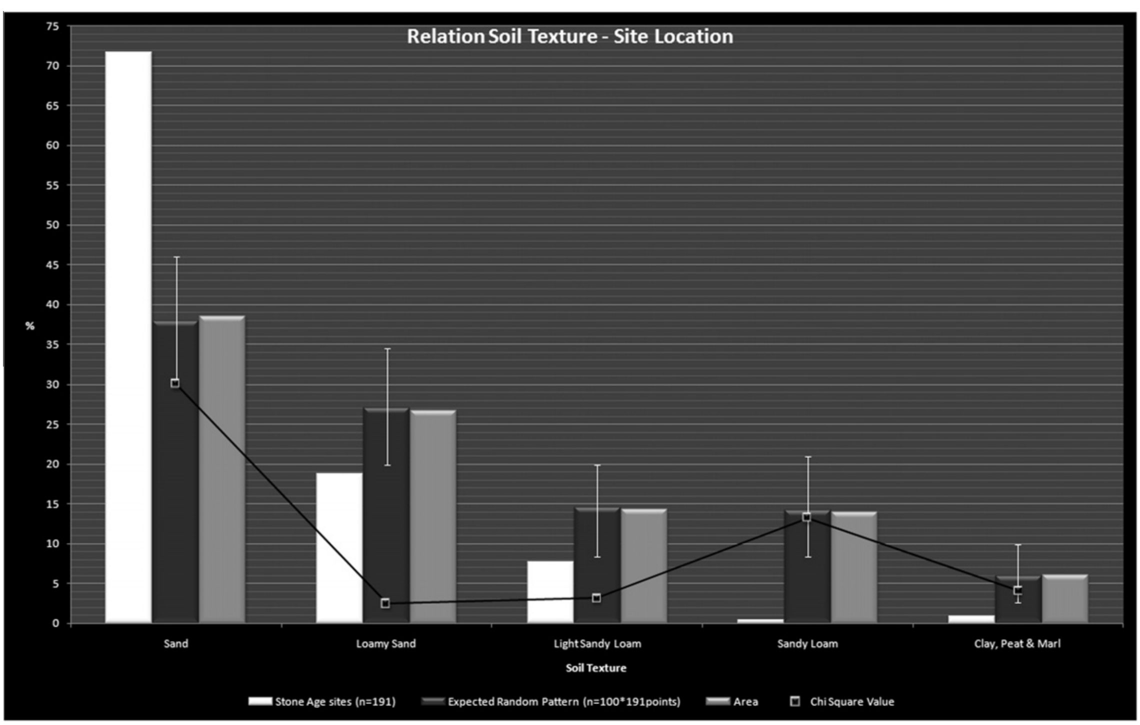

Fig. 8. Spatial analysis of soil texture of Stone Age sites in Sandy Flanders against 100 sets of random distributed points, indicating the preference for sandy soils for settlement location. The significance of the observed pattern is confirmed by a chi square test.

exploitation was the central area. Spatial analysis, by means of a GIS and statistical-based approach, of all prehistoric sites in relation to different environmental attributes (Fig. 7–10) clearly reveals that hunter–gatherers had a strong preference for settling their camp-sites on slightly higher positioned grounds preferably with a sandy (moderate) dry soil, within a distance of generally less than 200–300 m from open-water (lake border, river, etc.).

Investigation of diachronic variability in site distributions reveals some very interesting changes in land use from the Final Palaeolithic to the Final Mesolithic periods (Fig. 11–15). *Federmesser*

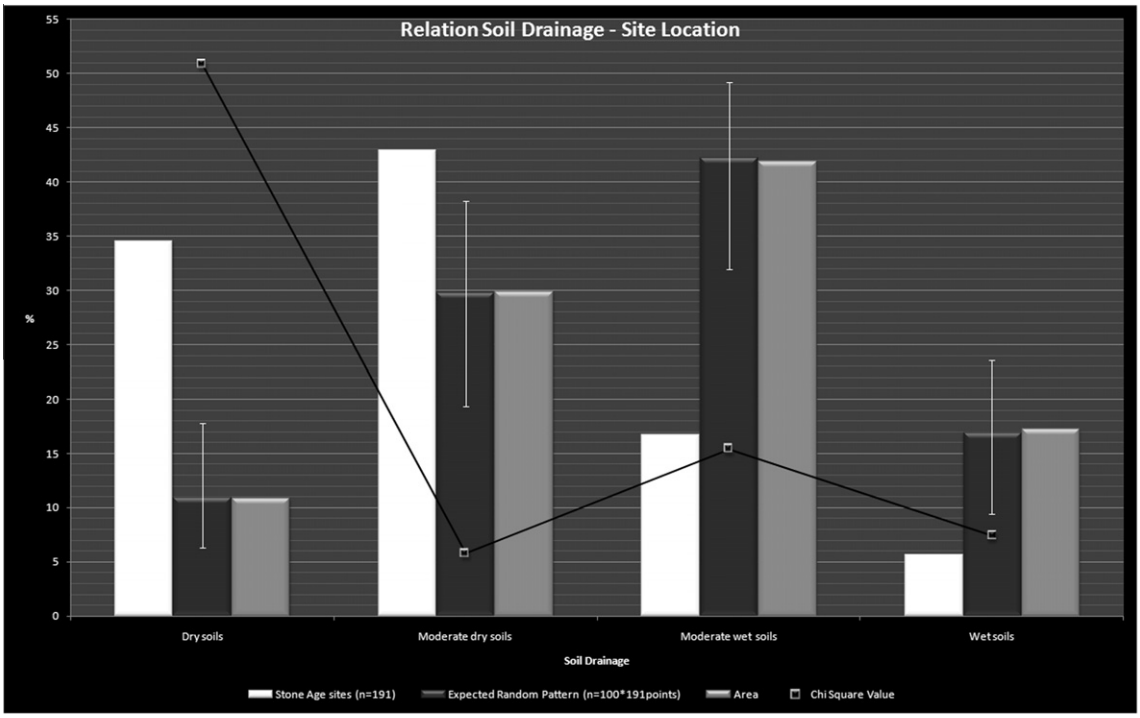

Fig. 9. Spatial analysis of soil drainage of Stone Age sites in Sandy Flanders against 100 sets of random distributed points, indicating the preference for dry and moderate dry soils for settlement location. The significance of the observed pattern is confirmed by a chi square test.

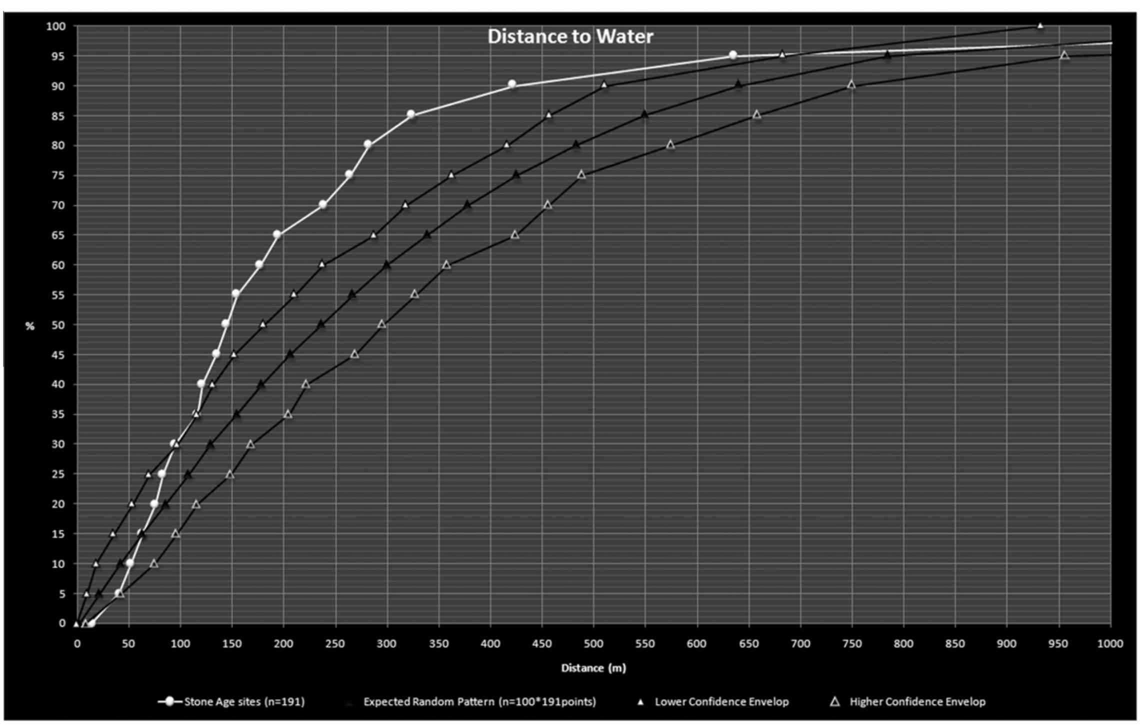

Fig. 10. Nearest neighbor analysis of the distance between Stone Age sites and open-water against 100 sets of random distributed points, indicating the clustered distribution of Stone Age sites in the near vicinity of open-water.

sites were distributed throughout the entire study-area, with a distance between sites of up to several kilometers (Figs. 11 and 16). A much denser occupation is attested along the northern dry bank of the extensive Late Glacial Moervaart lake; here *Federmesser* sites are located just a few hundred meters from each other. They form an almost continuous cluster of sites in a kind of site-complex stretching over 15 km; the interruption in the middle is caused by modern building (town of Moerbeke). The evidence clearly points to the fact that this former lake was an important component in the Late Glacial hunter–gatherer landscape, and formed one of the principal "central foci" or "persistent places" (Barton et al., 1995) within Sandy Flanders. The Moervaart lake

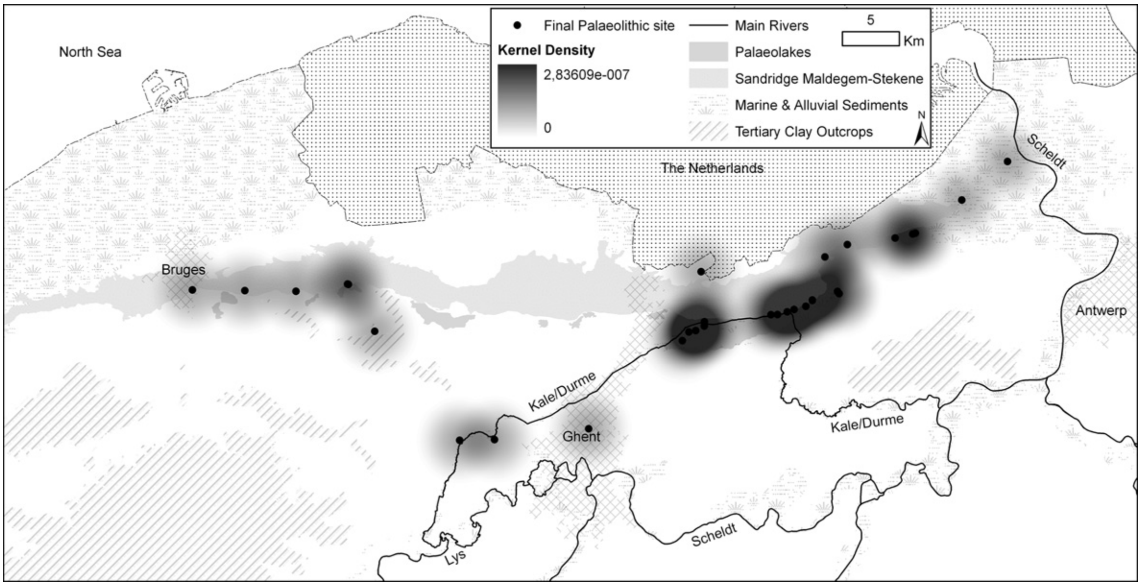

Fig. 11. Spatial distribution of Final Palaeolithic sites (*Federmesser* Culture) using kernel density estimates.

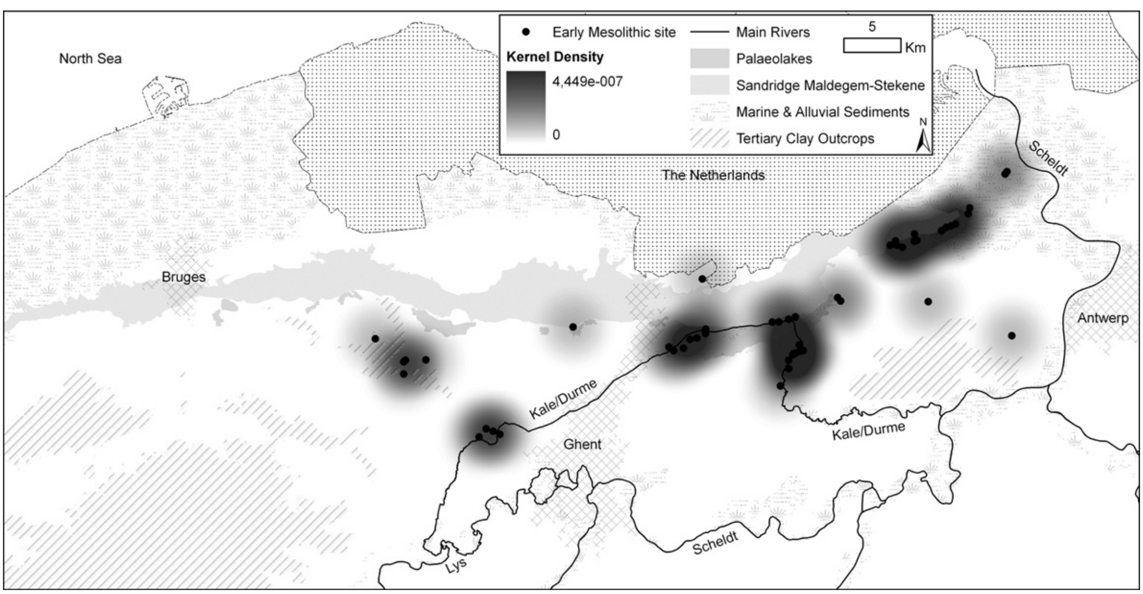

Fig. 12. Spatial distribution of Early Mesolithic sites using kernel density estimates.

represented one of the richest biotopes in terms of productivity, diversity and predictability within the area. The site-clustering might indicate either a higher frequency of site re-occupation by small groups, or a larger aggregation of small groups within the yearly cycles compared to elsewhere in Sandy Flanders. As a matter of fact the generally small size of the *Federmesser* assemblages throughout the study-area points to very temporary occupations, probably by small groups (cf. below). The lack of clear inter-site differences within the artifact and tool composition hints at only minor functional differences between these *Federmesser* sites.

The Early Mesolithic occupation pattern (Fig. 12 and 16) is very similar to the *Federmesser* one, except for the fact that dense and extensive site-complexes no longer occur along lake borders, as these were by that time already completely dried out. Site-complexes now appear on the dry banks of river systems, such as the Kale/Durme River and a possible fossil river system along the southern edge of the Great Ridge in the eastern part of the study-area (Waasland). During this period river banks became the seasonal focus of occupation in the settlement system. In the Waasland area an almost continuous series of small Early Mesolithic sites runs over a distance of ca. 8 km. Salvage excavation on some of these sites, e.g. at Verrebroek "Dok 1" (Crombé, 2005; Crombé et al., 2003, 2006) and Verrebroek "Aven Ackers" (Sergant et al., 2007; Crombé et al., 2009c) clearly indicate that this large site-complex results from long-term, seasonal re-occupation of the southern dune side over many hundreds of years. At Verrebroek "Dok 1" excavations over a total surface of 6210 m^2 yielded at least 55 artifact loci occupied diachronically over a period of ca.1 millennium, spanning the entire Early Mesolithic (Van Strydonck and Crombé, 2005). The generally small size of these loci (<20/25 m^2) probably indicates the presence of relatively small groups, who according to microwear analyses focused on hunting, and plant and hide processing (Beugnier and Crombé, 2005). The overall presence of carbonized hazelnut shells indicate that these

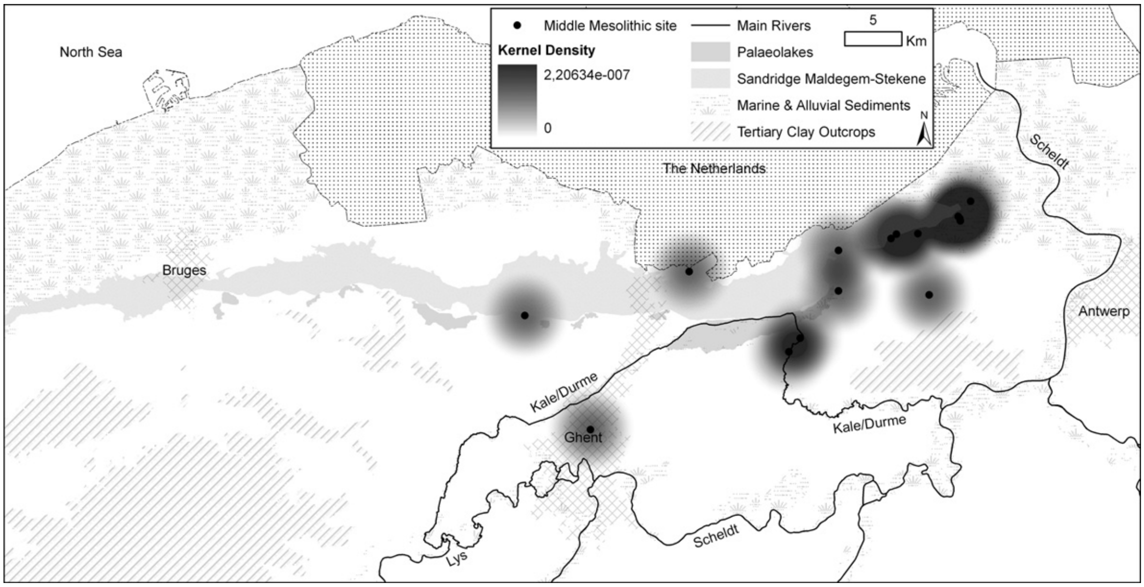

Fig. 13. Spatial distribution of Middle Mesolithic sites using kernel density estimates.

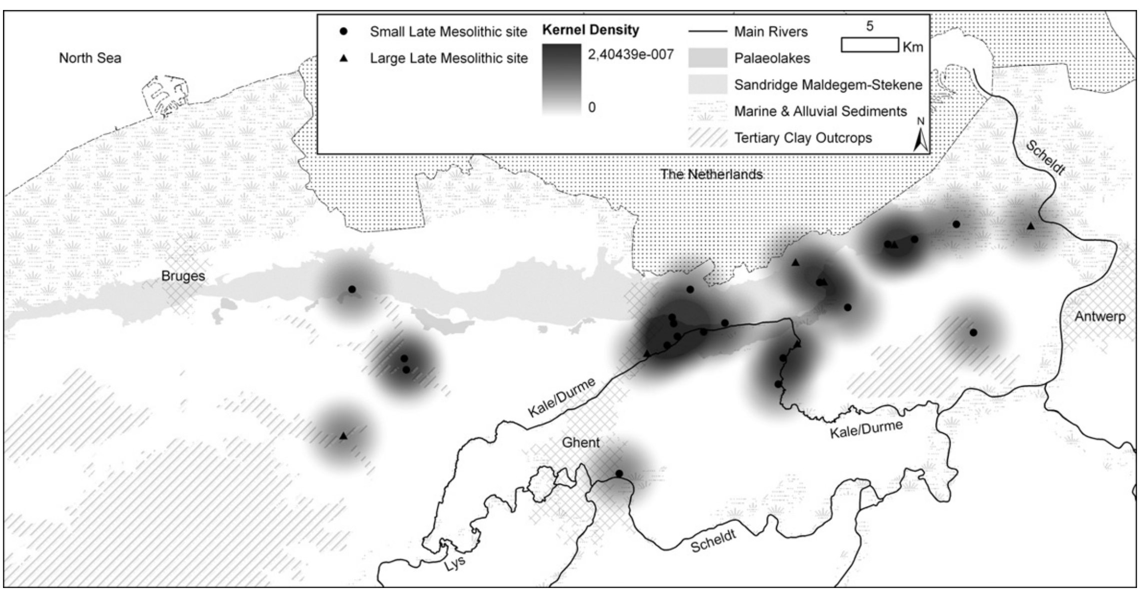

Fig. 14. Spatial distribution of Late Mesolithic sites using kernel density estimates. A distinction is made between small (<10 trapezes) and large sites (⩾15 trapezes).

activities were mainly performed during late summer or early autumn, although consumption of stored hazelnuts must be considered too. The overall picture that emerges from all these data is one of highly mobile Early Mesolithic groups of relatively small size (several families), who preferably settled along wet-dry gradients along waterways.

This settlement pattern contrasts sharply with that of the younger Mesolithic stages. Although river banks remain the most favored settlement locations, during the Middle (Fig. 13) and Late Mesolithic (Fig. 14) the site density drops considerably (Fig. 16). Typical site-complexes do not occur any longer, as camp-sites become more widely spaced. Simultaneously an important shift in the site location occurred, especially at the transition from the Early/Middle Mesolithic to the Late Mesolithic. Analysis indicates that there is much less re-occupation of old camp-sites in the Late Mesolithic (ca. 15%), compared to the Early (ca. 30%) and Middle Mesolithic (ca. 46%), suggesting that Late Mesolithic hunter–gatherers more often settled on locations which were not occupied in earlier Mesolithic stages. However, the environmental characteristics of the settlement locations (Fig. 17–19) did not change much through time, except that Middle and Late Mesolithic sites tend to be situated on somewhat lower and wetter grounds.

The above changes during the Late Mesolithic go together with a marked decrease in the number of small sites/assemblages (<10 microliths) compared to the Early Mesolithic (Fig. 20). Most of the small sites only yielded a few tools, e.g. trapezes and retouched blades, and no or only few knapping waste, suggesting a very brief and specialized use of these locations (e.g. as hunting stand, kill-site, etc.). At the same time the number of very large assemblages (>20 microliths) increases considerably (Fig. 20); these most likely represent settlements which were occupied much longer or were more frequently re-occupied. These larger sites occur at important nodal positions between the most dominant features in the landscape (Fig. 14), e.g. at the point where the Kale River enters

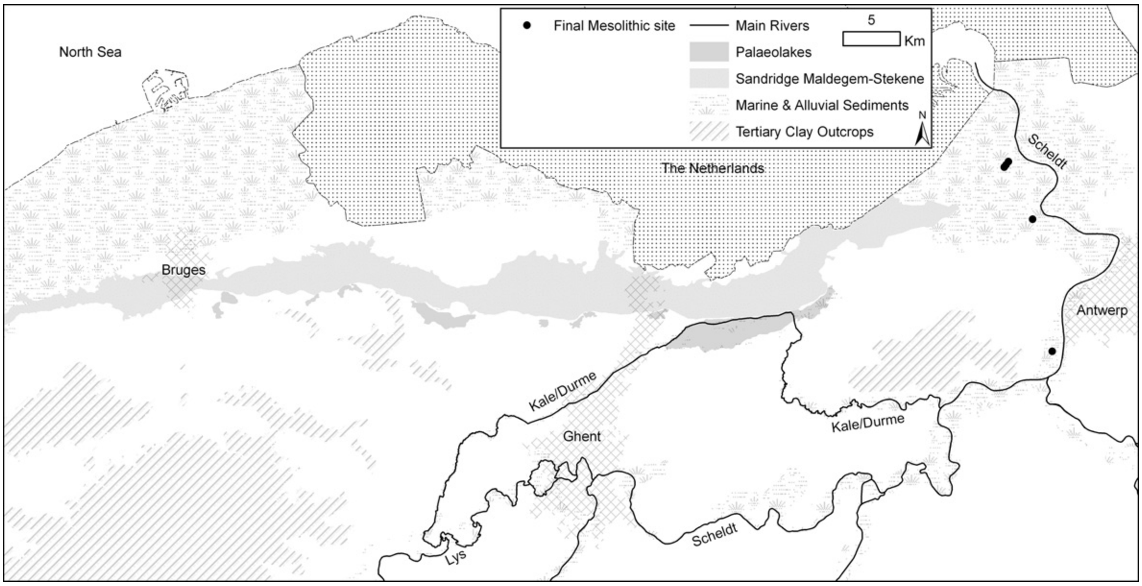

Fig. 15. Spatial distribution of Final Mesolithic sites (Swifterbant Culture).

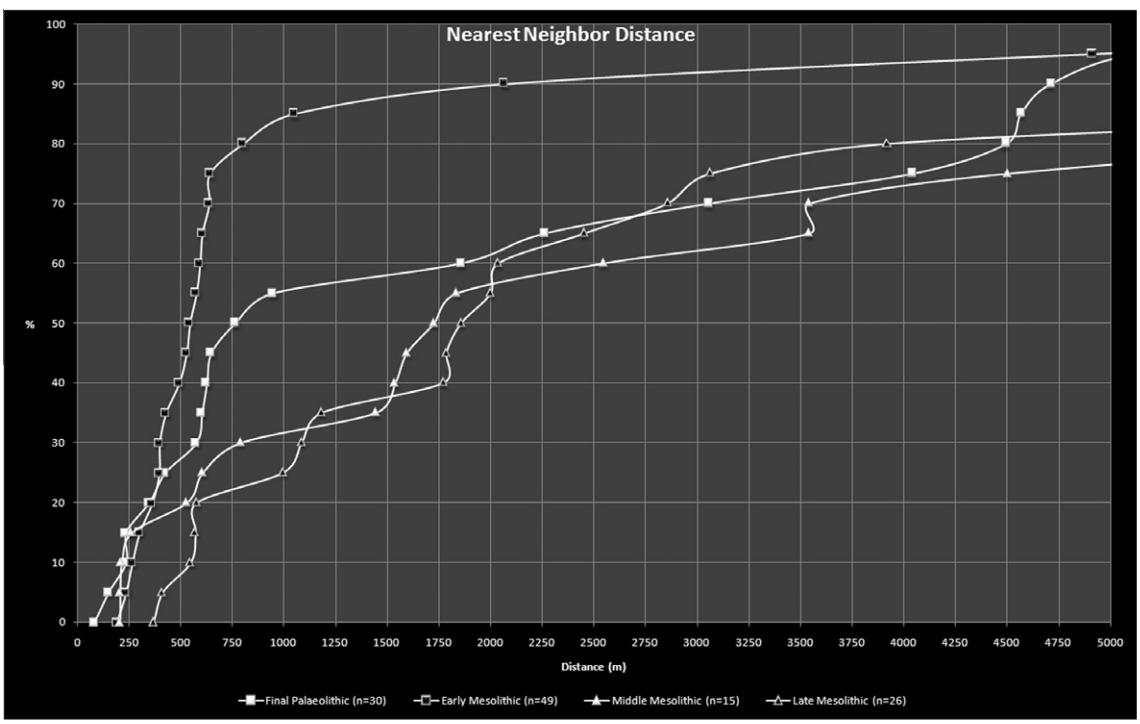

Fig. 16. Nearest neighbor analysis of all sites in Sandy Flanders for each chronological stage.

(Sint-Kruis-Winkel "Spanjeveer") and leaves (Eksaarde "Fondatie") the extensive Moervaart mire, at the northeastern outlet of the mire (Stekene "Molenberg") or on the top of a Tertiary hill (Aalter "Stratem"). In sum, the evidence clearly points to an important change in the settlement system within Sandy Flanders which might be connected with a change in the social organization and mobility of hunter–gatherers.

The settlement system of the Final (Swifterbant pottery) Mesolithic of the second half of the 5th millennium cal BC is currently difficult to analyze as only five sites are known in Sandy Flanders (Fig. 15). All of them are situated in the floodplain of the Scheldt River and were discovered during salvage excavations (Crombé et al., 2009b). So far no Swifterbant sites could be identified among the dryland surface sites, but according to some scholars (Raemaekers, 1999) this is due to taphonomy – it is claimed that soil acidity is responsible for the degradation of pottery – and the impossibility of discerning Late and Final Mesolithic lithic assemblages. Recent research has yielded results that contradict these earlier interpretations (Crombé and Sergant, 2008). In our opinion the Final Mesolithic testifies a further displacement of the occupation towards lower and wetter grounds, e.g. river fen-woods, which due to rising sea-level expanded rapidly in the lower Scheldt floodplain especially in the last decennium of the Atlantic period (Verbruggen et al., 1996). The dry interior was not inhabited any more or less

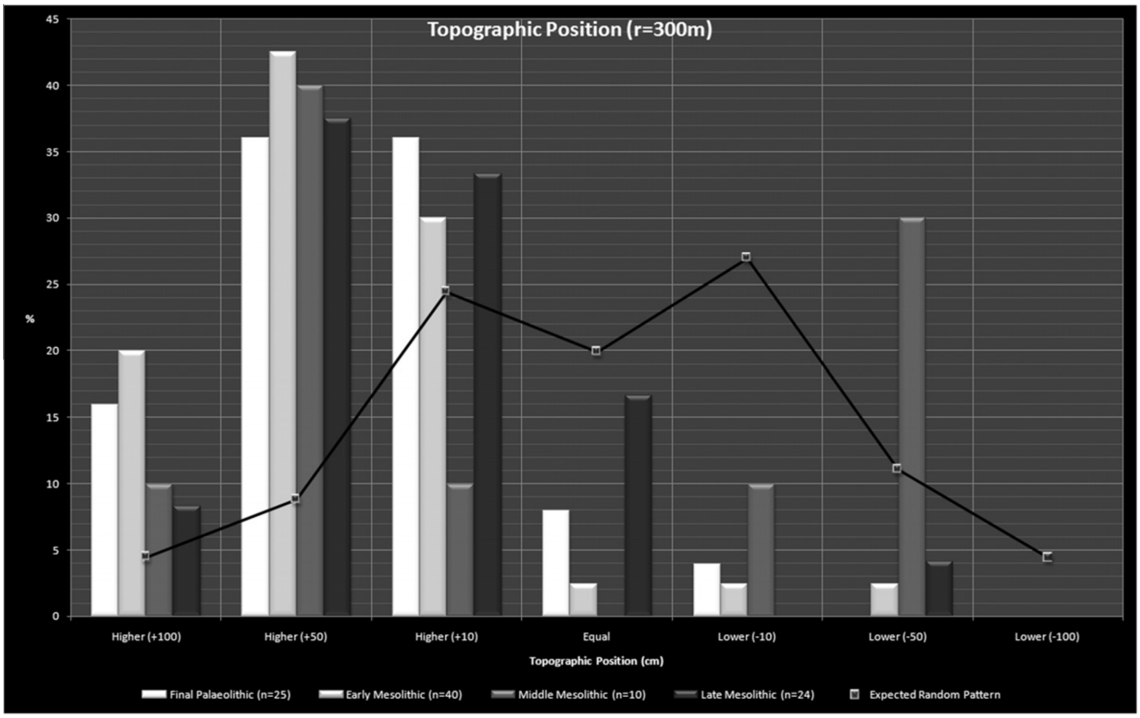

Fig. 17. Spatial analysis of the topographical position (difference between the height at the site location and the average height of the surrounding areas, in this case within a radius of 300 m) of sites for each chronological stage, compared with the expected ramdom pattern (generated out of 100 sets of random distributed points).

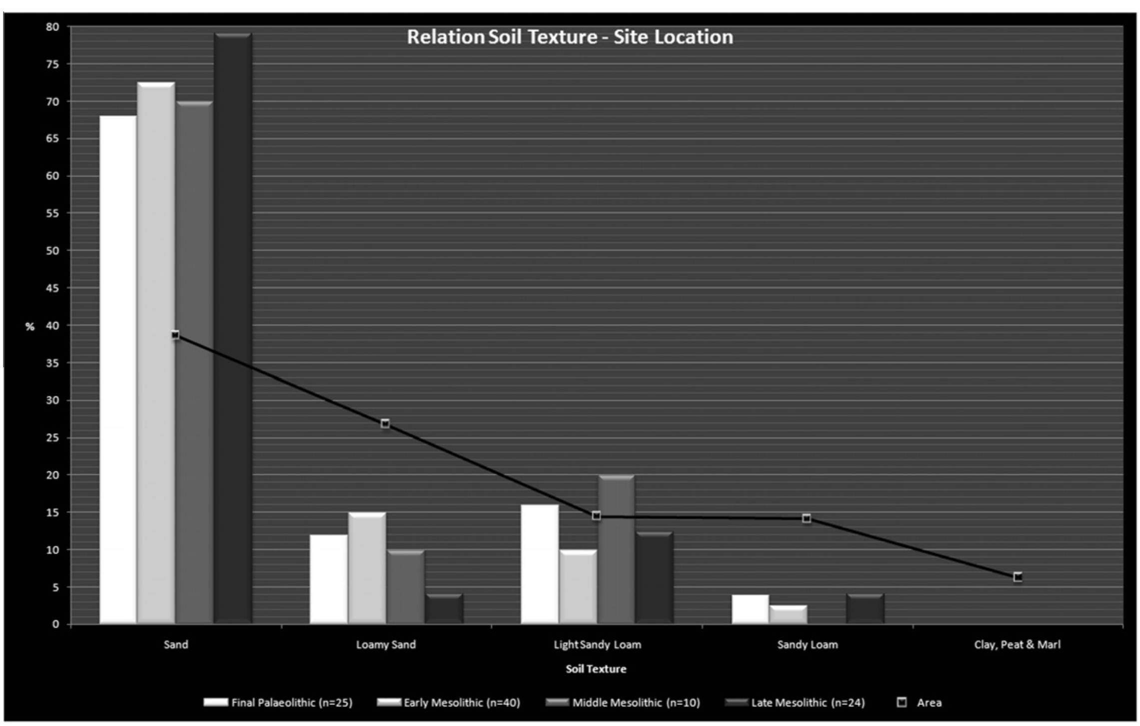

Fig. 18. Spatial analysis of soil texture of sites for each chronological stage, compared with the expected ramdom pattern (generated out of 100 sets of random distributed points).

frequently, but rather constituted the hinterland of the wetland sites. This further reduction in mobility is supported to a certain degree by recent microwear studies (Beugnier, 2007b), which found that Final Mesolithic tools generally yield more intense and combined use wear traces than Early Mesolithic tools, which possibly indicates prolonged use. Interestingly, the pattern of wear traces shows more affinities with what is usually observed on tools from Neolithic (semi)permanent settlements.

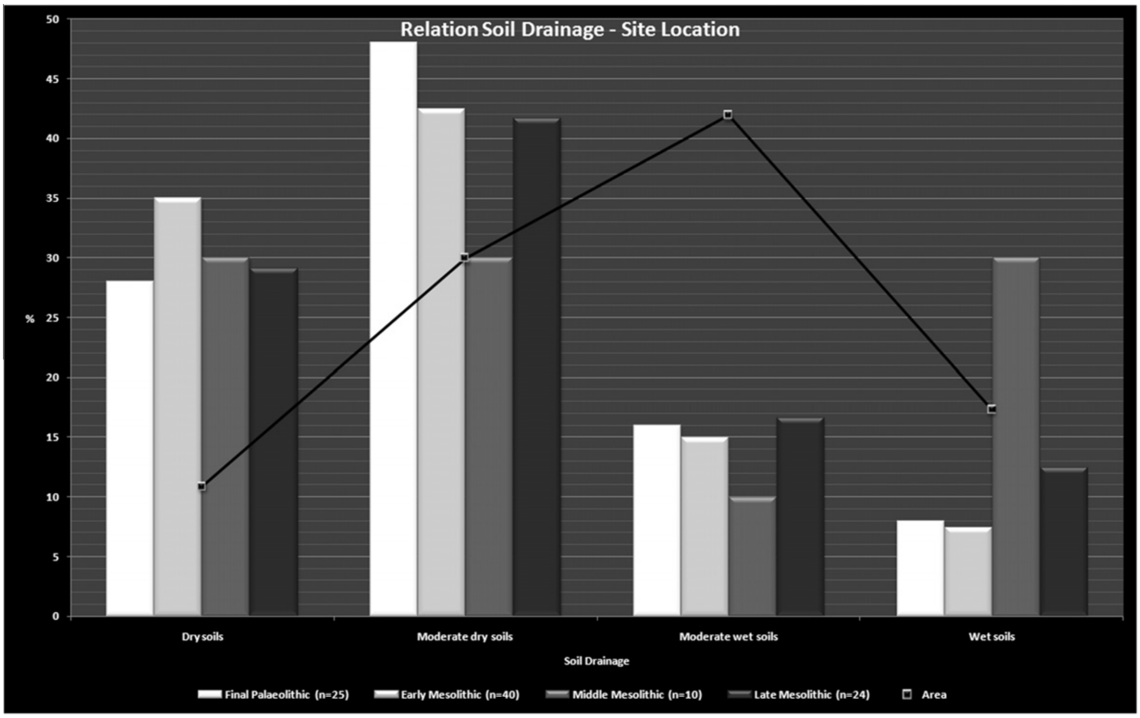

Fig. 19. Spatial analysis of soil drainage of sites for each chronological stage, compared with the expected ramdom pattern (generated out of 100 sets of random distributed points).

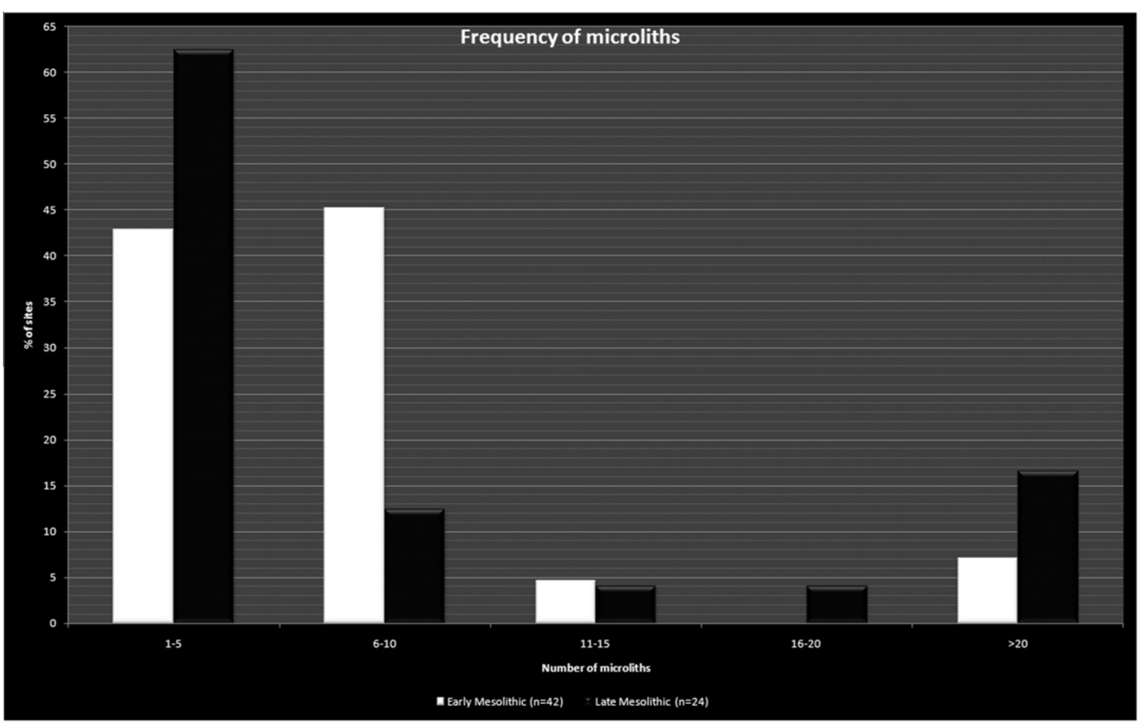

Fig. 20. Comparison of the size of lithic assemblages from the Early and Late Mesolithic based on the number of microliths.

Discussion

The gradual reduction in the number of sites and site density, together with changes in their geographical distribution are strong indications of changing land use between the *Federmesser*/Early Mesolithic and the Middle/Late/Final Mesolithic.

During the oldest stages mobility was very high, comprised of frequent displacements of camps and re-occupations of the same dunes over considerable time-spans. These findings are similar to the outcomes of research in other study-areas, e.g. in Central Europe (Jochim, 1998, 2006; Whittle, 1996; Fisher, 2006), where the Early Mesolithic is also characterized by highly mobile population and comparatively small group size. During the Late/Final Mesolithic mobility probably slowed down leading to prolonged and focused residential positioning of sites.

It is rather evident that the diachronic changes were due substantially to environmental changes, although other agencies (social, ritual, etc.) certainly must have played a role too (Robinson, 2007, 2010a). The rather uniform settlement pattern during the Late Glacial Allerød interstadial and Early Holocene might be explained by the environmental uniformity between both stages, despite a break in local conditions and occupation during the Younger Dryas. Except for the disappearance of nearly all lakes, no dramatic environmental differences can be observed between the Allerød interstadial and the Preboreal/Early Boreal. The vegetation cover were largely the same; in both stages a relatively open forest with birch and pine as principal tree species occurred; the only difference is the presence of hazel in the Holocene vegetation. Similarly, fauna would not have differed much between both stages; Allerød and Preboreal/Early Boreal faunal assemblages in NW Europe are mainly composed of temperate-boreal (thermophilous) species, such as aurochs, red and roe deer and elk (Street and Baales, 1999; Benecke, 2004; Valentin, 2008; Ducrocq et al., 2008). Horse is only present in Allerød and early Preboreal assemblages, while wild boar only appears from the Preboreal onwards. The unpredictable, dispersed character of these large to medium-sized mammals might have forced hunter–gatherers to move almost continuously through the landscape. High residential mobility also characterizes recent hunter–gatherer groups living in a forest boreal environment, such as the Onas, Micmacs and Montagnais, (Kelly, 1995, pp. 123–125; Houtsma et al., 1996, pp. 68–73; Wilmsen, 1973).

It is commonly accepted that with the appearance of deciduous tree species the forest got gradually denser leading to a darker and more closed environment, unfavorable for large game and dense undergrowth (for recent overview see Svenning (2002)). These were forced to move towards the limited open zones, e.g. forest edges and wetlands/floodplains (Waterbolk, 1968; Iversen, 1973; Paludan-Müller, 1987; Spikins, 1999). This change from dispersed to more clustered resources might have been the main reason for reduced mobility during the Atlantic/Late and Final Mesolithic. An increasing emphasis on aquatic resources may have also played a prominent role. Two Final Mesolithic sites in the Scheldt floodplain – Doel "Deurganckdock" sector B and M – have yielded, besides mammal bones, numerous fish remains mainly from freshwater species (Van Neer et al., 2005). Although the absence of fish remains on earlier sites might have been caused by taphonomy, the sites of Doel prove the importance of aquatic resources in Final Mesolithic subsistence. From ethnography it is well known that residential moves gradually reduce when dependence on aquatic resources is increasing (Kelly, 1995).

Clearly Sandy Flanders does not represent the entire exploitation area of (micro)bands. According to ethnographic data (Houtsma et al., 1996, pp. 78–72; Kelly, 1995) the annual territory or group territory in forested environments frequently encompasses >3000–5000 km^2. Extensions to the west and north in the direction of the North Sea basin must have been rather limited, certainly from the Middle Mesolithic onwards as the sea water level was rising rapidly (Van de Plassche, 1982; Kiden, 1991). Territorial extensions in a southern and (north)eastern direction are not hindered by natural boundaries. Distribution patterns of raw materials might inform us about former migration routes and socio-cultural landscape boundaries, if raw material procurement was imbedded in the basic subsistence practice (Binford, 1979; Rensink, 1995) and was not part of social interaction and exchange. Although raw material used in the *Federmesser* and Mesolithic is mainly of local origin, some "exotics" seem to have been in use.

During the *Federmesser* stage a fine-grained black to darkbrown flint was frequently brought into Sandy Flanders (Fig. 21); although its exact origin is still debated, a recent micropalaeontological analysis using dinoflagellates (Verhoeven, 2002) points to outcrops in western Hainault (Formation of Obourg) some 80 km further south (Fig. 22.1) and in the Meuse valley 120–130 km to the east (Formation of Zeven Wegen) of Sandy Flanders (Fig. 22.3). Whether one or both outcrops were visited remains

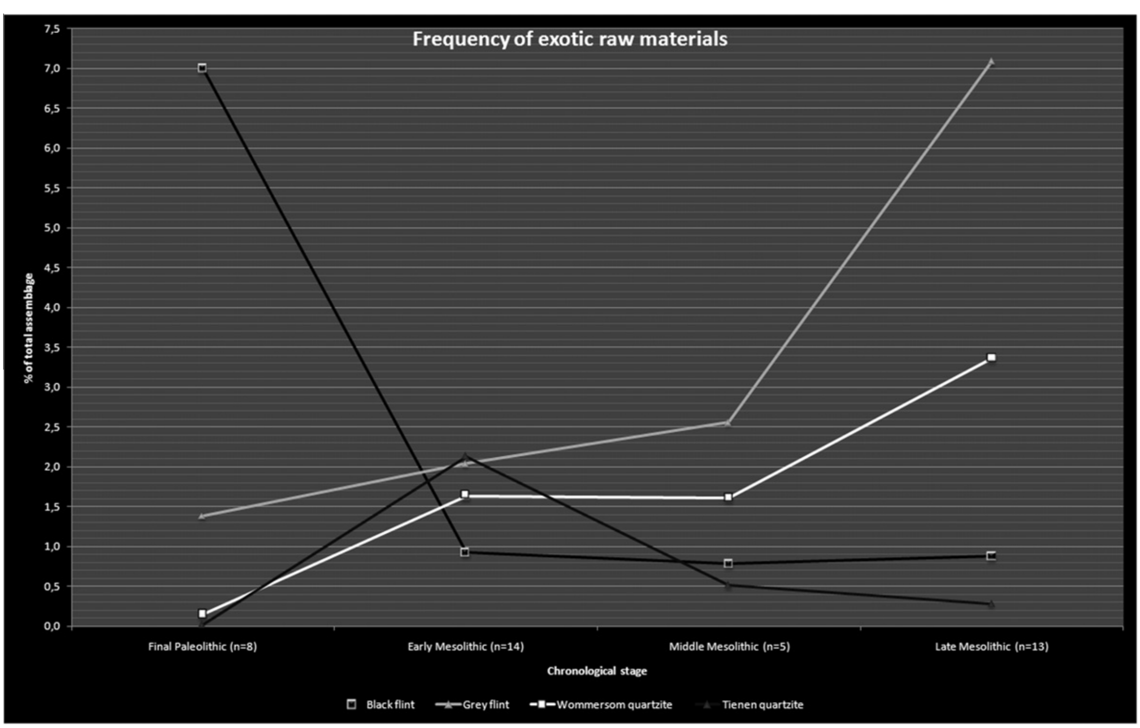

Fig. 21. Diachronic mean frequency of exotic raw materials in Sandy Flanders.

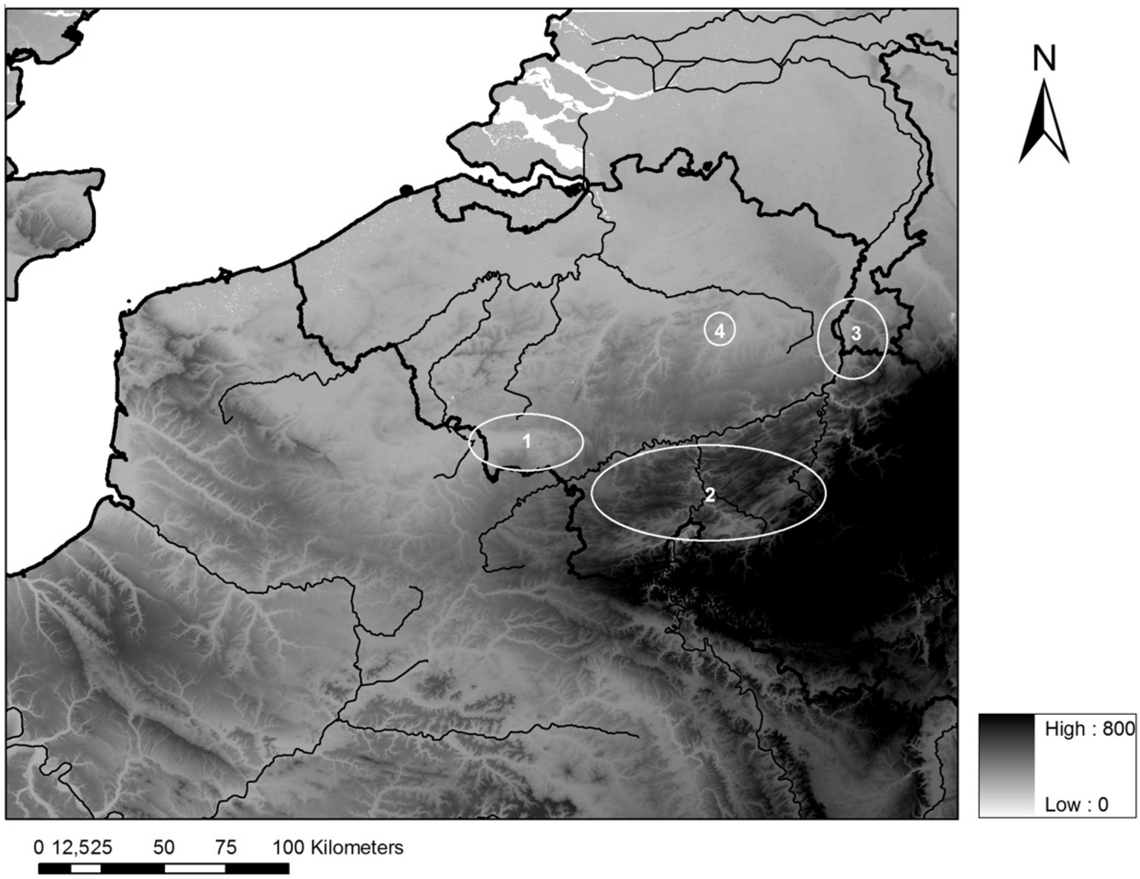

Fig. 22. Distribution of outcrops for exotic raw materials found in Sandy Flanders.

unclear, but the fact that apparently similar flint is also currently found on *Federmesser* sites in the Campine area of northern Belgium (De Bie and Vermeersch, 1998) and southern Netherlands (Deeben and Rensink, 2005, p. 183), sometimes as principal raw material (e.g. at Geldrop 3–4), favors a procurement from the Meuse valley. However, further analysis is needed in order to confirm if the fine-grained black flint found in these different regions really is identical.

Mobility during the Mesolithic on the other hand rather seems to be oriented towards the south and southeast. Throughout the different stages of the Mesolithic local flint has been supplemented with mostly small amounts of quartzites (Fig. 21), in casu Wommersom (WSQ) and Tienen quartzites (TQ), originating from outcrops situated ca. 70–80 km in southeastern direction into the hilly uplands (Gendel,1984; Perdaen et al., 2009a) (Fig. 22.4). Although some scholars link this with exchange networks (Gendel, 1984) or prehistoric "trade" organized by specialized migrating quartzite knappers (Huyge, 1987), in our opinion based on the relatively short distances involved, the distribution of these quartzites was mainly embedded in basic subsistence practices of mobile groups which visited the outcrop area during seasonal migration patterns. Interesting in this context is the fact that during the Early Mesolithic TQ was preferably moved to Sandy Flanders, while WSQ became important only from the Middle Mesolithic onwards in the disadvantage of TQ (Crombé, 1998; Perdaen et al., 2009a). The reason(s) for this shift in exotic raw material is not yet clear, but might have to do with changes in territoriality (cf. Crombé et al., 2008; Robinson, 2010a) linked to the inundation of the North Sea basin and the loss of former occupation areas. Another kind of exotic raw material found at several Mesolithic sites in Sandy Flanders are "plaquettes", used for polishing bone objects (Hamon, 2009), which are made of different kinds of sandstones. Some sandstones are from local origin, but there are also foreign sandstones which originate from distant areas, such as the Ardennes in southeast Belgium more than 100–120 km away (Fig. 22.2). It is questionable whether these raw materials were also directly procured. Given the greater distance one might consider an exchange with hunter–gatherer populations living in the Ardennes. The fact that these groups also used WSQ (Gob, 1981) might indicate that the outcrop area of WSQ (Fig. 22.4) was an important contact area for different local bands. Indeed, also bands living to the north of the outcrop, in the Belgian and Dutch Campine area, made use of WSQ (Huyge, 1987; Verhart and Arts, 2005). All these WSQ using bands, each living in their own territory separated by major river valleys (Scheldt, Meuse and Rhine), might have belonged to a specific cultural/technological transmission network covering an area of ca. 45,000 km^2.

If the yearly exploitation area of the hunter–gatherers living in Sandy Flanders included the upland area around TQ and WSQ, the seasonality of the migration must be questioned. Tool-typology as well as microwear analysis suggests little functional variability between the Mesolithic sites in Sandy Flanders, which might be an indirect indication of a seasonal exploitation of the area. If this is the case occupation during the warmer months of the year seems to be most likely. However, this hypothesis is based only on the occurrence of hazelnut shells on most Mesolithic sites (cf above; Crombé, 1998; Crombé et al., 2009a). Further seasonal information is not available as organic evidence is almost entirely lacking, except for the Final Mesolithic Swifterbant sites in the Scheldt floodplain. Faunal and plant remains on these sites suggest occupations during spring, (late) summer and (early) autumn (Bastiaens et al., 2005; Van Neer et al., 2005). Yet, activities in other seasons cannot be fully excluded, as the evidence is based on carbonized remains only. An additional, though indirect indication of occupation mainly during the warmer months is the abundance of plant processing traces on lithic artifacts from many sites in Sandy Flanders (Beugnier and Crombé, 2005; Beugnier, 2007a). Although the exact plant species cannot be determined yet (reeds, rushes, cattail,...), these artifacts were clearly involved in the processing of plant material, mainly scraping, in order to make relatively small objects, e.g. arrow shafts, basketry, nets or fibers for producing cordage or even textile, and not for harvesting plants for consumption (Beugnier, 2007a; Hardy, 2007; Hurcombe, 2007). For these purposes fresh plant material was needed which was only available during the warmer months. Direct seasonal information is also lacking for the supposed winter occupation area in the upland TQ and WSQ region, hence a further testing of our hypothesis is not really possible.

Probably from the Middle Mesolithic but definitely from the Late Mesolithic the flint procurement changed markedly. Compared to the Early Mesolithic a higher frequency and a greater variety of exotic, good quality flint types was introduced into Sandy Flanders, either as complete nodules or as (semi-)finished artifacts (mainly blades). Although the exact origin of these exotics has not yet been identified with certainty, it can be reasonably assumed that most of them come from southern flint rich regions within the Scheldt basin, such as the chalk areas of western Hainaut (Fig. 22.1) and northern France (Picardie), where flint mining started later in prehistory. One of the most "popular" flint types imported into Sandy Flanders is a medium-grained greyish flint with light spots (Fig. 21; average 7.17%). The occurrence of cores and numerous cortical artifacts on several Late Mesolithic sites points at transport as complete nodules. In the current state of analysis it is not possible to determine how these exotic flint types were moved to Sandy Flanders, but it is clear that both inter- and intra-regional exchange and procurement systems got more complex from the Late Mesolithic onwards (Robinson, 2010a). The reason(s) for this increased importance of exotic raw materials in Late Mesolithic hunter–gatherer communities within Sandy Flanders might have been purely practical /technological, e.g. a need for good quality flint in order to produce long and regular blades for microlith (trapeze) production. As a matter of fact the change in raw material procurement coincides perfectly with an important change in knapping technology, from irregular bladelet (Coincy) to regular blade (Montbani) technology. The demand for exotic raw materials might have stimulated and triggered inter-regional contact over longer distances and on a more frequent basis than earlier in the Mesolithic. Inter-regional contact became increasingly important towards the end of the Mesolithic, when hunter–gatherers of the 5th millennium came into contact with the first farmer communities of the loess belt, leading to the transmission of technological knowledge related to first pottery manufacturing and later crop cultivation and stock-breeding (Crombé and Vanmontfort, 2007; Crombé et al., 2009b; Robinson, 2010a,b).

Conclusion

Investigations of hunter–gatherer land use from the Late Glacial-Final Mesolithic in northwest Belgium have yielded important first-steps in the study of human responses to environmental change during the Pleistocene–Holocene transition in the southern North Sea basin. While site densities decreased and site sizes increased from the Late Glacial-Final Mesolithic, hunter–gatherers in this region continued to prefer river banks for setting up sites, with the only difference being in the move in the later Mesolithic to lower and wetter locations along the river banks. The most striking change from the Late Glacial–Final Mesolithic is the increasingly structured spacing of sites and the lack of re-occupation of previous sites through time. Despite these diachronic changes seeming to fit nicely into the evolutionary assumptions of the forager–collector model, the lack of subsistence data and the complex nature of the surface scatter assemblages require much further study. The contrast between the diachronic land use trajectories of Sandy Flanders and the southern Netherlands (Verhart, 2008) undoubtedly requires much further analysis due to the importance of this contrast for considerations of the spatial and temporal ranges of variability in mobility and social interaction during the Mesolithic (cf. Lovis et al., 2006a,b). This study has indicated that along the southern North Sea basin there were different inter-regional responses made by hunter–gatherers to environmental change at the Pleistocene–Holocene transition. Further analyses are required in order to determine whether these different responses were in fact made by different band-level hunter–gatherer groups, or the same group carrying out different mobility strategies within different landscapes.

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Appendix A. Supplementary material

Supplementary data associated with this article can be found, in the online version, at doi:10.1016/j.jaa.2011.04.001.

References

Bailey, G.N., 2007. Time perspectives, palimpsests and the archaeology of time. Journal of Anthropological Archaeology 26, 198–223.

Barton, R.N.E., Berridge, P.J., Walker, M.J.C., Bevins, R.E., 1995. Persistent places in the Mesolithic landscape: an example from the Black Mountain uplands of South Wales. Proceedings of the Prehistoric Society 61, 81–116.

Bastiaens, J., Deforce, K., Klinck, B., Meersschaert, L., Verbruggen, C., Vrydaghs, L., 2005. Palaeobotanical analyses. In: Crombé, P. (Ed.), The Last Hunter–Gatherer–Fishermen in Sandy Flanders (NW Belgium): the Verrebroek and Doel Excavation Projects. Part 1: Palaeo-environment, Chronology and Features, Gent, pp. 251–278 (Archaeological Reports Ghent University 3).

Bats, M., 2007. The Flemish Wetlands: an archaeological survey of the valley of the river Scheldt. In: Barber, J., Clark, C., Cressey, M., Crone, A., Hale, A., Henderson, J., Housley, R., Sands, R., Sheridan, A. (Eds.), Archaeology from the Wetlands: Recent Perspectives. Proceedings of the 11the WARP Conference, Edinburgh 2005. Society of Antiquaries of Scotland, Edinburgh, pp. 93–100 (WARP Occasional Paper 18).

Bats, M., De Reu, J., De Smedt, Ph., Antrop, M., Bourgeois, J., Court-Picon, M., De Maeyer, Ph., Finke, F., Van Meirvenne, M., Verniers, J., Werbrouck, I., Zwertvaegher, A., Crombé, P., 2009. Geoarchaeological research of the large palaeolake of the Moervaart (municipalities of Wachtebeke and Moerbeke-Waas, East Flanders, Belgium): from Late Glacial to Early Holocene. Notae Praehistoricae 29, 105–112.

Bats, M., De Reu, J., De Smedt, Ph., Antrop, M., Bourgeois, J., Court-Picon, M., De Maeyer, Ph., Finke, F., Van Meirvenne, M., Verniers, J., Werbrouck, I., Zwertvaegher, A., Crombé, P., 2010. Continued geoarchaeological research at the Moervaart palaeolake area (East Flanders, Belgium): preliminary results. Notae Praehistoricae 30, 55–61.

Baxter, M.J., Beardah, C.C., 1996. Beyond the histogram. Improved approaches to simple data display in archaeology using kernel density estimates. Archeologia e Calcolatori 7, 397–408.

Baxter, M.J., Beardah, C.C., Wright, R.V.S., 1997. Some archaeological applications of Kernel density estimates. Journal of Archaeological Science 24, 347–354.

Benecke, N., 2004. Faunal succession in the lowlands of northern Central Europe at the Pleistocene–Holocene transition. In: Terberger, Th., Eriksen, B.V. (Eds.), Hunters in a Changing World. Environment and Archaeology of the Pleistocene–Holocene Transition (ca. 11000–9000 cal BC) in Northern Central Europe. Internationale Archäologie, Kongress 5, pp. 43–51.

Beugnier, V., 2007a. Préhistoire du travail des plantes dans le nord de la Belgique. Le cas du Mésolithique ancien et du Néolithique final en Flandre. In: Beugnier, V., Crombé, P. (Eds.), Plant Processing from a Prehistoric and Ethnographic Perspective/Préhistoire et Ethnographie du Travail des Plantes. Proceedings of a Workshop at Ghent University (Belgium) (November 28, 2006). John & Erica

Hedges Ltd., Oxford, pp. 23–40 (=British Archaeological Reports, International Series 1718).
Beugnier, V., 2007b. Etude Tracéologique du Matériel Swifterbant du site de Doel, Secteur B (Belgique). Unpublished Internal Report, Ghent University.
Beugnier, V., Crombé, P., 2005. Etude fonctionnelle du matériel en silex du site Mésolithique ancien de Verrebroek (Flandres, Belgique): premiers résultats. Bulletin de la Société Préhistorique Française 102 (3), 527–538.
Binford, L.R., 1979. Organization and formation processes: looking at curated technologies. Journal of Anthropological Research 35 (3), 255–273.
Binford, L.R., 1980. Willow smoke and dog's tails: hunter–gatherer settlement systems and archaeological site formation. American Antiquity 45, 4–20.
Crombé, P., 1998. The Mesolithic in Northwestern Belgium. Recent Excavations and Surveys. Oxford, Archaeopress (BAR International Series, 716).
Crombé, P., 1999. Vers une nouvelle chronologie absolue pour le Mésolithique en Belgique. In: Thévenin, A. (Ed.), L'Europe des derniers chasseurs épipaléolithique et mésolithique. peuplement et paléoenvironnement de l'Epipaléolithique et du Mésolithique, Actes du 5° Congrès International UISPP, Grenoble, 18–23/09/1995, pp. 189–199.
Crombé, P. (Ed.), 2005. The Last Hunter–Gatherer–Fishermen in Sandy Flanders (NW Belgium). The Verrebroek and Doel Excavation Projects, vol. I. Ghent University, Gent.
Crombé, P., 2006. The wetlands of sandy Flanders (Northwest Belgium): Potentials and prospects for prehistoric research and management. In: Rensink, E., Peeters, H. (Eds.) Preserving the Early Past. Investigation, Selection and Preservation of Palaeolithic and Mesolithic Landscapes. Rijksdienst voor het Oudheidkundig Bodemonderzoek, Amersfoort (=Nederlandse Archeologische Rapporten, 31), pp. 41–54.
Crombé, P., Sergant, J., 2008. Tracing the Neolithic in the sandy lowland of Belgium: the evidence from Sandy Flanders. In: Fokkens, H., Coles, B., van Gijn, A., Kleijne, J., Ponjee, H., Slappendel, C. (Eds.), Between Foraging and Farming. An Extended Broad Spectrum of Papers Presented to Leendert Louwe Kooijmans, Leiden, Analecta Praehistorica Leidensia, vol. 40, pp. 75–84.
Crombé, P., Vanmontfort, B., 2007. The neolithisation of the Scheldt basin in western Belgium. In: Whittle, A., Cummings, V. (Eds.), Proceedings of the Conference "Going Over: The Mesolithic–Neolithic Transition in North-west Europe", Cardiff (16–18 May 2005). Proceedings of the British Academy Press, vol. 144. Oxford University Press, pp. 261–283.
Crombé, P., Verbruggen, C., 2002. The Lateglacial and early Postglacial occupation of northern Belgium: the evidence from Sandy Flanders. In: Eriksen, B.V., Bratlund, B. (Eds.), Recent Studies in the Final Palaeolithic of the European Plain, Proceedings of a UISPP Symposium, Stockholm, pp. 165–180 (14–17 October 1999) (=Jutland Archaeological Society Publications).
Crombé, P., Deforce, K., Langohr, R., Louwagie, G., Perdaen, Y., Sergant, J., Verbruggen, C., 1999. A small Final Palaeolithic knapping site at Verrebroek "Dok 2" (Flanders, Belgium). Notae Praehistoricae 19, 63–68.
Crombé, P., Perdaen, Y., Sergant, J., Van Roeyen, J.-P., Van Strydonck, M., 2002. The Mesolithic–Neolithic transition in the sandy lowlands of Belgium: new evidence. Antiquity 76, 699–706.
Crombé, P., Perdaen, Y., Sergant, J., 2003. The site of Verrebroek "Dok" (Flanders, Belgium): spatial organisation of an extensive early mesolithic settlement. In: Larsson, L., Kindgren, H., Knutsson, K., Loeffler, D., Akerlund, A. (Eds.), Mesolithic on the Move: Papers presented at the Sixth International Conference on the Mesolithic in Europe, Stockholm. Oxbow Books Ltd., Oxford, pp. 205–215 (2000)
Crombé, P., Perdaen, Y., Sergant, J., 2006. Extensive artefact concentrations: single occupations or palimpsests? The evidence from the Early Mesolithic site of Verrebroek "Dok" (Belgium). In: Kind, C.J. (Ed.), After the Ice Age Proceedings of the International Conference, Rottenburg, pp. 237–243 (9–12 September 2003).
Crombé, P., Perdaen, Y., Sergant, J., 2008. Le Mésolithique ancien dans l'ouest de la Belgique: Quelques réflexions concernant l'occupation du territoire. In: Fagnart, J.-P., Thévenin, A., Ducrocq, Th., Souffi, B., Coudret, P. (Eds.), Le début du Mésolithique en Europe du Nord-Ouest. Actes de la table ronde d'Amiens, Paris, Mémoires de la Société Préhistorique Française XLV, pp. 193–204 (9 et 10 octobre 2004).
Crombé, P., Van Strydonck, M., Boudin, M., 2009a. Towards a refinement of the absolute (Typo)chronology for the Early Mesolithic in the Coversand Area of Northern Belgium and the Southern Netherlands. In: Crombé, Ph., Van Strydonck, M., Sergant, J., Boudin, M., Bats, M. (Eds.), Proceedings of the International Congress Chronology and Evolution in the Mesolithic of North-West Europe. Cambridge Scholar Publishing, Brussels, pp. 95–112 (May 30 till June 1 2007).
Crombé, P., Sergant, J., Perdaen, Y., 2009b. The neolithisation of the Belgian lowlands: new evidence from the Scheldt Valley. In: McCartan, S.B., Schulting, R., Warren, G., Woodman, P. (Eds.), Mesolithic Horizons. Papers presented at the Seventh International Conference on the Mesolithic in Europe, Belfast. Oxbow books, Oxford, pp. 564–569 (2005).
Crombé, P., Sergant, J., Lombaert, L., Van Strydonck, M., Boudin, M., 2009c. The Mesolithic and Neolithic site of Verrebroek – Aven Ackers (East Flanders, Belgium): the radiocarbon evidence. Notae Praehistoricae 29, 15–21.
Crombé, P., Boudin, M., Van Strydonck, M., 2011. Swifterbant pottery in the Scheldt basin and the emergence of the earliest indigenous pottery in the sandy lowlands of Belgium. In: Carnap-Bornheim, C.L., Hartz, S., Lüth, F., Terberger, Th. (Eds.), The Earliest Pottery in the Baltic–Dating; Origin and Social Context. Berichte der Römisch-Germanische Kommission, Mainz, pp. 465–483.
Crombé, Ph., Deeben, J., Van Strydonck, M., in press. Hunting in a changing environment: the transition from the Younger Dryas to the (Pre)boreal in Belgium and the southern Netherlands. In: Naudinot, N., Michel, S. (Eds.), Actes du XXVIIe Congrès Préhistorique de France, Transitions, Ruptures et Continuité durant la Préhistoire, Bordeaux-Lez Eyzies, Mémoires de la Société Préhistorique Française (31 mai–5 juin 2010).
De Bie, M., Vermeersch, P.M., 1998. Pleistocene–Holocene transition in Benelux. Quaternary International 49 (50), 29–43.
De Moor, G., Heyse, I., 1978. De morfologische evolutie van de Vlaamse Vallei. De Aardrijkskunde 4, 343–375.
Deeben, J., Rensink, E., 2005. Het Laat-Paleolithicum in Zuid-Nederland. In: Deeben, J., Drenth, E., van Oorsouw, M.-F., Verhart, L. (Eds.), De Steentijd van Nederland, Archeologie, vol. 11/12, pp. 171–199.
Deforce, K., Gelorini, V., Verbruggen, C., Vrydaghs, L., 2005. Pollen and phytolith analyses. In Crombé, Ph. (Ed.), The Last Hunter–Gatherer–Fishermen in Sandy Flanders (NW Belgium). The Verrebroek and Doel Excavation Projects, vol. I. Ghent University, Gent, pp. 108–126 (=Archaeological Reports Ghent University 3).
Denys, L., Verbruggen, C., Kiden, P., 1990. Palaeolimnological aspects of a Late-Glacial shallow lake in Sandy Flanders, Belgium. Hydrobiologia 214, 273–278.
Ducrocq, Th., Bridault, A., Coutard, S., 2008. Le gisement mésolithique de Warluis (Oise): approche préliminaire. In: Fagnart, J.-P., Thévenin, A., Ducrocq, Th., Souffi, B., Coudret, P. (Eds.), Le début du Mésolithique en Europe du Nord-Ouest. Actes de la table ronde d'Amiens, 9 et 10 octobre 2004. Mémoires de la Société Préhistorique Française XLV, Paris, pp. 85–106.
Fisher, L., 2006. Blades and microliths: changing contexts of tool production from Magdalenian to Early Mesolithic in southern Germany. Journal of Anthropological Archaeology 25 (2), 226–238.
Gendel, P., 1984. Mesolithic Social Territories in North-western Europe. Oxford (BAR, International Series 218).
Gob, A., 1981. Le Mésolithique dans le basin de l'Ourthe. Liège (Mémoire de la Société Wallonne de Palethnologie 3).
Hamon, C., 2009. Les outils de broyage et polissage: des indicateurs chrono-culturels en contextes Mésolithique et Rubanés en Europe nord-occidentale? In: Crombé, Ph., Van Strydonck, M., Sergant, J., Boudin, M., Bats, M. (Eds.), Proceedings of the International Congress "Chronology and Evolution in the Mesolithic of North-West Europe". Cambridge Scholar Publishing, Brussels, pp. 785–799 (May 30 till June 1 2007).
Hardy, K., 2007. Where would we be without string? Ethnographic and prehistoric evidence for the use, manufacturing and role of string in the upper Palaeolithic and Mesolithic of Northern Europe. In: Beugnier, V., Crombé, P. (Eds.), Plant Processing from a Prehistoric and Ethnographic Perspective/Préhistoire et Ethnographie du Travail des Plantes. Proceedings of a Workshop at Ghent University, Belgium (November 28, 2006). John & Erica Hedges Ltd., Oxford, pp. 9–22 (=British Archaeological Reports, International Series 1718).
Heyse, I., 1979. Bijdrage tot de geomorfologische kennis va het noordwesten van Oost-Vlaanderen (België), Brussel.
Hodder, I., Hassall, M., 1971. The non-random spacing of Romano–British walled towns. Man 6 (3), 391–407.
Houtsma, P., Kramer, E., Newell, R.R., Smit, J.L., 1996. The Late Palaeolithic Habitation of Haule V: From Excavation Report to the Reconstruction of Federmesser Settlement Patterns and Land-Use. Assen, Van Gorcum.
Hurcombe, L., 2007. Plant processing for cordage and textile using serrated flint edges: new chaînes opératoires suggested by combining ethnographic, archaeological and experimental evidence for bast fibre processing. In: Beugnier, V., Crombé, P. (Eds.), Plant Processing from a Prehistoric and Ethnographic Perspective/Préhistoire et Ethnographie du Travail des Plantes. Proceedings of a Workshop at Ghent University, Belgium (November 28, 2006). John & Erica Hedges Ltd., Oxford, pp. 41–66 (=British Archaeological Reports, International Series 1718).
Huyge, D., 1987. De mesolithische vindplaatsen "Bolderdal" op de Wijvenheide te Zonhoven. Archaeologia Belgica III, 57–70.
In t'Ven, I., De Clercq, W. (Eds.), 2006. Een lijn door het landschap. Archeologie en het VTN-project 1997–1998. Archeologie in Vlaanderen, Brussel (Monografie 5).
Iversen, J., 1973. The Development of Denmark's Nature Since the Last Glacial. Geological Survey of Denmark, V Series 7c, Kopenhagen.
Jochim, M.A., 1998. A Hunter–Gatherer Landscape. Southwest Germany in the Late Paleolithic and Mesolithic. Plenum Press, London (Interdisciplinary Contributions to Archaeology).
Jochim, M.A., 2006. Regional perspectives on Early Mesolithic land use in southwestern Germany. Journal of Anthropological Archaeology 25 (2), 204–212.
Kelly, R.J., 1995. The Foraging Spectrum. Diversity in Hunter–Gatherer Lifeways. Smithsonian Institution Press, London.
Kiden, P., 1991. The Lateglacial and Holocene evolution of the Middle and Lower River Scheldt, Belgium. In: Starkel, L., Gregory, K.J., Thornes, J.B. (Eds.), Temperate Palaeohydrology. John Wiley and Sons Ltd., pp. 183–299.
Laloo, P., De Clercq, W., Perdaen, Y., Crombé, P. (Eds.), 2009. Het Kluizendokproject. Basisrapportage van het preventief archeologisch onderzoek op de wijk Zandeken (Kluizen, gem. Evergem, prov. Oost-Vlaanderen) (December 2005–December 2009) (=UGent Archeologische Rapporten 20), Ghent University, Gent.
Lovis, W.A., Whallon, R., Donahue, R.E., 2006a. Introduction to Mesolithic mobility, exchange, and interaction: a special edition of the Journal of Anthropological Archaeology. Journal of Anthropological Archaeology 25, 175–177.
Lovis, W.A., Whallon, R., Donahue, R.E., 2006b. Social and spatial dimensions of Mesolithic mobility. Journal of Anthropological Archaeology 25, 271–274.
Paludan-Müller, C., 1987. High atlantic food gathering in Northwestern Zealand, ecological conditions and spatial representation. In: Kristiansen, K., Paludan-

Müller, C. (Eds.), New Directions in Scandinavian Archaeology, Odensee, pp. 120–157.
Perdaen, Y., Crombé, P., Sergant, J., 2009a. The use of quartzite as a chrono-cultural marker in the Mesolithic cultures of the Low Countries. In: Sternke, F., Eigeland, L., Costa, L.-J. (Eds.), Non-flint Raw Material Use in Prehistory Old Prejudices and New Direction, Proceedings of the XVth Congress of the Union International de Sciences Pré-et Protohistoriques. Archaeo Press, Oxford, Lisbon, pp. 217–224 (2006) (BAR International Series 1939).
Perdaen, Y., Meylemans, E., Jacops, J., Bogemans, F., Storme, A., Verdurmen, I., 2009b. Prospectie-en evaluatieonderzoek in het kader van het Sigmaplan, deel 2. Notae Praehistoricae 29, 121–129.
Pinder, D., Shimada, I., Gregory, D., 1979. The nearest-neighbor statistic: archaeological application and new developments. American Antiquity 44 (3), 430–445.
Raemaekers, D.C.M., 1999. The Articulation of a 'New Neolithic'. The Meaning of the Swifterbant Culture for the Process of Neolithisation in the Western Part of the North European Plain (4900–3400 BC). Archaeological Studies Leiden University, Leiden (3).
Rensink, E., 1995. On Magdalenian mobility and land use in north-west Europe. Some methodological considerations. Archaeological Dialogues 2 (2), 85–119.
Robinson, E., 2007. Cultural landscapes and neolithisation processes: outline of a model for the Scheldt basin. Internet Archaeology (22).
Robinson, E., 2010a. Cultural Transmission of the Neolithic in Northwest Europe: A Critical Study. Unpublished PhD Thesis, University of Sheffield.
Robinson, E., 2010b. Technological Traditions and the 'dialectic of expansion': Contact, Transmission, and Neolithisation Along the Northwestern Fringes of the LBK. In: Hadjikoumis, A., Robinson, E., Viner, S. (Eds.), The Dynamics of Neolithisation in Europe: Studies in Honour of Andrew Sherratt. Oxbow Books, Oxford.
Rossignol, J., 1992. Concepts, methods, and theory building: a landscape approach. In: Rossignol, J., Wandsnider, L. (Eds.), Space, Time, and Archaeological Landscapes. Plenum Press, New York, pp. 3–19.
Rowley-Conwy, P., 2001. Time, change and the archaeology of hunter–gatherers: how original is the 'Original Affluent Society'? In: Panter-Brick, C., Layton, R.H., Rowley-Conwy, P. (Eds.), Hunter–Gatherers: An Interdisciplinary Perspective. Cambridge University Press, Cambridge, pp. 39–72.
Ryssaert, C., De Maeyer, W., Crombé, P., De Clercq, W., Perdaen, Y., Bats, M., 2007. Archeologisch (voor)onderzoek te Desteldonk 'Moervaart-zuid'. Ghent University, Gent (=UGent Archeologische Rapporten 3).
Sergant, J., Bats, M., Noens, G., Lombaert, L., D'Hollander, D., 2007. Voorlopige resultaten van noodopgravingen in het afgedekte dekzandlandschap van Verrebroek "Aven Ackers" (Mesolithicum, Neolithicum). Notae Praehistoricae 27, 101–107.
Sergant, J., Crombé, P., Perdaen, Y., 2009. Mesolithic territories and land-use systems in north-western Belgium. In: McCartan, S.B., Schulting, R., Warren, G., Woodman, P. (Eds.), Mesolithic Horizons. Papers Presented at the Seventh International Conference on the Mesolithic in Europe, Belfast 2005. Oxbow books, Oxford, pp. 277–281.
Sergant, J., Van de Vijver, M., Blanchaert, H., Vandendriessche, H., Langohr, R., Lombaert, L., Van Strydonck, M., Boudin, M., De Wulf, A., 2009. Een tweede vindplaats van de Deûle-Escaut groep in de Vlaamse Zandstreek. de site van Hertsberge-Papenvijvers 3 (gem. Oostkamp, West-Vlaanderen, België). Notae Praehistoricae 29, 93–99.
Spikins, P., 1999. Mesolithic Northern England. Environment, Population and Settlement. Oxford (BAR, British Series 283).
Spikins, P., 2008. Mesolithic Europe: glimpses of another world. In: Bailey, G., Spikins, P. (Eds.), Mesolithic Europe. Cambridge University Press, Cambridge, pp. 1–17.
Street, M., Baales, M., 1999. Pleistocene/Holocene changes in the Rhineland fauna in a northwest European context. In: Benecke, N. (Ed.), The Holocene History of the European Vertev-brate Fauna. Modern Aspects of Research, Workshop (6th to 9th April 1998). Verlag Marie Leidorf, Berlin, Rahden/Westf., pp. 9–38 (Archäologie in Eurasien 6).
Svenning, J.-Ch., 2002. A review of natural vegetation openness in north-western Europe. Biological Conservation 104, 133–148.
Valentin, B., 2008. Jalons pour une paléohistoire des derniers chasseurs (XIVe-VIe millénaire avant. J.-C. Paris (Cahiers archéologiques de Paris 1, 1).
Van de Plassche, O., 1982. Sea-level change and water-level movements in the Netherlands during the Holocene. Mededelingen Rijks Geologische Dienst 36 (1), 1–93.
Van der Haegen, G., Crombé, P., Semey, J., 1999. Steentijdvondsten in het Meetjesland. Gent (Archeologische Inventaris Vlaanderen, Buitengewone reeks 6).
Van Hove, R., 1997. De "klassieke" bolle akkers van het Waasland in archeologisch perspectief. Berichten van de Archeologische Dienst Waasland 3, 283–328.
Van Neer, W., Ervynck, A., Lentacker, A., 2005. Features: archaeozoological analyses. In: Crombé, P. (Ed), The Last Hunter–Gatherer–Fishermen in Sandy Flanders (NW Belgium); The Verrebroek and Doel Excavation Projects. Part 1: Palaeo-environment, Chronology and Features, Gent, pp. 279–294 (Archaeological Reports Ghent University 3).
Van Strydonck, M., Crombé, P., 2005. Radiocarbon dating, In: Crombé, P. (Ed.), The Last Hunter–Gatherer–Fishermen in Sandy Flanders (NW Belgium): The Verrebroek and Doel Excavation Projects. Part 1: Palaeo-environment, Chronology and Features, Gent, pp. 180–212 (Archaeological Reports Ghent University 3).
Van Vlaenderen, L., Sergant, J., De Bock, H., De Meireleir, M., 2007. Steentijdvondsten in de Moervaart. Gent (Archeologische Inventaris Vlaanderen, Buitengewone reeks 9).
Verbruggen, C., 1971. Postglaciale landschapsgeschiedenis van zandig-Vlaanderen. Botanisch, ecologisch en morfologische aspekten op basis van palynologisch onderzoek. Unpublished PhD, Ghent University.
Verbruggen, C., 1979. Vegetational and palaeoecological history of the Late-Glacial period in Sandy Flanders (Belgium). Acta Universitatis Gothoburgensis 3, 133–142.
Verbruggen, C., Van Dongen, W., 1976. De geokronologie van het Postpleniglaciaal in Zandig-Vlaanderen op basis van pollenanalyse en 14C-onderzoek. Natuurwetenschappelijk Tijdschrift 58, 233–256.
Verbruggen, C., Denys, L., Kiden, P., 1996, Belgium. In: Berglund, B.E., Birks, H.J.B., Ralska-Jasiewiczowa, M., Wright, H.E. (Eds.), Palaeoecological Events During the Last 15000 Years: Regional Syntheses of Palaeoecological Studies of Lakes and Mires in Europe. John Wiley & Sons, Chichester, pp. 553–574.
Verhart, L., 2008. New developments in the study of the mesolithic of the low countries. In: Bailey, G., Spikins, P. (Eds.), Mesolithic Europe. Cambridge University Press, Cambridge, pp. 158–181.
Verhart, L., Arts, N., 2005. Het Mesolithicum in Zuid-Nederland. In: Deeben, J., Drenth, E., van Oorsouw, M.-F., Verhart, L. (Eds.), De Steentijd van Nederland. Archeologie, vol. 11/12, pp. 235–260.
Verhoeven, K., 2002. Herkomstbepaling van silexartefacten uit de prehistorische sites van Doel, Spiere en Oeudeghien, door middel van micropaleontologisch onderzoek met dinoflaqgellatencysten. Unpublished Master thesis, Ghent University.
Waterbolk, H.T., 1968. Food production in prehistoric Europe. Science 162, 1093–1102.
Whallon, R., 1974. Spatial analysis of occupation floors II: the application of nearest neighbor analysis. American Antiquity 39 (1), 16–34.
Whittle, A., 1996. Europe in the Neolithic: The Creation of New Worlds. Cambridge University Press, Cambridge.
Wilmsen, E.N., 1973. Interaction, spacing behavior and the organization of hunting bands. Journal of Anthropological Research 29, 1–31.
Woodburn, J., 1980. Hunters and gatherers today and reconstruction of the past. In: Gellner, E. (Ed.), Soviet and Western Anthropology. Duckworth, London, pp. 95–117.