A GEOGRAPHICALLY REFERENCED ^{14}C DATABASE FOR THE MESOLITHIC AND THE EARLY PHASE OF THE SWIFTERBANT CULTURE IN THE NORTHERN NETHERLANDS

M.J.L.TH. NIEKUS
University of Groningen, Groningen Institute of Archaeology, Groningen, the Netherlands

ABSTRACT: In this paper a data set of more than 400 reliable ^{14}C dates for the Mesolithic and the Early Swifterbant culture in the northern part of the Netherlands is described. These dates, covering the period between 9600 and 5600 BP, are analysed for chronological and spatial patterning. The results of these analyses suggest that major changes occurred in the geographical location of dated sites during these 4000 radiocarbon years. In the course of the eighth millennium BC, the 'centre of gravity' of ^{14}C-dated sites gradually shifted from the higher Pleistocene interior in the eastern part of the study area to river valleys, lake-shores and other wetland zones. Several possible reasons for these patterns are briefly discussed. At the end of this article, a series of new ^{14}C dates are presented.

KEYWORDS: Northern Netherlands, Mesolithic, Early Swifterbant culture, ^{14}C dates, representativity, Early Holocene sea level rise, chronological patterns, geographical distribution, multiple occupations.

1. INTRODUCTION

This paper is the first in a series of articles on the Mesolithic and part of the Early Swifterbant occupation in the northern part of the Netherlands. The research presented here focuses primarily on ^{14}C dates, while other aspects such as typochronology and site types will be the subject of forthcoming publications.

In this article a large number of new ^{14}C dates are presented. Together with the catalogues published by Lanting & Van der Plicht (1997/1998; 1999/2000) there are now a total of more than 550 ^{14}C dates for the period between 9600 and 5600 radiocarbon years BP. This extensive data set, quite large if compared to the Late Upper Palaeolithic (Lanting & Van der Plicht, 1995/1996a) and the Neolithic (Lanting & Van der Plicht, 1999/2000), is valuable for a number of reasons. As Waterbolk (1983: p. 57) has argued, a large number of ^{14}C dates may provide us with "…initial and terminal datings for cultural phases, thus defining their duration" so that, more importantly from a behavioural point of view, differences in duration of occupation between areas may: "…provide definitive answers to long-disputed questions concerning the direction of cultural movements". A notable example of such an approach was published by the same author (Waterbolk, 1985; 1999). In these articles ^{14}C dates of mainly hearth-pits are used in combination with geographical data to reconstruct the settlement history of the Northern Netherlands. One of the most interesting patterns described by Waterbolk is an apparent shift in the location of settlements during the Early Atlantic, a view already expressed in the early 1960s (Waterbolk, 1962). Before approximately 7600 BP, most of the dates are from sites on higher Pleistocene soils in the eastern part of the area, whereas dated sites from the later Mesolithic and the early phase of the Swifterbant culture seem to occur more in river valleys, along the shores of lakes and in other 'wet' environments. Waterbolk explains this apparent retreat to wetlands as an adaptive response to the development of the Atlantic climax forest, and the resultant decline of large herbivores and disappearance of larger bodies of open water. As a consequence, Mesolithic people retreated to the fringes of these landscapes and focused more on fishing and hunting waterfowl than during the earlier part of the Mesolithic. This situation only changed in the course of the 5th millennium BP when the Pleistocene uplands were gradually 'recolonised' by farming communities.

The main aim of this paper is to examine whether these large-scale, supra-regional patterns are still valid, in view of the larger number of ^{14}C dates that are currently available. This will be done in several steps. First of all, the entire database is screened for any ^{14}C dates that may be unreliable for one or several reasons. These will be omitted and the remaining data set is described.[1] Special attention will be given to the representativity of these dates with respect to the geological history of the study area. Secondly, the chronological patterning in the ^{14}C dates is presented. Thirdly, the dates are plotted on a series of maps to show their spatial distribution through the centuries, in order to identify any geographical shifts of human

occupation. Finally, the chronological distribution of ^{14}C dates for individual sites is presented, which provides some insight into the structure of multiple occupations. This is followed by some suggestions regarding the causes of the observed patterning. Since we are dealing with many different landscapes and biotopes and covering a long period with major climatological, hydrological and other changes, this will be restricted to a fairly general discussion. In a later paper the focus will be more on smaller, regional or local, landscape units with comparable biotopes and on patterning on the level of the individual site.

The time-frame of this study not only includes the Mesolithic period but also the early phase of the Swifterbant culture, which is dated between c. 6000/5900 BP and 5600 BP (Lanting & Van der Plicht, 1999/2000; Raemaekers, 1999). There are two reasons for including this period. First of all, the transition from the Mesolithic to the Neolithic in the study area is seen as a gradual one, through this intermediate stage sometimes referred to as the ceramic Mesolithic stage (Lanting & Van der Plicht, 1999/2000: p. 19). Secondly, there are a few sites that have produced Late Mesolithic as well as Early Swifterbant ^{14}C dates, and it is assumed that the location of Swifterbant sites is rooted in a Mesolithic tradition of land-use systems (Peeters, 2004).

The study area is the part of the Netherlands situated to the north of the major river systems in the central part of the country. As such, it consists of the provinces of Groningen, Friesland, Drenthe, Overijssel, Flevoland, Utrecht, Noord-Holland and parts of Gelderland and Zuid-Holland (fig. 1). Today the total surface area of dry land is approximately 22,105 km^2 while 5,795 km^2 consists of inland waterways, lakes and other bodies of water, like Lake IJssel (Dutch: *IJsselmeer*) in the centre and the Wadden Sea (*Waddenzee*) in the north. To the east the area is bordered by Germany; the North Sea forms the natural border to the west and north.

To familiarize the reader with the study area, brief descriptions of the dynamic Holocene landscape and its Mesolithic habitation are presented in the following sections. A fuller description of the physical features of the landscapes in the study area can be found in Waterbolk (1985). For summarizing papers on the Dutch Mesolithic, the reader is referred to Lanting & Van der Plicht (1997/1998), Newell (1973), Peeters & Niekus (2005) and Verhart & Groenendijk (2005).

All dates used in this article are in conventional ^{14}C ages, designated in years BP. The most important reasons for this are to facilitate comparison with the data presented by Waterbolk (1985; 1999) and that for the chronological maps discussed in chapter 6 single data points are more suitable than calibrated age ranges. For the *sum probability plots* of the dates discussed in this article, the reader is referred to Niekus (2005).[2]

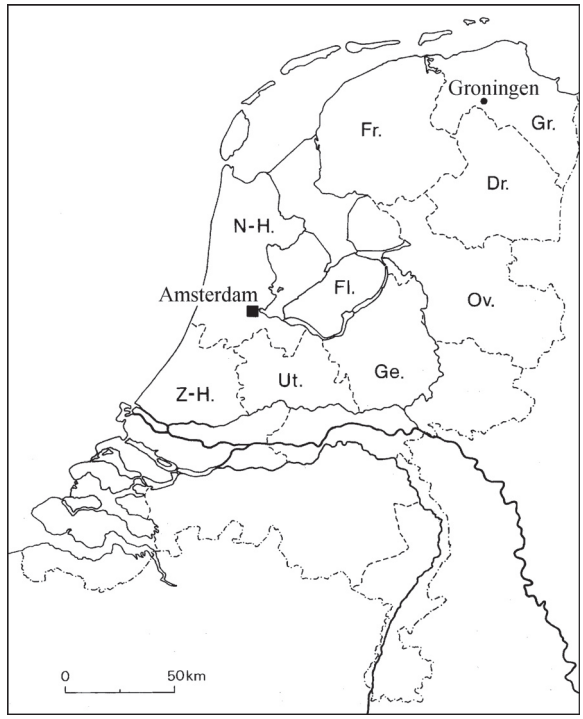

Fig. 1. Provinces of the Netherlands: Gr. Groningen, Fr. Friesland, Dr. Drenthe, Ov. Overijssel, Fl. Flevoland, Ge. Gelderland, Ut. Utrecht, N-H. Noord-Holland, Z-H. Zuid-Holland. Dot-dash line = national boundary; dash line = provincial boundary (drawing J.H. Zwier).

Most of the graphs and figures in this article were prepared by J.H. Zwier, S. Tiebackx, Mrs M.A. Los-Weijns, E. Bolhuis and the author (all GIA). The scatter plots and bar graphs were made with SigmaPlot, version 8.0 (2002). The statistical tests were performed with SPSS version 12.0.1 (2003).

2. THE STUDY AREA: GENERAL REMARKS

2.1. Holocene landscape development

From the beginning of the Holocene, major climatic changes affected the extent and physical appearance of the landscape occupied by Mesolithic hunter-gatherer-fishermen. In essence, the 'Mesolithic' landscape is characterised by two interrelated major developments; a marked decrease in the availability of 'dry' land and an accompanying increase in 'wetlands'.

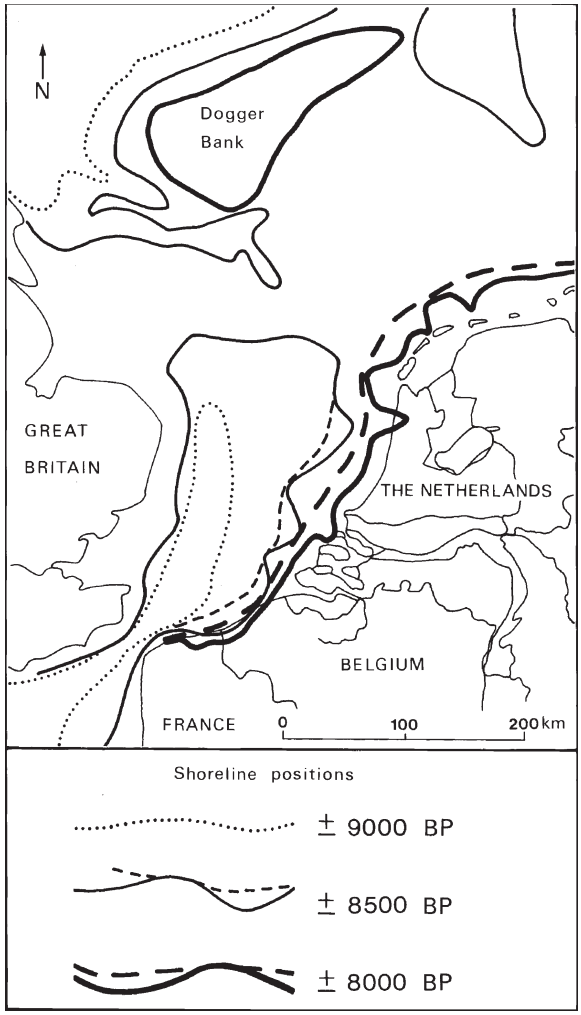

Fig. 2. The shifting of the coastline and drowning of the landscape during the Early Holocene (drawing J.H. Zwier, after Beets & Van der Spek, 2000).

During the earlier part of the Mesolithic the study area was in fact no more than the higher hinterland of an extensive region that extended well into the North Sea basin. With the onset of the Holocene, the basin gradually drowned and the prehistoric coastline shifted to the east and to the south (Zagwijn, 1986). The separation of the British Isles from the continent must have taken place before 7600 BP (Lanting & Van der Plicht, 1997/1998: p. 104). The coastline had more or less reached its present-day position between 8000 and 7500 BP (fig. 2) even though the sea level still was several metres lower than today.

The beginning of the Holocene is marked by an increase in *Betula* which started at the end of the Younger Dryas. During the Preboreal (c. 10,150–9450 BP) the landscape was dominated by *Betula-Pinus* forests which occurred mainly in stream valleys and other moist areas like pingo-scars (Bottema, 1984; Bakker, 2003).[3] The presence of *Gramineae* and *Cyperaceae* pollen points to a fairly open character of the landscape. Between 9900 and 9700 BP (Rammelbeek phase) the climate temporarily deteriorated; it became colder and drier and vegetation was sparse. Despite the rather dry climatic conditions in the Preboreal, peat deposits did develop locally.

Corylus and *Ulmus* were already present in low numbers during the Preboreal, but a significant increase in these species marks the beginning of the Boreal (c. 9450–8000 BP). Whether the marked increase in *Corylus* is solely due to natural causes or if Mesolithic people played a role in this, is still a matter of debate (Bottema & Walsweer, 1997). Because of the improved climatic conditions trees were not confined to moist areas but spread to higher and drier sandy soils, where *Pinus* became the dominant species. The open spaces in the landscape were colonized by *Corylus*, while *Betula* retreated to moist areas, *i.e.* peaty soils. Other species such as *Quercus*, *Alnus*, *Tilia* and *Ulmus* gradually migrated into the region. The vegetation on sandy soils was dominated by *Pinus*, *Betula* and *Populus* mixed with *Corylus*, while other species flourished on more favourable soils. The groundwater table must have dropped, as a result of increased evaporation. Hydrological systems were determined by local circumstances, with the Hunze, Tjonger, IJssel, Vecht and Eem as the largest watercourses.

During the Atlantic the vegetation of pine forests was gradually replaced by mixed deciduous forests as a result of optimal climatic conditions, and this will have resulted in depressed evapotranspiration (Pons, 1992: p. 13). A considerable increase in precipitation surplus as compared to the earlier *Pinus*-dominated vegetation will have caused a rise in the water table and swamping of lower-lying areas (*ibid.*: p. 13), which favoured the development of raised bogs and marshes with alder and birch carr. The deciduous forests characteristic of the Atlantic consisted mainly of *Quercus*, *Ulmus*, and *Fraxinus*. Owing to the density of the forest cover undergrowth was limited. Different soil types (*e.g.* glacial till, coversand) supported different types of forest vegetation. On coversand the vegetation was probably more open, consisting of *Corylus* and *Quercus*. *Alnus* and *Betula* were more dominant in carr woodland. The share of *Pinus* and *Betula* decreased and they were replaced by *Alnus* on relatively moist, peaty soils and in valleys. In coastal areas there must have been a noticeable tidal influence with stronger fluctuations in the ground-water table.

The effect of this on the higher grounds is not well-known but there must have been considerable regional differences.

2.2. The Mesolithic and the early Swifterbant culture

Several thousand Mesolithic sites are known from the area, most of which are situated on the higher sandy soils in the eastern part of the country, where the Pleistocene surface can be found at or closely below the present-day surface. High densities of sites are present in some areas, for example the Drenthe Plateau, the Veenkoloniën area in Groningen and the area around Lake Bergum (*Bergumermeer*) and Lake De Leijen in Friesland. Other areas are relatively poor in Mesolithic remains (map in Van Es, Sarfatij & Woltering, 1988: p. 65). These patterns most probably represent the intensity (or lack) of fieldwalking by amateur archaeologists and systematic regional surveys. To the north and west, Stone Age remains are generally inaccessible because of thick peat and clay deposits.

During the past 50 years dozens of sites have been excavated, be it rarely fully, by various institutes and organisations. Among these are well-known locations such as Bergumermeer (Newell & Vroomans, 1972), Havelte (Price, Whallon & Chappell, 1974; Price, 1975), Swifterbant (Price, 1981; Whallon & Price, 1976) and Mariënberg (Verlinde, 1979; Verlinde & Newell, 2005). Unfortunately, most excavated sites have only briefly been mentioned in the literature and still await final publication.

From these excavations it has become clear that Mesolithic sites are on the whole characterised by scatters or patches of flint artefacts and low numbers of features. The lack of organic remains other than charcoal, burnt hazelnut shells or more rarely calcined bone is due to the acidic conditions of the Pleistocene soils and biological processes such as bioturbation or tree-falls. These 'flint sites' vary considerably in size, total number of artefacts, artefact density, number of tool types and number of features, from small isolated artefact units to extensive accumulations of cultural materials. A number of settlement types have been defined on the basis of these differences, which in turn have been used for reconstructions of Mesolithic economy and settlement systems (Huiskes, 1988; Newell, 1973; Price, 1975, 1978). Regional studies are available for the Drenthe Plateau (Price, 1980), the Veenkoloniën (Groenendijk, 1997) and the central part of Overijssel (Musch, 1991). A few other studies have focused on specific types of artefacts or features: mace-heads (Hulst & Verlinde, 1976); *Spitzhauen* (Hulst & Verlinde, 1979); core- and flake-axes (Harsema, 1978; Newell, 1970). Studies on the typology of (mainly flint) artefacts have been published by Bohmers & Wouters (1956) and Newell & Vroomans (1972).

Owing to the lack of significant sedimentation since the beginning of the Holocene, many of these sites in 'dry' settings do not represent short-term occupations but comprise a mixture of cultural materials from different periods. Their *palimpsest* nature is often attested by ^{14}C dates and typological evidence. During the past decade more attention has been given to 'wetlands' (river valleys and peat-filled depressions) as important sources of information than to areas with a high density of finds like plateaus and coversand ridges. This shift in focus has led to the excavation of several sites with good organic preservation such as the Early Mesolithic faunal assemblage from Zutphen (Groenewoudt *et al.*, 2001; Groenewoudt, 2004), the Late Mesolithic site Jardinga (Prummel *et al.*, 2002) and the Late Mesolithic/Early Swifterbant site Hoge Vaart/A27 (Hogestijn & Peeters, 2001).[4] Several isolated organic artefacts are also known from the area. A few examples are the logboat from Pesse (Van Zeist, 1957; Beuker & Niekus, 1997), a barbed point from Emmen (Louwe Kooijmans, 1970–1971), an antler axe-sleeve from Ulft (Verhart, 1998) and a fragment of a barbed bone point dredged up from the river Regge (Verlinde, 1987).

The most typical and widespread type of feature on Mesolithic sites in the Northern Netherlands are hearth-pits (or pit-hearths): generally round pits, c. 0.40–0.80 m. in diametre, with a bowl-shaped base and an average depth of 0.40–0.50 m. (Groenendijk, 1987; Groenendijk & Smit, 1990). The fill of the pits normally consists of varying amounts of charcoal and occasionally (burnt) flint or fire-cracked cooking-stones or 'potboilers'. It is commonly thought that these pits relate to the preparation of food, but evidence is scarce (Exaltus, Groenendijk & Smit, 1993; Jansen & Peeters, 2001). At several sites, however, remains of edible plants and roots have been found in such pits and the pits were possibly used for the preparation of vegetable matter (Perry, 1997; 1999; 2002).[5] Some sites have produced large quantities of hearth-pits, sometimes in dense clusters ('pit-cluster' sites: Peeters & Niekus, 2005). At the following sites more than 100 pits have been found: Almere-Hoge Vaart (Hogestijn & Peeters, 2001), Mariënberg (Verlinde & Newell, in press), Nieuwe Pekela (NP-

3) (Groenendijk, 2004; Smit, 1995), Stadskanaal (S-1) (Niekus & Groenendijk, 1998) and Zwolle-Oude Deventerstraatweg (Hermsen, in press; section 9.4). Other allegedly anthropogenic features that have been reported in the literature are different kinds of pits, ditches, postholes and surface hearths. Concentrations of burnt flint, charcoal or burnt hazelnut shells are often interpreted as surface hearths. Possible dwelling structures have been reported from Bergumermeer S64-B (Newell, 1980), Siegerswoude (Price, 1975: p. 453) and Baarn (Van Haaff *et al*., 1988; Peeters & Niekus, 2005: p. 214). Mesolithic inhumations and cremations are rare. At the above-mentioned site Mariënberg six so-called "sitting graves" were found (Verlinde & Newell, in press). A possible cremation is reported from Dalfsen, not far from Mariënberg (Verlinde, 1974). Human remains have also been dredged up from the North Sea floor (Glimmerveen, Mol & Van der Plicht, 2006; section 9.8).

The Mesolithic in the Northern Netherlands most probably developed from the Epi-Ahrensburgian (*cf.* Gob, 1988; 1991). A handful of sites from this transitional stage between the Late Upper Palaeolithic and the Mesolithic are known from the area, but only three have been excavated, Oudehaske and Gramsbergen (Johansen & Stapert, 1997/1998) and Hoogkerk-Ruskenveen (Niekus, 2004). There are no reliable ^{14}C dates for these sites but it seems that they must be dated to the Friesland and Rammelbeek phases of the Preboreal (Johansen & Stapert, 1997/1998: pp. 2–3). The Rammelbeek phase is dated between 9900 and 9700 BP (Lanting & Van der Plicht, 1995/1996a: p. 83) and can serve as a *terminus post quem* for the earliest Mesolithic industries.[6] There are a few ^{14}C dates for this initial Mesolithic but little is known about the flint industry. It is likely that artefact assemblages from this period are comparable to those from Geldrop 3-2 with a date of 9770 BP (Deeben, 1996) and Bedburg in Germany, which is dated around 9600 BP (Street, 1991).

A subdivision of the Mesolithic into five phases, which is based primarily on a stylistic seriation of point types, was published in the early 1970s (Newell, 1973). These indigenous stages (fig. 3) were attributed to the *Northwest Kreis* (referred to here as *Northwest Group*) of the West European Mesolithic (*Tardenoisian*). The *De Leijen-Wartena Complex* (DLW) was seen as a non-local development: the manifestation of groups moving south from the gradually drowning North Sea basin. The presence of core- and flake-axes in DLW sites suggested a genetic relationship with the North-European Mesolithic (Maglemose-Kongemose tradition).

During the past decades, the validity of this subdivision has been repeatedly questioned (*e.g.* Price, Whallon & Chappell, 1974; Verhart & Groenendijk, 2005), mainly because it is largely based on surface collections and partly excavated sites with evidence of repeated occupation (Verhart & Groenendijk, 2005). Also the existence of the DLW is no longer tenable since core-axes are already present in a *Northwest Group* context from approximately 8800 BP onwards (Niekus, De Roever & Smit, 1997; Lanting & Van der Plicht, 1997/1998). Large sites, for example Bergumermeer S64-B, that were also seen as characteristic of the DLW, do not necessarily represent a single settlement but are likely to consist of overlapping artefact units from different periods.

An alternative typochronology in three stages (Early, Middle and Late) has been put forward by Verhart & Groenendijk (2005) even though they are not very clear about the dates that should be attached to the different stages in the Northern Netherlands.[7] At the moment there are no 'guidefossils' for the Middle Mesolithic, and Lanting & Van der Plicht (1997/1998) suggest dividing the Mesolithic into just two phases: an Early Mesolithic without trapezes and a Late Mesolithic with trapezes after c. 8000 BP.

During the Preboreal and the first half of the Boreal the material culture of Mesolithic groups is very similar, but between 9000 and 8500 BP two regional 'groups' begin to develop: the *Northwest Group* in the north and the *Rhine Basin Group* (formerly known as *Rhine Basin Kreis*) to the south. The border between the two groups is diffuse and situated somewhere between the rivers Rhine and Vecht (figure 8.3 in Verhart & Groenendijk, 2005). The Northwest Group is seen as a continuation of the Maglemose-Kongemose tradition of the northern European Mesolithic, while the *Rhine Basin Group*, sometimes referred to as the *Rhine-Meuse-Scheldt complex* (RMS) (*cf.* Gob, 1985), is grouped with the western European Mesolithic (Sauveterre-Tardenoisian tradition). The *Rhine Basin Group* is characterised by the use of surface-retouched points and 'exotic' raw materials (Wommerson-quartzite).

During the final phase of the Mesolithic (c. 6000–5600 BP), pottery was produced for the first time in the Swifterbant tradition, as is attested by finds from sites like Almere-Hoge Vaart (Hogestijn & Peeters, 2001) and Bronneger (Kroezenga *et al*., 1991). The flint industry of this 'ceramic Mesolithic stage' is still Mesolithic in character (Peeters, Schreurs & Verneau, 2001). Domestic cattle were introduced around 5600 BP, cereals around 5300 BP.

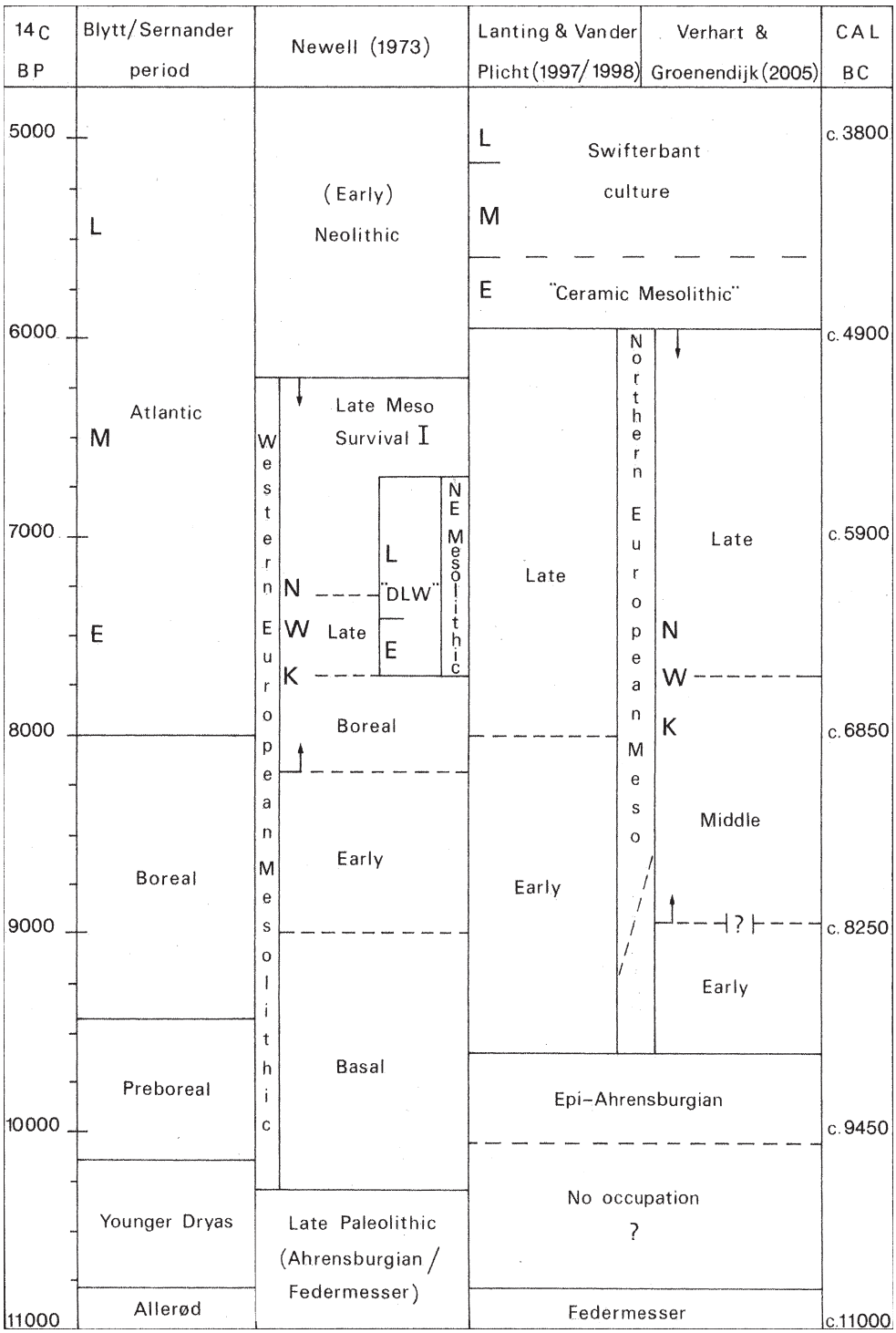

Fig. 3. Division of the last part of the Late Glacial and the Early Postglacial (after Lanting & Van der Plicht, 1995/1996a, 1997/1998) and different chronological subdivisions of the Mesolithic (Lanting & Van der Plicht, 1997/1998; Newell, 1973; Verhart & Groenendijk, 2005). The dates for the end of the Late Palaeolithic/beginning of the Mesolithic are based on Johansen & Stapert (1997/1998) and Lanting & Van der Plicht (1997/1998). The dates for the beginning and chronological subdivision of the Swifterbant culture are based on Lanting & Van der Plicht (1999/2000) and Raemaekers (1999; 2005). Key: E = Early, M = Middle and L = Late, DLW = De Leijen-Wartena Complex, NWK = Northwest Group (*Kreis*) Mesolithic (drawing M.J.L.Th. Niekus & J.H. Zwier).

3. THE ^{14}C DATABASE

In compiling the database the catalogues on the Mesolithic and Neolithic published by Lanting & Van der Plicht (1997/1998; 1999/2000) were taken as a starting point, complemented by more recently published and unpublished dates. In addition, almost 170 ^{14}C samples from different sites were collected for dating and submitted to the Centre for Isotopic Research (CIO) at the University of Groningen during the past few years. These samples derive from different kinds of research: rescue excavations and prolonged systematic investigations as well as artefacts dredged up from rivers and samples from corings. Samples were selected also with a view to further research, not only the study presented here. First of all, samples from areas poor in dating evidence, or where dates were lacking altogether, were preferred. Secondly, samples from excavated but as yet undated sites were chosen for a forthcoming study on typological and technological developments in the Mesolithic. Thirdly, additional samples from sites with numerous hearth-pits were submitted in order to gain insight into the time-depth of these pit-clusters and to assess possible contemporaneity of configurations of hearth-pits such as have been described by Groenendijk (1987; 2004).

All dates were entered into a database in Excel format with the following information, if available, attached to each date: site name, municipality, province, year(s) of excavation/discovery, laboratory code, type of date (conventional or AMS), dating material (charcoal, hazelnut shell, bone etc.), species of wood or animal, context of sample (hearth-pit, culture layer etc.), sample ID (find number or any other registration code), uncalibrated date in years BP, standard deviation, pre-treatment of the sample, elevation relative to Dutch sea level datum (*Nieuw Amsterdams Peil* or NAP), local coordinates and comments.

As mentioned earlier, most of the sites are situated on dry sandy soils with limited possibilities for organic preservation except for carbonized remains. The following dating materials are usually available and are also represented in the database: charcoal from hearth-pits, burnt hazelnut shells and charcoal from pits or pit-like features. Several sites have also produced varying amounts of charcoal outside hearth-pits, either as scattered particles or in more or less dense patches which have sometimes been interpreted as surface hearths (Price, Whallon & Chappell, 1974) or occasionally as a dump (Groenendijk & Smit, 1984–1985). Fragments of calcined bone have been reported from only a small number of sites in the study area (Mariënberg, Dalfsen, Zwolle, Slochteren, Stadskanaal and several locations near Zutphen).

Not all of these samples are equally reliable and suitable for studying the chronological and geographical patterning of ^{14}C dates. As Waterbolk (1971; 1983) and Crombé, Groenendijk & Van Strydonck (1999) have pointed out, samples should be carefully selected to guarantee that ^{14}C analysis provides reliable results that are relevant to the questions one wishes to answer. Several related aspects have to be taken into account:

1. The association between the samples and the archaeological event they are intended to date.
2. The context of the sample.
3. The possibility of contamination.
4. The dating material.
5. The inbuilt age of the dating material.

To avoid problems in interpreting the ^{14}C dates, all samples were screened to ensure that the database consists only of reliable dates. Information on the context of the samples was based on Lanting & Van der Plicht (1997/1998; 1999/2000), published and unpublished excavation reports or plans, personal observation or information provided by the researcher. The ^{14}C dates described in the following sections were excluded from the database even if they match the time range of other, more reliable dates from the same site.[8]

3.1. Association between ^{14}C samples and archaeological events

One of the most important factors to be considered in dating Mesolithic sites, and in fact any archaeological site, is the degree of certainty of association between analysed ^{14}C samples and the archaeological event they are intended to date (the Degree of Certainty of Association or 'DCA' system; Waterbolk, 1983). According to Crombé, Groenendijk & Van Strydonck (1999), a weak or doubtful association between the 'dated' event and the 'targeted' event, usually the lithic industry, is one of the factors responsible for unexpected age differences, as for example Price, Whallon & Chappell (1974) have noted in their analyses of the Havelte sites. Burnt hazelnut shells are probably the best suited material for directly dating artefact units and detailed typo-chronological research (Crombé, Groenendijk & Van Strydonck, 1999: p. 62).[9] There are a number of dates on lumps/particles of charcoal that are not demonstrably associated with cultural remains (flint or other artefacts), such as the 'Mesolithic' charcoal from Ermelo Romeins-Marskamp (Lanting & Van der Plicht, 1997/1998: p. 144), and a number of dates on charcoal from later prehistoric features at sites

that have not produced clear evidence of Mesolithic presence either. These dates might well be, but are not necessarily, of natural origin (forest fires?) and were excluded from the database. Other samples that were omitted are dated pieces of wood, bone or antler that do not show convincing signs of working or use. The total number of rejected dates in this category is 17.

3.2. The context of dated samples

Except for hearth-pits, which are generally easy to identify, Mesolithic sites often produce features that are difficult to interpret. A commonly occurring type is the 'charcoal pit' or irregularly shaped 'pit-like' feature (Crombé, Groenendijk & Van Strydonck, 1999; Crombé, Perdaen & Sergant, 2005). It is not clear whether these features are man-made or natural in origin and for this reason they were removed from the database, together with samples from features listed as possible hearth-pits, tree-falls and tree-sway structures (Crombé, 1993; Kooi, 1974; Langohr, 1993; Louwagie & Langohr, 2005), animal burrows, erosion gullies etc. Also excluded are samples from other highly questionable contexts such as so-called hut-dwellings (Waterbolk, 1985: p. 275). These vaguely outlined features have been found at sites including Haule I and Siegerswoude II and are most probably the result of tree falls. Other examples of questionable contexts are the 'post-hole' and 'ditch' from Bergumermeer S64-B. At this site later prehistoric remains (Neolithic-Iron Age) have also been found and these features may be considerably younger than Mesolithic. The total number of rejected dates is 36.

Another type of sample that should be mentioned here is charcoal found outside hearth-pits or other unmistakably Mesolithic features. This category is present at nearly all Mesolithic sites and includes scattered and possibly dislocated and migrated pieces of charcoal as well as 'concentrations'. In these cases it is unclear what exactly has been dated: a natural process or human activity (surface hearths?). The interpretation of these ^{14}C dates is further complicated by the fact that they mostly concern bulk samples that may consist of a mixture of charcoal from different events. Even if single pieces of charcoal have been dated by AMS the sample may still be a non-representative part of inhomogeneous material (Mook & Waterbolk, 1985). All of these dates (n=36) were rejected. The total number of rejected dates is 72.

3.3. Contamination

In the Northern Netherlands Mesolithic sites are usually found at or close to the present-day surface and contamination with younger material is a real possibility. Samples that have not received appropriate pre-treatment, Acid only (Ao) instead of Acid-Alkali-Acid (AAA), may still contain contaminating agents like roots, humic acids or secondary deposits of lime or carbonates and as a result dates may be hundreds of years too young (Waterbolk 1983). In addition, all dates on residue fractions, extracts and the 'solid carbon' date from Haule I (Lanting & Van der Plicht, 1997/1998: p. 137) were also omitted. In total 32 dates were excluded.

3.4. The dating material

All ^{14}C dates on pottery, either on organic temper or charred food remains, were removed from the database for several reasons. First of all, clay includes carbon by nature which usually leads to dates that are too old and consequently of no use (Lanting & Van der Plicht, 1997/1998: p. 145). The second reason is that a 'reservoir effect' may affect ^{14}C dates on food crusts. This effect is not restricted to marine foods but also has a freshwater counterpart (Lanting & Van der Plicht, 1995/1996b; Fischer & Heinemeier, 2003). A recently published paper by Raemaekers (2003/2004) on pottery from the Swifterbant culture considers some of these aspects in more detail. Fourteen dates were rejected in this study, including dates from Swifterbant S-11 (Whallon & Price, 1976), Almere-Hoge Vaart (Peeters, Hanraets, Hogestijn & Jansma, 2001) and the date from Bronneger (Lanting & Van der Plicht, 1997/1998, with further references). Three dates on bone were considered unreliable owing to the absence of collagen or to deviating $\delta\ ^{13}C$ values that pointed to a considerable reservoir effect. An example of the former is the 'Mesolithic' date for one of the human burials at Urk-E4, Domineesweg (Peters & Peeters, 2001: table 54 on p. 111; Raemaekers 2003/2004, table 2 on p. 17).

3.5. Inbuilt age of the dating material

An issue that has not yet been discussed is the inbuilt age of the dating material. Dates on short-lived materials such as burnt hazelnut shells are very reliable since it is reasonable to assume that not much time passed between the collection of these nuts and their consumption. Furthermore, these samples are less likely to have been affected by contamination with older or younger material as a result of bioturbation and/or percolation. Charcoal dates are more difficult to interpret because the reliability depends largely

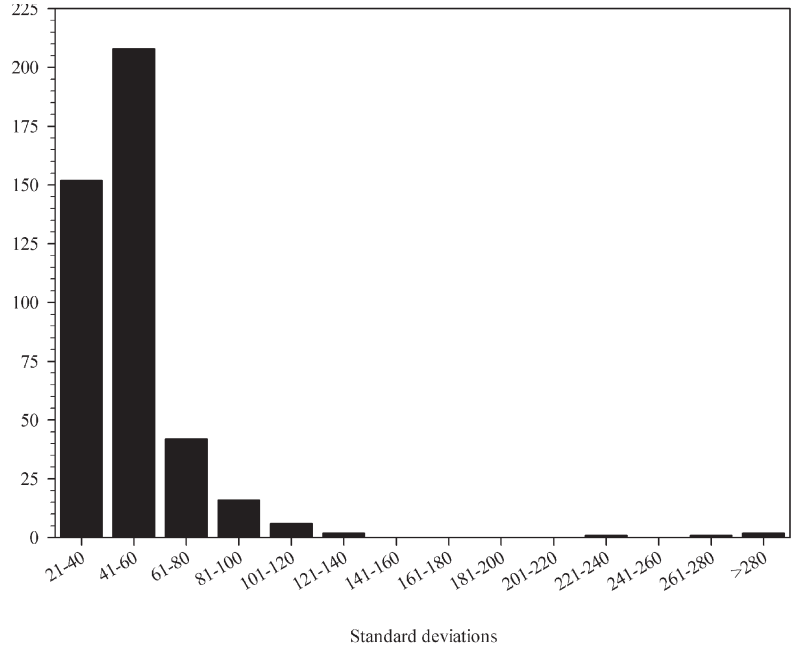

Fig. 4. Bar graph of standard deviations in classes of 20 radiocarbon years (n=430) (graph M.J.L.Th. Niekus).

on the part of the tree used for fuel, thin branches or trunkwood. The use of trunkwood for dating can lead to dates that are hundreds of years older than the actual time when it was burned.

However, anthracological analyses of charcoal from hearth-pits in the Veenkoloniën area has clearly shown that most of the wood that was used for combustion in hearth-pits consisted of thin branches, *i.e.* relatively young fuel (Groenendijk, 1997; Crombé *et al*., 1999: fig. 6). This fact as well as the small size of the pits and the lack of evidence for clearing out and re-use of the hearth-pits suggests that the ^{14}C dates are reliable and that the old-wood effect has little influence on the dates (see also Van Strydonck & Crombé, 2005). Furthermore, the charcoal is usually found at the bottom of the pit, where contamination caused by migration or percolation of charcoal is limited.

Obviously, with the large number of samples we are dealing with, anthracological analysis is not a realistic option. The species of wood used for combustion is known for dozens of hearth-pits but in only eight cases (five hearth-pits from Mariënberg and three from the AZG site in Groningen) were two different species from the same pit submitted for ^{14}C dating. For Mariënberg *Pinus* vs. *Quercus* was dated in three cases (Lanting & Van der Plicht, 1997/1998: p. 143) and *Quercus* vs. *Alnus* twice (section 9.4). Three hearth-pits from the AZG site in Groningen were dated by both *Pinus* and *Quercus* (section 9.2). These double dates were tested with a Chi-square test (see section 3.6 below) and in the case of a statistically significant difference the youngest date was chosen since it was the most likely to represent the archaeological event, in this case the use of the hearth-pit. If not different, the dates were combined into a weighted average. Pine wood proved to be statistically significantly older than oak in two out of six cases, while alder is considerably older than oak from the same pit in one of the two cases. If these data are representative of the entire set of ^{14}C-dated hearth-pits it means that nearly 40% of all charcoal dates may be erroneous, *i.e.* too old. Unfortunately, at present there is no possibility of correcting for this bias, unless all charcoal dates from hearth-pits are removed from the analysis, which evidently is not an option.

Finally, the four ^{14}C dates with standard deviations greater than 150 years were excluded as well (fig. 4).

3.6. Combining ^{14}C dates; the Chi-square test and weighted averaging

After removal of the rejected dates the database still contains a total of 426 ^{14}C dates. In twelve cases there are two ^{14}C dates available for the same object or from the same archaeological context and it is reasonable to assume that both dates reflect the same event. To determine if these dates do indeed represent a relatively short-lived episode, a Chi-square test was performed (Shennan, 1988; Siegel & Castellan, 1988; Ward & Wilson, 1978). This test compares the variation of the dates by taking into account the standard deviations. To put it simply: if the variation between the

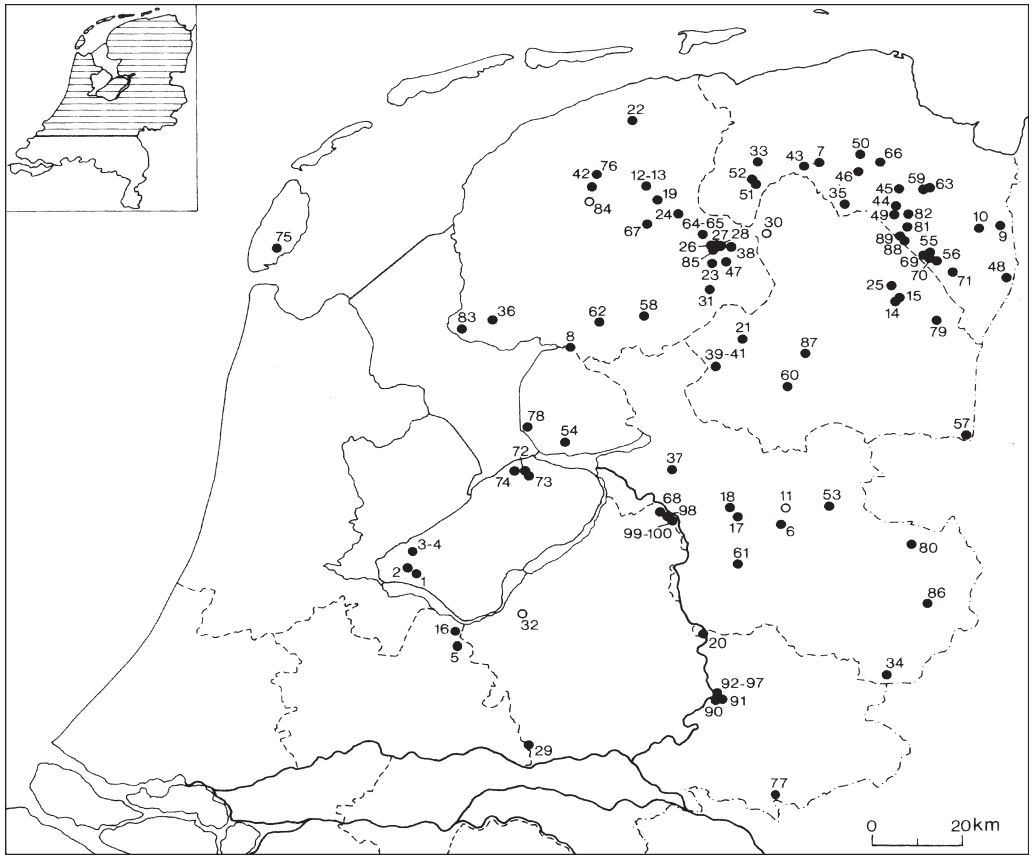

Fig. 5. Map of the study area, showing the location of all 100 sites with reliable ^{14}C dates. Solid circles: sites for which exact coordinates are known (n=96); open circles: sites for which the location is approximately known (n=4). The figures in brackets indicate the number of reliable dates. The extent of the study area is indicated by hatching (drawing M.J.L.Th. Niekus & J.H. Zwier).

1. Almere-Hoge Vaart (51), 2. Almere-Hout 'Zwaanpad' (2), 3. Almere-Zenit 1 (1), 4. Almere-Zenit 2 (1), 5. Amersfoort (1), 6. Archem (1), 7. AZG site, city of Groningen (25), 8. Bantega (2), 9. Bellingwedde Be-45 (1), 10. Bellingwedde Be-52 (1), 11. Beerzer Belten I (1), 12. Bergumermeer S-64A (1), 13. Bergumermeer S-64B (7), 14. Borger-'vuilstort' (3), 15. Bronneger-Voorste Diep (2), 16. Bunschoten-Spakenburg N-68 (1), 17. Dalfsen-Rechteren (3), 18. Dalfsen-Welsum (8), 19. De Leijen (Zwartmeer/Rottevalle) (2), 20. Deventer-Rielerenk (1), 21. Diever (1), 22. Dokkum-Jantjes Zeepolder (2), 23. Donkerbroek-'zwembad' (1), 24. Drachtster Compagnie (1), 25. Drouwenerzand I (2), 26. Duurswoude I (1), 27. Duurswoude III (1), 28. Duurswoude-Oud Leger (1), 29. Ede-Maanderbuurt (4), 30. Een 1953 (2), 31. Elsloo-Tronde (1), 32. Ermelo (1), 33. Grootegast-Niekerk ZWK III (2), 34. Haaksbergen-Hassinkbrink II (1), 35. Haren-Glimmer Es (1), 36. Harich (1), 37. Hasselt-Gasthuisstraat (1), 38. Haule I (1), 39. Havelte-De Doeze 1 (H1) (5), 40. Havelte-De Doeze 2 (H2) (2), 41. Havelte-De Doeze 3 (H3)(1), 42. Hempens-Wâldwei (2), 43. Hoogkerk-Ruskenveen (1), 44. Hoogezand-Sappemeer HS-17 (1), 45. Hoogezand-Sappemeer HS-22 (1), 46. Hoogezand-Sappemeer HS-30 (1), 47. Jardinga-'Johannahoeve' (13), 48. Jipsingboertange (1), 49. Kielsterachterweg KAW 64-A (4), 50. Lageland I (1), 51. Leek-AZC 'Blinksloot' (14), 52. Leek-Mensumaweg IV (2), 53. Mariënberg (53), 54. Nagele-J125/N.O.P. (1), 55. Nieuwe Pekela NP-3 (23), 56. Nieuwe Pekela NP-9 (2), 57. Nieuw-Schoonebeek (3), 58. Oldeholtwolde (1), 59. Oosterbroek Ok-8 (1), 60. Pesse (1), 61. Raalte-Jonge Raan/De Kaamp (2), 62. Rotsterhaule (Polder Westerschar) (3), 63. Scheemda Sa-18 (Scheemderzwaag-Medemertol) (2), 64. Siegerswoude I (1), 65. Siegerswoude II (1), 66. Slochteren-Hooilandspolder (2), 67. Smalle Ee (1), 68. Spoolde (Zwolle) (3), 69. Stadskanaal S-1 (28), 70. Stadskanaal S-51 (3), 71. Stadskanaal S-6 (2), 72. Swifterbant S-11 (3), 73. Swifterbant S-21/22/23 (4), 74. Swifterbant-Klingenweg (3), 75. Texel-Den Burg (2), 76. Tietjerk-Lytse Geast (Kleine Geest) IV (1), 77. Ulft (1), 78. Urk-E4 (Domineesweg/Noordgat) (6), 79. Valthermond-Exloërkijl (6), 80. Vasse-'De Steenbrei' (1), 81. Veendam Vm-24 (1), 82. Veendam Vm-25 (Golfbaan, De Compagnie) (2), 83. Warns (2), 84. Wartena (1), 85. Waskemeer-West (= Duurswoude V) (1), 86. Weerselo-Gammelke (3), 87. Wijster (3), 88. Wildervank Wv-42 (2), 89. Wildervank Wv-500 (1), 90. Zutphen-Ooyerhoek (1), 91. Zutphen-Looërenk (2), 92. Zutphen-Ooyerhoek Site A (1), 93. Zutphen-Ooyerhoek Site B (2), 94. Zutphen-Ooyerhoek Site C (1), 95. Zutphen-Ooyerhoek Site H (1), 96. Zutphen-Ooyerhoek Site M (8), 97. Zutphen-Ooyerhoek Site Q (1), 98. Zwolle-Hanzeland (9), 99. Zwolle-Ittersumallee/De Geren (2), 100. Zwolle-Oude Deventerstraatweg (Vrouwenlaan/Schellerhoek) (22).

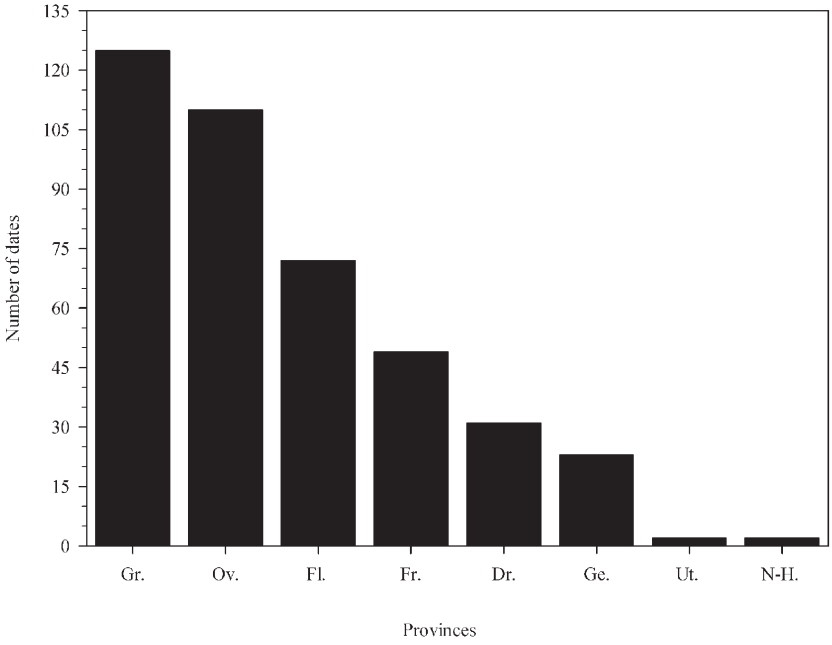

Fig. 6. Provinces: bar graph showing the number of reliable ^{14}C dates (n=414). For the key to the abbreviations see figure 1 (graph M.J.L.Th. Niekus).

dates is greater than the standard deviation allows, the dates cannot be combined, since it must be assumed that they represent different archaeological events. Following Bowman & Balaam (1990) and Buck, Litton & Scott (1994) the Chi-square test was applied only to sets of ^{14}C dates that were made on samples of the same type of organic material.

The Chi-square tests were performed with the *R_Combine* command in the Oxford Calibration Program version 3.10, 2005 (Bronk Ramsey, 2001; Reimer *et al*., 2004). The dates entered are automatically checked for internal consistency by a Chi-square test and an error message is generated when the confidence limit drops below 5%.[10] If this is the case, it is likely (from a statistical point of view) that the samples do not derive from the same event. For dates that can be combined a weighted average is automatically calculated according to the principles outlined by Long & Rippeteau (1974) and Ward & Wilson (1978). In the database the results of the Chi-square tests are presented in full. Instead of simply stating that dates are significantly different or not, the probability value (p) associated with the chi-squared value (in OxCal represented by T) at the 0.05 level of significance is given (table C in Siegel & Castellan, 1988). Statistically significant probabilities are underlined.

4. REPRESENTATIVITY OF THE ^{14}C DATES

At the time of closing of this manuscript (December 2005) there are 414 ^{14}C dates (including the twelve combined dates) from 100 locations that are plotted on the map in figure 5. This map clearly shows that the dated sites are not evenly distributed over the study area, which is reflected in the number of dates for each province (fig. 6).

In some parts of the study area there are many sites (and dates) while in other parts there are few or none at all. These marked differences are especially evident in the densities of dates and dated sites that were calculated for each province (table 1 and fig. 7).[11] The part of Zuid-Holland that falls within the study area is excluded because no reliable dates are available for this province.

Several factors are responsible for these differences, including the geology of the landscape, differences in archaeological research intensity and current land-use. These will be discussed in the following sections.

4.1. Geological history and sea level rise

The scarcity of dates in the western part of the Netherlands (provinces of Noord- and Zuid-Holland) and in the coastal areas of Friesland and Groningen can be explained by the region's geological history. In the course of the Holocene these areas gradually drowned as a result of the rising sea level and sites were either eroded away or covered by thick layers of marine-littoral sands and clays and peat deposits (shaded area in the distribution maps presented in section 6). As a con-

Table 1. Provinces: surface area in km², number of dated sites and number of dates.

	Surface area km²	*N sites*	*N sites/100km²*	*N dates*	*N dates/100km²*
Groningen	2336	26	1.1	125	5.4
Overijssel	3327	15	0.5	110	3.3
Flevoland	1419	9	0.6	72	5.1
Friesland	3349	24	0.7	49	1.5
Drenthe	2642	12	0.5	31	1.2
Gelderland	3317	11	0.3	23	0.7
Utrecht	1386	2	0.1	2	0.1
Noord-Holland	2670	1	0.04	2	0.07
Study area	20,446	100	0.5	414	2.0

sequence Late Pleistocene and Early Holocene sites and landscapes are situated at a greater depth below the present surface and are barely if not at all accessible for research. The relatively large number of dates for the province of Flevoland as compared to other drowned areas is mainly due to extensive systematic coring projects and several large-scale excavations. The majority of sites are however to be found on the comparatively high and dry Pleistocene soils in the eastern part of the country. To illustrate the effect of sea level rise, a scatter diagram was made, showing the relationship between ^{14}C dates and the elevation of sites above sea level (a.s.l.) in prehistoric times (fig. 8).

The height above prehistoric sea level was calculated by relating the modern sea level datum (NAP) of the dated samples to the relative rise in sea level during the early postglacial. For example: around 7000 BP the sea level was approximately 15 metres below that of today. If we have a date of 7000 BP for a site ten metres above NAP, it follows that the dated site was situated at an elevation of roughly 25 metres above the contemporary sea level. This calculation was performed for the 393 dates with a known NAP value.[12] For dates that fall between the 'fixed' data points in table 2, the prehistoric heights a.s.l. were calculated on the basis of the average rise in sea level in 100-year periods. Data on the relative sea level rise were averaged from publications by Beets & Van der Spek (2000), Behre (2003), Lanting & Van der Plicht (1997/1998) and Vos & Kiden (2005).

From the plot in figure 8 it is evident that a circa curvilinear relationship exists between ^{14}C dates and the sites' prehistoric height a.s.l.: the older a site, the higher it is situated above the prehistoric sea level (and generally speaking further away from the coast; see figure 2). The measure of association between prehistoric height a.s.l. and ^{14}C dates was tested with the Spearman rank-order correlation coefficient (Hurst Thomas, 1986; Siegel & Castellan, 1988).[13] A correlation coefficient of $r_s = 0.946$ (z-value = 18.73) proves that there is a near-perfect relationship between the variables with a one-tailed (the direction of association is predictable) significant probability of $p \leq 0.00003$.[14] This strong correlation is caused by a third variable, in this case the rise in sea level during the Early Holocene, which inundated part of the territory occupied during the Early Mesolithic.

Table 2. Reconstructed sea levels relative to NAP and inferred rates of increase.

10,000 BP	-90
10,000-9000 BP	-65 (2.5 m / 100 years)
9000-8500 BP	-53 (2.4 m / 100 years)
8500-8150 BP	-43 (2.9 m / 100 years)
8150-8000 BP	-40 (2.0 m / 100 years)
8000-7500 BP	-28 (2.4 m / 100 years)
7500-7000 BP	-15 (2.6 m / 100 years)
7000-6250 BP	-9 (0.8 m / 100 years)
6250-5500 BP	-7 (0.3 m / 100 years)

The empty area to the left of the scatter in figure 8 gives an idea of the amount of data that is missing from the archaeological record due to the drowning of the prehistoric landscape. A significant part of the earlier Mesolithic occupation in the western part of the study area is no longer available owing to erosion or sediment cover, and dates from this period are heavily biased towards non-coastal or inland sites.[15] In fact, the later the dates, the more representative of the overall prehistoric situation they potentially are. The Early Mesolithic sites in the study area may of course accurately represent the inland occupation. By the later Mesolithic the coastline had more or less reached its present-day position so that a wider range of Late Mesolithic site types are potentially available,

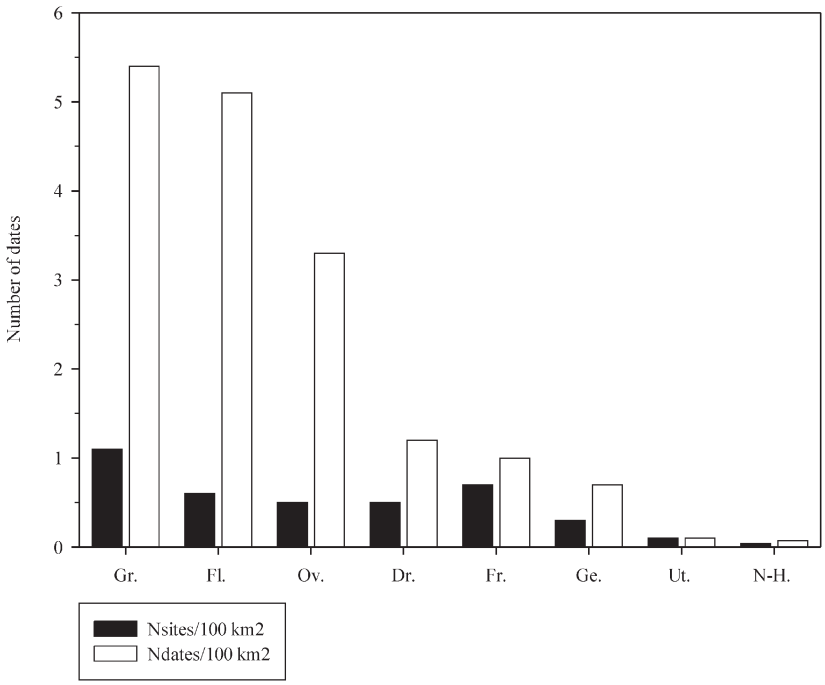

Fig. 7. Provinces: bar graph showing the relationship between the average number of sites/100 km^2 and the average number of dates/100 km^2. For the key to the abbreviations see figure 1 (graph M.J.L.Th. Niekus).

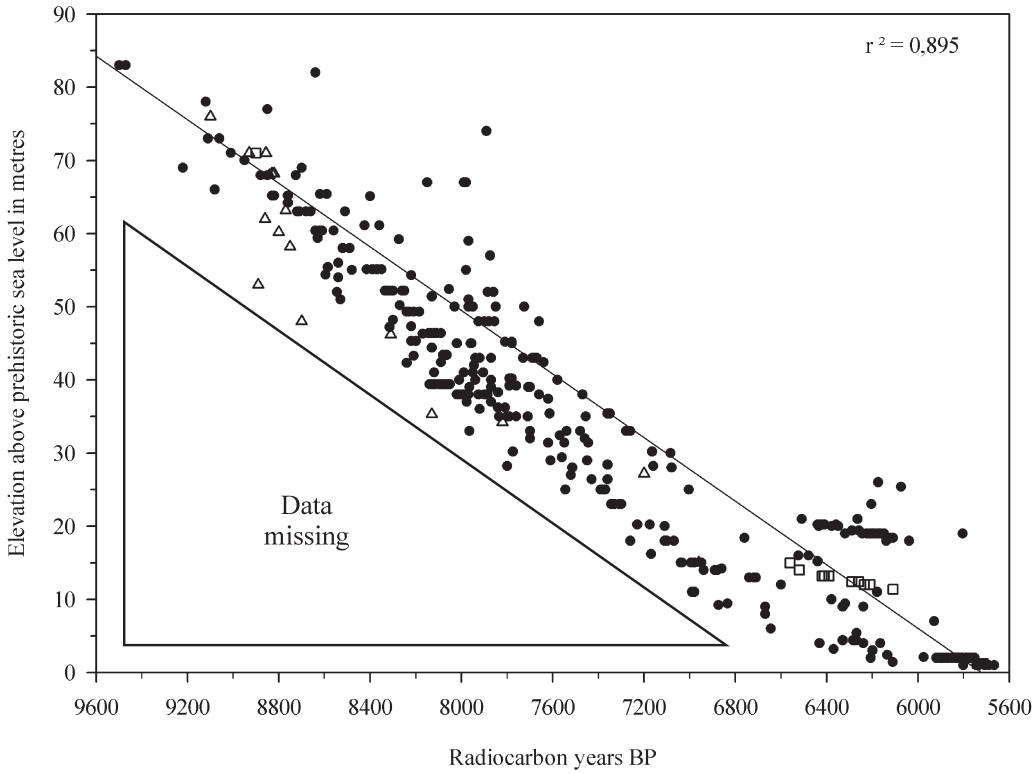

Fig. 8. Scatterdiagram showing the association between uncalibrated ^{14}C dates (n=393) and the calculated elevation in metres above prehistoric sea level. The regression line and the coefficient of determination (r^2) are indicated. Key to the symbols: solid circles: hearth-pits, open triangles: burnt hazelnut shell, open squares: bone, wood and antler (graph M.J.L.Th. Niekus).

from true coastal or intertidal sites to inland sites. In earlier publications (*e.g.* Newell, 1973; Price, 1978) sites from the earlier part of the Mesolithic were often analysed together with those from the later Mesolithic, which in a sense is comparing apples with pears because they may represent parts of totally different settlement systems.

To determine if the differences in representativity between the earlier and later Mesolithic can also be demonstrated statistically, the dates were divided into the two groups that are visible in the scatter. The larger group consists of the 266 dates between 9600 and 6900 BP and the smaller group covers the period from 6900 BP to 5600 BP (n=127). The first group was tested with the Pearson product-moment correlation coefficient, since the scatter approaches a normal distribution (fig. 9).

A correlation coefficient of r = 0.911 (z = 14.83) was produced, with a one-tailed significant probability of $p < 0.00003$, which is similar to the results for the entire scatter, and caused by the rise in sea level. Because the coastline had more or less reached its present-day position by about 6900 BP, it was expected that the test for the second period (figure 10) would yield a non-significant result. This proved not to be the case; the analysis (two-tailed) produced a Spearman correlation coefficient of $r_s = 0.669$ (z = 7.51), statistically significant at $\alpha = 0.01$: $p < 0.00006$.

This result is rather surprising because there is a visually strong linear relationship between the ^{14}C dates and prehistoric height a.s.l. in the scatter. What we are most probably dealing with is a pseudo-correlation, caused by the numerous outliers and the two major groups in the scatter; one with high values for both variables (c. 6500–6100 BP, 20 metres a.s.l.) and one with low values (after 6000 BP at c. 2 metres a.s.l.). The pseudo-correlation is confirmed by the low coefficient of determination ($r^2 = 0.448$) which means that only 44.8% of the variance can be explained by the regression and that the remaining 55.2% is the result of chance, measurement error, analytical error, ties etc.

Despite the fact that the test results described above are unreliable, there are some marked differences in general height a.s.l. Dates before 6000 BP show a wider spread in elevation, with an emphasis on 20 metres. Possibly there are even three groups; the first between

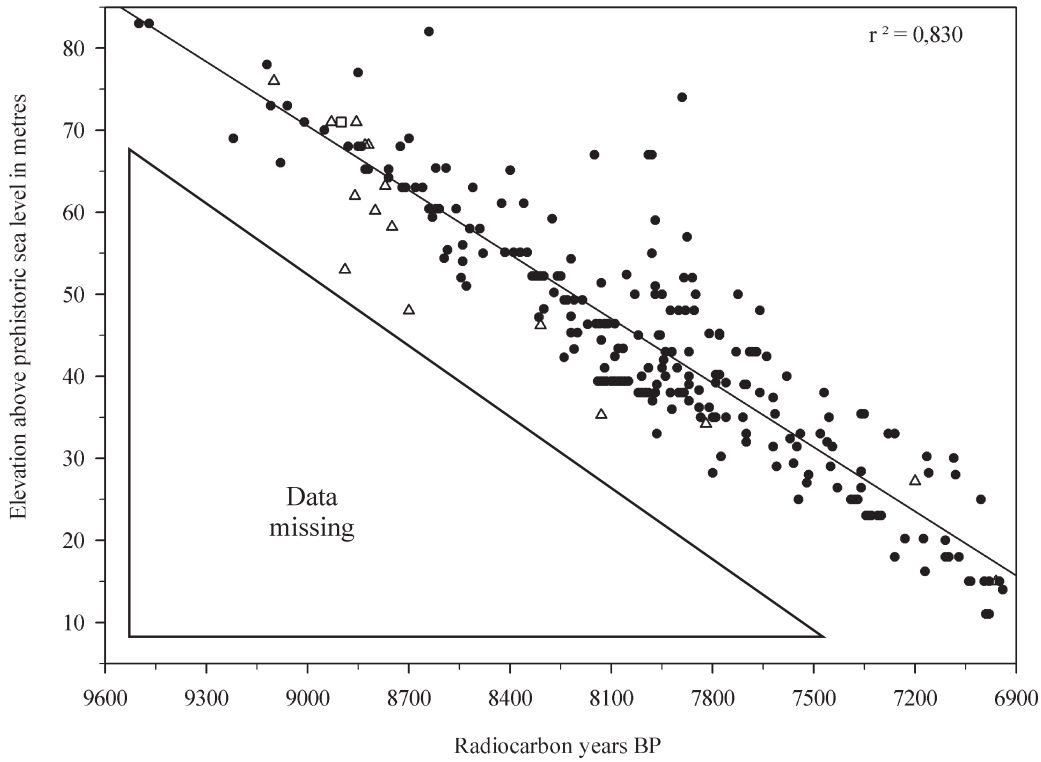

Fig. 9. Scatterdiagram showing the association between uncalibrated ^{14}C dates (n=266) and the calculated elevation in metres above prehistoric sea level for the period 9600–6900 BP. The regression line and the coefficient of determination (r^2) are indicated. For the key to the symbols see figure 8 (graph M.J.L.Th. Niekus).

0 and 5 metres, the second between 10 and 15 metres and a third around 20 metres a.s.l. For the period after 6000 BP nearly all sites are situated around 1–2 metres and there are few counterparts for the higher elevations. To test if there is a significant difference in height for dates before (n=81) and after 6000 BP (n=46), the *Mann-Whitney U test* or *Wilcoxon-Mann-Whitney test* was used (Hurst Thomas, 1986; Siegel & Castellan, 1988).[16] The following result (two-tailed) was obtained: U = 250, z = -8.436, p = 0.000 (table A in Siegel & Castellan, 1988). This statistically significant result indicates that there is a difference in prehistoric height a.s.l. between sites of the later Mesolithic before c. 6000 and the Early Swifterbant culture. Early Swifterbant sites are in general situated at a lower altitude relative to the sea level than Late Mesolithic sites, which seems to indicate a difference in preferred settlement location.

4.2. Differences in archaeological research intensity

Except for the major differences in the number of sites and dates between the eastern and western part of the study area, large differences exist within the comparatively high sandy interior as well. The high density of sites in for example the eastern part of Groningen is mainly the result of the region's research history. Since the early 1980s intensive systematic research has been conducted in the Veenkoloniën, a peat reclamation district, where hundreds of sites have since been discovered and parts of more than a dozen have been excavated (Groenendijk, 1997; 2004). Other areas, such as the northern part of Overijssel, have traditionally received far less attention from universities and other institutions and only a few amateur archaeologists have been active in this area. The low number of sites in Utrecht and parts of Gelderland are most probably due to poor visibility of Mesolithic remains, since extensive parts of these provinces consist of forested areas and peat-deposits (Peeters & Niekus, 2005). This situation is now slowly changing as the result of large-scale infrastructural works, housing development and the rise of commercial archaeology. An example is the area around the town of Zutphen where several Mesolithic sites have been excavated over the past few years. At present, this research bias

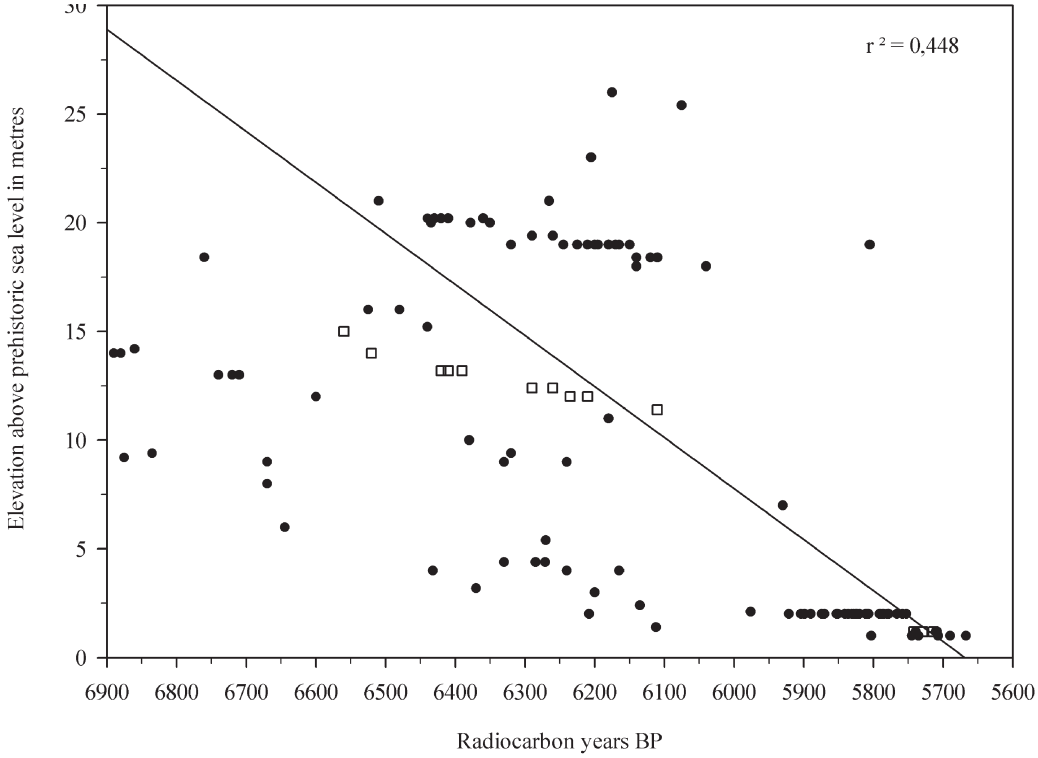

Fig. 10. Scatterdiagram showing the association between uncalibrated ^{14}C dates (n=127) and the calculated elevation in metres above prehistoric sea level for the period 6900–5600 BP. The regression line and the coefficient of determination (r^2) are indicated. For the key to the symbols see figure 8 (graph M.J.L.Th. Niekus).

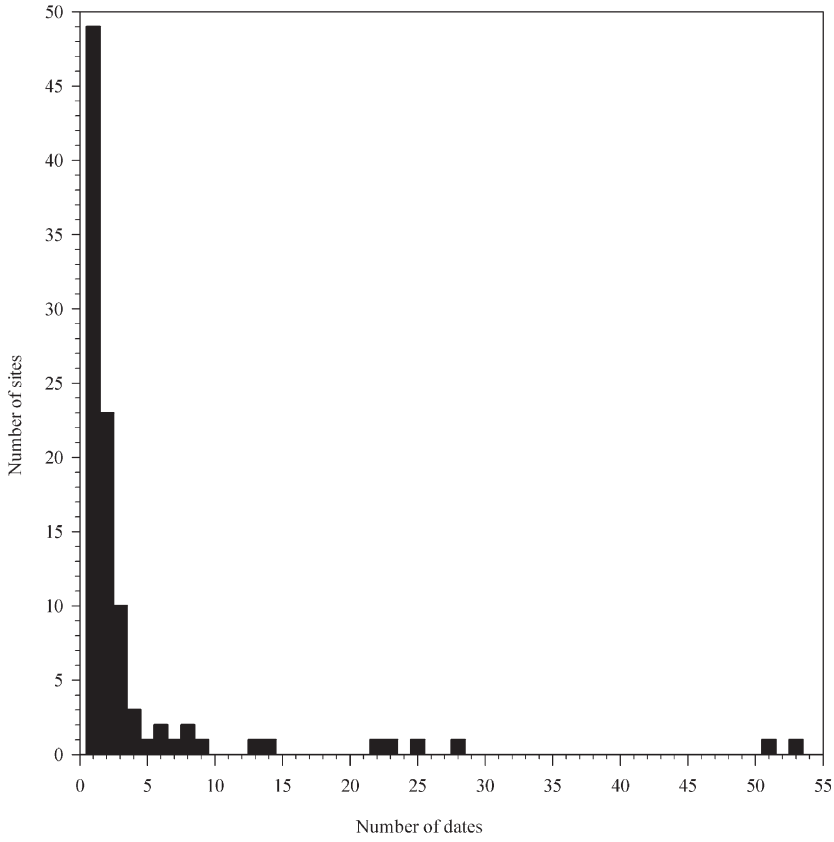

Fig. 11. All ^{14}C dates (n=414): histogram showing the number of ^{14}C dates per site (graph M.J.L.Th. Niekus).

is impossible to correct for and in future research projects more attention will have to be given to areas devoid of Mesolithic remains.

4.3. Inter-site differences

There are differences in the number of dates, not only on the scale of study area as a whole and between regions but also between sites. The number of dates per site ranges from 1 to 53 (fig. 11) with an average of 4.1 (std. deviation 8.4) dates per site for the study area as a whole.

At least four groups of dates are visible in this graph. The largest group represents sites (n=92) with less than ten dates each. More than half of these sites have produced only one reliable ^{14}C date. The sites Jardinga (Friesland) and Leek-AZC 'Blinksloot' make up the second group with 13 and 14 dates respectively. In the province of Groningen there are three sites with more than 20 dates; Stadskanaal S-1 (n=28), the AZG site in the city of Groningen (n=25) and Nieuwe Pekela NP-3 (n=23). This third group also includes Zwolle-Oude Deventerstraatweg (ODE) in Overijssel with 22 dates. The fourth group consists of two sites: Mariënberg and Almere-Hoge Vaart with 53 and 51 dates respectively. These two sites are responsible for nearly a quarter of all dates in the database, which is also reflected in the length of the bars for the provinces of Overijssel and Flevoland in figure 7.

The reason why Flevoland, Overijssel and Groningen are overrepresented (table 3) lies mainly in the character of the dated sites. Mariënberg, Zwolle-ODE, Almere-Hoge Vaart and some of the Groningen sites (*e.g.* S-1 and NP-3) are sites with dozens and sometimes hundreds of classic hearth-pits or, as in the case of Almere-Hoge Vaart, surface hearths.

At these sites there are ample opportunities for dating, which have been exploited for various research questions (Groenendijk, 1997; Peeters, in press; Verlinde & Newell, in press). A positive development is also the fact that budgets for ^{14}C dating have increased during the past decade. Hearth-pits are present at nearly all Mesolithic sites and are by far the most ^{14}C-dated context, especially in the northern part of the study area (table 4 and fig. 12).

Some figures: the total number of hearth-pits for 81 dated sites is 2166.[17] There are eleven sites, with a total of 17 dated hearth-pits, for which the actual number of pits could not be determined. For the remaining 70 sites the number of pits ranges between

Table 3. Provinces: average number of dates per site.

	N dates/site
Flevoland	8.0
Overijssel	7.3
Groningen	4.8
Drenthe	2.6
Gelderland	2.1
Friesland	2.0
Noord-Holland	2.0
Utrecht	1.0
Study area	4.1

1 and 539 with an average of 30.7 pits (std. deviation 84.38). Roughly speaking this means that a ^{14}C date is available for one out of every six known hearth-pits.

5. CHRONOLOGICAL PATTERNING

It was already mentioned in the introduction that this study employs uncalibrated dates rather than calibrated age ranges. The chronological distribution of all 414 ^{14}C dates is here shown in three different ways (figs 13–15), particularly to illustrate that dates BP and cal BC show hardly any differences in the shape of their distribution which might affect their interpretation. The first graph is a *sum probability plot* made with the Oxford calibration programme, version 3.10, 2005 (Bronk Ramsey, 2001; Reimer *et al*., 2004), the second a histogram and the third a cumulative frequency graph or trace line, sometimes referred to as an ogive (Fletcher & Lock, 1991). A discussion of trace lines and examples of their practical application in archaeology can be found in Stapert & Johansen (1995/1996). An important advantage of trace lines over histograms, and one of the main reasons why they are used in this section, is that the shape of the curve is not dependent upon arbitrarily chosen class boundaries.

5.1. All ^{14}C dates

The dates cover nearly 4000 radiocarbon years, from an axe-sleeve dredged up near Ulft in Gelderland (9550 BP: Verhart, 1998) to a shallow hearth-pit from Almere-Hoge Vaart which is dated to 5667 BP (Peeters, in press). All three graphs show a similar multimodal distribution. After a gradual increase during the earlier part of the Mesolithic, the number of dates quite rapidly grows until a maximum is reached around 7800 BP (c. 6600 cal BC), during the transition from the Boreal to the Atlantic period. During the first 400 radiocarbon years of the Atlantic, the number drops until 6700 BP. At this point, numbers are similar to the earlier Mesolithic. A second peak is present around 6300 BP (c. 5200 cal BC) which is again followed by a decrease in the number of dates during the transition from the Late Mesolithic to the Swifterbant culture. In the ceramic Mesolithic phase of the Swifterbant culture the number of dates increases once again. This peak mainly consists of dates from Almere-Hoge Vaart (Hogestijn & Peeters, 2001; Peeters, in press) and is dated to around 5800 BP or c. 4700 cal BC.

5.2. Hearth-pits and surface hearths

There are 364 hearth-pits in the dataset, all but one dated by charcoal. The exception is a hearth-pit from Zutphen from which burnt hazelnut shells were dated (Verneau, 1999). At the sites of Verrebroek and Doel in Flanders, dates from burnt hazelnut shell are always considerably older than charcoal dates from the same

Table 4. Provinces: number of dates and types of dating material/context.

	N sites	*hearth-pits*	*nutshells*	*bone, wood, antler*	*total*	*percentage*
Groningen	26	119	6	0	125	30.2%
Overijssel	15	107	0	3	110	26.6%
Flevoland	9	66	3	3	72	17.4%
Friesland	24	34	1	14	49	11.8%
Drenthe	12	28	0	3	31	7.5%
Gelderland	11	6	7	10	23	5.6%
Utrecht	2	2	0	0	2	0.5%
Noord-Holland	1	2	0	0	2	0.5%
Total	100	364 (87.9%)	17 (4.1%)	33 (8.0%)	414	100.1%

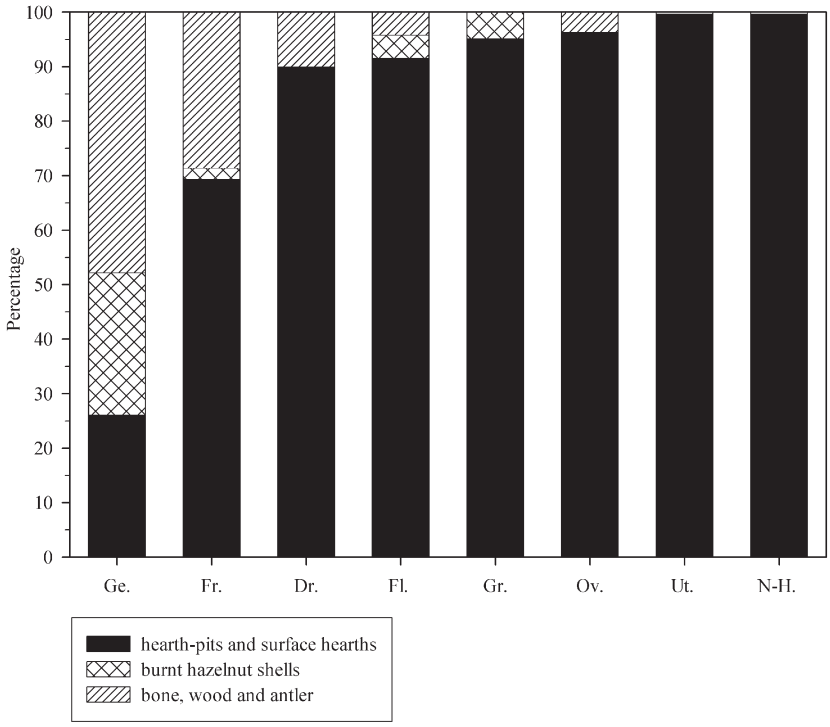

Fig. 12. Provinces: percentages of the dating categories (hearth-pits, burnt hazelnut shells and bone, wood and antler) based on the total number of dates for each province. For the abbreviations see figure 1 (graph M.J.L.Th. Niekus).

hearth-pit and hazelnut shells are considered residuals from earlier occupation in the area (Van Strydonck & Crombé, 2005). However, the small Zutphen site seems to be an isolated phenomenon where contamination with older material is unlikely but cannot be completely ruled out. Most hearth-pits are of the 'classic' type described in section 2.2. Forty-one hearths, all from Almere-Hoge Vaart, are relatively shallow and can be described as shallow hearth-pits or surface hearths. The trace line for all hearth-pits and the surface hearths is presented in figure 16.

If we compare the distribution of these dates to the graphs published by Waterbolk (1985; 1999) it can be seen that the overall shape of the curve has not changed much, except for the third peak in our data which consists of more recently published dates from Almere-Hoge Vaart (fig. 17). The first and second peaks are larger than before, both in the number of dates as well as in the spread of dates, which emphasizes the relative scarcity of dates from the Early Atlantic. Two sites with large numbers of dated hearth-pits, Mariënberg (Late Mesolithic) and Almere-Hoge Vaart (Late Mesolithic/Early Swifterbant), are largely responsible for the shape of the curve. If we omit these from the graph, the third peak disappears and the second is considerably reduced (fig. 18). Leaving out the four other sites with more than 20 dates (AZG site, NP-3, S-1 and Zwolle-ODE) mainly affects the earlier part of the curve, before c. 8000 BP (fig. 19). Both graphs underline the effect of only a small number of dated sites on the shape of the chronological curve. Furthermore these graphs show that extensive pit-cluster sites with many dates from the northern part of the study area are on the whole older than those further to the south.

5.3. Bone, wood and antler

There are 16 dates on bone, including two dates on calcined bone, and ten dates on wood (either used or worked). There are seven dates on antler, five of which display signs of working and/or use.[18] Two antlers belong to the Early Swifterbant votive deposit from Bronneger in Drenthe. The 33 dates do not show a continuous distribution but are clustered (fig. 20). The first group (9550–8700 BP) consists mainly of dates from the Early Mesolithic faunal assemblage of Zutphen (site M) but also includes a few isolated finds: the antler axe-sleeve from Ulft, the log boat from Pesse (Drenthe) and a piece of antler with cut-marks from Donkerbroek in Friesland (section 9.1). Only two dated finds are known for the period between

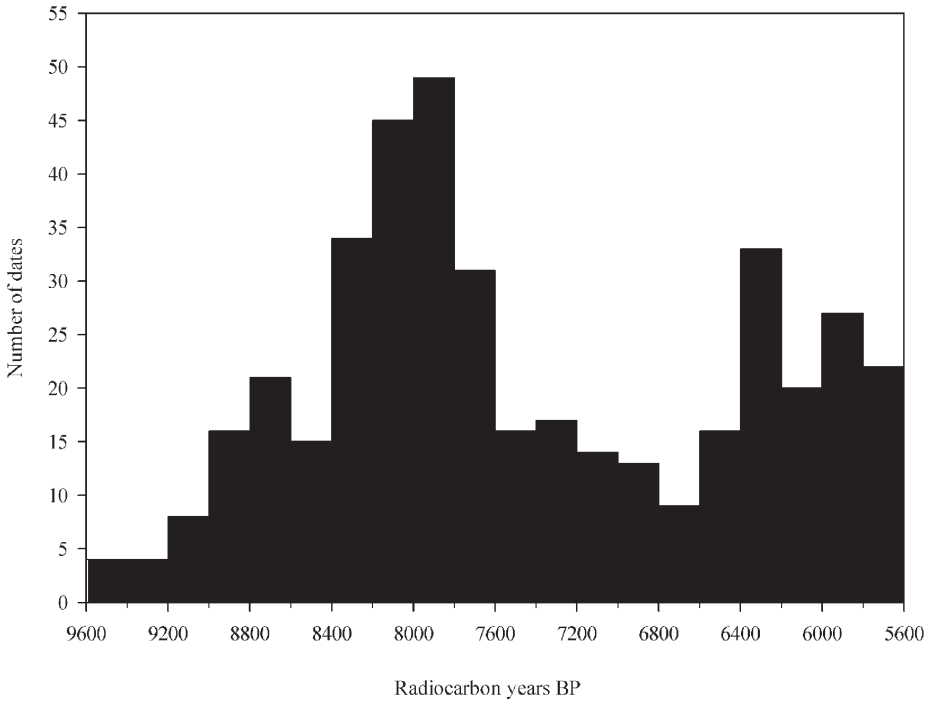

Fig. 13. Histogram of all ^{14}C dates (n=414) in intervals of 200 years (graph M.J.L.Th. Niekus).

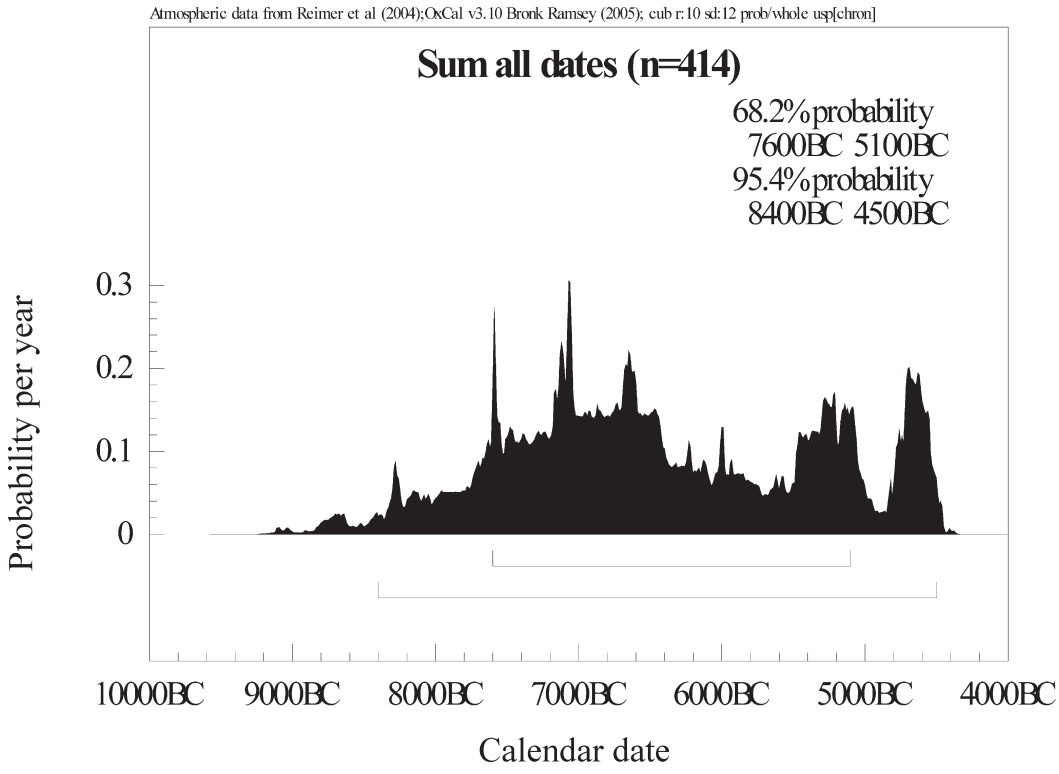

Fig. 14. *Sum probability plot* (Oxford calibration programme, version 3.10, 2005) of all 414 ^{14}C dates (graph M.J.L.Th. Niekus).

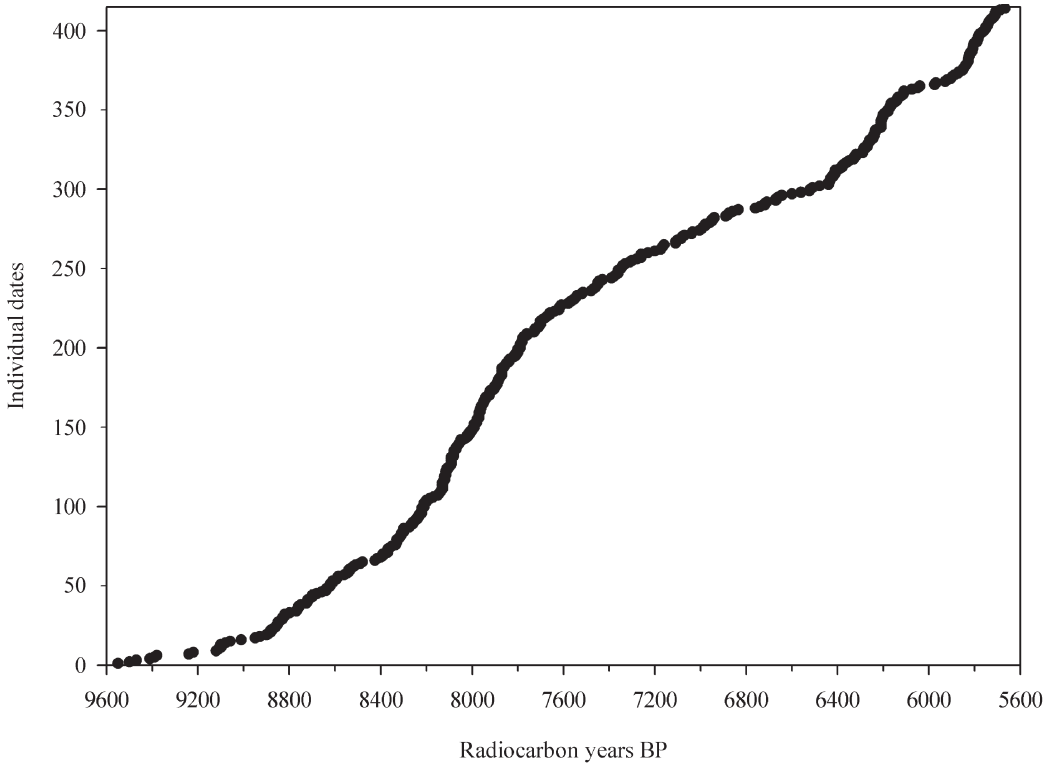

Fig. 15. Trace-line plot of all 414 ^{14}C dates (graph M.J.L.Th. Niekus).

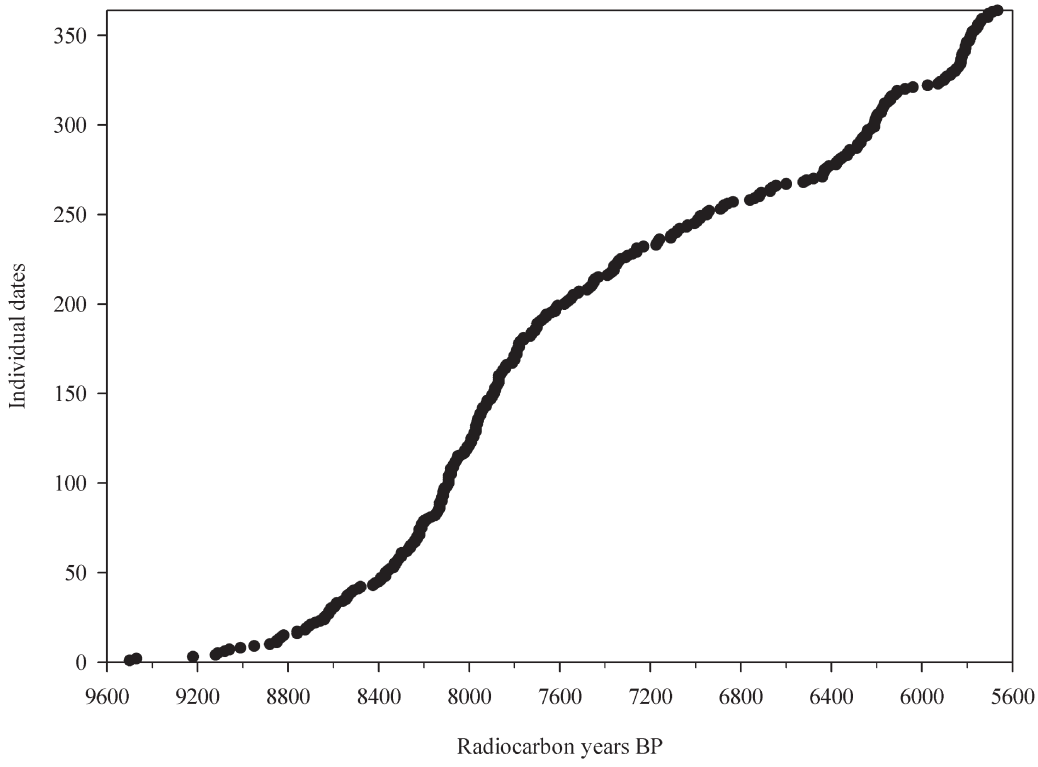

Fig. 16. Trace-line plot of all 364 ^{14}C dates on hearth-pits and surface hearths (graph M.J.L.Th. Niekus).

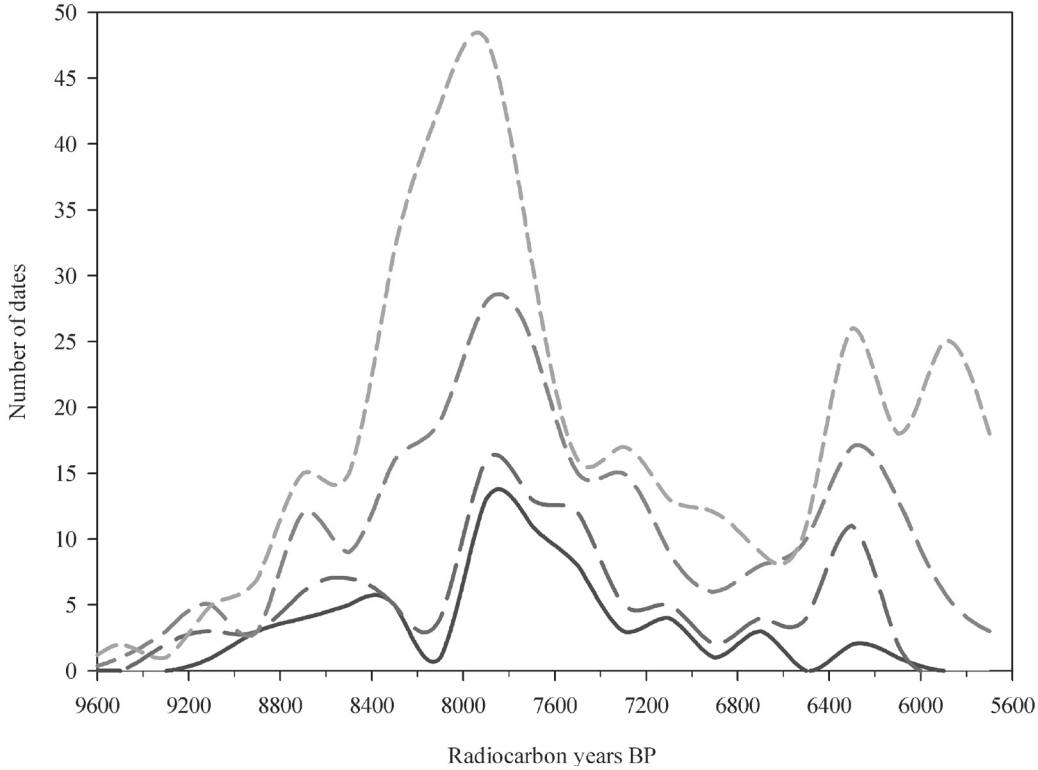

Fig. 17. Hearth-pits and surface hearths: comparison of the chronological distribution of 364 ^{14}C dates in this study (short dash) to Lanting & Mook, 1977 (solid line, n=65); Waterbolk, 1985 (long dash, n=104) and Waterbolk, 1999 (medium dash, n=223) (graph M.J.L.Th. Niekus).

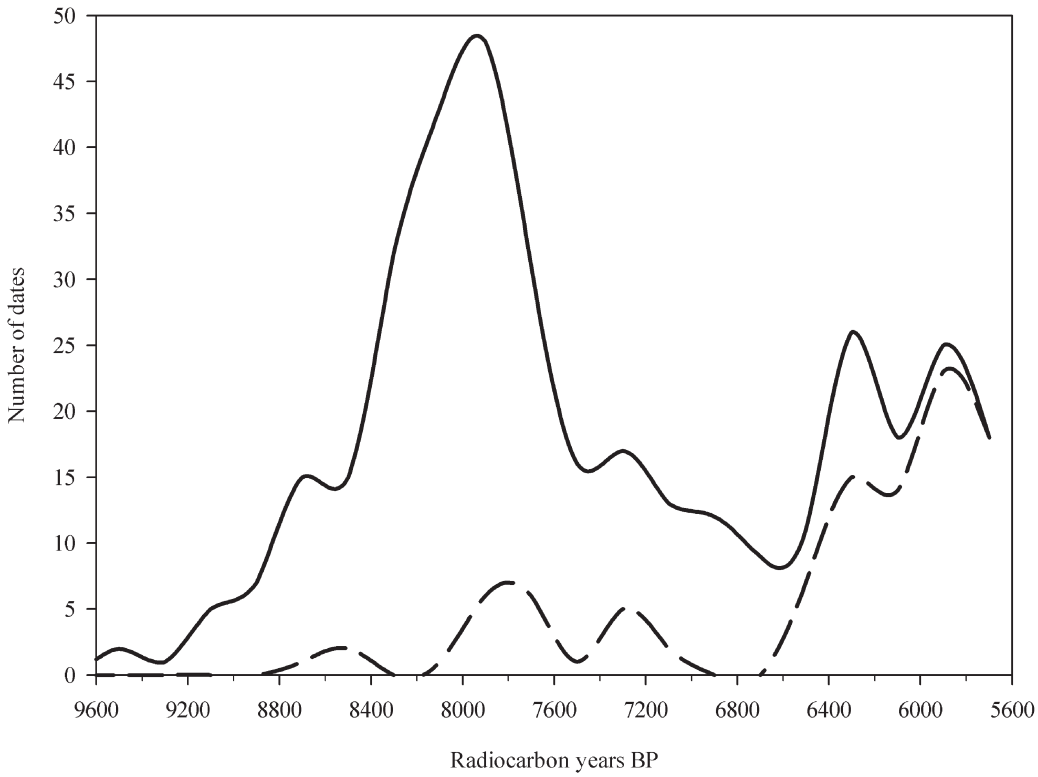

Fig. 18. Hearth-pits and surface hearths: comparison of the chronological distribution of 364 ^{14}C dates in this study (solid line) to the 101 dates from Mariënberg and Almere-Hoge Vaart (dashed line) (graph M.J.L.Th. Niekus).

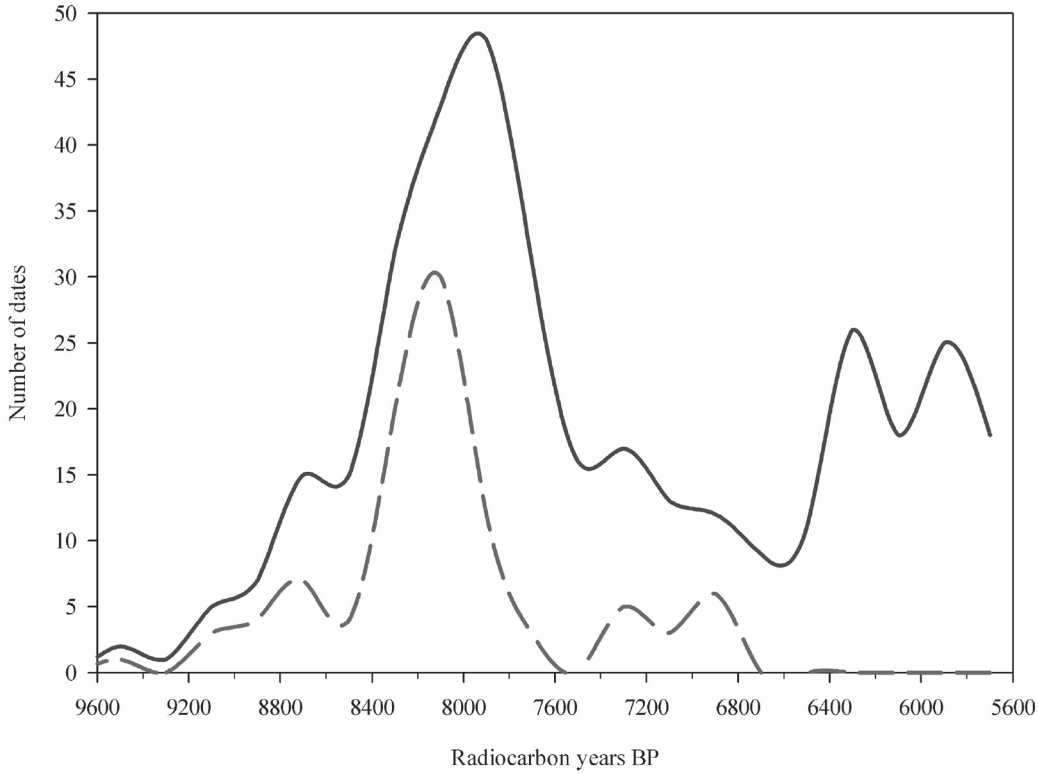

Fig. 19. Hearth-pits and surface hearths: comparison of the chronological distribution of 364 ^{14}C dates in this study (solid line) to the 98 dates from the AZG site, Nieuwe Pekela 3, Stadskanaal 1 and Zwolle-Oude Deventerstraatweg (dashed line) (graph M.J.L.Th. Niekus).

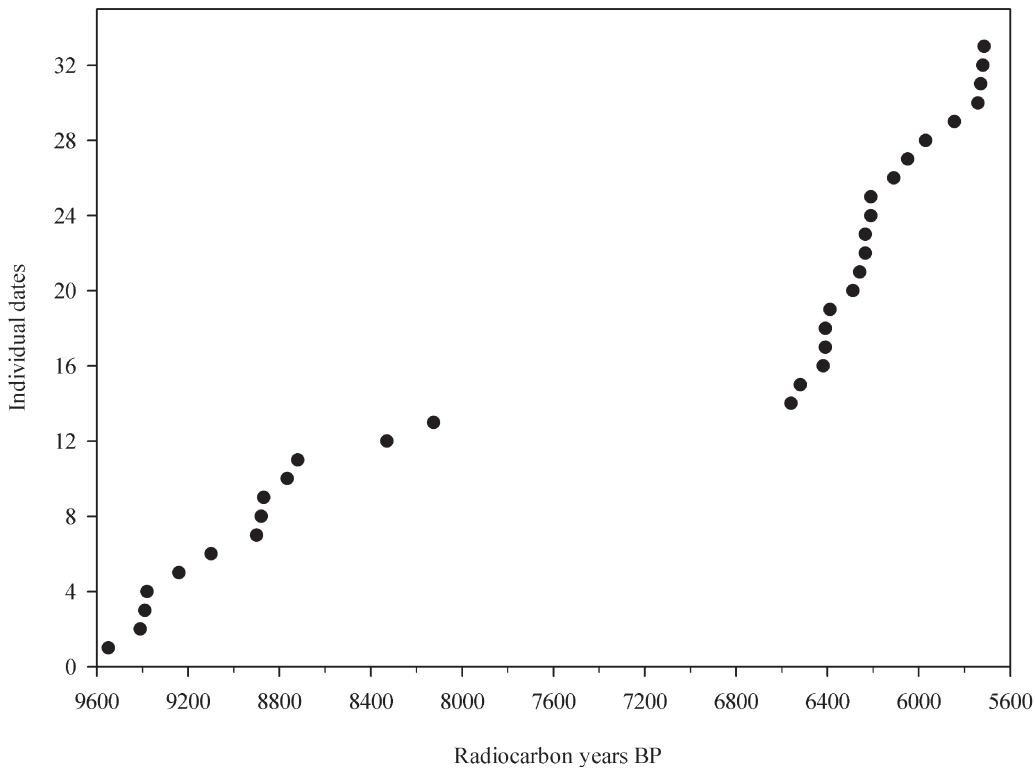

Fig. 20. Trace-line plot of all 33 ^{14}C dates on bone, wood and antler (graph M.J.L.Th. Niekus).

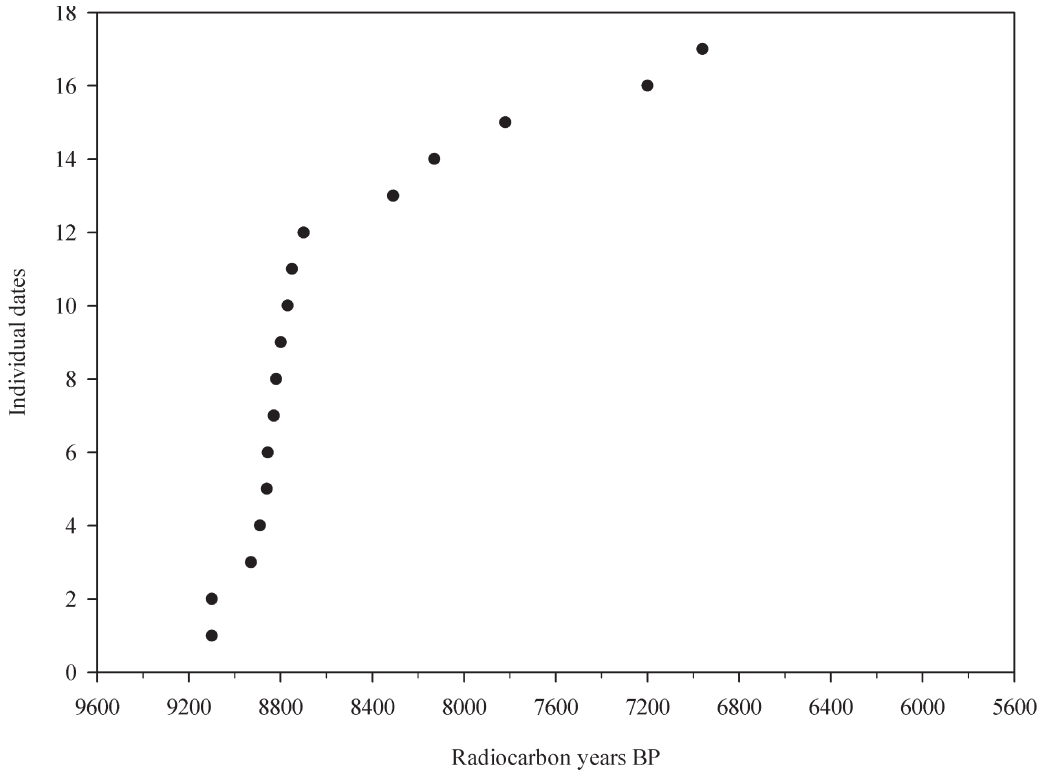

Fig. 21. Trace-line plot of all 17 ^{14}C dates on burnt hazel nutshell outside hearth-pits (graph M.J.L.Th. Niekus).

8400 and 8000 BP: a piece of antler with cut-marks from a suction-dredging area near Zwolle (Spoolde) and a fragment of a barbed bone point from Archem, both in Overijssel. The period between 8000 and 6600 BP (Early and first half of the Middle Atlantic) is strikingly empty in terms of unburnt organic material. Whether this hiatus merely reflects the general scarcity of dates in this period (see above), lack of research or low visibility, or indeed poor preservation conditions in pingo-scars, stream valleys and other wet environments (natural erosion, non-sedimentation, drought, excessive acidity or peat-digging) during these 1400 years, needs further investigation. From 6600 BP onward there are again quite a few dates, most of these from the Late Mesolithic site Jardinga in Friesland. This series also includes a T-shaped antler axe from Spoolde, the antlers from Bronneger and several dates from Zutphen site M and Almere-Hoge Vaart.

5.4. Burnt hazelnut shell

The 17 dates on burnt hazelnut shell are all on samples found outside hearth-pits and include concentrations of nutshells (possible surface hearths) as well as scattered pieces of shell. In the graph (fig. 21) at least two groups are visible. The two oldest dates are from sites near Zutphen and are followed by a relatively large number of dates between 9000 and 8700 BP. This group includes dates from the Zutphen area but also from three excavated sites in Groningen (Lageland I, Nieuwe Pekela NP-9 (Lanting & Van der Plicht, 1997/1998) and Slochteren-Hooilandspolder) and from two corings in Flevoland (section 9.6). A site from Friesland, 'De Leijen', produced the youngest date, around 7000 BP.

6. THE GEOGRAPHICAL DISTRIBUTION OF ^{14}C DATES

As with many other studies of spatial patterns, there is always the question of using the appropriate spatial scale. In his study, Waterbolk (1985; 1999) divided the Northern Netherlands into a number of different 'landscapes' to examine the patterning in ^{14}C dates. However, the meaning and relevance of these units to Mesolithic and Early Swifterbant foragers is difficult to assess and in this study the approach was abandoned. Instead of using predefined regions the coordinates of dated sites are plotted on maps of the study area (after Groenewoudt *et al*., 2001). Despite the fact that maps are more accurate, making it easier

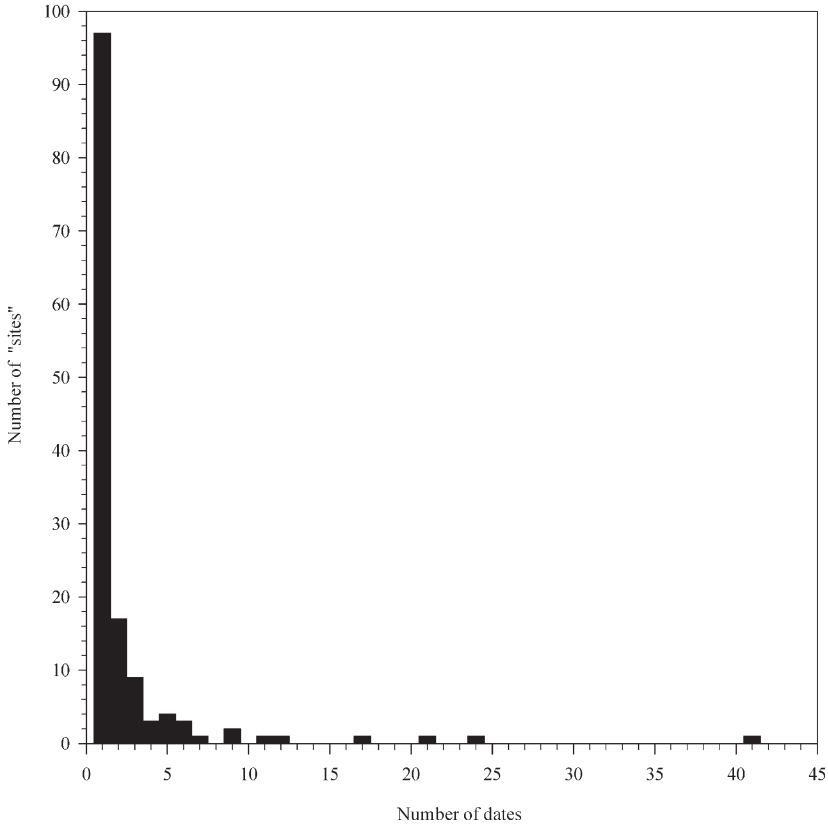

Fig. 22. Hearth-pits and surface hearths: number of dates (n=359) per site for individual maps (400-year periods) (graph M.J.L.Th. Niekus).

to identify large-scale shifts, there are also some clear disadvantages. Subtle changes on a more local level or on the scale of small regional units will be difficult or even impossible to identify. These will be the subject of future research.

For each map a time-frame of 400 radiocarbon years was considered to provide the best spatial resolution. The coordinates were taken from published and unpublished site-reports, excavation records or calculated from site distribution maps. There are four sites (fig. 5; Nos 11, 30, 32 and 84) without exact coordinates and these are not used in the maps. The locations of a small number of sites excavated during the 1960s and 1970s were recorded in Cartesian coordinates and these were transformed to the Dutch RD-system by using the *Coordinate Calculator* (version 4.1, 1999–2000) developed by the Geo-Information and ICT Department of the Ministry of Transport and Public Works (Ministerie van Verkeer en Waterstaat).[19] For all maps the same categories of dates as described in the foregoing sections were used: hearth-pits, burnt nutshells and bone, wood and antler, indicated on the map by different symbols. The size of the symbol reflects the number of dates from each site per chronological map. For burnt nutshells only one size class is used because the number of dates per site is limited, only one or two. The category bone, wood and antler is dominated by Zutphen Site M (17 dates) and Jardinga (14 dates). Two size classes were defined: 1–6 dates and 8 dates per site per map. The size classes for hearth-pits were defined on the basis of the histogram in figure 22. This diagram is not based on the total number of hearth-pits for each site but on the total number per site for each of the ten maps. Five size classes were defined: 1–3, 4–7, 9–12, 16–24 and the maximum of 41 hearth-pits per site in a single 400-year period (Almere-Hoge Vaart; map 10).

Map 1 (fig. 23) shows the distribution of the earliest dates, including the oldest (9500 BP) hearth-pit recorded in the study area. As a result of changing environmental conditions the reindeer had already migrated north, followed by Epi-Ahrensburgian hunter-gatherers. Apparently, part of the population stayed behind and adapted to the changing conditions during the Preboreal. Although the numbers are very small it is interesting to note that the three hearth-pits are all situated in the northern part of the study area, which may indicate that the tradition of digging hearth-pits

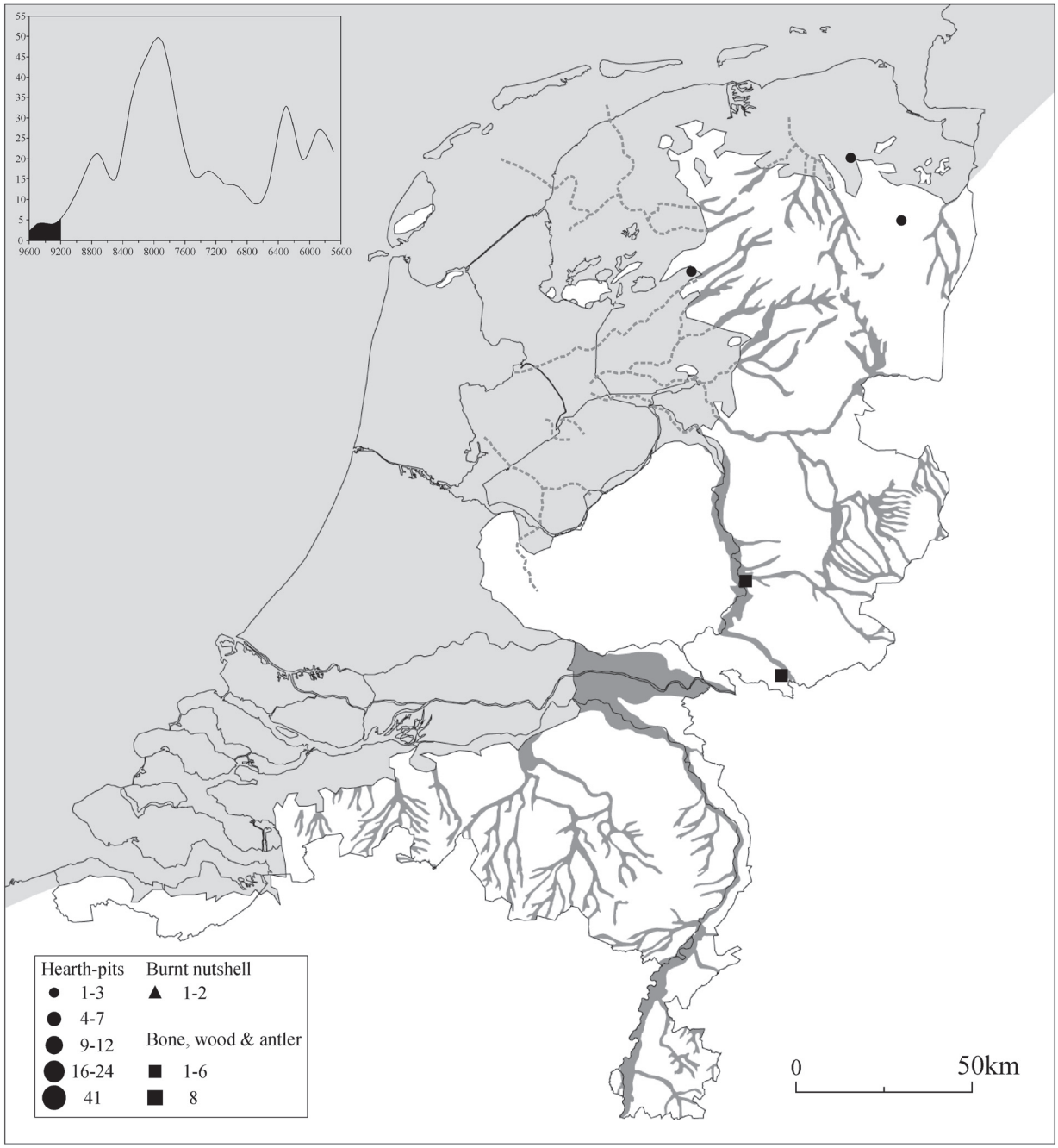

Fig. 23. Geographical distribution map of dates (n=8) in the period 9600–9200 BP. Key to the symbols: circles: hearth-pits, triangles: burnt hazelnut shells, squares: bone, wood and antler. Light shading: the area below the present-day sea level (NAP), dark shading: river and stream valleys. Dashed lines indicate the approximate position of river and stream valleys covered by later Holocene sediments (peat and clay) (drawing M.J.L.Th. Niekus & S. Tiebackx, modified after Groenewoudt *et al*., 2001).

originated somewhere in this region.[20] To test this hypothesis, all dates on classic Mesolithic hearth-pits (excluding surface hearths), including those from the southern part of the Netherlands (Lanting & Van der Plicht, 1997/1998) and Flanders in North-Western Belgium (Crombé, 2005) are arranged from north to south in figure 24. Due to the relatively small number of dated hearth-pits in the Southern Netherlands and adjacent Belgium these areas were not subdivided any further. The dates from the study area itself are subdivided into spatial classes (Dutch coordinates). Despite large differences in the number of dates between areas, a clear trend is visible: the further one moves south, the later hearth-pits seem to be 'introduced'.

Except for the larger number of dates, the overall picture does not change significantly between 9200 and 8800 BP (map 2; fig. 25), although hazelnuts were exploited for the first time in the area (see note 9).

Hearth-pits now also appear in other parts of the study area. This period perhaps saw the beginning of the 'pit-cluster' sites. At one site in Groningen, Stadskanaal 1 (S-1), there are six hearth-pits that fall within this time-frame. This could be taken as an indication that a more fixed pattern of land-use is developing and that some locations served as a focal point in the annual round. The dense cluster of dates in the southern part of the area marks the Early Mesolithic sites around Zutphen (Bos *et al*., 2005; Groenewoudt *et al*., 2001).

From approximately 8500 BP onwards the number of dates increases significantly and this is reflected in the density of data points and in the size classes of hearth-pits in maps 3 and 4 (figs 26–27). Especially in map 4, which covers the second half of the Boreal and the transition to the Atlantic, several large pit-cluster sites are evident in the northern part of the study area: the AZG site in the city of Groningen, Nieuwe Pekela NP-3 and Stadskanaal S-1 where occupation was recorded already in map 1. The AZG site is exceptional in the sense that all 25 hearth-pit dates fall in a period of only 320 radiocarbon years, which is short in comparison to other sites. Twenty-one of the dates appear in map 3 and four in map 4.

The more than doubling of dates from map 3 to 4 is probably the result of population increase, perhaps in combination with an influx of people from the drowning North Sea basin, but may also be an indication of more frequent re-use of the same location. A difference in research intensity is probably the main reason why the Veenkoloniën area in Groningen is so well-represented in these maps.

In this map, covering the period 8000–7600 BP (fig. 28), the number of dates has hardly changed but compared to the preceding map the emphasis has somewhat shifted from the north-eastern part to the central part of the study area. There are more data points in the northern part, mainly along the edges of the Drenthe Plateau, but fewer dates per site. A few pit-clusters are still evident in Groningen, such as at the AZG site and Leek, but now some are emerging in the central area as well. One of these is Mariënberg in Overijssel (eleven dates in this period) which is situated on the banks of the river Vecht. Generally speaking, pit-cluster sites from the northern part of the study area tend to be older than those situated further to the south. Other sites are Zwolle-Oude Deventerstraatweg (seven dates) and Dalfsen-Welsum (six dates), both also in Overijssel. The central and northern areas are separated by an empty region which corresponds to the northern part of Overijssel. The scarcity of dates from this area may be the result of a lack of research. Another possibility is that it represents a sort of (uninhabited?) border area between two cultural groups, the *Northwest Group* and the *Rhine Basin Group* (section 2.2).

The 'separation' between the northern and central part of the study area is even more evident in the period between 7600 and 7200 BP, when the number of dates has halved. In this phase (map 6, fig. 29) there are only two sites with more than three dates: Mariënberg and Zwolle-ODE.

The shift in a southward direction is clearly visible in the period between 7200 and 6400 BP (compare maps 7 and 8 in fig. 30–31). Especially after 6800 BP the number of dates for the northern part drops considerably, although a few scattered dates are still present. The Veenkoloniën were well-represented during the earlier Mesolithic, but now seem completely abandoned, at least in terms of ^{14}C dates. One of the best-dated sites is Jardinga in the valley of the river Tjonger in Friesland, where the remains from several butchered aurochs (*Bos primigenius*) were found. In phase 7 (7200–6800 BP) there are only two sites with more than three ^{14}C dates: Zwolle-ODE (nine dates) and a site in Flevoland, Urk-Domineesweg (E4) with four dates. In map 8 a string of sites in the Vecht valley, including Mariënberg with six dated hearth-pits, is clearly visible.

The distribution not only shifts southward but also seems to shift gradually in a westerly direction. During the late phase of the Mesolithic (6400–6000 BP, map 9, fig. 32) nearly half of all dates (24 out of 53) are from one site only, namely Mariënberg. The Vecht valley must have been an important route from the higher hinterland to the wetlands and coastal areas to the west. The importance of this river valley is em-

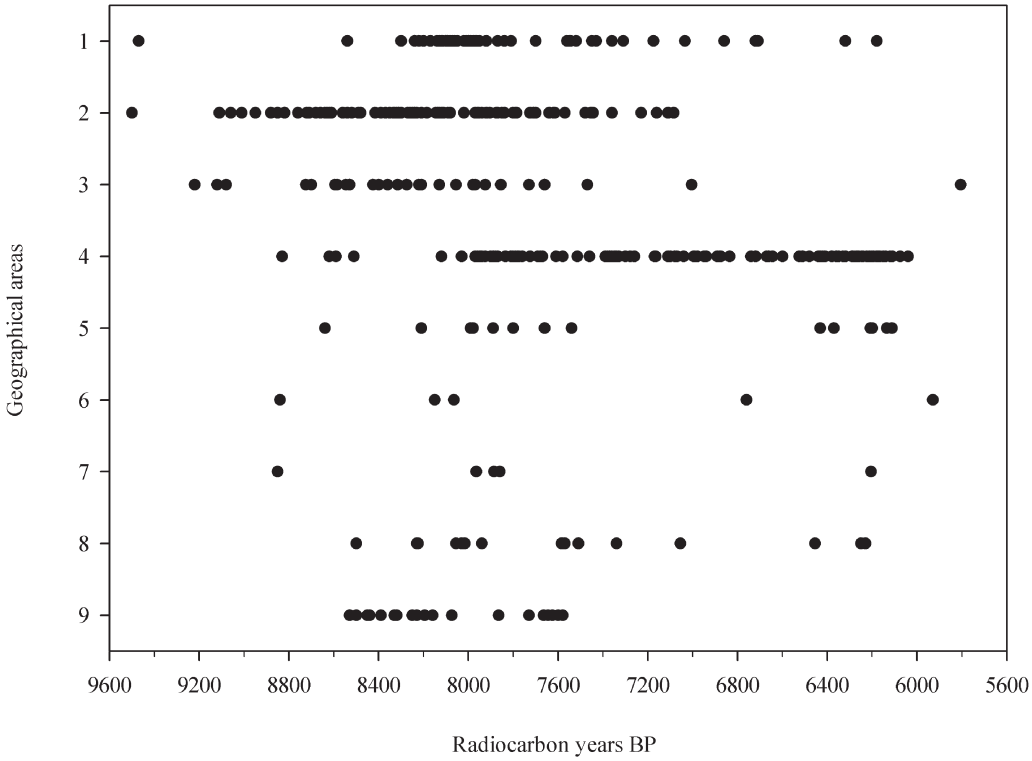

Fig. 24. Horizontal point plot with the individual ^{14}C dates for the 'classic' Mesolithic hearth-pits (n=360) arranged from the northern part of the study area (no. 1) to Belgium in the south (no. 9), according to the Dutch coordinate system. 1: 600–575 north (n=61), 2: 575–550 north (n=92), 3: 550–525 north (n=27), 4: 525–500 north (n=119), 5: 500–475 north (n=14), 6: 475–450 north (n=5), 7: 450–425 north (n=5), 8: southern part of the Netherlands (provinces of Noord-Brabant and Limburg)(n=17), 9: Belgium (mainly Sandy Flanders)(n=20) (graph M.J.L.Th. Niekus).

phasized by the presence of a small Mesolithic cemetery at Mariënberg which most probably dates to the Late Mesolithic, perhaps around 6000 BP (Verlinde & Newell, 2005: p. 10).

In Flevoland there are five dates for Almere-Hoge Vaart and six dates for sites in the area around Swifterbant, which lent its name to the Swifterbant culture. The second occupation phase at Jardinga is represented by eight ^{14}C dates.

In the final map (fig. 33), which covers the Early phase of the Swifterbant culture, the distribution pattern is dominated by Almere-Hoge Vaart with 41 dates including the youngest hearth-pit in the database. Evidence for use of the interior is sparse. A few hearth-pits and a closed find of a Swifterbant pot with two antlers from Bronneger in Drenthe are dated to this period.

The geographical patterning in the ^{14}C dates described in this section seems to confirm Waterbolk's idea (1985; 1999) that there is a shift in the location of sites during the Mesolithic. This shift took place during the Early Atlantic, from approximately 7600 BP onwards. During the earlier part of the Mesolithic, sites are scattered over the study area, especially the northern part, while in the course of the Atlantic the emphasis moves towards the central and western part of the study area.

Ideally, relocation or contraction of occupation from higher Pleistocene grounds to wetlands should also be visible in the elevation of the dated sites above Dutch ordnance level (NAP). In figure 34 all 393 dates are plotted against the NAP value of each date; the latter ranges between -10 m NAP and +36 m NAP. The lines of dates in this graph are caused by the many dates from some of the pit-clusters. An immediate correlation between date and height is not apparent (note the low value for the coefficient of determination!) but testing the group of dates before 7600 BP (n=212) against the group after 7600 BP (n=181) with the *Mann-Whitney U test* resulted in a statistically significant probability: $p < 0.0001$ (U = 13640.5, z = -4.975). Dates after 7600 BP are on average indeed situated at a lower altitude.

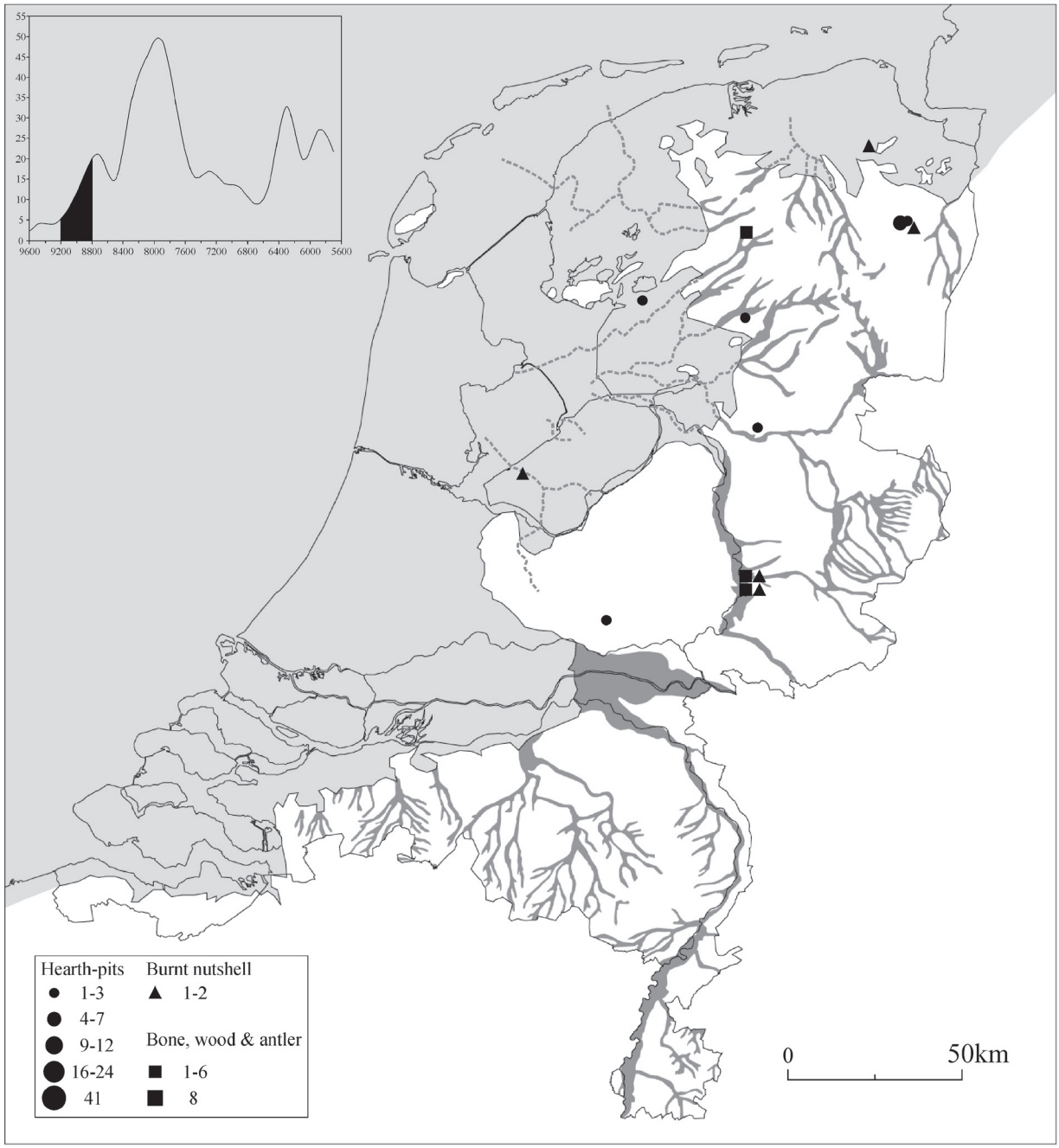

Fig. 25. Geographical distribution map of dates (n=25) in the period 9200–8800 BP. For key to the map see figure 23 (drawing M.J.L.Th. Niekus & S. Tiebackx).

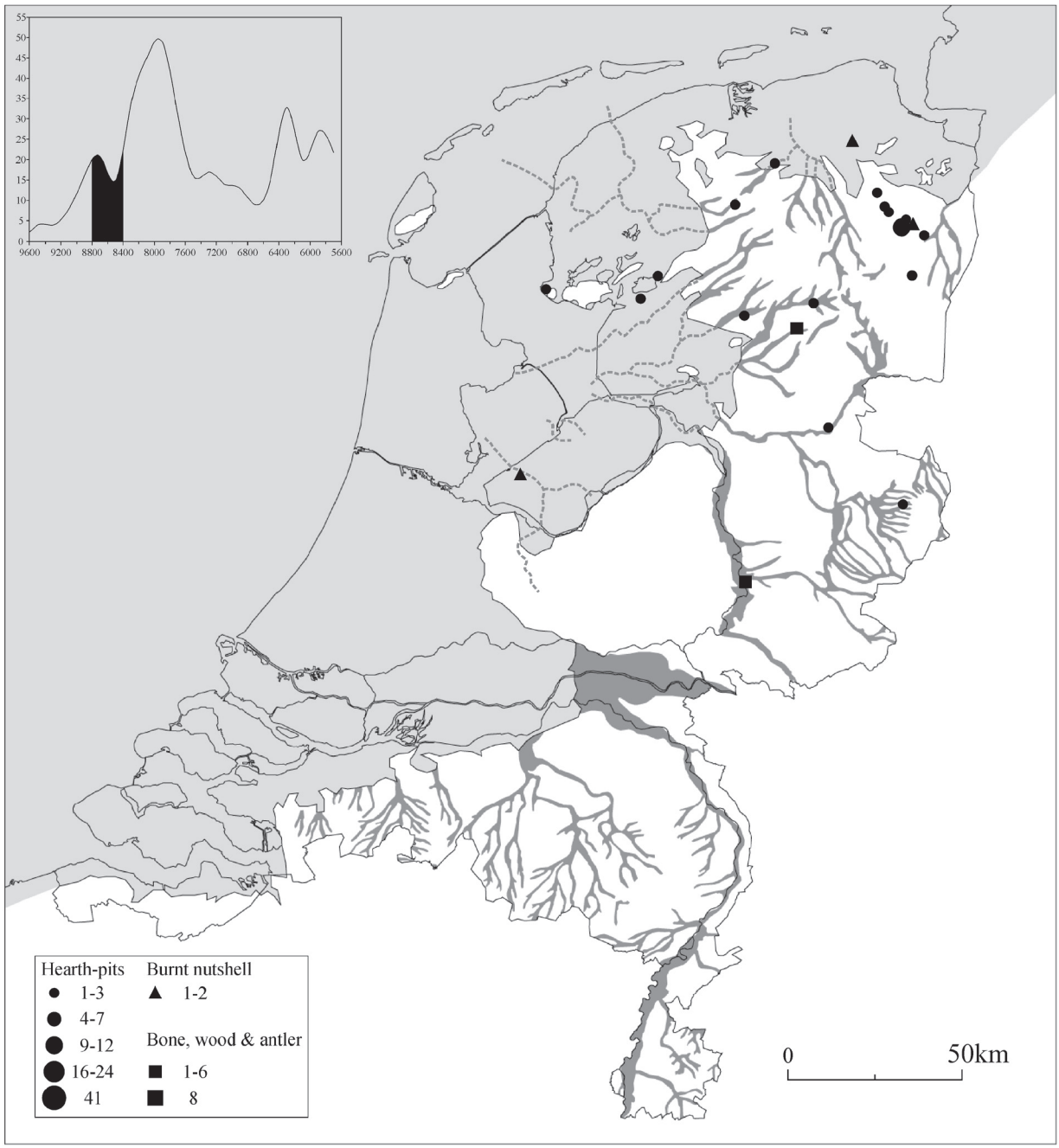

Fig. 26. Geographical distribution map of dates (n=35) in the period 8800–8400 BP. For key to the map see figure 23 (drawing M.J.L.Th. Niekus & S. Tiebackx).

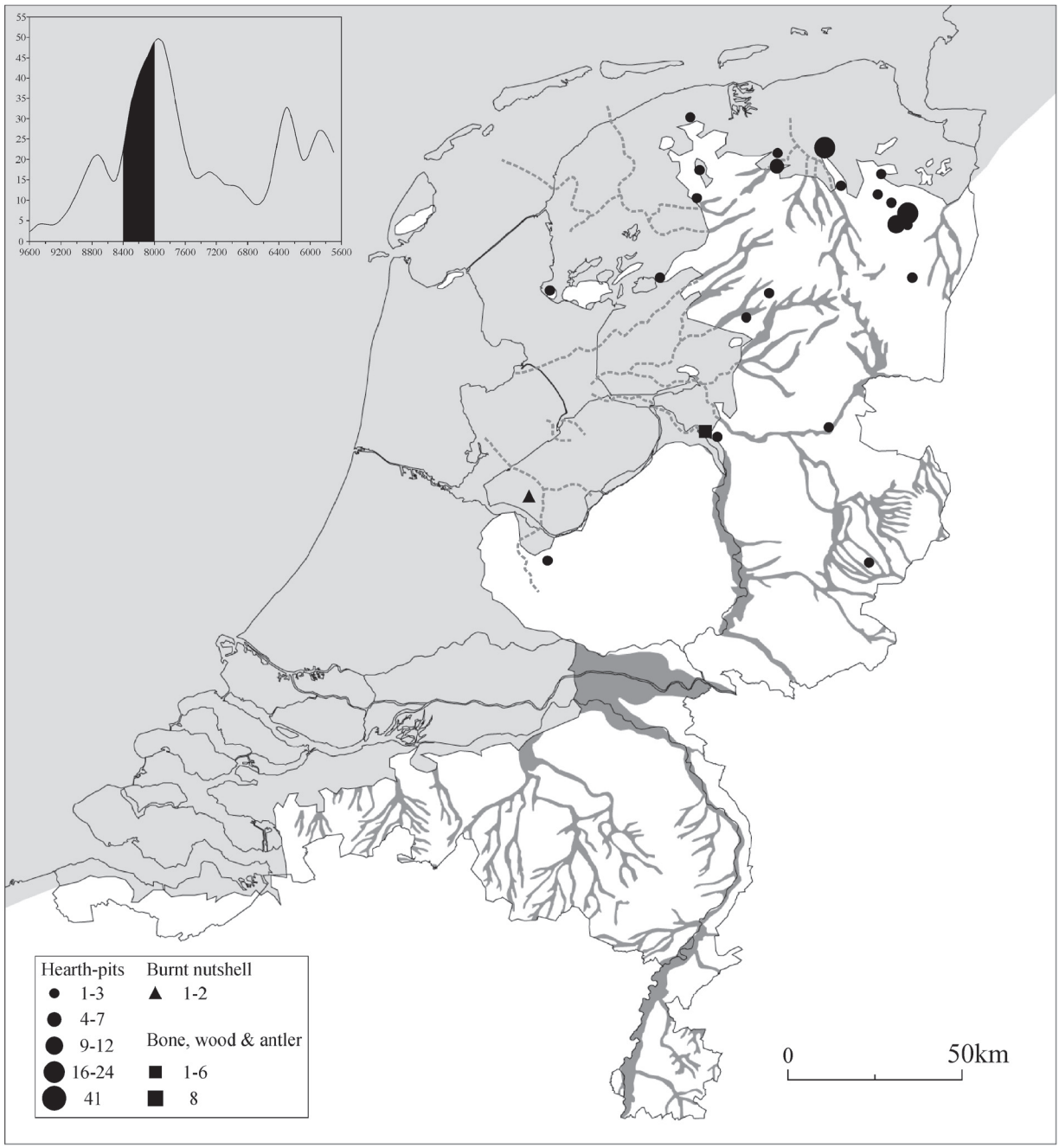

Fig. 27. Geographical distribution map of dates (n=79) in the period 8400–8000 BP. For key to the map see figure 23 (drawing M.J.L.Th. Niekus & S. Tiebackx).

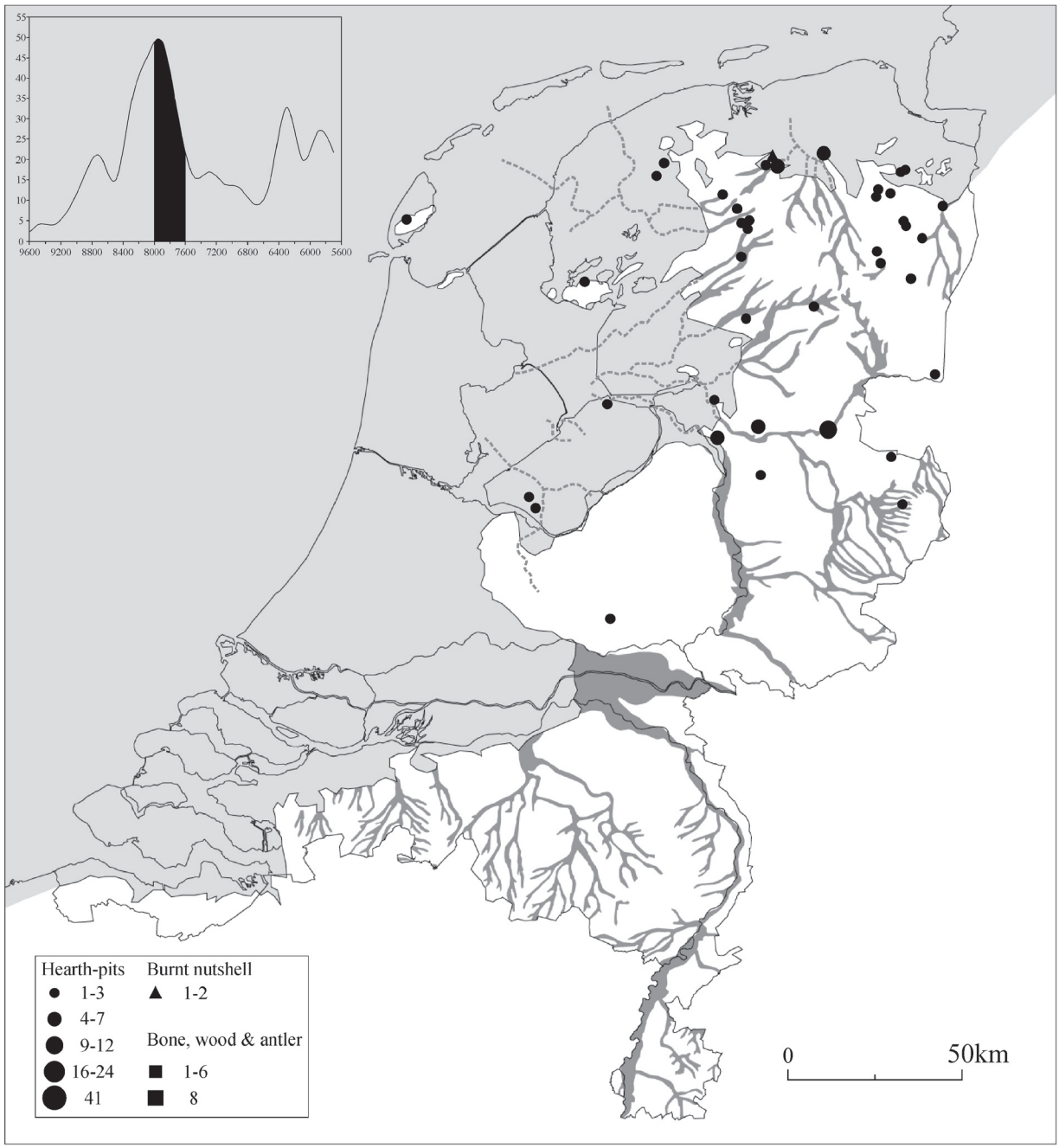

Fig. 28. Geographical distribution map of dates (n=77) in the period 8000–7600 BP. For key to the map see figure 23 (drawing M.J.L.Th. Niekus & S. Tiebackx).

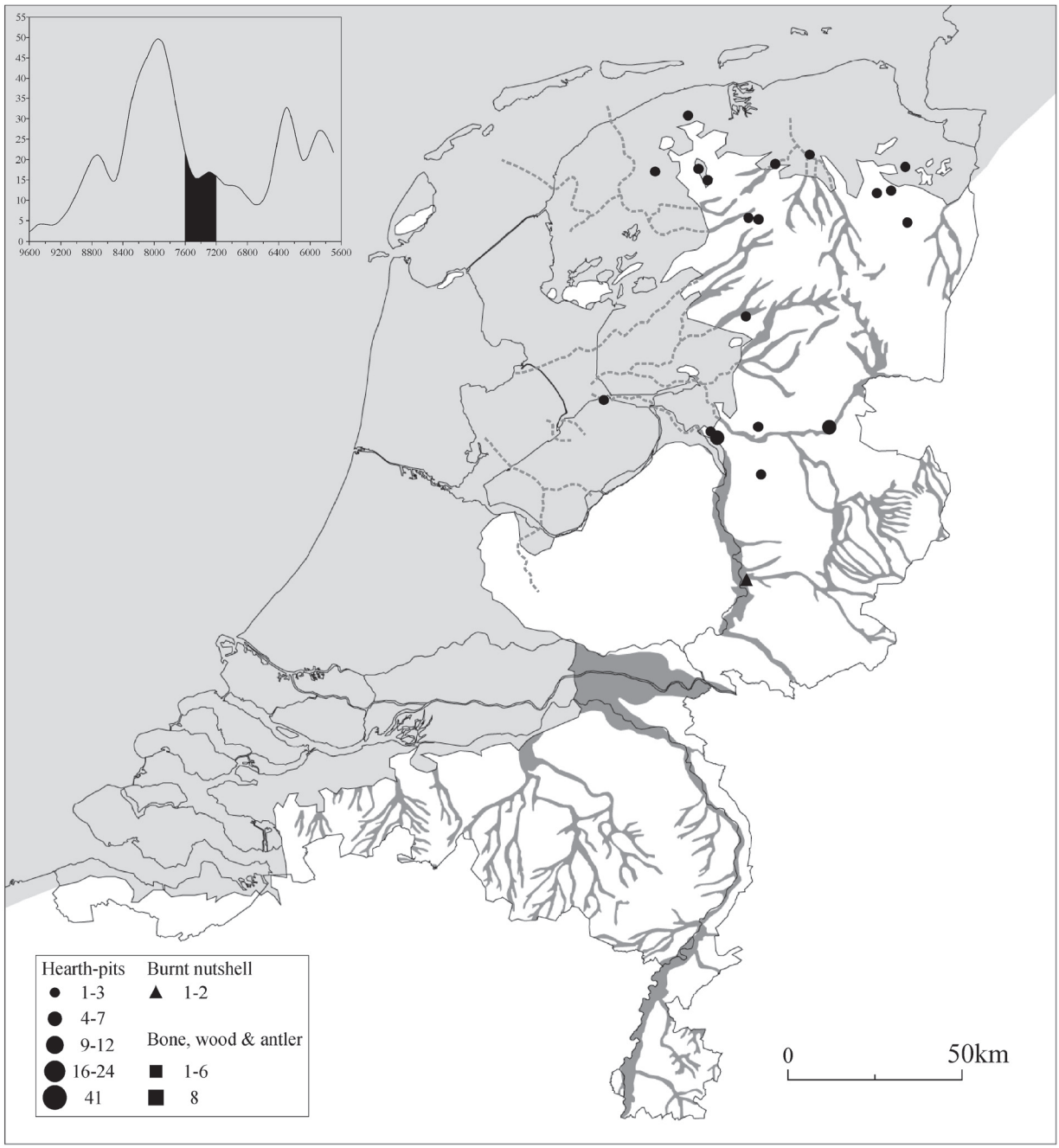

Fig. 29. Geographical distribution map of dates (n=33) in the period 7600–7200 BP. For key to the map see figure 23 (drawing M.J.L.Th. Niekus & S. Tiebackx).

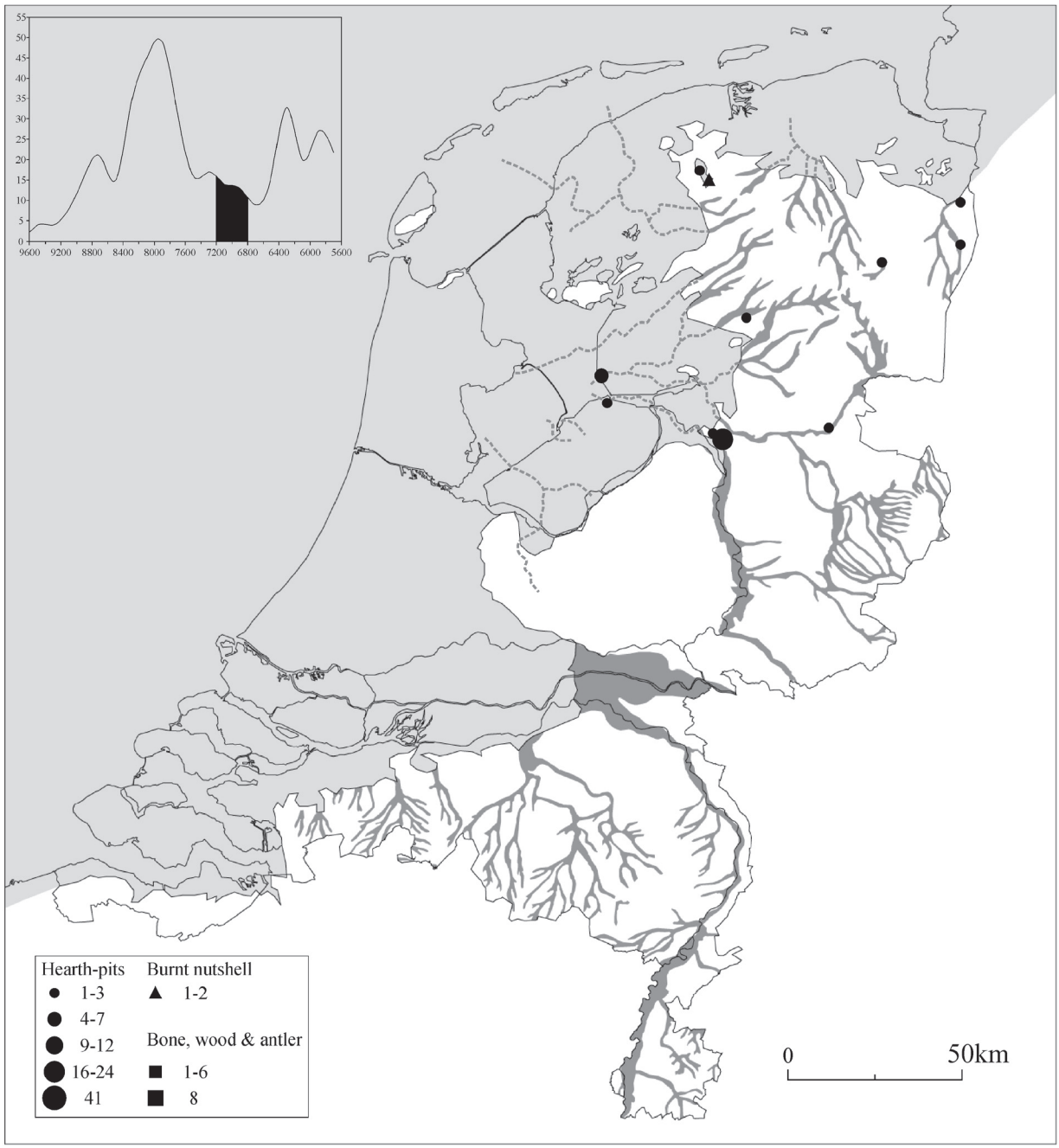

Fig. 30. Geographical distribution map of dates (n=26) in the period 7200–6800 BP. For key to the map see figure 23 (drawing M.J.L.Th. Niekus & S. Tiebackx).

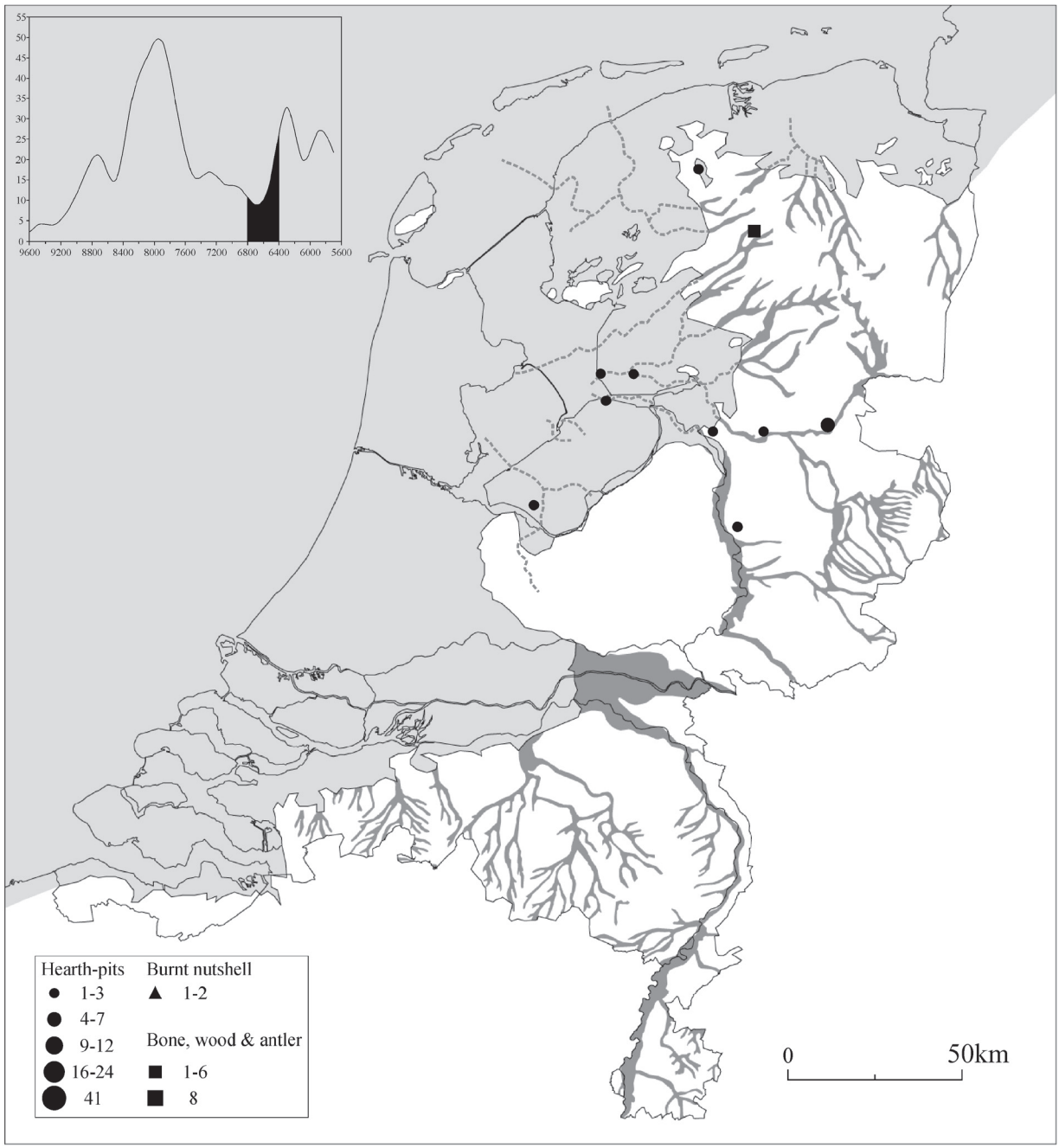

Fig. 31. Geographical distribution map of dates (n=24) in the period 6800–6400 BP. For key to the map see figure 23 (drawing M.J.L.Th. Niekus & S. Tiebackx).

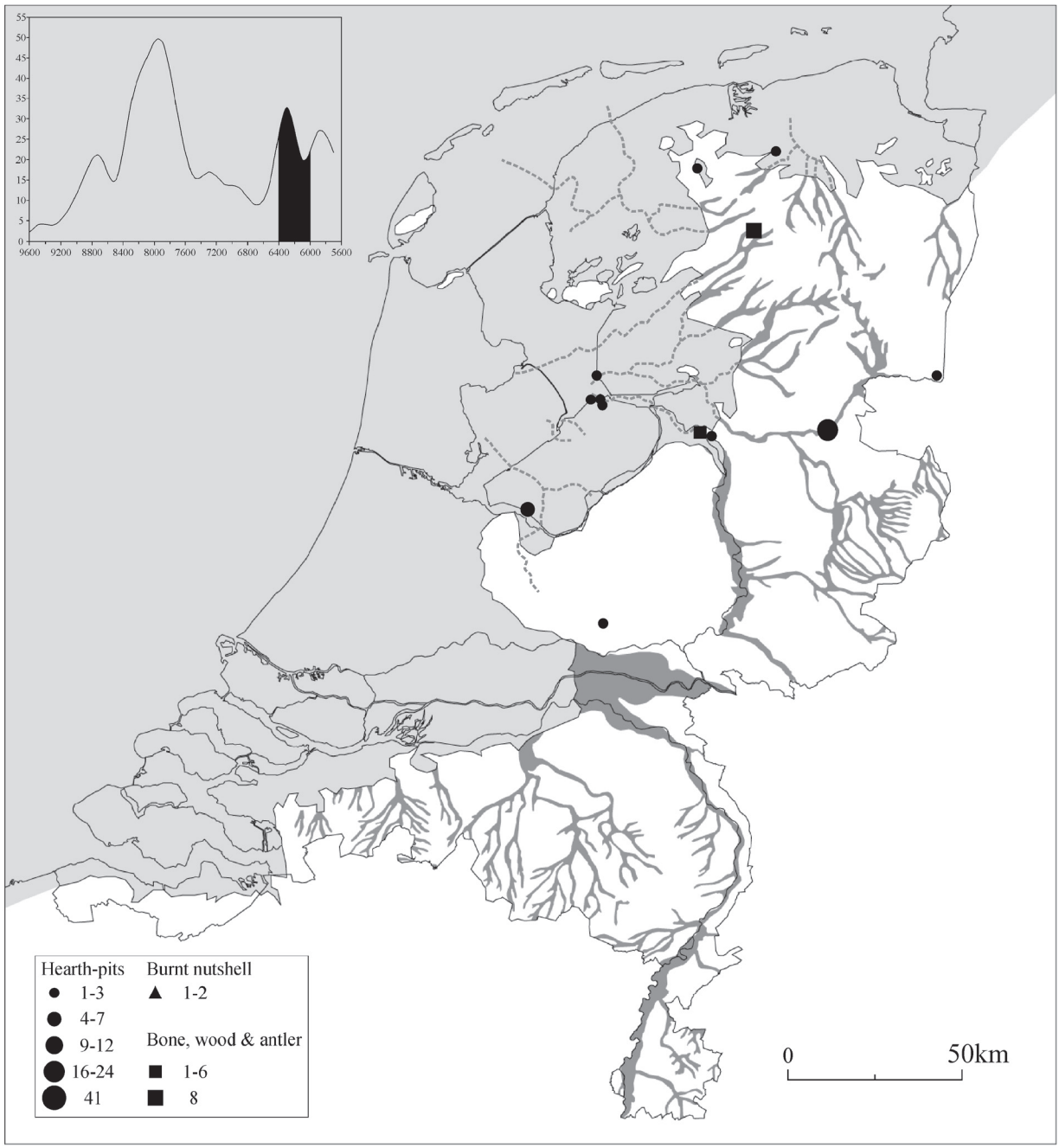

Fig. 32. Geographical distribution map of dates (n=53) in the period 6400–6000 BP. For key to the map see figure 23 (drawing M.J.L.Th. Niekus & S. Tiebackx).

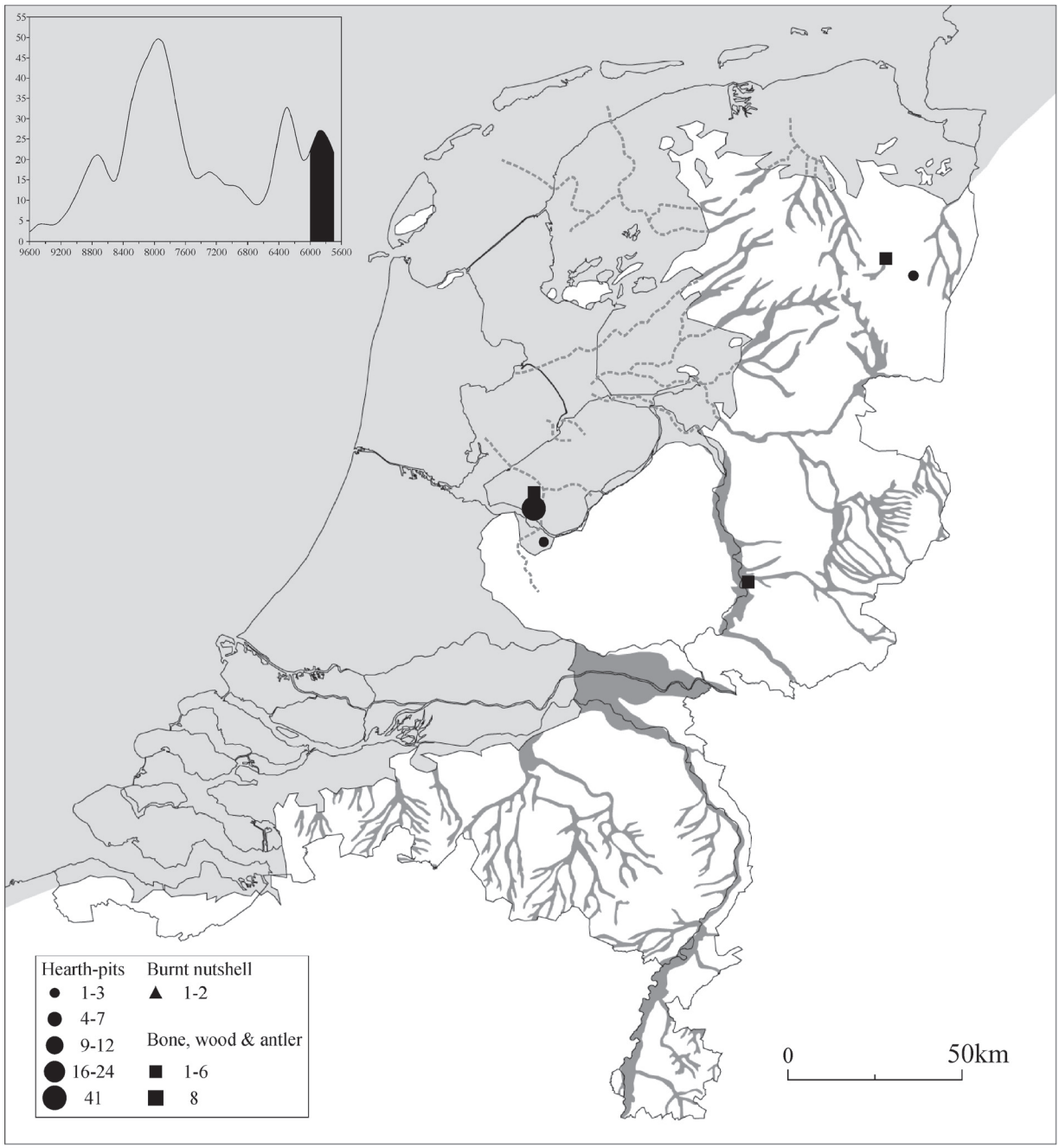

Fig. 33. Geographical distribution map of dates (n=49) in the period 6000–5600 BP. For key to the map see figure 23 (drawing M.J.L.Th. Niekus & S. Tiebackx).

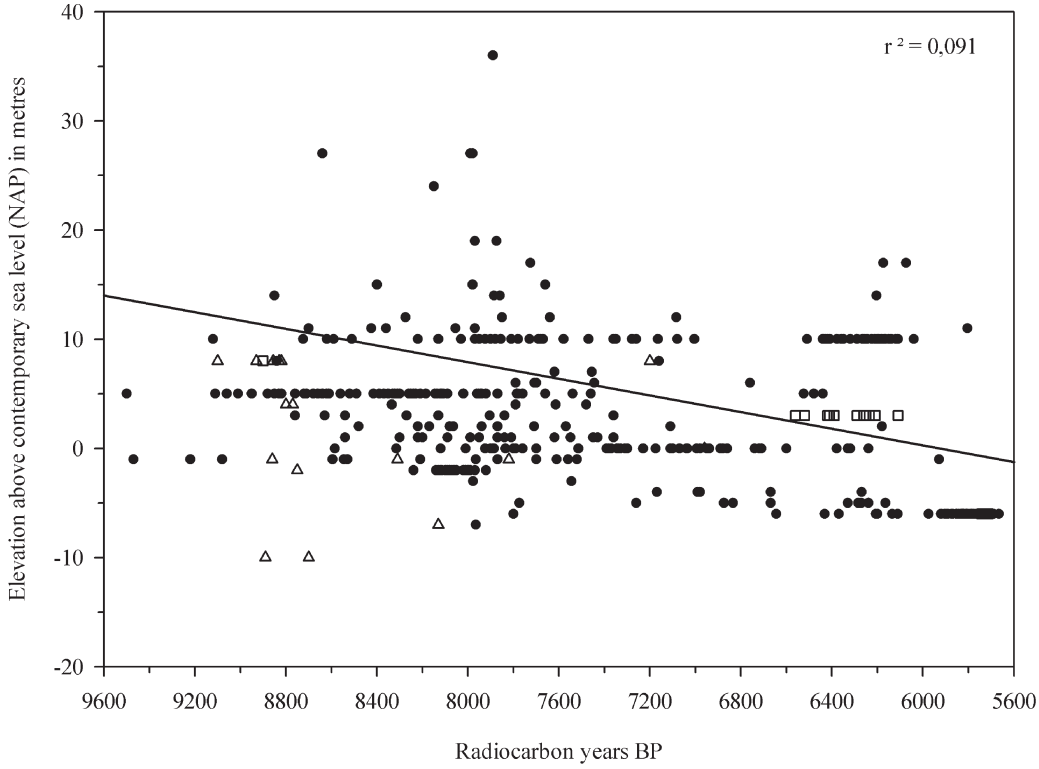

Fig. 34. Scatterdiagram showing the association between uncalibrated ^{14}C dates (n=393) and the elevation in metres above contemporary sea level (NAP). The regression line and the coefficient of determination (r^2) are indicated. For the key to the symbols see figure 8 (graph M.J.L.Th. Niekus).

7. CHRONOLOGICAL DISTRIBUTION AT INDIVIDUAL SITES

The geographical shift of dated sites described in the foregoing section should also be noticeable when we compare the ^{14}C dates between sites.[21] At least three groups of sites are expected on the basis of the chronological maps: sites dominated by early dates, a group of sites with earlier and later dates and a group of later sites, possibly mixed with earlier dates. Figure 35 shows all ^{14}C dates on hearth-pits, with the site codes listed on the y axis.[22] The sites are arranged according to the earliest recorded date for a particular site, so that the oldest hearth-pit is located in the lower left-hand corner of the diagram. The diagram shows a chronological succession of sites, from sites dominated by Early and Middle Mesolithic dates to sites with mainly later dates. At early sites there are no or only a few later dates, while at late sites, dates from the Early and Middle Mesolithic are generally sparse or absent.

The bar graph in figure 36 shows the number of sites for each of the four periods and the number of 'mixed' sites. Figure 37 shows only the mixed sites, subdivided according to combination of periods. Clearly the combination of Middle and Late Mesolithic is the most common, followed by sites with dates from both the Early and Middle Mesolithic. Other combinations are rare and there is no evidence of a site being occupied during the Early Mesolithic and the Early Swifterbant culture.

As we saw in the maps, sites like Zwolle-ODE (No. 100) and Mariënberg (No. 53) show a wider range of ^{14}C dates, emphasizing their intermediate geographical and chronological position between the sandy interior and the 'wetlands'. Not all of the larger sites show similar patterns in the distribution of ^{14}C dates. Some sites (for example NP-3 and S-1) show quite a wide range of dates without marked clustering while others exhibit clustering in a relatively short timespan, sometimes punctuated as in the case of Zwolle-ODE. A further study of this patterning of *locational redundancy* (*e.g.* Houtsma *et al*., 1996; Newell, 1995) at individual sites and between sites may provide additional insight into the nature of these pit-clusters and their possible function in an exploitation system, perhaps as *persistent places* in a Mesolithic landscape (Cummings, 2003) or *aggregation camps* (Peeters,

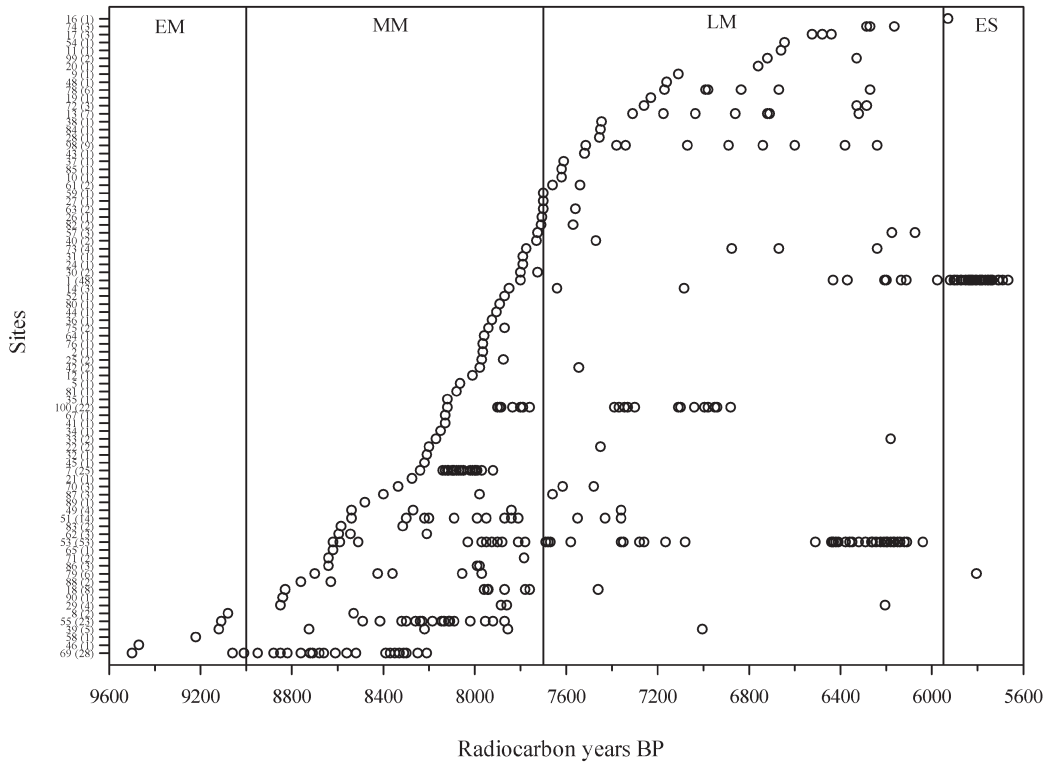

Fig. 35. Hearth-pits and surface hearths (n=364): horizontal point plot showing the chronological distribution of ^{14}C dates for 81 sites. For the site codes see figure 4. The figures in brackets indicate the number of dates. Key: EM = Early Mesolithic (c. 9600–9000 BP), MM = Middle Mesolithic (c. 9000–7700 BP), LM = Late Mesolithic (c. 7700–6000/5900 BP), ES = Early Swifterbant culture (c. 6000/5900–5600 BP) (graph M.J.L.Th. Niekus).

2004). I agree with Peeters (*ibid*.: p. 27) that holding a negative attitude towards sites with multiple occupations or *palimpsests*, writing them off as accumulations of cultural debris that are impossible to unravel, is not at all justified. Of particular interest are also the time-frames at sites like Zwolle-ODE for which there are no ^{14}C-dated hearth-pits. These hiatuses could, as one of many possibilities, signify periods when resources in the surrounding became depleted and groups of hunter-gatherers moved to other areas, only to return after a certain period of time.

Although hearth-pits may represent only part of an exploitation system, perhaps related to specific functions or seasons, it is clear that a significant change in preferred settlement location did take place during the Mesolithic. A similar change has also been noted in Sandy Flanders where only 10–15% of Early Mesolithic sites show evidence of use during the *Mésolithique récent* (Crombé, Perdaen & Sergant, in press).

The absence of later dates from earlier sites can partly be explained by the rise in sea level and the geographical shift (possible reasons are discussed below) but the absence of earlier dates from later sites cannot be explained in this way. This seems to suggest that the younger locations were previously considered unattractive for habitation and exploitation (see also Rensink, in press). Erosion at Late Mesolithic/Early Swifterbant locations (*e.g.* Almere-Hoge Vaart: Spek, Bisdom & Van Smeerdijk, 2001) may also be an explanation for the lack of earlier remains.

Several researchers have used site-counts to infer relative population densities for the Mesolithic and the large number of later Mesolithic sites (with trapezes) has led them to conclude that there was a significant (up to threefold) increase in population during the later Mesolithic (Newell, 1973; Price, 1980). Comparable figures have also been produced by Arts (1988) for the southern part of the Netherlands. This increase was attributed to the early Holocene rise in the sea level which caused part of the population of the North Sea basin to move into the higher hinterland and to a more sedentary way of life (Newell, 1973). On the basis of recent sea level curves and reconstructed coastlines, we now know that an influx of people must have taken place earlier, perhaps resulting in the maximum of

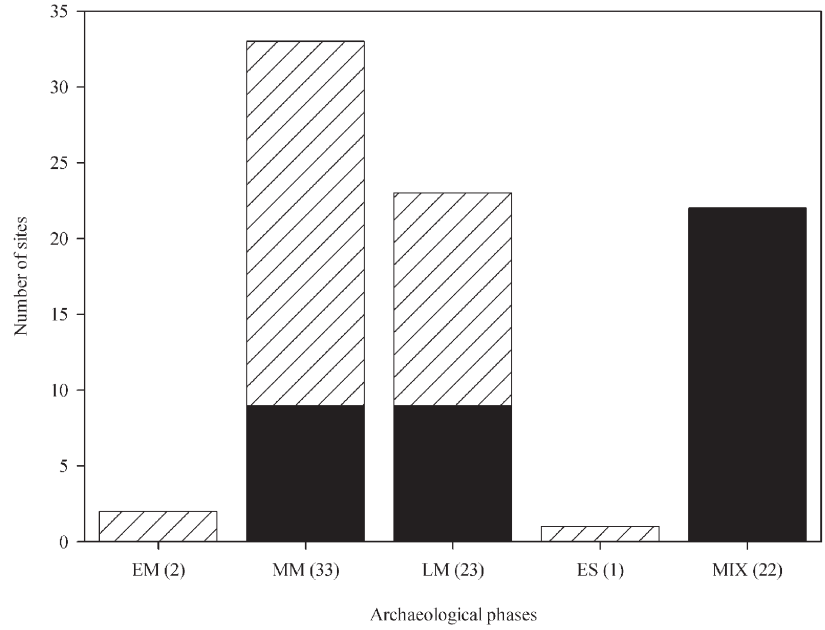

Fig. 36. Hearth-pits and surface hearths: bar graph showing the subdivision of sites according to archaeological period and the number of sites with 'mixed' dates. For the key to the abbreviations see figure 35. MIX = 'mixed' sites. The figures in brackets indicate the number of sites for each of the phases. The number of sites with only one date (hence one phase) is indicated by hatching (graph M.J.L.Th. Niekus).

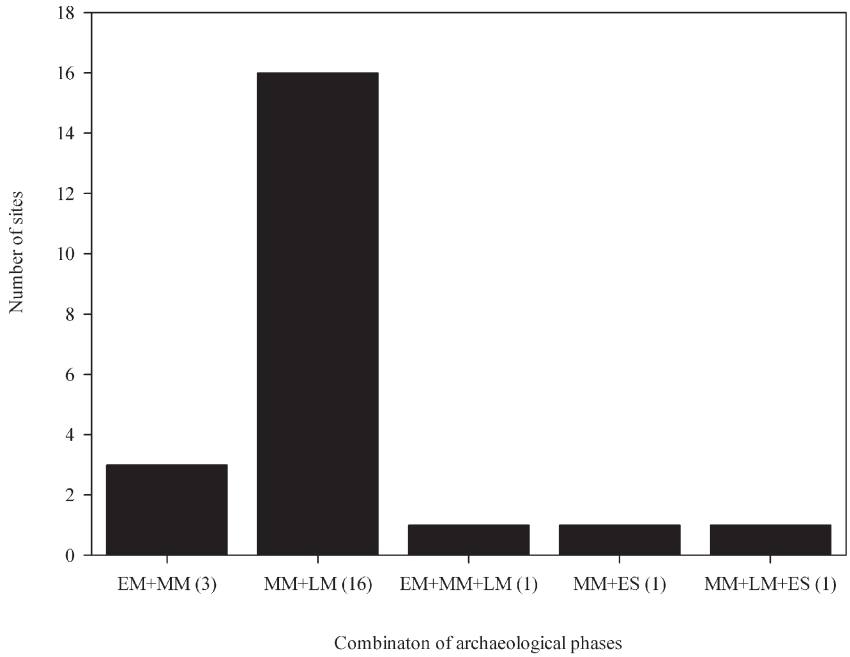

Fig. 37. Hearth-pits and surface hearths: bar graph showing the subdivision of mixed sites. The figures in brackets indicate the number of sites. For the key to the abbreviations see figure 35 (graph M.J.L.Th. Niekus).

dates around 8000 BP. Neither site-counts (Spikins, 1999) nor numbers of ^{14}C dates seem to be suitable for estimating relative population densities. Site numbers might be more indicative of the number of residential moves on an annual basis (foraging vs. collecting, *cf*. Binford, 1980) while the number of ^{14}C dates is more likely to reflect the population of Stone Age archaeologists working in a particular area. In any case the data presented here (see fig. 36) do not suggest that there was a dramatic increase in population during the later Mesolithic, rather a decrease.

8. CONCLUDING REMARKS

In the foregoing sections we saw that the ^{14}C dates for the Mesolithic and Early Swifterbant culture are characterised by two major patterns:

1. A fluctuation in the number of dates during the period 9600–5600 BP.
2. A subtle shift in the emphasis of ^{14}C-dated sites from the higher Pleistocene grounds in the study area to more low-lying parts of the landscape during the Early Atlantic.[23]

This patterning, which is based mainly on a large number of hearth-pits, is largely similar to that observed earlier (Waterbolk, 1985; 1999).

The most widely accepted explanation for the shift in emphasis of habitation toward stream and river valleys, estuaries, lake-shores and perhaps the coastal zone is the transformation of open coniferous forests to denser woodlands (*Quercetum Mixtum*) during the Atlantic, which is well attested by archaeobotanical and archaeozoological research (Bakker, 2003; Bottema, 1988; Zeiler & Kooistra, 1998) and by anthracological analysis of charcoal from hearth-pits (Groenendijk, 1997). For the northern part of the Netherlands this was earlier suggested by Waterbolk (1985; 1999) but for other parts of the study area and neighbouring Belgium similar explanations have been put forward more recently (Bos *et al*., 2005; Crombé, Perdaen & Sergant, in press).

These climax forests with scanty undergrowth would have led to a considerable decrease in grazing opportunities for large herbivores such as deer and aurochs (Spikins, 1999), which in turn will have reduced hunting opportunities. However, different soil types will have carried different types of forest, as Bakker (2003) has pointed out. In the boulder-clay areas of the Drenthe Plateau, for example, there must have been fairly dense forests rich in species, while the coversand areas probably supported a more open type of forest. The margins of these forests, especially the contact zones with streams and brooks, must have provided a more articulated environment with abundant animal and vegetative resources which would have attracted groups of hunter-gatherers. Some authors have stressed the importance of fishing in these areas (Price, 1980: p. 19) but the actual contribution of fish to the diet is difficult to establish since well-preserved sites are lacking in the sandy interior. This suggestion was questioned by Brinkhuizen (1989: thesis proposition 7), who argues that smaller streams and rivers probably did not contain enough fish to sustain a group of people for very long (personal communication D.C. Brinkhuizen, November 2005), so that in landscape units such as the Drenthe Plateau and the Veenkoloniën fishing must have been of minor importance. Fish presumably was of more importance near major rivers, lakes and coastal environments.[24]

However, the denser Atlantic forest is not necessarily people's only reason for leaving the interior because there is accumulating evidence that Mesolithic hunter-gatherers would keep the area around settlements open by deliberately burning the vegetation or woodland (Mellars & Dark, 1998). Botanical data from Zutphen suggest that burning of the reed swamp vegetation occurred during the Early Mesolithic, although it is not clear whether the fires were natural or intentional (Bos *et al*., 2005). In pollen diagrams from the Drenthe Plateau studied by Bakker (2003), relatively high values of bracken (*Pteridium aquilinum*) appear during the Early Atlantic (c. 8000–7000 BP) which are seen as an indication of burning. The occurrence of fires in this period is also attested by high peaks in charcoal particles (Bakker, 2003: p. 214). Although it is not clear whether these fires were natural in origin or were started by Mesolithic people it cannot be ruled out that vegetation around pingo-scars was burned to create more open space (*ibid*.: p. 214) perhaps also for stimulating the growth of certain herbs, to maintain visibility or to create natural 'pastures' for large herbivores (Bos *et al*., 2005; Deeben & Arts, 2005: p. 153).[25] It is perhaps no coincidence that half of the (undated) Mesolithic sites in the area around the pingo-scar 'Gietsenveentje' are situated at a distance of 250 metres or less from pingo-scars (*ibid*.: p. 215, fig. 67). Furthermore, flint axes were already known from approximately 8800 BP onwards and these, as well as antler axes, could have been used to cut down trees to create forest clearings or to enlarge those caused by forest fires or tree-falls.

Another reason why large herbivores and people would have left the sandy interior may have been the

absence of larger bodies of open water as a result of the marshy infilling of pingo-scars and the development of raised bogs (Waterbolk, 1985; 1999). Bos *et al*. (2005) suggest that the disappearance of open water caused by infilling of residual channels, in addition to denser forests, was in part responsible for the absence of Mesolithic habitation after c. 8700 BP in the Zutphen area. This idea does not hold for the entire study area and there must have been considerable differences between regions and even on a local scale. An example is the coversand area of the Veenkoloniën, where large-scale and peat growth did not start until c. 1500 years after the last Mesolithic habitation (Groenendijk, 1997). Furthermore, during the Boreal and Early Atlantic, ponds and lakes in the Veenkoloniën were of a temporary nature and peat developed only very locally during the Boreal (*ibid*.: p. 97). On the Drenthe Plateau open water was still present in at least some of the pingo-scars, such as the Gietsenveentje (Bakker, 2003: pp. 227–231).

Even though both the geographical shift and the decline in dates are clearly related in time, the first pattern does not necessarily explain the second, except if we make the (untestable) assumption that nearly the entire population abandoned the sandy interior and moved close to the prehistoric coast. Did the higher Pleistocene soils become largely depopulated as is suggested by the distribution maps and the decline in dates, or have we simply been overlooking the evidence? It was already noted that there are large differences in the intensity and scale of research between different areas. Within the Pleistocene parts of the Northern Netherlands research has mainly focused on relatively high and dry settings, such as coversand ridges where Stone Age remains are usually abundant, the 'high-density windows' (*cf*. Peeters, 2004). Little attention has been given to stream valleys and other relatively low-lying areas or even sandy parts with less diversity in relief and apparently empty zones in the landscape. In the central and western part of the study area the situation is somewhat different and research has predominantly, but not exclusively, focused on river and stream valleys, gullies etc. Sites like Mariënberg (valley of the Vecht), Almere-Hoge Vaart (Eem valley) and Swifterbant (river dunes) can serve as examples here. This bias in research focus may be at least partly responsible for the scarcity of later dates from the sandy Pleistocene interior.

There are good indications that a shift in emphasis did occur during the earlier part of the Atlantic but on a much smaller scale than in the study area as a whole. In a recent publication Groenendijk (2004) subdivided the ^{14}C dates from the eastern part of Groningen, one of the landscapes used by Waterbolk (1999), into a coversand component (*Veenkoloniën*) and a stream valley component. Although the evidence is meagre, dates from the end of the Mesolithic occupation, shortly before 7000 BP, concentrated more in stream valleys than in the coversand landscape (Groenendijk, 2004: p. 26, fig. 5). This tendency is corroborated by typological evidence, as only a small number of trapezes (after c. 8000 BP) are known from the coversand area. Larger numbers are found in the vicinity of stream valleys such as the Hunze valley to the west and the valley of the Oude Ae to the north. An example is the site Scheemda Sa-18 (section 9.2) but other sites are also known further to the north, around Slochteren, near the valleys of the Slochter Ae and Scharmer Ae. The geographical context of trapezes on the Drenthe Plateau, to the west of the Veenkoloniën, is largely comparable. Of the 84 sites with trapezes recorded by Price (1981), 43 (or 51%) are situated within 250 metres of a stream.[26] If we include 'high' sand sites adjacent to depressions that might have contained water during the occupation (setting 3 according to Price), the percentage is even higher, namely 63%. However, the exact age of these sites is not well established owing to a lack of differentiation in the (typological and technological) chronology of the later Mesolithic and the Early Swifterbant culture as was already noted by Price (1980).[27] We know that trapezes first occur around 8000 BP and they continue to be used well into the Swifterbant culture. Some authors (Newell, 1973; Groenendijk, 1997) have suggested that broad trapezes are younger (after c. 7600 BP) than narrow trapezes but separating them purely on the basis of metrical attributes is impossible (Peeters, Schreurs & Verneau, 2001; Price, 1981). Theoretically speaking, these trapeze sites could date from any time between c. 8000 and 5000 BP (Deckers, 1979; 1982) and it is a possibility that dating these sites will fill the 'gap' between c. 7600 and 6600 BP in figures 13–15. Unfortunately, the few dated sites with trapezes do not resolve this problem. Both Havelte (Price, Whallon & Chappell, 1974 and section 9.3) and Nieuw-Schoonebeek (Beuker, 1989) have produced ^{14}C dates covering hundreds or even thousands of years.

Besides differences in the scale of the shift there are also differences in timing between areas, as Waterbolk noted for the northern part of the study area (1999). In the sandy Pleistocene part of Flanders there is a clear drop in the number of dates which takes place slightly earlier than that in the northern part of the Netherlands (Crombé, Perdaen & Sergant, in press: fig. 6). After c. 8700 BP there is no evidence of Mesolithic presence around Zutphen until c. 7500 BP (Bos *et al*., 2005).

The relative lack of 'late' dates from the sandy interior does not mean that these parts of the landscape were not used; after all, absence of evidence does not necessarily imply absence of Mesolithic man (a similar view is held by Bos *et al*., 2005). Perhaps activities were carried out in the interior that left few archaeological traces, very specific remains such as untended facilities (traps, weirs etc.) or remains that are simply impossible to date such as undiagnostic (without trapezes) flint assemblages. A change in the type of fireplace should also be considered. If hearth-pits were indeed mainly used for the processing of food, more specifically vegetable foodstuffs, the absence of a diverse undergrowth (with edible herbs, roots etc.) in the climax forest could result in the absence of hearth-pits from these areas. Maybe surface hearths replaced hearth-pits in a densely forested environment, perhaps also because digging pits might have been more difficult because of extensive root systems or wetter conditions. Perhaps seasonal differences are also of importance. At a certain location in the landscape it might have been possible to dig pits in the dry seasons (summer/autumn) but not in winter and surface hearths may have functioned as a substitute in these settings.[28] At Almere-Hoge Vaart for example there seems to be a link between the type of hearth used and the depth of the local water table (Hogestijn & Peeters, 2001). Towards the end of the habitation the groundwater had risen so much that only shallower surface hearths could be used. The shallow nature of surface hearths leaves them more subject to natural and agricultural erosion and with a slimmer chance of survival on higher Pleistocene soils than in lower-lying areas covered by sediments. The evidence so far does not support this idea, as figure 38 shows. In this graph the distribution of classic hearth-pit dates is compared to dates on charcoal found outside hearth-pits and dates from questionable contexts, categories that were removed from the database at an earlier stage of the research. If concentrations of charcoal were the remains of later surface hearths their dates would fall between c. 7600 and 6600 BP or even later, and this is clearly not the case.

Factors other than of an environmental nature that might have induced a change in preferred settlement locations are cultural or social in nature, but these are more difficult to grasp. The provenance study of raw materials conducted by Crombé, Perdaen & Sergant (in press) is very promising in this respect, but lack of raw materials that can be attributed to a specific source prevents a similar approach in the study area.

This preliminary study has shown that there indeed seems to be a shift towards wetter zones of the landscape, but probably on a much smaller scale than previously assumed and perhaps for a variety of reasons, not solely the development of climax forests. This is also evidenced by differences in timing between areas, which suggest that local, regional and perhaps seasonal conditions relating to hydrology and vegetation were of prime importance. Although the maps in this article are very useful for identifying large-scale patterns, it is clear that shifts in population are best studied in smaller landscape units as suggested by Groenendijk (2004). Even the 'landscapes' used by Waterbolk are insufficiently discriminatory in this respect.

9. CATALOGUE OF NEW ^{14}C DATES

The dates in this catalogue are listed by province and site (in alphabetical order) and the following information is provided: laboratory number, dating material, context and excavation data (pit, square etc.). Unless mentioned otherwise, all samples received an AAA (Acid-Alkali-Acid) treatment. The ^{14}C dates that are considered to be not reliable in this study or that were not incorporated in the database for other reasons are marked with an asterisk. A short description of the site with available references is provided. Descriptions of cultural materials are kept to a minimum; these are the object of ongoing research and will be presented elsewhere. A few relatively unknown dates from bordering Germany and from the North Sea basin are also presented. The ^{14}C analyses were performed at the following laboratories: GrN (CIO University of Groningen, the Netherlands, conventional date); GrA (CIO University of Groningen, the Netherlands, AMS-date); UtC (Van de Graaff Laboratory, University of Utrecht, the Netherlands, AMS-date) and Hv (Hannover, Germany, conventional date).

9.1. Province of Friesland

Bantega. Extensive Mesolithic site excavated in 2003–2004 by members of the *Argeologysk Wurkferbân*, a group of Frisian amateur archaeologists. Approximately 10,000 flint artefacts were found (pers. comm. R.J. van der Molen). Seven hearth-pits were discovered; two were dated. Some preliminary notes on the excavation were recently published (De Jong & Van der Molen, 2005).

GrN-29547	hearth-pit 1	square B-56, feature 4	9080±60
GrN-29546	hearth-pit	square C-56, feature 5	8530±60

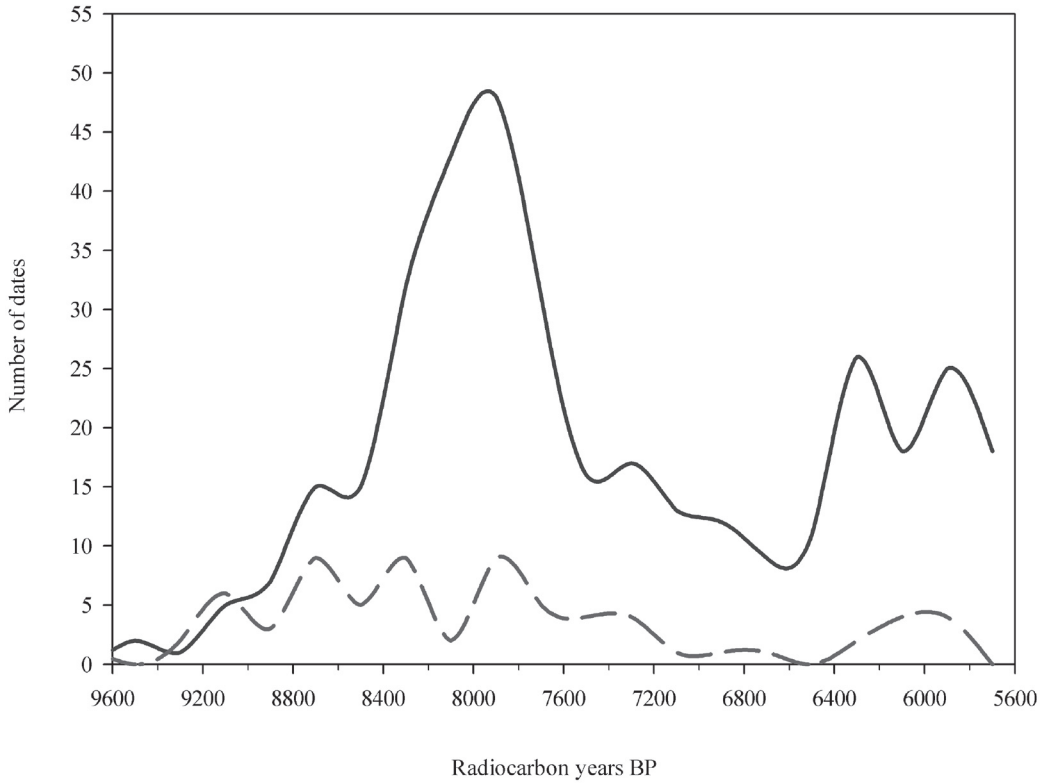

Fig. 38. Line graph with all dates from hearth-pits and surface hearths (solid line, n=364) versus the 72 dates (dash line) on charcoal from the culture layer and charcoal from questionable contexts (see section 3.2) (graph M.J.L.Th. Niekus).

Bergumermeer S64-B. The averaged date of 7090±30 BP (GrN-6843 and GrN-7927) for hearth-pit V is incorrect (Lanting & Van der Plicht, 1997/1998: p. 136). The charcoal samples derive from different hearth-pits and should not be averaged:

GrN-7927	hearth-pit	no. V, square BH-27	7175±35
GrN-6843	hearth-pit	no. I, square BK-27	7035±45

In view of the above, the charcoal date of 6710±90 BP (GrN-14884) apparently does not date hearth I. The sample was collected from square BE-26 but the feature identification is not clear. Furthermore, the published date of 7700±500 BP (GrN-14889, ditch 2) should read: 7700±50 BP.

Donkerbroek. Piece of antler (*Cervus elaphus*) with cut-marks found in 1933 during the digging of a swimming-pool to the south of the village of Donkerbroek. The site is located close to the river Tjonger. Other dated animal bones from the site indicate human activity in the Late Upper Palaeolithic (*Federmesser* tradition), Middle Neolithic and later. Published by Prummel (2001).

GrA-16239	red-deer antler	9100±80

Hempens-Wâldwei. In 2004 excavations were carried out in the bed of a new road near the city of Leeuwarden by Archaeological Research & Consultancy BV (ARC BV, Groningen) and in a later stage the State Service for Heritage Management (Rijksdienst voor het Oudheidkundig Bodemonderzoek or ROB, Amersfoort). Several dozen hearth-pits and over 70,000 flint artefacts were found on a coversand ridge at a depth of approximately 3 metres below the present-day sea level. Several hundred square metres were excavated. The site is covered with several metres of peat and c. one metre of Holocene clay. Middle Neolithic and later (Late Iron Age and Roman Period) artefacts were also found but at higher stratigraphic levels. The presence of trapezes suggests later Mesolithic occupation(s), which is confirmed by the two ^{14}C-dated hearth-pits. A preliminary report on the first stage of the excavation was published by Hielkema (2004).

UtC-13068	hearth-pit	trench 12, feature 43	7978±39
GrN-28976	hearth-pit	trench 12, feature 33	7545±50

Three dated charcoal samples place the Neolithic occupation around 4400 BP.

Jardinga-'Johannahoeve'. Late Mesolithic site with organic remains on the bank of the river Tjonger, excavated in 1981, 2002 and 2003 by the GIA. Nearly 90 animal bones were found, most of these from at least four aurochs (*Bos primigenius*). Remains of red deer (*Cervus elaphus*), beaver (*Castor fiber*) and European pond turtle (*Emys orbicularis*) were also found. Cutmarks are present on a number of bones. Several aurochs bones were cracked to remove the marrow. Other organic remains consist of three wooden stakes. A small number of flint artefacts, mostly blades and blade fragments were also present. The finds from 1981 were published by Prummel *et al*. (2002). On the excavation campaigns in 2002 and 2003 preliminary publications are available (Prummel & Niekus, 2005; Baak *et al*., 2005, Bottema, 2005; Bottema-Mac Gillavry, 2005). A final publication is in preparation. The following archaeological dates are available:

GrA-22652	beaver	no. 2002-3	6560±50
GrA-9645	aurochs 3	no. 1981-55	6520±50
GrA-9646	aurochs 2	no. 1981-67	6420±50
GrN-27515	wooden stake	no. 2002-232	6410±40
GrA-9649	red deer 1	no. 1981-72	6410±50
GrN-27516	wooden stake	no. 2002-232b	6390±50
GrN-27518	wooden stake	no. 2002-276	6290±60
GrA-9644	aurochs	no. 1981-12	6260±50
GrN-9643	aurochs 1	no. 1981-7	6240±50
GrA-24224	red deer	no. 2003-411	6235±45
GrA-14109	aurochs	no. 1981-24	6235±40
GrA-9650	aurochs 4	no. 1981-83	6210±50
GrA-9640	aurochs 1	no. 1981-6	6180±50
GrA-22806	red deer 2	no. 2002-18	6110±50
GrN-28069	charcoal	no. 2003-442	6100±50 *

From the two dates available for aurochs 1 (GrA-9640 and GrN-9643) a weighted average was calculated:

X^2 test: df=1, T=0.7, 0.50>p>0.30; weighted average: 6210±35[29]

A piece of shell from one of the turtles was also dated:

GrA-23019	pond turtle	no. 2002-173	9430±60 *

This date is most certainly too old as a result of the reservoir effect. A recently caught fish from the river Tjonger was dated to c. 3400 BP (GrN-28234) which indicates that the effect is considerable. Other periods that are (sparsely) represented at the site are the Middle phase of the Swifterbant culture (wooden post), the Early Bronze Age (fragment of barbed-wire pottery) and the Middle Bronze Age (wooden stakes).

Rotsterhaule (Polder Westerschar). Lanting & Van der Plicht (1997/1998: p. 138) mention a charcoal date from a hearth-pit in square D15 (GrN-3042: 8365±75 BP, Ao) but in the excavation plan this square does not exist. It is possible that the grid numbers were changed but it cannot be ruled out that the sample was collected at a different site.

Sippenfennen. Mesolithic site partially excavated (1998–1999) by members of the *Steentijd Werkgroep Fryslân* and RAAP-Consultancy. Nearly 2000 flint artefacts were discovered in an area covering 72 square metres. Among the finds are eight obliquely truncated points (B-points) and six core-axes. A preliminary report on the excavation was published by Asmussen & Veenstra (2001). Clear hearth-pits were not found. Samples from two 'concentrations' of charcoal were submitted for dating.[30]

GrN-29158	charcoal concentration square M35, layer 2	9110±60 *
GrN-29157	charcoal concentration square H38, layer 2	8580±40 *

If these dates are associated with the flint assemblage, the axes are among the oldest in the Northern Netherlands.

9.2. Province of Groningen

Academisch Ziekenhuisterrein (AZG), city of Groningen. In 1992, 28 hearth-pits and a small concentration of Late Palaeolithic (Hamburgian tradition) flint artefacts were found during building activities for a new wing of the University hospital (now Universitair Medisch Centrum Groningen) in Groningen (Kortekaas & Stapert 1993). Only a few presumably Mesolithic artefacts were found. In 2004 charcoal samples from 25 hearths were submitted for ^{14}C dating. The wood species were identified by F. Vrede (Stichting Monument & Materiaal). Compared to other sites with many hearth-pits, the dates from this site are closely related in time.

GrN-29195	hearth-pit	no. 30, *Pinus*	8240±70
GrN-29180	hearth-pit	no. 6, *Pinus*	8140±80
GrN-29202	hearth-pit	no. 38, *Pinus*	8130±70
GrN-29198	hearth-pit	no. 33, *Pinus*	8130±50
GrN-29177	hearth-pit	no. 3, *Pinus*	8120±70

GrN-29186	hearth-pit	no. 10, *Pinus*	8100±60
GrN-29178	hearth-pit	no. 4, *Pinus*	8090±70
GrN-29201	hearth-pit	no. 37	8090±70
GrN-29194	hearth-pit	no. 28, *Pinus*	8080±70
GrN-29193	hearth-pit	no. 19, *Pinus*	8080±70
GrN-29179	hearth-pit	no. 5, *Pinus*	8080±60
GrN-29197	hearth-pit	no. 32, *Pinus*	8070±70
GrN-29196	hearth-pit	no. 31, *Pinus*	8070±50
GrN-29185	hearth-pit	no. 9, *Pinus*	8060±50
GrN-29205	hearth-pit	no. 43, *Pinus*	8050±70
GrN-29199	hearth-pit	no. 35, *Pinus*	8050±70
GrN-29200	hearth-pit	no. 36, *Pinus*	8020±50
GrN-29204	hearth-pit	no. 41, *Pinus*	8010±70
GrN-29187	hearth-pit	no. 11, *Pinus*	8000±50
GrN-29203	hearth-pit	no. 40, *Pinus*	7990±50
GrN-29182	hearth-pit	no. 7, *Quercus*	7970±80
GrN-29188	hearth-pit	no. 13, *Pinus*	7920±90

From three hearth-pits double samples of charcoal (*Pinus* and *Quercus*) were submitted. The resulting dates, listed below, were tested for consistency by a Chi-square test.

GrN-29191	hearth-pit	no. 18, *Pinus*	8010±80
GrN-29192	hearth-pit	no. 18, *Quercus*	7980±90
X^2 test: df=1, T=0.1, 0.80>p>0.70; weighted average:			7997±60
GrN-29184	hearth-pit	no. 8, *Quercus*	8120±60
GrN-29183	hearth-pit	no. 8, *Pinus*	8070±60
X^2 test: df=1, T=0.3, 0.70>p>0.50; weighted average:			8095±42
GrN-29189	hearth-pit	no. 15, *Pinus*	8150±60
GrN-29190	hearth-pit	no. 15, *Quercus*	8080±60
X^2 test: df=1, T=0.7, 0.50>p>0.30; weighted average:			8115±42

The results of the tests indicate that there is no statistically significant age difference between *Quercus* and *Pinus* wood. In these cases the 'old wood' effect is clearly not operative.

Grootegast-Niekerk, ZWK III. Two hearth-pits discovered in 1995 by amateur archaeologist H.B. Versloot (Niekerk) during construction activities. Both hearth-pits were dated. From hearth-pit 1 two samples were submitted, one from the bottom of the pit and one from the upper part of the fill. A small number of flint artefacts including a triangle were found. Unpublished.

GrN-24745	hearth-pit	no. 1B, *Quercus*	6220±40
GrN-24436	hearth-pit	no. 1A, *Quercus*	6140±40
X^2 test: df=1, T=2.0, 0.20>p>0.10; weighted average:			6180±28
GrN-24437	hearth-pit	no. 2, *Pinus*	8170±60

Hoogkerk-Ruskenveen. Large-scale excavations carried out over the past years at the town of Hoogkerk, situated a few kilometres to the west of the city of Groningen. Remains from different periods were found, including a concentration of artefacts from the Ahrensburgian tradition (Niekus, 2004), several presumably Mesolithic hearth-pits and Neolithic artefacts. Short notes on the excavations have been published in *Hervonden Stad*. Charcoal (*Quercus*, personal communication F. Vrede, Stichting Monument & Materiaal) from one hearth-pit was dated.

GrN-29206	hearth-pit	no. 520, *Quercus*	7520±80

Jipsingboertange. Isolated hearth-pit (Harding 2001).

GrN-26320	hearth-pit	charcoal, *Pinus*	7160±50

Kielsterachterweg, KAW 64-A. Late Upper Palaeolithic (*Federmesser* tradition) and Mesolithic artefacts found in trenches for a gas pipeline. Partially investigated in 2003 by members of the Werkgroep Prehistorie van het Veenkoloniaal Museum Veendam (VKM). Three hearth-pits and a 'pit' were dated. A report was published by the Veenkoloniaal Museum (Anon., 2004).

GrN-28579	hearth-pit	R64, A-3	8540±40
GrN-28578	hearth-pit	R64, A-2	8270±30
GrN-28580	hearth-pit	R64, B-4	7840±30
GrN-28581	pit	R64, A-5	7650±40 *
GrN-28577	hearth-pit	R64, A-1	7360±60

Leek-AZC 'Blinksloot'. Large-scale excavation carried out by ARC BV (Groningen) in 2000. Mesolithic as well as Neolithic and later remains were uncovered. Approximately 60 hearth-pits were found in an area covering over 11,000 square metres. Published by De Wit (2001). A large number of hearth-pits were dated.

GrN-28293	hearth-pit	no. 61, *Pinus?*	8540±40
GrN-28291	hearth-pit	no. 45, *Pinus?*	8300±30
GrN-28295	hearth-pit	no. 1013, *Pinus*	8220±50
GrN-28284	hearth-pit	no. 8, *Pinus?*	8220±40
GrN-28294	hearth-pit	no. 1010, *Pinus?*	8200±50
GrN-28297	hearth-pit	no. 1091, *Pinus*	8090±45
GrN-28292	hearth-pit	no. 55	7990±30
GrN-28287	hearth-pit	no. 28, *Pinus*	7950±40
GrN-28286	hearth-pit	no. 17, *Pinus*	7870±50

GrN-28285	hearth-pit	no. 11, *Pinus?*	7840±30
GrN-28296	hearth-pit	no. 1039, *Quercus*	7810±50
GrN-28289	hearth-pit	no. 32, *Quercus*	7550±35
GrN-28288	hearth-pit	no. 30, *Quercus*?	7430±50
GrN-28290	hearth-pit	no. 36, *Quercus*	7360±40

Leek-Mensumaweg IV. Artefact assemblage discovered in 1996 by amateur archaeologist H.B. Versloot (Niekerk). The site was partially excavated (approximately 40 square metres) by the ROB and Versloot. Several hundred flint artefacts were found, including scrapers and a few points. A large stone (nearly 20 kilogrammes) with traces of polishing is also present. Two samples of burnt nutshell from a possible surface hearth and *Pinus* charcoal from a hearth-pit were dated at the time (Crombé, Groenendijk & Van Strydonck, 1999; Lanting & Van der Plicht, 1997/1998). A bulk sample of charcoal was now submitted, which turned out to be several hundred years older than the earlier dates:

GrN-28838	charcoal	8200±50 *

Leek-Mensumaweg (Tolberter Petten) V. Small concentration of flint artefacts excavated in 1997 by amateur archaeologist H.B. Versloot (Niekerk). Several hundred artefacts, including a small number of points, were found over an area covering 19 square metres. At the edge of the concentration three stones were found lying close together; one of these resembles a *retouchoir*. Five hearth-pits were found a few metres to the east of the concentration. These hearths were recorded and sampled by the GIA, but no samples were submitted for ^{14}C dating. One bulk sample of charcoal and a single piece of birch charcoal found within the concentration were dated. A publication by Versloot is in preparation.

GrN-24617	charcoal	square 11, *Pinus*	8310±80 *
GrA-16191	charcoal	square 9, *Betula*	8120±80 *

Scheemda, Sa-18 (Scheemderzwaag-Medemertol). Mesolithic site, partly excavated in 1991 by the GIA and the VKM (Groenendijk & Smit, 1992). The presence of trapezes indicates a relatively late date for the site. Five charcoal samples were dated:

GrN-28839	charcoal concentration	section	8100±70 *
GrN-28841	charcoal concentration	square 10/8	7920±50 *
GrN-28840	charcoal concentration	section	7910±60 *
GrN-28842	hearth-pit	square 15/6	7700±50
GrN-28843	hearth-pit	square 17/6	7560±60

Slochteren-Hooilandspolder. Mesolithic site excavated between 1983 and 1986 by the GIA with the aid of students, amateur archaeologists and members of the Archeologische Werkgemeenschap voor Nederland (AWN). The investigated area covers almost 200 square metres. More than 16,000 flint artefacts were found, of which approximately 450 were classified as tools. The assemblage is dominated by triangles and backed bladelets. Several atypical tanged points and a Tjonger point or *Federmesser* are present. Charcoal was found scattered over the site but no hearth-pits were observed. A concentration of burnt hazelnut shells possibly indicates the presence of a surface hearth. Two small pieces of calcined bone were found as well. Several bulk samples of charcoal (species identification by F. Vrede, Stichting Monument & Materiaal) and burnt hazelnut shell were submitted for ^{14}C dating. A preliminary report on the excavation was published by Kortekaas & Niekus (1994).

(sq. = square)

GrN-29291	charcoal	sq. 42/38, spits 4–5	9780±110 *
GrN-29288	charcoal	sq. 40/34, spits 5–9, *Pinus*	9050±80 *
GrN-29289	charcoal	sq. 42/27, spits 4–6, *Pinus*	8870±70 *
GrN-29586	hazelnut shells	bulk sample	8860±50
GrN-29293	charcoal	sq. 44/38, spits 5–6, *Pinus*	8850±80 *
GrN-29307	charcoal	sq. 43/24, spits 7–8, *Pinus*	8830±80 *
GrN-29287	charcoal	sq. 38/35, spit 5, *Pinus*	8720±80 *
GrN-29292	charcoal	sq. 44/24, spit 6, *Pinus*	8660±70 *
GrN-29290	charcoal	sq. 42/28, spit 7, *Pinus*	8640±60 *
GrA-27105	hazelnut shell	sq. 36/22, spit 1	8310±60
GrN-29295	charcoal	sq. 50/37, spit 5, *Quercus*	8300±50 *
GrN-29294	charcoal	sq. 45/39, spit 5, *Quercus*	7810±50 *

Stadskanaal, S-1. In 1997 large-scale excavations were carried out by ARC BV (Groningen) on an extensive coversand ridge. More than 100 hearth-pits were found scattered over an area of approximately 10,000 square metres. At some depth below the present-day surface an 'Usselo soil' dating to the Allerød interstadial was found. A small number of flint artefacts and a tiny fragment of burnt bone were found in this soil and might belong to the *Federmesser* tradition (Niekus & Groenendijk, 1998). A large bowl-shaped pit was found on the last day of the excavation and unfortunately could not be excavated completely. This pit somewhat resembled the *sitting graves* from Mariënberg (Verlinde & Newell, 2005; in press). No artefacts were found in the fill of the pit. The site is located on the same coversand ridge as Nieuwe Pekela 3 (NP-3) where more than 40,000 square metres were excavated between 1984 and 1997. The site NP-3 is well-known for its large number of hearth-pits; more

than 530 have been found so far, 23 of which are dated (Groenendijk, 1997; Lanting & Van der Plicht, 1997/1998). The distance between both locations is approximately 750 metres. Twenty-eight hearth-pits and two possible hearth-pits from S-1 were selected for dating purposes.

GrN-28147	hearth-pit	no. 39/72	9500±30
GrN-28144	hearth-pit	no. 31/52	9060±30
GrN-28163	hearth-pit	no. 137/245	9010±35
GrN-28155	hearth-pit	no. 62/132	8950±50
GrN-28160	hearth-pit	no. 123/191	8880±35
GrN-28145	hearth-pit	no. 33/55	8850±30
GrN-28146	hearth-pit	no. 38/70	8820±50
GrN-28143	hearth-pit?	no. 23/46	8780±30 *
GrN-28139	hearth-pit	no. 7/16	8760±30
GrN-28141	hearth-pit	no. 11/24	8720±30
GrN-28154	hearth-pit	no. 78/126	8710±50
GrN-28140	hearth-pit	no. 9/22	8680±40
GrN-28156	hearth-pit	no. 64/133	8660±30
GrN-28157	hearth-pit	no. 95/157	8610±35
GrN-28150	hearth-pit	no. 50/81	8610±30
GrN-28151	hearth-pit	no. 47/84	8560±30
GrN-28159	hearth-pit	no. 108/175	8520±60
GrN-28149	hearth-pit	no. 49/79	8390±30
GrN-28136	hearth-pit	no. 3/9	8390±30
GrN-28142	hearth-pit	no. 15/34	8370±30
GrN-28137	hearth-pit	no. 5/10	8370±30
GrN-28135	hearth-pit	no. 2/7	8370±30
GrN-28148	hearth-pit	no. 42/73	8350±30
GrN-28138	hearth-pit	no. 4/11	8330±30
GrN-28153	hearth-pit	no. 36/108	8300±30
GrN-28152	hearth-pit	no. 60/105	8210±30

Samples from four hearth-pits were used to test for differences between an AAA and Ao treatment. Only one set proved to be significantly different at the $\underline{p}$=0.05 level of significance. In this case the sample that was treated with acid only was statistically significantly younger than the AAA-treated sample.

GrN-28162	hearth-pit	no. 135/243	8250±30
GrN-28605	hearth-pit	no. 135/243	8200±40 Ao

X^2 test: df=1, T=1.0, 0.50>$\underline{p}$>0.30; weighted average: 8232±24

GrN-28606	hearth-pit?	no. 145/247	8260±40 Ao
GrN-28164	hearth-pit?	no. 145/247	8200±30

X^2 test: df=1, T=1.4, 0.30>$\underline{p}$>0.20; weighted average: 8222±24 *

GrN-28604	hearth-pit	no. 129/221	8320±40 Ao
GrN-28161	hearth-pit	no. 129/221	8310±30

X^2 test: df=1, T=0.0, p>0.70; weighted average: 8314±24 BP.

GrN-28158	hearth-pit	no. 104/169	8330±30
GrN-28603	hearth-pit	no. 104/169	8210±40 Ao *

X^2 test: df=1, T=5.735, $\underline{0.02>p>0.01}$

Wildervank, Wv-42. Heavily disturbed Mesolithic site, investigated in 1996 by the GIA and the VKM (Smit n.d.). Two hearth-pits were found and dated:

GrN-29116	hearth-pit	no. 2	8760±50
GrN-29115	hearth-pit	no. 1	8630±50

Wildervank, Wv-500. Mesolithic site investigated in 1996 by the GIA and the VKM (Smit n.d.). One hearth-pit and a possible hearth-pit were dated.

GrN-29118	hearth-pit?	square 50/55	8700±50 *
GrN-29117	hearth-pit	A	8480±60

Woudbloem, WB-1. Mesolithic site partially investigated in 1996 by the GIA and the VKM. A concentration of charcoal (surface hearth?) was dated. A report was published by Smit (1996).

GrN-29114	charcoal concentration		7860±50 *

9.3. Province of Drenthe

Drouwenerzand I. The laboratory number GrN-6465 (Lanting & Van der Plicht, 1997/1998: p. 140) is incorrect and should read: GrN-6456.

Havelte-De Doeze. Between 1970 and 1972 six artefact assemblages and a number of features were excavated near Havelte by the University of Michigan in cooperation with the GIA. A preliminary report on the excavations was published by Price, Whallon & Chappell (1974); the final report is being prepared by R. Whallon (personal communication). Six samples were submitted to the CIO in an attempt to clarify some of the discrepancies between the five ^{14}C dates that were available and the typological attribution of the assemblages (see the discussion in Price, Whallon & Chappell, 1974).

Havelte-De Doeze I (H1). Two additional hearth-pits and a concentration of charcoal from the 'culture layer' (feature 18) were dated. The charcoal concentration was interpreted by the excavators as a surface hearth.

GrA-27271	hearth-pit	feature 16	9120±50
GrA-27273	charcoal conc.	feature 18	7525±45 *
GrA-27270	hearth-pit	feature 13, *Pinus*	7005±45

Havelte-De Doeze II (H2). Two additional hearth-pits were dated.

GrA-27280	hearth-pit	feature 9	7730±45
GrA-27281	hearth-pit	feature 8, *Pinus*	7470±45

Havelte-De Doeze III (H3). Charcoal from a pit was dated.

GrA-27279	pit	feature 8	9310±50 *

Havelte-Holtingerzand. Location famous for the Late Palaeolithic remains and the type-site of the late phase of the Hamburgian tradition, the Havelte phase. Two pieces of charcoal were submitted for ^{14}C dating in the hope that they would provide a date for the Havelte-phase. This was not the case:

GrA-25780	'3e kuil' (third pit)	6020±50 *
GrA-25778	'1943'	5900±50 *

Valthermond-Exloërkijl. In 1996 building activities exposed dozens of hearth-pits and scatters of flint artefacts. Several hearth-pits were sampled for dating with the following results:

GrN-28280	hearth-pit	no. 5	8700±30
GrN-28283	hearth-pit	no. 26	8425±35
GrN-28281	hearth-pit	no. 8	8360±30
GrN-28282	hearth-pit	no. 22	8055±35
GrN-28279	hearth-pit	no. 3	7970±30
GrN-28278	hearth-pit	no. 1	5805±25

Vledder. Site belonging to the Hamburgian tradition (Havelte phase), excavated in the early 1950s. The site is exceptional for the presence of pieces of ochre, including an ornament, and amber. A small number of Mesolithic artefacts were also uncovered. The site was opened again in 1996, during which a piece of charcoal was found lying next to a flint borer from the Hamburgian occupation (Beuker & Niekus, 1996). As with the Havelte site (see above) it was hoped that the charcoal (*Betula*) might date the Late Palaeolithic occupation. This was not the case (Beuker & Niekus, 1999):

GrA-10938	charcoal	find no. 2	6150±60 *

9.4. Province of Overijssel

Deventer-Rielerenk. Excavation (2002) by the archaeological service of the municipality of Deventer, of mainly later prehistoric (Bronze Age, Iron Age and Medieval) remains. A short report on the excavation was published by Bartels & Eeltink (2003); a final publication is being prepared by Bartels & Vermeulen. A hearth-pit was found and dated:

GrN-28786	hearth-pit	6760±40

Haaksbergen-Hassinkbrink II. In 2002 members of the AWN excavated a Mesolithic site covering an area of nearly 100 square metres. In total c. 2600 flint artefacts were found, including 140 retouched tools. The tool kit is dominated by scrapers and points/backed bladelets, mostly obliquely truncated points (B-points) and points with a retouched base (C-points or *Tardenoisian* points). Several points display flat inverse retouch which may indicate a relation to the surface-retouched points that are common to the Mesolithic of the *Rhine Basin Group*. The only hearth-pit (with stones in the fill) was dated. A publication is being prepared by the author.

GrN-28836	hearth-pit	8150±60

Hasselt-Gasthuisstraat. A report on the excavation was published by Klomp (2005). A hearth-pit was dated:

GrN-29456	hearth-pit	GAS 04	7610±50

Mariënberg. Complex of Mesolithic sites with hundreds of hearth-pits excavated between 1975 and 1983. At one of these sites, referred to as 'Schaapskooi', six Mesolithic *sitting graves* were found (Verlinde & Newell, 2005; Verlinde & Newell, in press). In addition to the forty available ^{14}C dates, another 16 samples from 14 hearth-pits were submitted to the CIO. Two hearth-pits were dated twice by using different species of wood.

GrN-29378	hearth-pit	no. 52, *Pinus*	7950±60
GrN-29390	hearth-pit	no. 108, *Pinus*	7780±45
GrN-29403	hearth-pit	no. 170, *Pinus*	7680±40
GrN-29393	hearth-pit	no. 114, *Pinus*	7580±50
GrN-29385	hearth-pit	no. 87, *Quercus*	6435±25
GrN-29387	hearth-pit	no. 98, *Quercus*	6350±50
GrN-29399	hearth-pit	no. 127, *Quercus*	6320±35
GrN-29405	hearth-pit	no. 176, *Quercus*	6210±50

GrN-29402	hearth-pit	no. 161, *Quercus*	6170±35
GrN-29401	hearth-pit	no. 160, *Quercus*	6165±35
GrN-29394	hearth-pit	no. 115, *Alnus*	6140±35
GrN-29400	hearth-pit	no. 159, *Quercus*	6040±45
GrN-29375	hearth-pit	no. 40, *Alnus*	6390±35
GrN-29376	hearth-pit	no. 40, *Quercus*	6365±35

X^2 test: df=1, T=0.3, 0.70>p>0.50; weighted average: 6378±25

GrN-29379	hearth-pit	no. 59, *Alnus*	6450±60 *
GrN-29380	hearth-pit	no. 59, *Quercus*	6210±45

X^2 test: df=1, T=10.323, 0.01>p>0.001

Vasse-'De Steenbrei'. Site excavated in 2001 and 2002 by ARC BV (Groningen). Most of the features date to the Late Neolithic-Iron Age. A Mesolithic hearth-pit was also found. Final report published by De Wit (2002).

GrN-27344	hearth-pit	trench 7, feat. 189, no. 195, *Pinus?*	7890±30

Weerselo-Gammelke. Twenty-five hearth-pits, found during the excavation in 1971 of a barrow dating to the Middle Bronze Age. Approximately half of the pits were found underneath the barrow (Verlinde, 1973). Thirty-six pieces of flint (28 blocks, seven flakes and one core) were found close together and probably represent a *cache*, comparable to a similar find from Nieuwe Pekela NP-3 (Groenendijk, 2004). Charcoal from three hearth-pits was dated:

GrN-29369	hearth-pit	no. 1	8640±60
GrN-29371	hearth-pit	no. 3	7990±50
GrN-29370	hearth-pit	no. 2	7980±50

Zwolle-Oude Deventerstraatweg (Schellerhoek/Vrouwenlaan). Excavation (1994) in a housing development area, the 'Schellerhoek' in the town of Zwolle. Approximately 130 hearth-pits were discovered, three of which were initially dated (Lanting & Van der Plicht, 1997/1998: pp. 143–144 with further references). At some distance from the hearth-pits a concentration of flint artefacts was found, presumably of Late Palaeolithic or Mesolithic age. Scattered pieces of charcoal and calcined bone (studied by W. Prummel, GIA) were present. The bone fragments have not yet been dated. A report on the excavation is being prepared by I. Hermsen (R. van Beek Stichting). Twenty-one additional charcoal samples from hearth-pits were submitted with the following results:

GrN-29440	hearth-pit	ODE-94/S 64-76	8120±40
GrN-29427	hearth-pit	ODE-94/8-1-15	7900±40
GrN-29426	hearth-pit	ODE-94/8-1-13	7890±45
GrN-29421	hearth-pit	ODE-94/5-1-5	7885±45
GrN-29425	hearth-pit	ODE-94/8-1-6	7835±30
GrN-29423	hearth-pit	ODE-94/7-1-5	7800±30
GrN-29430	hearth-pit	ODE-94/8-1-36	7790±30
GrN-29424	hearth-pit	ODE-94/7-1-7	7760±30
GrN-29439	hearth-pit	ODE-94/S 58-70	7390±40
GrN-29419	hearth-pit	ODE-94/4-1-6	7370±60
GrN-29420	hearth-pit	ODE-94/4-1-7	7345±40
GrN-29431	hearth-pit	ODE-94/11-1-1	7330±35
GrN-29438	hearth-pit	ODE-94/S 54-55	7300±30
GrN-29428	hearth-pit	ODE-94/8-1-18	7040±30
GrN-29429	hearth-pit	ODE-94/8-1-20	6995±30
GrN-29418	hearth-pit	ODE-94/3-1-7	6980±30
GrN-29435	hearth-pit	ODE-94/S 41-53	6950±30
GrN-29433	hearth-pit	ODE-94/S 33-46	6940±60
GrN-29417	hearth-pit	ODE-94/3-1-5	6880±40

One of the hearth-pits (ODE-94/3-1-3) was accidentally dated twice:

GrN-20953	hearth-pit	6980±60
GrN-29416	hearth-pit	6920±60

X^2 test: df=1, T=0.5, 0.50>p>0.30; weighted average: 6950±42

Another supposedly Mesolithic hearth-pit was dated but clearly belongs to a later (Roman Period) occupation:

GrN-29422	hearth-pit?	ODE-94/5-2-6	1830±35 *

Zwolle-Hanzeland. A housing development area in Zwolle where several excavation campaigns were carried out in 1995, 1996 and 1998 by the archaeological service of the municipality of Zwolle. Unpublished.

GrN-29443	hearth-pit	HAN-95/F 1	7515±45
GrN-29445	hearth-pit	HAN-95/F 4	7380±30
GrN-29444	hearth-pit	HAN-95/F 2	7340±40
GrN-29447	hearth-pit	HAN-96/F 5	7070±60
GrN-29446	hearth-pit	HAN-96/F 3	6890±60
GrN-29448	hearth-pit	HAN-96/F 6	6740±50
GrN-29449	hearth-pit	HAN-96/F 7	6600±50
GrN-29451	hearth-pit	HAN-98/F 2	6380±30
GrN-29450	hearth-pit	HAN-98/F 1	6240±40

Zwolle-Ittersumallee/De Geren. Small-scale excavation carried out in 2004 by the archaeological service of the municipality of Zwolle. Twenty hearth-pits were discovered. In addition three pieces of flint, a

small number of burnt hazelnut shells and fragments of burnt bone were also found (Klomp, 2004). Two hearth-pits were dated.

GrN-29454	hearth-pit	ITA-04/S 74	6720±60
GrN-29455	hearth-pit	ITA-04/S 77	6330±50

9.5. Province of Gelderland

Ede-Maanderbuurt. The laboratory number GrN-6468 (7920±60 BP) for hearth-pit Z-unnumbered is incorrect (Lanting & Van der Plicht, 1997/1998: p. 144) and should read: GrN-6469.

Ulft. Piece of red-deer antler with perforation (axe-sleeve) dredged up from the valley of the river Old IJssel (Verhart, 1998).

UtC-2643	9550±90

Zutphen. Since the late 1990s several Mesolithic sites have been excavated in the surroundings of Zutphen by the ROB in cooperation with the archaeological service of the municipality of Zutphen. Most of the dates from the various sites (Zutphen-Ooyerhoek and Zutphen-Looërenk) have been published (Bos *et al*., 2005; Groenewoudt *et al*., 2001; Verneau, 1999). The following dates are from pit-like features (see note 2). A report by S.M.J.P. Verneau is in preparation.

GrA-29125	charcoal	8640±60 *
GrA-29123	charcoal	8420±50 *
GrA-29122	charcoal	8400±60 *
GrA-29127	charcoal	8280±50 *
GrA-29126	charcoal	8260±50 *
GrA-29121	charcoal	8260±50 *

9.6. Province of Flevoland

Almere-Hout 'Zwaanpad'. In 2003 part of a Mesolithic site was excavated at Almere-Hout, a district of the city of Almere. The excavation was carried out by members of the AWN. By careful screening of the sediment over a 1 mm mesh more than 5000 flint artefacts were collected, but only a few hundred are larger than 1 centimetre. Approximately 100 pieces are classified as tools. The tool kit is extremely specialized, 90% consisting of triangles (mostly scalene), backed bladelets and points. Krukowski-type micro-burins indicate that projectiles were manufactured at the site. Furthermore there are a few retouched flakes and blades but formal tool-types like scrapers, borers and burins are lacking. Most of the triangles are very small (average length 8.4 mm, range 4–14 mm). Similar 'micro-triangle' assemblages are also known from the excavated sites Ede-Maanderbuurt in Gelderland, Warns in Friesland (personal observation) and Deventer-Olthof Noord in Overijssel (personal communication B.I. Smit, GIA and personal observation). Tiny backed bladelets have been reported from excavations near Zutphen (personal communication J.H.M. Peeters, ROB). Seven ^{14}C dates are available for the site: two from a central hearth-pit (charcoal), one from a possible hearth-pit situated six metres to the north-east of the main concentration, three on charcoal from the culture layer and one on burnt hazelnut shells found in the vicinity of the central hearth. A publication is being prepared by the author.

GrN-28889	charcoal conc., sq. 24, spits 4–7	8580±60 *
GrN-29008	hazelnut shells, bulk sample	8130±60
UtC-12800	charcoal conc., sq. 18, spit 7, no. 373	7910±50 *
UtC-12801	hearth-pit? feat. 2, trench 1, no. 391	7810±60
UtC-12799	charcoal conc., sq. 18, spit 2, no. 34	7260±50 *

The hearth-pit in the centre of the artefact concentration was dated twice. In both cases charcoal was used.

GrN-28888	hearth-pit	feature 1, nos. 386/389	8000±50
UtC-12794	hearth-pit	feature 1, no. 387	7930±50

X^2 test: df=1, T=1.0, 0.50>p>0.30; weighted average: 7965±35

Almere-Zenit. Burnt hazelnut shells found in corings. Samples from two locations were submitted for AMS dating (Visscher & Huisman, 2004).

UtC-13404	hazelnut shell	3 KNS-430	8890±50
UtC-13403	hazelnut shell	3 KNS-404	8700±76

Swifterbant-Klingenweg. Partially excavated (2002) Mesolithic site. Five hearth-pits were found, three of which (all from trench 2) were dated. A report on the excavation was published by Jordanov (2005).

UtC-12486	hearth-pit	feature 2, DRO2869	6285±46
UtC-12484	hearth-pit	feature 6, DRO2784	6271±44
UtC-12485	hearth-pit	feature 5, DRO2767	6165±45

Urk-E4 (Domineesweg/Noordgat). Mesolithic and Neolithic site excavated in 1997 by the ROB. The results of the excavation were published in a standard report (Peters & Peeters, 2001). Several hearth-pits and possible hearth-pits and a pit were dated by charcoal.[31]

GrN-25683	hearth-pit?	no. 4903	7850±60 *
GrN-25690	hearth-pit	no. 5422	7170±110
GrN-25679	pit	no. 2415	7035±50 *
GrN-25676	hearth-pit	no. 0999	6990±70
GrN-25675	hearth-pit	no. 0997	6980±80
GrN-25678	hearth-pit?	no. 1491	6970±55 *
GrN-25680	hearth-pit	no. 4489	6835±80
GrN-25677	hearth-pit	no. 1477	6670±35
GrN-25687	hearth-pit	no. 5339	6270±60

The following date is unreliable because of the absence of collagen:

GrA-12899	human bone (grave 5)	no. 5533	7250±100 *

9.7. Germany

Menstede-Coldinne (Landkreis Aurich). Mesolithic site excavated in 1982 by the *Arbeitskreis Vorgeschichte der Ostfriesischen Landschaft* (Aurich). A total of 102 square metres were excavated. Within the excavated area four more or less dense concentrations of flint artefacts (*Schlägstätte*) were observed. Only one hearth-pit was discovered (in *Schlagstätte* I). Approximately 750 flint artefacts were found with trapezes and scrapers as the dominant tool-classes. An atypical tanged point was also found. Charcoal from the hearth-pit was dated. The finds from the excavation were published by Kitz (1986).

Hv-12322	hearth-pit	6605±55

Stöcken (Landkreis Soltau-Fallingbostel). Dense concentration of hearth-pits (c. 78) underlying a Late Neolithic barrow. According to Assendorp (1985) no flint artefacts were found. Radiocarbon dates are available for two of the hearth-pits.

Hv-11496	hearth-pit	6870±85
Hv-11495	hearth-pit	6750±75

Hesel 'Kloster Barthe' (*Landkreis Leer*). Between 1988 and 1992 excavations were carried out on the premises of the former monastery 'Barthe'. Six pits with charcoal were excavated and interpreted as hearths. Four of these pits were dated and proved to be Mesolithic in age. At a distance of a few metres from one of these hearth-pits a flint blade was found (Bärenfänger, 1997).

Hv-20473	hearth-pit	*Bef.* 360, *FdNr.* 2025	8535±70
Hv-20472	hearth-pit	*Bef.* 796, *FdNr.* 1948	7910±95
Hv-20478	hearth-pit	*Bef.* 760, *FdNr.* 1626	7870±95
Hv-20474	hearth-pit	*Bef. 1118*, *FdNr.* 2772	7645±95

9.8. The North Sea

Faunal and human remains, modified pieces of antler or bone and flint artefacts are regularly dredged up from the North Sea. The following dates have been kindly made available to me by the participants in the multidisciplinary CERPOLEX/Mammuthus research programme on the palaeontology and archaeology of the North Sea. Details of the dates have recently been published (Glimmerveen, Mol & Van der Plicht, 2006).

GrA-23205	*Homo sapiens*	9870±70
UtC-7886	*Sus scrofa*	9450±70
GrA-11642	*Homo sapiens*	8370±50
GrA-?	*Homo sapiens*	8340±130
GrA-22999	*Cervus elaphus*	8070±50

The crown of a skull from the North Hinder Bank was published earlier by Erdbrink & Tacoma (1997):

UtC-3750	*Homo sapiens*	no. 1063	9640±400 *

10. ACKNOWLEDGEMENTS

This article could not have been written without the cooperation of many colleagues, both professional and amateur archaeologists. In the first place a special word of thanks is due to J.H. van der Plicht (CIO, University of Groningen) and J.N. Lanting (GIA) for providing me with the opportunity of having so many samples ^{14}C-dated and for their assistence. Without their help, this article would not have been written. A draft version of this article was read by several people and I gratefully acknowledge their comments and suggestions which have greatly improved the text: J. Deeben (ROB), Ms I. Devriendt (GIA), P. Crombé (Dept. of Archaeology, University of Ghent), E. Drenth (ROB), H.A. Groenendijk (province of Groningen), B.J. Groenewoudt (ROB), J. Jelsma (De Steekproef, Zuidhorn), Ms M.E. van Kruining (Groningen), Y. Perdaen (Dept. of Archaeology, University of Ghent), D.C.M. Raemaekers (GIA), J. Sergant (Dept. of Archaeology, University of Ghent), B.I. Smit (GIA), D. Stapert (GIA), J.R. Veldhuis (ARC BV, Groningen), H.T. Waterbolk (Haren) and H. Woldring (GIA). Numerous other people have also contributed to this article, by providing me with samples, unpublished ^{14}C dates, information concerning sites, literature or otherwise. If I fail to mention someone in the following alphabetical list I sincerely apologise: M. Bartels (archaeological service, municipality of

Deventer), R. Bärenfänger (Archäologischer Dienst der Ostfriesischen Landschaft, Aurich), J. Beuker (Drents Museum, Assen), A.L. Brindley (GIA), D.C. Brinkhuizen (Stichting Monument & Materiaal, Groningen), C. Bronk-Ramsey (Oxford Radiocarbon Accelerator Unit, University of Oxford), Mrs. C.E. Buck (Dept. of Probability and Statistics, University of Sheffield), H. Clevis (archaeological service, municipality of Zwolle), Mrs H. Deenen (CIO), J.C. Glimmerveen (CERPOLEX/Mammuthus research programme), K. Helfrich (Stichting Monument & Materiaal, Groningen), I. Hermsen (R. van Beek Stichting), Ms J.B. Hielkema (ARC BV, Groningen), J.W.H. Hogestijn (municipality of Almere), B.J. ten Kate and members of the Werkgroep Prehistorie van het Veenkoloniaal Museum (Veendam), G.L.G.A. Kortekaas (municipality of Groningen), M. Kosian (ROB), M. Klomp (municipality of Zwolle), E. Kramer (Fries Museum, Leeuwarden), G. Kronsweide (Archäologischer Dienst der Ostfriesischen Landschaft, Aurich), J. Lankamp (AWN Twente), R. van der Molen and members of the Argeologysk Wurkferbân, J.H.M. Peeters (ROB), P. Pettitt (Dept. of Archaeology, University of Sheffield), Ms W. Prummel (GIA), E. Rensink (ROB), W.A.B. van der Sanden (Drents Plateau, Assen), H.J. Streurman (CIO), E. Taayke (Noordelijk Archeologisch Depot, Nuis), D. Velthuizen (NieuwLand Erfgoedcentrum, Lelystad) and members of the AWN, district of Flevoland, H.B. Versloot (Niekerk), L.B.M. Verhart (Archaeological Centre of Leiden University, Leiden), A.D. Verlinde (ROB), Mrs S.M.J.P. Verneau (Buro Lithos, Zutphen), F. Vrede (Stichting Monument & Materiaal, Groningen) and F. de Vries (Stiens).

Ms A.C. Bardet (Groningen) expertly corrected the English text.

11. NOTES

1. The entire database, including all the rejected dates, will be published in the authors dissertation.
2. Six ‘hearth-pits’ from a site near Zutphen (section 9.5) are included in the graphs but after publication it became clear that they should be labelled ‘charcoal-pits’ or ‘pit-like structures’ (personal communication J.H.M. Peeters, ROB). These were excluded from the present analyses as was one piece of unworked antler from Zwolle-Spoolde that was mistakenly included in the database. This did not, however, significantly affect the overall patterns.
3. The subdivision into biostratigraphical zones follows the classification by Blytt and Sernander. The ^{14}C dates for the three zones that are of interest here, viz. Preboreal, Boreal and Atlantic, are taken from Lanting & Van der Plicht (1997/1998: pp. 102–103). For the beginning of the Preboreal and Boreal the averaged dates are used: 10,150 and 9450 BP respectively.
4. The well-preserved sites Hardinxveld-Giessendam ‘Polderweg’ and ‘De Bruin’ (Louwe Kooijmans, 2001a & b) should also be mentioned although strictly speaking they fall outside the study area.
5. Other functions that have been put forward besides the preparation of food are: the drying or smoking of non-food items, the production of resin, the heating of flint and even the production of charcoal. Crombé (2005: p. 299) even questions whether hearth-pits are anthropogenic at all and suggests that they may be natural features! (see Crombé, 2005: pp. 297–298 for a discussion of several possibilities).
6. One of the few well-dated Epi-Ahrensburgian sites is Eersel-Panberg in the province of Noord-Brabant in the southern part of the Netherlands. A piece of calcined bone was dated: 9810±70 BP (GrA-15175) (Deeben, Dijkstra & Van Gisbergen, 2000/2001).
7. Several years earlier Groenendijk (1997: p. 75) published a different subdivision for the Mesolithic in the Northern Netherlands: Early Mesolithic: 10,000–8200 BP, Middle Mesolithic: 8200–7600 BP, Late Mesolithic: 7600–6000 BP. The author has chosen not to use these dates because there are indications that a date of c. 9000 BP is indeed appropriate for the Middle Mesolithic. First of all, core-axes appear from around 8800 BP, as well as points with a retouched base, referred to as C-points or Tardenoisian points (Slochteren, section 9.2). Moreover, the available dates for burnt hazelnut shells seem to indicate that these nuts were consumed for the first time around 8900 BP in the northern part of the study area.
8. Dates deemed unreliable for several reasons are counted only once and were removed from the database in the order described in sections 3.1–3.5.
9. The value of hazelnut shells for dating flint assemblages is of course dependent on their presence, which relates to preservation conditions and excavation techniques (sieving) but also on the timing of the appearance of *Corylus* in a specific area. A preliminary study of dates on burnt hazelnut shells from Mesolithic sites in different areas suggests that hazelnuts were incorporated in the diet several hundred ^{14}C years earlier in Sandy Flanders (c. 9490 BP) than in the northern part of the Netherlands (c. 8860 BP), even though *Corylus* pollen is already present several hundred years earlier. As a consequence, Mesolithic assemblages older than c. 8900 BP in the Northern Netherlands cannot be dated by nutshells.
10. The level of significance (α) in these tests is automatically set at 0.05. This value is the chance that the Null-hypothesis (H_0) which predicts randomness is falsely rejected in favour of the alternative hypothesis (H_1) which predicts a difference (see Siegel & Castellan, 1988 for a detailed explanation). A significance level of 0.05 is well suited for the analysis of data from a

single site, while for comparisons between sites a significance level of 0.01 is more suitable (Newell & Dekin, 1978).

11. The data on the surface area for each province are based on figures provided by the Central Bureau of Statistics (CBS) in the Netherlands and only refer to dry land. Inland waterways, lakes and sea are excluded.
12. The height a.s.l., current as well as prehistoric, was rounded off to the nearest metre.
13. The Pearson product-moment correlation coefficient (Siegel & Castellan, 1988) was considered not to be the appropriate test. One of the requirements of this parametric test is that the variables are normally distributed, which is not the case since at least two clusters of dates can be seen in the scatter diagram. The level of significance of these tests was set at $\alpha = 0.01$ (see note 5). The regression lines in the scatterdiagrams were calculated by using the 'least squares method' (Hurst Thomas, 1986: pp. 351–360), an option that is available in *SigmaPlot* (version 8.0, 2002).
14. For samples with $n > 50$, the z-value was determined with the formula $z = R_s \sqrt{n-1}$ (Siegel & Castellan, 1988: p. 243). The probability of this value can be found in Table A (*ibid*.: pp. 319–320).
15. Earlier Mesolithic presence in the area that is now the North Sea basin is well-attested by finds of human bone and modified faunal remains (see section 9.4), even though finds that can be attributed to settlement activities are lacking (Verhart, 2004).
16. This test uses the exact data instead of ranks and is preferred above the Kolmogorov-Smirnov two-sample test (Siegel & Castellan, 1988).
17. In Groningen, Friesland and Drenthe there are an additional ten sites with a total of 103 hearth-pits from which samples are no longer available or that have simply not yet been dated. These figures are based on excavation plans, excavation journals and other documentation.
18. A survey of findspots with Mesolithic organic tools (dated and undated) will be published shortly (Rensink, in press).
19. The programme can be downloaded at: http://www.rdnap.nl.
20. Lanting & Van der Plicht (1997/1998: p. 147) mention a hearth from Luiksgestel in the province of Noord-Brabant with a date of 9970±115 BP (GrN-4181) but it is not clear to me whether this is a classic hearth-pit or a surface-type hearth. No hearth-pits were found at the Epi-Ahrensburgian sites Oudehaske, Gramsbergen and Hoogkerk-Ruskenveen (Johansen & Stapert, 1997/1998; Niekus, 2004).
21. In the case of the sites NP-3 and S-1 in the Veenkoloniën (see section 9.2), which are situated on the same coversand ridge, a shift in ^{14}C dates for hearth-pits was observed. The dates from S-1 are on average older than those for NP-3, which suggests that the focal point of occupation moved from west to east over the sand ridge.
22. Only hearth-pits are used in this graph for the reasons that hearth-pits are the most common dated Mesolithic feature and that they are likely to represent similar activities, which ensures that the dates may be considered mutually comparable. Furthermore, in contrast to burnt hazelnut shells and the category of bone, wood and antler, their presence is less likely to be affected by erosion, preservation conditions or excavation techniques.
23. The designations 'high' and 'low' should not be taken as absolute terms; they only apply to the respective areas and not to the study area as a whole. Low on the Drenthe Plateau for example is high from a Flevoland point of view.
24. Overemphasizing the importance of coastal settlement and aquatic resources during the later Mesolithic as opposed to the Early Mesolithic should be avoided, for the simple reason that we are missing coastal settlements from the Early Mesolithic and this makes it impossible to compare their relative importance in the two periods (section 2.2). The shift from inland to coastal adaptations may be more apparent than real, as was remarked by Price & Gebauer (2005: p. 142), especially when we consider that Early Mesolithic settlements are often located near water such as lake shores (*e.g.* Bos *et al*., 2005; Mellars & Dark, 1998; Street, 1991; Urz, 2000).
25. At the Zutphen site there are indications of herbivore dung and trampling along the shores of the residual channel (Bos *et al*., 2005: p. 38).
26. The number of Late Mesolithic sites may even be higher. At the remaining 113 sites recorded by Price no trapezes were found, but this does not mean that they do not date to the later Mesolithic. Counting only the trapezes: 134 out of 232 were recovered near water (= 57.8%).
27. On the basis of a scarcity of core-axes it has been suggested that the Drenthe Plateau saw a decrease in population during the 7th millennium BC (Price, 1981: pp. 34–35, footnotes 78 & 83). This idea is no longer valid. Core-axes occur in the Northern Netherlands from around 8800 BP and during the past decades numerous specimens have been found in the area.
28. The study of growth characteristics of charred twigs in hearth-pits may provide important information in this respect (Perry, 1997; 1999). One twig from a hearth-pit in the Veenkoloniën was gathered in summer and might thus be a seasonal indicator (see Groenendijk, 2004: p. 24).
29. Df stands for degrees of freedom (equals N-1) and T stands for total (Chi-squared value or $\sum x^2$).
30. An analysis of the charcoal is being carried out by O. Brinkkemper (ROB, Amersfoort).
31. In Peters & Peeters (2001) the laboratory code for hearth-pit 1477 was reported as GrN-25675 but this should read GrN-25677 (personal communication J.H.M. Peeters, ROB, Amersfoort).

12. REFERENCES

ANONYMUS, 2004. *Verslag van de archeologische begeleiding tijdens de aanleg van een aardgasleiding van Kiel-Windeweer naar Wildervank*. Veendam, Veenkoloniaal Museum.

ARTS, N., 1988. Archaeology, environment and the social evolution of later band societies in a lowland area. In: C. Bonsall (ed.), *The Mesolithic in Europe*. Edinburgh, John Donald Publishers LTD, pp. 291–312.

ASMUSSEN, P. & H.W. VEENSTRA, 2001. Een mesolithische vindplaats in het Buitenveld bij Veenwouden. *De Vrije Fries* 80, pp. 210–215.

ASSENDORP, J., 1985. Ein Fenster in die Vergangenheit. *Ausgrabungen in Niedersachsen. Archäologische Denkmalpflege 1979–1984*. Stuttgart, K. Theiss, pp. 78–80.

BAAK, P.J., S. BOTTEMA, R.T.J. CAPPERS & H. WOLDRING, 2005. Vegetatiehistorie van Jardinga (Fr.). *Paleo-Aktueel* 14/15, pp. 38–44.

BAKKER, R., 2003. *The emergence of agriculture on the Drenthe Plateau. A palaeobotanical study supported by high-resolution ^{14}C dating* (= Archäologische Berichte 16). Bonn, Dr. Rudolf Habelt GmbH.

BÄRENFÄNGER, R., 1997. Aus der Geschichte der Wüstung "Kloster Barthe", Landkreis Leer, Ostfriesland. Ergebnisse der archäologischen Untersuchungen in den Jahren 1988 bis 1992. *Probleme der Küstenforschung im südlichen Nordseegebiet* 24, pp. 9–252.

BARTELS, M. & N. EELTINK, 2003. Deventer, Rielerenk (nr. 226). In: H. Clevis, M. Klomp & S. Wentink (eds), *Overijssels Erfgoed. Archeologische en Bouwhistorische Kroniek* 2002, pp. 17–20.

BEETS, D.J. & A.J.F. VAN DER SPEK, 2000. The Holocene evolution of the barrier and the back-barrier basin of Belgium and the Netherlands as a function of Late Weichselian morphology, relative sea-level rise and sediment supply. *Netherlands Journal of Geosciences* 79 (1), pp. 3–16.

BEHRE, K.E., 2003. Eine neue Meeresspiegelkurve für die südlichen Nordsee, Transgressionen und Regressionen in den letzten 10.000 Jahren. *Probleme der Küstenforschung im südlichen Nordseegebiet* 28, pp. 9–63.

BEUKER, J.R. (with contributions by W.A. CASPARIE), 1989. Mesolithische bewoningssporen op een zandopduiking te Nieuw-Schoonebeek. *Nieuwe Drentse Volksalmanak* 106, pp. 117–186.

BEUKER, J.R. & M.J.L.TH. NIEKUS, 1996. Verder met Vledder. Rendierjagers aan de rand van een ven. *Nieuwe Drentse Volksalmanak* 113, pp. 91–129.

BEUKER, J.R. & M.J.L.TH. NIEKUS, 1997. De kano van Pesse – de bijl erin. *Nieuwe Drentse Volksalmanak* 114, pp. 122–126.

BEUKER, J.R. & M.J.L.TH. NIEKUS, 1999. Vledder. In: W.A.B. van der Sanden & V.T. van Vilsteren (eds), Archeologie in Drenthe 1995–1997. *Nieuwe Drentse Volksalmanak* 116, p. 172.

BINFORD, L.R., 1980. Willow Smoke and Dogs' Tails: Hunter-Gatherer Settlement Systems and Archaeological Site Formation. *American Antiquity* 45 (1), pp. 4–20.

BOHMERS, A. & AQ. WOUTERS, 1956. Statistics and graphs in the study of flint assemblages, III: A preliminary report on the statistical analysis of the Mesolithic in northwestern Europe. *Palaeohistoria* 5, pp. 27–38.

BOS, J.A.A., B. VAN GEEL, B.J. GROENEWOUDT & R.C.G.M. LAUWERIER, 2005. Early Holocene environmental change, the presence and disappearance of early Mesolithic habitation near Zutphen (The Netherlands). *Vegetation History and Archaeobotany* 15, pp. 27–43.

BOTTEMA, S., 1984. Vegetatiegeschiedenis. In: J. Abrahamse, S. Bottema, M.H. Buruma, H.W. de Vroome & H.T. Waterbolk (eds), *Het Drentse Landschap*. Assen/Zutphen, Stichting Het Drentse Landschap/De Walburg Pers, pp. 19–25.

BOTTEMA, S., 2005. Vreemde activiteit en vreemd pollen aan de Tjonger (Fr.). *Paleo-Aktueel* 14/15, pp. 45–47.

BOTTEMA, S. & A. WALSWEER, 1997. De hazelaar, gesponsord door het klimaat of door de mens? *Paleo-Aktueel* 8, pp. 33–37.

BOTTEMA-MAC GILLAVRY, N., 2005. Hergebruik van hout in de prehistorie? *Paleo-Aktueel* 14/15, pp. 48–53.

BOWMAN, S. & N. BALAAM, 1990. Using radiocarbon. *Antiquity* 64, pp. 315–318.

BRINKHUIZEN, D.C., 1989. *Ichthyo-archeologisch onderzoek: methoden en toepassing aan de hand van Romeins vismateriaal uit Velsen (Nederland)*. PhD thesis, University of Groningen.

BRONK RAMSEY C., 2001. Development of the Radiocarbon Program OxCal. *Radiocarbon* 43 (2A), pp. 355–363.

BUCK, C.E., C.D. LITTON & E.M. SCOTT, 1994. Making the most of radiocarbon dating: some statistical considerations. *Antiquity* 68, pp. 252–263.

CROMBÉ, P., 1993. Tree-fall features on Final Palaeolithic and Mesolithic sites situated on sandy soils: how to deal with it. *Helinium* 33 (1), pp. 50–66.

CROMBÉ, P. (ED.), 2005. *The Last Hunter-Gatherer-Fishermen in Sandy Flanders (NW Belgium). The Verrebroek and Doel Excavation Projects (Vol. 1)* (= Archaeological Reports Ghent University 3). Ghent, Academia Press.

CROMBÉ, P., H.A. GROENENDIJK & M. VAN STRYDONCK, 1999. Dating the Mesolithic of the Low Countries: some practical considerations. In: J. Evin, C. Oberlin, J.P. Daugas & J.F. Salles (eds), *Actes du colloque "C14 et Archéologie",* 1998. Mémoires de la Société Préhistorique Française 26 et Supplément de la revue d'Archéométrie (= Proceedings of the 3rd International symposium ^{14}C and archaeology), pp. 57–63.

CROMBÉ, P., Y. PERDAEN & J. SERGANT, 2005. III. Features. In: P. Crombé (ed.), *The Last Hunter-Gatherer-Fishermen in Sandy Flanders (NW Belgium). The Verrebroek and Doel Excavation Projects (Vol. 1)* (= Archaeological Reports Ghent University 3). Ghent, Academia Press, pp. 141–179.

CROMBÉ, P., Y. PERDAEN & J. SERGANT, in press. Le Mésolithique ancien dans l'ouest de la Belgique: Quelques réflexions concernant l'occupation du territoire. In: T. Ducrocq, J.-P. Fagnart, B. Soufi & A. Thévenin (eds), *Le Mésolithique ancien et moyen de la France septentrionale et des pays limitrophes* (= Mémoires de la Société Préhistorique Française). Paris, Société Préhistorique Française.

CUMMINGS, V., 2003. The origins of monumentality? Mesolithic world-views of the landscape in western Britain. In: L. Larsson, H. Kindgren, K. Knutsson, D. Loeffler & A. Åkerlund (eds), *Mesolithic on the Move. Papers presented at the Sixth International Conference on the Mesolithic in Europe, Stockholm 2000*. Oxford, Oxbow Books, pp. 74–81.

DECKERS, P.H, 1979. The flint material from Swifterbant, Earlier Neolithic of the northern Netherlands, I: sites S-2, S-4 and S-51. *Palaeohistoria* 21, pp. 143–180.

DECKERS, P.H, 1982. Preliminary notes on the neolithic flint material from Swifterbant. *Helinium* 22, pp. 33–39.

DEEBEN, J., 1996. De laatpaleolithische en mesolithische sites bij Geldrop (N.Br.). Deel 3. *Archeologie* 7, pp. 3–79.

DEEBEN, J., P. DIJKSTRA & P. VAN GISBERGEN, 2000/2001. Nieuwe ^{14}C-dateringen van de Ahrensburg-cultuur in Zuid-Nederland. *Archeologie* 10, pp. 5–19.

DEEBEN, J. & N. ARTS, 2005. From tundra hunting to forest hunting, later Upper Palaeolithic and Early Mesolithic. In: L.P. Louwe Kooijmans, P.W. van den Broeke, H. Fokkens & A.L. van Gijn (eds), *The Prehistory of the Netherlands, vol. 1*. Amsterdam, Amsterdam University Press, pp. 139–156.

ERDBRINK, D.P. & J. TACOMA, 1997. Une calotte humaine datée au 14C du bassin sud de la mer du nord. *L'Anthropologie* 101, pp. 541–545.

ES, W.A. VAN, H. SARFATIJ & P.J. WOLTERING, 1988. *Archeologie in Nederland*. Amsterdam, Meulenhoff/Amersfoort, ROB.

EXALTUS, R.P., H.A. GROENENDIJK & J.L. SMIT, 1993. Voortgezet onderzoek op de mesolithische vindplaats NP-3. *Paleo-Aktueel* 4, pp. 22–25.

FISCHER, A. & J. HEINEMEIER, 2003. Freshwater reservoir effect in ^{14}C-dates of food residue on pottery. *Radiocarbon* 45, pp. 449–466.

FLETCHER, M. & G.R. LOCK, 1991. *Digging numbers; elementary statistics for archaeologists* (= Oxford University Committee for Archaeology, Monograph 33). Oxford, Oxford University Committee for Archaeology.

GLIMMERVEEN, J.C., D. MOL & J.H. VAN DER PLICHT, 2006. The Pleistocene reindeer of the North Sea – initial palaeontological data and archaeological remarks. *Quaternary International* 142/143, pp. 242–246.

GOB, A., 1985. Extension géographique et chronologique de la Culture Rhein-Meuse-Schelde (RMS). *Helinium* 25, pp. 23–36.

GOB, A., 1988. L'Ahrenbourgien de Fonds-de-Fôret et sa place dans le processus de Mésolithisation dans le nord-ouest de l'Europe. In: M. Otte (ed.), *De la Loire à l'Oder. Les civilisations du Paléolithique final dans le nord-ouest européen* (= British Archaeological Reports International Series 444). Oxford, B.A.R., pp. 259–285.

GOB, A., 1991. The early Postglacial occupation of the southern part of the North Sea Basin. In: N. Barton, A.J. Roberts & D.A. Roe (eds), *The Late Glacial in north-western Europe: human adaptation and environmental change at the end of the Pleistocene* (= CBA Research Report 77). London, C.B.A., pp. 227–233.

GROENENDIJK, H.A., 1987. Mesolithic hearth-pits in the Veenkoloniën (prov. Groningen, the Netherlands), defining a specific use of fire in the Mesolithic. *Palaeohistoria* 29, pp. 85–102.

GROENENDIJK, H.A., 1997. *Op zoek naar de horizon. Het landschap van Oost-Groningen en zijn bewoners tussen 8000 voor Chr. en 1000 na Chr*. Groningen, Regio-project Uitgevers.

GROENENDIJK, H.A., 2004. Middle Mesolithic occupation on the extensive site NP3 in the peat reclamation district of Groningen, the Netherlands. In: *Acts of the XIVth congress of the UISPP, Liège 2001* (= British Archaeological Reports International Series 1302). Oxford, B.A.R., pp. 19–26.

GROENENDIJK, H.A. & J.L. SMIT, 1984–1985. Een mesolithische vindplaats bij Wildervank. *Groningse Volksalmanak*, pp. 131–145.

GROENENDIJK, H.A. & J.L. SMIT, 1989. Nieuwe Pekela: mesolithisch onderzoek op site-niveau in de Groninger Veenkoloniën. *Paleo-Aktueel* 1, pp. 21–24.

GROENENDIJK, H.A. & J.L. SMIT, 1990. Mesolithische Herdstellen: Erfahrungens eines Brennversuchs. *Archäologische Informationen* 13, pp. 213–220.

GROENENDIJK, H.A. & J.L. SMIT, 1992. Aan de oevers van de Ae: verdwenen landschappen onder de Dollardklei. *Noorderbreedte* 93/3, pp. 89–94.

GROENEWOUDT, B.J., 2004. Afdalen in Oost-Nederland. In: F. Gerritsen & E. Rensink (eds), *Beekdallandschappen in archeologisch perspectief. Een kwestie van onderzoek en monumentenzorg* (= Nederlandse Archeologische Rapporten 28). Amersfoort, ROB, pp. 57–67.

GROENEWOUDT, B.J., J. DEEBEN, B. VAN GEEL & R.C.G.M. LAUWERIER, 2001. An early Mesolithic assemblage with faunal remains in a stream valley near Zutphen, the Netherlands. *Archäologisches Korrepondenzblatt* 31, pp. 329–348.

HARDING, B.J.W., 2001. Twee Jipsinghuizens? *Historisch Jaarboek Groningen*, pp. 142–143.

HAAFF, G. VAN, M.J.A. DE HAAN, J.W.H. HOGESTIJN & W.J. VAN TENT, 1988. *Jaarverslag ROB over 1988*. Baarn, gem. Baarn, pp. 60–61.

HARSEMA, O.H., 1978. Mesolithische vuurstenen bijlen in Drenthe. *Nieuwe Drentse Volksalmanak* 95, pp. 161–186.

HERMSEN, I., in press. Mesolithische haardkuilen of houtskoolmeilers aan de Vrouwenlaan. Verslag van een noodopgraving met brandkuilen en vuursteen uit de tijd van jagers en verzamelaars in Zwolle (= Archeologische Rapporten Zwolle 39). Zwolle, Gemeente Zwolle.

HIELKEMA, J.B. (with a contribution by J.R. VELDHUIS), 2004. *Een archeologisch onderzoek van een vindplaats uit het Laat-Mesolithicum, de Late IJzertijd en de Romeinse Tijd bij de Wâldwei te Hempens, gemeente Leeuwarden (Fr.), stap 1* (= ARC-Rapporten 2004-E10). Groningen, ARC, 33 p.

HOGESTIJN, J.W.H. & J.H.M. PEETERS (eds), 2001. *De Mesolithische en Vroeg-Neolithische vindplaats Hoge Vaart-A27*

(Flevoland) (= Rapportage Archeologische Monumentenzorg 79, 20 volumes). Amersfoort, ROB.

HOUTSMA, P., E. KRAMER, R.R. NEWELL & J.L. SMIT, 1996. *The Late Palaeolithic Habitation of Haule V: From Excavation Report to the Reconstruction of Federmesser Settlement Patterns and Land-Use*. Assen, Van Gorcum Publishers.

HUISKES, B., 1988. Tietjerk-Lytse Geast I: A reconstruction of a Mesolithic site from an anthropological perspective. *Palaeohistoria* 30, pp. 29–62.

HULST, R. & A.D. VERLINDE, 1976. Geröllkeulen aus Overijssel and Gelderland. *Berichten van de Rijksdienst voor het Oudheidkundig Bodemonderzoek* 26, pp. 93–126.

HULST, R. & A.D. VERLINDE, 1979. Spitzhauen aus den Niederlanden. *Berichten van de Rijksdienst voor het Oudheidkundig Bodemonderzoek* 29, pp. 185–207.

HURST THOMAS, D., 1986. *Refiguring Anthropology. Fist Principles Of Probability & Statistics*. Illinois, Waveland Press Inc.

JANSEN, J.B.H. & J.H.M. PEETERS, 2001. Deel 6. Geochemische aspecten: verkenningen in enkele toepassingsmogelijkheden. In: J.W.H. Hogestijn & J.H.M. Peeters (eds), *De Mesolithische en Vroeg-Neolithische vindplaats Hoge Vaart-A27 (Flevoland)* (= Rapportage Archeologische Monumentenzorg 79). Amersfoort, ROB.

JOHANSEN, L. & D. STAPERT, 1997/1998. Two "Epi-Ahrensburgian" sites in the northern Netherlands: Oudehaske (Friesland) and Gramsbergen (Overijssel). *Palaeohistoria* 39/40, pp. 1–87.

JONG, H. DE & R. VAN DER MOLEN, 2005. De opgraving van een Mesolithische vindplaats te Bantega. In: G.J. de Langen & F. Veenman (eds), Archeologische Kroniek van Fryslân 2003 en 2004. *De Vrije Fries* 85, pp. 236–240.

JORDANOV, M. (with a contribution by PH. VISSER), 2005. *Een mesolithische vindplaats op een rivierduin in het Swifterbantgebied. Standaardrapport Klingenweg (kavel H2)* (= Archeologische Rapportages en Notities 13). Almere, Provincie Flevoland.

KITZ, W., 1986. Die Fundstelle 13 bei Coldinne, Ldkr. Aurich – ein mesolithisches Jägerlager. *Archäologische Mitteilungen aus Nordwestdeutschland* 9, pp. 1–10.

KLOMP, M., 2004. *Archeologisch proefonderzoek Ittersumallee* (= Archeologische Rapporten Zwolle 13). Zwolle, Gemeente Zwolle.

KLOMP, M., 2005. *Gasthuisstraat/Eikenlaan* (= Archeologische Rapporten Gemeente Zwartewaterland 3). Zwolle, Gemeente Zwolle.

KOOI, P.B., 1974. De orkaan van 13 november 1972 en het ontstaan van hoefijzervormige grondsporen. *Helinium* 14, pp. 57–65.

KORTEKAAS, G.L.G.A. & D. STAPERT, 1993. Een jong-paleolithische vuursteenconcentratie in de stad Groningen. *Westerheem* XLII-5, pp. 217–229.

KORTEKAAS, G.L.G.A. & M.J.L.TH. NIEKUS, 1994. Een vindplaats uit het vroegere Mesolithicum in de Hooilandspolder, Gemeente Slochteren (Gr.). *Paleo-Aktueel* 5, pp. 27–31.

KROEZENGA, P., J.N. LANTING, R.J. KOSTERS, W. PRUMMEL & J.P. DE ROEVER, 1991. Vondsten van de Swifterbantcultuur uit het Voorste Diep bij Bronneger (Dr.). *Paleo-Aktueel* 2, pp. 32–36.

LANGOHR, R., 1993. Types of tree windthrow, their impact on the environment and their importance for the understanding of archaeological excavation data. *Helinium* 31-II/1, pp. 36–49.

LANTING, J.N. & J. VAN DER PLICHT, 1995/1996a. De ^{14}C-chronologie van de Nederlandse pre- en protohistorie, I: Laat-Paleolithicum. *Palaeohistoria* 37/38, pp. 71–125.

LANTING, J.N. & J. VAN DER PLICHT, 1995/1996b. Wat hebben Floris V, skelet Swifterbant S2 en visotters gemeen? *Palaeohistoria* 37/38, pp. 491–519.

LANTING, J.N. & J. VAN DER PLICHT, 1997/1998. De ^{14}C-chronologie van de Nederlandse pre- en protohistorie, II: Mesolithicum. *Palaeohistoria* 39/40, pp. 99–162.

LANTING, J.N. & J. VAN DER PLICHT, 1999/2000. De ^{14}C-chronologie van de Nederlandse pre- en protohistorie, III: Neolithicum. *Palaeohistoria* 41/42, pp. 1–110.

LANTING, J.N. & W.G. MOOK, 1977. *The pre- and protohistory of the Netherlands in terms of radiocarbon dates*. CIO, Groningen.

LONG, A. & B. RIPPETEAU, 1974. Testing contemporaneity and averaging radiocarbon dates. *American Antiquity* 39 (2), pp. 205–215.

LOUWAGIE, G. & R. LANGOHR, 2005. 3.3. Pedological analyses. In: P. Crombé (ed.), *The Last Hunter-Gatherer-Fishermen in Sandy Flanders (NW Belgium). The Verrebroek and Doel Excavation Projects (Vol. 1)* (= Archaeological Reports Ghent University 3). Ghent, Academia Press, pp. 213–250.

LOUWE KOOIJMANS, L.P., 1970–1971. Mesolithic bone and antler implements from the North Sea and from the Netherlands. *Berichten van de Rijksdienst voor het Oudheidkundig Bodemonderzoek* 20–21, pp. 27–73.

LOUWE KOOIJMANS, L.P. (ed.), 2001a. *Archeologie in de Betuweroute. Hardinxveld-Giessendam Polderweg. Een mesolithisch jachtkamp in het rivierengebied (5500–5000 v.Chr.)* (= Rapportage Archeologische Monumentenzorg 83). Amersfoort, ROB.

LOUWE KOOIJMANS, L.P. (ed.), 2001b. *Archeologie in de Betuweroute. Hardinxveld-Giessendam De Bruin. Een kampplaats uit het Laat-Mesolithicum en het begin van de Swifterbant-cultuur (5500–4450 v.Chr.)* (= Rapportage Archeologische Monumentenzorg 88). Amersfoort, ROB.

MELLARS, P. & P. DARK, 1998. *Star Carr in context: new archaeological and palaeoecological investigations at the Early Mesolithic site of Star Carr., North Yorkshire*. University of Cambridge, McDonald Institute for Archaeological Research Monographs.

MOOK, W.G. & H.T. WATERBOLK, 1985. *Handbook for Archaeologists No. 3: Radiocarbon dating*. Strasbourg, European Science Foundation.

MUSCH, J., 1991. Het laat-Paleolithicum en Mesolithicum van Centraal Overijssel. Een inventarisatie naar materiële cultuur en sitelocaties, met enkele opmerkingen over de plaats van deze regio in de toenmalige bewoning van Noordwest-Europa. Unpublished MA-thesis. Amsterdam, Institute of Pre- and Protohistory.

NEWELL, R.R., 1970. Een afslagbijl uit Anderen, gem. Anloo en zijn relatie tot het Atlantisch Mesolithicum. *Nieuwe Drentse Volksalmanak* 88, pp. 177–184.

NEWELL, R.R., 1973. The post-glacial adaptations of the indigenous population of the northwest European plain. In: S.F. Kozlowski (ed.), *The Mesolithic in Europe*. Warsaw, University Press, pp. 399–440.

NEWELL, R.R., 1980. Mesolithic dwelling-structures: fact and fantasy. *Veröffentlichungen des Museums für Ur- und Frühgeschichte Potsdam* 14/15, pp. 235–284.

NEWELL, R.R., 1995. De rol van etnologisch onderzoek bij de diagnose van steentijd-nederzettingssystemen en steentijd-nederzettingspatronen in West-Europa. In: T.S. Constandse-Westermann, M.J.L.Th. Niekus & J.L. Smit (eds), *Bundel Mesolithicumdag Veendam*. Veendam, Veenkoloniaal Museum, pp. 42–90.

NEWELL, R.R. & A. VROOMANS, 1972. *Automatic artefact registration and system for archaeological analysis with the Philips P1100 computer: a Mesolithic test-case*. Oosterhout, Anthropological Publication.

NEWELL, R.R. & A.A. DEKIN, 1978. An integrative strategy for the definition of behaviorally-meaningful archaeological units. *Palaeohistoria* 20, pp. 7–38.

NIEKUS, M.J.L.TH., 2004. Een kampement van jager-verzamelaars van de Ahrensburg-traditie bij Hoogkerk. *Hervonden Stad* 9, pp. 83–94.

NIEKUS, M.J.L.TH., 2005. Een ^{14}C-database voor het Mesolithicum en de vroege fase van de Swifterbant-cultuur in Noord-Nederland. Enkele algemene opmerkingen. *Notae Praehistoricae* 25, pp. 113–118.

NIEKUS, M.J.L.TH., P. DE ROEVER & J.L. SMIT, 1997. Een Vroeg-Mesolithische nederzetting met tranchetbijlen bij Lageland (Gr.). *Paleo-Aktueel* 8, pp. 28–32.

NIEKUS, M.J.L.TH. & H.A. GROENENDIJK, 1998. Mesolithisch onderzoek in de Wildervanksterdallen (GR.). *Paleo-Aktueel* 9, pp. 23–26.

PEETERS, H., 2004. The Mesolithic and Early Neolithic occupation at The Hoge Vaart (Almere, the Netherlands): forager land-use dynamics in the context of a drowning landscape. In: *Acts of the XIVth congress of the UISPP, Liège 2001* (= British Archaeological Reports International Series 1302). Oxford, B.A.R., pp. 27–37.

PEETERS, J.H.M., in press. *Hoge Vaart-A27 in context. Towards a model of Mesolithic-Neolithic land-use dynamics as a framework for archaeological heritage management.* Amersfoort. PhD thesis, University of Amsterdam.

PEETERS, J.H.M., E. HANRAETS, J.W.H. HOGESTIJN & E. JANSMA, 2001. Deel 12. Dateringen: ^{14}C-analyse en dendrochronologie. In: J.W.H. Hogestijn & J.H.M. Peeters (eds), *De Mesolithische en Vroeg-Neolithische vindplaats Hoge Vaart-A27 (Flevoland)* (= Rapportage Archeologische Monumentenzorg 79). Amersfoort, ROB.

PEETERS, J.H.M., J. SCHREURS & S.M.J.P. VERNEAU, 2001. Deel 18. Vuursteen: typologie, technologische organisatie en gebruik. In: J.W.H. Hogestijn & J.H.M. Peeters (eds), *De Mesolithische en Vroeg-Neolithische vindplaats Hoge Vaart-A27 (Flevoland)* (= Rapportage Archeologische Monumentenzorg 79). Amersfoort, ROB.

PEETERS, H. & M.J.L.TH. NIEKUS, 2005. Het Mesolithicum in Noord-Nederland. In: J. Deeben, E. Drenth, M.-F. van Oorsouw & L. Verhart (eds), *Archeologie* 11/12, pp. 201–234.

PERRY, D., 1997. The archaeology of hunter-gatherers: plant use in the Dutch Mesolithic. PhD thesis, New York University, Dept. of Archaeology.

PERRY, D., 1999. Vegetative tissues from Mesolithic sites in the northern Netherlands. *Current Anthropology* 40–2, pp. 231–237.

PERRY, D., 2002. Preliminary results of an archaeobotanical analysis of Mesolithic sites in the Veenkoloniën, Province of Groningen, the Netherlands. In: S.L.R. Mason & J.G. Hather (eds.), *Hunter-Gatherer Archaeobotany. Perspectives from the temperate zone*. London, Institute of Archaeology, University College London, pp. 108–116.

PETERS, F.J.C. & J.H.M. PEETERS (with contributions by S. BAETSEN, R. EXALTUS, M. D'HOLLOSY, J. OVERSTEEGEN, F.J.C. PETERS, D.G. VAN SMEERDIJK, S.M.J.P. VERNEAU), 2001. *De opgraving van de mesolithische en neolithische vindplaats Urk-E4 (Domineesweg, gemeente Urk)* (= Rapportage Archeologische Monumentenzorg 93). Amersfoort, ROB.

PONS, L.J., 1992. Holocene peat formation in the lower parts of the Netherlands. In: J.T.A. Verhoeven (ed.), *Fens and Bogs in the Netherlands: vegetation, history, nutrient dynamics and conservation*. Dordrecht/Boston/London, Kluwer, pp. 7–79.

PRICE, T.D., 1975. *Mesolithic settlement systems in the Netherlands*. PhD thesis, University of Michigan.

PRICE, T.D., 1978. *Mesolithic settlement systems in the Netherlands.* In: P. Mellars (ed.), The early postglacial settlement of northern Europe. London, Duckworth, pp. 81–113.

PRICE, T.D., 1980. The Mesolithic of the Drents Plateau. *Berichten van de Rijksdienst voor het Oudheidkundig Bodemonderzoek* 30, pp. 11–63.

PRICE, T.D., 1981. Swifterbant, Oost Flevoland, Netherlands: excavations at the river dune sites, S21-S24, 1976. *Palaeohistoria* 23, pp. 75–104.

PRICE, T.D., R. WHALLON & S. CHAPPELL, 1974. Mesolithic sites near Havelte, province of Drenthe (Netherlands). *Palaeohistoria* 16, pp. 7–61.

PRICE, T.D. & A.B. GEBAUER (eds), 2005. *Smakkerup Huse. A Late Mesolithic Coastal Site in Northwest Zealand, Denmark*. Aarhus University Press.

PRUMMEL, W., 2001. Dierenvondsten uit het dal van de Tjonger tussen Donkerbroek, Oosterwolde en Makkinga (Fr.). *Paleo-Aktueel* 12, pp. 30–35.

PRUMMEL, W., M.J.L.TH. NIEKUS, A.L. VAN GIJN & R.T.J. CAPPERS, 2002. A Late Mesolithic Kill Site of Aurochs at Jardinga, the Netherlands. *Antiquity* 76, pp. 413–424.

PRUMMEL, W. & M.J.L.TH. NIEKUS, 2005. De laatmesolithische vindplaats Jardinga: de opgravingen in 2002 en 2003. *Paleo-Aktueel* 14/15, pp. 31–37.

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)*. Leiden, PhD thesis, University of Leiden.

RAEMAEKERS, D.C.M., 2003/2004. An outline of Late Swifterbant pottery in the Noordoostpolder (province of Flevoland, the Netherlands) and the chronological development of the pottery of the Swifterbant culture. *Palaeohistoria* 45/46, pp. 11–36.

RAEMAEKERS, D.C.M., 2005. Het Vroeg- en Midden-Neolithicum in Noord-, Midden- en West-Nederland. In: J. Deeben, E. Drenth, M.-F. van Oorsouw & L. Verhart (eds), *Archeologie* 11/12, pp. 261–282.

REIMER, P.J., M.G.L. BAILLIE, E. BARD, A. BAYLISS *et al*., 2004. IntCal04 Terrestrial Radiocarbon Age Calibration, 0–26 Cal Kyr. *Radiocarbon* 46, pp. 1029–1058.

RENSINK, E., in press. Stones or bones? On Mesolithic fieldwork in the Netherlands and the potential of buried and surface sites for the preservation of bone and antler remains. In: C.J. Kind (ed.), *After the Ice Age. Settlement, subsistence and social development in the Mesolithic of Central Europe*. Proceedings international conference, Rottenburg/Neckar, 9–12 September 2003.

SHENNAN, S., 1988 *Quantifying archaeology* Edinburgh, Edinburgh University Press.

SIEGEL, S. & N. J. CASTELLAN, 1988. *Nonparametric Statistics for the Behavioral Sciences*. Second Edition. New York, McGraw-Hill International Editions.

SMIT, J.L., n.d. *Rapportage van de archeologische inventarisering t.b.v. Herinrichting Gronings Drentse Veenkoloniën, Deelgebied Oude Veenkoloniën, Uitvoeringsfase 1*. Veendam, Veenkoloniaal Museum.

SMIT, J.L., 1995. NP-3. De grootste boreaal-mesolithische nederzetting van Nederland. In: T.S. Constandse-Westermann, M.J.L.Th. Niekus & J.L. Smit (eds), *Bundel Mesolithicumdag Veendam 1992*. Veendam, Veenkoloniaal Museum, pp. 7–18.

SMIT, J.L., 1996. *Verslag van de werkzaamheden van de Werkgroep Prehistorie van het Veenkoloniaal Museum te Veendam in het tracé van de aardgasleiding van Grijpskerk naar Tripscompagnie in het jaar 1996*. Veendam, Veenkoloniaal Museum, 7 p.

SPEK, TH., E.B.A. BISDOM & D.G. VAN SMEERDIJK, 2001. Deel 8. Bodemkunde en landschapsecologie II: aanvullend onderzoek naar landschapsvormende processen. In: J.W.H. Hogestijn & J.H.M. Peeters (eds), *De Mesolithische en Vroeg-Neolithische vindplaats Hoge Vaart-A27 (Flevoland)* (= Rapportage Archeologische Monumentenzorg 79). Amersfoort, ROB.

SPIKINS, P., 1999. *Mesolithic Northern England. Environment, population and settlement* (= B.A.R. British Series 283). Oxford, Archaeopress.

STAPERT, D. & L. JOHANSEN, 1995/1996. Ring & sector analysis, and site "IT" on Greenland. *Palaeohistoria* 37/38, pp. 29–69.

STREET, M., 1991. Bedburg-Königshoven: a Pre-Boreal Mesolithic site in the Lower Rhineland, Germany. In: N. Barton, A.J. Roberts & D.A. Roe (eds), *The Late Glacial in north-western Europe: human adaptation and environmental change at the end of the Pleistocene* (= CBA Research Report, 77). London, C.B.A., pp. 256–270.

STRYDONCK, M. VAN & P. CROMBÉ, 2005. 3.2. Radiocarbon dating. In: P. Crombé (ed.), *The Last Hunter-Gatherer-Fishermen in Sandy Flanders (NW Belgium). The Verrebroek and Doel Excavation Projects (Vol. 1)* (= Archaeological Reports Ghent University 3). Ghent, Academia Press, pp. 180–212.

URZ, R., 2000. Begraben unter Auelehm: Frühmesolithische Siedlungsspuren im mittleren Lahntal. *Archäologisches Korrespondenzblatt* 30, pp. 33–43.

VERHART, L.B.M., 1998. Een mesolithische bijlvatting uit Ulft. *Westerheem*, 47-4, pp. 170–173.

VERHART, L.B.M., 2004. The implications of prehistoric finds on and off the Dutch coast. In: N.C. Flemming (ed.), *Submarine prehistoric archaeology of the North Sea. Research priorities and collaboration with industry* (= CBA Research Report 141). London, English Heritage/Council for British Archaeology, pp. 57–61.

VERHART, L.B.M. & H.A. GROENENDIJK, 2005. Living in abundance. Middle and Late Mesolithic. In: L.P. Louwe Kooijmans, P.W. van den Broeke, H. Fokkens & A.L. van Gijn (eds), *The Prehistory of the Netherlands, vol. 1*. Amsterdam, Amsterdam University Press, pp. 161–178.

VERLINDE, A.D. (with a contribution by W.A. CASPARIE), 1973. Two Barrows from the Middle Bronze Age at Gammelke, Municipality of Weerselo, Province of Overijssel. *Berichten van de Rijksdienst voor het Oudheidkundig Bodemonderzoek* 23, pp. 109–122.

VERLINDE, A.D., 1974. A Mesolithic settlement with cremation at Dalfsen. *Berichten van de Rijksdienst voor het Oudheidkundig Bodemonderzoek* 24, pp. 113–117.

VERLINDE, A.D., 1979. Archeologische kroniek van Overijssel over 1977/1978. Mariënberg, gem. Hardenberg. *Overijsselse Historische Bijdragen* 94, pp. 99–101.

VERLINDE, A.D., 1987. Archeologische kroniek van Overijssel over 1986. *Overijsselse Historische Bijdragen* 102, pp. 169–187.

VERLINDE, A.D. & R.R. NEWELL, 2005. Zes laat-mesolithische "sitting graves" tussen honderden haardplekken uit 7600 – 5000 voor Chr. te Mariënberg (Ov.). *Westerheem* 54 (1), pp. 2–13.

VERLINDE, A.D. & R.R. NEWELL, in press. *A Multi-Component Complex of Mesolithic Settlements with Late Mesolithic Grave Pits at Mariënberg in Overijssel* (= Nederlandse Archeologische Rapporten 22). Amersfoort, ROB.

VERNEAU, S., 1999. *Een Mesolithisch jachtkamp te Zutphen. 8000 jaar voor Christus: jagers-verzamelaars in de Ooyerhoek* (= Lithos Rapport 1). Zutphen, Lithos.

VISSCHER, H.C.J. & J.J. HUISMAN, 2004. *Basisrapportage vooronderzoek, waardestelling, selectieadvies en tekst bestemmingsplan. Plangebied 3KNS Spoorzone* (= Archeologische Rapporten Almere 8). Almere, Gemeente Almere.

VOS, P.C. & P. KIDEN, 2005. De landschapsvorming tijdens de steentijd. In: J. Deeben, E. Drenth, M.-F. van Oorsouw & L. Verhart (eds), *Archeologie* 11/12, pp. 201–234.

WARD, G.K. & S.R. WILSON, 1978. Procedures for comparing and combining radiocarbon age determinations: a critique. *Archaeometry* 20 (1), pp. 19–31.

WATERBOLK, H.T., 1962. The Lower Rhine Basin. In: R.J. Braidwood & G.R. Willey (eds), *Courses Toward Urban Life*. Chicago, Aldine Publishing Company, pp. 227–253.

WATERBOLK, H.T., 1971. Working with radiocarbon dates. *Proceedings of the Prehistoric Society* 37, pp. 15–33.

WATERBOLK, H.T., 1983. Ten guidelines for the archaeological interpretation of radiocarbon dates. In: W.G. Mook & H.T. Waterbolk (eds). *PACT* 8, pp. 57–70.

WATERBOLK, H.T., 1985. The Mesolithic and early Neolithic settlement of the northern Netherlands in the light of radiocarbon evidence. In: R. Fellmann *et al*. (ed.), *Jagen und Sammeln. Festschrift fur Hans-Georg Bandi zum 65. Geburtstag* (= Jahrbuch des Bern Hist. Museums 63–64, 1983–1984). Bern, Stämpfli, pp. 273–281.

WATERBOLK, H.T., 1999. De mens in het Preboreale, Boreale en Atlantische bos. *Paleo-Aktueel* 10, pp. 68–73.

WHALLON. R. & T.D. PRICE, 1976. Excavations at the river dune sites S11–S13. *Helinium* 16, pp. 222–229.

WIT, M.J.M. DE (with contributions by G.J. DE ROLLER, A. UFKES, M.J.L.TH. NIEKUS & J.R. VELDHUIS), 2001. *Een Aanvullend Archeologisch Onderzoek op het AZC te Leek, gemeente Leek* (= ARC-Publicaties 44). Groningen, ARC.

WIT, M.J.M. DE (with contributions by C.G. KOOPSTRA, M.J.L.TH. NIEKUS, G.J. DE ROLLER & A. UFKES), 2002. *Een Definitief Onderzoek te Vasse "De Steenbrei", gemeente Tubbergen (Ov.)* (= ARC-Publicaties 66). Groningen, ARC.

ZAGWIJN, W.H., 1986. *Nederland in het Holoceen*. Den Haag, Staatsuitgeverij.

ZEILER, J.T. & L.I. KOOISTRA, 1998. Parklandschap of oerbos? Interpretatie van het prehistorische landschap op basis van dieren- en plantenresten. *Lutra* 40, pp. 65–76.

ZEIST, W. VAN, 1957. De mesolithische boot van Pesse. *Nieuwe Drentse Volksalmanak* 75, pp. 4–11.